N91192.AR.000982
NIROP FRIDLEY
5090.3a

OPERATIONS & MAINTENANCE MANUAL FOR ORDNANCE PLAN GROUNDWATER EXTRACTION SYSTEM REVISION 6 NIROP FRIDLEY MN
10/1/1992
U S ARMY CORPS OF ENGINEERS

27

NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT GROUNDWATER EXTRACTION SYSTEM

OPERATIONS & MAINTENANCE MANUAL

FRIDLEY, MINNESOTA

OCTOBER 1992

U.S. Army Corps of Engineers
Omaha District

REVISION 6

Incorporated into this Document
on June 29, 1995
by
Morrison Knudsen Corporation

OPERATION AND MAINTENANCE MANUAL

NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT (NIROP)

GROUNDWATER EXTRACTION SYSTEM

FRIDLEY, MINNESOTA

MARCH 1993

Prepared for:

U.S. Army Corps of Engineers
Omaha District

Prepared by:

Morrison Knudsen Corporation
Environmental Services Division
7100 E. Belleview Avenue, Suite 300
Englewood, CO 80111

NIROP OPERATION AND MAINTENANCE MANUAL
GROUNDWATER EXTRACTION SYSTEM

TABLE OF CONTENTS

TABLE OF CONTENTS

Exhibits and Tables

PART A

OPERATION MANUAL

1.0 THEORY OF OPERATION

The Groundwater Pretreatment System includes extraction wells AT-1A, AT-2, AT-3A, AT-4, AT-5A and AT-5B, monitoring wells, metering system, air stripper tower, and carbon absorption vessel.

Groundwater is pumped from the extraction wells using submersible vertical turbine pumps. Each extraction well is equipped with a pitless adapter which connects the pump to the underground piping system.

The groundwater from the extraction well pumps is piped top the Control House which contains the flowmeters, control valves, header piping, static mixer, backflow preventer, sample valves and well pump control panels.

The groundwater is piped underground to the Pretreatment Building to the packed column air stripper for the removal of volatile organic compounds (VOC's) contained in the groundwater. The air stripper is a forced draft air stripping column, where contaminated water is pumped to the top of the stripping column and dispersed over the full diameter of the tower through the use of a hub and lateral inlet distributor assembly. The water flows downward by gravity through a packing media consisting of many spherical complex polypropylene "balls" forming a thin film on the surface of the media which allows a maximum amount of surface area for mass transfer to occur.

Outside ambient air is forced into the base of the lower section of the stripper column through the use of a centrifugal industrial blower. The air is forced upward (counter current to the water flow) through the packed tower and exits through the top of the tower via ducting.

The water, having been stripped of VOC's, collects in the sump base and exits the air stripper through the gravity piping system to the sanitary sewer.

The VOC-laden forced airstream exits the top of the tower and travels downward through ducting and is routed through the electric process air heater. The air enters the heater at approximately 50°F, and exits at approximately 90°F. The VOC-laden airstream is ducted to the granulated activated carbon (GAC) adsorption vessel. The VOC's are removed from the airstream through a process called adsorption. The air is forced upward through the carbon bed and exits the vessel through two weather proof discharge stacks to the atmosphere.

2.0 START-UP AND OPERATING PROCEDURES

Procedures for preparation for initial start-up and normal start-up are included in this section.

2.1 Preparation for Initial Start-Up

2.1.1 Air Stripper Blower

1. Check the inside of the blower housing. Remove any foreign material which could cause damage to the blower.
2. Be sure the bearings are lubricated.
3. Check for condensation in the blower housing and drain. If condensation is found, check inlet duct to determine if rain or snow is being sucked in.

> **NOTE:**
> Whenever the blower is not operated for extended periods, the shaft must be rotated by hand at least every two weeks to redistribute grease on internal bearing parts.

4. Check inlet duct to outside of building. Remove any foreign material which could be sucked into the blower.
5. Check the direction of blower rotation.

2.1.2 Blower Damper

1. Check damper control arm for proper setting. Ensure that it is locked in position.

2.1.3 Process Air Heater

1. Check the inside and outside of the heater. Remove any foreign material which could ignite or cause damage to the heating elements.
2. Check the heating level switch and set for low or high heat mode as required.

2.1.4 Air Stripping Column

1. Check for signs of leaks or cracks in piping and sump section. If leaks or cracks are found, repair before starting system.

2. Verify that the packing support grating and packing are installed.
3. Check that all support guy anchors are tight.
4. Check packing for fouling. When the coating on the packing starts to visibly build up or get "gunky" it is time to clean per manufacturer's recommendation.
5. Check level indicator sight glass for scum build-up. If level cannot be read, remove sight glass and clean per manufacturer's recommendation.

2.1.5 Carbon Adsorber

1. Check inlet off-gas ducting for leaks.
2. Check that all sample valves and ports are closed.
3. Check for any accumulation of condensation at drain connection.

2.1.6 Backflow Preventer Reduced Pressure Principle

1. Check for leaks in valves and fittings.
2. Check for trapped air in check valve and relief valve. To check for trapped air, open the four test cocks. When liquid appears, close the test cocks.
3. Check relief valve for leaking seat. If spitting or intermittent discharge from the relief valve occurs, check for water hammer or clogged sensing line. Clean line and rubber seats per manufacturer's recommendation.

2.1.7 Inline Static Mixing Unit

1. Check for proper installation and flow direction.
2. Check for leaks at flanged connection.

2.1.8 Sonic Flow Meters

1. Check that meter mounting cables and jacking screws are tight.
2. Verify that sensors are installed in the correct direction and at the correct offset distance. If sensors are removed for maintenance, refer to Badger meter Customer Instructions Manual and Series 4100 COMPU-SONIC flowmeter data/calculation sheet for sensor separation data and proper installation procedure.

2.1.9 Extraction Well Pump No. AT-1A

1. Verify main feeder circuit breaker B8-8S/1E-23E is in the "ON" position.
2. Check combination starter fused disconnect switch is in the "ON" position.
3. Check and verify that all valves in extraction line are in their full "OPEN" position.

2.1.10 Extraction Well Pump No. AT-2

1. Verify main feeder circuit breaker in Panel P1 is in the "ON" position.
2. Check combination starter fused disconnect switch is in the "ON" Position.
3. Check and verify that all valves in extraction line are in their full "OPEN" position.

2.1.11 Extraction Well Pump No. AT-3A

1. Verify main feeder circuit breaker in Panel P1 is in the "ON" position.
2. Check combination starter fused disconnect switch is in the "ON" Position.
3. Check and verify that all valves in extraction line are in their full "OPEN" position.

2.1.12 Extraction Well Pump No. AT-4

1. Verify main feeder circuit breaker B4-26S/1W-26W is in the "ON" position.
2. Check combination starter fused disconnect switch is in the "ON" Position.
3. Check and verify that all valves in extraction line are in their full "OPEN" position.

2.1.13 Extraction Well Pump No. AT-5A

1. Verify main feeder circuit breaker in Panel P3 is in the "ON" position.
2. Check combination starter fused disconnect switch is in the "ON" Position.
3. Check and verify that all valves in extraction line are in their full "OPEN" position.

2.1.14 Extraction Well Pump No. AT-5B

1. Verify main feeder circuit breaker in Panel P4 is in the "ON" position.
2. Check combination starter fused disconnect switch is in the "ON" Position.
3. Check and verify that all valves in extraction line are in their full "OPEN" position.

2.2 Preparation for Normal Start-Up

2.2.1 Air Stripper Blower

1. Open influent and effluent groundwater butterfly valves.
2. Make sure blower and process air heater switches are "OFF" at air stripper control panel.
3. Turn air stripper control main disconnect switch "ON". Blower low pressure alarm indicating light will be "ON".
4. Turn process air heater main disconnect switch "ON".
5. Turn blower control switch to "AUTO". Blower should start and blower run indicating light (green) will be "ON". Blower low pressure alarm indicating light will be "OFF" as soon as the blower pressure comes up. Read blower pressure (in inches water column) on gauge at air stripper control panel. Reading should be about 5 - 7 inches. The blower outlet damper should be about 50% open.

2.2.2 Process Air Heater

1. Turn process air heater enable switch to "ON". Heater indicating run light will be "ON". Check to see that the keyed heater "HIGH/LOW" selector switch in the correct position for the chosen GPM rate. (It should be set at "HIGH") **SEE NOTE 1.** Heater run indicating light will be "ON" only when the heater elements are on and heating. The light will go off and on with the normal cycling of the heater thermostat.

2. During normal operation, check that the process air heater is cycling on and off. To determine proper operation, watch green indicating light on front of control panel. Thios light should turn "OFF" and "ON" during cycling. Check bulb and replace if required. Check fuses and controller. Service as required.

NOTE 1

IMPORTANT: It should be noted that approximately 68% of the heater elements have been disabled by removing three #CJ-60A amp fuses from their clips in the heater control box. (Fuses are resting in the bottom of the box) This was necessary because at the time of installation there was insufficient power to available at the process air heater main disconnect. While there are currently 30 amps, 3 phase available, the heater requires 60 amp, 3 phase service to operate at it's full total capacity of 52 kilowatts. The remaining 32% of the heater elements will operate together in parallel at 6 kilowatts when the "HIGH/LOW" switch is in the "LOW" position. This same group of elements will operate in series at 17 kilowatts when the "HIGH/LOW" switch is in the "HIGH" position. During set-up and adjusting it was determined that operating the heater at 17 kilowatts in the "HIGH" setting (68% of the elements disabled) yields more efficient heating of the process airstream (flowing at about 500 CFM). For future increased demand on the heater to accommodate higher water and air flow rates, the service at the process air heater main disconnect must be increased to at least 60 amps, 3 phase. If the air flow rate increases beyond 800 CFM, the heater performance at the current setting would begin to suffer and must be switched to the "HIGH" mode (with all fuses installed). Be aware that the "HIGH" heater mode is designed for an air flow rate of 3600 CFM and would be overkill for 800 CFM, and will result in a high rate of thermostat cycling on and off. The original design specs called for a heater that could operate at air flow rates of 400 or 3600 CFM. There is no provision for linear heater operation relative to air flow rates between 400 and 3600 CFM.

2.2.3 Air Stripping Column

1. There are two magnehelic gauges mounted on the air stripper offgas ducting near the blower. The gauges are connected in parallel to a pitot tube in the blower inlet duct. When reading these gauges, refer to the bottom scale on the gauge to determine blower inlet duct air velocity. The top gauge, with an air velocity range of 300 to 2,000 feet per minute, is intended to register blower inlet velocity when the blower is operating in the low cubic feet per minute (400 to 500) range. The bottom gauge, with an air velocity range of 500 to 4,000 feet per minute, is intended to effectively extend the range of the top gauge and to register blower inlet velocity when the blower is operating in the high cubic feet per minute CFM (3,600) range. When operating the blower in the high CFM range, the top gauge will "peg" to beyond maximum scale readings. Due to the unique design of these gauges, no damage to the "pegged" gauge will occur.

2. Reading the appropriate gauge, check (adjust if needed) the 12-inch butterfly ducting damper so the gauges read the feet per minute (FPM) velocity required for the proper actual cubic feet per minute (ACFM). The LOW RANGE gauge should read about 500 FPM. With 500 FPM x 1.05 (cross-sectioned area of the blower inlet ducting, in square feet) you will get about 525 ACFM. This measurement is taken at the center of the inlet ducting and will be slightly higher than the true CFM.

3. The system is now ready to accept water for processing. The extraction pumps may now be started. For automatic operation, make sure the pumps are run on "AUTO" mode. Failure to do this could result in untreated water being released to the drain and/or a flooded air stripper building.

2.2.4 Extraction Well Start-Up

1. Check and verify all valves on each extraction line are in the open position from each well to the control house. All valves should be in the wide open position.

2. In the control house, make sure that the butterfly valves for the extraction well lines AT-1A to AT-5B are fully open. Do not forget to check the gate valve in front and behind the backflow preventer.

3. Double-check influent and effluent lines and valves for the air stripper in the water treatment building including, but not limited to, the direct discharge key valve below grade.

   CAUTION: Pumps running against a closed valve (dead head) for any period of time can permanently damage the pump and motor. The resulting damage is considered "operator error" and is not covered under the warranty.

4. Once all valves are in their open position check with FMC to ensure the cooling lines are closed.

5. Turn the main circuit breakers for each extraction well feeder to the "ON" position. Turn the starter disconnect switch to the "ON" position on each starter panel motor.

2.2.5 Extraction Well Pumps No. AT-1A, AT-2, AT-3A, AT-4, AT-5A and AT-5B

1. At the well pump control panel, turn the HOA selector switch to "AUTO", not "ON". The "ON" position should only be used for testing the pumps. The "ON" position by-passes all safety features (i.e., the low-level shutdown floats).

2. After turning the selector switch to "AUTO", go to the well, remove the pitless cover, and lower the upper float into the water. This should complete the "AUTO" circuit and the pump should start.

3. After the pump is running, replace the upper float to its original position (out of the water) approximately four feet below spool in the pitless unit. **DO NOT** raise the upper float too high because the float may become wedged in the spool and break. This would be considered a "Design Flaw" and "Operator Error" and would not be warranted. Make certain that each pitless cover is replaced and tightened with all the original bolts.

2.2.5 System Stabilization

1. At this point the system should be running. Return to the control house and check the pressure of each pump on the pipe riser where the pipe enters the control house. The acceptable line pressure should range from 35 psi to 55 psi. If the periodic line pressure reading does not fall in this range, further investigation should be taken to decide if the air stripper needs maintenance of if the entire system requires maintenance.

2. Check the specified flow rates and begin to throttle the pumps to the desired flow rate. The specified flow rates have been established and are recorded on the TOTAL DYNAMIC HEAD SPREAD SHEET. See Table A2.

NOTE

Since all the pumps are manifolded together in the control house, there will be a back pressure on the butterfly valve, making operation difficult. If the flow rates are slightly lower than anticipated there is no cause for concern. There have been system changes since the TDH requirements were calculated and the pumps designed. Also, reduced flow rates usually signal a routine maintenance call.

If the operator can operate the system with 10 to 20 percent reduction in flow rates, the operator can delay his maintenance calls. However, when a pump cannot pump enough water to cool the motor, a maintenance call is required. For a 6-inch Franklin motor with a flow inducer sleeve, the reduced flow rate at which the pump should not be operated below for extended periods of time is 35 gpm (below 0,5 ft/sec past the motor). For a 4-inch Franklin motor with a flow reducer sleeve, the reduced flow rate at which the pump should not be operated below is 10 gpm (below 0.25 ft/sec past the motor).

2.2.5 System Stabilization

3. Once the pumps have been started and stabilized, check the water level in the air stripper sight glass. This level is 19 inches at a flow rate of about 475 gpm (with 4 wells running), and must be determined by observation at a flow of 660 gpm, (with all 6 wells running), with little variation

   The stable sump level should not fall below 2 inches or rise above 30 inches. The air stripper can operate anywhere in this range. If the water level is too low, this will allow the blower pressure to escape through the effluent piping, thereby affecting air stripper performance. If water level is too high, the sump high level switch will shut down the system.

4. Recheck the air velocity gauges to see if the desired CFM is being forced into the air stripper. The current air velocity 480 to 500 feet per minute, as read on the low-range gauge of the dual-scale gauges mounted near the blower. As long as the water influent flow rate does not increase, the air flow rate will not need to be increased.

5. Once all systems are operating and stabilized, the autodialer should be turned "ON" and checked for proper programming. (See autodialer data sheets) The autodialer ID number is 1-612-572-2440. Temperature limits should be set at 100 (high) and 32 (low). The numbers to be called on alarm status are already programmed into the autodialer.

6. Check flow meters to see if they are registering correctly. It will take approximately 24 hours for the system to stabilize. The approximate flow rates are shown on the Total Dynamic Head Calculation Sheet, Table A2.

3.0 SYSTEM SHUTDOWN

3.1 General

In general, the groundwater extraction system will not be shut down. If a short-term shutdown is expected in the winter, and the temperature is expected to be less than 0°F with no heat in the control house or the water treatment building, the total system should be drained to prevent freezing. Draining is not necessary if the temperature is expected to be above freezing or if all heaters are left on during this shutdown period.

3.2 Shutdown

1. Turn off the autodialer.

2. Turn all extraction well pumps "OFF" at the well pump control panel.

3. Allow the blower and process heater to run after the well pumps have been shut down. This will continue to treat the water still left in the tower as it drains down to the sump. When the sump level no longer drops, the air stripper is through draining and the blower and process heater can be shut down.

4. Turn the process heater "OFF" at the air stripper control panel.

5. Turn the blower "OFF" at the air stripper control panel.

6. If at any time the process air heater is turned on while the blower is not running, the heater will overheat, causing an internal heater thermal shutdown. This is a safety feature built in to the heater. When the heater cools down enough the thermal switch will allow the heater to operate. If the heater "ENABLE" switch at the main panel is not shut off, the heater will continue to cycle between overheating and thermal shutdown. This situation should be avoided.

7. Close all butterfly valves for extraction well influent lines on the main header in the control house.

4.0 OPERATOR RESPONSE TO ALARMS

TABLE A1

INDICATION	PROBABLE CAUSE	SYSTEM RESPONSE	OPERATOR ACTION
External Building Alarm and Auto Dialer Call Out	Air Stripper Blower Off.	Shutdown of water treatment system extraction wells.	Check air stripper control panel. Blower run indicator will be "OFF". Restart system.
	Air Stripper Blower Low Pressure.	Shutdown of water treatment system and extraction wells.	Check air stripper control panel. Blower low pressure indicator will be "ON". Restart system.
	Air Stripper sump high level.	Shutdown of water treatment system and extraction wells.	Check air stripper control panel. Sump high level indicator will be "ON". Depress the "RESET" button after determining and rectifying the cause of sump high level. Restart system.
Auto Dialer Callout and Power Failure	Power failure longer than 5 minutes.	Shutdown of water treatment system and extraction wells.	Check cause for power failure. Restart system.
Auto Dialer Callout Building Temperature	Water Treatment Building temperature above 110°F.		Check Building wall exhauster and louvers for proper operation.
Auto Dialer Callout Building Temperature	Water Treatment Building temperature below 32°F.		Check building heaters that power in on. Check thermostat for proper setting. Check that building wall louvers are not open.
Autodialer Callout high noise level NOTE: To trigger an alarm status, the sound level must be 10 dB above normal, at 1000 Hz, for a period of more than 10 seconds.	Blower malfunction, Water leaking, Heater fan malfunction.		Check air stripper blower inspect all piping and valves check heater for proper operation.

E. H. Renner & Sons
INCORPORATED
WELL DRILLING FOR FOUR GENERATIONS
15688 JARVIS STREET N.W. / ELK RIVER, MN 55330 / (612) 427-6100

TABLE A2

TOTAL DYNAMIC HEAD CALCULATIONS

DESCRIPTION	AT-1A	AT-2	AT-3A	AT-4
TOTAL WELL DEPTH (TOC)	65.96ft	66.75ft	131.5ft	48.17ft
ELEVATION (TOC)	836.10ft	835.90ft	835.43ft	837.8ft
S.W.L. (TOC)	813.10ft	813.30ft	808.43ft	815.86ft
PUMPING RATE (GPH)	75	125	250	125
PUMPING LEVEL (TOC)	800.70ft	799.94ft	798.22ft	812.30ft
DISCHARGE ELEVATION	860.00ft	860.00ft	860.00ft	860.00ft
TOTAL LIFT	59.30ft	60.06ft	61.78ft	47.70ft
FRICTION LOSS				
SDR 21 PVC Piping	6.02ft	4.11ft	34.53ft	8.60ft
Galvanized Piping	55.54ft	0.00ft	0.00ft	31.78ft
PVC Schedule 80 Drop Pipe	2.86ft	2.48ft	5.07ft	0.67ft
Flow Meters	Minimal	Minimal	Minimal	Minimal
Static Mixer	1.46ft	2.49ft	4.99ft	1.46ft
Backflow Preventor	3.88ft	6.65ft	13.31ft	3.88ft
Fittings	11.41ft	2.03ft	7.28ft	4.08ft
AS250 Diffusion Nossels	1.94ft	3.33ft	6.65ft	1.94ft
TOTAL LOSS	83.11ft	21.09ft	71.83ft	52.41ft
TOTAL DYNAMIC HEAD	142.41ft	81.15ft	133.61ft	100.11ft
DESIGN FLOW RATE (GPH)	75	125	250	75
125% OF DESIGN FLOW RATE (GPH)	93.75	156.25	312.50	93.75
FEET OF PUMP CABLE	70.0ft	70.0ft	135.0ft	56.0ft
PUMP CABLE SIZE IN WELL	#12	#12	#8	#12
CABLE REQUIRED FROM WELL TO CONTROL HOUSE	#8	#14	#6	#6
EPG PUMP MODEL #	TSP 16-5 (5HP)	TSP 27-3 (5HP)	TSP 45-6 (15HP)	TSP 16-4 (15HP)
TOTAL HEAD DELIVERED	170.00ft	105.00ft	160.00ft	140.00ft
DISCHARGE PRESSURE (PSI) AT DESIGN FLOW RATE	11.94	10.32	11.42	17.31

PART B

MAINTENANCE MANUAL

1.0 PERIODIC MAINTENANCE

1.1 Carbon Replacement

During operations involving replacement of the spent carbon, increased care will be necessary due to contamination of the carbon with trichloroethylene (TCE). Greater protection will also be required when contact may be possible with the vapors and odors from TCE. Protection of personnel during removal of ductwork and sealing of inlet and outlet ports includes:

- Air purifying respirator with organic vapor cartridges.
- Chemical resistant suit (polyethylene-coated Tyvek® or equivalent).
- Rubber boots.
- Inner gloves (latex or vinyl).
- Outer gloves (nitrile or equivalent).
- Eye protection meeting ANSI Z-87 (if not provided by the respirator).
- Sealed interfaces between suit/boots and gloves/suit using duct tape or equivalent.

Protection needed during hook-up of the new carbon unit will not require any additional or special gear other than what is necessary for the site (no suits, gloves, or rubber boots).

This protection may be changed by an authorized individual with industrial hygiene experience based upon air monitoring data and observation of work operations.

1.2 Stripper Packing Cleaning

When to acid wash the stripper is a subjective decision based on the condition of the packing. Generally, when the coating on the packing starts to visibly build up or get "gunky" it is time to acid wash.

Other indications are the sludge build-up inside the sight glass and a gradual increase in blower pressure as shown on the main control panel blower pressure gauge. However, since the sight glass is relatively calm compared to the water in the packing and sump, it may appear more fouled than the interior of the air stripper. Also, the blower, in its current configuration, will not have the pressure to show much of a change on the gauge when packing fouls.

Attempts to calculate the exact time to acid wash the packing are not considered accurate.

1.3 Acid Washing

At times when acid washing of the air stripper will be performed, additional protection will be necessary if personnel will be in contact or have the potential for contact with the acid wash solution. Additional protection includes:

- Chemical resistant suit (polyethylene-coated Tyvek® or equivalent).
- Rubber boots.
- Inner gloves (latex or vinyl).
- Outer gloves (nitrile or equivalent).
- Eye protection (both splash goggles and a splash shield may be necessary if splashing may occur).
- Sealed interfaces between suit/boots and gloves/suit using duct tape or equivalent.

1.4 Spent Acid Solution

After the acid washing of the packing is complete per the manufacturer's recommendation, the HCL solution shall be monitored with a pH meter. The solution must be neutralized with caustic soda or lime (added manually) until a pH of 7 is achieved. The solution would then be run through the bag filters to remove suspended solids and may then be discharged to the sanitary sewer. When bag filters are dry, they may be properly disposed of. If fouling on the packing is excessive this procedure may need to be repeated.

1.5 Routine Maintenance

1. The precise routine maintenance procedures should be established for the NIROP System from observation of the system's operation after 12 to 24 months. However, suggested maintenance will follow along the same lines as the southern FMC extraction system E.H. Renner & Sons, Inc. currently services.

2. The major motivation for the routine maintenance is to sustain the flow rates of the pumps within acceptable ranges. This is difficult at NIROP because the water in the unconfined aquifer is naturally high in iron. Therefore, pressure and temperature changes will result in precipitation of iron. Over time, these iron deposits will:

   - Collect and reduce the inside diameter of pipe.
   - Collect in the pump bowls and impellers.

- Cause incorrect flow meter readings (which are calculated against a definite inside diameter value).
- Clog moving parts in backflow preventers.
- Plug diffusion nozzles at the top of air strippers.

These iron deposits increase the system's TDH (total dynamic head), reducing the flow rates the pumps can produce.

3. The wells should not require routine maintenance with the exception of bacteria, iron and other deposits accumulating on the well screen and can plugging the screen.

   CAUTION: The jetting velocity should be kept under 80 feet per second so that filter pack from the screen is not disturbed.

4. The teflon submersible pumps will need routine maintenance every 6 to 12 months. The maintenance of the pumps will involve pulling the pumps, disassembly, acid bath (phosphoric acid seems to be the most effective and safe method), reassembly, hot pressure wash, testing for performance, and reinstallation.

   The drop pipe should also be inspected (cracks, iron build-up, threads, couplings) when the pumps are pulled. Renner uses a pig-tail on a 3/8-inch cable with hot pressure wash to clean the inside of the drop pipe.

   When the pumps are pulled, the floats should also be checked. The primary concern should be cleaning the contacts of the floats. Also, the float leads should be inspected for cuts and abrasions.

5. When pulling the pumps, extraordinary care should be taken for the following:

   a. Turn off the power and lock-out the panel breaker switch.

   b. When pulling AT-1A and AT-4, make sure the valves on each extraction line are closed where they enter the building from the well. The reason for closing these valves is that when the spool is pulled, the check valves holding the water in the extraction line are removed. Without the check valves in-line, the water in the extraction lines can backflush into the well and screen. This backflushing could damage the filter pack design and cause a sand problem.

c. PVC couplings can easily break if improperly handled. The operator should always make certain that the clamp holding the drop pipe/pump below the coupling that is being unscrewed is securely attached so that in the even of a coupling breaking, the operator is not fishing the pump out of the well.

d. The no-splice motor leads have an oil/gas resistant outer sleeve. If this outer sleeve is abraded or cut, wicking can take place and eventually short out the motor. In the event of a cut of abrasion, the motor lead must be replaced.

e. The copper air lines are fragile. If the copper air lines are bent, they must be replaced. One should expect to replace these lines every time the pumps are pulled.

6. Occasionally, the O-rings in the spool of the pitless adapters will need to be replaced. They should be inspected when the pumps are pulled. The check valves in the spool should be manually cleaned when the drop pipe and pumps are maintenanced.

7. When doing routine maintenance, use the Checklist Log (Exhibit B-1) to record all equipment readings and performance data.

NIROP PERIODIC MAINTENANCE

TABLE B2

FREQUENCY	TAG NUMBER--SERVICE	PERIODIC MAINTENANCE
Monthly	Blower Assembly	Check V-belts drive for proper alignment and tension. Replace belts as a set, if worn.
		Check selscrews and bolts for tightness.
		Grease fan bearings. Use only one or two shots with a handgun, maximum handgun rating 40 PSI.
		Check for loose sheaves on shafts.
		Check for vibration. Check for bearing noise.
		Check for accumulation of liquid or dirt in fan housing. Remove as required.
Monthly	Blower Discharge Damper	Check that adjusting handle is set at correct flowrate. Check for any wear on linkage and damper vanes. Repair or replace as necessary.
	Process Air Heater	Check that heater selector switch is set at proper heat level (low-high) on air stripper control panel.
		Check for accumulation of dust and dirt within the duct and on duct heater clean as required.
		Check for loose electric connection to heater elements. Check for vibration and noise of heating elements mounting. Repair or replace. Check heating elements mounting compression fittings for looseness. Tighten as required.

NIROP PERIODIC MAINTENANCE

TABLE B2 (Continued)

FREQUENCY	TAG NUMBER--SERVICE	PERIODIC MAINTENANCE
		Check for corrosion of heating elements and clean or replace as required.
	Process Air Heater (Continued)	Check electric contactor in control panel for pitting of contacts. Replace.
	Air Stripper AS-250	Check the FRP scrubber, duct and stack for signs of cracks, especially around the flanges. Check for fouling of packing, clear per manufacturer's recommendation. Check for leaks at level sight glass connection and visibility of water level. Clean as required. Check distributor hub for cracks and loose or missing distribution laterals. Repair or replace if necessary.
		Check inlet and outlet piping and valves for leaks. Repair or replace.
	High-Level Switch (Air Stripper AS-250)	Check for loose electrical connection. Tighten or replace as necessary. Check for scum or scale accumulation on float and stem. Clean as required. Check operation of float for high, high-level alarm.
	Low Pressure Switch (Blower Pressure)	Check for leaks around diaphragm and impulse lines connection. Check that safety wire on adjustment screw is in place. Check for loose electrical connection. Tighten as necessary.
	Pressure Indicator (Blower Pressure)	Check for leaks in impulse lines and connecting fittings. Tighten or replace as necessary. Check that indicator is reading correctly. Recalibrate as necessary.

NIROP PERIODIC MAINTENANCE

TABLE B2 (Continued)

FREQUENCY	TAG NUMBER--SERVICE	PERIODIC MAINTENANCE
	System Alarm (External)	Check light (should be on when air stripper system is off). Replace bulb.
	Temperature Indicator (Carbon Adsorber Inlet)	Check for leaks around connection to header. Check that indicator is reading correctly. Recalibrate or replace as necessary.
	GAC Adsorption Vessel	Check for leaks at inlet and discharge ducts. Check for loose grounding bonding conductor connection.
Monthly	Autodialer	Check the telephone connector, making sure it is connected at both ends. Check that the AC power transformer is plugged into wall outlet. Check that the power "on" light is lit. Check the time. Check all dial-out telephone numbers. Check the rings until answer feature. Check the temperature limits. Check the ID number and check statements and comments for the system. Check the alarm sound level feature (smoke or burglar alarm). Check the call-in status report statement and comment. (This feature can only be done from a remote telephone.)

2.0 TROUBLESHOOTING

WARNING

All maintenance personnel must have hazardous waste site operations and emergency response training before working on this site. In addition, anyone working on or near exposed, energized circuits requires an OSHA safety-related work practices electrical orientation training.

Before servicing or doing maintenance on pumps, blowers, etc., a lockout/tagout procedure shall be in place per OSHA Control of Hazardous Energy Source.

NOTE

This troubleshooting list provides a quick overview. It is not intended to replace vendor-provided information. Please consult vendor data for complete instructions.

2.1 Health, Safety and Environmental Protection

All questions regarding health, safety or environmental protection are to be directed to the FMC Environmental Manager, Doug Hildre, at (216) 572-6983.

All personnel potentially coming in contact with the contaminants present in the water or spent carbon on the NIROP site are to comply with the OSHA regulations stipulated in 29 CFR 1910 and 1926, notably 1910.120. In addition, the EPA "Superfund Standard Operating Safety Guides" Office of Solid Waste and Emergency Response Directive 9285.1-03, June 1992, can be consulted for further information.

NIROP TROUBLE SHOOTING
TABLE B1

TAG NUMBER--SERVICE TROUBLE INDICATION	CORRECTIVE ACTION
BLOWER	
1. Excessive vibration	1a. Loose mounting bolts, setscrew, bearings or couplings. b. Misalignment or excessive wear of bearings. c. Misaligned or unbalanced motor. d. Bent shaft. e. Accumulation of foreign material on the wheel. f. Excessive wear or erosion of the wheel. g. Excessive system pressure or restriction of airflow due to closed dampers. h. Inadequate structural support, mounting procedures, or materials. i. Externally transmitted vibration.
2. Inadequate Performance	2a. Fan running too slowly. b. Fan wheel rotating in wrong direction. c. Wheel not properly centered relative to inlet. d. Closed dampers, air leaks, clogged filters or heating coils. e. Obstruction near inlet duct. f. Sharp deflection of airstream at fan outlet.
3. Excessive Noise	3a. Vibration originating elsewhere in system. b. Fan operating near "stall". c. System resonance or pulsation. d. Improper location or orientation of fan intake and discharge. e. Inadequate supporting structures. f. Nearby sound reflecting surfaces. g. Loose accessories or components. h. Loose drive belts. i. Worn bearings.
4. Premature component failure.	4a. Prolonged or major vibration. b. Misalignment or physical damage to rotating components or bearings. c. Bearing failure from incorrect or contaminated lubricant, or grounding through the bearing while arc welding.

NIROP TROUBLE SHOOTING
TABLE B1 (Continued)

TAG NUMBER--SERVICE TROUBLE INDICATION	CORRECTIVE ACTION
	d. Excessive fan speed. e. Extreme ambient or airstream temperatures. f. Improper belt tension g. Improper tightening of wheel bushing bolts.
5. Fan will not start	5a. Fan motor controller disconnect is open. b. Fan motor fuses are blown. c. Control panel disconnect is open; panel power is off. d. Control power fuse is blown. e. Overload is tripped. Reset and check for motoramperage. f. Check belts, broken or slippage.
BLOWER DISCHARGE DAMPER 1. Low air flow through system.	1a. Check damper actuator linkage, shafts for free movement. b. Check damper for leaks or flow restrictions. Manually open damper; if no flow, check for restrictions. Repair or replace.
PROCESS AIR HEATER 1. No heat.	1a. Heater controller disconnect is open. b. Heater fuses are blown. c. Control power fuse is blown. d. Loose electrical connection to heater elements.
2. Vibration or excessive noise.	2a. Check heating elements mounting. b. Loose element mounting compression fittings, tighten as required.
AIR STRIPPER 1. High water level in sump	1a. Outlet valve not fully open. b. High level switch not operating properly, clean or replace. c. High level switch set too high.

TAG NUMBER--SERVICE TROUBLE INDICATION	CORRECTIVE ACTION
2. High pressure indication	2a. Discharge butterfly valve improper setting. b. Sensing lines may be plugged or leaking. c. Check with known accurate pressure indicators. d. Packing in stripper is fouled.
GAC ADSORPTION VESSEL 1. Excessive accumulation of condensation in carbon bed.	1a. Process heater temperature incorrect setting.
EXTRACTION WELL PUMPS 1. Pump will not start.	1a. Pump motor controller disconnect is open. b. Pump motor controller fuses are blown. c. High water level in air stripper sump. d. Motor starter overloads have tripped out. e. Low water level in extraction well. f. Low or high water level float has open circuit. g. High level float above water level. h. Check electrical connection on control circuit.
2. Pump runs but no discharge.	2a. Ground water level in well is too low or well is collapsed. b. Inlet strainer is clogged. c. Check for valves in liner not opened. d. Check for piping or valve leaks. e. Check for flow restrictions.
3. Pump will not shut off.	3a. Short in wiring to level float. b. Improper wire size between motor controller and float switches. c. Low level float not operating properly.

Exhibit B-1
CHECKLIST LOG

Time am pm	S	M	T	W	Th	F	S
Operator	Date						

Vandalism/damage to water treatment/control building	Weather	Bright Sun	Clear	Overcast	Rain	Snow
Vandalism/damage to wells	Temp Outside	Below 32	32-50	50-70	70-85	Over 85
Check for alarms	Temp Inside	Below 32	32-50	50-70	70-85	Over 85

Maintenance performed

WELL NO.	AT-1A	AT-2	AT-3A	AT-4
Flow meter reading (gpm)				
Pumping level (ft)				
Pump pressure (psi)				
Pump motor current (amps)				

EQUIPMENT	Daily	Weekly	Monthly
Air stripper blower: inlet (clean) (dirty) (blocked)			
damper (setting)			
blower pressure (in wc)			
v-belts			
grease			
low pressure switch			
pressure indicator (5-7 in wc) actual indication			
periodic maintenance checklist			
Process air heater: heat range level (high) (low)			
temperature range (32-100°) setting ______			
periodic maintenance checklist			
Air stripper column: sump level (2-30 in) actual level ______			
air velocity (400-3600 cfm)			
periodic maintenance checklist			
high level switch			
Outside alarm light			
GAC adsorption vessel: sample effluent for VOC 50%			
75%			
100%			
Autodialer: dial out			
temperature limits			
periodic maintenance checklist			

Comments:

Exhibit B-2
CHECKLIST LOG

Time am pm	S	M	T	W	Th	F	S
Operator	Date						

Vandalism/damage to water treatment/control building	Weather	Bright Sun	Clear	Overcast	Rain	Snow
Vandalism/damage to wells	Temp Outside	Below 32	32-50	50-70	70-85	Over 85
Check for alarms	Temp Inside	Below 32	32-50	50-70	70-85	Over 85
Maintenance performed						

WELL NO.	AT-5A	AT-5B		
Flow meter reading (gpm)				
Pumping level (ft)				
Pump pressure (psi)				
Pump motor current (amps)				

EQUIPMENT		Daily	Weekly	Monthly
Air stripper blower: inlet (clean) (dirty) (blocked)				
damper (setting)				
blower pressure (in wc)				
v-belts				
grease				
low pressure switch				
pressure indicator (5-7 in wc) actual indication				
periodic maintenance checklist				
Process air heater: heat range level (high) (low)				
temperature range (32-100°) setting ____				
periodic maintenance checklist				
Air stripper column: sump level (2-30 in) actual level ____				
air velocity (400-3600 cfm)				
periodic maintenance checklist				
high level switch				
Outside alarm light				
GAC adsorption vessel: sample effluent for VOC	50%			
	75%			
	100%			
Autodialer: dial out				
temperature limits				
periodic maintenance checklist				

Comments:

3.0 SPARE PARTS DATA

This section included all spare parts lists.

CARBONAIR ENVIRONMENTAL SERVICES
8640 MONTICELLO LANE
MAPLE GROVE, MN 55369

AIR HEATER CONTROL PANEL

SPARE PARTS LIST

ITEM NO.	BOM ITEM	QTY	DESCRIPTION	MANUFACTURER	CATALOG NO.	PRICE	SUPPLIER	WHERE USED
1	4	2	FUSE, 500V, 2AMP, ATQ2	BUSSMANN	FNQ-2	$ 6.62	A	HEATER PANEL CONTROL FUSE
2	5	1	FUSE, 250VAC, 5AMP, MDX5	BUSSMANN	MDL-5	$ 0.68	A	HEATER PANEL CONTROL FUSE
3	19	3	FUSE, 600VAC, CJ-10A	LITTELFUSE	JLS-10	$ 10.24	A	HEATER PANEL LO ELEM/PARALLEL
4	21	3	FUSE, 600VAC,CJ-30A	LITTELFUSE	JLS-30	$ 8.65	A	HEATER PANEL LO ELEM/SERIES
5	22	3	FUSE, 600VAC, CJ-60A	LITTELFUSE	JLS-60	$ 14.14	A	HEATER PANEL HI ELEMENTS

SUPPLIERS:

A. STERLING ELECTRIC CO.
13415 WATER TOWER CIRCLE
PLYMOUTH, MN. 55411
(612) 553-7777

B. ELEC-TROL, INC.
1313 PLYMOUTH AVE. N.
MINNEAPOLIS, MN. 55411
(612) 521-5051

C. W.W. GRAINGER, INC.
4444 ROUND LAKE ROAD WEST
ARDEN HILLS, MN. 55112-3913
(612) 636-0090

CARBONAIR ENVIRONMENTAL SERVICES
8640 MONTICELLO LANE
MAPLE GROVE, MN 55369

AIR STRIPPER CONTROL PANEL NIROP 11 #301960

SPARE PARTS LIST

ITEM NO.	BOM ITEM	QTY	DESCRIPTION	MANUFACTURER	CATALOG NO.	PRICE	SUPPLIER	WHERE USED
1	12	1	FUSE, 250VAC, 5 AMP	BUSSMANN OR GOULD SHAWMUT	FRN-R 5 TR-5R	$ 3.07	A	MAIN PANEL CONTROL FUSE
2	12B	3	FUSE, 600VAC, 30AMP	BUSSMANN OR GOULD SHAWMUT	FRS-R 30 TR-30R	$ 5.57	A	MAIN PANEL 3 PH POWER
3	7	3	BULB, INCANDESCENT, 120VAC,2.5W #120MB,BAYONET BASE	SIEMENS	35B0A-BL1	$ 6.00	B	MAIN PANEL LIGHTS
4		2	V-BELT, COG-TYPE, 45" OUTSIDE LENGTH, .66" TOP WIDTH X .41" THICK	BROWNING GRAINGER	RMA # BX42 6A125-1	$ 14.23	C	AIRSTRIPPER BLOWER

SUPPLIERS:
A. STERLING ELECTRIC CO.
13415 WATER TOWER CIRCLE
PLYMOUTH, MN. 55411
(612) 553-7777

B. ELEC-TROL, INC.
1313 PLYMOUTH AVE. N.
MINNEAPOLIS, MN. 55411
(612) 521-5051

C. W.W. GRAINGER, INC.
4444 ROUND LAKE ROAD WEST
ARDEN HILLS, MN. 55112-3913
(612) 636-0090

REV 1 (3-18-93)

NAVEL INDUSTRIAL RESERVE ORDNANCE PLANT

ELECTRICAL EQUIPMENT LIST

Fixtures

Keystone Lighting - Number *k1240*
2-Lamp industrial light fixture
Northland Electric Supply (612) 341-6400

Light fixture spare parts:

120 Volt ballast	$65.00
F40T12 Fluoresent lamp	$2.00

Panels

PI Siemens - Number *BQCH424MB4060STGBGU*
Three phase 480 volt 60 amp main circuit breaker 24 circuit
Factory Services: (612) 942-8888
After hours: (800) 241-4453

Note: No spare parts recommended

P2 Siemens - Number "BQ21iMB1100SiGbGU*
One phase three wire 120/240 volt 100 amp main circuit breaker 18 circuit
Factory Service: Same as above

Note: No spare parts recommended

Transformer

Siemens ITE - Number 1D1Y015ST
480V three phase to 120/240 volt single phase 15 KVA
Factory Service - Same as above

Note: No spare parts recommended

NAVEL INDUSTRIAL RESERVE ORDNANCE PLANT

ELECTRICAL EQUIPMENT LIST

Motor Starters and Fuseable Disconnects

Siemens - World Series Full Voltage
Nonreversing
Class Sc F
Coil Voltage 110V
Control Transformer 480/120V
Factory Service - Same as Above

Motor Starter Recommended Spare Parts:

110 Volt Coil	$98.00
480/110V Control Transformer	$54.00

Fuses

Gould Shawmut-	TRS15R	15 amp 600 volt fuse
	TRS25R	25 amp 600 volt fuse

Heater

Berko - H.V.H 524TA-240V
1500W - Horizontal Down Draft
Factory Service - Viking Electric, (612) 289-0660

No spare parts recommended.

NAVEL INDUSTRIAL RESERVE ORDNANCE PLANT

ELECTRICAL EQUIPMENT LIST

Control Panel

Control Center, Inc.
Chris Carlson (612) 559-7177
UL Number W224402

Pilot Lite

Allen Bradley 800T-P16R $65.00

Selector Switch

Allen Bradley 800T-J2A, On/Off Auto $40.00

Four Pole Relay with 110V Coil

Allen Bradley 700N-800 $145.00

Allen Bradley Factory Parts and Service

Viking Electric (612) 289-0660

General Electric Control Transformer $75.00

120-120 Volts 1-KVA 9T58B2907
Graybar Electric (612) 721-3545

Bussman

FNMI Fuses $3.50
Graybar Electric (612) 721-3545

4.0 VENDOR DATA

Data is included in this section for the following manufacturers and suppliers.

*	Allen-Bradley - Selector Switch, Timing Relay and AC Relay
	American Colloid
**	Badger Compu-sonic Flow Meter
**	Baker Moniter PS - Pitless Well Adaptor
	Brainard Kilman Centralizers
*	B/W Controls - Low Voltage Relays
	Carbonair Services, Inc.
	Conbraco Air Cocks
**	Drexelbrook - Well Level Moniter
	EPG Companies - Well Float
	Franklin Electric - Pump Motors
**	Groudfos - Pumps and Motors
	Industrial Electric
	Komax Motionless Mixer
	Louvers and Dampeners, Inc.
	Marley Electric Heating - Berko Heating Unit
	Northstar PVC Pressure Pipes
	Penn Ventilator Co.
	Piping/PVE Midwest, Inc.
**	Siemens Electrical Products
*	Spears - Butterfly Valves
*	Watts - Ball Valves
	Wilkins Regulator Co. - Backflow Preventor
*	Weksler Instruments - Pressure Gauge

*	New Component Vendor Data added on 6/30/95
**	Additional Vendor Data incorporated on 6/30/95

ALLEN-BRADLEY

BULLETIN BULLETIN
800H / 800T

SELECTOR SWITCH INSTALLATION AND MOUNTING INSTRUCTIONS
INSTRUCTIONS DE MONTAGE ET D'INSTALLATION DU SELECTEUR
WAHLSCHALTER, EINBAU- UND MONTAGEANLEITUNG
INSTRUCCIONES DE INSTALACION Y MONTAJE DEL CONMUTADOR SELECTOR
INSTRUÇÕES DE INSTALAÇÃO E MONTAGEM DO COMUTADOR SELECTOR

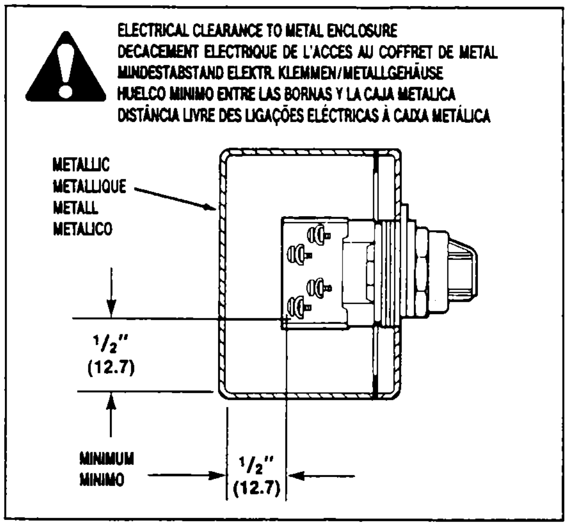
WARNING: Isolate before servicing. Install in suitable enclosure. Keep free from contaminants.

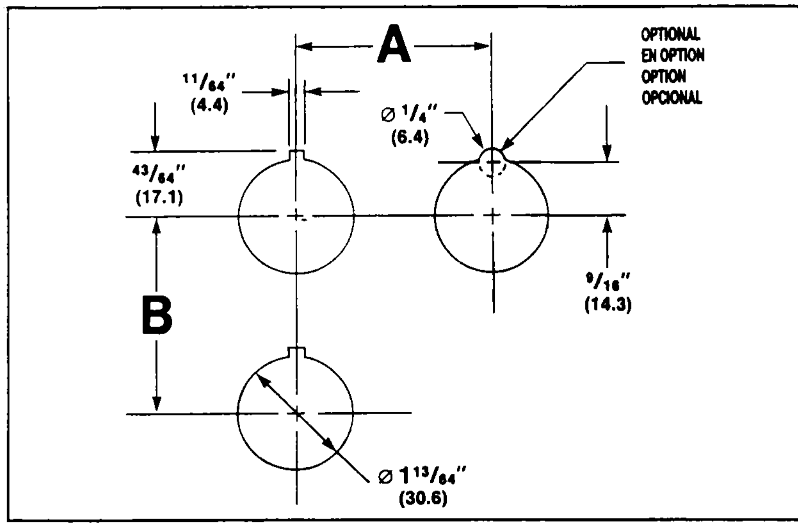
ATTENTION: Toujours couper toutes sources d'alimentation avant de commencer l'entretien. Installer dans une boite appropriée. Protéger le relais contre les contaminants.

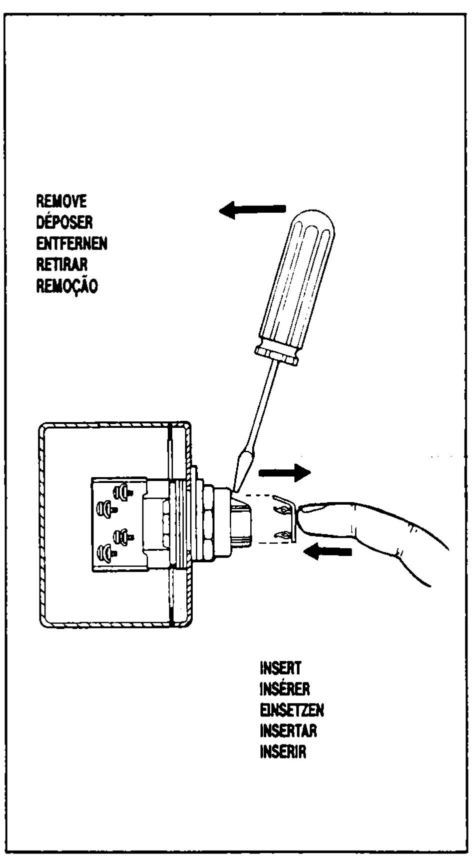
WARNUNG: Vor Wartungsarbeiten Anlage abschalten. Die Gerate müssen in einem passenden Gehäuse eingebaut und gegen Verschmutzung geschützt werden.

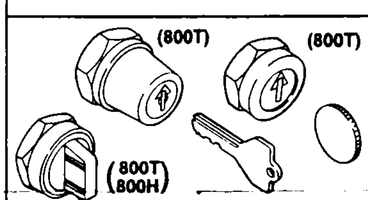
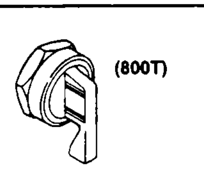
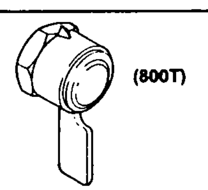
PRECAUCION: Desconéctelo antes de servirlo. Instálelo en una caja apropiada. Manténgalo libre de contaminantes.

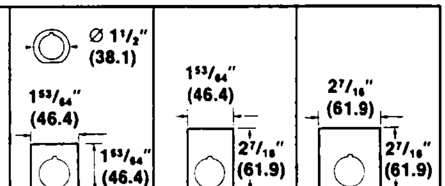
CUIDADO: Desconectar antes de usar. Instalar em caixa apropriada. Manter livre de contaminantes.







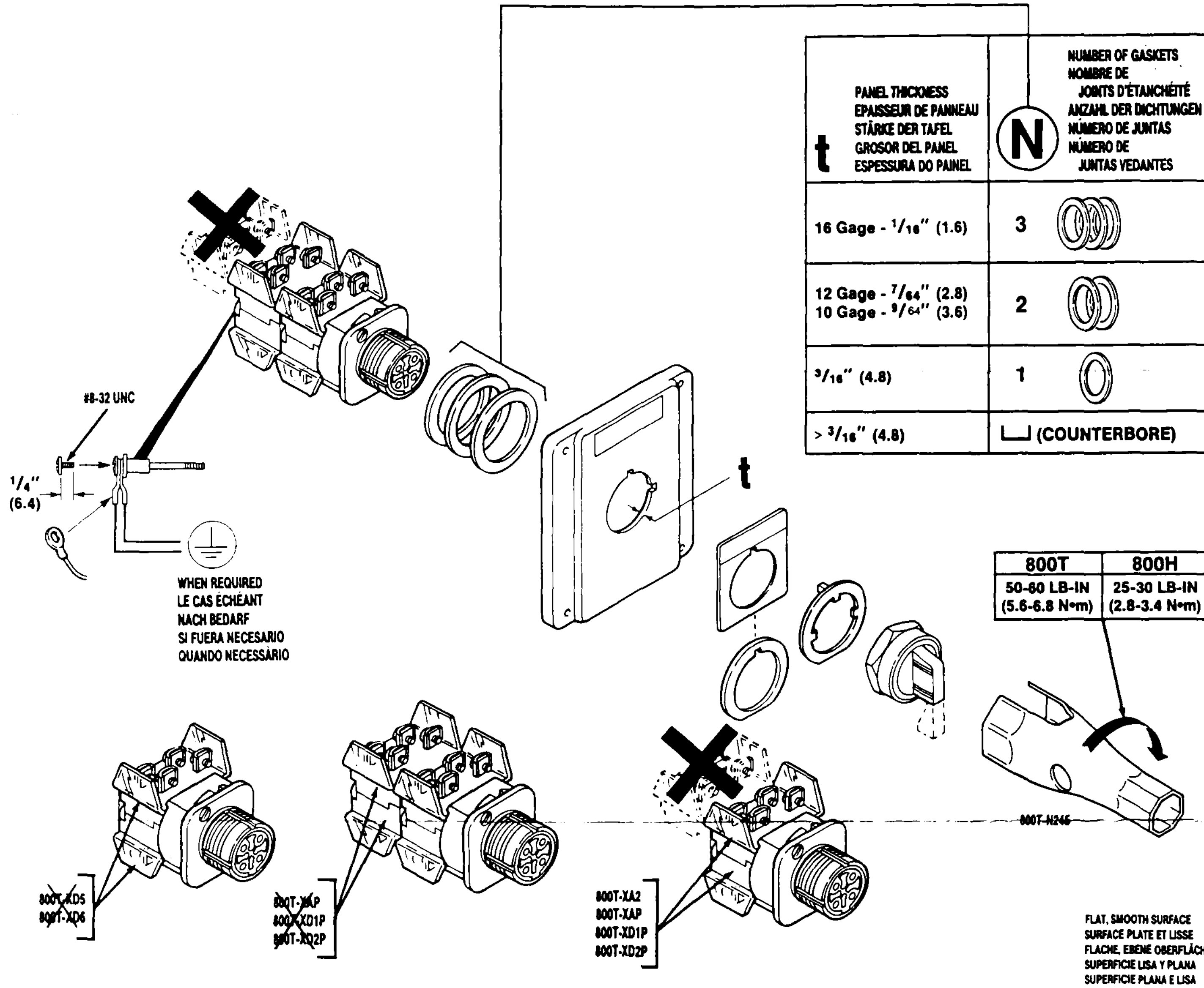
TYPE / TYP / TIPO / TIPO	POSITIONS / STELLUNGEN / POSICIONES / POSIÇÕES	Ø 1 1/2" (38.1); 1 53/64" (46.4) × 1 53/64" (46.4)		1 53/64" (46.4) × 2 7/16" (61.9)		2 7/16" (61.9) × 2 7/16" (61.9)	
		A	**B**	**A**	**B**	**A**	**B**
		2 1/4" (57.2)	1 27/32" (46.8)	2 1/4" (57.2)	2 1/2" (63.5)	2 1/2" (63.5)	2 1/2" (63.5)
		2 1/4" (57.2)	1 27/32" (46.8)	2 1/4" (57.2)	2 1/2" (63.5)	2 1/2" (63.5)	2 1/2" (63.5)
		2 1/4" (57.2)	1 27/32" (46.8)	2 1/4" (57.2)	2 1/2" (63.5)	2 1/2" (63.5)	2 1/2" (63.5)
		2 1/4" (57.2)	1 27/32" (46.8)	2 1/4" (57.2)	2 1/2" (63.5)	2 1/2" (63.5)	2 1/2" (63.5)
		2 1/4" (57.2)	1 27/32" (46.8)	2 1/4" (57.2)	2 1/2" (63.5)	2 1/2" (63.5)	2 1/2" (63.5)
		2 1/2" (63.5)	1 27/32" (46.8)	2 1/2" (63.5)	2 1/2" (63.5)	2 1/2" (63.5)	2 1/2" (63.5)
		3 1/4" (82.6)	3" (76.2)	3 1/4" (82.6)	3" (76.2)	3 1/4" (82.6)	3" (76.2)
		3 1/4" (82.6)	3" (76.2)	3 1/4" (82.6)	3" (76.2)	3 1/4" (82.6)	3" (76.2)
		4" (101.6)	3" (76.2)	4" (101.6)	3" (76.2)	4" (101.6)	3" (76.2)



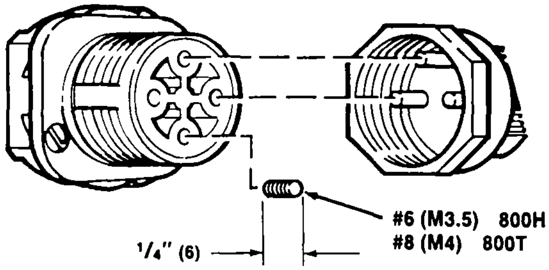
40061-060-01 (B)
Printed in U.S.A.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY

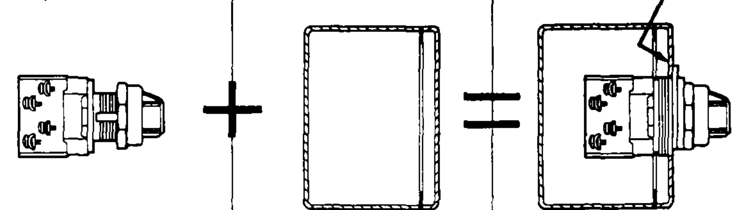
t PANEL THICKNESS EPAISSEUR DE PANNEAU STÄRKE DER TAFEL GROSOR DEL PANEL ESPESSURA DO PAINEL	N NUMBER OF GASKETS NOMBRE DE JOINTS D'ÉTANCHÉITÉ ANZAHL DER DICHTUNGEN NÚMERO DE JUNTAS NÚMERO DE JUNTAS VEDANTES
16 Gage - $^{1}/_{16}$" (1.6)	3
12 Gage - $^{7}/_{64}$" (2.8) 10 Gage - $^{9}/_{64}$" (3.6)	2
$^{3}/_{16}$" (4.8)	1
> $^{3}/_{16}$" (4.8)	(COUNTERBORE)



KNOB KEYING OPTION
OPTION DE DÉTROMPAGE DU BOUTON
WAHLWEISE KEILVERBINDUNG
OPCIÓN DE CODIFICACIÓN DEL MANDO
OPÇÃO DE ENCAIXE DO BOTÃO



PLUG (CUSTOMER SUPPLIED)
FICHE (FOURNIE PAR LE CLIENT)
STECKER (KUNDENSEITIGE LIEFERUNG)
CLAVIJA (SUMINISTRADA POR EL CLIENTE)
FICHA (FORNECIDA PELO CLIENTE)



DEVICE RATING PUISSANCE NOMINALE DU DISPOSITIF BEMESSUNG DER VORRICHTUNG RÉGIMEN DEL DISPOSITIVO GRADUAÇÃO DO INSTRUMENTO	ENCLOSURE RATING VALEUR NOMINALE DU COFFRET GEHÄUSESCHUTZGRAD REGIMEN DE LA CAJA CAPACIDADE DO COMPARTIMENTO	STATION RATING VALEUR NOMINALE DE LA STATION STATIONSLEISTUNG REGIMEN DE ESTACION CAPACIDADE DA ESTAÇÃO
800T UL LISTED: NEMA 4, 13 IP66	NEMA 1	NEMA 1
	NEMA 4	NEMA 4
	NEMA 4, 4X	NEMA 4
	NEMA 13	NEMA 13
	NEMA 4, 13	NEMA 4, 13
	IP66	IP66
	NEMA 4, IP66	NEMA 4, IP66
	NEMA 13, IP65	NEMA 13, IP65
800H UL LISTED: NEMA 4, 4X, 13 IP66	NEMA 1	NEMA 1
	NEMA 4	NEMA 4
	NEMA 4, 4X	NEMA 4, 4X
	NEMA 13	NEMA 13
	NEMA 4, 13	NEMA 4, 13
	IP66	IP66
	NEMA 4X, IP66	NEMA 4X, IP66
	NEMA 13, IP65	NEMA 13, IP65

INSTALLATION AND MOUNTING INSTRUCTIONS

BULLETIN 800T and 800H PILOT DEVICES

Bulletin 800T Devices are Rated NEMA Type 4 and 13.

Bulletin 800H Devices are Rated NEMA Type 4, 4X, and 13.

Install on a Flat, Smooth Surface of an Enclosure

Devices maintain their NEMA Type Ratings (4 and/or 4x and/or 13) only when properly mounted in an enclosure with the same rating(s).

> **WARNING:** To prevent injury, this device must be disconnected from all power sources prior to initiating work.
>
> **CAUTION:** When installing the device in a metal enclosure, maintain 1/2" (12.5) minimum clearance between exposed metal parts of contact block and enclosure.

INSTALLATION (see Figs. 1 and 2)

1. Remove the following parts from the unit:
   Lens or cap, mounting ring, thrust washer, and legend plate or trim washer.
2. Determine the correct number of gaskets to be used per the table in Fig. 1.
3. Place the unit into the mounting hole from the rear of the panel.
4. Position legend plate or trim washer and then thrust washer, with thrust washer tang engaging legend plate or trim washer and panel notches.
5. Install mounting ring and tighten against thrust washer to the following torque:
   800T device with **metal** mounting ring: **50 to 60 lb.-in. (5.6 to 6.8 N·m)**
   800H device with **plastic** mounting ring: **25 to 30 lb.-in. (2.8 to 3.4 N·m)**
6. Install lens or cap to operator.

> CAUTION: Lens or Cap must be tight against bushing to provide a tight seal.
> CAUTION: For those illuminated and pilot light devices rated for Class I Division 2 Hazardous Locations, the lens **must** be assembled to the device. **Those devices rated Class I Division 2 are marked specifically as such on the device.**

Available Mounting Accessories:

- Wrench for Octagonal Mounting Ring - **Catalog No. 800T-N245**
- Wrench for 800H Pilot Light Mounting Ring - **Catalog No. 800H-N10**
- Device Bonding Kit for 800T devices to meet the bonding requirements of CSA Standard C22.2 No. 0.4 - **Catalog No. 800T-N300**

MOUNTING INSTRUCTIONS

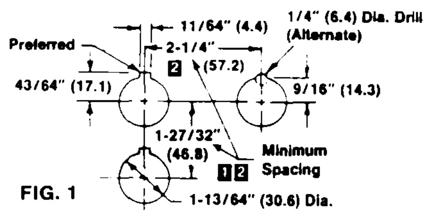


FIG. 1

1 **When jumbo Legend Plate is used, spacing is 2-1/2" (63.5).**
2 **When large (Automotive) Legend Plate is used, spacing is 2-1/2" (63.5).**

NOTE: Dimensions in parentheses are in millimeters.

GASKETS REQUIRED FOR VARIOUS PANEL THICKNESSES

	Products with octagonal mounting rings	Pilot lights with knurled mounting rings
Panel Thickness	Panels thicker than 3/16" (4.8) must be counterbored	Panels thicker than 1/4" (6.4) must be counterbored
16 Gage 1/16" (1.6)	3	4
12 Gage 7/64" (2.8) 10 Gage 9/64" (3.6)	2	3
3/16" (4.8)	1	2
1/4" (6.4)	—	1
Number of 1/16" (1.6) Gaskets shipped with the product	3	4

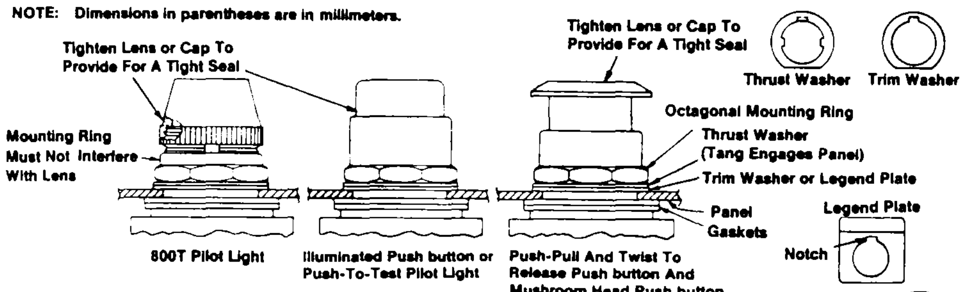


FIG. 2

LAMP REPLACEMENT: (Bayonet Base)

1. Remove Lens
2. To remove lamp: Push lamp inward, turn counterclockwise, and remove
3. To install new lamp: Insert in socket, push inward and turn clockwise (see Figure 3)
4. Reinstall Lens

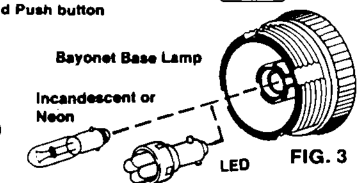


FIG. 3

(Continued on other side)

40061-052-01 (D)
Printed in U.S.A.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY

AVAILABLE ACCESSORIES FOR 800T AND 800H ILLUMINATED DEVICES

- Dual Input Module Kits: **800T-N290** (120 Vac Full Voltage) Power module and lamp
  800T-N291 (24 Vac Full Voltage) Power module and lamp
  800T-N296 (120 Vac Transformer Type) Relay module.
  CAUTION: 800T-N296 is not rated for Class I Division 2 Hazardous Location.
- Flashing Lamp (6 V): **800T-N212** Available for any illuminated device which uses the ANSI No. 755 or No. 1866 lamp.
- Lamp Installer: **800T-N82** Useful for installation or replacement of incandescent lamps
- LED Lamps and Power Modules for extended lamp life:
  (Consult A-B Catalog for ordering information)

CONTACT BLOCKS FOR 800T AND 800H PUSHBUTTONS

CAUTION: Only Sealed Switch and Logic Reed Blocks may be used on devices rated for Class I, Division 2 Hazardous Locations.

The contact blocks listed below may be mounted in various combinations on an operator.
Two Tiers High Maximum (for mounting instructions see contact block instruction sheet)
- Illuminated Pushbutton Operators Accept One (1) or Two (2) Contact blocks
- Non-Illuminated Pushbutton Operators Accept One (1) to Four (4) Contact blocks

Standard Block Cat. No. 800T-	Mini-Block Cat. No. 800T-	Sealed Switch Block Cat. No. 800T-	Logic Reed Block Cat. No. 800T-	Number of Contacts
XA	—	XAP [3]	XAR	1 N.O.-1 N.C.
XA1	—	—	—	1 N.O.-1 N.C. (Late Break)
XA2 [1]	—	—	XA2R	2 N.O.
XA4	—	—	XA4R	2 N.C.
XA7	—	—	—	1 N.C.-1 N.C. (Late Break)
XD1	XD5 [2]	XD1P [3]	XD1R	1 N.O.
XD2	XD6 [2]	XD2P [3]	XD2R	1 N.C.
XD3	—	—	—	1 N.O. (Early Make)
XD4	—	—	—	1 N.C. (Late Break)
Series C or later	**Series B or later**	**Series E or later**	**Series A or later**	

N.O. = Normally Open **N.C. = Normally Closed**

[1] **800T-XA2 contact blocks must be used only on the second level if stacked.**
[2] **Mini-blocks may be used on the second level only.**
[3] **Sealed Switch blocks are not stackable and may be used one tier high maximum.**

FIG. 4

CONTACT TARGET TABLE

To determine the contact targets of Allen-Bradley 800T and 800H Momentary Pushbuttons, 2 and 3 position Push-Pull Pushbuttons, and 2 position Twist-release Pushbuttons, proceed as follows:
1. Identify the **CONTACT BLOCK** used by looking at the contact block cover plate and finding a Catalog No. such as 800T-XA.
2. Identify the **CIRCUIT** for which the contact target is desired by looking again at the contact block cover plate for a wiring symbol such as "A", "B", "A1", etc.
3. Refer to Fig. 5 and find the contact block and wiring symbol.
   Read across the top to find the Lens or Cap position. (IN, CENTER, or OUT)
   The contact target is at the intersection of the contact block row and position column.

2 Circuit Contact Block Cat. No. 800T-	Single Circuit Contact Block Cat. No. 800T-	Normal Circuit Operation	Wiring Symbol	OUT Position	CENTER Position [4]	IN Position
XA, XAR, XAP	XD2, XD6 XD2R, XD2P	NC	B	X	O	O
	XD1, XD5 XD1R, XD1P	NO	A	O	O	X
XA1	XD4	NCLB [5]	BZ1	X	X	O
	XD1, XD5 XD1R, XD1P	NO	A2	O	O	X
[1] XA2, XA2R	XD1, XD5 XD1R, XD1P	NO	A1	O	O	X
	XD1, XD5 XD1R, XD1P	NO	A2	O	O	X
XA4, XA4R	XD2, XD6 XD2R, XD2P	NC	B1	X	O	O
	XD2, XD6 XD2R, XD2P	NC	B2	X	O	O
XA7	XD4	NCLB [5]	BZ1	X	X	O
	XD2, XD6 XD2R, XD2P	NC	B2	X	O	O
—	XD3	NOEM	AZ	O	X	X
—	XD4	NCLB [5]	BZ	X	X	O

[4] **3 position Push-Pull Only**
[5] Using the NCLB Contact function on 2 position Push-Pull and 2 position Twist-Release causes the following:
- When the button is pushed from the "OUT" to the "IN" position, the mechanical detent action of the operator occurs before the contacts change state
- When the button is pulled from the "IN" to the "OUT" position, the contacts change state before the mechanical detent action of the operator occurs.

Abbreviations and Symbols

NO = Normally Open   NC = Normally Closed   EM = Early Make   LB = Late Break   O = Open   X = Closed

FIG. 5

INSTRUCTIONS | BULLETIN **700** TYPE HR

Timing Relay

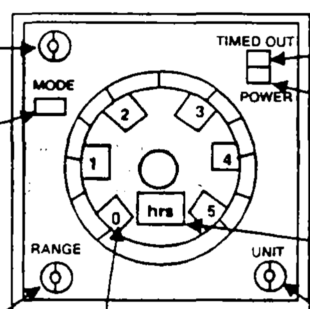
Relais Temporisé   Zeitrelais
Rele Temporizador   Relé De Tempo

HR		HRM	HRC
SA DPDT 24V DC 24V AC 100-240V AC		SA DPDT 24V DC 24V AC 100-240V AC	SA SPDT/SPDT 24V DC 100-240V AC
PO — (SIGNAL) ON DELAY SIGNAL DE DEBUT DE TEMPORISATION (SIGNAL) EINSCHALTVERZÖGERUNG RETARDO AL CONECTARSE (SEÑAL) (SINAL) COM RETARDAMENTO FL — FLICKER (REPEAT CYCLE) CLINGOTEMENT (RÉPÉTER CYCLE) FLACKER (WEIDEHOLZYKLUS) CENTELLEO (REPETIR EL CICLO) PISCA-PISCA (REPETIR CICLO)	SF — (SIGNAL) OFF DELAY SIGNAL D'ARRÊT DE TEMPORISATION (SIGNAL) AUSSCHALTVERZÖGERUNG RETARDO AL DESCONECTARSE (SEÑAL) (SINAL) SEM RETARDAMENTO OS — ONE SHOT UN COUP EINZELSCHRITT ETAPA UNICA ETAPA UNICA	ON DELAY DÉBUT DE TEMPORISATION EINSCHALTVERZÖGERUNG RETARDO AL CONECTARSE COM RETARDAMENTO	
11 PIN SOCKETS — TRACK/PANEL MOUNT SOCLE A 11 BROCHES — MONTAGE PANNEAU/RAIL STECKFASSUNG FÜR RUNDKONTAKT 11-POLIG — SCHIENEN-/SCHALTTAFELEINBAU ZOCALO 11 PIN REDONDO — MONTAJE EN PANEL RIEL SOQUETE DE 11 PINOS — MONTAGIM DE TRILHO O PAINEL	700-HN126 or 700-HN101	8 PIN SOCKETS — TRACK/PANEL MOUNT SOCLE A 8 BROCHES — MONTAGE PANNEAU/RAIL STECKFASSUNG FÜR RUNDKONTAKT. 8-POLIG — SCHIENEN-/SCHALTTAFELEINBAU ZOCALO 8 PIN REDONDO — MONTAJE EN PANEL/RIEL SOQUETE DE 8 PINOS — MONTAGIM DE TRILHO O PAINEL	700-HN125 or 700-HN100

MODE SELECTION
SÉLECTION DE MODE
AUSWAHL DER BETRIEBSART
SELECCION DE MODALIDAD
SELECAO DE DISPOSITIVO

MODE DISPLAY
AFFICHAGE DU MODE
DARSTELLUNG DER BETRIEBSART
MODALIDAD DE VISUALIZACION
DISPOSITIVO DE VISUALIZAÇÃO

PO | SF | OS | FL



TIMED OUT INDICATOR (RED)
INDICATEUR DE DÉPASSEMENT (ROUGE)
ZEITABLAUF-ANZEIGE (ROT)
INDICADOR DE TERMINACION DEL PERIODO DE TEMPORIZACION (ROJO)
INDICADOR DO TÉRMINO DA TEMPORIZAÇÃO (VERMELHO)

POWER/TIMING INDICATOR (GREEN)
INDICATEUR DU TEMPORISATEUR DE PUISSANCE (VERT)
STROM/ZEITREGELUNGS-ANZEIGE (GRÜN)
INDICADOR DE TEMPORIZACION (VERDE)
INDICADOR DA POTÊNCIA (VERDE)

UNIT DISPLAY
AFFICHAGE UNITÉ
DARSTELLUNG DER EINHEIT
VISUALIZACION DE LA UNIDAD
VISUALIZAÇÃO DA UNIDADE

SEC | MIN | HRS | 10H

RANGE SELECTION
SELECTION DE GAMME
AUSWAHL DES BEREICHES
SELECCION DEL RANGO
SELEÇÃO DE OPÇÃO

RANGE DISPLAYS
AFFICHAGE GAMME
DARSTELLUNG DES BEREICHES
VISUALIZACION DEL RANGO
VISUALIZACAO DA OPCAO

UNIT SELECTION
SELECTION D'UNITE
AUSWAHL DER EINHEIT
SELECCION DE UNIDAD
SELEÇÃO DE UNIDADE

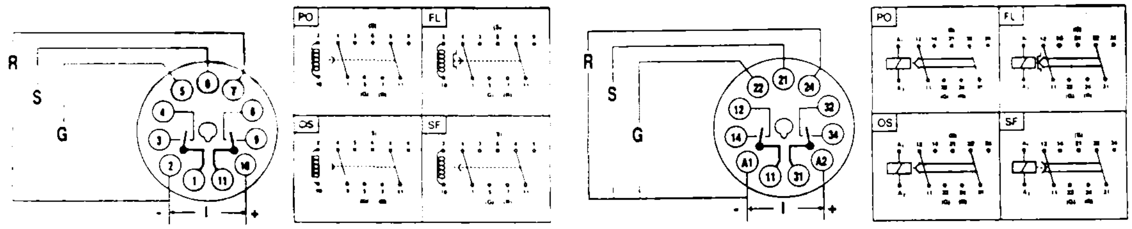
UNIT	RANGE			
SEC	0.05 - 0.5s	0.1 - 1.0s	0.5 - 5.0s	1.0 - 10s
MIN	0.05 - 0.5m	0.1 - 1.0m	0.5 - 5.0m	1.0 - 10m
HRS	0.05 - 0.5h	0.1 - 1.0h	0.5 - 5.0h	1.0 - 10h
10H	0.5 - 5.0h	1.0 - 10h	5.0 - 50h	10 - 100h

WARNING: To prevent electrical shock, disconnect from power source before installing or servicing.
AVERTISSEMENT: Préalablement à l'installation et aux opérations de service, couper l'alimentation secteur pour empêcher tous chocs électriques.
WARNUNG: Vor Installation oder Servicearbeiten Stromversorgung zur Vermeidung von elektrischem Schlag unterbrechen.
ADVERTENCIA: Desconecte la corriente eléctrica antes de la instalación o servicio para evitar descargas eléctricas.
ADVERTÊNCIA: Para evitar choques, desligar a corrente elétrica antes de iniciar a instalacão.

40063-057-01 (D)

Publication 700 - 5.0E – November, 1991
Supersedes Publication 700 - 5.0E Dated July, 1991

HR



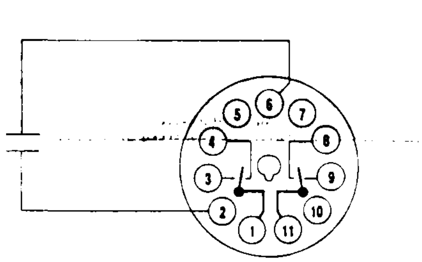
(I) Input Power (terminals ② and ⑩), Entrée, Eingang, Entrada, Entrada
- Power to terminals ② and ⑩ must be applied continuously. The time delay and output contacts reset immediately upon removal of power.
- For a DC power supply the positive (+) must be connected to terminal ⑩.

(S) Start Signal (terminals ② and ⑥), Signal De Démarrage, Startsignal, **Señal De Arranque, Sinal De Inicio**
- A signal must be applied across terminals ② and ⑥ to start the timing interval. This signal can be either momentary or maintained.

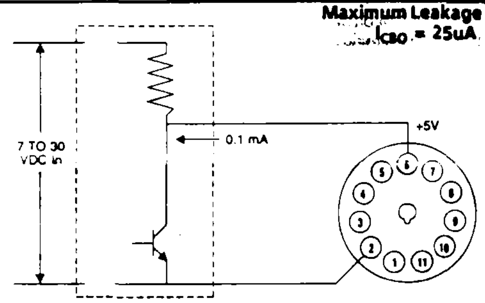
(R) Reset Signal (terminals ② and ⑦), **Signal De Réarmement, Rücksetzsignal**, Señal De Reposicion, Sinal De Rearmamento
- The reset signal is not required for normal operation. Reset can be accomplished by removing power from terminals ② and ⑩.
- To reset the timer without removing power, a signal must be applied across terminals ② and ⑦ which resets the timing cycle and returns the output contacts to their shelf state.
- The reset signal will override both the start signal and gate signal.
- The reset signal can be either momentary or maintained.

(G) Gate Signal (terminals ② and ⑤), **Signal Gate (Pause), Gate Signal (Pause), Señal De Compuerta (Pausa), Sinal De Comporta (Pausa)**
- The gate signal is not required for normal operation.
- The gate signal provides a pause or retentive timing function. When a signal is applied across terminals ② and ⑤ the timing cycle is momentarily interrupted. When the signal is removed the timing cycle resumes timing at the point the cycle was interrupted and will continue timing until the time delay is completed or the gate signal is re-applied.

CAUTION: The internal circuitry of the timer can be damaged if the input signal terminals ⑤, ⑥ or ⑦ are connected to other loads.



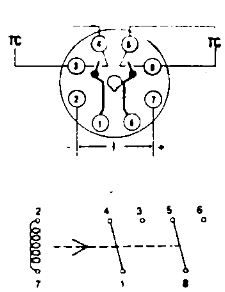
Maximum Leakage Current
I_{cbo} = 25uA

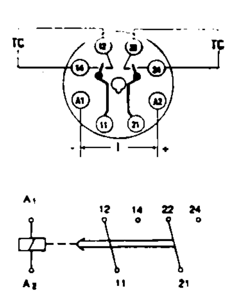


CONTACT INPUTS (R, S, G): For optimum reliability use external switches that are designed for low-level switching. (700-HC54--)
ENTREES CONTACTS (R, S, G): Pour une fiabilité maximum, utilisez des commutateurs externes prevus pour un bas niveau de commutation. (700-HC54--)
KONTAKT-EINGÄNGE (R, S, G): Für optimale zuverlässigkeit wird die benutzung von externen schaltern die für schwachstromschaltungen konstruiert wurden empfohlen. (700-HC54--)
ENTRADAS DE CONTATO (R, S, G): Para una optima confiabilidad use conmutadores externos que esten diseñados para un bajo nivel de conmutacion. (700-HC54--)
ENTRADAS DE CONTATO (R, S, G): Para perfeita confiabilidade use tomadas externas que são concebidas para baixas alterações. (700-HC54--)

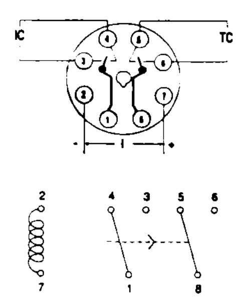
SOLID STATE SIGNAL INPUTS (R, S, G): Proximity switch, photoelectric switch, etc.
ENTRÉES DE SIGNAUX À SEMI-CONDUCTEURS (R, S, G): Commutatuer de proximité commutatuer photoélectrique etc.
FESTKÖRPER-SIGNAL-EINGÄNGE (R, S, G): Näherungsschalter, photoelektrischer schalter, etc
ENTRADAS DE SEÑAL TRANSISTORIZADAS (R, S, G): Conmutador de proximidad, conmutador fotoelectrico, etc.
ENTRADAS DE SINAL TRANSISTORIZADOS (R, S, G): Tomada de proximidade, tomada fotoélectrica, etc.

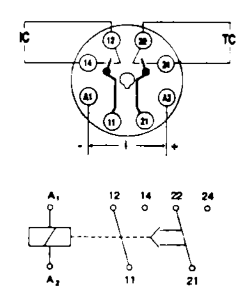
HRM





HRC



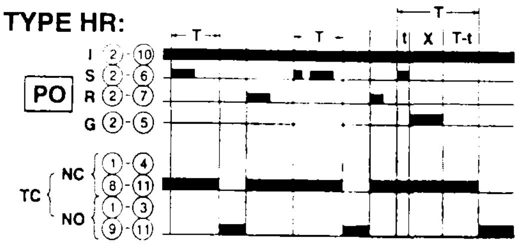


(I) Input Power (terminals ② and ⑦), Entrée, Eingang, Entrada, Entrada
- Power to terminals ② and ⑦ must be applied continuously. The time delay and output contacts reset immediately upon removal of power.
- For a DC power supply the positive (+) must be connected to terminal ⑦.

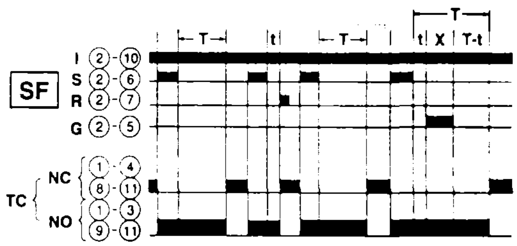
IC = **Instantaneous Contacts**, Contacts Instantanés, Sofort Ansprechende Kontakte, Contactos Instantaneos, Contactos Instantâneos
TC = Timed Contacts, Contacts Temporisés, Zeitgesteuerte Kontakte, Contactos Temporizados, Contactos Temporizados

TYPE HR:

PO

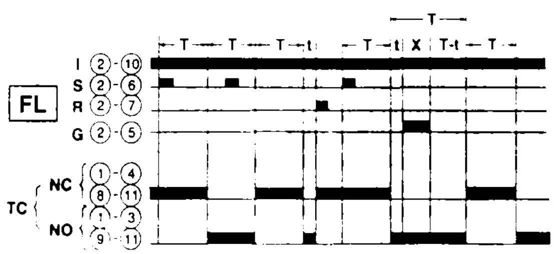


SF



OS

FL



On-Delay (PO): Input power must be applied continuously. When a start signal is applied the timing cycle begins. The output contacts change state after the time delay is completed. The contacts will return to their shelf state when a reset signal is applied or power is removed.

- The start signal can be either momentary or maintained.
- Re-applying a start signal during the timing cycle will have no effect on the time delay.
- The start signal can be eliminated by jumpering terminals ② and ⑥. The timing cycle will now begin upon application of power to terminals ② and ⑩.

Off-Delay (SF): Input power must be applied continuously. When a start signal is applied the output contacts change state immediately. When the start signal is removed the timing cycle begins. The output contacts will return to their shelf state once the time delay is completed. Reset will occur when a reset signal is applied or power is removed.

- The start signal must be maintained until the timing cycle is to begin.
- If the start signal is re-applied after the timing cycle has begun, the time delay resets and will not begin again until the start signal is removed.

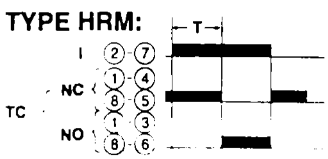
One Shot (OS): Input power must be applied continuously. When a start signal is applied the output contacts change state immediately and the timing cycle begins. The output contacts return to their shelf state once the time delay is completed. Reset will occur when a reset signal is applied or power is removed.

- The start signal can be either momentary or maintained.
- Re-applying a start signal during the timing cycle will have no effect on the time delay.
- Reapplying a start signal after the time delay is completed will start a new timing cycle (no reset is required).
- The start signal can be eliminated by jumpering terminals ② and ⑥. The time delay will now begin when power is applied to terminals ② and ⑩, similar to an "interval on" timing mode.

Repeat Cycle (FL): Input power must be applied continuously. When a start signal is applied the "off timing cycle" begins, but the output contacts remain in the shelf state. When the time delay is completed the output contacts change state and the next "on timing cycle" begins. When this time delay is completed the output contacts return to their shelf state. This sequence will repeat until a reset signal is applied or power is removed.

- The start signal can be either momentary or maintained.
- Re-applying a start signal during the timing cycle will have no effect on the time delay.
- The start signal can be eliminated by jumpering terminals ② and ⑥. The time delay will now begin when power is applied to terminals ② and ⑩.
- This is a symmetrical timing relay where the "off cycle" and "on cycle" are of equal value.

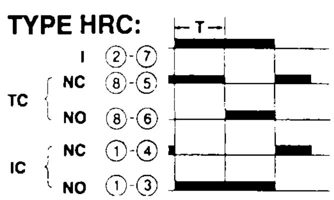
TYPE HRM:



TYPE HRM

On Delay: When power is applied to terminals ② and ⑦ the timing cycle begins. The output contacts change state after the time delay is completed. The contacts will return to their shelf state when power is removed.

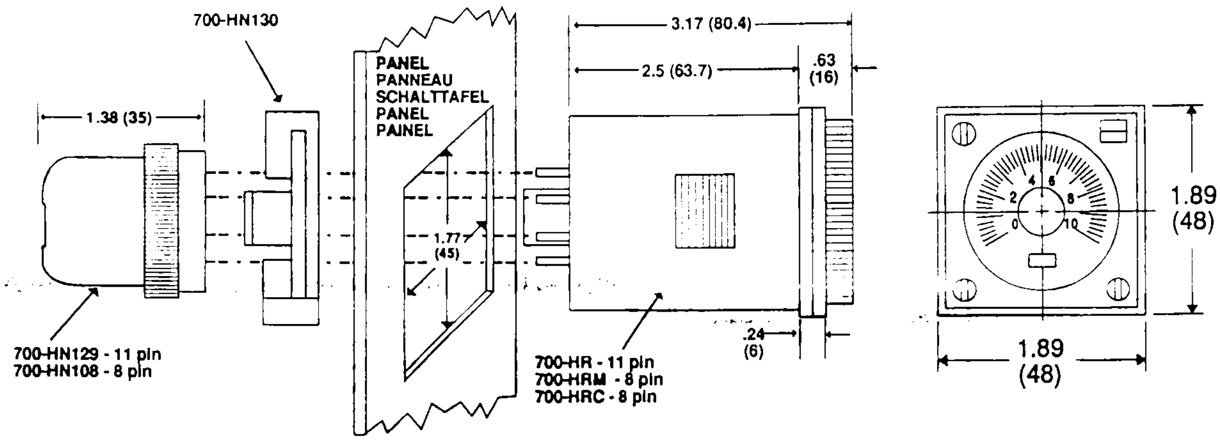
TYPE HRC:



TYPE HRC

On Delay: When power is applied to terminals ② and ⑦ the instantaneous output contacts (IC) change state and the timing cycle begins. The timed output contacts (TC) change state after the time delay is completed. All contacts will return to their shelf state when power is removed.

(T) is the set time delay.
(t) is a timing cycle less than the set time delay. (t) can reflect that a reset signal has been applied or power has been removed prior to completion of the time delay. (t) can also indicate that prior to completion of the time delay a gate signal has been applied which momentarily interrupts the timing cycle.
(T-t) is the completion of the time delay after the gate signal is removed.
(X) is the duration of the gate signal.



CAUTION:

- Do not remove timer from housing. This will invalidate product warranty.
- Remove power before changing timing range, unit or mode selection.
- The 700-HR timer utilizes a transformerless power supply. Do not touch the input terminals when power is applied.
- When 2 or more timers are controlled by the same input contact or transistor, connect the #2 terminals of the timers together.
- Recommendations for external input signal lines:
  - Use shielded wire.
  - Keep wire as short as possible.
  - Separate input signal wires from power supply for the timer and from other voltage or power lines.
- An AC timer controlled by a low voltage transistor circuit, should be supplied by an isolation transformer with the #2 terminal of the timer grounded.

ATTENTION:

- Ne pas retirer le temporisateur de son compartiment sous peine d'annuler la garantie.
- Couper le courant avant de changer la gamme de temporisation, la sélection de l'unité ou le mode.
- Le temporisateur 700-HR utilise une alimentation électrique snas transformateur. Ne pas toucher les bornes d'entrée pendant la mise sous tension.
- Les appareils d'entrée externes utilisés pour contrôler le temporisateur doivent être équipés d'un transformateur d'isolation et d'une sortie non mise à la masse.
- Lorsque 2 temporisateurs ou plus sont contrôlés par le même contact ou transistor d'entrée, connecter les bornes #2 des temporisateurs ensemble.
- Recommandations au sujet des lignes de signaux d'entrée externes:
  - Utiliser un câble blindé.
  - Le câble doit être le plus court possible.
  - Séparer les câbles des signaux d'entrée de l'alimentation électrique pour le temporisateur mais aussi des autres tensions ou lignes électriques.

VORSICHT:

- Das Zeitrelais nicht aus dem Gehäuse entfernen. Die Garantie für das Produkt wird dadurch ungültig gemacht.
- Vor Veränderungen im Zeitregelungsbereich, Auswahl einer Einheit oder Betriebsart, die Stromzufuhr unterbrechen.
- Das 700-HR Zeitrelais nutzt transformatorlose Stromversorgung. Die Eingangsklemmen nicht berühren, wenn Strom zugeführt wird.
- Die externen Eingangsgeräte, die zur Kontrolle des Zeitrelais benutzt werden, sollten mit einem Trenntrafo und einem nichtgeerdeten Ausgang ausgestattet sein.
- Wenn zwei oder mehrere Zeitrelais durch dieselben Eingangskontakte oder den Transistor kontrolliert werden, Klemmen Nr. 2 der Zeitrelais verbinden.
- Empfehlungen für die externen Eingangssignal-Leitungen:
  - Abgeschirmten Draht benutzen.
  - Den Draht so kurz wie möglich halten.
  - Eingangssignal-Leitungen vom Netzanschluss für das Zietrelais und von anderen Spannungs- oder Stromleitungen getrennt halten.

PRECAUCION:

- No saque el temporizador de su recinto. Esto invalidará la garantia del producto.
- Desconecte la energia antes de cambiar el rango de temporización, la selección de modalidad o de la unidad.
- El temporizador 700-HR usa un suministro eléctrico sin transformador. No toque los bornes de entrada cuando la energia esté conectada.
- Los dispositivos de entrada externos usados para controlar el temporizador deben estar equipados con un transformador aislador y una salida sin conexión a tierra.
- Cuando 2 o màs temporizadores estén controlados por el mismo transistor o contacto de salida, conecte los bornes #2 de los temporizadores juntos.
- Recomendaciones para lineas externas de señal de entrada:
  - Use Cable blindado.
  - Mantega el cable tan corto como sea posible.
  - Separe los cables de señal de entrada de los del suminstro eléctrico para el temporizador y los de otros voltajes o lineas eléctricas.

ATENÇÃO:

- Não remova temporizador da embalagem. Isto invalidará a garantia do produto.
- Desligar energia antes de alterar a temporização, a seleção de modalidade e da unidade.
- O temporizador 700-HR utiliza um transformador para a energia. Não toque os terminais da entrada quando energia é ativada.
- Os dispositivos de entrada externa devem ser equipados com transformador isolante e saida sem conexão terra.
- Quando 2 ou mais temporizadores são controlados pelo mesmo contato de entrada ou transistor, conectar, juntos, os terminais #2 dos temporizadores.
- Recomendação para linhas externas de sinal de entrada:
  - Use fio encapado.
  - Mantenha o fio tão curto o quanto for possivel.
  - Separe os fios de sinal de entrada dos elétricos do temporizador e dos outros elétricos ou de voltagem diferentes.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
Industrial Control Group
Milwaukee, Wisconsin 53204

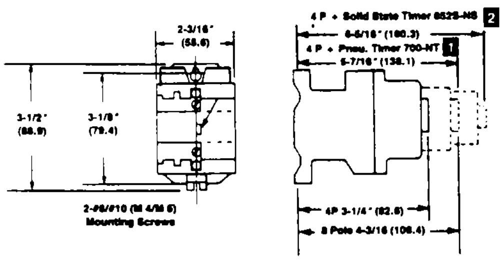
– Instructions –
Bulletin 700 • Type N • AC Relays

NOTE: Save this sheet for future use.

CAUTION

1. Disconnect power before servicing.
2. Retighten screws securely to specified torque.
3. Check for proper reassembly. Red bar is flush with cover when de-energized. Red bar or metal push-to-test tab on time delay unit must move freely through 9/64" (3.6) stroke when manually operated.
4. Use suitable enclosure to protect the contacts and magnet pole faces from dust, dirt, lint, oil mists, water or other contaminants. Do not spray solvent type contact cleaners into installed cartridges.
5. Do not apply oil, grease, rust inhibitors, or any spray to the magnet pole faces. Resulting films or residues could cause magnet sticking.

Installation



NOTE: Dimensions shown in parenthesis are in millimeters.

Type N relays are designed for two-point mounting on a vertical panel with coil terminals upward.

Self-lifting Terminal Clamps accept the following:

- Two #12 AWG (4.0 mm²) solid or stranded copper wire max. to one #18 AWG (0.75 mm²) min. Use a Strip Length of 5/16" (7.9)
- Two ring terminals — 21/64" max. tongue width or smaller (8.3 max.). Hole for a #6 Screw.
- Three ring terminals — long tongue type (AMP #33173 or equivalent)

Mounting Strip

Accessory mounting strips accomodate 4, 8, 12 or 16 relays and can be sawed to intermediate lengths.

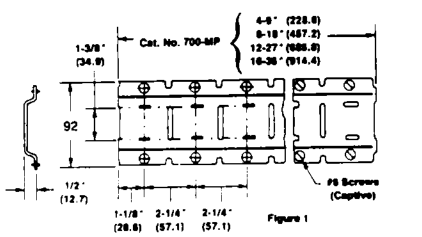


Figure 1

1.1 Mount strips horizontally with #8 screws, with at least one screw at each end and in an alternating upper and lower horizontal pattern with 2-1/4" (57.1) or 4-1/2" (114.2) spacing. If #10 screws are used, spacing may be increased to 6-3/4" (170.6).

1.2 Tighten #8 staked mounting strip screws securely 14-20 lb-in. (1.6-2.3 N·m).

1.3 Tighten unused screws in vacant positions to 7-14 lb-in. (.8-1.6 N·m) to resist loosening and falling out due to vibration.

1 NOTE: Relays field modified with any accessories described retains U.L. Listing and CSA Certification. See Tables 1 & 2.

2 NOTE: See Catalog for Range Designation & Options.

Contact Cartridges

Accessory contact cartridges are individually stamped on the side for identification. Factory-installed units, when not stamped, can be identified by the colors of component parts. See Table 1.

Table 1

Accessory Contact Cartridges 1					
Type of Contact Cartridge	Catalog No. Rear Deck	Catalog No. Front Deck	Color of Housing	Color of Spanner Guide	Plating on Terminal
Standard	700-C1	700-C2	Lt. Gray	White	Silver
Gold Plated	700-C1X	700-C2X	Lt. Gray	White	Gold
Bifurcated	700-C1B	700-C2B	Dk. Gray	White	Silver
Overlap	700-C11Z	700-C22Z	Lt. Gray	Black	Silver
Logic Reed	700-C1R	—	White	White	Gold
Pneu. Timer	[illegible]		Tan	White	Silver

- Gold plated contact cartridges. Tab and contact symbol one end only. Resist tarnish films. In absence of environmental dirt they provide higher reliability than standard cartridge below 24 volts.
- Bifurcated contact cartridge. Lightweight movable contact provides better shock and vibration resistance.
- Overlap contact cartridges. Sold in pairs. Tab and contact symbol one end only. Convertible to Early Make N.O. or Late Break N.C. Use together for overlap. DC rating is 125 volts maximum.
- Logic reed contact cartridge. Hermetically sealed contact for greater reliability in low energy switching. Rear deck only. Resistive rating:

AC 150V Max., 150 mA Max., 8 VA Max.
DC 30V Max., 60 mA Max.

Converting Contacts

To convert contacts (N.O. ⇄ N.C.):

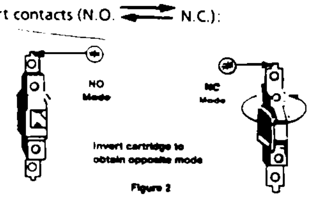


Figure 2

2.1 Remove cover (or front mounted accessory) with its two captive screws.

2.2 Remove terminal screws of cartridge.

2.3 Remove, invert and reinstall cartridge and terminal screws. Figure 2.

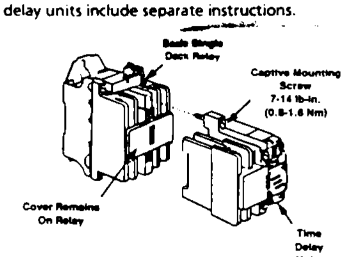
2.4 Replace cover (or accessory) and tighten screws securely.

IMPORTANT

- Front cartridges, Rear cartridges, and Pneu. Timer cartridges are *not* interchangeable.
- Vacant positions in rear deck must contain a white dummy plunger (Renewal part F27185) to maintain design pick-up voltage.

Adding A Time-Delay Unit

Time delay units include separate instructions.



1 Pneumatic: Cat. No. 700-NT
Solid State: Cat No. 852S 2

Table 2

Other Accessory Kits 1	Cat. No.
Jumper for Middle Pole to Outer Pole	700-N3
Jumper for Middle Poles	700-N4
Surge Suppressor (Terminal Mounted)	700-N24
Surge Suppressor (Mounted under relay)	700-N5
Check-Out Tool	700-N21

Adding A Front Deck

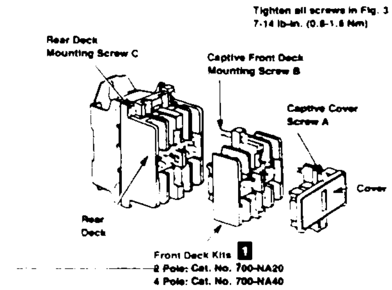


Figure 3

3.1 Remove cover and two captive screws A.

3.2 Convert any **Rear** deck cartridges to N.C.

3.3 Position front deck on relay. Note that a keying provides orientation. Tighten the captive mounting screws B securely.

3.4 Convert any **Front** deck cartridges to N.C.

3.5 Reinstall cover (note keying) and tighten the two captive cover screw A securely.

Coil Or Yoke And Armature Replacement

4.1 Pry coil outward with screwdriver in slot between coil terminals Fig. 4.

4.2 Grasp magnet assembly as coil is removed so that loose parts do not separate and fall.

4.3 Select replacement coil and/or yoke and armature assembly. See Renewal Parts Publication 700-6.11.

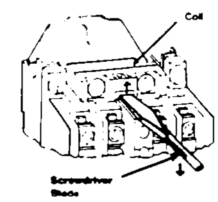


Figure 4

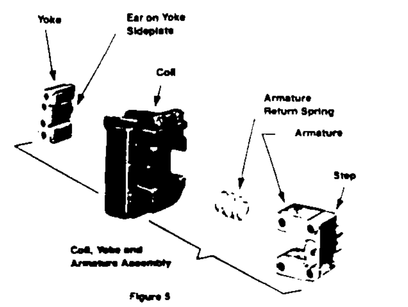


Figure 5

4.4 Reassemble replacement parts. Figure 5
- Be sure spring is seated between armature and coil.
- Orient yoke so that ear on sideplate nests in recess in bottom of coil.
- Orient armature with step adjacent to coil terminals.

4.5 While holding parts together, slide the assembly into the mounting base until the unit locks into place.

4.6 Manually check for proper operation by depressing red center bar with screwdriver through 9/64" (3.6) stroke.

IMPORTANT

If the coil is inserted in the base without the armature and yoke in place, it cannot be withdrawn without damaging the cartridge tips. Remove rear deck with its four captive screws C, Figure 3, to free the coil. Upon reassembly, tighten screws securely.

40061-022-01 (B)
Printed in U.S.A.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY

ACTUATOR COLOR	CONTACT BLOCK 800T-	SINGLE CIRCUIT OR OPTIONAL	NORMAL CIRCUIT OPERATION	WIRING SYMBOL	CAM CODE AND KNOB POSITIONS ❶														
					A1	A7	B7	C1	C7	D7	E7 ❷	Q1	Q7	R1 ❷	R7 ❷	T1 ❷	T7 ❷	U7 ❷	W1
WHITE	XA, XAR, XAP	XD2 or XD6 XD2R, XD2P	NC	B	OXO	OXO	OOX	OXO	OXO	OXO	OXX	OXO	OXO	OXO	OXO	XOO	OOX	OXO	OXO
		XD1 or XD5 XD1R, XD1P	NO	A	XOO	OOX	XOO	OOX	XOO	OOX	XOO	XOX	XOX	XOX	XOX	OOX	XOO	XOO	XOX
	XA1	XD4	NCLB	BZ1	OXX	XXO	OXX	XXO	OXX	XXO	OXX	OXO	OXO	OXO	OXO	XXO	OXX	OXX	OXO
		XD1 or XD5 XD1R, XD1P	NO	A2	XOO	OOX	XOO	OOX	XOO	OOX	XOO	XOX	XOX	XOX	XOX	OOX	XOO	XOO	XOX
	❸ XA2, XA2R	XD1 or XD5 XD1R, XD1P	NO	A1	XOO	OOX	XOO	OOX	XOO	OOX	XOO	XOX	XOX	XOX	XOX	OOX	XOO	XOO	XOX
		XD1 or XD5 XD1R, XD1P	NO	A2	XOO	OOX	XOO	OOX	XOO	OOX	XOO	XOX	XOX	XOX	XOX	OOX	XOO	XOO	XOX
	XA4, XA4R	XD2 or XD6 XD2R, XD2P	NC	B1	OXO	OXO	OOX	OXO	OXO	OXO	OXX	OXO	OXO	OXO	OXO	XOO	OOX	OXO	OXO
		XD2 or XD6 XD2R, XD2P	NC	B2	OXO	OXO	OOX	OXO	OXO	OXO	OXX	OXO	OXO	OXO	OXO	XOO	OOX	OXO	OXO
	XA7	XD4	NCLB	BZ1	OXX	XXO	OXX	XXO	OXX	XXO	OXX	OXO	OXO	OXO	OXO	XXO	OXX	OXX	OXO
		XD2 or XD6 XD2R, XD2P	NC	B2	OXO	OXO	OOX	OXO	OXO	OXO	OXX	OXO	OXO	OXO	OXO	XOO	OOX	OXO	OXO
	XD3	—	NOEM	AZ	XOX	XOX	XXO	XOX	XOX	XOX	❷	XOX	XOX	❷	❷	❷	❷	❷	XOX
	XD4	—	NCLB	BZ	OXX	XXO	OXX	XXO	OXX	XXO	OXX	OXO	OXO	OXO	OXO	XXO	OXX	OXX	OXO
BLACK	XA, XAR, XAP	XD2 or XD6 XD2R, XD2P	NC	B	OXO	OXO	OOX	XOO	OOX	OXO	XXO	OXO	OXO	XXO	OXX	XXO	OXX	XXO	OOX
		XD1 or XD5 XD1R, XD1P	NO	A	XOO	OOX	XOO	OOX	XOO	XOO	OOX	OOX	XOO	OOX	XOO	OOX	XOO	OOX	XOO
	XA1	XD4	NCLB	BZ1	OXX	XXO	OXX	XXO	OXX	OXX	XXO	XXO	OXX	XXO	OXX	XXO	OXX	XXO	OXX
		XD1 or XD5 XD1R, XD1P	NO	A2	XOO	OOX	XOO	OOX	XOO	XOO	OOX	OOX	XOO	OOX	XOO	OOX	XOO	OOX	XOO
	❸ XA2, XA2R	XD1 or XD5 XD1R, XD1P	NO	A1	XOO	OOX	XOO	OOX	XOO	XOO	OOX	OOX	XOO	OOX	XOO	OOX	XOO	OOX	XOO
		XD1 or XD5 XD1R, XD1P	NO	A2	XOO	OOX	XOO	OOX	XOO	XOO	OOX	OOX	XOO	OOX	XOO	OOX	XOO	OOX	XOO
	XA4, XA4R	XD2 or XD6 XD2R, XD2P	NC	B1	OXO	OXO	OOX	XOO	OOX	OXO	XXO	OXO	OXO	XXO	OXX	XXO	OXX	XXO	OOX
		XD2 or XD6 XD2R, XD2P	NC	B2	OXO	OXO	OOX	XOO	OOX	OXO	XXO	OXO	OXO	XXO	OXX	XXO	OXX	XXO	OOX
	XA7	XD4	NCLB	BZ1	OXX	XXO	OXX	XXO	OXX	OXX	XXO	XXO	OXX	XXO	OXX	XXO	OXX	XXO	OXX
		XD2 or XD6 XD2R, XD2P	NC	B2	OXO	OXO	OOX	XOO	OOX	OXO	XXO	OXO	OXO	XXO	OXX	XXO	OXX	XXO	OOX
	XD3	—	NOEM	AZ	XOX	XOX	XXO	OXX	XXO	XOX	❷	XOX	XOX	❷	❷	❷	❷	❷	XXO
	XD4	—	NCLB	BZ	OXX	XXO	OXX	XXO	OXX	OXX	XXO	XXO	OXX	XXO	OXX	XXO	OXX	XXO	OXX

❶ – The slanted lines represent the knob positions.

❷ – Noted cams cannot be used with metal wing lever operators or XD3 contact blocks because inertia upon spring return may cause unintended contact action.

❸ XA2 contact blocks must be used only on the 2 ND level if stacked

Abbreviations and Symbols

NO = Normally Open
NC = Normally Closed
LB = Late Break
EM = Early Make
X = Closed
O = Open
N/A = Not Available

CONTACT TARGET TABLE FOR 3 POSITION SELECTOR SWITCHES

To determine the contact targets of Allen-Bradley three position selector switches, proceed as follows:

1. Determine on which **SIDE** of the selector switch the contact block is mounted: **WHITE** or **BLACK**. On the back of the selector switch is a molded plastic cover. On this cover is a nameplate indicating Catalog No. of the operator and location of side 1 (white actuator). Side 2 (black actuator) is the opposite side.
2. Identify the **CONTACT BLOCK** used by looking at the contact block cover plate and finding a Catalog No., such as 800T-XA.
3. Identify the **CIRCUIT** for which the contact target is desired by looking again at the contact block cover plate for a wiring symbol such as "A", "B", "A1", etc.
4. Identify the **CAM** used by looking again at the nameplate on the molded plastic cover on the back of the selector switch operator. The Catalog No., with exceptions listed below, contains the cam identification following the flag letter "K".

   Example Catalog Nos.: 800T-J2K**A1** or 800H-JR2K**A1**

   The **A1** is the cam identification (there may be digits following).

   Exceptions: Selector switches where a special cam was **not** specified. On standard maintained and spring return three position, a **B7** cam is used.

   Example Catalog Nos. of standard selector switches: 800T-J2A, 800T-J17C, 800T-J2B, 800T-J42B.
5. Refer to the table on the reverse side and find the actuator color, contact block, and wiring symbol. Read across the top to find the cam and knob position. Where these two columns intersect will be the contact target.

40060-259-03 (F)
Printed in U.S.A.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY

AMERICAN COLLOID

Technical Data Sheet

DEC 28 1990

ENGINEER DISTRICT - ST. PAUL

AMERICAN COLLOID COMPANY

Water/Mineral Division

SEE ATTACHED COMMENTS

APPROVED SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.

4

DEC 28 1990

U.S. ARMY ENGINEER DISTRICT - ST. PAUL

By Mark E Koening

Volclay Tablets

Drill Hole Seal—¼″ and ½″ dia. sizes

Product Information

GENERAL DESCRIPTION

A pre-formed compressed tablet made of high swelling sodium bentonite. Forms a flexible, permanent, non-toxic seal where water flows and hydrostatic pressures are involved. The ½″ dia. tablets are used for general purpose sealing while the ¼″ tablets are sized for tight annulus spaces.

PACKAGING

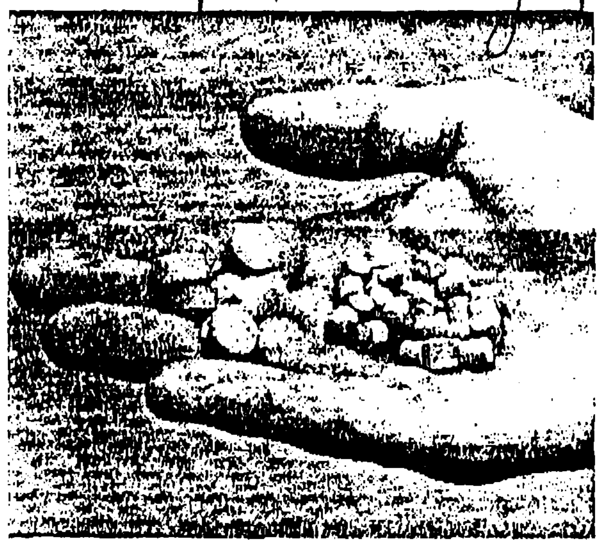
Volclay tablets are shipped in 50 lb. plastic pails for easy handling and 600 lb./55-gallon fiber drums.

PROPERTIES OF VOLCLAY TABLETS

- Increased hardness and density provides better settling characteristics. Can be placed in a dry or wet borehole with the same ease as pea gravel.
- Volclay Tablets swell 10 to 15 times their dry volume when hydrated with fresh water. The performance can be affected by water quality.
- Will provide an in place expansive seal.
- Will not shrink or crack with time.

FUNCTIONS OF VOLCLAY TABLETS

- Seal all types of piezometers.
- Seal surface casing for water wells and well pits.
- Provide an intermediate seal preventing interaquifer transfer.
- Seal at the upper most aquifer and prevent entrance of surface water into aquifer.
- Seal abandoned wells maintaining aquifer yield and artesian head.



PHYSICAL PROPERTIES

- ¼″ SP.G. = 1.269, ½″ SP.G. = 1.1949
- Composition: Bentonite—a hydrous silicate of alumina comprised essentially of the clay mineral montmorillonite.
- Purity: Montmorillonite content about 90% minimum. Contains small portions of feldspar, biotite, selenite, etc.
- pH: 8.5 to 10.5
- Dry Bulk Density: 80 lb./ft^3 for ¼″ dia. tablets; 75 lb./ft^3 for ½″ tablets.

Volclay Tablets Reference Table

Weight of Volclay Tablets required for a borehole seal with a depth of 1 ft.

1/4″	2″	3″	4″	5″	6″	7″	8″	9″	10″
	1.66	3.75	6.66	10.41	15	20.4	26.6	33.75	41.06
1/2″	2″	3″	4″	5″	6″	7″	8″	9″	10″
	1.77	4	7.11	11.11	16	21.77	28.44	36	44.44

1600 W. Shure Drive • Arlington Heights, Illinois 60004-1434 • (312) 392-4600

Drilling Fluid & Grout Products

AMERICAN COLLOID COMPANY
Water/Mineral Division

NO CORRECTIONS
TO THE PROVISIONS OF
THE SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig
SEE ATTACHED COMMENTS

12/09/88

VOLCLAY TABLETS

BENTONITE HOLE SEALING TABLETS IN 1/4", 3/8" AND 1/2" DIAMETER SIZE

DESCRIPTION: Volclay tablets are organic free, high-swelling 100% pure sodium bentonite. The tablets are compressed into 1/2", 3/8" and 1/4" in diameters.

RECOMMENDED USE: Volclay tablets are designed for use in the groundwater monitoring industry. They form a chemically resilient, low permeable, flexible seal. The tablet will isolate screened intervals of monitoring wells and provide an excellent seal for abandoned boreholes. The 1/4" tablets are ideal for providing seals in tight annular spaces while the 3/8" and 1/2" tablets are useful for larger borehole sealing.

CHARACTERISTICS:

- Chemically stable, results from EP Toxicity Metals Analysis are below RCRA limits for hazardous constituents
- Permeability range of 1×10^{-7} to 1×10^{-9} cm/sec
- High swell capacity, tablets swell 10 to 15 times their dry volume when hydrated with fresh water
- Self sealing, remains flexible when saturated and will rehydrate

APPLICATION:

For shallow applications Volclay tablets should be added slowly and steadily to prevent blocking and bridging. For deep applications tablets may be tremied into place. Tablets are added and water is pumped down the tremie pipe delivering the tablets to the desired depth quickly and accurately.

PACKAGING: Volclay tablets are shipped in 50 lb. plastic pails, 36 pails per pallet and stretch-wrapped. Tablets may also be purchased in 600 lb./55 gallon fiber drums.

1500 W. Shure Drive • Arlington Heights, Illinois 60004-1434 • (312) 392-4600

SEE ATTACHED COMMENTS

...ECT TO CORRECTIONS
...TO THE PROVISIONS OF
THE SPECIFICATIONS.

A
DEC 28 1990

U.S. ARMY ENGINEER DISTRICT - ST. PAUL

By Mark E. Koenig

AMERICAN COLLOID COMPANY

One North Arlington • 1500 West Shure Drive
Arlington Heights, Illinois 60004-1434 • USA
(312) 392-4600 • Telex ITT 4330321
Fax (312) 506-6199

51401
5141

MATERIAL SAFETY DATA SHEET - May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

PRODUCT NAME: 1/2" VOLCLAY TABLETS

Section I MANUFACTURER'S INFORMATION

Manufacturer's Name & Address:

American Colloid Company
1500 West Shure Drive
One North Arlington
Arlington Heights, Illinois 60004

Emergency Telephone Number: 312-392-4600
Telephone Number for Information: 312-392-4600
Date Prepared: August 31, 1988

Section II HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components (Specific Chemical Identity: Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Crystalline Quartz CAS# 14808-60-7	-	-	*	2-6%
Total Dust (Quartz)	$\frac{30mg/m^3}{\%SiO_2+2} = 3mg/m^3$	-	-	-
Respirable Crystalline Quartz				
present (TWA)	$\frac{10mg/m^3}{\%SiO_2+2} = 1mg/m^3$	$0.1mg/m^3$ TWA	NIOSH $50ug/m^3$ TWA	<2%
proposed (TWA)	$0.1mg/m^3$	$50ug/m^3$ TWA	-	-
Total Nuisance Dust	$15mg/m^3$	$10mg/m^3$	-	-
Respirable Nuisance Dust	$5mg/m^3$	$5mg/m^3$	-	-

* WARNING:
This clay product contains a small amount of crystalline silica which may cause delayed respiratory disease if inhaled over a prolonged period of time. Avoid breathing dust. Use NIOSH/MSHA approved respirator where TLV for crystalline silica may be exceeded. IARC Monographs on the evaluation of the Carcinogenic Risk of Chemicals to Humans (volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

PRODUCT IDENTIFICATION

Chemical Name: Bentonite Clay
Chemical Family: Natural Mineral, Montmorillonite
CAS No.: 1302-78-9
FORMULA: Naturally occurring hydrated aluminosilicate of sodium, calcium, magnesium, and iron
NFPA/HMIS: Health - 0, Fire - 0, Reactivity - 0, Specific Hazard - See Section VI
Dot Class: Not Regulated

...ECT TO CORRECTIONS
...TO THE PROVISIONS OF
...SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
Mark E. Koenig

SEE ATTACHED COMMENTS

AMERICAN COLLOID COMPANY

One North Arlington • 1500 West Shure Drive
Arlington Heights, Illinois 60004-1434 • USA
(312) 392-4600 • Telex ITT 4330321
Fax (312) 506-6199

51401
5141

PRODUCT NAME: 1/2" VOLCLAY TABLETS

Section III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	- Not Applicable	Specific Gravity (H_2O = 1)	- 2.5
Vapor Pressure (mm Hg.)	- Not Applicable	Melting Point	- Not Applicable
Vapor Density (AIR = 1)	- Not Applicable	Evaporation Rate (Butyl Acetate = 1)	- Not Applicable
Solubility in Water	- Negligible		
Appearance and Odor	- Pale grey to buff tablets, odorless		

Section IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used) - Not Applicable
Flammable Limits - Not Applicable LEL- - UEL- -
Extinguishing Media - Not Applicable
Special Fire Fighting Procedures - Inorganic Mineral/Non-Flammable
Unusual Fire and Explosion Hazards - Not Applicable

Section V REACTIVITY DATA

Stability Unstable - Conditions to Avoid - None Known
Stable - X

Incompatibility (Materials to Avoid) - None Known
Hazardous Decomposition or By-products - None Known

Hazardous Polymerization May Occur - Conditions to Avoid - None Known
Will Not Occur - X

Section VI HEALTH HAZARD DATA

Route(s) of Entry: Inhalation? Yes Skin? No Ingestion? No

Health Hazards (Acute and Chronic) - May cause delayed respiratory disease if dust inhaled over a prolonged period of time.

Carcinogenicity: NTP? No IARC Monographs? Yes OSHA Regulated? No

IARC Monographs on the evaluation of the Carcinogenic Risk of Chemicals to Humans (volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

Signs and Symptoms of Exposure - Excessive inhalation of dust may result in shortness of breath and reduced pulmonary function.

Medical Conditions Generally Aggravated by Exposure - Individuals with pulmonary and/or respiratory disease including but not limited to asthma and bronchitis should be precluded from exposure to dust.

Emergency and First Aid Procedures - Eyes - Flush with water.
- Gross inhalation of dust - Remove to fresh air; give oxygen or artificial respiration if necessary; get medical attention.

AMERICAN COLLOID COMPANY

One North Arlington • 1500 West Shure Drive
Arlington Heights, Illinois 60004-1434 • USA
(312) 392-4600 • Telex ITT 4330321
Fax (312) 506-6199

51401
5141

PRODUCT NAME: 1/2" VOLCLAY TABLETS

Section VII PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken in Case Material is Released or Spilled - Vacuum if possible to avoid generating airborne dust. Avoid breathing dust. Wear an approved respirator. Avoid adding water, the product will become slippery when wet.

Waste Disposal Method - Follow federal, state and local regulations for solid waste.

Precautions to Be Taken in Handling and Storing - Avoid breathing dust, use NIOSH/MSHA approved respirator where TLV limits for Crystalline Silica may be exceeded.

Other Precautions - Slippery when wet.

Section VIII CONTROL MEASURES

Respiratory Protection (Specify Type) - OSHA standard 1910.134 or ANSI Z88.2-1980 specification.

Ventilation - Local Exhaust - As appropriate
- Mechanical (General) - As appropriate
Protective Gloves - Not Required
Other Protective Clothing or Equipment - None Required
Work/Hygienic Practices - Use good housekeeping practices.

Special - None Required
Other - None Required
Eye Protection - Recommended

...ECT TO CORRECTIONS
...TO THE PROVISIONS OF
...SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig

SEE ATTACHED COMMENTS

Form CHEM 4-12

SEE ATTACHED COMMENTS

LEHIGH

LABORATORY TEST REPORT

LEHIGH PORTLAND CEMENT COMPANY

LEHIGH

APPROVED SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig

Consignee .... [illegible]

Address ....

Date .... [illegible]

Plant .... Mason City, IA

Cement Type .... I MHD

Car/Truck .... 1300 Tons

Bin No. 33-27F

Silo #1

RESULTS OF TESTS

CHEMICAL

SiO_2	21.6
Al_2O_3	5.1
Fe_2O_3	2.4
CaO	64.5
MgO	2.1
SO_3	3.0
Ignition Loss	0.94
Insoluble Residue	0.13
Potential Compounds:	
C_3S	53
C_2S	
C_3A	9
C_4AF	
Alkalies, Na_2O Equiv.	0.46

A
AUG 1990
RECEIVED

PHYSICAL

Fineness, Specific Surface - m^2/kg	
Wagner	
Blaine	361
Autoclave Exp. %	0.08
Time of Set: ☐ Vicat, ☒ Gillmore	
Initial (Hr: Min)	2:50
Final (Hr: Min)	4:45
Air Content %	5.8
Compressive Strength, psi:	
1-Day	
3-Day	3590
7-Day	4600
28-Day	

The material herein described has been sampled & tested as prescribed by the Hwy Div. of the IA & Minn. D.O.T. & complies with the applicable spec. requirements for Type I
Cement Bin no. 33-27F.

We certify that the above-described cement, at the time of shipment, meets the chemical and physical requirements of the current applicable specification ASTM C-150, Federal SS-C-1960/3, AASHTO M-85. We are not responsible for improper use or workmanship.

Date 08/02/90

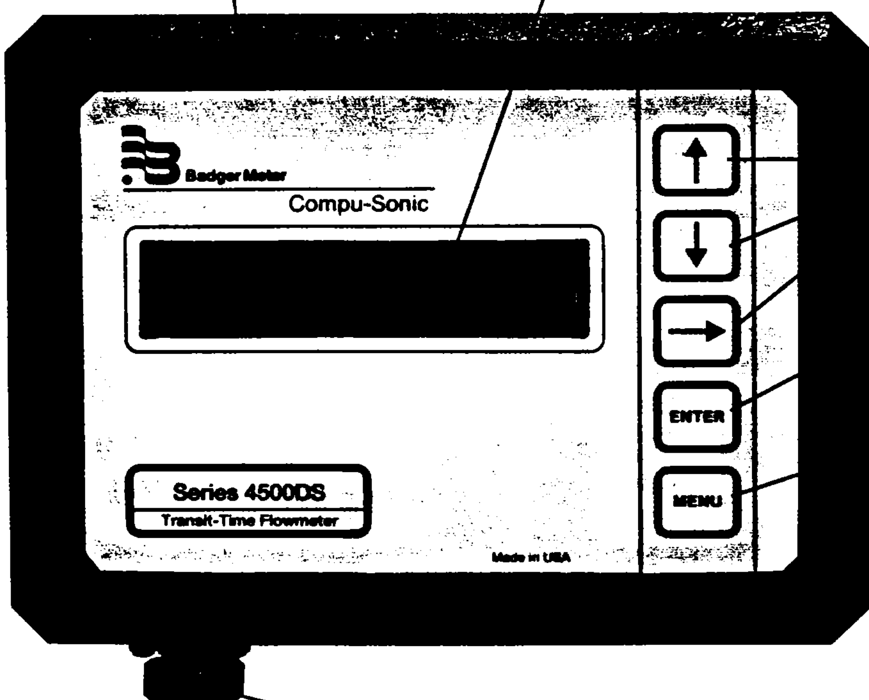
Chemist .... RJN

BADGER

Simple to Install, Simple to Operate, Highly Reliable

NEMA 4X corrosion-resistant, high density plastic housing with Cobaloy interior coating for RFI shielding. Small and lightweight, yet strong and durable.

LCD DISPLAY with large, clear alphanumeric characters makes it easy to monitor flow rate and flow totals, to check meter performance and signal quality and to insert specific inquiries. Menu-driven, using standard conversational English.



ARROW KEYS are used to raise or lower display items such as full scale flow rate, 4-20 mA signal levels, relay assignments, etc.

ENTER KEY steps through the various screens in the status and calibration modes.

MENU KEY allows the user to select meter status or calibration modes. The status screens check the meter's operating status. The calibration screens allow adjustments and calibration of various parameters such as; rescaling of full scale, 4-20 mA, zero and span calibration, etc.

BUILT-IN SERIAL PORT allows direct communication with meter programming and stored constants via hand-held computer, computer loop or modem. On-site, in-depth meter evaluation is readily achieved; and meter sizing, to adapt to alternative applications, is quickly accomplished by simple conversational commands.

Installation

- Externally mounted sensors avoid the need for process shutdowns.
- Small NEMA 4X enclosure conserves panel space.
- Template mounting guides assure proper sensor location.

Operation

- Interactive display provides operational "health" and flow data.
- Serial communication port permits de-bugging by means of hand-held minicomputer.
- Microprocessor controls eliminate mechanical settings.

Maintenance

- Non-doppler operation works on clean or dirty fluids.
- Interchangeable design minimizes spare parts inventory.
- Obstruction-free sensor design, nothing to wear or erode.

System Description

General

The Series 4500 Compu-Sonic is a transit-time ultrasonic flowmeter designed for accurate and reliable measurement of process water, influent/effluent, and industrial flows in full pipe applications.

The Series 4500 can be supplied for measuring flow rates in 3-inch and larger pipes. Three styles of transducer configurations are available to suit the application: strap-on transducers for metal and plastic pipes which can support ultrasonic transmission; insertion transducers, which penetrate pipe walls; and internally mounted transducers for large pipes. It is also capable of measuring both forward and reverse flow.

The microprocessor-based meter is supplied with a 24-character, 2-line alphanumeric LCD display for rate of flow and totalized flow information. Front panel switches activate commands which allow functions such as zero/span, self-test and rescaling to be selected.

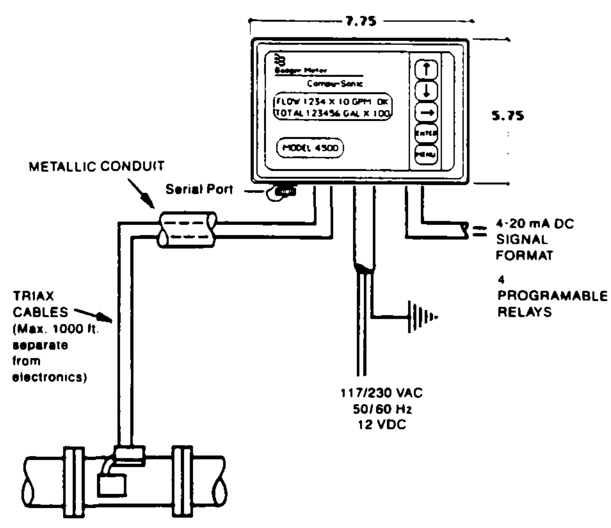
Piping Requirements

Model 4500 flowmeters may be either horizontally or vertically mounted. A well-developed velocity profile is needed. General practice requires the pipe to be full and the upstream piping run to be sufficient to assure predictable fluid velocity distribution.

Operation

The Model 4500 Compu-Sonic flowmeter operates as a transit-time flowmeter using Badger Meter's phase shift time detection system. This technique, exclusive to Badger Meter, improves time difference detectability to enhance accuracy and stable operation while substantially reducing noise effects.

SYSTEM DIAGRAM



Ultrasonic energy "bursts" are transmitted and received via well-defined paths across the flow stream. The velocity of the flow is accurately measured by the difference in the arrival times of signals from the upstream and downstream transducers. The overall "time of flight" is measured to accurately compensate for changes in the sonic velocity of the fluid. Sonic velocity variations in the fluid may result from changes in the amount of suspended and dissolved solids as well as temperature variations. The Model 4500 flowmeter also accounts for acoustic beam changes due to refraction and diffraction.

The electronics are microprocessor-controlled, and signals are digitized for processing before any analog modifications are able to distort data or cause drift which can contaminate the signals. This technique allows more precise and accurate measurement of the flow, improves meter reliability and minimizes meter drift normally associated with component instabilities. Early digitization also enhances interchangeability during maintenance. Digitized data is confirmed, stored and filtered by sophisticated mathematical algorithms to correct for signal distortions.

System Features

NO HEAD LOSS

The Series 4500 flowmeter, with its externally mounted sensors, has no moving parts in the flow stream to create an energy loss.

EASILY INSTALLED

Simple, yet reliable, sensor technology allows customer start-up with minimal mechanical effort. New or retrofit applications have the same high degree of accuracy.

HIGH ACCURACY

Transit-time operation assures dependable operation and system accuracy. Accuracies of +/−1% over the flow range are common for calibrated units.

BI-DIRECTIONAL

Standard with each unit is the ability to measure fluid velocity in either direction with the same degree of exactness.

ZERO STABILITY

The microprocessor-based electronics provide zero stability, reducing low end drift.

REPEATABILITY

The ultrasonic flowmeter provides exceptional repeatability results of +/−0.25% over the flow range within the predictable profile and Reynolds' regime.

REMOTE MOUNTING OF THE ELECTRONICS

The sophisticated signal processing technique allows locating the electronics up to 1000 feet from the sensors.

Application Guide

Design Consideration

The Badger Compu-Sonic flowmeters are precisely set up and calibrated to the conditions set forth by the customer. These meters are assigned a meter factor based on known transducer spacing to yield an absolute accuracy to within +/− 1% on calibrated spool sections and to +/− 2-4% for field installed meters. As with many other types of flowmeters, the ultrasonic must be installed in a piping run of sufficient length to establish a predictable velocity profile. Table 1 presents this data. These numbers apply only to Newtonian fluids at flow rates generally above one foot a second and Reynolds' numbers over 75,000.

Table 2 suggests an acceptable level of solids carried in suspension for transit-time operation. The data is based on the assumption that the attenuation loss of the fluid is equal to that of water. The magnitude of acoustic losses is dependent upon the viscous forces between neighboring particles, thermal conduction, and the physical nature of the solids. Consultation with the factory is suggested when applications deal with viscous fluids and solids.

The effect of aeration on ultrasonic measurements must be considered for any application. The problem can be classified into two regimes, large and small bubbles. Large bubbles (classified by size in relation to the transmitted wave length) normally block the signal for a brief period; this is taken care of electronically. Small bubbles, on the other hand, exhibit the phenomenon called "Rayleigh scattering" in which the medium tends to behave like a diffuse reflector which gives rise to weak waves scattered in many directions. This upper limit varies depending upon the application, but is directly related to the square of the transmitted frequency and is proportional to the volume of the scattering object. Air bubbles are easily compressed, thus the reflected intensity ratio is very large.

Transit-time ultrasonic flowmeters require acceptable levels of acoustic energy to operate. Known areas of concern generally center around small bubble air entrainment. This can be avoided by not locating the meter near the following:

- -Cascading water - fall in excess of pipe IDx1.5
- -Pump cavitation and/or leaking seals
- -Air-entrained fluids such as
  - Nitrified sludge
  - Aerobically digested sludge
  - Anaerobically digested sludge
  - DAF sludge

TABLE 1

Suggested straight run of pipe diameters required upstream of the meter

ITEM	REQUIRED PIPE DIAMETERS IN A SINGLE PLANE
1. Pumps	
centrifugal	40
positive	30
2. Valves	
throttling	20-40
globe	10-20
check	10-20
3. Reducer	10
4. Increaser	25
5. Long Radius Ells	15
6. Tees	10-20
7. Straightening Vanes	5
8. Downstream Clearance	2-5

TABLE 2
SOLIDS CONCENTRATION
Percent by Volume

Line Size	% Solids
3 inches	12.0
4	8.0
6	7.0
8	4.5
10	3.7
12	3.0
14	2.75
16	2.5
18	2.25
20	2.0
36	1.0

Sonic Velocity

The accuracy of the Badger Meter transit-time ultrasonic meter depends upon knowing the sonic velocity in a relative manner. Exact knowledge is not required but an estimate within 10-20% should be made. The following table illustrates the difference with several common fluids.

FLUID	SONIC VELOCITY	ATTENUATION
Water	1488 m/s	0.22 dB/um.
Alcohol	1200	0.302
Gasoline R grade	1208	0.18
Ethylene glycol	1658	1.20

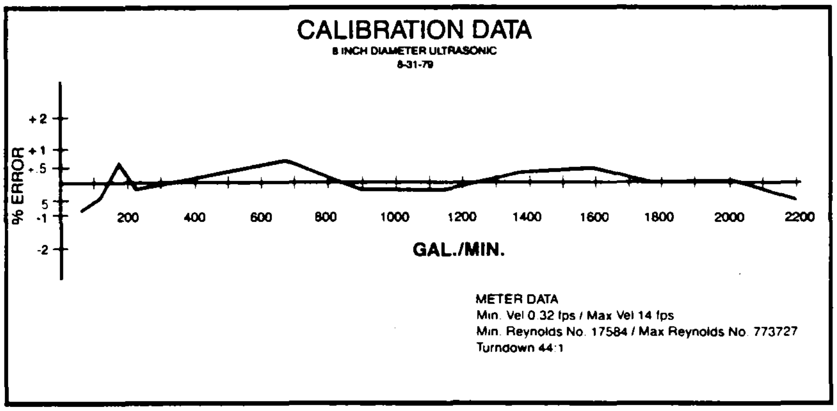
Application Guide

Hydraulic Considerations

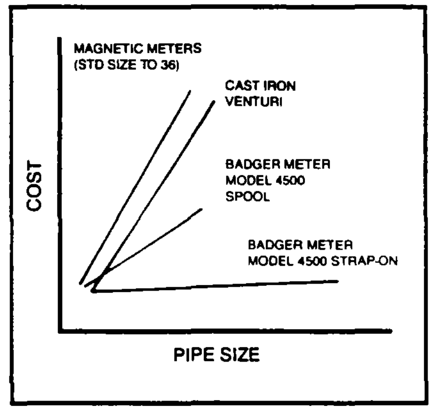
Transit-time single chord ultrasonic flowmeters do not measure the average velocity of the flow in the pipe but rather the average velocity of flow in the chord of the flow stream traversed by the acoustic beam. The relation between this measured chordal velocity and the true average flow velocity is a correction factor that is dependent upon Reynolds' number. For single chord transit-time ultrasonics, the correction factor K, (the ratio of chordal to average velocity), is expressed as:

$$K = 1 + .01\sqrt{6.25 + 435Re^{-0.23}}$$

This relationship is valid when the Reynolds' numbers indicate that the flow regime is in the turbulent zone. For those applications that operate in the laminar regime but with well-established and predictable profiles, the unit must be programmed for a different correction factor.



Calibration run showing the rangeability.

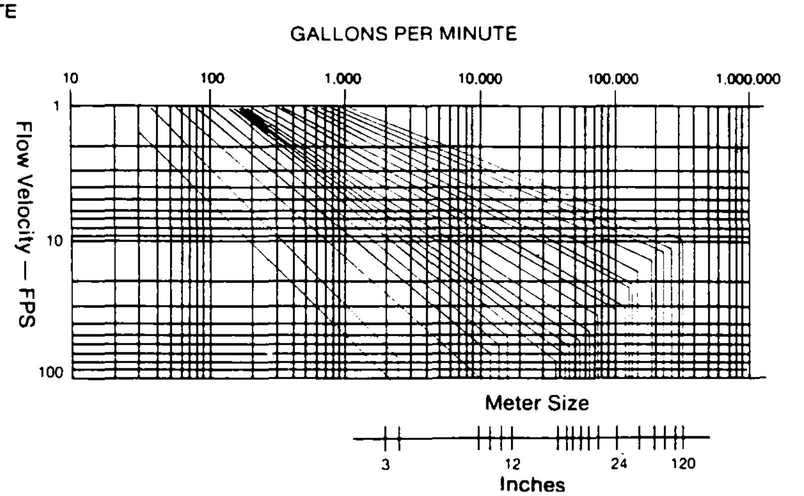


Cost-effective nature of the ultrasonic as compared to alternate technologies.

CAPACITY CHART

The following flow rates are based on nominal pipe sizes and are approximate due to variations in pipe diameter and wall thickness as well as the type of pipe material. The maximum flow rates are for single direction flow. For bi-directional flow, the maximum flow will be half this value. The minimum detectable values represent the lowest velocity the meter will sense. This value is below the predictable accuracy range of the meter. For flows over this rate, please consult the factory.

PIPE SIZE (inches)	MIN. DET. FLOW (gpm)	MAX. FLOW RATE (gpm)
3	12	2000
4	16	2700
6	24	7988
8	32	10650
10	40	13312
12	48	16000
14	56	37280
16	65	42612
18	73	47900
20	78	53268
24	96	63900
30	123	79840
36	140	100154
42	173	111752
48	226	127916
54	228	143908
60	246	159688
72	305	191876
84	345	223856
96	361	255384
120	423	320076



Technical Specifications

Display Function

The front panel of the Series 4500 contains a 24-character alphanumeric LCD display and five individual switches for selection of operating modes. The function switches are:

Menu- This key allows the user to select meter status or calibration modes. The status screens check the meter's operating status. The calibration screens allow adjustments and calibration of various parameters such as; rescaling of full scale, 4-20 zero and span calibration, etc. Each depression advances the menu and prompts the user. Among the menu items are span, zero, scale and self-test.

Enter- This key steps through the various screens in the status and calibration modes.

↑ ↓ → These switches are used to raise or lower display items such as full scale flow rate, 4-20 mA signal levels, etc.

External Communications

The Series 4500 is equipped with a bi-directional serial port which supports interactive communication with hand-held microcomputers as well as mainframe machines. The port is accessed by a plug mounted on the electronics unit. Versatile communication protocols have been established to ensure reliability. Serial port communications can be used to change the meter applications, to change the engineering units used for flow calculations, to ascertain signaling and operation quality of the meter, and to transmit data such as flow rate and flow totals.

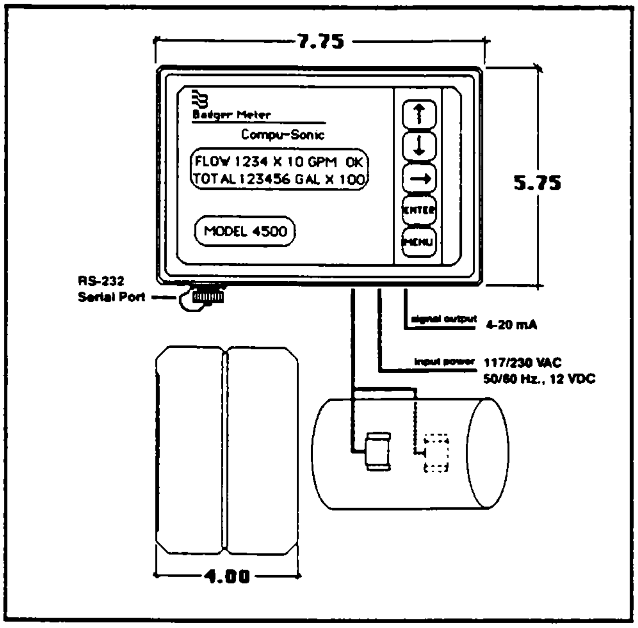
Mechanical Description

Electronics Unit: The standard unit is housed in a foam-molded polycarbonate enclosure suitable for wall or panel mounting. The enclosure is rated NEMA 4X for complete corrosion resistance and watertight integrity. Optional enclosure with heater and thermostat available for environments below 32° F.

Transducers: The transducers are constructed of corrosion-resistant material and sealed to provide sufficient protection from the environmental elements. Triax cable is used to provide shielding from external signal interference. The mounting hardware is designed to make the installation simple and easy. Three styles of transducers and mounting arrangements are available to meet the needs of the application.

PROGRAMMABLE RELAY OUTPUTS

The Series 4500 is supplied with 4 relay outputs. These relays are programmable for functions such as; High and Low alarms, Loss of Signal, Flow Direction, etc. These relays are SPDT, .5 A at 120 VAC or 1.0 A at 12 VDC.



General Specifications

Electronics

Microprocessor-based: Advanced single-chip microcomputer with 8K bytes of ROM, 512 bytes of EEROM and 256 bytes of RAM.

Linearity:	+/− 0.5%
Repeatability:	0.25%
Sensitivity:	+/− 0.005 ft./sec.
Accuracy:	+/− 1 to 3% above 1 fps velocity
Output signals:	LCD display, 4-20 mADC isolated RS-232 serial port 4 programmable relays
Operating temperature:	32° to 140° F
Operating humidity:	5 to 95% Relative
Power requirements:	117/230 VAC 50/60 Hz maximum 5 watts 12 VDC

Transducers

Operating temperature: -30° to 150° F (Optional strap-on to 300° F.)

Encapsulation: Able to withstand prolonged submergence or direct burial.

Interchangeability: Replacement without affecting meter accuracy.

Three mounting styles:

Strap-on for metal or plastic pipes which can support ultrasonic transmission.

Insertion for pipe walls that will not support ultrasonic transmission.

Internal for large pipes to eliminate costly meter vaults.

Technical Specifications

Ultrasonic Velocity Sensors

General

The transit-time flowmeters from Badger utilize acoustic signals transmitted from pipe-mounted sensors to accurately measure fluid velocities in both open channel and closed pipe conduits. Because of the diverse applications in fluid monitoring, as well as different pipe materials available, several versions of the acoustic velocity sensor can be provided. Shown below are the most common.

Description

Each sensor manufactured by Badger can both remotely transmit and receive acoustic pulses. These sensors can be mounted externally, clamp-on or welded; with "hot shot" wetted insert probes; mounted on the inside of the conduit, fully submerged; or premounted on a factory made spool, windowed or external. This flexibility in sensor design provides custom tailoring to fit the user's application. Also, these sensors can be isolated from the electronic processor up to 1000 feet (250 ft. windowed sensors), requiring only signal cable to be run from the power source to the meter site.

Mounting Hardware

The acoustic sensors and the associated mounting hardware manufactured by Badger Meter, Inc., are constructed from materials that are resistant to corrosive environments.

The hardware can be welded on for those applications where factory spool fabrication is required or can be strapped on using stainless steel cables for the field-installed unit.

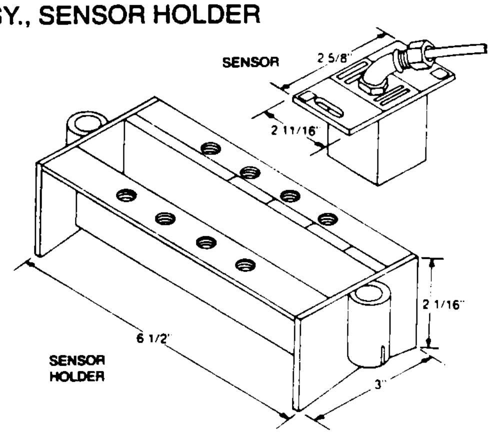
Standard Externally Mounted Velocity Sensor The externally mounted sensor is the preferred design when acoustic signals can be transmitted through the pipe or conduit material. These sensors are fully potted, incorporating an intrinsic safety design concept; they can be directly buried and operate under water. The sensor holders are stainless steel. These sensors can operate over a temperature range from -30° to 150° F (-30° to 300° F optional) They can be placed on all metallic and plastic piping, with the exception of pit cast iron and fiberglass pipe, and maintain pipe or conduit integrity.

Instream Velocity Sensor

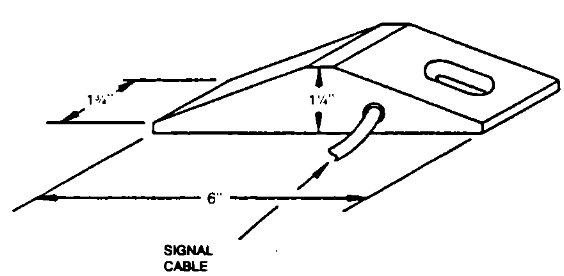
In open conduits over 24 inches in width or in large concrete pipes where the outside of the pipe is not accessible, the instream sensor is recommended for accurate fluid velocity measurement.

The unique design of the sensor facilitates simple installation. This sensor configuration allows flush mounting against the sidewall. After mechanical installation, the housing may be grouted to the sidewall, producing a streamlined profile in the conduit. The sensor construction is of a hydraulic efficient design, watertight, and is intended for continuous submergence.

ASSY., SENSOR HOLDER



UNDERWATER SENSOR HOUSING



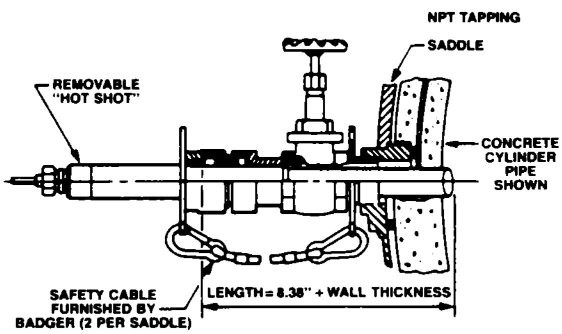
Technical Specifications

Also available is a unique internal hoop design that comes with the in-stream sensor accurately positioned and mounted. This mounting arrangement makes installation fast and precise.

These sensors are constructed of PVC, are fully potted, and incorporate the same unique technology associated with the standard externally mounted sensor.

"Hot Shot" Wetted Sensor
Badger's "Hot Shot" sensors are used where the pipe or conduit material will not allow transmission of acoustic energy. A standard concrete saddle tap is utilized for penetration through the pipe wall.

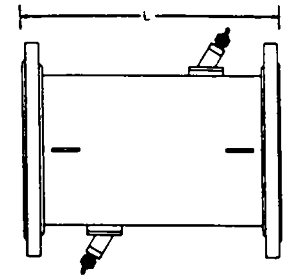
HOT SHOT WETTED SENSOR



NOTE: VALVE PROVIDED TO ASSURE WATERTIGHT CONNECTION DURING PROBE REMOVAL.

The sensor design allows for flush mounting with the conduit inside diameter, thereby eliminating solids buildup or turbulence around the measuring point. The sensors are used with an integral valve to allow sensor removal without process shutdown. Hot shot wetted sensors are recommended for concrete, asbestos cement, wood stave, fiberglass, and heavy mortar-lined pipe. They are constructed of PVC, fully potted, and incorporate the same unique technology associated with the standard externally mounted sensor. Maximum pressure rating is 150 PSI.

WINDOWED SPOOL



Fabricated Spool
Fabricated spool pieces are available in windowed sensor designs, with a choice of end connections and materials of construction. Spool pieces come with the sensors mounted and calibrated with the electronics.

Windowed sensors transmit and receive the ultrasonic pulse through an acoustic window which is in contact with the flow stream. The design allows sensor removal without de-watering the line. The sensors and windows are constructed of Ultem® (a registered trademark of General Electric) thermoplastic and have temperature ratings of 150°F. with a pressure rating to 150 psi.

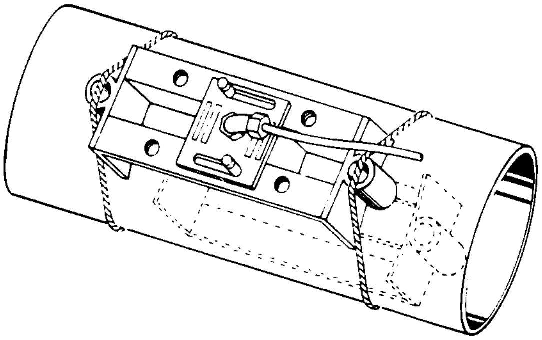
The windowed spool pieces are available in sizes 3" to 48 " with stainless or carbon steel construction, with ANSI, AWWA and plain end connections being standard.

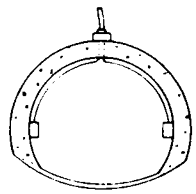
DIMENSIONS

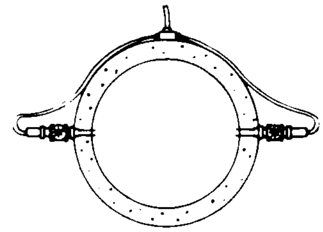
Nominal Pipe Size (Inches)	L	Nominal Pipe Size (Inches)	L	Nominal Pipe Size (Inches)	L
3"	12"	12"	18"	24"	30"
4"	12"	14"	21"	30"	30"
6"	12"	16"	24"	36"	36"
8"	14"	18"	27"	42"	42"
10"	15"	20"	30"	48"	48"

Mounting Configurations

Series 4500
Applied to existing piping systems with either externally mounted or wetted sensor design.







Externally Mounted Sensors
- Plastic pipe
- Metallic pipe
- Asbestos Cement pipe
- Ductile/Cast Iron pipe

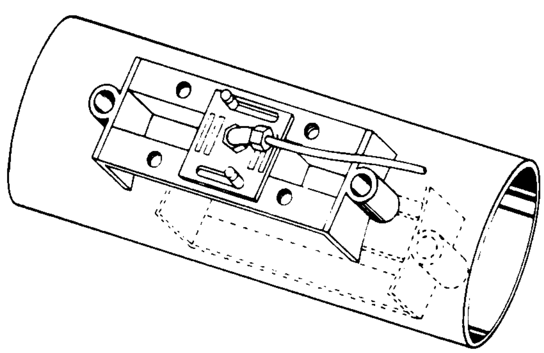
Pressure vessel integrity
Non-Intrusive
Can be buried or completely submerged

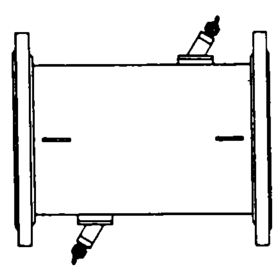
Internally Mounted Sensors
- Large diameter pipe
- Pipe or conduit not accessible from the outside

Wetted Mounted Sensors
("Hot Shot" Construction)
- Concrete pipe
- Wood Stave pipe
- Fiberglass

Field Installed Velocity Sensors

PIPE MATERIAL	CAST IRON		DUCTILE IRON		METALLIC			PLASTICS		CONCRETE		OPEN CHANNEL CONDUIT	NON-FULL PIPE CONDITIONS
	Pit Cast	Centrifugal	Unlined	Lined	Carbon Steel	Stainless	Exotic Metals	ABS	PVC	RCP	Asbestos Cement		
Standard Externally Mounted	No	≥ 3"	≥ 3"	≥ 6"	≥ 3"	≥ 3"	≥ 3"	≥ 3"	≥ 3"	No	≥ 3"	No	No
Instream Velocity Sensors	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 24"	≥ 12"	≥ 24"
Hot Shot Wetted Sensors	≥ 12"	≥ 12"	≥ 12"	≥ 12"	≥ 6"	≥ 6"	≥ 6"	≥ 12"	≥ 12"	≥ 12"	≥ 12"	≥ 12"	≥ 12"





Externally Mounted Sensors
- Non-Intrusive
- Stainless Steel Spools
- High Pressure Application
- Any Standard End Connections

Windowed Sensors
- Sizes 3" through 48"
- ANSI/AWWA/Plain End Flanges Available
- Carbon/SS construction

Sample Specifications

General
A transit-time ultrasonic flowmeter shall be installed on the piping system as shown in the plans and shall be in accordance with the manufacturer's recommendations. The meter shall consist of a set of acoustic transducers, interconnecting cable, remote microprocessor-based electronic transmitter and accessories as required for the installation. The meter shall be a Badger Meter Model 4500 Compu-Sonic.

Acoustic Sensors and Mounting Requirements
Two flow sensors shall be permanently mounted to the pipe to ensure accurate and stable measurement of flow. The sensors shall be positioned in accordance with the manufacturer's specifications and factory approved methods. Mounting templates and/or fixtures for sensor attachments shall be provided by the manufacturer.

The mounting hardware and transducers shall have sufficient integrity to maintain accurate sensor placement withstanding normal pipe vibration and shall be capable of operating over a temperature range of (-30° to 70° C) or (-30° to 150° F). In addition, the sensors shall be so designed as to operate under submerged conditions indefinitely.

The acoustic sensors shall alternately transmit and receive acoustic energy pulses propagated along the centerline of the fluid. Only transit-time method of operation will be accepted.

Four designs are available depending upon the application.

(1.) *For External Sensors (3" Dia. Meters and Larger):*
The integrity of the pipe shall be maintained during installation and operation. Cutting into the pipe to install the sensors or holders shall not be allowed. Stainless steel mounting bands shall be placed about the pipe circumference to secure the sensor brackets; the mounting bands shall have sufficient strength to maintain accurate sensor position. Positioning of the sensor mounting brackets shall be in accordance with the manufacturer's specifications.

The acoustic sensors shall be securely held in the sensor brackets and shall transmit acoustic energy through the (steel, cast iron, plastic) pipe wall for measurement of flow.

These sensors shall be so designed as to be operated directly buried (in accordance with the manufacturer's recommendations) or underwater.

(2.) *For "Hot Shot" Sensors (12" Dia. Meters and Larger):*
Two acoustic sensors of the "hot shot" style shall be mounted on the piping at the positions shown on plans. Valve assemblies shall be supplied to allow the insertion or withdrawal of the sensors without dewatering the conduit.

(3.) *For Instream Wetted Sensors (24" Dia. Meters and Larger):*
The sensor design and mounting hardware shall be such as to allow mounting against the inside of the pipewall. Installation shall be in accordance with the manufacturer's specifications.

(or)

The manufacturer shall supply an internal strap design that will be installed on the inside diameter of the conduit. This design will have the instream sensors accurately positioned and mounted on the field installed "hoop". The manufacturer shall supply all the necessary hardware to ensure proper installation.

(4.) *For Fabricated Spool Design:*
The meter body installed in the piping shall be _____" internal diameter with a laying length of _____. It shall be constructed from _________ material with (ANSI, 150, or 300#), (AWWA, Class D, 150#), carbon steel or plain end connections. The design shall incorporate externally mounted sensors that are field replaceable, factory mounted on the meter body. This design will be in accordance with ASME pressure vessel code

(or)

A windowed sensor design shall be supplied by the manufacturer that allows sensor removal without dewatering of the line. The sensors and windows shall be constructed of Ultem* thermoplastic and shall have a temperature rating of 150° F. The sensor shall be replaceable without dewatering the pipe.

Sample Specifications

Transmitter Requirements

The transmitter shall contain all the circuitry necessary to produce a 4-20 mA DC signal linear with the flow rate. The transmitter shall be capable of measuring and totalizing forward and reverse flow. It shall be microprocessor-controlled. The microprocessor shall be of a single chip design using at least 8K bytes of ROM, 512 bytes of EEROM, and 512 bytes of RAM. The transmitter shall be housed in a foam-moulded polycarbonate enclosure suitable for wall/panel mounting, rated NEMA 4X. The display on the enclosure will be a 24-character, 2-line alphanumeric LCD clearly indicating instantaneous flow rate and totalized flow information with the engineering units and multiplier as specified. The transmitter shall utilize menu-driven sequencing of the internal meter functions via five front panel switches. The meter shall be capable of performing the following functions from the front panel switches without the need or use of special external test equipment.

-RATE INDICATION
-TOTALIZATION
-ON-LINE METER STATUS
-SELF-TEST
-METER IDENTIFICATION AND TAG NUMBER
-SPAN ADJUSTMENT
-ZERO ADJUSTMENT
-FLOW DAMPING
-METER RESCALE
-METER RECALIBRATION

Meter output shall be an isolated 4-20mA DC signal linearly proportional to flow rate operating into a maximum of 1000 ohms. The power requirements for the meter shall be a maximum of 5 watts operating on 117 VAC 50/60 Hz. It shall be capable of operating off 12 VDC continuous or battery back up. The temperature range for the transmitter shall be from (32° to 140° F) or (0° to 60° C).

The transmitter shall be equipped with a serial communication port capable of interactive communication with hand-held microcomputers or mainframe machines.

Performance Specifications

The flowmeter shall measure, indicate and totalize the flow to within the following parameters:

Accuracy equal to or better than +/- 3% of actual flow above 1 fps velocity for field mounted sensors.
Accuracy +/-1% of actual flow above 1 fps velocity for spool piece mounted sensors.
Linearity of the units shall be +/- 0.5%.
Repeatability to within +/- 0.25%.
Sensitivity of +/- 0.005 ft./sec.

Flowmeter Maintenance

The flowmeter manufacturer shall incorporate troubleshooting guides with the instruction manuals. In addition, the meter shall be so designed as to provide a continuous on-line indication of meter status via the LCD display. Through the front panel menu, a user operated, self-test program can be activated that assesses the health of the meter by checking the EEROM, signal strength, transmission status, as well as the electronic circuitry to assure reliable operation of the meter.

Badger Meter ®

BADGER METER

HYDRO SUPPLY CO.

12231 Wood Lake Dr.
Burnsville, MN 55337

(612) 890-3811

DATE 09-21-92

SERIES 4100 COMPU-SONIC FLOWMETER
DATA/CALCULATION SHEET

BADGER S.O. NO.	969906
CUSTOMER	HYDRO SUPPLY
CUSTOMER P.O. NO.	451
USER	SAME
CONSULTING ENG.	
TAG NUMBER	3" PIPE UNIT 1

FLOW DATA:

FLOW UNITS	GPM	FLUID TYPE	WATER
MAXIMUM FLOW	2231 GPM	FLUID TEMPERATURE	AMBIENT
MAXIMUM VELOCITY	4.1 FPS		

METERING SECTION DATA:

TYPE OF INSTALLATION	STRAP-ON	SPOOL LENGTH	3'4"
FLANGE MATERIAL		FLANGE RATING	
NOMINAL PIPE SIZE	3 IN	PIPE MATERIAL	DUCTILE IRON
PIPE I.D.	3.155 IN	WALL THICKNESS	.32 IN
LINER MATERIAL	MORTAR	LINER THICKNESS	.0925
SENSOR STYLE	NEW STANDARD	SENSOR SEPARATION	.86 IN
4110 MANUAL SECTION	3	MOUNTING CONFIG.	CASE A
		SONIC VEL "C"	
		VISCOSITY CP	
		SP. GR.	

ELECTRONICS SECTION DATA:

SERIAL NUMBER	101225	FLOW RATE UNITS	GPM X 1
ENCLOSURE TYPE	NEMA4X	TOTALIZER UNITS	GALLONS X100
POWER REQUIRED	117VAC	SIGNAL OUTPUT(S)	4-20 MADC
ACCESSORIES			

REMARKS:

HYDRO SUPPLY CO.

12231 Wood Lake Dr.
Burnsville, MN 55337

(612) 890-3811

BADGER METER INC.
INDUSTRIAL PRODUCTS DIVISION
TULSA, OK

COMPU-SONIC Model 4100 Data Sheet
08-26-1992

CS4100PC	v1.21A	Equipment Serial No.	101225
Pipe O.D.	3.960 IN	Pipe Wall Thickness	.31 IN
Pipe I.D.	3.155 IN	Liner Thickness	.0925 IN
Pipe Material	Ductile Iron	Flow Direction	Uni
Liner Material	Mortar	Selected Full Scale	125
Maximum Flow Rate	2231	Minimum Flow Rate	0
Flow Rate Units	GPM	Display Rate Multiplier	1
Flow Total Units	Gallons	Flow Total Multiplier	100
Full Scale Velocity	4.1 FPS	Reference Reynolds No.	84773
Sensor Style	New Standard	Case -A- Offset IN	.86 IN
Fluid Viscosity	1.00 CP	Fluid Specific Gravity	1.00
Fluid Sonic Velocity	4800 FPS (Nom.)		

UNSAVED FILE DATA

Site ID	04
Scale	11C360EO
Delay	182E
Span	205
T12 max	6F
T12 min	52
Totcon	5DC1D38
Display	C8
Totmul	06
Ratemul	04
Display max	AFO
Display min	57
Display inc	OA
K Display	63
Rate Units	01
Tot Units	01
Serial No.	18B6E
Direction flag	01
Tot on/off	01

Fluid Transit Time	72.62 uS	System delay time	24.18 uS
Full Scale Phase	23.66 Deg	K Factor Correction	1.052
Cable Length		______________	0
Installed	20 Ft.		

HYDRO SUPPLY CO.

12231 Wood Lake Dr.
Burnsville, MN 55337

(612) 890-3811

DATE 09-21-92

SERIES 4100 COMPU-SONIC FLOWMETER
DATA/CALCULATION SHEET

BADGER S.O. NO.	969906
CUSTOMER	HYDRO SUPPLY
CUSTOMER P.O. NO.	451
USER	SAME
CONSULTING ENG.	
TAG NUMBER	3" PIPE UNIT 2

FLOW DATA:

FLOW UNITS	GPM	FLUID TYPE	WATER
MAXIMUM FLOW	2231 GPM	FLUID TEMPERATURE	AMBIENT
MAXIMUM VELOCITY	4.1 FPS		

METERING SECTION DATA:

TYPE OF INSTALLATION	STRAP-ON	SPOOL LENGTH	3'4"
FLANGE MATERIAL		FLANGE RATING	
NOMINAL PIPE SIZE	3 IN	PIPE MATERIAL	DUCTILE IRON
PIPE I.D.	3.155 IN	WALL THICKNESS	.32 IN
LINER MATERIAL	MORTAR	LINER THICKNESS	.0925
SENSOR STYLE	NEW STANDARD	SENSOR SEPARATION	.86 IN
4110 MANUAL SECTION	3	MOUNTING CONFIG.	CASE A
		SONIC VEL "C"	
		VISCOSITY CP	
		SP. GR.	

ELECTRONICS SECTION DATA:

SERIAL NUMBER	101224	FLOW RATE UNITS	GPM X 1
ENCLOSURE TYPE	NEMA4X	TOTALIZER UNITS	GALLONS X100

POWER REQUIRED 117VAC SIGNAL OUTPUT(S) 4-20 MADC
ACCESSORIES

REMARKS:

HYDRO SUPPLY CO.

12231 Wood Lake Dr.
Burnsville, MN 55337

(612) 890-3811

BADGER METER INC.
INDUSTRIAL PRODUCTS DIVISION
TULSA, OK

COMPU-SONIC Model 4100 Data Sheet
08-26-1992

CS4100PC	v1.21A	Equipment Serial No.	101224
Pipe O.D.	3.960 IN	Pipe Wall Thickness	.31 IN
Pipe I.D.	3.155 IN	Liner Thickness	.0925 IN
Pipe Material	Ductile Iron	Flow Direction	Uni
Liner Material	Mortar	Selected Full Scale	125
Maximum Flow Rate	2231	Minimum Flow Rate	0
Flow Rate Units	GPM	Display Rate Multiplier	1
Flow Total Units	Gallons	Flow Total Multiplier	100
Full Scale Velocity	4.1 FPS	Reference Reynolds No.	84773
Sensor Style	New Standard	Case -A- Offset IN	.86 IN
Fluid Viscosity	1.00 CP	Fluid Specific Gravity	1.00
Fluid Sonic Velocity	4800 FPS (Nom.)		

UNSAVED FILE DATA

Site ID	04
Scale	11C360EO
Delay	182E
Span	205
T12 max	6F
T12 min	52
Totcon	5DC1D38
Display	C8
Totmul	06
Ratemul	04
Display max	AFO
Display min	57
Display inc	OA
K Display	63
Rate Units	01
Tot Units	01
Serial No.	18B6E
Direction flag	01
Tot on/off	01

Fluid Transit Time	72.62 uS	System delay time	24.18 uS
Full Scale Phase	23.66 Deg	K Factor Correction	1.052
Cable Length Installed	20 Ft.	________________	0

Hydro Supply Company
12231 Wood Lake Dr
Burnsville, Mn 55337
(612) 890-3811

DATE 09-21-92

SERIES 4100 COMPU-SONIC FLOWMETER
DATA/CALCULATION SHEET

BADGER S.O. NO.	969906
CUSTOMER	HYDRO SUPPLY
CUSTOMER P.O. NO.	451
USER	SAME
CONSULTING ENG.	
TAG NUMBER	4" PIPE UNIT 3

FLOW DATA:

FLOW UNITS	GPM	FLUID TYPE	WATER
MAXIMUM FLOW	2811 GPM	FLUID TEMPERATURE	AMBIENT
MAXIMUM VELOCITY	5.17 FPS		

METERING SECTION DATA:

TYPE OF INSTALLATION	STRAP-ON	SPOOL LENGTH	3' 3 1/2"
FLANGE MATERIAL		FLANGE RATING	
NOMINAL PIPE SIZE	4 IN	PIPE MATERIAL	DUCTILE IRON
PIPE I.D.	4.16 IN	WALL THICKNESS	.32 IN
LINER MATERIAL	MORTAR	LINER THICKNESS	.0925
SENSOR STYLE	NEW STANDARD	SENSOR SEPARATION	1.142 IN
4110 MANUAL SECTION	3	MOUNTING CONFIG.	CASE A
		SONIC VEL "C"	
		VISCOSITY CP	
		SP. GR.	

ELECTRONICS SECTION DATA:

SERIAL NUMBER	101230	FLOW RATE UNITS	GPM X 1
ENCLOSURE TYPE	NEMA4X	TOTALIZER UNITS	GALLONS X100
POWER REQUIRED	117VAC	SIGNAL OUTPUT(S)	4-20 MADC
ACCESSORIES			

REMARKS:

BADGER METER INC.
INDUSTRIAL PRODUCTS DIVISION
TULSA, OK

COMPU-SONIC Model 4100 Data Sheet
08-26-1992

CS4100PC	v1.21A	Equipment Serial No.	101230
Pipe O.D.	4.80 IN	Pipe Wall Thickness	.32 IN
Pipe I.D.	4.16 IN	Liner Thickness	.0925 IN
Pipe Material	Ductile Iron	Flow Direction	Uni
Flow Media	Water	Selected Full Scale	300
Maximum Flow Rate	2811	Minimum Flow Rate	0
Flow Rate Units	GPM	Display Rate Multiplier	1
Flow Total Units	Gallons	Flow Total Multiplier	100
Full Scale Velocity	5.17 FPS	Reference Reynolds No.	114110
Sensor Style	New Standard	Case -A- Offset IN	1.142 IN

Fluid Viscosity	1.00 CP	Fluid Specific Gravity	1.00
Fluid Sonic Velocity	4800 FPS (Nom.)		

UNSAVED FILE DATA

Site ID	04
Scale	11C360EO
Delay	182E
Span	205
T12 max	6F
T12 min	52
Totcon	5DC1D38
Display	C8
Totmul	06
Ratemul	04
Display max	AFO
Display min	57
Display inc	OA
K Display	63
Rate Units	01
Tot Units	01
Serial No.	18B6E
Direction flag	01
Tot on/off	01

Fluid Transit Time	72.62 uS	System delay time	24.18 uS
Full Scale Phase	23.66 Deg	K Factor Correction	1.052
Cable Length		______________	0
Installed	20 Ft.		

Hydro Supply Company
12231 Wood Lake Dr
Burnsville, Mn 55337
(612) 890-3811

DATE 09-21-92

SERIES 4100 COMPU-SONIC FLOWMETER
DATA/CALCULATION SHEET

BADGER S.O. NO.	969906
CUSTOMER	HYDRO SUPPLY
CUSTOMER P.O. NO.	451
USER	SAME
CONSULTING ENG.	
TAG NUMBER	4" PIPE UNIT 4

FLOW DATA:

FLOW UNITS	GPM	FLUID TYPE	WATER
MAXIMUM FLOW	2811 GPM	FLUID TEMPERATURE	AMBIENT
MAXIMUM VELOCITY	5.17 FPS		

METERING SECTION DATA:

TYPE OF INSTALLATION	STRAP-ON	SPOOL LENGTH	3' 3 1/2"
FLANGE MATERIAL		FLANGE RATING	
NOMINAL PIPE SIZE	4 IN	PIPE MATERIAL	DUCTILE IRON
PIPE I.D.	4.16 IN	WALL THICKNESS	.32 IN
LINER MATERIAL	MORTAR	LINER THICKNESS	.0925
SENSOR STYLE	NEW STANDARD	SENSOR SEPARATION	1.142
4110 MANUAL SECTION	3	MOUNTING CONFIG.	CASE A
		SONIC VEL "C"	
		VISCOSITY CP	
		SP. GR.	

ELECTRONICS SECTION DATA:

SERIAL NUMBER	101227	FLOW RATE UNITS	GPM X 1
ENCLOSURE TYPE	NEMA4X	TOTALIZER UNITS	GALLONS X100
POWER REQUIRED	117VAC	SIGNAL OUTPUT(S)	4-20 MADC
ACCESSORIES			

REMARKS:

BADGER METER INC.
INDUSTRIAL PRODUCTS DIVISION
TULSA, OK

COMPU-SONIC Model 4100 Data Sheet
08-26-1992

CS4100PC	v1.21A	Equipment Serial No.	101227
Pipe O.D.	4.80 IN	Pipe Wall Thickness	.32 IN
Pipe I.D.	4.16 IN	Liner Thickness	.0925 IN
Pipe Material	Ductile Iron	Flow Direction	Uni
Flow Media	Water	Selected Full Scale	300
Maximum Flow Rate	2811	Minimum Flow Rate	0
Flow Rate Units	GPM	Display Rate Multiplier	1
Flow Total Units	Gallons	Flow Total Multiplier	100
Full Scale Velocity	5.17 FPS	Reference Reynolds No.	114110
Sensor Style	New Standard	Case -A- Offset IN	1.142
Fluid Viscosity	1.00 CP	Fluid Specific Gravity	1.00
Fluid Sonic Velocity	4800 FPS (Nom.)		

UNSAVED FILE DATA

Site ID	04
Scale	11C360EO
Delay	182E
Span	205
T12 max	6F
T12 min	52
Totcon	5DC1D38
Display	C8
Totmul	06
Ratemul	04
Display max	AFO
Display min	57
Display inc	OA
K Display	63
Rate Units	01
Tot Units	01
Serial No.	18B6B
Direction flag	01
Tot on/off	01

Fluid Transit Time	72.62 uS	System delay time	24.18 uS
Full Scale Phase	23.66 Deg	K Factor Correction	1.052
Cable Length Installed	20 Ft.	____________	0

☐ ULTRASONICS
☐ INSTRUMENTATION

Badger Meter

CUSTOMER INSTRUCTION MANUAL

SERIAL NUMBER 969906 4"

Badger Meter, Inc.
P.O. Box 581390
Tulsa, Oklahoma 74158
(918) 836-8411
Telex: RCA 203605
Fax: (918) 832-9962

SCOPE OF MANUAL

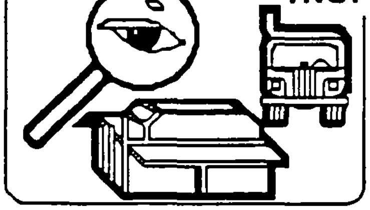
This manual contains information concerning the installation, operation and maintenance of the Series 4100 Compu-Sonic ultrasonic flowmeter. To ensure proper performance of the meter, the instructions given in this manual should be thoroughly understood and followed.

Keep the manual in a readily accessible location for future reference.

Changes and additions to the original edition of this manual will be covered by a "CHANGE NOTICE" supplied with the manual. The change notice will explain any differences between the product described in this manual.

SERIES 4100 COMPU-SONIC TABLE OF CONTENTS

UNPACKING & INSPECTION



To avoid damage in transit, Badger products are shipped to the customer in special shipping containers. Upon receipt of the product, perform the following unpacking and inspection procedures:

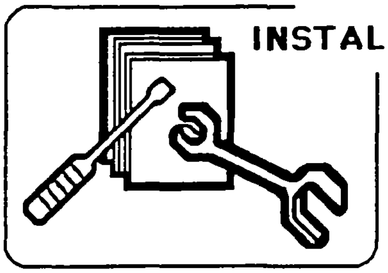
Note: If damage to the shipping container is evident upon receipt, request the carrier to be present when the product is unpacked.

a. Carefully open the shipping container following any instructions that may be marked on the box. Remove all cushioning material surrounding the product and carefully lift the product from the container.

Retain the container and all packing material for possible use in reshipment or storage.

b. Visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts or any other sign of damage that may have occurred during shipment.

Note: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the customer.



INSTALLATION

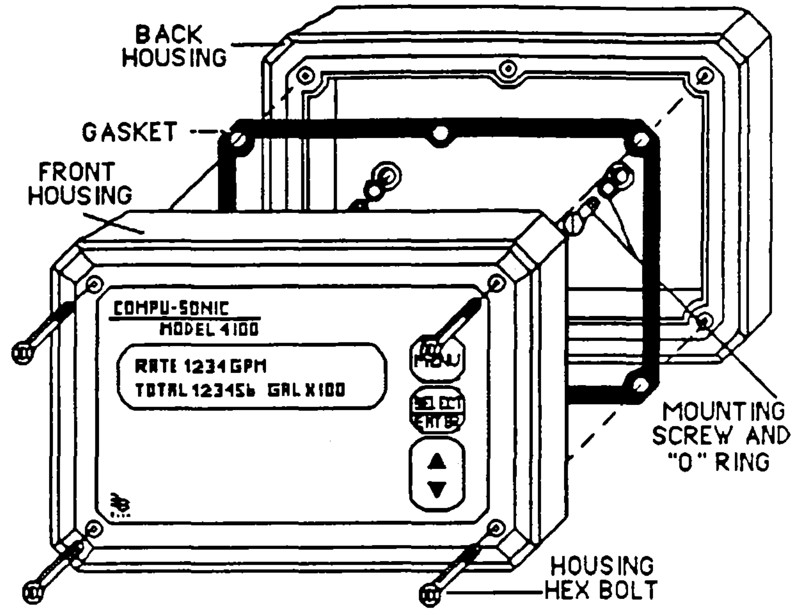


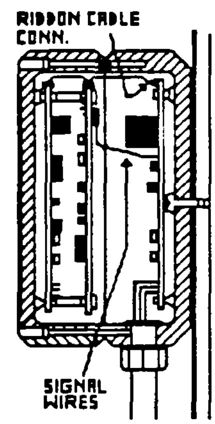
FIGURE 2-1

ELECTRONIC ENCLOSURE

The Series 4100 electronics is housed in a rugged, NEMA 4X rated, polycarbonate enclosure which can be wall mounted. Supplied with each unit are two 1/4-20x3/4 inch mounting screws for use with lead inserts, two 1/4-20x3/4 inch sheet metal screws for other wall materials and two "O" rings necessary to maintain the NEMA 4X rating of the enclosure.

When mounting the Series 4100 electronics, select a location that has good ventilation, temperature within the meter's specification, not subject to flooding, protection from accidental shock, and provides for accessibility to operate the meter and for future service.

FIGURE 2-2



ENCLOSURE MOUNTING

To mount the enclosure use the 5/32 inch Allen wrench, supplied in the mounting hardware package, to loosen and remove all four hex bolts in the front of the housing (see Figure 2-1). Separate the front and back housings. **CAUTION: THERE ARE TWO SIGNAL WIRES ON THE FRONT HOUSING AND A RIBBON CABLE ON THE POWER SUPPLY BOARD THAT WILL NEED TO BE DISCONNECTED WHEN REMOVING THE FRONT HOUSING (SEE FIGURE 2-2).** Place the front housing in a protected area so it will not be damaged while mounting the back housing.

To mount the back housing, two holes will need to be drilled in the wall 4.5 inches apart (center line to center line, see Figure 2-3). The size of the holes will depend on whether lead inserts are used or the mounting screws are screwed directly in the wall. Select the appropriate screws and place the "O" rings on the screws. With a 3/8 inch hex head driver, secure the back housing to the wall. **Since the power supply board is in the back housing, care should be taken to prevent damaging any components on the board.**

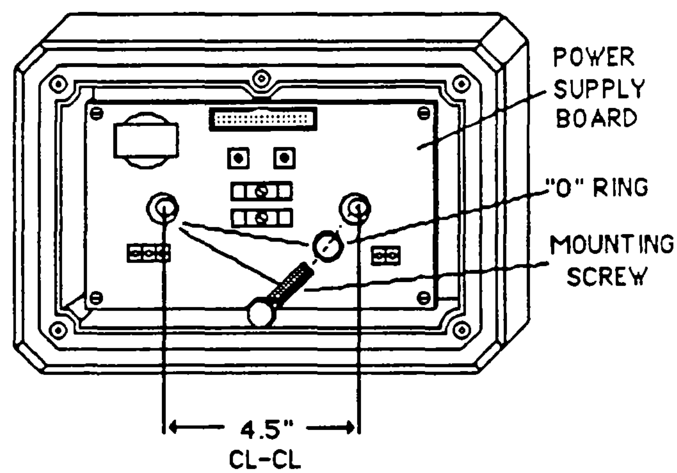


FIGURE 2-3

WIRING CONNECTIONS

The Series 4100 electronics enclosure is provided with three holes for 1/2 inch NPT conduit fittings. These holes are on the bottom of the back housing of the enclosure and allow entry for the 115 VAC power wires, sensor cables and 4 to 20 mADC signal output wires. **These three lines must be in separate conduits or the operation of the meter could be affected.**

The terminals on the power supply board will accept 14 to 22 gauge wire. A small common screw driver will be required to loosen and tighten the screws. There are two different power supplies that can be supplied with the Series 4100 flowmeters. The standard power supply is shown in Figure 2-4 and the accessory power supply is shown in Figure 2-5.

Standard power supply connections (Figure 2-4). The terminals marked TB1 are for the 115 VAC connections. Terminal 1 is the high side (black wire) connection. Terminal 2 is the low or neutral side (white wire) connection. Terminal 3 is the earth ground (green wire) connection. A magnetic switch (located on the left side of the back housing) removes power from the power supply board when the front housing is separated from the back housing.

The terminals marked TB3 are for the 4 to 20 mADC output signal. Terminal 1 is the positive (+) connection and terminal 2 is the negative (-) connection.

Two test points are provided on the bottom of the back housing to allow adjustment of the 4 to 20 mADC signal. Refer to the Operation section for use when adjusting Zero and Span.

The terminals marked DIR are for use when the Series 4100 flowmeters are programmed for bi-directional operation. This is an optically coupled open collector switch output. It is rated for 50VDC at 100 mA. When the flow is in the forward direction the switch will be open, and in the reverse direction the switch will be closed. Terminal 1 is the positive (+) connection and terminal 2 is the negative (-) connection.

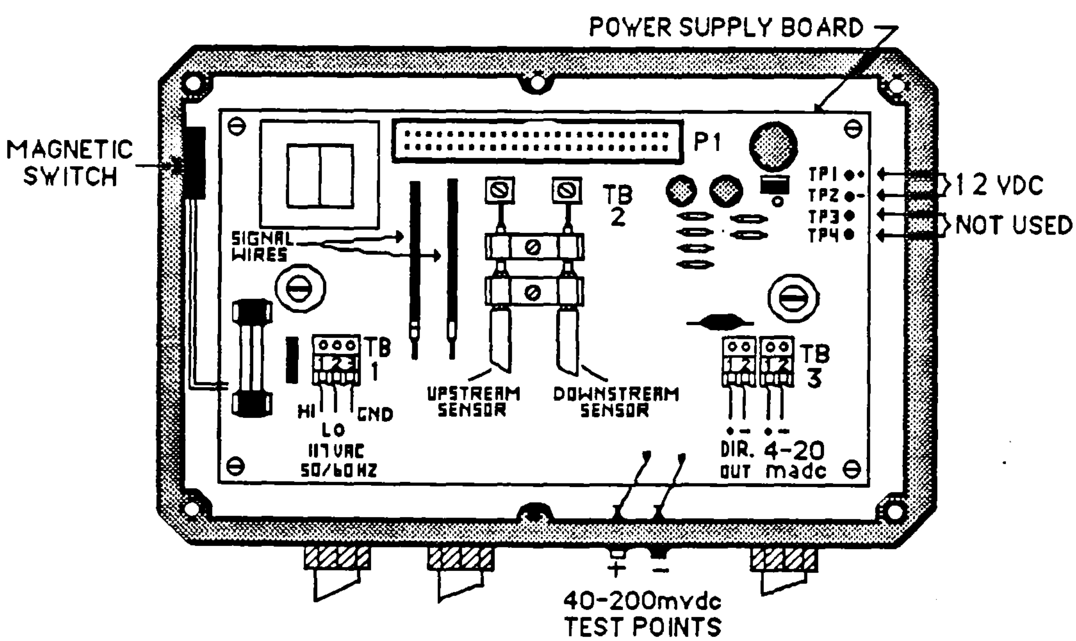


FIGURE 2-4
BACK HOUSING WITH STANDARD POWER SUPPLY

Accessory power supply connections (Figure 2-5). The terminals marked TB1 are for the 115 VAC connections. Terminal 1 is the high side (black wire) connection. Terminal 2 is the low or neutral side (white wire) connection. Terminal 3 is the earth ground (green wire) connection. A magnetic switch (located on the left side of the back housing) removes power from the power supply board when the front housing is separated from the back housing.

The terminals marked TB2 are for the accessory output and 4-20 mA output connections. The accessory outputs are optically coupled open collector outputs rated at a maximum of 50 VDC at 100 mA. The following defines these accessories:

Terminals 1 and 2 are the connections for the Low alarm output. Terminal 1 is the negative (-) connection and terminal 2 is the positive (+) connection.

Terminals 3 and 4 are the connections for the High alarm output. Terminal 3 is the negative (-) connec-tion and terminal 4 is the positive (+) connection.

Terminals 5, 6, 7 and 8 are for future accessory out-puts.

Terminals 9 and 10 are the connections for the flow direction output when operating the flowmeter in the bi-directional mode. Terminal 9 is the negative (-) connection and terminal 10 is the positive (+) connection.

Terminals 11 and 12 are the connections for the lost signal output. The switch output will be closed when the meter has detected a loss of signal and has defaulted to a zero output (no flow) condition. Terminal 11 is the negative (-) connection and terminal 12 is the positive (+) connection.

Terminals 13 and 14 are the connections for the 0 - 20 pulses per second output. This is a scalable output which can be factory set from 0-2 to 0-20 pps. If this has been activated then the 0-1000 can not be used. Terminal 13 is the negative (-) connection and terminal 14 is the positive (+) connection.

Terminals 15 and 16 are the connections for the 0 - 1000 pulses per second output. This is a non-scalable output. If this has been activated, then the 0-20 pps cannot be used. Terminal 15 is the negative (-) connection and terminal 16 is the positive (+) connection.

Terminals 17 and 18 are for the 4 to 20 mADC output signal. Terminal 17 is the positive (+) connection and terminal 18 is the negative (-) connection.

Two test points are provided on the bottom of the back housing to allow adjustment of the 4 to 20 mADC signal. Refer to the Operation section for use when adjusting Zero and Span.

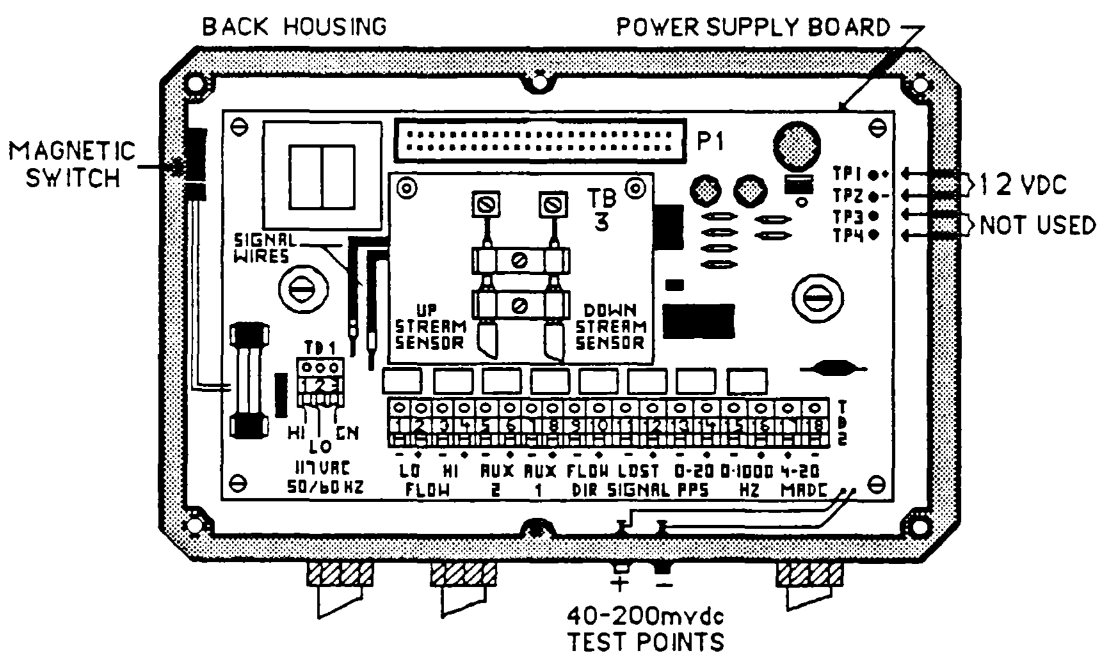


FIGURE 2-5
BACK HOUSING WITH ACCESSORY POWER SUPPLY

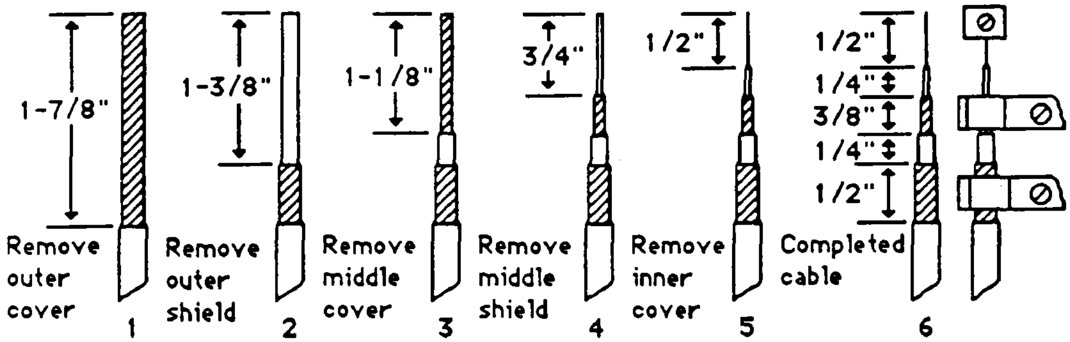


FIGURE 2-6
SENSOR CABLE PREPARATION

Sensor cable connections. Before pulling the sensor cables through the conduit, mark the ends of the cables to indicate which is the upstream and downstream sensor cable. Leave approximately 8 inches of cable extending from the conduit in the enclosure. Refer to Figure 2-6 and prepare the cable ends in the following manner.

1. Remove outer cable cover. Measure 1-7/8" from the end of the cable. With a cutting tool, carefully cut through the outer covering competely around the cable making sure not to cut into the outer shield. Make another cut from the first cut to the end of the cable and remove the outer cover.

2. Remove outer shield. Measure 1-3/8" from the end of the cable. With a pair of small cutters, cut the shield around the cable at the measured point and remove the cut off shield.

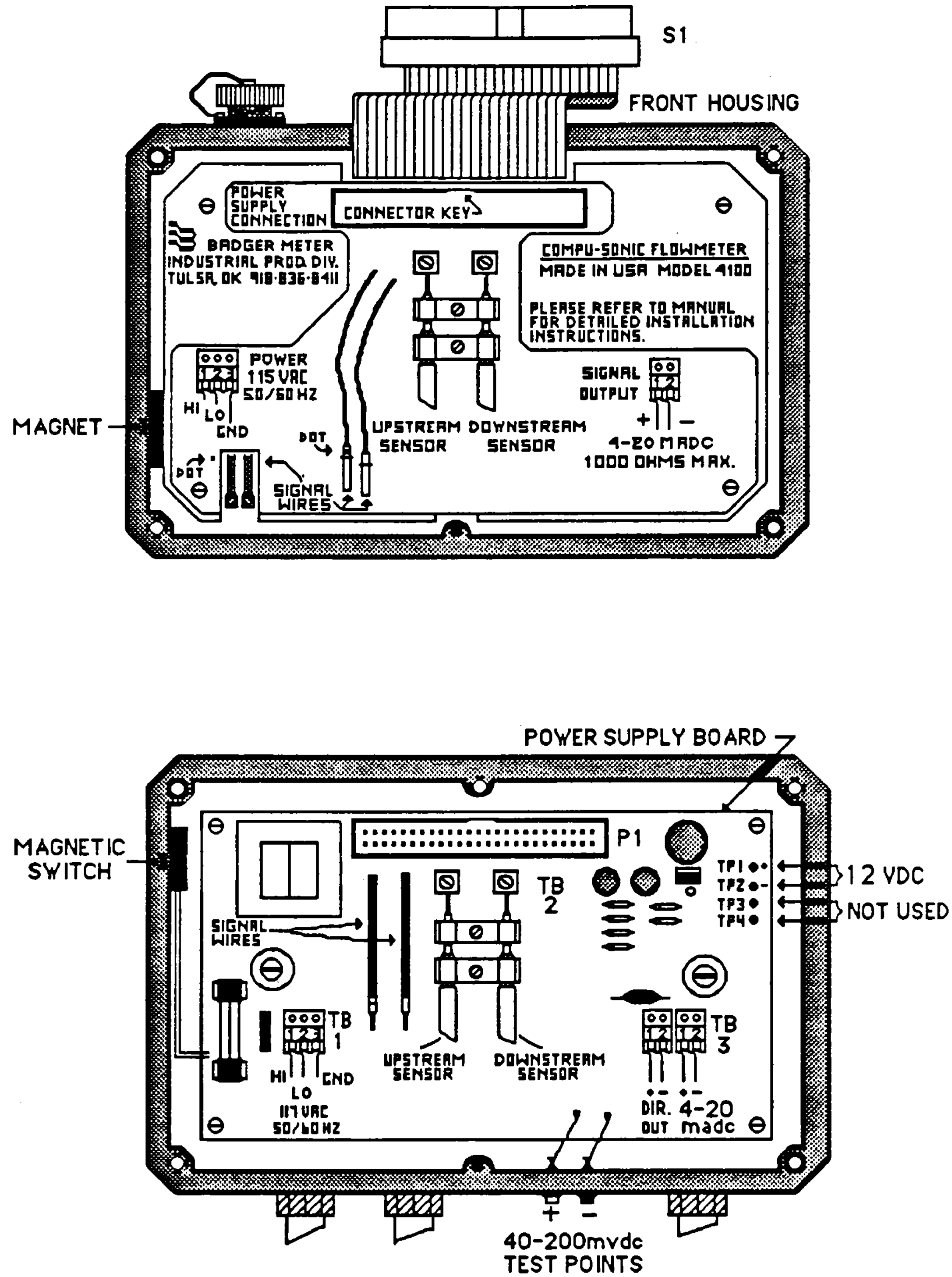
3. Remove middle cover. Measure 1-1/8" from the end of the cable. With a cutting tool, carefully cut through the middle covering completely around the cable making sure not to cut into the middle shield. Make another cut from the first cut to the end of the cable and remove the middle cover.

4. Remove middle shield. Measure 3/4" from the end of the cable. With a pair of small cutters, cut the shield around the cable at the measured point and remove the cut off shield.

5. Remove inner cover. Measure 1/2" from the end of the cable. With a cutting tool or pair of wire strippers, carefully cut the inner covering competely around the cable, making sure not to cut into the center conductor and remove the inner cover.

After the ends of the cables have been prepared loosen the screws on terminals 1 and 2 of TB2 on the standard power supply (TB3 on the accessory power supply) and remove the two pairs of clamps below TB2 (TB3). Take the upstream cable and insert the center conductor into terminal 1 of TB2 (TB3) and tighten the screw. Slightly pull on the cable to ensure the wire is secured to the terminal. Take the downstream cable and insert the center conductor into terminal 2 of TB2 (TB3) and tighten the screw. Slightly pull on the cable to ensure the wire is secured to the terminal.

Place the two pair of clamps over the middle and outer shields and secure them into place. Verify that the clamps are making good contact with the shields and that no wires of the shields are extending beyond their own clamp down area.



S1
FRONT HOUSING
POWER SUPPLY CONNECTION
CONNECTOR KEY
BADGER METER
INDUSTRIAL PROD. DIV.
TULSA, OK 918-836-8411
COMPU-SONIC FLOWMETER
MADE IN USA MODEL 4100
PLEASE REFER TO MANUAL FOR DETAILED INSTALLATION INSTRUCTIONS.
POWER
115 VAC
50/60 HZ
HI
LO
GND
MAGNET
POT
SIGNAL WIRES
UPSTREAM SENSOR
DOWNSTREAM SENSOR
SIGNAL OUTPUT
4-20 MADC
1000 OHMS MAX.
POWER SUPPLY BOARD
MAGNETIC SWITCH
P1
TB 2
TP1
TP2
TP3
TP4
12 VDC
NOT USED
SIGNAL WIRES
TB 1
HI
LO
GND
117 VAC
50/60 HZ
UPSTREAM SENSOR
DOWNSTREAM SENSOR
TB 3
DIR. OUT
4-20 madc
40-200mvdc
TEST POINTS

FIGURE 2-7

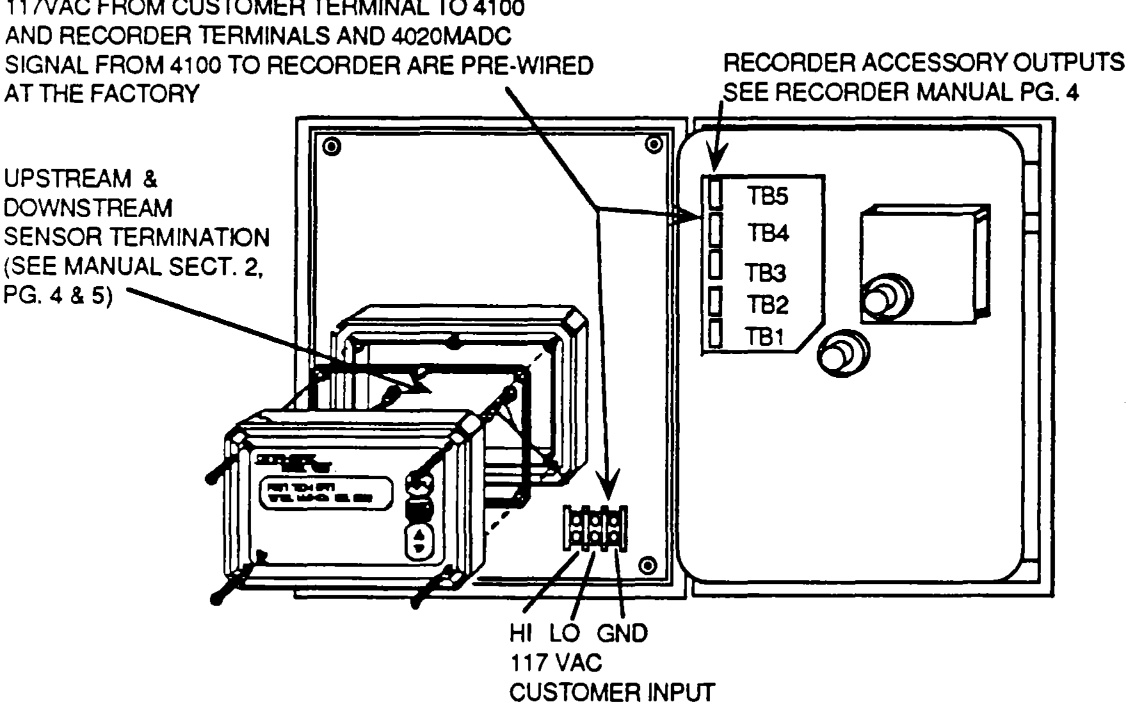
Front housing installation. After the wiring of the back housing is completed, the front housing can be reinstalled. The gasket is attached to the front housing to ensure proper alignment for maintaining a good seal.

Refer to Figure 2-7. On the front housing there is a protective cover for the electronic boards that also has the drawing for the wiring connections of the unit. Connect the ribbon cable plug S1 coming from the front housing into the socket connector P1 on the power supply in the back housing.

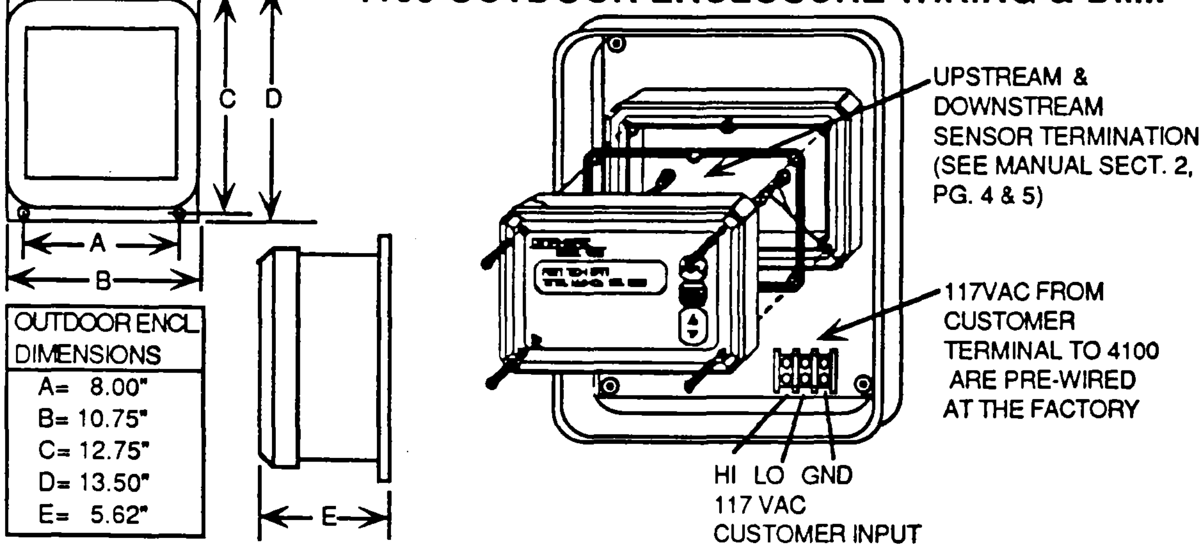
Insert the two signal wires coming from the power supply board in the back housing into the connectors on the electronic board in the front housing. One of the signal wires has a white dot marked on it and should be inserted into the connector next to the dot indicated on the protective cover drawing.

Secure the front housing to the back housing with the four hex bolts. This completes the enclosure installation procedure.

4100R+ WIRING DIAGRAM



4100 OUTDOOR ENCLOSURE WIRING & DIM.



TRIAX CABLE SPLICE PROCEDURE

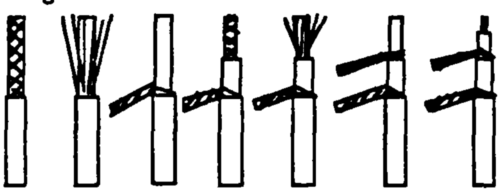
Materials Required

* 4 pigtail cap crimps (Wire size 18-12)
* 2 center conductor cap crimps (Wire size 22-14)
* 1 roll of electrical tape
* 2 epoxy resin envelopes

Crimp tool (customer supplied)
Knife (customer supplied)
Pointed tool (customer supplied)
Junction Box (customer supplied)

A cable connection kit may be purchased through Badger Meter that will include the * items above(part # 541874).

Trim each of the four cables at the junction box to nine inches in length. Each of the four cables can now be prepared as described in the sequence following:



A B C D E F G

Using a knife, trim two inches for outer jacket from each cable. The wire braid beneath the outer jacket must not be cut . See "A"

Using a pointed tool, carefully comb out the outer braid of each cable as shown in "B". Form the combed braid into a pigtail dressed to the side of the cable as shown in "C".

Trim one inch of the inner jacket from each of the cables as shown in "D". Again, use care to not cut the inner braid beneath the inner jacket.

Using a pointed tool, carefully comb out the inner braid "E" into a pigtail dressed to the same side of the cable as outer pigtail as in "F".

Remove 1/2 inch of insulation from the inner conductor of each cable. Cut the outer pigtail to the same length as the inner pigtail on each cable. "G" depicts the completed cable preparation.

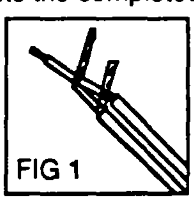


FIG 1

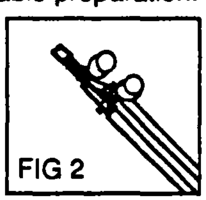


FIG 2

Cable Termination

Pull cables approximately 18 inches outside of junction box.Select one sensor cable and one cable from the electronic enclosure and place them side by side as shown in Fig. 1. Twist each cable's outer pigtails together, then the inner pigtails together and finally the center conductors together to form the cable splice. In similar fashion, connect the remaining sensor cable and the cable from the electronic enclosure.

Identification of upstream and downstream sensor cables must now be made. Connect a short wire from the center conductor splice to the inner shield pigtail splice on the upstream sensor cable. Using a multimeter determine the upstream sensor cable at the electronic enclosure end by continuity measurement. Identify the upstream cable for later termination.

Remove the shorting wire and using the cap crimps supplied, crimp the larger caps on each spliced pigtail and the small cap on the center conductor splice as shown in Fig. 2. Repeat this procedure for the second cable.

At this point turn power on at the electronics and verify that an OK signal condition appears on the display.

Turn power "OFF".

1. Read caution statement at bottom.
2. Remove guard bag, using caution not to damage inner bag.
3. Grip both edges of bag at the center barrier (fig.3) and wrinkle and flex the bag across the barrier. This will weaken the barrier.
4. Squeeze the clear side of the resin, forcing the resin through the center barrier.
5. Mix thoroughly to a uniform color by squeezing contents back and forth 25-30 times.
6. Squeeze resin to one end of bag, and cut off the other end (fig. 4).
7. Slowly insert connection into sealing pack until it fits snugly against the opposite end (fig 5).
8. Wrap open end of bag with vinyl electrical tape and position the taped end up untill resin jells (fig 6).

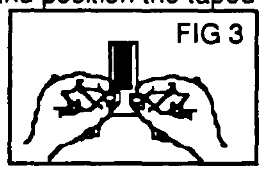


FIG 3

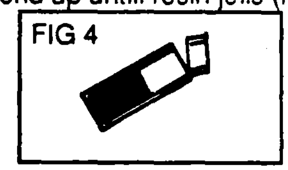


FIG 4

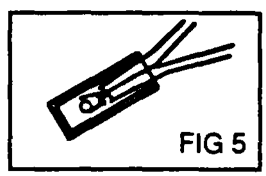


FIG 5

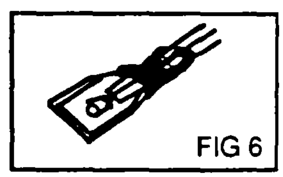


FIG 6

The finished splices should be coiled inside the junction box. When properly placed, the splices should be clear of the junction box cover area. Proper sealing of the junction box is necessary for watertight integrity.

This completes the triax cable splice connection.

The sealer kit above is a 3M Scotchlok #3570 product
IRRITATING TO SKIN AND EYES ON DIRECT CONTACT

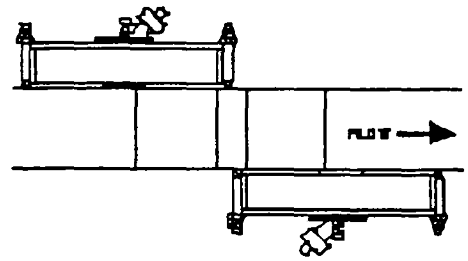
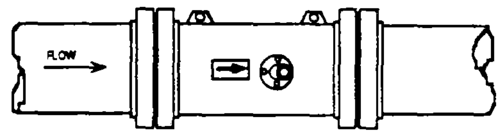
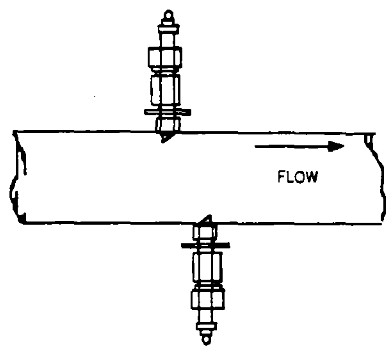
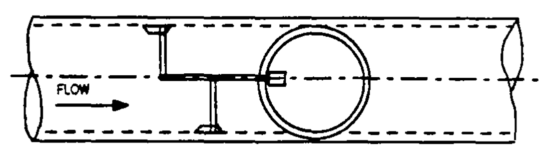
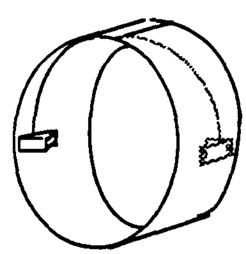
May cause skin sensitization in susceptible individuals. May be toxic by skin absorption. Harmful if swallowed. Vinyl cyclohexene dioxide has caused skin cancer in animal tests. Contains epoxy resin and vinyl cyclohexene dioxide.

Avoid skin and eye contact. Use only in well-ventilated areas with sufficient air movement to maintain airborne vapor levels at recognized health and safety levels. Wash thoroughly after using, before eating, drinking or smoking.

EYE CONTACT: Immediately flush eyes with water for at least ten minutes. Call physician
SKIN CONTACT: Wash with soap and water. INHALATION: Provide fresh air.

SECTION 3- SENSOR INSTALLATION

This section includes installation for the various sensors used with the Series 4000 ultrasonic flowmeter. Refer to the customer data sheet in the front of this manual to determine the type of sensors that is supplied.

SENSOR TYPE	SECTION/PAGE	
UNIVERSAL STRAP-ON	3A-1 THRU 3A-14	
WINDOW SPOOL	3B-1 THRU 3B-2	
HS3 "HOTSHOT" SENSOR	3C-1 THRU 3C-4	
INSTREAM WETTED REFRACTING SENSOR	3D-1	
WETTED SENSOR WITH HOOP	3E-1 THRU 3E-2	

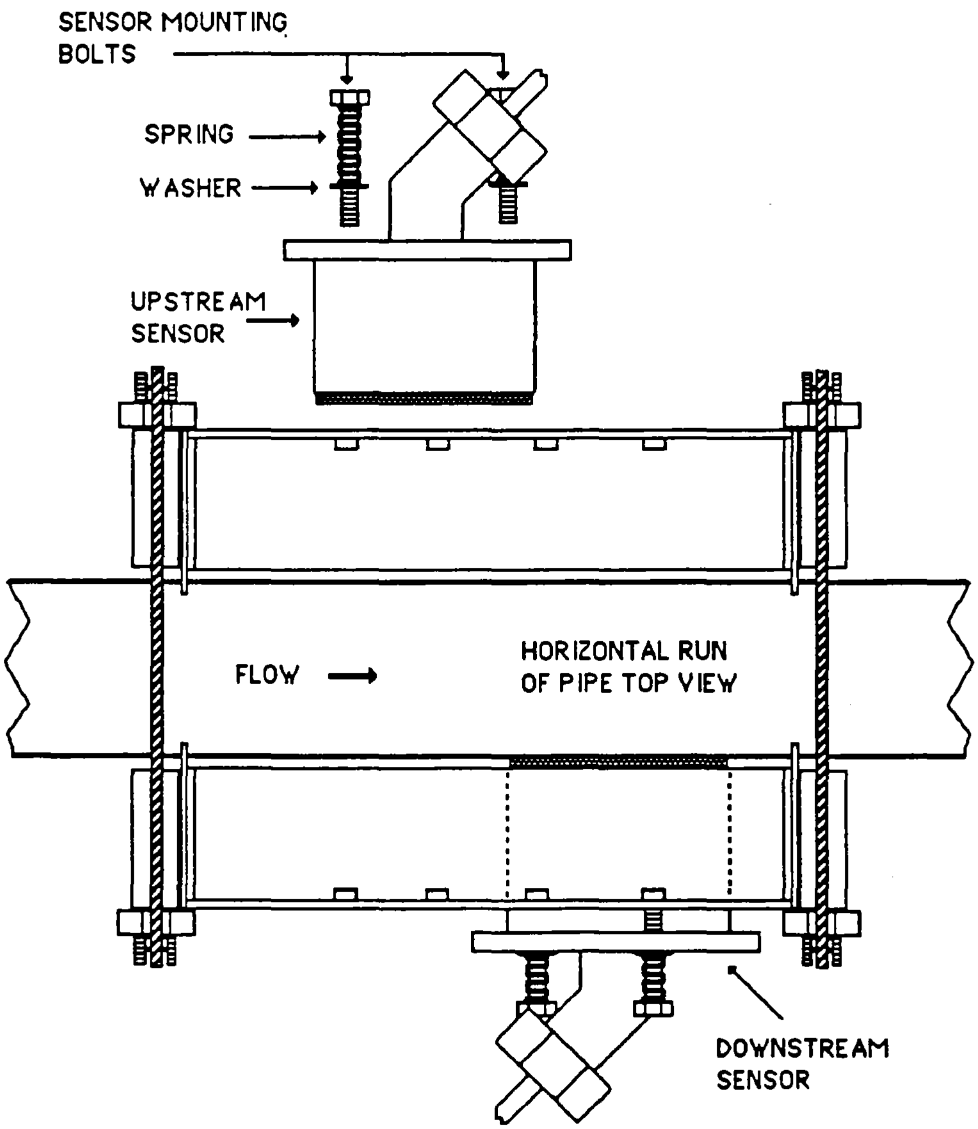
STRAP-ON SENSORS

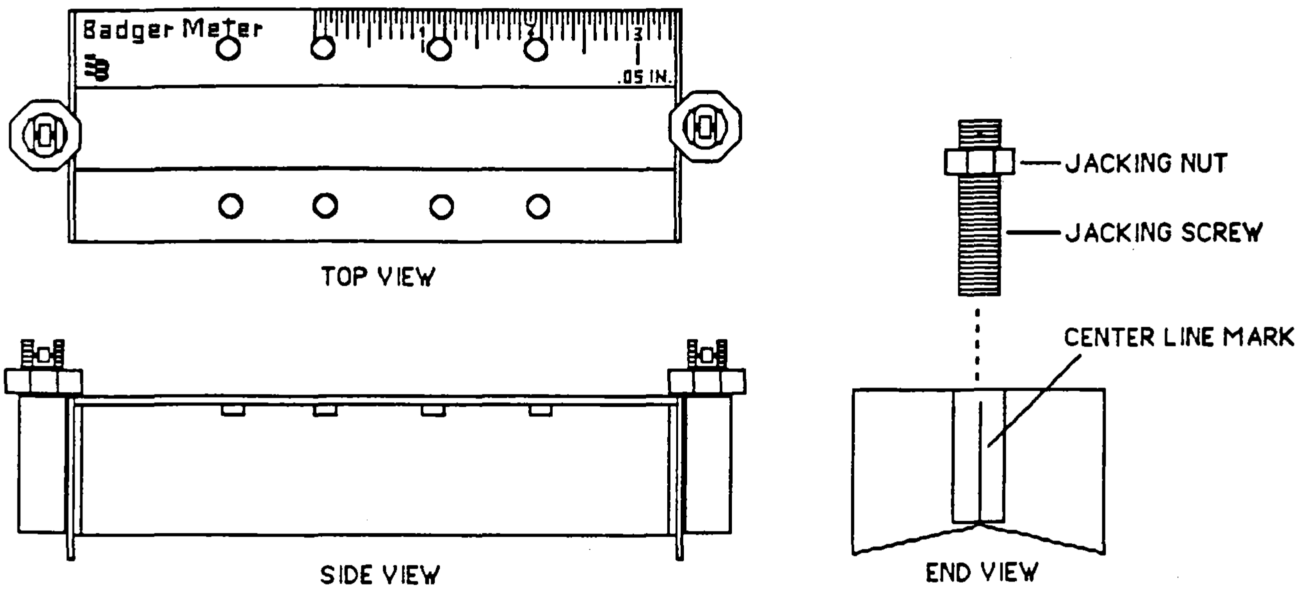
The universal strap-on sensors for the Series 4100 are designed for external mounting on pipes made of material, such as steel or plastics, that will support ultrasonic signal transmissions. The mounting hardware is constructed of corrosion resistant materials and designed for ease of installation.

It is important that the sensors are installed correctly on the pipe to ensure good accuracy. A template is provided for positioning the sensor holders on the pipe. There are three sensor mounting configurations. The proper configuration for your application is indicated on the data sheet in the front of this manual. When properly installed, the sensors will be located 180 degrees apart on opposite sides of the pipe and be offset upstream and downstream by the distance on the data sheet in the front of this manual. The sensors may be mounted on horizontal or vertical pipe runs. **If the pipe is horizontal, the sensors must be located on the sides and not on the top and bottom.**

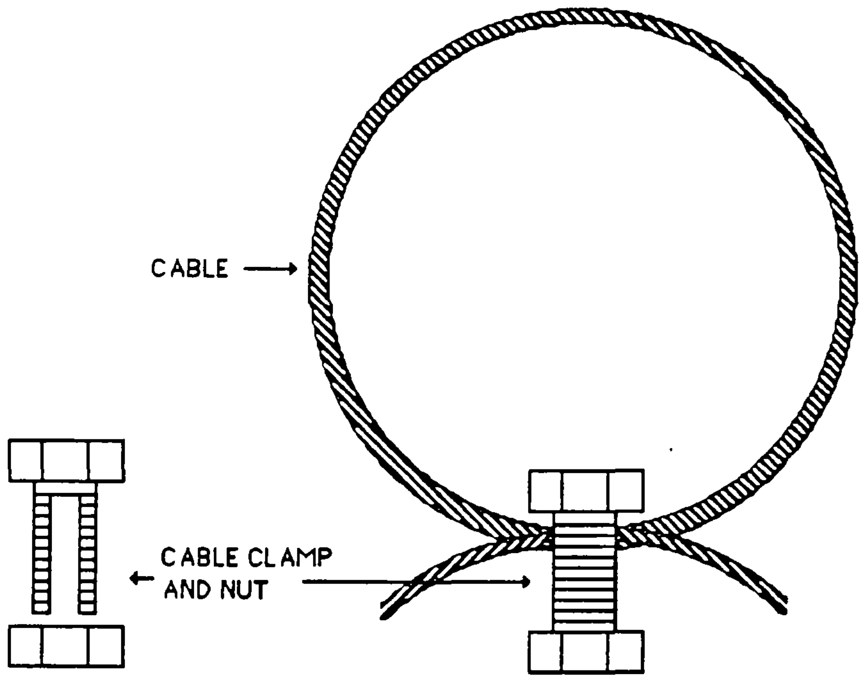
It is important that there be as much upstream straight run as possible so there will be a well developed velocity profile at the point of measurement. There should be 3 pipe diameters of downstream straight run after the point of measurement.

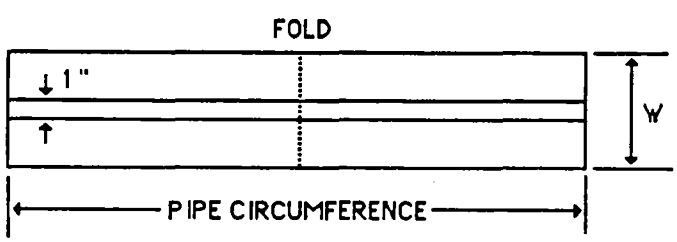
The drawings below and on the next page show the sensor mounting configuration Case A and sensor and mounting hardware. Included with the mounting hardware are: two sensor holders; four jacking screws and nuts; two or four lengths of stainless steel cables (depending on the sensor configuration); two or four cable clamps and nuts (depending on the sensor configuration); two sensors with four bolts, springs and washers; and a template.





SENSOR HOLDER





TEMPLATE

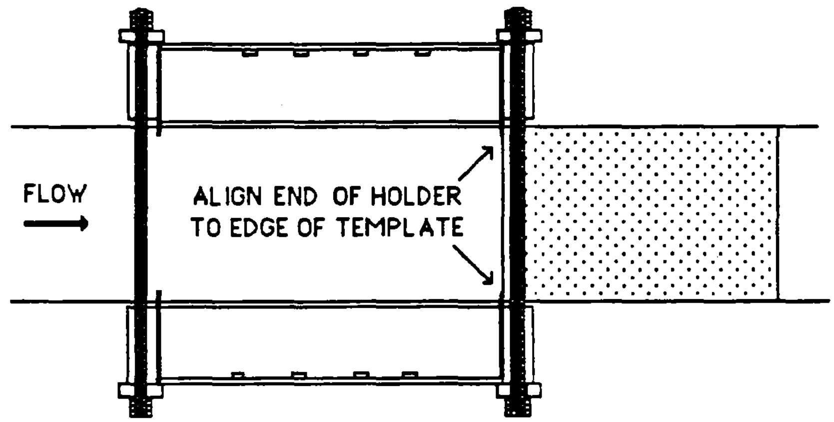
W (WIDTH)	MOUNTING CONFIGURATION
7"	Case A, B & C
14"	Case D
21"	Case E
28"	Case F
35"	Case G
42"	Case H
49"	Case I
56"	Case J

SENSOR HOLDER INSTALLATION

There are three different mounting configurations for the installation of the Series 4100 universal sensors and mounting hardware. These configurations are referred to as Case A, Case B and Case C through J. The difference in these configurations is the location of the sensor holders with reference to the template. See the data sheet in the front of this manual for the proper configuration for your application.

Once you have determined the mounting configuration for your application, inspect the pipe and select a section that is relatively smooth and free of any protrusions or large indentations. Take the sensor mounting template and wrap it around the pipe. Mark the template where it overlaps. Remove the template and cut off one end so that it is now the circumference of the pipe. Fold the template in half.

SENSOR MOUNTING
CONFIGURATION
CASE A

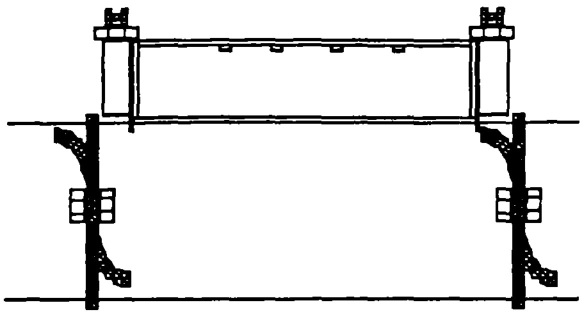


If your application calls for configuration Case A, the mounting will be as shown above. Case A requires that the sensor holders be mounted directly across from each other. The ends of the sensor holders will be aligned to the edge of the template. It does not matter if they are aligned to the left or right of the template.

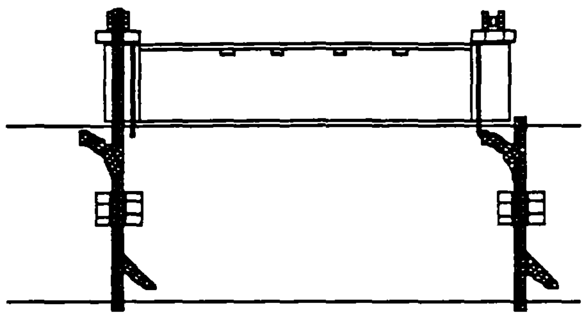
After the template has been folded in half to make the crease, wrap it around the pipe. Tape the ends together. The fold and the ends that meet will be used to locate the center of the holders.

Once the template is secured to the pipe, remove all extraneous material such as dirt, rust, coatings, etc. from the area of the pipe where the sensor holders will be located (at the fold and where the template ends meet). The pipe surface must be clean and smooth. A file or grinding tool may be required to ensure a smooth surface.

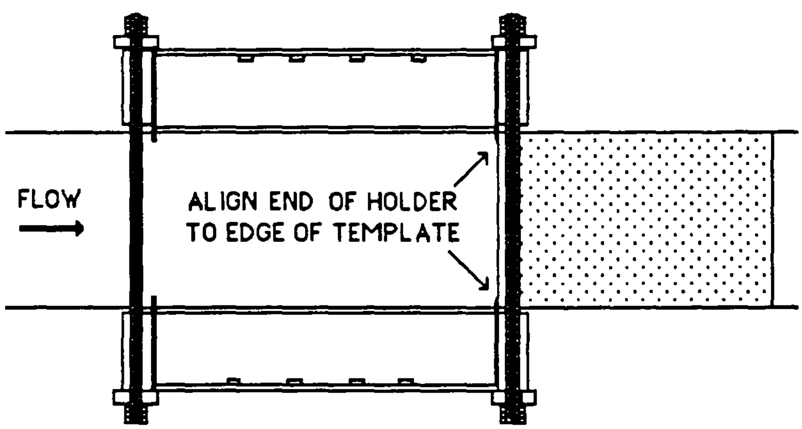
Take the two steel cables and cable clamps and attach the cables as shown . Tighten the cable clamps with your fingers where the cable will not be loose but the cable will slide through the cable clamp by pulling on it. The picture is a view from the side of the pipe.



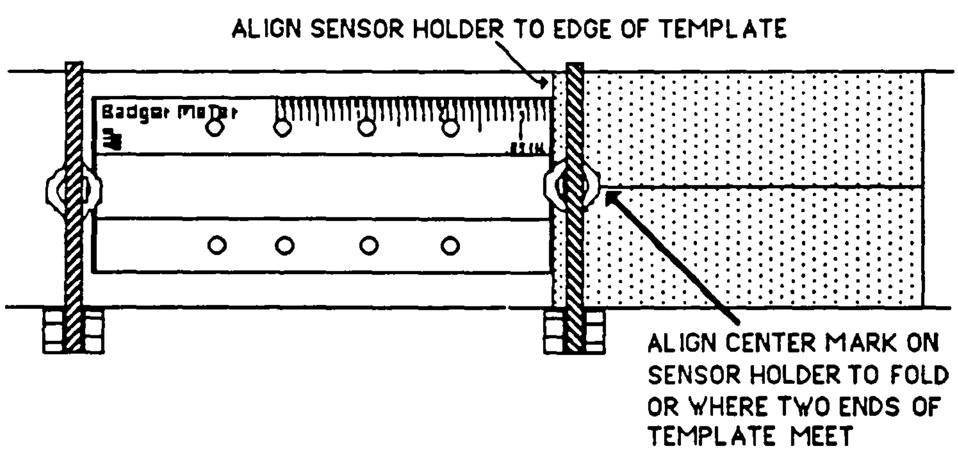
Place one of the sensor holders on the top of the pipe as shown. Be sure that the sensor holder is positioned so that when the sensor holders are rotated to align the center marks with the fold and ends of the template, the scale is on the top as pictured at the bottom of this page.



Pull on one of the cables and slip it over the notch of the jacking screw. Do the same with the other cable. Rotate the sensor holder and cables so that the sensor holder is now on the bottom of the pipe.

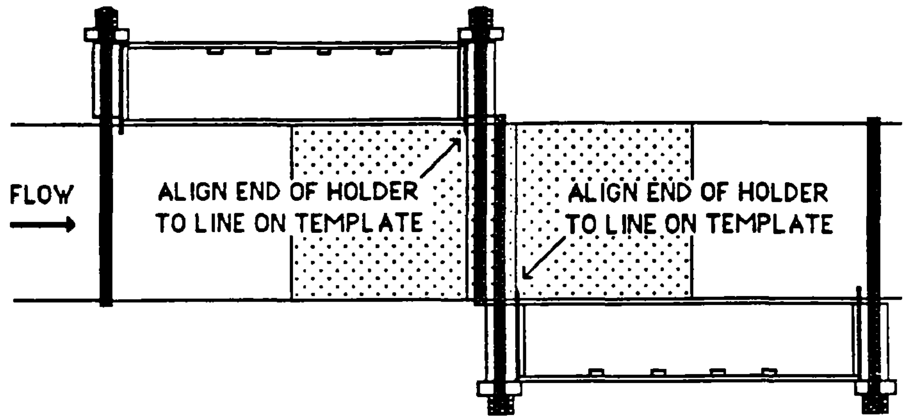


Install the second holder in the same manner as the first. Remember to position the sensor holder so that when the holders are rotated to align the centers with the fold and ends of the template that the scales will be readable and not upside down. Take up the slack in the cables and tighten the cable clamps securely (3/4" wrench).



Rotate the sensor holders so that the center line mark is aligned with the fold or two ends and that the end of the holder is to the edge of the template. Tighten the jacking screw nuts, gradually tightening one on one holder then on the other until the holders are secure to the pipe.

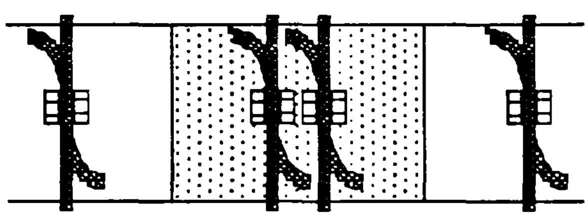
SENSOR MOUNTING
CONFIGURATION
CASE B



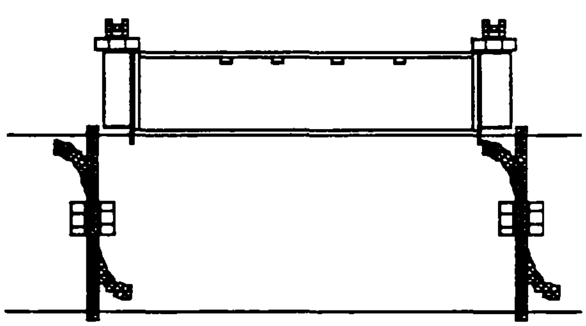
If your application calls for sensor configuration Case B, the sensor holders will be mounted as pictured above. The ends of the holders will be aligned to the two lines in the center of the template.

After the template has been cut to the circumference of the pipe, fold the template in half. Wrap the template around the pipe and mark on one side of the pipe to the right of the fold of the template and on the other side of the pipe to the right of where the two ends of the template meet. Remove the template and remove all extraneous material such as dirt, rust, coatings,etc. from the area of the pipe where the sensor holders will be located. The pipe surface must be clean and smooth. A file or grinding tool may be required to ensure a smooth surface.

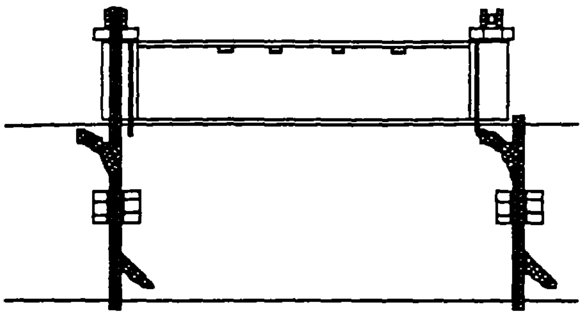
Reinstall the template securing it to the pipe and aligning the fold and the two ends of the template to the areas just prepared.



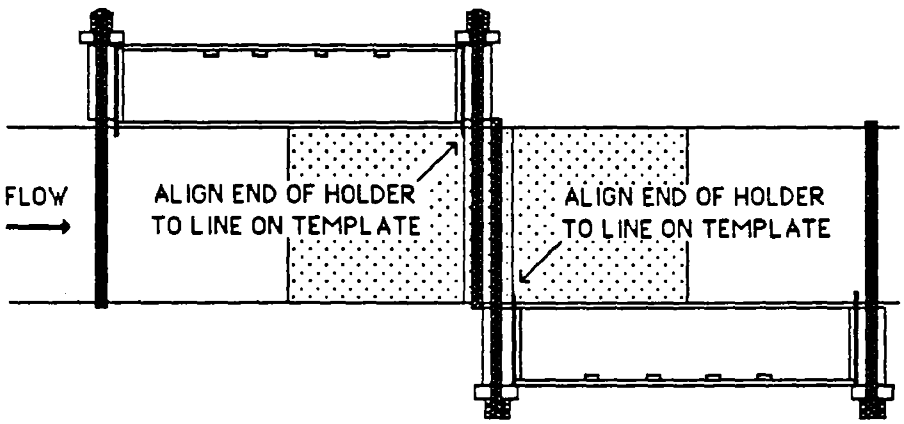
Take the four steel cables and cable clamps and attach the cables as shown . Tighten the cable clamps with your fingers where the cable will not be loose but the cable will slide through the cable clamp by pulling on it. The picture is a view from the side of the pipe. Rotate the cables so that the cable clamps are at the bottom of the pipe.



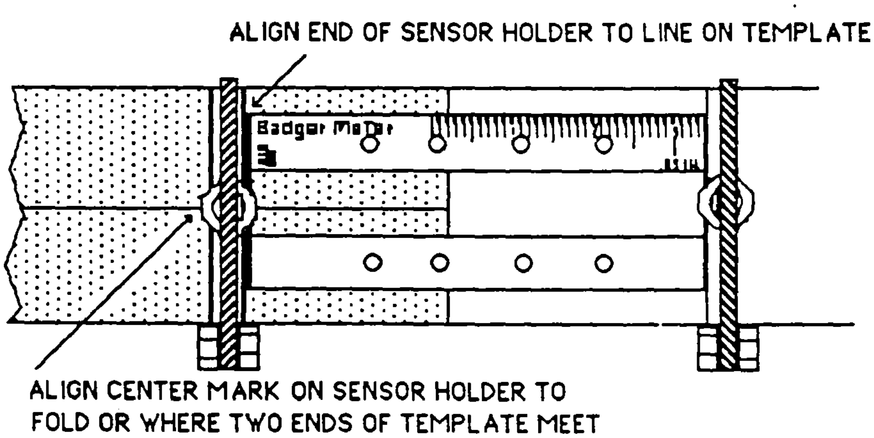
Place the sensor holders on the top of the pipe as shown. Be sure that the sensor holders are positioned so that when they are rotated to align the center marks with the fold and ends of the template, the scale is on the top as pictured on the bottom of the next page.



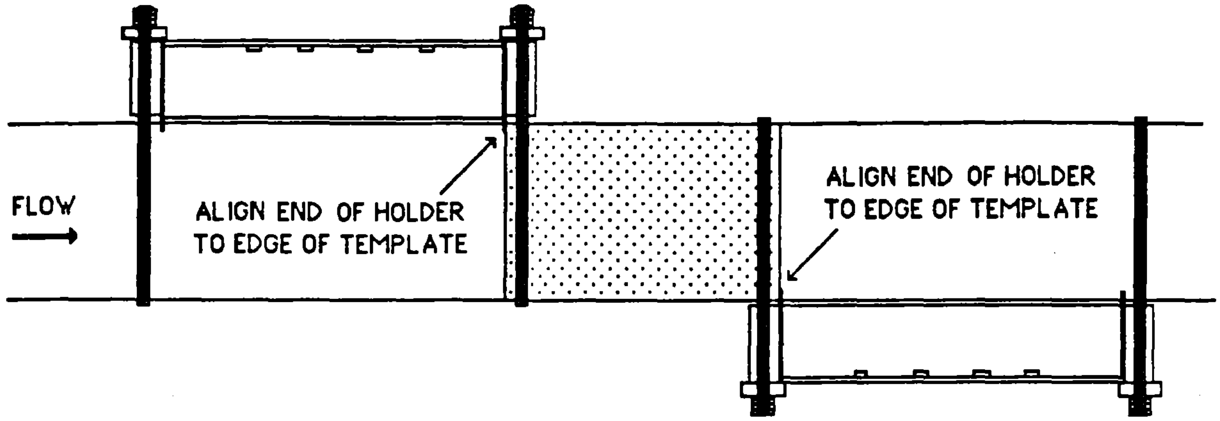
Pull on one of the cables and slip it over the notch of the jacking screw. Do the same with the other cable. Take up the slack in the cables and tighten the cable clamps securely (3/4" wrench).



Rotate the sensor holders and align the ends of the holders with the lines on the template. View is from top of pipe.



Align the end of the holder to the line on the template and the center mark on holder to fold or two ends of template. Adjust the jacking screw nuts so that the jacking screws tighten the holder securely to the pipe (3/4" wrench). Cut out the template paper under the holder.

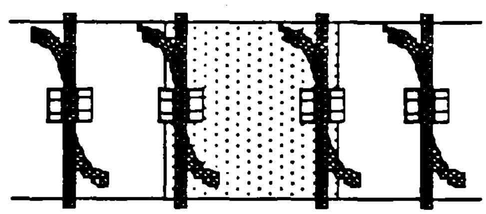


SENSOR MOUNTING
CONFIGURATION
CASES C TO J

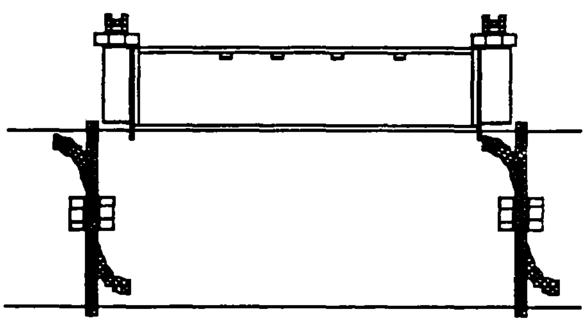
If your application calls for configuration Cases C to J, the mounting will be as shown above. Cases C to J require that the ends of the sensor holders be aligned to the edges of the template.

After the template has been folded in half to make the crease, wrap it around the pipe. Tape the ends together. The fold and the ends that meet will be used to locate the center of the holders.

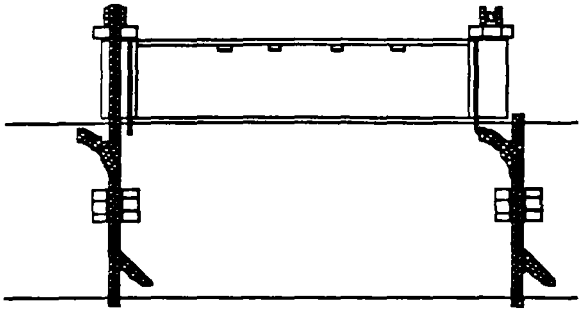
Once the template is secured to the pipe, remove all extraneous material such as dirt, rust, coatings, etc. from the area of the pipe where the sensor holders will be located (at the fold and where the template ends meet). The pipe surface must be clean and smooth. A file or grinding tool may be required to ensure a smooth surface.



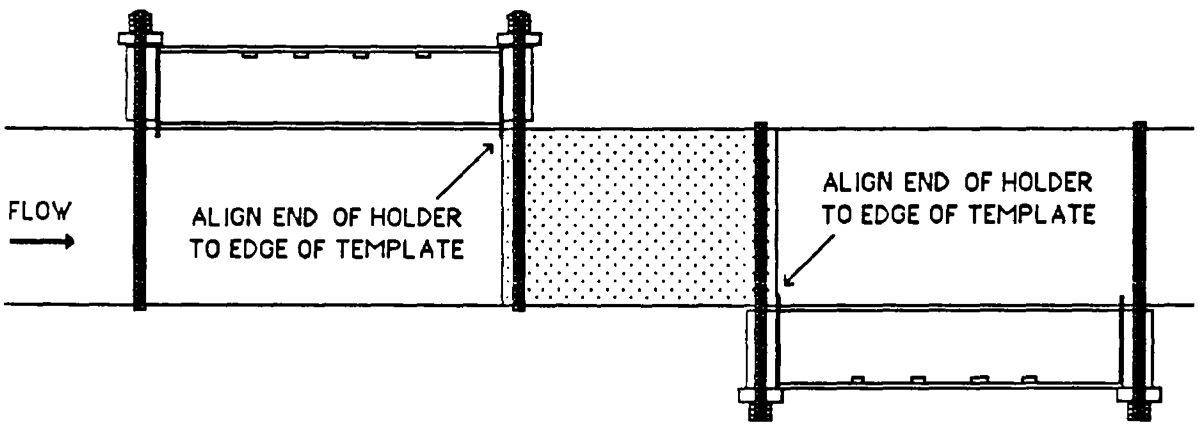
Take the four steel cables and cable clamps and attach the cables as shown . Tighten the cable clamps with your fingers where the cable will not be loose but the cable will slide through the cable clamp by pulling on it. The picture is a view from the side of the pipe. Rotate the cables where the cable clamps are at the bottom of the pipe.



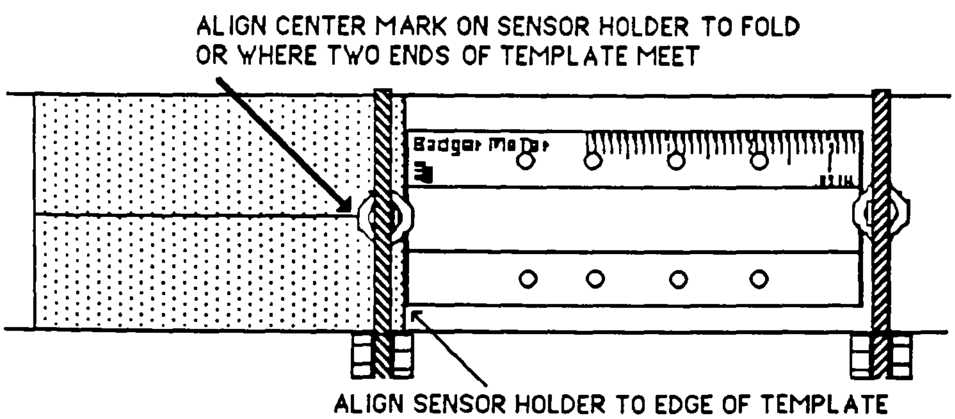
Place the sensor holders on the top of the pipe as shown. Be sure that the sensor holder is positioned so that when they are rotated to align the center marks with the fold and ends of the template, the scale is on the top as pictured on the bottom of the next page.



Pull on one of the cables and slip it over the notch of the jacking screw. Do the same with the other cable. Take up the slack in the cables and tighten the cable clamps securely (3/4" wrench).



Rotate the sensor holders and align the ends of the holders with the edges of the template. View is from top of pipe.



Align the end of the holder to the edge of the template and the center mark on holder to fold or two ends of template. Adjust the jacking screw nuts so that the jacking screws tighten the holder securely to the pipe (3/4" wrench).

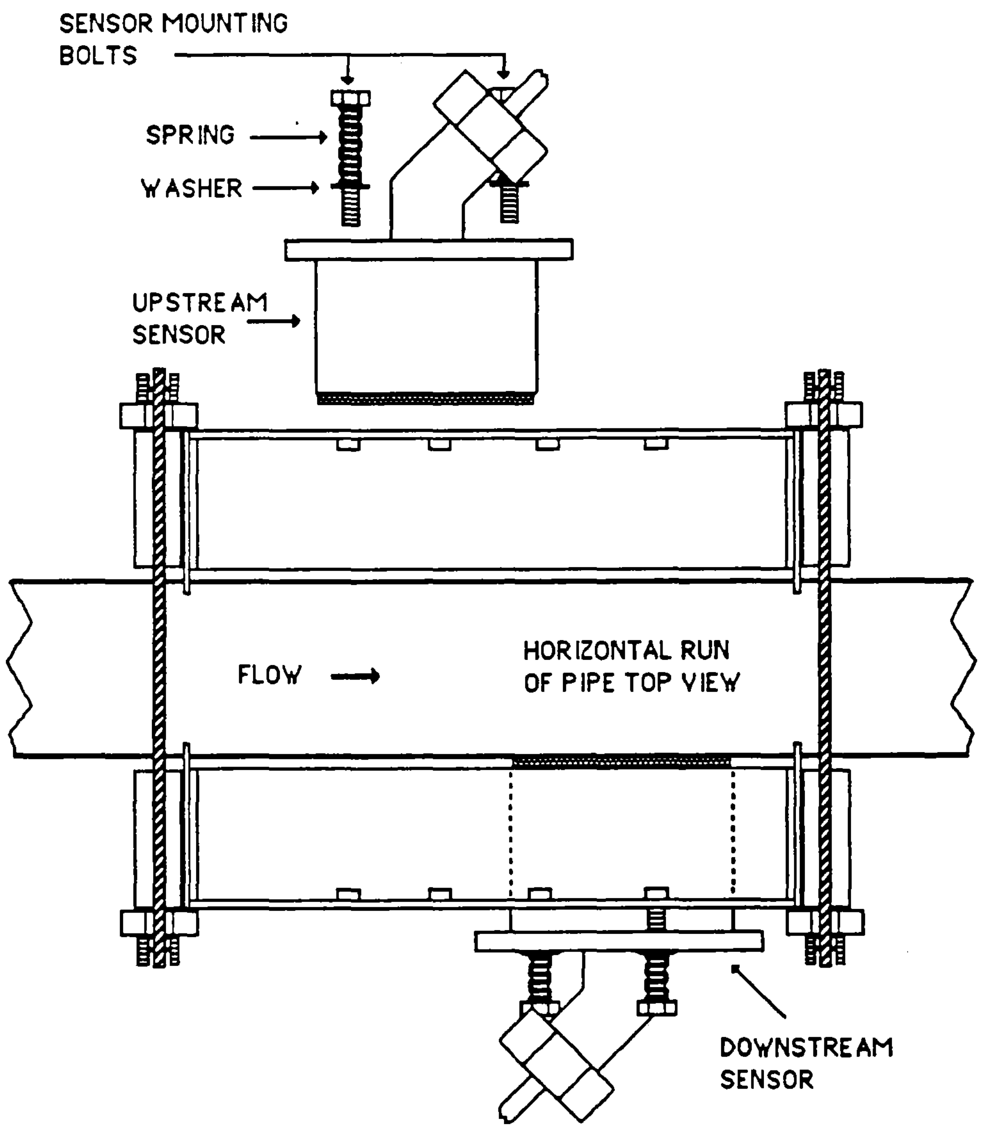
SENSOR INSTALLATION

After the sensor holders have been installed to the proper configuration, aligned to the template and secured to the pipe, the sensors can be installed.

It is very important that the sensors are installed in the correct direction and at the correct offset distance in order for the meter to function properly. The data sheet in the front of this manual will indicate the correct sensor offset.

The sensors are normally supplied with 100 feet of sensor cable. On the top plate of the sensor there is an arrow to indicate the position of the sensor with respect to the direction of flow. Mark the ends of the sensor cables to identify which sensor is upstream and which is downstream. This is so the cables will be connected to the correct sensor terminal connections in the electronic enclosure.

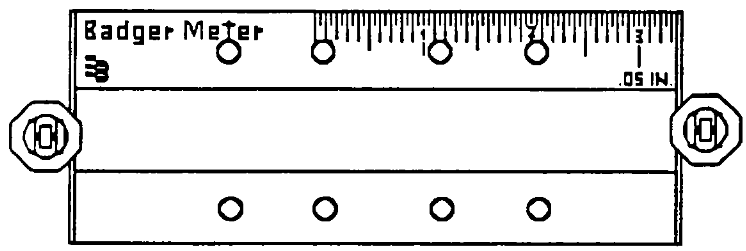
The picture below shows the mounting of the sensors in mounting configuration Case A. There are four bolts, washers and springs provided to mount the sensors to the sensor holders.



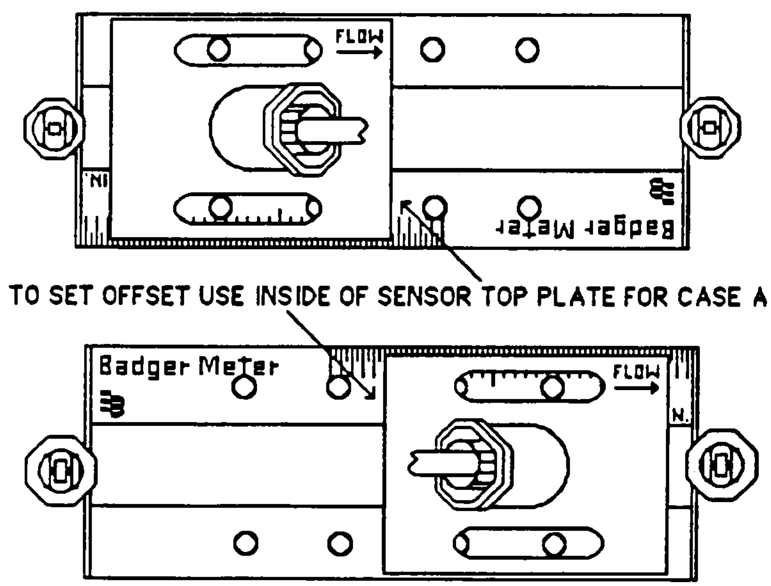
The position of the sensors in the holders is determined by the offset value. See the data sheet in the front of this manual to determine the value of the sensor offset.

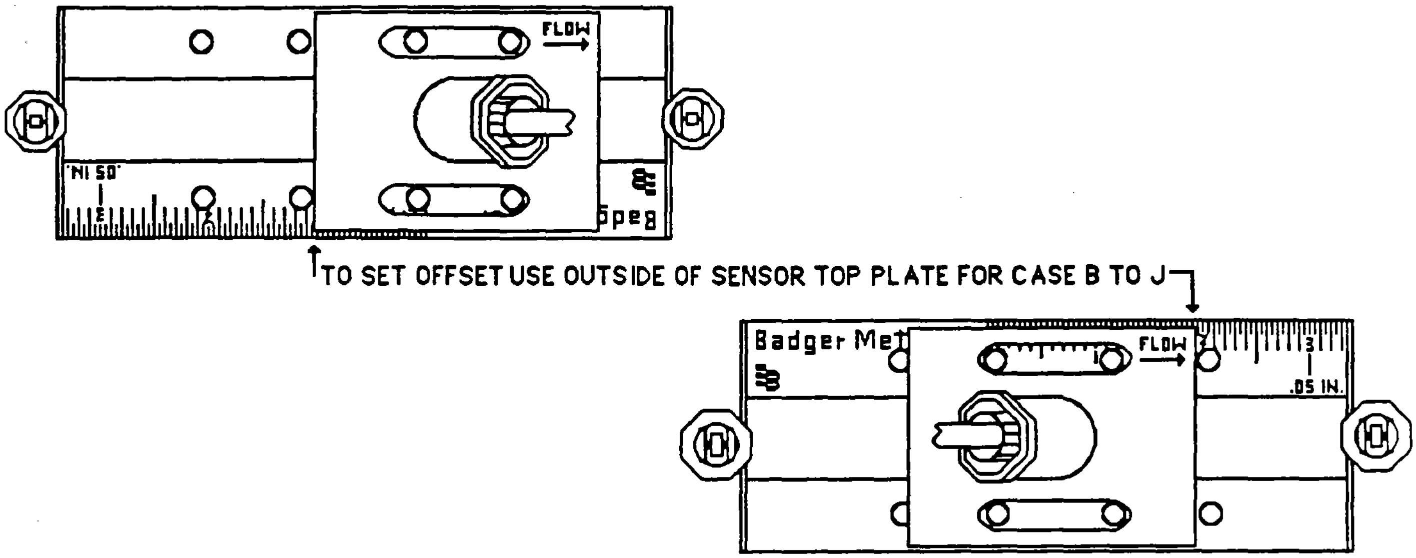
There is a scale on each of the sensor holders that is to be used when positioning the sensors to the offset called out on the data sheet. The outside or inside edge of the sensor top plate(depending on the mounting configuration) is used to align the sensor to a value on the scale. The offset value is the sum of the values set for each sensor. For example, if the sensor offset is 2.2 inches, then one sensor could be aligned with 1.1 inches on its scale and the other sensor would be aligned with 1.1 inches on its scale. The sum of the two would be 2.2 inches. This could have been 1.0 inch on one sensor and 1.2 inches on the other sensor, just as long as the two values added up to 2.2 inches.

This picture shows the sensor holder with the scale to be used when adjusting sensors for sensor offset. The scale is in 0.05 inch increments.



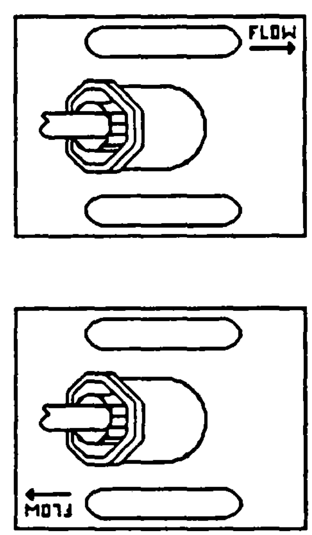
This picture shows that the inside edge of the sensor top plate is used to align the sensors for the proper offset value for the mounting configuration Case A. This example shows the sensor offset value to be 0.95 inches. The top sensor is set to 0.45 inches and the bottom sensor is set to 0.5 inches for a total offset of 0.95 inches.





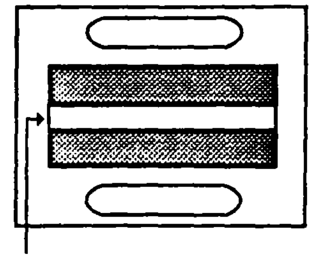
The above picture shows that the outside edge of the sensor top plate is used to align the sensors for the proper sensor offset for mounting configuration Cases B to J. This example shows the sensor offset value to be 3.00 inches. The top sensor is set to 1.05 inches and the bottom sensor is set to 1.95 inches for a total offset of 3.00 inches.

The pictures to the right show the top of the sensors. There is a flow direction arrow decal on the lower left corner on one sensor and on the upper right corner on the other sensor. When the sensors are installed correctly the arrows should be pointing in the direction of the flow. NOTE: On one of the sensors, when mounting on a horizontal pipe, the word FLOW will be upside down.



Prior to installing the sensors into the holders, apply a bead of the grease, furnished with the meter, across the center of the face of the sensor. The grease does not have to cover the entire face but only across the center as pictured to the right.

VIEW FROM FACE OF SENSOR



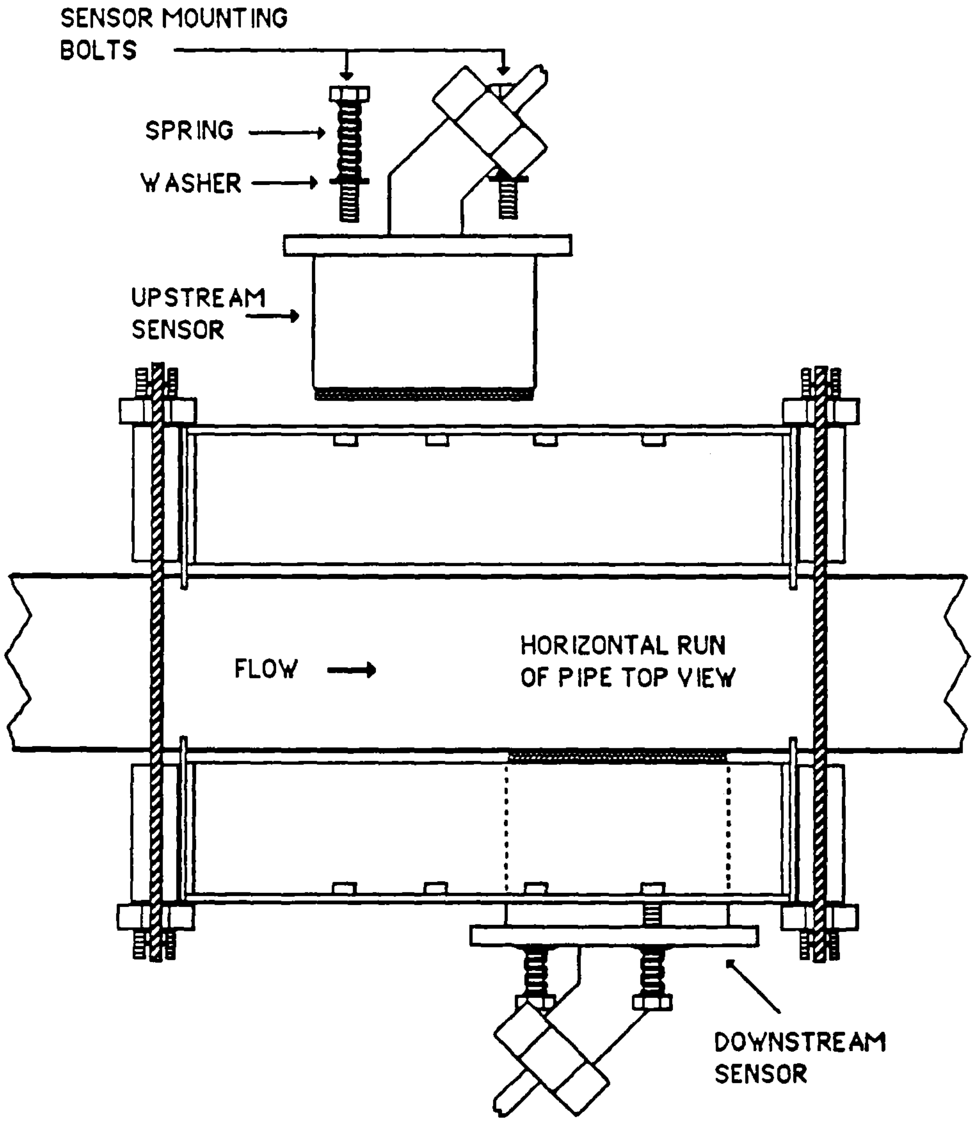
APPLY GREASE ACROSS CENTER OF SENSOR FACE

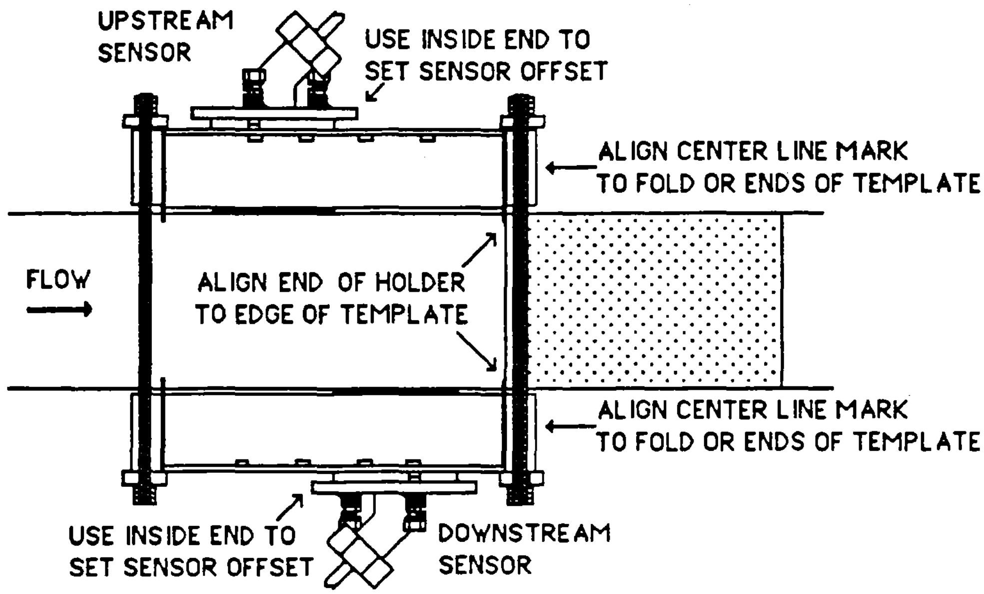
After determining the position to locate each sensor to get the sensor offset distance and having put the grease on the face of the sensor, install each sensor with the two bolts, springs and washers as pictured to the right.

If four threaded holes are visible through the slots in the top plate of the sensor, install the bolts at opposite corners.

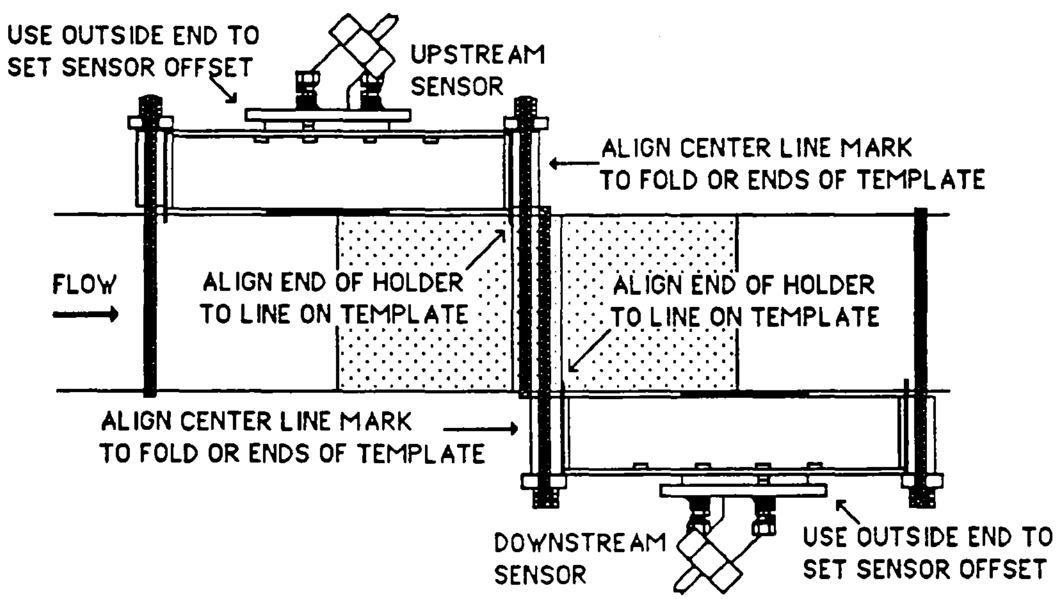
Tighten the bolts until the spring comes in contact with the holder and the bolt head. Tighten the bolts two and one-half more turns. This should be done one-half turn at a time, alternating between the two bolts.

Once the installation is complete, it should look like one of the pictures on the next pages depending on the mounting configuration for your application.

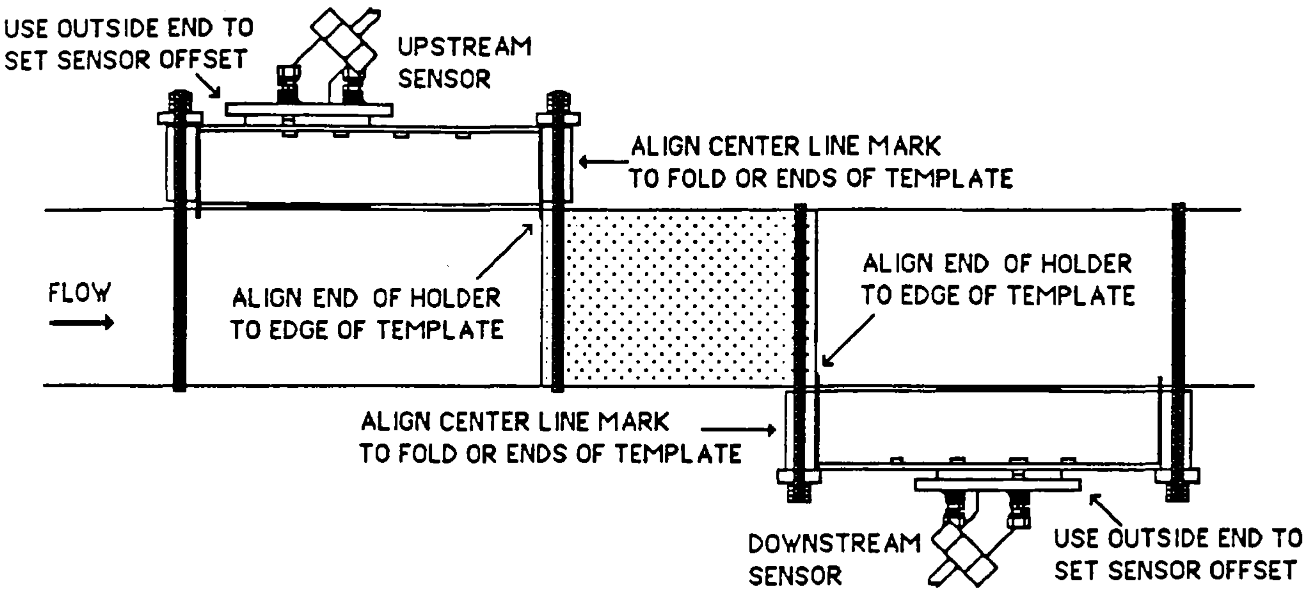




SENSOR MOUNTING CONFIGURATION
CASE A



SENSOR MOUNTING CONFIGURATION
CASE B



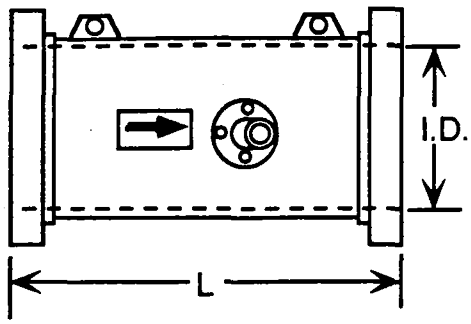
SENSOR MOUNTING CONFIGURATION
CASE C TO J

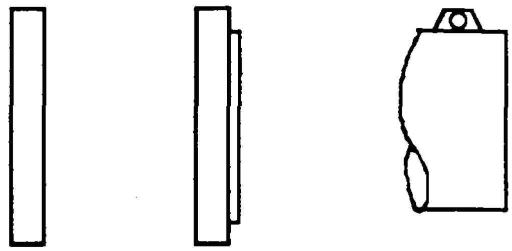
The sensors are supplied with 3/8 inch conduit fitting. It is recommended that flexible seal tight conduit be used to run the sensor cables to a junction box and then both cables can be run in a common conduit back to the electronics enclosure. <u>Be sure to mark the end of the sensor cables as upstream and downstream before pulling cables through the conduit.</u>

Refer to the electronic enclosure Wiring Section for instruction on wiring the sensor cables to the connections in the enclosure. To determine proper meter operation refer to the Operation Section of this manual.

This completes the installation procedure for the sensors and holders for the Series 4100 Compu-Sonic flowmeter.

WINDOW SPOOL INSTALLATION



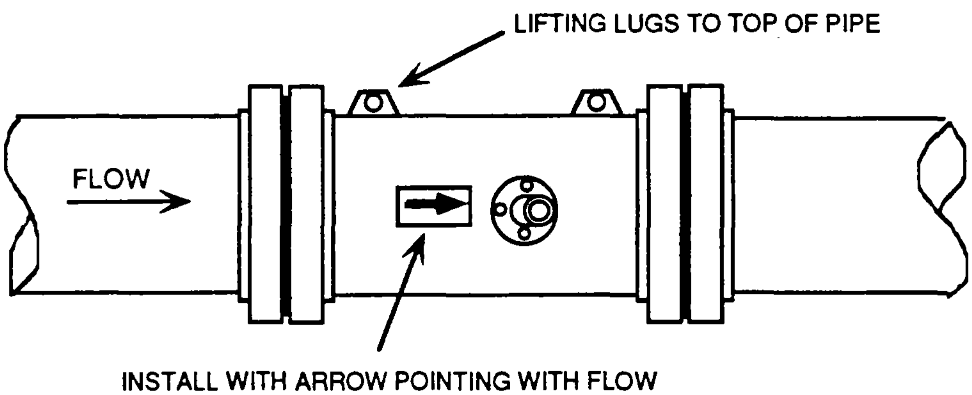


AWWA CL. D 125# FF — ANSI 150# RF — PLAIN END

REFER TO CUSTOMER DATA SHEET

L= LAYING LENGTH IN INCHES

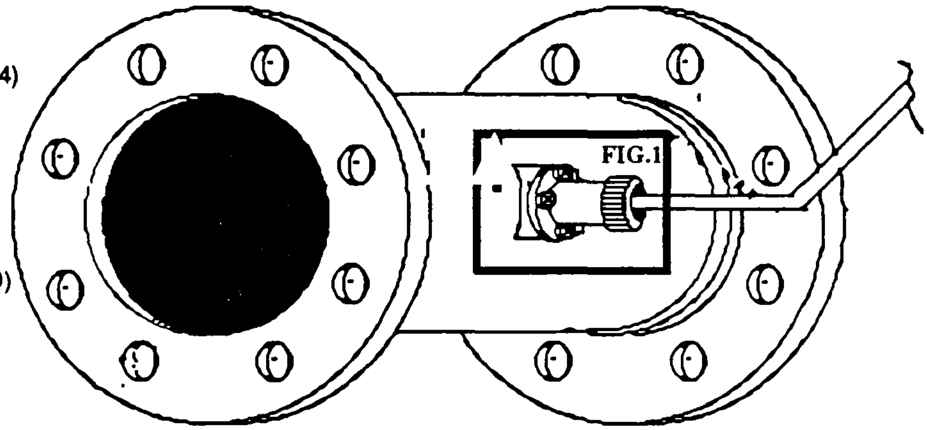
SIZE	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48
"L"	12	12	12	14	15	18	21	24	27	30	36	30	36	42	48

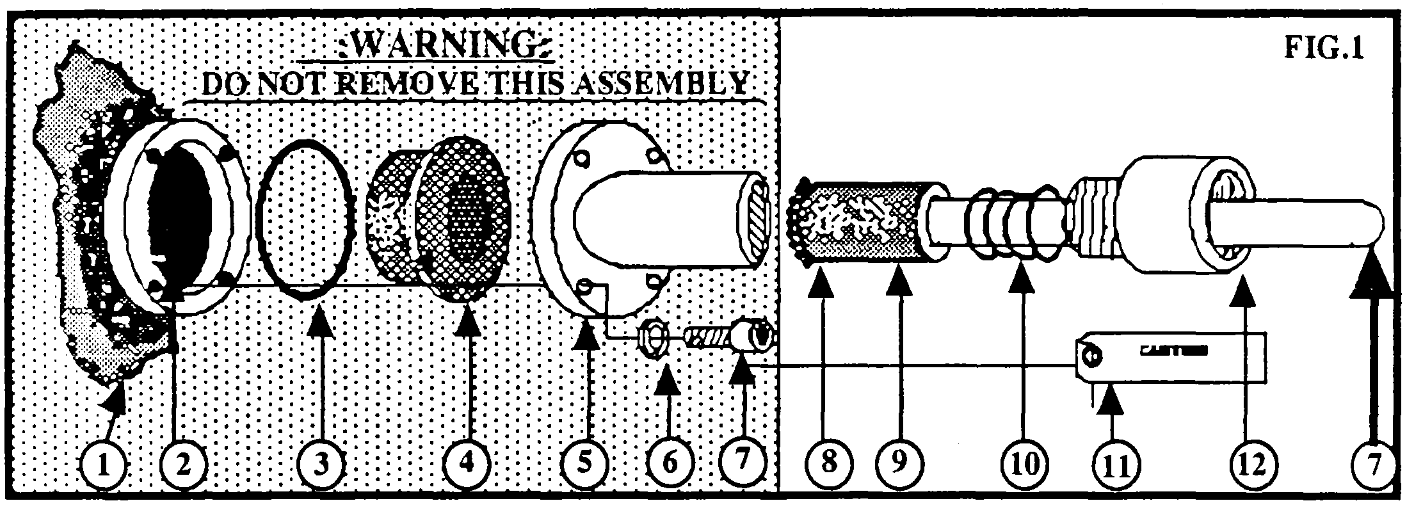


SPOOL PIECES MAY BE INSTALLED EITHER IN THE HORIZONTAL PLANE OR IN THE VERTICAL PLANE (WITH FLOW IN THE UP DIRECTION)

WINDOW SPOOL INSTALLATION

1. SPOOL
2. ROLL PIN (USED AS A GUIDE FOR # 4)
3. O RING
4. SENSOR WINDOW
5. SENSOR HOLDER
6. WASHER (4 PLACES)
7. SCREW (4 PLACES)
8. SILICONE GREASE
9. SENSOR & CABLE (25 FT STANDARD)
10. SPRING
11. CAUTION TAG
12. SENSOR RETAINER

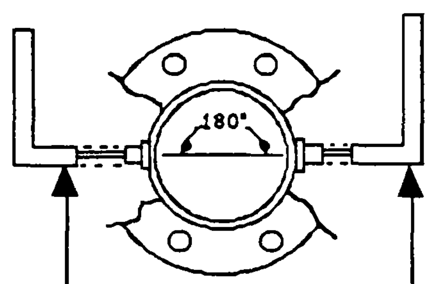




SENSOR REMOVAL PROCEDURE:

1. Remove conduit from the sensor retainer (12).
2. Unscrew the sensor retainer (12).
3. Gently pull on the sensor cable. The sensor spring (10) and the sensor (9), should "pop" out of the sensor holder (5).
4. Before reinstalling the sensor, carefully clean the sensor grease from the sensor window lens (4).

   NOTE: a long 6" cotton swab available at most electronic or audio stores works well for cleaning the window.



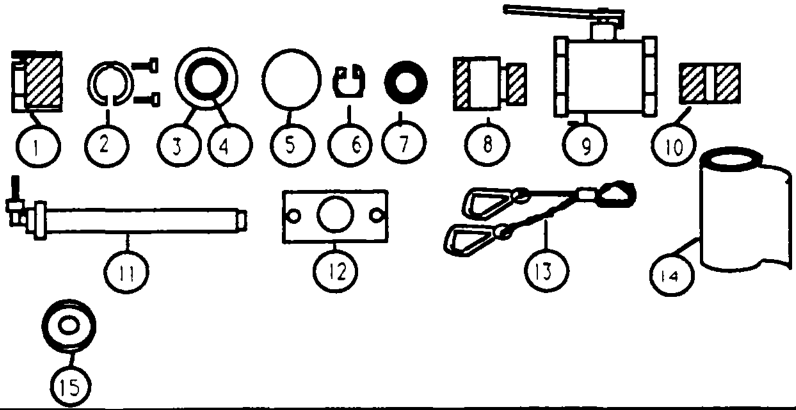
Metallic conduit or Seal-tite (by others)

5. Wipe the end and sides of the sensor clean, removing any grease and grit.
6. Spread a thin 1/32" layer of sensor grease (Dow Corning 111 valve* lubricant & sealant) on the end surface of the sensor.
7. Carefully reinsert the sensor into the sensor holder and gently push the sensor all the way in.

   NOTE: if the sensor will not push in, try to loosen the holder screws (7) slightly (without removing the safety wire seal) and shift the holder until the sensor will slide all the way in. retighten the holder screws.
8. Screw the sensor retainer down firm (hand tight) and reconnect the conduit. *Type 29 silicone heat sink compound may be used. (available at most electronic stores)

HS3 SENSOR INSTALLATION

PARTS LIST

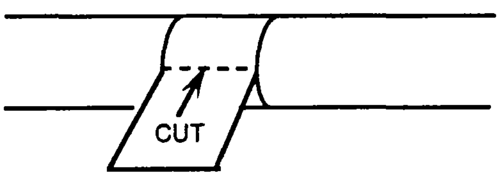


ITEM	DESCRIPTION	QTY.
1.	RETAINER BRZ	2
2.	SPLIT COLLAR	2
3.	BRASS COLLAR	2
4.	O-RING 1.287X2.7	2
5.	O-RING 2.112X2.318	2
6.	2" RETAINING RING	2
7.	BEARING SEAL	2
8.	BRASS TAIL PIECE	2
9.	BRZ BALL VALVE	2
10.	1-1/2" NIPPLE	2
11.	SENSOR W/100' CABLE	2
12.	SAFETY PLATE	4
13.	SAFETY CABLE	4
14.	TEMPLATE	1
15.	TEFLON TAPE	1

TEMPLATE INSTALLATION

1.

Using tape, attach one end of the template to the pipe and wrap the rest of the template around the pipe. Pull the template straight and mark the point of overlap on the template. Cut off the excess.

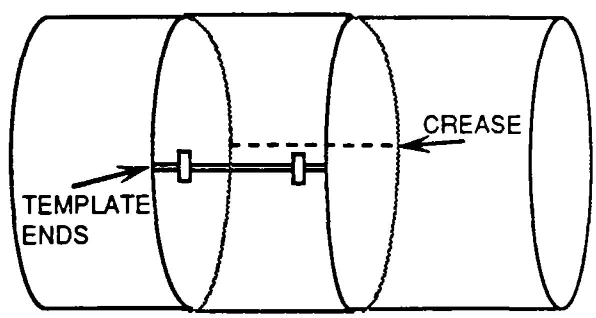


2.

Remove template from pipe. Fold template exactly in half and crease in the middle.

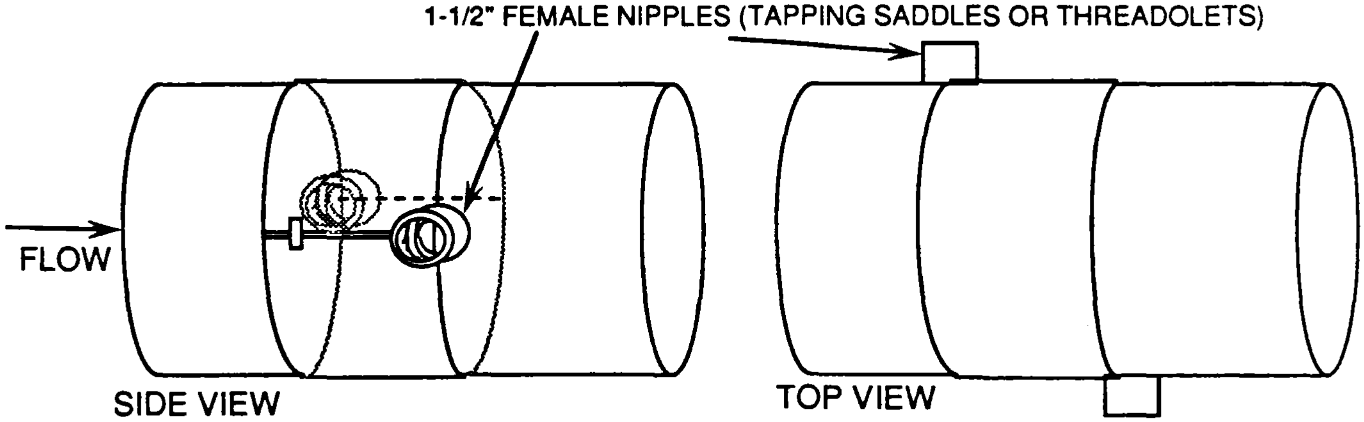
3.

Wrap the template around the pipe so that the crease is on one side of the pipe and the two ends of the template meet on the other side of the pipe.
Try to line up the crease and ends with the horizontal center of the pipe. Tape the ends of the template together with masking tape to hold in place on the pipe.

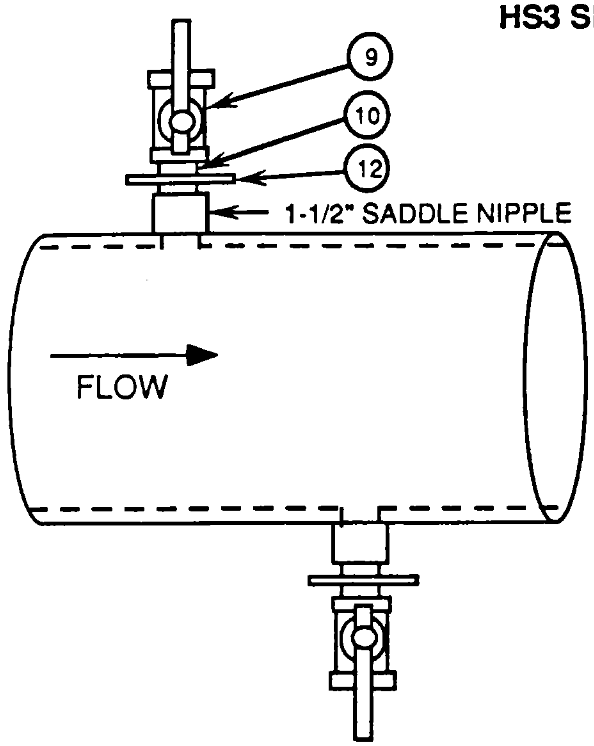


4.

1-1/2" FEMALE NIPPLES (TAPPING SADDLES OR THREADOLETS)



HS3 SENSOR INSTALLATION



TAPPING PROCEDURE:

1. Install template and nipples per 3-1.
2. Use teflon tape, wrap the end of male nipple (item 10) and screw into female nipple of tapping saddle.
3. Slide safety plate (item 12) over outer end of nipple.
4. Screw ball valve (item 9) onto nipple. adjust valve to the "open" position.
5. Connect tapping machine into end of ball valve, 1-1/2".
6. Use 1.38" minimum tapping bit and tap through pipe wall.
7. Back the tapping bit out past the valve assembly and move the valve handle to the "off" position.

PREPARATION TO INSTALL SENSORS:

TAIL PIECE ASSEMBLY
(ASSEMBLED AT FACTORY)

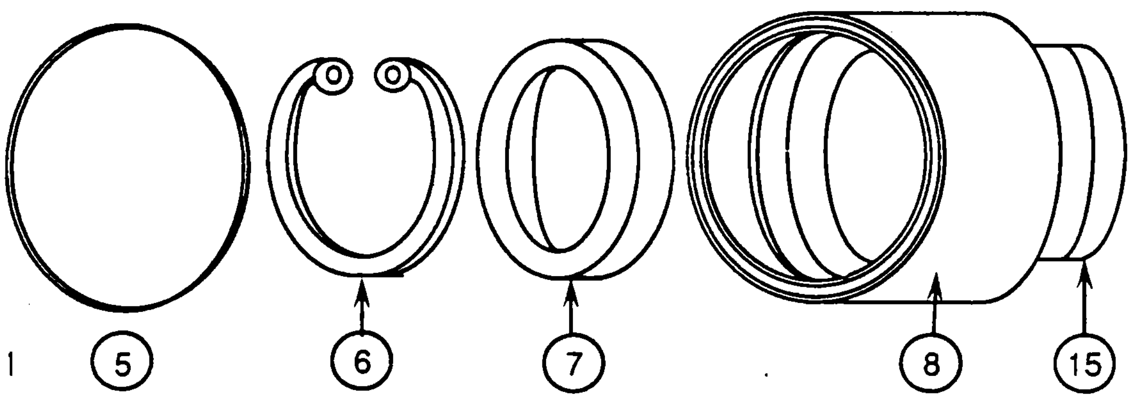


FIG. 1

SENSOR & COLLAR ASSEMBLY

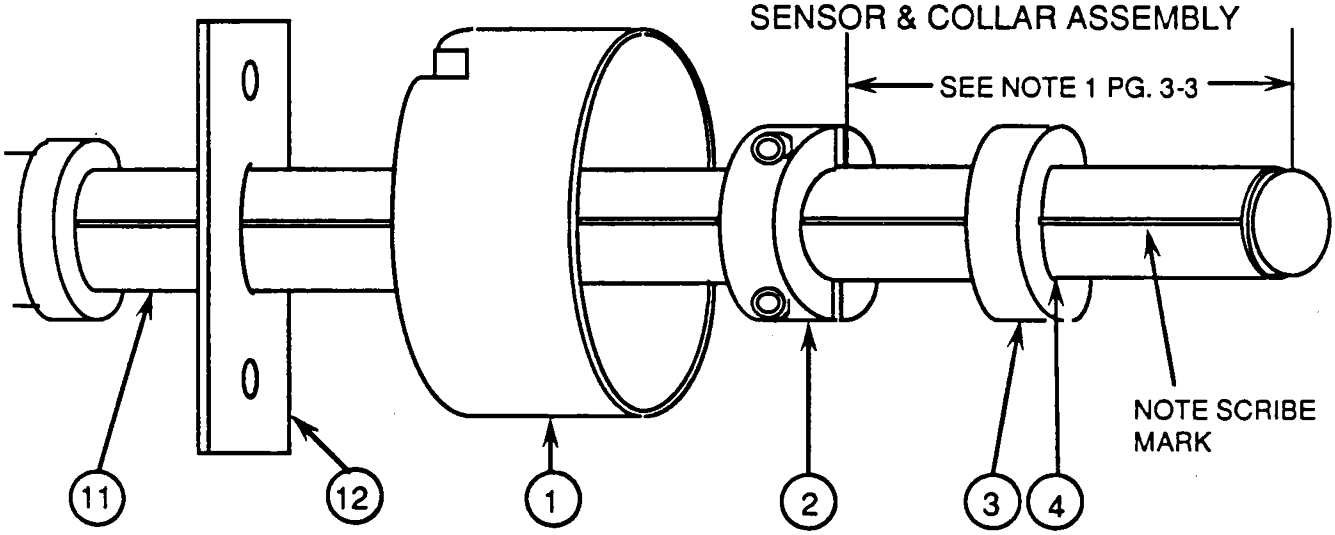


FIG. 2

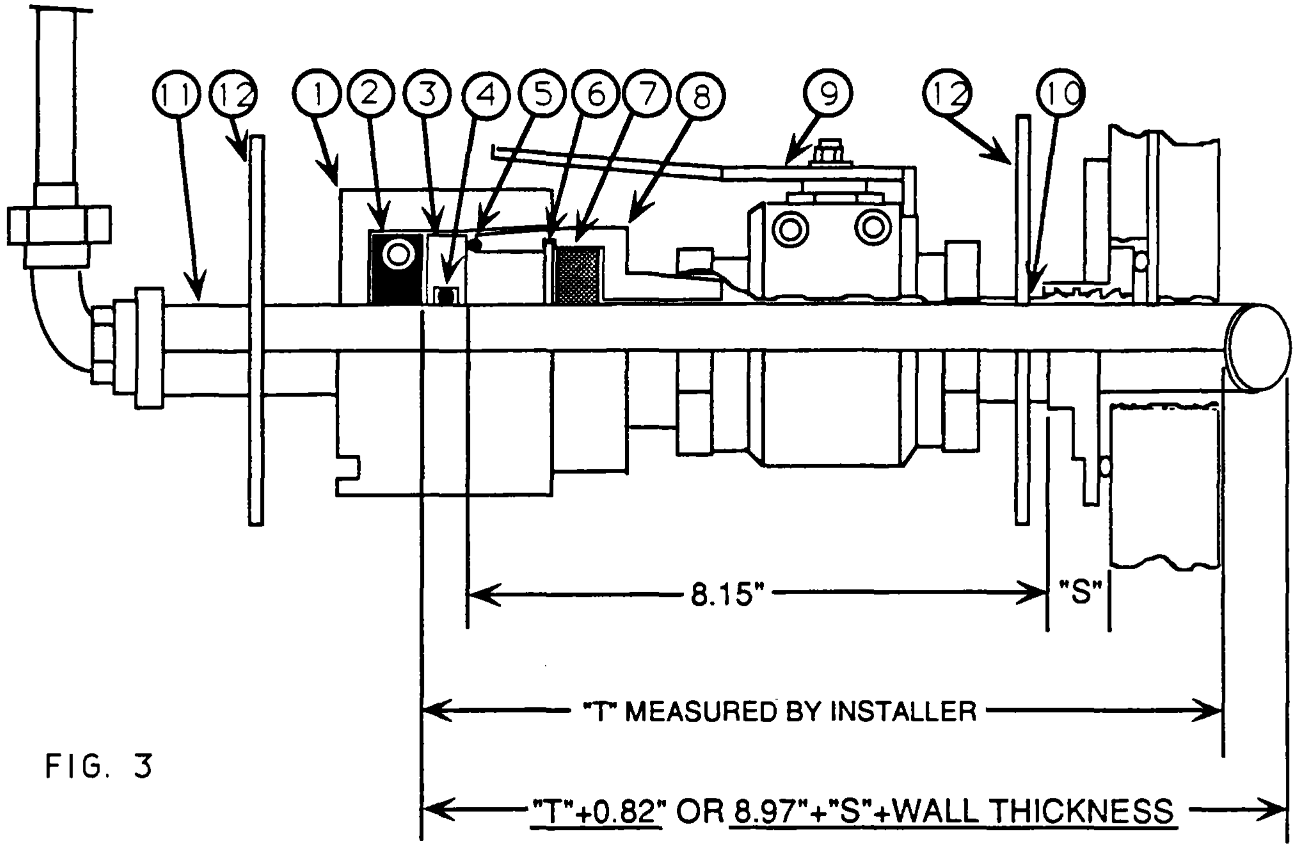


FIG. 3

"S"= Length of saddle or threadolet nipple
"T"= Length from i.d. of pipe to outside edge of item 8

NOTE 1: USE ABOVE FORMULAS TO DETERMINE THE PLACEMENT OF ITEM 2, ONCE COLLAR IS PLACED AT CORRECT DIMENSION TIGHTEN BOTH SOCKET HEAD SCREWS.

1. Screw tail piece assembly fig.1 (items 5, 6, 7 and 8) into ballvalve (item 9).
2. Slide items 12 and 1 onto sensor (item 11) use fig.2, pg. 3C-2.
3. Position collar (item 2) onto sensor and use above formula to calculate correct dimension. Please note that the collar should already be installed by the factory on new orders, the collar dimension will have to be changed only if pipe dimensions are other than given.
4. Slide brass collar and o-ring assembly (items 3 and 4) onto end of sensor and butt up against the split collar (item 2).

NOTE: USE SOAPY WATER, PETROLEUM JELLY OR SOME TYPE OF LUBRICANT TO SLIDE BRASS COLLAR AND O-RING ONTO SENSOR.

5. Note scribe mark running near the end of the sensor. This scribe mark, when the sensor is installed, should be facing toward the opposite sensor. (fig. 4)
6. Place tip of sensor through bearing seal (item 7) and carefully push until the sensor stops at the ball valve. Fasten safety cable clip (long length) to opposite safety plate.
7. Turn valve handle to the "on" position and insert the sensor until the brass collar (item 3)seats on the o-ring on the tail piece (items 5 & 8).
8. Tighten retainer (item 1) onto the tail piece (item 8) using a 1/16" square screw driver shaft in the notch on the end of the retainer.
9. Fasten short length of safety cable to opposite safety plate.

HS3 SENSOR INSTALLATION

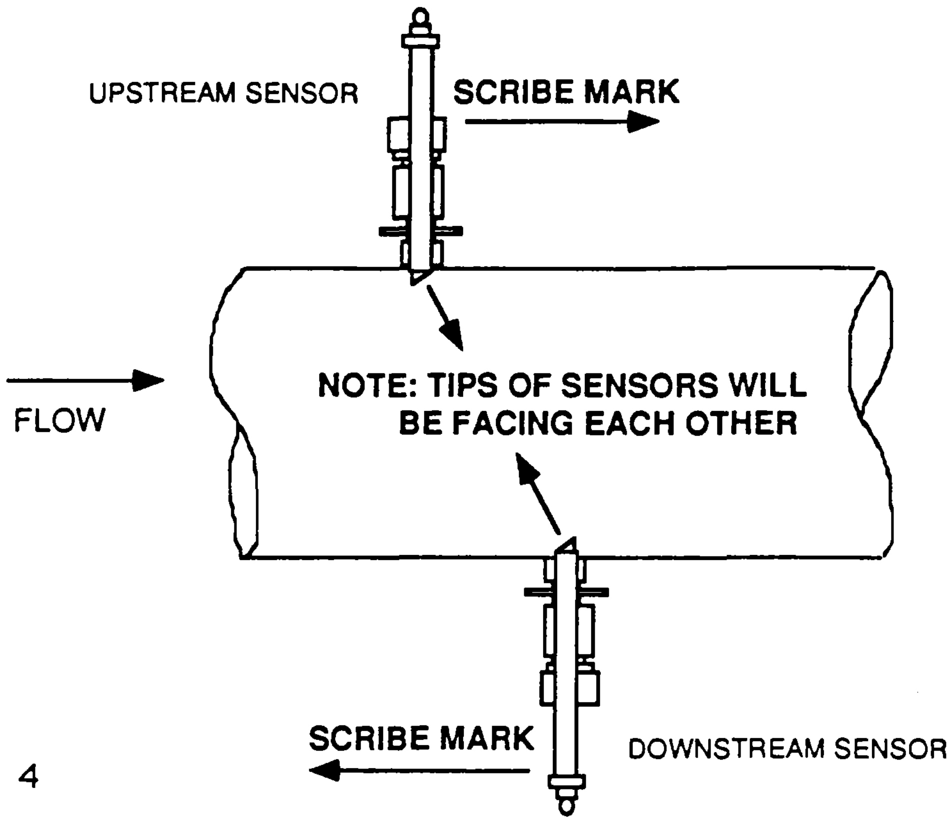
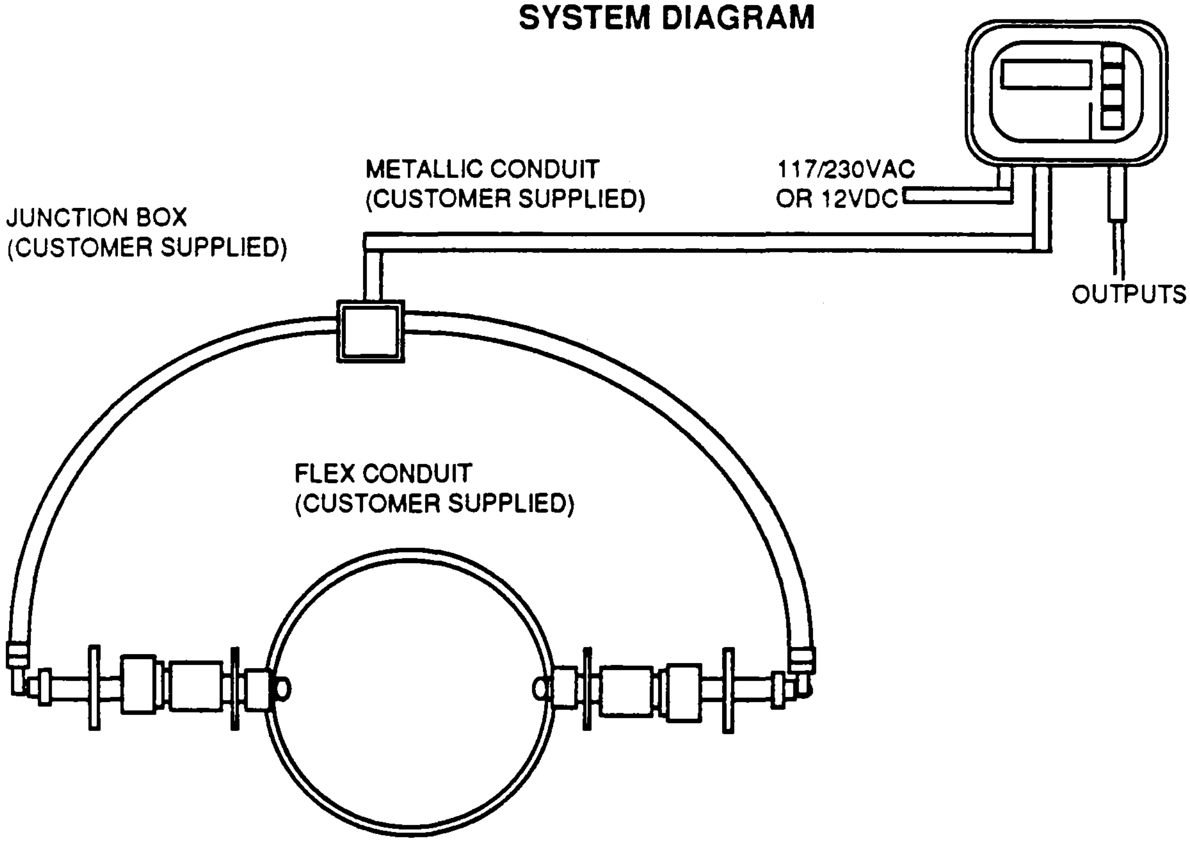


FIG. 4

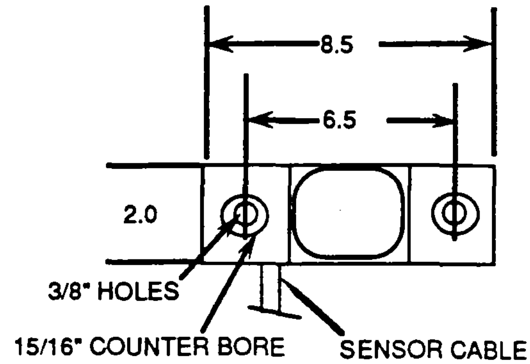
SYSTEM DIAGRAM



INSTREAM REFRACTING SENSORS

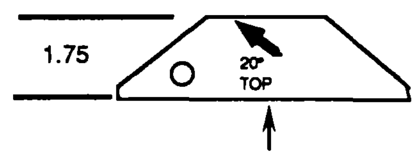
Description

The instream refracting sensors were designed for rectangular or circular concrete channels flowing full at all times. These sensors have a wedge shape to minimize possibilities of catching debris. The sensor is made of PVC materials with 50 ft. of Belden triax cable.

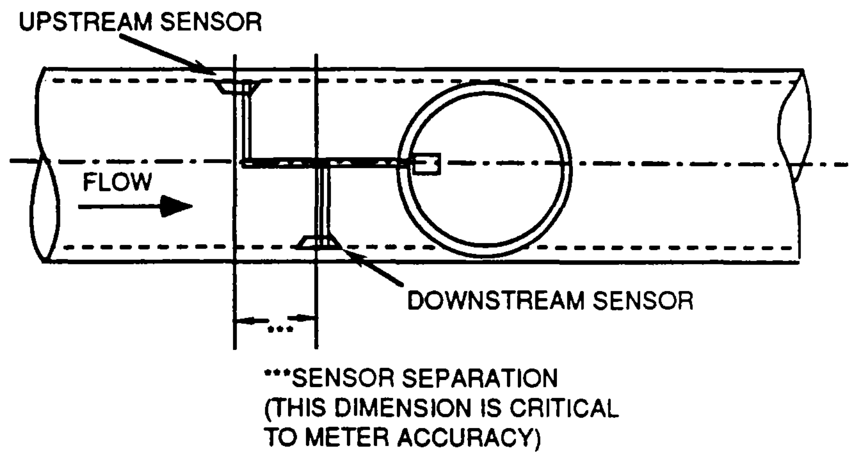


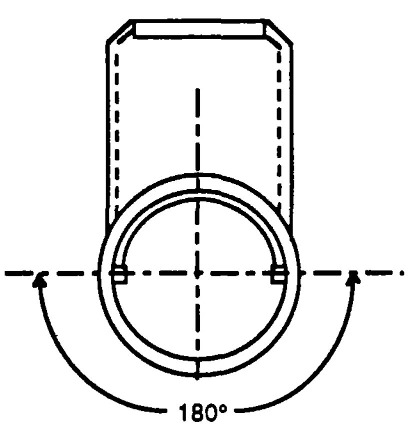
Installation

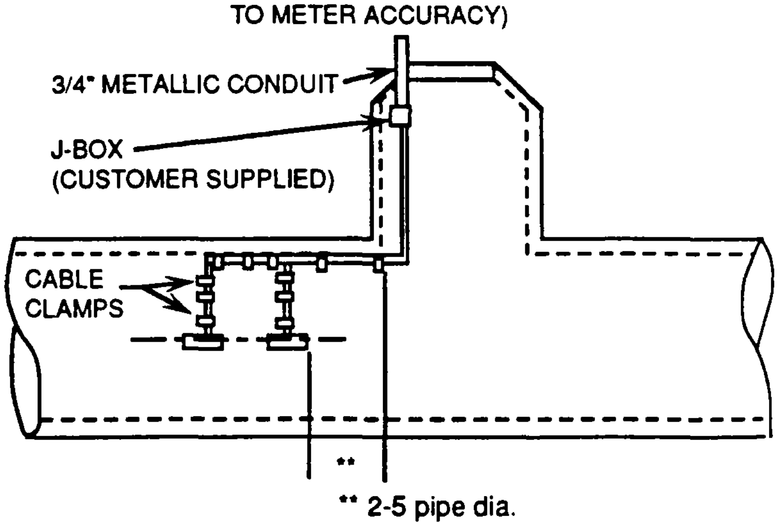
Refer to customer data sheet in front of this manual. Sensor separation=____.____inches. This dimension is from center line of the upstream sensor to the center line of the downstream sensor. Make sure that the arrow on the downstream sensor is pointing upstream and the arrow on the upstream sensor is pointing downstream. Mark holes on concrete conduit and use lead inserts. Place sensor over lead inserts and attach with screws (customer supplied). Route the sensor cables to the top of the conduit and use customer supplied cable clamps to fasten cable to the pipe at one foot intervals. Route the cables downstream and out the pipe outlet. Secure with cable clamps.
Terminate sensor cables to the 4100 electronics.



NOTE: ARROWS ON TOP OF SENSORS SHOULD BE POINTING TOWARDS EACH OTHER AFTER INSTALLATION







WETTED SENSORS WITH HOOP INSTALLATION

DESCRIPTION

The underwater sensors for the Series 4000 flowmeter are premounted on a stainless steel plate at the factory (see Figure 2). The sensor cables are secured to the plate with clamps. This plate is then formed into a hoop and inserted into the pipe just upstream of the 2-inch conduit opening in the top of the pipe or upstream of manhole entrance. The sensor cables are then pulled through the conduit and attached to the sensor connections on the Model 4000 electronic enclosure.

PROCEDURE

1. Inspect the sensor mounting plate for evidence of damage from shipping or handling.
2. Refer to Figure 1. Form the plate into a hoop. Insert the four 8-32 studs on one end of the plate into the slots on the other end. Loosely attach the holding strap to the four studs with the flat washer, Bellville washer and nut. Compress the hoop to its smallest diameter and tighten the nuts on the holding strap.
3. Lower the sensor mounting assembly into the discharge box at the end of the pipe, positioning it so the sensor cables exit downstream. Insert it into the pipe 3 inches upstream of the 2 inch conduit pipe opening in the top of the pipe or 2 to 5 pipe diameters upstream of the manhole. Position the hoop so the sensors are at 90 and 270 degrees in the pipe.
4. Loosen the nuts to the holding strap. Expand the hoop to the wall of the pipe and loosely tighten the nuts on the holding strap.
5. Use a large "C" ring pliers to secure the mounting plate to the pipe. Starting at the upstream side of the mounting plate, place the "C" ring pliers between the second slot and the holding strap. Slowly spread the mounting plate with the pliers forcing the mounting plate against the pipe. Using a rubber head mallet, tap the plate starting at the bottom and up the sides. Tighten the nut of the holding strap on the end you have been spreading. Place the "C" ring pliers on the downstream side of the plate and repeat the same process. Go back to the upstream end and loosen the end nut and use the "C" ring pliers to continue to force the plate against the pipe wall. Repeat this process until the mounting plate is secured against the pipe wall and there are no gaps between the plate and wall.
6. Refer to Figure 3. Route the sensor cables downstream to exit.
8. This completes the sensor installation. See the electronic assembly installation section for connecting and securing the cables.

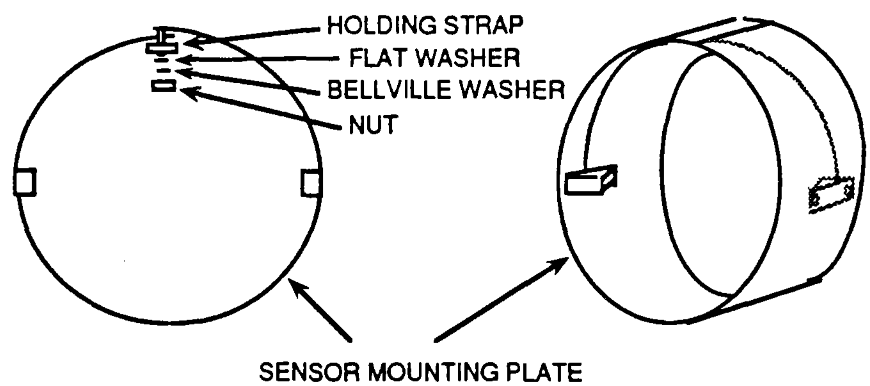


FIG. 1

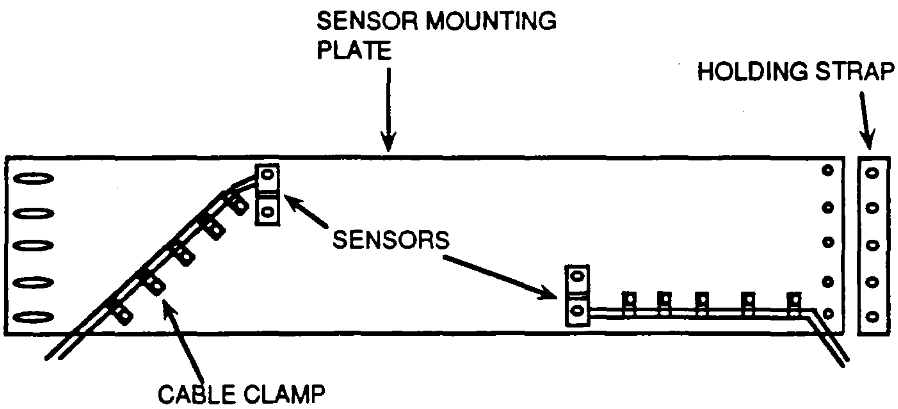

SENSOR MOUNTING
PLATE
HOLDING STRAP
SENSORS
CABLE CLAMP

FIG. 2

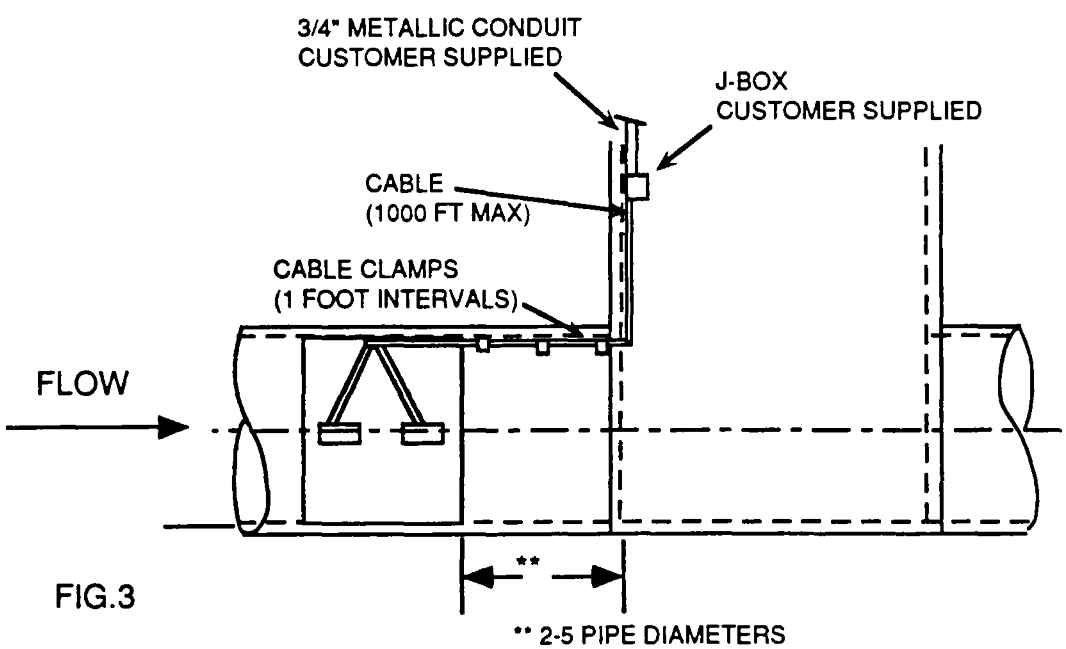
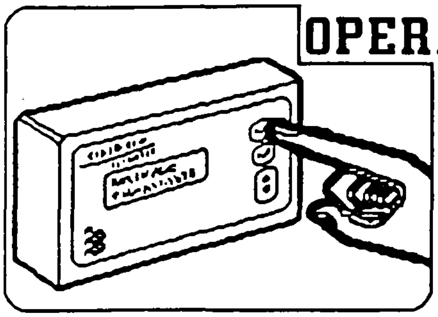

3/4" METALLIC CONDUIT
CUSTOMER SUPPLIED
J-BOX
CUSTOMER SUPPLIED
CABLE
(1000 FT MAX)
CABLE CLAMPS
(1 FOOT INTERVALS)
FLOW
**
** 2-5 PIPE DIAMETERS

FIG.3

OPERATION



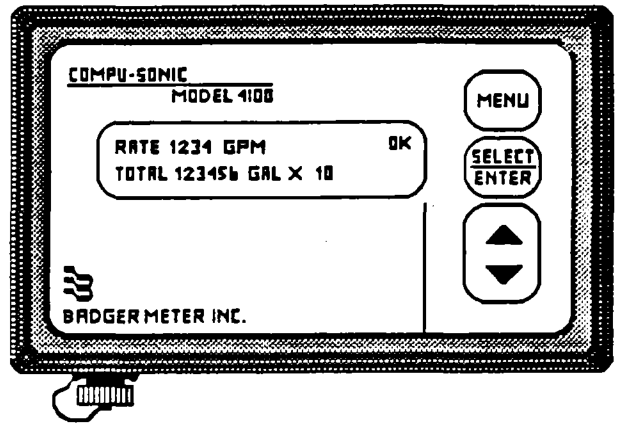


FIGURE 4-1

GENERAL DESCRIPTION

The Series 4100 flowmeter provides a number of menu functions from the front panel which allows the user to modify or interrogate meter operations to suit the user's needs. The user can activate the individual menu items through use of the front panel keys (see Figure 4-1). Each front panel key serves a variety of functions and each function of a key is dependent on the particular menu item involved. The user can follow the menu items to determine the operating state of the unit or to modify the operation of the unit. The functions of the front panel keys are common to all menus.

MENU KEY - This key allows the user to step through the list of menu items available. Each depression will advance the menu list to the next item. The MENU key will not change or activate the individual values in the menu functions but only allows the user to find the desired menu item or its value for further action. If no action is taken by selection of a further menu item using the MENU key or activation of a menu item using the SELECT/ENTER key, the Series 4100 will revert to its standard flow rate and flow total menu in about 10 seconds. This feature adds to the security of the unit since inadvertent depressions of any single key will not change operating parameters of the meter.

SELECT/ENTER KEY - This key is used to initiate a desired menu action or to save new data modified under a menu item. After the user reaches the desired menu item using the MENU KEY, the SELECT/ENTER KEY must be pressed to cause menu action. For example, to force the meter output signal to full scale or the SPAN value, the MENU key is successively pressed until the SPAN MODE is shown. Then the SELECT/ENTER key must be pressed to cause menu action. In this mode, to be described in detail later, the span value may be modified using the UP or DOWN keys as appropriate. After the desired action is completed, the new span value may be saved using the SELECT/ENTER key. If the new span value is not saved by pressing the SELECT/ENTER key, the meter will retain the original span value. The SELECT/ENTER key therefore has two uses; the first is to activate a menu function and the second is to enter changes as desired.

UP and DOWN KEYS - The UP and DOWN keys can be used to modify the operation of the Series 4100 as the user desires. They are active in menu items which allow changes. Pressing the UP key will increase the selected menu item value. In the SPAN mode, for example, pressing the UP key once will increase the value of the analog 4-20 mADC signal a small amount. Continued pressing of the UP key will continue to increase the value. Similarly, pressing the DOWN key will decrease the value.

MENU FUNCTIONS - The menu items with their display information are listed in the following pages with an explanation of the use of the menu. The menu items are listed in the order in which they appear when the MENU key is sequenced. The range of values for those menu items that can be modified is listed in each menu selection.

NORMAL DISPLAY UNI-DIRECTION FLOW OPERATION - The Series 4100 displays the values of flow rate and flow total in engineering units, such as GPM, MGD, etc. A multiplier is also displayed for both rate and total as necessary. The display will appear as shown below. This menu will continually be displayed unless the MENU KEY is pressed.

```
RATE     1234 GPM      OK
TOTAL 123456 GAL X 10
```

The first line displays the current flow rate. The four digits represent the actual number followed by the customer requested engineering units and a multiplier if necessary. The "OK" at the end of the first line indicates that no operating errors have been detected in the meter. Should an error occur, a two letter error code will appear in place of the "OK". When this happens refer to the Troubleshooting section of this manual for the appropriate action.

The second line of the display shows the total volume of the flow metered by the Series 4100. The amount is represented by the six digits and followed by the customer requested engineering units and a multiplier as necessary.

IDENTIFICATION MENU - The first menu item identifies the model number, site identification as requested by the user, the meter serial number and the software revision number. To the right of the ID number will be an L (locked) or a U (unlocked) which indicates if the other menus can be accessed. To lock or unlock, press and hold the SELECT/ENTER key and then the UP key. After the lock out feature has been changed, the meter must go to the main menu before it can be changed again. The display will appear as shown below.

```
Model 4100 SiteId  1234 L
S/N 123456 REV NO.  2.0
```

SELF TEST MODE - This menu item allows the user to interrogate the operating conditions present in the Series 4100. The self test mode has several screens and those items displayed below are the core portions of the self test screens. Badger Meter reserves the right to extend the screens adding new items without notice. If new items are added, the menu item itself should be self evident and the results of the additional testing clear in meaning and in user response. The self test mode of operation discontinues regular flowmeter operation. The self test menu appears as follows:

```
     SELF TEST MODE
PRESS SELECT TO ACTIVATE
```

To enter the self test mode and determine the operating characteristics of the meter, the user must press the SELECT/ENTER key. The meter will respond with a changed display as indicated below.

```
SELF TEST 4100
   --WAIT--
```

During the short waiting period the Series 4100 checks various internal characteristics and then responds to the user request. After completing the internal checks, the Series 4100 will automatically proceed to display the results of each test in a sequence of displays. The user should note the following series of displays as well as any further implementation added subsequent to this publication.

The first item, as shown below, indicates if the Series 4100 is transmitting signals to the sensors in acceptable limits. This will be displayed for about ten seconds.

```
SELF TEST 4100
   XM Pass
```

The second item, as shown below, indicates the hex value of the transit time of the signal and indicates whether this is an acceptable time. This will be displayed for about ten seconds.

```
SELF TEST 4100
  T12 OK 9C
```

The third item, as shown below, indicates the signal level and whether the operating value is reasonable. This will be displayed for about ten seconds.

```
SELF TEST 4100
RECEIVER OK 62
```

The fourth item, as shown below, indicates the read/write capability of the microprocessor has been checked and shows if it is operational or an error exists. This will be displayed for about ten seconds.

```
SELF TEST 4100
   EEROM OK
```

The last screen will indicate that the self test is complete. Should any error be indicated, refer to the Troubleshooting section for appropriate action.

ZERO MODE - In this menu item, the Series 4100 will force the analog 4-20 mADC signal to its zero flow value. This menu will be displayed as shown below. This will remain for ten seconds and then the display will return to indication flow rate and total if the SELECT/ENTER key is not depressed.

```
        ZERO MODE
 PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the zero mode and the display will show as indicated below and force the meter to indicate zero flow. The meter will stay in this mode until the MENU key is pressed or a change in the zero value is made and stored.

```
  METER IS IN ZERO MODE
CHANGE PRESS UP/DN-ENTER
```

The 4-20 mADC signal can be monitored by the test points on the bottom of the back housing. This test signal is in millivolts with 40 to 200 millivolts DC representing the 4 to 20 milliamp output signal. Use of the UP key will increase the signal value while the DOWN key will decrease the value. After the adjustment is completed, the user must press the SELECT/ENTER key to force the Series 4100 to store the new milliamp current output. If the new value for the zero analog current signal is saved, it will be so indicated on the display and this will immediately be used by the Series 4100. After the new value is saved, the meter will return to displaying flow rate and total. The range of the zero analog signal is between 3 and 5 mADC. **Remember: The meter will stay in the zero mode unless the MENU key is pressed or the SELECT/ENTER key is pressed.**

SPAN MODE - In this menu item, the Series 4100 will force the analog 4-20 mADC signal to its full scale value. This menu will be displayed as shown below. This will remain for ten seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
        SPAN MODE
 PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the span mode and the display will show as indicated below and force the meter to indicate full scale. The meter will stay in this mode until the MENU key is depressed or a change in the span value is made and stored.

```
  METER IS IN SPAN MODE
CHANGE PRESS UP/DN-ENTER
```

The 4-20 mADC signal can be monitored by the test points on the bottom of the back housing. This test signal is in millivolts with 40 to 200 millivolts DC representing the 4 to 20 milliamp output signal. Use of the UP key will increase the signal value while the DOWN key will decrease the value. After the adjustment is completed, the user must press the SELECT/ENTER key to force the Series 4100 to store the new milliamp current output. If the new value for the span analog current signal is saved, it will be so indicated on the display and this will immediately be used by the Series 4100. After the new value is saved, the meter will return to displaying flow rate and total. The range of the span analog signal is between 12 and 22 mADC. **Remember: The meter will stay in the span mode unless the MENU key is pressed or the SELECT/ENTER key is pressed.**

FLOW AVERAGING MODE - In this mode the Series 4100 allows the user to change the meter response time according to a preselected set of time intervals. The user can select meter response times of 1,2, 4, 8, 16, 32, 64 and 128 seconds. This menu will be displayed as shown below. This will remain for 10 seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
      FLOW AVERAGING
 PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the flow averaging mode and the display will show as indicated on the next page. The present flow averaging value will be shown as depicted by the 8. As the user presses the UP or DOWN keys, the display will show the time changes. Pressing the SELECT/ENTER key will store the new value. The

SELECT/ENTER or MENU key must be pressed to exit from this menu. If the MENU key is pressed, the meter will advance to the next menu and the change created by the UP/DOWN keys will be lost. If the new value for the flow averaging is saved, it will be so indicated on the display. After the new value is saved, the meter will revert to indicating flow rate and total unless the MENU key is pressed which will advance to the next menu.

```
FLOW AVERAGING    8 SEC
CHANGE PRESS UP/DN-ENTER
```

RESCALE MODE - In this mode, the Series 4100 allows the user to change the full scale flow rate as desired. The change must be within limits stored internally in the Series 4100 and must remain in the same engineering units as was originally selected for the meter. This menu will be displayed as shown below. This will remain for ten seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
METER RESCALE
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the rescale mode and the display will show as indicated below. The present full scale flow value and its multiplier will be shown. The user can press the UP and DOWN keys to change the value of the full scale flow as desired. When the full scale flow rate reaches the stored upper or lower flow rate limits, the display will not respond to further requests in the same direction. Pressing the SELECT/ENTER key will store the new value. The SELECT/ENTER or MENU key must be pressed to exit from this mode. If the MENU key is pressed, the meter will advance to the next menu and the change created by the UP/DOWN keys will be lost. If the new value for rescale is saved, it will be so indicated on the display. After the new value is saved, the meter will revert to the displaying flow rate and total unless the MENU key is pressed to advance to the next menu. **Remember: Changing the full scale of the meter will cause the 4-20 mADC output to change to reflect this new full scale value.**

```
FULL SCALE    1000 x 1
CHANGE PRESS UP/DN-ENTER
```

RECALIBRATION MODE - This mode allows the user to calibrate the Series 4100 as appropriate to reproduce actual flow conditions. The user can modify the meter factor for calibration of the meter to a known standard. This menu will be displayed as shown below. This will remain for 10 seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
METER RECAL
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the recal mode and the display will indicate a meter factor as indicated below.

```
METER FACTOR 1.000
CHANGE-PRESS UP/DN-ENTER
```

The user can modify the meter factor using the UP or DOWN keys. After saving the new meter factor, the Series 4100 will respond to the change and adjust the display readings and analog signal accordingly.

The meter factor is the relation between the indicated flow rate of the instrument and actual flow rate as proven by calibration tanks or other means. If, for example, the meter was installed on a pipe and due to uncertainty in the pipe dimensions, the meter was determined to be indicating a flow rate 5.6% higher than the actual flow, this means that the flow meter is indicating 1.056 times the true value. The initial meter factor will be 1.000 as set at the factory. To correct for the 5.6% error, the meter factor must be changed to 0.947 which is the inverse of 1.056 error. If the meter had been 5.6% low, then the meter factor would be 1.059. After the user has changed the meter factor to the new value, the SELECT/ENTER key must be pressed to store the value which will be indicated on the display. The meter will revert to the normal operation mode unless the MENU key is pressed. If the MENU key is pressed and **not** the SELECT/ENTER key, the meter will advance to the next menu and the change in the meter factor will not be stored.

ZERO OFFSET MODE- This menu item allows the user to capture and correct for zero offsets that may be present in the metering system. It is intended to be used for periodic maintenance to correct for small zero drifts. THE FLOW IN THE PIPE MUST BE ZERO TO USE THIS MODE. IF FLOW EXISTS IN THE PIPE, USE OF THIS MODE WILL CREATE LARGE ERRORS IN THE METER. Therefore, the user must prepare for use of this mode. Appropriate valving must be done to ensure that no flow exists; allow at least 10 minutes for the fluid to settle out. This menu will display as shown below. This will remain for 10 seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
ZERO OFFSET MODE
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select this mode and the display will indicate a waiting period as indicated below.

```
ZERO OFFSET MODE
--WAIT--
```

After approximately 30 seconds the display will show as indicated below. The SELECT/ENTER key must be pressed to enter the new Zero Offset value. The display will indicate that the new value has been stored. If the SELECT/ENTER key is not pressed, the meter will revert back to the main menu and the new value will not be saved. Also if the MENU key is pressed instead of the SELECT/ENTER key the meter will go back to the main display and the new value will not be saved.

```
ZERO OFFSET COMPUTED
PRESS ENTER TO SAVE
```

MENU ADDITIONS WHEN IN BI-DIRECTIONAL OPERATION - If your meter has been set up for measuring flow in both forward and reverse, there will be a few changes to the menu displays.

The main menu will have a "F" or "R" in front of the flow rate value and the total will have a "F" or "R" after the total value to indicate the direction of the flow. The totalizer automatically changes with the direction of flow.

There is also an additional menu that will display both the forward and reverse totalizers at the same time. This menu follows the Zero Offset menu and appears as shown below.

```
TOTALIZER DISPLAY SELECT
PRESS SELECT TO ACTIVATE
```

To view the two totalizers, press the SELECT/ENTER key. The display will show both totalizers as shown below. To exit this menu press the MENU key.

```
FORWARD TOTAL = 123456
REVERSE TOTAL = 123456
```

ADDITIONAL MENUS WHEN THE ACCESSORY POWER SUPPLY BOARD IS USED. If your meter is equipped with the accessory power supply board and the High and Low alarms have been activated, there will be additional screens after the Zero Offset screen or Totalizer Display screen for the setting of these alarms. These screens will appear as follows:

```
HIGH FLOW ALARM
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will allow entry into this alarm for setting the on and off points. The following screen will then appear:

```
HIGH ALARM SET ON 99%
CHANGE PRESS UP/DN-ENTER
```

This screen allows the setting of the switch on point as a percent of full scale. Use the UP or DOWN key to change to the desired value and press the SELECT/ENTER key. The display will indicate that this has been stored and the following screen will appear:

```
HIGH ALARM SET OFF 99%
CHANGE PRESS UP/DN-ENTER
```

This screen allows the setting of the off point (dead band) as a percent of full scale. Use the UP or DOWN key to change to the desired value and press the SELECT/ENTER key. The display will indicate that this has been stored. The next screen will be the LOW FLOW ALARM. Use the same procedure for setting this alarm as for the HIGH FLOW ALARM above.

This completes the instructions for the menu operation of the Series 4100 flowmeters.

THEORY OF OPERATION

The Series 4100 ultrasonic flowmeter is a microprocessor based flowmeter which uses powerful mathematical algorithms to sense and calculate flow rates and flow totals. The meter operates by transmitting ultrasonic energy to and fro with piezoelectric sensors attached to the pipe. Sensors can be either of the external mounted strap-on configuration or may be of the type which contacts the fluid. In either case the Series 4100 is initially set up at the factory or in the field using a hand held computer. The operating modes are similar. A block diagram (Figure 5-1) depicts the major section of the Series 4100 operating functions. The descriptions below all refer to the diagram.

Frequency Generator. The frequency generating section contains two crystal controlled oscillators. Each oscillator is frequency divided by binary counters to form two frequencies. One is the frequency used for transmission across the pipe and is referred to as fx. A second frequency is generated for use with the rf mixer and is referred to as fm. A third frequency is created by mixing fx and fm to get the difference frequency f3.

Transmitter and Sensor Switches. In a sequential fashion, the microprocessor (uP) sends out a digital code to the sensor switches which connects one sensor to the transmitter and the other to the receiver. Two switch connections can be made which alternately interchange which sensor is connected to either the transmitter or receiver. To initiate transmission to the sensors, the uP sends out an enable signal to the transmitter circuit. The transmit circuit begins driving energy to the sensors in the form of a long burst at the sensor operating frequency. This burst of energy is typically a train of sinusoidal waves with about 30 to 40 individual waves present. The transmitted energy, about 15 volts p-p, goes through the appropriate switch to the transmitter connected sensor. The sensor converts the electrical energy to acoustic energy in the form of mechanical vibrations. Acoustic energy travels through the pipe wall, across the fluid, through the opposite pipe wall and into the opposite sensor. In this sensor, the vibrational energy is converted to electrical energy and then passes through the sensor switch to the electronic receiver.

After the transmission cycle is completed and the data is processed, the uP will change the switches so as to reconnect the sensors. The sensor which was the transmitter will become the receiver, while the opposite function will be assigned to the other sensor. This process continues in the alternating fashion, under uP direction, at a rate of about 30 hertz.

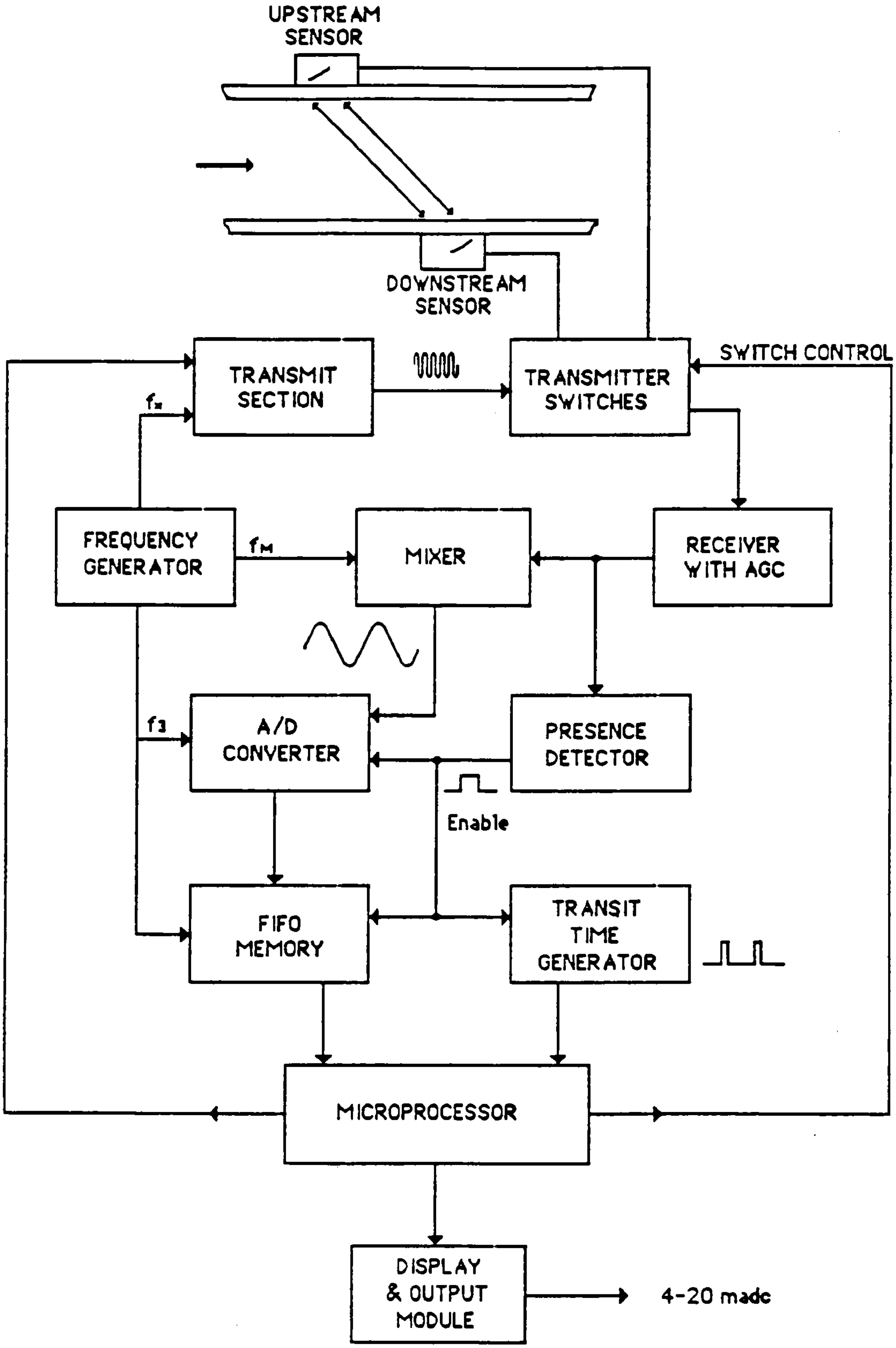
Receiver Operation. The receiver section, in the block diagram, consists of three individual items: first, an rf amplifier with automatic gain control, activated and controlled by the uP, which amplifies the signals from the sensors; next, a presence detector to determine when the transmitted energy is at the receiving sensor; finally, a mixer to convert the information in the transmitted burst to a lower frequency where much more accurate timing information can be measured. The uP, through its processing of reception data, sets the gain of the rf amplifier to maintain high signal levels without saturating the receiver at arrival of the reception waves. During transmission, the gain of the rf amplifier is drastically reduced, enabling a small leakage so the measurement of the transmitter starting time can be accurately made.

The presence detector is a self-multiplyng converter which provides a dc level during the presence of either the transmitted wave or the reception wave. This detector provides protection from noise and interference since it is a narrow band device. The mixer action, much like the i.f. strip in a heterodyne radio, acts like a vernier because each of the individual rf cycles of the long burst are reformed into one long cycle, at the much lower f3 frequency. The timing information on the rf waves is exactly reproduced on the mixer output wave. Since this wave is at the f3 frequency, the timing information is significantly larger and more readily detected. The noise levels on this third wave are also lower since the noise is averaged over the entire length of the long burst and is not a single point function.

Digital Encoding. The presence detector signal allows the uP to measure the time required for the energy to cross the fluid and also provides the enable signal to the A/D converter. The mixer output signal is fed to the A/D converter where digital samples are coded to represent the mixer out wave. The clock for this sampling is derived from the frequency generator previously described.

FIFO Memory. To enable rapid encoding of the mixer out data, the A/D converter data is "strobed" into the memory. Again the timing clock for the loading of the memory is generated in the frequency generator section and is gated by the presence detector output. The data is retrieved by the uP at a much lower reading rate from the memory and is processed internally. The timing reference used to

SERIES 4100 BLOCK DIAGRAM
FIGURE 5-1



encode the data in the memory forms a time reference between the two directions of transmission. When the same transmission action is achieved, but in the opposite direction in the pipe, the reception data is again encoded by the frequency generator wave. Therefore the two independently encoded reception waves can be compared to one another by virtue of the common f3 reference frequency.

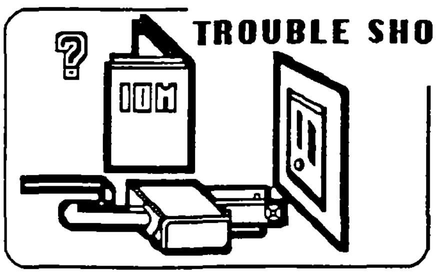
Microprocessor. The microprocessor used in the Series 4100 is an advanced 8 bit processor and contains a watch dog timer and an illegal OP code detector. The watch dog timer is a count down oscillator which must be periodically reset by program action. If the oscillator is not reset in the prescribed period, the watch dog timer resets the processor and reinitializes the measurement cycle. This prevents the microprocessor from entering a lock up mode of operation where it could be non-responsive in its tasks. The illegal code detector also analyzes the individual OP codes of the microprocessor. If, for some reason, an illegal code is detected, the microprocessor will reset and restart. Again, protection is afforded against noise spikes, etc.

The microprocessor also contains a serial data port which allows communications with external and other computers. The port has a specific protocol for communication. The internal protocol used for information exchange with external devices is Badger Meter proprietary, and Badger Meter reserves the right to change and alter the protocol without notification. The serial port is used to initialize a meter application by communication with a hand-held computer specially programmed by Badger Meter for analyzing applications. The hand held computer, after computing the essential meter parameters, communicates with the Series 4100 and transmits data constants which establish flowmeter operation.

Output Signals. The display for the Series 4100 is a two line, 24 character alphanumeric LCD display. The display module contains its own microprocessor for display control. The display programming is menu driven, providing user access to internal meter information, allowing the user to change the flowmeter scaling, and providing an easy means for meter field recalibration. Through the display, the analog output 4-20 mADC signal can be spanned and zeroed without internal meter access. Consult the Operation Instructions Section of the manual for detailed explanations.

The 4-20 mADC signal is fully isolated to prevent external ground loops. The microprocessor generates a frequency proportional to flow rate. This frequency is optically coupled to the 4-20 mADC generator. The 4-20 mADC signal is capable of driving into a 1000 ohm load.

Also available is an optional output for bi-directional operation. This output is an optically coupled transistor to indicate if the flow measurement is forward or reverse flow. The output will be open in the forward direction and closed in the reverse direction.



GENERAL

The Series 4100 is equipped with self test features which allow the user to identify the operation status of the unit and with the help of this section of the IOM manual to determine proper action to be taken. This section details the meaning of the operational codes which appear in the main menu, the meaning of the self test features and provides a step by step troubleshooting chart for determining the fault and the necessary action.

Operational Codes. The main menu of the Model 4100 indicates flow rate and flow total. In the upper right hand side of the display appears an operational code which indicates the operating condition of the meter. When the meter is first powered up, the flow rate will display XXXX and there will not be an operational code. The microprocessor is initializing the meter constants and performing a self test to ensure that all areas of the electronics are operating properly. This may take several seconds.

After initialization the X's in the flow rate will change to 0's. The operational code will display an OK which indicates the meter is operating properly. The meter may recycle a few times before locking onto a good signal. Should an OK not be displayed, refer to the troubleshooting chart for appropriate action.

The following is a list of the operational codes and their meanings.

- OK- Nominal Operation
- NS - No Signal Detected
- XM - Transmit Confirm Failure
- TL - Signal Transit Time Out of Bounds (too long)
- TS - Signal Transit Time Out of Bounds (too short)
- TM - FIFO Error (missing or misaligned timing mark)
- OF - Amplitude Overflow
- UF - Amplitude Underflow
- GE - Gain Error
- CM - Communications Mode Enabled

Self Test Features. The self test feature enables the user to view the status of various sections of the meter to determine the section of the meter that may have a problem should the operational code indicate a problem. Refer to the trouble shooting chart to determine the appropriate corrective action.

The following is a list of the self test areas and a brief explanation of their meaning.

XM PASS (or FAIL) - This indicates if the electronics is transmitting the proper signal to the sensors.
T12 008F OK (or ERROR) - This indicates the actual transit time, in HEX, of the transmitted signal between the sensors and if the time is correct.
RECEIVER 62 OK (or WEAK) - This indicates the strength of the received signal transmission between the two sensors.
EEROM OK (or ERROR) - This indicates if the read/write capability of the microprocessor is functioning properly.

REPLACEMENT OF PARTS

While the Model 4100 has been designed and built for maximum reliability, there can be instances where replacement of parts may be necessary. In those cases where the troubleshooting procedure calls for replacement of a part, the factory should be contacted for authorization and instruction to send in a defective part for repair or the replacement of a defective part.

The Model 4100 has been designed so that the front housing contains the major electronic hardware and can be easily removed and installed. It also allows the replacement unit to be preprogrammed with no adjustments required when installing the new unit. For this reason we must know the serial number of the defective unit when the user contacts the factory for replacement. Refer to the Installation Section of this manual for disassembly instruction.

The back housing contains the power supply circuit board. The replacement of this will require a little more effort. A soldering iron and a fast curing glue will be required. Refer to Figure 6-1. Disconnect the power wires, sensor cables and the 4-20 mADC wires. Pry off the magnetic switch with a small screwdriver or knife. Remove the four corner screws. Unsolder the two 4-20 mADC test point wires from the circuit board. Solder the test point wires to the replacement board. Mount the circuit board to the back housing with the four corner screws. Glue the magnetic switch to the housing (make sure it is in the same location as the old switch). Reconnect all of the wires and cables.

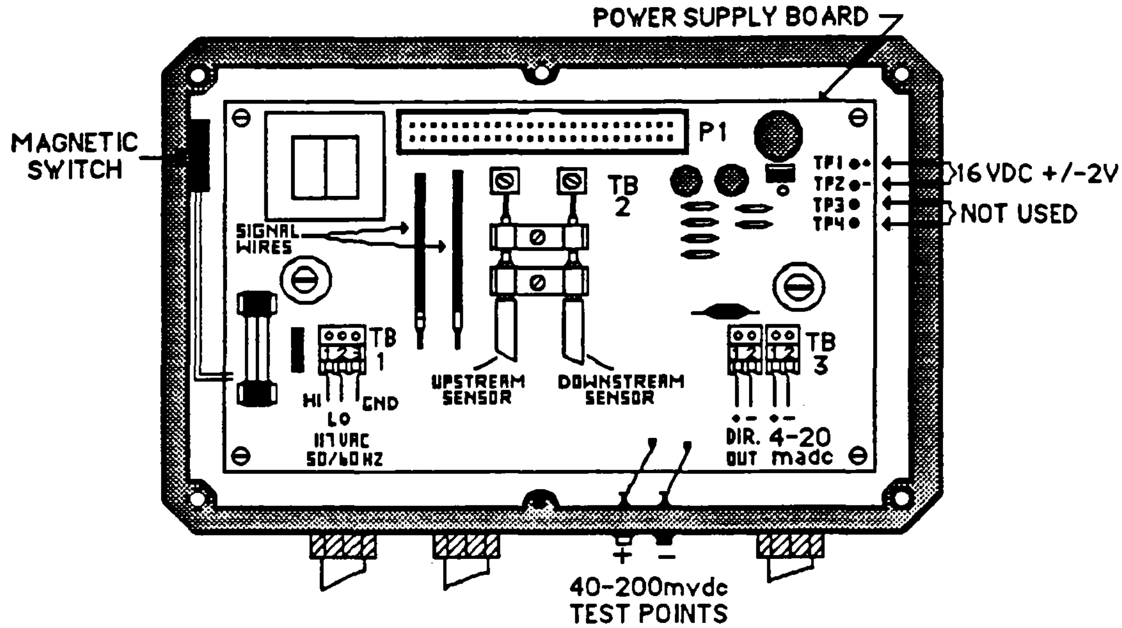


FIGURE 6-1

TROUBLESHOOTING CHART

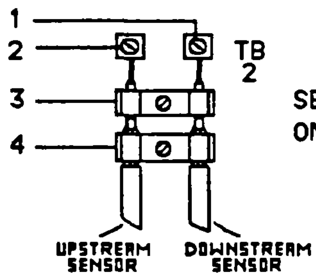
On the following two pages is the troubleshooting chart for the Series 4100 flowmeter. This chart will help you in isolating possible causes for problems you may encounter and give suggested corrective actions.

In the troubleshooting chart, there will be areas that require certain tests to be performed. The following describes these tests.

Sensor cable connection continuity test. This test will require the use of an ohmmeter. Connect the test leads of the ohmmeter to Points 1 and 3 of the sensor cable connections on the power supply as shown in Figure 6-2. If the signal wires on the power supply board are still connected to the front housing electronics, the ohmmeter should read 5000 ohms +/- 5%. If the signal wires are not connected, the reading should be 10000 ohms +/- 5%. Repeat this test at Points 2 and 3.

Connect the test leads to Points 3 and 4. The reading should indicate infinity (or an open).

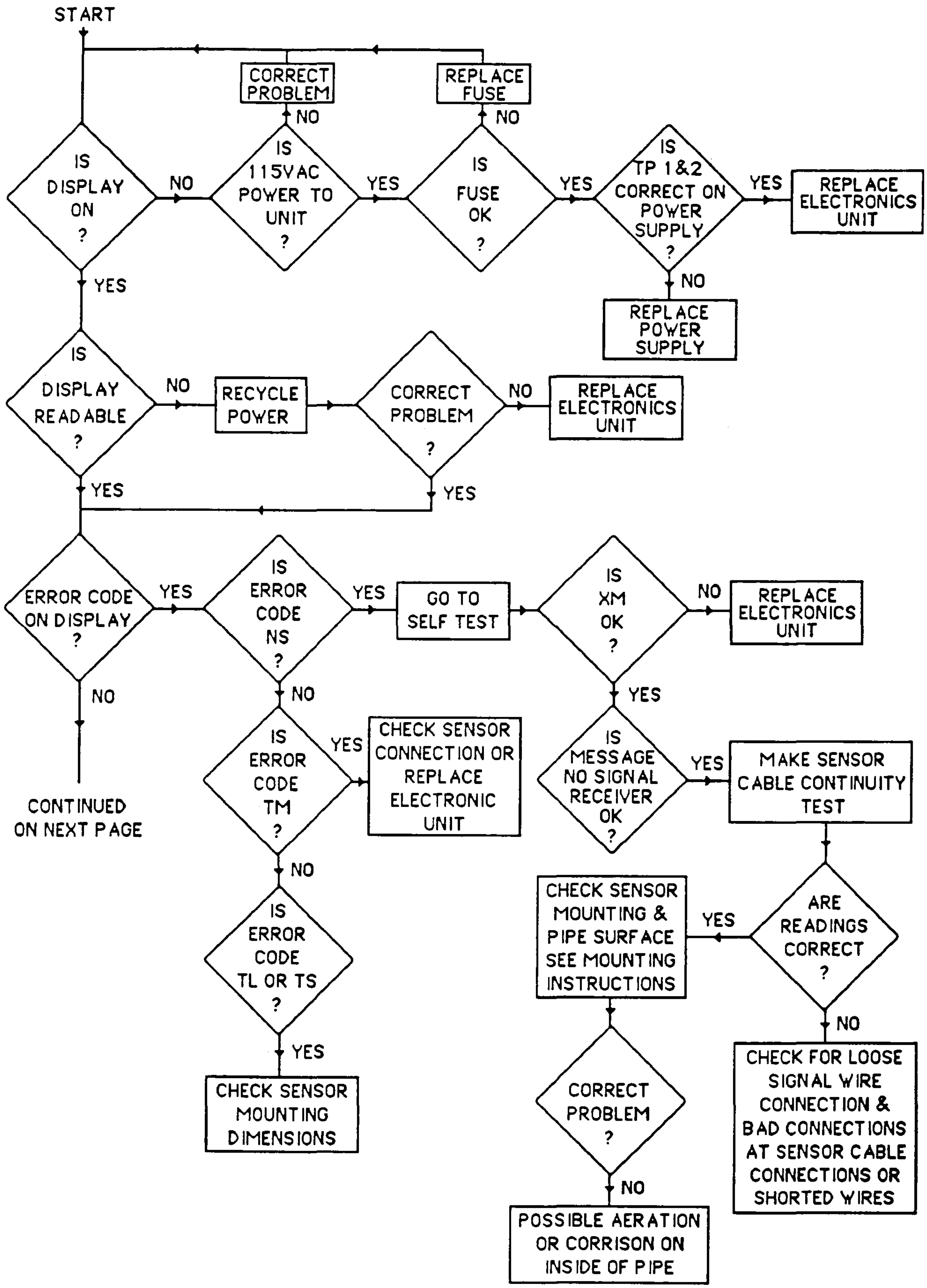
Power Supply Voltage test. This test will require the use of a voltmeter. Connect the test leads to test points 1 and 2 on the power supply board as shown on Figure 6-1. The voltmeter should read 16VDC +/- 2 volts. NOTE: With the front housing removed, a magnet will be required to close the magnetic switch on the back housing in order to perform this test.



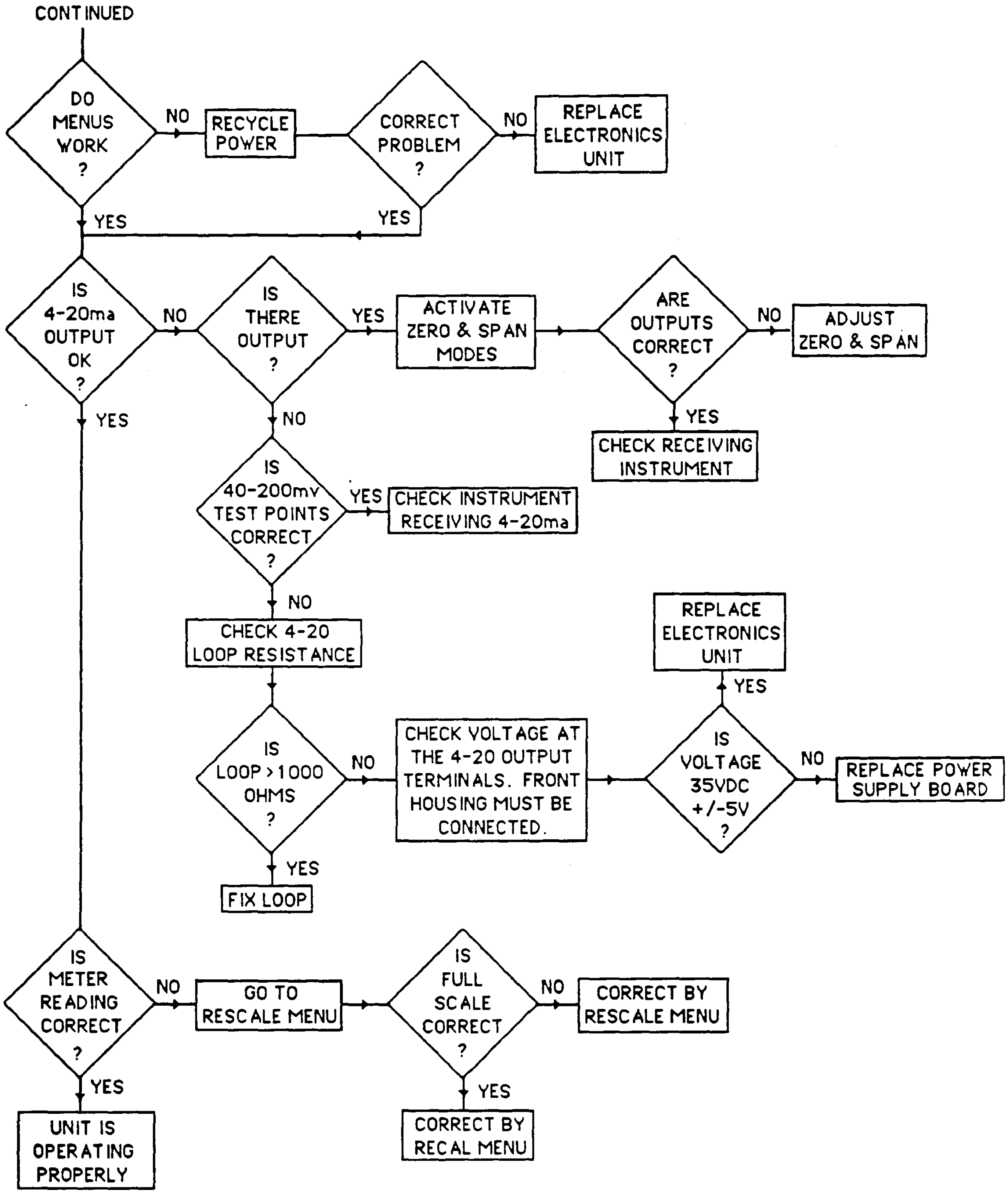
SENSOR CABLE CONNECTIONS ON POWER SUPPLY BOARD

FIGURE 6-2

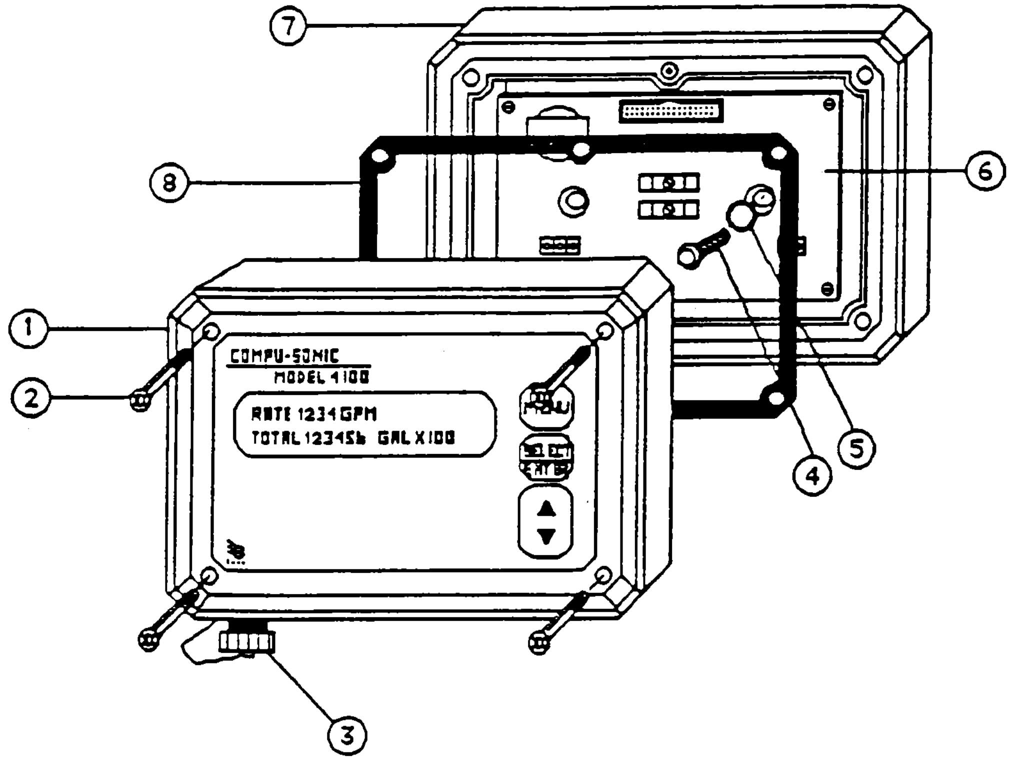
TROUBLE SHOOTING CHART



TROUBLE SHOOTING CHART
CONTINUED



ILLUSTRATED PARTS LIST
SERIES 4100 ENCLOSURE



ITEM #	PART #	DESCRIPTION	QUANITY
1	542751-9999	FRONT HOUSING W/ELECTRONICS	1
	542751-0008	MODEL 4100	
	542751-0011	MODEL 4110	
	542751-0021	MODEL 4120	
2	400003-0048	SCREW SCHCAP 10-32X2-1/2LG SS	4
3	501153-0001	CAP SEALING	1
	501101-0001	CONNECTOR RECP 8CKTS W/SQ-FLG	1
	400001-0025	SCREW PNH-S 4040X3/8 SS	4
4	400029-0002	SCREW HEXWSHRH 1/4-ABX.75 STL	2
or	400022-0016	SCREW HEXWHRH 1/4-20 (ROLOK) ZN	2
5	490004	O-RING	2
6	151915-0001	AC POWER SUPPLY 117VAC	1
or	151915-0002	AC POWER SUPPLY 240VAC	1
or	151921-0001	AC POWER SUPPLY 117VAC W/ACCESSORIES	1
or	151921-0002	AC POWER SUPPLY 240VAC W/ACCESSORIES	1
	160965-0002	FUSE 3AG 1/4A 250V	1
7	525119	BACK HOUSING	1
8	512310	GASKET	1

WARRANTY

Badger warrants meters and parts manufactured by it and supplied hereunder to be free from defects in materials and workmanship for a period of 18 months from date of shipment or 12 months from date of installation, whichever period shall be shorter. If within such period any meters or parts shall be proved to Seller's satisfaction to be defective, such meters or parts shall be repaired or replaced at Seller's option. Seller's obligation hereunder shall be limited to such repair and replacement and shall be conditioned upon Seller's receiving written notice of any alleged defect within 10 days after its discovery and, at Seller's option, return of such meters or parts to Seller f.o.b. its factory. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES WHATSOEVER INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES (EXCEPT OF TITLE) OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Badger shall not be liable for any defects attributable to acts or omissions of others after shipment, nor any consequential, incidental or contingent damage whatsoever.

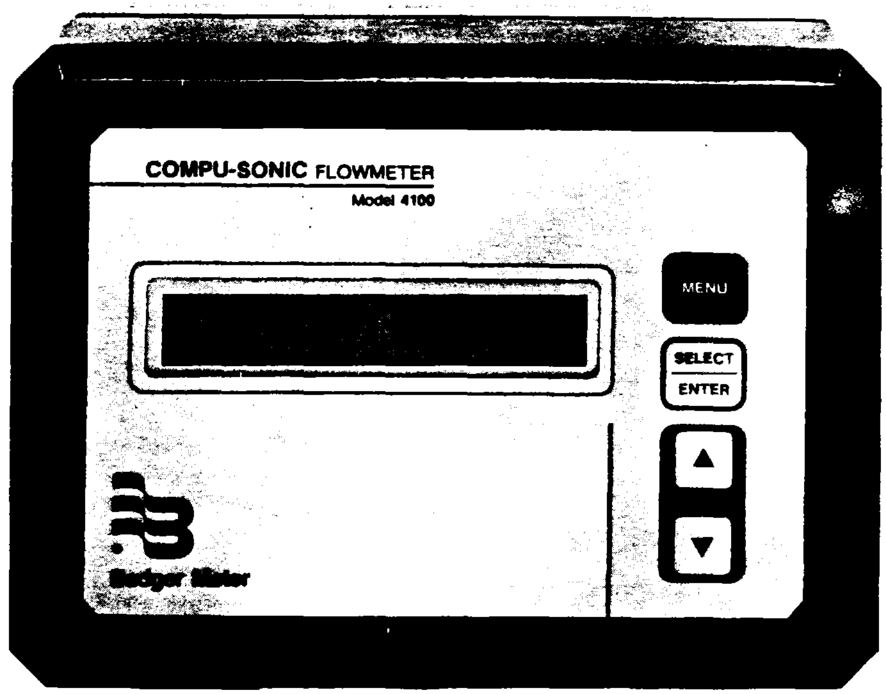
NUCLEAR DISCLAIMER

Equipment sold by Badger Meter, Inc. is not intended for use in connection with any nuclear facility or activity unless covered by a specific quotation where the conditions of such usage will be detailed. If equipment is used in a nuclear facility or activity without a supporting quotation, Badger Meter disclaims all liability for any damage, injury or contamination, and the buyer shall indemnify and hold Badger Meter, its officers, agents, employees, successors, assigns and customers, whether direct or indirect, harmless from and against any and all losses, damages or expenses of whatever form or nature (including attorneys' fees and other costs of defending any action) which they, or any of them, may sustain or incur, whether as a result of breach of contract, warranty, tort (including negligence), strict liability or other theories of law, by reason of such use.

Compu-Sonic Flowmeter
Closed Pipe

Badger Meter Instruction Manual

969906



SA 10225

Badger Meter, Inc. Industrial Products Division
P.O. Box 581390, 6116 East 15th, Tulsa, OK 74158

918/836-8411

RCA 203605

940891

SCOPE OF MANUAL

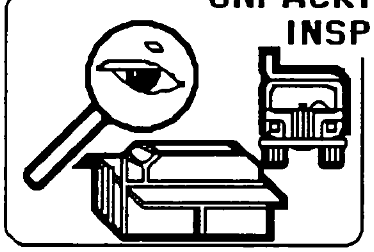
This manual contains information concerning the installation, operation and maintenance of the Series 4100 Compu-Sonic ultrasonic flowmeter. To ensure proper performance of the meter, the instructions given in this manual should be thoroughly understood and followed.

Keep the manual in a readily accessible location for future reference.

Changes and additions to the original edition of this manual will be covered by a "CHANGE NOTICE" supplied with the manual. The change notice will explain any differences between the product described in this manual.

SERIES 4100 COMPU-SONIC TABLE OF CONTENTS

UNPACKING & INSPECTION



To avoid damage in transit, Badger products are shipped to the customer in special shipping containers. Upon receipt of the product, perform the following unpacking and inspection procedures:

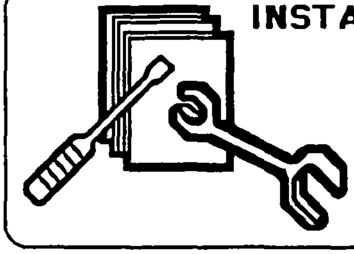
Note: If damage to the shipping container is evident upon receipt, request the carrier to be present when the product is unpacked.

a. Carefully open the shipping container following any instructions that may be marked on the box. Remove all cushioning material surrounding the product and carefully lift the product from the container.

Retain the container and all packing material for possible use in reshipment or storage.

b. Visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts or any other sign of damage that may have occurred during shipment.

Note: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the customer.



INSTALLATION

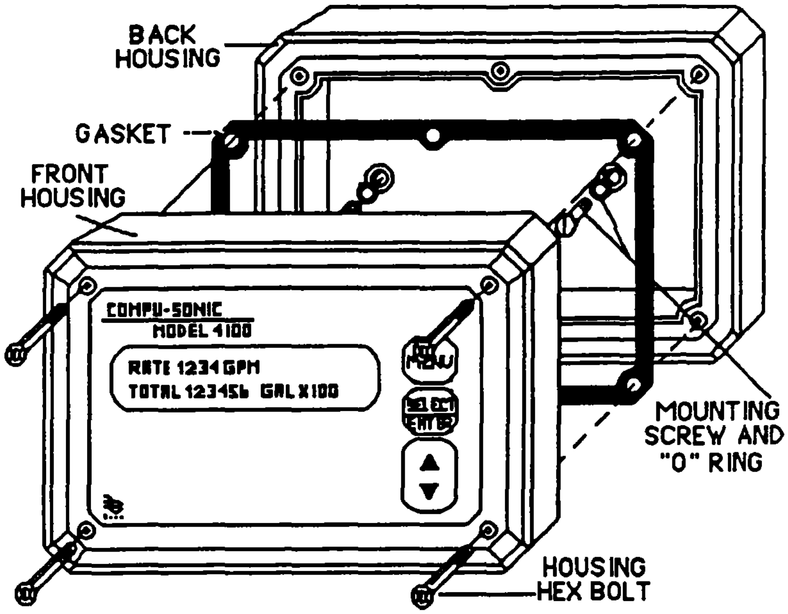


FIGURE 2-1

ELECTRONIC ENCLOSURE

The Series 4100 electronics is housed in a rugged, NEMA 4X rated, polycarbonate enclosure which can be wall mounted. Supplied with each unit are two 1/4-20x3/4 inch mounting screws for use with lead inserts, two 1/4-20x3/4 inch sheet metal screws for other wall materials and two "O" rings necessary to maintain the NEMA 4X rating of the enclosure.

When mounting the Series 4100 electronics, select a location that has good ventilation, temperature within the meter's specification, not subject to flooding, protection from accidental shock, and provides for accessibility to operate the meter and for future service.

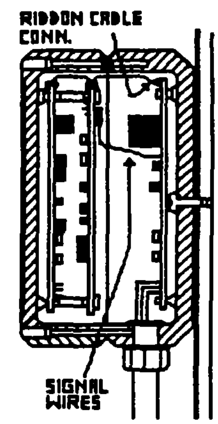


FIGURE 2-2

ENCLOSURE MOUNTING

To mount the enclosure use the 5/32 inch Allen wrench, supplied in the mounting hardware package, to loosen and remove all four hex bolts in the front of the housing (see Figure 2-1). Separate the front and back housings. **CAUTION: THERE ARE TWO SIGNAL WIRES ON THE FRONT HOUSING AND A RIBBON CABLE ON THE POWER SUPPLY BOARD THAT WILL NEED TO BE DISCONNECTED WHEN REMOVING THE FRONT HOUSING (SEE FIGURE 2-2).** Place the front housing in a protected area so it will not be damaged while mounting the back housing.

To mount the back housing, two holes will need to be drilled in the wall 4.5 inches apart (center line to center line, see Figure 2-3). The size of the holes will depend on whether lead inserts are used or the mounting screws are screwed directly in the wall. Select the appropriate screws and place the "O" rings on the screws. With a 3/8 inch hex head driver, secure the back housing to the wall. **Since the power supply board is in the back housing, care should be taken to prevent damaging any components on the board.**

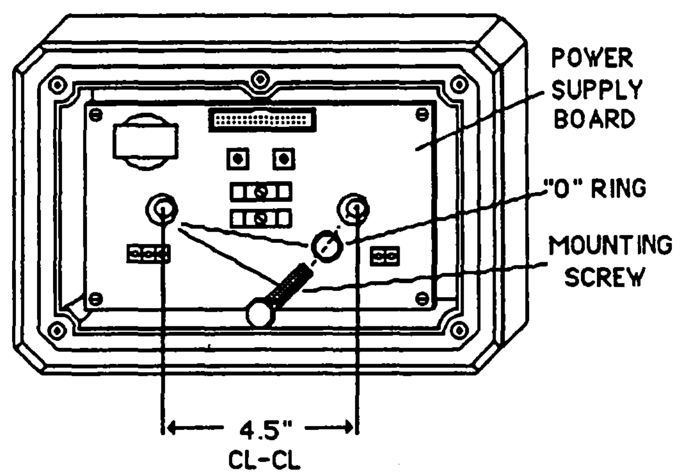


FIGURE 2-3

WIRING CONNECTIONS

The Series 4100 electronics enclosure is provided with three holes for 1/2 inch NPT conduit fittings. These holes are on the bottom of the back housing of the enclosure and allow entry for the 115 VAC power wires, sensor cables and 4 to 20 mADC signal output wires. **These three lines must be in separate conduits or the operation of the meter could be affected.**

The terminals on the power supply board will accept 14 to 22 gauge wire. A small common screw driver will be required to loosen and tighten the screws. There are two different power supplies that can be supplied with the Series 4100 flowmeters. The standard power supply is shown in Figure 2-4 and the accessory power supply is shown in Figure 2-5.

Standard power supply connections (Figure 2-4). The terminals marked TB1 are for the 115 VAC connections. Terminal 1 is the high side (black wire) connection. Terminal 2 is the low or neutral side (white wire) connection. Terminal 3 is the earth ground (green wire) connection. <u>A magnetic switch (located on the left side of the back housing) removes power from the power supply board when the front housing is separated from the back housing.</u>

The terminals marked TB3 are for the 4 to 20 mADC output signal. Terminal 1 is the positive (+) connection and terminal 2 is the negative (-) connection.

Two test points are provided on the bottom of the back housing to allow adjustment of the 4 to 20 mADC signal. Refer to the Operation section for use when adjusting Zero and Span.

The terminals marked DIR are for use when the Series 4100 flowmeters are programmed for bi-directional operation. This is an optically coupled open collector switch output. It is rated for 50VDC at 100 mA. When the flow is in the forward direction the switch will be open, and in the reverse direction the switch will be closed. Terminal 1 is the positive (+) connection and terminal 2 is the negative (-) connection.

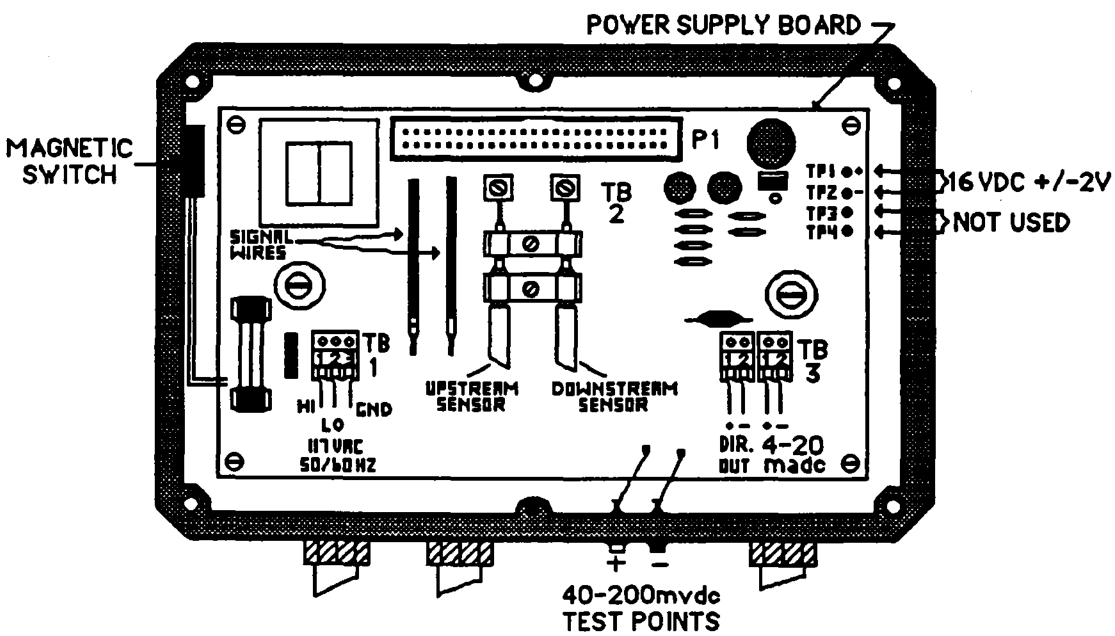


FIGURE 2-4
BACK HOUSING WITH STANDARD POWER SUPPLY

Accessory power supply connections (Figure 2-5). The terminals marked TB1 are for the 115 VAC connections. Terminal 1 is the high side (black wire) connection. Terminal 2 is the low or neutral side (white wire) connection. Terminal 3 is the earth ground (green wire) connection. A magnetic switch (located on the left side of the back housing) removes power from the power supply board when the front housing is separated from the back housing.

The terminals marked TB2 are for the accessory output and 4-20 mA output connections. The accessory outputs are optically coupled open collector outputs rated at a maximum of 50 VDC at 100 mA. The following defines these accessories:

Terminals 1 and 2 are the connections for the Low alarm output. Terminal 1 is the positive (+) connection and terminal 2 is the negative (-) connection.

Terminals 3 and 4 are the connections for the High alarm output. Terminal 3 is the positive (+) connection and terminal 4 is the negative (-) connection.

Terminals 5, 6, 7 and 8 are for future accessory outputs.

Terminals 9 and 10 are the connections for the flow direction output when operating the flowmeter in the bi-directional mode. Terminal 9 is the positive (+) connection and terminal 10 is the negative (-) connection.

Terminals 11 and 12 are the connections for the lost signal output. The switch output will be closed when the meter has detected a loss of signal and has defaulted to a zero output (no flow) condition. Terminal 11 is the positive (+) connection and terminal 12 is the negative (-) connection.

Terminals 13 and 14 are the connections for the 0 - 20 pulses per second output. This is a scalable output which can be factory set from 0-2 to 0-20 pps. If this has been activated then the 0-1000 cannot be used. Terminal 13 is the positive (+) connection and terminal 14 is the negative (-) connection.

Terminals 15 and 16 are the connections for the 0 - 1000 pulses per second output. This is a non-scalable output. If this has been activated, then the 0-20 pps cannot be used. Terminal 15 is the positive (+) connection and terminal 16 is the negative (-) connection.

Terminals 17 and 18 are for the 4 to 20 mADC output signal. Terminal 17 is the positive (+) connection and terminal 18 is the negative (-) connection.

Two test points are provided on the bottom of the back housing to allow adjustment of the 4 to 20 mADC signal. Refer to the Operation section for use when adjusting Zero and Span.

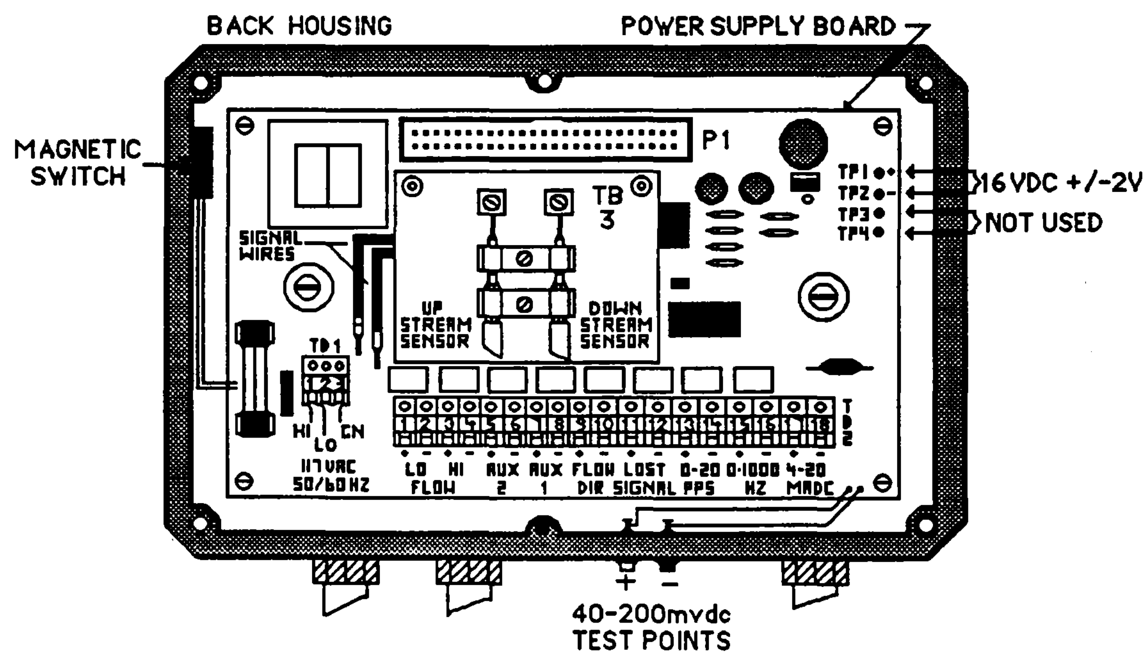


FIGURE 2-5
BACK HOUSING WITH ACCESSORY POWER SUPPLY

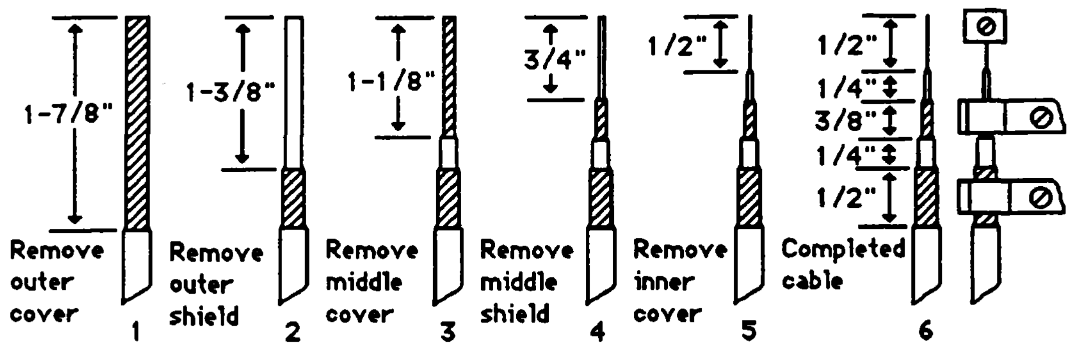


FIGURE 2-6
SENSOR CABLE PREPARATION

Sensor cable connections. Before pulling the sensor cables through the conduit, mark the ends of the cables to indicate which is the upstream and downstream sensor cable. Leave approximately 8 inches of cable extending from the conduit in the enclosure. Refer to Figure 2-6 and prepare the cable ends in the following manner.

1. Remove outer cable cover. Measure 1-7/8" from the end of the cable. With a cutting tool, carefully cut through the outer covering competely around the cable making sure not to cut into the outer shield. Make another cut from the first cut to the end of the cable and remove the outer cover.

2. Remove outer shield. Measure 1-3/8" from the end of the cable. With a pair of small cutters, cut the shield around the cable at the measured point and remove the cut off shield.

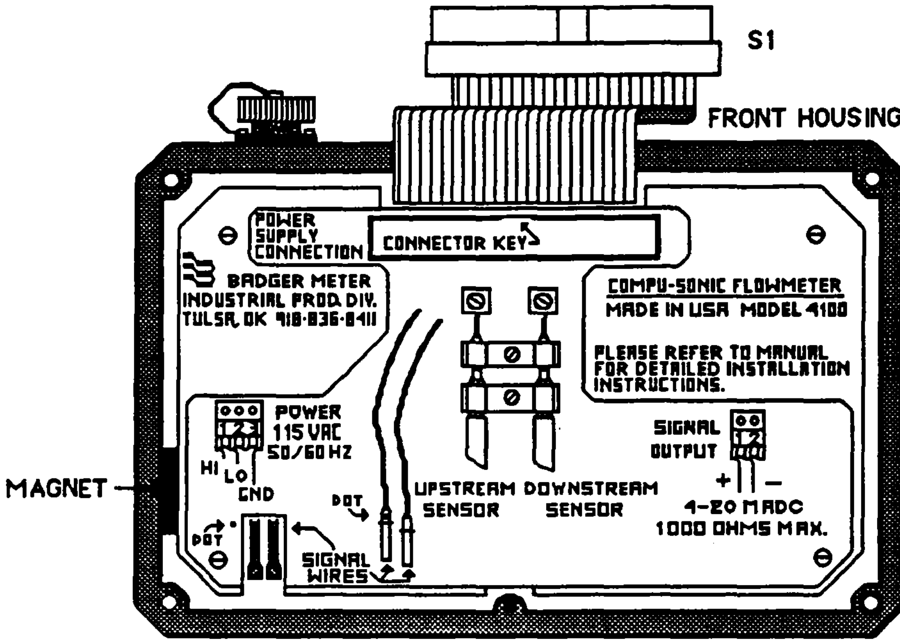
3. Remove middle cover. Measure 1-1/8" from the end of the cable. With a cutting tool, carefully cut through the middle covering completely around the cable making sure not to cut into the middle shield. Make another cut from the first cut to the end of the cable and remove the middle cover.

4. Remove middle shield. Measure 3/4" from the end of the cable. With a pair of small cutters, cut the shield around the cable at the measured point and remove the cut off shield.

5. Remove inner cover. Measure 1/2" from the end of the cable. With a cutting tool or pair of wire strippers, carefully cut the inner covering competely around the cable, making sure not to cut into the center conductor and remove the inner cover.

After the ends of the cables have been prepared loosen the screws on terminals 1 and 2 of TB2 on the standard power supply (TB3 on the accessory power supply) and remove the two pairs of clamps below TB2 (TB3). Take the upstream cable and insert the center conductor into terminal 1 of TB2 (TB3) and tighten the screw. Slightly pull on the cable to ensure the wire is secured to the terminal. Take the downstream cable and insert the center conductor into terminal 2 of TB2 (TB3) and tighten the screw. Slightly pull on the cable to ensure the wire is secured to the terminal.

Place the two pair of clamps over the middle and outer shields and secure them into place. Verify that the clamps are making good contact with the shields and that no wires of the shields are extending beyond their own clamp down area.


S1
FRONT HOUSING
POWER SUPPLY CONNECTION
CONNECTOR KEY
BADGER METER
INDUSTRIAL PROD. DIV.
TULSA, OK 918-836-8411
COMPU-SONIC FLOWMETER
MADE IN USA MODEL 4100
PLEASE REFER TO MANUAL FOR DETAILED INSTALLATION INSTRUCTIONS.
POWER
115 VAC
50/60 HZ
HI
LO
GND
SIGNAL OUTPUT
+ −
4-20 MADC
1000 OHMS MAX.
MAGNET
DOT
UPSTREAM SENSOR
DOWNSTREAM SENSOR
SIGNAL WIRES

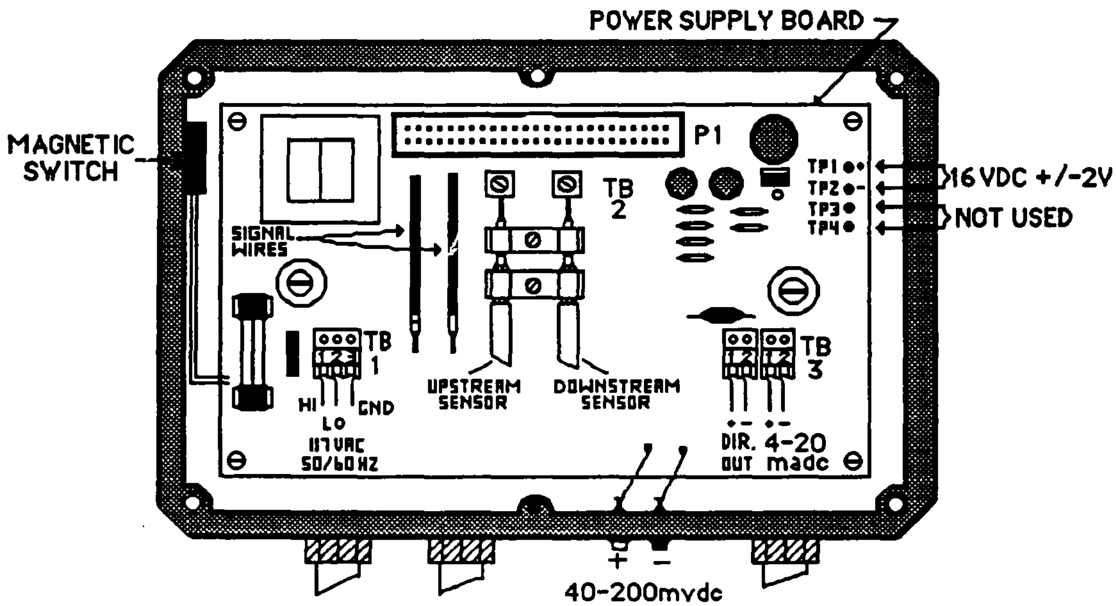

POWER SUPPLY BOARD
MAGNETIC SWITCH
P1
TB 2
TP1
TP2
TP3
TP4
16 VDC +/-2V
NOT USED
SIGNAL WIRES
TB 1
HI
LO
GND
117 VAC
50/60 HZ
UPSTREAM SENSOR
DOWNSTREAM SENSOR
TB 3
+ − + −
DIR. OUT
4-20 madc
+ −
40-200mvdc
TEST POINTS

FIGURE 2-7

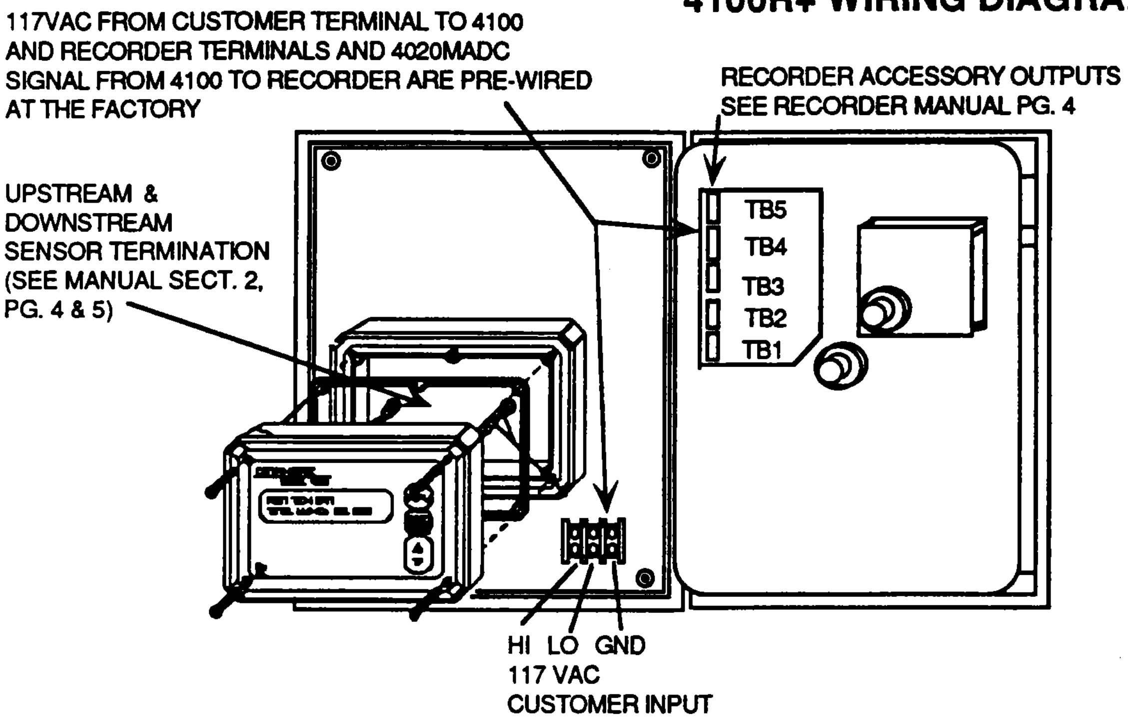
Front housing installation. After the wiring of the back housing is completed, the front housing can be reinstalled. The gasket is attached to the front housing to ensure proper alignment for maintaining a good seal.

Refer to Figure 2-7. On the front housing there is a protective cover for the electronic boards that also has the drawing for the wiring connections of the unit. Connect the ribbon cable plug S1 coming from the front housing into the socket connector P1 on the power supply in the back housing.

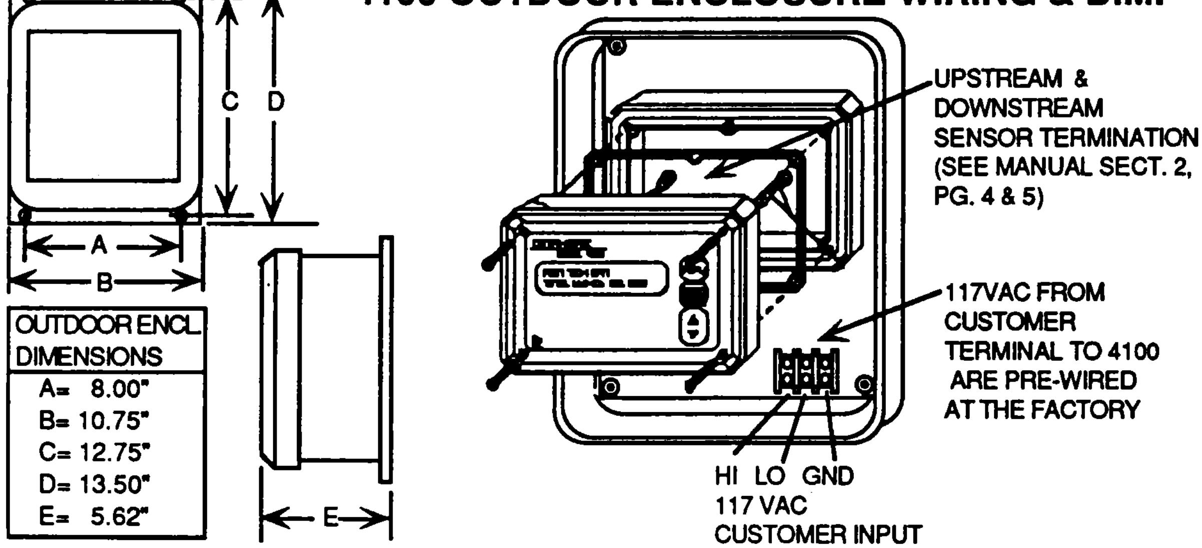
Insert the two signal wires coming from the power supply board in the back housing into the connectors on the electronic board in the front housing. One of the signal wires has a white dot marked on it and should be inserted into the connector next to the dot indicated on the protective cover drawing.

Secure the front housing to the back housing with the four hex bolts. This completes the enclosure installation procedure.

4100R+ WIRING DIAGRAM



4100 OUTDOOR ENCLOSURE WIRING & DIM.



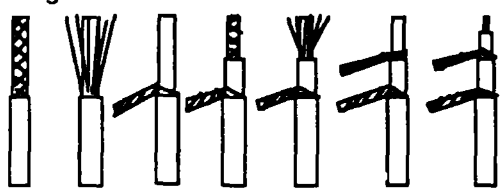
TRIAX CABLE SPLICE PROCEDURE

Materials Required

* 4 pigtail cap crimps (Wire size 18-12)
* 2 center conductor cap crimps (Wire size 22-14)
* 1 roll of electrical tape
* 2 epoxy resin envelopes
Crimp tool (customer supplied)
Knife (customer supplied)
Pointed tool (customer supplied)
Junction Box (customer supplied)

A cable connection kit may be purchased through Badger Meter that will include the * items above(part # 541874).

Trim each of the four cables at the junction box to nine inches in length. Each of the four cables can now be prepared as described in the sequence following:



A B C D E F G

Using a knife, trim two inches for outer jacket from each cable. The wire braid beneath the outer jacket must not be cut . See "A"

Using a pointed tool, carefully comb out the outer braid of each cable as shown in "B". Form the combed braid into a pigtail dressed to the side of the cable as shown in "C".

Trim one inch of the inner jacket from each of the cables as shown in "D". Again, use care to not cut the inner braid beneath the inner jacket.

Using a pointed tool, carefully comb out the inner braid "E" into a pigtail dressed to the same side of the cable as outer pigtail as in "F".

Remove 1/2 inch of insulation from the inner conductor of each cable. Cut the outer pigtail to the same length as the inner pigtail on each cable. "G" depicts the completed cable preparation.

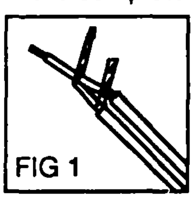


FIG 1

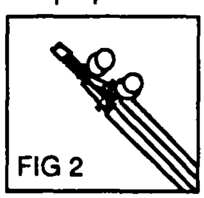


FIG 2

Cable Termination

Pull cables approximately 18 inches outside of junction box.Select one sensor cable and one cable from the electronic enclosure and place them side by side as shown in Fig. 1. Twist each cable's outer pigtails together, then the inner pigtails together and finally the center conductors together to form the cable splice. In similar fashion, connect the remaining sensor cable and the cable from the electronic enclosure.

Identification of upstream and downstream sensor cables must now be made. Connect a short wire from the center conductor splice to the inner shield pigtail splice on the upstream sensor cable. Using a multimeter determine the upstream sensor cable at the electronic enclosure end by continuity measurement. Identify the upstream cable for later termination.

Remove the shorting wire and using the cap crimps supplied, crimp the larger caps on each spliced pigtail and the small cap on the center conductor splice as shown in Fig. 2. Repeat this procedure for the second cable.

At this point turn power on at the electronics and verify that an OK signal condition appears on the display.

Turn power "OFF".

1. Read caution statement at bottom.
2. Remove guard bag, using caution not to damage inner bag.
3. Grip both edges of bag at the center barrier (fig.3) and wrinkle and flex the bag across the barrier. This will weaken the barrier.
4. Squeeze the clear side of the resin, forcing the resin through the center barrier.
5. Mix thoroughly to a uniform color by squeezing contents back and forth 25-30 times.
6. Squeeze resin to one end of bag, and cut off the other end (fig. 4).
7. Slowly insert connection into sealing pack until it fits snugly against the opposite end (fig 5).
8. Wrap open end of bag with vinyl electrical tape and position the taped end up untill resin jells (fig 6).

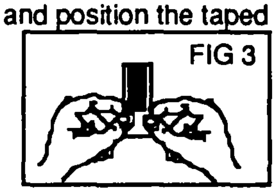


FIG 3

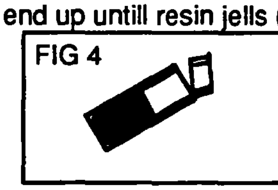


FIG 4

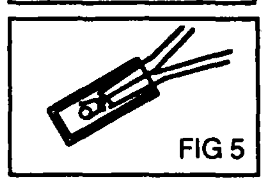


FIG 5

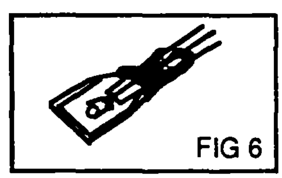


FIG 6

The finished splices should be coiled inside the junction box. When properly placed, the splices should be clear of the junction box cover area. Proper sealing of the junction box is necessary for watertight integrity.

This completes the triax cable splice connection.

The sealer kit above is a 3M Scotchlok #3570 product
IRRITATING TO SKIN AND EYES ON DIRECT CONTACT

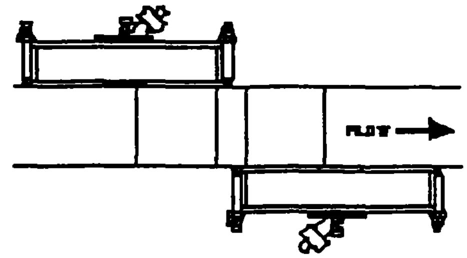
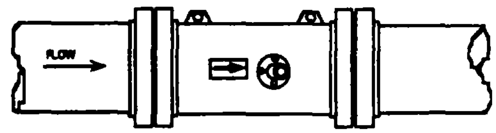
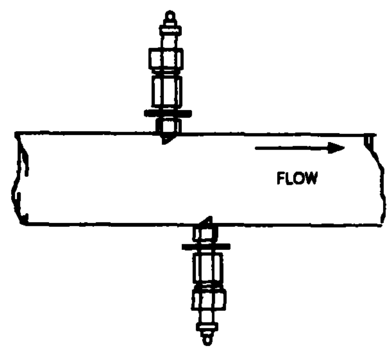
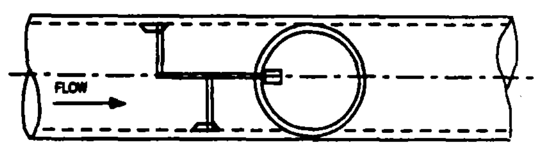
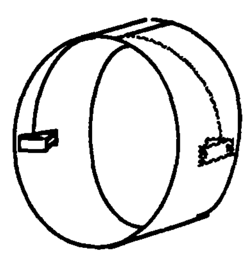
May cause skin sensitization in susceptible individuals. May be toxic by skin absorption. Harmful if swallowed. Vinyl cyclohexene dioxide has caused skin cancer in animal tests. Contains epoxy resin and vinyl cyclohexene dioxide.

Avoid skin and eye contact. Use only in well-ventilated areas with sufficient air movement to maintain airborne vapor levels at recognized health and safety levels. Wash thoroughly after using, before eating, drinking or smoking.

EYE CONTACT: Immediately flush eyes with water for at least ten minutes. Call physician
SKIN CONTACT: Wash with soap and water. INHALATION: Provide fresh air.

SECTION 3- SENSOR INSTALLATION

This section includes installation for the various sensors used with the Series 4000 ultrasonic flowmeter. Refer to the customer data sheet in the front of this manual to determine the type of sensors that is supplied.

SENSOR TYPE	SECTION/PAGE	
UNIVERSAL STRAP-ON	3A-1 THRU 3A-14	
WINDOW SPOOL	3B-1 THRU 3B-2	
HS3 "HOTSHOT" SENSOR	3C-1 THRU 3C-4	
INSTREAM WETTED REFRACTING SENSOR	3D-1	
WETTED SENSOR WITH HOOP	3E-1 THRU 3E-2	

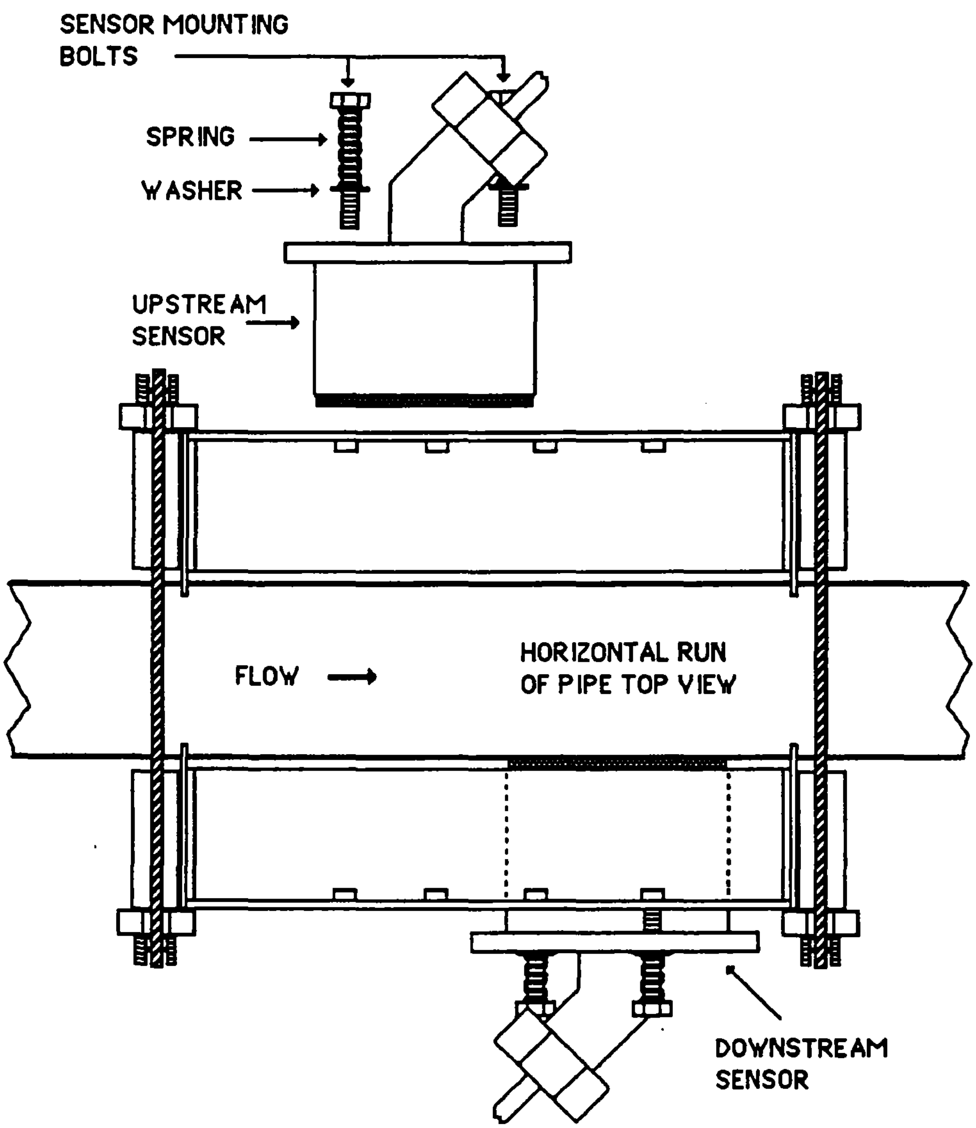
STRAP-ON SENSORS

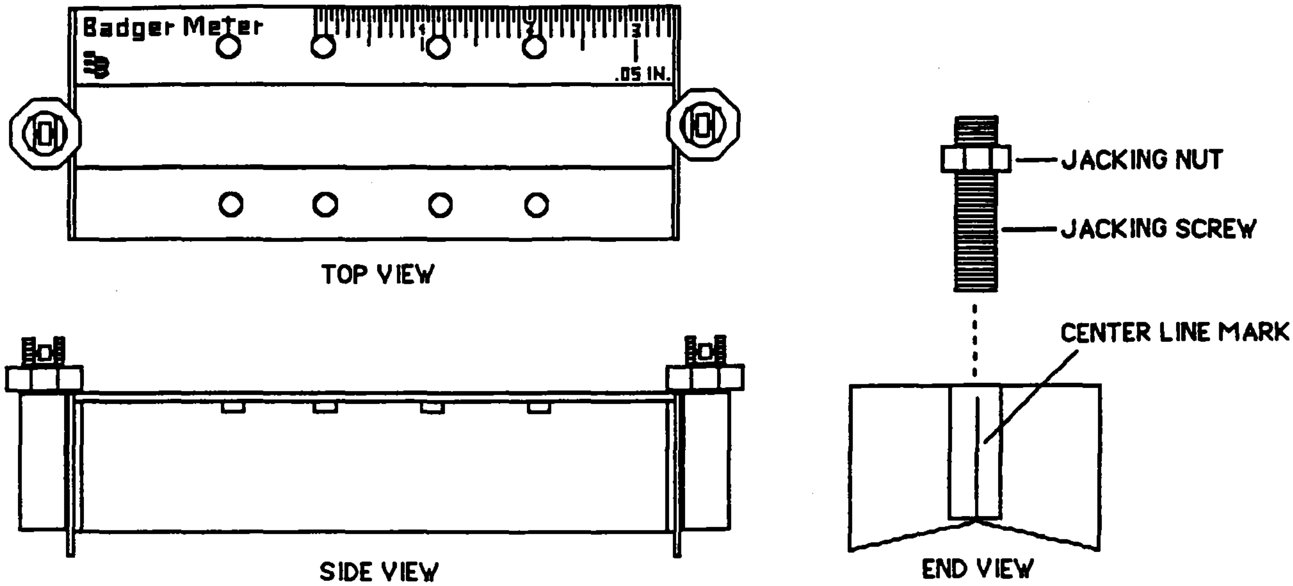
The universal strap-on sensors for the Series 4100 are designed for external mounting on pipes made of material, such as steel or plastics, that will support ultrasonic signal transmissions. The mounting hardware is constructed of corrosion resistant materials and designed for ease of installation.

It is important that the sensors are installed correctly on the pipe to ensure good accuracy. A template is provided for positioning the sensor holders on the pipe. There are three sensor mounting configurations. The proper configuration for your application is indicated on the data sheet in the front of this manual. When properly installed, the sensors will be located 180 degrees apart on opposite sides of the pipe and be offset upstream and downstream by the distance on the data sheet in the front of this manual. The sensors may be mounted on horizontal or vertical pipe runs. **If the pipe is horizontal, the sensors must be located on the sides and not on the top and bottom.**

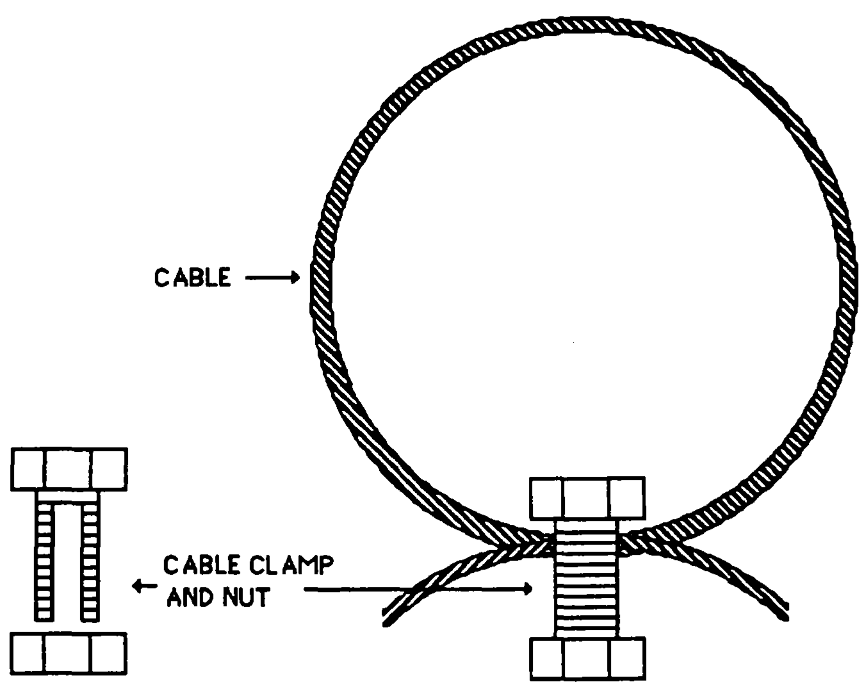
It is important that there be as much upstream straight run as possible so there will be a well developed velocity profile at the point of measurement. There should be 3 pipe diameters of downstream straight run after the point of measurement.

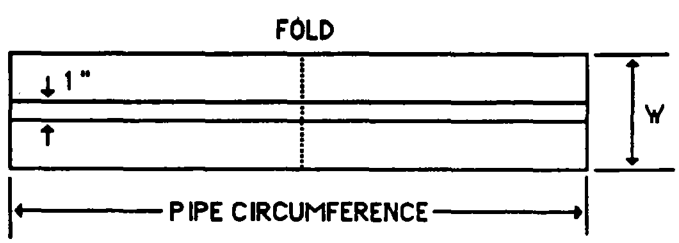
The drawings below and on the next page show the sensor mounting configuration Case A and sensor and mounting hardware. Included with the mounting hardware are: two sensor holders; four jacking screws and nuts; two or four lengths of stainless steel cables (depending on the sensor configuration); two or four cable clamps and nuts (depending on the sensor configuration); two sensors with four bolts, springs and washers; and a template.





SENSOR HOLDER





TEMPLATE

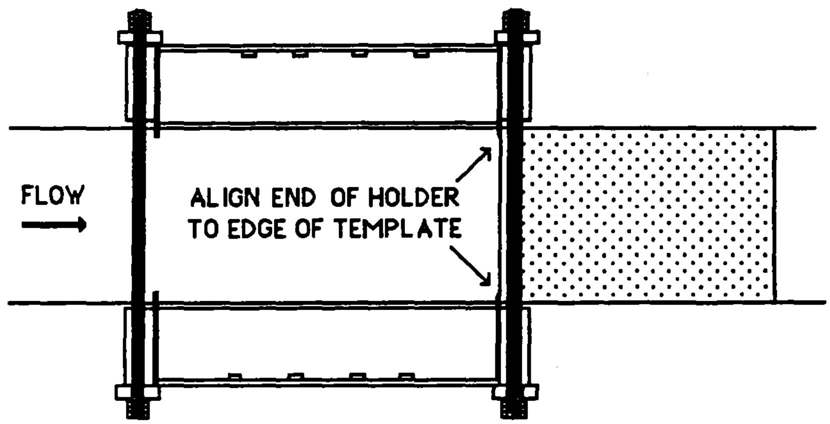
W (WIDTH)	MOUNTING CONFIGURATION
7"	Case A, B & C
14"	Case D
21"	Case E
28"	Case F
35"	Case G
42"	Case H
49"	Case I
56"	Case J

SENSOR HOLDER INSTALLATION

There are three different mounting configurations for the installation of the Series 4100 universal sensors and mounting hardware. These configurations are referred to as Case A, Case B and Case C through J. The difference in these configurations is the location of the sensor holders with reference to the template. See the data sheet in the front of this manual for the proper configuration for your application.

Once you have determined the mounting configuration for your application, inspect the pipe and select a section that is relatively smooth and free of any protrusions or large indentations. Take the sensor mounting template and wrap it around the pipe. Mark the template where it overlaps. Remove the template and cut off one end so that it is now the circumference of the pipe. Fold the template in half.

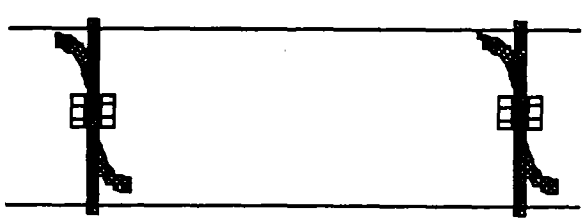
SENSOR MOUNTING
CONFIGURATION
CASE A



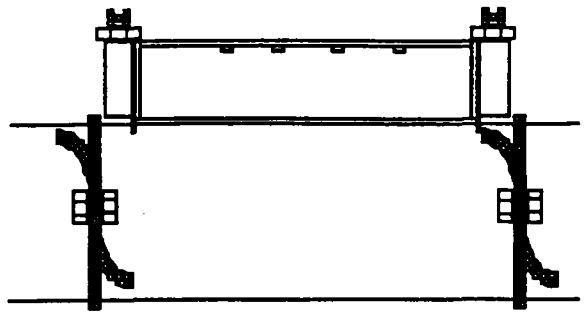
If your application calls for configuration Case A, the mounting will be as shown above. Case A requires that the sensor holders be mounted directly across from each other. The ends of the sensor holders will be aligned to the edge of the template. It does not matter if they are aligned to the left or right of the template.

After the template has been folded in half to make the crease, wrap it around the pipe. Tape the ends together. The fold and the ends that meet will be used to locate the center of the holders.

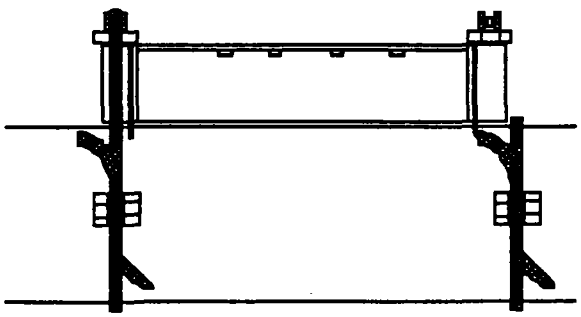
Once the template is secured to the pipe, remove all extraneous material such as dirt, rust, coatings, etc. from the area of the pipe where the sensor holders will be located (at the fold and where the template ends meet). The pipe surface must be clean and smooth. A file or grinding tool may be required to ensure a smooth surface.



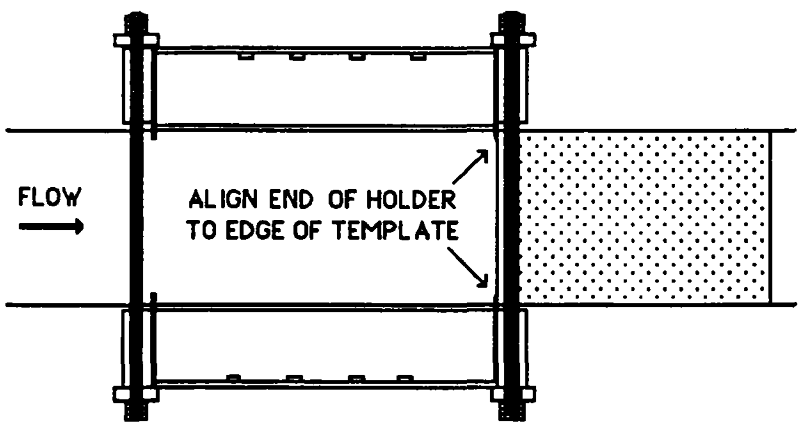
Take the two steel cables and cable clamps and attach the cables as shown . Tighten the cable clamps with your fingers where the cable will not be loose but the cable will slide through the cable clamp by pulling on it. The picture is a view from the side of the pipe.



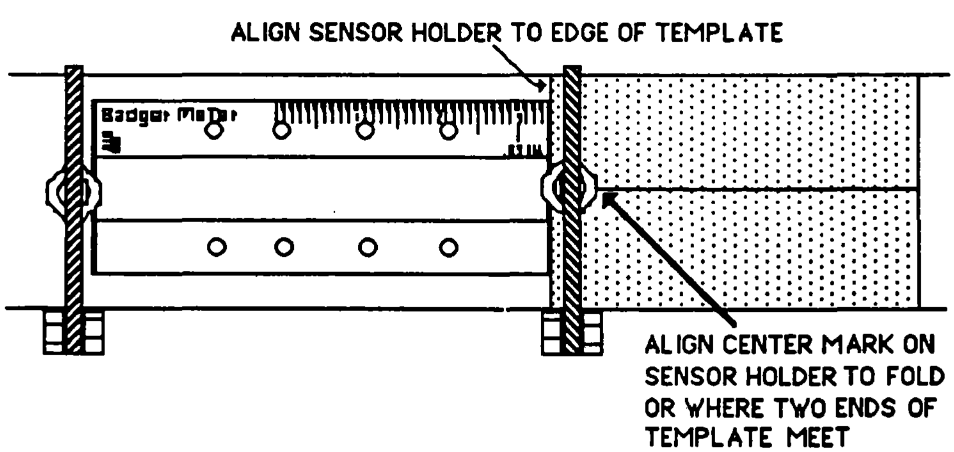
Place one of the sensor holders on the top of the pipe as shown. Be sure that the sensor holder is positioned so that when the sensor holders are rotated to align the center marks with the fold and ends of the template, the scale is on the top as pictured at the bottom of this page.



Pull on one of the cables and slip it over the notch of the jacking screw. Do the same with the other cable. Rotate the sensor holder and cables so that the sensor holder is now on the bottom of the pipe.

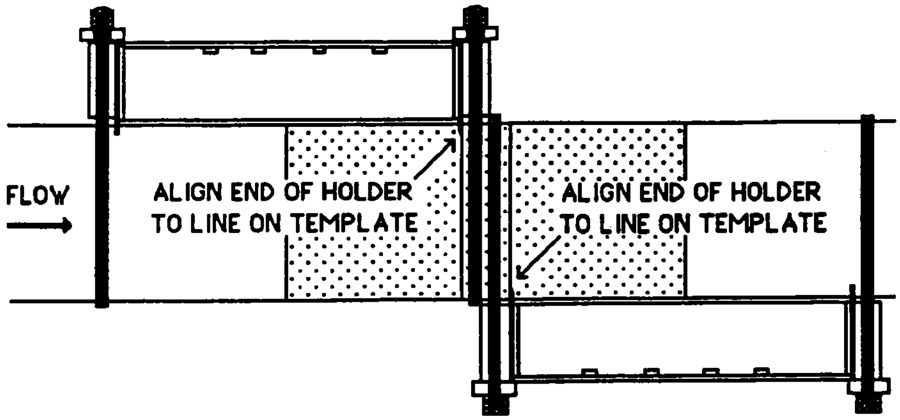


Install the second holder in the same manner as the first. Remember to position the sensor holder so that when the holders are rotated to align the centers with the fold and ends of the template that the scales will be readable and not upside down. Take up the slack in the cables and tighten the cable clamps securely (3/4" wrench).



Rotate the sensor holders so that the center line mark is aligned with the fold or two ends and that the end of the holder is to the edge of the template. Tighten the jacking screw nuts, gradually tightening one on one holder then on the other until the holders are secure to the pipe.

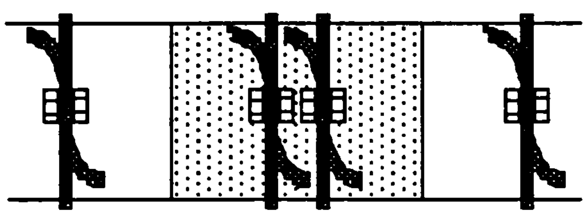
SENSOR MOUNTING
CONFIGURATION
CASE B



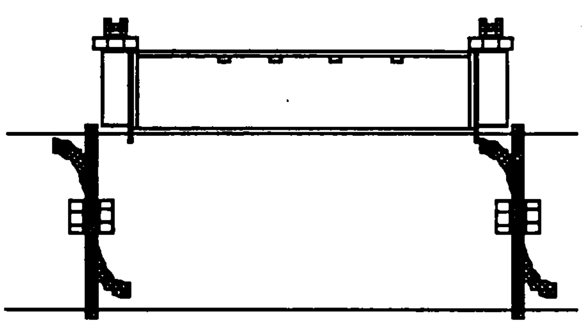
If your application calls for sensor configuration Case B, the sensor holders will be mounted as pictured above. The ends of the holders will be aligned to the two lines in the center of the template.

After the template has been cut to the circumference of the pipe, fold the template in half. Wrap the template around the pipe and mark on one side of the pipe to the right of the fold of the template and on the other side of the pipe to the right of where the two ends of the template meet. Remove the template and remove all extraneous material such as dirt, rust, coatings,etc. from the area of the pipe where the sensor holders will be located. The pipe surface must be clean and smooth. A file or grinding tool may be required to ensure a smooth surface.

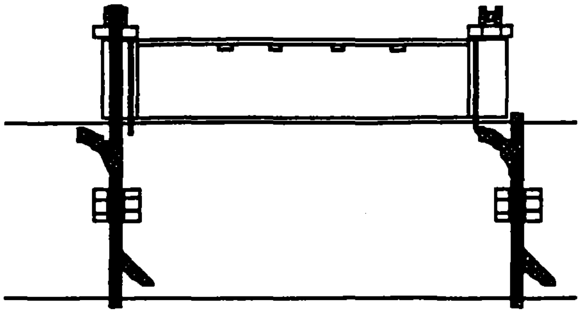
Reinstall the template securing it to the pipe and aligning the fold and the two ends of the template to the areas just prepared.



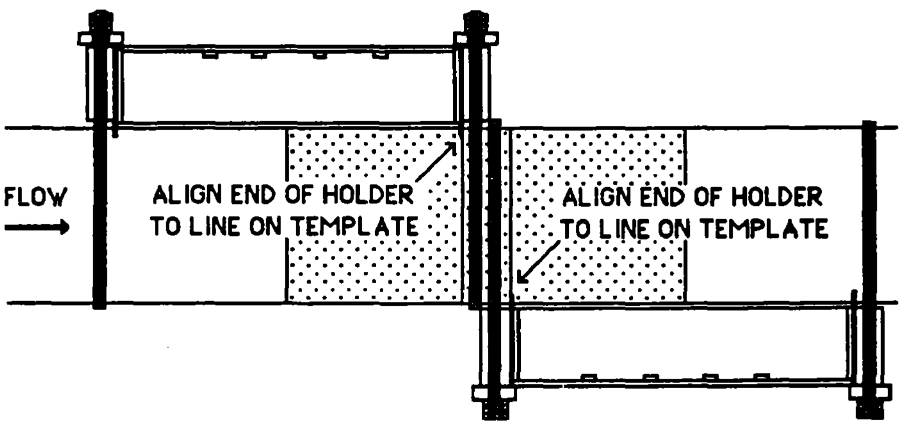
Take the four steel cables and cable clamps and attach the cables as shown . Tighten the cable clamps with your fingers where the cable will not be loose but the cable will slide through the cable clamp by pulling on it. The picture is a view from the side of the pipe. Rotate the cables so that the cable clamps are at the bottom of the pipe.



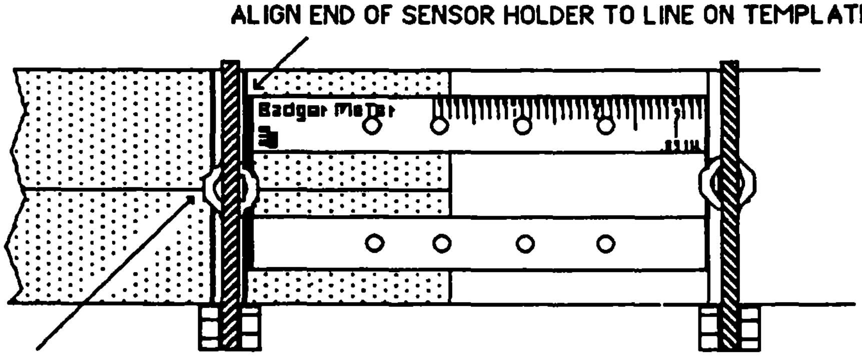
Place the sensor holders on the top of the pipe as shown. Be sure that the sensor holders are positioned so that when they are rotated to align the center marks with the fold and ends of the template, the scale is on the top as pictured on the bottom of the next page.



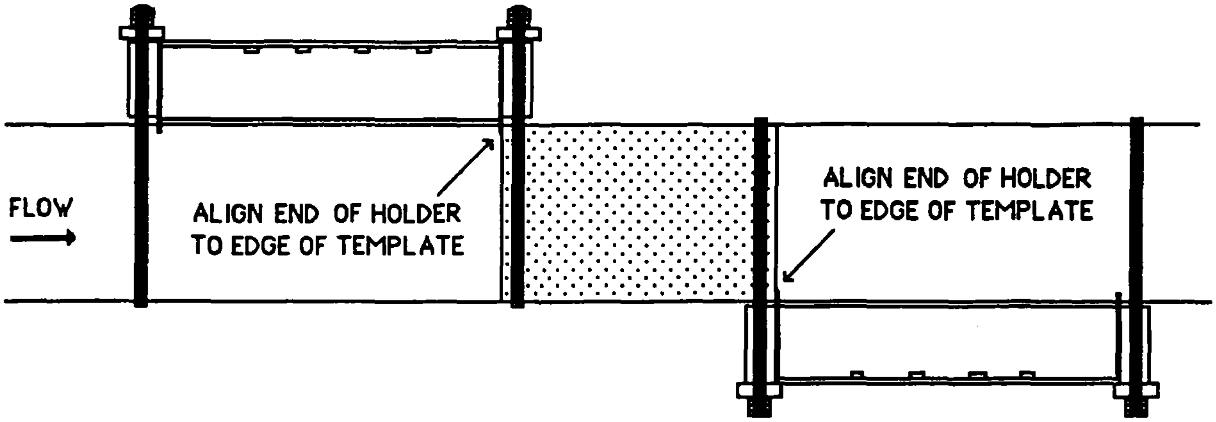
Pull on one of the cables and slip it over the notch of the jacking screw. Do the same with the other cable. Take up the slack in the cables and tighten the cable clamps securely (3/4" wrench).



Rotate the sensor holders and align the ends of the holders with the lines on the template. View is from top of pipe.



Align the end of the holder to the line on the template and the center mark on holder to fold or two ends of template. Adjust the jacking screw nuts so that the jacking screws tighten the holder securely to the pipe (3/4" wrench). Cut out the template paper under the holder.

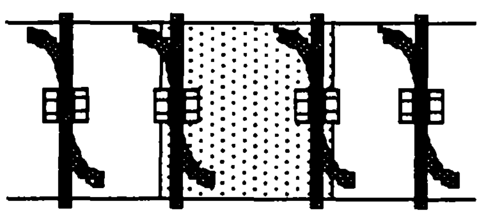


SENSOR MOUNTING
CONFIGURATION
CASES C TO J

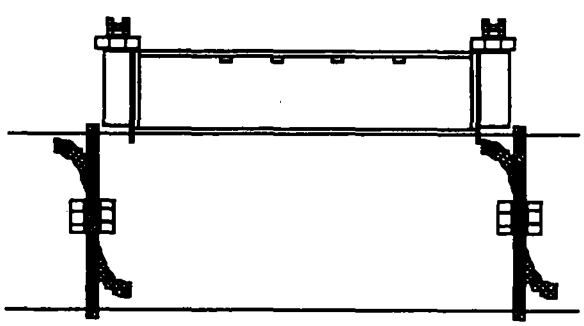
If your application calls for configuration Cases C to J, the mounting will be as shown above. Cases C to J require that the ends of the sensor holders be aligned to the edges of the template.

After the template has been folded in half to make the crease, wrap it around the pipe. Tape the ends together. The fold and the ends that meet will be used to locate the center of the holders.

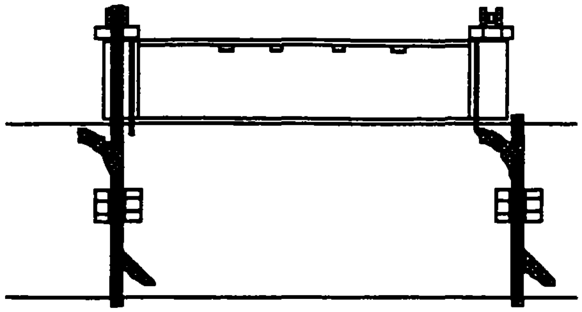
Once the template is secured to the pipe, remove all extraneous material such as dirt, rust, coatings, etc. from the area of the pipe where the sensor holders will be located (at the fold and where the template ends meet). The pipe surface must be clean and smooth. A file or grinding tool may be required to ensure a smooth surface.



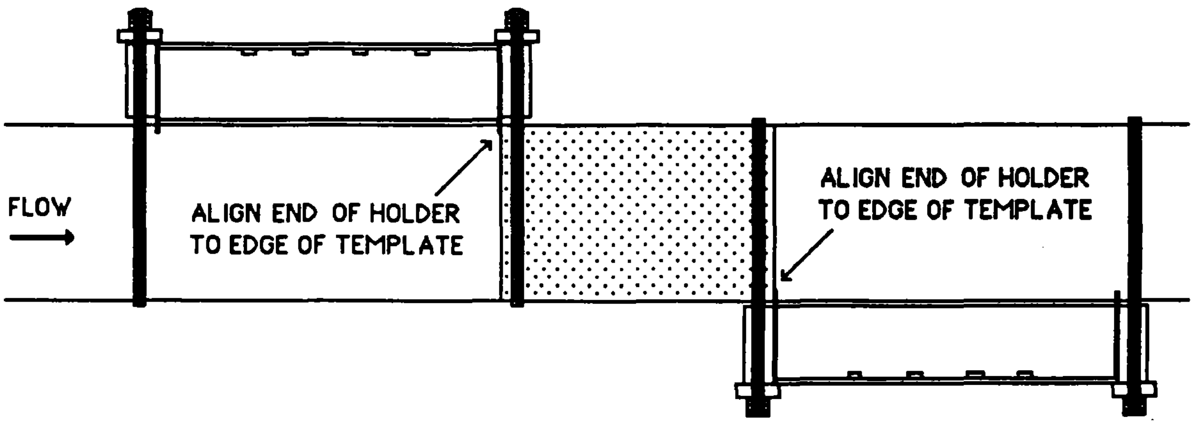
Take the four steel cables and cable clamps and attach the cables as shown . Tighten the cable clamps with your fingers where the cable will not be loose but the cable will slide through the cable clamp by pulling on it. The picture is a view from the side of the pipe. Rotate the cables where the cable clamps are at the bottom of the pipe.



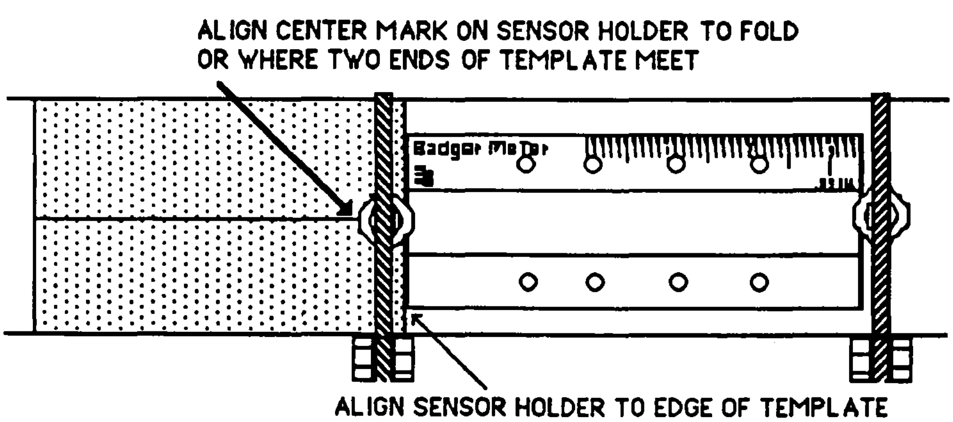
Place the sensor holders on the top of the pipe as shown. Be sure that the sensor holder is positioned so that when they are rotated to align the center marks with the fold and ends of the template, the scale is on the top as pictured on the bottom of the next page.



Pull on one of the cables and slip it over the notch of the jacking screw. Do the same with the other cable. Take up the slack in the cables and tighten the cable clamps securely (3/4" wrench).



Rotate the sensor holders and align the ends of the holders with the edges of the template. View from top of pipe.



Align the end of the holder to the edge of the template and the center mark on holder to fold or two ends of template. Adjust the jacking screw nuts so that the jacking screws tighten the holder securely to the pipe (3/4" wrench).

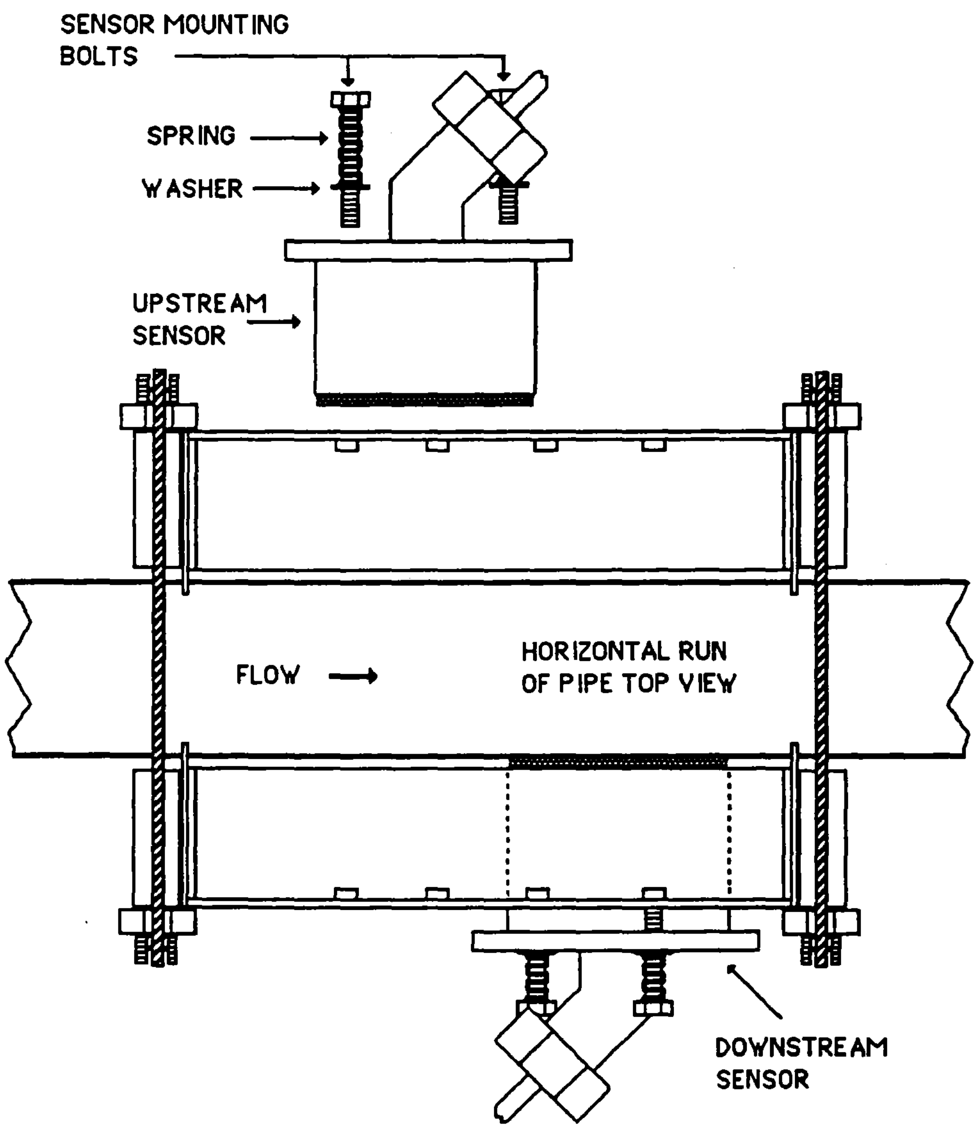
SENSOR INSTALLATION

After the sensor holders have been installed to the proper configuration, aligned to the template and secured to the pipe, the sensors can be installed.

It is very important that the sensors are installed in the correct direction and at the correct offset distance in order for the meter to function properly. The data sheet in the front of this manual will indicate the correct sensor offset.

The sensors are normally supplied with 100 feet of sensor cable. On the top plate of the sensor there is an arrow to indicate the position of the sensor with respect to the direction of flow. Mark the ends of the sensor cables to identify which sensor is upstream and which is downstream. This is so the cables will be connected to the correct sensor terminal connections in the electronic enclosure.

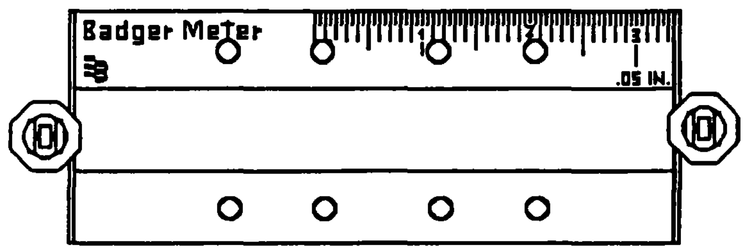
The picture below shows the mounting of the sensors in mounting configuration Case A. There are four bolts, washers and springs provided to mount the sensors to the sensor holders.



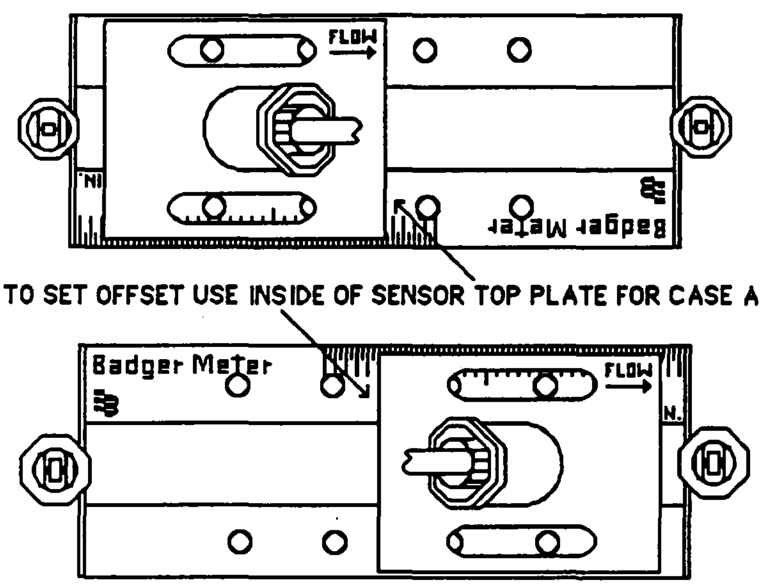
The position of the sensors in the holders is determined by the offset value. See the data sheet in the front of this manual to determine the value of the sensor offset.

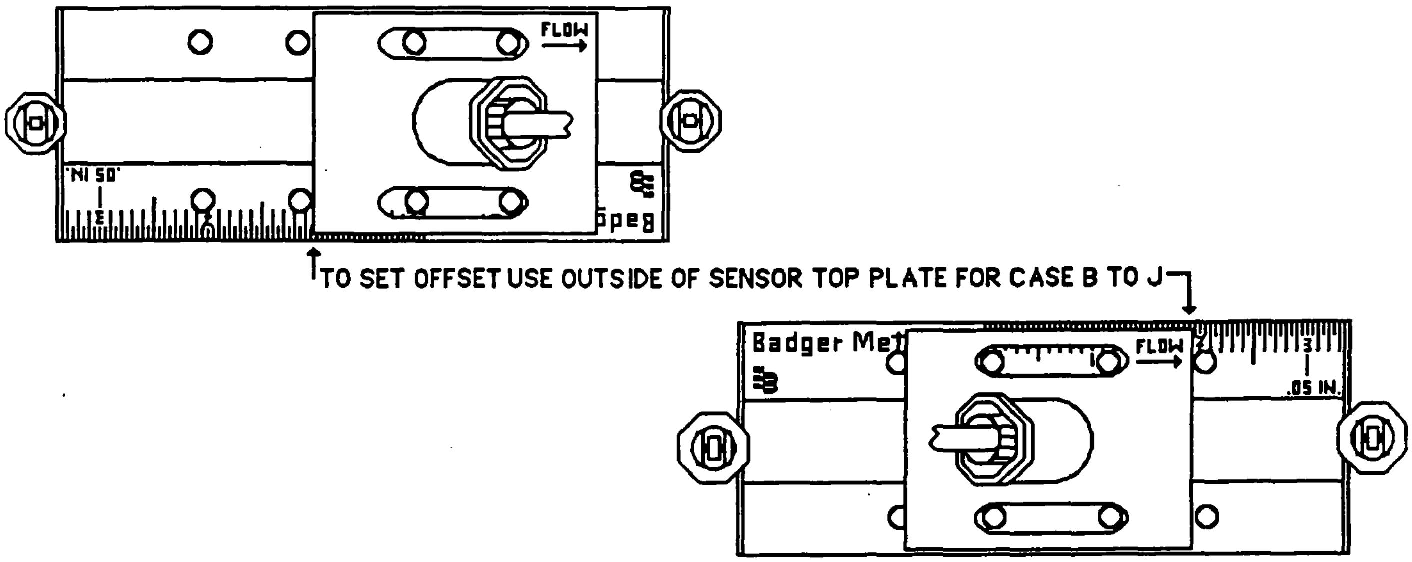
There is a scale on each of the sensor holders that is to be used when positioning the sensors to the offset called out on the data sheet. The outside or inside edge of the sensor top plate(depending on the mounting configuration) is used to align the sensor to a value on the scale. The offset value is the sum of the values set for each sensor. For example, if the sensor offset is 2.2 inches, then one sensor could be aligned with 1.1 inches on its scale and the other sensor would be aligned with 1.1 inches on its scale. The sum of the two would be 2.2 inches. This could have been 1.0 inch on one sensor and 1.2 inches on the other sensor, just as long as the two values added up to 2.2 inches.

This picture shows the sensor holder with the scale to be used when adjusting sensors for sensor offset. The scale is in 0.05 inch increments.



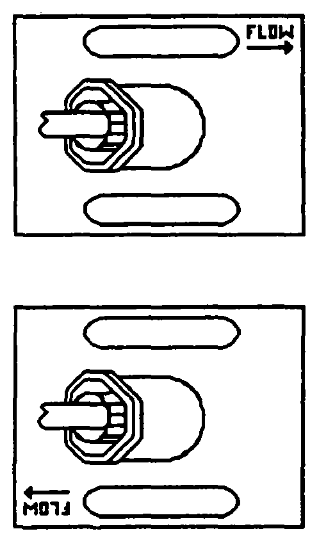
This picture shows that the inside edge of the sensor top plate is used to align the sensors for the proper offset value for the mounting configuration Case A. This example shows the sensor offset value to be 0.95 inches. The top sensor is set to 0.45 inches and the bottom sensor is set to 0.5 inches for a total offset of 0.95 inches.



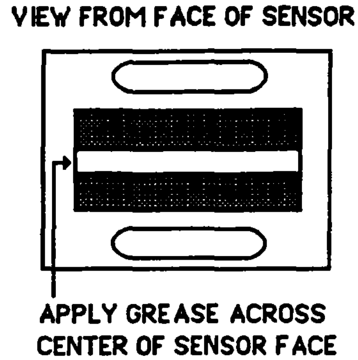


The above picture shows that the outside edge of the sensor top plate is used to align the sensors for the proper sensor offset for mounting configuration Cases B to J. This example shows the sensor offset value to be 3.00 inches. The top sensor is set to 1.05 inches and the bottom sensor is set to 1.95 inches for a total offset of 3.00 inches.

The pictures to the right show the top of the sensors. There is a flow direction arrow decal on the lower left corner on one sensor and on the upper right corner on the other sensor. When the sensors are installed correctly the arrows should be pointing in the direction of the flow. NOTE: On one of the sensors, when mounting on a horizontal pipe, the word FLOW will be upside down.



Prior to installing the sensors into the holders, apply a bead of the grease, furnished with the meter, across the center of the face of the sensor. The grease does not have to cover the entire face but only across the center as pictured to the right.

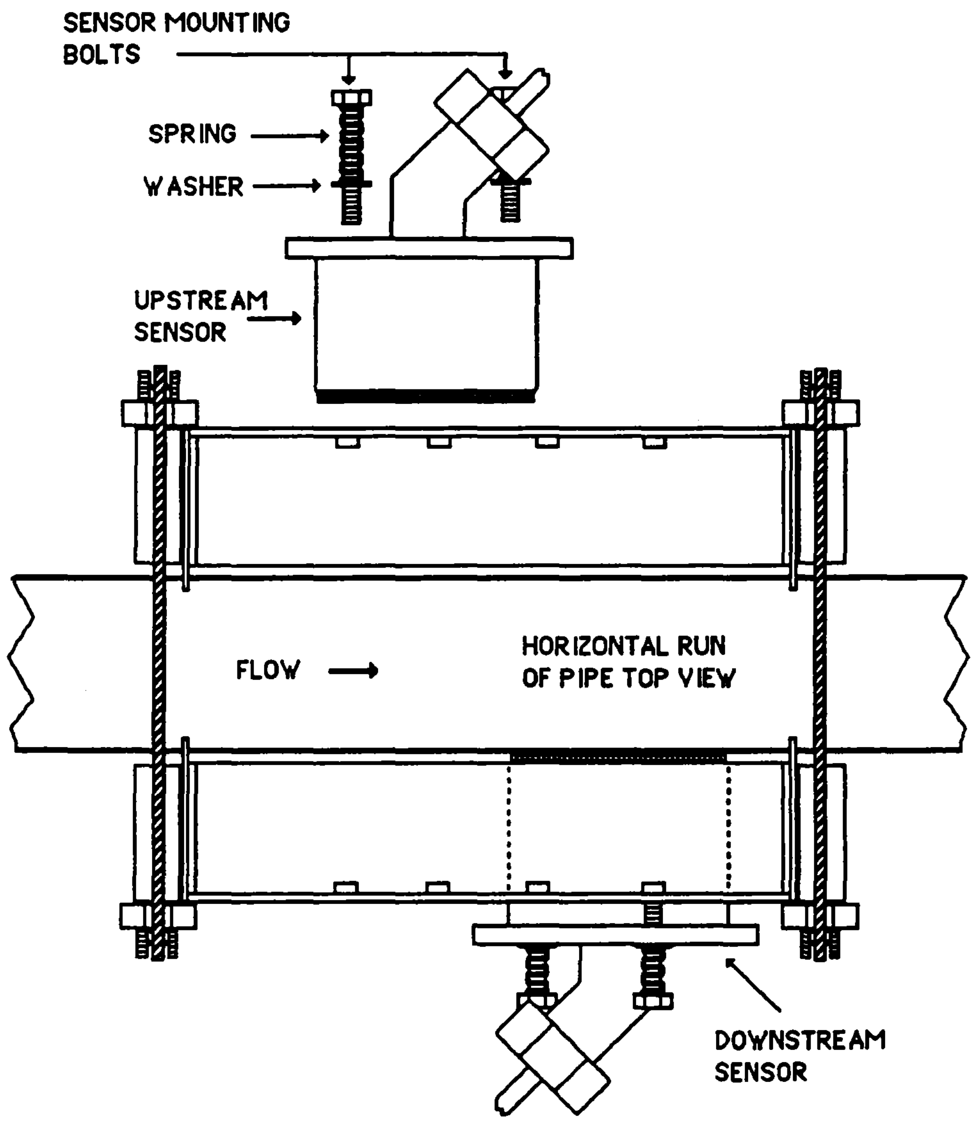


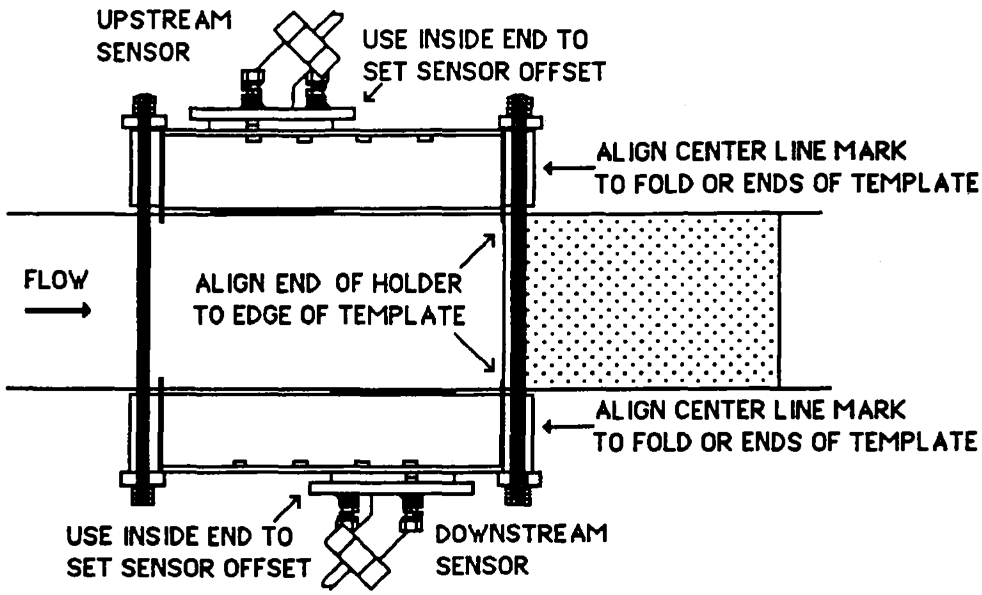
After determining the position to locate each sensor to get the sensor offset distance and having put the grease on the face of the sensor, install each sensor with the two bolts, springs and washers as pictured to the right.

If four threaded holes are visible through the slots in the top plate of the sensor, install the bolts at opposite corners.

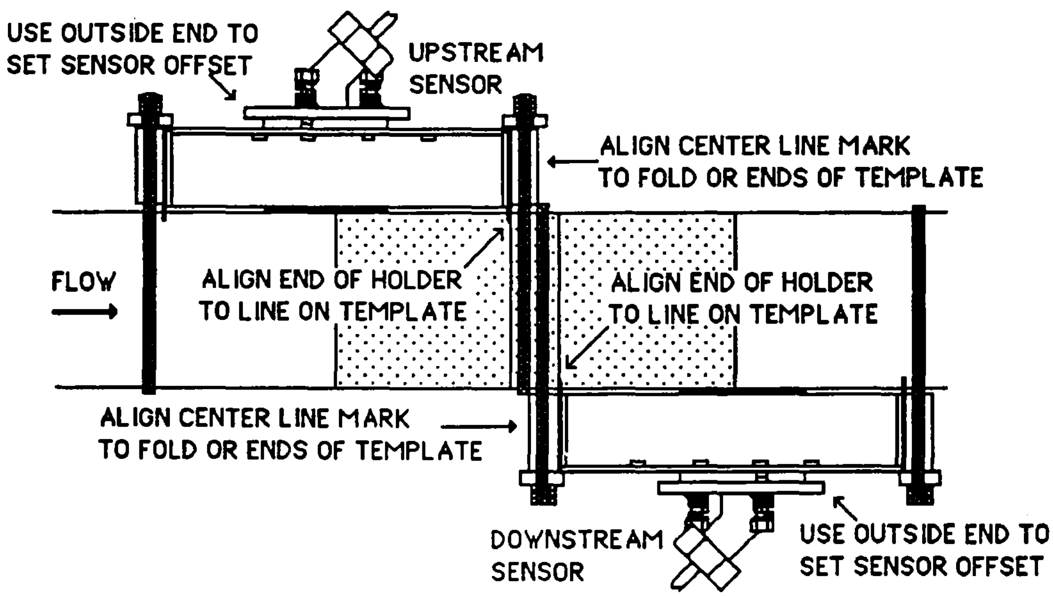
Tighten the bolts until the spring comes in contact with the holder and the bolt head. Tighten the bolts two and one-half more turns. This should be done one-half turn at a time, alternating between the two bolts.

Once the installation is complete, it should look like one of the pictures on the next pages depending on the mounting configuration for your application.

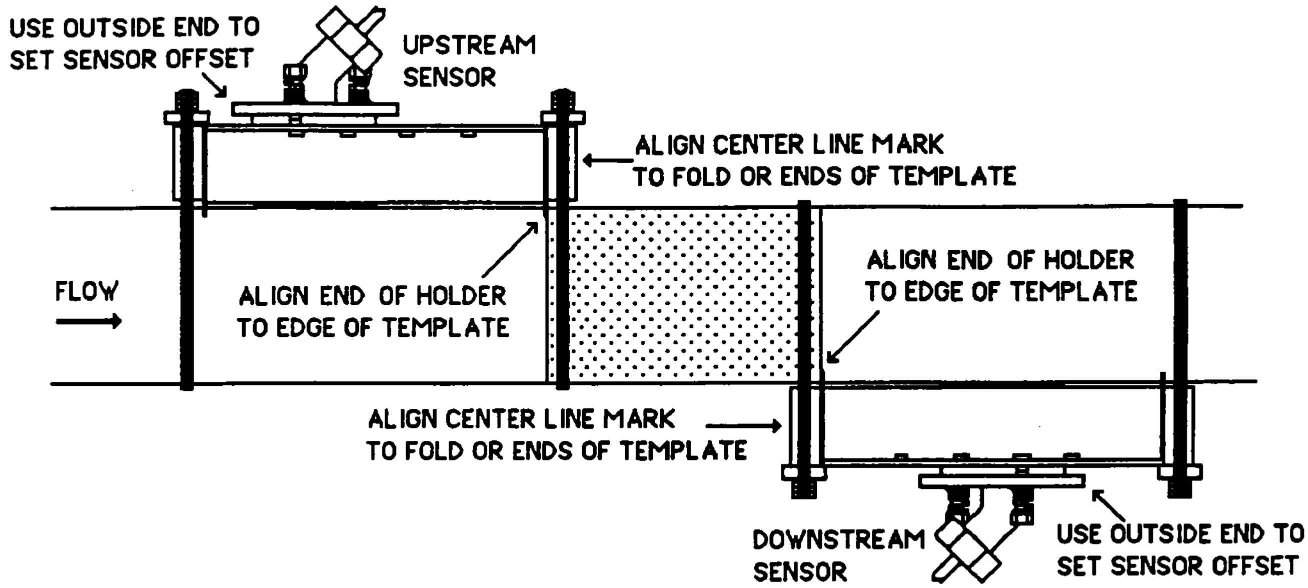




SENSOR MOUNTING CONFIGURATION
CASE A



SENSOR MOUNTING CONFIGURATION
CASE B



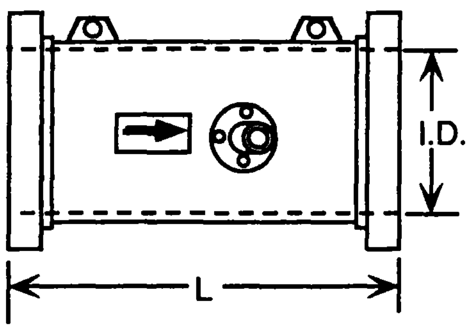
SENSOR MOUNTING CONFIGURATION
CASE C TO J

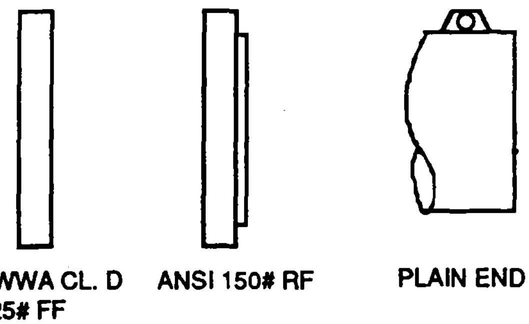
The sensors are supplied with 3/8 inch conduit fitting. It is recommended that flexible seal tight conduit be used to run the sensor cables to a junction box and then both cables can be run in a common conduit back to the electronics enclosure. <u>Be sure to mark the end of the sensor cables as upstream and downstream before pulling cables through the conduit.</u>

Refer to the electronic enclosure Wiring Section for instruction on wiring the sensor cables to the connections in the enclosure. To determine proper meter operation refer to the Operation Section of this manual.

This completes the installation procedure for the sensors and holders for the Series 4100 Compu-Sonic flowmeter.

WINDOW SPOOL INSTALLATION

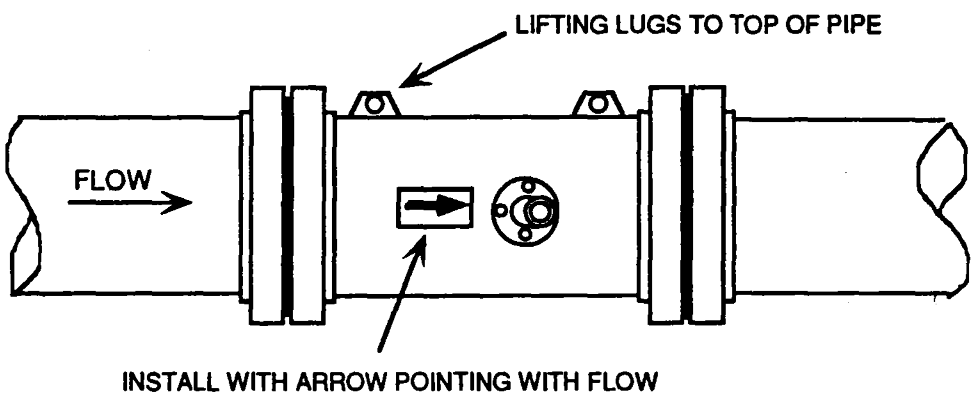




REFER TO CUSTOMER DATA SHEET

L= LAYING LENGTH IN INCHES

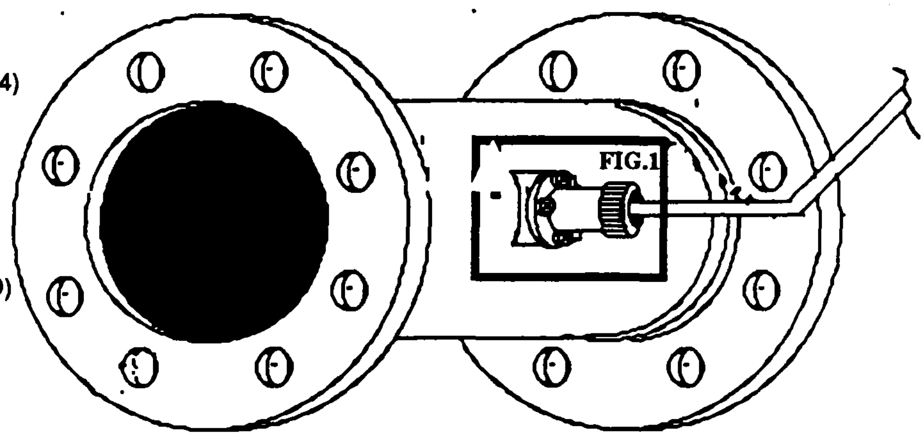
SIZE	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48
"L"	12	12	12	14	15	18	21	24	27	30	36	30	36	42	48

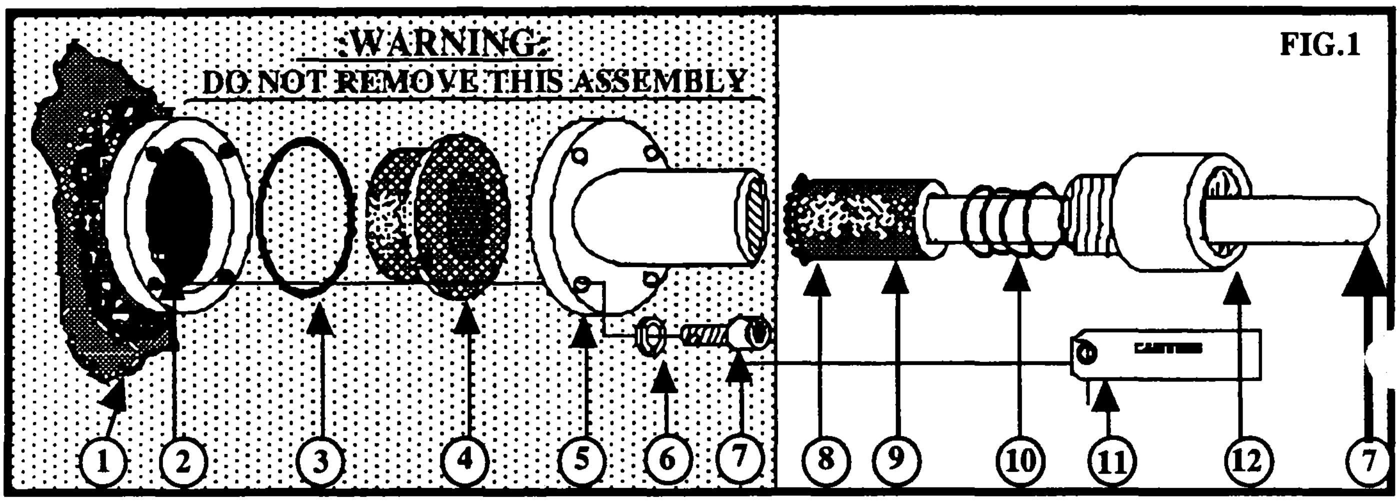


SPOOL PIECES MAY BE INSTALLED EITHER IN THE HORIZONTAL PLANE OR IN THE VERTICAL PLANE (WITH FLOW IN THE UP DIRECTION)

WINDOW SPOOL INSTALLATION

1. SPOOL
2. ROLL PIN (USED AS A GUIDE FOR # 4)
3. O RING
4. SENSOR WINDOW
5. SENSOR HOLDER
6. WASHER (4 PLACES)
7. SCREW (4 PLACES)
8. SILICONE GREASE
9. SENSOR & CABLE (25 FT STANDARD)
10. SPRING
11. CAUTION TAG
12. SENSOR RETAINER

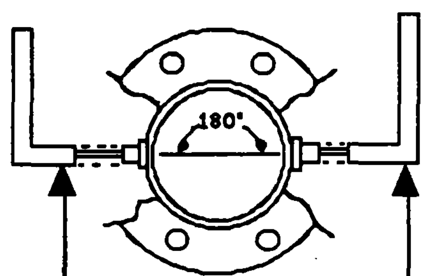




SENSOR REMOVAL PROCEDURE:

1. Remove conduit from the sensor retainer (12).
2. Unscrew the sensor retainer (12).
3. Gently pull on the sensor cable. The sensor spring (10) and the sensor (9), should "pop" out of the sensor holder (5).
4. Before reinstalling the sensor, carefully clean the sensor grease from the sensor window lens (4).

   NOTE: a long 6" cotton swab available at most electronic or audio stores works well for cleaning the window.



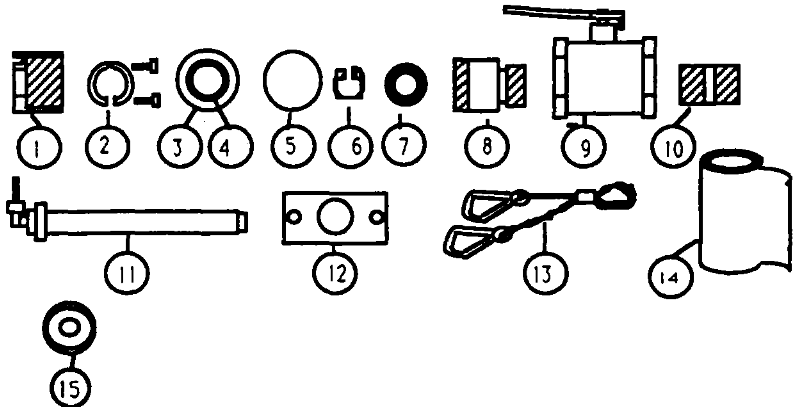
Metallic conduit or Seal-tite (by others)

5. Wipe the end and sides of the sensor clean, removing any grease and grit.
6. Spread a thin 1/32" layer of sensor grease (Dow Corning 111 valve* lubricant & sealant) on the end surface of the sensor.
7. Carefully reinsert the sensor into the sensor holder and gently push the sensor all the way in.

   NOTE: if the sensor will not push in, try to loosen the holder screws (7) slightly (without removing the safety wire seal) and shift the holder until the sensor will slide all the way in. retighten the holder screws.
8. Screw the sensor retainer down firm (hand tight) and reconnect the conduit. *Type 29 silicone heat sink compound may be used. (available at most electronic stores)

HS3 SENSOR INSTALLATION

PARTS LIST

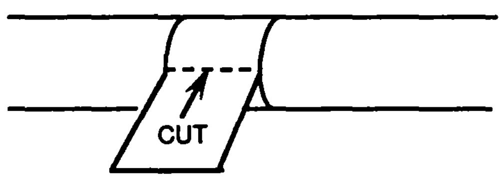


ITEM	DESCRIPTION	QTY.
1.	RETAINER BRZ	2
2.	SPLIT COLLAR	2
3.	BRASS COLLAR	2
4.	O-RING 1.287X2.7	2
5.	O-RING 2.112X2.318	2
6.	2" RETAINING RING	2
7.	BEARING SEAL	2
8.	BRASS TAIL PIECE	2
9.	BRZ BALL VALVE	2
10.	1-1/2" NIPPLE	2
11.	SENSOR W/100' CABLE	2
12.	SAFETY PLATE	4
13.	SAFETY CABLE	4
14.	TEMPLATE	1
15.	TEFLON TAPE	1

TEMPLATE INSTALLATION

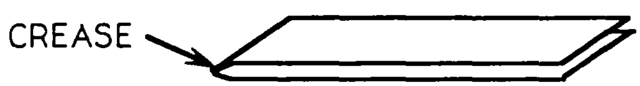
1.

Using tape, attach one end of the template to the pipe and wrap the rest of the template around the pipe. Pull the template straight and mark the point of overlap on the template. Cut off the excess.



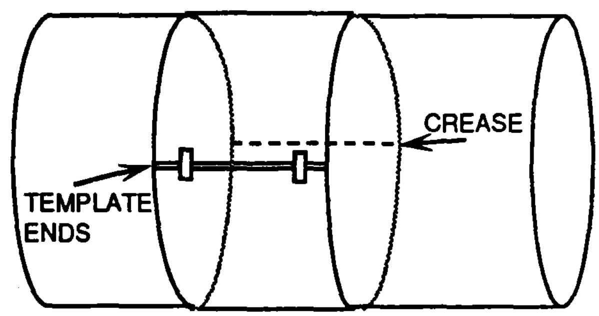
2.

Remove template from pipe. Fold template exactly in half and crease in the middle.



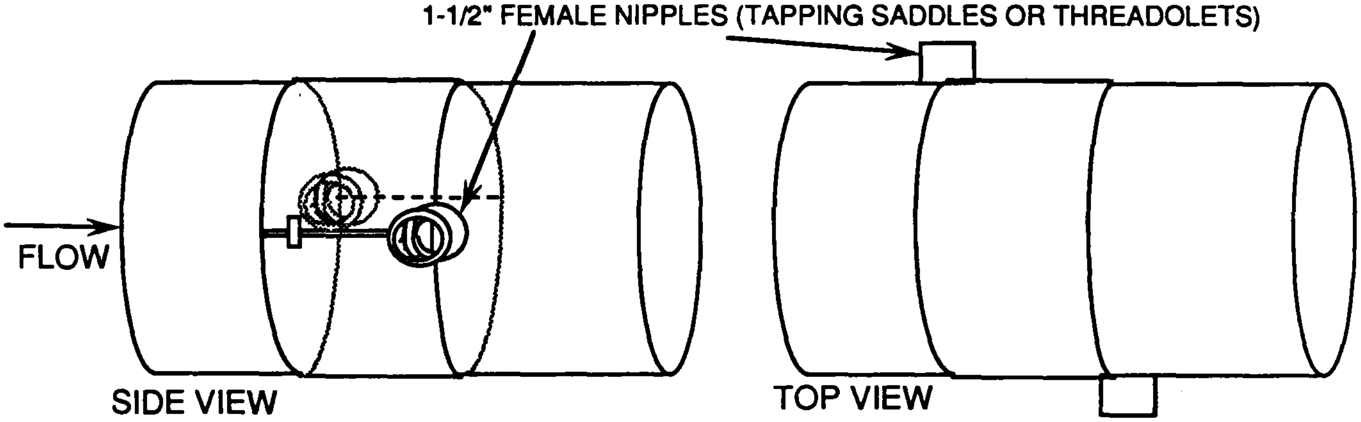
3.

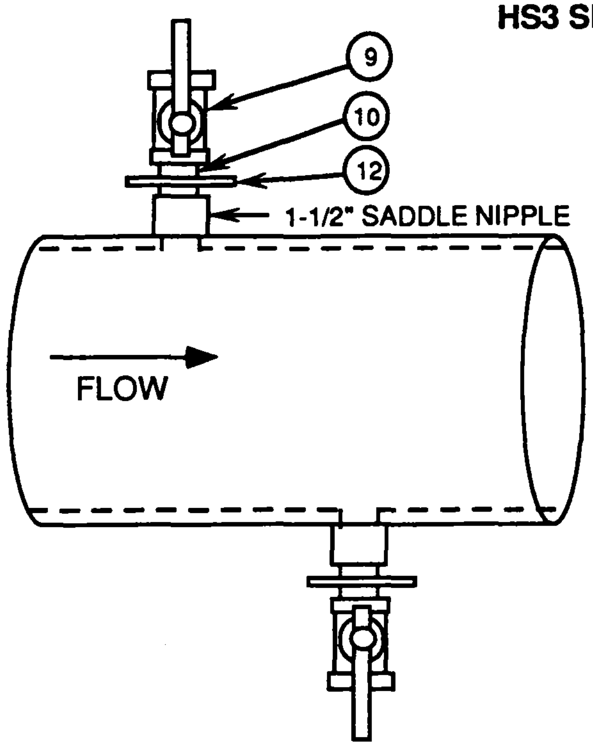
Wrap the template around the pipe so that the crease is on one side of the pipe and the two ends of the template meet on the other side of the pipe.
Try to line up the crease and ends with the horizontal center of the pipe. Tape the ends of the template together with masking tape to hold in place on the pipe.



4.

1-1/2" FEMALE NIPPLES (TAPPING SADDLES OR THREADOLETS)





HS3 SENSOR INSTALLATION

TAPPING PROCEDURE:

1. Install template and nipples per 3-1.
2. Use teflon tape, wrap the end of male nipple (item 10) and screw into female nipple of tapping saddle.
3. Slide safety plate (item 12) over outer end of nipple.
4. Screw ball valve (item 9) onto nipple. adjust valve to the "open" position.
5. Connect tapping machine into end of ball valve, 1-1/2".
6. Use 1.38" minimum tapping bit and tap through pipe wall.
7. Back the tapping bit out past the valve assembly and move the valve handle to the "off" position.

PREPARATION TO INSTALL SENSORS:

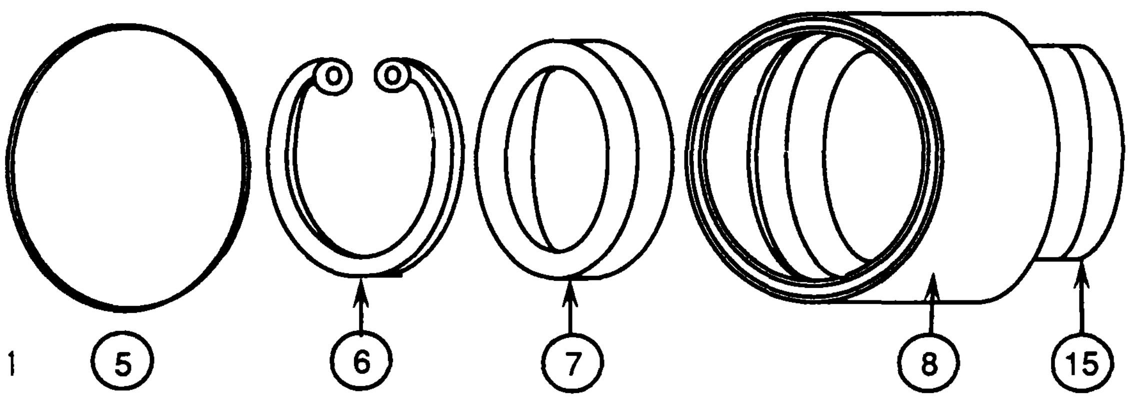


FIG. 1

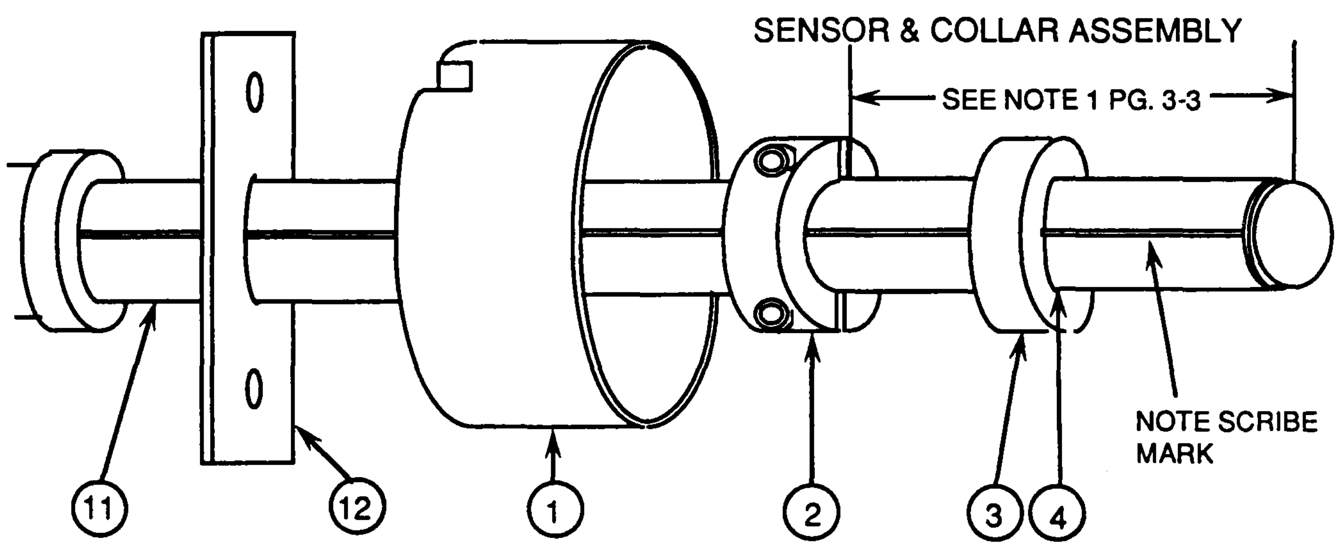


FIG. 2

HS3 SENSOR INSTALLATION

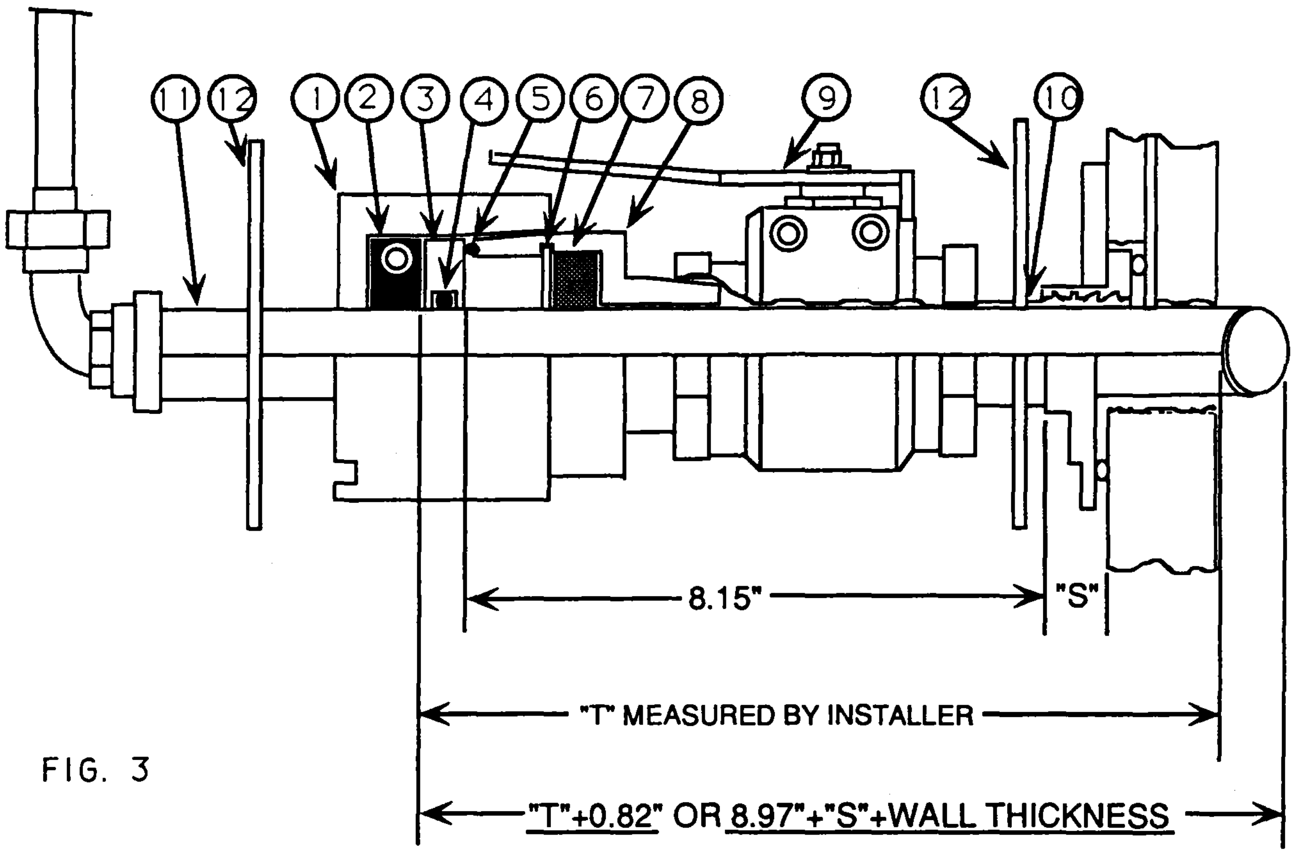


FIG. 3

"S"= Length of saddle or threadolet nipple
"T"= Length from i.d. of pipe to outside edge of item 8

NOTE 1: USE ABOVE FORMULAS TO DETERMINE THE PLACEMENT OF ITEM 2, ONCE COLLAR IS PLACED AT CORRECT DIMENSION TIGHTEN BOTH SOCKET HEAD SCREWS.

1. Screw tail piece assembly fig.1 (items 5, 6, 7 and 8) into ballvalve (item 9).
2. Slide items 12 and 1 onto sensor (item 11) use fig.2, pg. 3C-2.
3. Position collar (item 2) onto sensor and use above formula to calculate correct dimension. Please note that the collar should already be installed by the factory on new orders, the collar dimension will have to be changed only if pipe dimensions are other than given.
4. Slide brass collar and o-ring assembly (items 3 and 4) onto end of sensor and butt up against the split collar (item 2).

NOTE: USE SOAPY WATER, PETROLEUM JELLY OR SOME TYPE OF LUBRICANT TO SLIDE BRASS COLLAR AND O-RING ONTO SENSOR.

5. Note scribe mark running near the end of the sensor. This scribe mark, when the sensor is installed, should be facing toward the opposite sensor. (fig. 4)
6. Place tip of sensor through bearing seal (item 7) and carefully push until the sensor stops at the ball valve. Fasten safety cable clip (long length) to opposite safety plate.
7. Turn valve handle to the "on" position and insert the sensor until the brass collar (item 3)seats on the o-ring on the tail piece (items 5 & 8).
8. Tighten retainer (item 1) onto the tail piece (item 8) using a 1/16" square screw driver shaft in the notch on the end of the retainer.
9. Fasten short length of safety cable to opposite safety plate.

HS3 SENSOR INSTALLATION

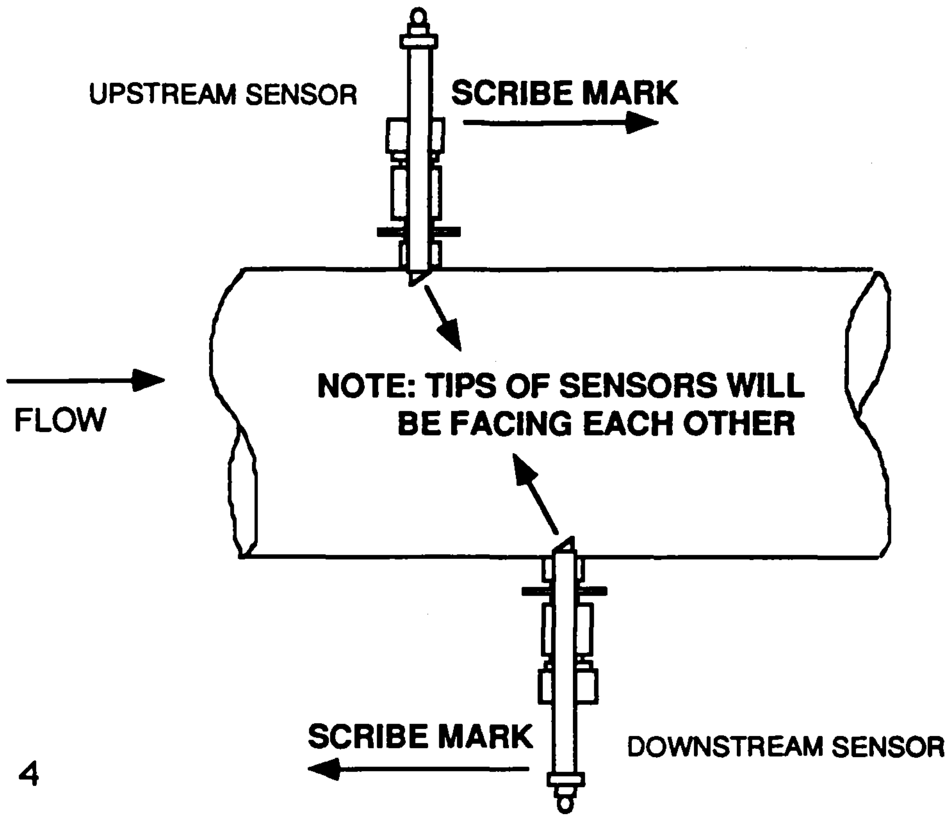
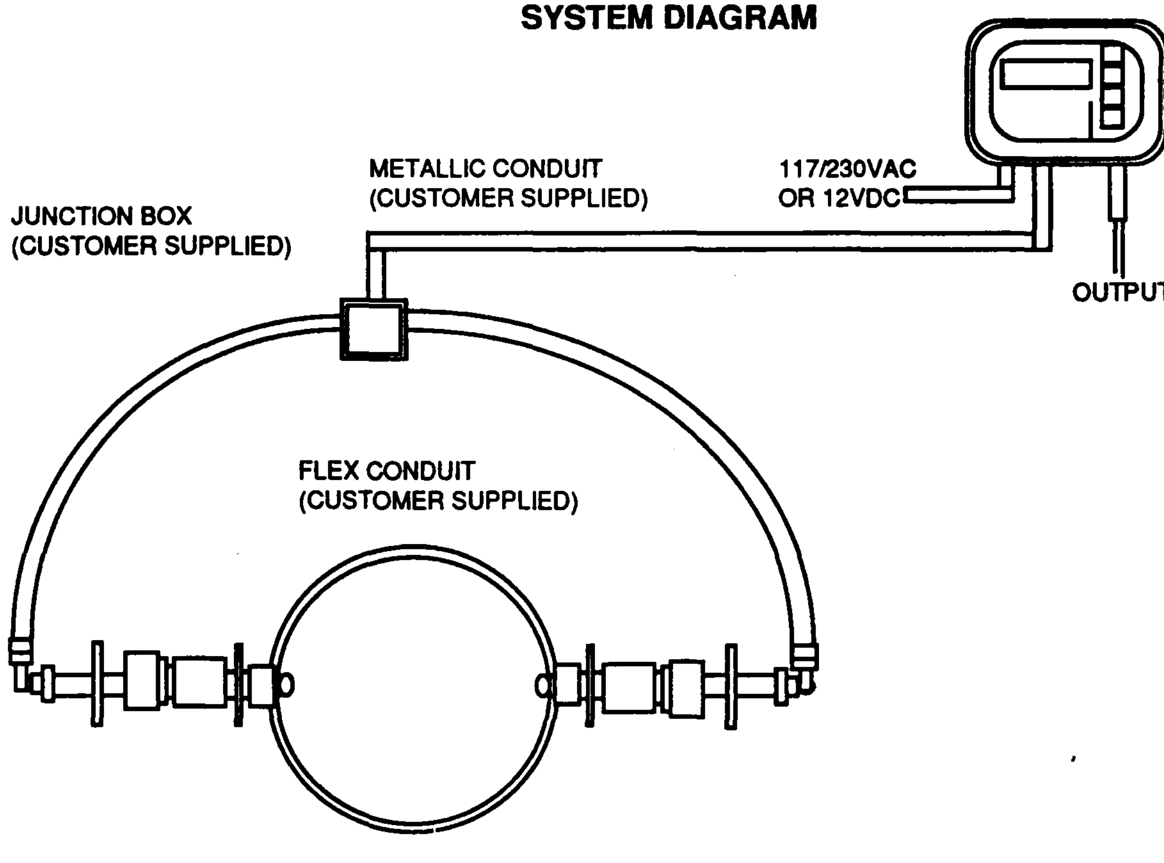


FIG. 4

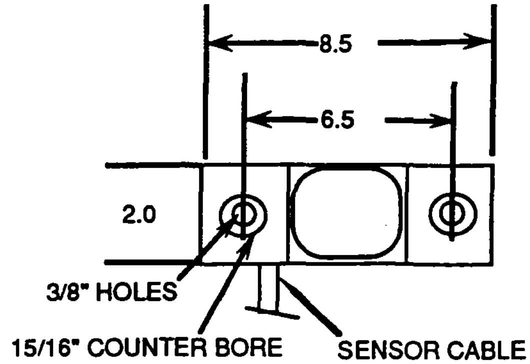
SYSTEM DIAGRAM



INSTREAM REFRACTING SENSORS

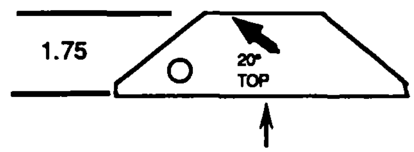
Description

The instream refracting sensors were designed for rectangular or circular concrete channels flowing full at all times. These sensors have a wedge shape to minimize possibilities of catching debris. The sensor is made of PVC materials with 50 ft. of Belden triax cable.

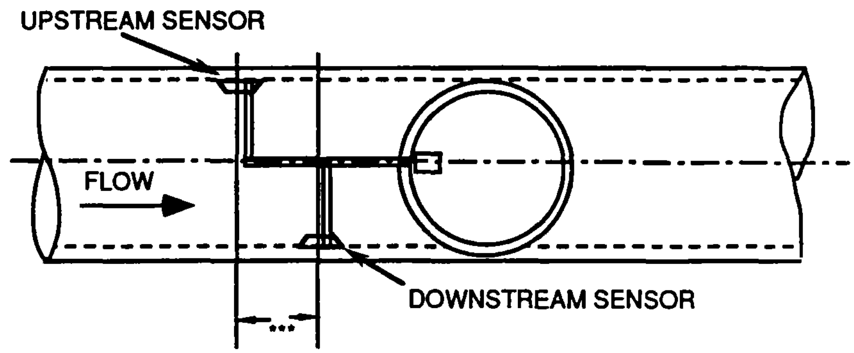


Installation

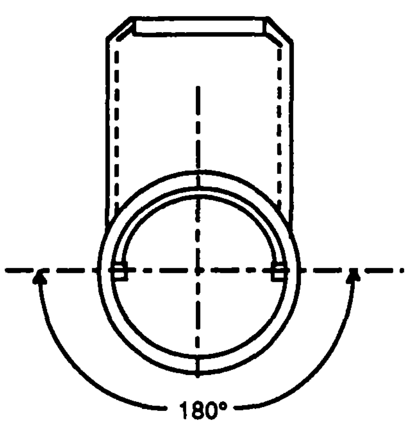
Refer to customer data sheet in front of this manual. Sensor separation=___.___inches. This dimension is from center line of the upstream sensor to the center line of the downstream sensor. Make sure that the arrow on the downstream sensor is pointing upstream and the arrow on the upstream sensor is pointing downstream. Mark holes on concrete conduit and use lead inserts. Place sensor over lead inserts and attach with screws (customer supplied). Route the sensor cables to the top of the conduit and use customer supplied cable clamps to fasten cable to the pipe at one foot intervals. Route the cables downstream and out the pipe outlet. Secure with cable clamps.
Terminate sensor cables to the 4100 electronics.

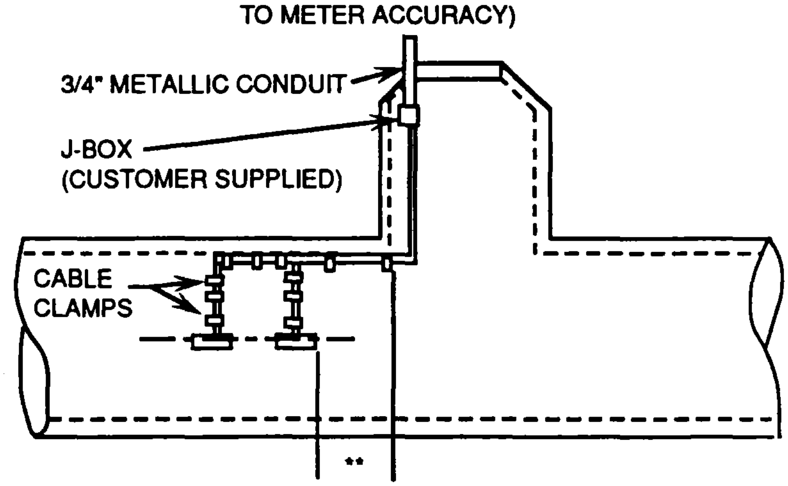


NOTE: ARROWS ON TOP OF SENSORS SHOULD BE POINTING TOWARDS EACH OTHER AFTER INSTALLATION



***SENSOR SEPARATION
(THIS DIMENSION IS CRITICAL
TO METER ACCURACY)





** 2-5 pipe dia.

WETTED SENSORS WITH HOOP INSTALLATION

DESCRIPTION

The underwater sensors for the Series 4000 flowmeter are premounted on a stainless steel plate at the factory (see Figure 2). The sensor cables are secured to the plate with clamps. This plate is then formed into a hoop and inserted into the pipe just upstream of the 2-inch conduit opening in the top of the pipe or upstream of manhole entrance. The sensor cables are then pulled through the conduit and attached to the sensor connections on the Model 4000 electronic enclosure.

PROCEDURE

1. Inspect the sensor mounting plate for evidence of damage from shipping or handling.
2. Refer to Figure 1. Form the plate into a hoop. Insert the four 8-32 studs on one end of the plate into the slots on the other end. Loosely attach the holding strap to the four studs with the flat washer, Bellville washer and nut. Compress the hoop to its smallest diameter and tighten the nuts on the holding strap.
3. Lower the sensor mounting assembly into the discharge box at the end of the pipe, positioning it so the sensor cables exit downstream. Insert it into the pipe 3 inches upstream of the 2 inch conduit pipe opening in the top of the pipe or 2 to 5 pipe diameters upstream of the manhole. Position the hoop so the sensors are at 90 and 270 degrees in the pipe.
4. Loosen the nuts to the holding strap. Expand the hoop to the wall of the pipe and loosely tighten the nuts on the holding strap.
5. Use a large "C" ring pliers to secure the mounting plate to the pipe. Starting at the upstream side of the mounting plate, place the "C" ring pliers between the second slot and the holding strap. Slowly spread the mounting plate with the pliers forcing the mounting plate against the pipe. Using a rubber head mallet, tap the plate starting at the bottom and up the sides. Tighten the nut of the holding strap on the end you have been spreading. Place the "C" ring pliers on the downstream side of the plate and repeat the same process. Go back to the upstream end and loosen the end nut and use the "C" ring pliers to continue to force the plate against the pipe wall. Repeat this process until the mounting plate is secured against the pipe wall and there are no gaps between the plate and wall.
6. Refer to Figure 3. Route the sensor cables downstream to exit.
8. This completes the sensor installation. See the electronic assembly installation section for connecting and securing the cables.

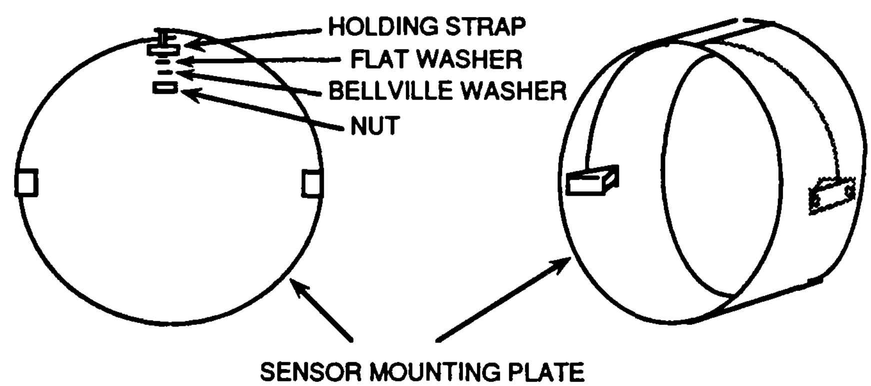


FIG. 1

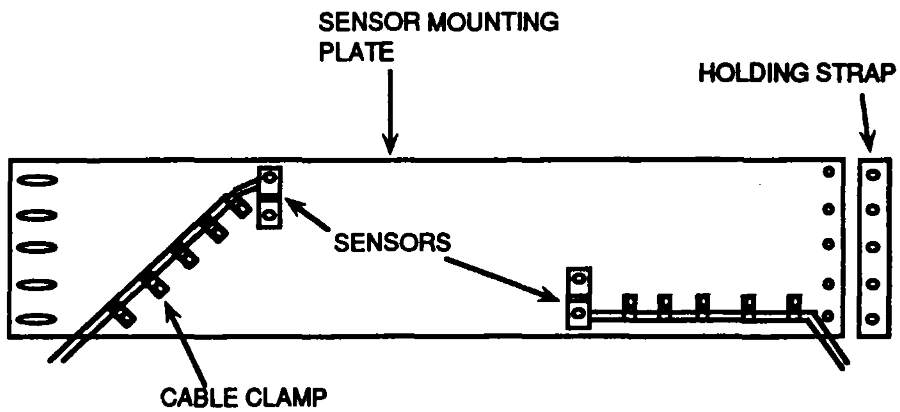

SENSOR MOUNTING
PLATE
HOLDING STRAP
SENSORS
CABLE CLAMP

FIG. 2

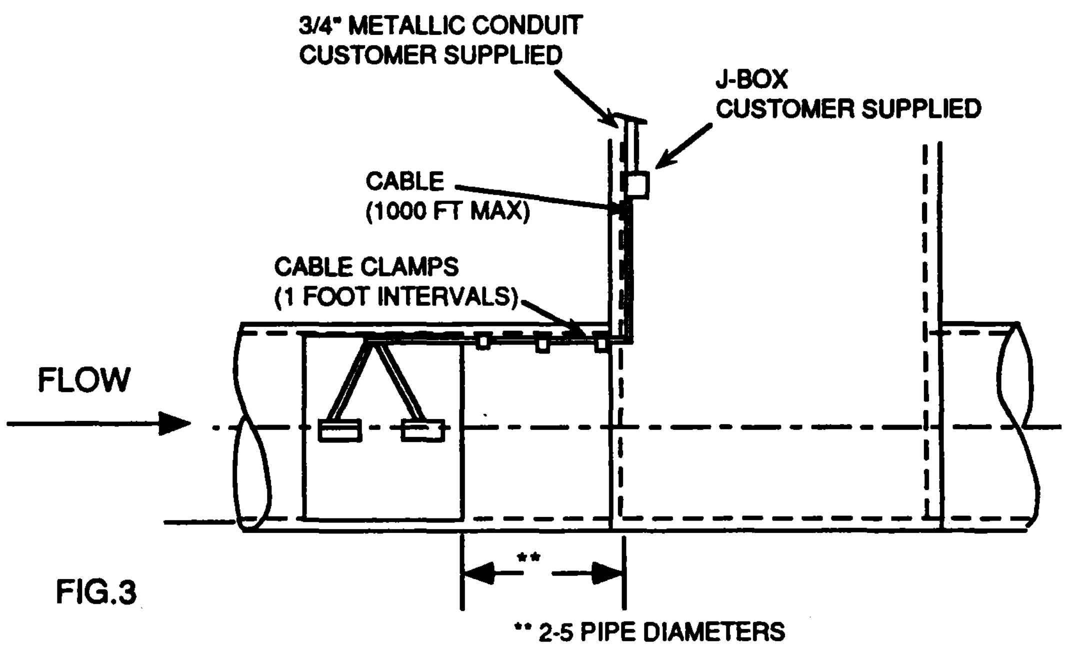
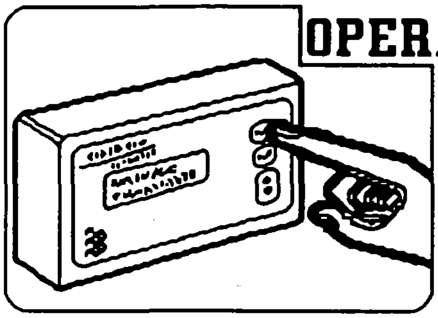

3/4" METALLIC CONDUIT
CUSTOMER SUPPLIED
J-BOX
CUSTOMER SUPPLIED
CABLE
(1000 FT MAX)
CABLE CLAMPS
(1 FOOT INTERVALS)
FLOW
**
** 2-5 PIPE DIAMETERS

FIG.3

OPERATION



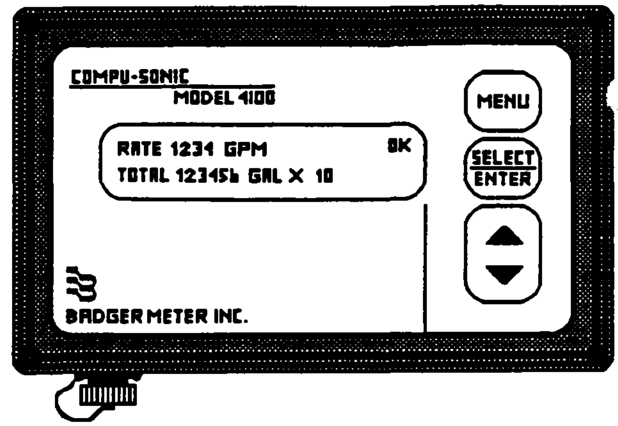


FIGURE 4-1

GENERAL DESCRIPTION

The Series 4100 flowmeter provides a number of menu functions from the front panel which allows the user to modify or interrogate meter operations to suit the user's needs. The user can activate the individual menu items through use of the front panel keys (see Figure 4-1). Each front panel key serves a variety of functions and each function of a key is dependent on the particular menu item involved. The user can follow the menu items to determine the operating state of the unit or to modify the operation of the unit. The functions of the front panel keys are common to all menus.

MENU KEY - This key allows the user to step through the list of menu items available. Each depression will advance the menu list to the next item. The MENU key will not change or activate the individual values in the menu functions but only allows the user to find the desired menu item or its value for further action. If no action is taken by selection of a further menu item using the MENU key or activation of a menu item using the SELECT/ENTER key, the Series 4100 will revert to its standard flow rate and flow total menu in about 10 seconds. This feature adds to the security of the unit since inadvertent depressions of any single key will not change operating parameters of the meter.

SELECT/ENTER KEY - This key is used to initiate a desired menu action or to save new data modified under a menu item. After the user reaches the desired menu item using the MENU KEY, the SELECT/ENTER KEY must be pressed to cause menu action. For example, to force the meter output signal to full scale or the SPAN value, the MENU key is successively pressed until the SPAN MODE is shown. Then the SELECT/ENTER key must be pressed to cause menu action. In this mode, to be described in detail later, the span value may be modified using the UP or DOWN keys as appropriate. After the desired action is completed, the new span value may be saved using the SELECT/ENTER key. If the new span value is not saved by pressing the SELECT/ENTER key, the meter will retain the original span value. The SELECT/ENTER key therefore has two uses; the first is to activate a menu function and the second is to enter changes as desired.

UP and DOWN KEYS - The UP and DOWN keys can be used to modify the operation of the Series 4100 as the user desires. They are active in menu items which allow changes. Pressing the UP key will increase the selected menu item value. In the SPAN mode, for example, pressing the UP key once will increase the value of the analog 4-20 mADC signal a small amount. Continued pressing of the UP key will continue to increase the value. Similarly, pressing the DOWN key will decrease the value.

MENU FUNCTIONS - The menu items with their display information are listed in the following pages with an explanation of the use of the menu. The menu items are listed in the order in which they appear when the MENU key is sequenced. The range of values for those menu items that can be modified is listed in each menu selection.

NORMAL DISPLAY UNI-DIRECTION FLOW OPERATION - The Series 4100 displays the values of flow rate and flow total in engineering units, such as GPM, MGD, etc. A multiplier is also displayed for both rate and total as necessary. The display will appear as shown below. This menu will continually be displayed unless the MENU KEY is pressed.

```
RATE     1234 GPM      OK
TOTAL 123456 GAL X 10
```

The first line displays the current flow rate. The four digits represent the actual number followed by the customer requested engineering units and a multiplier if necessary. The "OK" at the end of the first line indicates that no operating errors have been detected in the meter. Should an error occur, a two letter error code will appear in place of the "OK". When this happens refer to the Troubleshooting section of this manual for the appropriate action.

The second line of the display shows the total volume of the flow metered by the Series 4100. The amount is represented by the six digits and followed by the customer requested engineering units and a multiplier as necessary.

IDENTIFICATION MENU - The first menu item identifies the model number, site identification as requested by the user, the meter serial number and the software revision number. To the right of the ID number will be an L (locked) or a U (unlocked) which indicates if the other menus can be accessed. To lock or unlock, press and hold the SELECT/ENTER key and then the UP key. After the lock out feature has been changed, the meter must go to the main menu before it can be changed again. The display will appear as shown below.

```
Model 4100 SiteId  1234 L
S/N 123456 REV NO.  2.0
```

SELF TEST MODE - This menu item allows the user to interrogate the operating conditions present in the Series 4100. The self test mode has several screens and those items displayed below are the core portions of the self test screens. Badger Meter reserves the right to extend the screens adding new items without notice. If new items are added, the menu item itself should be self evident and the results of the additional testing clear in meaning and in user response. The self test mode of operation discontinues regular flowmeter operation. The self test menu appears as follows:

```
      SELF TEST MODE
PRESS SELECT TO ACTIVATE
```

To enter the self test mode and determine the operating characteristics of the meter, the user must press the SELECT/ENTER key. The meter will respond with a changed display as indicated below.

```
     SELF TEST 4100
        --WAIT--
```

During the short waiting period the Series 4100 checks various internal characteristics and then responds to the user request. After completing the internal checks, the Series 4100 will automatically proceed to display the results of each test in a sequence of displays. The user should note the following series of displays as well as any further implementation added subsequent to this publication.

The first item, as shown below, indicates if the Series 4100 is transmitting signals to the sensors in acceptable limits. This will be displayed for about ten seconds.

```
     SELF TEST 4100
         XM Pass
```

The second item, as shown below, indicates the hex value of the transit time of the signal and indicates whether this is an acceptable time. This will be displayed for about ten seconds.

```
     SELF TEST 4100
       T12 OK 9C
```

The third item, as shown below, indicates the signal level and whether the operating value is reasonable. This will be displayed for about ten seconds.

```
     SELF TEST 4100
     RECEIVER OK 62
```

The fourth item, as shown below, indicates the read/write capability of the microprocessor has been checked and shows if it is operational or an error exists. This will be displayed for about ten seconds.

```
     SELF TEST 4100
        EEROM OK
```

The last screen will indicate that the self test is complete. Should any error be indicated, refer to the Troubleshooting section for appropriate action.

ZERO MODE - In this menu item, the Series 4100 will force the analog 4-20 mADC signal to its zero flow value. This menu will be displayed as shown below. This will remain for ten seconds and then the display will return to indication flow rate and total if the SELECT/ENTER key is not depressed.

```
        ZERO MODE
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the zero mode and the display will show as indicated below and force the meter to indicate zero flow. The meter will stay in this mode until the MENU key is pressed or a change in the zero value is made and stored.

```
 METER IS IN ZERO MODE
CHANGE PRESS UP/DN-ENTER
```

The 4-20 mADC signal can be monitored by the test points on the bottom of the back housing. This test signal is in millivolts with 40 to 200 millivolts DC representing the 4 to 20 milliamp output signal. Use of the UP key will increase the signal value while the DOWN key will decrease the value. After the adjustment is completed, the user must press the SELECT/ENTER key to force the Series 4100 to store the new milliamp current output. If the new value for the zero analog current signal is saved, it will be so indicated on the display and this will immediately be used by the Series 4100. After the new value is saved, the meter will return to displaying flow rate and total. The range of the zero analog signal is between 3 and 5 mADC. **Remember: The meter will stay in the zero mode unless the MENU key is pressed or the SELECT/ENTER key is pressed.**

SPAN MODE - In this menu item, the Series 4100 will force the analog 4-20 mADC signal to its full scale value. This menu will be displayed as shown below. This will remain for ten seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
        SPAN MODE
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the span mode and the display will show as indicated below and force the meter to indicate full scale. The meter will stay in this mode until the MENU key is depressed or a change in the span value is made and stored.

```
 METER IS IN SPAN MODE
CHANGE PRESS UP/DN-ENTER
```

The 4-20 mADC signal can be monitored by the test points on the bottom of the back housing. This test signal is in millivolts with 40 to 200 millivolts DC representing the 4 to 20 milliamp output signal. Use of the UP key will increase the signal value while the DOWN key will decrease the value. After the adjustment is completed, the user must press the SELECT/ENTER key to force the Series 4100 to store the new milliamp current output. If the new value for the span analog current signal is saved, it will be so indicated on the display and this will immediately be used by the Series 4100. After the new value is saved, the meter will return to displaying flow rate and total. The range of the span analog signal is between 12 and 22 mADC. **Remember: The meter will stay in the span mode unless the MENU key is pressed or the SELECT/ENTER key is pressed.**

FLOW AVERAGING MODE - In this mode the Series 4100 allows the user to change the meter response time according to a preselected set of time intervals. The user can select meter response times of 1,2, 4, 8, 16, 32, 64 and 128 seconds. This menu will be displayed as shown below. This will remain for 10 seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
     FLOW AVERAGING
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the flow averaging mode and the display will show as indicated on the next page. The present flow averaging value will be shown as depicted by the 8. As the user presses the UP or DOWN keys, the display will show the time changes. Pressing the SELECT/ENTER key will store the new value. The

SELECT/ENTER or MENU key must be pressed to exit from this menu. If the MENU key is pressed, the meter will advance to the next menu and the change created by the UP/DOWN keys will be lost. If the new value for the flow averaging is saved, it will be so indicated on the display. After the new value is saved, the meter will revert to indicating flow rate and total unless the MENU key is pressed which will advance to the next menu.

```
FLOW AVERAGING    8 SEC
CHANGE PRESS UP/DN-ENTER
```

RESCALE MODE - In this mode, the Series 4100 allows the user to change the full scale flow rate as desired. The change must be within limits stored internally in the Series 4100 and must remain in the same engineering units as was originally selected for the meter. This menu will be displayed as shown below. This will remain for ten seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
METER RESCALE
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the rescale mode and the display will show as indicated below. The present full scale flow value and its multiplier will be shown. The user can press the UP and DOWN keys to change the value of the full scale flow as desired. When the full scale flow rate reaches the stored upper or lower flow rate limits, the display will not respond to further requests in the same direction. Pressing the SELECT/ENTER key will store the new value. The SELECT/ENTER or MENU key must be pressed to exit from this mode. If the MENU key is pressed, the meter will advance to the next menu and the change created by the UP/DOWN keys will be lost. If the new value for rescale is saved, it will be so indicated on the display. After the new value is saved, the meter will revert to the displaying flow rate and total unless the MENU key is pressed to advance to the next menu. **Remember: Changing the full scale of the meter will cause the 4-20 mADC output to change to reflect this new full scale value.**

```
FULL SCALE    1000 x 1
CHANGE PRESS UP/DN-ENTER
```

RECALIBRATION MODE - This mode allows the user to calibrate the Series 4100 as appropriate to reproduce actual flow conditions. The user can modify the meter factor for calibration of the meter to a known standard. This menu will be displayed as shown below. This will remain for 10 seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
METER RECAL
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select the recal mode and the display will indicate a meter factor as indicated below.

```
METER FACTOR 1.000
CHANGE-PRESS UP/DN-ENTER
```

The user can modify the meter factor using the UP or DOWN keys. After saving the new meter factor, the Series 4100 will respond to the change and adjust the display readings and analog signal accordingly.

The meter factor is the relation between the indicated flow rate of the instrument and actual flow rate as proven by calibration tanks or other means. If, for example, the meter was installed on a pipe and due to uncertainty in the pipe dimensions, the meter was determined to be indicating a flow rate 5.6% higher than the actual flow, this means that the flow meter is indicating 1.056 times the true value. The initial meter factor will be 1.000 as set at the factory. To correct for the 5.6% error, the meter factor must be changed to 0.947 which is the inverse of 1.056 error. If the meter had been 5.6% low, then the meter factor would be 1.059. After the user has changed the meter factor to the new value, the SELECT/ENTER key must be pressed to store the value which will be indicated on the display. The meter will revert to the normal operation mode unless the MENU key is pressed. If the MENU key is pressed and **not** the SELECT/ENTER key, the meter will advance to the next menu and the change in the meter factor will not be stored.

ZERO OFFSET MODE- This menu item allows the user to capture and correct for zero offsets that may be present in the metering system. It is intended to be used for periodic maintenance to correct for small zero drifts. <u>THE FLOW IN THE PIPE MUST BE ZERO TO USE THIS MODE. IF FLOW EXISTS IN THE PIPE, USE OF THIS MODE WILL CREATE LARGE ERRORS IN THE METER.</u> Therefore, the user must prepare for use of this mode. Appropriate valving must be done to ensure that no flow exists; allow at least 10 minutes for the fluid to settle out. This menu will display as shown below. This will remain for 10 seconds and then the display will return to indicating flow rate and total if the SELECT/ENTER key is not pressed.

```
ZERO OFFSET MODE
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will select this mode and the display will indicate a waiting period as indicated below.

```
ZERO OFFSET MODE
--WAIT--
```

After approximately 30 seconds the display will show as indicated below. The SELECT/ENTER key must be pressed to enter the new Zero Offset value. The display will indicate that the new value has been stored. If the SELECT/ENTER key is not pressed, the meter will revert back to the main menu and the new value will not be saved. Also if the MENU key is pressed instead of the SELECT/ENTER key the meter will go back to the main display and the new value will not be saved.

```
ZERO OFFSET COMPUTED
PRESS ENTER TO SAVE
```

MENU ADDITIONS WHEN IN BI-DIRECTIONAL OPERATION - If your meter has been set up for measuring flow in both forward and reverse, there will be a few changes to the menu displays.

The main menu will have a "F" or "R" in front of the flow rate value and the total will have a "F" or "R" after the total value to indicate the direction of the flow. The totalizer automatically changes with the direction of flow.

There is also an additional menu that will display both the forward and reverse totalizers at the same time. This menu follows the Zero Offset menu and appears as shown below.

```
TOTALIZER DISPLAY SELECT
PRESS SELECT TO ACTIVATE
```

To view the two totalizers, press the SELECT/ENTER key. The display will show both totalizers as shown below. To exit this menu press the MENU key.

```
FORWARD TOTAL = 123456
REVERSE TOTAL = 123456
```

ADDITIONAL MENUS WHEN THE ACCESSORY POWER SUPPLY BOARD IS USED. If your meter is equipped with the accessory power supply board and the High and Low alarms have been activated, there will be additional screens after the Zero Offset screen or Totalizer Display screen for the setting of these alarms. These screens will appear as follows:

```
HIGH FLOW ALARM
PRESS SELECT TO ACTIVATE
```

Pressing the SELECT/ENTER key will allow entry into this alarm for setting the on and off points. The following screen will then appear:

```
HIGH ALARM SET ON 99%
CHANGE PRESS UP/DN-ENTER
```

This screen allows the setting of the switch on point as a percent of full scale. Use the UP or DOWN key to change to the desired value and press the SELECT/ENTER key. The display will indicate that this has been stored and the following screen will appear:

```
HIGH ALARM SET OFF 99%
CHANGE PRESS UP/DN-ENTER
```

This screen allows the setting of the off point (dead band) as a percent of full scale. Use the UP or DOWN key to change to the desired value and press the SELECT/ENTER key. The display will indicate that this has been stored. The next screen will be the LOW FLOW ALARM. Use the same procedure for setting this alarm as for the HIGH FLOW ALARM above.

This completes the instructions for the menu operation of the Series 4100 flowmeters.

THEORY OF OPERATION

The Series 4100 ultrasonic flowmeter is a microprocessor based flowmeter which uses powerful mathematical algorithms to sense and calculate flow rates and flow totals. The meter operates by transmitting ultrasonic energy to and fro with piezoelectric sensors attached to the pipe. Sensors can be either of the external mounted strap-on configuration or may be of the type which contacts the fluid. In either case the Series 4100 is initially set up at the factory or in the field using a hand held computer. The operating modes are similar. A block diagram (Figure 5-1) depicts the major section of the Series 4100 operating functions. The descriptions below all refer to the diagram.

Frequency Generator. The frequency generating section contains two crystal controlled oscillators. Each oscillator is frequency divided by binary counters to form two frequencies. One is the frequency used for transmission across the pipe and is referred to as fx. A second frequency is generated for use with the rf mixer and is referred to as fm. A third frequency is created by mixing fx and fm to get the difference frequency f3.

Transmitter and Sensor Switches. In a sequential fashion, the microprocessor (uP) sends out a digital code to the sensor switches which connects one sensor to the transmitter and the other to the receiver. Two switch connections can be made which alternately interchange which sensor is connected to either the transmitter or receiver. To initiate transmission to the sensors, the uP sends out an enable signal to the transmitter circuit. The transmit circuit begins driving energy to the sensors in the form of a long burst at the sensor operating frequency. This burst of energy is typically a train of sinusoidal waves with about 30 to 40 individual waves present. The transmitted energy, about 15 volts p-p, goes through the appropriate switch to the transmitter connected sensor. The sensor converts the electrical energy to acoustic energy in the form of mechanical vibrations. Acoustic energy travels through the pipe wall, across the fluid, through the opposite pipe wall and into the opposite sensor. In this sensor, the vibrational energy is converted to electrical energy and then passes through the sensor switch to the electronic receiver.

After the transmission cycle is completed and the data is processed, the uP will change the switches so as to reconnect the sensors. The sensor which was the transmitter will become the receiver, while the opposite function will be assigned to the other sensor. This process continues in the alternating fashion, under uP direction, at a rate of about 30 hertz.

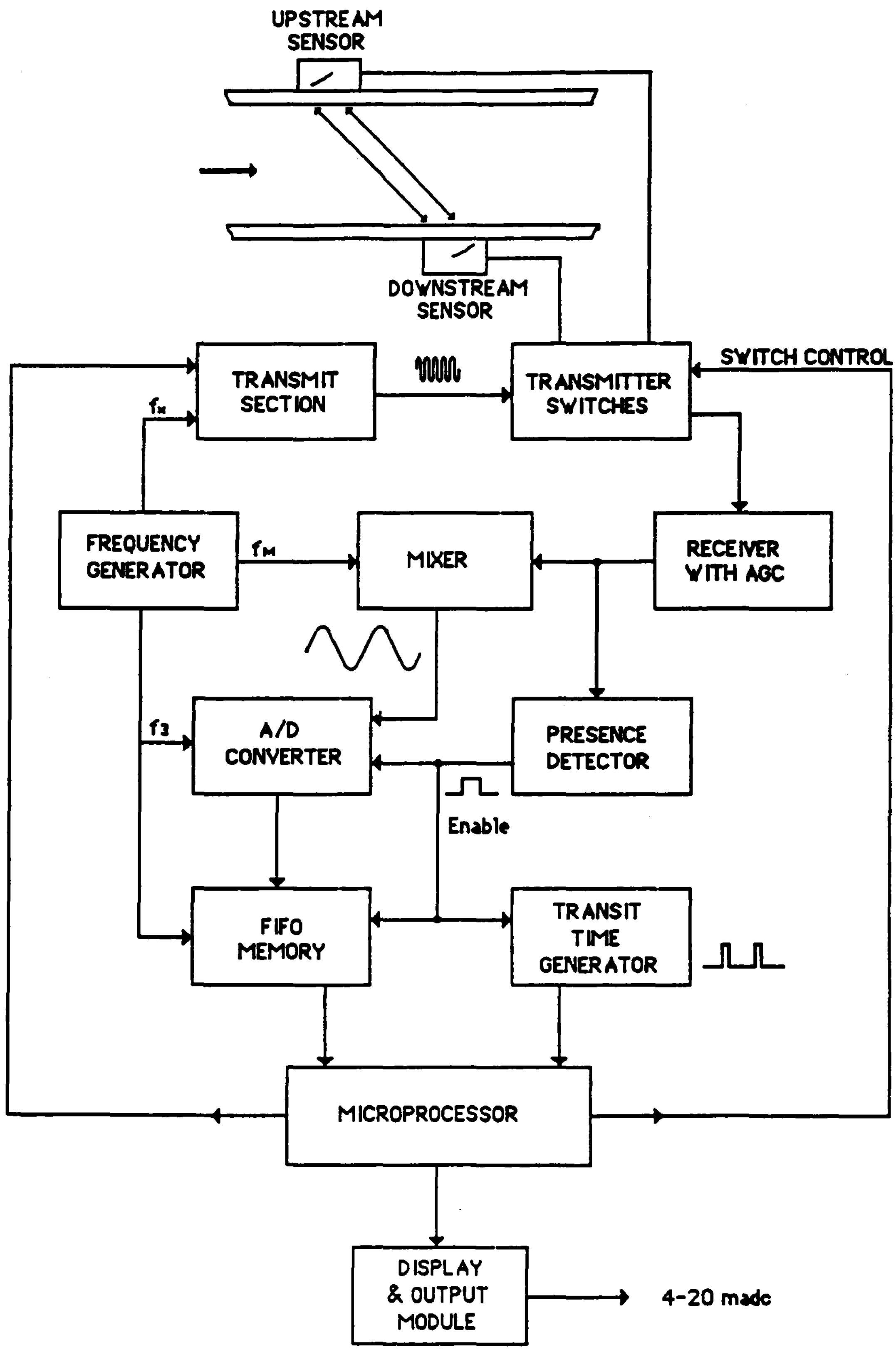
Receiver Operation. The receiver section, in the block diagram, consists of three individual items: first, an rf amplifier with automatic gain control, activated and controlled by the uP, which amplifies the signals from the sensors; next, a presence detector to determine when the transmitted energy is at the receiving sensor; finally, a mixer to convert the information in the transmitted burst to a lower frequency where much more accurate timing information can be measured. The uP, through its processing of reception data, sets the gain of the rf amplifier to maintain high signal levels without saturating the receiver at arrival of the reception waves. During transmission, the gain of the rf amplifier is drastically reduced, enabling a small leakage so the measurement of the transmitter starting time can be accurately made.

The presence detector is a self-multiplyng converter which provides a dc level during the presence of either the transmitted wave or the reception wave. This detector provides protection from noise and interference since it is a narrow band device. The mixer action, much like the i.f. strip in a heterodyne radio, acts like a vernier because each of the individual rf cycles of the long burst are reformed into one long cycle, at the much lower f3 frequency. The timing information on the rf waves is exactly reproduced on the mixer output wave. Since this wave is at the f3 frequency, the timing information is significantly larger and more readily detected. The noise levels on this third wave are also lower since the noise is averaged over the entire length of the long burst and is not a single point function.

Digital Encoding. The presence detector signal allows the uP to measure the time required for the energy to cross the fluid and also provides the enable signal to the A/D converter. The mixer output signal is fed to the A/D converter where digital samples are coded to represent the mixer out wave. The clock for this sampling is derived from the frequency generator previously described.

FIFO Memory. To enable rapid encoding of the mixer out data, the A/D converter data is "strobed" into the memory. Again the timing clock for the loading of the memory is generated in the frequency generator section and is gated by the presence detector output. The data is retrieved by the uP at a much lower reading rate from the memory and is processed internally. The timing reference used to

SERIES 4100 BLOCK DIAGRAM
FIGURE 5-1



encode the data in the memory forms a time reference between the two directions of transmission. When the same transmission action is achieved, but in the opposite direction in the pipe, the reception data is again encoded by the frequency generator wave. Therefore the two independently encoded reception waves can be compared to one another by virtue of the common f3 reference frequency.

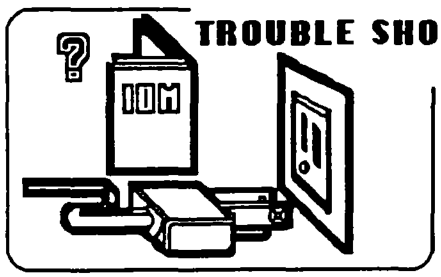
Microprocessor. The microprocessor used in the Series 4100 is an advanced 8 bit processor and contains a watch dog timer and an illegal OP code detector. The watch dog timer is a count down oscillator which must be periodically reset by program action. If the oscillator is not reset in the prescribed period, the watch dog timer resets the processor and reinitializes the measurement cycle. This prevents the microprocessor from entering a lock up mode of operation where it could be non-responsive in its tasks. The illegal code detector also analyzes the individual OP codes of the microprocessor. If, for some reason, an illegal code is detected, the microprocessor will reset and restart. Again, protection is afforded against noise spikes, etc.

The microprocessor also contains a serial data port which allows communications with external and other computers. The port has a specific protocol for communication. The internal protocol used for information exchange with external devices is Badger Meter proprietary, and Badger Meter reserves the right to change and alter the protocol without notification. The serial port is used to initialize a meter application by communication with a hand-held computer specially programmed by Badger Meter for analyzing applications. The hand held computer, after computing the essential meter parameters, communicates with the Series 4100 and transmits data constants which establish flowmeter operation.

Output Signals. The display for the Series 4100 is a two line, 24 character alphanumeric LCD display. The display module contains its own microprocessor for display control. The display programming is menu driven, providing user access to internal meter information, allowing the user to change the flowmeter scaling, and providing an easy means for meter field recalibration. Through the display, the analog output 4-20 mADC signal can be spanned and zeroed without internal meter access. Consult the Operation Instructions Section of the manual for detailed explanations.

The 4-20 mADC signal is fully isolated to prevent external ground loops. The microprocessor generates a frequency proportional to flow rate. This frequency is optically coupled to the 4-20 mADC generator. The 4-20 mADC signal is capable of driving into a 1000 ohm load.

Also available is an optional output for bi-directional operation. This output is an optically coupled transistor to indicate if the flow measurement is forward or reverse flow. The output will be open in the forward direction and closed in the reverse direction.



GENERAL

The Series 4100 is equipped with self test features which allow the user to identify the operation status of the unit and with the help of this section of the IOM manual to determine proper action to be taken. This section details the meaning of the operational codes which appear in the main menu, the meaning of the self test features and provides a step by step troubleshooting chart for determining the fault and the necessary action.

Operational Codes. The main menu of the Model 4100 indicates flow rate and flow total. In the upper right hand side of the display appears an operational code which indicates the operating condition of the meter. When the meter is first powered up, the flow rate will display XXXX and there will not be an operational code. The microprocessor is initializing the meter constants and performing a self test to ensure that all areas of the electronics are operating properly. This may take several seconds.

After initialization the X's in the flow rate will change to 0's. The operational code will display an OK which indicates the meter is operating properly. The meter may recycle a few times before locking onto a good signal. Should an OK not be displayed, refer to the troubleshooting chart for appropriate action.

The following is a list of the operational codes and their meanings.

- OK- Nominal Operation
- NS - No Signal Detected
- XM - Transmit Confirm Failure
- TL - Signal Transit Time Out of Bounds (too long)
- TS - Signal Transit Time Out of Bounds (too short)
- TM - FIFO Error (missing or misaligned timing mark)
- OF - Amplitude Overflow
- UF - Amplitude Underflow
- GE - Gain Error
- CM - Communications Mode Enabled

Self Test Features. The self test feature enables the user to view the status of various sections of the meter to determine the section of the meter that may have a problem should the operational code indicate a problem. Refer to the trouble shooting chart to determine the appropriate corrective action.

The following is a list of the self test areas and a brief explanation of their meaning.

XM PASS (or FAIL) - This indicates if the electronics is transmitting the proper signal to the sensors.
T12 008F OK (or ERROR) - This indicates the actual transit time, in HEX, of the transmitted signal between the sensors and if the time is correct.
RECEIVER 62 OK (or WEAK) - This indicates the strength of the received signal transmission between the two sensors.
EEROM OK (or ERROR) - This indicates if the read/write capability of the microprocessor is functioning properly.

REPLACEMENT OF PARTS

While the Model 4100 has been designed and built for maximum reliability, there can be instances where replacement of parts may be necessary. In those cases where the troubleshooting procedure calls for replacement of a part, the factory should be contacted for authorization and instruction to send in a defective part for repair or the replacement of a defective part.

The Model 4100 has been designed so that the front housing contains the major electronic hardware and can be easily removed and installed. It also allows the replacement unit to be preprogrammed with no adjustments required when installing the new unit. For this reason we must know the serial number of the defective unit when the user contacts the factory for replacement. Refer to the Installation Section of this manual for disassembly instruction.

The back housing contains the power supply circuit board. The replacement of this will require a little more effort. A soldering iron and a fast curing glue will be required. Refer to Figure 6-1. Disconnect the power wires, sensor cables and the 4-20 mADC wires. Pry off the magnetic switch with a small screwdriver or knife. Remove the four corner screws. Unsolder the two 4-20 mADC test point wires from the circuit board. Solder the test point wires to the replacement board. Mount the circuit board to the back housing with the four corner screws. Glue the magnetic switch to the housing (make sure it is in the same location as the old switch). Reconnect all of the wires and cables.

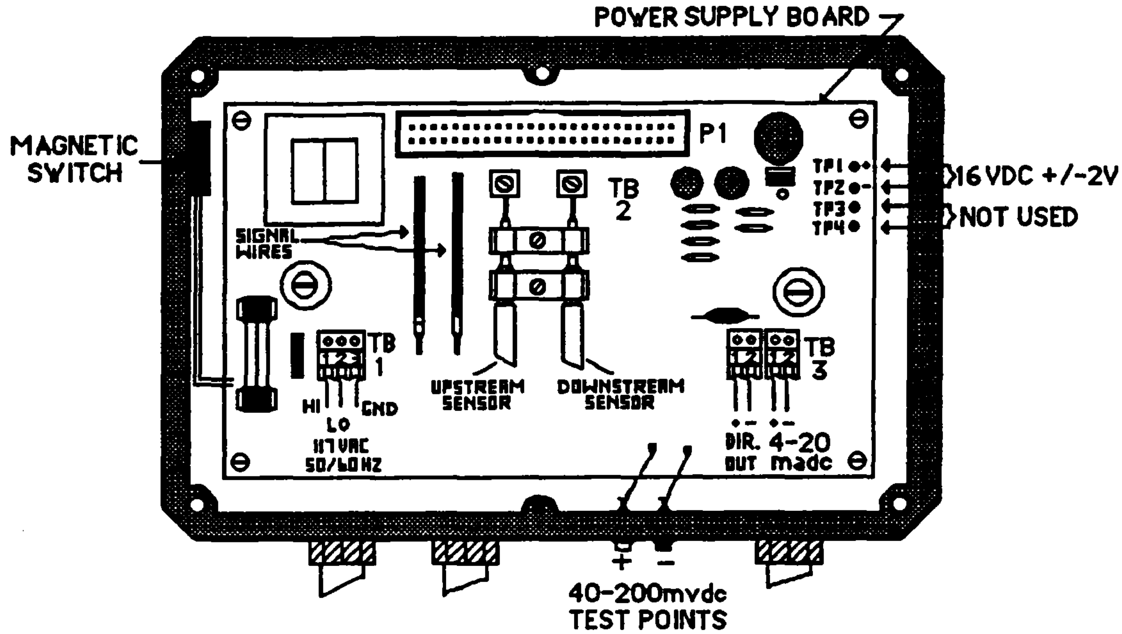


FIGURE 6-1

TROUBLESHOOTING CHART

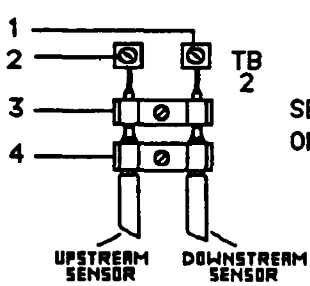
On the following two pages is the troubleshooting chart for the Series 4100 flowmeter. This chart will help you in isolating possible causes for problems you may encounter and give suggested corrective actions.

In the troubleshooting chart, there will be areas that require certain tests to be performed. The following describes these tests.

Sensor cable connection continuity test. This test will require the use of an ohmmeter. Connect the test leads of the ohmmeter to Points 1 and 3 of the sensor cable connections on the power supply as shown in Figure 6-2. If the signal wires on the power supply board are still connected to the front housing electronics, the ohmmeter should read 5000 ohms +/- 5%. If the signal wires are not connected, the reading should be 10000 ohms +/- 5%. Repeat this test at Points 2 and 3.

Connect the test leads to Points 3 and 4. The reading should indicate infinity (or an open).

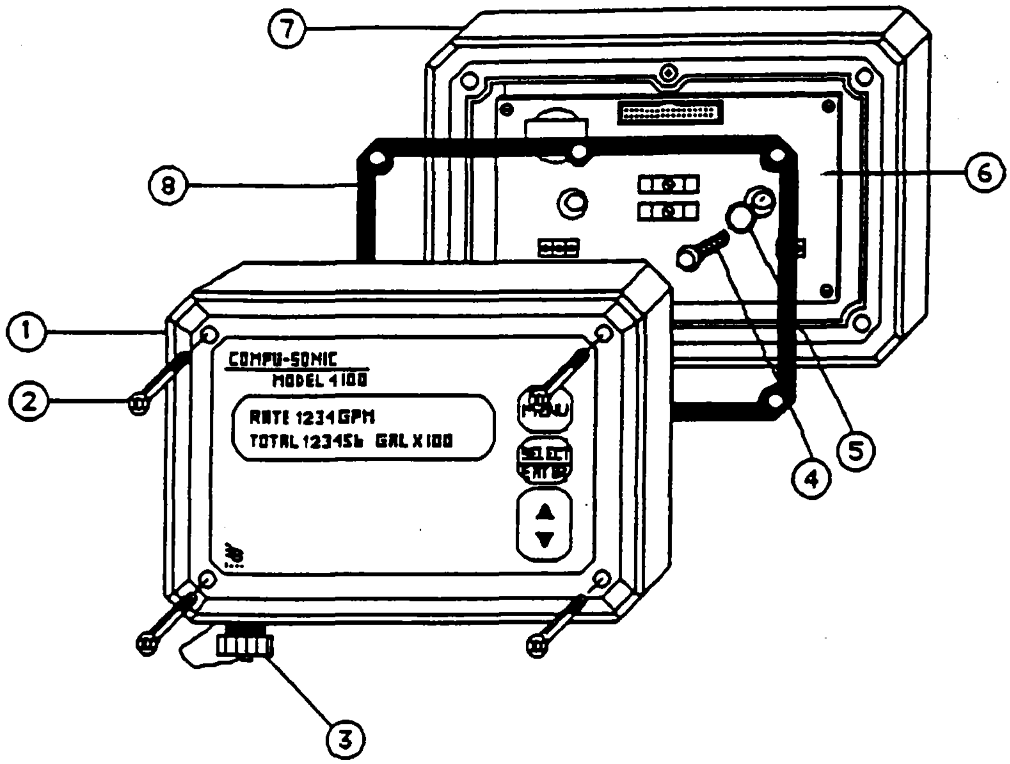
Power Supply Voltage test. This test will require the use of a voltmeter. Connect the test leads to test points 1 and 2 on the power supply board as shown on Figure 6-1. The voltmeter should read 16VDC +/- 2 volts. NOTE: With the front housing removed, a magnet will be required to close the magnetic switch on the back housing in order to perform this test.



SENSOR CABLE CONNECTIONS ON POWER SUPPLY BOARD

FIGURE 6-2

ILLUSTRATED PARTS LIST
SERIES 4100 ENCLOSURE



ITEM #	PART #	DESCRIPTION	QUANITY
1	542751-9999	FRONT HOUSING W/ELECTRONICS	1
	542751-0008	MODEL 4100	
	542751-0011	MODEL 4110	
	542751-0021	MODEL 4120	
2	400003-0048	SCREW SCHCAP 10-32X2-1/2LG SS	4
3	501153-0001	CAP SEALING	1
	501101-0001	CONNECTOR RECP 8CKTS W/SQ-FLG	1
	400001-0025	SCREW PNH-S 4040X3/8 SS	4
4	400029-0002	SCREW HEXWSHRH 1/4-ABX.75 STL	2
or	400022-0016	SCREW HEXWHRH 1/4-20 (ROLOK) ZN	2
5	490004	O-RING	2
6	151915-0001	AC POWER SUPPLY 117VAC	1
or	151915-0002	AC POWER SUPPLY 240VAC	1
or	151921-0001	AC POWER SUPPLY 117VAC W/ACCESSORIES	1
or	151921-0002	AC POWER SUPPLY 240VAC W/ACCESSORIES	1
	160965-0002	FUSE 3AG 1/4A 250V	1
7	525119	BACK HOUSING	1
8	512310	GASKET	1

WARRANTY

Badger warrants meters and parts manufactured by it and supplied hereunder to be free from defects in materials and workmanship for a period of 18 months from date of shipment or 12 months from date of installation, whichever period shall be shorter. If within such period any meters or parts shall be proved to Seller's satisfaction to be defective, such meters or parts shall be repaired or replaced at Seller's option. Seller's obligation hereunder shall be limited to such repair and replacement and shall be conditioned upon Seller's receiving written notice of any alleged defect within 10 days after its discovery and, at Seller's option, return of such meters or parts to Seller f.o.b. its factory. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES WHATSOEVER INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES (EXCEPT OF TITLE) OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Badger shall not be liable for any defects attributable to acts or omissions of others after shipment, nor any consequential, incidental or contingent damage whatsoever.

NUCLEAR DISCLAIMER

Equipment sold by Badger Meter, Inc. is not intended for use in connection with any nuclear facility or activity unless covered by a specific quotation where the conditions of such usage will be detailed. If equipment is used in a nuclear facility or activity without a supporting quotation, Badger Meter disclaims all liability for any damage, injury or contamination, and the buyer shall indemnify and hold Badger Meter, its officers, agents, employees, successors, assigns and customers, whether direct or indirect, harmless from and against any and all losses, damages or expenses of whatever form or nature (including attorneys' fees and other costs of defending any action) which they, or any of them, may sustain or incur, whether as a result of breach of contract, warranty, tort (including negligence), strict liability or other theories of law, by reason of such use.

☐ ULTRASONICS
☐ INSTRUMENTATION

Badger Meter

CUSTOMER INSTRUCTION MANUAL

SERIAL NUMBER 969906 3"

Badger Meter, Inc.
P.O. Box 581390
Tulsa, Oklahoma 74158
(918) 836-8411
Telex: RCA 203605
Fax: (918) 832-9962

BAKER MONITER

Monitor PS
Industrial Pitless Units for Submersible Pumps 6", 6.6", & 8" I.D. Well Sizes

The Monitor PS Industrial Pitless Unit for submersible pumps forms a watertight extension of the well casing which starts below the frostline, where it is buried permanently, and continues upward 12 or more inches above grade, where the pitless case is closed with a watertight cap.

TO INSTALL A PS INDUSTRIAL UNIT:

An excavation around the well casing below the frost line is made and well casing cut off at a prescribed level. The well cap is removed and the spool assembly lifted out of the pitless case with a hoist and set aside.* The pitless case is then welded or threaded tightly onto the well casing. The submersible motor, pump, and cable are attached to the drop pipe which is lowered into the well with a hoist; when the top of the last section of the drop pipe is one foot or more above the pitless case, the spool assembly is screwed onto the drop pipe. The spool assembly and drop pipe with motor, pump and cable are lowered into place; then finally the electrical service and well cap are installed.

* The spool assembly includes: A spool with two or no silent check valves; two O-ring seals; lift-out pipe and hold-down spider.

FEATURES:

CORROSION PROTECTION . . . All water passages are either hot-dipped galvanized or constructed of corrosion resistant material.

EASY TO SERVICE . . . Well cap can be removed without disconnecting cables. O-ring seals on spool permit withdrawal of the entire inner assembly simply by lifting. Replacement is equally simple. Spool support eliminates vertical adjustment and any possibility of dropping the inner assembly into the well.

RELIABLE SEAL . . . Neoprene O-rings between accurately machined hot-dipped galvanized surfaces on the spool and and within the unit provide positive seals.

O-RING SEAL PROTECTION . . . Monitor seal protection prevents seal damage during installation and service.

FROST PROOF . . . No heating is required. All water passages are below the frost line.

QUICK TO INSTALL . . . A quality pump installation can be made easily and economically without delay for masonry or building construction.

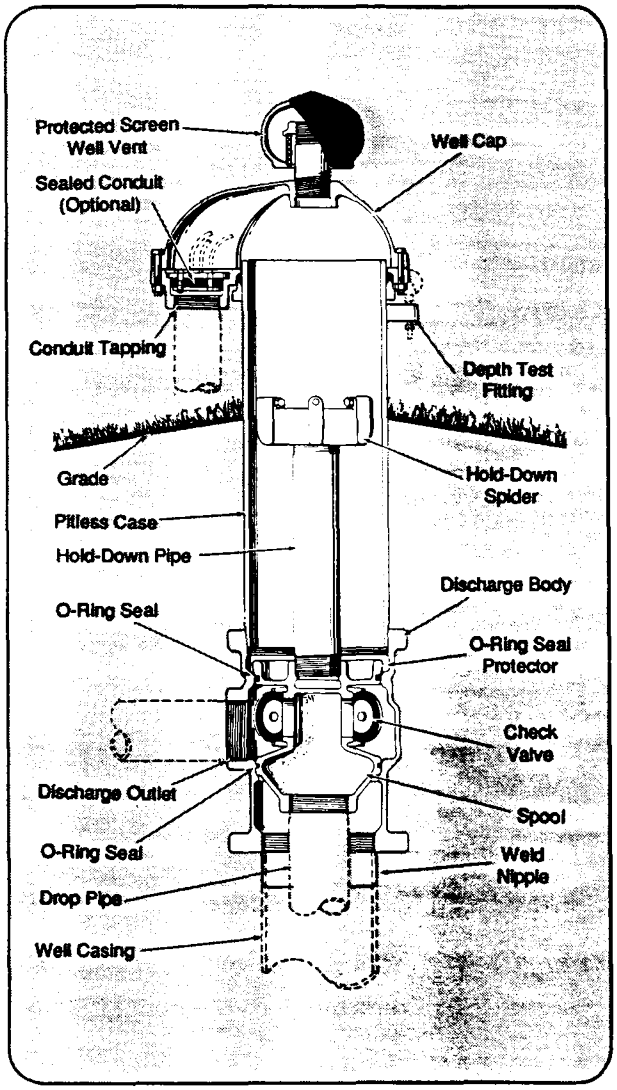
ALTERNATIVE SPOOLS
Spools are available plain (EO) or with silent check valves (E2-double). The Monitor Silent Check Valve has its operating parts automatically exposed when the spool is withdrawn. Complication and cost of installing separate check valve in the drop pipe are eliminated. Spools are supplied with tapping for either a pressure relief valve, or a pressure control.

WATERTIGHT WELL CAP . . . Designed to permit removal without disconnecting cables. Separate Junction Box is eliminated. Watertight cable and conduit sealing is optional. Alternate ventilated cap is available.

HOLD-DOWN . . . Supplied with each unit. Hold-down pipe also serves as lift-out pipe for installation and servicing.

DEPTH TEST BLOCK . . . Standard on all units.

FLOWING WELL . . . Units available.



ONE YEAR LIMITED WARRANTY

Any PS Pitless Unit discharge body, spool, upper case or well cap used in potable water applications, found defective in workmanship or material will be replaced without charge provided the defective item is returned prepaid to the distributor from whom purchased within one year from date of shipment. The Company does not assume responsibility for labor or consequential damage. All other terms and conditions of sale are as stated on the Baker Factory Sales Order Terms and Conditions–Form AD 100.

608-882-5100
FAX: 608-882-6776

BAKER
133 Enterprise Street
Evansville, Wisconsin 53536

Monitor

Catalog AD74 6-1-90

EXPLANATION OF PITLESS UNIT ORDERING NUMBERS

The diagram illustrates the meaning of the various letters and numerals used in Monitor Industrial Pitless Unit ordering numbers. A typical order number and the pitless unit it stands for are shown.

3 — **A.** The first numeral in the order number indicates the bury depth, in feet, of the unit. Bury depth on all units is measured from the center of the discharge line to ground level. The top of the pitless case extends 12" above ground level as is required by many codes.

PS — These letters indicate the type of pump the pitless unit is designed for. The unit shown is a PS for submersible pumps.

8 — **B.** This numeral indicates the well casing size. The 6 is 6" I.D. wells, 6.6 for 7" O.D. wells, and 8 for 8" I.D. wells.

10 — **C.** This numeral indicates the upper pitless case size. The 7 is for the 7" I.D. case, and 10 for 10" I.D. case.

W — **D.** Indicates the attachment to the well casing is a welded joint ("N" for KwiKonect - 6" I.D. & 8" I.D. only).

B — **E.** The presence of the letter "B" in the order number indicates the upper pitless case is black pipe.

W — **F.** Indicates the unit has a watertight cap with screened vent installed.

E — **G.** Indicates spool has pressure equalizing passages.

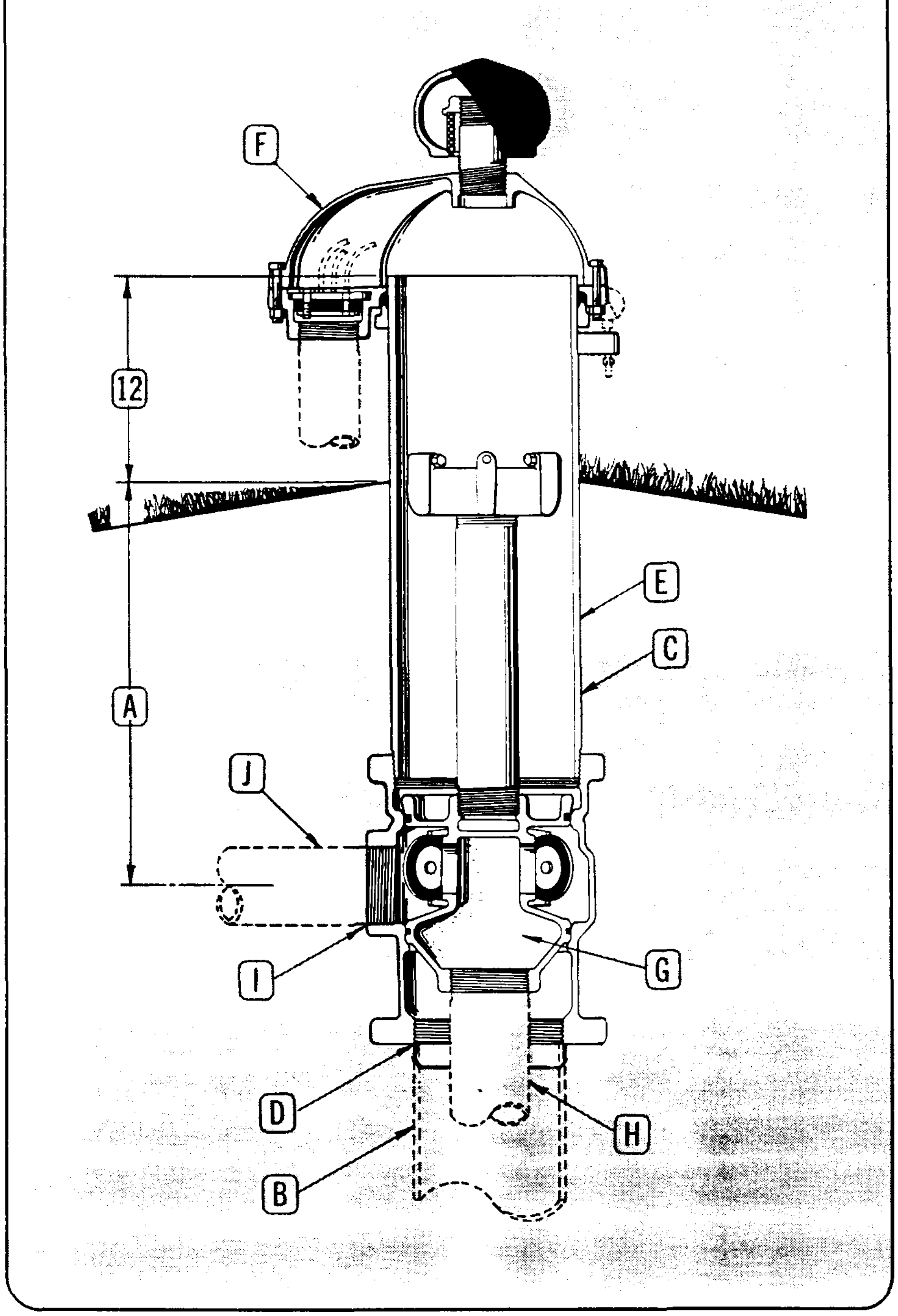
2 — This numeral indicates the type of spool which the pitless unit has. In this case it is a spool having two silent check valves.

4 — **H.** Indicates the size of drop pipe in inches.

T — **I.** Indicates the discharge connection is threaded.

4 — **J.** Indicates the size of discharge pipe in inches.

3PS-810WB-W-E24-T4-*



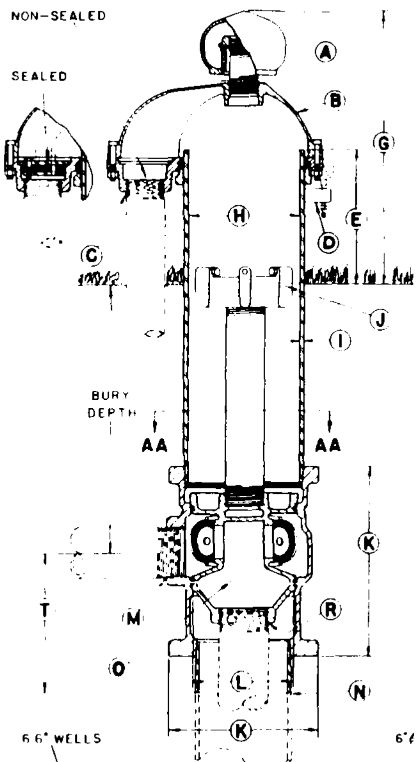
ACCESSORY LIST

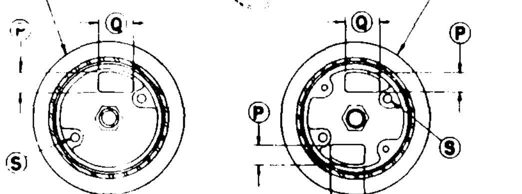
* Accessory(s) may be ordered by placing accessory letter at end of pitless model number. (Protected screen well vent is standard equipment, as is weld nipple).

S Sealed Conduit Connection.

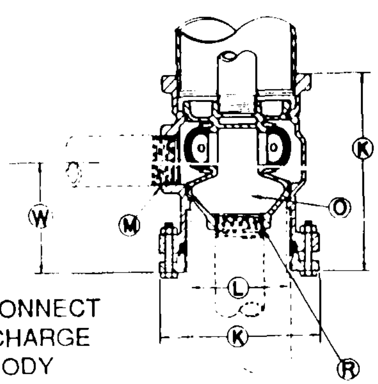
BAKER
133 Enterprise St.
Evansville, WI 53536
Monitor

Monitor PS STANDARD INDUSTRIAL PITLESS UNITS FOR SUBMERSIBLE PUMPS - 6, 6.6 & 8" WELLS





SECTION AA-AA SECTION AA-AA



KWIKONNECT DISCHARGE BODY

SPECIFICATIONS	6 " I.D.	6.6" I.D. 7 " O.D.	8" I.D.
Ⓐ Screened Well Vent Size:	1-1/2" F.I.P.	1-1/2" F.I.P.	2-1/2" F.I.P.
Ⓑ Seal Cap: *The Watertight cap bolts to a compression seal ring securing around the pitless case and comes with the screened well vent installed.*			
Ⓒ Conduit Tapping Size: *Watertight conduit seals for most common cable sizes are available for watertight cap*	1-1/2" F.I.P.	1-1/2" F.I.P.	3" F.I.P.
Ⓓ Depth Tester Tapping:	1/4" F.I.P.	1/4" F.I.P.	1/4" F.I.P.
Ⓔ Distance from ground level to top of pitless case:	12"	12"	12"
Ⓖ Distance from ground level to top of screened well vent. *(Vent height may be increased if necessary)*	19-1/12"	19-1/2"	24-5/16"
Ⓗ Pitless Case size:	7"	7"	10"
Ⓘ Pitless Case wall thickness:	.300"	.300"	.365"
Ⓙ "Hold-Down"-"Lift-Out" Mechanism *Three set screws in a spider atop the "Hold-Down", "Lift-Out" pipe brace against the interior of the pitless casing, locking the spool in place.*			
Hold-Down, Lift-Out pipe size:	2"	2"	3"
Designed "Lift-Out" Mechanism load:	10,000 lbs.	10,000 lbs.	20,000 lbs.
DISCHARGE BODY-STD.			
Ⓚ Discharge Body Width:	9-7/16 O.D.	9-7/16 O.D.	13-1/8" O.D.
Ⓚ Discharge Body Length:	11-1/4" L	11-1/4" L	(Welded to Upper Casing)
DISCHARGE BODY-KWIKONNECT			
Ⓚ Discharge Body Width:	8-7/8" O.D.	--------	12-1/16" O.D.
Ⓚ Discharge Body Length:	12-9/32" L.	--------	------
Ⓛ Pitless unit minimum I.D.:	6-3/8"	6-3/8"	9-1/8"
Ⓜ Discharge connection tapping size:	3" F.I.P.	3" F.I.P.	4" F.I.P.
Ⓝ Pitless unit to well casing connection:	6" Weld	6.6" Weld	8" Weld
Ⓞ ***SPOOL ASSEMBLY**			
Spool design load:	64,000 lbs.	64,000 lbs.	88,000 lbs.
-WITHOUT CHECK VALVES-			
Area of water passage(s):	10 sq. in.	10 sq. in.	15.8 sq. in.
Percent area of water passages to area of drop pipe:	135%	135%	124%
-WITH TWO CHECK VALVES-			
Area of valve passages:	6.28 sq. in.	6.28 sq. in.	12.6 sq. in.
Percent area of valve passages to area of drop pipe:	89%	89%	100%
Motor Cable Passages Through Spool			
Ⓟ	13/16"	13/16"	1-5/8"
Ⓠ	1-3/4"	1-3/4"	3-3/16"
Ⓡ Spool to drop pipe connection:	3" F.I.P.	3" F.I.P.	4" F.I.P.
Ⓢ Pressure switch tapping: 3/8 - 18 N.P.T.	(2) available	(2) available	(2) available
Ⓣ Dimension from center of discharge outlet to bottom of weld nipple:	9-3/8"	9-3/8"	12"
Ⓤ Overall length of seal cap:	12-3/8"	12-3/8"	18-1/2"
Ⓥ Dimension from center of discharge to bottom of discharge body.:	6-5/8"	6 5/8"	9-1/4"
Ⓦ Dimension from center of discharge to			

FIRST

Choose well size then make-up basic ordering number from proper column in specifications

ORDERING NUMBER SELECTION GUIDE

Bury Depth (Select One)	Pitless Submersible	Well Size - Inches	Upper Case Size - Inches	Attachment to Well Casing (Welded or Kwikonect)	Black Upper Case	Watertight Cap (Vent Installed)	Pressure Equalizing Spool Passages	Number of Check Valves (Select One)*	Drop Pipe I.D. Inches	Discharge Connect (Threaded)	Discharge I.D. - Inches
2 to 9	PS	6.6 6 8	7 7 10	W N	B	W	E	0 2	3 3 4	T	3 3 4

SECOND

Add desired accessory symbol

Accessory	Symbol
Sealed Conduit Connection	S

COMPONENT MATERIALS

Well Vent - cast iron, green enamel finish.
Cap & Conduit Box - cast iron, green enamel finish.
Hold-Down Spider - cast iron, green enamel finish.
Hold-Down Pipe, 2" - steel, black.
Hold Down Pipe, 3" - steel galvanized.
Pitless Case - steel, black.
Spool - cast iron, galvanized.
Discharge Body - cast iron, galvanized.
Check Valve Body & Arms - brass.
Check Valve Seat - Brass.
Check Valve Spring - Monel.
Compression Seal Ring & Check Valve Facing - Neoprene.
Conduit Seal & O-Rings - Neoprene.
Discharge Body - 8" x 10" - Ductile Iron

Specifications Subject to Change Without Notice.

BAKER
monitor division
133 Enterprise Street
Evansville, WI 53536
Fax No.: (608) 882-6776

608-882-5100

BB-1
Revised 9-15-93

BAKER MONITOR

Monitor PS

INSTRUCTION MANUAL

INSTALLATION INSTRUCTIONS

1-A All pitless unit cases are joined by threading or welding either to well casing or adapter.

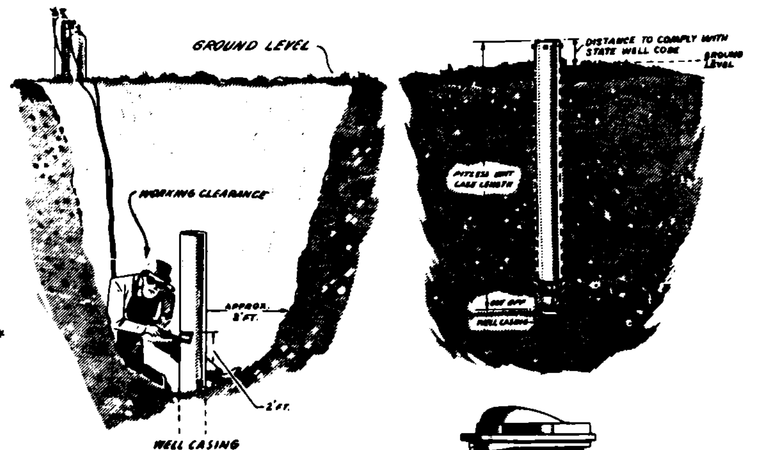
B Where there is a change in size between pitless unit casing diameter and well casing diameter an adapter must be threaded to pitless unit case.

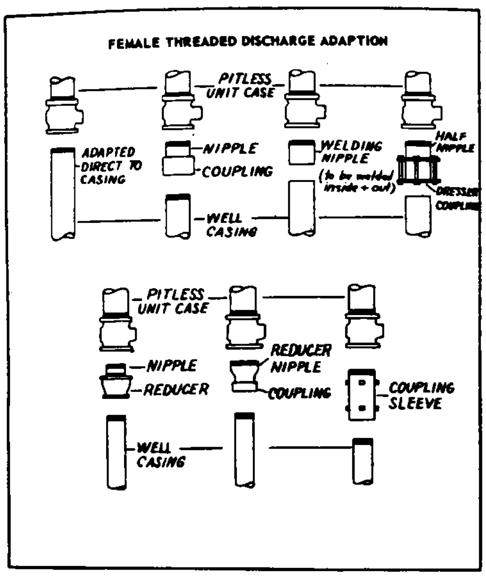
2- Establish ground level at the well location. It is desirable to have ground slope away from pitless unit case in all directions.

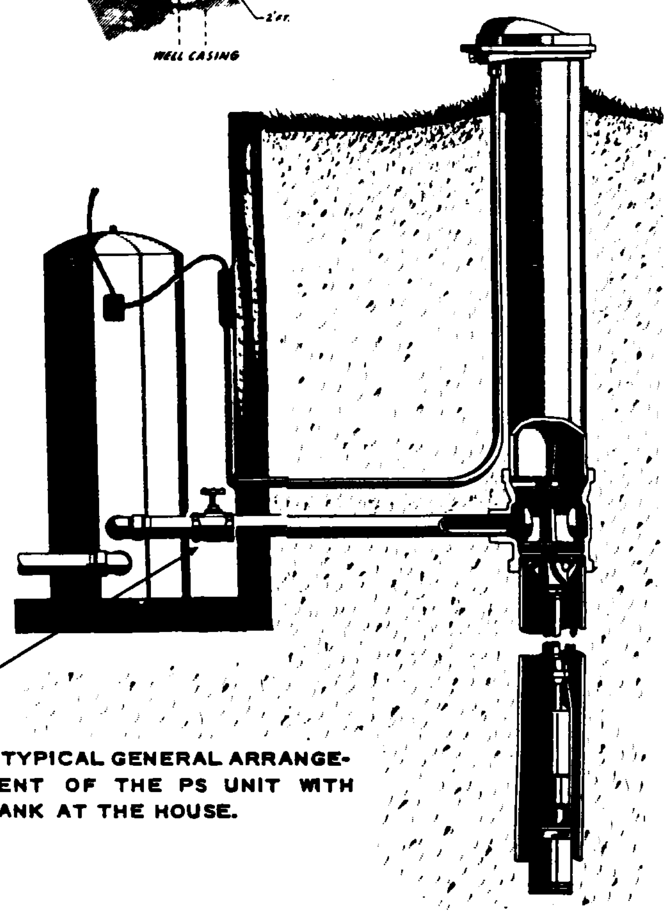
3- The pitless unit case should extend above the ground level according to state well code. To accomplish this the well casing must be cut off at a distance below the ground level equal to the distance above ground less than the pitless unit case length. Take into account the method of adaption.*

4- In order to do work, excavate around the well casing clearing a diameter of at least 4' to a depth of 2' below point where well casing is to be cut off.

5- Cut off the well casing perpendicular to well casing axis.







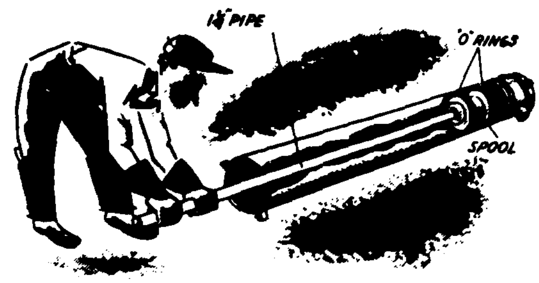
Valve in this location recommended.
To be closed when Pitless Unit is serviced.

A TYPICAL GENERAL ARRANGEMENT OF THE PS UNIT WITH TANK AT THE HOUSE.

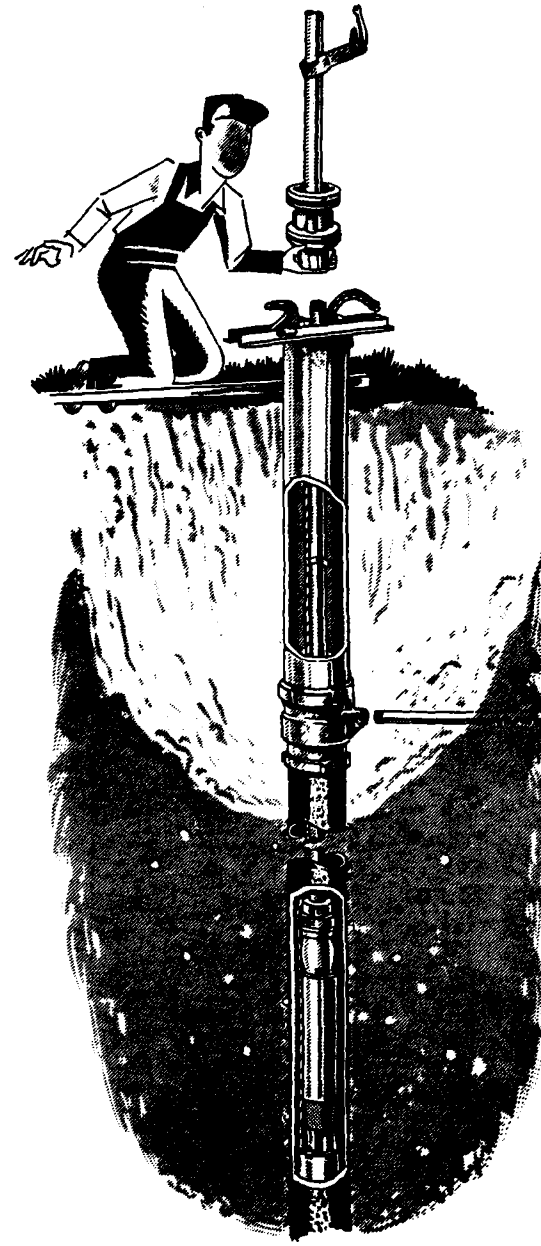
* NOTE: SEE LAST PAGE FOR KWIK CONNECT UNITS

BAKER
monitor division
EVANSVILLE, WISCONSIN 53536
PHONE: (608) 882-5100

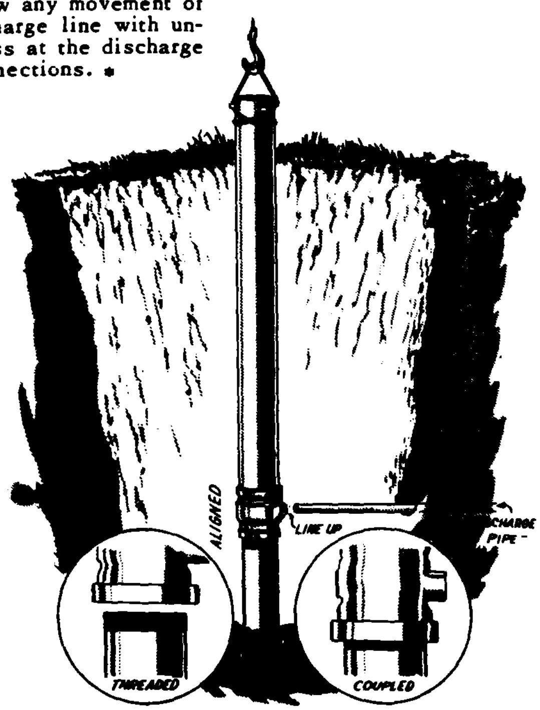
Monitor



6- The spool should now be removed from the case – to do this use a piece of 1¼" pipe with a thread on one end and a length of 2' or 3' longer than pitless unit. Remove seal cap – insert the threaded end of the pipe inside the case and into the end of the spool. Screw hand tight, then place a block of wood against the lower end of the spool casting and strike the block with a fairly heavy object and pull on the pipe which will remove the spool from the pitless case.



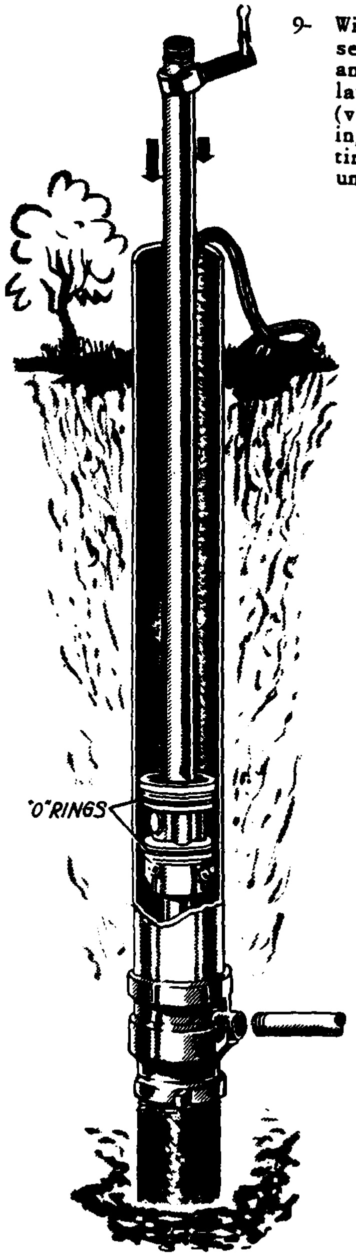
7- Lower the pitless case in place, rotate the discharge outlet to the desired angle. Rotating 90° to discharge line and using 90° elbow will allow any movement of the discharge line with undue stress at the discharge line connections. *



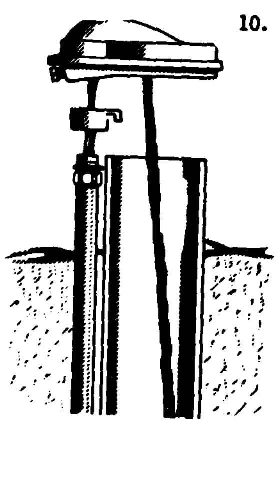
8- Lower submersible pump and drop pipe into casing. Screw spool onto drop pipe. Holes are provided in the spool through which the pump motor cable may be passed.

* NOTE: SEE LAST PAGE FOR KWIK CONNECT UNITS

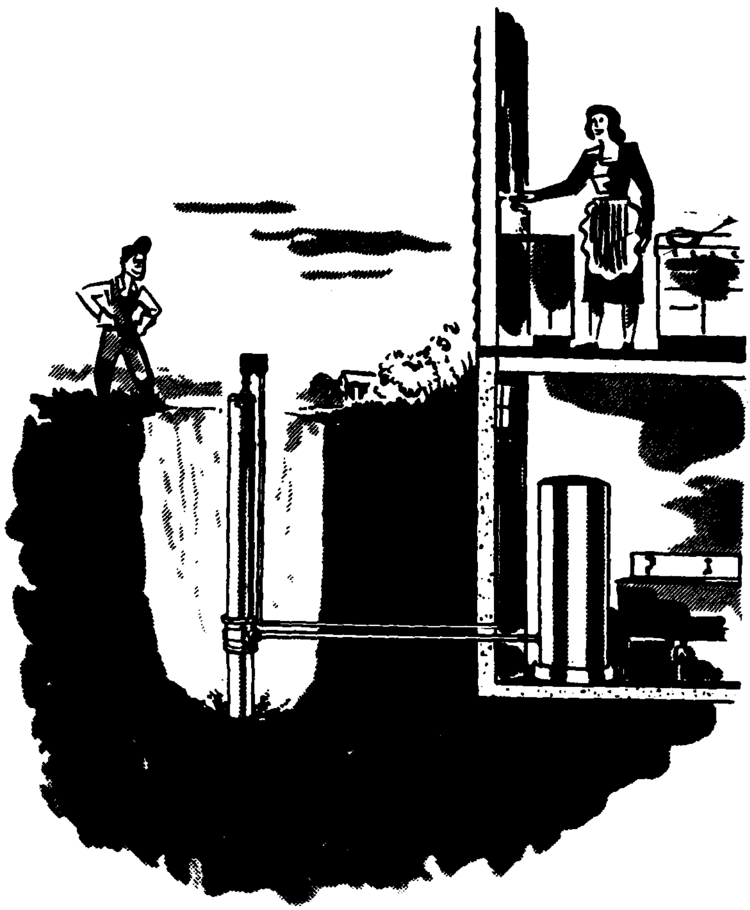
9- Wipe the rubber "O" ring seals with a clean cloth and then coat with a heavy layer of petroleum jelly (vaseline) for proper seating of rings. Lower the entire assembly into pitless unit case.



10. Remove the 1¼" pipe. Install the cap. Connect discharge outlet to water system and complete wiring.

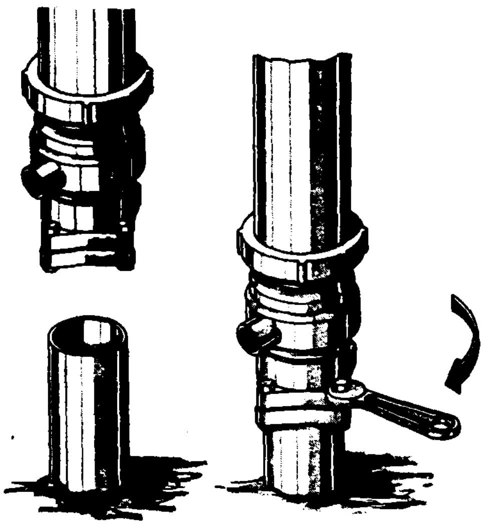


11-A The unit is now ready to operate under power and should be run a sufficiently long time to see that there are no leaks in the discharge pipe.



B The hole should not be filled in until the unit is running satisfactorily. Care should be exercised to fill under discharge line properly before back filling.

MONITOR KWIK CONNECT



Monitor PS Units with KWIK CONNECT on the bottom of the discharge body require no threading or welding. TO INSTALL:

1. Cut off the well casing at the desired point. (See Step 3)
2. Use a file to remove any burrs from the top of well casing after it is cut.
3. Loosen the bolts on the bottom of the discharge body, and slide the unit onto the well casing
4. Tighten all the bolts equally.

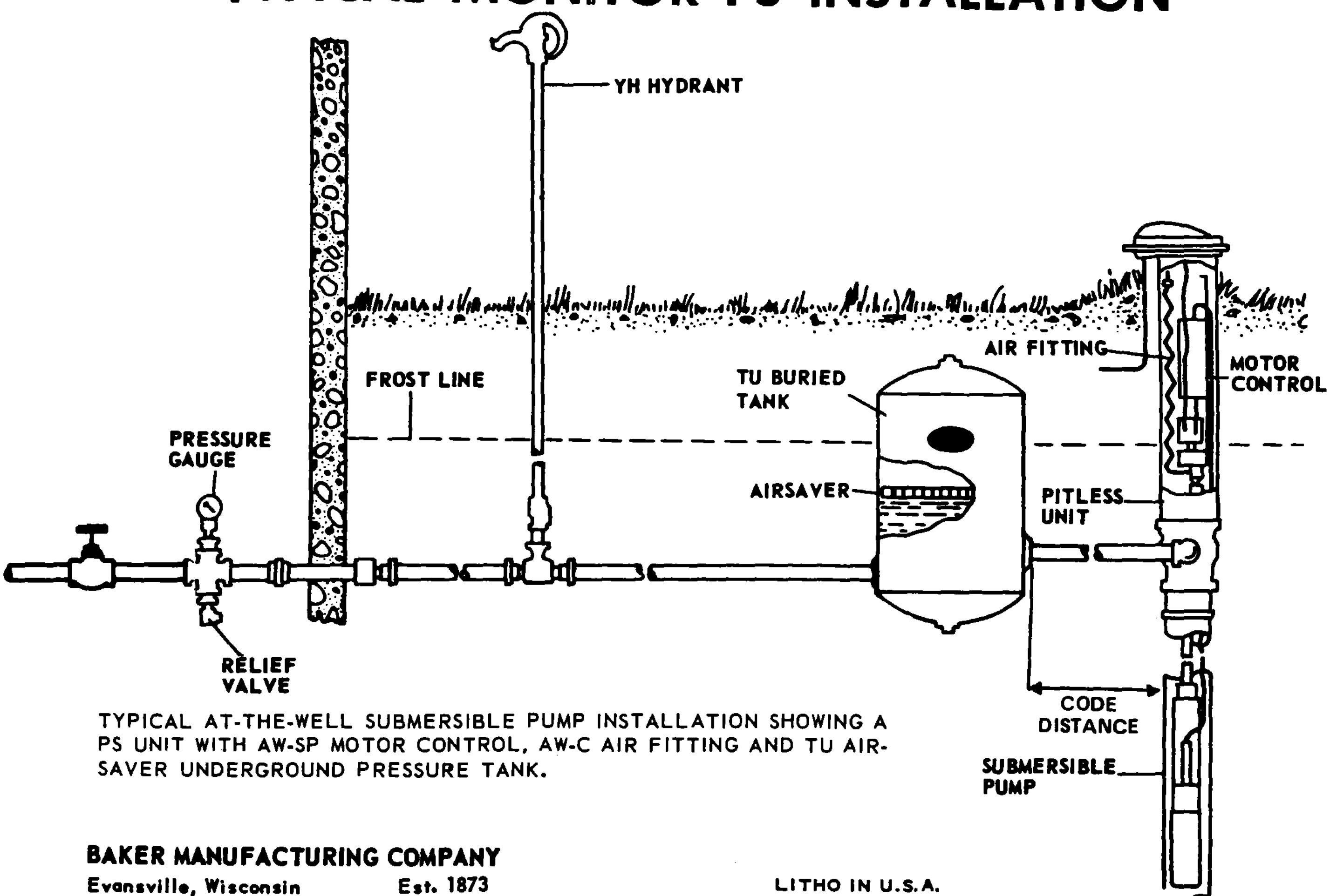
WARRANTY PROVISIONS - Every Monitor product is warranted against defective material or workmanship for a period not to exceed one year from the date of shipment, except as hereinafter stated or as otherwise stated on specific Monitor product brochures. Items which through normal use become unusable within one year are warranted only as to defaults in material and workmanship. For castings produced by Baker and sold as castings, those which are proven defective through inspection or machining prior to assembly will be replaced. On defective castings sold as castings, Baker assumes no liability for labor or consequential damages. Pump hoists, pressure tanks, prime movers, starting equipment, electrical apparatus, auxiliary fittings, and parts and materials manufactured by others, are warranted only to the extent of the warranty made by the manufacturer of such parts and material.

Baker's obligations under this warranty on Monitor products is limited to the replacement without charge of the part or parts which upon examination prove to Baker's satisfaction to have been defective and which have not been abused or carelessly handled. Baker shall not be liable for consequential or other damages, losses or expenses in connection with or by reason of defective materials or workmanship other than to replace without charge said defective parts as provided for herein. Baker's obligation under this warranty is limited to the extent the products are warranted by the original manufacturer.

Claims for defective merchandise, shortages, delays, or failures in shipment or delivery, or for any other cause, shall be deemed waived and released by the Buyer, unless made in writing within seven days after arrival of the merchandise.

BAKER MAKES NO WARRANTIES AS TO MERCHANTABILITY OR AS TO THE FITNESS OF THE MERCHANDISE FOR ANY PARTICULAR USE AND SHALL NOT BE LIABLE FOR ANY LOSS OR DAMAGE, DIRECTLY OR INDIRECTLY, ARISING FROM THE USE OF SUCH MERCHANDISE OR FOR CONSEQUENTIAL DAMAGES.

TYPICAL MONITOR PS INSTALLATION



TYPICAL AT-THE-WELL SUBMERSIBLE PUMP INSTALLATION SHOWING A PS UNIT WITH AW-SP MOTOR CONTROL, AW-C AIR FITTING AND TU AIR-SAVER UNDERGROUND PRESSURE TANK.

BAKER MANUFACTURING COMPANY
Evansville, Wisconsin Est. 1873

LITHO IN U.S.A.

OM-1700D

Monitor PS

SPOOL TYPE PITLESS UNITS
FOR 8" WELLS

The drawings and parts list apply to the model numbers listed below including those with B or G after the well casing attachment.

MODEL NUMBERS

Bury Depth	Unit	Well Size Tap.	Case Size	Well Casing Attach.	Cap Style	Spool	Drop Pipe I.D.	Disch. Conn.	Disch. I.D.
3' to 8'	PS	8"	10"	W	W	E2	4	T	4
3' to 8'	PS	8"	10"	W	W	E0	4	T	4
3' to 8'	PS	8"	10"	W	V	E2	4	T	4
3' to 8'	PS	8"	10"	W	V	E0	4	T	4

SPOOLS

Monitor Pitless Units listed above are equipped with one of the following types of spools:

E2 - Spool, with Two Check Valves, Figure No. 3
E0 - Spool, without Check Valves, Figure No. 5

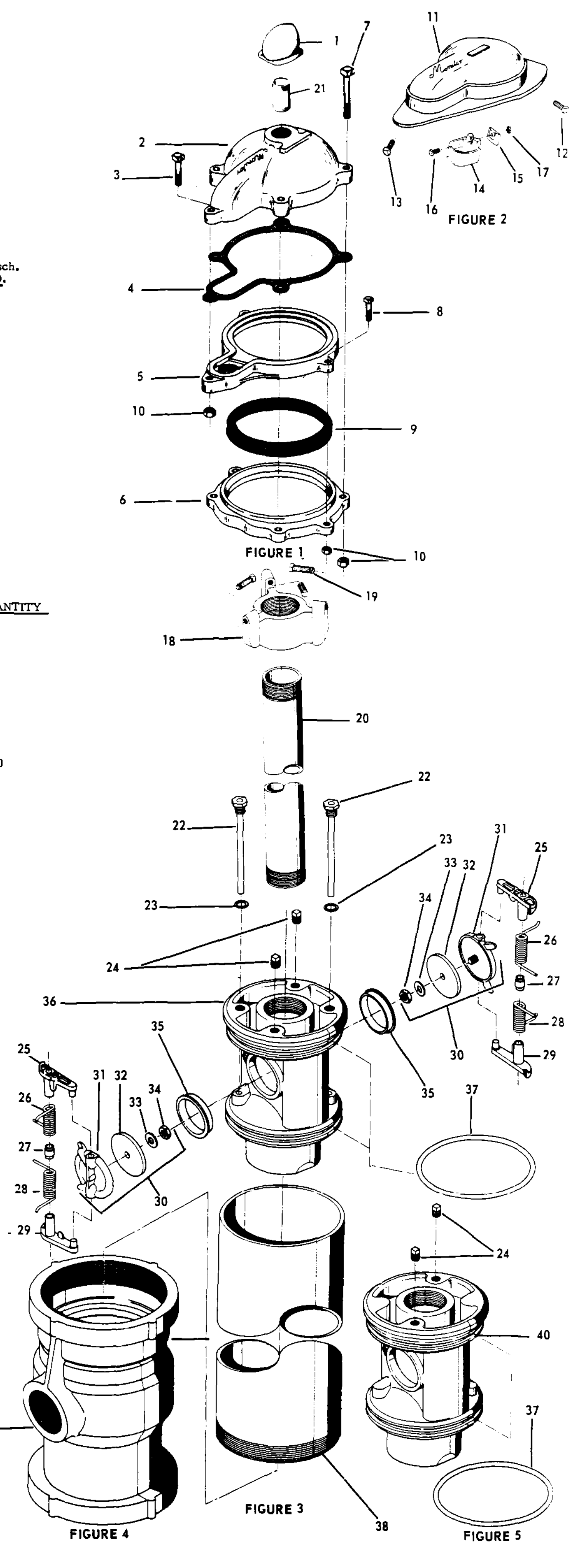
CAPS

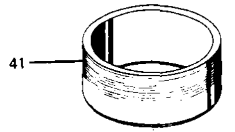
Monitor Pitless Units listed above are equipped with one of the following types of caps:

V - Ventilated, no gasket, set screw attached, 1-wire outlet, Figure No. 2.
W - Watertight, bolted gasket sealed, 1-wire outlet, Figure No. 1.

REPAIR PARTS LIST
(See RPL - 1000 for prices)

KEY NUMBER	ORDER NUMBER	DESCRIPTION	QUANTITY
----		**FIGURE No. 1**	
......	10W	Alternate Cap, watertight, includes Key Numbers 1 thru 10 assembled.	
1	PS155	Vent Assembly	1
2	PS350	Seal Cap & Plug Assembly	1
3	UE201	Machine Bolt, ½-13NC x 3¼ L.	1
4	PS342	Gasket	1
5	PS341	Retainer Ring	1
6	PS189	Depression Ring	1
7	PS220	Macine Bolt, ½-13NC x 4½ L.	6
8	PS111	Machine Bolt, ½-13NC x 2½ L.	3
9	PS170	Seal Ring	1
10	PC433	Hex Nut ½-13NC	10
......		**FIGURE No. 2**	
......	10V	Alternate Cap Ventilated includes Key Nos. 11 thru 17 assembled.	
11	PS420	Seal Cap Assembled includes Key Nos. 11 thru 13 assembled	
12	PS110	Set Screw ½-13NC x 1¼ L.	3
13	PS421	Set Screw ½-13NC x 1½ L.	1
......	PS422	Seal Cap Adapter Assembly includes Key Numbers 14 thru 17 assembled	1
14	PS156	Seal Cap Adapter	1
15	PS116	Seal Cap Adapter Plate	1
16	PS423	Machine Bolt ½-13NC x 1¾ L.	1
17	PC433	Hex Nut ½-13NC	1
.....		**FIGURE No. 3**	
18	UG260	Hold-Down Assembly includes Key Nos. 18 thru 19 assembled.	
19	UG191	Set Screw 7/16-14NC x 2¼ L.	3
20	....	3'Bury, 3" I.P. - 8 NPT. x 1'-6¼" L. 4' Bury, 3" I.P. - 8 NPT. x 2'-6¼" L. 5' Bury, 3" I.P. -8NPT x 3'-6¼" L. 6' Bury, 3" I.P. - 8 NPT x 4'-6¼" L. 7' Bury, 3" I.P.- 8 NPT. x 5'6¼" L. 8' Bury, 3" I.P.- 8 NPT. x 6'-6¼" L.	
......	10E2PS	Alternate Spool with Check Valves includes Key Nos. 22 thru 37 assembled.	
21	PS365	Pipe Nipple 2½ x 6	1
22	UG29	Hinge Pin	2
23	SW84	Hinge Pin Gasket	2
24	ZA66	Pipe Plug 3/8 - 18 NPT	2
25	UG147	Rocker Arm Top	2
26	UG146	Valve Spring Top	2
27	UG150	Valve Spring - Center Support	2
28	UG145	Valve Spring - Bottom	2
29	UG148	Rocker Arm - Bottom	2
30	UG223	Check Valve Assembly includes Key Nos. 31 thru 34 assembled	2
31	UG149	Valve Body	2
32	UG23	Rubber Check Valve Facing	2
33	SW42A	Brass Washer	2
34	TP34	Brass Nut ½ - 13 NC x 5/16 thick	2
35	UG22	Check Valve seat	2
36	UG194	Spool	1
37	UG15	"O" Ring	2
38	....	Pitless Case 10" Pipe with air test adapter – Order by Bury Depth	1
......		**FIGURE No. 4**	
39	UG3	Discharge Body	1
		FIGURE NO. 5	
.....	10E0PS	Spool without check valves includes Key Nos. 24, 37, 40 assembled	
40	UG140	Spool, also includes Key No. 24 assembled.	
41	8AWN	Welding Nipple	1





OM1421
1-15-84

Monitor® PS

SPOOL TYPE PITLESS UNITS FOR 7" O.D. INDUSTRIAL WELLS

The drawings and parts list apply to the model numbers listed below including those with B or G after the well casing attachment.

MODEL NUMBERS

Bury Depth	Unit	Well Size I.D.	Case Size	Well Casing Attach.	Cap Style	Spool	Drop Pipe I.D.	Disch. Conn.	Disch. I.D.
3' to 8'	PS	6.6"	7"	W	W	E0	3	T	3
3' to 8'	PS	6.6"	7"	W	W	E2	3	T	3
3' to 8'	PS	6.6"	7"	W	V	E0	3	T	3
3' to 8'	PS	6.6"	7"	W	V	E2	3	T	3

SPOOLS

Monitor Pitless Units listed above are equipped with one of the following types of Spools:

E2 – Spool, with check valves, Figure No. 3
E0 – Spool, without check valves, Figure No. 4

CAPS

Monitor Pitless Units listed above are equipped with one of the following types of Caps:

V – Ventilated, no gasket, set screw attached, 1-wire outlet, Figure No. 2
W – Watertight, bolted gasket sealed, 1-wire outlet, Figure No. 1.

REPAIR PARTS LIST
(See RPL–1000 for Prices)

Key Number	Ordering Number	Description	Quantity
———		**FIGURE NO. 1**	
———	7W	Alternate Cap, watertight, includes Key numbers 1 thru 11 assembled.	
1	PS150	Vent Assembly	1
2	PS217	Seal Cap & Plug Assembly	1
3	PS93	Machine Bolt, 3/8–16NC x 2½" L.	1
4	PS197	Gasket	1
5	PS377	Retainer Ring	1
6	PS187	Depression Ring	1
7	PS94	Machine Bolt, 3/8–16NC x 3¾" L.	6
8	PS132	Machine Bolt, 5/16–18NC x 2" L.	2
9	PS167	Seal Ring	1
10	UB17	Hex Nut, 3/8–16NC	7
11	PC434	Hex Nut, 5/16–18NC	2
———		**FIGURE NO. 2**	
———	7V	Alternate Cap, ventilated, includes Key Numbers 12 thru 14 assembled	
12	PS147	Seal Cap, includes Key Numbers 12 & 13 assembled.	1
13	PK13	Set Screw, 3/8–16NC x 7/8" L.	3
14	PK29	Seal Cap adapter	1
………		**FIGURE NO. 3**	
15	UC129	Hold-Down Assembly, includes Key Numbers 15 & 16 assembled	1
16	UC139	Set Screw, 7/16–14NC x 1¾"L.	3
17	………	Hold-Down pipe, 2" I.P.S.–11½ N.P.T. Length=Pitless Unit Bury Depth less 4 3/16" L.	
………	7E2PS3	Alternate spool with check valves includes Key Numbers 18 thru 31 assembled	
18	UC299	Hinge Pin	2
19	UC127	Hinge Pin Gasket	2
20	ZA66	Pipe plug, 3/8–18 N.P.T.	2
21	UC301	Valve Rocker Arm	4
22	UC302	Valve Spring	2
23	UC300	Center Coil Support	2
24	UC296	Check Valve assembly, includes key numbers 25 thru 28 assembled	2
25	UC292	Valve Body	2
26	UC295	Rubber Check Valve Facing	2
27	PS158	Brass Washer	2
28	PS159	Brass Nut, 3/8–16NC x ¼" thick	2
29	UC293	Check Valve Seat	2
30	UC290	Spool	1
31	UC15	"O" Ring	2
32	………	Pitless Case 2' Bury 7" I.P.S.–8NPT one end x 2' –8 9/16" L. Pitless Case 3' Bury 7" I.P.S.–8NPT one end x 3'–8 9/16" L. Pitless Case 4' Bury 7" I.P.S.–8NPT one end x 4'–8 9/16" L. Pitless Case 5' Bury 7" I.P.S.–8NPT one end x 5'–8 9/16" L. Pitless Case 6' Bury 7" I.P.S.–8NPT one end x 6'–8 9/16" L. Pitless Case 7' Bury 7" I.P.S.–8NPT one end x 7'–8 9/16" L. Pitless Case 8' Bury 7" I.P.S.–8NPT one end x 8'–8 9/16" L.	
33	UC391	Discharge Body	1
34	7AWN	Welding Nipple for 7" O.D. Casing	1
35	PS263	Pipe Nipple	1
———		**FIGURE No. 4**	
———	7E0PS3	Spool without check valves inclds. Key Nos 20, 31, 36 assembled.	
36	UC142	Spool, also includes Key No. 20 assembled.	

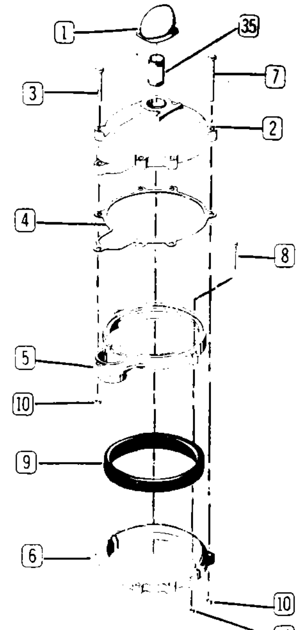


FIG. 1

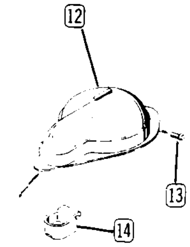


FIG. 2

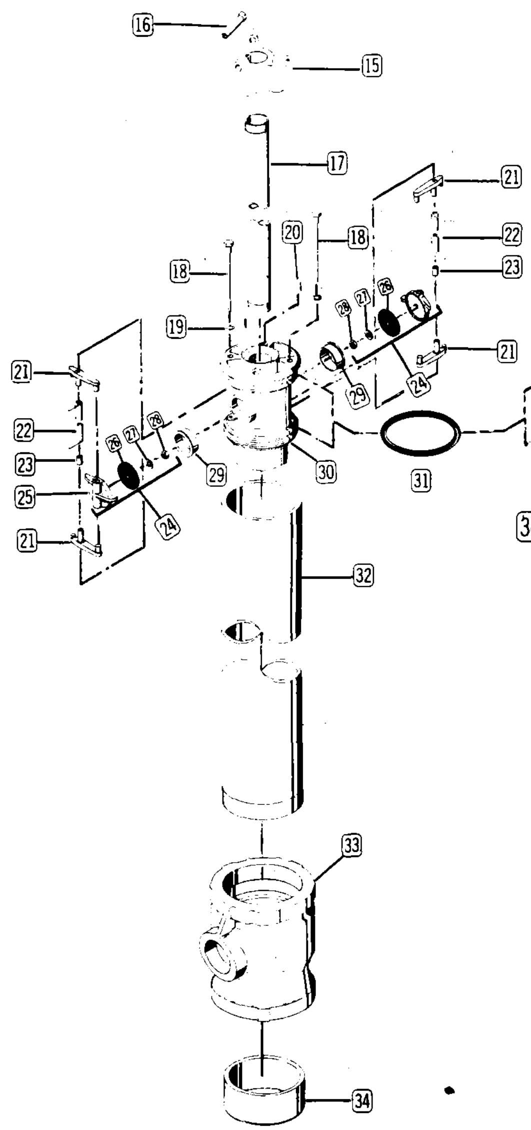


FIG. 3

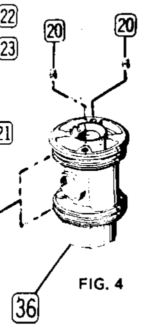


FIG. 4

WARRANTY PROVISIONS — Every Monitor product is warranted against defective material or workmanship for a period not to exceed one year from the date of shipment, except as hereinafter stated or as otherwise stated on specific Monitor product brochures. Items which through normal use become unusable within one year are warranted only as to defaults in material and workmanship. For castings produced by Baker and sold as castings, those which are proven defective through inspection or machining prior to assembly will be replaced. On defective castings sold as castings, Baker assumes no liability for labor or consequential damages. Pump hoists, pressure tanks, prime movers, starting equipment, electrical apparatus, auxiliary fittings, and parts and materials manufactured by others, are warranted only to the extent of the warranty made by the manufacturer of such parts and material.

Baker's obligations under this warranty on Monitor products is limited to the replacement without charge of the part or parts which upon examination prove to Baker's satisfaction to have been defective and which have not been abused or carelessly handled. Baker shall not be liable for consequential or other damages, losses or expenses in connection with or by reason of defective materials or workmanship other than to replace without charge said defective parts as provided for herein. Baker's obligation under this warranty is limited to the extent the products are warranted by the original manufacturer.

Claims for defective merchandise, shortages, delays, or failures in shipment or delivery, or for any other cause, shall be deemed waived and released by the Buyer, unless made in writing within seven days after arrival of the merchandise.

BAKER MAKES NO WARRANTIES AS TO MERCHANTABILITY OR AS TO THE FITNESS OF THE MERCHANDISE FOR ANY PARTICULAR USE AND SHALL NOT BE LIABLE FOR ANY LOSS OR DAMAGE, DIRECTLY OR INDIRECTLY, ARISING FROM THE USE OF SUCH MERCHANDISE OR FOR CONSEQUENTIAL DAMAGES.

BAKER
monitor d on
133 ENTERPRISE STREET
EVANSVILLE, WISCONSIN 53536
PHONE: (608) 882-5100

PRI'''D IN U.S.A.

SPECIFICATIONS AF JBJECT TO CHANGE WITHOUT NOTICE

OM1422
1-15-84

MSDSs ENCLOSED FOR:

- - Zinc

- - Welding

WARNING

**Welding galvanized products may cause zinc fumes.
Please review the enclosed MSDS for further information.**

Baker Manufacturing Company
133 Enterprise Street
Evansville, WI 53536
(608) 882-5100

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Form Approved
OMB No. 44-R1387

MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

SECTION I

MANUFACTURER'S NAME: Empire Metal Company	EMERGENCY TELEPHONE NO.: 315-463-6950
ADDRESS (Number, Street, City, State, and ZIP Code): 6800 Newbrook Ave. E. Syracuse, NY 13057	
CHEMICAL NAME AND SYNONYMS: Galvanize Brightener	TRADE NAME AND SYNONYMS: 90-10 Brightener(Silvermetal)
CHEMICAL FAMILY: Zinc	FORMULA: 90% Zn-10% Al

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)
Record specific composition, i.e. % Zn, % Pb, % Cd, and other potential toxic impurities that may be released during use.		

SECTION III - PHYSICAL DATA

BOILING POINT (°F.)	907°C	SPECIFIC GRAVITY (H_2O=1)	6.0
VAPOR PRESSURE (mm Hg.)	NA	PERCENT, VOLATILE BY VOLUME (%)	NA
VAPOR DENSITY (AIR=1)	NA	EVAPORATION RATE (________ =1)	NA
SOLUBILITY IN WATER	Negligible		
APPEARANCE AND ODOR	Bluish-white metal		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	FLAMMABLE LIMITS	Lel	Uel

EXTINGUISHING MEDIA
Dry type extinguisher. DO NOT USE WATER OR SAND ON BURNING METAL

SPECIAL FIRE FIGHTING PROCEDURES
Wear self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS
When heated excessively beyond melting point, metal vapor burns in air with bright greenish-yellow flame to produce ZnO fume (TLV-5mg/m^3).

INCO ALLOYS INTERNATIONAL, INC.
Material Safety Data Sheet
Welding Products

Inco Alloys International, Inc.
Welding Products Company
1401 Burris Road
Newton, N. C. 28658

NI-ROD®

Emergency Number: (304) 526-5780
General Information (704) 465-0352

SECTION 1 - Product Identification

This MSDS covers all Inco Alloys International, Inc., welding products identified as:
NI-ROD® Welding Electrodes and Cored Wire
Trade name and nominal composition are listed in Section 2-A

SECTION 2 - Hazardous Ingredients*

IMPORTANT This section covers the materials contained in the product as shipped. The fumes and gases produced during welding are covered in Section 6.

Ingredient	CAS No.	PEL(1)	TLV(2)	Ingredient	CAS No.	PEL(1)	TLV(2)
Aluminum (Al)	7429-90-5	NONE	10	Iron (Fe)	7439-89-6	NONE	NONE
Barium Carbonate ($BaCO_3$)	513-77-9	0.5(as Ba)	0.5(as Ba)	Iron Oxide (Fe_2O_3)	1309-37-1	10	5
Barium Fluoride (BaF_2)	7787-32-8	0.5(as Ba)	0.5(as Ba)	Manganese (Mn)	7439-96-5	C5	C5
Calcium Carbonate ($CaCO_3$)	1317-65-3	NONE	10	Sodium Aluminum Fluoride(Na_3AlF_6)	15096-52-3	2.5(as F)	2.5(as F)
Calcium Fluoride(CaF_2)	7789-75-5	2.5(as F)	2.5(as F)	Nickel (Ni)	7440-02-0	1	1
Carbon (C)	7440-44-0	3.5	3.5	Silicon Dioxide (SiO_2)	60676-86-0	0.1	0.1
Copper (Cu)	7440-50-8	1	1	Strontium Carbonate ($SrCO_3$)	1633-05-2	NONE	NONE

SECTION 2-A - Tradename and Nominal Composition

Wt. % of combined wire and flux 1% or greater.

1-10%-A 11-30%-B 31-60%-C 61-100%-D

PRODUCT NAME	Al	$BaCO_3$	BaF_2	$CaCO_3$	CaF_2	C	Cu	Fe	Fe_2O_3	Mn	Na_3Al_6	Ni	SiO_2	$SrCo_3$
NI-ROD® Welding Electrode	A	A	A			A		A				D	A	A
NI-ROD® 44 Welding Electrode			A	A		A	A	C		A		C	A	A
NI-ROD® 55 Welding Electrode			A	A		A	A	C				C	A	A
NI-ROD® 55X Welding Electrode	A		A	A		A	A	C				C	A	A
NI-ROD® 60 Welding Electrode			A	A		A	A	C	A			C	A	A
NI-ROD® 99X Welding Electrode			A	A		A	A	A		A		D	A	A
NI-ROD® FC55 Cored Wire				A	A			C		A	A	C		

® Registered Trademarks of the Inco family of companies

SECTION 3 - Physical Data

Welding electrodes are solid alloy wire which is flux coated or may have a flux core.

SECTION 4 - Fire and Explosion Data

Nonflammable; however, welding arcs and sparks can ignite flammable liquids and vapors and combustible solids.

Notes: *As defined by OSHA (29CFR1910.1200) or certain state regulations.

1 Permissible Exposure Limit - (mg/m^3) -OSHA (29CFR1910.1000). C= Ceiling Value

2 Threshold Limit Value - (mg/m^3) -American Conference of Governmental Industrial Hygienists (current as of MSDS revision date). C= Ceiling Value

XPLANATION OF TLESS UNIT ORDERING NUMBERS

The diagram illustrates the meaning of the various letters and numerals used in Monitor Industrial Pitless Unit ordering numbers. A typical order number and the pitless unit it stands for are shown.

3 **A.** The first numeral in the order number indicates the bury depth, in feet, of the unit. Bury depth on all units is measured from the center of the discharge line to ground level. The top of the pitless case extends 12" above ground level as is required by many codes.

PS These letters indicate the type of pump the pitless unit is designed for. The unit shown is a PS for submersible pumps.

8 **B.** This numeral indicates the well casing size. The 6 is 6" I.D. wells, 6.6 for 7" O.D. wells, and 8 for 8" I.D. wells.

) **C.** This numeral indicates the upper pitless case size. The 7 is for the 7" I.D. case, and 10 for 10" I.D. case.

W **D.** Indicates the attachment to the well casing is a welded joint ("N" for KwiKonect - 6" I.D. & 8" I.D. only).

B **E.** The presence of the letter "B" in the order number indicates the upper pitless case is black pipe.

W **F.** Indicates the unit has a watertight cap with screened vent installed. "V" would indicate a ventilated cap.

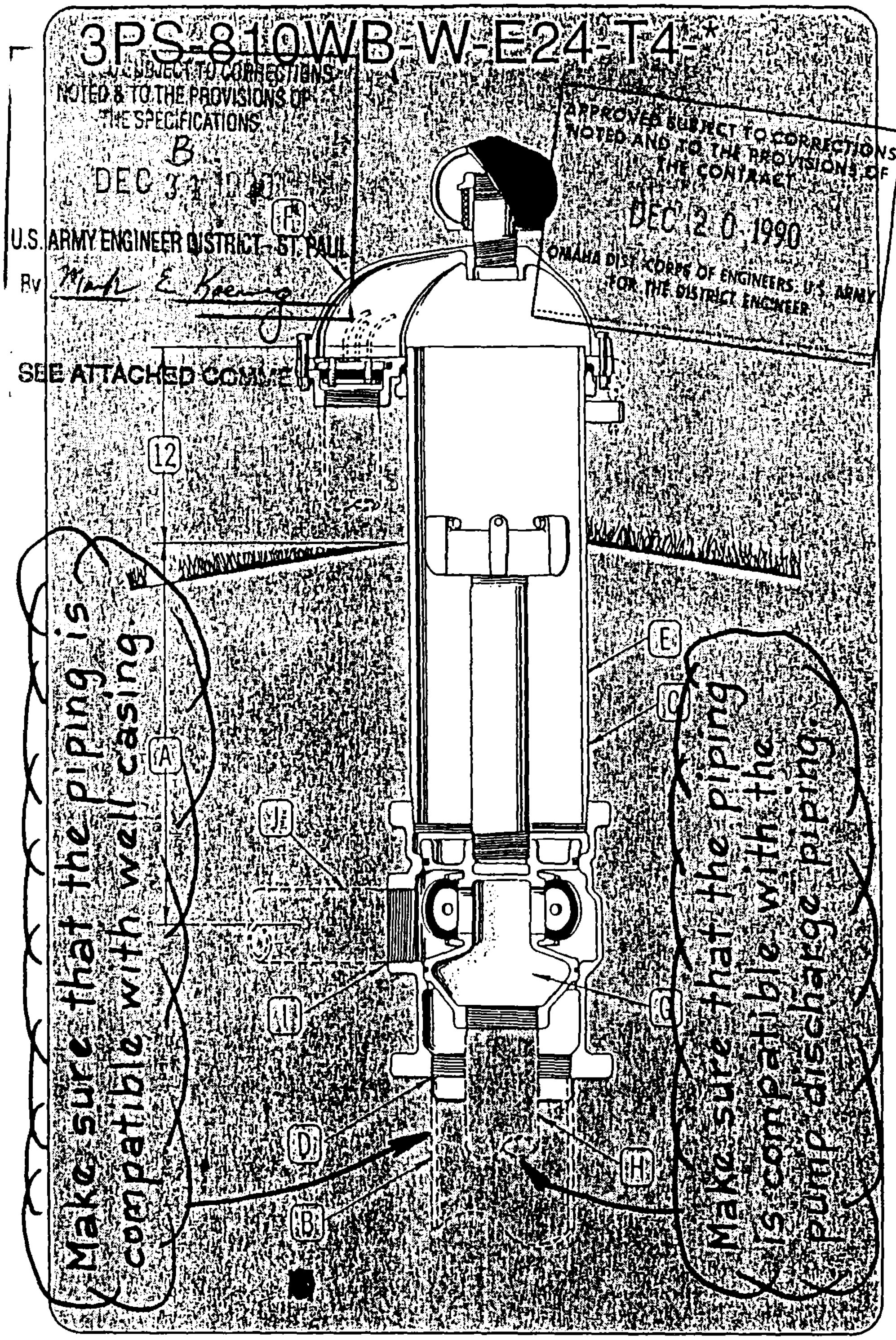
E **G.** Indicates spool has pressure equalizing passages.

2 This numeral indicates the type of spool which the pitless unit has. In this case it is a spool having two silent check valves.

4 **H.** Indicates the size of drop pipe in inches.

T **I.** Indicates the discharge connection is threaded.

4 **J.** Indicates the size of discharge pipe in inches.



ACCESSORY LIST

* Accessory(s) may be ordered by placing accessory letter at end of pitless model number. (Protected screen well vent is standard equipment, as is weld nipple).

S Sealed Conduit Connection.

BAKER

133 Enterprise St.
Evansville, WI 53536

Monitor

Monitor PS
Industrial Pitless Units for Submersible Pumps 6", 6.6", & 8" I.D. Well Sizes

The Monitor PS Industrial Pitless Unit for submersible pumps forms a watertight extension of the well casing which starts below the frostline, where it is buried permanently, and continues upward 12 or more inches above grade, where the pitless case is closed with a watertight cap.

TO INSTALL A PS INDUSTRIAL UNIT:

An excavation around the well casing below the frost line is made and well casing cut off at a prescribed level. The well cap is removed and the spool assembly lifted out of the pitless case with a hoist and set aside.* The pitless case is then welded or threaded tightly onto the well casing. The submersible motor, pump, and cable are attached to the drop pipe which is lowered into the well with a hoist; when the top of the last section of the drop pipe is one foot or more above the pitless case, the spool assembly is screwed onto the drop pipe. The spool assembly and drop pipe with motor, pump and cable are lowered into place; then finally the electrical service and well cap are installed.

The spool assembly includes: A spool with two or no silent check valves; two O-ing seals; lift-out pipe and hold-down spider.

FEATURES:

CORROSION PROTECTION . . . All water passages are either hot-dipped galvanized or constructed of corrosion resistant material.

EASY TO SERVICE . . . Well cap can be removed without disconnecting cables. O-ring seals on spool permit withdrawal of the entire inner assembly simply by lifting. Replacement is equally simple. Spool support eliminates vertical adjustment and any possibility of dropping the inner assembly into the well.

RELIABLE SEAL . . . Neoprene O-rings between accurately machined hot-dipped galvanized surfaces on the spool and and within the unit provide positive seals.

O-RING SEAL PROTECTION . . . Monitor seal protection prevents seal damage during installation and service.

FROST PROOF . . . No heating is required. All water passages are below the frost line.

QUICK TO INSTALL . . . A quality pump installation can be made easily and economically without delay for masonry or building construction.

ALTERNATIVE SPOOLS
Spools are available plain (EO) or with silent check valves (E2-double). The Monitor Silent Check Valve has its operating parts automatically exposed when the spool is withdrawn. Complication and cost of installing separate check valve in the drop pipe are eliminated. Spools are supplied with tapping for either a pressure relief valve, or a pressure control.

WATERTIGHT WELL CAP . . . Designed to permit removal without disconnecting cables. Separate Junction Box is eliminated. Watertight cable and conduit sealing is optional. Alternate ventilated cap is available.

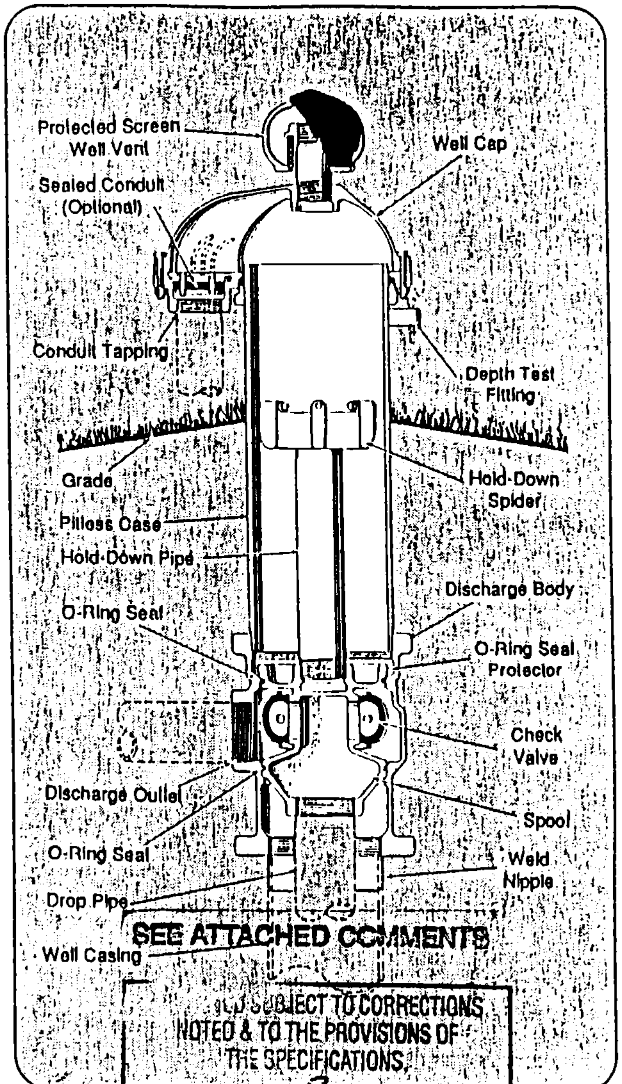
HOLD-DOWN . . . Supplied with each unit. Hold-down pipe also serves as lift-out pipe for installation and servicing.

DEPTH TEST BLOCK . . . Standard on all units.

FLOWING WELL . . . Units available.

ONE YEAR LIMITED WARRANTY

Any PS Pitless Unit discharge body, spool, upper case or well cap used in potable water applications, found defective in workmanship or material will be replaced without charge provided the defective item is returned prepaid to the distributor from whom purchased within one year from date of shipment. The Company does not assume responsibility for labor or consequential damage. All other terms and conditions of sale are as stated on the Baker Factory Sales Order Terms and Conditions-Form AD 100.



SEE ATTACHED COMMENTS

SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS

B

DEC 31 1990

U.S. ARMY ENGINEER DISTRICT - ST. PAUL

By Mark E. Koenig

608-882-5100
FAX: 608-882-6776

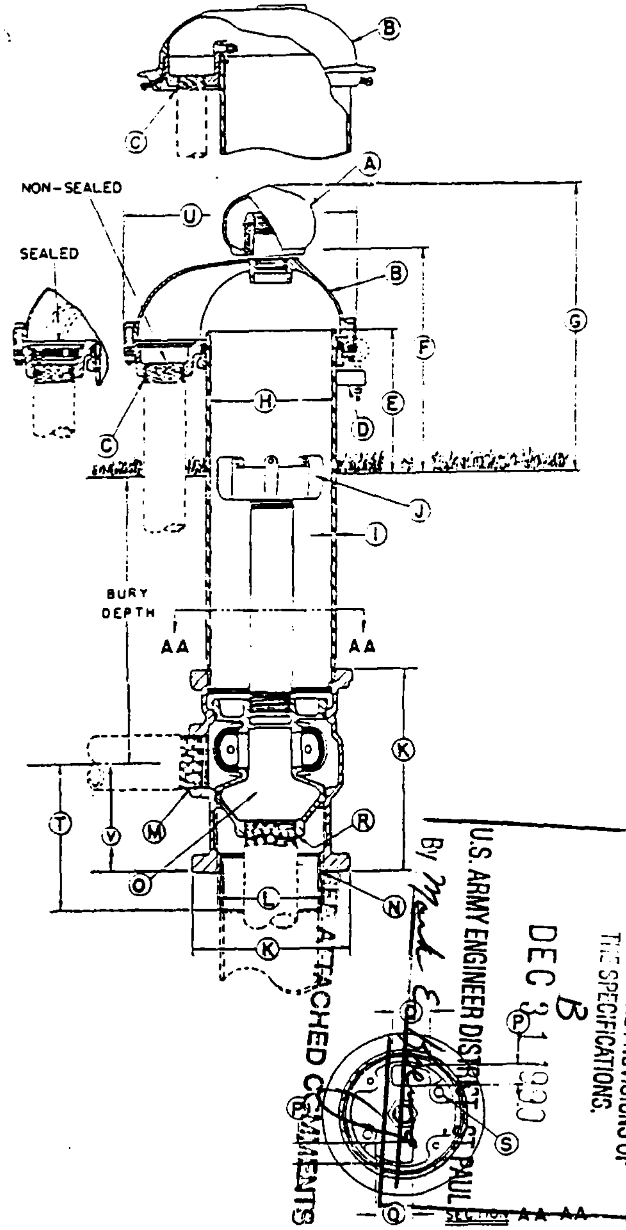
BAKER

133 Enterprise Street
Evansville, Wisconsin 53536

Monitor

Catalog AD74 4-1-89

Monitor® PS PITLESS UNITS FOR SUBMERSIBLE PUMPS 6", 6.6" & 8" Wells



U.S. ARMY ENGINEER DISTRICT, ST. PAUL
DEC 31 1990
B
SEE ATTACHED COMMENTS
NOTED SUBJECT TO THE PROVISIONS OF THE SPECIFICATIONS.
SUBJECT TO CORRECTIONS

SPECIFICATIONS

WELL SIZE I.D.	6 in.	6.6 in. (7" O.D.)	8 in.
[A] Screened Well Vent Size:	1½ in. F.I.P.	1½ in. F.I.P.	2½ in. F.I.P.
[B] Seal Cap: *The Watertight Cap bolts to a compression seal ring securing around the pitless casing and comes with the screened well vent installed. The Ventilated Cap is attached with set screws via the pitless casing.*			
[C] Conduit Tapping Size (Watertight Cap):	1½ in. F.I.P.	1½ in. F.I.P.	3 in. F.I.P.
Conduit Tapping Size (Ventilated Cap): *Watertight Conduit Seals for most common cable size are available for Watertight Cap Only.*	1" in. F.I.P.	1" in. F.I.P.	2" in. F.I.P.
[D] Depth Tester Tapping:	¼ in. F.I.P.	¼ in. F.I.P.	¼ in. F.I.P.
[E] Distance from Ground Level to Top of Pitless Case:	12 in.	12 in.	12 in.
[F] Distance from Ground Level to Top of Ventilated cap:	15½ in.	15½ in.	18-7/8 in.
[G] Distance from Ground Level to Top of Screened Well Vent installed on Watertight Cap. *(Vent Height may be increased if necessary).*	19½ in.	19½ in.	24-5/16 in.
[H] Pitless Case Size:	7 in.	7 in.	10 in.
[I] Pitless Case Wall Thickness	.300 in.	.300 in.	.365 in.
[J] "Hold-Down" — "Lift-Out" Mechanism *Three set screws in a spider atop the "Hold-Down". "Lift-Out" pipe brace against the interior of the pitless casing, locking the spool in place.*			
Hold-Down, Lift-Out Pipe Size:	2 in.	2 in.	3 in.
Designed "Lift-Out" Mechanism Load:	10,000 lb.	10,000 lb.	20,000 lb.
[K] Discharge Body Size:	9-7/16 in. O.D. x 13-1/16 in. L	9-7/16 in. O.D. x 13-1/16 in. Lg.	Welded to Upper Casing
[L] Pitless Unit Minimum I.D.:	6-3/8 in.	6-3/8 in.	9-1/8 in.
[M] Discharge Connection Tapping Size:	3 in. F.I.P.	3 in. F.I.P.	4 in. F.I.P.
[N] Pitless Unit to Well Casing Connection:	6 in. Weld.	6.6 Weld	8 in. Weld
[O] SPOOL ASSEMBLY			
Spool Design Load:	64,000 lbs.	64,000 lbs.	88,000 lbs.
—WITHOUT CHECK VALVES—			
Area of Water Passage(s):	10 sq. in.	10 sq. in.	15.8 sq. in.
Percent Area of Water Passages to Area of Drop Pipe:	135%	135%	124%
—WITH TWO CHECK VALVES—			
Area of Valve Passages:	6.28 sq. in.	6.28 sq. in.	12.6 sq. in.
Percent Area of Valve Passages to Area of Drop Pipe:	89%	89%	100%
MOTOR CABLE PASSAGES THROUGH SPOOL			
	13/16 in.	13/16 in.	1-5/8 in.
	1¾ in.	1¾ in.	3-3/16 in.
Spool to Drop Pipe Connection:	3 in. F.I.P.	3 in. F.I.P.	4 in. F.I.P.
Pressure Switch Tapping: 3/8 — 18 N.P.T.	(2) Available	(2) Available	(2) Available
Dimension from Center of Discharge Outlet to bottom of Weld Nipple:	8-3/8 in.	8-3/8 in.	11 in.
Overall length of Seal Cap:	12-3/8 in.	12-3/8 in.	18¼ in.
Dimension from center of Discharge Outlet to bottom of Discharge Body	6-5/8 in.	6-5/8 in.	9¼ in.

FIRST

Choose well size then make-up basic ordering number from proper column in specifications

ORDERING NUMBER SELECTION GUIDE													
Bury Depth - Ft. (Select One)	Pitless Submersible	Well Size - Inches	Upper Case Size - Inches	Attachment to Well Casing (Welded or Kwikonect)	Black Upper Case	Ventilated Cap	Watertight Cap (Vent Installed)	Pressure Equalizing Spool Passages	Number of Check Valves (Select One)*	Drop Pipe I.D. Inches	Discharge Connect (Threaded)	Discharge I.D. - Inches
2 to 9	PS	6.6 6 8	7 7 10	W N	B	V	W	E	0 2	3 3 4	T	3 3 4

SECOND

add desired accessory symbol

ACCESSORY	SYMBOL
SEALED CONDUIT CONNECTION	S

Monitor

COMPONENT MATERIALS

Well Vent — cast iron, red enamel finish.
Cap & Conduit Box — cast iron, red enamel finish.
Hold-Down Spider — cast iron, red enamel finish.
Hold-Down Pipe, 2" — steel, black.
Hold-Down Pipe, 3" — steel, galvanized.
Pitless Case — steel, black.
Spool — cast iron, galvanized.
Discharge Body — cast iron, galvanized.
Check Valve Body & Arms — brass.
Check Valve Seat — brass.
Check Valve Spring — Monel.
Compression Seal Ring & Check Valve Facing — Neoprene.
Conduit Seal & O-rings — Neoprene.

BAKER monitor division
133 ENTERPRISE STREET
EVANSVILLE, WISCONSIN 53536
PHONE: (608) 882-5100

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

BB1C
Litho in U.S.A.
Revised 3-15-88

EXPLANATION OF PITLESS ORDERING NUMBERS

The diagram illustrates the meaning of the various letters and numerals used in Monitor Industrial Pitless Unit ordering numbers. A typical order number and the pitless unit it stands for are shown.

3 A. The first numeral in the order number indicates the bury depth, in feet, of the unit. Bury depth on all units is measured from the center of the discharge line to ground level. The top of the pitless case extends 12" above ground level as is required by many codes.

PS These letters indicate the type of pump the pitless unit is designed for. The unit shown is a PS-for submersible pumps.

10 B. This numeral indicates the well casing size.

12 C. This numeral indicates the upper pitless case size.

W D. Indicates the attachment to the well casing is a welded joint.

B E. The presence of the letter "B" in the order number indicates the upper pitless case is black pipe.

W F. Indicates the unit has a water-tight cap. "V" would indicate a ventilated cap.

E G. Indicates spool has pressure equalizing passages.

0 This numeral indicates the number of check valves which the pitless unit has.

6 H. Indicates the size of drop pipe in inches.

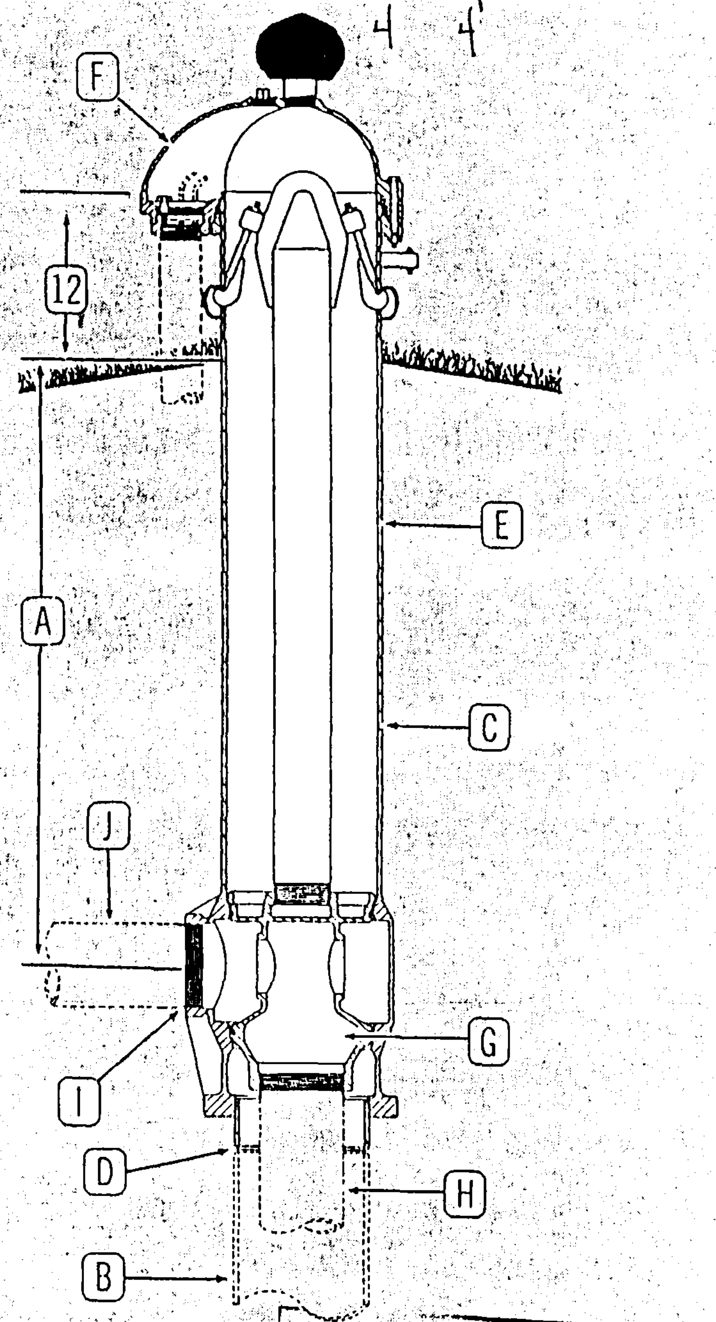
T I. Indicates the discharge connection is threaded.

6 J. Indicates the size of discharge pipe in inches.

E Economy Model

3PS-1012WB-W-E06-T6 E *

4 4



ACCESSORY LIST

* Accessory(s) may be ordered by placing accessory letter at end of pitless model number.

S Sealed Conduit Connection

SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.
DEC 31 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E. Koenig

SEE ATTACHED COMMENTS

BAKER 133 Enterprise Street · Evansville, Wisconsin 53536 · 608-882-5100
FAX: 608-882-6776

Monitor PS
Economy Model 10" Well Size

INDUSTRIAL PITLESS UNITS FOR SUBMERSIBLE PUMPS

The Monitor PS Industrial Pitless Unit for submersible pumps forms a watertight extension of the well casing which starts below the frostline, where it is buried permanently, and continues upward 12 or more inches above grade, where the pitless case is closed with a watertight cap.

TO INSTALL A PS INDUSTRIAL UNIT:

An excavation around the well casing below the frostline is made and well casing cut off at a prescribed level. The well cap is removed and the spool assembly lifted out of the pitless case with a hoist and set aside.* The pitless case is then welded onto the well casing. The submersible motor, pump, and cable are attached to the drop pipe which is lowered into the well with a hoist; when the top of the last section of the drop pipe is one foot or more above the pitless case, the spool assembly is screwed onto the drop pipe. The spool assembly and drop pipe with motor, pump, and cable are lowered into place; then finally the electrical service and well cap are installed.

* The spool assembly includes: A spool with two or no silent check valves; two O-ring seals; lift-out pipe with hold down assembly.

ONE YEAR LIMITED WARRANTY

Any PS Pitless Unit discharge body, spool, upper case or well cap, used in potable water applications, found defective in workmanship or material will be replaced without charge provided the defective item is returned prepaid to the distributor from whom purchased within one year from date of shipment. The Company does not assume responsibility for labor or consequential damage. All other terms and conditions of sale are as stated on the Baker Factory Sales Order Terms and Conditions-Form AD-100.

FEATURES:

CORROSION PROTECTION . . . All water passages are hot-dipped galvanized.

EASY TO SERVICE . . . Well cap can be removed without disconnecting cables. O-ring seals on spool permit withdrawal of the entire inner assembly simply by lifting. Replacement is equally simple. Spool support eliminates vertical adjustment and any possibility of dropping the inner assembly into the well.

RELIABLE SEAL . . . Neoprene O-rings between accurately machined hot-dipped galvanized surfaces on the spool and within the unit provide positive seals.

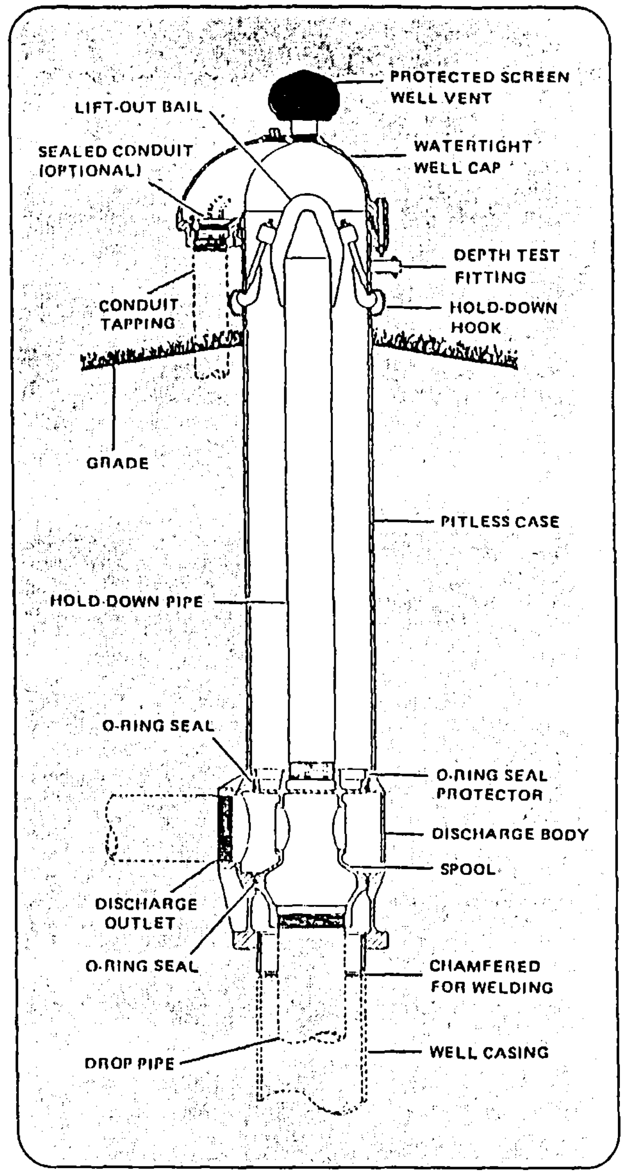
O-RING SEAL PROTECTION . . . Monitor seal protection prevents seal damage during installation and service.

FROSTPROOF . . . No heating is required. All water passages are below the frostline.

QUICK TO INSTALL . . . A quality pump installation can be made easily and economically without delay for masonry or building construction.

HOLD-DOWN . . . Supplied with each unit. Hold-Down pipe also serves as lift-out pipe for installation and servicing.

DEPTH TEST BLOCK . . . Standard on all units.



See PL2251PS for ... SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.

B

DEC 31 1990

U.S. ARMY ENGINEER DISTRICT - ST. PAUL

By Mark E Koenig

SEE ATTACHED COMMENTS

608-882-5100
FAX: 608-882-6776

BAKER

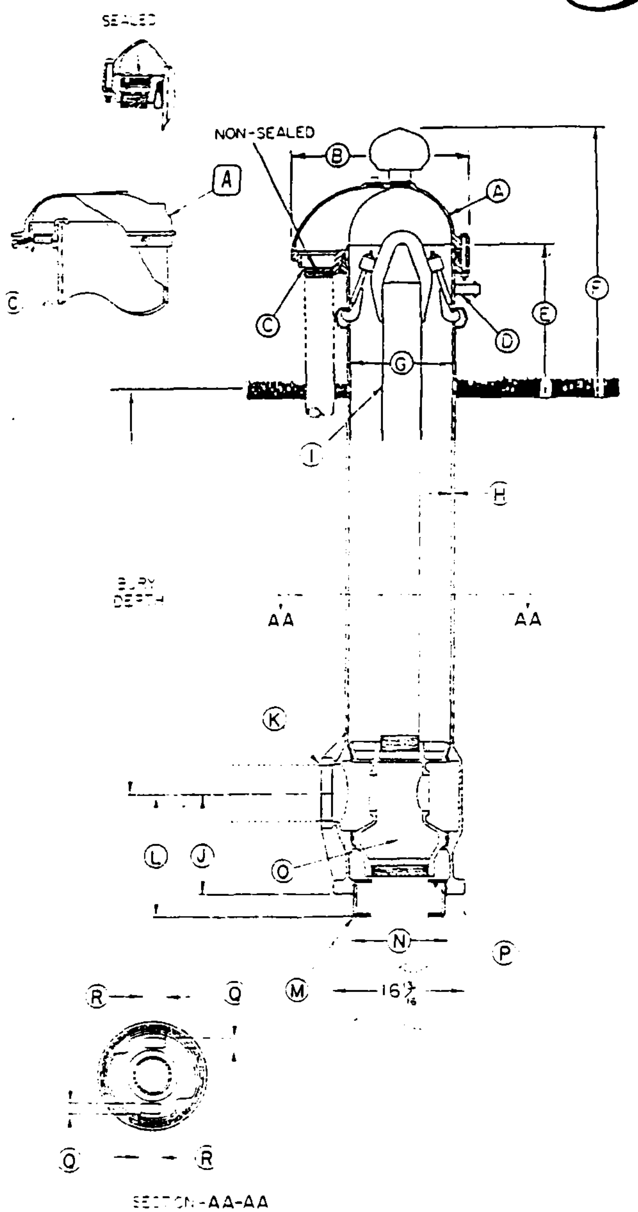
133 Enterprise Street
Evansville, Wisconsin 53536

Monitor

Catalog C40 3-25-89

ECONOMY MODEL Monitor PS INDUSTRIAL PITLESS UNITS FOR SUBMERSIBLE PUMPS

10" WELLS ONLY



SPECIFICATIONS

(A) SEAL CAP: Watertight cap bolts to a compression seal ring securing around the pitless casing and comes installed with 2½" screened well vent. Ventilated cap is attached with set screws to the pitless casing.

(B) Overall length of seal cap: 22½ in. with Watertight Cap 24-5/32 in. for Ventilated Cap

(C) Conduit tapping size: 3 in. F.I.P.. Watertight conduit seals for most common cable sizes are available for watertight cap only. (See accessory list).

(D) Depth tester block tappings: 1/4 in. F.I.P.

(E) Distance from ground level to top of casing: 12 in.

(F) Distance from ground level to top of screened well vent: 29½ in. Distance from ground level to top of ventilated cap: 17½ in.

(G) Pitless Case Size: 12 in.

(H) Pitless case wall thickness: .375 in.

(I) LIFT-OUT BAIL: Lift-out Pipe & Bail assembly designed for a 45,000 lbs. load to yield. Lift-out pipe size 4". HOLD-DOWN MECHANISM: Locks spool into place and prevents lifting & turning during pump start-up. Two adjustable hooks on lift-out pipe hook into side of Pitless Case.

(J) Dimension from center of Discharge outlet to bottom of Discharge Body: 11-7/8"

(K) Discharge connection tapping size: 6 in. F.I.P.

(L) Distance from center of discharge outlet to bottom of welding nipple: 14-3/8 in.

(M) Pitless unit to well casing connection: welded.

(N) Pitless unit minimum I.D.: 11 in.

(O) SPOOL ASSEMBLY: Designed to yield: 140,000 lbs.
—Without Check Valves—
Area of water passages: 26.73 sq. in.
Percent area of water passages to area of drop pipe: 93%
—With Two Check Valves—
Area of water passages: 26.73 sq. in.
Percent area of water passages to area of drop pipe: 93%

(P) Spool to drop pipe connection: 6 in. F.I.P.

MOTOR CABLE PASSAGES THROUGH SPOOL

(Q) 1-5/16 in.

(R) 2-5/8 in.

SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.
B
DEC 31 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
SEE ATTACHED COMMENTS

FIRST

CHOOSE WELL SIZE THEN MAKE UP BASIC ORDERING NUMBER FROM PROPER COLUMN IN SPECIFICATIONS

ORDERING NUMBER SELECTION GUIDE

BURY DEPTH - FT. (Select one)	PITLESS SUBMERSIBLE	WELL SIZE - IN.	UPPER CASE SIZE - IN.	ATTACHMENT TO WELL CASING (Welded)	BLACK UPPER CASE	SEAL CAP (Select one): VENTILATED CAP	SEAL CAP (Select one): WATERTIGHT CAP (Well Vent installed)	PRESSURE EQUALIZING SPOOL PASSAGES	NUMBER OF CHECK VALVES (Select one)*	DROP PIPE I.D. IN.	DISCHARGE CONNECTION (threaded)	DISCHARGE I.D. - IN.
2 to 19	PS	10	12	W	B	V	W	E	0 2	6	T	6

SECOND

ADD DESIRED ACCESSORY SYMBOL

ACCESSORY LIST	SYMBOL
SEALED CONDUIT CONNEC.	S

COMPONENT MATERIALS

Well Vent - cast iron, green enamel finish.
Cap & Conduit Box -cast iron, green enamel finish.
Combination Hold-Down & Lift-Out Mechanism - Galvanized steel.
Hold-Down Pipe - steel, corrossion resistant coating
Hold-Down Pipe - steel, corrosion resistant coating.
Pitless Case - steel, corrosion resistant coating.
Spool - cast iron, galvanized.
Discharge Body - cast iron, galvanized
Electrical Cable Seal & O-Rings - neoprene.
Check Valve Body & Arms - Brass.
Check Valve Springs - Monel.
Check Valve Facing, - Neoprene.
Check Valve Seats - Stainless steel.

NOTE: Design responsibility of these units is under the supervision of a Registered Professional Engineering (Certification of specifications by a Wisconsin Registered Engineer on request.) All welding on these units are qualified under Section 9 of ASME Code and AWS Standards are performed by a Certified Welder.

BAKER monitor division
133 ENTERPRISE STREET
EVANSVILLE, WISCONSIN 53536
PHONE: (608) 882-5100

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

PRINTED IN U. S. A.
BB-3
Revised 10-'

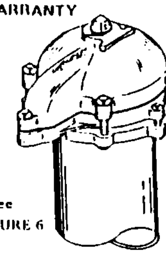
Monitor PS

SPOOL TYPE PITLESS UNITS

FOR 6" I.D. & 6" O.D. WELLS

SEE REVERSE SIDE FOR ONE YEAR LIMITED WARRANTY

The drawings and parts list apply to the model numbers listed below including those with either a B, G, N, or a BN after the Case Size.



MODEL NUMBERS

Bury Depth	Unit	Well Size Tap.	Case Size	Spool	Cap	
2' to 8'	PS	5.67N*	7"	S8	C4	See FIGURE 6
2' to 8'	PS	5.67N*	7"	S4	C4	
2' to 8'	PS	5.67N*	7"	S8	C1	
2' to 8'	PS	5.67N*	7"	S4	C1	
2' to 8'	PS	6"	7"	S8	C4	
2' to 8'	PS	6"	7"	S4	C4	
2' to 8'	PS	6"	7"	S8	C1	
2' to 8'	PS	6"	7"	S4	C1	

SPOOLS

Monitor Pitless Units listed above are equipped with one of the following types of spools:

S8 - Spool, with check valve, Figure No. 3
S4 - Spool, without check valves, Figure No. 4

CAPS

Monitor Pitless Units listed above are equipped with one of the following types of caps:

C1 - Ventilated, no gasket, set screw attached, 1-wire outlet, Fig. No. 2
C4 - Water-tight, bolted gasket sealed, 1-wire outlet, Figure No. 1

REPAIR PARTS LIST
(See RPL - 1000 for Prices)

KEY NUMBER	ORDER NUMBER	DESCRIPTION	QUANTITY
--		FIGURE #1	
--	7W	Alternate Cap water tight, includes Key numbers 1 thru 11 assembled.	
1	UC54	Pipe Plug, $1\frac{1}{2}$" - $11\frac{1}{2}$ NPT	1
2	PS217	Seal Cap and Plug Assembly, includes Key numbers 1 and 2.	1
3	PS93	Machine Bolt, 3/8 - 16NC x $2\frac{1}{2}$" L.	1
4	PS197	Gasket	1
5	PS177	Retainer Ring	1
6	PS187	Depression Ring	1
7	PS133	Machine Bolt, 3/8 - 16 NC x $3\frac{1}{4}$" L.	6
8	PS132	Machine Bolt, 5/16 - 18NC x 2" L.	2
9	PS167	Seal Ring	1
10	PC434	Hex Nut, 5/16 - 18 NC	2
11	UB17	Hex Nut, 3/8 - 16 NC	7
--		FIGURE #2	
--	7V	Alternate Cap ventilated, includes Key numbers 12 through 15	
12	PS147	Seal Cap and Set Screw Assembly, includes Key number 12 and 15.	1
14	PK29	Seal Cap Adapter	1
15	PK13	Set Screw, 3/8 - 16 NC x 7/8" L. Cup Point	3
16	UB85	Center Coil Support	1
--		FIGURE #3	
--	7S8PS	Completely assembled alternate spool with check valve for units with threaded discharge bodies as in Fig. 5 or Kwikonect (N) discharge bodies as in Figure 6	
17	PT29	Hinge Pin and Cap Assembly	1
18	PT27	Gasket for Hinge Pin	1
19	YC18	Check Valve Seat	1
20	E334	Hex Brass Machine Nut, 5/16 x 18 NC	1
21	C154	Brass Washer	1
22	EE70	Check Valve Facing	1
23	YC87	Valve Rocker Arm	2
24	YCM14	Valve Spring	1
25	UB90	Valve Body	1
26	UB198	Check Valve Assembly	1
27	ZA66	Pipe Plug, 3/8 - 18 NPT	2
28	UC146	Spool	1
29	UC15	"O" Ring	2
30	PC330	Reducer Bushing 2" x $1\frac{1}{4}$"	1
--		FIGURE #4	
--	7S4PS	Completely Assembled Spool without check valve for units with threaded discharge bodies as in Fig. 5 or Kwikonect (N) discharge bodies as in Figure No. 6	
31	UC145	Spool	1
--		FIGURE #5	
32	-------	Pitless case 2' bury, 7" I.P.S. - 8 NPT, 1 End x 2'-10"	
		Pitless case 3' bury, 7" I.P.S. - 8 NPT, 1 End x 3'-10"	
		Pitless case 4' bury, 7" I.P.S. - 8 NPT, 1 End x 4'-10"	
		Pitless case 5' bury, 7" I.P.S. - 8 NPT, 1 End x 5'-10"	
		Pitless case 6' bury, 7" I.P.S. - 8 NPT, 1 End x 6'-10"	
		Pitless case 7' bury, 7" I.P.S. - 8 NPT, 1 End x 7'-10"	
		Pitless case 8' bury, 7" I.P.S. - 8 NPT, 1 End x 8'-10"	
33	UC254	Discharge Body for well size tap 6" only	1
--		FIGURE #6	
		Discharge Body for Kwikonect (N) Unit, well size 6" only	
34	UC294	Discharge Body	1
35	PC433	Hex Nut, 1/2" - 13 NC	6
36	PS166	Seal Ring	1
37	UC255	Depression Ring	1
38	UB201	Machine Bolt, 1/2" - 13 NC x 3" L.	6
39	UC670	Discharge Body Assembly for Kwikonect (N) Unit, 6" Well Size. Includes Key Nos. 34 thru 38.	

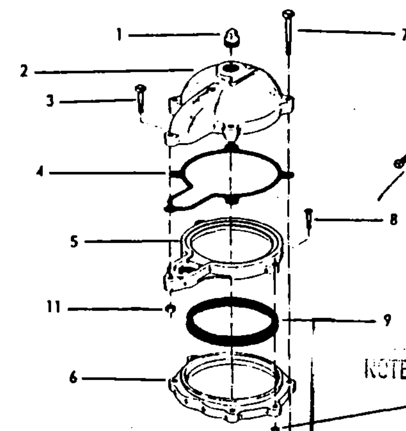


FIGURE 1

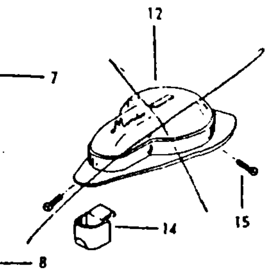


FIGURE 2

SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.
B
DEC 31 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig

SEE ATTACHED COMMENTS

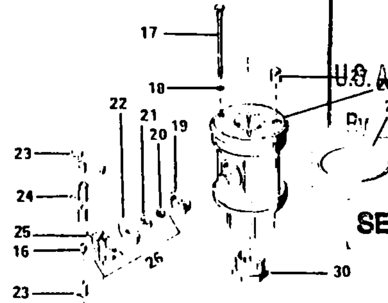


FIGURE 3

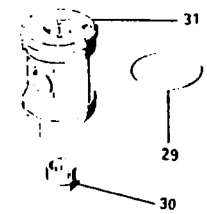


FIGURE 4

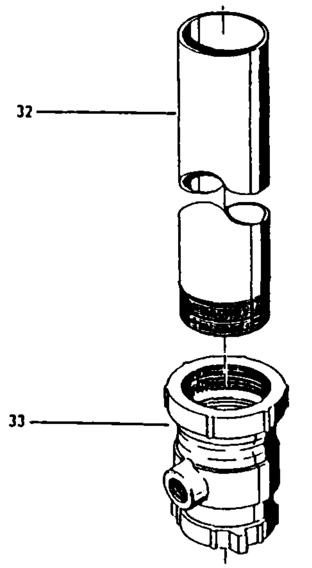


FIGURE 5

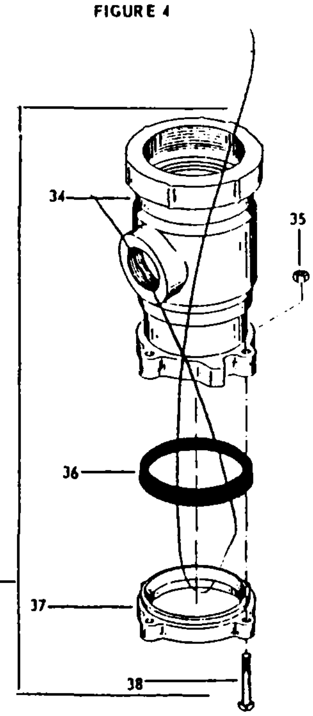


FIGURE 6

KEY NUMBER	ORDER NUMBER	DESCRIPTION	QUANTITY
--		FIGURE #6* Discharge Body for Kwikonect (N) Unit for Well Size No. 5.67" Only.	
34	UC264	Discharge Body	1
35	PC433	Hex Nut, 1/2" - 13 NC	6
36	PS166.6	Seal Ring	1
37	UC284	Depression Ring	1
38	UB201	Machine Bolt, 1/2" - 13 NC x 3" L.	6
39	UC567	Discharge Body Assembly for Kwikonect (N) Unit, 5.67" Well Size. Includes Key Nos. 34 thru 38.	

United States Steel Corporation

01.000.0798 (REV. 7-78)

TUBULAR PRODUCTS

METALLURGICAL TEST REPORT

JOB, CONTRACT NO.	P.O. DATE	PURCHASE ORDER NO.
		FS8365

SHIPPERS NO.	MILL ORDER NO.	INVOICE NO.
	CD19375	

VEHICLE IDENTITY

VENDOR

SOLD TO

MAIL TO

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MFGD., SAMPLED, TESTED, AND/OR INSPD. IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF:
E. J. BUECHE MGR. Q.A.

APPROVED SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.
DATE
C
FEB 7 1991
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig

SPEC. & SP.

SEE ATTACHED COMMENTS

14 std A53

ITEM NO.	SIZE	WALL	SPECIFICATION & GRADE	MATL.	HEAT/ LOT NO.	MIN. HYDRO PSI	YIELD STR. PSI	TENSILE STR. PSI	ELONG. % IN 2"	GAGE WIDTH IN.	FLAT	BEND
4	14	.375	API 5L GR B 35TH ED 5/85 ASTM A53-84A ASME SA53 GR B 1983	SMLS	L03012	1410	46900	73000	37.00	1 1/2	OK	
4	14	.375	API 5L GR B 35TH ED 5/85 ASTM A53-84A ASME SA53 GR B 1983	SMLS	N25265	1410	48400	74900	37.00	1 1/2	OK	
5	14	.500	API 5L GR B 35TH ED 5/85 ASTM A53-84A ASME SA53 GR B 1983	SMLS	N25284	1880	45200	72300	41.00	1 1/2	OK	

ITEM NO.	HEAT NO.	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	SN	AL	N	V	B	TI	CB	CO
4	L03012	HEAT	22	64	011	012													
4	L03012	PROD	22	63	009	012													
4	N25265	HEAT	24	61	013	012													
4	N25265	PROD	24	64	014	013													
5	N25284	HEAT	24	69	008	012													
5	N25284	PROD	24	69	008	012													

* * * * * * * END OF DATA THIS SHEET * * * * * *

ELDED F   CTION
EFORT C HEMICAL ANALYSIS AND PHYSICAL TESTS

Newport Steel

Oil Country Tubular Goods
Line Pipe - Piling

NEWPORT STEEL CORP. • NINTH & LOWELL STREETS • NEWPORT, KY. 41072
606-292-6000

DATE

CUSTOMER'S PURCHASE ORDER NUMBER: WH022330

MILL ORDER NUMBER: T5374

INVOICE DATE

INVOICE NUMBER

VEHICLE IDENTIFICATION

CERTIFI ION STATEMENT

We hereby certify that the included figures are correct as contained in the records of this company.

SIGNED

SHIP TO

DESCRIPTIONS AND SPECIFICATIONS: API-5L X42

GAUGE AND SIZE: .322" x 8-5/8"

HEAT NUMBER	LOT NUMBER	CHEMICAL ANALYSIS – LADLE CAR.	MAN.	PHOS.	SUL.		CHECK CAR.	MAN	PHOS.	SUL.		PHYSICAL TESTS – TENSILE STRENGTH LBS. PER SQ. INCH	YIELD POINT LBS. PER SQ. INCH	% ELONG. IN 2 INCHES	TEST PRESSURE	FLATTENING TEST
C7030	112189D	.23	.66	.007	.015		.21	.65	.007	.016		66500	47700	39	2350	OK
									Weld	Test		69900				

APPROVED SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.

FEB 7 1991

U.S. ARMY ENGINEER DISTRICT - ST. PAUL

By Mark E. Koenig

SEE ATTACHED COMMENTS

FOS COMPANY BLOOM SAM * SAM 09:57 AM 07.90.98

WELDE[ ] SECTION
REPORT [ ]HEMICAL ANALYSIS AND PHYSICAL TESTS

Newport Steel
Oil Country Tubular Goods
Line Pipe • Piling

NEWPORT STEEL CORP. • NINTH & LOWELL STREETS • NEWPORT, KY. 41072
606-292-6000

CUSTOMER'S PURCHASE ORDER NUMBER: VOCO

MILL ORD. NUMBER: T-8421

INVOICE DATE:

INVOICE NUMBER:

VEHICLE IDENTIFICATION:

CER[ ]ION STATEME[ ]

We h[ ]y certify that the [ ]cluded figures are correct [ ]contained in the records of [ ] company.

SIGNED

APPROVED SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.

FEB 7 1991

U.S. ARMY ENGINEER DISTRICT - ST. PAUL

By Mark E Koenig

SOLD TO

THESE MILL TEST REPORTS APPLY TO:
YOUR P. O. # 2824
INVOICE # 266522

SHIP TO

DESCRIPTIONS AND SPECIFICATIONS: API-5L X42

GAUGE AND SIZE: .280" x 6-5/8"

HEAT NUMBER	LOT NUMBER	CHEMICAL ANALYSIS — LADLE CAR.	LADLE MAN.	LADLE PHOS.	LADLE SUL.		CHECK CAR.	CHECK MAN	CHECK PHOS.	CHECK SUL.		PHYSICAL TESTS — TENSILE STRENGTH LBS. PER SQ. INCH	YIELD POINT LBS. PER SQ. INCH	% ELONG. IN 2 INCHES	TEST PRESSURE	FLATTENING TEST
C3437	414N	.18	.47	.005	.020		.19	.47	.004	.023		72900	57600	33	2660	OK
A5189	"	.20	.50	.006	.020		.21	.48	.005	.021		65600	50000	38	"	"
A5190	"	.20	.40	.004	.016		.20	.41	.004	.018		67800	54800	31	"	"
B2207	"	.18	.52	.004	.023		.19	.51	.005	.025		68600	56600	33	"	"
A5144	416N	.22	.53	.004	.015		.23	.53	.004	.017		70300	54300	33	"	"
C3270	356D	.20	.44	.005	.023		.21	.44	.006	.025		66000	54100	34	"	"
C3271	"	.18	.48	.007	.022		.17	.48	.006	.024		65900	55400	35	"	"

SEE ATTACHED COMMENTS

BRAINARD KILMAN

New from Brainard-Kilman

Centralizers

...ECT TO CORRECTIONS
...TO THE PROVISIONS OF
THE SPECIFICATIONS.
DEC 28 1990
C
U.S. ARMY ENGINEER DISTRICT - ST. PAUL

ALL STAINLESS STEEL!

Brainard-Kilman now has available all-stainless-steel constructed pipe centralizers. This new line of centralizers stabilizes your pipe, eliminating the danger of off-center, wavering well installations.

B-K Centralizers:

- Center pipe, screen, piezometers for all monitoring installations
- Are completely fabricated of high grade stainless spring steel for even the most critical of monitoring installations
- Self-locking nuts for non-slip clamping
- Spot welded for extra strength
- Adapts to fit up to 12" diameter holes
- Available in 2", 3", 4" and 6" sizes

QUANTITY DISCOUNT!

Ordering Information

Part No.	Description
T-2C	Centers 2" pipe, adjusts for up to 12" diameter hole
T-3C	Centers 3" pipe, adjusts for up to 12" diameter hole
T-4C	Centers 4" pipe, adjusts for up to 12" diameter hole
T-6C	Centers 6" pipe, adjusts for up to 12" diameter hole

Prices and Specifications subject to change without notice
Effective June 15, 1987

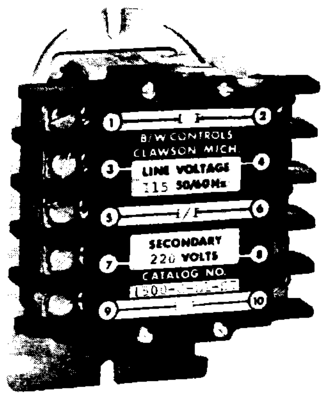
APPROVED SUBJECT TO CORRECTIONS
NOTED & TO THE PROVISIONS OF
THE SPECIFICATIONS.
C
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig
SEE ATTACHED COMMENTS

BRAINARD•KILMAN

P.O. Box 1959, 2175 West Park Court, Stone Mountain, GA 30086, (404)469-2720, 1-800-241-9468, TLX 54-2969

B/W CONTROLS

SERIES 1500
INDUCTION CONTROL RELAYS
SERVICE BULLETIN



PRINCIPLE OF OPERATION

A B|W floatless liquid level control system consists of a relay of the proper type, a holder designed to support one or more electrodes or probes in the liquid container, and the corrosion resistant electrodes themselves. Inasmuch as all B|W induction relays are quite similar — differing only in contact arrangement, the following description of how a 1500-C Relay functions on a pump down control application will serve to explain the design, construction, and operating principles for the entire line.

As shown in diagrams below, the laminated core of the relay is ■ shaped. The primary coil is assembled to the upper bar of the core, and the secondary coil for the electrode is placed on the lower bar. An armature located below the legs of the ■ core is connected to an insulated arm carrying the movable contacts. When the armature is raised, these contacts close or open the motor and electrode circuits, depending upon whether the contacts are normally open or closed. (Contacts shown normally open in this example.)

When a source of alternating current is connected to the primary coil at terminals 3 and 4, the primary coil sets up a magnetic flux which — following the lines of least resistance — circulates through the shortest path. As shown in Figure 1, this is through the lower bar of the laminated core on which the secondary coil is mounted. This magnetic flux induces a voltage in the secondary or electrode circuit coil. No current can flow in this coil, however, until the circuit is completed between the electrodes. **Thus, the electrode circuit voltage being generated within the relay has no connection with the power line.**

The B|W 1500 induction relay utilizes the liquid as an electrical conductor to complete the secondary circuit between the upper and lower electrodes. Thus, when the liquid contacts the upper electrode, the resulting flow of current in this circuit sets up a bucking action in the lower bar of the core. This action tends to divert lines of magnetic force to the core legs and sets up an attraction that pulls the armature into contact with the legs, as shown in Figure 2. This armature movement closes the electrode and load contacts.

The lower contacts on 1500-C Relays (terminals 9 and 10) connect the secondary circuit to ground when liquid contacts the upper electrode and act as a holding circuit to maintain the relay in its closed position until the liquid falls below the lower electrode. This holding circuit provides control of the relay over any desired range in the liquid level, depending on the distance between the upper and lower electrodes.

The flow of current through the low energy secondary circuit is very small and varies with the voltage of the secondary coil. The secondary coil is selected to operate over the resistance of the liquid being controlled. Accordingly, since there is a wide range of secondary coils from which to choose, it is important that complete information regarding the nature of the liquid be furnished when ordering B|W induction relays.

1500-C RELAY USED FOR PUMP DOWN CONTROL

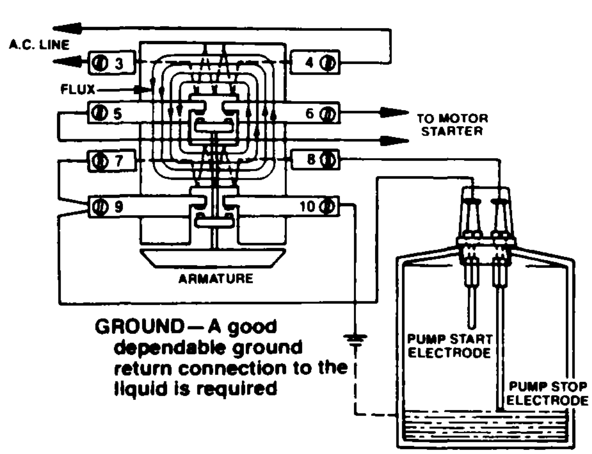


Figure 1—Secondary coil circuit open; armature down.

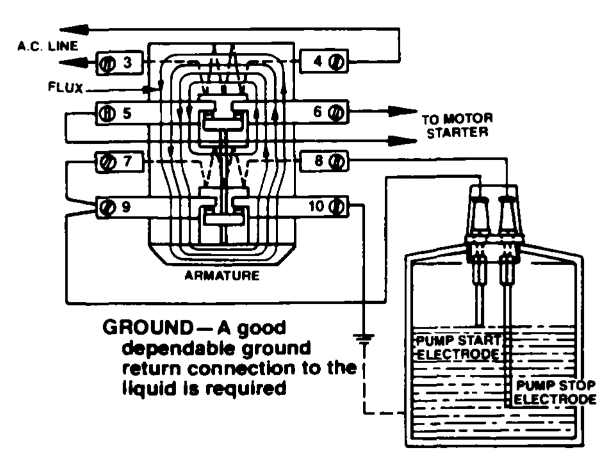


Figure 2—Secondary coil circuit closed; armature up.

Installation I tructions

Reı**ay:** Install relay in level upright position. Connect wires from AC supply to terminals #3 and #4 on relay. Make sure power is of same rated voltage and frequency as shown for connection to primary coil on relay data plate. Relays draw 9 volt amperes.

Electrodes: Install electrodes in tank or well by suspending them vertically from an electrode holder or some other suspending means. One electrode should be set at desired start level and one at desired stop level. For sewage or surface drainage sumps, make sure electrodes are hung far enough apart so that foreign matter floating on water cannot foul electrodes. Size 18 or larger Type TW or THW wire is recommended for connection to the relay.

CAUTION — Although the electrodes are connected to a low energy secondary coil output which has inherently low current, there may be up to 800 volts between the electrodes or from an electrode to ground. (See Secondary Coil Table.) Thus wiring and electrodes should be installed to protect personnel from accidental contact.

Ground: A system ground return circuit is required from the indicated relay terminal to the liquid in order to complete the secondary circuit of relay. *Conduit should not be used.* Instead, connection should be made directly to uninsulated metal tank, or to metal pipe connected to tank below normal low liquid level. In wells, con- ground to pump or metallic water pipe. For ete, wood, or insulated tanks, use an extra common electrode extending slightly below the longest operating electrode.

Secondary Coil: Because the secondary voltage on all BIW relays is an induced voltage generated within the relay itself, the secondary coil should never be connected to any source of power. Voltage of the secondary coil installed on a given relay is determined by conductivity of liquid to be controlled.

Load Connections: BIW relays are two-wire control devices having load contacts rated at 1 hp., single-phase, 115 or 230 volts AC or standard duty pilot rating up to 600 volts AC. In operation, load contacts act as a switch to open or close a circuit. Connecting them to an external load does not introduce a source of alternating current into the circuit.

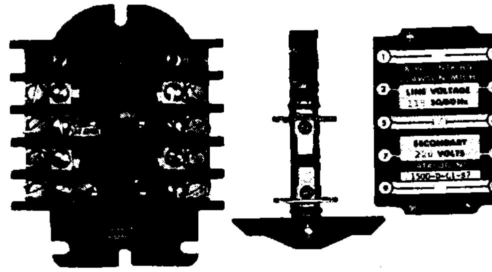
Accordingly, in making connections for direct operation of single-phase loads within rated capacity of relay, power connections must be made as shown in relay wiring diagram.

To operate higher rated single-phase loads or three-phase loads, a magnetic starter must be used. In making connections to motor starter, follow directions given on the starter wiring diagram for connecting two-wire control devices.

DISCOUNT SCHEDULE LL1
Prices Subject to Change without Notice

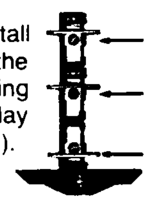
FIELD CONVERTIBLE CONTACTS PROVIDES NEW CIRCUIT VERSATILITY

The all new Series 1500 Induction Relay can have contacts easily added and/or changed from N.O. to N.C. or N.C. to N.O.



Remove cover plate and armature

For a N.O. contact, install the moveable contact in the armature assembly facing toward the top of the relay (away from the armature).



For a N.C. contact, install the moveable contact in the armature assembly facing toward the bottom of the relay (toward the armature).

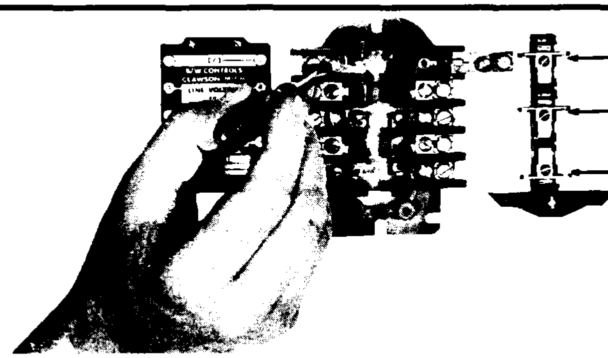
CONTACT KIT PART NO. 15-000001 $13.00 LIST
LESS DISCOUNT SCHEDULE LL

N.O. CONTACT

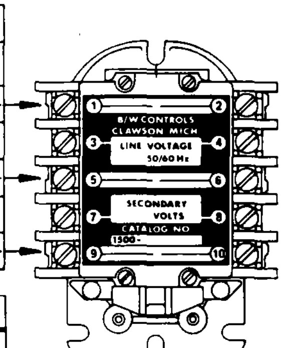
For a N.O. contact, install the stationary contacts facing toward the bottom of the relay (toward the armature).

N.C. CONTACT

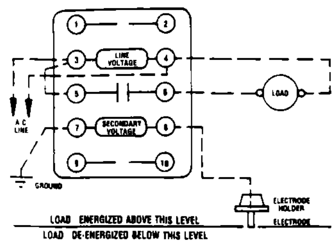
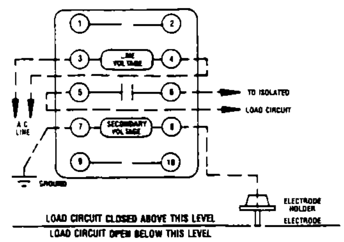
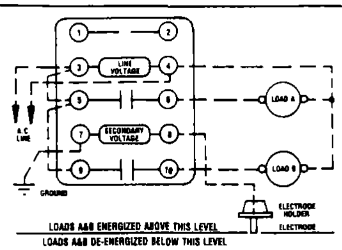
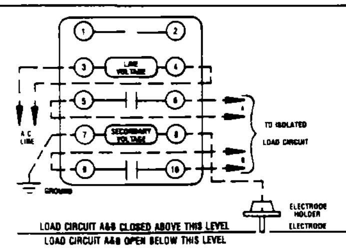
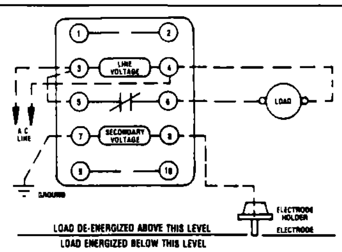
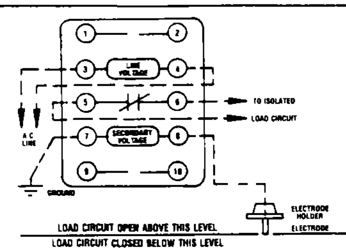
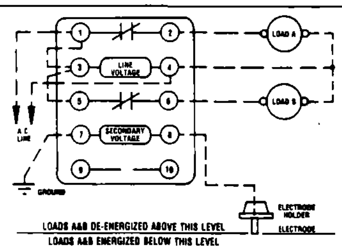
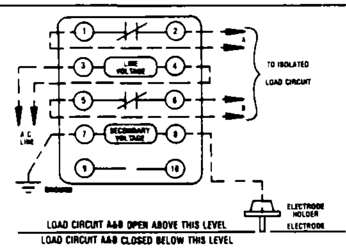
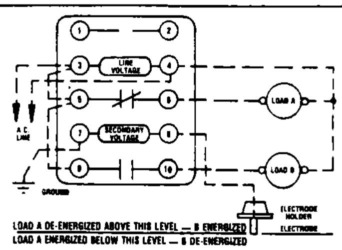
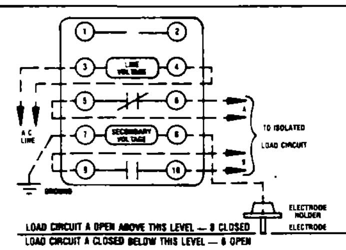
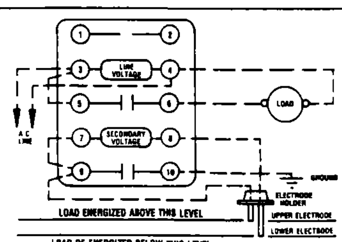
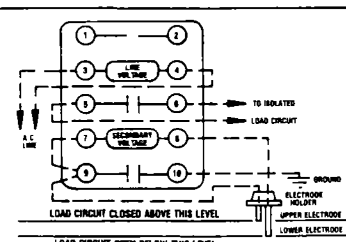
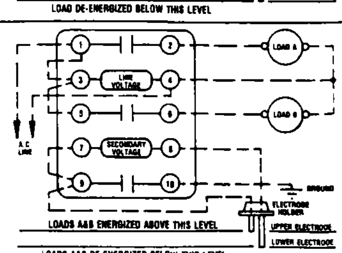
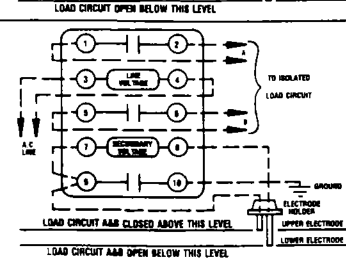
For a N.C. contact, install the stationary contacts facing toward the top of the relay (away from the armature).



	CONTACT ARRANGEMENT CODE								
	A 1 NO	B 1 NC	C 2 NO	D 1 NO 1 NC	E 2 NC	F 3 NO	G 2 NO 1 NC	H 1 NO 2 N.C.	J 3 NC
TOP CONTACT TERMINALS 1 & 2	— —	— —	— —	— —	⊣/⊢	⊣ ⊢	⊣ ⊢	⊣/⊢	⊣/⊢
MIDDLE CONTACT TERMINALS 5 & 6	⊣ ⊢	⊣/⊢	⊣ ⊢	⊣/⊢	⊣/⊢	⊣ ⊢	⊣/⊢	⊣/⊢	⊣/⊢
BOTTOM CONTACT TERMINALS 9 & 10	— —	— —	⊣ ⊢	⊣ ⊢	— —	⊣ ⊢	⊣ ⊢	⊣ ⊢	⊣/⊢

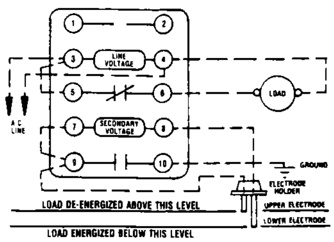
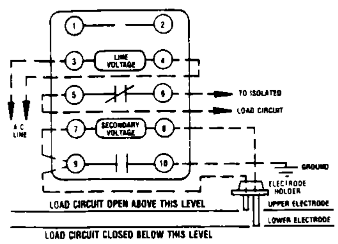
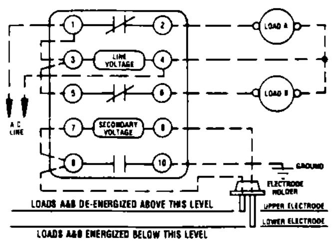
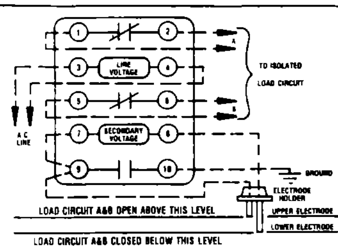
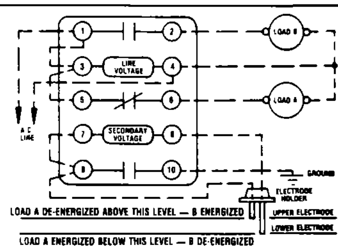
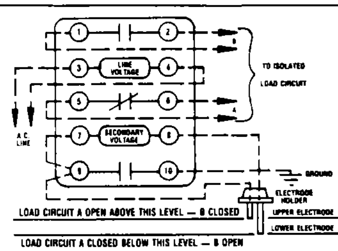


CONTACT RATINGS
25 Amp Resistive at 120, 240, or 480 VAC
1 HP Single Phase at 120 or 240 VAC
Heavy Duty Pilot 120 to 600 VAC
2 Amp Resistive at 120 VDC
10 Amp Resistive at 48 VDC

INDUCTION RELAY CONTACT ARRANGEMENT	WIRING DIAGRAM AND OPERATION — DIRECT OPERATION	WIRING DIAGRAM AND OPERATION — PILOT OPERATION	TYPICAL APPLICATIONS
1500-A RELAY Contact Arrangement Normally Open: 1 · Normally Closed: 0 · Holding Circuit: 0			High Level Signal Control. Low Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Remote, long distance and low voltage manual control applications, etc. (Similar to 1100-L)
1500-C RELAY Contact Arrangement Normally Open: 2 · Normally Closed: 0 · Holding Circuit: 0			Same as 1500-A Relay above except that an additional Normally Open contact is provided to permit simultaneous operation of different types of secondary signal devices in remote locations. (Similar to 1100-2L)
1500-B RELAY Contact Arrangement Normally Open: 0 · Normally Closed: 1 · Holding Circuit: 0			Low Level Signal Control. High Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Remote, long distance and low voltage manual control applications, etc. (Similar to 1100-R)
1500-E RELAY Contact Arrangement Normally Open: 0 · Normally Closed: 2 · Holding Circuit: 0			Same as 1500-B Relay above except that an additional Normally Closed contact is provided to permit simultaneous operation of different types of secondary signal devices in remote locations. (Similar to 1100-2R)
1500-D RELAY Contact Arrangement Normally Open: 1 · Normally Closed: 1 · Holding Circuit: 0			High or Low Level Signal Control. High or Low Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Can also be used to interlock various types of signal devices. (Similar to 1100-D)
1500-C RELAY Contact Arrangement Normally Open: 1 · Normally Closed: 0 · Holding Circuit: 1			Pump Down Control for sewage and sump pumps, condensate return system, etc. Low Level Cutoff for submersible pumps. Normally closed Solenoid Valve Control for discharging liquids from tanks, etc. (Similar to 1100-LH)
1500-F RELAY Contact Arrangement Normally Open: 2 · Normally Closed: 0 · Holding Circuit: 1			Same as 1500-C Relay above except that additional Normally Open contact is provided to permit simultaneous operation of second pump. Extra contact can also be used for signal purposes if desired. (Similar to 1100-2LH)

CAUTION: Electrodes are terminals of live electrical circuits and must be installed to prevent accidental contact by personnel. Control power must be disconnected before servicing.

A good dependable ground return connection to the liquid is required.

INDUCTION RELAY CONTACT ARRANGEMENT	WIRING DIAGRAM AND OPERATION — DIRECT OPERATION	WIRING DIAGRAM AND OPERATION — PILOT OPERATION	TYPICAL APPLICATIONS
1500-D RELAY Contact Arrangement Normally Open: 0 · Normally Closed: 1 · Holding Circuit: 1			Pump Up Control for supply pumps on elevated tanks and towers, carbonators, etc. High Level Cutoff for pumps and valves. Normally closed Solenoid Valve Control for plating tank and boiler make-up, etc. (Similar to 1100-RH)
1500-H RELAY Contact Arrangement Normally Open: 0 · Normally Closed: 2 · Holding Circuit: 1			Same as 1500-D Relay above except that additional Normally Closed contact is provided to permit simultaneous operation of second pump. Extra contact can also be used for signal purposes if desired. (Similar to 1100-2RH)
1500-G RELAY Contact Arrangement Normally Open: 1 · Normally Closed: 1 · Holding Circuit: 1			Pump Up or Pump Down Control for same applications listed above for B\W 1500-C and 1500-D Relays. It is also suitable for use in controlling hydropneumatic tanks and motorized valve installations. (Similar to 1100-DH)

CAUTION: Electrodes are terminals of live electrical circuits and must be installed to prevent accidental contact by personnel. Control power must be disconnected before servicing.

A good dependable ground return connection to the liquid is required.

CATALOG NUMBERING SYSTEM

1500—A—L1—S7

Catalog Section

	CONTACT ARRANGEMENTS NORMALLY OPEN	CLOSED
A	1	0
B	0	1
C	2	0
D	1	1
E	0	2
F	3	0
G	2	1
H	1	2
J	0	3

	LINE VOLTAGE
L1	110-120 Volts 50/60 HZ
L2	208-240 Volts 50/60 HZ
L3	440-480 Volts 50/60 HZ
L4	550-600 Volts 50/60 HZ

Consult Factory For Special Line Voltages Not Listed.

All contacts rated at:
25 Amp Resistive at 120, 240, or 480 VAC
1 HP Single Phase at 120 or 240 VAC
Heavy Duty Pilot 120 to 600 VAC
2 Amp Resistive at 120 VDC
10 Amp Resistive at 48 VDC

	SECONDARY COIL VOLTAGE	TYPICAL LIQUIDS
S1	12 Volts A.C.	Metallic circuits
S2	24 Volts A.C.	Metallic circuits
S3	40 Volts A.C.	Acid or caustic solutions: Milk; Brine and salt solutions; Plating solutions; Buttermilk; Soups.
S4	90 Volts A.C.	Weak acid or caustic solutions: Beer; Baby foods; Fruit juices.
S7	220 Volts A.C.	Sewage; Most water-except very soft; Pottery slip; Water soluble oil solutions; Starch solutions.
S8	360 Volts A.C.	Very soft water; Sugar syrup.
S9	480 Volts A.C.	Steam condensate; Strong alcohol solutions.
S11	800 Volts A.C.	Demineralized or distilled water.
S1Z	12 Volts A.C.	17 Volt D.C. Sensing Circuit
S2Z	24 Volts A.C.	34 Volt D.C. Sensing Circuit
S3Z	40 Volts A.C.	56 Volt D.C. Sensing Circuit

Service Instructions

B|W relays are designed and built to require a minimum of service in the field. Each one is tested and adjusted at the factory to insure positive operation and should not be altered or tampered with prior to installation. If a relay does not operate properly after it has been installed, the following information will be helpful in determining the probable cause.

A RELAY WILL NOT PULL IN

If relay will not pull in when liquid contacts upper electrode, failure to operate is probably caused by one of the following conditions:

1. Power Failure — A power failure to relay can be caused by broken wire, blown fuse, an open switch, loose screw, corroded connection, etc. Check for power failure with voltmeter or test light directly on relay line terminals (No. 3 and 4 on all B|W relays). Also check voltage at motor starter line terminals and overload heaters on motor starter to be sure they have not tripped.

2. Open Coils — Coils used in B|W relays very rarely fail unless struck by lightning or subjected to some severe over-voltage condition. To check coils, disconnect electrode connections from relay terminals, apply line voltage to the primary coil, and touch both ends of secondary coil with an insulated jumper wire. Relay should pull in when the jumper is connected and fall out when jumper is removed. Failure to do so indicates that one of the coils is open. If an open coil is found, contact dealer or the factory for a replacement relay.

3. Poor Ground Connections — B|W induction relays that operate from a single electrode — i.e., Types 1500-A, C, B, E and D — will not function unless a good dependable ground connection is made to complete the secondary circuit from one end of the secondary coil through the electrode and liquid, and back through ground to the other side of the secondary coil. If such a relay does not operate when liquid contacts the electrode, check ground connection to be sure it complies with Installation Instructions.

4. Broken Wires — A broken wire from relay to either electrode will prevent relay from operating. Broken wires can be checked by shorting the upper and lower electrode leads together at the electrode holder. If relay fails to pull in, one or both of the electrode leads is open. The individual leads can then be checked by running a temporary wire from the relay to holder outside conduit. If relay pulls in, it may be assumed that break is between the holder and the electrodes. This can be checked by shorting between the electrode tips with an insulated jumper.

5. Low Secondary Voltage — If the secondary coil voltage is too low for the resistance or conductivity of the liquid being controlled, the relay will not pull in — or it will buzz and chatter before pulling in. In either case, the relay should be replaced with one which has a higher voltage secondary coil. (See Table.) If in doubt about proper coil selection, furnish factory with details on liquid — or send sample for test.

6. Fouled Electrodes — Accumulation of dirt, grease or other deposits on the upper electrode will insulate it and prevent relay from pulling in. If this occurs, the electrodes should be inspected and cleaned at regular intervals as required to eliminate the difficulty. If unusual quantities of oil, grease, or sludge are encountered, the electrodes can be mounted inside a pipe that is flushed with clean water. A 4" pipe should be used — with the bottom located below the lowest water level, and vent holes provided at top so that the level inside and outside the pipe will be the same. A small flow of water entering the top of the pipe will cause an outward flow of water from the bottom of the pipe and prevent undesirable material from entering. Thus, the electrodes have a clear surface on which to operate and will stay clean.

7. Electrodes Too Short — It is possible for an installation to be completed in which the upper electrode is suspended at a point where the liquid cannot make contact. All installations should, of course, be checked to make sure that proper electrode lengths are provided.

B NOISY RELAY OPERATION

If the relay functions properly but is noisy in operation, it could be caused by the following:

1. Poor Electrode Connections — If wire suspended electrodes are used — and have either been lost or not properly connected — resultant increase in resistance is secondary circuit may cause relay to buzz or chatter in operation. This condition can be corrected by checking to see that proper electrode connections are made. Excessive accumulation of dirt, grease or other deposits on the electrodes can also result in noisy relay operation — in which case periodic cleaning will eliminate the problem.

2. Low Secondary Voltage — If resistance of the liquid being controlled is at the upper end of the sensitivity range of the relay secondary coil, noisy operation may result. Sensitivity may be increased slightly by interchanging the ground and lower electrode connections at the relay. If this does not correct the condition, the relay should be replaced with one having a higher voltage secondary coil.

C ONE LEVEL OPERATION

If a relay operates at one level only — starting and stopping at one electrode, check following:

1. Electrode Wires — If wires between relay and electrodes are interchanged, relay will not operate over range in level but from upper electrode only. To correct, simply reverse connections — either at relay or at electrodes.

2. Ground Connection — Poor ground connection will prevent holding circuit from functioning and cause relay to operate from the upper electrode only. This can be easily corrected by making sure that ground connections conform with Installation Instructions.

3. Holding Circuit — If the holding circuit is not closing, the relay will operate from the upper electrode only. Since the holding circuit contact carries only a small current, a slight film of grease or dirt can sometimes prevent proper closure. To correct, rub contact surface with a clean paper. Do not use sand paper or emery cloth.

4. Upper Electrode Lead — A ground in lead wire to the upper electrode will cause relay to operate from lower electrode only. This condition can be checked out as described below.

D RELAY WILL NOT DROP OUT

If relay will not drop out when liquid falls below lower electrode, check the following points:

1. Lower Electrode Lead — A ground in the lead wire from relay to lower electrode will prevent relay from dropping out on low liquid level. If distance from holder to relay is relatively short, the best way to check for a ground is to connect a replacement wire from relay to the electrode holder outside the conduit and test the relay for operation. If it drops out properly it is safe to assume that a ground exists in the original lower electrode lead wire.

If relay is located a considerable distance from electrode holder, check for ground as follows: Disconnect power to relay. Remove wires from terminals in electrode holder and allow them to stick up to eliminate possibility of contacting a grounded part. Then turn on power to relay. If relay pulls in, a short is indicated between the electrode leads, from both electrodes to ground, or secondary coil is shorted internally. If relay does not pull in, short secondary coil with piece of insulated wire by bridging between relay terminal connections for upper and lower electrodes. Relay should pull in when this connection is made and drop out when connection is broken. If relay does not drop out, a short to ground is indicated in lower electrode lead. This ground may not be enough to pull in relay, but it can be sufficient to hold relay in once it has been closed in normal operation.

If any of these conditions exist, disconnect power to relay and replace grounded wires.

2. Electrode Holder — Excessive dirt or moisture over insulation at electrode holder or electrodes can cause faulty relay operation. Interior of electrode holder and its underside should be kept clean and dry. Conduit connections should be made so that no condensation can enter holder. Underside of vertically mounted holders should never come in contact with the liquid. Insulated rod electrodes should be used with horizontally mounted holders.

Electrodes should be kept relatively clean and free of dirt or grease. Check them periodically to make sure they do not become fouled with floating debris or insulating deposits.

3. Length of Lead Wires — On installations with excessive distance — over 900 feet — between relay and tank, relay may tend to hold in due to capacitance in electrode lines and fail to drop out when liquid leaves lower electrode. Since there are a number of ways to achieve reliable long distance control, complete information regarding such applications should be submitted to factory for recommendations.

CAUTION

Be sure to disconnect relay control power before servicing electrodes or electrode holders.

SERIES 1500
INDUCTION CONTROL RELAYS
SERVICE BULLETIN

CONDUCTIVE LIQUIDS

With the exception of products such as oil, gasoline, animal fats and other similar products, most liquids and some moist bulk materials have sufficient conductivity to use BIW level detecting relays. The Series 1500 relay can be used on liquids with resistance up to about 90,000 ohm-cm (conductivity to 11 micromho/cm). For liquids with higher resistance the BIW Series 52 relay described in Catalog Section 5200 must be used for applications up to 12 megohms resistance. The vapor above some liquids is considered an explosive hazard and in these cases the BIW Series 53 relay with FM approved intrinsically safe sensing circuit should be used. See Catalog Section 5300.

Liquids such as milk and beer, and some pharmaceutical products will foam during processing. The liquid phase is always a better conductor than the foam, and when the interface level is to be detected, the relay sensitivity must be carefully selected and it would be well to check the factory for our recommendation.

With nearly 50 years of experience BIW has compiled a history of applications in most major industries around the world. If you have questions regarding the proper relay selection, write us, phone us, or send a sample for test. Chances are that we have the answer for you.

TYPICAL LIQUIDS

The following recommendations are satisfactory for general use, but because the conductivity of liquids varies greatly with concentration, purity, temperature and other factors, some applications may require a different selection.

A number of the products listed are produced as solids such as crystals or powders, and our relay selection is based on the normally used commercial solutions of these materials.

Liquid Description	Secondary Coil
Acetic Acid — Up to 75%	90 Volt
— 75 to 90%	220 Volt
— Glacial	Use 5200-H Relay
Acetone	Use 5200-H or 5300 Relay
Acids — General	40 or 90 Volt
— Anhydrous	Use 5200-H Relay
Alcohols	Use 5200-H or 5300 Relay
Alkalies — General	40 or 90 Volt
— Anhydrous	Use 5200-H Relay
Alum Solutions	220 Volt
Aluminum Sulphate	90 Volt
Aluminum Hydroxide	90 Volt
Amino Acids	90 Volt
Ammonia-Anhydrous Liquid	Use 5200-H Relay
Ammonium Chloride	40 Volt
Ammonium Hydroxide (Ammonia)	220 Volt
Ammonium Nitrate	Use 5300 Relay
Ammonium Sulphate	220 Volt
Baby Foods	90 Volt
Barium Chloride	40 Volt
Barium Nitrate	40 Volt
Beer	90 Volt
Black Liquor	40 Volt
Blood	220 Volt
Borax — Up to 10%	220 Volt
— Greater than 10%	90 Volt
Boric Acid	220 Volt
Bread Dough	90 Volt
Buttermilk	24 or 40 Volt
Cadmium Chloride	40 Volt
Cake Batter	220 Volt
Calcium Chloride	40 Volt
Calcium Hydroxide	220 Volt
Carbolic Acid — Up to 90%	220 Volt
— 90 to 100%	Use 5200-H Relay
Catsup	90 Volt
Caustic Soda (Sodium Hydroxide)	40 Volt
Cement Slurry	220 Volt
Chromic Acid	40 Volt
Citric Acid	40 or 90 Volt
Coffee	90 Volt
Condensate — Ordinary Water	480 Volt
— D.I. Water	Use 5200-H Relay
Corn Syrup	480 Volt
Corn — Cream Style	90 Volt
Ethylene Glycol	Use 5200-H Relay
Ferric Chloride	90 or 220 Volt
Ferrous Sulphate	220 Volt

Liquid Description	Secondary Coil
Formaldehyde	Use 5200-H Relay
Formic Acid — Up to 75%	90 Volt
— 75 to 90%	220 Volt
Glycerine (Glycerol)	Use 5200-H Relay
Hydrochloric Acid	40 Volt
Hydrofluoric Acid — Up to 20%	220 Volt
— Above 20%	40 Volt
Hydrofluorsilicic Acid	90 Volt
Hydrogen Peroxide	Use 5200-H or 5300 Relay
Jams & Jellies	360 Volt
Juices — Fruit & Vegetable	40 or 90 Volt
Lemon Oil Essence	Use 5200-H Relay
Lignite	800 Volt
Lithium Chloride	40 Volt
Magnesium Hydroxide	90 Volt
Mayonnaise	220 Volt
Methanol	Use 5200-H or 5300 Relay
Methyl Ethyl Keystone (MEK)	Use 5200-H Relay
Milk	40 Volt
Molasses	220 Volt
Muriatic Acid	40 Volt
Mustard	40 Volt
Nitric Acid	40 or 90 Volt
Orange Juice	90 Volt
Paper Stock	220 Volt
Penicillin	220 Volt
Phosphoric Acid	40 Volt
Plating Solutions	40 or 90 Volt
Salts — Chemical	40 or 90 Volt
Sodium Carbonate (Soda Ash)	90 Volt
Sodium Chloride (Table Salt)	40 Volt
Sodium Hydroxide (Caustic Soda)	40 Volt
Sodium Hypochlorate	40 Volt
Sodium Silicate (Water Glass)	90 Volt
Soups	40 Volt
Starch Solutions	220 Volt
Sugar — Low Concentrations	220 Volt
High Concentrations	360 Volt
Sulphuric Acid	40 Volt
Vinegar	90 Volt
Water — Sea	40 Volt
— Ordinary Potable	220 Volt
— Ordinary Soft	360 Volt
— Ordinary Condensate	480 Volt
— Purified Distilled	800 Volt or 5200-H Relay
— Purified Deionized	Use 5200-H Relay
Zinc Chloride	40 Volt

1080 N. Crooks Road, Clawson, MI 48017-1097
Phone: 810 435-0700 Fax: 810 435-8120
For Sales & Technical Assistance Call 800 814-1578
A Product of PATRIOT Sensors & Controls Corporation
FORM 511
11/94 10M

CARBONAIR

OPERATION AND MAINTENANCE MANUAL
CARBONAIR MODEL AS-250
PROCESS AIR HEATER
GPC-70 CARBON ADSORBER

NIROP II

09-11-92

CARBONAIR SERVICES, INC.
PROJECT NUMBER 301960

CARBONAIR

CONTENTS

CARBONAIR

CARBONAIR PHONE LIST

Carbonair main number: (612) 425-2992
Carbonair fax number: (612) 425-6882

Contacts:

Kelly Barnes
Project Manager

Roger Benson
Operations Manager

Rick Kolbow
Regional Sales Manager

On-site system autodialer/system update: (612) 572-2440

CARBONAIR

SYSTEM DESCRIPTION

Carbonair Services, Inc. has provided a water treatment system in the form of a packed column airstripper for the removal of volatile organic components (VOCs) contained in groundwater. To treat the discharge air from the airstripper, Carbonair has provided a process air heater to reduce the relative humidity of the airstream and a gas phase granular activated carbon adsorption vessel for removal of VOCs in the airstream. The system has automatic operating capabilities and is housed in an insulated steel building, also provided by Carbonair.

Forced Draft Airstripping Tower

Design of this system utilizes the volatile characteristics of the various VOCs present in the water being treated. A mass transfer of VOCs occurs, where the VOCs are transferred from the water to the airstream.

To facilitate this removal, Carbonair Services has provided a forced draft airstripping column. The column is manufactured of Fiberglass Reinforced Plastic (FRP) supported by a steel sump base, is 48 inches in diameter and utilizes 20 feet of packing height.

Contaminated water is pumped to the top of the airstripping column and is dispersed over the full diameter of the tower through the use of a hub and lateral inlet distributor assembly. The water flows downward by gravity through a packing media consisting of many spherical complex polypropylene "balls" forming a thin film on the surface of the media which allows a maximum amount of surface area for mass transfer to occur.

Outside ambient air is forced into the base of the tower through the use of a centrifugal industrial blower. Air from the blower is forced upward (countercurrent to the water flow) through the tower packing and exits through the top of the tower via FRP ducting. The blower is capable of producing the necessary air flow for the optimum air-to-water ratio for the removal of VOCs from the water. The blower has been sized to accommodate the pressure drop that it may experience in the tower, ducting and carbon adsorber. The blower drive sheaves may be adjusted and in conjunction with ducting damper settings can produce up to 3600 CFM should future demand call for increased water flow rates.

(continued)

As the water and air pass each other in opposing flows, a "mass transfer" occurs and the VOCs are entrained in and carried off by the airstream. The water, having been stripped of VOCs collects in the steel sump base and exits the airstripper through a gravity drain piping system. This system maintains a constant water level in the sump, which prevents the pressurized air from escaping through the sump drain.

Process Air Heater

The VOC-laden forced airstream exiting the tower travels downward through FRP ducting and is routed through a process air heater inserted in the ducting. The heater is electrically powered and controlled by an automatic thermostat. The heater has multiple tubular heating elements and has been designed to accommodate air flows of up to 3600 CFM for future use.

The air enters the heater at approximately 50 degrees F. (groundwater temp.) and exits at approximately 90 degrees F. By raising the temperature of the airstream, the relative humidity of the airstream is lowered by about 50%. The lowered humidity permits more efficient transfer of the VOCs from the airstream to the granular activated carbon (GAC) in the adsorption vessel.

GAC Adsorption Vessel

For treatment of the VOC-laden airstream, a GAC vessel is provided. The box-type vessel is rectangular in shape and is designed to hold 10,000 LBS of GAC. The vessel is constructed of steel and coated with an epoxy coating inside an a polyurethane coating outside. The GAC vessel has a lower air inlet chamber and an upper chamber containing the GAC with the discharge chamber. The chambers are separated by a stainless steel screen supported by a FRP grid. This screen/grid assembly also supports the carbon.

The VOC-laden forced airstream exiting the process air heater travels through FRP ducting headers and enters the lower air inlet chamber of the GAC vessel through six inlets. This air is evenly dispersed throughout the lower air chamber due to a slight back pressure caused by the restriction of air flow through the carbon bed. The forced air then flows upward through the carbon bed and exits the vessel (to atmosphere) through two weatherproof FRP discharge stacks which pass through the roof of the steel building.

(continued)

CARBONAIR

VOCs are removed from the airstream through a process called adsorption. Adsorption is a physical process whereby the VOCs adhere to the surface of the carbon granules. Carbon granules are highly porous and yield a very large surface area, which gives the carbon adsorption system a substantial capacity for removing VOCs from the air. The GAC vessel facilitates adsorption by allowing the airstream to come in contact with the carbon bed, where mass transfer of the VOCs from the air to the carbon occurs.

Eventually the carbon bed will reach full capacity to adsorb VOCs and will no longer be able to adsorb the most volatile components. This condition is called "breakthrough" and signals the end of the useful life of the carbon bed. Breakthrough is normally determined by periodically sampling the GAC vessel air discharge and sampling it for VOC concentration levels. Carbon that has seen breakthrough is said to be "spent".

Upon breakthrough, the spent carbon must be removed from the system and properly disposed of. To keep down-time at minimum, Carbonair has supplied a second GAC vessel (with carbon) which can be readied on short notice. These vessels are designed to be easily interchanged. The spent GAC vessel will be disconnected and removed from the system, and will then serve as shipping container for the spent carbon. The second GAC vessel containing fresh carbon will then be inserted and connected to the system, and the system re-started. Spent carbon will be sent to a licensed reactivation facility where it will be thermally reactivated, thereby destroying the VOCs.

System Description Electrical

The control panel for the Nirop II system is designed to be a complete and versatile controller. All panel wires and components are numbered and referenced to drawing #120871. The panel will allow the system to operate automatically without supervision.

The Process Air Heater has a separate main disconnect near the control panel, and has a dedicated control panel attached to the heater.

The system is monitored by an automatic device that will phone key personnel should there be an alarm status within the system.

(continued)

CARBONAIR

Control Panel

Pressure gauge:	A magnehelic gauge is provided to monitor air pressure in the sump base. Periodic reading of this gauge will give an indication of air flow and degree of packing fouling.
Pressure Switch:	A pressure differential switch is mounted in the control panel and monitors air pressure in the sump base. If the blower is shut off or fails, the pressure switch will signal an alarm condition, shutting off the well pumps and lighting alarm lights. The alarm condition also causes the Autodialer to call out to the pre-programmed numbers.
Motor Starter: Protection	All motor starters have motor starter protection units (MSP's).
Main Disconnect:	A main disconnect is provided
Terminal Strip:	A horizontal terminal strip has been provided at the bottom of the control panel.
Box:	The control box will have a dead front door and be NEMA 3R rated.

CARBONAIR

DESIGN CRITERIA SUMMARY

AS 250:

A. Mass Transfer Zone

1. 20' Packed height
2. 48" Tower diameter
3. 12.57 square feet cross-sectional area
4. 251 cubic feet Packing volume

B. Liquid Flow

1. 400-900 GPM

C. Gas Flow

1. Counter-current to liquid flow
2. Forced draft
3. 400-3600 CFM

D. Blower

1. 10 HP, 460v, 3 phase power
2. 400-3600 CFM, adjustable

PROCESS AIR HEATER:

1. 40 degree temp. increase (50 to 90 degrees F.)
2. 460v, 3 phase power
3. 6KW (400 CFM) or 52KW (3600 CFM)
4. Thermostatic control

GPC-70 CARBON ADSORBER:

A. Mass Transfer Zone

1. 5'-0" carbon bed depth
2. 15'-6" x 4'-6" bed area
3. 370.5 cubic feet carbon
4. Up to 10,000 LBS carbon

B. Air Flow

1. 400-3600 CFM
2. Forced Draft, upward

CARBONAIR

MECHANICAL EQUIPMENT LIST

A. Airstripping Column

1. Tower of UV resistant fiberglass reinforced plastic, with antique brown gel coat and a carbon steel sump with Carbonair specified epoxy paint.

2. Tower Dimensions

   a. 48" Diameter
   b. 34' Overall height
   c. 96" Sump section height
   d. 20' Packing zone

3. Access

   a. 18" Diameter Manways (6)

4. Piping Connections

   a. 1 - 6" Flange, outlet drain
   b. 1 - 2" Male Quick Connect, acid recirc outlet
   c. 1 - 3/4" Valve drain
   d. 1 - 3" Flange, Tower Inlet (demister section)
   e. 1 - 2" Female Quick Connect, acid recirc inlet
   f. 1 - 1/4" Effluent sample tap

5. Packing Support System

   a. 48" diameter grating
   b. FRP construction

6. Inlet Distributor Assembly

   a. Hub and Lateral distributor
   b. PVC construction

7. Offgas Ducting

   a. 12" diameter FRP
   b. Spiral wire reinforced vinyl flex joints
   c. Stainless steel clamps
   d. 12" flanged wafer type damper valve
   e. Two 3/4" access ports
   f. Ashcroft bimetal dial thermometer

(continued)

CARBONAIR

B. Column Packing

1. Jaeger Tri-Packs
   a. 2" Diameter
   b. Polypropylene
   c. 20' Depth total
   d. 251 cubic feet packing volume

C. Blower Assembly

a. New York Blower #194-GI-20
b. Belt Drive, adjustable
c. 10 HP, 460 VAC, 3 Phase, TEFC motor
d. Outlet damper
e. Quick Access port
f. Inlet duct with pitot tube & gauges

D. Level Control

a. Gems model
b. Buna N Float and Brass Shaft
c. 4" Operation

E. Control Package

a. Hoffman Nema 3R control box
b. Dead front door
c. 460 VAC 3 Phase with 120 VAC control voltage
d. 60 Amp control panel main disconnect
e. Terminal strip
f. Auxiliary Contacts
g. Manual/Off/Auto Blower switch
h. Process Heater enable switch
i. Heater High/Low switch (keyed)
j. Blower and Process Heater run lights
k. Blower low pressure alarm light
l. Sump high level alarm light
m. Outside red alarm light
n. Autodialer monitor system
o. 30 Amp Process Heater main disconnect
p. Blower pressure gauge & switch
q. Heat tape on inlet riser pipe

(continued)

MECHANICAL EQUIPMENT LIST / PAGE 3

F. Process Air Heater

a. Caloritech #DDFT18x18-52
b. 36 Tubular elements
c. 6KW/52KW Dual range
d. NEMA 4 Control box
e. Built-in high limit control
f. 0-100 degree F. thermostat
g. 460v, 3 phase power
h. Fused contactors

G. Steel Building

a. Tubular steel frame
b. Interior insulation
c. Automatic interior heater
d. 36" steel walk-through door
e. 8'-0" x 8'-0" steel roll-up door
f. Rain gutters with downspouts
g. Steel roll-off guide rails for carbon vessel
h. 3 Fluorescent lighting fixtures

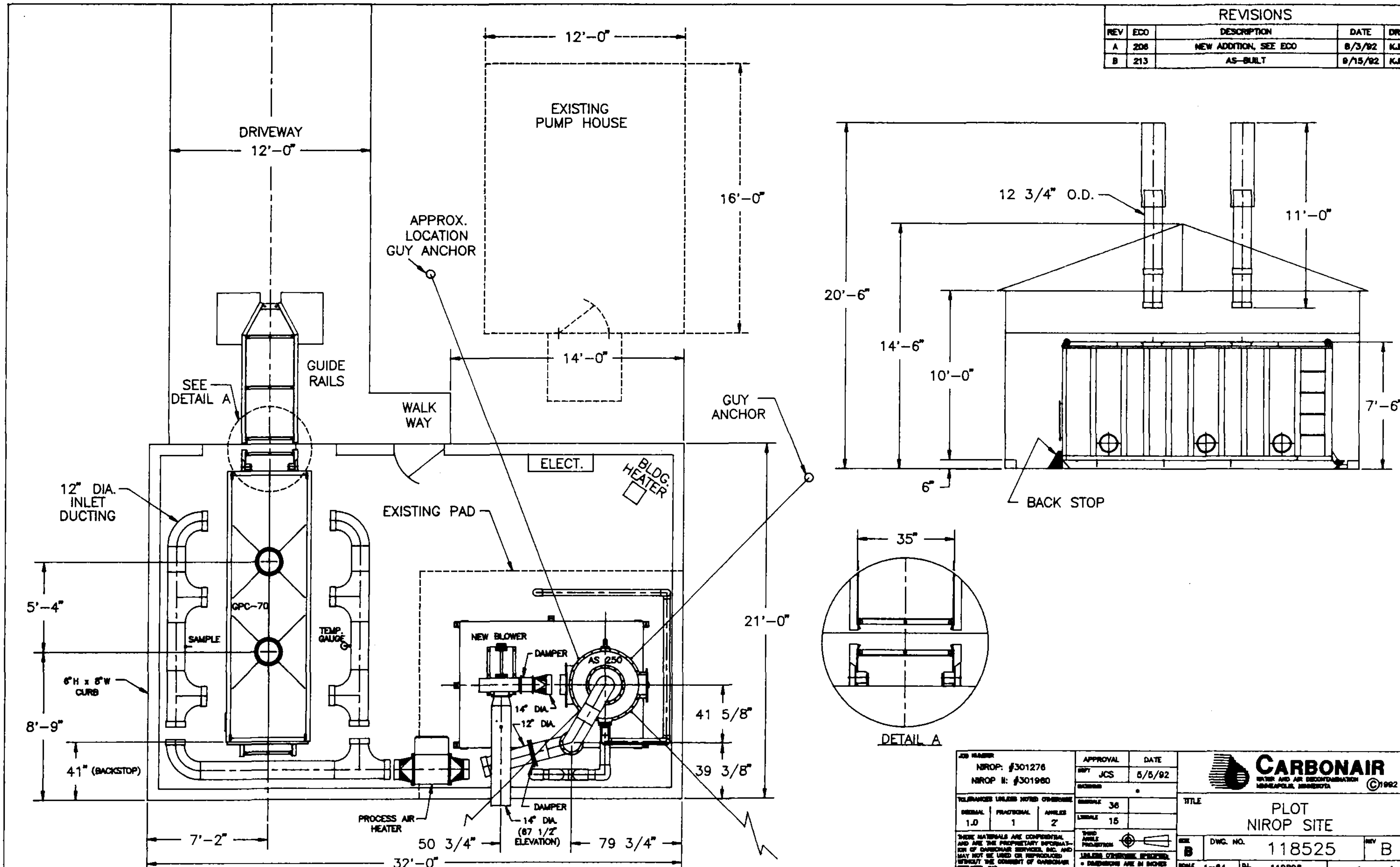
H. GPC-70 Carbon Adsorber

a. All steel construction
b. Epoxy interior coating
c. Polyurethane exterior coating
d. Six 16" inlets, 12" dia. inlet ducting
e. Two 20" outlet ports, 12" dia. discharge stacks
f. Stainless steel screen
g. FRP screen support grid
h. 2'-0" x 5'-0" access panel
i. 3/4" inlet and discharge chamber sample ports
j. Roll-off skid
k. Inlet and discharge port shipping covers
l. 16'-8" x 5'-0" x 7'-6" overall dimensions
m. 19,000 LBS operating weight, max total
n. Four lifting eyes
o. One 1" floor drain
p. Two ladders, integral
q. 370.5 cubic feet carbon capacity
r. 10,000 LBS 4 x 10 reactivated carbon

CARBONAIR

EQUIPMENT SPECIFICATION SHEETS

REVISIONS				
REV	ECO	DESCRIPTION	DATE	DRN
A	206	NEW ADDITION, SEE ECO	8/3/92	KJB
B	213	AS-BUILT	9/15/92	KJB



JOB NUMBER	APPROVAL	DATE
NIROP: #301276 NIROP II: #301960	DRFT JCS	5/5/92

TOLERANCES UNLESS NOTED OTHERWISE: DECIMAL 1.0 · FRACTIONAL 1 · ANGLES 2°

THESE MATERIALS ARE CONFIDENTIAL AND ARE THE PROPRIETARY INFORMATION OF CARBONAIR SERVICES, INC. AND MAY NOT BE USED OR REPRODUCED WITHOUT THE CONSENT OF CARBONAIR SERVICES, INC.

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES
- DO NOT SCALE DRAWING

CARBONAIR
WATER AND AIR DECONTAMINATION
MINNEAPOLIS, MINNESOTA
©1992

TITLE: PLOT
NIROP SITE

SIZE B · DWG. NO. 118525 · REV B

SCALE 1=64 · D.L. 119898 · SHEET 1 OF 1

CARBONAIR Water Treatment

AS 250 Packed Column Airstripper

The AS 250 Packed Column Airstripper by Carbonair offers the highest performance available in a maximum-flow airstripper. Skid-mounting of the AS 250 enables the unit to be wired and plumbed before shipment, requiring only electrical and influent/effluent connections for quick mobilization and installation. Carbonair's unique skid-mounted design together with the exceptionally durable FRP and welded-steel construction make the AS 250 suitable for all emergency response remediations, pilot tests and full-scale treatment systems.

Carbonair packed column airstrippers are available with a variety of options according to purchaser's specifications.

OPTIONS

Optional materials of construction.

Guy wire kit.

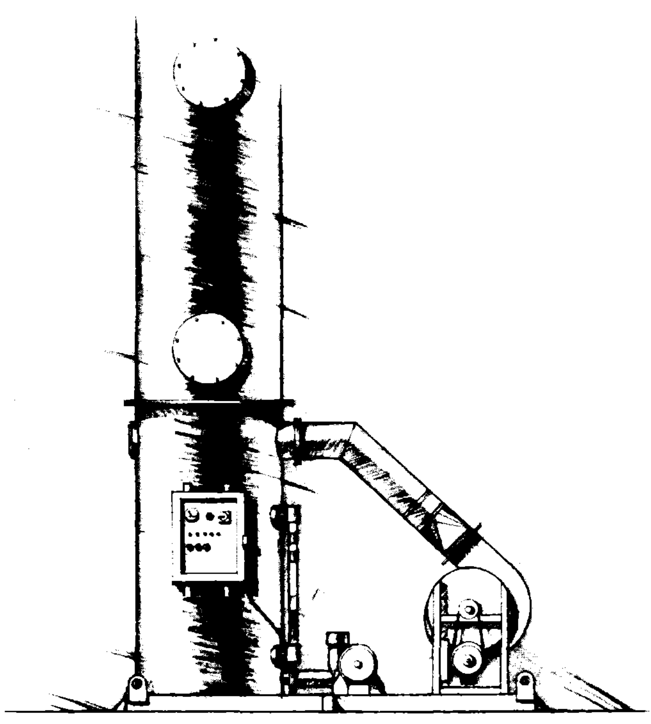
Additional 10-ft. packing sections.

Discharge pump, level controls, control panel.

Air-flow dampers.

Optional blowers.

Off-gas treatment ducting kit.



FEATURES

Skid-mounted design enables quick field mobilization and installation.

Epoxy-coated carbon steel sump and skid provide superior strength and high chemical resistance. Coating conforms to AWWA D 102 Inside System No. 1 and AWWA C 210-84 for immersion service, and has been tested and approved in accordance with FDA Regulations, Title 21, Section 175,300. It also meets U.S. EPA regulations for VOCs, as well as the abrasion resistance criteria established by ASTM D 4060.

Corrosion-resistant FRP and PVC internals provide exceptional durability.

15 horse-power blower ensures optimal air-to-water ratios at maximum liquid loadings.

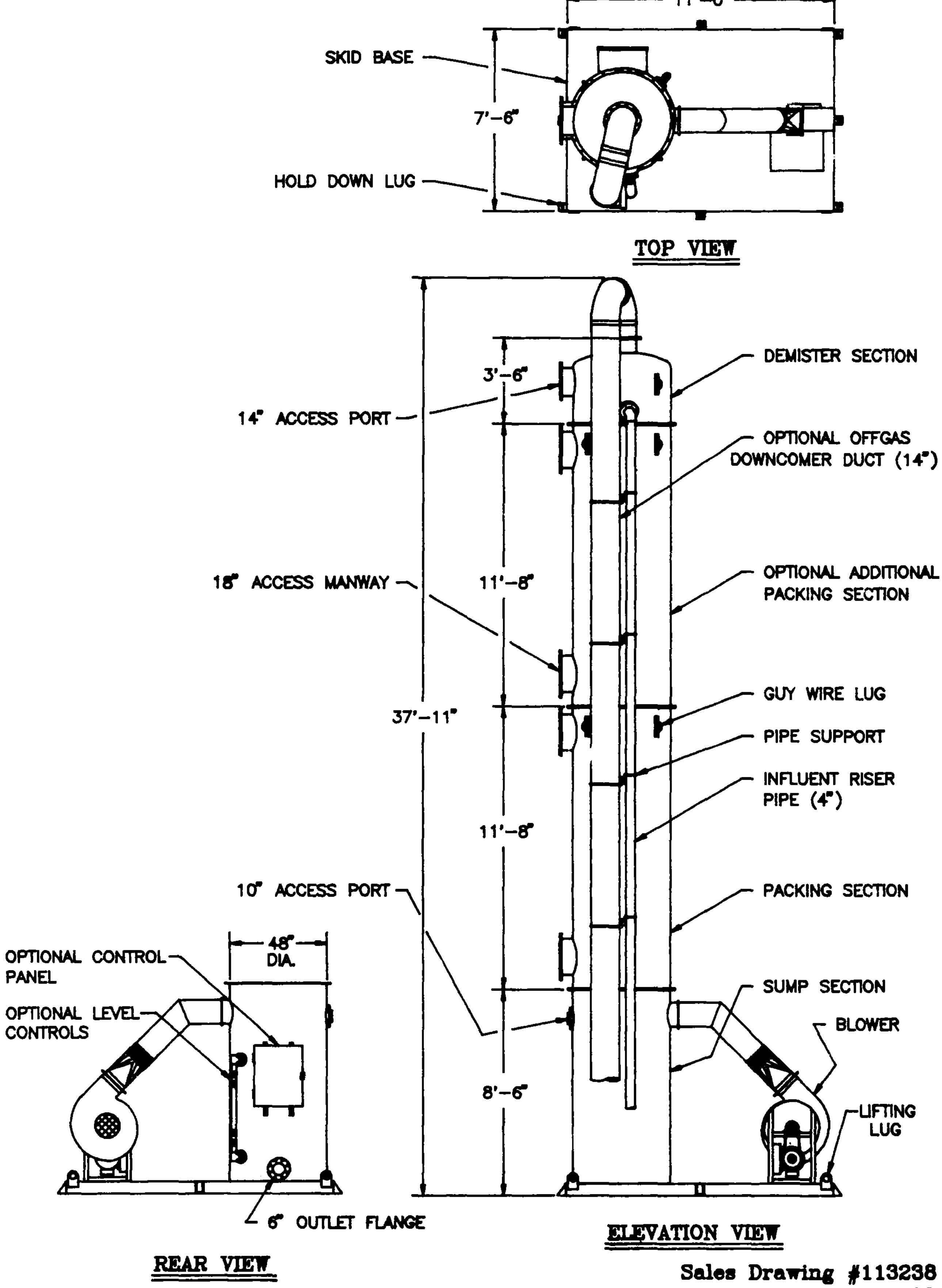
Large access ports make packing exchanges and internal maintenance quick and easy.

3½-inch polypropylene Jaeger Tri-pack tower packing ensures optimum performance.

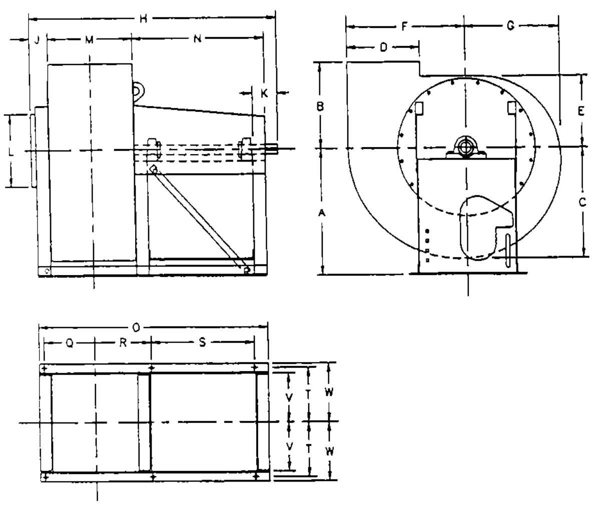
SPECIFICATIONS

DIMENSIONS	4 ft. diameter x 22 ft. 4 in. overall height (1.2 m x 6.9 m)
LIQUID FLOW	25-875 gpm (95-3,325 L/min)
AIR FLOW	7,900 cfm maximum (237 m^3/min)
FITTINGS	See drawing #113238
BLOWER	15 h.p., 240/480v, 3-phase, ODP
PACKING VOLUME	113 $ft.^3$ 3½-in. Jaeger Tri-pack per section (3.4 m^3)
EMPTY WEIGHT	3,835 lbs. (1,725 kg)
OPERATING WEIGHT	12,000 lbs. (5,400 kg)

Airstripper
AS 250



Sales Drawing #113238
91.11.25



Accessories

Items checked are to be furnished.

X FLANGED OUTLET, per drawing 2 .
X FLANGED INLET, per drawing 3 .
X OUTLET DAMPER, per drawing 4 .
___ EXTERNAL INLET DAMPER(294–364), per drawing ___ .
___ ISOLATION RAILS, per drawing ___ .
___ BELL MOUTH INLET, per drawing ___ .
Requires flanged inlet on fan.
___ INLET BOX, per drawing ___ .
___ INLET BOX DAMPER, per drawing ___ .
X QUICK OPENING CLEAN–OUT DOOR, at 3 O'clock.
___ BOLTED CLEAN–OUT DOOR, at ___ O'clock.
___ TYPE SRC CONSTRUCTION.
X DRAIN, 1"(144 and 174), or 1-1/2"(224–364)tank flange, less plug, located at low point of scroll.
___ POSITIVE SCREW ADJUSTMENT.
___ SHAFT SEAL, CERAMIC FELT.
___ 201°F. thru 600°F. HEAT FAN.
X WEATHER COVER/BELT GUARD.

FANS WITH LS WHEELS ARE ROTATABLE AND REVERSIBLE IN THE FIELD.

FANS WITH DH WHEELS ARE ONLY ROTATABLE IN THE FIELD.

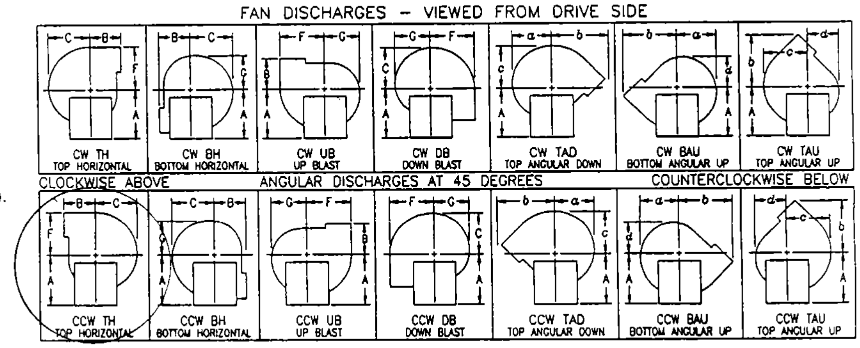
L, M, AND D ARE OUTSIDE DIMENSIONS.

DB MAY REQUIRE REMOVAL OF A SECTION OF BASE ANGLE ON OUTLET SIDE (BASE HOLES REMAIN UNCHANGED).

INLET BRACKET IS OMITTED ON SIZES 144 AND 174.

ALL HEAT FANS INCLUDE SHAFT COOLER, GUARD, MOTOR HEAT SHIELD, AND HIGH–TEMP. PAINT.

FAN DISCHARGES – VIEWED FROM DRIVE SIDE



TOLERANCE: ±1/8

FAN SIZE	A	B	C	D	E	F	G	H	J	K	L	M	N	O	Q
144	15 1/2	10 1/2	11 1/8	8 1/4	9 3/8	12	10 1/4	30	1 5/8	2 1/2	9	7 7/8	20	19 7/8	—
~~174~~	~~17 1/2~~	~~12 5/8~~	~~13 3/8~~	~~10 1/8~~	~~11 1/8~~	~~14 1/2~~	~~12 1/4~~	~~34 1/8~~	~~1 5/8~~	~~3~~	~~11~~	~~8 1/2~~	~~22~~	~~21 7/8~~	~~—~~
194	21 1/4	14	16	10 1/8	11 7/8	18	13 7/8	36 3/8	3 1/8	3 1/2	11	9 3/4	22	33 7/8	6
~~224~~	~~25 1/2~~	~~16 1/2~~	~~18 7/8~~	~~13~~	~~14~~	~~21 1/4~~	~~16 3/8~~	~~41 3/8~~	~~3 1/8~~	~~4~~	~~13~~	~~10 3/4~~	~~26~~	~~38 7/8~~	~~6 1/2~~
264	28	18 1/2	21 3/4	15	16 1/8	24 1/2	18 7/8	44 1/2	4 1/8	4 1/2	15	12 3/8	26	41 1/2	7 7/8
294	32 1/2	21	24 5/8	16 7/8	18 1/4	27 3/4	21 3/8	48	4 1/8	5 1/2	17	14	26 7/8	44	8 5/8
334	39 1/2	23	27 3/8	18 3/4	20 3/8	30 7/8	23 7/8	53 1/8	4 1/8	6	19	15 5/8	29 7/8	48 5/8	9 7/16
364	39 1/2	25 1/2	30 1/4	20 3/4	22 1/2	34 1/8	26 3/8	56	5 1/4	6	21	17 1/4	30	50 3/8	10 5/16

FAN SIZE	R	S	T	V	W	a	b	c	d	SHAFT DIA.	KEYWAY	BASE HOLES	MAX. MOTOR LIMITATIONS MOTOR FRAME OPEN	MOTOR FRAME TEFC	LENGTH C–NW
144	5 7/8	16 5/16	7 3/8	6 1/2	8	10 3/4	16	11 1/2	9 3/4	1 7/16	3/8x3/16	9/16	184T	184T	14 1/2
~~174~~	~~6 5/8~~	~~18 5/16~~	~~8 7/8~~	~~8~~	~~9 1/2~~	~~13 1/8~~	~~19 1/4~~	~~13 3/4~~	~~11 1/2~~	~~1 7/16~~	~~3/8x3/16~~	~~9/16~~	~~215T~~	~~215T~~	~~16 5/8~~
194	7 1/4	17 5/16	9 3/8	8 1/4	10 1/4	15	22 5/8	17	13	1 11/16	3/8x3/16	9/16	~~215T~~	215T	16 5/8
~~224~~	~~8 1/4~~	~~20 3/8~~	~~10 7/8~~	~~9 3/4~~	~~11 3/4~~	~~17 5/8~~	~~26 5/8~~	~~20~~	~~15 1/4~~	~~1 15/16~~	~~1/2x1/4~~	~~9/16~~	~~256T~~	~~254T~~	~~18 5/8~~
264	9 3/8	19 7/8	12 1/4	11	13	20 1/4	30 3/8	23	17 1/2	1 15/16	1/2x1/4	3/4	256T	254T	18 5/8
294	10 1/8	20 3/4	13 5/8	11 3/4	14 3/4	23	34 3/8	26 1/8	19 7/8	1 15/16	1/2x1/4	3/4	284T	254T	19 1/2
334	10 15/16	23 3/4	16	14	17	25 3/4	38 1/8	29 1/4	22 3/8	2 3/16	1/2x1/4	3/4	324T	286T	22 1/2
364	11 13/16	23 3/4	16	14	17	28 1/2	42 1/8	32 1/4	24 5/8	2 3/16	1/2x1/4	3/4	324T	286T	22 1/2

DIMENSIONS SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED.

DATE 7-6-92 CERTIFIED el ln CONTROL NO. 100

CUSTOMER'S NO. 309160
CUSTOMER'S NAME CARBONAIR SERVICES INC MAPLE GROVE, MN
TAG 309160

MOTOR BY nyb MTG. BY nyb DRIVE BY nyb

FAN DATA

SIZE	QTY.	DISCHARGE	WHEEL	CFM	OV	SP	BHP	°F	RPM
194	1	CCW TH	DH	400	606	10	2.1	70	2207
		FUTURE		3600	5454	8.92	10.0	70	2579

MOTOR DATA

RPM	HP	ELECTRICAL DATA	FRAME
1750	10	3-60-230/460V	215T
			TEFC

DRIVE DATA

BELTS	DRIVER	DRIVEN	CENTERS
2-BX42	6.1/7.3	4.9	12.7
DATUM DI #3826			

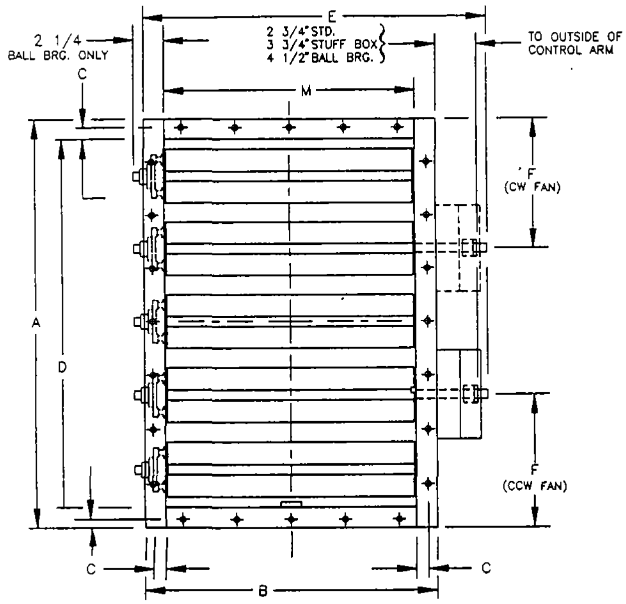
CERTIFIED DRAWING | FORM NO. D-41 A

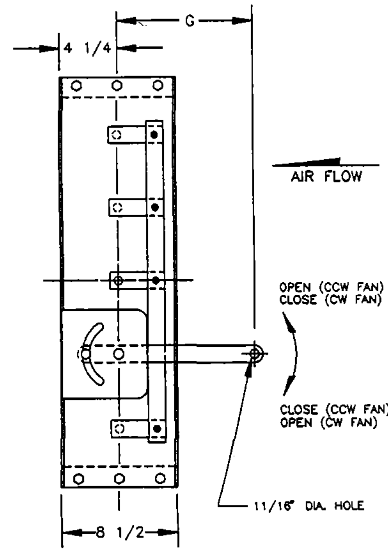
nyb | The New York Blower Company
7660 Quincy Street-Willowbrook, IL 60521

SERIES 20
GENERAL INDUSTRIAL FANS
ARR.10
SIZES 144 thru 364 LS
SIZES 194 thru 364 DH

DRAWING NUMBER
FILE H-6907 DWG. 1

1. CONTROL ARM (1/4" X 1 1/4" BAR) FOR MANUAL OR AUTOMATIC OPERATION SUPPLIED ON INLET SIDE OF FAN.
2. CONTROL ARM SWINGS 45° EACH SIDE OF CENTERLINE.
3. FLANGE IS #7 GUAGE STEEL WITH HOLES ON 4" CENTERS FROM CENTERLINES.
4. STUFFING BOX DAMPER FURNISHED WITH PACKING BOXES ON VANE ROD ON LINKAGE SIDE. CAPS ON SIDE OPPOSITE LINKAGE.
5. 301°F–1000°F DAMPERS FURNISHED WITH HIGH-TEMP. ALUMINUM PAINT AND STAINLESS STEEL BUSHINGS AS STANDARD.
6. 801°F–1000°F DAMPERS FURNISHED WITH STAINLESS STEEL VANES AND RODS AS STANDARD.
7. 800°F IS MAXIMUM TEMP. FOR BALL BRG. DAMPERS. 301°F–800°F BALL BRG. DAMPERS FURNISHED WITH HEAT SHIELDS FOR BALL BRGS.
8. MAXIMUM SAFE OPERATING TEMP. OF THE FAN MAY BE LOWER THAN DAMPER LIMITS.





TOLERANCE: ± 1/8"

DIMENSIONS (INCHES)

FAN SIZE	A	B	C	D	F	G	M	FLANGE HOLES QUANTITY SIDES	FLANGE HOLES QUANTITY TOP AND BOTTOM	FLANGE HOLES DIA.	E STD.	E STUFFING BOX	E BALL BRG.	WT (LBS)
144	10 3/4	10 3/8	3/4	8 1/4	3 5/16	7	7 7/8	6	2	7/16	14 1/8	15 1/8	17 3/8	13
~~174~~	~~12 5/8~~	~~12~~	~~3/4~~	~~10 1/8~~	~~3 3/4~~	~~7~~	~~9 1/2~~	~~6~~	~~6~~	~~7/16~~	~~15 3/4~~	~~16 3/4~~	~~19~~	~~20~~
194	13 1/4	12 3/4	7/8	10 1/4	4 1/8	7	9 3/4	6	6	7/16	16 1/2	~~17 1/2~~	~~19 3/4~~	25
~~224~~	~~16~~	~~13 3/4~~	~~7/8~~	~~13~~	~~3 11/16~~	~~8~~	~~10 3/4~~	~~6~~	~~6~~	~~7/16~~	~~17 1/2~~	~~18 1/2~~	~~20 3/4~~	~~29~~
264	18	15 3/8	7/8	15	4	7	12 3/8	10	6	7/16	19 1/8	20 1/8	22 3/8	38
294	19 7/8	17	7/8	16 7/8	4 5/16	10	14	10	6	7/16	20 3/4	21 3/4	24	48
334	21 3/4	18 5/8	7/8	18 3/4	8 9/16	10	15 5/8	10	6	7/16	22 3/8	23 3/8	25 5/8	60
364	23 3/4	20 1/4	7/8	20 3/4	9 5/16	10	17 1/4	10	10	7/16	24	25	27 1/4	73
404	26 7/8	23	1 1/8	22 7/8	10 9/16	10	19	14	10	9/16	26 3/4	27 3/4	30	89
454	29 3/4	25 3/8	1 1/8	25 3/4	11 5/8	10	21 3/8	14	10	9/16	29 1/8	30 1/8	32 3/8	113
504	32 3/4	27 7/8	1 1/8	28 3/4	10 11/16	10	23 7/8	14	10	9/16	31 5/8	32 5/8	34 7/8	141
574	36 5/8	31	1 1/8	32 5/8	18 5/16	10	27	18	14	9/16	34 3/4	35 3/4	38	151
644	40 1/2	34 3/8	1 1/8	36 1/2	17 1/4	10	30 3/8	18	14	9/16	38 1/8	39 1/8	41 3/8	162
714	44 3/8	37 5/8	1 1/8	40 3/8	18 13/16	10	33 5/8	22	14	9/16	41 3/8	42 3/8	44 5/8	173
784	48 1/4	40 7/8	1 1/8	44 1/4	20 1/2	10	36 7/8	22	18	9/16	44 5/8	45 5/8	47 7/8	209
854	52 1/4	44 1/8	1 1/8	48 1/4	26 1/8	10	40 1/8	26	18	9/16	47 7/8	48 7/8	51 1/8	247

DIMENSIONS SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED.

DATE 7-6-92 CERTIFIED el ln CONTROL NO. 105/605

CUSTOMER'S NO. 309160
CUSTOMER'S NAME CARBONAIR SERVICES INC MAPLE GROVE, MN
TAG 309160

SIZE	ROTATION	QTY.	STD.	STUFFING BOX	BALL BRG.
194	CCW	1	YES	NO	NO

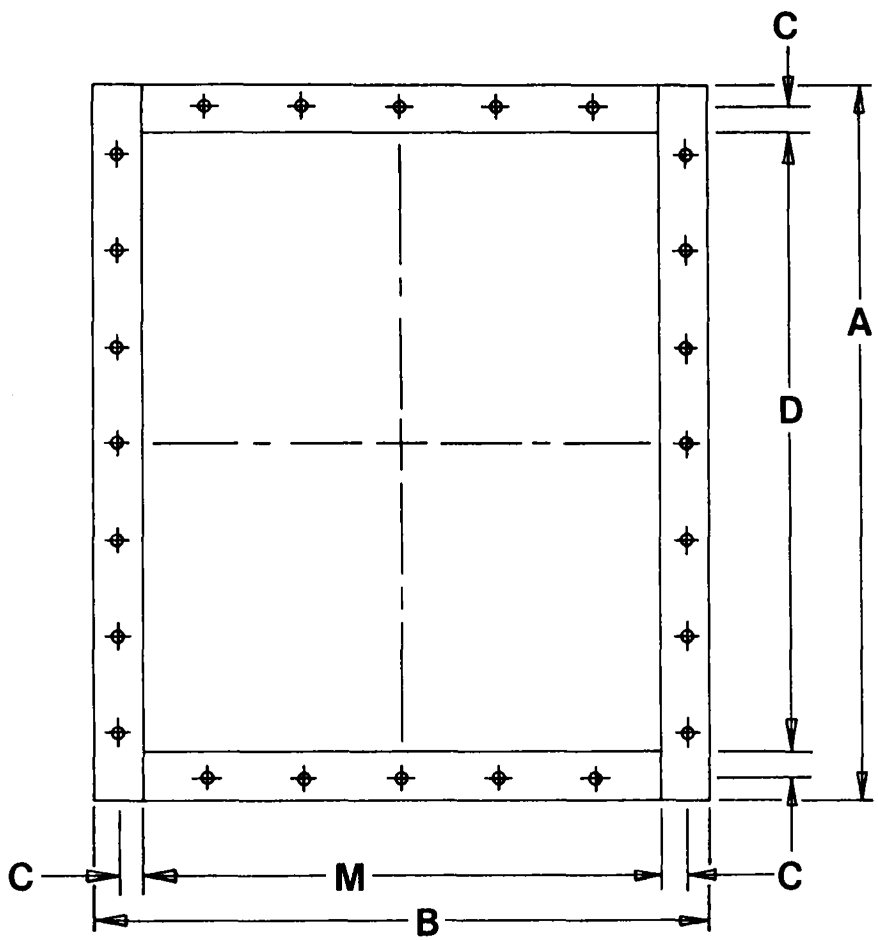
PARALLEL	OPPOSED	70°F – 300°F	301°F – 800°F	801°F – 1000°F
NO	YES	YES	NO	NO

CERTIFIED DRAWING | FORM NO. D-33 F

nyb The New York Blower Company
7660 Quincy Street–Willowbrook, IL 60521

OUTLET DAMPER FOR SERIES 20, 30, & 45 GI FANS

DRAWING NUMBER
FILE H-6907 DWG. 4



SIZE	A	B	C	D	M	HOLES	
						NO.	DIA.
144	10-3/4	10-3/8	3/4	8-1/4	7-7/8	8	7/16
~~174~~	~~12-5/8~~	~~12~~	~~3/4~~	~~10-1/8~~	~~9-1/2~~	~~12~~	~~7/16~~
194	13-1/4	12-3/4	7/8	10-1/4	9-3/4	12	7/16
~~224~~	~~16~~	~~13-3/4~~	~~7/8~~	~~13~~	~~10-3/4~~	~~12~~	~~7/16~~
264	18	15-3/8	7/8	15	12-3/8	16	7/16
294	19-7/8	17	7/8	16-7/8	14	16	7/16
334	21-3/4	18-5/8	7/8	18-3/4	15-5/8	16	7/16
364	23-3/4	20-1/4	7/8	20-3/4	17-1/4	20	7/16
404	26-7/8	23	1-1/8	22-7/8	19	24	9/16
454	29-3/4	25-3/8	1-1/8	25-3/4	21-3/8	24	9/16
504	32-3/4	27-7/8	1-1/8	28-3/4	23-7/8	24	9/16
574	36-5/8	31-1/8	1-1/8	32-5/8	27-1/8	32	9/16
644	40-5/8	34-1/2	1-1/8	36-5/8	30-1/2	32	9/16
714	44-3/8	37-5/8	1-1/8	40-3/8	33-5/8	36	9/16
784	48-3/8	40-7/8	1-1/8	44-3/8	36-7/8	40	9/16
854	52-1/4	44-1/8	1-1/8	48-1/4	40-1/8	44	9/16

Tolerance: ± ⅛"

1. Mounted flush with edge of housing outlet.
2. Furnished as standard with holes on 4" center from centerlines.

Dimensions should not be used for construction purposes unless certified.

CERTIFIED DRAWING | **FORM NO. D-47**

7660 Quincy Street
Willowbrook, IL. 60521

nyb | The New York Blower Company

DATE 7-6-92 CERTIFIED el ln

CUSTOMER'S NO. 309160

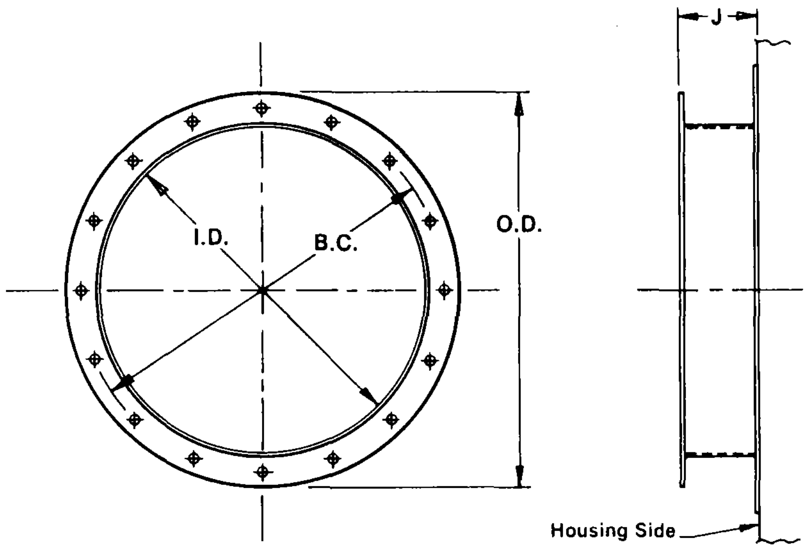
TAG 309160

SIZE	QTY.	Holes
194	1	YES

FLANGED OUTLET for GI FANS

DRAWING NUMBER

FILE H-6907 DWG. 2



SIZE	I.D	B.C.	O.D.	J	HOLES	
					NO.	DIA.
144	8-3/4	10-1/4	11-1/2	1-3/4	6	7/16
~~174~~	~~10-3/4~~	~~12-1/4~~	~~13-1/2~~	~~1-3/4~~	~~6~~	~~7/16~~
194	10-5/8	12-1/2	14	3-1/4	8	7/16
~~224~~	~~12-5/8~~	~~14-1/2~~	~~16~~	~~3-3/8~~	~~8~~	~~7/16~~
264	14-5/8	16-1/2	18	4-3/8	8	7/16
294	16-5/8	18-1/2	20	4-3/8	8	7/16
334	18-5/8	20-1/2	22	4-3/8	16	7/16
364	20-5/8	22-1/2	24	5-1/2	16	7/16
404	22-5/8	25	27	5-1/2	16	9/16
454	25-5/8	28	30	5-1/2	16	9/16
504	28-5/8	31	33	6-1/4	16	9/16
574	32-5/8	35	37	7-1/4	16	9/16
644	36-1/2	39	41	7-1/2	24	9/16
714	40-1/2	43	45	7-1/2	24	9/16
784	44-1/2	47	49	7-1/2	24	9/16
854	48-1/2	51	53	7-1/2	24	9/16

Tolerance: ± ⅛"

1. Furnished as standard with holes starting on vertical center line.
2. Dimension J is from housing side.

Dimensions should not be used for construction purposes unless certified.

CERTIFIED DRAWING | **FORM NO. D-46**

7660 Quincy Street
Willowbrook, IL. 60521

nyb | The New York Blower Company

FLANGED INLET for GI FANS

DATE 7-6-92 CERTIFIED el ln

CUSTOMER'S NO. 309160

TAG 309160

SIZE	QTY.	Holes
194	1	YES

DRAWING NUMBER

FILE H-6907 DWG. 3

nyb The New York Blower Company
7660 Quincy Street
Willowbrook, IL. 60521

PERFORMANCE CURVE

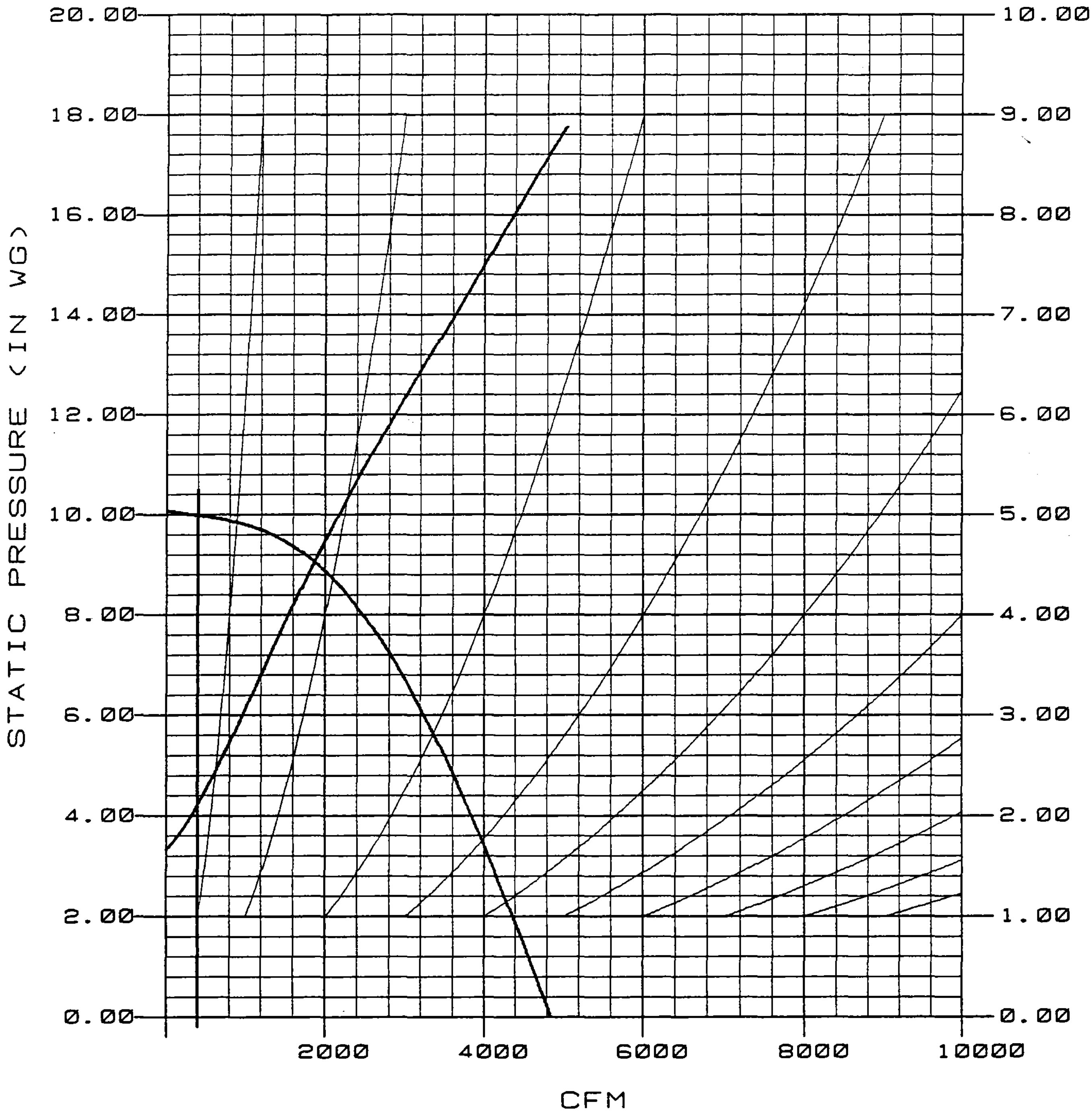
TO DETERMINE PERFORMANCE
AT ANOTHER RPM MULTIPLY:
CFM x K
SP x K^2
BHP x K^3
WHERE K IS NEW RPM DIVIDED
BY RPM SHOWN AT RIGHT.

DATE: Jul 6 1992

CUSTOMER'S NO: 309160
CUSTOMER : CARBONAIR SERVICES INC
TAGGING : 309160
FAN TYPE : Series 20 - DH
FAN SIZE : 194
CFM: 400
SP : 10.0
RPM: 2207
BHP: 2.10

TEMP: 70 deg F
DENS: 0.075 LB/FT^3
FILE : H06907/100

PERFORMANCE OPTIONS: Outlet Damper (and Evase' Damper)



nyb The New York Blower Company
7660 Quincy Street
Willowbrook, IL. 60521

PERFORMANCE CURVE

TO DETERMINE PERFORMANCE AT ANOTHER RPM MULTIPLY:
CFM x K
SP x K^2
BHP x K^3
WHERE K IS NEW RPM DIVIDED BY RPM SHOWN AT RIGHT.

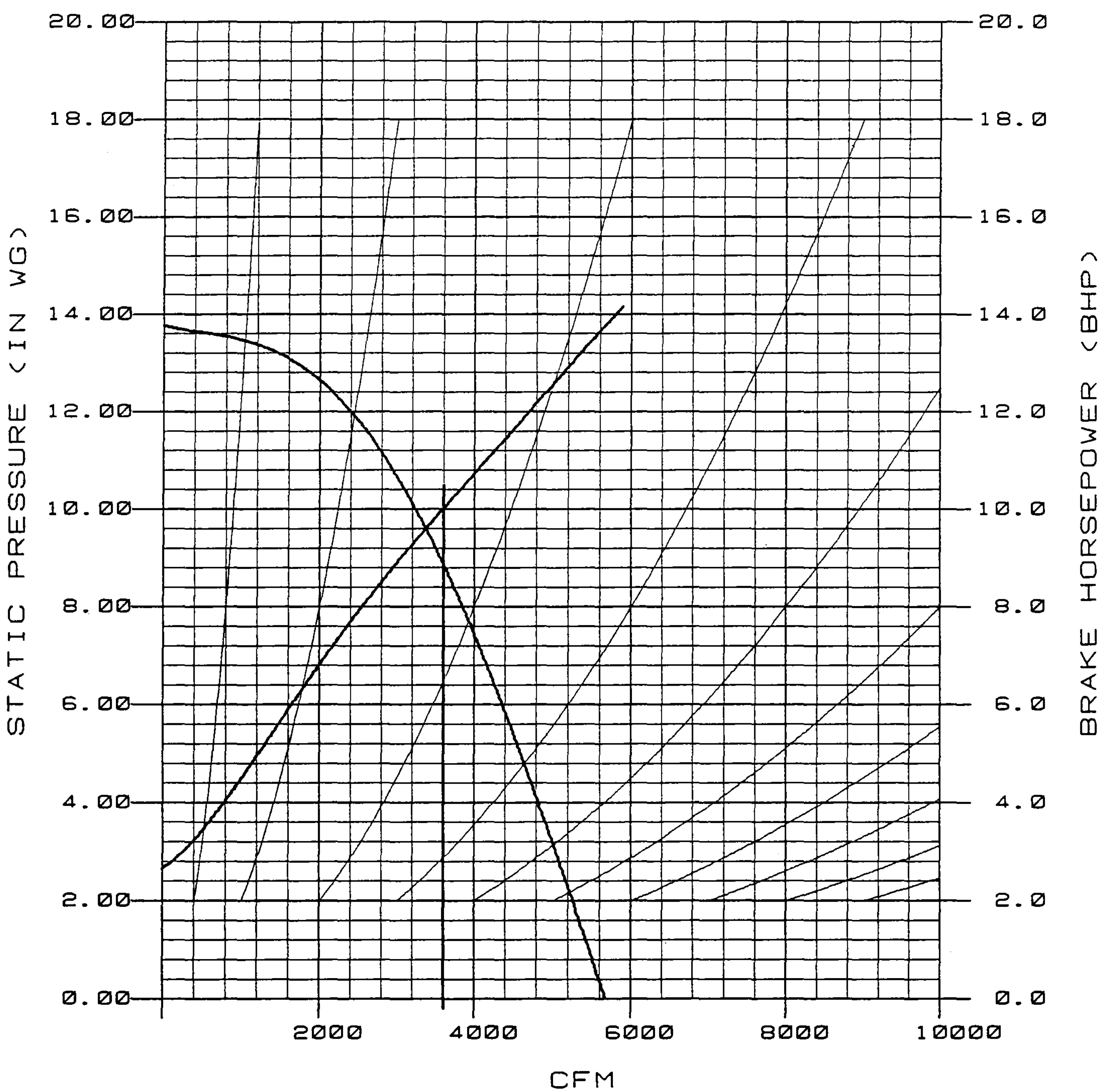
CUSTOMER'S NO: 309160
CUSTOMER : CARBONAIR SERVICES INC
TAGGING : 309160
FAN TYPE : Series 20 - DH
FAN SIZE : 194
CFM: 3600
SP : 8.92
RPM: 2579
BHP: 10.00

TEMP: 70 deg F
DENS: 0.075 LB/FT^3

DATE: Jul 6 1992

FILE : H06907/100

PERFORMANCE OPTIONS: Outlet Damper (and Evase' Damper)



The New York Blower Company 7660 QUINCY STREET — WILLOWBROOK, ILLINOIS 60521-5596	INSTALLATION MAINTENANCE, OPERATING INSTRUCTIONS	IM-110

CENTRIFUGAL FANS
General Industrial
Series 20, 30 & 45

CAUTION

THIS MACHINE HAS MOVING PARTS THAT CAN CAUSE SERIOUS BODILY INJURY. BEFORE OPERATING OR PERFORMING MAINTENANCE, THE FOLLOWING PRECAUTIONS MUST BE TAKEN.

1. **MAKE SURE ALL MOVING PARTS ARE SHIELDED FROM PERSONNEL AND FALLING OBJECTS.**
2. **READ THE INSTALLATION AND MAINTENANCE INSTRUCTIONS, AS WELL AS THE RECOMMENDED SAFETY PRACTICES MANUAL FURNISHED WITH THIS UNIT.**
3. **DO NOT OPERATE AT SPEEDS OR TEMPERATURES HIGHER THAN PUBLISHED FOR THE SPECIFIC OPERATING CONDITIONS FOR WHICH THE MACHINE WAS PURCHASED.**

A FAILURE TO TAKE THESE PRECAUTIONS COULD RESULT IN SERIOUS BODILY INJURY AND PROPERTY DAMAGE.

98-0250

A WORD ABOUT SAFETY

The above **CAUTION** decal appears on all **nyb** fans. Air moving equipment involves electrical wiring, moving parts, and air velocity or pressure which can create safety hazards if the equipment is not properly installed, operated and maintained. To minimize this danger, follow these instructions as well as the additional instructions and warnings on the equipment itself.

All installers, operators and maintenance personnel should study AMCA Publication 410, "Recommended Safety Practices for Air Moving Devices", which is included as part of every shipment. Additional copies can be obtained by writing to The New York Blower Company, 7660 Quincy Street, Willowbrook, IL 60521-5596.

ELECTRICAL DISCONNECTS

Every motor driven fan should have an independent disconnect switch to isolate the unit from the electrical supply. It should be near the fan and must be capable of being locked by maintenance personnel while servicing the unit, in accordance with OSHA procedures.

MOVING PARTS

All moving parts must have guards to protect personnel. Safety requirements vary, so the number and type of guards needed to meet company, local and OSHA standards must be determined and specified by the user. Never start a fan without having all safety guards installed. Check regularly for damaged or missing guards and do not operate any fan with guards removed. Fans can also become dangerous because of potential "windmilling," even though all electrical power is disconnected. Always block the rotating assembly before working on any moving parts.

AIR PRESSURE AND SUCTION

In addition to the normal dangers of rotating machinery, fans present another hazard from the suction created at the fan inlet. This suction can draw materials into the fan where they become high velocity projectiles at the outlet. It can also be extremely dangerous to persons in close proximity to the inlet, as the forces involved can overcome the strength of most individuals. Inlets and outlets that are not ducted should be screened to prevent entry and discharge of solid objects.

ACCESS DOORS

DANGER

DO NOT OPEN UNTIL THE POWER SUPPLY HAS BEEN LOCKED OFF AND THE SHAFT HAS STOPPED ROTATING.

FAILURE TO DO THIS CAN RESULT IN SERIOUS BODILY INJURY.

98-0249

The above **DANGER** decal is placed on all **nyb** cleanout doors. These doors, as well as access doors to the duct system, should never be opened while the fan is in operation. Serious injury could result from the effects of air pressure or suction.

Quick-opening doors must have the door handle bolts securely tightened to prevent accidental or unauthorized opening. Bolted doors must be tightened for the same reason.

2. Recheck setscrews, rotate the drive by hand and check for rubbing, then complete the installation of the belt guard.
3. Belts tend to stretch somewhat after installation. Recheck tension after several days of operation. Check sheave alignment as well as setscrew and/or bushing bolt tightness.

COUPLING

Coupling alignment should be checked after installation and prior to start up. Alignment is set at the factory, but shipping, handling and installation can cause misalignment. Fans with wheel sizes 40" and larger are normally shipped with the flexible element removed to minimize potential for damage (see section on alignment procedure). Also check for proper coupling lubrication. For details on lubrication and for alignment tolerances on the particular coupling supplied, see the manufacturer's installation and maintenance supplement in the shipping envelope.

Installation

Most **nyb** fans are shipped with the coupling installed. In cases where the drive is assembled after shipping, install the coupling as follows:

1. Remove all foreign material from fan and motor shafts and coat with machine oil for easy mounting of coupling halves.
2. Mount the coupling halves on each shaft, setting the gap between the faces specified by the manufacturer. Avoid using force. If mounting difficulty is encountered, lightly polish the shaft with crocus cloth until the halves slide on freely.

Alignment

1. Align the coupling to within the manufacturer's limits for parallel and angular misalignment (see Figure 2). A dial indicator can also be used for alignment where greater precision is desired. Adjustments should be made by moving the motor to change shaft angle, and by the use of foot shims to change motor shaft height. Do not move the fan shaft or bearing.
2. When correctly aligned, install the flexible element and tighten all fasteners in the coupling and motor base. Lubricate the coupling if necessary.
3. Recheck alignment and gap after a short period of operation, and recheck the tightness of all fasteners in the coupling assembly.

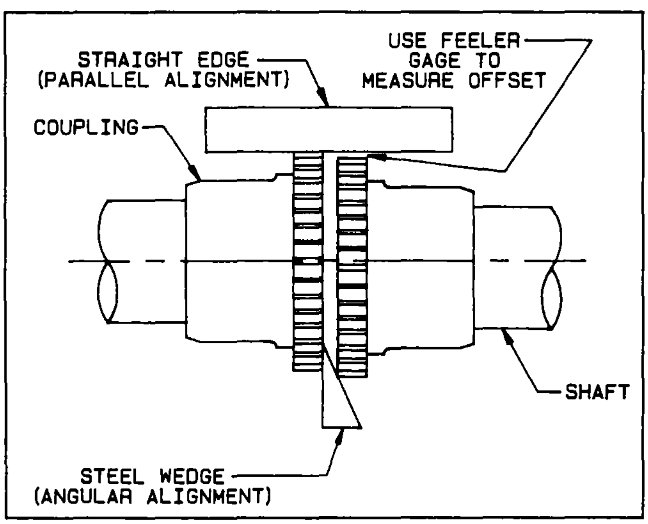


Figure 2

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific installation. This is the responsibility of the system designer and requires consideration of equipment location and accessibility as well as adjacent components. All safety accessories must be installed properly prior to start up.

Safe operating speed is a function of system temperature and wheel design. Do not under any circumstances exceed the maximum safe fan speed published in the **nyb** bulletin, which is available from your **nyb** field sales representative.

Procedure

1. If the drive components are not supplied by **nyb**, verify with the manufacturer that the starting torque is adequate for the speed and inertia of the fan.
2. Inspect the installation prior to starting the fan. Check for any loose items or debris that could be drawn into the fan or dislodged by the fan discharge. Check the interior of the fan as well. Turn the wheel by hand to check for binding.
3. Check drive installation and belt tension.
4. Check the tightness of all setscrews, nuts and bolts. When furnished, tighten hub setscrews with the wheel oriented so that the setscrew is positioned underneath the shaft.
5. Install all remaining safety devices and guards. Verify that the supply voltage is correct and wire the motor. "Bump" the starter to check for proper wheel rotation.
6. Use extreme caution when testing the fan with ducting disconnected. Apply power and check for unusual sounds or excessive vibration. If either exists, see the section on Common Fan Problems. To avoid motor overload, do not run the fan for more than a few seconds if ductwork is not fully installed. Without the ductwork attached, normal operating speed may not be obtained without motor overload. Once ductwork is attached, check for correct fan speed and complete installation. Ductwork and guards must be fully installed for safety.
7. Setscrews should be rechecked after a few minutes, eight hours and two weeks of operation (see Tables 1 & 2 for correct tightening torques).

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

WHEEL SETSCREW TORQUES
TABLE 1

Setscrew Size Diameter (in.)	Carbon Steel Setscrew Torque*	
	lb.-in.	lb.-ft.
1/4"	75	6.2
5/16"	144	12
3/8"	252	21
7/16"	396	33
1/2"	600	50
5/8"	1164	97
3/4"	2016	168
7/8"	3204	267
1"	4800	400

***Stainless Steel setscrews are not hardened and should not be tightened to more than 1/2 the values shown.**

BEARING SETSCREW TORQUE, lb.-in.
TABLE 2

Setscrew Diameter	Manufacturer				
	Link-Belt	Seal-master	SKF	McGill	Dodge
#10	40	—	35	35	—
1/4"	90	65	50	85	—
5/16"	185	125	165	165	160
3/8"	325	230	290	290	275
7/16"	460	350	350	—	—
1/2"	680	500	620	—	600
5/8"	1350	1100	1325	—	1200
3/4"	2350	—	—	—	2000

Note: Split pillow block bearings are fixed to the shaft with tapered sleeves and generally do not have setscrews.

Operation

Check setscrew torque before startup (see table for correct values). Since bearings are completely filled with grease at the factory, they may run at an elevated temperature during initial operation. Surface temperatures may reach 180°F. and grease may bleed from the bearing seals. This is normal and no attempt should be made to replace lost grease. Bearing surface temperatures will decrease when the internal grease quantity reaches a normal operating level. Relubrication should follow the recommended schedule.

Lubrication

Use the table for relubrication scheduling according to operating speed and shaft diameter. Bearings should be lubricated with a good quality lithium-based grease conforming to NLGI Grade 2 consistency. Examples are:

Mobil	—	Mobilith 22
Texaco	—	Premium RB
Standard Oil	—	Amolith #2
Gulf Oil	—	Gulf Crown #2
Shell	—	Alvania #2

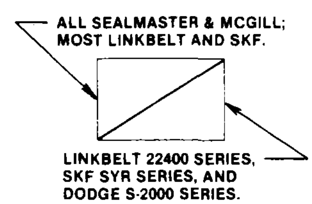
Do not use "high temperature" greases, as many are not formulated for the high speeds associated with fan bearings.

Add grease to the bearing while running the fan or rotating the shaft by hand. Be sure all guards are in place if lubrication is performed while the fan is operating. Add just enough grease to cause a slight purging at the seals. Do not overlubricate.

Split pillowblock bearings (Link-Belt P-LB6800 & P-LB6900, SKF SAF 22500, Dodge SAF-XT) should be cleaned and repacked at approximately every eighth lubrication interval. This requires removal of the bearing cap. Clean out old grease and repack the bearing with fresh grease. Pack the bearing fully and fill the housing reservoir to the bottom of the shaft on both sides of the bearing. Replace the bearing cap, being careful not to mix caps as they are not interchangeable from one bearing to another.

BEARING LUBRICATION INTERVAL (MONTHS)

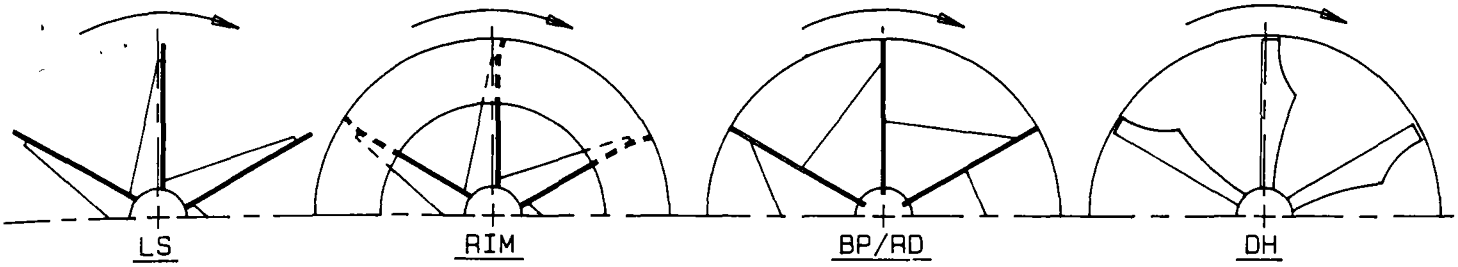
RPM / SHAFT DIAMETER	1-500	501-1000	1001-1500	1501-2000	2001-2500	2501-3000	3001-3500	3501-4000	4001-4500	4501-5000
5/8 thru 1	6	6	5-6	5-6	4-6	4-6	3-4	3-4	2	2
1 3/16 & 1 7/16	6 / 6	6 / 4	5-6 / 4	4-6 / 2	4-6 / 2	3-5 / 1	2-4 / 1	2-4 / 1	1-2 / 1	1 / 1/2
1 11/16 & 1 15/16	6 / 6	6 / 4	4-6 / 2	4-6 / 1	2-4 / 1	2-4 / 1	2 / 1/2	1-2 / 1/2	1-2	1
2 3/16	6 / 6	5-6 / 4	4-6 / 2	3-4 / 1	2-4 / 1	1-2 / 1/2	1-2	1-2		
2 7/16	6 / 4	4-6 / 2	4-6 / 1	3-4 / 1	2 / 1/2	1-2 / 1/2	1-2	1		
2 11/16 & 2 15/16	5-6 / 4	4-6 / 2	2-4 / 1	2 / 1	1-2 / 1/2	1				
3 3/16	6	6	4	2	2					
3 7/16 thru 4 3/16	4-6 / 4	3-5 / 2	2-4 / 1	1-2 / 1/2	1					
4 7/16	4-6 / 4	3-4 / 1	2 / 1/2	1						
4 15/16	4-6 / 2	3-4 / 1	2 / 1/2							
5 7/16	6	4	2							
6	6	4								



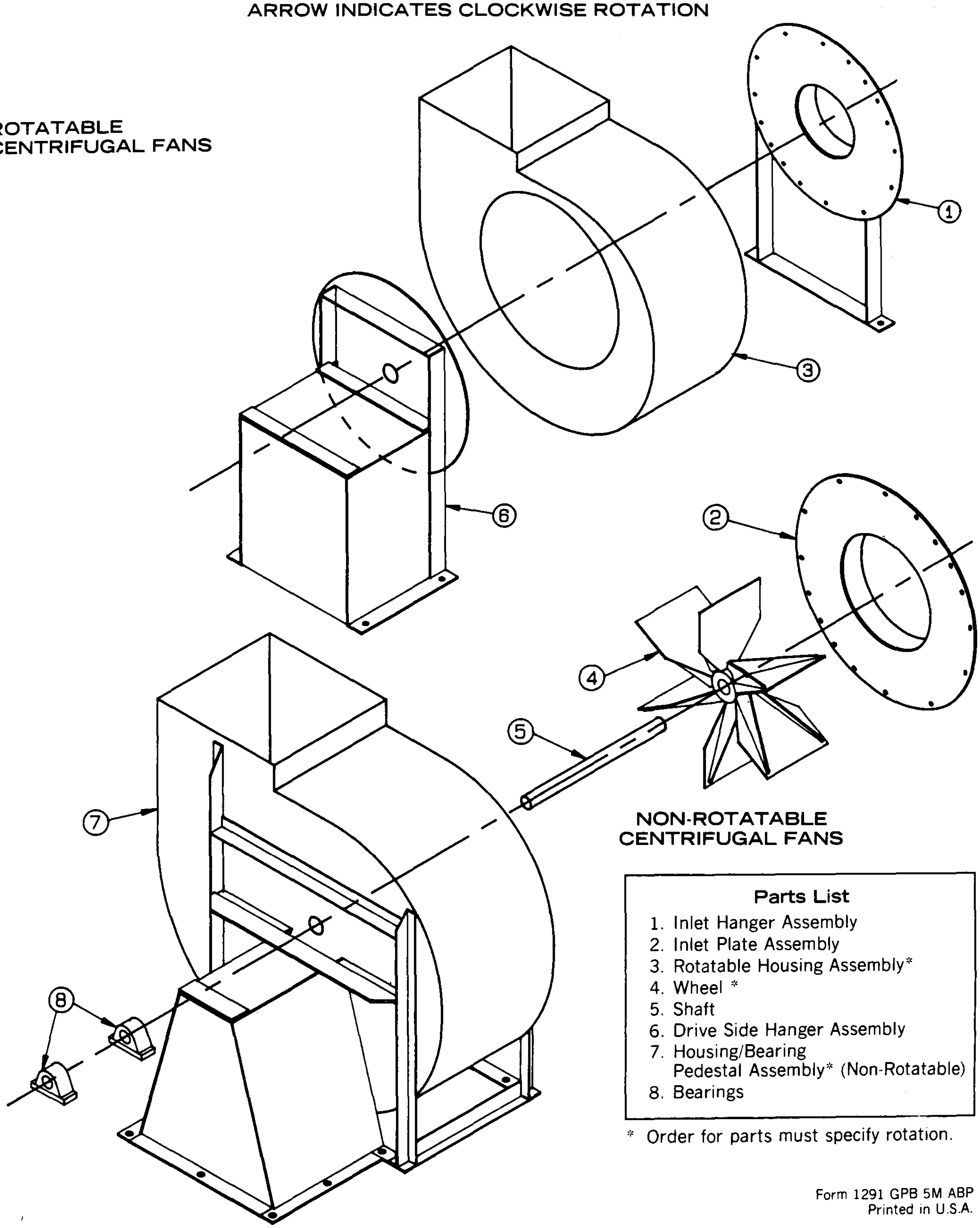
NOTE:

1. **These are general recommendations only; specific manufacturer's recommendations may vary slightly.**
2. **Assumes clean environment, 0°F. to 120°F.**
   - **a. Consult The New York Blower Company for operation below 0°F. ambient.**
   - **b. Ambient temperatures greater than 120°F. will shorten bearing life.**
   - **c. Under extremely dirty conditions, lubricate more frequently.**

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE



ARROW INDICATES CLOCKWISE ROTATION



Parts List

1. Inlet Hanger Assembly
2. Inlet Plate Assembly
3. Rotatable Housing Assembly*
4. Wheel *
5. Shaft
6. Drive Side Hanger Assembly
7. Housing/Bearing Pedestal Assembly* (Non-Rotatable)
8. Bearings

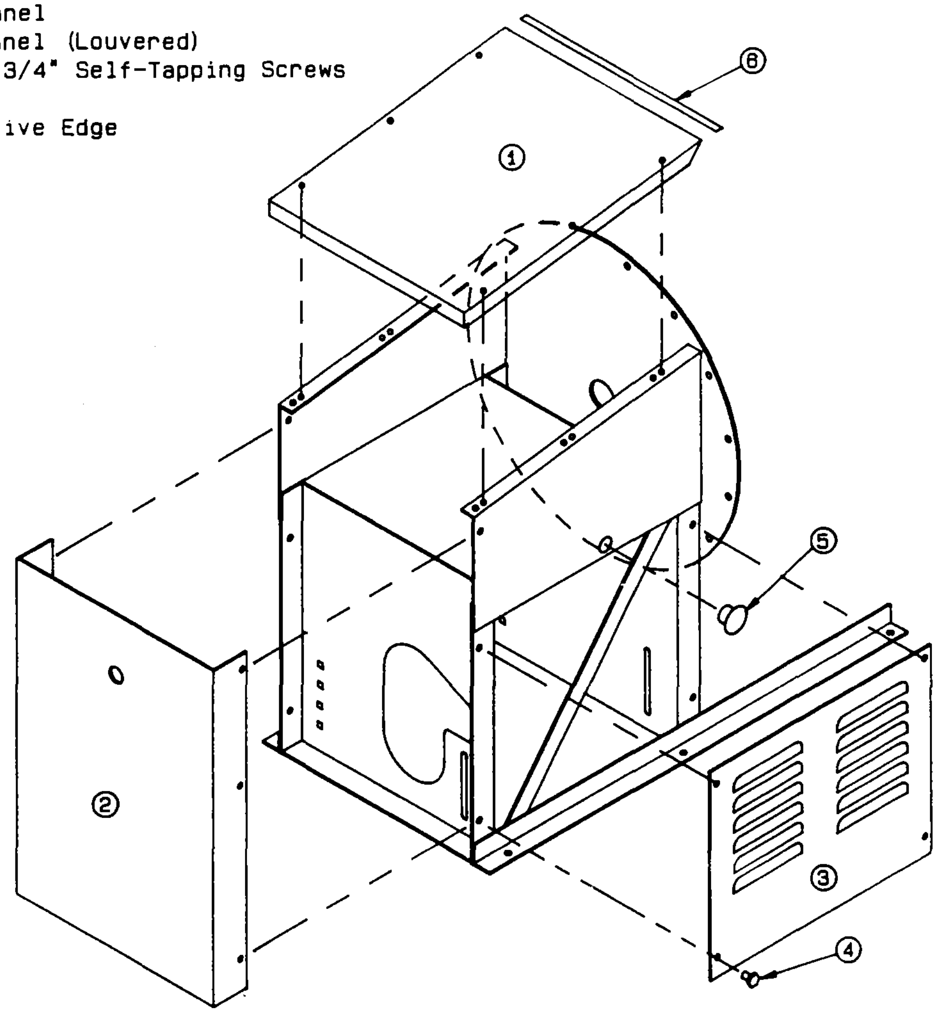
* Order for parts must specify rotation.

Form 1291 GPB 5M ABP
Printed in U.S.A.

nyb The New York Blower Company	WEATHER COVER/BELT GUARD INSTRUCTION SHEET
7660 QUINCY STREET – WILLOWBROOK, ILLINOIS 60521-5596	MZI0301 9-87

This package contains all parts to install the weather cover/belt guard on an nyb Arrangement 10 (motor inside base) fan. Parts are attached with self-tapping screws that require more torque during the first installation when threads are being cut. Leave screws loose until all parts are installed. Do not over tighten. WIRE MOTOR AND CHECK BELT TENSION PRIOR TO INSTALLATION.

ITEM NO.	QTY.	
1	1	Top Panel
2	1	Back Panel
3	2	Side Panel (Louvered)
4	16	5/16 x 3/4" Self-Tapping Screws
5	2	Plugs
6	1	Protective Edge

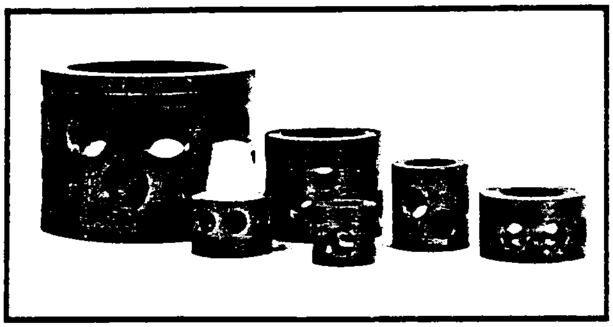


ORDER OF ASSEMBLY

1. Remove parts from box and confirm items and quantities against bill of materials.
2. Place side panels 3 on each side of motor compartment and align holes. Install two self-tapping screws 4 on fan housing end of each panel.
3. Install back panel 2 on the outside of the fan base and side panels. Align panel holes with base holes and install screws. Lower back panel screws also secure the rear edge of the side panel.
4. Place protector edge 6 over fan end of top panel 1 (see sketch) and install panel over base and rear panel. Two sets of holes are provided for attachment of top. For a fan operating below 500°F. airstream temp. use the forward (toward fan housing) set of holes. For fans operating above 500°F. airstream use the rear set of holes which allows for a ventilation gap at the fan end of the panel.
5. Secure all screws-use caution not to overtighten.
6. Install plug(s) 5 in the conduit holes(s) that have not been used for wiring.

EFFECTIVE DATE: NOVEMBER 1, 1987

PVC DISTRIBUTOR HUBS



HUB SPECIFICATIONS (SEE FIGURE 1 BELOW)								
PART NUMBER	PIPING SIZE	NO. OF OUTLETS	OVERALL HEIGHT	OUTSIDE DIAMETER	SIDE WALL	TOP WALL	DISTANCE A	DISTANCE B
C1-124	1"	(4) ½"	2"	1⅞"	⅜" Min.	¼" Min.	1¼"	—
C1-344	1"	(4) ¾"	2⅛"	2⅜"	⅜" Min.	¼" Min.	1⅜"	—
C14-126	1¼"	(6) ½"	2¼"	3"	½" Min.	⅜" Min.	1⅜"	—
C14-344	1¼"	(4) ¾"	2¼"	3"	½" Min.	⅜" Min.	1⅜"	—
C15-128	1½"	(8) ½"	2¼"	3"	½" Min.	⅜" Min.	1⅜"	—
C15-346	1½"	(6) ¾"	2⅜"	3"	½" Min.	⅜" Min.	1 13/32"	—
C2-348	2"	(8) ¾"	2 5/16"	4"	½" Min.	7/16" Min.	1⅜"	—
C25-3412	2½"	(12) ¾" 2 Rows 6	3⅝"	4"	½" Min.	7/16" Min.	1½"	2⅝"
C3-3416	3"	(16) ¾" 2 Rows 8	4"	4½"	½" Min.	7/16" Min.	1⅝"	3"
C4-116	4"	(16) 1" 2 Rows 8	4⅝"	5½"	½" Min.	7/16" Min.	2"	3½"
C6-1516	6"	(16) 1½" 2 Rows 8	6⅜"	8⅝"	9/16" Min.	1" Min.	2 5/16"	4¼"

Distributor hubs are stocked with the side outlets drilled 90 degrees to the main piping thread. These side outlets can also be drilled at an angle so the laterals will angle up when assembled in the tank. This allows the entire unit to sit lower in the bottom of the tank. Standard angle for lateral outlets to angle up is approximately 13 degrees. Choose the type of installation you want the hub to fit. TYPE A is where hub screws DOWN onto a nipple in the bottom of the tank. TYPE B is where the outlet of your tank is in the lower side wall of the tank. Your piping screws into the side wall. Elbow down toward the bottom of the tank and our hub then screws UP onto your bottom extension.

If ordering angle holes you MUST SPECIFY an A or B hub. Add $12.00 for double row angle hubs (2½"-6") and add $8.00 to single row angle hubs (1"-2").

Hubs may be ordered with a slip fit for cementing as opposed to a threaded opening.

*A set up charge will be added for less than minimum quantities on all special orders.

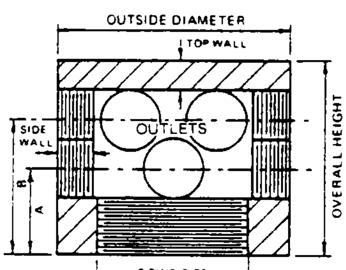
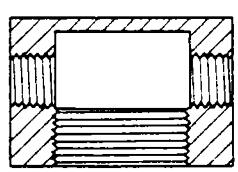
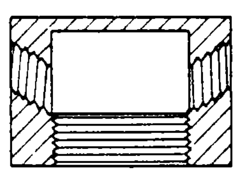
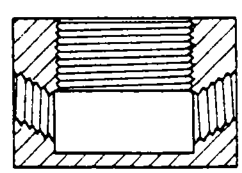


Figure 1


Standard


Type A

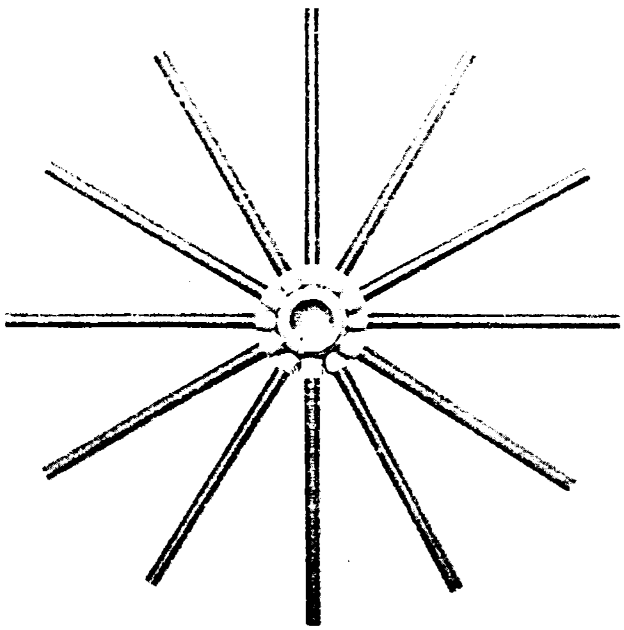

Type B

Form H1187

Carbon Air Services, Inc.

EFFECTIVE DATE: MARCH 1, 1985

P.V.C. DISTRIBUTION LATERALS



Standards:
.010, .012 or .020 slots on 3 sides
(specify when ordering)
3/16" spacings
N.P.T. one end, plugged other end

Lateral length can be determined by using the following formula:

$$\text{Lat. length} = \left[\frac{(\text{Tank dia.}) - (\text{Hub dia.})}{2}\right] - (1''\text{ for clearance})$$

EXAMPLE:
For a 24" diameter tank using a 2" hub (Part No. C2-348) where the hub diameter is 4" . . .

$$\text{Lat. length} = \left[\frac{24'' - 4''}{2}\right] - (1''\text{ for clearance}) = 9''\text{ max. lgth.}$$

PRICING:
8 pieces of a 3/4" SDR lateral 9" long would cost $.26 per inch.
OR 9" x $.26 = $2.34 x 8 pcs. = $18.72 total order

BEFORE ORDERING, see "Special Pricing Notes" below.

Laterals less than 8" have 1/8" spacing.

Slotting on one side or two sides only is available. Various spacing between blades on the same lateral can also be manufactured per your required flow rates and drawings.

Special Pricing Notes:
Special set-up charges will be added for non-standard laterals.

Call for quotes on KYNAR, POLYPROPOLENE, or SPECIAL CUSTOM laterals.

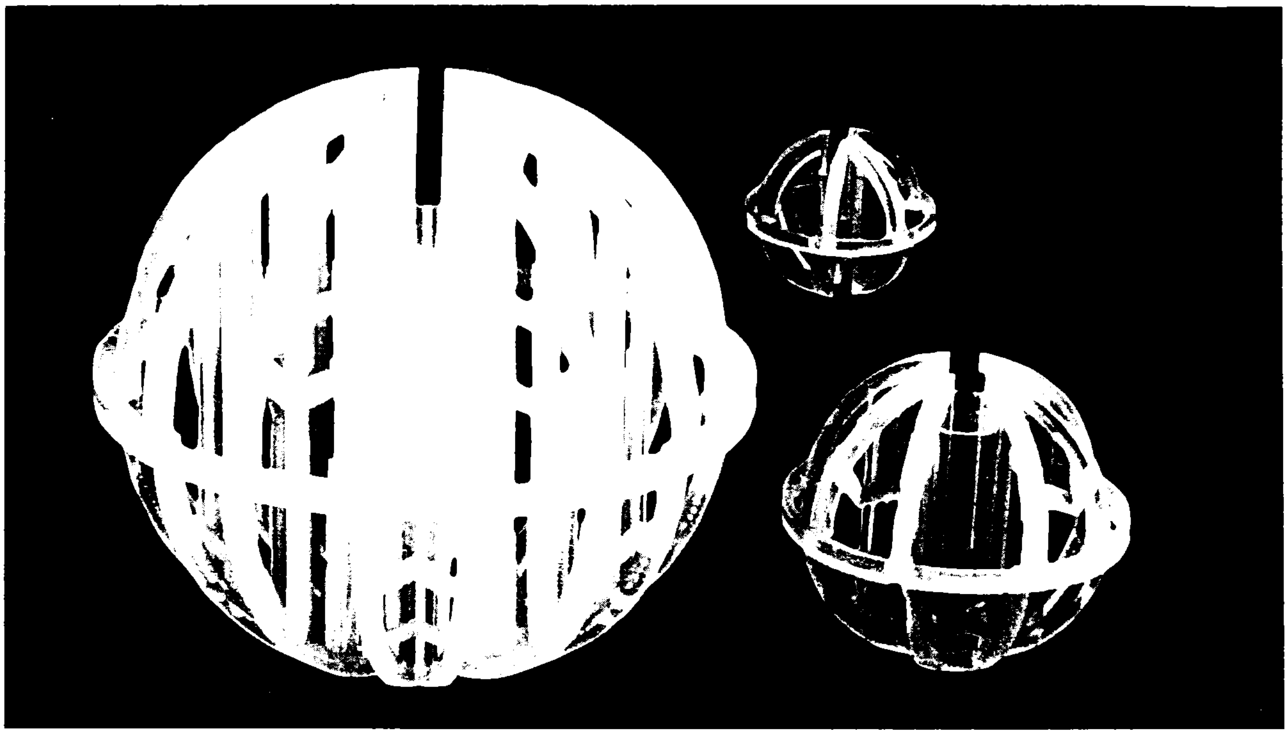
.006, .032, .125 and other slot sizes available at extra cost.

Form DL-385

Carbon Air Services, Inc.

PLASTIC JAEGER TRI-PACKS®

High performance column packing



FEATURES

Plastic Jaeger Tri-Packs® is a hollow, spherical-shaped packing made of injection molded plastic in three sizes: 1", 2" and 3½" diameter. Its symmetrical geometry made from a unique network of ribs, struts and drip rods yields unprecedented performance. It has high void space, greater than packings of comparable size, and achieves superior pressure drop values, up to 90% reduction, as compared to other products. The packing has a high ACTIVE surface area, exposing all of its surface area to be fully wetted during column operation. The performance capabilities of plastic Jaeger Tri-Packs® have resulted in significant savings in hundreds of packed column operations.

BENEFITS

- Highest mass and/or heat transfer rate
- Extremely low pressure drop
- Free of plugging, fouling, nesting and wall channeling
- Highest flooding point and lowest wetting point
- Even gas and liquid distribution
- No interlocking or meshing
- Used as a mist eliminator

JAEGER PRODUCTS, INC.

PLASTIC JAEGER TRI-PACKS®

SPECIFICATIONS

Materials. Nine standard, injection moldable plastics are available:

- * Polypropylene (PP)
- ~~Polyethylene (PE)~~
- Polypropylene Glass-Filled (PP-G)
- Noryl® (PPO)
- Kynar® (PVDF)
- Halar® (ECTFE)
- TopEx (LCP)
- Tefzel® (ETFE)
- Teflon® (PFA)

Others are available on request.

Sizes. Plastic Jaeger Tri-Packs® packings are made in three sizes:

No. ½ ... 1" Nominal
* No. 1 ... 2" Nominal
No. 2 ... 3½" Nominal

PHYSICAL PROPERTIES

Type	No. ½	No. 1	No. 2
Size	1"	2"	3½"
Geometric Surface Area (ft^2/ft^3)	85	48	38
Packing Factor (1/ft)	28	17	12
Void Space (%)	90	93	95
Weight (lb/ft^3)	6.2	4.2	3.3

MASS TRANSFER DATA

Absorption System	G ($lb/hr\text{-}ft^2$)	L ($lb/hr\text{-}ft^2$)	Temp. (°F)	HTU - Inches	
				2" & 3½"	1"
$HCl\text{-}H_2O$	1792	2048	77	10.6	7.0
$HCl\text{-}NaOH$	1567	2048	68	8.8	6.1
$Cl_2\text{-}NaOH$	1229	2202	122	14.5	9.9
$NO_2\text{-}Na_2S{+}NaOH$	717	1127	68	49.2	32
$NH_3\text{-}H_2SO_4$	492	1024	68	6.0	4.1
$NH_3\text{-}H_2O$	512	1024	68	8.4	5.6
$NH_3\text{-}H_2O$	512	4096	68	5.4	3.6
$SO_2\text{-}NaOH$	1946	4096	140	12.0	8.1
$HF\text{-}H_2O$	1844	3072	77	6.9	4.6
$CH_3COCH_3\text{-}H_2O$	1700	860	68	15.2	10.2
$H_2S\text{-}NaOH$	1229	1331	68	19.4	13.0

VOC Stripping	G ($lb/hr\text{-}ft^2$)	L ($lb/hr\text{-}ft^2$)	Temp. (°F)	HTU - Inches	
				2"	1"
TCE(ppm)-H_2O	479	12264	77	26.9	21.5
TCE(ppm/ppb)-H_2O	690	12494	60	37.6	30.1
BTX(ppb)-H_2O	722	4998	70	39.2	31.4

Superior performance by design

JAEGER PRODUCTS, INC.

Marketed by:

POLYMER PIPING & MATERIALS
P.O. Box 16117, Houston, Texas 77222
(713) 672-4200, Telex 79-0119
TX WATTS 800-833-8483
U.S. WATTS 800-231-0146

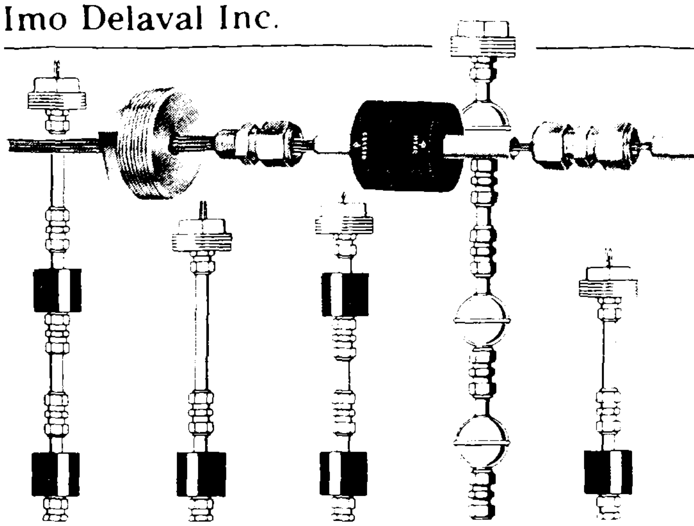
Represented by:

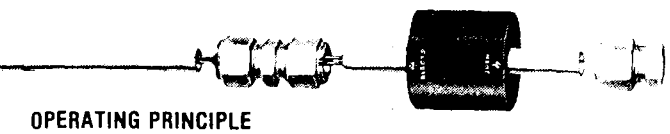
PPM-127-2M-3/87

GEMS® "FABRI-LEVEL" SWITCH KITS

Self-assemble from stock components in your plant... to your exact requirements

Imo Delaval Inc.





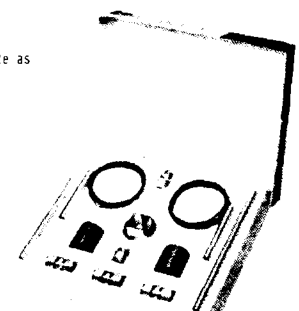
FUNCTION

Long manufactured by Gems for industry-wide use, Fabri-Level units can be custom-assembled in minutes from standard components. Only two wrenches, no special skills, are needed to assemble. From one to six level stations may be spaced as desired on a single unit. You merely follow simple assembly instructions provided, install in tank, connect electrical leads and your "tailor-made" unit is ready for use . . . in any media compatible with Brass and Buna N, or 316 Stainless Steel — the two materials options available.

Fabri-Level switch kits are conveniently packaged — contain all components necessary for complete assembly of a one or two station level switch unit, ready for pipe plug mounting in your tank. N.O. or N.C. operation of the single pole single throw switch is selectable when assembling — by merely inverting the float on its stem. The 10" (254mm) lengths of tube furnished extend or space level stations as desired. 36" lengths, available separately as components, or any standard non-magnetic 1/2" (12.7mm) tubing may be used with additional level stations for longer extensions and additional (up to six) level stations.

Kits are furnished in five versions, with complete assembly instructions. Each kit contains:

- One Tube Connector (1/2" – 3/8" npt)
- One Mounting Plug (1¼" or 2" npt)
- Two Level Stations (Switch, Tube, Float)
- Two Extension Tubes 1/2" x 10" Long (12.7mm x 25.4m)
- One Tube End Fitting (1/2" – 12.7mm)
- Three Tube Unions (1/2" – 12.7mm)



STANDARD FABRI-LEVEL SWITCH KITS

Kit No	Material	Mtg NPT	Primary Usage
24576	Brass Fittings, Buna N Floats	2"	In fuels, water at temperatures below 180°F.
26128	Brass Fittings, Buna N Floats	1¼"	In fuels, water at temperatures below 180°F.
26130	Stainless Steel Fittings, Buna N Floats	1¼"	In fuels, water at temperatures below 180°F.
26675	Stainless Steel Fittings, Buna N Floats	2"	In fuels, water at temperatures below 180°F.
24577	All 316 Stainless Steel	2"	High temperature, 275°F, high pressure, 750 psi, in corrosive liquids.

LIMITED WARRANTY

FABRI-LEVEL Kit equipment is guaranteed for a period of one year from the date of shipment from Gems' plant. This guarantee is limited to defects in the FABRI-LEVEL Kit caused by defective material or workmanship performed by Gems prior to shipment of the FABRI-LEVEL Kit. See Limited Warranty sheet included with product.

OPERATING PRINCIPLE

Fabri-Level units detect high, low or intermediate liquid levels magnetically, with precise accuracy. A magnet-equipped float, moving with liquid level, actuates a dry reed, hermetically sealed switch within the unit's central stem at each level station. Switches are wired to trigger a remote warning or indicating device or, using suitable relays, to provide automatic control of pumps and similar equipment.

APPLICATION

Fabri-Level units are being applied in just about every area of industry where accurate detection and indication of liquid level is called for, including automatic control of pumping and other systems.

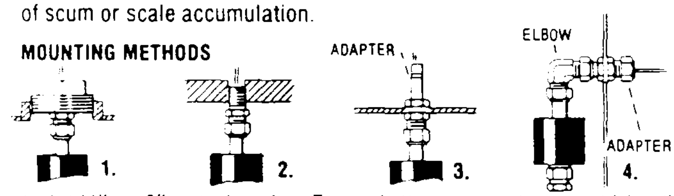
CONSTRUCTION

All configurations are extremely rugged and are virtually unaffected by shock, vibration, pressure or vacuum. Stems and fittings can be either brass or stainless steel, with Buna N floats. Alternatively, stem, fittings and floats can be all 316 stainless. No gaskets or seals are used, and the float is the only moving part, assuring long, trouble free service. Corrosion resistance is excellent.

INSTALLATION AND MAINTENANCE

Installation can be from top, bottom or side of tank as shown in sketches. Usually installed as nearly vertical as possible, units will operate reliably as much as 30° from the vertical. Maintenance requirements are minimal, and usually limited to occasional cleanup of scum or scale accumulation.

MOUNTING METHODS

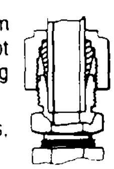


1. 1-1/4" or 2" npt pipe plug. Top or bottom mount, boss or thickwall tank. Permits unit insertion from outside.
2. 3/8" npt-m tube connector. Top or bottom mount from inside. Boss or thickwall tank.

3, 4. Top-mount through sheet metal cover, or with 90° elbow for mounting unit from inside of tank.

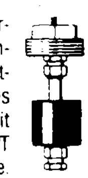
Pressure type fittings form positive seal. Tube cannot turn, wires cannot twist during tightening.

Nylon ferrule for brass units, SS ferrule for stainless units.



$^{13}/_{16}$" (20.6mm) and $^{7}/_{8}$" (22.2mm) hex. fittings.

2" NPT mounting plug permits entire unit to be inserted in tank from outside. ½" NPT-F provides direct electrical conduit connection. A 1¼" NPT mounting plug is available.



SPECIFICATIONS

	Brass/Buna N	All 316 SS
Ambient Temp. (Oil)	0°F to 230°F	0°F to 275°F
(Water)	0°F to 180°F	0°F to 275°F
Fluid Pressure (Max.)	150 psi	750 psi
Float Sp. Gr.	.55	.65
Fitting Ferrule Material	Nylon	316 SS
Mounting Thread	1¼" or 2" NPT-M	
Conduit Thread	½" NPT-F	
Tube/Fitting Size	½" (12.7mm) o.d. tube	
Max. No. Levels per Stem	6	6
Mounting Attitude	Vertical ±30°	

ASSEMBLY INSTRUCTIONS:

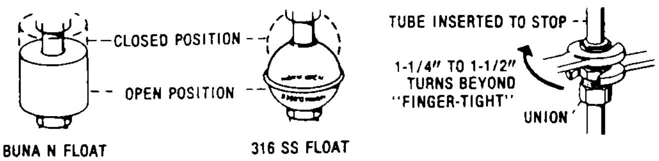
1 Determine type of assembly required from data on these pages.

2 Assemble unit, observing the following sketches and information.

Extension Tubes when required: Cut to proper length as illustrated. Tubes 36" (914.4mm) long available as components, or any ½" (12.7mm) tubing of suitable non-magnetic material may be used.

l Stations: Assemble floats on switch tubes for desired switch operation as shown. ed level station wires through switch tubes of each level station toward mounting plug.

Note: Floats shown in normally open (dry) position. To reverse operation, invert floats.



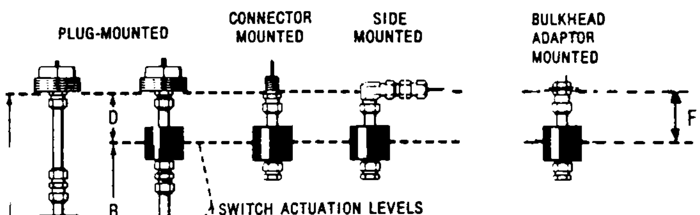
Coupling Components Together: Insert tubes to limit in fittings and tighten "finger-tight". After checking entire unit, wrench-tighten as illustrated.

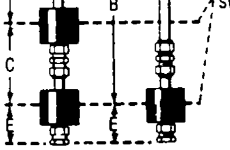
IMPORTANT: Always assemble entire unit "finger-tight" first, then check level locations and switch operation (N.O. or N.C.) before final tightening.

3 Install Unit in Tank: Fabri-Level units with 1¼" or 2" NPT mounting plugs are installed through a boss or tapped hole from outside of tank. Units with alternate mountings are installed from the inside.

4 Electrical Leads: Leads are readily identified for connection. I. E. switch leads nearest mounting end of unit project the farthest, etc. CAUTION: See "Switch Ratings" before connecting power to FABRI-LEVEL unit.

ACTUATION LEVEL DIMENSIONAL DATA . . .



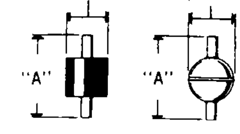


Note: Buna N floats shown.

When two or more extension tubes are coupled together for greater length, assemble coupling unions before cutting to length per "A" or "B" (below).

Dim.	Description	SPST Switches		SPDT Switches
		With Bunan Floats	With S.S. Floats	With Either Floats
A	Min. with tube extension	4¾" (120.7mm)	4½" (114.3mm)	4⅞" (123.8mm)
	Cut tube to length — "A" minus	2⅞" (73mm)	2⅝" (66.7mm)	3" (76.2mm)
B	Min. with tube extension	6 5/16" (160.3mm)	6⅝" (168.3mm)	6⅝" (168.3mm)
	Cut tube to length — "B" minus	4 15/16" (125.4mm)	4 11/16" (119.1mm)	4¾" (120.7mm)
C	Closest that levels can be	4¼" (108mm)	4½" (114.3mm)	4⅝" (117.5mm)
D	Highest possible level	2⅝" (66.7mm)	2⅜" (60.3mm)	3" (76.2mm)
E	Lowest possible level	2⅛" (54.1mm)	2⅝" (66.7mm)	2⅜" (60.3mm)
F	Minus tankwall thickness	2⅞" (73mm)	2⅝" (66.7mm)	3" (76.2mm)

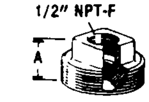
FABRI-LEVEL COMPONENTS



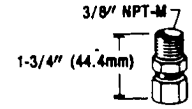
LEVEL STATION:
Float/tube/switch assy. Choice of Buna N or 316SS float, brass or 316SS tube. SPST switch with No. 18 AWG or SPDT switch with No. 22 AWG Teflon lead wires, 60"L.

For Mtg. Plug Size:	Float Mat.	Switch	P/N		Dim. "A"
			Tube Mat.		
			Brass	316SS	
1¼" NPT	Buna N	SPST SPDT	26609 26737	26608 26738	4.00" 4.45"
2" NPT	Buna N	SPST SPDT	24410 24578	25328 25329	4.00" 4.45"
	316 SS	SPST SPDT	— —	24411 24579	4.25" 4.45"

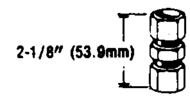
MOUNTING PLUG: Provides clearance for inserting unit in tank.
1¼" NPT: Brass—**P/N 26034**; 316SS—**P/N 26033**
2" NPT: Brass—**P/N 24408**; 316SS—**P/N 24407**



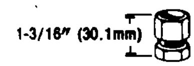
TUBE CONNECTOR, ½": Connects tube to mtg. plug, mounts unit from inside of tank.
Brass—**P/N 24633**; 316SS—**P/N 24634**



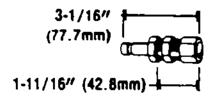
TUBE UNION, ½": Connects Fabri-Level stations or extension tubes.
Brass—**P/N 24412**; 316SS—**P/N 24413**



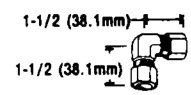
TUBE END FITTING, ½": Seals end of unit.
Brass—**P/N 24553**; 316SS—**P/N 24554**



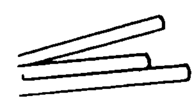
BULKHEAD ADAPTER, ½": For top or side entry into tank (with 90° elbow for side entry).
Brass—**P/N 24635**; 316SS—**P/N 24636**



90° ELBOW, ½": For side entry into tank (with bulkhead adapter).
Brass—**P/N 24631**; 316SS—**P/N 24632**



TUBING: ½" (12.7mm) O.D. For extending units or level station spacings.
10" long: brass—**P/N 25199**; 316SS—**P/N 25204**;
36" long: brass—**P/N 24637**; 316SS—**P/N 24638**



ELECTRICAL DATA

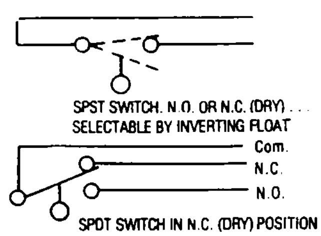
Standard snap-action switch is a 20VA, SPST, hermetically sealed, magnetically actuated, make and break type. Normally open or normally closed operation is selectable by inverting floats on unit stem.

A level station with SPDT 3-wire switch is available as a separate component if required.

SWITCH RATINGS — MAX. RESISTIVE LOAD . . .

VA	Volts	Amps AC	Amps DC
20	0-30	.4	.3
	120	.17	.13
	240	.08	.06

TYPICAL WIRING DIAGRAMS . . .



ORDERING DATA

When ordering kits, specify kit number(s) required. When ordering components, specify part numbers (P/N) and quantities of each required.

IMO

Imo Delaval Inc.
Gems Sensors Division
1 Cowles Road
Plainville, CT 06062-1198 U.S.A.
Tel. 203-677-1311 Facsimile 203-747-4244 Telex 99306

☐ TORONTO
Caloritech Inc.
2770 Brighton Road
Oakville, Ontario
L6H 5T4
Tel.: (416) 829-4422
Fax: (416) 829-4430

☐ ORILLIA
Caloritech Inc.
P.O. Box 44
Patterson Rd.
Orillia, Ontario L3V 6H9
Tel.: (705) 325-3473
Fax: (705) 325-2106

☐ MONTREAL
Caloritech Inc.
1221, Montrée de Liesse
St Laurent, Québec
H4S 1J7
Tel.: (514) 334-3720
Fax: (514) 334-6491

☒ MARYLAND
Caloritech, Inc.
229 Thelma Avenue
Box 846, Glen Burnie
MD 21060-0846
Tel.: (410) 766-6333
Fax: (410) 766-3981

Caloritech INC.

Quotation

CarbonAir
8640 Monticello Lane
Maple Grove, MN 55369

DATE	22 JUNE 92
YOUR INQUIRY NUMBER	
OUR REFERENCE NUMBER	DJP-92-2892 (49z)

ATTN: **Mr. Rick Kolbow**
FAX: (612) 425-6882

WE ARE PLEASED TO SUBMIT THE FOLLOWING QUOTATION FOR YOUR CONSIDERATION:

PAGE 1 OF 2

ITEM	QUANTITY	DESCRIPTION	PRICE PER UNIT
		1.0) Scope	
		1.1) Insert Type Duct Heater required.	
		1.2) 400 or 3600 CFM.	
		1.3) 40°F temperature increase required (50° to 90°F range).	
		1.4) 460v,-3ph power available.	
		1.5) NEMA 4 Area Classification.	
		1.6) Built in High Limit required.	
		1.7) Built in Adjustable Thermostat, 0°-100°F Range.	
		2.0) Equipment	
A	One Only	2.1) Catalog No. DDFT18x18-52, 460v, 3ph, 52KW Tubular Element Duct Heater complete with:	
		a) Generally per Pgs. 63 & 64 of Catalog 150.	
		b) Insert Type.	
		c) For 18" W x 18" H x 13" Deep Duct.	
		(continued)	

Net 30 Days ON APPROVED CREDIT

ry (Duty & Brokerage Included)

- 6 Weeks

' IS SUBJECT TO THE CONDITIONS SHOWN ON
ᵒF THIS FORM.

Caloritech INC.

BY: [signature]

D. Jerry Patterson,
Manager, Industrial Sales
GST R100735967

Caloritech INC.

☐ TORONTO
Caloritech Inc.
1360 Speers Road
Oakville, Ontario
L6L 5V3
Tel.: (416) 825-2922
Fax: (416) 825-4134

☐ ORILLIA
Caloritech Inc.
P.O. Box 44
Patterson Rd.
Orillia, Ontario L3V 6H9
Tel.: (705) 325-3473
Fax: (705) 325-2106

☐ MONTREAL
Caloritech Inc.
1221, Montée de Liesse
St-Laurent, Quebec
H4S 1J7
Tel.: (514) 334-3720
Fax: (514) 334-6491

☒ MARYLAND
Caloritech, Inc.
229 Thelma Avenue
P.O. Box 846
Glen Burnie, MD 21060
Tel.: (301) 766-6333
Fax: (301) 766-3981

QUANTITY | DESCRIPTION

2.0) Equipment (Cont'd.)

d) Thirty-six (36) only 0.430" dia., 0.035" Wall, Incoloy 800 Tubular Heating Elements mounted in two (2) rows (double wide).

1) Elements configured for 6KW or 52KW discrete operation.
2) Elements mounted into flange-plate via compression fittings to form a moisture tight seal.

e) Built-in:

1) Fused Contactors.
2) High Limit Cut-out.
3) Adjustable Thermostat, Range 0°-100°F, SPST, 25A.
4) Control Transformer.
5) Relay for remote signal to indicate 400 CFM or 3600 CFM operation.

f) Wired for dual purpose duty, with customer supplied remote signal enabling contactor switching from 6KW (400 CFM) to 52KW (3600CFM) operation.

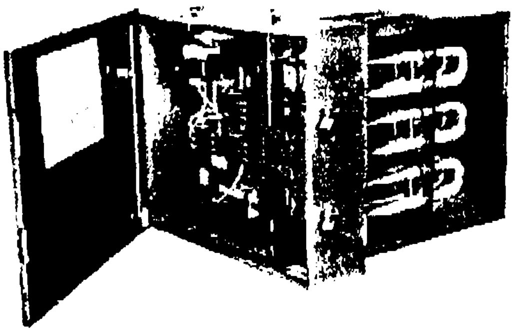
g) NEMA 4 Terminal Enclosure.

INQUIRY NO. ______

REFERENCE NO. DJP-92-2892

PAGE 2 OF 2

BY: D. Jerry Patterson



SELECTION

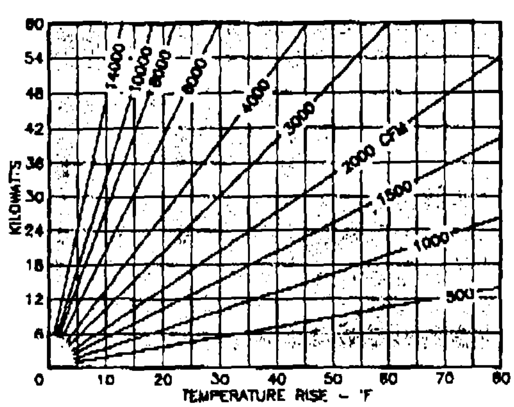
The finned tubular design is the engineering preference. It incorporates the highest wattage per cross sectional duct area thus making it more economical than the incoloy tubular design. It is not subject to shock hazard, allowing installation close to a register or grille. It is least effected by the accumulation of dust and dirt within the duct and is resistant to vibration and mechanical abuse.

The incoloy tubular design should be chosen where high humidity or slightly corrosive chemical contaminants are present in the air stream.

Where economy is the only factor to be considered the open coil design is best suited. However the open coil design is not suitable for applications where shock hazards, dust and dirt, vibration, or high humidity are factors.

In order to select the proper KW for your application use FIG. 6 below.

FIG. 6 - RECOMMENDED KILOWATTS

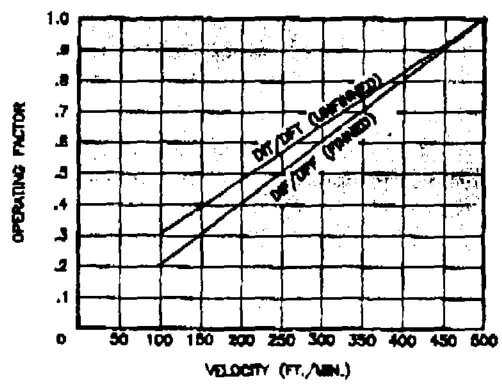


See TABLE 1 on page 64 for typical duct heater sizes and KW ratings based on an air flow velocity of 500 ft/min. or higher.

If the flow velocity is less than 500 ft./min., the typical maximum KW ratings in the table must be derated using FIG. 7 below.

Multiply the KW ratings shown in TABLE 1 by the appropriate derating factor from FIG. 7.

FIG. 7 - DERATING FACTORS



INSTALLATION

Finned tubular duct heaters are designed for horizontal installation where the maximum inlet air temperature does not exceed 25°C (77°F) and the maximum rating does not exceed 120KW.

Check factory for limitations on tubular and open coil designs.

STANDARD DIMENSIONS

Insert type duct heaters are slightly undersized to permit installation in ducts having the A and B dimensions listed in TABLE 1.

Refer to the table below for standard frame dimensions.

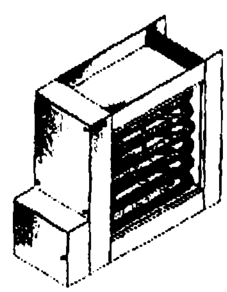
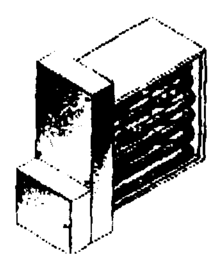


FIG. 9 - TYPES DFF/DFT

FIG. 8 - TYPES DIF/DIT



DIM.	in.	mm
C	6 1/2	163
D	6	150
E	2	50

Caloritech INC.

FINNED TUBULAR AND TUBULAR HEATERS

TABLE 1 below lists some of the more common heater sizes with maximum kilowatt ratings for each size. Stock modular frames allow quick delivery for other sizes in increments of 2".

TABLE 1 - TYPICAL DUCT HEATER SIZES
600V MAXIMUM - SINGLE OR THREE PHASE

DIMENSIONS INCHES A x B	TYPES DIF/DFF MAX. KW	TYPES DIF/DFF MAX. NO. OF ELEMS.	TYPES DIT/DFT MAX. KW	TYPES DIT/DFT MAX. NO. OF ELEMS.
6 x 6	2.5	3	1.5	6
8 x 6	3	3	3.0	6
10 x 6	4	3	2.5	6
10 x 8	5.5	4	3.5	8
12 x 6	5	3	3.5	6
12 x 8	6.5	4	4.5	8
12 x 10	8	5	5.5	10
14 x 8	7.5	4	5.5	8
14 x 10	9.5	5	6.5	10
14 x 12	11.5	6	8.0	12
16 x 10	11	5	7.5	10
16 x 12	13	6	9.0	12
16 x 14	15.5	7	10.5	14
18 x 12	15	6	10.5	12
18 x 14	17.5	7	12	14
18 x 16	20	8	14	16
20 x 14	19	7	13.5	14
20 x 16	22	8	15.5	16
20 x 18	25	9	17.5	18
22 x 16	24	8	17	16
22 x 18	27.5	9	19	18
22 x 20	30.5	10	21	20
24 x 18	30	9	21	18
24 x 20	33	10	23	20
24 x 22	36.5	11	25.5	22
26 x 20	36	10	25	20
26 x 22	39.5	11	27.5	22
26 x 24	43	12	30	24
28 x 22	42.5	11	29.5	22
28 x 24	46.5	12	32.5	24
28 x 26	50.5	13	35	26
30 x 24	50	12	35	24
30 x 26	54	13	37.5	26
30 x 28	58	14	40.5	28
30 x 30	62.5	15	43.5	30

Example Catalog No.
DIF-12X10-8
DIF - Indicates insert finned type (DFF - flanged finned type, DIT - insert tubular, DFT - flanged tubular)

12 x 10 is A x B DIM.'s in inches.

8 = KW rating.

HOW TO ORDER

When ordering specify volts, watts, phase, duct size, element type, frame type and optional features.

STANDARD FEATURES

- Primary linear cutout,
  160°F (71°C)
  277/600 VAC, 25/10 AMP non-inductive
- Secondary linear cutout - Manual reset complete with back-up magnetic contactor on units under 300V, 30kw and less, 225°F (107°C)
  277/600 VAC, 25/10 AMP non-inductive

OPTIONAL AUXILIARY DUCT HEATER CONTROLS

Tubular and finned tubular types only.

These controls are available as factory installed on the duct heater or as an EEMAC rated (specify) control panel for wall mount.

- Wall Thermostats
  T498A
  T6051A (1 STAGE)
  T6052A (2 STAGE)
  T921A (0-135 OHM)
- Duct Thermostats
  T675A (1 STAGE)
  T678A (2 STAGE)
  T991A (0-135 OHM)
- Bulb Holders
- Silent Contactors
- SCR Controllers
- Sail Switch
- Pressure Differential Switch
- Main Disconnect
- Pneumatic Electric Switches
- On-Off Switch
- Magnetic Contactors
- Step Controllers
- HRC Fusing
- Control Transformers
- Fan Interlock Relay
- Pilot Lights

See bulletin 89-132 for further details.

OPEN COIL HEATERS

Open coil duct heaters are suitable for both horizontal or vertical air flow in either direction for insert or flange mounting.

Not suitable for use in applications where shock hazards, dust and dirt, heavy vibration, or high humidity are factors.

Units are manufactured in sizes up to 36" (insert length) x 18" with a maximum kilowatt rating of 62KW depending on physical size and air velocity.

Maximum available voltage is 600V.

STANDARD FEATURES INCLUDE:

- Thermal cutouts
- Magnetic contactors
- Control circuit transformers for 24V control
- Supply and control terminals

OPTIONAL FEATURES INCLUDE:

- Air flow proving device
- Toggle disconnect switch
- Protective screens

INSTRUCTIONS FOR THE INSTALLATION AND USE OF ASHCROFT® BI-METAL DIAL THERMOMETERS

GENERAL

In removing the thermometer out of the packing box, handle it by the case or case outlet. Avoid handling it by the stem.

INSTALLATION OF THERMOMETERS

The thermometer should be mounted at any convenient location where it will be subjected to the average temperature variations to be indicated.

Avoid bending the stem as this will cause misalignment of the internal parts, resulting in undue frictional errors.

To tighten the thermometer to the apparatus, use a wrench applied to the hexagon head of the threaded connection located just outside of the case.

INSTALLATION

Locate the stem so that at least the last two inches will be subjected to the average temperature to be measured.

Exposing the stem to a temperature in excess of the highest dial reading should be avoided.

The thermometer is normally provided with a threaded connection. To tighten the thermometer to the apparatus or into the well, use an open-end wrench applied to the hexagon head of the threaded connection. Turn until reasonably tight, then tighten still further in the same manner as a pipe elbow or similar pipe fitting until the scale is in the desired position for reading. DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE. *Install the thermometer so that the maximum case temperature is kept below 200°F at all times.*

When a thermometer is equipped with a well, the well should be installed onto the apparatus first. The stem of the thermometer should then be coated with a heat conducting medium (a mixture of glycerine and graphite or vaseline or any other heavy lubricant may be used), after which the thermometer stem is inserted, and tightened into the well.

CAUTION: Thermowells should be used on all pressurized applications, to protect the thermometer stem from corrosion or physical damage, and to facilitate removal of thermometer without disturbing the process.

TESTING

Ashcroft Bi-metal Dial Thermometers are carefully calibrated at the factory and under most operating conditions will retain their accuracy indefinitely. However, as in the case of all instruments, it is well to make periodic checks for accuracy against known standards.

ADJUSTMENT

If it is necessary to make an adjustment to the thermometer, proceed as follows:

On thermometers fitted with an "External Adjustment"—Use a small wrench, small screwdriver or a coin to turn the slotted hexagon head in the back of the case until the pointer indicates the proper temperature on the dial.

MAINTENANCE OF DIAL THERMOMETERS

Aside from occasional testing, little or no maintenance is required.

Be sure that the gasketed glass cover is on the case at all times, as moisture and dirt inside the case will eventually cause the thermometer to lose its accuracy. (See caution note below).

If the thermometer is used for measuring the temperature of a material that may harden and build up an insulating layer on the stem, the thermometer should be removed from the apparatus occasionally, and the stem cleaned. Observe this precaution to insure the sensitivity of the instrument.

CAUTION: Bi-metal Thermometers operating below freezing must have a perfectly tight case to prevent entrance of moisture which eventually will condense and freeze inside the stem. This condition shows up as a failure of the thermometer to read accurately below 32°F or 0°C. For this reason it is important to avoid damage to the glass front, while the stem temperature is at freezing or below.

Thermometers fitted with the non-removable ring are hermetically sealed in a dry atmosphere at the factory and require no further maintenance.

DRESSER INDUSTRIES DRESSER

INSTRUMENT DIVISION
DRESSER INDUSTRIES INC.
STRATFORD, CONNECTICUT 06497

Form No. 250-999-J

Printed in U.S.A.

GPC 70 Gas Phase Carbon Adsorber

The GPC 70 Gas Phase Carbon Adsorber by Carbonair is the largest gas phase carbon adsorber available. Its welded-steel construction provides exceptional strength and durability, while the integrated lifting eyes and roll-off truck compatibility of the unit make transportation and installation quick and trouble-free. The interior is double-coated with a corrosion-resistant epoxy polyamide ideal for the corrosive and abrasive conditions of gas phase service. The unit's superior design and remarkable portability make the GPC 70 suitable for any gas phase application, including air-stripper and soil-venting off-gas treatment.

Carbonair adsorbers are available with a variety of options according to purchaser's specifications.

OPTIONS

Optional materials of construction.

Blower(s) and controls.

Humidity control.

Influent/effluent ducting.

Additional sampling couplings and valves.

Discharge stacks.

FEATURES

Skid-mounted, welded-steel construction provides superior durability.

Interior epoxy coating, stainless steel and FRP internals offer extraordinary chemical resistance. Coating conforms to AWWA D 102 Inside System No. 1 and AWWA C 210-84 for immersion service, and has been tested and approved in accordance with FDA Regulations, Title 21, Section 175,300. It also meets U.S. EPA regulations for VOCs, as well as the abrasion resistance criteria established by ASTM D 4060.

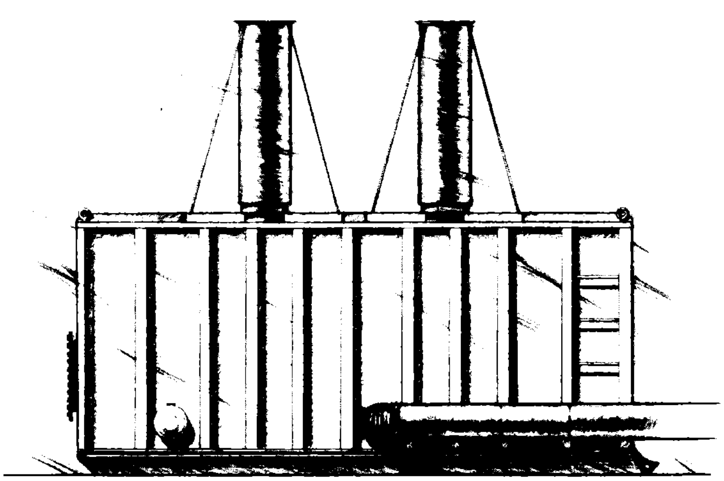
10,000-pound carbon capacity provides extended bed life.

12-inch inlet ports enable maximum carbon utilization.

16-inch discharge stacks promote optimum discharge of treated effluent.

Easy-access, stainless steel screen on FRP grate ensures full drainage of condensation.

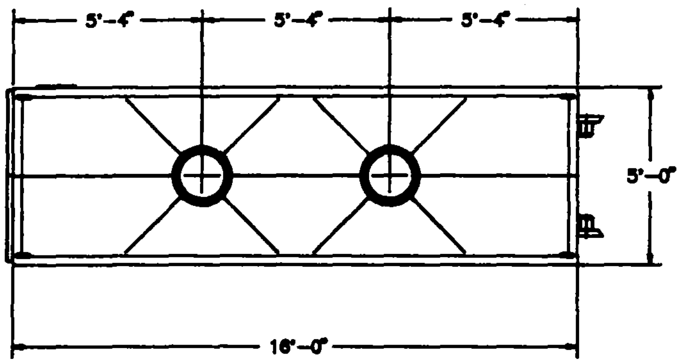
Built-in sample couplings afford easy sampling of both the influent and effluent streams.



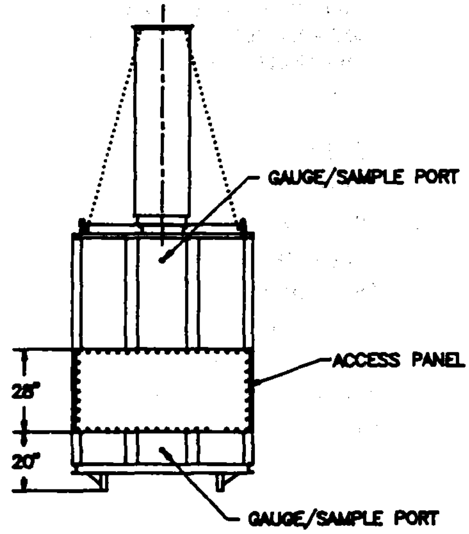
SPECIFICATIONS

DIMENSIONS	16 ft. 8½ in. length x 5 ft. width x 7 ft. 6 in. overall height (5.0 m x 1.5 m x 2.3 m)
BED AREA	69.8 $ft.^2$ (6.3 m^2)
FLOW RANGE	700-7,000 cfm (21-210 m^3/min)
CARBON CAPACITY	10,000 lbs. (4,500 kg)
FITTINGS	Six (6) 12-in. quick-connect air inlet ports Two (2) 16-in. quick-disconnect off-gas stacks with weather shields One (1) 1-in. condensation drain Two (2) ¾-in. full-coupling sample ports
EMPTY WEIGHT	5,500 lbs. (2,475 kg)
OPERATING WEIGHT	20,000 lbs. (9,100 kg)

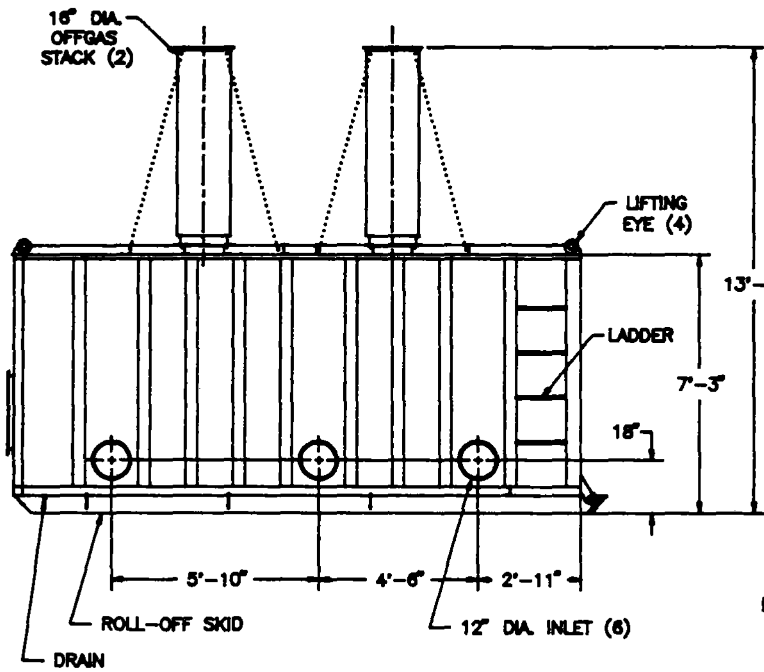
Carbon Adsorber–Vapor Phase
GPC 70



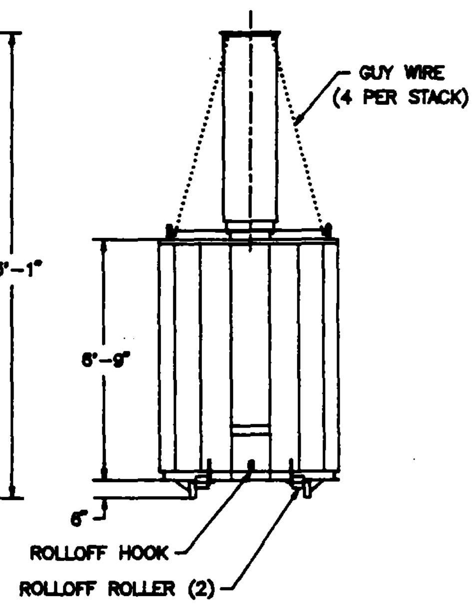
TOP VIEW



REAR END VIEW



SIDE VIEW

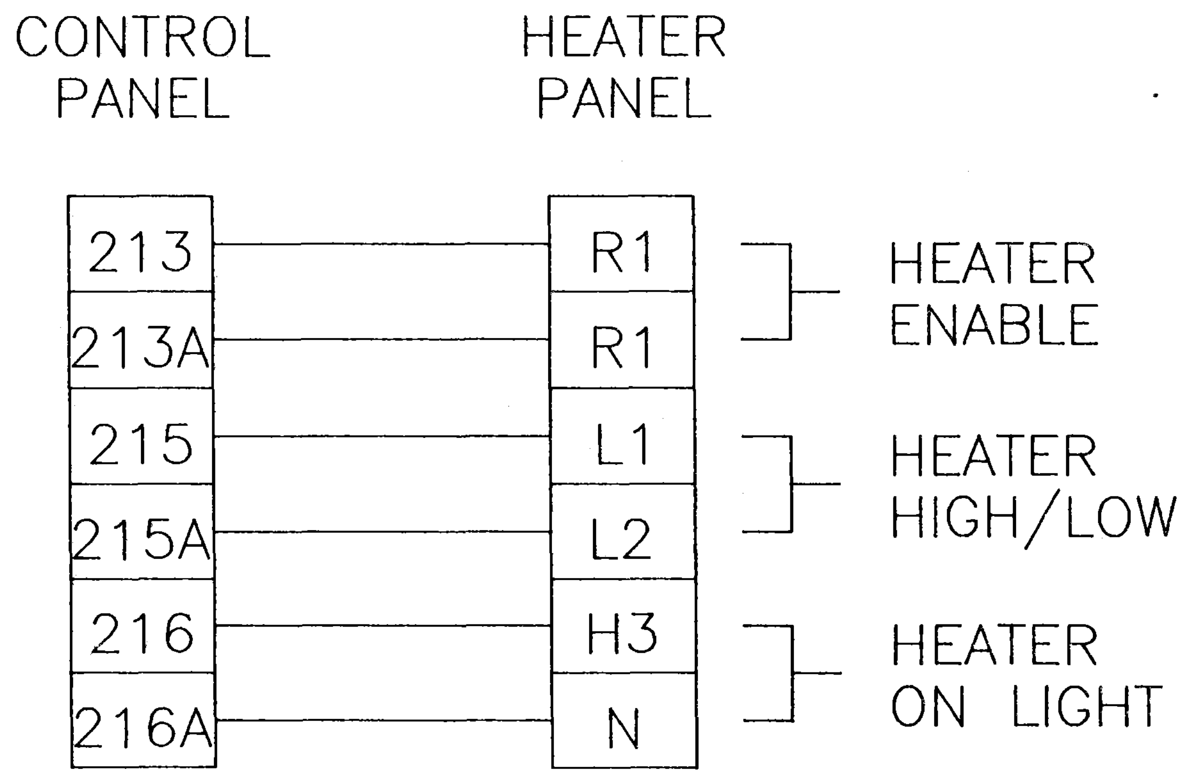


FRONT END VIEW

Sales Drawing #107196
91.06.20

REVISIONS

REV	ECO	DESCRIPTION	DATE	DRN
A	---	AS-WIRED	9/15/92	DK



JOB NUMBER 301960

TOLERANCES UNLESS NOTED OTHERWISE

DECIMAL	FRACTIONAL	ANGLES
----	----	----

APPROVAL		DATE
DRFT	DK	9/15/92
MATCHING		•
BISCALE	1	
LTSCALE	1	

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED:
- DIMENSIONS ARE IN INCHES
- DO NOT SCALE DRAWING

CARBONAIR
WATER AND AIR DECONTAMINATION
MINNEAPOLIS, MINNESOTA

TITLE
INTERFACE MAIN TO HEATER PANEL
NIROP II – FMC

SIZE	DWG. NO.	REV
A	120896	A

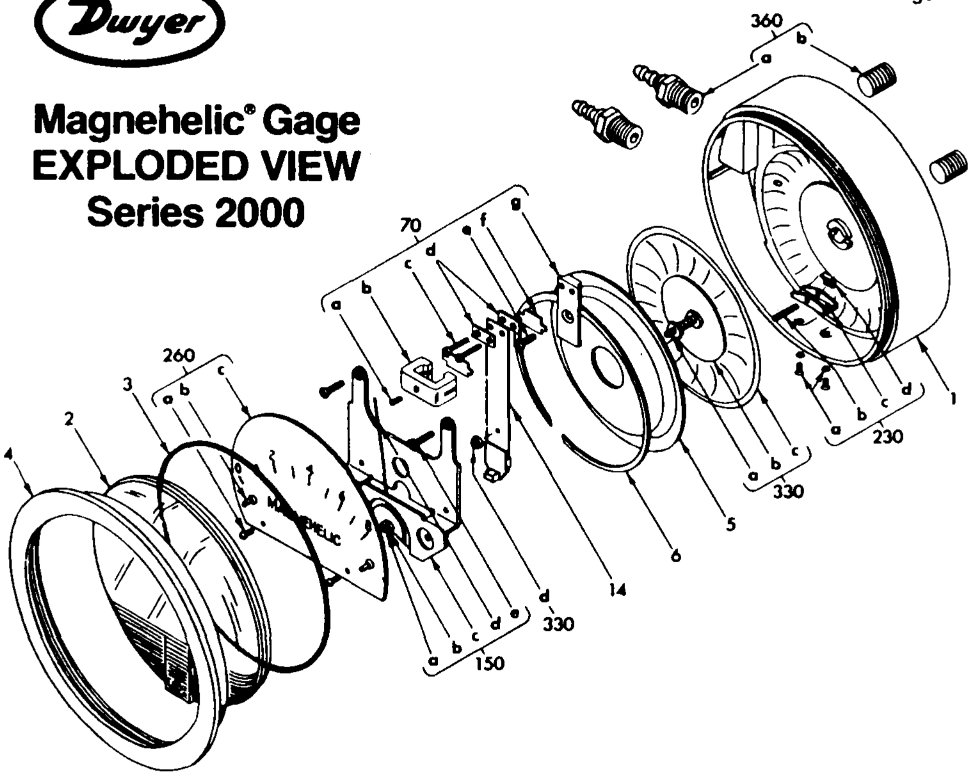
SCALE 1=1 | B.L. 119898 | SHEET 1 OF 1

ELECTRICAL LAYOUT: DRAWING A73095

NUMBER	ITEM	QTY	PART NO.
DET 1	CONTROL PANEL		INTEGRAL
DET 2	SPLITTER	1	65103
DET 3	TRANSFORMER	1	MH100CJ
DET 4	CTRL FUSE + HOLDER	2	ATQ2/30310
DET 5	CTRL FUSE + HOLDER	1	MDX5 - ~~MDK5~~/88000
DET 6	CONTACTOR	3	42CE35AF486
DET 7	AUX, CONTACT	2	49CE42SPDT
DET 8	MANUAL HIGH LIMIT		
DET 9	PD SWITCH		
DET 10	DPDT RELAY, 24 VAC	1	60.12P/5408
DET 11	CONTACT BLOCK	10	M4/6
DET 12	GROUND	1	SLU-35
DET 13	POWER WIRE		SEW #148A
DET 14	POWER WIRE		SEW #86A
DET 15	ELEMENTS INSTALLED	54	IXI-72739-19 460V 963W
	ELEMENTS CONNECTED	54	
	DENSITY (W/SQ.IN.)	22.5	
	KW PER CIRCUIT	17.3 FOR C1 IN HIGH HEAT MODE	
	KW PER CIRCUIT	5.8 FOR CY IN LOW HEAT MODE	
	KW PER CIRCUIT	34.7 FOR C2	
	TYPE	TUBULAR INCOLOY	
DET 16	AUTO.HIGH LIMIT	1	10H11
DET 17	SCR		
DET 18	CONTROL OR THERMOSTAT	1	ARO64
DET 19	POWER FUSE HRC-J	3	CJ10
DET 20	FUSE HOLDER	6	60305J
DET 21	POWER FUSE HRC-J	3	CJ30
DET 22	POWER FUSE HRC-J	3	CJ60
DET 23	FUSE HOLDER	3	60605J

Dwyer

Magnehelic® Gage EXPLODED VIEW Series 2000



1. Case
2. Cover with zero adjust assy.
3. "O" ring seal
4. Bezel
5. Diaphragm sealing plate
6. Retaining ring

70. Range Spring assembly
    a. Clamp set screw
    b. Clamp
    c. Mounting screws (2 req'd)
    d. Clamping shoe (2 req'd)
    e. Clamp plate screw
    f. Spacer (2 req'd)
    g. Clamp plate

14. Range Spring with magnet

150. Wishbone Assembly - consists of:
    a. Front jewel
    b. Locking nut
    c. Wishbone
    d. Pointer
    e. Mounting screws (2 req'd)
    f. Helix assembly (not shown)
    g. Pivots (2 req'd) (not shown)
    h. Rear jewel (not shown)

230. Zero adjust assembly - consists of:
    a. Foot screws with washers (2 req'd)
    b. Adjust screw
    c. Foot
    d. Finger

260. Scale Assembly - consists of:
    a. Mounting screws (2 req'd)
    b. Bumper pointer stop (2 req'd)
    c. Scale

330. Diaphragm Assembly - consists of: (Arbor press needed to install)
    a. Linkage assy., complete
    b. Front plate
    c. Diaphragm
    d. Rear plate (not shown)
    e. Plate washer (not shown)

360. Mounting Hardware Kit
    a. Adapter - pipe plug ⅛" NPT to rubber tubing - (2 req'd)
    b. Pipe plug ⅛" NPT - (2 req'd)
    c. Mounting lug (3 req'd)
    d. Long screw (3 req'd)
    e. Short screw (3 req'd)

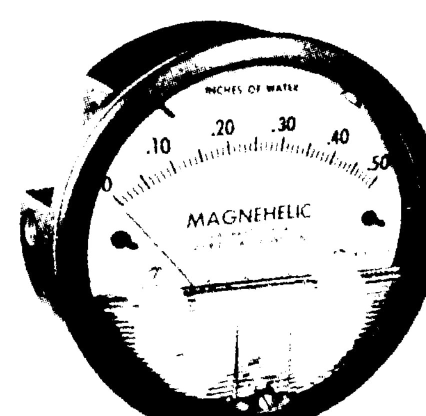
Ordering Instructions:

When corresponding with the factory regarding Magnehelic® gage problems, refer to the call-out numbers in this view. Be sure to include model number, pressure range, and any special options. Field repair is not recommended; contact the factory for repair service information.

OPERATING INSTRUCTIONS and PARTS LIST

Magnehelic® Differential Pressure Gage

Dwyer



SPECIFICATIONS

Dimensions: 4-3/4" dia. X 2-3/16" deep.

Weight: 1 lb. 2 oz.

Finish: Baked dark gray enamel.

Connections: 1/8 N.P.T. high and low pressure taps, duplicated, one pair side and one pair back.

Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).

Pressure Rating: 15 PSI.

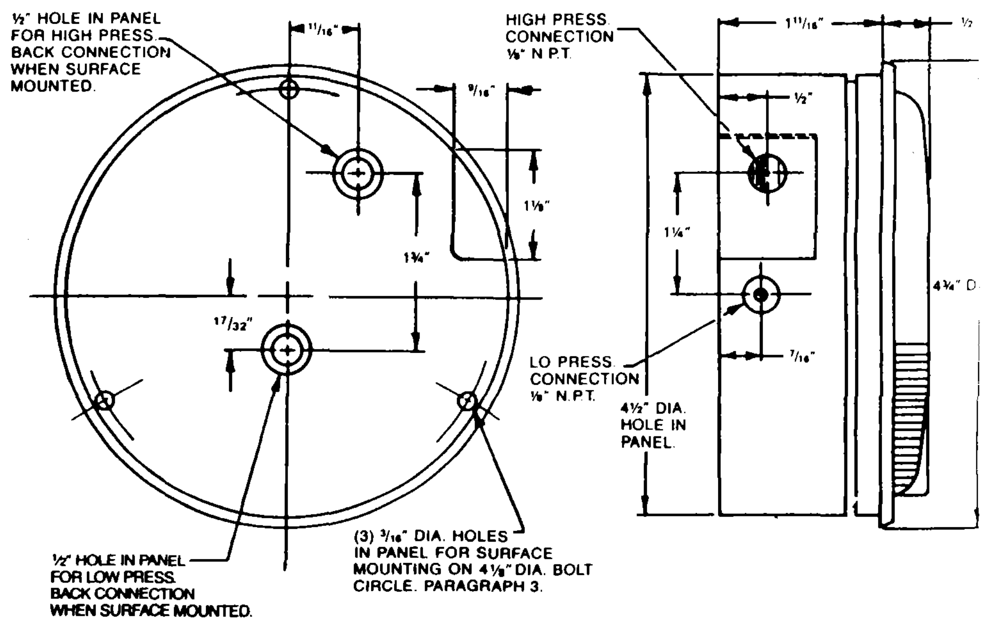
Ambient Temperature Range: 20° to 140°F.

Standard gage accessories include two 1/8" N.P.T. plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.

Caution: For use with air or compatible gases only.

For repeated over-ranging or high cycle rates, contact factory.

Hydrogen Gas Precautionary Note: The rectangular rare earth magnet used in the standard gage may not be suitable for use with hydrogen gas since a toxic and explosive gas may form. For hydrogen service, consult the factory for an alternate gage construction.

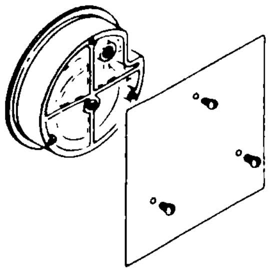


Overpressure Protection: Standard Magnehelic gages are rated for a maximum pressure of 15 psig and should not be used where that limit can be exceeded. Newer models employ a rubber plug on the rear which will unseat and vent the gage at approximately 25 psig. When surface mounting units with this feature, provide a vent hole, as indicated on the dimension drawing, or allow a minimum 1/8" clearance when flush mounting.

1. Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F. Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines may be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

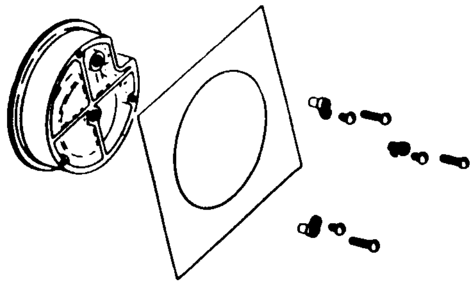
2. All standard Magnehelic gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range Model 2000-00 and metric equivalents must be used in the vertical position only.

3. Surface Mounting



Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

4. Flush Mounting



Provide a 4½" dia. opening in panel. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adaptors, Part No. 360c, firmly secured in place. To mount gage on 1¼"-2" pipe, order optional A-610 pipe mounting kit.

5. To zero the gage after installation

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

Operation

Positive Pressure: Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

Negative Pressure: Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

Differential Pressure: Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of gage is vented in a dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

a. For portable use or temporary installation, use 1/8" pipe thread to rubber tubing adapter and connect to source of pressure with rubber or Tygon tubing.

b. For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended. See accessory bulletin S-101 for fittings.

MAINTENANCE

Maintenance: No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves, (bulletin S-101), should be used in permanent installations.

Calibration Check: Select a second gage or manometer of known accuracy and in an appropriate range. Using short lengths of rubber or vinyl tubing, connect the high pressure side of the Magnehelic gage and the test gage to two legs of a tee. Very slowly apply pressure through the third leg. Allow a few seconds for pressure to equalize, fluid to drain, etc., and compare readings. If accuracy unacceptable, gage may be returned to factory for recalibration. To calibrate in the field, use the following procedure.

Calibration:

1. With gage case, P/N 1, held firmly, loosen bezel, P/N 4 by turning counterclockwise. To avoid damage, a canvas strap wrench or similar tool should be used.
2. Lift out plastic cover and "O" ring.
3. Remove scale screws and scale assembly. Be careful not to damage pointer.
4. The calibration is changed by moving the clamp, P/N. 70-b. Loosen the clamp screw(s) and move slightly toward the helix if gage is reading high, and away if reading low. Tighten clamp screw and install scale assembly.
5. Place cover and 0-ring in position. Make sure the hex shaft on inside of cover is properly engaged in zero adjust screw, P/N 230-b.
6. Secure cover in place by screwing bezel down snug. Note that the area under the cover is pressurized in operation and therefore gage will leak if not properly tightened.
7. Zero gage and compare to test instrument. Make further adjustments as necessary.

Caution: If bezel binds when installing, lubricate threads sparingly with light oil or molybdenum disulphide compound.

Warning: Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended. For best results, return gage to the factory. Ship prepaid to:

Dwyer Instruments, Inc.
Attn. Repair Department
55 Ward Street
Wakarusa, IN 46573

Trouble Shooting Tips:

• *Gage won't indicate or is sluggish.*

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O" ring damaged, missing.
5. Pressure sensors, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F, order gage with low temperature, (LT) option.

• *Pointer stuck-gage can't be zeroed.*

1. Scale touching pointer.
2. Spring/magnet assembly shifted and touching helix.
3. Metallic particles clinging to magnet and interfering with helix movement.
4. Cover zero adjust shaft broken or not properly engaged in P/N 230-b adjusting screw.

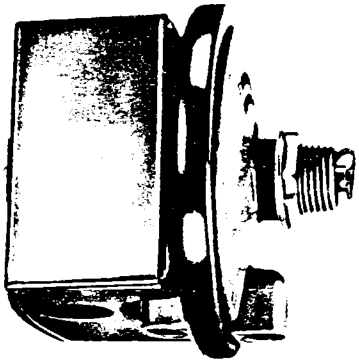
We generally recommend that gages needing repair be returned to the factory. Parts used in various sub-assemblies vary from one range of gage to another, and use of incorrect components may cause improper operation or failure. Gages repaired at the factory are carefully calibrated and tested to assure "like-new" operation. After receipt and inspection, we will be happy to quote repair costs before proceeding.

Consult factory for assistance on unusual applications or conditions.

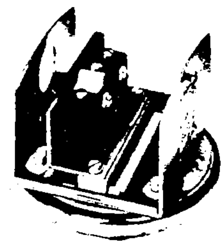
Use with air or compatible gases only.

SERIES 1800 Low Differential Pressure Switches for General Industrial Service

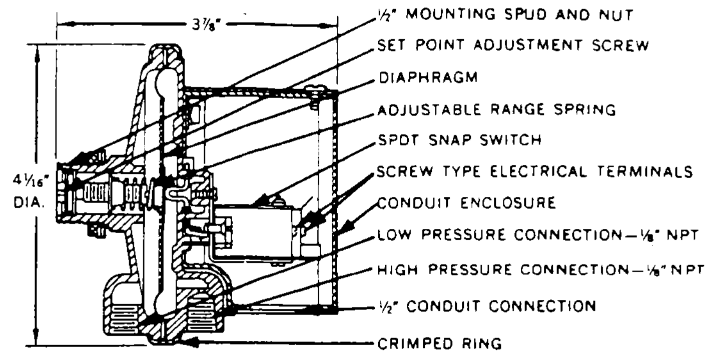
Compact, economically priced switches in 8 standard ranges. Set points from 0.15" to 85" W.C. Repetitive accuracy within 2%. U.L. and C.S.A. listed, F.M. approved.



Model 1823 pressure switch. U.L. and C.S.A. listed, F.M. approved.



Series 1823 pressure switch. Conduit enclosure removed to show electric switch.



Construction and dimensions. Series 1823 pressure switches.

One of our most popular pressure switches. Combines small size and low price with 2% repeatability for enough accuracy for all but the most demanding applications. Set point adjustment inside the mounting spud permits mounting switch on one side of a wall or panel with adjustment easily accessible on the opposite side.

U.L. and C.S.A. listed, F.M. approved.

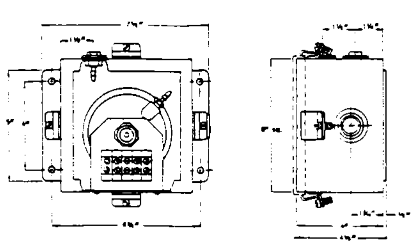
***Model 1823 shown; (1823 replaces 1820, 1821 and 1822 which are similar).**

Environmental (MIL) Switch

Unlisted Model 1820 can be furnished with special snap switch sealed against the environment for temperatures down to −65° F., high humidity and/or for government applications. Similar to standard Model 1823 except dead band is slightly greater. Specify Model 1820 (Range No.) "MIL" in ordering.

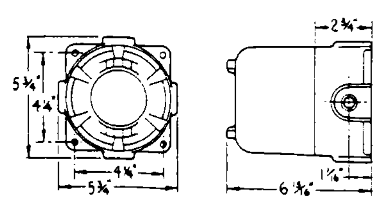
Weatherproof Enclosure

16 ga. steel enclosure for unusually wet or oily conditions. Withstands 200 hour salt spray test. Gasketed cover. Weight 5½ lbs. Switch must be installed at factory. Specify "WP" in addition to switch catalog number.



Explosion-Proof Housing

Cast iron base and aluminum dome cover. Approximate weight 7½ lbs. Specify "EXPL" in addition to switch catalog number.



How to Order: See price list, Bulletin S-26.

PHYSICAL DATA

Temperature limits: —30°F for dry air or gas to 180° F.

Maximum surge pressure: 25 psig

Rated pressure: 10 psig.

Pressure connections: ⅛" NPT.

Electrical rating: 15 amps, 120-480 volts, 60 Hz. A.C. Resistive ⅛ H.P. @ 125 volts, ¼ H.P. @ 250 volts, 60 Hz A.C. See INSTALLATION for derating information above 130° F.

Wiring connections: 3 screw type, common, normally open and normally closed.

Set point adjustment: Screw type inside mounting spud.

Housing: Aluminum die casting. Steel fittings zinc plated, dichromate dipped for 200 hour salt spray test.

Diaphragm: Silicone rubber on nylon with aluminum support plate.

Calibration Spring: Stainless steel.

Mounting spud: ½" pipe thread.

Weight: 1 lb., 5 oz.

Installation: Diaphragm vertical.

SERIES 1823 SWITCHES: OPERATING RANGES AND DEAD BANDS. U.L. and C.S.A. Listed, F.M. Approved.

Model Number	Operating Range Inches, W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to 10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.1
1823-80	9 to 85	1.3	3.0

Suggested Specification

Differential pressure switches shall be diaphragm operated with 4" diaphragm to actuate a single pole double throw snap switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Switches shall be Dwyer Instruments, Inc. Catalog No. 1823-____ for the required operating ranges.

SERIES 1823 DIFFERENTIAL PRESSURE SWITCHES

Specifications — Installation & Operating Instructions — Parts List

INSTALLATION AND OPERATION

INSTALLATION

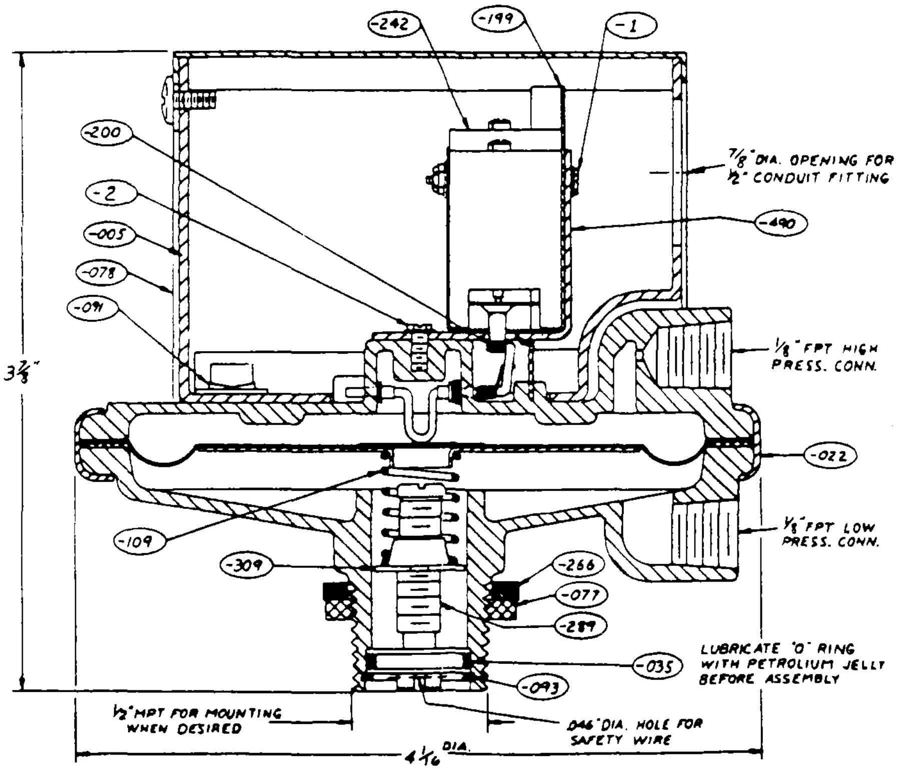
1. Select a location free from excessive vibration where oil or water will not drip upon the switch and where ambient temperature will not exceed 130°F. See special housings for unusual conditions.
2. **While not required, positioning the pressure connections down is recommended.** Mount the switch with the diaphragm in a vertical plane. Must be recalibrated for each change in operating position.
3. Connect switch to source of pressure differential. Metal tubing with 1/4" O.D. is recommended but any tubing system which will not restrict the air flow unduly is satisfactory. Note that the low pressure connection may be made to the 1/2" stud at the back of the switch if desired. If so connected, drill 1/16" diameter holes in the Spring Retainer flange (PN 1823-309) and the head of Adjustment Screw (PN 1823-289) to provide opening to the switch interior and plug the other low pressure connection.
4. Electrical connections to the standard single pole, double throw snap switch are provided by means of screw terminals marked "common", "norm open", and "norm closed". The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point.
5. Switch loads should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with an increase in ambient temperature above 130°F, high load inductance, or rapid cycle rates. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

ADJUSTMENT

1. If the switch has been factory preset, check the set-point before placing in service to assure it has not shifted in transit.
2. If switch has not been preset or if it is desired to change the set point, observe the following procedure:
   a. To adjust the set point turn the slotted Adjustment Screw (PN 1823-289) clockwise to increase the set point and counter-clockwise to decrease the set point.
   b. Important Note. The following is a recommended procedure for calibrating or checking calibration: Use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point slowly. Note that manometer and pressure switch will have different response characteristics due to different internal volumes, lengths of tubing, oil drainage, etc. Be certain switch is checked in position it will assume in use, i.e., vertical, horizontal, etc.

CROSS SECTIONAL VIEW

Part No.	Name
1823-005	Conduit Enclosure (1)
1823-022	Switch Body Assembly – Aluminum Die Casting Diaphragm Assembly .008" Silicone on Nylon and Aluminum Assembly Ring (1)
1823-035	"O" Ring 1/2" X 5/8" (1)
1823-077	Mounting Nut – 1/2" Electrical Nut – Steel (1)
1823-078	Conduit Cover Assembly (1)
1823-091	Conduit Enclosure Fasteners – Tinnerman Speed Nut (4)
1823-093	Retaining Ring (1)
1823-109	Calibration Spring – Stainless Steel (1)
1823-199	Insulation Shield – 1/32" Thick Hard Fibre (1)
1823-200	Switch Button – Nylon (1)
1823-242	Micro-Switch #BZ-RW84-A2
1823-266	Mounting Washer – 1-5/32" O.D. X .844" I.D. – Steel (2)
1823-289	Calibration Adjustment Screw (1)
1823-309	Calibration Spring Retainer – Brass (1)
1823-490	Switch Bracket – Steel (1)
1823-1H	#6-32 X 1 Steel Screw #6L Brass Washer #6-32 Lock Nut
1823-2H	#6-32 X .5/16" Steel Screw



When corresponding with the factory regarding 1800 series switch problems, please refer to the call-out numbers in this view to assure proper identification. Be sure to include the operating range and any optional features. Field service is not recommended. Contact the factory for service information.

Litho in U.S.A. 4/89

F. R. No. 24-440256-00

1 YEAR LIMITED WARRANTY

1. **WARRANTOR:** Dealer, Distributor, Manufacturer

2. **ELEMENTS OF WARRANTY:** This Product is warranted to be free from defects in materials and craftsmanship with only the limitations and exclusions set out below.

3. **WARRANTY AND REMEDY:**

One-Year Warranty -- In the event that the Product does not conform to this warranty at any time during the time of one year from original purchase, warrantor will repair the defect and return it to you at no charge

This warranty shall terminate and be of no further effect at the time the Product is (1) damaged by extraneous cause such as fire, water, lightning, etc. or not maintained as reasonable and necessary; (2) modified; (3) improperly installed; (4) repaired by someone other than warrantor; (5) used in a manner or purpose for which the Product was not intended; or (6) sold by original purchaser.

WARRANTORS' OBLIGATION UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT. THIS WARRANTY DOES NOT COVER PAYMENT OR PROVIDE FOR THE REIMBURSEMENT OF PAYMENT OF INCIDENTAL OR CONSEQUENTIAL DAMAGES.

It must be clear that the warrantors are not insuring your premises or guaranteeing that there will not be damage to your person or property if you use this Product. The warrantors shall not be liable under any circumstances for damage to your person or property or some other person or that person's property by reason of the sale of this product or its failure to operate in the manner in which it is designed. The warrantors' liability, if any, shall be limited to the original cost of the Product. The warrantors assume no liability for installation of the Product and/or interruptions of the service due to strikes, riots, floods, fire, and/or any cause beyond Seller's control.

4. **PROCEDURE FOR OBTAINING PERFORMANCE OF WARRANTY:** In the event that the Product does not conform to this warranty, the Product should be shipped or delivered freight prepaid to a warrantor with evidence of original purchase.

5. **LEGAL REMEDIES:** This warranty gives you specific legal rights, and you may also have other rights which vary from state to state to the extent allowed by law expressly in lieu or any other express or implied warranty, condition, or guarantee.

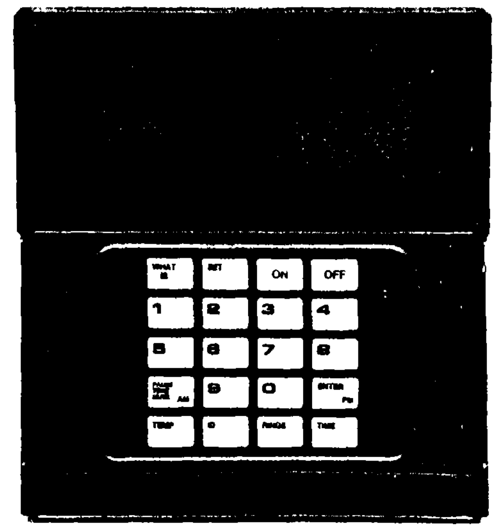
Effective date 7/01/90

Sensaphone® 1000

Desktop Environmental Monitoring System

OWNER'S MANUAL

Economical monitoring over telephone lines to protect your home or business



The SENSAPHONE system allows you to establish two-way communication and direct security monitoring of your property, even when there's no one there. It calls to tell you there's a problem and reports on:

- Fire and Smoke • Power Failure
- Temperature Changes • Intruders
- Leaks or Flooding . . . and more.

Phonetics, Inc.

901 Tryens Road, Aston, PA 19014

TABLE OF CONTENTS

INTRODUCTION

SENSAPHONE CAPABILITIES

The Sensaphone Model 1000 is an electronic watchman. It monitors specific environmental and operating conditions of your vacation home, business, or other property. The Model 1000 is equipped with built-in sensors that automatically monitor the following conditions:

AC electrical power--checks for power failure.

Temperature--it gives actual temperature and checks to see if it exceeds or falls below user-programmed high and low limits

High sound levels--such as smoke or burglar alarms.

Battery--the condition of its battery back-up.

The Sensaphone Model 1000 also has three digital alert inputs for sensors or switches (see Appendix C). The attachable sensors monitor other conditions at the unit's location or other areas, such as:

Intrusion into premises

Water leaks or floods

Temperature in remote areas

The use of each alert input can vary widely. One example is as follows:

Alert 1--Passive infrared sensor to detect intrusion

Alert 2--Water sensor for water seepage in a basement

Alert 3--Magnetic reed switch for a door

All monitoring is a continuous process. When a problem arises, the unit will sequentially dial up to four user-programmed telephone numbers with an alarm message. It will state the existing problem, then wait for the person answering to acknowledge the alarm call. The Model 1000 will continue dialing-out until its message is properly acknowledged.

You can also call-in to the Model 1000 to get a status report on the monitored conditions and listen in through the built-in microphone.

THE SENSAPHONE 1000 OWNERS' MANUAL

This manual describes the features and operation of the Sensaphone Model 1000. It provides explanations, illustrations, and examples to simplify its installation and programming.

Read this manual completely and experiment with the examples before starting your actual programming.

SENSAPHONE SPECIFICATIONS AND STATISTICS

SIZE

2 inches high, 7 1/2 inches wide, 8 1/2 inches deep.

SHIPPING WEIGHT

4 lb. (without batteries).

BATTERY SYSTEM

Six D-cell alkaline batteries (not included).

There is approximately 8 - 10 hours of continuous operation from the batteries when an AC power failure occurs and the unit is ON. Turning the unit OFF disconnects all functions, but if AC power is removed, the batteries will still be drained.

AC CONNECTION

UL-listed Class 2 wall transformer with a six-foot cord. Converts 110 VAC, 60 Hz, 8 Watt input to 9 VAC, 60 Hz, 600 mA output.

TELEPHONE CONNECTION

Standard modular connector (RJ11C) with a six-foot cord.

OPERATING CONDITIONS

The Sensaphone Model 1000 should not be operated in temperatures less than +40° F nor more than +120° F.

Do not use the Model 1000 in an environment where it is exposed to fumes or corrosive vapors. They might damage the unit, causing it to malfunction, and void the warranty.

POWER SURGE PROTECTION

Your Sensaphone Model 1000 may be affected by power surges through the telephone line or the 110 VAC power supply. **We recommend that you obtain additional protection for the 1000, and for any electronic equipment which is attached to your power supply and telephone lines. This is especially important if you live in a lightening-prone area.** One protection device is the TRIPP LITE "Isotel" Model IB-4. It is available through Phonetics. (see Appendix C).

IMPORTANT!

The Sensaphone Model 1000 should be periodically checked to ensure proper operation in your particular installation. If you are using external sensors, their operation must be checked periodically as well. **The system with its sensors (if any) should be COMPLETELY checked monthly to ensure proper operation.**

Always disconnect all telephone lines from wall outlets before servicing or disassembling this equipment, or replacing batteries.

FCC REQUIREMENTS

PART 68 - The Sensaphone Model 1000 complies with Part 68 of the FCC Rules. On the bottom of the unit is a label that contains, among other information, the FCC Registration Number and the Ringer Equivalence Number (REN). You must, upon request, provide this information to your telephone company.

The REN is useful for determining the quantity of devices that you may connect to your telephone line and still have all of those devices ring when your telephone number is called. In most areas, the sum of the RENs of all devices connected to one line should not exceed 5.0. To be certain of the number of devices that you may connect to your telephone line, you should contact your local telephone company.

Should the Sensaphone Model 1000 cause harm to the telephone network, the telephone company shall, if possible, notify you that temporary discontinuance of service may be required. However, if such action is necessary and prior written notice is not possible, the telephone company may temporarily discontinue service without notice. The telephone company may make changes in its communications facilities, equipment, and operations procedures, where such action is reasonably required in the operation of its business and is not inconsistent with the rules and regulations of the Federal Communications Commission.

The Sensaphone Model 1000 should not be used on coin telephone lines. Connection to party line service is subject to state tariffs.

If trouble is experienced, disconnect the Sensaphone Model 1000 from the telephone line to determine if the unit is causing the malfunction. If the Model 1000 is determined to be malfunctioning, its use should be discontinued until the problem has been corrected. We suggest that you do the following:

1) Refer to Appendix F, **TROUBLESHOOTING**.
2) Carefully write down your observations of the Model 1000's malfunctioning.
3) Call Phonetics' Technical Support at 1-215-558-2700 if any instructions are not clear or if you have any questions.

If your Sensaphone is programmed to dial to an emergency number (i.e. the police), you must do the following when testing:

1) Remain on the line and briefly explain to the dispatcher the reason for the call before hanging up.
2) Perform such activities in the off-peak hours, such as early morning or late evening.

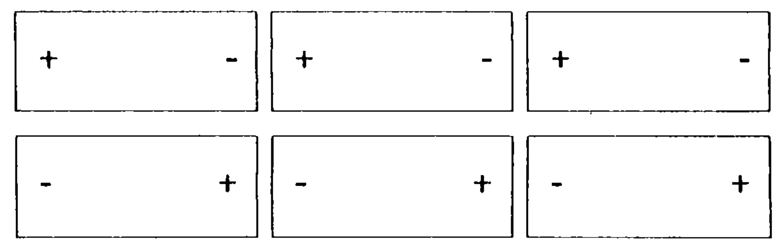
PART 15 - This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CHAPTER 1
INSTALLATION

POWER SUPPLY INSTALLATION AND TELEPHONE CONNECTION

Plug the provided AC transformer into any standard 110 VAC outlet. Next, install the 6 D-cell alkaline batteries (not included). They enable it to continue functioning when AC power is removed.

Before putting the batteries into the unit, be sure that the AC transformer is plugged into an outlet. Remove the battery compartment door on the back of the Sensaphone. Install the 6 D-cell batteries in accordance with the diagram below:



Finally, replace the battery compartment door. See Figure 1.

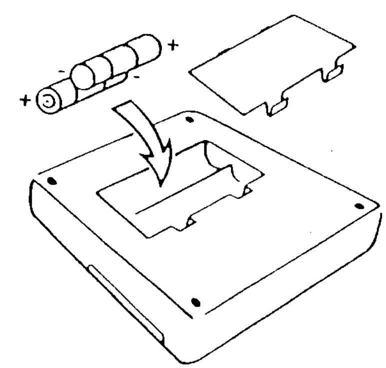


FIGURE 1: BATTERY INSTALLATION

Next, plug the provided male modular telephone jack into any standard modular telephone outlet (RJ11W for wall-mounted phones, RJ11C for other phones) (see Figure 2).

On the back of the Sensaphone is a female modular telephone jack . This is provided so that a telephone may be used on the same line as the unit. It is not necessary to hook up a telephone for the Sensaphone to operate.

If you do not have a modular telephone extension at the Model 1000's location, contact your local telephone company to have one installed (there is a nominal charge for this service). If you have four-pin jacks, adapters are readily available to convert them to the modular plugs. Contact your local telephone company or electronics parts store.

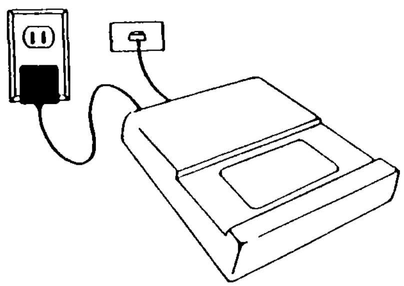


FIGURE 2: PLUGGING IN THE AC TRANSFORMER AND THE TELEPHONE JACK

IMPORTANT!

The Sensaphone Model 1000 will operate with all standard telephone systems that accept pulse or tone dialing.

Certain private telephone systems and public switching equipment may not accept Sensaphone dialing or may generate an unacceptable ring signal. In those cases, a dedicated line may be required for the 1000. Consult the supplier of your telephone system if you encounter problems.

The Sensaphone Model 1000 cannot be used on an extension line to dial its own telephone number. It should not be used on the same line with any telephone answering devices, such as modems and answering machines. Also, it may not be installed on a party line or pay telephone line.

CAUTION

Never install telephone wiring during a lightning storm. Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations. Never touch uninsulated telephone wires or terminals unless the telephone line has been disconnected at the network interface. Use caution when installing or modifying telephone lines.

You should use power surge suppression devices on both the 110 VAC power supply and the telephone line. Please refer to page 3 of the **INTRODUCTION** for further information.

MOUNTING THE SENSAPHONE 1000

The Sensaphone Model 1000 can be mounted on a wall with two screws, using the keyholes on the back panel of the unit. To do so, place two screws or bolts 3 13/16" apart at the desired height from the floor. Position the Sensaphone's keyholes over the screwheads. Slide the unit down towards the floor.

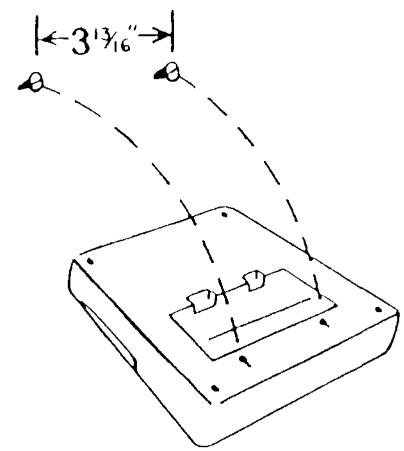


FIGURE 3: MOUNTING THE MODEL 1000

The 1000 can also be placed on top of a desk or any other horizontal surface.

THE ALERT INPUTS

The Sensaphone Model 1000 has three digital alert input terminals (see Figure 4). They are designated Alerts 1, 2, and 3.

An alert input can be used with any *normally open* (N.O.) or *normally closed* (N.C.) input device. *Open* is when there is no contact and *closed* is when a contact exists. The Model 1000 will adapt to N.O. or N.C. sensors when the unit's ID number is programmed (see Chapter 2, page 18).

CONNECTING A SENSOR TO AN ALERT TERMINAL

Each alert input consists of two screws, marked "ALERT (1, 2, or 3)." Directly above each screw is a number that designates the terminal number. For example, Alert 1 is terminals 7 & 8.

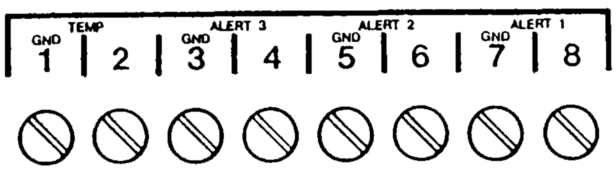


FIGURE 4: TERMINAL STRIP

You must determine what type of sensor will be connected to each alert input. For types, refer to Appendix C.

After you have selected the sensor, loosen the two screws of the alert input to which it will be connected. Two wire leads are used to connect any monitoring sensor. Fasten one lead to one screw and the other lead to the second screw. Tighten both screws. The Sensaphone may say "Alert condition (1, 2, or 3) exists" as you connect the sensor. If it does, just press any key and it will stop speaking.

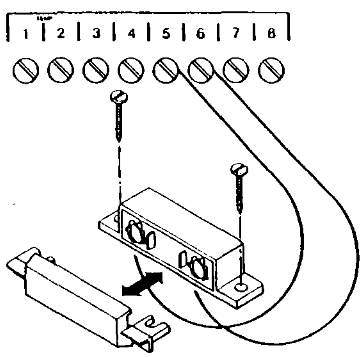


FIGURE 5: CONNECTING A SENSOR TO AN INPUT TERMINAL

NOTE:

Do not use sensors, switches, or relays that supply any voltage or current to the Model 1000.

Any N.O. or N.C. sensor can be attached to the Model 1000 using 22 gauge wire. The sensor can be several hundred feet from the unit, as long as the total resistance of the circuit is not greater than 50 ohms. Use wire appropriate for the application.

After all of the sensors are wired to the Sensaphone, and are in a normal (OK) position, the ID number must be programmed. When the ID number is programmed, the Sensaphone scans all the alert inputs, and whatever the unit sees at that time is the normal position for the inputs. This will set the normality of all the alert inputs. See Chapter 2 page 19.

The Sensaphone Model 1000 may have more than one sensor connected to the same terminal. However, the *normal* condition for each sensor on the same terminal must be identical (either N.O. or N.C.).

MULTIPLE NORMALLY CLOSED SENSORS

To have more than one *normally closed* sensors on one input, they must be connected in series. Connect one lead from the first sensor to the odd-numbered terminal of the alert pair. Next, take the other lead from the first sensor and connect it to one lead from the next sensor. Continue connecting sensors end-to-end until you have connected all of your sensors. Take the second lead from your last sensor and connect it to the even-numbered terminal of the alert pair. Refer to Figure 6.

Multiple N.C. inputs are typically magnetic reed switches to monitor the security of windows and doors.

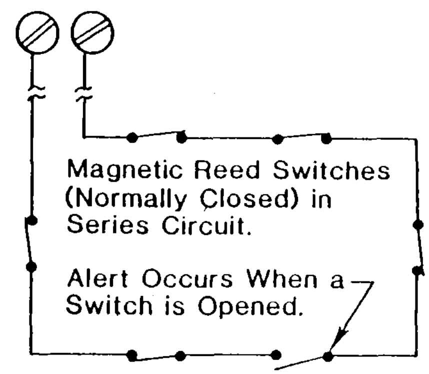


FIGURE 6: CONNECTING MULTIPLE N.C. SENSORS TO ONE INPUT TERMINAL

MULTIPLE NORMALLY OPEN SENSORS

To have several *normally open* sensors to one alert input, connect them in *parallel.* To do so, take one lead from each sensor and attach it to an odd-numbered terminal. Then, take the second lead from each sensor and attach each to the corresponding even-numbered (see Figure 7).

Multiple N.O. inputs are typically TEMP•ALERTs * to monitor the temperature in several different locations simultaneously.

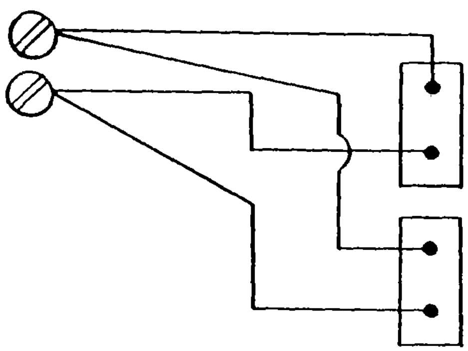


FIGURE 7: ATTACHING MULTIPLE N.O. SENSORS TO ONE INPUT TERMINAL

* trademark of Winland Electronics, Inc.

CHAPTER 2
KEYBOARD OPERATIONS

The Sensaphone Model 1000 stores the following important programmable information in its memory. Set these parameters using the Sensaphone Model 1000 keyboard (see Figure 8).

- Time
- Four telephone numbers automatically called in emergencies
- Tone or pulse dialing
- Number of rings before the Model 1000 answers the telephone to give a status report
- High and low temperature alarm limits
- The ID number
- Silencing the local speaker during dial-out and call-in

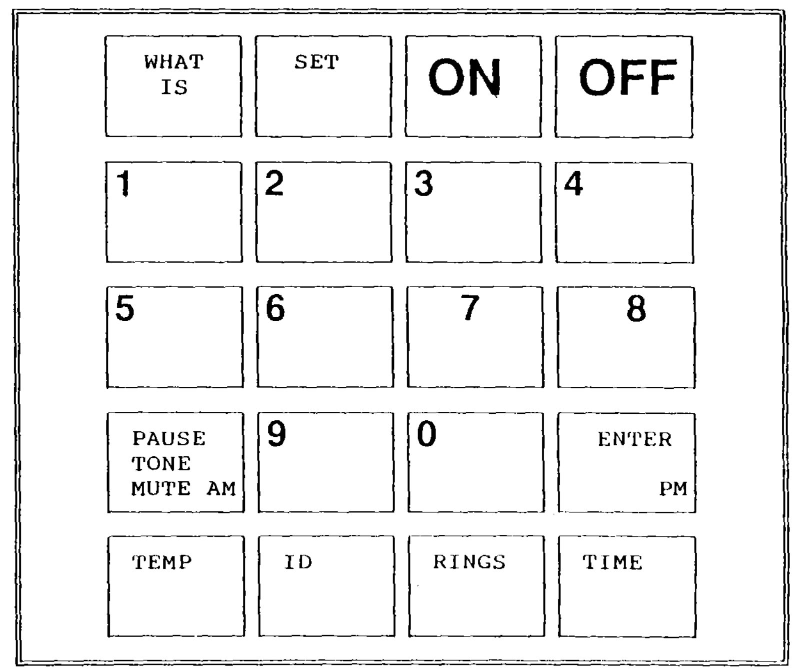


FIGURE 8: THE SENSAPHONE 1000 KEYBOARD

The keys on the Model 1000 are mentioned often in this chapter. In text, they will always be symbolized by **BOLDFACE, CAPITALIZED** letters. The sentence "Press **SET**, then **RINGS**" is read as "Press the key with the word SET on it, then press the key with the word RINGS on it."

Two of the keys are multi-functional. In programming instructions, only the word for the specific parameter being programmed will be used. For example, the sentence "Press **9**, then **PAUSE**" is read as "Press the key with the number 9 on it, then press the key with the words PAUSE/TONE/MUTE/AM on it." In illustrations, the parameter being used will be **boldface**, while the other parameter(s) will be normal typeface. So, "Press **9**, then **PAUSE**" will be shown as follows:

9	**PAUSE** TONE MUTE AM

Every time a key is pressed, the unit will beep. The beep is high-pitched when information is being entered. Any time you make a mistake in programming, the 1000 will say "Error."

To begin programming your unit, verify that your unit is fully installed and **ON**.

THE TIME

The Sensaphone Model 1000 has a built-in clock. Once the current time is programmed, the unit will monitor the time. If the AC fails, the clock will continue to keep time until the back-up battery is depleted. When both the AC power and the back-up battery fail, the clock will reset to 12 AM.

SETTING THE TIME

To set the time, press **SET**, followed by **TIME**. Enter the numbers for the correct time. Since there is no colon (:) key on the unit's keyboard, the time must be entered as numbers only. If the time is AM, press **AM**, then **ENTER**. If the time is PM, just press **ENTER**.

For example, to set the time to be 8:45 AM, press the following keys:

SET	TIME	8	4	5

PAUSE TONE MUTE **AM**	**ENTER** PM

To set the time to be 2:00 PM, press the following keys:

SET	TIME	2	0	0
ENTER **PM**				

CHECKING THE TIME

To check the time, press **WHAT IS**, then **TIME**. The unit will say "The time is (number, AM or PM).

WHAT IS	**TIME**

Referring to the two previous examples, the unit should respond with "The time is 8:45 AM" and "The time is 2:00 PM," respectively.

THE TELEPHONE NUMBERS

The Sensaphone Model 1000 has the capability to store up to four, 16-digit (or smaller) telephone numbers in its memory. They are known as Phones 1, 2, 3, and 4. These are the alarm *dial-out* telephone numbers. They are automatically called in sequence when an alarm condition occurs. You can program the Sensaphone to dial the Phone numbers using pulse (rotary) or tone dialing.

The telephone numbers are programmed in the sequence in which you want to have them called. They are programmed into Phone positions 1, 2, 3, and 4. Therefore, the number to be called first would be Phone 1, the number to be called second would be Phone 2, et cetera.

IMPORTANT!

Try to avoid programming dial out phone numbers that might be answered by an answering machine. There is no electrical or operational problem if an answering machine answers a phone call made by the Sensaphone, but if all the dial out phone numbers are programmed to call answering machines, the unit can potentially dial out forever, leaving the alarm situation unacknowledged.

Instruct key people at each telephone number about the Sensaphone Model 1000 and about what actions they should take if called with an alarm. If necessary, instruct switchboard operators to handle alarm and acknowledgement calls. Do not have the alarm call answered by a person who is unable to acknowledge the alarm or to take prompt, effective action to deal with the situation. If appropriate, conduct periodic drills to familiarize personnel with the operation of the unit.

In some areas, municipal services (i.e. police, fire, medical) will not respond to automatic voice messages. Check with your local municipal services.

SETTING A DIAL-OUT TELEPHONE NUMBER

The Sensaphone can dial out using pulse dialing or touch-tones. It will normally dial-out with pulse, but can be switched to touch-tones by inserting **TONE** as the first digit of the telephone number. The PAUSE/TONE/MUTE/AM key will only indicate tone dialing when it is the first digit of a telephone number. If **PAUSE** is inserted in the middle of a telephone number, it produces a 4 second pause during dial-out.

To set a pulse-dialed telephone number, press **SET**, then the Phone number (**1**, **2**, **3**, or **4**). Press the keys corresponding to the digits of the telephone number. Finally, press **ENTER**.

To set a tone-dialed telephone number, press **SET**, the Phone number (**1**, **2**, **3**, or **4**), then **TONE**. Press the keys corresponding to the digits of the telephone number. Finally, press **ENTER**.

For example, to set Phone 1 as 1-215-555-8379, press **SET**, then **1**. Press the keys corresponding to the digits of the telephone number. Finally, press **ENTER**.

SET	1	1	2	1
5	5	5	5	8
3	7	9	ENTER PM	

For example, to set Phone 2 as 1-215-555-9387 and tone-dialed, press **SET**, **2**, then **TONE**. Press the keys corresponding to the digits of the telephone number. Finally, press **ENTER**.

SET	2	PAUSE **TONE** MUTE AM	1	2
1	5	5	5	5
9	3	8	7	ENTER PM

USING PAUSE

With some telephone systems, you must first dial an access number to reach an outside line, then pause for the connection before dialing a regular telephone number. The Model 1000 also has this capability.

The 4-second pause can be programmed as part of the telephone number. To do so, press **SET**, and the Phone number (**1**, **2**, **3**, or **4**) (for a tone-dialed number, then press **TONE**). Next, press the keys corresponding to the digit(s) of the access number, then press **PAUSE**. Now press the keys corresponding to the digits of the regular telephone number. Finally, press **ENTER**.

For example, to set Phone 3 so that the Model 1000 will tone-dial 9 to access an outside line, wait for the dial tone, then tone-dial 1-215-555-4523, press the following keys:

SET	3	PAUSE **TONE** MUTE AM	9	**PAUSE** TONE MUTE AM

1	2	1	5	5 PM
5	5	4	5	2
3	ENTER PM			

USING A POUND AND ASTERISK

When calling some phone systems or beeper systems, a pound tone or an asterisk tone may be required. To incorporate a pound tone within the dial-out phone number, press SET at the appropriate position within the phone number. To incorporate an asterisk tone within the dial-out phone number, press WHAT IS at the appropriate position within the phone number.

DELETING A PHONE NUMBER

To delete a telephone number from memory, press **SET**, the Phone number, then **ENTER**.

For example, to delete Phone 3 from memory, press the following keys:

SET	3	ENTER PM

CHECKING A DIAL-OUT TELEPHONE NUMBER

To check a telephone number, press **WHAT IS**, then the Phone number you want to check. The Model 1000 will state the telephone number.

For example, to check Phone 1, press the following keys:

WHAT IS	1

When you check a telephone number that is tone-dialed, the Sensaphone will beep before it states the telephone number. For example, to check Phone 2 in SETTING A DIAL-OUT TELEPHONE NUMBER, press **WHAT IS** then **2**. The Sensaphone will beep, then say "One, two, one, five, five, five, five, nine, three, eight, seven."

When you check a telephone number that has a programmed pause, the unit will state the access number, beep when the pause is programmed, then state the rest of the telephone number.

For example, to check Phone 3 from the example in USING THE PAUSE KEY, press **WHAT IS**, then **3**. The Model 1000 will beep, say "Nine," beep again, then say "One, two, one, five, five, five, five, four, five, two, three."

If there is no *dial-out* telephone number in the unit's memory, it will say "No number. For example, to check Phone 3 after it has been deleted, press **WHAT IS**, then **3**. The Model 1000 will say "No number."

THE RINGS UNTIL ANSWER

The *Rings Until Answer* are the number of rings that must occur before the Model 1000 will answer the telephone in response to a *call-in*. The number of rings can be programmed to be from 1 to 79.

SETTING THE RINGS UNTIL ANSWER

To set this number, press **SET**, then **RINGS**. Enter the number of rings desired, then press **ENTER**.

For example, to set the of *Rings Until Answer*, press the following keys:

SET	RINGS	1	2	ENTER PM

If you do not set a *Rings Until Answer*, the Model 1000 will set it to be 4 rings.

CHECKING THE RINGS UNTIL ANSWER

To verify the number of *Rings Until Answer*, press **WHAT IS**, then **RINGS**. The Model 1000 should repeat the number you have entered.

WHAT IS	RINGS

Referring to the above example. the Model 1000 will say "Twelve."

THE TEMPERATURE LIMITS

The temperature limits determine the high and low readings at the temperature probe which will cause the Model 1000 to automatically *dial-out* with an alarm. The range of the temperature probe is +0° F to +128° F. The Model 1000 has high and low temperature limits of +98° F and +55° F, respectively, until you set in your own values.

SETTING THE TEMPERATURE LIMITS

To set the temperature limits, press **SET**, then **TEMP**. The unit will respond with "Enter high temperature limit." Enter the number, then press **ENTER**. The 1000 will then say "Enter low temperature limit." Enter that number, then press **ENTER**.

HINT:

Do not set the limits too close to the normal room temperature. Minor changes in temperature would cause frequent and unnecessary alarm *dial-outs*.

Setting the high temperature limit to 128° F and the low temperature limit to 0° F will disable the alarms and the Sensaphone will not dial-out with a temperature alarm.

For example, set the high temperature limit to be +94° F and the low temperature limit to be +10° F by pressing the following keys:

SET	TEMP	9	4	ENTER
1	0 PM	ENTER		

CHECKING THE TEMPERATURE LIMITS

To verify the temperature limits, press **WHAT IS**, then **ID** for a status report. The status report is given in CHECKING THE ID NUMBER (on page 19).

OBTAINING CURRENT TEMPERATURE

To obtain the current temperature, press **WHAT IS**, then **TEMP**.

WHAT IS	TEMP

The unit will state the temperature at the thermistor (or remote temperature probe).

THE ID NUMBER

The unit's identification (ID) number can be from 1 to 16 digits long. Typically, it is the telephone number where the unit is located, although it does not have to be. **The ID number should be programmed into the unit only after all sensors are wired to the unit and are in their normal state. This will establish the normal condition of the alert input sensors in the Model 1000's memory**. Any change in these states will cause an alert *dial-out*.

SETTING THE ID NUMBER

To set it, press **SET**, then **ID** Press the keys corresponding to the digits of the ID number. Finally, press **ENTER**.

For example, to set the unit's ID number to be 1-215-555-4687, press the following keys:

SET	ID	1	2	1
5	5	5	5	4
6	8	7	ENTER PM	

DELETING THE ID NUMBER

To delete the ID number from memory, press **SET**, **ID**, then **ENTER**.

SET	ID	**ENTER** PM

CHECKING THE ID NUMBER

To check the identification number, press **WHAT IS**, then **ID**.

WHAT IS	ID

The unit give you a status report, which follows:

STATEMENT	COMMENT
Hello	
This is telephone number _____	(the ID number)
The time is _____	(time, AM or PM)
The temperature is ____ degrees	(local temperature at Model 1000)
The electricity is ____	ON OFF
Sound level _____	OK HIGH
Alert condition _____	OK 1 EXISTS 2 EXISTS 3 EXISTS
(battery condition)	BATTERY CONDITION OK BATTERY CONDITION LOW REPLACE BATTERIES
High temperature limit ___ degrees	(High temp. limit, °F)
Low temperature limit ___ degrees	(Low temp. limit, °F)

Referring to the example in <u>SETTING THE ID NUMBER</u>, the Model 1000 would say "Hello. This is telephone number one, two, one, five, five, five, five, four, six, eight, seven," then give the rest of the status report.

If there is no ID number programmed, the unit will say "No number" after the phrase "This is telephone number" when it gives the status report.

MUTING THE SENSAPHONE DURING DIAL-OUT AND CALL-IN

The Sensaphone has a programmable mute as a security feature. The mute will only be in effect during dial-out and call-in; in other words, it will not affect programming the unit. The mute turns off the local speaker when the Sensaphone is dialing out with an alarm or accepting an incoming phone call.

To program the mute, press **MUTE** before you program the ID number. For example, to mute the speaker while programming the ID number to be 1-215-555-4687, press the following keys:

SET	ID	PAUSE TONE **MUTE** AM	1	2
1	5	5	5	5
4	6	8	7	**ENTER** PM

When you check the ID number, the Sensaphone will say "Hello. This is telephone number," beep to indicate that the mute is programmed, then continue on with the rest of the ID number and status report.

NOTE:

Another security feature of the ID key is leaving the building that the Sensaphone is in. When you press **WHAT IS**, then **ID**, the Sensaphone will begin giving the status report, which takes approximately 30 seconds. During those 30 seconds, the 1000 will not sense any changes in the alert inputs, though it will still acknowledge high/low temperature and AC power failure. This means you have 30 seconds to leave the building without tripping an alert condition.

CHAPTER 3
OPERATING FUNCTIONS

ON/OFF KEYS

There are two keys on the 1000's keyboard marked **ON** and **OFF**. They are used to activate and deactivate the unit.

ON

When you press **ON**, the red light on the 1000 will begin to glow while the unit says "Hello," states any existing alarms, then say "The time is twelve A.M."* If the unit is already on, it will just beep.

This activation state enables the Model 1000 to receive incoming calls and automatically *dial-out* in the event of the failure of a monitored condition. The red light will always glow while the unit is in the activation state.

OFF

When you press **OFF**, the Sensaphone will say "Have a good day" and the red light will stop glowing. All functions are disabled. If any alarm condition occurs, the Model 1000 will not *dial-out*. However, the clock will still keep time. An AC and battery back-up power failure would result in the loss of all memory, which would necessitate the reprogramming of the unit.

It is recommended that the 1000 stay **ON**, unless it is necessary to disable the unit temporarily. To store the 1000, remove the batteries; otherwise, the unit will drain the batteries, even if it is **OFF**.

* if the time was previously set, the 1000 will state the current time

MICROPHONE

The Sensaphone 1000 has a built-in microphone. It has two important functions:

> It will continuously listen for a high sound level that increases 10 db over the normal sound level at a frequency of 1000 Hertz or more. If this sound level exists for 10 consecutive seconds or longer (such as a smoke alarm or burglar alarm), then the Model 1000 will dial-out with an alarm message.
>
> During both a *call-in* and an automatic *dial-out*, the microphone allows a 15-second *listen-in* to the Model 1000's location.

The location of the smoke or burglar alarm in relation to the microphone is extremely important. Normally, the 1000 and the audible alarm must be in the same room. The maximum distance can vary considerably depending on the alarm, the acoustics, and the size of the room.

NOTE:

Please note that short duration or intermittent alarm signals **may not** trigger the alarm *dial-out*.

<u>ALARM CHECK</u>

After the Sensaphone and the alarm have been positioned, activate the alarm for 15 seconds. The Model 1000 should say "Sound level high" and start its *dial-out* procedure. Press any key to halt the *dial-out*.

If the unit fails to respond, the Sensaphone and the alarm must be moved closer together. **You must wait 60 seconds between tests to allow the Sensaphone to readjust.**

IMPORTANT!

The ability of the unit to react to an audible alarm must be checked upon installation and periodically verified!

THE CALL-IN STATUS REPORT

You can *call-in* to the Model 1000 anytime to obtain a verbal status report. The unit will answer the telephone after it rings the the number programmed as *Rings Until Answer*. You will receive the following message:

STATEMENT	COMMENT
Hello	
This is telephone number ____	(the ID number)
The time is ____	(time, AM or PM)
The temperature is ____ degrees	(local temperature at Model 1000)
The electricity is ____	ON OFF
Sound level ____	OK HIGH
Alert condition _____	OK 1 EXISTS 2 EXISTS 3 EXISTS
(battery condition)	BATTERY CONDITION OK BATTERY CONDITION LOW REPLACE BATTERIES

The Sensaphone will repeat the status report, then say "Listen to the sound level for 15 seconds." After the 15 second listen-in, the 1000 will say "Have a good day" and disconnect from the telephone line.

If you *call-in* for a status report after an alarm *dial-out* has been properly acknowledged but the alarm condition still exists, you will also be told:

STATEMENT	COMMENT
Warning message received by ____	(Phone number unit dialed prior to acknowledgement call)

This statement will go away when the alarm goes away.

AUTOMATIC DIAL-OUT

The Sensaphone Model 1000 will automatically *dial-out* to the four telephone numbers you had programmed into its memory when one (or more) of the following conditions occur:

The AC power goes OFF for at least 5 minutes. The unit waits this long because short duration electrical failures are common in some areas. During the 5 minute period, the speaker will announce "The electricity is OFF." every 15 seconds.

The temperature varies beyond the high or low limits you have programmed. The Sensaphone will say "The temperature is high" or "The temperature is low," respectively, for 30 seconds.

A high sound level occurs whose duration is 10 seconds or longer. The 1000 will say "Sound level high" for 30 seconds.

Alert condition 1,2, or 3 is activated when the status of a sensor on Alert input 1,2, or 3 changes for at least 200 milliseconds. The Sensaphone will say "Alert condition (1, 2, or 3) exists" for 30 seconds.

High or low temperature, high sound, and alert conditions will cause the 1000 to state the detected condition through its speaker for 30 seconds before starting to dial-out. If the mute is programmed, the unit will be silent during those 30 seconds.

AC power failure must exist for 5 continuous minutes for an alarm condition to exist. During those 5 minutes, the Sensaphone will announce "The electricity is off" every 15 seconds. However, the unit is capable of normal functioning during those 5 minutes. You can call-in for a status report, but you will be told the power is off even though it has not been off for 5 minutes. After the power has been off for 5 minutes, the Sensaphone will dial-out. To cancel the dial-out during the 5 minute recognition period, press **OFF**, then **ON**.

The Model 1000 will dial Phone 1, deliver its alarm message and status report, then state "Indicate you have received warning message" and pause for 5 seconds. During the five second pause, the unit will wait for a Touch-Tone acknowledgement If the Touch-Tones are not received, the unit will then ask for an acknowledgement call-back and wait sixty seconds for the call. If the alarm is not properly acknowledged, the 1000 will call Phone 2 and go through the same procedure. If there is no call-back, it will call the Phone 3 and repeat the procedure. If that call is not acknowledged, the unit will call Phone 4. If there is no acknowledging telephone call, the Model 1000 will then begin the entire procedure again, starting with Phone 1. If any Phone number is not programmed, the unit will skip to the next sequential programmed Phone number without any delay.

The Sensaphone begins talking after the last digit of the phone number is dialed. Therefore, when you answer the phone, the Sensaphone could be at any point within its dial out message, depending on how quickly you answer the phone.

If there is only one telephone number in memory, the Sensaphone will dial-out to 15 times, then stop, in accordance with FCC regulations.

The message you will receive is the following:

STATEMENT	COMMENT
Hello	
This is telephone number ____	(the ID number)
(warning message)	
Hello	
This is telephone number ____	(the ID number)
(warning message)	
Hello	
This is telephone number ____	(the ID number)
The time is _____	(time, AM or PM)
The temperature is _____ degrees	(local temperature at Model 1000)
The electricity is _____	ON OFF
Sound level _____	OK HIGH
Alert condition ______	OK 1 EXISTS 2 EXISTS 3 EXISTS
(battery condition)	BATTERY CONDITION OK BATTERY CONDITION LOW REPLACE BATTERIES
Listen to the sound level for 15 seconds	(15-second listen-in)

STATEMENT	COMMENT
Indicate you have received warning message	(5 second pause for Touch-Tone response)
Dial telephone number ______ within 60 seconds	(ID number)

If an alarm condition comes into existence while the 1000 is dialing-out for a different alarm condition, the Sensaphone will add the new condition to its dial-out report.

This cycle can be stopped at any time by pressing any key on the 1000 keyboard.

ACKNOWLEDGEMENT OF ALARMS

Locally - At any time during an alarm dial out, the alarm may be acknowledged locally by hitting any key on the keypad . This will stop the dial out procedure and the unit will indicate that the warning message was received by its ID number.

Touch-Tones - At the end of the dial-out alarm message, the unit will say "Indicate you have received warning message" and then pause for five seconds. During those five seconds of silence, you may acknowledge receipt of the alarm by pressing 5, 5, 5 on any Touch-Tone telephone. This will stop the dial-out procedure. When the Sensaphone receives the Touch-Tones 5, 5, 5, it will respond by saying "Warning message received by telephone number _______." and will disconnect from the phone line. If the unit does not receive these touch tones, it will continue by stating "Dial telephone number (ID number) within 60 seconds".

Call back - At the end of the dial-out alarm message, the unit will say "Indicate you have received warning message", pause for five seconds, and continue with "Dial telephone number (ID number) within 60 seconds". When acknowledging an alarm by calling back, the first ring of your call-back must occur within 60 seconds after the Sensaphone completes its alarm call and hangs up. The telephone must then ring 10 times. After the tenth ring, the unit will answer and state "Warning message received by (the telephone number it had just dialed)," followed by a status report. The 1000 will then discontinue further *dialing-out* for this alarm condition.

During the 60 second countdown, the unit will beep every second, unless the unit has been programmed to be mute upon an alarm dial-out. Once the first ring of the acknowledgement call-back is received, the unit will only beep every time it receives a ring signal.

If that condition reoccurs or if any other alarm occurs, the automatic *dial-out* procedure starts again.

APPENDIX A: EXPLANATION OF KEYS

KEY	FUNCTION
WHAT IS	-Used in interrogation of unit.
SET	-Used in programming of unit.
ENTER	-Used in programming of units to enter information into the Model 1000's memory.
TEMP	-Used with **SET** to set high and low temperature limits. -Used with **WHAT IS** to check the current temperature.
RINGS	-Used with **SET** to program the number of rings before the unit answers the telephone. -Used with **WHAT IS** to check the number of rings.
ID	-Used with **SET** to enter the identification number of the unit and *normal* status of alert inputs. -Used with **WHAT IS** to get a status report on the conditions that are being monitored.
TIME	-Used with **SET** to enter the present time into the Model 1000. -Used with **WHAT IS** to check the time.
PAUSE	-Used to set a pause into a telephone number when required to access an outside telephone line for a *dial-out*.
MUTE	-Used while programming the ID number to program the Sensaphone to silence the speaker during call-in and dial-out.
TONE	-Used to designate tone dialing for a telephone number.
AM	-Used when programming time to indicate the period between midnight and noon.
PM	-Used when programming time to indicate the period between noon and midnight.

APPENDIX B: VALID KEYBOARD SEQUENCES

NOTE: Commands inside brackets [] are optional

INTERROGATION COMMAND SEQUENCES

WHAT IS	TEMP	*temperature*
WHAT IS	RINGS	*rings until answer*
WHAT IS	ID	*ID number*
WHAT IS	TIME	*time*
WHAT IS	1	*Phone 1*
WHAT IS	2	*Phone 2*
WHAT IS	3	*Phone 3*
WHAT IS	4	*Phone 4*

PROGRAMMING COMMAND SEQUENCES

SET	TEMP	[PAUSE]	(number)	ENTER	[PAUSE]	(number)	ENTER	*temp. limits*
SET	RINGS		(number)				ENTER	*rings until answer*
SET	ID	[MUTE]	(number)				ENTER	*ID number*
SET	TIME		(number)	AM			ENTER	*AM time*
SET	TIME		(number)				PM	*PM time*
SET	1	[TONE]	(number)		[PAUSE]	(number)	ENTER	*Phone 1*
SET	2	[TONE]	(number)		[PAUSE]	(number)	ENTER	*Phone 2*
SET	3	[TONE]	(number)		[PAUSE]	(number)	ENTER	*Phone 3*
SET	4	[TONE]	(number)		[PAUSE]	(number)	ENTER	*Phone 4*

DELETING PARAMETERS

SET	ID	ENTER	*ID number*
SET	1	ENTER	*Phone 1*
SET	2	ENTER	*Phone 2*
SET	3	ENTER	*Phone 3*
SET	4	ENTER	*Phone 4*

APPENDIX C: ACCESSORIES

The sensors listed are the most commonly used input devices. However, there is a virtually unlimited variety of sensor/switch input devices available at commercial or industrial electrical supply houses. They can provide a device to monitor virtually any condition that might be required for your business, industrial or residential needs. Contact Phonetics' Sales department at (215) 558-2700 for more information.

MODEL NUMBER	SENSOR/SWITCH
FGD 0004	Water Detection Sensor
FGD 0005	Remote Temperature Sensor
FGD 0006	Magnetic Reed Switch
FGD 0007	Passive Infrared Motion Detector
FGD 0010	Accessory Wire (50 foot coil)
FGD 0011	Optical Pick-up
FGD 0022	TEMP•ALERT™
FGD 0023	ISOTEL™ surge protector
FGD 0027	Humidistat

APPENDIX D: APPLICATIONS

There are many ways to apply the Sensaphone Model 1000 to your needs. Listed below are some of the ways our customers have used the Model 1000, employing the built-in sensors for power failure, high sound level, and temperature, plus the additional sensors listed in Appendix C.

PURPOSE	LOCATION	SENSORS/INPUTS
SECURITY	RESIDENCES VACATION HOMES MOBILE HOMES BUSINESSES OFFICES BUILDINGS	MAGNETIC REED SWITCHES PASSIVE INFRARED MOTION DETECTORS
TEMPERATURE	RESIDENCES OFFICES FACTORIES REFRIGERATORS HVAC SYSTEMS GREENHOUSES ANIMAL BUILDINGS POULTRY BUILDINGS FANS/BLOWERS COMPUTER ROOMS TELECOM ROOMS	REMOTE TEMPERATURE SENSORS TEMP•ALERT™ TEMPERATURE SWITCHES* POWER FAILURE ALERT
FIRE	RESIDENCES OFFICES FACTORIES REFRIGERATORS HVAC SYSTEMS ANIMAL BUILDINGS POULTRY BUILDINGS COMPUTER ROOMS TELECOM ROOMS	SMOKE/FIRE ALARMS*

PURPOSE	LOCATION	SENSORS/INPUTS
HUMIDITY	LABORATORIES TEST CHAMBERS FACTORIES GREENHOUSES	HUMIDISTATS
FUMES/GASES	MINES FACTORIES LABORATORIES BOATS/SHIPS CHEMICAL PLANT FAN VENTILATORS ANIMAL BUILDINGS	FUME/GAS ALARM* POWER FAILURE ALARM
LIQUID LEAKS AND LEVELS	BOATS/SHIPS PUMPS/VALVES BASEMENTS STORAGE TANKS COMPUTER ROOMS WATER TREATMENT FACILITIES	WATER SENSOR POWER FAILURE ALARM

**Not available through Phonetics*

APPENDIX F: TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE
Unit does not talk.	-Unit not ON. -Wall transformer not plugged into a 110 VAC outlet.
Unit does not dial out automatically.	-No telephone numbers entered in Phone 1 through Phone 4. -Unit not ON. -Telephone jack not connected -Wall transformer not plugged into a 110 VAC outlet.
Unit does not answer incoming calls after the prescribed number of rings.	-Wall transformer not plugged into 110 VAC outlet. -Incompatibility with telephone system. -Unit not ON. -Telephone jack not connected.
Unit does not function normally.	-Unit programmed or installed incorrectly. -Unit was exposed to power surge through power and/or telephone lines. -Sensors and/or wiring damaged or defective.
Invalid temperature reading.	-There is a bad or broken temperature connection between the Model 1000 and the temperature sensor. If the temperature reads 0°, the circuit is open. If the temperature reads 128°, the circuit is shorted.

APPENDIX F: TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE
Unit does not talk.	-Unit not ON. -Wall transformer not plugged into a 110 VAC outlet.
Unit does not dial out automatically.	-No telephone numbers entered in Phone 1 through Phone 4. -Unit not ON. -Telephone jack not connected -Wall transformer not plugged into a 110 VAC outlet.
Unit does not answer incoming calls after the prescribed number of rings.	-Wall transformer not plugged into 110 VAC outlet. -Incompatibility with telephone system. -Unit not ON. -Telephone jack not connected.
Unit does not function normally.	-Unit programmed or installed incorrectly. -Unit was exposed to power surge through power and/or telephone lines. -Sensors and/or wiring damaged or defective.
Invalid temperature reading.	-There is a bad or broken temperature connection between the Model 1000 and the temperature sensor.

To service your Sensaphone Model 1000, do the following:

1) Carefully reread the instruction manual to be certain that all connections and programming were done correctly.

2) Check to see if the Model 1000 was damaged by a power surge.

   a) Remove the AC power supply from the 110 VAC wall outlet and remove the batteries.
   b) Allow the unit to remain unpowered for 10 to 15 minutes.
   c) Restart and reprogram the Model 1000 in accordance with the instructions in this manual.
   d) Retest all functions and sensors.

APPENDIX G: RETURNING YOUR UNITS FOR SERVICE

In the event that your Model 1000 does not function properly and you cannot reprogram it, we suggest that you do the following:

1) Refer to Appendix F, TROUBLESHOOTING.

2) Carefully write down your observations of the Model 1000's malfunctioning.

3) Call Phonetics' Technical Service at 1-215-558-2700 if any instructions are not clear or if you have any questions.

If the unit must be sent to us for servicing, do the following:

1) Unplug the AC power supply from the wall outlet, remove the batteries, and disconnect all sensors from the alert inputs.

2) Carefully pack unit into its original container or a sturdy shipping box. Be certain to use sufficient cushioning material to avoid damage in transit.

3) Address package to:

   SERVICE DEPARTMENT
   PHONETICS, INC.
   901 TRYENS ROAD
   ASTON, PA. 19014

4) Ship it prepaid and insured via UPS or US Mail to ensure a traceable shipment with recourse for damage or replacement.

5) If your Sensaphone is under our One Year Limited Warranty, include a copy of your sales receipt, check, or charge slip to serve as your Proof of Purchase. A copy of our One Year Limited Warranty appears on the back cover of this manual.

6) Include a letter explaining the Model 1000's problem. If the problem appears within 1 year after purchase, the unit will be repaired at no charge. If the unit is out of the one year warranty, you will be sent an estimate of the cost to repair. At that time the charges can be put on a credit card, we can wait for a check or your unit can be returned UPS C.O.D.

7) Under normal conditions, your Model 1000 will be in our shop for approximately 10 to 15 working days while it is being repaired, tested, and shipped back to you.

CARBONAIR

SYSTEM STARTUP & OPERATION

1. Open airstripper influent and effluent butterfly valves.

2. Make sure airstripper blower and process air heater switches are **"OFF"** at main control panel.

3. Turn main control panel main disconnect switch **"ON"**. Blower low pressure alarm light (red) should glow.

4. Turn Process Air Heater main disconnect switch **"ON"**.

5. Turn blower control switch to **"AUTO"**, blower should start and blower run light (green) should glow. Blower low pressure alarm lights should cease glowing as soon as pressure in the airstripper sump comes up. Read blower/sump pressure (in inches water column) on gauge at main control panel. Reading should be about 5 - 7 inches. At this writing, blower outlet damper should be about 50% open.

6. Turn process air heater enable switch to **"ON"**. Heater run light (green) should glow. Check to see that the keyed heater **"HIGH/LOW"** switch is in the correct position for the chosen GPM rate (at this writing should be set at **"HIGH"**). **IMPORTANT:** It should be noted that at this writing approximately 68% of the heater elements have been disabled by removing three #CJ-60A 60 amp fuses from their clips in the heater control box (fuses are resting in the bottom of the box). This was necessary because at the time of installation there was insufficient power available at the Process Air Heater main disconnect. While there is currently 30 amps, 3 phase available, the heater requires 60 amp, 3 phase service to operate at it's full total capacity of 52 kilowatts. The remaining 32% of the heater elements will operate together in parallel at 6 kilowatts when the **"HIGH/LOW"** switch is in the **"LOW"** position. This same group of elements will operate in series at 17 kilowatts when the **"HIGH/LOW"** switch is in the **"HIGH"** position. During setup and adjusting it was determined that operating the heater at 17 kilowatts in the **"HIGH"** setting (with 68% of the elements disabled) yields more efficient heating of the process air stream (flowing at about 500 CFM). For future increased demand on the heater to accommodate higher water and air flow rates, the service at the Process Air Heater main disconnect must be increased to at least 60 amps, 3 phase. The green heater run light will glow only when the heater elements are on and heating. This light will go off and on with the normal cycling of the heater thermostat.

(continued)

CARBONAIR

7. Check the blower and heater for proper operation.

8. There are two dual-scale Magnehelic gauges mounted on the airstripper offgas ducting near the blower. These gauges are connected in parallel to a pitot tube in the blower inlet duct. When reading these gauges, refer to the bottom scale on the gauge to determine blower inlet duct air velocity. The top gauge, with an air velocity range of **300-2000 feet per minute,** is intended to register blower inlet velocity when the blower is operating in the low **cubic feet per minute (400-500)** range. The bottom gauge, with an air velocity range of **500-4000 feet per minute,** is intended to effectively extend the range of the top gauge and to register blower inlet velocity when the blower is operating in the high **cubic feet per minute (3600)** range. When operating the blower in the high CFM range, the top gauge will "peg" to beyond maximum scale readings. Due to the unique design of these gauges, no damage to the "pegged" gauge will occur.

   Reading the appropriate gauge, check (adjust if needed) the 12" butterfly ducting damper so the gauges read the **FPM** (feet per minute) velocity required for the proper **ACFM** (actual cubic feet per minute). At this writing, the **LOW RANGE** gauge should read about **500 FPM.** With 500 FPM x 1.05 (cross-sectional area of the blower inlet ducting, in square feet) you will get about **525 ACFM.** This measurement is taken at the center of the inlet ducting and will be slightly higher than the true CFM.

9. The system is now ready to accept water for processing. The upstream pumps may now be started (see manual provided by others). For automatic operation, make sure the pumps are run in the **"AUTO"** mode. Failure to do this could result in untreated water being released to the drain and/or a flooded airstripper building.

10. Once pumps have been started and stabilized, check the water level in the airstripper sump sight glass. This level should be constant with little variation.

11. Recheck the air velocity gauge(s) to see if the desired CFM is being forced into the airstripper. Adjust if necessary.

(continued)

CARBONAIR

12. Once all systems are operating and stabilized, the autodialer should be turned "ON" and checked for proper programming (see autodialer data sheets). The autodialer I.D. number is 1 (612) 572-2440. Temperature limits should be set at 110 (high) and 32 (low). The numbers to be called upon alarm status are already programmed into the autodialer.

Shutdown

1. Follow startup procedure in reverse. As a rule the blower and process air heater should be the first items turned on and the last items turned off, and the autodialer should be the last item turned on and the first item turned off.

2. When shutting down the system, allow the blower and heater to run after the well pumps have been shut down. This will continue to treat the water still left in the tower as it drains down to the sump. When sump level no longer drops, the airstripper is through draining and the blower and heater can be shut down.

3. If at any time the process air heater is turned on while the blower is not running the heater will overheat causing an internal heater thermal shutdown. This is a safety feature built in to the heater. When the heater cools down enough the thermal switch will allow the heater to operate. If the heater **"ENABLE"** switch at the main panel is not shut off the heater will continue to cycle between overheating and thermal shutdown. This situation should be avoided.

CARBONAIR

MAINTENANCE & TROUBLESHOOTING

MAINTENANCE

Blower

a. System should be shut down once a month and the blower bearings lubricated, at this time the vee-belts should be inspected and replaced if necessary. Refer to blower specification sheets for details.

b. During operation, check the blower for excessive noise or vibration. These conditions could indicate a loose or unbalanced fan wheel or loose fan housing.

c. For future increased air flows (to accommodate future increased water flows) the drive pulleys on the blower motor may be adjusted to increase blower wheel rpm from 2207 to 2579 rpm. See blower specification sheets for details.

Airstripper

a. While the system is shut down for monthly blower maintenance, the packing in the airstripper should be checked for fouling. Remove the top access manway in the lower FRP packing section and visually inspect the packing media balls for sludge and "slime". If possible, take one or two photographs to document progression of fouling between inspections. It will be a judgement call as to when the packing appears to be fouled or clogged enough to need cleaning. Failure to maintain the packing could result in complete fouling. Packing fouled to this degree can be very difficult to clean while in the tower and difficult to remove from the tower for cleaning or replacement. Another indicator of fouling is the blower pressure magnehelic gauge in the main control panel. Regular reading of this gauge may show a gradual increase in airstripper back pressure as fouling increases.

b. Connections have been provided in the airstripper piping to allow hookup of an external pump for recirculating an acid washing solution in a closed circuit through the tower. The influent and effluent butterfly valves must be closed before acid washing.

(continued)

Usually a 10% solution of hydrochloric acid is added to the water collected in the sump section of the airstripper. The solution is then pumped out of the sump and up through the riser pipe to the top of the tower in a closed circuit recirculation until foaming (visible in the sight glass) has stopped. This procedure may have to be repeated to effectively remove matter from the packing. It may possible to operate the blower during the acid wash to strip VOCs from the solution. Depending on VOCs in the used solution, the spent solution may have to be pumped out to a remote tank for storage and/or proper disposal or treatment. **IT IS RECOMMENDED THAT CARBONAIR BE CONSULTED TO PERFORM OR ASSIST IN THIS PROCEDURE IN ORDER TO DETERMINE PROPER AMOUNT OF ACID TO BE USED.**

Carbon Adsorber

a. The only maintenance required for the GPC-70 gas phase carbon adsorber is to monitor the discharge airstream for breakthrough, and to remove the spent carbon, replacing it with fresh carbon. Before removing a vessel containing spent carbon, a Spent Carbon I.D. sheet (SCID) must be completed and submitted to the selected reactivation facility for acceptance. Transportation must also be arranged. To minimize down time be sure the replacement vessel containing fresh carbon is mobilized and ready to be installed.

b. To remove the vessel containing spent carbon the system must be shut down. Disconnect all six inlet ring-flange connectors and install the six inlet shipping covers. Let the flex ducting hang down out of the way to allow removal of the vessel. Disconnect the two discharge ring-flange connectors and install the two discharge shipping covers. Pull the discharge flex ducts up out of the way and secure to allow removal of the vessel.

c. Using a vehicle and cable hooked to the GPC-70 hook, slowly pull the disconnected GPC-70 out of the building onto the driveway. Make sure the lifting eyes are threaded securely into the top of the vessel.

(continued)

CARBONAIR

A crane must be available (20,000 LB capacity) to lift the vessel onto a truck for transport to the reactivation facility. When lifting the GPC-70, **USE SPREADER BARS WHENEVER POSSIBLE.**

d. Have the fresh GPC-70 delivered on a roll-off truck. Grease the guide rails on the driveway and in the building. The yellow guide rails will aid in dropping the vessel on the driveway. Once off the truck, the vessel can be pushed into position in the building. Be careful not to let any of the flex ducting get hung up on the vessel as it is being moved into position.

e. Remove the shipping covers and connect the six inlet and two discharge ducts to the fresh vessel. Take care that the gaskets are in place and seated properly. While tightening each flange ring, tap around the outside edge of the ring with a hammer to prevent binding. This will allow maximum tightness and minimum air leaks. System is ready for startup. Check for air leaks. Tighten or re-seat gaskets as needed.

Alarms/Failures

a. A blower low pressure alarm is indicated by a glowing red "BLOWER LOW PRESSURE" light on main control panel and glowing outdoor red light. This alarm will trigger autodialer call-out and will shut down the well pumps and the process air heater. The blower low pressure alarm is designed to indicate blower failure. Determine the reason for failure before re-starting the system. After determining and rectifying the cause of blower failure, depress the "RESET" button on the main panel and re-start the system.

b. A sump high level alarm is indicated by a glowing red "SUMP HIGH LEVEL" light on main control panel and glowing outdoor red light. This alarm will trigger autodialer call-out and will shut down the well pumps. The blower and process air heater will continue to run until they are shut off manually (this is to continue to strip contaminants from the water remaining in the airstripper as is drains down). The sump high level alarm is designed to indicate flooding in the airstripper sump.

(continued)

CARBONAIR

Determine the reason for failure before re-starting the system. After determining and rectifying the cause of sump high level, depress the "RESET" button on the main panel and re-start the system.

c. The autodialer will also call out to the preprogrammed phone numbers if any of the following conditions occur:

1) AC power failure lasting longer than 5 minutes.
2) Bldg. temp. above 110 or below 32 degrees F.
3) Higher than normal noise level in the building.

The autodialer is currently programmed to call Carbonair Services first, then 3 key Carbonair personnel if there is no response from Carbonair's main office. If Carbonair's involvement with this system ends, these numbers must be deleted from the autodialer and new numbers programmed in. See the autodialer specification sheets for instructions.

CONBRACO AIR COCKS

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

CONBRACO®

AIR COCKS

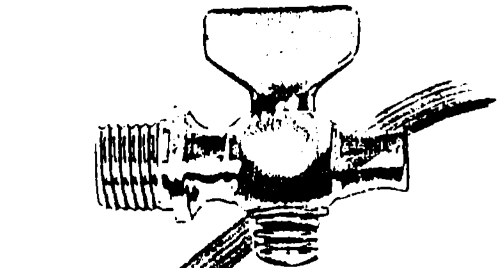
APPROVED SUBJECT TO CORRECTIONS NOTED & TO THE PROVISIONS OF THE SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig
SEE ATTACHED COMMENTS

41 SERIES
POLISHED BRASS OR SATIN FINISH

- TESTED AT 80 LBS. AIR PRESSURE — STANDARD — SPRING BOTTOM, 5/32" PORT.
- ALL AIR COCKS CAN BE FURNISHED WITH NUT BOTTOM FOR PRESSURES UP TO 20...

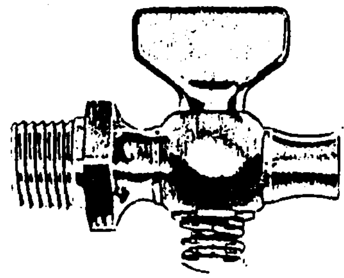
KEY

FOR ALL AIR COCKS	FINISH			
TYPE	SATIN BRASS	POLISHED BRASS	SATIN CHROME	POLISHED CHROME
Standard (Spring Bottom)	01	05	17	21
Nut Bottom	04	08	20	24



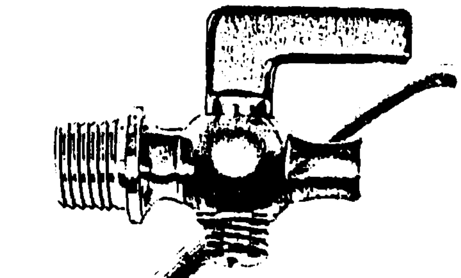
TEE HANDLE ROUND SHOULDER

NO.	SIZE-INCHES	WT./100
41-060-	1/8	12.0 lbs.
41-070-	1/4	13.1 lbs.



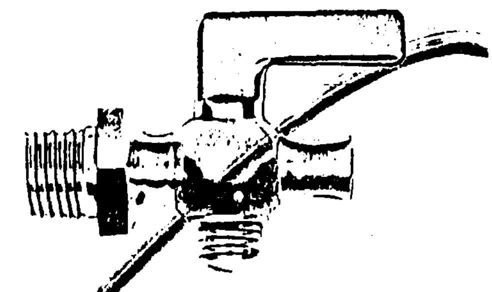
TEE HANDLE HEXAGON SHOULDER

NO.	SIZE-INCHES	WT./100
~~41-080-~~	~~3/8~~	~~17.2 lbs.~~
41-090-	1/2	20.0 lbs.



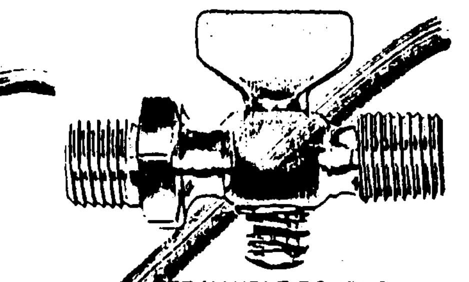
LEVER HANDLE ROUND SHOULDER

NO.	SIZE-INCHES	WT./100
41-120-	1/8	12.4 lbs.
41-130-	1/4	13.0 lbs.



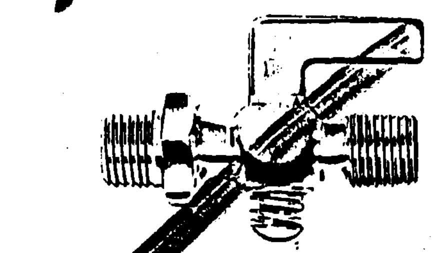
LEVER HANDLE HEXAGON SHOULDER

NO.	SIZE-INCHES	WT./100
41-140-	3/8	18.8 lbs.
41-150-	1/2	21.9 lbs.



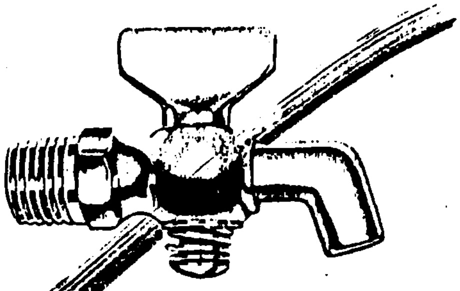
TEE HANDLE DOUBLE MALE THREAD

NO.	SIZE-INCHES	WT./100
41-180-	1/8	14.2 lbs.
41-190-	1/4	18.8 lbs.
41-203-	3/8	18.0 lbs.
41-210-	1/2	31.5 lbs.



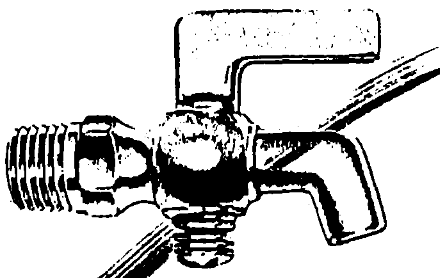
LEVER HANDLE DOUBLE MALE THREAD

NO.	SIZE-INCHES	WT./100
41-220-	1/8	14.5 lbs.
41-230-	1/4	16.6 lbs.
41-240-	3/8	19.1 lbs.
41-251-	1/2	31.3 lbs.



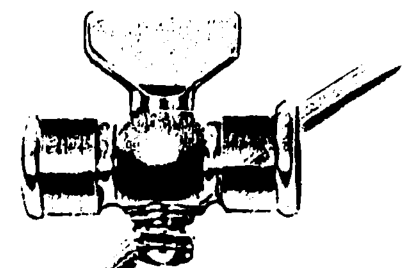
TEE HANDLE BIBB NOSE

NO.	SIZE-INCHES	WT./100
41-260-	1/8	14.4 lbs.
41-270-	1/4	14.7 lbs.
41-280-	3/8	28.9 lbs.
41-330-	1/2	34.9 lbs.



LEVER HANDLE BIBB NOSE

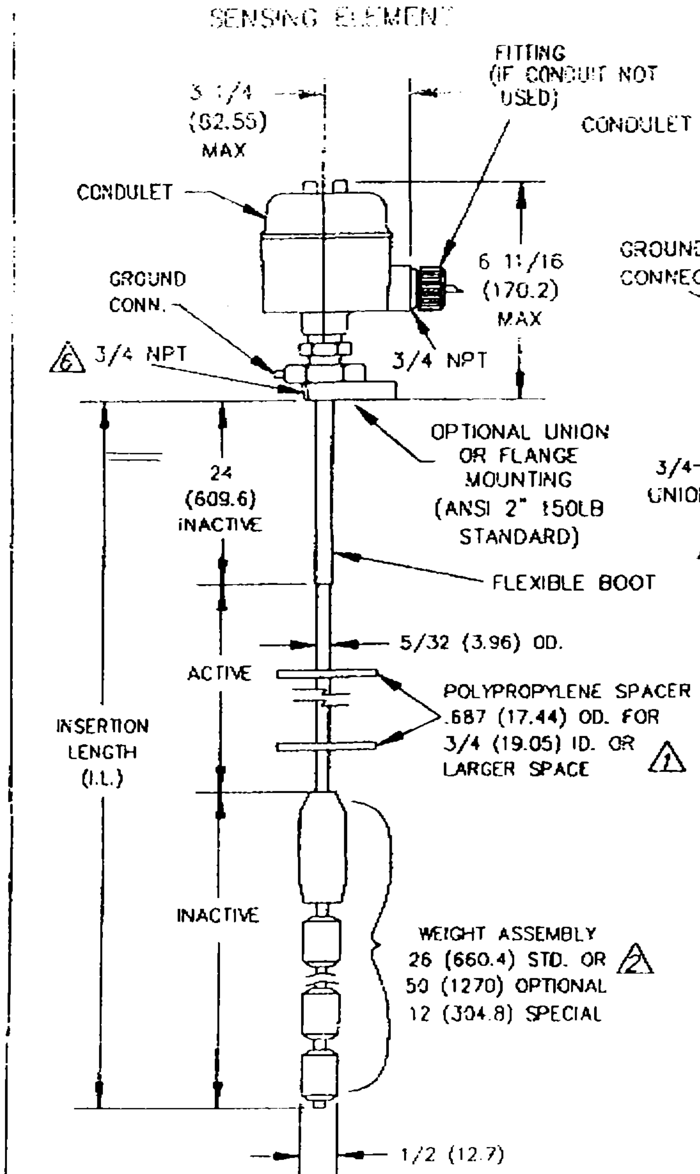
NO.	SIZE-INCHES	WT./100
41-290-	1/8	14.6 lbs.
41-300-	1/4	14.6 lbs.
41-310-	3/8	31.3 lbs.
41-320-	1/2	34.8 lbs.

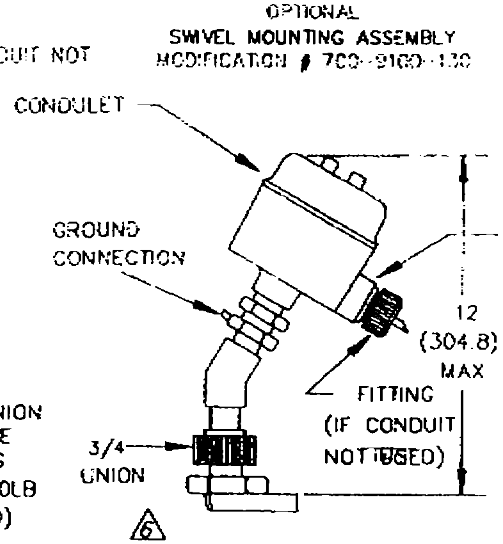


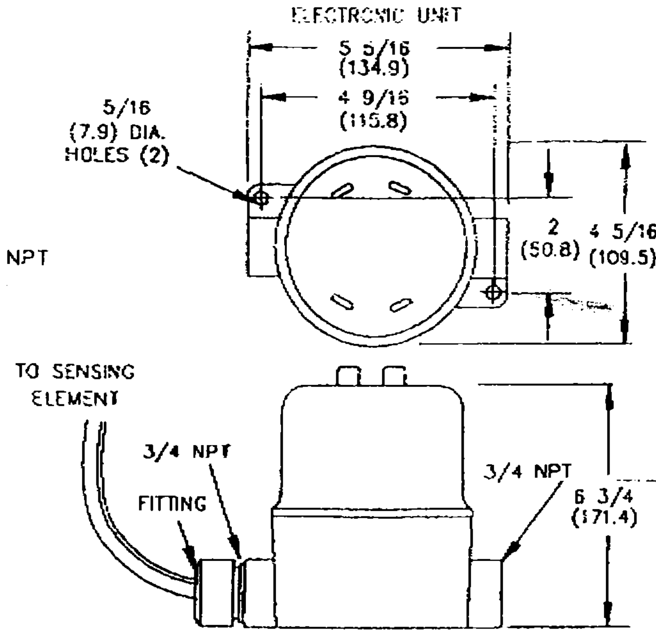
TEE HANDLE DOUBLE FEMALE

NO.	SIZE-INCHES	WT./100
41-370-	1/8	13.0 lbs.
41-380-	1/4	13.2 lbs.
41-390-	3/8	22.7 lbs.
41-391-	1/2	26.8 lbs.

DREXELBROOK







NOTES:

1. SPACERS FURNISHED WITH SENSING ELEMENT, ONE FOR EVERY 4' OF I.L., FIELD INSTALLED. FOR INSTALLATION IN 1/2" GAGE TUBE, OR FOR PFA SPACERS, CONSULT FACTORY.
2. WEIGHT ASSEMBLY LENGTH GUIDELINES:
   - I.L. TO 500' - 26" STD
   - I.L. 500' OR LONGER - 50" STD.
3. ALL METAL WETTED PARTS 316 SST.
4. SENSING ELEMENT IS FIELD SHORTENABLE. SHORTENING KIT IS FURNISHED WITH EACH SENSING ELEMENT (P/N 389-1-22) SEE 700-5-34-CD1 OR 700-5-35-CD1 FOR INSTRUCTIONS.
5. SEE 700-5-34-CD2 FOR GAGE SOUNDING TUBE & GROUNDING INSTALLATION DETAILS.
6. UNION MOUNTING RECOMMENDED FOR EASE OF INSTALLATION. UNION IS STANDARD WITH SWIVEL MOUNTING. IF GROUND WIRE IS USED SPECIFY UNION PART NUMBER 242-7-66.

SYSTEM #	SENSING ELEMENT			
	INSULATION	BOOT	CABLE DIA	S E #
508-11-734	P P	PVC	5/32	700-5-34
508-11-735	PFA	TEF	3/32	700-5-35

ISS.	ECO/DSR NO	APP'D	DATE
4	1-94-471	LOR	4/4/94
3	12-92-246	DL	1-20-93
2	7-92-251	DL	9-4-92
1	8-91-254	DL	10-10-91

CERTIFIED by
PO #
ENG
USER

SCALE NONE
UNLESS OTHERWISE STATED ALL DIMENSIONS IN INCHES (mm)
DR CDW
CK

DREXELBROOK Engineering Company
205 KEITH VALLEY RD
HORSHAM, PA 19044-9386
215-674-1234
FAX 215-674-2731

Check Well™ LEVEL MONITOR
TWO WIRE
REMOTE MOUNT
508-11-73X SERIES

508-0011-734-CD1 SHT 1 OF 2 ISS. 4

NO. 508-0011-734-CD1 SHT 1 OF 2

PRODUCTION WELLS

WELL TYPES INSTALLATION DETAILS	SHEET NUMBER	FIGURE NUMBER
PRODUCTION WELL WITH SENSOR MOUNTED "FREEHANGING" BETWEEN COLUMN & CASING	1	1
PRODUCTION WELL WITH SENSOR MOUNTED IN METAL GAGE TUBE.	1	2
MONITORING WELL WITH METAL CASING	2	3
MONITORING WELL WITH PLASTIC / PLASTIC LINED CASING	2	4
PRODUCTION WELL WITH SENSOR MOUNTED IN PLASTIC GAGE TUBE.	3	5
PRODUCTION WELL WITH SENSOR MOUNTED IN PERFORATED PLASTIC GAGE TUBE.	3	6
GAGE TUBE LOCATION, DETAIL.	3	7
GAGE TUBE INSTALLATION DETAILS	4	8
SENSING ELEMENT MOUNTING OPTIONS NPT, UNION, FLANGE, SWIVEL, ETC.	5	9
SPECIAL GROUNDING OPTIONS	6	10

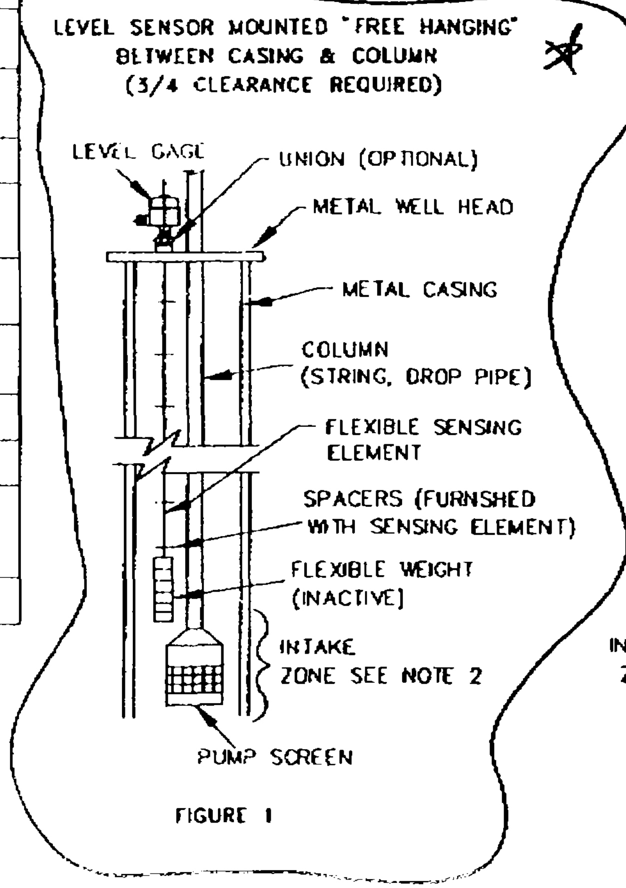


FIGURE 1

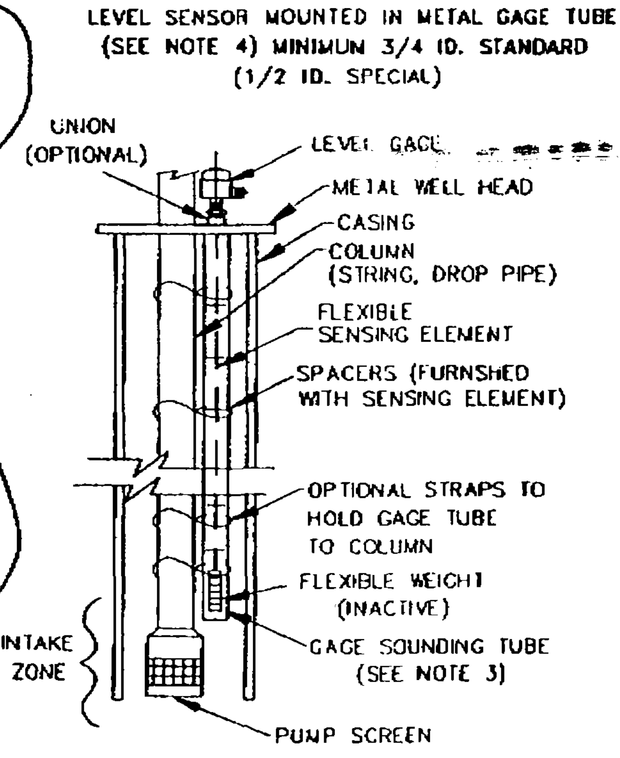


FIGURE 2

NOTES:

1. FOR DETAILED SYSTEM MOUNTING AND WIRING DRAWINGS SEE APPLICABLE SYSTEM DRAWING 508-11-34-CD1, 508-11-734-CD1, 303-401-20-CD1, 303-421-20-CD1, 303-431-20-CD1
2. BOTTOM OF WEIGHT MUST BE ABOVE OR BELOW INTAKE ZONE
3. BOTTOM OF TUBE MUST BE POSITIONED ABOVE OR BELOW INTAKE ZONE SO THAT PUMP WILL NOT SUCK WATER OUT OF GAGE TUBE
4. METAL GAGE TUBE MAY BE TUBING, PIPE, OR FLEXIBLE WITH PVC COATING. A GAGE SOUNDING TUBE ALLOWS FOR EASIER SENSING ELEMENT INSTALLATION AND REMOVAL. WHEN WELL HAS MULTIPLE AQUIFERS, A GAGE TUBE IS REQUIRED
5. A METAL UNION MOUNTING IS RECOMMENED FOR EASE OF SENSING ELEMENT INSTALLATION AND REMOVAL.

CERTIFIED BY
PO #
ENG
USER

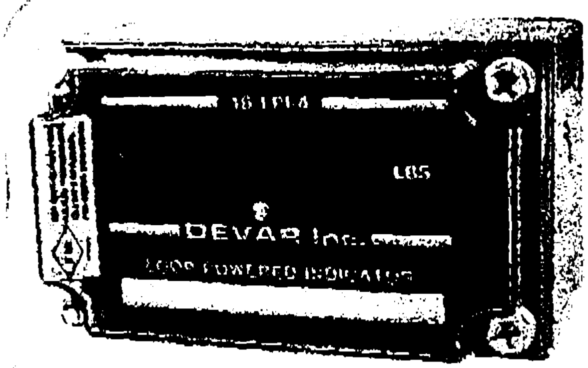
ISS	ECO/DSR NO	APP'D	DATE
2	2-92-238		9/1/92
1	8-91-258	DL	8/2/91

SCALE NONE
UNLESS OTHERWISE STATED ALL DIMENSIONS IN INCHES
DR RDC
CK

DREXELBROOK Engineering Company
205 KEITH VALLEY RD
HORSHAM, PA 19044-9995
215-674-1234
FAX 215-674-2731

CHECK WELL (TM) DEEP WELL LEVEL GAGE TYPICAL INSTALLATION DETAILS

NO. 700-5-34-CD2 SH 1 OF 6 ISS 2



18-LPI Series

This series of digital indicators includes models **18-LPI** with 3½ digit display, **18-LPI-4** with 4½ digit display and **18-LPI-1V** with 3½ digit display and LESS THAN ONE VOLT DROP.

All of the above models may be installed indoors or outdoors and are packaged in sturdy, NEMA-4X polycarbonate housings. The units are available with various mounting options. See "Product Features and Options" on facing page. A special feature of the 18-LPI-1V provides the user with a unique internal calibration circuit that allows field calibration or range change without disconnecting input circuits. Direct meter readout values of 4 to 20mA loop signals, in engineering units such as °C, °F, RPM, pH, etc. are provided by the series 18-LPI indicators.

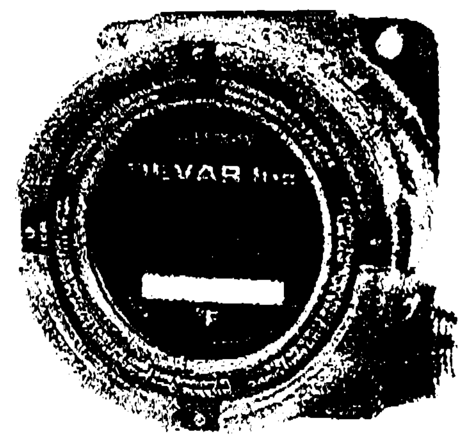
The large 0.5 inch high liquid crystal display facilitates easy readablility, even in a strong ambient light, thereby reducing potential reading errors.

Explosion-Proof 18-LPIX Series

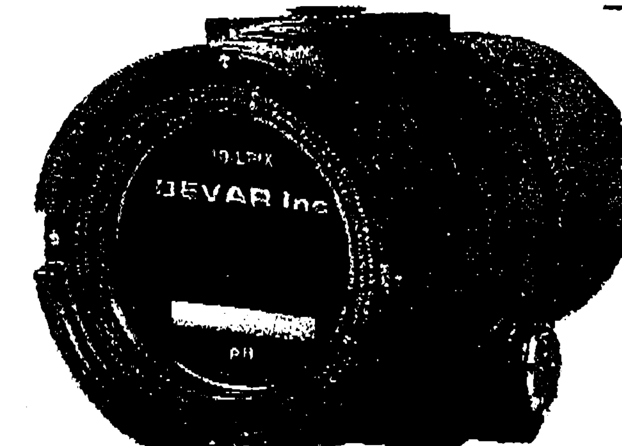
Loop-Powered Indicators enclosed in explosion-proof housing are available in models **18-LPIX** with 3½ digit display, **18-LPIX-1V** with 3½ digit display and LESS THAN ONE VOLT DROP and **18-LPIX-4** with 4½ digit display. All indicators are installable at any point along a 4 to 20mA-signal loop and do not require an outside power source.

All models are easily field calibrated using D.I.P. switches and non-interactive offset and span potentiometers. These explosion-proof models read values directly in engineering units such as, but not limited to °C, °F, RPM, pH, etc. Liquid crystal displays, 0.5 inches high are featured on 3½ digit mode. 4½ digit models provide 0.4 inch high numerals.

A wide variety of features and options are available. See Product Features and Options chart on facing page.



Transmitter Indicator M371



The transmitter Indicator, M371 incorporates a 3½ digit display and is supplied in an explosion-proof housing as standard. The transmitter component features Devar mini-pak temperature transmitters for thermocouple or R.T.D. sensors, field-proven pH and ORP signal analyzers or frequency signal converters. Readings utilizing variable resistance slidewires also provide a simple, local, valve position indication. M37 features (FM) approved dual chamber, NEMA-4 design with the indicator simply plugging into connections pre-wired to the transmitter output. The indicator may also be positioned by rotating it to facilitate viewing, regardless of the housing mounting position.

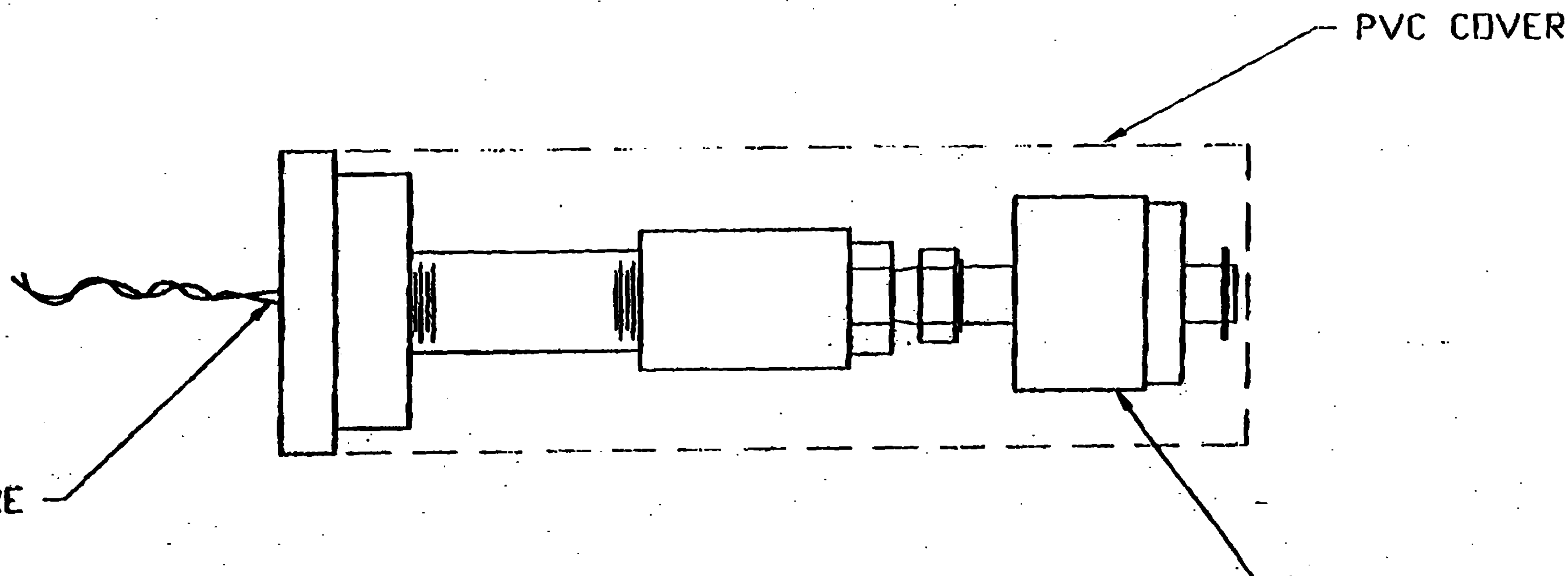
For detailed information, ask for our bulletin on "2-Wire, Mini-Pak Transmitters", Model 18-265A pH/ORP & 18-166 frequency transmitter.

Note. Devar 3½ digit indicators are (FM) approved and intrinsically safe for CL1, Division 1, GP, A, B, C, & D.
Explosion-proof, watertight models are NEMA-7 rated Class I, Groups B, C & D, Division 1; Class II, Groups E, F & G, Division I
Detailed mounting and specifications are outlined on inside spread.

Specifications

	For All NEMA 4X And Explosion Proof Models		
	18-LPI (3½ Digit)	**18-LPI-4 (4½ Digit)**	**18-LPI-1V (3½ Digit)**
Input			
Range	4 to 20mA		
Voltage Drop	3.0VDC @ 20mA	3.3VDC @ 20mA	.98V @ 20mA, 25°C
Max Input Current	60mA Forward or Reverse		100mA Forward or Reverse
Display			
Type	7 Segment, 3.5 Digit LCD	7 Segment, 4.5 Digit LCD	7 Segment, 3.5 Digit LCD
Character Height	0.5 in.	0.4 in.	.05 in.
Characters	1.8.8.8	1.8.8.8.8	1.8.8.8
Decimal Pts.	3 Position or Absent Switch Selectable	4 Position or Absent Plug in Jumper Selectable	3 Position or Absent Switch Selectable
Polarity Indication	Negative Sign		
Overrange	Blanks Least 3 Significant Digits	Blanks Least 4 Significant Digits	Blanks Least 3 Significant Digits
Range	-1999 to +1999 Cts.	-19999 to +19999 Cts.	-1999 to +1999 Cts.
Calibration			
Span Range	0 to 3998 Counts 3 Ranges, Switch Selectable Fine Adjustment on 15 Turn Span Trim Pot Non-interactive with ZERO POT	0 to 39998 Counts 16 Ranges, Switch Selectable Fine Adjustment on 15 Turn Span Trim Pot Non-interactive with ZERO POT	0 to 3998 Counts 3 Ranges, Switch Selectable Fine Adjustment on 15 Turn Span Trim Pot Non-interactive with ZERO POT
Offset Range	-1999 to +1999 Cts. 3 Ranges Switch Selectable Fine Adjustment on 15 Turn Zero Trim Pot, Non-interactive with SPAN POT	-19999 to +19999 Cts. 16 Ranges Switch Selectable Fine Adjustment on 15 Turn Zero Trim Pot, Non-interactive with SPAN POT	-1999 to +1999 Cts. 3 Ranges, Switch Selectable, Fine Adjustment on 15 Turn Zero Trim Pot, Non-interactive with SPAN POT
Performance			
Resolution	Better than 1 Count		
Accuracy (25°C)	±0.1% of Span Cts., ±1 Ct.	Reading ±3 Counts	±0.1% of Span Cts., ±1 Ct.
Temp. Effect Zero	±0.1 Count / °C	±(.0003% Span + 0.4 Cts.) Typ. (Per °C) ±(.0016% Span + 1.2 Cts.) Max.	±0.1 Count / °C
Temp. Effect Span	±0.01% Span / °C	±.001% Span Typ. (Per °C) ± .009% Span Max.	±0.01% of Span Count / °C
Operating Temp.	-20° to +70°C (-4° to +158°F)	-30° to +70°C (-22° to +158°F)	-20° to +70°C (-4° to +158°F)
Storage Temp.	-40° to +85°C (-40° to +185°F)		
Sample Rate	2.0 Per Sec.	2.4 Per Sec.	2 Per Sec.
Ripple Rejection	Less than 1 Count with 1mA Peak to Peak, 60Hz, Ripple at Input	< 0.01% of Span For 1mA, 60Hz, Ripple at Input	Less than 1 Count with 1mA Peak to Peak, 60Hz, Ripple at Input
Enclosures & Weight	NEMA-4x Polycarbonate (1 lb.) NEMA-7 Explosion Proof (2.8 lbs.)		

EPG COMPANIES WELL FLOAT



EPG Series F100 Well Float

The EPG series F100 float comes with a standard 100 foot lead
The lead is a two wire 16 gauge nylon jacketed material
The float is connected to the lead in a two part process
1) the leads are soldered to the float wires
2) the leads are then epoxy potted to the top of the float body
The float is configured to be a normally open circuit used in conjunction with an intrinsically safe level of 11.5 volts 5 ma.

THIS DRAWING IS PROPERTY OF * EPG COMPANIES *
FOR REFERENCE USE ONLY

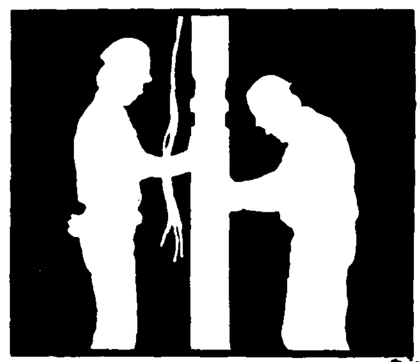
TOLERANCES	REVISIONS	EPG COMPANIES
		WELL FLOAT
		J.D. FULL
		12-28-90

TOTAL P.03

FRANKLIN ELECTRIC

SERVICE DATA
PAGE: 263SD
DATE: OCTOBER 1, 1988
Supersedes: 2-17-86

SUBMERSIBLE MOTORS



APPLICATION INSTALLATION MAINTENANCE MANUAL

Single and Three Phase Water Well Pump Motors • 4", 6" and 8" Diameter, 60 HZ

Franklin Electric
Water For A Thirsty World

SUBMERSIBLE MOTORS

APPLICATION • INSTALLATION MAINTENANCE MANUAL

CONTENTS

This manual describes the correct installation of Franklin Submersible Water Well Pump Motors and provides the electrical and mechanical information to aid in checking installations.

HOW TO USE THIS MANUAL

This manual is arranged with the first part devoted to application information with installation or maintenance aid in the latter pages.

Maximum benefit when checking installation will be derived from this manual when preliminary tests are made as outlined on Page 18 before referring to the trouble shooting procedure.

APPLICATION

Single Phase Motor Specifications Table 1

TYPE	MOTOR MODEL PREFIX	HP	Volts	HZ	S.F.	Rated Input (2) Amps	Rated Input Watts	Maximum Input (S.F. Load) (2) Amps	Maximum Input (S.F. Load) Watts	Max. Lbs. Thrust	(1) Line to Line Res. M = Main S = Start	Efficiency % S.F.	Efficiency % F.L.	Efficiency % ¾	Power Factor % S.F.	Power Factor % F.L.	Power Factor % ¾	Locked Rotor Amps	KVA Code	Fuse Size Ckt. Bkr. or Std.	Fuse Size Dual El.
4 INCH TWO WIRE	2443020	⅓	115	60	1.75	7.0	500	8.9	780	300	1.5-1.9	57.7	50.5	44.5	77.0	62.1	54.5	48.4	S	25	10
	2443030	⅓	230	60	1.75	3.5	500	4.4	780	300	6.0-7.4	57.7	50.5	44.5	77.0	62.1	54.5	24.2	S	15	5
	2443040	½	115	60	1.60	9.6	700	11.9	1050	300	1.0-1.3	59.0	53.7	48.1	78.0	63.8	55.8	62.4	R	30	15
	2443050	½	230	60	1.60	4.8	700	5.9	1050	300	4.2-5.2	59.0	53.7	48.1	78.0	63.8	55.8	31.2	R	15	7
	2443070	¾	230	60	1.50	6.4	980	8.0	1420	300	2.7-3.4	62.0	57.2	52.0	76.8	66.0	58.5	40.2	N	20	9
	2443081	1	230	60	1.40	8.2	1240	9.6	1700	650	2.2-2.8	62.9	60.5	56.1	78.2	67.6	59.0	46.0	M	25	12
	2443091	1½	230	60	1.30	10.6	1780	13.1	2400	650	1.5-1.9	65.0	62.8	59.4	79.7	74.2	66.1	56.8	L	35	15
4 INCH THREE WIRE	2143024	⅓	115	60	1.75	7.0	500	Y 8.9 B 8.9 R 0	770	300	1.5-1.9M 5.7-7.1S	57.7	50.5	44.5	77.0	62.0	54.5	32.8	N	20	8
	2143034	⅓	230	60	1.75	3.5	500	Y 4.4 B 4.4 R 0	770	300	6.0-7.4M 23.4-28.6S	57.7	50.5	44.5	77.0	62.0	54.5	16.4	N	15	5
	2143044	½	115	60	1.60	9.6	700	Y11.9 B11.9 R 0	1040	300	1.0-1.3M 3.8-4.7S	59.0	53.5	48.1	78.0	63.7	55.8	46.0	M	30	15
	2143054	½	230	60	1.60	4.8	700	Y 5.9 B 5.9 R 0	1040	300	4.2-5.2M 15.5-19.6S	59.0	53.5	48.1	78.0	63.7	55.8	23.1	M	15	7
	2143074	¾	230	60	1.50	6.4	980	Y 8.0 B 8.0 R 0	1400	300	2.7-3.4M 11.0-13.6S	61.9	57.2	52.0	76.8	66.0	58.5	33.1	M	20	9
	2143081	1	230	60	1.40	8.0	1240	Y 9.6 B 9.6 R 0	1700	650	2.2-2.8M 9.5-11.7S	62.8	60.5	56.1	78.0	67.5	59.0	42.0	L	25	12
4 INCH 3 WIRE W-RUN CAP.	2243001	1½	230	60	1.30	10.0	1700	Y11.5 B11.0 R 1.8	2150	650	1.5-2.3M 6.2-12.0S	67.9	66.0	62.0	81.4	74.4	66.1	52.8	J	30	15
	2243011	2	230	60	1.25	10.0	2100	Y13.2 B11.9 R 2.8	2750	650	1.6-2.3M 5.2-7.15S	70.0	71.0	68.8	93.1	90.5	86.7	51.0	G	30	15
	2243007	1½	230	60	1.30	10.0	1700	Y11.6 B11.0 R 1.8	2150	900	1.5-2.3M 6.2-12.0S	67.9	66.0	62.0	81.4	74.4	66.1	52.8	J	30	15
	2243017	2	230	60	1.25	10.0	2100	Y13.2 B12.0 R 2.8	2800	900	1.6-2.3M 5.2-7.1S	70.0	71.0	68.8	93.1	90.5	86.7	51.0	G	30	15
	2243027	3	230	60	1.15	14.0	3150	Y17.0 B14.5 R 4.5	3700	900	.9-1.5M 3.0-4.9S	70.9	71.8	69.6	98.0	97.5	96.0	71.0	F	45	20
	2243037	5	230	60	1.15	23.0	5200	Y27.5 B23.2 R 9.2	6100	900	.68-1.0M 2.1-2.8S	71.1	71.9	70.0	97.5	96.4	94.0	118.0	F	70	30
6 INCH	2261109	5	230	60	1.15	23.9	5070	Y29.5 B28.4 R 4.0	5820	1500	.55-.68M 1.3-1.6S	75.2	75.5	74.5	91.1	90.7	88.7	102.0	E	80	35
	2261119	7½	230	60	1.15	36.5	7300	Y42.0 B40.5 R 5.4	8800	1500	.36-.50M .92-1.2S	73.4	74.4	74.2	91.0	90.4	87.2	165.0	F	100	45
	2261129	10	230	60	1.15	45.0	9800	Y51.0 B47.5 R 8.9	11300	3500	.27-.33M .80-.99S	76.2	76.8	76.3	95.8	95.8	95.3	204.0	E	150	60
	2261139	15	230	60	1.15	62.0	13900	Y72.0 B62.5 R16.9	17500	3500	.17-.22M .68-.93S	79.4	80.3	79.7	97.3	97.9	98.2	303.0	E	200	80

(1) Measure main winding resistance — black to yellow
Measure start winding resistance — red to yellow

(2) Y = Yellow lead, line amps
B = Black lead, main winding amps
R = Red lead, start or auxiliary winding amps

Three Phase Motor Specifications Table 2

MOTOR MODEL PREFIX	HP	Volts	HZ	S.F.	Rated Input Amps	Rated Input Watts	Maximum Input (S.F. Load) Amps	Maximum Input (S.F. Load) Watts	Max. Lbs. Thrust	Line to Line Res.	Efficiency % S.F.	Efficiency % F.L.	Efficiency % ¾	Power Factor % S.F.	Power Factor % F.L.	Power Factor % ¾	Locked Rotor Amps	KVA Code	Fuse Size Crt. Bkr. or Std.	Fuse Size Dual Ele.
2343014	½	200	60	1.6	2.8	635	3.7	900	300	6.64-7.3	66.4	59.4	53.3	76.6	64.1	56.5	17.3	N	10	5
2343114	½	230	60	1.6	2.3	635	2.9	900	300	9.5-10.4	66.4	59.4	53.3	76.6	64.1	56.5	15.0	N	8	4
2343213	½	460	60	1.6	1.2	635	1.6	900	300	38.4-41.6	66.4	59.4	53.3	76.6	64.1	56.5	7.5	N	4	2
2343024	¾	200	60	1.5	3.7	920	4.7	1250	300	4.66-5.12	67.5	63.0	57.7	79.5	69.0	66.0	24.6	N	12	6
2343124	¾	230	60	1.5	3.3	920	4.1	1250	300	7.24-7.84	67.5	63.0	57.7	79.5	69.0	66.0	21.4	N	11	5
2343223	¾	460	60	1.5	1.6	920	2.0	1250	300	27.8-30.2	67.5	63.0	57.7	79.5	69.0	66.0	10.7	N	5	3
2343031	1	200	60	1.4	4.5	1140	5.7	1520	650	4.1-4.5	69.3	67.0	63.0	79.1	71.0	63.4	31.0	M	14	6
2343131	1	230	60	1.4	3.9	1140	4.8	1520	650	5.2-5.6	69.3	67.0	63.0	79.1	71.0	63.4	27.0	M	12	6
2343231	1	460	60	1.4	2.0	1140	2.4	1520	650	21.2-23.0	69.3	67.0	63.0	79.1	71.0	63.4	13.5	M	6	3
2343041	1½	200	60	1.3	6.1	1570	7.3	2000	650	2.4-3.4	75.0	74.0	70.9	80.0	73.0	64.5	39	K	20	9
2343141	1½	230	60	1.3	5.2	1570	6.3	2000	650	3.2-4.1	75.0	74.0	70.9	80.0	73.0	64.5	34	K	20	8
2343241	1½	460	60	1.3	2.6	1570	3.1	2000	650	11.3-15.0	75.0	74.0	70.9	80.0	73.0	64.5	17	K	15	4
2343341	1½	575	60	1.3	2.1	1570	2.5	2000	650	17.6-23.4	75.0	74.0	70.9	80.0	73.0	64.5	14	K	15	3
2343047	1½	200	60	1.3	6.1	1570	7.4	2050	900	2.4-3.4	75.0	74.0	70.9	80.0	73.0	64.5	39	K	20	9
2343147	1½	230	60	1.3	5.3	1570	6.4	2050	900	3.2-4.1	75.0	74.0	70.9	80.0	73.0	64.5	34	K	20	8
2343247	1½	460	60	1.3	2.7	1570	3.2	2050	900	11.3-15.0	75.0	74.0	70.9	80.0	73.0	64.5	17	K	15	4
2343347	1½	575	60	1.3	2.2	1570	2.6	2050	900	17.6-23.4	75.0	74.0	70.9	80.0	73.0	64.5	14	K	15	3
2343051	2	200	60	1.25	7.7	2050	9.3	2580	650	1.9-2.4	69.5	69.5	67.4	84.4	79.0	71.2	53	L	25	10
2343151	2	230	60	1.25	6.7	2050	8.1	2580	650	2.4-3.0	69.5	69.5	67.4	84.4	79.0	71.2	46	L	20	10
2343251	2	460	60	1.25	3.4	2050	4.1	2580	650	9.7-12.0	69.5	69.5	67.4	84.4	79.0	71.2	23	L	15	5
2343057	2	200	60	1.25	7.7	2150	9.3	2690	900	1.9-2.4	69.5	69.5	67.4	84.4	79.0	71.2	53	L	25	10
2343157	2	230	60	1.25	6.7	2150	8.1	2690	900	2.4-3.0	69.5	69.5	67.4	84.4	79.0	71.2	46	L	20	10
2343257	2	460	60	1.25	3.4	2150	4.1	2690	900	9.7-12.0	69.5	69.5	67.4	84.4	79.0	71.2	23	L	15	5
2343357	2	575	60	1.25	2.7	2150	3.2	2690	900	15.1-18.7	69.5	69.5	67.4	84.4	79.0	71.2	18	L	15	4
2343067	3	200	60	1.15	10.9	2980	12.5	3420	900	1.3-1.7	75.5	75.2	73.2	81.5	77.8	69.5	70	K	35	14
2343167	3	230	60	1.15	9.5	2980	10.9	3420	900	1.8-2.2	75.5	75.2	73.2	81.5	77.8	69.5	61	K	30	15
2343267	3	460	60	1.15	4.8	2980	5.5	3420	900	7.0-8.7	75.5	75.2	73.2	81.5	77.8	69.5	31	K	15	7
2343367	3	575	60	1.15	3.8	2980	4.4	3420	900	10.9-13.6	75.5	75.2	73.2	81.5	77.8	69.5	24	K	15	6
2343077	5	200	60	1.15	18.3	5050	20.5	5810	900	.70-.94	74.0	74.0	72.2	84.0	81.0	73.0	120	K	50	24
2343177	5	230	60	1.15	15.9	5050	17.8	5810	900	.93-1.2	74.0	74.0	72.2	84.0	81.0	73.0	104	K	45	20
2343277	5	460	60	1.15	8.0	5050	8.9	5810	900	3.6-4.4	74.0	74.0	72.2	84.0	81.0	73.0	52	K	25	10
2343377	5	575	60	1.15	6.4	5050	7.1	5810	900	5.6-6.9	74.0	74.0	72.2	84.0	81.0	73.0	42	K	20	8
2343087	7½	200	60	1.15	26.5	7360	30.5	8450	900	.46-.57	76.2	76.0	74.0	83.2	80.0	72.2	158	J	80	35
2343187	7½	230	60	1.15	23.0	7360	26.4	8450	900	.61-.75	76.2	76.0	74.0	83.2	80.0	72.2	143	J	70	30
2343287	7½	460	60	1.15	11.5	7360	13.2	8450	900	2.4-3.4	76.2	76.0	74.0	83.2	80.0	72.2	72	J	35	15
2343387	7½	575	60	1.15	9.2	7360	10.6	8450	900	3.5-5.1	76.2	76.0	74.0	83.2	80.0	72.2	57	J	30	12
2343297	10	460	60	1.15	17.0	10100	18.8	11700	900	1.8-2.3	75.2	74.5	72.0	79.2	75.5	67.1	116	K	45	20
2343397	10	575	60	1.15	13.6	10100	15.0	11700	900	2.8-3.5	75.2	74.5	72.0	79.2	75.5	67.1	93	K	40	20
2366506	5	200	60	1.15	17.5	4700	19.1	5400	1500	.68-.84	79.5	79.1	77.2	82.0	79.5	73.8	98.9	H	50	24
2366006	5	230	60	1.15	15.0	4700	16.6	5400	1500	.88-1.09	79.5	79.1	77.2	82.0	79.5	73.8	86	H	45	20
2366106	5	460	60	1.15	7.5	4700	8.3	5400	1500	3.53-4.37	79.5	79.1	77.2	82.0	79.5	73.8	43	H	25	10
2366206	5	575	60	1.15	6.0	4700	6.4	5400	1500	5.93-7.16	79.5	79.1	77.2	82.0	79.5	73.8	34.4	H	20	8
2366516	7½	200	60	1.15	25.1	7000	28.3	8000	1500	.39-.48	79.8	80.0	78.7	83.0	80.5	73.8	149.5	H	70	30
2366016	7½	230	60	1.15	21.8	7000	24.6	8000	1500	.57-.71	79.8	80.0	78.7	83.0	80.5	73.8	130	H	70	30
2366116	7½	460	60	1.15	10.9	7000	12.3	8000	1500	2.17-2.68	79.8	80.0	78.7	83.0	80.5	73.8	65.0	H	30	15
2366216	7½	575	60	1.15	8.7	7000	9.8	8000	1500	3.65-4.41	79.8	80.0	78.7	83.0	80.5	73.8	52	H	25	12
2366526	10	200	60	1.15	32.7	9400	37.0	10800	3500	.33-.42	79.2	79.4	78.0	85.5	83.2	77.2	197.8	H	100	40
2366026	10	230	60	1.15	28.4	9400	32.2	10800	3500	.44-.55	79.2	79.4	78.0	85.5	83.2	77.2	172	H	80	35
2366126	10	460	60	1.15	14.2	9400	16.1	10800	3500	1.76-2.17	79.2	79.4	78.0	85.5	83.2	77.2	86.0	H	40	20
2366226	10	575	60	1.15	11.4	9400	12.9	10800	3500	2.87-3.47	79.2	79.4	78.0	85.5	83.2	77.2	68.8	H	35	15

Three Phase Motor Specifications Table 3

Motor Model Prefix	HP	Volts	HZ	S.F.	Rated Input Amps	Rated Input Watts	Maximum Input (S.F. Load) Amps	Maximum Input (S.F. Load) Watts	Max. Lbs. Thrust	Line to Line ohms 3 Lead or Δ Conn. 6 Lead	Efficiency % S.F.	Efficiency % F.L.	Efficiency % ¾	Power Factor % S.F.	Power Factor % F.L.	Power Factor % ¾	Locked Rotor Amps	KVA Code	Fuse Size Crt. Bkr. or Std.	Fuse Size Dual Ele.
2366536	15	200	60	1.15	47.8	13700	54.4	15800	3500	.22-.27	81.0	81.5	80.2	84.9	82.8	76.5	306	H	150	60
2366036	15	230	60	1.15	41.6	13700	47.4	15800	3500	.27-.33	81.0	81.5	80.2	84.9	82.8	76.5	266	H	125	60
2366136	15	460	60	1.15	20.8	13700	23.7	15800	3500	1.07-1.32	81.0	81.5	80.2	84.9	82.8	76.5	133	H	60	30
2366236	15	575	60	1.15	16.6	13700	19.0	15800	3500	1.70-2.10	81.0	81.5	80.2	84.9	82.8	76.5	106.4	H	50	25
2366546	20	200	60	1.15	61.9	18100	69.7	20900	3500	.14-.17	82.0	82.3	81.6	86.8	84.8	79.5	416.3	J	200	80
2366046	20	230	60	1.15	53.8	18100	60.6	20900	3500	.20-.25	82.0	82.3	81.6	86.8	84.8	79.5	362	J	175	70
2366146	20	460	60	1.15	26.9	18100	30.3	20900	3500	.76-.94	82.0	82.3	81.6	86.8	84.8	79.5	181	J	80	35
2366246	20	575	60	1.15	21.5	18100	24.2	20900	3500	1.22-1.52	82.0	82.3	81.6	86.8	84.8	79.5	144.8	J	70	30
2366556	25	200	60	1.15	77.1	22500	86.3	25700	3500	.11-.14	82.8	83.0	82.0	87.0	85.0	79.2	552	J	225	100
2366056	25	230	60	1.15	67.0	22500	75.0	25700	3500	.15-.19	82.8	83.0	82.0	87.0	85.0	79.2	480	J	200	90
2366156	25	460	60	1.15	33.5	22500	37.5	25700	3500	.59-.73	82.8	83.0	82.0	87.0	85.0	79.2	240	J	100	45
2366256	25	575	60	1.15	26.8	22500	30.0	25700	3500	1.01-1.25	82.8	83.0	82.0	87.0	85.0	79.2	192	J	80	35
2366566	30	200	60	1.15	90.9	26900	104.0	31100	3500	.10-.12	82.5	83.0	82.6	87.5	85.4	80.3	602.6	J	300	125
2366066	30	230	60	1.15	79.0	26900	90.4	31100	3500	.12-.15	82.5	83.0	82.6	87.5	85.4	80.3	524	J	250	100
2366166	30	460	60	1.15	39.5	26900	45.2	31100	3500	.48-.60	82.5	83.0	82.6	87.5	85.4	80.3	262	J	125	50
2366266	30	575	60	1.15	31.6	26900	36.2	31100	3500	.78-.95	82.5	83.0	82.6	87.5	85.4	80.3	209.6	J	100	40
2366176	40	460	60	1.15	53.5	35600	62.0	42350	3500	.32-.40	83.2	83.4	82.9	85.8	83.6	77.6	397	J	150	70
2366276	40	575	60	1.15	42.8	35600	49.6	42350	3500	.53-.59	83.2	83.4	82.9	85.8	83.6	77.6	317.6	J	125	60
2366186	50	460	60	1.15	67.7	45100	77.0	52200	3500	.25-.32	82.5	83.0	82.7	85.2	84.0	80.0	414	H	200	90
2366286	50	575	60	1.15	54.2	45100	61.6	52200	3500	.39-.48	82.5	83.0	82.7	85.2	84.0	80.0	331.2	H	150	70
2366196	60	460	60	1.15	80.5	53500	91.0	61700	3500	.22-.27	84.2	84.5	84.0	85.0	83.3	78.0	518	H	250	100
2366296	60	575	60	1.15	64.4	53500	72.8	61700	3500	.35-.39	84.2	84.5	84.0	85.0	83.3	78.0	414	H	200	80
2391006	40	460	60	1.15	53.0	37000	60.0	42000	10000	.264-.292	82.0	81.3	79.3	87.3	86.4	83.7	342	H	175	70
2391106	40	575	60	1.15	42.4	37000	48.0	42000	10000	.424-.468	82.0	81.3	79.3	87.3	86.4	83.7	274	H	125	60
2391016	50	460	60	1.15	66.0	44000	75.0	51000	10000	.194-.216	84.4	84.0	82.5	85.5	84.5	81.0	433	H	200	90
2391116	50	575	60	1.15	52.8	44000	60.0	51000	10000	.300-.332	84.4	84.0	82.5	85.5	84.5	81.0	346	H	150	70
2391026	60	460	60	1.15	77.0	53000	89.0	61000	10000	.150-.166	85.5	85.0	83.5	87.5	86.7	83.6	560	J	225	100
2391126	60	575	60	1.15	61.6	53000	71.2	61000	10000	.240-.268	85.5	84.0	83.5	87.5	86.7	83.6	448	J	200	80
2391036	75	460	60	1.15	97.0	66000	110.0	76000	10000	.114-.126	85.2	85.0	83.6	87.1	86.0	82.7	750	J	300	125
2391136	75	575	60	1.15	77.6	66000	88.0	76000	10000	.180-.198	85.2	85.0	83.6	87.1	86.0	82.7	600	J	225	105
2391046	100	460	60	1.15	128.0	87000	148.0	102000	10000	.080-.088	86.5	86.0	84.2	86.8	85.1	81.0	1000	J	400	175
2391146	100	575	60	1.15	102.4	87000	118.4	102000	10000	.118-.130	86.5	86.0	84.2	86.8	85.1	81.0	800	J	300	150
2391056	125	460	60	1.15	165	109000	189	125000	10000	.057-.063	86.3	86.0	84.2	83.6	82.0	77.0	1300	K	500	225
2391156	125	575	60	1.15	132	109000	141	125000	10000	.090-.100	86.3	86.0	84.2	83.6	82.0	77.0	1040	K	400	175
2391266	150	460	60	1.15	193	128000	221	146000	10000	.049-.054	88.0	87.6	86.0	85.0	83.0	78.0	1600(1)	K	600	250
2391966	150	575	60	1.15	154	128000	177	146000	10000	.073-.081	88.0	87.6	86.0	85.0	83.0	78.0	1280(1)	K	450	200
2391276	175	460	60	1.15	218	150000	250	173000	10000	.045-.050	87.2	87.0	85.7	87.0	86.0	82.8	1850(1)	K	700	300
2391976	175	575	60	1.15	174	150000	200	173000	10000	.067-.074	87.2	87.0	85.7	87.0	86.0	82.8	1480(1)	K	500	225
2391286	200	460	60	1.15	245	169000	286	194000	10000	.038-.042	88.2	88.0	87.2	87.2	86.6	84.3	2100(1)	K	800	350
2391986	200	575	60	1.15	196	169000	229	194000	10000	.060-.066	88.2	88.0	87.2	87.2	86.6	84.3	1680(1)	K	600	300

(1) For 6 Lead Wye connected motor ÷ by 3.

Overload Protection Of Three Phase Submersible Motors

The characteristics of submersible motors are different from standard motors and special overload protection is required. If the motor is stalled, the overload protector must trip within approximately 10 seconds to protect the motor windings. For three phase submersible motors, the installer must use Subtrol or the quick trip protection tabulated below. All recommended overload selections are of the compensated type.

For submersible motors ambient compensation is necessary to provide adequate locked rotor protection at low air temperatures and to avoid nuisance tripping at high air temperatures.

The tables below list correct selections and settings for several manufacturers. Approval of other types may be requested from Franklin Electric.

60 HERTZ 4" MOTORS

HP	Volts	NEMA Starter Size	Heaters For Overload Relays: Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Adjustable Relays See Note 3: Set	Max.
½	200	00	K31	J16	L380A	3.13	3.4
	230	00	K29	J15	L343A	2.76	3.0
	460	00	—	J8	L174A	1.38	1.5
	575	00	—	J5	—	1.10	1.2
¾	200	00	K36	J19	L510A	4.23	4.6
	230	00	K33	J18	L463A	3.68	4.0
	460	00	K23	J11	L232A	1.84	2.0
	575	00	K21	J8	L193A	1.47	1.6
1	200	00	K37	J21	L618A	5.06	5.5
	230	00	K36	J19	L561A	4.42	4.8
	460	00	K26	J12	L282A	2.21	2.4
	575	00	K23	J10	L211A	1.75	1.9
1.5	200	00	K43	J24	L825A	6.81	7.4
	230	00	K41	J22	L750A	5.89	6.4
	460	00	K29	J15	L380A	2.94	3.2
	575	00	K27	J13	L310A	2.39	2.6
2	200	0	K50	J26	L111B	8.46	9.2
	230	0	K43	J25	L910A	7.36	8.0
	460	00	K33	J18	L463A	3.68	4.0
	575	00	K29	J15	L380A	2.94	3.2
3	200	0	K54	J29	L135B	11.2	12.2
	230	0	K52	J28	L122B	9.75	10.6
	460	0	K37	J20	L618A	4.88	5.3
	575	0	K33	J18	L463A	3.86	4.2
5	200	1	K61	J34	L220B	18.4	20.0
	230	1	K61	J32	L199B	16.0	17.4
	460	0	K49	J25	L100B	8.00	8.7
	575	0	K42	J23	L825A	6.44	7.0
7.5	200	1	K68	J38	L322B	27.0	29.3
	230	1	K67	J36	L293B	23.5	25.5
	460	1	K55	J29	L147B	11.8	12.8
	575	1	K52	J27	L122B	9.38	10.2
10	460	1	K58	J32	L181B	14.8	16.1
	575	1	K55	J30	L147B	11.9	12.9

60 HERTZ 6" MOTORS

HP	Volts	NEMA Starter Size	Heaters For Overload Relays: Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Adjustable Relays See Note 3: Set	Max.
5	200	1	K61	J34	L220B	18.4	20.0
	230	1	K61	J32	L199B	16.0	17.4
	460	0	K49	J25	L100B	8.00	8.7
	575	0	K42	J23	L825A	6.44	7.0
7.5	200	1	K68	J38	L322B	27.0	29.3
	230	1	K67	J36	L293B	23.5	25.5
	460	1	K55	J29	L147B	11.8	12.8
	575	1	K52	J27	L122B	9.38	10.2
10	200	2(1)	K72	J40	L426B	34.0	37.0
	230	2(1)	K70	J38	L390B	29.6	32.2
	460	1	K58	J32	L181B	14.8	16.1
	575	1	K55	J30	L147B	11.9	12.9
15	200	3(1)	K76	J43	L622B	50.1	54.5
	230	2	K75	J42	L520B	43.6	47.4
	460	2(1)	K64	J35	L265B	21.8	23.7
	575	2(1)	K61	J33	L220B	17.5	19.0
20	200	3	K78	J45	L787B	64.1	69.7
	230	3(1)	K77	J44	L710B	55.8	60.6
	460	2	K69	J38	L352B	27.9	30.3
	575	2	K64	J35	L293B	22.3	24.2
25	200	3	K86	J71	L950B	79.4	86.3
	230	3	K83	J46	L866B	69.0	75.0
	460	2	K72	J40	L426B	34.5	37.5
	575	2	K69	J37	L352B	27.6	30.0
30	200	4(1)	K88	J72	L107C	95.7	104.0
	230	3	K87	J71	L107C	83.2	90.4
	460	3(1)	K74	J41	L520B	41.6	45.2
	575	3(1)	K72	J39	L390B	33.3	36.2
40	460	3	K77	J44	L710B	57.0	62.0
	575	3	K74	J42	L593B	45.6	49.6
50	460	3	K83	J46	L866B	70.8	77.0
	575	3	K77	J44	L701B	56.7	61.6
60	460	4(1)	K87	J71	L107C	83.7	91.0
	575	4(1)	K78	J45	L787B	67.0	72.8

FOOTNOTES:

NOTE 1: Furnas intermediate sizes between NEMA starter sizes apply where (1) is shown in tables, size 1¾ replacing 2, 2½ replacing 3, and 3½ replacing 4. Heaters listed apply to Innova 45 designs and Definite Purpose Class 16 starters through their available range, and to standard starters in larger sizes. Overload relay adjustments should be set no higher than 100%, unless necessary to stop nuisance tripping with measured amps **in all lines** below nameplate maximum.

NOTE 2: General Electric heaters are type CR123 usable only on type CR124 overload relays. Adjustment should be set no higher than 100%, unless necessary to stop nuisance tripping with measured amps **in all lines** below nameplate maximum.

NOTE 3: Adjustable overload relay amp settings apply to approved types listed below. Approval of other types may be requested from Franklin Electric. Relay adjustment should be set at the **specified SET amps**, and only if tripping occurs with amps in all lines measured to be within nameplate maximum amps should the setting be increased, **not to exceed** the MAX value shown. Some approved types may only be available for part of the listed motor ratings. When relays are used with current transformers, relay setting is the specified amps divided by the transformer ratio. Approved manufacturer types include:

AEG series b17S, b27S 11-17A and 15-23A, b27-2 11-17A and 15-23A.
ASEA type RVH40.
Allen Bradley bulletin 193.
Fanal types K7 or K7D through K400.
General Electric CR4G1T-, CR4G1W-, CR4G2W-, CR4G3W-.
Klockner-Moeller types Z00, Z1, Z4, PKZM3.
Lovato RC-22 to RC-80.
RTE Delta types DQ, LR1-D, LR1-F.
Sprecher and Schuh types CT, CT1, CTA1.
Siemens types 3UA50, -52, -54, -58, -59, -62.
Square D Class 9065 types TUP, MR, TD, TE, TF, TR, TJE.
Telemecanique type LR1-D, LR1-F.
Westinghouse types FT13, FT23, FT33, FT43, K7D, K27D, K67D.

Other relay types from these and other manufacturers may or may not provide acceptable protection, and they should not be used without approval of Franklin Electric.

NOTICE: WARRANTY ON THREE PHASE SUBMERSIBLE MOTORS IS VOID UNLESS SUBTROL OR PROPER QUICK TRIP PROTECTION IN ALL 3 MOTOR LINES IS USED.

60 HERTZ 8" MOTORS							
			Heaters For Overload Relays			Adjustable Relays See Note 3	
HP	Volts	NEMA Starter Size	Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Set	Max.
40	460(4)	3	K77	J44	L710B	57.0	62
	575	3	K74	J42	L593B	45.6	49.6
50	460(4)	3	K83	J46	L866B	70.8	77
	575	3	K77	J44	L710B	56.7	61.6
60	460(4)	4(1)	K87	J71	L107C	83.7	91
	575	4(1)	K78	J45	L787B	67.0	72.8
75	460(4)	4(1)	K89	J73	L126C	101	110
	575	4(1)	K86	J70	L950B	81.0	88
100	460(4)	4	K94	J76	L155C	136	148
	575	4	K87	J73	L142C	108	118

60 HERTZ 8" MOTORS							
			Heaters For Overload Relays			Adjustable Relays See Note 3	
HP	Volts	NEMA Starter Size	Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Set	Max.
125	460(4)	5	K29	J15	L111B	173	189
	575	5	K26	J13	L910A	139	151
150	460(4)	5	K32	J17	L122B	203	221
	575	5	K28	J14	L100B	163	177
175	460(4)	5	K33	J18	L147B	230	250
	575	5	K31	J16	L111B	184	200
200	460(4)	5	K34	J20	L165B	263	286
	575	5	K32	J17	L135B	211	229

FOOTNOTES: Refer to page 5 for footnotes 1, 2, & 3.

(4) For 50 Hz, 380, 415 or 440 Volts, use the same heater or setting as 60 HZ 460V.

(5) Current transformers are used on all overload relays for starters larger than NEMA 4.

Cable Selection

SINGLE PHASE TWO OR THREE WIRE CABLE, 60 HZ (SERVICE ENTRANCE TO MOTOR)

Motor Rating		Copper Wire Size												
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	⅓	130	210	340	540	840	1300	1610	1960	2390	2910	3540	4210	5060
	½	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
230	⅓	550	880	1390	2190	3400	5250	6520	7960	9690	11770			
	½	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
	¾	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870		
	1	250	400	630	990	1540	2380	2960	3610	4410	5360	6520		
	1.5	190	310	480	770	1200	1870	2320	2850	3500	4280	5240		
	2	150	250	390	620	970	1530	1910	2360	2930	3620	4480		
	3	120	190	300	470	750	1190	1490	1850	2320	2890	3610		
	5	0	110*	180	280	450	710	890	1110	1390	1740	2170	2680	
	7.5	0	0	120*	200	310	490	610	750	930	1140	1410	1720	
	10	0	0	0	160*	250	390	490	600	750	930	1160	1430	1760
	15	0	0	0	0	170*	270	340	430	530	660	820	1020	1260

1 foot = .3048 meter

CAUTION Use of wire size smaller than listed will void warranty.

FOOTNOTES:

(1) Lengths marked * meet the U.S. National Electrical Code ampacity only for **individual** conductor 75°C cable. Only the lengths **without** * meet the code for **jacketed** 75°C cable. Local code requirements may vary.

(2) Maximum lengths shown maintain motor voltage at 95% of service entrance voltage, running at maximum nameplate amperes. If service entrance voltage will be at least motor nameplate voltage under normal load conditions, 50% additional length is permissable for all sizes.

(3) This table is based on copper wire. If aluminum wire is used it must be two sizes larger. Example: When the table calls for #12 copper wire you would use #10 aluminum wire.

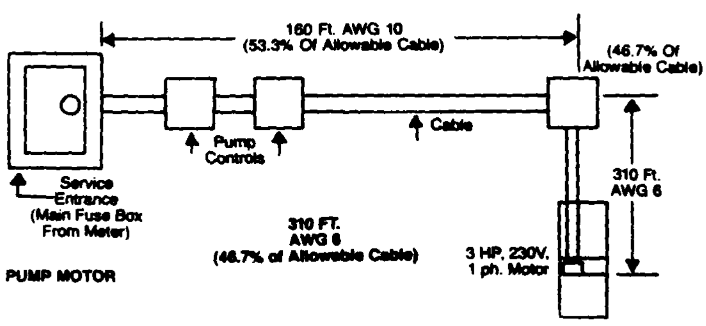
(4) Single phase control boxes may be connected at any point of the total cable length.

(5) Cables #14 to #0000 are AWG sizes.

In applications where two different cable sizes can be used

The example below is for reference. Depending on the installation, any number of combinations may be used, as long as the total percentage length of the two cables used does not exceed 100%. This is to insure that adequate voltage will be supplied to the motor.

EXAMPLE: 3 HP, 230 Volt, 1 PH Motor



In a replacement installation, the well already has 160 feet of buried #10 cable between the service entrance and the well head. The question is: What size cable is required in the well with a 3 HP, 230 volt, 1 PH motor setting at 310 feet?

1. According to the table #10 cable is large enough for the 3 HP motor, so the percent of the maximum allowable cable used by the 160-foot run is 160 ÷ 300 = 53.3%, since 300 feet is the total allowable.
2. With 53.3% of the total allowable cable already used between the service entrance and the well head, only 46.7% is left for the well. Therefore, the 310 feet needed in the well can only utilize 46.7% of the total feet allowed in the table.
3. From the table, 46.7% of the 470 feet for #8 cable equals only 220 feet, so a larger size is needed. For #6, 46.7% of 750 feet = 350 feet. As a result, #6 can be used for the 310 feet in the well.

THREE PHASE THREE WIRE CABLE, 60 HZ 200 AND 230 VOLTS (SERVICE ENTRANCE TO MOTOR)

Motor Rating		Copper Wire Size (1)																	
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200V 60 Hz Three Phase Three Wire	½	710	1140	1800	2840	4420													
	¾	510	810	1280	2030	3160													
	1	430	690	1080	1710	2670	4140	5140											
	1.5	310	500	790	1260	1960	3050	3780											
	2	240	390	610	970	1520	2360	2940	3610	4430	5420								
	3	180	290	470	740	1160	1810	2250	2760	3390	4130								
	5	110*	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030				
	7.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150	3560				
	10	0	0	150*	230	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420
	15	0	0	0	160*	250	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980
	20	0	0	0	0	190*	300	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360
	25	0	0	0	0	0	240*	300	370	460	570	700	840	1030	1170	1330	1500	1640	1900
	30	0	0	0	0	0	200*	250*	310	380	470	580	700	850	970	1110	1250	1360	1590
230V 60 Hz Three Phase Three Wire	½	930	1490	2350	3700	5760	8910												
	¾	670	1080	1700	2680	4190	6490	8060	9860										
	1	560	910	1430	2260	3520	5460	6780	8290										
	1.5	420	670	1060	1670	2610	4050	5030	6160	7530	9170								
	2	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780							
	3	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680					
	5	140*	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220	
	7.5	0	160*	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510
	10	0	0	190*	310	490	780	950	1170	1440	1780	2160	2610	3160	3590	4100	4600	5020	5840
	15	0	0	0	210*	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940
	20	0	0	0	160*	250*	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120
	25	0	0	0	0	200*	320	400	500	610	750	920	1120	1360	1540	1760	1960	2160	2520
	30	0	0	0	0	0	260*	330	410	510	620	760	930	1130	1280	1470	1650	1800	2110
460V 60 Hz Three Phase Three Wire	½	3770	6020	9460															
	¾	2730	4350	6850															
	1	2300	3670	5770	9070														
	1.5	1700	2710	4270	6730														
	2	1300	2070	3270	5150	8050													
	3	1000	1600	2520	3970	6200													
	5	590	950	1500	2360	3700	5750												
	7.5	420	680	1070	1690	2640	4100	5100	6260	7680									
	10	310	500	790	1250	1960	3050	3800	4680	5750	7050								
	15	0	340*	540	850	1340	2090	2600	3200	3930	4810	5900	7110						
	20	0	0	410	650	1030	1610	2000	2470	3040	3730	4580	5530						
	25	0	0	330*	530	830	1300	1620	1990	2450	3010	3700	4470	5430					
	30	0	0	270*	430	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860			
	40	0	0	0	320*	500*	790	980	1210	1490	1830	2250	2710	3290	3730	4250			
	50	0	0	0	0	410*	640	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850
	60	0	0	0	0	0	540*	670*	830	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100
	75	0	0	0	0	0	440*	550*	680*	840	1030	1260	1520	1850	2100	2400	2700	2950	3440
	100	0	0	0	0	0	0	0	500*	620*	760*	940	1130	1380	1560	1790	2010	2190	2550
	125	0	0	0	0	0	0	0	0	0	600*	740*	890*	1000	1220	1390	1560	1700	1960
	150	0	0	0	0	0	0	0	0	0	0	630*	760*	920*	1050	1190	1340	1460	1690
	175	0	0	0	0	0	0	0	0	0	0	0	670*	810*	930*	1060	1190	1300	1510
	200	0	0	0	0	0	0	0	0	0	0	0	590*	710*	810*	920*	1030	1130	1310
575V 60 Hz Three Phase Three Wire	½	5900	9410																
	¾	4270	6810																
	1	3630	5800	9120															
	1.5	2620	4180	6580															
	2	2030	3250	5110	8060														
	3	1580	2530	3980	6270														
	5	920	1480	2330	3680	5750													
	7.5	660	1060	1680	2650	4150													
	10	490	780	1240	1950	3060	4770	5940											
	15	330*	530	850	1340	2090	3260	4060											
	20	0	410*	650	1030	1610	2520	3140	3860	4760	5830								
	25	0	0	520	830	1300	2030	2530	3110	3840	4710								
	30	0	0	430*	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000				
	40	0	0	0	500*	790	1240	1540	1900	2330	2860	3510	4230	5140	5830				
	50	0	0	0	410*	640*	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580
	60	0	0	0	0	540*	850	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410
	75	0	0	0	0	0	690*	860	1060	1310	1600	1970	2380	2890	3290	3750	4220	4610	5370
	100	0	0	0	0	0	0	640*	790*	970	1190	1460	1770	2150	2440	2790	3140	3430	3990
	125	0	0	0	0	0	0	0	630*	770*	950*	1160	1400	1690	1920	2180	2440	2650	3070
	150	0	0	0	0	0	0	0	0	660*	800*	990*	1190	1440	1630	1860	2080	2270	2640
	175	0	0	0	0	0	0	0	0	0	700*	870*	1050*	1270	1450	1650	1860	2030	2360
	200	0	0	0	0	0	0	0	0	0	0	760*	920*	1110*	1260	1440	1620	1760	2050
460V-60 Hz Three Phase Six Wire	150	0	0	0	0	0	0	420	510	630	770	950	1140	1380	1570	1790	2000	2180	2530
	175	0	0	0	0	0	0	0	450	550	680	830	1000	1220	1390	1580	1780	1950	2270
	200	0	0	0	0	0	0	0	0	480	590	730	880	1070	1210	1380	1550	1690	1970
575V-60Hz Three Phase Six Wire	150	0	0	0	0	0	520	650	800	990	1210	1480	1780	2160	2450	2790	3120	3410	3950
	175	0	0	0	0	0	0	570	700	860	1060	1300	1570	1910	2170	2480	2780	3040	3540
	200	0	0	0	0	0	0	500	610	760	930	1140	1370	1670	1890	2160	2420	2640	3070

1 foot = .3048 meter

CAUTION Use of wire size smaller than listed will void warranty.

FOOTNOTES:

(1) Lengths marked * meet the U.S. National Electrical Code ampacity only for **individual** conductor 75°C cable. Only the lengths without * meet the code for **jacketed** 75°C cable. Local code requirements may vary.

(2) Maximum lengths shown maintain motor voltage at 95% of service entrance voltage, running at maximum nameplate amperes. If service entrance voltage will be at least motor nameplate voltage under normal load conditions, 50% additional length is permissable for all sizes.

(3) This table is based on copper wire. If aluminum wire is used it must be two sizes larger. Example: When the table calls for #12 copper wire you would use #10 aluminum wire.

(4) The portion of the total cable which is between the service entrance and a 3Φ motor starter should not exceed 25% of the total maximum length to assure reliable starter operation.

(5) Cables #14 to #0000 are AWG sizes, and 250 to 500 are MCM sizes.

Transformer Capacity Required For Submersible Motors

TABLE 6

Submersible 3 Phase Motor HP Rating	Total Effective KVA Required	Smallest KVA Rating — Each Transformer: Open WYE or DELTA 2 Transformers	WYE or DELTA 3 Transformers
1.5	3(1)	2	1
2	4(1)	2	1.5
3	5(1)	3	2
5	7.5(1)	5	3
7.5	10(1)	7.5	5
10	15(1)	10	5
15	20(1)	15	7.5
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
175	200	115	70
200	230	130	75

(1) KVA required for single phase motors also.

Power Factor Correction

In some installations, power supply limitations make it necessary or desirable to raise the power factor of a submersible pump. This table lists the capacitive KVAR required to increase power factor of large Franklin three phase submersible motors to the approximate values shown, at maximum input loading.

TABLE 7

MOTOR HP	Hertz	Motor P.F.	Required KVAR for P.F. of: .90	.95	1.00
5	60	.82	1.2	2.1	4.0
7.5	60	.83	1.7	3.1	6.0
10	60	.85	1.5	3.3	7.0
15	60	.85	2.2	4.7	10
20	60	.87	1.7	5.0	12
25	60	.87	2.1	6.2	15
30	60	.87	2.5	7.4	18
40	60	.86	4.5	11	24
50	60	.85	7.1	15	32
60	60	.85	8.4	18	38
75	60	.87	6.3	18	43
100	60	.86	11	27	60
125	60	.85	17	36	77
150	60	.85	20	42	90
175	60	.88	9.6	36	93
200	60	.87	16	46	110

Reduced Voltage Starters

Although starting torque is reduced at lowered voltages, motors will reliably start pumps if the supply meets running voltage limits. With maximum recommended cable length, the cable voltage drop will reduce starting current by about 20%, and torque about 36% compared with having rated voltage at the motor. On some installations this cable drop may reduce inrush current enough that installations normally requiring reduced voltage starters will not need them.

Reduced voltage starters may be used on larger three phase motors where required to reduce the starting line current, but it is recommended that the motor be supplied with 55% of rated volts minimum to ensure adequate starting torque.

Since standard motors have only three line leads, wye-delta type reduced voltage starters cannot be used, and resistance type or autotransformer type are the only common suitable types. Either can be used, but the autotransformer type is recommended because it draws lower line current for the same starting torque. On a 65% tap, disregarding cable drop, both the autotransformer and resistance starters will provide 42% of full voltage starting torque, but percent of full voltage line current is 65% for resistance type and only 42% for autotransformer type. If the cable length is less than 50% of the recommended maximum, either the 65% or 80% tap of a typical starter may be used, but over 50% of maximum cable only the 80% tap should be used.

The duration of the reduced voltage is not critical, but 1 to 3 seconds is recommended.

Use of Phase Converters

There are a number of phase converters on the market which are intended to allow the use of three phase motors on single phase lines. They usually consist of a tapped winding static or rotating transformer and an adjustable bank of capacitors. Phase converters often cause the windings of a three phase motor to draw considerably higher current than they were designed to carry due to poor design, inadequate taps to balance, varying line or load, or faulty installation.

Phase converters cannot possibly be made to work equally well on all types of motors, even though the horsepower and voltage ratings are the same. Motors of different makes, and designed for different purposes, vary considerably in their electrical characteristics and it is therefore impossible to make a universally applicable converter for a given horsepower and voltage rating of motor.

Some converters are equipped with a calibrated relay to cut out some capacitance after the motor comes up to operating speed. For every different make and type of motor, even though the horsepower and voltage ratings may be the same, the relay must be adjusted to operate at proper speed. Even with factory trained technicians using proper test equipment, it is very difficult and in some cases even impossible to adjust the relay to the proper winding cut-out speed. For some types of load even the best adjustment of the relay will not give proper operation with the result that the motor may at times operate abnormally and cause damage to the motor windings.

One type of phase converter has taps for adjustment of a transformer and capacitors which enable the current in the three phases to be nearly balanced at one given load. However, as the load fluctuates either below or above this point, the current in the three phases becomes severely unbalanced. Other types can be reasonably balanced and change less with loading, but are still difficult to maintain adequate balance over long periods of time.

It should be emphasized that the troubles mentioned above do not necessarily result from poor design of the phase converter, and satisfactory applications can be made with proper equipment and careful installation.

It is strongly recommended that phase converters not be used in connection with three phase submersible motors if it can be avoided. Faulty or improper operation is likely to result and may cause motor failure. If three phase power is not available, use a single phase motor when possible. When a phase converter must be used, select one rated for a motor at least as large as used, and avoid putting other loads on its output.

THE WARRANTY ON ALL THREE PHASE SUBMERSIBLE MOTORS IS VOID IF OPERATED FROM SINGLE PHASE POWER THROUGH A PHASE CONVERTER UNLESS 3-LEG AMBIENT-COMPENSATED QUICK TRIP OVERLOAD PROTECTORS ARE USED AND COMPLETE DETAILS ARE SENT IN WRITING TO FRANKLIN Customer Service Dept. at the date of installation, including operating amps and volts on all phases at all known load and line conditions, and make and type of converter, overload, and heaters.

Use of Engine Driven Generators

Where power lines are not available and submersible motors are operated from a gasoline or diesel engine driven generator, the rating of the unit must be selected to assure adequate capacity for the rating submersible motor needed. Ratings and types of engine driven generators, or portable power plants as they are sometimes called, vary with different manufacturers and it is recommended that whenever possible the manufacturer be consulted, especially on the larger sizes.

Two generator types are available, externally regulated and internally regulated. Internally regulated is a generator that has an extra winding in the generator stator to sense generator output current and automatically increase the excitation and output voltage of the generator.

Most other generators on the market would be referred to as externally regulated. They normally use an externally mounted voltage regulator that senses the output voltage of the generator. As the voltage dips at motor start up, the regulator increases the excitation and output voltage of the generator. The capacity of these generators in terms of motor HP per generator KW is about 50% less than the internally regulated type and consequently a larger KW rated generator is required to limit the voltage dip at start up.

Generators should be sized to deliver at least 65% of rated voltage to the motor circuit during starting conditions. This will insure adequate motor starting torque.

The following table lists recommended generator ratings, based on typical 80°C rise continuous duty generators, with 35% maximum voltage dip during starting the specific Franklin 3-wire motors, single and three phase. This table should be used when specific generator recommendations for 35% maximum voltage dip with the starting KVA code of the Franklin motor are not available from the generator manufacturer. Manufacturers motor starting recommendations which do not specify dip and motor KVA are not adequate. **NOTE** — For best starting of *two-wire* motor minimum generator ratings 50% higher than shown are recommended.

TABLE 8

Submersible Motor HP Single or Three Phase	Minimum Rating of Generator			
	Externally Regulated		Internally Regulated	
	KW	KVA	KW	KVA
⅓ HP	1.5	1.9	1.2	1.5
½ HP	2.0	2.5	1.5	1.9
¾ HP	3.0	3.8	2.0	2.5
1 HP	4.0	5.0	2.5	3.13
1½ HP	5.0	6.25	3.0	3.8
2 HP	7.5	9.4	4.0	5.0
3 HP	10.0	12.5	5.0	6.25
5 HP	15.0	18.75	7.5	9.4
7½ HP	20.0	25.0	10.0	12.5
10 HP	30.0	37.5	15.0	18.75
15 HP	40.0	50.0	20.0	25.0
20 HP	60.0	75.0	25.0	31.0
25 HP	75.0	94.0	30.0	37.5
30 HP	100.0	125.0	40.0	50.0
40 HP	100.0	125.0	50.0	62.5
50 HP	150.0	188.0	60.0	75.0
60 HP	175.0	220.0	75.0	94.0
75 HP	250.0	313.0	100.0	125.0
100 HP	300.0	375.0	150.0	188.0
125 HP	375.0	469.0	175.0	219.0
150 HP	450.0	563.0	200.0	250.0
175 HP	525.0	656.0	250.0	313.0
200 HP	600.0	750.0	275.0	344.0

Frequency of Starts

The average number of starts per day over a period of months or years influences the life of the motor and even more the life of control components such as starters, relays, and capacitors. The pump size, tank size, and other controls should be selected to keep the starts per day as low as practical for maximum life. Excessive cycling accelerates motor bearing and spline wear, pump wear, and control contact erosion.

TABLE 9

Motor Rating	Average Number of Starts Per 24 Hr. Day	
	Single Phase	Three Phase
Up to ¾ HP	300	300
1 HP to 5 HP	100	300
7½ HP to 30 HP	50	100
40 HP and over		100

Control Boxes

Single phase three wire submersible motors require the use of above ground control boxes for starting and thermal protection. Operation of motors without control boxes or with incorrect boxes can result in failure of motors and voids warranty. Make sure control box and motor rating match.

Control boxes contain starting capacitors, starting relay, overload protector and in some sizes running capacitors. The overload protector is mounted inside the starting capacitor case in control boxes with manufacturing date code prior to H-85 through 1½ HP, and separately on larger ratings.

Ratings through 1 HP may use either a solid state, current or a potential type starting relay, while larger ratings use potential relays. All Franklin control boxes contain connection diagrams and checking instructions.

CAUTION Be certain that control box HP and voltage match the motor.

Comparison of Operation of Relays

Solid State Switch-Used in control box models 28010-4910 & 28010-0110.

Control boxes through 1 HP starting in early July 1985 use a solid state switch. This printed circuit board switch uses motor current and phase angle to open the starting circuit as the motor comes up to speed.

Current Relays – used in control box models 280-----03

Before power is applied the starting relay contacts are open. When power is applied the high main winding current through the relay coil immediately closes the contacts, energizing the start winding and starting the motor. As the motor comes up to running speed, current through the relay coil gradually drops and allows the contacts to open the start winding circuit, and the motor completes acceleration and runs on the main winding.

Potential Relays – used in all other models

Before the power is applied the starting relay contacts are closed. When the power is applied, both start and main motor windings are energized, and the motor starts. At this instant the voltage across the start winding is relatively low, not enough to open the contacts of the starting relay.

As the motor comes up to speed, the voltage across the start winding (and the starting relay coil) increases enough to pick up the starting relay and open its contacts. This opens the starting circuit and the motor continues to run on the main winding alone, or the main plus running capacitor circuit and contacts remain open.

All Franklin control boxes should be mounted upright for best operation. Mounting in other positions may cause relay malfunction and overload trip at high or low voltage or load conditions.

Mounting Control Box in Extreme Temperatures

The control box should never be mounted in the direct sunlight or in high temperature locations, as this may cause short capacitor life or unnecessary tripping of the overload protector. The control boxes are designed to operate in a maximum ambient temperature of 50°C (122°F).

When the control box is mounted in extremely cold locations, there will be a reduction in the motor starting torque because of the action of the cold on the electrolytic starting capacitor. At minus 25°F, the starting torque is about 80% normal immediately and 90% after a few seconds. We recommend that when the control box is mounted where the temperature may go below minus 25°F, that a small enclosure be built around the control box and a small light bulb be left burning inside the enclosure.

2-Wire Motor Solid State Controls

Solid State Starting Switch

The solid state starting switch energizes the starting circuit when power is applied to the motor. When the motor has accelerated to running speed, the switch opens the starting circuit. The switch operation is properly matched to each motor for reliable starting with varying line voltage and pump inertia.

When the motor is de-energized the switch will reset and be ready for the next starting cycle. This "reset" time is the length of off time that is required before the motor can be restarted. Reset time is approximately one to five seconds to assure a positive restart of the motor, depending on motor temperature and other factors.

The starting switch on and reset time has been designed to prevent the start winding from overheating in the case of an extremely fast start and stop cycling. (Due to a waterlogged tank.)

Winding Protection

The thermal protector is positioned on the motor winding, which responds to current passing through it and heat received from the motor winding and ambient temperature. When the protector reaches a predetermined point corresponding to a maximum safe winding temperature, the protector opens and interrupts the circuit. When the winding temperature returns to a more reasonable safe limit, the protector will automatically reset.

Extreme Fast Cycling (Due to Water-Logged Tank)

The solid state starting switch will reset within one to five seconds after the motor is stopped. If an attempt is made to restart the motor before the starting switch has reset, the motor may not start; however, there will be current flow through the main winding until the overload protector interrupts the circuit. The time for the protector to reset is longer than the reset of the starting switch. Therefore, the start winding switch will have closed and the motor will operate. However, in just a few cycles the same condition will occur.

When a severely water-logged condition does occur, the user will be alerted to the problem during the off time (overload reset time) since the pressure will drop drastically. When the water-logged tank condition is detected the condition should be corrected to prevent nuisance tripping of the overload protector.

Grounding Control Boxes

It is recommended the control box grounding terminal always be connected to circuits which include a grounding conductor. In fact, this is a requirement of the National Electrical Code. If the circuit has no grounding conductor and no metal conduit from the box to supply panel, use a wire at least as large as line conductors and connect the grounding terminal to a metal drop pipe, casing, water pipe, or driven ground rod

WARNING:

Failure to ground the box frame can result in a serious electrical shock hazard if a circuit fault occurs.

Grounding Lightning Arrestors in Control Boxes

When the box has a lightning arrestor, it **must** be grounded, metal to metal, all the way to the water strata for the lightning arrestor to be effective. Grounding the arrestor to a driven ground rod provides little or no protection for the motor.

Following are three acceptable ways of grounding above ground lightning arrestors:

1. The best possible protection exists when metallic well casing extends within at most 20 feet of the motor. In this fortunate situation, the arrestor should be grounded to the well casing with a No. 12 or larger wire. See Figure 1.
2. If the well casing is plastic or terminates more than 20 feet above the motor, and metal drop pipe is used, then the best available protection is provided by grounding the arrestor to the metal drop pipe. See Figure 2. If the pump is electrically insulated from the motor as it would be with a nonmetallic pump adapter bracket, then a wire should connect the drop pipe to the motor studs. See Figure 3.
3. If the well casing is nonmetallic or terminates more than 20 feet above the motor and nonmetallic drop pipe is used, then protection is only provided when the arrestor is grounded to a No. 12 or larger bare copper wire run with the power cable to the motor and connected to a motor stud. This wire should also connect to the top of the well casing if metallic. See Figure 4.

POSSIBLE INSTALLATION CONDITIONS

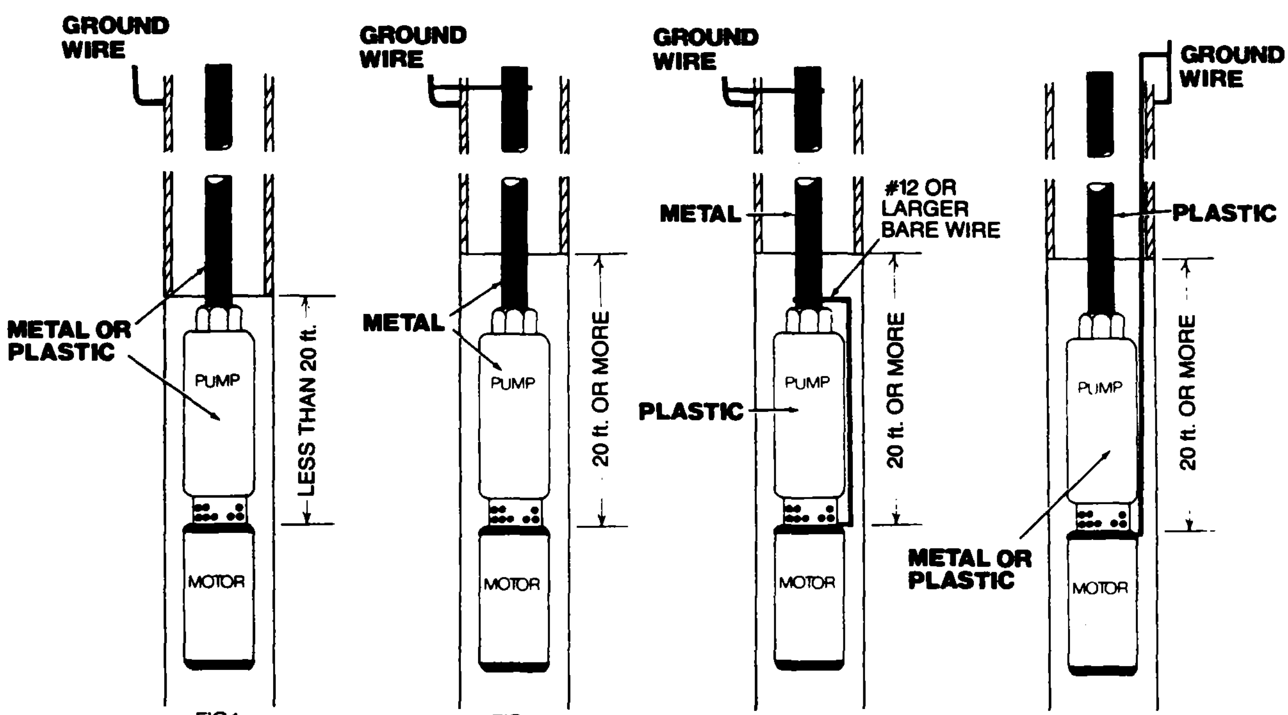


FIG.1 FIG.2 FIG.3 FIG.4

Auxiliary Running Capacitors for Noisy Installations

The addition of auxiliary running capacitors as a method of reducing noise in submersible installations is not a reliable method in all cases but in some cases does reduce the noise to an acceptable level. In some cases, there is space in the control box to add the additional running capacitor or capacitors. In others, there is not room and the additional capacitor(s) should be mounted in an auxiliary box and used in conjunction with the regular control box. Added capacitors must be connected across "Red" and "Black" control box terminals, in parallel with any existing running capacitors. Given below are the values of additional running capacitors **most likely** to reduce noise in cases where it may be a problem. The tabulation also gives the running capacitors originally supplied in each rating control box.

TABLE 10

Motor Rating		Normal Running Capacitor(s)	Auxiliary Running Capacitors For Noise Reduction		
HP	Volts	Mfd.	Mfd.	Min. Volts	Franklin Part
⅓	115	0	40(1)	236	One 155328104
½	115	0	60(1)	236	Two 155328108
⅓	230	0	10(1)	370	One 155328102
½	230	0	15(1)	370	One 155328101
¾	230	0	20(1)	370	One 155328103
1	230	0	25(1)	370	One ea. 155328101 155328102
1.5	230	10	20	370	One 155328103
2	230	20	10	370	One 155328102
3	230	35	10	370	One 155328102
5(4")	230	60	None		
5(6")	230	30	30	370	One 155327101
7.5	230	45	45	370	One ea. 155327101 155328101
10	230	75	30	370	One 155327101
15	230	135	None		

(1) **Do not** add running capacitors to standard production ⅓ through 1 HP control boxes which use current relays or solid state starting switches! Adding capacitors will cause relay failure. If the control box is converted to use a voltage relay, the specified running capacitance can be added.

Storage of Prefilled Submersible Motors

The Franklin Electric prefilled submersible motor is designed for trouble-free operation and a minimum of attention and restrictions, in storage and installation, as well as operation. However, reasonable care should be observed in storage.

The motor is provided with a pressure equalizing diaphragm to allow for expansion and contraction of the filling solution. The filling solution is suitable for temperatures down to −40°C (−40°F) and motors should be stored in areas that do not go below this temperature. The solution will partially freeze as temperature goes below −3°C (27°F), but no damage occurs. Repeated freezing and thawing should be avoided when possible to prevent the possible loss of filling solution.

Extended storage of the motors, either with or without pumps, may also result in loss of the filling solution. This loss occurs mainly at the check valve and shaft seal, and while it may not be discernible because the rate is extremely slow and it evaporates as fast as it comes out, in time the loss can be enough to cause possible damage. When the storage temperature does not exceed 100°F, storage time should be limited to two years. Where storage temperatures reach 130°F, storage time should be limited to one year.

A few drops loss of liquid will not damage the motor since an excess is provided when the motor is filled at the factory and also because after the motor is in service, the Franklin Filter-Check will allow the liquid lost to be replaced by filtered well water. If the above storage recommendations and limits are followed, there will be little or no liquid loss and no need for concern. If however, there is evidence of considerable leakage or there is reason to believe there has been leakage, the motor should be returned to a Franklin Electric Service Shop for checking or they should be contacted for instructions on checking.

Downward Deflection of Motor Shafts Under Thrust Load

The thrust bearings of Franklin Electric submersible motors are designed for high load capacity with very low losses and a minimum of shaft deflection under thrust load. Any permanent deflection is already set by the factory thrust test, but there is elastic deflection reducing shaft height as thrust is applied to the motor. All pump clearances should be designed to allow for this deflection, which is shown for each motor type in the table below:

TABLE 11

Motor Type	Rate of Deflection	Total Deflection at Rated Thrust
4", 300 lb. ⅓ thru ¾ HP	.002" per 100 lb.	.006" at 300 lb.
4", 650 lb. 1, 1½ and 2 HP	.0013" per 100 lb.	.009" at 650 lb.
4", 900 lb. 1½ thru 10 HP	.0005" per 100 lb.	.0045" at 900 lb.
6", 1500 lb. 5 and 7½ HP	.0005" per 100 lb.	.0075" at 1500 lb.
6", 3500 lb. 10 thru 30 HP	.004" per 1000 lb.	.014" at 3500 lb.
6", 3500 lb. 40 thru 60 HP	.006" per 1000 lb.	.021" at 3500 lb.
8", 10,000 lb. 40 thru 200 HP	.002" per 1000 lb.	.020" at 10,000 lb.

.004 inch = .10 millimeters

Use of Check Valves

It is recommended that check valves be used in all submersible pump installations. A line check valve should be installed in the discharge pipe within 25 feet of the pump, if the pump is not made with a built-in check valve.

Immediate motor or pump failure, or shortened service life can be the result of the following conditions:

a. **Backspin** — when no check valve is used or when a check valve becomes defective, the water in the drop pipe can flow back down when the pump stops. This backflow can keep thrust on the motor while it comes to a stop which can cause excessive thrust bearing wear.

b. **Up thrust** — when no check valve is used or the valve leaks the pump starts each time at no head. Many pumps exert an upward thrust on the impeller stack at low heads which can lift the rotor of the motor until the developing water column causes down thrust. Repeated up thrust at each start can cause wear and failure unless the pump construction prevents upward shaft movement.

c. **Water hammer** — if the lowest check valve is more than 30 ft. above the well water level, the weight of the falling water column draws a vacuum or evacuates a void below the check valve when the pump stops. On the next pump start, water moving at a high velocity fills this void and strikes the closed check valve and the stationary water in the pipe causing a hydraulic shock. This shock can split pipes, break joints or damage the pump and motor.

Pump Mounting Position

Motors are suitable for operation in mounting positions from vertical shaft up to horizontal. If 4 inch motors thru 2 HP, are started more than 10 times per day, it is recommended the shaft be tilted up at least 15° from horizontal to minimize coast-down wear of the upthrust washer.

Water Temperature

TABLE 12 Reduced motor loading in water over 30°C (86°F)

Water Temperature	Approximate Allowable % of Maximum Nameplate Amps		
	Through 3 HP	5 through 15 HP	Over 15 HP
35°C (95°F)	100%	100%	90%
40°C (104°F)	100%	90%	80%
45°C (113°F)	90%	80%	70%
50°C (122°F)	80%	70%	60%
55°C (130°F)	70%	60%	45%

Do not use submersible motors in water over 55°C (130°F).

With proper water flow past the motor, Franklin submersible motors are designed to operate up to nameplate amperage rating in water as hot as 86°F (30°C). If the water temperature exceeds 86°, reduce the load by changing pumps or throttling the pump discharge.

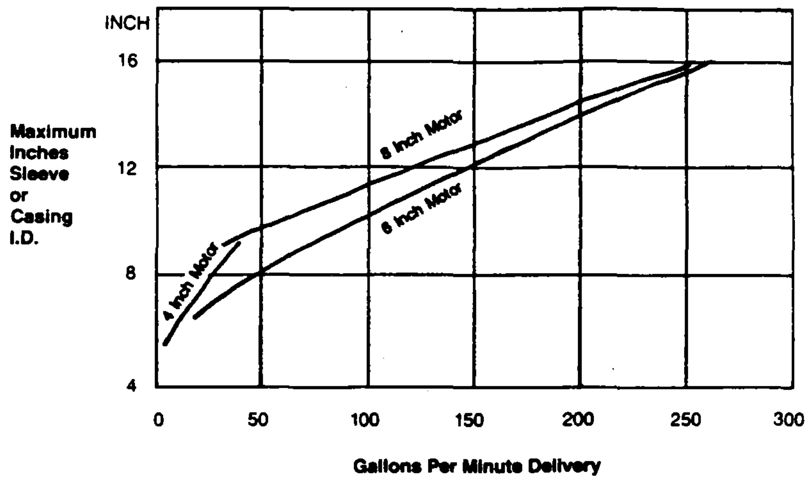
Submersible Motor Cooling

When the pump is set below any screen openings or below the bottom of the casing a top feeding well condition can exist which reduces the rate of cooling water flow past the motor.

If the flow rate is less than specified a flow inducer sleeve or an alternate method of increasing water velocity past the motor must be used for proper cooling.

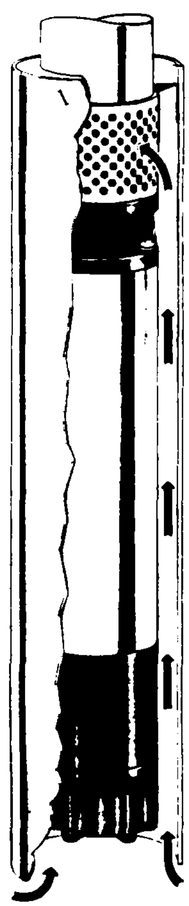
MINIMUM VELOCITY PAST THE MOTOR
4" dia. motor — .25 ft./sec.
6" dia. motor — .5 ft./sec.
8" dia. motor — .5 ft./sec.

COOLING FLOW REQUIREMENTS



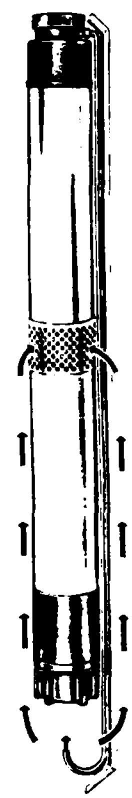
A flow inducer sleeve should always be used when the pump is in a large body of water. Make sure that such an installation is grounded as warned on the inside of the front cover.

FLOW INDUCER SLEEVE



A flow inducer sleeve is a tube over the motor, closed off above the pump intake and extended to the bottom of the motor or lower. The sleeve material is corrosion resistant metal or heavy plastic.

FLOW INDUCER DISCHARGE TUBE



If the casing is too small for a flow sleeve and the pump cannot be raised a tube may be installed as follows:

a) Tap a ¼" tube (ID) into the pump outlet (below check valve).
b) Clamp it to the pump and motor.
c) Aim tube upward so flow is introduced 1 foot below the motor.
d) Protect tube with spacers and angle iron.

Head Loss From Flow Past Motor

The following table lists the approximate feet of head loss from flow between an average length motor and smooth casing or sleeve.

TABLE 13

Motor (Nominal)		4"	4"	4"	6"	6"	6"	8"	8"
Casing I.D. Inches		4¼"	5"	6"	6"	7"	8"	8.1"	10"
GPM	25	0.3							
	50	1.2							
	100	4.7	0.3		1.7				
	150	10.2	0.6	0.2	3.7				
	200		1.1	0.4	6.3	0.5		6.8	
	250		1.8	0.7	9.6	0.8		10.4	
	300		2.5	1.0	13.6	1.2	0.2	14.6	
	400				23.7	2.0	0.4	24.6	
	500					3.1	0.7	37.3	0.6
	600					4.4	1.0	52.2	0.8
	800								1.5
	1000								2.4

1 inch = 25.4 millimeters

Splicing Submersible Cables

When the drop cable must be spliced or connected to the motor leads, it is necessary that the splice be water tight. This splice can be made with commercially available potting or heat shrink splicing kits or by careful tape splicing.

Tape splicing should use the following procedure.

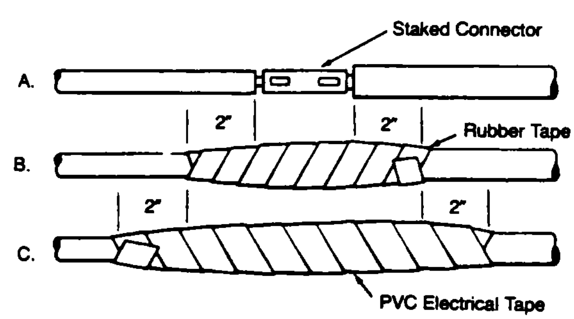
A) Strip individual conductor of insulation only as far as necessary to provide room for a stake type connector or a neatly twisted joint. If a twisted joint is used, it is essential that it be soldered. Tubular connectors of the staked type are preferred. (If connector O.D. is not as large as cable insulation, build-up with rubber electrical tape.)

B) Tape individual joints with rubber electrical tape, using two layers; the first extending one inch beyond each end of the conductor insulation end, the second layer one inch beyond the ends of the first layer. Wrap tightly, eliminating air spaces as much as possible.

C) Tape over the rubber electrical tape with #33 Scotch electrical tape, Minnesota Mining Co. (or equivalent), using two layers as in step "B" and making each layer overlap the end of the preceding layer by at least one inch.

In the case of a cable with three conductors encased in a single outer sheath, tape individual conductors as described, staggering joints.

Total thickness of tape should be no less than the thickness of the conductor insulation.



Tightening Lead Connector Jam Nut

4" Motors — 15 to 20 Lb. Ft.
6" Motors — 60 to 70 Lb. Ft.
8" Motors — 120 to 150 Lb. Ft.

It is recommended that a new lead assembly be used when one is removed from the motor, because rubber set and possible damage from removal may prevent resealing.

Pump to Motor Coupling

Assemble coupling with non-toxic waterproof grease such as Mobil FM2, Texaco Regal AFB2, or equivalent. Besides prolonging spline life of motor and coupling, it prevents abrasives from entering the spline area.

Three Phase Power Unbalance — Line Connections

A full three phase supply is recommended for all three phase motors, consisting of three individual transformers or one three phase transformer. So-called "open" delta or wye connections using only two transformers can be used, but are more likely to cause problems from current unbalance.

Transformer ratings should be no smaller than listed in Table 6 on page 8 for supply power to the motor alone.

Open Wye or Delta systems often suffer from line unbalance, which can cause poor motor performance, nuisance overload tripping, or premature motor failure.

Phase designation of leads for CCW rotation viewing shaft end. To reverse rotation, interchange any two leads.

Phase 1 or "A" — Black Motor Lead
Phase 2 or "B" — Yellow Motor Lead
Phase 3 or "C" — Red Motor Lead

NOTICE: Phase 1, 2 and 3 may not be L1, L2 and L3.

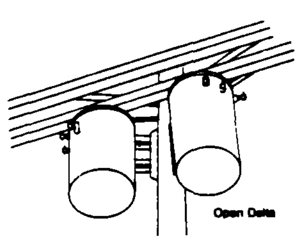
Procedure for checking and correcting rotation and current unbalance.

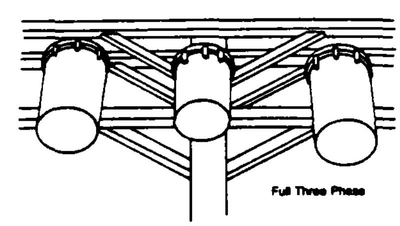
1. Establish correct motor rotation by running in both directions. Change rotation by exchanging any two of the three motor leads. The rotation that gives the most water flow is always the correct rotation.
2. Current readings in amps should be checked on each leg using the three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.
3. To calculate percent of current unbalance:
   A. Add the three line amp values together.
   B. Divide the sum by three, yielding average current.
   C. Pick the amp value which is furthest from the average current (either high or low).
   D. Determine the difference between this amp value (furthest from average) and the average.
   E. Divide the difference by the average.
   F. Multiply the result by 100 to determine percent of unbalance.
4. Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg furthest from the average stays on the same power lead, most of the unbalance is being caused by the power source. However, if the leg furthest from average moves on each of the hookups with a particular motor lead, the primary source of unbalance is on the "motor side" of the starter. In this instance, consider a damaged cable, leaking splice, poor connection, or a faulty motor winding.

	Hookup 1	Hookup 2	Hookup 3
Starter Terminals	L1 L2 L3	L1 L2 L3	L1 L2 L3
	T1 T2 T3	T1 T2 T3	T1 T2 T3
Motor Leads	R B Y	Y R B	B Y R

Example:

Hookup 1	Hookup 2	Hookup 3
R = 51 amps	Y = 50 amps	B = 50 amps
B = 46 amps	R = 48 amps	Y = 49 amps
Y = 53 amps	B = 52 amps	R = 51 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
÷3 = 50 amps	÷3 = 50 amps	÷3 = 50 amps
−46 = 4 amps	−48 = 2 amps	−49 = 1 amps
4 ÷ 50 = .08 or 8%	2 ÷ 50 = .04 or 4%	1 ÷ 50 = .02 or 2%



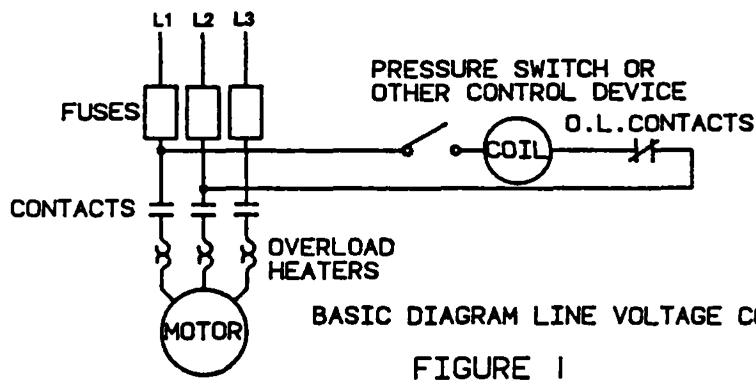


Three Phase Starter Diagrams

Three phase starters have two distinct circuits, the power circuit and the control circuit. The power circuit consist of a circuit breaker or a line switch with three identical sets of fuses, contacts, and overload heaters in series between the incoming power lines L1, L2, L3 and the three phase motor.

The control circuit consists of the magnet coil, overload contacts and a pressure switch or other control device, which when the contacts are closed, the contactor closes, applying power to the motor. Hand-off-auto switches and start timers may also be in series with the control circuit.

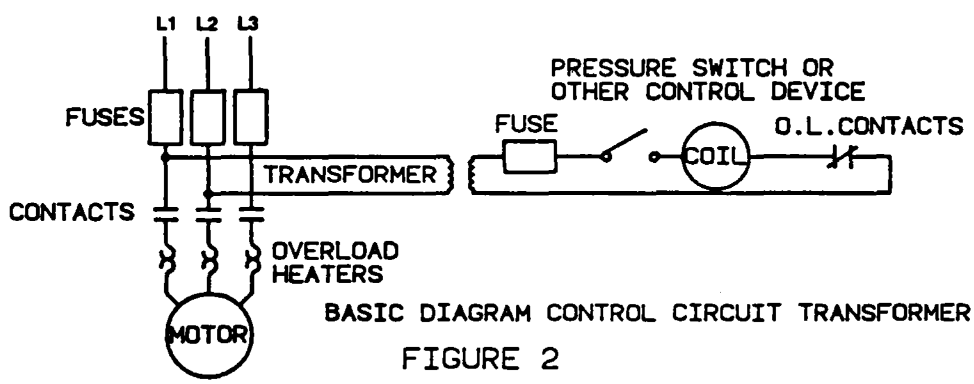
Line voltage control Fig. 1, is probably the most common type of control encountered. Since the coil is connected directly across the power lines L1 and L2, the coil voltage and frequency must match the line voltage.



BASIC DIAGRAM LINE VOLTAGE CONTROL

FIGURE 1

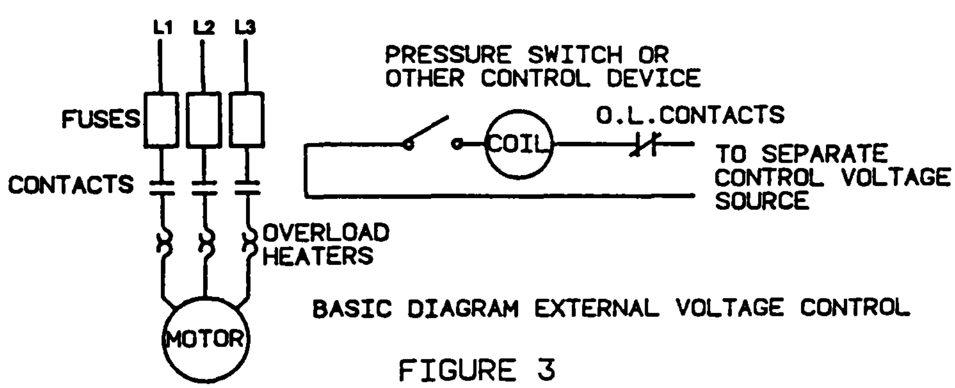
Control circuit transformer Fig. 2, is used when it is desirable to operate push buttons or other control devices at some voltage lower than the motor voltage. The transformer primary must match the line voltage and the coil voltage must match the secondary voltage of the transformer.



BASIC DIAGRAM CONTROL CIRCUIT TRANSFORMER

FIGURE 2

External voltage control Fig. 3. Control of a power circuit by a lower control circuit voltage can also be obtained by connecting to a separate control voltage source. The coil rating must match the control voltage source. A typical example of this would be 24 volt control.



BASIC DIAGRAM EXTERNAL VOLTAGE CONTROL

FIGURE 3

Preliminary Tests

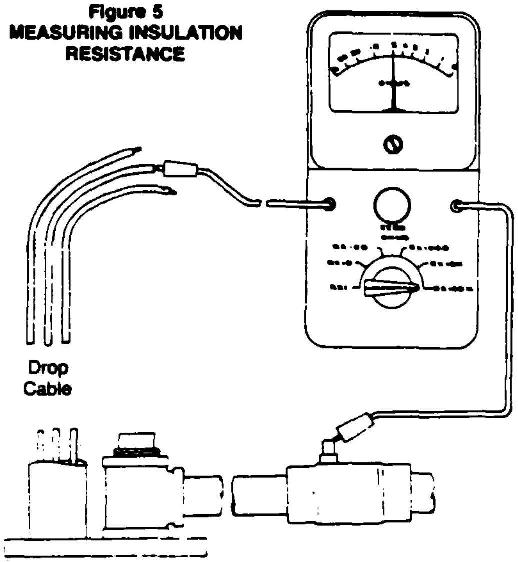
WHAT IS TO BE DONE	APPLIES TO	HOW IT IS TO BE DONE	WHAT IT MEANS
Measure resistance from any cable to ground. (insulation resistance)	1 Ph. 3 Ph.	Ohms will be per Table 14, page 19.	1. If the ohm value is normal, the motor windings are not grounded and the cable insulation is not damaged. 2. If the ohm value is below normal, either the windings are grounded or the cable insulation is damaged. Check the cable at the well seal as the insulation is sometimes damaged by being pinched.
Measure resistance between all leads. (Winding resistance)	1 Ph. 3 Ph.	Ohms will be per Tables 1, 2, or 3 and 15.	1. If all ohm values are normal, the motor windings are neither shorted nor open, and the cable colors are correct. 2. If any one ohm value is less than normal, the motor is shorted. 3. If any one ohm value is greater than normal, the winding or the cable is open, or there is a poor cable joint or connection. 4. If some ohm values are greater than normal and some less on single phase motors, the leads are mixed. See page 20 to verify cable colors.

How to Measure Ohm Values Between Leads And Ground (Insulation Resistance) — See Figure 5

1. Set the scale lever to R x 100K and set the ohmmeter on zero.
2. CAUTION Open master breaker and disconnect all leads from control box or pressure switch (Q-D type control, remove lid) to avoid damage to meter or electric shock hazard. Connect one ohmmeter lead to any one of the motor leads and the other to the metal drop pipe. If the drop pipe is plastic, connect the ohmmeter lead to the well casing. See Fig. 7, page 20 for the Q.D. type control.

"Q-D" means "Quick-Disconnect" Control Box

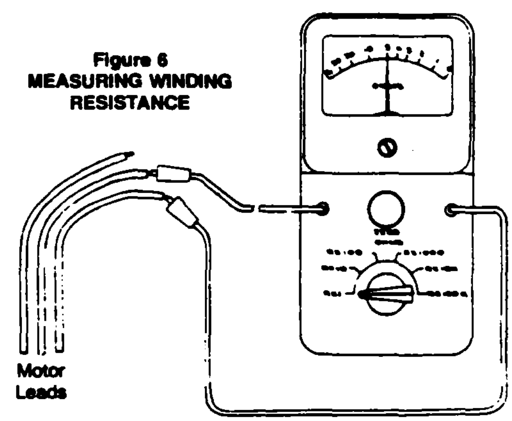
Figure 5
MEASURING INSULATION RESISTANCE



How to Measure Resistance Between Leads — See Figure 6

1. Set the scale lever to R x 1 for values under 10 ohms. For values over 10 ohms, set the scale lever to R x 10. Zero balance the ohmmeter.
2. CAUTION Open master breaker and disconnect all leads from control box or pressure switch (Q-D type control, remove lid) to avoid damage to meter or electric shock hazard. Connect the ohmmeter leads as shown in Figure 6. See Figure 7, page 20 for the Q.D. type control.

Figure 6
MEASURING WINDING RESISTANCE



Insulation Resistance Readings

TABLE 14 Normal Ohm and Megohm Values Between All Leads and Ground

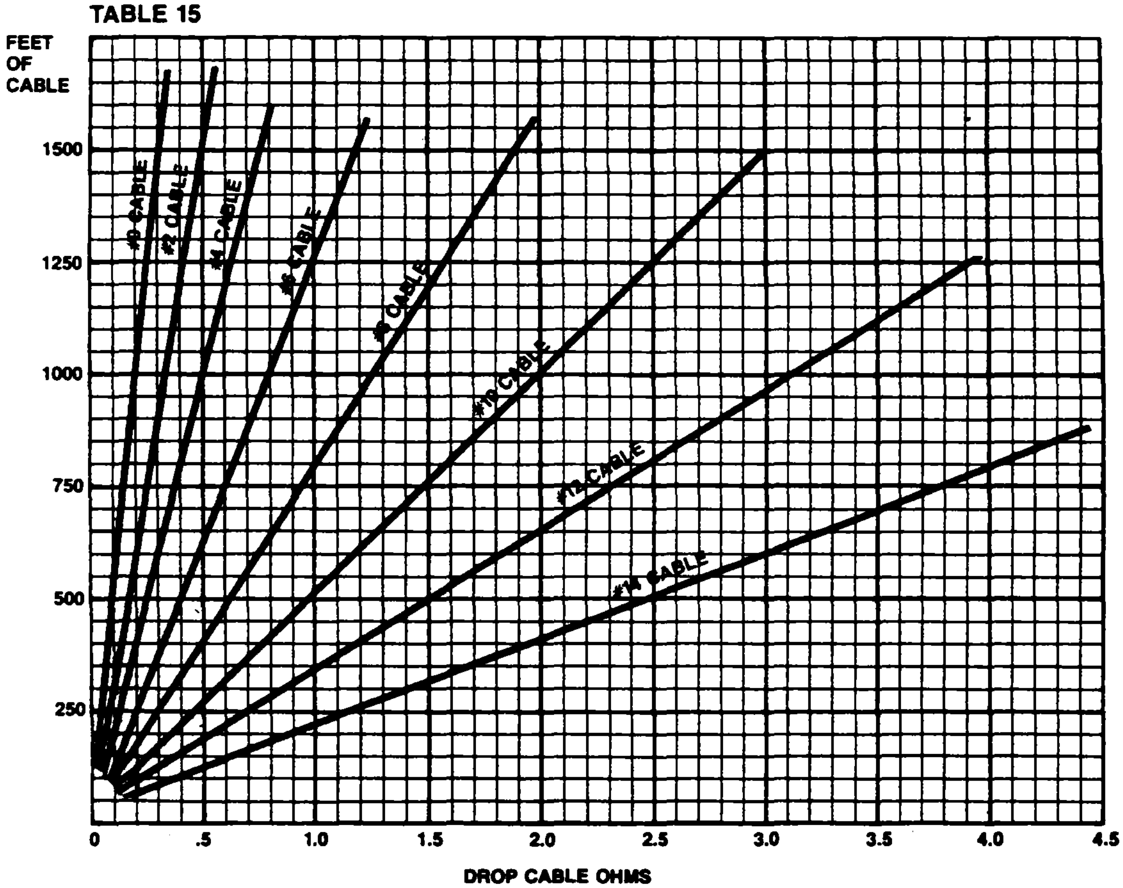
Insulation resistance does not vary with rating. All motors of all HP, voltage, and phase rating have the same value of insulation resistance.

CONDITION OF MOTOR AND LEADS	OMM VALUE	MEGOHM VALUE
A new motor (without drop cable).	20,000,000 (or more)	20.0
A used motor which can be reinstalled in the well.	10,000,000 (or more)	10.0
MOTOR IN WELL. Ohm readings are for drop cable plus motor.		
A new motor in the well.	2,000,000 (or more)	2.0
A motor in the well in reasonably good condition.	500,000-2,000,000	0.5-2.0
A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.	20,000- 500,000	0.02-0.5
A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will not fail for this reason alone, but it will probably not operate for long.	10,000- 20,000	0.01-0.02
A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced.	less than 10,000	0-0.01

Total Resistance of Drop Cable (Ohms)

The values below are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher for each foot of cable of the same size. To determine the actual resistance of aluminum drop cable, divide the ohm readings from this chart by 0.61. This chart shows total resistance of cable from control to motor and back.

TABLE 15



Winding Resistance Measuring

When measured as shown in Figure 6 page 18, motor resistance only should fall within the values in Tables 1, 2, or 3, on pages 2, 3, or 4. When measured through the drop cable the size and length of the cable must be known and the correct cable resistance from Table 15 subtracted from the ohmmeter reading to get the winding resistance for comparison with Tables 1, 2, or 3, on pages 2, 3 or 4.

Single Phase Control Boxes

Identification Of Cables When Color Code Is Missing

(FOR SINGLE PHASE 3-WIRE UNITS ONLY)

Procedure

If the colors on the individual drop cables cannot be found; that is, if no colored threads are visible and no identifying ribs are present and the leads cannot be identified, proceed as follows:

1. Disconnect all three drop cables from the control box. For temporary identification, tie tags to them and give each a number — 1, 2 and 3.
2. With an ohmmeter, measure the following three values of "unknown" ohms. Then match the item with the "unknown" item on the left with the "known" item on the right to determine the color of cables 1, 2 and 3.

"Unknown"	"Known"
Cable 1 to cable 2 (----ohms)	Lowest-Black to yellow
Cable 1 to cable 3 (----ohms)	Intermed.-Red to yellow
Cable 2 to cable 3 (----ohms)	Highest-Black to red

3. Note that "yellow" cable is that used to obtain lowest and intermediate readings and that "red" cable is that used to obtain highest and intermediate readings.

Example

Suppose that the ohm reading were:

1 to 2 measures 6 omms (highest)
1 to 3 measures 4 ohms (intermediate)
2 to 3 measures 2 ohms (lowest)

The actual ohm values are not important. What is important is which reading is highest, intermediate and lowest. This method will work regardless of the actual value of the ohm readings.

Cable 3 was used to obtain both the intermediate and lowest ohm reading. This is the yellow cable.

Cable 1 is the cable used to obtain the intermediate and highest ohm readings. This is the red cable.

Meter Connections for Motor Testing

Figure 7

Q.D. Control Box

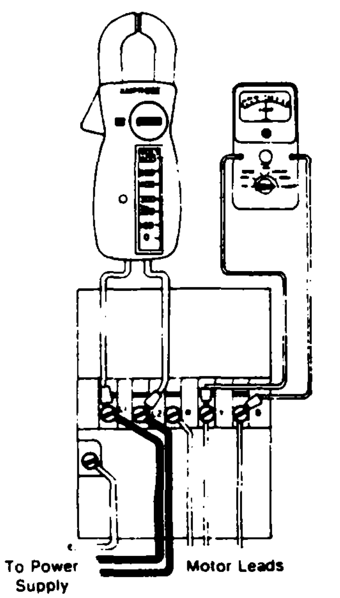


Figure 8

Non Q.D. Terminal Board

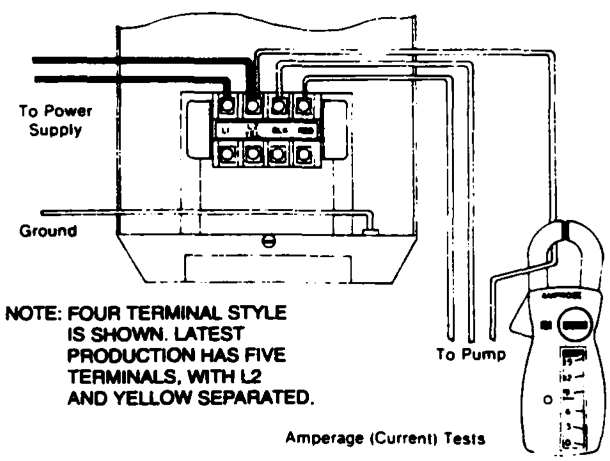
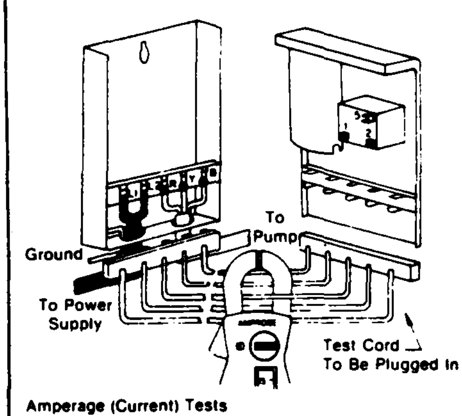


Figure 9

Q.D. Control Box



CHECKING MOTOR WITH "Q.D." TYPE CONTROL BOX

1. Remove cover to break all motor connection.

   CAUTION — L_1 and L_2 are still connected to power.
2. To check VOLTAGE: Use voltmeter on L_1 and L_2 as shown in Figure 7.
3. To check CURRENT (amps):
   (a) Connect test cord (150961 901) between control box cover and wall plate (See Fig. 9).
   (b) Use hook-on ammeter as shown.

   OR — If test cord is not available, without removing control box cover, use hook-on ammeter at fuse box or pressure switch.

Single Phase Control Boxes

Checking and Repairing Procedures

CAUTION TURN POWER OFF AND DISCHARGE CAPACITORS BEFORE USING OHMMETER

<table>
<tr><th>Test or Procedure</th><th>Non Q.D. Control Box</th><th>Q.D. Control Box</th></tr>
<tr><td>A. General Procedures</td><td>1. Disconnect line.
2. Inspect for damaged or burned parts, loose connections, etc.
3. Check for misconnections against diagram in control box.
4. If problem has not been found, check motor per Table 1 and control box as indicated below.</td><td>1. Remove cover to disconnect motor line.
CAUTION L_1 and L_2 are still connected to power source.
2. Same.
3. Same.
4. Same, except motor leads are disconnected when cover is removed.</td></tr>
<tr><td>B. Use of Ohmmeter</td><td colspan="2">1. Ohmmeter such as Simpson Model #372 or #260, Triplett Model #630 or #666 may be used.
2. Whenever scales are changed, short ohmmeter leads and "zero balance" meter.</td></tr>
<tr><td>C. Ground (Insulation Resistance) Test</td><td>1. Ohmmeter Setting: Highest scale (usually R x 100K or R x 10,000).
2. Terminal Connections: One ohmmeter lead to "Ground" terminal on control box and touch other lead to each of the other terminals on terminal board.
3. Ohmmeter Reading: Pointer should remain at (∞) and not deflect.</td><td>1. Same.
2. One ohmmeter lead to frame of control box lid and other to terminals on control box lid.
3. Same.</td></tr>
<tr><td>D. Overload Protector</td><td>1. Ohmmeter Setting: R x 1.
2. Terminal Connections: Connect one ohmmeter lead to Terminal Black and other lead to:
(a) Terminal L_1 in four-terminal boxes.
(b) Terminal L_2 in five-terminal boxes.
3. Ohmmeter Reading: Should be 0 to 0.5 ohms maximum.</td><td>1. Same.
2. Terminal Connections: Connect ohmmeter leads between Terminals Black and line terminal with blue wire.
3. Same.</td></tr>
<tr><td rowspan="2">E. Capacitor Tests</td><td>1. Ohmmeter Setting: R x 1,000.
2. Terminal Connections: One ohmmeter lead to relay terminal #1 and other to black terminal on terminal board.</td><td>1. Same.
2. Connect leads to Black and Orange wires out of capacitor case.</td></tr>
<tr><td colspan="2">3. Ohmmeter Reading: Pointer should swing toward "zero" and "float" back to (∞). Capacitor is shorted if pointer does not move back to (∞), open if it does not move from (∞).
4. If reading is not as above, disconnect capacitor from overload and test each component.</td></tr>
<tr><td>F. Relay Coil Test (potential relays only)</td><td colspan="2">1. Ohmmeter Setting: R x 1,000 (or R x 100).
2. Terminal Connections: #5 and #2 on Relay.
3. Ohmmeter Reading:
For 115 Volt Boxes / For 230 Volt Boxes
G.E. .7-1.8 (700-1800 ohms) / 4.5 - 7.0 (4500-7000 ohms)
Cardinal .55 - .85 (550- 850 ohms) / 2.8 - 4.2 (2800-4200 ohms)</td></tr>
<tr><td rowspan="2">G. Relay Contact Test (potential relays only)</td><td colspan="2">Most cases of inoperative relay contacts can be detected as follows:
1. Ohmmeter Setting: R x 1.
2. Terminal Connections: Terminal #1 and Terminal #2 on Relay.
3. Ohmmeter Reading: Should be "zero".
Note: This test verifies "making" of contacts. If it is desired to test "opening" and closing of contacts:</td></tr>
<tr><td>a. Connect control box components in control box as indicated on diagram in control box cover.
b. Connect three leads from motor of correct rating to control box terminal board.
c. Connect power source voltage to L_1 and L_2.
d. Current in Red lead should momentarily be a high value — then drop (within one second) to values on Page 2.</td><td>Same for all, except attach five conductor test cord to connect control box lid to wall mounted terminals for reading current in red lead. Check current as shown on page 2.</td></tr>
<tr><td>H. Relay Coil Test (current relays only)</td><td></td><td>1. Ohmmeter Setting: R x 1.
2. Terminal Connections: #1 and #3.
3. Ohmmeter Reading: Less than 1 ohm.</td></tr>
<tr><td>I. Relay Contact Test (current relays only)</td><td></td><td>1. Ohmmeter Setting: R x 1000.
2. Terminal Connections: #2 and #4.
3. Ohmmeter Reading: Infinity (∞)
4. Relay contact test verifies that contacts are open. To check closing of contacts, attach 5 conductor test cord to connect control box lid to wall mounted terminals. While applying power, monitor current in Red lead, current should be a high value then drop within one second to zero amps.</td></tr>
<tr><td>J. Triac Test (solid state switch only)</td><td></td><td>1. Ohmmeter Setting: R x 1000
2. Connect the leads to "R" (start) terminal and to orange lead terminal on start switch.
3. Ohmmeter Reading: Infinity.</td></tr>
<tr><td>K. Coil Test (solid state switch only)</td><td></td><td>1. Ohmmeter Setting: R x 1.
2. Connect leads to "Y" (common) and L_2 terminal.
3. Ohmmeter Reading: Less than 1 ohm.
4. To verify proper operation of switch with motor connected. Attach 5 conductor test cord to connect control box lid to wall mounted terminals. While applying power, monitor current in red lead, current should be a high value then drop within one second to zero amps.</td></tr>
<tr><td>L. Contactor Test</td><td colspan="2">1. Disconnect one coil lead.
2. Ohmmeter setting R x 100.
3. Check coil resistance: 180 to 1400 ohms.
4. Remove contact cover and inspect contacts.</td></tr>
</table>

Control Box Parts List

Q.D. CONTROL BOX COMPONENTS TABLE 16

HP	Volt (1)	Potential or Current Relay (1)(4)	Solid State (1) Switch	Capacitor (2)(5)	Super Stainless & MT3 Motors (3) Capacitor-Overload Ass'y (1)(6)	Super Stainless & MT3 Motors (3) Overload or Overload Kit (6)
⅓	115	155 031 101 or 155 252 103	152 138 905	275 461 122 or 275 464 125 110v, 159-191 mfd.	151 033 973	151 496 973 305 091 901
	230	155 031 102 or 155 252 101	152 138 901	275 461 123 or 275 464 126 220v, 43-53 mfd.	151 033 974	151 496 974 305 091 902
½	115	155 031 101 or 155 252 105	152 138 906	275 461 101 or 275 464 101 110v, 250-300 mfd.	151 033 975	151 496 975 305 091 903
	230	155 031 102 or 155 252 102	152 138 902	275 461 108 or 275 464 105 220v, 59-71 mfd.	151 033 976	151 496 976 305 091 904
¾	230	155 031 102 or 155 252 103	152 138 903	275 461 106 or 275 464 118 220v, 86-103 mfd.	151 033 978	151 496 978 305 091 905
1	230	155 031 102 or 155 252 104	152 138 904	275 461 107 or 275 464 113 220v, 105-126 mfd.	151 033 979	151 496 979 305 091 906

FOOTNOTES:

(1) Control boxes supplied with voltage relays are designed to operate on nominal 230v systems. For 208v systems or where line voltage is between 200v and 210v substitute 208v relay part no. 155 031 103 and cable 2 sizes larger, or use boost transformer. Control boxes supplied with solid state relays are designed to operate on nominal 230v systems. For 208v systems or where line voltage is between 200v and 210v use cable 2 sizes larger. Voltage relay kit 155 031 903 may be used to replace current relays used on 208v systems.

(2) Capacitors and capacitor-overload ass'y. are provided in plastic cases. Two inch diameter assemblies may be substituted for old style 1¾" dia. assemblies by bending control box terminal bracket.

(3) Super stainless control box parts may be used on MT & MT-3 motors.

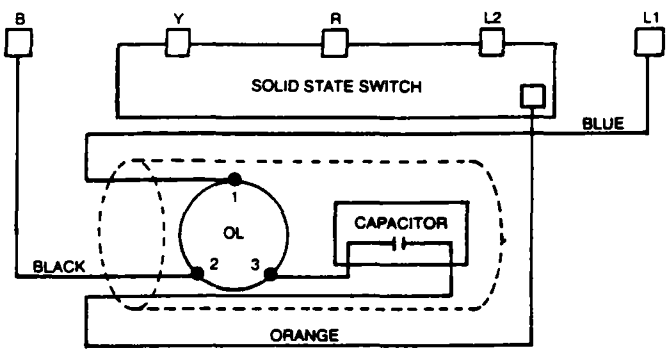
(4) Voltage relay kits, 115 volt, 155 031 901 and 230 volt, 155 031 902 will replace either current, voltage, or solid state switch relays.

(5) Capacitor's with part number prefix 275461 are designed for use with overload's.

(6) Q-D control boxes produced H85 or later do not contain an overload in the capacitor. On winding thermal overloads were added to three-wire motors rated ⅓-1 hp in A85. If a control box dated H85 or later is applied with a motor dated M84 or earlier, overload protection can be provided by replacing the capacitor with a capacitor / overload assembly or adding an overload kit to the control box.

REPLACEMENT INSTRUCTIONS

TO REPLACE A RELAY (VOLTAGE OR CURRENT) WITH A SOLID STATE SWITCH

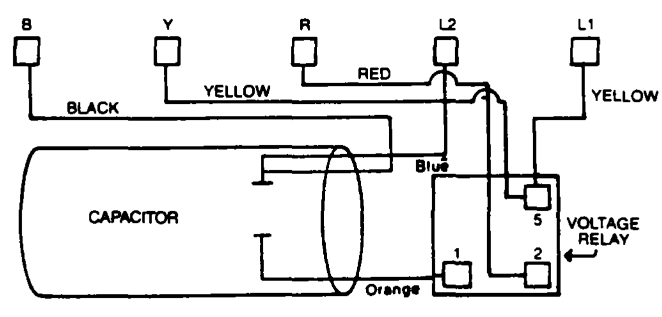


CONTROL BOX WIRING DIAGRAM WITH SOLID STATE SWITCH

1. Disconnect power to control box.
2. Remove control box cover. Disconnect all leads from the relay and terminal strip. Discard all loose leads.
3. Plug solid state switch into center terminals (Y, R, L2) on the side of the terminal strip nearest to the capacitor.
4. Connect all three leads from capacitor as follows:
   A. Blue lead to the "L1" terminal.
   B. Orange lead to the terminal on the solid state switch.
   C. Black lead to the ""B" main terminal.
5. Replace cover on the control box and reconnect the power.

NOTE: **Do not** add running capacitors to standard production ⅓ through 1 HP control boxes which use current relays or solid state starting switches. Adding capacitors will cause failures. If the control box is converted to use a voltage relay, the specified running capacitance can be added.

TO REPLACE A SOLID STATE SWITCH WITH A VOLTAGE RELAY.



CONTROL BOX WIRING DIAGRAM WITH VOLTAGE RELAY

1. Disconnect power to the control box.
2. Remove the control box cover. Disconnect orange lead from the solid state switch. Disconnect the blue lead from the "L1" terminal.
3. Remove solid state switch from the three center terminals. Install voltage relay next to capacitor.
4. Connect orange and blue leads from capacitor as follows:
   A. Orange lead to relay terminal #1.
   B. Blue lead to "L2" terminal.
   C. Black lead stays on "B" (main) terminal.
5. Make a red jumper wire and connect it from "R" (start) terminal to relay terminal #2.
6. Make two yellow jumper wires. Connect one jumper from "Y" (common) terminal to relay terminal #5. Connect other jumper from relay terminal #5 to "L1" terminal.
7. Replace cover on the control box and reconnect power.

Note: Voltage relay kits include necessary jumper wires and mounting hardware.

INTEGRAL HORSEPOWER CONTROL BOX COMPONENTS • 230 VOLT TABLE 17

Motor Rating HP-Dia.	Control Box (1) Model No.	Capacitors (2) Part No.	Mfd. Limits	Volts	Qty.	Overload (2) Part No.	Relay (7) Part No.	Contactor (2) Part No.
1½-4"	282 3007 202 or	275 461 107 S	105 - 126	220	1	151 496 922	155 031 102	
	282 3007 102	275 479 102 R (5)	10	370	1	151 033 946 (3)		
	282 3007 203 or	275 461 107 S	105 - 126	220	1	151 496 922	155 031 102	
	282 3007 103	155 328 102 R	10	370	1	151 033 946 (3)		
2 - 4"	282 3018 202	275 464 113 S	104 - 126	220	1	275 411 107 S	155 031 102	
		275 479 105 R (5)	20	370	1	275 411 112 R		
	282 3018 203 or	275 464 113 S	104 - 126	220	1	275 411 107 S	155 031 102	
	282 3018 103	155 328 103 R	20	370	1	275 411 113 R		
DLX	282 3019 103	275 464 113 S	105 - 126	220	1	275 411 107 S	155 031 102	155 325 102 L
		155 328 103 R	20	370	1	275 411 112 R		
3 - 4"	282 3028 202	275 463 111 S	208 - 250	220	1	275 411 108 S	155 031 102	
		275 481 102 R (5)	35	370	1	275 406 120 R		
	282 3028 203 or	275 463 111 S	208 - 250	220	1	275 411 108 S	155 031 102	
	282 3028 103	155 327 102 R	35	370	1	275 406 120 R		
DLX	282 3029 103	275 463 111 S	208 - 250	220	1	275 411 108 S	155 031 102	155 325 102 L
		155 327 102 R	35	370	1	275 406 120 R		
5 - 4"	282 1139 202	275 468 118 S	216 - 259	330	1	275 411 102 S	155 031 102 (6)	
		275 479 103 R (5)	15	370	4	275 406 103 R		
	282 1139 203 or	275 468 118 S	216 - 259	330	1	275 411 102 S	155 031 102 (6)	
	282 1139 003	155 327 101 R	30	370	2	275 406 103 R		
DLX	282 1139 303 or	275 468 118 S	216 - 259	330	1	275 411 102 S	155 031 102 (6)	155 325 102 L
DLX	282 1139 103	155 327 101 R	30	370	2	275 406 103 R		
5 - 6"								
	282 2009 202	275 468 117 S	130 - 154	330	2	155 249 102	155 031 601	
		275 479 103 R (5)	15	370	2			
	282 2009 203	275 468 117 S	130 - 154	330	2	155 249 102	155 031 601	
		155 327 101 R	30	370	1			
DLX	282 2009 303	275 468 117 S	130 - 154	330	2	155 249 102	155 031 601	155 325 102 L
		155 327 101 R	30	370	1			
7½ - 6"	282 2019 202	275 468 117 S	130 - 154	330	3	155 249 101	155 031 601	
		275 479 103 R (5)	15	370	3			
	282 2019 203	275 468 117 S	130 - 154	330	3	155 249 101	155 031 601	
		155 327 101 R	30	370	1			
		155 328 101 R	15	370	1			
DLX	282 2019 303	275 468 117 S	130 - 154	330	3	155 249 101	155 031 601	155 326 101 L
		155 327 101 R	30	370	1			
		155 328 101 R	15	370	1			
10 - 6"	282 2029 202	275 468 117 S	130 - 154	330	4	155 249 103	155 031 601 (4)	
		275 479 103 R (5)	15	370	5			
	282 2029 203	275 468 117 S	130 - 154	330	4	155 249 103	155 031 601 (4)	
		155 327 101 R	30	370	2			
		155 328 101 R	15	370	1			
	282 2029 207	275 468 119 S	270 - 324	330	2	155 409 101	155 031 102	155 325 102 S
		155 327 101 R	30	370	2			
		155 328 101 R	15	370	1			
	282 2029 303	275 468 117 S	130 - 154	330	4	155 249 103	155 031 601 (4)	155 326 102 L
		155 327 101 R	30	370	2			
		155 328 101 R	15	370	1			
DLX	282 2029 307	275 468 119 S	270 - 324	330	2	155 409 101	155 031 102	155 326 102 L
		155 327 101 R	30	370	2			155 325 102 S
		155 328 101 R	15	370	1			
15 - 6"	282 2039 303	275 468 119 S	270 - 324	330	2	155 409 102	155 031 102	155 429 101 L
		155 327 101 R	30	370	4			155 325 102 S
		155 328 101 R	15	370	1			

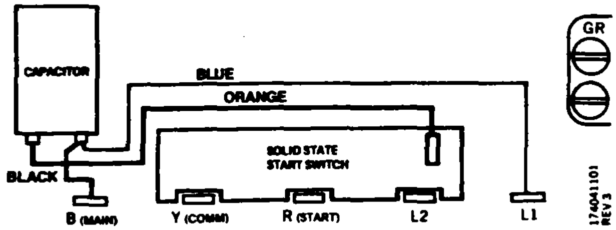
FOOTNOTES:

(1) Lightning arrestor 150 814 902 suitable for all control boxes.
(2) S = Start R = Run L = Line.
DLX = Deluxe control box with line contactor.
(3) Capacitor and overload ass'y.
(4) 2 required
(5) These parts may be replaced as follows:

Old	New
275 479 102	155 328 102
275 479 103	155 328 101
275 479 105	155 328 103
275 481 102	155 327 102

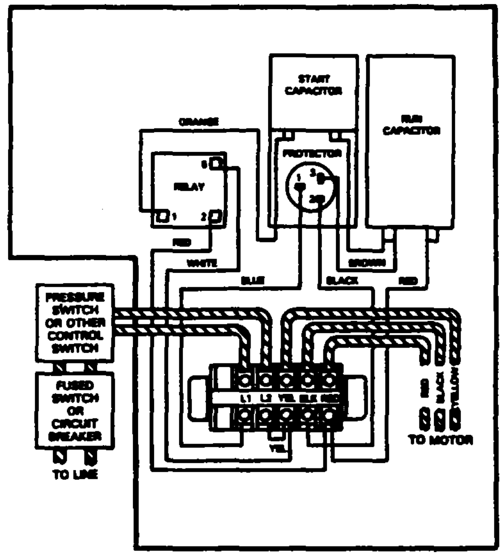
(6) May be replaced with 155 031 601 heavy duty relay.
(7) For 208v systems or where line voltage is between 200v and 210 volts special low voltage relays are required. Use relay part 155 031 103 in place of part 155 031 102 and use relay part 155 031 602 in place of part 155 031 601, and use cable 2 sizes larger; or use boost transformer.

Single Phase Control Box Diagrams



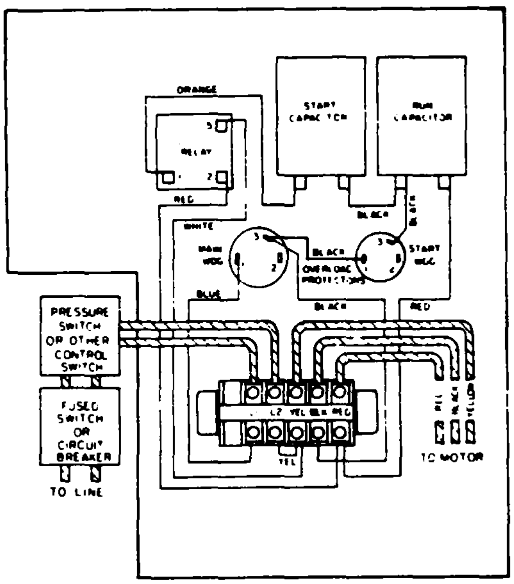
4"
⅓-1 HP Q.D.
280 10-4 910

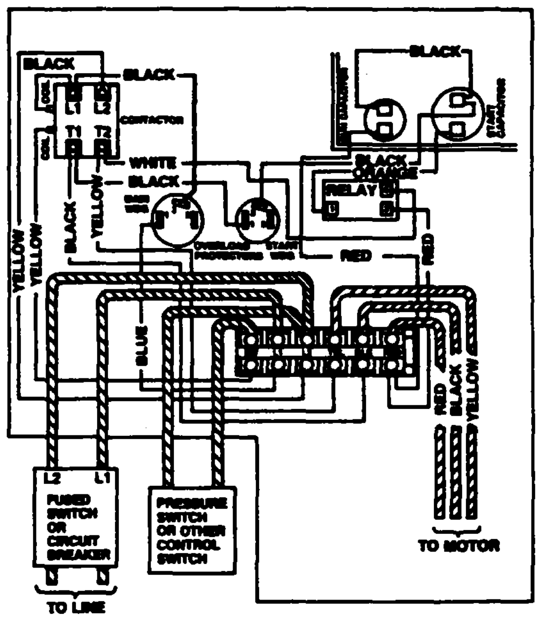
Sixth digit depends on HP



4"
1½ HP
282 3007 103

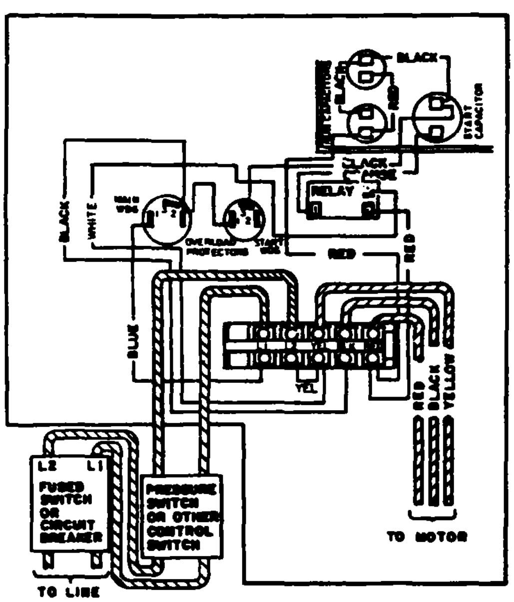
4"
2 AND 3 HP
STANDARD
282 3018 103
282 3028 103

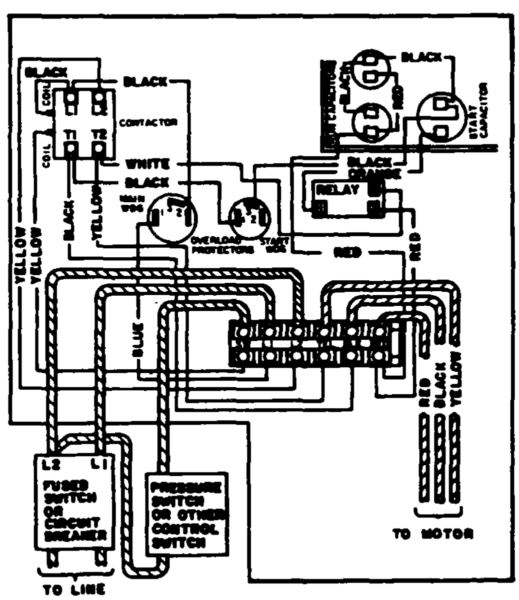




4"
2 AND 3 HP
DELUXE
282 3019 103
282 3029 103

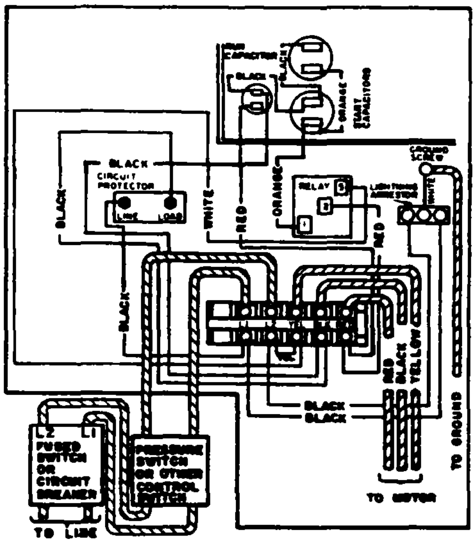
4"
5 HP
STANDARD
282 1139 003



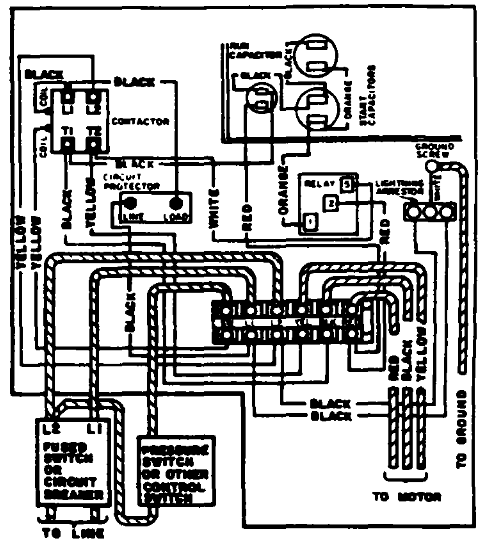


4"
5 HP
DELUXE
282 1139 103

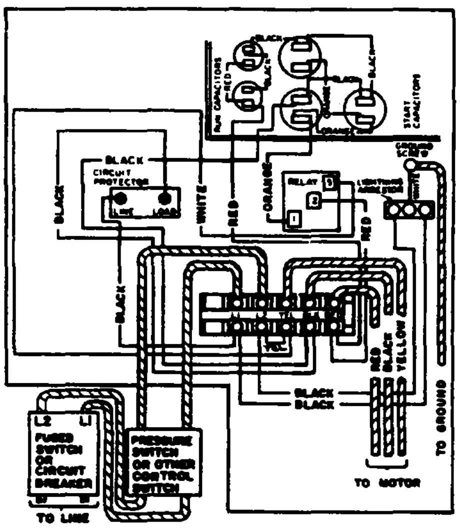
Single Phase Control Box Diagrams



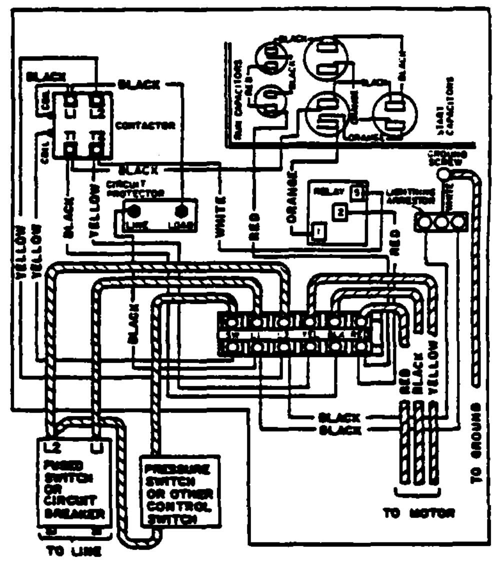
6"
5 HP
STANDARD
282 2009 203



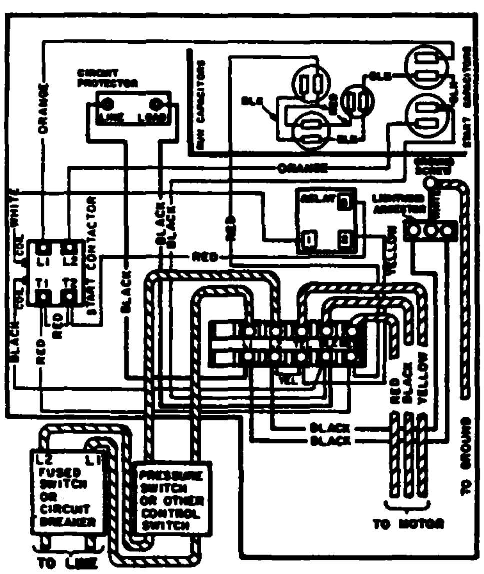
6"
5 HP
DELUXE
282 2009 303



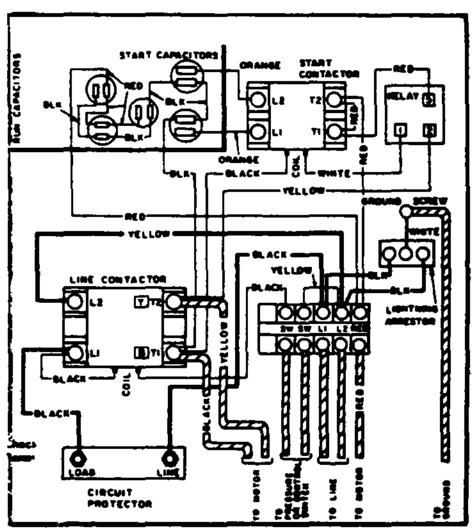
6"
7½ HP
STANDARD
282 2019 203



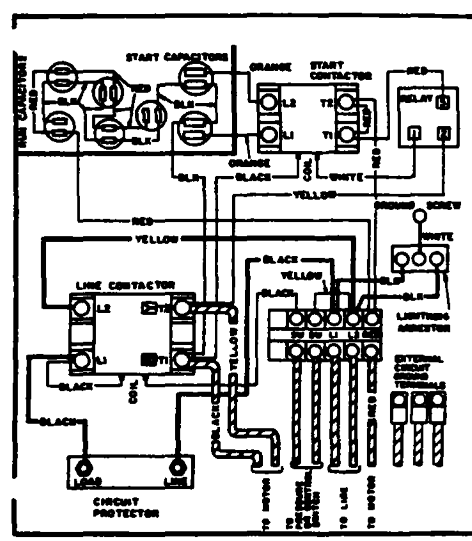
6"
7½ HP
DELUXE
282 2019 303



6"
10 HP
STANDARD
282 2029 207



6"
10 HP
DELUXE
282 2029 307



6"
15 HP
282 2039 303

System Trouble Shooting Procedure

Motor Does Not Start

Cause of Trouble	Checking Procedure	Corrective Action
A. No power or incorrect voltage.	Using voltmeter check the line terminals. Voltage must be ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Fuses blown or circuit breakers tripped.	Check fuses for recommended size and check for loose, dirty or corroded connections in fuse receptacle. Check for tripped circuit breaker.	Replace with proper fuse or reset circuit breaker.
C. Defective Pressure switch.	Check voltage at contact points. Improper contact of switch points can cause voltage less than line voltage.	Replace pressure switch or clean points.
D. Control box malfunction.	For detailed procedure, see page 21 for single phase.	
E. Defective wiring.	Check for loose or corroded connections. Check motor lead terminals with voltmeter for power.	Correct faulty wiring or connections.
F. Bound Pump.	Locked rotor conditions can result from misalignment between pump and motor or sand bound pump. Amp readings 3 to 6 times higher than normal will be indicated.	If pump will not start with several trials, it must be pulled and the cause corrected. New installations should always be run without turning off until water clears.
G. Defective cable or motor.	For detailed procedure, see pages 18 and 19.	

Motor Starts Too Often

A. Pressure switch.	Check setting on pressure switch and examine for defects.	Reset limit or replace switch.
B. Check valve, stuck open.	Damaged or defective check valve will not hold pressure.	Replace if defective.
C. Waterlogged tank. (air supply)	Check air volume control or snifter valve for proper operation.	Clean or replace. Drain and recharge tank.
D. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.

System Trouble Shooting Procedure

Motor Runs Continuously

Cause of Trouble	Checking Procedure	Corrective Action
A. Pressure switch.	Switch points may be "welded" in closed position. Pressure switch may be set too high.	Clean points or replace switch, or readjust setting.
B. Low level well.	Pump may exceed well capacity. Shut off pump, wait for well to recover. Check static and drawdown level from well head.	Throttle pump output or reset pump to lower level. Do not lower if sand may clog pump.
C. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.
D. Worn pump.	Symptoms of worn pump are similar to those of drop pipe leak or low water level in well. Reduce pressure switch setting, if pump shuts off worn parts may be at fault. Sand is usually present in tank.	Pull pump and replace worn impellers, casing or other close fitting parts.
E. Loose or broken motor shaft.	No or little water will be delivered if coupling between motor and pump shaft is loose or if a jammed pump has caused the motor shaft to shear off.	Check for damaged shafts if coupling is loose and replace worn or defective units.
F. Pump screen blocked.	Restricted flow may indicate a clogged intake screen on pump. Pump may be installed in mud or sand.	Clean screen and reset at less depth. It may be necessary to clean well.
G. Check valve stuck closed.	No water will be delivered if check valve is in closed position.	Replace if defective.
H. Control box malfunction.	See page 21 for single phase.	

Motor Runs But Overload Protector Trips

A. Incorrect voltage.	Using voltmeter, check the line terminals. Voltage must be within ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Overheated protectors.	Direct sunlight or other heat source can make control box hot causing protectors to trip. The box must not be hot to touch.	Shade box, provide ventilation or move box away from heat source.
C. Defective control box.	For detailed procedures, see page 21 for single phase.	
D. Defective motor or cable.	For detailed procedures, see pages 17 and 18.	
E. Worn pump or motor.	Check running current per tables 1, 2, or 3.	Replace pump and/or motor.

Shaft Height and Free End Play

TABLE 19

Motor	Nominal Shaft Height	Dimension Shaft Height	Free End Play	
			Min.	Max.
4" Super Stainless	1½"	1.508" / 1.498"	.010"	.045"
4" 900 #	1½"	1.508" / 1.498"	.010"	.045"
4" 900 # UniStruc	1½"	1.508" / 1.498"	.020"	.045"
6"	2⅞"	2.875" / 2.869"	.030"	.050"
8"	4"	4.000" / 3.990"	.008"	.020"
8" x 6"	2⅞"	2.875" / 2.869"	.008"	.020"

1 inch = 25.4 millimeters

Table 19 lists correct shaft height and end play for new motors. If the shaft height measured from the pump mounting surface of a motor is low and/or end play exceeds the limit, the motor thrust bearing is possibly damaged, and should be replaced before installation.

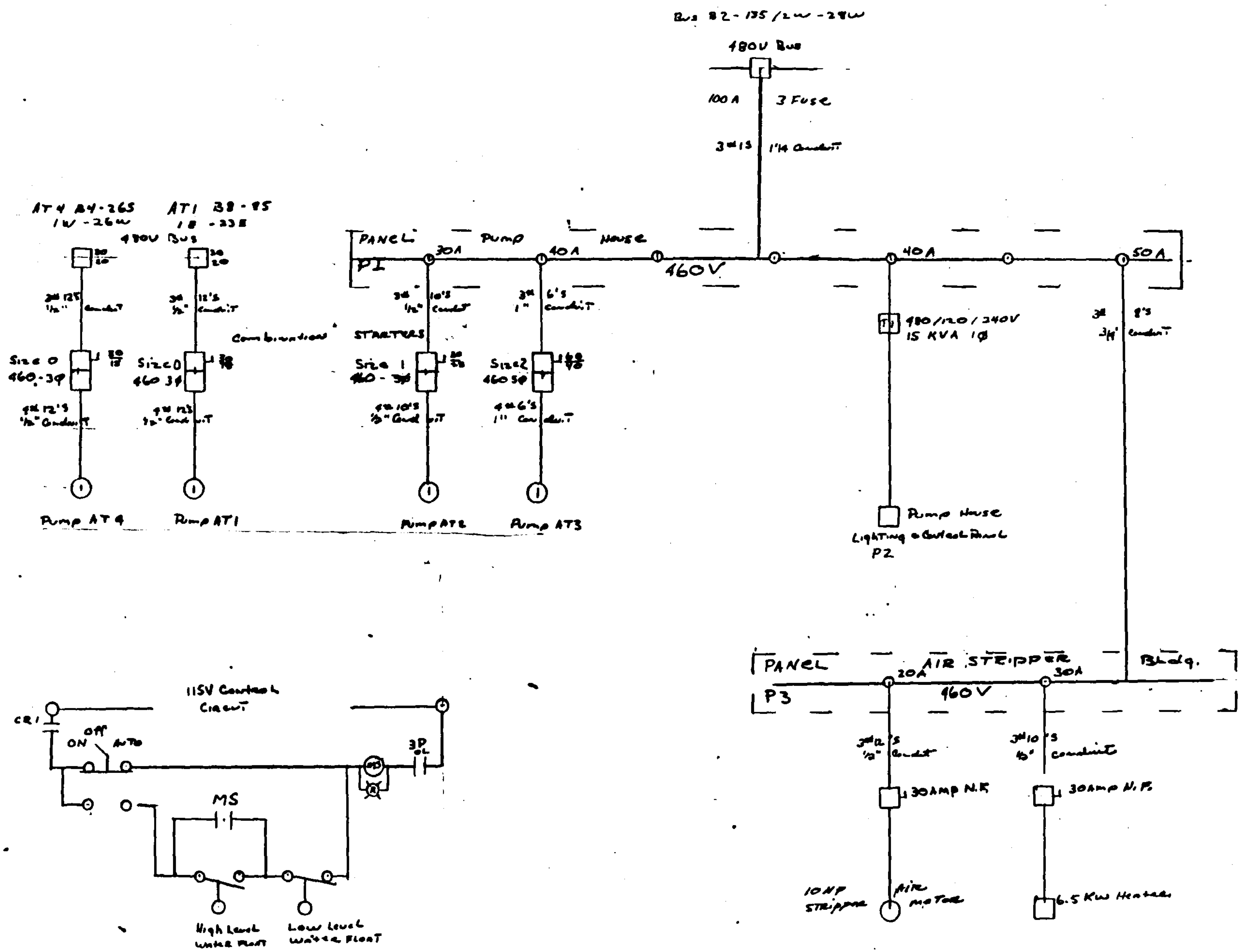
TOLL FREE HELP FROM A FRIEND

Phone Franklin's toll free SERVICE HOTLINE, for answers to your installation questions on submersible pump motors. When you call, a Franklin expert will offer assistance in troubleshooting submersible systems and provide immediate answers to your motor application questions.

Franklin Electric SERVICE HOTLINE 800/348-2420. In Indiana — 800/552-2322

Franklin Electric
Bluffton, Indiana 46714

INDUSTRIAL ELECTRIC



TYPICAL Pump Control Schematic

NOTES

1. 120V Power from STARTER Control TRANSFORMER
2. N.O. Contact CR2 Controlled By AIR STRIPPER High water Level Switch

INDUSTRIAL ELECTRIC COMPANY
ELECTRICAL CONTRACTORS

600 SOUTH NINTH STREET
MINNEAPOLIS, MINNESOTA 55404
TELEPHONE 339-1268
FAX NO. 339-7039

F.M.C.

NIROP

OPERATION AND MAINTENANCE INSTRUCTION

FMC NIROP

EQUIPMENT LIST

Panels

PI Siemens - Number *BQCH424MB4060STGBGU*
Three phase 480 volt 60 amp main circuit breaker 24 circuit
Factory Services: (612) 942-8888
After hours: (800) 241-4453

Note: No spare parts recommended

P2 Siemens - Number *BQ211MB1100S1GbGU*
One phase three wire 120/240 volt 100 amp main circuit breaker 18 circuit
Factory Service: Same as above

Note: No spare parts recommended

<u>Transformer</u>

Siemens ITE - Number 1D1Y015ST
480V three phase to 120/240 volt single phase 15 KVA
Factory Service - Same as above

Note: No spare parts recommended

<u>Motor Starters and Fuseable Disconnects</u>

Siemens - World Series Full Voltage
Nonreversing
Class Sc F
Coil Voltage 110V
Control Transformer 480/120V
Factory Service - Same as Above

Motor Starter Recommended Spare Parts:

110 Volt Coil	$98
480/110V Control Transformer	$54

<u>Heater</u>

Berko - H.V.H 524TA-240V
1500W - Horizontal Down Draft
Factory Service - Viking Electric, (612) 289-0660

No spare parts recommended.

PUMP DOES NOT RUN - TROUBLE CHECK PROCEDURE

1. Check power at combination starter disconnect various locations.

2. Check power line side of starter fuses.

3. Turn selector switch to on if pump does not run, check starter reset.

4. Starter on but pump still does not run, qualified electrician should check for power at well head. If power is O.k. at well head, contact personnel to check pump motor.

5. Pump runs with selector switch on but not in automatic position. At the well head, check float switches.

File: 2923

FMC NIROP

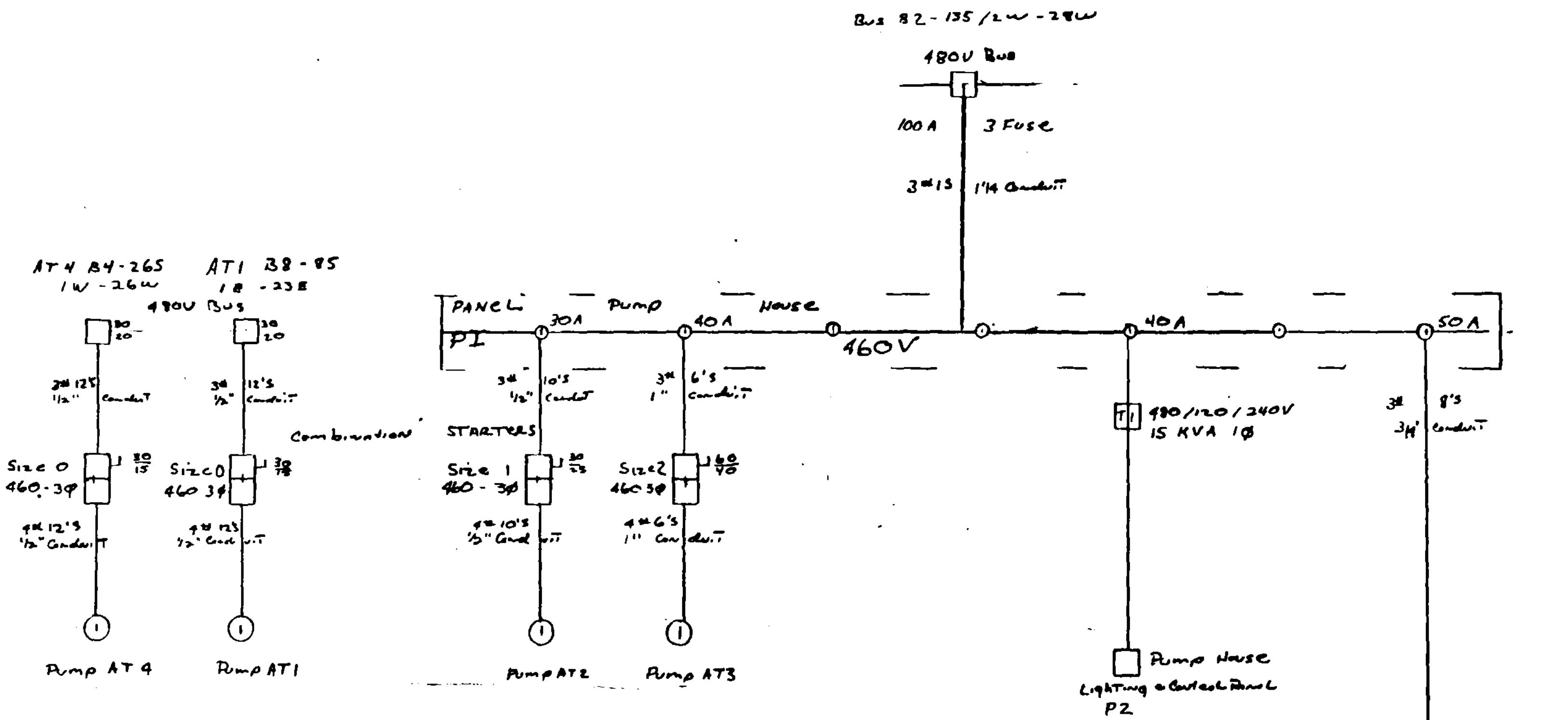
SEQUENCE OF PUMP OPERATIONS AT1, AT2, AT3 and AT4

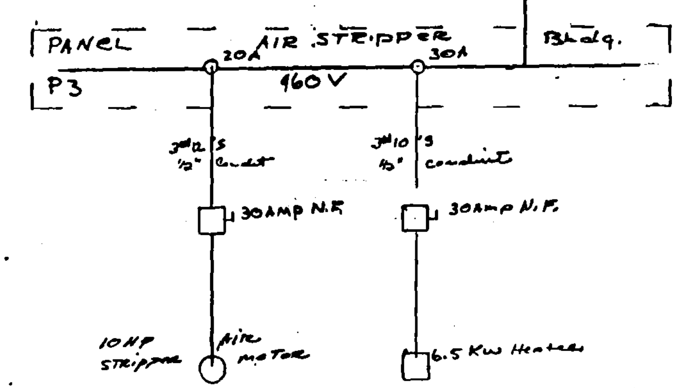
1. Selector switch in on position, pumps run continuous.

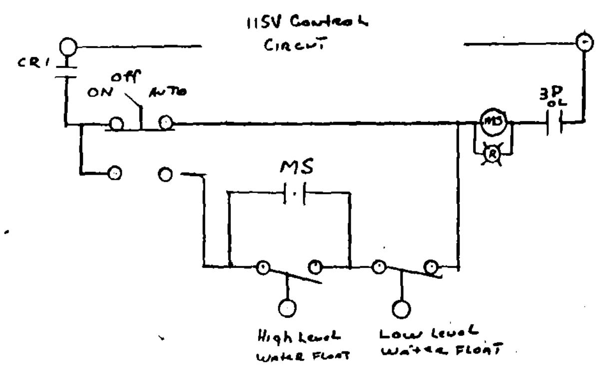
2. Selector switch in auto position -

   A - Water level raises to high level float - pump starts.
   B - Water level drops below lower float switch - pump turns off.

NIROP Power And Control





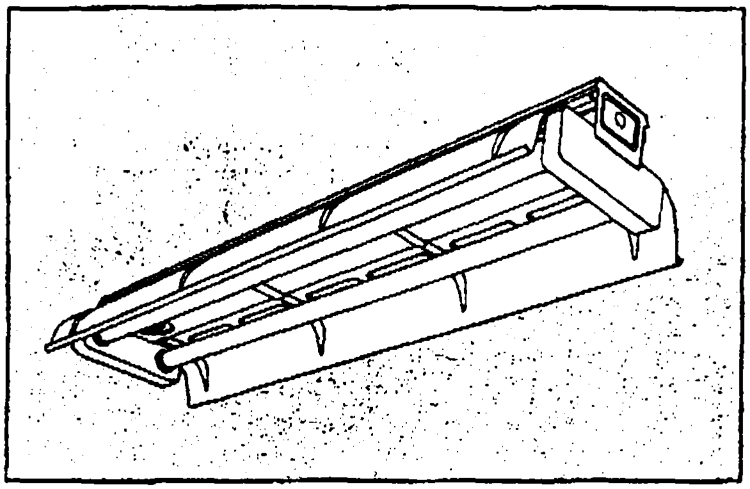


TYPICAL Pump Control
Schematic

Notes

① 120V Power from Starter Control Transformer

② N.O. Contact CR1 Controlled By Air Stripper High water Level Switch



KL240
KL240-8
DYNAMO INDUSTRIAL
TWO LAMP
RAPID START

TYPE ____________________

JOB INFORMATION ____________________

____

FEATURES:

- Available in 4′ and 8′ lengths.
- Reflectors have 15% uplight.
- Spring loaded turret lampholders.
- 6″ lamp spacing.
- For individual or continuous row mounting.
- Channel ends double as joiners.
- Reflector end closures available.

SPECIFICATIONS:

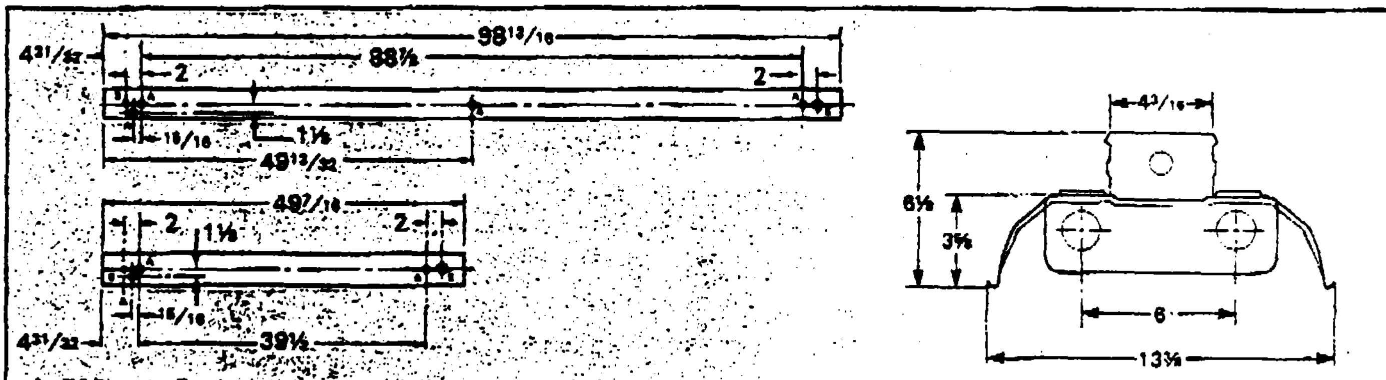
BALLASTS
40 watt Rapid Start thermally protected, automatic resetting, Class P, high power factor, CBM, sound rated A, unless otherwise specified. – w/zero degree balla.

HOUSING
Heavy steel with longitudinal reinforcing ribs for extra strength.

REFLECTOR
Die embossed with transverse ribs for maximum rigidity. Smooth extruded apertures for 15% uplight.

FINISH
All parts pre-painted with high gloss baked white enamel, minimum reflectance 86%, applied over iron phosphate pre-treatment for maximum adhesion and rust resistance.

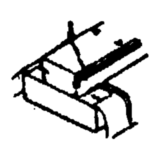
LABELS
All fixtures carry the U.L. label.



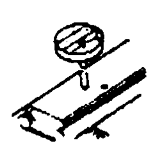
A - 7/8″ Diameter Knockout
B - .570 x .656 Strain Relief Knockout
E - 1 1/8″ Diameter Knockout

NOTE: All dimensions are in inches; dimensions are subject to change without notice. Please consult factory or check sample for verification.

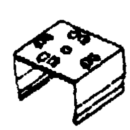
Mounting Accessories



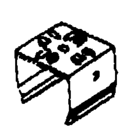
HC4



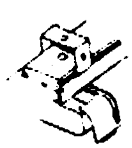
S-18



ZT-2F



ZT-2



CL-2

RAPID START (60 Hz.)

Lamp Data: Description	Lamp Data: Watts	Circuit (Volts)	Min. Starting Temp. (°F.)	Catalog Number (All Class P)	Notes	Electrical Data: Line Current (Amps)	Electrical Data: Input ANSI (Watts)	Sound Rating	Dimensions (Page 15)	Wiring Diagram No. (Page 16)	Shipping Data: Units/Std. Ctn.	Shipping Data: Weight/Std. Ctn. (Lbs.)
TWO LAMP – HIGH POWER FACTOR												
(2) F30T12	30	120	50	RM-2SP30-TP	1, 2	.68	81	[illegible]	[illegible]	21	10	35
			0	RC-2SP40-TP	2, 5	.75	79		R-5			39
		277	50	VM-2SP30-TP	1	.30	81	[illegible]	T-2	[illegible]	10	35
			0	VC-2SP40-TP	5	.33	79		R-5			39
(2) F30 Energy Savers (460 Ma)	25	120	60	RM-2SP30-TP	2	.63	73	[illegible]	T-2	21	10	38
		277	60	VM-2SP30-TP		.27	73	[illegible]	T-2	21	10	38
(2) F32T8	32	120	60	R-2P32-TP		.61	71	[illegible]	T-2	[illegible]	10	38
		277	60	V-2P32-TP		.26	71	[illegible]	T-2	21	10	38
(2) F40T8	40	120	50	R-2P840-TP		.77	92	[illegible]	T-2	21	10	38
		277	50	V-2P840-TP		.34	92	[illegible]	T-2	21	10	38
(2) F40T12	40	120	50	RQM-2S40-TP	1, 2	.80	96	[illegible]	T-2	[illegible]	10	33
			50	RS-2S40-TP (Mark I)	1, 2	.79	94		T-2			34
			50	RM-2S40-TP (Mark II)	1, 2	.77	92		T-2			35
			50	R-2S40-TP (Mark III)	1, 2	.73	86		T-2			37
			X 0	RC-2SP40-TP	2, 5	.75	90		[illegible]			38
		220	50	XQM-2S40-TP	4	.45	96	[illegible]	T-2	[illegible]	10	34
		240	50	YQM-2S40-TP	2	.42	96	[illegible]	T-2	21	10	34
		277	50	VQM-2S40-TP	1, 2	.35	96	[illegible]	T-2	[illegible]	10	34
			50	VS-2S40-TP (Mark I)	1, 2	.34	94		T-2			35
			50	VM-2S40-TP (Mark II)	1, 2	.34	92		T-2			36
			50	V-2S40-TP (Mark III)	1, 2	.32	86		T-2			37
			0	VC-2SP40-TP	5	.33	90		R-5			38
(2) F40 Energy Savers (460 Ma)	34, 35	120	60	RQM-2S40-TP	2	.72	82	[illegible]	T-2	[illegible]	10	33
				RS-2S40-TP (Mark I)	2	.70	80					34
				RM-2S40-TP (Mark II)	2	.68	78					35
				R-2S40-TP (Mark III)	2	.63	72					37
		240	60	YQM-2S40-TP		.36	82	[illegible]	T-2	21	10	34
		277	60	VQM-2S40-TP	2	.31	82	[illegible]	T-2	21	10	34
				VS-2S40-TP (Mark I)	2	.31	80					35
				VM-2S40-TP (Mark II)	2	.30	78					36
				V-2S40-TP (Mark III)	2	.27	72					37
(2) F40 Energy Saver Plus (460 Ma)	32	120	60	RQM-2S40-TP	2	.70	78	[illegible]	T-2	21	10	33
				RS-2S40-TP (Mark I)	2	.68	76					34
				RM-2S40-TP (Mark II)	2	.66	74					35
				R-2S40-TP (Mark III)	2	.61	68					37
		240	60	YQM-2S40-TP		.35	78	B	T-2	21	10	34
		277	60	VQM-2S40-TP	2	.30	78	A	T-2	21	10	34
				VS-2S40-TP (Mark I)	2	.30	76					35
				VM-2S40-TP (Mark II)	2	.29	74					36
				V-2S40-TP (Mark III)	2	.26	68					37
TWO LAMP – HIGH POWER FACTOR – REDUCED LIGHT OUTPUT												
(2) F40T12	40	120 277	50	R-2S35-TP V-2S35-TP	19	.65 .28	72	A	T-2	21	10	34

NOTES: 1. CBM Approved. 2. CSA Approved. 4. Not U/L Listed. 5. Operates any 2 lamp combination of F30T12, F40T12, 32 W. or 40 W circline lamps. 19. These low-energy ballasts operate standard or U-shaped 430 Ma lamps at a nominal lamp current of 300 Ma and thus provide a 20% reduction in light output with a corresponding 20% reduction in input watts.

Units shown are furnished with Class P ADVAN guard® Automatic Resetting Thermostat. Units packed in individual cartons. Add suffix IC.

SIEMENS

I-T-E Electrical Produc

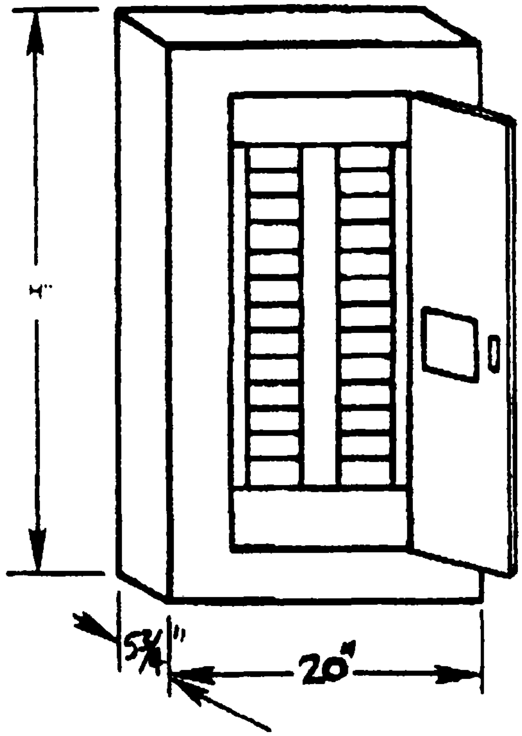
Typical Panelboard

Cabinets To Be Constructed Of Code Gauge Galvanized Steel. Standard Blank Ends In Top And Bottom.

Fronts To Be Constructed Of Code Gauge Steel. They Are Finish Painted With ANSI-61 Light Gray Paint. Doors Are Equipped With Flush Disc-Tumbler Locks, All Keyed Alike, And Supplied With One Key. Directory Holder With Directory Card Is Provided On Inside Of Door.

All Lugs Are Suitable For Use With Aluminum Or Copper Wire.

PANEL "P1"



X Copper Bus
__ Aluminum Bus
X Engraved Plastic Nameplate
__ Feed Through Lugs
__ Sub Feed Lugs
__ Compression Lugs
X Ground Bus
__ Nema-3R Enclosure

Note: Please provide Top or Bottom Feed, and Surface or Flush Mount if not indicated.

Panelboard to bear Underwriters' Laboratories, Inc. label.

SERVICE: 3 Ø 3 W 480 VOLTS

PANEL SCHEDULE

No. Ckts	Panel Design	Box Height "H"	MLO or MCB frame	Main Capacity	Lug Size Ø & N	Mtg. S	Mtg. F	Main Lugs T	Main Lugs B	Main Bkr. T	Main Bkr. B	Type ED4 Branch Breakers Minimum I.C. rating is 18 KA sym. at 480 volts.
24	CDP-7		MCB	60A	STANDARD	X				X		2-30/3, 4-20/3, 2-3 POLE SPACE

...ECT TO CORRECTIONS
...THE PROVISIONS OF
...CIFICATIONS.
A
DEC 31 1993
U.S. ARMY ENGINEER DISTRICT - ST PAUL
Mark E Koenig

Dist. VIKING ELECTRIC SUPPLY		By JRM
S.O.	P.O.	Chk.
Cont. INDUSTRIAL ELECTRIC		
Job Name EMC GROUND WATER	Dwg. No.	Apd

4.0-5A Supersedes 4.0-5B

SIEMENS

I-T-E Electrical Produc

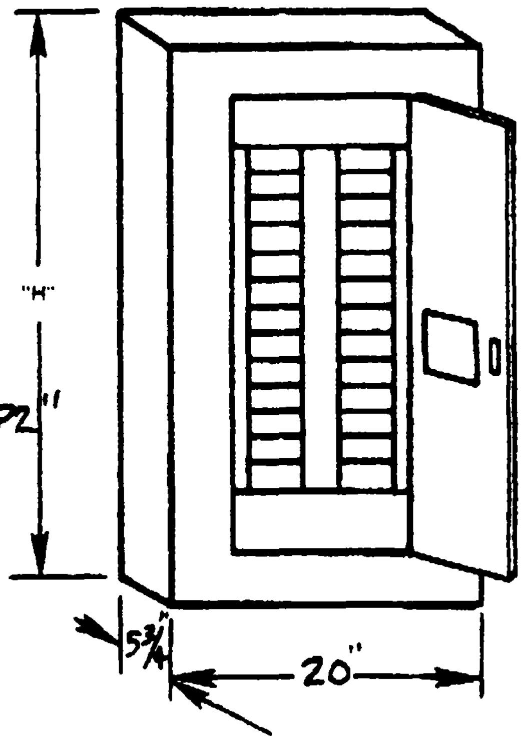
Typical Panelboard

Cabinets To Be Constructed Of Code Gauge Galvanized Steel. Standard Blank Ends In Top And Bottom.

Fronts To Be Constructed Of Code Gauge Steel. They Are Finish Painted With ANSI-61 Light Gray Paint. Doors Are Equipped With Flush Disc Tumbler Locks, All Keyed Alike, And Supplied With One Key. Directory Holder With Directory Card Is Provided On Inside Of Door.

All Lugs Are Suitable For Use With Aluminum Or Copper Wire.

PANEL "P2"



X Copper Bus
__ Aluminum Bus
X Engraved Plastic Nameplate
__ Feed Through Lugs
__ Sub Feed Lugs
__ Compression Lugs
X Ground Bus
__ Nema-3R Enclosure

Note: Please provide Top or Bottom Feed, and Surface or Flush Mount if not indicated.

Panelboard to bear Underwriters' Laboratories, Inc. label. SERVICE 1 Ø 3 W 120/240 VOLTS

PANEL SCHEDULE

No. Ckts	Panel Design	Box Height "H"	MLO or MCB frame	Main Capacity	Lug Size Ø & N	Mtg. S	Mtg. F	Main Lugs T	Main Lugs B	Main Bkr. T	Main Bkr. B	Type BQ Branch Breakers Minimum I.C. rating is 10 KA sym. at 120/240 volts.
18	CDP-7		MCB	100 A	STANDARD	X				X		6-20/1, 2-20/2, 8-1 POLE SPACE

...ECT TO CORRECTIONS
...THE PROVISIONS OF
...ECIFICATIONS.
A
DEC 31 1993
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
Mark E Koenig

Dist. VIKING ELECTRIC SUPPLY		By JRM
S.O.	P.O.	Chk.
Cont. INDUSTRIAL ELECTRIC		Apd
Job Name EMC GROUND WATER	Dwg No	

4.2.5A (Supersede 4.2.5B)

PANELBOARD AND DISTRIBUTION BOARD SECTION

OF THE

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

MEMBER COMPANIES

Challenger Electrical Equipment Corp.
Malvern, PA 19355

Crouse-Hinds Distribution Equipment
A Division Cooper Industries
Earlysville, VA 22936

Custom Switchgear and Controls, Inc.
Santa Clara, CA 94051

Eaton Corp. / Cutler Hammer Products
Milwaukee, WI 53216

Erickson Electrical Equipment Co.
Chicago, IL 60630

General Electric Company
Plainville, CT 06062

Anchor Electric, A Unit of General Signal Corporation
Manchester, NH 03105

Harvey Hubbell, Inc.
Orange, CT 06477

Milbank Manufacturing Co.
Kansas City, MO 64141

Nix and Miller, Inc.
Buford, GA 30518

Penn Panel and Box Company
Collingdale, PA 19023

Power Controls, Inc.
Commerce, CA 90040

The Pringle Electrical Manufacturing Co.
Ft. Washington, PA 19034

Ryco Manufacturing. Co. Inc.
City of Industry, CA 91748

I-T-E Electrical Products
A Division of Siemans-Allis, Inc.
Tucker, GA 30084

Square D Company
Palatine, IL 60067

Superior Switchboard and Devices
Canton, OH 44702

Unicorn Electrical Products
Anaheim, CA 92806

The Wadsworth Electric Mfg. Co., Inc.
Covington, KY 41012

Westinghouse Electric Corp.
Pittsburgh, PA 15222

MAINTENANCE INSTRUCTIONS

STORE BEHIND DIRECTORY CARD IN PANELBOARD AFTER CONSTRUCTION.

NEMA STANDARDS PUBLICATION PB 1.1-1986

GENERAL INSTRUCTIONS FOR PROPER INSTALLATION, OPERATION AND MAINTENANCE OF PANELBOARDS RATED 600 VOLTS OR LESS

RETAIN FOR USE BY QUALIFIED MAINTENANCE PERSONNEL

For Emergency Service
Call: 1-800-241-4453

Siemens Energy & Automation, Inc.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, DC 20037

TABLE OF CONTENTS

GENERAL INSTRUCTIONS FOR THE PROPER INSTALLATION, OPERATION, AND MAINTENANCE OF PANELBOARDS RATED 600 VOLTS OR LESS

(Approved as Authorized Engineering Information 5-19-1986)

FOREWORD

This publication is a guide of practical information containing instructions for the proper installation, operation, and maintenance of panelboards rated 600 volts or less. These recommendations of the Panelboard and Distribution Board Section of the National Electrical Manufacturers Association will be found useful by architects, electrical engineers, electrical contractors, electricians, maintenance engineers and others.

It is recommended that work described in this set of instructions be performed only by qualified personnel familiar with the construction and operation of panelboards and that such work be performed only after reading this complete set of instructions.

Further, if the maintenance personnel have specific questions not covered by these instructions, they are urged to contact the manufacturer of the panelboard directly.

These instructions will be reviewed periodically by the Section for the purpose of updating them to reflect advancing technology. Please address any comments or questions you may have on the text to:

Manager, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037

Publication No. PB 1.1-1986 revises and supersedes PB 1.1-1979

SCOPE

This Standards Publication covers single panelboards, or groups of panel units suitable for assembly in the form of single panelboards, including buses, and with or without switches and/or automatic overload protective devices (fuses or circuit breakers). These units are used in the distribution of electricity for light, heat and power at:

600 volts and less
1600-ampere mains and less
1200-ampere branch circuits and less

Specifically excluded are live-front panelboards, panelboards employing cast enclosures for special service conditions, and panelboards designed primarily for residential and light commercial service equipment.

Section 1

GENERAL

The successful operation of panelboards is dependent upon proper installation, operation, and maintenance. Neglecting fundamental installation and maintenance requirements may lead to personal injury as well as damage to electrical equipment or other property.

QUALIFIED PERSONNEL

Therefore, installation, operation and maintenance of panelboards should be conducted only by qualified personnel.

For purposes of these guidelines, a qualified person is one who is familiar with the installation, construction, and operation of the equipment and the hazards involved. In addition, the person is:

a. Trained and authorized to test, energize, clear, ground, tag, and lockout circuits and equipment in accordance with established safety practices.

b. Trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, and flash resistant clothing in accordance with established safety practices.

c. Trained in rendering first aid.

WARNING—THERE IS A HAZARD OF ELECTRIC SHOCK OR BURN WHENEVER WORKING IN OR AROUND ELECTRICAL EQUIPMENT. TURN OFF POWER SUPPLYING THE EQUIPMENT BEFORE WORKING INSIDE.

CAUTION—Hydrocarbon spray propellants and hydrocarbon based sprays or compounds may cause degradation of certain plastics. Contact the panelboard manufacturer before using those products to clean, dry, or lubricate panelboard components during installation or maintenance.

Section 2

INSTALLATION OF PANELBOARD CABINETS (BOXES)

Install the cabinet in a neat and workmanlike manner. Follow the manufacturer's installation instructions.

1. *Location in Building.* Locate the cabinet so that it is readily accessible and not exposed to physical damage.

2. *Flammable Material.* Locate the cabinet well away from flammable material.

Unusual Service Conditions. Do not locate the cabinet where it will be exposed to ambient temperatures above 40°C (104°F), corrosive or explosive fumes, dust, vapors, dripping or standing water, abnormal vibration, mechanical shock, high humidity, tilting, or unusual operating conditions, unless the cabinet/panelboard combination has been designed for these conditions.

4. *Indoor Damp Locations.* Locate or shield the cabinet so as to prevent moisture and water from entering and accumulating therein. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

5. *Wet Locations.* Cabinets should be specifically approved for wet locations. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

6. *Clearance from Ceiling.* Do not locate the cabinet against a non-fireproof ceiling; allow a space of 3 feet between the ceiling and cabinet unless an adequate fireproof shield is provided.

7. *Space Around the Cabinet.* When selecting a location, provide sufficient access and working spa around the cabinet (See NEC Section 110-16*). The width of the working space in front of t panelboard should be at least 30 inches and this space should not be used as storage. The workin space should have adequate lighting and a minimum head room of 6-1/4 feet.

8. *Mounting of Cabinet.* The cabinet should be reliably secured to the mounting surface. Do not depend on wooden plugs driven into holes in masonry, concrete, plaster or similar materials. (See Section 110-13 of the National Electrical Code.)

9. *Flush Mounting in Wall.* In walls of concrete, tile, or other noncombustible material, install the cabinet so that its front edge will not set back more than 1/4 inch from the finished surface. In walls of wood or other combustible material, cabinets should be flush with or project beyond the finished surface. (See Section 373-3 of the National Electrical Code.)

10. *Unused Openings in Cabinet.* Effectively close unused openings in the cabinet to provide protection which is substantially equivalent to that afforded by the wall of the cabinet.

11. *Grounding of Panelboard Cabinets.* Ground the cabinet or box as specified in Article 250 of the National Electrical Code. When the cabinet or box contains service equipment, it will be necessary to bond the box to the grounded (neutral) supply conductor.

Section 3

INSTALLATION OF CONDUIT AND WIRES

1. Conduits should be installed so as to prevent moisture or water from entering and accumulating within the enclosure. Provision should be made to protect conductors from abrasion in accordance with Article 373 of the National Electrical Code.

2. Knockouts should be removed as follows:

IMPORTANT: Remove knockouts, ONE AT A TIME, alternating INWARD and OUTWARD.

FIRST: Remove center knockout INWARD.

a. Place screwdriver blade against point farthest from tie and strike INWARD (Figure 3-1). Bend back and forth to break tie.

NEXT: Remove rings ONE AT A TIME without straining remaining rings.

b. Pry first ring OUTWARD with screwdriver midway between ties, using pliers flat against under screwdriver (Figure 3-2). Bend ring sections OUTWARD with pliers, then back and forth to break ties (Figure 3-3).

c. Remove second ring INWARD by striking screwdriver (with blade against point midway between ties) then breaking ring sections inward and back and forth to break ties.

3. Be sure that the lugs are suitable and approved for use with the cable being connected to the panelboard. See Item 7 of Section 4 for making proper connections. Before pulling any cables into the box, make sure that the temperature rating of the wire complies with the job specifications and the panelboard interior marking, if available.

*NFPA Pub. No. 70-1984, available from the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.

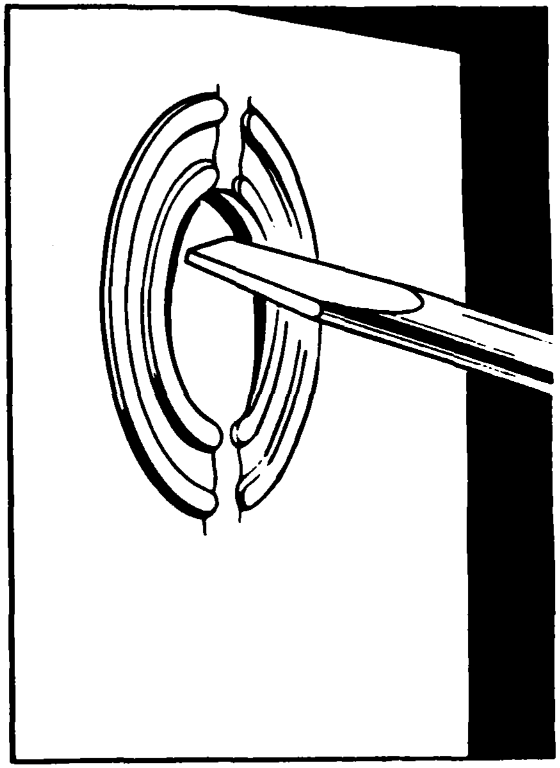


Figure 3-1
Knockout Removal - Step 1

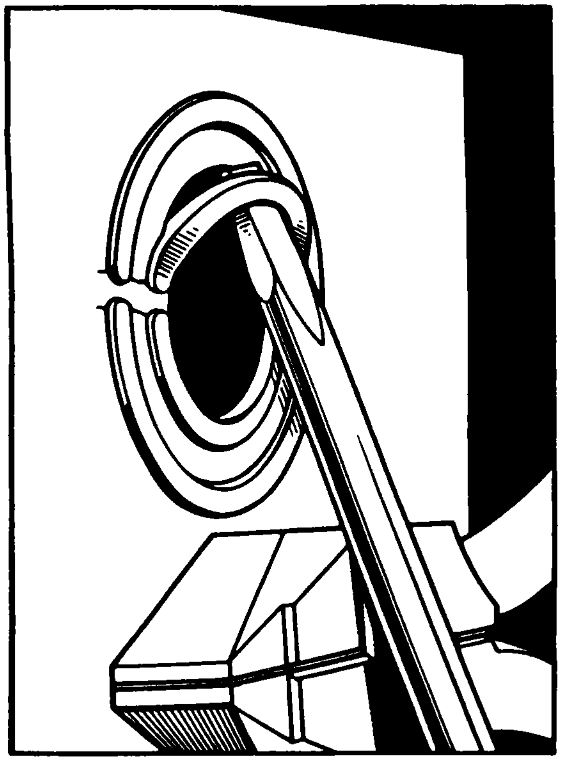


Figure 3-2
Knockout Removal - Step 2

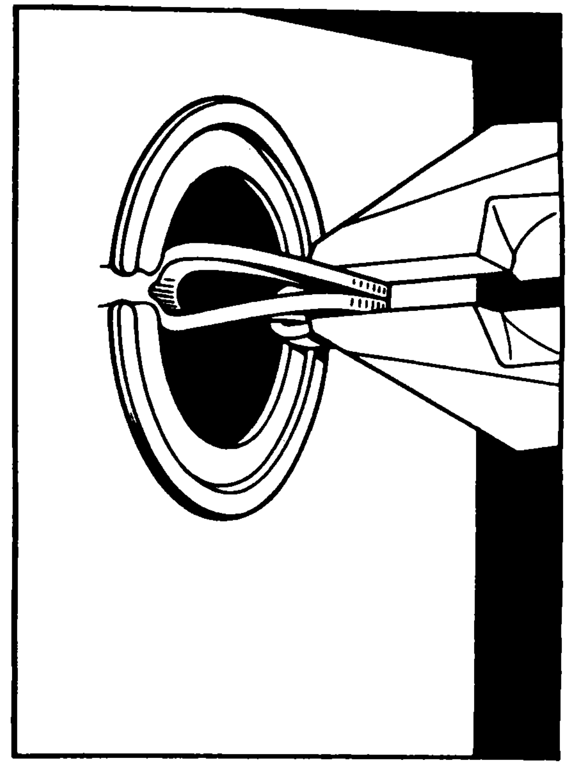


Figure 3-3
Knockout Removal - Step 3

4. Keep conductor lengths to a minimum within the wiring gutter. Excessive cable lengths will result in additional heating and may result in overheating. However, cables should be long enough to reach the terminal location in a manner that avoids strain on the connecting lug.

5. Exercise care to maintain the largest practical bending radius of conductors; otherwise the insulation may be damaged or terminal connections may become loosened.

Section 4

INSTALLATION OF PANELBOARD

1. *Proper Storage.* Store the panelboard in a clean, dry place located so that mechanical damage from work personnel in the area is not likely to happen.

2. *Unpacking.* Care should be exercised in unpacking the panelboard to prevent damage.

3. *Inspection.* Check for shipping damage and check to make sure that the panelboard is the correct one for installation in the cabinet.

WARNING—BE SURE THAT ALL POWER IS TURNED OFF AND REMAINS OFF DURING THE FOLLOWING INSTALLATION PROCEDURES.

4. *Cleaning.* Clean the cabinet of all foreign materials prior to installation of the panelboard. If parts at connection points are spattered with cement, plaster, paint or other foreign material, remove the foreign materials with great care to avoid damaging plated surfaces.

5. *Manufacturer's Instructions.* Carefully follow the manufacturer's instructions and labels.

6. *Installation*

   a. Adjust the alignment devices where provided.

   b. Install the panelboard, finalize its alignment, and tighten it securely in the cabinet.

   c. Unless otherwise instructed by the manufacturer, adjust the panelboard so that the return flange of the deadfront shield is no more than 3/16 inch from (1) the front of the box for surface mounting or (2) the surrounding wall surfaces for flush mounting.

7. *Connect Line and Branch Conductors*

   a. *Conductors.* Use care in stripping insulation from conductors so as not to nick or ring the conductor. For aluminum, clean all oxide from the stripped portion and apply a joint compound.

   b. Distribute and arrange conductors neatly in the wiring gutters. (See Section 3.)

   c. Be sure that the lugs are suitable and approved for use with the cable before being connected to the panelboard.

   d. Tighten all lugs. Use the manufacturer's torque values, if furnished.(See Section 5, Item 1.)

8. *Ground Panelboard.* (See Section 384-27 of the National Electrical Code.)

   a. *Cabinet.* Ground the panelboard cabinet in accordance with Item 11 of Section 2.

   b. *Equipment Grounding Conductors.* Prepare equipment grounding conductors in accordance with Item 7.a and connect them to the equipment grounding terminal bar. Check to be sure that the terminal bar is securely bonded to the cabinet or panelboard frame and that it is not connected to the neutral bar except at service equipment as required by Section 250-53(a) of the National Electrical Code.

9. When installing circuit breakers or fuses, ensure that they are of the proper type or class and rating.

10. Clean the cabinet of all debris which has accumulated during the panelboard installation.

11. In order to protect the panelboard before completion of the job, cut and install a piece of cardboard to fit the outline of the box. If the job is complete, perform the steps in Section 5 and then install the cabinet front, per Section 6.

Section 5

STEPS TO BE TAKEN BEFORE ENERGIZING

1. Tighten all accessible electrical connections to the manufacturer's torque specifications. If such information is not provided with the equipment, consult the manufacturer.

2. Make certain that all blocks used for shipment have been removed from all component devices and the panelboard.

3. Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain that they operate freely.

4. To make sure that the system is free from short circuits and grounds, conduct an insulation resistance test phase to ground and phase to phase with the switches or circuit breakers in both the open and closed positions. If the resistance reads less than 1 megohm while testing branch circuit devices in the open position, the system may be unsafe and should be investigated.

5. Check to determine that all grounding connections are properly made. If the panelboard is used as service equipment, make certain that the neutral is properly bonded to the enclosure.

6. Remove all debris, scrap wire, etc., from the panelboard and cabinet before installing the cabinet front. Make certain that all deadfront shields are properly aligned and tightened. Install the cabinet front in accordance with Section 6.

Section 6

INSTALLATION OF CABINET FRONT

The cabinet front or trim package is designed to prevent damage to the front during shipment and handling.

1. *Unpacking.* Care should be used when unpacking and handling the cabinet front.

2. *Touch-up.* A suitable paint or other corrosion-resistant finish should be applied to those places where the finish is damaged.

3. *Front Alignment.* The cabinet front may be provided with an adjusting means to align it squarely with the building even though the box may be slightly out of plumb with the building.

Section 7

ENERGIZING EQUIPMENT

1. Energizing a panelboard for the first time after initial installation or maintenance is potentially dangerous. Therefore, qualified electrical personnel should be present when the equipment is energized for the first time. If short circuits caused by damage or poor installation practices have not been detected in the procedures specified in Sections 1-6, serious damage can occur when the power is turned on.

2. There should be no load on the panelboard when it is energized. Turn off all of the downstream loads, including those such as other panelboards and devices which are remote from the panelboard.

3. The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. In other words, energize the main devices, then the feeder devices, and then the branch-circuit devices. Turn the devices on with a firm positive motion. Protective devices which are not quick-acting should not be "teased" into the closed position.

4. After all main, feeder, and branch circuit devices have been closed, loads such as lighting circuits, contactors, heaters, and motors may be turned on.

Section 8

CARE AND MAINTENANCE

A care and maintenance program for panelboards should be conducted on a regularly scheduled basis in accordance with the following:

1. A panelboard which has been carrying its regular load for at least 3 hours just prior to inspection should be field tested by feeling the deadfront surfaces of circuit breakers, switches, interior trims, doors, and enclosure sides with the palm of the hand. If the temperature of these surfaces does not permit you to maintain contact for at least 3 seconds, this may be an indication of trouble and investigation is necessary.

WARNING—BEFORE PERFORMING ANY OF THE FOLLOWING OPERATIONS, TURN OFF ALL POWER SUPPLYING THE PANELBOARD. CHECK THE VOLTAGE OF ALL INCOMING LINE TERMINALS TO POSITIVELY ASCERTAIN THAT THE EQUIPMENT IS TOTALLY DEENERGIZED.

CAUTION—Hydrocarbon spray propellants and hydrocarbon based sprays or compounds may cause degradation of certain plastics. Contact the panelboard manufacturer before using those products to clean, dry, or lubricate panelboard components during installation or maintenance.

2. Inspect the panelboard once each year or after any severe short circuit.

   a. Look for any moisture or signs of previous wetness or dripping inside the panelboard. Condensation in conduits or dripping from outside sources is one known cause of malfunction.

      (1) Seal off any conduits which have dripped condensate, and provide a means for further condensate to drain away from the panelboard.

      (2) Seal off any cracks or openings which have allowed moisture to enter the enclosure. Eliminate the source of any dripping on the enclosure and any other source of moisture.

      (3) Replace or thoroughly dry and clean any insulating material which is damp or wet, or shows an accumulation of deposited material from previous wettings.

   b. If there is an accumulation of dust and dirt, clean out the panelboard by using a brush, vacuum cleaner, or clean lint-free rags. Avoid blowing dust into circuit breakers or other components. Do not use a blower or compressed air.

   c. Carefully inspect all visible electrical joints and terminals.

      (1) Tighten bolts and nuts at bus joints if there is any sign of overheating or looseness. (See Section 5, Item 1.) If joints appear to be badly discolored, corroded, or pitted, the parts should be disassembled and replaced or cleaned.

CAUTION: DO NOT REMOVE PLATING ON ALUMINUM PARTS IN JOINTS. REPLACE DAMAGED ALUMINUM PARTS.

      (2) Examine all wire or cable connections for evidence of looseness or overheating. Torque if necessary. (See Section 5, Item 1.) If major discoloration or cable damage is apparent, replace the damaged parts and remove the damaged portion of the cable.

      (3) Closely examine fuse clips. If there is any sign of overheating or looseness, check the spring pressure, tightness of clamps, etc. Replace the fuse clips if the spring pressure compares unfavorably with that of other identical fuse clips in the panelboard.

      (4) Retighten plug fuses.

      (5) Look for signs of deterioration in insulating material or melting of sealing compound. Replace such insulating parts, and assemblies where sealing compound has melted.

      (6) BE SURE THAT THE CONDITION WHICH CAUSED THE OVERHEATING HAS BEEN CORRECTED.

   d. Check the operation of all mechanical components.

      (1) Exercise switch operating mechanisms and external operators for circuit breakers to determine that they operate freely to their full on and off positions.

      (2) Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms.

      (3) Whenever practical, check all devices for missing or broken parts, proper spring tension, free movement, corrosion, dirt, and excessive wear.

      (4) Adjust, clean, and lubricate or replace parts as required.

   e. After a severe short circuit, examine all devices and bus supports for cracks or breakage. Replace as required.

3. Lubricate the operating parts of switch mechanisms, etc., according to the manufacturer's instructions which are usually printed on diagrams or labels.

   a. Use *clean*, nonmetallic, light grease or oil as instructed.

   b. Do *not* lubricate parts of molded case circuit breakers.

   c. If no instructions are given on the devices, sliding copper contacts, operating mechanisms, and interlocks may be lubricated with clean, light grease.

   d. Wipe off excess lubrication to avoid accumulation of dirt.

4. Operate each switch or circuit breaker several times to ensure that all mechanisms are free and in proper working order. Replace as required.

5. Check circuit breakers and fuses to ensure they have the proper ampere and interrupting ratings. Ensure that noncurrent-limiting devices are never used as replacements for current-limiting devices. Never attempt to defeat rejection mechanisms which are provided to prevent the installation of the incorrect class of fuse.

6. Check insulation resistance:

   a. If a severe short circuit has occurred.

   b. If it has been necessary to replace parts or clean insulating surfaces.

   c. If the panelboard has been exposed to high humidity, condensation or dripping moisture.

Section 9

PERMISSIBLE LOADING OF PANELBOARDS

The ratio of load current to the ampere rating of the overcurrent protective device determines its operating temperature. In compliance with Section 384-16 of the National Electrical Code, the continuous loads of panelboard circuits should be not more than 80 percent of the rating of the overcurrent protective device, unless the marking of the device indicates that it is suitable for continuous duty at 100 percent of its rating.

NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status, are set forth in certain clauses of the NEMA *lardization Policies and Procedures* manual and are referenced below.

Purpose of Standards

National Electrical Manufacturers Association standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist purchasers in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard. *(Standardization Policies and Procedures, p. 1)*

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.
(Standardization Policies and Procedures, p. 2)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.
(Standardization Policies and Procedures, p.8)

Categories of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 7 & 16)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standa been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.
(Standardization Policies and Procedures, pp. 7 & 16)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment, and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon.
(Standardization Policies and Procedures, pp. 7 & 16)

Identification of Status

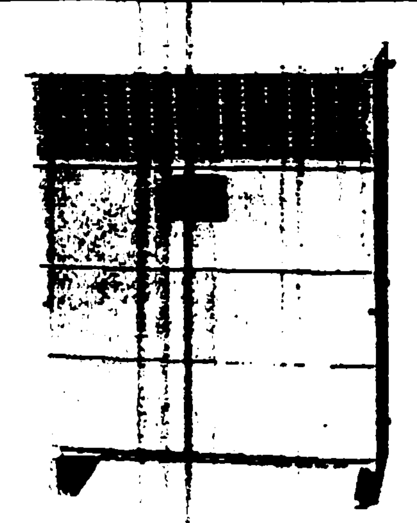
Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

SIEMENS

I-T-E® Dry Type Transformers

Single Phase—150°C Rise



15 TO 167 KVA

HV-240 x 480
LV-120/240

60 HZ

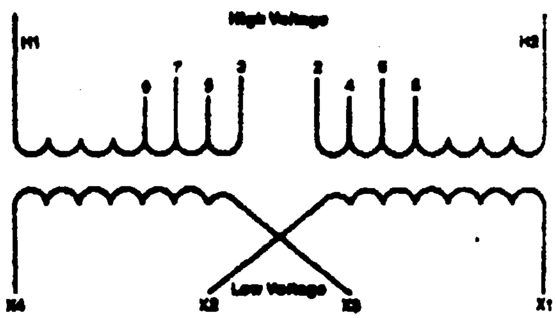
CAT. NO.	KVA 150°C	KVA 115°C	KVA 80°C	TAPS FCAN	TAPS FCBN
1D1Y015ST	15	12	10	2-2½%	4-2½%
1D1Y025ST	25	21	18		
1D1Y037ST	37.5	32.5	28		
1D1Y050ST	50	43	36		
1D1Y075ST	75	65	54		
1D1Y100ST	100	87	72		
1D1Y167ST	167	150	117		

Wiring Diagram

High Voltage
240 x 480

Low Voltage
120/240

Taps
2-2½% FCAN &
4-2½% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 to 3	H1-H2
492	3 to 4	H1-H2
480	4 to 5	H1-H2
468	5 to 6	H1-H2
456	6 to 7	H1-H2
444	7 to 8	H1-H2
432	8 to 9	H1-H2
252	2 to H1, 3 to H2	H1-H2
240	4 to H1, 5 to H2	H1-H2
228	6 to H1, 7 to H2	H1-H2
216	8 to H1, 9 to H2	H1-H2
240	X2 to X3	X1-X4
120	X1 to X3, X2 to X4	X1-X4
240/120	X2 to X3	X1-X2-X4

Specifications

Core and Coil: Wire wound coils on grain-oriented non-aging silicone steel cores. Complete assembly isolated from enclosure through vibration dampening pads.

Insulation: 220°C UL listed insulation system. 150°C maximum temperature rise.

Enclosure: Indoor ventilated heavy gauge steel enclosure with removable front and rear panels. Arranged for standard floor or platform mounting.

Finish: Light gray

Terminals: Wiring compartments located behind removable covers with fully sized terminals arranged to accept installer's cable connectors. Flexible grounding strap provided between core and core assembly and enclosure with stud for system ground connection.

Nameplate: Diagrammatic nameplate includes all rating data and provides wiring diagram with connection point identification.

Standards: UL-506
ANSI-C89.2
NEMA ST-20

UL LISTED

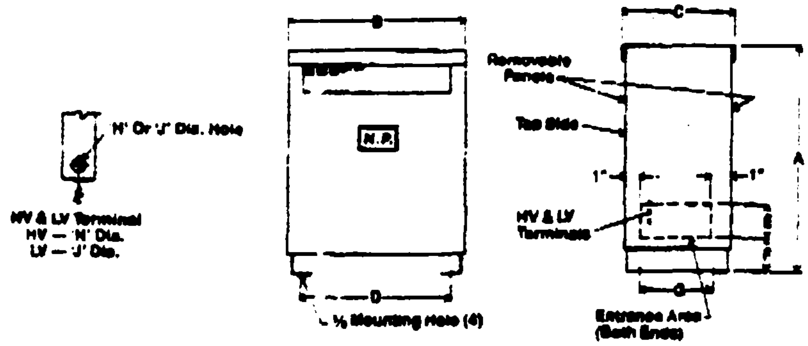
Sound Levels: Transformers are guaranteed to meet the maximum sound level requirements as established by ANSI Standard C89.2 as follows:
15-50 KVA 45 db
51-150 KVA 50 db
151-300 KVA 55 db

...ECT TO CORRECTIONS
... THE PROVISIONS OF
... SPECIFICATIONS.
4
DEC 31 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
Mark E Koenig

Dimensional Data①

Single Phase—150°C Rise

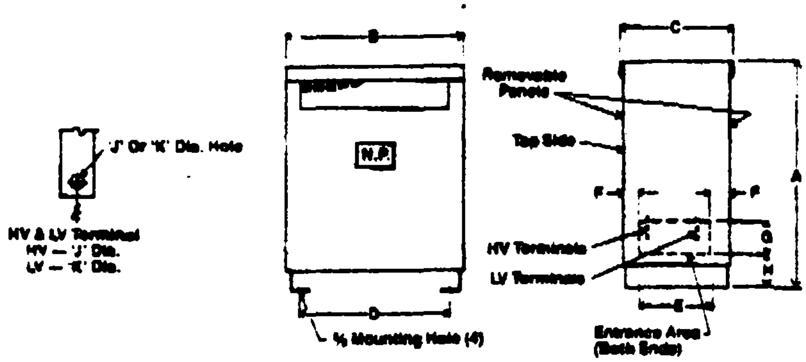
15-50 KVA



KVA	A	B	C	D	E	F	G	H	J	WT.(LBS)
15	27½	16¾	12½	14½	4	2⅝	10	7/16	7/16	145
25	30½	19⅜	12½	17½	4½	2⅝	10	7/16	7/16	205
37½	34½	19⅜	14¼	17½	6¼	2⅝	10	7/16	7/16	285
50	34½	19⅜	14¼	17½	5¾	2⅝	10	7/16	7/16	315

①All dimensions are shown in inches.

75-167 KVA



KVA	A	B	C	D	E	F	G	H	J	K	WT.(LBS)
75	40½	21⅜	16½	19	14	1	8	3	9/16	5/8	430
100	46	22⅜	16½	20	14	1	8	3	9/16	9/16	515
167	50	31⅞	19¾	29½	17¼	1	9	3	9/16	5/8	835

①All dimensions are shown in inches.

...ECT TO CORRECTIONS
... THE PROVISIONS OF
... SPECIFICATIONS.
A
DEC 31 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
Mark E. Koenig

Selection and ordering data

Ordering Information

- To complete Catalog No. replace the two dots (..) with appropriate coil voltage suffix. See Coil Voltage Suffix Table below.
- If a control power transformer is required, replace the two dots (..) with the control transformer **secondary voltage** suffix using the coil voltage suffix table below. Add the appropriate transformer suffix number, found in the starter modifications section, to the end of the catalog number.

Catalog Nos. with "00" suffix (e.g. SCF1B4417_5400P0) indicates that units are priced without overload relay installed. Overload relays should be ordered separately. To order starter with factory installed overload relay, replace the (00) with the appropriate overload relay suffix from the overload relay selection chart found on page 75. Add price of overload to starter to obtain complete list price.

Additional References

- For factory and field modifications refer to page 115.
- For dimension drawings and wiring diagrams refer to Section D.
- When coil is 120 volts or less, unit is wired for separate control, unless CPT is used.
- Contactor type 3TB40–43 includes 1 N.O. auxiliary contact.
- Contactor type 3TB44–56 includes 2 N.O. and 2 N.C. auxiliary contacts.
- Fuses not included.

UL Listed for 100 KA withstand ratings⑤

Max. 3 Phase H.P. Ratings at Motor Voltages									Fuse③ Clip Size Amps/Volts (600V Max.)	NEMA Type 1		NEMA Type 12 & 3R①		NEMA Type 4 Stainless Steel②		NEMA Type 4X Non-Metallic	
Max. H.P.				NEMA Rating				NEMA Size		Catalog No.	List Price Each $	Catalog No.	List Price Each $	Catalog No.	List Price Each $	Catalog No.	List Price Each $
200V	230V	460V	575V	200V	230V	460V	575V										
2	3	5	7.5	1.5	1.5	2	2	00	30A/250V 30A/600V	[illegible] [illegible]	542. 556.	[illegible] [illegible]	710. 724.	[illegible] [illegible]	1,214. 1,228.	[illegible] [illegible]	1,417. 1,431.
3	3	7.5	10						30A/250V 30A/600V	[illegible] [illegible]	577. 591.	[illegible] [illegible]	745. 759.	[illegible] [illegible]	1,249. 1,263.	[illegible] [illegible]	1,627. 1,466.
5	5	10	15	3	3	5	5	0	30A/250V 30A/600V	SCF1B4210_5200P0 SCF1B4210_5200P1	595. 609.	SCF2B4210_5200P0 SCF2B4210_5200P1	763. 777.	SCFSB4210_5200P0 SCFSB4210_5200P1	1,267. 1,281.	SCFXB4210_5200P0 SCFXB4210_5200P1	1,470. 1,484.
7.5	7.5	15	20						30A/250V 30A/600V 60A/250V	SCF1B4310_5200P0 SCF1B4310_5200P1 SCF1B4310_5200P2	605. 619. 619.	SCF2B4310_5200P0 SCF2B4310_5200P1 SCF2B4310_5200P2	773. 787. 787.	SCFSB4310_5200P0 SCFSB4310_5200P1 SCFSB4310_5200P2	1,277. 1,291. 1,291.	SCFXB4310_5200P0 SCFXB4310_5200P1 SCFXB4310_5200P2	1,480. 1,494. 1,494.
10	10	25	25	7.5	7.5	10	10	1	30A/250V 30A/600V 60A/250V 60A/600V	SCF1B4417_5400P0 SCF1B4417_5400P1 SCF1B4417_5400P2 SCF1B4417_5400P3	658. 672. 672. 686.	SCF2B4417_5400P0 SCF2B4417_5400P1 SCF2B4417_5400P2 SCF2B4417_5400P3	826. 840. 840. 854.	SCFSB4417_5400P0 SCFSB4417_5400P1 SCFSB4417_5400P2 SCFSB4417_5400P3	1,330. 1,344. 1,344. 1,358.	SCFXB4417_5400P0 SCFXB4417_5400P1 SCFXB4417_5400P2 SCFXB4417_5400P3	1,533. 1,547. 1,547. 1,561.
15	20	40	50	10	15	25	25	2	60A/250V 60A/600V 100A/250V 100A/600V	SCF1F4617_5800P2 SCF1F4617_5800P3 SCF1F4617_5800P4 SCF1F4617_5800P5	786. 798. 930. 930.	SCF2F4617_5800P2 SCF2F4617_5800P3 SCF2F4617_5800P4 SCF2F4617_5800P5	990. 1,002. 1,134. 1,134.	SCFSF4617_5800P2 SCFSF4617_5800P3 SCFSF4617_5800P4 SCFSF4617_5800P5	1,674. 1,685. 1,818. 1,818.	SCFXF4617_5800P2 SCFXF4617_5800P3 SCFXF4617_5800P4 SCFXF4617_5800P5	1,860. 1,872. 2,004. 2,004.

Rating Definitions

Max. H.P.—Maximum H.P. ratings for which the contactor can be used as tested by Underwriters Laboratory test procedure U.L. 508.

NEMA Rating—Maximum H.P. rating according to the National Electrical Manufacturers Association ICS2 standards.

Coil Voltage Suffix Table

Rated Coil Voltage AC V 50 Hz	Rated Coil Voltage AC V 60 Hz	Catalog No. Suffix (Example) SXL1F4417..5400
24④	24④	[illegible]
110	120	A8
	208	[illegible]
220	240	C8
	277	[illegible]
380	480	D8
	600	[illegible]

Coil Voltage tolerance 85 to 110% of rated voltage.

The ratings in above Table are NEMA standard motor ratings and only apply if the code letter of the motor is the same as shown in the table below or if the code letter is earlier in the alphabet. If the motor code letter occurs later in the alphabet, a larger size contactor or motor starter may be required. Consult the local Siemens sales office.

Motor H.P.-Rating	Max. Allowable Motor Code Letter
1½–2	L
3–5	K
7½ and above	H

Size 0 SCF 1B 4210 A8 5200 P1-08
Size 1 SCF 1B 4417 A8 5400 P1-08
Size 2 SCF 1F 4617 A8 5800 P3-08

①NEMA Type 12 enclosures are UL listed for NEMA Type 3R applications. Water tight hubs or equivalent provisions for water tight connection at the conduit entrance shall be used.

②For NEMA Type 4 painted steel enclosure, replace the 5th digit "S" in the catalog number with "4".

③Rejection type fuse clips are supplied as standard, fuses not included.

④24 volt coil not available on NEMA sizes 4 & 5.

⑤**All starter sizes through 480V are U.L. listed for 100,000 amps withstand ratings as standard. 100KA withstand ratings are available for starters in NEMA 1, 3R, 4 (painted steel or stainless steel) and 12 only.**

Selection and ordering data

Modification Description	24V③	⑤ Catalog Number Suffix	NEMA Enclosure Type	Contactor NEMA Size/List Price Each ($) 00-0 3TB40-43	1 3TB44	2 3TF46	3 3TF47 & 48	4 3TF50-52	5 3TF54-56
Pilot Devices⑥									
On-Off Pushbutton		A1	All	87.	87.	87.	87.	87.	141.
Start-Stop Pushbutton		A	1	87.	87.	87.	87.	—	—
Start-Stop Pushbutton		A	3R,4,4X,12	141.	141.	141.	141.	141.	141.
Forward-Reverse-Off Pushbutton		[illegible]	All	240.	240.	240.	240.	240.	240.
Hand-Off-Auto Selector Switch		C	1	87.	87.	87.	87.	—	—
Hand-Off-Auto Selector Switch		C	3R,4,4X,12	141.	141.	141.	141.	141.	141.
Start-Stop Selector Switch		D	All	141.	141.	141.	141.	141.	141.
Forward-Off-Reverse Selector Switch		E	All	141.	141.	141.	141.	141.	141.
Forward-Reverse Selector Switch		F	All	141.	141.	141.	141.	141.	141.
Pilot Light with Red Lens-"Run" (Does Not Include Electrical Interlock)		G	All	141.	141.	141.	141.	141.	141.
Pilot Light with Green Lens "Off" (Does Include Electrical Interlock)		[illegible]	All	207.	207.	207.	207.	207.	207.
Pilot Light with Red Lens-"Run" (2 Interlocks for Reversing)		[illegible]	All	273.	273.	273.	273.	273.	273.
Prest to Test Pilot Light with Red Lens "Run" (Does Not Include Electrical Interlock)		[illegible]	All	183.	183.	183.	183.	183.	183.
Prest to Test Pilot Light with Green Lens "Off" (Does Include Electrical Interlock)		[illegible]	All	249.	249.	249.	249.	249.	249.
Key Operated Selector Switch (Specify Marking and Key Withdrawal Position)		—	All	168.	168.	168.	168.	168.	168.
Illuminated Selected Switch (Specify Marking)		—	All	222.	222.	222.	222.	222.	222.
Illuminated Pushbutton (Specify Marking)		—	All	222.	222.	222.	222.	222.	222.
Single Oiltight Pushbutton (Specify Marking)		—	All	141.	141.	141.	141.	141.	141.
Overload Relay "Trip" Alarm Light		[illegible]	All	207.	207.	207.	207.	207.	207.
Pilot Light With Red Lens "Off"		M	All	207.	207.	207.	207.	207.	207.
Pilot Light With Green Lens "Run"		N	All	141.	141.	141.	141.	141.	141.
Pilot Light With Green Lens "On"		[illegible]	All	141.	141.	141.	141.	141.	141.
Extra Auxiliary Contact Blocks④									
Factory Installed 1 N.O.		[illegible]	All	—	—	66.	66.	66.	66.
Factory Installed 1 N.O. & 1 N.C.		[illegible]	All	—	—	132.	132.	132.	132.
Factory Installed 2 N.O. & 2 N.C.		[illegible]	All	—	—	264.	264.	264.	264.
Meters									
Ammeter (Includes Current Transformer if necessary)		[illegible]	N1, 12	420.	420.	840.	840.	1,188.	1,188.
Voltmeter		[illegible]	N1, 12	1,188.	1,188.	1,188.	1,188.	1,188.	1,188.
Ammeter with Switch with Three Current Transformers.		Q4	N1, 12	2,220.	2,220.	2,220.	2,220.	2,220.	2,220.
Voltmeter with Switch		Q5	N1, 12	1,800.	1,800.	1,800.	1,800.	1,800.	1,800.
Elapsed Time Meter		Q6	N1, 12	348.	348.	348.	348.	348.	348.
Control Transformer, Standard Capacity									
208/120V with 1-Secondary Fuse①	03	6H	All	162.	162.	228.			
240/120V with 1-Secondary Fuse①	04	07	All	162.	162.	228.			
480/120V with 1-Secondary Fuse①	[illegible]	[illegible]	All	162.	162.	228.			
575/120V with 1-Secondary Fuse①	[illegible]	[illegible]	All	162.	162.	228.			
208/120V With 2-Primary and 1-Secondary Fuse	[illegible]	HP	All	294.	294.	360.	468.	540.	594.
240/120V With 2-Primary and 1-Secondary Fuse	4P	7P	All	294.	294.	360.	468.	540.	594.
480/120V With 2-Primary and 1-Secondary Fuse	[illegible]	[illegible]	All	294.	294.	360.	468.	540.	594.
575/120V With 2-Primary and 1-Secondary Fuse	[illegible]	[illegible]	All	294.	294.	360.	468.	540.	594.
Control Transformer, with Extra Capacity									
With Additional 100VA With 2-Primary and 1-Secondary Fuse	J	J	All	420.	420.	504.	600.	660.	720.
With Additional 150VA With 2-Primary and 1-Secondary Fuse	K	K	All	522.	522.	618.	714.	774.	774.
Non-Standard Single Primary or Secondary Voltage②	—	—	All	30.	30.	30.	30.	30.	30.

Note:

①The standard control transformer supplied for starters NEMA sizes 0 thru 2 will be rated 45 VA and have the appropriate secondary fuse. Primary fuses will not be supplied as standard. For primary fuse option select appropriate suffix from table. According to N.E.C. 430-72, 50-3, and U.L. 508, section 32, primary fuses are not required for control transformers rated less than 50 VA and are inherently protected.

②Specify primary and secondary voltage on order.

③Catalog suffix for 24V secondary control transformers. Same price as 120V secondary control transformers.

④The U S Series Starters NEMA Size 0 & 1 are supplied with 2 N.O. & 2 N.C. auxiliary contacts as standard. This is the maximum number of auxiliary contacts than can be installed on the size 0 & 1. NEMA size 2 thru 5 also come with 2 N.O. & 2 N.C. Auxiliary contacts as standard but an additional 2 N.O. & 2 N.C. auxiliary interlocks can be added for a maximum total of 4 N.O. & 4 N.C. auxiliary contacts.

⑤Modifications not covered by a Catalog No. Suffix should be ordered by description.

⑥Pilot lights are full voltage type as standard. To order transformer type add $12. List and order by description.

SIEMENS

Schütze 3TF46, 3TF47, 3TF48, 3TF50

Contactors
Kontaktorer
Contacteurs
Contactores
Contattori

U_i AC 1000 V
VDE 0660
IEC 158
BS 542

Betriebsanleitung/Instructions

Bestell-Nr./Order No.: GWA 4NEB 526 4592-10

Deutsch

Technische Daten

● Nennbetriebsstrom I_e AC-1 (55 °C)
❷ Max. Motor-Nennleistung (AC-3)
Betätigungsspannung siehe Magnetspule
Arbeitsbereich der Magnetspule 0,8 ... 1,1 × U_s (Standard-ausführung)

● Max. Kurzschlußsicherungen ohne Überlastrelais
(NH-Sicherungen, Betriebsklasse gL)
I Verschweißung gemäß VDE 0660 Klasse „a" zulässig
II Verschweißung gemäß VDE 0660 Klasse „c" zulässig
III Schweißfrei I_k < 100xI_e
IV Schweißfrei I_k ≥ 100xI_e
Kurzschlußsicherungen für Schütz mit Überlastrelais siehe Angaben am Relais. Wert I nach Tabelle ● nicht überschreiten.

Motorschutz durch Überlastrelais 3UA/3UB
Bei Tasterbetätigung der Schütze können auch Überlastrelais mit automatischer Rückstellung verwendet werden. Bei Dauerkontaktgabe nur Überlastrelais mit Handrückstellung verwenden. Hinweis am Relais beachten! Relaisskale auf Motornennstrom einstellen.

English

Technical data

● Rated operating current I_e/AC-1 (55 °C)
❷ Maximum motor output rating (AC-3)
Control voltage marked on coil
Coil operating range: 0.8 to 1.1 × U_s (standard arrangement)

● Maximum fuse ratings without overload relay
(HRC fuses, duty class gL)
I Permissible contact welding according to VDE 0660 class "a"
II Permissible contact welding according to VDE 0660 class "c"
III No contact welding I_k < 100xI_e
IV No contact welding I_k ≥ 100xI_e
Fuse ratings for contactors with overload relay are specified on the relay. Value I to table ● must not be exceeded.

Motor protection by overload relay 3UA/3UB
A self-reset relay should be used for momentary-contact controlled contactors and a hand reset relay for maintained-contact controlled contactors. Reference should be made to the note on the relay. Set relay scale to the motor rating.

Svenska

Tekniska data

● Märkdriftström I_e/AC-1 (55 °C)
● Max. nominell motoreffekt (AC-3)
Manöverspänning se Magnetspole
Magnetspolens arbetsområde: 0,8...1,1 × U_s (Standardutförande)

● Max. kortslutningssäkringar utan överlastrelä
(knivsäkringar, driftklass gL)
I Svets enl. VDE 0660 Klass "a" tillåtlig
II Svets enl. VDE 0660 Klass "c" tillåtlig
III Utan svetsning I_k < 100xI_e
IV svetsfri I_k ≥ 100xI_e
Kortslutningssäkringar for kontaktor med överlastrelä, se uppgifter på reläet. Värde I i Tabell ● får ej överskridas.

Motorskydd genom överlastrelä 3UA/3UB
Vid tangentmanövrering av kontaktorerna kan man också använda överlastreläer med automatisk återställning. Vid kontinuerlig kontaktgivning används bara överlastreläer med manuell återställning. Ge akt på anvisningen på reläet! Ställ in reläskalan på motorns märkström.

Français

Caractéristiques techniques

● Courant nominal d'emploi I_e AC-1 (55 °C)
● Puissance nominale max. des moteurs (AC-3)
Tension de commande: voir bobine
Domaine d'action des bobines 0,8 à 1,1 × U_s (Version standard)

❷ Calibre max. de fusible pour contacteurs sans relais de surcharge
(cartouches NH, classe de service gL)
I Soudure des contacts selon VDE 0660 classe «a», admissible
II Soudure des contacts selon VDE 0660 classe «c», admissible
III Sans soudure des contacts I_k < 100xI_e
IV sans soudure des contacts I_k ≥ 100xI_e
Calibre des fusibles pour contacteurs avec relais de surcharge, se référer aux indications figurant sur le relais, ne pas dépasser les valeurs I du tableau ●

Protection thermique de moteur par relais de surcharge 3UA/3UB
Lorsque les contacteurs sont commandés par impulsions, on peut utiliser aussi des relais à réarmement automatique. Pour les contacteurs à commande maintenue utiliser que des relais de surcharge à réarmement manuel. Respecter les indications figurant sur le relais. Regler l'échelle du relais sur le courant nominal du moteur.

Español

Datos técnicos

● Intensidad nominal de servicio I_e 1 c.a. (55 °C)
● Potencia nominal max. del motor (3 c.a.)
Tensión de excitación: véase la bobina
Margen de operación de la bobina 0,8 ... 1,1 × U_s
(Ejecución estándar)

❷ Fusible max. de protección contra cortocircuitos sin relé de sobrecarga
(fusibles NH, clase de servicio gL)
I Admisible la soldadura de la clase "a" según VDE 0660
II Admisible la soldadura de la clase "c" según VDE 0660
III Sin soldadura I_k < 100xI_e
IV sin soldadura I_k ≥ 100xI_e
Para los fusibles de protección contra cortocircuito del contactor con relé de sobrecarga, véanse las indicaciones en el relé, no sobrepasar el valor I según la tabla ❶

Protección del motor mediante de relé de sobrecarga 3UA/3UB
Si los contactores se accionan con pulsadores, se pueden usar relés de sobrecarga con reposición automática. Si el contacto es permanente, el relé de sobrecarga se repondrá a mano. Observar las indicaciones en el relé ajustar su escala a la intensidad nominal del motor.

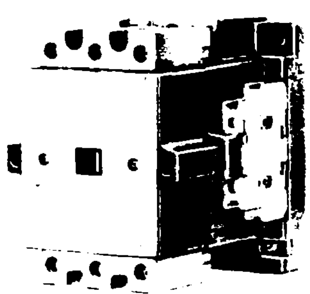
Italiano

Dati tecnici

● Corrente nominale d'impiego I_e/AC-1 (55 °C)
● Potenza nominale massima dei motori (AC-3)
Tensione di comando: v. bobina
Campo di lavoro della bobina: 0,8 ÷ 1,1 × U_s
(Esecuzione standard)

● Protezione contro corti circuiti dei contattori senza relè di sovraccarico
Cartucce NH, classe di funzionamento gL
I saldatura dei contatti ammissibile sec. VDE 0660 classe «a»
II saldatura dei contatti ammissibile sec. VDE 0660 classe «c»
III nessuna saldatura dei contatti I_k < 100xI_e
IV nessuna saldatura dei contatti I_k ≥ 100xI_e
Le cartucce da impiegare per la protezione contro corti circuiti dei contattori con relè di sovraccarico sono indicate sul relè, il valore I sec. tabella ● non dev'essere sorpassato.

Protezione del motore mediante relè di sovraccarico 3UA/3UB
Per contattori con circuito di comando ad impulso si possono impiegare anche relè con ripristino automatico, con circuito di comando a contatto permanente, solo relay con reset manuale. V. istruzione sul relè! Aggiustare la scala del relè sulla corrente nominale del motore.



	●	❷ 220 V	240 V	380 V	415 V	500 V	660 V	1000 V	I	● II	III	IV
3TF46	[illegible] A	[illegible] kW [illegible] hp	15 kW 20 hp	22 kW 29 hp	25 kW 33 hp	30 kW 40 hp	39 kW 52 hp	–	160 A	100 A	50 A	63 A
3TF47	[illegible] A	[illegible] kW 24 hp	20 kW 27 hp	30 kW 40 hp	34 kW 45 hp	41 kW 55 hp	55 kW 74 hp	–	160 A	125 A	63 A	80 A
3TF48	[illegible] A	22 kW 29 [illegible]	24 kW 32 hp	37 kW 49 hp	42 kW 56 hp	50 kW 67 hp	67 kW 89 hp	39 kW 52 hp	250 A	160 A	100 A	125 A
3TF50	[illegible] A	37 kW 49 hp	37 kW 49 hp	55 kW 73 hp	63 kW 84 hp	76 kW 101 hp	100 kW 134 hp	55 kW 73 hp	315 A	250 A	160 A	200 A

Deutsch

Montage

● Zulassige Einbaulage – Spulenanschluß oben
Bei 90°-Drehung treten Reduzierungen der Schalthäufigkeit und der mechanischen Lebensdauer auf (siehe Katalog NS 2)

Schraubbefestigung auf planer, vertikaler Befestigungsebene mit 2 Schrauben. Schrauben mit Scheiben und Federringen sichern.
● Befestigungsschrauben
● Max. Anziehdrehmoment
Bei Verschmutzungsgefahr, starkem Staubanfall oder aggressiver Atmosphare Schutz in Gehause einbauen

Anschlußquerschnitte für Schutze ohne Uberlastrelais (mit Uberlastrelais siehe Betriebsanleitung des Uberlastrelais). Anschluß von zwei Leitern moglich

Hauptleiter
● feindrahtig / feindrahtig mit Aderendhulse
● mehrdrahtig / eindrahtig
● Abisolierlange
● Anziehdrehmoment

Hilfsleiter
● eindrahtig
● feindrahtig mit Aderendhulse
● Anschlußschrauben
● Anziehdrehmoment

Anschließen der Hauptleiter
3TF46, 3TF47, 3TF48, 3TF50: Anschluß mit Rahmenklemmen
● 3TF50: Um das Anschließen starkerer Leiter zu erleichtern ist die Klemme teilbar
a) Teil 2 durch leichten Druck nach vorne von Teil 1 losen
b) Leiter von der Seite einlegen
c) Teil 2 seitlich in Teil 1 einsetzen und mit leichtem Druck nach hinten einrasten. Klemmenschrauben festziehen
Die Klemmen beim 3TF50 ist fur den Anschluß von Kabelschuhen oder Anschlußschienen abnehmbar

English

Installation

● Permissible mounting position – Coil connection at the top
If the contactor is turned through 90°, its permissible switching frequency and mechanical life will be reduced (see Cat. NS 2)

Screw mounting on flat vertical surface with two screws. Always secure with plain and spring washers.
● Fixing screws
● Max. tightening torque
Fit contactor inside a housing if it is exposed to contamination, dust or an aggressive atmosphere

Conductor sizes for contactors without overload relay (for contactors with overload relay see relay operating instructions). Connection of two conductors possible.

Main conductors
● Finely stranded / finely stranded with end sleeve
● Stranded / solid
● Stripped length
● Tightening torque

Auxiliary conductors
● Solid conductor
● Finely stranded with end sleeve
● Terminal screws
● Tightening torque

Connection of main conductors
3TF46, 3TF47, 3TF48, 3TF50: Connection with box terminals
● 3TF50: To facilitate the connection of conductors with larger cross-section, the terminal can be divided:
a) Apply slight pressure to pull off part 2 from part 1.
b) Insert conductor from the side.
c) Insert part 2 laterally in part 1 and apply slight pressure to push it into position. Tighten terminal screws
The terminals of 3TF50 can be removed to connect cable lugs or terminals bars

Svenska

Montering

● Tillatet monteringslage – spolanslutning uppat
Vid 90° vridning reduceras kopplingsfrekvensen och den mekaniska livslangden (se Katalog NS 2)

Skruvfaste med 2 skruvar pa plan, vertikal yta. Sakra skruvar na med bricka och fjaderbricka
● Fastskruvar
● Max. atdragningsmoment
Bygg in kontaktorn i en kapa vid risk for nedsmutsning, dammanhopning eller aggressiv miljo

Anslutningsareor for kontaktorer utan overlastrela (med overlastrela se driftsinstruktionen for overlastrelaet), 2 ledare kan anslutas

Huvudledare
● Fintradig / fintradig med tradandhylsa
● Flertradig / entradig
● Anslutningsskenor
● Atdragningsmoment

Hjälpledare
● entradig
● Fintradig med tradandhylsa
● Anslutningsskruvar
● Atdragningsmoment

Anslutning av huvudledarna
3TF46, 3TF47, 3TF48, 3TF50: anslutning med andtorslutning
● 3TF50: For att underlatta anslutning av kraftigare ledare ar klamman delbar
a) Lossa Del 2 fran Del 1 genom att forsiktigt trycka den framat
b) Lagg i ledaren fran sidan.
c) Satt i Del 2 i Del 1 fran sidan och snapp fast den med ett latt tryck bakat. Dra at kontaktskruvarna
Klammorna pa 3TF50 kan anvandas för anslutning av kabelskor eller anslutningsskenor.

Français

Montage

● Position de montage admissible: bornes de la bobine en haut
Une inclinaison de 90° par rapport a la verticale entraine une reduction de la frequence de manœuvre et de l'endurance mecanique (voir catalogue NS 2)

Fixation par 2 vis sur surface plane et verticale. Freiner les vis au moyen de rondelles plates et de rondelles Grower
● Vis de fixation
● Couple de serrage max
S'il y a risque d'encrassement, production importante de poussière ou presence d'atmosphere corrosive, monter le contacteur dans un boitier

Section des conducteurs pour contacteurs sans relais de surcharge (pour les contacteurs avec relais de surcharge, voir instructions de service du relais de surcharge). Possibilite de raccordement de deux conducteurs

Conducteurs principaux
● âme souple / âme souple avec embout
● âme rigide cablee / massive
● longueur denudee
● couple de serrage

Conducteurs auxiliaires
● ame massive
● ame souple avec embout
● vis de serrage
● couple de serrage

Raccordement des conducteurs principaux
3TF46, 3TF47, 3TF48, 3TF50: bornes a cage
● 3TF50: les bornes peuvent etre demontees pour faciliter le raccordement de conducteurs plus epais
a) détacher la partie 2 par legere pression vers l'avant.
b) introduire le conducteur par le côte
c) réintroduire la partie 2 dans la partie 1 et l'encliqueter par legere pression vers l'arriere. Serrer les vis
Sur 3TF50 les bornes peuvent être retirees pour permettre le raccordement par cosses ou barrettes

Español

Montaje

● Posicion admisible de montaje: Terminales de la bobina en la parte superior
En caso de girar en 90°, se reduce la frecuencia de maniobra y la vida mecanica (vease el catalogo NS 2)

Fijación con 2 tornillos a una superficie plana y vertical. Los tornillos se inmovilizan con arandelas planas y elasticas
● Tornillos de fijación
● Máx. par de apriete
Si existe peligro de ensuciamiento, abundante desprendimiento de polvo o atmosfera agresiva, montar el contactor en una caja

Secciones de conexion para contactores sin relais de sobrecarga (si se monta relais de sobrecarga, veanse sus instrucciones de servicio), es posible conectar dos conductores

Conductores activos
● Flexibles / flexibles con vaina terminal
● Multifilares / monofilares
● longitud sin aislamiento
● Par de apriete

Conductores auxiliares
● monofilares
● Flexibles con vaina terminal
● Tornillos de conexion
● Par de apriete

Conexion de los conductores activos
3TF46, 3TF47, 3TF48, 3TF50: Conexion con bornes de brida
● 3TF50: Para facilitar la conexion de conductores de mayor seccion, el borne se puede dividir
a) Soltar la pieza 2 de la pieza 1 presionado ligeramente hacia adelante
b) Colocar el conductor lateralmente
c) Colocar lateralmente la pieza 2 en la 1 y encajarla ejerciendo una ligera presion hacia atras. Apretar los tornillos
Los bornes de 3TF50 son desmontables para conectar terminals de los cables o las barras

Italiano

Montaggio

● Posizione di montaggio: con l'attacco della bobina in alto. Se il contattore viene ruotato di 90° puo verificarsi una riduzione del numero di manovre e della durata meccanica dell'apparecchio (v. anche catalogo NS 2)

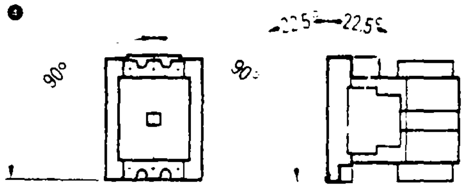
Fissaggio su superficie piana verticale con 2 viti (da assicurare con una rondella semplice ed una elastica)
● Viti di fissaggio
● Massima coppia di serraggio
In presenza di sudiciume, polverosita elevata o atmosfera aggressiva usare un contattore con custodia

Sezioni dei conduttori per contattori senza relè di sovraccarico (per contattori con relè di sovraccarico si vedano le istruzioni per l'uso del relè di sovraccarico). Si possono collegare due conduttori

Conduttori principali
● a corda flessibile / a corda flessibile con puntalino
● a corda rigida / a filo unico
● Lunghezza di spelatura
● coppia di serraggio

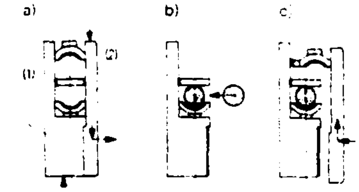
Conduttori ausiliari
● a filo unico
● a corda flessibile con puntalino
● viti di attacco
● coppia di serraggio

Collegamento dei conduttori principali
3TF46, 3TF47, 3TF48, 3TF50: collegare con morsetti passanti
● 3TF50: per collegare conduttori di diametro maggiore il morsetto può essere suddiviso
a) premendo leggermente in avanti si stacca la parte 2 dalla parte 1
b) inserire il conduttore da un lato
c) rimettere la parte 2 lateralmente nella parte 1 e fissarla a scatto spingendo indietro
Avvitare le viti del morsetto
I morsetti del tipo 3TF50 possono essere tolti per collegare delle capacorda o sbarra collettrici

●


	●	● Nm
3TF46	M4	3,1
3TF47	M4	3,1
3TF48	M5	6,2
3TF50	M6	10,5

	● mm²	● mm²	● mm	● Nm	● mm²	● mm²	●	● Nm
3TF46								
3TF47	4...25	6...35	16	3...4,5	1...2,5	0,75...1,5	M3,5	0,8...1,4
3TF48								
3TF50	25...50	25...70	22	4...5				

● a) b) c)


Wartung

Staubablagerungen entfernen (absaugen).
Dunkel verfärbte, rauhe Schaltstücke sind funktionsfähig, nicht nacharbeiten oder fetten. Schaltstücke auswechseln, wenn die Kontaktauflagen so weit abgebrannt sind, daß das Material des Trägers teilweise sichtbar wird. Bei unterschiedlichem Abbrand ist es zulässig, einzelne Schaltstücke auszutauschen.
Nach Kurzschluß in der Anlage Hauptschaltstücke überprüfen und verschweißte Schaltstücke mit Schraubendreher trennen. Beschädigte Lichtbogenkammer austauschen!

Austausch der Hauptschaltstucke

Bewegliches Schaltstück: Schaltstück anheben, drehen und herausziehen. Neues Schaltstück einschieben bis der Brückenhalter mittig einrastet. Auf leichte Beweglichkeit in Einschaltrichtung des Schützes achten.
Festes Schaltstück: Befestigungsschraube mit Schlitz-Schraubendreher lösen. Schaltstück samt Befestigungsschraube auswechseln, neues Schaltstuck fest anschrauben.

Austausch der Hilfsschalter

Am Schütz sind zwei Hilfsschalterblöcke mit jeweils 1S + 1Ö oder 2S + 2Ö vorhanden. Bei Bedarf Hilfsschalterblock austauschen.
6 Beim Abbau Klinke im schwarzen Feld betätigen (siehe Pfeil).
Jeder Hilfsschalterblock 1S + 1Ö kann durch Hinzufügen eines weiteren Hilfsschalterblocks 1S + 1Ö auf 2S + 2Ö erweitert werden.
Hilfsschalterblöcke symmetrisch anbauen, da ein unsymmetrischer Anbau zu Störungen führen kann.

Austausch der Lichtbogenkammer

Lösen der Schnellbefestigung:
Die 2 Bolzen mit Schraubendreher hineindrücken und um 90 nach links drehen. Die Lichtbogenkammer kann abgenommen werden.
Befestigung: Lichtbogenkammer aufsetzen; die 2 Bolzen bis zum Anschlag hineindrücken und um 90 nach rechts drehen; darauf achten, daß die Bolzen einrasten.
Bei abgenommener Lichtbogenkammer ist das Schütz mechanisch verriegelt. Spulenerregung ist in diesem Zustand unzulässig.

Maintenance

Remove dust by suction.
Discoloured and rough contacts are still serviceable and should not be dressed or greased. Replace contacts whose contact pieces have eroded so much that their supports can be seen. In the case of non-uniform erosion it is permissible to replace individual contact pieces.
Check main contacts after a short-circuit has occurred and separate welded contacts with a screwdriver. Replace damaged arc chute.

Replacement of main contacts

Moving contact: Lift, turn and pull out the contact. Insert a new contact up to the point where the contact holder latches in. Make sure that the contact can move easily in the closing direction.
Fixed contact: Loosen the fixing screw with a slotted screwdriver. Remove the contact together with the fixing screw. Fit new contact and tighten firmly into position.

Replacement of auxiliary contact blocks

The contactor is provided with two auxiliary contact blocks each with 1 NO and 1 NC contact or 2 NO and 2 NC contacts. If necessary, replace the complete auxiliary contact block.
6 For replacement, actuate the pawl in the black field (see arrow).
Each auxiliary contact block with 1 NO + 1 NC contact can be extended by adding another block so that 2 NO and 2 NC contacts are obtained.
Fit the auxiliary contact blocks symmetrically as otherwise faults will occur.

Replacement of arc chute

Undoing the quick fastening device:
Push in the two pins with a screwdriver and turn them to the left through 90. The arc chute can now be detached.
Fixing: Fit the arc chute; push in the two pins as far as they will go, turn them through 90, and ensure that they engage.
When the arc chute is removed, the contactor is mechanically interlocked. Coil excitation not permitted under these conditions.

Underhall

Avlägsna dammavlagringar (dammsug).
Kontaktstycken som mörknat skall ej slipas eller fettas in ut dem när kontaktytorna slitits ned så långt att man kan se materialet i hållarna. Vid olikmot slitage kan man byta enstaka kontaktstycken.
Efter kortslutning i systemet skall huvudkontaktstyckena kontrolleras och svetsade kontaktstycken skiljas åt med skruvmejsel. Byt ut skadade ljusbågekammare.

Byte av huvudkontaktstyckena

Rörligt kontaktstycke: lyft kontaktstycket, vrid och dra ut. Skjut in ett nytt stycke så långt att bygeln snapper fast i mitten. Kontrollera att kopplingsmekanismen rör sig lätt obehindrat.
Fast kontaktstycke: Lossa fastskruven med en 4 mm insexnyckel, byt kontaktstycke med fastskruv och skruva fast nya stycket.

Byte av hjälpkontakter

På kontaktorn finns två hjälpkontaktblock med vardera 1S 1Ö eller 2S + 2Ö. Dessa skall vid behov bytas ut.
6 Tryck på klinkan i det svarta fältet vid nedmontering (se pil).
Varje hjälpkontaktblock med 1S + 1Ö kan utvidgas till 2S 2Ö genom tillägg av ytterligare ett block 1S + 1Ö. Monteras blocken symmetriskt, eftersom osymmetrisk montering kan förorsaka störningar.

Byte av ljusbågekammare

Lossa snabbfästet på följande sätt:
Tryck in de båda stiften med skruvmejsel och vrid dem 90 mot vänster. Nu kan ljusbågekammaren tas av.
Fastsättning: Sätt på ljusbågekammaren, tryck in de båda stiften så långt det går och vrid 90 mot höger. Se till att stiften snäpper fast.
När ljusbågekammaren är avtagen är kontaktorn mekaniskt reglad. I detta läge får man ej magnetisera spolen.

Français

Entretien

Eliminer les dépôts de poussière à l'aspirateur.
Les contacts noircis ou rugueux ne gênent pas le fonctionnement; ne pas les retoucher ni les graisser. Remplacer les contacts lorsque leur revêtement est usé au point de laisser apparaître le matériau du porte-contact. En cas d'usure inégale, il est permis de ne remplacer que certains contacts.
Après un déclenchement sur un court-circuit, vérifier les contacts principaux et séparer les contacts soudés avec un tournevis. Remplacer les chambres de soufflage endommagées.

Remplacement des contacts principaux

Contact mobile: soulever le contact, le tourner et le sortir. Introduire le nouveau contact jusqu'à ce que l'étrier s'encliquette en position médiane. Vérifier la mobilité des contacts dans le sens de la fermeture.
Contact fixe: desserrer la vis de fixation à l'aide d'un tournevis. Remplacer le contact et sa vis de fixation. Bien visser le nouveau contact.

Remplacement des blocs de contacts auxiliaires

Le contacteur est muni de deux blocs de contacts auxiliaires comportant chacun 1 NC + 1 NS ou 2 NC + 2 NS. Remplacer les blocs de contacts auxiliaires lorsque cela s'avère nécessaire.
6 Avant la dépose, manœuvrer le levier dans la zone noire (voir flèche).
Les blocs de contacts auxiliaires 1 NO + 1 NF peuvent être complétés d'un second bloc de contacts auxiliaires 1 NO + 1 NF pour obtenir un bloc de contacts auxiliaires 2 NO + 2 NF.
Monter les blocs de manière symétrique. Un montage non symétrique peut provoquer des perturbations.

Remplacement de la chambre de soufflage

Desserrage de la fixation rapide:
enfoncer les deux tiges de fixation à l'aide d'un tournevis et les tourner de 90 vers la gauche. La chambre de soufflage peut maintenant être enlevée.
Fixation: mettre en place la chambre de soufflage; enfoncer les deux tiges jusqu'à leur butée et les tourner de 90 vers la droite. S'assurer que les tiges s'encliquettent.
Lorsque la chambre de soufflage est enlevée, le contacteur est verrouillé mécaniquement. Toute alimentation de la bobine est alors inadmissible.

Español

Mantenimiento

Quitar los sedimentos de polvo (¡aspirarlos!).
Las piezas de conexión rugosas y oscurecidas están en condiciones de funcionamiento, no repasarlas ni engrasarlas. Cambiar las piezas de conexión cuando las superficies de contacto se hayan desgastado por quemadura hasta tal punto que se vea en parte el material de base. Si el desgaste por quemadura no fuera uniforme, sería admisible recambiar piezas de conexión individuales.
Después de que haya habido un cortocircuito en la instalación, comprobar las piezas de conexión principales y, si se han soldado, separarlas con un destornillador. ¡Las cámaras de extinción deterioradas deben recambiarse!

Recambio de los contactos principales

Contacto móvil: Levantar el contacto, girarlo y extraerlo. Introducir el nuevo hasta que el puente enganche en el centro. ¡Observar la libre movilidad en el sentido de conexión del contactor!
Contacto fijo: Soltar el tornillo de fijación con un destornillador, recambiar el contacto inclusive tornillo y fijar el nuevo.

Recambio de los contactos auxiliares

El contactor lleva dos bloques de contactos auxiliares con 1 NA + 1 NC o 2 NA y 2 NC. Cuando sea preciso, recambiar el bloque.
6 Para desmontar, actuar sobre el resorte de la parte negra (véase flecha).
Todos los bloques de contactos auxiliares 1 NA y 1 NC se pueden ampliar a 2 NA y 2 NC incorporando otro bloque de contactos auxiliares con 1 NA y 1 NC.
Los bloques de contactos auxiliares se montarán de forma simétrica puesto que si no se observa la simetría podrían surgir perturbaciones.

Recambio de las cámaras de extinción

Soltar la fijación por resorte:
Con un destornillador introducir los 2 pernos y girar a uzquierdas 90. La cámara de extinción puede entonces quitarse.
Fijación: Colocar la cámara de extinción; empujar hacia adentro los 2 pernos hasta el tope y girarlos a derechas 90, cuidando de que se encajen.
Cuando esta desmontada la cámara de extinción, el contactor queda enclavado mecanicamente. En este estado es inadmisible excitar la bobina.

Italiano

Manutenzione

Togliere eventuali depositi di polvere con l'aspirapolvere.
Contatti anneriti o ruvidi sono ugualmente efficienti; non ripassarli od ingrassarli. Sostituire i contatti se la loro superficie è talmente consumata da rendere visibile in parte il materiale di supporto. In caso di consumo differente è permesso sostituire solo alcuni.
Dopo ogni disinserzione in cortocircuito, controllare i contatti principali e, all'occorrenza, separarli con un cacciavite; sostituiscano le camere spegniarco danneggiate.

Sostituzione dei contatti principali

Contatto mobile: sollevare, ruotare e sfilare il contatto. Inserire il contatto nuovo e premere finché la staffa di serraggio s'innesti a scatto nel mezzo. Fare attenzione che il contatto si muovi liberamente nella direzione di chiusura del contattore.
Contatto fisso: svitare la vite di fissaggio con un cacciavite. Sostituire il contatto assieme alla vite e riavvitare il nuovo contatto.

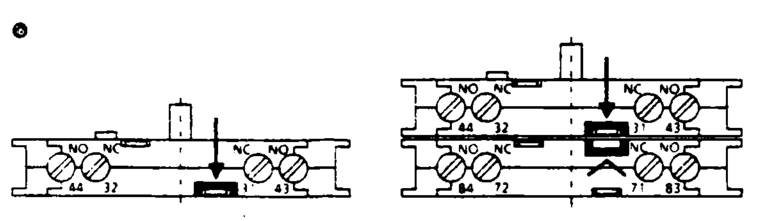
Sostituzione dei contatti ausiliari

Il contattore è provvisto di due blocchetti di contatti ausiliari ciascuno con 1 L + 1 R opp. 2 L + 2 R. Sostituire il blocchetto se necessario.
6 Per togliere i blocchetti azionare la leva sul pannello nero (v. freccia).
Ogni blocchetto 1 L + 1 R può essere ampliato (2 L + 2 R) aggiungendo un blocchetto da 1 L + 1 R.
I blocchetti dei contatti ausiliari devono essere assemblati simmetricamente da evitare anomalie.

Sostituzione della camera spegniarco

Disfare il fissaggio:
con un cacciavite premere indietro i 2 bulloni e ruotarli 90 in senso sinistrorso. La camera spegniarco può essere tolta.
Fissaggio: riapplicare la camera spegniarco; reinserire i 2 bulloni fino all'arresto e ruotarli di 90 in senso destrorso. Si faccia attenzione che i bulloni s'innestino. Con la camera spegniarco tolta il contattore è bloccato meccanicamente. In questa condizione la bobina non dev'essere eccitata.

6



Spulenaustausch
● 3TF46, 3TF47: Die zwei Befestigungsschrauben (1) für die Bodenplatte (5) lösen. Schutzsockel (2) nach oben abheben. Spule (3) mit Anschluß (4) herausnehmen. Neue Spule mit Anschluß in die Aussparungen der Bodenplatte einlegen. Schutzsockel (2) wieder aufsetzen und die Bodenplatte (5) festschrauben.
● 3TF48, 3TF50: Die Befestigungsschrauben (1) für das Bodenblech (4) lösen. Schutzsockel (2) nach oben abheben. Spule (3) austauschen. Schutzsockel wieder aufsetzen und das Bodenblech festschrauben.

Ersatzteile
● Hauptschaltglieder
● Lichtbogenkammer
● Spule
● Hilfsschalterblock 1S + 1Ö links
● Hilfsschalterblock 1S + 1Ö rechts
● ● Angaben in der zweiten Zeile für Erweiterungsblock 1S + 1Ö

Replacement of coil
● 3TF46, 3TF47: Remove the two fixing screws (1) from the baseplate (5). Lift off the contactor base (2). Take out the coil (3) together with the terminal connection (4). Fit a new coil with terminal in the cutouts in the baseplate. Refit contactor base (2) and firmly bolt on the baseplate (5).
● 3TF48, 3TF50: Remove the fixing screws (1) of the baseplate (4). Lift off the contactor base (2). Replace coil (3). Refit the contactor base and screw down the baseplate.

Spare parts
● Main contacts
● Arc chute
● Coil
● Auxiliary contact block with 1 NO and 1 NC, left
● Auxiliary contact block with 1 NO and 1 NC, right
● ● Data in the second line for extension block with 1 NO and 1 NC

Spolbyte
● 3TF46, 3TF47: Lossa de båda fästskruvarna (1) för bottenplattan (5). Lyft av kontaktorsockeln (2) uppåt. Ta ut spolen (3) med kontaktplat (4). Lägg in en ny spole med kontaktplåt urtagen i bottenplattan. Sätt åter på kontaktorsockeln (2) och skruva fast bottenplattan (5).
● 3TF48, 3TF50: Lossa fästskruvarna (1) för bottenplattan (4). Lyft av kontaktorsockeln (2) uppåt. Byt spole (3). Sätt åter på kontaktorsockeln och skruva fast bottenplattan.

Reservdelar
● Huvudkontaktstycken
● Ljusbågekammare
● Spole
● Hjälpkontaktblock 1S + 1Ö vänster
● Hjälpkontaktblock 1S + 1Ö höger
● ● Uppgifter på andra raden för kompletteringsblock 1S + 1Ö

Français

Remplacement de la bobine
● 3TF46, 3TF47: desserrer les deux vis de fixation (1) de la plaque de base (5). Soulever le socle (2) du contacteur. Retirer la bobine (3) avec ses bornes (4). Disposer la nouvelle bobine avec ses bornes dans l'évidement de la place de base. Remettre en place le socle (2) du contacteur et revisser la plaque de base (5).
● 3TF48, 3TF50: desserrer les vis de fixation (1) de la tôle de fond (4). Soulever le socle (2) du contacteur. Remplacer la bobine (3). Remettre en place le socle du contacteur et revisser la tôle de fond.

Pièces de rechange
● Contacts principaux
● Chambre de soufflage
● Bobine
● Bloc de contacts auxiliaires 1 NO + 1 NF de gauche
● Bloc de contacts auxiliaires 1 NO + 1 NF de droite
● ● deuxième ligne: bloc 1 NO + 1 NF d'extension

Español

Recambio de la bobina
● 3TF46, 3TF47: Soltar los dos tornillos de fijación (1) para la placa de base (5). Levantar el zócalo del contactor (2). Sacar la bobina (3) con sus terminales (4). Colocar en el alojamiento de la placa de base la nueva bobina con sus terminales. Volver a montar el zócalo del contactor (2) y atornillar la placa de base (5).
● 3TF48, 3TF50: Soltar los tornillos de fijación (1) para la chapa de base (4). Levantar el zócalo del contactor (2). Cambiar la bobina (3). Volver a colocar el zócalo del contactor y atornillar la chapa de base.

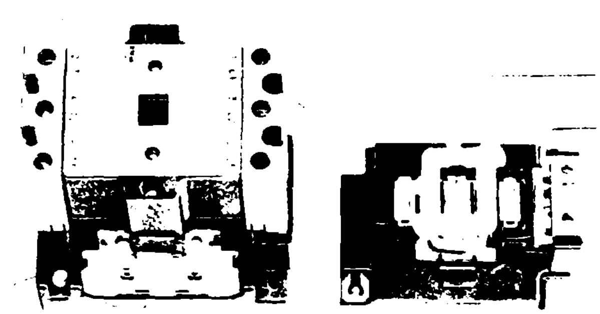
Piezas de repuesto
● Contactos principales
● Cámara de extinción
● Bobina
● Bloque de contactos auxiliares 1 NA + 1 NC, a la izquierda
● Bloque de contactos auxiliares 1 NA + 1 NC, a la derecha
● ● Indicaciones en la segunda línea para bloque de ampliación 1 NA + 1 NC

Italiano

Sostituzione della bobina
● 3TF46, 3TF47: staccare le 2 viti di fissaggio (1) dalla piastra base (5) e sfilare lo zoccolo del contattore (2) verso l'alto. Togliere la bobina (3) assieme all'attacco (4). Rimettere la bobina nuova con attacco nelle incavature della piastra base. Riapplicare lo zoccolo (2) della bobina (5) e riavvitare la piastra.
● 3TF48, 3TF50: togliere le viti di fissaggio (1) dalla piastra base (4). Sfilare lo zoccolo del contattore (2) verso l'alto. Sostituire la bobina (3). Riapplicare lo zoccolo del contattore e riavvitare la piastra base.

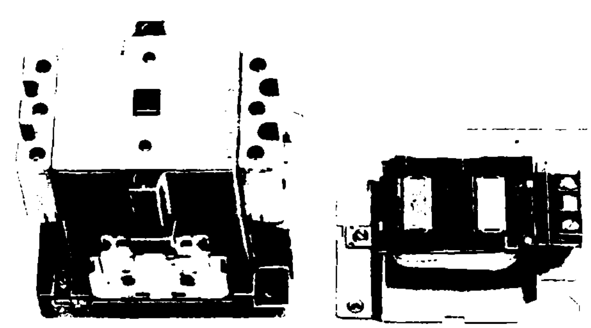
Pezzi di ricambio
● Contatti principali
● Camera spegniarco
● Bobina
● Blocchetto contatti ausiliari (1 L + 2 R), sinistro
● Blocchetto contatti ausiliari (1 L + 1 R), destro
● ● Avvertenze nella 2ª riga per un blocchetto di ampliamento (1 L + 1 R)

●



(1) (2) (5) (3) (4)

●



(1) (2) (4) (3)

	●	●	●	●	●
3TF46	3TY7460-0A	3TY746[illegible]-0A	3TY7463-0A	3TY7561-1A 3TY7561-1K	3TY7561-1B 3TY7561-1L
3TF47	3TY7470-0A	3TY747[illegible]-0A			
3TF48	3TY7480-0A	3TY748[illegible]-0A	3TY7483-0A		
3TF50	3TY7500-0A	3TY750[illegible]-0A	3TY7503-0A		

Deutsch

Schaltpläne
Klemmenbezeichnung nach EN 50012
● mit Hilfsschalter 2S + 2O
● mit Hilfsschalter 4S + 4O
● Tasterbetätigung
● Dauerkontaktgabe
● **Lage der Anschlußstellen**

● **Maßbilder** (mm)
● Typ/Größe
¹) Mindestabstand von isolierten Bauteilen 3 mm
von geerdeten Bauteilen 10 mm

English

Circuit diagrams
Terminal designation to EN 50012
● with 2 NO and 2 NC contacts
● with 4 NO and 4 NC contacts
● Momentary-contact operated
● Maintained-contact operated
● **Location of terminals**

● **Dimension drawings** (mm)
● Type/Size
¹) Minimum distance isolated parts: 3 mm
earthed parts 10 mm

Svenska

Kopplingsschemor
Kontaktbeteckningar enl. EN 50012
● med hjälpkontakter 2S + 2O
● med hjälpkontakter 4S + 4O
● manövertangent
● kontinuerlig kontaktgivning
● **Anslutningspunkternas placering**

● **Måttskisser** (mm)
● Typ Storlek
¹) Minsta avstånd från isolerade komponenter 3 mm
från jordade komponenter 10 mm

Français

Schémas électriques
Reperage des bornes conforme à EN 50012
● avec bloc de contacts auxiliaires 2 NO + 2 NF
● avec bloc de contacts auxiliaires 4 NO + 4 NF
● commande par impulsion
● commande maintenue
● **Disposition des bornes**

● **Encombrements** (mm)
● Type/Taille
¹) Distance minimale aux parties mises à la terre
aux parties isolees 3 mm
aux partie mises à la terre 10 mm

Español

Esquemas de conexiones
Designación de los bornes según EN 50012
● con contactos auxiliares 2 NA + 2 NC
● con contactos auxiliares 4 NA + 4 NC
● Excitación por pulsador (impulso)
● Excitación por contacto permanente
● **Posición de los bornes de conexión**

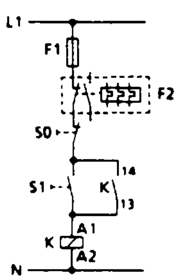
● **Croquis acotados** (mm)
● Tipo/Tamaño
¹) Distancia minima aisladas 3 mm a piezas
puestas a tierra 10 mm

Italiano

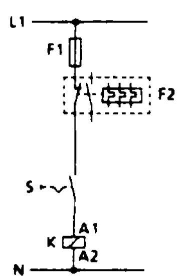
Schemi circuitali
Numerazione dei morsetti sec. EN 50012
● con blocchetto 2 L + 2 R
● con blocchetto 4 L + 2 R
● comando ad impulsi
● comando a contatto permanente
● **Punti di attacco**

● **Disegni d'ingombro** (in mm)
● Tipo/Grandezza
¹) Distanza minima da parti isolate: 3 mm
da parti collegate a terra: 10 mm

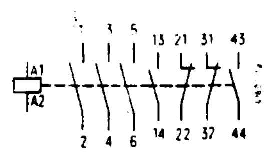
●



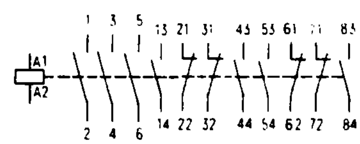
●



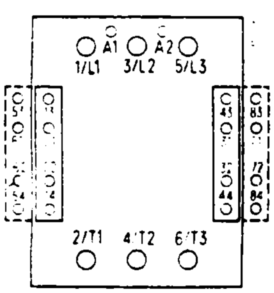
●



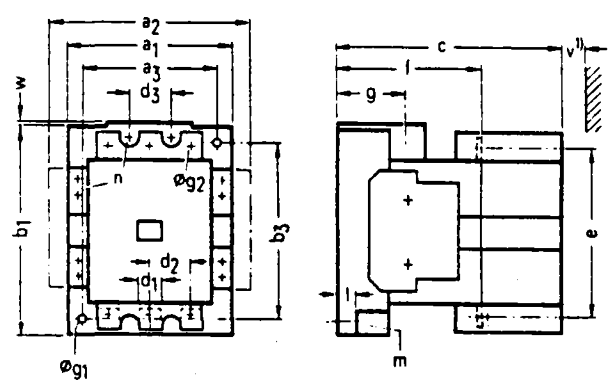
●



●



●



●

	a_1	a_2	a_3	b_1	b_3	c	d_1	d_2	d_3	e	f	g	$Øg_1$	$Øg_2$	l	m	n	v	w
3TF46, 3TF47 3	90	113	70	114	100	123	8	25	25	94	80	28	4,8	8,5	12	M4	M3,5	3	3
3TF46 4	100	123	80	130	110	140	8	25	25	107	89	39	5,5	8,5	12	M5	M3,5	3	2,5
3TF50 6	120	143	100	150	130	150	15	37	37	129	93	45	6,3	8,5	12	M6	M3,5	3	–

Bestell-Nr.: GWA 4NEB 526 4592-10
AG 1088500 E 5 De-En-Sv-Fr-Sp-It

SIEMENS

WORLD SERIES
CONTACTORS 3TB

CP 3052.8

Control Products
Division

INSTALLATION · MAINTENANCE · PARTS LIST

Effective
July, 1986

25-127-300-205

CAT NO. 3TB44 NEMA Size 1

WARNING

**HAZARDOUS VOLTAGE
CAN CAUSE ELECTRICAL SHOCK
AND BURNS.
DISCONNECT POWER BEFORE PROCEEDING
WITH ANY WORK ON THIS EQUIPMENT.**

DESCRIPTION

The contactor has three power poles and up to 4NO & 2NC auxiliary contacts (see Auxiliary Contact Options chart). Terminals for these contacts are marked on the contactor arc chute. Terminals for the coil are marked A1 & A2 on either side of the contactor just above the coil terminal lugs.

INSTALLATION

Mount the contactor on a vertical surface. Two screws are required (see Dimensions). The contactor may also be rail mounted (see Rail Mounting). A maximum tilt of 22.5 degrees from the vertical is permissible. Protect contactor in a proper enclosure when chemical or dust-laden atmospheres prevail. Dimensions and arrangement of mounting are shown on inside pages.

If the contactor is not installed immediately, store it in a clean dry place protected from sudden changes in temperature. Permissible ambient temperature is −25 °C to +55 °C.

Inspect to ensure that no wire cuttings are left inside the contactor or enclosure upon completion of installation. Tighten all terminal screws firmly including those that are not used.

MAINTENANCE

Periodically inspect and clean the contactor. This should be done frequently in case of severe switching duty or a badly contaminated atmosphere. Most importantly, the contacts should be inspected. Note that contacts which appear dark, rough, or both after the first few weeks of operation are normal and they should not be filed or dressed. The most important item to check is the thickness of the contact tips (see Fig. 2).

If the contactor hums, dust may have accumulated on the magnet pole faces. These pole faces can be cleaned by disassembling the contactor. (See section on Coil Replacement.) Clean the pole faces with a lint free cloth. Do not use a degreasing agent, nor scratch with a pointed object. A contactor that is beginning to hum or rattle after a prolonged period of operation should be replaced since it has reached the end of its service life. Check main contacts after short circuits and separate them with a screwdriver, if necessary, and examine for possible need of replacement.

Contact Replacement

See Fig. 3. To replace the stationary contacts, loosen terminal screw (1) but do not remove screw from terminal. Remove the contact complete with its screw (2). Firmly tighten the replacement contact. Remove movable contact by rotating it 90° and pulling it straight out. Insert contact by gently pushing it below the spring retainer.

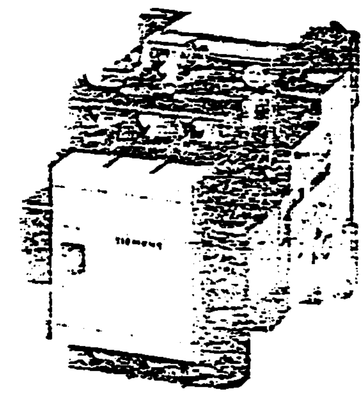


Fig. 1

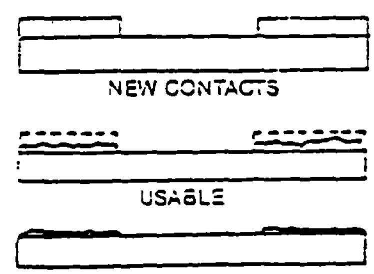


Fig. 2

Fig. 3

Coil Replacement

See Fig. 4. Loosen the two mounting screws (1). Remove the top half of the contactor base (2) together with the arc chute. Remove the coil (3) by slightly twisting it. Install the new coil by locating the cone shaped bosses on the springs and pressing into lower contactor base (4). Coil will snap into position. Place coil leads in slots and insert coil terminals (5) into the recesses (6). Be sure the wire clamps are oriented properly. Replace the top half of the contactor and tighten the two mounting screws.

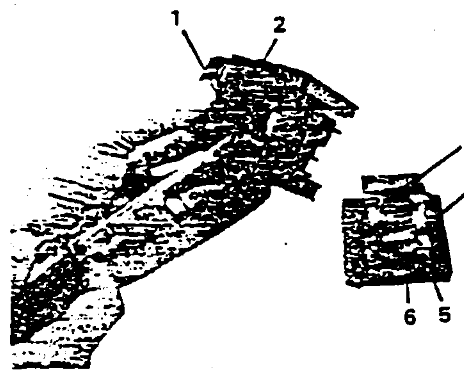


Fig. 4

Auxiliary Contact Replacement

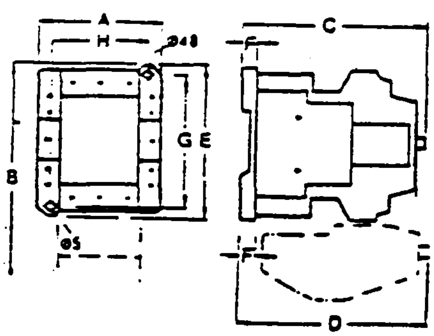
One auxiliary contact block is mounted on each side of the contactor. The block contains 1 NO and 1 NC contact. Two screws hold the block in place. Should contact replacement ever become necessary, refer to instruction sheet CP 3080 packed with each replacement auxiliary contact kit.

Fig. 5

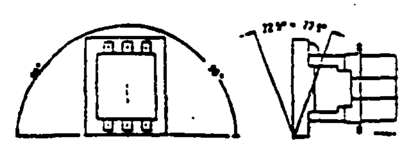
DIMENSIONS

MOUNTING

INSTALLATION



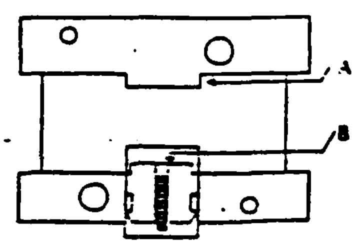
	A	B	C	D	E	F	G	H
INCHES	2.76	5.70	4.10	4.13	3.35	.31	2.95	1.97
MM	70	145	10.5	105	85	8	75	50



RAIL MOUNTING

The contactor may be rail mounted by hanging the hook (A) over the top of the rail and pushing in and down on the front of the contactor until the bottom catch (B) is caught under the bottom raised lip of the rail.

To remove the contactor from the rail, use a screwdriver to pry the catch (B) in the direction of the arrow. Then lift the contactor off the rail.



ELECTRICAL DATA

CONTACTOR CATALOG NUMBER	UL MAX. RATINGS AMPS		IEC MAX. RATINGS AMPS		MAX. HP-RATING; NORMAL DUTY①									
						S.-PHASE		THREE PHASE: MOTOR VOLTAGE						
	OPEN	ENCLOSED	Ie/AC1	Ie/AC3		115	230	200	220/230	380	460/500	575	660
3TB44	45	42	—	—	MAX HP	3	5	10	10	—	25	25	—
	—	—	45	32	KW	—	—	—	8.5	15	18.5	—	15
	—	27	—	—	NEMA SIZE 1 HP	2	3	7½	7½	10	10	10	—

COIL DATA②

P.-CONSUMPTION		OPERATING TIME	
INRUSH VA	SEALED VA	CLOSING MS	OPENING MS③
76VA pf = 0.79	10.5VA pf. = 0.3	10-40	5-25

COIL SUFFIX TABLE⑤

	VOLTS						
60Hz AC	24	48	120	240	208	480	600
	L8	H8	A8	C8	B8	D8	E8
50Hz AC	24	48	110	220	380	500	—
	*	*	A8	C8	D8	E8	—

* refer to factory

AUXILIARY CONTACT (STANDARD)

CATALOG NUMBER		
3TB4412	1NO	1NC
3TB4417	2NO	2NC

TIGHTENING TORQUES

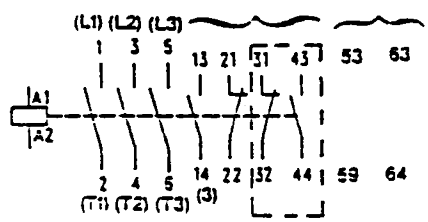
Connection	Screw Size	Torque Inch-Lb. Min.-Max
Line Terminals:	M 5	22.2 - 26.5
Load Terminals:	M 5	22.2 - 26.5
Control Terminals:	M 3.5	7 - 10.6
Auxiliary Contacts:	M 3.5	7 - 9

RENEWAL PARTS and ACCESSORIES

REPLACEMENT PARTS	CATALOG NO.
Main Contact Kit: Six (6) Stationary Contacts with terminals Three (3) movable contacts	KMC1
Auxiliary Contact Kit 1 NO + 1 NC	KAX1A11
Arc Chute	KAC1
Surge Suppressor	3TX6 406-00
AC COILS 24V 60Hz	3TY4803-1AF8
48V 60Hz	3TY4803-1AH8
120V 60Hz 110V 50Hz	3TY4803-1AA8
208V 60Hz	3TY4803-1AB8
240V 60Hz 220V 50Hz	3TY4803-1AC8
480V 60Hz 380V 50Hz	3TY4803-1AD8
600V 60Hz 500V 50Hz	3TY4803-1AE8

WIRING DIAGRAM

STANDARD OPTION⑤



AUXILIARY CONTACT RATING④

VOLTS (AC)	CURRENT RATING (Amps)	
	Make	Break
120	60A	6A
240	30A	3A
480	15A	1.5A
600	12A	1.2A

① Shaded Amp-ratings per UL; Nonshaded Amp-ratings are making currents for Standard Motor Applications per IEC 158/VDE0660; Ie/AC3. All Hp or Kw-Ratings are based on a Motor Service Factor of 1.0.
② Coil voltage tolerance is 0.85 to 1.10 times rated voltage at 60Hz.
③ Does not include arcing time of 10 msec.
④ Continuous duty: 10 amp.
⑤ For 3rd and 4th auxiliary contact block only KAX1A10 (1 NO only) may be used on each side.
⑥ For DC operated contactors refer to factory.

SIEMENS

Siemens Energy & Automation, Inc.
Control Products Division
Box 29265
New Orleans, LA 70189

SIEMENS

Control Transformer Kit
Cat. No's KT8XXX, KT9XXX, KTHXXX

CP3245
April 1990
Issue .03

Controls Division

Installation & Maintenance

Description:

The following transformer kits consist of:

A. KT8050, 9050 and H050:
- Control power transformer rated 45VA. with integraly mounted secondary fuse clips on the top.
- One time delay, non-rejection type, midget secondary fuse rated 250 volt.
- Mounting hardware and cable ties.
- Two primary wires (black), two secondary wires (red) and one ground wire (green) all crimped with the appropriate terminals.
- One fuse rating label.

B. All Other Transformer Kits:
- Control power transformer with integrally mounted primary and secondary fuse block.
- Two, time delay, rejection type, class CC, midget primary fuses rated 600V.
- One time delay, non-rejection type, midget secondary fuse rated 250 volt.
- Mounting hardware and cable ties.
- Two primary wires (black), two secondary wires (red) and one ground wire (green) all crimped with the appropriate terminals.
- Two fuse rating labels.

The Siemens transformer rating table shows the recommended transformer kits for use with Siemens across-the-line contactors or starters. However, the transformer rating may vary with the type of starters and the options to be fed directly from the transformer. Also, the table indicates the sizes and rating of the primary and secondary fuses selected according to NEC article 430-72 and 450-3 (b).

Installation

All enclosed combination and enclosed non-combination starters are provided with pre-drill mounting holes to accept the installation of a control transformer kit, with the exception of the NEMA type 1 lift-off enclosed non-combination starters. Most starters have provisions for oversized transformer kits. Select the appropriate kit and install as follows:

⚠ WARNING

HAZARDOUS VOLTAGE
CAN CAUSE ELECTRICAL SHOCK
AND BURNS.
DISCONNECT POWER BEFORE PROCEEDING
WITH ANY WORK ON THIS EQUIPMENT.

- Mount transformer to the plate using enclosed #10 or 1/4" self tap screws.
- Wire transformer and fuse block in accordance with the appropriate wiring diagram (usually affixed to the inside cover of the enclosure). Use the wires with lug terminals to make the connections - black wires for the primary side of the transformer, red wires for secondary side of the transformer, and green wire for ground. Loop, tie or trim excess length of wires needed.

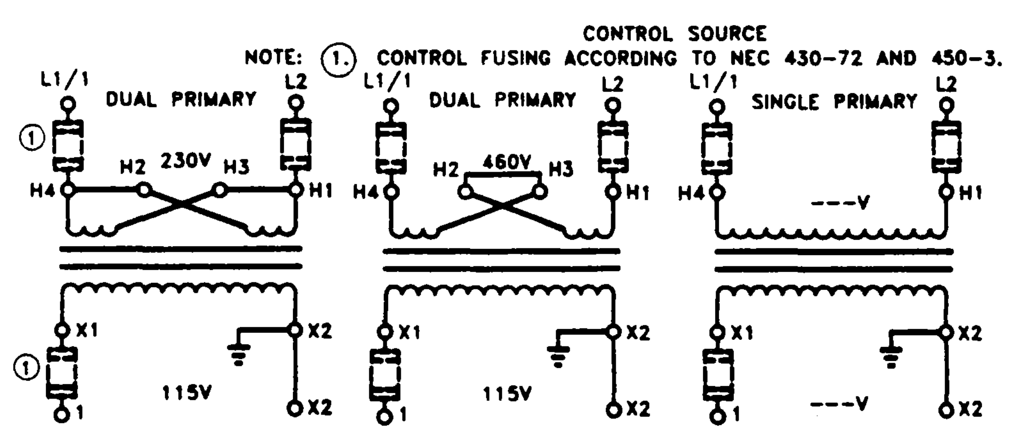
NOTICE: For the Dual Primary Voltage Transformers, two stacked metal jumpers are provided and connected between primary terminals H2 and H3 which is the appropriate connection for a 460 volt primary application. For 230 volt primary application, REMOVE the two jumpers between H2 and H3. Reconnect one jumper between H1 and H3, and the other jumper between H2 and H4.

- Check that all connections are properly wired according to the wiring diagram and screws are well tightened to provide secure connections. Special care need to be taken so that ground connector has made continuity to metal surface of the plate.
- Affix fuse rating labels to the panel in a place close to the transformer to identify fuses, if needed.

Siemens Transformer Kits Rating

Primary Voltage	Secondary Voltage	VA Rating	Standard for Contactor Style	Standard for NEMA Size	Transformer Kit Cat. No.	Secondary Fuse Amp. 1	Primary Fuse Amp. 2
230/460	115	45	3TB40-3TF47	0 - 2	KT8050	0.6	N/A 3
230/460	115	50	3TB40-3TF47	0 - 2	KT8050P	0.6	0.25
230/460	115	100	3TF48	3	KT8100	1.12	0.5
230/460	115	150	3TF50	-	KT8150	1.8	0.8
230/460	115	200	3TF52	4	KT8200	2.25	1.0
230/460	115	300	3TF54	-	KT8300	3.5	1.5
230/460	115	500	3TF56	5	KT8500	5.6	3.0
575	115	45	3TB40-3TF47	0 - 2	KT9050	0.6	N/A 3
575	115	50	3TB40-3TF47	0 - 2	KT9050P	0.6	0.25
575	115	100	3TF48	3	KT9100	1.12	0.25
575	115	150	3TF50	-	KT9150	1.8	0.5
575	115	200	3TF52	4	KT9200	2.25	0.5
575	115	300	3TF54	-	KT9300	3.5	0.8
575	115	500	3TF56	5	KT9500	5.6	1.0
208	115	45	3TB40-3TF47	0 - 2	KTH050	0.6	N/A 3
208	115	50	3TB40-3TF47	0 - 2	KTH050P	0.6	0.5
208	115	100	3TF48	3	KTH100	1.12	0.8
208	115	150	3TF50	-	KTH150	1.8	1.0
208	115	200	3TF52	4	KTH200	2.25	1.5
208	115	300	3TF54	-	KTH300	3.5	2.0
208	115	500	3TF56	5	KTH500	5.6	3.0

1 Time delay, non-rejection type, midget fuse rated 250V.
2 Time delay, rejection type, Class CC, midget fuse rated 600V.
3 According to N.E.C. - 430 - 72 , 450 - 3 (b) and UL 508, section 32, primary fuses are not required for control transformer rated less than 50 VA and are inherently protected.



Typical Transformer Wiring Diagram

Siemens Energy & Automation, Inc.

3333 State Bridge Road
Alpharetta, Georgia 30201
(404) 751-2000

SIEMENS

Siemens Energy & Automation, Inc.
Wilmington, N.C. 28403 U.S.A.
Assembled in Mexico

Piece No. 116422-A Rev. 5

Installation Procedure

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Turn off and lock out all power before installing or servicing.

⚠ SAFETY INSTRUCTIONS

NOTE: This instruction outlines the recommended installation procedure.

1. Turn off and lockout all power before installing or servicing.
2. These devices are approved for use with external handle operators. Refer to Siemens basic catalog numbers FDH10, FHOHS, RHOH and associated operating mechanism.
3. Locate switch as required by handle operating mechanism. Drill and tap the switch mounting holes (4 holes) as shown in Fig. 1.
4. Loosen screws and remove the line shield (Item 1) to access the switch top mounting holes. Note that the switch should be in open position to access lower mounting screws. Position the unit over the mounting holes. Use 10-32 x 1/2 screws with lockwashers to mount the switch. Torque all mounting screws to 25-28 in. lbs.
5. Reinstall the line shield (Item 1) and tighten using the screws provided.
6. Non-Fused:
   When non-fused application is desired, use TMK606 connector kit. See Pg. 3, Fig. 3, and Pc. No. 600010-A instruction sheet.
7. Fused:
   For fuse installation refer to Pg. 2.
8. For overfusing installation refer to OFCK661 instruction sheet. Pc. No. 116804.-A.

DISCONNECT SWITCH CAT. NO.

Catalog No.	Amps	Volts	Horse power Max.
MCS603R	30	600	20
MCS603L	30	600	20
MCS606R	60	600	50
MCS606L	60	600	50

Table 1
Above catalog numbers also rated for 250V DC.

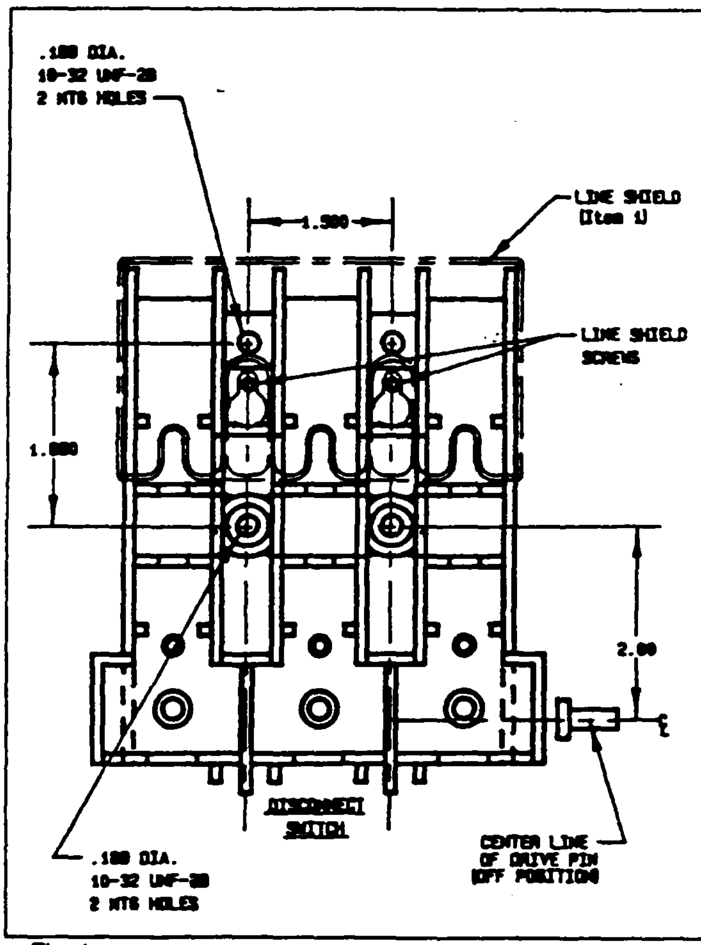


Fig. 1

Siemens Energy & Automation, Inc.
Wilmington, NC 28412 USA.
Assembled in Mexico

Piece No. 116422-A Rev. 5

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Turn off and lock out all power before installing or servicing.

Installation Instructions

9. Using Table 2, locate the proper fuse block Cat. No. for the type of fuses you are using. Read across until you locate the dimension necessary to position the fuse block at the proper distance from the switch.

10. Using 5/32" or no. 21 drill, drill two holes and tap #10-32 for mounting screws provided with fuse block kit. Align the fuse block parallel to the bottom of the disconnect switch before tightening screws to 25-28 in. lbs.

11. Using Figure 4, install the fuse clips provided, on the disconnect device with #10-32 x 5/16 long panhead machine screws and torque screws to 25-28 in. lbs.

12. For Cat. No. FCK203 & FCRK203 use Fig. 5, install fuse clip & strap on disconnect device.

13. For Cat. No. FCJK603 & FCRK606 refer to Fig. 5 & 6. Note Fig. 6 must be installed in center pole.

14. Install the proper class fuses before turning power on.

FUSE BLOCK KITS

Catalog No.	Fuse Type	Amps	Volts	Dimension "A"
FCK203	H	0-30	240	3.62
FCRK203	R	0-30	240	3.62
FCK206	H	31-60	240	3.38
FCRK206	R	31-60	240	3.38
FCRK206	R	0-30	600	5.50
FCJK603	J	0-30	600	3.88
FCK206	H	0-30	600	5.50
FCRK606	R	31-60	600	5.88
FCJK606	J	31-60	600	3.88
FCK606	H	31-60	600	5.88

Table 2

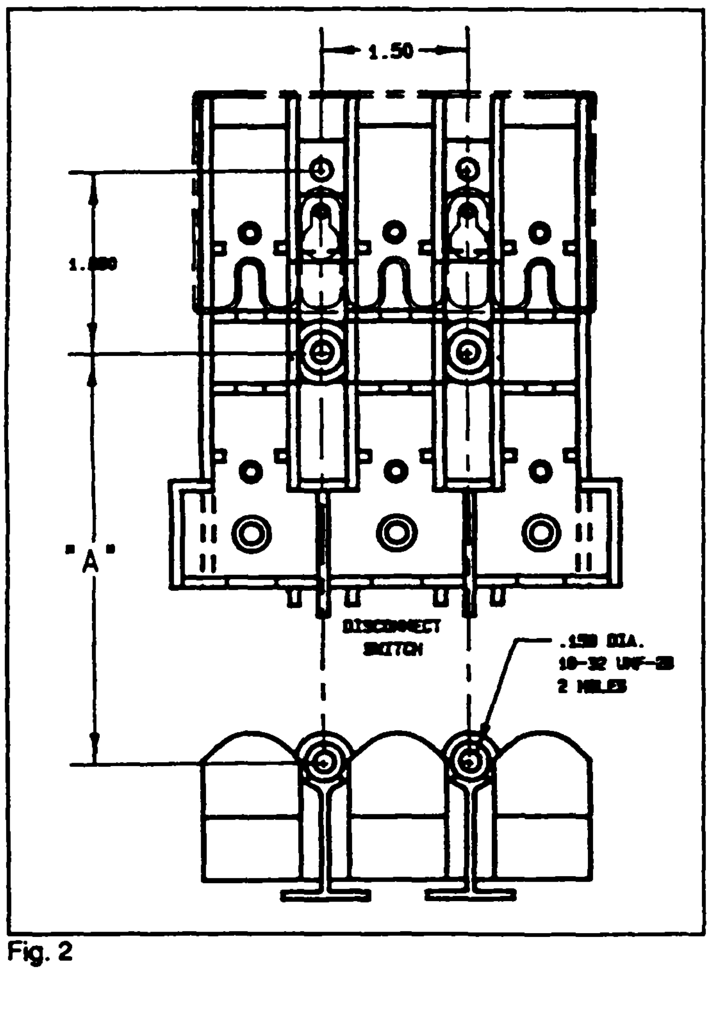
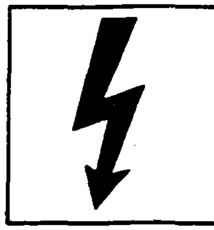


Fig. 2

Siemens Energy & Automation, Inc.
Wilmington, NC 28412 USA
Assembled in Mexico

Piece No. 116422-A Rev. 5



⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Turn off and lock out all power before installing or servicing.

Installation Instructions

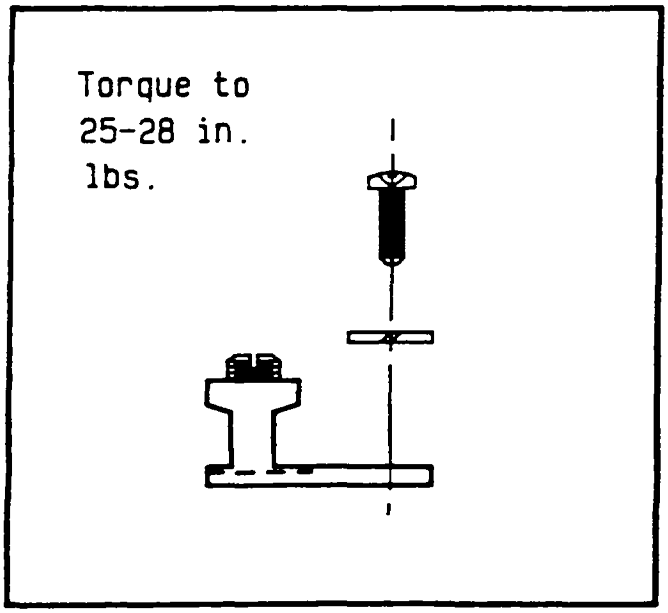


Fig. 3

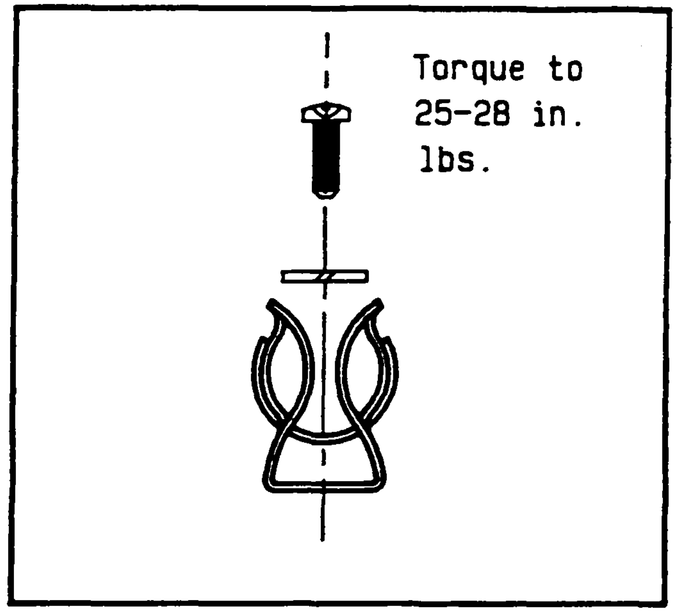


Fig. 4

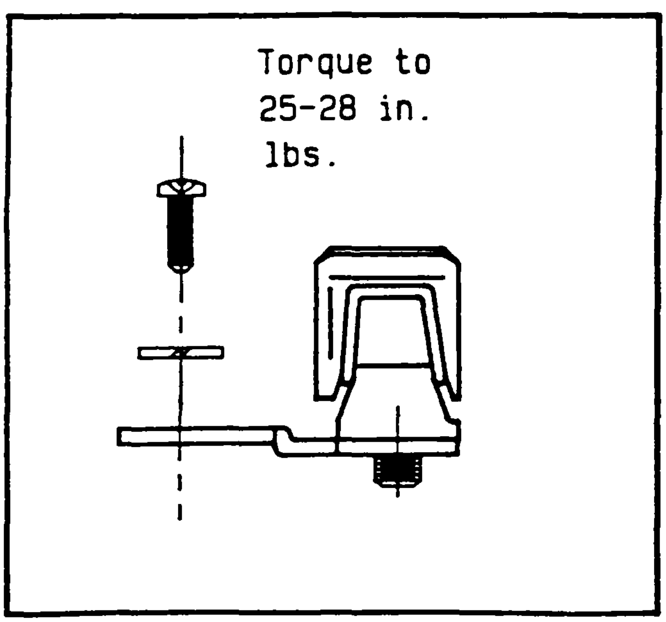


Fig. 5

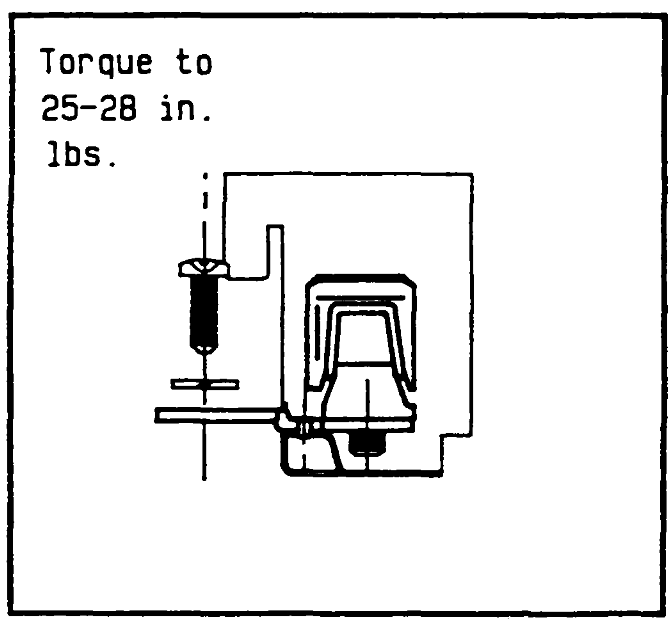


Fig. 6

SIEMENS

3SB06 Pilot Device Installation

Door or Flange Mounted

CP 3300.01
February, 1988

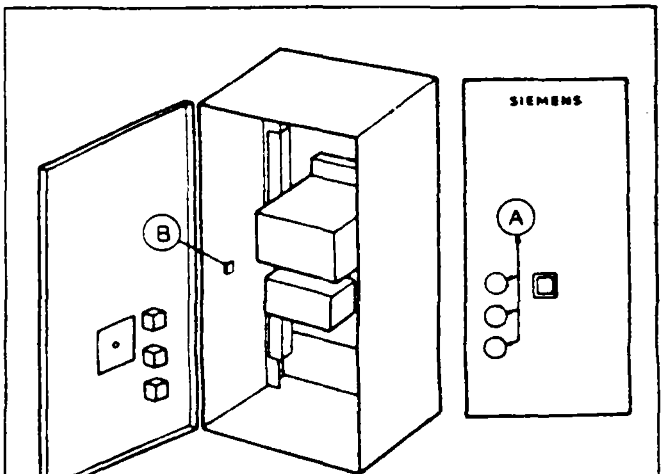
Control Products

Installation Instructions

⚠ WARNING

HAZARDOUS VOLTAGE
WILL CAUSE ELECTRICAL SHOCK
AND BURNS.

DISCONNECT POWER BEFORE PROCEEDING WITH ANY WORK ON THIS EQUIPMENT.



A - HOLES, WITH HOLE PLUG, FOR P30 DEVICES. NOTE: STOP BUTTONS MUST ALWAYS BE ON BOTTOM.

B - WIRE TIE SUPPORT LOCATION.

FIG. 1

General Instructions

1. Remove hole plugs or knockouts from desired number of pilot device mounting holes. If the mounting hole is not provided for flange mounted type, see Fig. 2, next page for instructions.

2. Remove the locking ring. Slip the operator into the mounting hole from inside of the enclosure; position legend plate and secure locking ring on outside of en closure. It is easier to connect the wires to the terminals of the pilot device before the device is secured to a flange type mounting.

3. For a typical circuit, refer to the wiring diagram on the inside of the enclosure door or refer to the component circuit shown at right.

4. Use 600V No.14 AWG for control wiring. Measure wire from pilot device(s)to starter or contactor, leaving enough slack for door swing when door mounting is used. Then cut to length.

5. Attach all wires to the control device terminals on the door. Also for door mounting, the wires from the pilot device terminals are put through the plastic sleeving provided in the kit in order to provide protection for the hinge section. Mount one pressure sensitive adhe sive back wire tie support as shown by Fig. 1, Item A.

6. Make the proper connections to the starters or contactors. Then tighten all connections. Finally, apply wire ties and second wire support as needed.

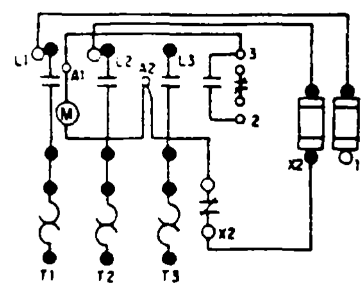
⚠ CAUTION

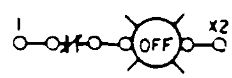
HAZARDOUS VOLTAGE
CAN CAUSE ELECTRICAL SHOCK
AND BURNS.

DISCONNECT POWER BEFORE PROCEEDING WITH ANY WORK ON THIS EQUIPMENT.

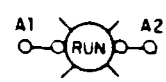
Typical Wiring of FVNR Devices

Line Voltage Control



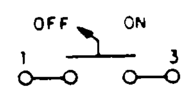


LG *

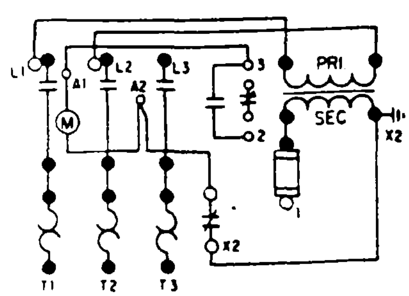


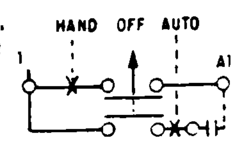
LR *

Control Power Transformer



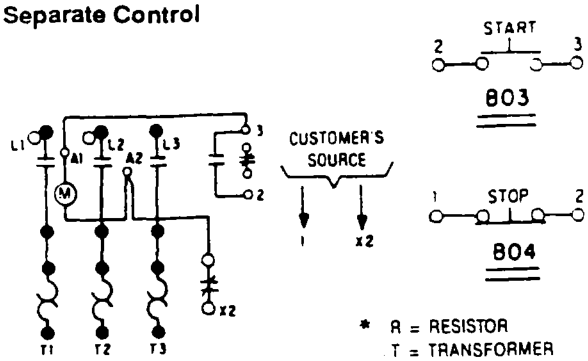
S50





S80

Separate Control



* R = RESISTOR
T = TRANSFORMER
See back page for full catalog number.

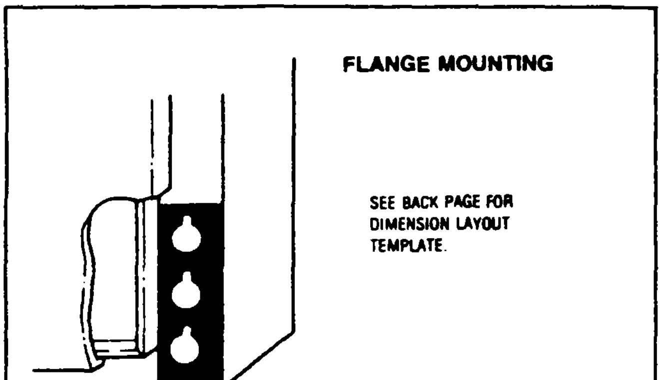


FIG. 2

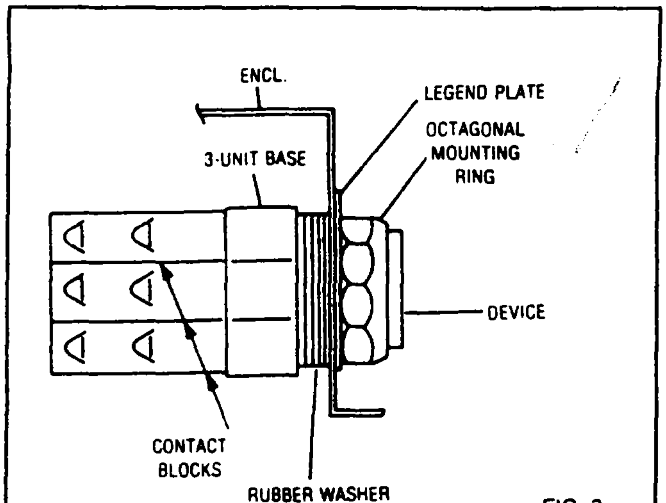


FIG. 3

⚠ WARNING

HAZARDOUS VOLTAGE WILL CAUSE ELECTRICAL SHOCK AND BURNS.

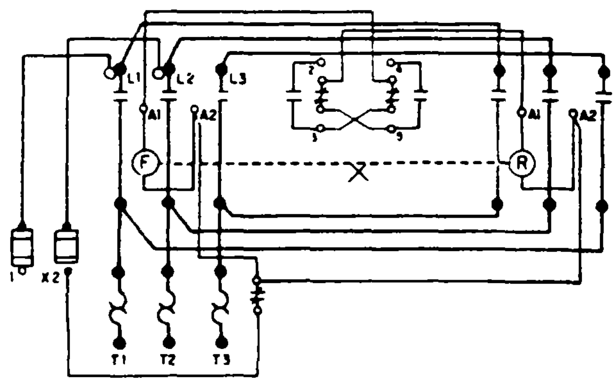
DISCONNECT POWER BEFORE PROCEEDING WITH ANY WORK ON THIS EQUIPMENT

Flange Mounting

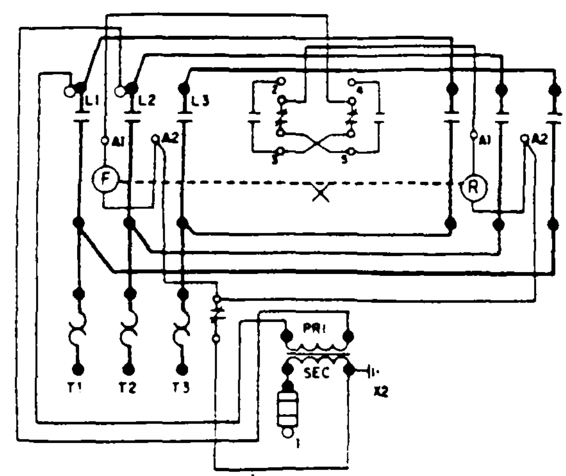
1. Prepare hole(s) for 3SB03 pilot device(s) in the desired location in the enclosure flange, using the dimensional layout shown.
   NOTE: For NEMA 1—If knockouts are provided, remove only the number required for pilot device installation.
2. Connect all wires to the pilot device(s) before securing the unit(s) into the flange. (See typical circuit.)
3. Remove retaining ring and nameplate from units(s).
4. Determine required rubber washers depending upon enclosure thickness.
5. Place pilot device through the prepared hole(s); add the nameplate and then secure unit in position using the retaining ring.
6. Tighten all connections. Then apply wire ties to secure the wire bundles, as needed.

Reverse Starters Showing Control Supply

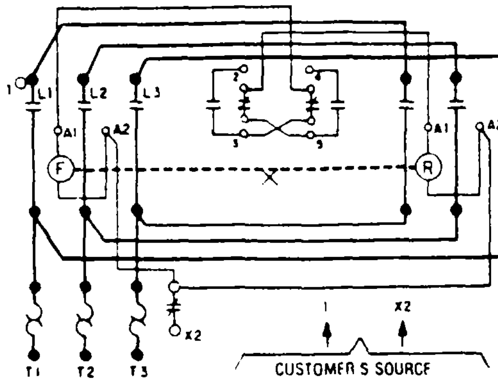
Line Voltage Control



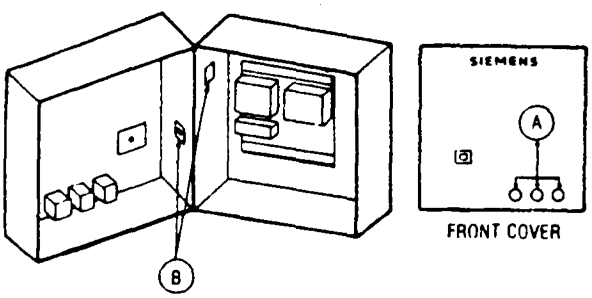
Control Power Transformer



Separate Control



NEMA 1 HINGED ENCLOSURE



A - HOLES, WITH HOLE PLUGS, FOR P30 DEVICES
NOTE: STOP BUTTON MUST ALWAYS BE ON RIGHT.

B - WIRE TIE SUPPORT LOCATIONS.

FIG. 4

Door Mounting

1. Remove the knockouts from the desired number of pilot device mounting holes (located on enclosure door). If knock-outs are not provided, punch holes as required.

2. Remove the locking ring. Slip operator into the mounting hole from the inside of enclosure. [See Fig. 4 and pay particular attention to the stop button re quirement (Item A).] Add appropriate legend plate and secure each device in place with the retaining ring.

3. Use 600V, No. 14 AWG wire for control wiring. Measure wire from pilot device(s) to inside wall of enclosure, to starter or contactor, leaving enough slack in wire for door swing. Then cut to length.

4. Attach all wires to control terminals on door. Put all wires from the control terminals on door through plastic sleeving provided in the kit. Mount pressure sensitive adhesive wire support on the left inside wall of enclosure (Fig.4, Item B.) Make proper connections to the starter or contactor.

5. Tighten all connections. Apply wire-ties to secure wire bundles, as needed.

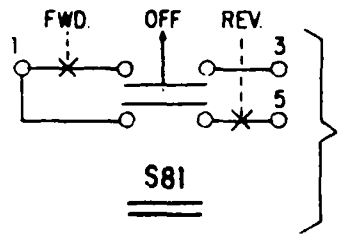
⚠ CAUTION

HAZARDOUS VOLTAGE
CAN CAUSE ELECTRICAL SHOCK
AND BURNS.

DISCONNECT POWER BEFORE PROCEEDING
WITH ANY WORK ON THIS EQUIPMENT.

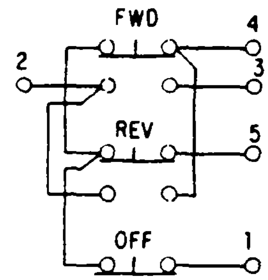
Typical Wiring of Reverse Starters

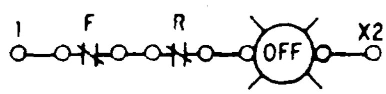
LR *



REMOVE PREWIRED CONDUCTORS, NUMBERED 3-6 AND 7-5, WHEN USING SELECTOR SWITCH.

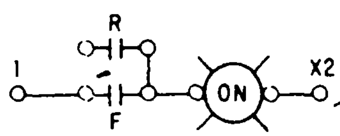
* R = RESISTOR
T = TRANSFORMER
See back page for full catalog number.



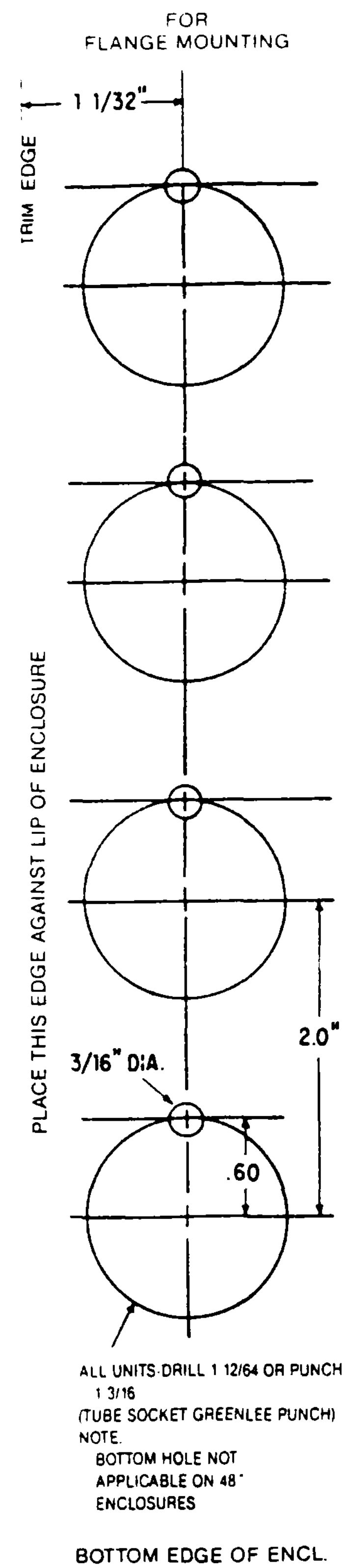


* R = RESISTOR
T = TRANSFORMER
See back page for full catalog number

LG *



TWO (2) N.C. AND ONE (1) N.O. AUX CONTACTS REQUIRED ON EACH CONTACTOR WHEN ELECTRICAL INTERLOCK AND TWO (2) PILOT LIGHTS ARE USED. THIS MAY REQUIRE THE ADDITION OF CONTROL RELAYS.



Pushbutton Kits

CONTENTS*	LEGEND	CATALOG NO.
1 Each Black Pushbutton 3SB03-PFB 1 Each Red Pushbutton 3SB03-PER	1 Each - "Start" - P30NPS03 1 Each - "Stop" - P30NPS04	P30KB51
2 Each Black Pushbutton 3SB03-PFB 1 Each Red Pushbutton 3SB03-PER	1 Each - "Forward" - P30NPS07 1 Each - "Off" - P30NPS02 1 Each - "Reverse" - P30NPS08	P30KB81
2 Each Black Pusnbutton 3SB03-PFB 1 Each Red Pushbutton 3SB03-PER	1 Each - "Slow" - P30NPS11 1 Each - "Stop" - P30NPS041 1 Each - "Fast" - P30NPS09	P30KB82

* Each kit contains the appropriate number of contact blocks for application shown.

Selector Switch Kits

CONTENTS*	LEGEND	CATALOG NO.
1 Each-3-Pos. Maintained Sel. SW-BLACK 3SB03-S3MKB	"Hands-Off-Auto" P30NPS80	P30KS80
1 Each-2-Pos. Maintained Sel. SW-BLACK 3SB03-S2MKB	"Stop-Start" P30NPS51	P30KS51
1 Each-3-Pos. Maintained Sel. SW-BLACK 3SB03-S3MKB	"Rev-Off-Fwd." P30NPS81	P30KS81
1 Each-3-Pos. Maintained Sel. SW-BLACK 3SB03-S3MKB	"Slow-Stop-Fast" P30NPS82	P30KS82
1 Each-2-Pos. Maintained Sel. SW-BLACK 3SB03-S2MKB	"Rev.-Fwd." P30NPS53	P30KS53

* Each kit contains the appropriate number of contact blocks for application shown.

Pilot Light Kits

CONTENTS	VOLTAGE	LEGEND	LENS COLOR	CATALOG NO.
1 Each-Resistor Type Pilot Light 3SB03-LR1	115VAC	Red	"Run" P30NPS06	P30KLRR1
1 Each-XFMR Type Pilot Light 3SB03-LR1	115VAC	Green	"Off" P30NPS02	P30KLGR1
1 Each-XFMR Type Pilot Light 3SB03-LT1	115VAC	Red	"Run" P30NPS06	P30KLRT1
1 Each-XFMR Type Pilot Light 3SB03-LT1	115VAC	Green	"Off" P30NPS02	P30KLGT1
1 Each-XFMR Type Pilot Light 3SB03-LR2	230VAC	Red	"Run" P30NPS06	P30KLRT2
1 Each-XFMR Type Pilot Light 3SB03-LR2	230VAC	Green	"Off" P30NPS02	P30KLGT2
1 Each-XFMR Type Pilot Light 3SB03-LR4	460VAC	Red	"Run" P30NPS06	P30KLRT4
1 Each-XFMR Type Pilot Light 3SB03-LR4	460VAC	Green	"Off" P30NPS02	P30KLGT4

Siemens Energy & Automation, Inc.

Controls Division
3333 State Bridge Road
Alpharetta, GA 30201
(404) 751 - 2000

ATF 1,2,4

SIEMENS

Type 3UA58
Thermal Overload Relays
16–25 to 63–80 Amperes
CP3156

Controls Division

Installation & Maintenance | Issue No. 01 | Effective Date: January 1987

Description

The three phase thermal overload relay is a fast acting NEMA Class 10 directly heated ambient compensated adjustable bimetallic device.

In addition to motor overload protection, a unique internal mechanism provides voltage unbalance and single phase protection. See Fig. 2. Curve 1 is the normal three phase Time Current Characteristic.

When any one of the three phases is opened, the relay senses this and its curve shifts to the left (Curve 2), thus making it more sensitive to the higher single phase current. If the relay trips, it could be due to either a normal three phase overload or single phase condition.

Integral heaters with adjustable overload set at full load motor current value, assures consistent motor protection. The relay has one normally closed contact and one normally open contact. The normally closed contact is used in the control circuit. The normally open contact can be used for an alarm if desired. The relay can be set for either manual, as shipped, or for automatic reset. Labels and terminal markings are on the relay for wiring and changing the method of reset. Labels also indicate trip range, contact rating, and maximum back-up fuse size.

Additional features include a trip indicator and a test button which can be used as a stop button or to test the NC contact.

Installation

These relays are for direct mounting on the following contactors or reversing contactors: 3TB46/47/48, CXL20/30, CRL20/30, CRLOB46/47/48, CSLOB46/47/48. For separate installation, use mounting bracket 3UX1 421.

The relay can be mounted in any position. Where chemical or dust-laden atmospheres prevail, protect the relay in a suitable enclosure. If the relay is not installed immediately, store it in a clean dry place. Dimensions and arrangement of mounting are shown on the reverse side.

Place the three load leads of the relay in the load terminals T1, T2, and T3 of the contactor, being sure the stud at the bottom of the relay is secure in the slot at the base of the contactor.

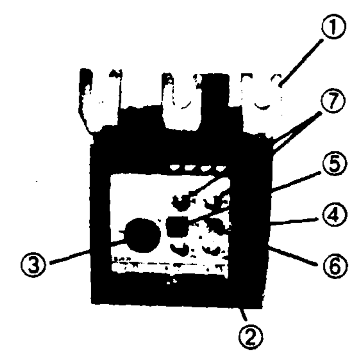
Connect the control circuit leads in the following manner: For overload protection, wire the control through the normally closed contacts marked 95 and 96. Terminals marked 97 and 98 are normally open contacts which can be used to initiate a command or turn on an alarm light.

Inspect to ensure that no wire cuttings are left inside the enclosure. Tighten all terminal screws firmly.

NOTE: Do not use automatic reset with two wire control.

⚠ WARNING

Hazardous Voltage.
Can Cause Electrical Shock And Burns.
Disconnect Power Before Proceeding With Any Work On This Equipment.



① Line Terminals
② Load Terminals
③ Adjustment Knob
④ Trip Indicator
⑤ Test Button
⑥ Manual or Automatic Reset
⑦ Aux. Contacts Terminals

Fig. 1

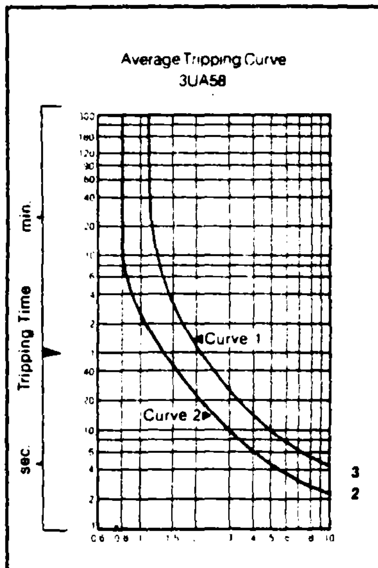


Fig. 2

Curves are based on "cold" start. For full running condition tripping time is 25% of rated values.

Adjustment

Marking on the dial denotes **Full Load Amps.**

Tripping current is 125% of dial setting.

Motors with a marked **Service Factor not less than** 1.15 or motors with a marked temperature rise not over 40°C:

Set dial to full load current marked on motor nameplate.

All other motors noted for continuous duty including motors with a marked **Service Factor of 1.0:**

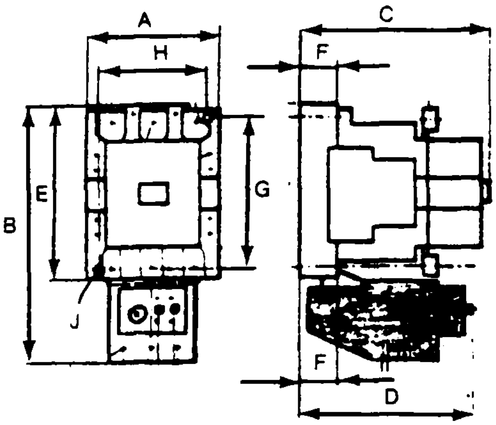
Multiply Motor Full Load current by 0.92 and set Overload Relay dial to that value. This will provide protection of 115% of Motor Full Load Current.

In case of overload relay tripping during motor starting or at maximum running conditions, the Overload Relay setting can be increased to the maximum value in accordance with NEC 430-34:

1.12 times motor full load current for motors with a marked Service Factor not less than 1.15

1.08 times motor full load current for motors with a marked Service Factor of 1.0 or temperature rise over 40°C.

Dimensions



NEMA Size 2

	A	B	C	D	E	F	G	H	J
INCHES	3.54	6.93	4.84	4.80	4.53	0.94	3.94	2.76	0.19
MM	90	176	123	122	115	24	100	70	4.8

NEMA Size 3

	A	B	C	D	E	F	G	H	J
INCHES	3.94	7.56	5.51	5.04	5.12	0.87	4.33	3.15	0.23
MM	100	192	140	128	130	22	100	80	5.8

NOTE: Reset Travel = 2.18 mm

Cat. No.	Current Rating Range (amps)		Maximum* Fuse Size (amps) (K5)	Max. Rating Circuit Breaker Thermal Magnetic (amps)	Former Catalog Number
	Low	High			
3UA5800-2C	16	25	60	50	OLR2500CS3
3UA5800-2D	20	32	70	50	OLR3200CS3
3UA5800-2E	25	40	80	70	OLR4000CS3
3UA5800-2F	32	50	100	80	OLR5000CS3
3UA5800-2T	40	57	100	100	OLR5700CS3
3UA5800-2P	50	63	110	100	OLR6300CS3
3UA5800-2V	57	70	125	100	OLR7000CS3
3UA5800-2U	63	80	150	125	OLR8000CS3

*Where the fuse size does not exceed 225% of the rated motor full load current, a time delay fuse may not be used (see NEC 430-52).

Technical Data

Rated Voltage	Volts AC	600
Permissible Ambient Temperature	°C °F	−25 to +55 −13 to +133
Setting Range from to	 Amps Amps	 16 to 25 63 to 80
Heating of Bimetal Elements		Direct
Permissible Frequency Range	Hz	Up to 400
Power Consumption-per Current Phase Max. at lower setting at upper setting	 Watts Watts	 1.6 4
Wire Size Range for Power Consumption		10-1 AWG
Auxiliary Contacts		1 NO & 1 NC Isolated Contact above 150V same polarity
Control Circuit Protection Type KTK or equivalent	 Amps	 6
Continuous Current	Amps	5
Contact Rating— NEMA B600		

Volts AC	make (Amps)	VA	break (Amps)	VA
120	30	3600	3	360
240	15	3600	1.5	360
480	7.5	3600	0.75	360
600	6	3600	0.6	360

Siemens Energy & Automation, Inc.
Controls Division
Box 29265
New Orleans, LA 70189

SIEMENS

Type 3UA54
Thermal Overload Relays
10–16 to 25–36 Amperes
CP3155

ATF3

Controls Division

Installation & Maintenance | Issue No. 01 | Effective Date: January 1987

Description

The three phase thermal overload relay is a fast acting NEMA Class 10 directly heated ambient compensated adjustable bimetallic device.

In addition to motor overload protection, a unique internal mechanism provides voltage unbalance and single phase protection. See Fig. 2. Curve 1 is the normal three phase Time Current Characteristic.

When any one of the three phases is opened, the relay senses this and its curve shifts to the left (Curve 2), thus making it more sensitive to the higher single phase current. If the relay trips, it could be due to either a normal three phase overload or single phase condition.

Integral heaters with adjustable overload set at full load motor current value, assures consistent motor protection. The relay has one normally closed contact and one normally open contact. The normally closed contact is used in the control circuit. The normally open contact can be used for an alarm if desired. The relay can be set for either manual, as shipped, or for automatic reset. Labels and terminal markings are on the relay for wiring and changing the method of reset. Labels also indicate trip range, contact rating, and maximum back-up fuse size.

Additional features include a trip indicator and a test button which can be used as a stop button or to test the NC contact.

Installation

These relays are for direct mounting on the following contactors or reversing contactors: 3TB44, CXLO, CXL1, CRL0, CRL1, C21JC, C21JR, CRLOB44, CSLOB44. For separate installation, use mounting bracket 3UX1 420.

The relay can be mounted in any position. Where chemical or dust-laden atmospheres prevail, protect the relay in a suitable enclosure. If the relay is not installed immediately, store it in a clean dry place. Dimensions and arrangement of mounting are shown on the reverse side.

The top of the relay is provided with a terminal A2 to which a wire lead is attached. Connect this lead to the contactor coil terminal A2.

Place the three load leads of the relay in the load terminals T1, T2, and T3 of the contactor, being sure the stud at the bottom of the relay is secure in the slot at the base of the contactor.

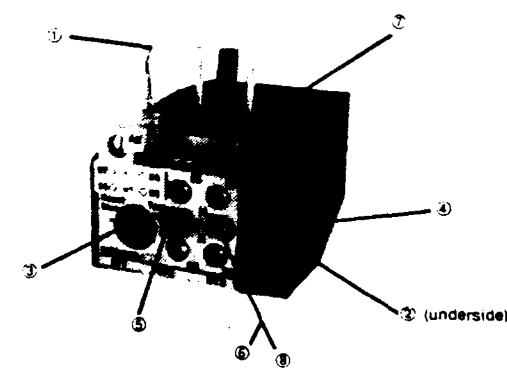
Connect the control circuit leads in the following manner: For overload protection, wire the control through the normally closed contacts marked 95 and 96. Terminals marked 97 and 98 are normally open contacts which can be used to initiate a command or turn on an alarm light.

Inspect to ensure that no wire cuttings are left inside the enclosure. Tighten all terminal screws firmly.

NOTE: Do not use automatic reset with two wire control.

⚠ WARNING

Hazardous Voltage.
Can Cause Electrical Shock And Burns.
Disconnect Power Before Procedding With Any Work On This Equipment.



① Line Terminals
② Load Terminals
③ Adjustment Knob
④ Trip Indicator
⑤ Test Button
⑥ Reset Button
⑦ Contact Terminals
⑧ Manual or Automatic Reset

Fig. 1

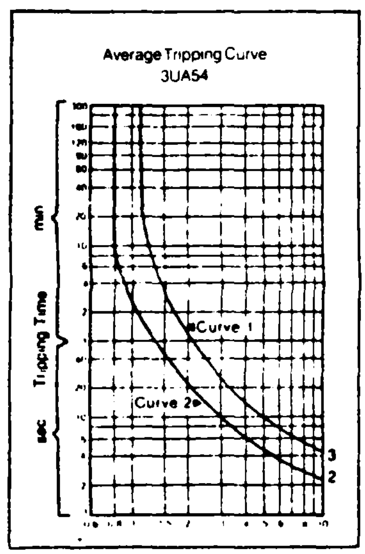


Fig. 2

Curves are based on "cold" start. For full running condition tripping time is 25% of rated values.

Adjustment

Marking on the dial denotes **Full Load Amps.**

Tripping current is **125%** of dial setting.

Motors with a marked **Service Factor not less than** 1.15 or motors with a marked temperature rise not over 40° C:

Set dial to full load current marked on motor nameplate.

All other motors noted for continuous duty including motors with a marked **Service Factor** of 1.0:

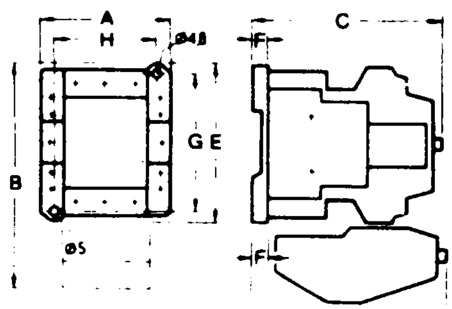
Multiply Motor Full Load current by 0.92 and set Overload Relay dial to that value. This will provide protection of 115% of Motor Full Load Current.

In case of overload relay tripping during motor starting or at maximum running conditions, the Overload Relay setting can be increased to the maximum value in accordance with NEC 430-34:

1.12 times motor full load current for motors with a marked Service Factor not less than 1.15

1.08 times motor full load current for motors with a marked Service Factor of 1.0 or temperature rise over 40° C.

Dimensions



	A	B	C	D	E	F	G	H
INCHES	2.76	5.70	4.10	4.13	3.35	.31	2.95	1.97
MM	70	145	104	105	85	8	75	50

NOTE: Reset Travel = 2.18 mm

Electrical Data

Catalog Number	Current Rating Range (amps)		Maximum* Fuse Size (amps)(K5)	Maximum Rating Circuit Breaker Thermal Magnetic (amps)	Former Catalog Number
	Low	High			
3UA5400-1G	4	6.3	15	15	OLR0630CS2
3UA5400-1J	6.3	10	25	20	OLR1000CS2
3UA5400-2A	10	16	40	30	OLR1600CS2
3UA5400-2B	12.5	20	50	40	OLR2000CS2
3UA5400-2C	16	25	60	50	OLR2500CS2
3UA5400-2D	20	32	80	50	OLR3200CS2
3UA5400-2Q	25	36	90	70	OLR3600CS2

Technical Data

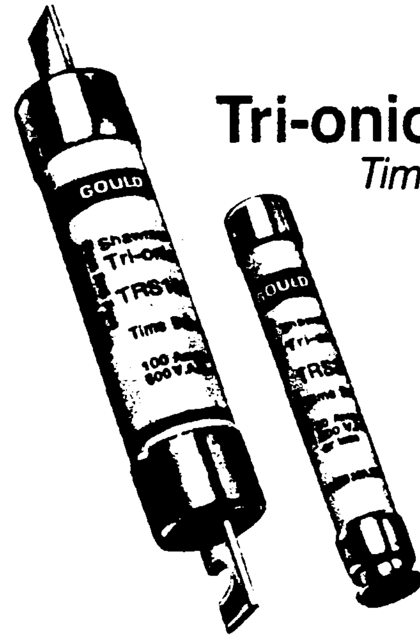
Rated Voltage	Volts AC	600
Permissible Ambient Temperature	°C °F	− 25 to + 55 − 13 to + 133
Setting Range from to	Amps Amps	10 to 16 25 to 36
Heating of Bimetal Elements		Direct
Permissible Frequency Range	Hz	Up to 400
Power Consumption - per Current Phase Max. at lower setting at upper setting	Watts Watts	0.8 2.0
Wire Size Range for Power Connection		14-10 AWG
Auxiliary Contacts		1 NO & 1 NC Isolated Contact above 150V same polarity
Control Circuit Protection Type KTK or equivalent	Amps	6
Continuous Current	Amps	5
Contact Rating— NEMA B600 Volts AC 120 240 480 600	make (Amps) 30 15 7.5 6	break VA (Amps) VA 3600 3 360 3600 1.5 360 3600 0.75 360 3600 0.6 360

Siemens Energy & Automation, Inc.
Controls Division
Box 29265
New Orleans, LA 70189

Most popular fuse for motor branch circuits. Also suitable for general purpose protection of transformers, service entrance equipment, feeder circuits and branch circuits. The time delay characteristic of the Tri-onic fuse allows it to ignore normal surge conditions without compromising overcurrent protection.

This is a rejection fuse. Replacement of this fuse with a fuse of a lower voltage or lower interrupting rating is not possible provided this fuse is used with rejection fuse blocks such as those listed on page 17.

The fiberglass body and plated contacts provide superior reliability in adverse industrial environments.



Tri-onic® –Class RK5

Time Delay Fuses

TR/TRS

FEATURES

- Fiberglass body for dimensional stability
- Plated contact surfaces for contact reliability
- Imprint labeling for permanent identification

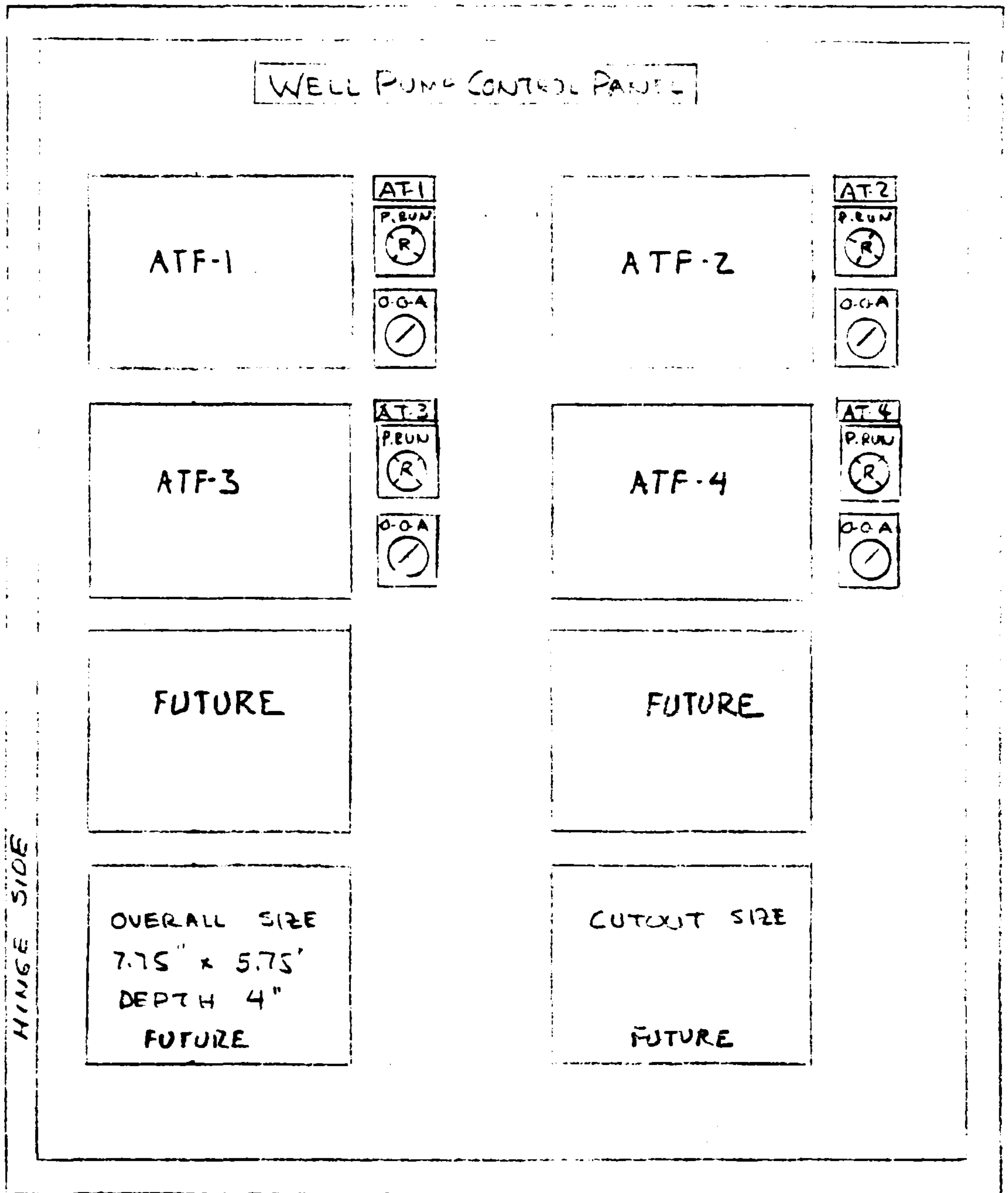
UL Class RK5

Time Delay
Current Limiting
200KA I.R.
250 and 600 Volts AC
1/10 to 600 Amperes
UL Listed
CSA Certified
MSHA Certified
DC Ratings

Standard Fuse Ampere Ratings, Catalog Numbers

AMPERE RATING	CATALOG NUMBER		AMPERE RATING	CATALOG NUMBER		AMPERE RATING	CATALOG NUMBER		AMPERE RATING	CATALOG NUMBER	
	250V	600V		250V	600V		250V	600V		250V	600V
1/10	TR1/10R	TRS1/10R	2¼	TR2¼R	TRS2¼R	10	TR10R	TRS10R	90	TR90R	TRS90R
15/100	TR15/100R	TRS15/100R	2½	TR2½R	TRS2½R	12	TR12R	TRS12R	100	TR100R	TRS100R
2/10	TR2/10R	TRS2/10R	2 8/10	TR2 8/10R	TRS2 8/10R	15	TR15R	TRS15R	110	TR110R	TRS110R
3/10	TR3/10R	TRS3/10R	3	TR3R	TRS3R	17½	TR17½R	TRS17½R	125	TR125R	TRS125R
4/10	TR4/10R	TRS4/10R	3 2/10	TR3 2/10R	TRS3 2/10R	20	TR20R	TRS20R	150	TR150R	TRS150R
½	TR½R	TRS½R	3½	TR3½R	TRS3½R	25	TR25R	TRS25R	175	TR175R	TRS175R
6/10	TR6/10R	TRS6/10R	4	TR4R	TRS4R	30	TR30R	TRS30R	200	TR200R	TRS200R
8/10	TR8/10R	TRS8/10R	4½	TR4½R	TRS4½R	35	TR35R	TRS35R	225	TR225R	TRS225R
1	TR1R	TRS1R	5	TR5R	TRS5R	40	TR40R	TRS40R	250	TR250R	TRS250R
1⅛	TR1⅛R	TRS1⅛R	5 6/10	TR5 6/10R	TRS5 6/10R	45	TR45R	TRS45R	300	TR300R	TRS300R
1¼	TR1¼R	TRS1¼R	6	TR6R	TRS6R	50	TR50R	TRS50R	350	TR350R	TRS350R
1 4/10	TR1 4/10R	TRS1 4/10	6¼	TR6¼R	TRS6¼R	60	TR60R	TRS60R	400	TR400R	TRS400R
1 6/10	TR1 6/10R	TRS1 6/10R	7	TR7R	TRS7R	70	TR70R	TRS70R	450	TR450R	TRS450R
1 8/10	TR1 8/10R	TRS1 8/10R	8	TR8R	TRS8R	75	TR75R	TRS75R	500	TR500R	TRS500R
2	TR2R	TRS2R	9	TR9R	TRS9R	80	TR80R	TRS80R	600	TR600R	TRS600R

NAVAL INDUSTRIAL RESERVE ORNANCE PLANT
GROUNDWATER EXTRACTION SYSTEM

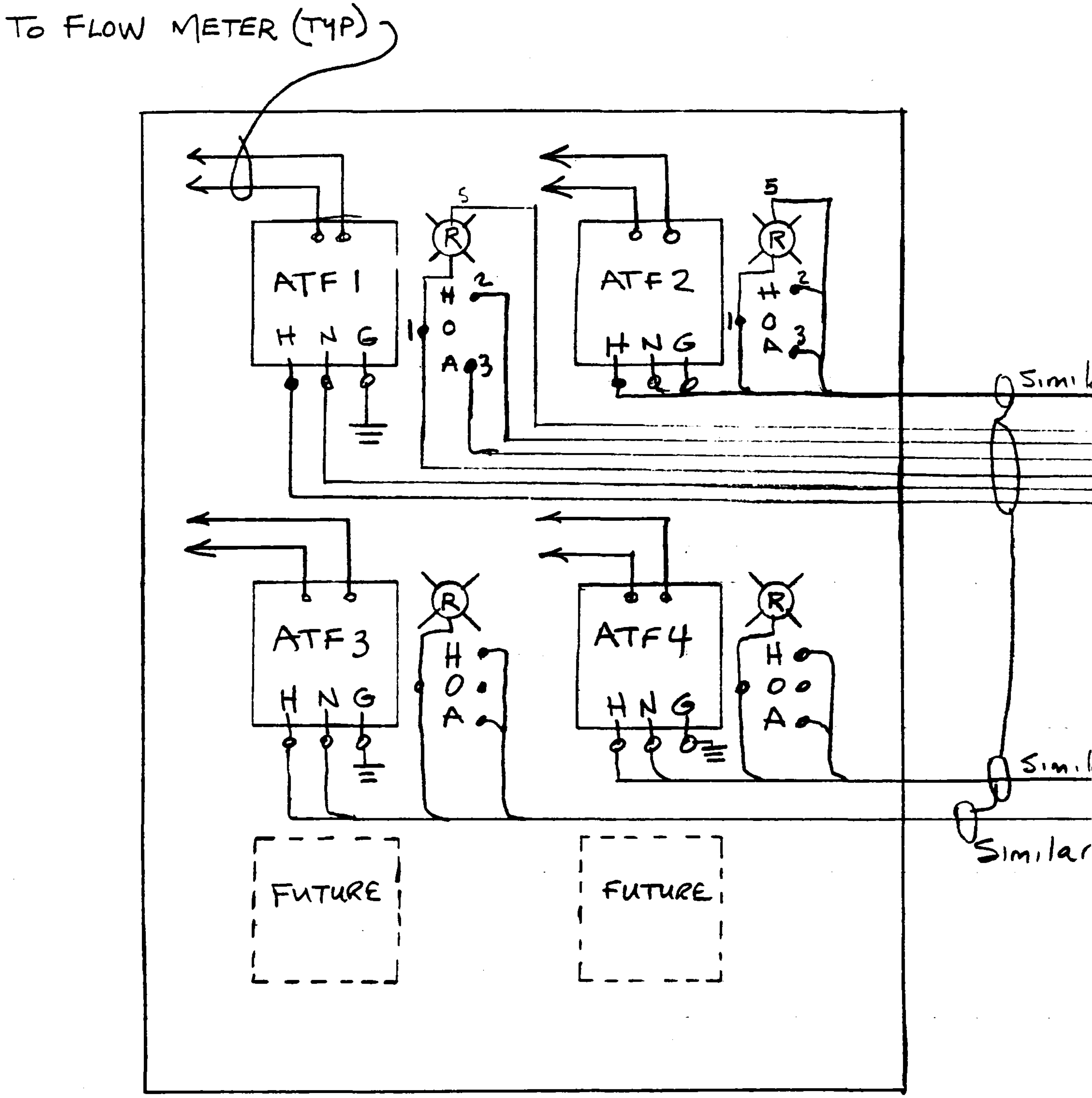


PANEL FRONT LAYOUT ~3/16 SCALE NEMA 12

ENCLOSURE : HOFF. A36-30-08LP W/ A36 P30 PLATE
PAINT: ASA 61 GRAY BAKED ENAMEL
PILOT LITE: AB-800T-P16 R "PUMP RUN"
SEL. SW.: " " -J2A "ON-OFF-AUTO"
ENGRAVED NAMEPLATES (NOTE: NP-8 WILL BE MOUNTED ON FRONT OF FLOW READOUT "FLOW METER TOTAL".
AT-6, 7 & 8 ARE FUTURE - BLANK SPACE ONLY

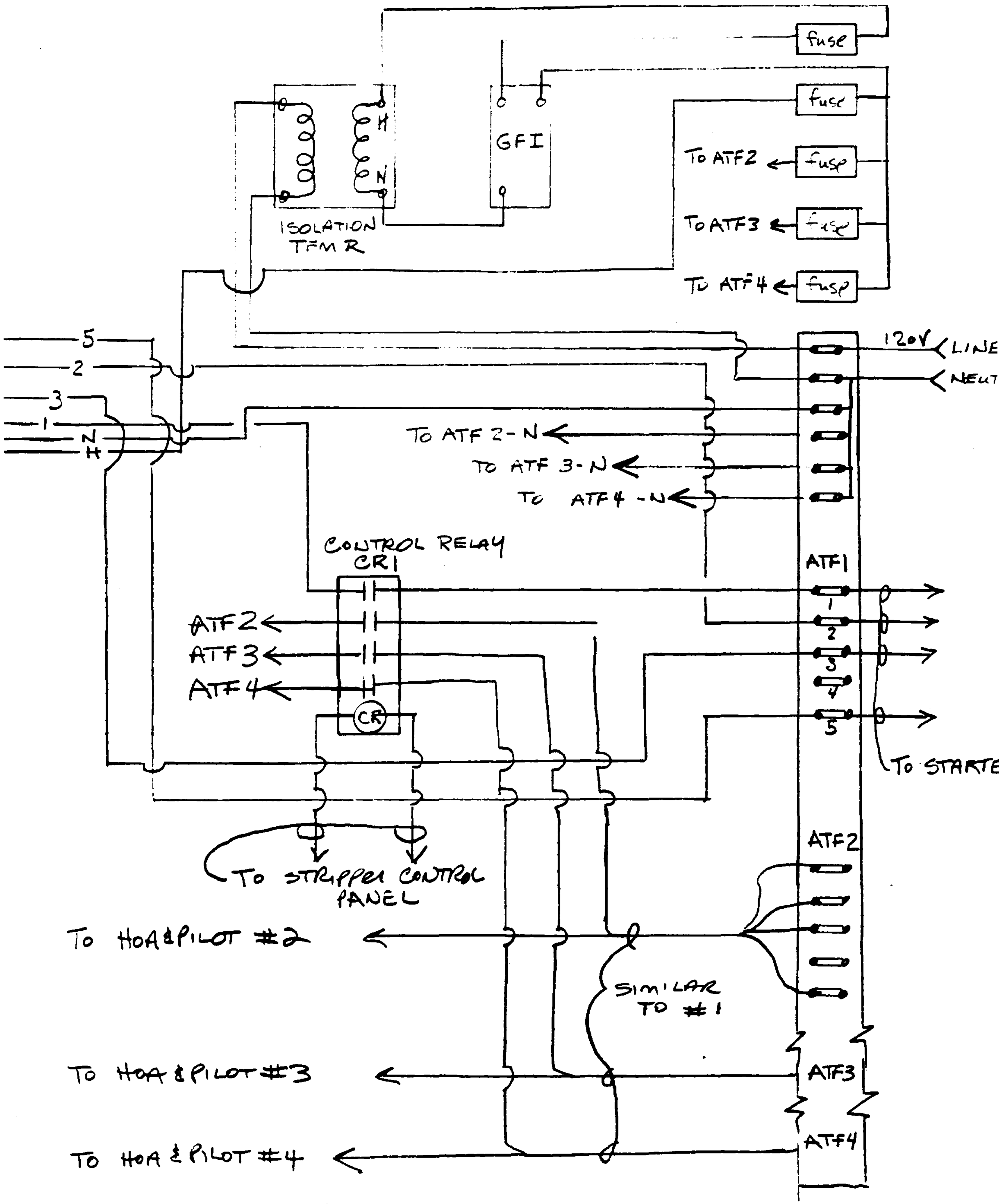
WELL PUMP CONTROL PANEL

FRONT COVER



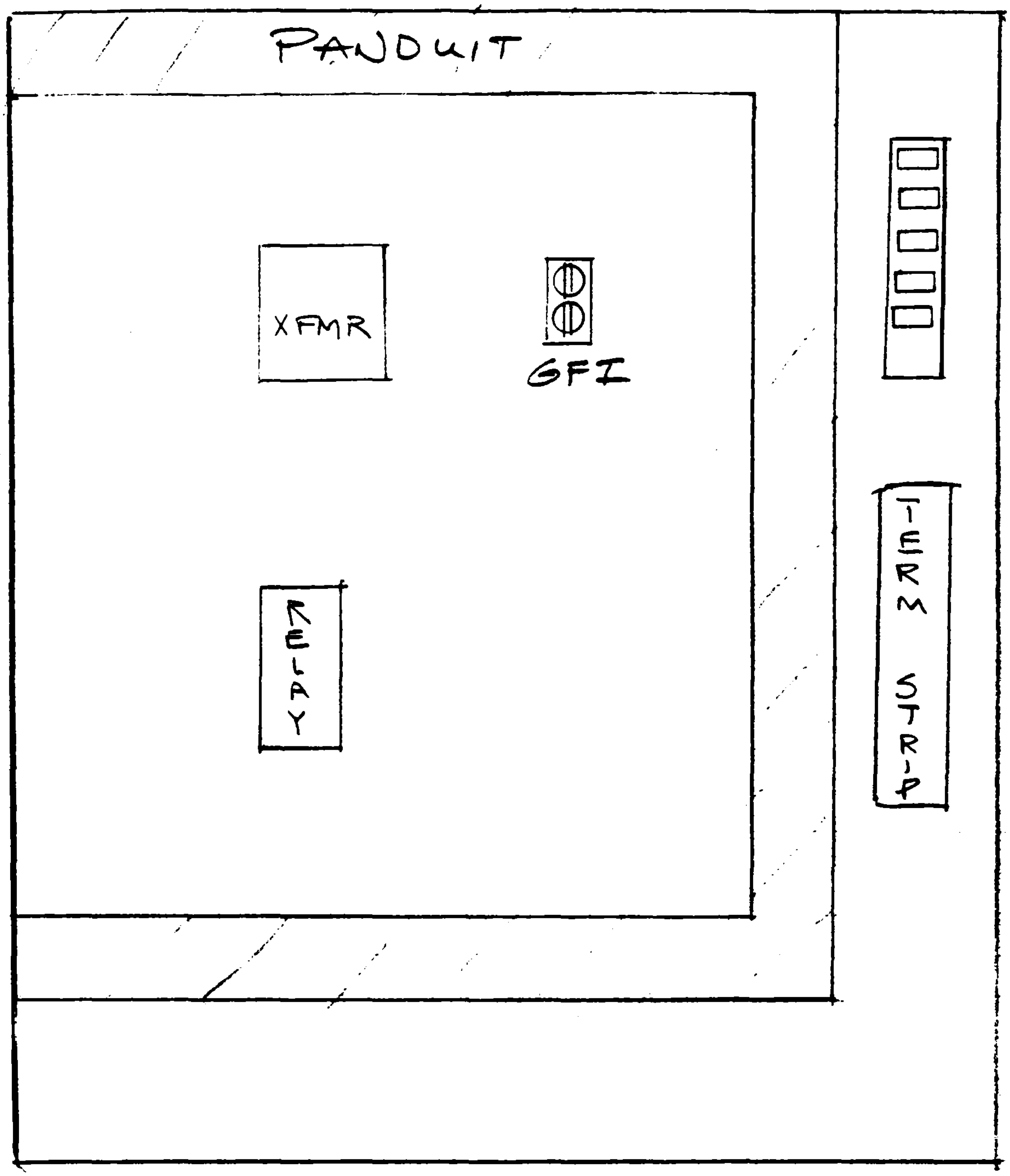
WELL PUMP CONTROL PANEL

INTERIOR



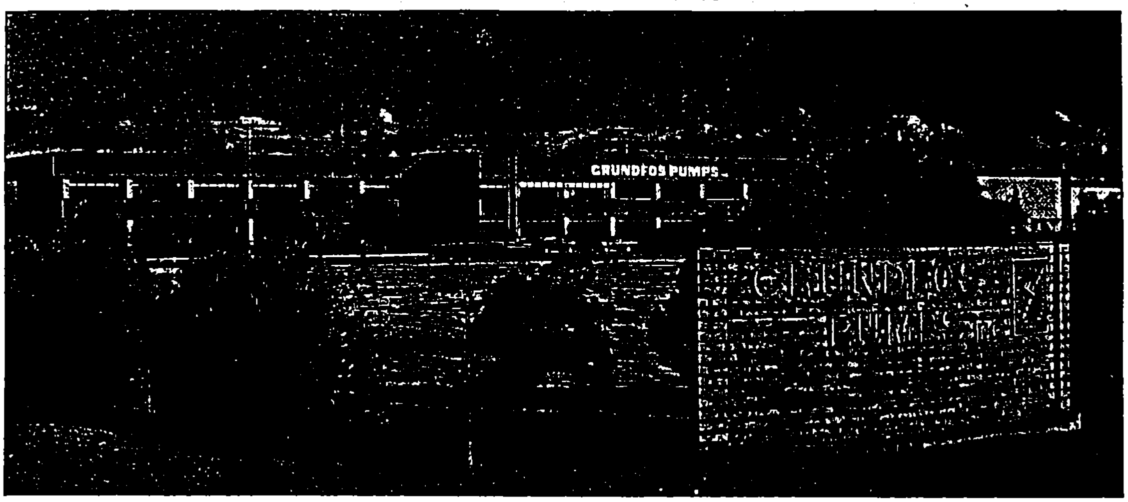
WELL PUMP CONTROL PANEL

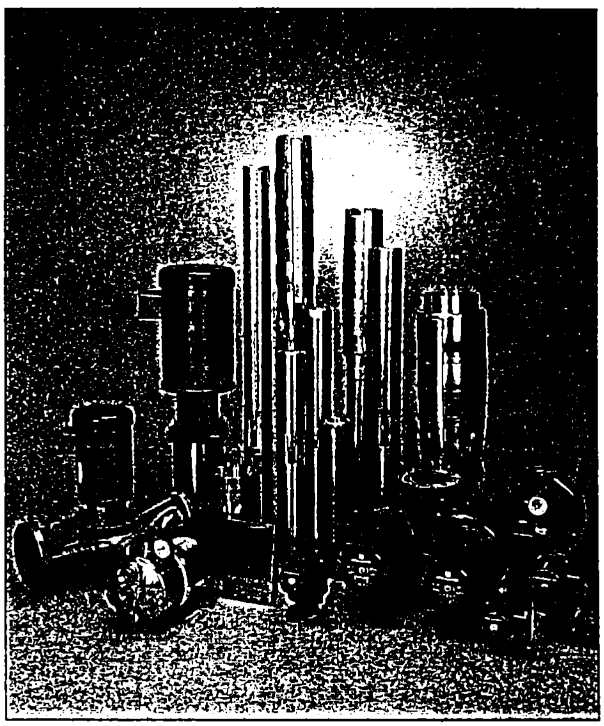
INTERIOR



GRUNDFOS

Grundfos Stainless Steel Pumps for Domestic, Commercial, Industrial and Agricultural Applications





Grundfos Pumps
Headquartered in Clovis, California Grundfos Pumps manufactures a full line of stainless steel submersibles, convertible jet pumps, and sump pumps as well as domestic and commercial circulators and multi-stage centrifugals.

Using stainless steel for nearly every vital component and highly automated, computer-assisted production techniques, the Grundfos commitment to quality can be found in every pump they produce. Reliable, efficient pumps...built to last.

For additional information on Grundfos ***SuperSteeler***™ submersibles or other Grundfos products, contact a Grundfos representative in your area, or:

Grundfos Pumps Corp.
2555 Clovis Avenue
Clovis, California 93612
(209) 292-8000
Telex: 35-5353
FAX: (209) 291-1357

...ECT TO CORRECTIONS
...TO THE PROVISIONS OF
...FICATIONS.
A
DEC 28 19..
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E. Koenig
SEE ATTACHED COMMENTS

GRUNDFOS®

Making the Best Even Better!

Grundfos Pumps Corp. / 2555 Clovis Ave. / Clovis, CA 93612
Distribution Centers: Allentown, PA • Atlanta, GA • Mississauga, Ontario, Canada

L-SP-SL-001 | 3/26/88
PRINTED IN USA

...ED TO THE PROVISIONS OF THE SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig

SEE ATTACHED COMMENTS

SUPER STEELER

Grundfos SuperSteeler™ Submersibles for 6, 8, & 10-Inch and Larger Wells.

Stainless steel construction, coupled with computer-aided design and manufacturing, assures top performance, reliable operation, and long life.

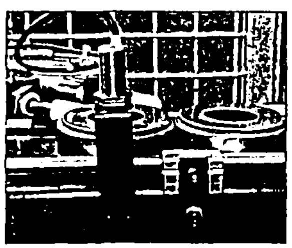
The Stainless Steel Advantage

PUMP PERFORMANCE – Grundfos ***SuperSteelers***™ are built to work hard with every component designed for maximum hydraulic efficiency. With the inherently smooth surfaces of fabricated stainless steel, peak performance is maintained over many years of service... unlike pumps made from plastic, bronze or cast iron.

RELIABLE OPERATION – Highly advanced design and manufacturing techniques have minimized the number of moving parts. This, plus the ***SuperSteeler's***™ rugged stainless steel construction, make it the toughest, most reliable pump on the market. *You get the water you need, when you need it!*

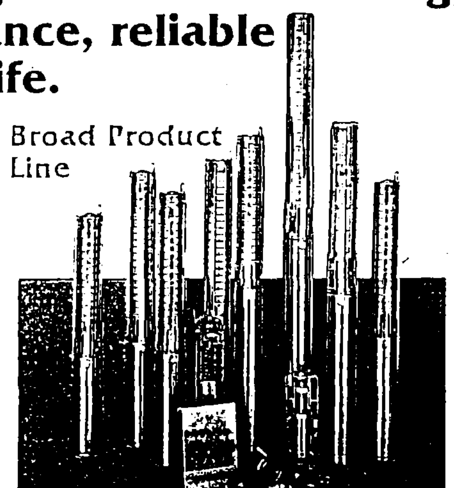
LONG LIFE – Stainless steel is the best available material to resist wear and corrosion in a water system application. Compare ***SuperSteeler's***™ stainless steel construction to the best the other manufacturers have to offer. The ***SuperSteeler***™ is designed to operate efficiently and effectively for a long, long time.

Automated Manufacturing



Computer-controlled manufacturing techniques assure that each ***SuperSteeler***™ is built to exacting tolerances. Grundfos' continuing investment in state-of-the-art production equipment includes an extensive use of robotics and the most advanced quality assurance methods available today. Each and every ***SuperSteeler***™ is built to maximize performance and reliability.

Broad Product Line



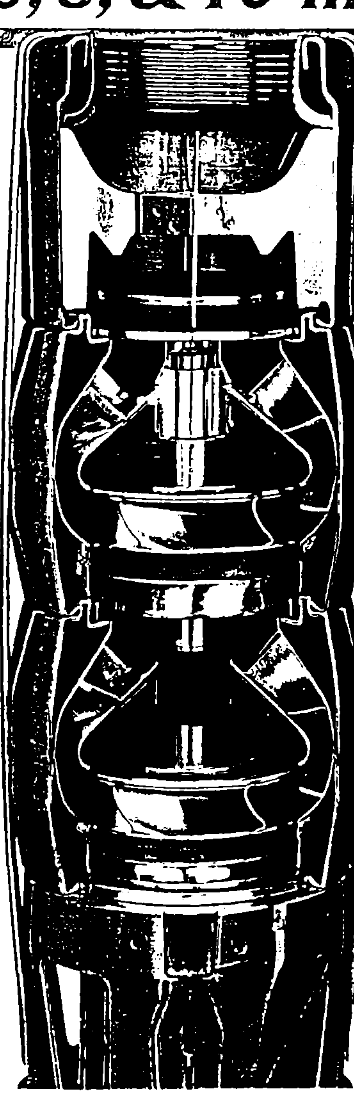
The 4-inch ***SuperSteeler***™ line covers all flow requirements from 1 to 95 gpm. This broad range assures an efficient and effective pump selection for every water system application.

For high flow and pressure requirements, the ***SuperSteeler***™ line includes 6, 8, and 10-inch models for flows up to 1,300 gpm and Deep Set models for well settings to nearly 2,000 feet.

Customer Service and Training

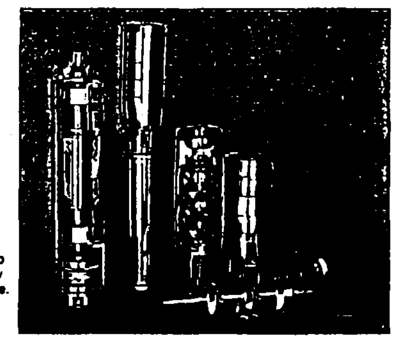
At Grundfos, customer satisfaction is just as important as putting the best submersible pump on the market. Our widespread distribution network assures prompt deliveries and a ready source of product information and pump selection assistance.

Education and training play an important role in our total customer service package. Formal training programs held at our factory and regional distribution centers develop a greater appreciation of the value built into the ***SuperSteeler***™ product line.

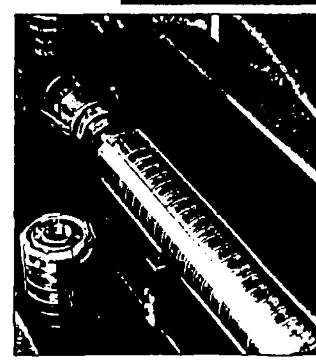


GRUNDFOS ***SuperSteeler***™ 6-INCH SUBMERSIBLE

STAINLESS STEEL IMPELLERS – Even the largest ***SuperSteeler***™ impellers are fabricated from stainless steel for maximum hydraulic efficiency.



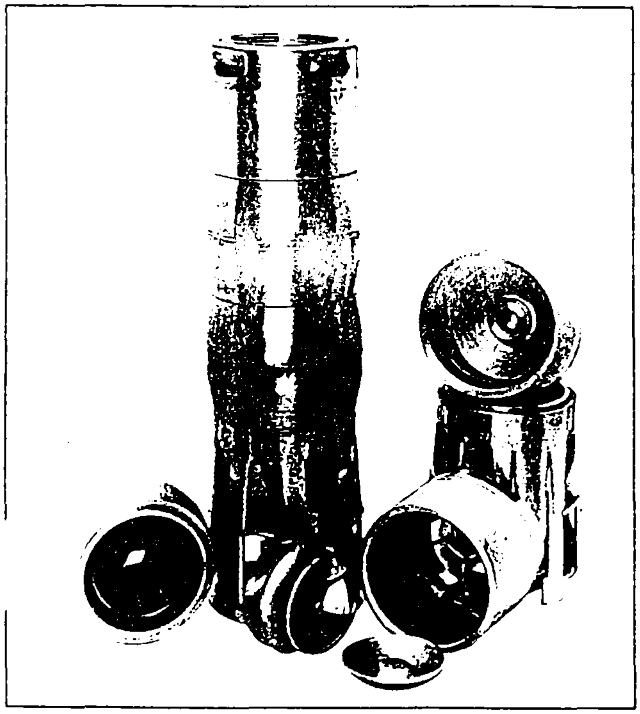
"NO-COMPROMISE" SPECIFICATIONS – Close tolerance, high strength stainless steel components assure top performance and many years of reliable service.

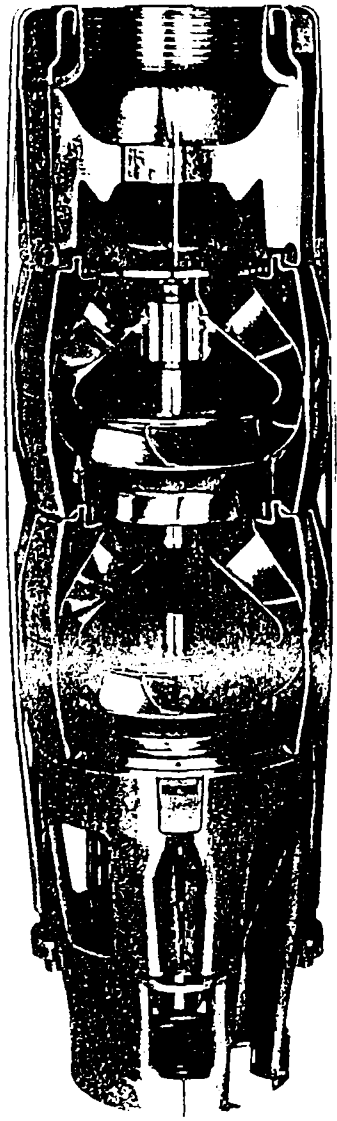


PERFORMANCE TESTED – No ***SuperSteeler***™ leaves the factory until it is rigorously tested to verify specified performance.

Pump Selection Guide

DEL	MIN. WELL SIZE	FLOW RANGE (GPM)	MAX. WORKING HEAD (FEET)	MAX. WORKING HEAD (PSI)
80S	6"	48-110	845	366
135S	6"	75-200	835	361
225S	6"	150-290	680	294
375S	8"	230-500	310	134
600S	10"	350-800	420	182
1000S	10"	600-1300	575	249

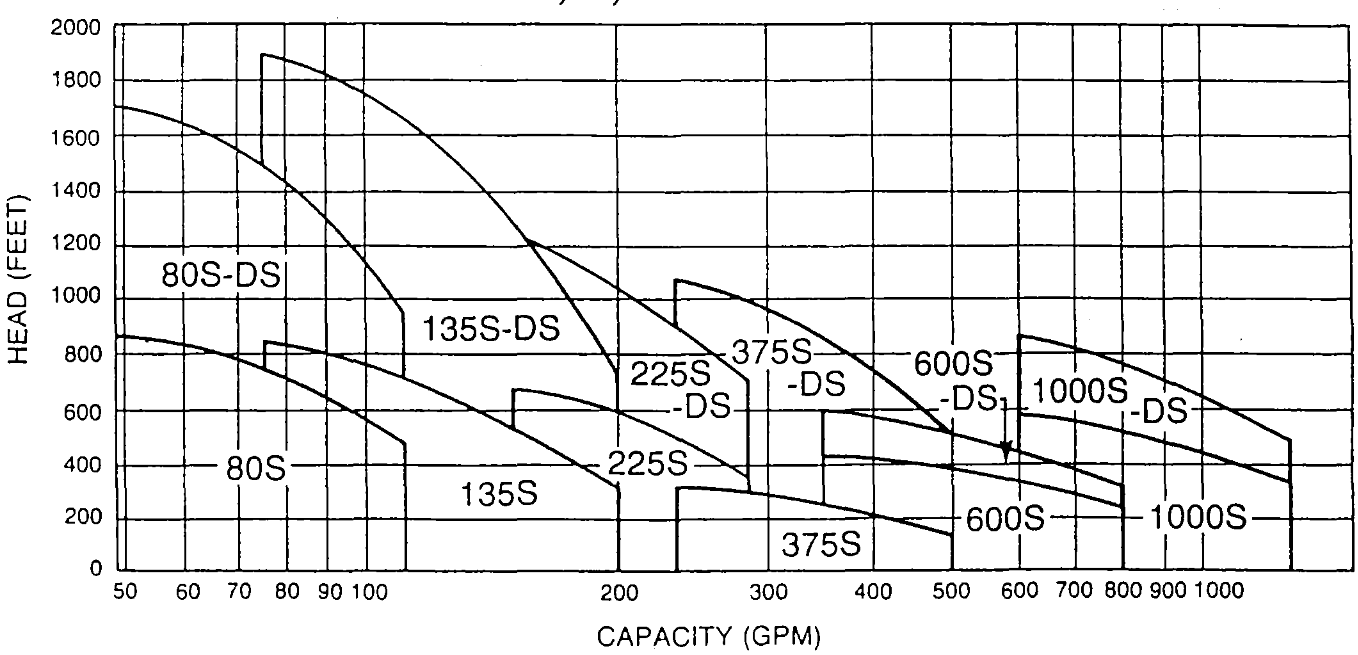




Features

- ☑ Built-in, jam-free check valve designed for failsafe operation.
- ☑ Stainless Steel cable guard is designed for easy installation and removal. Holds tight and provides maximum protection to motor leads.
- ☑ ***PrecisionForm***™ impellers are fabricated from stainless steel to provide long pump life, maximum hydraulic efficiency and top pump performance.
- ☑ Exclusive ***PrimeInducer***™ on models through the 225S provides maximum pump protection from dry-run damage during low water situations.
- ☑ Pump inlet is totally screened to prevent damage from debris.
- ☑ All Grundfos submersibles are performance tested at the factory to verify specified performance.

6, 8, & 10-Inch



 NOTE: For Deep Set models see Section 4.

Pump Selection Guide

4-Inch & Larger Wells

MODEL	MIN. WELL SIZE	FLOW RANGE (GPM)	MAX. HEAD (FEET)	MAX. HEAD (PSI)
5S	4"	1.2-7	870	377
7S	4"	3-10	680	294
10S	4"	5-14	950	411
16S	4"	10-20	990	429
25S	4"	18-32	630	273
40S	4" & 6"	24-55	755	327
60S	4"	40-75	505	219
75S	4"	45-95	460	199

6, 8, & 10-Inch and Larger Wells

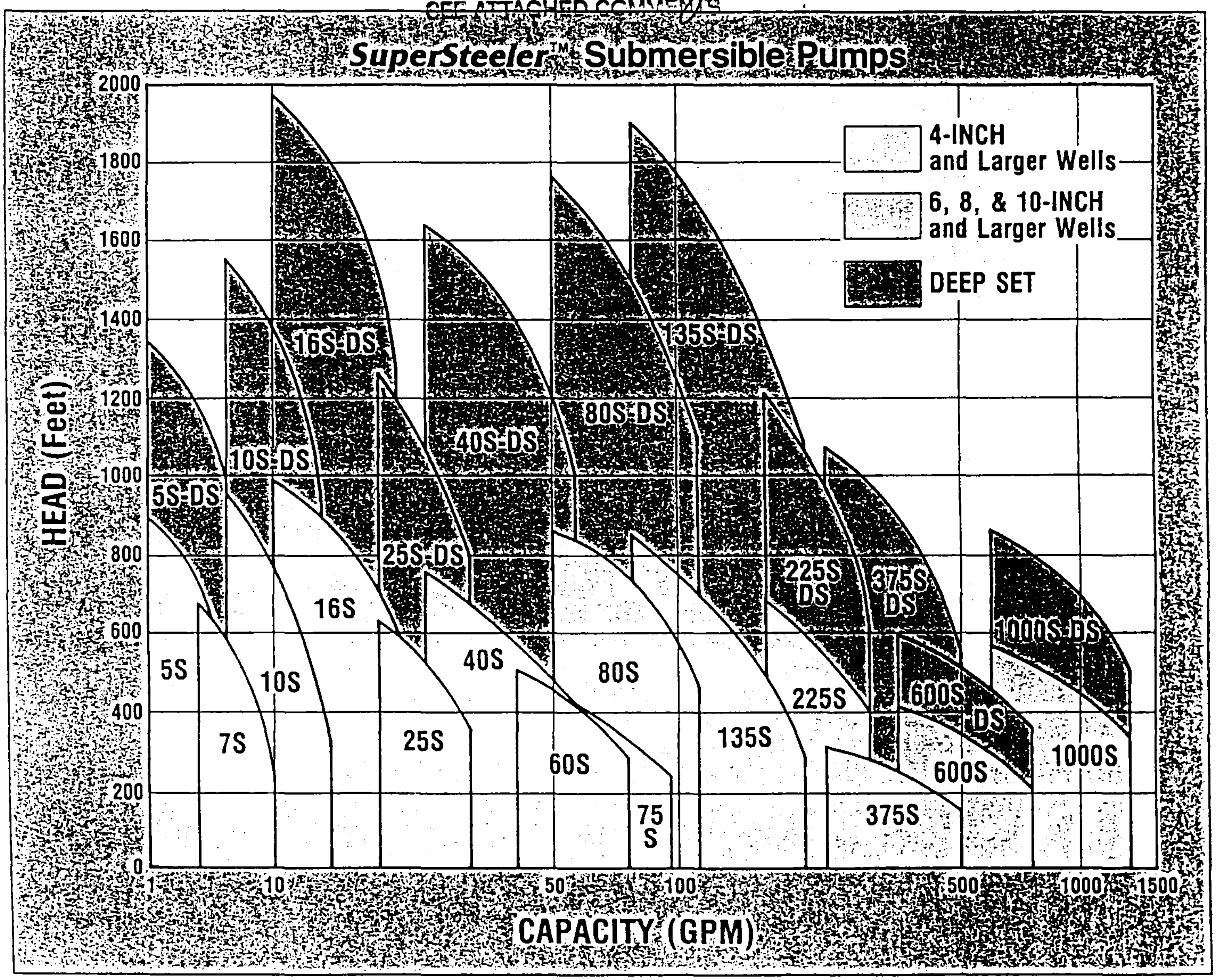
MODEL	MIN. WELL SIZE	FLOW RANGE (GPM)	MAX. HEAD (FEET)	MAX. HEAD (PSI)
80S	6"	48-110	845	366
135S	6"	75-200	835	361
225S	6" & 8"	150-290	680	294
375S	8"	230-500	310	134
600S	10"	350-800	420	182
1000S	10"	600-1300	575	249

Deep Set

MODEL	MIN. WELL SIZE	FLOW RANGE (GPM)	MAX. HEAD (FEET)	MAX. HEAD (PSI)
5S-DS	4"	1.2-7	1330	576
10S-DS	4" & 5"	5-14	1550	671
16S-DS	6"	10-20	1980	857
25S-DS	6"	18-32	1255	543
40S-DS	6"	24-55	1655	716
80S-DS	6" & 8"	48-110	1745	755
135S-DS	8"	75-200	1910	827
225S-DS	8"	150-290	1220	528
375S-DS	8"	230-500	1080	467
600S-DS	10"	350-800	590	255
1000S-DS	10"	600-1300	860	372

SUBJECT TO CORRECTIONS
NOTED & TO THE PROVISIONS OF
THE SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig
SEE ATTACHED COMMENTS

Pump Performance



Materials of Construction (Standard Pumps)

(Refer to "**Material Codes**" below for material specifications.)

COMPONENT	80S	135S	225S	375S	600S	1000S
	C	C	C	C	C	C
Check Valve Housing	2	2	2	2	2	2
Check Valve	2	2	2	2	2	2
Check Valve Seat	10/3	10/3	10/3	10/3	10/3	10/2
Diffuser Chamber	2	2	2	2	2	2
Top Bearing	10/3	10/3	10/3	10/3	10/3	10/3
Impeller Seal Ring	10/2	10/2	10/2	10/2	10/2	10/2
Split Cone Nut	2	2	2	2	8	2
Split Cone	2	2	2	2	8	2
Impeller	2	2	2	2	2	2
Suction Interconnector	2	2	2	2	2	2
Inlet Screen	2	2	2	2	2	2
Pump Shaft	7	7	7	7	7	7
Coupling	4/5	4/5	4/5	4/5	4/5	4/5
Coupling Key	1/2	1/2	1/2	1/2	1/2	1/2
Straps	2	2	2	2	2	2
Cable Guard	2	2	2	3	3	2
Priming Inducer	2	2	2	2	2	2
Intermediate Bearings	10	10	10	10	10	10
8" Motor Adaptor Plate	NR	9	9	9	NR	NR

NOTES: C: Cylindrical Shaft NR: Not Required

Material Codes

CODE NO.	MATERIAL
1	302 Stainless Steel
2	304 Stainless Steel
3	316 Stainless Steel
4	329 Stainless Steel
5	416 Stainless Steel
6	420 Stainless Steel
7	431 Stainless Steel
8	Zincless Bronze
9	Ni-Resist
10	NBR
11	PBT (Valox®)
12	PPS (Ryton® PPS)

NOTES:

Specifications are subject to change without notice.

Valox® is the registered trademark of General Electric Company.

Ryton® PPS is a registered trademark of Phillips 66.

Submersible Pump Nomenclature

10S05-9 = 10 S 05 - 9

Nominal Flow Rate (GPM) — 10

Submersible — S

Horsepower — 05

05 = ½ HP

50 = 5 HP

500 = 50 HP

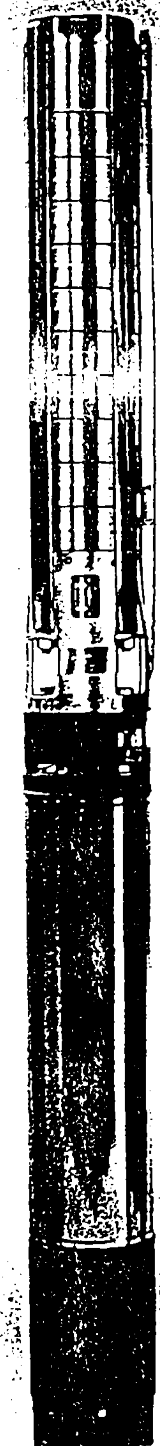
Number of Stages — 9

MODEL
80S

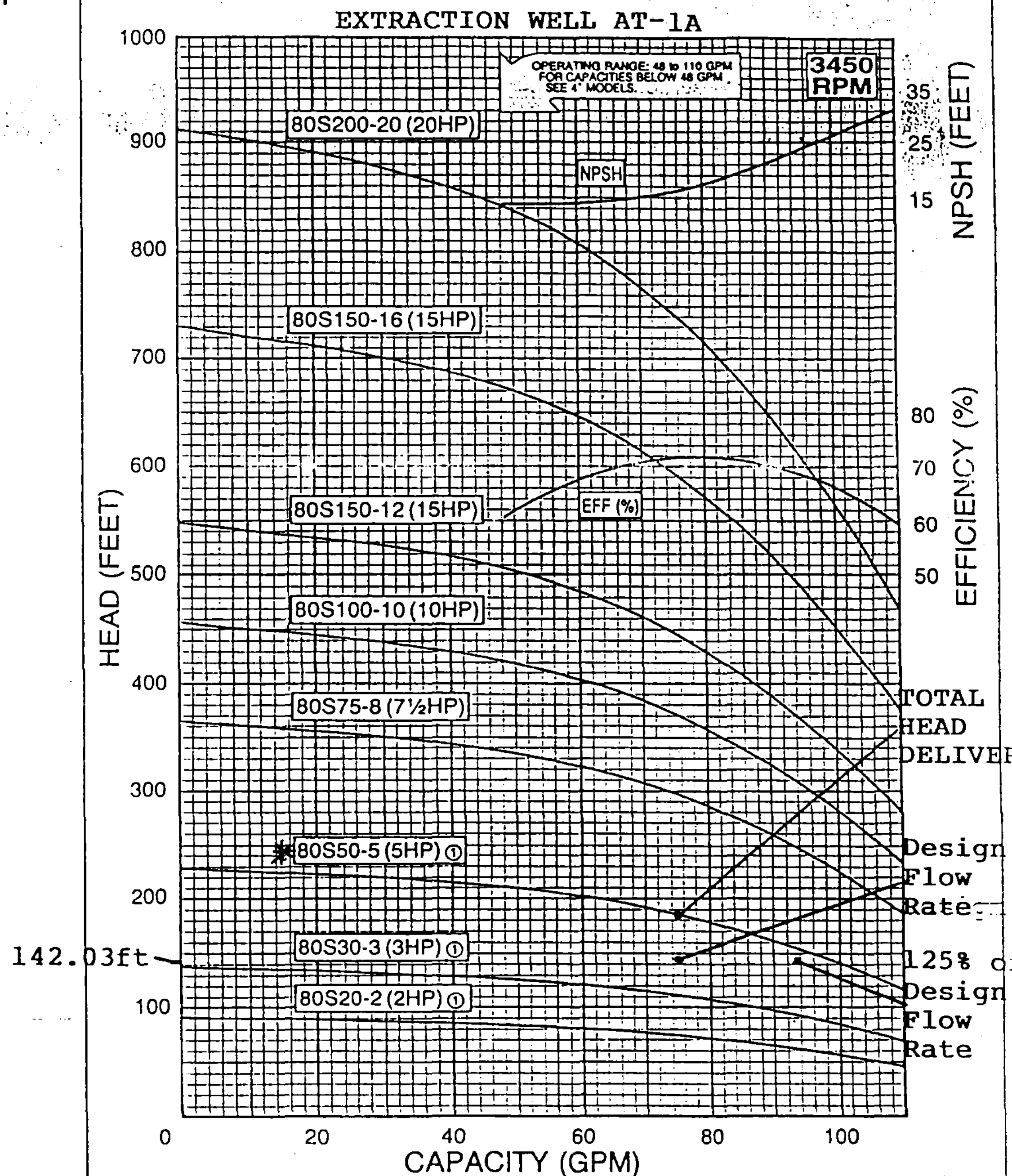
80 GPM

GRUNDFOS

FLOW RANGE
48 to 110 GPM
PUMP OUTLET
3" NPT



PERFORMANCE CURVES

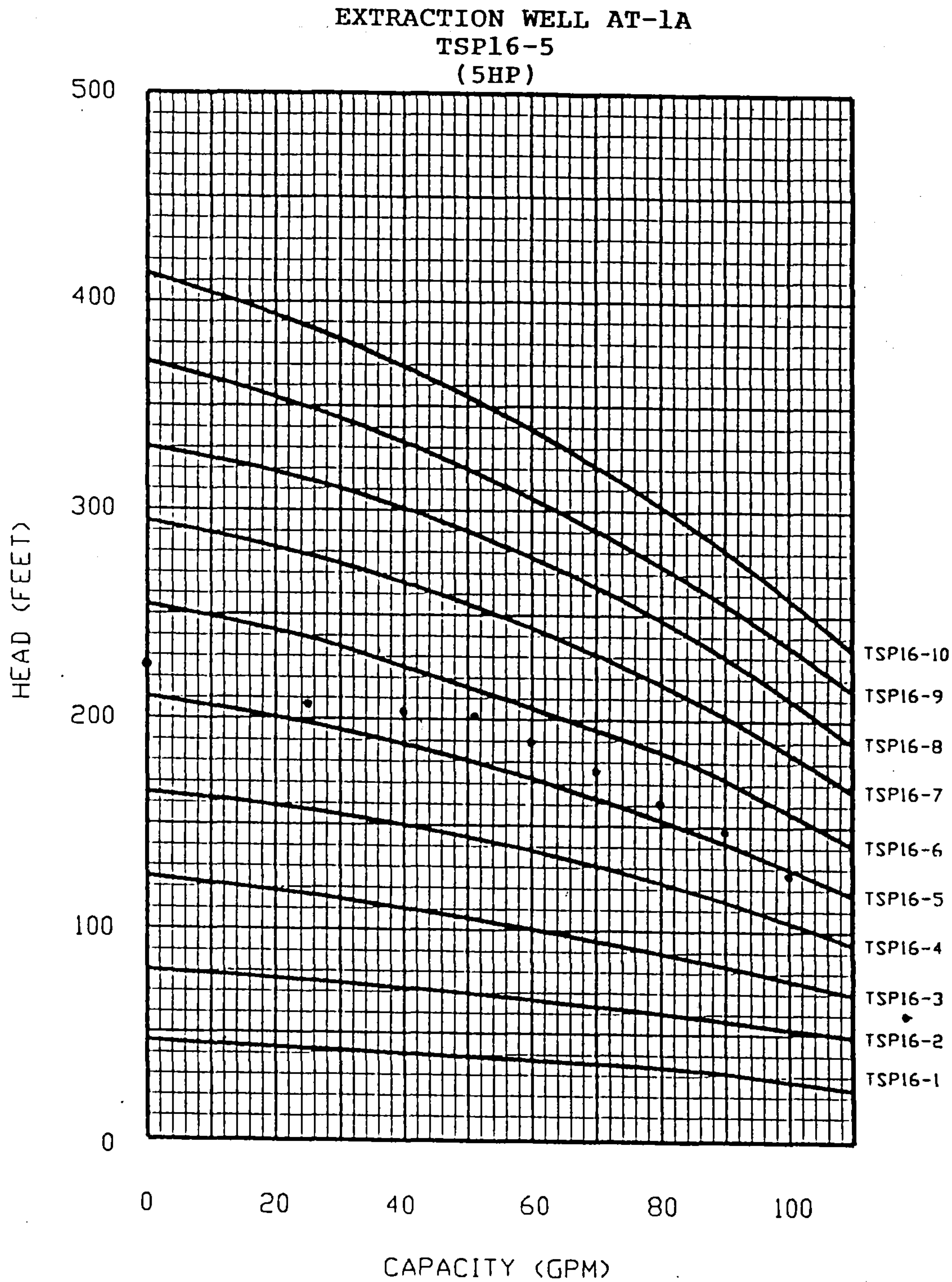


DIMENSIONS AND WEIGHTS

MODEL NO.	HP	MIN. WELL SIZE (INCHES)	LENGTH (INCHES)	MAX. WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
80S20-2	2①	6	33 5/8	5 3/16	51
80S30-3	3①	6	37 7/8	5 3/16	65
80S50-5	5①	6	44 3/8	5 3/16	87
80S75-8	7 1/2	6	51 1/2	5 1/2	144
80S100-10	10	6	56 1/4	5 1/2	154
80S150-12	15	6	62 1/4	5 1/2	173
80S150-16	15	6	69 1/2	5 1/2	184
80S200-20	20	6	99	5 1/2	207

NOTES: ① 4-Inch motor. Specifications are subject to change without notice.

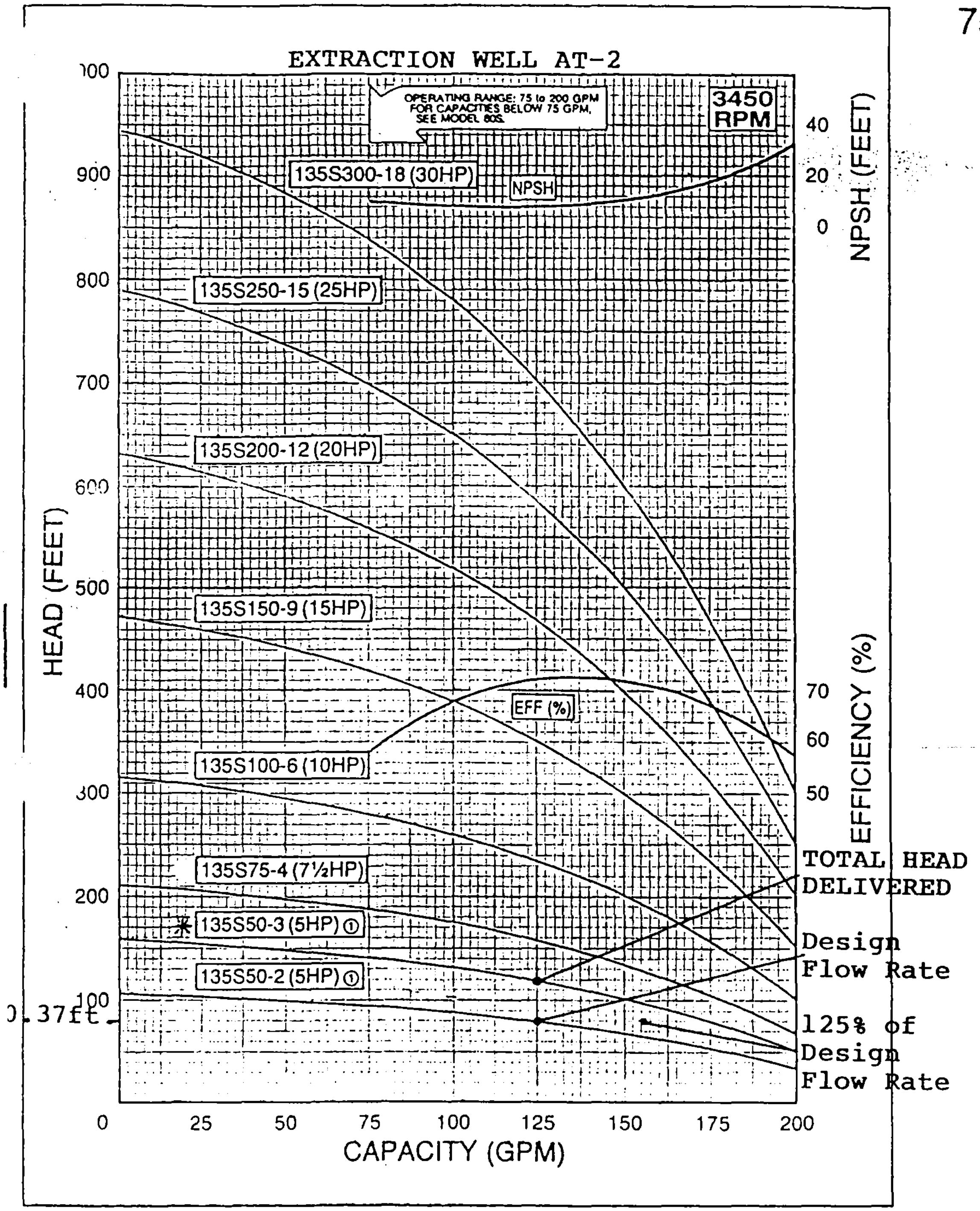
TSP16 PERFORMANCE CURVES



GRUNDFOS 135 GPM

MODEL
135S

PERFORMANCE CURVES



FLOW RANGE
75 to 200 GPM

PUMP OUTLET
3" NPT

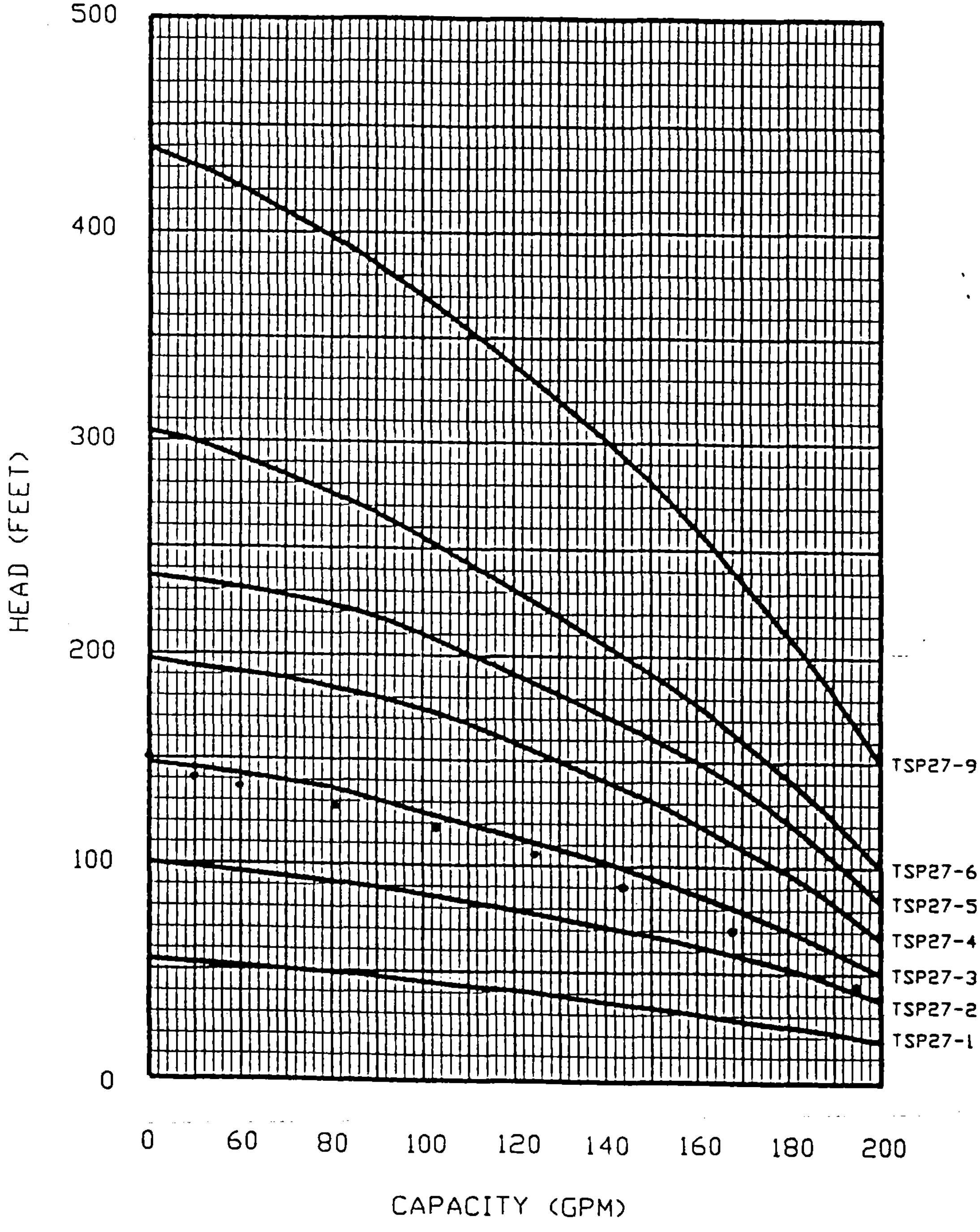
DIMENSIONS AND WEIGHTS

MODEL NO.	HP	MIN. WELL SIZE (INCHES)	LENGTH (INCHES)	MAX. WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
135S50-2	5①	6	42 ½	5 ½	84
135S50-3	5①	6	47	5 ½	88
135S75-4	7½	6	51 ½	5¾	146
1[illegible]5S100-6	10	6	59 7/8	5¾	167
[illegible]150-9	15	6	73	5¾	186
[illegible]00-12	20	6	86 ¼	5¾	225
135S250-15	25	6	99 ¼	5¾	243
135S300-18	30	6	112⅜	5¾	268

NOTES: ① 4-inch motor. Specifications are subject to change without notice.

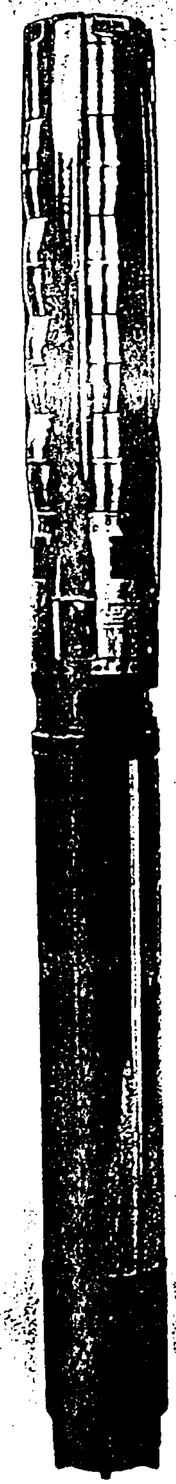
TSP27 PERFORMANCE CURVES

EXTRACTION WELL AT-2
TSP27-3
(5HP)

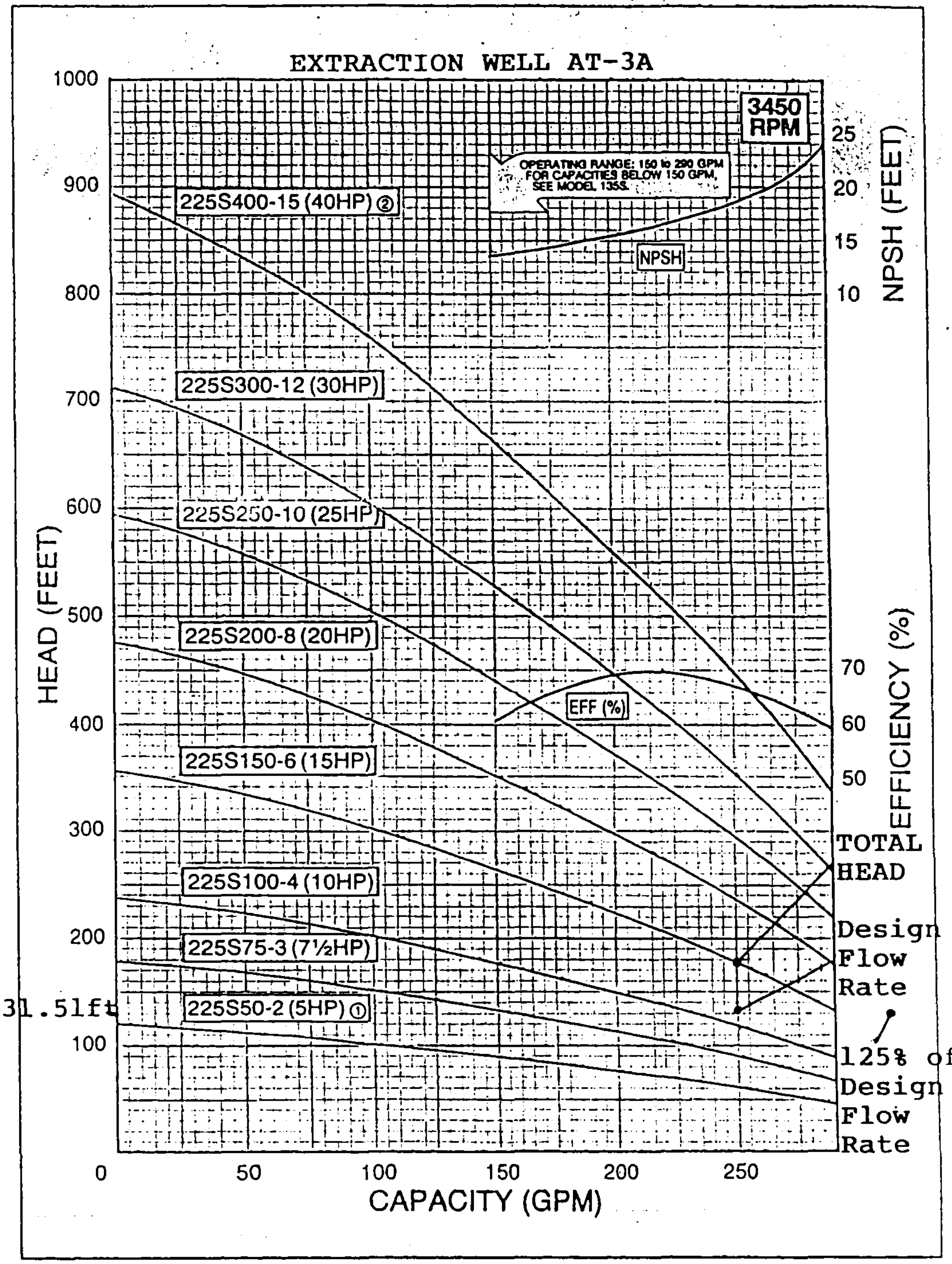


MODEL 225S	225 GPM	GRUNDFOS

FLOW RANGE
150 to 290 GPM
PUMP OUTLET
3" NPT



PERFORMANCE CURVES



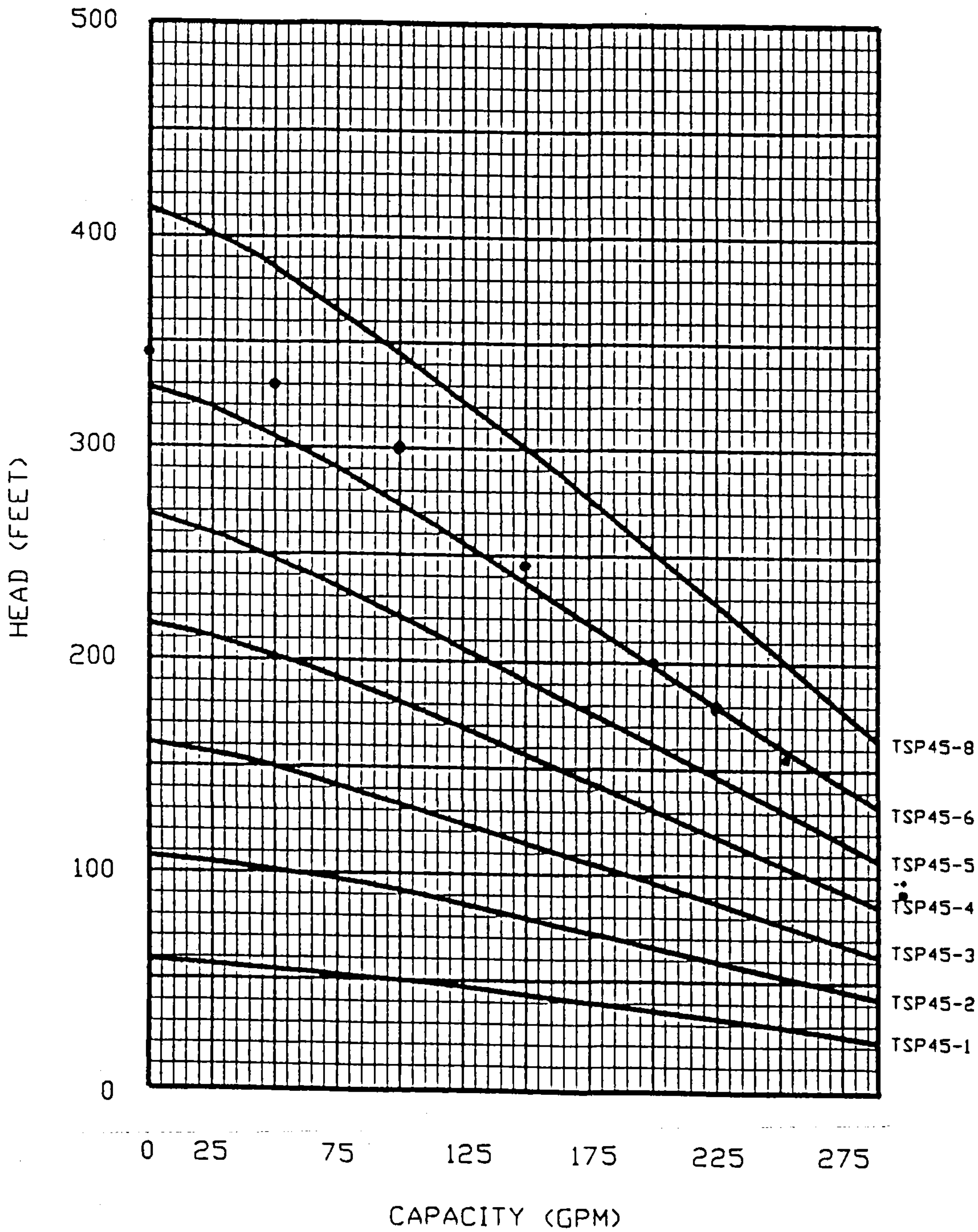
DIMENSIONS AND WEIGHTS

MODEL NO.	HP	MIN. WELL SIZE (INCHES)	LENGTH (INCHES)	MAX. WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
225S50-2	5①	6	43 3/8	5 5/8	86
225S75-3	7 1/2	6	48 1/2	5 3/4	133
225S100-4	10	6	54 3/8	5 3/4	145
225S150-6	15	6	64 3/4	5 3/4	174
225S200-8	20	6	75 1/4	5 3/4	195
225S250-10	25	6	85 5/8	5 3/4	221
225S300-12	30	6	96 7/8	5 3/4	260
225S400-15	40②	6	117 5/8	5 3/4	320

NOTES: ① 4-inch motor.
② 6-inch motor standard; 8-inch motor optional.
Specifications are subject to change without notice.

TSP45 PERFORMANCE CURVES

EXTRACTION WELL AT-3A
TSP45-6
(15 HP)



MODEL
80S

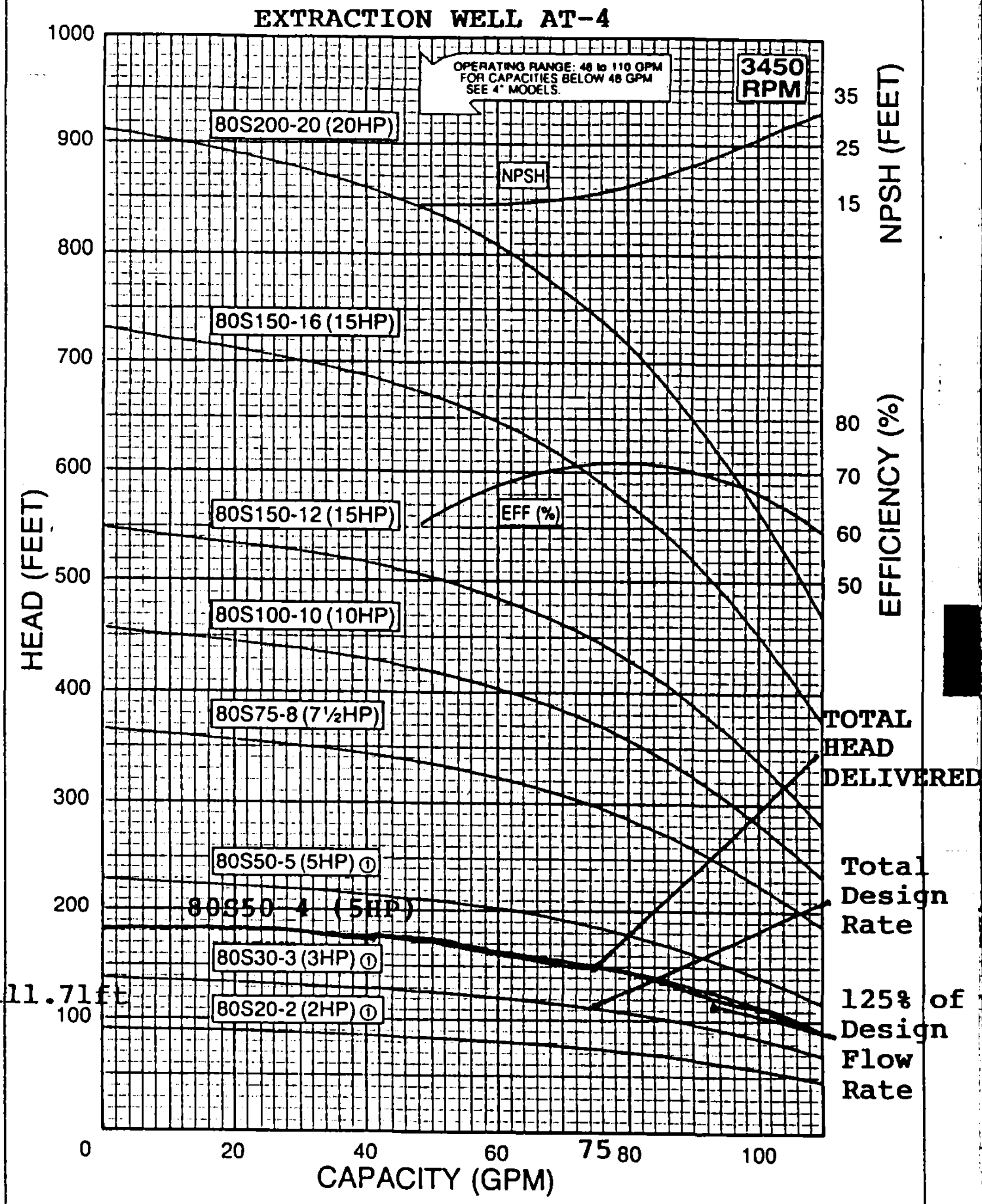
80 GPM

GRUNDFOS

FLOW RANGE
48 to 110 GPM

PUMP OUTLET
3" NPT

PERFORMANCE CURVES



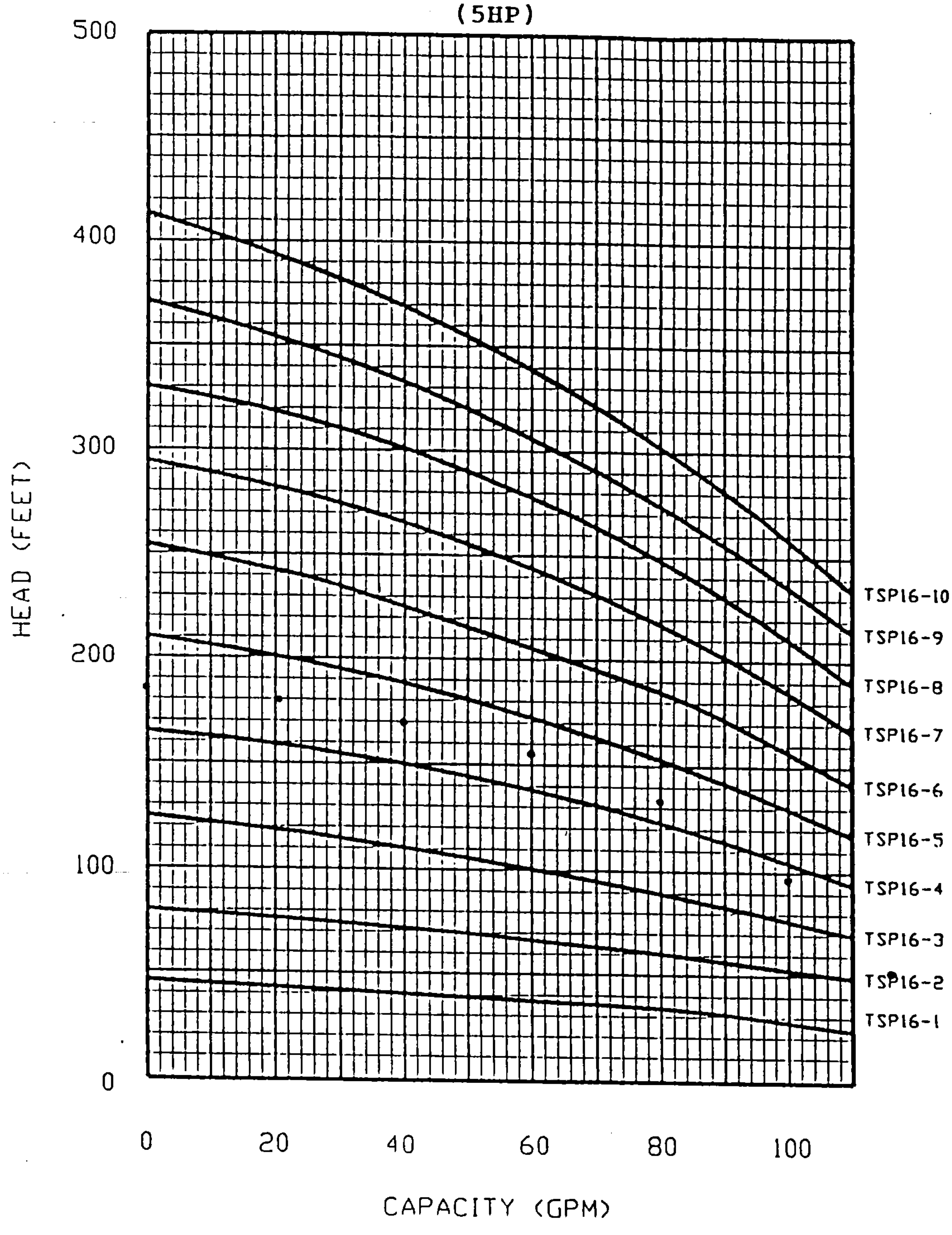
DIMENSIONS AND WEIGHTS

MODEL NO.	HP	MIN. WELL SIZE (INCHES)	LENGTH (INCHES)	MAX. WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
80S20-2	2①	6	33 5/8	5 3/16	51
80S30-3	3①	6	37 7/8	5 3/16	65
80S50-5	5①	6	44 3/8	5 3/16	87
80S75-8	7 ½	6	51 ½	5 ½	144
80S100-10	10	6	56 ¼	5 ½	154
80S150-12	15	6	62 ¼	5 ½	173
80S150-16	15	6	69 ½	5 ½	184
80S200-20	20	6	99	5 ½	207

NOTES: ① 4-inch motor. Specifications are subject to change without notice.

TSP16 PERFORMANCE CURVES

EXTRACTION WELL AT-4
TSP16-4
(5HP)



			60 HERTZ 8" MOTORS				
			Heaters For Overload Relays			Adjustable Relays See Note 3	
HP	Volts	NEMA Starter Size	Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Set	Max.
40	460(4) 575	3 3	K77 K74	J44 J42	L710B L593B	57.0 45.6	62 49.6
50	460(4) 575	3 3	K83 K77	J46 J44	L866B L710B	70.8 56.7	77 61.6
60	460(4) 575	4(1) 4(1)	K87 K78	J71 J45	L107C L787B	83.7 67.0	91 72.8
75	460(4) 575	4(1) 4(1)	K89 K86	J73 J70	L126C L950B	101 81.0	110 88
100	460(4) 575	4 4	K94 K87	J76 J73	L155C L142C	136 108	148 118

			60 HERTZ 8" MOTORS				
			Heaters For Overload Relays			Adjustable Relays See Note 3	
HP	Volts	NEMA Starter Size	Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Set	Max.
125	460(4) 575	5 5	K29 K26	J15 J13	L111B L910A	173 139	189 151
150	460(4) 575	5 5	K32 K28	J17 J14	L122B L100B	203 163	221 177
175	460(4) 575	5 5	K33 K31	J18 J16	L147B L111B	230 184	250 200
200	460(4) 575	5 5	K34 K32	J20 J17	L165B L135B	263 211	286 229

FOOTNOTES: Refer to page 5 for footnotes 1, 2, & 3.

(4) For 50 Hz, 380, 415 or 440 Volts, use the same heater or setting as 60 HZ 460V.

(5) Current transformers are used on all overload relays for starters larger than NEMA 4.

Cable Selection

SINGLE PHASE TWO OR THREE WIRE CABLE, 60 HZ (SERVICE ENTRANCE TO MOTOR)

Motor Rating		Copper Wire Size												
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	⅓	130	210	340	540	840	1300	1610	1960	2390	2910	3540	4210	5060
	½	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
230	⅓	550	880	1390	2190	3400	5250	6520	7960	9690	11770			
	½	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
	¾	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870		
	1	250	400	630	990	1540	2380	2960	3610	4410	5360	6520		
	1.5	190	310	480	770	1200	1870	2320	2850	3500	4280	5240		
	2	150	250	390	620	970	1530	1910	2360	2930	3620	4480		
	3	120	190	300	470	750	1190	1490	1850	2320	2890	3610		
	5	0	110*	180	280	450	710	890	1110	1390	1740	2170	2680	
	7.5	0	0	120*	200	310	490	610	750	930	1140	1410	1720	
	10	0	0	0	160*	250	390	490	600	750	930	1160	1430	1760
	15	0	0	0	0	170*	270	340	430	530	660	820	1020	1260

oot = .3048 meter

CAUTION Use of wire size smaller than listed will void warranty.

FOOTNOTES:

(1) Lengths marked * meet the U.S. National Electrical Code ampacity only for **individual** conductor 75°C cable. Only the lengths **without** * meet the code for **jacketed** 75°C cable. Local code requirements may vary.

(2) Maximum lengths shown maintain motor voltage at 95% of service entrance voltage, running at maximum nameplate amperes. If service entrance voltage will be at least motor nameplate voltage under normal load conditions, 50% additional length is permissable for all sizes.

(3) This table is based on copper wire. If aluminum wire is used it must be two sizes larger. Example: When the table calls for #12 copper wire you would use #10 aluminum wire.

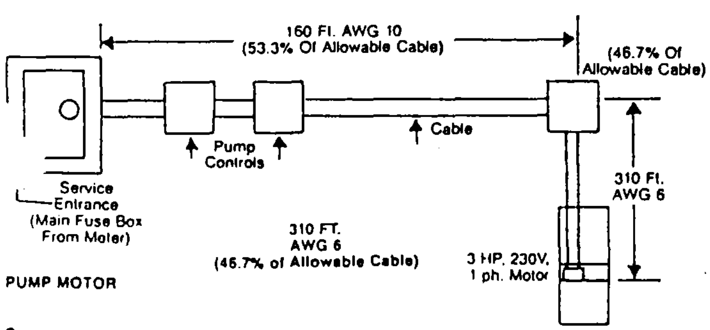
(4) Single phase control boxes may be connected at any point of the total cable length.

(5) Cables #14 to #0000 are AWG sizes.

In applications where two different cable sizes can be used

The example below is for reference. Depending on the installation, any number of combinations may be used, as long as the total percentage length of the two cables used does not exceed 100%. This is to insure that adequate voltage will be supplied to the motor.

EXAMPLE: 3 HP, 230 Volt, 1 PH Motor



In a replacement installation, the well already has 160 feet of buried #10 cable between the service entrance and the well head. The question is: What size cable is required in the well with a 3 HP, 230 volt, 1 PH motor setting at 310 feet?

1. According to the table #10 cable is large enough for the 3 HP motor, so the percent of the maximum allowable cable used by the 160-foot run is 160 ÷ 300 = 53.3%, since 300 feet is the total allowable.
2. With 53.3% of the total allowable cable already used between the service entrance and the well head, only 46.7% is left for the well. Therefore, the 310 feet needed in the well can only utilize 46.7% of the total feet allowed in the table.
3. From the table, 46.7% of the 470 feet for #8 cable equals only 220 feet, so a larger size is needed. For #6, 46.7% of 750 feet = 350 feet. As a result, #6 can be used for the 310 feet in the well.

THREE PHASE THREE WIRE CABLE, 60 HZ 200 AND 230 VOLTS (SERVICE ENTRANCE TO MOTOR)

Motor Rating		Copper Wire Size (1)																	
Volts	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
	½	710	1140	1800	2840	4420													
	¾	510	810	1280	2030	3160													
	1	430	690	1080	1710	2670	4140	5140											
	1.5	310	500	790	1260	1960	3050	3780											
	2	240	390	610	970	1520	2360	2940	3610	4430	5420								
200V	3	180	290	470	740	1160	1810	2250	2760	3390	4130								
60 Hz	5	110*	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030				
Three Phase	7.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150	3560				
Three Wire	10	0	0	150*	230	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420
	15	0	0	0	160*	250	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980
	20	0	0	0	0	190*	300	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360
	25	0	0	0	0	0	240*	300	370	460	570	700	840	1030	1170	1330	1500	1640	1900
	30	0	0	0	0	0	200*	250*	310	380	470	580	700	850	970	1110	1250	1360	1590
	½	930	1490	2350	3700	5760	8910												
	¾	670	1080	1700	2680	4190	6490	8060	9860										
	1	560	910	1430	2260	3520	5460	6780	8290										
	1.5	420	670	1060	1670	2610	4050	5030	6160	7530	9170								
230V	2	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780							
60 Hz	3	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680					
Three Phase	5	140*	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220	
Three Wire	7.5	0	160*	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510
	10	0	0	190*	310	490	760	950	1170	1440	1760	2160	2610	3160	3590	4100	4600	5020	5840
	15	0	0	0	210*	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940
	20	0	0	0	160*	250*	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120
	25	0	0	0	0	200*	320	400	500	610	750	920	1120	1360	1540	1760	1980	2160	2520
	30	0	0	0	0	0	260*	330	410	510	620	760	930	1130	1280	1470	1650	1800	2110
	½	3770	6020	9460															
	¾	2730	4350	6850															
	1	2300	3670	5770	9070														
	1.5	1700	2710	4270	6730														
	2	1300	2070	3270	5150	8050													
	3	1000	1600	2520	3970	6200													
460V	5	590	950	1500	2360	3700	5750												
60 Hz	7.5	420	680	1070	1690	2640	4100	5100	6260	7680									
Three Phase	10	310	500	790	1250	1960	3050	3800	4680	5750	7050								
Three Wire	15	0	340*	540	850	1340	2090	2600	3200	3930	4810	5900	7110						
	20	0	0	410	650	1030	1610	2000	2470	3040	3730	4580	5530						
	25	0	0	330*	530	830	1300	1620	1990	2450	3010	3700	4470	5430					
	30	0	0	270*	430	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860			
	40	0	0	0	320*	500*	790	980	1210	1490	1830	2250	2710	3290	3730	4250			
	50	0	0	0	0	410*	640	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850
	60	0	0	0	0	0	540*	670*	830	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100
	75	0	0	0	0	0	440*	550*	680*	840	1030	1260	1520	1850	2100	2400	2700	2950	3440
	100	0	0	0	0	0	0	0	500*	620*	760*	940	1130	1380	1560	1790	2010	2190	2550
	125	0	0	0	0	0	0	0	0	0	600*	740*	890*	1000	1220	1390	1560	1700	1960
	150	0	0	0	0	0	0	0	0	0	0	630*	760*	920*	1050	1190	1340	1460	1690
	175	0	0	0	0	0	0	0	0	0	0	0	670*	810*	930*	1060	1190	1300	1510
	200	0	0	0	0	0	0	0	0	0	0	0	590*	710*	810*	920*	1030	1130	1310
	½	5900	9410																
	¾	4270	6810																
	1	3630	5800	9120															
	1.5	2620	4180	6580															
	2	2030	3250	5110	8060														
	3	1580	2530	3980	6270														
575V	5	920	1480	2330	3680	5750													
60 Hz	7.5	660	1060	1680	2650	4150													
Three Phase	10	490	780	1240	1950	3060	4770	5940											
Three Wire	15	330*	530	850	1340	2090	3260	4060											
	20	0	410*	650	1030	1610	2520	3140	3860	4760	5830								
	25	0	0	520	830	1300	2030	2530	3110	3840	4710								
	30	0	0	430*	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000				
	40	0	0	0	500*	790	1240	1540	1900	2330	2860	3510	4230	5140	5830				
	50	0	0	0	410*	640*	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580
	60	0	0	0	0	540*	850	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410
	75	0	0	0	0	0	690*	860	1060	1310	1600	1970	2380	2890	3290	3750	4220	4610	5370
	100	0	0	0	0	0	0	640*	790*	970	1190	1460	1770	2150	2440	2790	3140	3430	3990
	125	0	0	0	0	0	0	0	630*	770*	950*	1160	1400	1690	1920	2180	2440	2650	3070
	150	0	0	0	0	0	0	0	0	660*	800*	990*	1190	1440	1630	1860	2080	2270	2640
	175	0	0	0	0	0	0	0	0	0	700*	870*	1050*	1270	1450	1650	1860	2030	2360
	200	0	0	0	0	0	0	0	0	0	0	760*	920*	1110*	1260	1440	1620	1760	2050
460V-60 Hz	150	0	0	0	0	0	0	420	510	630	770	950	1140	1380	1570	1790	2000	2180	2530
Three Phase	175	0	0	0	0	0	0	0	450	550	680	830	1000	1220	1390	1580	1780	1950	2270
Six Wire	200	0	0	0	0	0	0	0	0	480	590	730	880	1070	1210	1380	1550	1690	1970
575V-60Hz	150	0	0	0	0	0	520	650	800	990	1210	1480	1780	2160	2450	2790	3120	3410	3950
Three Phase	175	0	0	0	0	0	0	570	700	860	1060	1300	1570	1910	2170	2480	2780	3040	3540
Six Wire	200	0	0	0	0	0	0	500	610	760	930	1140	1370	1670	1890	2160	2420	2640	3070

1 foot = .3048 meter

CAUTION Use of wire size smaller than listed will void warranty.

FOOTNOTES:

(1) Lengths marked * meet the U.S. National Electrical Code ampacity only for individual conductor 75°C cable. Only the lengths without * meet the code for jacketed 75°C cable. Local code requirements may vary.

(2) Maximum lengths shown maintain motor voltage at 95% of service entrance voltage, running at maximum nameplate amperes. If service entrance voltage will be at least motor nameplate voltage under normal load conditions, 50% additional length is permissable for all sizes.

(3) This table is based on copper wire. If aluminum wire is used it must be two sizes larger. Example: When the table calls for #12 copper wire you would use #10 aluminum wire.

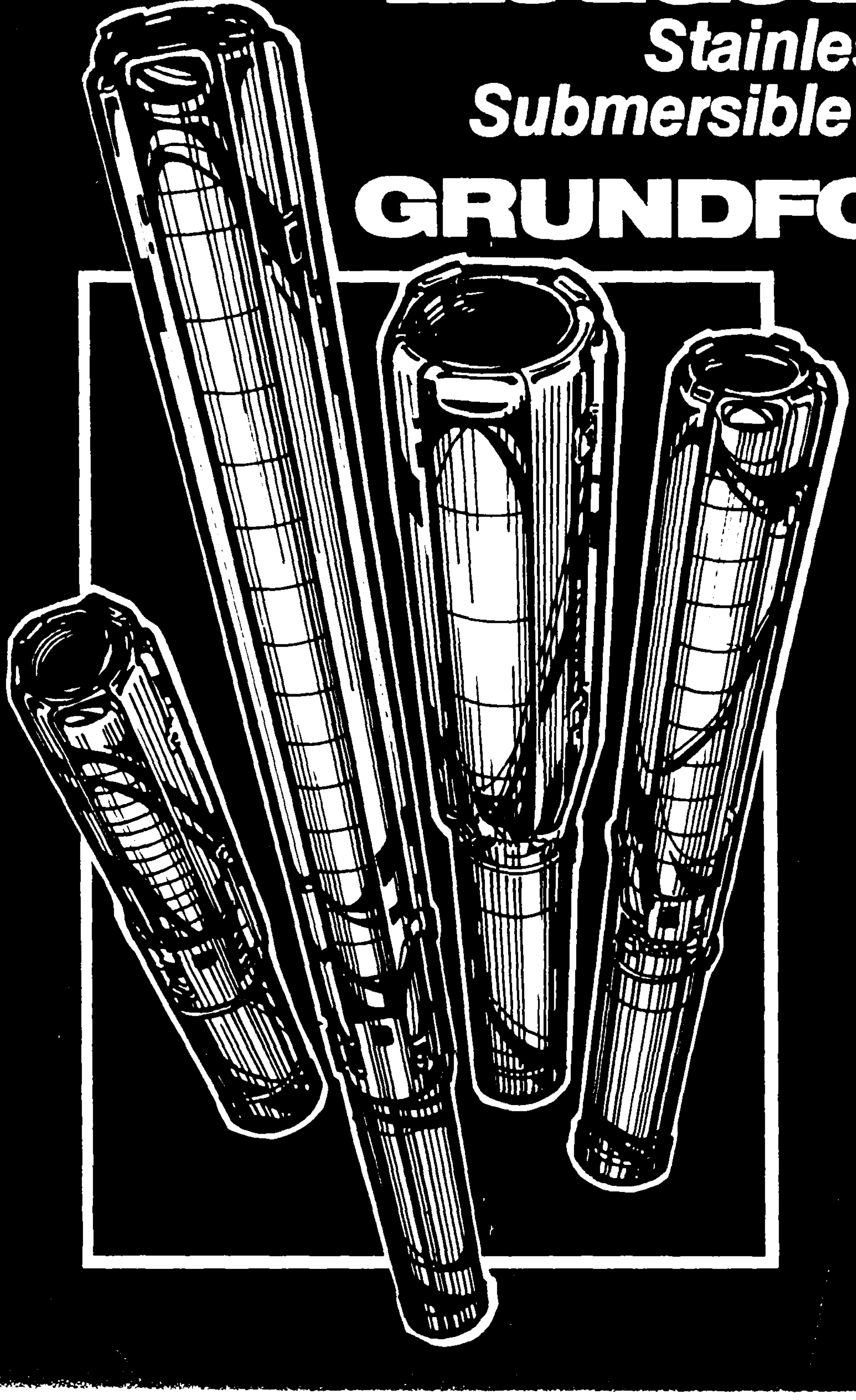
(4) The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation.

(5) Cables #14 to #0000 are AWG sizes, and 250 to 500 are MCM sizes.

Installation and Operating Instructions

Stainless-steel Submersible Pumps

GRUNDFOS®



1. Shipment Inspection

Examine the components carefully to make sure no damage has occured to the pump-end, motor, cable or control box during shipment.

This Grundfos Submersible Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **care should be taken that the pump is not dropped or mishandled;** if a submersible pump is damaged or bent, misalignment can occur.

The motor is equipped with an electrical cable. **Under no circumstances should the cable be used to support the weight of the pump.**

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

2. Pre-Installation Checklist

Before beginning installation procedures, the following checks should be made. They are all critical for the proper installation of this submersible pump.

1. Condition of the Well

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the Grundfos submersible makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, **the well must be blown or bailed clear of oil.**

Determine the maximum depth of the well, and the drawdown level at the pump's maximum capacity. Pump selection and setting depth should be made based on this data.

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor. Following are the minimum well sizes for the various Grundfos models:

4" wells or larger
SP2, SP4, SP10*

6" wells or larger
SP16, SP25, SP35

8" wells or larger
SP70

10" wells or larger
SP120

*(SP10-25 is normally equipped with a 6" motor)

2. Condition of the Water

Submersible well pumps are designed for pumping clear, cold water, free of air or gases. Decreased pump performance and life expectancy can occur if the water is not clear, cold or contains air or gases.

Maximum water temperature should not exceed 102°F. Special consideration must be given to the pump and motor if it is to be used to pump water above 102°F.

The Grundfos stainless steel submersible is highly resistant to the normal corrosive environment found in some water wells.

If water well tests determine an excessive or unusual corrosive quality, or exceeds 102°F, contact your Grundfos representative for information concerning specially designed pumps for these applications.

3. Installation Depth

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawndown level of the well.

The bottom of the motor should never be installed lower than the top of the well screen or at least five feet from the bottom of the well.

If the pump is to be installed in a lake, pond, stream, tank or larger diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling. The minimum water flow rates which insure proper cooling for the various motor sizes are listed in Table A.

4. Electrical Supply

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual available electrical supply. On Grundfos manufactured motors, the nameplate is attached to the bolt on the bottom of the motor. On motors manufactured by Franklin and Hitachi the nameplate can be found mounted on the side of the motor.

Wire Cable Type and Size 3.

The type of wire used between the pump and control boxes should be approved for submersible pump application. The conductor can be solid or stranded. The cable may be three individual conductors twisted, three conductors molded side by side in one flat cable or three conductors with a round overall jacket. The insulation conductor should be type RW, RUW, TW or equivalent and must be suitable for use with submersible pumps. See Table D for recommended sizes of cable for various cable lengths.

Splicing the Motor Cable 4.

The cable splice is a very important part of the installation of the submersible pump and must be done with extreme care.

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight.

There are a number of cable splicing kits available today — expoxy-filled, rubber sealed and so on. Many perform well if the manufacturer's directions are followed carefully. If one of these kits is not used, we recommend the following method for splicing the motor cable to the drop cable:

FIG. 4-A

FIG. 4-B

FIG. 4-C

FIG 4-D

1. Examine the motor cable and the drop cable carefully for damage.

2. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. (See Figure 4-A) On single-phase motors, **be sure to match the colors.**

3. Strip back and trim off ½ inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation.

4. Insert a properly sized "Sta-Kon" type connector on each pair of leads, again making sure that colors are matched. Using a "Sta-Kon" crimping pliers, indent the lugs. (See Figure 4-B) Be sure to squeeze down hard on the pliers, particularly when using large cable.

5. Form a piece of electrical insulation putty tightly around each "Sta-Kon". The putty should overlap on the insulation of the wire. (See Figure 4-C)

6. Use a good quality tape, such as "#33 Scotch Waterproof" or "Plymouth Rubber Company Slipknot Grey". Wrap each wire and joint tightly for a distance of about 2½ inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal. (See Figure 4-D)

Installation 5.

The riser pipe should be properly sized and selected based on estimated flow-rates and friction-loss factors. Attaching pump to riser pipe:

A back-up wrench should be used when the riser pipe is attached to the pump. The pump should only be gripped by the four flats on the top of the discharge chamber. **Under no circumstances, grip the body of the pump, cable guard or motor.**

The threaded end of the first section of the riser pipe or the nipple must not come in contact with the check valve retainer in the discharge chamber of the pump when tightened down.

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. **Do not clamp the pump.** When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only.

Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

If steel riser pipe is used:

We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendencey of the motor to loosen the joints when stopping and starting.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above and below the splice.

If plastic riser pipe is used:

It is recommended that plastic type riser pipe be used **only** with the smaller domestic submersibles. The manufacturer or representative should be contacted to insure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer. Besides making sure that joints are securely fastened, we recommend the use of a torque arrester when using plastic pipe.

Do not connect the first plastic riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber of the pump. **The threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump when tightened down.**

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

Important — plastic pipe tends to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave 3 to 4 inches of slack between clips or taped points. This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. For example, if you installed 200 feet of plastic riser pipe, the pump may actually be down 204 feet. If the depth setting is critical, check with the manufacturer of the pipe to determine exactly how much you have to compensate for pipe stretch.

When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge chamber of Grundfos 4 inch submersibles is designed to accommodate this cable (Figure 5-A).

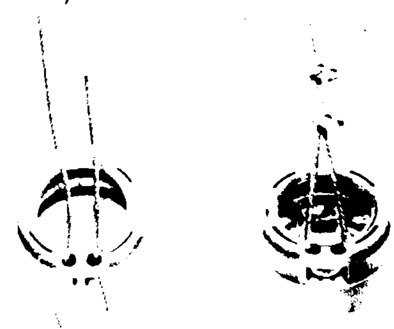


FIG. 5-A

Protect the well from contamination

To protect against surface water from entering the well and contaminating the water source, the well should be finished off above grade, and a locally approved well seal or pitless adapter unit utilized.

6. Electrical

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Verification of the electrical supply should be made to insure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. On Grundfos manufactured motors, the nameplate is attached to the bolt on the bottom of the motor. On motors manufactured by Franklin and Hitachi the nameplate can be found mounted on the side of the motor. Motor electrical data can be found on Table E.

If voltage variations are larger than ± 10%, do not operate the pump.

Generally, direct on-line starting is approved due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (maximum load amps) is between 4 and 6.5 times the full-load current.

If direct on-line starting is not acceptable, and reduced starting current is required, an auto-transformer or resistant starter should be used. It is recommended that resistant starters be used for 5 to 30 HP motors (depending on cable length). For motors over 30 HP, use auto-transformer starters.

Engine Driven Generators and Transformers

If the submersible pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contacted to insure the proper generator is selected and used. See Table B for generator sizing information.

If power is going to be supplied through transformers, Table C outlines the minimum KVA rating and capacity required for satisfactory pump operation.

Control Box

1. Single-Phase Motors:

Grundfos control boxes for single-phase motors should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor.

Some Grundfos motors are designed to rotate in either direction; therefore, wiring connections should be made in accordance with the wiring diagram for the specific motor and pump type being used.

Franklin and Hitachi single-phase motors must be connected as indicated in the respective motor control box.

2. Three-Phase Motors:

Grundfos, Franklin and Hitachi three-phase motors must be used with the proper size and type motor starter to ensure the motor is protected against damage from low voltage, phase failure, current unbalance and overload current. A properly sized starter with manual reset and ambient compensated extra quick-trip overloads should be used to give the best possible motor winding protection. **Each motor line must be protected on all three legs with overloads.** The thermal overloads supplied must trip in less than 10 seconds at locked rotor (starting) current. For starter and overload protection guide, see Table G.

Pumps should NEVER be started to check rotation unless the pump is totally submerged. Severe damage may be caused to the pump and motor if they are run dry.

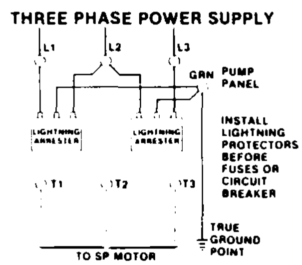
High Voltage Surge Arresters

In addition to the motor starter with overloads, a high voltage surge arrester should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated arrester should be installed on the supply (line) side of the control box or starter (see Figures 6-A and 6-B). **The arrester must be grounded in accordance with the National Electric Code and local governing regulations.**

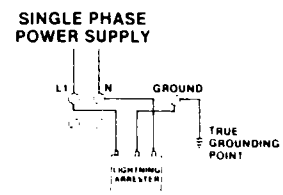
The warranty on all three-phase submersible motors is VOID if:

1. The motor is operated with single-phase power through a phase converter.
2. Three-leg ambient compensated extra quick-trip overload protectors are not used.
3. Three-phase current balance is not checked and recorded. (see **START-UP Section 7** for instructions.)
4. High voltage surge arresters are not installed.



THREE PHASE HOOKUP

FIG. 6-A



SINGLE PHASE HOOKUP

FIG. 6-B

Control Box and Surge Arrester Grounding

The control box shall be permanently grounded in accordance with the National Electric Code and local governing codes or regulations. The ground wire should be a bare stranded copper conductor at least the same size as the drop cable wire size. Ground wire should be run as short a distance as possible and securely fastened to a true grounding point.

True grounding points are considered to be: a grounding rod driven into the water strata; steel well casing submerged into the water lower than the pump setting level; and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box.

Wiring Checks

Before making the final wiring connections on the drop cable to the control box terminal, it is good practice to check the insulation resistance to ensure that the cable and splice are good. Measurement for a new installation must be 1,000,000 ohm or more. Do not start the pump if the measurement is less than this. If it is above, finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box and high voltage surge arrester have been grounded.

Start-Up 7.

After the pump has been set into the well and the wiring connections have been made, the following procedures should be performed:

a. Attach a temporary horizontal length of pipe to the riser pipe.

b. Install a gate valve and another short length of pipe to the temporary pipe.

c. Adjust the gate valve one-third of the way open.

d. Verify that the electrical connections are in accordance with the wiring diagram.

Single-Phase Motors

Grundfos single-phase motors should rotate in the correct direction if the wiring connections are made in accordance with the proper wiring diagram in the control box.

Three-Phase Motors

1. Check the direction of rotation.

Three-phase motors can run in either direction depending on how they are conhected to the power supply. So, when the three cable leads are first connected to the power supply, there is a 50% chance that the motor will run in the proper direction. **To make sure the motor is running in the proper direction, carefully follow the procedures below:**

a. Start the pump and check the water quantity, and pressure developed.

b. Stop the pump and interchange any two leads.

c. Start the pump and again check the water quantity and pressure.

d. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

2. Check for current unbalance.

Current unbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very important current unbalance be checked in all three-phase systems. **Current unbalance between the legs should not exceed 5% under normal operating conditions.**

The supply power service should be verified to see if it is a two or three transformer system. The information can be obtained by counting the transformers or by contacting your power company. If two transformers are present, the system is an "open delta" or "wye". If three transformers are present, the system is true three-phase.

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See Table C.

The percentage of current unbalance can be calculated by using the following formulas and procedures:

$$\% \text{ Current unbalance} = \frac{\text{Greatest amp difference from the average}}{\text{average current}} \times 100$$

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

Determine the percentage of current unbalance by:

Step 1. Measure and record current readings in amps for each leg (hookup). Disconnect power.

Step 2. Shift or roll the motor leads from left to right so the drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads in this manner will not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect power.

Step 3. Again shift drop cable leads from left to right so the lead on terminal 1 now goes to 2, 2 to 3, and 3 to 1 (hookup 3). Start pump, measure and record current reading on each leg. Disconnect power.

Step 4. Add together the values for each hookup.

Step 5. Divide the total by 3 to obtain the average.

Step 6. Compare each single leg reading from the average to obtain the greatest amp difference from the average.

Step 7. Divide this difference by the average to obtain the percentage of unbalance.

Use the wiring hookup which provides the lowest percentage of unbalance. (See Table "F" for a specific example of correcting for three-phase power unbalance).

Developing the Well

After proper rotation and current unbalance have been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

Slowly open the valve in small increments as the water clears until the valve is all the way open. **The pump should not be stopped until the water runs clear.**

If the water is clean and clear when the pump is first started, the valve should still be **slowly opened** until it is all the way open. As the valve is being opened, the draw down should be checked to ensure the pump is always submerged. **The dynamic water level should always be more than 3 feet above the inlet strainer of the pump.**

Disconnect the temporary piping arrangements and complete the final piping connections. Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

Operating and Maintenance

The pump and system should be periodically checked for water quantity, pressure, draw down, periods of cycling, and operation of controls.

Under no circumstances should the pump be operated for any prolonged periods of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief should be installed at the well head to prevent the pump from running against a closed valve.

If the pump fails to operate, or there is a loss of performance, refer to the Trouble Shooting Section 8.

Trouble-Shooting 8.

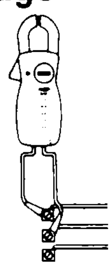
The majority of problems that develop with submersible pumps are electrical, and most of these problems can be serviced without pulling the pump from the well. The following charts cover most of the submersible service work. As with any trouble-shooting procedure, start with the simplest solution first; always make all the above ground checks before considering pulling the pump from the well.

Basically, only two instruments are needed — a combination voltmeter/ampmeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It's recommended that rubber gloves and boots be worn and that care be taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well. WARNING: Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply in neutral ground may result in serious electrical shock.

Preliminary Tests

Supply Voltage



How to Measure

By means of a volt meter, which has been set to the proper scale, measure the voltage at the control box or starter.

On single-phase units measure between line and neutral.

On three-phase units measure between the legs (phases).

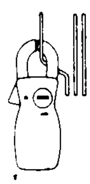
What it Means

When the motor is under load, the voltage should be withing ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low the motor should be changed to the correct supply voltage.

Current Measurement



How to Measure

By use of an ampmeter, set on the proper scale, measure the current on each power lead at the control box or starter. See the Electrical Data, Table E for motor amp draw information.

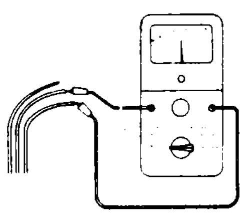
Current should be measured when the pump is operating at constant discharge pressure when the motor is fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current unbalance is greater than 5% between each leg on three-phase units, check the following:

1. Burnt contacts on motor starter.
2. Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances.
3. Too high or low supply voltage.
4. Motor windings are shorted.
5. Pump is damaged causing a motor overload.

Winding Resistance



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohm meter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms.

Zero adjust the meter and measure the resistance between leads. Record the values.

Motor resistance values can be found in the Electrical Data, Table E. Cable resistance values in Table H.

What it Means

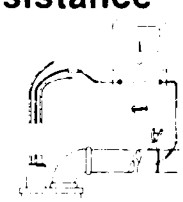
If all the ohm values are normal, and the cable colors correct, the windings are not damaged.

If any one ohm value is less than normal the motor may be shorted.

If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table E.

Insulation Resistance



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohm or mega ohm meter set the scale selector to Rx100K and zero adjust the meter.

Measure the resistance between the lead and ground. (Discharge pipe or well casing if steel.)

What it Means

For ohm values, refer to table on following page. Motors of all Hp, voltage, phase and cycles duties have the same value of insulation resistance.

* CONDITION OF MOTOR AND LEADS	OHM VALUE	MEGOHM VALUE
New Motor.	2,000,000 (or more)	2.0
'Ised motor which can be reinstalled in the well.	1,000,000 (or more)	1.0
MOTOR IN WELL. Ohm readings are for drop cable plus motor.		
A motor in the well in reasonable good condition.	500,000 - 1,000,000	0.5 - 1.0
A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.	20,000 - 500,000	0.02 - 0.5
A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will not fail for this reason alone, but it will probably not operate for long.	10,000 - 20,000	0.01 - 0.02
A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.	less than 10,000	0 - 0.01

Trouble Shooting Chart

Fault	Possible Causes	How to Check	How to Correct
A. Pump Does Not Run.	1. No electricity at pump panel.	Check for voltage at pump panel.	If no voltage at pump panel, check house or feeder panel for tripped circuits.
	2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor and cable must be checked.
	3. Motor starter overloads are burnt or have tripped out.	Check for voltage on line and load side of starter.	Replace burnt heaters or reset. Inspect starter for other damage If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize.	Energize control circuit and check for voltage at the holding coil.	If no voltage, check control circuit. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contact in control devices.	Replace worn or defective parts.
	6. Motor and/or cable are defective.	Turn off voltage, disconnect drop leads from control box to the motor. Measure the lead to lead resistances with ohmmeter (RX-1). Measure lead to ground values with ohmmeter (RX-100K). Record measured values.	If open winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
	7. Defective capacitor.	Turn off voltage, discharge capacitor. Check with ohmmeter (RX-100K).	Replace if defective.
B. Pump Runs But Does Not Deliver Water.	1. Water level in well is too low or well is collapsed.	Check well draw down.	Water level should be at least 3 feet above pump inlet during operation.
	2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off.	Remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and re install.
	3. Inlet strainer is clogged.	Same as number two above.	Remove pump and inspect. Clean strainer, check integral, check valve for blockage, rinse out pump and reinstall.

Fault	Possible Causes	How to Check	How to Correct
	4. Pump is defective.	Same as number two above.	Convert PSI to feet (PSI x 2.31 ft/PSI = ____ ft), add elevation from top of well to water level to the pressure reading. Refer to the specific pump curve for shut-off head for that pump model. If head is close to curve, pump is probably OK. If not, remove pump and inspect.
C. Pump Runs But at Reduced Capacity.	1. Wrong rotation.	Check for proper electrical connection in control box.	Correct wiring and change leads as required.
	2. Draw down is larger than anticipated.	Check draw down during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	3. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
	4. Pump strainer or check valve are clogged.	Remove pump and inspect.	Clean, repair, rinse out pump and reinstall.
	5. Pump worn.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off.	Convert PSI to feet (PSI x 2.31 ft/PSI = ____ft), add elevation from top of well to water level to the pressure reading. Refer to the specific pump curve for shut-off head for that pump model. If head is close to curve, pump is probably OK. If not, remove pump and inspect.
D. Pump Cycles Too Much.	1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Readjust switch or replace if defective.
	2. Level control is not properly set or is defective.	Check setting and operation.	Readjust setting (refer to manufacturer data). Replace if defective.
	3. Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphram chamber.	Check diaphram for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume.
	4. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.
	5. Tank is too small.	Check tank size.	Tank volume should be approximately 10 gallons for each gpm of pump capacity.
E. Fuses Blow Or Circuit Breakers Trip.	1. High or low voltage.	Check voltage at pump panel.	If not within ± 10%, check wire size and length of run to pump panel.
	2. Three phase current unbalance.	Check current draw on each lead.	Must be within ± 5%, if not contact power company.
	3. Control box wiring and components.	Check control box parts, match parts list. Check wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	4. Capacitor.	Discharge capacitor. Check using an ohmmeter (RX-100K).	When meter is made, the ohmmeter needle should jump forward and slowly drift back. If no meter movement, replace the capacitor.
	5. Starting relay (Franklin single phase motors only).	Check resistance of relay coil with an ohmmeter (RX-1000). Check contacts for wear.	Replace defective relay.

TABLE A

Minimum Water Flow Requirements for Submersible Pump Motors

Motor Diameter	Casing or Sleeve I.D. in Inches	Min. GPM Flow Pass the Motor
4"	4	1.2
	5	7
	6	13
	7	21
	8	30
6"	6	10
	7	28
	8	45
	10	85
	12	140
	14	198
	16	275
8"	8	10
	10	55
	12	110
	14	180
	16	255

a. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.

b. The minimum water velocity over 4" motors is 0.25 feet per second.

c. The minimum water velocity over 6" and 8" motors is 0.5 feet per second.

TABLE B

Engine Driven Generators for Submersible Pumps

Motor HP for Single or Three Phase Units	Minimum Kilowatt Rating of Generator for Three-Wire Submersible Pump Motors: Externally Regulated	Internally Regulated
0.33	1.5	1.2
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0
2.0	7.5	4.0
3.0	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0

Notes:

1. Table is based on typical 80°C. rise continuous duty generators with 35% maximum voltage dip during starting single and three phase motors.
2. Contact the manufacturer of the generator whenever possible to assure his unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

TABLE C

Transformer Capacity Required for Three-Phase Submersible Pump Motors

Three-Phase Motor HP	Minimum Total KVA Required*	Minimum KVA Rating for Each Transformer: 2 Transformers Open Delta or Wye	3 Transformers Delta or Wye
1½	3	2	1
2	4	2	1½
3	5	3	2
5	7½	5	3
7½	10	7½	5
10	15	10	5
15	20	15	7½
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40

*Pump motor KVA requirements only, and does not include allowances for other loads.

TABLE D
Submersible Pump Cable Selection Chart.

The following tables list the recommended copper cable sizes and various cable lengths for Grundfos and Franklin submersible pump motors.

These tables comply with the 1978 edition of the National Electric Code Table 310-16, Column 2 for 75°C wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To assure adequate starting torque, the maximum cable lengths are calculated to maintain 95% of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power usage.

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

Single-Phase Motors

135 Maximum length of copper cable in feet
(105) Maximum length from motor to control box or starter
(30) Maximum length from control box or starter to load center or transformer

AWG COPPER WIRE SIZES

VOLTS	HP	14	12	10	8	6	4	2	0	00
115V	1/3	135	210	330	520					
1φ		(105)	(160)	(250)	(390)					
60HZ		(30)	(50)	(80)	(130)					
	1/2	100	160	250	390	610				
		(75)	(120)	(190)	(295)	(460)				
		(25)	(40)	(60)	(95)	(150)				
	3/4		140	220	350	540	850			
			(105)	(165)	(265)	(405)	(640)			
			(35)	(55)	(85)	(135)	(210)			

Single-Phase Motors

530 Maximum length of copper cable in feet
(400) Maximum length from motor to control box or starter
(130) Maximum length from control box or starter to load center or transformer

AWG COPPER WIRE SIZES

VOLTS	HP	14	12	10	8	6	4	2	0	00
230V	1/3	530	850							
1φ		(400)	(640)							
60HZ		(130)	(210)							
	1/2	400	640	1000						
		(300)	(480)	(750)						
		(100)	(160)	(250)						
	3/4	290	470	740	1160					
		(220)	(355)	(555)	(870)					
		(70)	(115)	(185)	(290)					
	1.0	250	390	620	970	1510				
		(190)	(295)	(465)	(730)	(1135)				
		(60)	(95)	(155)	(240)	(375)				
	1.5	200	330	510	800	1250				
		(150)	(250)	(385)	(600)	(940)				
		(50)	(80)	(125)	(200)	(310)				
	2.0	180	290	450	730	1100	1670			
		(135)	(220)	(340)	(550)	(825)	(1255)			
		(45)	(70)	(110)	(180)	(275)	(415)			
	3.0		230	360	560	880	1340	2040		
			(175)	(270)	(420)	(660)	(1005)	(1530)		
			(55)	(90)	(140)	(220)	(335)	(510)		
	5.0			220	320	490	750	1140	1540	
				(165)	(240)	(370)	(565)	(855)	(1155)	
				(55)	(80)	(120)	(185)	(285)	(385)	
	7.5				270	360	550	840	1140	1420
					(205)	(270)	(415)	(630)	(855)	(1065)
					(65)	(90)	(135)	(210)	(285)	(355)

continued

TABLE D Submersible Pump Cable Selection Chart

continued

Three-Phase Motors

670 Maximum length of copper cable in feet
(505) Maximum length from motor to control box or starter
(165) Maximum length from control box or starter to load center or transformer

AWG COPPER WIRE SIZES

VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000
208V	1/2	670	1070	1670								
3ϕ		(505)	(805)	(1255)								
60HZ		(165)	(265)	(415)								
	3/4	500	800	1250	1960							
		(375)	(600)	(935)	(1470)							
		(125)	(200)	(315)	(490)							
	1.0	410	660	1030	1620							
		(310)	(495)	(775)	(1215)							
		(100)	(165)	(255)	(405)							
	1.5	320	510	800	1260							
		(240)	(385)	(600)	(945)							
		(80)	(125)	(200)	(315)							
	2.0	250	390	610	960	1500						
		(190)	(295)	(460)	(720)	(1125)						
		(60)	(95)	(150)	(240)	(375)						
	3.0	180	290	450	710	1110	1690					
		(135)	(220)	(340)	(535)	(835)	(1270)					
		(45)	(70)	(110)	(175)	(275)	(420)					
	5.0			300	470	730	1110	1690				
				(225)	(355)	(550)	(835)	(1270)				
				(75)	(115)	(180)	(275)	(420)				
	7.5				340	530	810	1230	1660			
					(255)	(400)	(610)	(925)	(1245)			
					(85)	(130)	(200)	(305)	(415)			
	10.0				250	390	600	920	1240	1540		
					(190)	(295)	(400)	(690)	(930)	(1155)		
					(60)	(95)	(200)	(230)	(310)	(385)		
	15.0					270	410	630	850	1060	1270	
						(205)	(310)	(475)	(640)	(795)	(955)	
						(65)	(100)	(155)	(210)	(265)	(315)	
	20.0						320	480	650	810	970	1150
							(240)	(360)	(490)	(610)	(730)	(865)
							(80)	(120)	(160)	(200)	(240)	(285)
	25.0							390	530	660	790	930
								(295)	(400)	(495)	(595)	(700)
								(95)	(130)	(165)	(195)	(230)
	30.0								430	540	640	750
									(325)	(405)	(480)	(565)
									(105)	(135)	(160)	(185)

Three-Phase Motors

910 Maximum length of copper cable in feet
(685) Maximum length from motor to control box or starter
(225) Maximum length from control box or starter to load center or transformer

AWG COPPER WIRE SIZES

VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000
230V	1/2	910	1450	2280								
3ϕ		(685)	(1090)	(1710)								
60HZ		(225)	(360)	(570)								
	3/4	630	1050	1640	2570							
		(475)	(790)	(1230)	(1930)							
		(155)	(260)	(410)	(640)							
	1.0	550	870	1360	2140							
		(415)	(655)	(1020)	(1605)							
		(135)	(215)	(340)	(535)							
	1.5	430	680	1070	1680							
		(325)	(510)	(805)	(1260)							
		(105)	(170)	(265)	(420)							
	2.0	320	510	790	1250	1940						
		(240)	(385)	(595)	(940)	(1455)						
		(80)	(125)	(195)	(310)	(485)						
	3.0	240	380	600	940	1470	2240					
		(180)	(285)	(400)	(705)	(1105)	(1680)					
		(60)	(95)	(200)	(235)	(365)	(560)					
	5.0		250	390	620	960	1470	2230				
			(190)	(295)	(465)	(720)	(1105)	(1675)				
			(60)	(95)	(155)	(240)	(365)	(555)				
	7.5			290	340	700	1070	1630	2200			
				(220)	(255)	(525)	(805)	(1225)	(1650)			
				(70)	(85)	(175)	(265)	(405)	(550)			
	10.0					520	800	1220	1640	2050		
						(390)	(600)	(915)	(1230)	(1540)		
						(130)	(200)	(305)	(410)	(510)		

continued

TABLE D Submersible Pump Cable Selection Chart

continued

AWG COPPER WIRE SIZES

VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000
230V 3φ 60HZ	15.0					360 (270) (90)	550 (415) (135)	830 (625) (205)	1130 (850) (280)	1410 (1060) (350)	1680 (1260) (420)	
	20.0						420 (315) (105)	640 (480) (160)	860 (645) (215)	1070 (805) (265)	1280 (960) (320)	1510 (1135) (375)
	25.0						340 (255) (85)	520 (390) (130)	700 (525) (175)	870 (655) (215)	1040 (780) (260)	1230 (925) (305)
	30.0							420 (315) (105)	570 (430) (140)	710 (535) (175)	850 (640) (210)	1000 (750) (250)

AWG COPPER WIRE SIZES

VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000
460V 3φ 60HZ	1/2	3660 (2745) (915)										
	3/4	2660 (1995) (665)										
	1.0	2290 (1720) (570)										
	1.5	1720 (1290) (430)	2690 (2020) (670)									
	2.0	1280 (960) (320)	2030 (1525) (505)									
	3.0	960 (720) (240)	1530 (1150) (380)	2400 (1800) (600)								
	5.0	630 (475) (155)	1000 (750) (250)	1570 (1180) (390)	2470 (1855) (615)							
	7.5	460 (345) (115)	730 (550) (180)	1150 (865) (285)	1800 (1350) (450)	2810 (2110) (700)						
	10.0		550 (415) (135)	850 (640) (210)	1340 (1005) (335)	2090 (1570) (520)	3190 (2395) (795)					
	15.0			590 (445) (145)	920 (690) (230)	1430 (1075) (355)	2190 (1645) (545)	3340 (2505) (835)				
	20.0				700 (525) (175)	1100 (825) (275)	1670 (1255) (415)	2550 (1915) (635)	3440 (2580) (860)			
	25.0				570 (430) (140)	890 (670) (220)	1360 (1020) (340)	2070 (1555) (515)	2800 (2100) (700)	3500 (2625) (875)		
	30.0					730 (550) (180)	1110 (835) (275)	1690 (1270) (420)	2280 (1710) (570)	2850 (2140) (710)	3400 (2550) (850)	
	40.0						850 (640) (210)	1300 (975) (325)	1750 (1315) (435)	2190 (1645) (545)	2610 (1960) (650)	3070 (2305) (765)
	50.0						680 (510) (170)	1040 (780) (260)	1400 (1050) (350)	1750 (1315) (435)	2090 (1570) (520)	2450 (1840) (610)
	60.0							870 (655) (215)	1180 (885) (295)	1470 (1105) (365)	1760 (1320) (440)	2070 (1555) (515)
	75.0								950 (715) (235)	1190 (895) (295)	1420 (1065) (355)	1670 (1255) (415)
	100.0									890 (670) (220)	1060 (795) (265)	1240 (930) (310)

Three-Phase Motors

3660 Maximum length of copper cable in feet
(2745) Maximum length from motor to control box or starter
(915) Maximum length from control box or starter to load center or transformer

TABLE E

Electrical Data — 60 HZ SP Pump Motors

Volts & Phase	HP	Diameter	MFG	Rotation [f]	Kw	Service Factor	Running Amps	Service Factor Amps	Locked Rotor Amps	NEMA Locked Rotor Code	Standard Fuse Size	Dual Element Fuse Size
115 x 1	1/3	4"	GF	B	0.25	1.75	6.0	7.6	17	G	20	8
	1/2	4"	GF	B	0.37	1.60	8.2	10.2	24	F	30	12
	3/4	4"	GF	B	0.55	1.50	11.2	13.4	36	F	35	15
230 x 1	1/3	4"	GF	B	0.25	1.75	3.0	3.8	8	G	15	5
	1/2	4"	GF	B	0.37	1.60	4.1	5.1	12	F	15	6¼
	3/4	4"	GF	B	0.55	1.50	5.6	6.7	18	F	25	8
	1	4"	GF	B	0.75	1.40	7.2	8.8	24	F	30	10
	1.5	4"	GF	B	1.10	1.30	9.2	10.8	32	E	30	12
	2 [a]	4"	GF	C	1.50	1.25	13.6	15.2	55	D	40	17.5
	3 [b]	4"	GF	C	2.20	1.15	16.8	18.6	55	D	60	20
	5	4"	F	B	5.20	1.00	23.0	23.0	97	D	80	25
	5 [c]	4"	F	A	5.20	1.00	23.0	23.0	97	D	80	25
	7.5	6"	F	B	8.50	1.15	34.5	40.0	161	E	125	45
208 x 3	1/2	4"	GF	C	0.37	1.60	2.5	3.2	12	K	15	4
	3/4	4"	GF	C	0.55	1.50	3.4	4.3	17	K	15	5
	1	4"	GF	C	0.75	1.40	3.9	5.2	17	G	15	6¼
	1.5	4"	GF	C	1.10	1.30	5.4	6.7	26	G	20	7
	2	4"	GF	C	1.50	1.25	7.0	8.4	34	G	25	9
	3	4"	GF	C	2.20	1.15	9.8	11.1	49	G	40	15
	5	4"	GF	C	3.70	1.15	15.9	17.9	82	G	50	20
	7.5 [d]	4"	F	C	8.90	1.15	26.0	29.0	158	J	90	35
	7.5	6"	F	C	8.20	1.15	23.2	26.4	126	G	80	30
	10	6"	F	C	11.10	1.15	30.9	35.4	181	H	100	40
	15	6"	F	C	16.10	1.15	44.1	50.2	280	H	150	60
	20	6"	F	C	21.60	1.15	59.2	67.4	383	H	200	80
	25	6"	F	C	26.10	1.15	70.8	81.4	500	J	225	90
	30	6"	F	C	32.00	1.15	89.3	102.0	590	J	300	110
230 x 3	1/2	4"	GF	C	0.37	1.60	2.4	3.0	10	K	15	4
	3/4 [e]	4"	GF	C	0.55	1.50	3.0	4.2	14	K	15	5
	1 [e]	4"	GF	C	0.75	1.40	3.8	5.0	14	G	15	6¼
	1.5	4"	GF	C	1.10	1.30	5.2	6.6	22	H	20	8
	2	4"	GF	C	1.50	1.25	6.8	8.4	28	G	25	10
	3	4"	GF	C	2.20	1.15	9.6	11.2	40	G	30	15
	5	4"	GF	C	3.70	1.15	15.6	18.0	66	G	50	20
	7.5 [d]	4"	F	C	8.90	1.15	23.5	26.2	143	J	80	30
	7.5	6"	F	C	8.20	1.15	21.0	23.9	114	G	70	30
	10	6"	F	C	11.10	1.15	27.9	32.0	164	H	90	35
	15	6"	F	C	16.10	1.15	39.9	45.4	253	H	125	50
	20	6"	F	C	21.60	1.15	53.5	61.0	346	H	175	70
	25	6"	F	C	26.10	1.15	64.0	73.6	452	J	200	80
	30	6"	F	C	32.00	1.15	80.8	92.0	534	J	250	110
460 x 3	1/2	4"	GF	C	0.37	1.60	1.2	1.5	5	K	15	2
	3/4 [d]	4"	GF	C	0.55	1.50	1.5	2.1	7	K	15	2½
	1 [d]	4"	GF	C	0.75	1.40	1.9	2.5	7	G	15	3
	1.5	4"	GF	C	1.10	1.30	2.6	3.3	11	H	15	4
	2	4"	GF	C	1.50	1.25	3.4	4.2	14	G	15	5
	3	4"	GF	C	2.20	1.15	4.8	5.6	20	G	15	6¼
	5	4"	GF	C	3.70	1.15	7.8	9.0	33	G	25	10
	7.5 [d]	4"	F	C	8.90	1.15	11.7	13.1	72	J	40	15
	7.5	6"	F	C	8.20	1.15	10.5	11.9	57	G	35	15
	10 [d]	4"	F	C	11.50	1.15	15.6	17.4	108	K	50	20
	10	6"	F	C	11.10	1.15	13.9	16.0	82	H	45	20
	15	6"	F	C	16.10	1.15	20.0	22.7	127	H	60	25
	20	6"	F	C	21.60	1.15	26.7	30.5	173	H	90	35
	25	6"	F	C	26.60	1.15	32.0	36.8	226	J	100	40
	30	6"	F	C	32.00	1.15	40.4	46.0	267	J	125	50
	40 [d]	6"	F	C	42.80	1.15	53.0	60.0	336	H	175	70
	40	8"	F	C	42.80	1.15	53.0	60.0	342	H	175	70
	50 [d]	6"	F	C	52.50	1.15	67.0	75.0	472	J	225	90
	50	8"	F	C	52.50	1.15	67.0	75.0	433	H	225	90
	60	8"	F	C	63.00	1.15	76.0	89.0	560	J	250	110
	75	8"	F	C	80.00	1.15	92.0	110.0	760	J	350	125
	100	8"	F	C	104.80	1.15	120.0	148.0	1000	J	450	175

TABLE E

Electrical Data — 60 HZ SP Pump Motors

Volts & Phase	HP	Motor Part No.	Stator Part No.	Winding Resistance Yel./Blk.	Winding Resistance Red/Blk.	Micro-farads	Capacitor Volts	Capacitor Part No.	Klixon Part No.
115 x 1	1/3	79.42 01 01	79.50 78	2.19/2.42	2.76/ 3.05	80	200	14 40	MEH26GX
	1/2	79.42 01 02	79.50 87	1.62/1.79	1.90/ 2.11	120	200	14 41	MEH16LX(s)
	3/4	79.42 01 03	79.50 88	0.86/0.95	1.05/ 1.16	160	200	14 42	MEJ18AX
230 x 1	1/3	79.45 01 01	79.50 79	8.65/9.56	10.93/12.08	20	400	14 43	MEG59HX
	1/2	79.45 01 02	79.50 93	5.51/6.09	6.84/ 7.56	30	400	14 45	MEG40HX
	3/4	79.45 01 03	79.50 94	3.23/3.57	4.18/ 4.62	40	400	14 46	MEH26GX
	1	79.45 01 04	79.50 95	2.57/2.84	2.95/ 3.26	50	400	14 47	MEH16LX
	1.5	79.45 01 05	79.50 96	1.71/1.89	2.00/ 2.21	60	400	14 48	CEH30JX
	2 [a]	79.45 00 06	79.50 68	0.95/1.05	0.95/ 1.05	100	400	14 52	CGH16KR
	3 [b]	79.45 00 07	79.50 69	0.95/1.05	0.95/ 1.05	120	400	14 54	CGH16KR(s)
	5	224-11320		0.68/1.00	2.10/ 2.80				
	5 [c]	224-11321		0.68/1.00	2.10/ 2.80				
	7.5	226-10190		0.40/0.50	0.98/ 1.20				
208 x 3	1/2	79.32 00 02	79.50 80	9.20/11.2					
	3/4	79.32 00 03	79.50 81	6.30/ 7.7					
	1	79.32 00 04	79.50 82	6.30/ 7.7					
	1.5	79.32 00 05	79.50 83	3.90/ 4.8					
	2	79.32 00 06	79.50 84	2.80/ 3.4					
	3	79.32 00 07	79.50 85	1.80/ 2.2					
	5	79.32 00 09	79.50 86	1.00/ 1.2					
	7.5 [d]	234-10828		0.76/0.93					
	7.5	236-13290		0.48/0.59					
	10	236-13390		0.38/0.46					
	15	236-13490		0.29/0.37					
	20	236-13590		0.17/0.22					
	25	236-13690		0.13/0.19					
	30	236-13790		0.10/0.14					
230 x 3	1/2	79.30 00 02	79.50 70	11.4/13.9					
	3/4 [e]	79.30 00 03	79.50 71	6.8/ 8.3					
	1 [e]	79.30 00 04	79.50 72	6.8/ 8.3					
	1.5	79.30 00 05	79.50 73	4.9/ 6.0					
	2	79.30 00 06	79.50 74	3.4/ 4.2					
	3	79.30 00 07	79.50 75	2.3/ 2.8					
	5	79.30 00 09	79.50 76	1.3/ 1.6					
	7.5 [d]	234-11828		0.76/0.93					
	7.5	236-10290		0.56/0.71					
	10	236-10390		0.45/0.55					
	15	236-10490		0.29/0.37					
	20	236-10590		0.22/0.27					
	25	236-10690		0.16/0.21					
	30	236-10790		0.11/0.15					
460 x 3	1/2	79.36 00 02	79.50 40	45.4/55.5					
	3/4 [d]	79.36 00 03	79.50 41	27.2/33.2					
	1 [d]	79.36 00 04	79.50 42	27.2/33.2					
	1.5	79.36 00 05	79.50 43	19.5/23.8					
	2	79.36 00 06	79.50 44	13.6/16.7					
	3	79.36 00 07	79.50 45	9.0/11.0					
	5	79.36 00 09	79.50 46	5.1/ 6.2					
	7.5 [d]	234-12828		2.4/ 3.4					
	7.5	236-11290		2.1/ 2.9					
	10 [d]	234-12928		1.8/ 2.3					
	10	236-11390		1.5/ 2.1					
	15	236-11490		1.1/ 1.4					
	20	236-11590		0.77/ 1.1					
	25	236-11690		0.53/0.81					
	30	236-11790		0.40/0.59					
	40 [d]	236-11890		0.44/0.54					
	40	239-10090		0.26/0.29					
	50 [d]	236-11990		0.32/0.40					
	50	239-10190		0.19/0.22					
	60	239-10290		0.15/0.17					
	75	239-10390		0.11/0.13					
	100	239-10490		0.08/0.09					

a) Motor No. 79.45 00 06 replaces model 79.45 01 06 with Stator No. 79.50 97 and 80 MF Capacitor, Part No. 14.50.

b) Motor No. 79.45 00 07 replaces model 79.45 01 07 with Stator No. 79.50 98 and 100 MF Capacitor, Part No. 14.52.

c) Special Franklin motor with clockwise rotation CANNOT rotate counter clockwise.

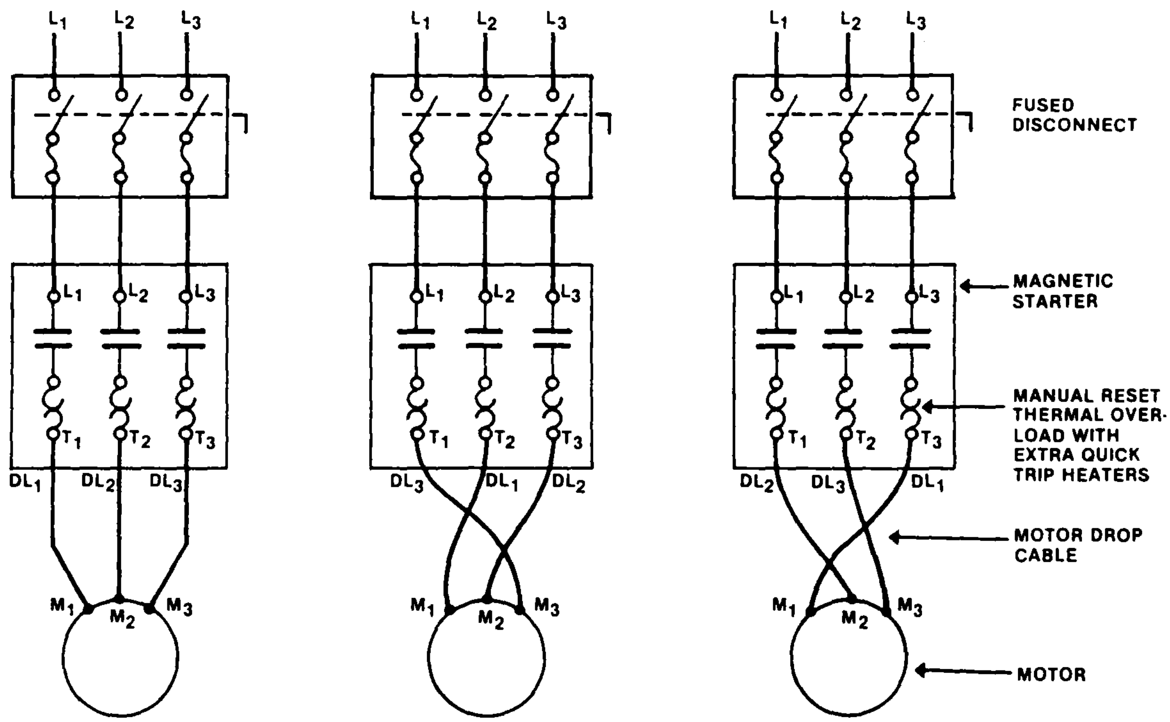
d) Franklin Uni-stru Motor.

e) Stators are the same for these models, but the nameplate is different.

f) A - Rotation is clockwise.
B - Rotation is counterclockwise.
C - Rotation is either direction.

TABLE F

Example: Correcting for Three Phase Power Unbalance



HOOKUP 1 HOOKUP 2 HOOKUP 3

Example: Check for current unbalance for a 230 volt, 3 phase, 60 Hz submersible pump motor, 18.6 full load amps.

Solution: Steps 1 to 3 measure and record amps on each motor drop lead for Hookups 1, 2, & 3.

	Step 1 (Hookup 1)	**Step 2** (Hookup 2)	**Step 3** (Hookup 3)
(T_1)	DL_1 = 19 amps	DL_3 = 17 amps	DL_2 = 17 amps
(T_2)	DL_2 = 14	DL_1 = 15	DL_3 = 14
(T_3)	DL_3 = 15	DL_2 = 16	DL_1 = 17
Step 4	Total = 48 amps	Total = 48 amps	Total = 48 amps

Step 5 Average Current = $\frac{\text{Total current}}{\text{3 readings}} = \frac{48}{3} = 16$ amps

Step 6 Greatest amp difference from the average:

(Hookup 1) = 19 — 16 = 3
(Hookup 2) = 16 — 15 = 1
(Hookup 3) = 16 — 14 = 2

Step 7 % Unbalance

(HOOKUP 1) $= \frac{3}{48} \times 100 = 6.25$

(HOOKUP 2) $= \frac{1}{48} \times 100 = 2.08$

(HOOKUP 3) $= \frac{2}{48} \times 100 = 4.17$

As can be seen Hookup 2 should be used since it shows the least amount of current unbalance. Therefore, the motor will operate at maximum efficiency and reliability.

By comparing the current values recorded on each leg, you will note the highest value was always on the same leg, L_1. This indicates the unbalance is in the power source. If the high current values were on a different leg each time the leads were changed, the unbalance would be caused by the motor or a poor connection.

If the current unbalance is greater than 5%, contact your power company for help.

*For a detailed explanation of three-phase balance procedures, see section Three Phase Motor, page 4.

TABLE G

Overload Protection of Three Phase - 60 HZ Submersible Motors

Volts & Phase	HP	DIA	MFG	Full Load Amps	Service Factor Amps	NEMA Sized Starters	Approved Ambient Compensated Quick Trip Heaters a)		
							Furnas Innovas-45 b)	AB	GE
208 x 3	1/2	4"	GF	2.5	3.2	00	K29	J14	L3.43A
	3/4	4"	GF	3.4	4.3	00	K34	J18	L4.63A
	1	4"	GF	3.9	5.2	00	K37	J20	L5.61A
	1.5	4"	GF	5.4	6.7	00	K42	J22	L7.50A
	2	4"	GF	7.0	8.4	0	K49	J25	L9.10B
	3	4"	GF	9.8	11.1	0	K54	J28	L12.2B
	5	4"	GF	15.9	17.9	1	K61	J33	L19.9B
	7.5 c)	4"	F	26.0	29.0	1	K70	J38	L32.2B
	7.5	6"	F	23.2	26.4	1	K68	J37	L29.3B
	10	6"	F	30.9	35.4	2	K78 d)	J39	L39.0B
	15	6"	F	44.1	50.2	3	K77	J43	L52.0B
	20	6"	F	59.2	67.4	3	K77 g)	J45	L71.0B
	25	6"	F	70.8	81.4	3	K85 g)	J70	L86.6B
	30	6"	F	89.3	102.0	4	K87 g)	J72	L107C
230 X 3	1/2	4"	GF	2.4	3.0	00	K29	J14	L3.43A
	3/4	4"	GF	3.0	4.2	00	K34	J18	L4.63A
	1	4"	GF	3.8	5.0	00	K36	J20	L5.61A
	1.5	4"	GF	5.2	6.6	00	K42	J22	L7.50A
	2	4"	GF	6.8	8.4	0	K49	[illegible]	[illegible]
	3	4"	GF	9.6	11.2	0	K54	[illegible]	[illegible]
	5	4"	GF	15.6	18.0	1	K61	[illegible]	[illegible]
	7.5 c)	4"	F	23.5	26.2	1	K68	[illegible]	[illegible]
	7.5	6"	F	21.0	23.9	1	K67	[illegible]	[illegible]
	10	6"	F	27.9	32.0	2	K72 [illegible]	[illegible]	[illegible]
	15	6"	F	39.9	45.4	2	K75	[illegible]	[illegible]
	20	6"	F	53.5	61.0	3	K78 g)	J44	L62.2B
	25	6"	F	64.0	73.6	3	K78 g)	J46	L78.7B
	30	6"	F	80.8	92.0	3	K86 g)	J71	L107C
460 x 3	1/2	4"	GF	1.2	1.5	00	K21	J7	L1.74A
	3/4	4"	GF	1.5	2.1	00	K24	J10	L2.32A
	1	4"	GF	1.9	2.5	00	K27	J13	L2.82A
	1.5	4"	GF	2.6	3.3	00	K31	J15	L3.43A
	2	4"	GF	3.4	4.2	00	K34	J18	L4.63A
	3	4"	GF	4.8	5.6	0	K39	J20	L6.18A
	5	4"	GF	7.8	9.0	0	K50	J25	L10.0B
	7.5 c)	4"	F	11.7	13.1	1	K57	J29	L14.7B
	7.5	6"	F	10.5	11.9	1	K56	J29	L13.5B
	10 c)	4"	F	15.6	17.4	1	K61	J32	L19.9B
	10	6"	F	13.9	16.0	1	K60	J32	L18.1B
	15	6"	F	20.0	22.7	2	K67 d)	J35	L24.1B
	20	6"	F	26.7	30.5	2	K70	J38	L32.2B
	25	6"	F	32.0	36.8	2	K73	J40	L39.0B
	30	6"	F	40.4	46.0	3	K75 e)	J41	L46.4B
	40 c)	6"	F	53.0	60.0	3	K76 g)	J44	L62.2B
	40	8"	F	53.0	60.0	3	K76 g)	J43	L62.2B
	50 c)	6"	F	67.0	75.0	3	K78 g)	J46	L78.7B
	50	8"	F	67.0	75.0	3	K78 g)	J45	L78.7B
	60	8"	F	76.0	89.0	4	K85 f,g)	J46	L86.6B
	75	8"	F	92.0	110.0	4	K87 f,g)	J71	L107C
	100	8"	F	120.0	148.0	4	K94 f,g)	J74	L155C

a) Cutler Hammer and Square D ambient compensated overload relays may be used. For Cutler Hammer use the same heater number as listed under General Electric. For Square D overloads refer to bulletin "SM 416R."

b) Furnas Innova-45 heater selections are based on the trip current adjustment in the normal position and should not be increased.

c) Franklin Unistruc motor.

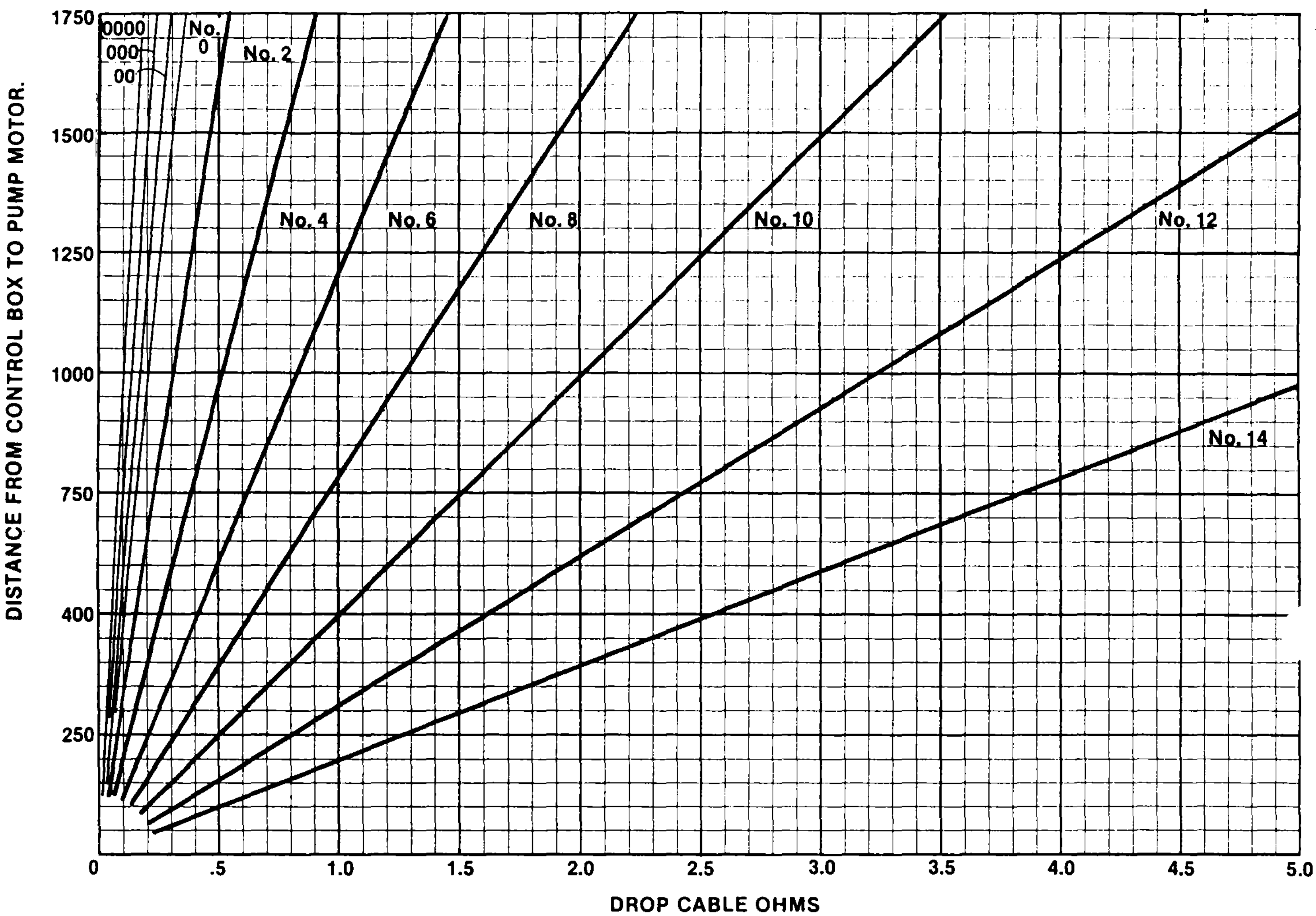
d) Heater selection based on using Furnas size 1¾ starter with this motor.

e) Heater selection based on using Furnas size 2½ starter with this motor.

f) Heater selection based on using Furnas size 3½ starter with this motor.

g) Furnas enclosed Nema 1 type starter.

TABLE H
Total Resistance of Drop Cable (OHMS)



a) Based on wire at 25°C (77°F)

The values shown on this chart are for copper conductors. Values are for the total resistance of drop cable from the **control box to the motor and back.**

To determine the resistance:

1. Disconnect the drop cable leads from the control box.
2. Record the size and length of drop cable.
3. Determine the cable resistance from the above chart.
4. Add drop cable resistance to motor resistance. Motor resistances can be found in the Electrical Data Chart, Table F.
5. Measure the resistance between each drop cable lead using an ohm meter. Meter should be set on RX-1 and zero balanced for this measurement.
6. The measured values should be approximately equal to the calculated values.

GRUNDFOS Service Manual For Submersible Pumps SP16 - SP35

REGISTRATION NO. 399.00

PLEASE READ THIS BEFORE YOU BEGIN. These instructions explain how to properly disassemble and reassemble 6" Grundfos pump ends: For correct assembly, it is important these instructions be followed in the order described. Special factory tools are required. These tools are described in the SP Pump Service Tool List.

A. DISASSEMBLY:

Removing Motor From Pump End

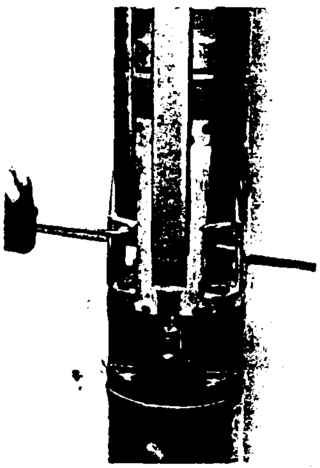


Fig. 1
Insert a large screwdriver in the suction interconnector to keep the pump from turning while loosening the nuts on the strap studs and motor nuts or bolts.

Fig. 2
Using a 17mm wrench (if the pump is mounted to a 4" motor) or a 19mm wrench (if the pump is mounted to a 6" motor), remove the nut from *one* of the straps holding the cable guard.

Fig. 3
Pull up the strap and remove it.

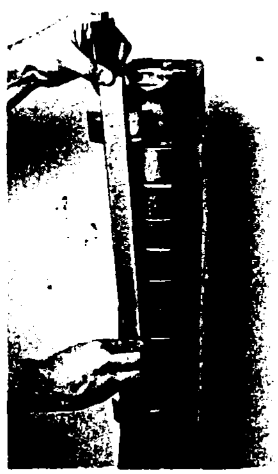


Fig. 4
Remove the rubber cable protector. Remove the cable guard by pulling up and sliding it away from the strap.

Fig. 5
On 6" motors bend back the clip at the bottom of the cable guard releasing the motor cable from the guard.

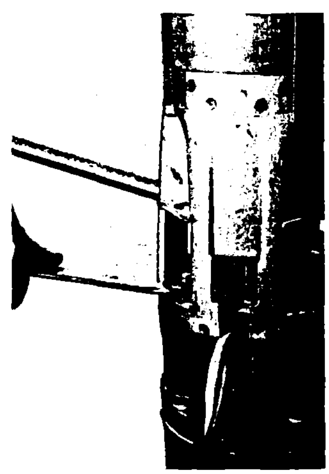


Fig. 6
Using the proper size wrench, remove the nuts or bolts holding the pump end to the motor.

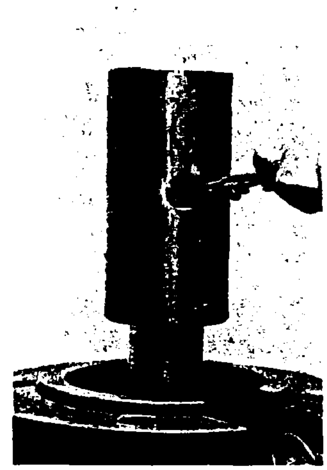


Fig. 7
For 8" Franklin motors, loosen the lock ring in the coupling, using the lock ring pliers (P/N SV.02 05). If the lock ring cannot be loosened, the two allen screws in the coupling can be removed. **See Figs. 9 & 10.** (Coupling is shown less suction interconnector for position clarity).

Fig. 8
Separate the pump end from the motor by pulling the pump end straight up. Care must be taken not to bend the motor shaft or

pump shaft and for 4" motors, the mounting studs.

Pump End Disassembly:
Before beginning, we suggest the pump be marked to indicate the position and order of the original components in order to facilitate locating specific areas of wear or damage. With a marking pen, draw a straight line down the entire length of the pump. One of the straps makes a convenient straight edge for this purpose. Number the chambers in order, starting with the first chamber above the suction interconnector. During disassembly, lay out the parts in the order and orientation in which they are removed to aid in proper reassembly.

Figs. 9 & 10
If the pump end is for 6" or 8" motors, the motor coupling must be removed before proceeding. Using the proper size allen wrench (1/8" [3.0mm] for 6" motors Service Tool P/N SV.00 52), (5/32" [4.0mm] for 8" motors Service Tool P/N SV.00 26), loosen the two set screws and gently pry the coupling off the shaft. Remove key from shaft if necessary and place with the coupling.

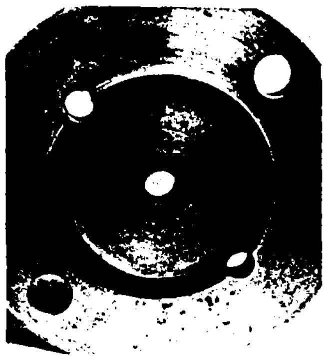


Fig. 11
Select the correct side of the mounting plate, P/N SV.00 49, which is determined by the diameter of the motor to be used. The suction interconnector will securely seat on the correct side of the mounting plate.

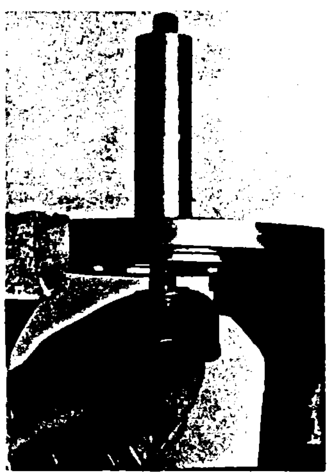


Fig. 12
Select the proper shaft height spacer and shaft holding bolt indicated on the SP Pump Service Tool List for the specific pump and motor type. Clamp the plate in a vise and place spacer in the center of the pump mounting plate.

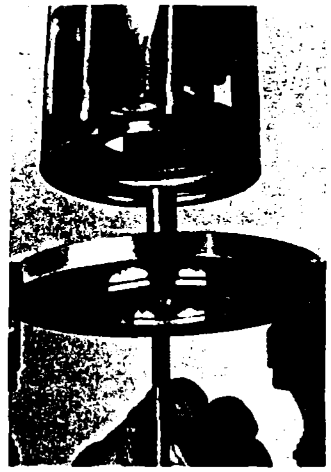


Fig. 13
Set the pump into place on the mounting plate so the shaft is centered on the shaft height spacer. Insert the correct size *metric* allen bolt up through the mounting plate, shaft spacer and thread into the shaft. Securely tighten. Bolt sizes and lengths are given in SP Service Tool List.

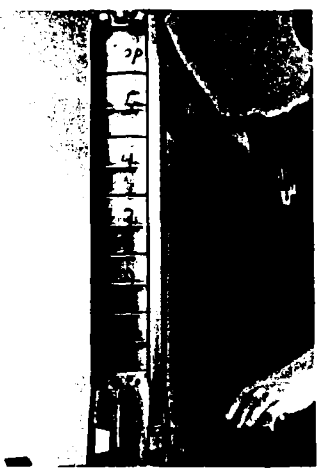


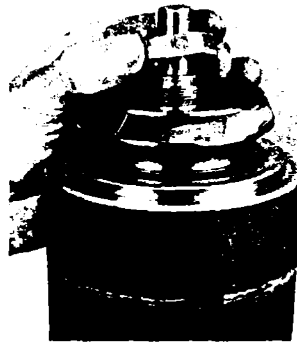
Fig. 14
Using the proper size metric wrench, loosen the remaining straps diagonally making sure not to bend the pump shaft. Remove straps.

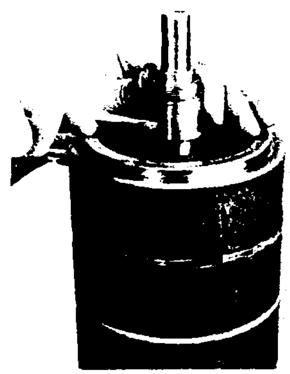
Figs. 15 & 16
Lift the check valve casing off the top diffuser chamber. If the valve casing sticks, it may be loosened by tapping it gently on the side with a rubber mallet.

Figs. 17 & 18
Remove the check valve cone and upper diffuser chamber. Note, on some models with a larger number of stages, the check valve casing and top diffuser chamber are welded together and are an integral unit. See the Spare Parts List for the specific models.

Fig. 19
Using the combination split cone wrench and driver (P/N SV.00 60 for SP16, P/N SV.00 61 for SP25 and SP35), loosen the split cone (right hand thread) but do not remove it.

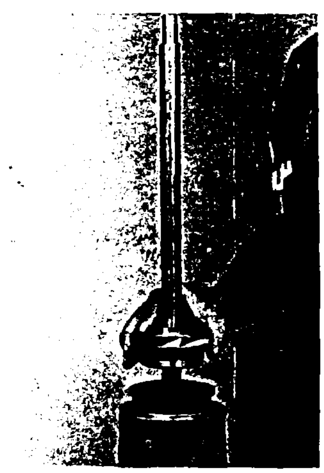
Fig. 20
Tap the split cone down releasing the grip of the split cone from the shaft.





Figs. 21, 22 & 23
Remove the split cone nut and impeller. The split cone can be removed by inserting a screwdriver in the slot of the cone and *gently* prying sideways while lifting up on the cone.

Fig. 24
Remove the next diffuser section.



Figs. 25 & 26
Continue to disassemble by loosening the split cone nuts, tapping down split cones, removing the split cone nuts, impellers, split cone and diffuser, until all stages have been removed.

It may not be necessary to remove the last impeller from the shaft, depending on whether or not the shaft or bottom impeller needs replacement.

It will be necessary to unbolt the shaft from the mounting plate to continue disassembly if the last impeller was not removed.

Fig. 27
SP25 only: Remove the seal ring retainer (Pos. 25).

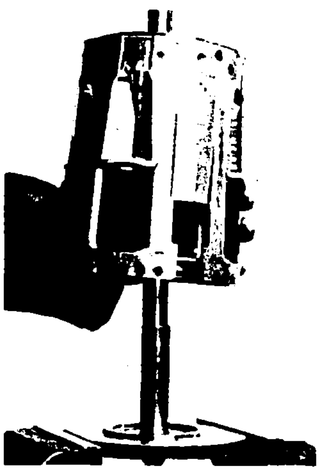


Fig. 28
Remove the suction interconnector.

Figs. 29, 30, 31 & 32
Can be skipped if further dismantling is not required.

Fig. 29
SP16 and 25 models: Remove the rubber seal ring by pressing a screwdriver between the seal ring and retainer for the strainer and gently pry up.

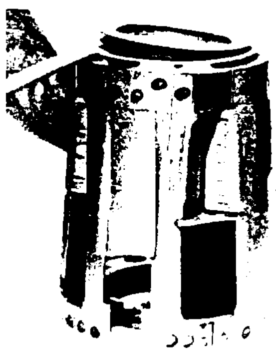


Fig. 30
SP16 models: Remove the seal ring retainer (Pos. 25) by inserting a screwdriver between the suction interconnector and retainer and gently pry up.

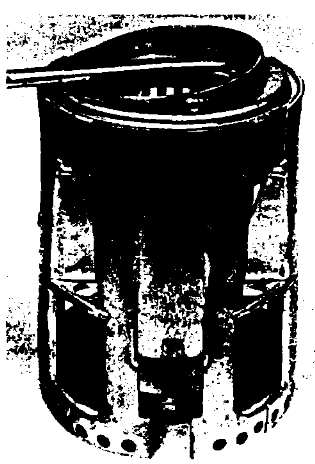


Fig. 31
SP35 models: The bottom seal ring can be removed by inserting a screwdriver under the ring and gently prying it up.

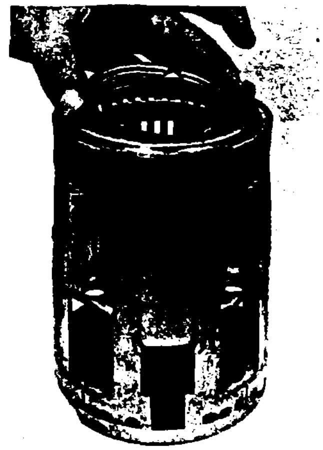


Fig. 32
SP25 and 35 models: Remove the retainer for the strainer (Pos. 26)

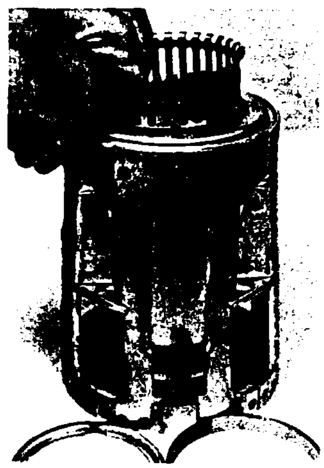


Fig. 33
Strainer can be removed from the suction interconnector by lifting up.

B. COMPONENT INSPECTION:

Thoroughly clean all parts and inspect for wear or damage. The following parts should be carefully checked. All worn parts should be replaced to ensure proper performance and life of the pump. The position numbers refer to the Spare Part Lists.

Pos. 2.
Check Valve Cone — The check valve cone must be smooth and straight, without deformation or wear grooves.

Fig. 34

Fig. 35

Pos. 3.
Valve Seat — The check valve cone should seat on the rubber portion of the seat and not touch metal. If the valve cone can touch metal when the cone is pressed down, the seat must be replaced. The seat can be removed by pressing a screwdriver under the seat and gently prying up. **See Fig. 34.** Clean the edge of the seat recess and reinstall new seat by firmly pressing up and tapping into place. **See Fig. 35**

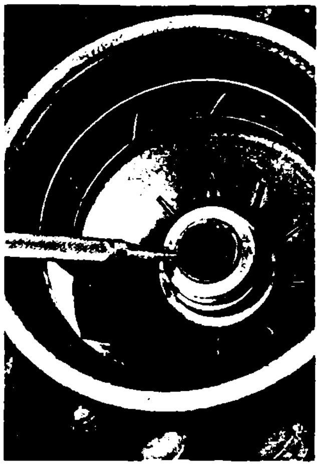


Fig. 36

Fig. 37

Fig. 38

Pos. 6.
Top Bearing — The top bearing(s) is fluted (hexed) and designed to allow for maximum water lubrication. The bearing(s) should be smooth inside and free of any signs of sand damage or dry running. **See Fig. 36.** On some pump models, there are two bearings. On others, a single bearing. The bearing(s) is pressed into place. For pumps with one bearing, the bearing can be driven out by using a punch and mallet. For pumps with two bearings, a narrow chisel should be inserted between the bearings. They should be driven out in the opposite direction in which they were inserted. Top bearing must be firmly seated and flush with the bearing retainer. **See Figs. 37 and 38.**

Note: On some models where the discharge and top sections are welded together, the entire section must be replaced if wear or damage is evident.

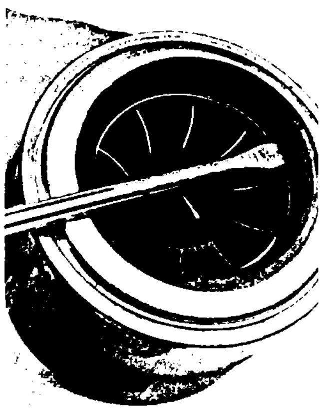


Fig. 39

Fig. 40

Pos. 7.
Seal Rings — This ring should be replaced when the lip touching the collar of the impeller is worn away. WORN SEAL RINGS MAY CAUSE REDUCED PUMP CAPACITY. The seal rings are removed from the diffuser chambers by pressing a screwdriver between the seal ring and bottom of the chamber and gently prying up. **See Fig. 39.** Clean edge of the ring recess and install new seal ring by tapping into place with a mallet. Lip of seal ring must face towards the diffuser chambers. **See Fig. 40.**

Fig. 41

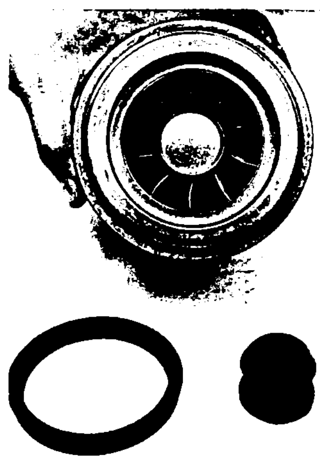


Fig. 42

Fig. 43

Pos. 8.
Intermediate Bearings — These bearings are fluted (hexed) and are also designed to allow for maximum water lubrication. Bearing(s) should be smooth inside and free of any sand damage or dry running. Bearings are removed by pressing against one side of the bearing and causing it to collapse toward its center. **See Fig. 41.** The bearing will then pass through the bearing retainer. **See Fig. 42.** Bearings are installed in the opposite manner. Soapy water may be used to lubricate the bearings for easier installation, but **never** use oil on any rubber parts. **See Fig. 43.**

Note: Tapered end of bearing must face upwards in the diffuser section.

Pos. 9.
Diffuser Chamber — Check for signs of wear, loose vanes and clogged water passages.

Pos. 13.
Impellers — Inspect each impeller and impeller collar for smoothness and wear. Replace impeller if collar is worn or grooved sufficiently that the neck ring will not properly seal. Check water passages for blockage and loose or damaged vanes.

Pos. 14.
Suction Interconnector — If the pump has been dropped or bent, the suction interconnector must be checked for alignment or replaced.

Pos. 16.
Shaft — The shaft should be smooth, straight and major signs of grooves or wear should not be evident.

Pos. 24
Coupling Splines — The coupling splines must be clean and free of any defects. There should be a smooth slide fit between the coupling and motor shaft splines.

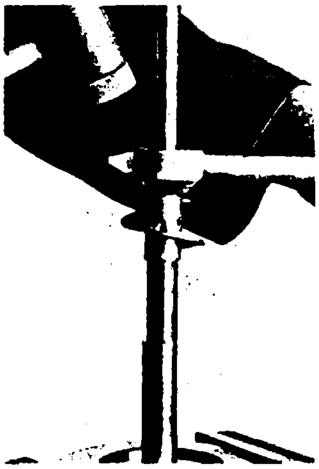


Fig. 44

Fig. 45

Pos. 64.

Priming Inducer — On the SP16 models, the priming inducer is attached to a sleeve which must firmly grip the shaft. It must be removed if it is loose or the shaft requires replacement. Using hammer and the combination split cone wrench and driver SV.00 60, tap the inducer off the end of the shaft. **See Fig. 44.** The inducer is replaced by tapping it on the shaft. For pumps with 4" motors, the inducer is pressed on the shaft until it touches the coupling. For pumps with 6" motors, the inducer is pressed on until it is approximately 0.20 inches (5mm) from the shoulder of the shaft.

On SP35 models, the inducer can be removed by gently squeezing it together with your fingers and lifting up. **See Fig. 45.** The spacer ring (Pos. 75) can now be driven off the end of the shaft. To replace the inducer, first slide the spacer ring down the shaft so it is approximately 0.20 inches (5mm) from the shoulder of the shaft.

With your fingers, NOT PLIERS, gently squeeze the inducer together and slide it into position above the spacer ring. The inducer must firmly grip the shaft.

C. PUMP END ASSEMBLY:

Check to ensure the correct side of the mounting plate P/N SV.00 49, is used. The suction interconnector will securely seat on the correct side of the mounting plate.

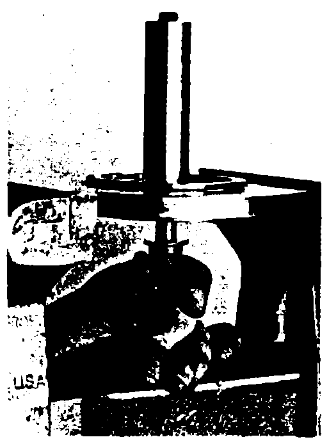


Fig. 46

Side selection is based on motor diameter. Select the proper shaft height spacer indicated on the SP Pump Service Tool List for the specific pump type. With the spacer between the shaft and mounting plate, bolt the shaft to the plate. Shaft must be clean and oil free. Pumps with 8" motors should be assembled like pumps for 6" motors. They should then be coupled to a 6" to 8" adapter flange. However, the following shaft spacers must be used:

8" Franklin:
P/N SV.02 00 (71 mm)

8" Pleuger:
P/N SV.01 91 (81mm)

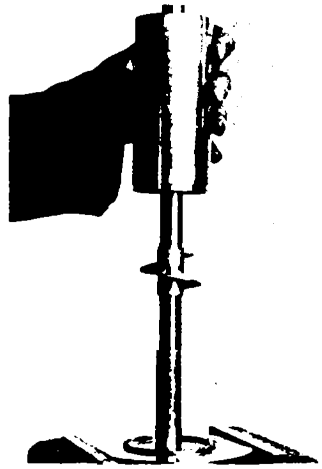
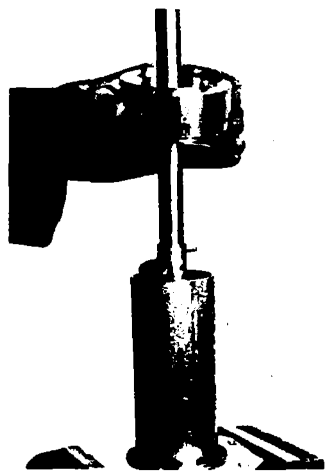


Fig. 47

Slide the spacer pipe (P/N SV.00 81) for the impeller spacer down over the shaft. The machined groove in one end of the spacer pipe faces down and fits into the machined recess in the mounting plate.



Figs. 48 & 49

Select the proper side of the impeller spacer (P/N SV.00 80) as determined by the motor diameter. Slide it down over the shaft fitting it into the spacer pipe. **See Fig. 48.**

Note: Impeller spacer ring (P/N SV.01 90) must also be used for SP16 model. This ring fits on top of impelle˙ spacer (P/N SV.00 80) wi the recess in the ring facing down. **See Fig. 49.**

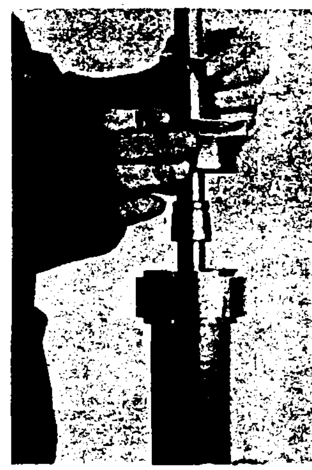


Fig. 50

Depending on the condition of the shaft it may be necessary to individually position each split cone on the shaft. If required, insert a screwdriver in the slot of the split cone and slide it down the shaft. Position above the upper edge the spacer ring. Replace the impeller over the shaft and seat it on the split cone.

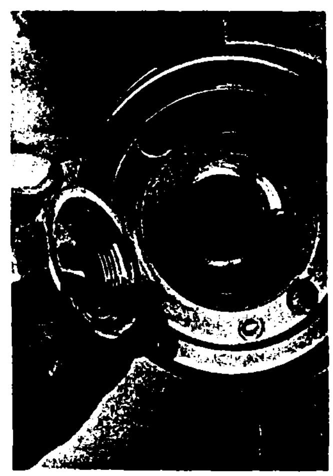


Fig. 51

Loosely screw the split cone nut on the split cone. On SP16, the tapered portion of the split cone nut faces the impeller. O˙ SP25 and SP35, the nut installed so the no. threaded portion of the nut faces towards the top of the impeller. **See Fig. 51.** Threads in the split cone nut must be at the top of the split cone. Using a plastic mallet, tap the impeller assembly down until it makes metallic contact with the spacer ring.

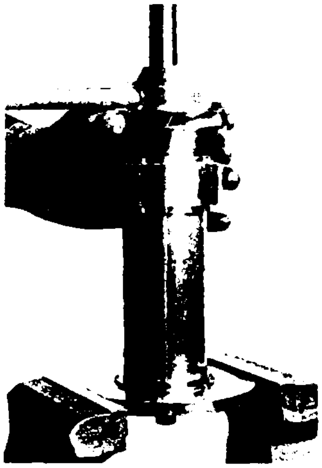
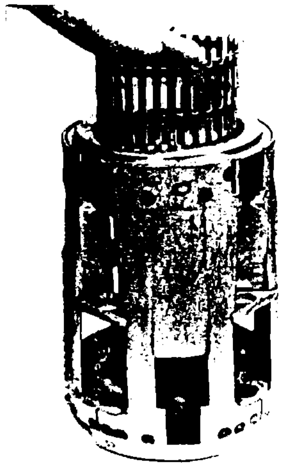
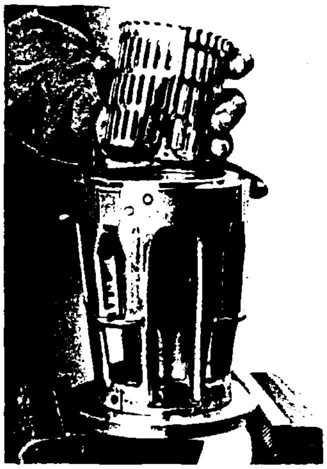


Fig. 52
Tighten split cone nut to 33-43 lbf-ft (40-60 Nm, 4.5-6.0 kgfm) torque. The threads in the split cone nut may strip out if the nuts are overtightened.

Fig. 53
Loosen and remove the shaft hold-down bolt. Remove the spacer pipe and impeller spacer ring.
Note: Figs. 54 through 59 can be skipped if the suction interconnector was not disassembled.

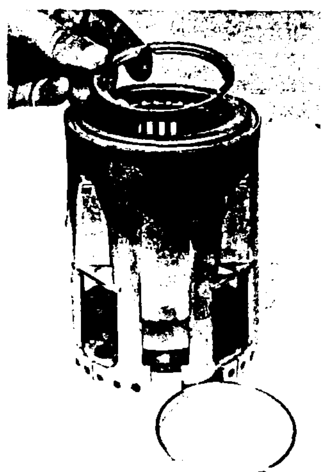




Figs. 54 & 55
If the strainer has been removed, insert it into the suction interconnector and press into place. **See Fig. 54.** If there is a recess in the strainer, it must be aligned with the indentation in the suction interconnector which is provided for the motor cable. **See Fig. 55.**

SP16 only

Fig. 56
SP16 — Install the rubber seal ring (Pos. 7) in the strainer retainer (Pos. 25). Lip of seal ring must face upward in retainer. Insert retainer in the suction interconnector.



25 + 27
Fig. 57 35 + 45
SP25 and SP35 — Install the strainer retainer (Pos. 26) in the suction interconnector. Recessed surface of the retainer faces down toward the motor.

Fig. 58 25 + 27
SP25 — Install the rubber impeller seal ring (Pos. 7) in the suction interconnector. Lip of seal ring must face upward in interconnector.

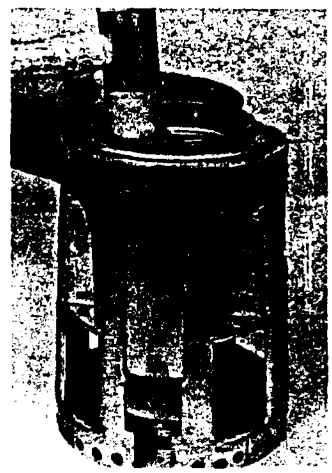


Fig. 59 35 + 45
SP35 — Position the seal ring so the edge with a taper faces down. With a plastic mallet gently tap the ring into place.

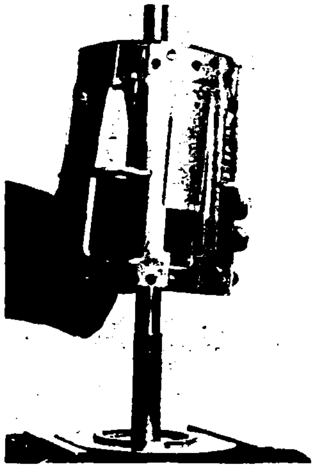


Fig. 60
Center the suction interconnector on the mounting plate.

25+27

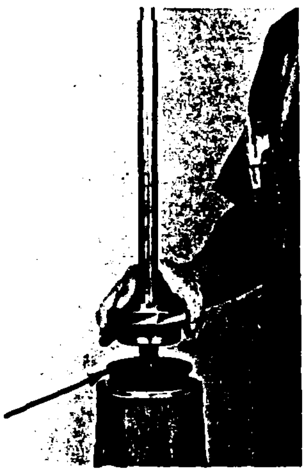


Fig. 61
Insert the shaft impeller assembly into the suction interconnector and rebolt the shaft to the mounting plate, being sure to use the proper shaft height spacer. Tightly bolt it down. On SP25 make sure the seal ring retainer is in place before the shaft impeller assembly is installed.

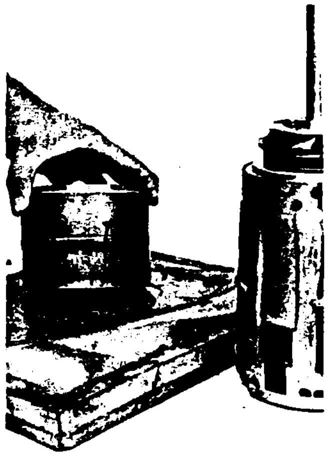


Fig. 62
Check to be sure the impeller seal ring and intermediate shaft bearing are properly installed in diffuser sections. Put a thin, even layer of sealing compound on the bottom seal surface of the first diffuser chamber. Sealing compound must be thin and even in consistency. Too much or too lumpy compound will cause assembly clearances to be out of tolerance and will result in improper assembly. Compound can be easily applied by spreading a layer on a piece of foam, then pressing the part against the foam.

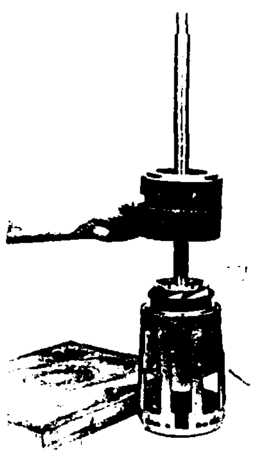


Fig. 63
Slide the diffuser chamber down the shaft and tap into place with a rubber mallet, being sure it is evenly seated.

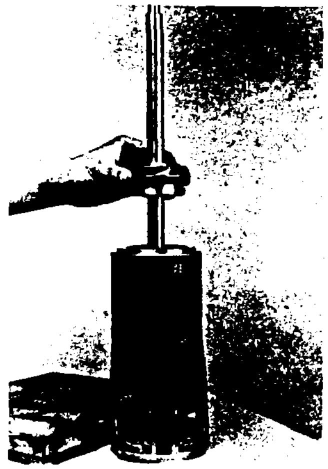


Fig. 64

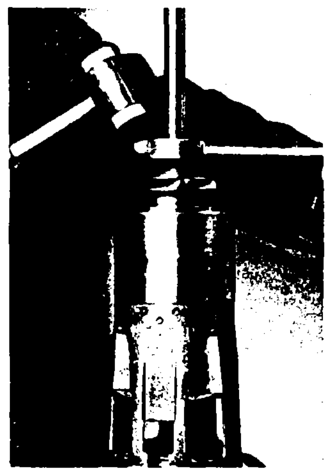


Fig. 65
Depending on the condition of the shaft, it may be possible to slide the impeller split cone assembly down the shaft. **See Fig. 64.** If the assembly fits too tightly to the shaft, remove the split cone from the impeller, *gently* insert a screwdriver into the split of the split cone. **See Figs. 50 and 51.** Reinstall split cone and slide down the shaft.

Note: The impeller must be firmly tapped into place and seated against the neck ring before the split cone nut is tightened to 33-43 lbf-ft (40-60 Nm, 4.5-6.0Kgfm) torque. **See Fig. 65.** Overtightened nuts may strip threads or reduce required tolerances. Diffuser chamber will not rotate when the nuts are adequately tightened.

Fig. 66
Coat lower bottom seal surface of next intermediate chamber with sealing compound **(See Fig. 62)** and install chamber. Position the impeller assembly with split cone and split cone nut on the shaft and firmly press into place. Securely tighten split cone nut.
Continue assembly until all intermediate chambers are in place. Be sure to use joint compound between all intermediate diffuser chambers as they are being assembled.

Fig. 67
Install the top diffuser-bearing section, making sure the upper bearing and check valve seat are free of defects. Replace if necessary. The upper bearing must fit tightly into the bearing retainer.
For SP16, check that the shaft end does not protrude past the upper edge of the bearing suppor which could prevent th check valve cone from firmly seating on the valve seat.

Fig. 68
Position the valve cone on the valve seat.

Fig. 69
Install the discharge section, making sure the slot in the casing for the straps is aligned to the points where the clip attaches to the suction interconnector.

Fig. 70
Insert the top of the straps into the slots in the discharge section. By slightly bowing the straps, insert the threaded stud through the hole in the suction interconnector.

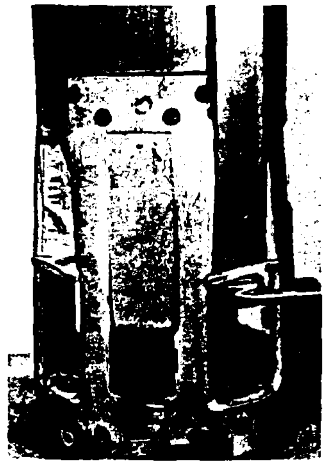


Fig. 71
Place metric nuts on strap studs and tighten adequately, but do not over torque 10mm nuts: 35-40 lbf-ft. 48-55 Nm, 4.8-5.5 Kgfm. 12mm nuts: 50-65 lbf-ft, 70-90 Nm, 7.0-9.0 Kgfm.

Loosen shaft mount bolt and remove pump from the mounting plate.

IMPORTANT: To be certain pump has been properly assembled, it is necessary to check shaft end play. For 6" and 8" motors, the coupling will be mounted after the shaft end play has been checked.

D. CHECKING PUMP END PLAY:

When the pump end is mounted to a motor, the motor shaft will raise the pump shaft to predetermined tolerances. To ensure these tolerances are met, it is extremely important to check pump shaft end play and motor shaft extension height.

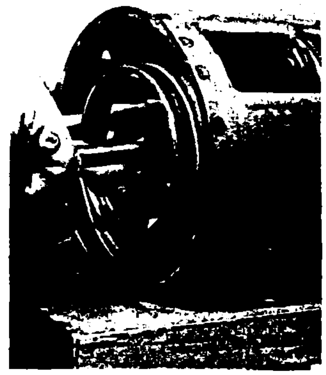


Fig. 72
To check pump end shaft travel, thread the correct *metric* tee bolt into tapped hole in the end of the pump shaft. Using a depth gauge, measure and record the distances required on Table A below. Next, push the shaft all the way in while rotating the pump shaft. Measure and record the travel. Be sure measurements are taken from correct reference point and pump shaft is fully extended up or down.

Fig. 73

Fig. 74

TABLE A

Motor Diameter	Measured From:	Min. Measurements ≤ Shaft Down	Shaft Up ≥
4 inch	Machined recess for the motor contact surface of the suction interconnector to the washer inside the coupling. **See Fig. 73.**	1.46 inches (37.1mm)	1.54 inches (39.1mm)
6 inch	Mounting surface of the suction interconnector to the end of the pump shaft *before* the coupling has been installed. **See Fig. 74.**	3.08 inches (78.2mm)	3.16 inches (80.3mm)
8 inch	Same as for 6 inch.	3.94 inches (100.1mm)	4.06 inches (103.1mm)

NOTE: The maximum end play measurement will vary from pump type to pump type. If the end play is less than stated above, the pump has been incorrectly assembled and will require rebuilding. Generally, insufficient end play is caused by assembly on the wrong shaft spacer or improper seating of the impellers.

dropped
↓
25 cw = 27 ccw
35 ccw = 45 ccw

E. SHAFT COUPLING:

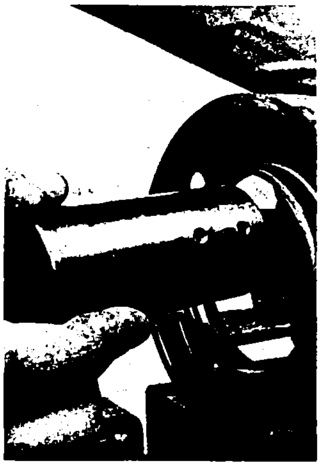


Fig. 75
For 6" and 8" motors, mount the motor shaft coupling to the shaft. Place key on shaft and slide coupling on the shaft. Firmly tap the coupling into place making sure the coupling seats against the end of the pump shaft.

Check to see the priming inducer spacer rings for SP35 (Pos. 25) is correctly installed between the coupling and the inducer. The inducer or spacer ring must touch the coupling.

Fig. 76
Tighten allen set screws.

F. MOTOR CHECKS BEFORE MOTOR/PUMP ASSEMBLY:

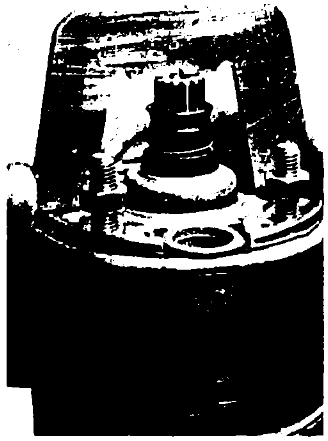


Fig. 77
Before the pump end is mounted on the motor, it is also important to check the motor shaft height extension. The shaft height for a 4" NEMA mount motor is 1.50 to 1.51 inches (38.10 to 38.35mm). The height is measured from the top surface of the shaft to the raised machined motor flange.

SV.01 14 can be used to determine if the shaft height must fall within the minimum 1.50 (38.1mm) and the maximum (38.35mm) indicators when the gauge is held above the shaft and it makes contact with the two motor flanges.

For 4" Grundfos 1/3 to 1-1/2 HP single-phase motors, the shaft height measurement should be 1.51 to 1.53 inches (38.35 to 38.73mm). Measurements for all other types and horsepowers must be between 1.50 and 1.51 inches (38.10 to 38.35mm).

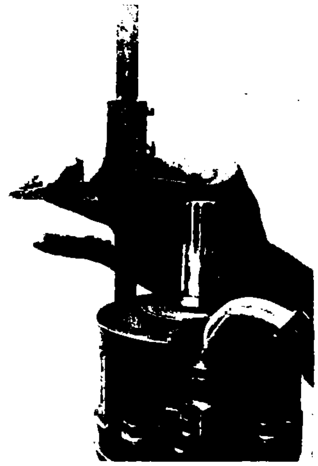


Fig. 78
The shaft height for 6" NEMA mount motors is 2.86 to 2.88 inches (72.64 to 73.15mm). The shaft height for 8" NEMA mount motors is 3.99 to 4.00 inches (101.34 to 101.60mm). The height is measured from the top surface of the motor shaft to the flanged surface of the motor. Use SV.01 15 to check 6" motor shaft height and SV.02 06 to check 8" motors. A vernier depth gauge can be used if SV.01 15 or SV.02 06 are not available.

The motor shaft heights will have to be adjusted if these dimensions are not correct. If the measurement on a used motor is less than specified, it may mean the thrust bearing is worn or defective and will require rebuilding.

G. INSTALLING MOTOR CABLE:

Inspect the motor socket to ensure the plug connection pins have not been damaged and the socket is dry and clean. The socket can be cleaned and dried, using compressed air. Inspect the motor lead plug for damage.

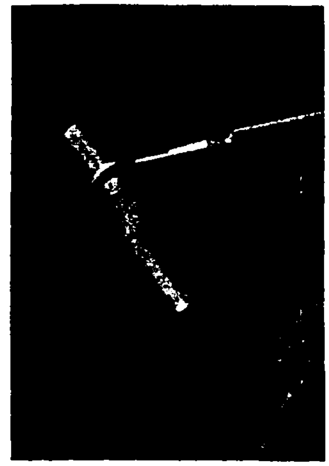


Fig. 79
Grundfos Motors: Check the o-ring and molded rubber portion of the plug for damage or defects. Insert the plug into the motor socket so the flat portion of the plug is parallel with the diameter of the motor. Gently push the plug into the socket. DO NOT use petroleum products or vaseline to lubricate o-ring or molded plug.

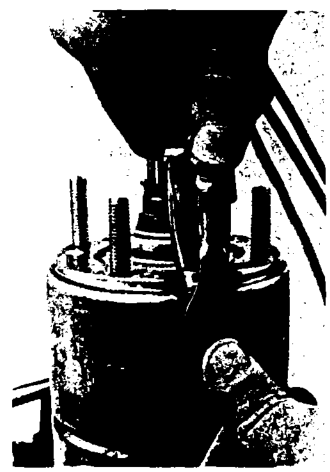
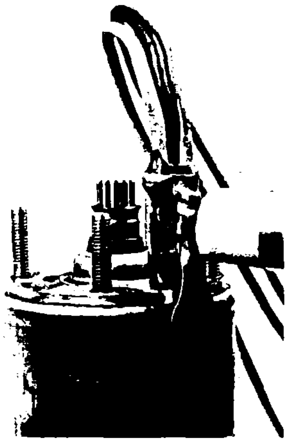
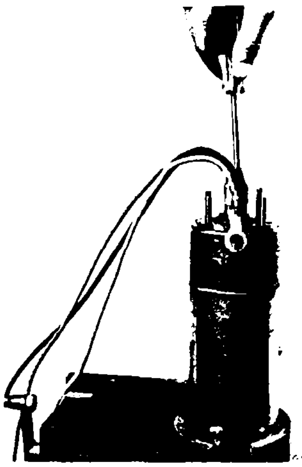


Fig. 80
Slide the clamp over the clamp retainer on the stator and tighten with a screwdriver.





Figs. 81 & 82
When the screw is fairly snug, *gently* tap the plug on the clamp with a rubber mallet and finish tightening the screw. This will reduce any misalignment that may occur as the plug seats into the socket.

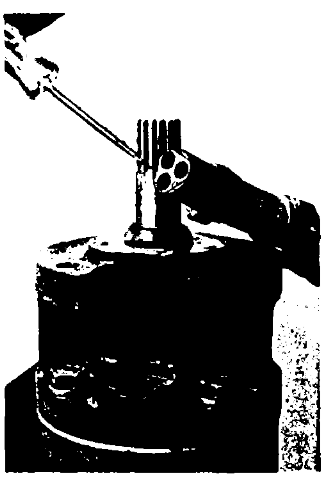


Fig. 83
Franklin Motors: Check motor cable leads and plug for damage.

Fig. 84
Insert the plug into the motor socket ensuring that the key on plug is aligned with the keyway in the socket. Press plug firmly into the socket and securely tighten the jam nut. (Do not overtighten jam nut.) Torque to:

4" motors: 20-25 lbf-ft., 27-34Nm, 3.8-3.4Kgfm

6" motors: 60-70 lbf-ft., 81-95Nm, 8.3-9.7Kgfm

8" motors: 120-150 lbf-ft., 163-203Nm, 16.6-20.7Kgfm

H. MOUNTING PUMP END TO MOTOR:

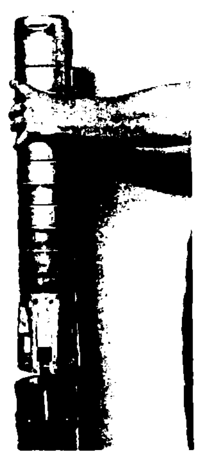


Fig. 85
Check and clean motor contact surface, motor splines and pump shaft couplings. Mount the pump on the motor so the cable opening in the suction interconnector will fit over the motor leads.

For 8" Franklin motors, check the lock ring in the coupling to ensure it snaps into the groove on the motor shaft and the motor and pump shaft contact each other.

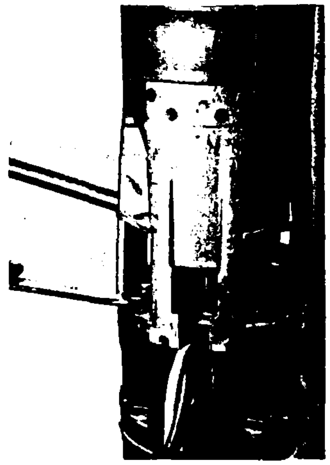


Fig. 86
Tighten motor bolt and nut torques as follows:

4" motors: 13-17 lbf-ft., 18-24Nm, 1.8-2.4 Kgfm

6" motors: 50-65 lbf-ft., 70-90Nm, 7.0-9.0 Kgfm

8" motors: 50-65 lbf-ft., 70-90Nm, 7.0-9.0 Kgfm

I. INSTALLING CABLE GUARD:

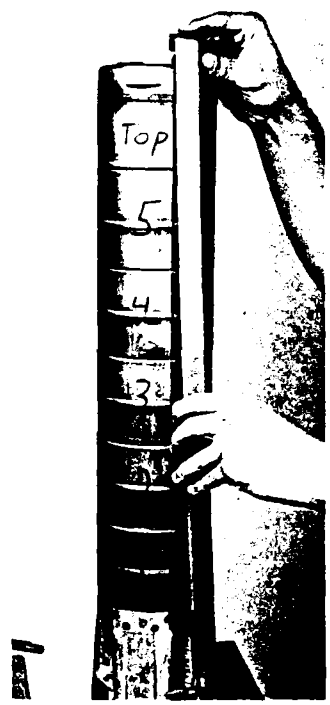
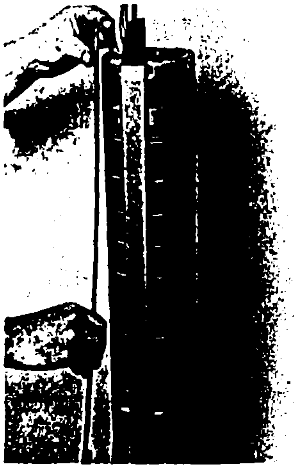


Fig. 87
Remove *one* of the pump straps on either side of the motor cable socket. Straighten the motor leads, removing any kinks and run lead parallel in the cable guard.

Fig. 88
On 6" motors, bend the clip at the bottom of the cable guard across motor leads to hold them in place.

Fig. 89
To protect cables from cutting or chaffing, install rubber motor cable guard protector around the leads at the top of the pump end. Slide the guard holder under the strap and slide down into the suction interconnector. Make sure the guard fits into place under the notch provided in the suction interconnector.



Figs. 90 & 91
Replace strap and nut. Retighten strap nut and recheck torque of remaining straps.

Torque to
10mm nuts: 35-40 lbf-ft, 48-55Nm, 4.8-5.5Kgfm.
12mm nuts: 50-65 lbf-ft., 70-90Nm, 7.0-9.0Kgfm.

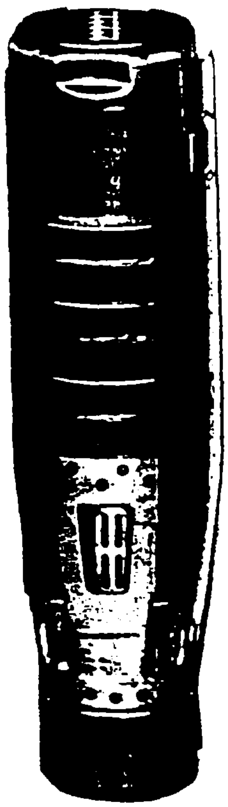
Test pump for performance (see SP Technical Data Sheets for head versus flow and electrical data).

APPENDIX F

GRUNDFOS

Spare Parts List And Service Tools For Submersible Pump

Type SP16



SP16

Spare Parts List & Pump End Service Tools

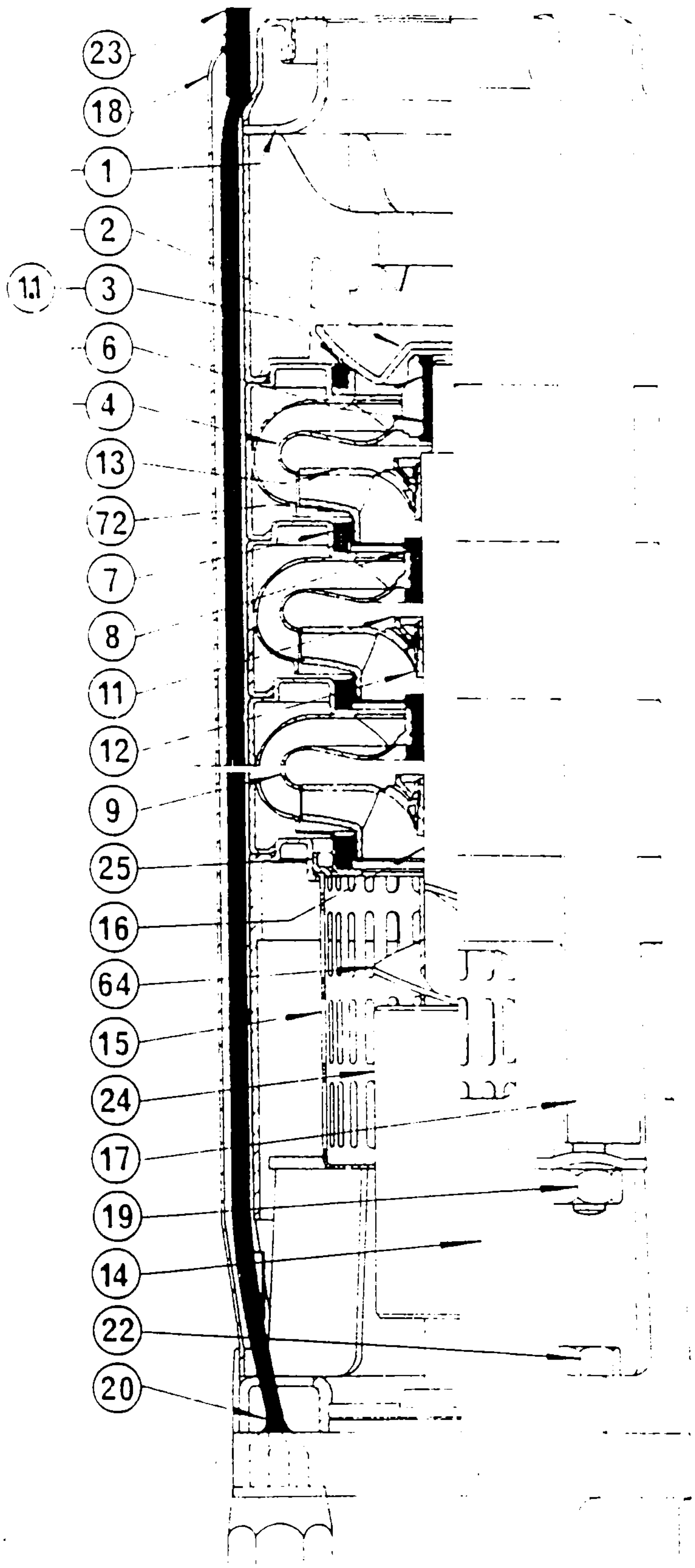
PRODUCT NUMBERS FOR PUMP ENDS WITHOUT MOTORS

PUMP TYPE	PRODUCT NO.	MOTOR		
60 HZ		HP	KW	TYPE
SP16-2	12.89 00 02	2.0	1.5	4" G & F
SP16-3	12.89 00 03	3.0	2.2	
SP16-5	12.89 00 05	5.0	3.7	
SP16-8	12.89 00 08	7.5	5.5	6" F
SP16-10	12.89 00 10	10.0	7.5	
SP16-12	12.89 00 12	15.0	11.2	
SP16-16	12.89 00 16	15.0	11.2	
SP16-20	12.89 00 20	20.0	15.0	
SP16-26	12.89 00 26	25.0	18.6	

GRUNDFOS

Spare Parts List For Submersible Pump

Type SP16



SPARE PARTS LIST

POS.	NO. REQ'D.	PART NUMBER	DIMENSIONS	TYPE	DESCRIPTION
1	1	12.50 08	2½" NPT	A = 2-20	Valve Casing
1.1	1	12.50 11	2½" NPT	A = 26-32	Discharge Section (Including Pos. 1, 2, 3, 4, & 6)
2	1	13.00 22		A = 2-20	Check Valve Cone
3	1	12.50 06		A = 2-20	Valve Seat
4	1	12.50 09		A = 2-20	Top Diffuser Chamber
6	1	09.50 13		A = 2-20	Top Bearing
7	A	22.50 14			Seal Ring
8	A-1	12.00 01			Intermediate Bearing
9	A-1	12.50 05			Diffuser Chamber
11	A	12.00 03			Split Cone Nut
12	A	12.00 02			Split Cone
13	A	12.50 03			Impeller
14	1	13.50 01	4" motor		Suction Interconnector
		13.50 14	6" motor		
15	1	13.50 29	4" motor		Strainer
		13.50 30	6" motor		
16	1	See Below			Pump Shaft
17	4	See Below			Strap
18	1	See Below			Cable Guard
19	4	ID.08 75	M10 4" motor		Strap Nut
		ID.08 76	M12 6" motor		
20		See Note 1			Motor Cable
21	4	ID.01 44	M8	4" G	Motor Stud Nut
(Not shown)		ID.01 43	5/16" UNF	4" F	Motor Stud Nut
22	3	79.00 72	M8 x 42mm	4" G	Motor Stud Bolt
	1	79.59 57	M8	4" G	Motor Stud Bolt with Filling Screw
	4	82.00 39	5/16" UNF x 56mm	4" F	Motor Stud Bolt
	4	ID.01 88	½" UNF x 40mm	6" F	Motor Cap Screw
23	1	11.00 33	4" motor		Rubber Motor Cable Protector
		13.00 43	6" motor		
24	1	10.00 18	4" motor	4" G	Coupling Complete
	1	01.00 17	4" motor		Washer for Coupling
	1	13.00 24	4" motor		Cap for Coupling
	1	79.59 39	6" motor, 7.5-20 Hp	6" F	Complete Coupling
	1	79.04 01	3/16" x 1/8" x 1-3/4"		Parallel Key
	2	ID.14 74	M6 x 12mm		Set Screw
	1	ID.14 75	1" I.D. x 1.25" O.D. x 0.12" T		O-Ring
		79.59 40	6" motor, 25 & 30 Hp	6" F	Complete Coupling
		79.04 02	1/4" x 3/16" x 1-3/4"		Parallel Key
		ID.14 74	M6 x 12mm		Set Screw
		ID.14 75	1" I.D. x 1.25" O.D. x 12" T		O-Ring
25	1	12.50 01			Seal Ring Retainer
64	1	12.50 02			Priming Inducer
72	A	12.00 05			Impeller Wear Ring

NOTES:

A = Number of Stages
G = Grundfos
F = Franklin

1. For Pos. 20 & 22 see Spare Parts Lists and Price List for 4" Grundfos submersible motors.

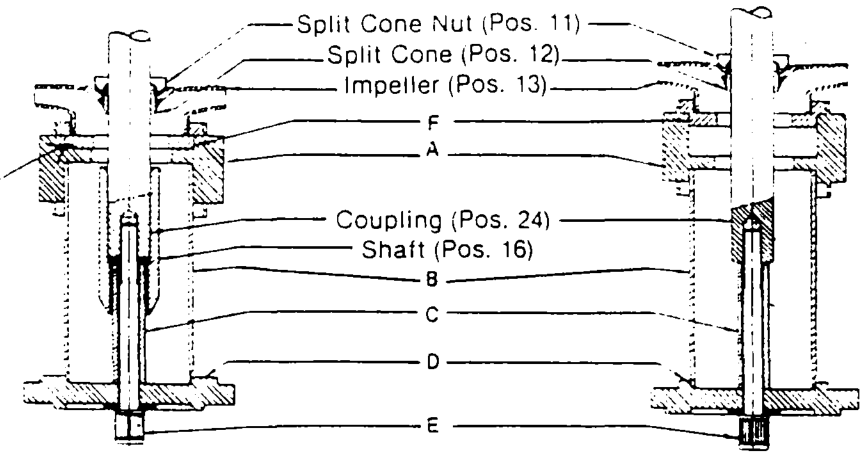
PART NUMBERS FOR PUMP SHAFT, STRAP AND CABLE GUARD

PUMP TYPE	POS. 16 — PUMP SHAFT WITH COUPLINGS		POS. 17 — STRAP		POS. 18 — CABLE GUARD	
	Part No.	Dimension	Part No.	Dimension	Part No.	Dimension
SP16-2	12.60 02	ø ¾" x 218 mm	12.90 02	L = 295 mm	12.91 02	L = 367 mm
SP16-3	12.60 03	ø ¾" x 263 mm	12.90 03	L = 340 mm	12.91 03	L = 412 mm
SP16-5	12.60 05	ø ¾" x 353 mm	12.90 05	L = 430 mm	12.91 05	L = 502 mm
SP16-8b	12.11 08	ø ¾" x 453 mm	12.92 08	L = 565 mm	12.93 08	L = 603 mm
SP16-10b	12.10 10	ø ¾" x 543 mm	12.92 10	L = 655 mm	12.93 10	L = 693 mm
SP16-12b	12.10 12	ø ¾" x 633 mm	12.92 12	L = 745 mm	12.93 12	L = 783 mm
SP16-16b	12.10 16	ø ¾" x 813 mm	12.92 16	L = 923 mm	12.93 16	L = 963 mm
SP16-20b	12.10 20	ø ¾" x 993 mm	12.92 20	L = 1103 mm	12.93 20	L = 1143 mm
SP16-26b	12.10 26	ø ¾" x 1263 mm	12.92 26	L = 1373 mm	12.93 26	L = 1413 mm

(b) 6" motor standard. Pump shaft does not include coupling.

GRUNDFOS | Service Tools | **Type SP16**

note SP16 only



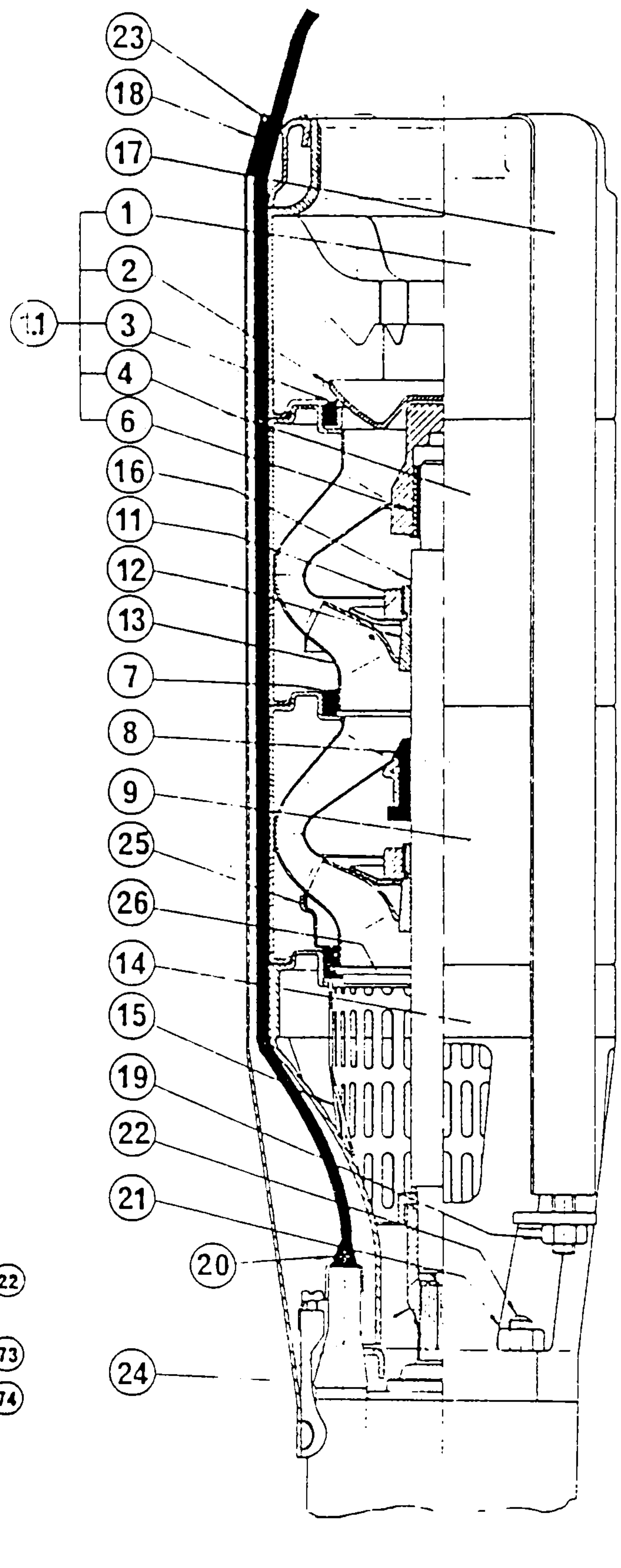
4" Motor   6" Motor

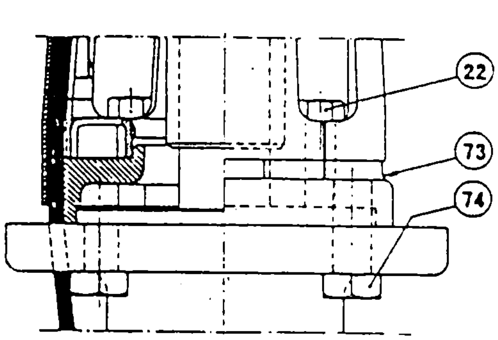
SERVICE TOOLS

POS.	PART NO.	DESCRIPTION	MOTOR DIA.	DIMENSIONS
A	or SV.0221 SV.00 80	Impeller Spacer	4" & 6"	
B	SV.00 81	Spacer Pipe for Impeller Spacer	4" & 6"	
C	SV.00 08 SV.00 11 SV.00 02 SV.01 91	Shaft Spacer Shaft Spacer Shaft Spacer Shaft Spacer	4" 6" 8" F 8" P	13mm O.D. x 8.5mm I.D. x 39.0mm Long 22mm O.D. x 10.5mm I.D. x 77.0mm Long 22mm O.D. x 10.5mm I.D. x 71.0mm Long 22mm O.D. x 10.5mm I.D. x 81.0mm Long
D	SV.00 49 SV.01 95	Mounting Plate Mounting Plate	4" & 6" 8" F & 8" P	
E	SV.00 74 SV.00 76 SV.02 10	Pump Shaft Bolt Pump Shaft Bolt Pump Shaft Bolt	4" 6" F & 8" P 8" F	M8 x 65mm Long (allen bolt) M10 x 110mm Long (allen bolt) M10 x 110mm Long (allen bolt)
F	SV.01 90	Impeller Ring Spacer	4" & 6"	
	SV.00 50 SV.00 51	6mm Tee Handle Allen Wrench 6mm Tee Handle Allen Wrench		Wrench for SV.00 74 & SV.00 76 Wrench for SV.02 10
21	SV.00 53	1/2" (12.7mm) Box & Open End Wrench	4" F	
19 & 22	SV.00 54	19mm Box & Open End Wrench	6"	
21	SV.00 55	13mm Box & Open End Wrench	4"	
19	SV.00 56	17mm Box & Open End Wrench	4"	
20	SV.00 73	30mm Box & Open End Wrench	6"	
11 & 12	SV.01 89	Comb. Split Cone Nut Wrench & Driver	4" & 6"	
6	SV.02 04	Shaft Bearing Driver		

APPENDIX G

GRUNDFOS | Spare Parts List For Submersible Pump | Type SP27





SP27 SPARE PARTS LIST

Pos.	No. Req.	P/N	Dimensions	Type	Description
1	1	13.50 19	3 NPT	A = 1-19	Valve Casing
1.1	1	13.50 42		A = 23-28	Discharge Section Including Pos. 1,2,3,4,&6
2	1	13.00 22			Check Valve Cone
3	1	13.50 09			Valve Seat
4	1	13.50 27			Top Diffuser Chamber
6	1	16.50 06			Top Bearing
7	A	13.50 10			Seal Ring
8	A-1	24.00 60			Intermediate Bearing
9	A-1	13.50 28			Diffuser Chamber
11	A	34.00 23			Split Cone Nut
12	A	34.00 24			Split Cone
13	A	13.50 09			Impeller
14	1	13.50 01 13.50 14	4" Motor 6" Motor		Suction Interconnector
15	1	13.50 29 13.50 30	4" Motor 6" Motor		Strainer
16	1	See Below			Pump Shaft
17	4	See Below			Strap
18	1	See Below			Cable Guard
19	4	ID.08 75 ID.08 76	M10 4" Motor M12 6" Motor		Strap Nut
20	1	See Note 1			Motor Cable
21	4	ID.01 44 ID.01 43	M8 5/16" UNF	4"G 4"F	Motor Stud Nut
22	3	79.00 72	M8 x 42 mm	4"G	Motor Stud Bolt
	1 4 4	79.59 57 82.00 39 ID.01 88	M8 5/16" UNF x 56 mm 1/2" UNF x 40 mm	4"G 4"F 6"F	Motor Stud Bolt w/Filling Screw

Pos.	No. Req.	P/N	Dimensions	Description
23	1	11.00 33	4" Motor	Rubber Motor Cable Protector
		13.00 43	6" Motor	
24	1	10.00 18	4" Motor	Complete Casing
		01.00 17	6" Motor	Washer for Coupling
		13.00 24	4" Motor	Cap for Coupling
		79.59 39	6" Motor, 7.5-20 HP	Complete Coupling
		79.04 01	3/16" x 1/8" x 1 3/4"	Parallel Key
		ID.14 74	M5 x 20	Set Screws
		ID.14 75	1" I.D. x 1.25" O.D. x 0.12"T	O-Ring
		79.59 40	6" Motor 25 & 30 HP	Complete Coupling
		79.04 02	1/4" x 3/16"	Parallel Key
		ID.14 74	M5 x 20	Set Screws
		ID.14 75	1" I.D. x 1.25" O.D. x 0.12"T	O-Ring
26	1	13.00 26		Retainer for Strainer
64 *	1	13.00 53		Priming Inducer
73	1	13.00 56	76.2 mm x 127 mm	6" - 8" Adapter Flange
74	4	ID.15 86		Set Screws
75 *	1	14.00 21		Spacer Ring for Priming Inducer

Notes:

A = Number of Stages
G = Grundfos
F = Franklin

* Not Pictured

1. For Pos. 20, 21, & 22, see Spare Parts Lists and Price List for 4" Grundfos submersible motors.

SP27 - PRODUCT NUMBERS FOR PUMP ENDS WITHOUT MOTORS

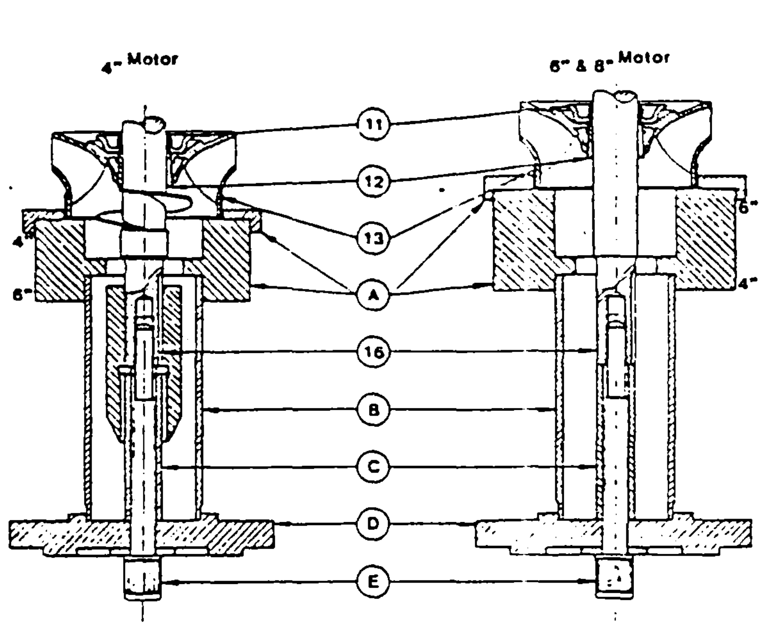
Pump Type 60 Hz	Product No.	Motor HP	KW	Type	Spacer Length
SP27-2	13.70 00 02	3.0	2.2	4" G&F	39.0 mm
SP27-3	13.70 00 03	5.0	3.7	4" G&F	39.0 mm
SP27-4	13.70 00 04	7.5	5.5	6" F	77.0 mm
SP27-6	13.70 00 06	10.0	7.5	6" F	77.0 mm
SP27-9	13.70 00 09	15.0	11.2	6" F	77.0 mm
SP27-12	13.70 00 12	20.0	15.0	6" F	77.0 mm
SP27-15	13.70 00 15	25.0	18.6	6" F	77.0 mm
SP27-18	13.70 00 18	30.0	22.4	6" F	77.0 mm

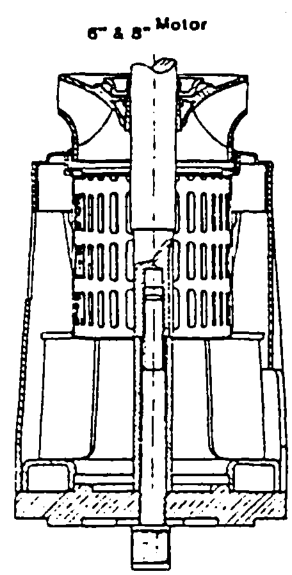
SP27 - PARTS LIST

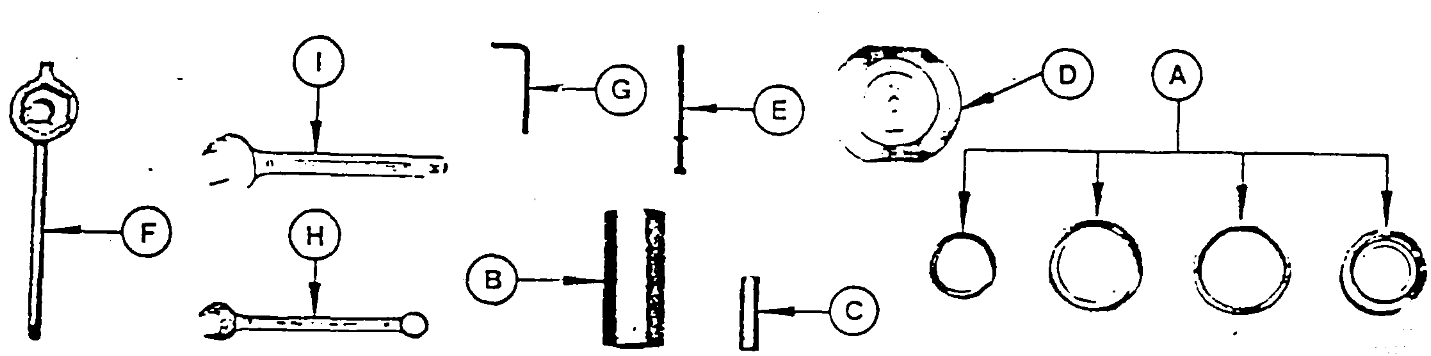
	Pump Shaft		Strap		Cable Guard	
	P/N	Dim.	P/N	Dim.	P/N	Dim.
SP27-2	13.10 02	7/8" x 271mm	13.97 02	L = 365mm	13.95 02	L = 460mm
SP27-3	13.10 03	7/8" x 361mm	13.97 03	L = 455mm	13.95 03	L - 550mm
SP27-4	13.12 04	7/8" x 451mm	13.96 04	L = 545mm	13.98 04	L = 601mm
SP27-6	13.10 06	7/8" x 612mm	13.96 06	L = 725mm	13.98 06	L = 781mm
SP27-9	13.10 09	7/8" x 882mm	13.96 09	L = 993mm	13.98 09	L =1051mm
SP27-12	13.10 12	7/8" x1152mm	13.96 12	L =1263mm	13.98 12	L =1321mm
SP27-15	13.12 15	7/8" x1422mm	13.96 15	L =1533mm	13.98 15	L =1591mm
SP27-18	13.12 18	7/8" x1692mm	13.96 18	L =1803mm	13.98 18	L =1861mm

SP16, 27 and 47

ASSEMBLY FIXTURE





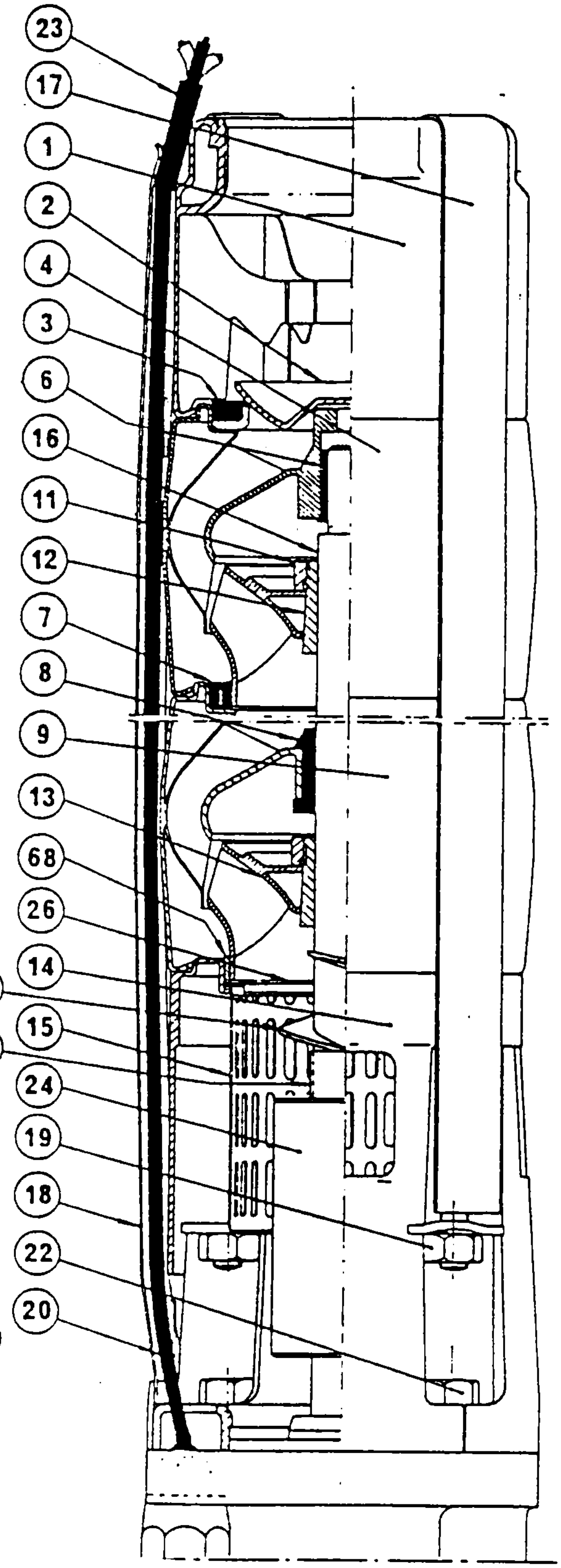


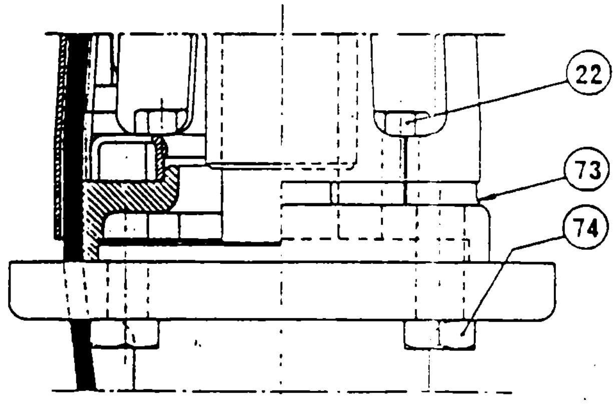
APPENDIX H

GRUNDFOS

Spare Parts List For Submersible Pump

Type SP





Engineering
2/16/82

SP 45 SPARE PARTS LIST

Pos.	No. Req.	P/N	Dimensions	Type	Description
1	1	13.50 19	3" NPT		Valve Casing
2	1	13.00 22			Check Valve Cone
3	1	14.50 02			Valve Seat
4	1	15.50 03			Top Diffuser Chamber
6	1	16.50 06			Top Bearing
7	A-1	24.50 19			Seal Ring
8	A-1	24.00 60			Intermediate Bearing
9	A-1	15.50 02			Diffuser Chamber
11	A	34.00 23			Split Cone Nut
12	A	34.00 24			Split Cone
13	A	15.50 01			Impeller
14	1	13.50 01			Suction Interconnector
		13.50 14			
15	1	13.50 29			Strainer
		13.50 30			
16	1	See Below			Pump Shaft
17	4	See Below			Strap
18	1	See Below			Cable Guard
19		ID.08 75	M10 4" Motor		Strap Nut
		ID.08 76	M12 6" Motor		
20	1	See Note 1			Motor Cable
21	4	ID.01 44		4"G	Motor Stud Nut
		ID.01 43		4"F	
22	3	79.00 72	M8 x 42mm	4"G	Motor Stud Bolt
	1	79.59 57	M8	4"G	Motor Stud Bolt w/Filling Screw
	4	82.00 39	5/16" UNFx56mm	4"F	Motor Stud Bolt
	4	ID.01 88	1/2" UNFx40mm	6"F	Motor Cap Screw

Pos.	No. Req.	P/N	Dimensions	Description
23	1	11.00 33	4" Motor	Rubber Motor Cable Protec:
		13.00 43	6" Motor	
24	1	10.00 18	4" Motor	Complete Coupling
	1	01.00 17	6" Motor	Washer for Coupling
	1	13.00 24	4" Motor	Cap for Coupling
	1	79.59 39	6" Motor, 7.5-20 Hp	Complete Coupling
	1	79.04 01	3/16" x 1/8" x 1 3/4"	Parallel Key
	2	ID.14 74	M6 x 20	Set Screws
	1	ID.14 75	1" I.D. x 1.75" O.D.x0.12"	O-Ring
	1	79.59 40	6" Motor, 25 and 30 Hp	Complete Coupling
	1	79.04 02	1/4" x 3/16"	Parallel Key
26	1	13.00 26		Retainer for Strainer
64	1	13.00 53		Priming Inducer
68	1	14.00 06		Bottom Seal Ring
73	1	13.00 56		6" - 8" Adapter Flange
74	4	ID.15 86		Set Screws
75	1	14.00 21		Spacer Ring for Priming Inducer

ıeering.
18/82
Rev. 2
4/20/82

SP45 SPARE PARTS LIST

Pump Type	Pump Shaft		Strap		Cable Guard	
	P/N	Dim.	P/N	Dim.	P/N	Dim.
SP45-2	15.10 02	7/8" x 290mm	15.80 02	L = 386mm	15.92 02	L = 483mm
SP45-4	15.10 04	7/8" x 470mm	15.81 04	L = 584mm	15.93 04	L = 644mm
SP45-6	15.10 06	7/8" x 670mm	15.81 06	L = 784mm	15.93 06	L = 844mm
SP45-8	15.10 08	7/8" x 870mm	15.81 08	L = 984mm	15.93 08	L = 1044mm
SP45-10	15.11 10	7/8" x 1070mm	15.81 10	L = 1184 mm	15.93 10	L = 1244mm
SP45-12	15.11 12	7/8" x 1270mm	15.81 12	L = 1382mm	15.93 12	L = 1444mm
SP45-15	15.61 15	7/8" x 1566mm	15.81 15	L = 1702mm	15.94 15	L = 1794mm

SP45 - PRODUCT NUMBERS FOR PUMP ENDS WITHOUT MOTORS

Pump Type		Motor			Spacer
60 Hz	Product No.	HP	KW	Type	Length
SP45-2	15.89 00 02	5.0	3.7	4" G&F	38.0 mm
SP45-4	15.89 00 04	10.0	7.5	6" F	76.0 mm
SP45-6	15.89 00 06	15.0	11.2	6" F	76.0 mm
SP45-8	15.89 00 08	20.0	15.0	6" F	76.0 mm
SP45-10	15.89 00 10	25.0	18.6	6" F	76.0 mm
SP45-12	15.89 00 12	30.0	22.4	6" F	76.0 mm
SP45-15	15.89 00 15	40.0	30.0	8" F	*80.0 mm

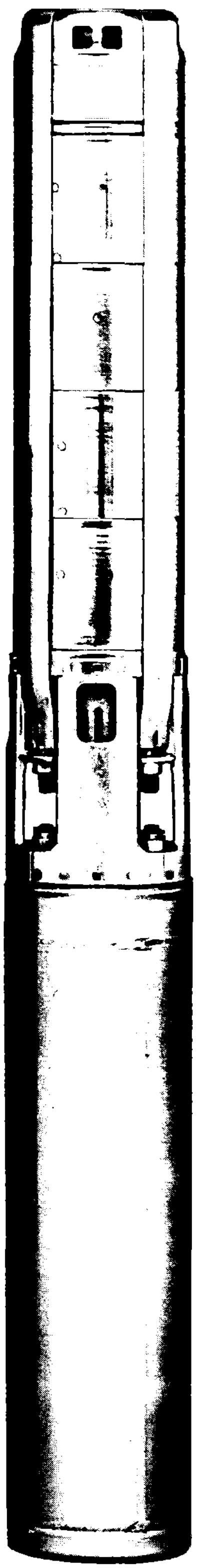
* When connecting piece, position 73 is not fitted to the suction interconnect.

MODEL
75S

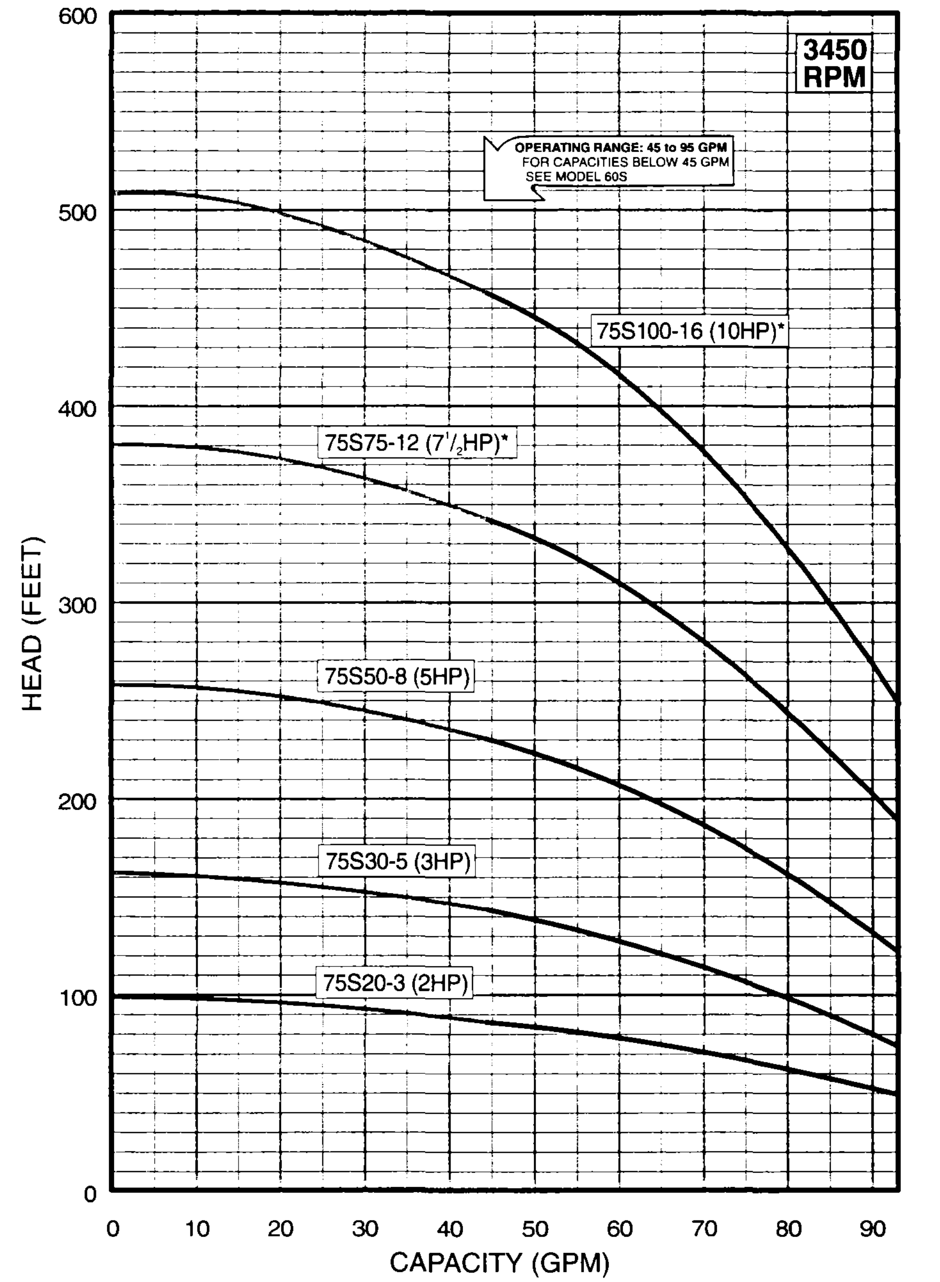
75 GPM

GRUNDFOS

FLOW RANGE
45 to 95 GPM
PUMP OUTLET
2" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
75S20-3	2	28 5/8	3 15/16	38
75S30-5	3	40 3/4	3 15/16	64
75S50-8	5	51 1/4	3 15/16	78
75S75-12	7 1/2*	67 1/2	3 15/16	100
75S100-16	10*	92 1/8	3 15/16	155

Specifications subject to change without notice.
* 6" inch motor is available.

Materials of Construction (Standard Pumps)

(Refer to "**Material Codes**" below for material specifications.)

MPONENT	5S		7S	10S		16S		25S		40S	60S	75S
	C	S	S	C	S	C	S	C	S	C	C	C
Check Valve Housing	2	2	2	2	2	2	2	2	2	2	2	2
Check Valve	2	2	2	2	2	2	2	2	2	2	2	2
Check Valve Seat	9/3	9/2	9/2	9/3	9/2	9/3	9/2	9/3	9/2	9/3	9/3	9/3
Diffuser Chamber	2	2	2	2	2	2	2	2	2	2	2	2
Top Bearing	9/3	NR	NR	9/3	NR	9/3	NR	9/3	NR	9/3	9/3	9/3
Impeller Seal Ring	9/11	9/10	9/10	9/11	9/10	9/11	9/10	9/11	9/10	9/3	9/2	9/2
Split Cone Nut	3	NR	NR	3	NR	3	NR	3	NR	2	2	2
Split Cone	2	NR	NR	2	NR	2	NR	2	NR	2	2	2
Impeller	2	2	2	2	2	2	2	2	2	2	2	2
Suction Interconnector	2	2	2	2	2	2	2	2	2	2	2	2
Inlet Screen	2	2	2	2	2	2	2	2	2	2	2	2
Pump Shaft	7	2	2	7	2	7	2	7	2	7	7	7
Shaft Washer	12	NR	NR	12	NR	12	NR	12	NR	12	12	12
Coupling	4/6/7	4/6/7	4/6/7	4/6/7	4/6/7	4/6/7	4/6/7	4/6/7	4/6/7	4/6/7 ①	4/6/7	4/6/7
Coupling Key	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR ①	NR	NR
Straps	2	2	2	2	2	2	2	2	2	2	2	2
Cable Guard	2	2	2	2	2	2	2	2	2	2	2	2
Priming Inducer	3	2	2	3	2	3	2	3	2	3	2	2
Intermediate Bearings	2	9	9	2	9	2	9	2	9	9/3	9	9

NOTES: ① If using 6" non-standard motors, refer to material code #5 for coupling and #1/2 for the coupling key.
C: Cylindrical Shaft S: Splined Shaft NR: Not Required.

Material Codes

CODE NO.	MATERIAL
1	302 Stainless Steel
2	304 Stainless Steel
3	316 Stainless Steel
4	329 Stainless Steel
5	416 Stainless Steel
6	420 Stainless Steel
7	431 Stainless Steel
9	TEFLON ®
10	PBT (Valox ®)
11	PPS (Ryton ® PPS)
12	LCP (Vectra ® LCP Resin)

NOTES:

Specifications are subject to change without notice.

Valox ® is the registered trademark of General Electric Company.

R[illegible] ® PPS is a registered trademark of F[illegible] 66.

Vectra ® LCP Resin is a registered trademark of Hoechast Celanese Corporation.

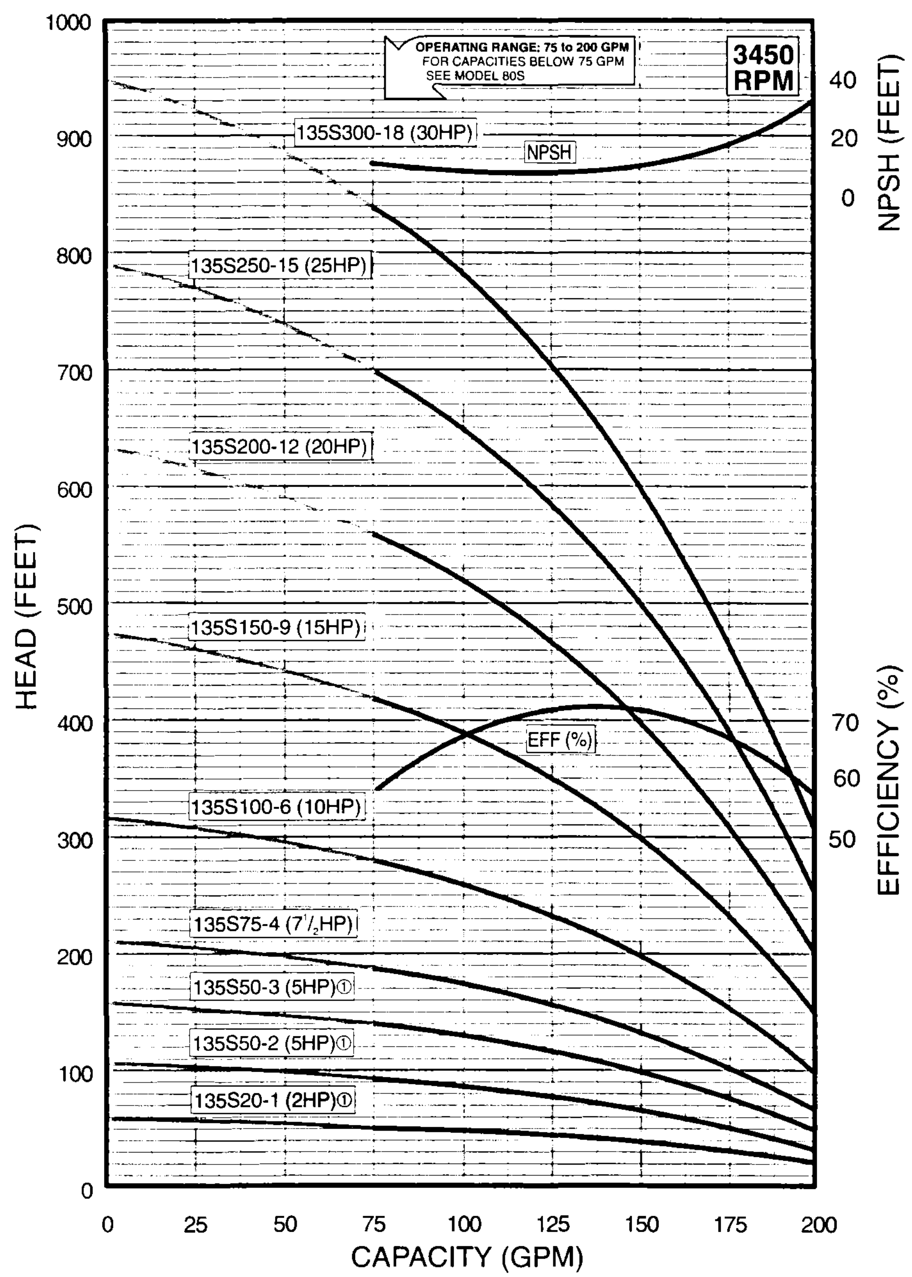
Submersible Pump Nomenclature

10S05-9 = 10 S 05 - 9

Nominal Flow Rate (GPM) — 10
Submersible — S
Horsepower — 05
05 = ½ HP
50 = 5 HP
500 = 50 HP
Number of Stages — 9

GRUNDFOS | 135 GPM | MODEL 135S

PERFORMANCE CURVES



FLOW RANGE
75 to 200 GPM

PUMP OUTLET
3" NPT

DIMENSIONS AND WEIGHTS

MODEL NO.	HP	MIN. WELL SIZE (INCHES)	LENGTH (INCHES)	MAX. WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
135S20-1	2①	6	27 1/4	5 1/2	35
135S50-2	5①	6	42 1/2	5 1/2	84
135S50-3	5①	6	47	5 1/2	88
135S75-4	7 1/2	6	51 1/2	5 3/4	146
135S100-6	10	6	59 7/8	5 3/4	167
135S150-9	15	6	73	5 3/4	186
135S200-12	20	6	86 1/4	5 3/4	225
135S250-15	25	6	99 1/4	5 3/4	243
135S300-18	30	6	112 3/8	5 3/4	268

NOTES:
① 4-inch motor.
Specifications are subject to change without notice.
See Deep Set models for higher head.

Materials of Construction (Standard Pumps)

(Refer to "**Material Codes**" below for material specifications.)

COMPONENT	80S	135S	225S	375S	600S	1000S
	C	C	C	C	C	C
Check Valve Housing	2	2	2	2	2	2
Check Valve	2	2	2	2	2	2
Check Valve Seat	9/3	9/3	9/3	9/3	9/3	9/2
Diffuser Chamber	2	2	2	2	2	2
Top Bearing	9/3	9/3	9/3	9/3	9/3	9/3
Impeller Seal Ring	9/2	9/2	9/2	9/2	9/2	9/2
Split Cone Nut	2	2	2	2	2	2
Split Cone	2	2	2	2	2	2
Impeller	2	2	2	2	2	2
Suction Interconnector	2	2	2	2	2	2
Inlet Screen	2	2	2	2	2	2
Pump Shaft	7	7	7	7	7	7
Coupling	4/5	4/5	4/5	4/5	4/5	4/5
Coupling Key	1/2	1/2	1/2	1/2	1/2	1/2
Straps	2	2	2	2	2	2
Cable Guard	2	2	2	3	3	2
Priming Inducer	2	2	2	NR	NR	NR
Intermediate Bearings	9	9	9	9	9	9
8" Motor Adaptor Plate	NR	2	2	2	NR	NR

NOTES: C: Cylindrical Shaft NR: Not Required

Material Codes

CODE NO.	MATERIAL
1	302 Stainless Steel
2	304 Stainless Steel
3	316 Stainless Steel
4	329 Stainless Steel
5	416 Stainless Steel
6	420 Stainless Steel
7	431 Stainless Steel
9	TEFLON®
10	PBT (Valox ®)
11	PPS (Ryton ® PPS)

NOTES:

Specifications are subject to change without notice.

Valox ® is the registered trademark of General Electric Company.

Ryton ® PPS is a registered trademark of Phillips 66.

316 and 904L Stainless Steel versions are available in some models - Contact the factory

Submersible Pump Nomenclature

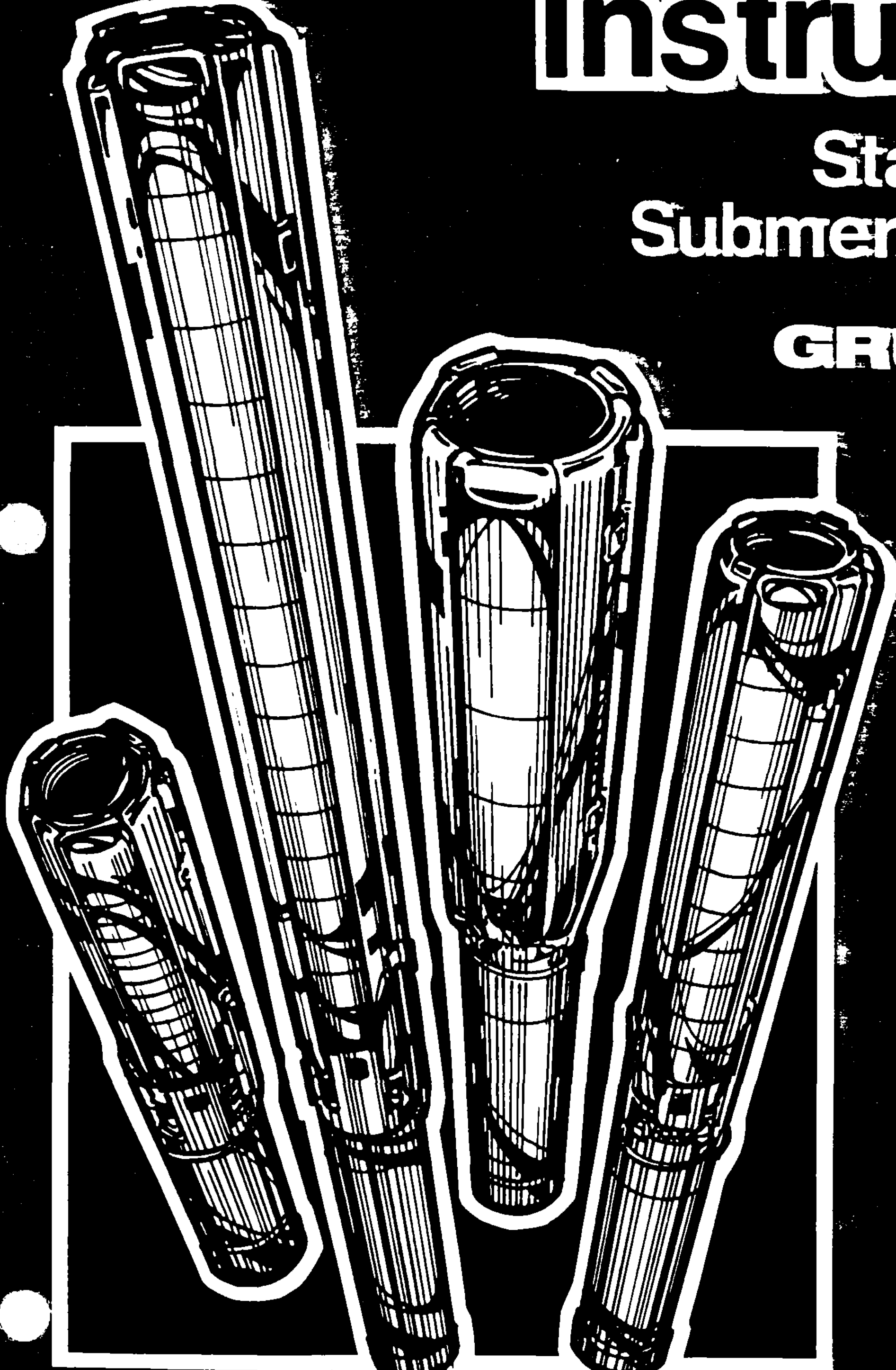
10S05-9 = 10 S 05 - 9

- Nominal Flow Rate (GPM) — 10
- Submersible — S
- Horsepower — 05
  - 05 = ½ HP
  - 50 = 5 HP
  - 500 = 50 HP
- Number of Stages — 9

Installation and Operating Instructions

Stainless Steel Submersible Pumps

GRUNDFOS



Installation and Operating Instructions

TABLE OF CONTENTS

Installation and Operation Instructions

GRUNDFOS STAINLESS STEEL SUBMERSIBLE PUMPS

Your Grundfos Submersible Pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

SECTION **1.**

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Submersible Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **make sure that the pump is not dropped or mishandled.**

The motor is equipped with an electrical cable. **Under no circumstance should the cable be used to support the weight of the pump.**

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

SECTION **2.**

Pre-Installation Checklist

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

☑ **A. CONDITION OF THE WELL**

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the Grundfos submersible make it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, **the well must be blown or bailed clear of oil.**

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

☑ **B. CONDITION OF THE WATER**

Submersible pumps are designed for pumping clear and cold water that is free of air and gases. Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gases.

Maximum water temperature should not exceed 102°F. Special consideration must be given to the pump and motor if it is to be used to pump water above 102°F.

The Grundfos stainless steel submersible is highly resistant to the normal corrosive environment found in some water wells. If water well tests determine the water has an excessive or unusual corrosive quality, or exceeds 102°F, contact your Grundfos representative for information concerning specially designed pumps for these applications.

☑ **C. INSTALLATION DEPTH**

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum draw-down level of the well. For flow rates exceeding 100 gpm, the NPSH may have to be considered. Refer to NPSH curves in the technical brochure.

The bottom of the motor should never be installed lower than the top of the well screen or within five feet of the well bottom.

If the pump is to be installed in a lake, pond, tank or large diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling. The minimum recommended water flow rates which ensure proper cooling are listed in Table A.

☑ **D. ELECTRICAL SUPPLY**

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply.

SECTION 3.

Wire Cable Type

The wire cable used between the pump and control box or panel should be approved for submersible pump applications. The conductor may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket.

The conductor insulation should be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association certified wire may also be used. See Table D for recommended sizes of cable lengths.

SECTION 4.

Splicing the Motor Cable

A good cable splice is critical to proper operation of the submersible pump and must be done with extreme care.

If the splice is carefully made, it will work as well as any other portion of the cable, and will be completely watertight.

Grundfos recommends using a heat shrink splice kit. The splice should be made in accordance with the kit manufacture's instructions. Typically a heat shrink splice can be made as follows:

1. Examine the motor cable and the drop cable carefully for damage.

2. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads (See Figure 4-A). On single-phase motors, **be sure to match the colors.**

3. Strip back and trim off ½ inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation.

4. Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-kon" type connector on each lead, making sure that lead colors are matched. Using a "Sta-kon" crimping pliers, indent the lugs (Figure 4-B). Be sure to squeeze hard on the pliers, particularly when using large cable.

5. Center the heat shrink tubing over the connector. Using a propane torch, lighter, or electric heat gun, uniformly heat the tubing starting first in the center working toward the ends (Figure 4-C).

6. Continue to apply the heat to the tubing using care not to let the flame directly contact the tubing. When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete (Figure 4-D).

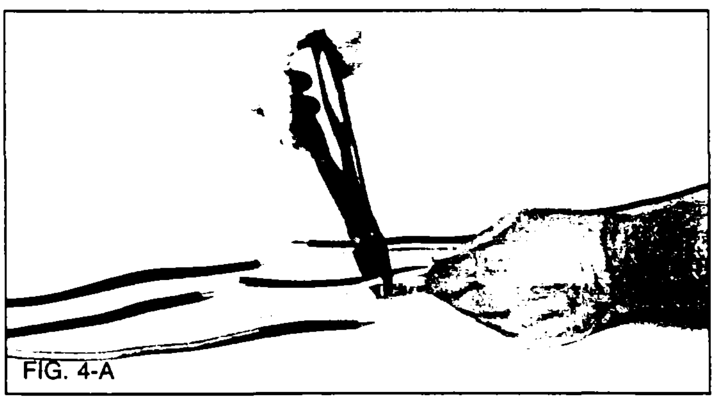


FIG. 4-A

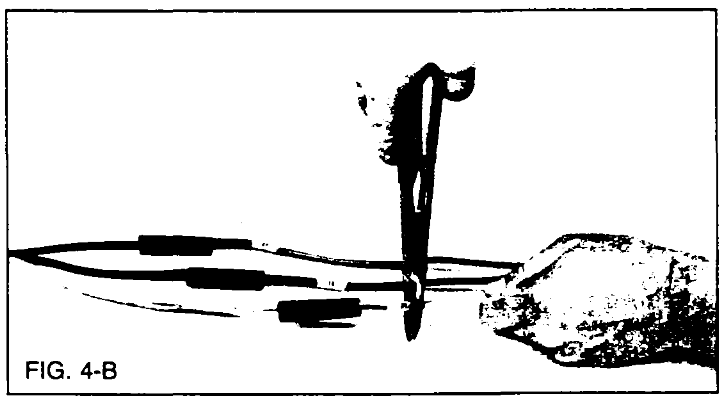


FIG. 4-B

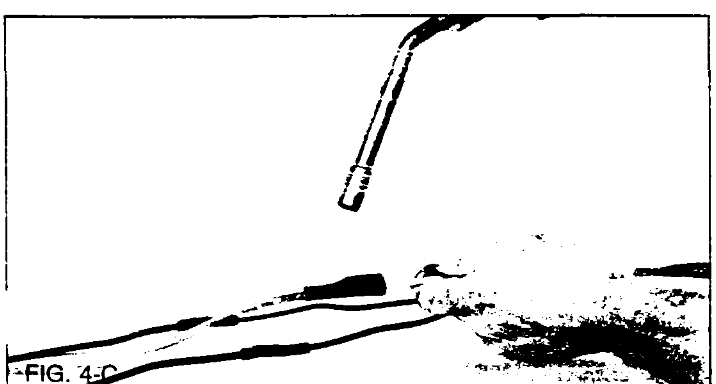


FIG. 4-C

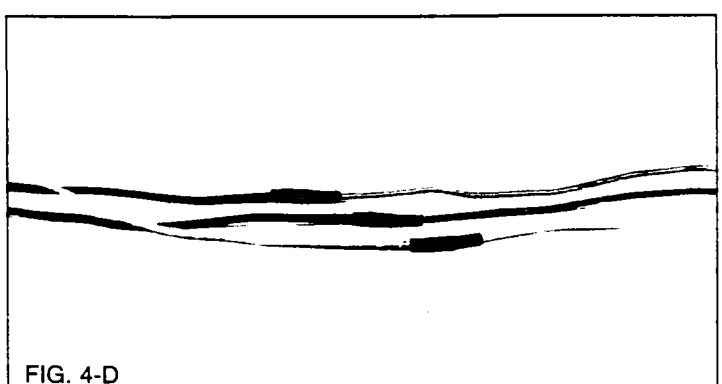


FIG. 4-D

Installation

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.

A back-up wrench should be used when the riser pipe is attached to the pump. The pump should be gripped only by the flats on the top of the discharge chamber. **The body of the pump, cable guard or motor should not be gripped under any circumstance.**

If Steel Riser Pipe is Used:

We recommend that steel riser pipes always be used with the larger submersibles. An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

When tightened, the first section of the riser pipe must not come in contact with the check valve retainer in the discharge chamber of the pump.

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. **Do not clamp the pump.** When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only.

Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above and below the splice.

If Plastic or Flexible Riser Pipe is Used:

It is recommended that plastic type riser pipe be used **only** with the smaller domestic submersibles. The pipe manufacturer or representative should be contacted to insure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the pipe manufacturer. In addition to making sure that joints are securely fastened, the use of a torque arrester is recommended when using plastic pipe.

Do not connect the first plastic or flexible riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber of the pump. When tightened, the threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

IMPORTANT- Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave 3 to 4 inches of slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. For example, if you installed 200 feet of plastic riser pipe, the pump may actually be down 204 feet. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge piece of a Grundfos 4 inch submersible is designed to accommodate this cable (Figure 5-A).

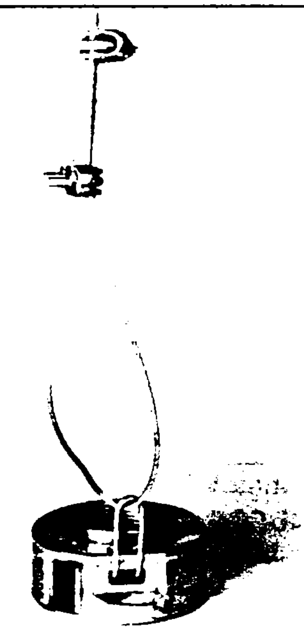


FIG. 5-A

Check valves:

A check valve should always be installed at the surface of the well. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

Protect the well from contamination:

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade, and a locally approved well seal or pitless adapter unit utilized.

SECTION 6.

Electrical

WARNING: To reduce the risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the wiring compartment.

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in Table E.

If voltage variations are larger than ± 10%, do not operate the pump.

Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current. If direct on-line starting is not acceptable and reduced starting current is required, an auto-transformer or resistant starters should be used for 5 to 30 HP motors (depending on cable length). For motors over 30 HP, use auto-transformer starters.

Engine-Driven Generators

If the submersible pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contacted to ensure the proper generator is selected and used. See Table B for generator sizing guide.

If power is going to be supplied through transformers, Table C outlines the minimum KVA rating and capacity required for satisfactory pump operation.

Control Box/Panel Wiring

*1. **Single-Phase Motors:***

Single-phase motors must be connected as indicated in the motor control box. A typical single-phase wiring diagram using a Grundfos control box is shown (Figure 6-A).

*2. **Three-Phase Motors:***

Three-phase motors must be used with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current unbalance and overload current. A properly sized starter with ambient-compensated extra quick-trip overloads must be used to give the best possible motor winding protection. **Each of the three motor legs must be protected with overloads.** The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current. For starter and overload protection guide, see Table H. A three-phase motor wiring diagram is illustrated below (See Figure 6-B).

Pumps should NEVER be started to check rotation unless the pump is totally submerged. Severe damage may be caused to the pump and motor if they are run dry.

Single-Phase Wiring Diagram for GRUNDFOS Control Boxes

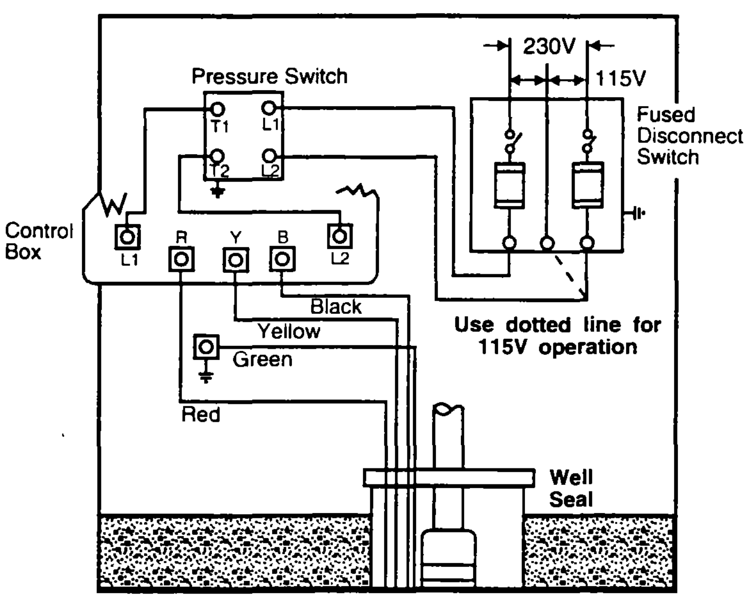


Figure 6-A

Three-Phase Wiring Diagram for GRUNDFOS and FRANKLIN Motors

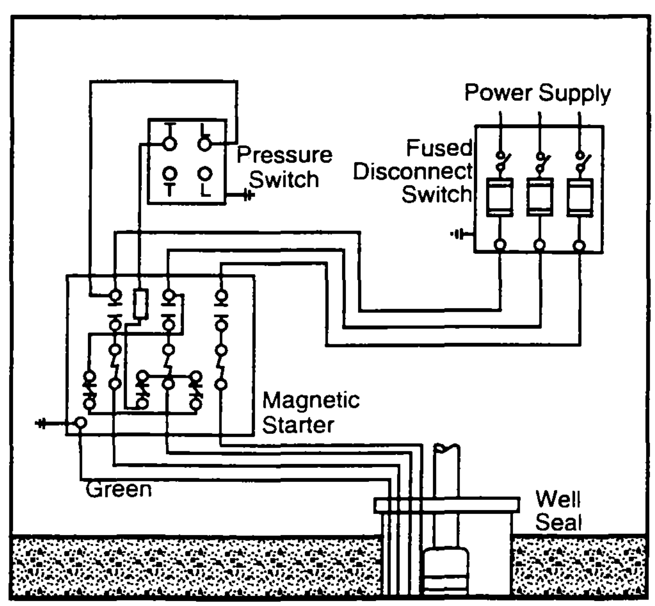


Figure 6-B

High Voltage Surge Arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated surge arrester should be installed on the supply (line) side of the control box (Figure 6-C and 6-D). **The arrester must be grounded in accordance with the National Electrical Code and local codes and regulations.**

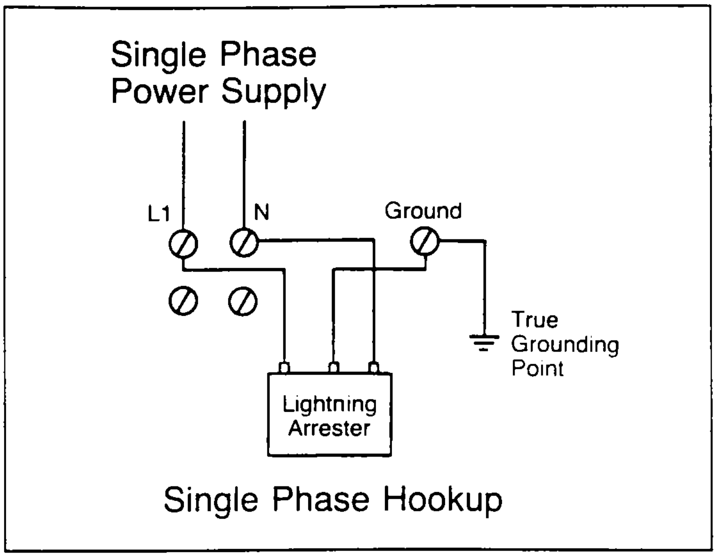


Figure 6-C

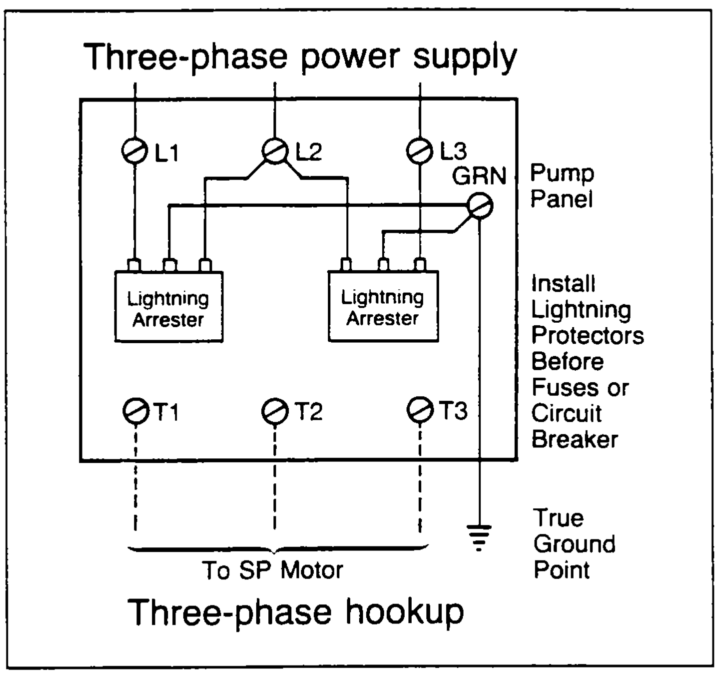


Figure 6-D

The warranty on all three-phase submersible motors is VOID if:

1. **The motor is operated with single-phase power through a phase converter.**
2. **Three-leg ambient compensated extra quick-trip overload protectors are not used.**
3. **Three-phase current unbalance is not checked and recorded. (See START-UP Section 7 for instructions.)**
4. **High voltage surge arresters are not installed.**

Control Box/Panel Grounding

The control box or panel shall be permanently grounded in accordance with the National Electrical Code and local codes or regulations. The ground wire should be a bare copper conductor at least the same size as the drop cable wire size. The ground wire should be run as short a distance as possible and be securely fastened to a true grounding point.

True grounding points are considered to be: a grounding rod driven into the water strata, steel well casing submerged into the water lower than the pump setting level, and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used or if a grounding wire is required by local codes, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box or panel.

Wiring Checks and Installation

Before making the final surface wiring connection of the drop cable to the control box or panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 2,000,000 ohm. Do not start the pump if the measurement is less than this.

If it is higher than 2,000,000 ohm, the drop cable should then be run through the well seal by means of a conduit connector in such a way as to eliminate any possibility of foreign matter entering the well casing. Conduit should always be used from the pump to the control box or panel to protect the drop cable (See Figure 6-E). Finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box or panel and high voltage surge arrester have been grounded.

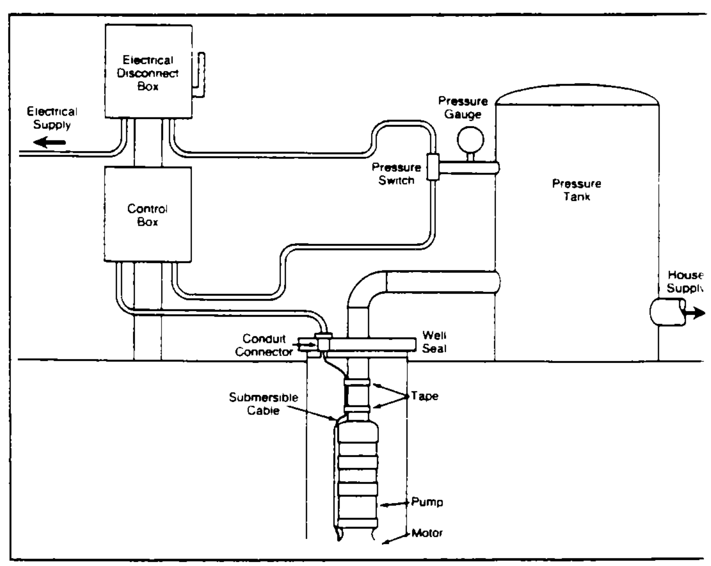


Figure 6-E

SECTION 7.

Start-Up

After the pump has been set into the well and the wiring connections have been made, the following procedures should be performed:

A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.

B. Adjust the gate valve one-third of the way open.

C. On three-phase units, check direction of rotation and current unbalance according to the instructions below.

For single-phase units proceed directly to "Developing the Well".

D. Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

Three-Phase Motors

1. Check the direction of rotation

Three-phase motors can run in either direction depending on how they are connected to the power supply. When the three cable leads are first connected to the power supply, there is a 50% chance that the motor will run in the proper direction. **To make sure the motor is running in the proper direction, carefully follow the procedures below:**

A. Start the pump and check the water quantity and pressure developed.

B. Stop the pump and interchange any two leads.

C. Start the pump and again check the water quantity and pressure.

D. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

2. Check for current unbalance

Current unbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very important that current unbalance be checked in all three-phase systems. **Current unbalance between the legs should not exceed 5% under normal operating conditions.**

The supply power service should be verfied to see if it is a two or three transformer system. If two transformers are present, the system is an "open" delta or wye. If three transformers are present, the system is true three-phase.

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See Table C.

The percentage of current unbalance can be calculated by using the following formulas and procedures:

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\text{\% Current unbalance} = \frac{\text{Greatest amp difference from the average}}{\text{average current}} \times 100$$

To determine the percentage of current unbalance:

A. Measure and record current readings in amps for each leg (hookup 1). Disconnect power.

B. Shift or roll the motor leads from left to right so the drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads in this manner will not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect power.

C. Again shift drop cable leads from left to right so the lead on terminal 1 goes to 2, 2 to 3 and 3 to 1 (hookup 3). Start pump, measure and record current reading on each leg. Disconnect power.

D. Add the values for each hookup.

E. Divide the total by 3 to obtain the average.

F. Compare each single leg reading from the average to obtain the greatest amp difference from the average.

G. Divide this difference by the average to obtain the precentage of unbalance

Use the wiring hookup which provides the lowest percentage of unbalance. (See Table F for a specific example of correcting for three-phase power unbalance.)

Developing the Well

After proper rotation and current unbalance have been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

Slowly open the valve in small increments as the water clears until the desired flow rate is reached. Do not operate the pump beyond its maximum flow rating. **The pump should not be stopped until the water runs clear.**

If the water is clean and clear when the pump is first started, the valve should still be **slowly opened until the desired flow rate is reached.** As the valve is being opened, the drawdown should be checked to ensure the pump is always submerged. **The dynamic water level should always be more than 3 feet above the inlet strainer of the pump.**

Disconnect the temporary piping arrangements and complete the final piping connections.

Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

(con't)

Operation

1. The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling and operation of controls.

2. If the pump fails to operate, or there is a loss of performance, refer to Troubleshooting, Section 8.

SECTION 8.

Troubleshooting

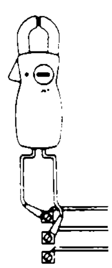
The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following chart covers most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed – a combination voltmeter/ammeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn and that care is taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well. WARNING: Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electrical shock.

Preliminary Tests

SUPPLY VOLTAGE



How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter.

On single-phase units, measure between line and neutral.

On three-phase units measure between the legs (phases.)

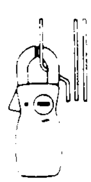
What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT



How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box or starter. See Electrical Data, Table E, for motor amp draw information.

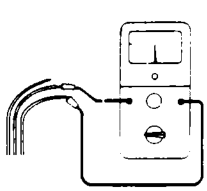
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current unbalance is greater than 5% between each leg on three-phase units, check for the following:

1. Burnt contacts on motor starter.
2. Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances
3. Supply voltage too high or low.
4. Motor windings are shorted.
5. Pump is damaged, causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and and Rx10 for values over 10 ohms.

Zero-adjust the meter and measure the resistance between leads. Record the values.

Motor resistance values can be found in Electrical Data, Table E. Cable resistance values are in Table G.

What it Means

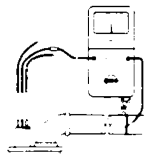
If all the ohm values are normal, and the cable colors correct, the windings are not damaged.

If any one ohm value is less than normal, the motor may be shorted.

If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table E.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohm or mega ohmmeter, set the scale selector to Rx100K and zero-adjust the meter.

Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed:
2,000,000 (or more)	2.0	New Motor.
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
		Motor in well (Ohm readings are for drop cable plus motor):
500,000 - 1,000,000	0.5 - 1.0	A motor in reasonably good condition.
20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

Troubleshooting Chart

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
A. Pump Does Not Run	1. No power at pump panel.	Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
	2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
	3. Motor starter overloads are burnt or have tripped out (three-phase only).	Check for voltage on line and load side of starter.	Replace burnt heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize (three-phase only).	Energize control circuit and check for voltage at the holding coil.	If no voltage, check control circuit. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
	6. Motor and/or cable are defective.	Turn off power. Disconnect motor leads from control box. Measure the lead-to-lead resistances with the ohmmeter (Rx1). Measure lead-to-ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
	7. Defective capacitor (single-phase only).	Turn off the power, then discharge capacitor. Check with an ohmmeter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no needle movement, replace the capacitor.

(con't)

Troubleshooting Chart (continued)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
B. Pump Runs But Does Not Deliver Water	1. Groundwater level in well is too low or well is collapsed.	Check well draw-down. Water level should be at least 3 ft. above pump inlet during operation.	If not, lower pump if possible, or throttle discharge valve and install water level control.
	2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off. After taking reading, open valve to its previous position. Convert PSI to feet (For water: PSI x 2.31 ft/PSI = ______ ft.), and add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.	If not close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and re-install.
	3. Inlet strainer is clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	4. Pump is damaged.	Same as B.2 above.	If damaged, repair as necessary. Rinse out pump and re-install.
C. Pump Runs But at Reduced Capacity	1. Wrong rotation (three-phase only).	Check for proper electrical connection in control panel.	Correct wiring and change leads as required.
	2. Draw-down is larger than anticipated.	Check draw-down during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	3. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
	4. Pump strainer or check valve are clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	5. Pump worn.	Same as B.2 above.	If not close to pump curve, remove pump and inspect.
D. Pump Cycles Too Much	1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
	2. Level control is not properly set or is defective.	Check setting and operation.	Re-adjust setting (refer to manufacturer data.) Replace if defective.
	3. Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphram chamber. Check diaphram for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume.	Repair or replace damaged component.
	4. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.
	5. Tank is too small.	Check tank size. Tank volume should be approximately 10 gallons for each gpm of pump capacity.	If tank is too small, replace with proper size tank.

(con't)

Troubleshooting Chart (continued)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
E. Fuses Blow or Circuit Breakers Trip	1. High or low voltage.	Check voltage at pump panel. If not within ± 10%, check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
	2. Three-phase current unbalance.	Check current draw on each lead. Unbalance must be within ± 5%.	If current unbalance is not within ± 5%, contact power company.
	3. Control box wiring and components (single-phase only).	Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	4. Defective capacitor (single-phase only).	Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If no meter movement, replace the capacitor.
	5. Starting relay (Franklin single-phase motors only).	Check resistance of relay coil with an ohmmeter (Rx1000K). Check contacts for wear.	Replace defective relay.

SECTION 9. Technical Data

Table A

Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30
6"	6	10
	7	28
	8	45
	10	85
	12	140
	14	198
	16	275
8"	8	10
	10	55
	12	110
	14	180
	16	255
10"	10	30
	12	85
	14	145
	16	220
	18	305

NOTES:
1. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.
2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.
3. The minimum recommended water velocity over 6, 8, and 10" motors is 0.5 feet per second.

Table B

Guide for Engine-Driven Generators in Submersible Pump Applications

	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
MOTOR HP FOR SINGLE OR THREE PHASE UNITS	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0
2.0	7.5	4.0
3.0	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

NOTES:
1. Table is based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single-phase and three-phase motors.
2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

Table C

Transformer Capacity Required for Three-Phase Submersible Pump Motors

THREE-PHASE MOTOR HP	MINIMUM TOTAL KVA REQUIRED*	MINIMUM KVA RATING FOR EACH TRANSFORMER: 2 TRANSFORMERS OPEN DELTA OR WYE	MINIMUM KVA RATING FOR EACH TRANSFORMER: 3 TRANSFORMERS DELTA OR WYE
1.5	3	2	1
2	4	2	1 ½
3	5	3	2
5	7 ½	5	3
7.5	10	7 ½	5
10	15	10	5
15	20	15	7 ½
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

* Pump motor KVA requirements only, and does not include allowances for other loads.

Table D

Submersible Pump Cable Selection Chart (60 Hz)

The following tables list the recommended copper cable sizes and various cable lengths for submersible pump motors.

These tables comply with the 1978 edition of the National Electric Table 310-16, Column 2 for 75°C wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To assure adequate starting torque, the maximum cable lengths are calculated to maintain 95% of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power usage.

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

SINGLE-PHASE MOTOR MAXIMUM CABLE LENGTH

(Motor to service entrance) (2)

MOTOR RATING		COPPER WIRE SIZE												
VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
115	⅓	130	210	340	540	840	1300	1960	2910					
	½	100	160	250	390	620	960	1460	2160					
230	⅓	550	880	1390	2190	3400	5250	7960						
	½	400	650	1020	1610	2510	3880	5880						
	¾	300	480	760	1200	1870	2890	4370	6470					
	1	250	400	630	990	1540	2380	3610	5360	6520				
	1½	190	310	480	770	1200	1870	2850	4280	5240				
	2	150	250	390	620	970	1530	2360	3620	4480				
	3	120	190	300	470	750	1190	1850	2890	3610				
	5			180	280	450	710	1110	1740	2170				
	7½				200	310	490	750	1140	1410				
	10					250	390	600	930	1160				

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

(con't)

THREE-PHASE MOTOR MAXIMUM CABLE LENGTH
(Motor to service entrance)(2)

MOTOR RATING		COPPER WIRE SIZE												
VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
208	1½	310	500	790	1260									
	2	240	390	610	970	1520								
	3	180	290	470	740	1160	1810							
	5		170	280	440	690	1080	1660						
	7½			200	310	490	770	1180	1770					
	10				230	370	570	880	1330	1640				
	15					250	390	600	910	1110	1340			
	20						300	460	700	860	1050	1270		
	25							370	570	700	840	1030	1170	
	30							310	470	580	700	850	970	1110
230	1½	360	580	920	1450									
	2	280	450	700	1110	1740								
	3	210	340	540	860	1340	2080							
	5		200	320	510	800	1240	1900						
	7½			230	360	570	890	1350	2030					
	10				270	420	660	1010	1520	1870				
	15					290	450	690	1040	1280	1540			
	20						350	530	810	990	1200	1450		
	25						280	430	650	800	970	1170	1340	
	30							350	540	660	800	970	1110	1270
460	1½	1700												
	2	1300	2070											
	3	1000	1600	2520										
	5	590	950	1500	2360									
	7½	420	680	1070	1690	2640								
	10	310	500	790	1250	1960	3050							
	15			540	850	1340	2090	3200						
	20			410	650	1030	1610	2470	3730					
	25				530	830	1300	1990	3010	3700				
	30				430	680	1070	1640	2490	3060	3700			
	40						790	1210	1830	2250	2710	3290		
	50						640	980	1480	1810	2190	2650	3010	
	60							830	1250	1540	1850	2240	2540	2890
	75								1030	1260	1520	1850	2100	2400
	100									940	1130	1380	1560	1790
	125											1080	1220	1390
	150												1050	1190
	200												1080	1300
	250													1080
575	1½	2620												
	2	2030												
	3	1580	2530											
	5	920	1480	2330										
	7½	660	1060	1680	2650									
	10	490	780	1240	1950									
	15		530	850	1340	2090								
	20			650	1030	1610	2520							
	25			520	830	1300	2030	3110						
	30				680	1070	1670	2560	3880					
	40					790	1240	1900	2860	3510				
	50						1000	1540	2310	2840	3420			
	60						850	1300	1960	2400	2890	3500		
	75							1060	1600	1970	2380	2890	3290	
	100								1190	1460	1770	2150	2440	2790

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

Table E

Electrical Data
Submersible Pump Motors - 60 Hz

GRUNDFOS MOTORS

4 Inch (Two Wire) Motors - Control Box Not Required

60 Hz

HP	Ph	VOLT	Ser. Fact.	Circ. Brk. or Stnd. Fuse	Dual Element Fuse	AMPERAGE Full Load	AMPERAGE Lock Rotor	AMPERAGE S.F. Amps	FULL LOAD Eff.	FULL LOAD Power Factor	Line-to-Line Resistance(Ohms) Blk-Yel	Line-to-Line Resistance(Ohms) Red-Yel	KVA Code **	Three-Phase Overload Protection Starter Size	Three-Phase Overload Protection Furnas Amb. Comp	Max. Thrust (lbs)	EGG CRATE NUMBER (stenciled into motor housing)	GRUNDFOS PART NO.
											Delta							
SINGLE PHASE																		
1/3	1	230	1.75	15	5	3.0	25.5	4.4	47.3	63.0	6.8-8.2		S	--	--	750	79.952101	79.1595018
1/2	1	230	1.60	15	7	4.3	34.5	5.9	50.6	64.7	5.2-6.3		R	--	--	750	79.952102	79.1595028
3/4	1	230	1.50	20	9	6.6	40.5	8.0	57.0	70.0	3.2-3.8		N	--	--	750	79.952103	79.1595038
1	1	230	1.40	25	12	8.0	47.4	9.6	59.8	74.3	2.5-3.1		M	--	--	750	79.952104	79.1595048
1 1/2	1	230	1.30	35	15	10.6	60.8	13.1	64.3	77.2	1.9-2.3		L	--	--	750	79.952105	79.1595058

4 Inch (Three Wire) Motors

HP	Ph	VOLT	Ser. Fact.	Circ. Brk. or Stnd. Fuse	Dual Element Fuse	Full Load	Lock Rotor	S.F. Amps	Eff.	Power Factor	Blk-Yel	Red-Yel	KVA Code	Starter Size	Furnas Amb. Comp	Max. Thrust (lbs)	EGG CRATE NUMBER	GRUNDFOS PART NO.
SINGLE PHASE																		
1/3	1	230	1.75	15	5	3.0	14.0	4.4	47.0	63.0	6.8-8.3	17.3-21.1	L	--	--	750	79.453101	79.1545018
1/2	1	230	1.60	15	7	4.3	20.0	5.9	50.7	64.6	4.7-5.7	15.8-19.6	L	--	--	750	79.453102	79.1545028
3/4	1	230	1.50	20	9	6.6	30.8	8.0	57.3	70.0	3.2-3.9	14-17.2	L	--	--	750	79.453103	79.1545038
1	1	230	1.40	25	12	8.0	36.3	9.6	59.8	74.5	2.6-3.1	10.3-12.5	K	--	--	750	79.453104	79.1545048
1 1/2	1	230	1.30	30	15	9.7	44.0	11.5	67.5	84.1	1.9-2.3	7.8-9.6	H	--	--	750	79.453105	79.1545058
THREE PHASE																		
1 1/2	3	230	1.30	15	8	5.0	32.0	6.3	70.0	80.6	3.9		K	0	K41	750	79.302005	79.1530058
		460	1.30	10	4	2.5	16.0	3.2	70.0	80.6	15.9		K	0	K32	750	79.362005	79.1536058
		575	1.30	10	4	2.0	12.8	2.5	70.0	80.6	25.2		K	0	K28	750	79.392005	79.1539058
2	3	230	1.25	20	10	6.0	12.8	7.5	73.0	86.8	3.0		J	0	K50	750	79.302006	79.1530068
		460	1.25	10	5	3.0	19.0	3.8	73.0	86.8	12.1		J	0	K34	750	79.362006	79.1536068
		575	1.25	10	4	2.4	15.2	3.0	73.0	86.8	18.8		J	0	K31	750	79.392006	79.1539068
3	3	230	1.15	30	15	9.6	51.0	11.2	68.5	83.8	2.2		H	0	K54	1000	79.300007	79.0930078
		460	1.15	15	7	4.8	25.5	5.6	68.5	83.8	9.0		H	0	K37	1000	79.360007	79.0936078
		575	1.15	15	6	3.8	20.4	4.5	68.5	83.8	13.0		H	0	K36	1000	79.390007	79.0939078
5	3	230	1.15	40	25	15.2	89	17.8	71.9	80.0	1.2		H	1	K61	1000	79.300009	79.0930098
		460	1.15	20	12	7.6	45	8.9	71.9	80.0	5.0		H	0	K50	1000	79.360009	79.0936098
		575	1.15	15	9	6.1	35	7.1	71.9	80.0	7.3		H	0	K43	1000	79.390009	79.0939096

6 Inch (Three Wire) Motors

HP	Ph	VOLT	Ser. Fact.	Circ. Brk. or Stnd. Fuse	Dual Element Fuse	Full Load	Lock Rotor	S.F. Amps	Eff.	Power Factor	Blk-Yel	Red-Yel	KVA Code	Starter Size	Furnas Amb. Comp	Max. Thrust (lbs)	EGG CRATE NUMBER	GRUNDFOS PART NO.
THREE PHASE																		
7 1/2	3	230	1.15	60	35	23.3	120	26.5	74.0	80.5	0.55		H	1	K67	1100	78.300116	78.1030168
		460	1.15	30	15	11.0	55	12.8	75.0	84.0	2.25		G	1	K56	1100	78.350116	78.1036168
10	3	230	1.15	80	45	30.0	150	34.5	74.9	85.0	0.41		G	1 3/4	K70	1100	78.300117	78.1030178
		460	1.15	40	20	14.8	70	17.0	75.0	86.2	1.70		F	1	K60	1100	78.350117	78.1036178
15	3	230	1.15	125	60	44.4	225	51	76.0	83.7	0.25		G	2 1/2	K76	3300	78.300118	78.1030188
		460	1.15	60	30	21.2	102	25	75.8	86.5	1.16		F	1 3/4	K67	3300	78.350118	78.1036188
20	3	230	1.15	150	80	56.1	290	66	78.0	87.8	0.20		G	3	K79	3300	78.300119	78.1030198
		460	1.15	80	40	28.0	145	33	77.5	87.0	0.78		G	2	K68	3300	78.350119	78.1036198
25	3	460	1.15	100	50	33.6	175	40	79.0	87.1	0.64		F	2	K73	3300	78.350120	78.1036208
30	3	460	1.15	110	60	40.8	220	48	78.8	88.0	0.52		G	2 1/2	K76	3300	78.350121	78.1036218

HITACHI MOTORS

Inch (Three Wire) Motors

60 Hz

HP	Ph	VOLTS	Service Factor	Circuit Breaker or Standard Fuse	Dual Element Fuse	AMPERAGE Full Load	AMPERAGE Locked Rotor	AMPERAGE S.F. Amps	FULL LOAD Eff.	FULL LOAD Power Factor	Line-to-Line Resistance(Ohms) Blk-Yel	Line-to-Line Resistance(Ohms) Red-Yel	KVA Code **	Three-Phase Overload Protection Starter Size	Three-Phase Overload Protection Furnas Amb. Comp	Maximum Thrust (lbs)	GRUNDFOS PART NO.
											Delta						
5	1	230	1.15	80	35	23.8	124	27.1	74.8	91.2	0.51	2.2	G	--	--	1500	82.4119H
	3	230	1.15	45	20	14.8	110	16.4	76.8	82.5	0.81		K	1	K58	1500	82.9115H3
	3	460	1.15	25	10	7.4	55	8.2	76.8	82.5	3.05		K	1	K43	1500	82.9115H6
7 1/2	1	230	1.15	125	45	35.2	167	40.9	72.9	94.9	0.40	1.40	F	--	--	1500	82.4121H
	3	230	1.15	70	30	21.8	144	24.4	78.5	81.8	0.65		J	1	K64	1500	82.9116H3
	3	460	1.15	35	15	10.9	72	12.2	78.5	81.8	2.43		J	1	K54	1500	82.9116H6
10	1	230	1.15	175	60	48.0	202	54.0	73.6	93.2	0.32	1.05	E	--	--	3500	82.4123H
	3	230	1.15	80	40	28.2	208	32.0	79.3	82.8	0.45		K	1.75	K68	3500	82.9117H3
	3	460	1.15	40	20	14.3	104	16.0	79.3	82.8	1.62		K	1	K58	3500	82.9117H6
15	1	230	1.15	250	100	70.8	275	84.9	73.7	93.2	0.23	0.68	D	--	--	3500	82.9118H3
	3	230	1.15	125	60	41.4	320	46.2	81.7	83.2	0.31		K	2	K74	3500	82.9118H3
	3	460	1.15	60	30	20.7	160	23.1	81.7	83.2	1.07		K	1.75	K63	3500	82.9118H6
20	3	230	1.15	175	70	53.0	392	63.0	83.2	84.9	0.26		K	2.5	K77	3500	82.9119H3
	3	460	1.15	90	35	26.5	196	30.0	83.2	84.9	0.86		K	2	K67	3500	82.9119H6
25	3	230	1.15	200	90	67.2	530	75.4	83.0	83.9	0.21		K	3	K83	3500	82.9120H3
	3	460	1.15	100	45	33.6	265	37.7	83.0	83.9	0.67		K	2	K72	3500	82.9120H6
30	3	230	1.15	250	110	80.8	610	90.6	82.5	84.3	0.16		K	3	K86	3500	82.9121H3
	3	460	1.15	125	50	40.4	305	45.3	82.5	84.3	0.55		K	2.5	K74	3500	82.9121H6
40	3	460	1.15	150	70	51.7	340	58.8	84.0	86.3	0.46		H	3	K76	5000	82.3228H
50	3	460	1.15	200	90	69.7	465	78.8	82.5	81.4	0.39		J	3	K83	5000	82.3229H
60	3	460	1.15	225	100	80.8	465	92.8	82.4	84.4	0.39		G	3.5	K86	5000	82.3230H

8 Inch Motors

HP	Ph	VOLTS	Service Factor	Circuit Breaker or Standard Fuse	Dual Element Fuse	Full Load	Locked Rotor	S.F. Amps	Eff.	Power Factor	Line-to-Line Resistance(Ohms)	KVA Code	Starter Size	Furnas Amb. Comp	Maximum Thrust (lbs)	GRUNDFOS PART NO.
40	3	460	1.15	150	70	54.3	380	60.9	83.9	82.1	0.37	J	3	K76	10.000	82.3270H
50	3	460	1.15	200	90	64.9	435	73.6	84.1	85.7	0.33	H	3	K78	10.000	82.3271H
60	3	460	1.15	225	100	77.8	510	88.5	84.7	85.3	0.28	H	3.5	K86	10.000	82.3272H
75	3	460	1.15	350	150	96.7	650	110	84.9	85.9	0.22	H	3.5	K88	10.000	82.3274H
100	3	460	1.15	400	175	127	795	145	85.2	86.6	0.16	H	4	K89	10.000	82.3275H
125	3	460	1.15	500	225	172.0	980	192	84.2	80.9	0.14	G	4.5	K28	10.000	82.36H042
150	3	460	1.15	600	250	187.0	1060	216	85.6	87.9	0.13	G	4.5	K29	10.000	82.36H043

10 Inch Motors

HP	Ph	VOLTS	Service Factor	Circuit Breaker or Standard Fuse	Dual Element Fuse	Full Load	Locked Rotor	S.F. Amps	Eff.	Power Factor	Line-to-Line Resistance(Ohms)	KVA Code	Starter Size	Furnas Amb. Comp	Maximum Thrust (lbs)	GRUNDFOS PART NO.
200	3	460	1.15	800	350	233.0	1260	270	87.2	92.2	0.09	F	5	K33	10.000	82.36H064
250	3	460	1.15	900	450	294.0	1500	344	86.5	92.1	0.08	E	6	K27	10.000	82.36H066

Franklin Motors

(refer to the Franklin Submersible Motors Application Maintenance Manual)

Table F

Example: Correcting for Three-Phase Power Unbalance

Example: Check for current unbalance for a 230 volt, 3 phase, 60 Hz submersible pump motor, 18.0 full load amps.

Solution: Steps 1 to 3 measure and record amps on each motor drop lead for Hookups 1, 2 and 3.

	Step 1 (Hookup 1)	**Step 2** (Hookup 2)	**Step 3** (Hookup 3)
(T_1)	DL_1 = 25.5 amps	DL_3 = 25 amps	DL_2 = 25.0 amps
(T_2)	DL_2 = 23.0 amps	DL_1 = 24 amps	DL_3 = 24.5 amps
(T_3)	DL_3 = 26.5 amps	DL_2 = 26 amps	DL_1 = 25.5 amps
Step 4	Total = 75 amps	Total = 75 amps	Total = 75 amps
Step 5	Average Current =	Total current / 3 readings =	75 / 3 = 25 amps
Step 6	Greatest amp difference from the average:	(Hookup 1) = 25-23 = 2 (Hookup 2) = 26-25 = 1 (Hookup 3) = 25.5-25 = .5	
Step 7	% Unbalance	(HOOKUP 1) = 2/25 X 100 = 8 (HOOKUP 2) = 1/25 X 100 = 4 (HOOKUP 3) = .5/25 X 100 = 2	

As can be seen, Hookup 3 should be used since it shows the least amount of current unbalance. Therefore, the motor will operate at maximum efficiency and reliability.

By comparing the current values recorded on each leg, you will note the highest value was always on the same leg, L_3. This indicates the unbalance is in the power source. If the high current values were on a different leg each time the leads were changed, the unbalance would be caused by the motor or a poor connection.

If the current is greater than 5%, contact your power company for help.

* For a detailed explanation of three-phase balance procedures, see Three-Phase Motor, section 2, page 6.

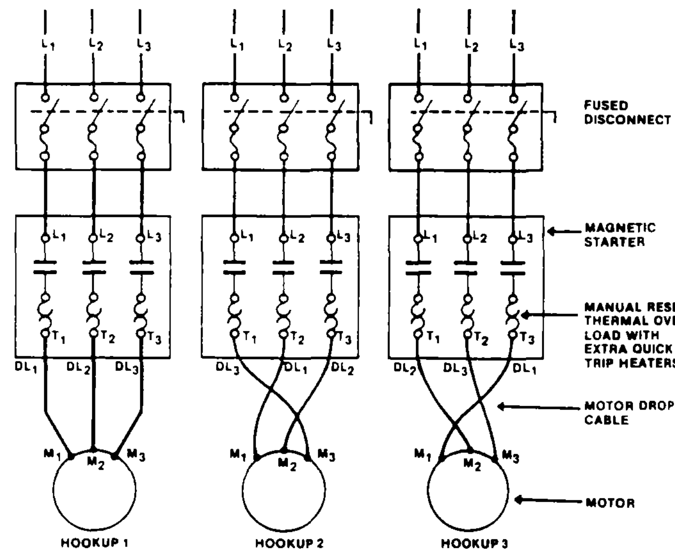


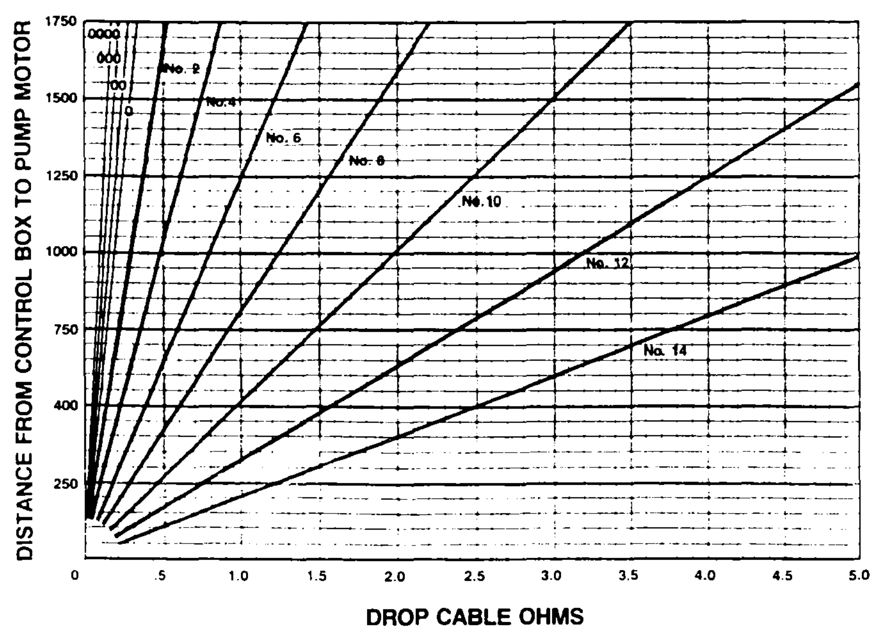
Table G

Total Resistance of Drop Cable (OHMS)

The values shown in this table are for copper conductors. Values are for the total resistance of drop cable from the **control box to the motor and back.**

To determine the resistance:

1. Disconnect the drop cable leads from the control box or panel.
2. Record the size and length of drop cable.
3. Determine the cable resistance from the table.
4. Add drop cable resistance to motor resistance. Motor resistances can be found in the Electrical Data Chart, Table E.
5. Measure the resistance between each drop cable lead using an ohmmeter. Meter should be set on Rx1 and zero-balanced for this measurement.
6. The measured values should be approximately equal to the calculated values.



Limited Warranty

Products manufactured by GRUNDFOS PUMPS CORPORATION (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

GRUNDFOS®

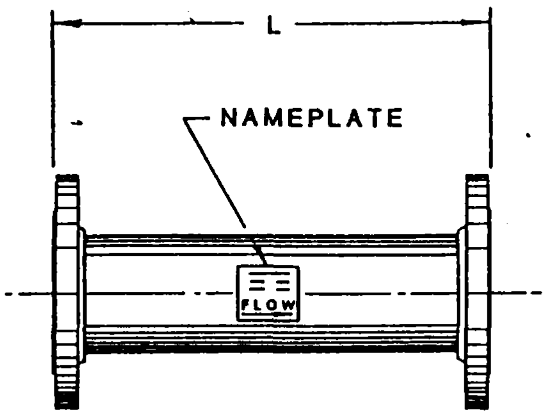
GRUNDFOS PUMPS CORP. • 2555 Clovis Ave. • Clovis, CA 93612
Sales Support Centers: Allentown, PA • Atlanta, GA • Buffalo Grove, IL
Canada: Mississauga, ONT

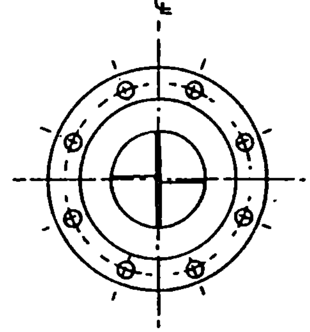
L-SP-TL-031 | Rev. 12/93
PRINTED IN USA

KOMAX MOTIONLESS MIXER

...S SUBJEC... ...ECTIONS
NOTED & TO THE ...OVISIONS OF
THE SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E. Koenig

SEE ATTACHED COMMENTS





"M" SERIES NUMBERING SYSTEM

Line Size, 4 inch in example
Number of Elements, 3 in example

M C - 4 - 3

Material, refers to Carbon Steel
Series identifier

MC - 6 - 3

Symbol	Material	MIXER RATING	HYDRO. TESTED (1)
C	Carbon Steel	240 PSIG/200°F	400 PSIG
S	Stainless Steel	240 PSIG/200°F	400 PSIG
F	Fiberglass	150 PSIG/200°F	225 PSIG
P	P.V.C.	150 PSIG/100°F	150 PSIG

HOUSING : CARBON STEEL - A53 Grade B Schedule 40
STAINLESS STEEL - Type 316 Schedule 40
P. V. C. - Schedule 80
F. R. P. - 150 psi rated filament wound

FLANGES : ANSI B16.5 - 150 lb. Drilling
CARBON STEEL & STAINLESS STEEL - Raised Face
P. V. C. - For Sizes : 3" & LARGER - Raised Face
Smaller than 3" - Flat face
F. R. P. - Flat Face

SUBMITTAL PRINT
NOV 26 1990

LINE SIZE NPS	L inches			SHIPPING WT. lb		
	2 eL	3 eL	4 eL	2 eL	3 eL	4 eL
2	7	9	13	14	15	16
2 1/2	8	11	14	21	23	25
3	9	13	16	27	29	33
4	11	16	21	43	49	55
6	16	24	31	78	93	110
8	21	31	41	132	163	195
10	26	39	52	213	267	326
	All Dimensions ± 1/8"					

NOTE :

WEIGHTS LISTED ARE FOR CARBON STEEL AND STAINLESS STEEL.

TO OBTAIN SHIPPING WEIGHT FOR PVC AND FRP UNITS, DIVIDE VALUES LISTED BY A FACTOR 3.

OUTLINE & MOUNTING CONFIGURATION

SCALE: NONE	APPROVED BY:			DRAWN BY L. N. H.
DATE: 12-13-84	[illegible]	[illegible]	[illegible]	REVISED 07-31-85

TYPICAL KOMAX "M" SERIES MIXERS

KOMAX SYSTEMS, INC.
Long Beach, Ca. 90810-1689

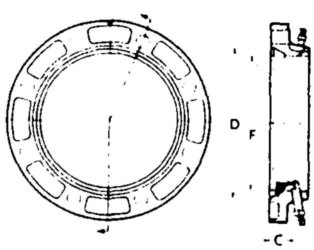
KQ: 23430-90
KJ: 12176-90

DRAWING NUMBER 9350

11517 PRINTED ON NO. 1000H CLEARPRINT

Tyler Pipe
Subsidiary of
Tyler Corporation

DUCTILE IRON AND GRAY IRON FLANGED FITTINGS



DUCTILE IRON ADAPTOR FLANGE
5-749

Size	Cast Iron Pipe OD ± .06	D +.06 −.04	F +.07 −.03	C	Wt.
3	3.96	4.94	4.06	.94	6.5
4	4.80	6.02	4.90	1.00	10.5
6	6.90	8.12	7.00	1.06	14.5
8	9.05	10.27	9.15	1.12	22.0
10	11.10	12.34	11.20	1.19	30.0
12	13.20	14.44	13.30	1.25	40.0

All set screws are ⅝" 90 lb. torque head.

*Wall thickness note: Installation suggestions are based on use with class 53 ductile iron pipe; results may vary if different classes or other pipe is used.

Size	Rated Working Pressure	No. of Set Screws	Bolt Circle	No. of Bolts & Nuts	Size of Bolt	Bolt Hole Dim.
3	250	4	6.00	4	⅝ x 2½	¾
4	250	4	7.50	8	⅝ x 3	¾
6	250	8	9.50	8	¾ x 3½	⅞
8	250	8	11.75	8	¾ x 3½	⅞
10	250	12	14.25	12	⅞ x 4	1
12	150	12	17.00	12	⅞ x 4	1

HOW TO USE TYLER 5-749 ADAPTOR FLANGES TO CONNECT PLAIN END PIPE TO 125 LB. FLAT FACE FLANGES (Based on Class 53 D.I. Pipe)

TO CONNECT DUCTILE IRON PIPE:

1. Make sure that the pipe is square-cut plain end, then slide on 5-749 adapter flange with flat side of flange facing other connection.
2. Set the pipe end flush with the face of the flange, and gently snug all set screws to square the flange face with the pipe.
3. Tighten set screws 180° to recommended torque of 90 ft. lbs. (Use caution not to over-torque.) NOTE: With torque-set screws, tops will break off at the recommended setting, so no torque wrench is required for initial assembly.
4. Properly seat MJ gasket: lubricate the gasket and slide on plain end of pipe with tapered gasket end facing the sealing area of the adapter flange.
5. Install machine bolts, pulling together each flange. Tighten evenly 180° apart to insure proper seal when maximum torque is applied (90 ft. lbs.)
6. No deflection is permitted during installation.

TO CONNECT STEEL O.D. SIZE PIPE:
Use same procedure with MJ transition gasket to make the seal.

…ROVED SUBJECT TO CORRECTIONS
NOTED & TO THE PROVISIONS OF
THE SPECIFICATIONS.
A
DEC 28 1990
U.S. ARMY ENGINEER DISTRICT - ST. PAUL
By Mark E Koenig

SEE ATTACHED COMMENTS

NOTE: Unless otherwise specified, all flanged fittings are furnished bituminous-coated. All special orders, whether bare or requiring special coating, are made-to-order only. . . not returnable.

ANSI AWWA C110/A21.10, ANSI AWWA C111/A21.11, ANSI-AWWA C115 A21.15
Tyler Pipe Utilities Division • P.O. Box 2027 • Tyler, Texas 75710 • (214) 882-5511 • Telex 88 0175

10-03-88

KOMAX® MOTIONLESS MIXERS

OPERATION, INSTALLATION AND MAINTENANCE INSTRUCTIONS

CONTENTS

MIXING BY DESIGN

KOMAX

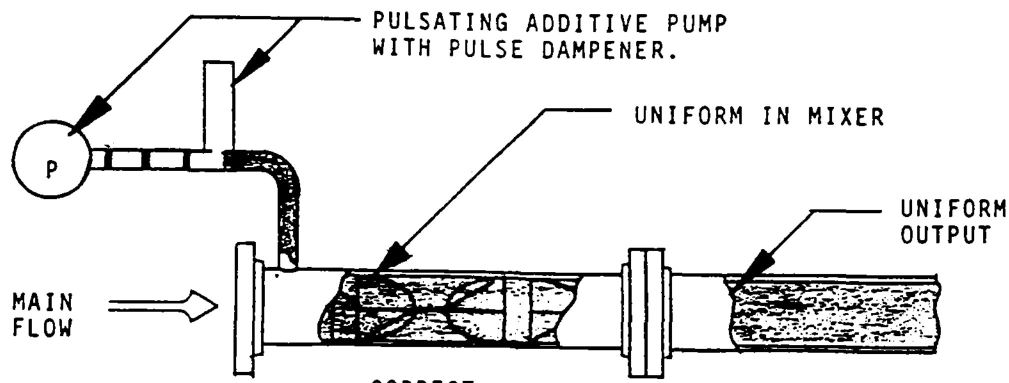
APPLICATION BULLETIN NO. 5180

PRINCIPLES OF OPERATION

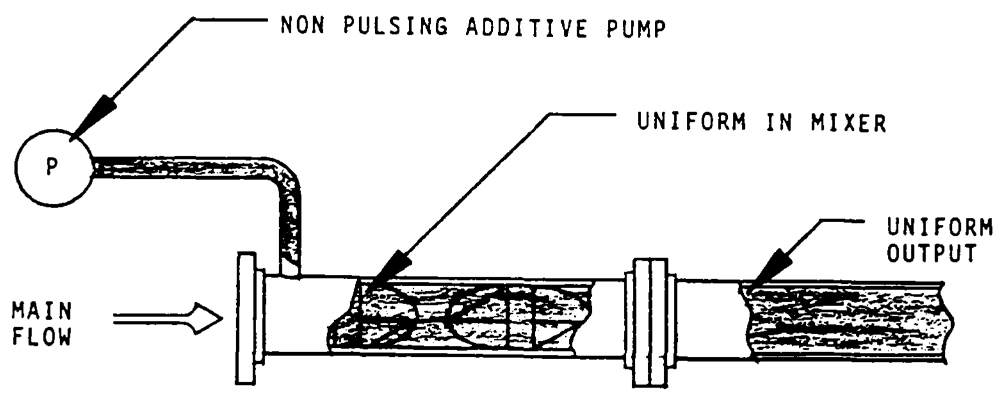
Komax motionless mixers produce mixing or blending of two or more input streams by a series of specially shaped elements. These elements produce multiple divisions and recombinations of the material so that under laminar flow conditions each element doubles the number of striations. If we have "m" input streams on "n" elements, the number of output striations is $m \times 2^n$. Under turbulent flow conditions the mixing is much further enhanced by elliptical counter rotating vortices on each side of each mixing element.

It is important to recognize that the input flow rates of materials must correspond to the output ratios required in the mixture. This must be kept in mind when selecting the material pumping system. Low viscosity materials for example may be handled by centrifugal pumps, while high viscosity materials will require positive displacement pumps.

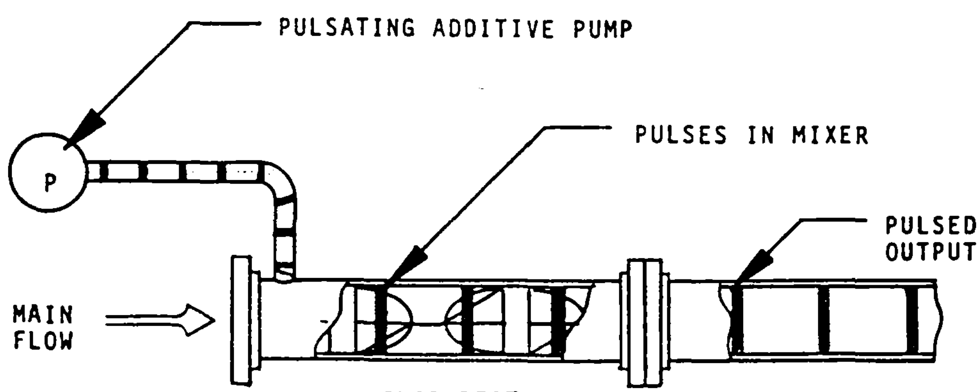
Additives to a main product flow must be introduced in a non-pulsating manner in order to avoid a pulsating output.



CORRECT



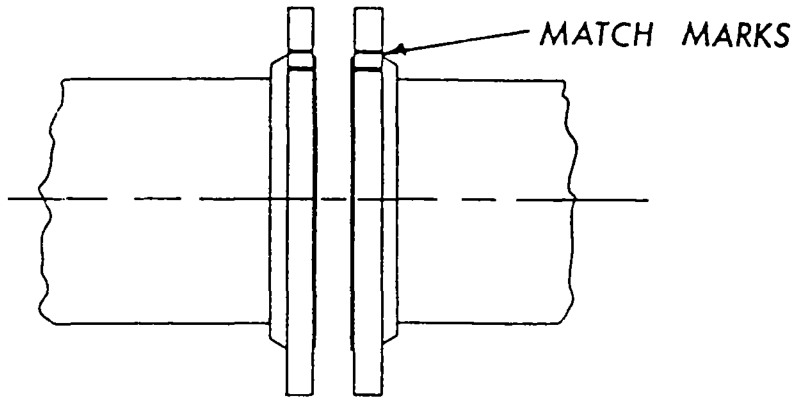
CORRECT



INCORRECT

MATCH MARKING

When two Komax mixers must be connected together, match marks are provided to assure correct operation.



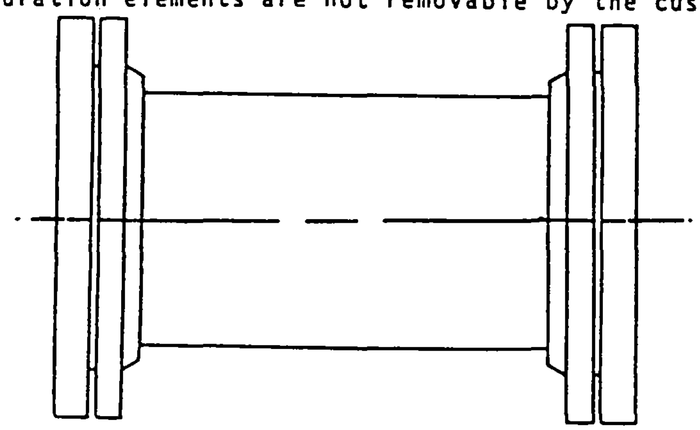
Failure to properly align the match marks may severely reduce mixing efficiency.

CONSTRUCTION MATERIALS & CONFIGURATION

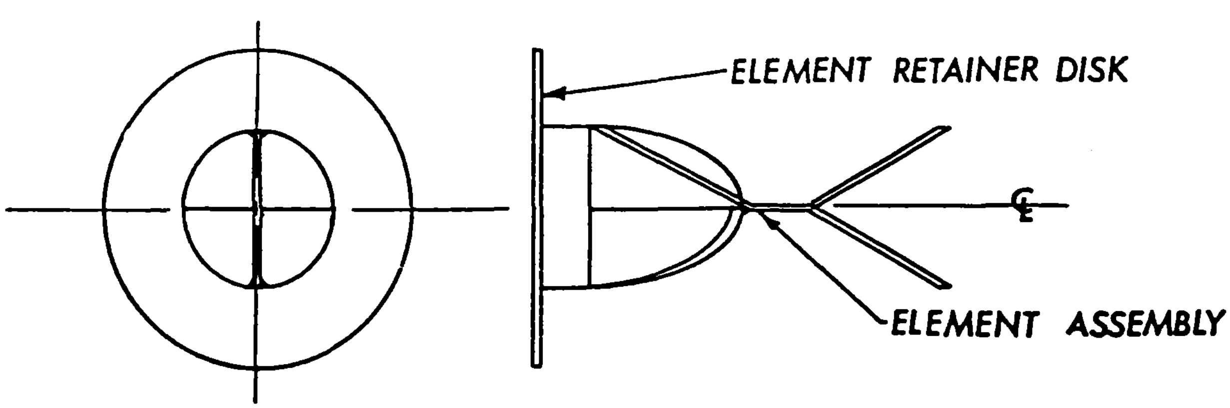
Construction materials include carbon steel, stainless steels, special alloys such as Carpenter 20 and Hastelloy B2, plastics such as PVC and CPVC, FRP (Fiberglass Reinforced Plastic) and combinations such as carbon steel spool pieces with Teflon or Kynar lining. End configurations include plain, prepared for welding, threaded and flanged.

Teflon and Kynar lined spool pieces can have elements retained in one of two ways.

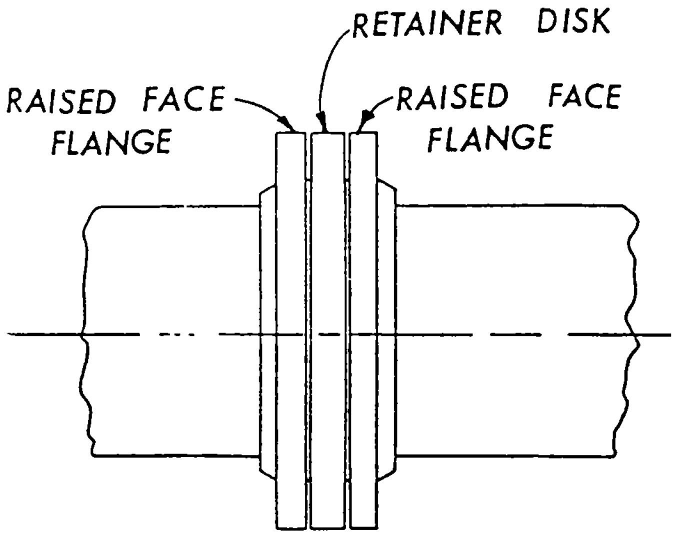
One way is with element retainer disks of Teflon or Kynar as shown below. In this configuration elements are not removable by the customer.



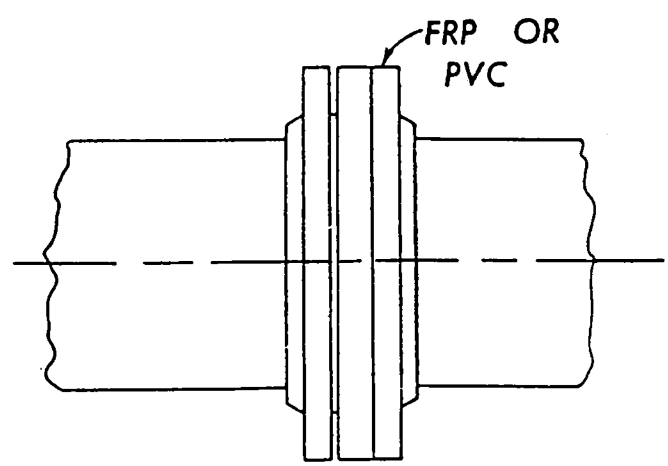
Another method which applies to metal elements in a Teflon or Kynar lined. spool piece is shown below. In this case, elements are removable as an assembly by the customer.



Note that units configured with a pair of element retainer disks are treated as raised face units. Although the retainer disk is flat, the flange to flange forces are from the spool raised face to the mating flange raised face.



YES



NO

The following torque recommendations are to be followed when installing lined pipe mixers

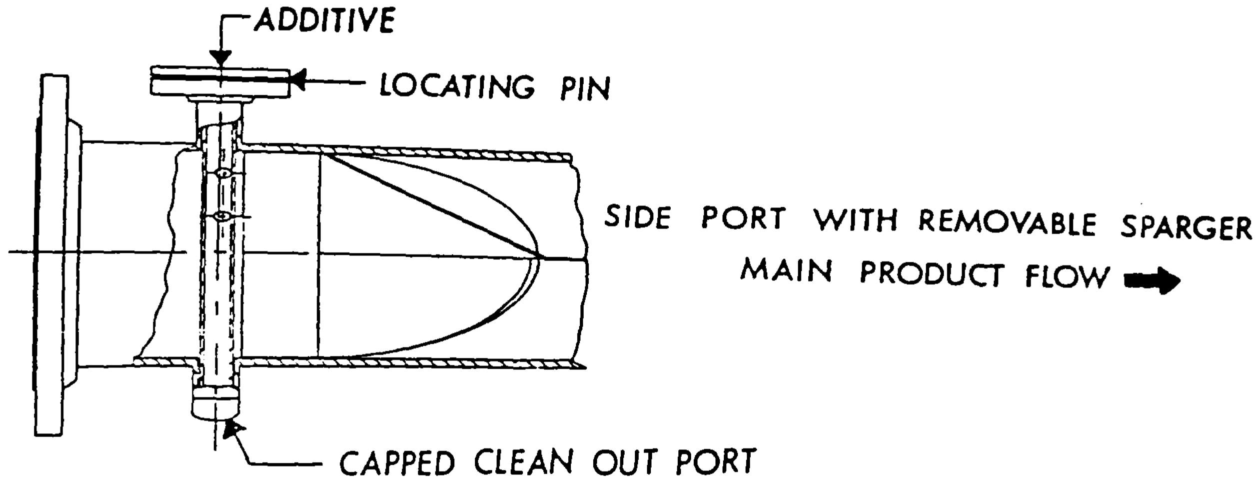
Pipe size	Torque ft. lb.	Pipe Size	Torque ft. lb.
1"	8 - 9	4"	27 - 36
1 1/2"	9 - 12	6"	35 - 50
2"	18 - 24	8"	45 - 60
2 1/2"	23 - 30	10"	75 - 85
3"	23 - 30	12"	95 - 110

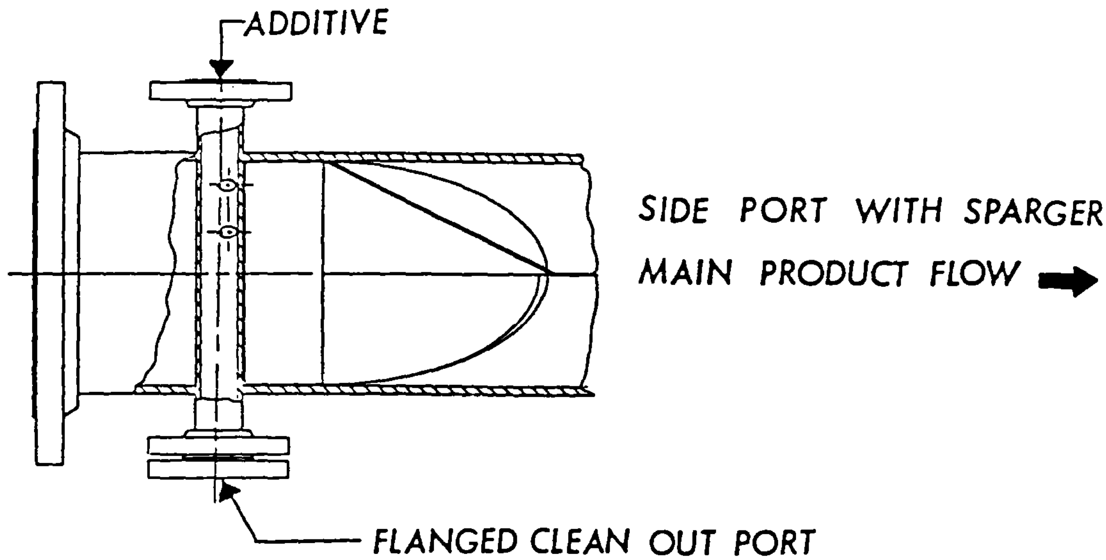
The following torque recommendations are to be followed when installing FRP flanges

Pipe Size	Torque ft. lb
2"	25
3"	30
4"	30
6"	30
8"	45
10"	50
12"	55
14"	55
16"	55
18"	55
20"	55
24"	55
30"	55
36"	55
42"	55

When installing FRP mixers, consideration must be given to the fact that the expansion coefficient for FRP is substantially higher than that for steel.

Steel expansion coefficient = 7×10^{-6} inch/inch/^{o}F approximately
-FRP- expansion coefficient = 20×10^{-6}





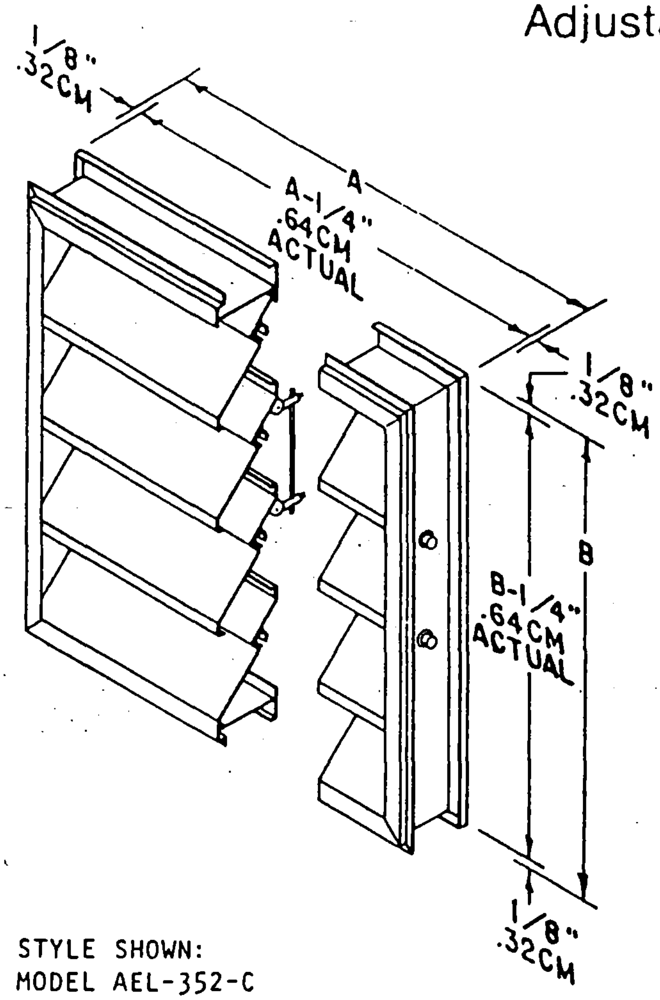
MAINTENANCE

Once installed, a Komax motionless mixer requires no routine maintenance since there are no moving parts to repair or replace. If a mixer has been supplied with internals designed for removal by the customer, these internals can be removed by him for inspection or cleaning. If elements have any special coating such as Teflon or Kynar, great care must be taken not to damage the protective coating.

LOUVERS AND DAMPERS, INC.

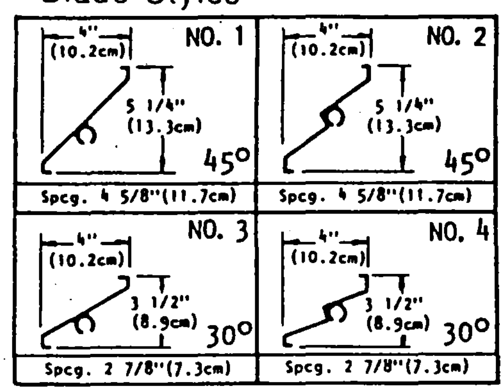
4" Deep Extruded Aluminum Adjustable Louver

AEL-350/360 Series

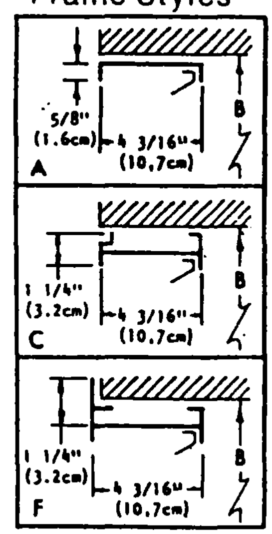


SPECIFICATIONS:
1. All welded construction. Mitered frame corners.
2. Frame and blades of mill finish .081" thk. extruded aluminum, alloy 6063-T5.
3. Blades pivot on 1/2"(1.27cm) dia. stub shafts in sintered bronze self-lubricating bearings.
4. Blade spans over 50"(127cm) employ exposed mullions.
5. 350 series: Exposed linkage of double .081" thk. clips with 1/4"(.64cm) dia. connect bar and push rod operator.
6. 360 series: Hidden linkage of welded/riveted construction concealed in the jambs with extended lever arm and push rod operator. (See Dwg. 014-A76-LD for standard operator.)
7. 1/2"(1.27cm) mesh, 19 ga. woven, galvanized steel screen standard. Front mounted on 350 series, rear mounted on 360 series.

Blade Styles



Frame Styles



STYLE SHOWN:
MODEL AEL-352-C
"C" frame shown. Be certain to specify frame style "A", "C" or "F" when ordering.

LINKAGE & OPERATOR SPECIFICATIONS:
Refer to Linkage & Standard Operator sheet. (014-A76-LD)

WITH 304SS. JAMB SEALS & POLYURATHANE BLADE SEALS.

LOUVER MODEL NO.	DESCRIPTION
☐ AEL-351-A, C or F*	Exposed linkage, blade style #1
☐ AEL-352-A, C or F*	Exposed linkage, blade style #2
☐ AEL-353-A, C or F*	Exposed linkage, blade style #3
☐ AEL-354-A, C or F*	Exposed linkage, blade style #4
☐ AEL-361-A, C or F	Hidden linkage, blade style #1
☐ AEL-362-A, C or F	Hidden linkage, blade style #2
☒ AEL-363-A, C or F	Hidden linkage, blade style #3
☐ AEL-364-A, C or F	Hidden linkage, blade style #4

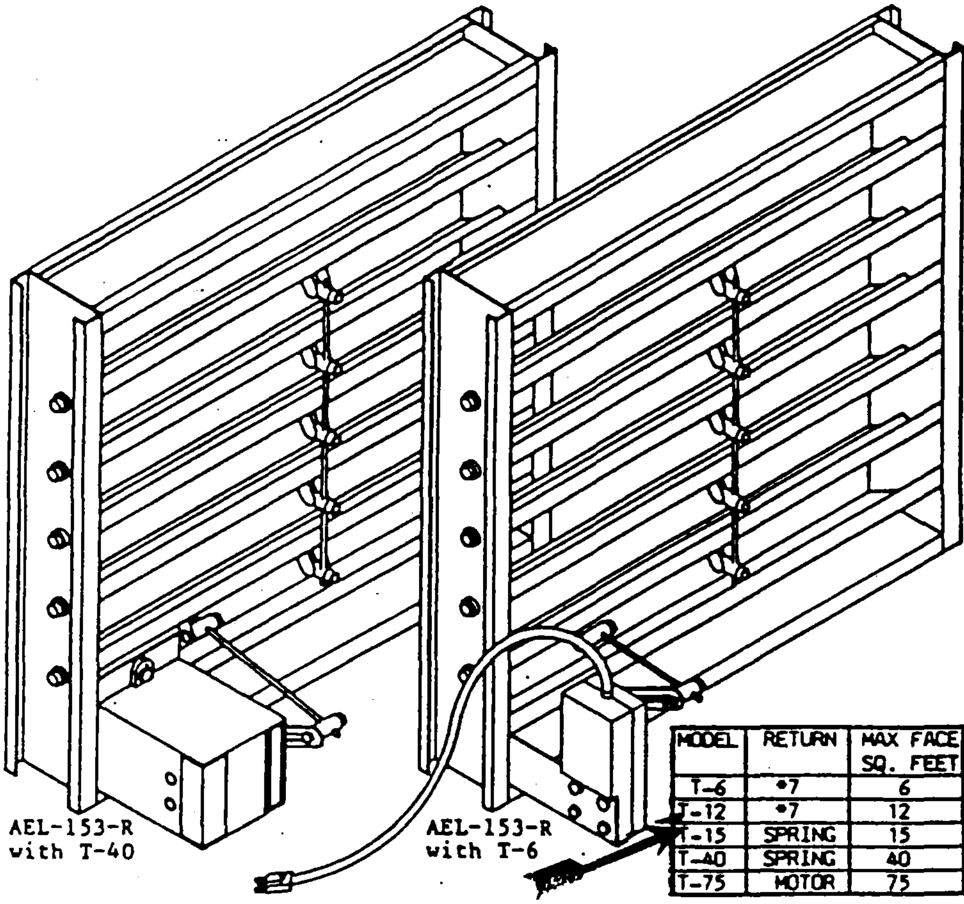
* No rear mounted screens will be installed on 350 series louvers; if a rear mounted screen is required specify 360 series.

ITEM NUMBERS SEE SHEET 113-A72-LD FOR FULL SCHEDULE OF SIZES	ARCHITECT ENGINEER: U.S. ARMY CORPS OF ENGINEERS CONTRACTOR: MORRISON/KNUTSON ENVIRONMENTAL	**Louvers & Dampers, Inc.** CINCINNATI • *Custom Manufacturers of Louvers, Dampers and Air Control Devices*

CUSTOMER PURCHASE ORDER	SHOP ORDER	DATE	DRAWING
		12-15-75	036-A75-LD

Electric Motors
To Operate Adjustable Louvers

MOTOR ACTUATORS



MODEL	RETURN	MAX FACE SQ. FEET	TORQUE LB.IN.	MANUFACTURER'S NUMBER		
				24/1/60	120/1/60	240/1/60
T-6	*7	6	-	MULTI	MULTI	MULTI
T-12	*7	12	-	MULTI	MULTI	MULTI
T-15	SPRING	15	16	MA3058C	MA4058C	MA407BC
T-40	SPRING	40	60	MA3188C	MA4188C	MA4198C
T-75	MOTOR	75	220	MC381BC	MC431BC	*8

NOTES:

1. Motors and motor mounting brackets are available installed on the louver or shipped loose.
2. If factory-installed, motor mounting bracket is welded to louver frame, and motor is bolted to mounting bracket. Motor may be linked to a blade as shown, or to a blade shaft in the jamb on units with concealed linkage.
3. Motor mounting shall be located according to motor application, louver design or installation requirements.
4. Each section of multi-section louvers may be furnished with an individual actuator for independent operation, or several sections may be linked to operate in unison by single actuator.
5. Louvers of 3 or more sections in the "A" dimension to be operated in unison require jackshafts.
6. Spring return motors are spring-loaded for a normally closed position unless otherwise specified.

*7. Factory-installed T-6 & T-12 Motor-Paks include motor mount and linkage, with louver blades spring-loaded for a normally closed position unless otherwise specified.

*8. T-75 Motor is unidirectional. 240 volt operation requires optional transformer.

[] T-6 [] T-75 [] For Multi-Section Louvers [] Motor Mount Only
[] T-12 [] Factory Installed [] Independent Operation [] Motor Linkage Only
[] T-15 [] Shipped Loose [] Operation in Unison (Crank Arm, Connect Bar, 2 Ball Joints)
[] T-40

ITEM NUMBERS	ARCHITECT	
SEE SHEET 113-A72-LD FOR FULL SCHEDULE OF SIZES	ENGINEER US. ARMY CORPS. OF ENGINEERS	**Louvers & Dampers, Inc.** CINCINNATI • *Custom Manufacturers of Louvers, Dampers and Air Control Devices*
	CONTRACTOR MORRISON KNUTSON [illegible]	

CUSTOMER PURCHASE ORDER	SHOP ORDER	DATE	DRAWING
		12-15-87	020 - LD

MARLEY ELECTRIC

BERKO™

HUH 524TA

HORIZONTAL/DOWNFLOW UNIT HEATER

- EIGHT WATTAGES, TWO VOLTAGES
- TO 5000 WATTS
- HORIZONTAL AND DOWNFLOW IN ONE UNIT
- BUILT-IN THERMOSTAT

APPLICATIONS

Auxiliary, supplementary or primary heat source in factories, stores, garages, basements, warehouses, public buildings, service stations, stockrooms, offices, workshops, toll booths, closing offices, large or exposed areas or additions.

FEATURES

HORIZONTAL AND DOWNFLOW IN ONE UNIT

Heater is shipped with a ceiling-mount bracket that allows the heater to be used in four indexed positions—straight out (horizontal), straight down (downflow), and two intermediate positions, as well as any position in between. In addition, louvers adjust up and down for even greater control of throw direction. Louvers have stops to prevent complete closing of the discharge area. Heater body also has top center hole with weld nut for mounting the heater and allowing it to pivot 360°. Wall mounting bracket also available (see accessories and controls).

EIGHT WATTAGES, TWO VOLTAGES

The HUH-524TA can be connected to either 208VAC or 240VAC, single phase service, and field-adjusted to adapt the unit to four different wattages for each voltage; eight wattages, from 1,874 to 5,000 (6,396 to 17,065 BTU/hr.).

BUILT-IN THERMOSTAT

Dial up or down for precise heating comfort with single-pole built-in thermostat. Temperature range 45°F to 135°F.

EASY TO INSTALL AND SERVICE

Remove one screw and bottom control box cover swings down on hinges for full access to controls and wiring. Loosen four screws through keyhole slots at the front of the heater for full access to: heating element, fan delay control and high limit cutout. Complete access to the motor and fan is obtained through the back by removing the four screws holding the fan guard.

PLATE FIN ELEMENT

The heater provides uniform discharge of all heated air with lower internal operating temperatures and prolonged element life—all due to the efficient design of the plate fin element. Steel fins are copper-brazed to low watt density, steel sheathed tubular heating element. Fins and elements are arranged in a uniform grid pattern and are closely fitted into the air discharge area to assure that all incoming air is discharged through the heating element.

SMOOTH, QUIET OPERATION

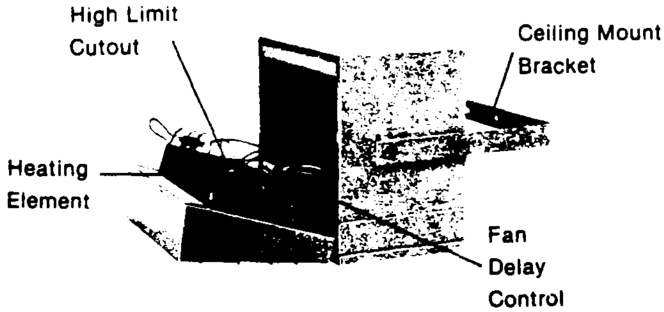
Motor is of unit bearing design with high starting and running torques. Large, dynamically balanced fan blades provide maximum air flow, thus, heater has minimum air turbulence and noise in operation.

AUTOMATIC FAN CONTROL

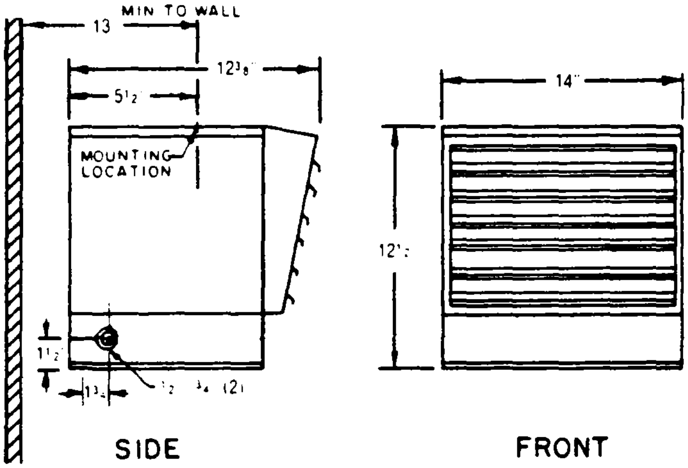
All heaters are equipped with an automatic fan delay control that delays fan action until the heating element is warm, and continues fan action until the heating element has cooled after the heating cycle. This action prevents circulation of cold air and avoids exposing the unit to residual heat, thus providing higher comfort level and prolonged component life.

THERMAL CUTOUT

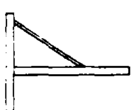
A high limit thermal cutout automatically shuts off the heater in the event of overheating and reactivates it when operating temperatures return to normal.



DIMENSIONS



ACCESSORIES AND CONTROLS

	CATALOG NO. DESCRIPTION
	DS-30 3-pole power disconnect switch for field installation on all heaters. Complies with "positive off" requirements.
	WB-1A Wall mounting bracket for all units. (Ceiling mounting bracket is included with all heaters)

ARCHITECT'S & ENGINEER'S SPECIFICATIONS*

The electric unit heater(s) shall be as manufactured by Berko Electric, A Division of Marley Electric Heating, Bennettsville, SC. Heater(s) shall be fully UL approved, designed for either wall or ceiling mounting without modification, and operate at either 208 or 240 VAC and have field-adjustable capacity from 1.875 to 5 KW.

HOUSING: The cabinet shall be of heavy gauge steel, welded and phosphatized; then completely painted by a baked enamel painting process. Front and back panels shall be removable to gain full access to element, motor and fan area. Fan guard shall be painted to match heater for appearance and durability. Heater(s) shall be furnished with attached ceiling mounting bracket and shall have capability of full horizontal and vertical position. Heater(s) shall be so designed as to permit mounting within two inches of the ceiling in full horizontal mode.

CONTROL BOX: The control box, housing all heater wiring and controls, shall be located at the bottom of the heater and equipped with a swingdown hinged cover to permit full access for installation and servicing without dismounting the heater.

WIRING: All heater and control wiring connections shall terminate in the control box. Proper wiring diagram shall be attached to the inside of the control box cover. 60°C wire may be used to bring entry wiring into compartment.

FAN MOTOR: Fan motor shall be totally enclosed, impedance protected and of unit bearing design suitable for horizontal or vertical operation with high starting and running torques. Fan motor and controls shall operate directly from the line voltage.

HEATING ELEMENT: The heating element shall be warranted for five years and shall be of non-glowing design consisting of a special resistance wire enclosed in the steel sheath to which steel plate fins are brazed. The heating element shall cover the entire air discharge area for uniform heating.

THERMAL CUTOUT: Thermal cutout shall be built into the system to automatically shut off heater in event of overheating and reactivate the heater when temperatures return to normal.

*Berko reserves the right to change specifications without prior notice.

SELECTION CHART

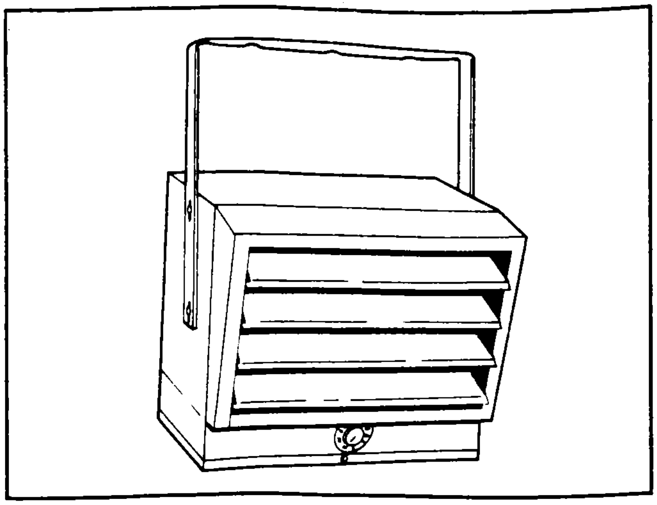
Catalog Number	Volts	Watts	BTU per hr.	Phase	Fan Motor Watts	Control Circuit & Fan Motor Volts	Fan Motor RPM	Air Volume CFM	Throw	Min. Mtg. Ht.	Heater Amps	Min. Ckt. Amps	Approx. Ship Wt. (Lbs.)
HUH-524TA	208	1874	6396	1	6	208	1350	270	16′	6′	9.0	11.3	25
		2500	8533								12.0	15.0	
		3123	10659								15.0	18.8	
		3750	12799								18.0	22.5	
	240	2500	8533			240					10.4	13.0	
		3332	11365								13.9	17.4	
		4165	14215								17.4	21.8	
		5000	17065								20.9	26.1	

UL LISTED

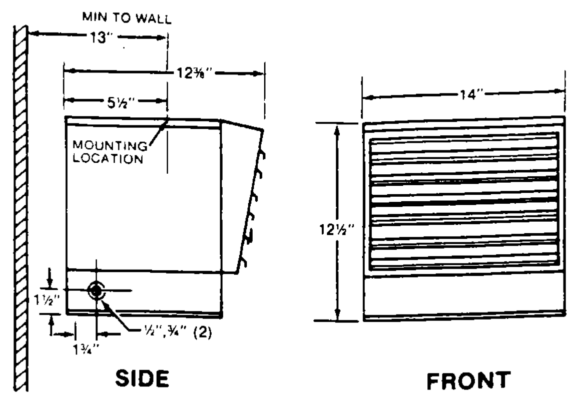
BERKO™
A Division of Marley Electric Heating

Installation Instructions
and
RENEWAL PARTS IDENTIFICATION

Catalog No. HUH-524TA
Horizontal/Vertical Unit Heater
(Field Adjustable from 1.9 KW @ 208V to 5 KW @ 240V)



Dimension Data



Specifications

Heater Rating and Voltage	BTU per Hr.	Phase	Contactor, Built-in	Mounting Height (ft.) Vertical Installation Min.	Vertical Installation Max.	Horizontal Installation Min.	Horizontal Installation Max.	Horizontal Air Throw (ft.)	Min. Distance from Mounting Hole to Wall (Inches)
*5000W @ 240V 4165W @ 240V 3332W @ 240V 2500W @ 240V	17,065 14,215 11,365 8,533	1	No	6′	11″	6′	8′	18′	**13″
*3750W @ 208V 3123W @ 208V 2500W @ 208V 1874W @ 208V	12,799 10,659 8,533 6,396	1	No	6′	11′	6′	8′	18′	**13″

*Heater is shipped from factory wired for these wattages. Heater can be field adjusted to the other wattages. (Refer to page 5.)
**48″ when heater air flow is between 45° downward and vertical.

WARNING

1. USE 60° COPPER WIRE ONLY.
2. HEATER AIR FLOW MUST BE DIRECTED PARALLEL TO, OR AWAY FROM ADJACENT WALLS.
3. OBSERVE WALL, FLOOR AND CEILING CLEARANCE REQUIREMENTS (PAGE 3).
4. ALL WIRING MUST CONFORM TO NATIONAL AND LOCAL ELECTRICAL CODES AND THE HEATER MUST BE GROUNDED AS A PRECAUTION AGAINST POSSIBLE ELECTRICAL SHOCK.
5. THE MOUNTING STRUCTURE AND THE ANCHORING HARDWARE MUST BE CAPABLE OF RELIABLY SUPPORTING THE WEIGHT OF THE HEATER (PLUS THE MOUNTING BRACKET, IF USED).
6. ALL ELECTRICAL POWER MUST BE DISCONNECTED AT THE MAIN SERVICE BOX BEFORE INSPECTING, CLEANING OR SERVICING THE HEATER. THIS IS A PRECAUTION TO PREVENT SERIOUS ELECTRICAL SHOCK.

WARNING

THIS UNIT OPERATES ON 240 OR 208 VOLTS AC. IMPROPER INSTALLATION OR FAILURE TO FOLLOW THE PROCEDURES AS OUTLINED IN THIS MANUAL CAN RESULT IN SERIOUS ELECTRICAL SHOCK. DISCONNECT ALL POWER FROM THE HEATER AT THE MAIN SERVICE BOX BEFORE ATTEMPTING TO INSTALL OR SERVICE THIS UNIT.

WARNING

ALL ELECTRICAL WIRING MUST CONFORM TO LOCAL ELECTRICAL CODES. HEATER CIRCUIT MUST BE PROTECTED WITH PROPER FUSES. SEE TABLE 1 ON PAGE 5.

TABLE OF CONTENTS

INTRODUCTION

Congratulations! You have just purchased one of the most versatile electric space heaters available. Your new Berko electric unit heater has unmatched operating flexibility. It is designed to meet a variety of heating requirements by simply switching a few easily accessible wires located in the base of the unit. Heat output ranges are from 6,396 to 17,065 BTU per hour. This unique feature lets you use a single unit to meet a wide range of heating applications.

The HUH-524TA's unique mounting system simplifies both installation and air flow control. The mounting bracket attaches to the ceiling with a single screw and allows you to turn the entire heater in a full circle. The mounting bolts on the sides of the heater permit you to adjust the air flow direction to any angle between horizontal and vertical. The louvers adjust up and down for even greater control.

These features combine to make the HUH-524TA the most versatile space heater available anywhere for applications ranging from garages, basements, and workshops, to public buildings, service stations, stores, mini-warehouses, stockrooms, or similar applications. And it can be installed easily by anyone in only a few minutes.

This manual shows you how to install, operate, and maintain your HUH-524TA electric heater.

Unpacking Your New Heater

Remove the heater from the box and inspect it for any damage. If the heater appears damaged, return it to the store immediately.

Check the contents of the box against the following packing list:

PACKING LIST

DESCRIPTION	QUANTITY
Heating unit	1
Mounting Bracket	1

Tools Needed

You will need the following tools to install your HUH-524TA electric heater:

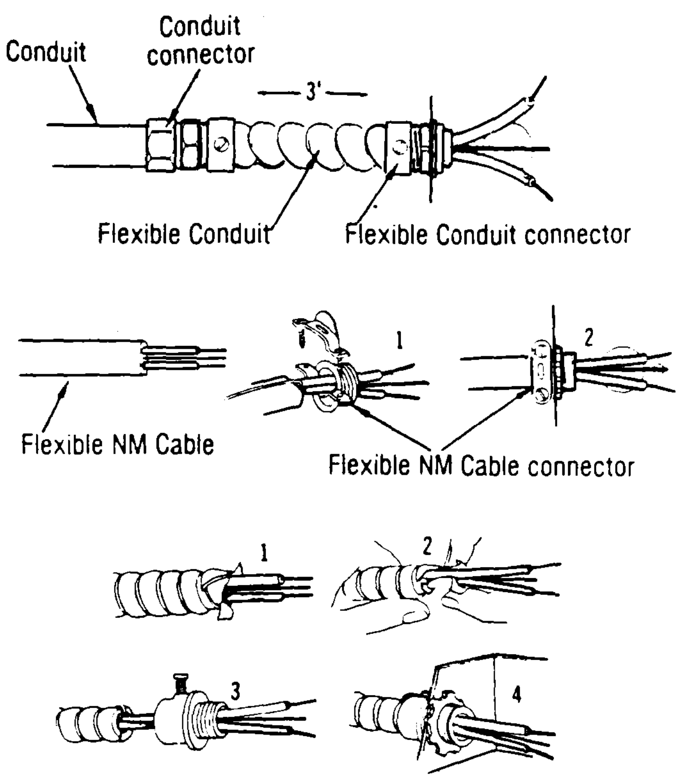
- Screwdriver
- Pliers
- Needle Nose Pliers
- Adjustable Wrench
- Electric Drill and ¼" bit

Hardware Needed

You will also need the following hardware, which you can purchase from your local hardware store or electrical supply house:

- Enough 10 gauge copper wire to run power from the service box to the heating unit. Copper wire must have a temperature rating of 60° C. Do not use aluminum wire with this unit.
- Proper size fuses or circuit breakers (See Table 1, page 5).
- Proper wire connectors for your application. (See Illustration below).
- Screw, wood, 3/8" x 2" (qty. 2).
- Washer, 3/8" (qty. 2).

For certain applications, conduit may be required. Check local electrical codes. Also, if you run the wiring in conduit and wish to be able to turn the heater, be sure to purchase enough flexible conduit to allow the heater to be turned.

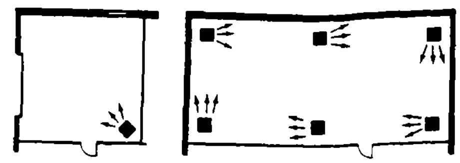


Connectors, cable, and hardware used to wire the HUH-524TA

INSTALLATION

Location Of Heater

The heater should be installed out of the reach of persons. The direction of air flow should not be restricted by columns, machinery, etc., and the air flow should wipe exposed walls, rather than blowing directly at them. When more than one heater is used in an area, the heaters should be arranged so that the air discharge of each heater supports the air flow of the others to provide best circulation of warm air.



Mounting Height

When the air flow of the heater is directed *vertically*, the minimum mounting height is 6 feet, the maximum mounting height is 11 feet. When the air flow of the heater is directed *horizontally*, the minimum recommended mounting height is 6 feet, and the maximum recommended height is 8 feet.

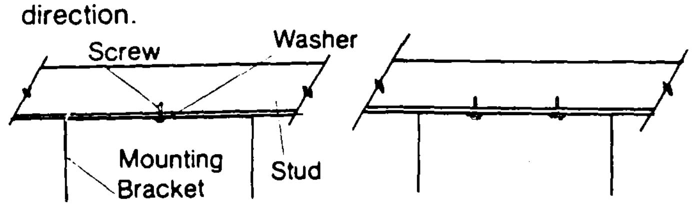
Distance From Walls

When the heater is mounted so that the air flow direction is at an angle *from horizontal to 45° downward*, the distance from the mounting bracket center hole to any wall should be *at least 13 inches*. When the heater is mounted so that the direction of air flow is at an angle *between 45° downward and vertical*, the distance from the mounting bracket to any wall should be *at least 48 inches*.

To install the HUH-524TA in three simple steps, proceed as follows:

1. Mounting The Bracket

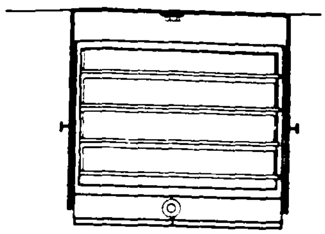
Locate a stud in the ceiling and attach the mounting bracket to the stud according to illustration 1 or 2. You will need to remove the mounting bracket from the heating unit by loosening the bracket screws with a wrench and slipping the handle off over the screw heads. Remember to place a washer on the screws before you insert them through the holes in the mounting bracket and screw them into the stud. Tighten the screws enough to securely hold the heating unit with the air flow pointed in the proper direction.



Single Screw Mounting　　Double (fixed) Screw Mounting

2. Hanging The Heater

Attach the heating unit to the mounting bracket. Lift the heater up and into the mounting bracket. The bracket screws, located on each side of the heating unit, allow the heater to be attached easily to the mounting bracket by aligning the screws with the keyhole slots in the mounting brackets. If the heater is to be tilted, it must be positioned in the lower keyhole slots. Tighten the bracket screws with a wrench so the unit is securely suspended at the desired horizontal or vertical angle.

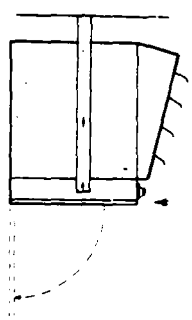


WARNING

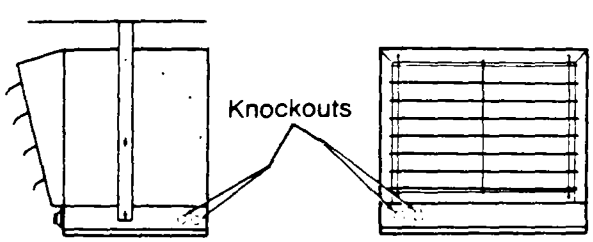
BEFORE PROCEEDING FURTHER WITH THE INSTALLATION OF THE HEATER, TURN OFF THE POWER TO THE SUPPLY LINE FOR THE HEATER AT THE MAIN SERVICE BOX.

3. Connecting The Power

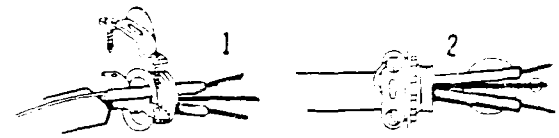
To connect the power to the heater, simply remove the screw from the front of the unit. This allows the hinged bottom to open, providing access to the electrical wiring and connectors.



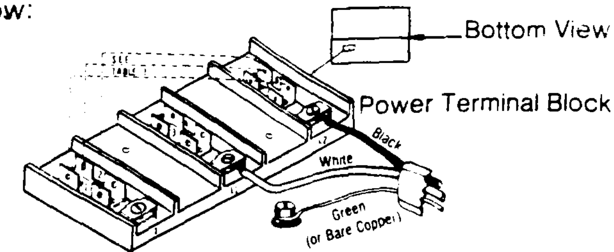
Remove one of the knockouts from the back or side of the unit.



Attach the cable connector to the unit as shown below, and slide the 10 gauge wire through the cable connector. Pull enough of the wire through the connector so you will have enough wire to work with when you make the connections.



Connect the wires to the terminal located in the base of the heater as shown in the illustration below:



NOTE

TO DECREASE THE HEAT OUTPUT OF THE HEATING UNIT, SEE TABLE 1 AND SCHEMATIC DIAGRAM ON PAGE 5.

Turn on the power at the main service.

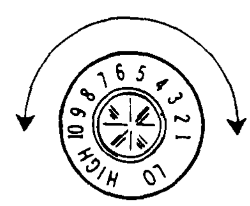
OPERATION

Setting The Thermostat

Adjust the thermostat to the highest setting.

NOTE

Fan will not turn on immediately.



NOTE

THE FIRST TIME YOU OPERATE THE UNIT, IT MAY SMOKE SLIGHTLY—THIS IS DUE TO THE RESIDUAL CLEANING AGENTS USED TO CLEAN THE ELEMENT WHEN THE HEATER IS MANUFACTURED—THIS IS NORMAL AND DOES *NOT* INDICATE A PROBLEM WITH THE UNIT. THIS CONDITION WILL STOP AFTER THE HEATER HAS BEEN IN OPERATION FOR A FEW MINUTES.

Automatic Fan Delay: The HUH-524TA has an automatic fan delay. When the thermostat calls for heat, fan action is delayed momentarily until the heating element is warm. This prevents the circulation of cold air. When the heater raises the temperature of the room to the thermostat set point, the heating element is turned off, but the fan will continue to run until the heating element cools down. This prevents exposing the unit to residual heat, provides a higher comfort level and prolonged element life.

Thermal Cutout: The HUH-524TA is also equipped with a thermal cutout which will automatically shut off the heater in the event of overheating. The heater will turn on when the operating temperature returns to normal. Should the unit overheat and activate the thermal cutout cycle, the cause of the overheating should be determined before further operation.

WARNING

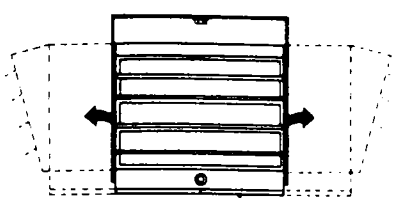
ALL POWER MUST BE SHUT OFF AT POWER SOURCE BEFORE INSPECTING OR SERVICING HEATER.

If the unit is installed in an area where the temperature is below 50°F, the fan may cycle on and off until the temperature in the room rises above 50°F—this is normal and does not indicate a problem with the unit. As soon as the heater warms the air in the room above 50°F, the unit will cycle normally.

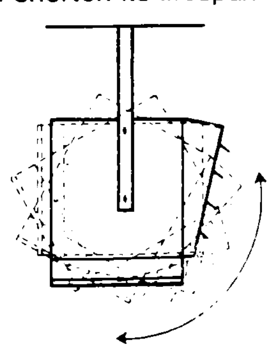
Adjusting Air Flow Direction

You can adjust the direction of air flow by (A) turning the unit, (B) tilting the heater, and (C) adjusting the louvers.

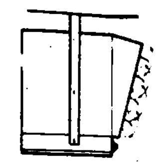
(A) If the unit has been installed with a single screw as shown in figure 1A on page 3, simply turn the entire unit as needed to adjust air flow.



(B) Loosen the bracket screws, tilt the heater to the desired position, and re-tighten the bracket screws. NOTE: if you tilt the heater, you will have to move it to the lower keyhole slots on the mounting bracket to allow at least 7¹¹⁄₁₆ inches between the back of the unit and the ceiling. This will allow sufficient draft for the fan to pull in air from the room. Mounting the unit too close to the ceiling in the vertical position will cause inadequate draft for the fan and will shorten its lifespan.



(C) Adjust the louvers to the desired position. NOTE: The louvers are designed so they can not be completelv closed. Do not attempt to defeat this feature—damage to the unit can result.



Adjusting Heat Output

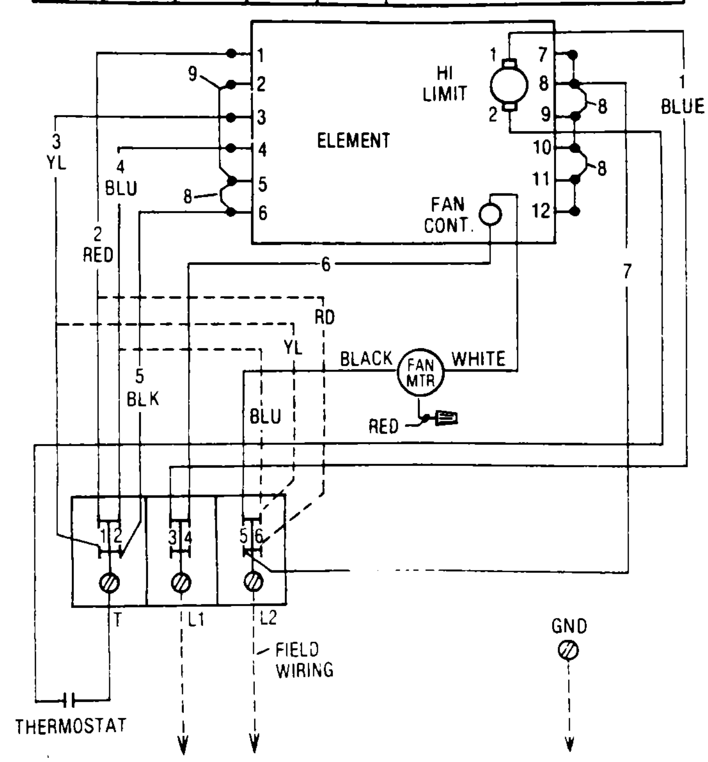
WARNING

DISCONNECT POWER TO THE HEATER AT THE MAIN SERVICE BOX BEFORE ATTEMPTING TO ADJUST THE HEAT OUTPUT OF THIS UNIT. SERIOUS ELECTRICAL SHOCK CAN OCCUR.

Heat output can be increased or decreased by switching wires at the power terminal located in the base of the unit. The heater is factory wired to deliver a heat output of 17,065 BTU per hour. Should your particular application require less heat output, refer to the table below and change the wires at the power terminal as shown in the illustration.

TABLE 1. HEAT OUTPUT ADJUSTMENTS

BTU Per Hour	Volts	Watts	Max. Fuse Size	Heater Amps	Move Jumpers From T to L2
17065	240	5000	30	20.9	NONE
14215	240	4165	25	17.4	BLUE
11365	240	3332	20	13.9	BLUE & YELLOW
8533	240	2500	15	10.4	BLUE, YELLOW, & RED
12799	208	3750	25	18.0	NONE
10659	208	3123	20	15.0	BLUE
8533	208	2500	15	12.0	BLUE & YELLOW
6396	208	1874	15	9.0	BLUE, YELLOW, & RED



MAINTENANCE

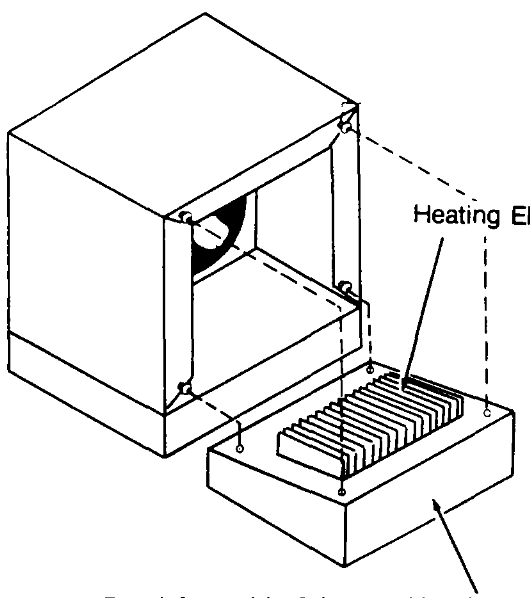
Because of its rugged design, superior engineering, and high quality craftsmanship and manufacturing, the HUH-524TA requires little maintenance, With proper care, your electric heater should last a lifetime, however, seasonal cleaning is recommended to maintain the efficiency of the heater.

WARNING

ALL POWER MUST BE SHUT OFF AT THE MAIN SERVICE BEFORE INSPECTING OR CLEANING THE HEATER.

Cleaning The Heating Element

To clean the heating element, loosen, but do not remove, the 4 Phillips-head screws located behind the louvers in the corners of the louver housing. Grasp the louver housing on both sides, lift up, and pull out. This provides access to the heating element. Remove dust or lint with a soft brush or a vacuum cleaner. Replace the louver housing, and tighten the Phillips-head screws.



Heating Element Bezel Assembly & Louver Housing

Cleaning the Fan And Motor

Remove the safety grill from the rear of the heater. This provides access to the fan and motor. Wipe off the fan and motor with a soft cloth or brush. The fan motor does not require lubrication.

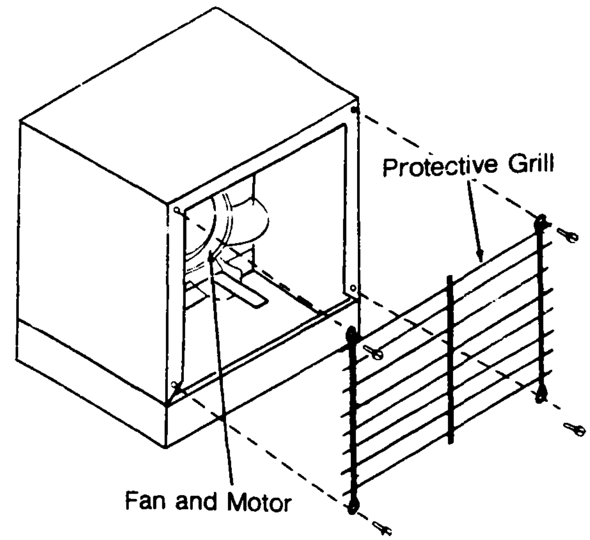
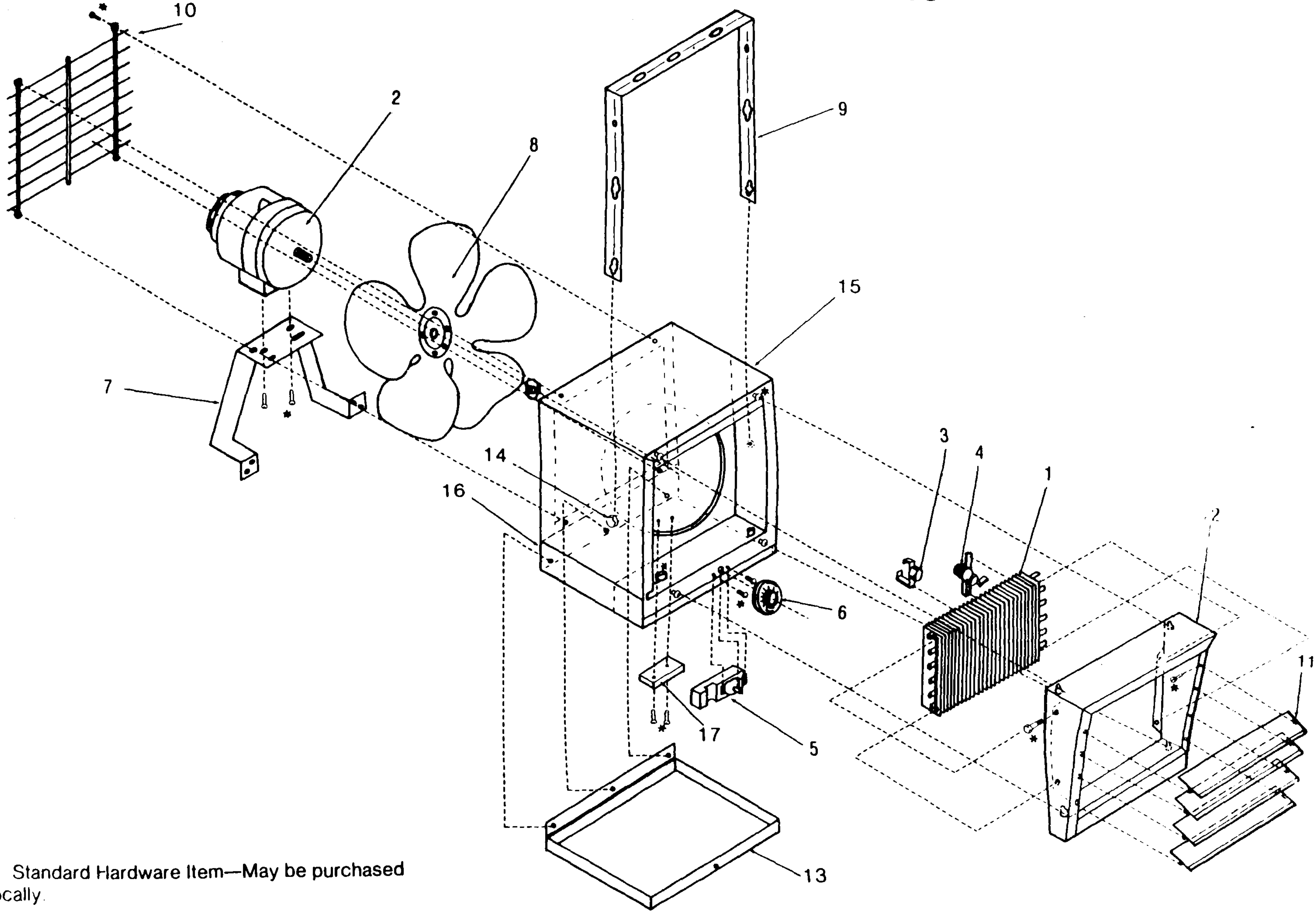


TABLE 2. REPLACEMENT PARTS
MODEL NO. HUH-524TA Electric Heater

Key NO.	Part NO.	Description
1	302006807	Element
2	3900-2002-002	Motor
3	410148000	Fan Control Assembly
4	410027000	High Temperature Limit Control
5	410129003	Thermostat
6	482080001	Thermostat Knob
7	310914001	Motor Mount
8	1210-2000-000	Fan Blade
9	310876001	Ceiling Bracket (Handle)
10	312056801	Wire Guard
11	310085001	Louver
12	200162901	Bezel Assembly
13	310104901	Cover (Access Door)
14	400029808	Bracket Screw
15	200193901	Cover Wrap Assembly
16	200161901	Control Box Assembly
17	480095000	Power Terminal Block
18	392346003	Owner's Manual

MODEL HUH-524TA REPLACEMENT PARTS



* Standard Hardware Item—May be purchased locally.

LIMITED WARRANTY

All products covered by this instruction sheet are warranted against defects in workmanship and materials for one year from date of installation, except heating elements which are warranted against defects in workmanship and materials for five years from date of installation. This warranty does not apply to damage from accident, misuse, or alteration; nor where the connected voltage is more than 5% above the nameplate voltage; nor to equipment improperly installed or wired or maintained in violation of this instruction sheet. All claims for warranty work must be accompanied by proof of the date of installation.

The customer shall be responsible for all costs incurred in the removal or reinstallation of products, including labor costs, and shipping costs incurred to return products to a Marley Electric Heating Service Center. Within the limitations of this warranty, inoperative units should be returned to the nearest Marley authorized service center, or the Marley Electric Heating Service Center, and we will repair or replace, at our option, at no charge to you with return freight paid by Marley. It is agreed that such repair or replacement is the exclusive remedy available from Marley Electric Heating.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH EXCEED THE AFORESAID EXPRESSED WARRANTIES ARE HEREBY DISCLAIMED AND EXCLUDED FROM THIS AGREEMENT. MARLEY ELECTRIC HEATING SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES ARISING WITH RESPECT TO THE PRODUCT, WHETHER BASED UPON NEGLIGENCE, TORT, STRICT LIABILITY OR CONTRACT.

Some states do not allow the exclusion or limitation of incidental or consequential damges, so the above exclusion or limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

For the address of your nearest authorized service center contact Marley Electric Heating, Route 3, Box 24, Bennettsville, South Carolina 29512. (803/479-9063). Merchandise returned to the factory **must** be accompanied by a return authorization and service identification tag, both available from the above location. When requesting return authorization, include all catalog numbers shown on the product.

HOW TO ORDER REPAIR PARTS

When ordering repair parts, always give the following information as shown in this list:

1. The Part Number
2. The Model Number
3. The Part Description

All parts listed herein may be ordered from:

Marley Electric Heating Company
Rt. 3, Box 24
Bennettsville, SC 29512

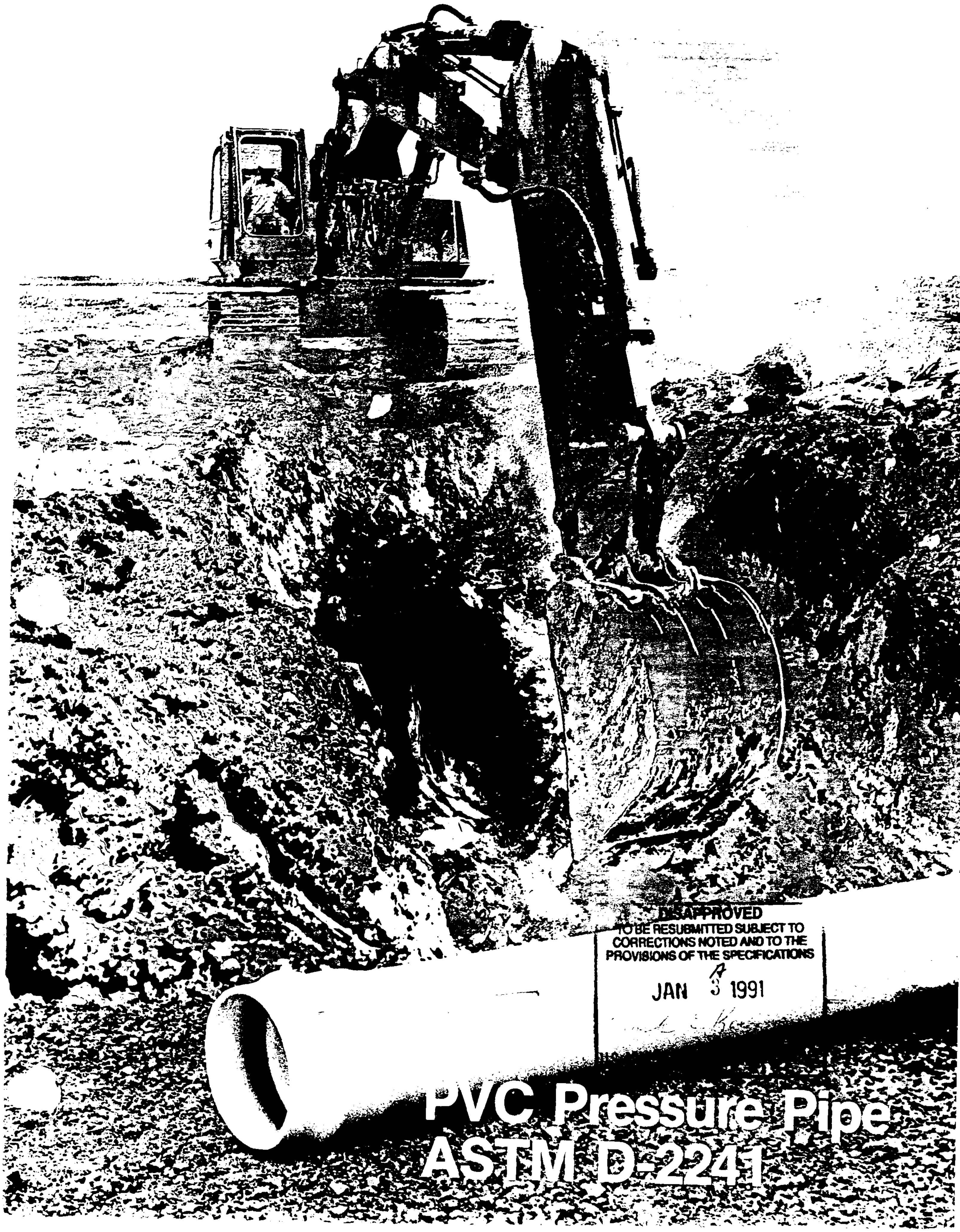
Need technical or warranty assistance?
Please call toll-free 1-800-642-HEAT;
within South Carolina call 1-479-9063.

Marley Electric Heating Co.
Rt. 3, Bennettsville, SC 29512

ECR 30133
4/89

392346003

NORTHSTAR



PVC Pressure Pipe ASTM D-2241

DISAPPROVED
TO BE RESUBMITTED SUBJECT TO
CORRECTIONS NOTED AND TO THE
PROVISIONS OF THE SPECIFICATIONS

JAN 3 1991

North Star PVC Pressure Pipe ASTM D-2241

Pressure Rated 160 — SDR 26
Pressure Rated 200 — SDR 21
NSF Approved

PIPE DESCRIPTION

This specification covers polyvinyl chloride (PVC) pressure pipe and fittings manufactured in accordance with ASTM standard D-2241 for conveyance of water under pressure. The pipe shall be made by continuous extrusion of prime white unplasticized PVC plastic and identified by the North Star trademark as well as other markings prescribed by the ASTM standard.

MATERIAL

The pipe shall be made of PVC plastic having a cell classification of 12454-B as prescribed in ASTM D-1784. Pipe shall have inherent resistance to corrosive substances found in aggressive soils. It shall have a smooth internal surface for minimum flow resistance. When properly bedded and backfilled it shall withstand normally encountered loads without rupture or leaking at the joints. In normal atmospheres, the pipe shall have a self-extinguishing flammability characteristic.

FITTINGS

All fittings shall be of the same material as the pipe and shall be consistent therewith in strength, dimension and utility. Adapters shall be provided for transitions to other products.

Gasketed fittings will be supplied unless otherwide specified. Solvent cement fittings will be the alternate to gasketed fittings.

DIMENSIONS

Dimensions of pipe and fittings up to 8" (203.2 mm) in diameter shall conform to ASTM D-2241 for Polyvinyl Chloride (PVC) pipe and fittings. Nominal laying lengths shall be 20 feet (6.10 meters). Joint and fitting dimensions shall be to the manufacturer's specifications.

PIPE TESTING

Pipe shall meet the tests described in ASTM D-2241:

Sustained Pressure test of 1000 hours duration shall not cause the pipe to lose pressure, balloon, burst or seep. Test pressures:
SDR21-420 psi (2.90 MPa)
SDR26-340 psi (2.34 MPa)

Burst Pressure — Minimum pressure required to burst a section of pipe in 60 to 70 seconds shall equal or exceed:
SDR21-630 psi (4.34 MPa)
SDR26-500 psi (3.45 MPa)

Flattening — Flatten a 2 inch long pipe specimen between parallel plates till the distance between the plates is 40% of the pipe O.D.

Extrusion Quality — This is determined by reaction to immersion in anhydrous acetone. Pipe should not flake or disintegrate when immersed.

JOINTS

Pipe joints are to be made either by the use of solvent cement or an integral bell with elastomeric gasket. In either case, each full length of pipe shall have one belled end of appropriate size and internal contour, to effect a watertight joint when assembled with a mating spigot, and sealed in accordance with the manufacturer's instructions.

Finished joints shall pass the performance tests found in ASTM D-3139. The joint shall not leak when hydrostatic internal pressure is applied at 2½ times the rated pressure for 1 hour, or when the pipe is subjected to an internal vacuum of 22 inches Hg (74.5 KPa) for 1 hour. In addition, the joint shall not leak when the pipe is axially deflected to the limit the joint design tolerances will allow, without stress at the internal pressure and vacuums listed above. Write for North Star's pocket size illustrated PVC pipe installation manual.

GASKETED JOINTS

Jointing procedure:

1. With a dry cloth, clean the mating surfaces of both bell and spigot ends to be joined. Absolute cleanliness is important in making a satisfactory joint. Make sure the gasket is clean and the correct size. Insert it into the preformed groove. Check that it is properly seated by running the hand around the perimeter of the gasket.
2. Cover the surface of the spigot 1" beyond its joint depth with *vegetable soap lubricant*. Be sure to lubricate the beveled edge of the spigot. *DO NOT* lubricate the inside of the bell.
3. Push the spigot end into the bell until you feel the resistance of the gasket.
4. With pipe sections in straight alignment, push the spigot into the bell by applying force to the far (bell) end of the pipe length or fitting being added to the line. If a pry bar is used to apply force, the pipe and bell must be protected by a short two-by-six board placed across the pipe end. If normal force is insufficient to complete the joint, disassemble the joint and examine the parts to make sure they are clean and free of obstructions. Do not disturb the previously joined sections of pipe.

INSTALLATION

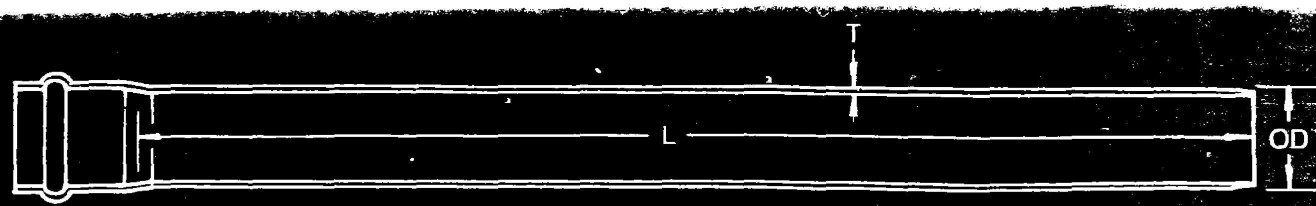
"Standard Specification for Underground Installation of Thermoplastic Pressure Piping." ASTM D-2774 is the guide for proper installation of the pipe.

PIPE STORAGE

Pipe shall be stored on a flat surface that will evenly support its entire length. For long storage periods, alternate the direction of the bell in each row to minimize the load on the bells. Storage in the field should be on level ground and not exceed three layers high. Pipe should be covered when stored for long periods in the sun because ultraviolet radiation may lead to degradation of PVC materials. Extra care should be exercised in the handling of pipe in cold weather.

GASKET STORAGE

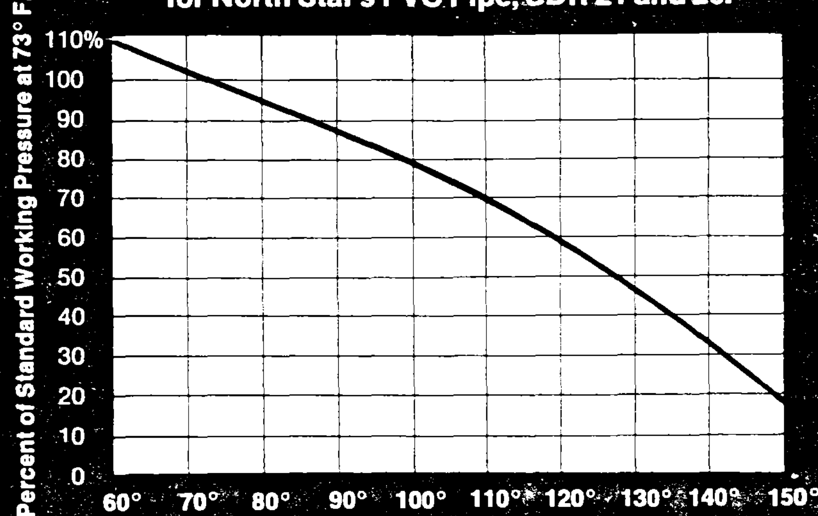
Gaskets shall be stored in a clean, stable environment. Avoid exposing gaskets to extremes in temperature, pressure, fluids, or sunlight. Do not expose gaskets to any ozone generating sources such as electric welders or motors. Ozone will cause rapid deterioration of the rubber.



NOMINAL SIZE	S D R	OD OUTSIDE DIAMETER	(P.S.I.) RATED PRESSURE	T MINIMUM WALL THICKNESS	L LAYING LENGTH	WEIGHT-POUNDS PER FOOT
4″	26	4.500″	160	0.173″	20.0′	1.47
6″	26	6.625″	160	0.255″	20.0′	3.22
8″	26	8.625″	160	0.332″	20.0′	5.465
10″	26	10.750″	160	0.413″	20.0′	8.80
12″	26	12.750″	160	0.490″	20.0′	12.39
4″	21	4.500″	200	0.214″	20.0′	1.81
6″	21	6.625″	200	0.316″	20.0′	3.94
8″	21	8.625″	200	0.410″	20.0′	6.679
10″	21	10.750″	200	0.511″	20.0′	10.78
12″	21	12.750″	200	0.606″	20.0′	15.16

EXAMPLE: To find the safe operating pressure at 110° F for PVC, look on the chart at 110° and go up to the PVC line. This intersects at 60%. Then take the 73° F rating and multiply it by .60 to get the reduced rating at 110°. For PR-160, the new rating would be 96 psi.

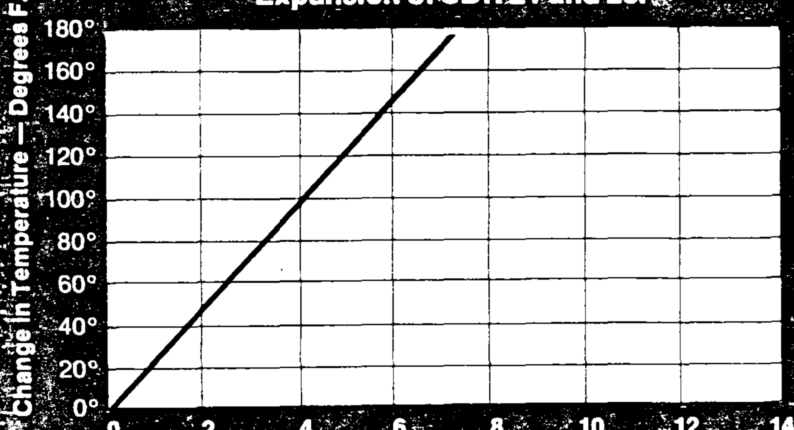
Effect of Temperature on Working Pressure, for North Star's PVC Pipe, SDR 21 and 26.



Temperature of Pipe

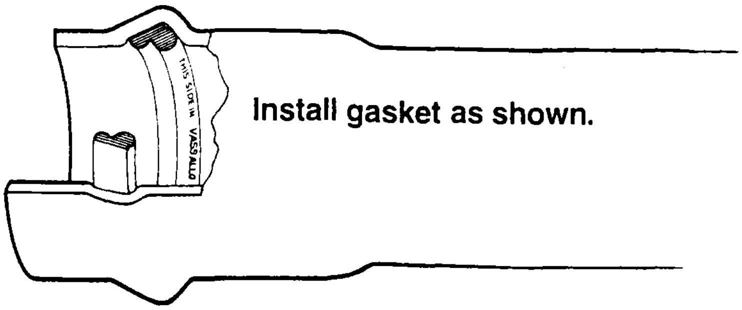
Percent Decrease in Working Pressure with Increase in Temperature

Thermal Contraction
Expansion of SDR 21 and 26.



Change in Length — inches per 100′ of run.

Note — Expansion or Contraction not a function of pipe diameter.



GASKET INSTALLATION

Proper gasket installation is important. Be sure the gasket is installed with the narrow, beveled edge out and lettering on gasket facing in. Do not lubricate gasket or bell area. Apply vegetable soap lubricant to the spigot end of pipe 1" beyond its joint depth.

PRODUCT WARRANTY

North Star warranties its PVC Pressure Pipe to be free from defects in materials and workmanship from the day delivered to the first purchaser until one year from that day. North Star makes no warranty as to the suitability of the product for any specific use or purpose. North Star liability is limited to our option of repair or replacement of the product and shall exclude any damage caused by accident, or improper handling or use of the product. North Star in no way shall be liable for incidental or consequential damages. The above warranty is the only warranty North Star gives, no other warranties are expressed or implied and no employees or agent of North Star shall make any additional warranty that is binding on North Star.

NORTH STAR GROUP

Approaching 100 years in business—

Winnebago Drainage Systems, Inc.
Winnebago, Minnesota 56098
Phone 507-893-3121

DISTRIBUTED BY:

SEE ATTACHED COMMENTS

Designation: D 2774 – 72 (Reapproved 1983)

Standard Recommended Practice for Underground Installation of Thermoplastic Pressure Piping[1]

This standard is issued under the fixed designation D 2774; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specification and Standards.

INTRODUCTION

In general, thermoplastic pressure pipe can support earth loads without sustaining excessive stress by mobilizing lateral passive soil forces and internal pressure forces. Thermoplastics have the ability to be deformed without a proportionate increase in stress allowing internal forces to oppose external forces. Proper installation technique ensures that the necessary passive soil pressures at the sides of the pipe will be developed and maintained.

Soils in which trenches are dug should be examined and identified and the trenches prepared and backfilled in accordance with sound bedding practices and this recommendation.

1. Scope

1.1 This recommended practice covers procedures and references ASTM specifications for underground installation of thermoplastic pressure piping, 6 in. nominal size and smaller. It is beyond the scope of this document to describe these procedures in detail since it is recognized that significant differences exist in their implementation depending on kind and type of pipe material, pipe size and wall thickness, soil conditions, and the specific end use. Specific pipe characteristics and end use requirements may dictate modification of the procedures stated or referenced herein.

NOTE—The values stated in U.S. customary units are to be regarded as the standard.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 6.

2. Referenced Documents

2.1 *ASTM Standards:*

2.1.1 *Pipe and Tubing:*

D 1503 Specification for Cellulose Acetate Butyrate (CAB) Plastic Pipe, Schedule 40[2]

D 1527 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80[3]

D 1785 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120[3]

D 2104 Specification for Polyethylene (PE) Plastic Pipe, Schedule 40[3]

D 2239 Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter[3]

D 2241 Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR) Series[3]

D 2282 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)[3]

D 2446 Specification for Cellulose Acetate Butyrate (CAB) Plastic Pipe (SDR-PR) and Tubing[3]

D 2447 Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80 Based on Outside Diameter[2]

D 2662 Specification for Polybutylene (PB) Plastic Pipe (SDR-PR)[3]

D 2666 Specification for Polybutylene (PB) Plastic Tubing[3]

D 2672 Specification for Joints for IPS PVC Pipe Using Solvent Cement[3]

D 2737 Specification for Polyethylene (PE) Plastic Tubing[3]

D 2740 Specification for Poly(Vinyl Chloride) (PVC) Plastic Tubing[3]

2.1.2 *Joining Materials:*

D 2235 Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings[2]

D 2464 Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80[3]

D 2465 Specification for Threaded Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 80[2]

D 2466 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40[3]

D 2467 Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80[3]

D 2468 Specification for Acrylonitrile-Butadiene Styrene (ABS) Plastic Pipe Fittings, Schedule 40[3]

D 2469 Specification for Socket-Type ...

[1] This recommended practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee ...

D 2560 Specification for Solvent Cements for Cellulose Acetate Butyrate (CAB) Plastic Pipe, Tubing, and Fittings[3]

D 2564 Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings[3]

D 2610 Specification for Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 40[4]

D 2611 Specification for Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 80[4]

D 2657 Practice for Heat-Joining Polyolefin Pipe and Fittings[2]

D 2683 Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing[3]

2.1.3 *End Use Specification:*

D 2513 Specification for Thermoplastic Gas Pressure Piping Systems[3]

2.1.4 *Miscellaneous:*

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure[3]

D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings[3]

D 2122 Method of Determining Dimensions of Thermoplastic Pipe and Fittings[3]

D 2152 Test Method for Degree of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion[3]

D 2444 Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)[3]

3. Joining

3.1 Plastic pipe may be joined together or to other pipes of dissimilar material using a number of different techniques. The technique used must be suitable for the particular pipes being joined to one another. Manufacturers should be consulted for specific instructions not covered by existing specifications. When requesting information, the intended service application should be made known.

3.2 Skill and knowledge on the part of the operator are required using recommended techniques to obtain quality joints. Training of new operators should be made under the guidance of skilled operators.

3.3 Joining specifications are listed under 2.1.2 of this recommended practice.

4. Trenching

4.1 *Trench Contour*—The trench bottom should be continuous, relatively smooth, and free of rocks. Where ledge rock, hardpan or boulders are encountered, it is advisable to pad the trench bottom using sand or compacted fine grained soils.

4.2 *Trench Width*—The width of the trench at any point below the top of the pipe should be sufficient to provide adequate room for: (*1*) joining the pipe in the ditch, if this is required; (*2*) snaking a pipe from side-to-side along the bottom of the ditch, if recommended by the pipe manufacturers; and (*3*) filling and compacting the side fills. Minimum trench widths may be utilized with most pressure pipe materials by joining the pipe outside the trench and lowering into the trench after adequate joint strength has been obtained.

4.3 *Trench Depth and Pipe Cover*—Soil conditions, pipe size and necessary cover determine trench depth. Sufficient cover must be maintained to keep external stress levels below acceptable design stresses.[5] Reliability and safety of service may assume major importance in determining minimum cover for any intended service. Local, state or national codes may also govern. Pipe intended for potable water service should be buried at least 305 mm (12 in.) below maximum expected frost penetration. A minimum cover of 609 mm (24 in.) is considered desirable for pipe subject to heavy overhead traffic. In areas of light overhead traffic a cover of 305 to 457 mm (12 to 18 in.) is usually considered sufficient.

5. General Requirements for Bedding and Backfill

5.1 The pipe should be uniformly and continuously supported over its entire length on firm stable material. Blocking should not be used to change pipe grade or to intermittently support pipe across excavated sections.

5.2 Pipe is installed in a wide range of subsoils. These soils should be not only stable but also applied in such a manner as to physically shield the pipe from damage. Attention should be given to local pipe laying experience which may indicate solutions to particular pipe bedding problems.

5.3 Backfill materials according to the requirements of "Soil Types" (see Appendix X1) with a particle size of 12.7 mm (½ in.) or less should be used to surround the pipe. It should be placed in layers. Each soil layer should be sufficiently compacted to uniformly develop lateral passive soil forces during the backfill operation. It may be advisable to have the pipe under pressure.

5.4 Effects of ground freezing should be considered when pipe is installed at depths subject to frost penetration.

5.5 Vibratory methods are preferred when compacting sand or gravels. Best results are obtained when the soils are in a nearly saturated condition. Where water flooding is used, the initial backfill should be sufficient to ensure complete coverage of the pipe. Additional material should not be added until the water flooded backfill is firm enough to walk on. Care should be taken to avoid floating the pipe.

5.6 Sand and gravel containing a significant proportion of fine-grained material, such as silt and clay, should be compacted by hand or, preferably, by mechanical tamper.

5.7 The remainder of the backfill should be placed and spread in approximately uniform layers in such a manner as to fill the trench completely so that there will be no unfilled spaces under or about rocks or lumps of earth in the backfill. Large rocks, frozen clods and other debris greater than 76 mm (3 in.) in diameter should be removed. Rolling equipment or heavy tampers should only be used to consolidate the final backfill.

[4] Discontinued, see *1977 Annual Book of ASTM Standards*, Part 34.

[5] Spangler, M. G., "Secondary Stresses in Buried Pressure Lines," The Iowa State College Bulletin, Engineering Report 23 of the Iowa Engineering Experiment Station, 1954 to 1955.

6. Installation Precautions

6.1 Plastic pipe should be stored so as to prevent damage / crushing or piercing. If stored at any length of time, it should be under cover and not in direct sunlight in accordance with the manufacturer's recommendations.

6.2 Care should be taken to protect the pipe from excessive heat or harmful chemicals. Cleaning solutions, detergents, solvents, etc., should be used with caution.

6.3 Pipe may be bent to a minimum radius recommended by the manufacturer for the kind, type, grade, wall thickness, and diameter of a specified pipe. Otherwise changes in direction should be made using suitable fittings.

6.4 Pipe joined using solvent cementing techniques should not be handled or installed in the ditch until after the joints are sufficiently "cured" to prevent weakening the joint.

6.5 During pipe lowering in operations, care should be taken to avoid imposing strains that will overstress or buckle the piping or impose excessive stress on the joints.

6.6 When ditched pipe has been assembled on top of the ditch, it is advisable to cool the pipe to ground temperature before backfilling to prevent pull out due to thermal contraction.

6.7 Suitable anchoring methods should be used to prevent excessive longitudinal or bending movement of the piping.

APPENDIXES

(Nonmandatory Information)

X1. SOIL TYPES

X1.1 A soil is considered stable if it provides dependable support to the pipe and undergoes only slight volume change with variation in its moisture content. The ability of a soil to provide support depends upon its resistance to consolidation and its shear strength. In general, coarse grained soils are considered stable; in the United Soil Classification these are defined as soils of which 50 percent or less pass U.S. Standard No. 200 sieve.

NOTE X1—The particle passing through No. 200 sieve is about the smallest size visible to the naked eye.

X1.2 Using the group symbols of the Unified Soil Classification (Appendix X3) the following are considered stable backfill: Gw, GP, GM, GC, SW Sp, provided that maximum particle size is not greater than 12.7 mm (½ in.).

X1.3 In terms of all over-all use, gravel with fines and sand are the best backfill materials for pressure pipe. Sand or gravel mixed with silts or clays, in which the sand or gravel constitute at least 50 percent of the mixture, are also suitable. Certain soils should not be used as backfill material; these include organic soils, identified by odor or spongy feel, and fat, highly plastic expansive clay. Frozen soil should not be placed in contact with the pipe.

X2. FIELD IDENTIFICATION OF SOILS

X2.1 *Gravel*—Minimum grain size 6.4 mm (¼ in.).

X2.2 *Sand*—Individual grains visible to the naked eye with maximum particle size about 6.4 mm (0.25 in.). Fine sands display dilatancy and are nonplastic.

NOTE X2—To test for dilatancy, place a pat of moist soil on the palm of the hand. If the soil displays dilatancy, water will appear at the surface of the pat on shaking and disappear when the pat is compressed by the fingers.

X2.3 *Silt*—Individual grains difficult to see with the naked eye. May be slightly plastic. Displays dilatancy. Easily washed from fingers. Low dry-strength.

X2.4 *Lean Clay*—Individual grains difficult to see with the naked eye. Dry lumps have moderate to high strength. Can be rolled into a 3.2-mm (⅛-in.) thread having low to moderate strength. Does not display dilatancy.

X2.5 *Fat Clay*—Shows no or very slow dilatancy and should not be used unless mixed with coarse grained material. Has high dry-strength. Has soapy feel and shiny streak results if fingernail is run over damp surface. Can be rolled into 3.2-mm (⅛-in.) threads having relatively high strength.

X3. UNIFIED SOIL CLASSIFICATION—GROUP SYMBOLS

GW—Well-graded gravels, gravel-sand mixtures, little or no fines.

GP—Poorly graded gravels, gravel-sand mixtures, little or no fines

GM—Silty gravels, poorly graded gravel-sand-silt mixtures.

GC—Clayey gravels, poorly graded gravel-sand-clay mixtures.

SW—Well-graded sands, gravelly sands, little or no fines.

SP—Poorly graded sands, gravelly sands, little or no fines.

SM—Silty sands, poorly graded sand-silt mixtures.

DESIGN PRESSURE RATING

The pressure rating of POLY PIPE is determined by the grade of polyethylene being used (PE 3408), and the wall thickness of the pipe. All calculations are based on using water at 73.4° F, and are determined by using standard formulas for the industry.

$$P = \frac{2S}{SDR-1}$$

Where:

S – Hydrostatic Design Stress, psi
P – Pressure Rating, psi

$$SDR = \frac{O.D.}{t}$$

Where:

O.D. – Outside Diameter, Inches
t – Minimum Wall Thickness, Inches

Hydrostatic Design Stress – Hydrostatic Design Basis (HDB) of POLY PIPE with a 2 to 1 safety factor calculated.

$$S = \frac{HDB}{2}$$

Therefore, the S of POLY PIPE PE 3408 (1600 HDB) is 800 psi.

Internal Pressure Ratings (psi) for PE3408 POLY PIPE at Various Temperatures and 50 year Service Life for Water

TEMP. (°F)	STANDARD DIMENSIONAL RATIO (SDR)								
	7.3	9	11	13.5	15.5	17	21	26	32.5
50	262	210	168	131	116	105	94	63	52
73.4	250	200	160	125	110	100	80	60	50
100	200	162	128	105	90	81	62	52	38
125	171	133	109	86	72	67	52	43	33
150	119	95	76	57	52	48	38	29	24

An additional environmental SERVICE FACTOR should be utilized to compensate for the effect of substances other than water, and for temperature. These factors, in chart at right, should be utilized in pressure calculations for the appropriate substance.

Substance	Environmental Service Factor
Crude Oil	.50
Wet Natural Gas	.50
Federally Regulated Dry Natural Gas	.64

LIQUID FLOW:

For liquid flow, POLY PIPE recommends the Hazen-Williams equation. The constant for the inside pipe roughness has been determined to have a factor of 150. Thus, the equation for liquid flow would be:

$$f = 0.0976 \frac{q^{1.852}}{d^{4.8655}} \quad \text{where:}$$

f - friction head in feet of water per 100 feet of pipe
q - flow in U.S. Gallons per minute
d - Inside diameter of pipe in inches

For conversion to pounds per square inch (PSI) from head in feet of water, note that: $f = 2.31\,p$ or $p = 0.4335\,f$ where p is in PSI.

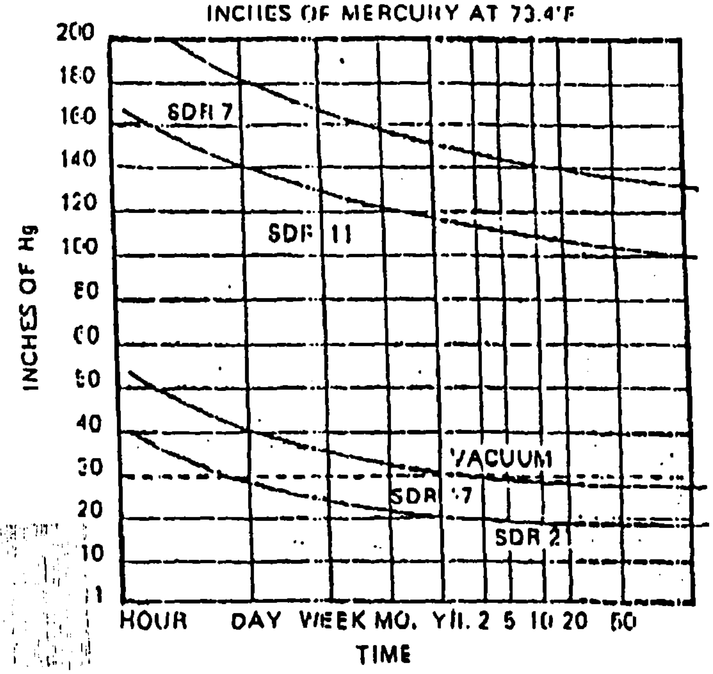
Water velocities in feet per second (v) may be calculated as follows:

$$v = \frac{0.408709q}{d^2}$$

VACUUM LOADING:

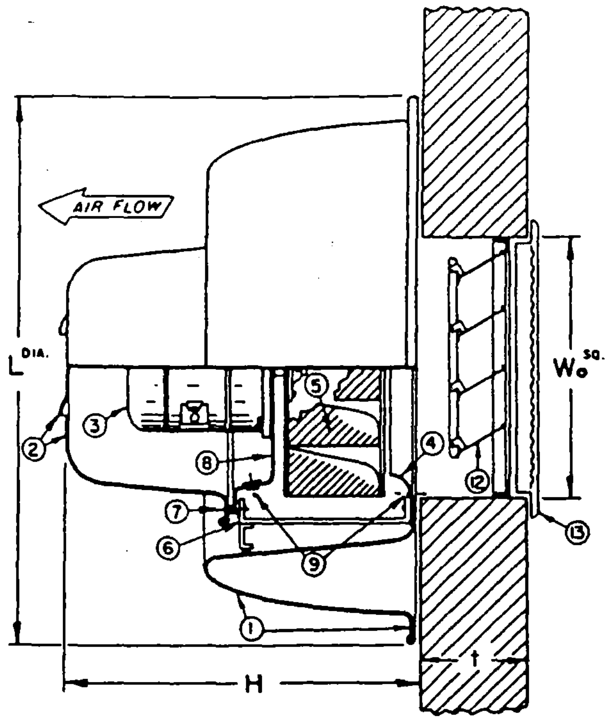
POLY PIPE is capable of withstanding internal vacuum in both above ground and buried applications. Proper primary backfill, compacted as evenly and densely as possible, greatly enhances the ability of POLY PIPE to withstand additional pressure from external loading. The Vacuum Loading Chart may be used to select the proper SDR pipe for the anticipated application. Values given are for water at 73.4°F., and may be effected by higher temperature and the material being transported in the pipe. The greater the wall thickness (the smaller the SDR), the greater the ability of the pipe to withstand vacuum loading.

VACUUM LOADING
INCHES OF MERCURY AT 73.4°F

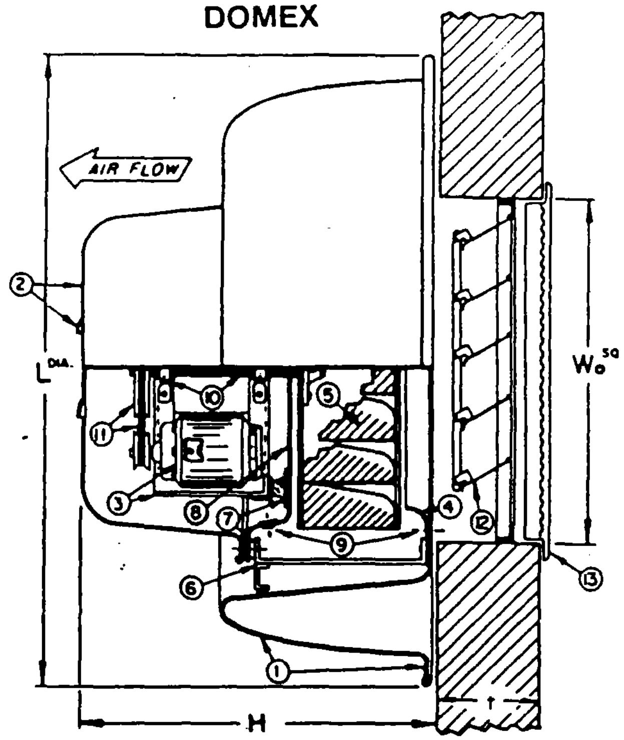


PENN VENTILATOR

DIRECT DRIVE
DOMEX



BELT DRIVE
DOMEX



LEGEND

1. MOUNTING FLANGE & DISCHARGE APRON
2. MOTOR DOME WITH AIR VENT LOUVERS
3. ELECTRIC FAN MOTOR
4. SPUN INLET VENTURI
5. CENTRIFUGAL FAN WHEEL
6. MAIN FASTENING ASSEMBLY
7. ANTI-VIBRATION MOUNTS
8. MOTOR SUPPORT PLATE
9. CONDUIT HOLE
10. FAN SHAFT & BEARINGS (BELT DRIVE ONLY)
11. V-BELT & PULLEYS (BELT DRIVE ONLY)
12. BACKDRAFT DAMPER † (OPTIONAL)
13. WALL GRILLE (OPTIONAL)

DIMENSIONAL TABLE

MODEL	DIRECT DRIVE				V-BELT	
	WX	WA	WB	WC	WCB	WLB
Wo SQ.	9	13	16½	20	20	25
H	10¾ •	17¾	20¼	24½	24½	28½
L DIA.	23¼	32½	38	46½	46½	57

ALL DIMENSIONS IN INCHES.

• 12" ON ALL WXQ & WXT MODELS

† MIN. 5" FOR SELF-ACTING DAMPER

NOTE: Space limitations require that explosion proof disconnect switches be mounted externally when used with Wall Domex units WX and WA.

MATERIAL: SPUN ALUMINUM HOUSING

PENN VENTILATOR CO., INC.
RED LION AND GANTRY ROADS
PHILADELPHIA, PA 19115
(AREA CODE 215) 464-8900
TELEX NO. 83-4545 FAX NO. (215) 677-1647

SUBMITTAL SHEET

DOMEX (Direct and V-Belt)

Spun Aluminum Centrifugal Wall Exhausters

FORM ES-WDX
REV.1 2/89

PIPING/PVF MIDWEST, INC.

PVF MIDWEST INC.
Industrial Pipe, Valves and Fittings

September 9, 1992

Horwitz, Inc.
5000 North Highway 169
Minneapolis, Minnesota 55428

Attention: Mr. Larry Swanson

Reference: GES Main Building and Pumphouse Piping O&M Manual

Dear Larry,

We submit for your approval and/or comment the following Pipe, Valves and Fittings.

Galvanized S/40 Steel Pipe	ASTM A53 CW
Galvanized M.I. Fittings	WWP 521
Galvanized Flanges	WWP 406
Full Port Ball Valves	Watts B-6080
Roller Hangers MSS	MSS SP 69 Type 43
Protection Saddles	WW-H-171 Type 40A-40B, MSS SP-69
Roller Chair	MSS SP-69
Gate Valves	AWWA C-509
Sample Tap	Conbraco 41 Series
Back Flow Preventer 575RP	AWWA C-506
Butterfly Valves	MSS-SP-67

If you have any further questions please contact me.

Sincerely,

PVF Midwest, Inc.

Rodd Johnson

Rodd Johnson

RJ/mln

1618 New Brighton Blvd. • Minneapolis, MN 55413 • (612) 781-4342

PVF MIDWEST INC.
Industrial Pipe, Valves and Fittings

November 19, 1990

Horwitz Inc.
5000 N. Hwy 169
Minneapolis, MN 55425

Re: Our Sales Order 2623
    Your Purchase Order 450291 FMC Job 2397-45

Gentlemen:

We hereby certify to the best of our knowledge that the material furnished on the above numbered order conforms to the following specifications.

A.S.T.M. A-53 Type F

PVF Midwest, Inc.

EW Jones

E.W. Jones

EWJ/pal

2688   3 Std A53 C.W. Galvanized Pipe T&C

1618 New Brighton Blvd. • Minneapolis, MN 55413 • (612) 781-4342

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

Standard Malleable Pipe Fittings — Class 150

"WARD" Malleable Iron Fittings are First Quality Pipe Fittings.

The iron from which they are made is held to strict formula, by careful chemical analysis and control.

Tapping is done on the most modern type of threading machines. All tappings are to American National Standards for iron pipe threads.

Straightness and correct depth of threads are assured through continuous careful inspection, by carefully trained inspectors.

Every fitting is hand sorted and inspected to eliminate defective castings.

"WARD" Fittings are made strictly to specifications as published by the American National Standards Committee for pipe fittings. They also conform to the United States Federal Specifications.

A chamfer is cut or cast in all openings permitting easy entrance of pipe and preventing damage to the first thread in handling and shipping. All regular patterns are flat banded.

Because of the close attention paid to formula control together with the careful selection of raw materials, we are able to produce a close grained non-porous Malleable Iron of High Tensile strength, providing a very liberal factor of safety over the recommended working pressures.

All Ward Black Malleable fittings in sizes ranging from 1/2" through 4" are air tested at 100 p.s.i. pressure. This test is part of a constant program to maintain the highest quality fittings available.

Pressure-Temp. Rating

Temp. °F	P.S.I.G.
-20 to 150	300
200	265
250	225
300	185
350	150

Specifications:

* Fed. Spec. WWP 521
ANSI B 16.3 — FOR DIMENSION & PRESSURE RATING
A.S.T.M. — A 197 — FOR MATERIAL
A.S.T.M. — (ANSI) — A 153, B 633 — FOR GALVANIZING
ANSI B. 1.20.1 FOR PIPE THREADS
150 LB. — STEAM PRESSURE
150 LB. MALLEABLE PIPE FITTINGS ARE U.L. LISTED WHERE APPLICABLE

GENERAL DIMENSIONS, in inches to nearest 1/32".
These dimensions apply to all standard malleable banded fittings, both straight and reducing.
Length of thread also applies to plain fittings. For center-to-face dimensions, see fittings tables.

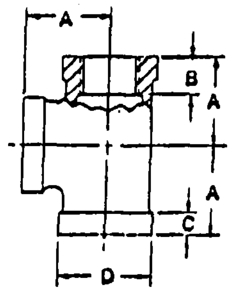
PIPE SIZE	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4
O.D. of Band	11/16	27/32	1	1 3/16	1 15/32	1 25/32	2 5/32	2 7/16	2 31/32	3 19/32	4 9/32	4 27/32	5 13/32
Vidth of Band	3/16	7/32	7/32	1/4	9/32	5/16	11/32	3/8	7/16	15/32	9/16	19/32	21/32
Thread Length (min.)	1/4	5/16	3/8	7/16	1/2	19/32	21/32	11/16	3/4	29/32	31/32	1 1/32	1 3/32

Section 1

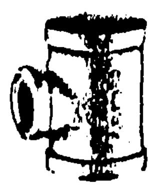
TEE MALLEABLE IRON FIG. 52

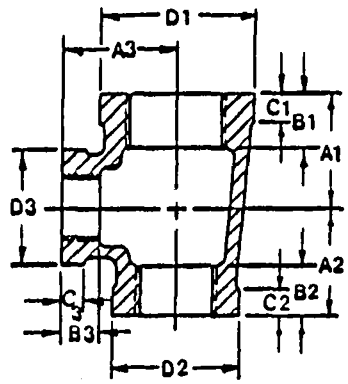
PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

PIPE SIZE	A	B	C	D
⅛	.690	.280	.220	.720
¼	.810	.360	.235	.875
⅜	.950	.400	.250	1.046
½	1.120	.470	.269	1.230
¾	1.310	.540	.298	1.490
1	1.500	.620	.327	1.805
1¼	1.750	.710	.370	2.187
1½	1.940	.740	.393	2.465
2	2.250	.790	.447	3.000
2½	2.700	.960	.508	3.630
3	3.080	1.020	.578	4.300
4	3.790	1.130	.691	5.450



REDUCING TEE MALLEABLE IRON FIG. 52



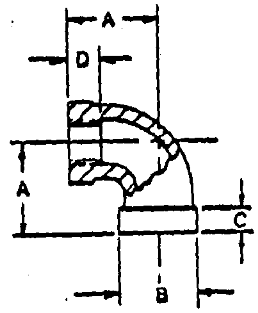


PIPE SIZE	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3
½ x ½ x ⅜	1.040	1.040	1.030	.430	.430	.360	.249	.249	.230	1.197	1.197	1.015
½ x ½ x ¼	.970	.970	.980	.430	.430	.320	.249	.249	.215	1.197	1.197	.844
½ x ⅜ x ½	1.120	1.030	1.120	.430	.360	.430	.249	.230	.249	1.197	1.015	1.197
½ x ⅜ x ⅜	1.040	.950	1.030	.430	.360	.360	.249	.230	.230	1.197	1.015	1.015
⅜ x ⅜ x ½	1.030	1.030	1.040	.360	.360	.430	.230	.230	.249	1.015	1.015	1.197
¾ x ¾ x ½	1.200	1.200	1.220	.500	.500	.430	.273	.273	.249	1.458	1.458	1.197
¾ x ¾ x ⅜	1.120	1.120	1.130	.500	.500	.360	.273	.273	.230	1.458	1.458	1.015
¾ x ½ x ¾	1.310	1.220	1.310	.500	.430	.500	.273	.240	.273	1.458	1.137	1.458
¾ x ½ x ½	1.200	1.120	1.220	.500	.430	.430	.273	.249	.249	1.458	1.197	1.197
¾ x ⅜ x ¾	1.310	1.130	1.130	.500	.360	.500	.273	.230	.273	1.458	1.015	1.458
½ x ½ x ¾	1.220	1.220	1.200	.430	.430	.500	.249	.249	.273	1.197	1.197	1.458
1 x 1 x ¾	1.370	1.370	1.450	.580	.580	.500	.302	.302	.273	1.771	1.771	1.458
1 x 1 x ½	1.260	1.260	1.360	.580	.580	.430	.302	.302	.249	1.771	1.771	1.197
1 x 1 x ⅜	1.180	1.180	1.270	.580	.580	.360	.302	.302	.230	1.771	1.771	1.015
1 x ¾ x 1	1.500	1.450	1.500	.580	.500	.580	.302	.273	.302	1.771	1.458	1.771
1 x ¾ x ¾	1.370	1.310	1.450	.580	.500	.500	.302	.273	.273	1.771	1.458	1.458
1 x ¾ x ½	1.260	1.200	1.360	.580	.500	.430	.302	.273	.249	1.771	1.458	1.197
1 x ½ x 1	1.500	1.360	.1500	.580	.430	.580	.302	.249	.302	1.771	1.197	1.771
1 x ½ x ¾	1.370	1.220	1.450	.580	.430	.500	.302	.249	.273	1.771	1.197	1.458
1 x ½ x ½	1.260	1.120	1.360	.580	.430	.430	.302	.249	.249	1.771	1.197	1.197
1 x ¼ x 1	1.500	1.200	1.500	.580	.320	.580	.302	.215	.302	1.771	.844	1.771
1 x ⅛ x 1	1.500	1.100	1.500	.580	.290	.580	.302	.200	.302	1.771	.693	1.771
¾ x ¾ x 1	1.450	1.450	1.370	.500	.500	.580	.273	.273	.302	1.458	1.458	1.771
1¼ x 1¼ x 1	1.580	1.580	1.670	.670	.670	.580	.341	.341	.302	2.153	2.153	1.771
1¼ x 1¼ x ¾	1.450	1.450	1.620	.670	.670	.500	.341	.341	.273	2.153	2.153	1.458
1¼ x 1¼ x ½	1.340	1.340	1.530	.670	.670	.430	.341	.341	.249	2.153	2.153	1.197
1¼ x 1 x 1¼	1.750	1.670	1.750	.670	.580	.670	.341	.302	.341	2.153	1.771	2.153
1¼ x 1 x 1	1.580	1.500	1.670	.670	.580	.580	.341	.302	.302	2.153	1.771	1.771
1¼ x 1 x ¾	1.450	1.370	1.620	.670	.580	.500	.341	.302	.273	2.153	1.771	1.458

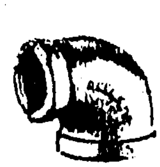
PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

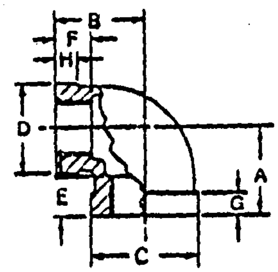
90° ELL MALLEABLE IRON FIG. 47

PIPE SIZE	A	B	C	D
1/8	.690	.720	.220	.280
1/4	.810	.875	.235	.360
3/8	.950	1.046	.250	.400
1/2	1.120	1.230	.269	.470
3/4	1.310	1.490	.298	.540
1	1.500	1.805	.327	.620
1 1/4	1.750	2.187	.370	.710
1 1/2	1.940	2.465	.393	.740
2	2.250	3.000	.447	.790
2 1/2	2.700	3.630	.508	.960
3	3.080	4.300	.578	1.020
3 1/2	3.420	4.880	.634	1.070
4	3.790	5.450	.691	1.130



REDUCING 90° ELL MALLEABLE IRON FIG. 47





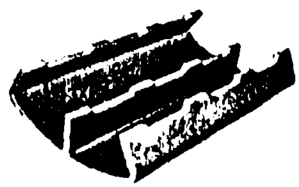
PIPE SIZE	A	B	C	D	E	F	G	H
1/4 x 1/8	.740	.760	.844	.693	.320	.250	.215	.200
3/8 x 1/4	.880	.900	1.015	.844	.360	.320	.230	.215
1/2 x 1/4	.970	.980	1.197	.844	.430	.320	.249	.215
1/2 x 3/8	1.040	1.030	1.197	1.015	.430	.360	.249	.230
3/4 x 3/8	1.120	1.130	1.458	1.015	.500	.360	.273	.230
3/4 x 1/2	1.200	1.220	1.458	1.197	.500	.430	.273	.249
1 x 3/8	1.180	1.270	1.771	1.015	.580	.360	.302	.230
1 x 1/2	1.260	1.360	1.771	1.197	.580	.430	.302	.230
1 x 3/4	1.370	1.450	1.771	1.485	.580	.500	.302	.273
1 1/4 x 1/2	1.340	1.530	2.153	1.197	.670	.430	.341	.249
1 1/4 x 3/4	1.450	1.620	2.153	1.458	.670	.500	.341	.273
1 1/4 x 1	1.580	1.670	2.153	1.771	.670	.588	.341	.302
1 1/2 x 1/2	1.410	1.660	2.427	1.197	.700	.430	.368	.249
1 1/2 x 3/4	1.520	1.750	2.427	1.458	.700	.500	.368	.273
1 1/2 x 1	1.650	1.800	2.427	1.771	.700	.580	.368	.302
1 1/2 x 1 1/4	1.820	1.880	2.427	2.153	.700	.670	.368	.341
2 x 1/2	1.490	1.880	2.963	1.197	.750	.430	.422	.249
2 x 3/4	1.600	1.970	2.963	1.458	.750	.500	.422	.273
2 x 1	1.730	2.020	2.963	1.771	.750	.580	.422	.302
2 x 1 1/4	1.900	2.100	2.963	2.153	.750	.670	.422	.341
2 x 1 1/2	2.020	2.160	2.963	2.427	.750	.700	.422	.368
2 1/2 x 1 1/2	2.160	2.510	3.629	2.467	.960	.740	.518	.408
2 1/2 x 2	2.390	2.600	3.629	3.003	.960	.790	.518	.462
3 x 2	2.520	2.890	4.285	2.963	.980	.750	.548	.422

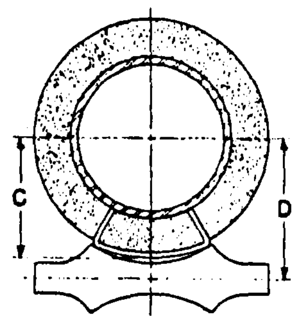
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

pipe covering protection saddle

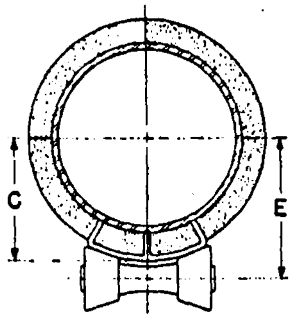
for nominal thickness of covering:

1 inch: fig. 160
1½ inch: fig. 161
2 inch: fig. 162
2½ inch: fig. 163
3 inch: fig. 164
4 inch: fig. 165
4 inch (Alloy): fig. 165A
5½ inch (Alloy): fig. 166A





saddle with roll fig. 173



saddle with roll fig. 273

SIZE RANGE: For use with ¾ to 36 inch pipe.

MATERIAL: Figs. 160, 161, 162, 163, 164 and 165 are curved carbon steel plate. Figs. 165A and 166A are alloy steel manufactured from ASTM A-387 Grade 22 Chrome Molybdenum steel plate. Figs. 165A and 166A have a welded-in center plate in all sizes. All other saddles have a welded-in center plate for pipe sizes 12 inch and larger. All saddles are 12 inches long with side edges turned up.

SERVICE: Designed for high temperature service or where heat losses are to be kept at a minimum and to protect insulation against damage.

APPROVALS: Complies with Federal Specification WW-H-171E (Type 40A or Type 40B) and Manufacturers Standardization Society SP-69 (Type 39A or Type 39B).

FEATURES: Permits finished, weathertight covering at all points of pipe support.

ORDERING: Specify pipe size, figure number, name. Data for 42 inch size available on request.

loads • weights • dimensions (inches)

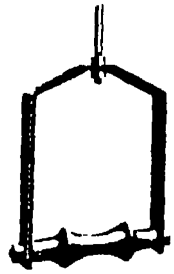
pipe size	fig. no.	max recom load, lbs	wgt (approx) lbs each	actual thickness of covering	size of pipe roll: figs. 171, 175 177	size of pipe roll: figs. 174, 181	size of pipe roll: figs. 271-277	center line of pipe to outside of saddle C	center line of pipe to center line of roll: D figs. 171, 175 177	center line of pipe to center line of roll: D figs. 174, 181	center line of pipe to center line of roll: E
¾	160	1200	1.4	7/8	2	2½	2-3½	1 5/8	2 1/16	2 1/8	2¼
	161	1200	2.1	1 7/16	3	3½	2-3½	2 3/16	2¾	2¾	2 7/8
	162	1200	2.8	1 7/8	4	5	2-3½	2 11/16	3 5/16	3 5/16	3 3/8
1	160	1200	1.4	1 1/16	2½	3	2-3½	1 13/16	2 5/16	2¼	2 7/16
	161	1200	2.1	1 9/16	3	4	2-3½	2 6/16	2 7/8	2 7/8	3
	162	1200	2.8	2 1/8	4	5	2-3½	2 7/8	3½	3½	3½
1¼	160	1200	1.4	7/8	2½	3	2-3½	1 15/16	2½	2 7/16	2 9/16
	161	1200	2.1	1 3/8	3½	5	2-3½	2 9/16	3 1/16	3 1/16	3 3/16
	162	1200	2.8	1 15/16	4	5	2-3½	3	3 5/8	3 5/8	3 11/16
	163	1200	3.6	2 7/16	5	6	4-6	3¾	4 3/8	4 3/8	4 3/8
1½	160	1200	1.5	1	3	3½	2-3½	2 1/8	2 5/8	2 5/8	2 11/16
	161	1200	2.1	1½	3½	5	2-3½	2 5/8	3¼	3¼	3 5/16
	162	1800	3.2	2 5/16	5	6	4-6	3 5/16	4	4	3 7/8
	163	1800	3.6	2 13/16	6	8	4-6	3 7/8	4½	4 5/8	4½
2	160	1200	1.7	1 1/16	3½	4	2-3½	2 3/8	3	2 15/16	3 1/16
	161	1200	2.3	1 9/16	4	5	2-3½	2 7/8	3½	3½	3 9/16
	162	1800	3.2	2 1/8	5	6	4-6	3 9/16	4¼	4¼	4 3/16
	163	1800	3.6	2 5/8	6	8	4-6	4 1/16	4¾	4 13/16	4¾
	164	1800	4.5	3 1/8	8	8	4-6	4 9/16	5 3/8	5 3/8	5¼

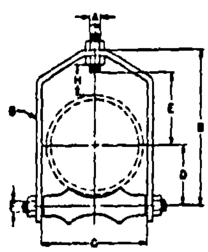
continued next page

■ Maximum recommended loads are applicable only when saddle is used on a flat bearing surface and tack welded to pipe.
When saddle is used with a pipe roll, the maximum load given for the pipe roll applies to the saddle.

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

adjustable steel yoke pipe roll fig. 181





SIZE RANGE: 2 1/2 through 20 inch pipe.

MATERIAL: Cast iron roll; carbon steel yoke, roll rod and hex nuts.

SERVICE: For suspension of pipe from a single rod where horizontal movement may occur because of expansion or contraction.

APPROVALS: Complies with Federal Specification WW-H-171 E (Type 44) and Manufacturers Standardization Society SP-69 (Type 43).

HOW TO SIZE: If the roll is to support bare pipe, select the size directly from nominal pipe size (see below). If used with pipe covering protection saddle, see page ph-70 - 72 for size of pipe roll to be used.

ORDERING: Specify pipe roll size, figure number, name. Be certain to order oversized rolls where insulation makes this necessary.

loads • weights

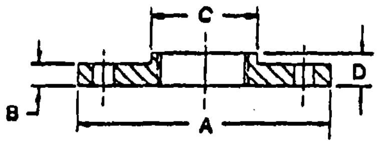
pipe size	maximum O.D. of covering	max recom load, lb	wgt (approx) lbs each
2 1/2	3	225	1.7
3	3 5/8	310	2.2
3 1/2	4 1/8	390	2.5
4	4 11/16	475	3.2
5	5 3/4	685	6.3
6	6 7/8	780	9.3
8	9	780	14.5
10	11	965	18.8
12	13	1200	27.7
14	14 1/4	1200	39.1
16	16 1/4	1200	49.1
18	18 1/4	1400	57.8
20	20 1/4	1600	75.9

dimensions (inches)

pipe size	A	B	C	D	E	F	G	H
2 1/2	1/2	5 3/4	3 1/4	1 15/16	2 7/8	1/2	3/16 x 1 1/4	1 11/16
3	1/2	6 3/8	3 7/8	2 1/4	3 1/8	1/2	3/16 x 1 1/4	1 5/8
3 1/2	1/2	7	4 3/8	2 9/16	3 1/2	1/2	1/4 x 1 1/4	1 11/16
4	5/8	7 9/16	4 15/16	2 13/16	3 5/8	1/2	1/4 x 1 1/2	1 5/8
5	5/8	9 1/8	6	3 7/16	4 1/2	5/8	3/8 x 1 3/4	1 15/16
6	3/4	10 5/16	7 1/8	4	5	3/4	3/8 x 2	1 7/8
8	7/8	12 11/16	9 1/4	5 1/8	6 1/8	7/8	3/8 x 2 1/2	2
10	7/8	15 1/16	11 1/4	6 3/8	7 1/4	7/8	3/8 x 2 1/2	2 1/16
12	7/8	17 7/16	13 1/4	7 7/16	8 3/8	1	1/2 x 2 1/2	2 1/4
14	1	18 7/8	14 1/2	8 3/8	8 3/4	1 1/8	1/2 x 2 1/2	2
16	1	20 13/16	16 1/2	9 3/8	9 11/16	1 1/4	1/2 x 2 1/2	1 15/16
18	1	23 3/4	18 1/2	10 7/16	11 7/16	1 1/4	1/2 x 3	2 13/16
20	1 1/4	26	20 1/2	11 5/8	12 1/4	1 1/4	5/8 x 3	2 1/2

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

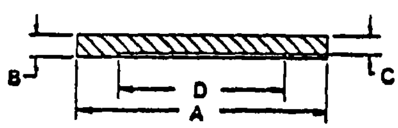
125 LB. SCREWED COMPANION FLANGES CAST IRON FIG. 20



PIPE SIZE	A	B	C	D
1 x 4¼	4.250	.437	1.937	.687
1¼ x 4⅝	4.625	.500	2.312	.812
1½ x 5	5.000	.562	2.562	.875
2 x 6	6.000	.625	3.062	1.000
2½ x 7	7.000	.687	3.562	1.125
3 x 7½	7.500	.750	4.250	1.187
3½ x 8½	8.500	.812	4.812	1.250
4 x 9	9.000	.937	5.312	1.312
5 x 10	10.000	.937	6.437	1.437
6 x 11	11.000	1.000	7.562	1.562
8 x 13½	13.500	1.125	9.687	1.750
10 x 16	16.000	1.187	11.937	1.937

FIG. 20 — FACED & DRILLED
FIG. 76 — FACED ONLY

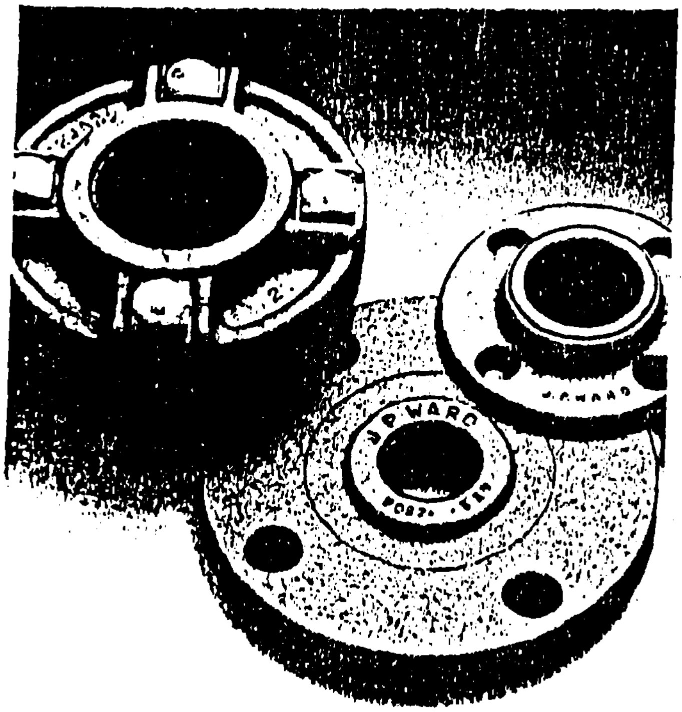
125 LB. BLIND FLANGE CAST IRON FIG. 19



PIPE SIZE	A	B	C	D
1 x 4¼	4.250	.437	.375	1.000
1¼ x 4⅝	4.625	.500	.437	1.250
1½ x 5	5.000	.562	.500	1.500
2 x 6	6.000	.625	.562	2.000
2½ x 7	7.000	.687	.625	2.500
3 x 7½	7.500	.750	.687	3.000
3½ x 8½	8.500	.812	.750	3.500
4 x 9	9.000	.937	.875	4.000
5 x 10	10.000	.937	.875	5.000
6 x 11	11.000	1.000	.937	6.000
8 x 13½	13.500	1.125	1.062	8.000
10 x 16	16.000	1.187	1.125	10.000

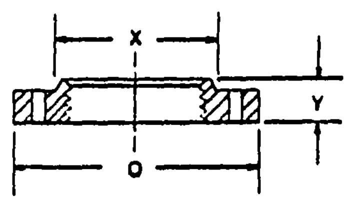
PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

Flanges
Flange Unions
Companion Flanges



"WARD" Fittings are made strictly to specifications as published by the National American Standards Committee for flanges and flanged fittings.

Cast iron flanges are regularly supplied in black and galvanized.



PIPE SIZE	FLANGE DIA. O	HUB DIA. X	LENGTH OF HUB AND THREADS Y
1	4.250	1.940	.690
1¼	4.620	2.310	.810
1½	5.000	2.560	.880
2	6.000	3.060	1.000
2½	7.000	3.560	1.120
3	7.500	4.250	1.190
3½	8.500	4.810	1.250
4	9.000	5.310	1.310
5	10.000	6.440	1.440
6	11.000	7.560	1.560
8	13.500	9.690	1.750
10	16.000	11.940	1.940

Specifications:

* Fed. Spec. WWP 406 *
ANSI B 16.1 — (DIMENSION AND DRILLING)
A.S.T.M. — (ANSI) — A 153 — FOR GALVANIZING
U.L. LISTED WHERE APPLICABLE
A.S.T.M. — A 126 CLASS A FOR MATERIAL
ANSI B. 1.20.1 FOR PIPE THREADS

Grinnell

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

protection saddle

loads • weights • dimensions (inches) *(continued)*

pipe size	fig. no.	max recom load, lbs	wgt (approx) lbs each	actual thickness of covering	size of pipe roll: figs. 171, 175 177	size of pipe roll: figs. 174, 181	size of pipe roll: figs. 271-277	center line of pipe to outside of saddle, C	center line of pipe to center line of roll: D figs. 171, 175 177	center line of pipe to center line of roll: D figs. 174, 181	center line of pipe to center line of roll: E
2 1/2	160	1200	1.7	1 1/16	3 1/2	5	2- 3 1/2	2 11/16	3 1/4	3 1/4	3 5/16
	161	1200	2.8	1 7/8	5	6	4- 6	3 5/16	4	4	3 15/16
	162	1800	3.2	2 5/16	6	8	4- 6	3 7/8	4 1/2	4 5/8	4 1/2
	163	1800	4.1	2 7/8	8	8	4- 6	4 1/4	5 1/8	5 1/8	5
	164	1800	4.5	3 3/8	8	10	4- 6	4 7/8	5 5/8	5 3/4	5 1/2
3	160	1200	1.9	1	4	5	2- 3 1/2	2 15/16	3 1/2	3 1/2	3 9/16
	161	1800	2.8	1 9/16	5	6	4- 6	3 5/8	4 5/16	4 5/16	4 1/4
	162	1800	3.6	2 1/16	6	8	4- 6	4 1/8	4 13/16	4 13/16	4 11/16
	163	1800	4.1	2 9/16	8	8	4- 6	4 11/16	5 7/16	5 7/16	5 5/16
	164	1800	4.9	3 1/16	8	10	8-10	5 1/16	6	6	6 1/16
3 1/2	160	1200	2.3	1 1/4	5	6	4- 6	3 5/16	4	4	3 15/16
	161	1800	3.2	1 13/16	6	8	4- 6	3 11/16	4 9/16	4 9/16	4 1/2
	162	1800	3.6	2 1/4	8	8	4- 6	4 5/16	5 1/8	5 1/8	5
	163	1800	4.5	2 3/4	8	10	8-10	4 11/16	5 5/8	5 5/8	5 11/16
	164	1800	4.9	3 5/16	10	10	8-10	5 3/8	6 5/16	6 5/16	6 3/8
4	160	1800	2.3	1 1/16	5	6	4- 6	3 9/16	4 1/4	4 1/4	4 3/16
	161	1800	3.2	1 9/16	6	8	4- 6	4 1/16	4 7/8	4 7/8	4 3/4
	162	1800	3.6	2 1/16	8	8	4- 6	4 9/16	5 3/8	5 3/8	5 1/4
	163	1800	4.5	2 9/16	8	10	8-10	5	5 15/16	5 15/16	6
	164	1800	4.9	3 1/16	10	10	8-10	5 5/8	6 9/16	6 9/16	6 5/8
	165	1800	6.1	4 1/16	10	12	12-14	6 1/2	7 5/8	7 5/8	7 9/16
	165A	5000	11.6	4 1/16	10	12	12-14	6 1/2	7 5/8	7 5/8	7 9/16
	166A	5000	15.7	5 11/16	14	16	12-14	8 1/8	9 5/8	9 1/2	9 5/16
5	160	1800	2.3	1	6	8	4- 6	4 1/8	4 13/16	4 13/16	4 3/4
	161	1800	3.2	1 1/2	8	8	4- 6	4 11/16	5 1/2	5 1/2	5 3/8
	162	1800	3.6	2	8	10	8-10	5 3/16	6	6 1/16	6 1/8
	163	1800	4.5	2 9/16	10	10	8-10	5 5/8	6 9/16	6 9/16	6 5/8
	164	1800	4.9	3 1/16	10	12	8-10	6 3/16	7 1/8	7 1/4	7 1/4
	165	1800	6.1	4 3/16	12	14	12-14	7 1/8	8 3/16	8 3/8	8 3/16
	165A	5000	11.6	4 3/16	12	14	12-14	7 1/8	8 1/8	8 3/8	8 3/16
	166A	5000	15.7	5 11/16	16	16	12-14	8 11/16	10 1/16	10 1/16	9 7/8
6	160	1800	3.8	1	8	8	4- 6	4 1/2	5 3/8	5 3/8	5 1/4
	161	1800	4.4	1 1/2	8	10	8-10	5 1/16	5 7/8	5 11/16	6
	162	1800	5.7	2	10	10	8-10	5 1/2	6 7/16	6 7/16	6 1/2
	163	1800	6.5	2 1/2	10	12	8-10	6 3/16	7 1/8	7 3/16	7 1/4
	164	1800	7.7	3	12	12	8-10	6 9/16	7 5/8	7 5/8	7 5/8
	165	1800	10.2	4 1/8	14	16	16-20	7 9/16	9	9	8 3/4
	165A	5000	12.9	4 1/8	14	16	16-20	7 5/8	9 1/8	9	8 13/16
	166A	5000	16.3	5 5/8	16	18	16-20	9 1/8	10 5/8	10 9/16	10 7/16
8	161	1800	5.8	1 1/2	10	12	8-10	6	7 1/16	7 1/16	7 1/16
	162	1800	6.3	2	10	12	8-10	6 1/2	7 9/16	7 9/16	7 9/16
	163	1800	7.2	2 11/16	12	14	8-10	7 1/4	8 5/16	8 1/2	8 5/16
	164	1800	7.7	3 1/8	14	16	12-14	7 11/16	9	9	8 3/4
	165	1800	10.2	4 3/16	16	18	12-14	8 11/16	10 1/8	10 1/8	9 7/8
	165A	7200	16.9	4 3/16	16	18	12-14	8 11/16	10 1/16	10 1/8	9 7/8
	166A	7200	22.6	5 5/8	18	20	16-20	10 1/4	11 7/8	11 13/16	11 5/8
10	161	1800	5.8	1 9/16	12	14	8-10	7 1/4	8 5/16	8 1/2	8 5/16
	162	1800	7.7	2 1/16	14	16	12-14	7 5/8	9 1/16	9	8 13/16
	163	1800	8.2	2 9/16	14	16	12-14	8 1/8	9 9/16	9 9/16	9 5/16
	164	1800	8.8	3 1/16	16	18	16-20	8 11/16	10 1/8	10 1/16	10
	165	1800	10.8	4 1/16	18	20	16-20	9 3/4	11 1/4	11 1/4	11 1/8
	165A	7200	18.9	4 1/16	18	20	16-20	9 11/16	11 5/16	11 1/4	11 1/8
	166A	7200	24.3	5 9/16	20	...	22-24	11 1/8	12 15/16	...	12 1/2

continued next page

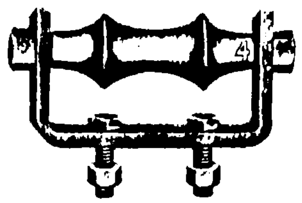
■ Maximum recommended loads are applicable only when saddle is used on a flat bearing surface and tack welded to pipe. When saddle is used with a pipe roll, the maximum load given for the pipe roll applies to the saddle.

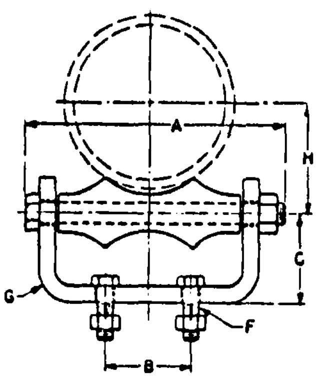
Grinnell

pipe rolls

roller chair
fig. 175

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342





SIZE RANGE: 2 through 20 inch pipe.

MATERIAL: Cast iron roll, steel chair, roll rod, bolts and hex nuts.

SERVICE: For support of pipe where horizontal movement due to expansion and contraction will occur but where no vertical adjustment is expected.

INSTALLATION: Two bolts and nuts provide anchorage to floor or top of steel beam or bracket or chair may be welded to supporting steel.

HOW TO SIZE:

(1) If the roll is to support bare pipe, select the size directly from nominal pipe size (see below).

(2) If used with pipe covering protection saddle, see pages ph-64, 65 or 66 for size of pipe roll.

(3) If roll is to support covered pipe, the O.D. of the covering should not be greater than the O.D. of the pipe for which the roll was designed.

ORDERING: Specify size of roll, figure number, name. Be certain to order oversized rolls where insulation makes this necessary.

weights • dimensions (inches)

pipe size	wgt (approx) lbs each	A	B	C	F	G	H
2	1.1	4	1¼	1½	⅜ x 1½	¼ x 1¼	1⅝
2½	1.4	4⅞	1¼	1⅝	⅜ x 1½	¼ x 1¼	1 15/16
3	1.6	5⅜	2	1¾	⅜ x 1½	¼ x 1¼	2¼
3½	2.6	6⅛	2	2 1/16	⅜ x 1½	⅜ x 1½	2 9/16
4	2.9	6⅝	2	2 5/16	½ x 1½	⅜ x 1½	2 13/16
5	3.9	7⅞	3	2½	½ x 1½	⅜ x 1½	3 7/16
6	6.0	9¼	3⅛	2¾	½ x 1½	⅜ x 2	4
8	9.0	11⅝	3⅜	3	⅝ x 1½	⅜ x 2	5⅛
10	13.8	14⅛	5¼	3⅝	⅝ x 2	½ x 2	6⅜
12	18.9	16⅛	5½	4⅛	⅝ x 2	½ x 2	7 7/16

14-20 dimensional data supplied upon request.

WATTS BALL REGULATOR VALVES

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

No. B-6010, 6011, 6012, 6013, 6014, 6015

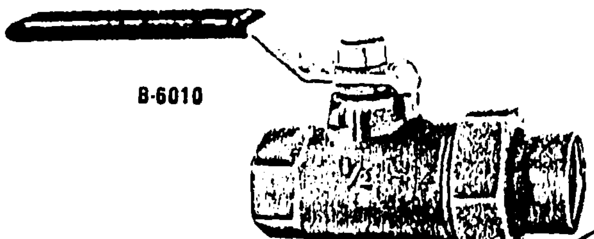
½"- 2" - 600 WOG - Single Union End x NPT or Solder Ends (400 WOG)

This series features a union end x NPT female thread or solder end connection.

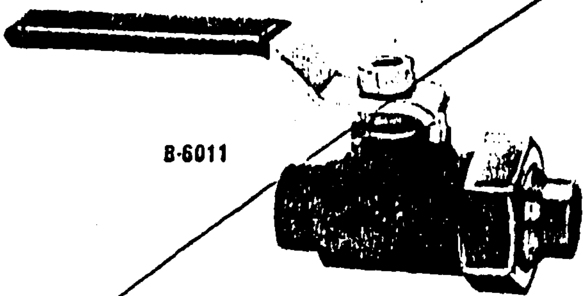
Various models are available as shown below, all offering the advantage of "repairability" after initial installation without pipeline disassembly. Simply loosen the union nut and unscrew valve body from piping system for repair.

Features and options are identical to B-6000. Operating limits are 600 PSI for NPT connections and 400 PSI for solder end at 100°F, with a maximum operating temperature of 225°F @ 50 PSIG. Because of seal materials, no steam rating applies.

B-6010



B-6011



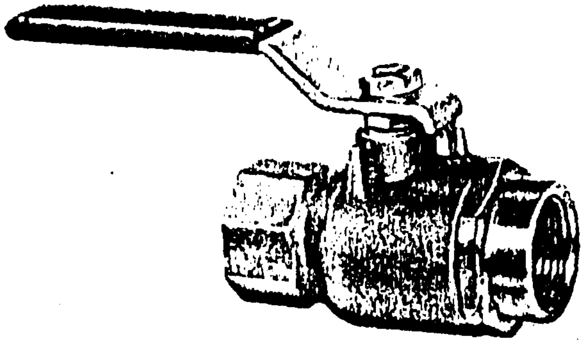
MODELS AVAILABLE:

- ½"- 2" **B-6010** - NPT female x NPT female union end
- ½"- 2" **B-6011** - Solder end x solder union end (400 psi)
- ½"- 2" **B-6012** - Solder end x NPT female union end
- ½"- 1" **B-6013** - Solder end x NPT male union end (400 psi)
- ½"- 1" **B-6014** - NPT female x NPT male union end
- ½"- 2" **B-6015** - NPT female x solder union end

For Additional Information, send for ES-B6010.

No. B-6080, 6081 Bronze, 2-Piece

½"- 2" - 400 WOG - Full Port



The B-6080 (NPT ends) and B-6081 (solder ends) ball valve series is standardly full port, ideal for critical flow applications or where specifications require a full port orifice. Virgin PTFE seats and seals are standard, as are bottom loaded stem and packing nut threaded to body.

FEATURES

- **Full port**
- **Bottom loaded stem**
- **400 WOG/125 WSP rating**

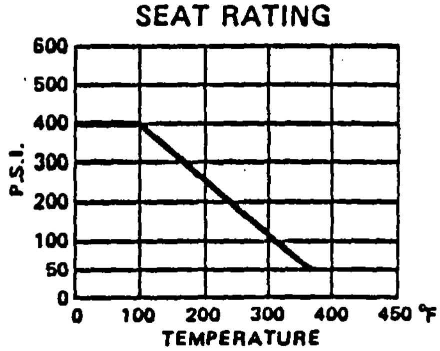
OPTIONS:

Suffix	
SS	316 stainless steel ball and stem
OH, OL	High or low profile safety oval handles
RH	Round handles
SH	Stainless steel handle and nut
BS	Balancing stops
XH	Extended handles
VT	Virgin PTFE seats
TH	Tee handles

SPECIFICATIONS

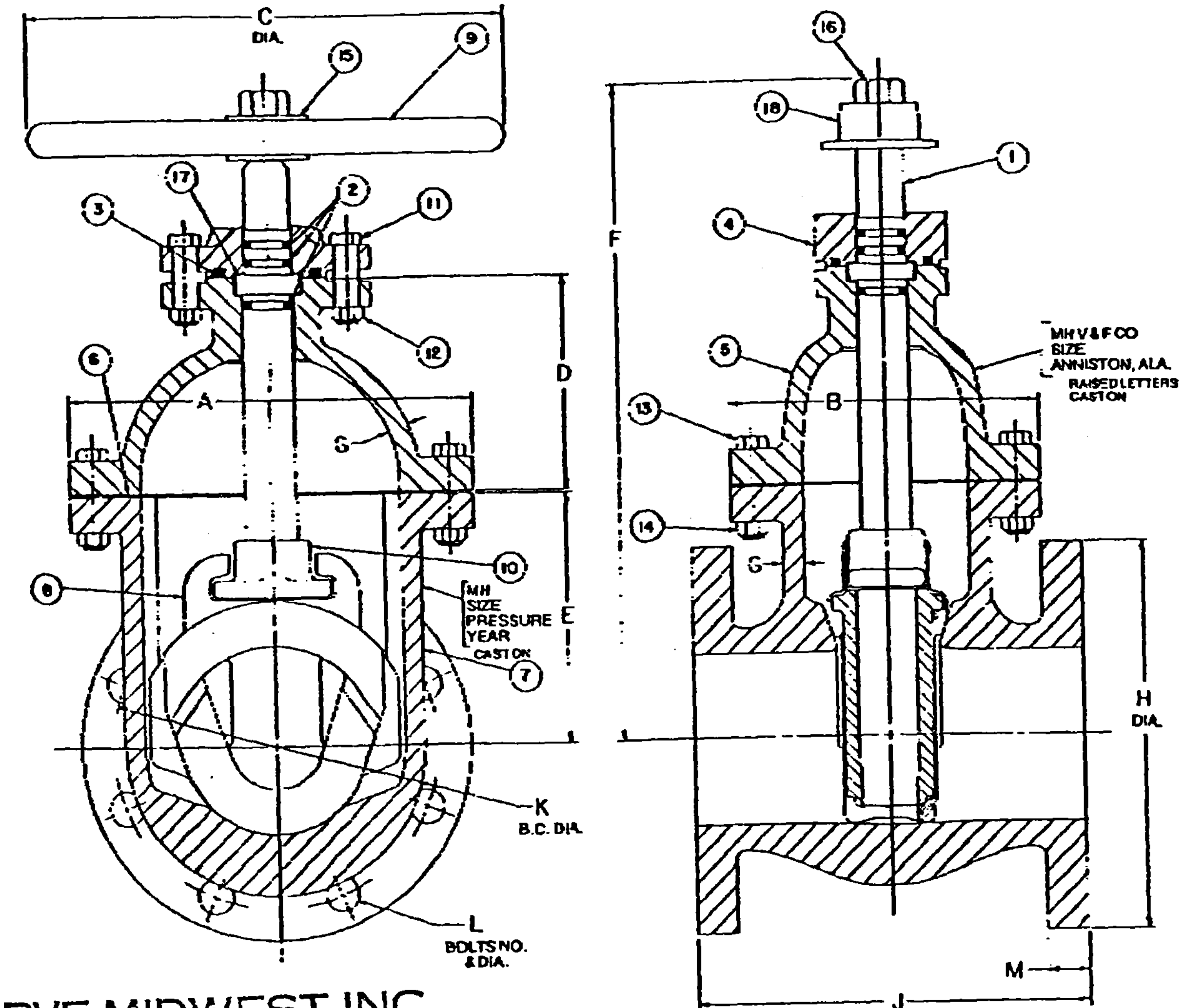
Size	CV Rating	Operating Torque (In.-Lbs.)
1/2"	15	60
3/4"	30	150
1"	60	200
1¼"	110	250
1½"	130	320
2"	360	500

SEAT RATING



For Additional Information, send for ES-B6080.

ITEM NO.	DESCRIPTION	MATERIAL
1	STEM	BRONZE ASTM B584 CDA 86400
2	SEAL PLATE "O" RING	BUNA "N"
3	SEAL PLATE GASKET "O" RING	BUNA "N"
4	SEAL PLATE	CAST IRON A-126 CLASS B
5	BONNET	CAST IRON A-126 CLASS B
6	BONNET GASKET	NON-ASBESTOS
7	BODY	CAST IRON A-126 CLASS B
8	GATE	(BUNA-S ENCAPSULATED) CAST IRON A-126 CLASS B-4", 6", & 8" DUCTILE IRON A-536 GRADE 65-45-12 10" & 12"
9	HANDWHEEL	CAST IRON A-126 CLASS B
10	STEM NUT	BRONZE ASTM B584 CDA 86400
11	SEAL PLATE BOLTS	STEEL ASTM A-307
12	SEAL PLATE NUTS	STEEL ASTM A-563
13	BONNET BOLTS	STEEL ASTM A-307
14	BONNET NUTS	STEEL ASTM A-563
15	WASHER	MILD STEEL
16	CAPSCREW HEX	STEEL ASTM A-307
17	THRUST WASHER	18/8 STAINLESS STEEL
18	OPERATING NUT	CAST IRON A-126 CLASS B



PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

GENERAL DIMENSIONS IN INCHES					
VALVE SIZE	4"	6"	8"	10"	12"
A	9¼	11¼	14⅜	17 3/16	19¾
B	7⅛	8⅛	9⅝	10⅜	11¾
C	9	12	14	16	18
D	5	6 11/16	8 1/16	9⅜	10⅝
E	6¼	7 9/16	9½	11 13/16	13¾
F	15 7/16	18 13/16	22⅝	25⅜	29 1/16
G	½	9/16	⅝	23/32	13/16
H	9	11	13½	16	19
J	9	10½	11½	13	14
K	7½	9½	11¾	14¼	17
L	8⅝	8¾	8¾	12⅞	12⅞
M	15/16	1	1⅛	1 3/16	1¼
TURNS TO OPEN	13	19	26	32	38

NOTES:

ALL STEEL BOLTS & NUTS ARE ELECTRO ZINC PLATED UNLESS OTHERWISE SPECIFIED.

COMPLIES WITH A.W.W.A. SPECIFICATION C-509 LATEST EDITION.

4"-12"—200 LBS. WATER WORKING PRESSURE.
400 LBS. HYDROSTATIC TEST.

VALVE WILL BE FURNISHED OPEN LEFT WITH HANDWHEEL UNLESS OTHERWISE SPECIFIED.

COATING—FUSION BONDED EPOXY (INTERNAL & EXTERNAL)

STYLE NO. 3067-02

A.W.W.A. RESILIENT SEATED GATE VALVES W/FLANGED ENDS		
M&H Valve Co. Anniston, Alabama	DRAWN BY D.F.S. / CHECKED / APPROVED	DATE / SCALE NTS / DWG. NO. 12444 REV. C

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

CONBRACO®

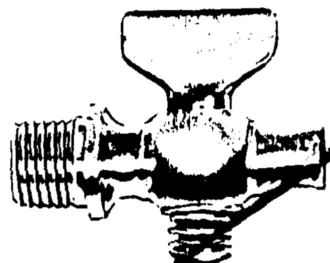
AIR COCKS

41 SERIES
POLISHED BRASS OR SATIN FINISH

- TESTED AT 80 LBS. AIR PRESSURE — STANDARD — SPRING BOTTOM, $\frac{5}{32}$" PORT.
- ALL AIR COCKS CAN BE FURNISHED WITH NUT BOTTOM FOR PRESSURES UP TO 200 P.S.I., $\frac{1}{8}$" PORT.

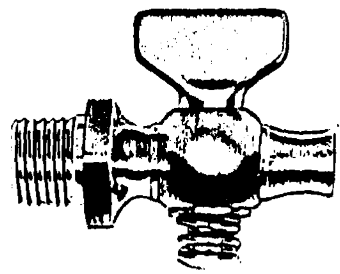
KEY

FOR ALL AIR COCKS TYPE	FINISH SATIN BRASS	POLISHED BRASS	SATIN CHROME	POLISHED CHROME
Standard (Spring Bottom)	01	05	17	21
Nut Bottom	04	08	20	24



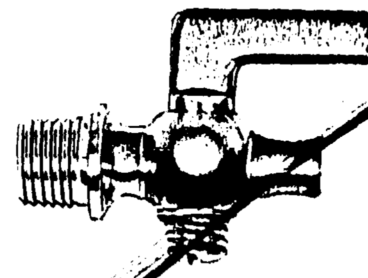
TEE HANDLE ROUND SHOULDER

NO.	SIZE-INCHES	WT./100
41-060-	1/8	12.0 lbs.
41-[illegible]70-	1/4	13.1 lbs.



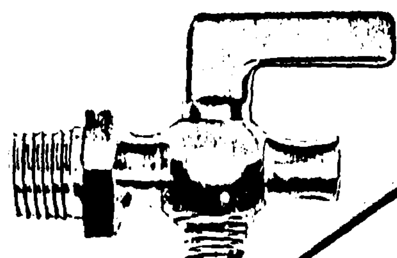
TEE HANDLE HEXAGON SHOULDER

NO.	SIZE-INCHES	WT./100
41-080-	[illegible]	17.2 lbs.
41-090-	1/2	20.0 lbs.



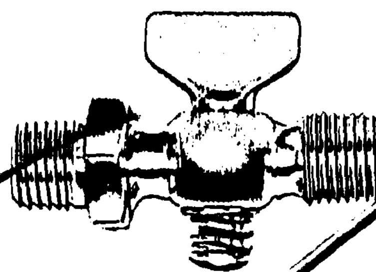
LEVER HANDLE ROUND SHOULDER

NO.	SIZE-INCHES	WT./100
[illegible]20-	1/8	12.4 lbs.
[illegible]1-130-	1/4	13.0 lbs.



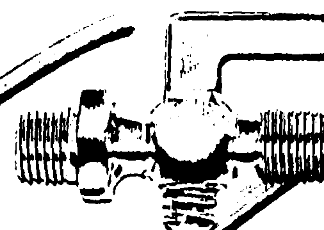
LEVER HANDLE HEXAGON SHOULDER

NO.	SIZE-INCHES	WT./100
41-140-	3/8	18.8 lbs.
41-1[illegible]-	1/2	21.9 lbs.



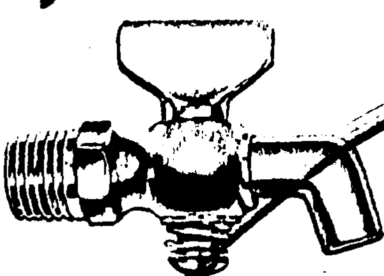
TEE HANDLE DOUBLE MALE THREAD

NO.	SIZE-INCHES	WT./100
41-180-	1/8	14.2 lbs.
41-190-	1/4	18.8 lbs.
41-[illegible]3-	3/8	18.0 lbs.
[illegible]1-210-	1/2	31.5 lbs.



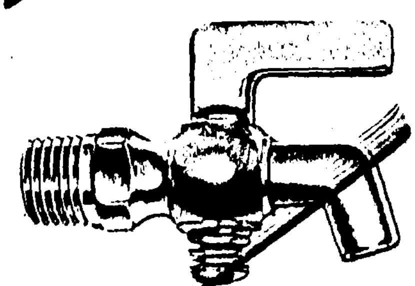
LEVER HANDLE DOUBLE MALE THREAD

NO.	SIZE-INCHES	WT./100
41-[illegible]20-	1/8	14.5 lbs.
[illegible]1-230-	1/4	16.6 lbs.
41-240-	3/8	19.1 lbs.
41-251-	1/2	31.3 lbs.



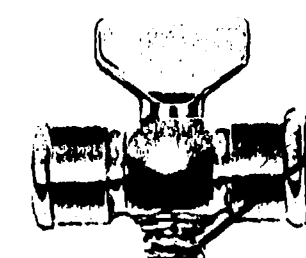
TEE HANDLE BIBB NOSE

NO.	SIZE-INCHES	WT./100
41-[illegible]60-	1/8	14.4 lbs.
41-[illegible]70-	1/4	14.7 lbs.
41-280-	3/8	28.9 lbs.
41-330-	1/2	34.9 lbs.



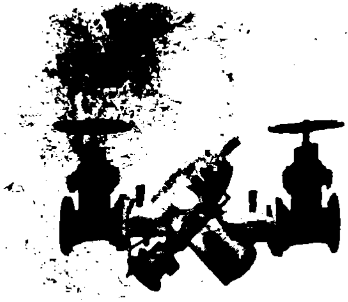
LEVER HANDLE BIBB NOSE

NO.	SIZE-INCHES	WT./100
41-2[illegible]-	1/8	14.6 lbs.
[illegible]300-	1/4	14.6 lbs.
41-310-	3/8	31.3 lbs.
41-320-	1/2	34.8 lbs.



TEE HANDLE DOUBLE FEMALE

NO.	SIZE-INCHES	WT./100
[illegible]70-	1/8	13.0 lbs.
[illegible]1-380-	1/4	13.2 lbs.
41-390-	3/8	22.7 lbs.
41-391-	1/2	26.8 lbs.



WILKINS REGULATOR CO.

A Division of Zurn Industries, Inc.

MODEL 575

REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER

Sizes 2½" — 6"

MODEL 550

DOUBLE CHECK VALVE ASSEMBLY

INSTALLATION · TESTING · MAINTENANCE

BASIC INSTALLATION INSTRUCTIONS

CAUTION:

Installation of Backflow Preventers must be performed by qualified licensed personnel. Faulty installation could result in an improperly functioning device.

The installer, to be sure he has the up-to-date information, should read all installation instructions before attempting to install the device.

The installer should be sure the proper device has been selected for the particular installation.

WILKINS Model 575 Reduced Pressure Principle Backflow Preventers are for use on potable water lines **where a health hazard could exist** if a backflow or backsiphonage situation were to occur.

WILKINS Model 550 Double Check valve assemblies are for use on a **potable water line where a health hazard does not exist** in event of a backflow situation.

Proper performance is dependent upon following these Installation Instructions, and prevailing governmental and industry standards and codes. Failure to do so, according to the WILKINS Certificate of Limited Warranty "releases WILKINS of any liability that it might otherwise have with respect to that device." Such failure could also result in an improperly functioning device.

Damage to the device could result wherever water hammer and/or water thermal expansion could cause excessive line pressure. Where this could occur, shock arrestors and/or pressure relief valves should be installed downstream of the device.

1. Before installing either a Model 575 Backflow Preventer or a Model 550 Double Check valve unit, **flush the lines thoroughly** to remove all debris, chips and other foreign matter.
2. The Backflow Preventer must be installed in a horizontal position to provide proper operation of the relief valve.

   The cast arrow on the side of the unit must point in the direction of water flow.
3. Provide adequate space around the installed unit so that the test cocks will be accessible for testing, servicing and repair.
4. If installation of a Model 575 unit is in a building, provide a suitable drain arrangement to drain off spillage from the relief valve. An air gap of at least two times the pipe diameter must be provided between the relief valve and the drain piping to prevent a cross-connection. **Do not pipe the relief valve solidly to a floor drain, sewer or sump.**
5. Always consult local codes for installation methods, approvals and guidance.

OUTDOOR INSTALLATION

Model 575 Backflow Preventers and Model 550 Double Check valve units may be installed outdoors only if the device is protected against any freezing conditions. Exposure to freezing conditions will result in improper functioning of the device. The installation location must be kept above 32°F. All the basic installation instructions apply.

If installation is above ground, install the unit at least 12 inches above surrounding flood level.

If installation is in a pit or vault, observe the following additional precautions:

1. The installed backflow preventer must never be submerged in water because this could cause a cross-connection. Make sure that the pit or vault always remains dry by providing ample drainage.
2. If there is any possibility of freezing, protect the backflow preventer by providing heat or insulation sufficient to prevent unit from freezing.
3. Allow enough space in the pit or vault for testing and repair of the backflow preventer.

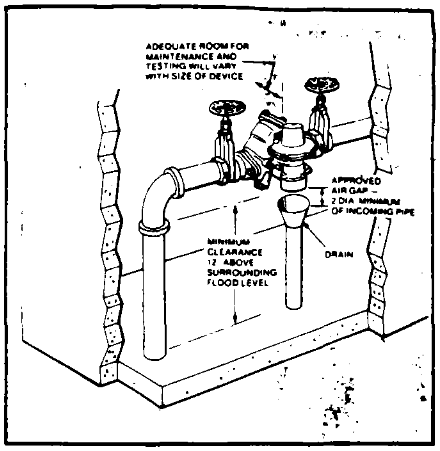


FIGURE 1 TYPICAL INSTALLATION IN BUILDING

INDOOR INSTALLATION

Indoor installation is preferred in areas that are subject to freezing conditions. All the basic installation instructions apply to such installations. (FIG. 1)

PARALLEL INSTALLATION

Where uninterrupted service from a single meter connection must be maintained, two or more Model 575 Reduced Pressure Principle Backflow Preventers or Model 550 Double Check Valve assemblies may be connected in parallel. Parallel installation permits testing of backflow preventers individually without interrupting service. When two backflow preventers are used in parallel, the total capacity of the device must equal or exceed the capacity of the main line. All the basic installation instructions apply to a parallel installation.

When paralleling devices, adequate room (6" or more) must be provided between units to allow for testing and repair.

PLACING THE DEVICE IN SERVICE

After the installation of a Model 575 or Model 550 unit has been completed, place the unit in service as follows:

MODEL 575 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTERS

1. Start with both gate valves closed. Slowly open the inlet gate valve until the backflow preventer is completely pressurized.
2. A sizable, short discharge from the relief valve may occur while the device is pressurizing. The discharge should cease by the time the gate valve is fully open.

   If the discharge should continue, close the gate valve. Loosen the vent screws (2) on the relief valve and reopen the gate valve. Close the vent screws when water flow is noted.
3. If the discharge still does not stop, refer to "*Maintenance Instructions*" for Repair Procedures.
4. Repressurize device as in Step 1. Device should function properly.
5. After the device has been pressurized, vent all trapped air from both check valves and the relief valve by opening each of the four test cocks. When liquid appears at all the vents close the four test cocks.
6. Slowly open the discharge gate valve. The Model 575 Reduced Pressure Principle Backflow Preventer is now in service.
7. If "spitting" or intermittent discharges from the relief valve are noted, "spitting" (drainage) from the relief valve could be a result of pressure fluctuations and/or water hammer condition in the system. If such condition exists, install water pressure reducing valves or water hammer shock arrestors in compliance with industry standards as needed.
8. After the backflow preventer has been properly installed, test the device (see "Testing the Model 575 Device"). If the device fails the test, remove the first and second check valves and thoroughly flush the device. If the relief valve fails to operate properly, inspect the sensing line for clogging (also see maintenance instructions). Clean rubber seats of all debris and place the unit back in service.

MODEL 550 DOUBLE CHECK VALVE ASSEMBLIES

1. Start with both gate valves closed. Slowly open the inlet gate valve until the backflow preventer is completely pressurized.
2. When the unit has been pressurized, vent any trapped air by opening the test cocks. Close the test cocks when water appears at the vents.
3. Slowly open the discharge gate. The double check valve assembly is now in service.
4. After the device has been placed in service, test the device (see "Testing The Model 550 Device").

TEST PROCEDURE

NOTE: The following test procedures conform to the recommendations of the "Foundation for Cross-Connection Control of the University of Southern California."

The test procedure for the Model 575 Reduced Pressure Backflow Preventer is based on use of the Midwest Model 830 Test Kit.

The test procedure for the Model 550 Double Check Valve Assembly is based on use of the Midwest Model 890 Test Kit.

TESTING THE MODEL 575 DEVICE WITH RP TEST KIT

1. PRELIMINARY STEPS (Fig. 2)

a. Connect the HIGH (red) hose of the test kit to the No. 2 test cock of the backflow preventer.

b. Connect the LOW (green) hose of the test kit to the No. 3 test cock of the backflow preventer.

c. Open test cock No. 2 and test cock No. 3 on the backflow preventer.

d. Open the VENT valve of the gauge (black).

e. Open the HIGH (red) valve and bleed to atmosphere until air has been expelled. Then, close the HIGH valve.

f. Open the LOW (green) valve and bleed to atmosphere until all air has been expelled. Then, close the LOW valve.

g. Close the VENT valve.

h. Close the No. 2 gate valve on the backflow preventer.

i. Proceed with the No. 1 check valve test.

j. Be sure there are no leaks. This will distort testing results.

2. NUMBER 1 CHECK VALVE TEST

Purpose: To determine the static pressure drop across check valve #1.

Requirement: The static pressure drop across check valve No. 1 shall be at least 3 psi greater than the opening pressure of the differential relief valve.

The PSID (differential pressure) reading on the kit gauge is the normal static pressure with no flow for the No. 1 check valve. This value should be recorded for record purposes. The reading should hold steady and not decrease.

If the reading decreases and continues to do so, the valve is leaking. Clean and inspect the No. 1 seal ring and seat. Refer to "Maintenance Procedure" for correction steps.

3. RELIEF VALVE OPENING PRESSURE TEST

Purpose: To test operation of pressure differential relief valve.

Requirements: The pressure differential relief valve must open before the "line to zone differential pressure" reaches 2 psi.

a. Open the HIGH (red) valve on the test kit a number of turns.

b. Open the LOW (green) valve very slightly until the gauge pointer begins to drop. This establishes a bypass, line to zone.

c. Hold the LOW (green) valve at this position. Observing the PSID gauge, place one hand beneath the relief valve drain to sense the first discharge.

Record the gauge reading of first discharge.

If this value is less than 2 psi, the relief valve is malfunctioning. Repeat preliminary steps (1a thru 1i) and test steps 3 a thru 3c. If results are repeated make sure the No. 2 gate is completely closed. If condition persists, check for a plugged sensing line or the relief valve is stuck closed by corrosion. Refer to "Maintenance Procedure" for valve repair steps.

4. NUMBER 2 CHECK VALVE TEST

Purpose: To test the No. 2 check valve for tightness against reverse flow.

Requirements: The valve must be tight against reverse flow under all pressure differentials.

a. Connect the VENT (black) hose of the test kit to the No. 4 test cock on the backflow preventer. Open the No. 4 test cock.

b. Observe the differential pressure with all gauge valves closed.

c. Open the HIGH (red) and VENT (black) valves on the test kit. This places line pressure on the downstream side of the No. 2 check valve.

The PSID reading on the gauge should hold steady with valves open.

If the gauge reading continues to decrease the valve is leaking. Clean and inspect the No. 2 seal ring and seat. Refer to "Maintenance Procedure" for correction steps.

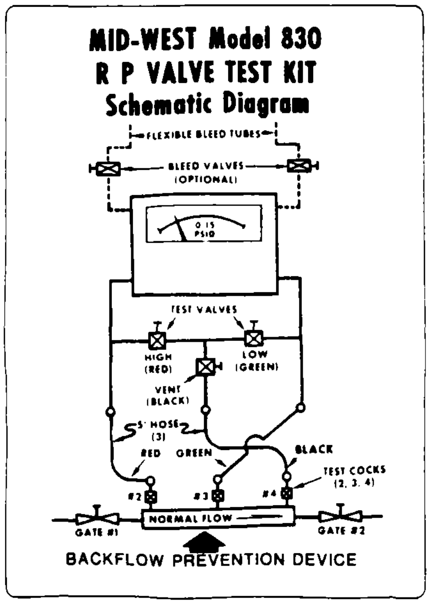


FIGURE 2. TYPICAL TEST SET-UP, SCHEMATIC DIAGRAM – RP

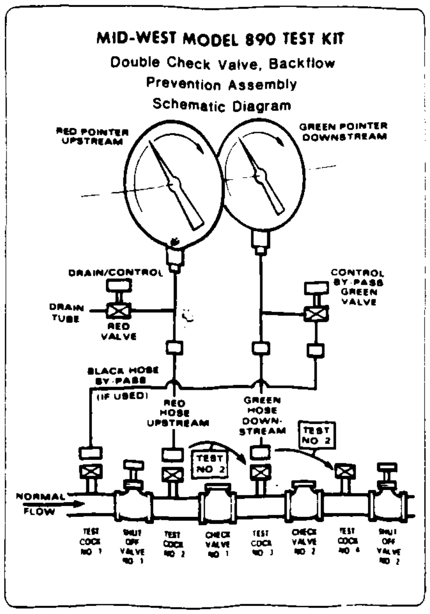


FIGURE 3. TYPICAL TEST SET-UP, SCHEMATIC DIAGRAM – DC

TESTING THE MODEL 550 DEVICE WITH DC TEST KIT

1. PRELIMINARY STEPS (Fig. 3)

a. Connect HIGH (red) hose to test cock No. 2 of the double check valve assembly.

b. Connect LOW (green) hose to test cock No. 3.

c. Open test cocks No. 2 and No. 3.

d. Open HIGH (red) and LOW (green) valves on test kit to bleed air from lines and fill hoses.

e. Close red and green valves.

f. Close shutoff valve No. 2

g. Close shutoff valve No. 1

2. TESTING NUMBER 1 CHECK VALVE

Purpose: To test No. 1 check valve for tightness against reverse flow.

Requirements: The valve must be tight against reverse flow under all pressure differentials.

a. Bleed off upstream pressure by slowly opening HIGH (red) valve until red pointer on test kit reads about 2 psi less than downstream side as indicated by green pointer.

b. Close red valve.

c. Both pointers should hold steady and maintain 2 psi differential.

d. If both pointers drop in (a.) check valve indicates leakage.

e. To confirm if valve leaks:

1. With No. 1 shutoff valve still closed, open green valve and bleed both pointers down about 10 psi.
2. Close green valve.
3. Connect bypass (black) hose to No. 1 test cock on device.
4. Open test cock No. 1
5. Slowly open both red and green valves together, placing line pressure on downstream side of check valve and venting upstream side.
6. Red Pointer should decrease and green pointer increase.
7. Close red valve.
8. Red pointer should hold steady.
9. If red pointer continues to increase, the check valve leaks. See "Maintenance Instructions" for correction steps.

f. Close all kit valves, test cocks and disconnect hoses from device.

3. TESTING NUMBER 2 CHECK VALVE

Purpose: To test No. 2 check valve for tightness against reverse flow.

Requirements: The valve must be tight against reverse flow under all pressure differentials.

Repeat steps of test of No. 1 check valve except with hoses connected red to test cock No. 3 and green to test cock No. 4.

APPARENT PROBLEMS

PROBLEM	POSSIBLE CAUSE	REMEDY
Relief Valve Continuously Discharges	1. Fouled 1st check 2. Fouled relief valve seat 3. Plugged sensing tube 4. Fouled 2nd check with backflow condition	Inspect seal rings and seats for dirt or wear. Inspect sensing tubes for blockage.
Relief Valve Intermittently Discharges	1. Water hammer 2. Wide line pressure fluctuations on inlet 3. Properly working valve 4. Air trapped in valve	Check for water hammer or line fluctuations and correct if needed. Bleed air from valve.
Low or No Flow	1. Device installed backwards. 2. Gates not fully opened. 3. Low supply pressure.	

MAINTENANCE INSTRUCTIONS

CAUTION:

Proper performance is dependent upon licensed, qualified personnel performing regular, periodic testing according to WILKINS' specifications and prevailing governmental and industry standards and codes. Failure to do so could result in an improperly functioning device.

All Model 575 Backflow Preventers and Model 550 Double Check Valve units must be inspected and maintained by licensed personnel at least once a year or more frequently as specified by local codes. Replacement of worn or damaged parts must only be made with genuine "WILKINS" parts. The WILKINS Certificate of Limited Warranty provides that failure to do so "releases WILKINS of any Liability that it might otherwise have with respect to that device." Such failure could also result in an improperly functioning device.

Model 575 devices should be thoroughly flushed after backflow conditions occur to prevent any type of corrosive deterioration to its components. Failure to do so could result in malfunction of the device.

1. GENERAL

Maintenance of either the Model 575 Backflow Preventer or the Model 550 Double Check Valve Unit can be performed without removing the device from the line. There are NO SPECIAL TOOLS required.

2. CHECK VALVES

To service the Check Valves, proceed as follows:

a. Shut off the No. 2 gate valve, then shut off the No. 1 gate valve.

b. Open the No. 2, No. 3 and No. 4 test cocks to release pressure and drain water from the backflow preventer.

c. On the Model 575, loosen the sensing tube nuts and remove the sensing tube from the top of the check valve and the relief valve.

CAUTION: Take care in removing the cover in the following steps. The cover is spring loaded.

d. Holding the cover down firmly, loosen and remove the bolts which mount the cover of the check valve.

e. Holding the cover firmly, remove the loosened bolts. Dispose of bolts so as to free both hands for component removal.

f. Ease cover outward until spring tension has been relieved.

g. Reach behind cover and hold spring and/or poppet assembly in place while disposing of cover.

h. If spring and poppet are not unitized, for ease of handling, ease spring out, restraining poppet while disposing of spring. Otherwise, remove poppet assembly.

i. On some models, the sleeve is not held in place by retaining screws.

Restrain sleeve by holding flange while removing and disposing of poppet.

NOTE: If poppet and spring are utilized, sleeve is retained by screws.

j. If sleeve is not retained, loosen and remove sleeve. otherwise, loosen screws and withdraw sleeve for inspection.

WARNING

Unitized poppet assemblies are factory repairable only. Do not attempt to disassemble. Springs are held in compression and injury can result if springs are released.

k. Inspect the rubber seal of the poppet assembly for cuts or embedded debris.

l. If damage is noted, loosen and remove the screw holding the seal retaining washer in place.

m. Remove seal ring.

n. If reverse side of seal is unused, invert seal and reassemble, otherwise replace with proper "WILKINS" seal. In reassembly, be sure seal is fully seated and "flat" in poppet.

o. Inspect valve cavity, remove accumulated silt, dirt or debris. Wipe O-ring seats clean.

p. Inspect sleeve and valve seat area. Wipe clean. If valve seat has been damaged, sleeve should be replaced.

q. Inspect O-ring seals on sleeve. If damaged or cut, replace with proper "WILKINS" part.

r. Inspect cover. Wipe O-ring seat clean.

s. When inspection and cleaning and repairs are completed, reassemble, check valve following steps j through c above.

t. Reassemble the sensing tube removed in (c.). Be sure clamping collars are tight. (See "Relief Valve" before reassembling.)

u. Refer to "Placing Device in Service" section above to reuse device.

v. Inspect device after water is turned on and before testing to eliminate leaks.

3. RELIEF VALVE

The relief valve is more easily serviced if it is dismounted from the valve body.

To dismount:

a. Close No. 1 and No. 2 gate valves and open test cocks No. 2 and No. 3 to relieve pressure.

b. Loosen and unscrew the sensing tube nuts.

c. Remove and inspect tubes for possible deposits of debris. Clear out tubes and their connectors on the check valve unit.

d. Hold the valve to keep it from falling. Loosen and remove the two mounting bolts.

To service the relief valve:

a. Loosen and remove the bolts holding the cover in place (cover is not spring loaded).

b. CAUTION: During disassembly and reassembly take care not to twist or apply torque to the diaphragm. Twisting could tear the diaphragm. Do not remove the relief valve disc while the cover is in place. Damage to the disc could result from such removal.

c. Remove the O-Ring surrounding the diaphragm. Loosen and free rim of diaphragm from body.

CAUTION: Spring seat beneath diaphragm **is spring loaded.** Hold firmly down while disassembling.

d. Pressing and holding diaphragm down loosen and remove retainer nut.

e. Slowly ease spring seat upward until spring pressure is relieved.

f. Carefully lift off the diaphragm and spring seat.

NOTE: In some models the spring seat and diaphragm backing are two separate pieces.

g. Inspect the diaphragm for possible pinholes, cuts, tears or frayed fabric. If damage is noted, replace the diaphragm with proper "WILKINS" part.

h. Replace the O-ring with new, proper "WILKINS" part.

i. Loosen and remove screws holding shaft guide in place. Remove shaft guide.

j. With a 9/64" Allen wrench, loosen and remove screws holding lower diaphragm and retainer in place.

k. Lift valve stem to expose stainless diaphragm retainer. Carefully loosen and remove retainer.

l. Invert valve body. Loosen and remove bolts holding mounting flange in place. Remove flange.

WARNING: DO NOT NICK OR OTHERWISE DAMAGE THE BEVELLED SEATING SURFACE, EVEN SLIGHT DAMAGE CAN RESULT IN A LEAKING VALVE.

NOTE: In some models, the mounting flange and valve seat are two separate pieces.

m. If stainless valve seat is a separate part, press firmly on far end of stem to dislodge seat. Remove seat.

n. Remove and replace O-rings on mounting flange and valve seat (only if separate part) with proper "WILKINS" parts.

o. Inspect bevelled valve seat, if damaged, replace with proper "WILKINS" part.

p. Grasp legs of valve seal retainer and withdraw valve stem.

q. Replace O-ring on stem with proper "WILKINS" part.

r. Reach into cavity and use fingers to carefully dislodge lower diaphragm.

s. Inspect diaphragm for possible pinholes, cuts, tears or frayed fabric. If damaged, replace with proper "WILKINS" part.

t. Loosen and remove bolt holding seal retainer. Remove seal retainer.

u. Carefully insert knife blade between outer edge of rubber seal and brass retainer. Pry edge of seal upward. Remove seal.

v. Inspect seal for possible embedded debris or cuts. If damaged, and reverse side of seal is unused, invert and reassemble; otherwise, replace seal with proper "WILKINS" part.

NOTE: When reassembling seal, first, be sure seal cavity is wiped clean. Then be sure seal is fully seated (no bulges) before assembling and securing retainer.

TO REASSEMBLE VALVE

Reassemble the relief valve following sequence of steps "p" to "a" above with following guides.

To Reassemble Valve Seat and Stem to Valve body (Ref. items p to l).

Carefully insert legs of retainer into valve seat and lower into valve body. Then bolt mounting flange in place.

To Assemble Lower Diaphragm (Ref. items n, k, j.)

1. Fit stainless lower diaphragm retainer over distended diaphragm properly aligning holes in retainer and diaphragm.
2. Holding flange of diaphragm lightly press cup down until flush with flange.
3. Holding valve body and pressing stem upward, lower diaphragm and retainer over stem, aligning all holes and lightly press into place on stem.
4. Insert and tighten retaining screws.
5. Place valve body with "mounting flange down" on clean work surface.
6. Carefully press flange of diaphragm into place in body.

To Assemble Spring, Diaphragm, etc. (Ref. items g to d).

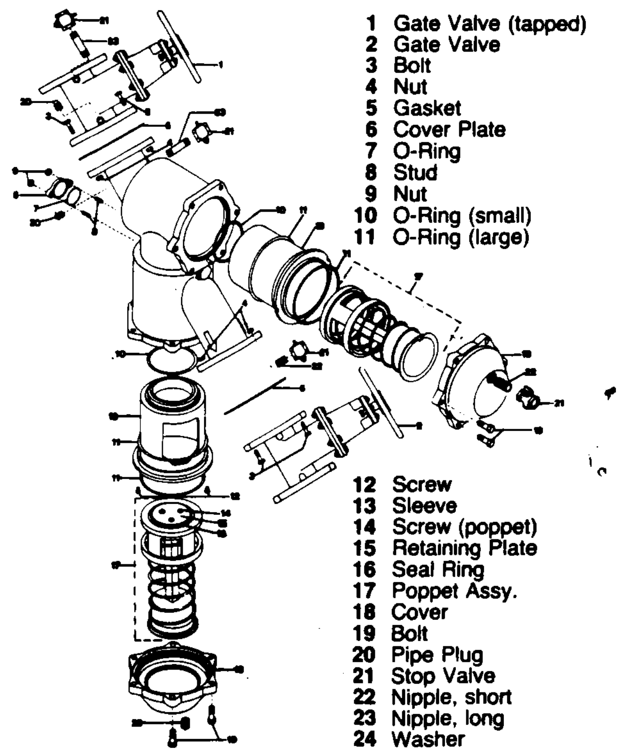
1. After valve guide is assembled, place spring and spring seat (with pivoting diaphragm backing washer, if separate) in place on spring. Place diaphragm with printing against backing plate.
2. Carefully depress spring fully by pressing on diaphragm, allowing threaded stem to protrude through hole in diaphragm. Place washer and finger tighten nut.
3. Holding backing place from turning, tighten nut.
4. Carefully seat diaphragm on body by tucking excess down alongside backing plate. Minimize wrinkles as far as possible.
5. Seat O-ring around outside of diaphragm.
6. Place cover w/ports on same side of valve. Place and tighten cover bolts.

PLACING BACKFLOW UNITS BACK IN SERVICE

1. Remount valve to backflow unit being sure O-ring seat is in place in valve.
2. Before reassembling sensing tubes from valve to device as required, check to be sure lines are free of debris, etc., as are fittings on device. Reconnect sensing lines.
3. Open gate valve No. 1 and bleed any entrapped air through vent cocks.
4. Check complete unit for leaks. Tighten as required.

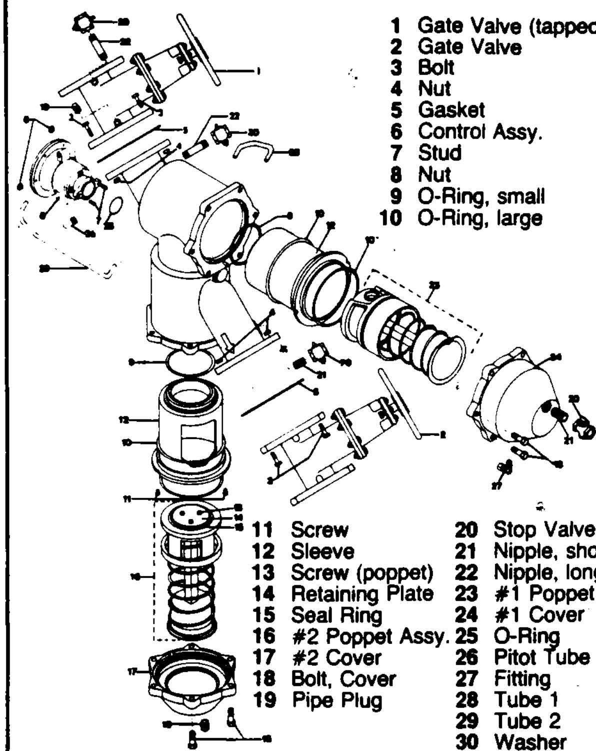
   IMPORTANT: After servicing either the Model 575 or Model 550 devices, they must be tested per "Test Procedure" above.
5. After testing, open gate valves and the device is in service.

NOTE: If any questions concerning the installation, inspection or maintenance instructions arise, contact the Manager of Consumer Relations at WILKINS' Home Office.



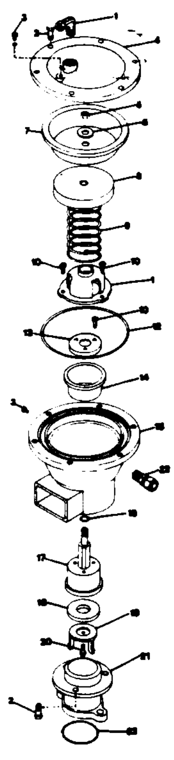
1 Gate Valve (tapped)
2 Gate Valve
3 Bolt
4 Nut
5 Gasket
6 Cover Plate
7 O-Ring
8 Stud
9 Nut
10 O-Ring (small)
11 O-Ring (large)
12 Screw
13 Sleeve
14 Screw (poppet)
15 Retaining Plate
16 Seal Ring
17 Poppet Assy.
18 Cover
19 Bolt
20 Pipe Plug
21 Stop Valve
22 Nipple, short
23 Nipple, long
24 Washer

MODEL 550



1 Gate Valve (tapped)
2 Gate Valve
3 Bolt
4 Nut
5 Gasket
6 Control Assy.
7 Stud
8 Nut
9 O-Ring, small
10 O-Ring, large
11 Screw
12 Sleeve
13 Screw (poppet)
14 Retaining Plate
15 Seal Ring
16 #2 Poppet Assy.
17 #2 Cover
18 Bolt, Cover
19 Pipe Plug
20 Stop Valve
21 Nipple, short
22 Nipple, long
23 #1 Poppet Assy.
24 #1 Cover
25 O-Ring
26 Pitot Tube Assy.
27 Fitting
28 Tube 1
29 Tube 2
30 Washer

MODEL 575



1 Fitting
2 Screw
3 Bleed Screw
4 Cover
5 Hex Nut
6 Washer
7 Large Diaphragm
8 Spring Retainer
9 Spring
10 Pan Head Screw
11 Guide
12 Large O-Ring
13 Retainer
14 Small Diaphragm
15 Body
16 Small O-Ring
17 Piston
18 Seal Ring
19 Seat Guide
20 Hex Head Screw
21 Seat Flange
22 Fitting
23 O-Ring

RELIEF VALVE

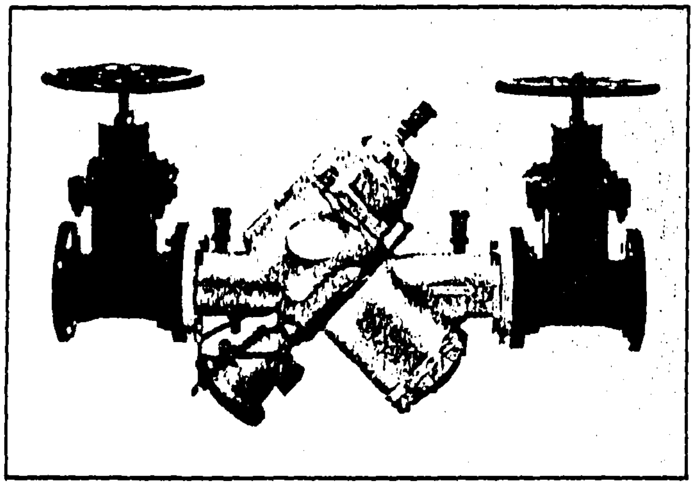
FOR PART NUMBERS PLEASE SEE THE WILKINS BACKFLOW PREVENTER PARTS CATALOG.

WILKINS REGULATOR CO.
A Division of Zurn Industries, Inc.

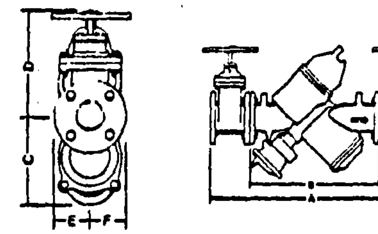
1747 Commerce Way
Paso Robles, CA 93446
805-238-7100

backflow preventers
reduced pressure principle
sizes 2½", 3", 4", & 6"

UL | UPC | ASSE 1013 | AWWA C-506



Dimensions:



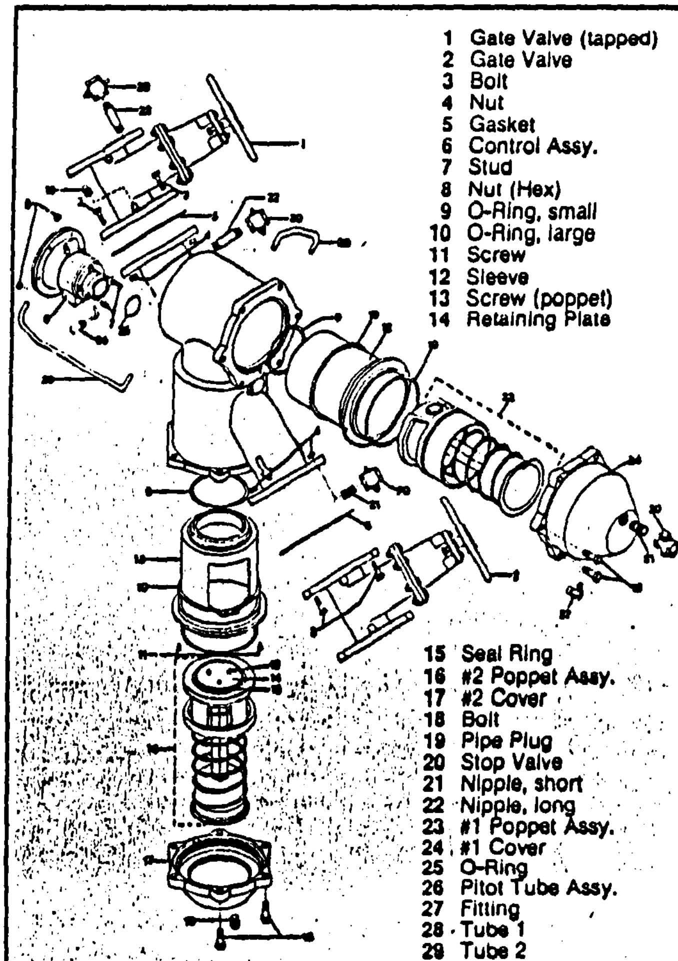
Size inches	Dimensions (inches)						Wt. lbs. (approx.)
	A	B	C	D	E	F	
3	36	20	8¾	13⅝	5	5	287
4	46½	28	9	15	5	5	462
6	57⅛	36	16	18	7	7	737

Specifications: The Reduced Pressure Backflow Preventer shall consist of a connecting pressure differential relief valve located between two independently operated spring-loaded poppet type check valves. The maincase shall be epoxy coated inside and outside and consist of four test cocks which provide for in-line testing and maintenance. Stainless steel springs and corrosion resistant materials shall be used throughout. Head loss characteristics shall be at least equal to Wilkins' Model 575. The relief valve functions automatically by sensing the pressure differential across the first check valve and discharges backflow to atmosphere in the event the check valves become damaged or fouled.

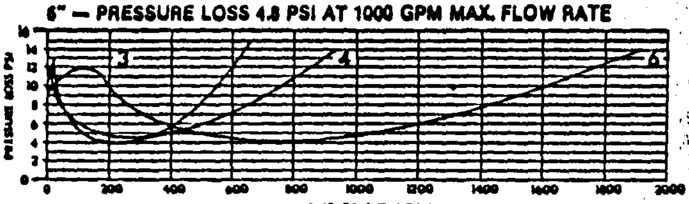
Features:
- Low head loss — exceeds all standards, lowest in industry.
- Low maintenance costs — no special tools required to service units, few moving parts, in-line serviceability.
- Compact size — easy to install.
- Epoxy coated maincase - inside and outside — corrosion resistant, heat treated application for long life, sturdy and durable.
- Bronze poppet type check valves — unitized spring assembly for safety, independently operated, stainless steel springs, corrosion resistant.
- One piece bronze sleeve and seat — easy to remove, corrosion resistant.
- Hydraulically actuated relief valve — discharges backflow to atmosphere.
- Temperature range — 33°F - 140°F.
- Maximum operating pressure — 150 psi.

Application: Designed for potable water systems where a potential health hazard exists.

Configurations:
- Sizes — 2½", 3", 4", 6"
- Manifolds for uninterrupted service —
  6" Line — 6" × 3" × 3".
  8" Line — 8" × 4" × 4".
  10" Line — 10" × 6" × 6".
- Gate Valves — Specify with gates, less gates or OS & Y.
- Connections — Flanged.



3" — PRESSURE LOSS 4.5 PSI AT 320 GPM MAX. FLOW RATE
4" — PRESSURE LOSS 5.1 PSI AT 500 GPM MAX. FLOW RATE
6" — PRESSURE LOSS 4.8 PSI AT 1000 GPM MAX. FLOW RATE



Additional flow capacity available within allowable pressure loss.

PVF MIDWEST INC.
1618 NEW BRIGHTON BLVD.
MINNEAPOLIS, MN 55413
(612) 781-4342

BUTTERFLY VALVE WITH RESILIENT SEAT

MODEL #51—WAFER STYLE
MODEL #52—FULL LUG STYLE

Superior design and construction of a 150 psi WOG rated butterfly valve provides bubble tight performance with minimum torque, and with three oil impregnated bushings you are assured years of trouble free service.

Designed for ANSI 125/150 lb. class flanges, these valves comply with MSS-SP-25, MSS-SP-67 and API-609 specifications.

Features

- Cast in-place mounting flange accommodates gear operators; pneumatic, hydraulic, diaphragm and electric actuators.
- O-ring seal provides permanent lubrication and prevents atmospheric contamination.
- Streamlined disc design reduces pressure drop and minimizes turbulence.
- Resilient seat design eliminates the need for flange gaskets.
- Each valve hydrostatically tested on both sides to 175 psi.
- Three heavy-duty bronze stem bushings are oil-impregnated to provide maximum stem support while keeping torque at a minimum by absorbing side loading for optimum operator performance.
- Redundant stem seal is obtained between disc and seat hub (primary); a secondary seal is obtained with the seat O-ring.
- One piece stem design provides high strength, positive attachment to disc with pins and welch plugs.
- Long-neck design allows ample clearance for insulation.
- All lug bodies are threaded.
- All wafers have drilled guide lugs, except 20″ and 24″ which are threaded.
- Lug style suitable for dead-end service when downstream flange is used.

2″-12″ SERIES 55/56 BUTTERFLY VALVE WITH RESILIENT SEAT

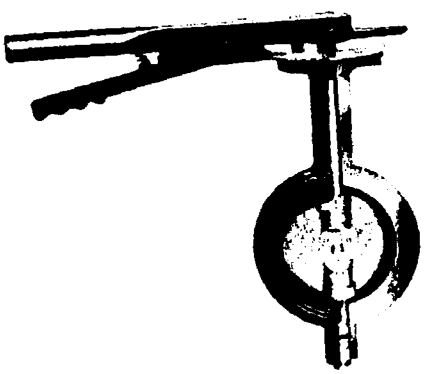
MODEL #55—WAFER STYLE
MODEL #56—FULL LUG STYLE

An economic, general purpose, full performance butterfly valve, bubble tight rated at 200 psi WOG that meets the stringent demands of the processing industries as well as the needs of the mechanical contractor in HVAC applications.

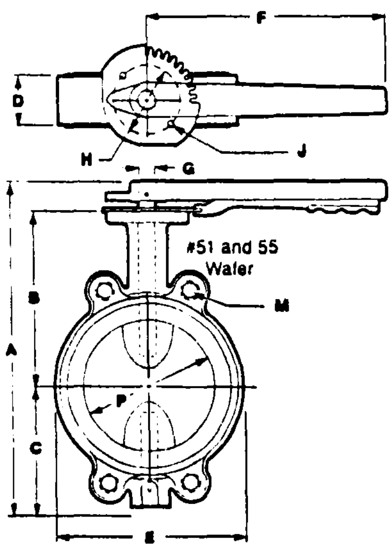
Designed for ANSI 125/150 lb. class flanges, these valves comply with MSS-SP-25, MSS-SP-67 and API-609 specifications.

Features

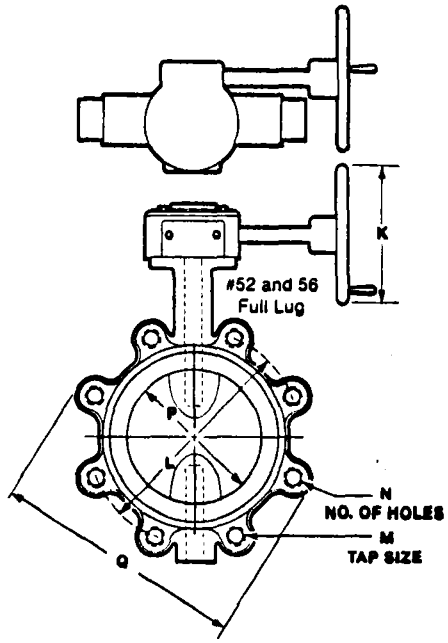
- Cast in-place mounting flange accommodates all types of operators: manual handles and gear operators; pneumatic, hydraulic, diaphragm and electric actuators.
- Each valve hydrostatically tested on both sides to 225 psi.
- Dual stem seal is between disc and seat spherical hubs (Patent 356394), additional seal from seat O-ring.
- Oil impregnated bronze bushings provide maximum stem support while accepting side loading to minimize torque for peak operator performance.
- Two piece stem design allows field replacement of seats.
- Streamlined disc design reduces pressure drop and minimizes turbulence.
- Resilient seat design eliminates the need for flange gaskets.
- Long neck design allows ample clearance for insulation.
- All lug bodies are threaded.
- 10″ and 12″ wafers have drilled guide lugs.
- Lug style suitable for dead-end service when downstream flange is used.

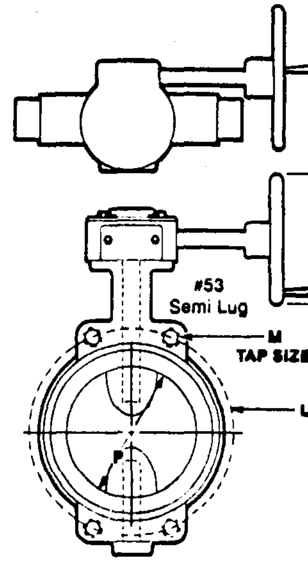


DIMENSIONAL/WEIGHT DATA



Drilled guide lugs on 10" and 12."





2"-12" 51-56 SERIES

Size	2	2 1/2	3	4	5	6	8	10	12
A	9 3/8	10 3/16	10 11/16	13	14	15 3/16	17 3/4	20 1/2	23 1/2
B	5 3/8	5 15/16	6	7	7 9/16	7 15/16	9 3/16	10 1/2	12 1/16
C	3	3 1/4	3 11/16	4 13/16	5 1/4	5 7/8	6 15/16	8 3/8	9 13/16
D	1 5/8	1 3/4	1 3/4	2	2 1/8	2 1/8	2 3/8	2 11/16	3
E (51, 52)	4 1/4	4 15/16	5 7/16	6 15/16	7 3/4	8 3/4	11	13 3/8	16
E (53)	4 1/4	4 15/16	5 7/16	6 1/16	7 1/2	8 1/16	10 3/4	13 1/8	15
E (55, 56)	4	4 3/4	5 1/4	6 5/16	7 1/2	8 1/2	10 5/8	12 1/2	14 3/4
F	8	8	8	11	11	11	16	16	16
G	.561	.561	.561	.686	.686	.811	.936	1.123	1.247
H	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	4 3/4	4 3/4	4 3/4
J	9/32	9/32	9/32	9/32	9/32	9/32	17/32	17/32	17/32
K	6	6	6	6	6	6	10	10	10
L	4 3/4	5 1/2	6	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4	17
M	5/8-11 UNC	5/8-11 UNC	5/8-11 UNC	5/8-11 UNC	3/4-10 UNC	3/4-10 UNC	3/4-10 UNC	7/8-9 UNC	7/8-9 UNC
N	4	4	4	8	8	8	8	12	12
P	2	2 1/2	3	4	5	6	8	10	12
Q	6	7	7 1/2	9 1/8	10	11 1/4	13 3/4	16	19
R	3	3	3	3	3	3	3	3	3

Clearance hole diameter for the drilled lug option or wafer is tapped size + 1/8."

VALVE WEIGHT DATA*

Size	2"	2 1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"
2"-24" 51-Series Wafer	8	9	9	13	18	20	34	61	93	147	202	260	333	511
2"-24" 52-Series Full Lug	8	11	11	18	22	25	42	72	110	160	231	286	378	543
2"-12" 53-Series Semi-Lug	—	—	—	16	20	23	38	66	101	—	—	—	—	—
2"-12" 5-Series Wafer	5	7	8	11	15	19	34	59	94	—	—	—	—	—
2"-12" 56-Series Full-Lug	7	8	9	17	21	25	42	73	112	—	—	—	—	—

*Does not include operator.

MATERIAL SPECIFICATIONS

Example: 1—2"—51—ANI3—1

2"-12" PHENOLIC REINFORCED RESILIENT SEAT

SIZE:	2" 2½" 3" 4" 5" 6" 8" 10" 12"
STYLE:	51—Wafer; 52—Full Lug; 53—Semi Lug
BODY:	A —Cast Iron/ASTM A-126-B C —M Metal/ASTM B-61 D —Carbon Steel/ASTM A-216 Grade WCB H —316 Stainless/ASTM A-351 Grade CF-8M I —Ductile Iron/ASTM A-395 Class 60-40-18 J —Aluminum/ASTM B-26 356T6
STEM:	H—316 SS/ASTM A-479; N—416 SS/ASTM A-582; P—Alloy 20 SS; Q—Monel/ASTM B-164
DISCS:	H —316 SS/ASTM A-351 Grade CF-8M I —Ductile Iron Nickel Coated/ASTM A-395 Class 60-40-18 K —Bronze/ASTM B-62 Q —Monel/ASTM A-743 M-35-2 Z —Ductile Iron Non-Coated*/ASTM A-395 Class 60-40-18 **Fluoropolymer Coated Discs:** W—Ductile Iron, Kynar (PVDF) Coated/(Pin Hole Free) Y —Ductile Iron, Halar (ECTFE) Coated/(Pin Hole Free)
SEATS:	3—Buna-N ASTM D-2000 MZBF 717 B14 B34 E014 E034 4—Viton ASTM D-2000 M4HK 707 5—Hypalon ASTM D-2000 MZCE 717 A16 B15 6—EPDM ASTM D-2000 MZCA 714 A25 B44 EA14 S17 7—Teflon Buna-Base† 8—Black Neoprene ASTM D-2000 M3BC 710 A14 E104 E034 9—White Neoprene ASTM D-2000 M5BC 714 B14 E014 E034 G21/FDA Title 21, Paragraph 177.2600
OPERATOR:	0—Without Operator 1—10 Position Handle 2—10 Pos. with Memory 3—Infinite Position 4—Infinite Pos. with Memory 5—Gear Operator 6—Electric Operator 7—Hydraulic Operator 8—Pneumatic Operator 9—Other Operator

14"-24" RESILIENT SEAT

SIZE:	14" 16" 18" 20" 24"
STYLE:	51—Wafer; 52—Full Lug
BODY:	A —Cast Iron/ASTM A-126-B; I —Ductile Iron/ASTM A-395 Class 60-40-18
STEM:	H—316 SS/ASTM A-479; N—416 SS/ASTM A-582; P—Alloy 20 SS
DISCS:	H —316 SS/ASTM A-351 Grade CF-8M I —Ductile Iron Nickel Coated/ASTM A-395 Class 60-40-18 K —Bronze/ASTM B-62 Z —Ductile Iron Non-Coated*/ASTM A-395 Class 60-40-18
SEATS:	3—Buna-N ASTM D-2000 MZBF 717 B14 B34 E014 E034Z 4—Viton ASTM D-2000 M4HK 707 5—Hypalon ASTM D-2000 MZCE 717 A16 B15 6—EPDM ASTM D-2000 MZCA 714 A25 B44 EA14 S17Z 8—Black Neoprene ASTM D-2000 M3BC 710 A14 E104 E034 9—White Neoprene ASTM D-2000 M5BC 714 B14 E014 E034 G21/FDA Title 21, Paragraph 177.2600
OPERATOR:	0—Without Operator 5—Gear Operator 6—Electric Operator 7—Hydraulic Operator 8—Pneumatic Operator 9—Other Operator

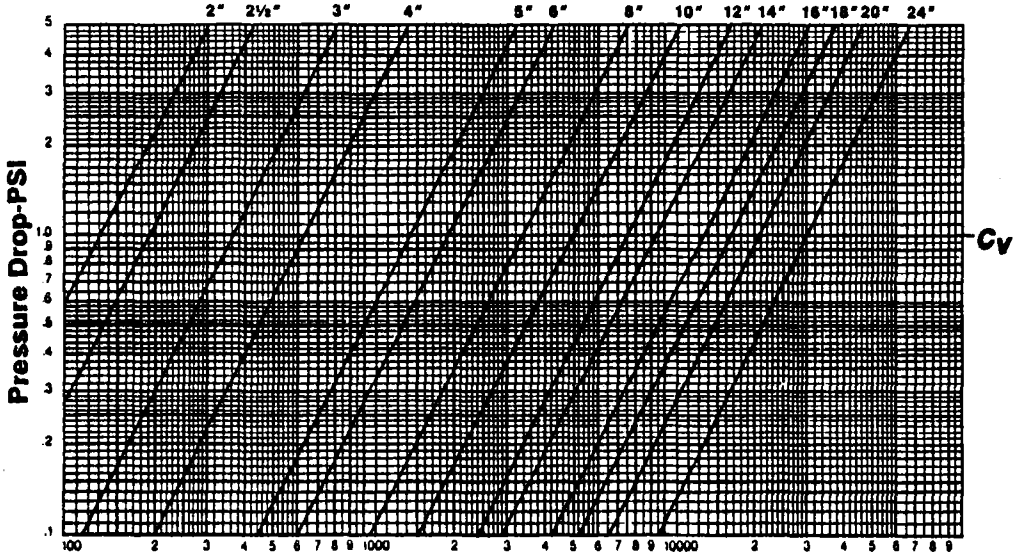
2"-12" RESILIENT SEAT

SIZE:	2" 2½" 3" 4" 5" 6" 8" 10" 12"
STYLE:	55—Wafer; 56—Full Lug
BODY:	A —Cast Iron/ASTM A-126-B; I —Ductile Iron/ASTM A-395 Class 60-40-18
STEM:	H—316 SS/ASTM A-479; N—416 SS/ASTM A-582; P—Alloy 20 SS; Q—Monel/ASTM B-164
DISCS:	H —316 SS/ASTM A-351 Grade CF-8M I —Ductile Iron Nickel Coated/ASTM A-395 Class 60-40-18 K —Bronze/ASTM B-62 Q —Monel/ASTM A-743 M-35-2 Z —Ductile Iron Non-Coated*/ASTM A-395 Class 60-40-18 **Fluoropolymer Coated Discs:** W—Ductile Iron, Kynar (PVDF) Coated/(Pin Hole Free) Y —Ductile Iron, Halar (ECTFE) Coated/(Pin Hole Free)
SEATS:	3—Buna-N ASTM D-2000 MZBF 717 B14 B34 E014 E034Z 6—EPDM ASTM D-2000 MZCA 714 A25 B44 EA14 S17Z 6—EPDM (Food Grade)** ASTM D-2000 8CA 7520 A25 B35 G21 EA14/FDA Title 21, Paragraph 177.2600
OPERATOR:	0—Without Operator 1—10 Position Handle 2—10 Pos. with Memory 3—Infinite Position 4—Infinite Pos. with Memory 5—Gear Operator 6—Electric Operator 7—Hydraulic Operator 8—Pneumatic Operator 9—Other Operator

Available Options: Other material available, consult factory. *Non-Coated Ductile Iron Disc not recommended for water or corrosive service. **Specify: Food Grade †150 PSI rated. Above items not necessarily carried in stock.

FLOW/PRESSURE DROP DATA

MAXIMUM FLOW/ PRESSURE DROP DATA
Flow with Valve Full Open



Flow in Q = Gallons Per Minute

C_V VALUES

The flow characteristic of a valve is described as its C_V value. C_V is defined as the maximum flow of 60°F water expressed in GPM (Gallons Per Minute) which produces a 1 PSI drop across the valve.

Formula for fluids:

$$C_V = Q\sqrt{\frac{G}{\Delta P}}$$

Q = Flow GPM

ΔP = Pressure Drop in PSI

G = Specific Gravity

To size a valve:

For "On/Off" Service: simply select a valve which is the same as the piping system.

For Throttling Service: Use C_V data 30° to 60° disc opening value from C_V table.

Valve sizing for throttling, follow these steps:

1. Flow required in the system (Q). Maximum allowable pressure drop (ΔP). Specific Gravity of pipe line medium (G).
2. Calculate C_V using above formula.
3. Determine valve size and degree disc must be open from C_V table.
4. Make sure that maximum line velocity does not exceed the recommended maximum valve velocity, i.e., LIQUIDS: 20 ft./second. GASES: 15,000 ft./minute.

$$V = \frac{Q \times .321}{A} \text{ (liquid only)}$$

A = Area of pipe in square inches

Example: Throttling Service

Given: Q = 5,000 GPM (Flow)
ΔP = 1.75 PSI (Pressure Drop)
G = .750 (Specific Gravity/ Gasoline)

1. $C_V = Q\sqrt{\frac{G}{\Delta P}} = 5000\sqrt{\frac{.750}{1.75}} = 3273.$
2. From C_V table: 12" valve has C_V range 825-3450, 30°-60° open disc.
3. Velocity $= V = \frac{Q \times .321}{A}$

$$= \frac{5000 \times .321}{113.1} = 14.2 \text{ ft/sec}$$

which is within the limits, so for the given conditions a 12" valve should be used.

C_V VALUES

Size							
2	130	87	60	43	25	14	6
2½	190	127	87	63	36	21	9
3	360	241	166	119	68	39	18
4	650	435	300	214	123	71	32
5	1,400	938	644	462	266	154	70
6	1,900	1,273	875	627	361	209	95
8	3,300	2,200	1,518	1,089	627	363	165
10	5,000	3,350	2,300	1,650	950	550	250
12	7,500	5,025	3,450	2,475	1,425	825	375
14	9,500	6,365	4,370	3,135	1,800	1,050	475
16	13,400	8,978	6,165	4,420	2,550	1,475	670
18	17,200	11,500	7,910	5,676	3,270	1,892	860
20	21,300	14,270	9,800	7,030	4,050	2,350	1,065
24	30,000	20,100	13,800	9,900	5,700	3,300	1,500
	FULL OPEN	72°	60°	50°	40°	30°	20°

SIEMENS

SIEMENS

World Series
3TF Contactors
Cat. No. 3TF40
3TF41

CP 3052.16
Issue 02, February, 1995

Installation and Maintenance

	WARNING
ϟ	**Hazardous voltage could result in death or serious injury.** Disconnect power before proceeding with any work on this equipment.

Description

The contactor has three (3) power poles and up to four (4) auxiliary contacts. See faceplate for terminal marking. The coil terminals are marked A1 and A2. Terminals 1 through 6 are power pole terminals; 13 through 44 are auxiliary contact terminals.

Maintenance

No maintenance is required on the contacts. Main and auxiliary contacts are not accessible and the entire contactor needs to be replaced when end of life is reached.

If the contactor hums, dust may have accumulated on the magnet pole faces. These pole faces can be cleaned by disassembling the contactor. Clean the pole faces with a lint free cloth. Do not use a degreasing agent, nor scratch with a pointed object. After prolonged period of operation, excessive humming or rattling may indicate that the device has reached the end of its service life and should be replaced.

AC Coil Replacement

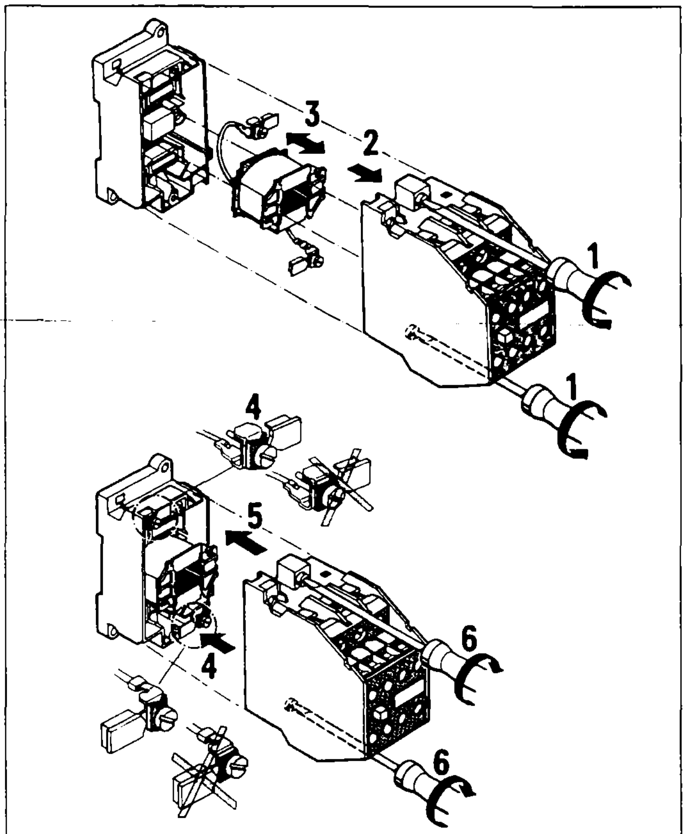


Figure 1

DC Coil Replacement

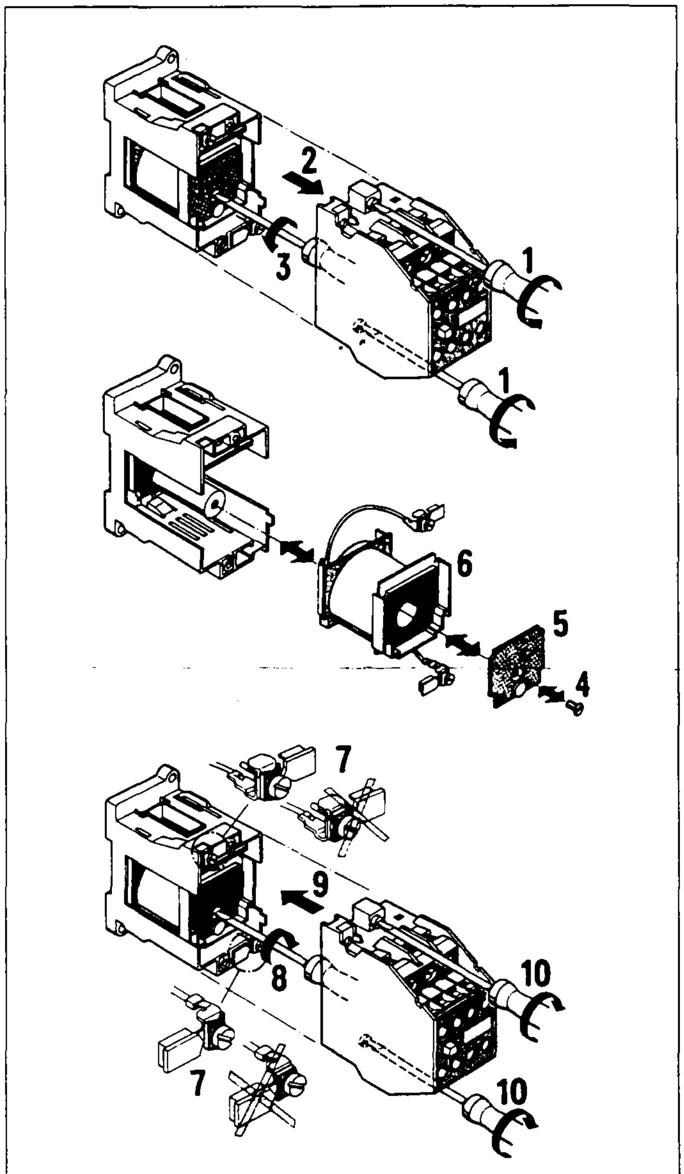


Figure 2

Contactor Rating

Catalog Number	UL Max. Ratings Amperes	Maximum Horsepower Rating					
		Single Phase		Three Phase: Motor Voltage			
		115	230	200	230	460	575
3TF40	20	1/2	1-1/2	2	3	5	7-1/2
3TF41	20	1	2	3	3	7-1/2	10

Terminals

Type	Wire Size	Tightening Torque
Power	(2) 18 - 12 AWG	7 - 12 lb. in.
Control	(2) 18 - 12 AWG	7 - 12 lb. in.

Auxiliary Contact Ratings - Heavy pilot duty A600/P600

Volts (AC)	Make		Break	
	VA	Amps	VA	Amps
120	7200	60	720	6
240	7200	30	720	3
480	7200	15	720	1.5
600	7200	12	720	1.2

Volts (DC)	Make/Break Amps
125	1.1
250	0.56
600	0.2

Renewal Parts

Description	Catalog No.
AC Coils:	
24V 60 Hz	3TY7403-0AC2
120V 60 Hz	3TY7403-0AK6
208V 60 Hz	3TY7403-0AM1
240V 60 Hz	3TY7403-0AP6
277V 60 Hz	3TY7403-0AU1
460V 60 Hz	3TY7403-0AQ0
600V 60Hz	3TY7403-0AS0
DC Coils:	
24V	3TY4803-0BB4
48V	3TY4803-0BW4
125V	3TY4803-0BG4
240V	3TY4803-0BQ4

Coil Data ①

AC Operation		
Inrush	VA	75
	pf	0.75
Sealed	VA	9.4
	pf	0.29
DC Operation		
Inrush = Sealed	W	6.2

① Coil voltage tolerance is 0.8 to 1.10 times rated coil voltage.

Short Circuit Withstand

Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 600 volts maximum. Use Branch Circuit Protection device in accordance with the National Electrical Code (NEC) Article 430-52. See starter enclosure for higher short circuit ratings.

Ambient Temperature

Range permissable during:
Operation = -25 to +55°C (-13 to + 131°F)
Storage = -50 to +80°C (-58 to + 176°F)

Siemens Energy & Automation, Inc.
Canton, Georgia 30114

SIEMENS

Siemens Energy & Automation, Inc.
Wilmington, N.C. 28403 U.S.A.
Assembled in Mexico

Piece No. 116422-A Rev. 5

Installation Procedure

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Turn off and lock out all power before installing or servicing.

⚠ SAFETY INSTRUCTIONS

NOTE: This instruction outlines the recommended installation procedure.

1. Turn off and lockout all power before installing or servicing.
2. These devices are approved for use with external handle operators. Refer to Siemens basic catalog numbers FDH10, FHOHS, RHOH and associated operating mechanism.
3. Locate switch as required by handle operating mechanism. Drill and tap the switch mounting holes (4 holes) as shown in Fig. 1.
4. Loosen screws and remove the line shield (Item 1) to access the switch top mounting holes. Note that the switch should be in open position to access lower mounting screws. Position the unit over the mounting holes. Use 10-32 x 1/2 screws with lockwashers to mount the switch. Torque all mounting screws to 25-28 in. lbs.
5. Reinstall the line shield (Item 1) and tighten using the screws provided.
6. Non-Fused:
   When non-fused application is desired, use TMK606 connector kit. See Pg. 3, Fig. 3, and Pc. No. 600010-A instruction sheet.
7. Fused:
   For fuse installation refer to Pg. 2.
8. For overfusing installation refer to OFCK661 instruction sheet. Pc. No. 116804.-A.

DISCONNECT SWITCH CAT. NO.

Catalog No.	Amps	Volts	Horse power Max.
MCS603R	30	600	20
MCS603L	30	600	20
MCS606R	60	600	50
MCS606L	60	600	50

Table 1
Above catalog numbers also rated for 250V DC.

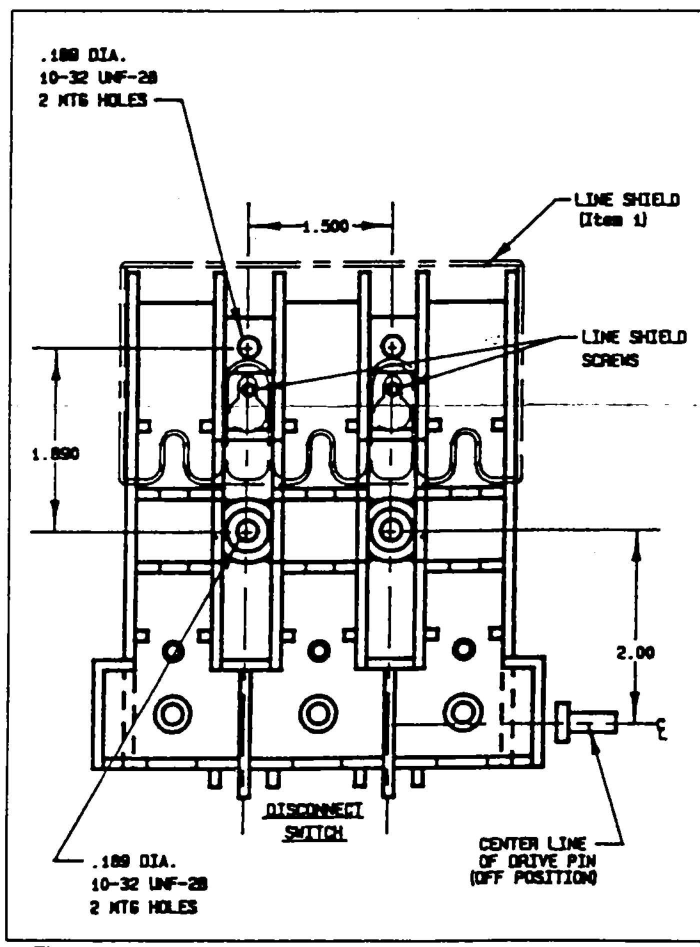
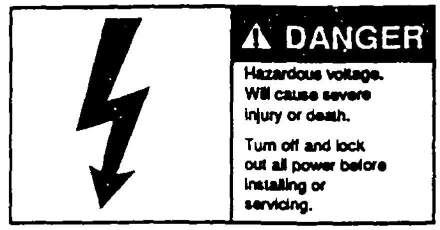


Fig. 1

Siemens Energy & Automation, Inc.
Wilmington, NC 28412 USA.
Assembled in Mexico

Piece No. 116422-A Rev. 5



Installation Instructions

9. Using Table 2, locate the proper fuse block Cat. No. for the type of fuses you are using. Read across until you locate the dimension necessary to position the fuse block at the proper distance from the switch.

10. Using 5/32" or no. 21 drill, drill two holes and tap #10-32 for mounting screws provided with fuse block kit. Align the fuse block parallel to the bottom of the disconnect switch before tightening screws to 25-28 in. lbs.

11. Using Figure 4, install the fuse clips provided, on the disconnect device with #10-32 x 5/16 long panhead machine screws and torque screws to 25-28 in. lbs.

12. For Cat. No. FCK203 & FCRK203 use Fig. 5, install fuse clip & strap on disconnect device.

13. For Cat. No. FCJK603 & FCRK606 refer to Fig. 5 & 6. Note Fig. 6 must be installed in center pole.

14. Install the proper class fuses before turning power on.

FUSE BLOCK KITS

Catalog No.	Fuse Type	Amps	Volts	Dimension "A"
FCK203	H	0-30	240	3.62
FCRK203	R	0-30	240	3.62
FCK206	H	31-60	240	3.38
FCRK206	R	31-60	240	3.38
FCRK206	R	0-30	600	5.50
FCJK603	J	0-30	600	3.88
FCK206	H	0-30	600	5.50
FCRK606	R	31-60	600	5.88
FCJK606	J	31-60	600	3.88
FCK606	H	31-60	600	5.88

Table 2

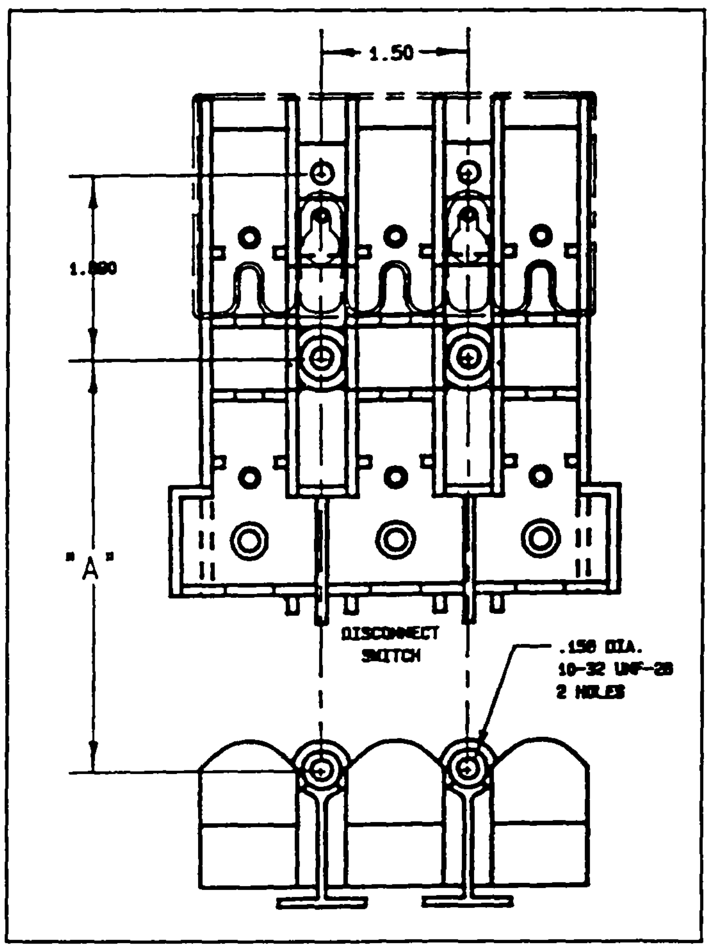


Fig. 2

Siemens Energy & Automation, Inc.
Wilmington, NC 28412 USA
Assembled in Mexico

Piece No. 116422-A Rev. 5

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Turn off and lock out all power before installing or servicing.

Installation Instructions

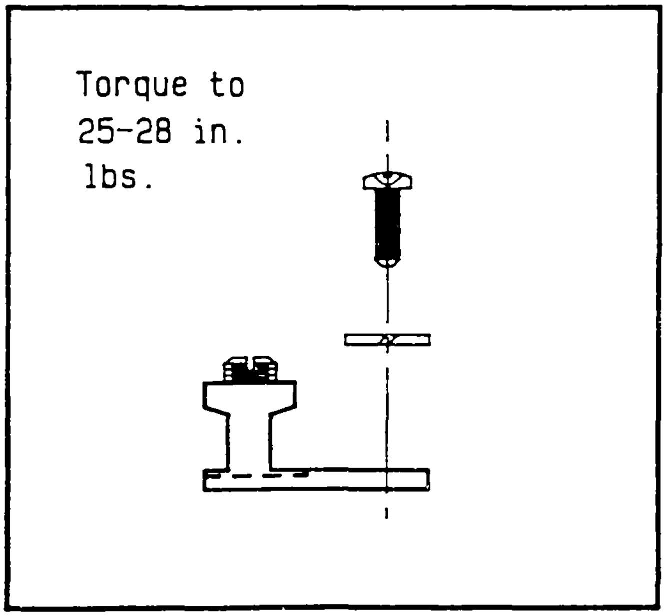


Fig. 3

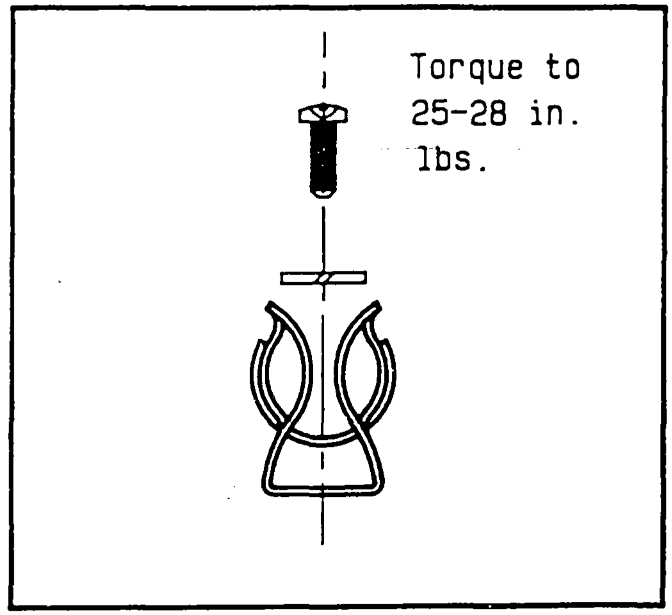


Fig. 4

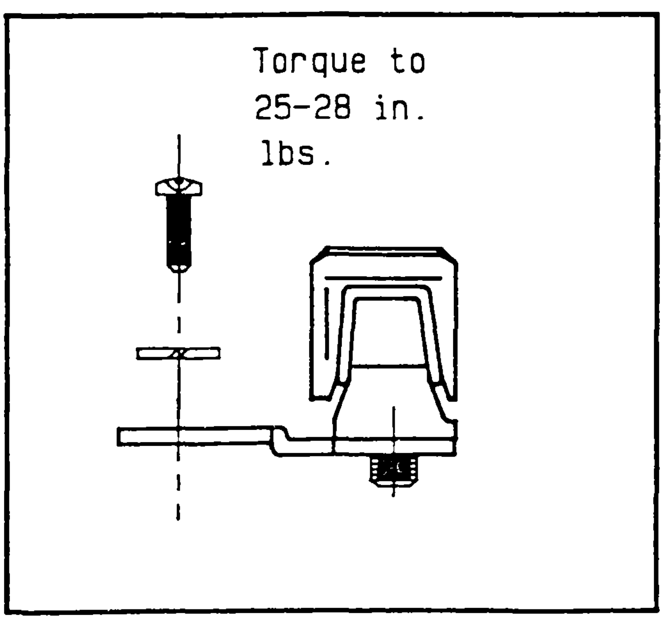


Fig. 5

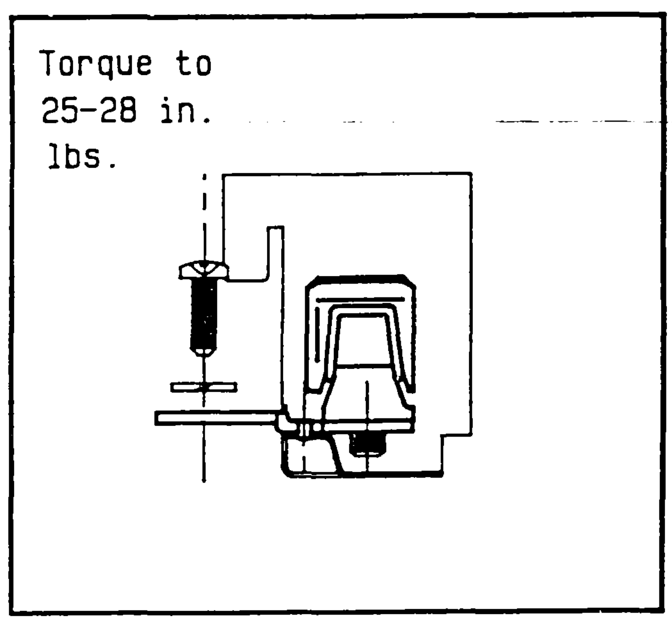


Fig. 6

SIEMENS

Control Transformer Kit
Cat. No's KT8XXX, KT9XXX, KTHXXX

CP3245
April 1990
Issue .03

Controls Division

Installation & Maintenance

Description:

The following transformer kits consist of:

A. KT8050, 9050 and H050:
- Control power transformer rated 45VA. with integraly mounted secondary fuse clips on the top.
- One time delay, non-rejection type, midget secondary fuse rated 250 volt.
- Mounting hardware and cable ties.
- Two primary wires (black), two secondary wires (red) and one ground wire (green) all crimped with the appropriate terminals.
- One fuse rating label.

B. All Other Transformer Kits:
- Control power transformer with integrally mounted primary and secondary fuse block.
- Two, time delay, rejection type, class CC, midget primary fuses rated 600V.
- One time delay, non-rejection type, midget secondary fuse rated 250 volt.
- Mounting hardware and cable ties.
- Two primary wires (black), two secondary wires (red) and one ground wire (green) all crimped with the appropriate terminals.
- Two fuse rating labels.

The Siemens transformer rating table shows the recommended transformer kits for use with Siemens across-the-line contactors or starters. However, the transformer rating may vary with the type of starters and the options to be fed directly from the transformer. Also, the table indicates the sizes and rating of the primary and secondary fuses selected according to NEC article 430-72 and 450-3 (b).

Installation

All enclosed combination and enclosed non-combination starters are provided with pre-drill mounting holes to accept the installation of a control transformer kit, with the exception of the NEMA type 1 lift-off enclosed non-combination starters. Most starters have provisions for oversized transformer kits. Select the appropriate kit and install as follows:

⚠ WARNING

HAZARDOUS VOLTAGE
CAN CAUSE ELECTRICAL SHOCK AND BURNS.
DISCONNECT POWER BEFORE PROCEEDING WITH ANY WORK ON THIS EQUIPMENT.

- Mount transformer to the plate using enclosed #10 or 1/4" self tap screws.
- Wire transformer and fuse block in accordance with the appropriate wiring diagram (usually affixed to the inside cover of the enclosure). Use the wires with lug terminals to make the connections - black wires for the primary side of the transformer, red wires for secondary side of the transformer, and green wire for ground. Loop, tie or trim excess length of wires needed.

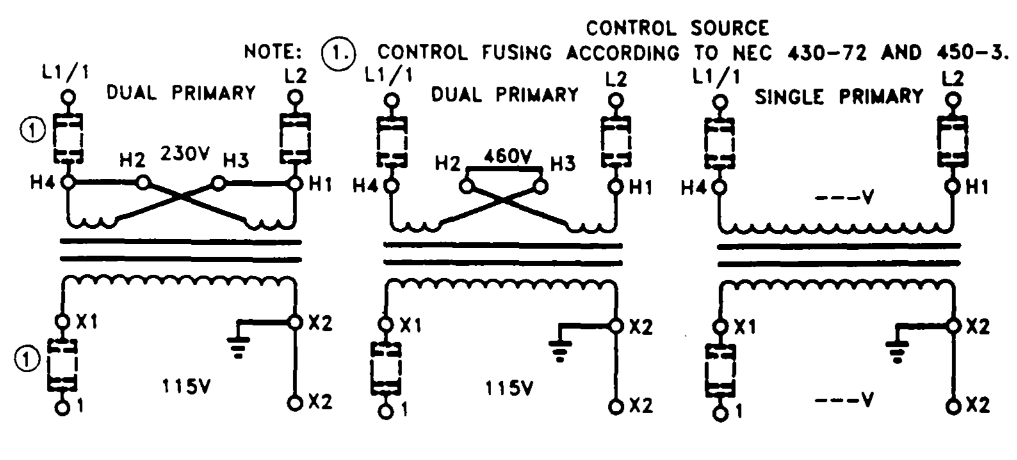
NOTICE: For the Dual Primary Voltage Transformers, two stacked metal jumpers are provided and connected between primary terminals H2 and H3 which is the appropriate connection for a 460 volt primary application. For 230 volt primary application, REMOVE the two jumpers between H2 and H3. Reconnect one jumper between H1 and H3, and the other jumper between H2 and H4.

- Check that all connections are properly wired according to the wiring diagram and screws are well tightened to provide secure connections. Special care need to be taken so that ground connector has made continuity to metal surface of the plate.
- Affix fuse rating labels to the panel in a place close to the transformer to identify fuses, if needed.

Siemens Transformer Kits Rating

Primary Voltage	Secondary Voltage	VA Rating	Standard for Contactor Style	Standard for NEMA Size	Transformer Kit Cat. No.	Secondary Fuse Amp. (1)	Primary Fuse Amp. (2)
230/460	115	45	3TB40-3TF47	0 - 2	KT8050	0.6	N/A (3)
230/460	115	50	3TB40-3TF47	0 - 2	KT8050P	0.6	0.25
230/460	115	100	3TF48	3	KT8100	1.12	0.5
230/460	115	150	3TF50	-	KT8150	1.8	0.8
230/460	115	200	3TF52	4	KT8200	2.25	1.0
230/460	115	300	3TF54	-	KT8300	3.5	1.5
230/460	115	500	3TF56	5	KT8500	5.6	3.0
575	115	45	3TB40-3TF47	0 - 2	KT9050	0.6	N/A (3)
575	115	50	3TB40-3TF47	0 - 2	KT9050P	0.6	0.25
575	115	100	3TF48	3	KT9100	1.12	0.25
575	115	150	3TF50	-	KT9150	1.8	0.5
575	115	200	3TF52	4	KT9200	2.25	0.5
575	115	300	3TF54	-	KT9300	3.5	0.8
575	115	500	3TF56	5	KT9500	5.6	1.0
208	115	45	3TB40-3TF47	0 - 2	KTH050	0.6	N/A (3)
208	115	50	3TB40-3TF47	0 - 2	KTH050P	0.6	0.5
208	115	100	3TF48	3	KTH100	1.12	0.8
208	115	150	3TF50	-	KTH150	1.8	1.0
208	115	200	3TF52	4	KTH200	2.25	1.5
208	115	300	3TF54	-	KTH300	3.5	2.0
208	115	500	3TF56	5	KTH500	5.6	3.0

(1) Time delay, non-rejection type, midget fuse rated 250V.
(2) Time delay, rejection type, Class CC, midget fuse rated 600V.
(3) According to N.E.C. - 430 - 72 , 450 - 3 (b) and UL 508, section 32, primary fuses are not required for control transformer rated less than 50 VA and are inherently protected.



Typical Transformer Wiring Diagram

Siemens Energy & Automation, Inc.

3333 State Bridge Road
Alpharetta, Georgia 30201
(404) 751-2000

SIEMENS

Thermal Overload Relays
Type 3UA50

CP 3153
Issue 02, December, 1994

Adjustment Ranges:
0.10 - 0.16 to 10 - 14.5 Ampere

Installation and Maintenance

These relays are for direct mounting on contactors:
3TF30, 3TF31
3TF40, 3TF41
Reversing contactors:
CRL0F30, CRL0F31
CRL0F40, CRL0F41

⚠ WARNING

Hazardous voltage could result in death or serious injury.

Disconnect power before proceeding with any work on this equipment.

Description

This three phase overload relay is a NEMA Class 10, (IEC Class 10A) directly heated, ambient compensated, adjustable bimetallic motor protective device.

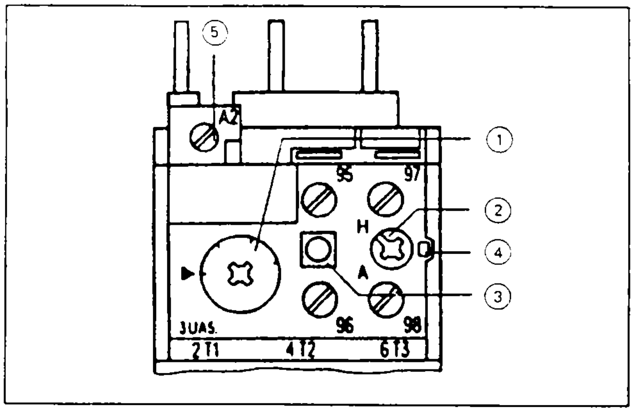
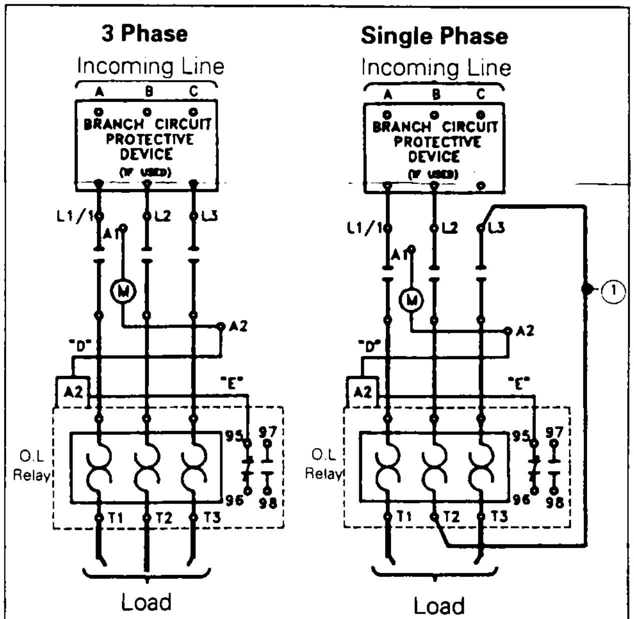


Figure 1

See Figure 1.
1 - Adjustment dial
2 - Reset, blue
Hand/auto reset (see note). Allow about 1 minute for cooldown.
3 - Test button, red
4 - Trip indicator, green
flush - not tripped
above surface - tripped
5 - Contactor coil repeat terminal A2

Note: Do not use automatic reset with 2-wire control or other controls where automatic restart of the motor can cause injury to persons or damage to equipment.

Typical Applications



"D" wire is an integral part of the overload relay.
"E" wire is factory installed.
① Connection to be provided by installer.

Figure 2

Application Data

Ambient Temperature Compensation
-25 to +55°C (-13 to +131°F)

Terminals:

Type	Wire Size	Tightening Torque
Power	14-10 AWG	9-13 lb.in. (1-1.5 Nm)
Control	(2) 18-12 AWG	7-12 lb.in. (0.8-1.2Nm)

Type of Current; Frequency:
AC up to 400Hz max; DC

Application Notes:

- Always connect the NC contact (95-96) in series with the contactor coil (wire "D")
- After installation, check function of the OLR by depressing test (red) button. Contactor should drop out. Reset by depressing reset (blue) button.
- After a fault, check OLR for proper functioning. If in doubt, replace OLR.

Setting of Overload Relay

Relay is a NEMA Class 10 (IEC 947 class 10A). Turn dial to align desired current with mark:

For motor with Service Factor 1.15 or larger
Set dial to motor full load current marked on motor.

For motor with Service Factor of less than 1.15
Set dial at 92% of motor full load current.

For Y-Delta Applications (with relay carrying phase current)
Follow instruction above, **except** multiply motor full load current with the factor 0.58.

In order to inhibit accidental or unauthorized changes use **Sealable Cap 3UX1 111.**

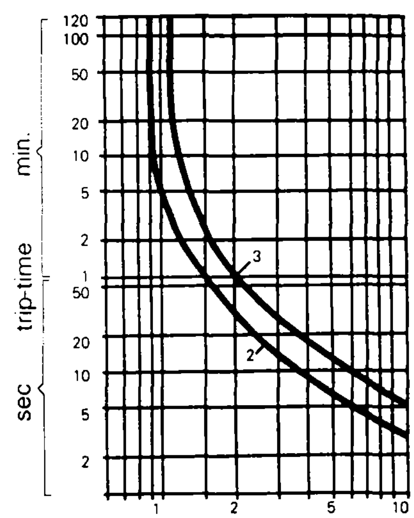


Figure 3

Curves based on "cold" start. At warm conditions, tripping values are 25% of shown values.
Curve 1 - denotes balanced 3-phase loading
Curve 2 - denotes tripping time at single phase condition

Short-Circuit Withstand Ratings:

Suitable for use on a circuit sutiable to deliver not more than 5000 rms symmetrical Amperes, 600 volts maximum.

See marking on enclosure for short-circuit ratings exceeding 5000 amperes.

Overload Relay Cat. No.	Motor Full Load Amps	Branch Circuit Protection						
		Maximum Ratings (4)			IEC Type 2 Protection (3)			
		Fuses (1)	Circuit Breaker		Required Fuse Amps @ 480V max.			
		RK5	Therm. Mag.	Mag only ITE Type (2)	J	RK1	RK5	CC
3UA5000-0A	0.1 - 0.16	1	15	ED63A001	1	1	0.5	1
3UA5000-OC	0.16 - 0.25	1	15	ED63A001	1	1	0.5	1
3UA5000-0E	0.25 - 0.4	1	15	ED63A001	1	1	0.8	1
3UA5000-0G	0.4 - 0.63	3	15	ED63A001	1	1	0.8	1.25
3UA5000-0J	0.63 - 1	3	15	ED63A002	1.5	1.4	1	1.6
3UA5000-0K	0.8 - 1.25	3	15	ED63A002	2	1.6	1.4	2
3UA5000-1A	1 - 1.6	6	15	ED63A002	2	1.6	1.4	2.25
3UA5000-1B	1.25 - 2	6	15	ED63A003	3	2.8	2	3
3UA5000-1C	1.6 - 2.5	10	15	ED63A003	3	2.8	2.5	3
3UA5000-1D	2 - 3.2	10	15	ED63A005	6	6	4	6
3UA5000-1E	2.5 - 4	15	15	ED63A005	6	6	5	6
3UA5000-1F	3.2 - 5	20	20	ED63A010	8	8	6	10
3UA5000-1G	4 - 6.3	25	25	ED63A010	10	10	6	10
3UA5000-1H	5 - 8	30	30	ED63A025	15	15	9	20
3UA5000-1J	6.3 - 10	40	40	ED63A025	15	15	15	20
3UA5000-1K	8 - 12.5	50	50	ED63A025	20	20	15	30
3UA5000-2S	10 - 14.5	50	50	ED63A030	25	25	20	30

(1) The use of RK5 fuses is recommended. Where the line fuse does not exceed 225% of the motor full load current, a time delay fuse may be used (see NEC 430-52).
(2) For use in factory assembled combination starters only.
(3) No damage in accordance with IEC 947-4-1.
(4) UL Listed.

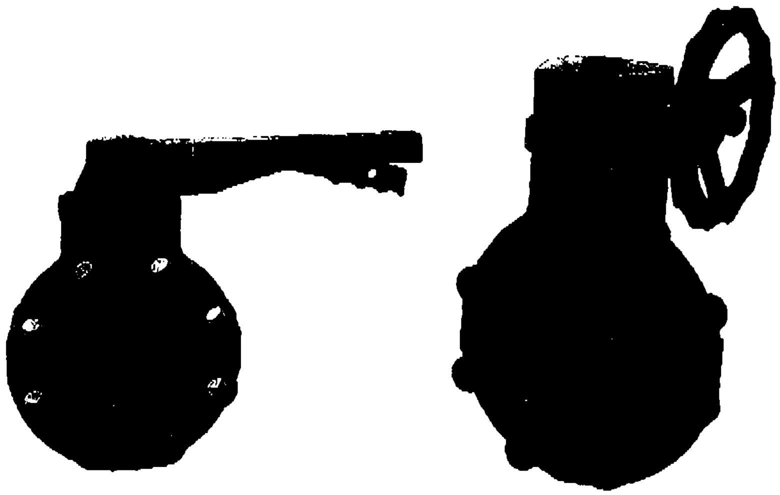
Siemens Energy & Automation, Inc.
Canton, Georgia 30114

SPEARS

BUTTERFLY VALVES

BF-2-1094

High Performance Valve Technology Now in a Chemical & Corrosion Resistant Thermoplastic Valve !

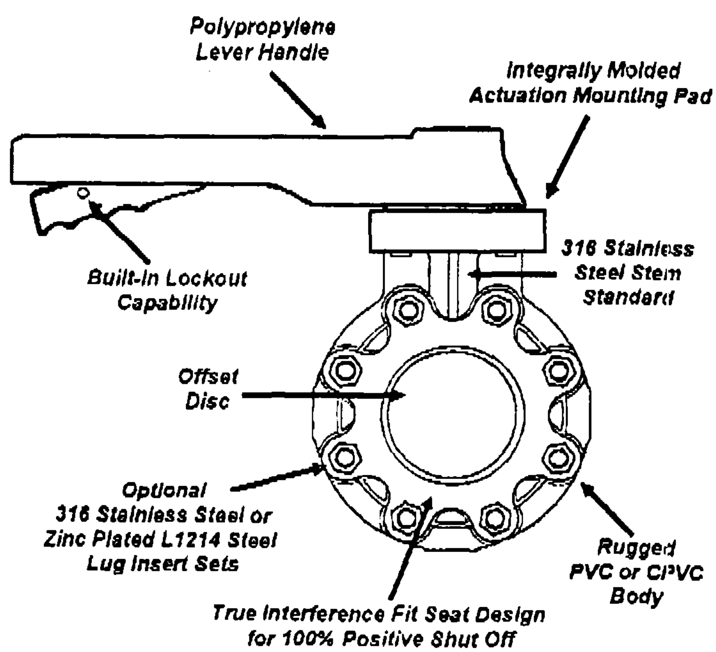


Features

- **Special Offset Disc**
  Lifts quickly from sealing surface to reduce seat wear and lower operating torque, with positive seal-off at high, low and vacuum pressures. Glass reinforced PVC or CPVC disc material improves strength and stability.
- **True Interference Fit Seat Design**
  Does not rely on line pressures to assist sealing. Eliminates seat creep and extrusion typical with conventional liner-type seats.
- **Solid, Chemical & Corrosion Resistant 316 Stainless Steel Stem and Hardware**
  Standard 316 Stainless Steel Stem and Hardware for structural integrity and superior chemical and corrosion resistance.
- **Rugged PVC or CPVC Body**
  Incorporates integrally molded actuation mounting pad and lug receptacles.
- **150 psi Maximum Internal Pressure**
  150 psi Maximum Internal Pressure Rating @ 73°F **— Including Dead-End Service**

Options

- **High Impact Polypropylene Lever Handle**
  Provides Quick Selection From Any One Of Seven Stop Positions, With Built-In Lockout Capability (standard on 3" - 8" sizes). Reversible 180° For Either Right Or Left Side Operation
- **Low Profile Gear Operator (standard on 10" & 12" sizes)**
  With High Impact Polypropylene Handwheel And Built In Position Indicator. High Efficiency Worm Gear Drive With Chemical And Corrosion Resistant Epoxy Coated Housing
- **Valve Assembly Less Handle/Gear Operator For Custom Actuation**
- **Standard EPDM Or Optional Viton® Seat Is Replaceable — Without Full Valve Disassembly**
- **316 Stainless Steel or Zinc Plated L1214 Steel Lug Inserts**
  Field Installable for Easy Single-Side Installation and Quick System Add-On — No Special Body Needed
- **Teflon® Lined High Purity Valve**
  Custom Manufactured. Contact Spears Technical Services for additional information.



Sample Engineering Specification

All Butterfly Valves shall be produced by Spears Manufacturing Company from PVC, cell classification 12454B, or CPVC, cell classification 23447-B, conforming to ASTM Standard D 1784. Seats shall be EPDM or Viton®. Bolt hole patterns shall conform to ANSI/ASME B-16.5 CL 150 . Disc shall be offset design with 316 stainless steel stem and hardware. Handle shall be lever style high impact polypropylene with lockout capability. Gear operator shall be equipped with position indicator and polypropylene handwheel. Lug inserts shall be 316 stainless steel or zinc plated steel and field installable.

SPEARS Butterfly Valves are designed for installation with user supplied full-face, 1/8" thick Neoprene (or desired elastomer) gaskets, hex bolts, nuts, and washers. Valves may be installed for flow in either direction in a dual flange (flange each side) installation, but require attention to direction or flow when installed in a single-side (flange one-side only) application for dead-end service. Consult installation instructions for details of single-side installation and special instructions for use of lug-insert option.

General Conformance Specifications

Material —ASTM D 1784 (PVC Cell Classification 12454-B, CPVC Cell Classification 23447-B); NSF Approved for potable water service.

Bolt Hole Pattern —ANSI/ASME B-16.5 CL 150; ASTM D 4024

Pressure Class —150, AWWA C504-87

Hydrostatic Pressure Test —AWWA C504-87, ASTM D 1599

Not For Use With Compressed Air or Gases

The information contained in this publication is based on current information and product design at the time of publication and is subject to change without notification. Our ongoing commitment to product improvement may result in some variations. No representations, guarantees or warranties of any kind are made as to its accuracy, suitability for particular application or results to be obtained therefrom. For additional information not contained herein, please contact Spears Technical Services Department [West Coast: (818) 364-1611 — East Coast: (717) 938-9006].

SPEARS® MANUFACTURING COMPANY

CORPORATE OFFICES

15853 Olden Street, Sylmar, California 91342
P.O. Box 9203, Sylmar, CA 91392
(818) 364-1611

MADE IN THE U.S.A. WITH PRIDE

PACIFIC SOUTHWEST
12740 Arroyo Street
Sylmar (Los Angeles), CA 91342
P.O. Box 9203, Sylmar, CA 91392
(818) 364-1611
(800) 862-1499
FAX: (818) 367-3014

NORTHWEST
3902 "B" Street N.W.
Auburn (Seattle), WA
98002
(206) 939-4433
(800) 347-7327
FAX: (206) 939-7557

ROCKY MOUNTAIN
4800 Nome Street
Denver, CO
80239
(303) 371-9430
(800) 777-4154
FAX: (303) 375-9546

SOUTH CENTRAL
1838 Forms Drive
Carrollton (Dallas), TX
75006
(214) 245-0387
(800) 441-1437
FAX: (214) 245-4205

UTAH
1415 South 700 West #3
Salt Lake City, UT
84104
(801) 972-0659
FAX: (801) 972-0668

NORTHEAST
543 Industrial Drive
Lewisberry (Harrisburg), PA
17339-9532
(717) 938-8844
(800) 233-0275
FAX: (717) 938-6547

SOUTHEAST
2751 Miller Road
Decatur (Atlanta), GA
30035
(404) 981-7122
(800) 662-6326
FAX: (404) 981-6106

FLORIDA
3445 Bartlett Boulevard
Orlando, FL
32811
(407) 843-1960
(800) 432-4762 Inside FL
(800) 327-6390 Outside FL
FAX: (407) 425-3563

MIDWEST
854 Fairway Drive
Bensenville (Chicago), IL
60106
(708) 773-0075
(800) 662-6330
FAX: (708) 773-0435

INTERNATIONAL SALES
15853 Olden Street
Sylmar (Los Angeles), CA 91342
P.O. Box 9203
Sylmar, CA 91392
(818) 364-1611
FAX: (818) 898-3774

WATTS

BRONZE BALL VALVES -

Series B-6000 2-piece, NPT Ends, Reduced Port, ¼"- 2" 600 WOG, 2½"- 4" 400 WOG
Series B-6001 2-piece, Sweat Ends, Reduced Port, ⅜"- 3" 400 WOG

BRASS BALL VALVES -

Series B-6800 3-piece, NPT Ends, Full Port, ¼"- 1" 600 WOG, 1¼"- 2" 400 WOG
Series B-6801 3-piece, Sweat Ends, Full Port, ½"- 1" 600 WOG, 1¼"- 2" 400 WOG
Series B-6802 3-piece, Sil-braze Ends, Full Port, ½"- 1" 600 WOG, 1¼"- 2" 400 WOG

Watts **Series B-6000** has been the standard in the bronze ball valve market since its introduction. Offered in a complete size range, standard Durafill seats up through 3", Virgin PTFE seats in the 4" size, and hard chrome plated ball provide highest possible operating pressure/temperature limits, with a steam rating of 150 WSP (over 50 psi steam requires stainless steel trim). Temperatures from 0°F to +450°F at 50 psi for Durafill and 0°F to +350° at 50 psi for Virgin PTFE.

Watts Series **B-6801** offers serviceability of all operating parts without disturbing the rigid pipeline system. Simply remove one body bolt, loosen the other three and lift the entire body section out of the piping for service or replacement.

Full port orifice size insures maximum flow capacity, while Durafill seats, hard chrome plated ball and bottom loaded stem provided maximum safety and highest operating temperature/pressure limits with a steam rating of 150 WSP (over 50 psi steam requires stainless steel trim). Temperatures from -55°F to +450°F at 50 psi.

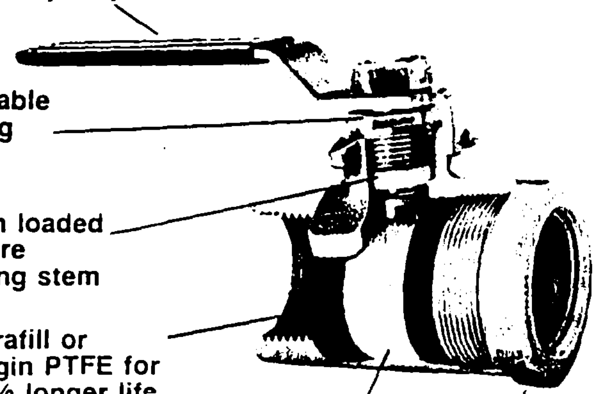
FEATURES:

Series B-6000

- Standard Durafill (up to 3") or Virgin PTFE (4") seats and chrome plated ball
- Large orifice sizes
- AISI 316 stainless steel ball and stem available
- Bottom loaded stem and packing nut threaded to body

Series B-6800

- Maintenance design
- Hard chrome plated ball
- Full port
- Durafill seats



MODELS:

*B-6001 end connections are solder type in compliance with ANSI B16.18 (⅜"- 3")
*B-6801 end connections are solder type (½"- 2")
B-6802 end connections are sil-braze (½"- 2")

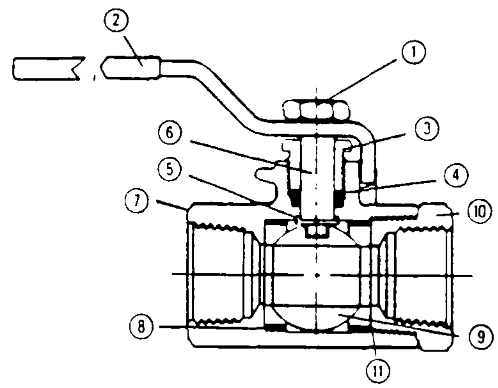
*"This valve is designed to be soft soldered into lines without disassembly, using a low temperature solder (420°F). Other solders such as 95/5 tin antimony (460°F) or 96/4 tin silver (430°F) can be used, however, extreme caution must be used to prevent seat damage. Higher temperature solders will damage the seat material. ANSI B16.18 states that the maximum operating pressure of 50-50 solder sweat connections is 200 PSI at 100°F, and decreases with higher temperatures."
"Apply heat with the flame directed AWAY from the center of the valve body. Excessive heat can harm the seats. After soldering, the packing nut may have to be tightened."

SPECIFICATIONS

Series B-6000 - Approved valves shall have bottom loaded pressure retaining stems, glass reinforced Durafill or Virgin PTFE seats and reinforced PTFE stem packing seals. Valve shall be pressure rated at 600 psi WOG ¼"- 2" and 400 psi WOG 2½" and 3", 150 psi saturated steam. Valve must conform to Federal Spec. WW-V-35C, Type II, Class A, Style 3.

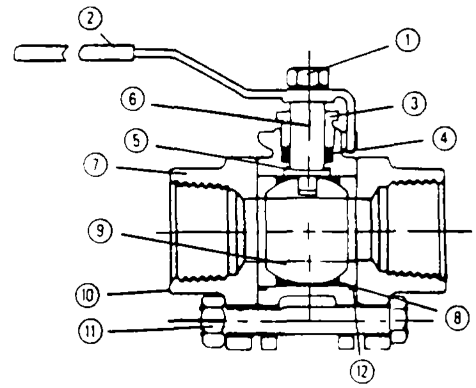
Series B-6800 - Approved valves shall have bottom loaded pressure retaining stem, glass reinforced Durafill seats and reinforced PTFE stem packing seal and thrust washer. Valve must conform to Federal Spec. WW-V-35C, Type II, Class A, Style 1.

MATERIALS



Series B-6000

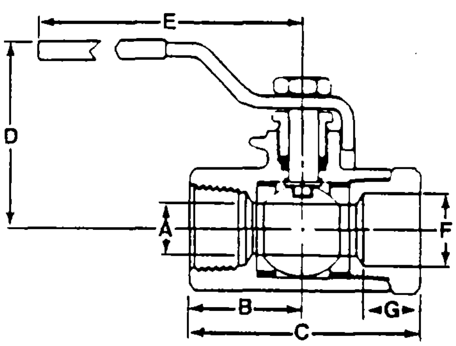
1	Handle Nut	Plated carbon steel
2	Handle	Plated carbon steel with vinyl insulator
3	Packing Nut	Brass
4	Stem Packing	Glass reinforced PTFE
5	Thrust Washer	Glass reinforced PTFE
6	Stem	Brass Stem designed to stay in place when packing is removed
7	Body	Bronze
8	Seats	Durafill (1/4"- 3"), Virgin PTFE (4")
9	Ball	Hard chrome plated brass
10	Adapter	Brass
11	Body Seal	PTFE (1 1/4"- 4" only)



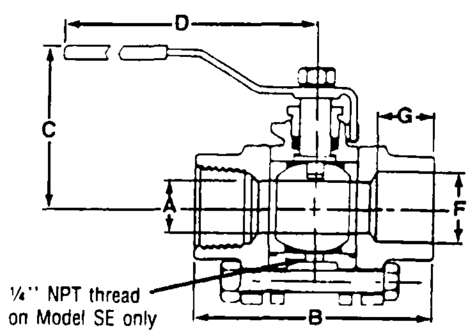
Series B-6800

1	Handle Nut	Cadmium plated carbon steel
2	Handle	Cadmium plated carbon steel with vinyl insulator
3	Packing Nut	Brass
4	Stem Packing	Glass reinforced PTFE
5	Thrust Washer	Glass reinforced PTFE
6	Stem	Brass Stem designed to stay in place when packing is removed
7	Body	Brass
8	Seats	Durafill (Virgin PTFE for Model SE)
9	Ball	Hard chrome plated brass
10	Adapters	Bronze
11	Body Nuts and Bolts	Cadmium plated carbon steel
12	Body Seals	PTFE

DIMENSIONS - WEIGHT



Two Piece Design
B-6000, *B-6001



Three Piece Design
B-6800, *B-6801, B-6802

B-6000

Size	A Ball Orifice Inches	A mm	B Center to End Inches	B mm	C End to End Inches	C mm	D Center to Handle Inches	D mm	E Radius of Handle Inches	E mm	F Dia. Sweat Connection Inches	F mm	G Depth Sweat Connection Inches	G mm	Weight Lbs.	Weight kg.
1/4"	3/8	9.5	1 1/16	26.9	2 1/16	52.4	1 3/4	44.5	3 1/16	95.3	–	–	–	–	.58	.26
3/8"	3/8	9.5	1 1/16	26.9	2 1/16	52.4	1 3/4	44.5	3 1/16	95.3	–	–	–	–	.60	.27
1/2"	1/2	12.7	1 1/16	26.9	2 3/16	55.5	1 3/4	44.5	3 3/4	95.3	–	–	–	–	.63	.28
3/4"	11/16	17.4	1 7/16	36.5	2 13/16	71.4	2	50.8	3 3/4	95.3	–	–	–	–	1.19	.54
1"	7/8	22.2	1 11/16	42.8	3 7/16	87.3	2 5/16	58.7	4 1/2	114.3	–	–	–	–	2.13	.96
1 1/4"	1	25.4	1 15/16	49.2	3 7/8	98.4	2 15/16	74.6	5 1/2	139.7	–	–	–	–	3.25	1.47
1 1/2"	1 1/4	31.7	2 1/8	53.9	4 1/4	107.9	2 15/16	74.6	5 1/2	139.7	–	–	–	–	4.13	1.87
2"	1 1/2	38.1	2 7/16	61.9	4 13/16	122.2	3 5/8	92.1	8 1/8	206.3	–	–	–	–	6.38	2.89
2 1/2"	2	50.8	3 3/16	80.9	6 1/2	165.1	4 1/4	107.9	8 1/8	206.3	–	–	–	–	12.75	5.78
3"	2 1/2"	63.5	3 7/16	87.3	6 13/16	173.0	4 1/2	114.3	8 1/8	206.3	–	–	–	–	17.75	8.05
4"	3	76.2	3 7/8	98.4	7 11/16	204.4	5	137.0	11	279.4	–	–	–	–	25.00	10.89

*B-6001

Size	A Inches	A mm	B Inches	B mm	C Inches	C mm	D Inches	D mm	E Inches	E mm	F Inches	F mm	G Inches	G mm	Lbs.	kg.
3/8"	3/8	9.5	1 1/16	26.9	2 3/8	52.4	1 3/4	44.5	3 3/4	95.3	1/2	12.7	3/8	9.5	.50	.22
1/2"	1/2	12.7	1 1/16	26.9	2 3/8	52.4	1 3/4	44.5	3 3/4	95.3	5/8	15.9	1/2	12.7	.63	.28
3/4"	11/16	17.4	1 7/16	36.5	3 5/16	73.0	2	50.8	3 3/4	95.3	7/8	22.2	3/4	19.1	1.13	.51
1"	7/8	22.2	1 3/4	44.5	3 13/16	88.9	2 5/16	58.7	4 1/2	114.3	1 1/8	28.6	7/8	22.2	1.81	.82
1 1/4"	1	25.4	2 1/4	57.2	4 1/2	114.3	2 15/16	74.6	5 1/2	139.7	1 3/8	34.9	1 1/16	26.9	2.88	1.30
1 1/2"	1 1/4	31.7	2 1/2	63.5	5	127.0	2 15/16	74.6	5 1/2	139.7	1 5/8	41.3	1 1/8	28.6	4.25	1.93
2"	1 1/2	38.1	3 1/8	79.4	6 1/4	158.8	3 5/8	92.1	8 1/8	206.3	2 1/8	53.9	1 3/8	34.9	6.81	3.09
2 1/2"	2	50.8	3 11/16	93.6	7 5/8	203.7	4 1/2	114.3	8 1/8	206.3	2 5/8	66.7	1 7/16	36.5	13.00	5.66
3"	2 1/2	63.5	4 1/16	120.7	8 3/16	217.9	4 1/2	114.3	8 1/8	206.3	3 1/8	79.4	1 11/16	42.8	18.00	7.84

B-6800

Size	A Ball Orifice Inches	A mm	B End to End Inches	B mm	C Center to Handle Inches	C mm	D Radius of Handle Inches	D mm	F Dia. Sweat Connection Inches	F mm	G Depth Sweat Connection Inches	G mm	Weight Lbs.	Weight kg.
1/4"	3/8	9.5	2 3/8	52.4	1 3/4	44.5	3 7/8	98.4	–	–	–	–	1.12	.50
3/8"	3/8	9.5	2 3/8	52.4	1 3/4	44.5	3 7/8	98.4	–	–	–	–	1.12	.50
1/2"	1/2	12.7	2 3/8	52.4	1 3/4	44.5	3 7/8	98.4	–	–	–	–	1.12	.50
3/4"	3/4	19.0	3 1/4	82.5	2 1/4	57.1	4 1/2	114.3	–	–	–	–	2.50	1.13
1"	1	25.4	3 7/8	98.4	2 3/4	69.8	6 1/8	155.5	–	–	–	–	4.12	1.86
1 1/4"	1 1/4	31.7	4 1/2	114.3	3	76.2	6 1/8	155.5	–	–	–	–	6.25	2.83
1 1/2"	1 1/2	38.1	5	127.0	3 1/2	88.9	8	203.1	–	–	–	–	9.25	4.19
2"	2	50.8	5 5/8	142.8	3 7/8	98.4	8	203.1	–	–	–	–	13.75	6.23

*B-6801

Size	A Inches	A mm	B Inches	B mm	C Inches	C mm	D Inches	D mm	F Inches	F mm	G Inches	G mm	Lbs.	kg.
1/2"	1/2	12.7	2 3/8	52.4	1 3/4	44.5	3 7/8	98.4	5/8	15.9	1/2	12.7	1.12	.50
3/4"	3/4	19.0	3 1/4	82.5	2 1/4	57.1	4 1/2	114.3	7/8	22.2	3/4	19.1	2.50	1.13
1"	1	25.4	3 7/8	98.4	2 3/4	69.8	6 1/8	155.5	1 1/8	28.6	7/8	22.2	4.12	1.86
1 1/4"	1 1/4	31.7	4 1/2	114.3	3	76.2	6 1/8	155.5	1 3/8	34.9	1 1/16	26.9	6.25	2.83
1 1/2"	1 1/2	38.1	5	127.0	3 1/2	88.9	8	203.1	1 5/8	41.3	1 1/8	28.6	9.25	4.19
2"	2	50.8	6 5/8	168.2	3 7/8	98.4	8	203.1	2 1/8	53.9	1 3/8	34.9	13.75	6.23

*See solder instructions on left.

WEKSLER

WEKSLER INSTRUMENTS

PVF MIDWEST INC.
1618 New Brighton Blvd.
Mpls., MN 55413
Phone: (612) 781-4342
Fax: (612) 781-9666

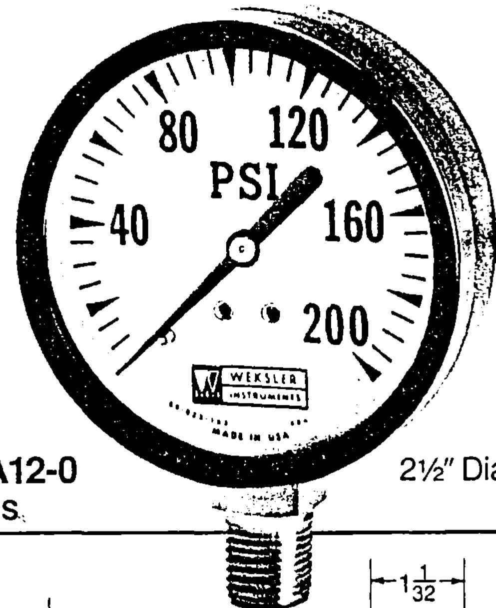
BEE LINE PRESSURE GAUGE

AVAILABLE WITH 2½″ OR 3½″ DIAL SIZES

An inexpensive utility pressure gauge for the broad commercial and industrial market. 3-2-3% accuracy.

Furnished in ¼″ NPT, bottom connected steel cases, the Bee Line gauges measure water, air, oil, gas or any other medium not corrosive to brass and phosphor bronze.

When Ordering: Please specify (1) Type UA12-0 or UA13-0 and (2) Range.



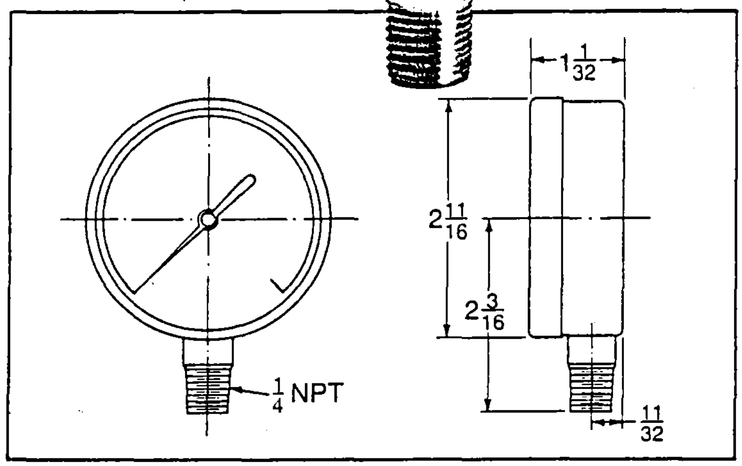
2½″ Dial Size

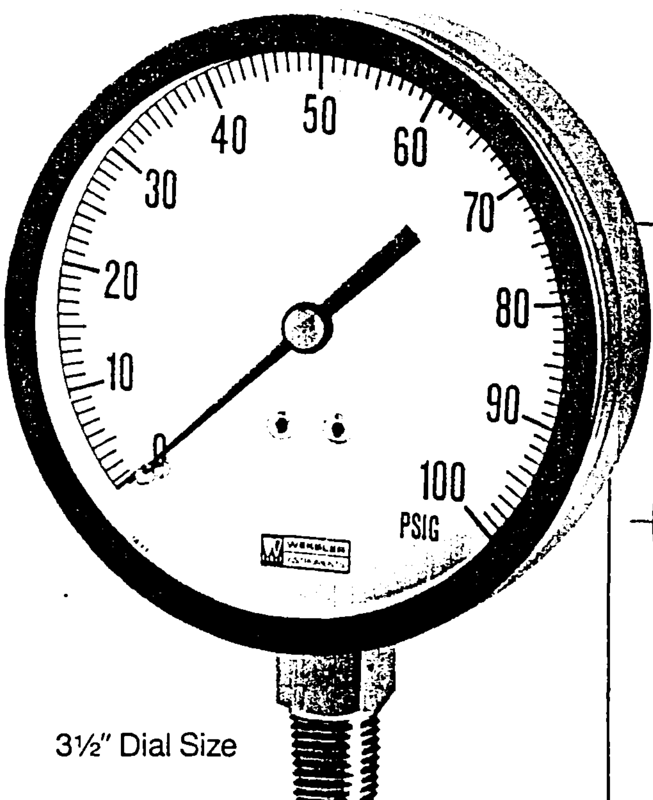
RANGES

30″-0 Hg. Vac.	0-15 p.s.i.
	0-30 p.s.i.
	0-60 p.s.i.
30″-0-30 PSI	0-100 p.s.i.
30″-0-60 PSI	0-160 p.s.i.
30″-0-150 PSI	0-200 p.s.i.
30″-0-300 PSI	0-300 p.s.i.
	0-600 p.s.i.

TYPE UA12-0

DIMENSIONS

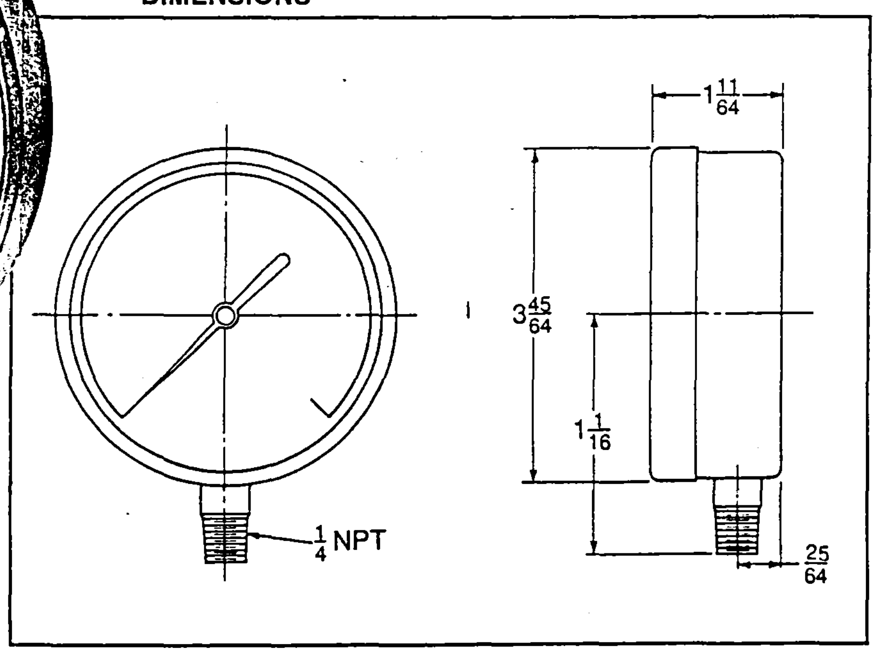




3½″ Dial Size

TYPE UA13-0

DIMENSIONS



5.0 LOCAL SERVICE REPRESENTATIVES

	Local Representative
American Colloid Company	Recovery Equipment Supply P.O. Box 322 9060 Zachary Lane North Maple Grove, MN 55369 (612) 493-4818
Badger Compu-Sonic Flow Meter	Hydro Supply Company 12231 Wood Lake Drive Burnsville, MN 55337 (612) 890-3811
Baker Moniter PS	Baker Wholesale Division 6100 Wayzata Blvd. Golden Valley, MN 55416 (612) 592-7660
** Bergerson-Caswell, Inc.	Robert Caho 5115 Industrial Street Maple Plain, MN 55359 (612) 479-3121
Brainard Kilman Centralizers	Carbonair 8640 Monticello Lane Maple Grove, MN 55369 (612) 425-2992
Conbraco Air Cocks	PVF Midwest Inc. 1618 New Brighton Blvd. Minneapolis, MN 55413 (612) 781-4342

** Additional Vendor Data incorporated on 6/30/95

	Local Representative
Construction/Mechanical	Horwitz, Inc. 5000 North Highway 169 Minneapolis, MN 55428 (612) 533-1900
Dwyer Instruments, Inc.	Dwyer Instruments, Inc. P.O. Box 373 Michigan City, IN 46360 (219) 879-8000
Electrical	Electrical Maintenance Services 3548 Idaho Avenue North Minneapolis, MN 55427 (612) 533-4484
EPG Companies Well Float	EH Renner & Sons 15688 Jarvis Street NW Elk River, MN 55330 (612) 427-6100
Franklin Electric Submersable Motors	Electric Motor Repair 2010 North Fourth Street Minneapolis, NM 55411 (612) 588-4693 (800) 348-2420
Grundfos Stainless Steel Pumps	Woodruff 7367 Washington Avenue South Edina, MN 55439 (612) 941-1800
	Pumps of Oklahoma 1220 NW 3rd Street Oklahoma City, OK 73106 (405) 235-2695

** Additional Vendor Data incorporated on 6/30/95

		Local Representative
**	Industrial Electronic Supply	Hallock Company, Inc. 7185 Washington Avenue South Edina, MN 55439 (612) 941-9111 (800) 871-7348
	Industrial Electric Co.	Industrial Electric Co. 600 South Ninth Street Minneapolis, MN 55404 (612) 339-1268
	Komax Motionless Mixer	Northwest Power Equipment 684 Transfer Road St. Paul MN 55114 (612) 646-7904
	Louvers and Dampers, Inc.	Thermodyne 14149 21st Avenue North Plymouth, MN 55447 (612) 557-4900
	Marley Electric Heating	Carroll Appliance 3150 Mercer Street, Suite 526 Kansas City, MO 64111 (800) 654-3545
	Northstar PVC Pressure Pipes	JM Manufacturing Highway 169 South, Box 6 Winnebago, MN 56098 (507) 893-3121
	Penn Ventilator Company	Penn Ventilator Company 1126 N. Main Street Lombard, IL 60148 (708) 268-9700

** Additional Vendor Data incorporated on 6/30/95

	Local Representative
PVF Midwest, Inc.	PVF Midwest, Inc. 1618 New Brighton Blvd. Minneapolis, MN 55413 (612) 781-4342
Siemens Electrical Products	Viking Electrical Supply 924 N. Fifth Street Minneapolis, MN 55401 (612) 338-3420
Wilkins Regulator Company Backflow Preventor	PVF Midwest, Inc. 1618 New Brighton Blvd. Minneapolis, MN 55413 (612) 781-4342

** Aditional Vendor Data incorporated on 6/30/95

6.0 WARRANTY INFORMATION

Copies of all warranties are included in this section.

Horwitz INC.
mechanical contractors

MECHANICAL GUARANTEE

ISSUED TO: Morrison Knudsen Company

JOB NAME: FMC - Contract #SC43424-019

JOB NUMBER: 1281.44

DATE: 5/11/95

****

Horwitz Inc. hereby guarantees all workmanship and materials supplied by ourselves and our subcontractors for one year starting 5 / 15 / 95

If, during the guarantee period, any defects of installation or faulty materials are found, we shall correct such defects within a reasonable period of time. Service calls required to repair damage or defects due to improper maintenance or abuse will be billed at our current standard service rate.

Helen C Hagberg

Helen Hagberg
HH:sd

A Tradition of Innovation and Excellence
5000 North Highway 169 Minneapolis, MN 55428
612-533-1900 FAX 612-533-1438
Equal Opportunity Employer

BERGERSON = CASWELL INC.

Commercial • Municipal • Residential
Submersible & Turbine Pumps
Environmental Drillers

Well Drilling, Abandonment & Repair Since 1948

KNOWLEDGE EXPERIENCE ABILITY
national water well association

Certified Well Drillers
Certified Pump Installers

May 17, 1995

Mr. Greg Hibbard
MORRISON KNUDSEN ENVIRONMENTAL SERVICES
180 Howard Street
San Francisco, California 94105

Morrison Knudsen Proj.# 2826.05
Bergerson-Caswell Proj.# 95E4812

RE: Warranty for extraction wells numbered AT-5A and AT-5B at the NIROP facility, 5001 East River Road, Fridley, Minnesota

Mr. Hibbard:

In reference to the above well and pump installations, all well materials purchased by Bergerson Caswell are 100% warranted (parts and labor) for a period of one year beginning May 16, 1995 and extending to May 16, 1996. For materials purchased by others, Bergerson Caswell warrants the installation labor for the equivalent time period.

We appreciate the opportunity to be of service to you for this project. If you have any questions, regarding the warranties or if we may be of further assistance to you, please do not hesitate to contact me at (612) 479-3121.

Sincerely,

BERGERSON-CASWELL, INC.

Robert W. Caho

Robert W. Caho
Operations Manager

RWC/dap

g:\publix\wrdprf\dap\95e4812let

CARBONAIR
ENVIRONMENTAL SERVICES

8640 MONTICELLO LANE
MAPLE GROVE, MINNESOTA
55369-4547
612/425-2992 800/526-4999
FAX 612/425-6882

DEC 1992

December 16, 1992

Mr. Delbert Zirger
Morrison Knudsen Corp.
7100 Belleview Avenue #300
Englewood, CO 80111

RE: **Warranty - NIROP**
Carbonair Project No. 301960
MK Purchase Order 3917-008

Dear Mr. Zirger:

As requested, we have reviewed the warranty language in the attached Terms and Conditions. We have amended the language to reflect a twelve-month warranty period beginning from the start-up date (September 21, 1992).

This amended language applies only to the equipment purchased under the referenced purchase order and will not apply to any other equipment installed at this site or any other in the future.

Please sign both of the letters and initial in the appropriate place on the attached Terms and Conditions. Return a fully executed original of the letter and Terms and Conditions to Carbonair at your earliest convenience. Retain the other originals for your records.

Sincerely,

Thomas M. FitzGerald
Sales & Marketing Director

Kelly Barnes
Project Manager

TMF:cb
Enclosure

Accepted by: [illegible]

Title: 12/22/92

Date: [illegible]

CARBONAIR

Terms & Conditions of Sale

11/15/92

ACCEPTANCE - This proposal is an invitation for an offer and will become a binding contract when accepted.

LIMITATION OF PROPOSAL - The prices and terms quoted in this proposal are subject to acceptance by the Purchaser within a period of thirty (30) calendar days from the date hereon.

EXCLUSIONS - This proposal is based solely and completely on specifications submitted to Carbonair Services, Inc. (Carbonair) at the time of the drawing of the proposal. General plans and specifications not actually submitted shall not apply. This proposal, when accepted, shall be the complete agreement between the parties; and any alterations or unusual and undisclosed conditions or deviations from the above specifications involving extra costs shall be agreed upon by the parties and shall become an additional charge over and above the proposal price set forth herein.

Delays or impossibility of performance by Carbonair because of strikes, accidents, or other reasons beyond the control of Carbonair shall relieve us from all liability herein.

SHIPMENT - Time of shipment specified is after receipt of order and acceptance and final approval of all drawings.

TERMS OF PAYMENT -
To purchasers of approved credit, net upon receipt of invoice. We reserve the right to cancel the contract or cease work if payments thereon are not received when due. Eighteen percent (18%) interest per annum shall be charged on all unpaid balances.

TAXES:

Any local, state or federal sales, excise or use tax imposed on the equipment or work covered by this proposal shall be paid by the Purchaser in addition to the prices quoted.

TMF 12/15/92
CAS

WARRANTY LIMITATION:

There are no warranties which extend beyond the warranties hereinafter expressed.

WARRANTIES:

twelve (12) months September 21, 1992

MK 12/..

All work shall be done in a workmanlike manner according to standard practices. We warrant performance against defects in workmanship for a period of ~~six (6) months~~ from ~~date of installation or delivery~~. We agree to pass on to the Purchaser such warranties, if any, as may be extended by the manufacturer for material supplied. Labor for replacing defective materials shall not be provided by us unless it is specifically spelled out in the proposal. We shall not be responsible for materials damaged, lost or stolen after delivery, through no fault of ours, or for failure to deliver and perform because of reasons beyond our control.

EXCLUSIVE REMEDIES:

Remedies are limited to the repair or replacement at F.O.B. point of shipment. Consequential damages are excluded. In no event shall Carbonair be responsible for consequential damages of any such defective material or workmanship including, but not limited to, the Purchaser's loss of material or profits, increased expenses of operation, downtime or reconstruction of the work, and in no event shall Carbonair's obligation under this warranty exceed the original contract price of the defective item. It is agreed that any action for breach of express or implied warranty shall be initiated within one year from the date of shipment by Carbonair or from the date of one year from the date of shipment by Carbonair or from the date of installation by Carbonair.

DISCLAIMER:

Carbonair will not be responsible for damage to equipment or materials through improper installation, storage, improper servicing, or through attempts to operate it in excess of its rated capacity or recommended use, intentional or otherwise, by parties other than Carbonair or its authorized representatives. No Carbonair equipment is certified for operation until the installation is inspected and start-up is performed by Carbonair or its authorized representatives.

CONDITIONS OF SALE - Prices quoted are those now in effect. Seller reserves the right to bill at the prices in effect at the time of shipment if the proposal is not accepted in writing within thirty (30) days, unless a longer term of validity is in writing on the proposal.

LIMITATIONS OF LIABILITY

A. Neither Seller nor its suppliers of any tier will be liable to Purchaser, whether in contract, in tort (including negligence and strict liability), under any warranty, or otherwise, for any special, indirect, incidental, or consequential loss or damage whatsoever, or for loss of or to the plant, loss of use of equipment or power system, cost of capital, loss of profits or revenues or the loss of use thereof, cost of environmental damage or clean-up, or claims of customers of Purchaser. The remedies set forth herein are exclusive, and the total cumulative liability of seller and its suppliers under any purchase order or any act or omission in connection therewith or related thereto, whether in contract, in tort (including negligence and strict liability), under any warranty, or otherwise, will be limited to the price of the contract.

B. The provisions of this Article shall survive termination, cancellation or expiration of the purchase order and shall apply, notwithstanding any other provisions of this Agreement or any related document thereto, to the fullest extent permitted by law. Prior to the transfer of any equipment or material furnished or for which work is furnished hereunder from the project site (except temporarily for repair work or permanently for disposal), or the transfer of any interest therein or in the plant, Purchaser shall obtain for Seller written assurances from the transferee of imitation of and protection against liability following the proposed transfer at least equivalent to that afforded seller and its suppliers under the purchase order.

Standard terms and conditions of sale

1. WARRANTY—Company warrants that on the date of shipment to Purchaser the goods will be of the kind and quality described herein, merchantable, and free of defects in workmanship and material.

   If within one year from date of initial operation, but not more than eighteen months from date of shipment by Company, of any item of the goods, Purchaser discovers that such item was not as warranted above and promptly notifies Company in writing thereof, Company shall remedy such defect by, at Company's option, adjustment, repair or replacement of the item and any affected part of the goods. Purchaser shall assume all responsibility and expense for removal, reinstallation and freight in connection with the foregoing remedy. The same obligations and conditions shall extend to replacement items furnished by Company hereunder. Company shall have the right of disposal of items replaced by it. Purchaser shall grant Company access to the goods at all reasonable times in order for Company to determine any defect in the goods. In the event that adjustment, repair or replacement does not remedy the defect, the Company and Purchaser shall negotiate in good faith an equitable adjustment in the contract price.

   The Company's responsibility does not extend to any item of the goods which has not been manufactured and sold by Company. Such item shall be covered only by the express warranty, if any, of the manufacturer thereof. The Company and its suppliers shall also have no responsibility if the goods have been improperly stored, handled or installed, if the goods have not been operated or maintained according to their ratings or according to instructions in Company or supplier furnished manuals, or if unauthorized repairs or modifications have been made to the goods.

   THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES (EXCEPT TITLE) INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND CONSTITUTES THE ONLY WARRANTY OF COMPANY WITH RESPECT TO THE GOODS.

   The foregoing states Purchaser's exclusive remedy against Company and its suppliers for any defect in the goods or for failure of the goods to be as warranted, whether Purchaser's remedy is based on contact, warranty, failure of such remedy to achieve its essential purpose, tort (including negligence) strict liability indemnity or any other legal theory, and whether arising out of warranties, representations, instructions, installations or defects from any cause.

2. PATENTS—Company shall pay costs and damages finally awarded in any suit against Purchaser or its vendees to the extent based upon a finding that the design or construction of the goods as furnished infringes a United States patent (except infringement occurring as a result of incorporating a design or modification at Purchaser's request), provided that Purchaser promptly notifies Company of any charge of infringement, and Company is given the right at its expense to settle such charge and to defend or control the defense of any suit based upon such charge. THIS PARAGRAPH SETS FORTH COMPANY'S ENTIRE LIABILITY WITH RESPECT TO PATENTS.

3. PERFORMANCE; DELAYS—Timely performance by Company is contingent upon Purchaser's supplying to Company, when needed, all required technical information and data, including drawing approvals, and all required commercial documentation.

   If Company suffers delay in performance due to any cause beyond its reasonable control, including but not limited to act of God, act or failure to act of government, act or omission of Purchaser, war, fire, flood, strike or labor trouble, sabotage, or delay in obtaining from others suitable services, materials, components, equipment or transportation, the time of performance shall be extended a period of time equal to the period of the delay and its consequences. Company will give to Purchaser notice in writing within a reasonable time after Company becomes aware of any such delay.

4. DELAYED SHIPMENT; STORAGE—Any item of the goods on which manufacture or shipment is delayed by Purchaser or by causes which affect Purchaser's ability to receive the goods may be placed in storage by Company for Purchaser's account and risk, and Purchaser shall pay all charges for storage, trucking and other incidental expenses incurred by Company. In the event of delayed shipment, Company may invoice Purchaser upon completion of manufacture or upon date the goods would have been ready for shipment.

5. SHIPMENT, TITLE AND RISK OF LOSS—The term "shipment" means delivery to the initial carrier in accordance with the delivery terms of this order. Company may make partial shipments. Company shall select method of transportation and route, unless terms are f.o.b. point of shipment and Purchaser specifies the method and route and is to pay the freight costs in addition to the price. When terms are f.o.b. destination or freight allowed to destination, "destination" means common carrier delivery point (within the continental United States, excluding Alaska) nearest the destination.

   Title to the goods and risk of loss or damage shall pass to Purchaser at the f.o.b. point. Company shall not be responsible for damage to the goods after having received "in good order" receipts from the carrier. All claims for loss, damage and delay in transit are to be handled by Purchaser directly with the carrier. Claims for shortages or incorrect items must be made in writing to Company within thirty days after receipt of shipment. Failure to give such notice shall constitute an unqualified acceptance and waiver by Purchaser of all claims for such shortages or incorrect items.

6. TAXES—Any applicable duties or sales, use, excise, value-added or similar taxes will be added to the price and invoiced separately (unless an acceptable exemption certificate is furnished).

7. TERMS OF PAYMENT—Unless otherwise stated, all payments shall be in United States dollars, and a pro rata payment shall become due as each shipment is made. If shipment is delayed by Purchaser, date of notice of readiness for shipment shall be deemed to be date of shipment for payment purposes.

   On late payments, the contract price shall, without prejudice to Company's right to immediate payment, be increased by 1½% per month on the unpaid balance, but not to exceed the maximum permitted by law.

   If at any time in Company's judgment Purchaser is unable or unwilling to meet the terms specified, Company may require satisfactory assurance or full or partial payment as a condition to commencing or continuing manufacture or making shipment, and may, if shipment has been made, recover the goods from the carrier, pending receipt of such assurances.

8. NONCANCELLATION—Purchaser may not cancel or terminate for convenience, or direct suspension of manufacture, except with Company's written consent and then only upon terms that will compensate Company for its engineering, fabrication and purchasing charges and any other costs relating to such cancellation, termination or suspension, plus a reasonable amount for profit.

9. GOODS RETURNED FOR CREDIT—Company will not accept goods for return unless an authorization for such return has been issued by Company in writing. Only goods currently manufactured by Company and invoiced within the preceding twelve month period will be considered for return. If Company's permission to return any goods is granted, the amount of credit will be governed by the facts in each case. Credit issued for any item not returned in its original crate or carton will be subject to a deduction to compensate for crate or carton replacement. Special goods fabricated to order are not returnable under any conditions.

10. NUCLEAR—Purchaser represents and warrants that the goods covered by this contract shall not be used in or in connection with a nuclear facility or application.

11. LIMITATION OF LIABILITY—Neither Company nor its suppliers shall be liable, whether in contract, warranty, failure of a remedy to achieve its essential purpose, tort (including negligence) strict liability indemnity or any other legal theory, for loss of use, revenue or profit, or for cost of capital or of substitute use or performance, or for indirect, special, liquidated, incidental or consequential damages, or for any other loss or cost of a similar type, or for claims by Purchaser for damages of Purchaser's customers.

12. COMPLIANCE WITH LAWS—Company will comply with all laws applicable to Company during manufacture and sale of the goods. Purchaser will comply with all laws applicable to Purchaser during operation or use of the goods.

13. GOVERNING LAW AND ASSIGNMENT—The laws of the State of Georgia shall govern the validity, interpretation and enforcement of this contract. Assignment may be made only with written consent of both parties.

If this Proposal includes goods manufactured by the Company's Circuit Protection or Electrical Apparatus Divisions, the following additional terms and conditions shall apply to those goods:

14. PROPOSALS—Fuses are not considered a component part of any device and are not included in this proposal unless specifically listed. Oral proposals are subject to immediate acceptance and terminate on the day made.

15. PRICES—In the event of a price increase, the price of goods on order but unshipped will be adjusted to the price in effect at the time of shipment. In the event of a price reduction, all goods unshipped as of the effective date of the reduction (except shipment held by request of the Purchaser) will be invoiced at the reduced price. Goods already shipped are not subject to price reduction. Orders on a bid or contract basis are not subject to this clause. Orders amounting to less than $100.00 net will be invoiced at $100.00 plus transportation charges for goods covered by Discount Schedules. The company's prices include the costs of standard domestic packing only. Any deviation from this standard packing (domestic or export), including U.S. Government sealed packing, necessitates extra charges. To determine such extra charges, consult Company's sales offices.

16. ADDITIONAL TERMS OF PAYMENT—Invoice payment terms are as shown on latest discount sheets as issued from time to time. Cash discounts are not applicable to notes or trade acceptances, to prepaid transportation charges when added to Company's invoices or on discountable items if there are undisputed past due items on the account. Portions of an invoice in dispute should be deducted and the balance remitted with a detailed explanation of the deduction. Cash discounts will only be allowed on that portion of the invoice paid within the normal discount period.

    Freight will be allowed to any common-carrier free-delivery point within the United States, excluding Alaska and Hawaii, on shipments exceeding $1,000 net or more providing the Company selects the carrier. On shipments to Alaska and Hawaii, freight will be allowed to dockside at the listed port of debarkation nearest the destination point on shipments of $1,000 net or more. The Purchaser shall pay all special costs such as cartage, stevedoring and insurance. Special freight allowances are as shown on latest discount sheets as issued from time to time. Catalogued weights are estimated, not guaranteed. The Company assumes no responsibility for tariff classifications of carriers.

BERKO

A Division of Marley Electric Heating

TERMS AND CONDITIONS OF SALE

9. *LIMITED WARRANTY*

All products covered by the List Price Sheet are warranted against defects in workmanship and materials for one year from date of sale. This warranty does not apply to damage from accident, misuse, or alterations; nor where the connected voltage is more than 5% above the nameplate voltage, nor to equipment improperly installed or wired or maintained in violation of the instruction sheet. This warranty is valid only in the fifty states of the United States. No other written or oral warranty applies. No employee, agent, dealer, or other person is authorized to give any warranties on behalf of Berko.

The customer shall be responsible for all costs incurred in the removal or reinstallation and shipping of the product for repairs. Within the limitations of this warranty, inoperative units should be returned to the nearest Berko authorized service center, or the Marley Electric Heating Service Center, and we will repair or replace, at out option, at no charge to you, with return freight paid by Berko. It is agreed that such repair or replacement is the exclusive remedy available from Berko, and that MARLEY IS NOT RESPONSIBLE FOR DAMAGES OF ANY KIND, INCLUDING INCIDENTAL AND CONSEQUENTIAL DAMAGE. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion or limitations may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

For the address of your nearest authorized service center, contact Berko, A Division of Marley Electric Heating, 470 Beauty Spot Rd. E., Bennettsville, South Carolina 29512 (803/479-4006). Merchandise returned to the factory must be accompanied by a return authorization and service identification tag, both available from above location. When requesting return authorization, include all catalog numbers shown on the product.

TERMS AND CONDITIONS OF SALE

GENERAL — Allen-Bradley Company, Inc. ("A-B") and Customer agree that the terms and conditions identified in this document and in any written A-B specification of services to be furnished hereunder shall govern exclusively the sale or licensing by A-B of all hardware, firmware, software and services (collectively referred to as "Goods") within the United States. The term "services" shall include without limitation any programming and commissioning of a control system, equipment start-up and repair, application engineering services, on- and off-site classroom training courses, and exchange and repair of Goods. No addition or modification to any of the terms and conditions as they appear in this document shall be binding upon A-B unless in writing and signed by an authorized representative at A-B Headquarters. A-B objects to other terms and conditions that may be proposed by Customer.

TERMS — Payment terms to Customers with satisfactory credit are net thirty (30) days from date of invoice.

If payment of any amount owed A-B is not made when due, A-B reserves the right (in addition to and without limitation of its other rights) to suspend further performance, without liability, until such payment has been made.

SHIPMENT — Shipment will be F.O.B. A-B's factory, warehouse or other point of shipment by A-B. Customer to pay all shipping, insurance and related expenses. For Industrial Control Group Goods, A-B shall pay the lowest cost shipping expenses within the continental United States. Scheduled or stipulated shipping dates are approximate and based upon prompt receipt of all necessary information from Customer.

If shipment is delayed at the request of, or due to acts or omissions by Customer, A-B shall have the right to store the Goods at a place of its own choice at Customer's risk and expense.

TITLE AND RESPONSIBILITY — Title to hardware shall remain with A-B as security only and until full payment therefor. Title for software or firmware remains with A-B and is licensed for use by Customer pursuant to A-B's license agreement. Risk of loss or damage shall pass to Customer upon shipment from F.O.B. point.

All replacement Goods provided hereunder shall be furnished on an exchange basis, and may be new or used if equivalent to new in performance. The replaced Goods shall become the property of A-B.

EXPORT PACKING — A-B will pack Goods for air shipment and underdeck overseas shipment in accordance with its regular export standard at no additional charge to Customer. Where such packing for export must conform to definite specifications that differ from the A-B standard, the Customer will be charged for the extra cost incurred.

SHIPPING WEIGHTS AND DIMENSIONS — Published weights are careful estimates but are not warranted. Dimensions shown in catalog are approximate.

QUOTATIONS — All written quotations automatically expire unless accepted within thirty (30) days from the date quoted. Verbal quotations expire the same day they are made. In order for catalog orders to be binding, quotations must specifically identify Goods and list the actual quantities involved. All stenographic and clerical errors are subject to correction. All quotations are subject to approval by an authorized representative at A-B Headquarters.

PUBLISHED PRICES — Prices shown in any A-B publication are subject to change without notice and are not to be construed as a definite quotation or offer to sell by A-B. Such publication is maintained only as a source of general information, and any prices shown therein are subject to confirmation with a specific quotation.

With respect to services, unless otherwise agreed in writing by A-B and Customer, (i) the price of any services shall be A-B's published price therefor in effect as of the date such services are provided; and (ii) A-B shall have the right to increase or decrease the price of any service, effective with respect to any portion of services which have not been provided as of the date of such price change.

Hourly service prices are based on a standard work day of 8:00 a.m. to 5:00 p.m. Monday through Friday. Unless otherwise agreed in writing between A-B and Customer, services provided outside the standard work day will be charged at one and one-half times the applicable base service rate, except on Sundays and holidays observed by A-B, in which case the services will be charged at two times the applicable base rate.

Billable service time includes all time A-B representatives spend traveling to and from the job site and all time A-B representatives are available for work and waiting (whether on or off the job site) to perform the services. In addition to billable service time, Customer shall pay or reimburse A-B at cost for all travel and living expenses incurred by A-B representatives (in accordance with A-B policies) in the course of providing services to Customer, including without limitation hotel, meals, air, rail, bus or taxi transportation, car rental, and automobile mileage cost reimbursement if a personal vehicle is used.

TAXES — The Customer shall pay or reimburse A-B for all sales, use, excise or similar taxes.

SCOPE CHANGE — All changes affecting Goods, delivery date or otherwise affecting the scope of the order are to be documented in writing and subject to prior approval at A-B Headquarters. All changes approved by A-B may result in price, delivery, specification, and/or other changes.

WARRANTY —

A. **HARDWARE:** Unless otherwise provided in writing and approved by A-B Headquarters, A-B warrants for a period of one (1) year from the date of A-B invoice that all hardware furnished under the order will be of merchantable quality free from defects in material, workmanship and design each as determined, at the date of shipment by A-B, by generally recognized, applicable and accepted practices and procedures in the industry - to include any specifications as specifically agreed to in writing by A-B prior to the date of shipment. A-B will not be liable for any design furnished by Customer and incorporated into hardware. Hardware includes products purchased by A-B for sale with the hardware manufactured by A-B when the decision to include such products is solely that of A-B. Otherwise, any warranty applicable to such products shall be limited solely to the warranty extended to A-B by the original manufacturer. Repaired or replacement hardware is warranted for a period of six (6) months from the date of invoice, or the remainder of the original warranty term, whichever is longer.

B. **SOFTWARE AND FIRMWARE:** Unless otherwise provided in an A-B or third party license agreement, A-B warrants for a period of one (1) year from the date of invoice that the software or firmware furnished under this order will perform in accordance with published or other written specifications prepared, approved, and issued by A-B Headquarters, when used with specifically identified hardware. In any event, A-B makes no representation or warranty, express or implied, that the operation of the software or firmware will be uninterrupted or error free, or that the functions contained in the software or firmware will meet or satisfy the Customer's intended use or requirements.

TERMS AND CONDITIONS OF SALE

ware or firmware support is the terms and conditions of license agreement or A-B ex- upport agreement. Software ware corrections are war- r a period of three (3) months date shipped by A-B, or the er of the original warranty ichever is longer.

ion of this warranty, consis- other provisions herein, will ed to the replacement, or re- nodification of, or issuance of for the Goods involved, at ption, only after the return of oods with A-B's consent in ac- e with **RETURN OF EQUIP-** Any warranty service (consist- time, travel and expenses to such services) performed ian at A-B's factory, shall be at ner's expense.

arranty satisfaction is available (a) A-B is promptly notified in upon discovery of an alleged and (b) A-B's examination of ibject Goods discloses, to its ction, that any alleged defect it been caused by misuse; neg- mproper installation; improper ion; improper maintenance, re- alteration or modification; acci- or unusual deterioration or deg- on of the Goods or parts thereof physical environment or due to cal or electromagnetic noise en- nent. THIS WARRANTY IS IN OF ALL OTHER WARRANTIES HER EXPRESSED, IMPLIED OR UTORY INCLUDING IMPLIED ANTIES OF MERCHANTABILI- FITNESS and thereby excludes cations or the like for product nance, use or design with re- to any standard, regulation or e (unless and to the extent in- dently approved in writing at Headquarters) AND EXTENDS TO CUSTOMER PURCHASING A-B OR AUTHORIZED A-B LLER.

LIABILITY — IN NO EVENT, LESS OF CAUSE, SHALL A-B RESPONSIBILITY FOR OR BE) FOR PENALTIES OR PENAL- SES OF ANY DESCRIPTION, OR INDEMNIFICATION OF CUS- R OTHERS FOR COSTS, DAM- R EXPENSES EACH ARISING OR RELATED TO THE GOODS ICES OF THIS ORDER, OR FOR ATION, UNLESS OTHERWISE ALLY PROVIDED HEREIN, OR NDIRECT OR CONSEQUENTIAL S UNDER ANY CIRCUM- INCLUDING ANY LOSS, INJU- THER DAMAGES. A-B'S MAXI-MUM LIABILITY, INCLUDING DIRECT DAMAGES, SHALL NOT EXCEED THE AMOUNT OF THE PURCHASE ORDER. THIS LIMITATION OF A-B'S LIABILITY WILL APPLY REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT OR TORT, INCLUDING NEGLIGENCE. ANY ACTION AGAINST A-B MUST BE BROUGHT WITHIN EIGHTEEN (18) MONTHS AFTER THE CAUSE OF ACTION ACCRUES.

LICENSED SOFTWARE AND FIRMWARE — Software or firmware which is subject to A-B license agreement (a) is also subject to Terms and Conditions herein unless inconsistent with the A-B license agreement, in which case the license agreement shall govern, and (b) shall not be provided to Customer until Customer agrees to the terms and conditions of the A-B license agreement.

EXPORT CONTROL — Any Goods or technical data supplied by A-B under these Terms and Conditions are subject to the United States Export Administration Act and Regulations thereunder, which includes the licensing of certain products. It is the responsibility of the exporter to comply with the Act and Regulations.

RETURN OF EQUIPMENT — Approval for return of Goods, whether under the **Warranty** clause or otherwise, must be obtained from A-B Headquarters. No approval shall be granted for the return of Goods under any circumstances where the original invoice date for such Goods is more than ninety (90) days prior to the date that a request is made to A-B for such approval. All Goods returned must include reference to all pertinent order information for those Goods to include order, part, model and serial numbers as well as details of the system from which the Goods were removed, when appropriate. Except for Goods under warranty, cost for placing Goods returned for credit in a saleable condition will be charged to Customer. Goods returned must be carefully packed so as to reach A-B without damage.

No credit will be issued for returned Goods where the net amount involved is less than $100.00, except when an error made by A-B is to be corrected.

Goods accepted for return, which are not covered by warranty, are subject to a **minimum** restocking charge plus all transportation charges incurred by A-B.

Replacement Goods returned to A-B must in a repairable condition; otherwise Customer will be billed per A-B policy.

Goods built to a Customer's specification or Goods that have been modified by the Customer cannot be returned for credit under any conditions.

All Goods to be returned must be shipped to locations stipulated by A-B at the time A-B approves the return of the Goods. The shipping container of all returned Goods must be clearly marked in accordance with A-B directives.

CANCELLATION AND TERMINATION
Any order or contract may be terminated by the Customer only by written notice and upon payment to A-B of reasonable and proper cancellation charges, including but not limited to all labor, facility, and equipment costs identified in the order or contract and which have been incurred prior to the date of notice of cancellation. All additional costs resulting from the cancellation and ten percent (10%) of the final net price will be included in the cancellation charges to compensate for disruptions in scheduling, planned production, and other direct costs. Payment shall be made within thirty (30) days from date of invoice.

A-B shall have the right to cancel any order or contract at any time by written notice for any breach of the order or contract by the Customer and A-B shall be entitled to collect cancellation charges as identified above.

No termination by Customer for default shall be effective unless and until A-B shall have failed to correct such alleged default within forty-five (45) days after receipt by A-B of the written notice specifying such default.

TECHNICAL TRAINING COURSES —
The fee for classroom training ("Technical Training") courses shall include all course materials furnished by A-B, but A-B shall not be responsible for any transportation lodging, meal and other expenses incurred by Customer or its representative in attending the course. Published course descriptions are for general reference only. A-B reserves the right, without liability to Customer, to change course schedules, modify course content, discontinue courses, limit class size and cancel courses.

For Technical Training courses to be presented at A-B's premises, a cancellation charge equal to fifty percent (50%) of the course tuition shall be payable if A-B receives notice of cancellation less than fourteen days before the first day of training for which Customer's representative is scheduled. If a student fails to appear for a scheduled course, the full tuition will be payable.

For Technical Training courses to be presented at Customer's premises, a cancellation charge equal to fifty percent (50%) of the course fee shall be payable

IONS
55330
3

/for

EPG
of

93.

93.

3.

3.

3.

Warranties include both materials, equipment and labor to switch and replace these units.

Not covered under any warranty are lightning or power spikes, sand wear, or running the pumps out of the respective pumping range for cooling or upthrusting.

If the pump or motor is not covered under the warranties given by the manufacture, the labor and equipment is also chargeable.

If you should have any questions concerning these warranties, please feel free to call me at any time.

Sincerely Submitted,

Roger E. Renner

Roger E. Renner, President
MASTER WATER WELL CONTRACTOR
E.H. RENNER & SONS, INC.
MINNESOTA LICENSE #71015
\PRJ.93\FIROP-CO

APR 7 1992

Franklin Electric

SUBMERSIBLE MOTOR WARRANTY

SCOPE OF POLICY

This service policy applies to all Franklin Electric submersible motors.

LIMITED WARRANTY

Franklin Electric warrants apparatus sold against faulty workmanship or the use of defective materials. Franklin Electric shall in no way be liable for any special, incidental or consequential damages resulting from any cause whatsoever, which might be claimed as the result of the use or malfunction of the apparatus sold.

WARRANTY DETERMINATION

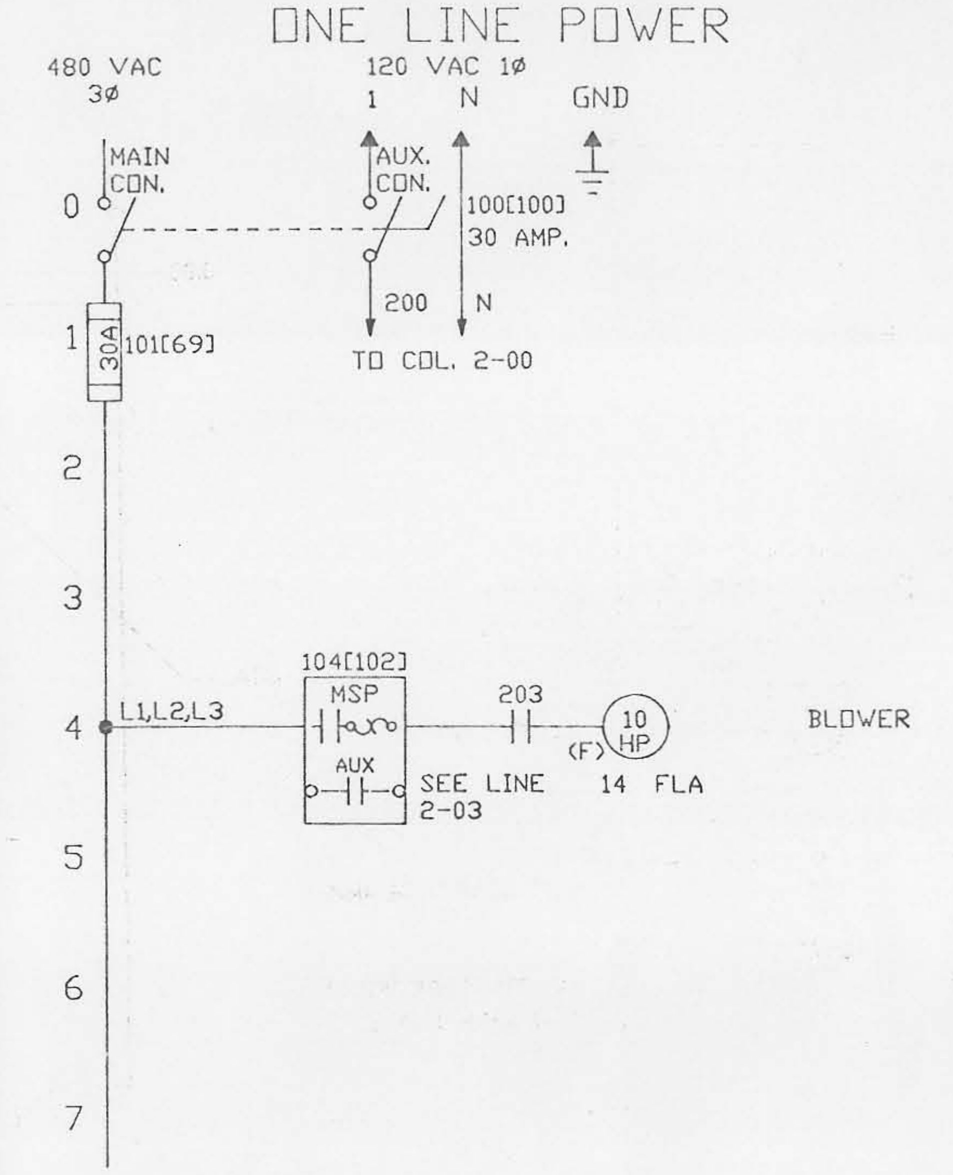
The duration of the warranty period is one year from the date of a product's installation, within two years from the date of its manufacture.
For delayed installation, the warranty period, which applies to motors only, is one year from date of installation, within three years from the date of manufacture.

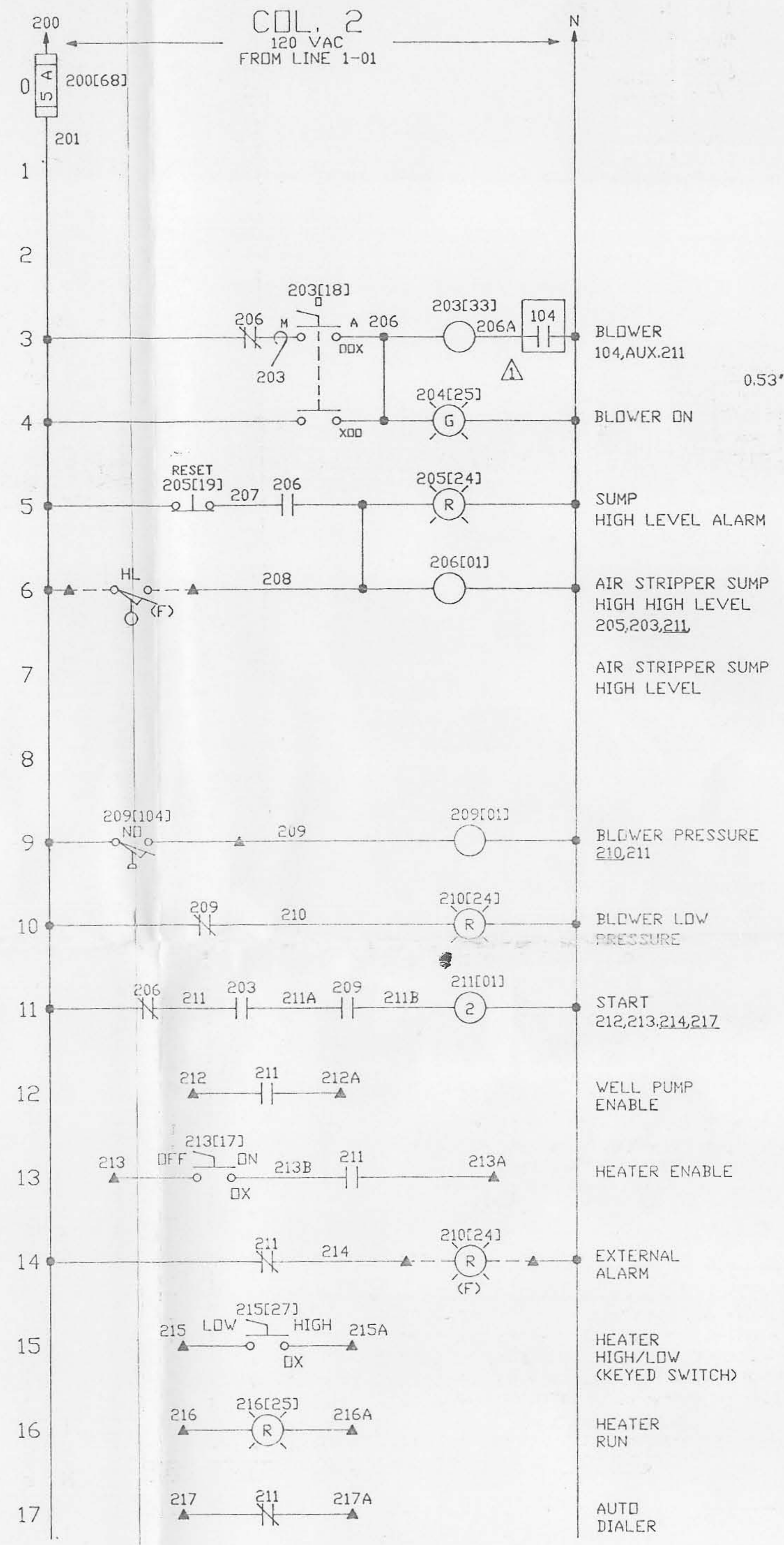
SUBTROL WARRANTY is three years from date of installation, within four years from date of manufacture.
This warranty is applicable only for water well installations and applies only to Franklin Electric three phase motors equipped with and used with SUBTROL retrofit kits and with a properly grounded lightning arrestor. In order to validate the SUBTROL warranty, the SUBTROL warranty registration card must be completed with all requested information and mailed within 10 days of installation.

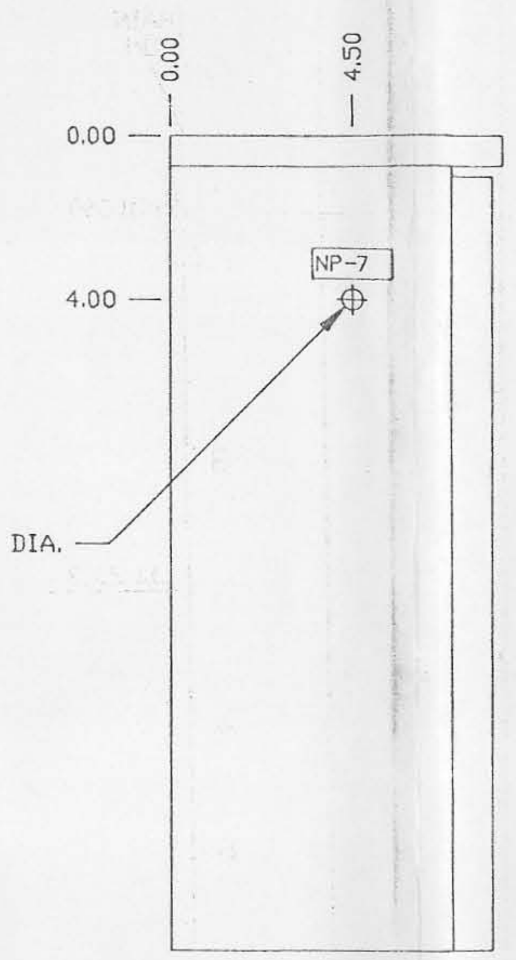
WARRANTY SERVICE

A Franklin Electric motor which fails in warranty will be replaced with a new motor. The exception is minor type repairs on an emergency basis. A minor repair may include all repair except rotor and/or stator.

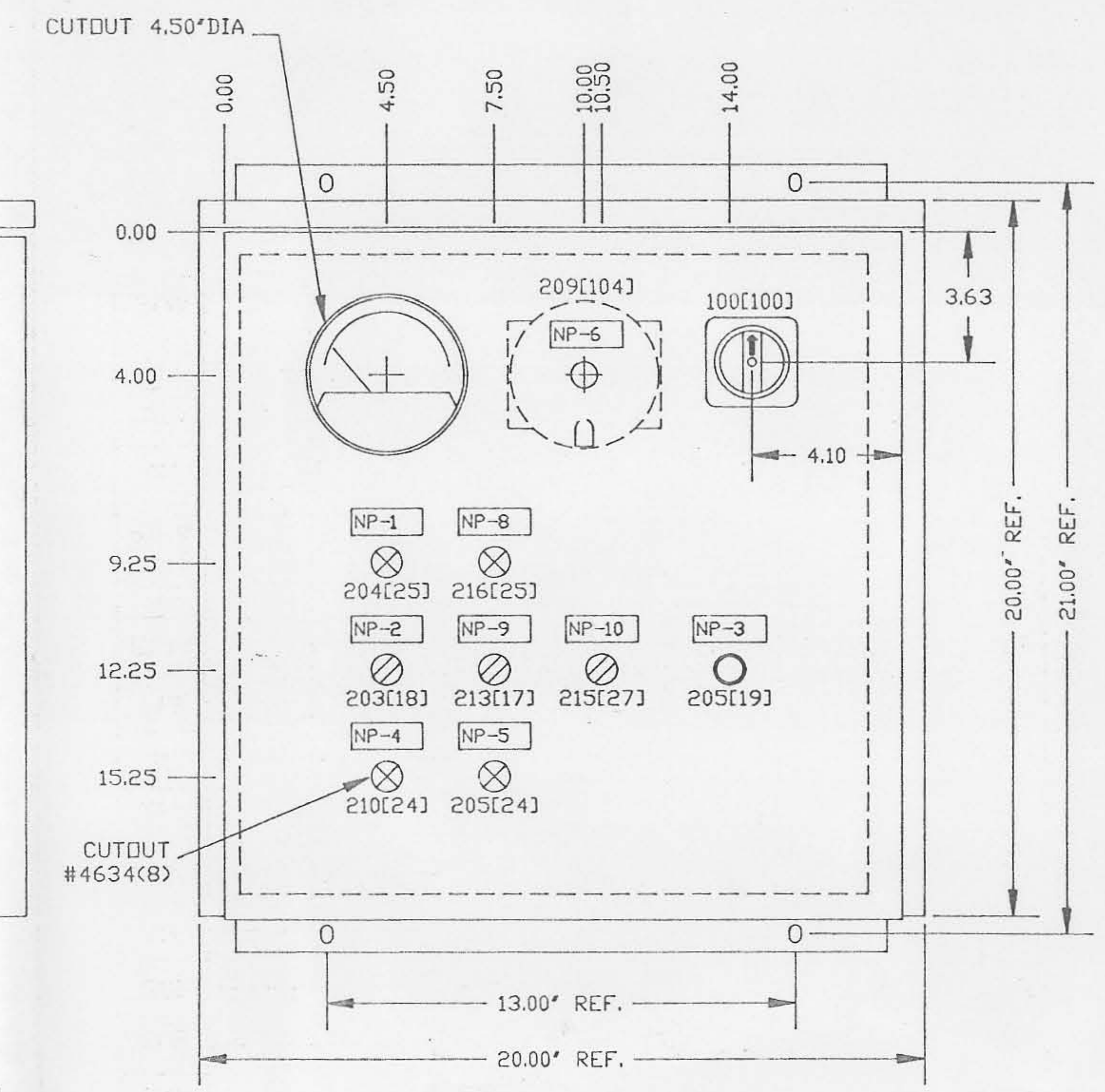
ONE LINE POWER



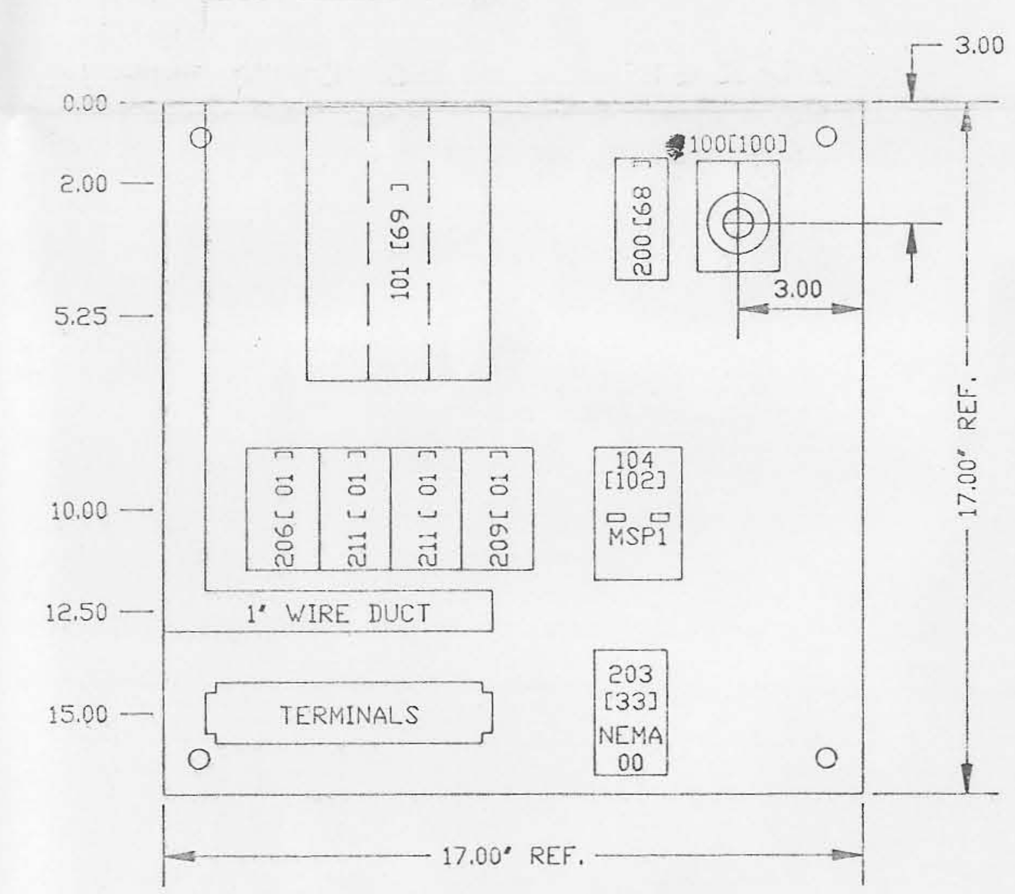




LEFT SIDE VIEW



ENCLOSURE: HOFFMAN A-20R208HCR



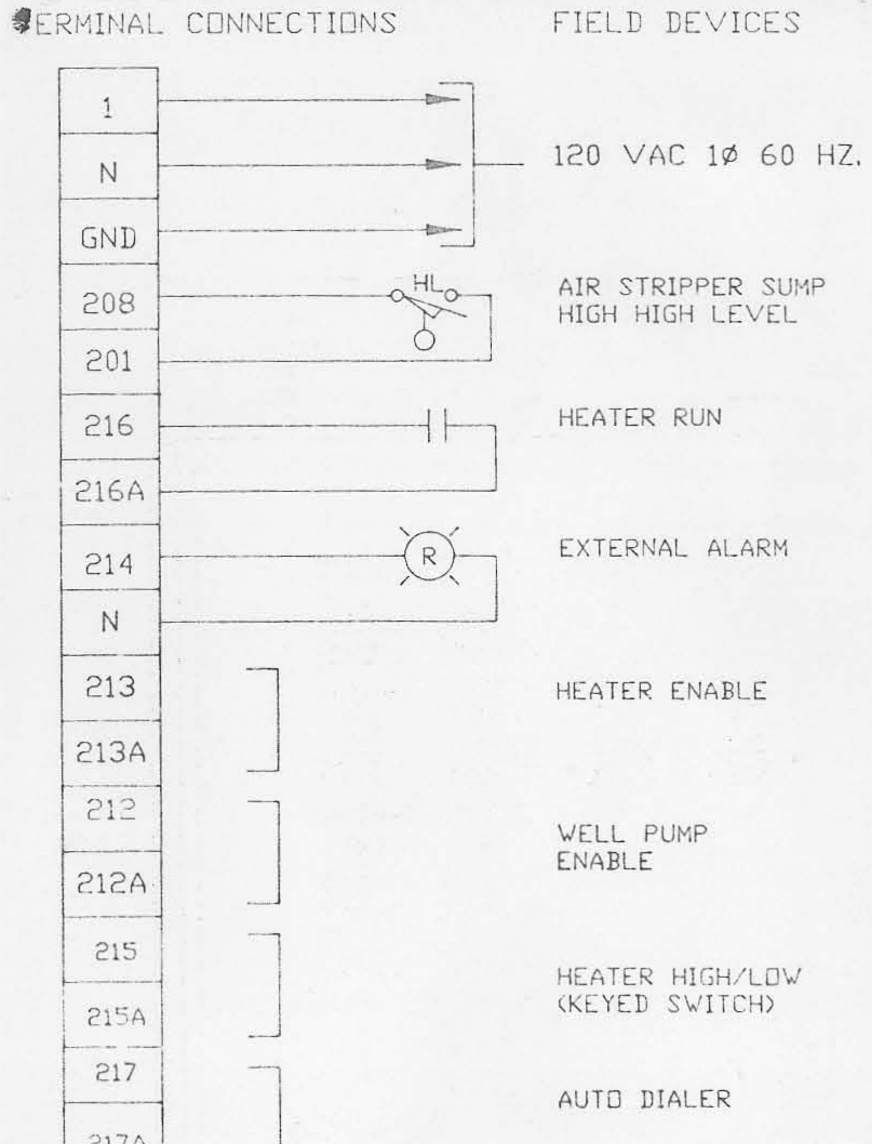
BACK PANEL: HOFFMAN # A-20P20

NAMEPLATE LIST

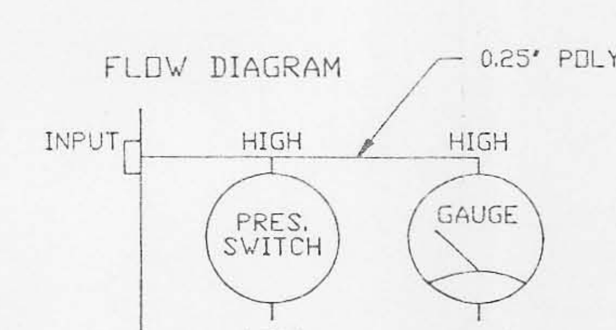
* 1/8' LETTERING UNLESS NOTED

NO.#	DESCRIPTION
1	BLOW ON
2	BLOWER MAN OFF AUTO
3	RESET
4	BLOWER LOW PRESSURE
5	SUMP HIGH LEVEL
6	BLOWER LOW PRESSURE SET POINT
7	HIGH
8	HEATER ON
9	HEATER ENABLE OFF ON
10	HEATER LOW HIGH

TERMINAL CONNECTIONS — FIELD DEVICES



FLOW DIAGRAM



⚠ PANEL TO BE UL LISTED
⚠ VARISTORS ON ALL AC COILS

WO#/SER#:14719		
PART NUMBER:0006485		
UL FILE:E131727		
MAIN VAC 480	PH 3	HZ 60
SEC. VAC 120	PH 1	HZ 60
TOTAL FLA 14	LARGEST FLA 14	

ENGINEERING UNLIMITED,INC
Minneapolis MN-55411-4063

REVISIONS

REV	ECO	DESCRIPTION	DATE	DRN
A	EU#549	FIELD AS BUILT	9/10/92	EU/GW

~~ITEM NUMBERS APPEAR ON PAGE 2~~

BILL OF MATERIALS

ITEM	QTY.	EU #	LOC.	DISCRIPTION
1	4	4480	01	RELAY, 3PDT, 120 VAC COIL, 15 A. SCHRACK #RM702615
2	4	4234	01	SOCKET,RELAY,11 PIN BLADE,IDEC #SR3B05
3	1		17	SEL.SW,2 POS,BKL,SIEMENS #3SB02-2MKB
4	4		17,18,27	CONTACT BLOCK,1 N.O.,SIEMENS #3SB1400-0B
4A	1		18	SEL. SW.,3POS., SIEMENS #3SB02-3MKB
4B	1		27	KEY SW, 2POS., SIEMENS #3SB02-2MHC4
5	1		19	PB,BLK,MIN,FLUSH,SIEMENS #3SB02-PFB
6	1		19	CONTACT BLOCK,1 N.C.,SIEMENS #3SB1400-0C
7	4		24,25	PILOT LIGHT (LESS LENS), SIEMENS #3SB02-LR1
8	2		24	LENS, PILOT LIGHT, RED,SIEMENS#3SB1910-1GC
9	2		25	LENS, PILOT LIGHT, GREEN,
9	2		25	SIEMENS #3SB1910-1GE
10	1	5696	33	CONTACTOR, NEMA 0, SIEMENS #3TF-3200-0AK6
11	1	4493	68	FUSE BLOCK,1 POLE,250 VAC 30 A, GOULD #20321
12	1	5854	68	FUSE, 250 VAC, 5 AMP, GOULD #TR-5R
12A	1	4349	69	FUSE, BLOCK, 3 POLE,600VAC, 30A, GOULD #60328
12B	3		69	FUSE, 600VAC,30AMP, GOULD #TRS-30R
13	1		100	DISCONNECT, 30 AMP, 3Ø, ABB #OETLNF30
14	1		100	DISCONNECT, OPERATOR ABB #OETLZX44/90
15	1		100	SHAFT, ABB #OETL-XS57
16	1		100	AUX. CONTACT, 1 N.O. & 1 N.C., ABB #OETLZX79
18	1		102	MSP, 10-16A, SIEMENS #3VU1300-1MM00
19	1		104	PRESSURE SWICH, (SUPPLIED BY CARBONAIR)
20	1			MAGNEHLIC GAUGE,(SUPPLIED BY CARBONAIR)
21	1	5202		BULKHEAD UINON,1/4T X 1/4T, 3186-56-00
22	1	5198		MALE BRANCH TEE1/4T X 1/4M, 3108-56-14
23	20	4877		TERMINALS, ENTRLEC #115118.11
24	2	4878		END STOP, ENTRLEC #103002.26
25	1	4879		END SECTION, ENTRLEC #1183368.16
26	1	5041		TERMINAL, GROUND, ENTRLEC #165115.10
27	10	4390		NAMEPLATE, 3/4' X 2', BLK/WHT/BLK, PHENOLIC (SEE NAMEPLATE LIST)
28	1			ENCLOSURE, HOFFMAN #A-20R208HCR
29	1			PANELS, HOFFMAN #A-20P20
31	13			SCREW, PAN HEAD #8-32 x 1/2', PLATED
32	1			FITTING, 1/4' BARB x 1/8'MPT, BRASS
33	40'			TUBING, 1/4' O.D., POLY
34	15			WASHER, FLAT, #8, PLATED
35	2			SCREW, HEX HEAD, 1/4'NC x 3/4', PLATED
36	4			NUT, JAM, 1/4'NC, PLATED
37	4			WASHER, LOCK, INT.-EXT. TOOTH, 1/4'
38	23			MOUNT, CABLE TIE, ADHESIVE BACK, PLASTIC
39	58			TIE, CABLE, 3' LONG, NYLON
40	1			RAIL, MOUNTING, CENELEC, 4' LONG, PLATED
41	1			RAIL, MOUNTING, CENELEC, 17' LONG, PLATED
42	1			RAIL, MOUNTING, CENELEC, 15' LONG, PLATED
43	2			SCREW, PAN HEAD, #8-32 x 1', PLATED
44	1			DUCT, WIRING, OPEN SLOT, W/COVER, 1' x 2' x 7' LONG, PLASTIC
45	1			DUCT, WIRING, OPEN SLOT, W/COVER, 1' x 2' x 11' LONG, PLASTIC
46	9			LABEL, SELF-STICK, 1/2' x 1', WHITE WITH BLACK FIGURES (SEE PAGE 2)
47	2			TERMINAL, SOLDERLESS, RING TONGUE FOR 10 GA. WIRE x 1/4' STUD

NOTE: SEE PAGES .

MATERIAL	APPROVAL	DATE
SEE B.O.M	DRFT EU-JF	7/21/92
	CHKR	
TOLERANCES UNLESS NOTED OTHERWISE: DECIMAL .03 / FRACTIONAL 1/32" / ANGLES 1°	DIMSCALE 4	
	LTSCALE 4	
THESE MATERIALS ARE CONFIDENTIAL AND ARE THE PROPRIETARY INFORMATION OF CARBONAIR SERVICES, INC. AND MAY NOT BE USED OR REPRODUCED WITHOUT THE CONSENT OF CARBONAIR SERVICES, INC.	THIRD ANGLE PROJECTION	
	UNLESS OTHERWISE SPECIFIED: * DIMENSIONS ARE IN INCHES * DO NOT SCALE DRAWING	

OLD CAS CC500
EU ACAD FILE #6485A
EU REV. PER EO #549

CARBONAIR
WATER AND AIR DECONTAMINATION
MINNEAPOLIS, MINNESOTA

TITLE
AIR STRIPPER CONTROL PANEL NIROP II ← #301960

SIZE	DWG. NO.	REV
D	120871	A
SCALE 1=4	DL NO. 119898	SHEET 1 OF 1

SEP 11 1992