Algas-SDI™

...Innovative liquid vaporizing and gas mixing solutions

ISO 9001 Certified

# Blendaire

## LPG/Air Mixer

# *Operations & Maintenance Manual*

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FILE: MANUAL PN 52638 REV 10-17-03 BLENDAIRE.DOC

ECLIPSE Innovative Thermal Solutions

# ***WARNING***

**Read the OPERATION MANUAL before operating this equipment.**

- **NOTE: Algas-SDI reserves the right to use alternate manufacturers' components as vendor delivery applicability dictates. Vendors have supplied literature contained in the Operation Manual. Please check to be sure supplied data matches your configuration. Contact Algas-SDI if any questions exist.**
- **This equipment uses LPG-a flammable fuel, or NH3-a toxic gas, (depending on the model), handled under pressure. Inherent hazards exist and a thorough understanding of the equipment is required to allow safe operation and maintenance.**
- **Allow only a TRAINED and FULLY QUALIFIED PERSON to service this equipment.**
- **Any time a component must be replaced, use the same type, model, etc. DO NOT SUBSTITUTE! The consequence from such actions are unpredictable and may lead to dire consequences. When components are replaced with components not approved for use in our FM/CSA listed equipment, the FM/CSA listing becomes void for that unit.**

# Warranty Registration

To Register your new equipment: Visit Algas-SDI's web site at: algas-sdi.com, then click on the "Tech Support" button. Select online Registration or print out the Acrobat Warranty Registration.

OR

Fill out the Warranty Registration information on the last page of this manual. Then make a photocopy and mail to the address shown at the bottom.

# Warranty and Copyright

## WARRANTY

Algas-SDI International, LLC (ASDI) warrants that the equipment is free of defects in materials and workmanship under normal use and service. ASDI agrees to repair or replace, at our option, without charge f.o.b. factory, any part which has proven defective to the satisfaction of Algas-SDI International, LLC within one (1) year from the date of the original installation or within 18 months from the date of shipment, whichever is earlier. Equipment, which in the opinion of ASDI, has been damaged by improper installation or operation, or has been abused or tampered with in any way, will not be accepted for return under warranty.

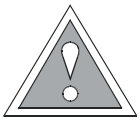
Algas-SDI International, LLC will not accept back charges for work performed by others upon or in conjunction with ASDI equipment, unless prior authorization is given by means of an Algas-SDI International, LLC purchase order. Algas-SDI International, LLC will not be liable by reason of shutdown, non-operation or increased expense of operation of other equipment, or any other loss or damage of any nature, whether direct or consequential, arising from any cause whatsoever.

Algas-SDI International, LLC makes NO other warranty of any kind, whatsoever expressed or implied; and all warranties of merchantability and fitness for a particular purpose are hereby disclaimed by Algas-SDI International, LLC and excluded from these terms of sale. No person has any authority to bind Algas-SDI International, LLC to any representation or warranty other than this warranty.

## COPYRIGHT

# Symbols and Conventions

***Special symbols are used to denote hazardous or important information. You should familiarize yourself with their meaning and take special notice of the indicated information.***
***Please read the following explanations thoroughly.***



## GENERAL WARNING OR CAUTION

***Indicates hazards or unsafe practices, which can result in damage to the equipment or cause personal injury. Use care and follow the instructions given.***


## FLAMMABLE GAS HAZARD

***Indicates a potential hazard, which can result in severe personal injury or death. Use extreme care and follow the instructions given.***

## ELECTRICAL DISCONNECT REQUIRED

***Indicates a potentially dangerous situation, which can result in severe personal injury or death or damage to equipment. Use great care and follow the instruction given.***

## ASDI CONTACT NUMBERS

If you have questions, need help with your equipment, or want information on other products, contact Algas-SDI at:

Telephone: 206.789.5410

Facsimile: 206.789.5414

Email: sales@algas-sdi.com

Internet: http://www.algas-sdi.com

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## 7. Troubleshooting



## Appendix A: Component Information

## Appendix B: Technical Information



Warranty Registration - Refer to the nameplate on the unit to fill out the product registration. Then Photo copies and mail to address shown. Or register on line by visiting Algas-SDI web site under "Tech Support".

# Introduction 1

**DESCRIPTION**

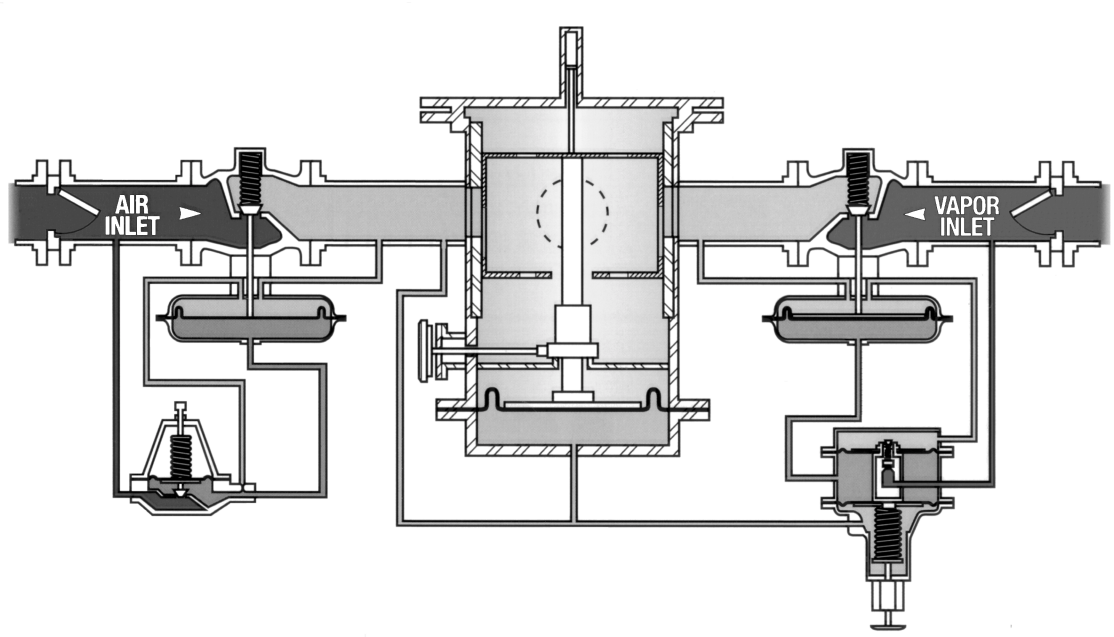
The **BLENDAIRE** is designed to mix LPG vapor with air in a wide range of ratios and deliver the mixed gas at a fixed designated pressure from 10 to 150 psi (0.70 - 10.55 kg/cm$^2$) (S*ee Figure 1*).

There are two separate flow paths into the **BLENDAIRE**, one for air and one for LPG vapor. They combine at the mixing valve into a single gas line. The airline contains a check valve and an air regulator, which determines the pressure at the mixing valve inlet. The vapor line contains a check valve and vapor regulator (gas governor). The gas governor maintains the vapor pressure at the mixing valve inlet equal to the air pressure by slaving it to the air side.

The air regulator also delivers control pressure to the diaphragm-actuated piston and controls the gas governor through a common sensing line. Consequently, regulated air pressure, regulated LPG vapor pressure and mixed LPG/Air pressure remain constant.

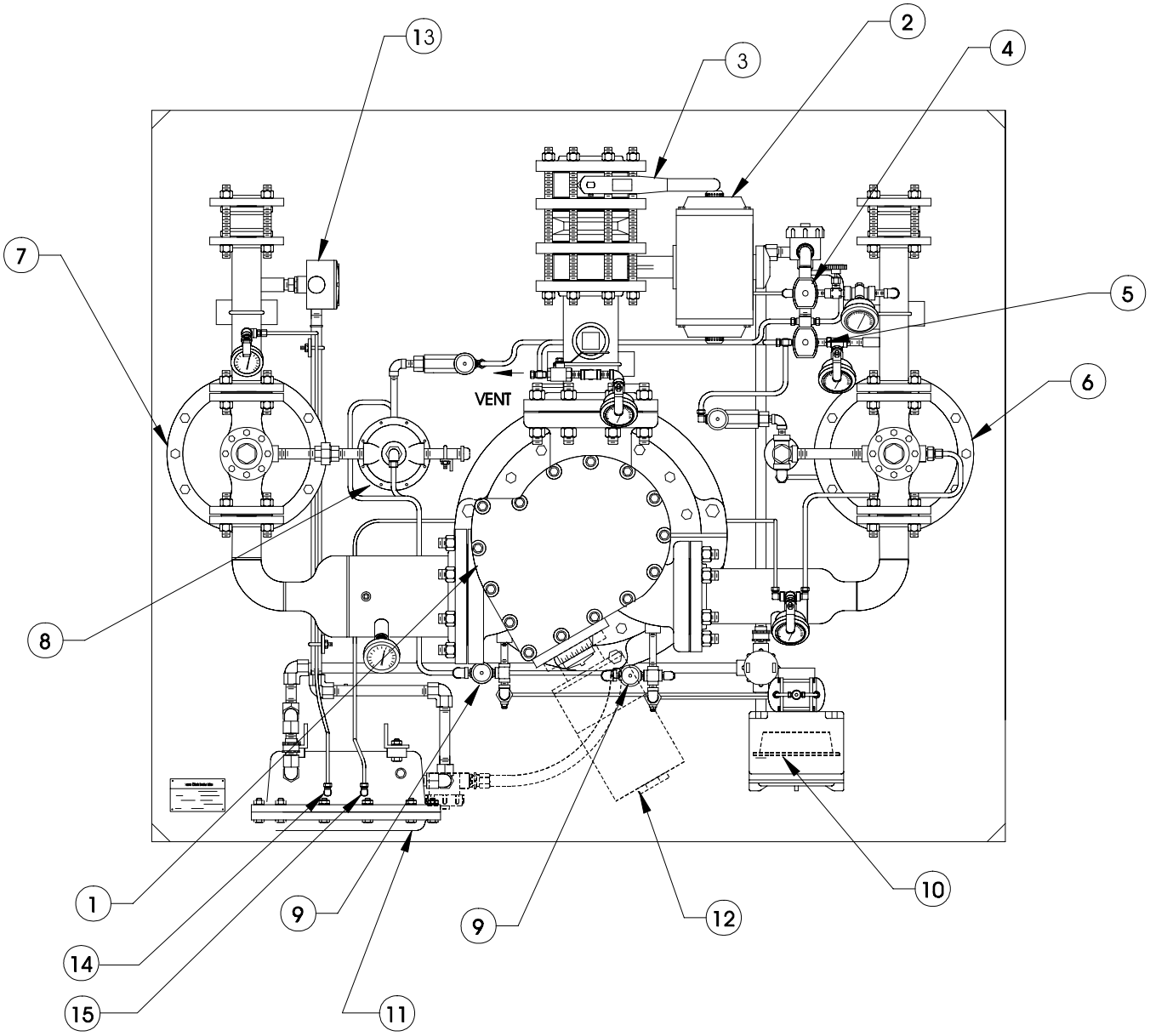
If there is a malfunction, the safety shut-off valve(s) and the two regulators will shut down the system.

***Figure 1 -*** *General Layout (FVO valve shown)*




*Description.gif*

***Figure 2 -*** *Component Diagram (Selas Valve shown)*

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# Major Components 2

**1 - MIXING VALVE**

This valve is the heart of the system. It blends air and LPG vapor over a broad range of flow rates at a selected ratio.

**2 - AUTOMATIC SAFETY SHUT-OFF VALVE**

This is located either at the outlet or at each inlet and will automatically close if there is an alarm condition, lack of electricity or if the air supply is low.

**3 - MANUAL SHUT-OFF VALVE**

Allows system to be shut off manually at the outlet pipe and allows the operator to manually control the outlet flow rate when starting the system.

**4 - AUTOMATIC SAFETY SHUT-OFF VALVE CONTROL**

Used with the automatic shut-off valve. The three-way solenoid provides on/off control of the valve. The regulator and needle valve controls the rate of opening of the automatic safety shut-off valve.

**5 - AIR AND GAS PILOT LOADING VALVE**

The three-way solenoid provides on/off operation of air regulator and gas governor.

**6 - AIR REGULATOR**

Controls the air pressure entering the mixing valve.

**7 - GAS GOVERNOR**

Controls the LPG pressure entering the mixing valve (additional regulator required upstream by user).

**8 - GAS GOVERNOR PILOT**

Controls the gas governor pressure bias relative to the air pressure.

**9 - PRECISION ORIFICE VALVE**

Controls feedback rate to gas governor pilot. Both the gas governor pilot and the precision orifice valve allow the LPG governor to function.

**10 - DIFFERENTIAL PRESSURE SWITCH AND GAUGES**

Indicates the pressure difference between the air and LPG before they enter the mixing valve. The differential switch will shut down the system if the established differential pressure is exceeded.

## 11 - ELECTRICAL CONTROL BOX

The electrical control box houses the process controller or a terminal strip for connection to an external process controller and houses the air and LPG pressure transducers.

## 12 - AUTOMATIC AIR-GAS RATIO CONTROL SYSTEM (OPTIONAL)

The electric motor driving the control system is connected to and controlled by the process controller.

## 13 - LPG VAPOR TEMPERATURE SENSOR

Determines if LPG gas vapor is at safe operating temperature. The system will shut down if LPG vapor temperature is close to dewpoint. The chart at the end of this section has the dewpoints for propane,
N-butane and Isobutane.

## 14 - VAPOR PRESSURE SENSOR

It is used to prevent liquid LPG from entering the system and also to prevent low LPG pressure from forcing lean mixtures.

## 15 - AIR PRESSURE SENSOR

Is used to prevent high air pressure from causing lean mixtures.

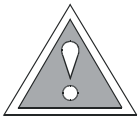
# Installation 3

The **BLENDAIRE** mixer should be housed in a well-ventilated area suitable for its use. The mixer must be placed on a level pad with no pits or depressions so no gas will accumulate. Care must be taken in the entire operating area so that LPG is never near or below its dewpoint in the system at any time.

Heat tracing may be required depending upon location, LPG content and pressure. Mount each **BLENDAIRE** unit on a concrete pad strong enough to support its weight (See data sheet). For ease of operation and maintenance, a 1 1/2" or larger vent line or flare stack with shut-off valve should be installed at the connection point provided on the blender between the mixing valve outlet and the safety shut-off valve.

A vent line (3/8" tube) must be provided to exhaust bleed down products (air and a small amount of LPG) when the system shuts down.

If the unit is equipped with Auto-Ratio-Control, a gas quality-measuring device suitable for the specific operating conditions is required. The total response time, including sample lag time, should be kept to a minimum.



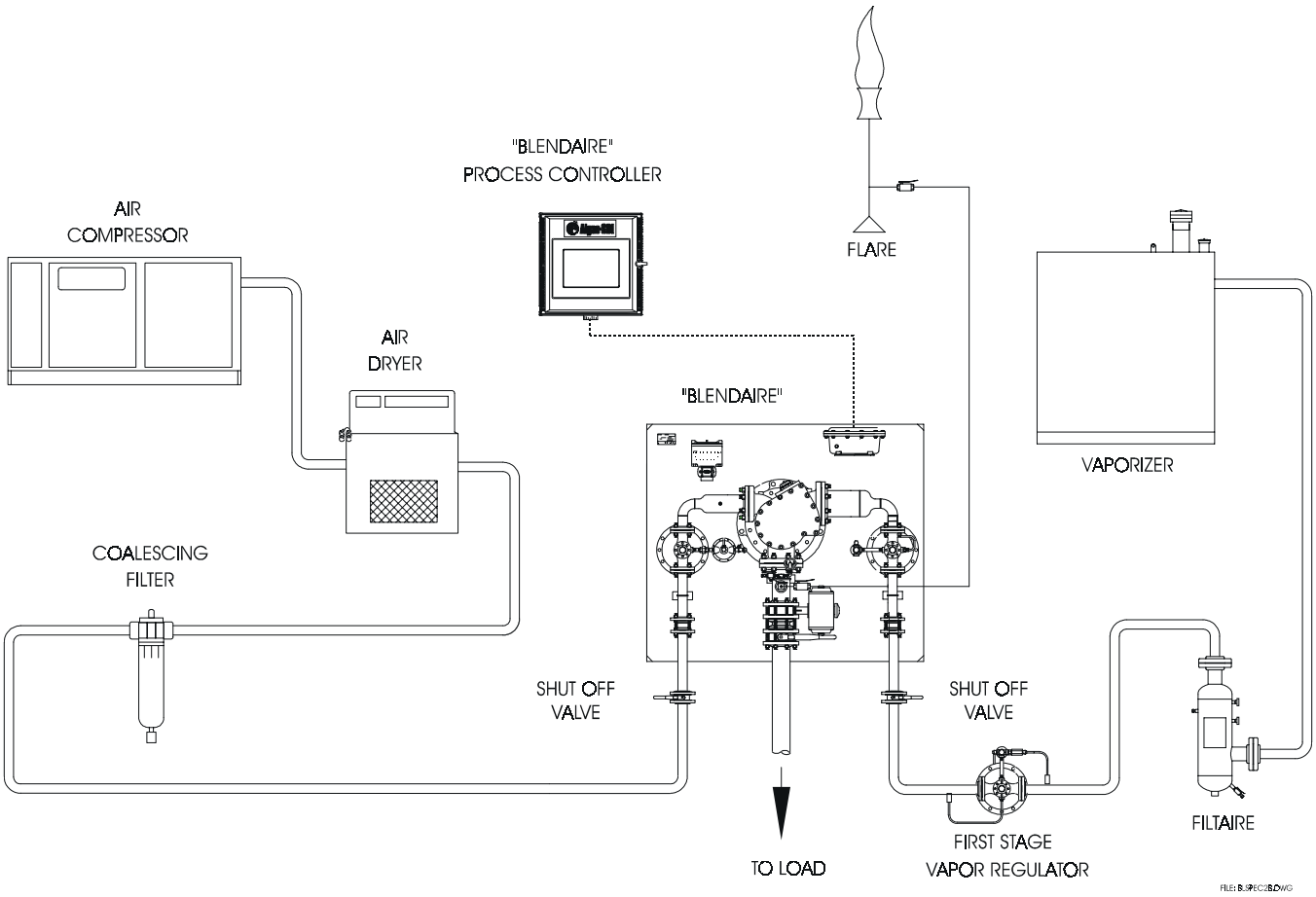
## CAUTION

***Always consult with local codes and authorities prior to installing equipment.***

## NOTE

***On Blendaires with an FVO valve the ratio adjuster indicator is a 'weight loaded' device which can turn independently from the adjuster wheel during transportation due to sudden motion. When the unit was assembled at the factory the piston and indicator where at the 50% position. If the indicator does not read 50% DO NOT TURN THE ADJUSTER WHEEL. Remove the indicator from the wheel and place the indicator at 50% by rotating it. Replace indicator in its original position and tighten setscrew. The wheel may then be turned to adjust the ratio as desired.***

*Figure 3 –* ***Installation Drawing***




*Installation.dxf*

The following equipment must be installed for proper operation of the blending systems:

1. Air supply
2. Vapor supply
3. Mixed gas outlet
4. Process controls

**AIR SUPPLY**

1. Air filters at the incoming air pipes. The user must determine the cleaning schedule for the filters. Dirty air will cause problems in the mixing systems. Supply air must be free of oil and all particulate matter greater than one micron in diameter.

2. An air dryer for the incoming air supply.

3. A First stage pressure regulator in the air supply pipe to reduce the air pressure to the operating pressure specified on the data sheet at the beginning of this manual. This regulator must be of good quality.

4. A vapor shut-off valve must be installed between the blender and the incoming LPG gas vapor line.

**VAPOR SUPPLY**

1. First stage gas supply pressure regulator reduces the operating pressure to 10 psig (0.70 kg/cm$^2$) over desired mixed gas pressure.

2. If the LPG has a heavy end content, filters must be provided upstream of the regulator on the vapor inlet pipe to each Blendaire. The user must determine the cleaning schedule for the filters. A drip leg to drain the heavier particles should be provided immediately upstream of the first stage regulator.

3. Heat tracing must be placed over the vapor supply pipes if the ambient temperature goes within 10°F of the dewpoint of the LPG gas. Electric heat tracing is preferred with an appropriate controller. All heat tracing must be suitable for the class of hazardous location in which it is to be installed. Always consult with the appropriate authorities and all applicable codes.

4. A vapor shut-off valve must be installed between the blender and the incoming LPG gas vapor line.

**MIXED GAS OUTLET**

1. The temperature of the pipe must be kept above the dewpoint of the air/gas mixture. Heat tracing over the outlet pipe may be required as well.

***NOTE***

***See the LPG gas dewpoints given in the manual (Table 1).***

**PROCESS CONTROLLERS**

1. The Blendaire process controller is mounted on the unit unless an external controller is used.

2. The Blendaire uses two (2) control and sensing signal types: alternating current (AC) and direct current (DC). These signals must be transmitted in separate conduit runs. A 3/4" NPT conduit opening is provided for DC signals and a 1/2" NPT opening are provided for AC signals.

3. See wiring Diagram for wire type and required field connections.

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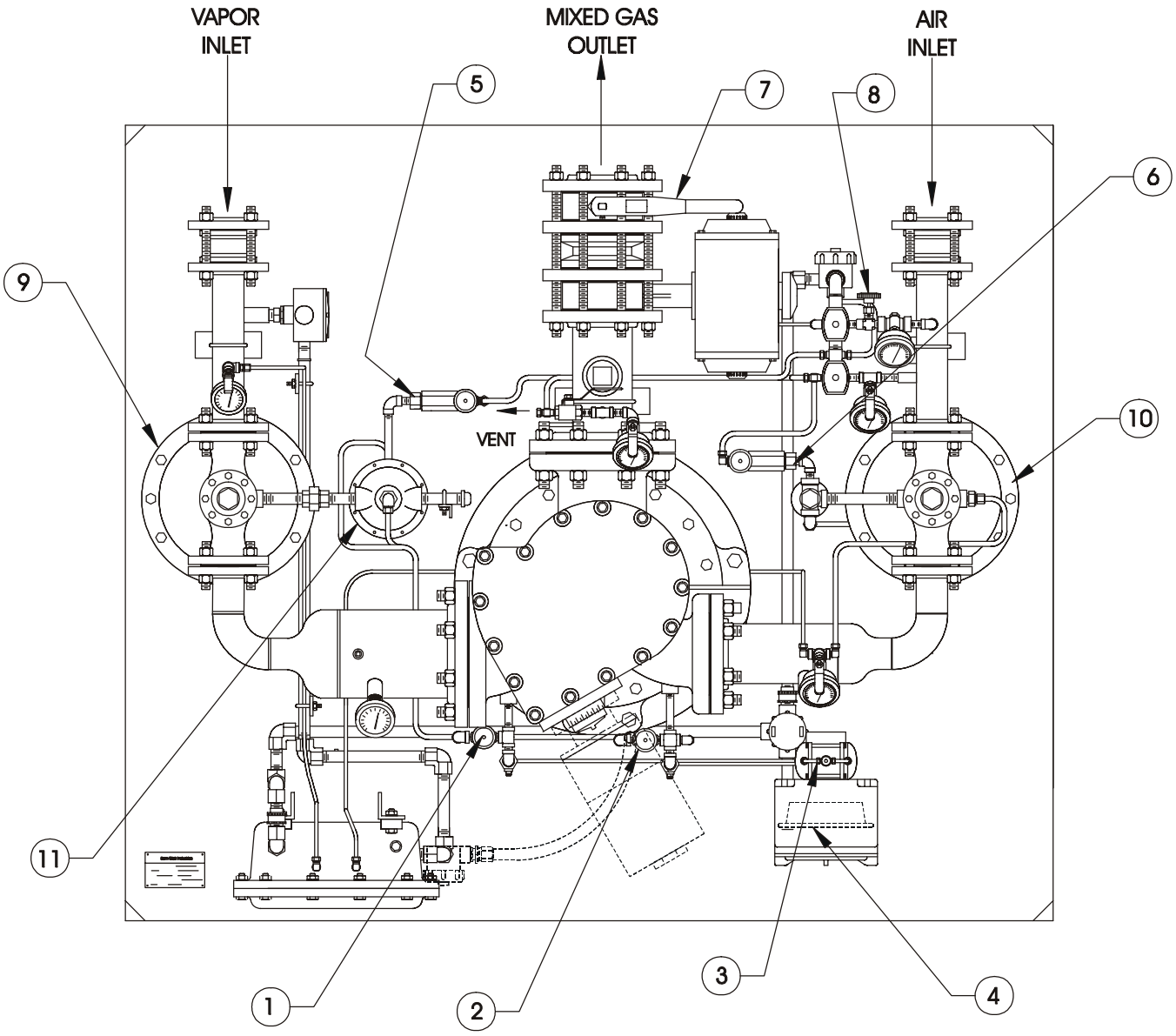
# Start-Up 4

The following procedures must be performed to each Blendaire system when they are first installed.

**STARTING THE MIXING SYSTEM (INITIAL ADJUSTMENT)**

***Figure 4 –*** *Adjustment Reference Drawing*




*Adjustment.dxf*

**BLENDAIRE REGULATOR ADJUSTMENT PROCEDURE**

1. Open the differential pressure bypass valve (#3).
2. Open valves (#1), (#2), (#5), (#6), and (#8).
3. Check that the air and LPG supply is sufficient.
4. Prepare a non-critical load to consume the mixed gas produced during the set-up procedure. A flare stack or other device should exhaust the non-critical load.
5. Start the mixing system.
6. Slowly open valve (#7) approximately 20°.
7. If the regulators (#9) and (#10) have travel indicators (1098-EGR's) remove the covers and observe the travel and timing. The regulators must operate so that both valves open and close simultaneously. If the regulators do not have travel indicators, the differential pressure (#4) will have to be used to indicate the operation of the regulators (#9) and (#10). To do this, slowly close the bypass valve (#3) and observe the needle movement of the differential pressure gauge. The needle will move in the direction of the higher pressure (either LPG or air). Re-open the bypass valve (#3) before the needle reaches the alarm set point (± 28" W.C.), other wise the Blendaire will need to be restarted.
8. If the regulators (#9) and (#10) operate with similar timing and the differential pressure is stable (± 2 – 3" w.c.), no adjustment is required. When the differential pressure is stable, it may be offset to one side or the other to achieve the proper mixing ratio. However, the mixing ratio should never exceed 8 – 9" w.c. offset.
9. If the regulators (#9) and (#10) oscillate, perform the following adjustment steps:

***NOTE***

***The LPG in the system must remain in the gaseous state at all times. The regulators will not operate properly if there is ANY liquid in the system. Perform all necessary procedures to eliminate liquid in the system.***

   a. Lower the inlet air pressure to 5 – 10 psi (0.35 – 0.70 kg/cm$^2$) over the discharge pressure. (Only units with a first stage air regulator.)
   b. Lower the inlet LPG vapor pressure to 5 – 10 psi (0.35 – 0.70 kg/cm$^2$) over the discharge pressure.
   c. Close valves (#1) and (#2). Slowly open valve (#2) for one turn. Now open valve (#1) for one-half turn. Monitor the performance.
   d. Gradually adjust valve (#1) until the operation is stable. Continue to monitor the performance. Valve (#2) may also have to be adjusted to obtain stable operation.

10. Tighten the packing nuts on valves (#1) and (#2) to keep them from being unintentionally re-adjusted or moved.
11. Close the bypass valve (#3).
12. If necessary, adjust the mixing ratio by following the approved procedure.

## BLENDAIRE MIXING RATIO ADJUSTMENT PROCEDURE

These procedures require a mixed gas quality indicator or other gas quality measurement device. After performing the regulator adjustment procedure as outlined above, start the mixing system and establish a moderate flow rate. Perform the following adjustments:

1. Set the mixing ratio adjustment knob (manual) or the PID loop controller output (auto ratio control) to 50%.
2. Monitor the gas quality. If the mixture is close to the desired range, re-adjust the mixing ratio by using the adjustment knob or the PID loop controller output until the mixture is adequate.
3. If the desired quality of gas mixture cannot be achieved by the procedure outlined above, the differential pressure may also be adjusted.
4. If the mixture is too lean (low calorific value) the differential pressure must be increased to the LPG side. If the mixture is too rich, it must be increased to the airside.
5. To make the mixture richer, turn the differential pressure pilot (#11) adjustment knob clockwise (in). To make the mixture leaner, turn the adjustment knob counter-clockwise (out).

***NOTE***

***Do not exceed 8 – 9" w.c. for the normal adjustment.***

The blender can be started after these procedures are completed.

## STARTING THE BLENDER

With the air and the LPG systems operating, close both LPG and air inlet valves to the Blender. Close the LPG/air outlet valve at the blender.

### STARTING THE SYSTEM EQUIPPED WITH MANUAL ADJUSTMENT

1. Apply power to the control panel.
2. Depress the **START** switch**.**
3. The solenoid valves will be actuated and the outlet pressure should increase to operational pressure.
4. Open the manual valve.
5. Start the system on a **FLARE STACK** to dispose of the initial gas.

6. As the system reaches a steady operating condition, check the differential pressure gauge. It should show a fluctuation less than + or – 3" w.c. (Inches of water). If necessary, follow the adjustment procedures on the previous pages. Check all other pressure readings, and trim the corresponding regulators as required.

NOTE

***If the start-up is done under cold conditions, and the vapor temperature alarm comes on begin the process all over. If liquid has entered the system, do not restart until all liquid has been removed. If this condition exists, it is an indication that the system needs adequate heat tracing.***

7. The outlet pressure can be trimmed by adjusting the air regulator pilot if necessary. (Do not change the output pressure from the design system pressure without changing the safety set points to the corresponding values).

   To restart the blender after a safety shutdown, determine and eliminate the cause of failure and begin the start procedure over.

NOTE

***During initial start-up, the mixing ratio adjuster should be adjusted to the approximate setting. The scale is based on port areas, not percent gas, as different gases have different flowing characteristics.***

# Operation 5

## SAFETY OPERATING GUIDELINES

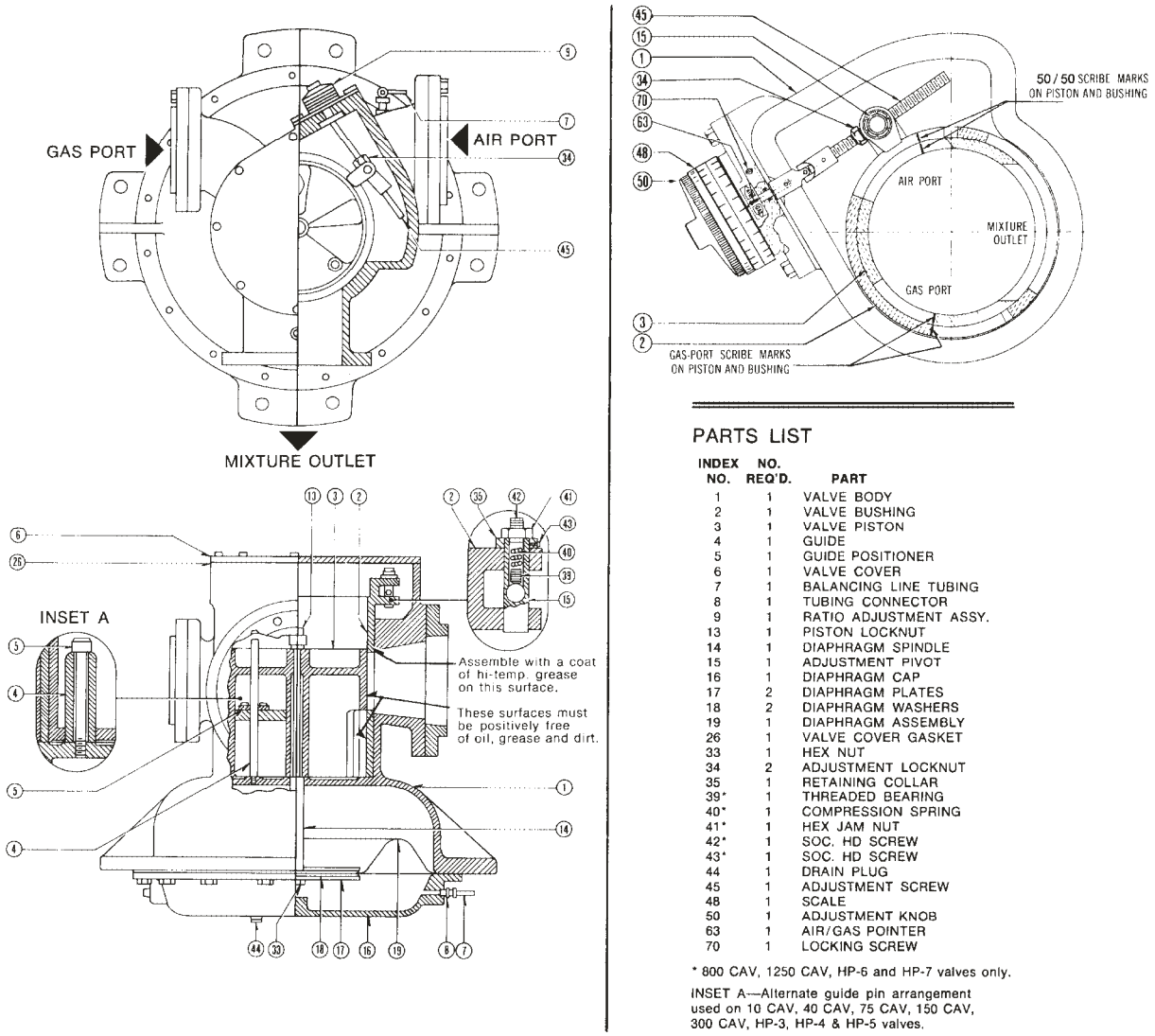
The process control panel monitors the following safety functions:

1. Regulated air pressure at the inlet of the mixing valve.
2. Regulated vapor pressure at the inlet of the gas governor.
3. Vapor temperature at the gas governor inlet.
4. Differential pressure between the air and vapor inlets of the mixing valve.
5. Calorific value from a mixed gas quality indicator.

## SHUTTING DOWN THE BLENDER

1. Put the PID loop controller in the stop mode (if equipped with automatic ratio adjustment).
2. Close the outlet valve.
3. Press the **STOP** switch.
4. If the unit is to be serviced, close the air inlet isolation valve and the vapor inlet isolation valve.
5. Do not disconnect power to the control panel. The servo motor and control panel on the Blendaire is equipped with a heating element and thermostat, which are used to prevent corrosion of the components inside the enclosures. This circuit must always remain **ON**.

**Figure 5 –** Blender Valve Drawing



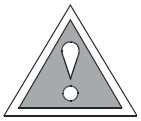

PARTS LIST

| INDEX NO. | NO. REQ'D. | PART |
|---|---|---|
| 1 | 1 | VALVE BODY |
| 2 | 1 | VALVE BUSHING |
| 3 | 1 | VALVE PISTON |
| 4 | 1 | GUIDE |
| 5 | 1 | GUIDE POSITIONER |
| 6 | 1 | VALVE COVER |
| 7 | 1 | BALANCING LINE TUBING |
| 8 | 1 | TUBING CONNECTOR |
| 9 | 1 | RATIO ADJUSTMENT ASSY. |
| 13 | 1 | PISTON LOCKNUT |
| 14 | 1 | DIAPHRAGM SPINDLE |
| 15 | 1 | ADJUSTMENT PIVOT |
| 16 | 1 | DIAPHRAGM CAP |
| 17 | 2 | DIAPHRAGM PLATES |
| 18 | 2 | DIAPHRAGM WASHERS |
| 19 | 1 | DIAPHRAGM ASSEMBLY |
| 26 | 1 | VALVE COVER GASKET |
| 33 | 1 | HEX NUT |
| 34 | 2 | ADJUSTMENT LOCKNUT |
| 35 | 1 | RETAINING COLLAR |
| 39* | 1 | THREADED BEARING |
| 40* | 1 | COMPRESSION SPRING |
| 41* | 1 | HEX JAM NUT |
| 42* | 1 | SOC. HD SCREW |
| 43* | 1 | SOC. HD SCREW |
| 44 | 1 | DRAIN PLUG |
| 45 | 1 | ADJUSTMENT SCREW |
| 48 | 1 | SCALE |
| 50 | 1 | ADJUSTMENT KNOB |
| 63 | 1 | AIR/GAS POINTER |
| 70 | 1 | LOCKING SCREW |

* 800 CAV, 1250 CAV, HP-6 and HP-7 valves only.

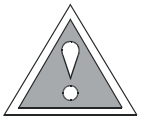
INSET A—Alternate guide pin arrangement used on 10 CAV, 40 CAV, 75 CAV, 150 CAV, 300 CAV, HP-3, HP-4 & HP-5 valves.

*Blender Valve.wmf*



**CAUTION**

***Turn off the LPG gas inlet valve to the mixer before performing any maintenance or repairs.***



**CAUTION**

***Before performing any work on the blender, follow all safety procedures for LPG gas; make sure there are no open flames or electrical sparks, and wear appropriate clothing. Turn off all electrical power to the blender.***

## Selas Blender Valve

**(See Figure 5)**

**DISASSEMBLY**

Place the valve at 50% air / 50% gas before doing any maintenance on the valve. Scribe a mark on the sleeve and body of the valve so they will be aligned when re-assembled. Mark and note the position of the adjustment screw. All these components must be re-installed in the same position they were in when removed.

The blender sleeve and piston operate at close tolerances. For proper operation the piston must have free movement. If the LPG gas entering the system is very dirty or has heavy end products, the blender valve may have to be cleaned more frequently.

**PROCEDURE FOR CLEANING THE BLENDER VALVE**
**(See figure 5)**

1. To expose the internal parts, remove the valve cover (#6). Next, unscrew the piston locknut (#13) from the diaphragm spindle (#14) and remove the piston (#3).

**NOTE**

***For easier removal, coat the hex nuts of the valve cover and the gasket with a light grease or anti-seize compound.***

2. Remove all debris that has accumulated in the valve. Wipe clean all accessible areas, using a cloth saturated with solvent. Do not overlook the orifice opening located in the valve body – they must be free of any obstruction.

3. Remove loose grit and dirt from the piston (#3) and sleeve (#2) and carefully inspect the surfaces for corrosion and abrasions.

4. Remove hard deposits with a crocus cloth or steel wool dipped in a quick evaporating solvent such as acetone or lacquer thinner. Never use grit or emery since metal removal can alter the fit of the components. It is important during this cleaning operation not to mar or deform in any way the sharp metering edges of both the piston and sleeve ports.

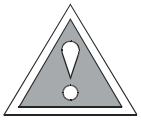
5. Remove the balancing line tubing (#7) and clean by blowing high pressure air through the tube. (Make sure that both ends of the balancing lines are disconnected).

6. A drain plug (#44) is located in the diaphragm cap (#16). It should be removed to drain excessive condensation from the mixing valve.

7. If the sleeve does not rotate easily in the valve body is also needs to be cleaned. For preventive maintenance the sleeve should also be cleaned every year.

   To clean the sleeve, remove the ratio adjustment assembly (#9) from the adjustment pivot (#15). Carefully lift the sleeve from the valve body, using a steady vertical lift in order to prevent binding. Clean it the same way the piston is cleaned.

***NOTE***



***Never coat any part of the piston or inside of the sleeve with oil or grease, as this will attract abrasive impurities from the gas or air supply and may clog or restrict operation.***

Before re-assembling the sleeve in the valve body, coat the outside of the sleeve and the inside of the valve body with a dry lubricant such as graphite. Carefully replace all of the parts, making sure not to force them. Wipe off all excess lubricant from the port area.

8. Re-install the clean piston and line it up with the scribe marks that were made before disassembly.

   If no scribe marks were made, the indicator scale must be reset according to the scribe marks on the piston and sleeve made at the factory.

9. Replace the ratio adjustment assembly and apply lithium grease to the adjustment screw (#45).

**RESETTING OF SCALE**

1. The scale assembly must be adjusted with the blender valve cover removed so scribe marks on the piston and sleeve can be observed.

2. Scribe marks are put on the piston and sleeve at the factory to show their relative alignment. When these "Gas" port scribe marks are matched, they indicate the position of 50% "Air" – "50"% Gas.

3. To correctly set the scale, the marks must match. With the marks set, screw the ratio adjuster motor into the adjustment pivot. The 50% "Air" position on the scale must be maintained for the system to be aligned.

4. When the motor assembly is flush with the valve body and the scribe marks are aligned, secure the assembly.

5. Re-install the valve cover.

**REPLACING THE DIAPHRAGMS**
**(See figure 5)**

The elastomeric diaphragm (#19) requires little maintenance and only needs to be replaced if it becomes brittle and/or is ruptured. If either occurs, the diaphragm can be replaced as follows:

1. Disconnect the tube fitting (#8), and remove the diaphragm cap.

2. Remove the valve cover (#6) and unscrew the piston lock nut (#13).

3. Unscrew the hex nut (#33), removing the diaphragm assembly (#17) and diaphragm washers (#18).

4. The assembly and diaphragm spindle will drop out.

5. Clean the diaphragm spindle.

6. Replace the diaphragm spindle and re-assemble the piston lock nut.

7. Replace the defective diaphragm with a new one.

8. Reassemble the plates and washers.

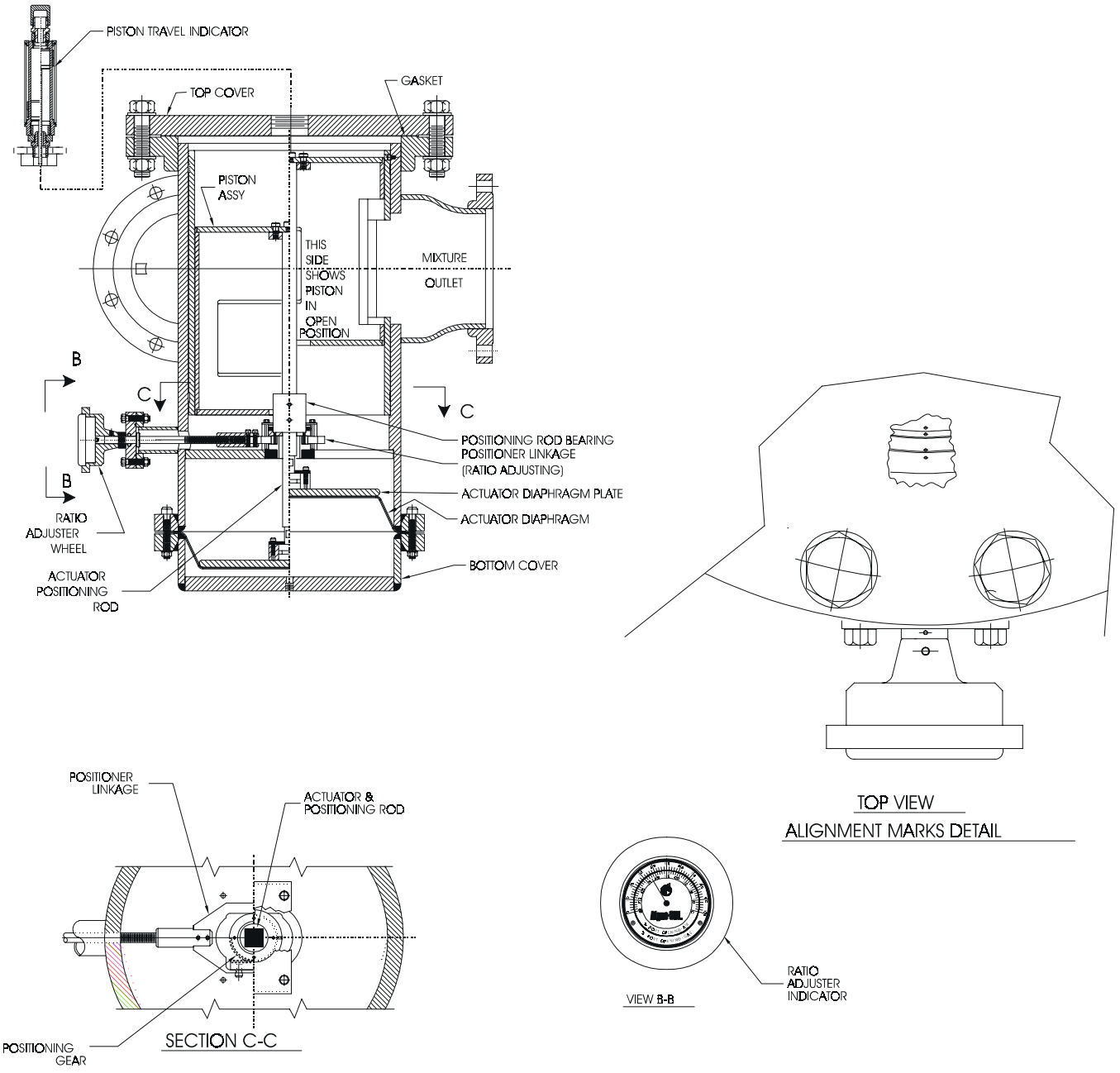
9. Check for full diaphragm travel to assure the new diaphragm travels freely.

10. Lift the diaphragm cap into position and fasten it to the valve body with cap screws.

*NOTE*

***Flat diaphragms require a pleating along the outer edge to provide the slack, which will allow vertical movement. To accomplish this, evenly space the pleats between the bolt holes allowing no more than one fold at any one point under the clamping surface.***

**Figure 6** – FVO valve drawing

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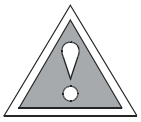
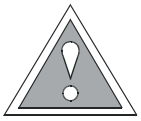


### CAUTION

***Turn off the LPG gas inlet valve and air inlet valve to the mixer before performing any maintenance or repairs.***

### CAUTION



***Before performing any work on the blender, follow all safety procedures for LPG gas; make sure there are no open flames or electrical sparks, and wear appropriate clothing. Turn off all electrical power to the blender.***

## FVO Blender Valve

**(See Figure 6)**

**ASSEMBLY**

Clean the blender valve as operating experience dictates. The blender sleeve and piston operate at close tolerances. They must be clean for free movement. If the LPG gas entering the system is very dirty or has heavy end products, the blender valve may have to be cleaned more frequently. Dirty air may also require more frequent cleaning.

Place the valve back at 50% air / 50% gas before doing any maintenance on the valve. This will align all of the alignment marks in line with the discharge.

**PROCEDURE FOR CLEANING THE BLENDER VALVE**
**(See figure 6)**

1. To expose the internal parts, remove the valve cover. Next, unscrew the thumbscrew with the Travel Indicator Push Rod still attached from the Piston Rod and the 4 allen head screws around the top of the piston. Remove the piston.

### NOTE

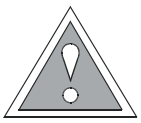
***For easier removal, coat the hex nuts of the valve cover gasket with a light grease or anti-seize compound.***

2. Remove all debris that has accumulated in the valve. Wipe clean all accessible areas, using a cloth saturated with solvent. Do not overlook the orifice opening located in the valve body – it must be free of any obstruction.

3. Remove loose grit and dirt from the piston and sleeve and carefully inspect the surfaces for corrosion and abrasions.

4. Remove hard deposits from the piston with a crocus cloth or steel wool dipped in a quick evaporating solvent such as acetone or lacquer thinner. Do not use any abrasives on the sleeve, it might remove the anodized surface. Never use grit or emery since metal removal can alter the fit of the components. It is important during this cleaning operation not to mar or deform in any way the sharp metering edges of both the piston and sleeve ports.

**NOTE**



***Never coat any part of the piston or inside of the sleeve with oil or grease, as this will attract abrasive impurities from the gas or air supply and may clog or restrict operation.***

5. Remove the balancing line tubing and clean by blowing high pressure air through the tube. (Make sure that both ends of the balancing lines are disconnected). This will drain any excessive condensation from the mixing valve.

6. If the ratio adjustment assembly does not move easily it will also need to be cleaned. For preventive maintenance the ratio adjustment assembly may need to be cleaned every year.

   To clean the ratio adjustment assembly, remove the Piston Rod Clamp from the Piston Rod. Remove the bearing hold down plate. Before removing the bearing and adjuster sector gear scribe a mark on the gear and rack so that they can be reassembled in the right orientation. Loosen the 4 setscrews in the bearing and lift the bearing and sector gear together.

   When re-assembling the Adjuster Sector Gear on the Piston Rod, be careful not to damage or lose the felt wipers in the top and bottom of the bearing. Make sure to line up the scribe marks between the Adjuster Sector Gear and the Adjuster Rack Gear. Before re-tighten the set screws in the bearing apply a low strength lock-tight to the threads to prevent them from backing out. Carefully replace all of the parts, making sure not to force them. The top of the Piston rod clamp should be flush with the top of the Piston Rod. Wipe off all excess lubricant from the port area.

7. Re-install the clean piston by aligning the alignment mark with the mark on the sleeve.

8. Replace the 4 Allen head screws and the thumbscrew with the travel indicator push rod still attached. Replace the lid and tighten bolts in a star pattern.

**RESETTING OF SCALE**

1. The scale assembly must be adjusted with the blender valve cover removed so alignment marks on the piston, sleeve, and valve body can be observed.
2. Alignment marks are put on the piston, sleeve, and valve body at the factory to show their relative alignment. When these marks are matched, they indicate the position of 50% "Air" – 50% “Gas”.
3. The ratio adjuster indicator should be installed at 50% “Air” – 50% “Gas”.
4. Stroke the servomotor in forced mode to 50% and re-install.
5. Re-install the valve cover and check for leaks.

**REPLACING THE DIAPHRAGMS**

The diaphragm supplied requires little maintenance and only needs to be replaced if it becomes brittle and/or is ruptured. If either occurs, the diaphragm can be replaced as follows:

1. Remove the valve cover.
2. Support the piston from above in the full open position.
3. Disconnect the tube fitting, and remove the diaphragm cap.
4. Remove the old diaphragm.
5. Make sure the chamber that houses the diaphragm is clean and dry.
6. Apply talcum powder to both sides of the diaphragm.
7. Replace the defective diaphragm with the new one.
8. Check the spacers in the diaphragm cap (if equipped). They should be mounted firmly. If they are loose they need to be glued down.
9. Check for full diaphragm travel to assure the new diaphragm travels freely.
10. Lift the diaphragm cap into position and retighten all fasteners.
11. Replace the valve cover and check for leaks.

**TEMPERATURE SENSOR**

The temperature sensor on the LPG side of the Blendaire must be calibrated once every year. Perform the following procedures to calibrate the sensor.

1. Turn of the electricity to the system.

2. As previously described, shut down the system and bleed it down completely so all pressures are zero.

3. Remove the wire connection and the temperature transmitter.

4. The accuracy of the temperature transmitter can be tested by measuring the resistance across the two wires it while it is immersed in water of a known temperature. For example, if the temperature transmitter is immersed in a container of ice water with the temperature 0° C, the resistance should be 100.000. If it is placed in a container of boiling water, 100° C, the resistance should be 138.500. If the resistance is off by 2%, a new temperature transmitter should be installed. See the enclosed resistance/temperature table for a reference.

**REPLACEMENT OF THE ROTARY ACTUATOR SERVO-MOTOR**

1. Check all circuits for operation and functionality.
2. Make all necessary connections from the process control panel to the motor on the Blendaire valve.
3. Remove the aluminum cover from the motor and switch assembly.
4. Remove motor from shaft. Using the PID controller controls in manual, run the motor to 50% gas.
5. Position the blender valve inner sleeve so that it is in the 50% gas position. Re-install the motor at this time.
6. Slowly operate the motor to 70% gas using the PID controller. Adjust the outer limit switch to trip at this point. Now operate the motor to 30% gas using the PID controller. Adjust the outer limit switch to trip at this point.
7. Run the motor slowly from 100% to 0% and back to double check the range and limit switches. Set the motor to 50%.
8. Check the heater for operation. The aluminum body of the motor should be warm to the touch. (Do not touch the heating element directly because it is very hot).
9. Apply a sealer to the locknuts of the limit switches to secure them.

# BLENDAIRE PLC CONTROLLER

The ASDI **Blendaire** PLC Controller is accessed by removing the cover.

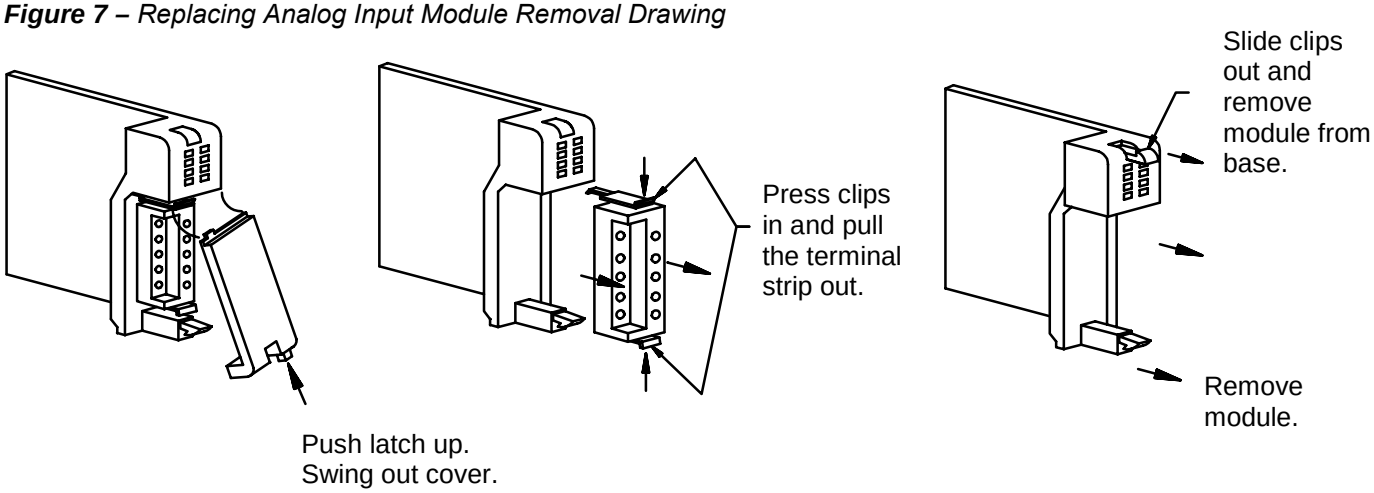
*NOTE*

***Do not attempt to repair the PLC modules. If the module is defective, the entire module should be replaced.***

**REPLACING ANALOG INPUT MODULE (SLOT 0):**

- Turn off power at the disconnect. **MODULES** must not be removed with power applied to the PLC.
- Press the small tab on the right located under the cover and pull the cover out from the bottom.
- Squeeze the tabs on the top and bottom of the terminal block and pull it out.
- Pull outward on the retaining clips, located at the top and bottom, to unlock the module.
- Remove the module by grasping the top and bottom and sliding it outward.
- Replace the module by sliding it into the slot. Align the PC board(s) on the module with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the back-plane connector.
- Once the module is inserted into the base, push the retaining clips located at the top and bottom to firmly secure the module.
- Replace the terminal block. Replace the cover by inserting the tab in the top and push in the cover.

***Figure 7 –*** *Replacing Analog Input Module Removal Drawing*

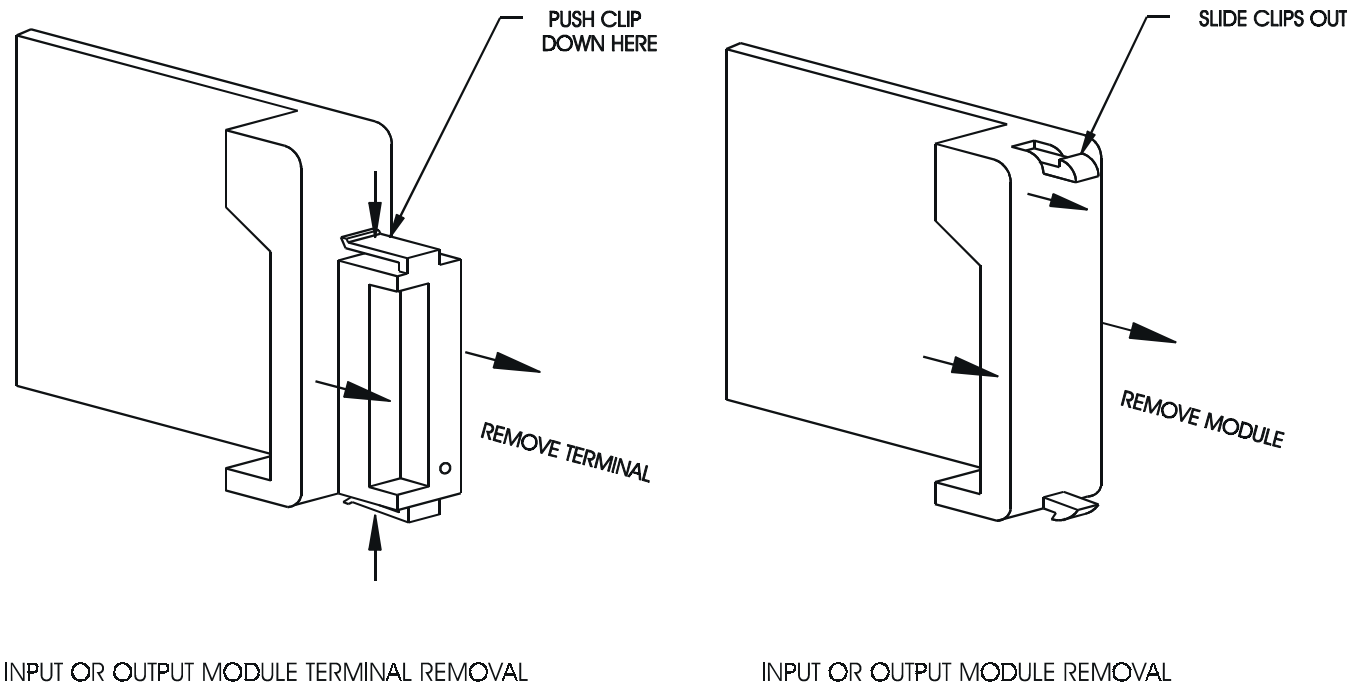



*Analog Input Module Removal.wmf*

**REPLACING AC INPUT AND OUTPUT MODULES (SLOT 1 AND 2):**

- Turn off power at the disconnect. Modules must not be removed with power applied to the PLC.
- Squeeze the tabs on the top and bottom of the terminal block and pull it out.
- Pull outward on the retaining clips, located at the top and bottom, to unlock the module.
- Remove the module by grasping the top and bottom and sliding it outward.
- Replace the module by sliding it into the slot. Align the PC board(s) on the module with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the back-plane connector.
- Once the module is inserted into the base, push the retaining clips located at the top and bottom to firmly secure the module.
- Replace the terminal block.

***Figure 8** – Replacing AC Input and Output Modules*




*Module Removal.wmf*

## CONTROL BOX HEATER

The **CONTROL BOX** is equipped with a heater to prevent condensation and to insure that all the electrical components operate within their allowed temperature range. The heater is mounted on the back side of the control panel and is not visible. The heater is controlled by two thermostats. One thermostat (#1) (heater operating thermostat) is mounted on the STOP Switch and the second thermostat (#2) over temperature safety is mounted directly on the control panel.

## TESTING THE CONTROL BOX HEATER

If the heater is not on due to ambient temperature being higher than the thermostat settings, the heater can be checked by the following procedure:

The operating thermostat is on at 45° F and off at 60° F. The high temperature limit thermostat opens at 150° F.

- Turn off the control box power at the disconnect.
- Open the control box.
- Jumper the thermostat #1 mounted on the STOP Switch.
- Turn on the power at the disconnect.
- Monitor the control panel temperature to determine if it is heating up.

***CAUTION***

***Control Panel will get hot!***

- Turn off the control box power at the disconnect.
- Remove the thermostat jumpers.
- Put the cover on the control box .
- Turn on the power.

## *Blendaire Maintenance Schedule*

| DESCRIPTION | FIRST MONTH | EVERY MONTH | EVERY 6 MONTHS | EVERY YEAR | EVERY 2 YEARS |
|---|---|---|---|---|---|
| Selas Mixing Valve | Clean and dry lube*. | Clean and dry lube*. (if required) | | Clean and dry lube*(if required) outer sleeve and adjustment screw. | Polish piston and sleeve.<br>Replace diaphragm. |
| FVO Mixing Valve | Clean and dry lube. | Clean and dry lube. (if required) | | | Polish piston and sleeve.<br>Replace diaphragm. |
| Pilot | Clean pilot filters with solvent. | | Clean pilot filters with solvent. | | Re-build pilot.<br>Replace pilot filters. |
| Regulator | Inspect and clean lines. | | Clean upper body. | | Clean and re-build. |
| Safety Valve | | | Check. | | Rebuild actuator.<br>Replace main valve seal. |
| Temperature Transducers | | | Re-calibrate. | | Re-calibrate or replace. |
| PLC Controller Circuits | | | Check. | | |
| PLC Controller Safeties | Check. | | Check. | | |
| Solenoid Valves | | | Check operation. | Clean valve. | Rebuild valve. |
| Differential Pressure Switch Check Points | | | Check | | |
| Control Lines | | | | Clean and purge. | |

* Only use dry lubricant on the outside of the sleeve and the inside of the valve body.

| PROBLEM | CAUSE | SOLUTION |
|---|---|---|
| **Alarm** and **Vaporizer Limits** sound immediately. | Vaporizer not functioning normally. | Vaporizer must be operating correctly. |
| **Alarm** and **High Pressure** sound after 15 seconds. | Air pressure regulator is set too high or is malfunctioning. | Check air pressure regulator operation. |
| | High pressure gas is trapped in the blender. | Bleed the LPG gas line. |
| **Alarm** and **Low Vapor Pressure** sound after 15 seconds. | The first stage vapor regulator located near the vaporizer is malfunctioning or is misadjusted. | Check and repair the first stage regulator. |
| | The pump pressure to the vaporizer is low. | Check pump operation and incoming lines. |
| | Safety solenoid valves malfunctioning. | Repair solenoid valves. |
| | Vapor shut-off valve is closed. | Open vapor shut-off valves. |
| **Alarm** and **Differential Pressure** sound after 15 seconds. | Broken gas governor. | Check the gas governor for operation. |
| | Faulty mixing valve diaphragm. | Check the mixing valve for ruptured diaphragm. |
| | Improper air pressure. | Check the high pressure air supply. |
| | Faulty solenoid valves. | Check the safety solenoid valves. |
| **Alarm** and **Low Vapor Temperature** come on after the delay period. | System not yet warmed up. | Re-start the blender at the control panel and put a small load on the system to warm up the temperature switch. |
| | The vaporizer is not set warm enough. | Re-set the vaporizer. |
| | The system load is too high for the vaporizer. | Reduce the system load to operating parameters. |

# *APPENDIX A*

# *Component Information*

# NOTE

***This manual covers all ranges of models;***
***therefore, some components in the enclosed section***
***will not be applicable.***

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**User's Manual: Series 340I**
**Model 340I DC-Powered Input Isolator**

**Table of Contents** **Page**



**List of Drawings**



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IMPORTANT SAFETY CONSIDERATIONS

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It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.


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8500-334-B93K008

**INSTRUCTIONS: SERIES 340I**
**Process Current Input Isolator, DC Powered**

## INTRODUCTION:

These instructions cover the model types listed in Table 1 below. Supplementary sheets are attached for units with special options or features.

**Table 1:**

A. Model Number Format : 340I-Input-Output-Mounting-Certification
B. Typical Model Number: 340I-C1-Y-DIN-NCR

| Series | -Input | -Output | -Mounting | -Certification |
|---|---|---|---|---|
| 340I | -C1 | -Y | -DIN | -NCR<br>-Agency Approval [2] |

Notes (Table 1):

1. All units are factory calibrated for 4 to 20mA DC input and 4 to 20mA DC output (no "-C" suffix needed).
2. Consult the factory for current information on agency (e.g. Canadian Standards Association, etc.) approvals.

## DESCRIPTION:

This DC powered input isolator accepts a 4 to 20mA DC input signal and provides an *isolated* 4 to 20mA DC output signal. The isolator operates from a wide supply range, has a low input burden, is RFI and EMI protected, and operates over a large temperature range with excellent temperature coefficients, which minimize effects from the harsh plant environment.

The Series 340I is a DIN-rail mounted, process current isolator, designed to be used as another functional component to provide the user with a modular approach to the varied applications in the field. Unlike the Series 270I which is a two-wire loop-powered isolator, the Series 340I is a three-wire isolator. That is, Series 340I Isolators require a separate power supply connection, while the output signal and DC power share a common lead. The small package size, low power requirements, and wide supply range offers maximum flexibility to the user. As a three-wired DC powered device, it can also be used in critical applications that require the use of redundant supplies. The Series 340I includes reverse polarity protection, current limiting, and operates from a single 10V to 36V DC supply. In applications requiring only a single isolator, the 340I can use available DC power, or it can be wired to an optional Series 35PS power supply module. The Series 35PS power supply module receives it's power from either 115V AC or 230V AC. Applications requiring multiple isolators at a single location can more efficiently share a single DC supply. The modular approach of this design and companion Acromag flat-pack modules allows additional transmitters, input modules, isolators, and alarms to be easily integrated, as required. See Drawing 4501-261 for a simplified Series 340I schematic.

Input wiring is inserted in the bottom of the unit, while output and power wiring is inserted at the top of the unit. Screws to secure the wiring are located on the front panel. Connectors are screw-clamp type and accept wire size up to #14 AWG.

**Key 340I Features:**

* True Galvanic (Transformer) Isolation
* Wide Ambient Temperature Range
* 1-Inch Wide DIN Mounted Package
* DC Powered, Wide Supply Range
* Allows Use of Redundant Supplies
* Low Input Burden (less than 1.5V)
* Highly Accurate and Stable
* No Load Trimming Required
* Current Limiting Included
* 0-500 ohm Load Range (15V supply)

## SPECIFICATIONS:

**Function:** This DC powered isolator accepts a 4 to 20mA DC input, has input circuit isolation, and provides a 4 to 20mA DC output. The output and DC power share a common terminal (3-Wire connection). The Zero and Span trim adjustments utilize 15-turn potentiometers accessible from the front of the unit. This isolator is DIN-rail mounted.

**MODEL/SERIES: 340I-** (Color coded with a white label)

**INPUT:**

**-C1:** 4 TO 20mA DC, with an input drop less than 1.5V at full-scale.
**IMPORTANT:** Input current must not exceed 100mA or damage to the unit could occur.

**Isolation:** The input circuit is electrically isolated from the output and power circuits, allowing the input to operate at up to 250V AC, or 354V DC off ground, on a continuous basis (will withstand 1500V AC dielectric strength test for one minute without breakdown). This complies with test requirements outlined in ANSI/ISA-S82.01-1988 for the voltage rating specified.

**OUTPUT:**

**-Y:** 4 to 20mA DC. The output shares a common with the power supply.

NOTE: A voltage output option is not available for the Series 340I. Instead, specify Model 350T-C1-Vx-NCR-C if this is a requirement of your application.

Load Resistance Range Equation: The maximum load resistance is a function of available power supply voltage as follows (refer to Drawing 4501-265):

R-Load (Maximum) = (Minimum VDC supply - 5.0V) / 0.02A

That is, with a 10.0V DC supply, R-Load = 0 to 250 ohms
with a 15.0V DC supply, R-Load = 0 to 500 ohms
with a 24.0V DC supply, R-Load = 0 to 950 ohms

**Output Limiting:** Output current is limited to 27mA, nominal.

**Output Ripple:** Less than +/-0.1% of the maximum output span.

**Power:** 10.0V to 36.0V DC, 27mA, nominal. The external DC power supply is connected between the output (P) and (-) terminals. The output shares a common connection with the power supply. The current specified is for rated supply inputs and full-scale output. Supply current is limited to 34mA, maximum. Diode installed in isolator provides reverse polarity protection.

IMPORTANT: Do not exceed 36V DC peak, to avoid damage to the isolator.

**Power Supply Effect:**

DC Volts: less than +/-0.001% of output span per volt DC change in supply.
60/120Hz Ripple: less than +/-0.01% of span per volt peak-to-peak of power supply ripple.

**Reference Test Conditions:** Input/Output current: 4 to 20mA; output load 250 ohms; 77$^{o}$F (25$^{o}$C); +15V DC supply.

**Accuracy:** Better than +/-0.1% of output span. This error includes the combined effects of isolator repeatability, hysteresis, terminal point linearity and adjustment resolution. Does not include sensor error.

**Ambient Temperature Range:** -13$^{o}$F to 185$^{o}$F (-25$^{o}$C to 85$^{o}$C).

**Ambient Temperature Effect:** Less than +/-0.003% of output span change per $^{o}$F (+/-0.005% per $^{o}$C) over the ambient temperature range for reference test conditions. This specification includes the combined effects of zero and span over temperature.

**Bandwidth:** -3dB at 50Hz, typical, with 500 ohm load.

**Response Time:** For a step input, the output reaches 98% of output span in 25ms, typical, with 500 ohm load.

**Noise Rejection:**

Normal Mode: -6dB at 60 Hz, typical, with 500 ohm load.

Common Mode: -95dB at 60Hz, typical, with 500 ohm load.

**RFI Resistance:** Less than +/-0.5%, of output span with RFI field strengths of up to 10V/meter at frequencies of 27, 151 and 467 MHz.

**EMI Resistance:** Less than +/-0.25% of output span effect with switching solenoids or commutator motors.

**Surge Withstand Capability (SWC):** Input/Output terminations rated per ANSI/IEEE C37.90-1978. Unit is tested to a standardized test waveform that is representative of surges (high frequency transient electrical interference), observed in actual installations.

**Construction:**

Printed Circuit Boards: Military grade FR-4 epoxy glass circuit board.
Terminals: Compression type, wire size 14 AWG maximum.
Case: Self-extinguishing NYLON Type 6.6 polyamide thermoplastic UL94V-2, color black. General Purpose, NEMA Type 1 enclosure.
Printed Circuit Board Coating: Fungus resistant acrylic conformal coat.
Mounting Position: Position insensitive.

**MOUNTING:**

**-DIN:** General Purpose Housing, DIN-Rail Mount - "G" & "T" rails. "G" Rail (32mm), Type EN50035; "T" Rail (35mm), Type EN50022. Refer to Drawing 4501-262 for outline and clearance dimensions. Shipping Weight: 1 pound (0.45Kg) packed.

**CERTIFICATION:** Consult the factory for current information on the availability of agency (e.g. Canadian Standards Association, Factory Mutual, etc.) approvals.

**-NCR:** No Certification Required.

**INSTALLATION:**

The isolator is packaged in a general purpose type of enclosure. Use an auxiliary enclosure to protect against unfavorable environments and locations. Maximum operating ambient temperatures should be within -13 to 185$^{o}$F (-25 to 85$^{o}$C) for satisfactory performance. If the has been calibrated, it is ready for installation. Connect as shown in the connection diagram of Drawing 4501-261. To verify calibration, refer to the "CALIBRATION" section.

**Mounting:**

Mount isolator assembly - refer to Drawing 4501-262 for DIN-rail mounting and clearance dimensions.

**DIN Rail Mounting:** Using suitable fastening hardware, secure the DIN rail to the designated mounting surface. A transmitter, can be mounted to either the "T" or "G" Rail. Installation of the transmitter to the rail depends on the type of DIN rail used. Units can be mounted side by side on 1.0 inch centers, if required.

**"T" Rail (35mm), Type EN50022:** To attach a transmitter to this style of DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps solidly into place. To remove a transmitter, insert a screwdriver into the lower arm of the connector and pull downwards while applying outward pressure to the bottom of the unit.

**"G" Rail (32mm), Type EN50035:** To attach a transmitter to this style of DIN rail, angle the unit so that the upper groove of the adapter hooks under the top lip of the rail. Firmly push the unit towards the rail until it snaps solidly into place. To remove a transmitter, pull the lower part of the unit outwards until it releases from the rail, lift unit from rail.

**Electrical Connections:**

The wire size used to connect the unit to the control system is not critical. All terminal strips can accommodate wire from 14-26 AWG. Strip back the insulation 1/4 inch on each lead before installing it into the terminal block. Input wiring may be either shielded or unshielded twisted pair. Output wires should be twisted pair. Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. It is recommended that output and power wiring be separated from the signal wiring for safety, as well as for low noise pickup.

1. **Power:** Connect DC power supply per connection diagram, refer to Drawing 4501-261. This isolator operates from DC power supplies only. Power supply voltage is not critical and should normally be from 10 to 36V DC. The supply voltage must not exceed 36V, or damage to the unit may occur. The power supply voltage must be adequate to furnish full-scale current to the load(s). Rated variations in power supply voltage or load resistance have negligible effect on isolator accuracy. Refer to "Power" in the preceding "SPECFICATIONS" section for current requirements. The minus (-) power supply lead and the minus (-) output lead share a common terminal. Power connections are reverse polarity protected. Refer to Drawing 4501-263 for other power supply configurations.

   Ripple and Noise: Power supply ripple at 60Hz/120Hz is reduced at the load by the isolator. The ripple at the load will be less than +/-0.01% of span per volt peak-to-peak of power supply ripple.

2. **Output:** Connect output per connection diagram, refer to Drawing 4501-261. Load range is a function of the module's power supply voltage; refer to "Output" in the preceding "SPECIFICATIONS" section (see Drawing 4501-265). The output shares a common with the power supply.

3. **Grounding:** The transmitter housing is plastic and does not require an earth ground connection.

4. **Input:** Input is 4 to 20mA DC. Connect input per connection diagram, observe proper polarity. NOTE: The input circuit is electrically isolated from the output/power circuit allowing the input to operate up to 250V AC or 354V DC off ground on a continuous basis.

CALIBRATION:

All units are calibrated and checked for proper performance at the factory before they are shipped. The calibration example below is provided for reference.

**Isolator - Adjustment Procedure:**

Connect the isolator as shown in the recommended calibration connections of the connection diagram (Drawing 4501-261). The input current source must be adjustable over the entire input range of the unit and settable to an accuracy of 0.05% or better for proper results.

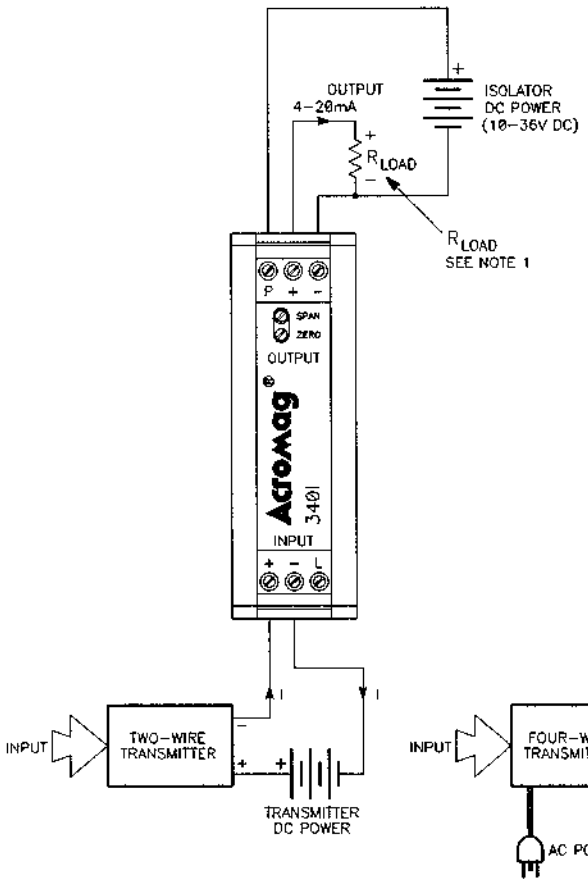
The Zero and Span adjustments are accessible on the front panel of the isolator, see Drawing 4501-261 for location. The Zero and Span trim provided are not wide-range adjustable and are suitable for fine tuning only. The screwdriver blade used to adjust the potentiometers should not be more than 0.1 inch (2.54mm) wide.

Isolator - Calibration Example: MODEL : 340I-C1-Y-DIN-NCR
Input : 4 to 20mA DC
Output: 4 to 20mA DC

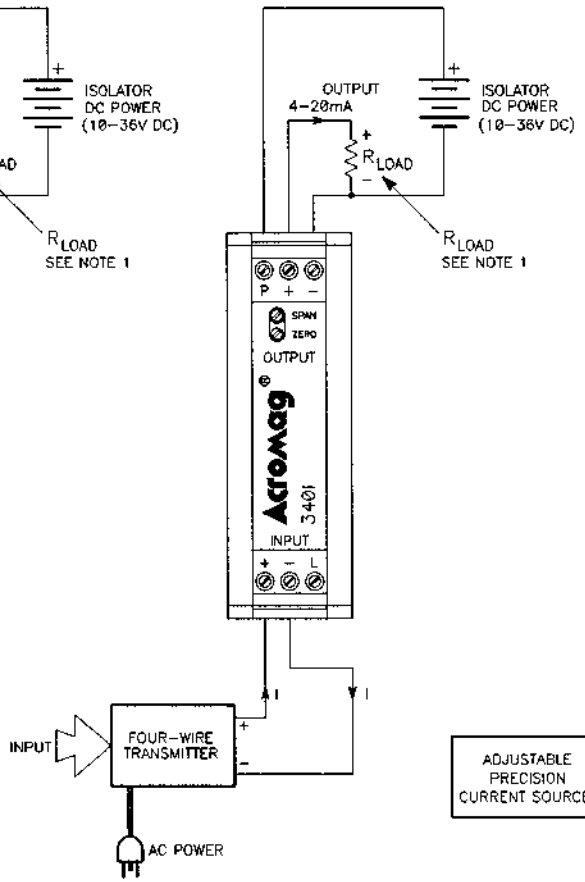
1. Set the input source to 4.000mA. Adjust the Zero (Z) pot until the output reads 4.000mA DC (NOTE: If you have trouble reaching zero, you may have to first set the span near 16.000mA).
2. Set the input source to 20.000mA. Adjust the Span (S) pot until the output reads 20.000mA DC.
3. Repeat steps 1 and 2 until the readings converge.
4. Check the midpoint by setting the input source to 12.000mA. The output should read 12.000mA +/-0.016mA DC. The instrument is now calibrated.

**GENERAL MAINTENANCE:**

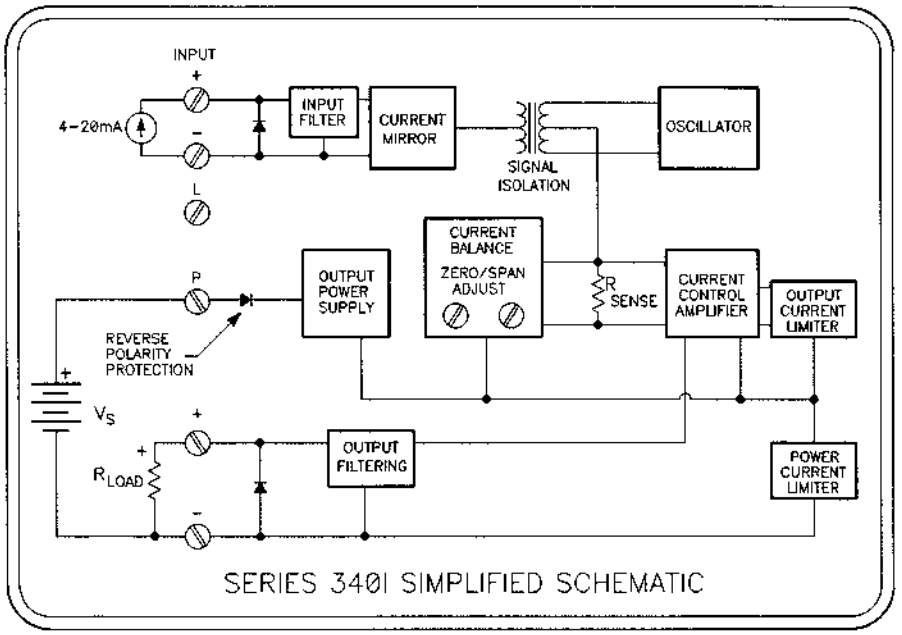
The isolator contains solid-state components and requires no maintenance except for periodic cleaning and calibration verification. When a failure is suspected, a convenient method for identifying a faulty isolator is to exchange it with a known good unit. It is highly recommended that a non-functioning isolator be returned to Acromag for repair, since Acromag makes use of tested and burned-in parts, and in some cases, parts that have been selected for characteristics beyond that specified by the manufacturer. Further, Acromag has automated test equipment that thoroughly checks the performance of each isolator.



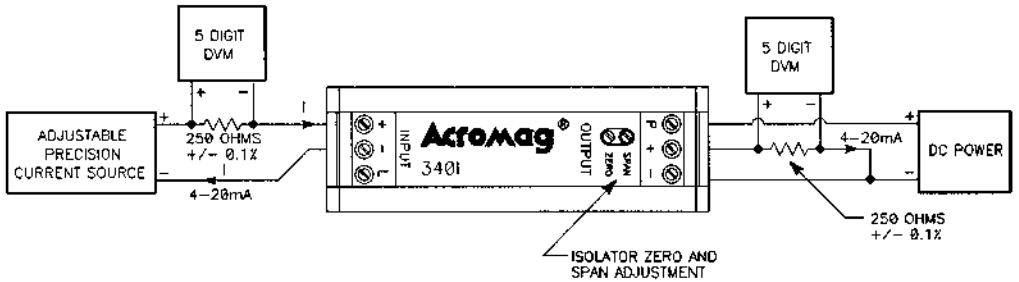

TYPICAL TWO–WIRE
TRANSMITTER CONNECTIONS




TYPICAL FOUR–WIRE
TRANSMITTER CONNECTIONS




SERIES 3401 SIMPLIFIED SCHEMATIC



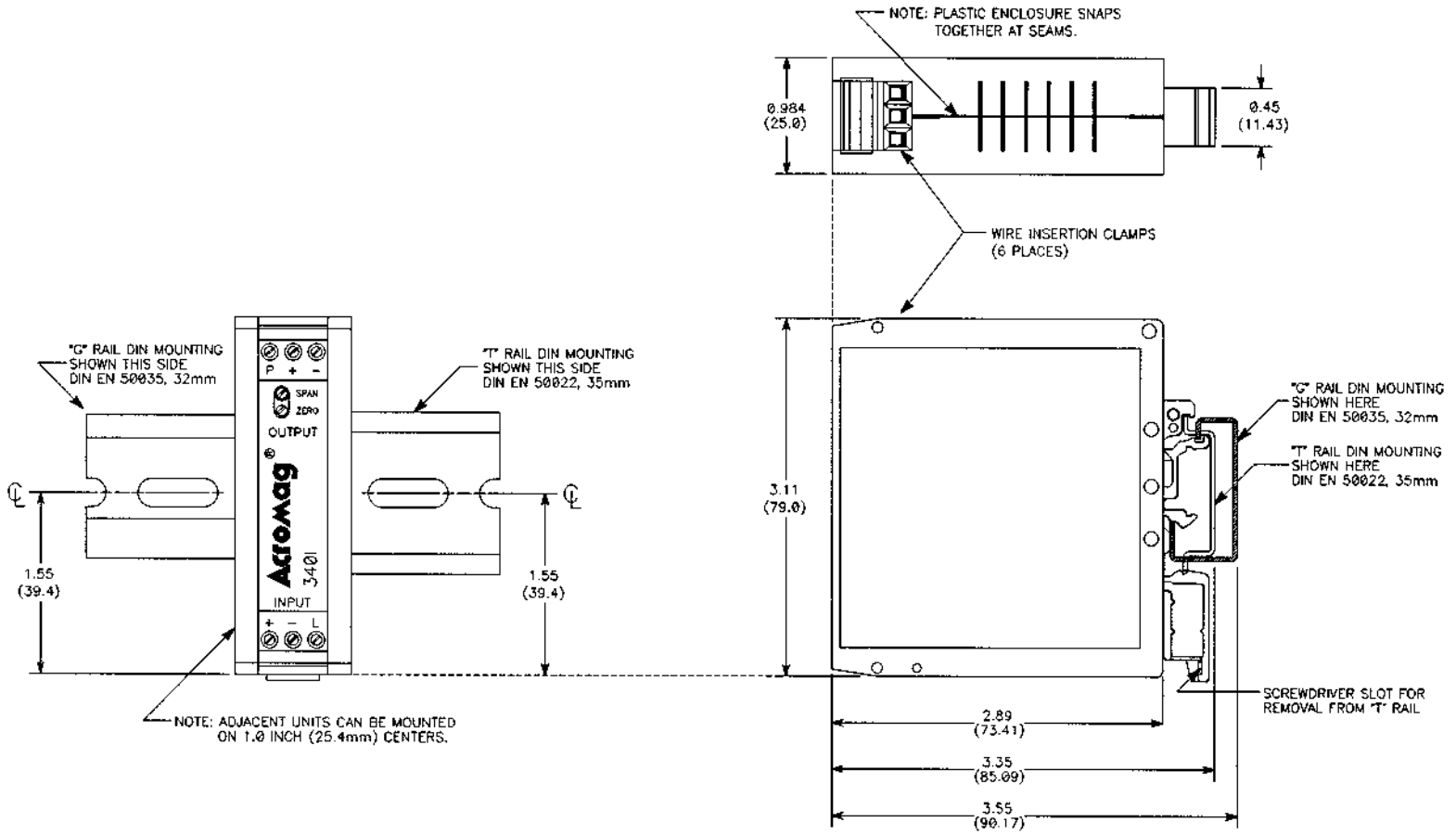

RECOMMENDED CALIBRATION CONNECTIONS

# SERIES 3401 INPUT ISOLATOR ELECTRICAL CONNECTIONS

NOTE:

1. MAXIMUM LOAD RESISTANCE IS A FUNCTION OF ISOLATOR POWER AS FOLLOWS: R–LOAD MAXIMUM = (MINIMUM SUPPLY – 5.0V) / 0.02A.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Acromag WIXOM, MICH. | | 08-FEB-03 | A | | BC | BC | |
| | | DATE | REV | SCH | BM | ENG | CLP |
| TITLE: SERIES 3401 ISOLATOR CONNECTIONS | | | | | | | |
| D | SERIES: 3401 | | 1 OF 1 | DWG NO. 4501-251 | | | A REV |



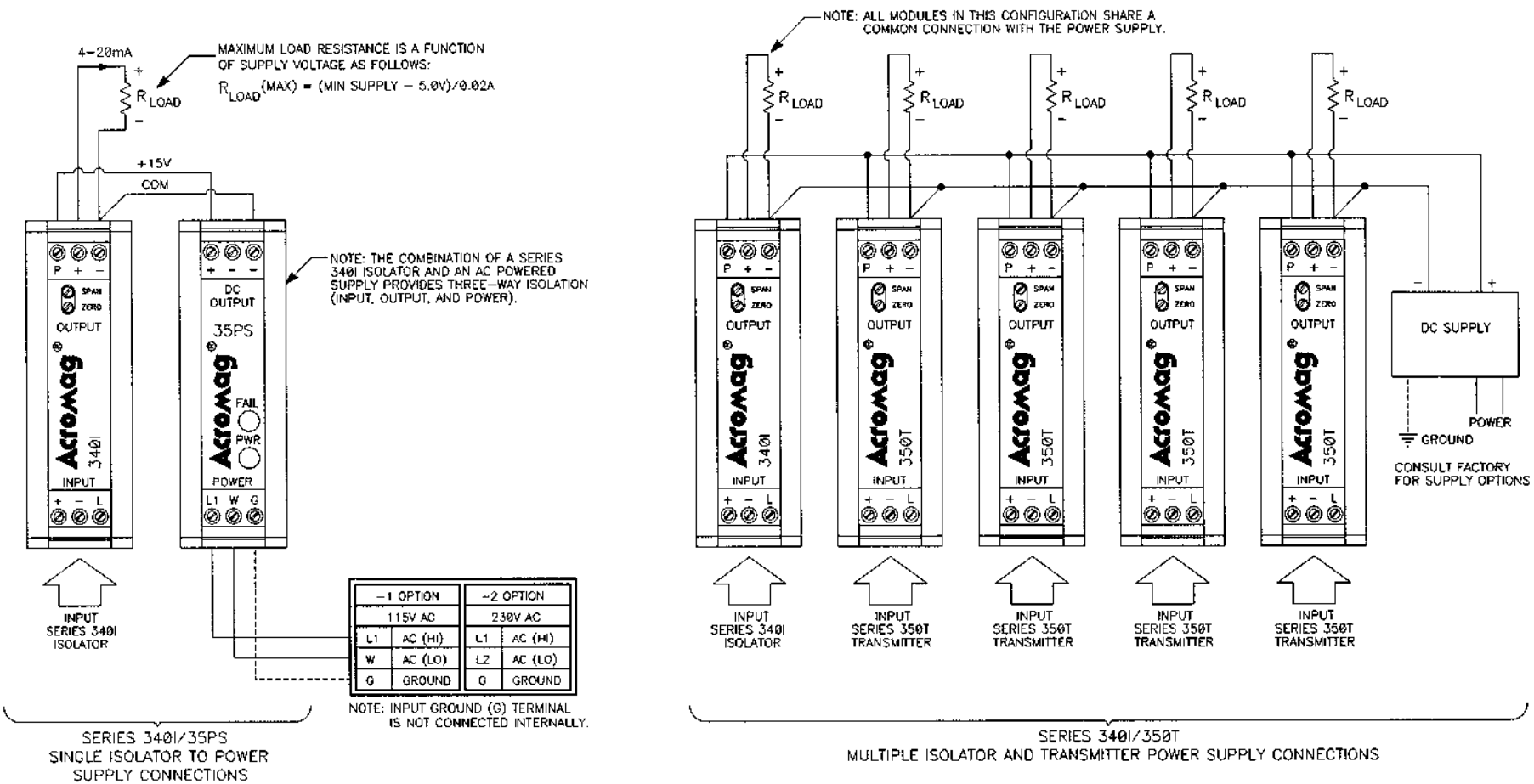

# ENCLOSURE DIMENSIONS WITH DIN RAIL MOUNTING

NOTE: ALL DIMENSIONS ARE IN INCHES (MILLIMETERS).

Acromag WIXOM, MICH. 06-FEB-03 A

3401 HOUSING: DIN RAIL MOUNT

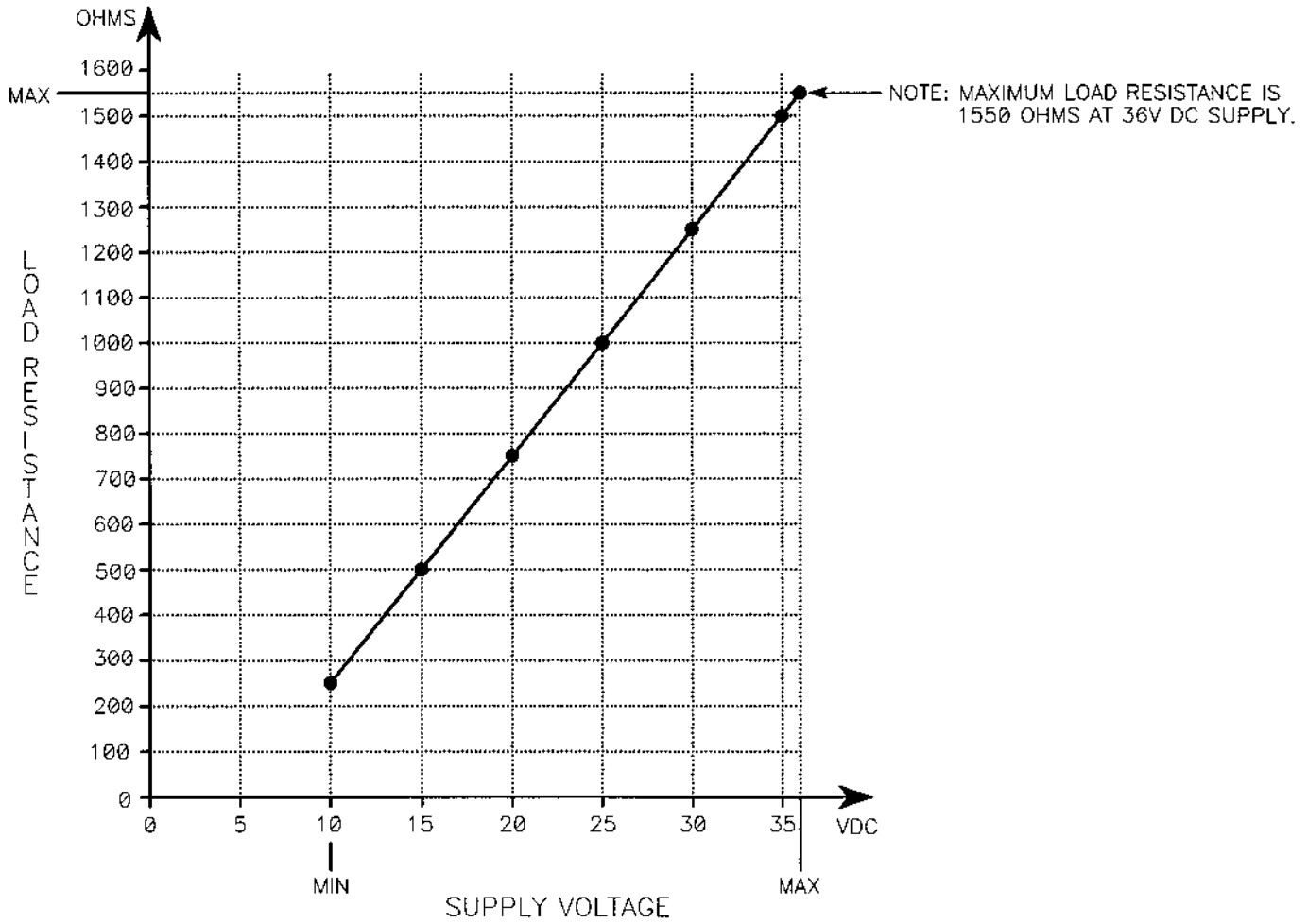
D | SERIES 3401 | 1 OF 1 | DWG NO. 4501-262 | A




# POWER SUPPLY CONFIGURATIONS

Acromag WIXOM, MICH.
05-FEB-93 A BC BC
DR ENG CLP
TITLE: ELECTRICAL CONNECTIONS
D SERIES 340I 1 OF 1 DWG NO 4501-263 A

## SERIES 340I MAXIMUM LOAD RESISTANCE VERSUS SUPPLY VOLTAGE




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Acromag® WIXOM, MICH. | | | | | | | |
| 15-OCT-93 | A | —— | BC | BC | BC | | |
| DATE | REV | ECN | DR | ENG | CLP | | |
| TITLE: SERIES 340I MAX LOAD VERSUS SUPPLY | | | | | | | |
| C | SERIES 340I | 1 OF 1 | DWG NO. 4501-265 | A | REV | | |

# INSTALLATION AND MAINTENANCE INSTRUCTIONS

## 3-WAY SOLENOID VALVES, NORMALLY OPEN NORMALLY CLOSED AND UNIVERSAL CONSTRUCTION

BULLETIN 8320

ASCO

Form No.V5291R2-T84

### DESCRIPTION

Bulletin 8320 is a small 3-way solenoid operated valve with all three pipe connections located in the body. The bodies are of brass or stainless steel construction. Standard valves have General Purpose, Nema Type I Solenoid Enclosures. Valves that are equipped with a solenoid enclosure which is designed to meet Nema Type 4-Watertight, Nema Type 7 (C or D) Hazardous Locations — Class I, Group C or D, and Nema Type 9 (E, F or G) Hazardous Locations — Class II, Group E, F or G are shown on separate sheets of Installation and Maintenance Instructions, Form Numbers V-5391 and V-5381.

### MANUAL OPERATORS (OPTIONAL)

Valves with suffix "MO" or "MS" in catalog number are provided with a Manual Operator which allows manual operation when desired or during an interruption of electrical power.

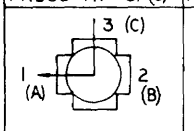
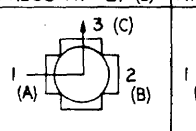
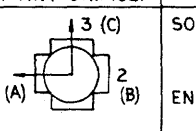
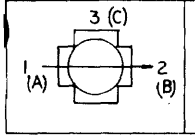
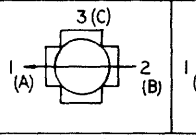
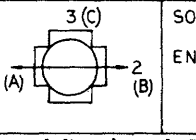
### OPERATION

**Normally Closed:** Applies pressure when solenoid is energized; exhausts pressure when solenoid is de-energized.

**Normally Open:** Applies pressure when solenoid is de-energized; exhausts pressure when solenoid is energized.

**Universal:** For normally closed or normally open operation, selection or diversion of pressure can be applied at Port 1 (A), 2 (B), or 3 (C).

### FLOW DIAGRAMS

| NORMALLY OPEN PRESS AT 3 (C) | NORMALLY CLOSED PRESS AT 2. (B) | UNIVERSAL-PRESS AT ANY ORIFICE. | FORM |
|---|---|---|---|
|   |   |   | SOLENOID DE-ENERGIZED |
|   |   |   | SOLENOID ENERGIZED |

**NOTE: Port Markings 1, 2, and 3 correspond directly to A, B and C.**

### INSTALLATION

Check Nameplate for correct Catalog Number, pressure, voltage and service.

### POSITIONING

Valve may be mounted in any position.

### PIPING

Connect piping to valve according to markings on valve body. Refer to Flow Diagram provided. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening pipe, do not use valve as a lever.

**IMPORTANT:** For protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on the service conditions. See Bulletin 8600, 8601 and 8602 for strainers.

### WIRING

Wiring must comply with Local and National Electrical Codes. For valves equipped with an explosion-proof, watertight solenoid enclosure, the electrical fittings must be approved for use in the approved hazardous locations. Housings for all solenoids are made with connections for 1/2 inch conduit. The general purpose enclosure may be rotated to facilitate wiring by removing the retaining cap.

**NOTE**

Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid, including the core assembly.

### SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the bare hand for only an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

### MAINTENANCE

**WARNING:** Turn off electrical power and line pressure to valve before making repairs. It is not necessary to remove valve from pipe line for repairs.

### CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary, depending on the media and service conditions. In general, if the voltage to the coils is correct, sluggish valve operation or excessive leakage will indicate that cleaning is required.

### IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires or splice.
2. **Burned-Out Coil:** Check for open-circuited coil. Replace coil, if necessary.
3. **Low Voltage:** Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within the range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace parts that are worn or damaged with a complete Spare Parts Kit for best results.

### COIL REPLACEMENT (REF. FIG. 2)

Turn off electrical power, disconnect coil lead wires and proceed as follows:

1. Remove retaining cap, nameplate and cover.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when molded coil is used. In some D. C. Constructions, a single flux plate over the coil replaces yoke, sleeves and insulating washers.
3. Reassemble in reverse order of disassembly.

### VALVE DISASSEMBLY AND REASSEMBLY (REF. FIG. 2)

Turn off electrical power supply and de-pressurize valve.

1. Remove retaining cap and slip entire solenoid off solenoid base sub-assembly or plugnut/core tube sub-assembly.
2. Unscrew bonnet or solenoid base sub-assembly. Remove core assembly, core spring and body gasket.
3. Remove end cap, body gasket, disc spring, disc holder, disc or disc holder assembly.
4. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
5. Reassemble in reverse order of disassembly paying careful attention to exploded view provided.

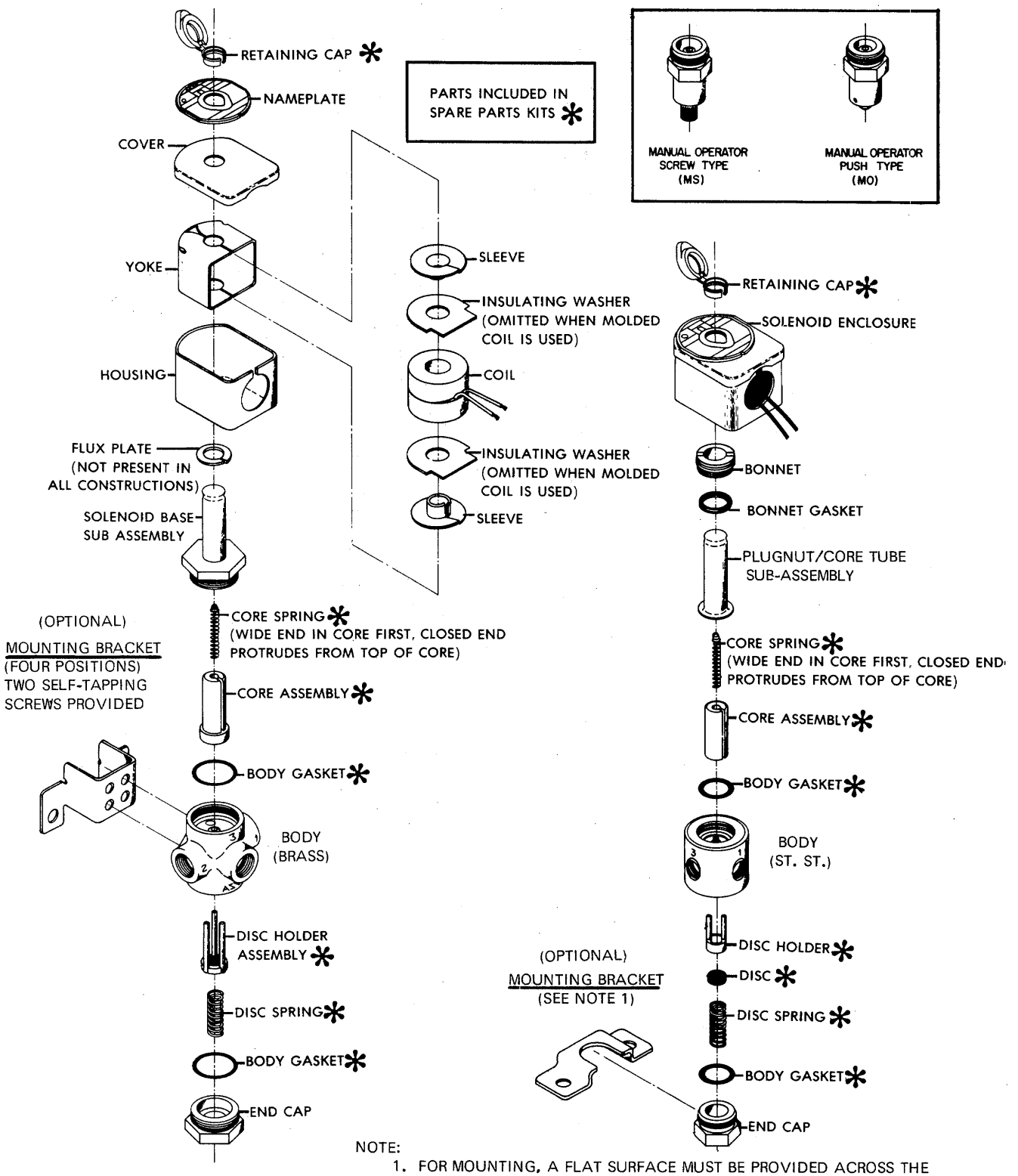
### TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart below. For higher ambient and fluid temperatures, consult factory. Check catalog number and watt rating on nameplate to determine the maximum temperatures.

| WATTAGE | CATALOG NUMBER COIL PREFIX | COIL CLASS | MAXIMUM AMBIENT TEMP. °F | MAXIMUM FLUID TEMP. °F |
|---|---|---|---|---|
| 6 | none or DA,S | A | 77 | 180 |
| 15.4 | none or DA,S | A | 77 | 200 |
| 6, 15.4 | DF,FT,or SF | F | 122 | 200 |
| 6, 15.4 | HT | H | 140 | 200 |
| 9, 10.7 | none or DP,SP | F | 77 | 200 |
| 9.7 | none or FT, HT, S, SF | A,F or H | 77 | 120 |
| 16.8 | none or FT, HT,S,SF | A,F or H | 77 | 180 |
| 20 | none or DP,SP | F | 77 | 200 |

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

**ORDERING INFORMATION FOR SPARE PARTS KITS**
When Ordering Spare Parts Kits or Coils Specify Valve Catalog Number, Serial Number and Voltage.




NOTE:

1. FOR MOUNTING, A FLAT SURFACE MUST BE PROVIDED ACROSS THE ENTIRE LENGTH OF THE BRACKET. THE VALVE BODY BECOMES SECURE TO BRACKET, WHEN BRACKET IS TIGHTENED IN TO POSITION. IF THE VALVE HAS A MANUAL OPERATOR, A HOLE MUST BE MADE THROUGH THE MOUNTING SURFACE FOR THE OPERATOR STEM.

Figure 2

Bulletin 8320

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 FORM NO. V-5291R2 PRINTED IN U. S. A. 1969

# Installation & Maintenance Instructions

**3-WAY SOLENOID VALVES — NORMALLY OPEN, NORMALLY CLOSED AND UNIVERSAL OPERATION**
**1/4 NPT — BRASS AND STAINLESS STEEL CONSTRUCTION**

**BULLETIN**
**8320**
**Form No.V5688R3**

## DESCRIPTION

Bulletin 8320 valves are small 3-way solenoid valves with all three connections located in the body. Valve bodies are made of brass or stainless steel.

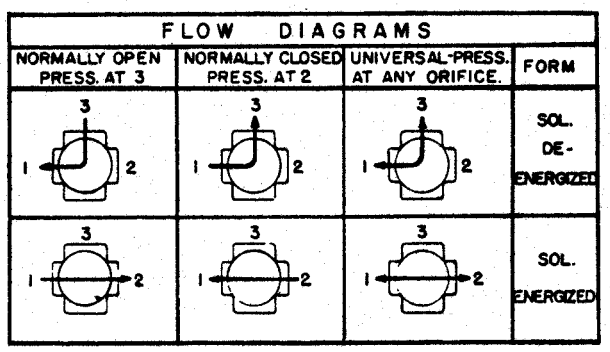
Standard valves have a Type 1, General Purpose Solenoid Enclosure. Valves may also be provided with an explosion-proof solenoid enclosure designed to meet Enclosure Type 3-Raintight, Type 7 (C & D)-Explosion-Proof Class I, Groups C & D and Type 9 (E, F, & G)-Dust Ignition-Proof Class II, Groups E, F, & G, and have a temperature range code of TC3. Installation and maintenance instructions for the explosion-proof solenoid enclosure are on Form No.V5380.

## OPERATION

**Normally Open** (Pressure at 3)
Applies pressure when solenoid is de-energized; exhausts pressure when solenoid is energized. When solenoid is de-energized, flow is from Port "3" to Port "1." Port "2" is closed. When solenoid is energized, flow is from Port "1" to "2." Port "3" is closed.

**Normally Closed** (Pressure at 2)
Applies pressure when solenoid is energized; exhausts pressure when solenoid is de-energized. When solenoid is de-energized, flow is from Port "1" to Port "3." Port "2" is closed. When solenoid is energized, flow is from Port "2" to Port "1." Port "3" is closed.

**Universal** (Pressure at 1, 2, or 3)
For normally closed or normally open operation, selection or diversion of pressure can be applied to Ports "1", "2", or "3."




**Manual Operator** (Optional)
Manual operator allows manual operation when desired or during an electrical power outage. Two types of manual operators are available - push type (Suffix MO) and screw type (Suffix MS). To operate valve manually with push type operator, push stem at base of valve body as far upward as possible. Valve will now be in the same position as when the solenoid is energized. Removing pressure from stem will release manual operator to original position. To operate valve with a screw type manual operator, rotate manual operator stem at base of valve body clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. Rotate manual operator stem fully counterclockwise before operating valve electrically.

## INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service.

**Temperature Limitations**
For maximum valve ambient and fluid temperatures, refer to chart below. Check catalog number prefix and watt rating on nameplate to determine the maximum temperatures. See example below chart.

| Construction AC or DC | Catalog Number Prefix | Watts | Maximum Ambient Temp. °F | Maximum Fluid Temp. °F |
|---|---|---|---|---|
| AC | None, DA, or S | 10.5 | 77 | 200 |
| | DF, FT, or SF | 10.5 | 122 | 200 |
| | HT | 10.5 | 140 | 200 |
| | None, DP, or SP | 16.7* | 77 | 200 |
| DC | None, FT, or HT | 11.2* | 77 | 150 |

* Catalog Nos. 8320A170, 8320A180, and 8320A190 are limited to 140 °F fluid temperature.

EXAMPLES: For Catalog No. HT8320A201, AC construction with a watt rating of 10.5, the maximum ambient temperature is 140°F with a maximum fluid temperature of 200°F. For Catalog No. 8320A204, AC construction with a watt rating of 10.5, the maximum ambient temperature is 77°F with a maximum fluid temperature of 200°F.

**Positioning**
This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

**Mounting**
For mounting dimensions of body boss (brass) or mounting brackets (optional on brass construction), refer to Figures 1, 2, and 3.

**Piping**
Connect piping to valve according to markings on valve body. Refer to flow diagrams provided. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.
**IMPORTANT: To protect the solenoid valve, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Bulletins 8600, 8601, and 8602 for strainers.**

**Wiring**
Wiring must comply with local codes and the National Electrical Code. Solenoid housings are provided with a 7/8" diameter hole to accommodate 1/2" conduit. On some constructions, a green grounding wire is provided. Use rigid metallic conduit to ground all enclosures not provided with a green grounding wire. To facilitate wiring, the enclosure may be rotated 360° by removing the retaining cap or clip. **WARNING: When metal retaining clip disengages, it will spring upward.** Rotate enclosure to desired position. Then replace retaining cap or clip before operating.

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid, including the solenoid base sub-assembly and core assembly.



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### Solenoid Temperature

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched by hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

## MAINTENANCE

NOTE: It is not necessary to remove the valve from the pipeline for repairs.
**WARNING: Turn off electrical power supply and depressurize valve before making repairs.**

### Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise, or leakage will indicate that cleaning is required. Clean valve strainer or filter when cleaning the valve.

### Preventive Maintenance

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, the valve should be operated at least once a month to insure proper opening and closing.
3. Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace worn or damaged parts. However, for best results, replace all parts as supplied with an ASCO Rebuild Kit.

### Causes Of Improper Operation

1. **Faulty Control Circuits:** Check the electrical system by energizing the solenoid. A metallic "click" signifies that the solenoid is operating. Absence of the "click" indicates loss of power supply. Check for loose or blown fuses, open circuited or grounded coil, broken lead wires or splice connections.
2. **Burned-Out Coil:** Check for open-circuited coil. Replace coil as necessary. Check supply voltage; it must be the same as specified on nameplate.
3. **Low Voltage:** Check voltage across the coil lead. Voltage must be at least 85% of nameplate rating.
6. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve (see Maintenance) and clean all parts. Replace worn or damaged parts. However, for best results, replace all parts as supplied with an ASCO Rebuild Kit.

### Coil Replacement (Refer to Figures 4 and 5 )

**WARNING: Turn off electrical power supply.**

1. Disconnect coil lead wires.
2. Remove retaining cap or clip, nameplate and housing. **WARNING: When metal retaining clip disengages, it will spring upward.**
3. Remove spring washer, insulating washer, coil, insulating washer, ground wire terminal (if present) from solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.
4. Reassemble in reverse order of disassembly. Use exploded view provided for identification and placement of parts.

**CAUTION: The solenoid must be fully reassembled because the housing and internal parts complete the magnetic circuit. Be sure to replace insulating washer at each end of the non-molded coil.**

### Valve Disassembly (Refer to Figures 4 and 5 )

**WARNING: Depressurize valve and turn off electrical power supply.**

1. Disassemble valve in an orderly fashion. Use exploded views for identification and placement of parts.
2. If necessary, disconnect coil lead wires, grounding wire (if present), and rigid conduit from solenoid housing.
3. Remove retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. **WARNING: When metal retaining clip disengages, it will spring upward.**
4. Unscrew solenoid base sub-assembly from valve body.
5. Remove core assembly, core spring, core guide (AC construction only), and solenoid base gasket.
6. Unscrew end cap (or manual operator assembly) and remove end cap gasket, disc holder spring, and disc holder sub-assembly.
7. All parts are now accessible to clean or replace. Replace worn or damaged parts. However, for best results, replace all parts as supplied with an ASCO Rebuild kit.

### Valve Reassembly

1. Reassemble in reverse order of disassembly. Use exploded views for identification and placement of parts.
2. Lubricate all gaskets with DOW CORNING® 111 Compound lubricant or an equivalent high-grade silicone grease. For stainless steel valve constructions, apply a small amount of LOCTITE® PST® pipe sealant (ASCO No. 208-832-11) to male threads of end cap (or manual operator assembly). Pipe sealant supplied in ASCO Rebuild Kits.
3. Replace disc holder sub-assembly, disc holder spring, end cap gasket, and end cap (or manual operator assembly). For brass construction, torque end cap to 175 ± 25 inch-pounds (19,8 ± 2,8 newton-meters). For stainless steel, torque end cap to 90 ± 10 inch-pounds (10,2 ± 1,1 newton-meters).
4. Replace solenoid base gasket, core assembly, core spring, core guide (on AC construction only), and solenoid base sub- assembly. Torque solenoid base sub-assembly to 175 ± 25 inch-pounds (19,8 ± 2,8 newton-meters).
5. Replace solenoid enclosure and retaining cap or clip.
6. Restore line pressure and electrical power supply to valve.
7. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic "click" signifies the solenoid is operating.

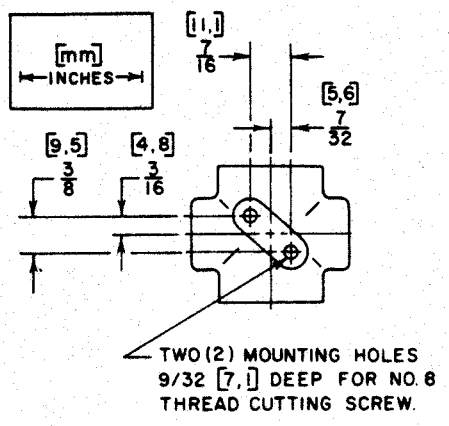


Figure 1. Brass Valve Body Mounting

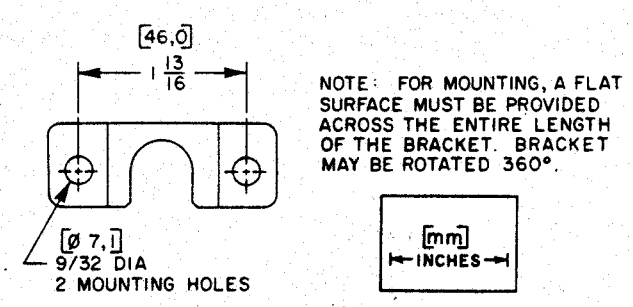


Figure 2. Mounting Bracket for Stainless Steel

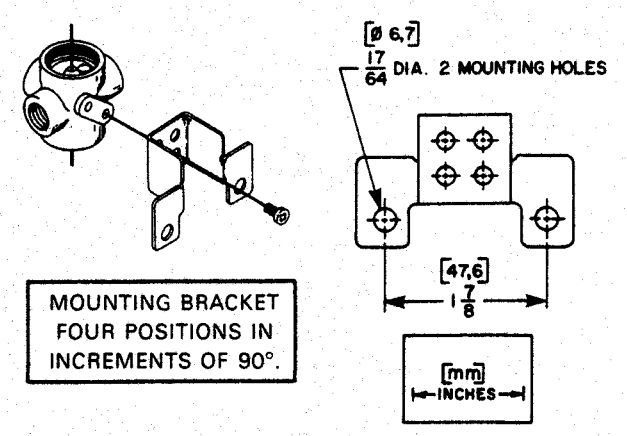


Figure 3. Optional Mounting Bracket for Brass



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**ORDERING INFORMATION**
**FOR ASCO REBUILD KITS AND COILS**

**Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits.**

- **When Ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate.+**
- **When Ordering Coils for ASCO valves, order the number stamped on your coil.+**

**+ If the number of the Rebuild Kit or the Coil is not visible, order them and specify your valve's Catalog Number, Serial Number, Voltage, and Frequency.**

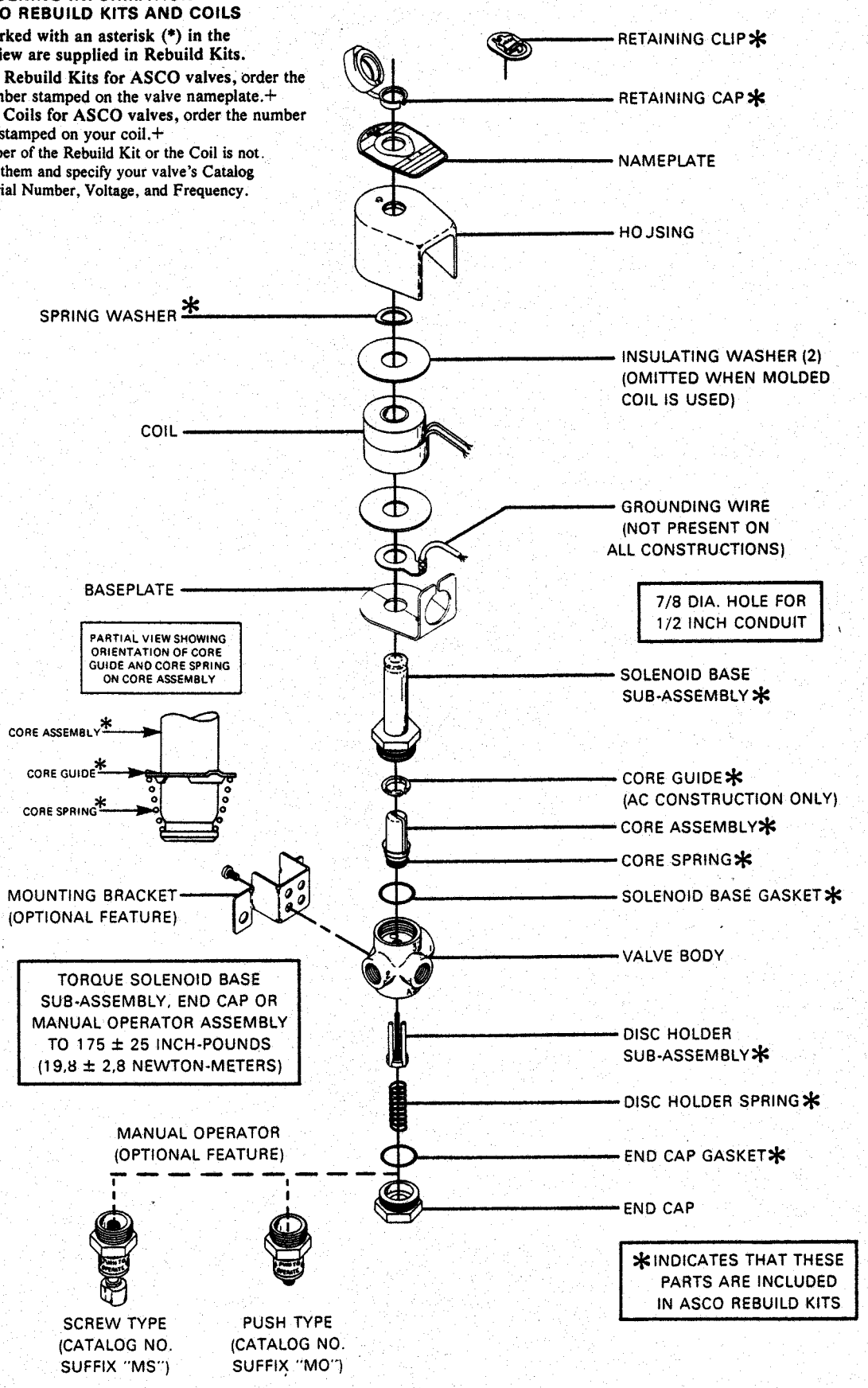


**Figure 4. Bulletin 8320, Brass Construction**
**With General Purpose Solenoid Enclosure Shown**
**For Explosion-Proof Solenoid Enclosure, See Form No.V5380.**




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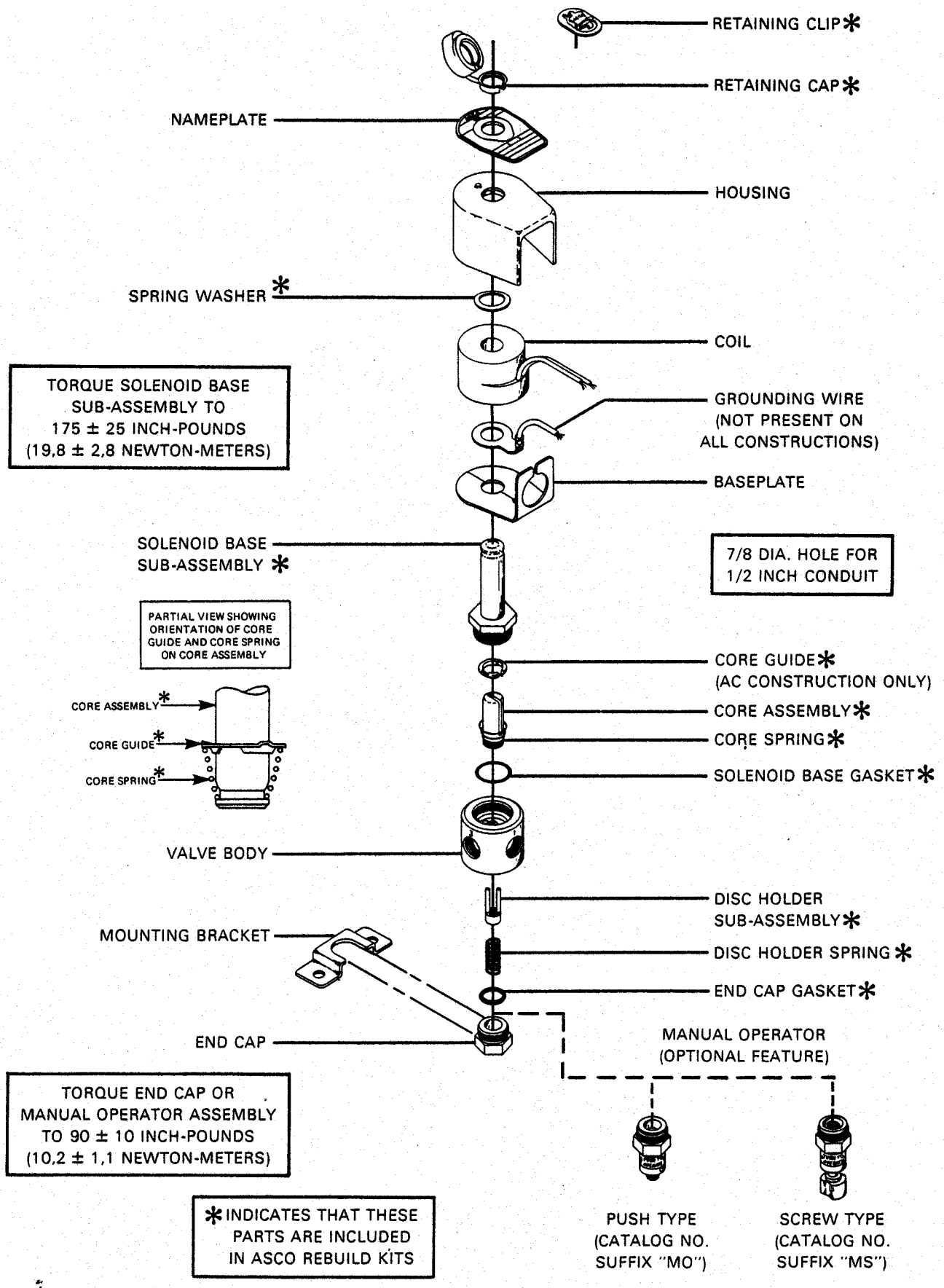


**Figure 5. Bulletin 8320, Stainless Steel Construction With General Purpose Solenoid Enclosure Shown. For Explosion- Proof Solenoid Enclosure, See Form No.V5380.**



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# INSTALLATION AND MAINTENANCE INSTRUCTIONS

## 3-WAY DIRECT ACTING SOLENOID VALVES NORMALLY CLOSED, NORMALLY OPEN AND UNIVERSAL OPERATION 1/8, 1/4, 3/8 and 1/2" NPT—RESILIENT SEATING

BULLETINS
8300
8302

ASCO

FORM NO. V-5942

### DESCRIPTION

Bulletin 8300's are 3-way, direct acting solenoid valves having only four moving parts—a core, a lever and two poppet type valve discs. Valves are supplied with resilient seats and plastic discs and valve bodies of brass, steel or stainless steel construction. Standard valves have a General Purpose, NEMA Type 1 Solenoid Enclosure.

Bulletin 8302's are the same as Bulletins 8300 except the solenoids are equipped with an enclosure which is designed to meet NEMA Type 4 Watertight, NEMA Type 7 (C or D) Hazardous Locations—Class I, Groups C or D and NEMA Type 9 (E, F or G) Hazardous Locations—Class II, Groups E, F or G. Installation and Maintenance Instructions for the Explosion-Proof/Watertight Solenoid Enclosure are shown on Form No. V5381.

### OPERATION

**Normally Closed (Suffix Letter "F")**
Solenoid De-energized: Flow is from Cylinder Connection (1) to Exhaust Connection (3). Pressure Connection (2) is closed.

Solenoid Energized: Flow is from Pressure Connection (2) to Cylinder Connection (1). Exhaust Connection (3) is closed.

**Normally Open (Suffix Letter "G")**
Solenoid De-energized: Flow is from Pressure Connection (3) to Cylinder Connection (1). Exhaust Connection (2) is closed.

Solenoid Energized: Flow is from Cylinder Connection (1) to Exhaust Connection (2). Pressure Connection (3) is closed.

**Universal (Suffix Letter "U")**
Solenoid De-energized: Flow is from Connection (3) to Connection (1) or Connection (1) to Connection (3). Connection (2) is closed.

Solenoid Energized: Flow is from Connection (1) to Connection (2) or Connection (2) to Connection (1). Connection (3) is closed.

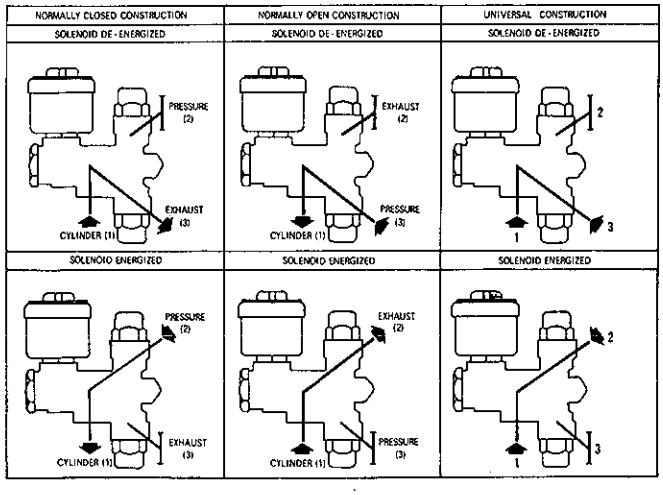
NOTE: Operation forms are identified by catalog suffix letters as follows:
Suffix Letter "F" Normally Closed Operation
Suffix Letter "G" Normally Open Operation
Suffix Letter "U" Universal Operation

### CHANGING OPERATION FORMS

Universal valves (U) may be used for any operation form without internal changes. However, normally closed (F) and normally open (G) valves cannot be used for a different operation form unless internal parts (upper and lower springs) are changed. Consult factory for new internal parts and nameplate for proper valve identification. Refer to **"NEW SPRING INSTALLATION"** Section when changing operation forms.

**IMPORTANT: No minimum operating pressure is required.**

**FLOW DIAGRAMS**




**NOTE: PORT MARKINGS 1, 2 AND 3 CORRESPOND DIRECTLY TO A, B, AND C.**

### MANUAL OPERATOR (Optional)

Valves with Suffix "MO" after catalog number are provided with a manual operator which allows operation when desired or during an interruption of electrical power. To actuate valve manually, push knob upward and rotate one half (1/2) turn. Valve will now be in same position as when solenoid is energized. To disengage manual operator, rotate manual operator approximately one half (1/2) turn until guide pin in manual operator stem engages slots in stuffing box bonnet and drops down. CAUTION: For valve to operate electrically, manual operator stem must be fully retracted.

### INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

### POSITIONING

Valve must be mounted with the solenoid vertical and upright.

### MOUNTING

For mounting bracket mounting dimensions, refer to Figure 3.

### PIPING

Connect piping to valve according to markings on valve body. The form of flow is indicated by the Suffix Letters ("F," "G" or "U") following the valve catalog number on the nameplate. Refer to flow diagrams provided. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter the valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening pipe, do not use valve as a lever. Wrenches applied to valve body or piping are to be located as close as possible to connection point.

**IMPORTANT: For protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on the service conditions. See Bulletins 8600, 8601 and 8602 for strainers.**

### WIRING

Wiring must comply with Local and National Electrical Codes. Housings for all solenoids are provided with connections or accommodations for 1/2 inch conduit. The general purpose solenoid enclosure may be rotated to facilitate wiring by removing the retaining cap or clip. CAUTION: When metal retaining clip disengages, it will spring upward. Rotate enclosure to desired position. Replace retaining cap or clip before operating.

NOTE: Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the solenoid base sub-assembly, core/spring sub-assembly or core.

### SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the hand for only an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

### MAINTENANCE

**WARNING: Turn off electrical power and depressurize valve before making repairs. It is necessary to remove valve from pipe line for repairs.**

### PREVENTIVE MAINTENANCE

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, operate the valve at least once a month to insure proper opening and closing.
3. Periodic inspection (depending on medium and service conditions) of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.
4. Inspect resilient-seated valves after the first three years of service or more frequently depending upon rate of valve cycling. Check seats and measure strokes to be certain they comply with the strokes given in Form No. V-5940. Based on initial inspection results, an Inspection/Maintenance program should be established.

### IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires or splice connections.
2. **Burned-Out Coil:** Check for open-circuited coil. Replace coil if necessary.
3. **Low Voltage:** Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check pressure at the solenoid valve. Pressure to the valve must not exceed that stamped on nameplate.
5. **Incorrect Pressure Connection:** Refer to valve catalog suffix letter on nameplate and flow diagrams.
6. **Excessive Leakage:** Disassemble valve and clean all parts and passageways. Leakage between the seats and discs is usually caused by lodgement of foreign material on the valve seating surfaces. The foreign material, though not present upon examination, may have damaged the seating surfaces enough to cause leakage. Leakage thru resilient seats can only be corrected by installing new seat assemblies. When new seats are installed, the strokes must be rechecked and adjusted where necessary. Refer to paragraphs on **"NEW SEAT AND DISC INSTALLATION"** under **"INSTALLATION OF NEW SPARE PARTS KIT"** Section.

### COIL REPLACEMENT (Refer to Figure 4)

**Turn off electrical power supply and disconnect coil lead wires.**

1. Remove retaining cap or clip, nameplate and solenoid cover. CAUTION: When metal retaining clip disengages, it will spring upward.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. For D-C construction, a fluxplate over the coil replaces the yoke and sleeves. Insulating washers are omitted when a molded coil is used.
3. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.

**CAUTION: Solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Place an insulating washer at each end of coil, if required.**

**ASCO Valves**

Form No. V-5942 PRINTED IN U.S.A. 1978 Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932

## VALVE DISASSEMBLY FOR GENERAL CLEANING AND INSPECTION

(Refer to Figure 4)

**Depressurize valve and turn off electrical power supply. It is strongly recommended that the valve be removed from the pipe line for ease of maintenance. If it is not practical to remove the valve from the pipe line and resetting of strokes is required or a new Spare Parts Kit is to be installed, consult factory for special bonnet tools which are available. When consulting the factory, be sure to include the valve catalog number and serial number from the nameplate on the valve.**

1. Disassemble valve in an orderly fashion paying careful attention to exploded view provided for identification of parts.
2. Remove retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. CAUTION: When metal retaining clip disengages, it will spring upward. For Explosion-Proof/Watertight Enclosure, refer to Installation and Maintenance Instruction Sheet, Form No. V-5381.
3. Unscrew solenoid base sub-assembly and remove bonnet gasket. For Explosion-Proof/Watertight Solenoid Enclosure, a special bonnet adapter wrench is available, Order No. 102-649-1.
4. Unscrew disc guide caps (both ends) and remove disc guide cap gaskets, upper and lower springs, discs, and disc stems. CAUTION: Tag springs, discs and disc stems as they are not interchangeable and must be returned to the original location. Tag upper and lower for ease of identification.
5. Remove end cap, end cap gasket and slip core/spring sub-assembly (A-C Construction) or core (D-C Construction) off the end of the valve lever and lift it out through solenoid base sub-assembly opening.
6. Inspect upper and lower valve seats but do not remove from valve body unless installing a complete Spare Parts Kit.
7. Clean all parts thoroughly and replace worn or damaged parts with a complete Spare Parts Kit. If a Spare Parts Kit is required, refer to section on **"INSTALLATION OF NEW SPARE PARTS KITS"** for complete rebuild. **IMPORTANT: Install all new parts. Do not retain any old parts when rebuilding valve. If only partial installation is made, valve malfunction may occur.**

## VALVE REASSEMBLY

1. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.
2. Lubricate all gaskets with Dow Corning's Valve Seal silicone lubricant or an equivalent high grade silicone grease.
3. Replace core/spring sub-assembly (A-C Construction) or core (D-C Construction) through solenoid base sub-assembly opening and engage with lever.
4. Install end cap gasket and end cap. Torque end cap to 55 ± 5 foot-pounds [74.6 ± 6.8 newton meters].
5. Replace bonnet gasket and solenoid base sub-assembly. Torque solenoid base sub-assembly to 175 ± 25 inch-pounds [19.8 ± 2.8 newton meters].
6. Replace solenoid enclosure and retaining cap or clip.
7. For stroke setting requirements (adjustment of valve disc stems), refer to **"NEW SEAT AND DISC INSTALLATION"** Paragraphs under **"INSTALLATION OF NEW SPARE PARTS KIT"** Section.
8. Install upper and lower springs. Refer to **"NEW SPRING INSTALLATION"** Section.
9. Replace disc guide cap gaskets and disc guide caps (both ends). Torque disc guide caps to 180 ± 15 inch-pounds [20.3 ± 1.7 newton meters].
10. After maintenance, operate the valve a few times to be sure of proper opening and closing. A metallic click signifies that the solenoid is operating.

## NEW SPRING INSTALLATION (Refer to Figures 1 and 4)

When it is desired to change to a different form of flow or operating conditions, new upper and lower springs corresponding to the new requirements must be installed. Depressurize valve and turn off electrical supply. Remove the two disc guide caps and old springs. Install new springs in their proper location as indicated on the factory labeled tags. Replace disc guide caps and torque to 180 ± 15 inch-pounds [20.3 ± 1.7 newton meters]. The smaller diameter end of the Type "38" body springs faces the discs.

NOTE: The lower spring is always the weaker of the two and should always be located at the bottom. If the springs are installed in the wrong position, the valve will not function properly.

A method to determine which spring is the weaker is by placing the two springs on the shaft of a screwdriver or similar tool and compressing them. The spring which compresses to the "L" dimension (Figure 1) first is the weaker of the two springs and should be placed on the bottom.

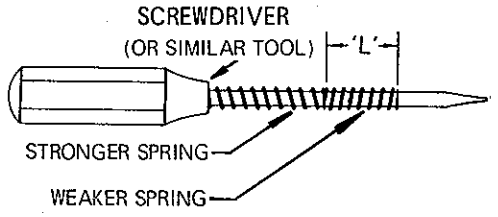
## MANUAL OPERATOR DISASSEMBLY AND REASSEMBLY (Refer to Figure 4)

1. Unscrew stuffing box bonnet from valve body. (Be certain manual operator stem is fully retracted). Remove the manual operator intact.
2. Remove gasket from stuffing box bonnet.
3. Press or drive out knob/stem pin from operating knob and stem. CAUTION: When removing knob/stem pin from knob/stem sub-assembly, do not let parts fly apart.
4. Remove spring and slide stem out of stuffing box bonnet. CAUTION: Before sliding stem thru stuffing box bonnet, be certain there are no burrs on stem from removing knob/stem pin. Do not damage captive gasket seat ("O"-ring) in stuffing box sub-assembly.
5. All parts are now accessible for cleaning.
6. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.
7. Torque stuffing box bonnet to 16 ± 3 foot-pounds [22.7 ± 4.1 newton meters].

## SPARE PARTS KITS

Spare Parts Kits and Coils are available for ASCO valves.
Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

**ORDERING INFORMATION FOR SPARE PARTS KITS**
When Ordering Spare Parts Kits or Coils, Specify Valve Catalog Number, Serial Number and Voltage.




| BODY TYPE | 'L' DIM. |
|---|---|
| '37' | 3/4" |
| '38' | 1-3/16" |

Figure 1. Method to Determine Weaker Spring

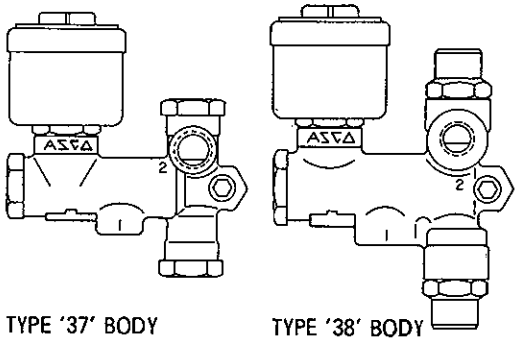



Figure 2. Identification of Body Type

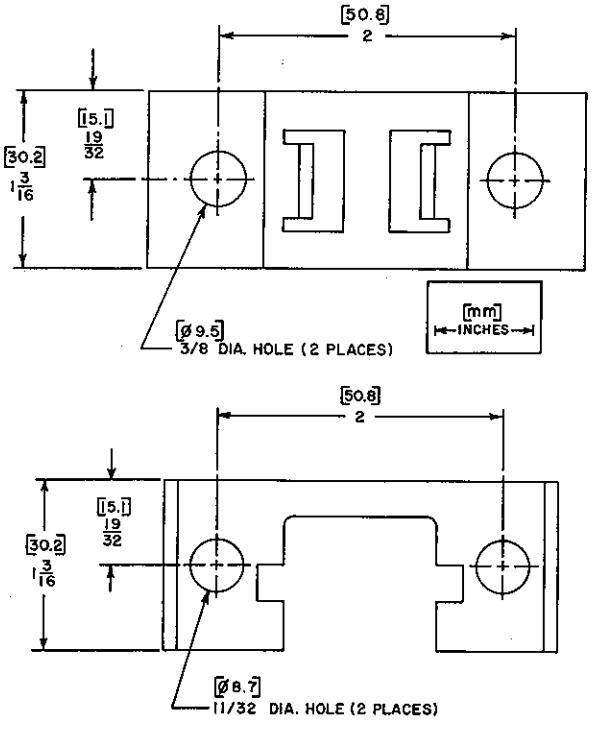



Figure 3. Mounting Bracket Dimensions

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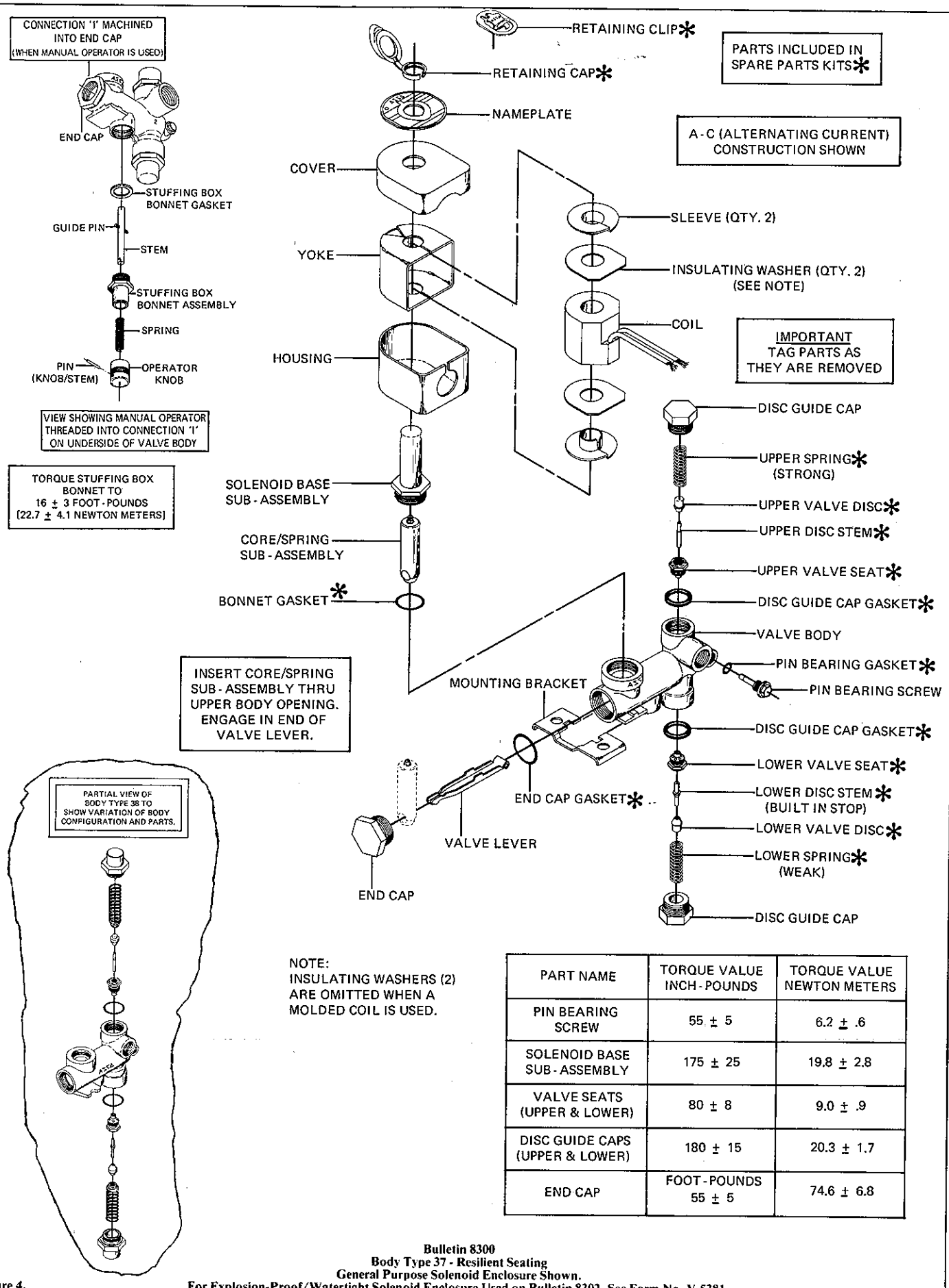


NOTE:
INSULATING WASHERS (2) ARE OMITTED WHEN A MOLDED COIL IS USED.

| PART NAME | TORQUE VALUE INCH-POUNDS | TORQUE VALUE NEWTON METERS |
|---|---|---|
| PIN BEARING SCREW | 55 ± 5 | 6.2 ± .6 |
| SOLENOID BASE SUB-ASSEMBLY | 175 ± 25 | 19.8 ± 2.8 |
| VALVE SEATS (UPPER & LOWER) | 80 ± 8 | 9.0 ± .9 |
| DISC GUIDE CAPS (UPPER & LOWER) | 180 ± 15 | 20.3 ± 1.7 |
| END CAP | FOOT-POUNDS 55 ± 5 | 74.6 ± 6.8 |

**Bulletin 8300**
**Body Type 37 - Resilient Seating**
**General Purpose Solenoid Enclosure Shown.**
**For Explosion-Proof/Watertight Solenoid Enclosure Used on Bulletin 8302, See Form No. V-5381.**

**Figure 4.**

## INSTALLATION OF NEW SPARE PARTS KITS

Depressurize valve and turn off electrical power supply. Disassemble valve in an orderly fashion paying careful attention to exploded views provided for identification of parts. For ease of maintenance, valve should be removed from the pipe line. Spare Parts Kits include springs for all three forms of flow (F, G and U). Check the catalog number suffix on the nameplate to determine which form of flow you have. For example, a Form "F" valve is normally closed operation. When the correct springs have been chosen, immediately discard remaining two (2) sets of springs to avoid any difficulty.

1. Remove retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. CAUTION: When metal retaining clip disengages, it will spring upward. For Explosion-Proof/Watertight Solenoid Enclosure, refer to Form V-5381 for disassembly.
2. Unscrew solenoid base sub-assembly and remove bonnet gasket. For explosion-Proof/Watertight Solenoid Enclosure, a special wrench is required to remove the solenoid base sub-assembly. Wrench adapter Order No. 102-649-1.
3. Unscrew disc guide cap (both ends) and remove disc guide cap gaskets, upper and lower springs, discs and disc stems.
4. Remove upper and lower valve seats using a 1/2 inch thin wall socket wrench.
5. Remove end cap and end cap gasket. Slip core/spring sub-assembly (A-C Construction) or core (D-C Construction) off the end of the valve lever and lift out through the solenoid base sub-assembly opening.
6. Remove pin bearing screw and pin bearing gasket.
7. Slide valve lever out through the end cap opening of the valve body.
8. All parts are now accessible for replacement. Clean all internal passageways. Install a complete Spare Parts Kit. IMPORTANT: Install all new parts. Do not retain any old parts when rebuilding valve.
9. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.
10. Lubricate all gaskets with Dow Corning's Valve Seal silicone lubricant or an equivalent high grade silicone grease.
11. Insert valve lever and replace pin bearing gasket and pin bearing screw through the valve lever. Torque pin bearing screw to 55 ± 5 inch-pounds [6.2 ± .6 newton meters].
12. Position core/spring sub-assembly (A-C Construction) or core (D-C Construction) thru solenoid base sub-assembly opening and engage with valve lever. Install end cap gasket and end cap. Torque end cap to 55 ± 5 foot-pounds [74.6 ± 6.8 newton meters].
13. Replace bonnet gasket and solenoid base sub-assembly. Torque solenoid base sub-assembly to 175 ± 25 inch-pounds [19.8 ± 2.8 newton meters].
14. Install upper and lower valve seats using a small amount of pipe compound on the seat threads to avoid possible leakage. Torque upper and lower valve seats to 80 ± 8 inch-pounds [9.0 ± .9 newton meters].
15. Replace solenoid enclosure and retaining cap or clip. For Explosion-Proof/Watertight Solenoid Enclosures, refer to Form No. V-5381.

## NEW SEAT AND DISC INSTALLATION

16. New upper and lower seats and discs cannot be installed without making some minor adjustments. It is important that the stroke of the valve discs be set carefully in order to obtain the proper orifice opening and reliable operation of the valve. Check valve nameplate for the catalog number and refer to "Stroke Chart", Form No. V5940 for stroke setting requirements. Refer to Figure 5 for the method of measuring the stroke and Figure 6 for stroke setting (grinding). Spaces are provided on this sheet for your calculations.
17. Place the valve in a vertical and upright position. NOTE: Solenoid and core/spring sub-assembly or core must be assembled in the valve when strokes are measured. Install upper disc stem (large diameter first and valve disc). Use a depth gauge to measure the distances. NOTE: Upper disc stem is a straight stem while the lower disc stem has a built-in stop. Refer to Figure 6.
18. With valve de-energized, measure Dimension "A." Dimension "A" is from the top of the valve body to the top of the upper disc as illustrated in Figure 5. _____
19. With valve energized, measure Dimension "B." Dimension "B" is from the top of the valve body to the top of the upper disc as illustrated in Figure 5. _____
20. Dimension "A" — "B" = upper disc stroke. _____

    The differences between the two distances "A" minus "B" is the upper disc stroke. If the stroke is more than can be allowed in the "Stroke Chart" Form No. V-5940 (according to catalog number and body type), the end of the upper disc stem (small diameter end) which contacts the upper valve disc, (see Figure 6) must be ground off until the proper stroke is obtained. After grinding, the end of the disc stem must be chamfered slightly.
21. Replace upper valve spring (strong spring), disc guide cap with disc guide cap gasket attached. Torque disc guide cap to 180 ± 15 inch-pounds [20.3 ± 1.7 newton meters].
22. Turn valve upside-down to install lower disc stem (without lower valve disc). The lower disc stem stroke is to be .010 ± .002 less than the upper disc stroke.
23. Upper disc stroke minus .010 equals the correct lower stem stroke. _____ ± .002
24. With valve energized, measure Dimension "C." _____
25. With valve de-energized, measure Dimension "D." _____
26. Dimension "C" – "D" = lower stem stroke. _____

    The difference between the two distances "C" – "D" is the lower stem stroke. If the stroke is more than that calculated in Paragraph No. 23, the end of the lower disc stem which contacts the valve lever must be ground off until the proper stroke is obtained. After grinding, the end of the disc stem must be crowned slightly and polished smooth.
27. Install lower valve disc on disc stem.
28. With valve energized, measure Dimension "E." _____
29. With valve de-energized, measure Dimension "F." _____
30. Dimension "E" – "F" = lower disc stroke. _____

    The difference between the two distances "E" minus "F" is the lower disc stroke. If the stroke is more than that allowed in the "Stroke Chart," Form No. V-5940 (according to catalog number and body type) the end of the lower disc stem (small diameter end) which contacts the lower valve disc (see Figure 6) must be ground off until the proper stroke is obtained. After grinding, the end of the disc stem must be chamfered slightly.
31. When the strokes have been set in accordance with Figure 5 and the "Stroke Chart," Form No. V-5940 a gap will automatically be obtained between the lower disc stem and the lever when the solenoid is energized. This gap will assure proper operation of the valve.
32. Replace lower valve spring (weak spring), disc guide cap with disc guide cap gasket attached. Torque disc guide cap to 180 ± 15 inch-pounds [20.3 ± 1.7 newton meters].
33. After maintenance, operate the valve a few times to be sure of proper opening and closing. A metallic click signifies that the solenoid is operating.

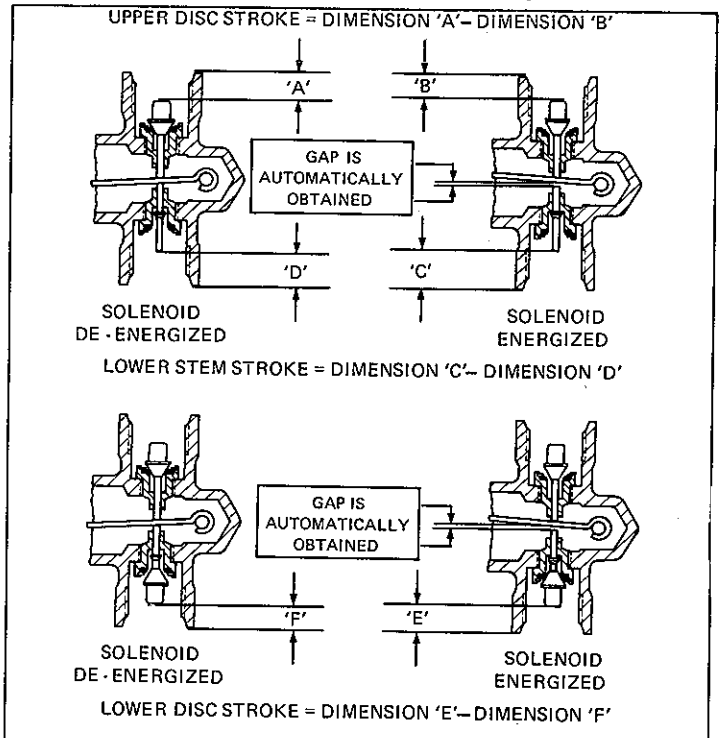


**Figure 5.** **Method of Stroke Measurement**

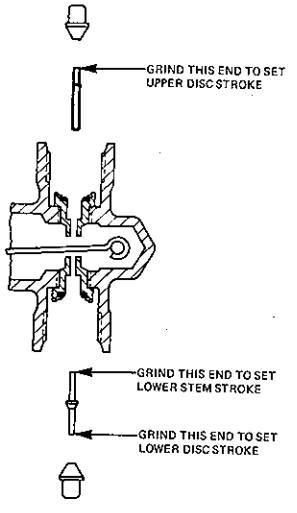


**Figure 6.** **Setting Strokes (Grinding)**

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# Installation & Maintenance Instructions

ASCO Red-Hat II®

**OPEN–FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS**

**SERIES**
**8003G**
**8202G**
**Form No.V6584R8**

## — SERVICE NOTICE —

ASCO® solenoid valves with design change letter "G" or "H" in the catalog number (ex. 8210G 1) have an epoxy encapsulated ASCO® Red Hat II® solenoid. This solenoid replaces some of the solenoids with metal enclosures and open–frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

***See separate instructions for basic valve.***

## DESCRIPTION

Catalog numbers 8003G and 8202G are epoxy encapsulated pull–type solenoids. The green solenoid with lead wires and 1/2″ conduit connection is designed to meet Enclosure Type 1–General Purpose, Type 2–Dripproof, Types 3 and 3S–Raintight, and Types 4 and 4X–Watertight. The black solenoid on catalog numbers prefixed "EF" or "EV" is designed to meet Enclosure Types 3 and 3S–Raintight, Types 4 and 4X–Watertight, Types 6 and 6P–Submersible, Type 7 (A, B, C & D) Explosionproof Class I, Division 1 Groups A, B, C, & D and Type 9 (E, F, & G)–Dust–Ignitionproof Class II, Division 1 Groups E, F & G. The Class II, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See *Temperature Limitations* section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250–28 UNF–2B tapped hole, 0.38 or 0.63 minimum full thread.

NOTE: Catalog number prefix "EV" denotes stainless steel construction.

Catalog numbers 8202G1, 8202G3, 8202G5 and 8202G7 are epoxy encapsulated push–type, reverse–acting solenoids having the same enclosure types as previously stated for Catalog numbers 8003G1 and 8003G2.

### Series 8003G and 8202G solenoids are available in:

- **Open–Frame Construction:** The green solenoid may be supplied with 1/4″ spade, screw or DIN terminals. (Refer to Figure 4)
- **Panel Mounted Construction:** These solenoids are specifically designed to be panel mounted by the customer through a panel having a .062 to .093 maximum wall thickness. Refer to Figure 1 and section on *Installation of Panel Mounted Solenoid.*

### Optional Features For Type 1 – General Purpose Construction Only

- **Junction Box:** This junction box construction meets Enclosure Types 2,3,3S,4, and 4X. Only solenoids with 1/4″ spade or screw terminals may have a junction box. The junction box provides a 1/2″ conduit connection, grounding and spade or screw terminal connections within the junction box (See Figure 5).
- **DIN Plug Connector Kit No.K236034:** Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).

## OPERATION

Series 8003G – When the solenoid is energized, the core is drawn into the solenoid base sub–assembly. **IMPORTANT: When the solenoid is de–energized, the initial return force for the core, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 5 ounces for DC construction.**

Series 8202G – When the solenoid is energized, the disc holder assembly seats against the orifice. When the solenoid is de–energized , the disc holder assembly returns. **IMPORTANT: Initial return force for the disc or disc holder assembly, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force is 1 pound, 5 ounces.**

## INSTALLATION

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency.

**⚠ WARNING: Electrical hazard from the accessibility of live parts. To prevent the possibility of death, serious injury or property damage, install the open – frame solenoid in an enclosure.**

### FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

**⚠ CAUTION: To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature of hazardous atmosphere is less than 165° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180°C. See nameplate/retainer for service.**

NOTE: These solenoids have an internal non–resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or a shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/dust–ignitionproof enclosures (Types 7 & 9).

**⚠ CAUTION: To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601, and 8602 for strainers.**

### Temperature Limitations

For maximum valve ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90°C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for maximum fluid temperature. NOTE: For steam service, refer to *Wiring* section, *Junction Box* for temperature rating of supply wires.

**Temperature Limitations For Series 8003G or 8202G Solenoids for use on Valves Rated at 10.1, 11.6, 17.1, or 22.6 Watts**

| Watt Rating | Catalog Number Coil Prefix | Class of Insulation | Maximum † Ambient Temp. |
|---|---|---|---|
| 10.1 & 17.1 | None, FB, KF, KP SC, SD, SF, & SP, | F | 125°F (51.7°C) |
| 10.1 & 17.1 | HB, HT, KB, KH, SS, ST, SU, | H | 140°F (60°C) |
| 11.6 & 22.6 | None, FB,KF, KP, SC, SD, SF, & SP. | F | 104°F (40°C) |
| 11.6 & 22.6 | HP, HT, KB, KH, SS, ST, SU, & SV | H | 104°F (40°C) |

† Minimum ambient temperature –40° F (–40° C).

### Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub–assembly area.

### Wiring

Wiring must comply with local codes and the National Electrical Code. All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2″ conduit connection. To





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facilitate wiring, the solenoid may be rotated 360°. For the watertight and explosionproof solenoid, electrical fittings must be approved for use in the approved hazardous locations.

**⚠ CAUTION: Cryogenic Applications — Solenoid lead wire insulation should not be subjected to cryogenic temperatures. Adequate lead wire protection and routing must be provided.**

## Additional Wiring Instructions For Optional Features:

- **Open−Frame solenoid with 1/4″ spade terminals.**

For solenoids supplied with screw terminal connections use #12−18 AWG stranded copper wire rated at 90°C or greater. Torque terminal block screws to 10 ± 2 in−lbs [1,0 ± 1,2 Nm]. A tapped hole is provided in the solenoid for grounding, use a #10−32 machine screw. Torque grounding screw to 15 − 20 in−lbs [1,7 − 2,3 Nm]. On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15 − 20 in−lbs [1,7 − 2,3 Nm] with a 5/32″ hex key wrench.

- **Junction Box**

The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2″ conduit connection. Connect #12−18 AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90°C or greater for connections. For steam service use 105°C rated wire up to 50 psi or use 125°C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

- **DIN Plug Connector Kit No.K236034**

1. The open−frame solenoid is provided with DIN terminals to accommodate the plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12−18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4″ for installation in socket terminals. The use of wire−end sleeves is also recommended for these socket terminals. Maximum length of wire−end sleeves to be approximately 1/4″. Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer and connector cover.

NOTE: Connector housing may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5 ± 1 in−lbs [0,6 ± 1,1 Nm].

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it may be necessary to change the complete solenoid including the core and solenoid base sub−assembly, not just the solenoid. Consult ASCO.

## Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid.

## Installation of Panel Mounted Solenoid (See Figure 1)

1. Disassemble solenoid following instruction under *Solenoid Replacement* then proceed.
2. Install solenoid base sub−assembly through customer panel.
3. Position spring washer on opposite side of panel over solenoid base sub−assembly.
4. Replace solenoid, nameplate/retainer and red cap.
5. Make electrical hookup, see *Wiring* section.

## Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

# MAINTENANCE

**⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.**

## Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

## Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- While in service, the solenoid operator or valve should be operated at least once a month to insure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

## Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open−circuited or grounded solenoid, broken lead wires or splice connections.
- **Burned−Out Solenoid:** Check for open−circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

## Solenoid Replacement

1. Disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid. For 3−way construction, piping or tubing must be removed from pipe adapter.

2. Disassemble solenoids with optional features as follows:

- **Spade or Screw Terminals**

Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

- **Junction Box**

Remove conduit and socket head screw (use 5/32″ hex key wrench) from center of junction box. Disconnect junction box from solenoid.

- **DIN Plug Connector**

Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32″ hex key wrench), DIN terminal adapter, and gasket from solenoid.

3. Snap off red cap from top of solenoid base sub−assembly. For 3−way construction with pipe adapter (Figure 3), remove pipe adapter, nameplate and solenoid. Omit steps 4 and 5.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade between solenoid and nameplate/retainer. Pry up slightly and push to remove.

NOTE: Series 8202G solenoids have a spacer between the nameplate/retainer and solenoid.

5. Remove solenoid from solenoid base sub−assembly.
6. Reassemble in reverse order of disassembly. Use exploded views for identification and placement of parts.
7. Torque pipe adapter to 90 inch−pounds maximum [10,2 Nm maximum]. Then make up piping or tubing to pipe adapter on solenoid.

## Disassembly and Reassembly of Solenoids

1. Remove solenoid, see *Solenoid Replacement*.
2. Remove spring washer from solenoid base sub−assembly. For 3−way construction, remove plugnut gasket.
3. Unscrew solenoid base sub−assembly from valve body.
4. Remove internal solenoid parts for cleaning or replacement. Use exploded views for identification and placement of parts.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Torque solenoid base sub−assembly and adapter to 175±25 in−lbs [19,8±2,8 Nm].

### ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

## Torque Chart

| Part Name | Torque Value Inch—Pounds | Torque Value Newton—Meters |
|---|---|---|
| solenoid base sub—assembly & adapter | 175 ± 25 | 19,8 ± 2,8 |
| pipe adapter | 90 maximum | 10,2 maximum |

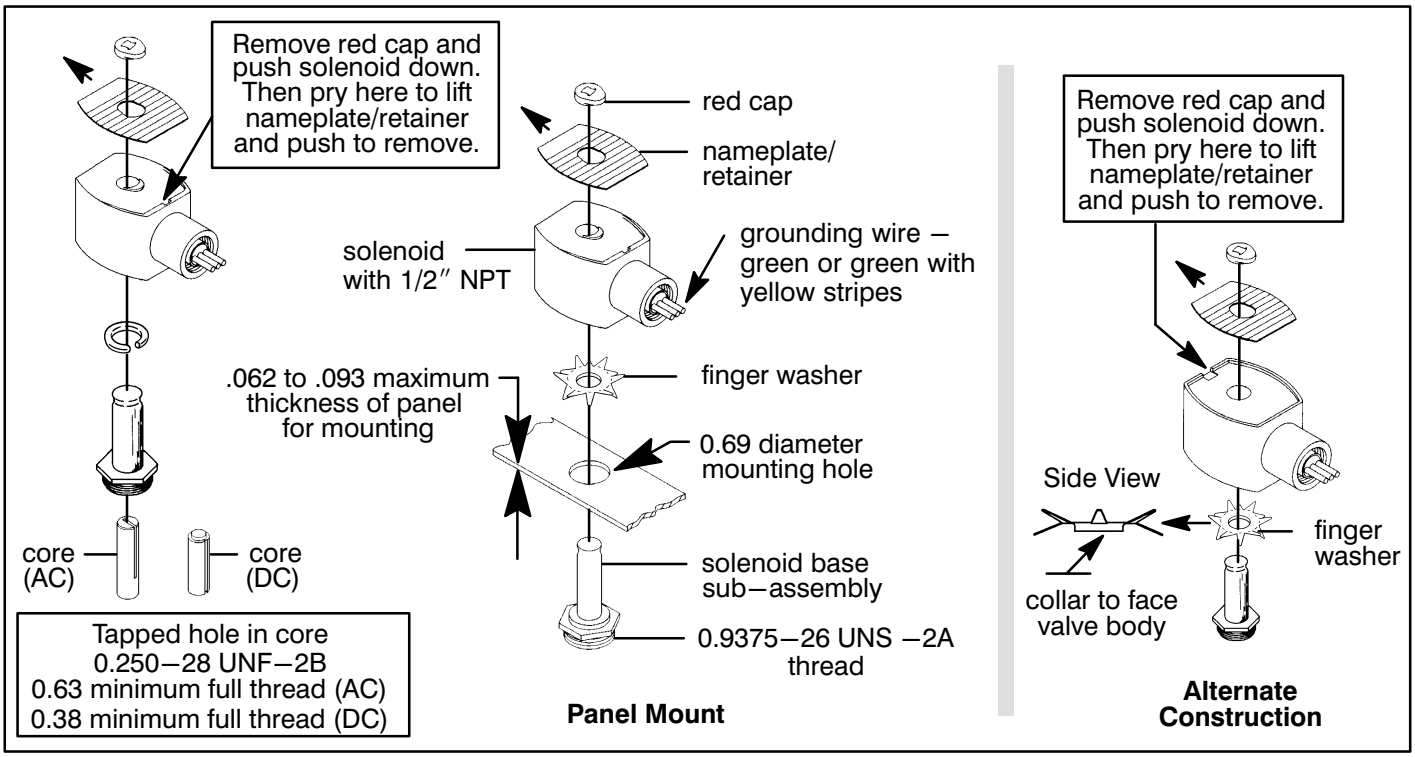


Figure 1. Series 8003G solenoids

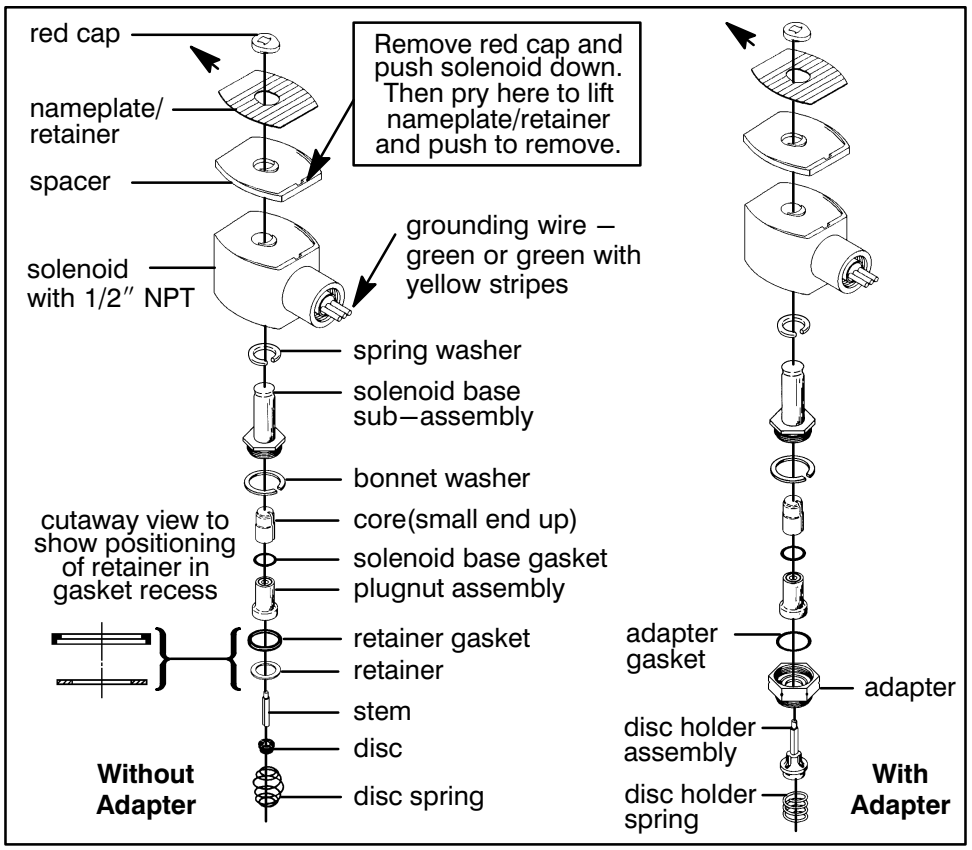


Figure 2. Series 8202G solenoids

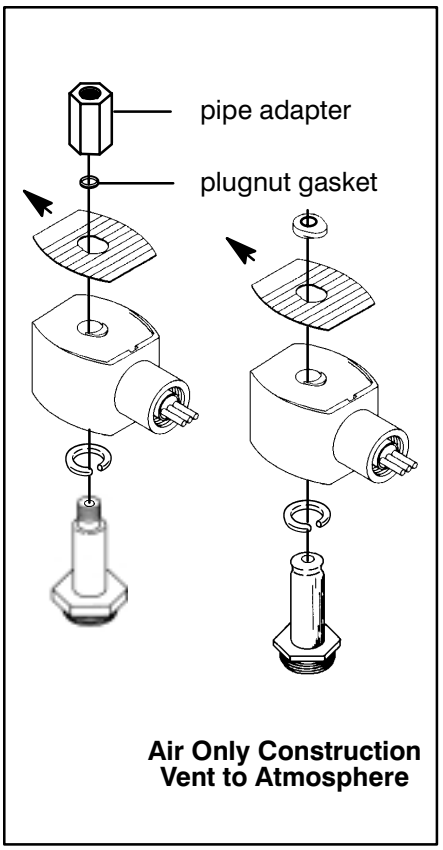


Figure 3. 3—Way Construction



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## Torque Chart

| Part Name | Torque Value in Inch—Pounds | Torque Value in Newton—Meters |
|---|---|---|
| terminal block screws | 10 ± 2 | 1,1 ± 0,2 |
| socket head screw | 15 — 20 | 1,7 — 2,3 |
| center screw | 5 ± 1 | 0,6 ± 0,1 |

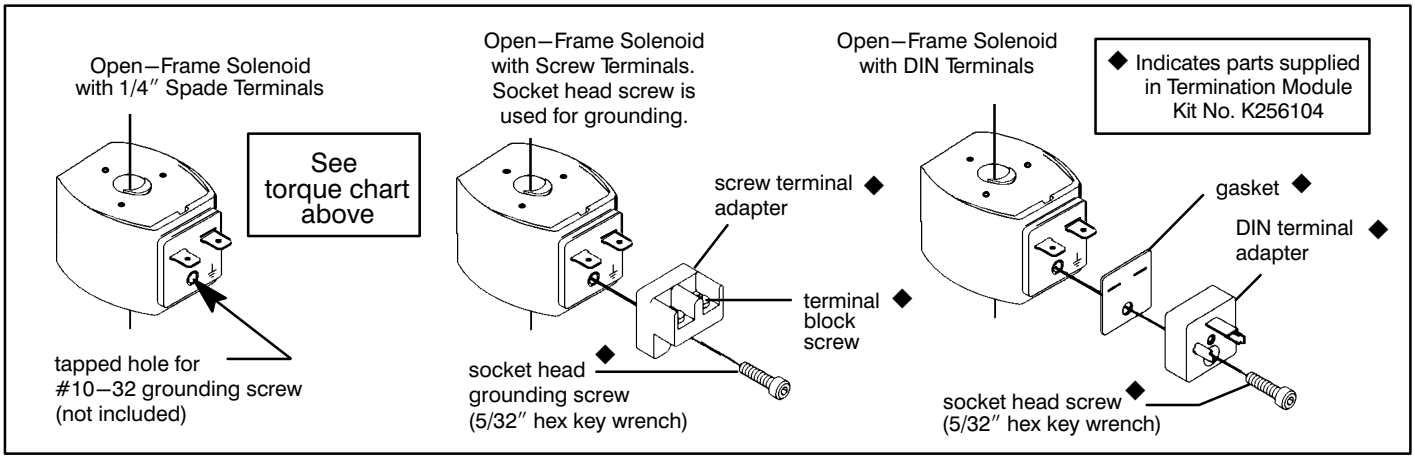


Figure 4. Open—frame solenoids

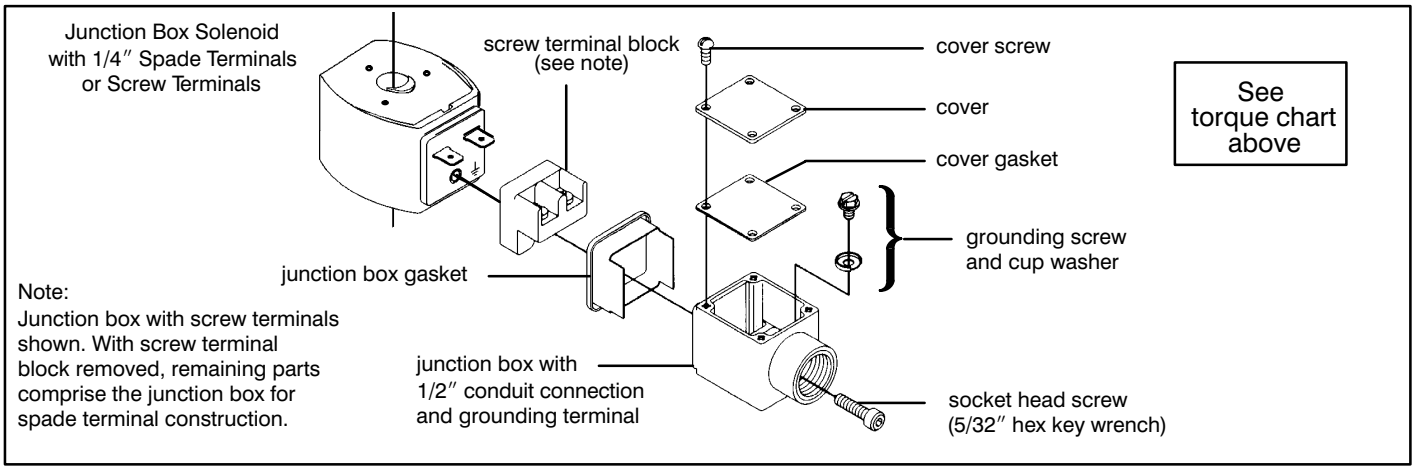


Figure 5. Junction box (optional feature)

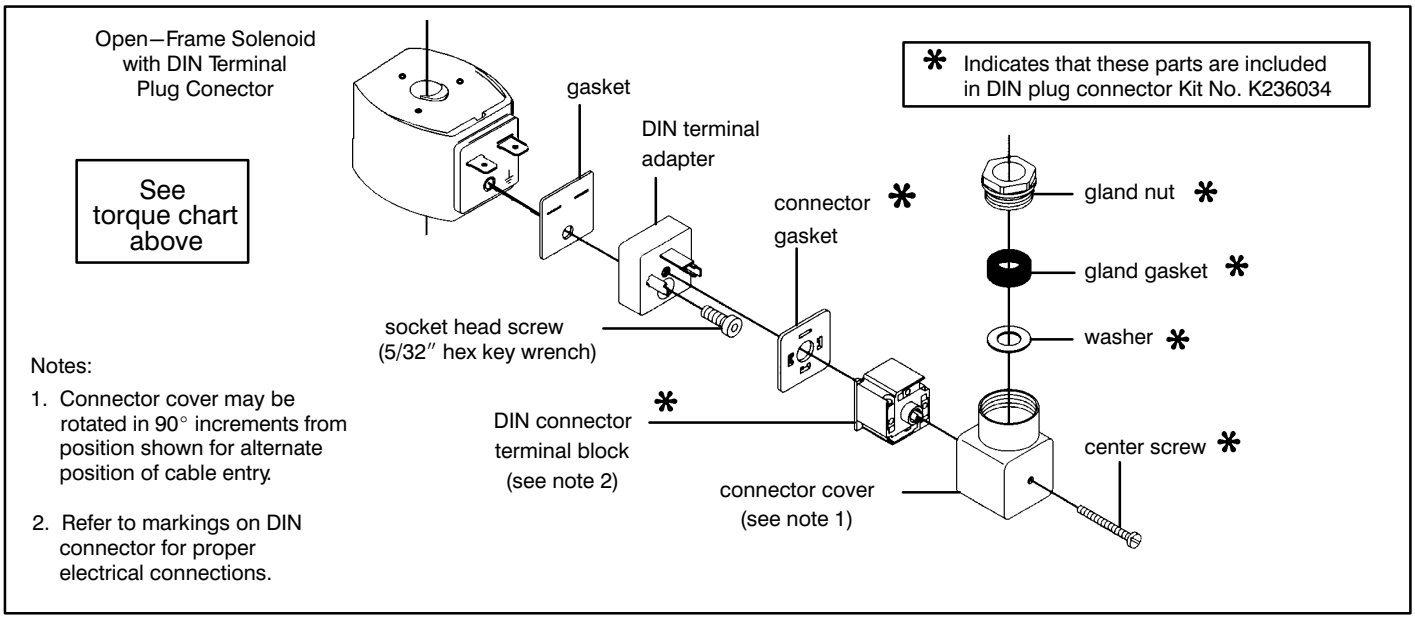


Figure 6. DIN plug connector kit No. K236034 (optional feature)



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# Series 90/91 Method of Operation

## Technical Bulletin No. 1016

July 1993

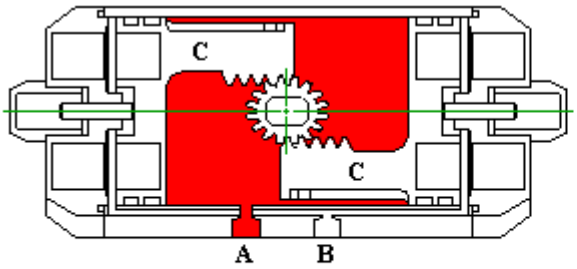


Figure 1 - S90 Double Acting
Air Stroke to Open

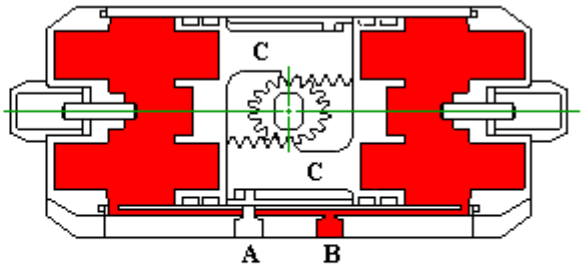


Figure 2 - S90 Double Acting
Air Stroke to Close

Figure 1 shows a S90 Double Acting Actuator completing the Air Stroke Counterclockwise to the Open Position. When pressure is applied to the Left Input Port (A), the actuator will exhaust through the Right Input Port (B). The Pistons (C) will move away from each other, and the Output Shaft (D) will rotate in a counterclockwise direction when viewed from the top. The Pistons will move until they reach the adjustable Travel Stops (E). Adjustment of the Travel Stops will precisely regulate the rotation of the Output Shaft.

Figure 2 shows a S90 Double Acting Actuator completing the Air Stroke Clockwise to the Close Position. When pressure is applied to the Right Input Port (B), the actuator will exhaust through the Left Input Port (A). The Pistons (C) will move toward each other, and the Output Shaft (D) will rotate in a clockwise direction when viewed from the top. The Pistons will move until they touch each other.

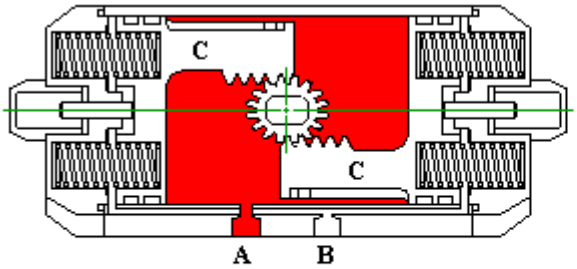


Figure 3 - S91 Single Acting
Air Stroke to Open

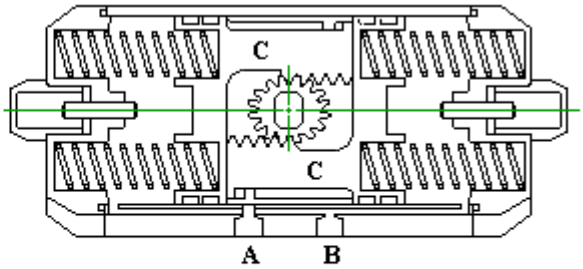


Figure 4 - S91 Single Acting
Spring Stroke to Close

Figure 3 shows a S91 Single Acting Actuator completing the Air Stroke Counterclockwise to the Open Position. When pressure is applied to the Left Input Port (A), the actuator will exhaust through the Right Input Port (B). This Pistons will move away from each other, compressing the spring cartridges, and the Output Shaft (D) will rotate in a counterclockwise direction when viewed from the top. The Pistons will move until they reach the adjustable Travel Stops (E). Adjustment to the Travel Stops will precisely regulate the rotation of the Output Shaft.

Figure 4 shows a S91 Single Acting Actuator completing the Spring Stroke Clockwise to the Close Position. When no pressure is applied to the Input Ports (A and B), the springs will force the Pistons (C) toward each other, and the Output Shaft (D) will rotate in a clockwise direction when viewed from the top. The Pistons will move until they touch each other. Air will be drawn in through the Right Input Port (B) as the Pistons move together.

*ATTENTION*

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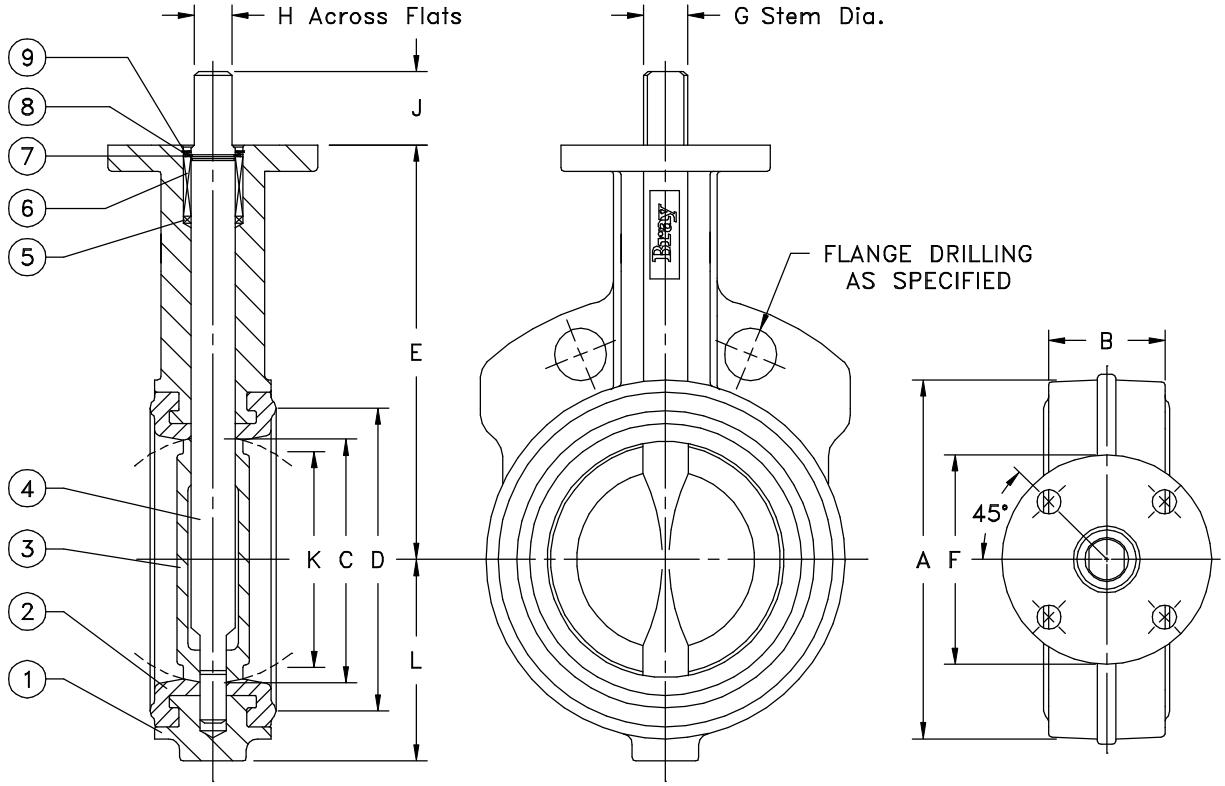
**SERIES 30**
**ES11A-0010**
**Date: June 1993**

| Valve Size | A | B | C | D | E | F | Top Plate Drilling BC | No. of Holes | Hole Diameter | G | H | J | K | L | Adapter Code | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3.69 | 1.62 | 2.00 | 2.84 | 5.50 | 3.54 | 2.76 | 4 | .39 | .55 | .39 | 1.25 | 1.32 | 2.22 | A | 5.5 |
| 2½ | 4.19 | 1.75 | 2.50 | 3.34 | 6.00 | 3.54 | 2.76 | 4 | .39 | .55 | .39 | 1.25 | 1.91 | 2.47 | A | 7.0 |
| 3 | 4.88 | 1.75 | 3.00 | 4.03 | 6.25 | 3.54 | 2.76 | 4 | .39 | .55 | .39 | 1.25 | 2.55 | 2.81 | A | 7.5 |
| 4 | 6.06 | 2.00 | 4.00 | 5.16 | 7.00 | 3.54 | 2.76 | 4 | .39 | .63 | .43 | 1.25 | 3.57 | 3.41 | B | 11.5 |
| 5 | 7.06 | 2.12 | 5.00 | 6.16 | 7.50 | 3.54 | 2.76 | 4 | .39 | .75 | .51 | 1.25 | 4.63 | 4.03 | C | 14.0 |
| 6 | 8.12 | 2.12 | 5.75 | 7.02 | 8.00 | 3.54 | 2.76 | 4 | .39 | .75 | .51 | 1.25 | 5.45 | 4.53 | C | 17.0 |
| 8 | 10.50 | 2.50 | 7.75 | 9.47 | 9.50 | 5.91 | 4.92 | 4 | .57 | .87 | .63 | 1.25 | 7.45 | 5.75 | D | 34.0 |
| 10 | 12.75 | 2.50 | 9.75 | 11.47 | 10.75 | 5.91 | 4.92 | 4 | .57 | 1.18 | .87 | 2.00 | 9.53 | 7.12 | E | 49.0 |
| 12 | 14.88 | 3.00 | 11.75 | 13.47 | 12.25 | 5.91 | 4.92 | 4 | .57 | 1.18 | .87 | 2.00 | 11.47 | 8.12 | E | 67.0 |

Note: K dim is disc chordal dimension at valve face.




| ITEM No. | NAME | No. REQUIRED | SERIES/PART No. | MATERIAL | SPECIFICATION/REMARKS |
|---|---|---|---|---|---|
| 9 | RETAINING RING | 1 | | | |
| 8 | THRUST WASHER | 1 | | | |
| 7 | STEM RETAINER | 2 | | | |
| 6 | BUSHING | 1 | | | |
| 5 | PACKING | 1 | | | |
| 4 | STEM | 1 | | | |
| 3 | DISC | 1 | | | |
| 2 | SEAT | 1 | | | |
| 1 | BODY | 1 | | | |

Valve Size _____ Flg. Drilling _____
Pressure Rating _____
Customer/Project _____
Inq./P.O. No. _____
Bray Order No. _____
Certified Correct By _____ Date _____

The High Performance Company

BRAY VALVE & CONTROLS
A Subsidiary of BRAY INTERNATIONAL, Inc.

PARTS LIST AND DIMENSIONS (Inches)
BUTTERFLY VALVE, SERIES 30 SIZES 2"-12"

| Series | Size | Part No. | Material Trim Code | Drawing No. |
|---|---|---|---|---|
| | | | | ES11A-0010 |

Bray

REV. 1 / ERN-1238

DISK NO. 300

# Installation, Maintenance, & Repair Specifications: Series 30/31/34

## Technical Bulletin No. 1071

February 1993

### I. Shipment & Storage

**A.** The seat, disc, stem, and bushing of the butterfly valve should be coated with silicone lubricant as recommended by Bray Technical Bulletin 1028.

**B.** The disc should be positioned at 10% open.

**C.** The faces of each valve should be covered with cardboard, plywood, plastic plates, etc. to prevent damage to the seat face, disc edge, or butterfly valve interior.

**D.** Valves should be stored indoors with face protectors intact. Temperature should preferably be 40°F to 85°F.

**E.** When valves are stored for a long time, open and close the valves once every 3 months.

**F.** Ship and store valves so that no heavy loads are applied to the bodies.

### II. Installation Considerations - Piping and Valve Orientation and Placement

**A. Piping and Flange Compatibilities** - The Series 20/21 butterfly valves have been designed to be suitable for all types of ANSI 125/150 flanges, whether flat-faced, raised-face, slip-on, weld-neck, etc. (Type C stub-end flanges conform to no standard for the flange face and are not recommended for use with resilient-seated butterfly valves.)These valves have been engineered so that the critical disc chord dimension at the full open position will clear the adjacent inside diameter of most types of piping, including Schedule 40, lined pipe, heavy wall, etc. If in question, one should compare the minimum pipe I.D. with the published disc cord dimension at full open.

**B. Valve Location and Orientation in Piping -**

1. **Valve Location** - Butterfly valves should be installed if possible a minimum of 6 pipe diameters from other line elements, i.e., elbows, pumps, valves, etc. Of course, 6 pipe diameters is not always practical, but it is important to achieve as much distance as possible. Where the butterfly valve is connected to a check valve or pump, use an expansion joint between them to ensure the disc does not interfere with the adjacent equipment.
2. **Valve Orientation -**
   - **a.** In general, Bray recommends the valve be installed with the stem in the vertical position and the actuator mounted vertically directly above the valve,; however there are those applications as discussed below where the stem should be horizontal. The valve should not be installed upside down.
   - **b.** For slurries, sludge, mine tailings, pulp stock, dry cement, and any media with sediment or particles, Bray recommends the valve be installed with the stem in the horizontal position with the lower disc edge opening in the downstream direction.
   - **c.** For valve orientation downstream of pump, bend, etc., see Bray Technical Bulletin 1025.

### III. Installation Procedure

**A. General Installation**

1. Make sure the pipeline and pipe flange faces are clean. Any foreign material such as pipe scale, metal chips, welding slag, welding rods, etc., can obstruct disc movement or damage the disc or seat.
2. The Bray elastomer seat has molded o-rings on the face of the seat. As a result, no gaskets are requiredas these o-rings serve the function of a gasket.
3. Align the piping and then spread the pipe flanges a distance apart so as to permit the valve body to be easily

dropped between the flanges without contacting the pipe flanges.

4. Check to see that the valve disc has been positioned to a partially open position, with the disc edge about 1/2" to 3/8" from the face of the seat (approximately 10 degrees open.)
5. Insert the valve between the flanges, taking care not to damage the seat faces. Always pick the valve up by the locating holes or by using a nylon sling on the neck of the body. Never pick up the valve by the actuator or operator mounted on top of the valve.
6. Place the valve between the flanges, center it, and then span the valve body with all flange bolts, but do not tighten the bolts. Carefully open the disc to the full open position, making sure the disc does not hit the adjacent pipe I.D. Now systematically remove jack bolts on the other flange spreaders, and hand-tighten the flange bolts. Very slowly close the valve disc to ensure disc edge clearance from the adjacent pipe flange I.D. Now open the disc to full open and tighten all flange bolts per specification. Finally repeat a full close to full open rotation of the disc to ensure proper clearances.

**B. Installation with Flange Welding -** When butterfly valves are to be installed between ANSI welding type flanges, care should be taken to abide by the following procedure to ensure no damage will occur to the seat:

1. Place the valve between the flanges with the flange bores and valve body bore aligned properly. The discs should be in the 10 degrees open position.
2. Span the body with the bolts.
3. Take this assembly of flange-body-flange and align it properly to the pipe.
4. Tack weld the flanges to the pipe.
5. When tack welding is complete, remove the bolts and the valve from the pipe flanges and complete the welding of the flanges. Be sure to let the pipe and flanges cool before installing the valve.

   NOTE: Never complete the welding process (after tacking) with the valve between pipe flanges. This causes severe seat damage due to heat transfer.

## IV. Maintenance and Repair

The many Bray features minimize wear and maintenance requirements. No routine lubrication is required. All components - stem, disc, seat, bushing, stem seal, etc., are field replaceable, no adjustment is required. If components require replacement, the valve may be removed from the line by placing the disc near the closed position, then supporting the valve and removing the flange bolts. No valve maintenance, including removal of manual or power actuators, should be performed until the piping system is completely de-pressurized.

## V. Disassembly and Assembly

**A. Disassembly** - Remove handle, gear operator, or actuator from actuator mounting flange. Remove the "Spirolox" retaining ring and the two C-ring stem retainers from the stem hole, then remove the stem, bushing and seal. Remove the disc from the seat, protecting disc edge at all times. Push the seat into an oval shape, then remove the seat fromthe body.

**B. Assembly** - Push the valve seat into an oval and push it into the body with seat stem holes aligned to body stem holes. Insert stem seal and bushing. Push stem into the stem hole of body until the bottom of the stem is flush with the inner top edge of the seat. Install a light coating of silicone or grease on the I.D. of seat. Insert the disc into the seat by lining up the disc hole with the stem hole of the seat. NOTE: the braoched double "D" flats in the disc must be toward teh bottom of the valve body. With a downward pressure and rotating the stem back and forth, push the stem until the stem touches the bottom of the body stem hole. Make certain that when pushing stem through disc bottom, the broached flats of stem and disc are aligned. Replace the stem bushing and two stem retainers, then replace the "Spirolox" retaining ring back into position.

# XPRO® • *LOW COST PRESSURE TRANSMITTER*

***APPLICATIONS***

- FREON® AND AMMONIA REFRIGERATION
- PROCESS CONTROL
- FLOW DETECTION
- PNEUMATIC SYSTEMS
- WATER RESOURCE MANAGEMENT
- LIQUID LEVEL MEASUREMENT

**The XPRO® pressure transmitter provides both the instrument engineer and OEM designer with a reliable and affordable measurement. The 4-20 mA output signal is particularly suited for long cable runs in electrically noisy environments.**

**The XPRO's silicon strain gages are mounted on a beam coupled to a 300 series stainless steel diaphragm for maximum isolation from thermal transients. The pressure cavity is a brazed assembly of 300 series stainless steel with no elastomer seals or adhesive bonds to corrode or deteriorate.**

**The XPRO is recognized by Underwriters Laboratories as an intrinsically safe* device for use in hazardous locations.**


***When used with approved barriers.**

| *FEATURES* | *BENEFITS* |
|---|---|
| • Low cost | • Savings for the OEM |
| • 1% accuracy | • Useful for secondary process measurements |
| • All stainless steel | • Corrosion resistant |
| • Sealed, rugged package | • Suited for industrial environments |

## TECHNICAL SPECIFICATIONS

### RANGE

| | | |
|---|---|---|
| | 0-15, 25, 50 PSIG<br>0-100, 200 PSIS | 0-500, 1000,<br>3000, 5000 |
| | (0-1, 2, 3.5 bar g)<br>(0-7, 14, bar s) | (0-35, 70, 207,<br>345 bar s) |
| | (bar values are approximate) | |

### PHYSICAL

| | | |
|---|---|---|
| **Proof Pressure** | 2 x rated range | 1.5 x rated range |
| **Burst Pressure** | 20 x rated range | 5 x rated range |
| **Material in Contact With Media** | Brazed assembly of 300 series stainless steel | |
| **Shock** | 50 g's peak (5 milliseconds) | |
| **Vibration** | Meets MIL-STD 810-C, Figure 514.2-5, Curve AK, 20.7 g rms minimum | |
| **Weight** | Less than 3 oz (85 gm) without cable | |

### ELECTRICAL

| | |
|---|---|
| **Full Scale Output** | 16 ± 0.32 mA into 0-1400 Ω loop resistance @ 25˚C (4-20 mA) |
| **Zero Output** | 4 ± 0.4 mA @ 25˚C |
| **Excitation**** | 12 to 40 Vdc*<br>Linear derating to 35 Vdc from 25˚ to 100˚C |
| **Reverse Polarity Protection** | Yes |
| **Insulation Resistance** | 1000 MΩ @ 250 Vdc |
| **Electrical Connection** | 2-conductor cable, 22 AWG, color coded shielded cable, 3 ft (0.91m) long |

### PERFORMANCE

| | |
|---|---|
| **Accuracy** | ± 1% FSO from best fit straight line including effects of nonlinearity hysteresis and nonrepeatability |
| **Operating Temperature Range** | -18˚ to 100˚C (0˚ to 212˚F)<br>Hirschmann -18˚ to 90˚C (0˚ to 194˚F) |
| **Compensated Temperature Range** | -1˚ to 54˚C (30˚ to 130˚F) |
| **Thermal Effect on Zero** | Less than ± 1% FSO within the compensated range |
| **Thermal Effect on Full Scale Output** | Less than ± 1% within the compensated range |

* *29.5 V max when used with energy barrier strip*
* *The minimum rated excitation voltage must be maintained at the transmitter. Therefore you must take into account voltage losses due to cable resistance when selecting a power supply.*

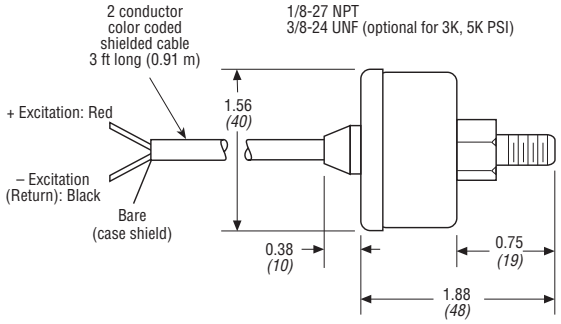
### OPTIONS

- Hirschmann connector, including mate
- Absolute pressure version available in 0-15, 25, 50, 100 and 200 PSIA

XPRO with Hirschmann Connector

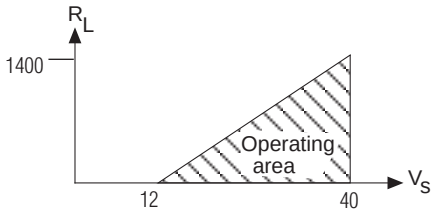
### DIMENSIONS

xx.xx = inches
*(xx.x) = mm*




1/2 Hex for 1/8-27 NPT port
9/16 Hex for 3/8-24 UNF port

### *Load resistance in current loop*




### PIN AND WIRE CODES

| Wire Color Code | Hirschmann Pin Code | Function |
|---|---|---|
| Red | 4 | + Excitation |
| Black | 3 | - Excitation (Return) |
| Bare | NC | Case Shield |

*Incorporates Erratas Dated 06/97, 08/99, and 07/02*

**Fisher Controls**

Instruction Manual

# Type 1098-EGR & 1098H-EGR Pilot-Operated Regulators

*May 1987* *Form 5084*

## Contents




**TYPE 1098-EGR-6352 REGULATOR**


**TYPE 1098H-EGR-6354L REGULATOR**

*Figure 1. Typical Regulator Constructions*

D100339 X012

# Introduction

## Scope of Manual

This manual describes and provides instructions and parts list for a Type 1098-EGR or 1098H-EGR regulator (figure 1) complete with standard P590 Series filter and either a 6350 Series regulator or a Type 61LD pilot. The Type 1806 relief valve also is covered when a Type 61LD pilot is used. However, instructions and parts lists for monitoring pilots and other equipment used with this regulator are found in separate manuals.

## Product Description

Type 1098-EGR and 1098H-EGR regulators provide economical, accurate pressure control in a wide variety of applications such as gas distribution systems, heat-treating furnaces, and boiler plants. They are also used in plant air service and in liquid service where a slow stroking time (approximately 30 to 90 seconds) is desired on both opening and closing the main valve. The Type 1098-EGR regulator is used with a Type 6351, 6352, 6353 or the 61 series pilot. The Type 1098H-EGR regulator is used with a Type 6351, 6352, 6353, 6354H, 6354L, or 6354M pilot.

## Specifications

Table 1 lists specifications for various Type 1098-EGR and 1098H-EGR constructions. Specifications for a given regulator as it originally comes from the factory are stamped on nameplates (figure 2) located on the actuator and main valve body, while the pilot control spring range appears on the pilot spring case and the pilot restriction code is stamped on the pilot body.

*Table 1. Specifications*

**BODY SIZES AND END CONNECTION STYLES**

| Body Size, Inch | Material | End Connection Style | Rating(1) |
|---|---|---|---|
| 1, 2 | Cast iron | NPT screwed | Class 250B |
| | WCB steel | NPT screwed, butt-welding, or socketwelding | Class 600 |
| 2, 3, 4, 6, 8 x 6 | Cast iron | Flat-face flanged | Class 125B |
| | | Raised-face flanged | Class 250B |
| | WCB steel | Raised-face flanged | Class 150, 300, or 600 |
| | | Buttwelding | Class 600 |

**MAXIMUM MAIN VALVE INLET PRESSURE(1)**: 400 psig (28 bar) or body rating limit, whichever is lower, except 20 psig (1.4 bar) for boiler fuel installations as shown in table 2

**MAXIMUM PILOT SUPPLY PRESSURE(1, 2)**: 600 psig (41 bar)

**PILOT RESTRICTION(3)**

| TYPE NUMBER | GAIN | RESTRICTION | | |
|---|---|---|---|---|
| | | Used | Color Code | Letter Code |
| 6351 | Standard | No | None | None |
| 6352 through 6354M | Standard | Yes | Green | S |
| | Low for liquid service and/or broader proportional bands | No | None | L |
| | High for narrower proportional bands | Yes | Red | H |

**OUTLET (CONTROL) PRESSURE RANGES(4)**

**Type 6351 Pilot:** **J** 3 to 20 psig (0.21 to 1.4 bar) with green spring **J** 5 to 35 psig (0.34 to 2.4 bar) with cadmium spring or **J** 35 to 100 psig (2.4 to 6.9 bar) with red spring

**Type 6352 Pilot:** **J** 2 inch wc to 2 psig (5 to 140 mbar) with yellow spring or **J** 2 to 10 psig (140 to 690 mbar) with black spring

**Type 6353 Pilot:** **J** 3 to 40 psig (0.21 to 2.8 bar) with yellow spring or **J** 35 to 125 psig (2.4 to 8.6 bar) with red spring

**Type 6354L Pilot:** 85 to 200 psig (5.9 to 14 bar) with blue spring and no diaphragm limiter

**Type 6354M Pilot:** 175 to 220 psig (12 to 15 bar) with blue spring and diaphragm limiter

**Type 6354H Pilot:** 200 to 300 psig (14 to 21 bar) with green spring and diaphragm limiter

**Type 61LD Pilot:** **J** 0.25 to 2 psig (0.017-0.138 bar) with red spring **J** 1 to 5 psig (0.069-0.34 bar) with yellow spring **J** 2 to 10 psig (0.138-0.69 bar) with blue spring **J** 5 to 15 psig (0.34-1.02 bar) with brown spring **J** 10 to 20 psig (0.69-1.4 bar) with green spring

**MAXIMUM AND MINIMUM DIFFERENTIAL PRESSURES**: See table 2

*Table 1. Specifications (Continued)*

**ACTUATOR SIZES AND MAXIMUM ACTUATOR PRESSURES(1)**

| ACTUATOR SIZE | | OUTLET (CONTROL) PRESSURE | | EMERGENCY CASING PRESSURE | |
|---|---|---|---|---|---|
| | | Psig | Bar | Psig | Bar |
| Type 1098 | 30 | 100 | 6.9 | 115 | 7.9 |
| | 40 | 75 | 5.2 | 82 | 5.7 |
| | 70 | 50 | 3.4 | 65 | 4.5 |
| Type 1098H | 30 | 300 | 21 | 400 | 28 |

**MAIN VALVE FLOW CHARACTERISTIC** **J** Linear (standard) or **J** quick-opening

**MAIN VALVE FLOW DIRECTION** In through seat ring and out through cage

**MATERIAL TEMPERATURE CAPABILITIES(1)** **Standard Elastomers: -**20 to 150_F (-29 to 66_C)
**High-Temperature Elastomers:** 0 to 300_F (-18 to 149_C), except 0 to 180_F (-18 to 82_C) for water service

**PORT DIAMETERS AND TRAVELS**

| BODY SIZE INCH | PORT DIAMETER | | TRAVEL | | | | |
|---|---|---|---|---|---|---|---|
| | | | Standard | | Restricted Capacity | | |
| | Inch | mm | Inch | mm | Percentage of Flow Capacity | Inch | mm |
| 1 | 1-5/16 | 33.3 | 3/4 | 19 | - - - | - - - | |
| 2 | 2-3/8 | 60.3 | 1-1/8 | 29 | 30 | 3/8 | 10 |
| | | | | | 70 | 5/8 | 16 |
| 3 | 3-3/8 | 85.7 | 1-1/2 | 38 | 40 | 7/8 | 22 |
| 4 | 4-3/8 | 111.1 | 2 | 51 | 40 | 1 | 25 |
| 6 & 8 X 6 | 7-3/16 | 182.6 | | | | | |

**APPROXIMATE WEIGHTS (WITH STANDARD SINGLE-PILOT CONSTRUCTION)**

| ACTUATOR SIZE | | BODY SIZE, INCH | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 6 |
| | | | | | Lb | |
| Type 1098 | 30 | 55 | 75 | 115 | 165 | 350 |
| | 40 | 65 | 85 | 125 | 175 | 360 |
| | 70 | 140 | 160 | 200 | 250 | 435 |
| Type 1098H | 30 | 80 | 100 | 140 | 190 | 375 |
| | | | | | Kg | |
| Type 1098 | 30 | 25 | 34 | 52 | 75 | 159 |
| | 40 | 29 | 39 | 57 | 79 | 163 |
| | 70 | 64 | 73 | 91 | 113 | 197 |
| Type 1098H | 30 | 36 | 45 | 64 | 86 | 170 |

1. The pressure/temperature limits in this manual, and any applicable standard limitation should not be exceeded.
2. For stability or overpressure protection, a reducing regulator may be installed upstream of the pilot according to the installation section.
3. Restriction part numbers are given in the parts list.
4. Pilot control spring part numbers are given in the parts list.

## Installation and Startup

**WARNING**

**Personal injury, equipment damage, or leakage due to escaping accumulated gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in tables 1 and 2 and on the appropriate nameplate, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by Title 49, Part 192, of the U.S. Code of Federal Regulations, by the National Fuel Gas Code Title 54 of the National Fire Codes of the National Fire Protection Association, or by other applicable codes) to prevent service conditions from exceeding those limits.**

**Additionally, physical damage to the regulator could results in personal injury and property damage due to escaping accumulated gas. To avoid such injury and damage, install the regulator in a safe location.**

## Standard Single-Pilot Regulator

### Installations

A Type 1098-EGR or 1098H-EGR regulator bleeds no gas to atmosphere, making it suitable for installation in pits and other enclosed locations without elaborate venting systems. This regulator also can be installed in pits subject to flooding, by installing a special antiflood breather vent or by venting the pilot spring case above the expected flood level so that the pilot diaphragm can be referenced to atmospheric pressure.

**Note**

**On the Design EGR main valve, normal pressure drop assists shutoff. Therefore, leakage may result during any reverse pressure drop condition.**

1. Use qualified personnel when installing, operating, and maintaining regulators. Before installing, inspect the main valve, pilot, and tubing for any shipment damage or foreign material that may have collected during crating and shipment. Make certain the body interior is clean and the pipelines are free of foreign material. Apply pipe compound

*Table 2. Maximum and Minimum Differential Pressures for Main Valve Spring Selection*

| CONSTRUCTION | | | Low-differential boiler fuel installation Type 1098-EGR requiring quick-opening cage and limited to 20 psig (1.4 bar) max inlet pressure | All Other Constructions | | |
|---|---|---|---|---|---|---|
| **MAXIMUM ALLOWABLE DIFFERENTIAL PRESSURE** | | | **20 psig (1.4 bar)** | **60 psi (4.1 bar)** | **125 psi (8.6 bar)** | **400 psig (28 bar) or body rating limit, whichever is lower** |
| **MINIMUM DIFFERENTIAL PRESSURE REQUIRED FOR FULL STROKE** | **1 Inch Body** | **Size 40 Actuator** | **Not available** | **2.5 psi (0.17 bar)** | **4 psi (0.28 bar)** | **5 psi (0.34 bar)** |
| | | **Size 30 Actuator** | **Not available** | **3.5 psi (0.24 bar)** | **5 psi (0.34 bar)** | **7 psi (0.48 bar)** |
| | | **Size 70 Actuator** | **1.0 psi (0.069 bar)** | **1 psi (0.069 bar)** | **1.5 psi (0.10 bar)** | **2.5 psi (0.17 bar)** |
| | **2 Inch Body** | **Size 40 Actuator** | **Not available** | **3 psi (0.21 bar)** | **5 psi (0.34 bar)** | **10 psi (0.69 bar)** |
| | | **Size 30 Actuator** | **Not available** | **4 psi (0.28 bar)** | **6 psi (0.42 bar)** | **11 psi (0.76 bar)** |
| | | **Size 70 Actuator** | **1.0 psi (0.069 bar)** | **1.5 psi (0.10 bar)** | **2 psi (0.14 bar)** | **3 psi (0.21 bar)** |
| | **3 Inch Body** | **Size 40 Actuator** | **Not available** | **4 psi (0.28 bar)** | **6 psi (0.41 bar)** | **11 psi (0.76 bar)** |
| | | **Size 30 Actuator** | **Not available** | **5 psi (0.34 bar)** | **8 psi (0.55 bar)** | **14 psi (0.97 bar)** |
| | | **Size 70 Actuator** | **1.0 psi (0.069 bar)** | **2 psi (0.14 bar)** | **2.5 psi (0.17 bar)** | **4 psi (0.28 bar)** |
| | **4 Inch Body** | **Size 40 Actuator** | **Not available** | **5 psi (0.34 bar)** | **8 psi (0.55 bar)** | **13 psi (0.90 bar)** |
| | | **Size 30 Actuator** | **Not available** | **10 psi (0.69 bar)** | **13 psi (0.90 bar)** | **22 psi (1.5 bar)** |
| | | **Size 70 Actuator** | **1.3 psi (0.090 bar)** | **2.5 psi (0.17 bar)** | **3 psi (0.21 bar)** | **5 psi (0.34 bar)** |
| | **6, 8 x 6 Inch Body** | **Size 40 Actuator** | **Not available** | **9.5 psi (0.66 bar)** | **14 psi (0.97 bar)** | **19 psi (1.3 bar)** |
| | | **Size 30 Actuator** | **Not available** | **13 psi (0.90 bar)** | **19 psi (1.3 bar)** | **28 psi (1.9 bar)(1)** |
| | | **Size 70 Actuator** | **2.2 psi (0.15 bar)** | **4 psi (0.28 bar)** | **6 psi (0.42 bar)** | **8 psi (0.55 bar)** |
| **MAIN VALVE SPRING COLOR CODE (2)** | | | **Yellow, except green for 1 inch body** | **Green** | **Blue** | **Red** |

1. Requires special 6350 Series pilot construction with Type 1806H relief valve.
2. Spring part numbers are given in the parts list.

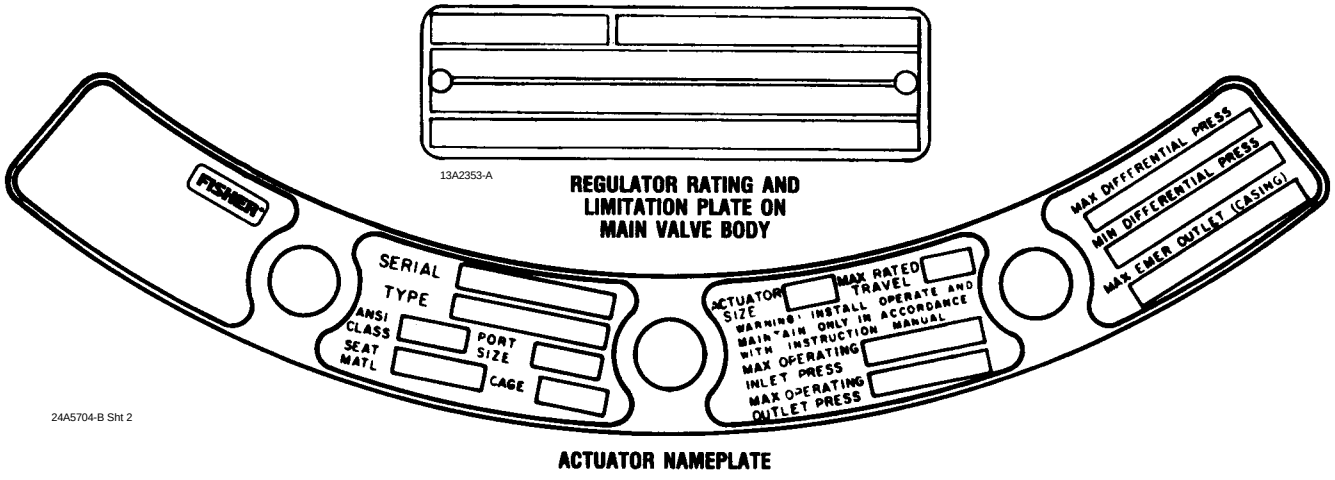



*Figure 2. Regulator Nameplates*

only to the male pipe threads with a screwed body, or use suitable line gaskets and good bolting practices with a flanged body.

With a weld end body, be sure to remove the trim package, including the gasket (key 4, figure 11), according to the Maintenance section before welding the body into the line. Do not install the trim package until any post-weld heat treatment is completed. If heat treating, prevent scale buildup on all machined guiding and sealing surfaces inside the body and at the bonnet flange/body joint.

**Note**

**All Type 1098-EGR and 1098H-EGR regulators should be installed so that flow through the main valve matches the flow arrow attached to the valve body.**

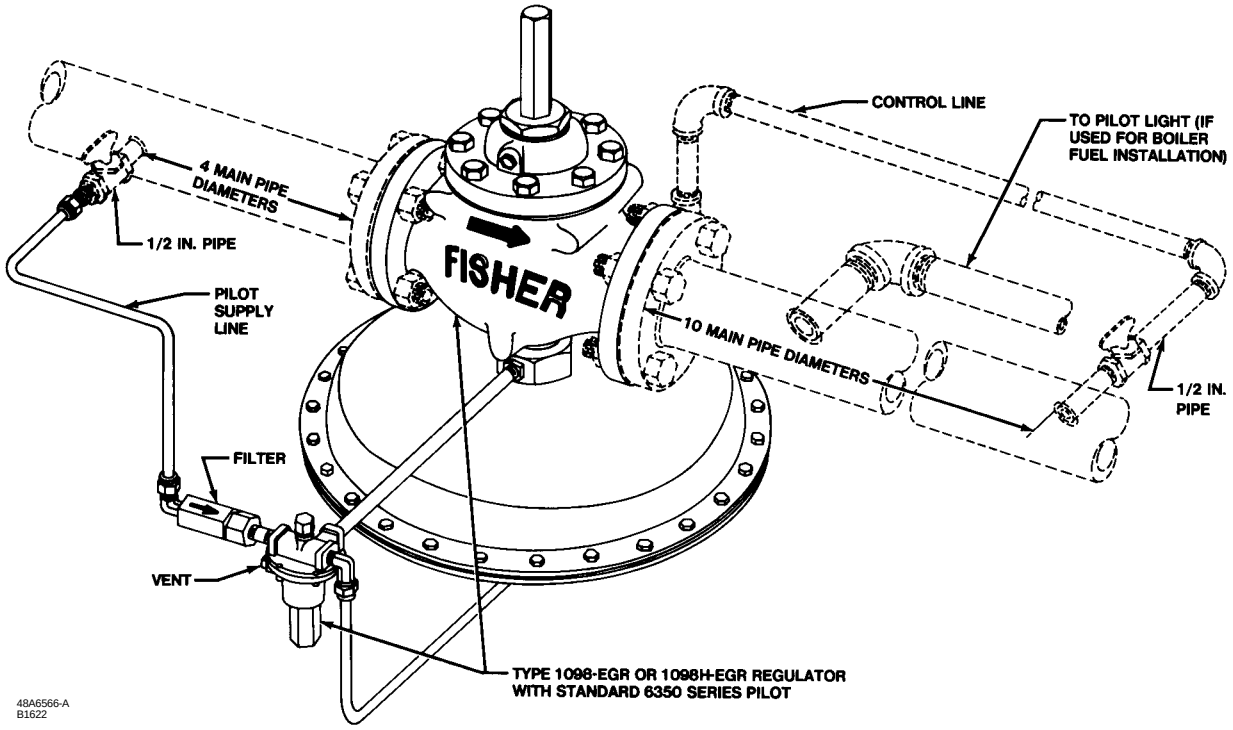



*Figure 3. Standard Single-Pilot Installation*

2. Install a three-valve bypass around the regulator if continuous operation is necessary during maintenance or inspection.

The standard pilot mounting position is shown in figure 1, the pilot may be field-changed to the opposite-side mounting position by swapping the pilot pipe nipple to the opposite bonnet tapping.

**WARNING**

**A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate, and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous location. The vent line or stack opening must be protected against condensation or clogging.**

3. To keep the pilot spring case vent from being plugged or the spring case from collecting moisture, corrosive chemicals, or other foreign material, point the vent down or otherwise protect it. Vent orientation may be changed by removing the spring case and remounting it on the pilot body or on a standard Type 6352 through 6354M pilot, by twisting the vent (key 35, figure 13, or key 13, figure 14) in the spring case. To remotely vent a standard Type 6352 through 6354M pilot, remove the vent and install obstruction-free tubing or piping into the 1/4-inch NPT vent tapping. The Type 61LD pilot is vented by installing the vent piping in place of the pipe plug (key 22, figure 18). Then remove the closing cap assembly (key 5, figure 18) in order to remove the machine screw from inside the closing cap and tightly install it in the vent hole in the center of the closing cap. Provide protection on a remote vent by installing a screened vent cap into the remote end of the vent pipe.

4. Run a 3/8-inch outer diameter or larger pilot supply line from the upstream pipeline to the filter inlet as shown in figure 3, bushing the line down to fit the 1/4-inch NPT filter connection. Do not make the upstream pipeline connection in a turbulent area, such as near a nipple, swage, or elbow. If the maximum pilot inlet pressure could exceed the pilot rating, install a separate reducing regulator in the pilot supply line. Install a hand valve in the pilot supply line, and provide vent valves to properly isolate and relieve the pressure from the regulator.

5. Attach a 1/2-inch NPT downstream pressure control line downstream of the regulator in a straight run of pipe as shown in figure 3. Connect the other end of the control line to the bonnet connection. Do not make the tap near any elbow, swage, or nipple that might cause turbulence. Install a hand valve in the control line to shut off the control pressure when the bypass is in use.

6. If a quick acting solenoid is to be installed downstream of a regulator, the regulator and solenoid should be located as far apart as practical. This will maximize the gas piping volume between the regulator and solenoid and improve the regulator response to quick changing flow rates.

7. Consult the appropriate instruction manual for installation of an optional pneumatic or electric remote control drive unit. For optional remote pneumatic loading of a 6350 Series or 61LD pilot, make the loading piping connections to the 1/4-inch NPT vent connection.

### Prestartup Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:

- **D** Block valves isolate the regulator.
- **D** Vent valves are closed.
- **D** Hand valves are closed.

**CAUTION**

**Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.**

**Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.**

**Note**

**For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.**

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

### Pilot Adjustment

**To adjust standard 6350 Series pilots:** loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

**WARNING**

**To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.**

**To adjust the Type 61LD pilot:** remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

### Startup

1. Slowly open the hand valve in the pilot supply line.
2. Slowly open the upstream block valve, and partially open the downstream block valve for minimum flow.
3. Slowly open the hand valve in the control line.
4. Adjust the pilot setting if necessary.
5. Completely open the downstream block valve.
6. Slowly close the bypass valve, if any.

## Dual-Pilot Boiler Fuel Control Regulator

### Installation

1. Perform the Standard Single-Pilot Regulator Installation section through step 3, making sure that the regulator is installed in a horizontal pipeline with the actuator below the main valve as shown in figure 4.

2. Run a 1/2-inch outer diameter or larger pilot supply line from the upstream pipeline to the 1/2-inch NPT supply connection in the pipe tee as shown in figure 4. Do not make the connection in a turbulent area, such as near a nipple, swage, or elbow. If the maximum pilot inlet pressure could exceed the pilot rating, install a separate reducing regulator in the pilot line. Install a hand valve in the pilot supply line, and provide vent valves so that pressure can be properly isolated and relieved from the regulator.

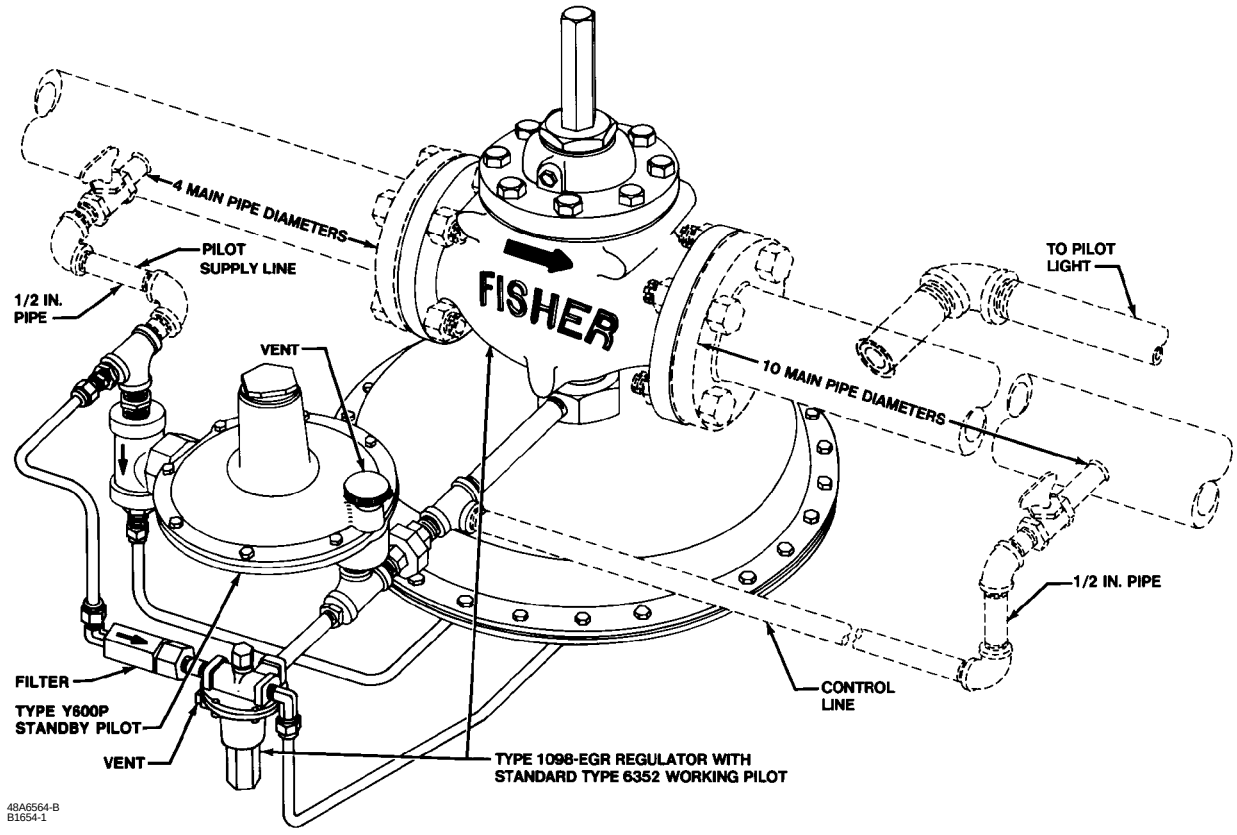



*Figure 4. Typical Dual-Pilot Boiler Fuel Installation*

3. Attach a 1/2-inch NPT downstream pressure control line ten pipe diameters downstream of the regulator in a straight run of pipe. Connect the other end of the control line to the 1/4-inch NPT connection in the control line pipe tee as shown in figure 4. Do not make the tap near any elbow, swage, or nipple which might cause turbulence. Install a hand valve in the control line to shut off the control pressure when the bypass is in use. Also use the hand valve to dampen out pulsations which may cause instability or cycling of the regulator.

4. Consult the appropriate instruction manual for installation of an optional pneumatic or electric remote control drive unit. For optional remote pneumatic loading of a 6350 Series or Type 61LD pilot, make the loading piping connections to the 1/4-inch NPT vent connection.

## Prestart Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:

- **D** Block valves isolate the regulator.
- **D** Vent valves are closed.
- **D** Hand valves are closed.

**CAUTION**

**Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.**

**Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.**

**Note**

**For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.**

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into

the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

### Pilot Adjustment

**To adjust standard 6350 Series pilots:** loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

**WARNING**

**To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.**

**To adjust the Type 61LD pilot:** remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

### Startup

1. Slowly open the hand valve in the pilot supply line.

2. Slowly open the upstream block valve, and partially open the downstream block valve for minimum flow.

3. Slowly open the hand valve in the control line and make sure that the standby pilot is set far enough below the working pilot so that the standby pilot remains closed during normal operation. For example, with final desired settings of 11 inches wc (27 mbar) for the working pilot and 10 inches wc (25 mbar) for the standby pilot, begin by reducing the working pilot setting far enough below 10 inches wc (25 mbar) for the working pilot to shut off. Then set the standby pilot for an outlet pressure of 10 inches wc (25 mbar). Finally, set the working pilot for an outlet pressure of 11 inches wc (27 mbar).

Table 3 shows how close the standby pilot can be set to the working pilot setting.

4. Completely open the downstream block valve.

5. Slowly close the bypass valve, if any.

## Working Monitor

### Installation

1. For both the working monitor regulator and the working regulator, perform the Standard Single-Pilot Regulator Installation section through step 6.

2. Connect another downstream pressure control line and hand valve (figure 5) to the monitoring pilot according to the monitoring pilot instruction manual. Attach a 1/2-inch NPT intermediate pressure control line and hand valve from the intermediate pressure pipeline to the working monitor regulator. Pipe supply pressure between the monitoring pilot and the working monitor regulator according to the monitoring pilot manual.

For two typical monitoring pilots, table 4 gives the spread between normal distribution pressure and the minimum pressure at which the working monitor regulator can be set to take over if the working regulator fails open.

### Prestartup Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:

- **D** Block valves isolate the regulator.
- **D** Vent valves are closed.
- **D** Hand valves are closed.

**CAUTION**

**Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.**

**Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.**

**Note**

**For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.**

*Table 3. Standby Pilots for Boiler Fuel Control Applications*

| STANDBY PILOT INFORMATION | | | MINIMUM PRESSURE AT WHICH STANDBY PILOT CAN BE SET |
|---|---|---|---|
| **Construction** | **Spring Range** | **Spring Part Number** | |
| Type Y600P with 3/8 inch (9.5 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet | 3 to 8 inch wc (8 to 20 mbar)(1)<br>5 to 15 inch wc (12 to 38 mbar)(1)<br>11 to 28 inch wc (27 to 68 mbar)(1) | 1B6358 27052(1)<br>1B6539 27022(1)<br>1B5370 27052(1) | 1 inch wc (2.5 mbar) under working pilot set point |
| | 1 to 2-1/2 psig (0.069 to 0.17 bar)(2)<br>2-1/4 to 4-1/2 psig (0.16 to 0.31 bar)(2)<br>4-1/2 to 7 psig (0.31 to 0.48 bar)(2) | 1B5371 27022(2)<br>1B5372 27022(2)<br>1B5373 27052(2) | 0.2 psig (14 mbar) under working pilot set point |
| Type 621-107 with 3/8 inch (9.5 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet for cast iron body or 750 psig (52 bar) maximum allowable pilot inlet for malleable iron or steel body | 5 to 10 psig (0.34 to 0.69 bar) | 1D8923 27022 | 0.3 psig (21 mbar) under working pilot set point |

1. With standard diaphragm plate.
2. With heavy diaphragm plate.

*Table 4. Working Monitor Performance*

| MONITORING PILOT INFORMATION | | | MINIMUM PRESSURE AT WHICH WORKING MONITOR REGULATOR CAN BE SET |
|---|---|---|---|
| **Construction** | **Spring Range** | **Spring Part Number** | |
| Type Y600M with 1/8 inch (3.2 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet | 5 to 15 inch wc (12 to 38 mbar)<br>11 to 28 inch wc (27 to 68 mbar) | 1B6539 27022<br>1B5370 27052 | 3 inch wc (7 mbar) over normal distribution pressure |
| | 1 to 2-1/2 psig (0.069 to 0.17 bar)<br>2-1/4 to 4-1/2 psig (0.16 to 0.31 bar)<br>4-1/2 to 7 psig (0.31 to 0.48 bar) | 1B5371 27022<br>1B5372 27022<br>1B5373 27052 | 0.5 psig (0.034 bar) over normal distribution pressure |
| Type 621-109 with 1/8 inch (3.2 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet for cast iron body or 750 psig (52 bar) maximum allowable pilot inlet for malleable iron or steel body | 5 to 15 psig (0.34 to 1.0 bar)<br>10 to 25 psig (1.0 to 1.7 bar)<br>20 to 35 psig (1.4 to 2.4 bar)<br>25 to 60 psig (1.7 to 4.1 bar) | 1D8923 27022<br>1D7515 27022<br>1D6659 27022<br>1D7555 27142 | 30 psig (0.21 bar) over normal distribution pressure |
| | 40 to 80 psig (2.8 to 5.5 bar)<br>80 to 150 psig (5.5 to 10 bar)<br>130 to 200 psig (9.0 to 14 bar) | 1E5436 27142<br>1P9013 27142(1)<br>1P9013 27142(2) | 5.0 psig (0.34 bar) over normal distribution pressure |

1. With large diaphragm plate.
2. With small diaphragm plate.

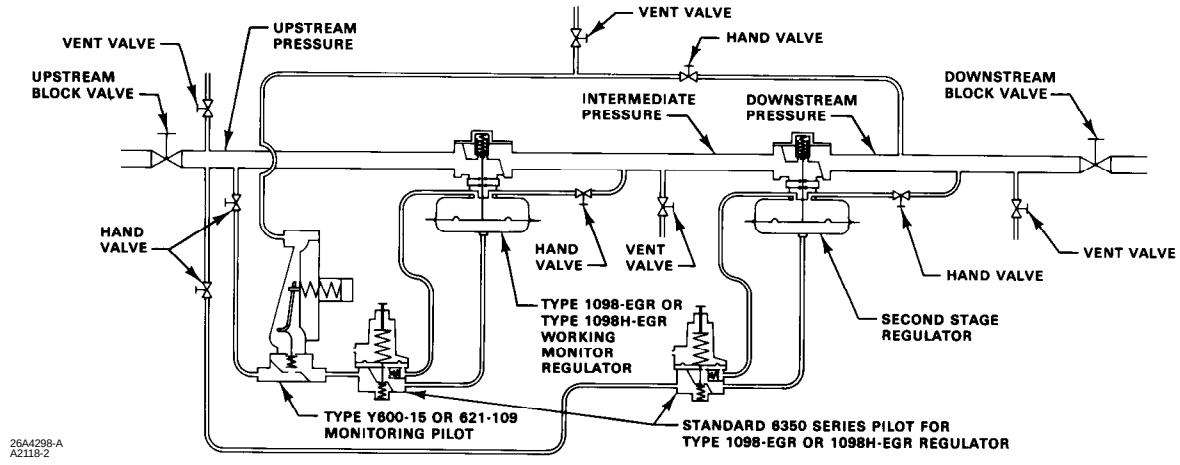



*Figure 5. Typical Working Monitor Installation*

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

### Pilot Adjustment

**To adjust all standard 6350 Series pilots:** loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

**WARNING**

**To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.**

**To adjust the Type 61LD pilot:** remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

### Startup

On a working monitor installation (figure 5), be sure that the second-stage working regulator is set to operate at a pressure lower than the Type 1098-EGR or 1098H-EGR working monitor regulator. To do this, increase the setting of the monitoring pilot until the working pilot is in control of the intermediate pressure and the second-stage working regulator is in control of the downstream pressure. If this is not done, the monitoring pilot tries to take control of the downstream pressure.

1. Slowly open the upstream block valve and the hand valves in both pilot supply lines. This energizes both pilots so that their setpoints can be adjusted. Partially open the downstream block valve for minimum flow.

2. To enable intermediate pressure adjustment with the working monitor regulator, slowly open the hand valve in the intermediate pressure control line.

3. To enable downstream pressure adjustment with the second-stage working regulator, slowly open the hand valve in the control line to this regulator.

4. Adjust the setting of the monitoring pilot to establish the desired emergency downstream pressure, which is to be maintained in the event of open failure of the second-stage working regulator. The emergency downstream pressure should exceed the desired downstream pressure by at least the amount listed in table 4. The steps followed to set the monitoring pilot may vary with each piping situation; however, the basic method remains the same. The following substeps a and b may be used as examples for setting the monitoring pilot:

a. Increase the outlet pressure setting of the second-stage working regulator until the monitoring pilot takes control of the downstream pressure. Adjust the monitoring pilot setting until the desired emergency downstream pressure is achieved. Then readjust the second-stage working regulator to establish the desired downstream pressure.

b. Install special piping (not shown in figure 5) so that the monitoring pilot senses the intermediate pressure. The intermediate pressure then appears to the monitoring pilot as if it were increased downstream pressure, and the monitoring pilot controls and reduces the intermediate pressure. Adjust the monitoring pilot setting until the desired emergency downstream pressure is achieved at the intermediate pressure stage. Then slowly close the special piping, and open up the monitoring downstream control line for normal service.

5. Slowly open the downstream block valve.

6. Slowly close the bypass valve, if any.

## Wide-Open Monitor

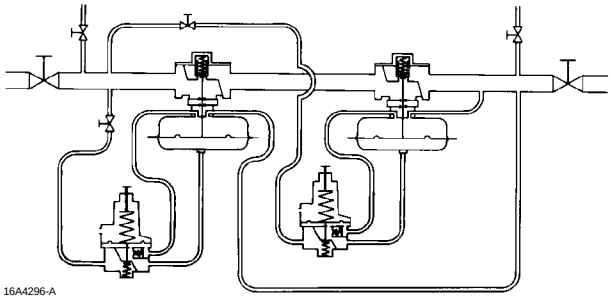
### Installation

1. For both the wide-open monitoring regulator and the working regulator, perform the Standard Single-Pilot Regulator Installation section through step 6.

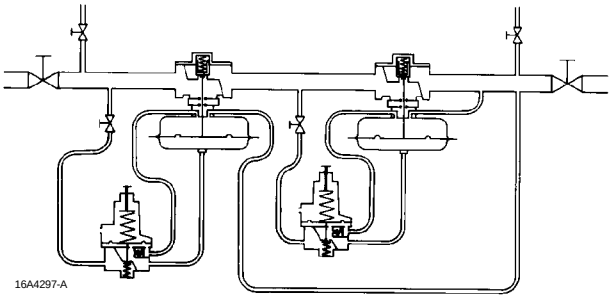
2. Connect the control line of a wide-open monitoring regulator (figure 6) to downstream piping near the working regulator control line connection. During normal operation the wide-open monitoring regulator stands wide open with the pressure reduction being taken across the working regulator. Only in case of working regulator failure does the wide-open monitoring regulator take control at its slightly higher setting.

### Prestartup Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:




FLEXIBLE WIDE-OPEN MONITOR ARRANGEMENT THAT PERMITS WIDE-OPEN MONITOR TO BE EITHER UPSTREAM OR DOWNSTREAM




MINIMUM PIPING WIDE-OPEN MONITOR ARRANGEMENT THAT REQUIRES WIDE-OPEN MONITOR ALWAYS TO BE UPSTREAM

*Figure 6. Typical Wide-Open Monitor Installations*

**D** Block valves isolate the regulator.

**D** Vent valves are closed.

**D** Hand valves are closed.

**CAUTION**

**Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.**

**Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.**

**Note**

**For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.**

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

## Pilot Adjustment

**To adjust all standard 6350 Series pilots:** loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

**WARNING**

**To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.**

**To adjust the Type 61LD pilot:** remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

## Startup

Repeat this procedure in turn for each regulator in the installation.

1. Slowly open the hand valve in the pilot supply line.

2. Slowly open the upstream block valve, and partially open the downstream block valve for minimum flow.

3. Slowly open the hand valve in the control line and adjust the pilot setting if necessary. Set the monitoring regulator at a slightly higher control pressure than the working regulator.

4. Completely open the downstream block valve.

5. Slowly close the bypass valve, if any.

## Shutdown

Installation arrangements vary, but in any installation it is important that the valves be opened or closed slowly and that the outlet pressure be vented before venting inlet pressure to prevent damage caused by reverse pressurization of the pilot or main valve. The following steps apply to the typical installation as indicated.

## Single-Pilot, Dual-Pilot Regulator or Wide-Open Monitor

As well as applying to a single-pilot regulator (figure 3), the steps in this procedure also are valid for a dual-pilot regulator (figure 4) or a wide-open monitoring installation (figure 6) and just need to be repeated for each regulator in such an installation.

1. Slowly close the downstream block valve. If the control line is downstream of the block valve, also close the hand valve in the control line.

2. Slowly close the upstream block valve and the hand valve in the pilot supply line.

3. Slowly open the vent valve in the downstream pipeline. If the control line is downstream of the block valve, also open the vent valve in the control line. Permit all pressure to bleed out.

4. Slowly open the vent valve in the upstream pipeline. Permit all pressure to bleed out of both the piping and the pilot.

## Working Monitor

1. Slowly close the downstream block valve and the hand valve in the downstream pressure control line.

2. Slowly close the upstream block valve and the hand valves in both pilot supply lines.

3. Slowly open all vent valves and permit all pressures to bleed out of the piping and regulators.

## Principle of Operation

The pilot-operated Type 1098-EGR and Type 1098H-EGR regulators both use inlet pressure as the operating medium, which is reduced through pilot operation to load the actuator diaphragm. Outlet or downstream pressure opposes loading pressure in the actuator and also opposes the pilot control spring. The operation of each regulator is the same, and the Type 1098-EGR regulator operation schematic is shown in figure 7.

In operation, assume that outlet pressure is below the pilot control setting. Control spring force on the pilot diaphragm thus opens the pilot valve plug (Type 6351 pilot) or relay orifice (Type 61LD pilot), providing additional loading pressure to the actuator diaphragm. This diaphragm loading pressure opens the main valve plug, supplying the required gas to the downstream system.

When downstream demand has been satisfied, outlet pressure tends to increase, acting on the pilot and actuator diaphragms. This pressure exceeds the pilot control spring setting, moving the pilot diaphragm away and letting the valve plug spring (Type 6351 or Type 61LD pilots) or bellows (Type 6352 through 6354M pilot) close the pilot valve plug (unbalanced in the Type 6351 or Type 61LD pilots but balanced in the Type 6352 through 6354M pilot). Excess loading pressure on the actuator diaphragm escapes downstream through the bleed hole (Type 6351 pilot), bleed orifice (Type 61LD pilot), or restriction (Type 6352 through 6354M pilot).

Reduced actuator loading pressure permits the main valve to close. The combination of main valve spring force and valve plug unbalance provides positive shutoff of the valve plug against the port and upper seals.

To protect the Type 1098 or 1098H actuator diaphragm from excessive differential pressure, all 6300 series and 61LD pilots have a relief valve that allows loading pressure to bleed downstream at approximately 25 psi (1.7 bar) differential across the actuator diaphragm.

A dual-pilot regulator (figure 7) also operates similarly to a single-pilot regulator. In addition, the large ports of the standby pilot open to quickly supply additional loading pressure to the Type 1098 diaphragm. This extra loading pressure strokes the main valve quickly in order to satisfy rapid load changes in the boiler system.

A working monitor system (figure 5) reduces pressure and throttles while the working monitor regulator is in operation. If the working regulator fails open, the working monitor regulator takes over the entire pressure reduction function. The working monitor concept allows observation of the performance of the first-stage regulator at all times.

As long as the second-stage working regulator maintains normal downstream pressure, the monitoring pilot stays wide open. This permits inlet pressure to go straight through to the working monitor pilot for reduction to actuator loading pressure.

Downstream pressure is piped back to the monitoring pilot. As long as the downstream pressure is less than the monitoring pilot setting, the working pilot controls the actuator to maintain intermediate pressure. If the second-stage working regulator fails open, the downstream pressure increases to the setting of the monitoring pilot (slightly higher than the original downstream pressure). The monitoring pilot takes control and the working monitor pilot throttles down the loading pressure to

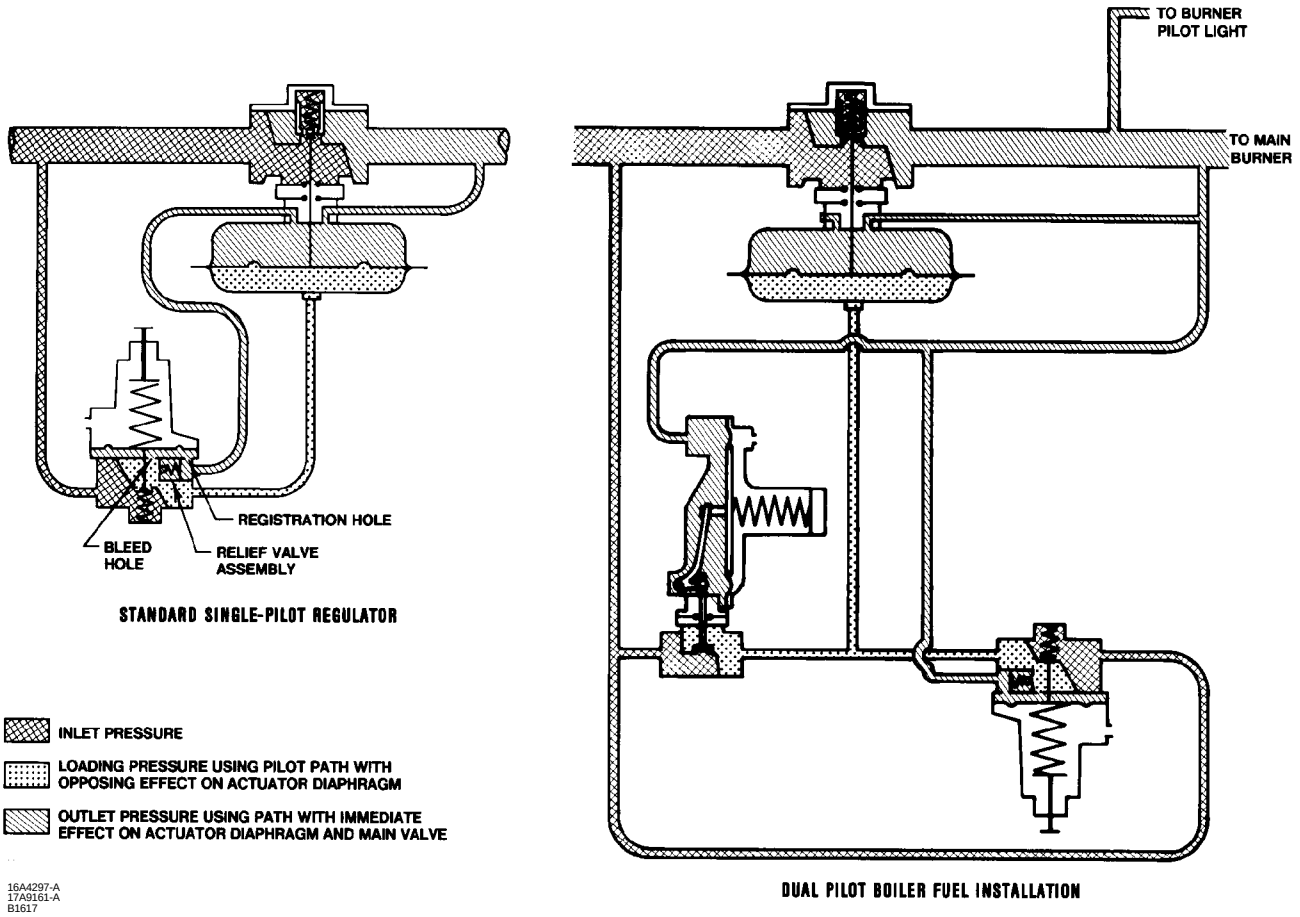



*Figure 7. Principle of Operation Schematics*

the working monitor regulator actuator. This actuator will move the valve plug and control the downstream pressure at the emergency level. Thus, downstream equipment is protected against a major overpressure condition without disrupting service or venting gas to the atmosphere.

## Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends upon the severity of service conditions or the requirements of local, state, and federal regulations. Due to the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher. The stem O-rings on the Type 1098 or 1098H actuator can be lubricated annually, using the grease fitting (key 28, figure 20). Stem O-rings can be checked for damage during normal operation by line pressure leakage or unexpected grease extrusion from the actuator vent (key 27, figure 20). All O-rings, gaskets, and seals should be lubricated with a good grade of general-purpose grease and installed gently rather than forced into position. Be certain that the nameplates are updated to accurately indicate any field changes in equipment, materials, service conditions, or pressure settings.

**WARNING**

**To avoid personal injury resulting from sudden release of pressure, isolate the regulator from all pressure and cautiously release trapped pressure from the regulator before attempting disassembly.**

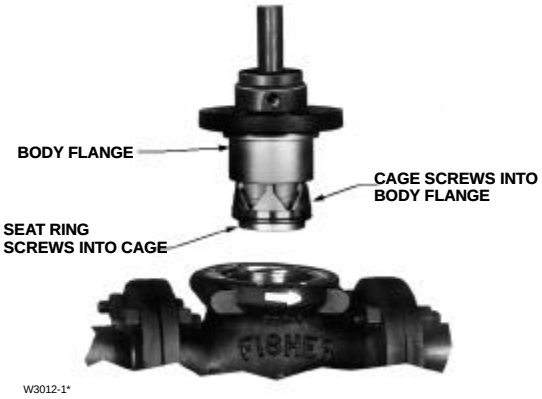



*Figure 8. Trim Package Removal*


*Figure 9. Exploded View of Full-Capacity Trim Package Assembly*

## Design EGR Main Valve

### Replacing Quick-Change Trim Package

Perform this procedure if the entire trim package (figure 8) is replaced. Key numbers for both the complete main valve and its trim package are referenced in figure 11. Some replacement trim package assembly numbers are listed in a table in the parts list.

**Note**

**All disassembly, trim change, and reassembly steps in this section may be performed with the regulator in the main line and without disconnecting pilot supply or control lines.**

1. Remove the cap screws (key 3) with a cast iron body, or remove the stud bolt nuts (key 29, not shown) with a steel body. Pry the body flange (key 2) loose from the valve body (key 1), and lift out the trim package.

2. Perform any required inspection, cleaning, or maintenance on the exposed surfaces of the valve body or trim package. Replace the gasket (key 4) or cage O-ring (key 17) as necessary.

3. On a pre-built replacement trim package, check indicator zeroing by unscrewing the indicator protector (key 19) and seeing if the flange of the indicator nut (key 22) lines up evenly with the bottom marking on the indicator scale (key 18). If not, remove the indicator scale and separate the indicator nut and hex nut (key 8). Hold the indicator scale against the indicator fitting (key 5) with the scale base resting against the shoulder of the fitting, and turn the indicator nut until its flange is aligned with the bottom scale marking. Then lock both nuts against each other, and install the indicator scale and protector.

4. Coat the cage seating surfaces of the valve body web and the body flange seating surfaces of the valve body neck with a good grade of general-purpose grease. Install the trim package, and secure it evenly with the cap screws or stud bolt nuts. No particular trim package orientation in the body is required.

### Replacing Trim Parts

Perform this procedure if inspecting, cleaning, or replacing individual parts in a trim package. Key numbers are referenced in figure 11. An exploded view of a standard full-capacity trim package only is shown in figure 9.

**Note**

**Access to the spring (key 9), flange O-ring (key 21), travel indicator parts, or optional travel stop (key 32) in step 1 can be gained without removing the body flange (key 2).**

1. Remove the indicator fitting (key 5) and attached parts. Proceed to step 5 if only maintenance on the fitting or attached parts is performed.

2. Remove the cap screws (key 3) with a cast iron body, or remove the stud bolt nuts (key 29, not shown) with a steel body, and pry the body flange loose from the valve body (key 1).

3. Use the valve body as a holding fixture if desired. Flip the body flange over, and anchor it on the valve body as shown in figure 10, removing the pipe plug (key 31) first if necessary.

4. To gain access to the port seal (key 12), upper seal (key 15), or valve plug parts, unscrew the seat ring (key 13) from the cage (key 11) and the cage from the body flange. For leverage, a wrench handle or similar tool may be inserted into the seat ring slots (figure 10) and a strap wrench may be wrapped around a standard or a Whisper Trim**R** cage, or a soft bar may be inserted through the windows of a standard cage. To remove the piston ring (key 14) and/or plug O-ring (key 20), remove the valve plug (key 16) from the body flange, insert a screwdriver into the precut foldover area of the piston ring, and unfold the piston ring. Proceed to step 6 if no further maintenance is necessary.

5. To replace the body flange or gain access to the spring, indicator stem (key 10), stem O-ring (key 7), spring seat (key 28), E-ring (key 23), or optional travel stop, remove the indicator protector (key 19) and indicator scale (key 18). Since some compression is left in the spring, carefully remove the flanged nut (key 22) and hex nut (key 8). A screwdriver may be inserted through the press-fit bushing (key 6) to remove the stem O-ring without removing the bushing. If necessary, unscrew the travel stop (if used), and unclip the E-ring from the indicator stem.

6. Replace and lubricate parts such as the gasket (key 4) and cage O-ring (key 17) as necessary, making sure that if the port and upper seals were removed they are installed in their retaining slots with the grooved sides facing out. Also lubricate any other surfaces as necessary for ease of installation. No further main valve maintenance is necessary if just the indicator fitting and attached parts were removed.

7. Install the plug O-ring (key 20) and piston ring (key 14) onto the valve plug. Insert the valve plug into the body flange, install the cage plus upper seal and O-ring into the body flange, and then install the seat ring plus port seal into the cage. Use the valve body as a holding fixture during this step as shown in figure 10, and insert a wrench handle or similar tool into the seat ring slots for leverage when tightening the seat ring and cage.

8. Remove the upside-down body flange if it was anchored on the body. Coat the cage seating surfaces of the valve body web and the body flange seating surfaces of the valve body neck with a good grade of general-purpose grease. Install the body flange on the body, and secure it evenly with the cap screws or stud bolt nuts. Except on the 1-inch body, which does not use it, the pipe plug (key 31) must be installed in the side tapping of the flange for proper operation.


*Figure 10. Seat Ring/Cage Removal or Installation Using Body as Holding Fixture*

9. Make sure that the flange and stem O-rings and the bushings are installed in the indicator fitting. Orient the spring seat as shown in figure 11, and attach it with the E-ring to the slotted end of the indicator stem. Install a travel stop (if it is used) on the spring seat, and then install the spring.

10. Being careful not to cut the stem O-ring with the stem threads, install the indicator fitting down over the indicator stem until resting on the spring. Install the hex nut and then the flanged indicator nut on the indicator stem, pushing on the fitting if necessary to provide sufficient stem thread exposure. To maintain clearance for indicator part installation, draw up the spring seat by turning the hex nut down on the stem until the threads bottom.

11. Install the indicator fitting with attached parts into the body flange. Back the hex nut off until the spring completely closes the valve plug against the port and upper seals, as indicated by stem threads showing between this nut and the fitting. Hold the indicator scale against the fitting with the scale base resting against the shoulder of the fitting, and turn the indicator nut until its flange is aligned with the bottom scale marking. Then lock both nuts against each other, and install the indicator scale and protector.

## P590 Series Filter

Perform this procedure to clean or replace filter parts in a standard Type P593-1 or P594-1 filter assembly. Remove the following as shown in figure 12: filter body (key 1), machine screw (key 4), gasket (key 7), two flat washers (key 5), and filter element (key 2).

Upon reassembly, one of the flat washers must go between the filter element and filter head (key 3) and the other must go between the filter element and gasket. Use a good grade of pipe thread sealant on the filter head pipe threads as shown by L.S. in figure 12.

## Type 6351 Pilot

Perform this procedure if changing the control spring for one of a different range, or if inspecting, cleaning, or replacing any other pilot parts. Pilot key numbers are referenced in figure 13 and mounting key numbers in figure 15, 16, or 17.

**Note**

**The body assembly (key 1) may remain on the pipe nipple (key 23, figure 15, or key 39, figure 16) unless the entire pilot is replaced. The optional spring case (key 2) for a Type 661 electric remote control drive unit may remain installed during maintenance.**

1. To gain access to the diaphragm assembly (key 7), control spring (key 9), or spring seat (key 8), loosen the locknut (key 11, not used with Type 661 mounting), and turn the adjustment screw (key 10) out until compression is removed from the spring. Remove the machine screws (key 12), and separate the body assembly from the spring case.

2. Inspect the removed parts, and replace as necessary. Make sure the registration and bleed holes in the pilot body are free from debris. After assembly, make sure of the proper control spring setting according to the Startup section, and re-mark the spring case if necessary.

3. To replace the valve plug (key 4), remove the body plug (key 3) and body plug gasket (key 23). Be careful to keep the valve plug spring (key 6) and valve plug spring seat (key 5) from falling out and possibly getting lost while removing the valve plug. Inspect the removed parts, and replace as necessary. Make sure the valve plug seating surfaces are free from debris.

## Type 6352 Through 6354M Pilots

Perform this procedure if changing the control spring for one of a different range, or if inspecting, cleaning, or replacing any other pilot parts. Pilot part key numbers are referenced in figure 14. Mounting key numbers are referenced in figure 15 for single-pilot constructions and in figure 16 or 17 for dual-pilot constructions.

**Note**

**The body (key 1) may remain on the pipe nipple (key 23, figure 15 or key 39, figure 16) unless the entire pilot is replaced.**

1. To gain access to the diaphragm assembly (key 5), diaphragm limiter (key 23) if used, control spring (key 6), restriction (key 22), stem guide (key 8), or spring seat (key 7), remove the closing cap (key 11), loosen the locknut (key 10), and turn the adjusting screw (key 9) counterclockwise until compression is removed from the spring. Remove the machine screws (key 14), and separate the body from the spring case (key 2).

2. Inspect the removed parts, and replace as necessary. Make sure the restriction and the registration hole in the body are free from debris. After assembly, make sure of the proper control spring setting according to the Startup section, and re-mark the spring case if necessary.

3. To replace the valve plug (key 4) or bellows O-ring (key 17), remove the body plug (key 3) and body plug gasket (key 12). Be careful to keep the bellows assembly (key 16) from falling out and possibly getting lost while removing the valve plug. Inspect the removed parts, and replace as necessary. Make sure the valve plug seating surfaces are free from debris.

## Type 61LD Pilot and Type 1806 Relief Valve

Perform this procedure if changing the control spring for one of a different range, or if inspecting, cleaning, or replacing relief valve or any other pilot parts. Pilot part key numbers are referenced in figure 18 and mounting part and relief valve key numbers in figure 19.

1. Remove the pilot from the pipe nipple (key 14) unless just the control spring is to be changed.

2. To gain access to the control spring or other internal parts, remove the closing cap assembly (key 5) and relieve control spring (key 7) compression by turning the adjusting screw (key 6) counterclockwise. Change the control spring and install the adjusting screw and closing cap assembly if no other maintenance will be performed. Make sure of the proper control spring setting according to the Installation and Startup section, and restamp the nameplate if necessary.

3. For any other internal maintenance, relieve control spring compression according to step 2. Then remove the cap screw (key 20) and separate the pilot into three sections; spring case (key 1), body (key 2), and diaphragm case (key 3).

4. To inspect the two diaphragm (keys 14 and 15) thoroughly, remove the diaphragm nut (key 11), hex nut (key 19), and the upper and lower diaphragm plates (key 16 and 17). The projecting prong in the body may be used as the restraining member to keep the yoke from turning while removing the nuts. Also inspect the O-ring (key 12), and replace any parts as necessary.

5. Take the yoke (key 4) and attached parts out of the body to examine the disk holder assembly (key 9). Remove the relay orifice (key 8) to check for clogging and replace if necessary.

6. To replace the disk holder assembly, first unscrew the bleed orifice (key 10). Remove it and the associated parts. Then unscrew the disk holder assembly from the bleed valve (key 26) to gain access to the relay spring (key 13). Clean or replace any parts as necessary before reassembling.

7. Upon reassembly, pay particular attention to the following assembly suggestions.

a. Before replacing the diaphragm case or spring case, be sure the yoke assembly is positioned so that it will not bind or rub on the prong in the relay body.

b. Avoid wrinkling the diaphragms when replacing the diaphragm case and spring case.

c. Replace the diaphragm case, carefully working the upper diaphragm (key 14) into the recess in the diaphragm case. If the diaphragm case rocks with respect to the pilot body, the diaphragm is probably wrinkled.

d. Replace the spring case, using care to smooth the lower diaphragm (key 15) evenly into the recess in the pilot body.

e. Install the eight cap screws, tightening them down evenly in a crisscross pattern to avoid crushing the diaphragm. Recommended final torque on these cap screws in 10 to 12 foot pounds (14 to 16 N$m).

8. After assembly, make sure of the proper control spring setting according to the Installation and Startup section, and restamp the nameplate (key 27) if necessary.

9. To gain access to the Type 1806 relief valve (key 17), disconnect the relief tubing at the connector fitting (key 21) and unscrew the relief valve. Make sure the spring closes the ball, or replace the relief valve if necessary. Install the relief valve back in the pipe tee (key 16) and reconnect the relief tubing (key 18) and connector fitting.

## Type 1098 and 1098H Actuator and Pilot Mounting Parts

Perform this procedure if changing the actuator or inspecting, cleaning, or replacing actuator and/or pilot mounting parts. Actuator part key numbers are referenced in figure 20, and mounting part key numbers in figure 15, 16, or 17 unless otherwise indicated.

1. The actuator and pilot(s) may be removed and replaced as a unit by disconnecting the control line and pilot supply line.

2. Access to all internal parts except the stem O-rings (key 6) may be gained without removing the bonnet (key 3) or upper diaphragm case (key 2) from the main valve or the pilot(s) from the bonnet pipe nipple (key 23, figure 15, or keys 37 and 39, figure 16). Disconnect the loading tubing (key 24, figure 15, 16, or 17) from the actuator elbow fitting (key 25, figure 15, or key 41, figure 16), and with a Type 61LD pilot also disconnect the relief tubing (key 18, figure 19) from the fitting tee.

3. Remove the cap screws (key 10), nuts (key 11), lower diaphragm case (key 1), diaphragm (key 7), and diaphragm plate (key 8). To separate the stem (key 12) from the diaphragm plate (key 8), remove the stem cap screw (key 9).

4. **To remove the Type 1098 case O-ring (key 5),** unscrew the four case cap screws (key 4), remove the upper diaphragm case (key 2), and remove the case O-ring.

**To remove the Type 1098 and Type 1098H stem O-rings (key 6),** remove the pilot(s) and pipe nipple(s) if necessary. Unscrew either the Type 1098 bonnet (key 3) or the Type 1098H upper diaphragm case (key 2), and remove the O-rings.

5. Lubricate both stem O-rings (key 6) with grease, and install them in either the Type 1098 bonnet (key 3) or in the Type 1098H upper diaphragm case (key 2).

**For the Type 1098H actuator,** thread the upper diaphragm casing into the main valve body.

**For the Type 1098 actuator,** lubricate the case O-ring (key 5), and install it in the bonnet (key 3). Line up the holes in the upper diaphragm casing and the bonnet; insert and tighten the four case cap screws to secure the parts together. Thread the bonnet into the main valve body.

6. Secure the diaphragm plate to the stem with the stem cap screw (key 9). Lay the entire diaphragm, diaphragm plate, and stem assembly into the lower diaphragm case so the diaphragm convolution laps up over the diaphragm plate according to figure 20. Then install the stem slowly up

into the bonnet to prevent stem or O-ring damage, and secure the lower diaphragm case to the upper diaphragm case with the cap screws and nuts. Tighten the cap screws and nuts evenly in a crisscross pattern to avoid crushing the diaphragm.

7. Grease the stem O-rings through the grease fitting (key 28) until excess grease starts coming out the vent (key 27).

8. Install the pipe nipple(s) and pilot(s) if they were removed during maintenance. Connect the actuator loading tubing if it was disconnected.

## Parts Ordering

Each Type 1098-EGR or 1098H-EGR regulator is assigned a serial number or F.S. number which can be found on the nameplates (figure 2). Refer to this number when contacting your Fisher sales office or sales representative for assistance, or when ordering replacement parts.

When ordering a replacement part, be sure to include the complete 11-character part number from the following parts list. Some commonly used trim packages can be ordered according to the 11-character assembly number given in the parts list.

## Parts List

**Note**

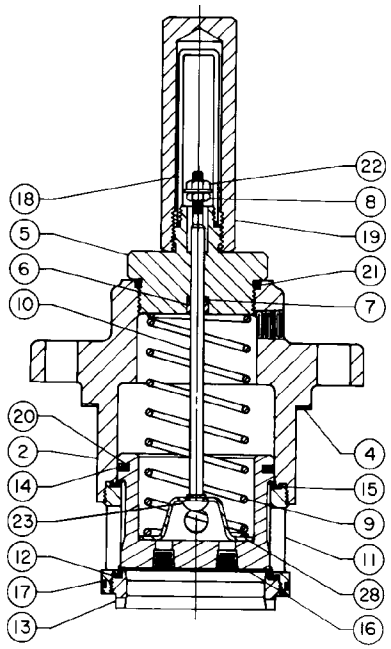
**Except where indicated, sizes shown are valve body sizes.**

## Design EGR Main Valve (figure 11)

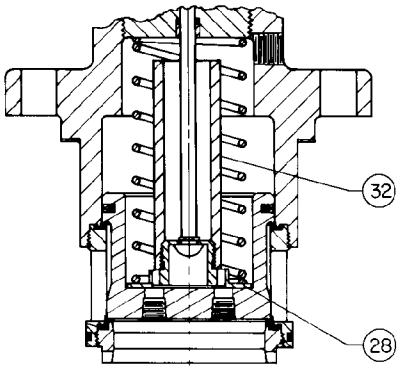
| Key | Description | Part Number |
|---|---|---|
| | Parts kit (included are: gasket, key 4; stem O-ring, key 7; port seal, key 12; piston ring, key 14; upper seal, key 15; cage O-ring, key 17; plug O-ring, key 20; and indicator fitting O-ring, key 21) | |
| | 2-inch | R63EG X00022 |
| | 3-inch | R63EG X00032 |
| | 4-inch | R63EG X00042 |
| | 6-inch | R63EG X00062 |
| | Parts kit, Quick Change Trim Assembly (included are: body flange, key 2; linear cage, key 11; spring, key 9; valve plug, key 16; seat ring, key 13; travel indicator, key 10; and standard elastomers) | |
| | 60 Psi (4.1 bar) spring color green | |
| | Cast Iron Body Flange | |
| | 1-inch | 25A3170 X012 |
| | 2-inch | 25A3170 X102 |
| | 3-inch | 25A3170 X152 |
| | 4-inch | 25A3170 X222 |
| | 6-inch | 25A3170 X272 |
| | Steel Body Flange | |
| | 1-inch | 25A3170 X422 |
| | 2-inch | 25A3170 X452 |
| | 3-inch | 25A3170 X372 |
| | 4-inch | 25A3170 X482 |
| | 6-inch | 25A3170 X512 |
| | 125 Psi (8.6 bar) spring color blue | |
| | Cast Iron Body Flange | |
| | 1-inch | 25A3170 X032 |
| | 2-inch | 25A3170 X082 |
| | 3-inch | 25A3170 X142 |
| | 4-inch | 25A3170 X192 |
| | 6-inch | 25A3170 X282 |
| | Steel Body Flange | |
| | 1-inch | 25A3170 X432 |
| | 2-inch | 25A3170 X382 |
| | 3-inch | 25A3170 X462 |
| | 4-inch | 25A3170 X492 |
| | 6-inch | 25A3170 X342 |
| | 400 Psi (28 bar) spring color red | |
| | Cast Iron Body Flange | |
| | 1-inch | 25A3170 X052 |
| | 2-inch | 25A3170 X112 |
| | 3-inch | 25A3170 X172 |
| | 4-inch | 25A3170 X242 |
| | 6-inch | 25A3170 X312 |
| | Steel Body Flange | |
| | 1-inch | 25A3170 X442 |
| | 2-inch | 25A3170 X332 |
| | 3-inch | 25A3170 X472 |
| | 4-inch | 25A3170 X502 |
| | 6-inch | 25A3170 X522 |

| Key | Description | Part Number |
|---|---|---|
| 1 | Valve Body | |
| | Cast Iron | |
| | NPT screwed | |
| | 1 inch | 34A6351 X012 |
| | 2 inch | 34A6763 X012 |
| | Class 125B FF | |
| | 1 inch | 34A6353 X012 |
| | 2 inch | 34A5694 X012 |
| | 3 inch | 34A5695 X012 |
| | 4 inch | 34A5703 X012 |
| | 6 & 8 x 6 inch | 34A6999 X012 |
| | Class 250B RF | |
| | 1 inch | 34A6354 X012 |
| | 2 inch | 34A5672 X012 |
| | 3 inch | 34A5657 X012 |
| | 4 inch | 34A5642 X012 |
| | 6 & 8 x 6 inch | 34A7000 X012 |
| | WCB steel, heat-treated | |
| | NPT screwed | |
| | 1 inch | 34A6352 X012 |
| | 2 inch | 34A6764 X012 |
| | 2 inch (NACE)(1) | 34A6764 X022 |
| | Class 150 RF | |
| | 1 inch | 34A6355 X012 |
| | 1 inch (NACE) | 34A6355 X042 |
| | 2 inch | 34A6765 X012 |
| | 2 inch (NACE) | 34A6765 X022 |
| | 3 inch | 34A6773 X012 |
| | 3 inch (NACE) | 34A6773 X032 |
| | 4 inch | 34A6776 X012 |
| | 4 inch (NACE) | 34A6776 X032 |
| | 6 inch | 34A6998 X012 |
| | 6 inch (NACE) | 34A6998 X032 |
| | 8 x 6 inch | 38A4214 X012 |
| | 8 x 6 inch (NACE) | 38A4214 X022 |
| | Class 300 RF | |
| | 1 inch | 34A6754 X012 |
| | 2 inch | 34A6766 X012 |
| | 2 inch (NACE) | 34A6766 X032 |
| | 3 inch | 34A6774 X012 |
| | 3 inch (NACE) | 34A6774 X022 |
| | 4 inch | 34A6777 X012 |
| | 4 inch (NACE) | 34A6777 X032 |
| | 6 inch | 34A6993 X012 |
| | 6 inch (NACE) | 34A6993 X022 |
| | 8 x 6 inch | 38A5825 X012 |
| | 8 x 6 inch (NACE) | 38A5825 X032 |
| | Class 600 RF | |
| | 1 inch | 34A6755 X012 |
| | 2 inch | 34A6767 X012 |
| | 2 inch (NACE) | 34A6767 X032 |
| | 3 inch | 34A6775 X012 |
| | 3 inch (NACE) | 34A6775 X022 |
| | 4 inch | 34A6778 X012 |
| | 4 inch (NACE) | 34A6778 X022 |

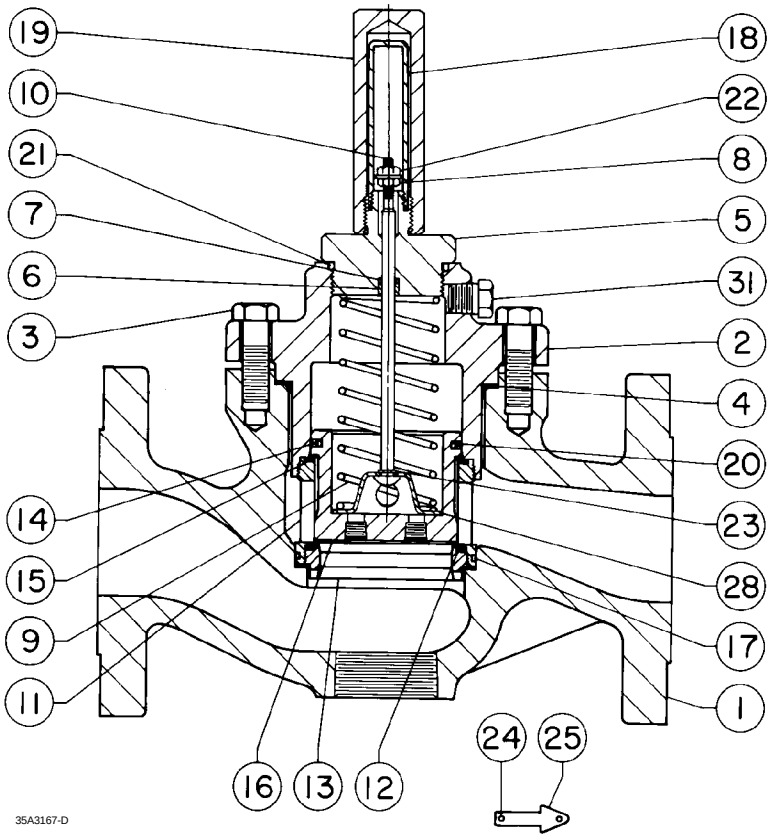
1. National Association of Corrosion Engineers (NACE) standard MR-01-75.




QUICK-CHANGE TRIM PACKAGE ASSEMBLY




DETAIL OF OPTIONAL RESTRICTED-CAPACITY CONSTRUCTION




COMPLETE CAST IRON FULL-CAPACITY MAIN VALVE ASSEMBLY

*Figure 11. Design EGR Main Valve*

| Key | Description | Part Number |
|---|---|---|
| 1 | Valve Body (Continued) | |
| | Class 600 RF | |
| | 6 inch | 34A6997 X012 |
| | 6 inch (NACE) | 34A6997 X022 |
| | 8 x 6 inch | 39A7068 X012 |
| | 8 x 6 inch (NACE) | 39A7068 X022 |
| | Socket weld | |
| | 1 inch | 36A3941 X012 |
| | 2 inch | 36A3945 X012 |
| | Schedule 40 butt weld | |
| | 1 inch | 36A3942 X012 |
| | 2 inch | 36A3944 X012 |
| | 3 inch | 36A3947 X012 |
| | 4 inch | 36A3949 X012 |
| | 6 & 8 x 6 inch | 36A3952 X012 |
| | Schedule 80 butt weld | |
| | 1 inch | 36A3943 X012 |
| | 2 inch | 36A3946 X012 |
| | 3 inch | 36A3948 X012 |
| | 4 inch | 36A3950 X012 |
| | 6 & 8 x 6 inch | 36A3951 X012 |

| Key | Description | Part Number |
|---|---|---|
| 2 | Body Flange | |
| | Cast iron, ENC(2) | |
| | 1 inch | 24A6761 X012 |
| | 2 inch | 25A3168 X012 |
| | 3 inch | 24A9034 X012 |
| | 4 inch | 25A2309 X012 |
| | 6 & 8 x 6 inch | 34A8172 X012 |
| | WCB steel, ENC, heat-treated | |
| | 1 inch | 24A6779 X012 |
| | 1 inch (NACE) | 24A6779 X032 |
| | 2 inch | 25A2254 X012 |
| | 2 inch (NACE) | 25A2254 X022 |
| | 3 inch | 25A2300 X012 |
| | 3 inch (NACE) | 25A2300 X022 |
| | 4 inch | 24A9032 X012 |
| | 4 inch (NACE) | 24A9032 X022 |
| | 6 & 8 x 6 inch | 34A7152 X012 |
| | 6 & 8 x 6 inch (NACE) | 34A7152 X022 |

*Recommended spare part.
2. Part included in trim package assembly can be ordered according to the parts kit trim package.

| Key | Description | Part Number |
|---|---|---|
| 3 | Cap Screw, zn pl steel (use w/cast iron body) | |
| | 1 inch (4 req'd) | 1R2811 24052 |
| | 2 inch (8 req'd) | 1A4533 24052 |
| | 3 inch (8 req'd) | 1A4541 24052 |
| | 4 inch (8 req'd) | 1A4857 24052 |
| | 6 & 8 x 6 inch (12 req'd) | 1U5131 24052 |
| 3 | Stud Bolt, steel (use w/steel body) (not shown) | |
| | 1 inch (4 req'd) | 1R2848 31012 |
| | 2 inch (8 req'd) | 1K2429 31012 |
| | 3 inch (8 req'd) | 1A3781 31012 |
| | 4 inch (8 req'd) | 1R3690 31012 |
| | 6 & 8 x 6 inch (12 req'd) | 1A3656 31012 |
| 4*(2) | Gasket, composition | |
| | 1 inch | 14A6785 X012 |
| | 2 inch | 14A5685 X012 |
| | 3 inch | 14A5665 X012 |
| | 4 inch | 14A5650 X012 |
| | 6 & 8 x 6 inch | 14A6984 X012 |
| 5(2) | Indicator Fitting, pl steel | |
| | 1 inch | 14A6758 X012 |
| | 1 inch (NACE) | 14A6758 X022 |
| | 2, 3, & 4 inch | 14A9689 X012 |
| | 2, 3, & 4 inch (NACE) | 14A9689 X042 |
| | 6 & 8 x 6 inch | 24A8183 X012 |
| | 6 & 8 x 6 inch (NACE) | 24A8183 X022 |
| 6(2) | Bushing | |
| | 416 stainless steel | 14A5677 X012 |
| | 410 stainless steel (NACE) | 14A5677 X022 |
| 7* | Stem O-Ring | |
| | Nitrile(2) | 1D6875 06992 |
| | Fluoroelastomer | 1N4304 06382 |
| 8(2) | Hex Nut, pl steel | 1A6622 28992 |
| 9(2) | Spring, steel | |
| | 20 psi (1.4 bar) maximum drop yellow | |
| | 2 inch | 14A6768 X012 |
| | 3 inch | 14A6771 X012 |
| | 4 inch | 14A6770 X012 |
| | 6 & 8 x 6 inch | 15A2253 X012 |
| | 60 psi (4.1 bar) maximum drop green | |
| | 1 inch | 14A9687 X012 |
| | 2 inch | 14A6626 X012 |
| | 2 inch (NACE) | 16A5501 X012 |
| | 3 inch | 14A6629 X012 |
| | 3 inch (NACE) | 16A5503 X012 |
| | 4 inch | 14A6632 X012 |
| | 4 inch (NACE) | 16A5506 X012 |
| | 6 & 8 x 6 inch | 14A9686 X012 |
| | 6 & 8 x 6 inch (NACE) | 16A5510 X012 |
| | 125 psi (8.6 bar) maximum drop blue | |
| | 1 inch | 14A9680 X012 |
| | 1 inch (NACE) | 10B1882 X012 |
| | 2 inch | 14A6627 X012 |
| | 2 inch (NACE) | 16A5995 X012 |
| | 3 inch | 14A6630 X012 |
| | 3 inch (NACE) | 16A5996 X012 |
| | 4 inch | 14A6633 X012 |
| | 4 inch (NACE) | 16A5997 X012 |
| | 6 & 8 x 6 inch | 14A9685 X012 |
| | 6 & 8 x 6 inch (NACE) | 16A5999 X012 |
| | 400 psi (28 bar) maximum drop red | |
| | 1 inch | 14A9679 X012 |
| | 2 inch | 14A6628 X012 |
| | 2 inch (NACE) | 16A5499 X012 |
| | 3 inch | 14A6631 X012 |
| | 3 inch (NACE) | 16A5500 X012 |
| | 4 inch | 14A6634 X012 |
| | 4 inch (NACE) | 16A5998 X012 |
| | 6 & 8 x 6 inch | 15A2615 X012 |
| | 6 & 8 x 6 inch (NACE) | 16A6000 X012 |
| 10(2) | Indicator Stem | |
| | Stainless steel | |
| | 1 inch | 14A6756 X012 |
| | 2 inch | 14A6994 X012 |
| | 3 inch | 14A6995 X012 |
| | 4 inch | 14A8179 X012 |
| | 6 & 8 x 6 inch | 14A6986 X012 |
| 10(2) | Indicator Stem (Continued) | |
| | 316 stainless steel (NACE) | |
| | 1 inch (NACE) | 14A6756 X022 |
| | 2 inch (NACE) | 14A6994 X022 |
| | 3 inch (NACE) | 14A6995 X022 |
| | 4 inch (NACE) | 14A8179 X022 |
| | 6 & 8 x 6 inch (NACE) | 14A6986 X022 |
| 11 | Cage | |
| | Linear | |
| | Cast iron, ENC(2) | |
| | 1 inch | 24A6783 X012 |
| | 2 inch | 24A5669 X012 |
| | 3 inch | 24A5654 X012 |
| | 4 inch | 24A5639 X012 |
| | 6 & 8 x 6 inch | 24A6990 X012 |
| | WCB steel, ENC, heat-treated | |
| | 1 inch | 24A6783 X022 |
| | 1 inch (NACE) | 24A6783 X032 |
| | 2 inch | 24A5669 X022 |
| | 2 inch (NACE) | 24A5669 X032 |
| | 3 inch | 24A5654 X022 |
| | 3 inch (NACE) | 24A5654 X042 |
| | 4 inch | 24A5639 X022 |
| | 4 inch (NACE) | 24A5639 X032 |
| | 6 inch | 24A6990 X022 |
| | 6 & 8 x 6 inch (NACE) | 24A6990 X032 |
| | Whisper Trim | |
| | 416 stainless steel | |
| | 1 inch | 24A2043 X012 |
| | 2 inch | 24A5707 X012 |
| | 3 inch | 24A5708 X012 |
| | 4 inch | 24A5709 X012 |
| | 6 & 8 x 6 inch | 24A8174 X012 |
| | 316 stainless steel (NACE) | |
| | 2 inch (NACE) | 24A5707 X022 |
| | 3 inch (NACE) | 24A5708 X032 |
| | 4 inch (NACE) | 24A5709 X022 |
| | 6 & 8 x 6 inch (NACE) | 24A8174 X022 |
| | Quick Opening, cast iron, ENC | |
| | 1 inch | 37A7211 X012 |
| | 2 inch | 37A7212 X012 |
| | 3 inch | 37A7213 X012 |
| | 4 inch | 37A7214 X012 |
| | 6 & 8 x 6 inch | 37A7215 X012 |
| 12* | Port Seal | |
| | Nitrile(2) standard | |
| | 1 inch | 14A6788 X012 |
| | 2 inch | 24A5673 X012 |
| | 3 inch | 24A5658 X012 |
| | 4 inch | 24A5643 X012 |
| | 6 & 8 x 6 inch | 14A8175 X012 |
| | Fluoroelastomer | |
| | 1 inch | 14A8186 X012 |
| | 2 inch | 25A7412 X012 |
| | 3 inch | 25A7375 X012 |
| | 4 inch | 25A7469 X012 |
| | 6 & 8 x 6 inch | 14A6996 X012 |
| 13*(2) | Seat Ring | |
| | 416 stainless steel | |
| | 1 inch, 1-5/16 inch (33 mm) port | 24A6781 X012 |
| | 2 inch, 2-3/8 inch (60 mm) port | 24A5670 X012 |
| | 3 inch, 3-3/8 inch (86 mm) port | 24A5655 X012 |
| | 4 inch, 4-3/8 inch (111 mm) port | 24A5640 X012 |
| | 6 inch, 7-3/16 inch (183 mm) port | 24A6989 X012 |
| | 8 x 6 inch 7-3/16 inch (183 mm) port | 38A4216 X012 |
| | 316 stainless steel (NACE) | |
| | 1 inch, 1-5/16 inch (33 mm) port (NACE) | 24A6781 X022 |
| | 2 inch, 2-3/8 inch (60 mm) port (NACE) | 24A5670 X022 |
| | 3 inch, 3-3/8 inch (86 mm) port (NACE) | 24A5655 X022 |
| | 4 inch, 4-3/8 inch (111 mm) port (NACE) | 24A5640 X022 |
| | 6 inch, 7-3/16 inch (183 mm) port (NACE) | 24A6989 X022 |
| | 8 x 6 inch 7-3/16 inch (183 mm) port (NACE) | 38A4216 X022 |
| 14*(2) | Piston Ring | |
| | 1 inch, TFE (clear) | 14A6786 X012 |
| | 2 inch, TFE (clear) | 14A5675 X012 |
| | 3 inch, TFE (clear) | 14A5660 X012 |
| | 4 inch, TFE (clear) | 14A5645 X012 |
| | 6 & 8 x 6 inch, glass-filled TFE (yellow) | 14A6985 X022 |

*Recommended spare part

2. Part included in trim package assembly which can be ordered according to the parts kit trim package.

| Key | Description | Part Number |
|---|---|---|
| 15* | Upper Seal | |
| | Nitrile(2) (standard) | |
| | 1 inch | 14A6789 X012 |
| | 2 inch | 24A5674 X012 |
| | 3 inch | 24A5659 X012 |
| | 4 inch | 24A5644 X012 |
| | 6 & 8 x 6 inch | 14A8176 X012 |
| | Fluoroelastomer | |
| | 1 inch | 14A8187 X012 |
| | 2 inch | 25A7413 X012 |
| | 3 inch | 25A7376 X012 |
| | 4 inch | 25A7468 X012 |
| | 6 & 8 x 6 inch | 14A8185 X012 |
| 16*(2) | Valve Plug, heat-treated | |
| | 416 stainless steel | |
| | 1 inch | 14A6780 X012 |
| | 2 inch | 24A6772 X012 |
| | 3 inch | 24A9421 X012 |
| | 4 inch | 24A8182 X012 |
| | 6 & 8 x 6 inch | 24A6992 X012 |
| | 316 stainless steel (NACE) | |
| | 1 inch (NACE) | 14A6780 X022 |
| | 2 inch (NACE) | 24A6772 X032 |
| | 3 inch (NACE) | 24A9421 X022 |
| | 4 inch (NACE) | 24A8182 X022 |
| | 6 & 8 x 6 inch (NACE) | 24A6992 X022 |
| 17* | Cage O-Ring | |
| | Nitrile(2) (standard) | |
| | 1 inch | 10A7777 X012 |
| | 2 inch | 10A7779 X012 |
| | 3 inch | 14A5688 X012 |
| | 4 inch | 10A3481 X012 |
| | 6 & 8 x 6 inch | 18A2556 X022 |
| | Fluoroelastomer | |
| | 1 inch | 10A7778 X012 |
| | 2 inch | 10A7779 X022 |
| | 3 inch | 10A3441 X012 |
| | 4 inch | 10A3483 X012 |
| | 6 & 8 x 6 inch | 18A2556 X032 |
| 18 | Indicator Scale, plastic | |
| | 1 inch(2) | 14A6759 X012 |
| | 2 inch(2) | 14A5678 X012 |
| | 3 inch(2) | 14A5662 X012 |
| | 4 inch | |
| | w/2 inch (51 mm) travel(2) | 14A5647 X012 |
| | w/1-1/2 inch (38 mm) travel | 14A5662 X012 |
| | 6 & 8 x 6 inch(2) | 14A5647 X012 |
| 19 | Indicator Protector | |
| | Zn pl steel | |
| | 1 & 2 inch(2) | 14A8180 X012 |
| | 3, 6 & 8 x 6 inch(2) | 14A6769 X012 |
| | 4 inch(2) w/2 inch (51 mm) travel | 14A6769 X012 |
| | Pl steel | |
| | 4 inch w/1-1/2 inch (38 mm) travel | 14A5664 X012 |
| 20* | Plug O-Ring | |
| | Nitrile(2) (standard) | |
| | 1 inch | 14A6981 X012 |
| | 2 inch | 14A5686 X012 |
| | 3 inch | 1V3269 06562 |
| | 4 inch | 14A5688 X012 |
| | 6 & 8 x 6 inch | 1K8793 06992 |
| | Fluoroelastomer | |
| | 1 inch | 14A8188 X012 |
| | 2 inch | 14A5686 X022 |
| | 3 inch | 1V3269 X0042 |
| | 4 inch | 10A3441 X012 |
| | 6 & 8 x 6 inch | 1V5476 06382 |
| 21* | Indicator Fitting O-Ring | |
| | Nitrile(2) | |
| | 1 inch | 10A8931 X012 |
| | 2, 3, & 4 inch | 10A3800 X012 |
| | 6 & 8 x 6 inch | 1F2629 06992 |
| | Fluoroelastomer | |
| | 1 inch | 10A0811 X012 |
| | 2, 3, & 4 inch | 1R7276 06382 |
| | 6 & 8 x 6 inch | 1P4877 06382 |
| 22(2) | Flange Nut, pl steel | 14A5693 X012 |
| 23(2) | E-Ring | |
| | stainless steel | 14A8181 X012 |
| | 1577 steel, heat treated (NACE) | 14A8181 X022 |
| 24 | Drive Screw, stainless steel (4 req'd) | 1A3682 28982 |
| 25 | Flow Arrow, stainless steel | 1V1059 38982 |
| 26 | Body Rating Plate, stainless steel (not shown) | 13A2353 X012 |
| 28 | Spring Seat | |
| | Full capacity trim(2) | |
| | zinc plated steel | |
| | 1 inch | 14A6982 X012 |
| | 2, 3, & 4 inch | 15A2206 X012 |
| | 6 & 8 x 6 inch | 14A8177 X012 |
| | Heat-treated wrought steel (NACE) | |
| | 1 inch (NACE) | 14A6982 X022 |
| | 2 inch, 3 inch, 4 inch (NACE) | 15A2206 X022 |
| | 6 & 8 x 6 inch (NACE) | 14A8177 X022 |
| | Restricted capacity trim, heat-treated, | |
| | 416 stainless steel | |
| | 2, 3, & 4 inch | 14A9678 X012 |
| | 6 inch | 14A9688 X012 |
| | 2, 3, & 4 inch (NACE) | 14A9678 X012 |
| | 6 & 8 x 6 inch (NACE) | 14A9688 X012 |
| 29 | Hex Nut Steel (use w/steel body) | |
| | (not shown) | |
| | 1 inch (4 req'd) | 1C3306 24072 |
| | 2 inch (8 req'd) | 1A3772 24072 |
| | 3 inch (8 req'd) | 1A3760 24072 |
| | 4 inch (8 req'd) | 1A3520 24072 |
| | 6 & 8 x 6 inch (12 req'd) | 1A4409 24072 |
| 31(2) | Pipe Plug | |
| | zinc plated steel | 1A7675 24662 |
| | steel (NACE) | |
| | 2, 3, or 4 inch (NACE) | 1A7675 24012 |
| | 6 or 8 x 6 inch (NACE) | 1B5731 X0012 |
| 32 | Travel Stop, galvanized zn pl steel (not used w/full capacity trim) | |
| | 2 inch | |
| | 30% capacity | 14A9677 X012 |
| | 70% capacity | 14A9676 X012 |
| | 3 inch, | |
| | 40% capacity | 14A9671 X012 |
| | 4 inch, | |
| | 40% capacity | 14A9670 X012 |
| | 6 inch, | |
| | 40% capacity | 14A9682 X012 |
| 33 | NACE Tag (not shown) (NACE) | |
| | 18-8 stainless steel (NACE) | 19A6034 X012 |
| 34 | Tag Wire (not shown) (NACE) | |
| | 304 stainless steel (NACE) | 1U7581 X0022 |

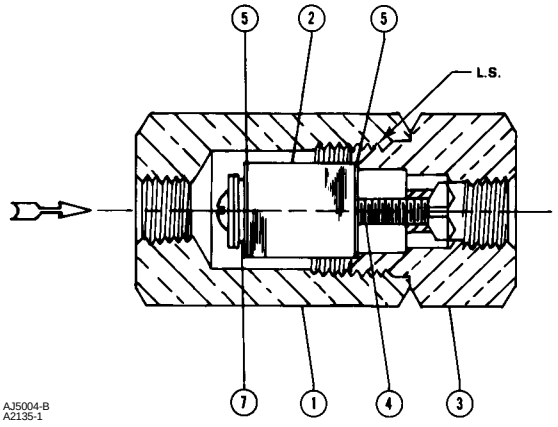
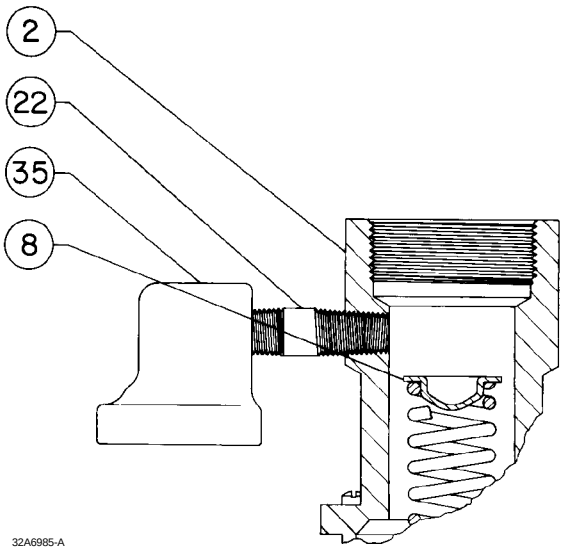
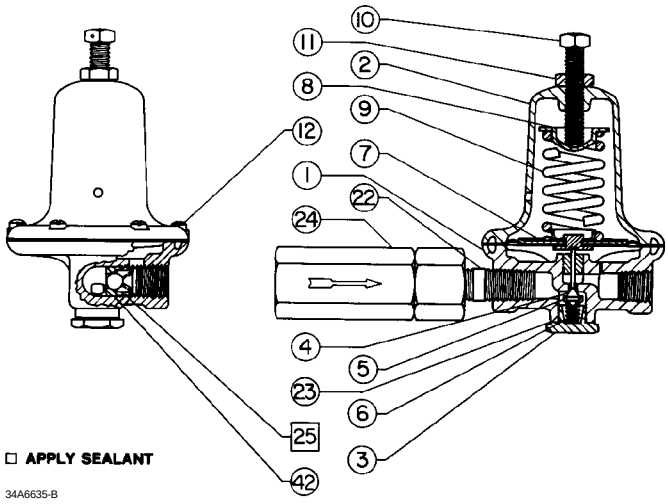



*Figure 12. Standard P590 Series Filter Assembly*

*Recommended spare part
2. Part included in trim package assembly which can be ordered according to the parts kit trim package.




DETAIL OF SPRING CASE AND VENT FOR TYPE 661 MOUNTING

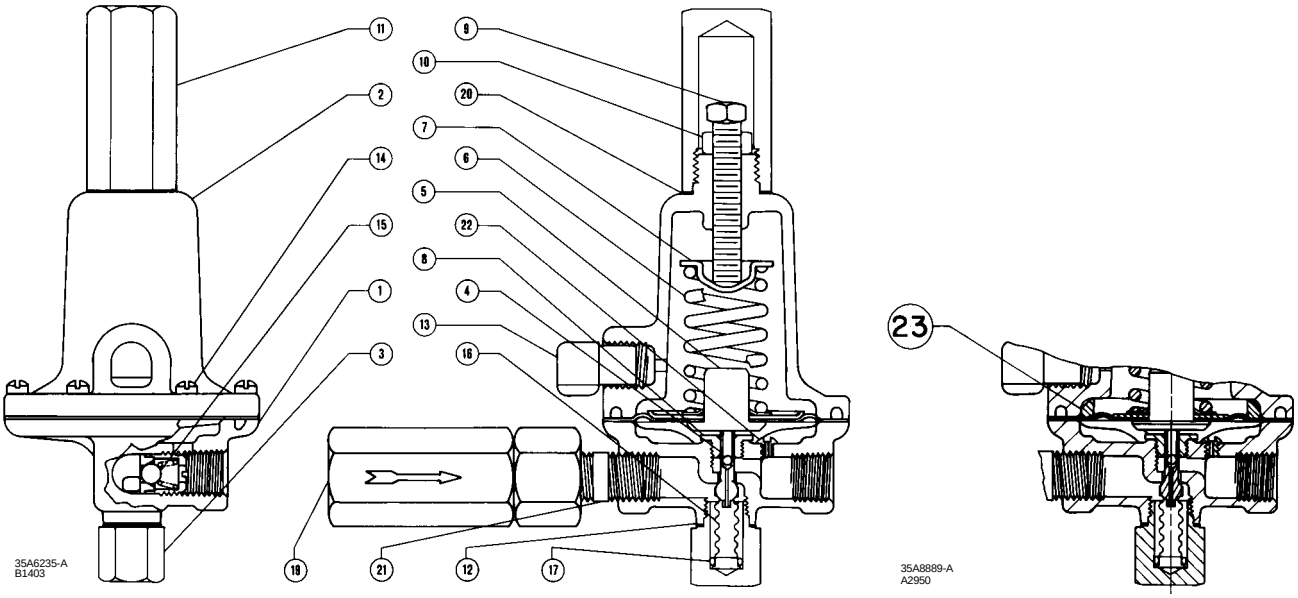



COMPLETE PILOT SHOWING STANDARD SPRING CASE CONSTRUCTION

*Figure 13. Type 6351 Pilot Assembly*

| Key | Description | Part Number |
|---|---|---|
| | **Standard P590 Series Filter (figure 12)** | |
| 1 | Filter Body | |
| | Type P594-1, brass | 1E3124 14012 |
| | Type P593-1, | |
| | aluminum | 1E3124 09012 |
| | aluminum (NACE) | 1E3124 09012 |
| 2* | Filter Element, | |
| | cellulose | 1E3126 06992 |
| | cellulose (NACE) | 1E3126 06992 |
| 3 | Filter Head | |
| | Type P594-1, brass | 1E3125 14012 |
| | Type P593-1, | |
| | aluminum | 1E3125 09012 |
| | aluminum (NACE) | 1E3125 09012 |
| 4 | Machine Screw | |
| | Type P594-1, brass | 1J5002 18992 |
| | Type P593-1, | |
| | aluminum | 1J5002 09012 |
| | aluminum (NACE) | 1J5002 09012 |
| 5 | Washer (2 req'd) | |
| | Type P594-1, brass | 1J5000 18992 |
| | Type P593-1, | |
| | aluminum | 1J5000 10062 |
| | aluminum (NACE) | 1J5000 10062 |
| 7* | Gasket, composition | 1F8268 04022 |
| 11 | NACE Tag (Type P593-1 only) (NACE) | |
| | 18-8 stainless steel (not shown) | 19A6034 X012 |
| 12 | Tag Wire (Type P593-1 only) (NACE) | |
| | 303 stainless steel (NACE) | 1U7581 X0022 |
| | **Type 6351 Pilot (figure 13)** | |
| | Parts kit (included are: valve plug, key 4; valve spring, key 6; diaphragm assembly, key 7; body plug gasket, key 23 and for the P590 Series Filter, filter element, key 2; and gasket, key 7) | R6351 X00012 |
| 1 | Body Assembly | |
| | Aluminum w/brass bushing | 1B7971 X0092 |
| | Aluminum w/315 stainles steel bushing (NACE) | 1B7971 X0232 |
| | Brass w/brass bushing | 1B7971 X0112 |
| | 316 stainless steel w/303 stainless steel bushing | 1B7971 X0122 |
| 2 | Spring Case, aluminum | |
| | w/untapped vent (standard) | 2B7974 08012 |
| | w/1/4 inch NPT tapped vent (for use w/Type 661 mtg) | 13A0166 X012 |
| 3 | Body Plug | |
| | Aluminum | 1B7975 09032 |
| | Brass | 1B7975 14012 |
| | 316 Stainless steel | 1B7975 35072 |
| | Stainless steel (NACE) | 1B7975 09032 |
| 4* | Valve Plug | |
| | Nitrile w/brass stem | 1D5604 000A2 |
| | Nitrile w/stainless steel stem | 1D5604 000B2 |
| | Fluoroelastomer w/brass stem | 1N3798 71662 |
| | Fluoroelastomer w/stainless steel stem | 1N3798 000C2 |
| 4 | Inner Valve, 304 stainless steel/nitrile (NACE) | 1D5604 000B2 |
| 5 | Valve Plug Spring Seat | |
| | Aluminum (use w/brass stem) | 1E5322 11032 |
| | 316 stainless steel (use w/stainless steel stem) | 1L2511 35072 |
| | 316 stainless steel (NACE) | 1L2511 35072 |
| 6 | Valve Plug Spring, | |
| | stainless steel | 1B7979 37022 |
| | heat-treated alloy 600 (UNS N07750) | 19A2860 X012 |
| 7* | Diaphragm Assembly (includes zn pl steel diaphragm plate) | |
| | Nitrile w/aluminum pusher post | 1B7980 000B2 |
| | Fluoroelastomer w/aluminum pusher post | 1B7980 000C2 |
| | Nitrile w/stainless steel post | 1B7980 X00A2 |
| | Nitrile diaphragm w/stainless steel pusher post & diaphragm plate (NACE) | 1B7980 X0112 |
| 8 | Upper Spring Seat, zn pl steel | 1B7985 25062 |
| 9 | Control Spring, Cd pl steel | |
| | 3 to 20 psig (0.21 to 1.4 bar) range, green | 1B9860 27212 |
| | 5 to 35 psig (0.34 to 2.4 bar) range,cadmium | 1B7883 27022 |
| | 35 to 100 psig (2.4 to 6.9 bar) range, red | 1K7485 27202 |
| 10 | Adjusting Screw, pl steel (not used w/Type 661 mtg) | 10A2099 X012 |
| 11 | Locknut, zn pl steel (not used w/Type 661 mtg) | 1A9463 24122 |
| 12 | Machine Screw, pl steel (6 req'd) | 1B7839 28982 |
| 22 | Body Inlet Pipe Nipple, | |
| | galvanized zn pl steel (use w/P590 Series filter) | 1C4882 26232 |
| | steel (NACE) | 1C4882 X0032 |
| 22 | Spring Case Vent Pipe Nipple, | |
| | galvanized zn pl steel (use w/Type 661 mtg) | 1C6789 26232 |
| 23* | Body Plug Gasket, composition | 1C4957 04022 |
| 24 | P590 Series Filter (parts listed under separate heading) | |
| | Type P594-1, brass & cellulose (standard) | AJ5004 000A2 |
| | Type P593-1, aluminum & cellulose | AJ5004 T0012 |
| 25 | Sealant Loctite N. 516 (one pint can, not supplied) | 1M1137 X0012 |
| 35 | Type Y602-13 Vent Assembly, zinc | |
| | w/stainless steel screen (use w/Type 661 mtg) | 17A6572 X042 |
| 42 | Relief Valve Assembly Aluminum/stainless steel | |
| | 25 psi (1.7 bar differential) | 16A5929 X022 |
| 42 | Aluminum/302 stainless steel (NACE) | |
| | 25 psi (1.7 bar differential) | 16A5929 X042 |

*Recommended spare part




COMPLETE TYPE 6352, 6353, OR 6354L PILOT

DETAIL OF TYPE 6354H OR 6354M PILOT

*Figure 14. Type 6352 Through 6354M Pilot Assemblies*

| Key | Description | Part Number |
|---|---|---|
| | **Type 6352 Through 6354M Pilot (figure 14)** | |
| | Parts kit (included are: valve plug, key 4; diaphragm assembly, key 5; body plug gasket, key 12; bellows O-ring, key 17; closing cap gasket, key 20; and for the P590 Series Filter, filter element, key 2; and gasket, key 7) | |
| | Type 6352 | R6352 X00012 |
| | Type 6353 | R6353 X00012 |
| | Type 6354 | R6354 X00012 |
| 1 | Body | |
| | Aluminum | 35A6228 X012 |
| | Brass | 35A6224 X012 |
| | Steel | 35A6226 X012 |
| | 316 stainless steel | 39A5971 X012 |
| | Aluminum (NACE) | 35A6228 X012 |
| | 316 stainless steel (NACE) | 39A5971 X012 |
| 2 | Spring Case | |
| | Aluminum | |
| | Use w/closing cap | 25A6220 X012 |
| | Use w/o closing cap | 15A1581 X012 |
| | Use w/Type 661 mtg | 26A6790 X012 |
| | Brass | 25A6790 X012 |
| | Steel | 25A6223 X012 |
| | 316 Stainless steel | 28A9277 X012 |
| | Aluminum (NACE) | 25A6220 X012 |
| | 316 stainless steel (NACE) | 28A9277 X012 |
| 3 | Body Plug | |
| | Aluminum | 15A6221 X012 |
| | Brass | 15A6221 X022 |
| | Steel | 15A6221 X032 |
| | 316 stainless steel | 15A6221 X042 |
| | Aluminum (NACE) | 15A6221 X012 |
| | 316 stainless steel (NACE) | 15A6221 X042 |
| 4* | Valve Plug & Stem Assembly, | |
| | nitrile disk w/stainless steel stem | 15A6207 X012 |
| | 316 stainless steel stem (NACE) | 15A6207 X052 |
| 5* | Diaphragm Assembly | |
| | Type 6352 w/natural rubber diaphragm | 15A6216 X012 |
| | Fluoroelastomer diaphragm (NACE) | 15A6216 X132 |
| | Type 6353 w/nitrile diaphragm | 15A6216 X022 |
| | Type 6354L, 6354M, or 6354H w/neoprene diaphragm | 15A6216 X032 |

| Key | Description | Part Number |
|---|---|---|
| 6 | Control Spring | |
| | Zn pl steel | |
| | Type 6352 | |
| | 2 inch wc to 2 psig (5 to 140 mbar), yellow | 14A9672 X012 |
| | Type 6352 | |
| | 2 to 10 psig (0.14 to 0.69 bar), black | 14A9673 X012 |
| | 2 inch wc to 2 psig (5 to 140 mbar), yellow (NACE) | 14A9672 X012 |
| | 2 inch wc to 2 psig (5 to 140 mbar), black (NACE) | 14A9673 X012 |
| | Type 6353 | |
| | 3 to 40 psig (0.21 to 2.8 bar), yellow | 1E3925 27022 |
| | 35 to 125 psig (2.4 to 6.9 bar), red | 1K7485 27202 |
| | Type 6354L | |
| | 85 to 200 psig (5.9 to 14 bar), blue | 1L3461 27142 |
| | Type 6354M | |
| | 175 to 220 psig (12 to 15 bar), blue | 1L3461 27142 |
| | 17-4PH stainless steel | |
| | Type 6354H | |
| | 200 to 300 psig (14 to 21 bar), green | 15A9258 X012 |
| 7 | Spring Seat | |
| | Zn pl steel (for Types 6352 & 6353) | 1B7985 25062 |
| | Pl steel (for Type 6354L, 6354M, or 6354H) | 1K1558 28982 |
| 8 | Stem Guide | |
| | 416 stainless steel, heat-treated | 15A6222 X012 |
| | 410 stainless steel (NACE) | 15A6222 X022 |
| 9 | Adjusting Screw | |
| | Zn pl steel (for Types 6352 & 6353) | 1H3050 28982 |
| | Pl steel (for aluminum spring case w/closing cap & Type 6354L, 6354M, or 6354H) | 1B7986 28982 |
| 10 | Locknut, zn pl steel | 1A9463 24122 |
| 11 | Closing Cap | |
| | Aluminum | 1H2369 X0012 |
| | Brass | 1H2369 14012 |
| | Steel | 1H2369 X0022 |
| | 316 stainless steel | 1H2369 X0032 |
| 12* | Body Plug Gasket | |
| | Composition | 1C4957 04022 |
| | Composition (NACE) | 1C4957 04022 |
| 13 | Type Y602-12 Vent Assembly, plastic w/stainless steel screen | 27A5516 X012 |
| 14 | Machine Screw (6 req'd) | |
| | Steel | 1H4217 28992 |
| | Pl steel | |
| | For aluminum spring case w/o closing cap | 1H2676 28982 |
| | For Type 661 mtg | 1E9752 28982 |

*Recommended spare part

| Key | Description | Part Number |
|---|---|---|
| 15 | Relief Valve Assembly | |
| | Aluminum/stainless steel | |
| | 25 psi (1.7 bar) differential | 16A5929 X052 |
| | Aluminum/302 stainless | |
| | steel for 25 psi (1.7 bar) differential (NACE) | 16A5929 X042 |
| 16 | Bellows Assembly, stainless steel/ nickel | 15A6202 X012 |
| 17* | Bellows O-Ring, nitrile | 1D6825 06992 |
| 19 | P590 Series filter (parts listed under separate heading) | |
| | Type P594-1, brass & cellulose (standard) | AJ5004 000A2 |
| | Type 593-1, aluminum & cellulose | AJ5004 T0012 |
| 20* | Closing Cap Gasket, composition | 15A6218 X012 |
| 21 | Pipe Nipple | |
| | Galvanized zn pl steel | 1C4882 26232 |
| | Noncorrosive, NACE steel (NACE) | 1C4882 X0032 |
| | Corrosive, 316 stainless steel (NACE) | 1C4882 X0042 |
| 22 | Restriction, pl steel (not used for low-gain construction) | |
| | Standard gain (indicated by S stamped on pilot body), No. 51 drill size or 0.067 inch (1.7 mm) diameter, green | 17A2030 X012 |
| | High gain for narrower proportional bands (indicated by H stamped on pilot body), No. 57 drill size or 0.043 inch (1.09 mm) diameter, red | 17A2029 X012 |
| 22 | Restriction, NACE construction 316 stainless steel (not used for low-gain construction) Standard gain (indicated by S stamped on pilot body), No. 51 drill size or 0.067 inch (1.7 mm) diameter, green color code | 17A2030 X022 |
| | High gain for narrower proportional bands (indicated by H stamped on pilot body), No. 57 drill size or 0.043 inch (1.09 mm) diameter, red color code | 17A2029 X022 |
| 23 | Diaphragm Limiter, aluminum (for Types 6354H or 6354M) | 15A9259 X012 |
| 26 | NACE Tag (Type 6352 only), NACE 18-8 stainless steel not shown) | 19A6034 X012 |
| 27 | Tag Wire (Type 6352 only), NACE 303 stainless steel (not shown) | 1U7581 X0022 |

## Type 61LD Pilot (figure 18)

| | | |
|---|---|---|
| | Parts kit (included are: relay orifice, key 8; disk holder assembly, key 9; bleed orifice, key 10; O-ring, key 12 relay spring, key 13; upper relay diaphragm, key 14; lower relay diaphragm, key 15; bleed valve, key 26; and closing cap gasket, key 28) | R61LD X00012 |
| 1 | Spring Case, cast iron | 1B9839 19012 |
| 2 | Body, cast iron | 2J5819 19012 |
| 3 | Diaphragm Case, Cast iron | 2C5186 19012 |
| 4 | Yoke | |
| | Zinc | 1D6625 44012 |
| | Cast iron | 1B9840 19012 |
| 5 | Closing Cap Assembly (includes keys 5a, 5b, 5c and 5d) | AD5586 000A2 |
| 5A | Screen, stainless steel (not used with Type 661 mtg) | 1B6335 38392 |
| 5B | Snap Ring, stainless steel (not used with Type 661 mtg) | 1B6336 38992 |
| 5C | Machine Screw, steel (not used with Type 661 mtg) | 1D5589 28992 |
| 5D | Closing Cap, zinc (not used with Type 661 mtg) | 2D3715 44012 |
| 6 | Adjusting Screw, zinc (not used with Type 661 mtg) | 1B5379 44012 |
| 7 | Control Spring, steel pl | |
| | 1/4-2 psig (0.017-0.138 bar) range, red spring | 1B8863 27022 |
| | 1-5 psig (0.069-0.34 bar) range, yellow spring | 1J8578 27022 |
| | 2-10 psig (0.138-0.69 bar) range, blue spring | 1B8864 27022 |
| | 5-15 psig (0.34-1.02 bar) range, brown spring | 1J8579 27142 |
| | 10-20 psig (0.69-1.4 bar) range, green spring | 1B8865 27022 |
| 8 | Relay Orifice, stainless steel | 1C5201 35032 |
| 9 | Disk Holder Assembly | |
| | Brass/nitrile (standard) | 1B8868 000A2 |
| | Stainless steel/nitrile (corrosive) | 1B8868 000B2 |
| 10 | Bleed Orifice, stainless steel | 1B8873 35032 |
| 11 | Diaphragm Nut | |
| | Brass | 1B9895 14012 |
| | Stainless Steel | 1B9895 35072 |
| 12* | O-ring, nitrile | 1B8855 06992 |
| 13 | Relay Spring, 302 stainless steel | 1E6436 37022 |
| 14* | Upper Diaphragm, Nitrile | 1B8852 02052 |
| 15* | Lower Diaphragm, Nitrile | 1B8860 02052 |
| 16 | Upper Diaphragm Plate, Steel | 1B9893 25072 |
| 17 | Lower Diaphragm Plate, Steel | 1B9894 25072 |
| 18 | Spring Seat, steel, cd pl | 1B8862 25072 |
| 19 | Hex Nut, steel, cd pl | 1A3403 24122 |
| 20 | Cap Screw, steel, (8 req'd) | 1B9896 24052 |
| 22 | Pipe Plug, steel (not used with Type 661 mtg) | 1A6495 28992 |
| 23 | Vent Screen, alloy 400 (used only with Type 661 mtg) | 0L0783 43062 |
| 24 | Pipe Nipple, steel zinc pl | 1C4882 26232 |
| 25 | P590 Series filter (parts listed under separate heading) | |
| | Type P594-1, brass & cellulose (standard) | AJ5004 000A2 |
| | Type 593-1, aluminum & cellulose | AJ5004 T0012 |
| 26 | Bleed Valve, 416 stainless steel | 1H9516 35132 |
| 27 | Nameplate, aluminum | 14A1711 X012 |
| 28* | Gasket, neoprene | 1P7533 06992 |
| 30 | Pipe Plug, cast iron (2 req'd) | 1A3619 19012 |
| 35 | Spring Seat, steel (used only with Type 661 mtg) | 1J4284 24092 |
| 50 | Drive Screw, steel, pl (2 req'd) | 1E9530 28982 |

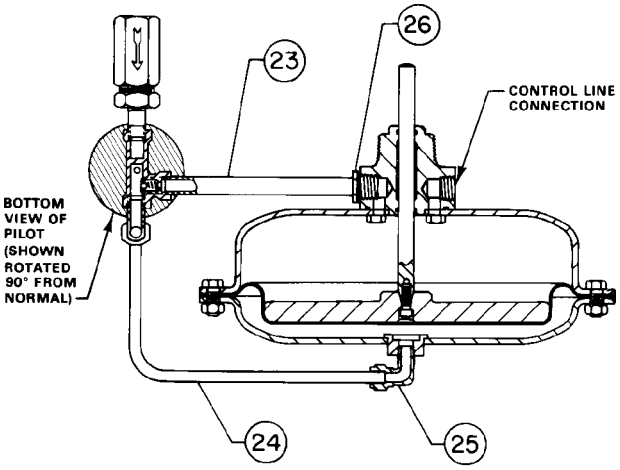



*Figure 15. Single-Pilot Mounting Parts*

## Standard Single-Pilot Mounting Parts (figures 15 & 19)

**Note**

**Key numbers 14 through 22 are only for mounting a Type 61LD pilot.**

| | | |
|---|---|---|
| 14 | Pipe Nipple, galvanized zn pl steel | 1F7315 26012 |
| 15 | Pipe Nipple, galvanized zn pl steel | 1F7302 26012 |
| 16 | Pipe Tee, Malleable iron | 1A4736 21992 |
| 17 | Type 1806 Relief Valve, SST ball and spring | |
| | Brass body and spring seat | AF5001 X00A2 |
| | Aluminum body and spring seat | AF5001 X0012 |
| | Stainless steel body and spring seat | AF5001 X0022 |
| 18 | Relief Tubing | |
| | Copper | 14A9457 X012 |
| | Aluminum | 14A9457 X032 |
| | Steel | 14A9457 X022 |
| | Stainless steel | 14A9457 X042 |

*Recommended spare part

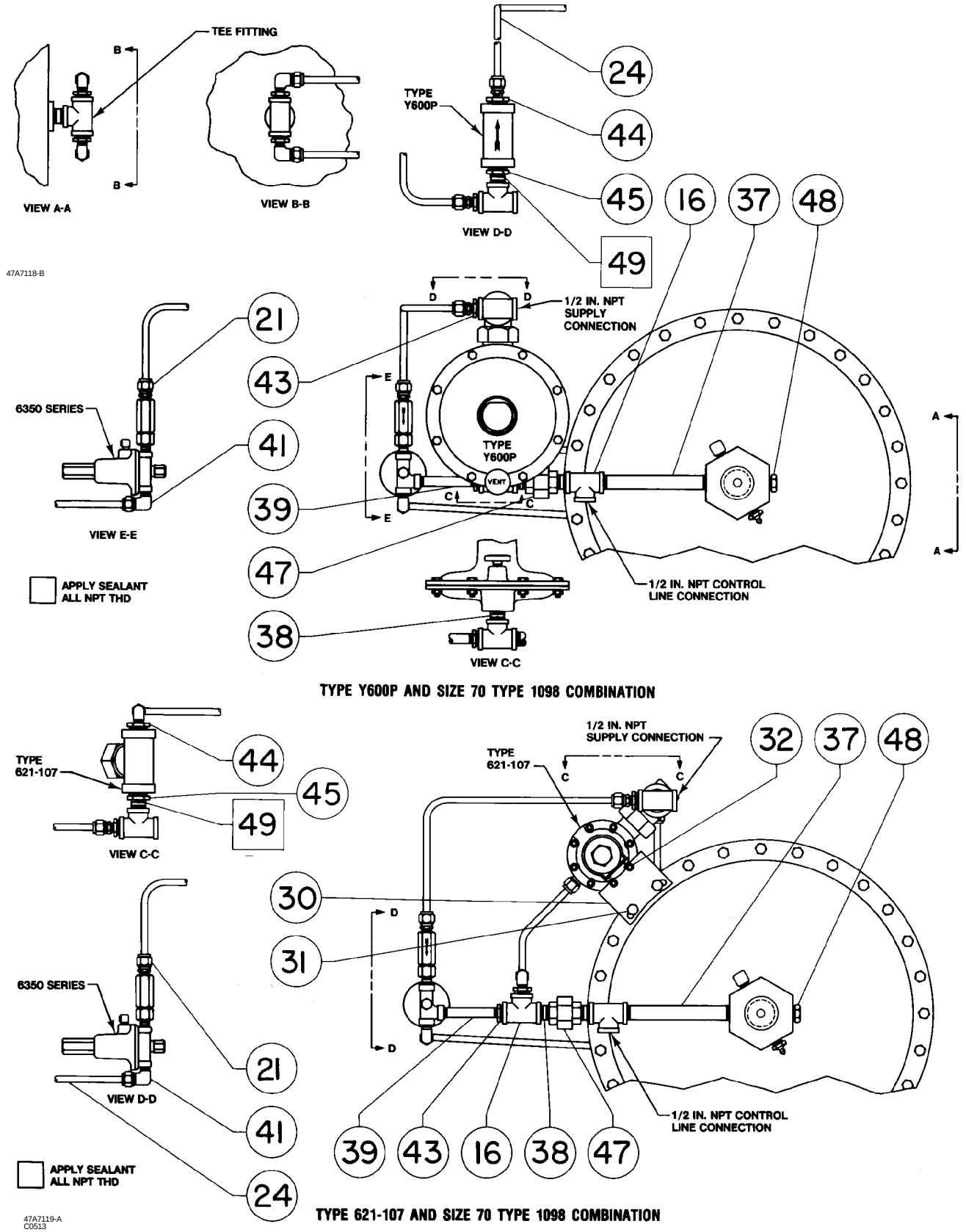



*Figure 16. Dual-Pilot Mounting Parts for Boiler Fuel Installations*

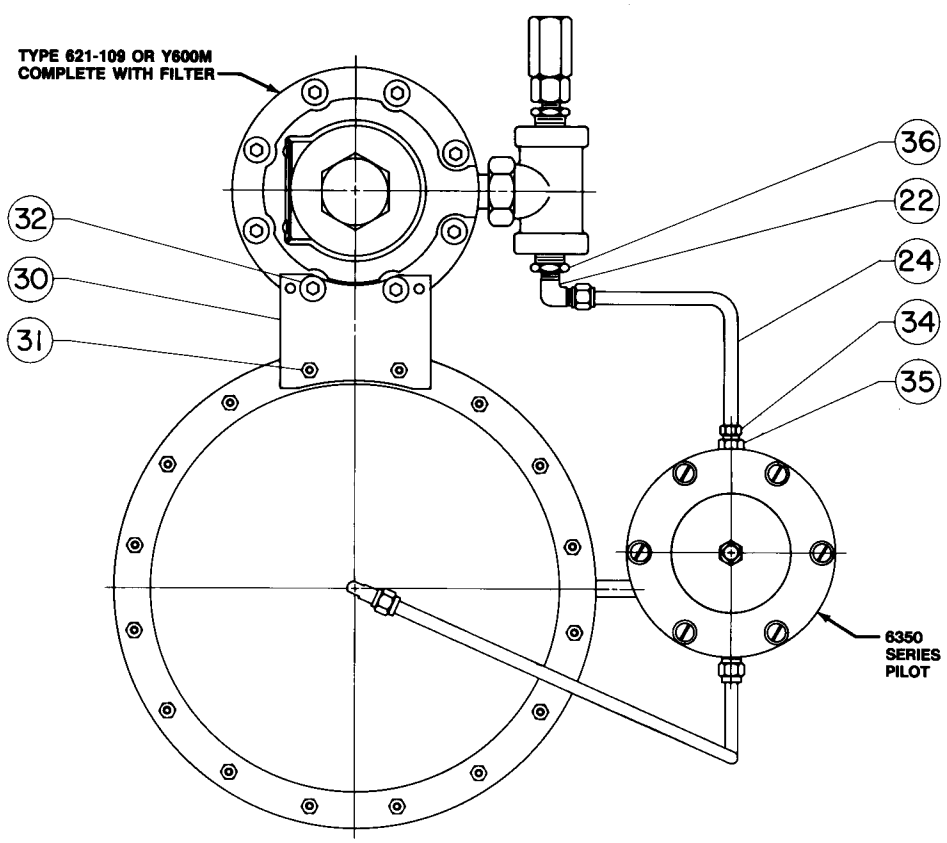



*Figure 17. Dual-Mounting Parts for Working Monitor Regulator*

| Key | Description | Part Number |
|---|---|---|
| 19 | Tee Fitting | |
| | Brass | 14A9056 X012 |
| | Steel | 14A9056 X032 |
| | Stainless steel | 14A9056 X042 |
| 20 | Loading Tubing | |
| | Copper | 24A9459 X012 |
| | Aluminum | 24A9459 X032 |
| | Steel | 24A9459 X022 |
| | Stainless steel | 24A9459 X042 |
| 21 | Connector Fitting | |
| | Brass | 1H8682 18992 |
| | Aluminum | 1J9886 11992 |
| | Steel | 1J1395 28992 |
| | Stainless steel | 1L9272 38992 |
| 22 | Elbow Fitting | |
| | Brass | 1L2497 18992 |
| | Aluminum | 1K5654 11992 |
| | Steel | 1J1396 28992 |
| | Stainless steel | 1N6856 38992 |
| 23 | Pipe Nipple, galvanized zn pl steel | |
| | Size 30 or 40 actuator | 1C2100 26232 |
| | Size 70 actuator | 19A7858 X012 |
| | Pipe Nipple, NACE construction | |
| | Size 30 or 40 actuator | |
| | Aluminum | 1C2100 X0022 |
| | 316 stainless steel | 1C2100 X0012 |
| | Size 70 actuator | |
| | Aluminum | 19A7858 X022 |
| | 316 stainless steel | 19A7858 X032 |
| 24 | Loading Tubing | |
| | Steel (standard) | |
| | Size 30 or 40 actuator | 14A9458 X022 |
| | Size 70 actuator | 050021 2401W |
| | Stainless steel | |
| | Size 30 or 40 actuator | 14A9458 X042 |
| | Size 70 actuator | 050198 3807W |

| Key | Description | Part Number |
|---|---|---|
| 24 | Loading Tube (Continued) | |
| | Copper | |
| | Size 30 or 40 actuator | 14A9458 X012 |
| | Size 70 actuator | 050021 1701W |
| | Aluminum | |
| | Size 30 or 40 actuator | 14A9458 X032 |
| | Size 70 actuator | 050021 1107W |
| | NACE construction | |
| | Size 30 or 40 actuator | |
| | Aluminum | 14A9458 X032 |
| | 304 stainless steel | 14A9458 X042 |
| | Size 70 actuator (specify main valve type number and body size) | |
| | Aluminum | 050021 1107W |
| | 304 stainless steel | 050198 3807W |
| 25 | Elbow Fitting (2 req'd) | |
| | Pl steel (standard) | 15A6002 X472 |
| | Stainless steel | 15A6002 X612 |
| | Brass | 15A6002 X162 |
| | Aluminum | 15A6002 X402 |
| | Aluminum (NACE) | 15A6002 X402 |
| | 316 stainless steel (NACE) | 15A6002 XC72 |
| 26 | Pipe Bushing | |
| | Malleable iron | 1B2928 21992 |
| | Steel (NACE) | 1B2928 X0032 |

## Boiler Fuel Installation Dual-Pilot Mounting Parts (figure 16)

| | | |
|---|---|---|
| 16 | Pipe Tee, galvanized malleable iron (4 req'd) | 1A4736 21992 |
| 21 | Tubing Connector, pl steel (3 req'd) | 15A6002 X462 |
| 24 | Tubing, steel | 050021 2401W |
| 30 | Mounting Bracket, steel (for Type 621-107) | 1H3504 X0012 |
| 31 | Cap Screw, zn pl steel (2 req'd) (for Type 621-107) | 1A5828 24052 |
| 32 | Cap Screw, zn pl steel (2 req'd) (for Type 621-107) | 1K7646 24052 |

| Key | Description | Part Number |
|---|---|---|
| 37 | Pipe Nipple, galvanized zn pl steel | 1F7315 26012 |
| 38 | Pipe Nipple, galvanized zn pl steel (5 req'd for Type Y600P; 4 req'd for Type 621-107) | 1K2015 26022 |
| 39 | Pipe Nipple, galvanized zn pl steel | 1C5599 26232 |
| 41 | Tubing Elbow pl steel (3 req'd for Type Y600P; 5 req'd for Type 621-107) | 15A6002 X472 |
| 43 | Pipe Bushing, pl steel (4 req'd) | 1C3790 26232 |
| 44 | Pipe Bushing, steel | 1A3424 28992 |
| 45 | Pipe Bushing, galvanized zn pl steel | 1K2895 28992 |
| 47 | Female Union, malleable iron | 1B5405 21992 |
| 48 | Pipe Plug, steel | 1A3692 24492 |
| 49 | Led-Plate(3) No. 250 Sealant, 5 lb (2.3 kg) can (not furnished w/regulator) | 1M5240 06992 |

## Working Monitor Dual-Pilot Mounting Parts (figure 17)

| | | |
|---|---|---|
| 22 | Tubing Elbow, pl steel | 15A6002 X472 |
| 24 | Tubing, steel | 050021 2401W |
| 30 | Mounting Bracket, steel | 1H3504 X0012 |
| 31 | Cap Screw, zn pl steel (2 req'd) | 1A5828 24052 |
| 32 | Cap Screw, zn pl steel (2 req'd) | 1K7646 24052 |
| 34 | Flared Nut, zn pl steel | 1D6921 24272 |
| 35 | Tubing Connector, brass | 1D6922 14012 |
| 36 | Pipe Bushing, steel (2 req'd) | 1A3424 28992 |

## Type 1098 and 1098H Actuators (figure 20)

| | | |
|---|---|---|
| | Parts kit (included are: casing O-ring, key 5; stem O-ring, key 6; and diaphragm, key 7) | |
| | Size 30 | R1098 X00302 |
| | Size 40 (standard) | R1098 X00402 |
| | Size 70 | R1098 X00702 |
| 1 | Lower Diaphragm Case | |
| | Type 1098 | |
| | Size 30, zn pl steel | 2E8007 28992 |
| | Size 40, steel | 24A7155 X012 |
| | Size 70, zn pl steel | 2N1266 28992 |
| | Type 1098H | |
| | Size 30, WCB steel | 36A8537 X012 |
| | NACE Construction | |
| | Type 1098 | |
| | Size 30, heat-treated zinc plated steel (NACE) | 2E8007 X0022 |
| | Size 40, NACE steel | 24A7155 X032 |
| | Size 70, NACE steel | 2N1266 X0022 |
| | Type 1098H (size 30 only), heat-treated WCB steel (NACE) | 36A8537 X022 |
| 2 | Upper Diaphragm Case | |
| | Type 1098 | |
| | Size 30 | |
| | Steel | 25A7340 X012 |
| | Wrought steel (NACE) | 25A7340 X022 |
| | Size 40 | |
| | zinc plated steel | 24A5680 X012 |
| | Wrought steel (NACE) | 24A5680 X022 |
| | Size 70 | |
| | zinc plated steel | 25A2607 X012 |
| | Wrought steel (NACE) | 25A2607 X022 |
| | Type 1098H | |
| | Size 30 | |
| | WCB steel | 36A8535 X012 |
| | Heat-treated WCB steel (NACE) | 36A8535 X022 |
| 3 | Bonnet (for Type 1098 only) | |
| | Steel | 24A5681 X012 |
| | Wrought steel (NACE) | 24A5681 X022 |
| 4 | Cap Screw (for Type 1098 only) | |
| | Zinc plated steel | 1D5287 24952 |
| | B7M zinc plated steel (NACE) | 1D5298 X0012 |
| 5* | Casing O-Ring | |
| | Nitrile (not req'd for Type 1098H) | 1F9141 06992 |
| | Fluoroelastomer | 1F9141 X0012 |
| 6* | Stem O-Ring (2 req'd) | |
| | Nitrile | 1C7822 06992 |
| | Fluoroelastomer | 1K7561 06382 |
| 7* | Diaphragm, nitrile | |
| | Size 30 | 2E7919 02202 |
| | Size 40 | 2E6700 02202 |
| | Size 70 | 2N1269 02202 |
| 8 | Diaphragm Plate | |
| | Cast iron | |
| | Size 30 | 15A7339 X012 |
| | Size 40 | 14A5682 X012 |
| | Size 70 | 15A2606 X012 |
| | Heat-treated WCB steel (NACE) | |
| | Type 1098 | |
| | Size 30 | 19A7317 X012 |
| | Size 40 | 19A7318 X012 |
| | Size 70 | 19A7319 X012 |
| | Type 1098H (size 30 only) | 19A7317 X012 |
| 9 | Stem Cap Screw | |
| | Plated steel | |
| | Size 30 or 40 | 1L5454 28982 |
| | Size 70 | 11B1768 X012 |
| | Grade 8 black steel (NACE) | |
| | Type 1098 (NACE) | |
| | Size 30 or 40 (NACE) | 1L5454 X0012 |
| | Size 70 (NACE) | 11B1768 X022 |
| | Type 1098H (size 30 only) (NACE) | 1L5454 X0012 |
| 10 | Cap Screw, zn pl steel | |
| | Type 1098 | |
| | Size 30 (12 req'd) | 1E7603 24052 |
| | Size 40 (16 req'd) | 1E7603 24052 |
| | Size 70 (28 req'd) | 1A5828 24052 |
| | Type 1098H | |
| | Size 30 (12 req'd) | 1A9155 24052 |
| 11 | Hex Nut, zn pl steel | |
| | Type 1098 | |
| | Size 30 (12 req'd) | 1A3465 24122 |
| | Size 40 (16 req'd) | 1A3465 24122 |
| | Size 70 (28 req'd) | 1A3465 24122 |
| | Type 1098H | |
| | Size 30 (12 req'd) | 1A3403 24122 |
| 12 | Stem | |
| | 17-4PH stainless steel | |
| | 1 inch | 14A6757 X012 |
| | 2 inch | 14A5683 X012 |
| | 3 inch | 14A5663 X012 |
| | 4 inch | 14A5648 X012 |
| | 6 inch | 14A6987 X012 |
| | 8 x 6 inch | 18A4217 X012 |
| | 316 stainless steel (NACE) | |
| | 1 inch main valve body (NACE) | 14A6757 X022 |
| | 2 inch main valve body (NACE) | 14A5683 X022 |
| | 3 inch main valve body (NACE) | 14A5663 X022 |
| | 4 inch main valve body (NACE) | 14A5648 X022 |
| | 6 inch main valve body (NACE) | 14A6987 X022 |
| | 8 x 6 inch main valve body (NACE) | 18A4217 X022 |
| 13 | Nameplate, stainless steel (not shown) | |
| | Size 30 | 25A8373 X012 |
| | Size 40 | 24A5704 X012 |
| | Size 70 | 25A8374 X012 |
| 26 | NACE Tag, 18-8 stainless steel (not shown) | 19A6034 X012 |
| 27 | Type Y602-12 Vent Assembly | 27A5516 X012 |
| 27 | Tag Wire, 303 stainless steel (not shown) (NACE) | 1U7581 X0022 |
| 28 | Grease Fitting, steel | 1L8478 28992 |

*Recommended spare part
3. Trademark of Armite Laboratories.

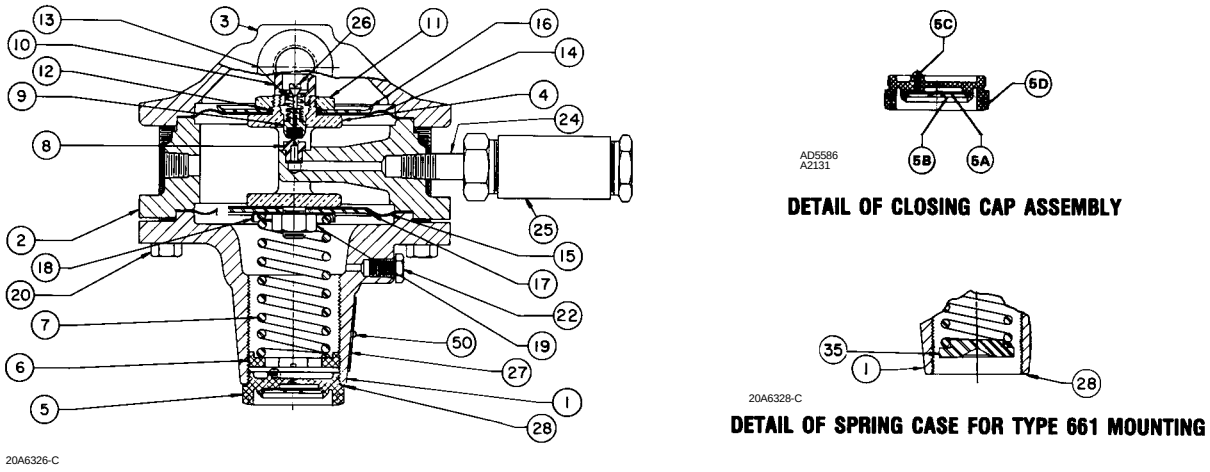



*Figure 18. Type 61LD Pilot Assembly*

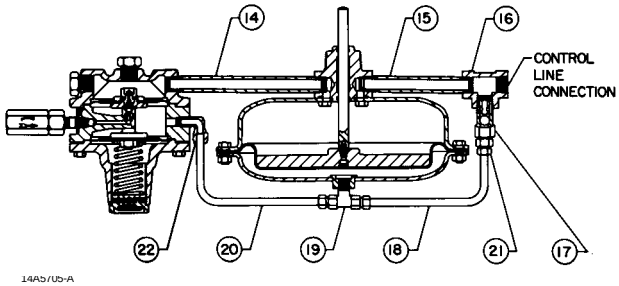



*Figure 19. Type 61LD Pilot and Type1806 Relief Valve Mounting*

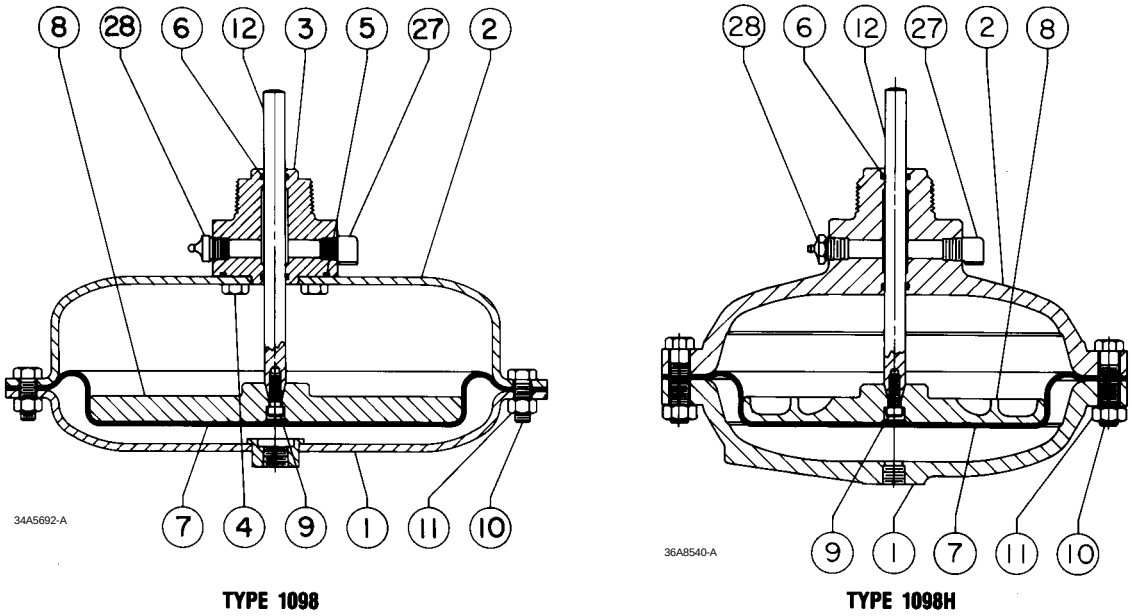



*Figure 20. Type 1098 and 1098H Actuator Assemblies*



**Fisher Controls**

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Singapore 0512

May 1997

**Errata Sheet**
**for**

Type 1098-EGR & 1098H-EGR Pilot-Operated Regulators,
Form 5084, May 1987

This errata sheet covers updated information on the Type 1098-EGR Pilot Operated Regulators. Each bullet on this errata sheet refers to the Type 1098 and 1098H Actuator and Pilot Mounting Parts section on page 17 and figure 20 on page 28 of the Type 1098-EGR & 1098H-EGR Pilot-Operated Regulators instruction manual Form 5084.

The Type 1098 bonnet has been redesigned to incorporate a wiper ring, bearings and larger casing O-ring. This redesign effects all body sizes and actuator sizes (size 30, 40, 70 and 30H) for the Type 1098.

When doing maintenance on the Type 1098 original bonnet design and the bonnet redesign, the repair kits R1098X00302, R1098X00402 and R1098X00702 will include all the necessary parts to repair both designs. When repairing the original design, key numbers 56 (bearings) and 57 (wiper ring) will not be needed (refer to figure 20).

- Replace the steps in the section Type 1098 and 1098H Actuator and Pilot Mounting Parts on page 17 with the following steps.

2. Access to all internal parts except the stem O-rings, bearings and wiper (keys 6, 56, 57) may be gained without removing the bonnet (key 3) or upper diaphragm case (key 2) from the main valve or the pilot(s) from the bonnet pipe nipple (key 23, figure 15, or keys 37 and 39, figure 16). Disconnect the loading tubing (key 24, figure 15, 16, or 17) from the actuator elbow fitting (key 25, figure 15, or key 41, figure 16), and with a Type 61LD pilot also disconnect the relief tubing (key 18, figure 19) from the fitting tee.

Second paragraph of step 4.

**To remove the Type 1098 and Type 1098H stem O-rings (key 6),** remove the pilot(s) and pipe nipple(s) if necessary. Unscrew either the Type 1098 bonnet (key 3) or the Type 1098H upper diaphragm case (key 2), and remove the wiper ring, bearings and O-rings.

5. Lubricate both stem O-rings (key 6), and wiper ring (key 57) and install them with the stem bearings (key 56) in either the Type 1098 bonnet (key 3) or in the Type 1098H upper diaphragm case (key 2).

- Add the diagram on the following page to figure 20 on page 28 of the instruction manual.



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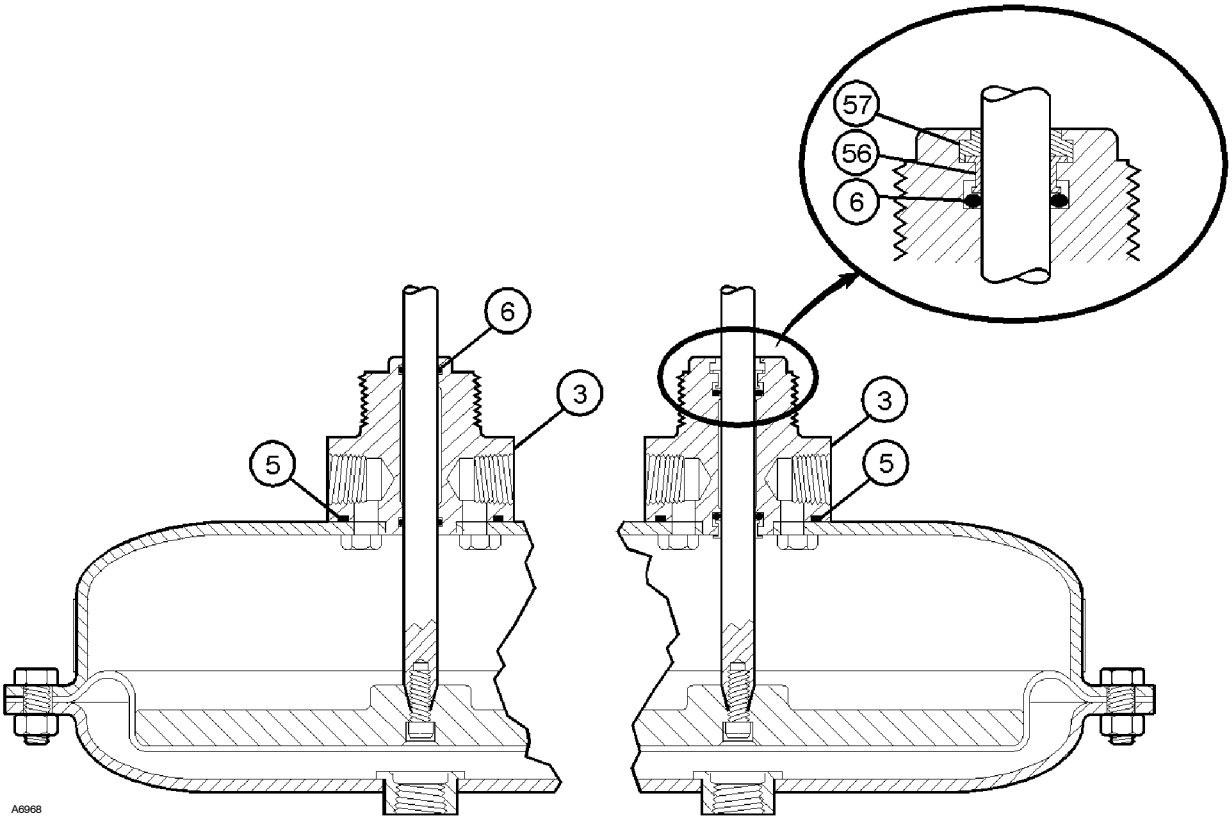


**TYPE 1098 ORIGINAL DESIGN**

| Key | Description | Part Number |
|---|---|---|
| 3 | Bonnet, Steel | 24A5681X012 |
| 5 | Casing O-ring, Nitrile | 1F914106992 |
| 6 | Stem O-ring (2 req d) | |
| | Nitrile | 1C782206992 |
| | Fluoroelastomer | 1K756106382 |

**TYPE 1098 REDESIGN**

| Key | Description | Part Number |
|---|---|---|
| 3 | Bonnet, Steel | 33B0301X012 |
| 5 | Casing O-ring, Nitrile | 1F358106992 |
| 6 | Stem O-ring (2 req d) | |
| | Nitrile | 1C782206992 |
| | Fluoroelastomer | 1K756106382 |
| 56 | Bearing, Nylon (2 req d) | 17A7112X012 |
| 57 | Wiper Ring | 15A6002XN12 |

*Figure 20. Type 1098 and 1098H Actuator Assemblies*

August 1999

**Errata Sheet**
**for**

Types 1098-EGR & 1098H-EGR Pilot-Operated Regulators
Form 5084, May 1987

The body plug on the Type 6351 pilot has been redesigned. The body plug gasket and body plug previously used on the Type 6351 pilot have been replaced with a new body plug assembly. The body plug assembly includes the body plug and the body plug O-ring. Replace or add the following information on the Types 1098-EGR & 1098H-EGR Instruction Manual, form 5084.

- **Replace step 3 of the Type 6351 Pilot section on page 16 with the following:**

3. To replace the valve plug (key 4), remove body plug (key 3 or 3A) to let the plug spring (key 6) and plug/stem assembly (key 4) drop freely from the body (key 1). Inspect the removed parts, replace if neccessary. Make sure the plug seating surfaces are free from debris. Inspect body plug O-ring (key 3B), replace if necessary. Type 6351 pilots manufactured before May 1999 need to have the body plug gasket (key 23) and the body plug (key 3) replaced with a new body plug assembly (key 3), which includes the body plug (key 3A) and the body plug O-ring (key 3B). Install the body plug O-ring (key 3B) over the body plug (key 3A). Stack the plug spring (key 6) and the plug/stem assembly on the body plug assembly (key 3), and install the body plug assembly with stacked parts into the body (key 1).

- **Replace the following Parts List information beginning on page 21 with the information below:**

## Type 6351 Pilot (figure 13)

| Key | Description | Part Number |
|---|---|---|
| | Parts Kit (includes keys 3, 4, 6, 7, and P590 Series filter, key 2) | R6351X00012 |
| 3 | Body Plug Assembly (includes body plug and O-ring) | |
| | Aluminum body plug | |
| | with nitrile O-ring | 18B6542X022 |
| | with fluoroelastomer O-ring | 18B6542X042 |
| | Stainless steel body plug | |
| | with nitrile O-ring | 18B6542X052 |
| | with fluoroelastomer O-ring | 18B6542X062 |

- **Delete the following Parts List information on page 22:**

| Key | Description | Part Number |
|---|---|---|
| 23* | Body Plug Gasket, composite | 1C495704022 |



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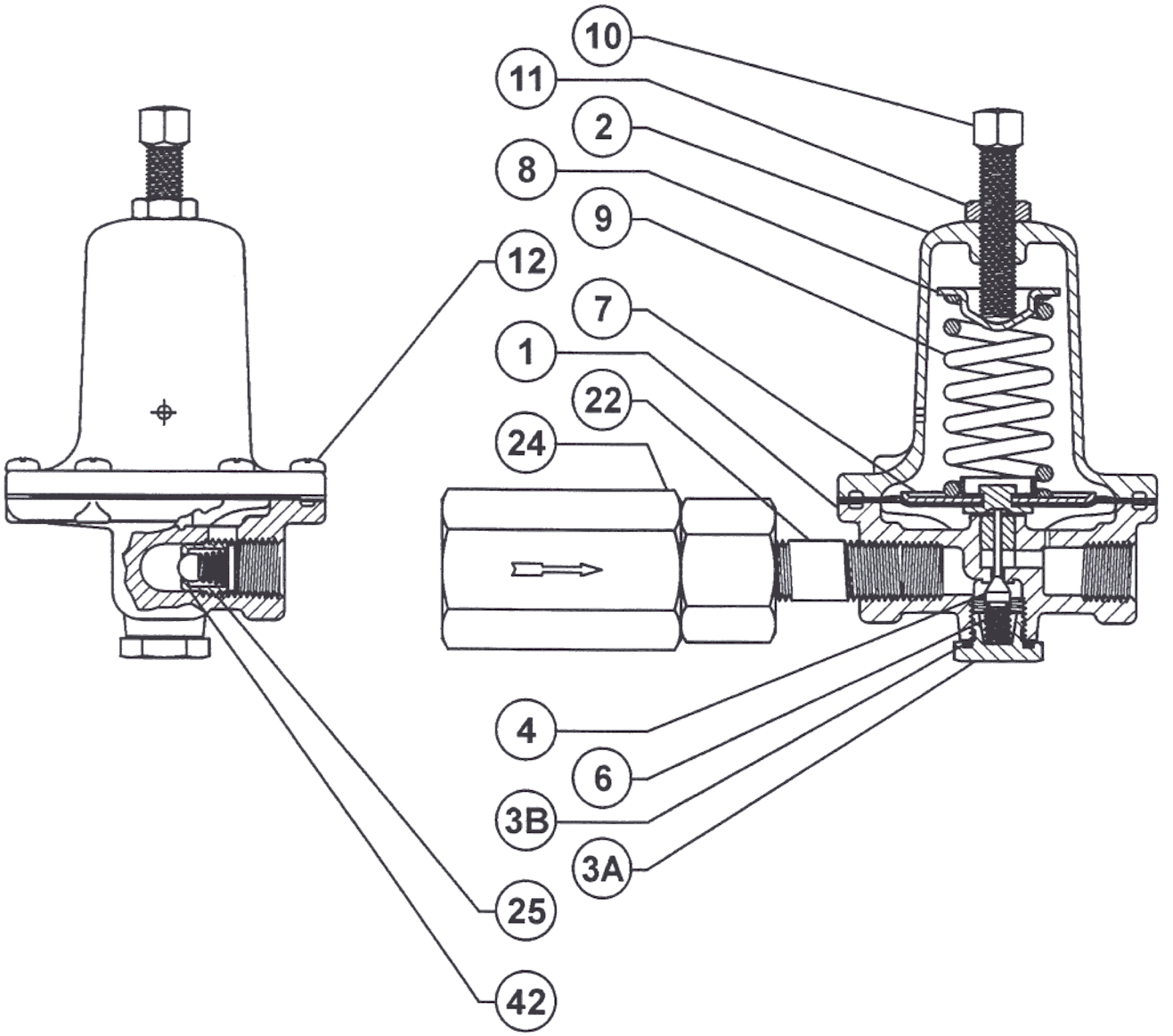
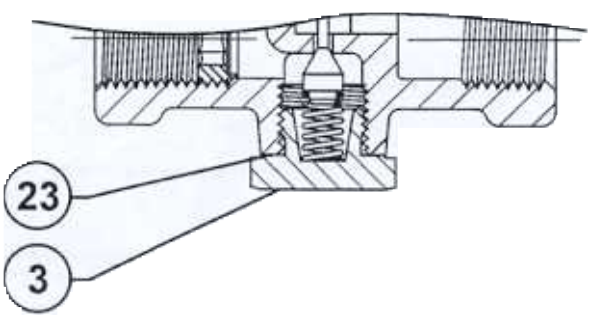
- **Replace the Type 6351 Interior Assembly in figure 13 on page 22 with the figure below:**




NEW TYPE 67 OR 67R ASSEMBLY DRAWING
SHOWING NEW BODY PLUG AND BODY PLUG GASKET




OLD TYPE 67 OR 67R ASSEMBLY DRAWING
SHOWING OLD BODY PLUG AND BODY PLUG GASKET

July 2002

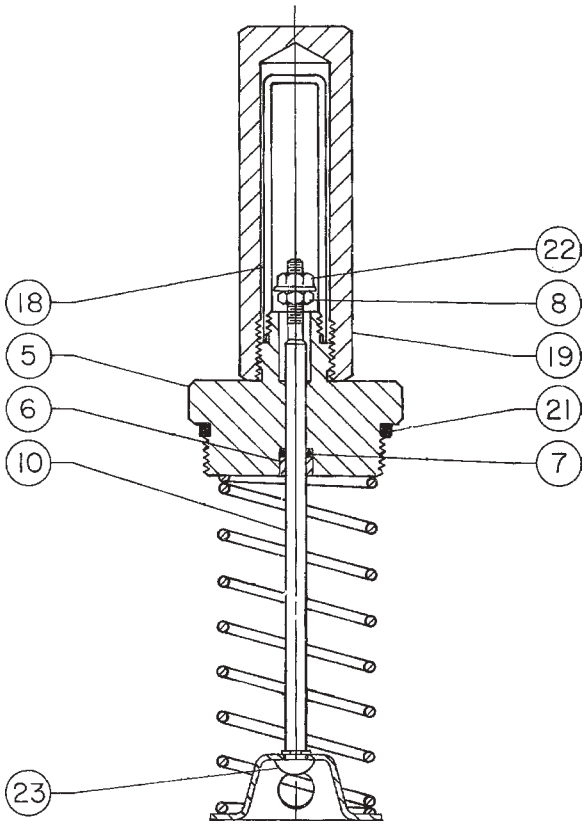
**Errata Sheet**
**for**

Type 1098-EGR and 1098H-EGR Pilot-Operated Regulators
Form 5084, May 1987

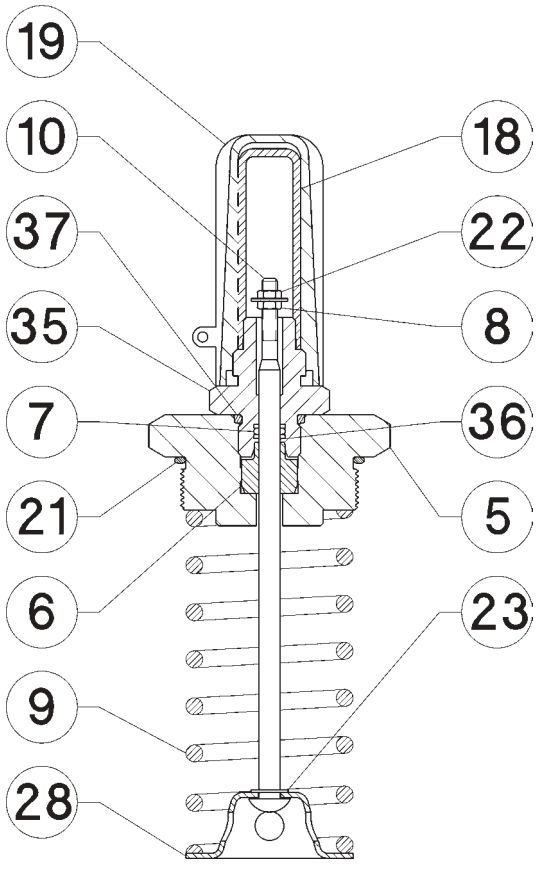
This errata sheet covers the redesign of the Type 1098-EGR and 1098H-EGR travel indicator assemblies. This redesign has been incorporated into all body sizes, regardless of actuator size. The Type 1098-EGR and 1098H-EGR travel indicator assemblies now incorporate a redesigned O-ring retainer (key 6), TFE back-up rings (key 36), and an additional indicator fitting (key 35).

When performing maintenance on the original Type 1098-EGR or 1098H-EGR body flange, travel indicator replacement is recommended. The redesigned travel indicator assembly is incorporated into all Quick-Change Trim kits (e.g. 25A3170X012) and on the Travel Indicator Kits (see table by size). The elastomer repair kits contain the components for the redesigned travel indicator assembly.

See the drawings below for old versus new design.




**TYPE 1098 ORIGINAL DESIGN (PRIOR TO SPRING 2002)**




**TYPE 1098 REDESIGN (10C1212 KIT)**

*Type 1098-EGR and 1098H-EGR Travel Indicator Assemblies*

- Insert the following steps after “Replacing Quick-Change Trim Package” section on page 14.

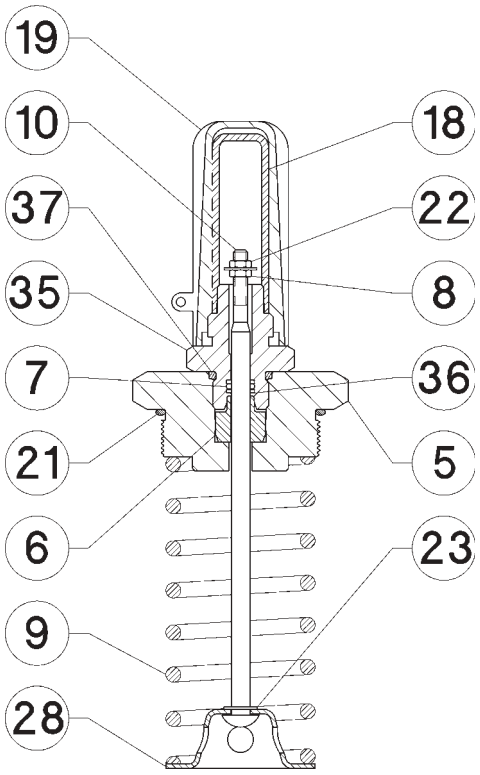
## Replacing Travel Indicator Assembly

1. Remove the travel indicator assembly by removing lower indicator fitting (key 5) from body flange (key 2).
2. Coat the threads of the lower indicator fitting (key 5) with a good grade of general-purpose grease.
3. Install travel indicator assembly (10C1212), torque to 40 inch-pounds.
4. Check indicator zeroing by unscrewing the indicator protector (key 19) and seeing if the flange of the indicator nut (key 22) lines up evenly with the bottom marking on the indicator scale (key 18). If not, remove the indicator scale and separate the indicator nut and hex nut (key 8). Hold the indicator scale against the indicator fitting (key 5) with the scale base resting against the shoulder of the fitting, and turn the indicator nut until its flange is aligned with the bottom scale marking. Then lock both nuts against each other, and install the indicator scale and protector.

- Insert the following parts kit list after “Quick Change Trim Assembly” on page 18

| Key | Description | Part Number |
|---|---|---|
| | Parts kit, QuickChange Travel Indicator Kit (included are: indicator stem, key 10;O-ring retainer, key 6; indicator fitting, key 35; lower indicator fitting, key 5; mach hex nut, key 8; nitrile O-ring, key 7; back-up scarf ring, key 36, 2 required; nitrile o-ring, key 21; indicator cover, key 18; flange nut, key 22; E-ring, key 23; nitrile O-ring, key 37; adjusting screw cap, key 19; spring seat, key 28; spring, key 9) | |
| | Note: Indicator zeroing of key 8, 12 and 18 may be needed. See Step 4 above. | |
| | 60 Psi (4,1 bar) spring color green | |
| | 1-inch | 10C1212X042 |
| | 2-inch | 10C1212X012 |
| | 3-inch | 10C1212X022 |
| | 4-inch | 10C1212X032 |
| | 6-inch | 10C1212X052 |
| | 125 Psi (8.6 bar) spring color blue | |
| | 1-inch | 10C1212X092 |
| | 2-inch | 10C1212X062 |
| | 3-inch | 10C1212X072 |
| | 4-inch | 10C1212X082 |
| | 6-inch | 10C1212X102 |
| | 400 Psi (28 bar) spring color red | |
| | 1-inch | 10C1212X142 |
| | 2-inch | 10C1212X112 |
| | 3-inch | 10C1212X122 |
| | 4-inch | 10C1212X132 |
| | 6-inch | 10C1212X152 |

- Insert “1098 Redesign” into figure 11, page 19.




*Travel Indicator Assembly*



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# Type 99 and Type 99VSX Regulators

## Introduction

### Scope of Manual

This manual describes and provides instructions and parts lists for Type 99 and Type 99VSX regulators complete with standard P590 Series integral filter. However, complete instructions and parts listing for the Type 1301F pilot supply regulator, and other Fisher equipment such as monitoring pilots will be found in separate instruction manuals.

### Description

The Type 99 gas regulators provide a broad capacity for controlled pressure ranges and capacities in a wide variety of distribution, industrial, and commercial applications.

A Type 99 regulator has a Type 61L (low pressure), Type 61H (high pressure), or a Type 61HP (extra high pressure) pilot integrally mounted to the actuator casing as shown in figure 1. The Type 99 regulator can handle up to 1000 psig (69 bar) inlet pressures (the 1000 psig (69 bar) regulator requires a Type 1301F pilot supply regulator and a Type H110 pop relief valve). The pilot supply regulator reduces inlet pressure to a usable 200 psig (14 bar) for the extra high pressure pilot. This regulator comes standard with O-ring seals on the guide bushing and valve carrier (key 26, figure 6) to keep main valve body outlet pressure from interfering with outlet pressure in the lower casing assembly (key 29, figure 9).

The Type VSX module on the Type 99 regulator is a safety shut-off valve which provides overpressure or overpressure and underpressure protection by completely shutting off the flow of gas to the downstream system. The safety shut-off module s actions are independent of the Type 99 regulator and of variations to the inlet pressure. The Type VSX has external registration requiring a downstream sensing line.

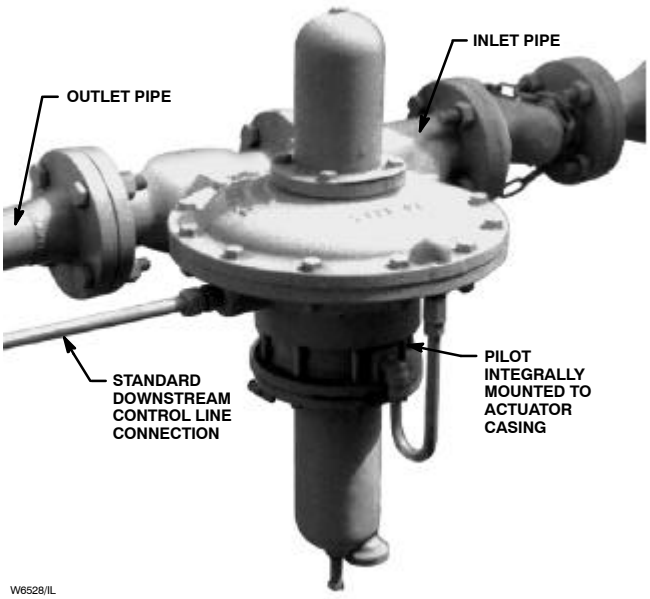


*Figure 1. Type 99 Regulator With Type 61H (high pressure) Pilot*


*Figure 2. Type 99 Regulator With Type VSX Safety Shut-off Module*



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*Table 1. Specifications*

**Body Size**

■ 2-inch

**End Connection Styles**

■ 2-inch NPT screwed, or
■ ANSI Class 125, 150, 250, or 300 flanged
■ Swedged or Buttweld

**Maximum Allowable Inlet Pressure(1)**

**150 psig (10 bar):** Type 99VSX inlet pressure, limited by Type VSX pressure rating
**400 psig (28 bar):** When using Types 61L and 61H pilots
**600 psig (41 bar):** Type 61HP pilot (5/8-inch orifice maximum)
**1000 psig (69 bar):** Type 61HP pilot, along with Type 1301F pilot supply regulator and Type H110 relief valve (1/2-inch orifice only)

**Maximum Pilot Spring Case Pressure For Pressure Loading(1,2)**

**Types 61L, 61LD(3) And 61LE(4):** 50 psi (3.5 bar) with special steel closing cap
**Types 61H And 61HP:** 100 psi (7 bar)

**Outlet (Control) Pressure Ranges**

See Table 2

**Maximum Outlet Pressure for Type 99VSX**

5 psig (300 mbar)

**Minimum and Maximum Trip Pressure Ranges for Type 99VSX**

See Table 6

**Approximate Proportional Bands**

See Table 3

**Maximum Allowable Pressure Drop(1)**

See Table 4

**Minimum Differential Pressure Required For Full Stroke**

See Table 4

**Maximum Actuator Pressures(1)**

**Operating:** 100 psig (6.9 bar)
**Emergency:** 110 psig (7.6 bar)

**Flow Coefficients And Orifice Diameters**

See Table 5

**Maximum Rated Travel**

1/4-inch (6.4 mm)

**Material Temperature Capabilities(1)**

**Type 99 Standard Elastomers:** -20° to 180°F (-29° to 82°C)
**Type 99 High Temperature Elastomers:** 0° to 300°F (-18° to 149°C)
**Type 99VSX:** -20° to 140°F (-29° to 60°C)

1. The pressure/temperature limits in this bulletin and any applicable standard or code limitation should not be exceeded.
2 . For stability or overpressure protection, a pilot supply regulator may be installed in the pilot supply tubing between the main valve and pilot.
3. Type 61LD construction has narrower proportional band than does the standard Type 61L pilot.
4. Type 61LE construction has broader proportional band than does the standard Type 61L pilot.

## Specifications

**WARNING**

**Since a pilot-operated regulator is constructed of both a pilot and a main valve, care should be used not to exceed the maximum inlet pressure shown on the nameplate of either unit.**

**When inlet pressure exceeds the pilot limitation, a pilot supply reducing regulator and/or relief valve will be required.**

Table 1 lists specifications for various Type 99 constructions. Some specifications for a given regulator as it originally comes from the factory are stamped on nameplates located on the pilot and actuator spring cases. A tag (key 159, parts list) additionally may be installed on the pilot to indicate a regulator with O-ring stem seal. These regulators and their installations should be checked for compliance with applicable codes.

*Table 2. Outlet Pressure Ranges*

| PILOT TYPE | MAXIMUM PILOT SUPPLY PRESSURE | OUTLET (CONTROL) PRESSURE RANGES | PILOT CONTROL SPRING | | | |
|---|---|---|---|---|---|---|
| | | | Part Number | Color Code | Wire Diameter Inches (cm) | Free Length Inches (cm) |
| 61L | 400 Psig (28 bar) | 2 to 4 inches w.c. (5 to 10 mbar)<br>3 to 12 inches w.c. (7 to 30 mbar)<br>0.25 to 2 psig (17 to 138 mbar)<br>1 to 5 psig (0.069 to 0.34 bar) | 1B558527052<br>1C680627222<br>1B886327022<br>1J857827022 | Orange<br>Cadmium<br>Red<br>Yellow | .075 (0.19)<br>.080 (0.20)<br>.109 (0.28)<br>.142 (0.36) | 4-1/8 (10.5)<br>3-1/4 (8.3)<br>2-3/4 (7.0)<br>2-3/4 (7.0) |
| 61LD(1) | 160 Psig (11 bar) | | | | | |
| 61LE(2) | 400 Psig (28 bar) | 2 to 10 psig (0.14 to 0.69 bar)<br>5 to 15 psig (0.34 to 1.0 bar)<br>10 to 20 psig (0.69 to 1.4 bar) | 1B886427022<br>1J857927142<br>1B886527022 | Blue<br>Brown<br>Green | .172 (0.44)<br>.187 (0.47)<br>.207 (0.53) | 2-7/8 (7.3)<br><br>3-1/8 (7.9) |
| 61H | 400 Psig (28 bar) | 10 to 65 psig (0.69 to 4.5 bar) | 0Y0664000A2 | Green Stripe | .363 (0.92) | 6 (15.2) |
| 61HP | 600 Psig (41 bar) | 35 to 100 psig (2.4 to 6.9 bar) | 1D387227022 | Blue | .200 (0.51) | 1-11/16 (4.3) |

1. Type 61LD construction has narrower proportional band than does the standard Type 61L pilot.
2. Type 61LE construction has broader proportional band than does the standard Type 61L pilot

*Table 3. Approximate Proportional Bands*

| PILOT TYPE NUMBER | PILOT CONTROL SPRING | | | | APPROXIMATE PROPORTIONAL BANDS |
|---|---|---|---|---|---|
| | Part Number | Color Code | Wire Diameter Inch (cm) | Free Length Inch (cm) | |
| 61LD | 1B558527052 | Orange | .075 (0.19) | 4-1/8 (10.5) | 0.1 to 0.5 inches w.c. (0.25 to 1.2 mbar) |
| | 1C680627222 | Cadmium | .080 (0.20) | 3-1/4 (8.3) | |
| 61L | 1B886327022 | Red | .109 (0.28) | 2-3/4 (7.0) | 1 to 2 inches w.c. (2.5 to 5 mbar) |
| 61LD | 1B886327022 | Red | .109 (0.28) | 2-3/4 (7.0) | 0.25 to 1 inches w.c. (0.62 to 2.5 mbar) |
| 61LE | 1B886327022 | Red | .109 (0.28) | 2-3/4 (7.0) | 5 to 8 inches w.c. (12 to 20 mbar) |
| 61L, 61LD, & 61LE | 1B886527022 | Green | .207 (0.53) | 3-1/8 (7.9) | 0.1 to 0.3 psi (6.9 to 21 mbar) |
| | 1J857927142 | Brown | .187 (0.47) | | |
| | 1B886427022 | Blue | .172 (0.44) | 2-7/8 (7.3) | |
| | 1J857827022 | Yellow | .142 (0.36) | 2-3/4 (7.3) | |
| 61H | 0Y0664000A2 | Green Stripe | .363 (0.92) | 6 (15.2) | 0.1 to 0.3 psi (6.9 to 21 mbar) |
| 61HP | 1D387227022 | Blue | .200 (0.51) | 1-11/16 (4.3) | 1 to 2 psi (69 to 138 mbar) |

*Table 4. Maximum Allowable Drop and Minimum Differential Pressures*

| MAXIMUM ALLOWABLE DROP PSIG (BAR) | MAIN VALVE SPRING | | | MINIMUM DIFFERENTIAL PRESSURE FOR FULL STROKE PSI (BAR) | SEAT MATERIAL | MAXIMUM ORIFICE SIZE(1) | |
|---|---|---|---|---|---|---|---|
| | Part Number | Wire Diameter Inch (cm) | Free Length Inch (cm) | | | Inch | mm |
| 25 (1.7) | 1C277127022 | .148 (0.38) | 6 (15.2) | 0.75 (0.052) | Nitrile, Neoprene, Fluoroelastomer | 1-1/8 | 28.6 |
| 50 (3.4) | 1N801927022 | .156 (0.40) | 7-1/8 (18.1) | 1.5 (0.10) | Nitrile, Neoprene, Fluoroelastomer | 1-1/8 | 28.6 |
| 150 (10) | 1B883327022 | .187 (0.47) | 6-5/8 (17.0) | 3 (0.21) | Nitrile, Neoprene, Fluoroelastomer | 1-1/8 | 28.6 |
| 175 (12) | 1B883327022 | .187 (0.47) | 6-5/8 (17.0) | 3 (0.21) | Nitrile, Neoprene, Fluoroelastomer(3) | 7/8 | 22.2 |
| 250 (17) | 1B883327022 | .187 (0.47) | 6-5/8 (17.0) | 3 (.021) | Nitrile, Fluoroelastomer | 7/8 | 22.2 |
| | 0W019127022 | .281 (0.71) | 6 (15.2) | 10 (.069) | Nitrile, Fluoroelastomer,(4) | 1-1/8 | 28.6 |
| 300 (21) | 0W019127022 | .281 (0.71) | 6 (15.2) | 10 (.069) | Nylon | 1-1/8 | 28.6 |
| 400 (28) | 0W019127022 | .281 (0.71) | 6 (15.2) | 10 (.069) | Nylon | 7/8 | 22.2 |
| 600 (41) | 0W019127022 | .281 (0.71) | 6 (15.2) | 10 (.069) | Nylon | 5/8 | 15.9 |
| 1000 (69) | 0W019127022 | .281 (0.71) | 6 (15.2) | 10 (.069) | Nylon | 1/2(2) | 12.7 |

1. Can use all orifices up to maximum size listed.
2. 1/2 inch (12.7 mm) is the only orifice size available for 1000 psig (69 bar) maximum inlet pressure regulator.
3. Class 125 flanged body only.
4.O-ring seat only

*Table 5. Flow Coefficients and Orifice Diameters*

| TRIM CONSTRUCTION | ORIFICE DIAMETER | | FOR RELIEF SIZING WIDE OPEN $C_g$ | REGULATING $C_g$ |
|---|---|---|---|---|
| | Inch | mm | | |
| Restricted Capacity Trim, Straight Bore Composition Or Nylon Disk Seat Only | 3/8<br>1/2(1)<br>9/16<br>5/8<br>3/4 | 9.5<br>12.7<br>14.3<br>15.9<br>19.1 | 115<br>200<br>235<br>300<br>425 | 90<br>155<br>188<br>216<br>330 |
| Restricted Capacity Trim, Stepped Bore Composition Or Nylon Disk Seat Only | 7/8 X 3/8<br>7/8 X 1/2<br>7/8 X 5/8 | 22.2 X 9.5<br>22.2 X 12.7<br>22.2 X 15.9 | 115<br>200<br>300 | 110<br>190<br>280 |
| Full Capacity Trim Composition Or Nylon Disk Or O-Ring Seat | 7/8<br>1<br>1-1/8 | 22.2<br>25.4<br>28.6 | 550<br>680<br>850 | 408<br>550<br>680 |
| 1. 1/2 inch (12.7 mm) is the only orifice size available for 1000 psig (69 bar) maximum inlet regulator. | | | | |

## Installation

**WARNING**

**• Personal injury, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts might result if this regulator is overpressured or is installed where service conditions could exceed the limits for which the regulator was designed, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.**

**• A regulator may vent some gas to the atmosphere in hazardous or flammable gas service, vented gas might accumulate and cause personal injury, death or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous location. The vent line or stack opening must be protected against condensation or clogging.**

Like most regulators, the Type 99 regulator has a outlet pressure rating lower than its inlet pressure rating. Complete downstream overpressure protection is needed if the actual inlet pressure can exceed the regulator outlet pressure rating or the pressure ratings of any downstream equipment. Although the Type H110 relief valve provides sufficient relief capacity to protect the extra high pressure pilot of the 1000 psig (69 bar) maximum inlet regulator in case the Type 1301F supply regulator fails open, this protection is insufficient if the main valve body fails open. Regulator operation within ratings does not preclude the possibility of damage from external sources or from debris in the lines. A regulator should be inspected for damage periodically and after any overpressure condition.

**WARNING**

**The 1000 psig (69 bar) maximum inlet regulator must not be used on hazardous gas service unless the Type H110 relief valve can be vented into a safe area. If vented gas can accumulate and become a hazard in enclosed conditions such as in a pit, underground, or indoors, the relief valve must be repiped to carry the gas to a safe location.**

**A repiped vent line or stack must be located to avoid venting gas near buildings, air intakes, or any hazardous location. The line or stack opening must be protected against condensation, freezing, and clogging.**

Clean out all pipelines before installation and check to be sure the regulator has not been damaged or collected foreign material during shipping.

Apply pipe compound to the male pipe threads only with a screwed body, or use suitable line gaskets and good bolting practices with a flanged body. This regulator may be installed in any position desired as long as the flow through the body is in the direction indicated by the arrow on the body. Install a three-valve bypass around the regulator if continuous operation is necessary during maintenance or inspection.

Although the standard orientation of the actuator and pilot to the main valve body is as shown in figure 1, this orientation may be changed as far as the inlet tubing (key 24, figure 9, or 11) will permit by loosening the union nut (key 14, figure 9), rotating the actuator lower casing (key 29, figure 9) as desired, and tightening the union nut. To keep the pilot spring case from being plugged or the spring case from collecting moisture,

corrosive chemicals, or other foreign material, the vent must be pointed down, oriented to the lowest possible point on the spring case, or otherwise protected. Vent orientation may be changed by rotating the spring case with respect to the pilot body, or on the extra high pressure pilot with optional tapped spring case by rotating the vent with respect to the spring case.

To remotely vent a low pressure pilot, install the vent line in place of the pressed-in vent assembly (key 60, figure 9). Install obstruction-free tubing or piping into the 1/4-inch vent tapping. Provide protection on a remote vent by installing a screened vent cap into the remote end of the vent pipe.

To remotely vent a high pressure pilot, or an extra high pressure pilot with optional tapped spring case, remove the screwed-in vent assembly (key 72, figure 9) from the high pressure pilot spring case or the pressed-in vent assembly from the extra high pressure pilot spring case and install obstruction-free tubing or piping into the 1/4-inch vent tapping. Provide protection on a remote vent by installing a screened vent cap into the remote end of the vent pipe.

An upstream pilot supply line is not required because of the integral pilot supply tubing (key 24, figure 9, or 11). However, as long as the 1/4-inch NPT tapping in the main valve body is plugged, this tubing may be disconnected from both the main valve and filter assembly (key 75, figure 9) in order to install a pilot supply line from a desired remote location into the filter.

If the maximum pilot inlet pressure will be exceeded by main valve pressure, install a separate reducing regulator (if not already provided) in the pilot supply line.

A Type 99 regulator has two 1/2-inch 14 NPT control line pressure taps on opposite sides of the lower casing (key 29, figure 9). The regulator normally comes from the factory with the tap closest to the regulator outlet left unplugged for the downstream control line as shown in figure 1, and with opposite tap plugged.

Attach the control line from the unplugged tap two to three feet (0.6 to 0.9 meter) downstream of the regulator in a straight run of pipe. If impossible to comply with this recommendation due to the pipe arrangement, it may be better to make the control line tap nearer the regulator outlet rather than downstream of a block valve. Do not make the tap near any elbow, swage, or nipple which might cause turbulence.

In many instances, it will be necessary to enlarge the downstream piping to keep flow velocities within good engineering practices. Expand the piping as close to the regulator outlet as possible.

**WARNING**

**Adjustment of the pilot control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring can cause personal injury or equipment damage due to bursting of pressure-containing parts or the dangerous accumulation of gases if the maximum actuator emergency casing pressure in table 1 is exceeded. If the desired outlet pressure is not within the range of the pilot control spring, install a spring of the proper range according to the Maintenance section.**

Each regulator is factory-set for the pressure setting specified on the order. If no setting was specified, outlet pressure was factory-set at the midrange of the pilot control spring. In all cases, check the control spring setting to make sure it is correct for the application.

## Startup

Key numbers are referenced in figure 9 for a low or high pressure pilot and in figure 12 for an extra high pressure pilot.

With proper installation completed and downstream equipment properly adjusted, perform the following procedure while using pressure gauges to monitor pressure.

1. Very slowly open the upstream block valve.
2. Slowly open the hand valve (if used) in the control line. The unit will control downstream pressure at the pilot control spring setting. See the adjustment paragraph following these numbered steps if changes in the setting are necessary during the startup procedure.
3. Slowly open the downstream block valve.
4. Slowly close the bypass valve, if any.
5. Check all connections for leaks.

The only adjustment on the regulator is the reduced pressure setting affected by the pilot control spring (key 43, figure 9 or 11). Remove the closing cap assembly (key 46, figure 9) and turn the adjusting screw (key 45, figure 9 or 11). Turning the adjusting screw clockwise into the spring case increases the controlled or reduced pressure setting. Turning the screw counterclockwise decreases the reduced pressure setting. Always replace the closing cap, if used, after making the adjustment.

## Shutdown

Isolate the regulator from the system. Vent the downstream pressure first; then vent inlet pressure to release any remaining pressure in the regulator.

## Principle of Operation

### Type 99

The regulator (figure 3) is pilot-loaded and the upstream or inlet pressure is utilized as the operating medium, which is reduced through pilot operation to load the main diaphragm chamber. Tubing connects the inlet pressure to the pilot through a filter assembly.

Downstream pressure registers underneath main diaphragm (E) through the downstream control line (not shown).

In operation, assume the downstream pressure is less than the setting of the pilot valve spring (A). The top side of pilot diaphragm assembly (F) will have a lower pressure than the setting of spring (A). Spring (A) forces the diaphragm head assembly upward, opening relay orifice (C). Additional loading pressure is supplied to the pilot body and to the top side of main diaphragm.

This creates a higher pressure on the top side of main diaphragm (E) than on the bottom side, forcing the diaphragm downward. This motion is transmitted through a lever, which pulls the valve disk open, allowing more gas to flow through the valve.

When the gas demand in the downstream system has been satisfied, the downstream pressure increases. The increased pressure is transmitted through the downstream control line and acts on top of the pilot diaphragm head assembly (F). This pressure exceeds the pilot spring setting and forces the head assembly down, closing relay orifice (C). The loading pressure acting on the main diaphragm (E) bleeds through a small slot provided in the pilot bleed valve seat to the downstream system. When rapid main valve closure is required by unusual control conditions, bleed valve (D) opens for increased bleed rate.

With a decrease in loading pressure on top of main diaphragm (E), main spring (B) exerts an upward force on the diaphragm rod connected to main diaphragm (E), pulling it upward. This moves the main valve toward its seat, decreasing flow to the downstream system.

Diaphragm (G) in the pilot valve acts as a sealing member for the loading chamber and as a balanced member to diaphragm (F). These two diaphragms are connected by a yoke so that any pressure change in the pilot chamber has little effect on the positioning of the pilot valve. Therefore the active diaphragm in the pilot is (F) and the pressure on the top side of this diaphragm opposes the force of pilot adjusting spring (A).

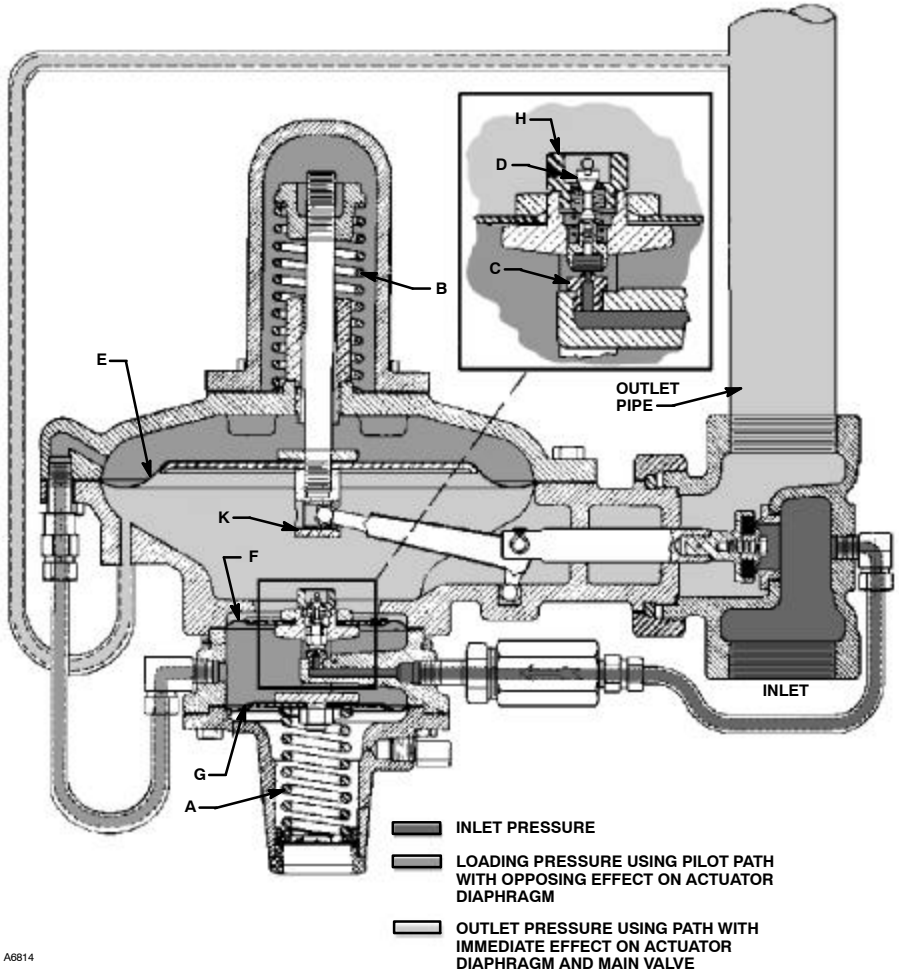



*Figure 3. Operational Schematic of Type 99 Regulator With a Type 61L (low pressure) Pilot*

## Type 99VSX

The safety shut-off disk of the 99VSX module (figure 4) is held in the open position (reset position) by a small ball holding the disk stem. In the open (or reset) position the travel indicator is visible through the clear reset button. If the pressure below the diaphragm increases (or decreases) reaching the Type VSX set-point, the diaphragm will travel upwards (or downwards) operating a lever which in turn releases the ball.

Once the ball is released, the spring force on the stem will push the stem and disk to the closed position against the seat shutting off all gas flow. The pilot supply pressure is also shut off when the Type VSX is closed. In the closed position, the travel indicator is no longer visible through the reset button. The manual reset has an internal bypass to equalize the reset pressure on either side on the shut-off disk.

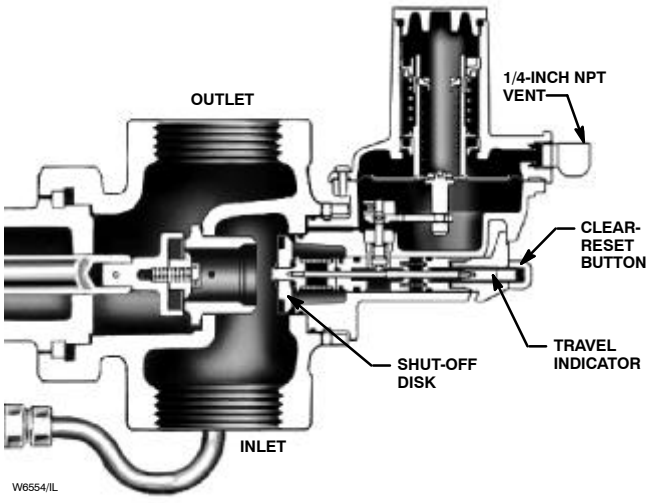



*Figure 4. Operational Schematic of Type 99VSX*

*Table 6. Type VSX Trip Pressure Ranges*

| | TYPE VSX WITH HIGH PRESSURE TRIP ONLY | |
|---|---|---|
| | **Minimum To Maximum Trip Pressure Inches of W.C. or Psig (mbar)** | **Spring Part Number** |
| High Pressure Set Point Ranges | 8 to 13 in. w.c. (19 to 33 mbar) | T13751T0012 |
| | 9 to 20 in. w.c. (22 to 49 mbar) | T13752T0012 |
| | 12 in. w.c. to 1.5 psig (29 to102 mbar) | T13753T0012 |
| | 20 in. w.c. to 2.5 psig (50 to172 mbar) | T13754T0012 |
| | 26 in. w.c. to 3.3 psig (64 to 230 mbar) | T13755T0012 |
| | 1.5 to 5.7 psig (104 to 390 mbar) | T13756T0012 |
| **TYPE VSX WITH HIGH AND LOW PRESSURE TRIP** | | |
| | **Minimum To Maximum Trip Pressure Inches of W.C. or Psig (mbar)** | **Spring Part Number** |
| High Pressure Set Point Ranges | 14 to 20 in. w.c. (34 to 50 mbar) | T13751T0012 |
| | 20 in. w.c. to 1.3 psig (50 to 90 mbar) | T13752T0012 |
| | 1.3 to 2.4 psig (90 to 165 mbar) | T13753T0012 |
| | 2.2 to 3.3 psig (150 to 225 mbar) | T13754T0012 |
| | 3.3 to 5.4 psig (225 to 370 mbar) | T13755T0012 |
| | 4.4 to 8.0 psig (300 to 550 mbar) | T13756T0012 |
| Low Pressure Set Point Ranges | 2 to 9 in. w.c. (6 to 23 mbar) | T13757T0012 |
| | 4 to 24 in. w.c. (10 to 60 mbar) | T13760T0012 |
| | 19 in. w.c. to 2.3 psig (48 to 160 mbar) | T13761T0012 |
| | 24 in. w.c. to 4.6 psig (60 to 320 mbar) | T13762T0012 |

# Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends on the severity of service conditions or the requirements of local, state, and federal rules and regulations.

**WARNING**

**Avoid personal injury or damage to property from sudden release of pressure or uncontrolled gas or other process fluid. Before starting to disassemble, isolate the pilot or regulator from all pressure and cautiously release trapped pressure from the pilot or regulator. Use gauges to monitor inlet, loading, and outlet pressures while releasing these pressures.**

On reassembly of the regulator, it is recommended that a pipe thread sealant be applied to pressure connections and fittings as indicated by PTS in figures 6 and 9, that Molykote(1) No. M88, Molylube(2) No. 80, or equivalent lubricants be applied to sliding and bearing surfaces as indicated by M.K. or M.L. in figures 6 and 9, and that an anti-seize compound be applied to adjusting screw threads and other areas indicated by A.S. in figures 9 and 11.

## Actuator and Standard P590 Series Filter

This procedure is to be performed if changing the main spring and spring seat for those of a different range, or if inspecting, cleaning, or replacing any other parts. Unless otherwise indicated, part key numbers for a Type 99 regulator with low or high pressure pilot and disk or O-ring seat are referenced in figure 9, part key numbers unique to the 1000 psig (69 bar) maximum inlet regulator are referenced in figure 11, and part key numbers for a Type 61HP (extra high pressure) pilot is referenced in figure 12.

1. Access to all internal actuator parts can be gained without removing the main valve body from the line. Disconnect the loading tubing from the upper casing.

**CAUTION**

**If the regulator has an indicator assembly, perform the following step carefully to avoid bending the travel indicator stem (key 103, figure 5).**

**Note**

**The O-rings and gaskets (keys 111 and 108, figure 5) in the indicator assembly are static seals and need not be disturbed, unless they are leaking.**

2. Remove the four cap screws (key 58, figure 9) and lift off the spring case (key 1, figure 9). Remove the travel indicator stem, if any, by unscrewing the indicator stem adapter (key 101, figure 5).

1. Trademark of Dow Corning Corp.
2. Trademark of Bel-Ray Co., Inc.

3. Remove the main spring seat (key 2, figure 9) and main spring (key 3, figure 9).

4. Remove the twelve cap screws (key 12, figure 9) and hex nuts (key 13, figure 9), and lift off the upper casing.

5. Remove the diaphragm (key 11, figure 9) and diaphragm plate (key 10, figure 9) by tipping it so that the lever (key 9, figure 9) slips out of the pusher post (key 8, figure 9).

6. Separate the diaphragm and diaphragm plate by unscrewing the diaphragm rod (key 4, figure 9) from the pusher post. Inspect the diaphragm (key 11, figure 9) and pusher post gasket (key 7, figure 9). Either part must be replaced if it is damaged or no longer pliable.

7. If the unit has a stem seal O-ring (key 64, figure 6 or 11), this O-ring may be replaced by removing the retaining ring or cotter pin (key 28, figure 9) and disconnecting the lever from the valve carrier (key 26, figure 9 or 11), unscrewing the union nut (key 14, figure 9 or 11), disconnecting the pilot supply tubing (key 24, figure 9 or 11), and sliding the lower casing (key 29, figure 9) away from the valve body (key 17, figure 9), with a disk or O-ring seat, the valve carrier must be pulled out of the lower casing to gain access to the O-ring. Another O-ring, held captive by the pressed-in bushing, is part of the lower casing assembly on a stem seal unit and normally does not require replacement.

8. If clogging is suspected in the upstream regulator passages, disconnect the pilot supply tubing (key 24, figure 9 or 11), remove the filter assembly (key 75, figure 9), and blow through it to check for filter clogging. If necessary, to clean or replace filter parts in a standard P590 Series filter assembly, remove the following as shown in figure 7: filter body (key 1), machine screw (key 4), spring washer (key 6), gasket (key 7), washer (key 5), and filter element (key 2). Upon reassembly, one of the flat washers must go between the filter element and filter head (key 3) and the other must go between the filter element and gasket.

9. If the lower casing was removed, install a new body gasket (key 16, figure 9) and, with a disk or O-ring seat, slide the valve carrier into the casing. Then slide the entire assembly into the valve body (disk or O-ring seat) and secure with the union nut. Secure the lever to the valve carrier with the retaining ring or cotter pin.

10. Loosely reassemble the diaphragm and diaphragm plate so that the bolt holes and loading connection hole in the diaphragm can be properly aligned with the corresponding holes in the casing when the lever is fitted properly into the pusher post. When this orientation is made, install the collar (key 6, figure 9) and tighten the diaphragm rod into the pusher post (key 8, figure 9).

11. In order for the regulator to operate properly, the assembled collar, diaphragm, diaphragm plate, pusher post, and diaphragm rod must be mounted on the ball of the lever so that the pusher post (key 8, figure 9) orientation is as shown in figure 9.

12. Install the upper casing and secure it to the lower casing with the twelve cap screws and hex nuts. Put lower casing back on body and install union nut.

**CAUTION**

**To avoid part damage due to overcompressing the main spring seat, always use main spring seat 1E242724092 with main spring OW019127022.**

13. Install the main spring and main spring seat, turning the main spring seat until its bottom shoulder is even with the bottom thread of the diaphragm rod.

14. Install a new spring case gasket (key 57, figure 9), the spring case, and the four cap screws, making sure the indicator stem, O-ring, and gaskets (keys 103, 111, and 108, figure 5) are installed if used.

15. Connect the loading tubing, then refer to the Start-up section for putting the regulator into operation.

## Types 61L, 61LD, 61LE (low) or 61H (high pressure) Pilots

This procedure is to be performed if changing the control spring for one of a different range, or if inspecting, cleaning or replacing any other pilot parts. Key numbers are referenced in figure 9.

1. Remove the closing cap (key 46) if used and unscrew the adjusting screw (key 45) to relieve control spring compression.

2. Disconnect the loading tubing (key 53) and pilot supply tubing (key 24).

3. Unscrew the eight cap screws (key 47) and remove the pilot assembly from the lower casing (key 29).

4. Use the projecting prong in the relay valve body (key 39) as the restraining member and remove the diaphragm nuts (key 13 and 51). Separate the parts and inspect the diaphragms (key 30 and 40) and O-ring seal (key 33). Replace if worn or damaged.

5. Unscrew the bleed orifice (key 52) from the yoke (key 37). Also removed with the bleed orifice are the relay disk assembly (key 48) and bleed valve (key 50). These parts can be unscrewed for inspection and replacement, if necessary.

6. When reassembling the pilot, the relay disk holder assembly and both diaphragms should be tightened on the yoke after it is placed in the body.

**Note**

**Before putting the relay spring case over the diaphragm, make certain the yoke is square with respect to the prong in the relay body. (The yoke can bind on the prong if it is not square.)**

7. Use care in reassembly to be sure the edges of the diaphragms slip properly into the recess on the lower casing and relay valve body. With the pilot in place, check to see if it can be rocked. If it does not rock, it is in place and the diaphragm is free of wrinkles. With both diaphragms firmly in place, the eight cap screws can be installed. Draw them up evenly using a crisscross pattern to avoid placing a strain on the unit, tightening to a final bolt torque of about 12.5 foot-pounds (17 N·m) to avoid crushing the diaphragm. Set the pilot control spring (key 43) according to the adjustment information in the Startup section.

8. Reinstall the closing cap (key 46, if used). If you have a plastic closing cap, be sure that you have a vent (key 60) inplace of the pipe plug installed in the low pressure pilot spring case.

## Type 61HP (extra high pressure) Pilot

This procedure is to be performed if changing the control spring for one of a different range, or if inspecting, cleaning, or replacing any other pilot parts. Key numbers are referenced in figure 12.

1. Unscrew the adjusting screw (key 45) to relieve control spring compression.

2. Disconnect the loading tubing and pilot supply tubing.

3. Remove the six cap screws (key 123) which fasten the spring case (key 44) spring seat (key 68) and control spring (key 43) to the pilot body.

4. Unscrew the diaphragm nut (key 128) and remove a diaphragm plate (key 41), diaphragm (key 40), and another diaphragm plate.

5. Unscrew the eight cap screws and remove the pilot body (key 39) and gasket. Remove six cap screws, seal washers and the flange adapter.

6. Unscrew the relief valve body (key 119) and remove a diaphragm plate, diaphragm, and another diaphragm plate. Inspect the diaphragm inserts (key 150) and both diaphragms. Replace if worn or damaged.

7. The relief valve assembly can be further disassembled for inspection by unscrewing the relief valve cap (key 118).

8. Four machine screws (key 130) hold both yoke caps (key 37 and 116) to the yoke legs (key 31). Separate these parts to expose the pilot valve.

9. Unscrew the inlet orifice (key 38) to inspect its seat, the inlet valve plug (key 117), and valve spring (key 124).

**Note**

**Make certain that the yoke assembly is square with respect to the cross member of the body casting so that it will not bind on the body.**

10. When reassembling, screw in the inlet orifice all the way and secure the yoke caps to the yoke legs. Replace two diaphragm plates, the diaphragms, and inserts, two more diaphragm plates, the hex nut, and the relief valve assembly.

11. Assemble the control spring and spring seat into the body and spring case, being careful that the diaphragms are free of wrinkles and properly in place, and evenly installing the six cap screws in a crisscross pattern to avoid placing a strain on the unit. Install the body flange adapter with six seal washers and cap screws. Install a new gasket and secure the pilot to the lower casing with eight cap screws. Set the control spring according to the adjustment information in the Startup section.

## Converting the Pilot

**Note**

**A complete pilot assembly rather than individual parts may be ordered for the following conversion procedure. When a low pressure pilot is ordered for field conversion of a high pressure pilot or vice versa, the replacement pilot assembly comes complete with a pilot cover (key 132, figure 9). Remove this cover before installing replacement pilot on the existing regulator. The cover can then be installed on the removed pilot to form a complete Type 61 (low or high pressure) pilot for use elsewhere.**

When changing one pilot construction (low pressure, high pressure, or extra high pressure) for another, all parts attached to the lower casing (key 29, figure 9) may need to be replaced with those appropriate for the desired construction. At the very least, when changing from a low to high pressure pilot or vice versa, everything below the lower pilot diaphragm (key 40, figure 9) except the cap screws and the hex nut (key 47 and 13, figure 9) will need to be replaced. Actuator and main valve parts may remain unchanged unless a change in service conditions requires a change in seat construction, main spring, or main spring seat. See the Parts List sections for obtaining the appropriate conversion parts.

### Main Valve Trim with Disk or O-Ring Seat

This procedure is to be performed if inspecting, cleaning, or replacing trim parts. Part key numbers for a Type 99 regulator with disk or O-ring seat are referenced in figure 9, and part key numbers for the disk seat unique to the 1000 psig (69 bar) maximum inlet regulator are referenced in figure 11.

**Note**

**All trim maintenance may be performed with the valve body (key 17, figure 9 or 11) in the line and with the elbow (key 23, figure 9 or 11), pilot supply tubing (key 24, figure 9 or 11), and pilot supply regulator (key 155, figure 11, if used) attached to the valve body unless the valve body itself will be replaced.**

1. Disconnect the pilot supply tubing and downstream control line.

2. Loosen the union nut (key 14, figure 9) and remove the lower casing (key 29, figure 9) with the cap screw (key 22, figure 9) or disk and holder assembly (key 18, figure 11) on disassembly or reassembly. A thin-walled socket may be used to remove the orifice.

3. On a Type 99 regulator, access to the disk or O-ring (key 19, figure 9) can be gained by removing the cap screw and retainer (key 21, figure 9), while on the 1000 psig (69 bar) maximum inlet regulator the entire disk and holder assembly is removed as a unit. If necessary, the holder (key 18, figure 9 or 11) or adapter (key 157, figure 11) can be removed by taking out the cotter pin (key 25, figure 9 or 11).

4. Install a new body gasket (key 16, figure 9) and a new disk, O-ring, or disk and holder assembly as necessary. Then slide the entire assembly into the valve body and secure with the union nut.

5. Connect the pilot supply tubing and downstream control line, then refer to the Startup section for putting the regulator into operation.

## Type VSX Installation, Maintenance and Reset

### Installation

Place new o-rings (keys 2 and 3, figure 8) on the VSX module and slide the module into the Type 99 body (key 17, figure 8). Secure to Type 99 body with four set screws. The VSX module may be oriented in any direction with respect to the sensor line connection.

### Maintenance

The VSX module (key 1, figure 8) is designed to be removed as a unit from the Type 99 body (key 17, figure 8) and be replaced as a complete unit. The high and low pressure springs may be adjusted or replaced without removing the module from the Type 99 body.

The only replaceable parts in the VSX module are the o-rings (keys 2 and 3, figure 8) and the high and low pressure set point springs (keys 7 and 8, figure 8).

### Reset

1. Push in reset button and rotate it slightly to open equalizing bypass.

2. Turn the button 180° and pull out on button until it stops. The VSX plug is reset.

3. Push in on the button while turning it 180° until it rests behind the tab. Release the button so it is in contact with the tab.

4. The VSX is now reset

5. The high and low pressure VSX can only be reset if the Type 99 outlet pressure is between maximum and minimum VSX set points.

## Parts Ordering

A serial number is assigned to each regulator, and this number is stamped on both the actuator and pilot nameplates. If the pilot is replaced, the new pilot will have its own serial number different from the main regulator serial number. Always indicate one or both serial numbers when communicating with your Fisher representative regarding replacement spare parts or technical information.

When ordering a replacement part, be sure to include the complete eleven-character part number from the following parts list

## Parts List

| Key | Description | Part Number |
|---|---|---|
| | Repair kits include parts for regulator with composition trim only, key numbers 7, 11, 16, 19, 20, and 57. Also included are parts for pilot, key numbers 30, 33, 38, 40, 48, 49, 50, 52, 71, 117, 126, 129, 150, 153 and P590 Series filter, key numbers 2 and 7. | |
| | With low pressure pilot | |
| | 7/8-inch (22.2 mm) orifice | R99LX000012 |
| | 1-1/8-inch (28.6 mm) orifice | R99LX000022 |
| | With high pressure pilot | |
| | 7/8-inch (22.2 mm) orifice | R99HX000012 |
| | 1-1/8-inch (28.6 mm) orifice | R99HX000022 |
| | With extra high pressure pilot | |
| | 7/8-inch (22.2 mm) orifice | R99HPX00012 |
| | 1-1/8-inch (28.6 mm) orifice | R99HPX00022 |

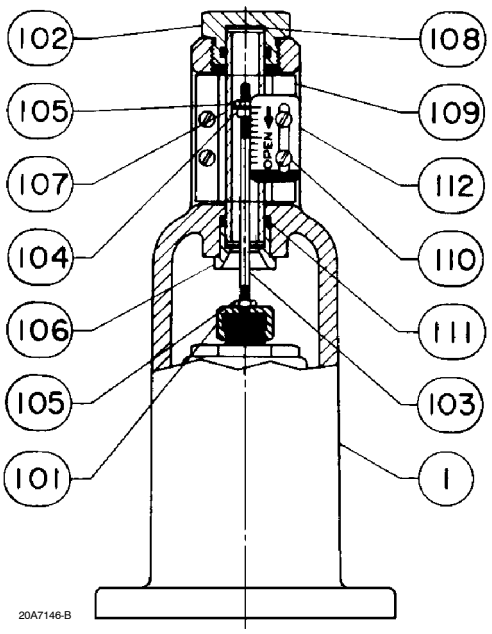



*Figure 5. Travel Indicator Assembly*

## Travel Indicator Assembly (figure 5)

| Key | Description | Part Number |
|---|---|---|
| | Complete Assembly (includes individual parts listed below) | BI2868000A2 |
| 1 | Spring Case, cast iron | 2L296209012 |
| 101 | Indicator Stem Adaptor, aluminum | 1R395909012 |
| 102 | Indicator Cap, aluminum | 1L290809012 |
| 103 | Indicator Stem, aluminum | 1L296509022 |
| 104 | Disk Nut, plastic | 1F730506992 |
| 105 | Machine Screw Nut, plated steel (2 req d) | 1A342024152 |
| 106 | Retainer, aluminum | 1L291009012 |
| 107 | Indicator Window, glass | 1L296706992 |
| 108* | Gasket, neoprene (2 req d) | 1L291103012 |
| 109* | Indicator Cover, plastic (2 req d) | 1L296405032 |
| 110 | Machine Screw, plated steel (8 req d) | 1A331928982 |
| 111* | O-Ring, nitrile (2 req d) | 1E591406992 |
| 112 | Indicator Scale, SST | 1J511638982 |

## Actuator and Main Body (figures 6, 9, 10, and 11)

| Key | Description | Part Number |
|---|---|---|
| 1 | Standard Spring Case w/o travel indicator, cast iron | 1B883119012 |
| 2 | Main Spring Seat, zinc plated steel | |
| | 250 psi (17 bar differential) max allowable pressure drop , cast iron | 1B883219042 |
| | 1000 psi (69 bar differential) max allowable pressure drop (requires main spring seat 1E242724092) | 1E242724092 |
| 3 | Main Spring, zinc plated steel | |
| | 25 psi (1.7 bar differential) max allowable pressure drop | 1C277127022 |
| | 50 psi (3.4 bar differential) max allowable pressure drop | 1N801927022 |
| | 250 psi (17 bar differential) max allowable pressure drop | 1B883327022 |
| | 1000 psi (69 bar differential) max allowable pressure drop (requires main spring seat 1E242724092) | 0W019127022 |
| 4 | Diaphragm Rod, 416 stainless steel | 1B883435232 |
| 5 | Diaphragm Rod Guide | |
| | Brass w/bronze insert | 1D9712000A2 |
| | 316 stainless steel | 1B883535072 |
| 6 | Collar | |
| | Brass | 1B883614012 |
| | 316 stainless steel | 1B883635072 |
| 7* | Pusher Post Gasket, composition | 1B883704022 |
| 8 | Pusher Post | |
| | Brass w/bronze insert | 1D9714000A2 |
| | 316 stainless steel | 1B883835072 |
| 9 | Lever, steel | 2F823423072 |
| 10 | Diaphragm Plate, zinc plated steel | 1B989225072 |
| 11* | Diaphragm | |
| | Nitrile | 1B884102052 |
| | Fluoroelastomer | 1N378902312 |
| 12 | Cap Screw, plated steel (12 req d) | 1B884224052 |
| 13 | Hex Nut, zinc plated steel (13 req d) | 1A340324122 |
| 14 | Union Nut, iron | 0Z017619062 |
| 15 | Body Snap Ring, zinc plated steel | 0Y095828982 |
| 16* | Body Gasket, composition | 1A348004032 |
| 17 | Valve Body | |
| | 2-inch NPT | |
| | Cast iron | 1C254619012 |
| | Steel | 2N153522012 |
| | Brass | 1C254612012 |
| | 2-inch Class 125 flanged cast iron | 2D986519012 |
| | 2-inch Class 250 flanged cast iron | 2D986619012 |
| | 2-inch Class 150 flanged | |
| | Steel | 2E275622012 |
| | Brass | 2N379012012 |
| | 2-inch Class 300 flanged | |
| | Steel | 2E275722012 |
| | Brass | 2N379112012 |
| | Type VSX valve bodies | Consult Factory |
| 18 | Holder for Type 99 regulator | |
| | Disk seat | |
| | Brass | 1B884314012 |
| | 316 stainless steel | 1B884335072 |
| | O-Ring Seat | |
| | 7/8-inch (22.2 mm) orifice | |
| | Brass | 1E603214012 |
| | 316 stainless steel | 1E603235072 |
| | 1-1/8-inch (28.6 mm) orifice | |
| | Brass | 1E342414012 |
| | 316 stainless steel | 1E342435072 |



*Recommended spare parts

| Key | Description | Part Number |
|---|---|---|
| 18* | Disk & Holder Assy for 1000 psig (69 bar) max inlet regulator, nylon/316 stainless steel | 1C1860000B2 |
| 19 | Disk for Type 99 Regulator | |
| | 250 psi (17 bar differential) max allowable pressure drop | |
| | Neoprene | 1C997403032 |
| | Nitrile | 1C158703332 |
| | Fluoroelastomer | 1C9974X0012 |
| | 400 psi (28 bar differential) max allowable pressure drop | |
| | Nylon | 1E480603152 |
| | TFE | 1C997406242 |
| 19* | O-Ring | |
| | 7/8-inch (22.2 mm) orifice | |
| | Nitrile | 1D237506992 |
| | Fluoroelastomer | 1D237506382 |
| | 1-1/8-inch (28.6 mm) orifice | |
| | Nitrile | 1H8498X0012 |
| | Fluoroelastomer | 1H8498X0032 |
| 20* | Orifice | |
| | Disk seat for all regulators | |
| | 3/8-inch (9.5 mm) orifice | |
| | Brass | 19A73901412 |
| | 416 stainless steel | 19A7390X012 |
| | 1/2-inch (12.7 mm) orifice | |
| | Brass | 14A84101412 |
| | 416 stainless steel | 14A8410X012 |
| | 9/16-inch (14.3 mm) orifice | |
| | Brass | 10B22541412 |
| | 416 stainless steel | 10B2254X012 |
| | 5/8-inch (19.9 mm) orifice | |
| | Brass | 19A73911412 |
| | 416 stainless steel | 19A7391X012 |
| | 7/8-inch x 3/8-inch (22.2 x 9.5 mm) orifice | |
| | Brass | 1N878114012 |
| | 316 stainless steel | 1N8781X0012 |
| | 7/8-inch x 1/2-inch (22.2 x 12.7 mm) orifice | |
| | Brass | 1C942314012 |
| | 316 stainless steel | 1C942335072 |
| | 7/8-inch x 5/8-inch (22.2 x 19.9 mm) orifice | |
| | Brass | 1C942414012 |
| | 316 stainless steel | 1C9424X0012 |
| | 3/4-inch (19.1 mm) orifice | |
| | Brass | 1C780414012 |
| | 316 stainless steel | 1C780435072 |
| | 7/8-inch (22.2 mm) orifice | |
| | Brass | 1C394714012 |
| | 316 stainless steel | 1C394735072 |
| | 1-inch (25.4 mm) orifice | |
| | Brass | 13A5017X012 |
| | 1-1/8-inch (28.6 mm) orifice | |
| | Brass | 1B884414012 |
| | 316 stainless steel | 1B884435072 |
| | 1/2-inch (12.7 mm) disk seat for 1000 psig (69 bar) max inlet regulator, 416 stainless steel | 14A8410X012 |
| | O-Ring seat for all regulators | |
| | 7/8-inch(22.2 mm) orifice | |
| | Brass | 1E603014012 |
| | 316 stainless steel | 1E603035072 |
| | 1-1/8-inch (28.6 mm) orifice | |
| | Brass | 1E342514012 |
| | 316 stainless steel | 1E342535072 |
| | Type VSX seat ring | Consult Factory |

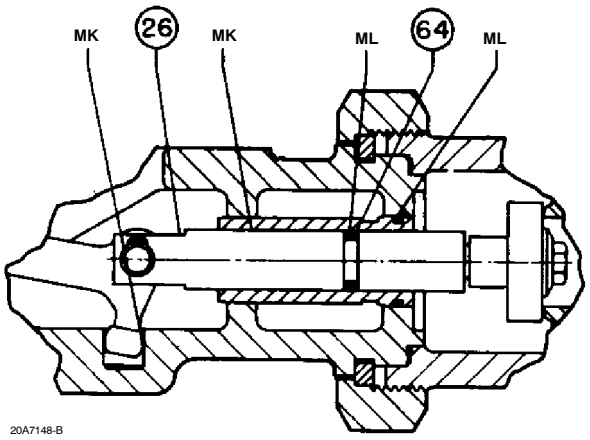



*Figure 6. O-Ring Stem Seal*

| Key | Description | Part Number |
|---|---|---|
| 21 | Retainer | |
| | Disk seat (19.1 mm) | |
| | All except 3/4-inch (19.1 mm) or 1-1/8-inch (28.6 mm) orifice or 1000 psig (69 bar) max inlet regulator | |
| | Brass | 1C394814012 |
| | 303 stainless steel | 1C394835072 |
| | 3/4-inch (19.1 mm) orifice | |
| | Brass | 1C780314012 |
| | 316 stainless steel | 1C7803X0012 |
| | 1-1/8-inch (28.6 mm) orifice | |
| | Brass | 1B884514012 |
| | 316 stainless steel | 1B884535072 |
| | O-Ring seat for all regulators | |
| | 7/8-inch (22.2 mm) orifice | |
| | Brass | 1E603114012 |
| | 316 stainless steel | 1E603135072 |
| | 1-1/8-inch (28.6 mm) orifice | |
| | Brass | 1E342614012 |
| | 316 stainless steel | 1E342635072 |
| 22 | Cap Screw, plated steel | 1A391724052 |
| 25 | Cotter Pin, 316 stainless steel | 1B108438992 |
| 26 | Valve Carrier | |
| | Brass | 1E597114072 |
| | 416 stainless steel | 1E597135132 |
| 27 | Lever Pin | |
| | 316 stainless steel | 1B884935162 |
| | 303 stainless steel | 1C911635032 |
| 28 | Retaining Ring for brass trim, plated steel (2 req d) | 1B885028982 |
| 28 | Cotter Pin for stainless steel trim, 316 stainless steel (2 req d) | 1A866537022 |
| 29 | Lower Casing, cast iron | |
| | Standard | 4B983719012 |
| | For use with optional protector, spring washer, & machine screw (keys 61, 62, & 63) | 2N379419012 |
| 29 | Lower casing Assy for use w/O-ring stem seal, cast iron w/SST guide bushing | |
| | Complete w/nitrile O-ring | 2R7230000A2 |
| | Complete w/fluoroelastomer O-ring | 2R7230X0022 |
| 32 | Nameplate, aluminum | 14A1711X012 |

*Recommended spare parts

| Key | Description | Part Number |
|---|---|---|
| 56 | Upper Casing, cast iron | 3B887619012 |
| 57* | Spring Case Gasket, composition | 1B8877X0012 |
| 58 | Cap Screw, plated steel (4 req d) | 1A675124052 |
| 61(1) | Optional Lower Casing Protector (not shown) | |
| | Brass | 1N379514012 |
| 62(1) | Optional Spring Washer (not shown) | |
| | Zinc plated brass (2 req d) | 1N339518992 |
| 63(1) | Optional Machine Screw (not shown) | |
| | Zinc plated brass (2 req d) | 1H340518992 |
| 64* | O-Ring (for use only w/O-ring stem seal) | |
| | Nitrile | 1E220206992 |
| | Fluoroelastomer | 1R620106382 |
| 73 | Pipe plug, zinc plated steel (not shown) | 1A767524662 |
| 75 | Standard P590 Series Filter Assembly (parts listed under separate heading) | |
| | Type P594-1, brass | FSP594-1 |
| | Type P593-1, aluminum | FSP593-1 |
| 77 | Bonnet | |
| | Cast iron | 2V610219022 |
| | Steel | 2V610422012 |
| 133 | Pipe Elbow | |
| | Plated steel | 1B860828992 |
| 134 | Pipe Nipple | |
| | Plated steel | 1B218826232 |
| 152 | Drive Screw, 18-8 stainless steel (4 req d for low pressure pilot and 6 req d for high pressure pilot) | 1A368228982 |
| 155 | Type 1301F Pilot Supply Regulator (2) (for use only w/extra high pressure pilot) | See footnote 2 |
| 156 | Type H110 Pop Relief Valve, (for use only w/extra high pressure pilot) brass w/nitrile disk & 316 stainless steel spring | Consult Factory |
| 157 | Adaptor for 1000 psig (69 bar) max inlet regulator, 416 stainless steel | 14A8411X012 |
| 159 | Tag (for use only w/O-ring stem seal and extra high pressure pilot) alloy 1100 (not shown) | 16A0957X012 |

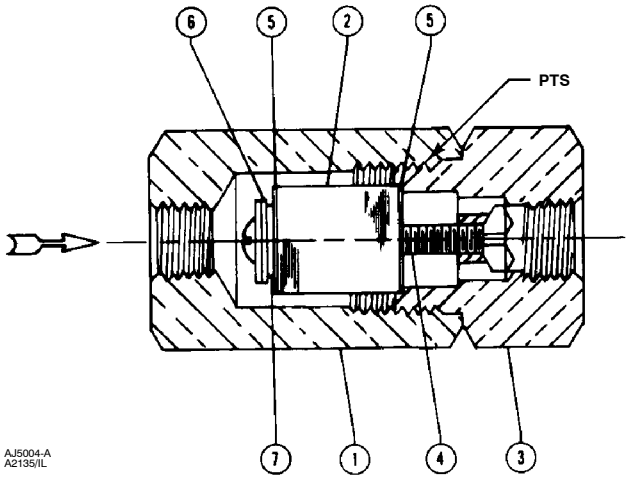



*Figure 7. Standard P590 Series Filter Assembly*

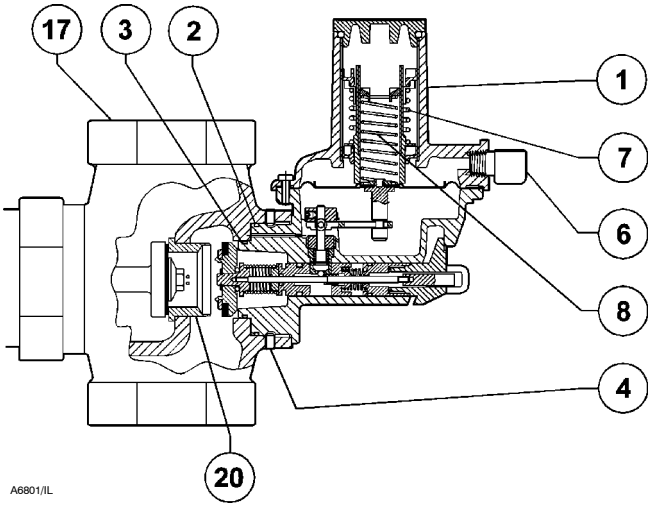



*Figure 8. Type VSX Module*

## Standard P590 Series Filter Assembly (figure 7)

| Key | Description | Part Number |
|---|---|---|
| 1 | Filter Body | |
| | Type P594-1, brass | 1E312414012 |
| | Type P593-1, aluminum | 1E312409012 |
| 2* | Filter Element, cellulose | 1E312606992 |
| 3 | Filter Head | |
| | Type P594-1, brass | 1E312514012 |
| | Type P593-1, aluminum | 1E312509012 |
| 4 | Machine Screw | |
| | Type P594-1, brass | 1J500218992 |
| | Type P593-1, aluminum | 1J500209012 |
| 5 | Washer (2 req d) | |
| | Type P594-1, brass | 1J500018992 |
| | Type P593-1, aluminum | 1J500010062 |
| 6 | Spring Washer, plated carbon steel | 1H885128982 |
| 7* | Gasket, composition | 1F826804022 |

## Type VSX Module (figure 8)

| Key | Description | Part Number |
|---|---|---|
| 1 | VSX Module | |
| | High and low pressure shutoff | T13750T0012 |
| | High pressure shutoff only | T13750T0022 |
| 2 | Upper O-ring | T13769T0012 |
| 3 | Lower O-ring | T13770T0012 |
| 4 | Set Screw | 1C629828992 |
| 6 | Vent Assembly | 27A5516X012 |
| 7 | Control Spring, zink plated steel | |
| | High pressure | |
| | 13.6 to 20-inches w.c. (34 to 50 mbar) | T13751T0012 |
| | 20 to 36-inches w.c. (50 to 90 mbar) | T13752T0012 |
| | 1.3 to 2.4 psi (90 to 165 mbar) | T13753T0012 |
| | 2.2 to 3.5 psi (150 to 225 mbar) | T13754T0012 |
| | 3.25 to 5.4 psi (225 to 370 mbar) | T13755T0012 |
| | 4.4 to 8.0 psi (300 to 550 mbar) | T13756T0012 |



* Recommended spare part
1. Required with lower casing 2N379419012
2. Specific pilot supply regulator parts may be found in the Types 1301F and 1301G instruction manual.

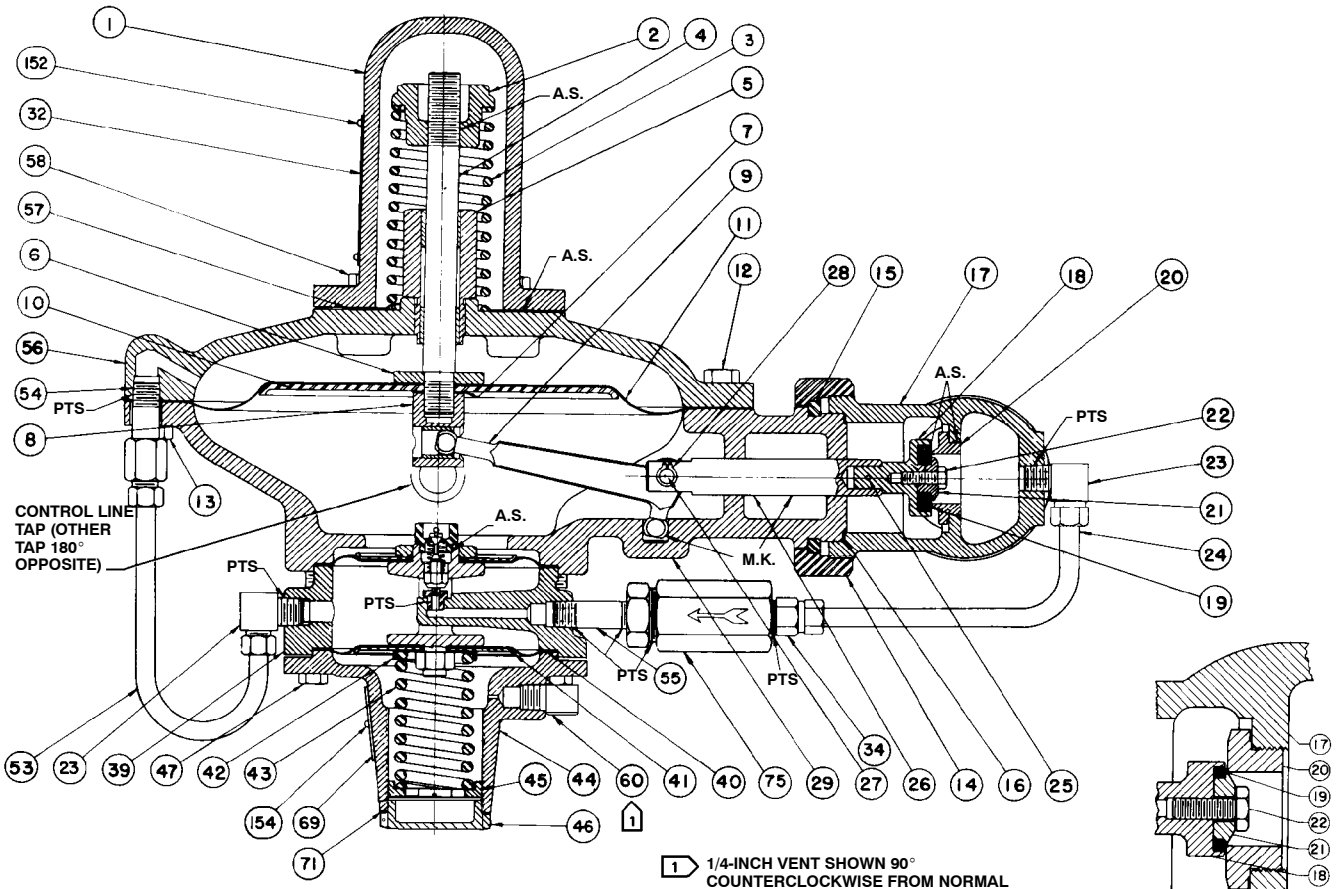
| Key | Description | Part Number |
|---|---|---|
| 8 | Control Spring, zink plated steel | |
| | Low pressure | |
| | 2.4 to 9.2-inches w.c. (6 to 23 mbar) | T13757T0012 |
| | 4 to 24-inches w.c. (10 to 60 mbar) | T13760T0012 |
| | 0.7 to 1.25 psi (40 to 160 mbar) | T13761T0012 |
| | 0.9 to 4.6 psi (60 to 320 mbar) | T13762T0012 |

## Pilot and Tubing Parts[3] Low or High Pressure Pilot (figure 9)

| Key | Description | Part Number |
|---|---|---|
| 13 | Hex Nut, zinc plated steel (13 req d) | 1A340324122 |
| 23 | Elbow (2 req d) | |
| | Brass | 15A6002X292 |
| | Aluminum | 15A6002X402 |
| | 316 stainless steel | 15A6002X612 |
| 24 | Pilot Supply Tubing | |
| | Disk or O-ring main valve seat | |
| | Copper | 1D8793000A2 |
| | Aluminum | 1L917511072 |
| | 317 stainless steel | 1L9175X6012 |
| 30* | Upper Relay Diaphragm | |
| | Nitrile | 1B885202052 |
| | Fluoroelastomer | 1N162802332 |
| 31 | Upper Relay Diaphragm Plate, plated steel | |
| | For use w/all low pressure pilots except LE | 1B989225072 |
| | For use w/all high pressure pilots & LE low pressure pilot | 1D558425072 |
| 33* | O-Ring Seal | |
| | Nitrile | 1B885506992 |
| | Fluoroelastomer | 1B8855X0012 |
| 34 | Connector | |
| | Brass | 1D692214012 |
| | Aluminum | 15A6002X392 |
| | 316 stainless steel | 15A6002X602 |
| 37 | Yoke | |
| | Zinc | 1D662544012 |
| | Cast iron | 1B984019012 |
| 38* | Relay Orifice, stainless steel | |
| | For use w/25 psi (1.7 bar) max allowable pressure drop actuator main spring | 1D373735032 |
| | For use w/all other main springs | 1C520135032 |
| | For use w/oxygen service | 1N162314042 |
| 39 | Relay Valve Body, cast iron | 2J581919012 |
| 40* | Lower Relay Diaphragm | |
| | Low pressure pilot | |
| | Nitrile | 1B886002052 |
| | Fluoroelastomer | 1N536102332 |
| | High pressure pilot | |
| | Nitrile | 1B894202192 |
| | Fluoroelastomer | 1N162702302 |
| 41 | Lower Relay Diaphragm Plate, plated steel | |
| | Low pressure pilot | 1B989425072 |
| | High pressure pilot | 1D558325072 |
| 42 | Spring Seat, zinc plated steel | |
| | Low pressure pilot | 1B886225072 |
| | High pressure pilot | 1D558525072 |
| 43 | Control Spring, zinc plated steel | |
| | for use only w/LD low pressure pilot | |
| | 0 to 4-inches w.c. (0 to 10 mbar) range, orange | 1B558527052 |
| | 3 to 12-inches w.c. (7 to 30 mbar) range, silver | 1C680627222 |
| | For use w/all low pressure pilots | |
| | 0.25 to 2 psig (17 to 138 mbar) range, red | 1B886327022 |
| | 1 to 5 psig (0.069 to 0.34 bar) range, yellow | 1J857827022 |
| | 2 to 10 psig (0.14 to 0.69 bar) range, blue | 1B885427022 |
| | 5 to 15 psig (0.34 to 1.0 bar) range, brown | 1J857927142 |
| | 10 to 20 psig (0.69 to 1.4 bar) range, green | 1B886527022 |
| | For use w/high pressure pilot, green stripe | 0Y066427022 |
| 44 | Spring Case, cast iron | |
| | Low pressure pilot | 1B983919012 |
| | High pressure pilot | |
| | Standard | 1B984119012 |
| | For use w/closing cap (not shown) | 1H232619012 |
| 45 | Adjusting Screw | |
| | Low pressure pilot | |
| | Standard, zinc | 1B537944012 |
| | Handwheel-style, plated steel | 1J496428982 |
| | O-ring seated handwheel assembly | 1R759414012 |
| | High pressure pilot, plated steel | |
| | Standard | 1A279128982 |
| | For use w/closing cap 1H236514012 | 1J881524102 |
| 46 | Closing Cap | |
| | For use w/std low pressure pilot, plastic | T11069X0012 |
| | For use w/handwheel-style low pressure pilot, brass (not shown) | 1A926114012 |
| | For use w/O-ring sealed handwheel assembly | 1R759314012 |
| | For use w/high pressure pilot w/spring case 1H232619012, brass (not shown) | 1H236514012 |
| 47 | Cap Screw, plated steel (8 req d) | 1B989624052 |
| 48* | Relay Disk Ass y | |
| | Brass/Nitrile | 1B8868000A2 |
| | 303 stainless steel/Nitrile | 1B8868000B2 |
| | Brass/Fluoroelastomer | 1B8868X0012 |
| | 303 stainless steel/Fluoroelastomer | 1B8868X0022 |
| 49* | Bleed Valve Spring, stainless steel | |
| | For use w/low pressure pilot w/relay orifice 1D373735032 or bleed valve 1H951635132 | 1E643637022 |
| | For use w/all low and high pressure pilots | |
| | Inlet pressure to 250 psig (17 bar) | 1C911537022 |
| | Inlet pressure over 250 psig (17 bar) | 1N859137022 |
| 50* | Bleed Valve, stainless steel | |
| | For use w/LD low pressure pilot w/bleed valve spring 1E643637022 | 1H951635132 |
| | For use w/all low and high pressure pilots | 1D986735132 |

* Recommended spare part

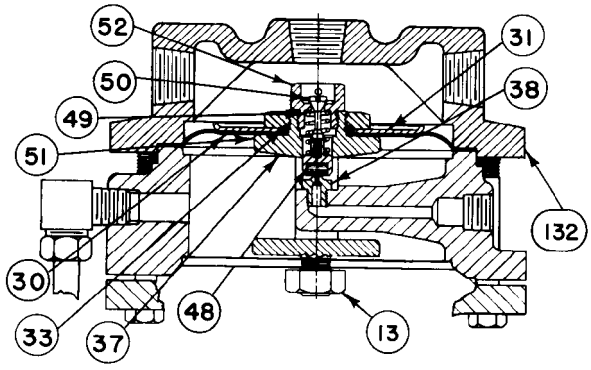
3. An entire pilot assembly may be ordered from your Fisher representative by specifying a 61L, a 61H, or a 61HP pilot for field conversion.



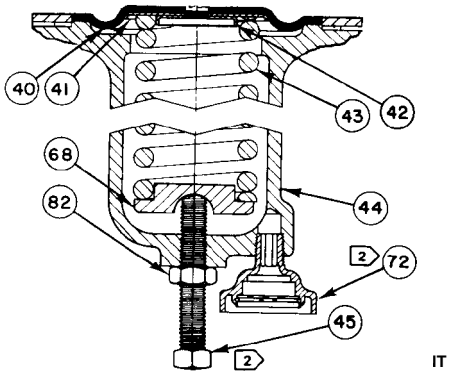

COMPLETE REGULATOR SHOWING 61L PILOT AND DISK SEAT



O-RING SEAT DETAIL



PILOT RELAY AND COVER DETAIL



HIGH PRESSURE PILOT PARTS

DJ6642-C
14A8370-A
30A6800-C
C0289-1/IL

*Figure 9. Type 99 Regulator with 61L (low) or 61H (high pressure) Pilot*

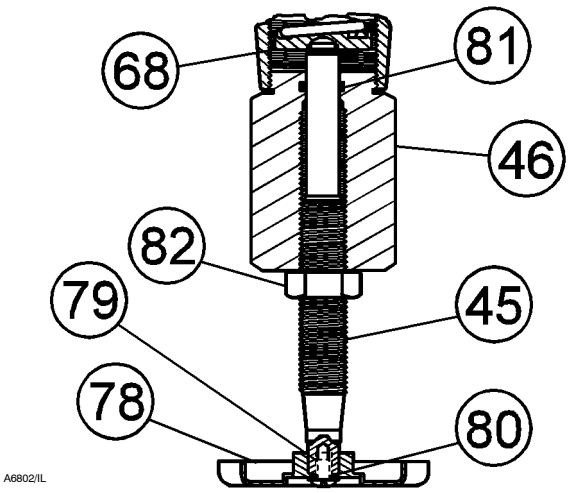



*Figure 10. Type 99 O-Ring Sealed Handwheel*

| Key | Description | Part Number |
|---|---|---|
| 51 | Diaphragm Nut | |
| | Brass | 1B989514012 |
| | 316 stainless steel | 1B989535072 |
| 52* | Bleed Orifice, 316 stainless steel | 1B887335032 |
| 53 | Loading Tubing | |
| | Copper | 1J4928000A2 |
| | Aluminum | 1J492711052 |
| | 316 stainless steel | 1J4927X00A2 |
| 54 | Connector | |
| | Brass | 1H628114012 |
| | Aluminum | 15A6002X432 |
| | 316 stainless steel | 15A6002X992 |
| 55 | Pipe Nipple, plated steel (1 req d w/copper tubing & 2 req d w/aluminum tubing | 1C488226232 |
| | 316 stainless steel | 1C488238982 |
| 59 | Pipe plug, steel (not shown) | 1A369224092 |
| 60 | Type Y602-1 Vent Ass y | 27A5516X012 |
| 68 | Spring Seat | |
| | Handwheel-style low pressure pilot, steel, (not shown) | 1J618124092 |
| | High pressure pilot, zinc | 0W019344022 |
| 69 | Nameplate, aluminum | 14A1711X012 |
| 71* | Closing Cap Gasket (for use only w/low pressure pilot), neoprene | 1P753306992 |
| 72 | Type Y602-1 Vent Ass y (for use only w/std high pressure pilot spring case), zinc/18-8 stainless steel | 17A6570X012 |
| 78 | Handwheel (for use only w/handwheel-style low pressure pilot), zinc | 1J496144012 |
| 79 | Machine Screw (for use only w/handwheel-style low pressure pilot), plated steel | 1A851728982 |
| 80 | Lockwasher (for use only w/handwheel-style low pressure pilot), steel | 1A352332992 |
| 81 | O-Ring (for use only w/O-ring sealed handwheel assembly) | 1D541506992 |
| 82 | Hex nut | |
| | (for use only w/O-ring sealed handwheel assembly) | 1A351124122 |
| | (for use w/high pressure pilot), zinc plated steel | 1A352224122 |
| 114* | Gasket (for use only w/high pressure pilot w/spring case 1H232619012), steel/composition (not shown) | 1B487099202 |
| 115 | Adaptor (for use only w/high pressure pilot w/spring case 1H232619012), steel (not shown) | 1J881624092 |
| 132 | Pilot Cover (used only w/complete replacement pilot ass y for field conversion), cast iron | 2C518619012 |
| 152 | Drive Screw, 18-8 stainless steel (4 req d for low pressure pilot and 6 req d for high pressure pilot) | 1A368228982 |
| 154 | Drive Screw (for use only w/low pressure pilot), 18-8 stainless steel (2 req d) | 1A368228982 |

## Type 61HP (Extra High Pressure) Pilot (figure 12)

| Key | Description | Part Number |
|---|---|---|
| 23 | Elbow | |
| | For use w/all std regulators | |
| | Brass | 15A6002X292 |
| | Aluminum | 15A6002X402 |
| | 316 stainless steel | 15A6002X202 |
| | For use w/1000 psig (69 bar) max inlet regulator, steel | 1J139628982 |
| 24 | Pilot Supply Tubing | |
| | For use w/all std regulators | |
| | Copper | 1D7703000A2 |
| | Aluminum | 1K546511062 |
| | 316 stainless steel | 1L91752X602 |
| | For use w/1000 psig (69 bar) max inlet regulator, steel | 19A4385X012 |
| 30* | Diaphragm | |
| | Neoprene | 13A9840X012 |
| | Fluoroelastomer/Dacron | 13A9840X022 |
| 31 | Yoke Leg, 416 stainless steel (2 req d) | 13A9838X012 |
| 34 | Connector (3 req d) | |
| | For use w/all std regulators | |
| | Brass | 1D692214012 |
| | Aluminum | 15A6002X392 |
| | 316 stainless steel | 15A6002X602 |
| | For use w/1000 psig (69 bar) max inlet regulator, steel | 15A6002X392 |
| 35 | Cap Screw, plated steel (6 req d) | 1A930424052 |
| 36 | Elbow, plated steel | 1B860828992 |
| 37 | Yoke Cap, 416 stainless steel | 13A9837X012 |

*Recommended spare part

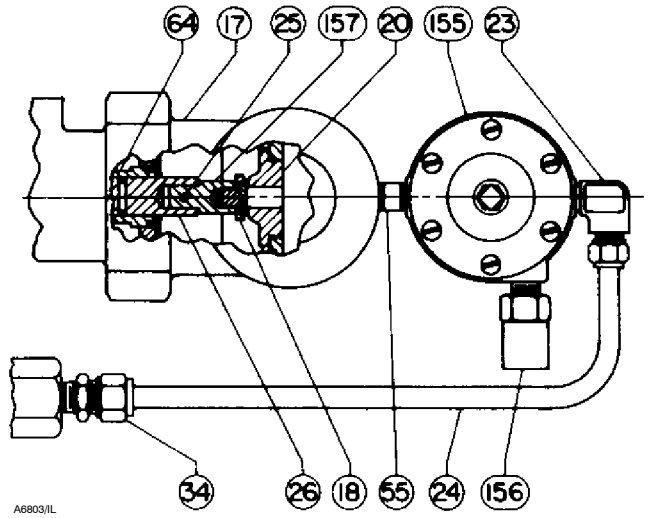



*Figure 11. 1000 Psig(69 bar) Max Inlet Regulator Partial Detail*

| Key | Description | Part Number |
|---|---|---|
| 38 | Inlet Orifice | |
| | Brass | 1N379714012 |
| | 303 stainless steel | 1D318135032 |
| 39 | Pilot Body, cast iron | 33A9845X012 |
| 40* | Diaphragm | |
| | Neoprene | 13A9841X022 |
| | Fluoroelastomer/Dacron(4) | 13A9841X012 |
| 41 | Diaphragm Plate, | |
| | 416 Stainless steel (4 req d) | 13A9839X012 |
| 43 | Control Spring, zinc plated steel (blue) | 1D387227022 |
| 44 | Spring Case, cast iron | |
| | Std | 2P969419012 |
| | 1/4-inch NPT tapped for use w/closing cap 1E599914012 (not shown) | 20A4735X012 |
| 45 | Adjusting Screw, plated carbon steel | |
| | Std | 1C216032992 |
| | for use w/closing cap 1E599914012 (not shown) | 1F6635X0012 |
| 46 | Closing Cap (for use only w/tapped spring case 20A4735012), brass (not shown) | 1E599914012 |
| 47 | Cap Screw, plated steel (8 req d) | 1B787724052 |
| 49 | Relief Valve Spring, 316 stainless steel | 1C374037022 |
| 50 | Relief Valve plug, 316 stainless steel | 1K377535162 |
| 52 | Bleed Orifice | |
| | Brass | 1B329014012 |
| | 316 stainless steel | 1K377625162 |

| Key | Description | Part Number |
|---|---|---|
| 53 | Loading Tubing | |
| | For use w/all std regulators | |
| | Copper | 1D7702000A2 |
| | Aluminum | 1K546611072 |
| | 317 stainless steel | 1J4927X00A2 |
| | For use w/1000 psig (69 bar) max inlet regulator, steel | 1K5466X0042 |
| 55 | Pipe Nipple, plated steel (2 req d) | 1C488226232 |
| 60 | Pipe plug, steel (not shown) | 1A649528992 |
| 68 | Spring Seat, zinc plated steel | 10A3963X012 |
| 72 | Type Y602-12 Vent Assy (for use only w/tapped spring case 20A4735X012), zinc w/18-8 stainless steel screen | 27A5516X012 |
| 82 | Locknut, zinc plated steel | 1A352224122 |
| 116 | Yoke Cap, 416 stainless steel | 13A9836X012 |
| 117* | Inlet Valve plug | |
| | 304 stainless steel/nitrile | 1D5604000B2 |
| | 304 stainless steel/fluoroelastomer | 1N3798000C2 |
| 118 | Relief Valve Cap | |
| | Brass | 1D904914012 |
| | 303 stainless steel | 1D904935072 |
| 119 | Relief Valve Body | |
| | Brass | 1D904814012 |
| | 316 stainless steel | 1D904835072 |
| 120 | Spring Seat | |
| | Brass | 1K377718992 |
| | 316 stainless steel | 1K377735072 |
| 121 | Spring Seat Washer | |
| | Brass | 1B495118992 |
| | 316 stainless steel | 1K377835072 |
| 122 | Pipe Bushing, malleable iron, zinc gal (not shown) | 1B292821992 |
| 123 | Cap Screw, plated steel (6 req d) | 1P327028982 |
| 124 | Valve Spring, 316 stainless steel | 1B797937022 |
| 125 | Flange Adaptor, steel | 23A9846X012 |
| 126* | Gasket, composition | 0U0365X0022 |
| 128 | Diaphragm Nut, zinc plated steel | 1A346524122 |
| 129* | Valve Spring Seat, aluminum | 1L251135072 |
| 130 | Machine Screw, | |
| | 303 Stainless steel (4 req d) | 1A866935032 |
| 131 | Pipe plug, steel (not shown) | 1A369224092 |
| 150 | Diaphragm Insert (2 req d) | |
| | Nitrile | 13A9842X012 |
| | Fluoroelastomer | 13A9842X022 |
| 151 | Nameplate, aluminum | 14A2742X012 |
| 152 | Drive Screw, | |
| | 18-8 Stainless steel (2 req d) | 1A368228982 |
| 153 | Seal Washer, nitrile/plated steel (6 req d) | 13A9849X012 |



*Recommended spare parts

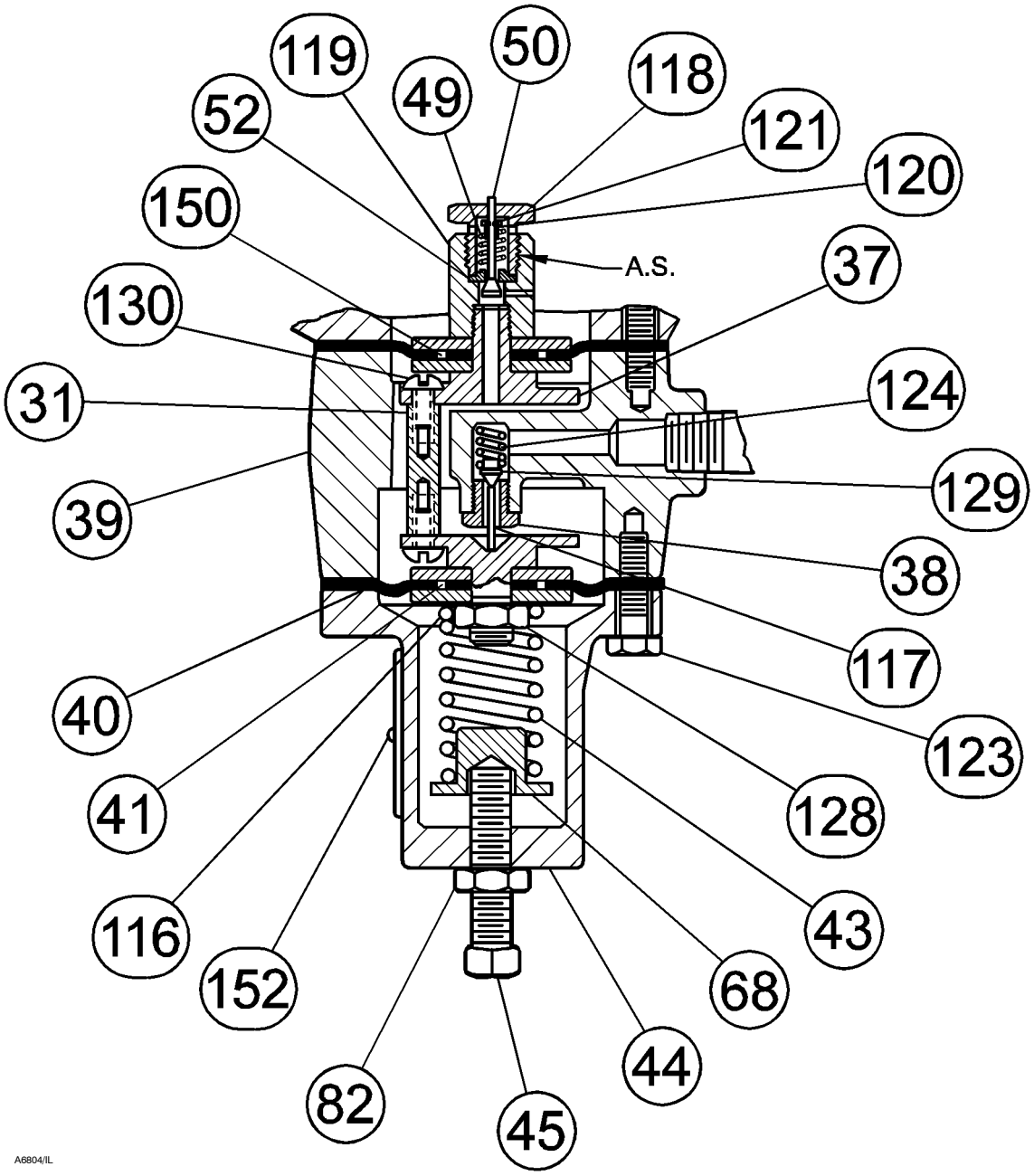



*Figure 12. Type 61HP (extra high pressure) Pilot*

*For information, contact Fisher Controls:*
Marshalltown, Iowa 50158 USA
Cernay 68700 France
Sao Paulo 05424 Brazil
Singapore 0512

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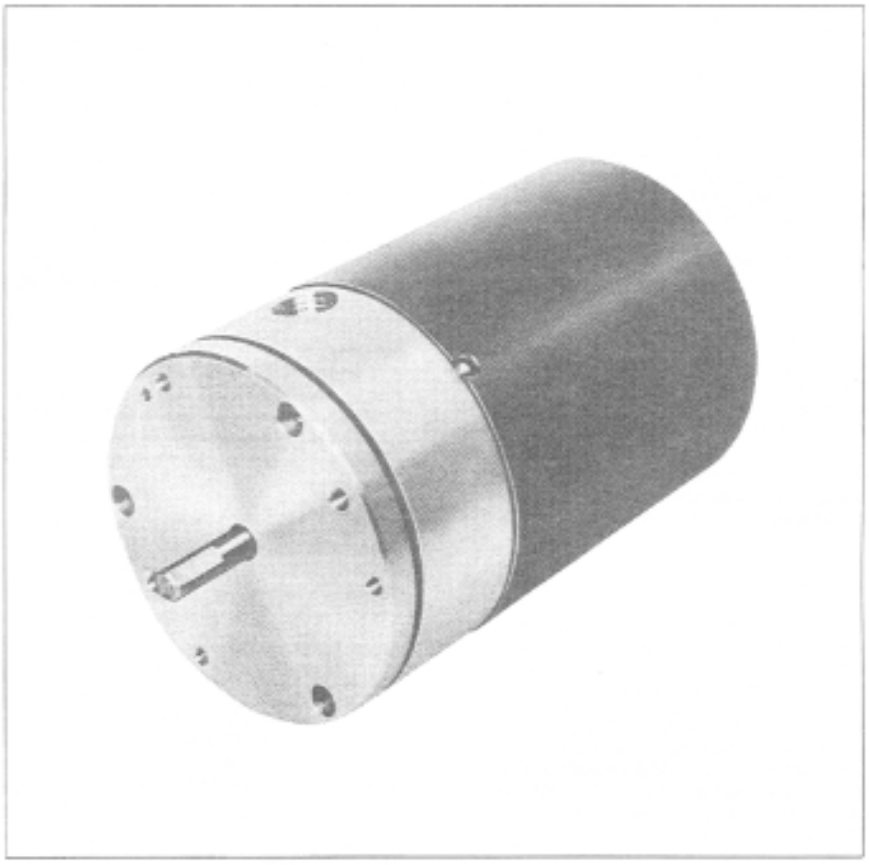
# Jordan Controls, Inc.

IM-2033

**SM-1100 Series**

## Instruction Manual

# ROTARY ACTUATOR



*Due to wide variations in the terminal numbering of actuator products, actual wiring of this device should follow the print supplied with the unit.*

Jordan CONTROLS

# GENERAL DESCRIPTION

The SM-1100 series are electro-mechanical, bi-directional rotary actuators. They can provide up to 100 inch-pounds of torque with output shaft turns between .25 and 60. These actuators may be installed in indoor, outdoor, hazardous gas and hazardous dust environments.

These actuators are equipped with minimum and maximum position limit switches. Position feedback options include a 1000 ohm potentiometer or a 4 to 20 mA loop-powered transmitter for remote position indication.

The SM-1100 series include 120 V ac, 240 V ac, and single-phase models as well as 24 V dc and 90 V dc models. These actuators are controlled by "switched" power inputs or a remotely installed servo amplifier.

## FEATURES

- Dust resistant enclosures rated for NEMA Type 12 - indoors
- Compact size
- Temperature range: -40°C (-40°F) to +65°C (150°F)
- Any position mounting
- Permanantly lubricated
- Maximum and minimum SPDT position limit switches
- Torque output to 100 inch-pounds (maximum)
- Output speeds from .065 to 140 rpm

## OPTIONS

- Available with or without a built-in ac or dc servo amplifier
- Potentiometer, or 4 to 20 mA transmitter position feedback
- Enclosures rated NEMA Type 4 indoor/outdoor, or hazardous locations for Class I, Division 1, Groups C and D, or Class II, Division 1, Groups E, F, and G, indoor/outdoor. Also rated for NEMA Type 4 applications indoor and outdoor.
- Canadian Standards Association (CSA) approved models
- Custom mounting and interface hardware

## APPLICATION

These actuators have been designed to meet the exacting requirements for closed-loop positioning controls in a number of process industries under the most adverse environmental conditions. They can be mounted to valves, variable speed drives, metering pumps, hydraulic and pneumatic pressure regulators, dampers, and many more industrial/process control applications where reliable remote positioning control is required. Jordan Controls provides a wide range of engineering services to precisely match the SM-1100 series to your exact application requirements. Accessories such as couplings, special mounting brackets and special output shafts are available.

## MATERIALS OF CONSTRUCTION

MAIN HOUSING: cast aluminum alloy
REAR COVER: (enclosure Type "D"): spun steel, painted blue
(enclosure Type "E" and "X"): cast aluminum alloy
REAR COVER SEAL: Bune N (nitrile) o-ring
RACK: stainless steel
OUTPUT SHAFT SEAL: Bune N (nitrile) rotary lip seal

## BASIC MODELS

**SM-1110**
120 V ac, 1 phase, 50/60 Hz, running current 0.25A, stall current 0.26A, modulating duty.
**Control Compatibility**: Jordan Controls models AD-8813, and AD-8710 servo amplifiers, MT-6220 remote control and readout, CS-7250 control station or any bi-directional contact type control.

**SM-1120**
120 V ac, 1 phase, 50/60 Hz, running current 0.6A, stall current 0.7A, 12% duty cycle, maximum 5 minute on-time.
**Control Compatibility**: Jordan Controls model AD-8813 servo amplifier, MT-6220 remote control and readout, CS-7250 control station, or any bi-directional contact type control.

**SM-1140**
24 V dc (permanent magnet field), running current 1.2A, stall current 4.8A, modulating duty.
**Control Compatibility**: Jordan Controls model AD-7530 servo amplifier, battery or power supply with reversing contacts.

**SM-1150**
120 V ac, 1 phase (synchronous motor), 60 Hz, running current 0.1A, stall current 0.1A, modulating duty.
**Control Compatibility**: Jordan Controls models AD-8813 and AD-8710 servo amplifiers, MT-6220 remote control and readout, CS-7250 control station, or any bi-directional contact type control.

**SM-1160**
90 V dc (permanent magnet field), running current 0.3A, stall current 1.7A, modulating duty.
**Control Compatibility**: Jordan Controls model AD-7300 (90 V dc output), or any compatible 90 V dc output servo amplifier.

**SM-1170**
240 V ac, 1 phase, 50/60 Hz, running current 0.14A, stall current 0.15A, modulating duty.
**Control Compatibility**: Jordan Controls models AD-8833 or AD-8730 servo amplifiers, or any bi-directional contact type control.

**SM-1180**
24 V dc (permanent magnet field) with built-in tachometer for rate feedback, running current 1.9A, stall current 5.2A, modulating duty.
**Control Compatibility**: Jordan Controls model AD-7530 servo amplifier, or other compatible 24 V dc output servo amplifier. This actuator is most often used on applications requiring high-speed positioning or precise speed control over a broad speed range.

## STORAGE

If the actuator will not be installed immediately, it should be stored in a clean, dry area where the ambient temperature is not less than -20°F. The actuator should be stored in a non-corrosive environment. The actuator is not sealed to NEMA 4 until the conduit entries are properly connected.

## MOUNTING

Outline and mounting dimensions are shown on page 7 for standard models. (For special models, drawings will be supplied.) Allow clearance above the unit for removal of cover.

When the actuator is directly coupled to a driven shaft, it is recommended that a flexible no-backlash type coupling be used. The two shafts should be carefully aligned to minimize side loading.

Be sure that no excessive inward thrust is applied to the output shaft. Equipment coupled to the output shaft should be positively secured so no slippage may occur.

## ELECTRICAL INTERCONNECT

The internal wiring of the actuator is shown on page 6 for standard models. (For special models, drawings will be supplied.) Wire size should be compatible for voltage and current rating as shown on nameplate.

If the unit is used with a Jordan Controls servo amplifier, the interconnect information is supplied with the amplifier.

## START-UP

If the actuator is to be used with a Jordan Controls servo amplifier, factory phasing has been accomplished and all that is necessary is the zeroing of the actuator to match the minimum/maximum requirements of the equipment being controlled. (See appropriate amplifier instruction manual.)

Before mounting, ensure the actuator is moving in the correct direction. To change directions:

3 wire motors - reverse wires 2 with 3; and 4 with 6
dc motors - reverse wires 1 with 2; and 3 with 5

Apply power and drive the actuator to the zero position. Move controlled equipment to mechanical zero position and couple.

Loosen potentiometer jam nut and turn body to reach electrical zero. If no limit switches are supplied, loosen 3 pan head screws and rotate complete servo disc.

Limit switches are actuated by the flat of the cam or by the adjustment screw in the multiplier assembly. When the mechanical zero is reached, adjust the proper limit switch to cut motor power at this point. Apply power and drive actuator to maximum desired position and adjust other limit switch.

## OPERATION

The SM-1100 series is a self-contained bi-directional, electrically operated motor, coupled to a reduction gear train to give a low speed, high torque output suitable for rotary positioning.

AC units have dual balanced windings and use a tuning capacitor for phase shift and reversal of direction.

DC units have a permanent magnet field and require polarity reversal of armature voltage to reverse direction.

Several gear reductions are avilable to provide a choice of speed-torque ranges. Maximum gear train rating is 100 inch-pounds.

**NOTE:** Actuator should never be subjected to excessive shock loads nor run into mechanical stops at full speed or damage may result.

The speed and torque information is given at the maximum power point of the motor which is about two-thirds the no-load speed. Actual speed of the output shaft will depend upon the load. Since the motor stall torque is greater than the running torque, a slight safety margin for overload is provided.

**NOTE:** Intermittent duty ac units and dc units will burn out under prolonged stall conditions.

The optional feedback device, which consists of a combination of potentiometers and/or limit switches, is coupled to the ouput shaft through appropriate gearing.

Potentiometers are used as position transmitters for meter readout or feedback when used in conjunction with servo amplifiers in closed-loop applications.

Limit switches are single pole double throw (SPDT), with isolated contacts which are used to interrupt the motor circuit when end-of-travel is reached. They can also be used for remote indication of travel limits.

Feedback Gearing Revolutions, as shown in the nameplate "CODE" indicates the gearing between the output shaft and feedback shaft. The output shaft revolutions on page 6 describe the number of output shaft revolutions for 270° rotation of the feedback shaft. For instance ½ would indicate that the output shaft will make ½ revolution while the feedback device shaft rotates 270°. The "ACTUAL" revolutions available can be increased by a factor of 12 if a 10-turn potentiometer or a limit switch "MULTIPLIER" assembly is used as feedback.

Approximately 30% more range can also be realized if a precision, single-turn potentiometer is used instead of a commercial type.

## MAINTENANCE

LUBRICATION - The actuator has been factory lubricated, but should the unit be disassembled, repack the gear housing with Penola Thixotropic grease or equivalent.

The 1110 and 1120 motors have lifetime lubricating spherical bearings and require no further attention. All other motors have ball bearings.

TROUBLESHOOTING - If the actuator fails to operate check the following in sequence: (1) power input, (2) limit switch continuity and operation, (3) motor, (4) continuity of potentiometer winding and wiper, (5) gear train including feedback gearing, for wear or breakage.

## MOTOR SPECIFICATIONS

MODEL DESIGNATION AND CODE EXPLANATION
(Refer to Nameplate)

Model: SM-1110 Standard
SM-1110-1006 Non-Standard
5P73-38 Special

Code: 1114 / 2.5 / .7 -
- Feedback gearing revolutions
- Power gearing R.P.M. (Output shaft speed)
- Engineering revisions not affecting function or dimensions
- Motor type
- Basic unit

Serial: 110B77-24485 Factory designated
PH/HZ/V/A: Phase/Cycles/Voltage/Amps
AC units 1 50-60 115
DC units 24 V dc
90 V dc

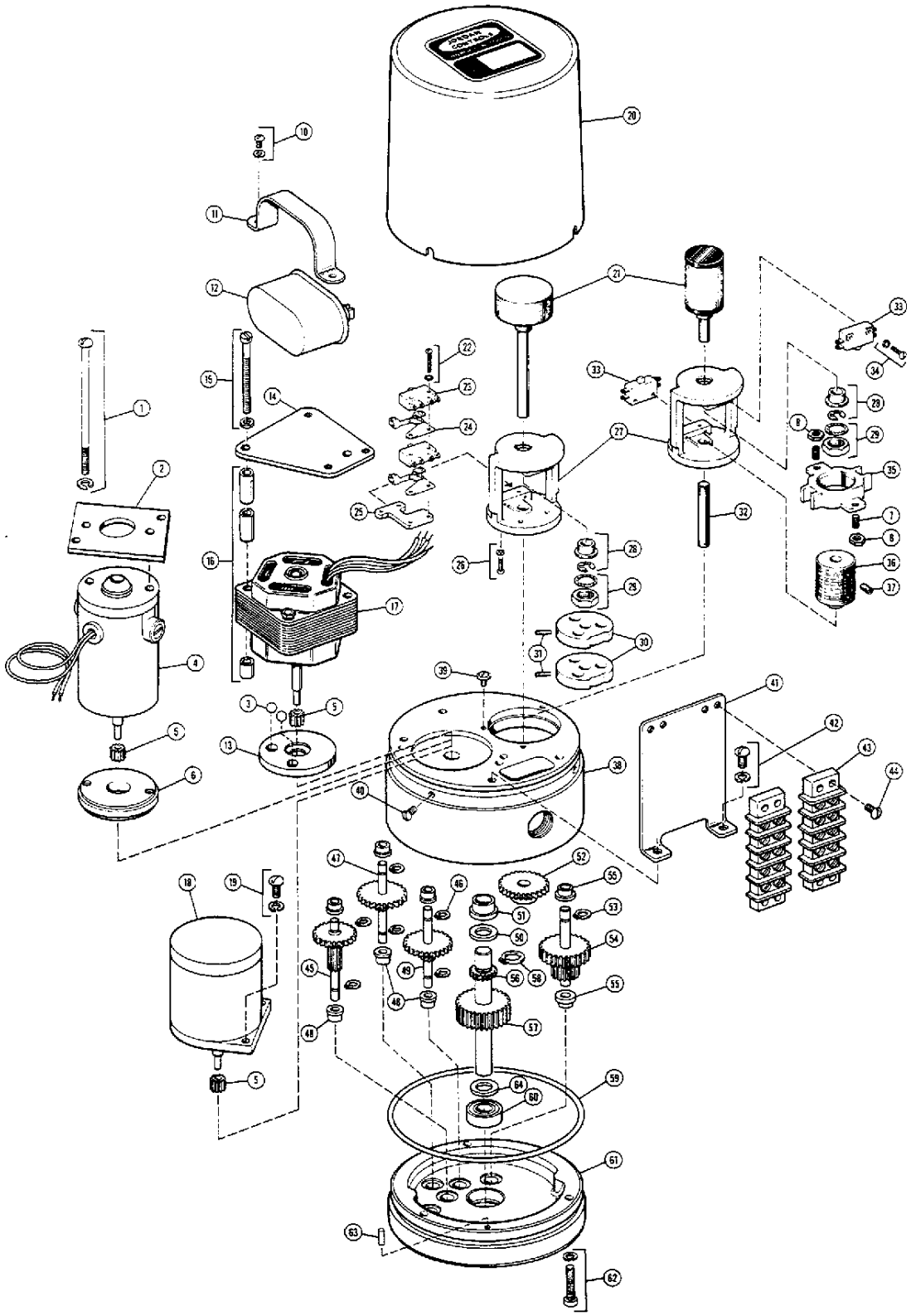
| Motor Type | Duty | Input | Resistance (Ohms) | Running Current (Amps) | Stall Current (Amps) | Motor Speed No-Load RPM | Tuning Capacitor |
|---|---|---|---|---|---|---|---|
| 1110 | Continuous | 115 V ac 1 Phase 50-60 Cycle | 135 | .27 | .31 | 2000 | 3 MFD 330 VAC |
| 1120 | Intermittent | 115 V ac 1 Phase 50-60 Cycle | 110 | .38 | .56 | 2000 | 7.5 MFD 220/365 VAC |
| 1140 | Continuous | 24 V dc | 5 | 1.2 | 4.8 | 3500 | -- |
| 1150 | Continuous | 115 V ac 1 Phase 50-60 Cycle | 1100 | .27 | .27 | 72 | .68 MFD 600 VAC & 500 Ohm 10W Res. |
| 1160 | Continuous | 90 V dc | 55 | .35 | 1.7 | 3620 | -- |
| 1170 | Continuous | 220 V ac 1 Phase 50-60 Cycle | 270 | .14 | .15 | 2000 | 1 MFD 660 VAC |
| 1180 | Continuous | 24 V dc 1 Phase | 1.70-2.50 | 2.2 | 5.2 | 5800-7000 | -- |

# PARTS LIST

## PARTS ORDERING PROCEDURE

All parts shown are not supplied with all models, or may differ slightly.
To order, furnish the following information:

1. Item number, quantity and description.
2. Complete model and code information.
3. Completed serial number. (The serial number is located on the nameplate and is stamped on base casting near the motor.)



| Item | Description | Qty. |
|---|---|---|
| 1 | Screw and Lock, Round Head, No. 8-32 x 3-3/4" | 2 |
| † 2 | End Bell, Upper Motor, SM-1140-1160 | 1 |
| 3 | Steel Locator Balls | 2 |
| † 4 | Motor Assembly, SM-1140-1160 | 1 |
| 5 | Motor Pinion, SM-1100 | 1 |
| † 6 | Motor End Bell, Lower, SM-1140-1160 | 1 |
| 7 | Screw, Allen, No. 8-32 x 3/8" | 2 |
| † 8 | Hex Nut, No. 8-32 | 2 |
| † 9 | Deleted | |
| 10 | Screw and Lock, Round Head, No. 8-32 x 1/4" | 2 |
| 11 | Bracket, Capacitor Mounting | 1 |
| 12 | Capacitor | 1 |
| 13 | Pilot Adapter | 1 |
| 14 | Plate, Capacitor Mounting | 1 |
| 15 | Screw and Lock, Fillister Head, No. 8-32 x 3-1/4" SM-1110, 1120 W/F.B. | 2 |
| 16 | Spacer Set | 4 |
| † 17 | Motor Assembly, SM-1110-1120 | 1 |
| † 18 | Motor Assembly, SM-1150 | 1 |
| 19 | Screw and Lock, Round Head, No. 8-32 x 3/8" | 3 |
| 20 | Name Plate and Rear Cover | 1 |
| **21 | Potentiometer, Feedback | 1 |
| 22 | Screw and Lock, Round Head, No. 2-56 x 5/8" | 2 |
| **23 | Switch, Limit | 2 |
| 24 | Actuator, Limit Switch | 2 |
| 25 | Plate, Limit Switch Mounting | 1 |
| 26 | Screw and Lock, Round Head, No. 2-56 x 5/16" | 2 |
| 27 | Frame, Limit Switch Mounting | 1 |
| **28 | Switch, Limit, Mounting Frame Bushing and 1/4" E Ring (No feedback pot) | 1 |
| 29 | Nut and Star Washer, 3/8-32 | 1 |
| 30 | Cam, Limit Switch | 2 |
| 31 | Screw, Allen, No. 8-32 x 3/8" | 2 |
| 32 | Shaft, Multi-Turn Extension | 1 |
| **33 | Switch, Limit | 2 |
| 34 | Screw, Self-Tapping, No. 2-56 x 3/8" | 4 |
| 35 | Nut, Traveling | 1 |
| 36 | Screw, Multi-Turn | 1 |
| 37 | Screw, Allen, No. 8-32 x 1/4" | 2 |
| 38 | Gear Case | 1 |
| 39 | Screw, Pan Head, No. 8-32 x 1/4" | 3 |
| 40 | Screw, Round Head, No. 10-24 x 1/4" | 3 |
| 41 | Bracket, Terminal Strip | 1 |
| 42 | Screw and Lock, Round Head, No. 8-32 x 5/16" | 2 |
| 43 | Strip, Terminal | 2 |
| 44 | Screw, Round Head, No. 6-32 x 5/16" | 4 |
| * 45 | Gear Assembly, First Stage Power | 1 |
| * 46 | C-Ring, First, Second and Third Stage Assembly, 3/16" | 6 |
| * 47 | Gear Assembly, Second Stage Power | 1 |
| * 48 | Bushing, First, Second and Third Stage Assembly | 6 |
| * 49 | Gear Assembly, Third Stage Power | 1 |
| * 50 | Washer, Thrust | 1 |
| * 51 | Bushing, Output Shaft | 1 |
| **52 | Gear, Feedback Potentiometer | 1 |
| * 53 | C-Ring, Fourth Stage Assembly, 7/32" | 1 |
| * 54 | Gear Assembly, Fourth Stage Power | 1 |
| * 55 | Bushing, Fourth Stage Assembly | 2 |
| **56 | Gear, Output Shaft Assembly Feedback | 1 |
| * 57 | Shaft Assembly, Output | 1 |
| * 58 | C-Ring Output Shaft Assembly, 3/8" | 1 |
| 59 | O-Ring (1 for Gear Case — 1 for Rear Cover) | 2 |
| * 60 | Bearing, Output Shaft | 1 |
| 61 | Gear Case Cover | 1 |
| 62 | Screw and Lock, Fillister Head, No. 10-24 x 7/8" | 3 |
| 63 | Pin, Dowel, 1/8" x 3/8" | 1 |
| 64 | Output Shaft Spacer | 1 |
| † 65 | Motor Assembly SM-1170 | 1 |

† Consult Code and Motor Specification Table
* Consult Code and Power Gearing Parts List
**Consult Code and Feedback Variations Parts List

# FEEDBACK VARIATIONS AND GEARING REVOLUTIONS

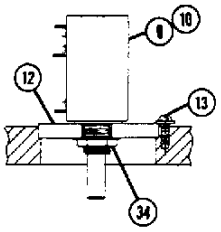


FIGURE 1

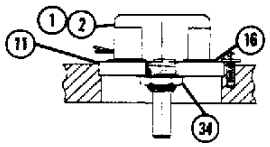


FIGURE 2

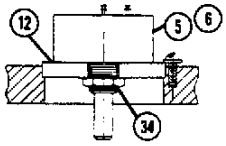


FIGURE 3

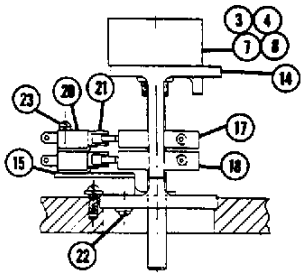


FIGURE 4

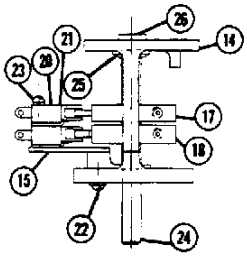


FIGURE 5

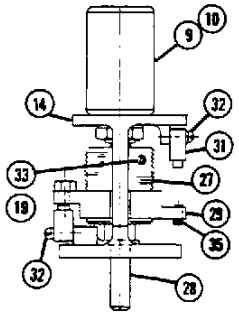


FIGURE 6

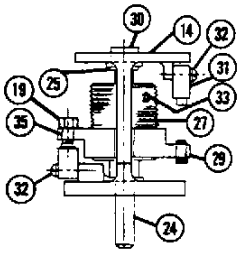


FIGURE 7

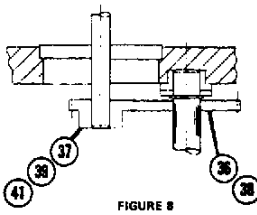


FIGURE 8

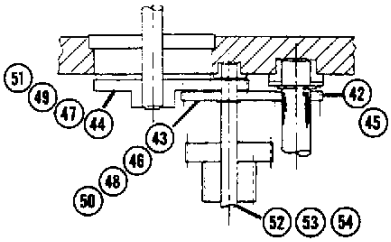
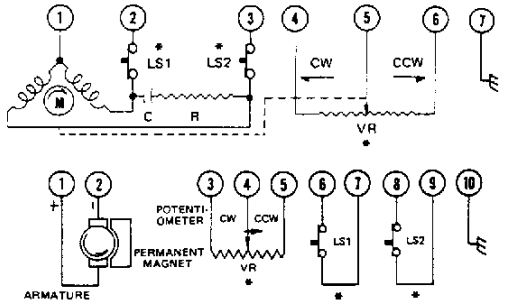


FIGURE 9

| Item | Fig. | Description | Stock No. |
|---|---|---|---|
| | | **POTENTIOMETERS** | |
| 1 | 2 | Commercial One Turn, 1K | 34-B-100078-005 |
| 2 | 2 | Commercial One Turn, 15K | 34-B-100078-006 |
| 3 | 4 | Commercial One Turn, 1K | 34-B-100078-005 |
| 4 | 4 | Commercial One Turn, 15K | 34-B-100078-006 |
| 5 | 3 | Precision One Turn, 1K | 34-B-100032-013 |
| 6 | 3 | Precision One Turn, 10K | 34-B-100032-014 |
| 7 | 4 | Precision One Turn, 1K | 34-B-100032-013 |
| 8 | 4 | Precision One Turn, 10K | 34-B-100032-014 |
| 9 | 1,6 | Precision Ten Turn, 1K | 34-B-100033-001 |
| 10 | 1,6 | Precision Ten Turn, 10K | 34-B-100033-002 |
| | | **HARDWARE** | |
| 11 | 2 | Disc, Adapter | 61-A-SM3304-001 |
| 12 | 1,3 | Disc, Adapter | 61-A-SM3304-003 |
| 13 | | Screw, Pan Head, No. 8-32 x 1/4" | |
| 14 | 4,5,6,7 | Frame, Limit Switch Mounting | 14-C-008600-001 |
| 15 | 4,5 | Plate, Limit Switch Mounting | 13-A-010187-001 |
| 16 | 2 | Insulator, Pot (Commercial pot only) | 75-A-003958-001 |
| 17 | 4,5 | Cam, Limit Switch | 14-A-SM2341-001 |
| 18 | 4,5 | Screw, Allen, No. 8-32 x 3/8" | 54-A-015037-038 |
| 19 | 6,7 | Nut, Hex, No. 8-32 | 55-A-015038-001 |
| 20 | 4,5 | Switch, Limit | 46-B-004053-405 |
| 21 | 4,5 | Actuator, Limit Switch | 46-B-004053-406 |
| 22 | 4,5 | Screw and Lock, Round Head, No. 2-56 x 5/16" | 54-A-015003-031 |
| 23 | 4,5 | Screw and Lock, Round Head, No. 2-56 x 5/8" | 54-A-015003-062 |
| 24 | 5,7 | Shaft, Feedback (No pot) | 62-A-005842-001 |
| 25 | 5,7 | E-Ring, Truarc, No. 5133-25 | |
| 26 | 5 | Bushing | 18-B-SP1988-006 |
| 27 | 6,7 | Screw, Multi-Turn | 61-A-006804-001 |
| 28 | 6 | Shaft, Multi-Turn Extension (Precision pot only) | 62-A-008806-001 |
| 29 | 6,7 | Nut, Traveling | 14-B-009802-001 |
| 30 | 7 | Bushing | 18-B-SP1988-005 |
| 31 | 6,7 | Switch, Limit | 46-B-004053-409 |
| 32 | 6,7 | Screw and Lock, Self Tapping, No. 2-56 x 3/8" | |
| 33 | 6,7 | Screw, Allen, No. 8-32 x 1/4" | 54-A-015037-025 |
| 34 | 1,2,3 | Nut and Star Washer, 3/8" - 32 | |
| 35 | 6,7 | Screw, Allen, No. 8-32 x 3/8" | 54-A-015037-038 |
| | | **FEEDBACK GEARING** | |
| 36 | 8 | Gear, Output Shaft (1/2 turn) | 16-B-003812-090 |
| 37 | 8 | Gear, Potentiometer (1/2 turn) | 16-B-003811-056 |
| 38 | 8 | Gear, Output Shaft (3/4 turn) | 16-B-003812-072 |
| 39 | 8 | Gear, Potentiometer (3/4 turn) | 16-B-003811-072 |
| 40 | 8 | Gear, Output Shaft (1 turn) | 16-B-003812-058 |
| 41 | 8 | Gear, Potentiometer (1 turn) | 16-B-003811-082 |
| 42 | 9 | Gear, Output Shaft (1/4 turn) | 16-B-003812-086 |
| 43 | 9 | Gear Assembly, Intermediate (1/4 turn) | 65-A-012605-001 |
| 44 | 9 | Gear, Potentiometer (1/4 turn) | 16-B-003811-064 |
| 45 | 9 | Gear, Output Shaft (2, 3 and 5 turn) | 16-B-003812-033 |
| 46 | 9 | Gear Assembly, Intermediate (2 turn) | 65-A-003946-002 |
| 47 | 9 | Gear, Potentiometer (2 turn) | 16-B-003811-161 |
| 48 | 9 | Gear Assembly, Intermediate (3 turn) | 65-A-SM3214-002 |
| 49 | 8 | Gear, Potentiometer (3 turn) | 16-B-003811-132 |
| 50 | 9 | Gear Assembly, Intermediate (5 turn) | 65-A-SM3215-002 |
| 51 | 9 | Gear, Potentiometer (5 turn) | 16-B-003811-130 |
| | | Following items required only when there is 3-stage power gearing (Figure 9) | |
| 52 | 9 | Shaft, Intermediate | 62-A-007168-001 |
| 53 | 9 | Bushing | 18-B-SP1988-002 |
| 54 | 9 | C-Ring, Truarc, No. 5100-21, 7/32" | 58-B-014183-021 |

## INTERNAL WIRING




**3-WIRE MOTOR –**

To operate actuator without amplifier, if furnished without internal motor capacitor (C), connect proper capacitor as shown.

Facing output shaft, input to (1) and (2) operates actuator in CCW direction; input to (1) and (3) operates actuator in CW direction.

Feedback potentiometer (VR) resistance increases on terminals (4) and (5) with input to (1) and (2).

Limit switch (LS1) opens at CCW limit; (LS2) opens at CW limit.

**DC – 2-WIRE MOTOR –**

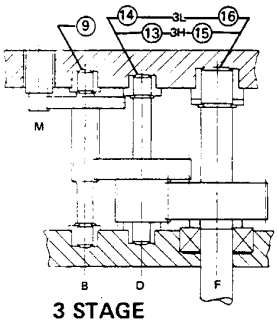
Voltage applied with polarity shown will result in clockwise rotation (facing output shaft). Reverse polarity to terminals (1) and (2) for CCW rotation.

*OPTIONAL

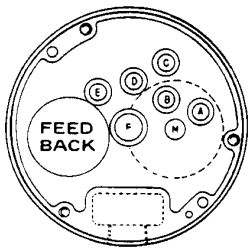
Output shaft revolution for 270° rotation of the feedback shaft (limit switches or potentiometer)

| SM-1100 | 1/4 | 1/2 | 3/4 | 1 | 2 | 3 | 5 |
|---|---|---|---|---|---|---|---|

# POWER GEARING VARIATIONS AND LOCATIONS



3 STAGE

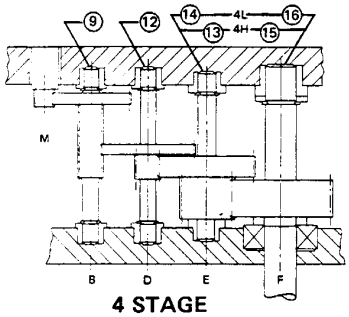


GEAR HOUSING

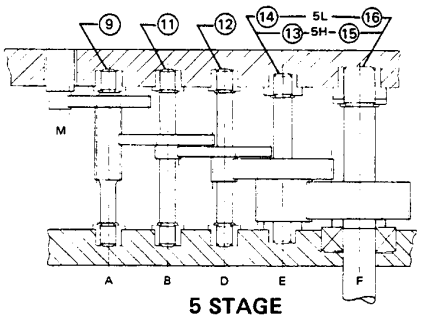
## OUTPUT SHAFT REVOLUTIONS

| SM-1110-1120 | | SM-1140-1160 | | SM-1150 | | SM-1170 | | SM-1180 | |
|---|---|---|---|---|---|---|---|---|---|
| RPM | Stages | RPM | Stages | RPM | Stages | RPM | Stages | RPM | Stages |
| .5 | 6L | .7 | 6L | | 6L | .5 | 6L | 1 | 6L |
| 1 | 6H | 1.5 | 6H | | 6H | 1 | 6H | 2 | 6H |
| 1.7 | 5L | 3 | 5L | .06 | 5L | 1.7 | 5L | 4 | 5L |
| 3.5 | 5H | 6 | 5H | .12 | 5H | 3.5 | 5H | 9 | 5H |
| 7 | 4L | 12 | 4L | .25 | 4L | 7 | 4L | 18 | 4L |
| 14 | 4H | 25 | 4H | .5 | 4H | 14 | 4H | 35 | 4H |
| 28 | 3L | 50 | 3L | 1 | 3L | 28 | 3L | 70 | 3L |
| 56 | 3H | 100 | 3H | 2 | 3H | 56 | 3H | 137 | 3H |

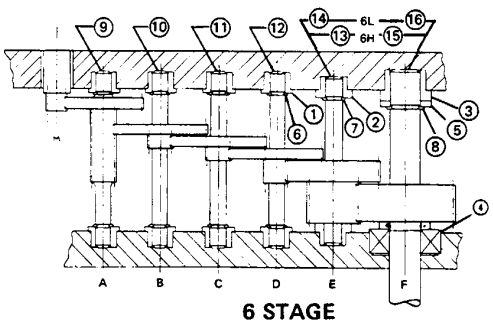
*All speeds are at full load rating.*



4 STAGE



5 STAGE



6 STAGE

## POWER GEARING PARTS LIST

| Item | Description | Stock No. |
|---|---|---|
| 1 | Bushing | 18-B-SP1988-011 |
| 2 | Bushing | 18-B-SP1988-002 |
| 3 | Bushing | 18-B-SP1988-003 |
| 4 | Bearing | 17-B-003813-025 |
| 5 | Washer, Thrust | 56-B-004107-020 |
| 6 | C-Ring, Truarc 5100-18, 3/16" | 58-B-014183-018 |
| 7 | C-Ring, Truarc 5100-21, 7/32" | 58-B-014183-021 |
| 8 | C-Ring, Truarc 5100-37, 3/8" | 58-B-014183-037 |

Note – Hardware shown on 6-stage typical for all stages.

| | | |
|---|---|---|
| 9 | Shaft Assy, Intermediate | 65-A-006897-001 |
| 10 | Shaft Assy, Intermediate | 65-A-006896-001 |
| 11 | Shaft Assy, Intermediate | 65-A-006895-001 |
| 12 | Shaft Assy, Intermediate | 65-A-006894-001 |

| Item | Description | Stock No. |
|---|---|---|
| 13 | Shaft Assy, Intermediate | 65-A-006893-002(H) |
| 14 | Shaft Assy, Intermediate | 65-A-006893-001(L) |
| 15 | Shaft Assy, Output | 65-A-006888-002(H) |
| 16 | Shaft Assy, Output | 65-A-006889-002(L) |
| 17 | Shaft, Spacer Output | 61A-017492-001 |

NOTES:

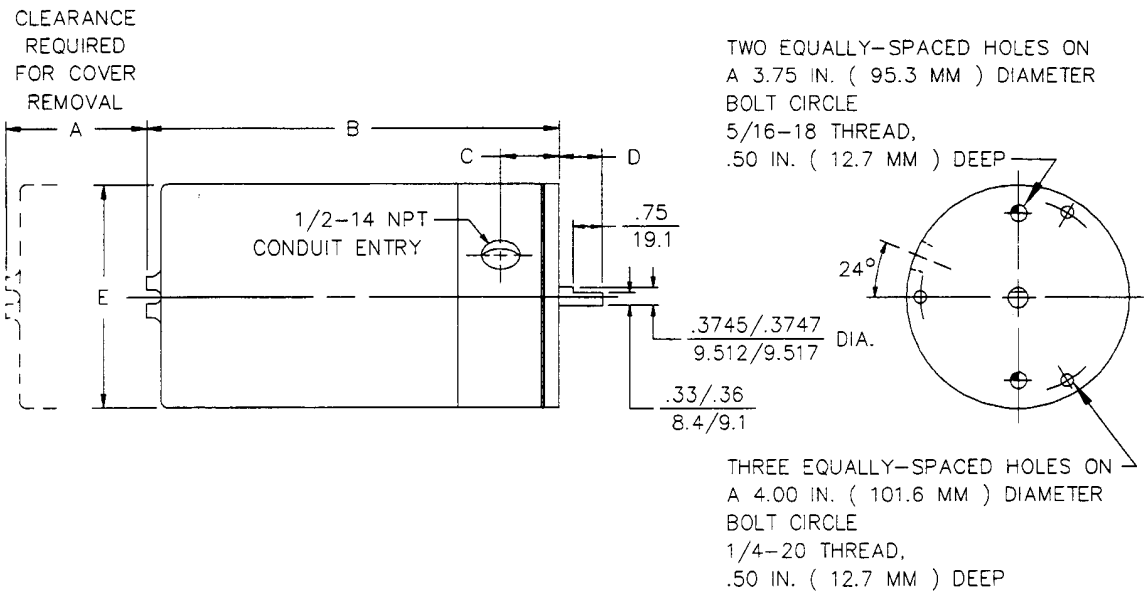
1. Assemblies shown for output shaft are standard unit only. For special output shaft, include serial number and model number as per parts order procedure and include item and description only.

2. C-rings are normally supplied with gear assemblies.

3. Feedback gearing is not supplied as part of power gearing and must be ordered separately. Refer to Feedback Variation Parts List.

# INSTALLATION DIMENSIONS

INCHES
MILLIMETERS




| SM-1100 Series | A | B | C | D | E | Approx. Weight (Lbs.) |
|---|---|---|---|---|---|---|
| NEMA Type 12 (Enclosure "D") (Except model SM-1180) | 5.00 / 127.0 | 7.13 / 181.1 | 1.59 / 40.4 | 1.25 / 31.8 | 4.50 (DIA.) / 114.3 | 8 |
| NEMA Type 12 (Enclosure "D") (Model SM-1180 only) | 5.50 / 139.7 | 7.63 / 193.8 | 1.59 / 40.4 | 1.25 / 31.8 | 4.50 (DIA.) / 114.3 | 8 |
| NEMA Type 4 (Enclosure "E") Watertight and X-proof (Enclosure "X") | 6.28 / 159.5 | 8.65 / 219.7 | 1.84 / 46.7 | .88 / 22.4 | 4.88(DIA.) / 124.0 | 12 |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IM-2033 10/91



Jordan CONTROLS

# Jordan Controls, Inc.

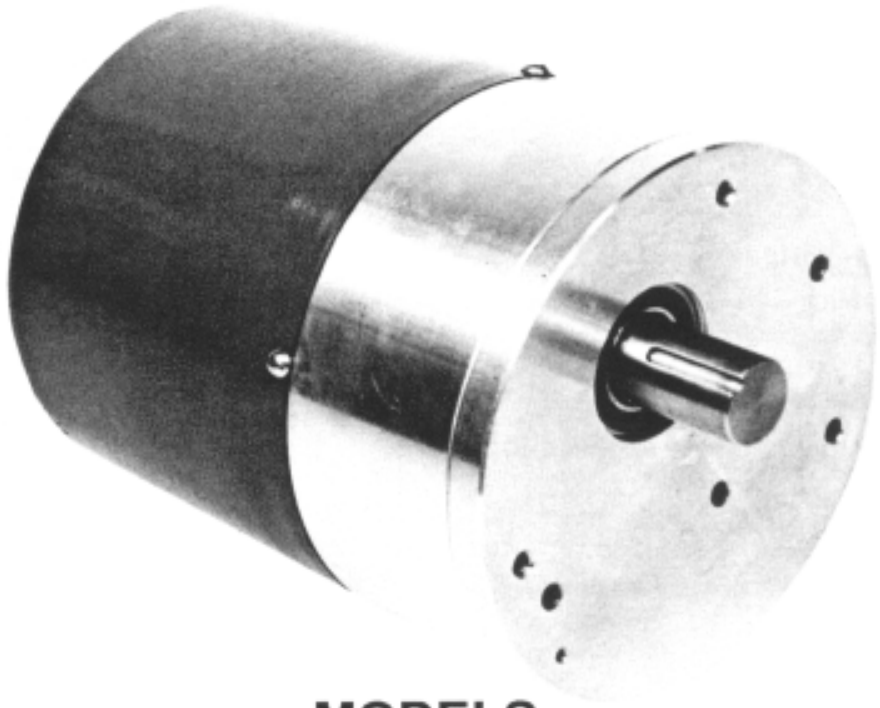
IM-0402

## Instruction Manual

## ROTARY ACTUATOR

**SM-1500/1600 SERIES**
**SM-1500/AD-8200 SERIES**
**SM-1600/AD-8200 SERIES**

*Due to wide variations in the terminal numbering of actuator products, actual wiring of this device should follow the print supplied with the unit.*



## MODELS

| | | | | |
|---|---|---|---|---|
| SM-1510 | SM-1540 | SM-1570 | SM-1510/AD-8210 | SM-1550/AD-8220 |
| SM-1520 | SM-1550 | SM-1580 | SM-1520/AD-8210 | SM-1570/AD-8220 |
| SM-1530 | SM-1560 | SM-1590 | SM-1530/AD-8210 | SM-1590/AD-8220 |
| SM-1630 | SM-1650 | SM-1630/AD-8210 | | |
| SM-1640 | SM-1660 | SM-1650/AD-8220 | | |

Jordan CONTROLS

# PRODUCT IDENTIFICATION

## IDENTIFICATION LABEL

An identification label is attached to each actuator cover. The serial number is also stamped on the aluminum housing, directly above the conduit entry. When ordering parts, requesting information or service assistance, please provide all of the label information.

EXAMPLE:

| | |
|---|---|
| MODEL | SM-1510 |
| CODE | 1510/5/10 |
| SERIAL | 1234E89 - 12345 |
| PH/HZ/V/A | 1/60/120/1 |

MODEL NUMBER.....SM-1510
ACTUATOR SERIES — MOTOR TYPE

CODE.....1510/5/10
MODEL SERIES — OUTPUT SHAFT RPM — OUTPUT SHAFT TURNS (FEEDBACK GEARING)

SERIAL NUMBER.....1234E89 - 12345
SEQUENCIAL NUMBER — MONTH BUILT — YEAR BUILT — JOB REFERENCE NO.

PH/HZ/V/A.....1/60/120/1
INPUT POWER REQUIREMENT

PH = PHASE
HZ = HERTZ
V = VOLTAGE
A = AMPERES

NOTE: Model number for actuators with built-in amplifier.

MODEL NUMBER....SM-1510/AD-8210
MODEL NUMBER OF BUILT-IN AMPLIFIER

## OUTPUT SHAFT TURNS

The last number in the CODE indicates the nominal OUTPUT SHAFT TURNS for the range of the feedback gearing in the actuator.

Nominal OUTPUT SHAFT TURNS are given as if the unit is built with cam activated position limit switches and/or a 1 turn feedback potentiometer.

If the unit is built with a multi-turn switch assembly and/or a 10 turn potentiometer, the nominal output shaft turns range is 12 times the turns indicated by the code number.

EXAMPLE: CODE.....1510/5/10
Nominal output turns with cam activated switches and/or a 1 turn potentiometer.

CODE.....1510/5/10
10 x 12 = 120 turns
Nominal output turns with multi-turn switch assembly and/or a 10 turn pot.

Refer to page 17 for the actual feedback gearing used.

# Table of Contents

## ** GENERAL INSTRUCTIONS **

Jordan Controls designs, manufactures, and tests its products to meet many national and international standards. However, for these products to operate within their normal specifications, you must properly install, use, and maintain these products. The following instructions must be adhered to and intergrated with your safety program when installing, using and maintaining Jordan Controls Inc. products.

Read and save all instructions prior to installing, operating, and servicing the product.

If you do not understand any of the instructions, contact your Jordan Controls representative for clarification.

Follow all warnings, cautions, and instructions marked on and supplied with the product.

Inform and educate your personnel in the proper installation, operation, and maintenance of the product.

Install your equipment as specified on Jordan Controls Inc. installation instructions and per applicable local/national codes. Connect all products to the proper electrical sources.

Handle, move, and install each product using the appropriate number of personnel and moving devices/equipment (dolly, forklift, crane, etc.). Failure to do so could cause serious personal injury.

To ensure proper performance, use qualified personnel to install, operate, update, tune, and maintain the product.

When replacement parts are required, ensure that the qualified service technician uses replacement parts specified by Jordan Controls. Unauthorized substitutions may result in fire, electrical shock, other hazards, or improper equipment operation.

Ensure all actuator protective covers are in place, except when maintenance is being performed by qualified personnel, to prevent electrical shock, personal injury, or damage to the actuator.

## ** CAUTION **

Before beginning actuator installation, make sure the actuator supplied is suitable for the intended application with respect to environmental conditions and the voltage/frequency of available line power. If you are unsure of the suitability of this equipment for your installation, consult Jordan Controls Inc. prior to proceeding.

## ** WARNING - SHOCK HAZARD **

Installation and servicing must be performed only by qualified personnel. De-energize all sources of power BEFORE removing actuator cover. KEEP COVER TIGHT WHEN CIRCUITS ARE ALIVE. Failure to follow these precautions may result in serious injury or death.

DESCRIPTION

The SM-1500/1600 series rotary actuators are self contained bi-directional electrically operated devices with a maximum gear train rating of 400 in. lbs. for the SM-1500 series and 1000 in. lbs. for the SM-1600 series. The drive motor may be AC or DC. The unit may contain position feedback, limit switches, motor brake, heater and thermostat, manual handcrank and built-in amplifier. The positioning range with selected feedback gear ratios will control the output shaft from 1/4 revolution to 324 revolutions. The actuator may be mounted in any position. The gearing is totally enclosed, permanently lubricated. The actuator housing may be NEMA 12 Inside Industrial, NEMA 4 Watertight or Explosionproof rated for Class I, Div. 1,Groups C,D and Dust-ignitionproof Class II, Div. 1, Groups E, F, G Hazardous Location.

| BASIC MODEL | MOTOR USED (ac motors are single phase, permanent split capacitor, plug reversible) (dc motors are permanent magnet) |
|---|---|
| SM-1510 | 120 V ac, modulating duty, run current .44 A, stall .65 A |
| SM-1510/AD-8210 | SM-1510 above with built-in amplifier |
| SM-1520 | 120 V ac, intermittent duty, run current 2.5 A, stall 2.9 A |
| SM-1520/AD-8210 | SM-1520 above with built-in amplifier |
| SM-1530 | 120 V ac, modulating duty, run current .9 A, stall 1.2 A |
| SM-1530/AD-8210 | SM-1530 above with built-in amplifier |
| SM-1540 | 24 V dc (PM), run current 1.7 A, max. cont. duty 1.9 A |
| SM-1550 | 240 V ac, intermittent duty, run current .45 A, stall .5 A |
| SM-1550/AD-8220 | SM-1550 above with built-in amplifier |
| SM-1560 | 90 V dc (PM), run current .4 A, max. cont. duty .5 A |
| SM-1570 | 240 V ac, modulating duty, run current .27 A, stall .4 A |
| SM-1570/AD-8220 | SM-1570 above with built-in amplifier |
| SM-1580 | 24 V dc (PM) with tach, run current 5.2 A, max. cont. duty 6.25 A |
| SM-1590 | 240 V ac, intermittent duty, run current 1.1 A, stall 1.6 A |
| SM-1590/AD-8220 | SM-1590 above with built-in amplifier |
| SM-1630 | 120 V ac, modulating duty, run current .9 A, stall 1.2 A |
| SM-1630/AD-8210 | SM-1630 above with built-in amplifier |
| SM-1640 | 24 V dc (PM), run current 1.7 A, max. cont. duty 1.9 A |
| SM-1650 | 240 V ac, modulating duty, run current .45 A, stall .5 A |
| SM-1650/AD-8220 | SM-1650 above with built-in amplifier |
| SM-1660 | 90 V dc (PM), run current .4 A, max. cont. duty .5 A |

ACTUATOR SPEED/TORQUE

| MODEL | SM-1510 SM-1570 | SM-1520 SM-1590 | SM-1530 SM-1550 | SM-1540 SM-1560 | SM-1580 | SM-1630 SM-1650 | SM-1640 SM-1660 |
|---|---|---|---|---|---|---|---|
| SPEED (rpm) / TORQUE (in-lb) | | | | | | | |
| | .4 / 400 | .5 / 400 | .4 / 400 | .8 / 400 | 1 / 400 | | |
| | 1.5 / 400 | 2 / 400 | 1.5 / 400 | 3 / 400 | 3.5 / 400 | 2 / 1000 | 4 / 720 |
| | 3 / 210 | 4 / 400 | 3 / 400 | 6 / 400 | 7.5 / 400 | 4 / 500 | 8 / 350 |
| | 5 / 150 | 6 / 400 | 5 / 400 | 10 / 300 | 12 / 400 | | |
| | 10 / 75 | 14 / 400 | 10 / 200 | 20 / 140 | 25 / 270 | | |
| | 18 / 37 | 24 / 300 | 18 / 100 | 36 / 80 | 44 / 160 | | |
| | 28 / 25 | 38 / 190 | 28 / 67 | 56 / 52 | 70 / 100 | | |
| | 36 / 18 | 49 / 150 | 36 / 50 | 73 / 40 | 90 / 75 | | |

## Actuator Characteristics

- The actuator is permanently lubricated, it is not oil or grease filled and may be mounted in any desired plane.
- The actuator weighs approximately 20 lbs. The mass of the actuator varies, depending upon the configuration of options selected.
- The actuator output shaft is made of stainless steel and the housing is aluminum.
- The keyway in the output shaft is not correlated in relation to the mounting holes, unless the customer has specified correlation at time of order.
- The actuator is a very effecient design and the output shaft may coast or be back-driven by the load if the actuator is not supplied with the optional motor brake.

## Mounting Brackets

- When designing mounting brackets and considering mounting locations, allow adequate clearance from the top of the actuator cover to any obstructions such as brick walls or steel structures that could interfere with cover removal.
- Consideration should be given for the location of the conduit entry as conduit will be connected to the actuator.
- If the actuator is supplied with a manual handcrank, allow for operator access.
- The standard SM-1500 series actuators are designed to be face mounted with two, 5/16-18 Grade 5 (or better) mounting bolts. The mounting holes are tapped 1/2 inch deep and the bolts selected should engage a minimum of 6 full threads (5/16").
- The standard SM-1600 series actuators are designed to be face mounted with three, 3/8-16 Grade 5 (or better) mounting bolts. The mounting holes are tapped 1/2 inch deep and the bolts selected should engage a minimum of 6 full threads (3/8").
- Care should be taken not to use bolt lengths that are too long which will bottom in the tapped holes. This will cause a loose mount and applying excessive torque to further tighten the bolts may damage the aluminum threads or shear the bolts.

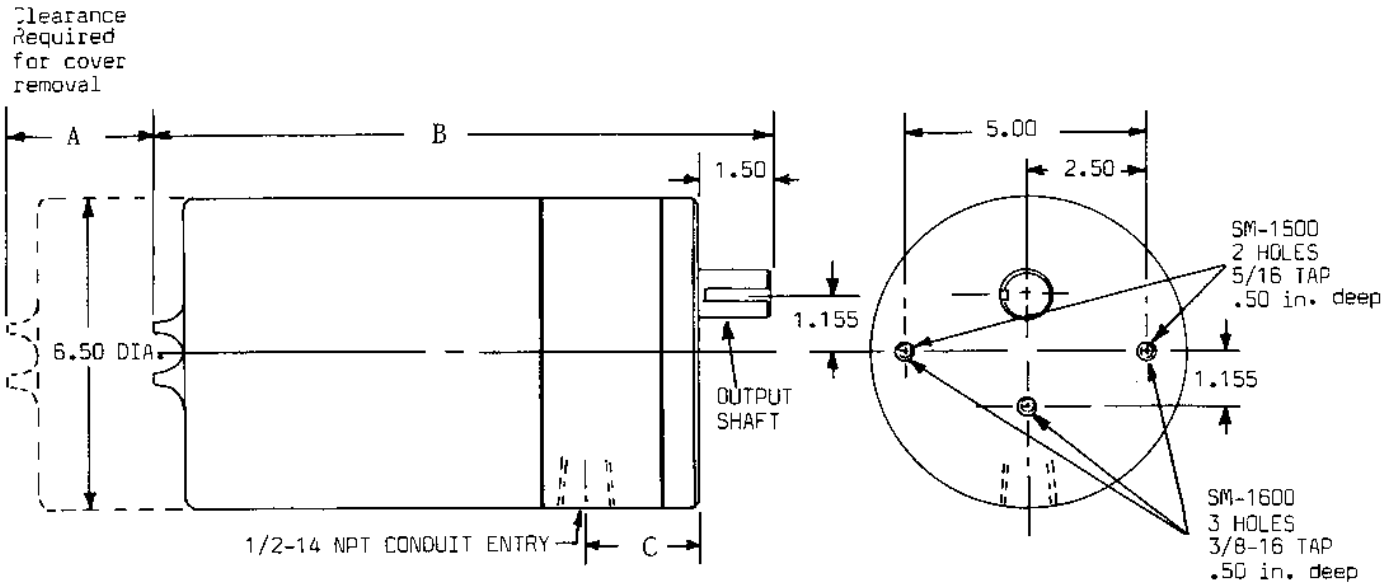
## Coupling the Output Shaft

- For maximum actuator life and efficiency, avoid side loading caused by incorrect shaft alignment. The use of solid, one piece couplings is not recommended.
- When coupling the actuator shaft to the driven shaft, select flexible couplings that can transfer the proper torque without any lost motion or the driven shaft may not be positioned as it should be in relation to the actuator's output shaft.
- The coupling end placed on the actuator's output shaft should be a slip fit. Avoid forcing or pounding the coupling onto the shaft as you may damage the actuator or the coupling.

## Overhung Loads and End Thrust on Output Shaft

- Overhung loads on the actuator output shaft are limited to a maximum of 350 lbs on the SM-1500 series and 650 lbs on the SM-1600 series actuators as measured from a point (center of keyway) .81 inches from the mounting face of the actuator.
- The maximum allowable end thrust applied to the output shaft of the SM-1500 or SM-1600 series actuator is 780 lbs.

# INSTALLATION DIMENSIONS
(NOMINAL)
INCHES




Handcrank and Manual Brake Release options not shown.
Approximate Mass: 20 pounds
Maximum overhung or side load on output shaft as measured .81" from actuator face:
SM-1500 = 350 pounds. SM-1600 = 650 pounds.
Maximum allowable end thrust on output shaft: SM-1500 or SM-1600 = 780 pounds.

| | | A | | | | B | | | | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Options 1,3,5,6 | Options 1,4,6 | Options 2,3,5,6 | Options 2,4,6 | Options 1,3,5,6 | Options 1,4,6 | Options 2,3,5,6 | Options 2,4,6 | |
| HOUSING TYPE | MODEL | | | | | | | | | |
| Nema 12 | SM-1510,70 | 5.25 | 7.99 | N/A | N/A | 9.70 | 12.44 | N/A | N/A | 2.86 |
| | SM-1530,50 SM-1630,50 | 6.25 | 7.99 | N/A | N/A | 10.70 | 12.44 | N/A | N/A | 2.86 |
| | SM-1520,40,60,90 SM-1640,60 | 6.25 | 9.24 | N/A | N/A | 10.70 | 13.69 | N/A | N/A | 2.86 |
| | SM-1580 | 6.25 | N/A | N/A | N/A | 10.70 | N/A | N/A | N/A | 2.86 |
| Nema 4 | SM-1510,30,50,70 SM-1630,50 | 6.88 | 8.00 | 10.00 | 11.12 | 12.01 | 13.13 | 15.13 | 16.25 | 3.20 |
| | SM-1520,90 | 6.88 | 9.44 | 10.00 | 11.12 | 12.01 | 14.58 | 15.13 | 16.25 | 3.20 |
| | SM-1540,60 | 6.88 | 9.44 | N/A | N/A | 12.01 | 14.58 | N/A | N/A | 3.20 |
| | SM-1580 | 6.88 | N/A | N/A | N/A | 12.01 | N/A | N/A | N/A | 3.20 |
| Explosionproof | SM-1500, SM-1600 | 6.88* | N/A | 10.00* | N/A | 12.01* | N/A | 15.13* | N/A | 3.20 |

OPTIONS

1 -- Without built-in AD-8200 Amplifier
2 -- With built-in AD-8200 Amplifier
3 -- Without Motor Brake
4 -- With Motor Brake
5 -- Without Handcrank
6 -- With Handcrank

* ---- Explosionproof Units are not available with Handcrank Option #6.

N/A = Not Available.

| | SM-1500 Series | SM-1600 Series |
|---|---|---|
| Output Shaft Diameter | .7490/.7496" | .9990/.9996" |
| Keyway Dimensions | .187"W x .105"D x 1.25" long | .250"W x .145"D x 1.25" long |
| Key (supplied) | 3/16" Sq. x 1.19" long | 1/4" Sq. x 1.19" long |

## ** WARNING - SHOCK HAZARD **

Installation and servicing must be performed only by qualified personnel.

De-energize all sources of power BEFORE removing the actuator cover. KEEP COVER TIGHT WHEN CIRCUITS ARE ALIVE. Voltages hazardous to your health are applied to these actuators. Failure to follow these precautions may result in serious injury or death.

EXPLOSIONPROOF and DUST-IGNITIONPROOF ACTUATORS are not explosionproof or dust-ignitionproof until final installation is complete. "Hazardous location enclosures must be installed in accordance with The National Electric Code requirements as well as state and local codes".

WATERTIGHT ACTUATORS are not watertight until final installation is complete with conduit entry sealed and actuator cover in place.

## ** CAUTION **

All ac powered actuators contain single phase, 3 wire, permanent split capacitor motors. Motor power is applied across the motor common winding wire and one of the directional input wires. The capacitor creates a phase shift to the other motor directional input wire. This allows the motor to run and develop torque. With external input power applied to one winding, the opposite winding (energized by the capacitor) will have a voltage on it which is greater than the applied voltage while the motor is running. The voltage will be approximately 150 V ac for 120 V ac units and 300 V ac for 240 V ac units. Because of this characteristic the actuator directional input wires must never be connected in parallel from one actuator to another. No inductive or resistive load can be connected in parallel with the directional inputs. When operating more than one actuator from a common source, the use of isolated contacts between each actuator is required. Wiring ac actuators in parallel without isolation will cause one of the actuators to operate at a reduced torque when an end of travel limit switch in the other actuator is opened. The actuator with the opened switch may continue to run, receiving power to the direction winding with the closed switch, by way of the power supplied from the actuator that has not reached its limit switch.

END OF TRAVEL LIMIT SWITCHES built into single phase, ac motor driven units are factory wired in series with the proper motor directional winding. When a switch is tripped (opened), motor power will be removed from the winding and the motor will stop.

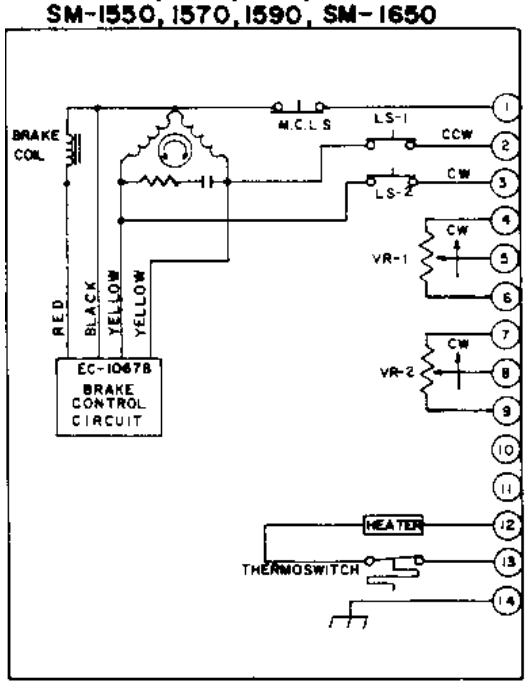
END OF TRAVEL LIMIT SWITCHES built into dc motor driven units are wired to the field wiring terminals and will only stop the motor when they are properly phased and wired to your motor control circuit.

FUSING IS NOT PROVIDED WITHIN THE ACTUATOR. Line fusing must be provided by the customer. Fuse rating should not exceed 5 amperes and fuses should be motor type.

All installation must be in accordance with The National Electric Code requirements as well as state and local codes.

# AC ACTUATOR WIRING

## SM-1510, 1520, 1530, SM-1630
## SM-1550, 1570, 1590, SM-1650




"YOUR ACTUATOR MAY OR MAY NOT BE WIRED AS SHOWN"

NOTES:

1) The SM-1510, 1520, 1530 and SM-1630 use 120 V ac input power.
   The SM-1550, 1570, 1590 and SM-1650 use 240 V ac input power.

2) Voltage applied across terminals 1 and 3 will result in "CW" rotation of the output shaft (as viewed from the shaft end). Voltage applied across terminals 1 and 2 will result in "CCW" output shaft rotation.

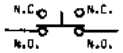
3) When the optional Motor Brake is supplied, an electro-mechanical brake and a brake circuit (EC-10678) will be wired as shown. The brake releases whenever the motor is energized.

4) Clockwise rotation of the actuator output shaft results in decreasing resistance as measured across terminals 4 and 5 when feedback pot VR-1 is supplied and decreasing resistance across terminals 7 and 8 when feedback pot VR-2 is supplied.

5) Position Limit Switch LS-1 "trips" at the "CCW" end of actuator output shaft rotation and LS-2 "trips" at the "CW" end of actuator output shaft rotation. Switches are shown at mid-travel.

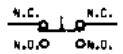
   Single Turn Feedback Ass'y:

   LS-1 is operated by a white cam. LS-2 is operated by a red cam. LS-1 and LS-2 are wired with the N.O. contacts as shown.




   Multi-turn Feedback Ass'y:

   LS-1 and LS-2 are operated with screws on a "travel nut" and are wired using the N.C. contacts as shown.




6) M.C.L.S. indicates the Manual Crank Limit Switch. The switch is only supplied on units with the Manual Handcrank option. The switch is normally closed. When the Manual Handcrank is engaged, the circuit to the motor is opened.

7) Optional Heater Circuit:
   The heater is powered thru the thermoswitch. The switch closes at 90°F and opens at 110°F. 120 V ac units use a 30 WATT heater and 240 V ac units use a 75 WATT heater.

8) Optional Transmitter:
   The ST-4130, 4 to 20mA TRANSMITTER wired as shown will result in a DECREASING SIGNAL for "CW" rotation of the actuator output shaft. Operation requires an EXTERNAL DC POWER SUPPLY with an output in the range of 12.5 Vdc (MIN) to 36.0 Vdc (MAX) and a LOAD connected in series with one lead from the power supply.

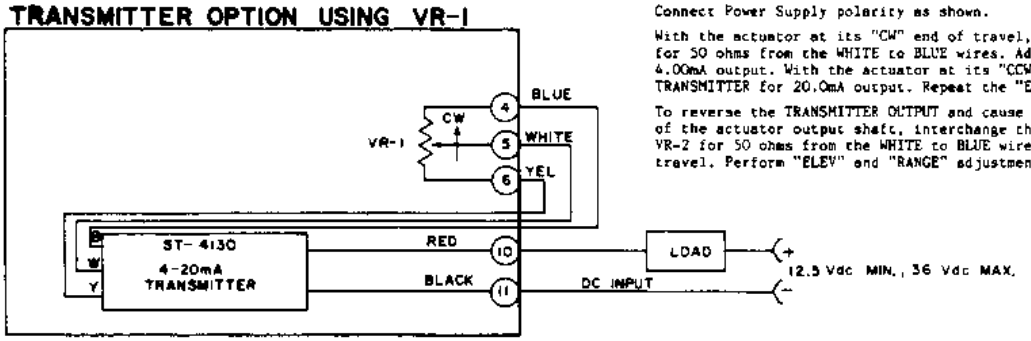
$$\frac{\text{POWER SUPPLY VOLTAGE} - 12\text{V}}{.020\text{A}} = \text{LOAD RESISTANCE MAX.}$$

   Connect Power Supply polarity as shown.

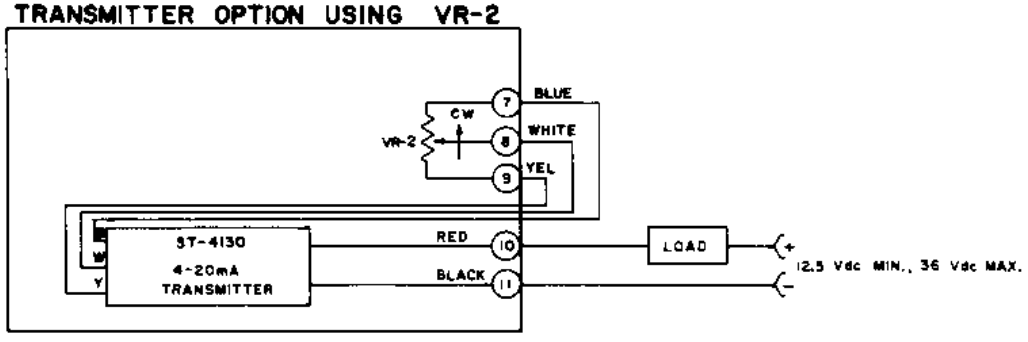
   With the actuator at its "CW" end of travel, adjust VR-1 or VR-2 (the one being used), for 50 ohms from the WHITE to BLUE wires. Adjust "ELEVATION" on the TRANSMITTER for 4.00mA output. With the actuator at its "CCW" end of travel, adjust "RANGE" on the TRANSMITTER for 20.0mA output. Repeat the "ELEV" and "RANGE" adjustments.

   To reverse the TRANSMITTER OUTPUT and cause the signal to DECREASE for "CCW" rotation of the actuator output shaft, interchange the BLUE and YELLOW wires. Adjust VR-1 or VR-2 for 50 ohms from the WHITE to BLUE wires with the actuator at its "CCW" end of travel. Perform "ELEV" and "RANGE" adjustments.

## TRANSMITTER OPTION USING VR-1

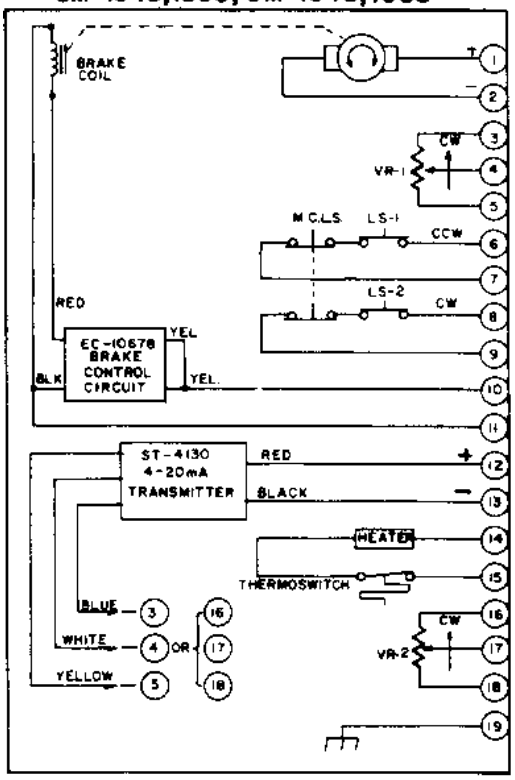



## TRANSMITTER OPTION USING VR-2



# DC ACTUATOR WIRING

## SM-1540,1560, SM-1640,1660




"YOUR ACTUATOR MAY OR MAY NOT BE WIRED AS SHOWN"

NOTES:

1) The SM-1540 and SM-1640 use 24 V dc input power.
   The SM-1560 and SM-1660 use 90 V dc input power.

2) Voltage applied to terminals 1 and 2 with the polarity shown will result in "CW" rotation of the output shaft (as viewed from the shaft end).
   Reversing the polarity reverses the direction.

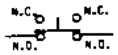
3) When an optional Motor Brake is supplied, an electro-mechanical brake and a brake circuit (EC-10678) will be wired as shown. 120 V ac must be applied across terminals 10 and 11 to release the brake whenever the motor is energized.

4) Clockwise rotation of the actuator output shaft results in decreasing resistance as measured across terminals 3 and 4 when feedback pot VR-1 is supplied and decreasing resistance across terminals 16 and 17 when feedback pot VR-2 is supplied.

5) Position Limit Switch LS-1 "trips" at the "CCW" end of actuator output shaft rotation and LS-2 "trips" at the "CW" end of actuator output shaft rotation. Switches are shown at mid-travel.

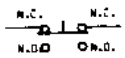
   Single Turn Feedback Ass'y:

   LS-1 is operated by a white cam. LS-2 is operated by a red cam. LS-1 and LS-2 are wired with the N.O. contacts as shown.




   Multi-turn Feedback Ass'y:

   LS-1 and LS-2 are operated with screws on a "travel nut" and are wired using the N.C. contacts as shown.




6) M.C.L.S. indicates the Manual Crank Limit Switch. The switch is only supplied on units with the Manual Handcrank option. The switch is normally closed. When the Manual Handcrank is engaged, the switch is opened. Provision must be made in the customer wiring to interrupt the motor circuit when the Handcrank is engaged.

7) Optional Heater Circuit:
   The heater is powered thru the thermoswitch. The switch closes at 90°F and opens at 110°F. 120 V ac power is applied across terminals 14 and 15. The heater is 30 WATTS.

8) Optional Transmitter:
   The ST-4130, 4 to 20mA TRANSMITTER wired as shown to either VR-1 or VR-2 will result in a DECREASING SIGNAL for "CW" rotation of the actuator output shaft. Operation of the TRANSMITTER requires an EXTERNAL DC POWER SUPPLY with an output in the range of 12.5 Vdc (MIN) to 36.0 Vdc (MAX) and a LOAD connected in series with one lead from the power supply.

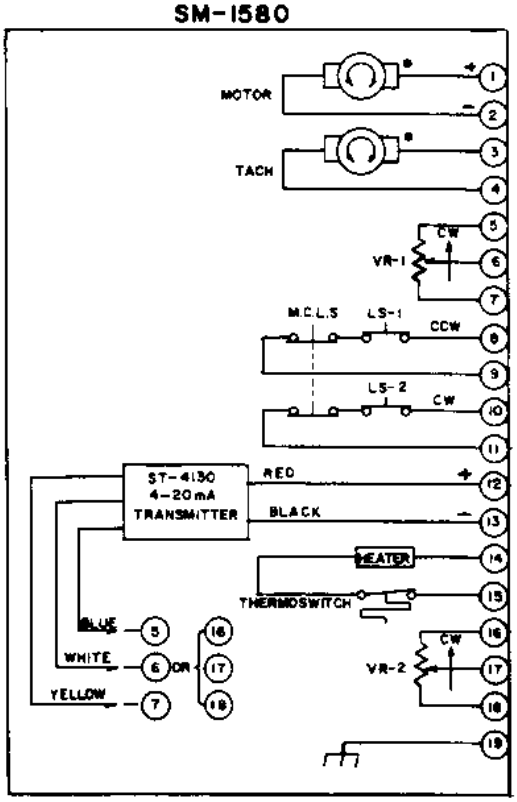
$$\frac{\text{POWER SUPPLY VOLTAGE - 12V}}{.020\text{A}} = \text{LOAD RESISTANCE MAX.}$$

   Connect Power Supply polarity as shown.

   With the actuator at its "CW" end of travel, adjust VR-1 or VR-2 (the one being used), for 50 ohms from the WHITE to BLUE wires. Adjust "ELEVATION" on the TRANSMITTER for 4.00mA output. With the actuator at its "CCW" end of travel, adjust "RANGE" on the TRANSMITTER for 20.0mA output. Repeat the "ELEV" and "RANGE" adjustments.

   To reverse the TRANSMITTER OUTPUT and cause the signal to DECREASE for "CCW" rotation of the actuator output shaft, interchange the BLUE and YELLOW wires. Adjust VR-1 or VR-2 for 50 ohms from the WHITE to BLUE wires with the actuator at its "CCW" end of travel. Perform "ELEV" and "RANGE" adjustments.

## SM-1580




NOTES:

1) The SM-1580 uses 24 V dc input power to the armature.

2) The motor has a built-in tachometer.

3) Voltage applied to terminals 1 and 2 with the polarity shown will result in "CW" rotation of the output shaft (as viewed from the shaft end).
   "CW" rotation of the output shaft results in tachometer output of terminal 4 positive with respect to terminal 3.
   Reversing the polarity at terminals 1 and 2 will reverse the output shaft rotation and the tachometer output polarity at terminals 3 and 4.

4) Clockwise rotation of the actuator output shaft results in decreasing resistance as measured across terminals 5 and 6 when feedback pot VR-1 is supplied and decreasing resistance across terminals 16 and 17 when feedback pot VR-2 is supplied.

5) For Limit Switches, Heater and Transmitter see notes 5 thru 8 above.

NOTE: Unless specified by the customer at time of order, the keyway on the actuator output shaft has no specific orientation to the actuator mounting face.

The actuator has been factory calibrated for the range specified by the customer and only minor adjustments should be needed to match it to the controlled equipment.

FINAL ALIGNMENT CONSISTS OF:

A) Setting the end of travel limit switches for the range of the driven unit without running the actuator into any type of mechanical stops.

B) Aligning the feedback potentiometer (pot) to the range of the actuator set by the end of travel limit switches.

C) Calibrating the 4 to 20 mA transmitter (if supplied).

ACTUATOR ALIGNMENT ac UNITS

1) If the actuator has been mounted and coupled to the controlled equipment, remove the coupling between the actuator shaft and the driven unit.

2) Remove the actuator cover to gain access to the limit switches, feedback pot and terminals.

3) Determine which direction of rotation (CW or CCW) is to be the "zero" end of travel on the driven shaft and on the actuator output shaft. This will be the starting point for alignment.

) Apply power across terminals 1 and 2 to drive the actuator output shaft "CCW" or to termials 1 and 3 to drive the shaft "CW" (looking at the shaft from the mounting face side). Select the appropriate terminals to drive the shaft to the "zero" position as it relates to the shaft being controlled.

5) With both shafts at the "zero" starting position, couple the shafts together. If the keyway on the actuator output shaft must be orientated to obtain coupling, apply power to the actuator to move the shaft in the increase direction until the keyway is located where you want it.

6) At this position it is necessary to set the "zero" limit switch to just "trip" before a mechanical stop (if the driven unit has one) is reached.

If only a very small amount of adjustment is needed, loosen 3 truss head screws (item 11 on page 11) and rotate the complete limit switch assembly until the switch just trips. Tighten the 3 screws.

If a large amount of adjustment is needed, remove the 3 screws, lift the switch assembly off of the mounting plate, turn the switch shaft until the switch just trips, re-insert the frame into the mounting plate and install the 3 screws.

7) If the actuator is equipped with a feedback pot (VR-1), measure the resistance from terminal 5 to terminal 4 or 6 (whichever is the zero end). Loosen the pot body nut (shown on page 19, Fig. 2 and 6) and rotate the body of the pot for a resistance reading of 5% of the total pot value. Rotating the pot too far may cause the pot terminals to hit the cover or motor. If this is the case refer to step 6 and re-adjust the switch shaft and end of travel switch.

8) Monitor the feedback pot from terminal 5 to the terminal which represents the increase end. Apply power to drive the actuator to the desired maximum rotation position. Do not allow the actuator to drive into a mechanical stop and do not drive the pot to less than 5% of its value at the actuator end of travel. Travel to the ends of a pot will break a ten turn pot or cause the signal to be lost on a one turn pot.

9) If the actuator is supplied with a 4 to 20 mA transmitter, refer to the appropriate wiring diagram (supplied with the actuator) for transmitter calibration. (or pages 8 and 9).

When alignment is complete or when stopping work on the actuator, install the actuator cover to protect the internal components.

ACTUATOR ALIGNMENT dc UNITS

The alignment of a dc actuator is similar to that of the ac actuator with a few exceptions.

1) The input power is applied across terminals 1 and 2. The polarity of the input power determines the actuator output shaft direction of rotation.

2) The end of travel position limit switches are not wired in series with the motor and must be field wired to your motor control circuit and phased properly to turn off motor power when the proper switch is "tripped".

3) If the actuator is supplied with a motor brake, power must be supplied from an external source to the motor brake terminals. When motor power is applied, brake power must also be applied.

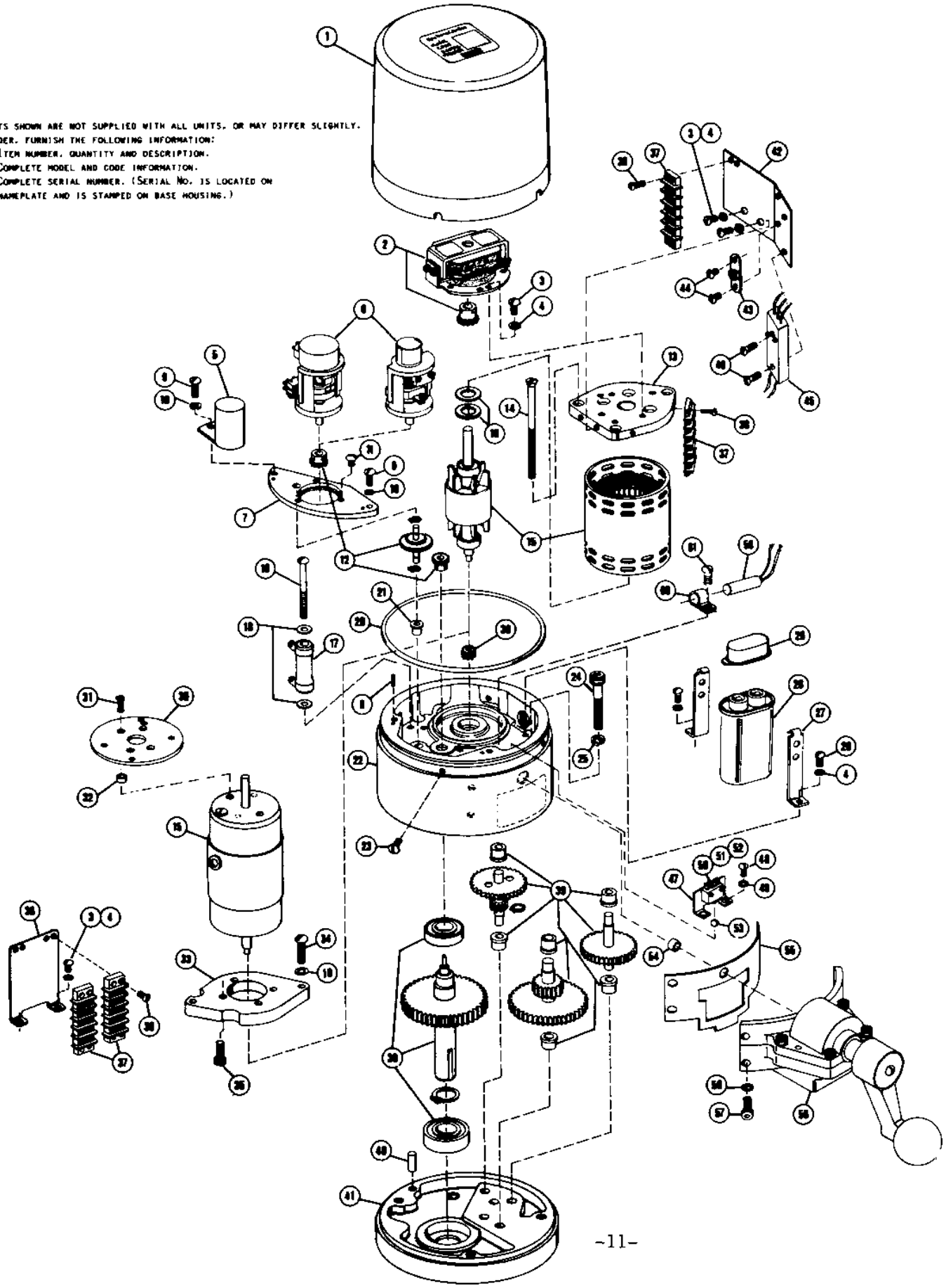
4) The terminal numbers for the components in the dc actuator are different than the terminal numbers in an ac actuator.

5) The operation and phase control of the limit switch circuit should be checked with the actuator near its center of travel, to prevent damage of the controlled unit or the actuator. Improper phasing of the limit switch circuit will cause the actuator motor to receive power and run when the switch is supposed to stop it.

# PARTS ORDER PROCEDURE

ALL PARTS SHOWN ARE NOT SUPPLIED WITH ALL UNITS, OR MAY DIFFER SLIGHTLY.
TO ORDER, FURNISH THE FOLLOWING INFORMATION:

1. ITEM NUMBER, QUANTITY AND DESCRIPTION.
2. COMPLETE MODEL AND CODE INFORMATION.
3. COMPLETE SERIAL NUMBER. (SERIAL NO. IS LOCATED ON NAMEPLATE AND IS STAMPED ON BASE HOUSING.)



# PARTS LIST

## (ALL MODELS)

| ITEM | DESCRIPTION | PART NUMBER | QTY |
|---|---|---|---|
| 1 | Cover | See Page 13 | 1 |
| 2 | Motor Brake | | 1 |
| | (Without Manual Release) | | |
| | SM-1510,20,30, SM-1630 | 22B-009033-001 | |
| | SM-1550,70,90, SM-1650 | 22B-009033-003 | |
| | SM-1540,60, SM-1640,60 | 61A-021147-001 | |
| | (With Manual Release) | | |
| | SM-1510,20,30, SM-1630 | 68B-017132-001 | |
| | SM-1550,70,90, SM-1650 | 68B-017132-003 | |
| | SM-1540,60, SM-1640,60 | 68B-017132-006 | |
| 3 | 8-32x.31 Rd Hd Screw | 54A-015033-031 | 6 |
| 4 | #8 Lockwasher | 56A-015190-002 | 8 |
| 5 | Brake Control Circuit | 70A-022661-001 | 1 |
| 6 | Pot/Limit Switch Assy | See Page 18 | 1 |
| 7 | Feedback Mounting Plate | 61A-SM2542-001 | 1 |
| 8 | .093 x .50 Dowel Pin | 57A-015176-050 | 2 |
| 9 | 10-24x.50 Rd Hd Screw | 54A-015043-050 | 2 |
| 10 | #10 Lockwasher | 56A-015200-001 | 4 |
| 11 | 8-32x.25 Truss Hd Screw | 54A-015032-025 | 3 |
| 12 | Feedback Gearing | See Page 17 | |
| 13 | Motor Top | 60C-012753-001 | 1 |
| | Motor Top (use with brake release) | 61B-017133-001 | |
| 14 | Motor Screws 10-24 Thread | | 3 |
| | SM-1510,70 4.00 long | 54A-015044-400 | |
| | SM-1520,30,50 5.00 long | 54A-015044-500 | |
| | SM-1590 5.50 long | 54A-015044-550 | |
| | SM-1630,50 5.00 long | 54A-015044-500 | |
| 15 | Motor | See Page 13 | 1 |
| 16 | Belleville Washer | 56A-005478-001 | 2 |
| 17 | Resistor | | 1 |
| | SM-1510,30,50,70,90 | 33B-003852-205 | |
| | SM-1520 | 33B-003852-305 | |
| | SM-1630,50 | 33B-003852-205 | |
| 18 | Fiber Washer | 56B-005479-003 | 2 |
| 19 | Screw, 10-24 Thread | | 1 |
| | SM-1510,30,50,70,90 | 54A-015043-250 | |
| | SM-1630,50 2.50 long | 54A-015043-250 | |
| | SM-1520 4.50 long | 54A-015043-450 | |
| 20 | O'Ring | | |
| | NEMA 12 Units | 74B-004108-001 | 1 |
| | NEMA 4 & Explosionproof | 74B-010957-163 | 2 |
| 21 | Bushing | 18B-SP1988-001 | 1 |
| 22 | Gear Housing | See Page 14 | 1 |
| 23 | 10-24x.25 Rd Hd Screw | 54A-015043-025 | 4 |
| 24 | 5/16-18x2.25 Soc Hd Screw | 54A-015070-225 | 3 |
| 25 | 5/16 Hi Collar Lockwasher | 56A-015221-001 | 3 |

| ITEM | DESCRIPTION | PART NUMBER | QTY |
|---|---|---|---|
| 26 | Capacitor | See Page 13 | 1 |
| 27 | Capacitor Bracket | See Page 13 | 2 |
| 28 | Bracket Screws | See Page 13 | 2 |
| 29 | Boot | 24B-004066-110 | 1 |
| 30 | Brake Mounting Plate | 61A-021327-001 | 1 |
| 31 | 4-40x.75 Flat Hd Screw | 58B-024244-013 | 4 |
| 32 | Spacer | 61B-SP1324-100 | 4 |
| 33 | DC Motor Mounting Plate (not used if motor has a brake on it) | 60B-020716-001 | 1 |
| 34 | 10-24x1.00 Rd Hd Screw | 54A-015043-100 | 2 |
| 35 | DC Motor Mounting Screws | | |
| | M5x10MM for mtg to plate | 58B-024244-024 | 4 |
| | M5x15MM for mtg to housing | 58B-024244-029 | 4 |
| | SM-1580 10-32x1.00 long | 54A-015050-100 | 2 |
| 36 | Terminal Bracket | 13B-024486-001 | 1 |
| 37 | Terminal Block 7 Pin | 43B-003888-107 | 2 |
| | Terminal Block 8 Pin | 43B-003888-108 | |
| | Terminal Block 6 Pin | 43B-003888-106 | |
| 38 | 6-32x.38 Rd Hd Screw | 54A-015023-038 | 8 |
| 39 | Power Gearing & Bearings | See Page 15 & 16 | |
| 40 | .250x.88 Dowel Pin | 57A-015226-088 | 1 |
| 41 | Gear Housing Cover | See Page 14 | 1 |
| 42 | Accessory Mtg Bracket | 13B-024555-001 | 1 |
| 43 | Thermal Switch | 74A-023565-001 | 1 |
| 44 | 6-32x.19 Rd Hd Screw | 54A-015023-019 | 2 |
| 45 | 4 to 20 mA Transmitter | 70A-019948-001 | 1 |
| 46 | 6-32x.75 Rd Hd Screw | 54A-015023-075 | 2 |
| 47 | Switch Bracket | 12A-015384-001 | 1 |
| 48 | 6-32x.38 Fil Hd Screw | 54A-015183-038 | 2 |
| 49 | #6 Lockwasher | 56A-015180-002 | 2 |
| 50 | Switch SPDT | 46B-004053-405 | 1 |
| | Switch DPDT | 46B-004053-414 | |
| 51 | 2-56x.38 Rd Hd Screw | 54A-015003-038 | 2 |
| 52 | #2 Lockwasher | 56A-023922-004 | 2 |
| 53 | .250 Dia. Steel Ball | 74A-014865-001 | 1 |
| 54 | Bushing | 18B-003814-055 | 1 |
| 55 | Gasket | 13B-015482-001 | 1 |
| 56 | Handcrank Assy SM-1500 | 68D-022196-001 | 1 |
| | Handcrank Assy SM-1600 | 68D-022196-002 | 1 |
| 57 | 1/4-20x.75 Soc Hd Screw | 54A-015060-075 | 4 |
| 58 | 1/4" Lockwasher | 56A-015210-001 | 4 |
| 59 | Heater 120 Vac 30 Watt | 74A-016946-001 | 1 |
| | Heater 240 Vac 75 Watt | 74A-016946-002 | |
| 60 | Clamp for 120 V Heater | 74A-016947-001 | 1 |
| | Clamp for 240 V Heater | 74A-016947-002 | |
| 61 | 8-32x.38 Rd Hd Screw | 54A-015033-038 | 1 |

## COVER SELECTION ITEM 1

NEMA 12 UNITS
WITHOUT MOTOR BRAKE RELEASE

| MODEL | PART NUMBER |
|---|---|
| SM-1510,70 | 118-SM1197-002 |
| SM-1520,30,40,50,60,80,90 | 118-SM1197-005 |
| SM-1630,40,50,60 | 118-SM1197-005 |

NEMA 12 UNITS
WITH MOTOR BRAKE RELEASE

| MODEL | PART NUMBER |
|---|---|
| SM-1510,70 | 68C-017138-004 |
| SM-1520 | 68C-017138-007 |
| SM-1530,50, SM-1630,50 | 68C-017138-002 |
| SM-1540,60, SM-1640,60 | 68C-017138-010 |
| SM-1590 | 68C-017138-008 |

NEMA 4 and EXPLOSIONPROOF UNITS
WITHOUT MOTOR BRAKE RELEASE
WITHOUT BUILT-IN AD-8200 AMPLIFIER

| MODEL | PART NUMBER |
|---|---|
| SM-1500, SM-1600 ALL | 608-001573-001 |

NEMA 4 and EXPLOSIONPROOF UNITS
WITHOUT MOTOR BRAKE RELEASE
WITH BUILT-IN AD-8200 AMPLIFIER

| MODEL | PART NUMBER |
|---|---|
| SM-1500, SM-1600 ALL | 60C-024806-001 |

NEMA 4 UNITS
WITH MOTOR BRAKE RELEASE
WITHOUT BUILT-IN AD-8200 AMPLIFIER

| MODEL | PART NUMBER |
|---|---|
| SM-1510,70 | 68C-017138-003 |
| SM-1520 | 68C-017138-005 |
| SM-1530,50, SM-1630,50 | 68C-017138-001 |
| SM-1540,60, SM-1640,60 | 68C-017138-009 |
| SM-1590 | 68C-017138-006 |

NEMA 4 UNITS
WITH MOTOR BRAKE RELEASE
WITH BUILT-IN AD-8200 AMPLIFIER

| MODEL | PART NUMBER |
|---|---|
| SM-1510,70 | 68C-025134-001 |
| SM-1520 | 68C-025134-002 |
| SM-1530,50, SM-1630,50 | 68C-025134-003 |
| SM-1590 | 68C-025134-004 |

## MOTOR SELECTION ITEM 15

| ACTUATOR CONFIGURATION | NO MOTOR BRAKE NO HANDCRANK | WITH MOTOR BRAKE NO HANDCRANK | NO MOTOR BRAKE WITH HANDCRANK | WITH MOTOR BRAKE WITH HANDCRANK |
|---|---|---|---|---|
| MODEL | | | | |
| SM-1510 | 61B-021200-002 | 23B-020702-001 | 61B-021200-002 | 23B-020702-001 |
| SM-1520 | 61B-021200-004 | 23B-011999-002 | 61B-021200-004 | 23B-011999-002 |
| SM-1530, SM-1630 | 61B-021200-003 | 23B-020700-001 | 61B-021200-003 | 23B-020700-001 |
| SM-1540, SM-1640 | 61B-021694-001 | 61B-021089-002 | 61B-021694-001 | 61B-021089-003 |
| SM-1550, SM-1650 | 61B-021200-005 | 61B-021240-001 | 61B-021200-005 | 61B-021240-001 |
| SM-1560, SM-1660 | 61B-021694-002 | 61B-021089-001 | 61B-021694-002 | 61B-021089-004 |
| SM-1570 | 61B-021200-001 | 23B-020701-001 | 61B-021200-001 | 23B-020701-001 |
| SM-1580 | 23B-012722-001 | NOT AVAILABLE | 23B-012722-001 | NOT AVAILABLE |
| SM-1590 | 61B-021200-006 | 23B-018106-002 | 61B-021200-006 | 23B-018106-002 |

## CAPACITOR and MOUNTING HARDWARE SELECTION ITEMS 26, 27 and 28

| MODEL | CAPACITOR DESCRIPTION | CAPACITOR PART NUMBER | CAPACITOR MTG. BRACKET | MOUNTING SCREWS DESCRIPTION | SCREW PART NUMBER |
|---|---|---|---|---|---|
| SM-1510 | 5uf, 330 Vac | 24B-029812-005 | 24B-029943-103 | 8-32 x .88 long | 54A-015033-088 |
| SM-1520 | 30uf, 236 Vac | 24B-029812-009 | 24B-029943-111 | 8-32 x 2.75 long | 54A-015033-275 |
| SM-1530, SM-1630 | 10uf, 330 Vac | 24B-029812-008 | 24B-029943-103 | 8-32 x 2.50 long | 54A-015033-250 |
| SM-1550, SM-1650 | 3uf, 440 Vac | 24B-029812-004 | 24B-029943-103 | 8-32 x 1.00 long | 54A-015033-100 |
| SM-1570 | 1.5uf, 440 Vac | 24B-029812-002 | 24B-029943-103 | 8-32 x .50 long | 54A-015033-050 |
| SM-1590 | 7.5uf, 440 Vac | 24B-029812-006 | 24B-029943-111 | 8-32 x 1.50 long | 54A-015033-150 |

NEMA 12 GEAR HOUSING (ITEM 22)

| ACTUATOR CONFIGURATION | NO MOTOR BRAKE NO HANDCRANK | WITH MOTOR BRAKE NO HANDCRANK | NO MOTOR BRAKE WITH HANDCRANK NOTE #1 | WITH MOTOR BRAKE WITH HANDCRANK NOTE #1 | COVER (ITEM 41) |
|---|---|---|---|---|---|
| ACTUATOR MODEL | | | | | |
| SM-1510,20,30,50,70,90 | 60D-005914-001 | 60D-005914-001 | 60D-015375-001 | 60D-015375-001 | 60C-005916-001 |
| SM-1540,60 | 60D-005914-001 | 60B-021360-001 | 60D-015375-001 | 60D-015375-004 | 60C-005916-001 |
| SM-1580 | 60C-017188-001 | NOTE #2 | 60C-017188-002 | NOTE #2 | 60C-005916-001 |
| SM-1630,50 | 60D-022670-001 | 60D-022670-001 | 60D-015375-002 | 60D-015375-002 | 60C-016393-001 |
| SM-1640,60 | 60D-022670-001 | 60B-021360-002 | 60D-015375-002 | 60D-015375-005 | 60C-016393-001 |

| | NEMA 12 UNITS WITH 2A GEARING | | | NEMA 12 UNITS WITH 2B GEARING | | |
|---|---|---|---|---|---|---|
| ACTUATOR CONFIGURATION | NO MOTOR BRAKE WITH HANDCRANK | WITH MOTOR BRAKE WITH HANDCRANK | COVER (ITEM 41) | NO MOTOR BRAKE WITH HANDCRANK | WITH MOTOR BRAKE WITH HANDCRANK | COVER (ITEM 41) |
| ACTUATOR MODEL | | | | | | |
| SM-1510,20,30,50,70,90 | 60C-022077-001 | 60C-022077-001 | 60C-022078-001 | 60C-022077-002 | 60C-022077-002 | 60C-022078-002 |
| SM-1540,60 | 60C-022077-001 | 60C-022077-005 | 60C-022078-001 | 60C-022077-002 | 60C-022077-006 | 60C-022078-002 |
| SM-1580 | 60C-022077-009 | NOTE #2 | 60C-022078-001 | 60C-022077-010 | NOTE #2 | 60C-022078-002 |

NEMA 4 and EXPLOSIONPROOF GEAR HOUSING (ITEM 22)

| ACTUATOR CONFIGURATION | NO MOTOR BRAKE NO HANDCRANK | WITH MOTOR BRAKE NO HANDCRANK | NO MOTOR BRAKE WITH HANDCRANK NOTE #1 & #3 | WITH MOTOR BRAKE WITH HANDCRANK NOTE #1 & #3 | COVER (ITEM 41) |
|---|---|---|---|---|---|
| ACTUATOR MODEL | | | | | |
| SM-1510,20,30,50,70,90 | 60D-018267-001 | 60D-018267-001 | 60D-016586-001 | 60D-016586-001 | 60C-018268-001 |
| SM-1540,60 | 60D-018267-001 | 60B-021091-001 | 60D-016586-001 | 60D-016586-006 | 60C-018268-001 |
| SM-1580 | 60D-018279-001 | NOTE #2 | 60D-016586-007 | NOTE #2 | 60C-018268-001 |
| SM-1630,50 | 60D-018914-001 | 60D-018914-001 | 60D-016586-004 | 60D-016586-004 | 60C-018269-001 |
| SM-1640,60 | 60D-018914-001 | 60B-021091-002 | 60D-016586-004 | 60D-016586-008 | 60C-018269-001 |

| | NEMA 4 UNITS WITH 2A GEARING | | | NEMA 4 UNITS WITH 2B GEARING | | |
|---|---|---|---|---|---|---|
| ACTUATOR CONFIGURATION | NO MOTOR BRAKE WITH HANDCRANK | WITH MOTOR BRAKE WITH HANDCRANK | COVER (ITEM 41) | NO MOTOR BRAKE WITH HANDCRANK | WITH MOTOR BRAKE WITH HANDCRANK | COVER (ITEM 41) |
| ACTUATOR MODEL | | | | | | |
| SM-1510,20,30,50,70,90 | 60C-022077-003 | 60C-022077-003 | 60C-022078-003 | 60C-022077-004 | 60C-022077-004 | 60C-022078-004 |
| SM-1540,60 | 60C-022077-003 | 60C-022077-007 | 60C-022078-003 | 60C-022077-004 | 60C-022077-008 | 60C-022078-004 |
| SM-1580 | 60C-022077-011 | NOTE #2 | 60C-022078-003 | 60C-022077-012 | NOTE #2 | 60C-022078-004 |

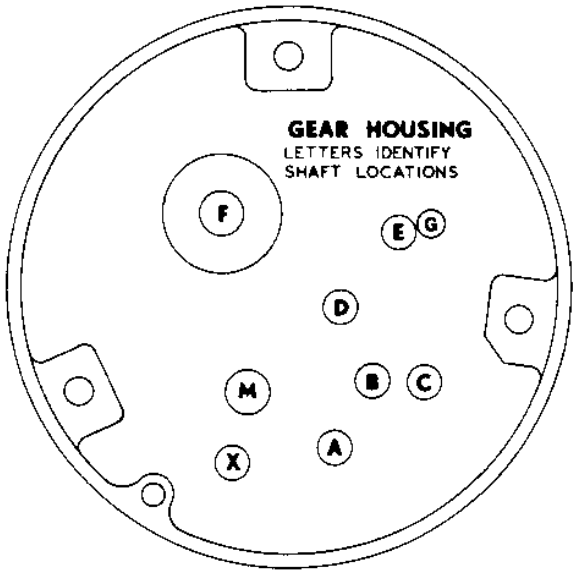
NOTES: #1 FOR SM-1500 ACTUATORS WITH 2A or 2B POWER GEARING AND HANDCRANK OPTION, REFER TO PROPER CHART.

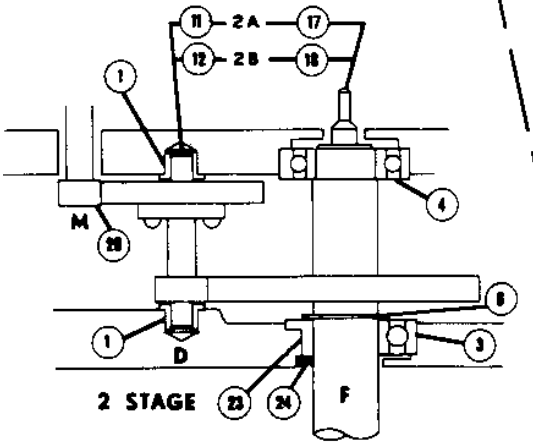
#2 SM-1580 IS NOT AVAILABLE WITH MOTOR BRAKE.

#3 EXPLOSIONPROOF UNITS ARE NOT AVAILABLE WITH HANDCRANK OPTION.

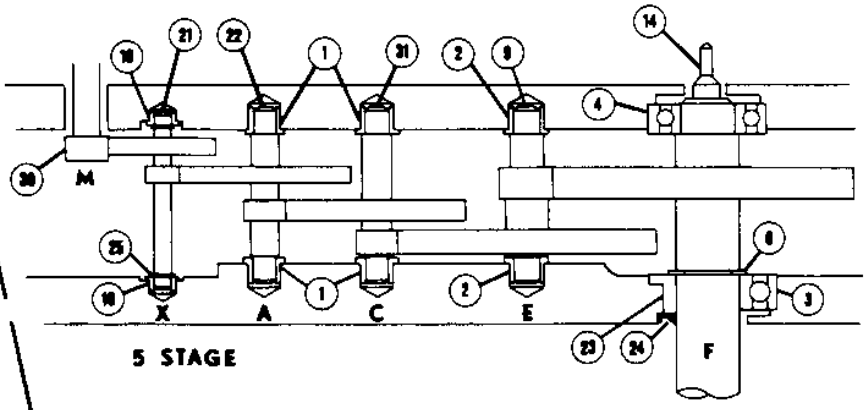
# SM 1500 SERIES
## POWER GEARING VARIATIONS AND LOCATIONS

| SM 1510<br>SM 1530<br>SM 1550<br>SM 1570 | SM 1520<br>SM 1590 | SM 1540 | SM 1560 | SM 1580 | POWER GEARING STAGES |
|---|---|---|---|---|---|
| ← R.P.M. → | | | | | |
| .4 | .5 | .8 | .8 | 1 | 5 A |
| 1.5 | 2 | 3 | 3 | 3.5 | 4 A |
| 3 | 4 | 6 | 6 | 7.5 | 4 B |
| 5 | 6 | 10 | 10 | 12 | 3 A |
| 10 | 14 | 20 | 20 | 25 | 3 B |
| 18 | 24 | 36 | 36 | 44 | 3 C |
| 28 | 38 | 56 | 56 | 70 | 2 A |
| 36 | 49 | 73 | 73 | 90 | 2 B |

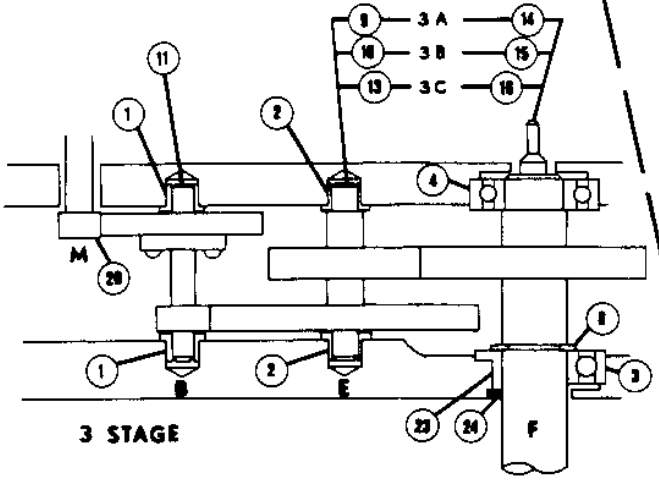


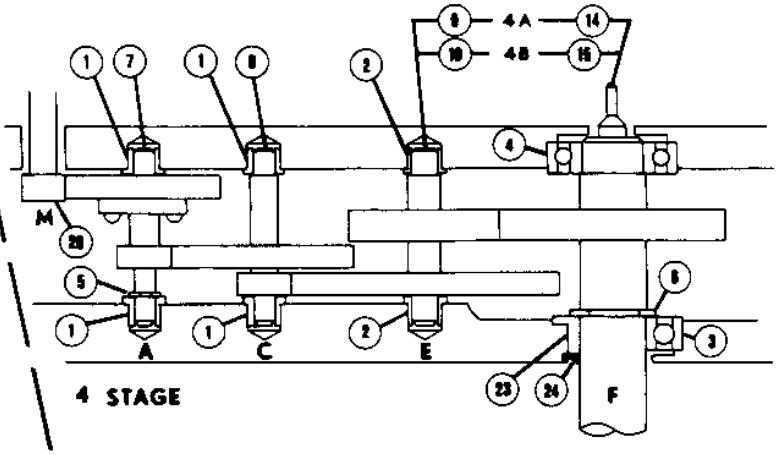

2 STAGE




5 STAGE



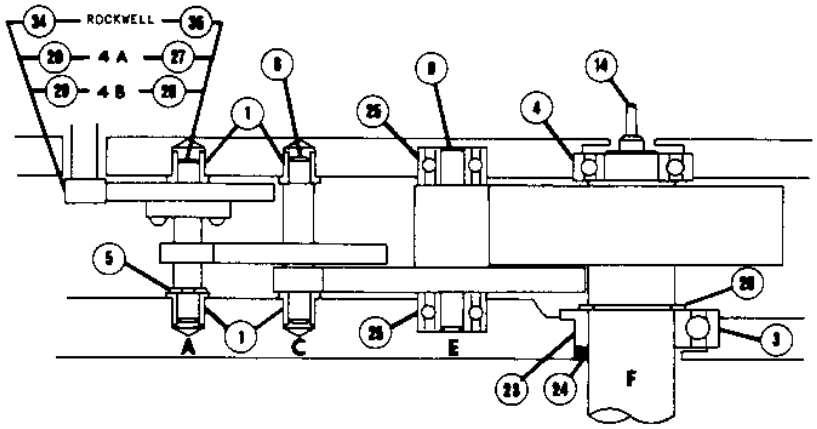

3 STAGE




4 STAGE

# SM 1600 SERIES
# POWER GEARING VARIATIONS AND LOCATIONS

| SM 1630 SM 1650 | SM 1640 | SM 1660 | POWER GEARING STAGES |
|---|---|---|---|
| ← R.P.M. → | | | |
| 2 | 4 | 4 | 4 A |
| 4 | 8 | 8 | 4 B |

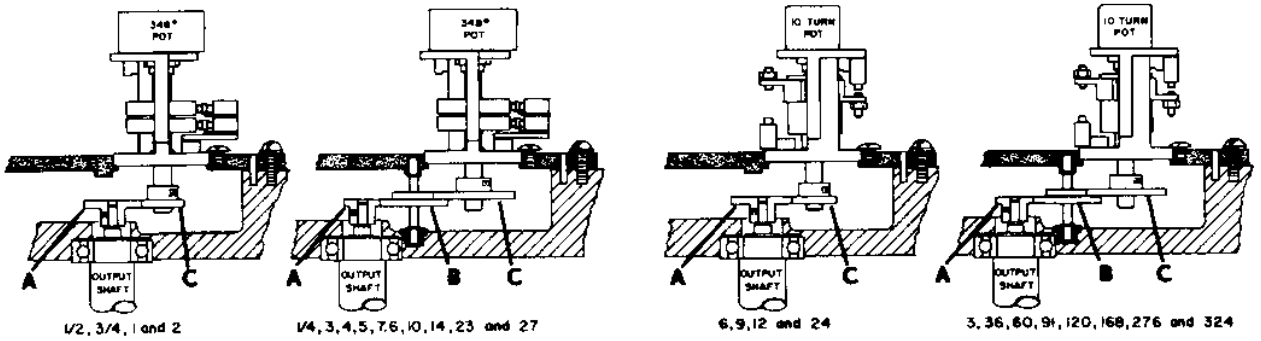



# POWER GEARING PARTS LIST

| | | SM-1500 SERIES | | | SM-1600 SERIES | |
|---|---|---|---|---|---|---|
| | | NEMA 12 INSIDE INDUSTRIAL HOUSING | NEMA 4 WATERTIGHT and EXPLOSIONPROOF HOUSING | | NEMA 12 INSIDE INDUSTRIAL HOUSING | NEMA 4 WATERTIGHT and EXPLOSIONPROOF HOUSING |
| ITEM | DESCRIPTION | PART NUMBER | PART NUMBER | | PART NUMBER | PART NUMBER |
| 1 | Bushing | 18B-SP1988-006 | 18B-SP1988-006 | | 18B-SP1988-006 | 18B-SP1988-006 |
| 2 | Bushing | 18B-SP1988-007 | 18B-SP1988-007 | | | |
| 3 | Bearing | 17B-003813-012 | | | 17B-003813-031 | |
| 4 | Bearing | 17B-003813-010 | 17B-003813-010 | | 17B-003813-010 | 17B-003813-010 |
| 5 | C'Ring 5100-25 | 58B-014183-025 | 58B-014183-025 | | 58B-014183-025 | 58B-014183-025 |
| 6 | C'Ring 5100-75 | 58B-014183-075 | 58B-014183-075 | | | |
| 7 | Gear Assembly | 65A-022648-001 | 65A-022648-001 | | | |
| 8 | Gear Assembly | 65A-022649-001 | 65A-022649-001 | | 65A-016691-001 | 65A-016691-001 |
| 9 | Gear Assembly | 65A-SM3265-001 | 65A-SM3265-001 | | 65A-016856-001 | 65A-016856-001 |
| 10 | Gear Assembly | 65A-SM3265-002 | 65A-SM3265-002 | | | |
| 11 | Gear Assembly | 65A-200485-003 | 65A-200485-003 | | | |
| 12 | Gear Assembly | 65A-200485-001 | 65A-200485-001 | | | |
| 13 | Gear Assembly | 65A-SM3265-003 | 65A-SM3265-003 | | | |
| 14 | Output Shaft Assembly | 65A-005901-001 | 65A-005901-002 | | 65A-009632-001 | 65A-009632-003 |
| 15 | Output Shaft Assembly | 65A-005902-001 | 65A-005902-002 | | | |
| 16 | Output Shaft Assembly | 65A-005903-001 | 65A-005903-002 | | | |
| 17 | Output Shaft Assembly | 65A-005899-001 | 65A-005899-002 | | | |
| 18 | Output Shaft Assembly | 65A-005900-001 | 65A-005900-002 | | | |
| 19 | Bushing | 18B-SP1988-011 | 18B-SP1988-011 | | | |
| 20 | Motor Pinion | 16B-003806-003 | 16B-003806-003 | | 16B-003806-003 | 16B-003806-003 |
| 21 | Gear Assembly | 65A-016312-001 | 65A-016312-001 | | | |
| 22 | Gear Assembly | 65A-016313-001 | 65A-016313-001 | | | |
| 23 | Bushing | | 18B-SP1988-017 | | | 18B-SP1988-034 |
| 24 | Seal | | 19B-003815-019 | | | 19B-003815-020 |
| 25 | Bearing | | | | 17B-003813-017 | 17B-003813-017 |
| 26 | C'Ring 5100-100 | | | | 58B-014183-100 | 58B-014183-100 |
| 27 | Gear Assembly | | | | 65A-009637-001 | 65A-009637-001 |
| 28 | Gear Assembly | | | | 65A-009637-002 | 65A-009637-002 |
| 29 | Motor Pinion | | | | 16B-003806-021 | 16B-003806-021 |
| 30 | Motor Pinion | 16B-003804-011 | 16B-003804-011 | | | |
| 31 | Gear Assembly | 65A-200488-001 | 65A-200488-001 | | | |
| 32 | Gear Assembly (NOTE #2) | 65A-022076-001 | 65A-022076-001 | | | |
| 33 | Bushing (NOTE #2) | 18B-SP1988-011 | 18B-SP1988-011 | | | |
| 34 | Motor Pinion 16 Tooth | | | | 16B-003806-027 | 16B-003806-027 |
| 35 | Gear Assy (NOTE #3) | | | | 65A-027904-001 | 65A-027904-001 |

NOTES:
1. Output Shaft Assemblies are standard;
   SM-1500 --- .750" dia., 1.50" long with 3/16" keyway.
   SM-1600 --- 1.00" dia., 1.50" long with 1/4" keyway.
   (Consult factory for special shafts.)
2. Gear Assy (item 32) and Bushings (item 33) not shown are used in hole G when actuator is built with 2A or 2B gearing and a handcrank.
3. Motor Pinion (item 34) and Gear Assy (item 35) are used for 4 RPM Rockwell units.

# POTENTIOMETER AND LIMIT SWITCH GEARING




1/2, 3/4, 1 and 2 | 1/4, 3, 4, 5, 7.6, 10, 14, 23 and 27 | 6, 9, 12 and 24 | 3, 36, 60, 91, 120, 168, 276 and 324

NOMINAL OUTPUT SHAFT TURNS | NOMINAL OUTPUT SHAFT TURNS times 12

| NOMINAL OUTPUT SHAFT TURNS | FEEDBACK GEAR RATIO | GEARS (NO. OF TEETH) A | B | C | PART NUMBER GEAR A | GEAR ASSY B | GEAR C |
|---|---|---|---|---|---|---|---|
| 1/4 | .346:1 | 60 | 52-90 | 36 | 16B-003811-058 | 65A-007127-001 | 16B-003811-036 |
| 1/2 | .647:1 | 62 | ------ | 42 | 16B-003811-062 | ---------- | 16B-003811-039 |
| 3/4 | 1.000:1 | 52 | ------ | 52 | 16B-003811-049 | ---------- | 16B-003811-051 |
| 1 | 1.311:1 | 45 | ------ | 59 | 16B-003811-042 | ---------- | 16B-003811-057 |
| 2 | 2.714:1 | 28 | ------ | 76 | 16B-003811-023 | ---------- | 16B-003811-077 |
| 3 | 3.934:1 | 36 | 76-44 | 82 | 16B-003811-033 | 65A-007127-002 | 16B-003811-082 |
| 4 | 5.277:1 | 36 | 76-36 | 90 | 16B-003811-033 | 65A-007127-003 | 16B-003811-091 |
| 5 | 6.739:1 | 34 | 78-32 | 94 | 16B-003811-030 | 65A-007127-004 | 16B-003811-095 |
| 7.6 | 10.136:1 | 26 | 86-31 | 95 | 16B-003811-019 | 65A-007127-005 | 16B-003811-097 |
| 10 | 13.279:1 | 21 | 91-31 | 95 | 16B-003811-016 | 65A-007127-006 | 16B-003811-097 |
| 14 | 19.846:1 | 26 | 86-18 | 108 | 16B-003811-019 | 65A-007127-008 | 16B-003811-110 |
| 23 | 31.333:1 | 18 | 94-18 | 108 | 16B-003811-011 | 65A-007127-009 | 16B-003811-110 |
| 27 | 36.000:1 | 16 | 96-18 | 108 | 16B-003811-007 | 65A-007127-010 | 16B-003811-110 |

| NOMINAL OUTPUT SHAFT TURNS | FEEDBACK GEAR RATIO | POTENTIOMETER USAGE 348° POT 60% | 90% | 100% | LIMIT SWITCH RESET | POTENTIOMETER USAGE 10 TURN POT 60% | 90% | 100% | LIMIT SWITCH RESET |
|---|---|---|---|---|---|---|---|---|---|
| 1/4 | .346:1 | 72.37° | 108.57° | 120.62° | 3.5° | 2.08T | 3.12T | 3.46T | 70.0° |
| 1/2 | .647:1 | 141.44° | 212.16° | 235.74° | 4.0° | 4.06T | 6.09T | 6.77T | 120.0° |
| 3/4 | 1.000:1 | 208.80° | 313.20° | 348.00° | 5.5° | 6.00T | 9.00T | 10.00T | 210.0° |
| 1 | 1.311:1 | 273.74° | 1.14T | 1.26T | 8.0° | 7.86T | 11.79T | 13.11T | 215.0° |
| 2 | 2.714:1 | 1.57T | 2.36T | 2.62T | 15.0° | 16.28T | 24.42T | 27.14T | 535.0° |
| 3 | 3.934:1 | 2.28T | 3.42T | 3.80T | 25.0° | 23.60T | 35.40T | 39.34T | 1.9T |
| 4 | 5.277:1 | 3.06T | 4.59T | 5.10T | 35.0° | 31.66T | 47.49T | 52.77T | 2.6T |
| 5 | 6.739:1 | 3.91T | 5.86T | 6.51T | 40.0° | 40.43T | 60.65T | 67.38T | 3.6T |
| 7.6 | 10.136:1 | 5.88T | 8.82T | 9.79T | 60.0° | 60.81T | 91.22T | 101.36T | 5.9T |
| 10 | 13.279:1 | 7.70T | 11.55T | 12.83T | 75.0° | 79.77T | 119.51T | 132.79T | 6.5T |
| 14 | 19.846:1 | 11.51T | 17.26T | 19.18T | 112.0° | 119.07T | 178.61T | 198.46T | 9.5T |
| 23 | 31.333:1 | 18.17T | 27.25T | 30.28T | 170.0° | 187.99T | 281.99T | 313.33T | 15.7T |
| 27 | 36.000:1 | 20.87T | 31.31T | 34.79T | 200.0° | 216.00T | 324.00T | 360.00T | 17.5T |

OUTPUT SHAFT TURNS

° = DEGREES T = TURNS

LIMIT SWITCH RESET:
THE MAXIMUM REVERSE ROTATION REQUIRED OF THE ACTUATOR OUTPUT SHAFT TO RESET THE END OF TRAVEL POSITION LIMIT SWITCH AFTER IT HAS BEEN TRIPPED.

MAXIMUM RECOMMENDED OUTPUT SHAFT ROTATION:
THE MAXIMUM RECOMMENDED OUTPUT SHAFT ROTATION IS 90% OF THE FEEDBACK POTENTIOMETER. USING MORE THAN 90% OF THE POT WILL CAUSE OVERLAP OF THE CAM OPERATED LIMIT SWITCHES AND COULD CAUSE BREAKAGE OF A TEN TURN POTENTIOMETER.

# POTENTIOMETER AND LIMIT SWITCH ASSEMBLIES

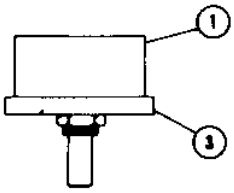


Figure 1

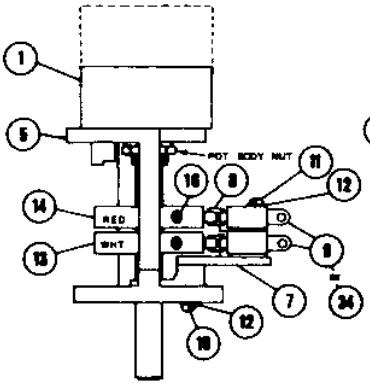



Figure 2

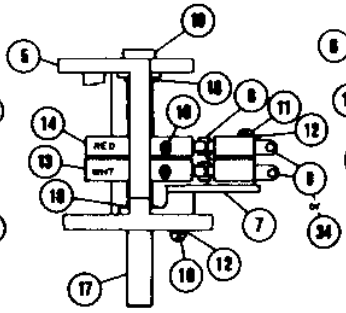


Figure 3

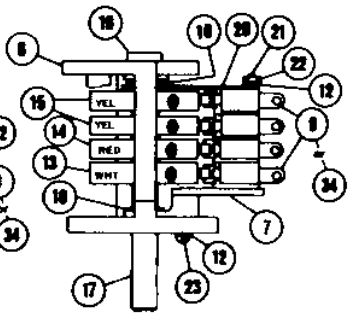



Figure 4

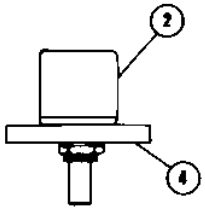


Figure 5

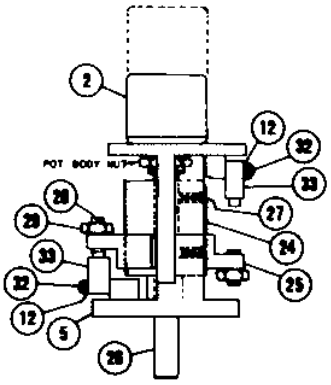



Figure 6

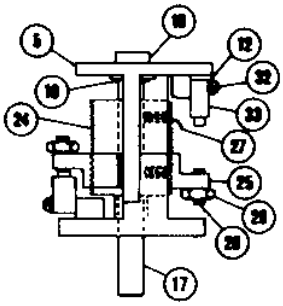


Figure 7

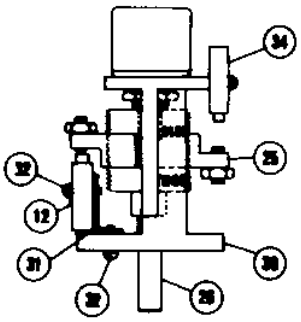


Figure 8

## ITEMIZED PARTS LIST

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1 | POTENTIOMETER, 1 TURN, 1K | 34C-015848-001 |
| | POTENTIOMETER, 1 TURN, TANDEM, 1K/1K | 34B-003956-026 |
| | POTENTIOMETER, 1 TURN, 10K | 34B-100032-014 |
| 2 | POTENTIOMETER, 10 TURN, 1K | 34B-100033-001 |
| | POTENTIOMETER, 10 TURN, TANDEM,1K/1K | 34B-100033-007 |
| | POTENTIOMETER, 10 TURN, 10K | 34B-100033-002 |
| 3 | POT MOUNTING DISC (for 1 turn pot) | 61A-SM3304-001 |
| 4 | POT MOUNTING DISC (for 10 turn pot) | 61A-SM3304-003 |
| 5 | MOUNTING FRAME | 14C-008600-001 |
| 6 | MOUNTING FRAME (4 switch only) | 61A-009180-001 |
| 7 | SWITCH MOUNTING PLATE | 13A-010187-001 |
| 8 | SWITCH LEVER | 46B-004053-406 |
| 9 | LIMIT SWITCH (SPDT) | 46B-004053-405 |
| 10 | 2-56 x .50 lg. RD.HD. SCREW | 54A-015003-050 |
| 11 | 2-56 x .62 lg. RD.HD. SCREW | 54A-015003-062 |
| 12 | #2 STARWASHER | 56A-015160-002 |
| 13 | CAM (WHITE) | 14B-SM2341-001 |
| 14 | CAM (RED) | 14B-SM2341-004 |
| 15 | CAM (YELLOW) | 14B-SM2341-007 |
| 16 | 8-32 x .38 lg. SET SCREW | 54A-015037-038 |
| 17 | SHAFT (units without potentiometer) | 62A-005942-001 |
| 18 | E"RING 5133-25 | 58A-024086-001 |
| 19 | BUSHING | 18B-SP1968-005 |
| 20 | SWITCH SUPPORT PLATE | 61A-014663-001 |
| 21 | 2-56 x .88 lg. THRD. STOCK (3 sw units) | 54A-015088-001 |
| | 2-56 x 1.19 lg. THRD. STOCK (4 sw units) | 54A-015539-119 |
| 22 | 2-56 NUT | 55A-015088-001 |
| 23 | 2-56 x .31 lg. RD.HD. SCREW (4 sw units) | 54A-015033-031 |
| 24 | MULTI-TURN SCREW | 61A-006804-001 |
| 25 | TRAVEL NUT | 14B-006602-001 |
| 26 | SHAFT | 62A-006806-001 |
| 27 | 8-32 x .25 lg. SET SCREW | 54A-015037-025 |
| 28 | 8-32 x .50 lg. SET SCREW | 54A-015037-050 |
| 29 | 8-32 NUT | 55A-015038-001 |
| 30 | MOUNTING FRAME (for DPDT switches) | 14C-014391-001 |
| 31 | SWITCH MOUNTING BRACKET | 13A-014392-001 |
| 32 | 2-56 x .38 lg. RD.HD. SCREW | 54A-015003-038 |
| 33 | LIMIT SWITCH (SPDT) | 46B-004053-409 |
| 34 | LIMIT SWITCH (DPDT) | 46B-004053-414 |

## COMPLETE ASSEMBLY

| FIGURE | DESCRIPTION | PART NUMBER |
|---|---|---|
| | ( FIGURES 1 thru 4 are single turn assemblies) | |
| 1 | 1K POT AND MOUNTING DISC | 68A-007162-003 |
| | 10K POT AND MOUNTING DISC | 68A-007162-004 |
| 2 | 1K POT, 2 SWITCHES (SPDT) | 68B-018200-001 |
| | 1K POT, 3 SWITCHES (SPDT) | 68B-018200-002 |
| | 1K POT, 4 SWITCHES (SPDT) | 68B-018200-003 |
| | 1K POT, 2 SWITCHES (DPDT) | 68B-018200-004 |
| | 1K/1K TANDEM POT, 2 SWITCHES (SPDT) | 68B-018200-009 |
| | 10K POT, 2 SWITCHES (SPDT) | 68B-018200-017 |
| 3 | NO POT, 2 SWITCHES (SPDT) | 68B-018200-006 |
| | NO POT, 2 SWITCHES (DPDT) | 68B-018200-038 |
| 4 | NO POT, 3 SWITCHES (SPDT) | 68B-018200-007 |
| | NO POT, 4 SWITCHES (SPDT) | 68B-018200-008 |
| | (FIGURES 5 thru 8 are ten turn assemblies) | |
| 5 | 1K POT AND MOUNTING DISC | 68A-007162-005 |
| | 10K POT AND MOUNTING DISC | 68A-007162-006 |
| 6 | 1K POT, 2 SWITCHES (SPDT) | 68B-006800-001 |
| | 10K POT, 2 SWITCHES (SPDT) | 68B-006800-002 |
| | 1K/1K TANDEM POT, 2 SWITCHES (SPDT) | 68B-006800-046 |
| 7 | NO POT, 2 SWITCHES (SPDT) | 68B-006800-003 |
| 8 | 1K POT, 2 SWITCHES (DPDT) | 68B-006800-026 |
| | NO POT, 2 SWITCHES (DPDT) | 68B-006800-032 |

NOTE:
DUE TO THE MANY CONFIGURATIONS POSSIBLE NOT ALL ARE LISTED.
ONLY STANDARD POTENTIOMETER VALUES ARE LISTED.
CONSULT FACTORY FOR OTHER COMBINATIONS.

# TROUBLE-SHOOTING
## SM-1500/1600 ACTUATOR WITHOUT BUILT-IN AMPLIFIER

| PROBLEM | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| Motor won't run in either direction. | 1. Power not applied from source.<br>2. Motor overheated and internal thermal switch tripped.<br>3. Motor is burnt out.<br>4. Motor brake not releasing.<br>5. Both end of travel switches open or one open and one defective.<br>6. Actuator output shaft stalled.<br>7. Manual handcrank engaged or handcrank switch M.C.L.S. is open.<br>8. Defective motor run capacitor. | 1. Check source, fuses, wiring.<br>2. Let motor cool, determine why overheating occurred.<br>3. Replace motor and determine what caused burn out.<br>4. Check brake and brake circuit.<br>5. Adjust switch settings or replace defective switch.<br>6. Check load on output shaft.<br>7. Disengage handcrank to close switch.<br>8. Replace capacitor. |
| Motor hums but does not run. | 1. Actuator output shaft stalled.<br>2. Power applied to both directions of rotation at same time.<br>3. Jammed, damaged power gearing.<br>4. Motor brake not releasing.<br>5. Defective motor run capacitor. | 1. Check load on output shaft.<br>2. Apply power to only one direction of rotation at a time.<br>3. Repair gearing.<br>4. Check brake and brake circuit.<br>5. Replace capacitor. |
| Motor runs only one way. | 1. Power not applied for other direction.<br>2. Power always applied to one direction and electrically stalls when applied for opposite direction.<br>3. Open limit switch for other direction.<br>4. Open motor winding. | 1. Correct power problem.<br>2. Correct power problem.<br>3. Reset switch adjustment or replace.<br>4. Replace motor. |
| Motor runs, output shaft does not turn. | 1. Broken or worn power gearing. | 1. Repair power gearing. |
| Motor does not shut off at limit switch. | 1. Switch defective or wired wrong.<br>2. Actuator is coasting thru switch cam dwell area and switch is resetting. | 1. Replace switch or correct wiring.<br>2. Change power gearing to slower speed. Add motor brake and brake circuit. |
| Motor brake does not hold motor shaft. | 1. Brake disc worn.<br>2. Set screws in brake hub are loose. | 1. Adjust brake air gap.<br>2. Remove brake and tighten set screws. |
| Motor brake does not release. | 1. Defective brake control circuit.<br>2. No brake air gap.<br>3. Defective brake coil. | 1. Replace control circuit.<br>2. Adjust air gap.<br>3. Replace entire brake. |
| Pot feedback signal not present at some position of actuator output shaft. | 1. Pot not aligned with end of travel switches and is being driven thru dead region.<br>2. Pot signal is erratic or pot broken. | 1. Align pot to range of actuator.<br>2. Replace pot. |
| Pot signal does not change as output shaft turns. | 1. Broken or burnt out pot.<br>2. Feedback gear not turning pot shaft. | 1. Replace pot.<br>2. Check gearing engagement and set screws in gear hubs. |
| Pot signal is reversed for output shaft rotation. | 1. Pot is wired wrong to terminals. | 1. Reverse wiring from ends of pot at actuator terminal block. |
| Output shaft rotates wrong direction for CW and CCW input power. | 1. Wiring to actuator incorrect.<br>2. Wiring from motor to terminals or switches is backward. | 1. Correct field wiring.<br>2. Correct internal actuator wiring. |
| Water droplets inside motor area of actuator. | 1. Condensation caused by temperature variations and humidity.<br>2. Water entering actuator. | 1. Add heater and thermostat circuit or keep existing circuit energized.<br>2. Keep cover tight, check conduit entry. |

# AD-8200 SERIES ( BUILT-IN ) AMPLIFIER

DESCRIPTION:

The built-in AD-8200 Series Amplifiers are used to control the actuator output shaft position, in relation to the CUSTOMER SUPPLIED 4 to 20 mA COMMAND SIGNAL.

The amplifier requires two input signals. One signal is from the CUSTOMER SUPPLIED 4 to 20 mA COMMAND SIGNAL and the other is the FEEDBACK SIGNAL from the actuator. The 4 to 20 mA COMMAND SIGNAL is converted to a .8 V dc to 4.0 V dc signal at the amplifiers input, by use of a 200 ohm shunt resistor. The FEEDBACK SIGNAL is obtained from a 1000 ohm potentiometer built into the actuator. The potentiometer has a dc voltage applied to it from the amplifier. The voltage applied to the potentiometer is adjustable with the HI-TRIM and LO-TRIM adjustments located on the amplifier circuit board. The feedback potentiometer is gear driven from the actuator output shaft and the voltage derived from it changes as the output shaft is rotated. The LO-TRIM is used to adjust the minimum signal from the feedback potentiometer to a level of .8 V dc and the HI-TRIM is used to adjust the maximum signal from the feedback potentiometer to a level of 4.0 V dc. When properly adjusted for the range of the actuator output shaft, the feedback signal and the command signal will be equal at the minimum and maximum voltage levels and the actuator output shaft will follow the command signal in a linear fashion.

If the two signals are equal, the amplifier's output circuit is "OFF" and both light emitting diodes (LED 1 and LED 2) on the amplifier will be "OFF". When the COMMAND SIGNAL is greater than the FEEDBACK SIGNAL, LED 2 will be turned "ON" and power from the amplifier will drive the actuator in the "increase" direction. When the COMMAND SIGNAL is less than the FEEDBACK SIGNAL, LED 1 will be turned "ON" and power from the amplifier will drive the actuator in the "decrease" direction. The actuator motor will run until the FEEDBACK SIGNAL is equal to the COMMAND SIGNAL (within the amplifier DEADBAND setting) and the LED turns "OFF" or until an end of travel limit switch is tripped in the actuator. If a limit switch is tripped and the LED is "ON", the HI and LO TRIM adjustments are not properly adjusted. The DEADBAND adjustment on the amplifier is used to adjust the amplifier's sensitivity to the difference of the COMMAND and FEEDBACK SIGNALS. It must be adjusted to stabilize the AMPLIFIER/ACTUATOR loop, in final installation with the CUSTOMER COMMAND SIGNAL.

A DYNAMIC BRAKE CIRCUIT is built into the amplifier. The function of this circuit is selected with a jumper for "ON" or "OFF" by the customer. When the jumper is in the "OFF" position the circuit is not used. When the jumper is in the "ON" position, the circuit causes both motor directional outputs to be turned "ON" for a period of 130 ms whenever the amplifier nulls. This electrically stalls the motor by applying power to both the INCREASE and DECREASE windings at the same time to prevent motor coasting. The use of the DYNAMIC BRAKE CIRCUIT depends upon the number of actuator positioning changes per hour, as each time the circuit is energized heat will be generated within the motor. Excessive motor heat will cause the thermal overload in the motor to shut off the motor. The overload will reset automatically when the motor windings cool down.

The amplifier has a built-in LOSS OF SIGNAL (LOS) detection circuit. This circuit monitors the 4 to 20 mA COMMAND SIGNAL. Loss of signal may be either a broken wire or a "low command signal". The detection level is adjustable from 0 to 7 mA with the "LOS" pot on the amplifier. When in "LOS", a jumper on the amplifier is selected to cause the actuator to "RUN TO HI LIMIT, LOCK IN PLACE" or "RUN TO LOW LIMIT". Adjusting the "LOS" pot for a signal detection level above 4 mA will not allow normal signal control at 4.0 ma. The "LOS" pot is normally adjusted for a 3.6 mA trip point.

If the actuator has a built-in motor brake, the brake coil is energized from the amplifier each time one of the LEDS turn "ON" to drive the motor. When the LED turns "OFF" the motor brake friction disc stops the motor. This is not the same function as "DYNAMIC BRAKING" previously described. When the actuator is supplied with a motor brake, the DYNAMIC BRAKE CIRCUIT JUMPER should be selected to the "OFF" position.

START-UP

Actuators with built-in AD-8200 Series Amplifier

(Actuators without built-in AD-8200 Series Amplifier -- Refer to page 10)

The ACTUATOR/AMPLIFIER combination has been factory calibrated and only minor adjustments will need to be made during installation.

INITIAL INSTALLATION CALIBRATION

1) If the actuator has been mounted and coupled to the controlled equipment, remove the coupling from the actuator output shaft to the driven unit.
2) Apply a COMMAND SIGNAL that can be varied from 0 to 20 mA. Adjust the signal for 12.0 mA.
3) Apply INPUT POWER. A light emitting diode (LED) on the amplifier will turn "ON" and the actuator output shaft will be rotated to mid-travel. Upon positioning to this set point, the LED will turn "OFF" and the output shaft will stop.
4) Set the COMMAND SIGNAL to 4.0 mA. The actuator output shaft will rotate in the "DECREASE" direction until LED 1 turns "OFF" or the "DECREASE" END OF TRAVEL LIMIT SWITCH (in the actuator) is tripped. Adjust "LO TRIM" (on the amplifier) to just turn "OFF" LED 1 before the limit switch trips. If the switch trips before LED 1 turns "OFF", adjust "LO TRIM" to turn LED 1 "OFF" with the switch tripped.
5) Determine the amount of actuator output shaft rotation needed for the travel of the driven unit.
6) Mark the output shaft with a pencil and slowly give the amplifier an INCREASING COMMAND SIGNAL while counting the output shaft revolutions. When the shaft rotation corresponds to the rotation required for the driven unit, adjust the "INCREASE" END OF TRAVEL LIMIT SWITCH to just trip.
7) Set the COMMAND SIGNAL to 20.0 mA.
8) Adjust "HI TRIM" on the amplifier to just turn "OFF" LED 2 before the switch trips.
9) Repeat the "LO" and "HI TRIM" adjustments until the actuator stops at each end of travel, just before the ends of travel switches are tripped and the LEDS turn "OFF".
10) Set the COMMAND SIGNAL to 4.00 mA and allow the actuator to stop running.
11) With the actuator output shaft and the driven units shaft at the 4.00 mA position, couple the shafts together.
12) Adjust the COMMAND SIGNAL to various settings between 4 and 20 mA and adjust the "DEADBAND" potentiometer (on the amplifier) for best response without having the actuator oscillate at set points.
13) Repeat the "LO" and "HI TRIM" adjustments until LED 1 and LED 2 TURN "OFF" just before their respective end of travel limit switch trips.
14) Select the "LOS" jumper for the desired function - RUN HI, LOCK-IN-PLACE or RUN LO.
15) Adjust the COMMAND SIGNAL to 3.6 mA. The "LOS" function selected should occur. If it doesn't, adjust "LOS TRIM" to trip at 3.6 mA.

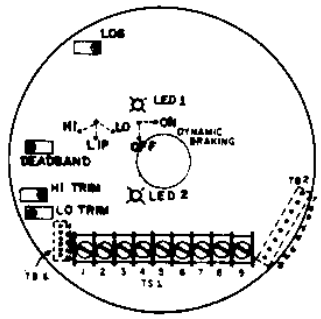
REVERSING THE ACTUATOR ROTATION WITH RESPECT TO AN INCREASING COMMAND SIGNAL

1) Refer to NOTE 2 on PAGE 22.
2) Perform INITIAL INSTALLATION CALIBRATION.

CALIBRATION IF LIMIT SWITCHES HAVE BEEN ALTERED or POTENTIOMETER REPLACED

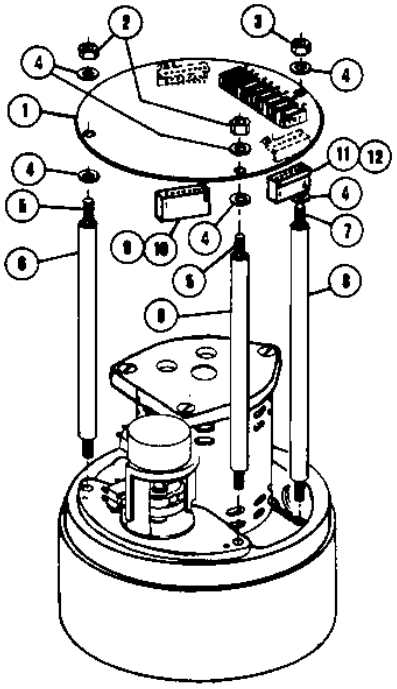
1) If an INCREASING COMMAND SIGNAL is to result in "CCW" rotation of the actuator output shaft.
   A) Remove plug TB-1 from the amplifier.
   B) Loosen the pot bushing nut holding the feedback pot VR-1.
   C) Rotate the body of the pot until 50 ohms is measured from PIN 1 to PIN 3 of TB-1.
   D) Tighten the pot bushing nut.
   E) Adjust limit switch LS-2 to trip at this point.
   F) Insert plug TB-1 on the amplifier and perform INITIAL INSTALLATION CALIBRATION.
2) If an INCREASING COMMAND SIGNAL is to result in "CW" rotation of the actuator output shaft.
   A) Same as above except step E - change LS-2 to read LS-1.

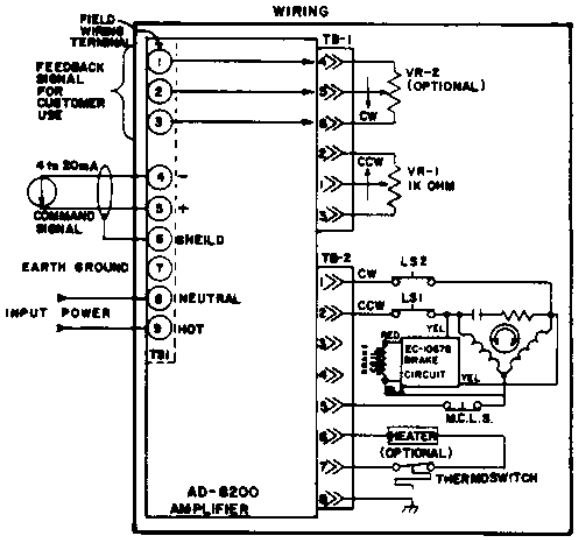
# ACTUATOR WITH BUILT-IN AMPLIFIER

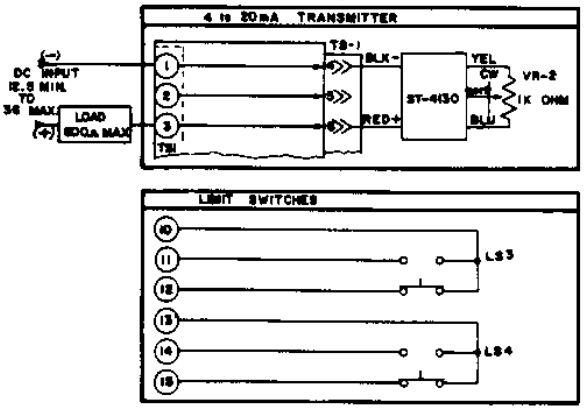



AD-8200
AMPLIFIER TOP
VIEW

| ITEM | DESCRIPTION | PART NUMBER | QTY |
|---|---|---|---|
| 1 | AMPLIFIER | | 1 |
| | AD-8210 (120 Vac) | 70A-023905-001 | |
| | AD-8220 (240 Vac) | 70A-023905-002 | |
| 2 | 10-24 ESNA Nut | 58B-024264-206 | 2 |
| 3 | 8-32 ESNA Nut | 58B-024264-205 | 1 |
| 4 | Fiber Washer | 56B-005479-003 | 6 |
| 5 | 10-24x6.93 long stud | 61A-025129-001 | 2 |
| 6 | Spacer 5.911 long | 61A-025128-001 | 2 |
| 7 | 8-32x8.06 long stud | 61A-025130-001 | 1 |
| 8 | Spacer 7.281 long | 61A-025128-003 | 1 |
| 9 | Connector 8 Pin | 45B-019364-108 | 1 |
| 10 | Crimp Terminals | 45B-019364-201 | 8 |
| 11 | Connector 6 Pin | 45B-023445-806 | 1 |
| 12 | Crimp Terminals | 45B-023445-101 | 6 |




NOTES:

1) The SM-1510,20,30/AD-8210 and the SM-1630/AD-8210 require 120 Vac INPUT POWER. The SM-1550,70,90/AD-8220 and the SM-1650/AD-8220 require 240 Vac INPUT POWER.

   FUSING IN NOT PROVIDED WITHIN THE ACTUATOR/AMPLIFIER:
   Fuse the INPUT POWER LINE for a value slightly higher than the units rating. In most cases a 2 AMP SLO-BLO fuse will be the proper size.

2) An INCREASING COMMAND SIGNAL will result in "CCW" ROTATION of the ACTUATOR OUTPUT SHAFT (as viewed facing the output shaft end).

   If it is desired that an INCREASING COMMAND SIGNAL result in "CW" ROTATION of the ACTUATOR OUTPUT SHAFT, it will be necessary to interchange the MOTOR DIRECTION wires to PINS 1 and 2 in the PLUG of TB-2 and also the POTENTIOMETER wires to PINS 2 and 3 in the PLUG of TB-1. After reversing the wires and with LIMIT SWITCH LS-1 just tripped, remove PLUG TB-1 from the AMPLIFIER, loosen the pot bushing nut and rotate the body of VR-1 until 50 ohms is read from PIN 1 to PIN 3 of PLUG TB-1. Tighten the pot nut and insert the plug into the amplifier connector.

3) CALIBRATION: Refer to AMPLIFIER/ACTUATOR CALIBRATION.

4) When VR-2 is supplied for FEEDBACK (for customer use), resistance as measured between FIELD WIRING TERMINALS 1 and 2 will be INCREASING as the ACTUATOR OUTPUT SHAFT rotates in the "CW" direction.

5) OPTIONAL TRANSMITTER:
   The ST-4130 4 to 20mA TRANSMITTER wired as shown will result in an INCREASING SIGNAL for "CW" rotation of the ACTUATOR OUTPUT SHAFT.
   Operation of the TRANSMITTER requires an EXTERNAL DC POWER SUPPLY with an output in the range of 12.5 Vdc (MIN) to 36.0 Vdc (MAX) and a LOAD connected in series with one lead from the power supply.

   $$\frac{\text{POWER SUPPLY VOLTAGE} - 12\text{V}}{.020\text{A}} = \text{LOAD RESISTANCE MAX.}$$

   Connect (-) to FIELD WIRING TERMINAL 1 and (+) to FIELD WIRING TERMINAL 3.

   With the ACTUATOR at it's "CCW" end of travel, adjust VR-2 pot body for 50 ohms from the WHITE to BLUE pot wires. Adjust "ELEVATION" on the TRANSMITTER for 4.00mA output. With the ACTUATOR at it's "CW" end of travel, adjust "RANGE" for 20.0mA output. Repeat the "ELEV" AND "RANGE" adjustments.

   To reverse the TRANSMITTER OUTPUT and cause the signal to INCREASE for "CCW" rotation, interchange the BLUE AND YELLOW WIRES AT THE POT TERMINALS. Adjust the body of the pot for 50 ohms across the WHITE and BLUE pot wires with the ACTUATOR at it's "CW" end of travel. Adjust "ELEV" for 4.00mA output. With the ACTUATOR at it's "CCW" end of travel adjust "RANGE" for 20.0mA output.

6) Shielded wiring is recommended for all incomming COMMAND and FEEDBACK SIGNAL wiring. Connect the shield to TERMINAL 6.

7) OPTIONAL LIMIT SWITCHES LS-3 and LS-4 are available on "CAM" activated switch assemblies only and may be adjusted with YELLOW CAMS to trip anywhere within the range of the actuators end of travel limits.

8) SWITCH M.C.L.S. (MANUAL CRANK LIMIT SWITCH) is only used on units equipped with the MANUAL HANDCRANK OPTION. The switch is normally closed and when the handcrank is engaged the motor power circuit is opened.

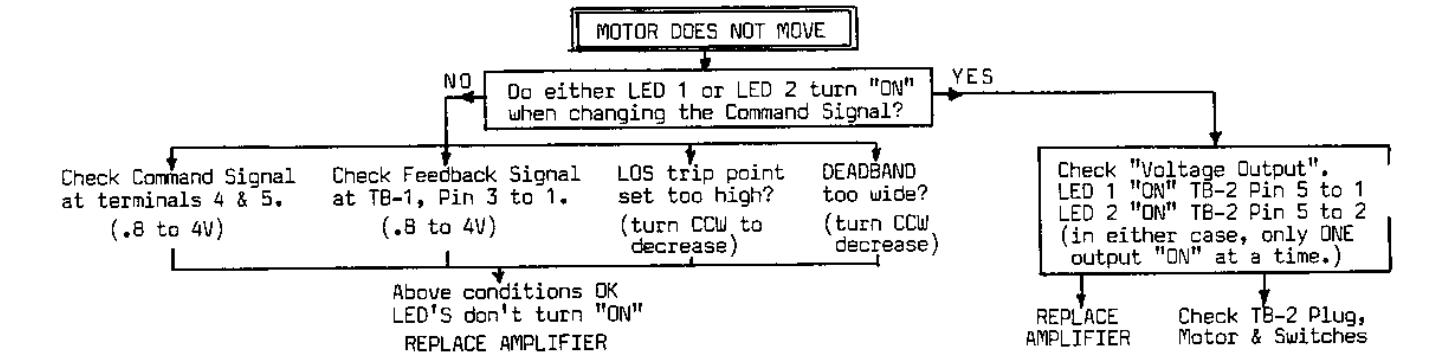
9) OPTIONAL HEATER and THERMOSWITCH:
   The HEATER is powered thru the THERMOSWITCH from the AMPLIFIERS LINE POWER. The THERMOSWITCH is CLOSED at 90°F and OPENS at 110°F. 120Vac units use a 30 WATT HEATER and 240Vac units use a 75 WATT HEATER.

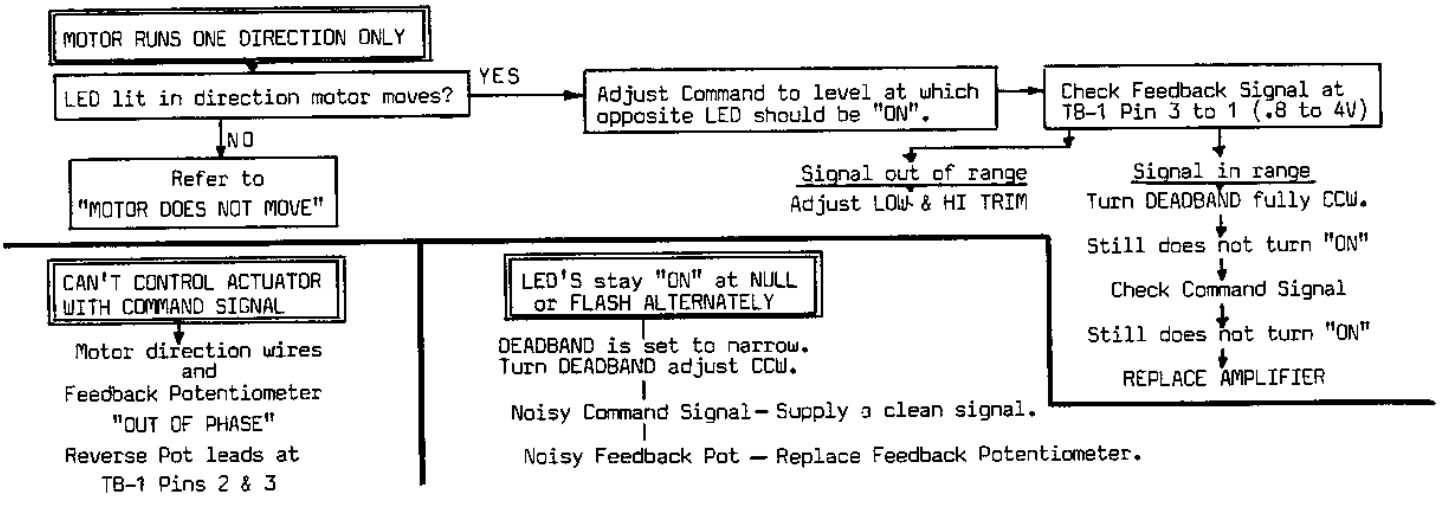
10) Refer to IM-0530 for further information on the AD-8200 SERIES AMPLIFIER.

# TROUBLE-SHOOTING
## ACTUATOR WITH AD-8200 BUILT-IN AMPLIFIER

| FUNCTION TO TEST | MEASUREMENT TO BE MADE | CORRECTION TO MAKE |
|---|---|---|
| INPUT POWER "ON". | Line voltage at terminals 8 to 9. | Check INPUT POWER source. |
| Command set to 12.0mA | 2.4V dc, terminal 4 (-), terminal 5 (+) | Check Command signal and resistor R23 (200 ohms) on amplifier. |
| Feedback Power Supply | TB-1 Pin 3 (-), to Pin 2 (+) should read 15V dc or less depending on settings of LOW and HI TRIM pots on amp. | Read nothing -- Replace amplifier. Read 15V dc -- Check pot VR-1 in actuator and plug connections. |
| Feedback Pot Signal | TB-1 Pin 3 to Pin 1 Should read signal input from VR-1 The signal changes as actuator is running. | No signal or erratic Check pot VR-1 in actuator and plug. |
| Decrease the Command Signal to cause LED 1 to turn "ON" then increase to turn "OFF". | With LED 1 "ON" measure Voltage Output TB-2 Pin 5 to Pin 1. *LED 1 "OFF" read 0 volts out. | If output does not turn "ON" and "OFF". Replace amplifier. |
| Increase the Command Signal to cause LED 2 to turn "ON" then decrease to turn "OFF". | With LED 2 "ON" measure Voltage Output TB-2 Pin 5 to Pin 2. *LED 2 "OFF" read 0 volts out. | If output does not turn "ON" and "OFF". Replace amplifier. |

* With motor running, a voltage greater than "Voltage Output" will be present. -- caused by Motor/Capacitor phase shift.



## ** WARNING - SHOCK HAZARD **

Maintenance must be performed only by qualified personnel.
Voltages hazardous to your health are applied to these actuators.
De-energize all sources of power before removing actuator cover.
Failure to follow these precautions may result in serious injury or death.

### LUBRICATION

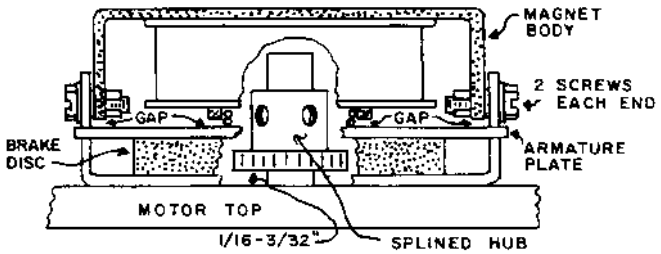
The gearing is permanently lubricated with AMOCO-RYKON PREMIUM GREASE #2 or equal. Re-lubrication is only required during repairs to the power gearing.

The bronze bushings are lubricated with a few drops of SAE-10 or 20 NON-DETERGENT oil, re-lubricate when repairs are made.

### MOTOR BRAKE REPLACEMENT

Refer to page 11.

1) Remove 2 screws and lockwashers (3 & 4).
2) Remove brake ass'y (2) from motor top (13).
3) The brake hub is held to the motor shaft with 2 set screws. Loosen the set screws and remove the brake hub from the motor shaft.
4) Place the new brake hub on the motor shaft with the spline toward the motor top, positioning the hub 1/16 to 3/32" from the motor top. Tighten the set screws.
5) Place the new brake ass'y over the hub, engaging the brake disc with the spline hub.
6) Rotate the brake ass'y to align the mounting holes and secure with screws and lockwashers.
7) Remove the old brake coil wires at their terminations and connect the new wires.
8) Measure the brake gap using feeler gages and adjust if required.




"BRAKE GAP ADJUSTMENT"

When air gap between magnet body and armature plate exceeds .025" reset to .010".

Loosen 4 screws holding magnet body in place. Insert feeler gages between magnet body and plate. Push magnet body down against feeler gages and tighten 4 screws. Remove feeler gages and check brake operation.

### MOTOR REPLACEMENT ac MOTORS

1) If the actuator has a built-in amplifier as shown on page 22, remove the amplifier.
   Refer to page 11.
2) Remove the motor brake (2) if supplied.
3) Remove 3 screws (14), motor top (13) belleville washers (16) and motor stator (15).
4) Pull rotor with pinion gear out of housing.
5) Insert new rotor with pinion gear into housing.
6) Install new stator with the thermal overload (on one end of the windings) outward away from the housing. This may be opposite of the way the old stator was mounted. Care must be taken to prevent nicking or cutting the windings when guiding the stator over the rotor.
7) Place the belleville washers (16) on top of the rotor bearing with the first washer "cupped" down to touch the outer race of the bearing and the second washer "cupped" upward.
8) Position the motor top over the motor, install the motor mounting screws and tighten evenly. The rotor must rotate freely.
9) Remove old motor wires and wire the new motor. The motor wire colors may or may not match the old motor. If the old motor was mounted with the thermal overload opposite of the new, the motor direction leads must be reversed as compared to the original wiring.
10) Install any other parts that were removed and test the actuator.

### MOTOR REPLACEMENT dc MOTORS

1) IF MOTOR IS MOUNTED WITH ADAPTOR PLATE (33).
   A) Remove 2 screws and lockwashers (34 & 10).
   B) Remove motor with adaptor plate from housing.
   C) Remove screws (35) holding motor to plate.
   D) Mount new motor with pinion gear attached to its shaft, insert and tighten screws (35).
   E) Mount motor and adaptor to housing with screws and lockwashers (34 & 10), tighten evenly.
   F) Remove old motor wires and connect new wires.
   G) Install any other parts removed and test.

2) IF MOTOR IS NOT MOUNTED USING ADAPTOR PLATE (33).
   A) Remove feedback ass'y and feedback gearing.
   B) Remove housing screws and washers (24 & 25).
   C) Remove gear housing cover (41).
   D) Remove motor mounting screws (35) from inside of actuator housing.
   E) Install new motor with pinion gear attached and tighten screws (35) evenly.
   F) Remove old motor wires, connect new wires.
   G) Test actuator and align feedback for range.

## FEEDBACK GEARING REPLACEMENT

Refer to page 11

1) Remove 2 screws and lockwashers (9 & 10) holding mounting plate (7) to housing (22).
2) Carefully lift mounting plate (7) off of the locating dowel pins (8).
3) Refer to page 17. Depending upon the gear ratio, the feedback gearing will consist of only gears A and C or it will include gear assembly B.
4) Gear A is attached to the output shaft tip with either 2 set screws in its hub or it is pressed onto the tip and loctite is used to bond it. If loctite is used and removal is required, the gear will be destroyed. To remove it, apply heat and carefully pull the gear off without bending the shaft tip. If the gear is held with set screws, loosen them to remove the gear.
5) Gear C is held to the pot/switch shaft using 2 set screws in its hub. Loosen them to remove the gear.
6) Gear ass'y B consists of two gears pressed onto a shaft with retaining rings on each end to position it in the housing. If replacing this assembly, replace the complete assembly, do not attempt to salvage a gear or the shaft.
7) If the gear ratio is being changed and gear B is being added, a bushing must be installed in the housing (item 21 on page 12).
8) Changing the gear ratio to add or delete gear assembly B will change the rotation of the potentiometer/limit switch assembly in relation to the actuator output shaft. This will require re-wiring of the limit switches and potentiometer for proper direction of rotation. Failure to re-wire will result in switches not shutting off motor power when they are tripped and reverse phasing of the potentiometer signal.
9) Install the gearing in the reverse order and check for proper gear mesh. The gears should have at least 90% face width engagement. Lightly grease the gears. Test and align unit.

## POTENTIOMETER/LIMIT SWITCH ASSEMBLY REPLACEMENT

Refer to page 11

1) Remove 3 truss head screws (11).
2) Lift the feedback ass'y off the mounting plate.
3) A gear is attached to the shaft on the bottom of the ass'y. Measure the distance from the bottom of the disc or frame to the outer face of the gear. Loosen 2 set screws in the gear hub and remove the gear from the shaft.
4) Place the gear on the new ass'y to the dimension measured above and tighten the set screws.
5) Insert the ass'y into the mounting plate, check gear mesh and install 3 truss head screws.
6) Using a 25 watt solder iron, transfer the wires from the old ass'y to the new, one at a time to prevent wiring errors.
7) Test and align the actuator.

## LIMIT SWITCH REPLACEMENT

Refer to page 18

Switches are mounted with screws, remove the screws, remove the switch, mount the new switch, transfer the wires from the old switch to the new.

Check the cam action with the switch and switch lever for proper operation.

Check the switch alignment for ends of travel.

## POTENTIOMETER REPLACEMENT

1) Perform POTENTIOMETER/LIMIT SWITCH ASSEMBLY REPLACEMENT steps 1, 2 and 3.
2) Refer to page 18. The assembly will look like one of those shown. Perform step 3A,3B,3C or 3D.

3A) BUILT AS SHOWN IN Fig. 1

A) Remove the pot body nut and lockwasher.
B) Seperate the potentiometer from the disc.
C) Measure the length of the old pot shaft.
D) Carefully cut the shaft of the new pot to the length of the old and de-burr the shaft.
E) Mount the pot to the disc using the new nut and lockwasher supplied.
F) Perform steps 4 thru 7 of POTENTIOMETER/LIMIT SWITCH ASSEMBLY REPLACEMENT.

3B) BUILT AS SHOWN IN Fig. 5

A) Same as Fig. 1 instructions but pot is a 10 turn device, shaft does not need cutting.

3C) BUILT AS SHOWN IN Fig. 2

A) Loosen set screws holding the cams to the pot shaft. Observe the relation of the set screws to that of the dwell in the cams. The cams must be installed properly to allow access to the set screws in final adjustment.
B) Loosen the pot body nut and remove the pot from the frame. Replace cams if needed.
C) Insert the new pot into the top of the frame, guiding the shaft thru the lockwasher, pot nut, cams and bottom hole of the frame.
D) Tighten the pot nut and perform steps 4 thru 7 of POT/LIMIT SWITCH ASS'Y REPLACEMENT.

3D) BUILT AS SHOWN IN Fig. 6 or 8

A) Hold the frame and rotate shaft (26) "CW" until upper set screw (27) is visible.
B) Loosen the set screw and the pot body nut.
C) Remove the pot from the top of the frame.
D) If the travel nut needs replacing, turn shaft (26) until the lower set screw (27) is visible loosen the screw and remove the shaft. Install new nut with switch adjustment screws set so end of each screw is exposed 2 threads. Position the travel nut to mid-travel on the multi-turn screw. With the shoulder of the multi-turn screw touching the inside bottom of the frame, insert shaft (26). With the shaft extended .70" from the bottom of the frame tighten lower set screw (27).
E) Turn the shaft of the new pot to its center of travel (5 turns from either end) and insert into the frame guiding the shaft thru the lockwasher, nut and into the multi-turn screw. Tighten the pot body nut.
F) With the multi-turn screw just touching the inside bottom of the frame, tighten upper set screw (27).
G) Turn shaft (26) fully "CW" until the end stop of the pot is touched then turn it "CCW" 1/2 turn and set the lower adjusting screw to just trip the lower limit switch.
H) Turn the shaft (26) 9 revolutions "CCW" and set the upper adjusting screw to just trip the upper limit switch.
I) Turn the shaft (26) to position the assembly to mid-travel between the switches and perform steps 4 thru 7 of POTENTIOMETER/LIMIT SWITCH ASSEMBLY REPLACEMENT.

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IM-0402 5/89 Supersedes IM-0402-S 4/79



Jordan
CONTROLS

# DL205 User Manual

*Automationdirect.com*

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## Environmental Specifications

The following table lists the environmental specifications that generally apply to the DL205 system (CPU, Bases, I/O Modules). The ranges that vary for the Handheld Programmer are noted at the bottom of this chart. I/O module operation may fluctuate depending on the ambient temperature and your application. Please refer to the appropriate I/O module specifications for the temperature derating curves applying to specific modules.

| Specification | Rating |
|---|---|
| Storage temperature | -4° F to 158° F (-20° C to 70° C) |
| Ambient operating temperature* | 32° F to 131° F (0° C to 55° C) |
| Ambient humidity** | 30% - 95% relative humidity (non-condensing) |
| Vibration resistance | MIL STD 810C, Method 514.2 |
| Shock resistance | MIL STD 810C, Method 516.2 |
| Noise immunity | NEMA (ICS3-304) |
| Atmosphere | No corrosive gases |

* Operating temperature for the Handheld Programmer and the DV-1000 is 32° to 122° F (0° to 50° C) Storage temperature for the Handheld Programmer and the DV-1000 is -4° to 158° F (-20° to70° C).
**Equipment will operate below 30% humidity. However, static electricity problems occur much more frequently at lower humidity levels. Make sure you take adequate precautions when you touch the equipment. Consider using ground straps, anti-static floor coverings, etc. if you use the equipment in low humidity environments.

## Power

The power source must be capable of supplying voltage and current complying with the base power supply specifications.

| Specification | AC Powered Bases | 24 VDC Powered Bases | 125 VDC Powered Bases |
|---|---|---|---|
| Part Numbers | D2-03B, D2-04B, D2-06B, D2-09B | D2-03BDC-1, D2-04BDC-1, D2-06BDC-1, D2-09BDC-1 | D2-03BDC-2, D2-04BDC-2, D2-06BDC-2, D2-09BDC-2 |
| Input Voltage Range | 85-132 VAC (110 range)<br>170-264 VAC (220 range) | 10.2 - 28.8VDC (24VDC) with less than 10% ripple | 90-264 VDC (125 VDC) with less than 10% ripple<br>115-264 VDC (9-slot base) |
| Maximum Inrush Current | 30 A | 10A | 20A |
| Maximum Power | 50 VA<br>80 VA (D2-09B) | 15W<br>25 W (D2-09BDC-1) | 30W |
| Voltage Withstand (dielectric) | 1 minute @ 1500 VAC between primary, secondary, field ground, and run relay | | |
| Insulation Resistance | > 10 M□ at 500 VDC | | |
| Auxiliary 24 VDC Output | 20-28 VDC, less than 1V p-p<br>200 mA max.<br>(300 mA max., 9-slot base) | None | 20-28 VDC, less than 1V p-p<br>200 mA max.<br>(300 mA max., 9-slot base) |

## Agency Approvals

Some applications require agency approvals. Typical agency approvals which your application may require are:

- UL (Underwriters' Laboratories, Inc.)
- CSA (Canadian Standards Association)
- FM (Factory Mutual Research Corporation)
- CUL (Canadian Underwriters' Laboratories, Inc.)

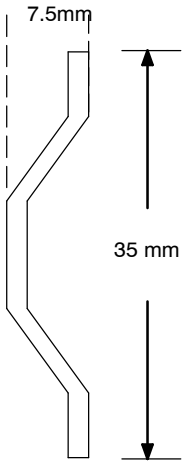
**Using Mounting Rails**

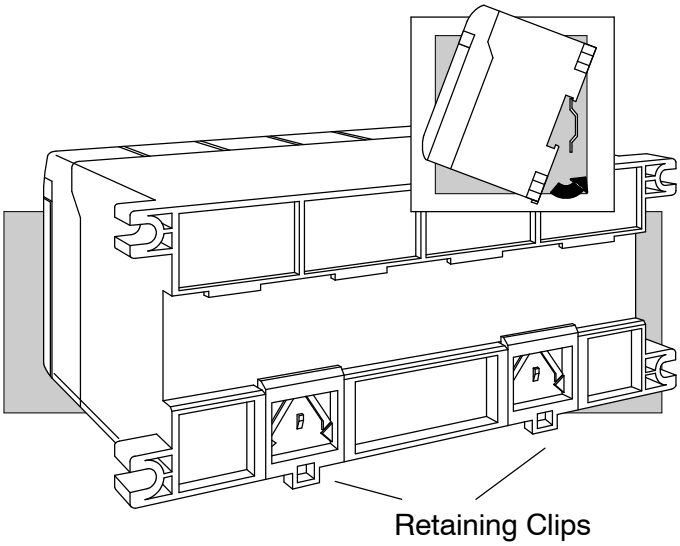
The DL205 bases can also be secured to the cabinet by using mounting rails. You should use rails that conform to DIN EN standard 50 022. Refer to our catalog for a complete line of DIN rail and DINnectors, DIN rail mounted apparatus. These rails are approximately 35mm high, with a depth of 7.5mm. If you mount the base on a rail, you should also consider using end brackets on each end of the rail. The end bracket helps keep the base from sliding horizontally along the rail. This helps minimize the possibility of accidentally pulling the wiring loose.

If you examine the bottom of the base, you'll notice two small retaining clips. To secure the base to a DIN rail, place the base onto the rail and gently push up on the retaining clips. The clips lock the base onto the rail.

To remove the base, pull down on the retaining clips, lift up on the base slightly, and pull it away from the rail.

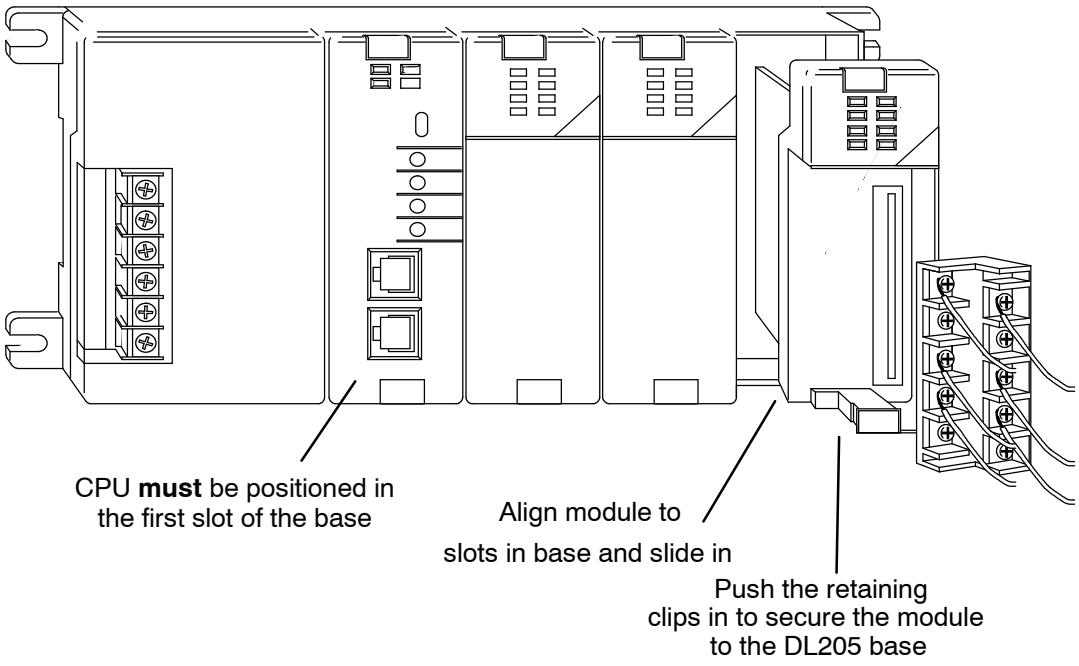
DIN Rail Dimensions

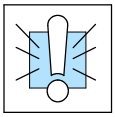


# Installing Components in the Base

When inserting components into the base, align the PC board(s) of the module with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the backplane connector. Once the module is inserted into the base, push in the retaining clips (located at the top and bottom of the module) to firmly secure the module to the base.



**WARNING:** Minimize the risk of electrical shock, personal injury, or equipment damage, always disconnect the system power before installing or removing any system component.

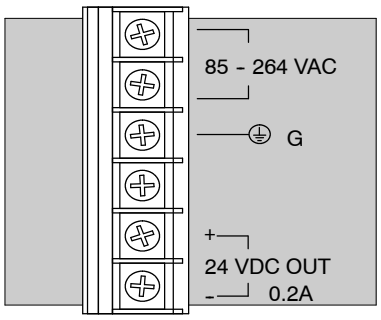
# Base Wiring Guidelines

### Base Wiring

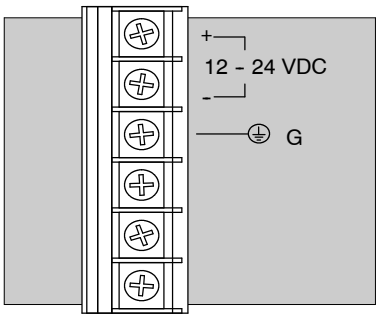
The diagram shows the terminal connections located on the power supply of the DL205 bases. The base terminals can accept up to 16 AWG. You may be able to use larger wiring depending on the type of wire used, but 16 AWG is the recommended size. Do not overtighten the connector screws; recommended torque value is 7.81 pound-inches (0.882 N•m).

**NOTE:** You can connect either a 115 VAC or 220 VAC supply to the AC terminals. Special wiring or jumpers are not required as with some of the other ***Direct***LOGIC™ products.

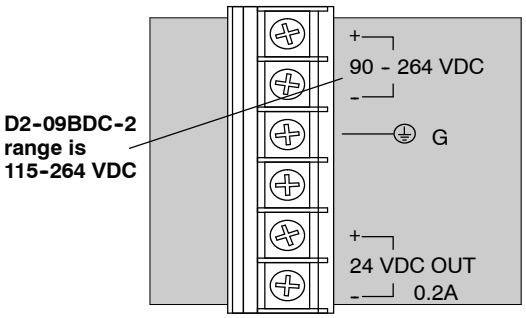
**110/220 VAC Base Terminal Strip**




**12/24 VDC Base Terminal Strip**




**125 VDC Base Terminal Strip**

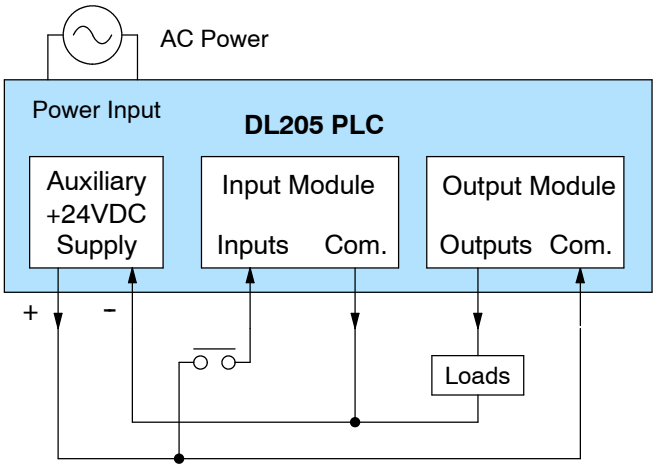



**WARNING:** Once the power wiring is connected, install the plastic protective cover. When the cover is removed there is a risk of electrical shock if you accidentally touch the wiring or wiring terminals.

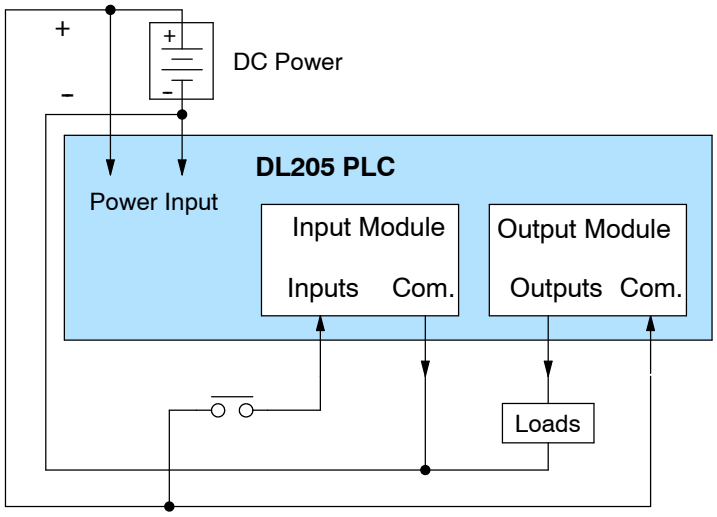
In some cases, using the built-in auxiliary +24VDC supply can result in a cost savings for your control system. It can power combined loads up to 200 mA on 3-6 slot bases and 300mA on the 9-slot base. Be careful not to exceed the current rating of the supply. If you are the system designer for your application, you may be able to select and design in field devices which can use the +24VDC auxiliary supply.

**Powering I/O Circuits with the Auxiliary Supply**

All AC powered DL205 bases feature the internal auxiliary supply. If input devices AND output loads need +24VDC power, the auxiliary supply may be able to power both circuits as shown in the following diagram.



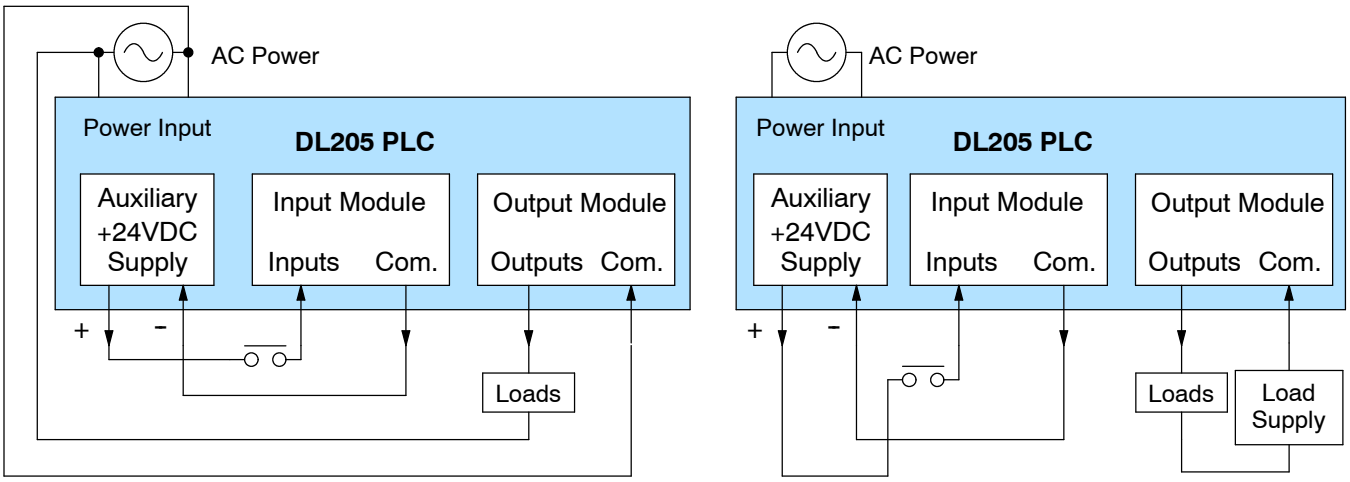

DC-powered DL205 bases are designed for application environments in which low-voltage DC power is more readily available than AC. These include a wide range of battery-powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this application type, all input devices and output loads typically use the same DC power source. Typical wiring for DC-powered applications is shown in the following diagram.



**Powering I/O Circuits Using Separate Supplies**

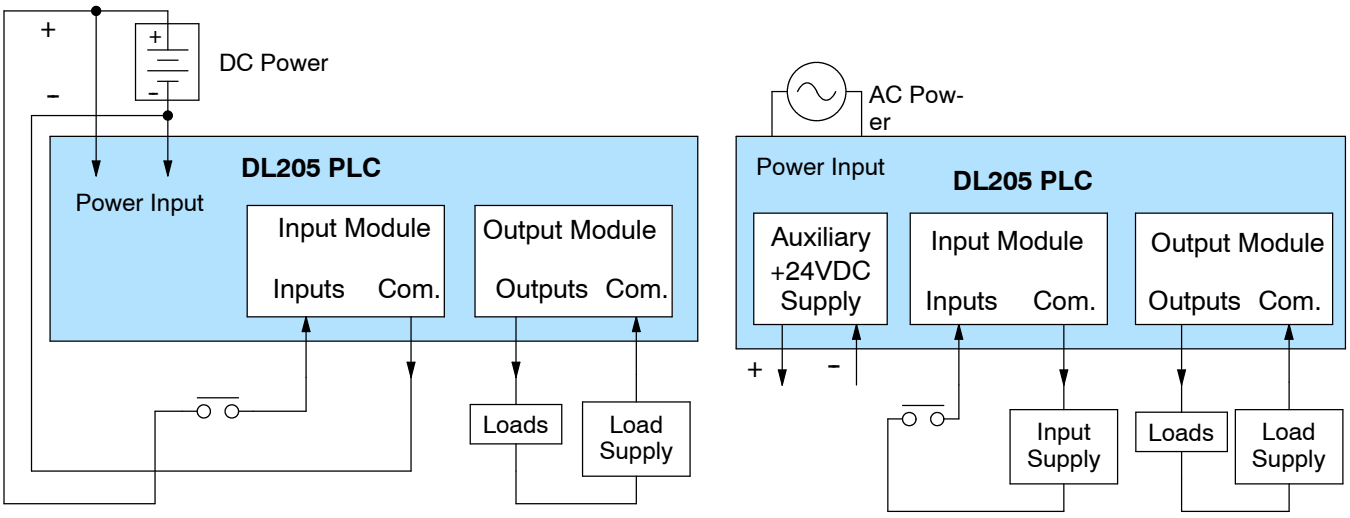
In most applications it will be necessary to power the input devices from one power source, and to power output loads from another source. Loads often require high-energy AC power, while input sensors use low-energy DC. If a machine operator is likely to come in close contact with input wiring, then safety reasons also require isolation from high-energy output circuits. It is most convenient if the loads can use the same power source as the PLC, and the input sensors can use the auxiliary supply, as shown to the left in the figure below.

If the loads cannot be powered from the PLC supply, then a separate supply must be used as shown to the right in the figure below.



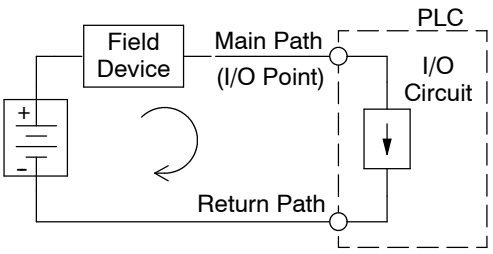

Some applications will use the PLC external power source to also power the input circuit. This typically occurs on DC-powered PLCs, as shown in the drawing below to the left. The inputs share the PLC power source supply, while the outputs have their own separate supply.

A worst-case scenario, from a cost and complexity view-point, is an application which requires separate power sources for the PLC, input devices, and output loads. The example wiring diagram below on the right shows how this can work, but also the auxiliary supply output is an unused resource. You will want to avoid this situation if possible.

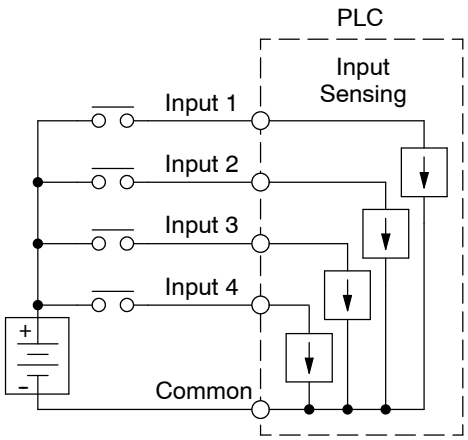


## I/O "Common" Terminal Concepts

In order for a PLC I/O circuit to operate, current must enter at one terminal and exit at another. Therefore, at least two terminals are associated with every I/O point. In the figure to the right, the Input or Output terminal is the *main path* for the current. One additional terminal must provide the *return path* to the power supply.



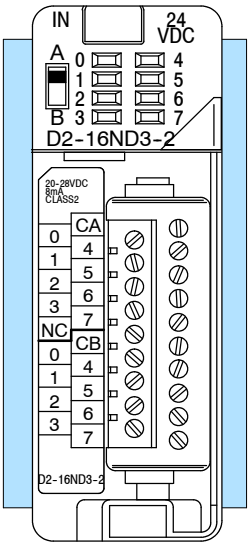

If there was unlimited space and budget for I/O terminals, every I/O point could have two dedicated terminals as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output points on PLCs are in groups which share the return path (called *commons*). The figure to the right shows a group (or *bank*) of 4 input points which share a common return path. In this way, the four inputs require only five terminals instead of eight.

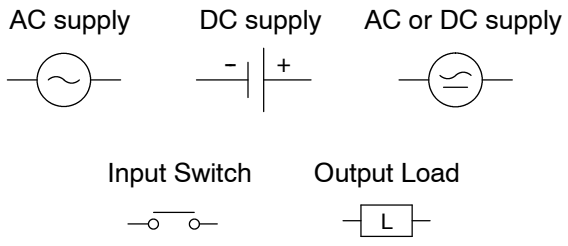



**NOTE:** In the circuit above, the current in the common path is 4 times any channel's input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons.

Most DL205 input and output modules group their I/O points into banks that share a common return path. The best indication of I/O common grouping is on the wiring label, such as the one shown to the right. The miniature schematic shows two circuit banks with eight input points in each. The common terminal for each is labeled "CA" and "CB", respectively.

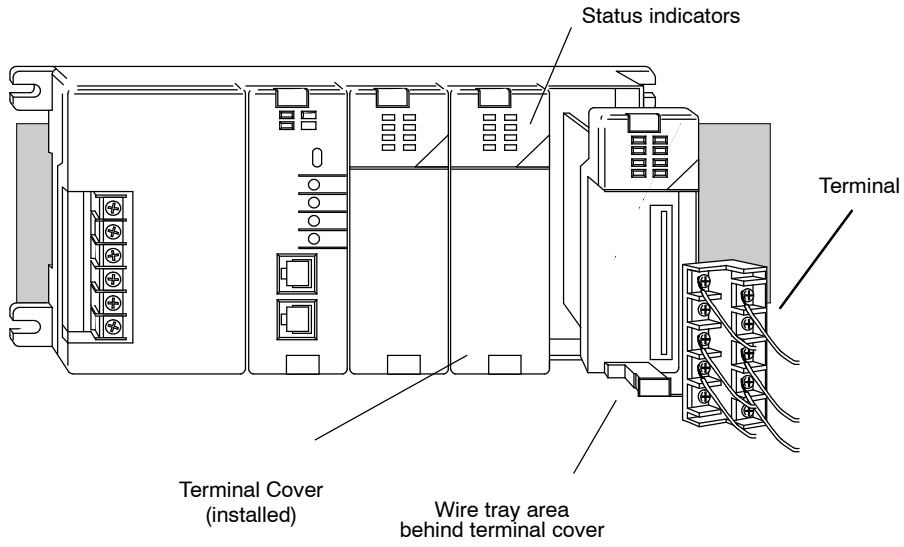
In the wiring label example, the positive terminal of a DC supply connects to the common terminals. Some symbols you will see on the wiring labels, and their meanings are:



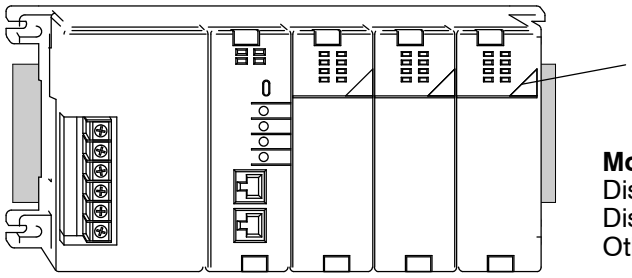
**Discrete Input Module Status Indicators**

The discrete modules provide LED status indicators to show the status of the input points.




**Color Coding of I/O Modules**

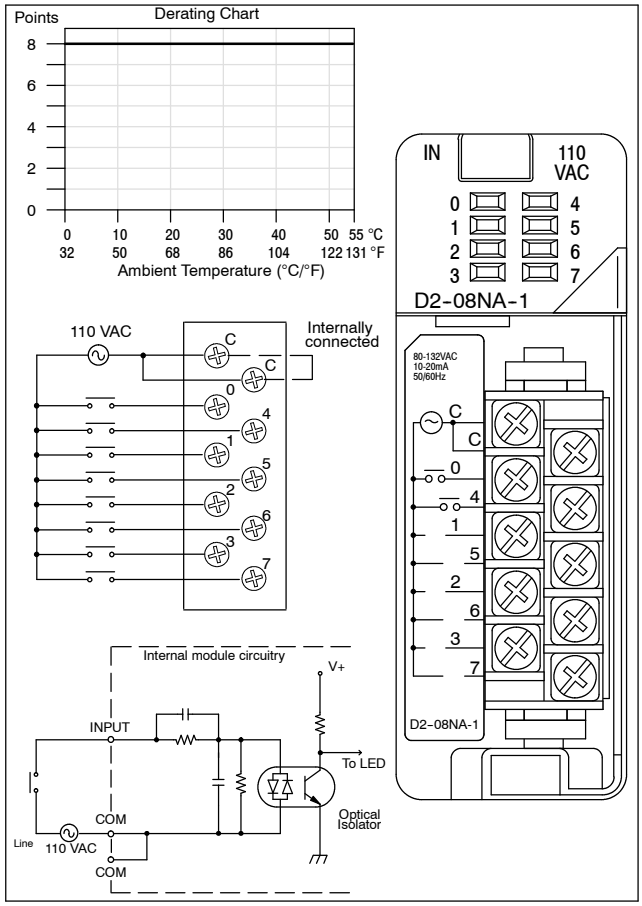
The DL205 family of I/O modules have a color coding scheme to help you quickly identify if a module is either an input module, output module, or a specialty module. This is done through a color bar indicator located on the front of each module. The color scheme is listed below:




| Module Type | Color Code |
|---|---|
| Discrete/Analog Output | Red |
| Discrete/Analog Input | Blue |
| Other | White |

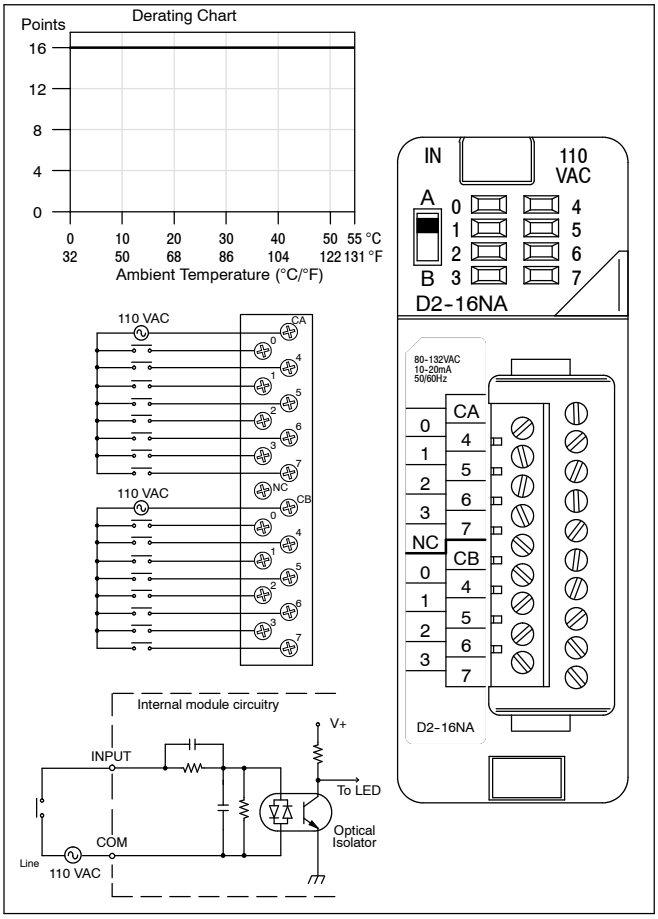
## D2-08NA-1 AC Input

| | |
|---|---|
| Inputs per module | 8 |
| Commons per module | 1 (2 I/O terminal points) |
| Input voltage range | 80-132 VAC |
| Peak voltage | 132 VAC |
| AC frequency | 47-63 Hz |
| ON voltage level | 75 VAC minimum |
| OFF voltage level | 20 VAC maximum |
| Input impedance | 12K @ 60 Hz |
| Input current | 13mA @ 100VAC, 60Hz<br>11mA @ 100VAC, 50Hz |
| Minimum ON current | 5 mA |
| Maximum OFF current | 2 mA |
| Base power required | 50 mA Max |
| OFF to ON response | 5 to 30 ms |
| ON to OFF response | 10 to 50 ms |
| Terminal type | Removable |
| Status indicator | Logic side |
| Weight | 2.5 oz. (70 g) |




## D2-16NA AC Input

| | |
|---|---|
| Inputs per module | 16 |
| Commons per module | 2 (isolated) |
| Input voltage range | 80-132 VAC |
| Peak voltage | 132 VAC |
| AC frequency | 47-63 Hz |
| ON voltage level | 70 VAC minimum |
| OFF voltage level | 20 VAC maximum |
| Input impedance | 12K @ 60 Hz |
| Input current | 11mA @ 100VAC, 50Hz<br>13mA @ 100VAC, 60Hz<br>15mA @ 132VAC, 60Hz |
| Minimum ON current | 5 mA |
| Maximum OFF current | 2 mA |
| Base power required | 100 mA Max |
| OFF to ON response | 5 to 30 ms |
| ON to OFF response | 10 to 50 ms |
| Terminal type | Removable |
| Status indicator | Logic side |
| Weight | 2.4 oz. (68 g) |

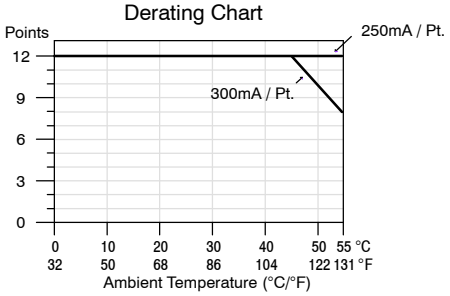


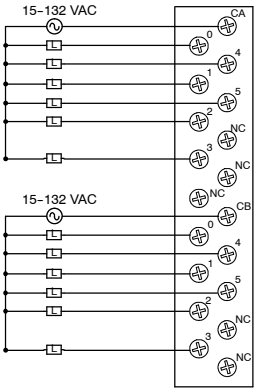
# D2-12TA AC Output

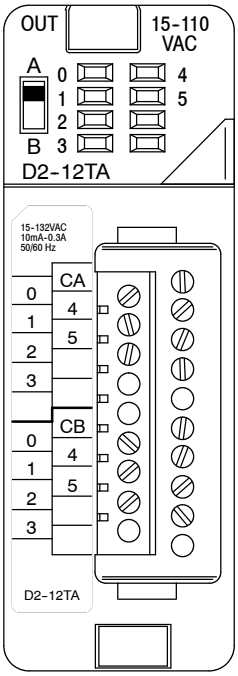
| | |
|---|---|
| Outputs per module | 12 |
| Output Points Consumed | 16 (4 unused, see chart below) |
| Commons per module | 2 (isolated) |
| Operating voltage | 15-132 VAC |
| Output type | SSR (Triac) |
| Peak voltage | 132 VAC |
| AC frequency | 47 to 63 Hz |
| ON voltage drop | < l.5 VAC (> 50mA)<br>< 4.0 VAC (< 50mA) |
| Max load current | 0.3A / point,<br>1.8A / common |

| | |
|---|---|
| Max leakage current | 2mA (132VAC, 60Hz) |
| Max inrush current | 10A for 10 ms |
| Minimum load | 10 mA |
| Base power required | 350 mA Max |
| OFF to ON response | 1 ms |
| ON to OFF response | 1 ms +1/2 cycle |
| Terminal type | Removable |
| Status indicators | Logic Side |
| Weight | 2.8 oz. (80 g) |
| Fuses | (2) 1 per common<br>3.15A slow blow, replaceable<br>Order D2-FUSE-1 (5 per pack) |

Derating Chart



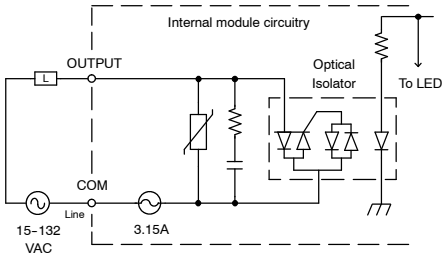




Addresses Used

| Points | Used? | Points | Used? |
|---|---|---|---|
| Yn+0 | Yes | Yn+10 | Yes |
| Yn+1 | Yes | Yn+11 | Yes |
| Yn+2 | Yes | Yn+12 | Yes |
| Yn+3 | Yes | Yn+13 | Yes |
| Yn+4 | Yes | Yn+14 | Yes |
| Yn+5 | Yes | Yn+15 | Yes |
| Yn+6 | No | Yn+16 | No |
| Yn+7 | No | Yn+17 | No |

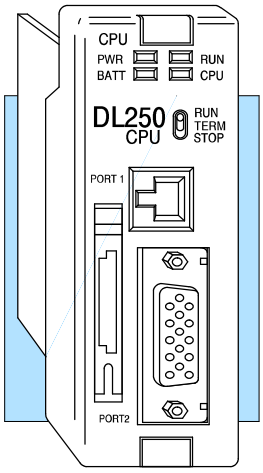
n is the starting address



# Overview

The CPU is the heart of the control system. Almost all system operations are controlled by the CPU, so it is important that it is set-up and installed correctly. This chapter provides the information needed to understand:

- the differences between the different models of CPUs
- the steps required to setup and install the CPU




**General CPU Features**

The DL230, DL240, and DL250 are modular CPUs which can be installed in 3, 4, 6, or 9 slot bases. All I/O modules in the DL205 family will work with any of the CPUs. The DL205 CPUs offer a wide range of processing power and program instructions. All offer RLL and Stage program instructions (See Chapter 5). They also provide extensive internal diagnostics that can be monitored from the application program or from an operator interface.

**DL230 CPU Features**

The DL230 has 2.4K words of memory comprised of 2.0K of ladder memory and approximately 400 words of V-memory (data registers). It has 90 different instructions available for programming, and supports a maximum of 128 I/O points.

Program storage is in the EEPROM which is installed at the factory. In addition to the EEPROM there is also RAM on the CPU which will store system parameters, V-memory, and other data which is not in the application program.

The DL230 provides one built-in RS232C communication port, so you can easily connect a handheld programmer or a personal computer without needing any additional hardware.

**DL240 CPU Features**

The DL240 has a maximum of 3.8K of memory comprised of 2.5K of ladder memory and approximately 1.3K of V-memory (data registers). There are129 instructions available for program development and a maximum of 128 points local I/O and 896 points with remote I/O are supported.

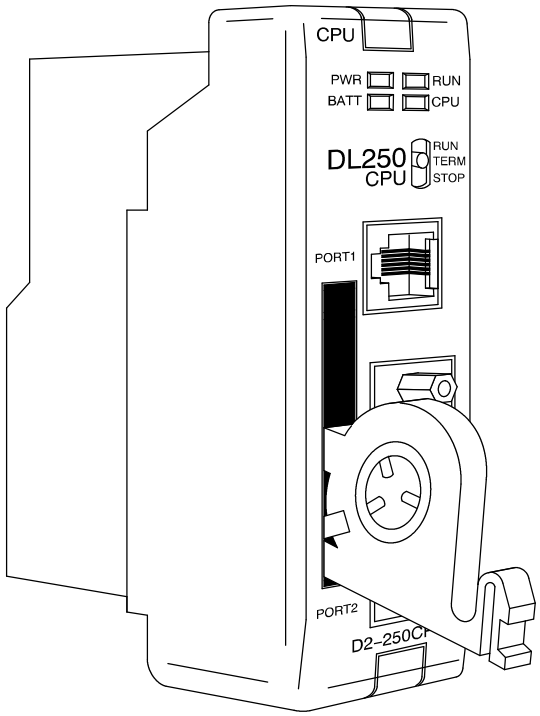
Program storage is in the EEPROM which is installed at the factory. In addition to the EEPROM there is also RAM on the CPU which will store system parameters, V-memory and other data which is not in the application program.

The DL240 has two communication ports. The top port is the same port configuration as the DL230. The bottom port also supports the ***Direct***LINK™ protocol, so you can use the DL240 in a ***Direct***NET™ network. Since the port is RS232C, you must use an RS232C/RS422 converter for multi-drop connections.

**DL250 CPU Features**

The new DL250 offers all the DL240 features, plus more , program instructions, and built-in Remote I/O Master. It has a maximum of 14.8K of program memory comprised of 7.6K of ladder memory and 7.2K of V-memory (data registers). It supports a maximum of 128 points of local I/O, and 2048 points with remote I/O if you use the DL250 as a Remote master. It includes an additional internal RISC-based microprocessor for greater processing power. The DL250 has 170 instructions. The additional 41 instructions to the DL240 instruction set include drum timers, a print function, floating point math, and PID loop control for 4 loops.

The DL250 has a total of two communications ports. The top port is identical to the top port of the DL240 with the exception of ***Direct***Net slave feature. The bottom port is a 15-pin RS232C/RS422 port. It will interface with ***Direct***SOFT, and operator interfaces, and provides ***DirectNet*** and MODBUS RTU Master/Slave connections.

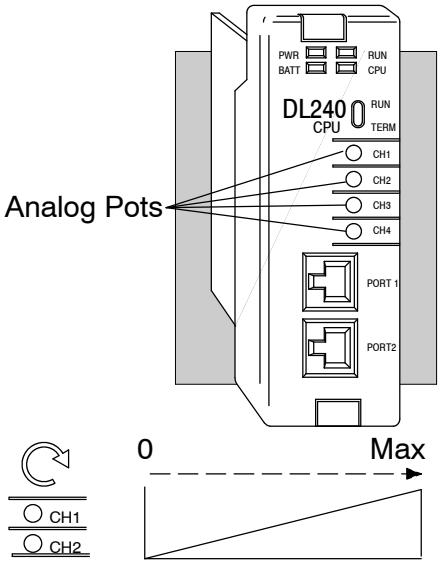


## Adjusting the Analog Potentiometers

| ✗ | ✓ | ✗ |
|---|---|---|
| 230 | 240 | 250 |

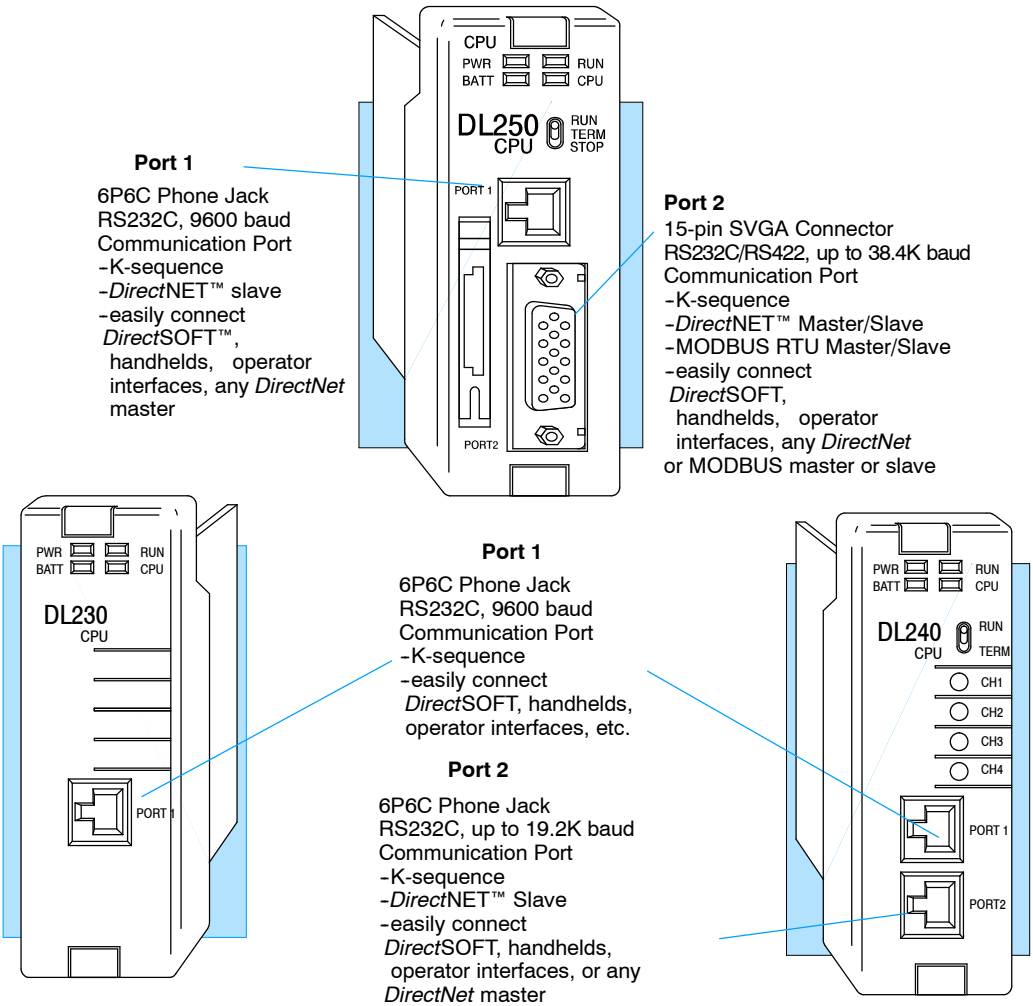
There are 4 analog potentiometers (pots) on the face plate of the DL240 CPU. These pots can be used to change timer constants, frequency of pulse train output, etc. Each analog channel has corresponding V-memory locations for setting lower and upper limits for each analog channel. The setup procedures are covered later in this chapter.

To increase the value associated with the analog pot, turn the pot clockwise. To decrease the value, turn the pot counter clockwise.




## Communication Ports

DL205 CPUs provide up to two communications ports. The DL240 and DL250 CPUs have two ports while the DL230 has only one.

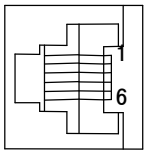


### Port 1 Specifications

✓ ✓ ✗
230 240 250

The operating parameters for Port 1 on the DL230 and DL240 CPUs are fixed.

- 6 Pin female modular (RJ12 phone jack) type connector
- K-sequence protocol
- RS232C, 9600 baud
- Connect to ***Direct***SOFT, D2-HPP, DV-1000, operator interface panels
- Fixed station address of 1




6-pin Female
Modular Connector

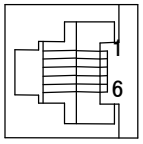
| Port 1 Pin Descriptions (DL230 and DL240) | | |
|---|---|---|
| 1 | 0V | Power (-) connection (GND) |
| 2 | 5V | Power (+) connection |
| 3 | RXD | Receive Data (RS232C) |
| 4 | TXD | Transmit Data (RS232C |
| 5 | 5V | Power (+) connection |
| 6 | 0V | Power (-) connection (GND) |

### Port 1 Specifications

✗ ✗ ✓
230 240 250

The operating parameters for Port 1 on the DL250 CPU are fixed.

- 6 Pin female modular (RJ12 phone jack) type connector
- ***Direct***Net (slave), K-sequence protocol
- RS232C, 9600 baud
- Connect to ***Direct***SOFT, D2-HPP, DV1000 or ***DirectNet*** master




6-pin Female
Modular Connector

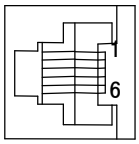
| Port 1 Pin Descriptions (DL250 only) | | |
|---|---|---|
| 1 | 0V | Power (-) connection (GND) |
| 2 | 5V | Power (+) connection |
| 3 | RXD | Receive Data (RS232C) |
| 4 | TXD | Transmit Data (RS232C |
| 5 | 5V | Power (+) connection |
| 6 | 0V | Power (-) connection (GND) |

### Port 2 Specifications

✗ ✓ ✗
230 240 250

The operating parameters for Port 2 on the DL240 CPU is configurable using Aux functions on a programming device.

- 6 Pin female modular (RJ12 phone jack) type connector
- ***Direct***Net (slave), K-sequence protocol
- RS232C, Up to 19.2K baud
- Address selectable (1-90)
- Connect to ***Direct*** SOFT, D2-HPP, DV1000, MMI, or ***DirectNet*** master




6-pin Female
Modular Connector

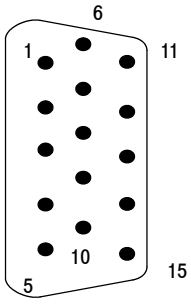
| Port 2 Pin Descriptions (DL240 only) | | |
|---|---|---|
| 1 | 0V | Power (-) connection (GND) |
| 2 | 5V | Power (+) connection |
| 3 | RXD | Receive Data (RS232C) |
| 4 | TXD | Transmit Data (RS232C |
| 5 | RTS | Request to Send |
| 6 | 0V | Power (-) connection (GND) |

## Port 2 Specifications

| 230 | 240 | 250 |
|---|---|---|
| X | X | ✓ |

Port 2 on the DL250 CPU is located on the 15 pin D-shell connector. It is configurable using AUX functions on a programming device.

- 15 Pin female D type connector
- Protocol: K sequence, ***DirectNet*** Master/Slave, MODBUS RTU Master/Slave, Remote I/O
- RS232C, non-isolated, distance within 15 m (approx. 50 feet)
- RS422C, non-isolated, distance within 1000 m
- Up to 38.4K baud
- Address selectable (1-90)
- Connects to ***Direct***SOFT, D2-HPP, operator interfaces, any ***DirectNet*** or MODBUS master or slave




15-pin Female
D Connector

| Port 2 Pin Descriptions (DL250 CPU) | | |
|---|---|---|
| 1 | 5V | 5 VDC |
| 2 | TXD2 | Transmit Data (RS232C) |
| 3 | RXD2 | Receive Data (RS232C) |
| 4 | RTS2 | Ready to Send (RS-232C) |
| 5 | CTS2 | Clear to Send (RS-232C) |
| 6 | RXD2- | Receive Data - (RS-422) |
| 7 | 0V | Logic Ground |
| 8 | 0V | Logic Ground |
| 9 | TXD2+ | Transmit Data + (RS-422) |
| 10 | TXD2 - | Transmit Data - (RS-422) |
| 11 | RTS2 + | Request to Send + (RS-422) |
| 12 | RTS2 - | Request to Send - (RS-422) |
| 13 | RXD2 + | Receive Data + (RS-422) |
| 14 | CTS2 + | Clear to Send + (RS422) |
| 15 | CTS2 - | Clear to Send - (RS-422) |

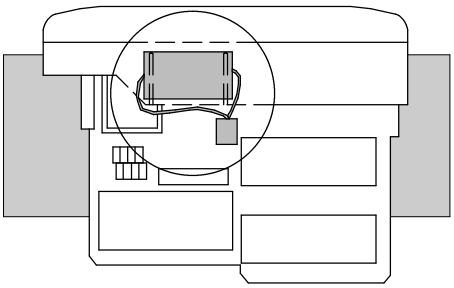
# Using Battery Backup

An optional lithium battery is available to maintain the system RAM retentive memory when the DL205 system is without external power. Typical CPU battery life is five years, which includes PLC runtime and normal shutdown periods. However, consider installing a fresh battery if your battery has not been changed recently and the system will be shutdown for a period of more than ten days.

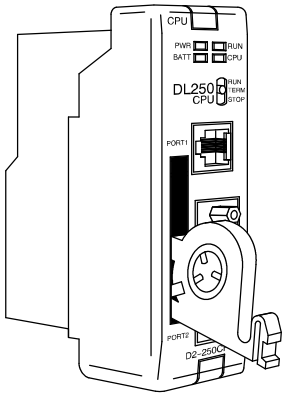
**NOTE:** Before installing or replacing your CPU battery, back-up your V-memory and system parameters. You can do this by using ***Direct***SOFT to save the program, V-memory, and system parameters to hard/floppy disk on a personal computer.

To install the D2-BAT CPU battery in DL230 or DL240 CPUs:

1. Gently push the battery connector onto the circuit board connector.
2. Push the battery into the retaining clip. Don't use excessive force. You may break the retaining clip.
3. Make a note of the date the battery was installed.



**DL230 and DL240**




**DL250**

To install the D2-BAT-1 CPU battery in the DL250 CPU:

1. Press the retaining clip on the battery door down and swing the battery door open.
2. Place the battery into the coin-type slot.
3. Close the battery door making sure that it locks securely in place.
4. Make a note of the date the battery was installed.

**WARNING:** Do not attempt to recharge the battery or dispose of an old battery by fire. The battery may explode or release hazardous materials.

### Enabling the Battery Backup

The battery can be enabled by setting bit 12 in V7633 ON. In this mode the battery Low LED will come on when the battery voltage is less than 2.5VDC (SP43) and error E41 will occur. In this mode the CPU will maintain the data in C,S,T,CT, and V memory when power is removed from the CPU, provided the battery is good. The use of a battery can also determine which operating mode is entered when the system power is connected. See CPU Setup, which is discussed later in this chapter.

Even if you have installed a battery, the battery circuit can be disabled by turning off bit 12 in V7633. However, if you have a battery installed and select "No Battery" operation, the battery LED will not turn on if the battery voltage is low.

## Setting the CPU Network Address

✗ ✓ ✓
230 240 250

The DL240 and DL250 CPUs have built in ***DirectNet*** ports. You can use the Handheld Programmer to set the network address for the port and the port communication parameters. The default settings are:

- Station Address 1
- Hex Mode
- Odd Parity
- 9600 Baud

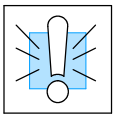
The ***DirectNet*** Manual provides additional information about choosing the communication settings for network operation.

## Setting Retentive Memory Ranges

The DL205 CPUs provide certain ranges of retentive memory by default. The default ranges are suitable for many applications, but you can change them if your application requires additional retentive ranges or no retentive ranges at all. The default settings are:

| Memory Area | DL230 | | DL240 | | DL250 | |
|---|---|---|---|---|---|---|
| | Default Range | Avail. Range | Default Range | Avail. Range | Default Range | Avail. Range |
| Control Relays | C300 – C377 | C0 – C377 | C300 – C377 | C0 – C377 | C1000 – C1777 | C0 – C1777 |
| V Memory | V2000 – V7777 | V0 – V7777 | V2000 – V7777 | V0 – V7777 | V1400 – V3777 | V0 – V17777 |
| Timers | None by default | T0 – T77 | None by default | T0 – T177 | None by default | T0 – T377 |
| Counters | CT0 – CT77 | CT0 – CT77 | CT0 – CT177 | CT0 – CT177 | CT0 – CT177 | CT0 – CT177 |
| Stages | None by default | S0 – S377 | None by default | S0 – S777 | None by default | S0 – S1777 |

You can use AUX 57 to set the retentive ranges. You can also use ***Direct***SOFT™ menus to select the retentive ranges.



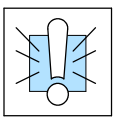
**WARNING:** The DL205 CPUs do not come with a battery. The super capacitor will retain the values in the event of a power loss, but only for a short period of time, depending on conditions. If the retentive ranges are important for your application, make sure you obtain the optional battery.

## Password Protection

The DL205 CPUs allow you to use a password to help minimize the risk of unauthorized program and/or data changes. The DL240 and DL250 offer multi-level passwords for even more security. Once you enter a password you can "lock" the CPU against access. Once the CPU is locked you must enter the password before you can use a programming device to change any system parameters.

You can select an 8-digit numeric password. The CPUs are shipped from the factory with a password of 00000000. All zeros removes the password protection. If a password has been entered into the CPU you cannot enter all zeros to remove it. Once you enter the correct password, you can change the password to all zeros to remove the password protection.

For more information on passwords, see the appropriate appendix on auxiliary functions.



**WARNING:** Make sure you remember your password. If you forget your password you will not be able to access the CPU. The CPU must be returned to the factory to have the password removed.

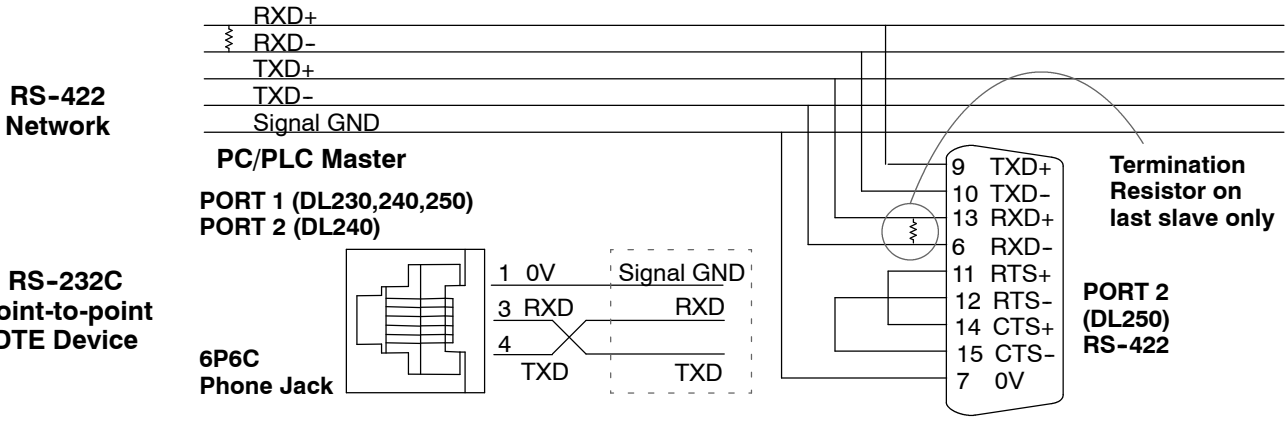
# Network Connections to MODBUS® and *Direct*Net

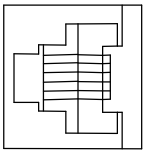
**Configuring the CPU's Comm Ports**

| ✗ | ✓ | ✓ |
|---|---|---|
| 230 | 240 | 250 |

This section describes how to configure the CPU's built-in networking ports. for either MODBUS or ***Direct***NET. This will allow you to connect the DL205 PLC system directly to MODBUS networks using the RTU protocol, or to other devices on a ***Direct***NET network. MODBUS hosts system on the network must be capable of issuing the MODBUS commands to read or write the appropriate data. For details on the MODBUS protocol, please refer to the Gould MODBUS Protocol reference Guide (P1-MBUS-300 Rev. B). In the event a more recent version is available, check with your MODBUS supplier before ordering the documentation. For more details on ***Direct***NET, order our ***Direct***NET manual, part number DA-DNET-M.

You will need to determine whether the network connection is a 3-wire RS-232 type, or a 5-wire RS-422 type. Normally, the RS-232 signals are used for shorter distances (15 meters max), for communications between two devices. RS-422 signals are for longer distances (1000 meters max.), and for multi-drop networks (from 2 to 247 devices). Use termination resistors at both ends of RS-422 network wiring, matching the impedance rating of the cable (between 100 and 500 ohms).

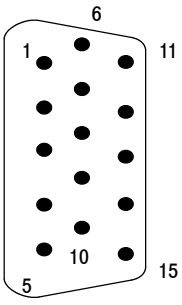


6-pin Female Modular Connector

| Port 1 Pinouts (DL230, DL240,DL250) | | |
|---|---|---|
| 1 | 0V | Power (-) connection (GND) |
| 2 | 5V | Power (+) conection |
| 3 | RXD | Receive Data (RS232C) |
| 4 | TXD | Transmit Data (RS232C |
| 5 | 5V | Power (+) conection |
| 6 | 0V | Power (-) connection (GND) |

| Port 2 Pin Descriptions (DL240 only) | | |
|---|---|---|
| 1 | 0V | Power (-) connection (GND) |
| 2 | 5V | Power (+) conection |
| 3 | RXD | Receive Data (RS232C) |
| 4 | TXD | Transmit Data (RS232C |
| 5 | RTS | Request to Send |
| 6 | 0V | Power (-) connection (GND) |




15-pin Female D Connector

| Port 2 Pin Descriptions (DL250 CPU) | | |
|---|---|---|
| 1 | 5V | 5 VDC |
| 2 | TXD | Transmit Data (RS-232C) |
| 3 | RXD | Receive Data (RS-232C) |
| 4 | RTS | Ready to Send (RS-232C) |
| 5 | CTS | Clear to Send (RS-232C) |
| 6 | RXD - | Receive Data (RS-422) |
| 7 | 0V | Logic Ground |
| 8 | 0V | Logic Ground |
| 9 | TXD + | Transmit Data + (RS-422) |
| 10 | TXD - | Transmit Data - (RS-422) |
| 11 | RTS + | Request to Send + (RS-422) |
| 12 | RTS - | Request to Send - (RS-422) |
| 13 | RXD + | Receive Data + (RS-422) |
| 14 | CTS + | Clear to Send + (RS-422) |
| 15 | CTS - | Clear to Send - (RS-422) |

The recommended cable for RS422 is Belden 9729 or equivalent.

# Hardware Maintenance

**Standard Maintenance**

The DL205 is a low maintenance system requiring only a few periodic checks to to help reduce the risks of problems. Routine maintenance checks should be made regarding two key items.

- Air quality (cabinet temperature, airflow, etc.)
- CPU battery

**Air Quality Maintenance**

The quality of the air your system is exposed to can affect system performance. If you have placed your system in an enclosure, check to see the ambient temperature is not exceeding the operating specifications. If there are filters in the enclosure, clean or replace them as necessary to ensure adequate airflow. A good rule of thumb is to check your system environment every one to two months. Make sure the DL205 is operating within the system operating specifications.

**Low Battery Indicator**

The CPU has a battery LED that indicates the battery voltage is low. You should check this indicator periodically to determine if the battery needs replacing. You can also detect low battery voltage from within the CPU program. SP43 is a special relay that comes on when the battery needs to be replaced. If you are using a DL240 CPU, you can also use a programming device or operator interface to determine the battery voltage. V7746 contains the battery voltage. For example, a value of 32 in V7746 would indicate a battery voltage of 3.2V.

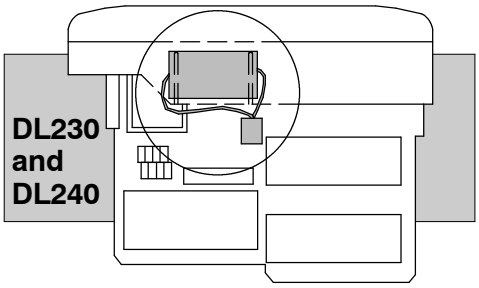
**CPU Battery Replacement**

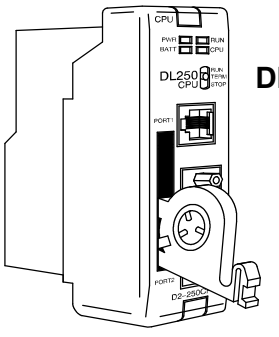
The CPU battery is used to retain program V memory and the system parameters. The life expectancy of this battery is five years.

**NOTE:** Before installing or replacing your CPU battery, back-up your V-memory and system parameters. You can do this by using ***Direct***SOFT to save the program, V-memory, and system parameters to hard/floppy disk on a personal computer.

To install the D2-BAT CPU battery in DL230 or DL240 CPUs:

1. Gently push the battery connector onto the circuit board connector.
2. Push the battery into the retaining clip. Don't use excessive force. You may break the retaining clip.
3. Make a note of the date the battery was installed.

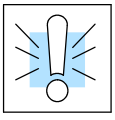



**DL250**

To install the D2-BAT-1 CPU battery in the DL250 CPU:

1. Press the retaining clip on the battery door down and swing the battery door open.
2. Place the battery into the coin-type slot.
3. Close the battery door making sure that it locks securely in place.
4. Make a note of the date the battery was installed.

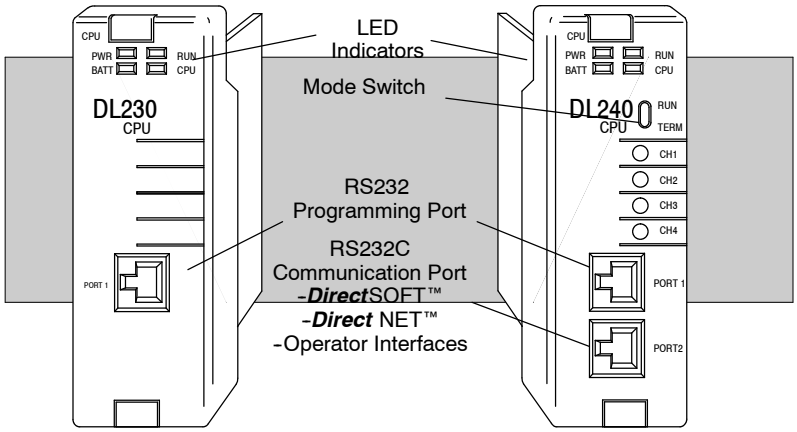


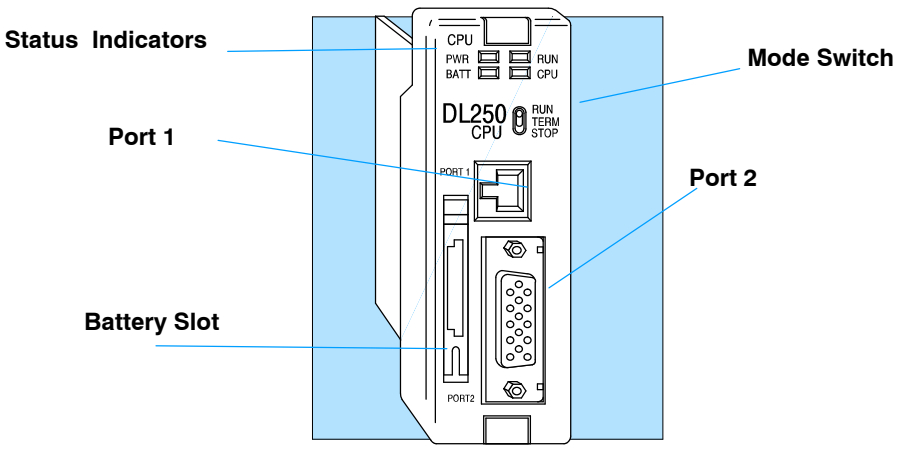
**WARNING:** Do not attempt to recharge the battery or dispose of an old battery by fire. The battery may explode or release hazardous materials.

# CPU Indicators

The DL205 CPUs have indicators on the front to help you diagnose problems with the system. The table below gives a quick reference of potential problems associated with each status indicator. Following the table will be a detailed analysis of each of these indicator problems.

| Indicator Status | Potential Problems |
|---|---|
| PWR (off) | 1. System voltage incorrect.<br>2. Power supply/CPU is faulty<br>3. Other component such an I/O module has power supply shorted<br>4. Power budget exceeded for the base being used |
| RUN<br>(will not come on) | 1. CPU programming error<br>2. Switch in TERM position<br>3. Switch in STOP position (DL250 only) |
| CPU (on) | 1. Electrical noise interference<br>2. CPU defective |
| BATT (on) | 1. CPU battery low<br>2. CPU battery missing, or disconnected |



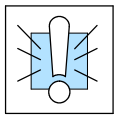
# PWR Indicator

There are four general reasons for the CPU power status LED (PWR) to be OFF:

1. Power to the base is incorrect or is not applied.
2. Base power supply is faulty.
3. Other component(s) have the power supply shut down.
4. Power budget for the base has been exceeded.

**Incorrect Base Power**

If the voltage to the power supply is not correct, the CPU and/or base may not operate properly or may not operate at all. Use the following guidelines to correct the problem.



**WARNING:** To minimize the risk of electrical shock, always disconnect the system power before inspecting the physical wiring.

1. First, disconnect the system power and check all incoming wiring for loose connections.
2. If you are using a separate termination panel, check those connections to make sure the wiring is connected to the proper location.
3. If the connections are acceptable, reconnect the system power and measure the voltage at the base terminal strip to insure it is within specification. If the voltage is not correct shut down the system and correct the problem.
4. If all wiring is connected correctly and the incoming power is within the specifications required, the base power supply should be returned for repair.

**Faulty CPU**

There is not a good check to test for a faulty CPU other than substituting a known good one to see if this corrects the problem. If you have experienced major power surges, it is possible the CPU and power supply have been damaged. If you suspect this is the cause of the power supply damage, a line conditioner which removes damaging voltage spikes should be used in the future.

**Device or Module causing the Power Supply to Shutdown**

It is possible a faulty module or external device using the system 5V can shut down the power supply. This 5V can be coming from the base or from the CPU communication ports.

To test for a device causing this problem:

1. Turn off power to the CPU.
2. Disconnect all external devices (i.e., communication cables) from the CPU.
3. Reapply power to the system.

If the power supply operates normally you may have either a shorted device or a shorted cable. If the power supply does not operate normally then test for a module causing the problem by following the steps below:

If the PWR LED operates normally the problem could be in one of the modules. To isolate which module is causing the problem, disconnect the system power and remove one module at a time until the PWR LED operates normally.

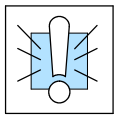
Follow the procedure below:

- Turn off power to the base.
- Remove a module from the base.
- Reapply power to the base.

Bent base connector pins on the module can cause this problem. Check to see the connector is not the problem.

**Power Budget Exceeded**

If the machine had been operating correctly for a considerable amount of time prior to the indicator going off, the power budget is not likely to be the problem. Power budgeting problems usually occur during system start-up when the PLC is under operation and the inputs/outputs are requiring more current than the base power supply can provide.



**WARNING:** The PLC may reset if the power budget is exceeded. If there is any doubt about the system power budget please check it at this time. Exceeding the power budget can cause unpredictable results which can cause damage and injury. Verify the modules in the base operate within the power budget for the chosen base. You can find these tables in Chapter 4, Bases and I/O Configuration.

## RUN Indicator

If the CPU will not enter the Run mode (the RUN indicator is off), the problem is usually in the application program, unless the CPU has a fatal error. If a fatal error has occurred, the CPU LED should be on. (You can use a programming device to determine the cause of the error.)

If you are using a DL240 or DL250 and you are trying to change the modes with a programming device, make sure the mode switch is in the TERM position.

Both of the programming devices, Handheld Programmer and ***Direct***SOFT™, will return a error message describing the problem. Depending on the error, there may also be an AUX function you can use to help diagnose the problem. The most common programming error is "Missing END Statement". All application programs require an END statement for proper termination. A complete list of error codes can be found in Appendix B.



## CPU Indicator

If the CPU indicator is on, a fatal error has occurred in the CPU. Generally, this is not a programming problem but an actual hardware failure. You can power cycle the system to clear the error. If the error clears, you should monitor the system and determine what caused the problem. You will find this problem is sometimes caused by high frequency electrical noise introduced into the CPU from an outside source. Check your system grounding and install electrical noise filters if the grounding is suspected. If power cycling the system does not reset the error, or if the problem returns, you should replace the CPU.

## BATT Indicator

If the BATT indicator is on, the CPU battery is either disconnected or needs replacing. The battery voltage is continuously monitored while the system voltage is being supplied.

## Communications Problems

If you cannot establish communications with the CPU, check these items.

- The cable is disconnected.
- The cable has a broken wire or has been wired incorrectly.
- The cable is improperly terminated or grounded.
- The device connected is not operating at the correct baud rate (9600 baud for the top port. Use AUX 56 to select the baud rate for the bottom port on a DL240 and DL250).
- The device connected to the port is sending data incorrectly.
- A grounding difference exists between the two devices.
- Electrical noise is causing intermittent errors
- The CPU has a bad communication port and the CPU should be replaced.

If an error occurs the indicator will come on and stay on until a successful communication has been completed.

# Noise Troubleshooting

**Electrical Noise Problems**

Noise is one of the most difficult problems to diagnose. Electrical noise can enter a system in many different ways and fall into one of two categories, conducted or radiated. It may be difficult to determine how the noise is entering the system but the corrective actions for either of the types of noise problems are similar.

- Conducted noise is when the electrical interference is introduced into the system by way of a attached wire, panel connection ,etc. It may enter through an I/O module, a power supply connection, the communication ground connection, or the chassis ground connection.
- Radiated noise is when the electrical interference is introduced into the system without a direct electrical connection, much in the same manner as radio waves.

**Reducing Electrical Noise**

While electrical noise cannot be eliminated it can be reduced to a level that will not affect the system.

- Most noise problems result from improper grounding of the system. A good earth ground can be the single most effective way to correct noise problems. If a ground is not available, install a ground rod as close to the system as possible. Insure all ground wires are single point grounds and are not daisy chained from one device to another. Ground metal enclosures around the system. A loose wire is no more than a large antenna waiting to introduce noise into the system; therefore, you should tighten all connections in your system. Loose ground wires are more susceptible to noise than the other wires in your system. Review Chapter 2 Installation, Wiring, and Specifications if you have questions regarding how to ground your system.
- Electrical noise can enter the system through the power source for the CPU and I/O. Installing a isolation transformer for all AC sources can correct this problem. DC sources should be well grounded good quality supplies. Switching DC power supplies commonly generate more noise than linear supplies.
- Separate input wiring from output wiring. Never run I/O wiring close to high voltage wiring.

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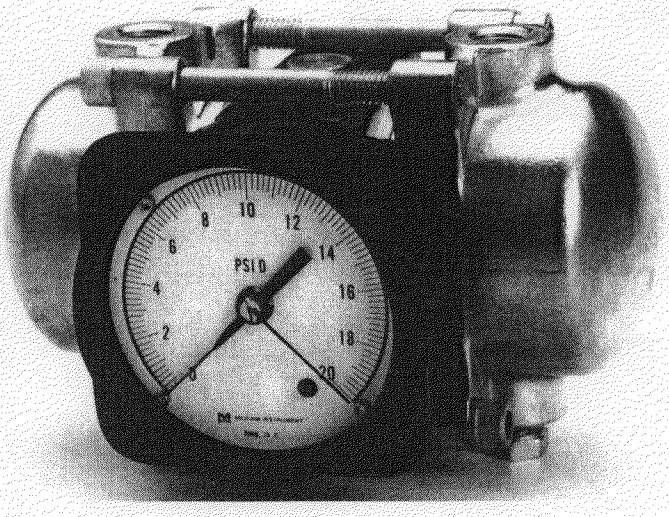
FILE No. 1100:440-10

# INSTALLATION & OPERATING INSTRUCTIONS




# MERIAM SERIES 1120 BELLOWS D/P INDICATORS AND SERIES 1220 BELLOWS D/P INDICATING SWITCHES

## TABLE OF CONTENTS

# *Fragile* — UNPACK WITH CARE

Thank you for buying Meriam products. We appreciate your business. We have packed this shipment with care to be certain you receive what you ordered in good condition. Carefully remove all packing material and thoroughly inspect contents to be positive all items shown on the packing list are included and not damaged. Check contents for:

- Differential Pressure Indicator or Indicating Switch
- Service Manual
- Accessories supplied per customer purchase order

## Precautions:

If the instrument was ordered for service in a critical medium requiring special cleaning (e.g. oxygen) remove the plastic bag only under controlled cleanliness conditions.

Your Meriam instrument was inspected during manufacture and prior to shipping. However, an inspection should be performed at the time of unpacking to detect any damage that may have occurred during shipment. If any irregularities are found:

1. Report damage to carrier.
2. Claims to trucking, express, or air carriers are to be filed by the customer.
3. Claims to United Parcel Service must be filed by Meriam.
4. Advise Meriam of damage and obtain authorization to return for repair or replacement. Do this promptly to assure coverage and avoid delay.

Thank you again for your order. If applied to designed specifications, these products will provide you with many years of service. We look forward to serving you again.

# PRINCIPLE OF OPERATION

The Meriam Model 1020 Differential Pressure Unit is a proven and reliable sensing element. Available in ranges from as low as 0-30" $H_2O$ to 0-500 PSI. It is especially adaptable where size and weight are critical factors. The light weight and compact differential pressure unit incorporates a rupture-proof and leak-proof bellows plus other construction features that make it second to none. This unit is suitable for activating indicators, recorders, transmitters, switches, and controllers and is available as a separate assembly for that purpose.

The basic D/P unit consists of a high and a low pressure bellows, both liquid filled and connected to a center plate. The bellows are enclosed in the high and low pressure end housings which in turn are bolted to the center plate. When differential pressures are applied to the high and low pressure connections, the high pressure bellows contracts forcing the fill fluid through the center plate into the low pressure bellows causing it to expand.

The resulting linear motion of the low pressure bellows is converted to a 6° rotary motion of the output shaft through a temperature compensated linkage. Overrange protection is provided by two opposed valves located on this linkage allowing the unit to withstand overranging up to the full static pressure rating of the housing without damage. The interior of the bellows and center plate are completely filled with a clean, non-corrosive, low freezing point liquid. This output shaft is part of a low friction, "O" ring sealed shaft and bearing assembly which carries the rotary motion to the external area of the bellows unit and into the instrument case.

In the Meriam bellows unit all of the fill fluid must pass through the Meriam Pulsation Dampening valve in the center plate. This valve is field adjustable so that the desired dampening effect can be obtained. Because of this Meriam design, other types of external dampening devices are not required on services involving measurement of fluctuating differential pressures. The Meriam bellows D/P unit incorporates a special design which completely isolates the process fluid from the center plate.

# CONSTRUCTION SPECIFICATIONS

| MODEL | 1123 | 1124 | 1126 | 1224-1 | 1224-2 | 1226-1 | 1226-2 | 1124-P-3 | *1124-P-4 | 1126-P-2 | SERIES 1020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DIAL SIZE | 3" | 4½" | 6" | 4½" | 4½" | 6" | 6" | 4½" | 4½" | 6" | Basic D/P Unit For All Models |
| HOUSING MATERIAL & PRESSURE RATING | ALL MODELS<br>ENDHOUSINGS: Brass; Steel; 316 Stainless Steel<br>CENTERPLATE: Brass; Steel or Brass (1000 SWP only); 316 SS, Steel or Brass (1000 SWP only)<br>S.W.P.: 500 or 1000 p.s.i.; 1000, 1500, 3000 or 6000 p.s.i.; 1000, 1500, 3000 or 6000 p.s.i.<br>PROCESS CONNECTIONS: 1/4" & 1/4" NPT; 1/4" & 1/2" NPT; 1/4" & 1/2" NPT | | | | | | | | | | |
| BELLOWS MATERIAL | ALL MODELS<br>Beryllium Copper (30" W.C. to 65 PSID), 316L Stainless Steel (50" W.C. to 500 PSID) or MONEL 400 (50" W.C. to 65 PSID) | | | | | | | | | | |
| MOUNTING STYLES | ALL MODELS (except 1124P & 1126P)<br>FLUSH PANEL using indicator case for mounting — WALL or ¾" NPT using universal mounting bracket<br>PIPE SADDLE or WALL using "H" mounting bracket and 2" U-Bolts — 2" Ell Pipe Stand | | | | | | | | | | |
| SPECIAL FEATURES | ALL MODELS<br>Range Variations<br>270° Pointer Travel, 6° Shaft Rotation<br>Temperature Compensation for Varying Ambients<br>Built-In Pulsation Dampening (Field Adjustable)<br>Lo-Torque Instrument Shaft & Bearing<br>Break-Resistant Acrylic Viewing Window<br>Die-Cast Aluminum Case With Gasketed Cover<br>Simple Zero, Span and Linearity Adjustment | | | | | | | | | | |

* Available in Brass Construction Only

# PERFORMANCE SPECIFICATIONS

## INDICATORS

Accuracy:
- 0 to 30" W.C. range ..... 1.50% FS
- 0 to 50" thru 0 to 500 PSID range ..... 0.75% FS
- Optional ±0.50% FS for ranges 100" W.C. to 50 PSID .... Consult Factory
- Linearity ..... Within above stated accuracy

Zero Elevation:
Maximum 100% of range

Suppression:
Maximum 100% of range, 150 PSID Max.

Operating Temperature Limits ..... -60° to +200° F

Full Scale Displacement:
- 0 to 30" thru 0 to 130" W.C. range ..... .19 Cu. In.
- 0 to 135" W.C. thru 0 to 60 PSID range .... .12 Cu. In.
- 0 to 75 PSID thru 0 to 500 PSID range .... .06 Cu. In.

## INDICATING SWITCHES

| | |
|---|---|
| Accuracy | Before activation, ±¾% of full diff. At activation point, ±2% of full diff. After activation point, switch activated, ±1½% of full diff. |
| Linearity, Suppression & Displacement | Refer to "Indicators" |
| Switch Dead Band | 10% of full diff. Maximum (7% nominal). |
| Switch Setting | Increasing 10 to 100% of differential or 10" of water whichever is greater.<br>Decreasing: 5% or 5" of water whichever is greater.<br>15% of F.S. minimum between set points. |
| Switch Type | Snap action SPDT. |
| Switch Rating | 5 amperes at 125 or 250 V.A.C.<br>3 amperes inductive or 5 amperes resistive at 30 V.D.C. |

# INSTALLATION

## OPERATING LIMITATIONS

The One-Year Warranty of the Differential Pressure Unit will not apply if the following limitations are exceeded:

**Useful Temperature:**
-60° F. to +200° F.
(-35° F. with oil fill)
(+35° F. to 150° F. with distilled water)

**Pressure:** Units are capable of line pressures up to the SWP stamped on the I.D. Tag (located on the bottom of the centerplate) without damage. Zero reset or recalibration may be required.

**Pulsation:** If the meter body is to be subjected to pulsation, make sure the externally adjustable pulsation dampener is adjusted correctly to prevent damage to the instrument. All instruments are shipped with the dampener valve 1/4 turn open. Use a screwdriver to adjust the dampener valve until the proper dampening effect is obtained. Approximately 1-1/2 turns is fully open. Severe pulsations will affect the accuracy of the instrument; when pulsation is severe, the installation of a pulsation damping device upstream of the meter run is recommended.

**Vibration and Shock:** Do not subject instrument to severe mechanical vibration or hydraulic shock, unless the unit has been specially ordered for such severe operating conditions.

**Corrosion:** The bellows of the Differential Pressure Unit are made of either beryllium copper, Type 316L stainless steel or of MONEL 400.

## LOCATION

1. Locate the indicator's meter body so it will be easily accessible from ground level.
2. Select a reasonably vibration-free location where ambient temperature does not exceed operating temperature limits. Do not locate the instrument near vents or bleed holes discharging corrosive vapors or gases.
3. In Liquid Measurement (Figs. 7-9) locate the meter body below the primary element to permit entrapped air or gas to be vented into the flow line.

   For Steam and Gas Measurement (Figs. 2-7) place the meter body above the flow line to facilitate condensate draining.
4. The distance between the primary device and the DPU shall be as short as possible. For distances up to 50 feet use 1/4 inch or 3/8 inch pipe or tubing. For runs 50 to 100 feet use 1/2 inch pipe or tubing. Distances exceeding 100 feet are not recommended. The recommended distance limitation does not apply if an air-purge system is used.

**MOUNTING:** Refer to Pgs. 4 & 5 for dimensions.

The instrument must be approximately level for proper operation.

**Wall Mtg.** — Universal Bracket or 2" Pipe Saddle.

Drill four mounting holes on wall to match the "H" mounting bracket.

Secure instrument with bolts and nuts.

**Pipe Mtg.**

1. Universal Bracket: Place a suitable length of 3/4 inch threaded pipe into a well-secured floor or wall flange. Thread instrument onto pipe and properly orient meter with wrench or bar on meter body bracket.

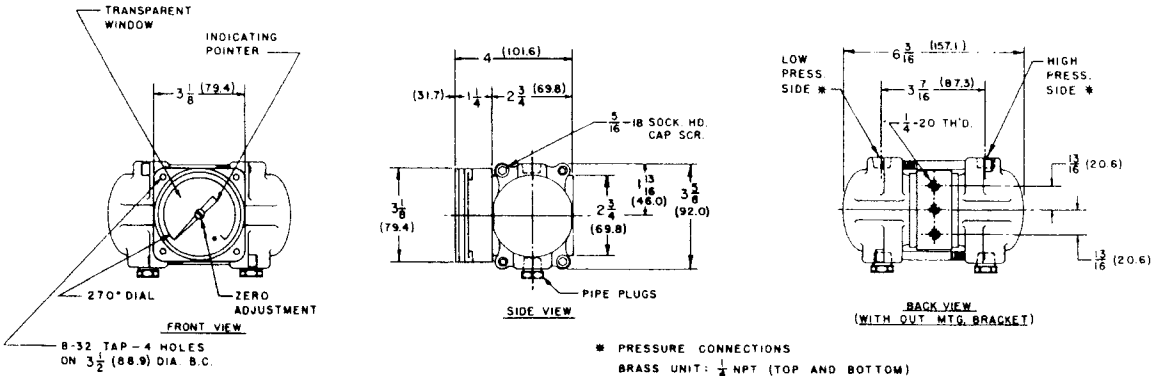
   CAUTION: Do not orient by turning or grasping the indicator case.
2. Pipe Saddle or Stand: Attach to existing 2" piping, or to a 2" pipe secured in a manner similar to (1.) above by means of the "U" bolts or Ell supplied.

**Flush or Panel Mtg.**

1. Remove the gauge cover and provide a hole in the panel per the mounting dimensions. Insert the gauge and install washers and retaining nuts on the four mounting bolts.
2. Orient the axes of the dial for readability and appearance and wrench tighten the retaining nuts. Replace the gauge cover to complete the installation.

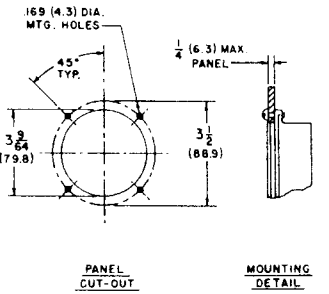
   On Models 1124 and 1224, the washers will overhang onto the panel, retaining and locking the gauge in place. If holes are felt necessary for the retaining bolts of Models 1124 and 1224, a more complex cutout may be used in the panel (refer to the drawing). This cutout will also pass the DPU.

NOTE: ALL DIMENSIONS ARE IN INCHES AND (MM)
FINISH: BLACK POLYURETHANE ENAMEL ON INDICATOR HOUSING

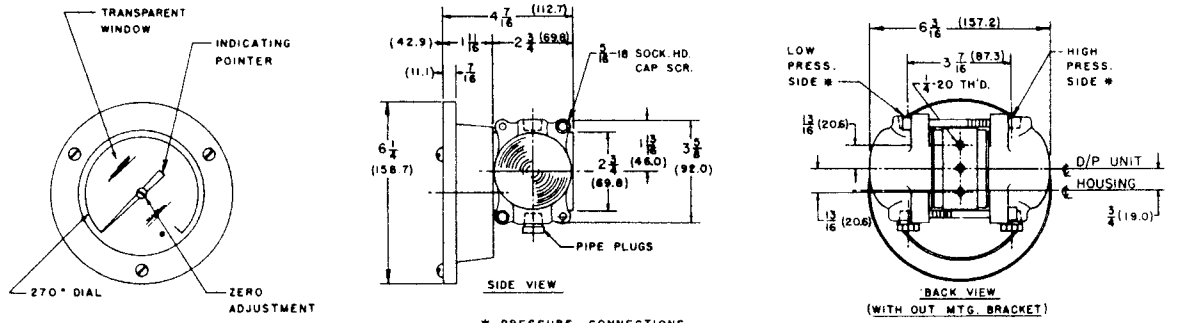



* PRESSURE CONNECTIONS
BRASS UNIT: $\frac{1}{4}$ NPT (TOP AND BOTTOM)
STEEL OR STAINLESS UNITS: $\frac{1}{2}$ NPT (TOP), $\frac{1}{4}$ NPT (BOTTOM)
OPTIONAL $\frac{1}{4}$ NPT (TOP), $\frac{1}{2}$ NPT (BOTTOM)

## MODEL 1123 BELLOWS DIFFERENTIAL PRESS. INDICATOR

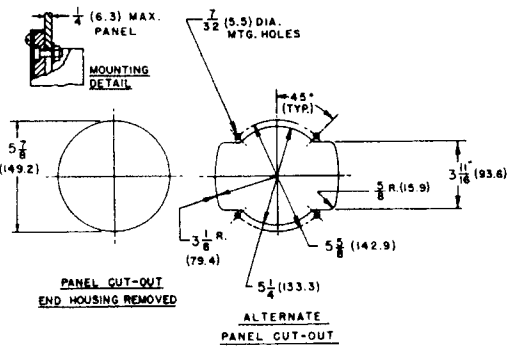



## FLUSH PANEL MOUNTING

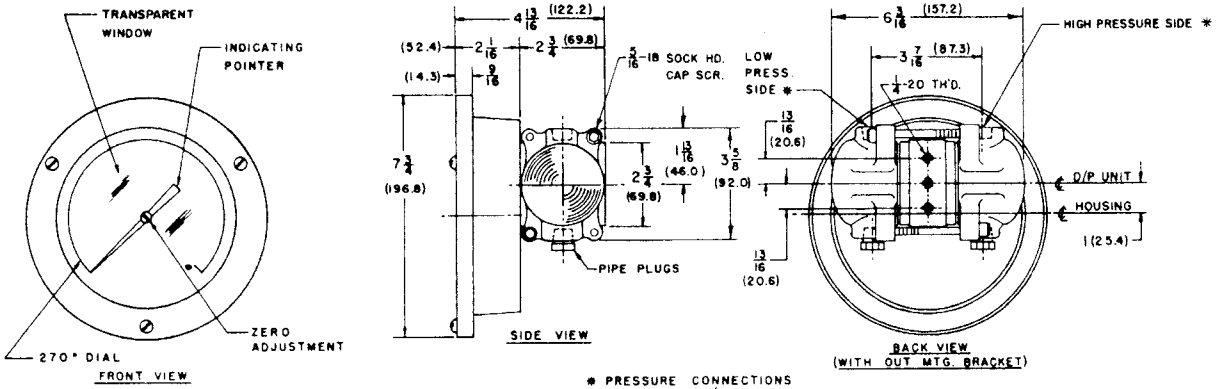



* PRESSURE CONNECTIONS
BRASS UNIT: $\frac{1}{4}$ NPT (TOP AND BOTTOM)
STEEL OR STAINLESS UNITS: $\frac{1}{2}$ NPT (TOP), $\frac{1}{4}$ NPT (BOTTOM)
OPTIONAL $\frac{1}{4}$ NPT (TOP), $\frac{1}{2}$ NPT (BOTTOM)

## MODEL 1124 AND 1224 BELLOWS DIFFERENTIAL UNIT

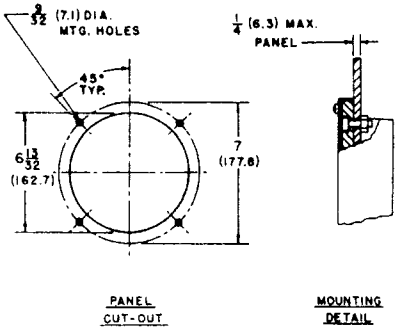



## FLUSH PANEL MOUNTING



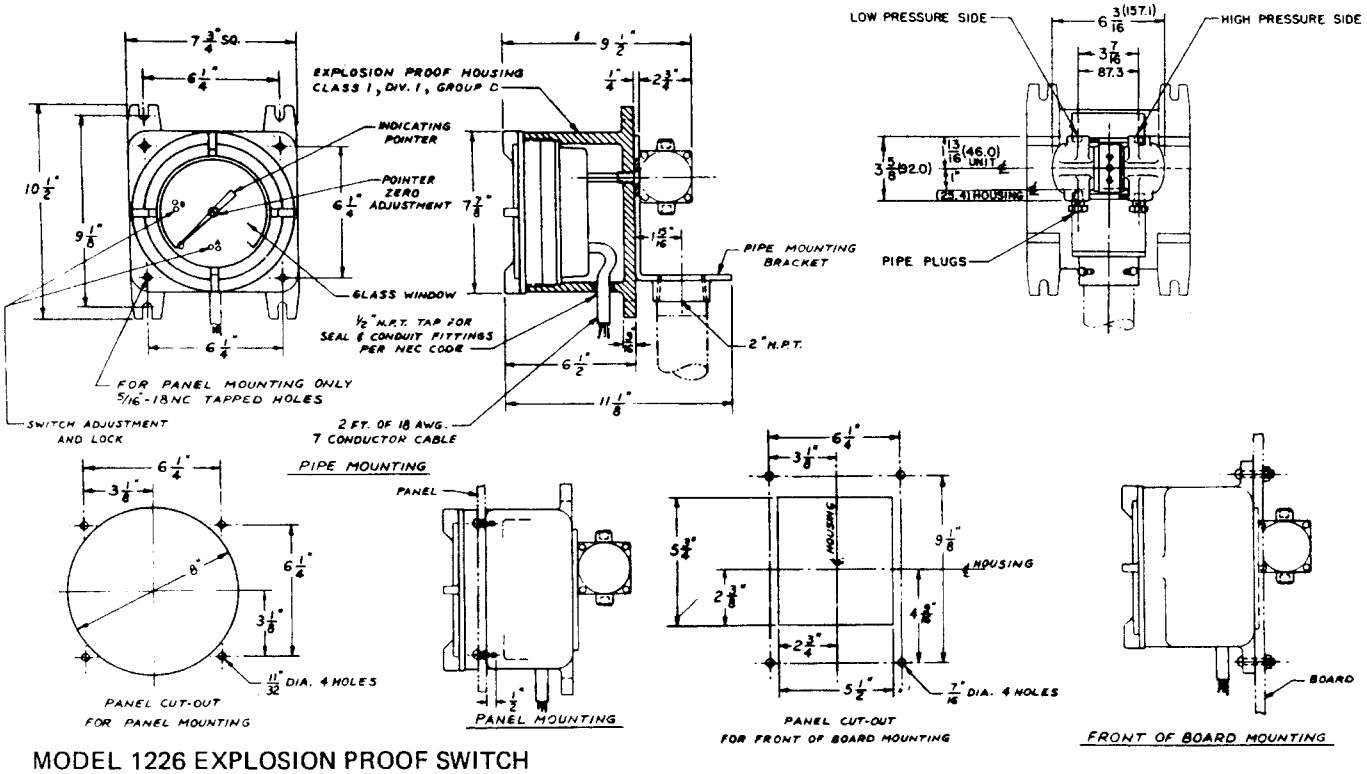

* PRESSURE CONNECTIONS
BRASS UNIT: $\frac{1}{4}$ NPT (TOP AND BOTTOM)
STEEL OR STAINLESS UNITS: $\frac{1}{2}$ NPT (TOP), $\frac{1}{4}$ NPT (BOTTOM) - OPTIONAL $\frac{1}{4}$ NPT (TOP), $\frac{1}{2}$ NPT (BOTTOM)

## MODEL 1126 AND 1226 BELLOWS DIFFERENTIAL UNIT

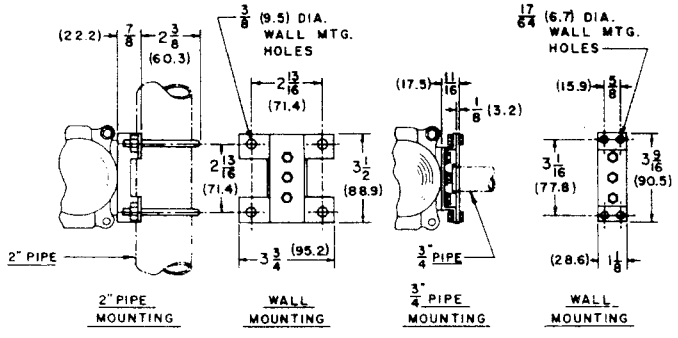



## FLUSH PANEL MOUNTING

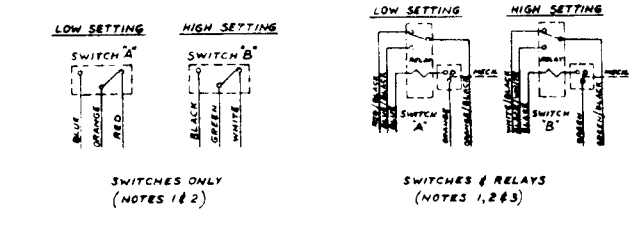
## MOUNTING DIMENSIONS (Cont.)




MODEL 1226 EXPLOSION PROOF SWITCH




SADDLE MOUNTING | UNIVERSAL MOUNTING




NOTES:
1. SWITCH RATING: 5 AMP AT 125 OR 250 V.A.C. UL RATED, 5 AMPS AT 30 V.D.C.
2. DELETE SWITCH "B" FOR SINGLE SWITCH MODEL 1226-1
3. RELAY CONTACT RATING: 10 AMP AT 115 VAC OR 28 VDC RESISTIVE LOAD NOMINAL COIL POWER: 3VA, COIL VOLTAGE: 118 VAC

SCHEMATIC WIRING DIAGRAMS

ALL MODELS

## PIPING

Refer to Figs. 2 through 15 for typical piping arrangements.

Certain practices should be followed on all flow and liquid level DPU piping:

1. Locate piping per pg. 3 "location" para. 4.
2. Make up all joints using a suitable pipe joint compound to reduce measurement errors caused by leaks in the pipe joints.
3. Slope all piping at least 1 inch per linear foot to avoid liquid or gas entrapment.
4. If process media exceeding 200° F (93° C) is to be measured, provide 2 feet of uninsulated piping between the primary device and the DPU for each 100° F (37.8° C) in excess of 200° F.
5. Install a valve manifold connecting the DPU and the differential pressure source to facilitate operation and checking of the DPU. Locate shutoff and bypass valves to be readily accessible to the operator from the front of the instrument. The shutoff valve should be the first valve from the process line or vessel.
6. Steel and Stainless Steel DPU's have two pressure connections in each housing, one ¼" and one ½" NPT. If necessary, rotate the housings 180 degrees to place the connections in the desired position.

# INSTRUMENT STARTUP

**IMPORTANT:** PRIOR TO PLACING THE INSTRUMENT IN SERVICE, PERFORM THE FOLLOWING OPERATIONS:

1. Since the bellows may have taken a slight "set" due to possible extended periods of storage prior to installation, it is advised that the first time the DPU is used and prior to actual operation, the unit be exercised to ensure correct indications. To exercise the unit, sequentially apply maximum and minimum differential pressure to the high pressure side for at least ten cycles.

2. Check manifold and piping for leakage by opening the block valves, one shutoff valve, and the bypass valve to pressurize the instrument. Then close the shutoff valve and bypass valve. If pointer travels upscale, leak in low pressure piping; pointer travels downscale, leak in high pressure piping.

3. Zero check the instrument. To do this, close the block valves and open the bypass valve(s). This equalizes the pressure on both sides of the instrument. If the instrument does not indicate zero, set pointer by holding pointer hub with the screwdriver and turning pointer to zero reference.

4. Check Calibration: First zero the instrument at atmospheric pressure and connect a calibration instrument such as a Meriam 35JA10 Portable Manometer to the high pressure connection of the meter. The low pressure connection is vented to atmosphere. Turn meter valves to use flowing gas pressure, or use pressure source such as Meriam 961AB2 aspirator bulb, to apply increasing pressures of 20, 50, 80 and 100 percent of full-scale differential to the HP housing. Exercise care to <u>always</u> approach the desired scale reading from the low D/P side; if you overshoot and drop back to the reading, your calibration will be incorrect. Reverse the procedure, bleeding pressure and stopping at the same scale readings, now taking care to always approach readings from the high D/P side. Compare DPU readings with the calibration instrument.

Inconsistent readings may be the result of the pointer dragging against the scale plate. To inspect for this condition, remove the lens as described under "Complete Calibration." The end of the pointer should be no closer to the scale plate than 1/32 inch throughout its arc of travel. If necessary, bend the pointer away from the scale by gently pulling on the outer end.

If indications are within specified tolerances, no further calibration is required.

If instrument readings are outside specified tolerances, refer to "Complete Calibration".

After instrument has been checked to read correctly, replace lid and/or glass assembly.

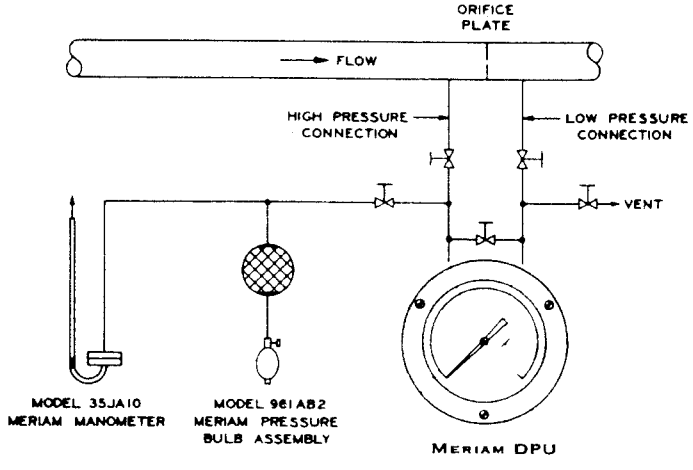



**FIG. 1 Typical Schematic Arrangement For Calibration Of Bellows D/P Meter**

**CAUTION:** Although the Meriam DPU is a seamless rupture-proof bellows type instrument, care should be taken not to subject the DPU to unnecessary shock or over-range pressure during startup.

Make sure block and bypass valves are closed when beginning start-up procedures.

# METER PIPING DIAGRAMS

FIG. 2

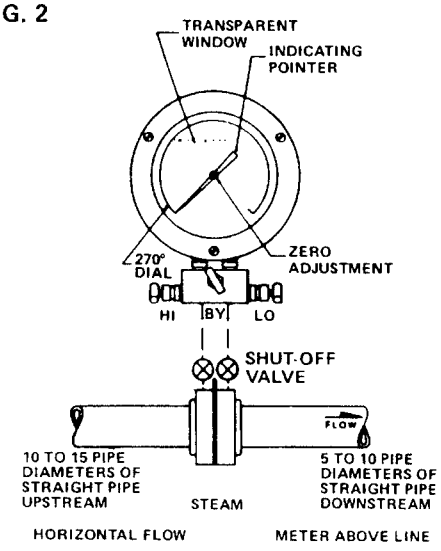



FIG. 3

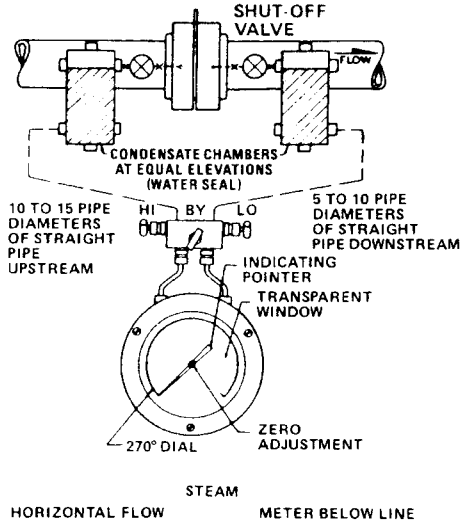
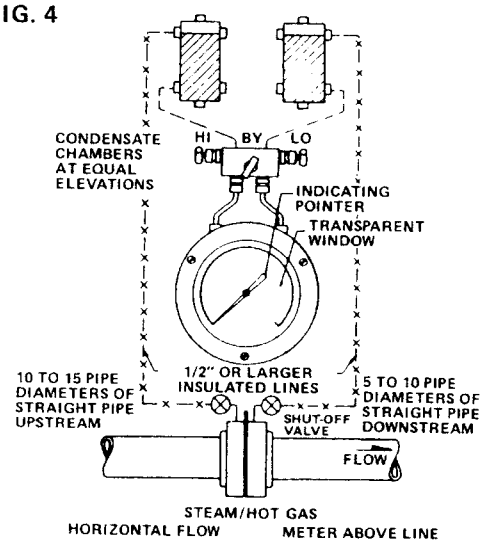



FIG. 4




Diagrams for typical and special installations are presented in Figures 2 through 15. The start-up procedure for each installation is presented with the respective piping diagram. Use the diagram most applicable to your specific requirement as a guide.

## STEAM

### START-UP

Recommended for use whenever possible to realize self-draining of DPU. If DPU must be located below the primary element, see Fig. 3.

CAUTION: Maximum DPU operating temperature is 200°F. For higher temperatures, see Fig. 4.

1. Whatever the location of the meter body, make all primary element taps at or near top of pipe.
2. Close block valves and vent valves (if used). Open bypass valve and shut-off valves.
3. Slowly and simultaneously open block valves, then close shut-off valves. Check for leaks (see #2 pg. 6).
4. Slowly and simultaneously open shut-off valves.
5. Close bypass valve for D/P reading.

## STEAM

### START-UP

Used if DPU must be located below primary element.

NOTE: To prevent overheating during instrument blowdown, monitor the temperature by placing your hand on the pipe between the DPU and the vent valves.

1. Close shut-off valves and vent valves (if used). Open bypass valve and block valves.
2. Remove side and fill plugs from condensate chambers.
3. Fill piping and meter body chambers with water by pouring into fill port in both condensate chambers to the level of the side plugs. Meter chambers and piping must be free of bubbles. When instrument and piping are completely full, pointer will rest at zero.
4. Install plugs in ports of condensate chambers.
5. Slowly and simultaneously open shut-off valves then close. Check for leaks (see #2 pg. 6).
6. Slowly and simultaneously open shut-off valves.
7. Close bypass valve for D/P reading.

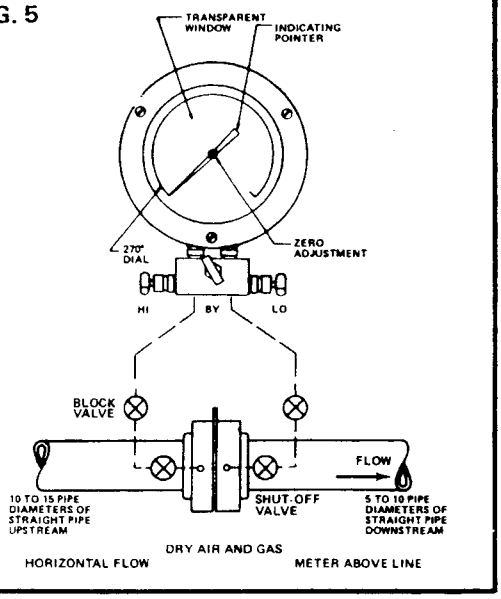
## STEAM or HOT GASES

### START-UP

Recommended for use when process temperature exceeds 200°F.

See "Piping" #3 pg. 5; then follow steps in Fig. 3.

FIG. 5




## GASES

### START-UP

Recommended for use whenever possible, as DPU is self-draining. NOT recommended when hydrates are present. If hydrates are present, or the meter body must be located below the primary element, See Fig. 6.

1. Whatever the location of the meter body, make all primary element taps at or near the top of the pipe.
2. Open manifold valves and bypass valve, open one block valve and one shutoff valve to pressurize meter.
3. Then close block valve and bypass valve and check for leaks (see "Instrument Start-up" #2, pg. 6).
4. Open bypass valve, open block valves and slowly open both shutoff valves simultaneously.
5. Close bypass valve for D/P reading.

## GASES

### START-UP

Used if hydrates or heavy solids are present. Piping diameter not less than 1/2". Drain valves are required.

1. through 5. Follow steps in Fig. 5.
6. Drain condensate chambers of hydrates at regular intervals.

## CORROSIVE FLUIDS

### START-UP

When the flowing medium is highly corrosive, contains solids in suspension, is highly volatile, or for some other reason would damage the meter body, install liquid or chemical seals to prevent its entering the meter body.

In selecting a location for seals:

Place as close as possible to the primary element to reduce the length of piping filled with process fluid.

On high temperature applications, locate the seal at least 36" from the primary element shutoff valves to prevent overheating.

NOTE: When measuring liquids, locate pressure taps at or near BOTTOM of pipe. Diaphragm type seals can be used in place of condensate chambers (eliminate Steps 2 through 6).

1. Close shutoff valves; open manifold valves and block valves.
2. Remove fill and side plugs from seal pots.
3. Fill seal pots, piping and meter housings with the immiscible seal fluid by pouring into upper fill ports. Meter housings, tubing and seal pots must be filled to seal pot side ports with bubble-free liquid. Pointer will indicate zero when both high and low pressure chambers are filled equally.
4. Install side plugs and close all valves.
5. Slowly open each shutoff valve alternately until bubble-free process liquid spills from upper fill port (skip this step in gas applications).
6. Replace fill plugs.
7. Check piping for leaks (see #2 pg. 6).
8. Open manifold valves and block valves, then SLOWLY open both shutoff valves simultaneously.
9. Close bypass valve for D/P reading.

FIG. 6

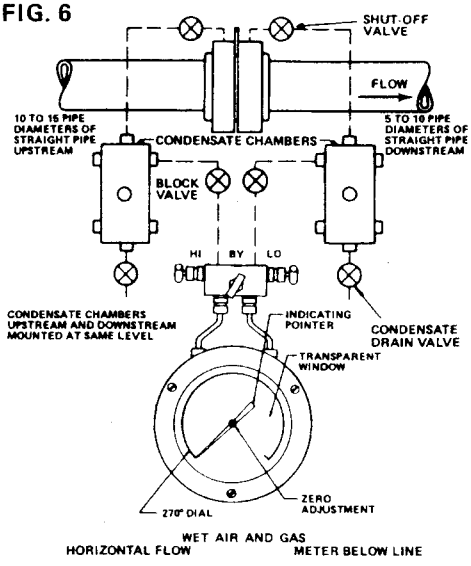



FIG. 7

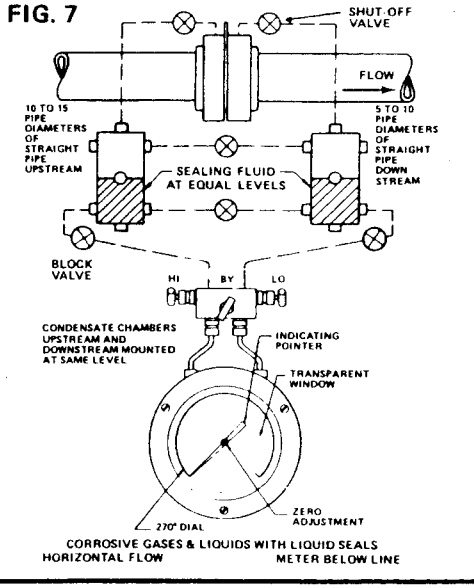
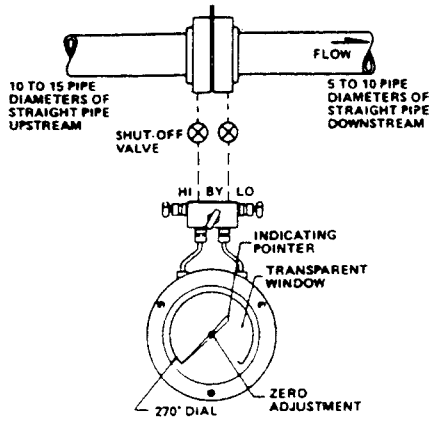
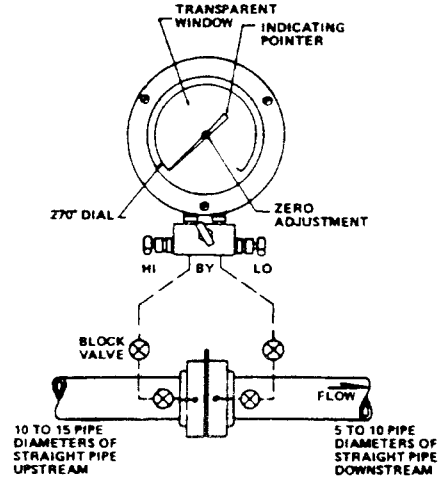


FIG. 8



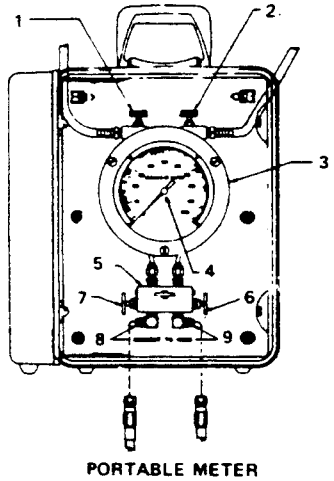

LIQUID
HORIZONTAL FLOW METER BELOW LINE

FIG. 9




LIQUID
HORIZONTAL FLOW METER ABOVE LINE

FIG. 10




PORTABLE METER
FOLLOW APPLICABLE DIAGRAM FOR HOOK-UP

# LIQUIDS

## START-UP

Recommended for use in all liquid flow applications, especially volatile or gassy liquids. Make all primary element taps at or near bottom of pipe.

CAUTION: Maximum meter operating temperature is 200°F (93°C). For higher temperature media, first see "Piping" #3, page 5. With hot or gassy fluids, disconnect meter and fill both housings and piping through manifold with process fluid cooled to below 200°F, then reconnect.

1. Open block valves, bypass valve, and one shutoff valve.
2. Alternately crack drain valves (connected to lower meter body ports) until liquid, free of bubbles, spills out both ports.
3. Close both drain valves and shutoff valve.
4. Pointer should indicate zero. If not, and no leaks are detected, the housings and/or piping are not completely full of bubble-free liquid. Repeat steps 1 through 4 until pointer remains stationary at zero.
5. Open both block valves and shutoff valves; close bypass valve for D/P reading.

# LIQUIDS

## START-UP

Recommended for use when sediments are present or when meter cannot be mounted below line. Where sediments are NOT present, make primary element taps at or near bottom of pipe. Periodically inspect and clean instrument lines.

NOTE: Where process fluid is gassy or system is subject to numerous no-flow conditions and meter cannot be mounted below line, install automatic air bleed fittings in top meter body ports or at high point of instrument lines.

1. Open both block valves, bypass valve, and one shutoff valve.
2. Alternately crack vent valves or loosen plugs from top ports of meter body housings until liquid, free of bubbles, spills out of both upper meter body ports.
3. Close vent valves or replace plugs and close shutoff valve.
4. Pointer should indicate zero. If not, and no leaks are detected, the housings and/or piping are not completely full of bubble-free liquid. Repeat steps 1 through 4 until pointer remains stationary at zero.
5. Open both shutoff valves, close bypass valve for D/P reading.

# PORTABLE METER

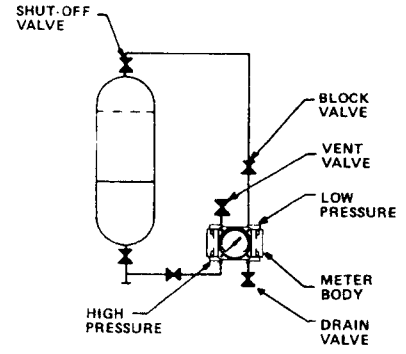
## START-UP

NOTE: Hose pressure and temperature limits: Brass units — 500 psi at 160°F; Steel and SS — 3000 psi at 200°F.

CAUTION: Maximum temperature of meter body is 200°F; for higher temperatures, see "Piping" #3, page 5.

1. Place instrument with dial face vertical (or horizontal in case of 1124P-4 only). Open vent valves (1 and 2). Zero pointer as necessary; remove cover and glass (3); turn screw (4) until pointer reads zero; replace glass and cover.
2. Close vent valves (1 and 2). Open bypass valve (5). Close block valves (6 and 7).
3. Connect high pressure fitting (8) to upstream primary device tap and connect low pressure fitting (9) to downstream primary device tap using hoses provided.
4. Open valves at primary device. For gas or steam measurement, go to step 7.
5. For liquid measurement, open block valves (6 and 7) and partially open vent valves (1 and 2) until all air has been expelled from instrument and hoses.
6. Close vent and block valves, keeping bypass valve open; pointer should indicate zero; if not, air is trapped in the system. Repeat step (5), opening block valves alternately until all air is removed.
7. Open block valves, close bypass valve; read pressure differential.
8. When through with test, open bypass valve, close valves at primary device, and remove hoses.
9. Open vent valves and drain instrument hoses.

FIG. 11




TANK LEVEL NON-CONDENSING LIQUIDS
METER LEVEL WITH TANK BOTTOM

## COOL LIQUIDS

### START-UP

Recommended for use with water, oil, or other media which will not condense in low pressure piping. For hot (volatile) liquids, see Fig. 12.

Mount meter body centerline level with lower tank reading point. If meter is mounted below lower tank reading point, install a reference leg per Fig. 9, a bubbler system per Fig. 13, a Meriam 961C4 hand pump, or order special D/P and dial range from factory.

**NOTE:** Do not share fill or vapor return lines with meter piping.

1. Close all valves; open high pressure block valve and crack high pressure vent valve.
2. Slowly open bottom (high pressure) shut-off valve. When bubble-free liquid spills from high pressure vent valve, close vent valve.
3. Open low pressure block valve; slowly open top (low pressure) shutoff valve.
4. Crack low pressure drain valve to drain any condensation and reclose.

## COOL or HOT LIQUIDS

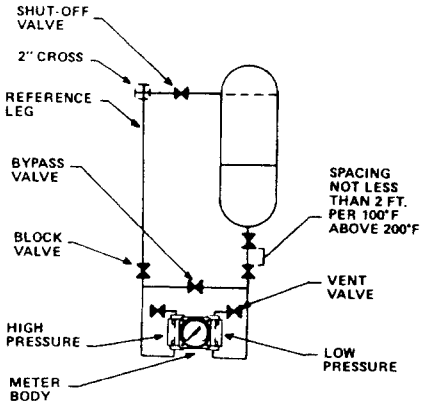
### START-UP

Recommended for use to cancel out the "dead leg" (piping from tank bottom to centerline of meter body) when meter is mounted below tank. Process medium can be used as reference leg seal fluid if it will condense in the leg under all conditions. Otherwise, a non-miscible seal fluid must be used.

**CAUTION:** If bypass valve is opened at any time when the tank liquid level is below maximum, the reference leg must again be filled.

**NOTE:** Do not share fill or vapor return lines with meter piping.

FIG. 12




TANK LEVEL COOL OR VOLATILE LIQUIDS
METER BELOW TANK WITH REFERENCE LEG

### COOL LIQUIDS

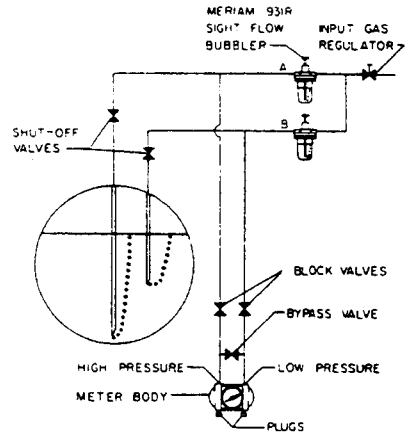
1. Partially fill reference leg by opening bottom shutoff valve, both block valves and bypass valve.
2. Crack vent valves on meter body housings; close when clear, bubble-free liquid flows out.
3. Close bypass and block valve on reference leg.
4. Remove plug from side port in 2 inch pipe cross connection used for reference level reservoir, and fill the leg by opening block valve and cracking the bypass valve until bubble-free liquid spills out.
5. Close bypass valve. Replace plug in cross.
6. Slowly open upper shutoff valve.

### HOT (VOLATILE) LIQUIDS

**CAUTION:** Maximum meter operating temperature is 200°F. See "Piping" #3, page 5, before proceeding.

1. Close shutoff valves; open both block valves, vent valves, and by-pass valve.
2. Remove plug from top port in 2" pipe cross. Use process liquid (cooled to below 200°F) or other suitable seal fluid, and fill both high and low pressure meter housings through cross until it runs out vent valves bubble-free.
3. Close HP vent valve and bypass valve. Fill reference leg and replace plug.
4. Crack LP (bottom) shutoff valve until fluid flows bubble-free from LP vent, and reclose. AVOID danger of scalding from hot liquid.
5. Slowly open both shutoff valves.

FIG. 13




SPECIFIC GRAVITY / TANK LEVEL COOL LIQUIDS METER INSTALLED WITH BUBBLER SYSTEM

FIG. 14

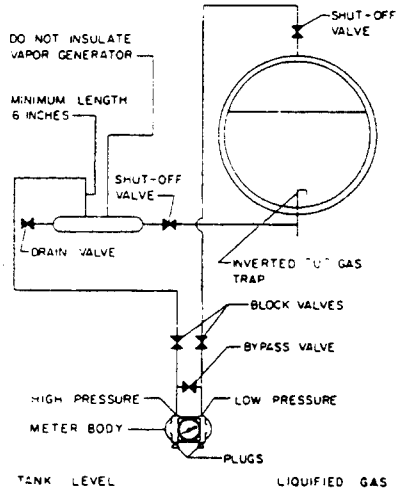
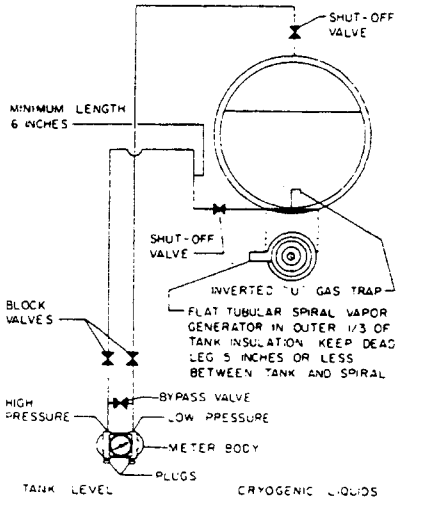



FIG. 15




# COOL (NON-VOLATILE) LIQUIDS

## START-UP

**NOTE:** Do not share fill or vapor return lines with meter piping

### SPECIFIC GRAVITY

For use to determine specific gravity changes in a process medium.

1. Set bubbler input gas regulator at a pressure slightly higher than process vessel pressure.
2. Open shutoff valves and block valves. Close bypass valve.
3. Adjust sight bubblers for equal gas flow to each tube, approximately one bubble per second. Continuous bubbling is necessary.

### LIQUID LEVEL

Recommended for use whenever solids or sludge are present, or when meter must be mounted above tank bottom.

1. Delete LP sight flow bubbler (B).
2. On a pressurized tank, pipe the LP meter housing directly to upper tank connection. On a vented tank, vent the LP meter housing to atmosphere.
3. Follow steps 1 through 3 under "Specific Gravity" above.

# LIQUIFIED GASES

## START-UP

Recommended for use with $CO_2$, Butane, Propane, Freon, and other liquified gases warmer than -150° F (-101° C). Meter may be mounted above or below tank.

Vapor generator is a 12-inch length of 1" to 1-1/2" diameter pipe; avoid traps or pockets between vapor generator and tank. Install inverted "U" gas trap inside tank. Do not insulate piping below lower shutoff valve. Do not share fill or vapor return lines with meter piping.

1. Close tank shutoff valves.
2. Open bypass valve, then open meter block valves.
3. Open drain valve and loosen meter housing plugs to remove all liquid from system. Replace plugs.
4. Close meter block valves.
5. Close drain valve and slowly open tank bottom shutoff valve to allow liquid to enter vapor generator.
6. Open tank upper shutoff valve.
7. Open meter block valves. Check meter zero. Close bypass valve and read tank level.

# CRYOGENIC LIQUIDS

## START-UP

Recommened for use with Oxygen, Nitrogen and Argon. Meter may be mounted above or below tank. Vapor generator is a spiral of 3/8" tubing. Install an inverted "U" gas trap inside tank. Do not share fill and vapor return lines with meter piping.

**CAUTION:** Meters designed for use with Oxygen are specially cleaned and packaged, and MUST be kept clean. No organic compounds, oil, grease, dirt or scale of any kind can be tolerated in an oxygen installation.

1. Close tank shutoff valves.
2. Open bypass valve, then open meter block valves.
3. Loosen meter housing plugs to remove all liquid from system. Replace plugs.
4. Close meter block valves.
5. Slowly open tank bottom shutoff valve to allow liquid to enter vapor generator.
6. Open tank upper shutoff valve.
7. Open meter block valves. Check meter zero. Close bypass valve and read tank level.

# FINAL ADJUSTMENT

It is advisable to recheck instrument zero and to test the operation of the bypass valve after the DPU has been placed in service and fully subjected to differential pressure, line pressure, and process/ambient temperature.

**CAUTION:** Never zero check when only one block valve is shut.

Where seal pots are used, it is possible to lose or displace some of the sealing fluid. In gas flow service, a standing wave effect in the process line can displace the indicator; the displacement could be assumed to be an erroneous reading.

1. With the meter body subjected to differential pressure and in service, observe the position of the pointer on the scale and use this reading as a reference for checking the effectiveness of the bypass valve on the meter body piping manifold.

   Close the H.P. meter body block valve. (Note that when checking instrument zero where seal pots are involved, the primary element shutoff valve is used instead of the meter body valve on the piping manifold). If the pointer moves from the reference position towards zero, the bypass valve on the piping manifold is leaking and must be replaced. If the pointer remains in the reference position, the bypass valve is functioning properly.

2. Open the bypass valve on the meter body piping manifold. The pointer should go to zero on the scale. If the instrument does not indicate zero, check for gas or liquid entrapment in the lines or in the DPU (depending on the orientation of the piping layout and service). If necessary, adjust the pointer by holding the pointer hub with a screwdriver and turning the pointer to zero reference.

3. **Adjustment of the Pulsation Dampener**

**CAUTION:** Never try to remove the pulsation dampener adjusting screw. Meter body fill fluid will be lost. Serious injury can result if adjustment screw is removed with the meter under pressure.

When an increase in dampening is required, as indicated by a quivering movement of the instrument pointer, turn the damping screw clockwise until the pointer just stops its oscillation. Do not over-adjust. (See "Operating Limitations – Pulsation" pg. 3) Further damping will decrease the speed of response and introduce unnecessary time lag into the measuring system. Recheck instrument zero.

# TROUBLESHOOTING

If trouble occurs, it is recommended that the routine shown below in tabular form be followed:

| TROUBLE | POSSIBLE SOURCES | MALFUNCTION | REMEDY |
|---|---|---|---|
| LOW OR NO INDICATION | Primary element or differential pressure source | Orifice installed backwards, or oversize. | Replace orifice, or install properly. |
| | | Flow blocked upstream from run. | Clean out run or open valve. |
| | | Loss of liquid in reference leg (liquid level). | Refill reference leg. |
| | | Density changes in process medium or reference leg. | Refill reference leg with liquid of same density as process medium. |
| | Piping from primary element to meter | Pressure tap holes plugged. | Clean out piping. |
| | | Piping plugged | Clean out piping. |
| | | Bypass valve open or leaking. | Close bypass valve(s) or replace. |
| | | Liquids or gases trapped in piping. | Vent piping. |
| | | Block or shutoff valves closed. | Open block or shutoff valves. |
| | | Piping leaks, high pressure side. | Repair leaks. |
| | Bellows unit | End housings filled up with solids restricting bellows movement. | Clean out housing. |
| | | Gas trapped in housing in liquid service or liquid trapped in housing in gas service. | Vent or drain housing. |
| | | High pressure housing gasket leaks. | Replace gasket. |
| | | Meter body tampered with. | Return bellows unit assembly for repairs. |
| | Movement mechanism | Loose linkage arms or movement. | Tighten or replace. |
| | | Out of calibration. | Recalibrate. |
| | | Corrosion or dirt in mechanism. | Clean or replace. |
| | | Pointer loose. | Tighten or replace. |
| HIGH INDICATION | Primary element | Orifice partially restricted or too small. | Clean out or replace. |
| | Piping from primary element to meter | Leak in low pressure piping. | Repair. |
| | | Incorrect hook-up for tank level indication. | See "Meter Piping Diagrams" and "Final Adjustment". |
| | Bellows unit | Gas trapped in low pressure housing in liquid service or liquid trapped in high pressure housing in gas service. | Vent or drain housing. |
| | | Low-pressure housing gasket leaks. | Replace gasket. |
| | | Range spring broken. | Replace range spring. |
| | | Meter body tampered with. | Return bellows unit assembly for repair. |
| | Movement mechanism | Loose linkage arms or movement. | Repair or replace. |
| | | Out of calibration. | Recalibrate. |
| ERRATIC INDICATION | Primary element | Flow pulsating. | Adjust pulsation dampener. |
| | Piping from primary element to meter | Liquid trapped in gas piping or gas bubble in liquid piping. | Remove (See startup instructions). |
| | | Vapor generator incorrectly installed. | Repipe. |
| | | Reference leg gassy or liquid vaporizing. | See piping instructions and diagrams. |
| | Bellows unit | Obstructed bellows travel. | See "Meter Body Inspection and Cleaning." |
| | | Gas trapped in high-pressure or low-pressure housing. | Remove (See "Meter Piping Diagrams"). |
| | | Loose range spring. | Tighten and adjust (See "Range Changes"). |
| | Mechanism | Movement dragging or dirty. | Adjust and clean. |
| | | Pointer dragging on scale plate. | Adjust. |

If you have any questions not answered in this chart, contact your local Meriam Representative, or the factory direct.

# MAINTENANCE

Periodic inspection and cleaning of the DPU is standard recommended practice. Recalibration, unless required because of a defective component or workmanship, is also considered a normal maintenance function.

## REMOVING THE METER BODY FROM SERVICE

1. Close the H.P. primary element shutoff valve.
2. Open bypass valve in the line between the seals (where applicable).
3. Close the low pressure primary element shutoff valve.
4. Close the high pressure meter body shutoff valve on the piping manifold.
5. Open the bypass valve on the piping manifold.
6. Close the low pressure meter body shutoff valve on the piping manifold.

## METER BODY INSPECTION AND CLEANING TOOLS

| | Tool | Purpose |
|---|---|---|
| 1. | Allen wrench, 1/8 in | To remove mounting bracket |
| 2. | Small screwdriver | Calibration adjustment |
| 3. | Medium screwdriver | Bezel (case lid) |
| 4. | Allen wrench, 5/64 in. | For Model 1123 (case lid and dial) |
| 5. | Allen wrench, 3/32 in. | Calibration adjustment |
| 6. | Allen wrench, 1/4 in. | Housing bolts |
| 7. | Soft bristle brush | To clean bellows |
| 8. | A 3-, 4-1/2-, or 6-in, dial, as applicable with the center cut out, showing only the numbers and graduations | Calibration |
| 9. | Manometer or sensitive test gauge | Calibration |

## METER BODY INSPECTION AND CLEANING

When instruments are used in services where solids or semi-solids can accumulate, the meter body housing and bellows will require periodic inspection and cleaning. This can be performed as follows:

1. Remove meter from service and remove housing bolts.
2. Carefully and slowly remove end housings. If accumulation of material is extensive, removing the housings too rapidly can damage bellows convolutions.
3. Use a solvent, if possible, to remove accumulations from between bellows convolutions and end housings. A soft bristle brush can also be used.

   CAUTION: Do not use a sharp instrument between the convolutions.

4. After cleaning, check condition of range springs and bellows.
5. Replace end housings (new gaskets are recommended). Lubricate housings bolt threads, and secure housings. Torque end housing bolts as follows:
   - 10 ft.-lbs. for 5/16" bolt (3000 PSIG & below SWP)
   - 50 ft.-lbs. for 1/2" bolt (above 3000 PSIG SWP)

## RANGE CHANGES

1. There is ample adjustment in the indicator linkage and movement for a range change of ±5% of the full range of the instrument.
2. Bellows assemblies with ranges from 0-30 in. W.C. to 0-139 in. W.C. range cannot be changed in the field. (Range springs are internal to the bellows.)
3. Bellows assemblies available in ranges from 0-140 in. W.C. to 0-60 PSID may be changed by changing only the range spring, providing the new range as confined between 0-140 in. W.C. and 0-60 PSID.
4. Bellows assemblies available in ranges from 0-61 PSID to 0-500 PSID may be changed by changing only the range spring, providing the new range as confined between 0-61 PSID and 0-500 PSID.
5. Calibration range of your DPU was carefully set at the factory; follow this procedure to maintain the original settings while changing the range spring. Zero the DPU, then remove the LP housing, range spring lock nut, and four retaining screws.
6. Unscrew the old range spring assembly and carefully thread the replacement assembly onto the bellows fitting. Occasionally pressing the range spring ring against its seat on the bellows isolation ring (see pg. 17 for part identification), thread the spring assembly to where, when the spring ring is against the bellows ring, the pointer indicates zero.
7. Rotate the spring assembly to align with screw holes in ring, add and tighten spring assembly lock nut, and replace four retaining screws.
8. Adjust pointer as necessary, and check calibration (see #4, pg. 6).

## REPLACING BELLOWS UNIT ASSEMBLY

When removing mounting bracket, **do not loosen the fill plug**, which is located in the top of the bellows unit assembly. If plug is loosened, the bellows fill fluid will be lost, and the instrument warranty will be void. To replace the bellows unit assembly:

1. Remove instrument from service.
2. Remove indicator lid, glass, pointer and scale plate.
3. Loosen drive arm screw, and slip drive arm rod off the bearing shaft.
4. Remove movement mounting screws, and lift movement assembly, drive arm, and linkage from the indicator case.
5. Remove the screws securing the case to the meter body and remove case from meter body.
6. Remove end housing bolts and the end housings.
7. Carefully unpack replacement bellows unit assembly and 0-rings. To reassemble, follow steps 1 through 6 in reverse.
8. After assembly, calibrate the instrument in accordance with the procedure outlined.

## COMPLETE CALIBRATION

Normally, to restore an instrument to factory set tolerances, only a calibration check is required per #4 page 6.

Complete calibration may be required when the differential range has been changed, or when the meter body assembly has been replaced.

If a calibration check shows an indicator to be out of tolerance or if a complete calibration is required, remove the cover glass scale plate and pointer.

For the Model 1123, remove the cover glass, pointer and scale as follows:

1. Remove exterior face lid.
2. Remove cover glass and cover glass gasket.
3. Carefully remove pointer.
4. Using a 5/64 in. Allen wrench, remove scale retaining screws and scale.

For Series 1120 and 1220 (4½" & 6" only) remove lid, pointer and scale as follows:

1. Loosen the three lid screws and remove the face lid.
2. Carefully remove the pointer.
3. Use a 3/32 in. Allen wrench to remove dial mounting screws and scale.

At this point, the movement and all calibration adjustments will be accessible.

1. Vent low-pressure connection of meter body to atmosphere by removing the pipe plug.
2. Connect standard pressure source to high-pressure connection.
3. Apply 100 percent of full-scale differential pressure to high-pressure connection and release, to exercise bellows. Repeat exercise twice.
4. Check instrument to make sure there is no excessive play in pivots, that pivots are free of dirt, and that there are no loose screws or nuts.
5. Set movement; if movement is not clean, immerse in cleaning solution. Align movement in case by projecting a line through top left and bottom right dial mounting screws (Fig. 16, points 6 and 7) and resting extreme lower edge of brass bushing in sector gear (Fig. 16, Point 5) on that imaginary line. Proper hairspring tension is obtained by disconnecting gear sector from pinion (after unfastening movement linkage arm) and unwinding the spring (counterclockwise) approximately 1 turn; engage sector to pinion and release (pinion should rest at upper spline of sector). Refasten to linkage; point 3 should be in the center of sector slot, and point 2 should be approximately .960" (for 3" and 4-1/2" indicators) or 1-3/4 (for 6" indicators) from point 1.
6. Apply 50 percent of full-scale differential pressure to the high pressure connection, with the low-pressure connection left open to atmosphere. A line drawn thru points 1 and 2A should be parallel to a line drawn thru points 3 and 4. (See Fig. 16). Alternately, a line from point 1 and 2 should be at 90° to a line from point 2 to 3. DO NOT change these angles significantly once they are set.
7. Install a calibration scale ring and set the indicating pointer at 50% of full scale.

   **NOTE:** Dials graduated for tank curve or flow (i.e., square-root scale), are furnished with dots on the dial at 20%, 50% and 80% of full-scale for calibration purposes.
8. Increase pressure to 80% of maximum differential pressure. Note if pointer is fast or slow (high or low).
9. Decrease pressure to 20%. Note if pointer is fast or slow (high or low).
10. Decrease pressure to 0. Note if pointer is fast or slow (high or low).

    **NOTE:** At all times that corrections are being made, pointer must be reset at 50% of range.
11. If fast at 80%, fast at 20% and above zero, adjust movement counterclockwise. If slow and below zero, rotate movement clockwise.
12. If fast at 80%, slow at 20% and below zero, move sector gear linkage (See Fig. 16, Point 2) out. If slow at 80%, fast at 20%, and above zero, move linkage in. Only very slight movements are required.
13. If indicator reads correctly at 20%, 50%, and 80% but above zero, apply more tension on the hairsprings, or adjust movement counterclockwise; if below zero, decrease tension or adjust clockwise. (Disconnect the linkage on Fig. 16 at Point 2, rotate the sector gear until clear of the pinion gear; then, by rotating the pinion gear slightly, increase or decrease the tension as needed, clockwise to increase and counterclockwise to decrease (See #5).
14. After calibration has been completed, remove pointer, calibration scale ring, and reassemble case parts. When replacing pointer, position it as close as possible to zero and make final adjustment with zero adjust pointer gear.

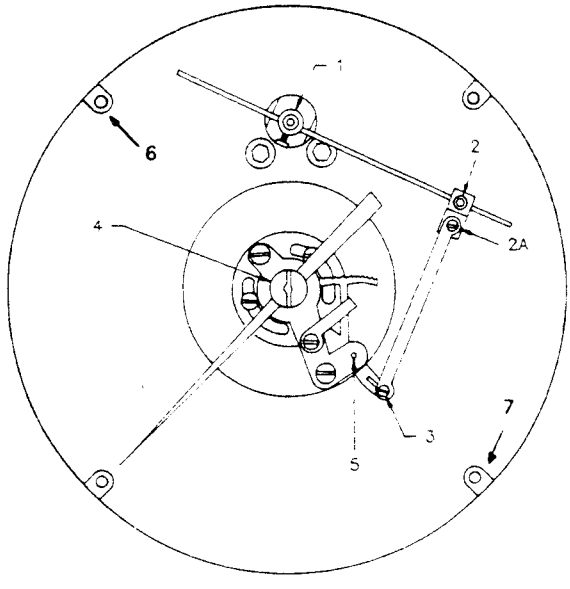



FIG. 16 INDICATOR ASSEMBLIES

# SWITCH ADJUSTMENTS

**NOTE:** Calibrate the indicator portion of Models 1224 and 1226 separately from switches and prior to adjusting switches by disconnecting Switch Linkage Arm (#42 on Parts List page 20 at Pt. #40). After adjusting switches, reconnect linkage and check calibration.

The switches used in the Meriam switch indicator are single pole double throw. Multiple Pole Double Throw is available through the use of externally-mounted relays. The set point of the individual switch is adjustable over the span of the dial from 10% increasing and 5% decreasing (or 10" W.C. and 5" W.C. respectively, whichever is greater) to 100% scale. That is, switch A or B may be set at the high or low end of the scale to open or close on increasing or decreasing rotation of the pointer.

Two circuits can be actuated at the same point under different voltage conditions by using an external relay which in turn is activated by one switch. The open – closed mode is determined by the external wiring hookup.

The set points of both switches are adjusted by removing the indicator bezel ring and lens. The switch locking screws and adjustment screws are located in the lower left hand quadrant of the dial face.

1. Unlock the switch set point location by turning the lock screws (slotted shaft) counterclockwise; only one-half turn is needed. (See Fig. 17).

2. Apply a differential pressure across the D/P unit to indicate the desired value at which the switch is to be set.

3. Rotate the "Inc." adjustment screw next to the locking screw slowly and at the same time turn the locking screw clockwise to provide a slight friction to the adjustment screw. Continue to rotate the Inc. adjustment screw slowly until the circuit responds to the "make" or "break" of the switch.

**NOTE:** "Increase" rotation direction on dial means the set point will move up scale.

Only slight turning is needed; full-scale adjustment equals 1/3 turn.

If the pointer seems to hesitate and "jump" excessively at switch activation, check whether the switch arm linkage block (#41 on page 20) is within 1/2-3/4" of the the meter body shaft, and adjust as necessary.

4. Lock switch in place by turning the locking screw clockwise while holding the adjustment screw in place. Decrease pressure to zero and then increase pressure slowly and observe "make" or "break" point. If the set point has changed from the desired set point, repeat steps 2, 3, and 4.
5. It may be necessary to repeat the adjustment procedure two or three times to obtain a set point at the exact desired point. However, a precise non-changing set point can be achieved when the locking screw is adjusted to apply slight friction to the adjustment screw.

6. Repeat steps 2, 3 and 4 for second switch.

7. Replace bezel and lens assembly and return instrument to service.

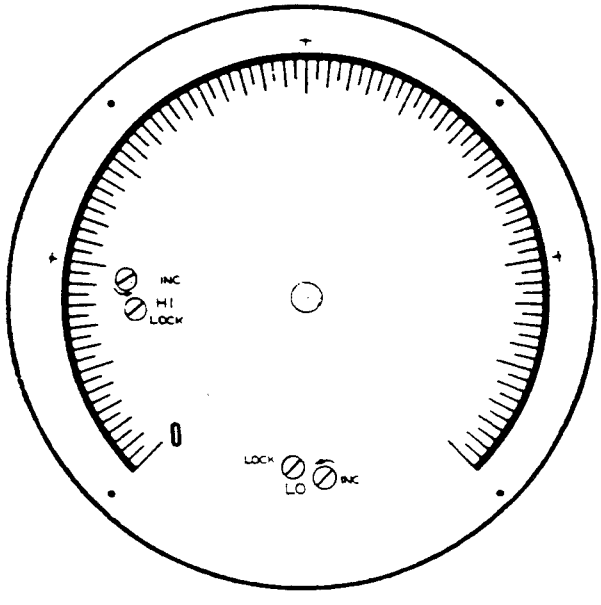



FIG. 17 SWITCH DIAL FACE

# REPLACEMENT PARTS FOR MERIAM MODEL 1020 BELLOWS DIFFERENTIAL PRESSURE UNIT

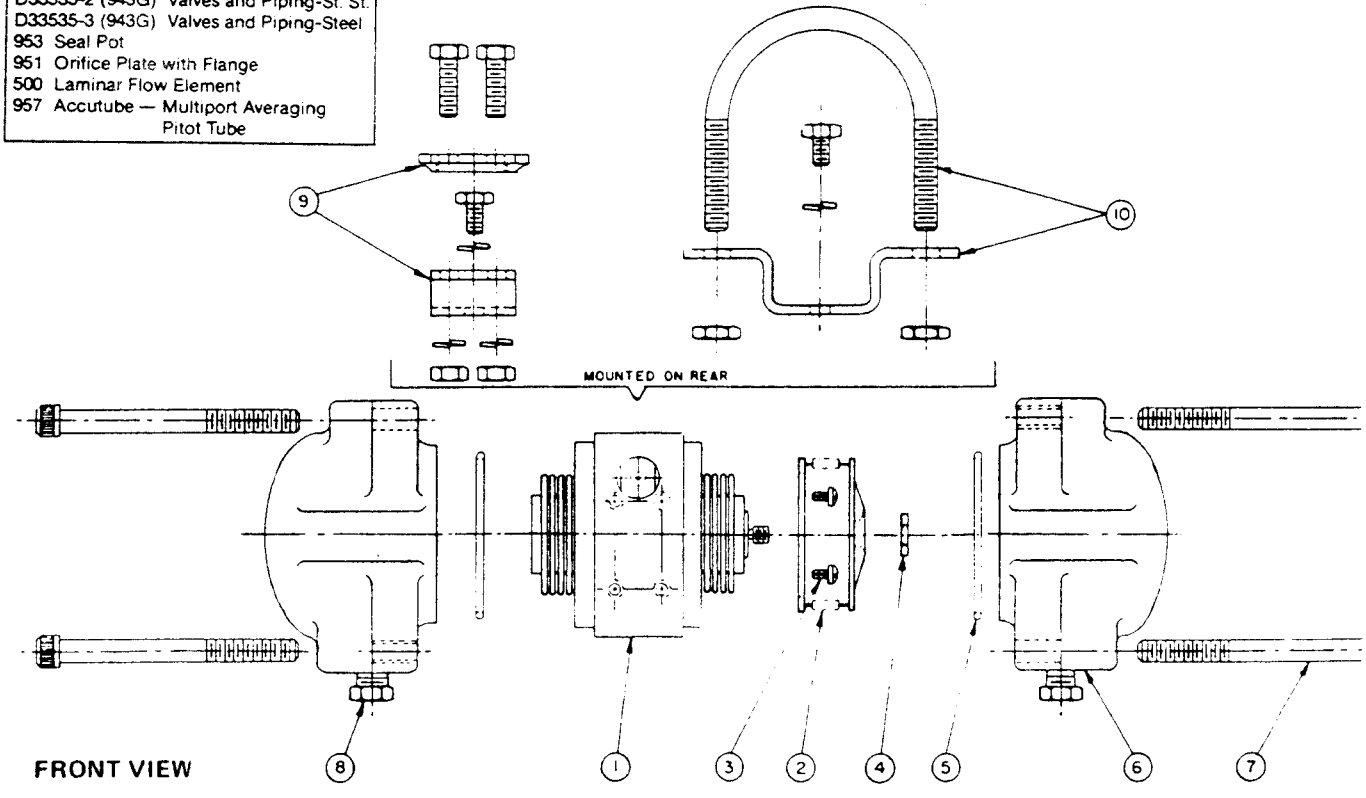
WHEN ORDERING:
SPECIFY — QTY., PART NO., D/PU SERIAL NO., RANGE, CONSTRUCTION, SWP, MOUNTING STYLE

| INDEX ITEM (1) | DESCRIPTION | QTY. REQ'D. | Brass Body PART NO. | Steel Body PART NO. | SS Body PART NO. | Monel PART NO. | NACE MR-01-75 PART NO. |
|---|---|---|---|---|---|---|---|
| 1 | Bellow Unit Assy. | 1 | CONSULT FACTORY — FILE NO. 1020:110 | | | | |
| 2 | Range Spring Assy | 1 | CONSULT FACTORY — FILE NO. 1000:413 | | | | |
| 3 | Screw Range Assy. | 4 | C80006-17 | C80006-17 | C80006-17 | C80006-119 | C80006-119 |
| 4 | Hex Nut, Range Spring | 1 | A1060-1 | A1060-2 | A1060-2 | A1060-3 | A1060-3 |
| *5 | O-Ring, Housing | 1 | | | | | |
| | Buna-N | | A50862-1 | A50862-1 | A50862-1 | A50862-1 (STD) | A50862-1 |
| | Viton | | A50862-2 (STD) | A50862-2 (STD) | A50862-2 (STD) | A50862-2 | A50862-2 |
| | Teflon | | A50862-3 | A50862-3 | A50862-3 | A50862-3 | A50862-3 |
| | Ethylene-Propylene | | A50862-4 | A50862-4 | A50862-4 | A50862-4 | A50862-4 |
| | Neoprene | | A50862-5 | A50862-5 | A50862-5 | A50862-5 | A50862-5 (STD) |
| 6 | End Housing | 2 | | | | | |
| | SWP 500BR/1000BR/ 1500/3000 STL & SS | | C-51468-4 | C-51468-1 | C-51468-2 | C-51468-3 | C-51468-2 |
| | SWP 6000 STL & SS | | | C-50645-1 | C-50645-2 | C-50645-3 | C-50645-2 |
| *7 | Bolt End Housing | | | | | | |
| | SWP 500BR/1000BR/ 1500/3000 STL & SS | 4 | A-50863-3 | A-50863-3 | A-50863-3 | A-50863-3 | A-51144-2 |
| (2) | | 8 | (A-50863-2) | (A-50863-1) | (A-50863-1) | (A-50863-1) | (A-51144-1) |
| | SWP 6000 STL & SS | 4 | | A-50710 | A-50710 | A-50710 | A-51150 |
| *8 | Plug, End Housing | | | | | | |
| | SWP 500 to 6000 | | | | | | |
| | 1/4" Hex Head | 2 | D1560-1 | D1560-2 | D1560-4 | D1560-6 | D1560-4 |
| | 1/2" Sq. Head | 2 | D5118-4 | D5118-2 | D70136-8 | D70136-17 | D70136-8 |
| 9 | Mounting Kit | 1 | | | | | |
| | Universal (STD) | | A50505 | A50505 | A50505 | A50505 | A50505 |
| 10 | Pipe Saddle | | A50506 | A50506 | A50506 | A50506 | A50506 |
| | *Not Shown* | | | | | | |
| | Tank Hardware (Ryan Bracket) | | A50550 | A50550 | A50550 | A50550 | A50550 |
| | Pipe Stand | | C50625 | C50625 | C50625 | C50625 | C50625 |

(1) Parts are listed in correct assembly sequence.
(2) Part numbers in parenthesis are for end housing bolts which bolt to center plate. These bolts changed with end housings in 1985-86.
*Recommended spare parts for two years of operation per 10 units. Combined with replacement parts for Model 1020 DPU. (See file no. 1020:460)

**SUGGESTED ACCESSORIES**

D33535-1 (943G) Valves and Piping-Brass
D33535-2 (943G) Valves and Piping-St. St.
D33535-3 (943G) Valves and Piping-Steel
953 Seal Pot
951 Orifice Plate with Flange
500 Laminar Flow Element
957 Accutube — Multiport Averaging Pitot Tube




FRONT VIEW

# REPLACEMENT PARTS FOR MERIAM 1100 SERIES

# BELLOWS D/P INDICATOR

WHEN ORDERING:
SPECIFY — QTY., PART NO., D/PI SERIAL NO., RANGE, CONSTRUCTION, SWP, MOUNTING STYLE

| INDEX ITEM (1) | DESCRIPTION | QUANTITY REQUIRED | 1123 PART NO. | 1124 PART NO. | 1126 PART NO. |
|---|---|---|---|---|---|
| 1 | Bellows D/P Unit | 1 | Refer to File No. 1020:460 | | |
| 2 | Indicator Case: | | | | |
| | Bracket Mounting | 1 | B2038-2 | C50001-1 | C50046-1 |
| | Flush Panel Mounting | 1 | B2038-2 | C50001-2 | C50046-2 |
| 3 | Case Mounting Gasket | 1 | A50085 | A50085 | A50085 |
| 4 | Case Mounting Screws | 4 | A3748-2 | C80012-160 | C80012-160 |
| 5 | Indicator Movement | 1 | B51821 | B51821 | B51820 |
| 6 | Movement Screws | 2 | C80002-8 | C80002-8 | C80002-15 |
| 7 | Drive Arm Boss | 1 | A50419 (2) | A50038 | A50038 |
| 8 | Drive Arm Boss Screw | 1 | C80014-11 | C80012-8 | C80012-8 |
| 9 | Drive Arm Rod | 1 | A50342 (2) | A50337 | A50045 |
| 10 | Drive Arm Screws | 2 | C80014-92 | C80014-92 | C80014-92 |
| 11 | Linkage Block (1126 Only) | 1 | A50037 | A50037 | A50037 |
| 12 | Movement Linkage Arm | 1 | A51823 | A51837 | A51822 |
| 13 | Linkage Arm Screws | 1 | A3304 | A3304 | A3304 |
| 14 | Shoulder Screw | 1 | A51831 | A51831 | A51830 |
| 15 | Linkage Arm Spacer | 1 | A51835 | A51835 | A51834 |
| 16 | Linkage Arm Nut | 1 | A51825 | A51825 | A51824 |
| 17 | Movement Stop | 1 | A51203 | A51203 | A50479 |
| 18 | Stop Movement Screw | 1 | C80002-13 | C80002-13 | C80002-13 |
| 19 | Aluminum Dial: | | Consult Factory File No. 1100:461 | | |
| | Standard or Special Furnish Full Description ..... | | | | |
| 20 | Rubber Bumper | 1 | A51146 | A51146 | A51146 |
| *21 | Dial Mounting Screws | 4 | C80012-1 | C80012-161 | C80012-161 |
| *22 | Aluminum Pointer (STD) | 1 | A50450-3 | A50450-4 | A50450-6 |
| | Optional | | | | |
| | Red Set Assy (Incl. Window) | 1 | A51798 | A51802 | A51801 |
| | Micrometer Adjustable | 1 | N/A | A51180-4 | A51180-6 |
| 23 | Window Gasket | 1 | A3094 | A3676-1 | A51315 |
| *24 | Plexiglass Window | 1 | A50019 | A3227 | A50671 |
| 25 | Screw for FF Mounting | 4 | N/A | C80012-40 | C80012-162 |
| 26 | Case Cover Bezel | 1 | A3154-2 | B2042-2 | B50038 |
| *27 | Cover Screw | 3 | C80000-4 | C80021-8 | C80021-3 |

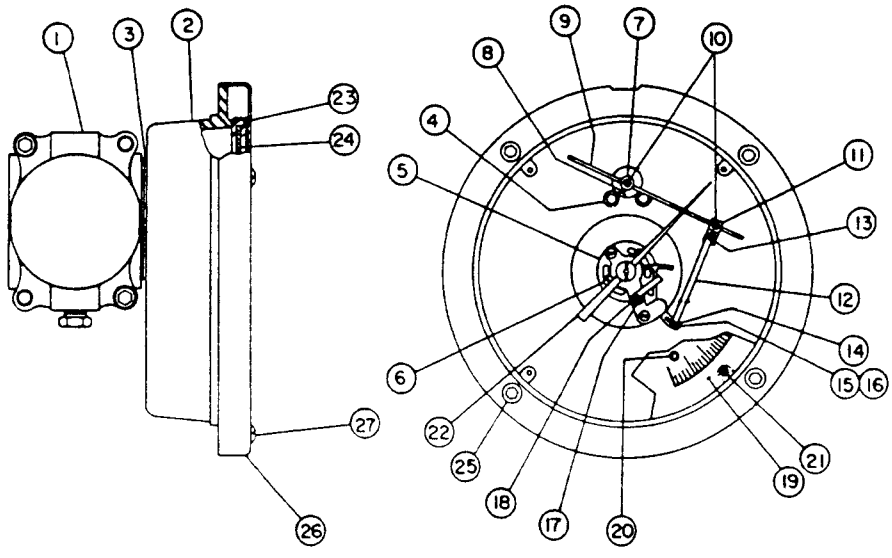
(1) Parts are listed in correct assembly sequence

(2) Drive Arm Rod and Drive Arm Boss are sold as a single assembly, P/N A50793

* Recommended spare parts for two years operation per ten units combined with replacement parts for Model 1020 DPU. (File No. 1020:460)

**SUGGESTED ACCESSORIES**

B33535-1 (943G) Valves & Piping—Brass
B33535-2 (943G) Valves & Piping—Stainless Steel
B33535-3 (943G) Valves & Piping—Steel
953 ..... Seal Pot
951 ..... Orifice Plate with Flanges
500 ..... Laminar Flow Element
957 ..... Accutube Multiport Averaging Pitot Tube



# REPLACEMENT PARTS FOR MERIAM 1200 SERIES
# BELLOWS D/P INDICATING SWITCH

WHEN ORDERING:
SPECIFY — QTY., PART NO., D/PI SERIAL NO., RANGE, CONSTRUCTION, SWP, MOUNTING STYLE, RATINGS

| INDEX ITEM (1) | DESCRIPTION | QTY. REQ. (2) | 1224 PART NO. | 1226 PART NO. | 1226 CSA |
|---|---|---|---|---|---|
| 1 | BELLOWS D/P UNIT | 1 | REFER TO FILE NO. 1020:460 | | |
| 2 | INDICATOR SWITCH CASE | | | | |
| | a. BRACKET MOUNTING | 1 | C50057-1 | C50050-1 | C50050-3 |
| | b. FLUSH PANEL MOUNTING | 1 | C50057-2 | C50050-2 | C50050-4 |
| 3 | CASE MOUNTING GASKET | 1 | A50085 | A50085 | A50058 |
| 4 | CASE MOUNTING SCREWS | 4 | C80012-160 | C80012-160 | C80012-160 |
| 5 | BOX SPACER | 1 | A51330-1 | A51330-1 | A51330-1 |
| 6 | SWITCH ASSEMBLY | | | | |
| | a. SINGLE SWITCH - STANDARD | 1 | B50079-2 | B50079-2 | N/A |
| | b. SINGLE SWITCH CSA APPROVED | 1 | N/A | N/A | B50079-3 |
| | c. DOUBLE SWITCH - STANDARD | 1 | B50080-2 | B50080-2 | N/A |
| | d. DOUBLE SWITCH - CSA APPROVED | 1 | N/A | N/A | B50080-3 |
| | PARTS INCLUDED IN ABOVE SWITCH ASSEMBLIES: | | | | |
| | 7. SWITCH SUB-PLATE | 1 | A3541-2 | A3541-2 | A3541-2 |
| | 8. POST, ADJUSTABLE SWITCH PLATE AND CAM ASSEMBLY | 1 | A3610 | A3610 | A3610 |
| | 9. 1/4" LOCK WASHER | 1 | C80022-1 | C80022-1 | C80022-1 |
| | 10. ADJUSTABLE SWITCH PLATE | 1 or 2 | A3542-1 | A3542-1 | A3542-1 |
| | 11. MICROSWITCH MOUNTING POST | 2 or 4 | A3176 | A3176 | A3176 |
| | 12. MICROSWITCH POST SPACER | 1 or 2 | A3692 | A3692 | A3692 |
| | 13. INSULATING BARRIER (CSA UNITS ONLY) | 1 or 2 | N/A | N/A | A50508 |
| | 14. MICRO SWITCH | 1 or 2 | A3758 | A3758 | A3758 |
| | 15. SWITCH HOLDER PLATE | 1 or 2 | A3167 | A3167 | A3167 |
| | 16. SWITCH HOLDER NUT | 2 or 4 | C80019-1 | C80019-1 | C80019-1 |
| | 17. ROLLER ARM ASSEMBLY | | | | |
| | a. R.H., LOW SET, SINGLE SWITCH | 1 | A50256 | A50256 | A50256 |
| | b. L.H., HIGH SET, #2 SWITCH | OPT | A50314 | A50314 | A50314 |
| | 18. RETAINING RING - ADJ. SWITCH PLATE & ADJ. SCREW | 2 or 3 | A50229 | A50229 | A50229 |
| | 19. SWITCH PLATE LOCK SCREW | | | | |
| | a. STANDARD | 1 or 2 | A3547-1 | A3547-1 | N/A |
| | b. CSA APPROVED | 1 or 2 | N/A | N/A | A3547-2 |
| | 20. THREADED BRAD | 1 or 2 | A3727 | A3727 | A3727 |
| | 21. SWITCH ADJUSTMENT SCREW | 1 or 2 | A3735 | A3735 | A3735 |
| | 22. ADJUSTMENT SCREW SPACER | 1 or 2 | A3736 | A3736 | A3736 |
| | 23. ADJUSTMENT SCREW TENSION SPRING | 1 or 2 | A3576 | A3576 | A3576 |
| | 24. SWITCH SUB-PLATE MOUNTING SCREW | 3 | C80000-152 | C80000-147 | C80000-147 |
| | 25. SWITCH SUB-PLATE SPACER | 3 | C80020-12 | A50042 | A50042 |
| | 26. CAM ASSEMBLY | 1 | A50200 | A50200 | A50200 |
| | 27. CAM SCREW | 1 | A80002-1 | C80002-1 | C80002-1 |
| 28 | WIRING CABLE - INDICATE LENGTH IN FEET | | | | |
| | a. STANDARD, SHEATHED, SINGLE SWITCH | 1 | B50078-1 | B50078-1 | N/A |
| | b. STANDARD, SHEATHED, DOUBLE SWITCH | 1 | B50079-3 | B50078-3 | N/A |
| | c. SEPARATE LEADS, CSA APPROVED | | | | |
| | 1. RED LEAD | 1 | N/A | A51043-1 | A51043-1 |
| | 2. ORANGE LEAD | 1 | N/A | A51043-2 | A51043-2 |
| | 3. BLUE LEAD | 1 | N/A | A51043-3 | A51043-3 |
| | d. SEPARATE LEADS, CSA APPROVED, #2 SWITCH | | | | |
| | 1. BROWN LEAD | 1 | N/A | N/A | A51043-4 |
| | 2. YELLOW LEAD | 1 | N/A | N/A | A51043-5 |
| | 3. VIOLET LEAD | 1 | N/A | N/A | A51043-6 |
| 29 | RING TONGUE TERMINAL ASSEMBLY | 1 | N/A | N/A | A51195 |
| 30 | RING TONGUE SCREW | 1 | N/A | N/A | C80002-27 |
| 31 | WASHER | 1 | N/A | N/A | C80023-5 |
| 32 | HEAT SHRINK TUBING | 1 | N/A | N/A | B900544-105AJO |
| 33 | CABLE CLAMP | 1 | N/A | A50515 | A50515 |
| 34 | CLAMP SCREW | 1 | N/A | C80002-24 | C80002-24 |
| 35 | MOVEMENT | 1 | B51821 | B51820 | B51820 |
| 36 | MOVEMENT SCREWS | 2 | C80002-8 | C80002-15 | C80002-15 |
| 37 | DRIVE ARM ROD | 1 | A50337 | A50045 | A50045 |
| 38 | DRIVE ARM BOSS | 1 | A50038 | A50038 | A50038 |
| 39 | DRIVE ARM SCREW - BOSS | 1 | C80012-8 | C80012-8 | C80012-8 |
| 40 | DRIVE ARM SCREW | 3 | C80014-92 | C80014-92 | C80014-92 |
| 41 | LINKAGE BLOCK | 2 | A50037 | A50037 | A50037 |
| 42 | ADJUSTABLE SWITCH LINKAGE ARM | 1 | B50878-1 | B50878-5 | B50878-5 |
| 43 | MOVEMENT LINKAGE ARM | 1 | A51837 | A51822 | A51822 |
| 44 | LINKAGE ARM SCREW | 2 | A3304 | A3304 | A3304 |
| 45 | SHOULDER SCREW | 1 | A51831 | A51830 | A51830 |
| 46 | LINKAGE ARM SPACER | 1 | A51835 | A51834 | A51834 |
| 47 | LINKAGE ARM NUT | 1 | A51825 | A51824 | A51824 |
| 48 | MOVEMENT STOP | 1 | A51203 | A50479 | A50479 |
| 49 | MOVEMENT STOP SCREW | 1 | C80002-13 | C80002-13 | C80002-13 |
| 50 | ALUMINUM DIAL - FURNISH FULL DESCRIPTION | 1 | | | |
| | a. STANDARD - INDICATE SINGLE OR DOUBLE SWITCH | | CONSULT FACTORY - FILE NO. 1100:461 | | |
| | b. SPECIAL | | CONSULT FACTORY - FILE NO. 1100:110S | | |

*(See next page for "Footnotes" and "Suggested Accessories".)*

| INDEX ITEM (1) | DESCRIPTION | QTY. REQ (2) | 1224 PART NO. | 1226 PART NO. | 1226 CSA |
|---|---|---|---|---|---|
| 51 | DIAL MOUNTING SCREWS | 4 | C80012-161 | C80012-161 | C80012-161 |
| 52 | RUBBER BUMPER | 1 | A51146 | A51146 | A51146 |
| 53 | POINTER - STANDARD | 1 | A50450-4 | A50450-6 | A50450-6 |
| 53 | MICROMETER ADJUSTABLE POINTER (OPTIONAL) | 1 | A51180-4 | A51180-6 | A51180-6 |
| 53 | RED SET POINTER (OPTIONAL AND IN ADDITION TO STD. OR MICRO) | 1 | A51802 | A51801 | A51801 |
| 54 | WINDOW GASKET | 1 | A3676-1 | A51615 | A51615 |
| 55 | WINDOW | | | | |
| | a. PLEXIGLAS - STANDARD | 1 | A3227 | A50671 | A50671 |
| | b. SHATTERPROOF GLASS - OPTIONAL | 1 | A51920 | A50672 | A50672 |
| 56 | SCREWS FOR FLUSH FRONT MOUNTING | 4 | C80012-40 | C80012-162 | C80012-162 |
| 57 | CASE COVER (BEZEL) | | | | |
| | a. BLACK (CARBON STEEL) | 1 | B2042-2 | B50038 | B50038 |
| | b. 304 STAINLESS STEEL (OPTIONAL) | 1 | N/A | B51635 | B51635 |
| 58 | WIRING COLOR CODE TAG | | | | |
| | a. SINGLE SWITCH | 1 | A50173-1 | A50173-1 | A50173-1 |
| | b. DUAL SWITCH - SINGLE SWITCH TAG PLUS: | 1 | A50173-2 | A50173-2 | N/A |
| | c. DUAL SWITCH CSA - INGLE SWITCH TAG PLUS: | 1 | N/A | N/A | A50173-3 |
| 59 | COVER SCREWS | | | | |
| | a. STANDARD | 3 | C80021-8 | C80021-3 | C80021-3 |
| | b. STAINLESS STEEL (USED WITH SS BEZEL | 3 | N/A | C80021-7 | C80021-7 |

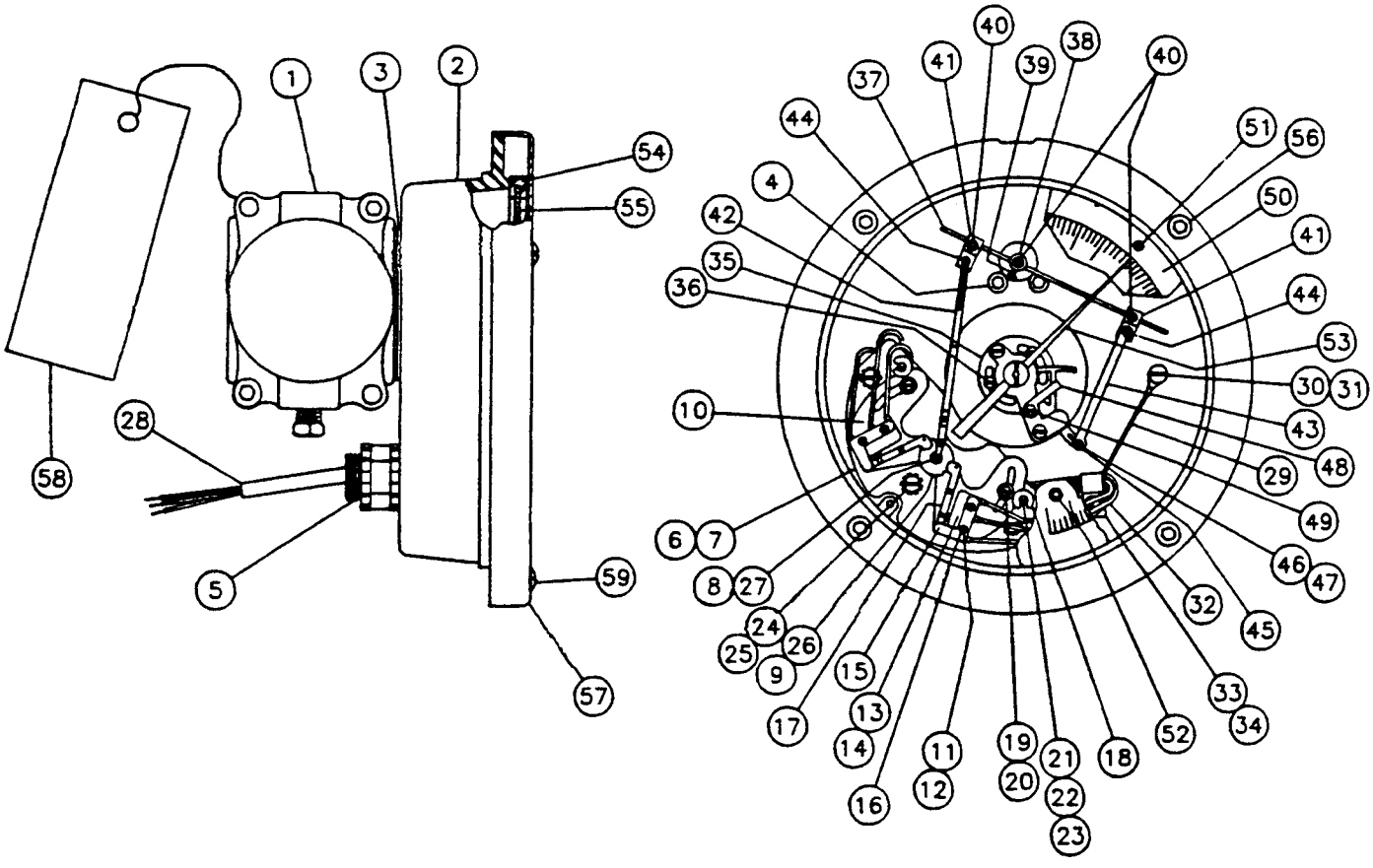
(1) PARTS ARE LISTED IN THEIR CORRECT ASSEMBLY SEQUENCE

(2) WHERE TWO QUANTITIES ARE LISTED, THE LESSER QUANTITY TO SINGLE SWITCH UNITS AND THE GREATER QUANTITY TO DUAL SWITCH UNITS.

*RECOMMENDED SPARE PARTS FOR TWO YEARS OF OPERATION (PER 10 UNITS). COMBINE WITH REPLACEMENT PARTS FOR MODEL 1020 DPU. (SEE FILE NO. 1020:460)

SUGGESTED ACCESSORIES

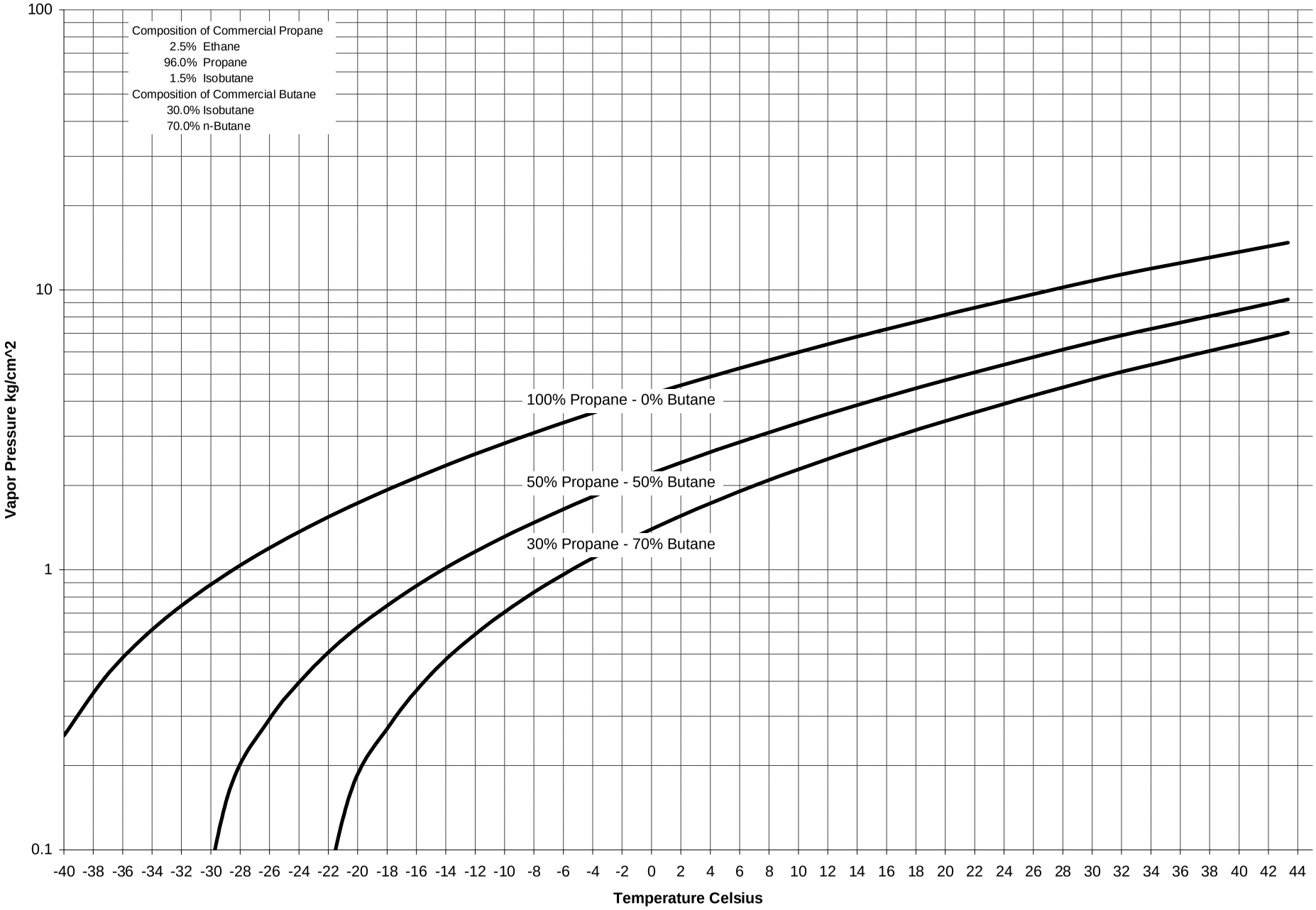
| | |
|---|---|
| B33535-1 | (943G) VALVES&PIPING - BRASS |
| B33535-2 | (943G) VALVES&PIPING - ST STEEL |
| B33535-3 | (943G) VALVES&PIPING - STEEL |
| 953 | SEAL POT |
| 951 | ORIFICE PLATE WITH FLANGE |
| 500 | LAMINAR FLOW ELEMENT |
| 957 | ACCUTUBE -MULTIPORT AVERAGING PITOT TUBE |



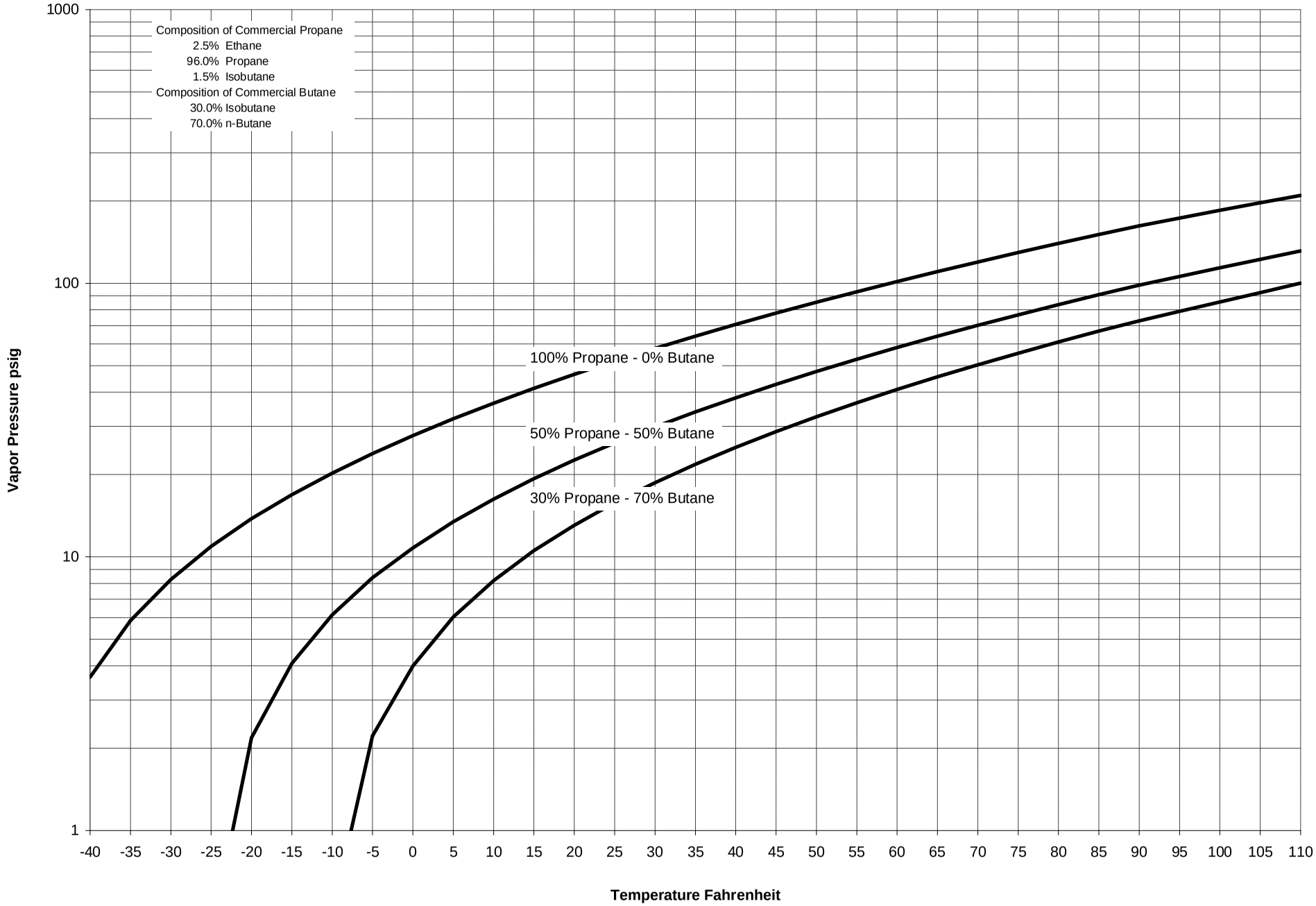
# *APPENDIX B*

# *Technical Information*

# Vapor Pressures of Commercial Butane - Propane Mixtures



# Vapor Pressures of Commercial Butane - Propane Mixtures



Algas-SDI™

ISO 9001 Certified

*...Innovative liquid vaporizing and gas mixing solutions*

# WARRANTY REGISTRATION

*Please copy the information from the data sheet supplied with your manual.*

Type of Equipment: _____ Serial Number: _____

ASDI Sales Order #: _____ Order Date: _____

Purchased By: _____

_____

_____

To help us provide better service to you, please fill out this warranty registration form and retur n it to us. Keep a copy for your records.

This will register your recent purchase and aide us in tracking the performance of your equipment. Please help us with a small amount of information about your company and about how you are using the equipment. Contact us via phone, fax, or email if you have a question, problem, or concern about your equipment. Please have the type of equipment and serial number available so we can give you accurate information.

End Customer/Company Name: _____

Address: _____ Tel: _____

City: _____ State: _____ Zip: _____ Fax: _____

Name of individual to contact for follow up information: _____

When was the equipment put in service?_____/_____/_____

| | | | | |
|---|---|---|---|---|
| **Usage - Circle one:** | Base Load | Standby System | | |
| | Peak Shaving | Other please specify: _____ | | |
| **Application - Circle one:** | **Agriculture:** | Poultry | Livestock | Grain drying |
| | **Commercial:** | Restaurant | Hospital | School |
| | **Industrial** : | Construction | Automotive | Glass/ceramics |
| | **Other:** | Please specify: _____ | | |

Note: If you have more than one piece of our equipment, fill out one warranty sheet and staple the others to it, we'll do the rest.

1140 NW 46 Street
Se at tle Wash ing ton 98107 USA
Tel: 206.789.5410
Fax: 206.789.5414
email: sales@algas-sdi.com
Internet: www.algas-sdi.com

***Algas-SDI International, LLC***
***1140 NW 46th Street***
***Seattle, Washington 98107***
***USA***

***Ph.: 1.206.789.5410***
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