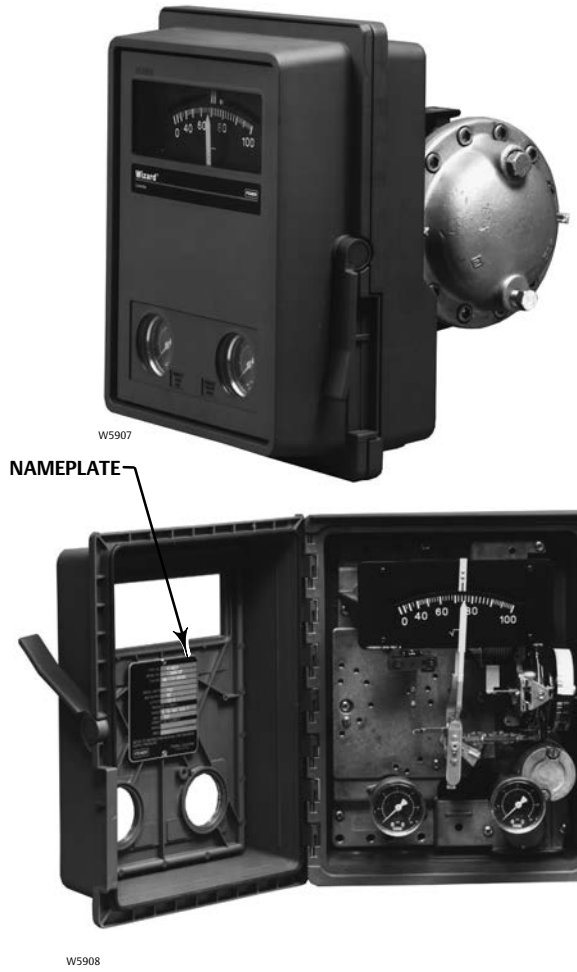
Fisher™ 4194HS Differential Pressure Indicating Controllers

Contents

Figure 1. Fisher 4194HS Differential Pressure Controller



Contents (continued)

Introduction

Scope of Manual

This instruction manual provides installation, operating, calibration, maintenance, and parts ordering information for the 4194HS (high static pressure) differential pressure indicating controllers.

The type number of the controller is on the nameplate. Refer to figure 1 for the location of the nameplate.

Configurations of the controller are indicated by letter suffixes in the type number that correspond to the mode and option designated in table 1. Refer to table 1 for definition of each 4194HS type number.

Description

The controllers described in this manual provide differential gap control with options as shown in table 1. The controller shows process differential pressure and set point on an easy-to-read process scale. The controller output is a pneumatic signal that operates a final control element.

Table 1. Available Configurations

Controller[1]	Internal Auto/Manual Station (Suffix Letter E)	Remote Set Point (Suffix Letter M)
4194HS		
4194HSE	X	
4194HSM		X
4194HSME	X	X

1. Reverse-acting constructions are designated by an R suffix in the type number.

Table 2. Specifications

Available Configurations

See table 1

Input Signal (Sensing Element Range)

Lower and Upper Range Limits: See tables 3 and 4

Maximum Allowable Operating Limits: See tables 3 and 4

Output Signal

Differential Gap Range: 0 and 1.4 bar (0 and 20 psig) or 0 and 2.4 bar (0 and 35 psig)
Action: Field-reversible between direct (increasing differential pressure increases output pressure) or reverse (increasing differential pressure decreases output pressure)

Process Scale

Standard scale is matched to the range of the sensing element. Optional scales available(1).

Process Connections

Standard: 1/4 NPT internal stainless steel (all input ranges)

Optional: 1/2 NPT internal stainless steel

Supply and Output Connections

1/4 NPT internal

Supply Pressure Requirements(2)

See table 4

Supply Pressure Medium

Air or Natural Gas

Supply medium must be clean, dry and non-corrosive

Per ISA Standard 7.0.01
A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized.

Per ISO 8573-1
Maximum particle density size: Class 7
Oil content: Class 3
Pressure Dew Point: Class 3 or at least 10°C less than the lowest ambient temperature expected

Remote Set Point Pressure Ranges(2)

0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.0 bar (6 to 30 psig)

Controller Adjustments

Differential Gap Control: 1 to 100% of process scale range
Set Point: Continuously adjustable from 0 to 100% of the scale range

Steady-State Air Consumption(3)(4)

0 to 1.4 Bar (0 to 20 Psig) Output:
0.08 normal m^3/h (2.8 scfh)
0 to 2.4 Bar (0 to 35 Psig) Output:
0.07 normal m^3/h (2.5 scfh)

Operative Ambient Temperature Limits(2)(5)

-40 to 70°C (-40 to 160°F)

Housing

Designed to NEMA 3 (weatherproof) and IEC 529 IP54 specifications

Hazardous Area Classification

Complies with the requirements of ATEX Group II Category 2 Gas and Dust

CE Ex II 2 G D — Ex h IIC Tx Gb
Ex h IIIC Tx Db

Maximum surface temperature (Tx) depends on operating conditions

Gas: T6
Dust: T70

– Continued –

Table 2. Specifications (continued)

Mounting

Controller is mounted on a pipestand. See figure 2.

Approximate Weight

Controller: 4.5 kg (10 lb) without the differential pressure unit

Differential Pressure Unit: 21.5 kg (47 lb)

Total Weight: 26 kg (57 lb) controller with a Barton® 199 differential pressure unit.

Declaration of SEP

Fisher Controls International LLC declares this product to be in compliance with Article 4 paragraph 3 of the PED Directive 2014/68/EU. It was designed and manufactured in accordance with Sound Engineering Practice (SEP) and cannot bear the CE marking related to PED compliance.

However, the product *may* bear the CE marking to indicate compliance with *other* applicable European Community Directives.

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 - Process Instrument Terminology.
1. Consult your Emerson sales office for additional information.
2. The pressure/temperature limits in this document, and any applicable standard or code limitation should not be exceeded.
3. With Barton 199 differential pressure unit.
4. Normal m^3/hr: normal cubic meters per hour (m^3/hr, 0°C and 1.01.325 bar). Scfh: standard cubic feet per hour (ft^3/hr, 60°F and 14.7 psia).
5. Also for transportation and storage limits.

Table 3. Process Sensor (Barton 199 Differential Pressure Unit) Range and Pressure Ratings

DIFFERENTIAL PRESSURE RANGE(1,2)		SAFE WORKING PRESSURE(3)		HOUSING MATERIAL(2)
		Bar	Psig	
Psig (bar)	0 to 15 (0 to 1) 0 to 30 (0 to 2) 0 to 40 (0 to 2.8) 0 to 50 (0 to 3.4) 0 to 60 (0 to 4) 0 to 75 (0 to 5)	68.9	1000	Stainless steel
	0 to 15 (0 to 1) 0 to 30 (0 to 2) 0 to 40 (0 to 2.8) 0 to 50 (0 to 3.4) 0 to 60 (0 to 4) 0 to 75 (0 to 5)	172	2500	Steel
	0 to 15 (0 to 1) 0 to 30 (0 to 2) 0 to 40 (0 to 2.8) 0 to 50 (0 to 3.4) 0 to 60 (0 to 4) 0 to 75 (0 to 5)	414	6000	Steel
Inches w.c. (mbar)	0 to 20 (0 to 50) 0 to 25 (0 to 62) 0 to 50 (0 to 124) 0 to 75 (0 to 186) 0 to 100 (0 to 248)	68.9	1000	Stainless steel
	0 to 20 (0 to 50) 0 to 25 (0 to 62) 0 to 50 (0 to 124) 0 to 75 (0 to 186) 0 to 100 (0 to 248)	172	2500	Steel
	0 to 20 (0 to 50) 0 to 25 (0 to 62) 0 to 50 (0 to 124) 0 to 75 (0 to 186) 0 to 100 (0 to 248)	414	6000	Steel

1. Differential pressure ranges are in English units of measurement; metric equivalents are shown here for reference only. Consult your Emerson sales office for special differential pressure ranges.
2. For other ranges and materials, contact your Emerson sales office.
3. The Barton 199 differential pressure unit may be pressured to this value (after reaching the travel stop at the upper range limit) without permanent zero shift or structural damage to controller components.

Table 4. Supply Pressure Data

Output Signal Range		Normal Operating Supply Pressure(1)	Maximum Pressure Limit(2)
bar	0 & 1.4	1.4	3.4
	0 & 2.4	2.4	3.4
psig	0 & 20	20	50
	0 & 35	35	50

1. If this pressure is exceeded, control stability may be impaired.
2. If this pressure is exceeded, damage to the controller may result.

Do not install, operate, or maintain a 4194HS differential pressure indicating controller without being fully trained and qualified in valve, actuator and accessory installation, operation and maintenance. To avoid personal injury or property damage it is important to carefully read, understand, and follow all of the contents of this manual, including all safety cautions and warnings. If you have any questions about these instructions, contact your Emerson sales office before proceeding.

Specifications

Specifications for the 4194HS controllers are listed in table 2.

⚠ WARNING

This product is intended for a specific range of pressure, temperatures and other application specifications. Applying different pressure, temperature and other service conditions could result in malfunction of the product, property damage or personal injury.

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Installation, Mounting, and Connections

⚠ WARNING

To avoid personal injury or property damage from sudden release of process pressure:

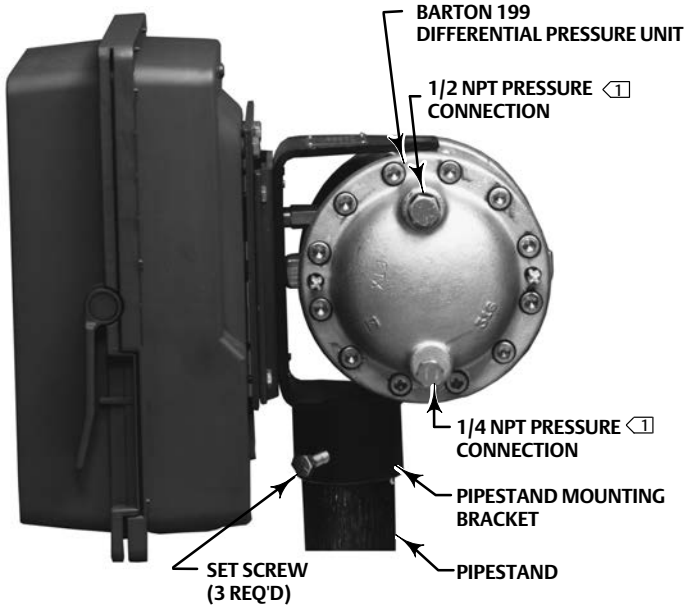
- **Always wear protective clothing, gloves, and eyewear when performing any installation operations to avoid personal injury.**
- **Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and preventative measures are not taken. Preventative measures may include, but are not limited to, one or more of the following: Remote venting of the unit, re-evaluating the hazardous area classification, ensuring adequate ventilation, and the removal of any ignition sources. For information on remote venting of this controller, refer to page 8.**

- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**
- **If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.**

Pipestand Mounting

A 4194HS controller mounts on a pipestand and must be installed with the vent opening facing down. The coupling is secured to the pipestand by three set screws as shown in figure 2.

Figure 2. Right Side View of Controller



NOTE:
1 LOW PRESSURE CONNECTION ON A BARTON 199 DIFFERENTIAL PRESSURE UNIT.
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Pressure Connections

⚠ WARNING

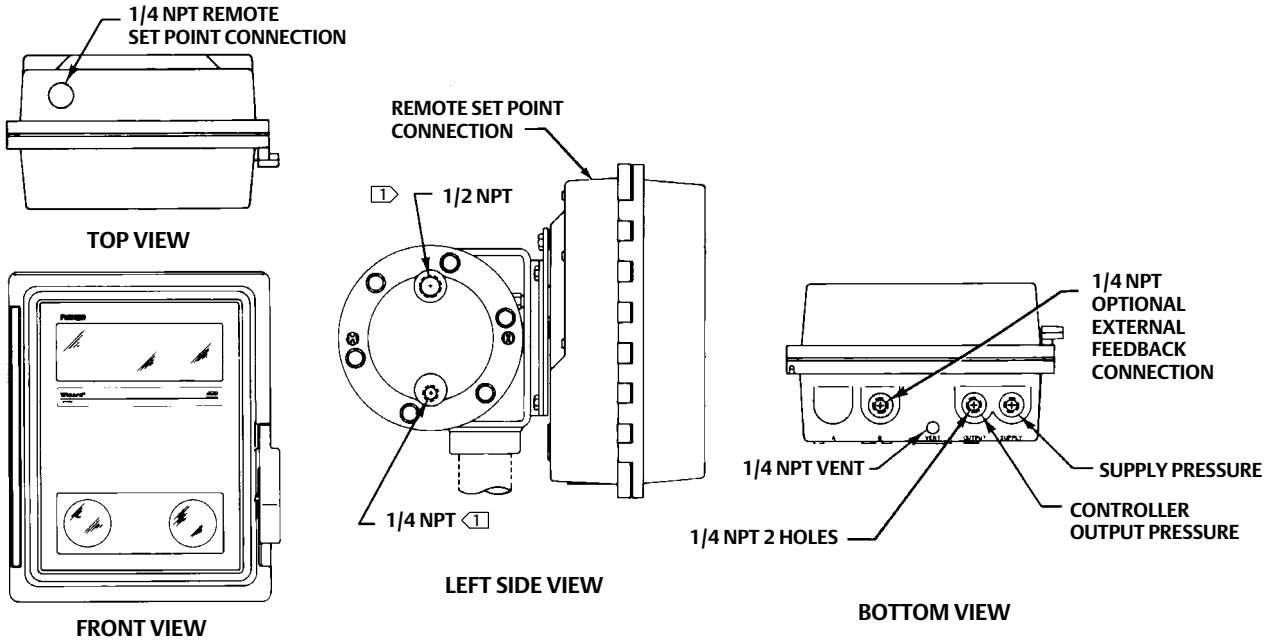
To avoid personal injury or property damage resulting from the sudden release of pressure, do not install any system component, including the differential pressure unit, where service conditions could exceed the limits given in this manual or on the appropriate nameplates. Use pressure-relieving devices as required by government or accepted industry codes and good engineering practices.

NOTICE

Do not use sealing tape on pneumatic connections. This instrument contains small passages that may become obstructed by detached sealing tape. Thread sealant paste should be used to seal and lubricate pneumatic threaded connections.

Refer to figures 2 and 3 for the location of all input and output connections for the controller and differential pressure unit. Also, refer to the differential pressure unit instruction manual for specific information about connections and piping.

Figure 3. Connections



NOTE:
1 HIGH PRESSURE CONNECTION ON A BARTON 199 DIFFERENTIAL PRESSURE UNIT

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Supply, output, vent, and remote set point connections are 1/4 NPT. Use 1/4- or 3/8-inch pipe or tubing for supply, output, vent, and remote set point piping.

Process pressure connections are 1/4 or 1/2 NPT (optional). When installing process piping from the differential pressure sensing unit in the process pipeline to the differential pressure unit attached to the controller, follow accepted engineering, installation, and safety practices to insure the safe and accurate transmission of the process differential pressure to the differential pressure unit. Install shutoff valves, vents, drains, or seal systems as required by accepted practices.

Process Pressure Connections

Process pressures are piped to the connections on the ends of the differential pressure unit (figure 4).

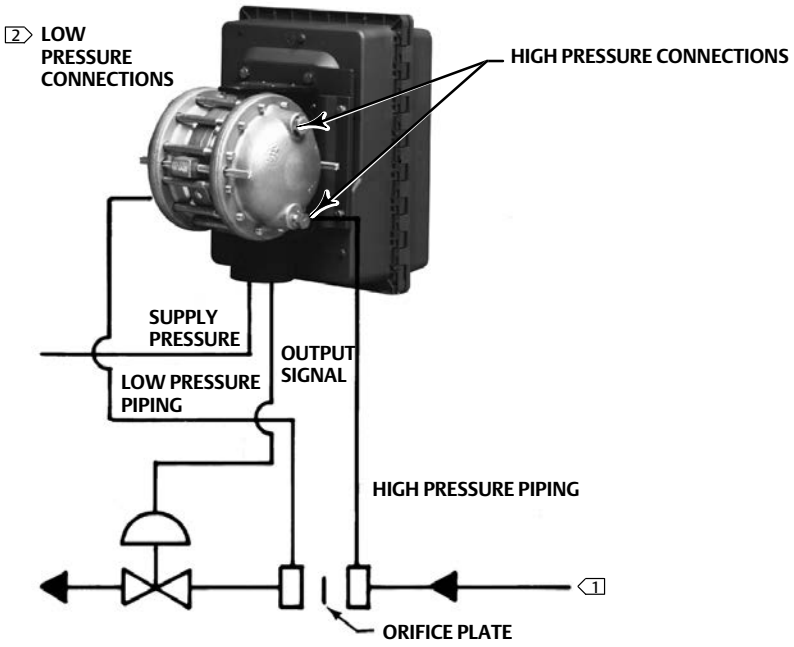
Refer to the differential pressure unit instruction manual for the high and low pressure connections.

When installing process piping, follow accepted practices to ensure accurate transmission of the process pressures to the differential pressure unit.

Install a three-valve bypass, shutoff valves, vents, drains, or seal systems as needed in the process pressure lines.

If the instrument is located such that the adjacent process pressure lines will be approximately horizontal, the lines should slope downward to the instrument for liquid-filled lines and upward toward the instrument for gas-filled lines. This will minimize the possibility of air becoming trapped in the sensor with liquid-filled lines or of condensate becoming trapped with gas-filled lines. The recommended slope is 83 millimeters per meter (1 inch per foot).

Figure 4. Simplified Control Loop Diagram



NOTE:
1 TO ALLOW A REAR VIEW OF THE CONTROLLER/ DIFFERENTIAL PRESSURE UNIT, THE SCHEMATIC SHOWS PROCESS FLOW FROM RIGHT TO LEFT.
2 SEE FIGURE 2 FOR LOW PRESSURE CONNECTIONS.

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Vent Connection

⚠ WARNING

If a flammable gas is to be used as the supply pressure medium and the controller is in an enclosed area, personal injury or property damage could result from fire or explosion of accumulated gas. The controller assembly does not form a gas-tight seal and a remote vent line is recommended. However, a remote vent line cannot be relied upon to remove all hazardous gas. Leaks may still occur. Provide adequate ventilation and necessary safety measures. Vent line piping should comply with local and regional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.

NOTICE

When installing a remote vent pipe, take care not to over-tighten the pipe fitting in the vent connection. Excessive torque will damage the threads in the connection.

If a remote vent is required, the vent line must be as short as possible with a minimum number of bends and elbows. Vent line piping should have a minimum inside diameter of 19 mm (3/4 inches) for runs up to 6.1 m (20 feet) and a minimum inside diameter of 25 mm (1 inch) for runs from 6.1 to 30.5 m (20 to 100 feet).

If a remote vent is not required, the vent opening (figure 3) must be protected against the entrance of any foreign material that could plug it. Check the vent periodically to be certain it is not plugged.

Supply Pressure

⚠ WARNING

Personal injury or property damage may occur from an uncontrolled process if the supply medium is not clean, dry, oil-free air or a non-corrosive gas. While use and regular maintenance of a filter that removes particles larger than 40 micrometers in diameter will suffice in most applications, check with a Emerson field office and industry instrument air quality standards for use with corrosive gas or if you are unsure about the proper amount or method of air filtration or filter maintenance.

Supply pressure medium must be clean, dry, and noncorrosive and meet the requirements of ISA Standard 7.0.01 or ISO 8573-1. A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the supply medium should be minimized.

Use a suitable supply pressure regulator to reduce the supply pressure source to 1.4 bar (20 psig) for an output signal range of 0 and 1.4 bar (0 and 20 psig) and to 2.4 bar (35 psig) for an output signal range of 0 and 2.4 bar (0 and 35 psig).

Remote Set Point (suffix letter M) Connection

If the controller has the remote set point option, connect the remote set point pressure to the top of the controller case at the location shown in figure 3. Use clean, dry air or noncorrosive gas. If pressure is supplied to the remote set point connection with a regulator, a small bleed orifice should be placed between the regulator and remote set point connection to prevent pressure variations due to regulator lock-up.

Controller Operation

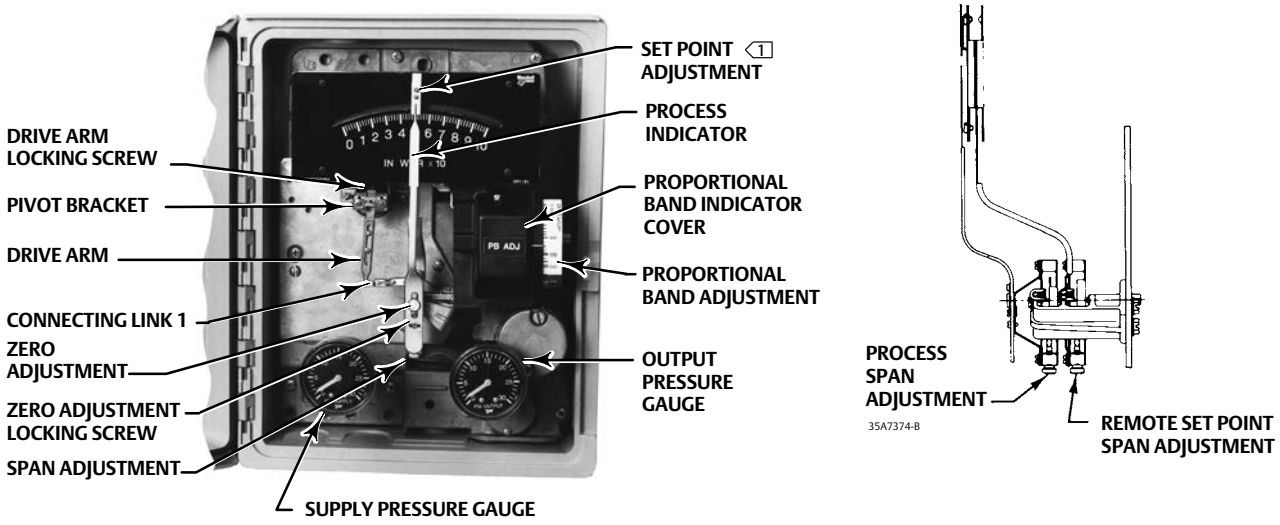
Note

Some of the following procedures require that the proportional band knob be adjusted to between DIRECT and REVERSE. If this is done, it will be necessary to set the proportional band knob to 400 (direct or reverse action) before replacing the proportional band indicator cover.

This section includes descriptions of adjustments and procedures for prestartup and startup. Location of adjustments is shown in figures 5 and 6.

To better understand the adjustments and overall operation of the controller, refer to the Principle of Operation section which appears later in this manual. Also, refer to the schematic diagrams, figures 8 and 9.

Figure 5. Location of Controller Parts and Adjustments



NOTE:
1 ON CONTROLLERS EQUIPPED WITH REMOTE SET POINT OPTION, THIS IS THE REMOTE SET POINT INDICATOR.

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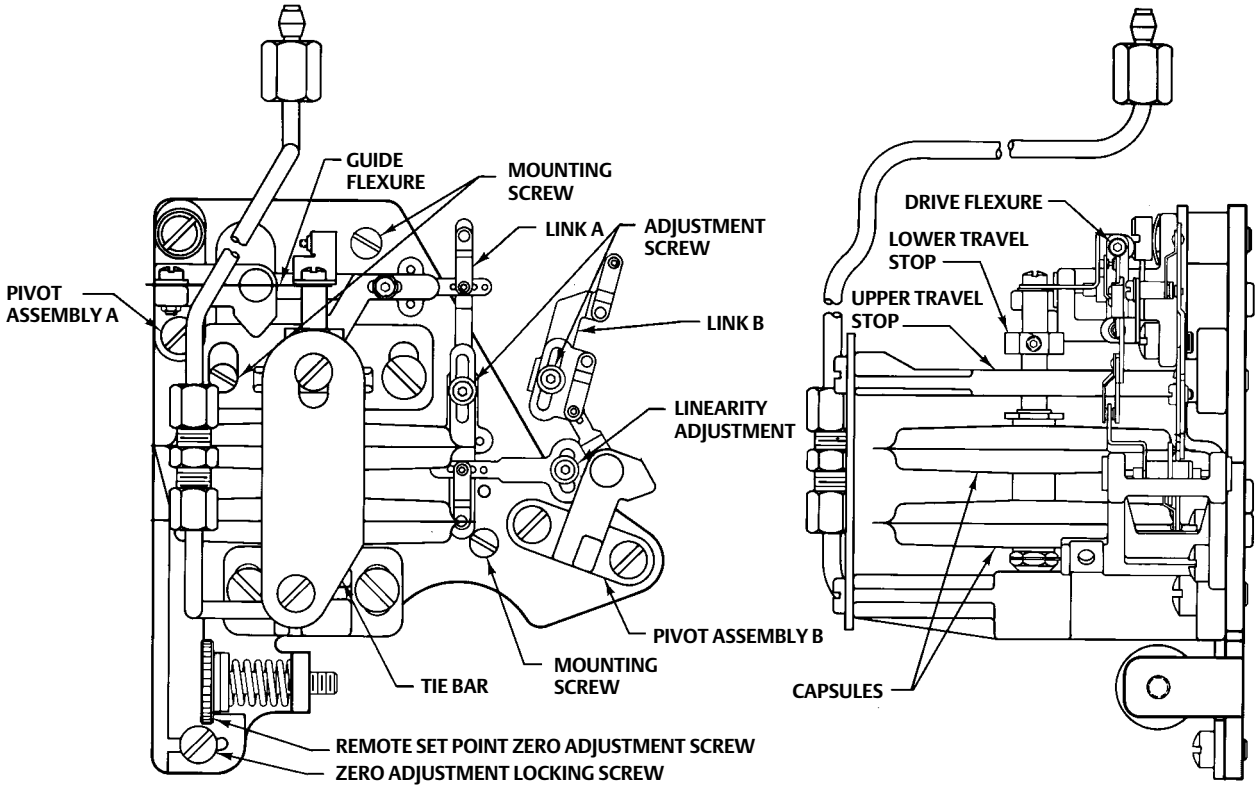
FRONT VIEW

SIDE VIEW OF SET POINT / PROCESS INDICATOR ASSEMBLY

Figure 6. Parts and Adjustments, Remote Set Point Option



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FRONT VIEW

SIDE VIEW

Adjustments

Remote Set Point (suffix letter M)

NOTICE

Do not move the set point adjustment manually on controllers equipped with remote set point. Moving the set point adjustment could damage the controller.

If the controller is equipped with the remote set point option, vary the remote set point pressure to change the set point. Increase the pressure to increase the set point and decrease the pressure to decrease the set point.

Manual Set Point

The set point adjustment changes the upper or lower switching point depending on controller action. To adjust the set point, open the controller cover and move the set point adjustment indicator until the desired value on the process pressure scale is below the line on the set point indicator. Move the adjustment to the right to increase the set point and to the left to decrease it.

Changing the set point adjustment does not affect the differential gap setting.

Proportional Band (Differential Gap)

The proportional band knob adjusts the width of the gap between switching points. Rotate the proportional band knob until the desired value is opposite the line on the proportional band indicator cover.

Changing Controller Action

Controller action is switchable from direct to reverse or vice versa by simply loosening the screws on the proportional band indicator cover and moving the cover out so the proportional band knob can be rotated to the desired action. The white portion of the adjustment enables direct controller action; the black portion enables reverse controller action.

Switching The Auto/Manual Station (suffix letter E)

NOTICE

Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.

Refer to figure 28 if the controller has the auto/manual option.

To switch from automatic to manual mode, you must balance the manual output with the controller output. Two balance methods are available to equalize the manual output with the controller output.

To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, adjust the set point manually or with remote set point pressure to move the ball into the switching zone. Turn the switch to AUTOMATIC and adjust the set point manually or with remote set point pressure to control the output.

When the automatic/manual switch is in AUTOMATIC, adjusting the loader knob has no effect on the controller output. When the automatic/manual switch is in MANUAL, changing the set point adjustment has no effect on the controller output.

Prestartup Checks

When performing the checks, open process loop conditions must exist. Refer to figure 5 for location of adjustments.

Note

If the controller has the auto/manual option (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks.

1. Connect supply pressure to the supply pressure regulator and be sure it is delivering the proper supply pressure to the controller. Provide a means of measuring the controller output pressure.
2. For controllers with remote set point (suffix letter M), connect regulated pressure of 0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.1 bar (6 to 30 psig) to the remote set point connection at the top of the controller case.
3. Loosen two screws (key 6), lift off the proportional band indicator cover (key 36), and set the proportional band knob between DIRECT and REVERSE.
4. The process indicator should indicate the process differential pressure. For example, with the process differential pressure at 50 percent of the input span, the process pointer should be at 50 ±1.0 percent of its span. Slight adjustment of the indicator zero screw might be necessary. See figure 5 for zero adjustment and locking screw location.
5. If desired, the accuracy can be verified at other points on the scale. If the indicator is out of calibration, refer to the process zero-and-span adjustment portion of the calibration procedure.
6. Install the proportional band indicator cover (key 36) and tighten two screws (key 6).

Startup

Set the controller switching point as described in the calibration procedures.

If manual control valves are being used to bypass the control valve package (valve, actuator, positioner, controller), slowly open the upstream and downstream manual control valves in the pipeline and close the manual bypass valve.

Calibration

Note

Some of the following procedures require that the proportional band knob be adjusted to between DIRECT and REVERSE. If this is done, it will be necessary to set the proportional band knob to 400 (direct or reverse action) before replacing the proportional band indicator cover.

Note

If the controller has the auto/manual option, be sure the controller is in the automatic mode before performing calibration procedures.

If the prestartup checks revealed faulty adjustment of the process indicator, perform the calibration procedures.

These procedures are valid for either shop or field calibration, if open process loop conditions exist.

Process Indicator Zero-and-Span Adjustment

Note

Any change in process pointer span will require readjustment of the process pointer zero adjustment screw.

Refer to figure 5 for location of adjustments.

1. Loosen two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Adjust the process differential pressure to the low limit of the input range.
4. Adjust the process indicator to the lowest limit of the input scale by loosening the zero adjustment locking screw and turning the zero adjustment screw.
5. Adjust the process differential pressure to the upper limit of the input span. Note whether the pointer indication is above or below the upper limit of the process scale.
6. Adjust the span screw as follows: Clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication. Adjust the span screw to correct one-half the error.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Install the proportional band indicator cover(key 36) and tighten two screws (key 6).

Remote Set Point Zero-and-Span Adjustment (suffix letter M)

Note

Any adjustment of the pointer span adjustment screw will require readjustment of the pointer zero adjustment screw.

Refer to figures 5 and 6 for location of adjustments.

1. Loosen two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Adjust the set point pressure to the low limit of the input range.
4. Adjust the set point indicator to the lowest limit of the input scale by loosening the zero adjustment locking screw and turning the zero adjustment screw.

5. Adjust the set point pressure to the upper limit of the input span. Note whether the pointer indication is above or below the upper limit of the process scale.
6. Adjust the span screw as follows: Clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication. Adjust the span screw to correct one-half the error.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Install the proportional band indicator cover (key 36) and tighten two screws (key 36).

Setting Switching Points

Direct-Acting Controllers

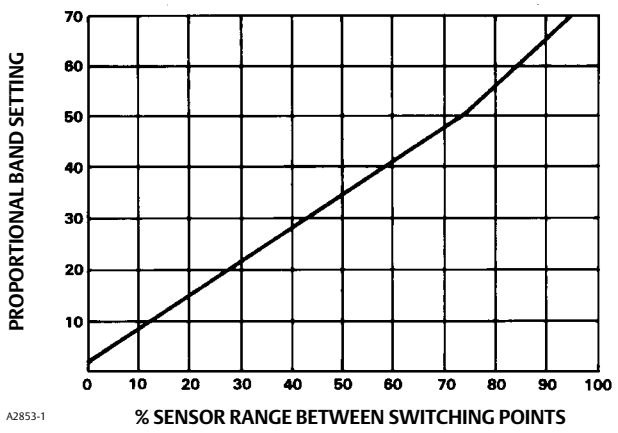
The controller output signal will switch from zero pressure to full supply pressure when increasing process differential pressure passes the upper switching point.

The controller output signal will not return to zero pressure until decreasing process differential pressure passes the lower switching point. When adjusting the controller as described in the following steps, keep in mind that:

- Changing the set point adjustment will move both switching points equally in the direction of adjustment.
- Changing the proportional band adjustment will widen or narrow the differential gap between the two switching points by moving the position of the lower switching point.

Figure 7 shows the relationship between the percent of sensor range between switching points and the proportional band setting on the controller. The following example illustrates how to use figure 7.

Figure 7. Curve for Determining Proportional Band Setting



Example: The sensing element has a range of 30 psi. The lower switching point is to be set at 10 psi and the upper switching point is to be set at 25 psi.

Proceed as follows:

- Divide the differential gap (the difference between the upper and lower switching points) by the sensing element range. Multiply the result by 100 as shown in the following equation:

$$\frac{Differential\ Gap}{Sensing\ Element\ Range} \times 100 = \frac{15\ psi}{30\ psi} \times 100 = 50\%$$

- Locate the 50 percent line on figure 7. Move along this line until you intersect the curve. Read the proportional band setting on the left hand axis. For this example, the setting is approximately 35 percent.

1. Using the curve in figure 7, determine the correct proportional band setting for the desired gap (expressed as a percent of the input span) between the switching points.
2. Set the proportional band knob to the desired setting determined in step 1.
3. Adjust the set point to the desired upper switching point.
4. Increase the process differential pressure until the controller output signal switches from zero pressure to full supply pressure.
5. Decrease the process differential pressure to the desired switching point at which the controller output signal switches from full supply pressure to zero pressure.
6. Narrow or widen the proportional band slowly until the output signal switches from full supply pressure to zero pressure.
7. Repeat steps 4 through 6 until the controller output switches at the desired points.
8. Observe the process pointer when the output switches at the upper switching point. The process pointer indication should be within ± 2 percent of the set point indication.

Reverse-Acting Controllers

The controller output signal will switch from zero pressure to full supply pressure when decreasing process differential pressure passes the lower switching point.

The controller output signal will not return to zero pressure until increasing process differential pressure passes the upper switching point. When adjusting the controller as described in the following steps, keep in mind that:

- Changing the set point adjustment will move both switching points equally in the direction of adjustment.
- Changing the proportional band adjustment will widen or narrow the differential gap between the two switching points by moving the position of the upper switching point.

Figure 7 shows the relationship between the percent of sensor range between switching points and the proportional band setting on the controller. The following example illustrates how to use figure 7.

Example: The sensing element has a range of 30 psi. The lower switching point is to be set at 10 psi and the upper switching point is to be set at 25 psi.

Proceed as follows:

- Divide the differential gap (the difference between the upper and lower switching points) by the sensing element range. Multiply the result by 100 as shown in the following equation:

$$\frac{Differential\ Gap}{Sensing\ Element\ Range} \times 100 = \frac{15\ psi}{30\ psi} \times 100 = 50\%$$

- Locate the 50 percent line on figure 7. Move along this line until you intersect the curve. Read the proportional band setting on the left hand axis. For this example, the setting is approximately 35 percent.

1. Using the curve in figure 7, determine the correct proportional band setting for the desired gap (expressed as a percent of the maximum input element span) between the switching points.
2. Set the proportional band knob to the desired setting determined in step 1.
3. Adjust the set point to the lower desired switching point.
4. Decrease the process differential pressure until the controller output signal switches from zero pressure to full supply pressure.

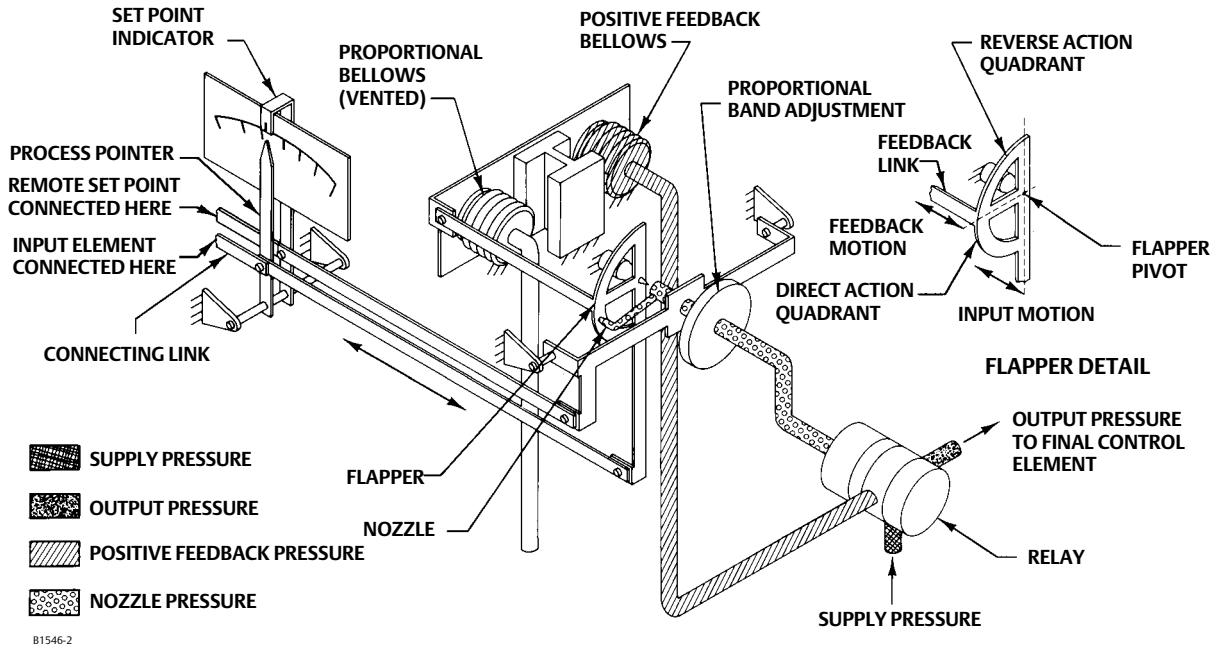
5. Increase the process differential pressure to the desired switching point at which the controller output signal switches from full supply pressure to zero pressure.
6. Narrow or widen the proportional band slowly until the output signal switches from full supply pressure to zero pressure.
7. Repeat steps 4 through 6 until the controller output switches at desired points.
8. Observe the process pointer when the output switches at the lower switching point. The process pointer indication should be within ±2 percent of the set point indication.

Principle of Operation

Overall Operation

Refer to the schematic diagram in figure 8.

Figure 8. Schematic of Fisher 4194HS Controller



The input element is connected to the process pointer and to the flapper by connecting links. As the process differential pressure increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the positive feedback bellows. The action of this bellows is a positive feedback action that moves the flapper closer to the nozzle, increasing nozzle pressure, which in turn, increases the relay output. Output pressure to the final control element switches to full supply pressure.

As the process differential pressure decreases, approaching the lower switching point, the flapper moves away from the nozzle (in a direct-acting controller) reducing nozzle pressure. Through relay action, pressure to the positive feedback bellows is reduced, moving the flapper farther away from the nozzle and further reducing nozzle pressure. Output pressure to the final control element switches to zero.

The set point adjustment changes the proximity of the nozzle and flapper as does a change in process pressure except that, when the set point is changed, the nozzle moves with respect to the flapper. The set point adjustment moves both the upper and lower switching points.

The proportional band knob positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle away from the input connection. When the proportional band adjustment moves the nozzle across the feedback connection, the controller action changes between direct and reverse. On a direct-acting controller, changing the proportional band adjustment will widen or narrow the differential gap between the two switching points. This is accomplished by changing the position of the lower switching point. On a reverse-acting controller, changing the proportional band adjustment will widen or narrow the differential gap between the two switching points. This is accomplished by changing the position of the upper switching point.

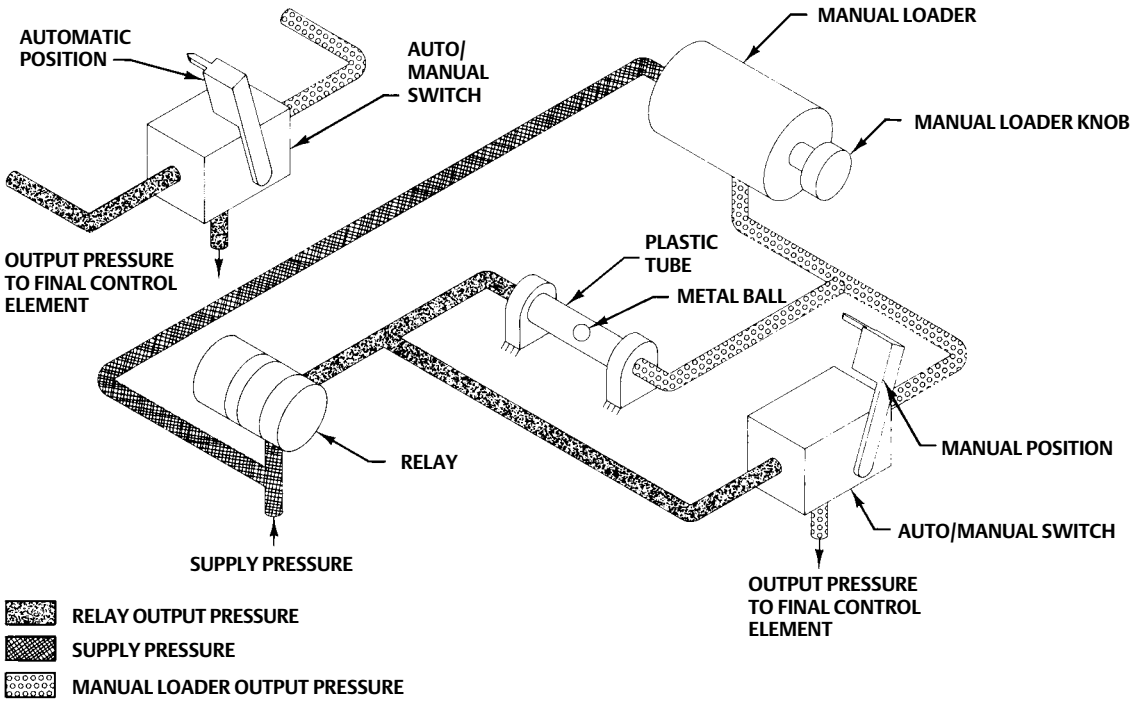
Remote Set Point (suffix letter M)

The capability to adjust the controller set point from a remote location is available with all 4194HS controllers. This option is designated by the suffix letter M in the type number.

Auto/Manual Station (suffix letter E)

Controllers with the auto/manual option (designated by the suffix letter E in the type number) have piping on the output side of the relay as shown in figure 9. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator, applies pressure to one side of the plastic tube and to the auto/manual switch. Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

Figure 9. Schematic of Auto/Manual Option



When the auto/manual switch is in the MANUAL position, the output of the manual loader is channeled through the auto/manual switch and becomes the output of the controller. When the auto/manual switch is in the AUTO position, the output of the relay is channeled through the switch to become the output of the controller.

Before the auto/manual switch is operated, the output of the relay must equal the output of the manual loader to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side. When the pressures are equal, the metal ball is centered in the tube. Pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

Maintenance

Inspection and Maintenance

⚠ WARNING

The following maintenance procedures require taking the controller out of service. To avoid personal injury and property damage caused by uncontrolled process pressure, observe the following before performing any maintenance procedures:

- **Always wear protective clothing, gloves, and eyewear when performing any installation operations to avoid personal injury.**
- **Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and preventative measures are not taken. Preventative measures may include, but are not limited to, one or more of the following: Remote venting of the unit, re-evaluating the hazardous area classification, ensuring adequate ventilation, and the removal of any ignition sources. For information on remote venting of this controller, refer to page 8.**
- **Provide some temporary means of control for the process before taking the controller out of service.**
- **Shut off the supply pressure to the controller.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Note

Unless otherwise noted, key numbers refer to figure 26. Figures 5 and 6 show the location of adjustments and major components. For maintenance on the indicator assembly, refer to figures 29 and 30.

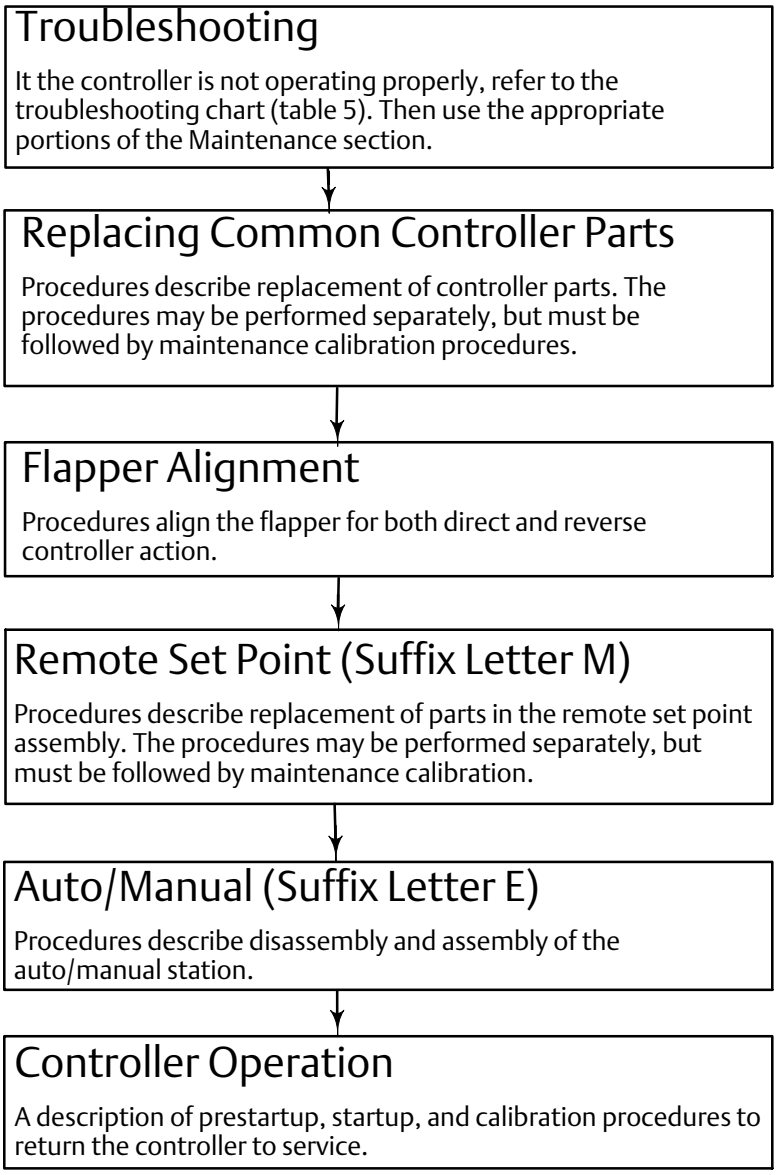
Parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends upon the severity of the service conditions. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job. Figure 10 is a maintenance guide that summarizes the information available in the maintenance procedures.

Select the appropriate maintenance procedure and perform the numbered steps. Shut off the supply pressure and process pressure before beginning maintenance.

The Maintenance section describes part replacement common to this type of Fisher controller. Other portions of the maintenance procedures describe replacing the differential pressure unit, making process zero-and-span and flapper alignments, and other calibration and maintenance procedures.

When maintenance procedures, including flapper alignment, have been completed, refer to the appropriate prestartup procedure.

Figure 10. Maintenance Guide



Troubleshooting

As an aid to troubleshooting, table 5 lists some common operating faults, their probable cause, and suggested procedures for correcting the fault.

Table 5. Troubleshooting Chart

Fault	Possible Cause	Check	Correction
1. Output does not snap when process pointer and set point indicator are aligned	1.1 Flapper out of alignment	1.1 Refer to flapper alignment procedure	1.1 Align flapper as necessary
	1.2 Process pointer not calibrated correctly	1.2 Refer to the process zero and span adjustment procedures	1.2 Adjust as necessary
	1.3 No supply pressure	1.3 Check supply pressure	1.3 Provide correct supply pressure
	1.4 Leak in nozzle or feedback tubing	1.4 Using a soap solution, check for leaks	1.4 Repair or replace defective parts
	1.5 Leak in relay O-rings	1.5 Using a soap solution, check for leaks	1.5 Repair or replace defective O-rings
2. Controller output will not snap to full output pressure	2.1 Output pressure gauge not functioning	2.1 Check output with external gauge	2.1 Replace gauge if necessary
	2.2 Supply pressure incorrect	2.2 Check with external source	2.2 Repair or replace pressure regulator if necessary
	2.3 Leak in positive feedback tubing	2.3 Using a soap solution, check for leaks	2.3 Replace defective parts as necessary
	2.4 Leak in nozzle tubing assembly	2.4 Using a soap solution, check for leaks	2.4 Replace defective parts as necessary
	2.5 Sensing element or linkage failure	2.5 Inspect element or linkage for damaged parts	2.5 Repair or replace damaged parts
	2.6 Relay malfunction	2.6 Manually cap the nozzle output by pushing the flapper toward the nozzle. Output should go to supply pressure.	2.6 If output does not change as described, remove relay. Replace O-rings if necessary. Replace relay if necessary
	2.7 Switching point has not been reached	2.7 Refer to the flapper alignment or to the setting switching points procedure	2.7 Make alignments and adjustments as necessary
	2.8 Link 4 not adjusted correctly	---	2.8 Refer to the maintenance procedures for link adjustment
3. Controller output will not snap to zero pressure.	3.1 Flapper out of alignment	3.1 Refer to the flapper alignment procedure	3.1 Align flapper as necessary
	3.2 Switching point has not been reached	3.2 Refer to the setting switching points procedure	3.2 Adjust switching as necessary
	3.3 Sensing element or linkage failure	3.3 Inspect sensing element and linkage for damaged parts. Using soap solution, check for leaks.	3.3 Repair or replace faulty parts
	3.4 Links 2, 3, and 4 defective	3.4 Inspect links for loose screws and improper connections. Ensure links are not rubbing or catching on other parts.	3.4 Replace links as necessary
	3.5 Relay malfunction or clogged nozzle	3.5 Manually push the flapper away from the nozzle. The output should go to zero.	3.5 Replace the relay. If the output still does not go to zero, replace the nozzle pivot assembly

Changing Controller Action

The following steps describe changing controller action from direct (increasing process differential pressure produces increasing output pressure) to reverse (increasing process differential pressure produces decreasing output pressure) or vice versa.

1. Loosen two screws (key 6) in the proportional band indicator cover (key 36). The screws do not need to removed.

2. Lift the proportional band indicator cover as shown in figure 11.

Figure 11. Changing Controller Action

W3439

3. Rotate the proportional band knob (key 25) to the desired controller action.
4. Install the proportional band indicator cover (key 36) and tighten the two screws (key 6).

Replacing the Differential Pressure Unit

Before performing any maintenance procedure, remove the controller and differential pressure unit from the mounting position. Then, move the controller and differential pressure unit to a maintenance area. Be sure the unit is properly supported before trying to separate the controller and differential pressure unit.

Use this procedure in reverse to connect a differential pressure unit to a controller.

Refer to figures 26 and 27 for key number locations.

1. Is the process under temporary control? If so, shut off the pressure pressure and supply pressure. Carefully bleed pressure from the controller and differential pressure unit.
2. Disconnect all tubing. Refer to the installation procedures for process and supply tubing connections that must be disconnected when the differential pressure unit is removed from the pipestand.

⚠ WARNING

The combined weight of the controller and differential pressure unit is approximately 26 kilograms (57 pounds). Provide adequate support for the unit during removal procedures to prevent personal injury or property damage.

3. Remove the controller and differential pressure unit from the mounting position. Figure 2 shows the location of the set screws that connect the mounting bracket (key 337) to the pipestand. Move the controller and differential pressure unit to a maintenance area.

Be sure the unit is properly supported before trying to separate the controller and differential pressure unit.

4. To separate the controller and differential pressure unit, open the cover, locate link number 1 (key 323) and disconnect it from the drive arm (key 322).

NOTICE

When reassembling the pivot bracket, it must be carefully aligned so it will not cause binding on the extension shaft (key 331).

5. Remove the pivot bracket (key 320) by removing the screws and washers (keys 329 and 332).
6. Loosen the locking screw (key 331) and slide the drive arm (key 322) off the extension shaft.

NOTICE

When removing the controller from the controller mounting plate (key 327), be careful not to bend the extension shaft (key 321).

7. Remove four screws (key 336) from the controller mounting plate (key 328) and carefully slide the controller off the extension shaft.
8. For controller maintenance—remove the controller mounting plate (key 328) by removing three screws (key 335) to gain access to the back of the controller.
9. For differential pressure unit maintenance—loosen the set screw (key 333) and remove the extension shaft.
10. Remove four screws (key 334) from the mounting plate (key 327) to gain access to the differential pressure unit.
11. For maintenance of the differential pressure unit, refer to the instruction manual for the unit.

NOTICE

When reinstalling the differential pressure unit, carefully insert the extension shaft (key 321) into the controller to avoid damage to controller parts.

12. Follow this procedure in reverse to rejoin the controller and differential pressure unit. Before returning the unit to process control, perform maintenance calibration and flapper alignment procedures.

Refer to the installation procedures when reinstalling the unit.

Replacing Controller Parts

Note

Remove the controller and differential pressure unit to a maintenance area to perform the following procedures. Refer to the installation procedures for process and supply tubing connections that must be disconnected when the differential pressure unit is removed from the pipestand. Figure 2 shows the location of the set screws that connect the mounting bracket (key 337) to the pipestand.

Refer to the installation procedures when reinstalling the unit.

Note

Some of the following procedures require that the proportional band knob be adjusted to between DIRECT and REVERSE. If this is done, it will be necessary to set the proportional band knob to 400 (direct or reverse action) before replacing the proportional band indicator cover.

Process Pressure Scale

NOTICE

Take care not to bend the process indicator or the set point adjustment while performing the following procedure.

1. Refer to figure 12. Adjust the set point adjustment manually or with the remote set point pressure to 50 percent of scale range.
2. Remove four screws (key 37).
3. Slide the process scale (key 61) so the top of the slot touches the set point adjustment. Deflect the lower portion of the slot and carefully slide the scale upward and off, clearing the set point adjustment as shown in figure 12.

Figure 12. Changing the Scale

W3440

DEFLECT LOWER PORTION OF THE SLOT

W3492

AND LIFT THE SCALE UP AND OFF

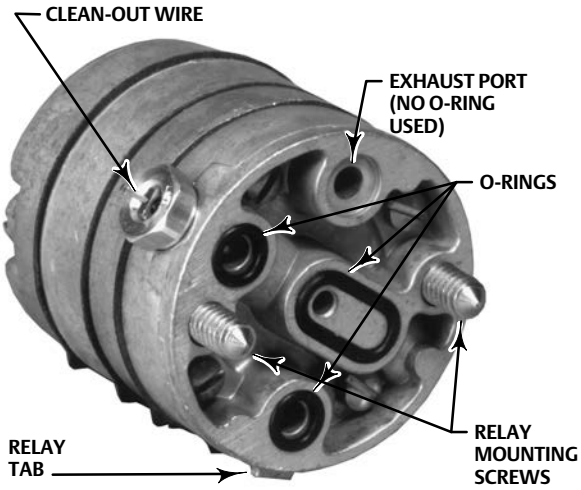
4. To install the replacement scale, bend the lower part of the slot slightly so the scale slides downward over the set point adjustment and under the process indicator.
5. Install and tighten the four screws on the scale.
6. A slight zero adjustment (figure 5) might be necessary so the process indicator aligns with the 0 mark on the scale. This procedure is described in the zero-and-span adjustment portion in the calibration procedure.

Relay

1. Loosen the two captive screws that hold the relay (key 50) in place.
2. Tip the relay slightly toward the case to clear output pressure gauge and lift out the relay.
3. Make sure the replacement relay has three O-ring assemblies as shown in figure 13. The fourth port is for exhaust and does not require an O-ring.

4. Install the replacement relay, making sure the tabs on the relay line up with the tab on the frame (figure 13).

Figure 13. Relay Features



5. Install and tighten the two screws that hold the relay in place.

Case and Cover

NOTICE

The case and cover are an integral unit; trying to separate them will damage the hinge. If the cover needs to be replaced, replace the case also.

Note

To remove the controller from the case, first perform steps 1 through 7 found in the procedures for replacing the differential pressure unit. Then, perform steps 1 through 3 below.

1. Perform the procedures required in the Note above:
   - Bleed away any process or supply pressure. Disconnect piping. Remove the controller and differential pressure unit from the field mounting position.
   - Remove the differential pressure unit from the controller.
2. Remove the nine screws (key 38) from the case (key 1) and lift out the controller assembly.
3. Install the controller assembly in the replacement case.
4. Slide the controller frame down to assure an O-ring seal at the pressure connection. Hold the frame in place.
5. Install and tighten the nine mounting screws.
6. Remove the blow-out plug (key 72) from original case and install in the replacement case.
7. Reinstall the differential pressure unit using the procedures in that portion of this section.

8. Mount the controller as described in the Installation section.
9. Connect the supply, output, and process pressure piping to the controller.
10. Perform necessary calibration steps.

Gauges

NOTICE

Before performing this procedure, be sure the replacement gauges are the correct range so the gauges are not damaged by overpressure.

1. Unscrew the output gauge (key 46) or the supply gauge (key 47) from the frame (key 3).
2. Before installing the replacement gauge, coat the threads on the gauge with a suitable sealant.
3. Screw the replacement gauge into the frame.

Links

This section describes the separate replacement of four links in the controller. To clarify the location of each link, the links are numbered as follows:

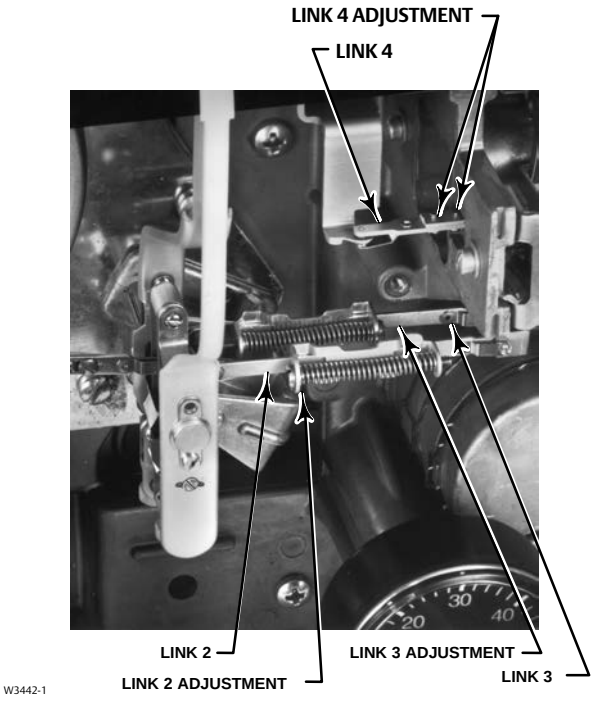
- Link Number 1 connects the drive arm and the process pointer.
- Link Number 2 connects the process pointer and the input feedback beam assembly (key 11).
- Link Number 3 connects the set point adjustment and the set point beam assembly (key 23).
- Link Number 4 (key 65) connects the input feedback beam assembly and the bellows bracket assembly (key 31).

Figures 5 and 14 show the location of each link.

Link Number 1

1. See figure 5 for the location of link number 1. Note where the link is connected. Disconnect the link from the drive arm and from the process pointer assembly. Remove the link. Then, install the replacement link.
2. Attach the replacement link to the process pointer assembly and drive arm in the position noted in step 1.
3. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point manually or with remote set point pressure to 100 percent of the scale range and set the proportional band between DIRECT and REVERSE.
5. The process pointer should be lined up with the pointer subassembly (as shown in figure 15). If not, loosen the zero adjustment locking screw. Then, adjust the fine zero adjustment to align the pointer and pointer assembly.
6. With a regulated air supply, adjust process differential pressure to 50 percent of process scale range. The process pointer should be at the 50± 1.0 percent position on the scale. If not, refer to the zero-and-span adjustment procedures in the Calibration section.
7. Refer to the maintenance calibration and flapper alignment procedures.

Figure 14. Link Locations



Link Number 2

1. Remove two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Note where the link is connected. Disconnect the link from process pointer assembly and from the input feedback beam assembly (key 11). Remove the link.
3. Install the replacement link with the screw head nearest the process pointer as shown in figure 14. Connect the link to the process pointer assembly only and in the position noted in step 2.
4. Adjust the set point adjustment manually or with the remote set point pressure to 100 percent of scale range. Set the proportional band between DIRECT and REVERSE.
5. Disconnect link number 1 from the pivot arm and manually position the process pointer to 100 percent of the scale.
6. Adjust the length of link number 2 (by turning the adjusting screw clockwise to increase length, counterclockwise to decrease length) so the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the input feedback beam assembly as shown in figure 16. The adjustment provides the proper tension on the link.
7. Connect the link to the input feedback beam assembly.
8. Connect link number 1 to the drive arm.
9. Refer to the maintenance calibration and flapper alignment procedures.

Figure 15. Process Pointer Alignment

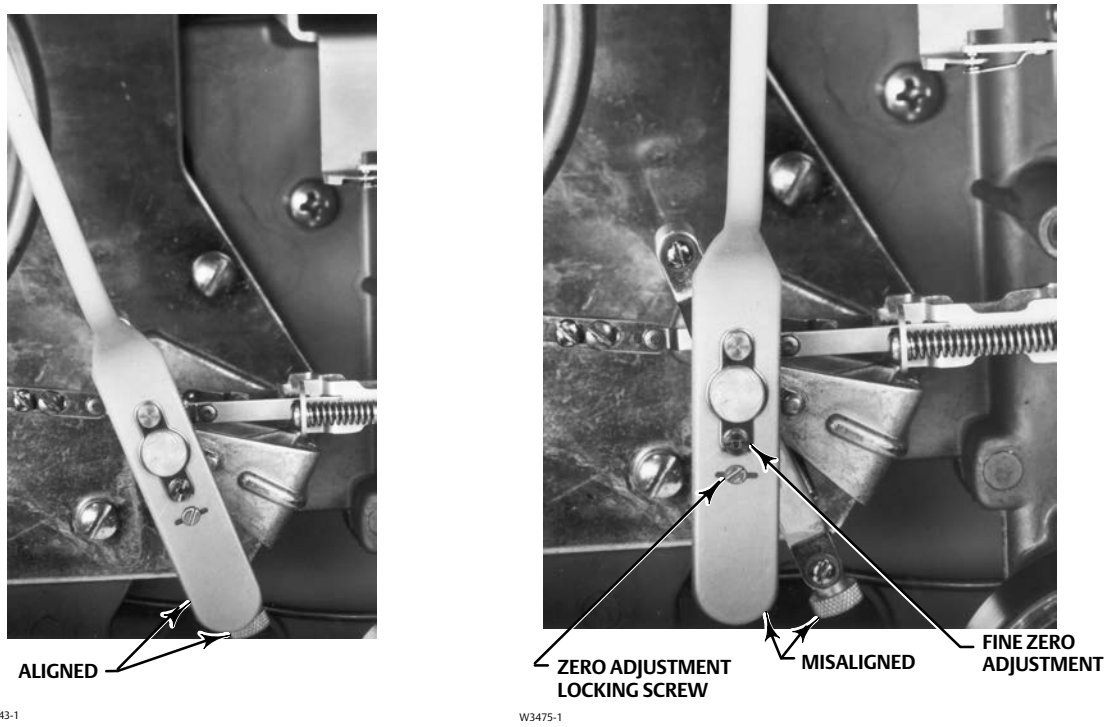
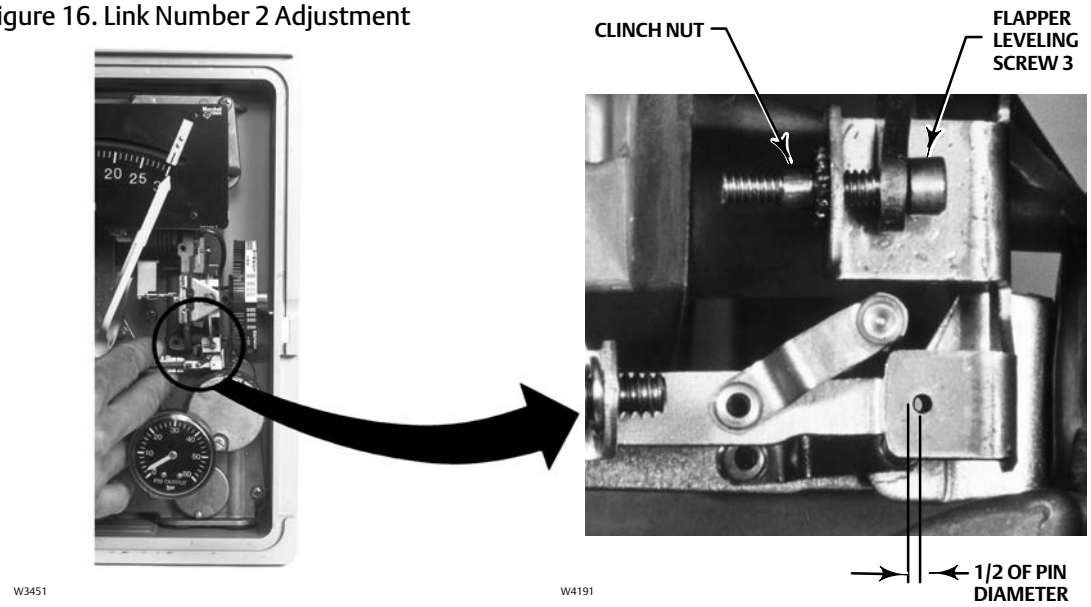


Figure 16. Link Number 2 Adjustment

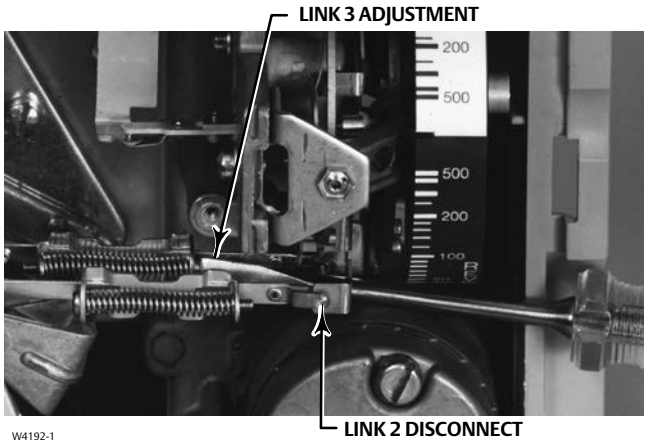


Link Number 3

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Note where the link is connected. Disconnect link number 3 from set point adjustment assembly and the set point beam assembly (key 23).

3. Install the replacement link with the screw head toward set point beam assembly as shown in figure 17 and in the position as noted in step 2.

Figure 17. Link Number 3 Adjustment



4. Check that set point beam bias spring (key 28) is correctly located in frame bore and spring seat on the set point beam assembly as shown in figure 18.
5. Adjust the proportional band between DIRECT and REVERSE.
6. Adjust the set point adjustment manually, or with the remote set point pressure, to 50 percent of scale. Adjust the screw on the link so the edge of the proportional band knob is parallel to the case or set point adjustment as shown in figure 5.
7. Refer to the maintenance calibration and flapper alignment procedures.

Link Number 4

1. Remove the two screws (key 6) and lift off the proportional band cover (key 36).
2. Refer to figure 14 for location of link 4. Note where the link is connected. Disconnect the link from bellows bracket assembly (key 31) and the input feedback assembly (key 11).
3. Connect the replacement link to the input feedback assembly so the two adjusting screws on the link are nearest to the feedback bellows bracket. The screw heads should face the bottom of the controller as shown in figure 19 and be positioned as noted in step 2.
4. Adjust the process differential pressure to 0 percent of the process scale range. Adjust the proportional band to 5 percent direct acting and adjust the set point manually or with remote set point pressure to 100 percent of scale range. Controller output should be 0 psig.
5. With zero pressure in the feedback bellows, loosen the two adjusting screws on the link. Connect the free end of the link to the bellows bracket assembly and allow the link to find its free length.
6. Tighten the two adjusting screws on the link.
7. Refer to the maintenance calibration and flapper alignment procedures.

Supply Tubing and Positive Feedback Tubing Assemblies

Note

The following procedure requires that the controller be removed from the case. Perform steps 1 through 7 found in the replacing the differential pressure unit procedure. Then, perform steps 1 through 3 found in the replacing the case and cover procedure.

Refer to figure 26 for key number locations.

1. Remove the nuts that hold the supply gauge tubing assembly (key 39) or the positive feedback tubing assembly (key 40) to the frame. Remove the tubing.
2. Install the replacement tubing assemblies.
3. Apply the correct supply pressure and check for leaks. Then remove pressure.
4. Install the controller assembly into the case. Slide the controller assembly down and make sure the O-rings (key 7) form a proper seal at the pressure connections. Hold the frame in place.
5. Install and tighten the nine self-tapping screws (key 38) into the frame.
6. Mount the assembled controller on a pipestand as described in the Installation section.
7. Connect supply, output, and process pressure piping to controller.

Proportional Band Knob, Nozzle Pivot, and Set Point Beam Assembly

Note

The following procedure requires that the controller be removed from the case. Perform steps 1 through 7 found in the replacing the differential pressure unit procedure. Then, perform steps 1 through 3 found in the replacing the case and cover procedure.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Disconnect link number 3 from the set point beam assembly (key 23). Refer to figure 18 for location of the link.
3. Remove the set point beam bias spring (key 28). Refer to figure 18 for spring location.
4. Remove the screw and washer (keys 19 and 20) that hold the pivot assembly (figure 19) to the frame and remove the pivot assembly.
5. Disconnect the nut that holds relay nozzle tubing (key 18) into the frame (key 3).
6. While holding the proportional band knob, remove the screw and washer (keys 19 and 20) which holds the relay nozzle tubing assembly (key 18) to the frame.
7. Remove the proportional band knob nozzle pivot and set point beam assembly from controller.
8. Remove the relay nozzle tubing assembly (key 18) from the set point beam assembly (key 23, figure 18).
9. Remove the E-ring (key 27) from the nozzle tubing assembly (key 21).
10. Remove the nozzle tubing assembly (key 21) from the bottom of the set point beam assembly (key 23).
11. Remove the retaining clip (key 26).
12. Remove the proportional band knob (key 25) from the set point beam assembly (key 23).
13. Inspect the nozzle pivot O-ring (key 24).
14. Inspect the nozzle tubing assembly (key 21) and replace it, if necessary. Inspect the nozzle orifice and clean it if necessary.
15. Lubricate (key 318) and install the proportional band knob (key 25) on the set point beam assembly (key 23).
16. Install the retaining clip (key 26) on the three posts on the proportional band knob.
17. Install the nozzle tubing assembly (key 21) through the set point beam assembly (key 23), the proportional band knob (key 25) and the retaining clip (key 26) into the cap, aligning the nozzle with the tab on the proportional band knob (shown in figure 18).
18. While holding the nozzle tubing (key 21) against the set point beam assembly (key 23), depress the retaining clip (key 26) and install the E-ring (key 27) into the E-ring groove on the nozzle tubing assembly (key 18).

19. Inspect the O-ring on the relay nozzle tubing assembly (key 18) and replace it if necessary. Apply a suitable lubricant (key 318) to the O-ring.
20. Install the relay nozzle tubing assembly (key 18) into the set point beam assembly.
21. Adjust the proportional band between DIRECT and REVERSE. Do this by aligning the tab on the proportional band knob with the hole in the set point beam assembly as shown in figure 20.
22. Position the proportional band knob, nozzle pivot and the set point beam assembly on frame. Install the relay nozzle tubing nut loosely into frame manifold while positioning the nozzle in the center of the flapper as shown in figure 21.
23. Install the screw and washer (keys 19 and 20) into the relay nozzle tubing assembly (key 18) as shown in figure 19.
24. Install the screw (key 19) through the frame (key 3) and into the relay nozzle tubing assembly (key 18). Tighten the screw. Make sure the nozzle remains centered on the flapper with the set point beam assembly slid snugly towards the relay nozzle tubing assembly.
25. Install the pivot of the set point pivot assembly (key 17) in the hole in the set point beam assembly (key 23).
26. Install the washer (key 20) on the screw (key 19).
27. Install the screw (key 19) through the frame (key 3) into the set point pivot assembly (key 23). Do not tighten.
28. First, slide the beam assembly snugly toward the relay tubing assembly. Then, slide the pivot assembly (key 17) toward the set point beam until the cone lightly contacts the set point beam and tighten the screw. The proportional band knob should fall freely when the controller is in the upright position. If it does not, reposition the set point pivot assembly (key 17) until the proportional band knob falls freely.
29. Tighten the nut on the relay nozzle tubing assembly (key 18) and apply full supply pressure to check for leaks with the controller developing full output pressure.
30. Install the set point beam bias spring (key 28) into frame bore and onto the spring seat on the set point beam assembly (figure 18).
31. Attach link number 3 to the set point beam assembly (key 23). See figure 18.
32. If the position of the set point beam shoe (key 29, figure 18), was changed relative to the set point beam assembly (key 23), go to step 33. If the position of the set point beam shoe was not changed, go to step 53.
33. Connect supply pressure and a regulated process differential pressure to the controller. Also, provide a means of measuring controller output pressure.
34. Perform the flapper alignment procedure. Then, proceed as directed by the following note.

Note

For direct acting controllers, go to step 35. For reverse acting controllers, go to step 44.

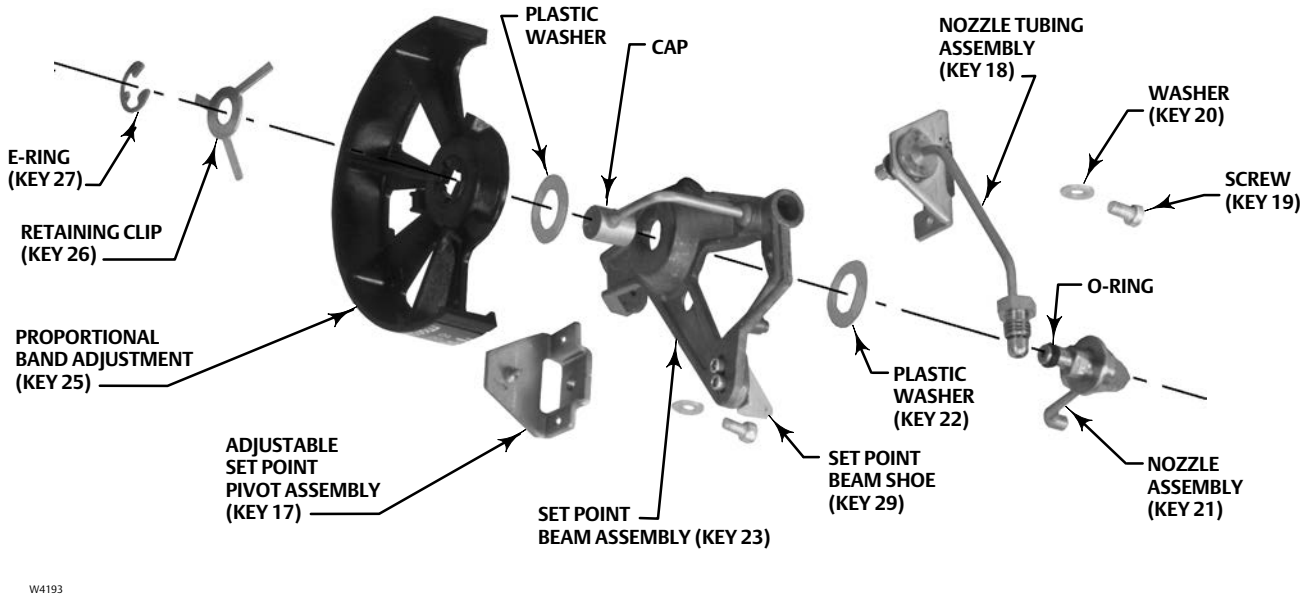
35. For direct acting controllers, adjust the proportional band knob to 5 percent direct acting. Adjust the set point manually or with remote set point pressure to 5 percent of the process scale range.

⚠ WARNING

In step 36, do not exceed the operating limits of the controller (refer to table 3). Personal injury or equipment damage could result from overpressure.

36. Slowly increase the process differential pressure from zero until the output pressure snaps to supply pressure. The output pressure should snap to supply pressure within ±2 percent of set point.

Figure 18. Proportional Band Knob and Set Point Beam Details



EXPLODED VIEW

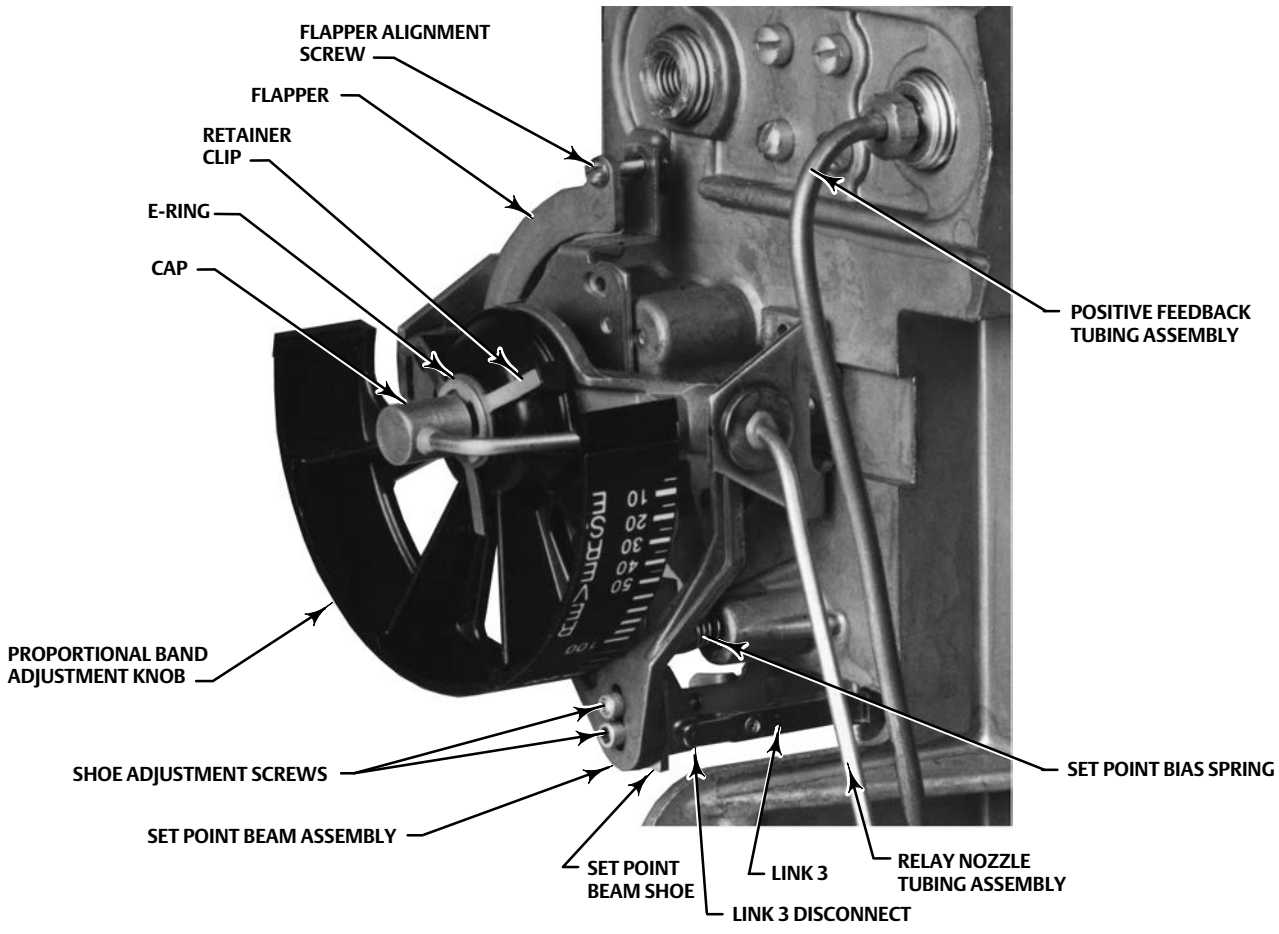
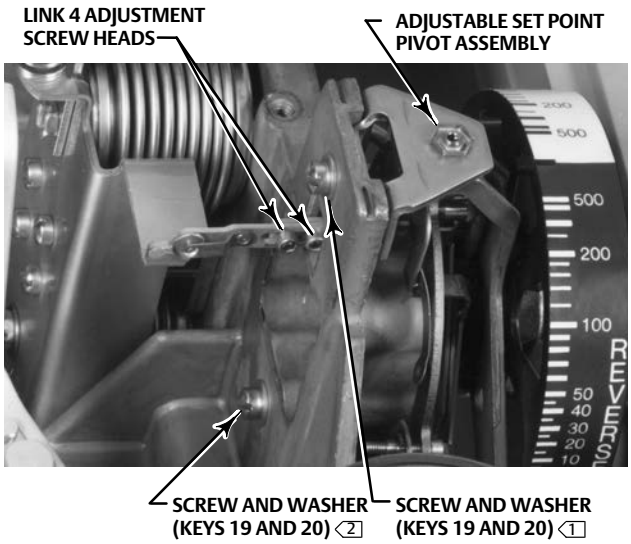


Figure 19. Position of Link Number 4 Adjustment Screws



NOTES:
1 SCREW INSERTED INTO THE ADJUSTABLE SET POINT PIVOT ASSEMBLY.
2 SCREW INSERTED INTO THE RELAY NOZZLE TUBING ASSEMBLY.

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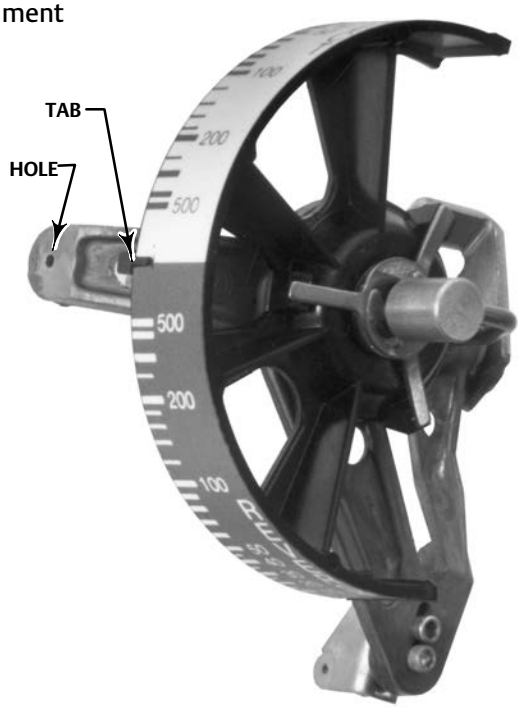
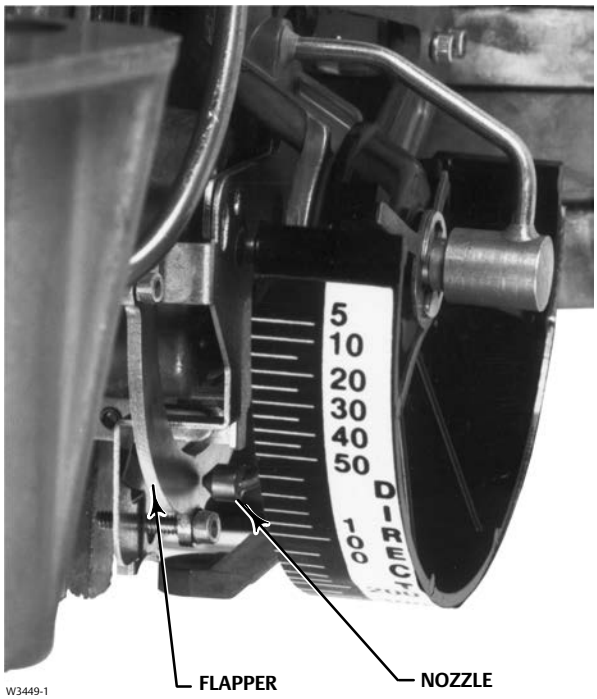
Figure 20. Proportional Band Adjustment Knob Alignment



W3761

Figure 21. Nozzle/Flapper Alignment



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37. If the output pressure snaps to supply pressure below 2 percent of set point, adjust flapper leveling screw number 3 clockwise (see figure 5 for location of screw). If the output pressure snaps to supply pressure above 2 percent of set point, adjust flapper leveling screw number 3 counterclockwise.
38. Repeat steps 36 and 37 until the output pressure snaps within ±2 percent. If the tolerance cannot be obtained with the flapper leveling screw, go to step 42.
39. Adjust the set point manually or with remote set point pressure to 95 percent of the process scale range.
40. If the output pressure is not 0 psig, decrease the process differential pressure until the output pressure snaps to zero. Then, slowly increase the process differential pressure until the output snaps to supply pressure. The output should snap to supply pressure within ±2 percent of set point.
41. If the output pressure snaps to supply pressure within ±2 percent of set point, go to step 53. If the output pressure does not snap to supply pressure within ±2 percent of set point, go to step 42.
42. If the output pressure snaps to supply pressure below 2 percent of set point, adjust the set point beam shoe (key 29) slightly toward the center of the nozzle pivot. If the output snaps to supply pressure above 2 percent of set point, adjust the set point beam shoe slightly away from the center of the pivot.
43. Repeat steps 35 through 42 until the output pressure snaps to supply pressure within ±2 percent of set point at 5 and 95 percent on the process scale range. Then, go to step 53.
44. For reverse acting controllers, adjust the proportional band knob to 5 percent reverse acting. Adjust the set point manually or with remote set point pressure to 5 percent of the process scale range.
45. Carefully adjust the process differential pressure to 100 percent of the process scale range. Then, slowly decrease the process differential pressure until the output pressure snaps to supply pressure. The output should snap to supply pressure with ±2 percent of set point.
46. If the output pressure snaps to supply pressure below 2 percent of set point, adjust flapper leveling screw number 1 counterclockwise (see figure 5 for location of screw). If the output pressure snaps to supply pressure above 2 percent of set point, adjust flapper leveling screw number 1 clockwise.
47. Repeat steps 44 through 46 until the output pressure snaps to supply pressure within ±2 percent of set point. If the tolerance cannot be obtained with the flapper leveling screw, go to step 51.
48. Adjust the set point manually or with remote set point pressure to 95 percent of the process scale range.

⚠ WARNING

In step 49, do not exceed the operating limits of the controller (refer to table 3). Personal injury or equipment damage could result from overpressure.

49. Increase the process differential pressure until the output pressure snaps to zero. Then, slowly decrease the process differential pressure until the output pressure snaps to supply pressure. The output should snap to supply pressure within ± 2 percent of set point.
50. If the output pressure snaps to supply pressure within ±2 percent of set point, go to step 53. If the output pressure does not snap to supply pressure within ±2 percent, go to step 51.
51. If the output pressure snaps to supply pressure below 2 percent of set point, adjust the set point beam shoe (key 29) slightly toward the center of the nozzle pivot. If the output pressure snaps to supply pressure above 2 percent of set point, adjust the set point beam shoe slightly away from the center of the nozzle pivot.
52. Repeat steps 44 through 51 until the output pressure snaps to supply pressure within ±2 percent of set point at 5 and 95 percent of the process scale range; then go to step 53.
53. Install the controller assembly in the case. Slide the controller frame down to assure an O-ring seal at the pressure connections. Hold the frame in place.
54. Install and tighten the nine mounting screws that hold the controller assembly in place.
55. Refer to the flapper alignment procedures.

56. Replace the proportional band indicator cover (key 36) and tighten two screws (key 6).

Flapper Flexure Pivot Assembly

Note

The following procedure requires that the controller be removed from the case. Perform steps 1 through 7 in the replacing the differential pressure unit procedure. Then, perform steps 1 through 3 in the replacing the case and cover procedure.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Disconnect link number 3 from the set point beam assembly (key 23). Refer to figure 18 for link location.
3. Remove the set point beam bias spring (key 28), refer to figure 18 for the spring location.
4. Remove the screw and washer (keys 19 and 20) that holds the set point pivot assembly (key 17) to the frame.
5. Remove the set point pivot assembly (key 17).
6. Disconnect the nut that holds relay nozzle tubing (key 18) into the frame (key 3).
7. While holding the proportional band knob, remove the screw and washer (keys 19 and 20, figure 19) which holds the relay nozzle tubing assembly (key 18) to the frame.
8. Remove the proportional band knob nozzle pivot and set point beam assembly from controller.
9. Disconnect link number 2 from the input feedback beam assembly (key 11) shown in figure 17. Refer to figure 14 for location of link.
10. Disconnect link number 4 from the bellows bracket (key 31).
11. Remove the screws (key 12) and washers (key 13) from the flexure pivot assembly (key 9). See figure 22 for screw location.
12. Remove the input feedback beam assembly as shown in figure 23.
13. Remove the four screws (key 10) as shown in figure 23 that hold the flexure pivot assembly to the frame.
14. Remove the flexure pivot assembly (key 9).
15. Install the replacement flexure pivot assembly with the four screws (key 10). Do not tighten the screws.
16. Move the flexure pivot assembly towards the relay as far as possible and tighten the four screws (key 10).
17. Place the input feedback beam assembly (key 11) onto the flexure pivot assembly (key 9) with link 4 through the square hole in the frame.
18. Install the screw (key 12) with the washer (key 13) through the input feedback beam assembly (key 11) into the flexure pivot assembly (key 9). Do not tighten the screw.
19. Align flapper leveling screw number 2 with the centerline of the oblong hole in the frame as shown in figure 22. Tighten the screw (key 12). Make sure link 4 does not touch the frame.
20. Disconnect link number 1 from the pivot assembly and manually position the process pointer to 100 percent of the scale. Refer to figure 14 for location of link.
21. Adjust the length of link number 2 by turning the adjustment screw clockwise to increase the length or counterclockwise to decrease the length so the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the input feedback beam assembly, as shown in figure 16.
22. Connect link number 2 to the input feedback beam assembly.
23. Connect link number 1 to the drive arm.
24. Adjust the proportional band between DIRECT and REVERSE. Do this by aligning the tab on the proportional band knob with the hole in the set point beam assembly as shown in figure 20.

Figure 22. Flapper Assembly and Leveling Screws

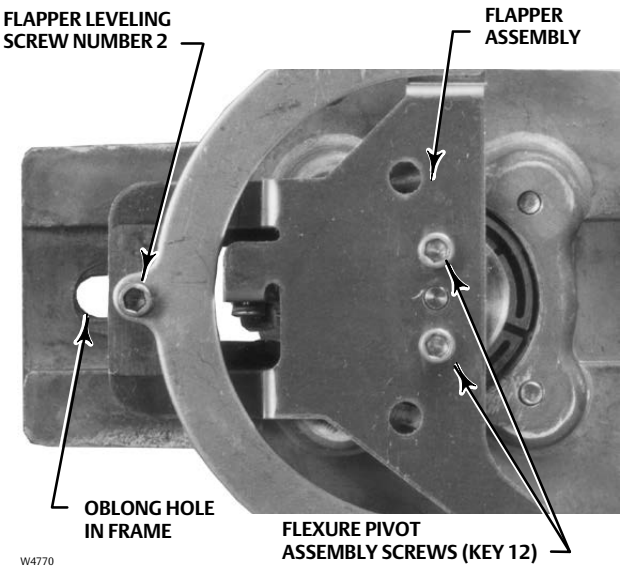
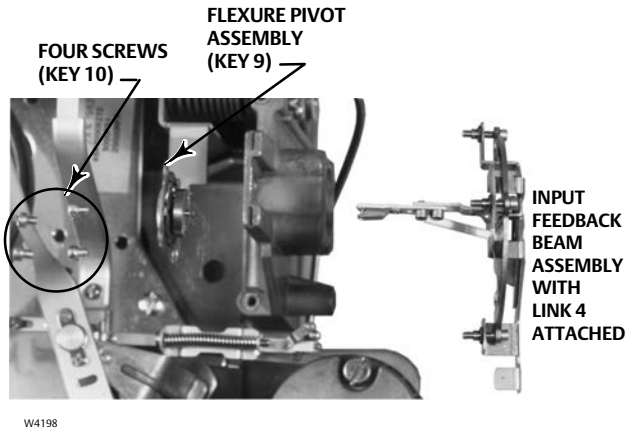


Figure 23. Exploded View, Flexure Pivot Assembly



25. Position the proportional band knob, nozzle pivot, and set point beam assembly on frame. Install the relay nozzle tubing nut loosely into frame manifold while positioning the nozzle in the center of the flapper as shown in figure 21.
26. Install the washer (key 20) on the screw (key 19).
27. Install the screw (key 19) through the frame (key 3) and into the relay nozzle tubing assembly (key 18). Tighten the screw. Be sure the nozzle remains centered on the flapper with the set point beam assembly slid snugly towards the relay nozzle tubing assembly.
28. Install the pivot of the set point pivot assembly (key 17) in the hole in the set point beam.
29. Install washer (key 20) on screw (key 19).
30. Install the screw (key 19) through the frame (key 3) into the set point pivot assembly (key 23). Do not tighten.
31. Slide the set point pivot assembly (key 17) toward the set point beam until the cone lightly contacts the set point beam and tighten the screws. The proportional band knob should fall freely when the controller is in the upright position. If it does not, reposition the set point pivot assembly (key 17).
32. Tighten the relay nozzle tubing nut (key 18). Apply full supply pressure and check for leaks. Disconnect the supply pressure.
33. Install the set point beam bias spring (key 28) into frame (key 3) bore and onto spring seat on the set point beam assembly (key 23).
34. Attach link number 3 to the set point beam assembly.
35. Apply proper supply pressure to the controller and check for leaks.
36. Apply process differential pressure equal to the lower range value.
37. Adjust the proportional band to 5 percent direct acting and adjust set point to the maximum value on the process scale. Controller output should be 0 psig. Remove supply and differential pressure from the controller.
38. With zero pressure in both bellows, loosen the two adjusting screws on link 4 and connect the link to the bellows bracket assembly, allowing the link to find its free length.
39. Tighten the two adjusting screws.

40. Determine the position of the set point beam shoe (key 29).
    - If the position of the set point beam shoe was changed during this procedure, relative to the set point beam assembly (key 23), refer to the procedure for replacing proportional band knob, nozzle pivot, and set point beam assembly. Perform steps 32 through 51 there.
    - If the position of the set point beam shoe (key 29) **did not change** during this procedure, relative to the set point beam assembly (key 23), perform the following step (step 40, replacing proportional band knob procedure):
41. If the output pressure is not 0 psig, decrease the process differential pressure until the output pressure snaps to zero. Then, slowly increase the process differential pressure until the output snaps to supply pressure. The output should snap to supply pressure within ±2 percent of set point.
42. Install the controller assembly in the case. Slide the controller frame down to assure an O-ring seal at the pressure connections. Hold the frame in place.
43. Install and tighten the nine screws that hold the controller assembly in the case.
44. Refer to the flapper alignment procedure.
45. Replace the proportional band cover (key 36) and tighten the two screws (key 6).

Positive Feedback Bellows

Note

The following procedure requires that the controller be removed from the case. Perform steps 1 through 7 in the replacing the differential pressure unit procedure. Then, perform steps 1 through 3 in the replacing the case and cover procedure.

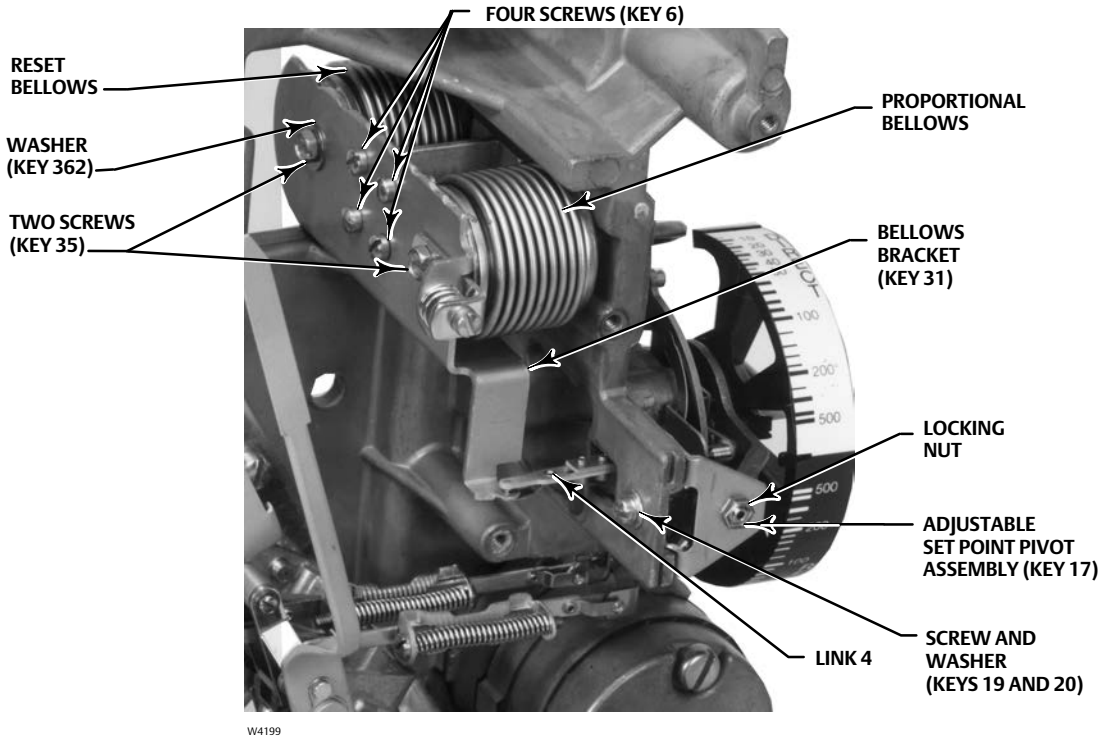
1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Disconnect link 4 (key 65) from the bellows bracket (key 31).
3. Remove the screw (key 34), spring (key 33), and bellows adjustment bracket (key 32) from the bellows bracket (key 31).
4. Refer to figure 24 for locations. Remove two screws (key 35) from the bellows assembly.
5. Remove the four screws (key 6) from the bellows beam (key 49) and remove the bellows bracket.
6. Remove the positive feedback tubing assembly (key 45) from the positive feedback bellows.

NOTICE

When removing and replacing the proportional or positive feedback bellows, keep in mind that the bellows has left-hand threads. Overtightening could damage the threads.

7. Unscrew the bellows.
8. Before installing the replacement bellows, coat the threads with a suitable lubricant. Screw in the replacement bellows until it is finger tight against the frame (key 3).
9. Install the four screws (key 6) through the bellows bracket (key 31) into bellows beam (key 49).

Figure 24. Bellows Assembly and Proportional Band Adjustment (Process Scale and Proportional Band Adjustment Cover Removed)



10. Install the two screws (key 35) through the bellows bracket (key 31) into the bellows. Install the bellows adjustment bracket (key 32), spring (key 33), and tighten the screw (key 34) until the spring is compressed completely. Tighten the two screws (key 35). Make sure the bellows bracket (key 31) is installed correctly so it does not touch the frame.
11. Replace the proportional or reset tubing assembly on the bellows base.
12. Apply the correct supply pressure and check for leaks. Remove the supply pressure.

    If the length of link 4 (key 65) was not changed, proceed with step 14.
13. If the length of link 4 was changed during this procedure, refer to the replacement procedures for the flapper flexure assembly. Perform steps 36 through 38 of the procedures.
14. Replace link 4 on the bellows bracket. Make sure the link does not touch the frame. If it does, repeat steps 8 through 12 to straighten the bellows bracket (key 31).
15. Refer to the flapper alignment procedures.
16. Remove the supply pressure, the output measurement device, and the regulated differential process pressure source.
17. Rotate the proportional band indicator cover (key 36) and tighten the two screws (key 6).
18. Install the controller assembly in the case. Slide the controller frame down to assure an O-ring seal at the pressure connections. Hold the frame in place.
19. Install and tighten the nine screws that hold the controller assembly in the case.

Calibration After Controller Maintenance

Process Zero-and-Span Adjustment

If the prestartup checks procedures revealed faulty adjustment of the process indicator, perform the calibration procedures. These instructions are valid for either shop or field calibration, if open loop conditions exist.

Note

If the controller has the auto/manual station option, be sure the controller is in the automatic mode before performing calibration.

Note

Any adjustment of the pointer span adjustment screw will require readjustment of the pointer zero adjustment screw.

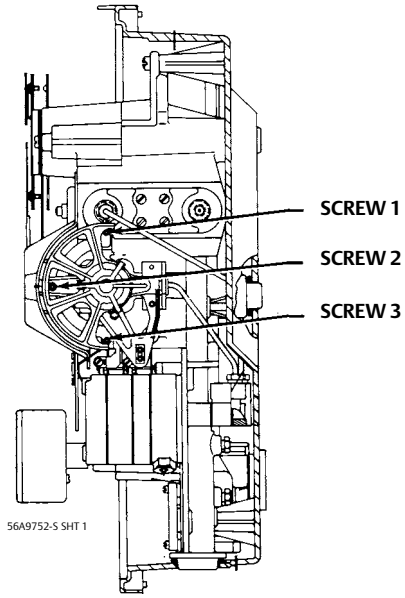
Refer to figure 5 for location of adjustments.

1. Remove two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Adjust the process differential pressure to the low limit of the input range.
4. Align the process pointer with the support as shown in figure 15.
5. Loosen the locking screw (key 331, figure 29) on the pivot assembly.
6. Apply 50 percent differential pressure to the differential pressure unit.
7. Adjust the process pointer by manually moving the pointer to the 50 percent mark on the process scale (within ±2 percent) and tighten the locking screw (key 331).
8. Adjust the process differential pressure to the low limit of the input range.
9. Adjust the process pointer to the lowest limit of the input scale by loosening the zero adjustment locking screw and turning the zero adjustment screw.
10. Adjust the process differential pressure to the upper limit of the input span. Note whether the pointer indication is above or below the upper limit of the process scale.
11. Adjust the span screw as follows: Clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication. Adjust the span screw to connect one-half the error.
12. Repeat steps 7 through 11 until the error is eliminated.
13. Refer to the flapper alignment procedure.

Flapper Alignment

Leveling screw numbers and adjustments are shown in figure 25. Provide a means of applying process differential pressure and supply pressure to the controller and a means of measuring output pressure. After flapper alignment, go to the appropriate prestartup procedures.

Figure 25. Leveling Screws



SIDE VIEW OF CONTROLLER SHOWING FLAPPER LEVELING SCREWS

1. For controllers with manual set point, move the set point adjustment to 50 percent of the scale range. For controllers with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
2. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
3. Adjust the proportional band adjustment to 5 percent direct acting.

⚠ WARNING

In step 4, do not exceed the operating limits for the controller (refer to table 3). Personal injury or equipment damage could result from overpressure.

4. Slowly increase the process differential pressure from zero until the output pressure snaps to supply pressure. The output pressure should snap to supply pressure within ±2 percent of set point.
5. If the output snaps to supply pressure below 2 percent of set point, adjust flapper leveling screw number 3 clockwise. If the output snaps above 2 percent of set point, adjust flapper leveling screw number 3 counterclockwise.
6. Repeat steps 4 and 5 until the output pressure snaps within ±2 percent of set point.
7. Adjust the proportional band adjustment between DIRECT and REVERSE.
8. If the output pressure snaps to supply pressure, depress the flapper with a screwdriver so the output pressure snaps to zero pressure. Slowly release the flapper. If the output snaps to supply pressure, adjust flapper leveling screw number 2 clockwise until the output does not snap to supply pressure. Then, adjust screw number 2 counterclockwise 1/8 of a turn at a time until the output snaps to supply pressure.
9. Repeat step 8 to recheck the adjustment of flapper leveling screw number 2.
10. Adjust the proportional band adjustment to 5 percent reverse acting.

11. Carefully adjust the process differential pressure to 100 percent of the process scale range. Then, slowly decrease the process differential pressure until the output pressure snaps to supply pressure. The output pressure should snap to supply pressure within ±2 percent of set point.
12. If the output pressure snaps to supply pressure below 2 percent of set point, adjust flapper leveling screw number 1 counterclockwise. If the output snaps to supply pressure above 2 percent of set point, adjust flapper leveling screw number 1 clockwise.
13. Repeat steps 11 and 12 until the output pressure snaps within ±2 percent of set point.
14. Repeat steps 3 through 13 to recheck adjustments. Continue to adjust flapper leveling screws 1, 2, and 3 as necessary until no flapper adjustments are required.
15. Set the proportional band adjustment to 400 percent in the desired controller action. Replace the proportional band indicator cover (key 36) and tighten the two screws (key 6).

Replacing Remote Set Point (suffix letter M) Parts

Note

After replacing parts, perform the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Figure 6 shows the location of the parts. Key numbers refer to figure 27.

Pivot Assembly A (Key 114)

NOTICE

Avoid bending or kinking the drive flexure during this procedure. Bending or kinking the drive flexure can result in product damage, as well as impaired performance.

1. Decrease the remote set point pressure to 0 psig.
2. Remove the tie bar (key 106).
3. Note where link A (key 116) is connected. Disconnect the link from the lever arm on the pivot assembly.
4. Disconnect the drive flexure (key 79) from the adjustment arm of the pivot assembly. Be careful not to bend or kink the drive flexure.
5. Remove the screw (key 122), the washer (key 123) and the nut (key 124) that attach the guide flexure to the top of the pivot assembly.
6. Remove the pivot screw and spring washer (keys 109 and 112) and the mounting screw (key 102) attaching the pivot assembly to the mounting plate. Lift out the pivot assembly.
7. Loosen the screw (key 118) on the adjustment arm of the replacement pivot assembly and set the arm to the same length as the arm on the pivot assembly being replaced. Tighten the screw.
8. To replace the pivot assembly, first put the spring washer on the screw. Then, install the screw through the pivot assembly into the mounting plate.
9. Connect the guide flexure to the top of the new pivot assembly with the screw (key 122), the washer, and the nut as it was before.

10. Increase the remote set point pressure to 50 percent of input span.
11. Connect the drive flexure to the arm on the new pivot assembly, making sure it stays straight and horizontal. Before tightening down the drive flexure, set the pivot in the middle of the bushing end play. Tighten down the drive flexure to hold the pivot in that position. Do not kink or twist the flexure when tightening the screws. Adjust the length of the pivot arm if necessary until the flexure is straight.
12. Decrease the remote set point pressure to 0 psig.
13. Connect the end of link A (key 116) in figure 30 to the pivot lever arm in the same position noted in step 3.
14. Replace the tie bar (key 106).
15. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Pivot Assembly B (Key 115)

Refer to figure 27 for the key-numbered assembly.

1. Decrease the remote set point pressure to 0 psig.
2. Note where the links are connected. Disconnect the links (keys 116 and 126) from the arms of the pivot assembly (key 115).
3. Remove the two screws (key 102) attaching the pivot assembly to the mounting plate (key 111). Remove the pivot assembly.
4. Loosen the linearity adjustment screw on the replacement pivot assembly and set it in the same position as the adjustment on the original pivot assembly. Tighten the screw.
5. Set the replacement pivot assembly on the mounting plate and attach it with two machine screws.
6. Attach the links (keys 116 and 126) to the arm locations for the new pivot assembly as noted in step 2.
7. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Drive Flexure

NOTICE

Avoid bending or kinking the drive flexure during this procedure. Bending or kinking the drive flexure can result in product damage, as well as impaired performance.

1. Disconnect the flexure (key 79) from the drive bracket (key 121) and from the adjustment arm of pivot assembly A. Remove the screws and washers (key 12 and 13); remove the flexure.
2. Set remote set point pressure at 50 percent of input span.
3. Connect the new flexure making sure it stays straight and horizontal. Before tightening down the drive flexure, set pivot A in the middle of the bushing end play. Tighten down the drive flexure to hold the pivot in that position. Do not kink or twist the flexure when tightening the screws.
4. Decrease the remote set point pressure to 0 psig.
5. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Tubing

1. Decrease the remote set point pressure to 0 psig.

2. Disconnect the pressure connection (key 93) into the pedestal assembly (key 105) and the connection to the case exterior at the top of the case.
3. Remove the tubing (key 104).
4. Install the replacement tubing and reconnect the two pressure connections.
5. Apply full remote set point pressure and check for leaks.

Remote Set Point Capsular Element Assembly

Note
Remove the supply pressure gauge before trying to remove the capsular element assembly.

1. Decrease the remote set point pressure to 0 psig.
2. Remove the pressure connection (key 93) at the pedestal assembly (key 105).
3. Disconnect link B (key 126) from the pivot hole on set point indicator assembly.
4. Remove the three mounting screws that attach the capsular element assembly to the process/set point indicator assembly. See figure 6 for location of screws.

NOTICE

In the following step, do not lift out the capsular element assembly by holding the capsule or the linkages. These parts are easily damaged.

5. Lift out the capsular element assembly by holding the plate (key 111), travel stop (key 83), or pedestal assembly (key 105).
6. Align the replacement assembly with the mounting screw holes. Replace the mounting screws.
7. Reconnect the process pressure connection union (key 93). Apply remote set point pressure and check for leaks.
8. Connect the link (key 126) to the pivot hole on the set point indicator assembly.
9. Replace the supply pressure gauge.
10. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Link A

1. Note where link A (key 116) is connected (figure 27). Disconnect both ends of the link from the lever arms on the two pivots.
2. Loosen the screw in the replacement link and adjust the length to match the link being replaced. Tighten the screw. Refer to figure 27 for correct orientation of the link.
3. Attach the replacement link to the two lever arms in the same position as noted in step 1.
4. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Link B

1. Note where link B (key 126) is connected (figure 27). Disconnect both ends of the link from the pivot arm and from the set point indicator assembly.

2. Loosen the screw in the replacement link and adjust the length to match the link being replaced. Tighten the screw.
3. Attach both ends of the replacement link. Refer to figure 28 for correct orientation of the link and position the link as noted in step 1.
4. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Pressure Control Block for Remote Set Point

1. Remove remote set point pressure.
2. Loosen the nut on that portion of the tubing that connects the capsular element to the pressure control block (key 57).
3. Remove the two cap screws (key 58) that hold the pressure control block to the frame (key 3) and lift out the pressure control block.
4. Install the O-ring (key 7) on the replacement pressure control block.
5. Install the replacement pressure control block to the frame with two screws (key 58).
6. Tighten the nut that was loosened in step 2.
7. Apply the maximum value of remote set point pressure and check for leaks.

Remote Set Point Maintenance Calibration

Note

Perform all maintenance calibration procedures upon completion of maintenance. If only zero-and-span or linearity adjustments are required, use only those procedures. Key numbers are referenced in figure 27. Adjustments are shown in figure 5. After maintenance calibration, perform the flapper alignment procedures if directed to do so. Otherwise, go to the appropriate prestartup instructions in the Controller Operation section.

Refer to figure 6 for parts location. Key numbers refer to figure 27.

Remote Set Point Precalibration Procedures

1. Set the proportional band adjustment between DIRECT and REVERSE.
2. Remove the tie bar (key 106).
3. Apply 50 percent of full span remote set point pressure.
4. The drive flexure (key 79) should be straight. If not, proceed as follows:
   a. Loosen the screw on the adjustment arm on pivot assembly A (key 114) and the screws holding the drive flexure.
   b. Set the length of the adjustment arm so the drive flexure is parallel to the centerline of the capsules.
   c. Tighten the screw on the adjustment arm.

Note

The adjustment arm of pivot A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings “float' inside the bearings and do not rest against the end of either bearing.

d. Set pivot A in the middle of the bushing end play.

e. Tighten the screws that hold the drive flexure in place.

5. The guide flexure should also be straight. If not, loosen the screw (key 122) on the end of the flexure that is attached to the top of pivot A (key 114) and allow the flexure to straighten itself. Tighten the screw on the flexure.

Setting Remote Set Point Travel Stops

1. Loosen the set screw in the travel stop nut (key 86).

NOTICE

Make sure the loose travel stop nut does not bind up on the diaphragm capsule extension when pressurizing the capsules. Damage to the capsules could result.

2. Full span stop—Adjust remote set point pressure input to 5 percent greater than full span pressure.

Loosen the screws mounting the travel stop (key 83) to the mounting plate. Slide the travel stop until it is just touching the end of the capsule stack. Tighten the travel stop mounting screws to lock it into that position.

3. Zero stop—Adjust set point differential pressure input to 0 percent of full span.

Slide the travel stop nut (key 86), along the diaphragm capsule extension (key 82) until it is approximately 0.4 mm (1/64 inch) away from the travel stop. Tighten the set screw to lock the travel stop nut in that position.

Aligning Remote Set Point Linkage

1. Adjust the remote set point pressure to the capsules to 50 percent of full span.
2. Set the linearity adjustment screw in the center of the slot on the lever arm of pivot clevis assembly B (key 115).
3. Set the length of link B (key 126) in the middle of its adjustment.
4. Set the length of link A (key 116) so the lever arms of pivots A and B are parallel and that link A is perpendicular to them.
5. To complete maintenance calibration, the zero-and-span adjustments must be set. Refer to the zero-and-span adjustment procedures. If linearity adjustments must also be made, refer to the linearity adjustment procedure.
6. Replace the tie bar (key 106).
7. Refer to the flapper alignment procedure.

Remote Set Point Zero-and-Span Adjustment

1. Decrease the remote set point pressure to 0 psig.
2. Loosen the screw on link A (key 116) and adjust the length so the set point pointer points to scale zero. Tighten the screw.
3. Make fine zero adjustments by loosening the zero adjustment locking screw (key 102) and turning the zero adjustment screw (key 108). Tighten the locking screw. Refer to figure 6 for location of screws.
4. Apply 100 percent of the remote set point pressure input span.
5. To increase the span, proceed as follows:

a. Turn the span adjustment screw clockwise. (Adjust span to correct one-half the error).

b. To increase the span further than the adjustment will allow, move both ends of link A to the right. Refer to figure 6 for link location.

c. Make fine adjustments with the span adjustment screw.

6. To decrease the span, proceed as follows:

a. Turn the span adjustment screw counterclockwise. (Adjust span to correct one-half of the error).

b. To decrease the span further than the adjustment will allow, move both ends of link A to the right. Refer to figure 6 for link location.

c. Make fine adjustments with the span adjustment screw.

7. Repeat the adjustments until the zero-and-span indications are within ±1 percent of input span.
8. Check the pointer position at 50 percent of full pressure input span. If the error is greater than ±1 percent of input span, perform the linearity adjustment procedure.

Remote Set Point Linearity Adjustment

Adjust the linearity by rotating the linearity adjustment screw in the curved slot on the lever arm of the short pivot B (key 115). Adjusting the linearity affects the zero-and-span.

1. Adjust the set point pressure to 50 percent of input span. The set point pointer should indicate the 50 percent mark on the scale.
2. If the pointer indicates high, loosen the linearity screw and rotate it counterclockwise in the slot. If the pointer indicates low, rotate the linearity screw clockwise in the slot.
3. Check the zero-and-span as described in the zero-and-span adjustment procedures. Make any necessary adjustment.
4. Repeat steps 1 through 3 until zero, span, and linearity indications are within ±1 percent of input span.

Auto/Manual Station (suffix letter E)

Note

Each of the following procedures requires that the controller be removed from the case. Refer to steps 1 through 7 found in the procedures for replacing the differential pressure unit. Then, perform steps 1 through 4 of the procedure for replacing the controller case and cover.

Replacing the Auto/Manual Station

Note

This procedure also permits replacement of the switch manifold O-rings (key 312), the auto/manual tubing assembly (key 138), and the frame gaskets (keys 4 and 5).

Disassembly

Refer to figures 29 and 30 for key number location.

1. Loosen the screw (key 316) that holds the auto/manual station (key 273) to the controller frame.
2. Loosen the two screws (keys 314 and 315) that hold the auto/manual station to the auto/manual tubing assembly (key 138).
3. Remove the auto/manual station from the controller frame.
4. Remove the switch manifold O-rings (key 312).
5. Carefully loosen the nut on the relay nozzle tubing assembly (key 18, figure 26) where it connects to the auto/manual tubing assembly (key 138). Loosen three screws (keys 34 and 131) and remove the tubing assembly and body gaskets (keys 4 and 5).
6. Inspect the gaskets (keys 4 and 5) and O-rings (key 312) for wear. Replace if necessary.

Assembly

1. Install the gaskets and the tubing assembly to the frame. Start, but do not tighten, the three screws (keys 34 and 131) and the nut on the nozzle tubing assembly (key 18).
2. Install the three O-rings (key 312) and secure the auto/manual station to the controller frame with the screw (key 316) and to the tubing assembly (key 138) with two screws (keys 314 and 315). Do not tighten any screws.

NOTICE

In the next step, take care to tighten the two screws (keys 314 and 315) evenly. Uneven tightening could damage the tubing assembly.

3. Position the auto/manual station as far down on the frame and toward the scale as possible. Carefully tighten the two screws (keys 314 and 315) so the auto/manual station contacts the three pads on the tubing assembly.
4. Carefully tighten the remaining screws and nuts.
5. Apply air pressure to the controller and check for leaks.
6. Install the controller assembly in the case. Slide the controller frame down to assure an O-ring seal at the pressure connections. Hold the frame in place.
7. Install and tighten the nine screws that hold the controller assembly in the case.
8. Refer to the flapper alignment procedure.

Replacing the Auto/Manual Station Switch Body Assembly, Lever O-ring, Switch Body O-ring, and the Tubing Assembly

Disassembly

Refer to figure 28 for key number locations.

1. Remove the auto/manual station from the controller frame as described in steps 1 through 4 of the procedure for replacing the auto/manual station.
2. Loosen the two screws (key 288) and remove the lever cover plate (key 305).

⚠ WARNING

The lever spring (key 302) is under preload. To avoid personal injury or parts loss, carefully disassemble the auto/manual station.

3. Using a 1.5 mm (1/16-inch) punch, push the groove pin (key 303) out toward the surface of the lever cover plate.

Note

When removing the groove pin, hold onto the switch lever (key 304) and slowly pull the switch lever from the lever assembly shaft (key 297). Then, remove the lever spring (key 302) and lever spring seat (key 301).

4. Remove the switch lever (key 304), lever spring (key 302), and lever spring seat (key 301).
5. Remove the tubing assembly (key 309).

⚠ WARNING

The switch body springs (key 295) are under preload. To avoid personal injury or parts loss, carefully separate the switch body assembly from the loader assembly.

6. Loosen the two screws (key 290) and separate the switch body assembly (key 291) from the loader assembly (key 282).
7. Remove the O-rings (keys 292, 293, and 294), switch body springs (key 295), and balls (key 296).
8. Loosen two screws (key 308). Remove the closing plate (key 307) and the closing plate gasket (key 306).
9. Pull the clip (key 300) from its engagement with the shaft of the lever assembly (key 297).
10. Pull the lever assembly from the switch body assembly (key 291) and rocker (key 299).
11. Remove the O-ring (key 298).
12. Inspect the O-rings and the gaskets for damage or wear and replace if necessary.

Assembly

1. Insert the lever assembly (key 297) into the switch body assembly (key 291) and hold the rocker (key 299) with the flats on the lever assembly shaft.
2. Insert the clip (key 300) in the groove of the lever assembly shaft to hold the lever assembly (key 297) in the switch body assembly (key 291).
3. Position the closing plate gasket (key 306) and the closing plate (key 307). Secure with two screws (key 308).

Note

After assembly in step 3, be sure the side of the closing plate marked OUT is visible.

4. Place the balls (key 296), switch body springs (key 295), and O-rings (keys 292, 293, and 294) in the switch body (key 291).

Note

In the following step, the ends of the springs must be in the counterbored spring seats before compression.

5. Compress the switch body springs with the loader assembly (key 282) and bolt the switch (key 291) to the loader assembly using the two screws (key 290).
6. Reconnect the tubing assembly (key 309).
7. Locate the lever spring (key 302) and the spring seat (key 301) on the switch lever (key 304) and position these parts in the opening of the loader assembly (key 282).
8. Push the switch lever down, using the lever spring seat (key 301) and the lever assembly (key 297) to preload the spring. Make sure the notch of the switch lever engages the pin of the lever assembly.
9. Drive in the groove pin (key 303) to hold the switch lever.
10. Replace the lever cover plate (key 305) and attach with two screws (key 288).
11. Perform the assembly portion of the replacing the auto/manual station procedure.

Replacing Auto/Manual Station Loader Range Spring, Diaphragm Assembly, Ball Seat, Tubing, and Ball

Disassembly

Refer to figure 28 for key number location.

1. Remove the auto/manual station from the controller frame as described in steps 1 through 4 of the procedure for replacing the auto/manual station.
2. Remove tubing assembly (key 309).

⚠ WARNING

To avoid personal injury caused by preload from the range spring (key 282), turn the loader knob (key 287) counterclockwise (opposite to the arrow) to relieve pressure on the spring.

3. Loosen the four screws (key 289) and separate the loader assembly (key 282) and the lower loader assembly (key 274).
4. Remove the loader range spring (key 283), range spring cup (key 284), and diaphragm assembly (key 281).
5. Remove the tube (key 278), ball seats (key 280), and ball (key 279).

Assembly

1. Turn the loader knob (key 287) counterclockwise to back the spring adjusting screw (key 285) all the way out to eliminate loading the range spring.
2. Position the range spring cup (key 284), the range spring (key 283), and the diaphragm assembly (key 281) on the loader assembly (key 282).
3. Position the ball (key 279), the tube (key 278), and the ball seats (key 280) between the ears of the loader assemblies (keys 282 and 274); position the diaphragm assembly (key 281) between the main halves of the loader assemblies.

Note

The tube (key 278) must be well-seated in the cups of the ball seats (key 280).

4. Bolt the loader assembly halves together using the four screws (key 289).

Note

Be sure that the supply and exhaust seats of the loader are correctly aligned. Misalignment will impair loader performance.

5. Attach the tubing assembly (key 309).
6. Perform the assembly portion in the replacing the auto/manual station procedure.

Replacing the Auto/Manual Station Loader Valve Plug and Valve Plug Spring

Refer to figure 30 for key number location.

1. Loosen the spring seat screw (key 275).
2. Remove the valve plug spring (key 276) and the valve plug (key 277).
3. Inspect the parts and replace as necessary.
4. Install the valve plug spring and valve plug.
5. Tighten the spring seat screw.
6. Temporarily apply supply pressure and process differential pressure and check for leaks.
7. Install the controller assembly in the case. Slide the controller frame down to assure an O-ring seal at the pressure connections. Hold the frame in place.
8. Install and tighten the nine screws that hold the controller assembly in the case.

Parts Ordering

Whenever corresponding with your Emerson sales office about this equipment, always mention the controller serial number.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson should not, under any circumstances, be used in any Fisher instrument. Use of components not supplied by Emerson may void your warranty, might adversely affect the performance of the instrument, and could cause personal injury and property damage.

Parts Kits

Description	Part Number
4190 Controller Auto/Manual Repair Kit Contains keys 277, 278, 279, 281, 292, 293, 294, 295, 298, 306, 312	R4190X0AM12
4190 Controller Auto/Manual Retrofit Kit Contains keys 138, 273, 312, 313, 314, 315, 316	
Brass tubing	R4190X00B12
SST tubing	R4190X00S12

Description	Part Number
4190 Controller Case Handle Kit	
Contains lever and mounting hardware	R4190X00H12
4190 Controller Repair Kit	
Contains keys 4, 5, 7, 8, 24, 52	R4190X00C12
4190 Controller Pointer and Bracket Repair Kit	
Contains pointer and bracket ass'y, three machine screws, three washers	R4190X00P12
4190 Controller Relay Replacement Kit	
Contains Relay Assembly, key 50	
0.2 to 1.0 bar (3 to 15 psig)	RRELAYX83C2
0.4 to 2.0 bar (6 to 30 psig)	RRELAYX83D2

Parts List

Note
Contact your Emerson sales office for Part Ordering information.

Controller Parts (figure 26)

Key	Description
1	Case and cover ass'y
2	Nameplate
3	Frame
4*	Gasket for use between internal frame and frame manifold (key 135)
5*	Gasket for use between frame manifold (key 135) and positive feedback tubing manifold (key 136)
6	Machine screw, fill hd (6 req'd)
7*	O-ring (2 req'd)
8*	O-ring (3 req'd)
9	Flexure pivot ass'y
10	Machine screw, fill hd (4 req'd)
11*	Flapper ass'y
12	Cap screw, hex socket For flapper ass'y (key 11) (2 req'd)
17	Adjustable set point pivot ass'y
18	Relay nozzle tubing ass'y
19	Machine screw, fill hd (3 req'd)
20	Plain washer (2 req'd)
21	Nozzle ass'y
22	Washer
23	Set point beam ass'y
24*	O-ring (2 req'd)
25	Proportional band knob
26	Retaining clip
27	E-ring
28	Set point beam bias spring
29	Set point beam shoe
30	Cap screw, hex socket (2 req'd)
31	Bellows bracket
32	Bellows adj bracket
33	Bellows adj spring
34	Machine screw, fill hd (2 req'd)
35	Machine screw, hex hd (2 req'd)
36	Proportional band indicator cover
37	Self-tapping screw For indicator ass'y (key 101) (4 req'd)
38	Self-tapping screw (9 req'd)
39	Supply gauge tubing ass'y
41	Plug
45	Positive Feedback Tubing Assembly

Note
One type of pressure gauge is used for both output pressure and supply pressure indication.

46*	Output gauge
47*	Supply gauge
48*	Bellows ass'y (2 req'd)
49	Bellows beam 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig)
50	Relay Assembly The relay assembly is included in the Replay Replacement kit Relay, 0.2 to 1.0 bar (3 to 15 psig) Relay, 0.4 to 2.0 bar (6 to 30 psig)
51	Relief valve cover plate
52*	O-ring
53	Machine screw, fill hd (2 req'd)
56	Process and set point indicator ass'y w/o remote set (for 4194HS and 4194HSE) w/remote set (for 4194HSM and 4194HSME)

Note
Key 56 is the complete process and set point indicator ass'y. Individual indicator ass'y parts are listed in two subsections of this parts list: the Process and Set Point Indicator Assembly (key 56) subsection and the Indicator Assembly (key 101) subsection. Key numbers for individual indicator parts also appear in figures 29 and 30.

*Recommended spare parts

Key	Description
57	Pressure control block (w/remote set only) 1/4-18 NPT internal process connection
58	Cap screw, hex hd for use w/pressure control block (key 57), w/remote set point (2 req'd)
61	Process scale for indicator ass'y 0-5 psid 0-10 psid 0-15 psid 0-20 psid 0-30 psid 0-40 psid 0-50 psid 0-60 psid 0-75 psid 0-250 mbar differential 0-0.6 bar differential 0-1.4 bar differential 0-1.6 bar differential 0-2.0 bar differential 0-20 in. w.c. differential 0-25 in. w.c. differential 0-50 in. w.c. differential 0-75 in. w.c. differential 0-100 in. w.c. differential 0-100 percent 0-10 square root 0-100 square root
62	Remote set point ass'y (suffix letter M) (for 4194HSM and HSME only) 0.8 bar (12 psig) span 1.7 bar (24 psig) span

Note
Key 62 is the complete remote set point (suffix letter M) assembly. Individual assembly parts are listed in the Remote Set Point Assembly subsection of the parts list. Key numbers for individual assembly parts also appear in figure 27.

Key	Description
63	Machine screw, pan hd (2 req'd)
64	Machine screw, fill hd (4 req'd)
65	Feedback link ass'y
71	Machine screw, fill hd (4 req'd)
72	Blowout plug

Key	Description
101	Indicator ass'y For use w/o remote set point For use w/remote set point

Note
Key 101 is the indicator ass'y without a differential pressure unit attached. Individual key numbers are listed in the Indicator Assembly subsection of this parts list. Key numbers for individual assembly parts also appear in figure 30.

Key	Description
120	Machine screw, fill hd For 4194HSM and HSME only. Required to mount remote set point ass'y (suffix letter M) to indicator ass'y (2 req'd)
131	Machine screw, fill hd (2 req'd)
135	Frame manifold (for 4194HS and HSM only)
136	Rate/reset (positive feedback) manifold

Note
Key 136, rate/reset manifold, is used as a positive feedback manifold in this unit.

Key	Description
138	Auto/manual tubing ass'y Use w/suffix letter E, int auto/manual station option (for 4194HSE and HSME only)
140	Machine screw, fill hd For 4194HSM and HSME only. Required to mount remote set point ass'y (suffix letter M) to indicator ass'y (2 req'd)
162	Machine screw, hex hd
310	Lithium Grease (not furnished with controller)
311	Anti-Seize Sealant (not furnished with controller)
317	Silicone based lubricant (not furnished with controller)
318	Lubricant, silicone sealant (not furnished with controller
337	Barton 199 Differential Pressure Unit Key 337 includes the pipestand mounting bracket and three set screws (square hd, 3/8-16 x 5/8-inch)
362	Spring retaining washer
365	Washer

Key	Description

Process and Set Point Indicator Assembly (key 56) (figure 29)

101	Indicator ass'y For use w/o remote set point For use w/remote set point
319	Support bracket
320	Pivot bracket ass'y
321	Shaft extension
322	Drive arm ass'y
323	Zero link ass'y
324	Clamp block
325	Nut (2 req'd)
326	Boot
327	Mounting plate (for differential pressure unit)
328	Controller mounting plate
329	Machine screw, pan hd (2 req'd)
330	Machine screw, fill hd (2 req'd)
331	Machine screw, fill hd
332	Plain washer (2 req'd)
333	Set screw, hex socket (2 req'd)
334	Cap screw, hex hd (4 req'd)
335	Cap screw, hex hd (3 req'd)
336	Cap screw, hex hd (4 req'd)

Remote Set Point Assembly (key 62) (figure 27)

12	Cap screw, hex socket (2 req'd)
13	Plain washer (3 req'd)
79	Drive flexure
80	Diaphragm capsule ass'y, for remote set point ass'y 1 bar (15 psig) span 1.6 bar (24 psig)
83	Travel stop
86	Travel stop nut
87	Set screw, hex socket
93	Union
99	Plain washer
102	Machine screw, fill hd (4 req'd)
103	Machine screw, pan hd (2 req'd)
104	Remote set point tubing ass'y
105	Pedestal ass'y
106	Tie bar
107	Spring
108	Zero adj screw
109	Pivot screw
110	Zero adj bracket
111	Mounting plate
112	Spring washer
114	Pivot clevis ass'y A
115	Pivot clevis ass'y B

Key	Description
116	Connecting link ass'y
118	Cap screw, hex socket
119	Guide flexure
121	Drive bracket
122	Machine screw, fill hd (2 req'd)
123	Plain washer
124	Nut, Hex
125	Spacer
126	Connecting link ass'y
134	Diaphragm ass'y extension
139	Machine screw, fill hd (3 req'd)
141	Adj arm
311	Anti-Seize Sealant (not furnished with controller)

Indicator Assembly (key 101) (figure 30)

37	Self-tapping screw (4 req'd)
61	Process scale — See key 61 under Controller Parts
353	Machine screw, pan hd (4 req'd)
366	Controller Mounting Plate
367	Support bracket ass'y
368	Link ass'y (2 req'd)
369	Process pointer adj ass'y
370	Set point pointer ass'y
371	Pivot pin (2 req'd)
372	Washer, plain (4 req'd)
374	Pointer and bracket ass'y
375	Set point indicator ass'y for controllers w/remote set point for controllers w/o remote set point
376	Dial Bracket
377	Dial bracket
378	Screw, self-tapping (2 req'd)

Auto/Manual Station (suffix letter E) (figure 28)

138	Auto/manual tubing ass'y (suffix letter E)
273	Auto/manual station
274	Lower loader ass'y
275	Spring seat screw
276	Valve plug spring (“music wire”)
277*	Valve plug
278	Tube
279	Ball
280	Ball seat (2 req'd)
281	Diaphragm ass'y
282	Loader ass'y
283	Range spring

Key	Description
284	Range spring cup
285	Spring adj screw
286*	Retaining ring
287	Loader knob
288	Machine screw, rd hd (2 req'd)
289	Machine screw, fill hd (4 req'd)
290	Machine screw, fill hd (2 req'd)
291	Switch body ass'y
292*	O-ring
293*	O-ring
294*	O-ring
295	Switch body spring (“music wire”) (2 req'd)
296	Ball (2 req'd)
297	Lever ass'y
298*	O-ring
299	Rocker arm
300	Clip
301	Lever spring seat
302	Lever spring (“music wire”)
303*	Groove pin
304	Switch lever
305	Switch lever cover plate
306*	Closing plate gasket
307	Closing plate
308	Machine screw, pan hd (2 req'd)
309	Continuous output tubing ass'y
310	Lithium Grease (not furnished with controller)
311	Anti-Seize Sealant (not furnished with controller)
312*	O-ring (3 req'd)
313	Auto/Manual scale
314	Machine screw, fill hd
315	Machine screw, fill hd
316	Machine screw, fill hd

Controller Mounting Parts

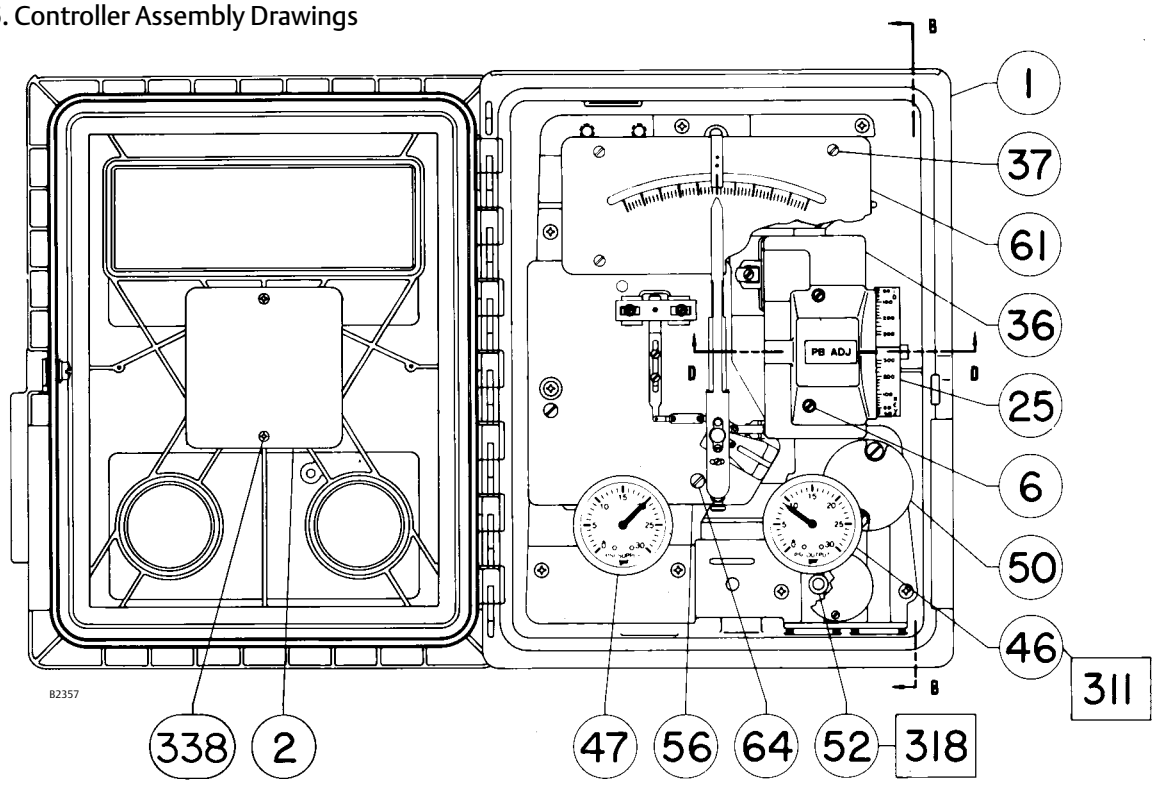
Note
Specify quantity of fittings required.

Fittings

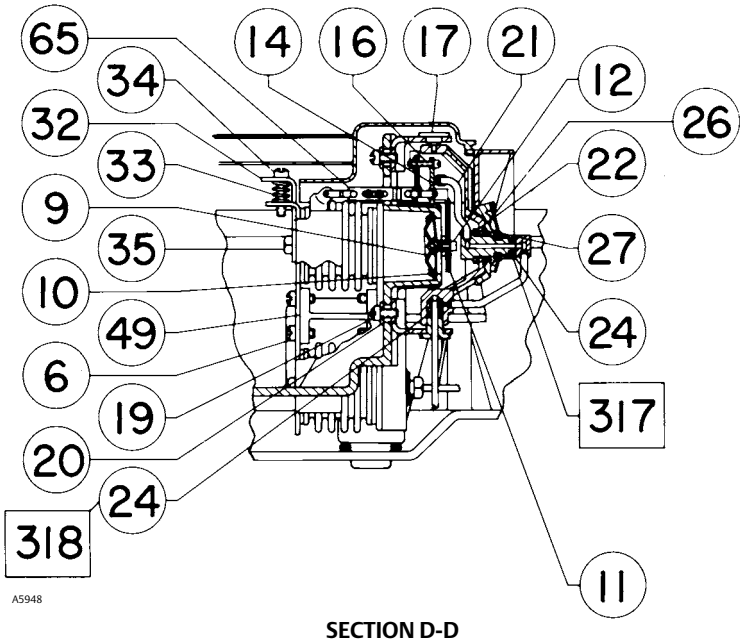
For 1/4 inch or 3/8 inch tubing
- Connector
- Elbow

*Recommended spare parts

Figure 26. Controller Assembly Drawings

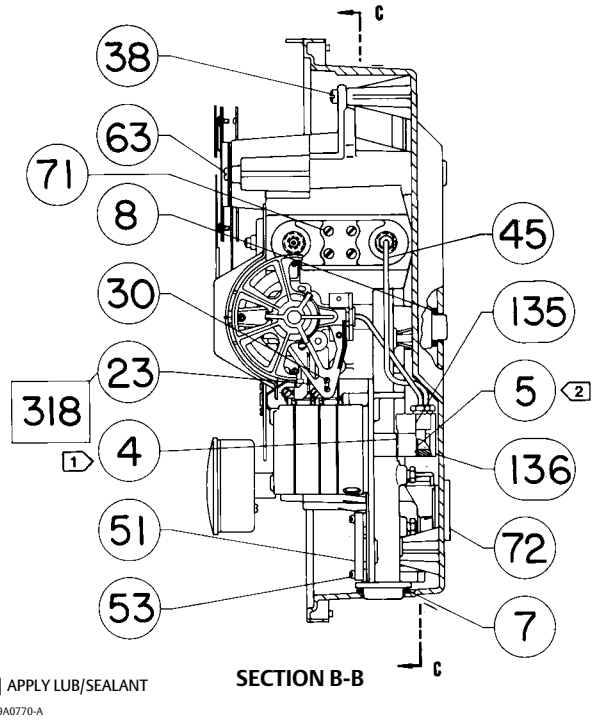


CONTROLLER COMMON PARTS



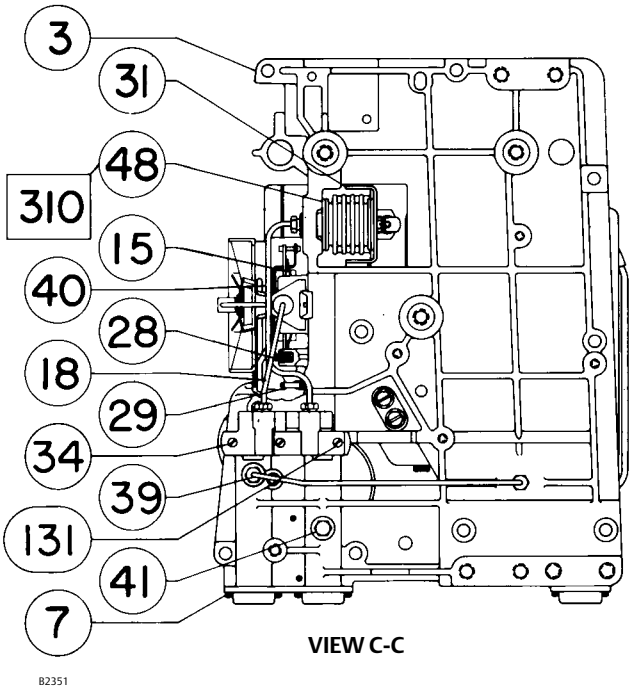
SECTION D-D

Figure 26. Controller Assembly Drawings (Continued)



NOTES:

1 KEY 4, GASKET, IS USED BETWEEN INTERNAL FRAME AND FRAME MANIFOLD
2 KEY 5, GASKET, IS USED BETWEEN FRAME MANIFOLD AND POSITIVE FEEDBACK TUBING MANIFOLD.



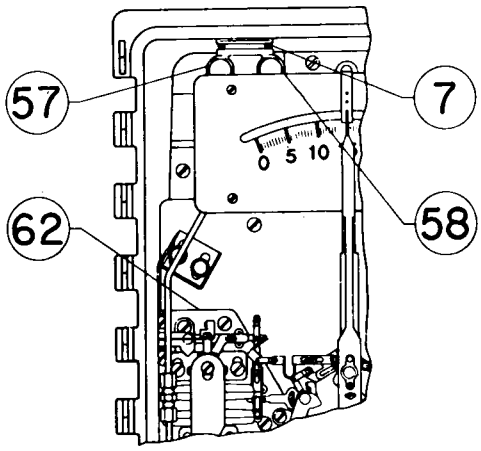


Figure 27. Remote Set Point Assembly

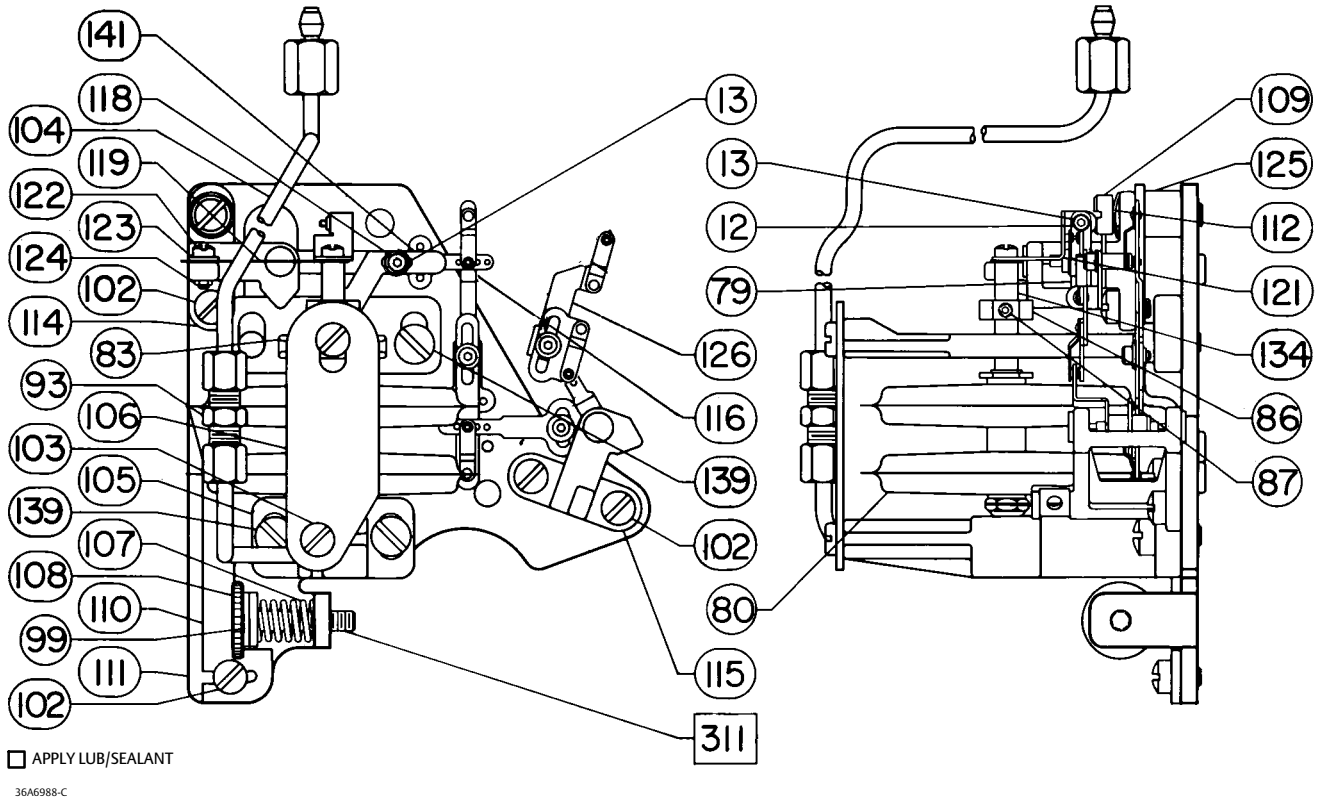


Figure 28. Auto/Manual Station

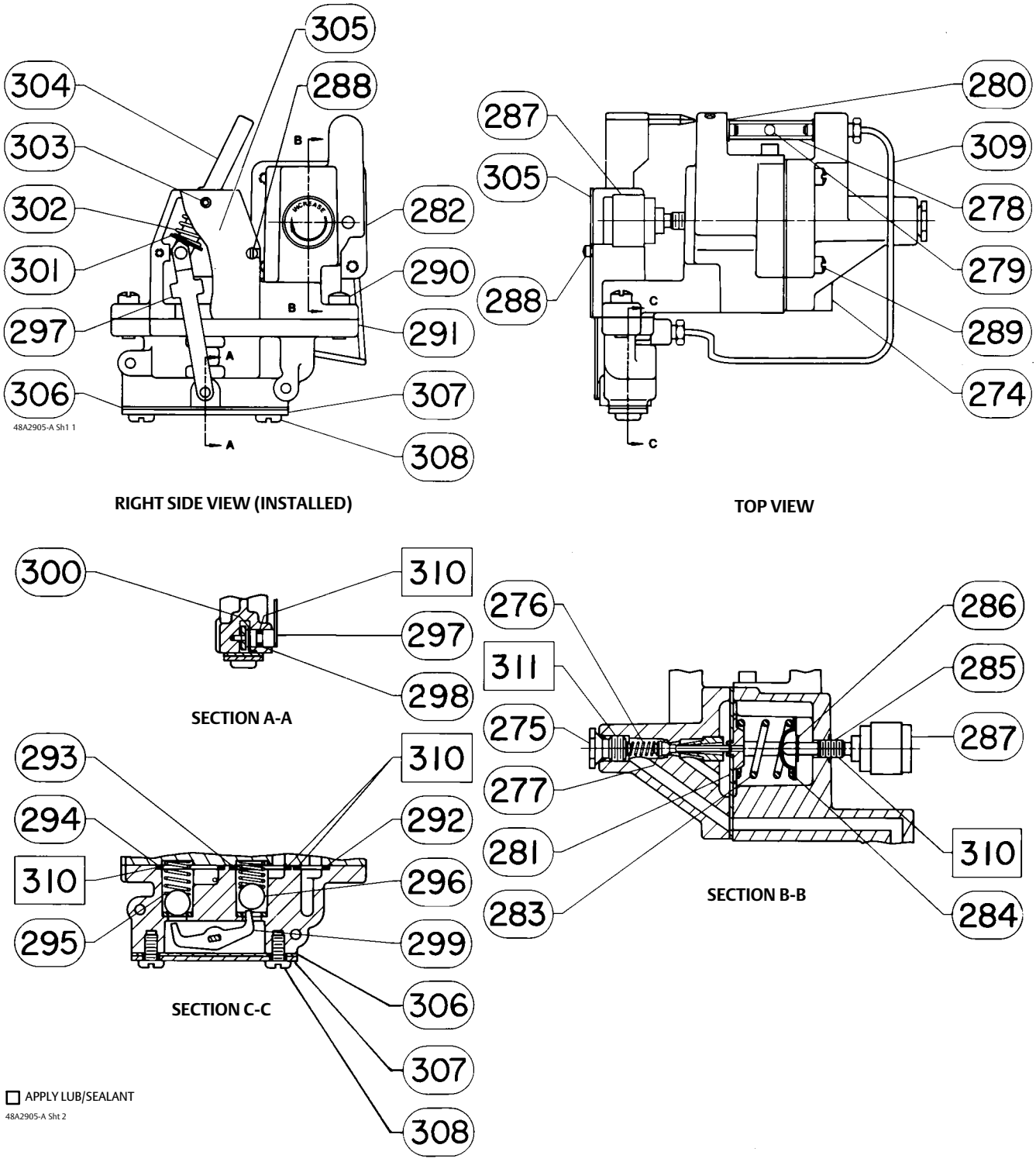


Figure 28. Auto/Manual Station (Continued)

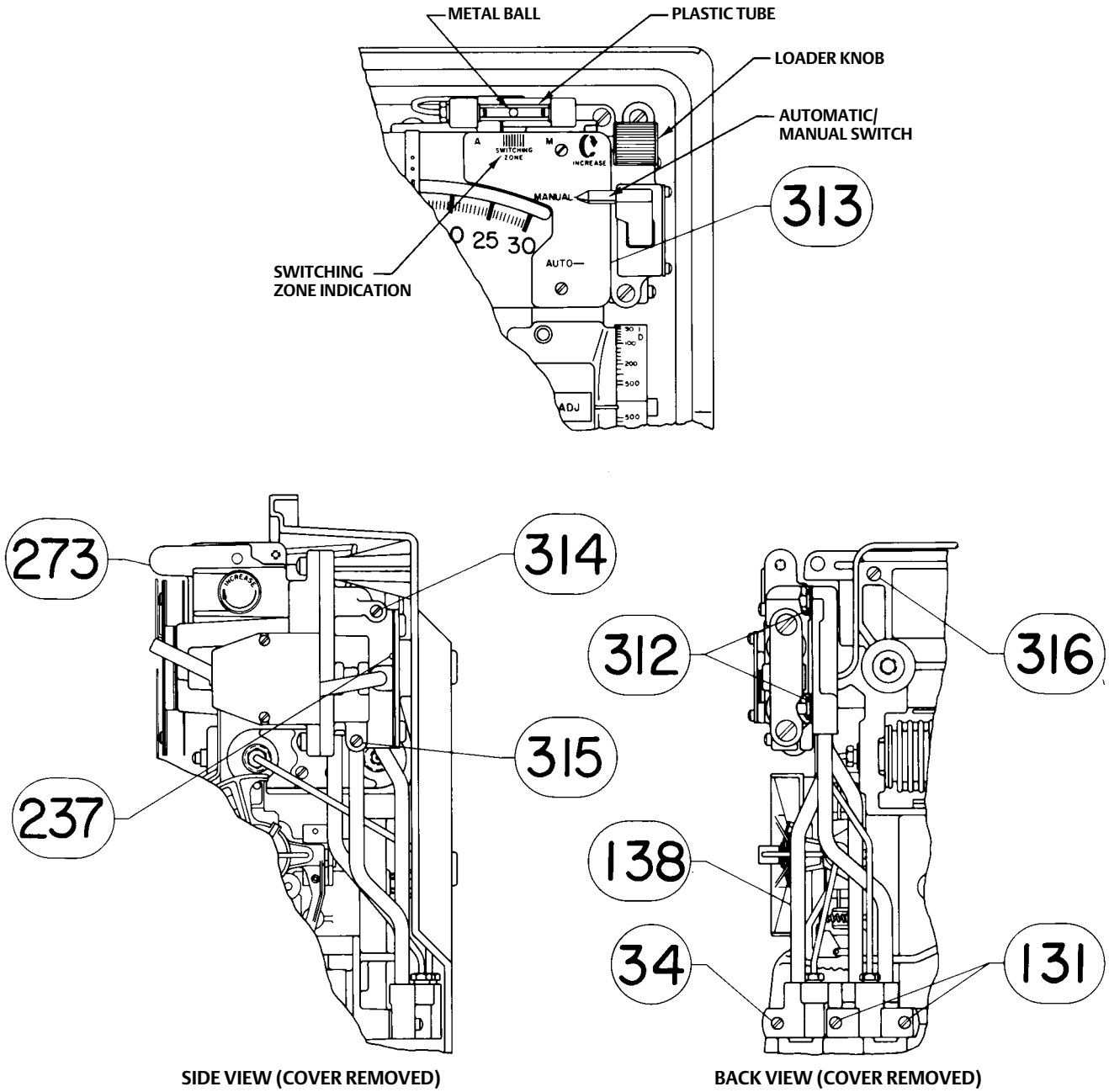


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Figure 29. Process and Set Point Indicator Assembly with Differential Pressure Unit

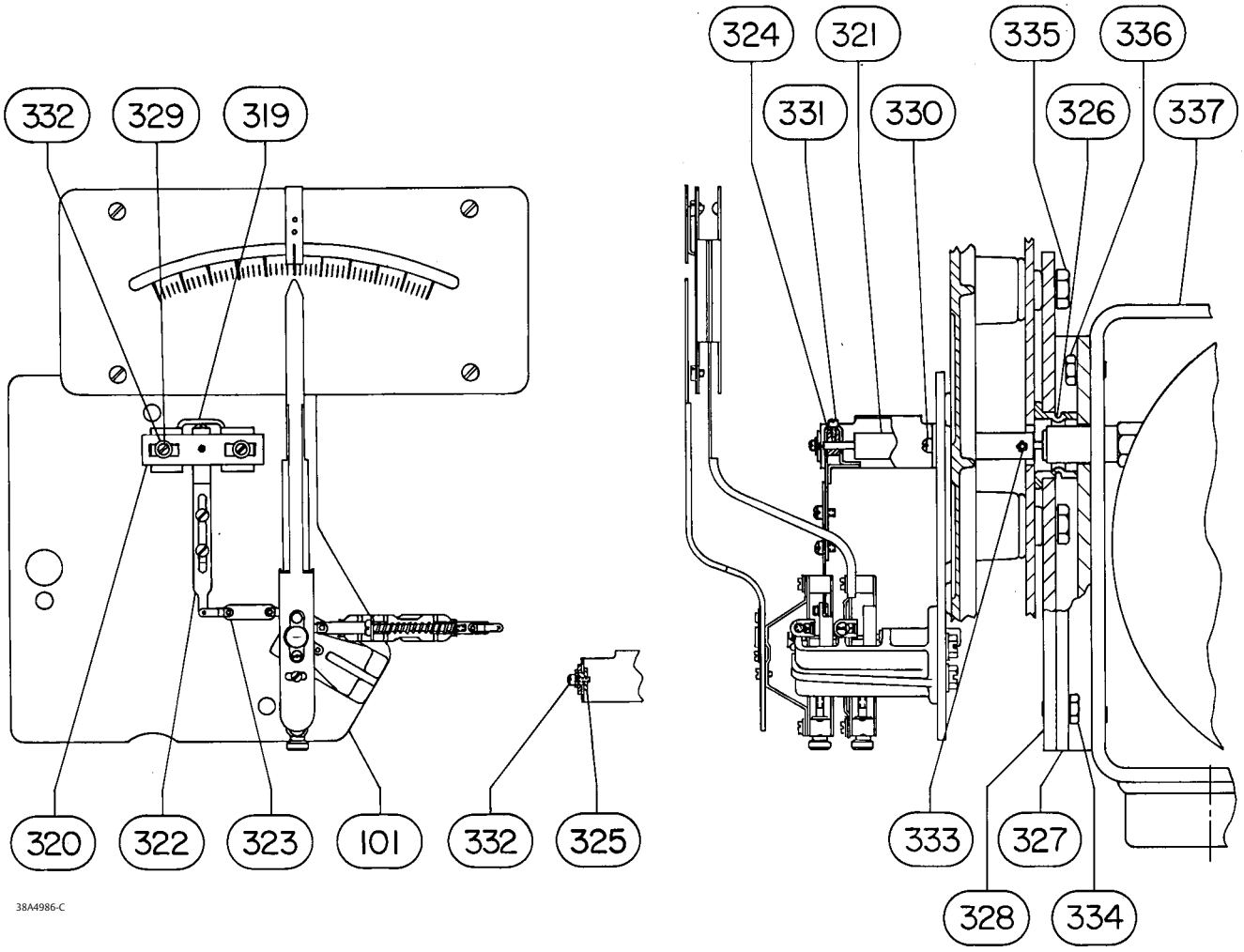
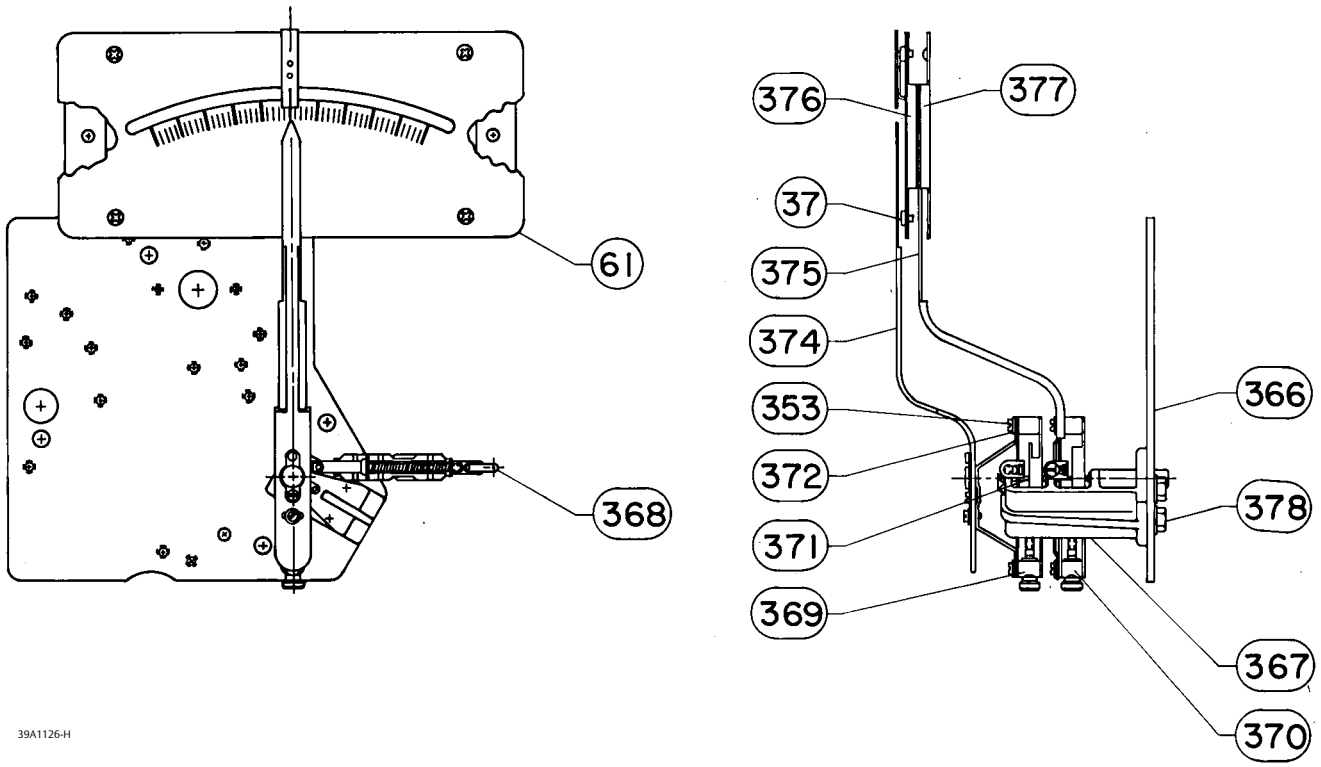


Figure 30. Process and Set Point Indicator Assembly (Manual Set Point)



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