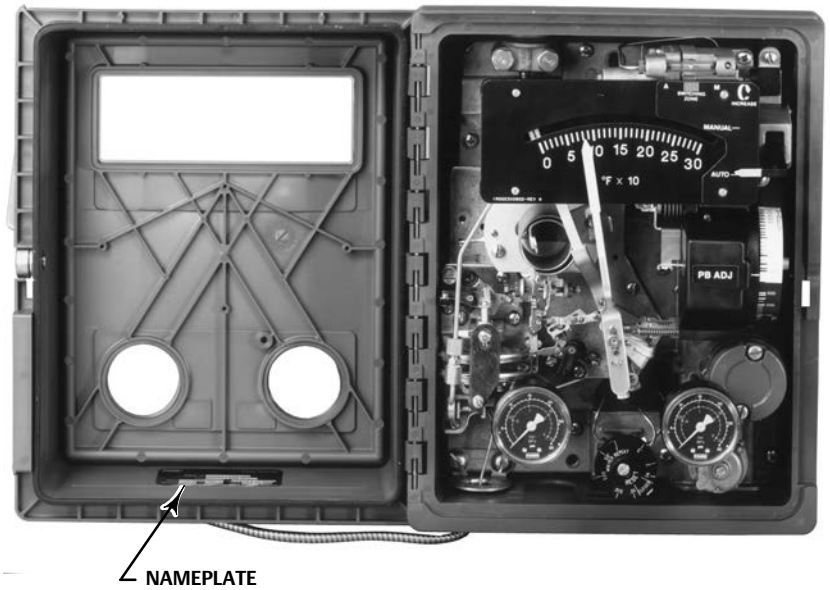
Fisher™ 4196A, B, C, and S Temperature Indicating Controllers

Contents

Contents (cont'd)

Figure 1. Fisher 4196 Temperature Controllers



INTERIOR OF CONTROLLER

Contents (cont'd)

Section 1 Introduction

Scope of Manual

This instruction manual provides installation, operating, calibration, maintenance, and parts ordering information for Fisher 4196A, 4196B, 4196C, and 4196S temperature indicating controllers.

Portions of this manual apply only to specific configurations in the 4196 controller configurations. These configurations are indicated by letter suffixes in the type number that correspond to the mode and option designated in table 2.

The specific controller type number (with letter suffixes) is on the nameplate shown in figure 1. Refer to table 2 for the definition of each 4196 type number.

Do not install, operate, or maintain a 4196 temperature indicating controller without being fully trained and qualified in field instrument 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.

Description

The controllers described in this manual provide temperature control with options as shown in table 1.

- 4196A: Proportional-only control
- 4196B: Proportional-plus-reset control
- 4196C: Proportional-plus-reset-plus-rate control
- 4196S: Differential gap control

These controllers show process temperature and set point on an easy-to-read process scale. The controller output is a pneumatic signal that operates a final control element.

Specifications

Specifications for the 4196A, B, C, and S controllers are listed in table 1.

⚠ 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.

Educational Services

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Table 1. Specifications

Available Configurations

See table 2

Process Sensor Range (Input Signal)

Type: Temperature between -73 and 371°C (-100 and 700°F). See table 4 for available ranges
Minimum Span: 60°C or 100°F
Maximum Span: 300°C or 600°F

Output Signal

Proportional-Only, Proportional-Plus-Reset, or Proportional-Plus-Reset-Plus-Rate Range: 0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.0 bar (6 to 30 psig)
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 sensed temperature increases output pressure) or reverse (increasing sensed temperature decreases output pressure)

Process Scale

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

Supply and Output Connections

1/4 NPT internal

Supply Pressure Requirements

See table 3

Supply Pressure Medium

Air or Natural Gas

Supply medium must be clean, dry, and noncorrosive

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 Pressures

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

Maximum Allowable Pressure In Closed Vessel (For Temperature Bulb)(2)

9.7 mm (3/8-inch) Diameter Temperature Bulb:
69 bar (1000 psig)
14.3 mm (9/16-inch) Diameter Temperature Bulb:
34.5 bar (500 psig)
Also, see tables 5 and 6 for thermowell maximum process fluid velocities and maximum process pressures.

Controller Adjustments

Proportional Band: 5 to 500% of process scale range
Reset: Adjustable from 0.01 to more than 74 minutes per repeat (from 100 to less than 0.0135 repeats per minute)
Rate: Adjustable from 0 to 20 minutes
Differential Gap Controller: 5 to 100% of process scale range
Set Point: Adjustable from 0 to 100% of the scale range

Controller Performance

Repeatability: 0.4% of output span
Dead Band: Less than 0.3% of process scale span
Time Constant of Temperature Bulb: 6 to 12 seconds for a 93°C (200°F) span (bare bulb in agitated liquid)

Steady-State Air Consumption (A, B, and C Controllers)(3)

Without Auto/Manual Station
0.2 to 1.0 Bar (3 to 15 psig) Output:
0.08 m^3/hr (2.8 scfh)
0.4 to 2.0 Bar (6 to 30 psig) Output:
0.07 m^3/hr (2.5 scfh)

With Auto/Manual Station (suffix letter E)
Add 0.01 m^3/hr (0.5 scfh)

Steady-State Air Consumption Differential Gap (S Controllers)(3)

0 and 1.4 bar (0 and 20 psig) Output:
0.08 m^3/hr (2.8 scfh)
0 and 2.4 bar (0 and 35 psig) Output:
0.07 m^3/hr (2.5 scfh)

Operative Ambient Temperature Limits

-40 to 70°C(-40 to 160°F)

-continued-

Table 1. Specifications (continued)

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

Mounting

Controller can be mounted on actuator, panel, wall, or pipestand.

Approximate Weight

4.5 kg (10 pounds)

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* EC 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. At 40°C (100°F).
3. Normal m^3/hr-Normal cubic meters per hour (0°C and 1.01325 bar, absolute); Scfh-Standard cubic feet per hour (60°F and 14.7 psia).

Table 2. Available Configurations

Controller(1)		Modes				Options		
		Proportional-Only (One-Mode Controllers)	Proportional-Plus-Reset (Two-Mode Controllers)	Proportional-Plus-Reset-Plus-Rate (Three-Mode Controllers)	Differential Gap (Snap-Acting Controllers)	Internal Auto/Manual Station (Suffix Letter E)	Anti-Reset Windup (Suffix Letter F)	Remote Set Point (Suffix Letter M)
4196A	4196A	X	---	---	---	---	---	---
	4196AE	X	---	---	---	X	---	---
	4196AM	X	---	---	---	---	---	X
	4196AME	X	---	---	---	X	---	X
4196B	4196B	---	X	---	---	---	---	---
	4196BE	---	X	---	---	X	---	---
	4196BF	---	X	---	---	---	X	---
	4196BFE	---	X	---	---	X	X	---
	4196BM	---	X	---	---	---	---	X
	4196BME	---	X	---	---	X	---	X
	4196BFM	---	X	---	---	---	X	X
	4196BFME	---	X	---	---	X	X	X
4196C	4196C	---	---	X	---	---	---	---
	4196CE	---	---	X	---	X	---	---
	4196CF	---	---	X	---	---	X	---
	4196CFE	---	---	X	---	X	X	---
	4196CM	---	---	X	---	---	---	X
	4196CME	---	---	X	---	X	---	X
	4196CFM	---	---	X	---	---	X	X
	4196CFME	---	---	X	---	X	X	X
4196S	4196S	---	---	---	X	---	---	---
	4196SE	---	---	---	X	X	---	---
	4196SM	---	---	---	X	---	---	X
	4196SME	---	---	---	X	X	---	X

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

Table 3. Supply Pressure Data

Output Signal Range		Normal Operating Supply Pressure(1)	Maximum Pressure to Prevent Internal Part Damage(2)
Metric Units	0.2 to 1.0 bar 0.4 to 2.0 bar	1.4 bar 2.4 bar	2.8 bar 2.8 bar
U.S. Units	3 to 15 psig 6 to 30 psig	20 psig 35 psig	40 psig 40 psig

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

Table 4. Available Temperature Ranges of Temperature Bulbs(1)

Temperature Span			Element Range	Operating Range	Temperature Bulb Diameter	Overrange Limits(2)		Maximum Temperature(3)
	°C Minimum	°C Maximum	°C	°C	mm	°C Minimum	°C Maximum	°C
Metric Units	100	100	0 to 100	-15 to 150	9.5	-10	150	230
			50 to 150			40	200	
			-15 to 85			-25	135	
	150	150	0 to 150	-30 to 160		-15	225	
	60	60	-20 to 40	-30 to 95	14.3	-26	70	190
			0 to 60	-30 to 95		-6	90	
			60 to 120	38 to 150		54	150	
	150	150	-75 to 75	-75 to 135		-90	150	400
			50 to 200	-5 to 200		35	275	
	170	200	0 to 200	-75 to 230		-20	300	
	275	300	0 to 300	-75 to 370		-30	450	590
	°F Minimum	°F Maximum	°F	°F	Inch	°F Minimum	°F Maximum	°F
U. S. Units	175	200	0 to 200	0 to 300	3/8	-20	300	450
			50 to 250			30	350	
			100 to 300			80	400	
	250	300	0 to 300	-25 to 325		-30	450	
	100	100	0 to 100	-25 to 200	9/16	-10	150	375
			50 to 150			40	200	
			100 to 200	75 to 300		65	250	
	125	150	0 to 150	-25 to 225		-15	225	
			50 to 200			35	275	
	270	300	-100 to 200	-100 to 275		-130	350	750
			100 to 400	25 to 400		70	550	
	300	400	0 to 400	-100 to 450		-40	600	
	525	600	0 to 600	-100 to 700		-60	900	1100

1. Contact your Emerson sales office about other spans and ranges.
2. All temperature bulbs are tested to+50 percent of overrange limits. With travel stops in place,if the overrange limits are exceeded, the controller may require recalibration.
3. With travel stops in place, temperatures in excess of these values may cause permanent damage to the temperature element.

Section 2 Installation

⚠ 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 preventive measures are not taken. Preventive 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 16.**
- **If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

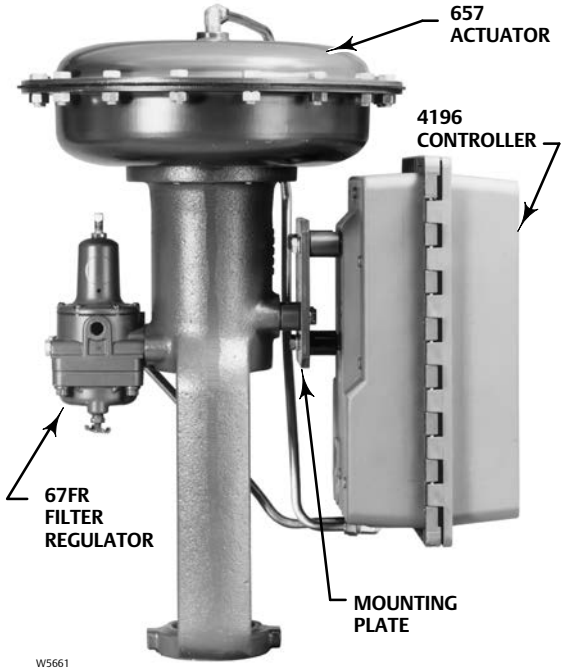
NOTICE

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.

Controller Mounting Orientation

Mount the controller with the housing vertical, as shown in figure 2, so that the vent points down.

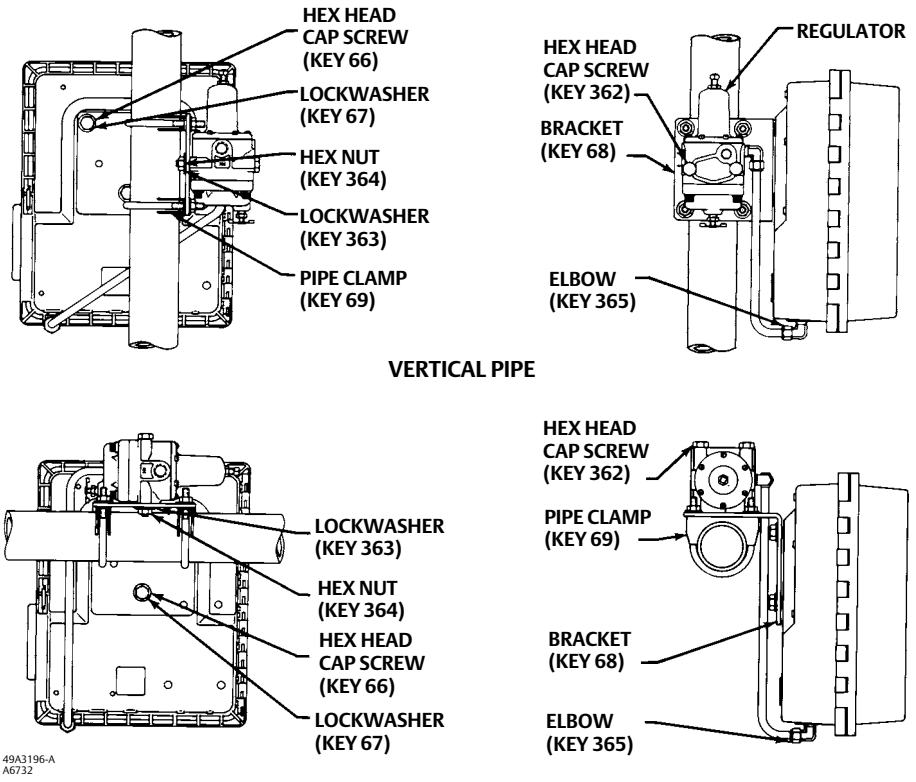
Figure 2. Typical Actuator Mounting



Pipestand Mounting

Refer to figure 3. Pipestand mounting parts are provided to mount the controller to a 2-inch (nominal) pipe. Attach a bracket (key 68) to the controller with cap screws (key 66) and lock washers (key 67). Attach two clamps (key 69) to the bracket, and fasten the controller to the pipe.

Figure 3. Pipestand Mounting



Panel Mounting

Using the Panel Mounting dimensions shown in figure 4, cut a hole in the panel surface. Slide the controller into the hole and attach the bracket (key 68) to the rear of the controller using three cap screws (key 66) and washers (key 67). Tighten the screws (key 70) to seat the case snugly and evenly against the panel surface.

Wall Mounting

Using the Wall Mounting dimensions in figure 5, drill holes in the wall to align with the four holes in the bracket (key 68). If the tubing is to run through the wall, drill a hole in the wall large enough to accept the tubing.

Mount the controller to the bracket using three cap screws (key 66) and lock washers (key 67). Attach the bracket to the wall, using suitable screws or bolts.

Figure 4. Panel Mounting

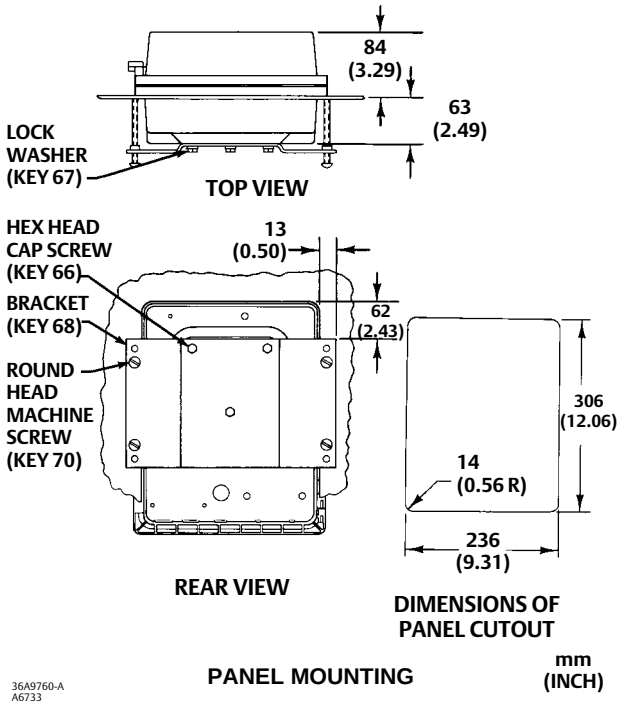
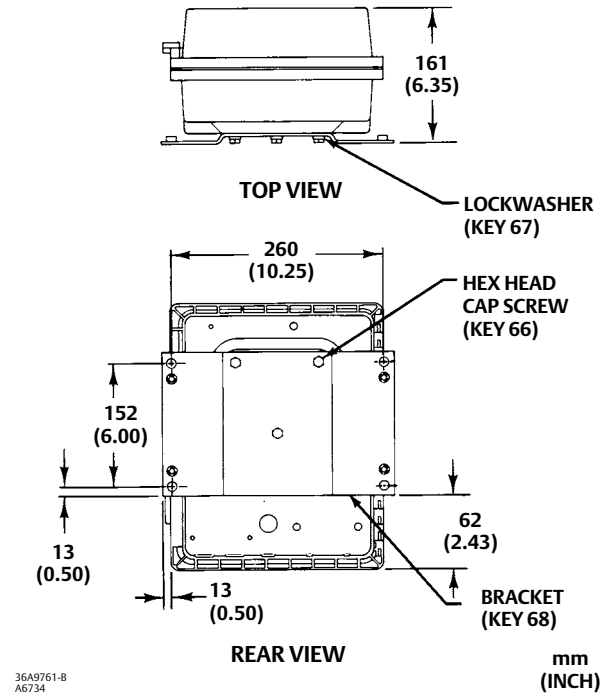


Figure 5. Wall Mounting



Actuator Mounting

Refer to figure 2. A controller specified for mounting on a control valve actuator is mounted at the factory. If the controller is ordered separately for installation on a control valve actuator, mount the unit as described in this section. Mounting parts vary for different actuator types.

Attach the mounting bracket to the actuator yoke with cap screws, lock washers, and spacer spools. Attach the controller to the bracket with cap screws, lock washers, and spacer spools. On some designs, the mounting bracket is attached to the actuator casing rather than to the yoke.

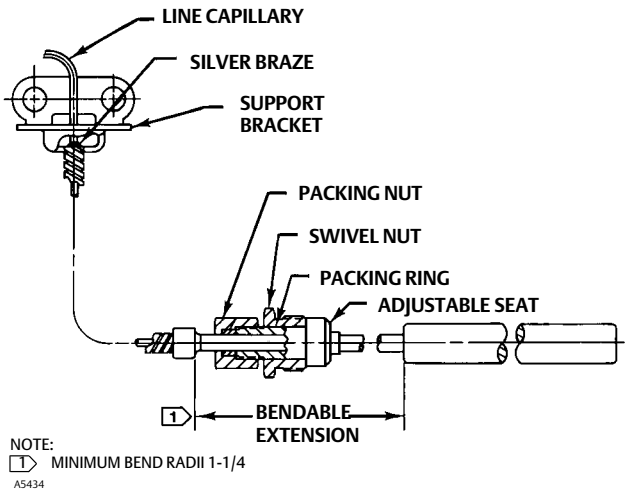
Temperature Sensing Bulb, Bushings, and Thermowells

⚠ WARNING

Failure of the thermowell may result in personal injury or equipment damage due to escaping process fluid. To avoid such injury or damage, be sure the process fluid velocity and pressure are within the thermowell limits in tables 5 and 6.

Process temperature is sensed by a temperature element consisting of a bulb immersed in the process fluid, a bendable extension, and an armored capillary tube (see figure 6). When the temperature bulb is to be placed within a closed vessel, bushings are available to attach the bulb to the vessel. The bushing (dimensions are shown in figure 7) penetrates the vessel and the temperature element is attached to the bushing with a threaded connection.

Figure 6. Temperature Element Assembly with Adjustable Union



If the process pressure exceeds the limitations of the temperature bulb, or if the process fluid is corrosive, a thermowell (dimensions are shown in figure 7) is recommended which penetrates the vessel and isolates the temperature bulb from the process fluid. Table 5 lists process fluid velocities for thermowells. Table 6 lists maximum process pressures for thermowells.

With the controller case mounted so the temperature bulb reaches the process, screw the bulb into the bushing or thermowell. To make installation of the temperature bulb easier, bend the bendable extension. The bendable extension has a minimum bend radii of 1-1/4 inch.

If the temperature bulb is to be installed in a pipe, process velocity is an important consideration. Install a thermowell where the process temperature is to be measured, keeping in mind the velocity limits shown in table 5. Tapered thermowells, built to withstand even greater process velocities, are also available. After proper installation of the thermowell, the temperature element is then attached to the thermowell with a threaded connection.

Table 5. Maximum Process Fluid Velocities(1) for Thermowells

Thermowell Size	Temperature Bulb Diameter		Material	Insertion Length(2), mm (Inch)							
				191 (7.5)		267 (10.5)		406 (16)		610 (24)	
	mm	Inch		m/s	Feet/s	m/s	Feet/s	m/s	Feet/s	m/s	Feet/s
1/2 NPT	10	3/8	Brass	11.6	38	5.8	19	2.4	8	---	---
			Carbon steel	14.6	48	7.6	25	3.4	11	---	---
			304 stainless steel/316 stainless steel	15.2	50	7.9	26	3.4	11	---	---
			N04400	14.6	48	7.3	24	3.4	11	---	---
3/4 NPT	10	3/8	Brass	16.5	54	8.2	27	3.7	12	---	---
			Carbon steel	21.0	69	10.7	35	4.6	15	---	---
			304 stainless steel/316 stainless steel	21.9	72	11.3	37	4.9	16	---	---
			N04400	20.7	68	10.7	35	4.6	15	---	---
3/4 NPT	14	9/16	Carbon steel	29.6	97	14.9	49	6.4	21	3.0	10
			304 stainless steel/316 stainless steel	30.5	100	15.5	51	6.7	22	3.0	10
			N04400	28.9	95	14.9	49	6.4	21	2.7	9

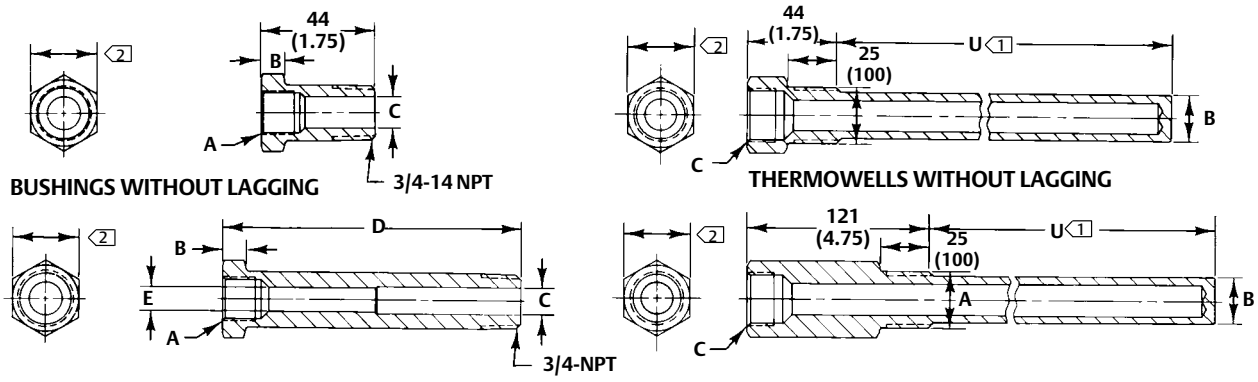
1. For gas, air, or steam. Values may be lower for liquids.
2. This is the U dimension in figure 7.

Figure 7. Bushing and Thermowell Dimensions

BUSHING						
Temperature Bulb Diameter		Dimension				
		A(1)	B		C	
mm	Inch		mm	Inch	mm	Inch
10	3/8	1/2-14 NPSM	11	0.44	11	0.44
14	9/16	1-20 UNEF	19	0.75	16	0.63
1. Seat area per SAMA Standard RC-17-10.						

LAGGED BUSHING										
Temperature Bulb Diameter		Dimension								
		A(1)	B		C		D		E	
mm	Inch		mm	Inch	mm	Inch	mm	Inch	mm	Inch
10	3/8	1/2-14 NPSM	11	0.44	12	0.47	113	4.44	11	0.44
14	9/16	1-20 UNEF	19	0.75	17	0.66	121	4.75	16	0.63
1. Seat area per SAMA Standard RC-17-10.										

THERMOWELL							
Temperature Bulb Diameter		Dimension					
		A(1)	B		C	U (Insertion Length)	
mm	Inch		mm	Inch		mm	Inch
10	3/8	1/2-14 NPT 3/4-14 NPT	16 20	0.63 0.77	1/2-14 NPSM-2B	191 267 406	7.5 10.5 16
14	9/16	3/4-14 NPT	22	0.88	1-20 UNEF-2B	191 267 406 610	7.5 10.5 16 24
1. Seat area per SAMA Standard RC-17-10.							



NOTES:
1 TOLERANCES FOR THIS DIMENSION ARE AS FOLLOWS: ±1.5 mm (0.06 INCH) WHEN LENGTH IS 305 mm (12 INCHES) OR LESS ±3.2 mm (0.125 INCH) WHEN LENGTH IS GREATER THAN 305 mm (12 INCHES).
2 7/8 INCH HEX FOR 3/8-INCH TEMPERATURE BULB; 1-1/8 INCH HEX FOR 9/16-INCH TEMPERATURE BULB

mm (INCH)

A3240-2

Table 6. Maximum Process Pressures for Thermowells

Thermowell Size	Temperature Bulb Diameter		Material	Temperature °C (°F)											
				21 (70)		93 (200)		204 (400)		316 (600)		427 (800)		538 (1000)	
	mm	Inch		Bar	Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar	Psig
1/2 NPT	10	3/8	Brass	193.9	2810	174.6	2530	30.4	440	---	---	---	---	---	---
			Carbon steel	218.0	3160	209.8	3040	200.1	2900	191.1	2770	145.6	2110	63.4	920
			304 SST	284.3	4120	258.1	3740	234.6	3400	226.3	3280	219.4	3180	189.8	2750
			316 SST	284.3	4120	284.3	4120	265.7	3850	259.4	3760	253.9	3680	212.5	3080
			N04400	263.6	3820	243.6	3530	224.3	3250	221.5	3210	215.9	3130	---	---
3/4 NPT	10	3/8	Brass	345.0	5000	289.8	4200	69.0	1000	---	---	---	---	---	---
			Carbon steel	358.8	5200	345.0	5000	331.2	4800	317.4	4600	241.5	3500	103.4	1500
			304 SST	483.0	7000	427.8	6200	386.4	5600	372.6	5400	358.8	5200	310.5	4500
			316 SST	483.0	7000	483.0	7000	441.6	6400	427.8	6200	441.6	6100	351.9	5100
			N04400	448.5	6500	414.0	6000	372.6	5400	365.7	5300	358.8	5200	103.4	1500
3/4 NPT	14	9/16	Carbon steel	159.4	2310	140.1	2030	131.1	1900	125.6	1820	98.7	1430	---	---
			304 SST	239.4	3470	212.5	3080	173.9	2520	167.7	2430	127.7	1850	112.5	1630
			316 SST	239.4	3470	239.4	3470	223.6	3240	217.4	3150	213.9	3100	179.4	2600
			N04400	211.8	3070	173.2	2510	169.7	2460	166.3	2410	148.4	2150	---	---

Pressure Connections

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not install any system component where service conditions could exceed the limits given in this manual. 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.

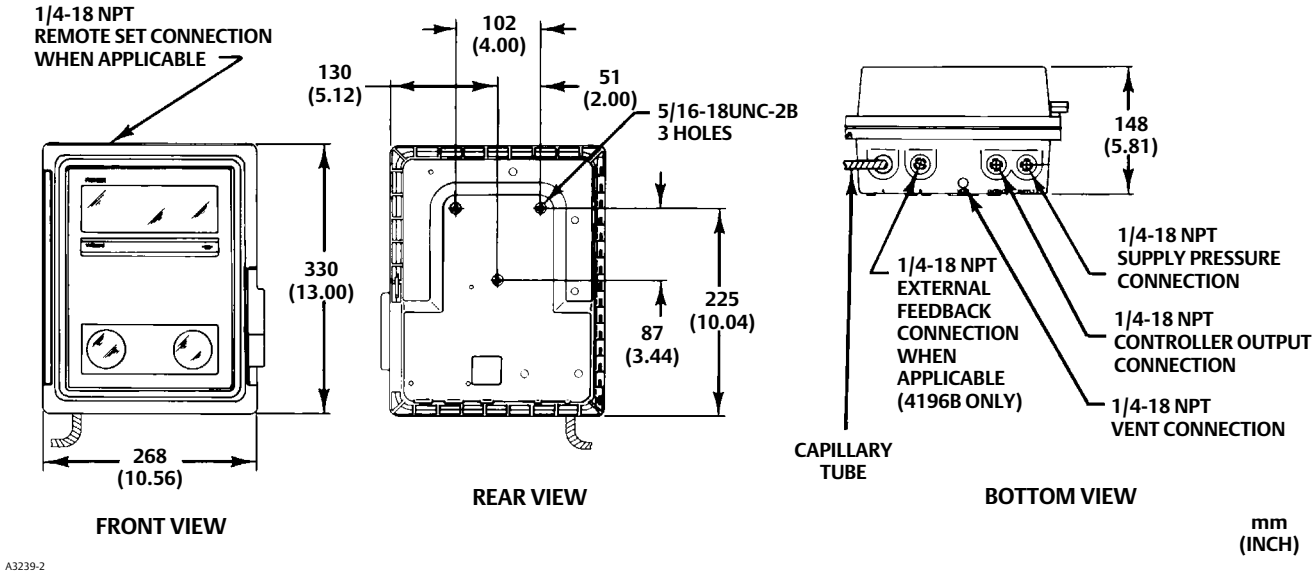
Refer to figure 8 for pressure connection locations. All pressure connections are 1/4 NPT internal. Use 1/4-inch or 3/8-inch pipe or tubing for supply, output, and remote set point connections.

Supply Pressure Connection

⚠ WARNING

Severe personal injury or property damage may occur if the instrument supply medium is not clean, dry air, or oil-free or noncorrosive 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 an 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.

Figure 8. Location of Connections



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 the normal operating supply pressure shown in table 3. Connect supply pressure to the SUPPLY connection on the bottom of the case, as shown in figure 8.

Remote Set Point (suffix letter M) Pressure Connection

If the controller has remote set point (suffix letter M), connect the remote set point pressure to the top of the controller case at the location shown in figure 8. Use clean, dry air or a non-corrosive gas. Use a 0.2 to 1.0 bar (3 to 15 psig) remote set point pressure range for a 0.2 to 1.0 bar (3 to 15 psig) controller output pressure range. Use a 0.4 to 2.0 bar (6 to 30 psig) remote set point pressure range for a 0.4 to 2.0 bar (6 to 30 psig) controller output pressure range. 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.

External Feedback Pressure Connection (4196B Controllers Only)

When a secondary controller in an override application has this option, reset windup is minimized in the secondary controller. Connect the external feedback connection, shown in figure 8, of the secondary controller to the customer-supplied high or low select relay.

Vent

⚠ WARNING

Personal injury or property damage could result from fire or explosion of accumulated gas, or from contact with hazardous gas, if a flammable or hazardous gas is used as the supply pressure medium. Because the instrument case and cover assembly do not form a gas tight seal when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used to prevent the accumulation of flammable or hazardous gas. However, a remote vent pipe alone cannot be relied upon to remove all flammable and hazardous gas. 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 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 inch) for runs up to 6.1 meters (20 feet) and a minimum inside diameter of 25 mm (1 inch) for runs from 6.1 to 30.5 meters (20 to 100 feet)

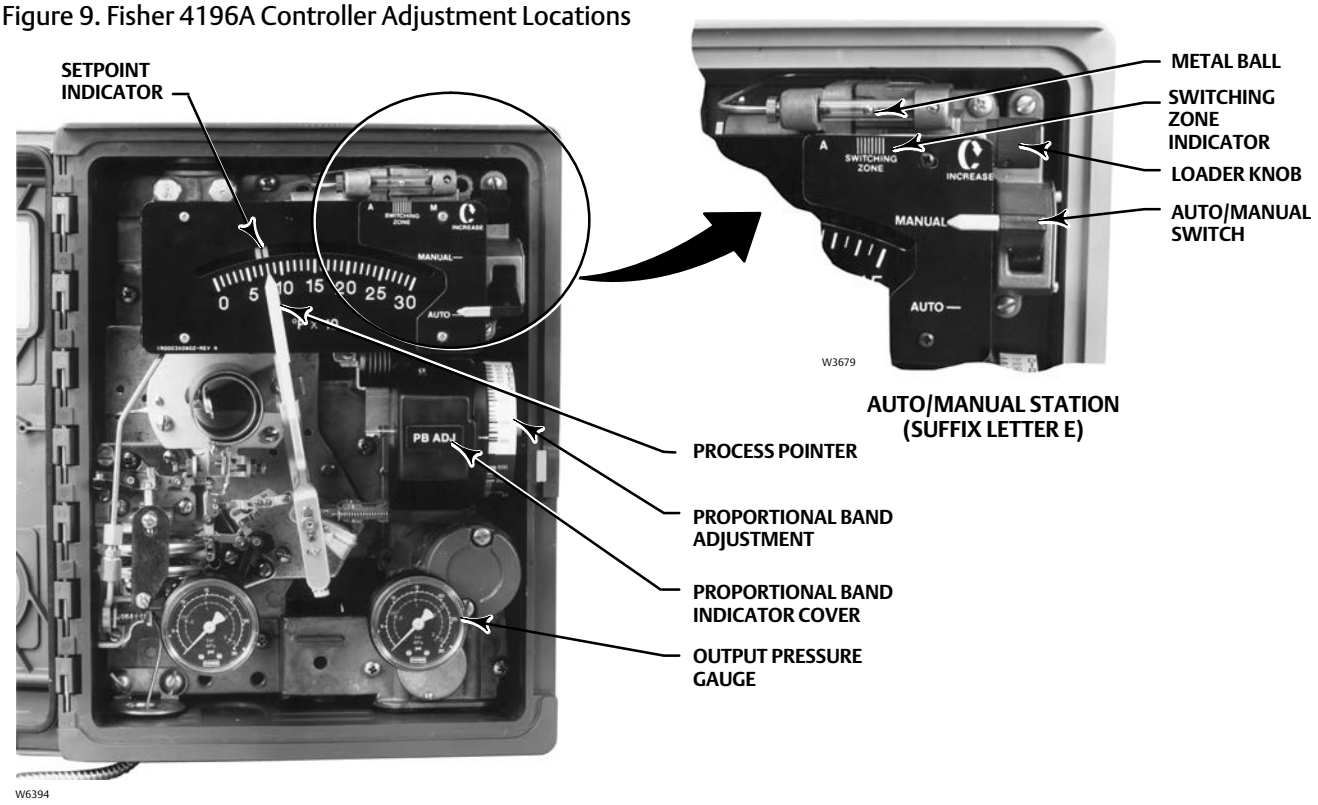
The vent must be protected against the entrance of any foreign material that could plug it; or, if a remote vent is not required, the vent opening in the case, shown in figure 8, must be protected against the entrance of any foreign material that could plug it. Check the vent periodically to be certain it is not plugged.

Section 3 4196A Proportional-Only Controllers

Adjustments for 4196A Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup and calibration. Adjustment locations are shown in figures 9 and 11. To better understand the adjustments and overall controller operation, refer to the principle of operation section and to the schematic diagrams in figures 12 and 13 Unless otherwise noted, key numbers given in this section are found in figure 48.

Figure 9. Fisher 4196A Controller Adjustment Locations



Manual Set Point Adjustment

Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process temperature scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not affect the proportional band setting.

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point, and counterclockwise to decrease the process set point.

Remote Set Point (suffix letter M) Adjustment

NOTICE

Do not manually move the set point indicator on controllers equipped with remote set point. Manually moving the set point indicator could damage the controller.

If the controller is equipped with remote set point (suffix letter M), 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.

Proportional Band Adjustment (PB ADJ)

The proportional band determines the output sensitivity of the controller. The proportional band adjustment is marked in percentages of process temperature required to drive the controller from zero output to full output.

To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 10 and rotate the proportional band adjustment to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

Figure 10. Fisher 4196A Controller Changing Controller Action

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For direct control action:

An increasing process temperature increases output pressure.

For reverse control action:

An increasing process temperature decreases output pressure.

After changing the action, tighten the two screws on the proportional band indicator cover.

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 9 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first 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 to move the ball into the switching zone. Turn the switch to AUTO, and move the set point to control the output.

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

Prestartup Checks for 4196A Controllers

Refer to figure 9 for adjustment locations and refer to figure 48 for key number locations.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input temperature or other control signal to the controller.

Note

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

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator, and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 3.
2. For a controller 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. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of input span above the process pointer.
5. Adjust the proportional band for 5 percent DIRECT.

6. The process pointer should read ambient temperature ±1 percent of span. Be sure that the bulb is exposed to air only and is not resting against the floor, test bench, or other surface.
7. The controller output pressure should be 0 bar (0 psig).
8. Rotate the proportional band to 5 percent REVERSE.
9. The controller output should be within 0.14 bar (2 psig) of the supply pressure.
10. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action, secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4196A calibration procedure for recalibration.

Startup for 4196A Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

Note

When performing the startup procedures, keep in mind that the initial settings are guidelines. They will vary, depending on the actual process being controlled.

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.
2. For controllers with:

Manual set point:

Move the set point indicator to the desired set point.

Remote set point:

a. See figure 8 for the location of the remote set point connection. Connect an adjustable pressure source to the remote set point connection.

b. Adjust the pressure source until the set point indicator reaches the desired set point. Remember: Increasing the remote set point pressure increases the set point.

3. Determine the initial proportional band setting in percent from the following equation:

$$\text{P.B.} = \frac{200 \times \text{Allowable Overshoot}}{\text{Temperature Span}}$$

For example:

$$\frac{200 \times 10^{\circ}\text{F}}{100^{\circ}\text{F}} = 20\%$$

4. If the controller is used in conjunction with a control valve, slowly open the upstream and downstream manual control valves in the pipeline, and close the manual bypass valve if one is used.
5. Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until the system cycles. At this point, double the proportional band setting (proportional band setting × 2).
6. Check the stability of the recommended proportional band setting by introducing a disturbance and monitoring the process.

Calibration of 4196A Controllers

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

General Calibration Instructions

Note
If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode prior to performing calibration.

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers are found in figure 48.

Do not use gauges supplied with the controller during calibration. Monitor supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

Temperature Baths

Some calibration procedures require that the process temperature be simulated. A temperature bath (liquid or sand, depending on temperature requirements) is recommended. Bath temperature should be able to cover 0 to 100 percent of the temperature element input span.

The bath should be capable of maintaining a temperature to within ±0.10 percent of the input span and should be agitated so that the temperature is consistent throughout.

If available, three baths, preset at 0 percent, 50 percent, and 100 percent of input span, could be used to simplify and speed up the calibration process. Also, provide a means of measuring bath temperature. Use a thermometer or resistance temperature detector (RTD) accurate to within ±0.05 percent of input span.

Process Indicator Zero and Span Calibration

Before starting this procedure:

- Provide a means of changing the process temperature to the controller and a means of measurement external to the controller.
- Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 3.

Note
Any change to the process pointer span adjustment will require readjustment of the process pointer zero adjustment.

Refer to figure 9 and 11 for adjustment locations.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
5. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase the span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Place the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize. The process pointer should indicate the mid-scale mark, ±2 percent of span. If the error is greater than ±2 percent, refer to the Maintenance section and perform the zero and span adjustment procedure.
9. Adjust the process pointer to within ±1 percent of the mid-scale mark by loosening the zero adjustment locking screw and turning the zero adjustment screw. This distributes the error over the entire scale span and brings all points within ±1 percent of the process scale span. Tighten the zero adjustment locking screw.
10. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
11. The process pointer should indicate the process scale lower limit ±1 percent of the scale span.
12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
13. The process pointer should indicate process scale upper limit ±1 percent of the process scale span.
14. If the error is greater that ±1 percent, repeat steps 3 through 13.

Remote Set Point (suffix letter M) Zero and Span Calibration

Refer to figure 9 and 11 for adjustment locations. Refer to figures 48 and 51 for key number locations.

Note

Any adjustment of the remote set point span adjustment screw requires readjustment of the remote set point zero adjustment screw.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.
5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication.
7. Repeat steps 3 through 6 until the error is eliminated.

8. Apply remote set point pressure equal to the mid-range value.
9. Make sure the set point indicator is within ±1 percent of the mid-scale mark and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within ±2 percent of the mid-scale mark, then proceed with step 10. If the set point indicator is not within ±2 percent, proceed to the remote set point calibration procedure in the Maintenance section.
10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw to correct for half the error at mid-scale. Tighten the zero adjustment locking screw.
11. Apply remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within ±1 percent.
12. If necessary, perform the process indicator zero and span calibration procedure in this section. Otherwise, perform the flapper alignment procedure in this section.

Flapper Alignment

Note

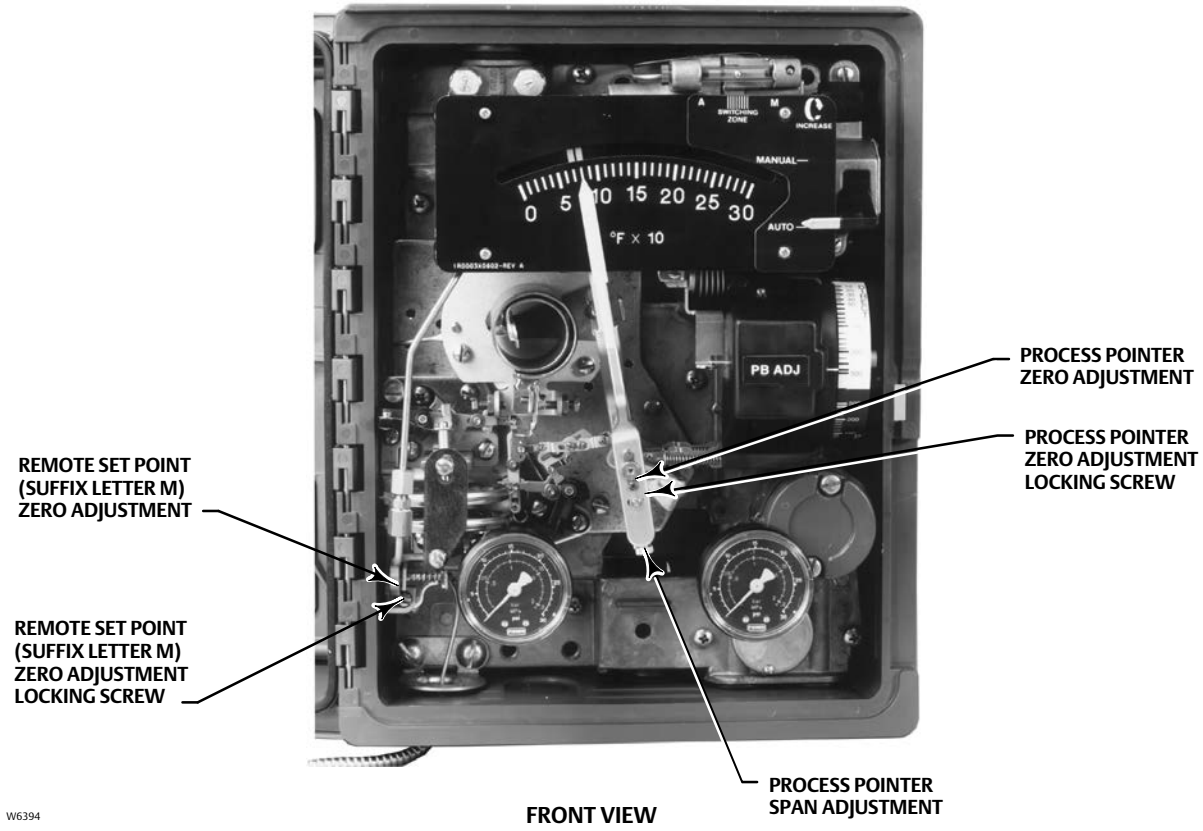
Perform the process indicator zero and span calibration procedure and, for controllers with remote set point (suffix letter M), the remote set point zero and span calibration procedure before the flapper alignment.

Flapper leveling screw numbers and adjustments are shown in figure 11. Key number locations are shown in figure 48.

Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 3. After performing the flapper alignment procedure, go to the startup procedure.

1. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at mid-scale on the process scale.
2. If a temperature bath is available, adjust the bath for 50 percent of the scale range and place the temperature bulb in the bath. Allow 5 minutes for the controller to stabilize. If a bath is not available, an alternate method is to disconnect link number 1 at the temperature element and tape the process pointer at the mid-scale mark of the process scale. Note the hole from which link number 1 was removed for proper replacement. This method should only be used if a temperature bath is not available to simulate a process temperature at mid-scale value.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Set the proportional band between DIRECT and REVERSE.
5. The controller output should be 0.62 ±0.007 bar (9 ±0.10 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 1.2 ±0.01 bar (18 ±0.2 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. If not, adjust flapper leveling screw 2 (the screw nearest the nozzle) until the output is within tolerance.
6. Set the proportional band to 30 percent DIRECT.
7. The controller output should be 0.62 ±0.02 bar (9 ±0.25 psig) or 1.2 ±0.04 bar (18 ±0.5 psig). If not, adjust flapper leveling screw 3 (the screw nearest the nozzle).
8. Set the proportional band to 30 percent REVERSE.
9. The controller output should be 0.62 ±0.02 bar (9 ±0.25 psig) or 1.2 ±0.04 bar (18 ±0.5 psig). If not, adjust flapper leveling screw 1 (the screw nearest the nozzle).
10. Repeat steps 4 through 9 until the controller output remains in tolerance without further leveling screw adjustment.

Figure 11. Fisher 4196A Controller Calibration Adjustment Locations



11. If link 1 was disconnected, remove the tape and reconnect link 1 to the temperature element using the hole noted in step 2.
12. Set the proportional band to 400 percent in the desired controller action and replace the proportional band indicator cover.

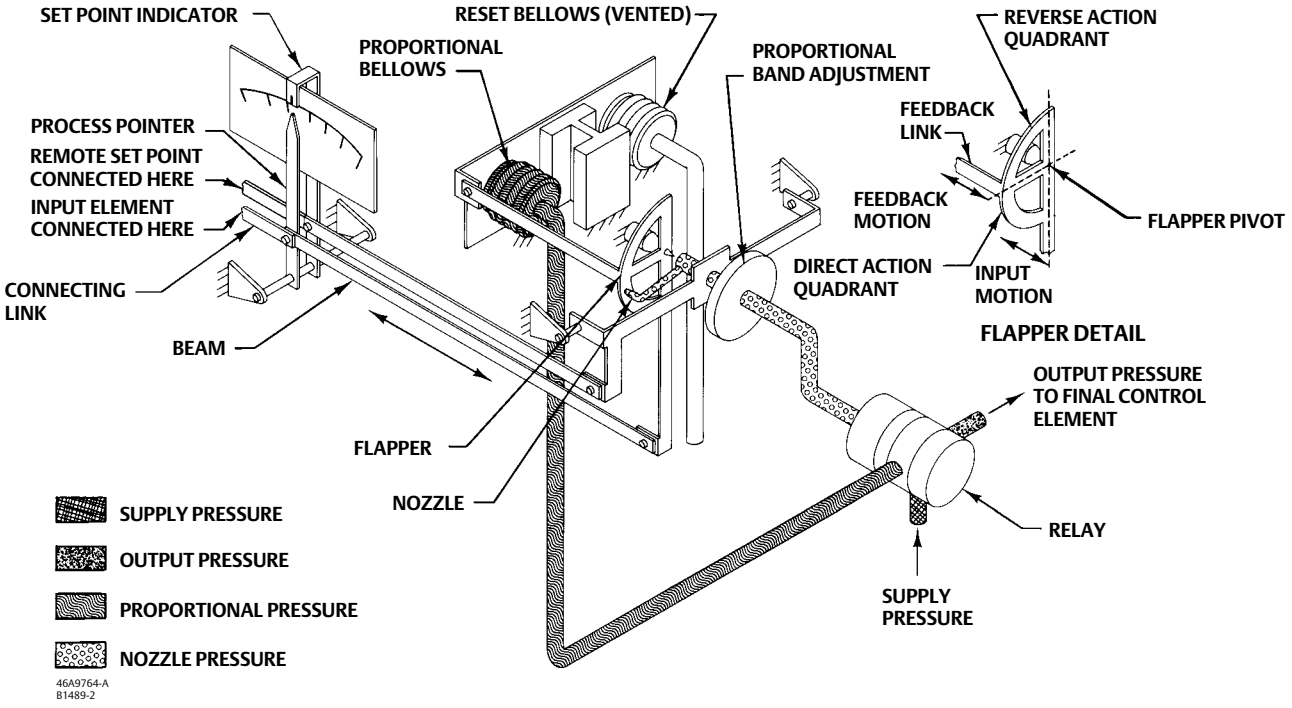
Principle of Operation for 4196A Controllers

Overall Operation

Refer to the schematic diagram in figure 12.

The input element is connected to the process pointer and to the flapper by connecting links. As the process temperature 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 proportional bellows. The action of the proportional bellows counteracts the flapper movement that resulted from the process temperature change and backs the flapper away from the nozzle until equilibrium is reached.

Figure 12. Fisher 4196A Controller Schematic



Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process temperature except that, when the set point is changed, the nozzle moves with respect to the flapper.

The proportional band adjustment positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more

input and less feedback motion occurs, which increases the gain. The controller action is changed from direct to reverse by turning the proportional band adjustment to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed as shown in the flapper detail of figure 12. With the controller in the reverse-acting mode, an increase in process temperature causes a decrease in output pressure.

Remote Set Point (suffix letter M) Operation

The capability to adjust the controller set point from a remote location is available with all 4196A controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via a connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

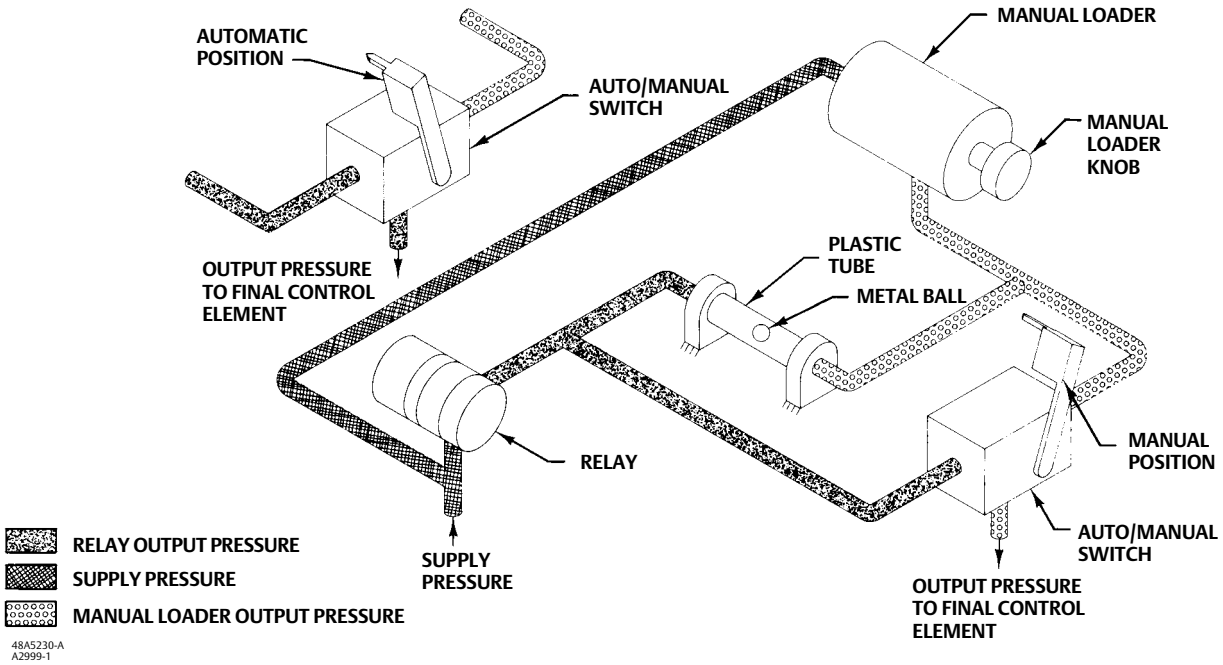
Auto/Manual Station (suffix letter E) Operation

A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 13. 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.

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

Before the auto/manual switch is operated, the relay output must equal the manual loader output 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 and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

Figure 13. Fisher 4196A Auto/Manual Station Schematic

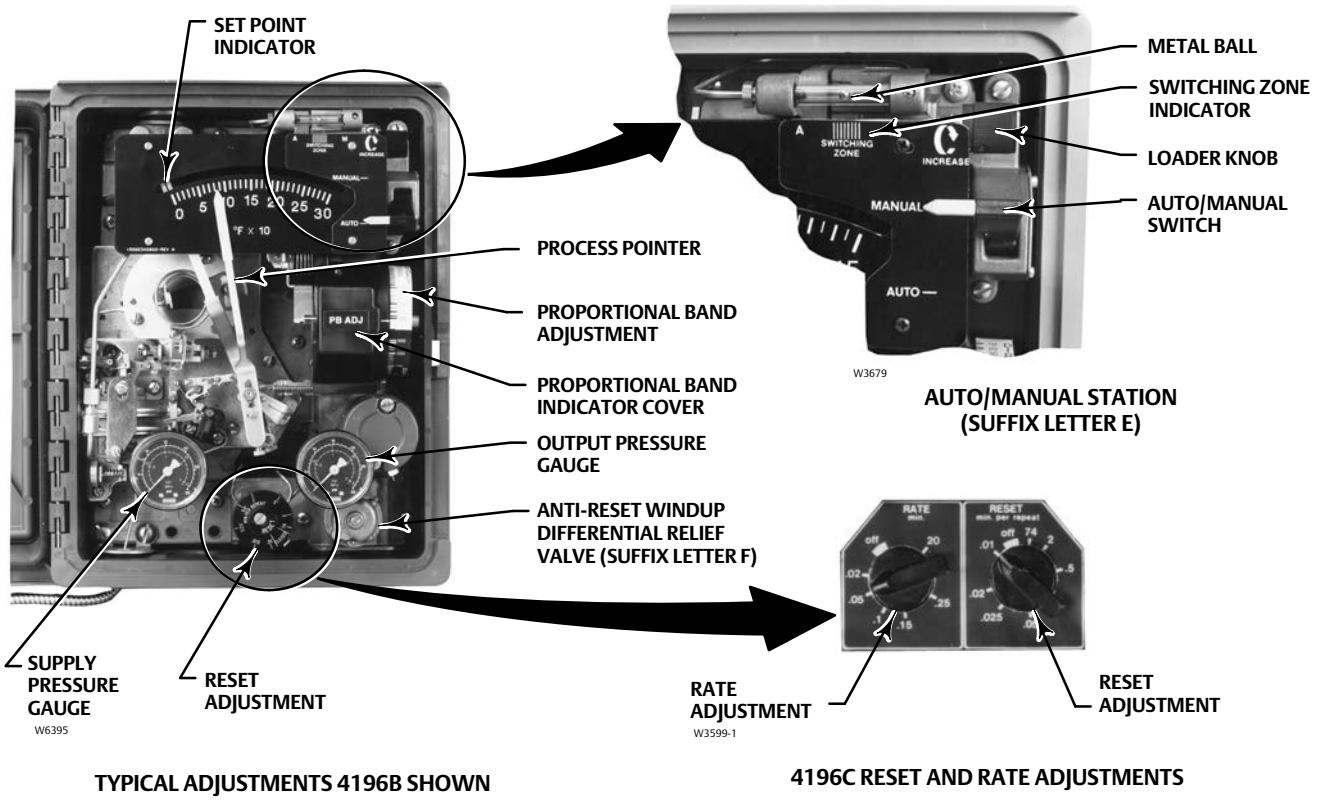


Section 4 4196B Proportional- Plus-Reset Controllers and 4196C Proportional- Plus-Reset- Plus-Rate Controllers

Adjustments for 4196B and C Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup, and calibration. Adjustment locations are shown in figures 14 and 16. To better understand the adjustments and overall controller operation, refer to the principle of operation section and to the schematic diagrams in figures 18 through 22. Unless otherwise noted, key numbers refer to figure 48.

Figure 14. Fisher 4196B and C Controller Adjustment Locations



Manual Set Point Adjustment

Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process temperature scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not affect the proportional band setting.

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point, and counterclockwise to decrease the process set point.

Remote Set Point (suffix letter M) Adjustment

NOTICE

Do not manually move the set point indicator on controllers with remote set point. Manually moving the set point indicator could damage the controller.

If the controller is equipped with remote set point (suffix letter M), 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.

Proportional Band Adjustment (PB ADJ)

The proportional band determines the output sensitivity of the controller. The proportional band adjustment is marked in percentages of process temperature required to drive the controller from zero output to full output.

To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 15 and rotate the proportional band adjustment to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

Figure 15. Fisher 4196B and C Controller Changing Controller Action

W3439

For direct control action:

An increasing process temperature increases output pressure.

For reverse control action:

An increasing process temperature decreases output pressure.

After changing the action, tighten the two screws on the proportional band indicator cover.

Reset Adjustment

To adjust reset, open the controller cover, and locate the RESET adjustment. Rotate the adjustment clockwise to decrease the minutes per repeat or counterclockwise to increase the minutes per repeat. Increasing the minutes per repeat provides a slower reset action.

Rate Adjustment

To adjust rate, open the controller cover and locate the RATE adjustment. Rotate the adjustment clockwise to decrease the minutes (less rate action) or counterclockwise to increase the minutes (more rate action).

Anti-Reset Windup (suffix letter F) Adjustment

If the arrow on the differential relief valve points toward the bottom of the controller case, as shown in figure 14, the relief valve opens with increasing controller output pressure. If the arrow points in the opposite direction, the relief valve opens with decreasing controller output pressure. Differential relief pressure is factory set at 0.3 bar (5 psi). Maximum differential relief pressure is 0.5 bar (7 psi); minimum is 0.1 bar (2 psi).

Turn the adjusting screw counterclockwise to increase differential relief pressure; clockwise to decrease it.

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 14 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first 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 to move the ball into the switching zone. Turn the switch to AUTO and adjust the set point to control the output.

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

Prestartup Checks for 4196B and C Controllers

Refer to figure 14 for adjustment locations and refer to figure 48 for key number locations.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input pressure or other control signal to the controller.

Note

If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks. If the controller has the external feedback option, connect the controller output connection to the external feedback connection (see figure 8). Adjust the controller for full output pressure and with the RESET knob adjusted to 0.01 minutes/repeat, verify the tubing connections do not leak. Disconnect after completing the prestartup checks.

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 3.
2. For a controller 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. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of the scale span above the process pointer.
5. Set the reset adjustment to 0.01 minutes per repeat.
6. Set the rate adjustment to OFF (4196C controllers).
7. Adjust the proportional band for 5 percent DIRECT.
8. The controller output pressure should be 0 psig.
9. Rotate the proportional band to 5 percent REVERSE.
10. The controller output should be within 0.14 bar (2 psig) of the supply pressure.
11. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action. Secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4196B and C calibration procedure for recalibration.

Startup for 4196B and C Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

Note

When performing the startup procedures, keep in mind that the initial settings are guidelines. They will vary depending on the actual process being controlled.

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.
2. For controllers with:

Manual set point:

Move the set point indicator to the desired set point.

Remote set point:

a. See figure 8 for the location of the remote set point connection. Connect an adjustable pressure source to the remote set point connection.

b. Adjust the pressure source until the set point indicator reaches the desired set point. Remember: Increasing the remote set point pressure increases the set point.

3. Set the reset adjustment to 0.5 minutes per repeat. For controllers with rate, set the rate adjustment to OFF.
4. Determine the initial proportional band setting in percent from the following equation:

$$\text{P.B.} = \frac{200 \times \text{Allowable Overshoot}}{\text{Temperature Span}}$$

For example:

$$\frac{200 \times 10^{o}\text{F}}{100^{o}\text{F}} = 20\%$$

5. Turn the proportional band adjustment (PB ADJ) to the percentage calculated from the equation.
6. If the controller is used in conjunction with a control valve, slowly open the upstream and downstream manual control valves in the pipeline, and close the manual bypass valve if one is used.
7. Tune the various controller actions.

Tuning proportional action: Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until the system cycles. At this point, double the proportional band setting (proportional band setting $\times$ 2) and begin tuning the reset.

Tuning reset action: Disturb the system. If the system does not cycle, speed up the reset by changing the setting to a lower value (faster reset) and disturb the system again. Continue this procedure until the system cycles. When the system cycles, multiply the reset time setting by a factor of three (reset setting $\times$ 3) and slow down the reset by changing the reset setting to the higher value. The reset is now tuned.

Tuning rate action: For a controller with rate (4196C), adjust the rate toward the higher setting until cycling occurs. When the system cycles, divide the rate value by a factor of three (rate setting $\div$ 3) and decrease the rate by changing the setting to the lower value. The rate is now tuned

8. Check the stability of the recommended tuning settings by introducing a disturbance and monitoring the process.
9. Once stable control is attained, the process pointer and set point indicator should be in line. If they are aligned, adjust the set point to the desired value. If they are not, readjust the set point to the desired control point, and proceed with step 10.
10. If the process pointer is within 5 percent of the set point indicator, turn the link 3 adjustment (see figure 41 for location) until the process pointer aligns with the set point indicator. Turn the link 3 adjustment screw clockwise to increase the process indication or counterclockwise to decrease it. If the process pointer is misaligned with the set point indicator by more than 5 percent of the scale span, perform the calibration procedures for 4196B and C controllers.

Calibration of 4196B and C Controllers

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

General Calibration Instructions

Note

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

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers refer to figure 48.

Do not use gauges supplied with the controller during calibration. Monitor supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

Temperature Baths

Some calibration procedures require that the process temperature be simulated. A temperature bath (liquid or sand, depending on temperature requirements) is recommended. Bath temperature should be able to cover 0 to 100 percent of the temperature element input span.

The bath should be capable of maintaining a temperature to within ±0.10 percent of the input span and should be agitated so that the temperature is consistent throughout.

If available, three baths, preset at 0 percent, 50 percent, and 100 percent of input span, could be used to simplify and speed up the calibration process. Also, provide a means of measuring bath temperature. Use a thermometer or resistance temperature detector (RTD) accurate to within ±0.05 percent of input span.

Process Indicator Zero and Span Calibration

Before starting this procedure:

- Provide a means of changing the process temperature to the controller and a means of measurement external to the controller.
- Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 3.

Note

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

Refer to figures 14 and 16 for adjustment locations.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.

3. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
5. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase the span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Place the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize. The process pointer should indicate the mid-scale mark, ±2 percent of span. If the error is greater than ±2 percent, refer to the Maintenance section and perform the zero and span adjustment procedure.
9. Adjust the process pointer to within ±1 percent of the mid-scale mark by loosening the locking screw and turning the zero adjustment screw. This distributes the error over the entire scale range and brings all points within ±1 percent of the process scale span.
10. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
11. The process pointer should indicate the process scale lower limit ±1 percent of the scale span.
12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
13. The process pointer should indicate the process scale upper limit ±1 percent of the process scale span.
14. If the error is greater than ±1 percent, repeat steps 3 through 13.

Remote Set Point (suffix letter M) Zero and Span Calibration

Refer to figures 14 and 16 for adjustment locations. Refer to figures 49 and 51 for key number locations.

Note

Any adjustment of the remote set point span adjustment screw requires readjustment of the remote set point zero adjustment screw.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.
5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication: counterclockwise to decrease span for a high indication.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Adjust the remote set point pressure to the mid-range value.
9. Make sure the set point indicator is within ±1 percent of the mid-scale mark, and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within ±2 percent of the mid-scale mark, proceed with step 10. If the set point indicator is not within ±2 percent, proceed to the remote set point zero and span adjustment procedure in the Maintenance section.

10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw to correct for half the error at mid scale. Tighten the zero adjustment locking screw.
11. Apply remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within ±1 percent.
12. If necessary, perform the process indicator zero and span calibration procedure in this section. Otherwise, perform the flapper alignment procedure in this section.

Flapper Alignment

Note

Perform the process indicator zero and span calibration procedure and, for controllers with remote set point (suffix letter M), the remote set point zero and span calibration procedure before the flapper alignment.

Flapper leveling screw numbers and adjustments are shown in figure 16. Key number locations are shown in figure 48.

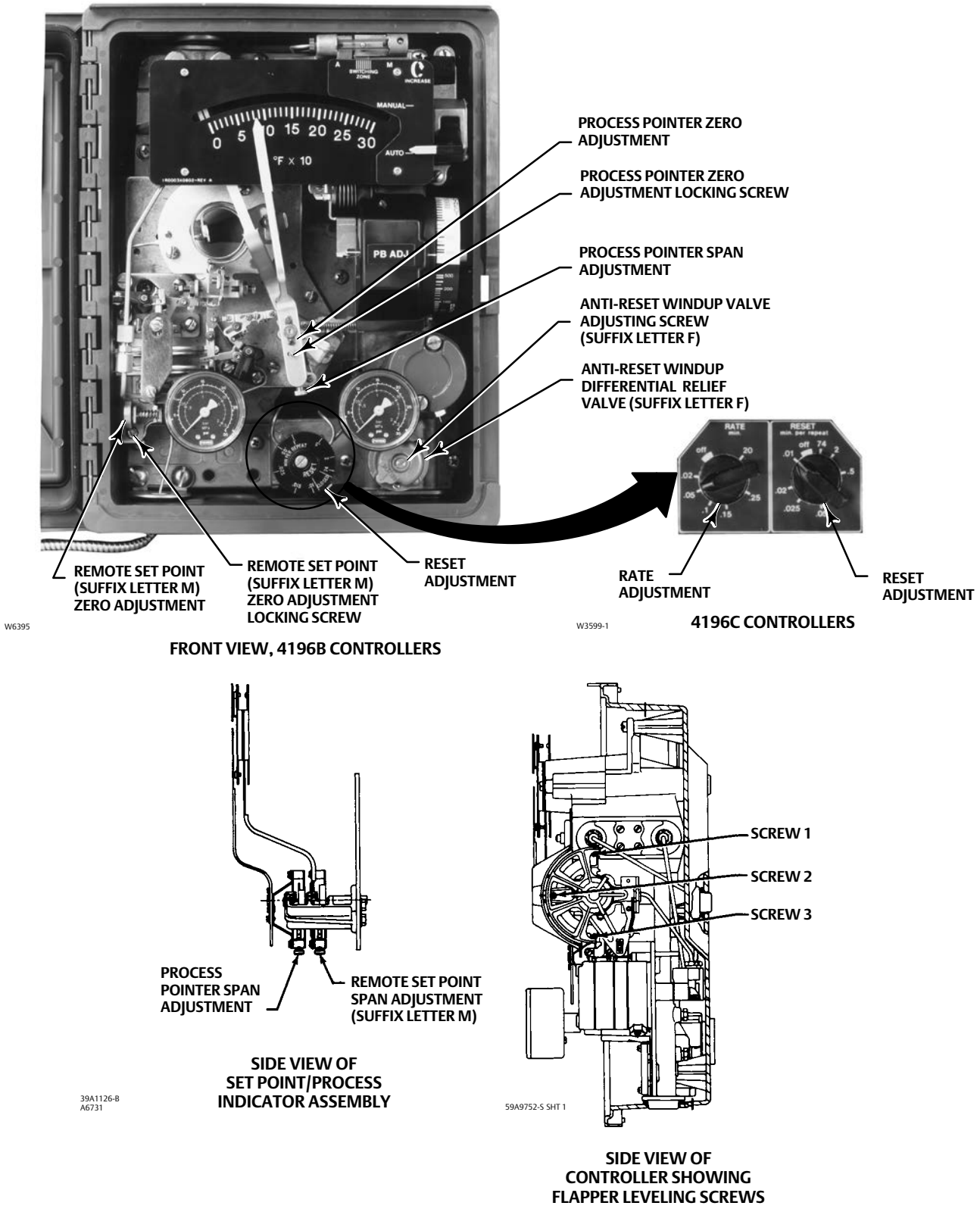
Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time

Note

4196B and C controllers with anti-reset windup (suffix letter F) are supplied with two O-rings (key 52), a valve cover (key 51) and two machine screws (key 53). Use these parts in the next step.

1. For controllers with anti-reset windup (suffix letter F), record the direction of the arrow on the anti-reset windup relief valve (key 55). Remove the relief valve and install the two O-rings (key 52) and valve cover (key 51) supplied with the controller. Secure the valve cover with the two machine screws (key 53) provided.
2. If the controller has the external feedback option (available with the 4196B only), connect the controller output to the external feedback connection. See figure 8 for the location of the output and external feedback connections.
3. If necessary, remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Provide regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 3.
5. For a controller with manual set point, move the set point indicator to the mid-scale mark of the process scale span. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at the mid-scale mark of the process scale.
6. Set the reset adjustment to 0.01 minutes per repeat.
7. If the controller has rate (4196C controllers), turn the rate adjustment to OFF.
8. If a temperature bath is available, adjust the bath for 50 percent of the scale range and place the temperature bulb in the bath. Allow 5 minutes for the controller to stabilize. If a bath is not available, an alternate method is to disconnect link number 1 at the temperature element and tape the process pointer at the mid-scale mark of the process scale. Note the hole from which link number 1 was removed for proper replacement. This method should only be used if a temperature bath is not available to simulate a process temperature at mid-scale value.

Figure 16. Fisher 4196B and C Controller Calibration Adjustment Locations



Note

Because of the high controller gain, the controller output will not remain stable in steps 9 through 13. The controller output gauge is adequate to monitor the output pressure during this procedure.

9. Set the proportional band between DIRECT and REVERSE.
10. The controller output should be relatively stable at any value within the output range. If not, adjust flapper leveling screw 2 (the screw nearest the nozzle) until the output is relatively stable.
11. Set the proportional band to 30 percent DIRECT. The controller output should be relatively stable at any value within the output range. If not, adjust flapper leveling screw 3 (the screw nearest the nozzle) until the output is relatively stable.
12. Set the proportional band to 30 percent REVERSE. The controller output should be relatively stable within the output range. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is relatively stable.
13. Repeat steps 9 through 12 until the controller output remains relatively stable without further flapper leveling screw adjustment.

Note

Steps 14 through 20 check the flapper alignment.

14. Set the proportional band to 30 percent DIRECT.
15. If link number 1 was previously disconnected, remove the tape and align the process pointer with the right-hand edge of the set point indicator as shown in figure 17. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the right-hand edge.

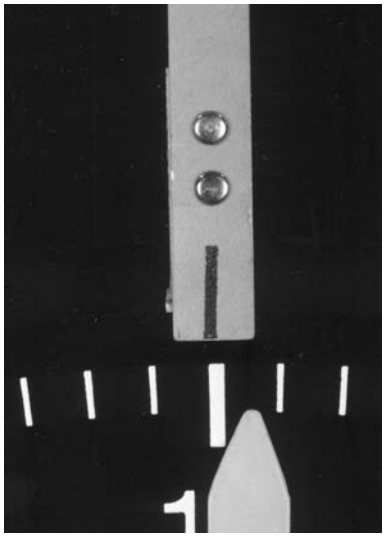
    The controller output should be within 0.14 bar (2 psig) of the supply pressure.
16. If link number 1 was previously disconnected, remove the tape and align the process pointer with the left-hand edge of the set point indicator as shown in figure 17. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the left-hand edge.

    The controller output pressure should go to 0 bar (0 psig).
17. Set the proportional band to 30 percent REVERSE.
18. If link number 1 was previously disconnected, remove the tape and align the process pointer with the right-hand edge of the set point indicator as shown in figure 17. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the right-hand edge.

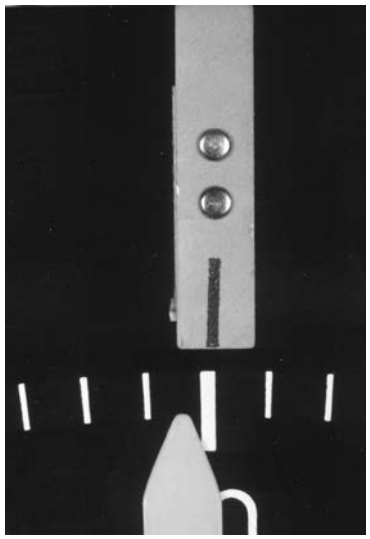
    The controller output pressure should be 0 bar (0 psig).
19. If link number 1 was previously disconnected, remove the tape and align the process pointer with the left-hand edge of the set point indicator as shown in figure 17. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the left-hand edge.

    The controller output should be within 0.14 bar (2 psig) of supply pressure.

Figure 17. Alignment of the Process Pointer with the Set Point Indicator



W4039
RIGHT-HAND EDGE



W4038
LEFT-HAND EDGE

20. If the controller does not perform as indicated in steps 14 through 19, the flapper is not correctly aligned. This may occur because the output was not sufficiently stabilized in steps 9 through 13. Repeat steps 9 through 19.
21. Set the proportional band to 400 percent in the desired controller action. Replace the proportional band indicator cover (key 36) and tighten the two screws (key 6). Reconnect link number 1, if disconnected, to the same hole in the temperature element noted in step 8.
22. For controllers with anti-reset windup (suffix letter F), remove the two machine screws, valve cover and two O-rings installed in step 1 of this procedure. Install the anti-reset windup relief valve (key 55) with the arrow pointing in the direction recorded in step 1.
23. If the controller has the external feedback option (available with the 4196B controllers only), remove the connection between the controller output and the external feedback connection.

Anti-Reset Windup (Suffix Letter F) Differential Relief Valve Calibration

Calibration for the differential relief valve to relieve on rising controller output pressure

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time.
2. Set the reset adjustment to 0.01 minutes per repeat (wide open) and the rate adjustment (4196C controllers only) to OFF.
3. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at the mid-scale mark of the process scale.
4. Set the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.
5. Refer to figure 16 for the location of the anti-reset windup differential relief valve. For the differential relief valve to relieve on rising controller output pressure, install the valve so the arrow on the valve points down. To change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall the valve with the arrow pointing down. Tighten the two mounting screws.

6. Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 3.

Note

Because of the high controller gain with the reset adjustment at 0.01 minutes per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

7. Increase the process temperature to the controller until the controller output pressure balances at 0.4 bar (6 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output range or 0.8 bar (12 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output range.
8. Turn the reset adjustment to the CLOSED (4196B controllers) or OFF (4196C controllers) position.
9. Increase the controller output pressure in small steps (approximately 0.04 bar (0.5 psig)) by changing the process temperature or by changing the controller set point. After each change in temperature or set point, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to change the controller output pressure in 0.04 bar (0.5 psi) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp upward to supply pressure with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the differential relief valve has relieved.
11. To obtain the differential relief valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential pressure by turning the differential relief valve adjustment screw, shown in figure 16. Turn the screw clockwise to decrease the differential pressure or counterclockwise to increase the differential pressure. The differential relief valve is set at the factory to relieve at approximately 0.4 bar (5 psi) differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Calibration for the differential relief valve to relieve on falling controller output pressure

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time.
2. Set the reset adjustment to 0.01 minutes per repeat (wide open) and the rate adjustment (4196C controllers) to the OFF position.
3. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at the mid-scale mark on the process scale.
4. Set the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.
5. Refer to figure 16 for the location of the anti-reset windup differential relief valve. For the differential relief valve to relieve on falling controller output pressure, install the valve so the arrow on the valve points up. To change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall the valve with the arrow pointing up. Tighten the two mounting screws.
6. Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 3.

Note

Because of the high controller gain with the reset adjustment at 0.01 minutes per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

7. Increase the process temperature to the controller until the controller output pressure balances at 0.8 bar (12 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output range or 1.6 bar (24 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output range.
8. Turn the reset adjustment to the CLOSED (4196B controllers) or OFF (4196C controllers) position.
9. Decrease the controller output pressure in small steps (approximately 0.04 bar (0.5 psig)) by changing the process temperature or by changing the controller set point. After each change in temperature or set point, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to change the controller output pressure in 0.04 bar (0.5 psi) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp downward to 0 psig with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the differential relief valve has relieved.
11. To obtain the differential relief valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential pressure by turning the differential relief valve adjustment screw, shown in figure 16. Turn the screw clockwise to decrease the differential pressure or counterclockwise to increase the differential pressure. The differential relief valve is set at the factory to relieve at approximately 0.4 bar (5 psi) differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Principle of Operation for 4196B and C Controllers

Overall Operation

Refer to the schematic diagram in figure 18 for 4196B controllers. Refer to the schematic diagram in figure 19 for 4196C controllers.

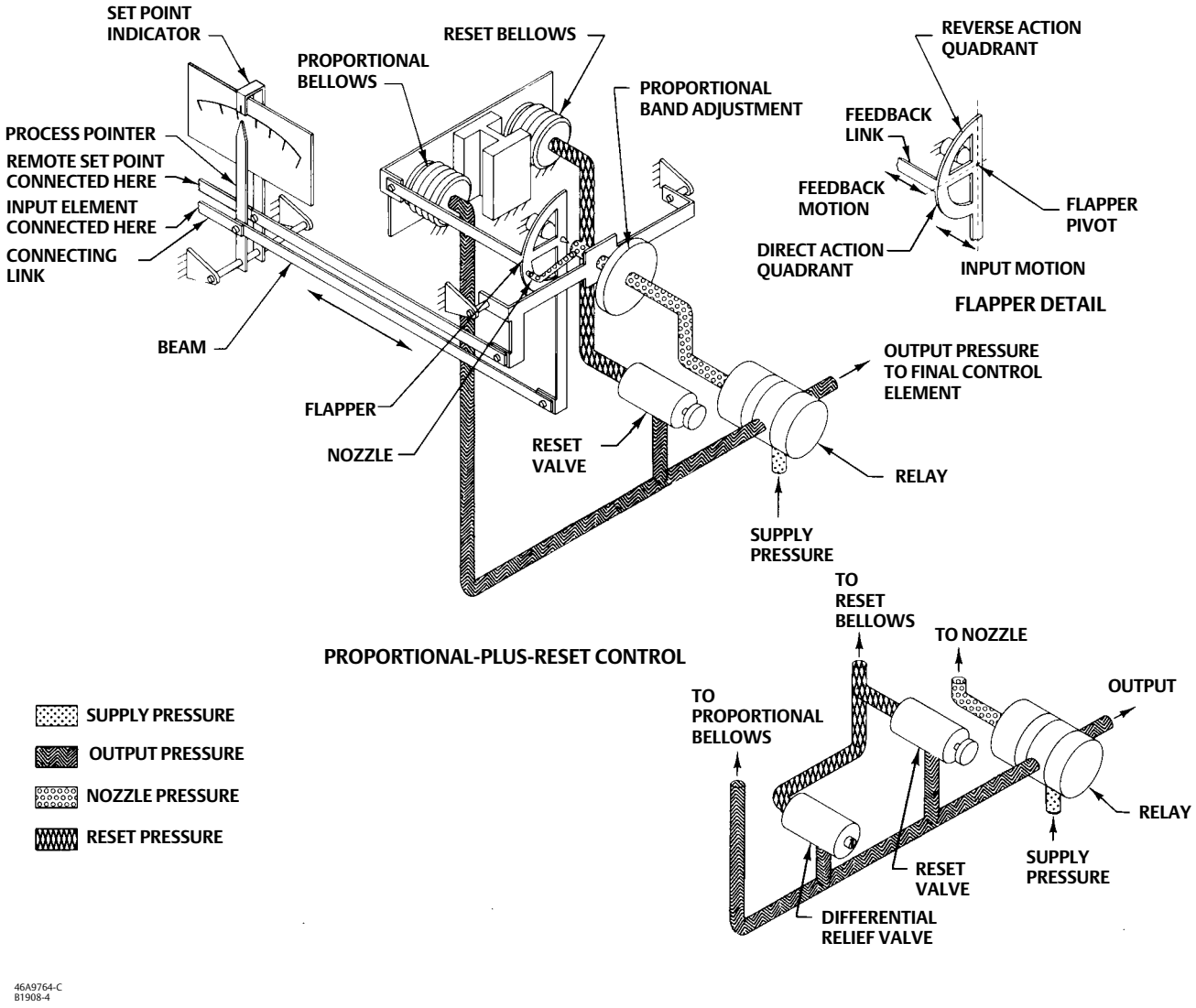
The input element connects to the process pointer and to the flapper by connecting links. As the process temperature increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the proportional bellows and to the reset bellows. The action of the proportional bellows quickly counteracts the flapper movement that resulted from the process temperature change and backs the flapper away from the nozzle.

Pressure in the reset bellows opposes the action of the proportional bellows and slowly moves the flapper closer to the nozzle. The result of this interaction is that when the process temperature changes, proportional action temporarily reduces the gain of the controller for improved stability. The process temperature then slowly returns to set point, as pressure in both bellows equalizes via the reset action.

Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process temperature, except that when the set point is changed, the nozzle moves with respect to the flapper.

The proportional band adjustment positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more input and less feedback motion occurs, which increases the gain. The controller action is changed from direct to reverse by turning the proportional band adjustment to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed as shown in the flapper detail of figure 18 or 19. With the controller in the reverse-acting mode, an increase in process temperature causes a decrease in output pressure.

Figure 18. Fisher 4196B Controller Schematic



A 4196C controller also has a rate valve as shown in figure 19 and 20. This valve is an adjustable restriction that momentarily increases the controller gain to accelerate the corrective action for slow responding systems. A proportional-plus-reset- plus-rate controller responds to a change in process temperature as follows:

- First, the rate action delays the proportional action just long enough to allow the controller to respond to the change quickly with high gain, but not long enough for the high gain to cause instability.
- Then, the low gain provided by the proportional action keeps the system stable. Finally, reset action slowly increases the gain and returns the process temperature toward the set point.

Figure 19. Fisher 4196C Controller Schematic

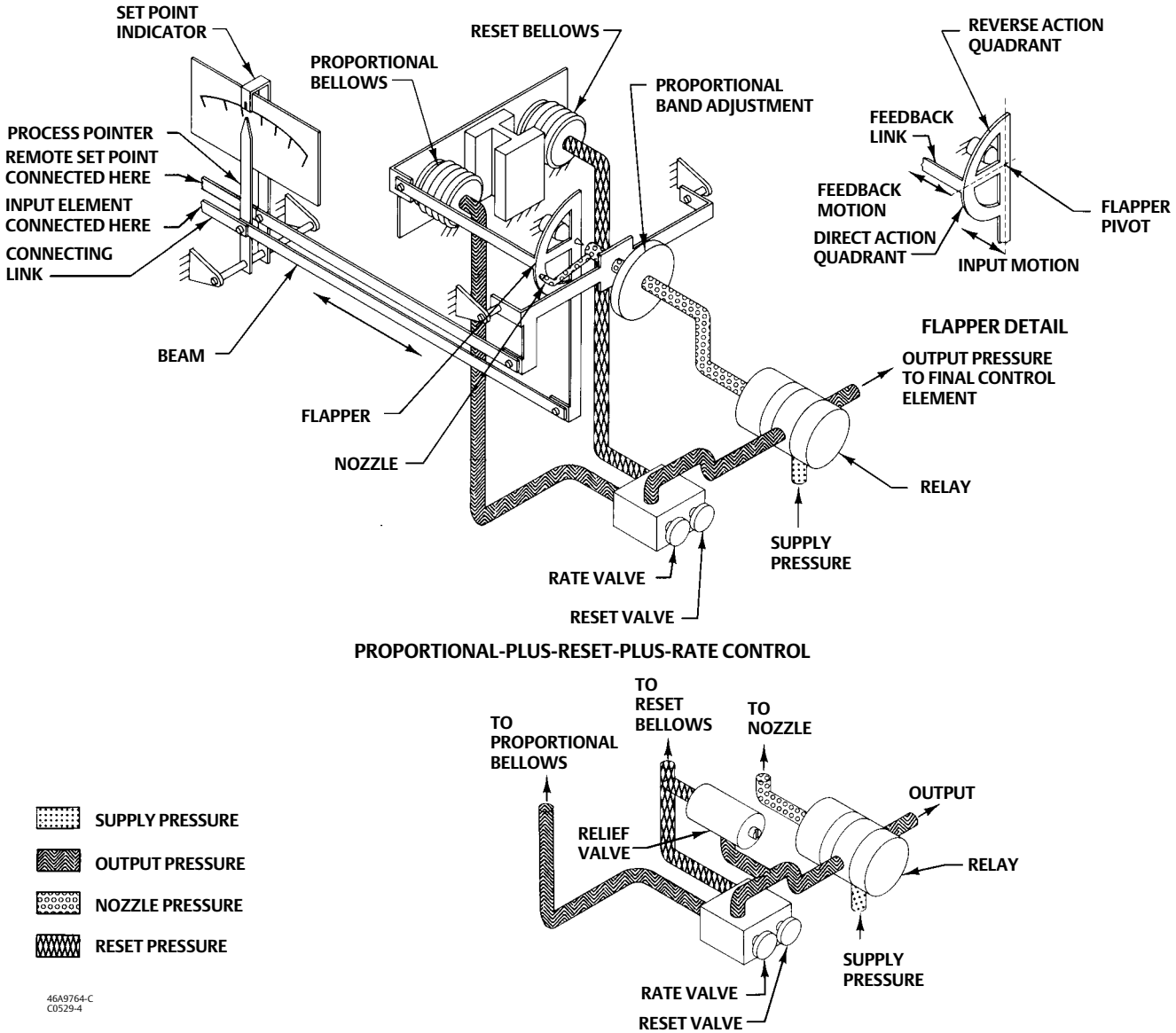
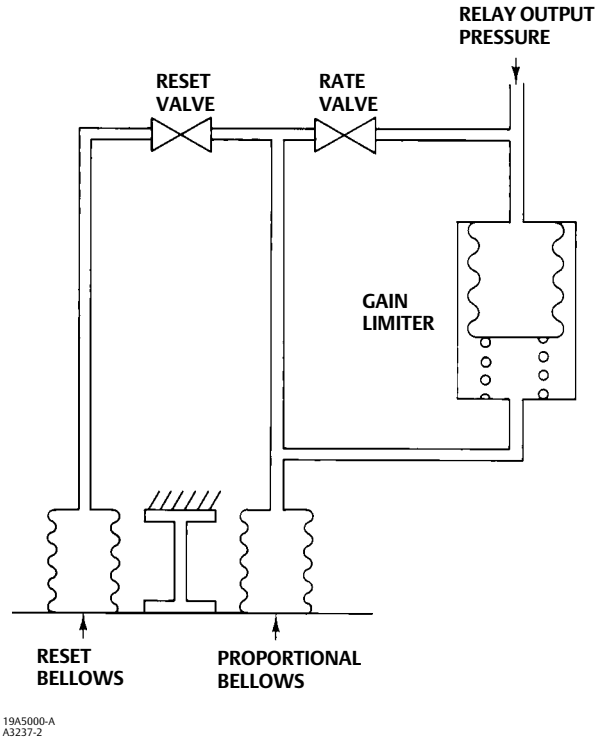


Figure 20. Reset-Rate Schematic



Anti-Reset Windup (suffix letter F) Operation

Anti-reset windup is available on all 4196B and C controllers and is designated by the letter F in the type number. The differential relief valve operates when the difference between proportional bellows pressure and reset bellows pressure reaches a predetermined value. Anti-reset windup reduces overshoot of the process temperature that can result from large or prolonged deviation from set point.

Remote Set Point (suffix letter M) Operation

The capability to adjust the controller set point from a remote location is available with all 4196B and C controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via connecting linkage. Increasing the control pressure to the capsule increases the set point setting, and decreasing the control pressure reduces the set point setting.

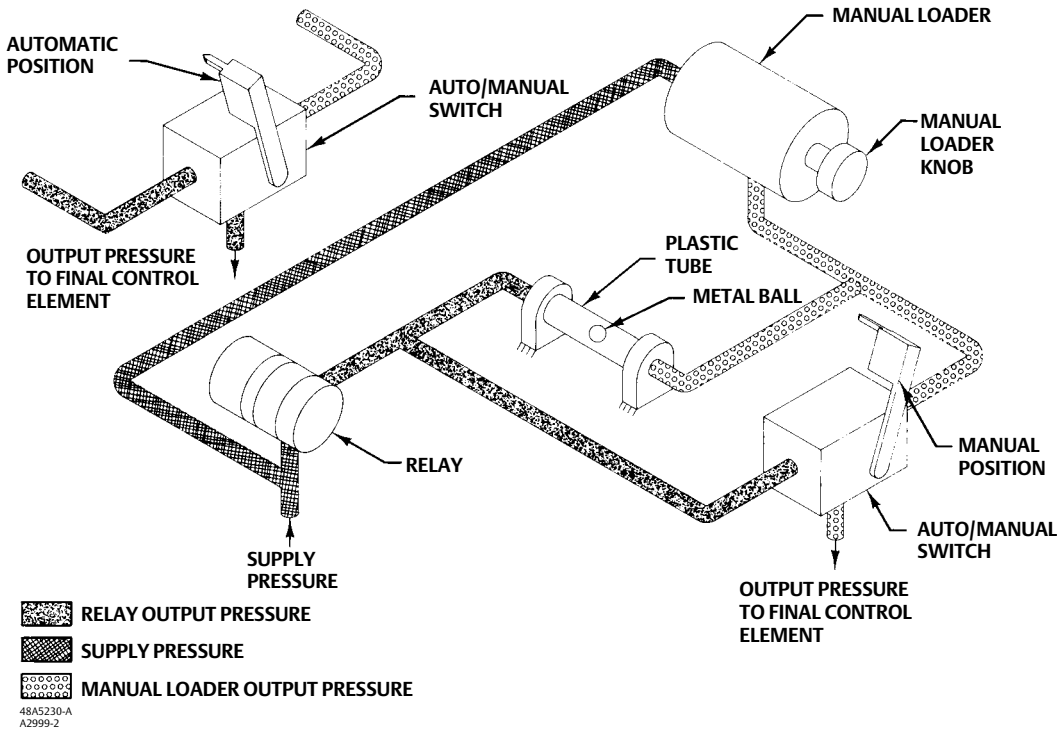
Auto/Manual Station (suffix letter E) Operation

A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 21. 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.

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

Before the auto/manual switch is operated, the relay output must equal the manual loader output 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 and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal blocking air flow through the tube.

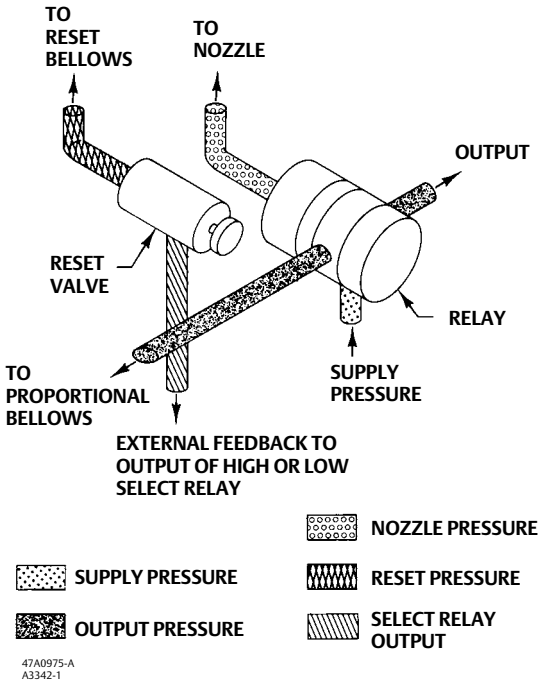
Figure 21. Fisher 4196B and C Controller Auto/Manual Station Schematic



External Feedback Operation

External feedback is available with all 4196B controllers. Controllers with this option have an external connection on the bottom of the controller case as shown in figure 8. This connection breaks the positive feedback (reset) loop inside the controller and brings it outside as shown in figure 22. The connection allows the positive feedback loops of two controllers (primary and secondary) to be tied together when the controllers are used in an override application. When connected, the secondary controller tracks the primary controller, minimizing reset windup.

Figure 22. Schematic of External Feedback Option

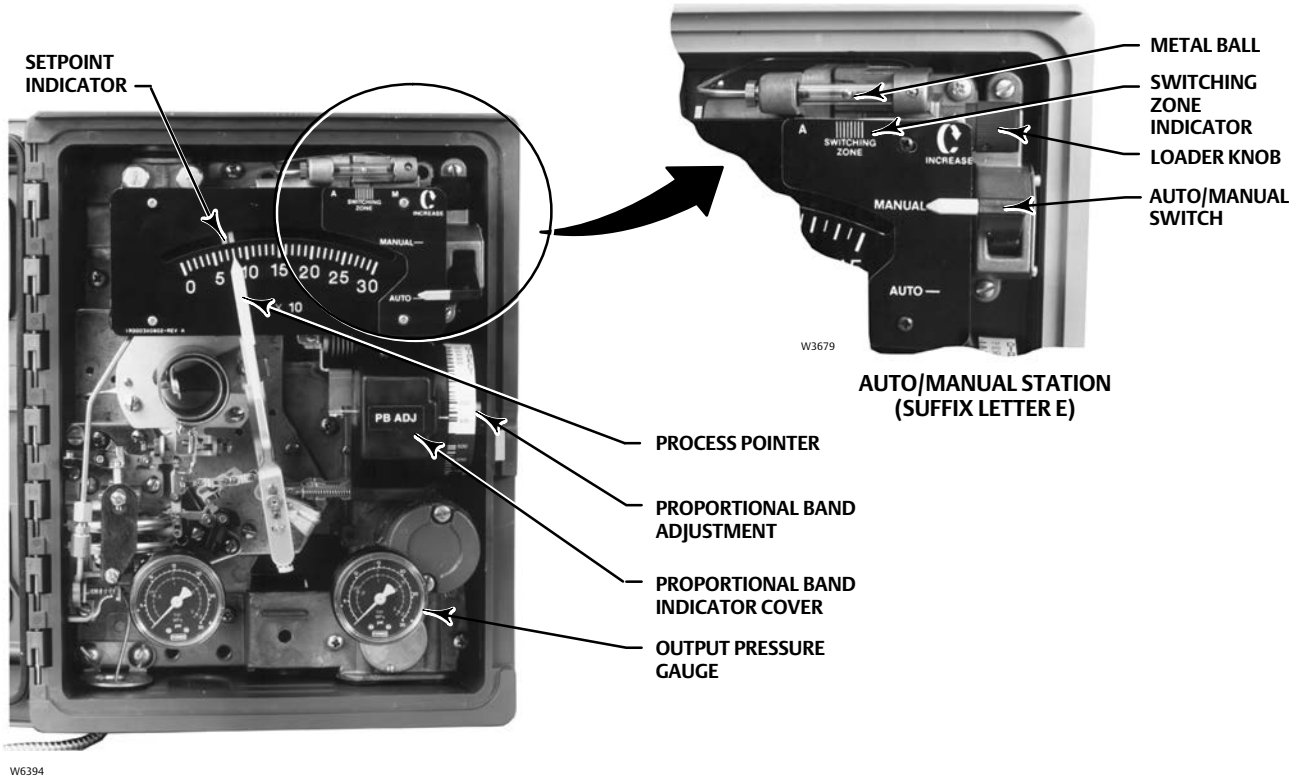


Section 5 4196S Differential Gap Controllers

Adjustments for 4196S Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup, and calibration. Adjustment locations are shown in figures 23 and 25. To better understand the adjustments and overall controller operation, refer to the Principle of Operation section and to the schematic diagram in figure 27. Unless otherwise noted, key numbers given in this section are found in figure 48.

Figure 23. Fisher 4196S Controller Adjustment Locations



Manual Set Point Adjustment

The set point indicator adjusts the upper or lower switching point, depending on controller action. Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process temperature scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not effect the differential gap setting.

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point, and counterclockwise to decrease the process set point.

Remote Set Point (suffix letter M) Adjustment

NOTICE

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

If the controller is equipped with remote set point (suffix letter M), 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.

Proportional Band Adjustment (PB ADJ)

The proportional band adjusts the width of the gap between switching points. To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

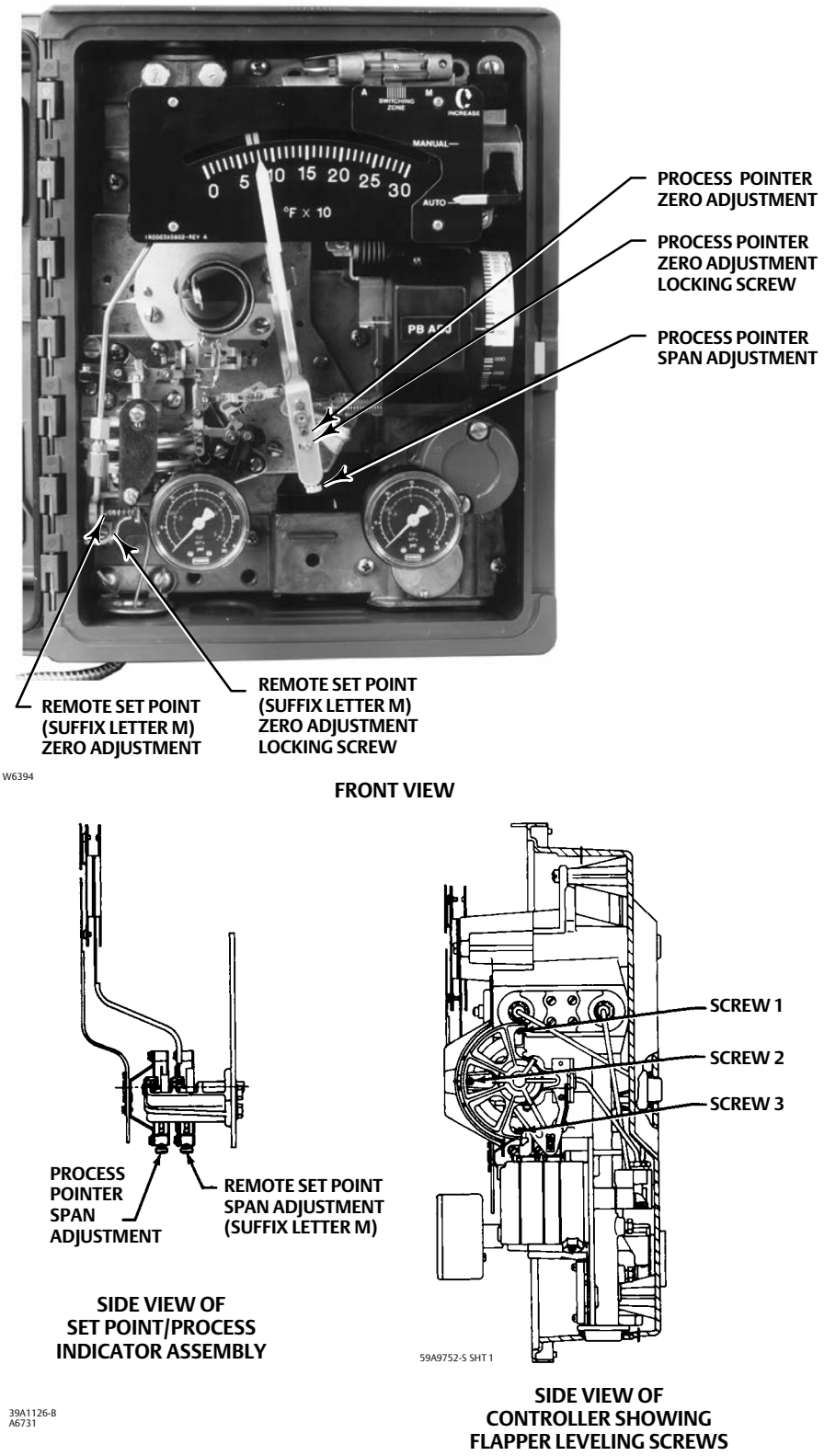
Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 24 and rotate the proportional band adjustment to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

Figure 24. Changing Controller Action (Fisher 4196S Controllers)

W3439

Figure 25. Fisher 4196S Controller Calibration Adjustment Locations



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 23 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first 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 to move the ball into the switching zone. Turn the switch to AUTO and adjust the set point to control the output.

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

Prestartup Checks for 4196S Controllers

Refer to figure 23 for adjustment locations and refer to figure 48 for key number locations.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input temperature or other control signal to the controller.

Note

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

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator, and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 3.
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. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of input span above the process pointer.
5. Adjust the proportional band for 5 percent DIRECT.
6. The process pointer should read ambient temperature ±1 percent of span. Be sure that the bulb is exposed to air only and is not resting against the floor, test bench, or other surface.
7. The controller output pressure should be 0 psig.
8. Rotate the proportional band to 5 percent REVERSE.

9. The controller output should be within 0.14 bar (2 psig) of the supply pressure.
10. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action, secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4196S calibration procedure for recalibration.

Startup for 4196S Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

Note

When performing the startup procedures, keep in mind that the initial settings are guidelines and will vary, depending on the actual process being controlled.

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

When placing a controller in service, slowly open the upstream and downstream manual control valves in the pipeline and close the manual bypass valve if such valves are used.

Calibration of 4196S Controllers

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

General Calibration Instructions

Note

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

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers are shown in figure 48.

Do not use gauges supplied with the controller during calibration. Monitor supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

Temperature Baths

The calibration procedure requires that the process temperature be simulated. A temperature bath (liquid or sand, depending on temperature requirements) is recommended. Bath temperature should be able to cover 0 to 100 percent of the temperature element input range.

If available, two baths could be used to simplify and speed up the calibration process. The minimum bath should be preset at 0 percent of input range and the maximum bath should be set at 100 percent of input range.

Also, provide a means of measuring bath temperature. Use a thermometer or resistance temperature detector (RTD) accurate to within ±0.05 percent of input span.

Process Indicator Zero and Span Calibration

Before starting this procedure:

- Provide a means of changing the process temperature to the controller and a means of measurement external to the controller.
- Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 3.

Note

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

Refer to figures 23 and 25 for adjustment locations.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
5. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase the span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Place the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize. The process pointer should indicate the mid-scale mark, ±2 percent of span. If the error is greater than ±2 percent, refer to the Maintenance section and perform the zero and span adjustment procedure.
9. Adjust the process pointer to within ±1 percent of the mid-scale mark by loosening the zero adjustment locking screw and turning the zero adjustment screw. This distributes the error over the entire scale span and brings all points within ±1 percent of the process scale span. Tighten the zero adjustment locking screw.
10. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
11. The process pointer should indicate the process scale lower limit ±1 percent of the scale span.
12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
13. The process pointer should indicate process scale upper limit ±1 percent of the process scale span.
14. If the error is greater that ±1 percent, repeat steps 3 through 13.

Remote Set Point (suffix letter M) Zero and Span Calibration

Refer to figures 23 and 25 for adjustment locations. Refer to figures 48 and 51 for key number locations.

Note

Any adjustment of the remote set point span adjustment screw will require readjustment of the remote set point zero adjustment screw.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.
5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Apply remote set point pressure equal to the mid-range value.
9. Make sure the set point indicator is within ±1 percent of the mid-scale mark and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within ±2 percent of the mid-scale mark, then proceed with step 10. If the set point indicator is not within ±2 percent, proceed to the remote set point calibration procedure in the Maintenance section.
10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw to correct for half the error at mid-scale. Tighten the zero adjustment locking screw.
11. Apply remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within ±1 percent.
12. If necessary, perform the process indicator zero and span calibration procedure in this section.

Setting Switching Points

Direct-Acting Controllers

The controller output switches from zero pressure to full supply pressure when an increasing process temperature passes the upper switching point. The controller output does not return to zero pressure until a decreasing process temperature passes the lower switching point. When making adjustments as described in the following steps, keep in mind that:

- Changing the set point moves both switching points equally in the direction of adjustment.
- Changing the proportional band adjustment widens or narrows the differential gap between the two switching points by moving the lower switching point.

Figure 26 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 26.

Example: The sensing element has a range of 38°C (100°F). The lower switching point is to be set at -1°C (30°F) and the upper switching point is to be set at 27°C (80°F).

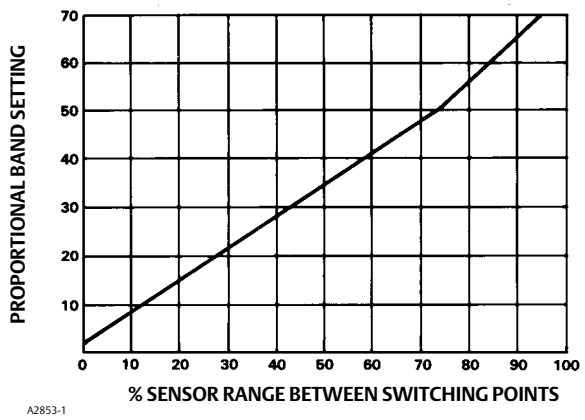
Proceed as follows:

- 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:

$$\frac{\text{Differential Gap}}{\text{Sensing Element Range}} \times 100 = \frac{50^{o}F(10^{o}C)}{100^{o}F(38^{o}C)} \times 100 = 50\%$$

- Locate the 50 percent line on figure 26. 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.

Figure 26. Curve for Determining the Proportional Band Setting



1. Using the curve in figure 26 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 to the desired setting determined in step 1.
3. Adjust the set point to the desired upper switching point.
4. Increase the process temperature until the controller output switches from zero pressure to full supply pressure.
5. Decrease the process temperature to the desired switching point at which the controller output switches from full supply pressure to zero pressure.
6. Narrow or widen the proportional band slowly until the output 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 switches from zero pressure to full supply pressure when a decreasing process temperature passes the lower switching point. The controller output does not return to zero pressure until an increasing process temperature passes the upper switching point. When making adjustments as described in the following steps, keep in mind that:

- Changing the set point moves both switching points equally in the direction of adjustment.

- Changing the proportional band adjustment widens or narrows the differential gap between the two switching points by moving the upper switching point.

Figure 26 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 26.

Example: The sensing element has a range of 38°C (100°F). The lower switching point is to be set at -1°C (30°F) and the upper switching point is to be set at 27°C (80°F).

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:

$$\frac{\text{Differential Gap}}{\text{Sensing Element Range}} \times 100 = \frac{50^{o}F(10^{o}C)}{100^{o}F(38^{o}C)} \times 100 = 50\%$$

- Locate the 50 percent line on figure 26. 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 26 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 to the desired setting determined in step 1.
3. Adjust the set point to the lower desired switching point.
4. Decrease the process temperature until the controller output switches from zero pressure to full supply pressure.
5. Increase the process temperature to the desired switching point at which the controller output switches from full supply pressure to zero pressure.
6. Narrow or widen the proportional band slowly until the output 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 lower switching point. The process pointer indication should be within ±2 percent of the set point indication.

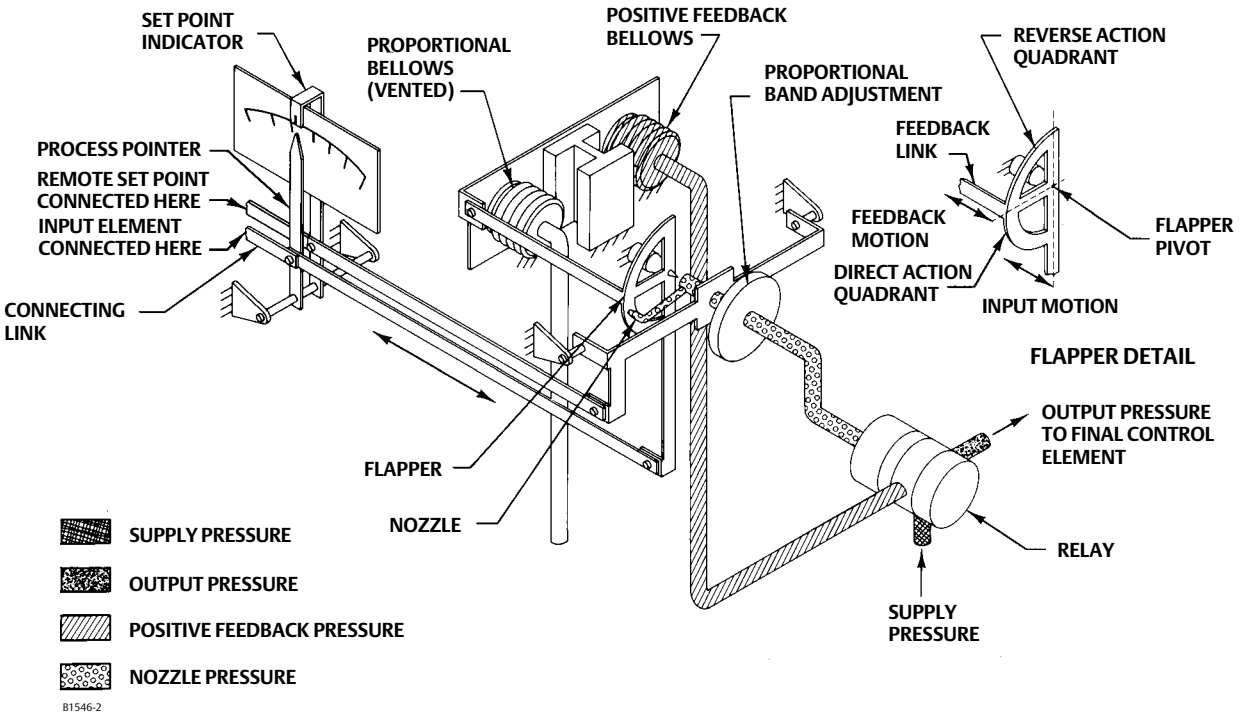
Principle of Operation for 4196S Controllers

Overall Operation

Refer to the schematic diagram in figure 27.

The input element is connected to the process pointer and to the flapper by connecting links. As the process temperature 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 the nozzle pressure even higher, which in turn, increases the relay output. Thus, the output pressure to the final control element switches to full supply pressure.

Figure 27. Fisher 4196S Controller Schematic



As the process temperature 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 further away from the nozzle. Thus, the nozzle pressure falls even further. Output pressure to the final control element switches to zero.

Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process temperature except that, when the set point is changed, the nozzle moves with respect to the flapper. Adjusting the set point moves both the upper and lower switching points.

The proportional band adjustment 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 widens or narrows 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 widens or narrows 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) Operation

The capability to adjust the controller set point from a remote location is available with all 4196 controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via a connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

Auto/Manual Station (suffix letter E) Operation

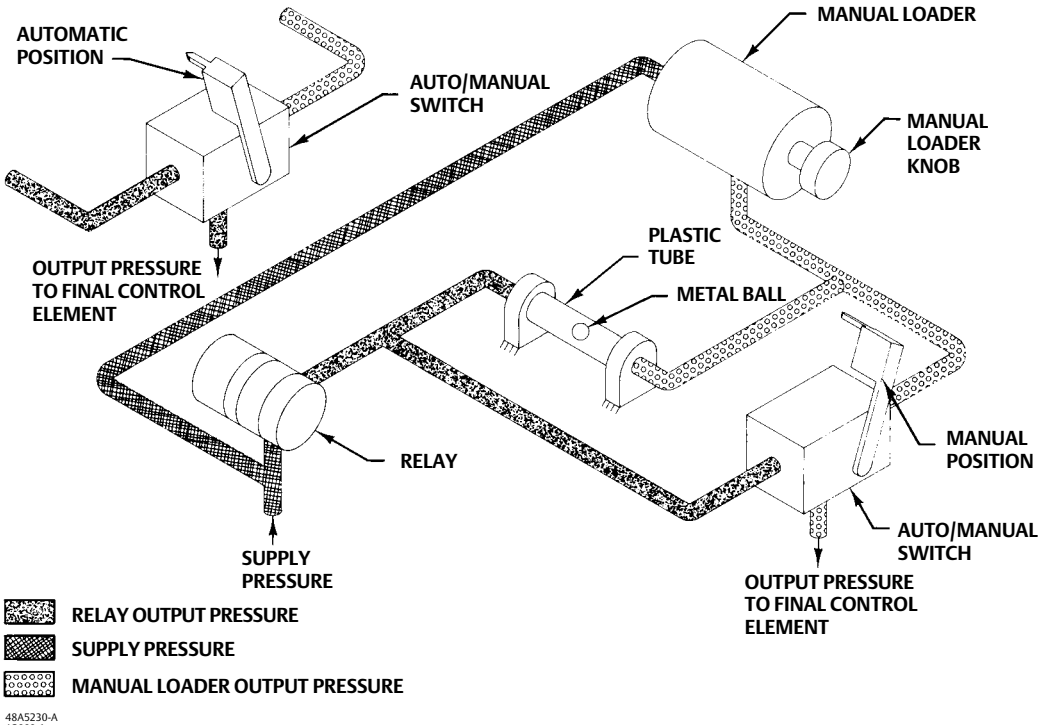
A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 28. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator, applies pressure to one 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.

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

Before the auto/manual switch is operated, the relay output must equal the manual loader output 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 and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

Figure 28. Fisher 4196S Auto/Manual Station Schematic



Section 6 Maintenance

Controller parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and parts replacement depends upon the severity of the service conditions. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job.

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.**
- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and preventive measures are not taken. Preventive 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 16.**
- **Natural gas, if used as the supply medium, will seep from the unit into the surrounding atmosphere if the relay cleanout wire is used to clean the relay primary orifice. Personal injury or property damage may result from fire or explosion if preventive measures are not taken, such as adequate ventilation and the removal of any ignition sources.**
- **Provide some temporary means of control for the process before taking the controller out of service.**
- **Shut off the supply pressure to the controller.**
- **Disconnect any operating lines providing supply air pressure, a process input signal, or other pressure source 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 48. Figures 9 and 11 show the adjustment locations for 4196A controllers. Figures 14 and 16 show adjustment locations for 4196B and C controllers. Figures 23 and 25 show adjustment locations for 4196S controllers. For maintenance on the indicator assembly, please refer to figures 49 and 50.

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

The maintenance procedures section describes part replacement common to 4196A, B, C, and S controllers. After completing the maintenance procedures, perform the appropriate calibration procedures. Unless otherwise noted, calibration procedures for the 4196A controller are in Section 3; calibration procedures for the 4196B and C controller are in Section 4; and calibration procedures for the 4196S controllers are in Section 5. If difficulty is encountered performing the calibration procedures in Sections 3, 4, or 5, refer to the calibration procedures in this section.

Some procedures require temperature baths. Please refer to the appropriate calibration procedure for information on temperature baths.

Troubleshooting

As an aid to troubleshooting, table 8 lists some common operating faults, their probable cause, and suggests procedures for correcting the fault.

Table 8. Troubleshooting Chart

Fault	Possible Cause	Check	Correction
1. Process wanders or cycles about set point	1.1 Proportional band and reset settings	1.1 Refer to the Start-up section for controller settings.	1.1 If stable control cannot be attained, and all other elements of the loop are functionally correct, examine other possible causes related to the controller.
	1.2 Supply pressure varying	1.2 Monitor the supply pressure with an external gauge. Ensure that it is set correctly and does not fluctuate. Note the number of instruments being supplied by the regulator.	1.2 Correct as necessary. One regulator per instrument is recommended.
	1.3 Process pointer rubbing on cover or scale	1.3 Note if the pointer is bent.	1.3 Bend pointer to provide clearance.
	1.4 Input element failure	1.4 Inspect the element for loose screws and damaged flexures, links or pivots. Using a soap solution, check the sensing element for leaks.	1.4 Repair or replace parts as necessary.
	1.5 Linkage failure	1.5 Check for links bent or not connected properly, flexures bent or broken, pivots broken.	1.5 Replace or repair as necessary.
	1.6 Relay malfunction	1.6 By changing the process set point and observing the output, verify that the output moves at about the same speed in both directions.	1.6 If the output moves fast in one direction and sluggishly in the other, replace the relay.
	1.7 Anti-Reset Windup differential relief valve set too low (suffix letter F only)	1.7 The minimum relief valve setting is dependent on the loop dynamics and the controller settings. If under normal load changes the relief valve opens, instability can occur. Check by observing the controller reaction to a set point or load change under closed loop conditions.	1.7 If the anti-reset windup differential relief valve appears to be set too low, perform the anti-reset windup calibration procedures on page in Section 4.
2. Controlling off set point as reflected by process and set point indicators	2.1 Supply pressure not set correctly	2.1 Check with an external source.	2.1 Reset the supply pressure if necessary. If the condition occurs again, rebuild or replace the regulator.
Note: Some offset is inherent with proportional only controllers (4196A controllers). The amount of offset is a function of the proportional band setting.	2.2 Linkage not connected correctly.	2.2 Inspect for loose screws and damaged flexures, links or pivots.	2.2 Repair or replace parts as necessary.
	2.3 Leak in input element/tubing assembly.	2.3 Using soap solution, check the input element and tubing for leaks.	2.3 Repair or replace parts as necessary.
	2.4 Indicators out of calibration.	2.4 Refer to the process indicator and remote set point (if applicable) zero and span calibration procedures in Section 3, 4, or 5.	2.4 Adjust as necessary.
	2.5 Flapper not aligned.	2.5 Refer to the Flapper alignment procedures in Section 3, 4, or 5.	2.5 Align the flapper as necessary.

-Continued-

Table 8. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
2. Controlling off set point as reflected by process and set point indicators Note: Some offset is inherent with proportional only controllers (4196A controllers). The amount of offset is a function of the proportional band setting.	2.6 Leak in feedback system.	2.6 Open the reset valve to .01 minutes/repeat. Adjust output pressure to 1.4 bar (20 psig). Using soap solution, check for leaks in the proportional and reset bellows and in the tubing that connects these bellows.	2.6 Repair as necessary.
	2.7 Reset valve leaks.	2.7 Adjust output to 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Close the reset valve. If the controller output varies and no leaks were found in the rest of the feedback system (Step 2.6), the reset valve is leaking.	2.7 Replace the reset valve.
	2.8 Leak in the remote set point system (suffix letter M only).	2.8 Adjust remote set point pressure to 1.0 bar (15 psig). Using soap solution, check for leaks in the remote set point element and tubing assembly.	2.8 Repair or replace parts as necessary.
	2.9 Input element over pressured.	2.9 Check for zero shift.	2.9 Replace input element and adjust travel stops.
3. Controlling off set point but not reflected by process and set point indicators	3.1 Out of calibration	3.1 Refer to the process indicator, remote set point (if applicable), and flapper alignment procedures in Section 3, 4, or 5.	3.1 Adjust as necessary
4. No reset action (4196B and 4196C controllers)	4.1 Reset valve is plugged	4.1 Turn the reset valve through its range several times to remove any restrictions.	4.1 If reset action returns, no further action is necessary. If not, replace the reset valve (4196B controllers) or the rate/reset valve (4196C controllers).
	4.2 Reset pressure leak	4.2 Adjust the output to 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Close the reset valve. If the output varies and no leaks were found in the rest of the feedback system (see Step 2.6), the reset valve is leaking.	4.2 Replace the reset valve (4196B controllers) or the rate/reset valve (4196C controllers)
	4.3 Tubing leak	4.3 With reset valve positioned at 0.01 minutes/repeat, put 15 psig (1.0 bar) to the output port. Using soap solution, check for leaks in the reset bellows and attached tubing assembly.	4.3 Repair or replace parts as necessary.
5. Abnormal control point shift when proportional band is changed	5.1 Flapper is dirty or pitted	5.1 Inspect the flapper.	5.1 Clean, or replace flapper as necessary.
	5.2 Flapper is out of alignment	5.2 Refer to flapper alignment procedures in Section 3, 4, or 5.	5.2 Align flapper as necessary.
6. Controller will not attain full output range	6.1 Output pressure gauge not functioning	6.1 Measure the output with an external pressure gauge.	6.1 Replace the gauge if it is defective.
	6.2 Supply pressure not correct	6.2 Check with an external source.	6.2 Repair or replace the supply pressure regulator, if necessary. Replace the supply pressure gauge if necessary.
	6.3 Proportional band setting too wide (4196A controllers only)	6.3 Adjust proportional band setting to 10. Manually cap the nozzle. Output should increase.	6.3 Use a narrower proportional band setting (decrease the proportional band setting).

-Continued-

Table 8. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
6. Controller will not attain full output range	6.4 Input element or linkage failure	6.4 Inspect the element for alignment, loose screws and damaged flexures, links or pivots. Using soap solution, check the sensing element for leaks.	6.4 Repair or replace parts as necessary.
	6.5 Leak in nozzle pressure tubing	6.5 Using soap solution, check for leaks in the nozzle tubing assembly.	6.5 Replace faulty parts as necessary. Clean out the relay primary orifice with the cleanout wire attached to the relay to ensure the orifice is not clogged. Refer to the Maintenance warning on page 59.
	6.6 Relay malfunction	6.6 Manually push the flapper away from the nozzle. The output pressure should be zero. Cap the nozzle. The output should increase rapidly to within 35 mbar (0.5 psig) of the supply pressure.	6.6 If the output does not change as described, remove the relay. Replace O-rings, if necessary. Replace relay, if necessary.
7. Controller remains at full output	7.1 Supply pressure too high	7.1 Check with an external pressure gauge.	7.1 Replace supply pressure regulator or gauge as necessary.
	7.2 Output gauge not functioning	7.2 Vary supply pressure to see if output gauge responds.	7.2 If output gauge does not respond, replace it.
	7.3 Input element or linkage failure	7.3 Vary the process temperature and observe the flapper for movement. Inspect the input element and linkage for damage.	7.3 Repair or replace parts as necessary.
	7.4 Mechanical alignment	7.4 Move the set point and verify that the nozzle is uncapped by the flapper. If not, inspect linkages and flexures for damage.	7.4 Repair or replace parts as necessary.
	7.5 Relay failure or restriction in nozzle passage	7.5 Manually move flapper 1.6 mm (1/16-inch) from the nozzle.	7.5 If the output pressure remains at the supply pressure, remove the controller case and cover assembly and test again with the relay nozzle tubing nut (key 18) loose. If the output is 0 psig, clean or replace the nozzle assembly. If the output remains at supply pressure, replace the relay.
	7.6 Flapper misaligned	7.6 Manually push the flapper away from the nozzle. Controller output should go to 0 psig.	7.6 Perform the flapper alignment procedure in Section 3, 4, or 5.
8. Controller remains at zero output	8.1 Gauge not functioning	8.1 Verify that the supply pressure is at its correct value and that the controller output is zero.	8.1 Replace gauges as necessary
	8.2 Input element or linkage failure	8.2 Vary the process temperature and observe the flapper for movement. Inspect the input element and linkage for damage.	8.2 Repair or replace parts as necessary
	8.3 Mechanical alignment	8.3 Move the set point and verify that the nozzle is capped by the flapper. If not, inspect linkages and flexures for damage.	8.3 Repair or replace parts as necessary

-Continued-

Table 8. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
8. Controller remains at zero output	8.4 Relay malfunction	8.4 Check for air at the nozzle. Cap the nozzle and note that the controller output increases to within 0.5 psig of supply pressure.	8.4 Clean out the relay primary orifice with the cleanout wire attached to the relay to ensure the orifice is not clogged. If the problem persists, replace the relay.
	8.5 Nozzle pressure leak	8.5 Using a soap solution, check for nozzle tubing leaks with the nozzle capped by the flapper. Press the nozzle cap (key 23) gently to ensure nozzle O-ring (key 24) is sealing. Ensure the relay nozzle tubing nut (key 18) and the manifold screws (keys 34 and 131) are tight.	8.5 Tighten the relay nozzle tubing nut (key 18), tighten manifold screws (keys 34 and 131), or replace nozzle assembly O-ring or set point beam assembly as appropriate.

Replacing Common Controller Parts

⚠ WARNING

To avoid personal injury or property damage caused by the uncontrolled release of pressure, be sure any trapped process pressure is properly vented from the controller. Vent any supply pressure from the controller before disassembly.

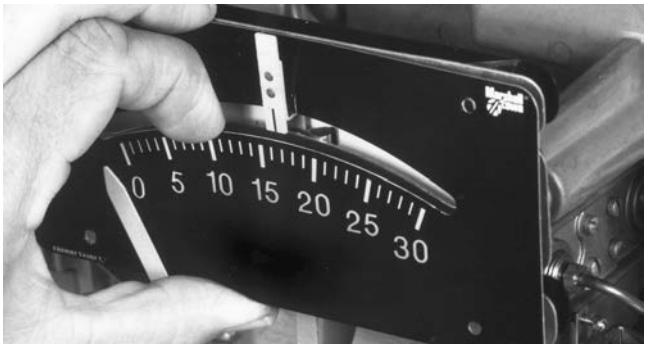
Replacing the Process Temperature Scale

NOTICE

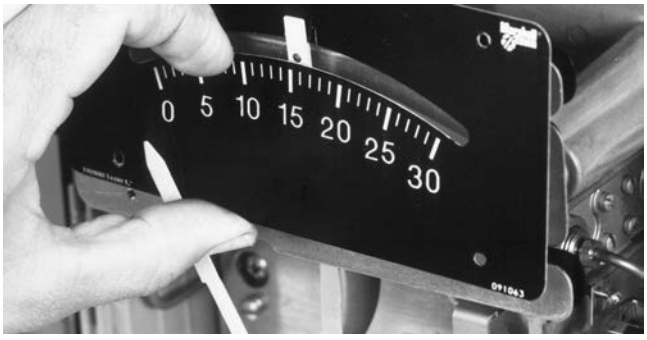
To prevent inaccurate indication and operation, take care not to bend the process pointer or the set point indicator while performing the following procedure.

Refer to figure 29.

Figure 29. Changing the Scale



W4295 **DEFLECT LOWER PORTION OF THE SLOT**



W4296 **AND LIFT THE SCALE UP AND OFF**

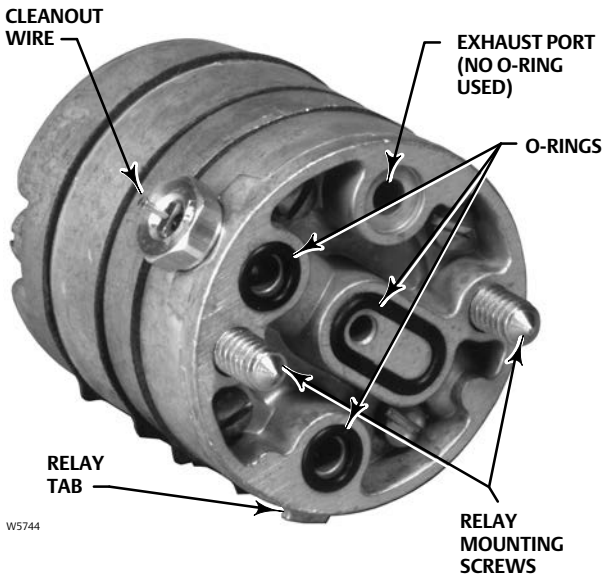
1. Adjust the set point indicator (either manually or with the remote set point pressure) to the mid-scale mark on the process scale.

2. Remove the four self-tapping screws (key 37).
3. Slide the process scale (key 61) downward so that the top of the slot touches the set point indicator. Deflect the lower portion of the slot outward, and carefully slide the scale upward and off, clearing the set point indicator as shown in figure 29.
4. To install the replacement scale, deflect the lower part of the slot slightly so that the scale slides downward over the set point indicator and under the process pointer.
5. Secure the scale with the four self-tapping screws (key 37).
6. If the controller has remote set point (suffix letter M), perform the appropriate remote set point zero and span calibration procedure in Section 3, 4, or 5.
7. Perform the appropriate process indicator zero and span calibration and the flapper alignment procedures in Section 3, 4, or 5.

Replacing the Relay

1. Loosen the two captive screws that hold the relay (key 50) in place.
2. Tip the relay slightly toward the side of the case to clear the output pressure gauge (key 46), and lift out the relay.
3. Make sure the replacement relay has three O-rings (keys 13 and 15) installed as shown in figure 30. The fourth port is for exhaust and does not require an O-ring.
4. Install the replacement relay, making sure the tab on the relay, shown in figure 30, aligns with the tab on the frame.
5. Tighten the two screws that hold the relay in place.
6. Perform the appropriate Flapper Alignment procedure in Section 3, 4, or 5.

Figure 30. Relay Construction



Replacing the Case and Cover

NOTICE

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

1. Remove the external piping and fittings from the controller.
2. If the temperature bulb is not in a thermowell, make provisions to ensure that the process fluid does not escape from the process vessel as the temperature bulb is removed.
3. Remove the controller from its mounting to a maintenance area.
4. Remove the nine screws (key 38) from the case and cover assembly (key 1) and lift out the controller assembly. If the controller has remote set point (suffix letter M), use a screwdriver or appropriate tool to deflect the case slightly at the remote set point connection to remove the controller assembly.
5. Carefully draw the capillary tube and the temperature bulb through the process connection opening in the case. Inspect the O-rings around the external piping connections and replace as necessary.
6. Carefully feed the temperature bulb through the opening in the replacement case and pull the capillary tube all the way through.
7. Position the controller assembly in the replacement case and cover.
8. Start the nine mounting screws, but do not tighten.
9. Slide the controller assembly down to assure an O-ring seal at the pressure connections and thermal system connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
10. Remove the blow-out plug (key 72) from the original case, and install in the replacement case.
11. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
12. Mount the controller as described in the Installation section.
13. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Replacing the Gauges

NOTICE

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

1. Unscrew the output pressure gauge (key 46) or the supply pressure gauge (key 46) from the frame (key 3).
2. Before installing the replacement gauge, coat the threads on the gauge with a suitable sealant such as key 311.
3. Screw the replacement gauge into the frame.
4. Apply the correct supply pressure and check for leaks with the nozzle capped for full output pressure.

Replacing the Supply Gauge, Proportional, Reset, and Reset Valve Tubing Assemblies

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.

2. Unscrew the nuts at each end of the tubing assembly. Remove the tubing assembly.
3. Install the replacement tubing assembly.
4. Set the reset adjustment to 0.01 (4196B and C controllers) and set the rate adjustment to OFF (4196C controllers).
5. Apply the correct supply pressure and check for leaks with the nozzle capped for full output pressure. Then, remove the pressure.
6. Perform steps 6 through 9 of the case and cover replacement procedure.
7. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
8. Mount the controller as described in the Installation section.
9. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

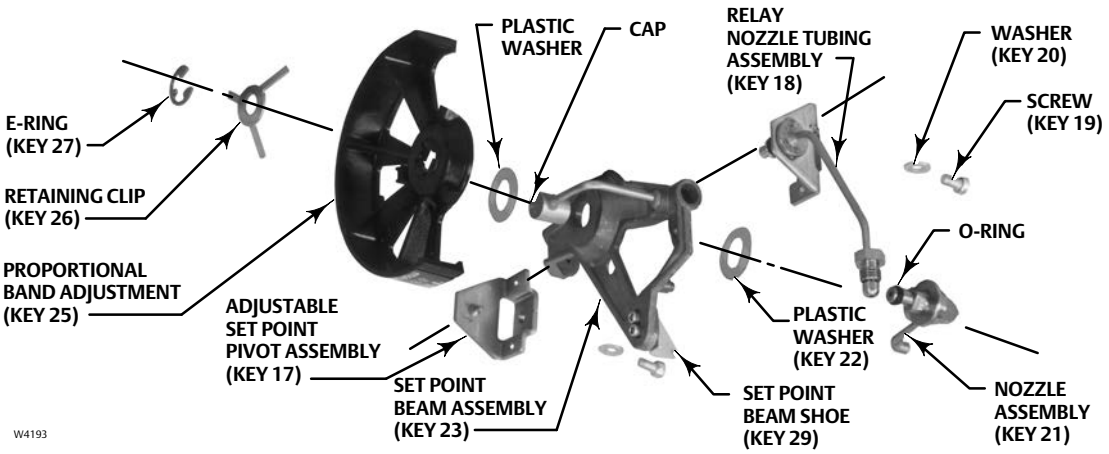
Replacing the Proportional Band Adjustment Knob, Nozzle Assembly, and Set Point Beam Assembly

Figure 31 shows the parts locations for the proportional band adjustment and set point beam. Unless otherwise noted, refer to this figure while performing the following procedures.

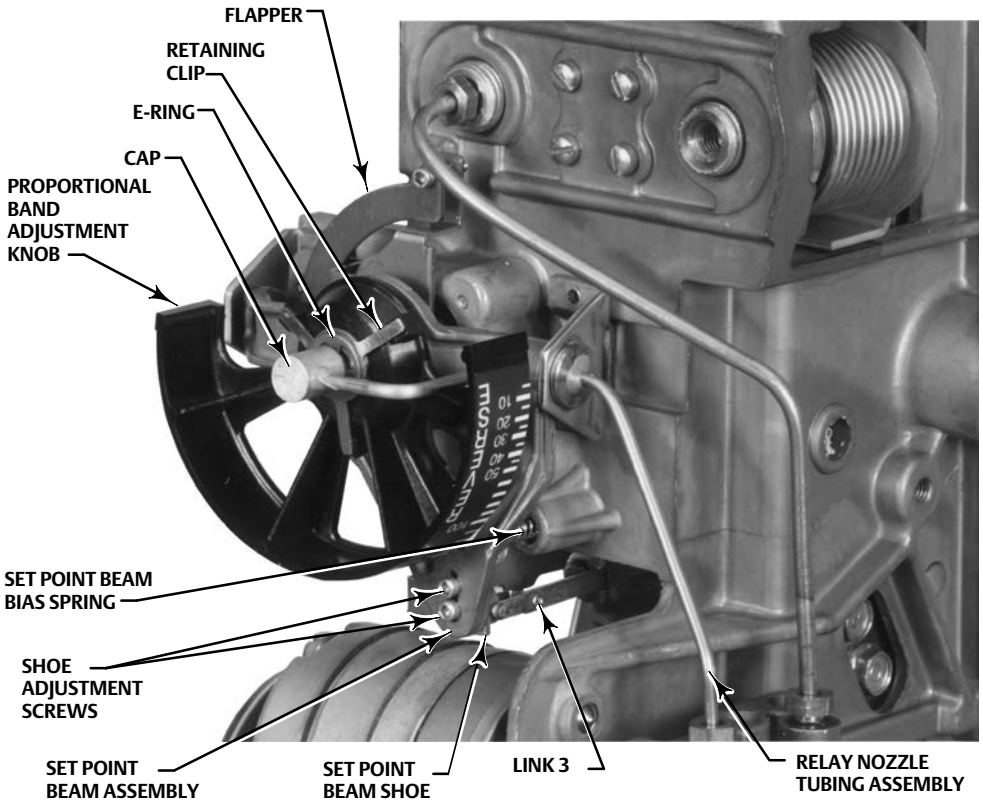
Disassembly

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the two machine screws (key 6), and lift off the proportional band indicator cover (key 36). See figure 48 for parts location.
3. Disconnect link 3 from the set point beam shoe, part of the set point beam assembly (key 23).
4. Remove the set point beam bias spring (key 28).
5. Remove the screw and washer (keys 19 and 20) that hold the adjustable set point pivot assembly (key 17) to the frame, and remove the pivot assembly.
6. Unscrew the nut that secures the relay nozzle tubing assembly (key 18) to the frame manifold (key 135).
7. While holding the proportional band adjustment knob, remove the screw and washer (keys 19 and 20) that hold the relay nozzle tubing assembly (key 18) to the frame.
8. Remove the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly from the controller.
9. Remove the relay nozzle tubing assembly (key 18) from the set point beam assembly (key 23).
10. Remove the E-ring (key 27) from the nozzle assembly (key 21).
11. Remove the nozzle assembly (key 21) and plastic washer (key 22) from the bottom of the set point beam assembly (key 23).
12. Remove the retaining clip (key 26).
13. Remove the proportional band adjustment knob (key 25) and plastic washer from the set point beam assembly (key 23).
14. Inspect the nozzle assembly (key 21) and replace it if necessary. Inspect the nozzle orifice, and clean it if necessary. Also inspect the plastic washers, and replace them if necessary.
15. Inspect the nozzle assembly O-ring (key 24) and replace it, if necessary.

Figure 31. Proportional Band Adjustment and Set Point Beam Details



EXPLODED VIEW

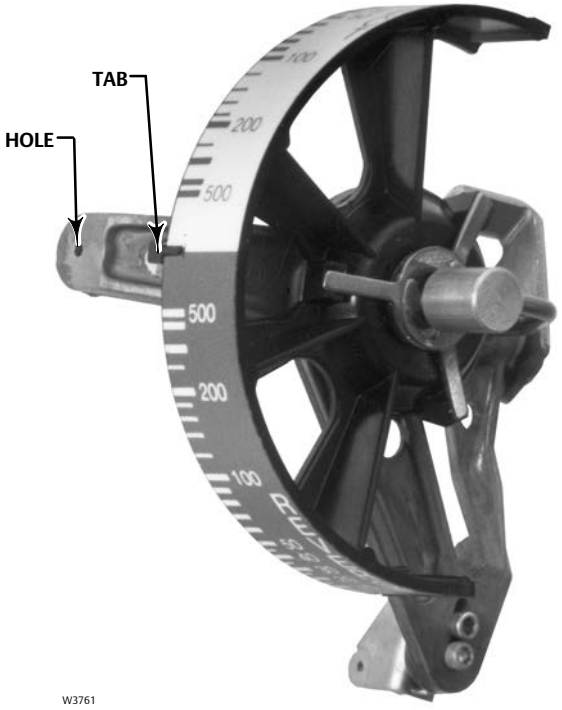


ASSEMBLED VIEW (CONTROLLER REMOVED FROM CASE)

Assembly

1. Apply a suitable lubricant, such as key 318, to the set point beam assembly; then position a plastic washer (key 22) and the proportional band adjustment knob (key 25) on the set point beam assembly (key 23) as shown in figure 31.
2. Position the retaining clip (key 26) on the three posts of the proportional band adjustment knob.
3. Place the second plastic washer on the nozzle assembly. Apply a suitable lubricant, such as key 317, to the nozzle assembly O-ring.
4. Insert the nozzle assembly (key 21) through the set point beam assembly (key 23), the plastic washer (key 22), the proportional band adjustment knob (key 25) and the retaining clip (key 26) into the cap. Align the nozzle with the tab on the proportional band adjustment knob shown in figure 32; make sure the proportional band adjustment knob engages the flats on the nozzle assembly.

Figure 32. Proportional Band Adjustment Knob Setting



5. While holding the nozzle assembly (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 assembly (key 21). Ensure that all three tabs of the E-ring are engaged.
6. Inspect the O-ring on the relay nozzle tubing assembly (key 18), and replace it, if necessary. Apply a suitable lubricant to the O-ring.
7. Install the relay nozzle tubing assembly (key 18) into the set point beam assembly.
8. Set the proportional band adjustment between DIRECT and REVERSE. Do this by aligning the tab on the proportional band adjustment knob with the hole in the set point beam assembly as shown in figure 32.
9. Position the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly on the frame. Screw the relay nozzle tubing nut loosely into the frame manifold.

10. Insert the machine screw, with plain washer (keys 19 and 20), through the frame and start it into the relay nozzle tubing assembly (key 18), but do not tighten.
11. Center the nozzle on the flapper as shown in figure 33 while squeezing the set point beam assembly firmly against the relay nozzle tubing assembly. With the nozzle centered on the flapper, tighten the machine screw (key 19). Ensure that the nozzle is still centered on the flapper.
12. Insert the pivot of the adjustable set point pivot assembly (key 17) into the hole in the set point beam assembly (key 23).
13. Insert the screw, with washer (keys 19 and 20) through the frame (key 3) and start it into the adjustable set point pivot assembly (key 17), but do not tighten.
14. Squeeze the adjustable set point pivot assembly against the set point beam assembly. Check to be sure the nozzle is still centered on the flapper and tighten the machine screw (key 19). If necessary, loosen both machine screws (key 19) to allow slightly moving the adjustable set point pivot assembly, set point beam assembly and the relay nozzle tubing assembly as a unit to center the nozzle on the flapper. After centering the nozzle, tighten the two machine screws.
15. Turn the proportional band adjustment knob to 5 percent DIRECT. Refer to figure 34 to locate the locking nut on the adjustable set point pivot assembly. Loosen the locking nut and back out the set screw slightly so that the set point beam assembly falls under its own weight when pivoted upward. Also, maintain a minimum side play between the adjustable set point pivot assembly and the nozzle tubing assembly. Tighten the locking nut.
16. At the frame manifold (key 135), tighten the nut that secures the tubing from the relay nozzle tubing assembly (key 18). Apply full supply pressure with the nozzle capped and check for leaks. Remove supply pressure.
17. Install the set point beam bias spring (key 28) into the frame bore and onto the spring seat on the set point beam assembly.

Figure 33. Nozzle-Flapper Positioning

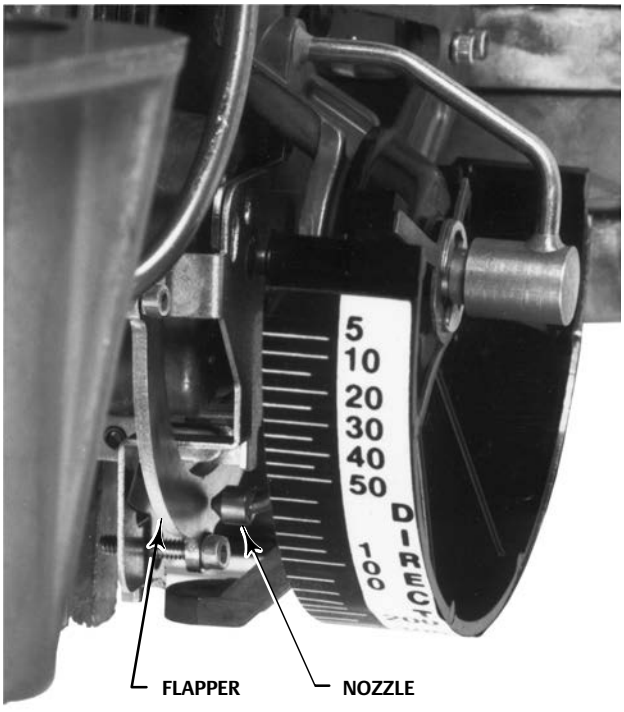
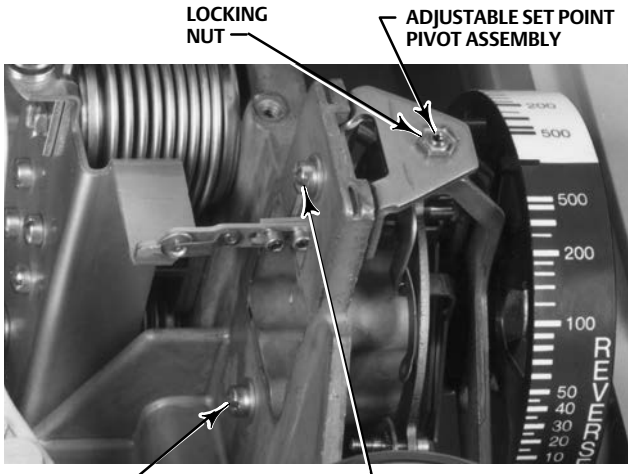


Figure 34. Adjustable Set Point Pivot Assembly Locking Nut Location



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

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18. Attach link 3 to the set point beam shoe as shown in figure 31.
19. For controllers with reset or rate adjustment (4196B and 4196C controllers), turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position. Set the rate adjustment to the OFF position.

    The controller output must be 0 bar (0 psig). To be sure the controller output is 0 bar (0 psig), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position.
20. Apply the correct supply pressure (refer to table 3) to the controller and provide an accurate means of measuring the controller output pressure.
21. Perform the appropriate process indicator zero and span calibration procedure and, if necessary, the remote set point zero and span calibration procedure in Section 3, 4, or 5. When calibration is complete, continue with step 22 below.

Note

The following procedure (steps 22 through 28) matches the process pointer motion to the set point indicator motion so the controller will control at set point at all positions on the process scale.

22. Set the proportional band to 40 percent REVERSE or DIRECT depending on the desired controller action.
23. Adjust the set point to the lower limit on the process scale.
24. Disconnect link 1 from the temperature element, noting the hole from which it is removed and tape the process pointer to the lower limit on the process scale. The output pressure may be anywhere between 0.2 and 1.0 bar (3 and 15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output signal range or between 0.4 and 2.0 bar (6 and 30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output signal range. If the output is not within the specified range, adjust the flapper leveling screw nearest the nozzle until the output is within the range specified. Record the output pressure.
25. Adjust the set point to the upper limit on the process scale.
26. Remove the tape and move the process pointer until the controller output equals the pressure recorded in step 24. Note the process temperature indication.
27. The process temperature indication should be within ±2 percent of the upper limit on the process scale.

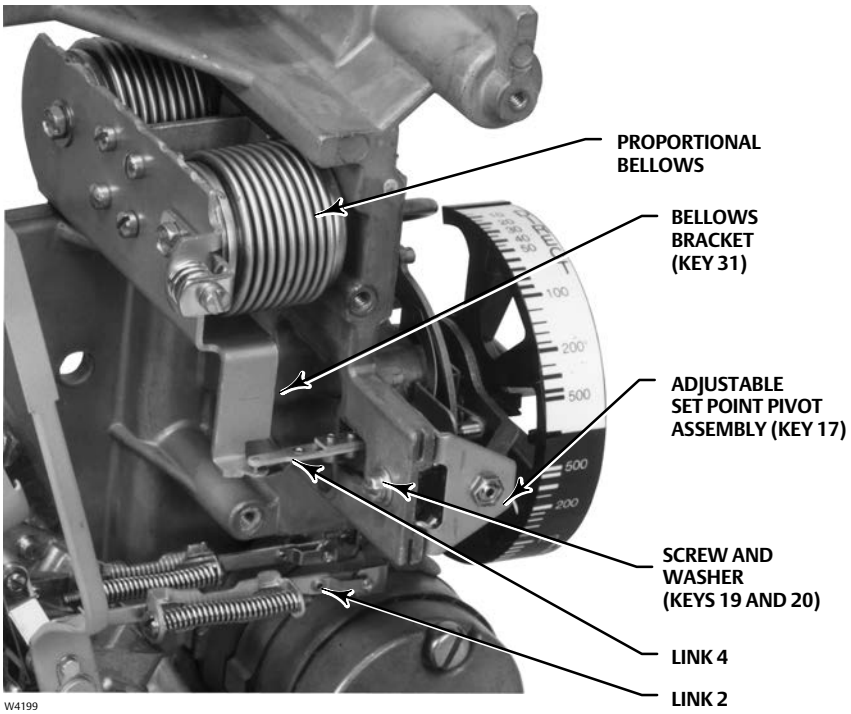
    If the process temperature indication (in step 26) is greater than the upper limit of the process scale by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 31, and move the set point beam shoe (key 29) slightly away from the center of the flapper assembly.

    If the process temperature indication (in step 26) is less than the upper limit of the process scale by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 31, and move the set point beam shoe (key 29) slightly toward the center of the flapper assembly.
28. Repeat steps 23 through 27 until the error is less than 2 percent of the process scale range at the upper limit of the process scale.
29. Remove the tape from the process pointer and reconnect link 1 to the temperature element. Be sure to reconnect link 1 in the same hole noted in step 24.
30. Perform steps 6 through 9 of the case and cover replacement procedure.
31. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
32. Mount the controller as described in the Installation section.
33. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Replacing the Flapper Assembly And Flapper Flexure Pivot Assembly

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the two screws (key 6), and lift off the proportional band cover (key 36).
3. Disconnect link 3 from the set point beam shoe, part of the set point beam assembly (key 23). Refer to figure 31 for the link location.
4. Remove the set point beam bias spring (key 28), refer to figure 31 for the spring location.
5. Remove the screw and washer (keys 19 and 20) that hold the adjustable set point pivot assembly (key 17) to the frame.
6. Remove the adjustable set point pivot assembly (key 17).
7. Unscrew the nut that secures the relay nozzle tubing assembly (key 18) to the frame manifold (key 135). Refer to figure 31.
8. While holding the proportional band adjustment knob, remove the screw and washer (keys 19 and 20) that hold the relay nozzle tubing assembly (key 18) to the frame.
9. Remove the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly from the controller.
10. Disconnect link 2 from the flapper assembly (key 11). Refer to figure 35 for the link location.

Figure 35. Bellows Assembly and Proportional Band Adjustment (Process Scale and Proportional Band Indicator Cover Removed)



11. Disconnect link 4 from the bellows bracket (key 31). Refer to figure 35 for the link location.

12. Remove the two cap screws (key 12) from the flexure pivot assembly (key 9). See figure 36 for screw location.
13. Remove the flapper assembly and link 4 as shown in figure 37.
14. Remove the four machine screws (key 10) shown in figure 37 that hold the flexure pivot assembly to the frame.

Figure 36. Leveling Screw Alignment

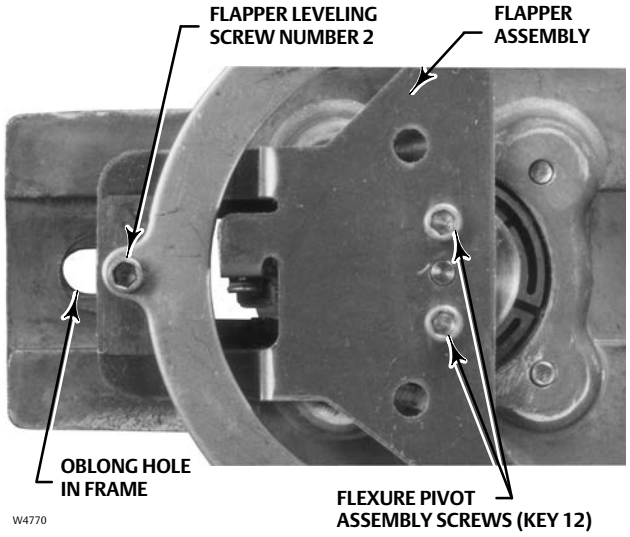
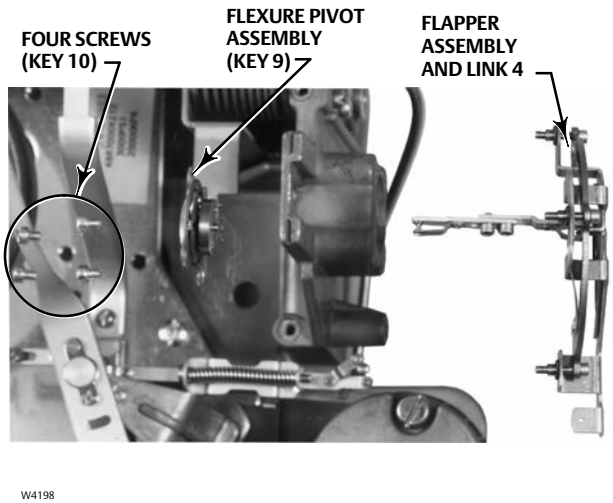


Figure 37. Exploded View of Flexure Pivot Assembly



15. Remove the flexure pivot assembly (key 9).
16. Install the replacement flexure pivot assembly with the four screws (key 10). Do not tighten the screws.
17. With the controller in the upright position, slide the flexure pivot assembly down as far as possible, and tighten the four screws (key 10).
18. Place the flapper assembly (key 11) on the flexure pivot assembly (key 9) with link 4 through the hole in the frame.
19. Start the two cap screws (key 12) that hold the flapper assembly (key 11) to the flexure pivot assembly (key 9). Do not tighten the screws.
20. Align flapper leveling screw number 2 with the centerline of the oblong hole in the frame as shown in figure 36. Tighten the cap screws (key 12).

Note

The following procedure (steps 21 through 23) adjusts link 2 to ensure that it will always be in tension to eliminate possible instability due to lost motion.

21. Note to which hole link 1 is connected and then disconnect link 1 from the temperature element, and manually position the process pointer to the process scale upper limit. Tape the pointer in this position.
22. Adjust the length of link 2 by turning the adjustment screw, shown in figure 38, clockwise to increase the length or counterclockwise to decrease the length, so that the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the flapper assembly, as shown in figure 39.
23. Connect link 2 to the flapper assembly.

Figure 38. Link 2 and 4 Adjustment Locations

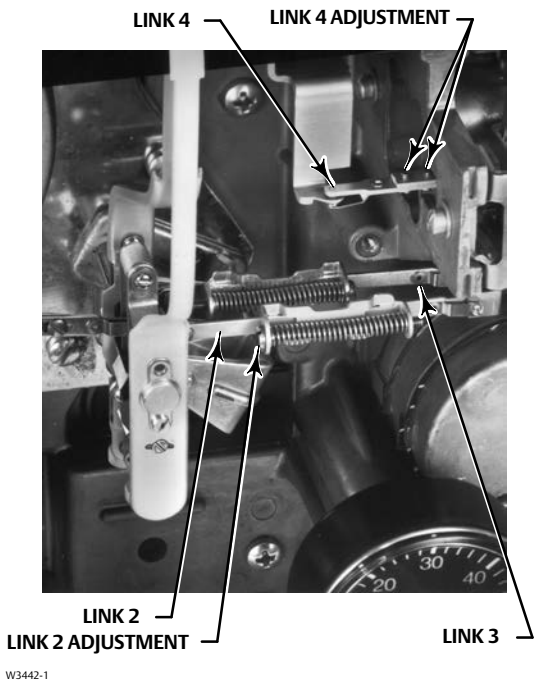
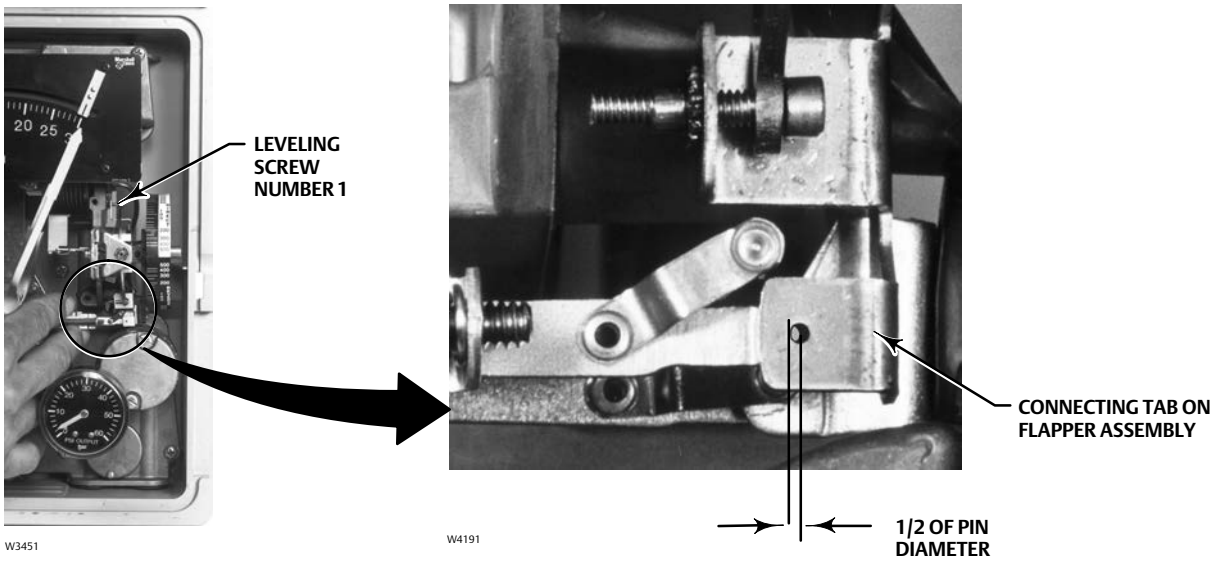


Figure 39. Link 2 Adjustment



24. Set the proportional band between DIRECT and REVERSE. Do this by aligning the tab on the proportional band adjustment knob with the hole in the set point beam assembly as shown in figure 32.
25. Position the proportional band adjustment knob, nozzle assembly, set point beam assembly, and nozzle tubing assembly on the frame, and screw the relay nozzle tubing assembly nut loosely onto the frame manifold (key 135).
26. Insert the machine screw, with plain washer (keys 19 and 20), through the frame and start it into the relay nozzle tubing assembly (key 18), but do not tighten.

27. Center the nozzle on the flapper as shown in figure 33, while squeezing the set point beam assembly firmly against the relay nozzle tubing assembly. With the nozzle centered on the flapper, tighten the machine screw (key 19). Ensure that the nozzle is still centered on the flapper.
28. Insert the pivot of the adjustable set point pivot assembly (key 17) into the hole in the set point beam assembly (key 23).
29. Insert the screw, with washer (keys 19 and 20), through the frame (key 3) and start it into the adjustable set point pivot assembly (key 17), but do not tighten.
30. Squeeze the adjustable set point pivot assembly against the set point beam assembly. Check to be sure the nozzle is still centered on the flapper and tighten the machine screw (key 19). If necessary, loosen both machine screws (key 19) to allow slightly moving the adjustable set point pivot assembly, set point beam assembly and the relay nozzle tubing assembly as a unit to center the nozzle on the flapper. After centering the nozzle, tighten the two machine screws.
31. Turn the proportional band adjustment knob to 5 percent DIRECT. Refer to figure 34 to locate the locking nut on the adjustable set point pivot assembly. Loosen the locking nut and back out the set screw slightly so that the set point beam assembly falls under its own weight when pivoted upward. Also, maintain a minimum side play between the adjustable set point pivot assembly and the nozzle tubing assembly. Tighten the locking nut.
32. At the frame manifold (key 135), tighten the nut that secures the tubing from the relay nozzle tubing assembly (key 18). Apply full supply pressure with the nozzle capped (to obtain maximum output pressure) and check for leaks. Remove supply pressure.
33. Install the set point beam bias spring (key 28) into the frame bore and onto the spring seat of the set point beam assembly as shown in figure 31.
34. Attach link 3 to the set point beam shoe as shown in figure 31.

Note

The following procedure (steps 35 through 41) adjusts link 4 so it will always be in compression to eliminate possible instability due to lost motion.

35. For controllers with reset and rate adjustments (4196B or 4196C controllers), remove the supply pressure; then, turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position.

    The controller output must be 0 bar (0 psig). To be sure the controller output is at 0 bar (0 psig), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position.
36. Apply the correct supply pressure (refer to table 3) to the controller, and provide an accurate means of measuring the controller output pressure.
37. Adjust the proportional band to 5 percent REVERSE, and adjust the set point to the process scale upper limit.
38. With link 1 disconnected, tape the process pointer at the process scale lower limit. The output pressure should be within 0.14 bar (2 psig) of the supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 0.14 bar (2 psig) of supply pressure.
39. Loosen the two adjusting screws on link 4, shown in figure 38, and connect the link to the bellows bracket (key 31), allowing the link to find its free length.
40. Tighten the two adjusting screws on link 4.
41. Lift link 4 out of the hole in the bellows bracket (key 31) and ensure it drops back into the hole under its own weight. If not, repeat steps 39 and 40.
42. Adjust the proportional band to 40 percent REVERSE or DIRECT depending on the desired controller action.
43. Adjust the set point to the process scale lower limit.

44. Tape the process pointer at the process scale lower limit. The output pressure may be anywhere between 0.2 and 1.0 bar (3 and 15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output signal range or between 0.4 and 2.0 bar (6 and 30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output signal range. If the output is not within the specified range, adjust the flapper leveling screw nearest the nozzle until the output is within the range specified. Record the output pressure.
45. Adjust the set point to the process scale upper limit.
46. Remove the tape and move the process pointer until the controller output equals the pressure recorded in step 44. Note the process temperature indication.
47. The process temperature indication should be within ±2 percent of the process scale upper limit.

    If the process temperature indication (in step 47) is greater than the process scale upper limit by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 31, and move the set point beam shoe (key 29) slightly away from the center of the flapper assembly.

    If the process temperature indication (in step 47) is less than the process scale upper limit by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 31, and move the set point beam shoe (key 29) slightly toward the center of the flapper assembly.
48. Repeat steps 43 through 47 until the error is less than 2 percent of the process scale span at the process scale upper limit.
49. Remove the tape from the process pointer and reconnect link 1 to the temperature element. Be sure to reconnect link 1 in the same hole noted in step 21.
50. Perform steps 6 through 9 of the case and cover replacement procedure.
51. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
52. Mount the controller as described in the Installation section.
53. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Replacing the Proportional or Reset Bellows

Refer to figure 40, unless otherwise noted.

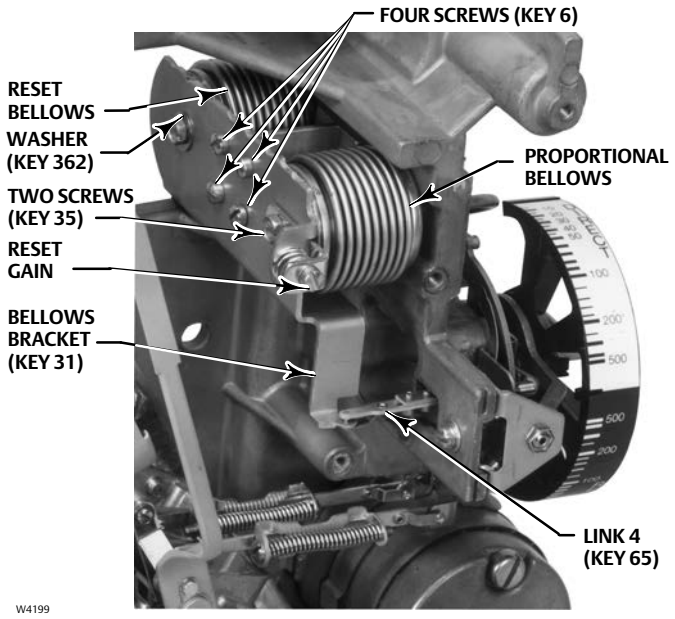
1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
3. Disconnect link 4 (key 65) from the bellows bracket (key 31).
4. Remove the two machine screws (key 35) and washers (key 362) from the bellows assemblies.
5. Remove the four machine screws (key 6) from the bellows beam (key 49), and remove the bellows bracket (key 31).
6. Remove the proportional tubing assembly (key 40) from the proportional bellows, or remove the reset tubing assembly (key 43) from the reset bellows, depending on which bellows is to be replaced.
7. Remove the four machine screws (key 71) from the bellows beam and remove the bellows beam from the frame.

NOTICE

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

8. Unscrew the bellows assembly (key 48). If the bellows assembly cannot be removed by hand, thread a machine screw (key 35) into the bellows until tight, then loosen the bellows assembly by applying clockwise torque to the machine screw.

Figure 40. Bellows Assembly, Bellows Bracket, and Bellows Beam Location



9. Before installing the replacement bellows, coat the threads with a suitable lubricant, such as key 310. Screw in the replacement bellows until it is finger tight against the frame (key 3).
10. Reinstall the bellows beam (key 49) and tighten the four machine screws (key 71).
11. Position the bellows bracket (key 31) over the bellows. Insert a machine screw (key 35) through the bellows bracket (key 31) into the proportional bellows. Do not tighten.
12. Place the washer (key 362) on the second machine screw (key 35) and start the screw through the bellows bracket (key 31) into the reset bellows. Do not tighten.
13. Compress the bellows and start the four machine screws (key 6) through the bellows bracket (key 31) into the bellows beam (key 49), but do not tighten.
14. Be sure that the bellows bracket is aligned such that it does not rub on the frame at any point and tighten the screws (keys 6 and 35).
15. Install the proportional or reset tubing assembly on the bellows base.
16. For a 4196B or C controller, set the reset adjustment for 0.01 minutes per repeat. For a 4196C controller, set the rate adjustment to OFF.
17. Apply the correct supply pressure with the nozzle capped and check for leaks. Remove the supply pressure.
18. Reconnect link 4 (key 65) to the bellows bracket. Be sure that the link does not contact the frame. If it does, loosen the four screws (key 6) which attach the bellows bracket to the bellows beam, and reposition the bellows bracket to provide clearance. Be sure the bellows bracket does not rub the frame; then, tighten the screws.
19. Lift link 4 out of the hole in the bellows bracket (key 31) and ensure it drops back into the hole under its own weight. If not, perform steps 35 through 41 of the Flapper Assembly and Flapper Flexure Pivot Assembly replacement procedures.

20. If the controller is proportional only (4196A) go the step 34. If the controller has reset (4196B or C) continue with step 21.

Note

The following procedure (steps 21 through 33) adjusts the reset gain of the controller to minimize steady-state offset.

21. Apply the correct supply pressure to the controller and provide an accurate means of measuring controller output pressure.
22. Adjust the proportional band to 100 percent DIRECT.
23. Adjust the set point to the mid-scale mark on the process scale.
24. Adjust the reset adjustment to 0.01 minute per repeat. For a 4196C controller, set the rate adjustment to OFF.
25. Note to which hole link 1 is connected and then disconnect link 1 from the temperature element.
26. Starting from the process scale lower limit, manually move the process pointer to the right until the output pressure stabilizes at 0.2 bar (3 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 0.4 bar (6 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Record the process temperature indication.

Note

When the reset valve is at 0.01, the controller is very sensitive to any process pointer movement. Only a small amount of process pointer movement may be necessary.

27. Very slowly move the process pointer until the output pressure stabilizes at 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Record the process temperature indication.
28. If the difference between the recorded process temperature indications in step 26 and step 27 is larger than ±1 percent of the process scale span, proceed with step 29. If the difference is less than ±1 percent, go to step 34.
29. Loosen the proportional bellows screw (key 35).
30. If the indication recorded in step 27 is greater than in step 26, adjust the reset gain screw (key 34) one-half turn in (clockwise). If the indication recorded in step 27 is less than in step 26, adjust the reset gain screw (key 34) one-half turn out (counterclockwise).
31. Tighten the proportional bellows screw (key 35).
32. Repeat steps 26 through 31 until the difference is less than ±1 percent of the process scale span.
33. If ±1 percent of the process scale span cannot be achieved by adjusting the reset gain screw (key 34), loosen the screw (key 35) attaching the reset bellows and slide it to the left if the indication in step 27 is greater than in step 26, or to the right if the indication in step 27 is less than in step 26. Tighten the screw and repeat steps 26 through 32.
34. Remove the supply pressure and the output measurement device.
35. Reconnect link 1 to the temperature element. Be sure to connect link 1 in the same hole noted in step 25.
36. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
37. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
38. Mount the controller as described in the Installation section.
39. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Replacing the Reset Restriction Valve (4196B Controller)

Refer to the 4196B portion of figure 48 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the reset valve tubing assembly (key 42) from the reset restriction valve (key 54).
3. Remove the reset tubing assembly (key 43) from the reset restriction valve.
4. For controllers with anti-reset windup (suffix letter F), remove the relief valve tubing assembly (key 44) from the reset restriction valve.
5. Remove the screw (key 162) that fastens the reset restriction valve to the frame.
6. Install the replacement reset restriction valve, and secure it with the screw removed in step 5.
7. Install the reset valve tubing assembly (key 42), the reset tubing assembly (key 43), and for controllers with anti-reset windup, the relief tubing assembly (key 44). Tighten all connections.
8. Set the reset adjustment to 0.01 minutes per repeat.
9. Apply the correct supply pressure to the controller, cap the nozzle and check for leaks. Remove the supply pressure.
10. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
11. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
12. Mount the controller as described in the Installation section.
13. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Replacing the Rate/Reset Valve Assembly (4196C Controller)

Note

Read this entire procedure before removing any parts. Refer to the 4196C portion of figure 48 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the two machine screws (key 71) on the side of the rate/reset valve assembly (key 262).
3. Gently pull the rate tubing assembly away from the rate/reset assembly and remove the gasket (key 5) from the side of the rate/reset assembly.
4. Unscrew the nut holding the reset tubing assembly (key 43) into the rate/reset valve assembly.
5. Unscrew the nut holding the proportional tubing assembly (key 40) into the rate/reset valve assembly.
6. For controllers with anti-reset windup (suffix letter F), unscrew the nut holding the relief tubing assembly (key 44) into the rate/reset assembly.
7. While holding the rate/reset valve assembly, remove the machine screw (key 162) from the frame.
8. Remove the rate/reset valve assembly from the frame.
9. Inspect, and if necessary, replace the gasket (key 5).
10. To install the replacement rate/reset valve assembly, position the assembly on the frame (key 3) and secure it with the mounting screw (key 162).
11. Position the gasket (key 5) on the rate/reset valve assembly. Hold the gasket in place while installing the rate tubing assembly (key 137) on the valve assembly using the two machine screws (key 71).

12. Insert the reset tubing assembly (key 43) into the rate/reset valve assembly and tighten the nut.
13. Insert the proportional tubing assembly (key 40) into the rate/reset valve assembly and tighten the nut.
14. For controllers with anti-reset windup (suffix letter F), insert the relief tubing assembly (key 44) into the rate/reset valve assembly and tighten the nut.
15. Set the reset to 0.01 minutes per repeat and the rate to OFF.
16. Apply the correct supply pressure to the controller, cap the nozzle and check for leaks.
17. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
18. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
19. Mount the controller as described in the Installation section.
20. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Replacing the Anti-Reset Windup (suffix letter F) Differential Relief Valve

Refer to the 4196B or 4196C suffix letter F portion of figure 48 for key number locations.

1. Loosen the two screws in the differential relief valve (key 55) and remove the relief valve.
2. Inspect the O-rings on the replacement relief valve. Apply a suitable lubricant (key 318) to the O-rings.
3. Install the replacement relief valve into the controller frame, keeping in mind that:
   - When the arrow points up, the valve relieves with decreasing output pressure.
   - When the arrow points down, the valve relieves with increasing output pressure.
4. Tighten the two screws that hold the relief valve to the frame.
5. The relief valve differential pressure is factory-set at 0.3 bar (5 psi). Maximum differential pressure is 0.5 bar (7 psi); minimum differential pressure is 0.14 bar (2 psi). If a different differential pressure setting is desired, refer to the anti-reset windup valve calibration procedure in Section 4.

Replacing the Anti-Reset Windup (suffix letter F) Relief Valve Tubing Assembly

Refer to the 4196B or 4196C suffix letter F portion of figure 48 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Loosen the nuts at both ends of the relief valve tubing (key 44), and remove the tubing.
3. Install the replacement relief valve tubing, and tighten the tubing nuts at both ends.
4. Apply the correct supply pressure to the controller, cap the nozzle and check for leaks. Remove the supply pressure.
5. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
6. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.
7. Mount the controller as described in the Installation section.
8. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Replacing the Temperature Element

1. Note in which hole link 1 (key 128) is connected and disconnect the link from the temperature element.
2. Remove the three screws (key 127) from the temperature element assembly.

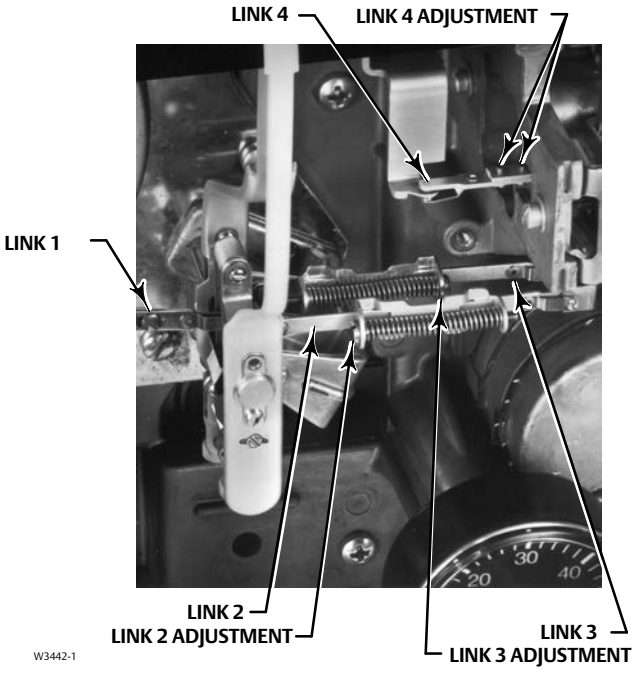
3. Remove the two screws (key 129) at the bottom of the controller case.
4. Lift off the temperature element assembly and withdraw the capillary tube and temperature bulb through the opening in the bottom of the case.
5. Thread the bulb and capillary tube of the replacement assembly into the opening and out through the bottom of the case.
6. With the assembly in position, install and tighten the three screws (key 127).
7. Install the screws (key 129) at the bottom of the controller case.
8. Connect link 1 (key 128) to the temperature element takeoff assembly.
9. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.

Replacing the Links

This section describes the separate replacement of four links in the controller. Figure 41 shows the location of each link. To clarify the location of each link, the links are numbered as follows:

- Link 1 connects the temperature element assembly and the process pointer
- Link 2 connects the process pointer and the flapper assembly (key 11)
- Link 3 connects the set point indicator and the set point beam assembly (key 23)
- Link 4 (key 65) connects the flapper assembly and the bellows bracket (key 31).

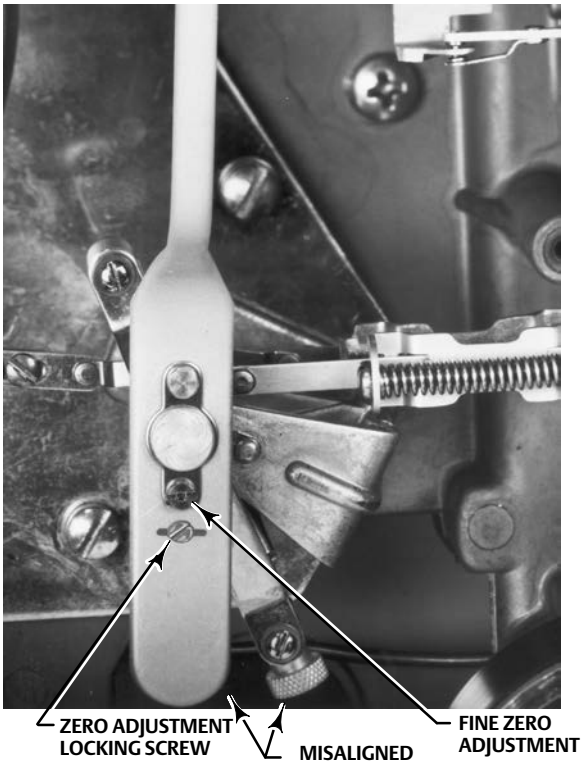
Figure 41. Link Locations



Replacing Link 1

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Note the hole position of link 1 in the temperature element assembly and the process pointer assembly. Disconnect the link from the temperature element assembly and from the process pointer. Remove the link.
3. Adjust the length of the replacement link to the same length as the link being replaced.
4. Attach the replacement link in the same holes noted in step 2 to the process pointer and temperature element assembly.
5. Move the set point indicator, manually or with remote set point pressure, to the mid-scale mark on the process scale, and set the proportional band between DIRECT and REVERSE.
6. The process pointer should be aligned with the pointer subassembly as shown in figure 42. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment to align the process pointer and pointer subassembly. Tighten the zero adjustment locking screw.

Figure 42. Process Pointer Alignment



7. Place the temperature bulb in the 50 percent bath. The process pointer should indicate 50 ±3 percent of the process scale span. If not, loosen the screws on link 1, move the pointer to 50 percent of process scale span, and tighten the screws.
8. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.

Replacing Link 2

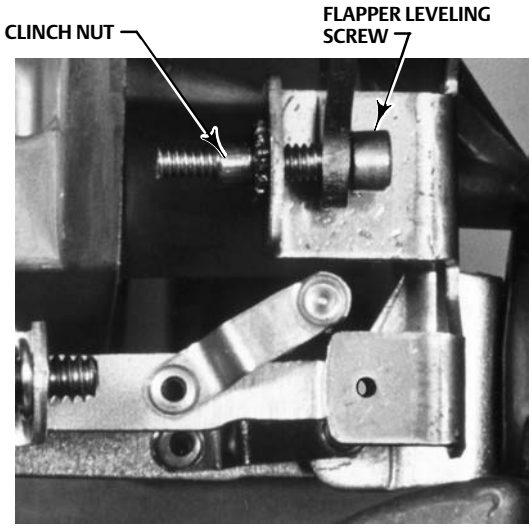
1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Disconnect link 2 from the process pointer and from the flapper assembly (key 11). Remove the link.

3. Install the replacement link with the screw head nearest the process pointer as shown in figure 41. Connect the link to the process pointer only.
4. The process pointer should be aligned with the pointer subassembly as shown in figure 42. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment to align the pointer with the process pointer subassembly. Tighten the zero adjustment locking screw.
5. Move the set point indicator, manually or with remote set point pressure, to the process scale lower limit, and set the proportional band to 5 percent REVERSE. The nozzle should not be touching the flapper. If it is, adjust flapper leveling screw 1 (the screw nearest the nozzle) until clearance is obtained.
6. Note the hole position and disconnect link 1 from the temperature element assembly. Manually position the process pointer to the process scale upper limit, and tape the process pointer in this position.
7. Adjust the length of link 2 (by turning the adjusting screw clockwise to increase the length or counterclockwise to decrease the length) so that the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the flapper assembly as shown in figure 39. This adjustment provides the proper tension on the link to eliminate lost motion.
8. Connect link 2 to the flapper assembly.
9. Remove the tape from the process pointer and reconnect link 1 to the hole in the temperature element assembly noted in step 6.
10. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.

Replacing Link 3

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Disconnect link 3 from the set point indicator assembly and the set point beam assembly (key 23).
3. Adjust the replacement link to the same length as the link removed.
4. Install the replacement link with the screw head toward the set point beam assembly as shown in figure 41.
5. Check that the set point beam bias spring (key 28) is correctly located in the frame bore and the spring seat on the set point beam assembly as shown in figure 31.
6. Move the set point indicator to the mid-scale mark on the process scale.
7. Disconnect link number 1 from the temperature element assembly and tape the process pointer at the mid-scale mark on the process scale.
8. Adjust the proportional band to 5 percent DIRECT. Turn flapper leveling screw 3 (the screw nearest the nozzle) until the nozzle just touches the flapper.
9. Adjust the proportional band to 5 percent REVERSE. Turn flapper leveling screw 1 (the screw nearest the nozzle) until the nozzle just touches the flapper.
10. Flapper leveling screws 1 and 3 should protrude the same distance from the clinch nuts (see figure 43).
11. If leveling screw 1 protrudes further than leveling screw 3, turn the link 3 adjusting screw counterclockwise. If leveling screw 3 protrudes further than leveling screw 1, turn the link 3 adjusting screw clockwise.
12. Repeat steps 8 through 11 until leveling screws 1 and 3 protrude an equal distance from the clinch nuts.
13. Remove the tape and reconnect link number 1 to the same hole in the temperature element assembly.
14. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.

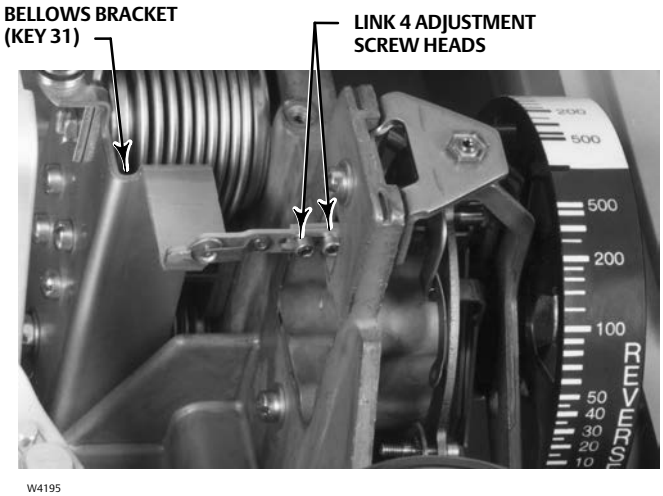
Figure 43. Flapper Leveling Screw and Clinch Nut



Replacing Link 4

1. Remove the screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Disconnect link 4 from the bellows bracket (key 31) and the flapper assembly (key 11).
3. Connect the replacement link to the flapper assembly so that the two adjusting screws on the link are nearest to the bellows bracket (key 31) and so that the screw heads are facing the bottom of the controller as shown in figure 44.

Figure 44. Position of Link 4 Adjustment Screws



4. For controllers with reset (4196B) or reset and rate (4196C), turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position. Turn the rate adjustment (4196C) to the OFF position.

   The controller output must be 0 bar (0 psig). To be sure the controller output is at 0 bar (0 psig), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4196B) or OFF 4196C) position.

5. Adjust the proportional band to 5 percent REVERSE and move the set point indicator to the process scale upper limit.
6. Disconnect link 1 from the temperature element assembly. Tape the process pointer to the process scale lower limit (the last mark on the left side of the scale).
7. Apply the correct supply pressure to the controller. The output of the controller should be within 0.14 bar (2 psig) of supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 0.14 bar (2 psig) of supply pressure.
8. Loosen the two adjusting screws on link 4. Connect the free end of the link to the bellows bracket and allow the link to find its free length.
9. Tighten the two adjusting screws on the link.
10. Raise link 4 out of the hole in the bellows bracket (key 31) and ensure that it drops back into the hole under its own weight. If not, repeat steps 8 and 9.
11. For a controller with reset, adjust the reset adjustment to 0.01. The rate adjustment (4196C) should remain in the OFF position.
12. The controller output should be within 0.14 bar (2 psig) of the supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 0.14 bar (2 psig) of supply pressure.
13. Remove the tape from the process pointer and connect link 1 to the temperature element assembly.
14. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.

Zero and Span Adjustment

⚠ WARNING

Refer to the Maintenance WARNING on page 59.

Note

For routine zero and span calibration, refer to the appropriate procedures in Section 3, 4, or 5. Use the following maintenance zero and span procedure only if difficulty is encountered with the routine procedure or if nonlinearity occurs.

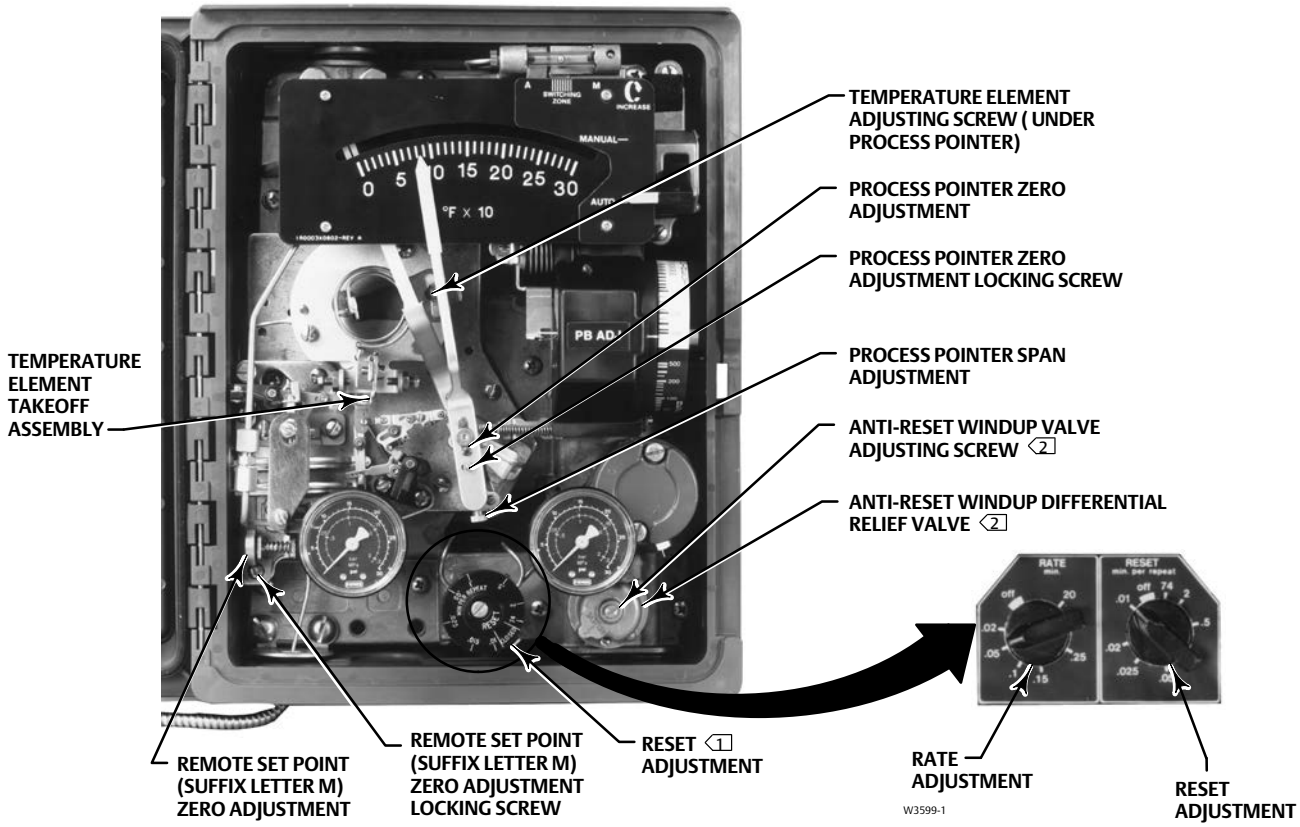
Provide a means of changing the process temperature to the controller and a means of measurement external to the controller. Also provide a regulated supply pressure adjusted to the normal operating pressure (see table 3). Plug the controller output or connect it to a gauge. Monitoring the controller output is not necessary. However, the flapper should not contact the nozzle at any time while performing this procedure. If it does, adjust flapper screw 2 (the screw nearest the nozzle) to provide clearance. Refer to figure 45 for adjustment locations. Refer to figure 48 for the key number locations.

Note

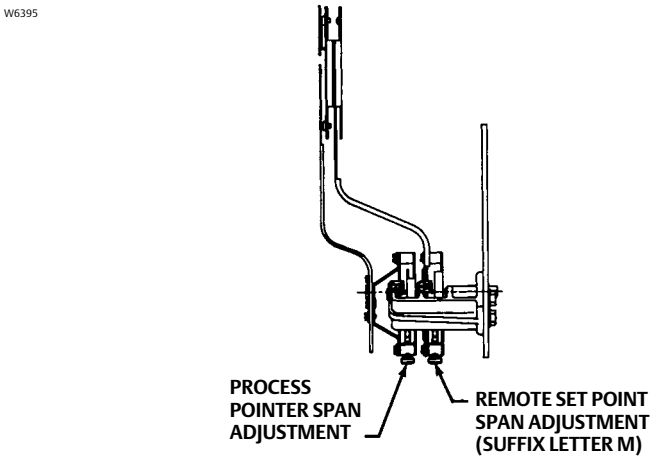
Any adjustment of the process pointer span adjustment screw requires readjustment of the process pointer zero adjustment screw. When checking the zero and span adjustments, ensure that the temperature element assembly does not contact the travel stops.

1. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).

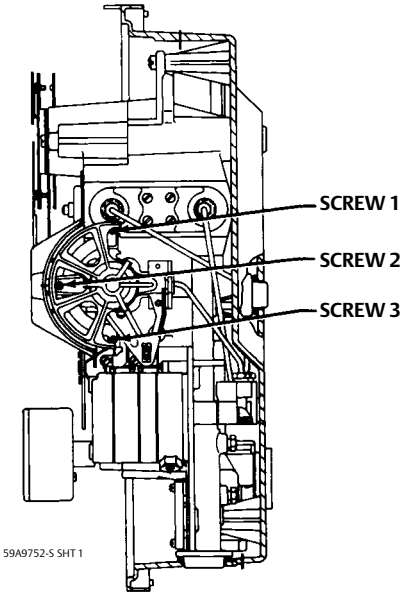
Figure 45. Fisher 4196 Controller Calibration Adjustment Locations



NOTES:
1 AVAILABLE ON 4196B CONTROLLERS ONLY
2 AVAILABLE ON 4196B AND C CONTROLLERS SUFFIX LETTER F ONLY



SIDE VIEW OF
SET POINT/PROCESS INDICATOR ASSEMBLY



SIDE VIEW OF CONTROLLER
SHOWING FLAPPER LEVELING SCREWS

2. Set the proportional band between DIRECT and REVERSE.
3. Adjust the reset valve (4196B and C controllers only) to 0.01 minutes per repeat.
4. Adjust the rate valve (4196C controllers only) to OFF.

Note

Temperature baths are required for the following steps. Please refer to the appropriate section of this manual for more information on temperature baths.

5. Immerse the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
6. The takeoff assembly should be vertical. If not, loosen the temperature element adjusting screw and reposition the assembly so it is vertical. Tighten the adjusting screw.
7. The process pointer should be aligned with the pointer subassembly as shown in figure 42. If not, loosen the zero adjustment locking screw and adjust the zero adjustment screw to align the process pointer with the pointer subassembly. Tighten the zero adjustment locking screw.
8. The process pointer should indicate 50 ±3 percent of the process scale span. If not, loosen the screws on link 1 and adjust the length so that the process pointer indicates 50 percent of scale span. Tighten the two screws.
9. Immerse the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
10. Check for 0.80 to 1.0 mm (0.03 to 0.04 inch) clearance between the temperature element takeoff assembly and the travel stop located farthest from the process pointer. If the clearance is incorrect, loosen the travel stop locking nut and readjust the travel stop. Retighten the locking nut.
11. The process pointer should indicate the process scale lower limit. If not, loosen the zero adjustment locking screw and adjust the zero adjustment screw until the process pointer indicates the lower limit. Tighten the zero adjustment locking screw.
12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
13. Check for 0.80 to 1.0 mm (0.03 to 0.04 inch) clearance between the temperature element takeoff assembly and the travel stop located nearest the process pointer. If the clearance is incorrect, loosen the travel stop locking nut and readjust the travel stop. Retighten the locking nut.
14. The process pointer should indicate the process scale upper limit. If not, proceed as follows:

    a. If the pointer indication is less than the process scale upper limit, rotate the pointer span adjustment clockwise to increase the span. Adjust the span adjustment screw to correct for one-half of the error.

    b. If the pointer indication is greater than the process scale upper limit, rotate the pointer span adjustment counterclockwise to decrease the span. Adjust the span adjustment screw to correct for one-half of the error.

15. Repeat steps 9 through 14 until the zero and span indications are within ±1 percent of the scale limits with no further adjustment. If the span adjustment screw is adjusted to its limit and the span is still too short or too long, proceed with step 16. If proper span is achieved, proceed to step 17.
16. At either end of link 1 there are three holes in which the link may be connected. A coarse span adjustment can be made by moving both ends of link 1 up or down.

    a. If the span is short (process pointer indication is less than the process scale upper limit), disconnect both ends of link 1, move the link down one set of holes, and return to step 5.

    b. If the span is long (process pointer indication is greater than the process scale upper limit), disconnect both ends of link 1, move the link up one set of holes, and return to step 5.

17. Immerse the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

18. If the process pointer indicates 50 ±1 percent of process scale span, tighten the zero adjustment locking screw and proceed to the appropriate flapper alignment procedure. If the error is greater the ±1 percent but less than ±2 percent, correct for half of the error with the zero adjustment screw.
19. Immerse the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
20. The process pointer should indicate the process scale lower limit ±1 percent of scale span.
21. Immerse the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
22. The process pointer should indicate the process scale upper limit ±1 percent of process scale range.
23. If the error is greater than ±1 percent, repeat steps 9 through 22.
24. Perform the flapper alignment procedure and, if necessary, the appropriate remote set point calibration procedure in Section 3, 4, or 5.

Remote Set Point (suffix letter M) Maintenance

⚠ WARNING

Refer to the Maintenance WARNING on page 59.

Replacing the Remote Set Point Assembly

Use the following procedures to replace the remote set point assembly. Figure 46 shows the parts locations. Refer to figure 51 for key number locations.

Note

Remove the supply pressure gauge before attempting to remove the remote set point assembly.

1. Decrease the remote set point pressure to 0 bar (0 psig).
2. Remove the supply pressure gauge.
3. Disconnect the union (key 93) from the pedestal assembly (key 105).
4. Disconnect link B (key 126) from the connecting hole on the set point indicator.
5. Remove the three mounting screws (keys 120 and 140) that attach the remote set point assembly to the process/set point indicator assembly. Figure 46 shows the mounting screw locations.

NOTICE

In the following step, do not lift out the remote set point assembly by holding the capsular element or linkages. These parts may be damaged.

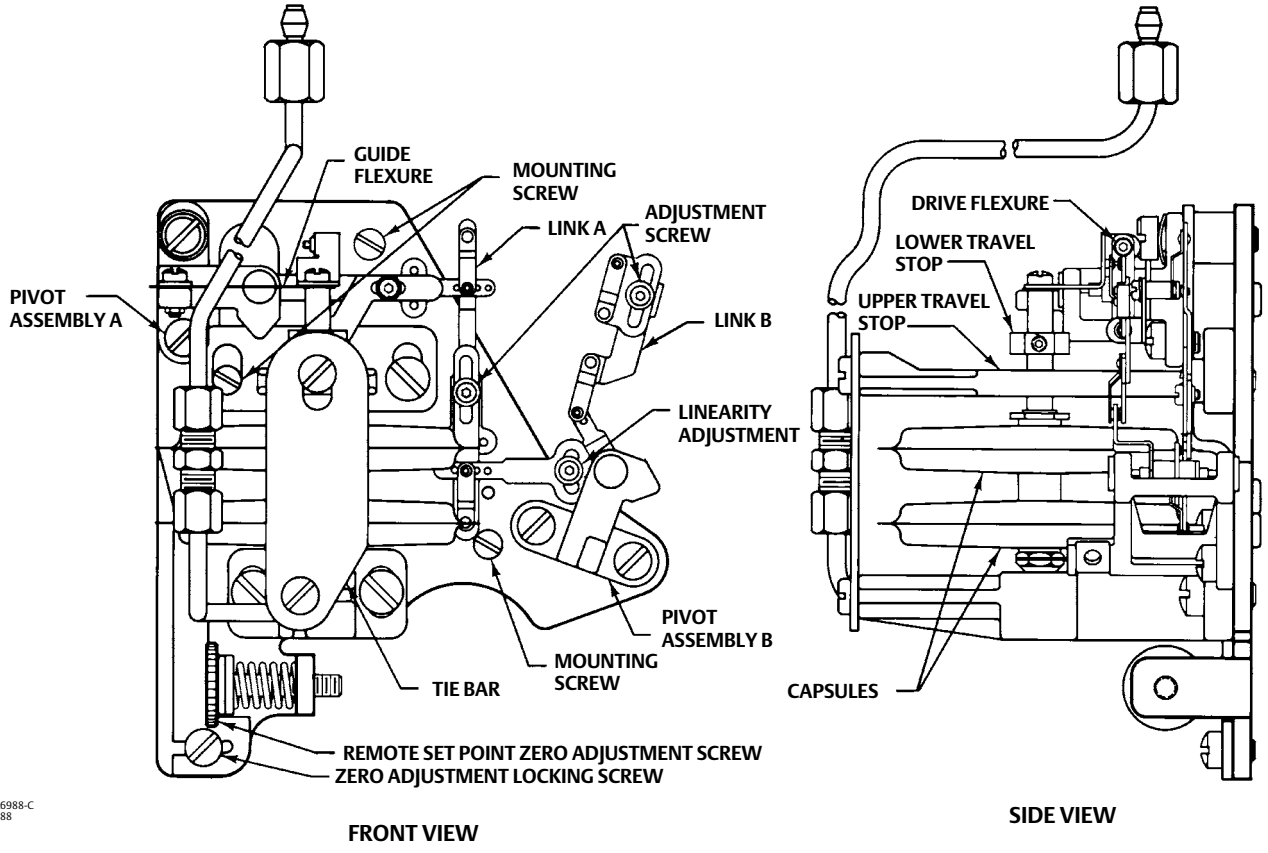
6. Lift out the remote set point assembly by holding the tie bar (key 106, mounting plate (key 111), travel stop (key 83), or pedestal assembly (key 105).
7. Align the replacement assembly with the mounting screw holes. Replace the mounting screws.

8. Reconnect the remote set point pressure connection union (key 93). Apply full remote set point pressure, and check for leaks.
9. Connect link B (key 126) to the connecting hole on the set point indicator.
10. Replace the supply pressure gauge.
11. Perform the remote set point maintenance calibration procedures. Perform the appropriate process indicator zero and span calibration and flapper alignment procedure in Section 3, 4, or 5.

Replacing Remote Set Point Assembly Parts

Figure 46 shows the parts and adjustment locations. Refer to figure 51 for key number locations.

Figure 46. Remote Set Point (suffix letter M) Parts and Adjustment Locations



Replacing Pivot Assembly A (Key 114)

NOTICE

Avoid bending or kinking the drive flexure during the following procedure. Bending or kinking the drive flexure can result in product damage and impaired performance.

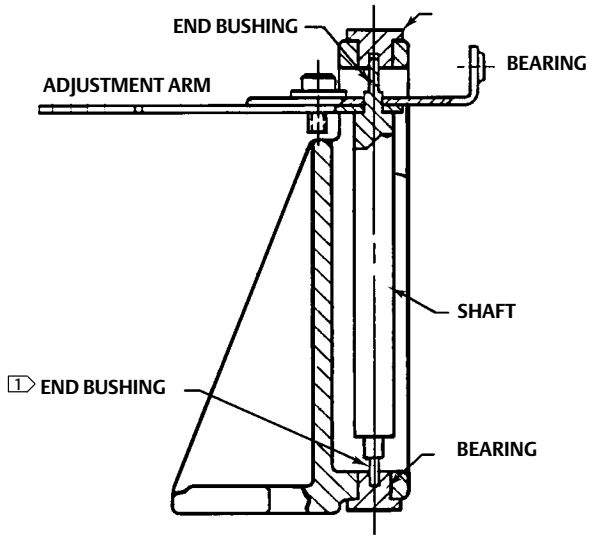
1. Decrease the remote set point pressure to 0 bar (0 psig).

2. Remove the two screws (key 103) and the tie bar (key 106).
3. Note where link A is connected. Disconnect link A (key 116) from the lever arm on pivot assembly A (key 114).
4. Disconnect the drive flexure (key 79) from the adjustment arm of pivot assembly A. Be careful not to bend or kink the drive flexure.
5. Remove the screw (key 122), washer (key 123) and nut (key 124) that attach the guide flexure (key 119) 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 (key 111). Lift out pivot assembly A.
7. Loosen the adjustment 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 (key 112) on the screw (key 109). Then, insert the screw through the replacement pivot assembly and into the mounting plate and tighten. Install the mounting screw (key 102) and tighten.
9. Connect the guide flexure (key 119) to the top of the replacement pivot assembly with the screw (key 122), washer (key 123), and nut (key 124) as it was before. The guide flexure should be straight and horizontal as shown in figure 46. If not, loosen the screws (key 122) and retighten to eliminate any bowing. Loosen the screws (key 139) and raise or lower the pedestal assembly (key 105) to get the link horizontal. Retighten the screws (key 139) and ensure the diaphragm assembly extension (key 134) is centered in the upper travel stop (key 83) hole.
10. Apply remote set point pressure equal to 50 percent of the remote set point input range.

Note

See figure 47. The adjustment arm of the remote set point pivot assembly 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.

Figure 47. Cutaway of Long Pivot Clevis Assembly



NOTE:
1 BEFORE TIGHTENING THE DRIVE FLEXURE MOUNTING SCREWS, POSITION THE SHAFT SO THE END BUSHINGS “FLOAT” IN THE BEARINGS.

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11. Connect the drive flexure (key 79) to the arm on the replacement pivot assembly, making sure it stays straight and vertical. Adjust the length of the pivot arm, if necessary, until the flexure is vertical. Before tightening the drive

flexure screws, hold the pivot assembly shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure screws to hold pivot assembly A in this position. Do not bend or twist the flexure when tightening the screws.

12. Decrease the remote set point pressure to 0 bar (0 psig).
13. Connect the end of link A (key 116) to the pivot lever arm in the same holes noted in step 3.
14. Replace the tie bar (key 106).
15. Perform the remote set point maintenance calibration procedures. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3, 4, or 5.

Replacing Pivot Assembly B (Key 115)

1. Decrease the remote set point pressure to 0 bar (0 psig).
2. Note the holes where links A and B are connected. Disconnect links A and B (keys 116 and 126) from the arms of pivot assembly B (key 115).
3. Remove the two screws (key 102) that attach pivot assembly B 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 the two machine screws.
6. Attach links A and B (keys 116 and 126) to the arms of the replacement pivot assembly in the same holes noted in step 2.
7. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3, 4, or 5.

Replacing the Drive Flexure

1. Using an Allen wrench, remove the cap screws (key 12) and washers (key 13) to disconnect the drive flexure (key 79) from the drive bracket (key 121) and from the adjustment arm of pivot assembly A. Remove the drive flexure.
2. Set the remote set point pressure to 50 percent of the remote set point input range.

Note

See figure 47. The adjustment arm of the remote set point pivot assembly 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.

3. Connect the new drive flexure making sure it stays straight and vertical. Adjust the length of the pivot arm, if necessary, until the drive flexure is straight. Before tightening the drive flexure screws, hold the pivot assembly A shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure screws to hold the pivot shaft in that position. Do not bend or twist the flexure when tightening the screws.
4. Decrease the remote set point pressure to 0 bar (0 psig).
5. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3, 4, or 5.

Replacing the Remote Set Point Tubing

1. Decrease the remote set point pressure to 0 bar (0 psig).

2. Using two 5/16-inch open-end wrenches, disconnect the pressure connection union (key 93) from 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.

Replacing Link A

This procedure describes link A (key 116) replacement in the input portion of the remote set point assembly. Figure 46 shows the link location.

1. Note the holes where link A is connected. Disconnect link A (key 116) from the lever arms on pivot assembly A and pivot assembly B.
2. Loosen the screw in the replacement link A and adjust the length to match the link being replaced. Tighten the screw.
3. Refer to figure 46 for the correct link orientation. Attach the replacement link A to the two lever arms in the same holes noted in step 1.
4. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3, 4, or 5.

Replacing Link B

This procedure describes the link B (key 126) replacement of the remote set point assembly. Figure 46 shows the link location.

1. Note the holes where link B is connected. Disconnect link B (key 126) from the pivot arm and from the set point indicator.
2. Loosen the screw in the replacement link B and adjust the length to match the link being replaced. Tighten the screw.
3. Refer to figure 46 for the correct orientation of link B. Attach replacement link B to the pivot arm and to the set point indicator in the same position as noted in step 1.
4. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3, 4, or 5.

Remote Set Point (suffix letter M) Maintenance Calibration

Refer to figure 46 for parts and adjustment locations. Refer to figure 51 for key number locations.

⚠ WARNING

Refer to the Maintenance WARNING on page 59.

Precalibration Procedures

1. Remove the two screws (key 6) and lift off proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Remove the two screws (key 103) and remove the tie bar (key 106) from the remote set point assembly.

Aligning the Flexures

1. Apply remote set point pressure input equal to 50 percent of the remote set point input range.

2. The guide flexure (key 119) should be straight and horizontal. If not, straighten the flexure by loosening the machine screw (key 122) on the end of the flexure that is attached to the top of pivot assembly A (key 114), and allow the flexure to straighten itself. Tighten the machine screw.
3. If the flexure is not horizontal, loosen the two machine screws (key 139) and raise or lower the pedestal assembly (key 105) until the guide flexure is horizontal. Retighten the machine screws (key 139) and ensure the diaphragm assembly extension (key 134) is centered in the upper travel stop (key 83) hole.
4. The drive flexure (key 79) should be straight. It not, proceed as follows:

   a. Loosen the screw (key 118) on the adjustment arm of pivot assembly A (key 114) and loosen the screws holding the drive flexure.

   b. Set the length of the adjustment arm so that the drive flexure is parallel to the centerline of the diaphragm capsule assembly (key 80).

   c. Tighten the screw (key 118) on the adjustment arm.

Note

See figure 47. The adjustment arm of the remote set point pivot assembly 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. Hold the pivot assembly A shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing.

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

Setting the Travel Stops

1. Loosen the set screw (key 87) in the travel stop nut (key 86).

NOTICE

Make sure the loose travel stop nut does not bind on the diaphragm capsule extension (key 134) when pressurizing the capsules (key 80). Damage to the capsules may result.

2. Full span stop—Adjust the remote set point pressure to 2-1/2 percent of span greater than the remote set point input range upper limit.

   Loosen the two screws (keys 139 and 140) that secure the travel stop (key 83) to the mounting plate (key 111). 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 position.

3. Zero stop—Adjust the remote set point pressure input to 2-1/2 percent of span less than the remote set point input range lower limit.

   Slide the travel stop nut (key 86) along the diaphragm capsule extension (key 134) until it is just touching the travel stop (key 83). Tighten the set screw (key 87) to lock the travel stop nut in position.

Aligning the Linkage

1. Adjust the remote set point pressure to 50 percent of the remote set point input range.

2. Set the linearity adjustment screw in the center of the slot on the lever arm of pivot clevis assembly B (key 115). See figure 46 for the linearity adjustment location.
3. Set the length of link A (key 116) so the lever arms of pivot assembly A and pivot assembly B are parallel and link A is perpendicular to them.
4. Set the length of link B (key 126) so the set point indicator indicates mid-scale on the process scale span.
5. Replace the tie bar (key 106) and install the two screws (key 103).

Remote Set Point Zero and Span Adjustment

Note

For routine remote set point zero and span calibration, refer to the appropriate procedures in Section 3, 4, or 5. Use the following maintenance remote set point zero and span adjustment procedure only if difficulty is encountered with the routine procedures or if nonlinearity occurs.

Refer to figures 45 and 46 for adjustment locations.

1. Decrease remote set point pressure to 0 percent of remote set point input range.
2. The set point indicator should indicate the lower limit of the process scale span. If not, loosen the adjustment screw on link A (key 116), and adjust the length so that the set point indicator points to the lower limit of the process scale. 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 46 for the screw locations.
4. Apply a remote set point pressure equal to 100 percent of the remote set point input range.
5. The set point indicator should indicate the upper limit of the process scale span.
6. To increase the span, proceed as follows:
   a. Turn the remote set point span adjustment screw clockwise.
   b. To increase the span further than the adjustment screw allows, move both ends of link A (key 116) to the right.
   c. Make fine adjustments with the remote set point span adjustment screw.
7. To decrease the span, proceed as follows:
   a. Turn the remote set point span adjustment screw counterclockwise.
   b. To decrease the span further than the adjustment screw allows, move both ends of link A (key 116) to the left.
   c. Make fine adjustments with the remote set point span adjustment screw.
8. Repeat the adjustments until the upper and lower indications are aligned with the upper and lower limits on the process scale.
9. Adjust the remote set point pressure for 50 percent of the remote set point input range.
10. The set point indicator should indicate mid-scale ±2 percent of the process scale span. If the error is within ±2 percent, proceed to step 11. If the error is greater than ±2 percent of the scale span, proceed to the remote set point linearity adjustment procedure.
11. Adjust the set point indicator to 50 ±1 percent of the process scale span by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the locking screw.

12. Adjust the remote set point pressure to the upper and lower limits of the the remote set point input range and make sure the set point indicator is still within ±1 percent at the lower and upper limits of the process scale.
13. Perform the appropriate flapper alignment procedure and, if necessary, the process indicator zero and span calibration procedure in Section 3, 4, or 5.

Remote Set Point Linearity Adjustment

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

1. Adjust the remote set point pressure to 50 percent of the remote set point input range. The set point indicator should indicate 50 ±1 percent, of the process scale span. If not, make fine adjustments by loosening the zero adjustment locking screw and turning the zero adjustment screw.
2. Adjust the remote set point pressure to 0 percent of the remote set point input range and note the indicator position relative to the process scale lower limit.
3. Adjust the remote set point pressure to 100 percent of the remote set point input range and note the indicator position relative to the process scale upper limit.
4. If the greatest misalignment is positive (the set point indicator is to the right of the process scale limits), loosen the linearity screw and move it clockwise in the slot. If the misalignment is negative, move the linearity screw counterclockwise in the slot.
5. If misalignment is greater than 1 percent of the process scale span at the lower and upper limits, with one positive and the other negative, perform the remote set point zero and span adjustment procedure to correct a span error.
6. Repeat steps 1 through 4 until lower, middle, and upper indications are within ±1 percent of the process scale markings.

Auto/Manual Station (suffix letter E) Maintenance

Replacing the Auto/Manual Station

Refer to figure 48 and 52 for key number locations.

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

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Loosen the screw (key 316) that holds the auto/manual station (key 273) to the controller frame.
3. Loosen the two screws (keys 314 and 315) that hold the auto/manual station to the auto/manual tubing assembly (key 138).
4. Remove the auto/manual station from the controller frame.
5. Remove the switch manifold O-rings (key 312).
6. Carefully loosen the nut on the relay nozzle tubing assembly (key 18) where it connects to the auto/manual tubing assembly (key 138). Loosen three screws (keys 34 and 131), and remove the tubing assembly and frame gaskets (keys 4 and 5).

7. 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 switch manifold 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 that the auto/manual station contacts the three pads on the tubing assembly.
4. Carefully tighten the remaining screws and nuts.
5. Plug the controller output connection and apply supply pressure to the controller. Check for leaks.
6. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
7. Perform the appropriate calibration procedure in Section 3, 4, or 5.

Replacing the Switch Body Assembly, Lever O-Ring, Switch Body O-Ring, and Tubing Assembly

Refer to figure 52 for key number locations.

Disassembly

1. Remove the auto/manual station from the controller as described in steps 1 through 4 of the Replacing the Auto/Manual Station procedure.
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 remove the switch cover plate.

3. Using a 1/16-inch (1.5 mm) 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), and remove the closing plate (key 307) and the closing plate gasket (key 306).
9. Pull the clip (key 300) from its engagement with the lever assembly shaft (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-ring and gaskets for damage or wear; 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 assembly (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 body assembly (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. Install the auto/manual station on the controller as described in steps 3 through 7 of the Replacing the Auto/Manual Station procedure.

Replacing the Loader Range Spring, Diaphragm Assembly, Ball Seat, Tubing, and Ball

Refer to figure 52 for key number location.

Disassembly

1. Remove the auto/manual station from the controller as described in steps 1 through 4 of the Replacing the Auto/Manual Station procedure.
2. Remove the tubing assembly (key 309).

⚠ WARNING

To avoid personal injury caused by preload from the range spring (key 283), 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 upper 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 adjustment 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 upper 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 procedure in the replacing the auto/manual station procedure.

Replacing the Loader Valve Plug and Valve Plug Spring

Refer to figure 52 for key number location.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Loosen the spring seat screw (key 275).
3. Remove the valve plug spring (key 276) and the valve plug (key 277).
4. Inspect the parts, and replace as necessary.
5. Install the valve plug spring and valve plug.
6. Tighten the spring seat screw.
7. Temporarily plug the controller output connection, apply supply pressure, and check for leaks.
8. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
9. Mount the controller as described in the Installation section.
10. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

Section 7 Parts

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 or 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, and 312	R4190X0AM12
4190 Controller Auto/Manual Retrofit Kit, SST tubing Contains keys 138, 273, 312, 313, 314, 315, 316	R4190X00S12
4190 Controller Case Handle Kit Contains lever and mounting hardware	R4190X00H12
4190 Controller 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
4196BF Anti-Reset Windup Retrofit kits, SST tubing contains keys 44 and 55)	R4190X00S22
4190 Relay Replacement Kit Contains Relay Assembly, key 50 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig)	 RRELAYX83C2 RRELAYX83D2

Parts List

Note
Contact your Emerson sales office for Part Ordering information.

Controller Common Parts (figure 48)

Key Description

Note
Figure 48 shows key numbers for the 4196A, 4196B and 4196C controllers. Figure 48 continues over several pages. Be sure to check all pages to find the key numbers.

1 Case and cover assembly
For use w/ or w/o int set pt and w/o remote or ext set pt
For use w/remote set pt and w/o int or ext set pt

2 Nameplate

3 Frame

4* Gasket, for use between frame and frame manifold (key 135)

5* Gasket
4196A and 4196B (1 req'd)
4196C (2 req'd)

*Recommended spare parts

Key	Description
6	Machine Screw, fill hd 2 req'd to mount the prop band ind cover to the frame 4 req'd to mount bellows bracket (key 31) to bellows beam (key 49) 2 req'd to attach process scale brackets (keys 376, 377) to frame
7*	O-Ring Used between frame and case at conns: temperature bulb capillary, output and supply pressure, ext feedback and remote set pt conn 3 req'd w/o remote set pt and w/o ext feedback 4 req'd w/remote set pt or ext feedback 5 req'd w/remote set pt and ext feedback)
8*	O-Ring (3 req'd) Used between frame and case on mounting bosses extending from the frame through the back of the case (3 req'd)
9	Flexure pivot assembly
10	Machine screw, fill hd Used to attach the flexure pivot ass'y (key 9) to the frame (4 req'd)
11*	Flapper ass'y
12	Cap screw, hex socket For flapper ass'y (key 11) (2 req'd)
17	Adjustable set pt pivot ass'y
18	Relay nozzle tubing ass'y
19	Machine screw, fill hd 1 req'd to attach adjustable set pt pivot ass'y (key 17) to frame 1 req'd to attach relay nozzle tubing ass'y (key 18) to frame
20	Plain washer, used w/key 19 (2 req'd)
21	Nozzle ass'y
22	Washer (1 req'd)
23	Set pt beam ass'y
24*	O-ring 1 req'd for nozzle tubing ass'y (key 18) 1 req'd for nozzle ass'y (key 21)
25	Proportional band knob
26	Retaining clip
27	E-ring
28	Set pt beam bias spring
29	Set pt beam shoe
30	Cap screw, hex socket, used w/key 29 (2 req'd)
31	Bellows bracket
32	Bellows adj bracket
33	Bellows adj spring
34	Machine screw, fill hd Used to attach frame manifold (key 135) to frame and for reset gain adjustment (2 req'd)
35	Machine screw, hex hd Used to attach bellows bracket (key 31) to each bellows ass'y (key 48) (2 req'd)
36	Proportional band indicator cover
37	Self-tapping screw 4 req'd to attach process scale (key 61) to process scale bracket (key 376)
38	Self-tapping screw Used to attach frame inside case (9 req'd)
39	Supply gauge tubing ass'y
40	Proportional tubing assembly For 4196A or 4196B controllers For 4196C controllers
41	Plug For all 4196A & B controllers (1 req'd) For 4196C, CM, CE and CME (2 req'd) For 4196CF, CFM, CFE, and CFME (1 req'd)
42	Reset valve tubing ass'y (for 4196B controllers w/o ext feedback)
43	Reset tubing ass'y For 4196B controllers For 4196C controllers
44	Relief tubing assembly For 4196BF, BFE, BFM, and BFME only For 4196CF, CFE, CFM and CFME only
45	Positive feedback tubing ass'y, for 4196S controllers only
46*	Pressure gauges (2 req'd)
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 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, used w/key 51 (2 req'd)
53	Machine screw, fill hd, used w/key 51 (2 req'd)
54	Reset restriction valve (4196B controllers only)
55	Differential relief valve For all 4196B and C controllers w/suffix letter F, anti-reset windup
56	Process and set pt indicator ass'y w/temperature element 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 49 and 50.
57	Pressure control block 1 req'd w/remote set pt; 2 req'd w/remote set pt and external feedback

*Recommended spare parts

Key	Description
58	Cap screw, hex hd 2 req'd for use w/each pressure control block (key 57)
61	Process scale, for indicator ass'y (key 101)
62	Remote set pt ass'y (suffix letter M) Individual assembly parts are listed in the Remote Set Point Assembly subsection of the parts list. Key numbers for individual ass'y parts also appear in figure 51. 0.8 bar (12 psi) span 1.7 bar (24 psi) span
64	Machine screw, fill hd 4 req'd to attach process and set pt indicator ass'y (key 56) to frame
65	Feedback link ass'y
71	Machine screw, fill hd For all 4196A and B controllers (4 req'd) For all 4196C controllers (6 req'd)
72	Blow out plug
120	Machine screw, fill hd 2 req'd to attach remote set pt ass'y (suffix letter M) to indicator ass'y base plate (key 56)
129	Machine screw (2 req'd)
131	Machine screw, fill hd 2 req'd to attach rate/reset manifold (key 136) to frame manifold (key 135)
135	Frame manifold For all types except w/suffix letter E, auto/manual station
136	Rate/reset manifold For all types except 4196C controllers
137	Rate tubing assembly (for 4196C controllers only)
138	Automatic/manual tubing assembly Use w/suffix letter E, auto/manual station only

Key	Description
140	Machine screw, fill hd Used to attach remote set pt ass'y (suffix letter M) to indicator ass'y (key 56)
162	Machine screw, hex hd Used to attach the reset valve (4196B controllers) or rate/reset valve (4196C controllers) to the frame For 4196B and C controllers only
262	Rate/reset valve ass'y (for 4196C controllers only) 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig)
273	Auto/manual station (suffix letter E) Individual assembly parts are listed in the Auto/Manual Station subsection of the parts list. Key numbers for individual ass'y parts also appear in figure 52.
310	Lithium grease (not furnished with controller)
311	Anti-seize sealant (not furnished with controller)
312*	O-ring For all types w/suffix letter E, auto/manual station (3 req'd)
313	Auto/Manual Scale For all types w/suffix letter E auto/manual station
314	Machine screw, fill hd For all types w/suffix letter E auto/manual station
315	Machine screw, fill hd For all types w/suffix letter E auto/manual station
316	Machine screw, fill hd For all types w/suffix letter E auto/manual station
317	Silicone-based lubricant (not furnished with controller)
318	Lubricant, silicone sealant (not furnished with controller)
339	External feedback assembly
362	Spring Retaining Washer
365	Washer

*Recommended spare parts

Figure 48. Controller Assembly Drawing

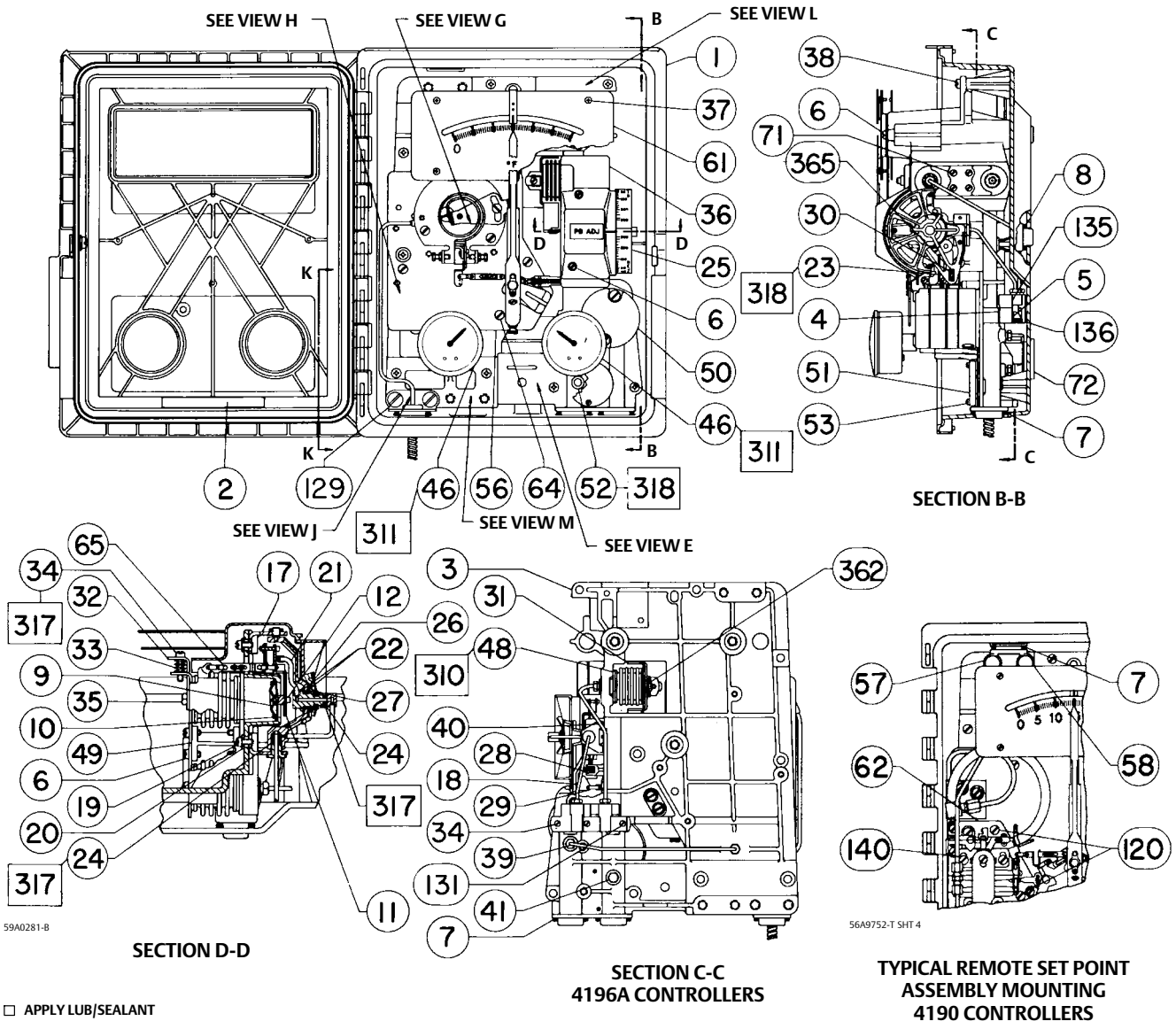
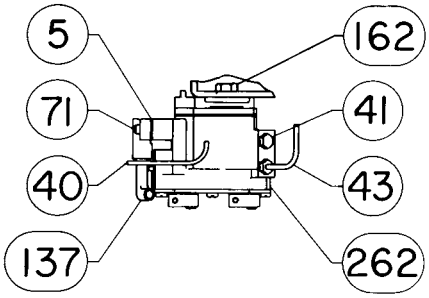
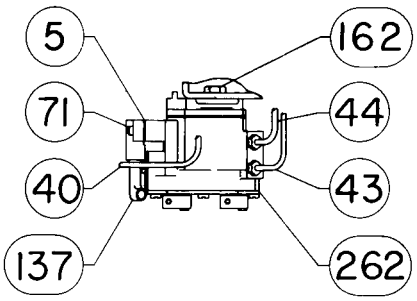


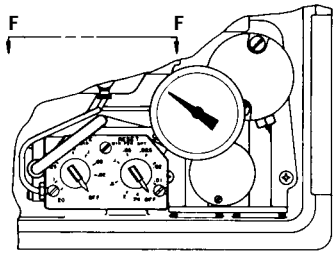
Figure 48. Controller Assembly Drawing (cont'd)



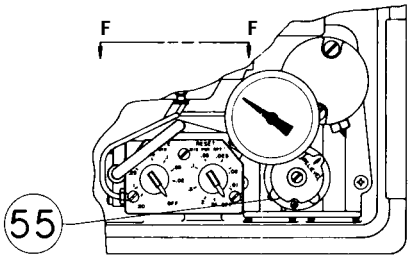
VIEW F-F



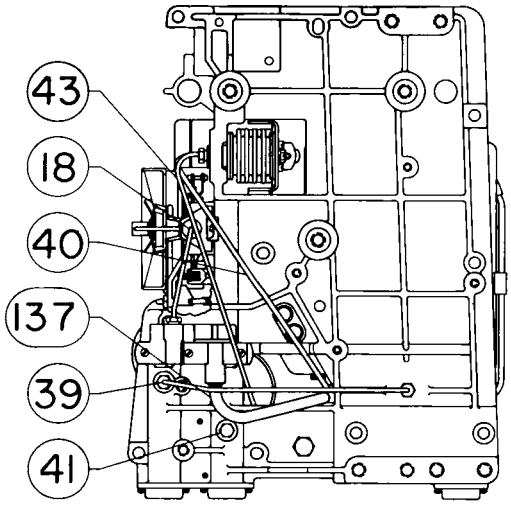
VIEW F-F



VIEW E
4196C CONTROLLERS



VIEW E
4196C CONTROLLERS
WITH ANTI-RESET WINDUP
(SUFFIX LETTER F)



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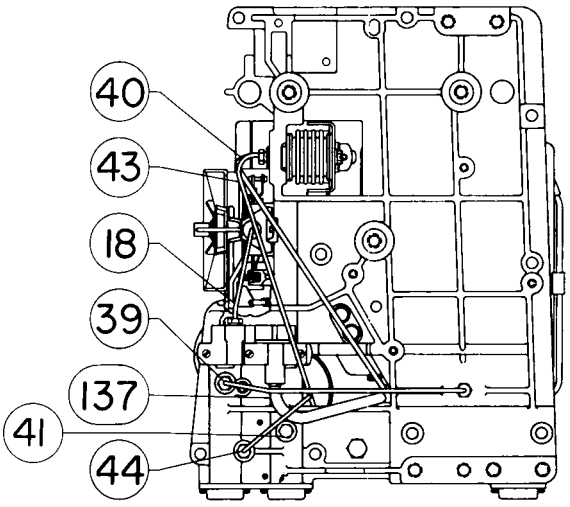
VIEW C-C
4196C CONTROLLERS



VIEW C-C
4196C CONTROLLERS
WITH ANTI-RESET WINDUP
(SUFFIX LETTER F)

Figure 48. Controller Assembly Drawing (cont'd)

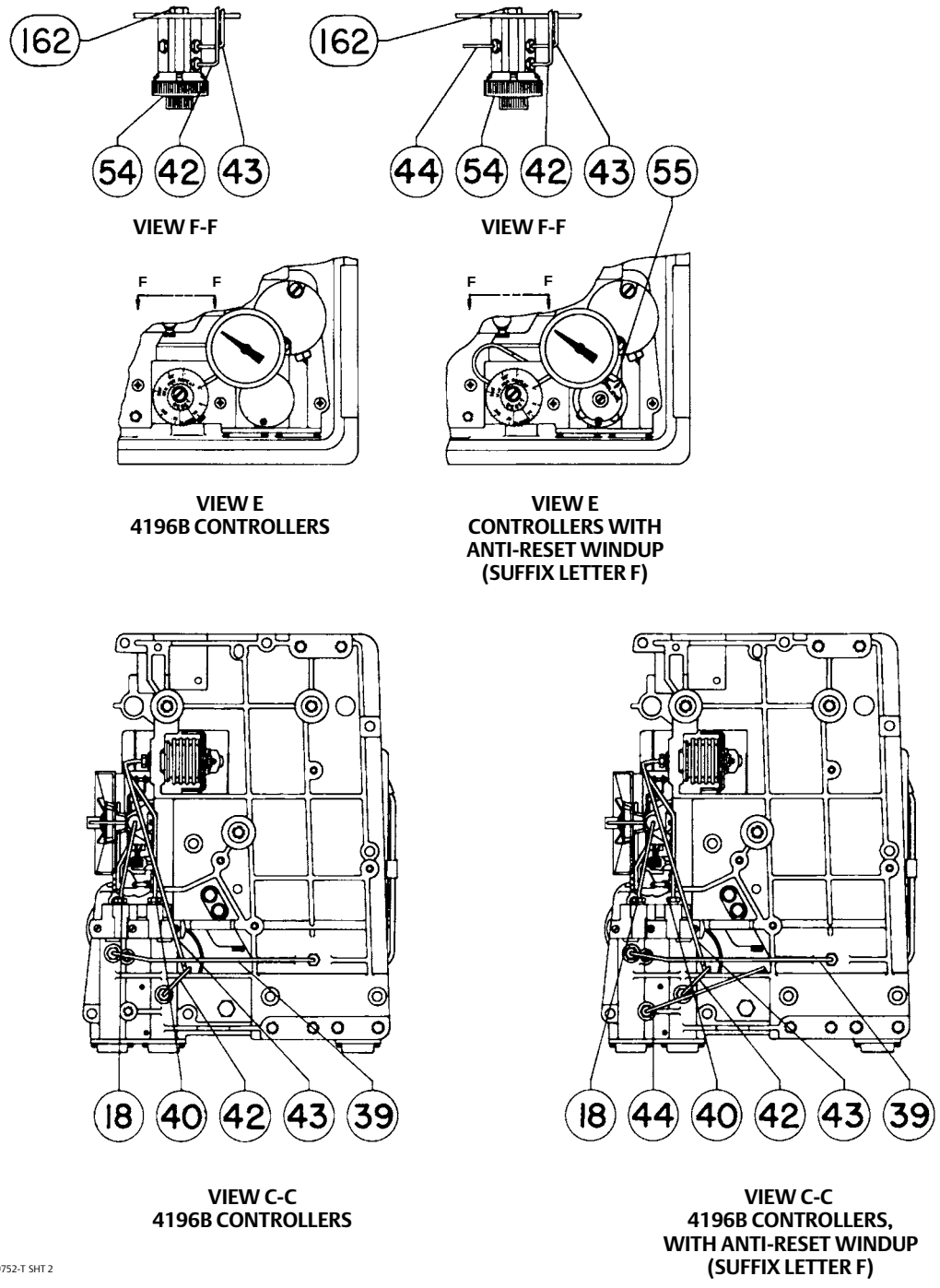
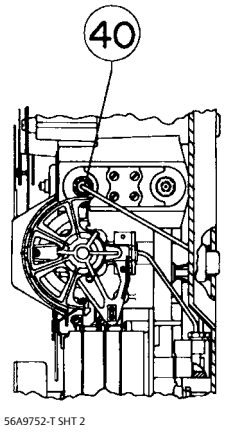
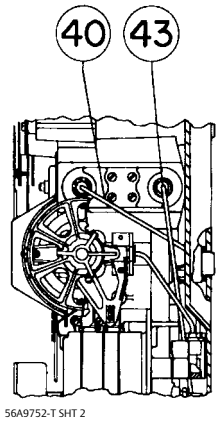


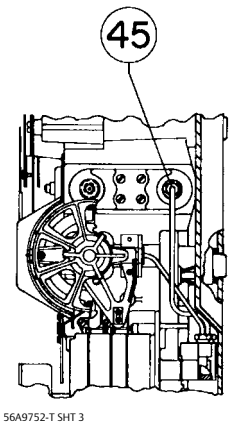
Figure 48. Controller Assembly Drawing (cont'd)



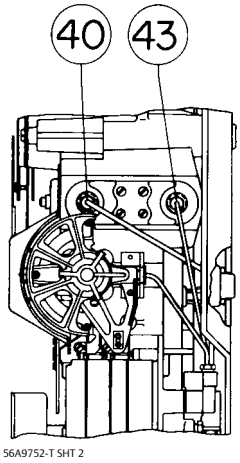
SECTION B-B
4196A CONTROLLERS



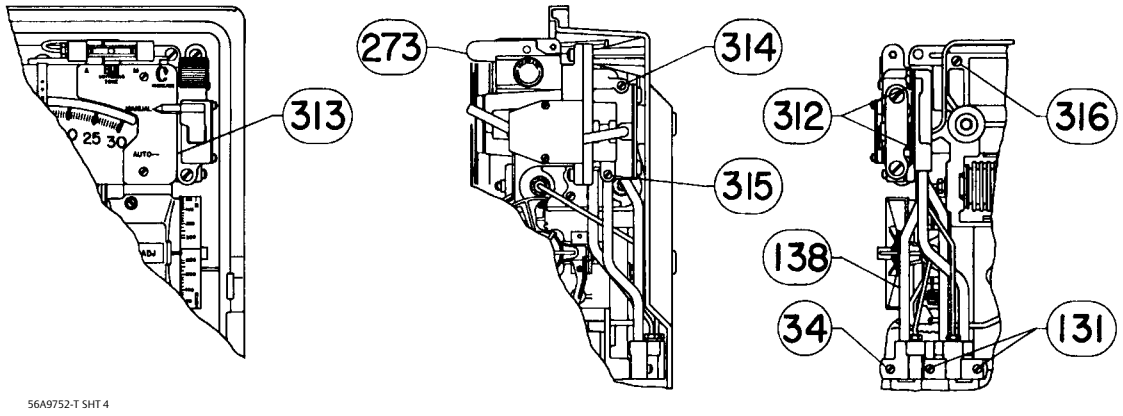
SECTION B-B
4196A CONTROLLERS



SECTION B-B
4196A CONTROLLERS



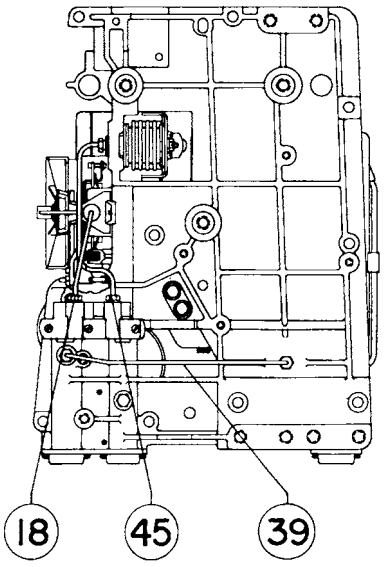
SECTION B-B
4196A CONTROLLERS



VIEW L

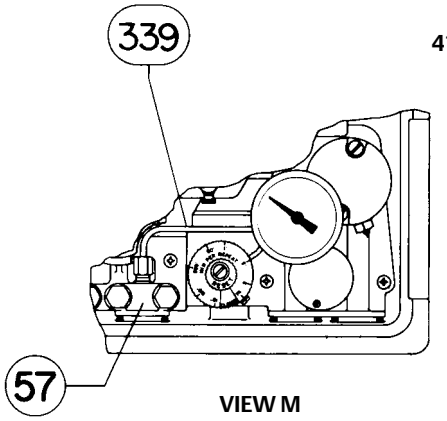
CONTROLLERS WITH AUTO/MANUAL STATION
(SUFFIX LETTER E)

Figure 48. Controller Assembly Drawing (cont'd)



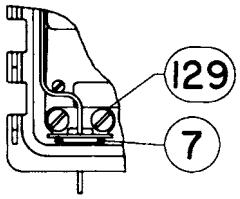
56A9752-T SHT 2

VIEW C-C
4196S CONTROLLERS



56A9752-T SHT 3

VIEW M

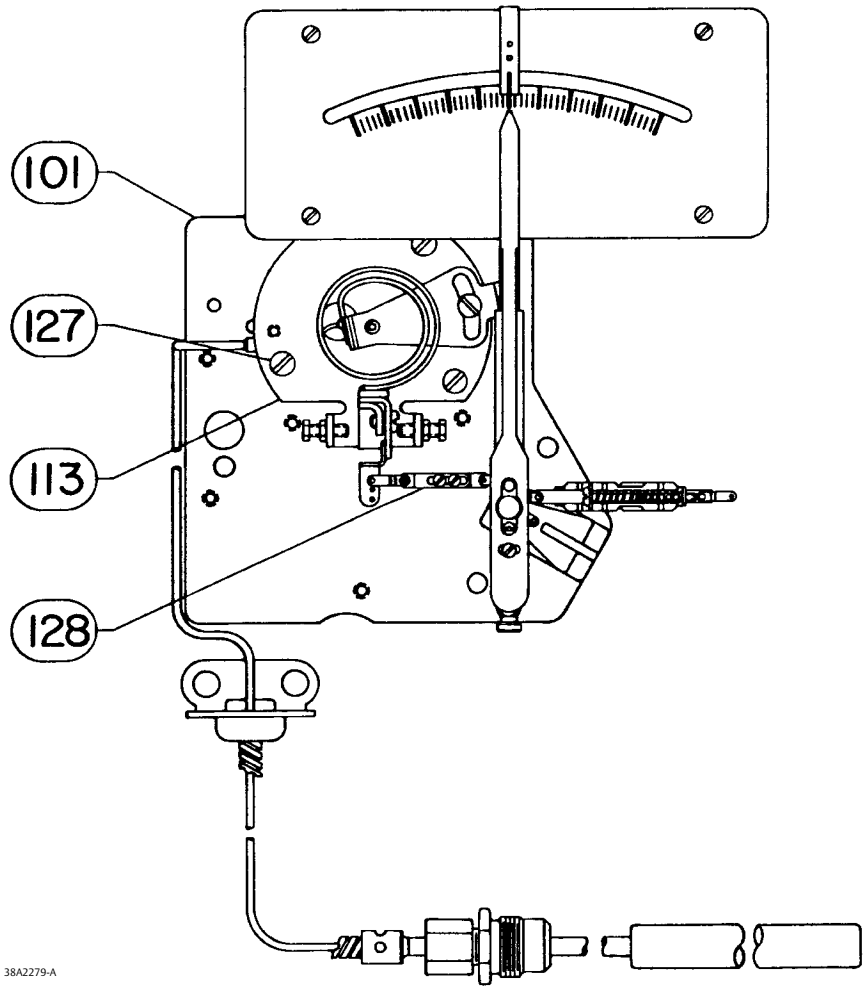


56A9752-T SHT 4

VIEW J

CONTROLLERS WITH EXTERNAL FEEDBACK OPTION

Figure 49. Process and Set Point Indicator Assembly



Key	Description

Process and Set Point Indicator Assembly (key 56) (figure 49)

101 Indicator ass'y

Individual parts are listed in the indicator assembly subsection of this parts list. Key numbers for individual assembly parts also appear in figure 50.

For use w/o remote set pt
For use w/remote set pt

113 Temperature Element Ass'y

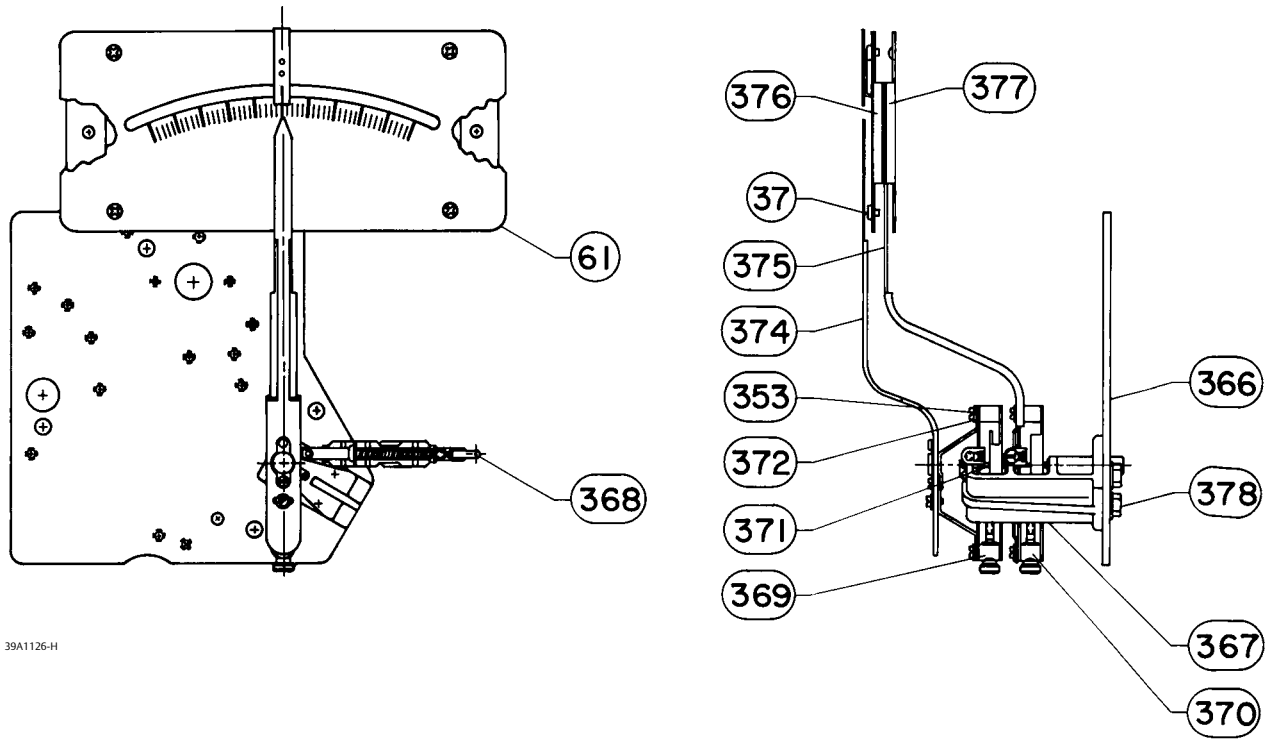
Key	Description
127	Machine screw, fill hd For mounting temperature element ass'y to indicator ass'y (3 req'd)
128	Connecting link assembly

Indicator Assembly (key 101) (figure 50)

Note
Key numbers 37, 61, 376, 377, and 378 are not included as part of the indicator assembly (Key 101). If replacing the indicator assembly and these parts are required, order them separately.

37 Self-tapping screw (4 req'd)
61 Process scale

Figure 50. Indicator Assembly

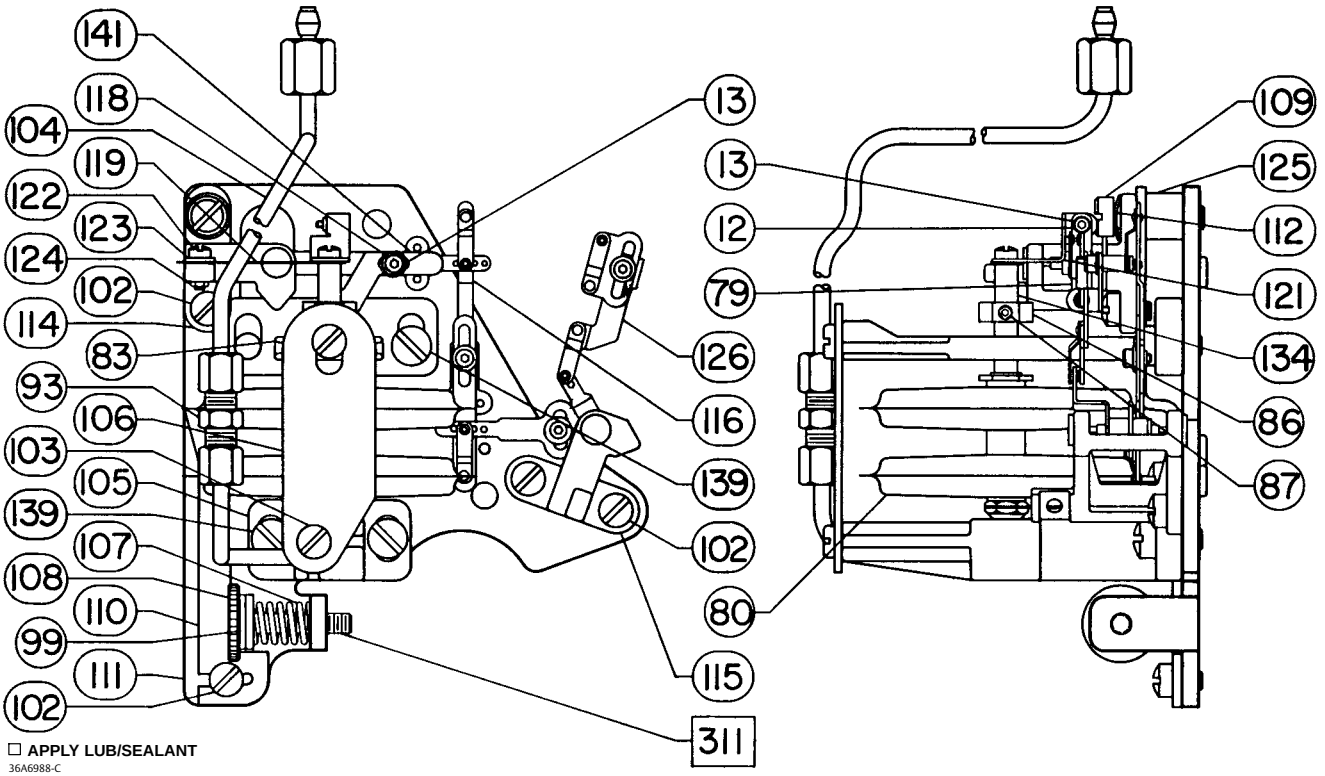


Key	Description
367	Support bracket ass'y
353	Machine screw, pan hd (4 req'd)
366	Controller mounting plate
368	Link ass'y (2 req'd)
369	Process pointer adj ass'y
370	Set pt pointer adj ass'y
371	Pivot pin (2 req'd)
372	Plain washer (4 req'd)
374	Pointer and bracket ass'
375	Set pt indicator ass'y for controllers w/remote set pt for controllers w/o remote set pt
376	Dial bracket
377	Dial bracket
378	Self-tapping screw (2 req'd)

Remote Set Point Assembly (suffix letter M) (key 62) (figure 51)

Key	Description
12	Cap screw, hex socket (2 req'd)
13	Plain washer (3 req'd)
79	Drive flexure
80	Diaphragm capsule ass'y 1 bar (12 psi) span 1.6 bar (24 psi) span
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 pt 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
116	Connecting link ass'y
118	Cap screw, hex socket

Figure 51. Remote Set Point Assembly Drawing



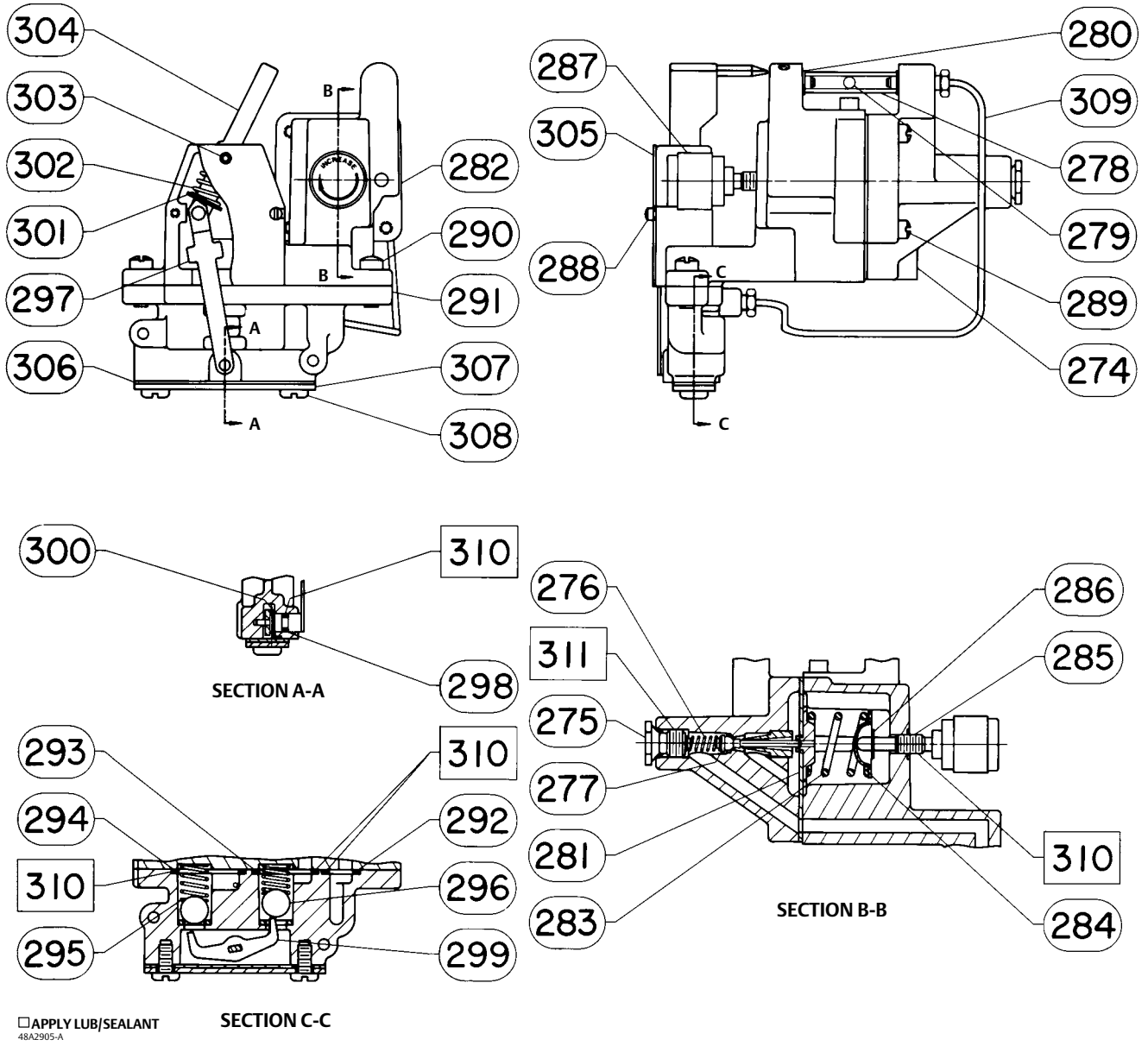
Key	Description
119	Guide flexure
121	Drive bracket
122	Machine screw, fill hd (2 req'd)
123	Plain washer
124	Hex nut
125	Spacer
126	Connecting link ass'y
134	Diaphragm ass'y extension
139	Machine screw, fill hd (3 req'd)
141	Adj arm
311	Anti-seize sealant (not furnished with controller)

Auto/Manual Station (suffix letter E) (figure 52)

Key	Description
274	Lower loader ass'y
275	Spring seat screwl
276	Valve plug spring (“music wire”)
277	Valve plug
278	Tube
279	Ball
280	Ball seat (2 req'd)
281*	Diaphragm ass'y
282	Upper loader ass'y
283	Range spring
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

*Recommended spare parts

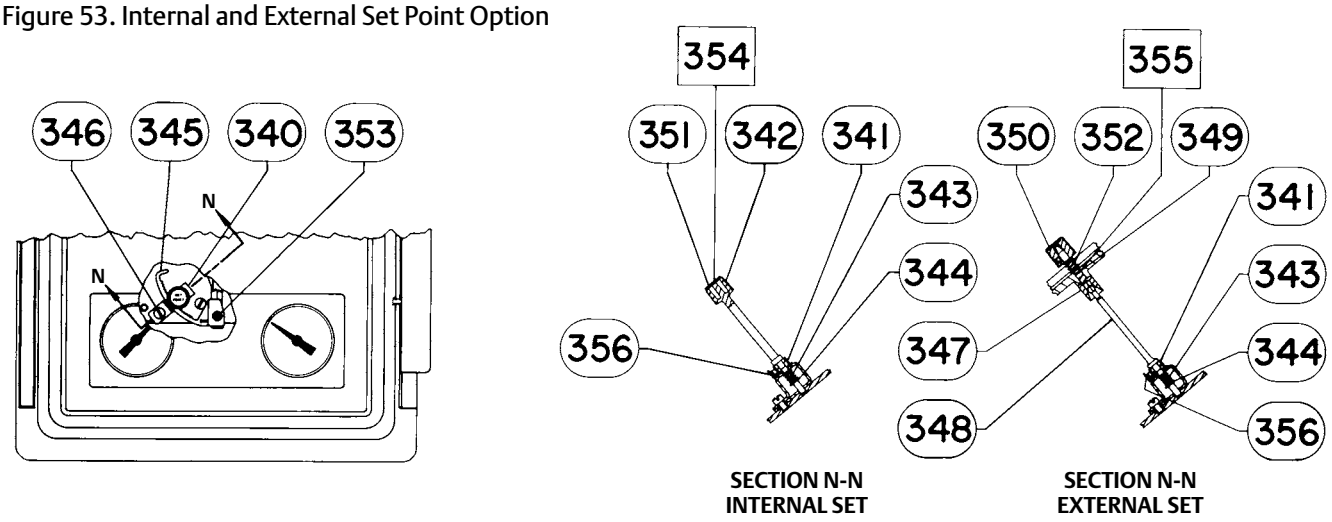
Figure 52. Auto/Manual Station Assembly Drawing



Key	Description
299	Rocker
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)

*Recommended spare parts

Figure 53. Internal and External Set Point Option



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56A9752-S

Key Description

Internal/External Set Point Assembly (Option) (figure 53)

340 Bracket
341 Pinion gear
342 Pinion shaft, for int set pt ass'y only

343 Spring
344 E-ring
345 Pinion rack
346 Machine screw, rd hd

347 Drive coupler, for ext set pt ass'y only
348 Flexible drive, for ext set pt ass'y only
349* O-ring, for ext set pt ass'y only
350 Knob, for ext set pt ass'y only

351 Knob insert, for int set pt ass'y only

352 Spring, for ext set pt ass'y only
353 Machine screw, pan head

354 Adhesive, for int set pt ass'y only (not furnished with controller)
355 Lubricant, for ext set pt ass'y only (not furnished with controller)

356 Rack support

Key Description

Controller Mounting Parts

Note
Contact your Emerson sales office for any additional parts required for controller mounting.

Pipestand Mounting (figure 3)

66 Cap screw, hex hd (3 req'd)
67 Lock washer (7 req'd)
68 Bracket
69 Clamp (2 req'd)

Pipestand Mounting with Regulator (figure 3)

66 Cap screw, hex hd (3 req'd)
67 Lock washer (7 req'd)
68 Bracket
69 Clamp (2 req'd)
362 Cap screw, hex hd (2 req'd)
363 Lock washer (2 req'd)
364 Hex nut (2 req'd)
365 Tubing fittings (2 req'd) See fittings subsection

*Recommended spare parts

Key Description

Panel Mounting (figure 4)

66 Cap screw, hex hd (3 req'd)
67 Lock washer (3 req'd)
68 Bracket
70 Machine Screw, rd hd (4 req'd)

Wall Mounting (figure 5)

66 Cap screw (3 req'd)
67 Lock washer (3 req'd)
68 Bracket

Actuator with Casing Mounted Controller

Spacer Spool (3 req'd)
Cap screw, hex hd (3 req'd)

Lock washer (5 req'd)
Mounting bracket
Cap screw, hex hd (2 req'd)
Mounting bracket

Cap screw, hex hd (2 req'd)
Hex nut (2 req'd)
Washer (2 req'd)
Washer (2 req'd)

Actuator With Yoke Mounted Controller (figure 2)

Spacer spool(3 req'd)
Cap screw, hex hd (3 req'd)
Lock washer (5 req'd)
Mounting bracket
  For 657/667, size 80 & 100
  For all other types
Spacer spool (2 req'd)
Cap screw (2 req'd)

Key Description

Regulator Mounting Parts

Casing-Mounted Regulator

Cap screw, hex hd (2 req'd)
Lock washer (2 req'd)
Cap screw, hex hd (2 req'd)
Hex nut (2 req'd)
Mounting bracket
  For 657/667, size 80 & 100
  For all other types

Yoke-Mounted Regulator (Mounting Bracket Not Required)

Cap screw, hex hd (2 req'd)
Lock washer (2 req'd)

Yoke-Mounted Regulator (With Mounting Bracket)

Cap screw, hex hd (2 req'd)
Lock washer (4 req'd)
Cap screw, hex hd (2 req'd)
Hex nut (2 req'd)
Mounting bracket
  For 657/667, size 80 & 100
  For all other types

Fittings

Fittings for 3/8 inch tubing casing- or yoke-mounted controller with regulator
  Connector (2 req'd)
  Elbow (2 req'd)
Fittings for 3/8-inch copper tubing, pipestand-mounted controller with regulator
  Elbow (2 req'd)
Fittings for 3/8-inch copper tubing, all controllers without regulator
  Connector (1 req'd)
  Elbow (1 req'd)
Fittings for 1/2-inch synthetic rubber hose, all controllers with or w/o regulator
  Connector
  Elbow
  Swivel (2 req'd)

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