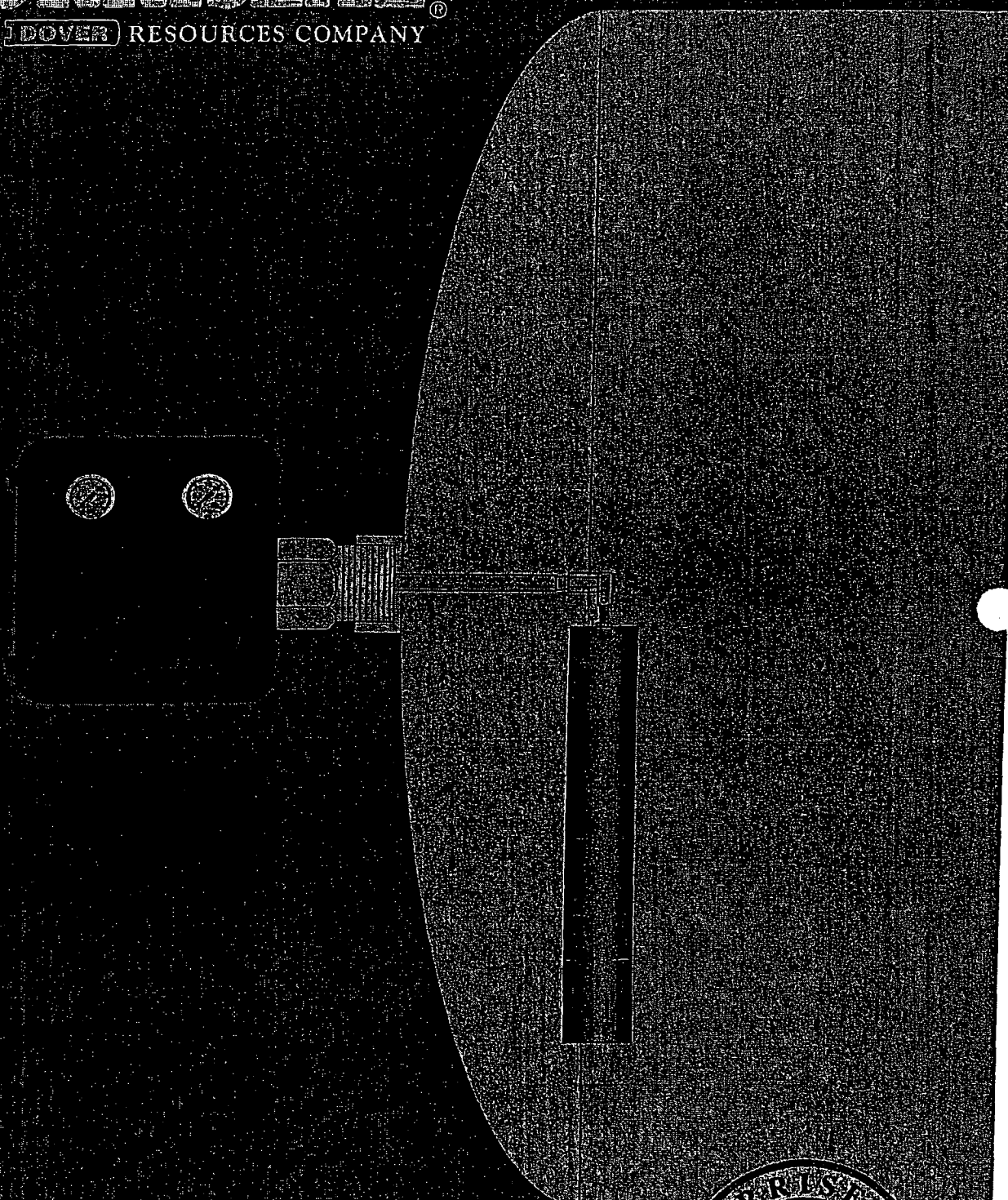


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Solutions through engineered products.

NORRISEAL
A **DOVER** RESOURCES COMPANY



LEVEL CONTROLLERS

SERIES 1001, 1001A, AND 1001XL

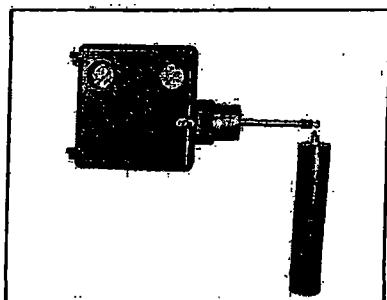


INTRODUCTION

Norriseal has been a leader in providing quality level measurement devices to the petroleum market for over 30 years. In addition to the petroleum market, Norriseal level products serve the marine, steel, and industrial markets.

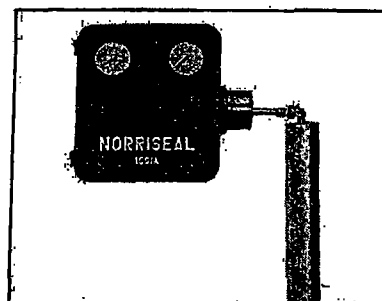
This brochure describes the Series 1001, the 1001A, and the 1001XL Liquid Level Controllers.

The Series 1001 and 1001A can be right hand or left hand mounted while the 1001XL is used where back mounted is preferred.



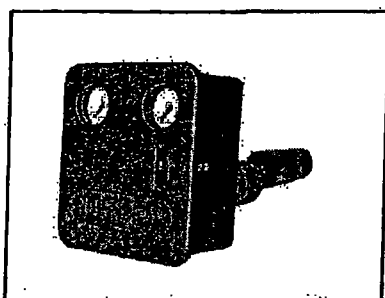
SERIES 1001

The economical Series 1001 Level Controller uses a non-weatherproof case/cover.



SERIES 1001A

The Series 1001A Level Controller uses a weatherproof case/cover and a manifold style pilot assembly.



SERIES 1001XL

The Series 1001XL Level Controller uses a back mount connection.

FEATURES

Pneumatic Controller - The controller can be equipped with one of three types of pilots: a snap pilot, throttling pilot, or relief pilot (1001A only).

Removable Door - The controller door can only be removed after opening 90°. This feature prevents the door from vibrating loose while in the closed position. A cam-type latch keeps a positive engagement between the case and the door.

Sealed Case (1001A & 1001XL) - An "O"-Ring gasket seals internals from outside weather and allows the harmful exhaust gases to be vented to a remote area by tubing the vent connection to an exhaust manifold.

Built-In Filter - A built-in filter in the gas supply connection reduces required maintenance of the controller's pilot.

Interface Control - A wide spring range makes the control of a liquid interface possible with the standard displacer.

Marine Service - Stainless steel internals are available.

Field Reversible Action - This adjustment determines whether rising liquid level will increase or decrease pilot output.

Right or Left Hand Mount (1001 & 1001A) - The controller may be changed for right hand or left hand mount in the field without additional parts.

Electric Controller - This option utilizes a standard electric switch; SPDT or DPDT.

Split Displacer - For liquid dump spans greater than the standard displacers can provide, a split displacer can give dump spans up to 70 feet in length.

NACE - All controllers can be configured to meet NACE MR01.75 specifications.

DESIGN

SNAP PILOT

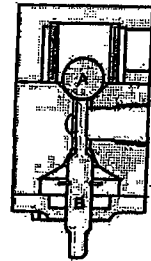
The pilot is comprised of two valves - one to admit pilot pressure, and one to exhaust pressure.

Ball "A" controls the flow of gas into the pilot and is held closed with force exerted by supply pressure on the seating area of the ball.

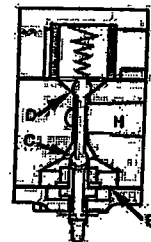
When the force transmitted to thrust pin "B" is sufficient to overcome the force holding Ball "A" seated, "A" snaps upward allowing gas to flow past "A" and out the side port of the pilot.

The spherical end of thrust pin "B" closes the exhaust port the instant ball "A" snaps upward. The exhaust port seating area is smaller than the seating area of the supply port; therefore, the push rod must remain seated against supply pressure until force on the rod diminishes.

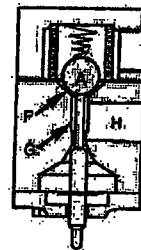
A simultaneous action occurs as force is removed from thrust pin "B". Pilot pressure opens the exhaust port by unseating the push rod, and supply pressure forces ball "A" to close the supply port. The difference in seating area gives this pilot Snap-Action.



Snap Pilot



Throttling Pilot



Relief Pilot

THROTTLING PILOT

Again two valves are used to admit and exhaust pressure. A diaphragm "E" used in cooperation with the valves create a Force-Balance Pilot.

The pilot output pressure acts upon the diaphragm so that the diaphragm pushes back with the same force being applied by the push rod. These balanced forces are the reason for the term "Force-Balance."

The throttle pilot works in the same manner as the snap pilot except the output pressure is proportioned to the amount of force applied to the push rod. More force on the rod produces a proportionate increase in pilot pressure.

When the push rod force changes, the pilot seeks a new balance point by either exhausting the output loading at valve "C" or unseating valve "D" to increase output loading. Instrument gas does not flow while the pilot is in balance.

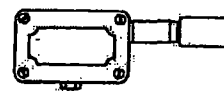
RELIEF PILOT (1001A ONLY)

This pilot works identically to the snap pilot. The difference between the two is Seal "F" and passage "G". Seal "F" is an "O" Ring and gives a positive seal (no leak) to Ball "A". Passage "G" is larger than the passage in the snap pilot. This enlarged area permits the instrument supply air to exhaust out of the pilot at a faster rate. This pilot cannot be converted to a throttle pilot.

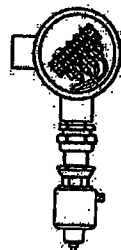
ELECTRIC LEVEL SWITCH

The electric level switch uses the force balance principle to open and close an electrical switch in response to rising or falling levels. Two standard switches are available, single pole double throw (SPDT) or double pole double throw (DPDT). Splash-proof, explosion-proof, and hermetically sealed enclosures are available.

Hermetically Sealed
Electric Switch



Electric Switch



* See 1600 Bulletin for Transmitter/Controller

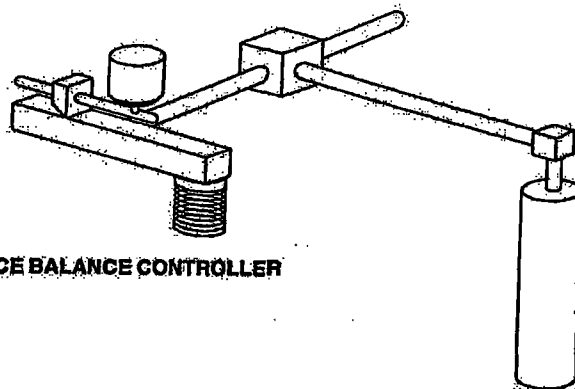
PRINCIPLE OF OPERATION

FORCE BALANCE PRINCIPLE

The operation of the Series 1001, 1001A, and the 1001XL Level Controllers are based on the **Force Balance Principle**. A spring balances the weight of a displacement type displacer, and as the displacer is immersed into the liquid, the amount of force available is proportional to the weight of the liquid displaced. The result of this force is transmitted to the controller.

The figure in the upper right shows a schematic of the force balance controller. The downward force due to the weight of the displacer about the shaft is balanced by the tension of the spring. The weight of the displacer decreases as the liquid level rises, and the force created by the spring tension is transmitted to the pilot thrust pin by a lever and fulcrum. The pilot will convert this direct-acting force to a pneumatic or electric output signal.

FORCE BALANCE CONTROLLER



For on-off control, the snap pilot output will be equal to the supply pressure over the span of the liquid displaced. The span of the liquid level can be changed by sliding the fulcrum on a lever. Moving the fulcrum away from the pilot thrust pin increases the proportional band, and moving the fulcrum toward the pilot thrust pin decreases the proportional band. The control is direct acting when the rising level increases pilot output signal. A reverse acting control is when the rising level decreases pilot output signal.

FUNCTION OF THE ADJUSTABLE SPRING

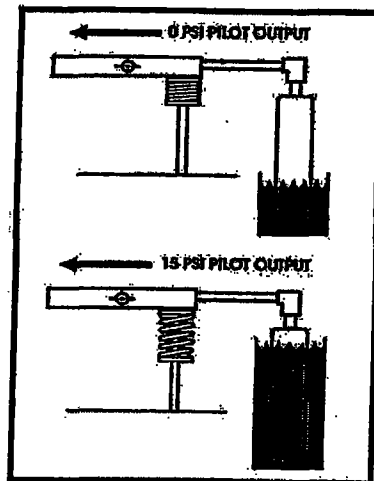
As previously mentioned, a spring is used to balance the weight of the displacer. With spring force held constant, the higher the liquid level on the displacer, the greater becomes the force available to the pilot. When spring force is reduced (by decompressing the spring), a higher level on the displacer is required to produce the same force as before.

Spring compression can be reduced to a further position where a hydrocarbon liquid level will rise above the displacer.

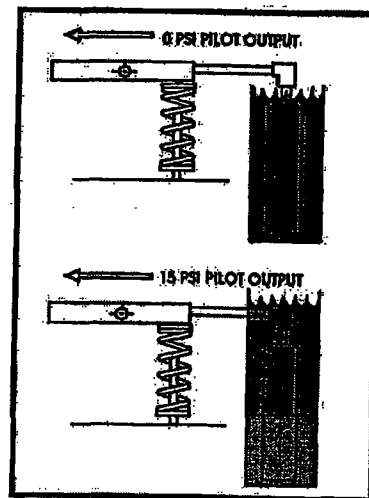
This wide spring range makes the control of a **Liquid Interface** possible with the standard displacer. The adjustment is usually made as the lighter liquid rises on the displacer.

After the spring is adjusted so the lighter liquid will not operate the control, there is adequate spring force in reserve to enable displacement of the heavier liquid to actuate the pilot.

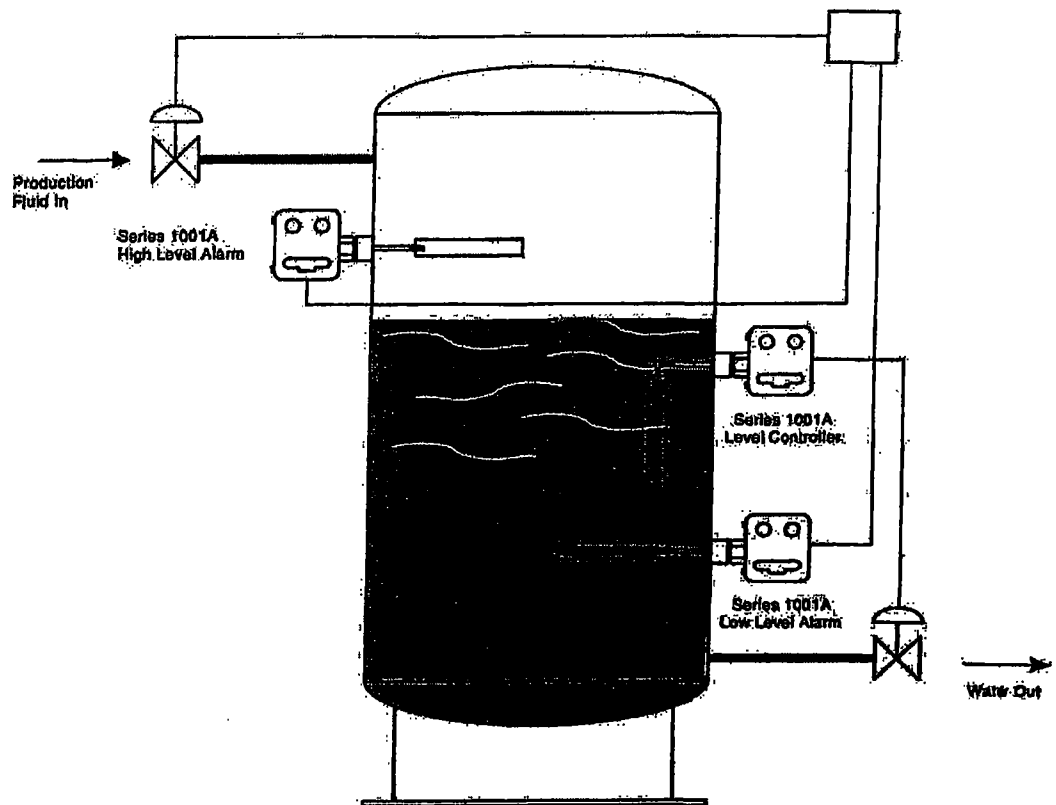
TOP LEVEL CONTROL



LIQUID INTERFACE CONTROL

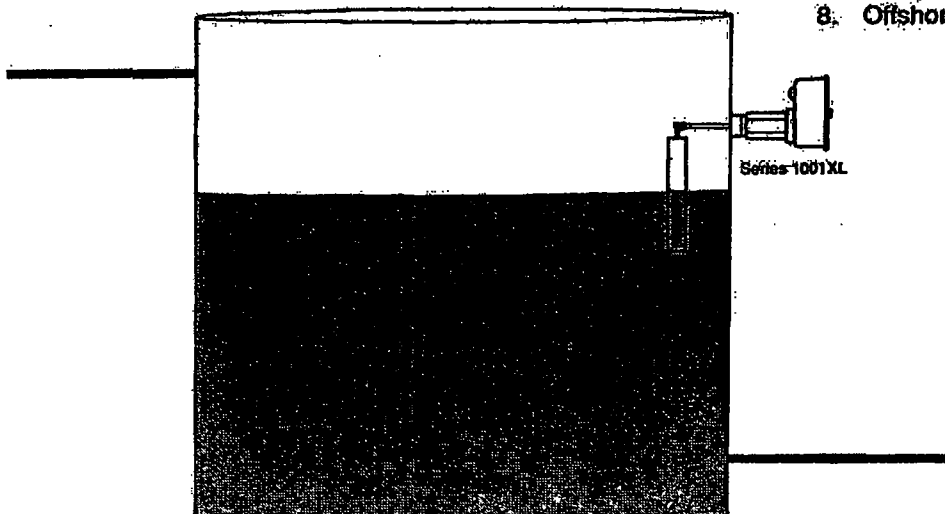


APPLICATIONS



Common Applications Include:

1. Custody Transfer Measurement Systems
2. Separators
3. Dehydrators
4. Heater Treaters
5. Well Test Systems
6. Interface Detection
7. Compressor Scrubbers
8. Offshore Production Facilities



SPECIFICATIONS

PERFORMANCE CHARACTERISTICS

Pilot - Pneumatic

Output		Ambient Temperature	-40 to +180°F
Proportional - Throttle	3 - 15 PSIG		-40 to +275°F (High Temp)
	6 - 30 PSIG	Pilot Capacity	
Differential Gap - Snap	0 - 20 PSIG	Throttle C _v	0.394
	0 - 30 PSIG	Snap C _v	0.262
Block & Bleed - Relief	0 - 30 PSIG	Relief C _v	0.403
	0 - 50 PSIG		
	0 - 100 PSIG		
Supply Pressure Requirement		Proportional Band Adjustment	
3 - 15 PSIG, 0 - 20 PSIG	20 - 30 PSIG (min)	(Recommended adjustment for a full output pressure change over a percent of sensing element)	
6 - 30 PSIG, 0 - 30 PSIG	35 - 40 PSIG (min)	Throttle	20 - 150%
0 - 50 PSIG	60 PSIG (max)	Snap	7 - 55%
0 - 100 PSIG	100 PSIG (max)	Relief	@ 30 PSI Supply = 7-55%
			@ 50 PSI Supply = 20-100%
Supply and Output			@ 100 PSI Supply = 50-200%
Connection	1/4 Inch NPT Female		

Pilot - Electric - On/Off Switch

Output		Switch Ratings	
Proportional Band Adjustment		SPDT	15 amps at 125, 250, or 480 V.A.C.
(Electric - Micro Switch)		DPDT	10 amps at 125 V.A.C.
SPDT	7 - 55%		
DPDT	20 - 150%		
(Electric - Hermetically Sealed)		Ambient Temperature	-40 to +160°F
SPDT	10 - 75%	(A Case Extension is used for extreme process temperatures or when body insulation is used.)	
DPDT	10 - 75%		

General

Repeatability	1.0% of output span	Temperature Limits	
Dead Band	5.0% of input span	Body Process Temperature (dependent on material selection)	-70 to +600°F
Linearity	1.75% of output span	Process Pressure Rating	
Ambient Temperature		Beveled - Butt Weld	To 6000 PSIG
Effect on Setpoint	1.0% @ -40°F	Threaded (NPT)	To 6000 PSIG
	3.0% @ +170°F	Grooved	To 2500 PSIG
Mechanical Disturbance Effects on Setpoint	1.0%	Flanged (RF & RTJ)	150 thru 2500 ANSI CLASS
Specific Gravity		Union	To 10,000 PSIG
Interface Detection	0.035	Union w/Sight Glass	To 1500 PSIG
Top Level Range	0.35 to 2.00		

SPECIFICATIONS

MATERIAL

Pilot - Pneumatic

Body		Internal Valving	303 SST
Throttle	Aluminum w/Aluminum Seat	Filter Element	40 micron Phenolic Resin Impregnated Felt
Relief	Aluminum w/Elastomer Seat		
Snap	Aluminum Seat	Screws & Nuts	SST
Gasket/Diaphragm	Nitrile (Standard) Fluorocarbon (Optional)		

Pilot - Electric - On/Off Switch

Micro-Switch Enclosure	Cast Aluminum
Hermetic Switch Enclosure	SST
Junction Box	Cast Aluminum

General

Body - LLC		Bearings	440C SST (-70 to +600°F)
1001/1001A	ASTM A696/A105 (-20 to +600°F) ASTM A276/A182 (-70 to +600°F)	Shaft Seals	Nitrile (-50 to +180°F) Nitrile Lo-Temp (-70 to +180°F) Fluorocarbon (-20 to +400°F) Aflas (-20 to +450°F) EPR (-70 to +250°F)
1001XL	ASTM A216 WQC/A105 (-20 to +600°F) ASTM A216 LCC (-50 to +600°F) ASTM A351 CF8M/A182 (-70 to +600°F)	Case & Cover	Die Cast Anodized Aluminum with Enamel Paint
Hammer Nut (where applicable)	ASTM A105	Supply & Output Gauges	Brass (Standard) 316 SST (Optional) Brass Liquid Fill (Optional) 316 SST Liquid Fill (Optional)
Sight Glass	Acrylic (-20 to +200°F) (For Special DU/AU Union Body)	Torque Bar	Aluminum (Standard) 303 SST (Marine)
Displacers	PVC (-20 to +140°F) Acrylic (-20 to +200°F) Aluminum (-70 to +600°F) 316 SST (-70 to +600°F)	Flapper Bar	303 SST
Displacer Arm	303 SST (Standard) 316 SST (Optional)	Spring Adjusting Knob	Aluminum (Standard) 303 SST (Marine)
Vertical Hanger	303 SST (Standard) (swivel for vertical displacer position) 316 SST (Optional)	Fulcrum	Nylon w/SST Screw
Chain	316 SST (for vertical extension and/or split displacer)	Balancing Spring	Light - SST w/Green Marking Medium - SST w/No Marking Heavy - SST w/Yellow Marking Extra Heavy - SST w/Red Marking
Shaft	303 SST (Std -70 to +600°F) 316 SST (Opt -70 to +600°F)		
Bearing Blocks	303 SST (Std -70 to +600°F) 316 SST (Opt -70 to +600°F)		

Note:

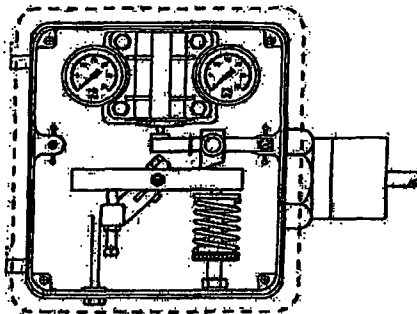
Materials that are certified compatible for NACE service are available upon request.

HOW TO SPECIFY

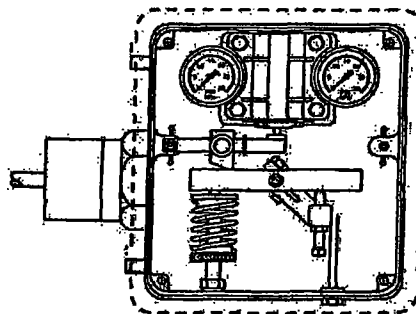
DETERMINE THE MODEL NUMBER. This specifies series and size connection, type pilot, left or right hand mount, pilot action, seals, and service condition.

REQUIRED APPLICATION INFORMATION:

- | | |
|--|--|
| <p>A. Fluid Media</p> <p>B. Process Temperature (Maximum and Minimum)</p> <p>C. Process Pressure</p> <p>D. Vessel Size and Diameter (Distance of connection from bottom of vessel, any obstructions that may hinder performance)</p> | <p>E. Body Connection Type, Size, & Rating</p> <p>F. Displacer Position (Vertical or Horizontal)</p> <p>G. Controller Mount (Right or Left) If applicable</p> <p>H. Pilot Action</p> <p>I. Area Electrical Classification If applicable</p> <p>J. Top Level or Interface</p> |
|--|--|



RIGHT HAND MOUNT



LEFT HAND MOUNT

RIGHT HAND MOUNT VS. LEFT HAND MOUNT

The Series 1001 and Series 1001A can be configured as Right Hand Mount or Left Hand Mount. The orientation of the displacer to the controller (while facing the front side of the controller) designates the mounting style. The mounting can be adjusted in the field. The Series 1001XL is utilized when neither Right Hand or Left Hand Mount are practical.

ELECTRIC LEVEL SWITCH

The electric level switch uses the force balance principle to apply force to a standard Honeywell Micro-switch.

Two standard switches are available, single pole double throw (SPDT) or double pole double throw (DPDT). Rating for SPDT switch is 15 amps at 125, 250, or 480 volts A.C. The DPDT switch rating is 10 amps at 125 or 250 volts A.C. An explosion-proof or splash-proof enclosure is available.

EX

Explosion Proof
 U-L listed explosion proof
 switch for hazardous location
 Class I — Groups C & D
 Class II — Groups E, F & G

OP

Splash Proof
 Splash proof switches sealed
 against the splash of oil,
 water and other liquid of a
 non-corrosive nature; but are
 not sealed against immersion.

MODEL NUMBER CODE

Model 2 SM 60 - S R D A - A B

END CONNECTIONS	
SIZE	CODE
1/50	15
1/200	20
3/600	23
1/400	24
1/600	26

END CONNECTIONS		CODE
Revised Bore/Shaft	Revised Bore/Shaft	15
Revised Bore/Shaft	Revised Bore/Shaft	20
Revised Bore/Shaft	Revised Bore/Shaft	23
Revised Bore/Shaft	Revised Bore/Shaft	24
Revised Bore/Shaft	Revised Bore/Shaft	26
Revised Bore/Shaft	Revised Bore/Shaft	27
Revised Bore/Shaft	Revised Bore/Shaft	28
Revised Bore/Shaft	Revised Bore/Shaft	29
Revised Bore/Shaft	Revised Bore/Shaft	30
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Revised Bore/Shaft	Revised Bore/Shaft	97
Revised Bore/Shaft	Revised Bore/Shaft	98
Revised Bore/Shaft	Revised Bore/Shaft	99
Revised Bore/Shaft	Revised Bore/Shaft	100

PRESSURE RATING		
PRESS.	RATING	CODE
1/50	15	15
1/200	20	20
3/600	23	23
1/400	24	24
1/600	26	26
1/800	28	28
1/1000	30	30
1/1200	32	32
1/1400	34	34
1/1600	36	36
1/1800	38	38
1/2000	40	40
1/2200	42	42
1/2400	44	44
1/2600	46	46
1/2800	48	48
1/3000	50	50
1/3200	52	52
1/3400	54	54
1/3600	56	56
1/3800	58	58
1/4000	60	60
1/4200	62	62
1/4400	64	64
1/4600	66	66
1/4800	68	68
1/5000	70	70
1/5200	72	72
1/5400	74	74
1/5600	76	76
1/5800	78	78
1/6000	80	80
1/6200	82	82
1/6400	84	84
1/6600	86	86
1/6800	88	88
1/7000	90	90
1/7200	92	92
1/7400	94	94
1/7600	96	96
1/7800	98	98
1/8000	100	100

* BODY PRESSURE RATING SUBJECT TO SELECTION OF DISPLACER. SEE DISPLACER CHART.

MATERIAL - BODY/SHAFT/BLOCK			
BODY	SHAFT	BEARING	CODE
W/60/CS/2W/00	W/60/CS	W/60/CS	15
W/10/CS/2W/00	W/10/CS	W/10/CS	20
W/20/CS/2W/00	W/20/CS	W/20/CS	23
W/30/CS/2W/00	W/30/CS	W/30/CS	24
W/40/CS/2W/00	W/40/CS	W/40/CS	26
W/50/CS/2W/00	W/50/CS	W/50/CS	28
W/60/CS/2W/00	W/60/CS	W/60/CS	30
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W/130/CS/2W/00	W/130/CS	W/130/CS	44
W/140/CS/2W/00	W/140/CS	W/140/CS	46
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W/170/CS/2W/00	W/170/CS	W/170/CS	52
W/180/CS/2W/00	W/180/CS	W/180/CS	54
W/190/CS/2W/00	W/190/CS	W/190/CS	56
W/200/CS/2W/00	W/200/CS	W/200/CS	58
W/210/CS/2W/00	W/210/CS	W/210/CS	60
W/220/CS/2W/00	W/220/CS	W/220/CS	62
W/230/CS/2W/00	W/230/CS	W/230/CS	64
W/240/CS/2W/00	W/240/CS	W/240/CS	66
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W/310/CS/2W/00	W/310/CS	W/310/CS	80
W/320/CS/2W/00	W/320/CS	W/320/CS	82
W/330/CS/2W/00	W/330/CS	W/330/CS	84
W/340/CS/2W/00	W/340/CS	W/340/CS	86
W/350/CS/2W/00	W/350/CS	W/350/CS	88
W/360/CS/2W/00	W/360/CS	W/360/CS	90
W/370/CS/2W/00	W/370/CS	W/370/CS	92
W/380/CS/2W/00	W/380/CS	W/380/CS	94
W/390/CS/2W/00	W/390/CS	W/390/CS	96
W/400/CS/2W/00	W/400/CS	W/400/CS	98
W/410/CS/2W/00	W/410/CS	W/410/CS	100

PILOT MODE		CODE
Electric DPDT (Ex-Pro)	Electric DPDT (Ex-Pro)	D
Electric SPDT (Ex-Pro)	Electric SPDT (Ex-Pro)	E
Electric DPDT (Splash-Pro)	Electric DPDT (Splash-Pro)	F
Pneumatic Relief (W/60/CS/G Gauge)	Pneumatic Relief (W/60/CS/G Gauge)	G
Electric SPDT (Splash-Pro)	Electric SPDT (Splash-Pro)	O
Electric SPDT (Hermatic Sealed)	Electric SPDT (Hermatic Sealed)	K
Electric DPDT (Hermatic Sealed)	Electric DPDT (Hermatic Sealed)	L
Pneumatic Snap (On/Off)	Pneumatic Snap (On/Off)	S
Pneumatic Throttle (Modulating)	Pneumatic Throttle (Modulating)	T

ENCLOSURE	
CODE	TYPE
7A	Standard Case (100 Only)
7B	Sealed Case/Cover Only
7C	Sealed Case/Cover and Pipe/Exhaust
7D	Sealed Case/Cover and Pipe/Exhaust and Special Made Internals
7E	Sealed Case/Cover and Special Made Internals

SERVICE CONDITION	
CODE	SERVICE
7A	Standard/Standard Gauges
7B	Vibration/Standard Gauges
7C	Vibration/Vibration Gauges
7D	Vibration/Liquid Filled Gauges

SEAL/BEARING MATERIAL			
CODE	ORING	BEARING	TEMP. RY
7A	7A	7A	7A
7B	7B	7B	7B
7C	7C	7C	7C
7D	7D	7D	7D
7E	7E	7E	7E

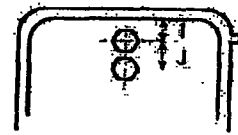
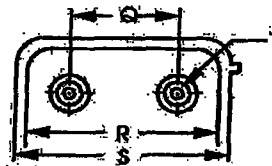
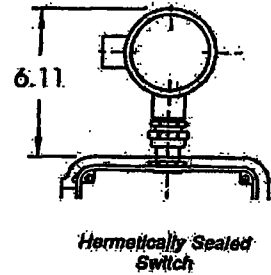
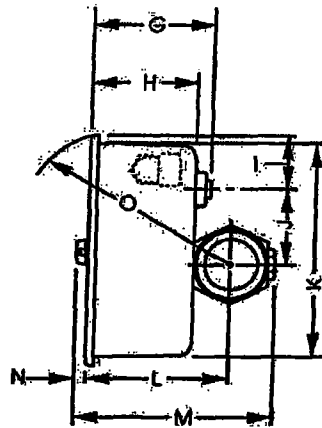
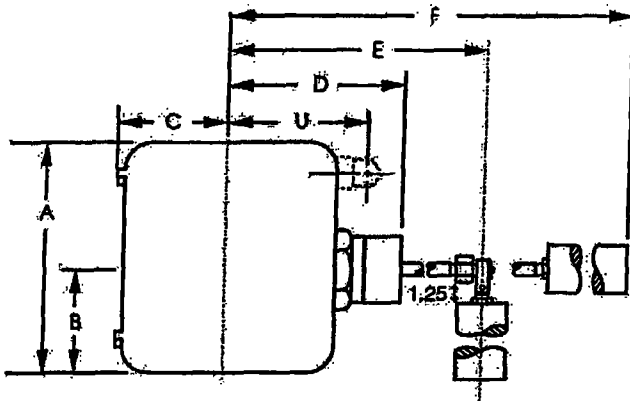
** SEAL TEMPERATURE RATING SUBJECT TO SELECTION OF DISPLACER. SEE DISPLACER CHART.

PILOT ACTION	
CODE	ACTION TYPE
7A	Direct Action
7B	Reverse Action

MOUNTING CASE	
CODE	MOUNTING TYPE
7A	Standard Back
7B	Standard Front
7C	Standard Side
7D	Standard Top

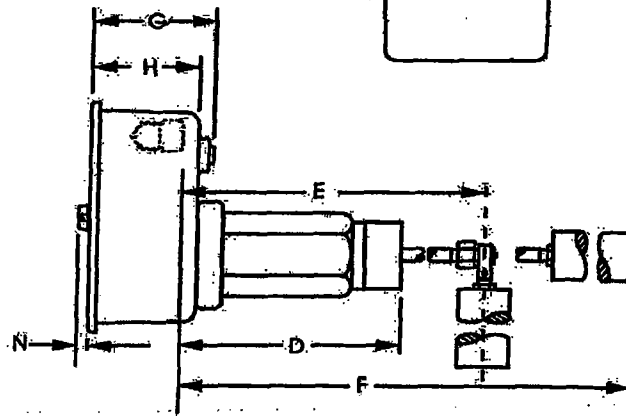
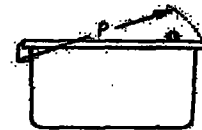
DISPLACER CHART		
DISPLACER TEMPERATURE/PRESSURE RATING		
MATERIAL	MAX. TEMP. (°C)	MAX. PRESSURE (PSIG)
7A	20/16/140	16/14
7B	20/16/200	16/14
7C	20/16/200	16/14
7D	20/16/200	16/14
7E	20/16/200	16/14
7F	20/16/200	16/14
7G	20/16/200	16/14
7H	20/16/200	16/14
7I	20/16/200	16/14
7J	20/16/200	16/14
7K	20/16/200	16/14
7L	20/16/200	16/14
7M	20/16/200	16/14
7N	20/16/200	16/14
7O	20/16/200	16/14
7P	20/16/200	16/14
7Q	20/16/200	16/14
7R	20/16/200	16/14
7S	20/16/200	16/14
7T	20/16/200	16/14
7U	20/16/200	16/14
7V	20/16/200	16/14
7W	20/16/200	16/14
7X	20/16/200	16/14
7Y	20/16/200	16/14
7Z	20/16/200	16/14

DIMENSIONS



1001A/1001XL

1001



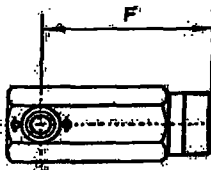
Side View of 1001XL

MODEL	1001	1001A	1001XL
A	7.68	8.74	8.74
B	6.00	3.85	3.00
C	4.09	4.13	4.13
D	6.00	6.00	6.00
E	13.67	13.67	13.67
F	24.43*	24.43*	24.44*
G	6.12	4.36	4.36
H	2.75	3.95	3.95
I	0.90	1.90	1.90
J	1.00	2.98	2.98
K	7.68	7.98	7.98
L	4.00	5.19	—
M	6.25	7.47	—
N	0.62	0.69	0.69
O	6.00	7.13	—
P	7.75	7.85	7.85
Q	—	4.00	4.00
R	—	7.06	7.06
S	—	8.01	8.01
T	1/4 NPT	1/4 NPT	1/4 NPT
U	4.75	4.87	5.16

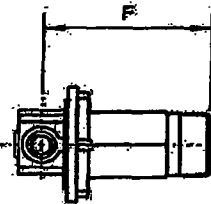
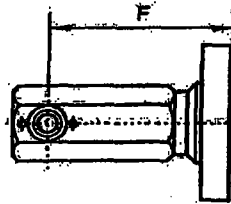
*Using standard 1.875 dia. X .12 inch displacer and .125 inch displacer arm. Length is dependent upon displacer arm and displacer.

DIMENSIONS

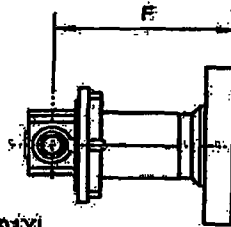
DIMENSION "F"				
BODY STYLES X	BODY SIZE			
	2.00	3.00	4.00	6.00
Beveled BAW SCH 40	6.00			
SCH 80	6.00			
SCH XXH	6.00			
Beveled Slip-On	6.00			
Screwed Male NPT	6.00			
Grooved	6.00	6.88	6.94	7.00
Flanged 1/2 Bolt Special	6.88			
-150 RF	6.50	6.56	6.56	6.75
-150 RTJ	6.56	6.88	6.88	6.94
-300 RF	6.81	6.75	6.88	9.19
-300 RTJ	7.06	7.00	7.25	9.25
-400 RF	7.19	7.13	7.38	9.75
-400 RTJ	7.25	7.31	7.41	9.81
-600 RF	7.19	7.13	7.50	10.13
-600 RTJ	7.25	7.31	7.56	10.19
-900 RF	8.00	9.69	10.13	10.56
-900 RTJ	8.06	9.69	10.19	10.63
-1500 RF	8.00	10.25	10.63	11.88
-1500 RTJ	8.06	10.31	10.69	11.94
-2500 RF	9.13	11.00	11.75	13.50
-2500 RTJ	9.19	11.06	11.81	13.56



Series 1001 and 1001A



Series 1001XL

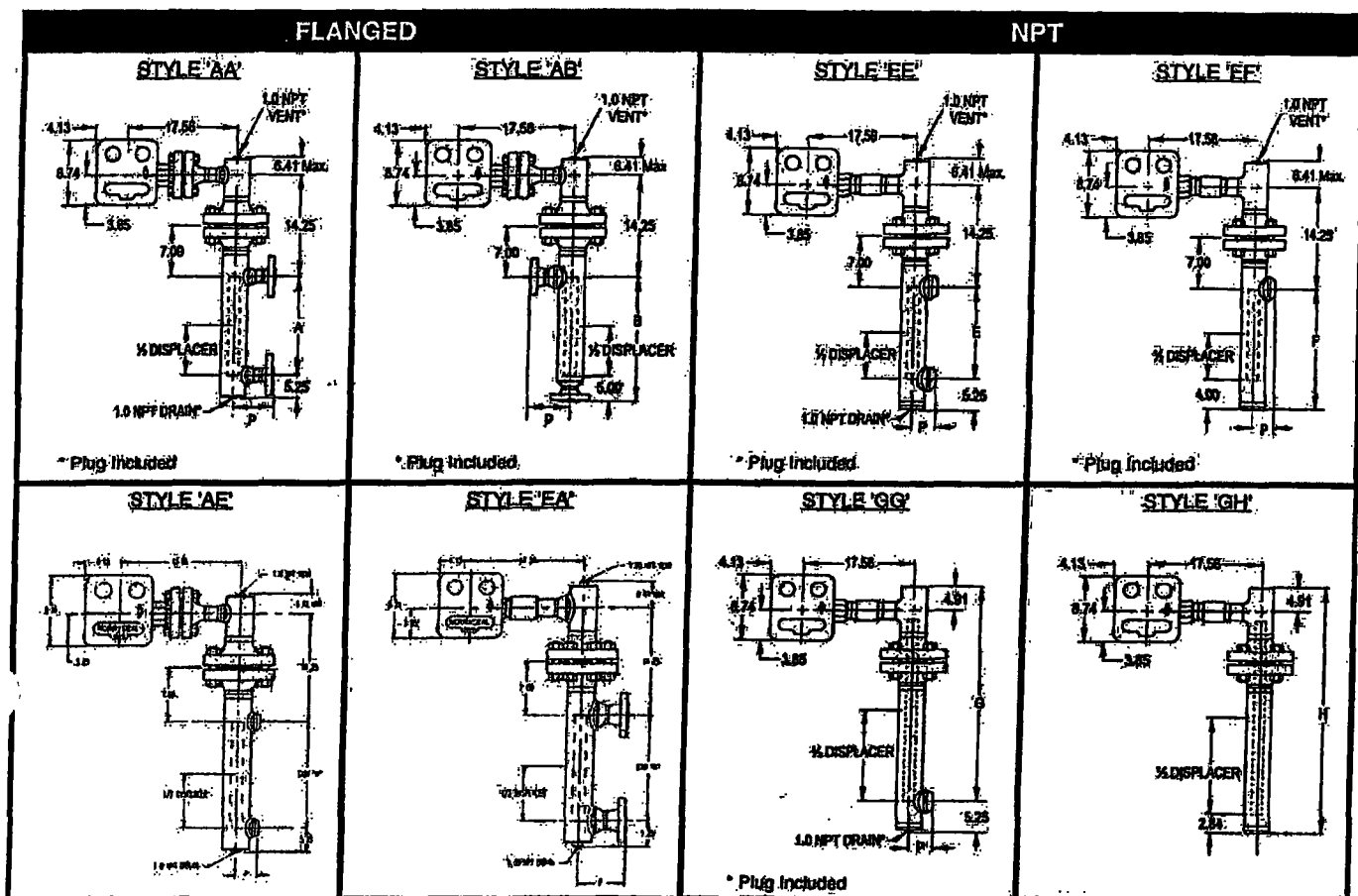


WEIGHTS				
BODY STYLES X	BODY SIZE			
	2.00	3.00	4.00	6.00
Beveled BAW SCH 40	17	NA	NA	NA
SCH 80	17	NA	NA	NA
SCH XXH	17	NA	NA	NA
Beveled Slip-On	18	NA	NA	NA
Screwed Male NPT	18	NA	NA	NA
Grooved	18	19	20	
Flanged 1/2 Bolt Special	25	NA	NA	
-150 RF	25	30	34	
-150 RTJ	25	30	34	
-300 RF	27	35	45	
-300 RTJ	27	35	45	
-400 RF				
-400 RTJ				
-600 RF	29	37	55	
-600 RTJ	29	37	55	
-900 RF	40	51	75	
-900 RTJ	40	51	75	
-1500 RF	45	72	95	
-1500 RTJ	45	72	95	
-2500 RF	61	110	150	
-2500 RTJ	61	110	150	

Weights are for 1001. For 1001A add 1 lb, and for 1001XL add 2 lb.

SERIES 1006 VERTICAL CHAMBERS

The Series 1001 and Series 1001A can be externally mounted using our Series 1006 Vertical or Horizontal External Chambers. These external chambers provide more stable operation for vessels with internal obstruction or considerable internal turbulence.



* Other process connections available.

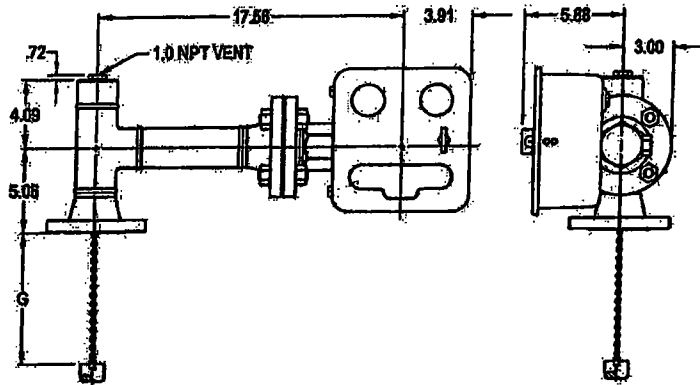
PROCESS CONNECTIONS DIMENSIONS (INCHES)				
TYPE	STYLE	DISPLACER*	DIM**	DIM
Flanged	AA	14	A	14
		32		32
	AB	14	B	19
		32		37
	CC	14	C	21
		32		39
	CD	14	D	26
		32		44
Screwed	EE	14	E	14
		32		32
	EF	14	F	18
		32		36
	GG	14	G	19
		32		37
	GH	14	H	23
		32		41

PROCESS CONNECTIONS					
ANSI CLASS		150	300	600	
P	3.00 X RF	5.62	5.88	6.19	
	1.50 FLG RTJ	5.88	6.12	6.19	
	3.00 X RF	5.88	6.12	6.50	
	2.00 FLG RTJ	6.12	6.44	6.56	
	4.00 X RF	6.12	6.38	6.69	
	1.50 FLG RTJ	6.38	6.62	6.69	
	4.00 X RF	6.38	6.62	7.00	
	2.00 FLG RTJ	6.62	6.94	7.06	
	NPT SIZE		1.00	1.50	2.00
	3.00 X NPT		3.12	3.19	3.31
4.00 X NPT		3.62	3.69	3.81	

Other displacer lengths available on request.

Charted dimensions are for process connecting piping. All other dimensions may vary with respect to flange size and ANSI class.

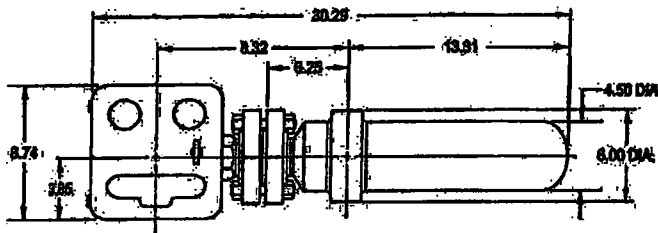
DOMES AND HORIZONTAL CHAMBERS



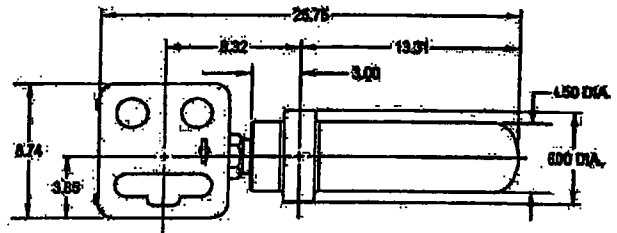
Series 1006D Dome

To specify a Dome Only (this is the top of the vertical chamber) add a suffix letter 'D' to the end of the Series Number. Refer to the Model Code, section Vertical Chamber Style.

Series 1006 Horizontal Chamber (For Model Number Code, refer to page 15)



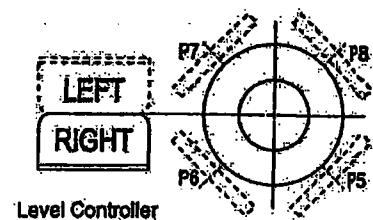
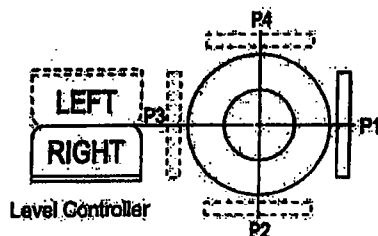
with Flanged Level Controller



with Screwed Level Controller

Position of Process Connections

The following diagram illustrates the location of the process connections and level controller relative to Position 1 (P1) which is zero. Refer to Model Number Code, section Position Process Connection.



MODEL NUMBER CODE

The following model codes apply to the Series 1006 Vertical Chamber with Dome and to the Series 1006D Dome Only.

Model 3 A A 14 - 20 RF 14 - P1

CHAMBER/DOME PIPE SIZE		
DESCRIPTION	CODE	
1/2" NPT	1/2	
3/4" NPT	3/4	
1" NPT	1	
1 1/2" NPT	1 1/2	
2" NPT	2	

VERTICAL DOME STYLE		
DESCRIPTION	CODE	
Flanged LLC W/NET Venti	1	
Flanged LLC W/Top Flanged Process Conn	2	
AScrewed LLC W/NET Venti	3	
AScrewed LLC W/Top Flanged Process Conn	4	

VERTICAL CHAMBER STYLE														
TYPE		TYPE		PROCESS		PROCESS		PROCESS		PROCESS		CODE		
CONNECTION		CONNECTION		CONNECTION		CONNECTION		CONNECTION		CONNECTION				
Flanged	See Dome	Side Top	Side Btm	1	Flanged	See Dome	Side Top	Side Btm	2	Flanged	See Dome	Side Top	Side Btm	3
Flanged	See Dome	Side Top	Side Btm	4	Flanged	See Dome	Side Top	Side Btm	5	Flanged	See Dome	Side Top	Side Btm	6
Flanged	See Dome	Side Top	Side Btm	7	Flanged	See Dome	Side Top	Side Btm	8	Flanged	See Dome	Side Top	Side Btm	9
Screwed	See Dome	Side Top	Side Btm	10	Screwed	See Dome	Side Top	Side Btm	11	Screwed	See Dome	Side Top	Side Btm	12
Screwed	See Dome	Side Top	Side Btm	13	Screwed	See Dome	Side Top	Side Btm	14	Screwed	See Dome	Side Top	Side Btm	15
Screwed	See Dome	Side Top	Side Btm	16	Screwed	See Dome	Side Top	Side Btm	17	Screwed	See Dome	Side Top	Side Btm	18
Screwed	See Dome	Side Top	Side Btm	19	Screwed	See Dome	Side Top	Side Btm	20	Screwed	See Dome	Side Top	Side Btm	21
TOTAL													22	

DISPLACER LENGTH		
DESCRIPTION	CODE	
12.00 inch	12	
14.00 inch	14	
16.00 inch	16	
18.00 inch	18	
20.00 inch	20	
22.00 inch	22	
24.00 inch	24	
26.00 inch	26	
28.00 inch	28	
30.00 inch	30	
32.00 inch	32	
34.00 inch	34	
36.00 inch	36	
38.00 inch	38	
40.00 inch	40	
Dome Only	0	

DOME/CHAMBER MATERIAL		
DESCRIPTION	CODE	
Carbon Steel A105/A106	1	
Carbon Steel A105/A106 Except Domestic	2	
Material	3	
304 Stainless Steel	4	
Carbon Steel NACE/A889/A850/A504	5	
Monel NACE	6	
Carbon Steel NACE/A105/A106	7	
316 L Stainless Steel X-Ray NACE	8	
316 Stainless Steel	9	
316 L Stainless Steel X-Ray	10	

Carbon Steel A105/A106 Except X-Ray

PROCESS CONNECTION		
DESCRIPTION	CODE	
1/2" NPT	1/2	
3/4" NPT	3/4	
1" NPT	1	
1 1/2" NPT	1 1/2	
2" NPT	2	

POSITION PROCESS CONNECTION		
CODE	DESCRIPTION	
1P1	1/2" Degrees W/LLC at 180 Degrees	
1P2	1/2" Degrees W/LLC at 180 Degrees	
1P3	1/2" Degrees W/LLC at 180 Degrees	
1P4	1/2" Degrees W/LLC at 180 Degrees	
1P5	1/2" Degrees W/LLC at 180 Degrees	
1P6	1/2" Degrees W/LLC at 180 Degrees	
1P7	1/2" Degrees W/LLC at 180 Degrees	
1P8	1/2" Degrees W/LLC at 180 Degrees	

STUD & GASKET MATERIAL			
CODE	STUD/NUT	GASKET	
1	ASTM A193 B7	316 SS	
2	ASTM A193 B7	316 SS	
3	ASTM A193 B7	316 SS	
4	ASTM A193 B7	316 SS	
5	ASTM A193 B7	316 SS	
6	ASTM A193 B7	316 SS	
7	ASTM A193 B7	316 SS	
8	ASTM A193 B7	316 SS	
9	ASTM A193 B7	316 SS	
10	ASTM A193 B7	316 SS	
11	ASTM A193 B7	316 SS	
12	ASTM A193 B7	316 SS	
13	ASTM A193 B7	316 SS	
14	ASTM A193 B7	316 SS	
15	ASTM A193 B7	316 SS	
16	ASTM A193 B7	316 SS	
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28	ASTM A193 B7	316 SS	
29	ASTM A193 B7	316 SS	
30	ASTM A193 B7	316 SS	
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33	ASTM A193 B7	316 SS	
34	ASTM A193 B7	316 SS	
35	ASTM A193 B7	316 SS	
36	ASTM A193 B7	316 SS	
37	ASTM A193 B7	316 SS	
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39	ASTM A193 B7	316 SS	
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50	ASTM A193 B7	316 SS	
51	ASTM A193 B7	316 SS	
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63	ASTM A193 B7	316 SS	
64	ASTM A193 B7	316 SS	
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68	ASTM A193 B7	316 SS	
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96	ASTM A193 B7	316 SS	
97	ASTM A193 B7	316 SS	
98	ASTM A193 B7	316 SS	
99	ASTM A193 B7	316 SS	
100	ASTM A193 B7	316 SS	

RATING PROCESS CONNECTION		
CODE	DESCRIPTION	
1	150	
2	150	
3	150	
4	150	
5	150	
6	150	
7	150	
8	150	
9	150	
10	150	
11	150	
12	150	
13	150	
14	150	
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94	150	
95	150	
96	150	
97	150	
98	150	
99	150	
100	150	

NOTE:

1. Flanged - LLC & Dome/Chamber Connection Rated Same as Process Connection. Except - ANSI 150 Class Dome/Chamber Flange Connection is ANSI 300.
2. Threaded - Unless otherwise specified, Dome/Chamber Connection is ANSI 600 Class.

TYPE PROCESS CONNECTION		
CODE	DESCRIPTION	
RF1	Flanged RF (Raised Face)	
RF2	Flanged RF (Ring Type Joint)	
RF3	Flanged RF (Full Face)	
GR	Grounded	
EA	Butt Weld - Schedule 40	
EB	Butt Weld - Schedule 80	
EC	Butt Weld - Schedule 160	
EXX	Butt Weld - Schedule XXH (Extra Heavy)	
WA4	Socket Weld - Schedule 40	
WA6	Socket Weld - Schedule 80	
WA	Socket Weld - Schedule 160	
WX	Socket Weld - Schedule XXH (Extra Heavy)	
SCF	Screwed Female	
SM	Screwed Male	

MODEL NUMBER CODE

Series 1006 Horizontal Chamber

Model 4 V 14 20 RF 14

CHAMBER PIPE SIZE	
DESCRIPTION	CODE
12" 400mm	12

HORIZONTAL DOME STYLE	
DESCRIPTION	CODE
Flat	1

HORIZONTAL CHAMBER STYLE			
TYPE PROCESS CONNECTION	TYPE INLET CONNECTION	PROCESS CONNECTION MOUNTING STYLE	CODE
Screwed	Hanged	Top Bottom	11
Hanged	Screwed	Top Bottom	12
Hanged	Hanged	Top Bottom	13
Screwed	Hanged	Top Bottom	14
Screwed	Screwed	Top Bottom	15
Screwed	Hanged	Top Bottom	16
Screwed	Screwed	Top Bottom	17
Butt Weld	Hanged	Top Bottom	18
Butt Weld	Screwed	Top Bottom	19

DISPLACER LENGTH	
DESCRIPTION	CODE
1000mm	10
1200mm	12
1400mm	14
1600mm	16

CHAMBER MATERIAL	
DESCRIPTION	CODE
Carbon Steel A105/A106	10
Carbon Steel A105/A106 Except Domes	11
Material A105/A106	12
304 Stainless Steel	13
Carbon Steel A105/A106 Except X-Ray	14
304 Stainless Steel	15
Carbon Steel A105/A106	16
304 Stainless Steel	17
304 Stainless Steel	18
Carbon Steel A105/A106 Except X-Ray	19

Carbon Steel A105/A106 Except X-Ray

STUD & GASKET MATERIAL			
CODE	STUD/NUT	GASKET	
1	ASTM A193 B7	1/8" GR	304 SS
2	ASTM A193 B7	1/8" GR	304 SS
3	ASTM A193 B7	1/8" GR	304 SS
4	ASTM A193 B7	1/8" GR	304 SS
5	ASTM A193 B7	1/8" GR	304 SS
6	ASTM A193 B7	1/8" GR	304 SS
7	ASTM A193 B7	1/8" GR	304 SS
8	ASTM A193 B7	1/8" GR	304 SS
9	ASTM A193 B7	1/8" GR	304 SS
10	ASTM A193 B7	1/8" GR	304 SS
11	ASTM A193 B7	1/8" GR	304 SS
12	ASTM A193 B7	1/8" GR	304 SS
13	ASTM A193 B7	1/8" GR	304 SS
14	ASTM A193 B7	1/8" GR	304 SS
15	ASTM A193 B7	1/8" GR	304 SS
16	ASTM A193 B7	1/8" GR	304 SS
17	ASTM A193 B7	1/8" GR	304 SS
18	ASTM A193 B7	1/8" GR	304 SS
19	ASTM A193 B7	1/8" GR	304 SS

RATING PROCESS CONNECTION	
CODE	DESCRIPTION
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11	100
12	100
13	100
14	100
15	100
16	100
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18	100
19	100
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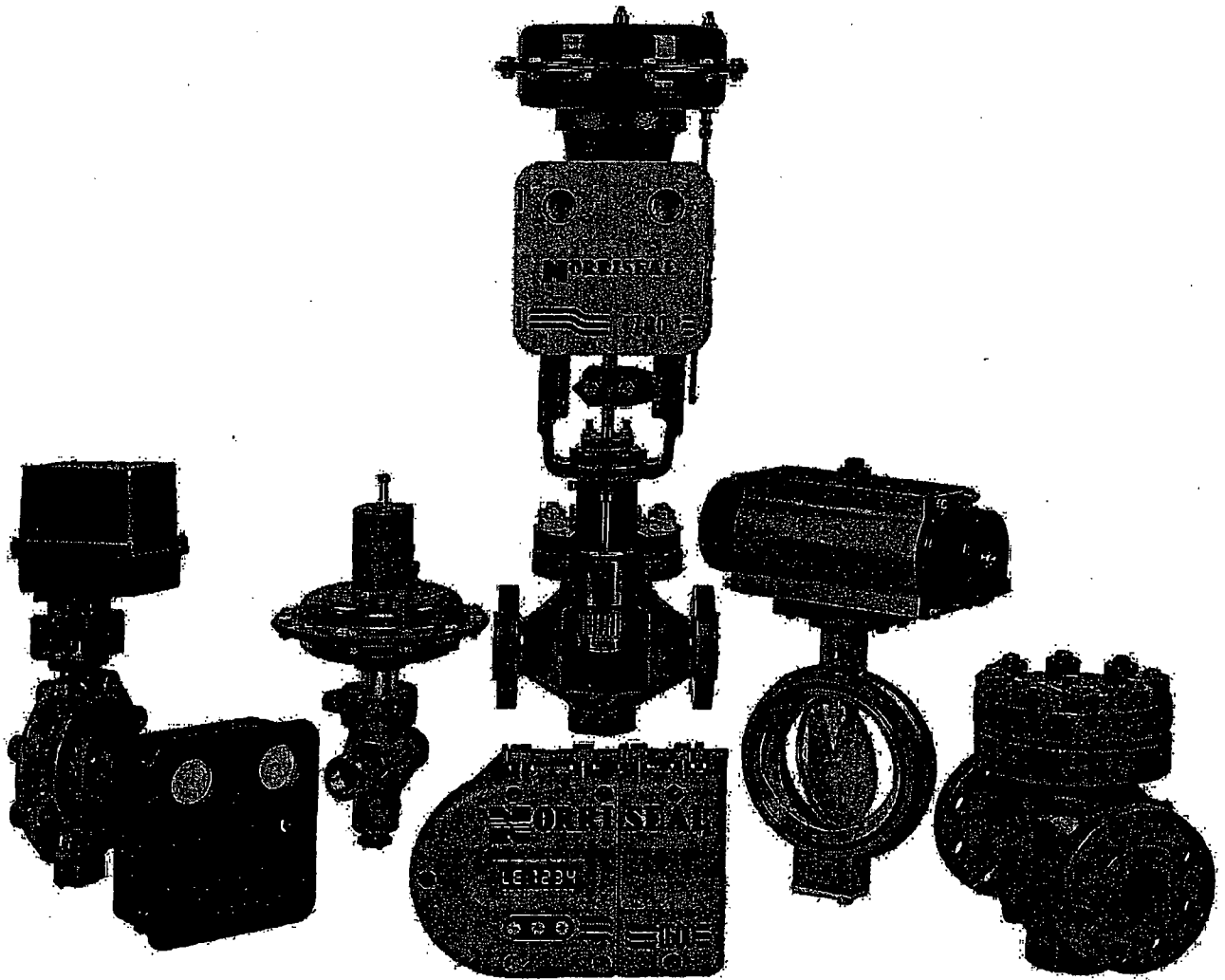
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PROCESS CONNECTION	
CODE	DESCRIPTION
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99	100mm
100	100mm

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Installation for L1100, L1200, L1200N Series Liquid Level Switches and DV850, DV875, and DV2100 Series Dump Valves

DV models are Patent pending.

LDV-92151N
Revised 1201
Section 15
(00-02-0175)



Please read the following instructions before installing. A visual inspection for damage during shipping is recommended before mounting.

GENERAL INFORMATION

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ Disconnect all electrical power to the machine.
- ✓ Make sure the machine cannot operate during installation.
- ✓ Follow all safety warnings of the machine manufacturer.
- ✓ Read and follow all installation instructions.
- ✓ OBSERVE all pressure and electrical ratings and requirements for the devices and the operating environment.
- ✓ BE SURE all pressure HAS BEEN REMOVED from the vessel before opening any pressure connections.

Description

Series L1100 and L1200 Liquid Level Switches are float activated to operate an electrical SPDT snap switch (optional DPDT on some models) for alarm or shutdown of an engine or electric motor. They screw directly into the wall of the vessel. Series L1200 can also be used with a weld collar or external float chamber.

Series L1200N is a float-activated, pneumatic-vent level device used to operate dump valves or similar devices. This model screws directly into the vessel or can be mounted via an external float chamber. It cannot be used with weld collar 15050375. Model variations include a dump valve operator with or without a filter/pressure regulator and indicating pressure gauge.

NOTE: All stainless steel versions of L1100, L1200, L1200N, L1200NDVO, and L1200NDVOR series carry Canadian Registration Number OF1476.2.

Series DV850, DV875 & DV2100 Dump Valves receive a pneumatic input signal to cause an orifice to open or close allowing liquid condensate to be drained from a pressure vessel. A pop up button indicates valve open/closed. Stainless steel versions available. **NOTE:** All stainless steel versions of DV850, DV875, and DV2100 series carry Canadian Registration Number OC1476.2.

Specifications	L1100	L1111	L1150	L1200	L1250	L1200N	L1200NDVO	L1200NDVOR
Body								
Standard: Electroless Nickel plated steel	X ^A	X ^A	X ^A	X ^B	X ^B	X ^B	X ^B	X ^B
Optional: 316 Stainless Steel†	X ^A	X ^A	X ^A	X ^B	X ^B	X ^B	X ^B	X ^B
Pressure Rating								
• 15 psi (103 kPa) [1.03 bar] Polyethylene Float			X		X			
• 1500 psi (10.3 MPa) [103.42 bar] Stainless Float	X	X		X		X	X	X
• 2000 psi (13.8 MPa) [138 bar] BUOYGLAS™ Float	X	X		X		X	X	X
Temperature Rating								
• Standard: -20/175°F (-29/79°C)			X		X			
• Standard: -20/300°F (-29/149°C)	X	X		X		X	X	X
• Optional: -20/400°F (-29/204°C)*	X	X		X		X	X	X
Specific Gravity								
• Standard: 0.5 with BUOYGLAS™ float	X	X		X		X	X	X
• Optional: 0.65 with 304 Stainless Steel†	X	X		X		X	X	X
• Standard 0.73 Polyethylene Float			X		X			
Electrical								
• Standard SPDT: 5 A @ 125/480 VAC (see p. 3 for full ratings)	X	X	X	X	X			
• Optional DPDT: 10 A @ 250 VAC (see p. 3 for full ratings)	X	X	X	X	X			
Wire: 18 AWG x 36 in. (1.0 mm² x 914 mm)	X	X	X	X	X			
O-Rings: Viton	X	X	X	X	X	X	X	X
Valve: Two-way snap-action vent type								
• 1/8 in. (3 mm) orifice w/Viton "A" seat								
• 1/8 NPT inlet; 1/4 NPT outlet						X	X	X
• 30-70 psi (207-483 kPa) [2.07-4.83 bar] operating pressure								
Dump Valve Operator: Operates Murphy DV Series dump valves or similar.							X	X
Pressure Regulator/Filter and Murphy 20BPG: 0-75 psi (0-517 kPa) [0-5.17 bar] pressure gauge. Maximum Input 300 psi (2.07 MPa) [20.68 bar].								X
Operation: H=For high level, L=For low level	H	L	H	H	H	H	H	H

A=1-1/2 NPT B=2 NPT †Meets NACE standard MR-01-75 for direct exposure to H₂S service.

*Not available with DPDT snap-switch.

**Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility.

REPLACING AND INSTALLING THE DVOA ASSEMBLY

When replacing/installing the old style DVO assembly with the new style (DVOA), tubing and fitting modifications are required. We suggest removing the L1200NDVO/DVOR from the vessel. Relieve pressure from the vessel or use block valves before removing the L1200NDVO/DVOR.

Replacing and Installing the DVOA Assembly For Models L1200NDVO & L1200NDVOR

Tools Needed: Strap or pipe wrench; 3/4" Hex wrench; 9/16" hex wrench; needle nose pliers; tubing cutters and benders and the appropriate tools for the fittings.

1. Block off and bleed the instrument gas pressure supply to the L1200NDVO.
2. Remove the tubing between the L1200NDVO and the separator dump valve, and remove the supply gas tubing (regulator [-R] if used).
3. Remove the L1200NDVO from the vessel (optional).
4. If the L1200N was removed from the vessel, mount it in a suitable vise on a work bench (if possible).
5. Using the proper tools, disconnect the Inlet, Outlet and Exhaust fittings from the existing DVO (see fig. 1). You will re-connect these to the new DVOA in a later step.

NOTE: The following steps must be done with the DVO in the upright position (on top of the L1200N).

6. Remove the L1200N cover (this will aid with the alignment of the new DVOA Valve Bushing). The use of a strap wrench or a pipe wrench may be needed.
7. Insert the new Valve Bushing through the new DVOA (see fig. 2). The markings on top of the DVOA must be facing up. This will be needed in step 9.
8. With a 3/4" hex wrench loosen the existing DVO, valve stem, and static seal (see fig. 3). Once the assembly is loosened, VERY CAREFULLY use needle nose pliers to hold the Valve Seat Assembly in place. Remove the existing DVO making sure the Valve Seat Assembly inside the L1200NDVO is aligned and straight (see fig. 4).



CAUTION: MAKE SURE the Valve Seat Assembly inside the L1200N remains in place after removing the DVO.

9. Holding the Seat Assembly up with the needle nose pliers inside the L1200NDVO body, place the tip of the new DVOA valve bushing through the spring and into the hole in the center of the valve seat, and tighten the valve bushing. The Valve Seat Assembly should be able to move freely up and down after the bushing has been tighten. The DVO red button must face away from the vessel.
10. With the new DVOA aligned over the hex on the L1200NDVO body, tighten the Valve Bushing using the 9/16" hex wrench. You may need to hold the DVOA while tightening the Valve Bushing to keep it from rotating (see fig. 5).
11. If the L1200N is in the vise, operate the float and inspect for smooth and proper operation of the Valve Seat Assembly.
12. Replace the L1200NDVO cover (see fig. 6).
13. Using the appropriate tools re-install the Inlet, the Outlet and the Exhaust fittings to the new DVOA (see fig. 5).
14. If the L1200N was removed from the vessel re-install it at this time.
15. Modify existing or install new tubing to connect the Inlet, the Outlet and Exhaust fittings.

NOTE: Clean, dry instrument quality gas should be used. Use of filters will improve service life and reliability.

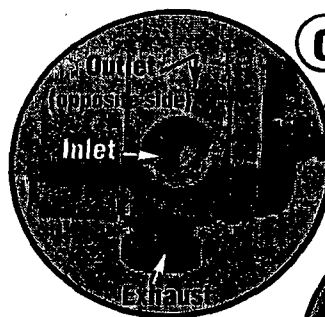


Figure 1



Figure 2 New DVOA



Figure 3

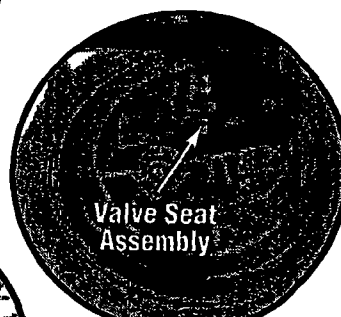


Figure 4

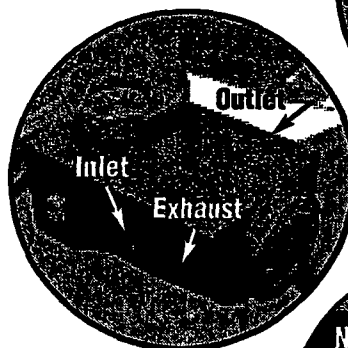


Figure 5

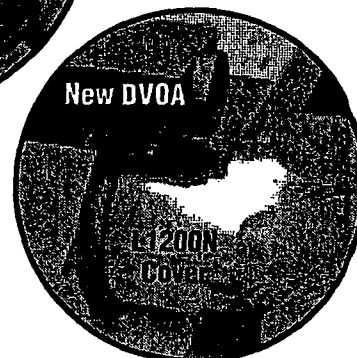
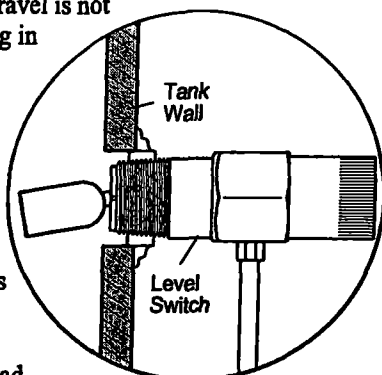


Figure 6

PRESSURE VESSEL INSTALLATION: L1100, L1200, and L1200N

Direct Installation into the Wall of the Pressure Vessel

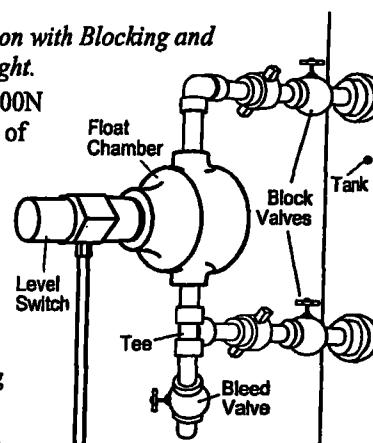
1. Determine that the float travel is not obstructed by the coupling in the vessel wall, internal baffles, etc.
Do NOT use more than one arm extension P/N 15050395.
2. BE SURE that the float and extension are tight and that the lock washer is in place.
3. Before installing the level switch a suitable pipe thread sealant is recommended. Screw the unit directly into the threaded connection in the wall of the pressure vessel.
4. Be sure that the electrical connection is positioned at the bottom. For L1200N the 1/8 NPT pneumatic connection should be on top (the 1/4 NPT vent connection should be on the bottom). See "Pneumatic models" section for further instructions for the L1200N.
5. Make the electrical wiring connections according to appropriate wiring diagrams for the alarm or shutdown system to be used. The electrical connection is 1/2-14 NPT.
6. BE SURE all electrical connections are insulated and the cover is fully installed before reconnecting electrical power.
7. BE SURE all pressure connections are tight before pressurizing the system.



2. A tee is typically installed at the bottom of the lower 1 inch pipe riser to allow draining of the float chamber for servicing or replacement.

NOTE: A typical installation with Blocking and Bleed valves is shown at right.

3. Install the L1200 or L1200N in the 2 NPT connection of the float chamber.
BE SURE float travel is not restricted and that the float is tight onto the float shaft.
4. To complete installation and wiring, follow the instructions for mounting directly into wall of the vessel and for wiring.



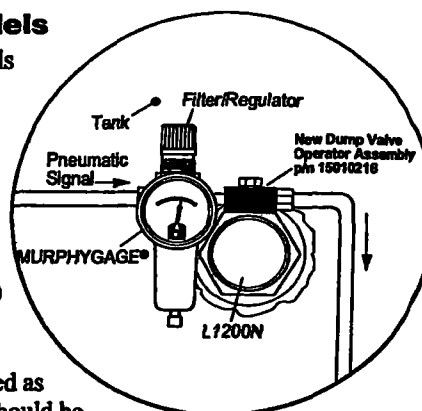
Pneumatic Models

1. All pneumatic models operate on the vent principle. The pneumatic signal source MUST BE CLEAN AND DRY. The input pneumatic signal must be regulated between 30 and 70 psi (207-483 kPa) [2.07-4.83 bar].

If produced gas is used as the signal source, it should be taken after gas passes through the final scrubber. A suitable filter must be positioned before the L1200NDVO to prevent liquids and/or particulates from entering the dump valve operator.

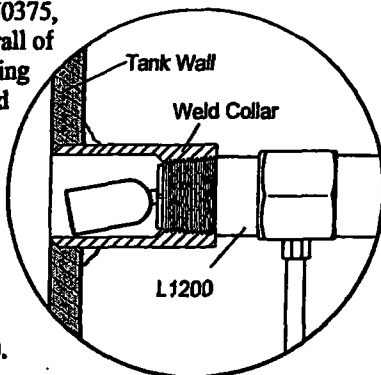
NOTE: Check filter periodically for wear and tear and elements that hamper the flow of the pneumatic signal.

2. All pressure connections must be tight and maintained tight so as not to leak air/gas.
3. Valve seat adjustment can be made if air/gas begins to leak. Care should be taken when adjusting as only slight movement is necessary to stop the leakage; excessive force will bind the seating mechanism.



Installation with a Weld Collar

1. The weld collar, P/N 15050375, must be welded into the wall of the pressure vessel according to code standards and good welding practices.
2. Follow above instructions for installation directly into the wall of the pressure vessel.
3. **NOTE:** Weld collar 15050375 can be used ONLY with model L1200.

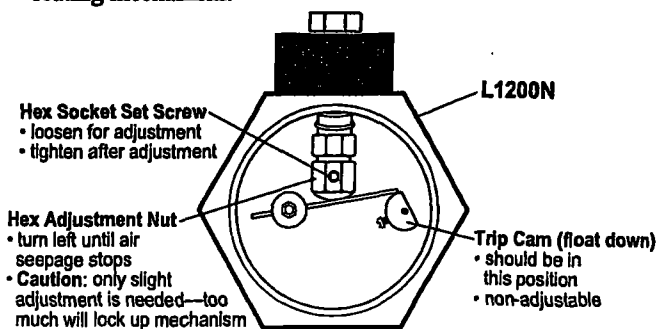


Installation Using External Float Chamber 15050697



CAUTION: USE "NON SPARKING TOOLING".

1. Install the float chamber 15050697 on the outside wall of the pressure vessel using 1 NPT piping. Position the 2 NPT threaded connection at the height where you want the level switch to operate. The 2 NPT threaded connection must be positioned away from the tank wall.



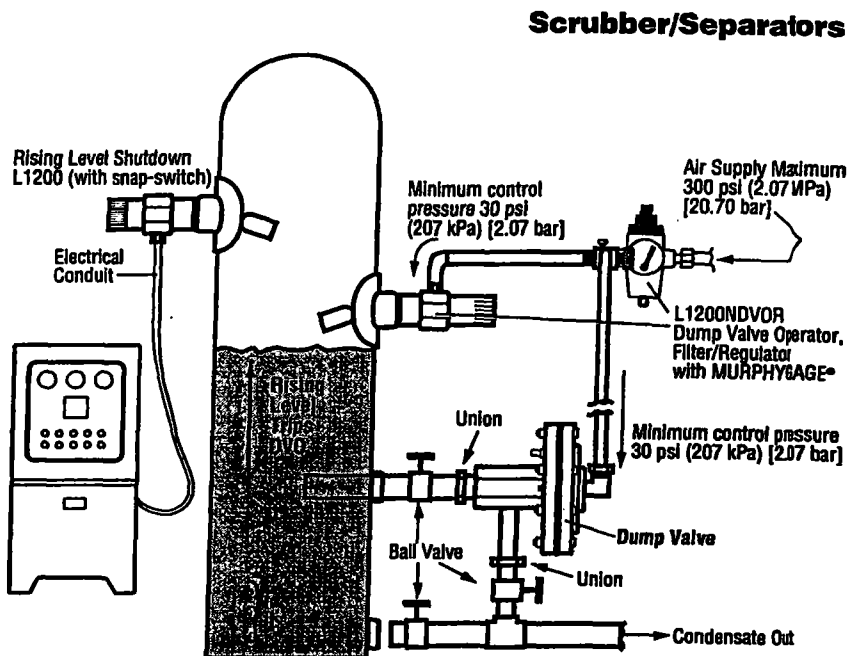
TYPICAL INSTALLATION ON GAS COMPRESSORS

Basic Operation

As condensate rises in the scrubber, the float on the L1200NDVOR rises and trips its pneumatic valve. The valve opens allowing pressure to enter the dump valve pilot chamber. Once the pressure enters the pilot chamber it forces the diaphragm and valve stem forward thus opening the valve seat (valve open/closed indicator button pops out) and releasing condensate through the valve stem and out the drain. As the condensate level drops, the L1200NDVOR pneumatic valve closes to shut off the pressure to the dump valve causing it to close.

If for any reason the condensate continues to rise beyond normal dump levels, model L1200 operates the alarm and/or shuts down the equipment.

The L1200NDVOR Filter/Regulator and the MURPHYGAGE® help keep the control pressure clean and dry. They also allow the operator to adjust pressure to recommended levels.



DUMP VALVE INSTALLATION

DV850 - DV875 - DV2100



CAUTION: USE "NON SPARKING TOOLING".

The following steps describe the "Block and Bleed" method for installing the dump valve. The "Direct Mounting" method to the tank wall is also accepted.

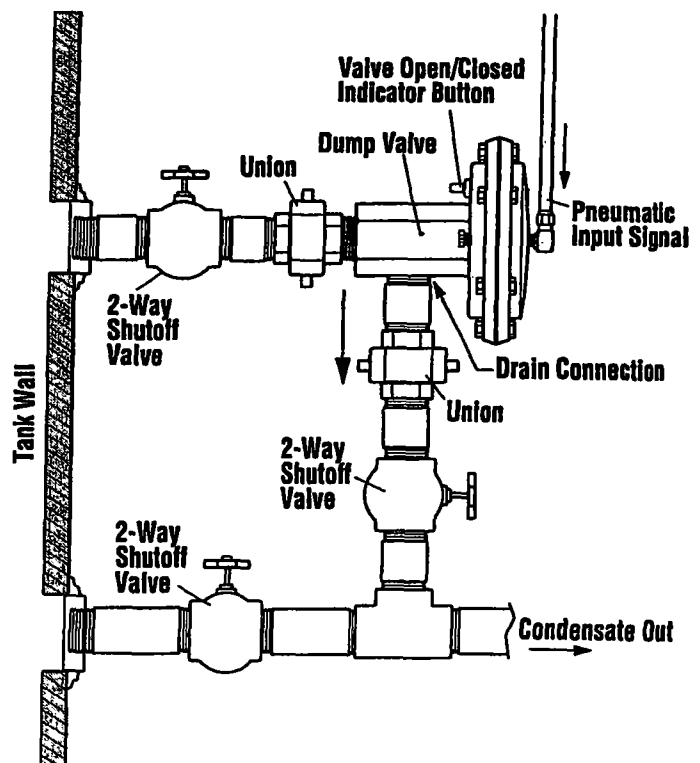
1. Install a manual shutoff (2-way) valve and a union between the DV valve and the vessel to facilitate valve repair or replacement.
2. Position the DV valve drain connection so it is on the bottom.
3. Install a 2-way valve to the drain line between the lower vessel entry and the condensate out line.
4. Be sure the unit is screwed tight and does not leak liquid.
5. Install the piping for the pneumatic input signal into the 1/8 NPT threaded connection of the pressure inlet port (on top of the DV valve).
6. Install a 2-way valve and union between the DV drain connection and the condensate out line.

NOTE: The typical procedure to remove the valve should be:

1. Close the shutoff valve between the scrubber and the DV valve.
2. Operate the dump valve to equalize pressure to the drain (condensate out) line.
3. Close the shutoff valve downstream of the drain.

Be Careful, pressure will still be in the system at the drain pressure when the unions are loosened.

Typical Dump Valve Installation



REPLACING THE DUMP VALVE SEAT KIT

Replacing the Seat Kit on the Dump Valves

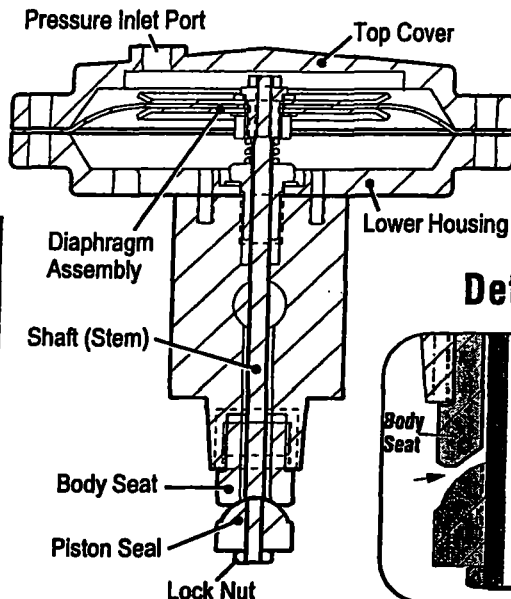
Tools needed: 7/8" hex wrench, 7/16" hex wrench, 1-1/8" hex wrench, and thread sealer; optional pressure source.

NOTE: Relieve pressure from scrubber or use the block valves before removing the DV dump valve.

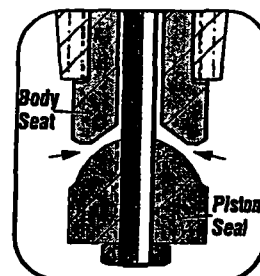
1. Remove the valve from the Scrubber.



CAUTION: THE BODY SEAT AND PISTON SEAL WILL BE DAMAGED IF ALLOWED TO TURN AGAINST EACH OTHER. THE PREFERRED METHOD IS TO USE AIR TO KEEP THE VALVE OPEN. IF AIR IS NOT AVAILABLE, CAREFULLY FOLLOW THE ALTERNATE INSTRUCTIONS (STEPS 2A & 8A). ALSO, DO NOT GRIP THE OPERATING STEM WITH ANY TOOLS. IF STEM NEEDS TO BE HELD, USE THE NUT ON THE BACK OF THE DIAPHRAGM.



Detail



2. Apply 30 psi to the pressure inlet port (top of valve). The Shaft and Piston Seal will extend.
- 2A. **IF AIR IS NOT AVAILABLE DO THE FOLLOWING:** Remove the valve Top Cover (bolts/nuts). Note the orientation of the Top Cover to the bottom. Mark both sides of the Diaphragm Housing before dis-assembly. Once the Top Cover is removed, carefully turn the valve upside down with the Piston Seal pointing up. Clamp the bottom housing down, or secure it against a flat surface to compress the spring and open the Piston Seal and Body Seat. Be careful not to damage the diaphragm. The valve must be kept in this fashion, with this much clearance throughout the following operations.
3. Hold the Piston Seal with the 7/8" hex wrench, and remove the Locknut with 7/16" hex wrench.
4. Unscrew the Piston Seal with the 7/8" hex wrench. Now, unscrew the Body Seat (use 7/8" hex wrench for DV850 and DV875 models). Use the 1-1/8" hex wrench for the DV2100 Series models.

5. Apply thread sealer to new Body Seat, and screw it in place tightening with the wrench until it stops. **NOTE:** Clean the female threads in the body before inserting the new Body Seat to facilitate threading.
6. Apply thread sealer to the shaft (stem), and screw the new Piston Seal on to the shaft (stem).
7. Hold the Piston Seal with the 7/8" hex wrench and screw the Locknut in place.
8. Remove the 30 psi pressure to the pressure inlet port, and re-install the valve into the scrubber.
- 8A. Re-install the Top Cover, paying attention to the alignment marks made in step 2A. Re-install the DV into the scrubber.

REPLACING THE DUMP VALVE DIAPHRAGM ASSEMBLY

Replacing the Diaphragm Assembly for all DV models (Refer to the Illustration above)

Tools needed: 7/8" hex wrench, 7/16" hex wrench, 5/8" hex wrench or socket, and thread sealer.

NOTE: Relieve pressure from scrubber or use the block valves before removing the DV dump valve.

1. Remove the valve from the Scrubber.
2. Remove the valve Top Cover (bolts/nuts). Note the orientation of the Top Cover to the bottom. Mark both sides of the Diaphragm Housing before dis-assembly.



CAUTION: MAKE SURE TO USE A 7/8" HEX WRENCH TO HOLD THE PISTON SEAL WHILE REMOVING THE DIAPHRAGM ASSEMBLY. DO NOT GRIP THE DIAPHRAGM (BLACK RUBBER) WITH ANY TOOLS.

3. Hold the Piston Seal with a 7/8" hex wrench making sure to keep the shaft (stem) from turning, and remove the nut on the back of the diaphragm assembly with the 7/16" wrench.
4. While holding the piston seal with the 7/8" wrench, proceed to remove the diaphragm assembly by hand.

NOTE: You will be turning the assembly against the spring when unscrewing the diaphragm assembly.

5. To re-assemble the assembly, apply thread sealer to the shaft/stem threads and hold the Piston Seal with a 7/8" hex wrench.
6. Keep holding the Piston Seal with 7/8" hex wrench. Make sure the 3/4" nut side of the new diaphragm assembly is toward the shaft. Press the diaphragm assembly into the shaft threads and tighten it on to the shaft threads by hand.
7. Keep holding the Piston Seal with 7/8" hex wrench. Apply thread sealer to 7/16" nut, and screw it on to the shaft threads to lock the diaphragm assembly in place, tighten the nut with the 7/16" wrench.
8. Press down the diaphragm assembly with your hands to open the valve, and *very carefully* turn to align the diaphragm holes with the lower housing bolt holes.

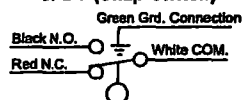


CAUTION: THE BODY SEAT AND PISTON SEAL WILL BE DAMAGED IF ALLOWED TO TURN AGAINST EACH OTHER.

9. Re-install the Top Cover, paying attention to the alignment marks made in step 2. Be sure to tighten the bolts and nuts evenly. Re-install the DV into the scrubber.

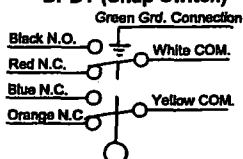
ELECTRICAL INFORMATION

SPDT (Snap Switch)



Switch Rating: 5 A @ 125-250-480 VAC
 1/2 A @ 125 VDC
 1/4 A @ 250 VDC
 2A @ 8-30 VDC Resistive
 1A @ 8-30 VDC Inductive

DPDT (Snap Switch)



Switch Rating: 10 A @ 125-250 VAC
 1/2 A @ 125 VDC
 1/4 A @ 250 VDC
 10 A @ 8-24 VDC
 Inductive/Resistive

REPLACEMENT PARTS

Order by part number designation.

L1100/L1200*

- 15000893: *BUOYGLAS™ float*
- 15000894: *Stainless Steel float for L1200*
- 15000937: *Stainless Steel float for L1100/L1111*
- 15000124: *SPDT snap switch assembly*
- 15010213: *L1100 counter balance assembly*
- 15010214: *L1200 counter balance assembly*

L1200N

- 15050420: *Cam spring return*
- 15050421: *Cam*
- 15000893: *BUOYGLAS™ float*
- 15000894: *Stainless Steel float for L1200N*
- 15050453: *Valve stem*
- 15010189: *Counter balance assembly*

L1200NDVO and L1200NDVOR

- 55050621: *Regulator only*
- 05706499: *20BPG-D-75 Pressure MURPHYGAGE®*
0-75 psi (517 kPa) [5.17 bar]
- 15010216: *DVOA assembly (New rectangular style)*
- 15000940: *DVO assembly (Old round style)*
- 00003341: *Filter for regulator*
- 00003340: *Regulator Diaphragm Kit*

DV850, DV850SS, DV875, DV875SS, DV2100 and DV2100SS

- 55000219: *Diaphragm Assembly (all models)*
- 55000224: *Seat Kit (DV850, DV850SS, DV875 and DV875SS)*
- 55000225: *Seat Kit (DV2100 and DV2100SS)*
- 55050617: *Optional Adapter Bushing 2 NPT to 1 NPT*

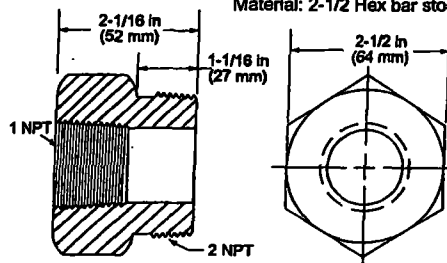
*To maintain hazardous location listings, all other repairs must be made by the factory.

ACCESSORIES

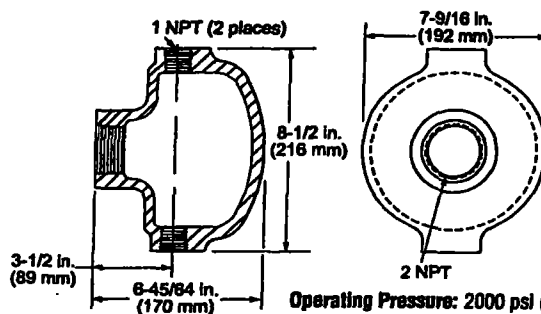
Order by part number designation.

55050617: DV850/DV875 Adapter Bushing

Material: 2-1/2 Hex bar stock C.R.S

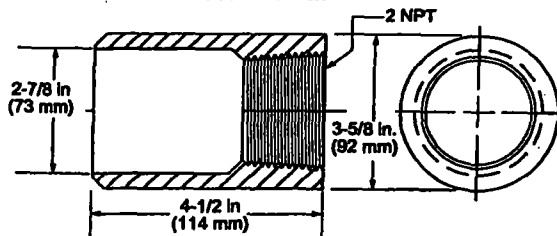


15050697: External Float Chamber



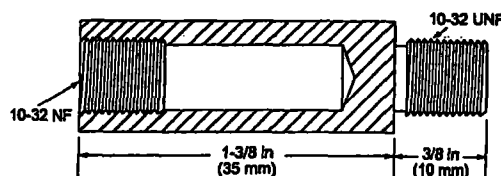
Operating Pressure: 2000 psi (13.8 MPa) [138 bar].
 Operating Temperature: 400°F (204°C).

15050375: Weld Collar



Operating Pressure: 2000 psi (13.8 MPa) [138 bar].
 Operating Temperature: 400°F (204°C).

15000892: Float Shaft Extension



NOTES

Warranty

A two-year limited warranty on materials and workmanship is given with this Murphy product.
Details are available on request and are packed with each unit.



FWMurphy

P.O. Box 470248
Tulsa, Oklahoma 74147 USA
(918) 317-4100
fax (918) 317-4266
e-mail sales@fwmurphy.com
www.fwmurphy.com

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
(281) 342-0297 fax (281) 341-6006
e-mail sales@fwmurphy.com

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Rocha Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
+52-444-8206264 fax +52-444-8206336
e-mail ventasmex@murphymex.com.mx
www.murphymex.com.mx

FRANK W. MURPHY, LTD.
Church Rd.; Laverstock, Salisbury SP1 1QZ; U.K.
+44 1722 410055 fax +44 1722 410088
e-mail sales@fwmurphy.co.uk
www.fwmurphy.co.uk

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
(661) 772-4700 fax (661) 947-7570
e-mail sales@murphyswitch.com
www.murphyswitch.com

MACQUARRIE CORPORATION
1620 Hume Highway
Campbellfield, Vic 3061; Australia
+61 3 9358-5555 fax +61 3 9358-5558
e-mail murphy@macquarrie.com.au



In order to consistently bring you the highest quality, full featured products, we reserve the right to change our specifications and designs at any time.

4150K and 4160K Series Wizard® II Pressure Controllers and Transmitters

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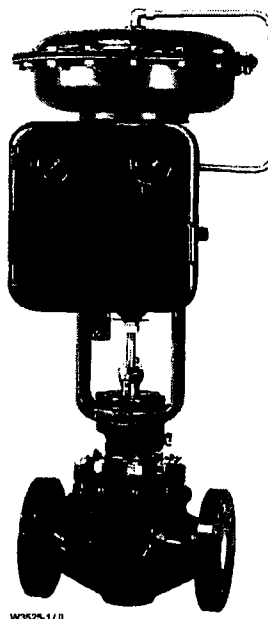


Figure 1. Wizard® II Controller Yoke-Mounted on Control Valve Actuator

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4150K and 4160K Series

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Introduction

Scope of Manual

This instruction manual provides installation, operating, maintenance, and parts information for the 4150K and 4160K Series Wizard® II pressure controllers and transmitters shown in figure 1. Refer to separate instruction manuals for information regarding the control valve, actuator, and accessories.

Only personnel qualified through training or experience should install, operate, and maintain this instrument. If there are any questions concerning these instructions, contact your Fisher sales office or sales representative before proceeding.

Description

The 4150K and 4160K Series pneumatic pressure controllers and transmitters use a bellows or Bourdon tube sensing element to sense the gauge pressure, vacuum, compound pressure, or differential pressure of a liquid or gas. The controller or transmitter output is a pneumatic pressure signal that can be used to operate a final control element, indicating device, or recording device.

Specifications

Specifications for the 4150K and 4160K Series controllers and transmitters are listed in table 1. Table 2 explains available configurations and options.

Installation

Standard Installation

The instruments are normally mounted vertical with the case/cover as shown in figure 1. If installing the instrument in any other position, be sure that the vent opening shown in figure 3 is facing downward.

Panel Mounting

Refer to figure 3.

Cut a hole in the panel surface according to the dimensions shown in figure 3. Remove the cap screws (key 252), brackets (key 251), and vent assembly (key 15). Slide the controller or transmitter into the cutout and reattach the brackets. Tighten the cap screw located in the center of each bracket to draw the case snugly and evenly against the panel. Reinstall the vent unless a remote vent will be used.

4150K and 4160K Series

Table 1. Specifications

Available Configurations

See table 2

Input Signal⁽¹⁾

Type: ■ Gauge pressure, ■ vacuum, ■ compound pressure, or ■ differential pressure of a liquid or gas

Limits: See table 3 or 4

Output Signal⁽¹⁾

Proportional-Only or Proportional-Plus-Reset Controllers and Transmitters:

■ 3 to 15 psig (0.2 to 1.0 bar) or

■ 6 to 30 psig (0.4 to 2.0 bar) pneumatic pressure signal

Differential Gap Controllers:

■ 0 and 20 psig (0 and 1.4 bar) or

■ 0 and 35 psig (0 and 2.4 bar) pneumatic pressure signal

Action: Control action is field reversible between ■ direct (increasing sensed pressure produces increasing output signal) and ■ reverse (increasing sensed pressure produces decreasing output signal). The suffix R is added to the type number of a construction specified for reverse action.

Supply Pressure Requirements

See table 5

Steady-State Air Consumption⁽¹⁾

See figure 2

Supply and Output Connections

1/4-inch NPT female

Common Signal Pressure Conversions

See table 6

Proportional Band⁽¹⁾ Adjustment

For Proportional-Only and Proportional-Plus-Reset Controllers: Full output pressure change adjustable from 3 to 100% for a 3 to 15 psig (0.2 to 1.0 bar), or 6 to 100% for a 6 to 30 psig (0.4 to 2.0 bar) of the sensing element range.

Differential Gap Adjustment

For Differential Gap Controllers: Full output pressure change adjustable from 15% to 100% of sensing element range

Reset⁽¹⁾ Adjustment

For Proportional-Plus-Reset Controllers: Adjustable from 0.01 to 74 minutes per repeat (100 to 0.01 repeats per minute)

Zero⁽¹⁾ Adjustment (Transmitters Only)

Continuously adjustable to position span of less than 100% anywhere within the sensing element range

Span⁽¹⁾ Adjustment (Transmitters Only)

Full output pressure change adjustable from 6 to 100% of sensing element range

Performance

Repeatability⁽¹⁾: 0.5% of sensing element range
Deadband⁽¹⁾ (Except Differential Gap Controllers⁽²⁾): 0.1% of output span

Typical Frequency Response at 100% Proportional Band

Output to Actuator: 0.7 Hz and 110 degree phase shift with 113 inches³ (1850 cm³) volume, actuator at mid-stroke

Output to Positioner Bellows: 9 Hz and 130 degree phase shift with 3 to 15 psig (0.2 to 1.0 bar) output to 2 inches³ (33 cm³) bellows

Ambient Operating Temperature Limits

■ **Standard Construction:** -40 to 160°F (-40 to 71°C)

■ **High Temperature Construction:** 0 to 220°F (-18 to 104°C)

Typical Ambient Temperature Operating Influence

Proportional Control only: Output pressure changes $\pm 3.0\%$ of sensing element range for each 50°F (28°C) change in temperature between -40 and 160°F (-40 and 71°C) for a controller set at 100% proportional band

Reset Control only: Output pressure changes $\pm 2.0\%$ of sensing element range for each 50°F (28°C) change in temperature between -40 and 160°F (-40 and 71°C) for a controller set at 100% proportional band

Transmitters only: Output pressure changes $\pm 3.0\%$ of sensing element range for each 50°F (28°C) change in temperature between -40 and 160°F (-40 and 71°C) for a transmitter set at 100% span

Options

Case pressure tested to 2 psig (0.14 bar)

Approximate Weight

18 pounds (8.2 kg)

1. This term is defined in ISA Standard S51.1 - 1979.

2. An adjustable differential gap (differential gap controllers) is equivalent to an adjustable deadband.

4150K and 4160K Series

Table 2. Available Configurations

DESCRIPTION		TYPE NUMBER ⁽¹⁾		
		Bourdon Tube Sensing Element (Gauge Pressure Only)	Bellows Sensing Element	
			Gauge Pressure	Differential Pressure
Proportional-only controller		4150K	4152K	4154K
Proportional-plus-reset controller	Without anti-reset windup	4160K	4162K	4164K
	With anti-reset windup	4160KF	4162KF	---
Differential gap controller		4150KS	4152KS	---
Transmitter		4157K	4158K	4155K

1. The suffix R is added to the type number of a construction specified for reverse action.

Table 3. Bourdon Tube Pressure Ranges and Materials

PRESSURE RANGES ⁽¹⁾		MAXIMUM ALLOWABLE STATIC PRESSURE ⁽²⁾ LIMITS ⁽³⁾				MATERIAL
		Standard		With Optional Travel Stop ⁽⁴⁾		
Psig	Bar	Psig	Bar	Psig	Bar	316 stainless steel
0 to 30	0 to 2.0	30	2.0	48	3.3	
0 to 60	0 to 4.0	60	4.0	96	6.6	
0 to 100	0 to 7.0	100	7.0	160	11	
0 to 200	0 to 14	200	14	280	19	
0 to 300	0 to 20	300	20	420	29	
0 to 600 ⁽⁵⁾	0 to 40	600	40	720	50	
0 to 1000 ⁽⁵⁾	0 to 70	1000	70	1200	83	
0 to 1500 ⁽⁵⁾	0 to 100	1500	100	1650	115	
0 to 3000	0 to 200	3000	200	3300	230	
0 to 5000	0 to 350	5000	350	5500	380	
0 to 8000	0 to 550	8000	550	8000	550	
0 to 10,000	0 to 700	10,000	700	10,000	700	

1. Range marked on Bourdon tube may be in kPa (1 bar = 100 kPa)

2. This term is defined in ISA Standard S51.1-1979.

3. Bourdon tube may be pressurized to limit shown without permanent zero shift.

4. With travel stop set at 110% of the range.

5. These Bourdon tubes are also available in K-Monel for sour gas service.

1. Range marked on Bourdon tube may be in kPa (1 bar = 100 kPa)

2. This term is defined in ISA Standard S51.1-1979.

3. Bourdon tube may be pressurized to limit shown without permanent zero shift.

4. With travel stop set at 110% of the range.

5. These Bourdon tubes are also available in K-Monel for sour gas service.

Table 4. Bellows Pressure Ranges and Materials

PRESSURE RANGES			MAXIMUM ALLOWABLE STATIC PRESSURE ⁽¹⁾ LIMITS ⁽²⁾			
			Brass Construction		Stainless Steel Construction	
			Psig	Bar	Psig	Bar
Gauge Pressure	Vacuum	0 to 60 inch wc (0 to 150 mbar)	20	1.6	---	---
		0 to 10 inch Hg (0 to 340 mbar)	40	2.8	---	---
		0 to 30 inch Hg (0 to 1.0 bar)	40	2.8	100	6.9
	Compound Pressure	30 inch wc vac. to 30 inch wc (75 mbar vac. to 75 mbar)	20	1.4	---	---
		15 inch Hg vac. to 7.5 psig (500 mbar vac. to 500 mbar)	40	2.8	100	6.9
		30 inch Hg vac. to 15 psig (1.0 bar vac. to 1.0 bar)	40	2.8	100	6.9
	Positive pressure	0 to 60 inch wc (0 to 150 mbar)	20	1.4	---	---
		0 to 100 inch wc ⁽³⁾ (0 to 250 mbar)	20	1.4	---	---
		0 to 140 inch wc ⁽⁴⁾ (0 to 350 mbar)	40	2.8	---	---
		0 to 5 psig (0 to 0.35 bar)	40	2.8	---	---
		0 to 7.5 psig (0 to 0.5 bar)	40	2.8	---	---
		0 to 10 psig (0 to 0.7 bar)	40	2.8	---	---
		0 to 15 psig (0 to 1.0 bar)	40	2.8	100	6.9
		0 to 20 psig (0 to 1.4 bar)	40	2.8	---	---
		0 to 30 psig (0 to 2.0 bar)	40	2.8	100	6.9
Differential Pressure ⁽⁵⁾		0 to 80 inch wc (0 to 300 mbar)	20	1.4	---	---
		0 to 10 psi (0 to 0.7 bar)	40	2.8	---	---
		0 to 20 psi (0 to 1.4 bar)	40	2.8	---	---
	0 to 30 psi (0 to 2.0 bar)	---	---	100	6.9	

1. This term is defined in ISA Standard S51.1-1979.

2. Bellows may be pressured to limit shown without permanent zero shift.

3. Type 4158K transmitter only.

4. Except Type 4158K transmitter.

5. The overrange limit for these sensing elements is a differential pressure equal to the maximum allowable static pressure limit.

1. This term is defined in ISA Standard S51.1-1979.

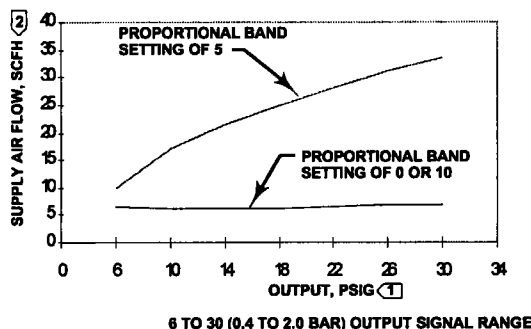
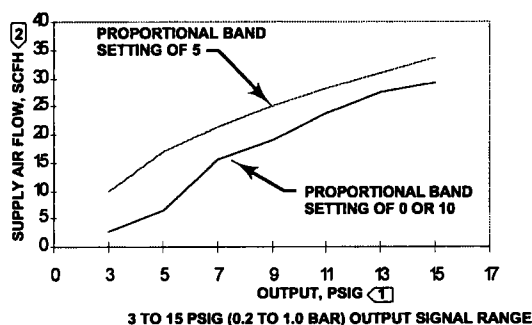
2. Bellows may be pressurized to limit shown without permanent zero shift.

3. Type 4158K transmitter only.

4. Except Type 4158K transmitter.

5. The overrange limit for these sensing elements is a differential pressure equal to the maximum allowable static pressure limit.

4150K and 4160K Series



NOTES
 ① TO CONVERT PSIG TO BAR, MULTIPLY BY 0.06895.
 ② SCFH—STANDARD CUBIC FEET PER HOUR (60°F AND 14.7 PSIA).
 TO CONVERT TO NORMAL M³/HR—NORMAL CUBIC METERS PER HOUR (0°C AND 1.01325 BAR, ABSOLUTE), MULTIPLY BY 0.0268

A7242/L

Figure 2. Steady-State Air Consumption

Wall Mounting

Refer to figure 3.

Drill four holes in the wall using the dimensions shown in figure 3. In the bracket (key 251) are 11/32-inch (8.7 mm) diameter holes. Back out the cap screw located in the center of each bracket. (The screws are used for panel mounting but are not required for wall mounting.) If tubing runs through the wall, drill holes in the wall to accommodate the tubings. Figure 3 shows the pressure connection locations in the back of the case.

Mount the controller to the bracket using the four cap screws (key 252) provided. Attach the bracket to the wall, using suitable screws or bolts.

Pipestand Mounting

Refer to figure 3.

Attach the spacer spools (key 228) and the mounting plate (key 213) to the controller with cap screws, lock washers, and nuts (keys 215, 221, and 216). Attach the controller to a 2-inch (nominal) pipe with pipe clamps (key 250).

Actuator Mounting

Refer to figure 4.

Controllers specified for mounting on a control valve actuator are mounted at the factory. If the instrument is ordered separately for installation on a control valve actuator, mount the instrument according to the following instructions.

Mounting parts for the different actuator types and sizes vary. Two typical actuator-mounting installations are shown in figure 4; see the parts list for parts required for the specific actuator type and size involved. Attach the spacer spools (key 228) and the mounting plate (key 213) to the controller with machine screws, lock washers, and nuts (keys 215, 221, and 216).

Attach the mounting bracket to the actuator yoke with cap screws (key 222) and, if needed, spacer spools. On some designs, the mounting bracket is attached to the actuator diaphragm casing rather than to the yoke.

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.

All pressure connections on 4150K and 4160K Series instruments are 1/4-inch NPT female. Use 1/4-inch (6 mm) or 3/8-inch (10 mm) pipe or tubing for supply and output piping. The pressure connection locations are shown in figure 3.

Supply Pressure



WARNING

Personal injury or property damage may occur from an uncontrolled process if the supply medium is not clean, dry, oil-free, air or a non-corrosive gas. Industry instrument air quality standards describe acceptable dirt, oil, and moisture content. Due to the variability in nature of the problems these influences can have on pneumatic equipment, Fisher Controls has no technical basis to recommend the level of filtration equipment required to prevent perfor-

4150K and 4160K Series

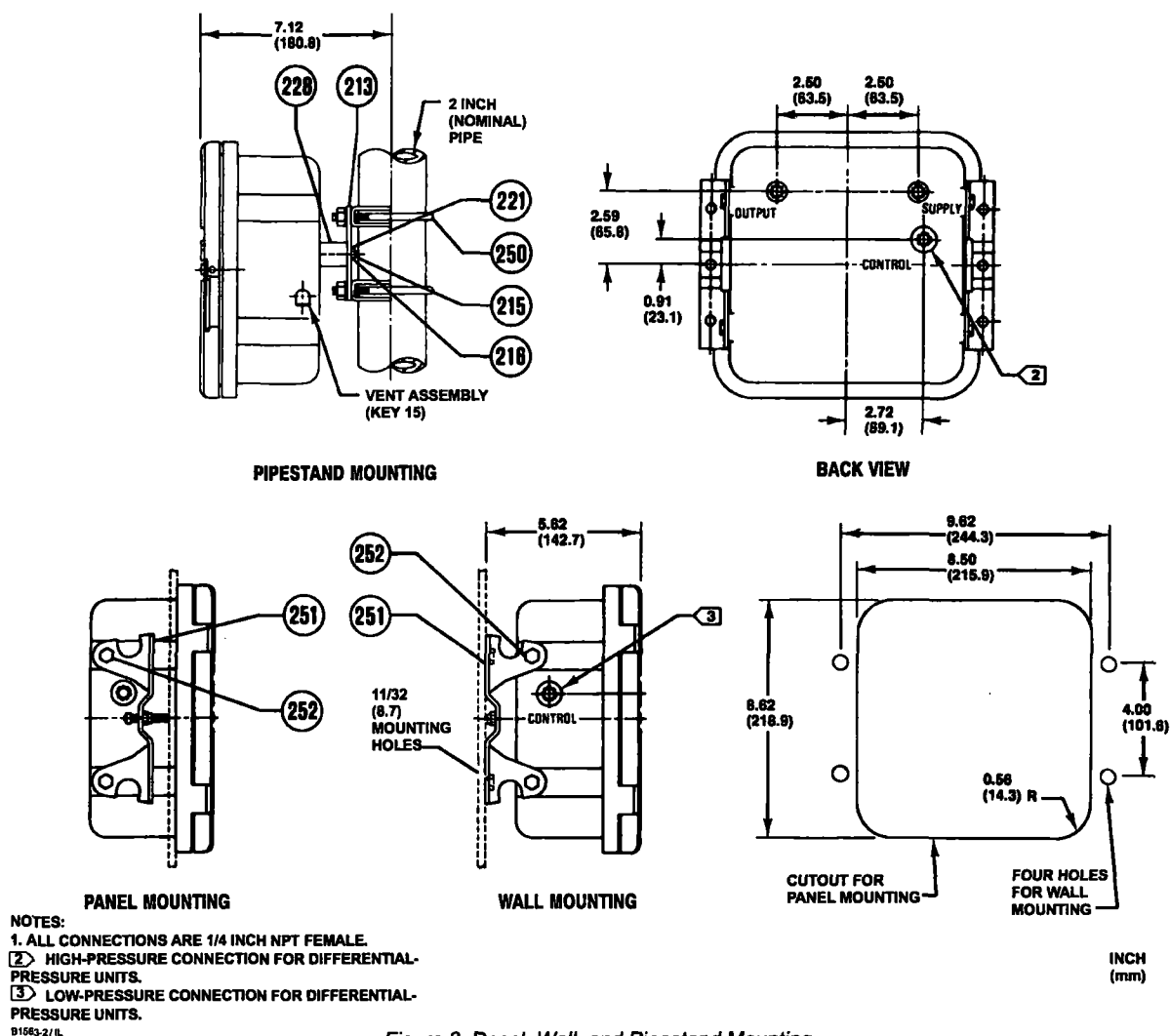


Figure 3. Panel, Wall, and Pipestand Mounting

mance degradation of pneumatic equipment. A filter or filter regulator capable of removing particles 40 microns in diameter should suffice for most applications. Use of suitable filtration equipment and the establishment of a maintenance cycle to monitor its operation is recommended.

Supply pressure must be clean, dry air or noncorrosive gas that meets the requirements of ISA Standard S7.3-1975 (R1981). Use a suitable supply pressure regulator to reduce the supply pressure source to the normal operating supply pressure shown in table 5. Connect supply pressure to the SUPPLY connection at the back of the case.

If operating the controller or transmitter from a high pressure source [up to 2000 psig (138 bar)], use a high pressure regulator system, such as the Type

1367 High Pressure Instrument Supply System. For Type 1367 system installation, adjustment, and maintenance information, see the separate instruction manual.

Process Pressure

WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure when using corrosive media, make sure the tubing and instrument components that contact the corrosive medium are of suitable noncorrosive material.

4150K and 4160K Series

Table 5. Supply Pressure Requirements

OUTPUT SIGNAL RANGE		NORMAL OPERATING SUPPLY PRESSURE ⁽¹⁾	MAXIMUM ALLOWABLE SUPPLY PRESSURE TO PREVENT INTERNAL PART DAMAGE
Psig	3 to 15 or 0 and 20 (differential gap)	20	40
Psig	6 to 30 or 0 and 35 (differential gap)	35	40
Bar	0.2 to 1.0 or 0 and 1.4 (differential gap)	1.4	2.8
	0.4 to 2.0 or 0 and 2.4 (differential gap)	2.4	2.8

1. If this pressure is exceeded, control may be impaired.

Table 6. Common Signal Pressure Conversions

Psi	kPa	bar	kg/cm ²	Mps
3	20 ⁽¹⁾	0.2 ⁽²⁾	0.2	0.02
5	35	0.3	0.3	0.03
6	40 ⁽¹⁾	0.4	0.4	0.04
7	50	0.5	0.5	0.05
9	60	0.6	0.6	0.06
11	75	0.8	0.8	0.07
12	80	0.8	0.8	0.08
14	95	1.0	1.0	0.09
15	100 ⁽¹⁾	1.0 ⁽²⁾	1.0 ⁽³⁾	0.10
18	125	1.2	1.3	0.12
20	140	1.4	1.4	0.14
22	150	1.5	1.5	0.15
25	170	1.7	1.8	0.17
27	185	1.9	1.9	0.18
30	200 ⁽¹⁾	2.0 ⁽³⁾	2.0	0.20
32	220	2.2	2.2	0.22
33	230	2.3	2.3	0.23
35	240	2.4	2.5	0.24
50	345	3.4	3.5	0.34
80	550	5.5	5.6	0.55
100	690	6.9	7.0	0.69
150	1035	10.3	10.5	1.03

1. Values as listed in ANSI/S7.4.

2. Values as listed in IEC Standard 382.

3. Values rounded to correspond with kPa values.

The pressure connections to the controller depend upon the type of pressure sensing, gauge or differential. Gauge pressure controllers use either a Bourdon tube or bellows as the sensing element, as indicated in table 2. Differential pressure controllers use two bellows to sense differential pressure.

For gauge pressure instruments: The control pressure block (key 8 in figure 19) has two connections. Process pressure can be connected either to the CONTROL connection on the back of the case, or to the connection on the left side of the case, shown in figure 3, depending on the instrument application. Plug the unused connection.

For differential pressure instruments: Connect the low pressure line to the CONTROL connection on the side of the case and the high pressure line to the CONTROL connection on the back of the case as shown in figure 3.

When installing process piping, follow accepted practices to ensure accurate transmission of the process pressure to the controller or transmitter. Install shutoff valves, vents, drains, or seal systems as needed in

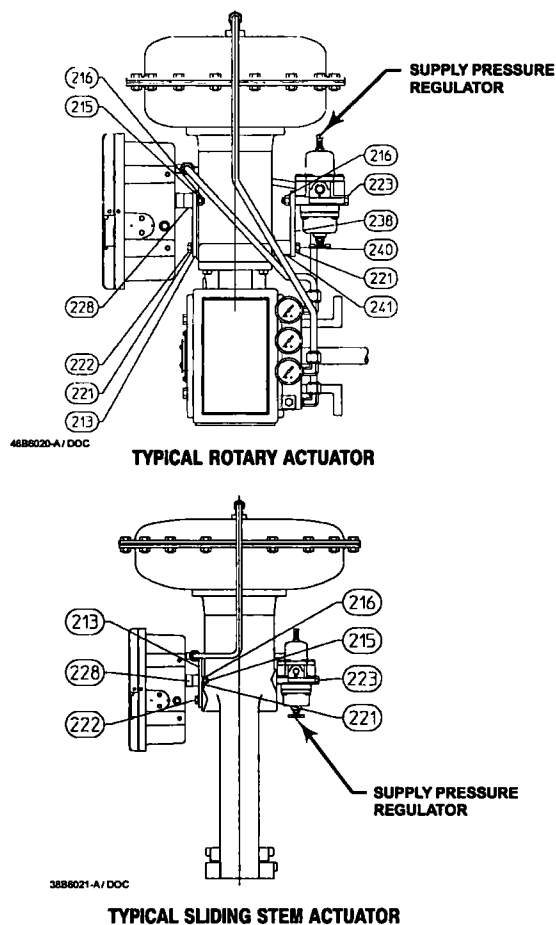


Figure 4. Actuator Mounting

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

If a controller is being used in conjunction with a control valve to control pipeline pressure, connect the pro-

4150K and 4160K Series

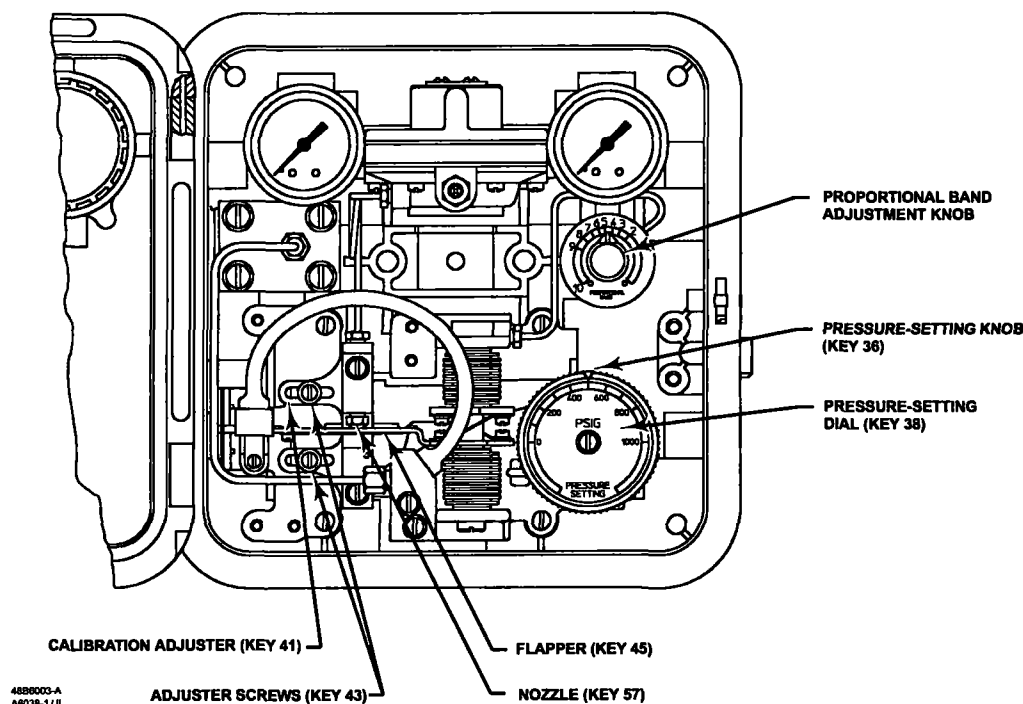


Figure 5. Proportional-Only Controller Adjustment Locations

cess pressure line in a straight section of pipe approximately 10 pipe diameters from the valve but away from bends, elbows, and areas of abnormal fluid velocities. For pressure-reducing service, the process line must be connected downstream of the valve. For pressure-relief service, the process pressure line must be connected upstream of the control valve. Install a needle valve in the process pressure line to dampen pulsations.

Vent Assembly

WARNING

If a flammable, toxic, or reactive gas is to be used as the supply pressure medium, personal injury or property damage could result from fire or explosion of accumulated gas or from contact with a toxic, or reactive gas. The instrument case and cover assembly does not form a gas-tight seal, and when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used. A remote vent pipe alone cannot be relied upon to remove all hazardous gas. Vent line piping should comply with local and re-

gional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.

CAUTION

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

The vent assembly (key 15, figure 3) or the end of a remote vent pipe must be protected against the entrance of all foreign matter that could plug the vent. Use 1/2-inch (13 mm) pipe for the remote vent pipe, if one is required. Check the vent periodically to be certain it has not become plugged.

Controller Operation

Proportional-Only Controllers

This section describes the adjustments and procedures for calibration and startup. Adjustment locations are shown in figure 5 unless otherwise specified. All adjustments must be made with the cover open. When

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the adjustments and calibration procedures are complete, close and latch the cover.

To better understand the adjustments and overall operation of the controller, refer to the Principle of Operation section in this manual for proportional-only controllers. Refer also to the schematic diagram in figure 14.

Adjustments

Adjustment: Set Point

Adjust the pressure-setting knob by turning the knob clockwise to increase the set point and counterclockwise to decrease the set point. Note: The dial setting and actual process pressure may vary significantly, especially with a wide proportional band setting.

Adjustment: Proportional Band

To adjust the proportional band, rotate the proportional band knob to the desired value.

The proportional band adjustment determines the amount of change in controlled pressure required to cause the control valve to stroke fully. It may be adjusted from 3–100 percent of the nominal sensing element pressure rating.

Calibration: Proportional-Only Controllers

Unless otherwise indicated, key number locations are shown in figure 5.

Provide a process pressure source capable of simulating the process pressure range of the controller. If an output pressure gauge is not provided, install a suitable pressure gauge for calibration purposes.

Connect a pressure source to the supply pressure regulator and be sure the regulator is delivering the correct supply pressure to the controller. The controller must be connected open loop (Open loop: The controller output pressure changes must be dead ended into a pressure gauge). The following procedures use a 3 to 15 psig (0.2 to 1.0 bar) output pressure range as an example. For a 6 to 30 psig (0.4 to 2.0 bar) output range, adjust the values as appropriate.

1. Complete the above connections and provide a process pressure equal to the sensing element range.
2. Rotate the proportional band knob, shown in figure 5, to 1.5 (15 percent proportional band).
3. Verify that the calibration adjuster screws (key 43) are at mid-position in the calibration adjuster (key 41) slots.

Depending upon the controller action, perform one or the other of the following procedures.

For direct-acting controllers:

4. Apply an input pressure equal to the sensing element lower range value.
5. Rotate the pressure setting knob to the minimum value.
6. Adjust the nozzle (key 57) until the controller output pressure is between 8 and 10 psig (0.6 and 0.7 bar).
7. Apply an input pressure equal to the sensing element upper range value.
8. Rotate the pressure-setting knob to the maximum value.

Note

When performing the span adjustment in step 9, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster, the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.

Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

9. If the output is not between 8 and 10 psig, adjust the controller span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 6.
10. Repeat steps 4 through 9 until no further adjustment is necessary.
11. Proceed to the startup procedure for proportional controllers.

For reverse-acting controllers:

4. Apply an input pressure equal to the sensing element upper range value.

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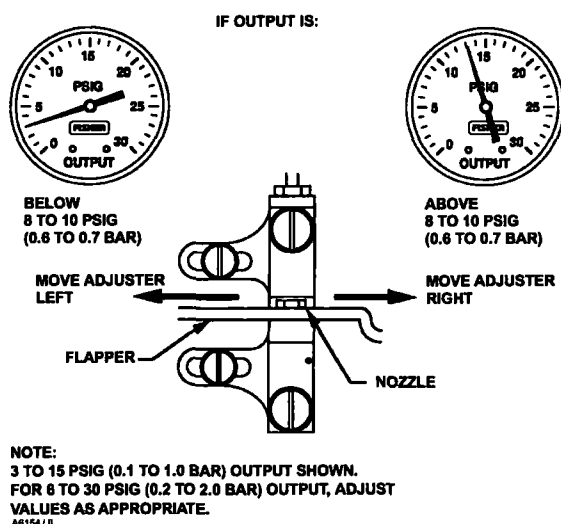


Figure 6. Direct-Acting Controller Span Adjustment—Proportional-Only Controllers

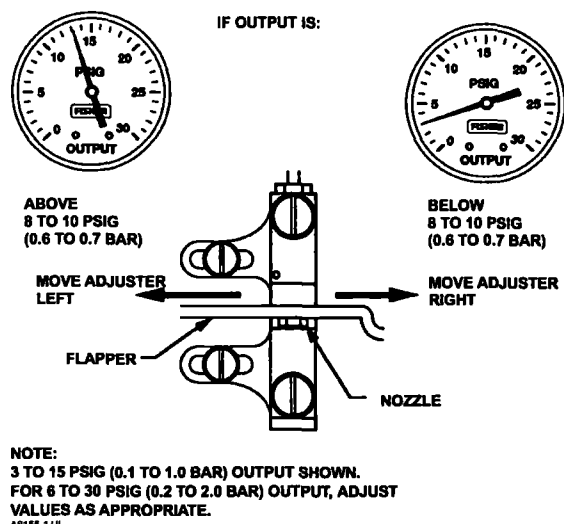


Figure 7. Reverse-Acting Controller Span Adjustment—Proportional-Only Controllers

5. Rotate the pressure setting knob to the maximum value.
6. Adjust the nozzle (key 57) until the controller output pressure is between 8 and 10 psig (0.6 and 0.7 bar).
7. Apply an input pressure equal to the sensing element lower range value.
8. Rotate the pressure-setting knob to the minimum value.

Note

When performing the span adjustment in step 9, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster, the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.

Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the

two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

9. If the output is not between 8 and 10 psig, adjust the controller span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 7.
10. Repeat steps 4 through 9 until no further adjustment is necessary.
11. Proceed to the startup procedure for proportional controllers.

Startup: Proportional-Only Controllers (General Tuning Guidelines)

Calibrate the controller prior to this procedure.

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.
2. Rotate the pressure-setting knob to the desired set point.
3. Set the proportional band adjustment to 100 percent for fast processes (example: liquid pressure or liquid flow). For slow processes (example: temperature), calculate the percentage from the equation below:

For a slow process, determine the initial proportional band setting in percent from the following equation:

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

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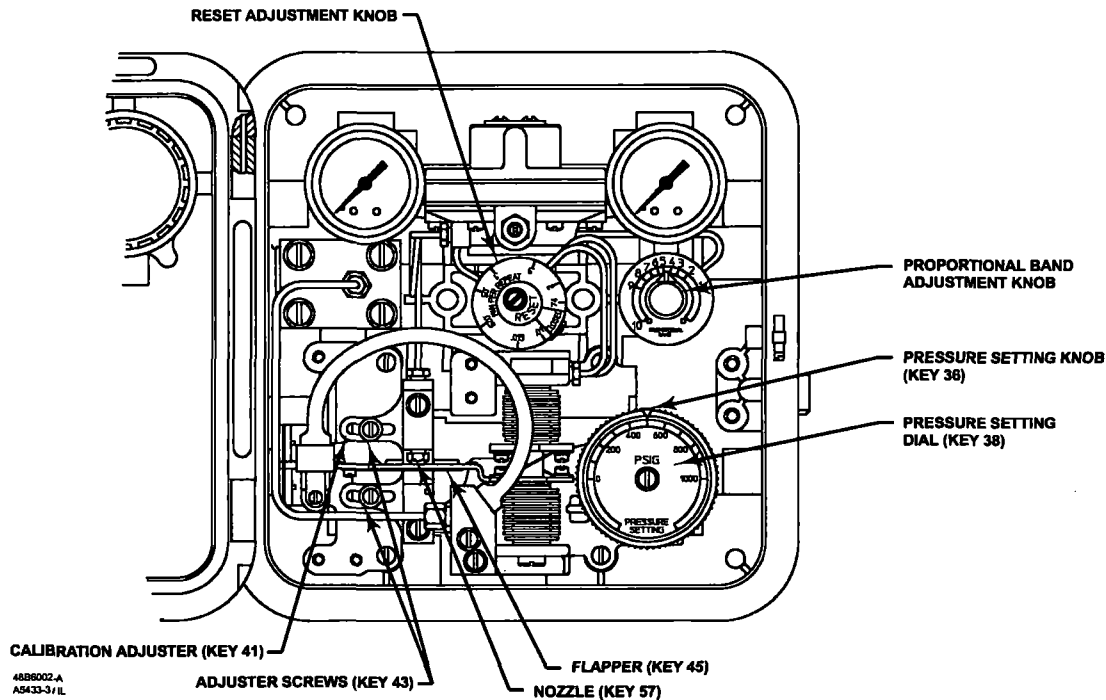


Figure 8. Proportional-Plus-Reset Controller Adjustment Locations

For example:

$$\frac{200 \times 2 \text{ psig}}{30 \text{ psig}} \approx 13\%$$

(1.3 proportional band setting)

4. Proportional Action

Disturb the system by tapping the flapper lightly or change the set point a small amount and check for system cycling. If the system does not cycle then lower the proportional band (raising the gain) and disturb the system again. Continue this procedure until the system cycles. At that point, double the proportional band setting.

Note

Proportional band adjustment affects the set point. Proportional-only controllers will show some offset from set point depending upon proportional band setting and process demand. After adjusting the proportional band, re-zero by carefully rotating the nozzle (key 57) until the steady-state process pressure equals the process pressure knob reading.

This tuning procedure may be too conservative for some systems. The recommended proportional band

setting should be checked for stability by introducing a disturbance and monitoring the process.

Proportional-Plus-Reset Controllers

This section describes the adjustments and procedures for calibration and startup. The adjustment locations are shown in figure 8 unless otherwise specified. All adjustments must be made with the cover open. When the adjustments and calibration procedures are complete, close and latch the cover. To better understand the adjustments and overall operation of the controller, refer to the Principle of Operation section in this manual for proportional-plus-reset controllers. Refer also to the schematic diagram in figure 14.

Adjustments

Adjustment: Set Point

Adjust the pressure-setting knob by turning the knob clockwise to increase the set point and counterclockwise to decrease the set point.

Rotate the knob until the indicator points to the desired set point pressure value. The pressure setting dial will reflect the desired set point if the controller is accurately calibrated.

Adjustment: Proportional Band

To adjust the proportional band, rotate the proportional band knob to the desired value.

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The proportional band adjustment determines the amount of change in controlled pressure required to cause the control valve to stroke fully. It may be adjusted from 3–100 percent of the nominal sensing element pressure rating.

Adjustment: Reset

To adjust reset action turn the knob clockwise to decrease the minutes per repeat. Turn the knob counter-clockwise to increase the minutes per repeat. Increasing the minutes per repeat provides a slower reset action.

The reset adjustment dial is calibrated in minutes per repeat. By definition, this is the time in minutes required for the reset action to produce an output change which is equal to the change produced by proportional control action. This is in effect, the time in minutes required for the controller to increase (or decrease) its output pressure by an amount equal to a proportional increase (or decrease) caused by a change in set point or process pressure.

Adjustment: Anti-Reset Windup

The externally mounted differential relief valve can be mounted to relieve on increasing or decreasing output pressure.

Calibration

Calibration: Proportional-Plus-Reset Controllers

Unless otherwise indicated, key number locations are shown in figure 8.

Before starting this procedure:

- Provide a process pressure source capable of simulating the process pressure range of the controller.

- If an output pressure gauge is not provided, install a suitable pressure gauge for calibration purposes. The controller must be connected open loop (Open loop: The controller output pressure changes must be dead ended into a pressure gauge).

Note

Type 4160KF and 4162KF (anti-reset windup) controllers are supplied with two O-rings (key 367, not shown), an anti-reset windup cover (key 369, not shown), and two machine screws (key 368, not shown). Use these parts in the next step.

1. For controllers with anti-reset windup (Type 4160KF and 4162KF), record the direction of the ar-

row on the anti-reset windup assembly (key 186, in figure 20). Remove the assembly and install the two O-rings (key 367, not shown), and cover (key 369, not shown) supplied with the controller. Secure the cover with the two machine screws (key 368, not shown) provided.

2. Connect regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 5.

3. Rotate the reset knob to 0.01 minutes per repeat (fastest setting).

4. Rotate the proportional band knob to 1.5 (15 percent proportional band).

5. Verify that the calibration adjuster screws (key 43) are at mid-position in the calibration adjuster (key 41) slots.

Depending upon the controller action, perform one or the other of the following procedures.

For direct-acting controllers:

6. Apply an input pressure equal to the sensing element lower range value.

7. Rotate the pressure setting knob to the minimum value.

8. Adjust the nozzle (key 57) until the controller output pressure is between 8 and 10 psig (0.6 and 0.7 bar).

9. Apply an input pressure equal to the sensing element upper range value.

10. Rotate the pressure-setting knob to the maximum value.

Note

When performing the span adjustment in step 11, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster, the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.

Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the

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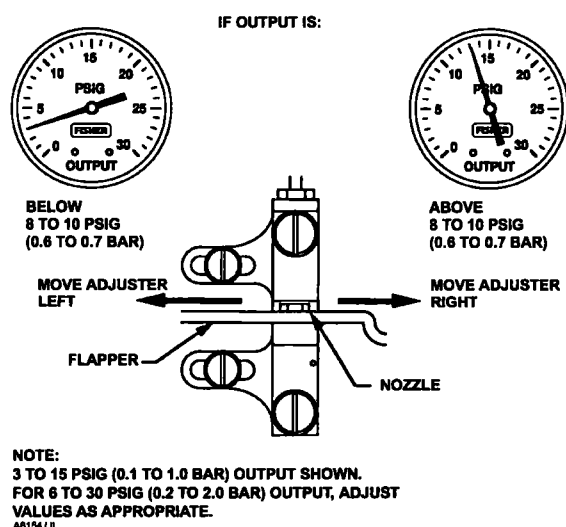


Figure 9. Direct-Acting Controller Span Adjustment—Proportional-Plus-Reset Controllers

screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

11. If the output pressure is not between 8 and 10 psig, adjust the controller span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 9.

12. Repeat steps 6 through 11 until no further adjustment is necessary.

13. For controllers with anti-reset windup (Type 4160KF and 4162KF), remove the two machine screws, anti-reset windup cover, and two O-rings installed in step 1 of this procedure. Install the anti-reset windup assembly (key 186) with the arrow pointing in the direction recorded in step 1.

14. Proceed to the Startup procedures for proportional-plus-reset controllers.

For reverse-acting controllers:

6. Apply an input pressure equal to the sensing element upper range value.

7. Rotate the pressure setting knob to the maximum value.

8. Adjust the nozzle (key 57) until the controller output pressure is between 8 and 10 psig (0.6 and 0.7 bar).

9. Apply an input pressure equal to the sensing element lower range value.

10. Rotate the pressure-setting knob to the minimum value.

Note

When performing the span adjustment in step 11, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster, the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.

Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

11. If the output pressure is not between 8 and 10 psig, adjust the controller span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 10.

12. Repeat steps 6 through 11 until no further adjustment is necessary.

13. For controllers with anti-reset windup (Type 4160KF and 4162KF), remove the two machine screws, anti-reset windup cover, and two O-rings installed in step 1 of this procedure. Install the anti-reset windup assembly (key 186) with the arrow pointing in the direction recorded in step 1.

14. Proceed to the Startup procedures for proportional-plus-reset controllers.

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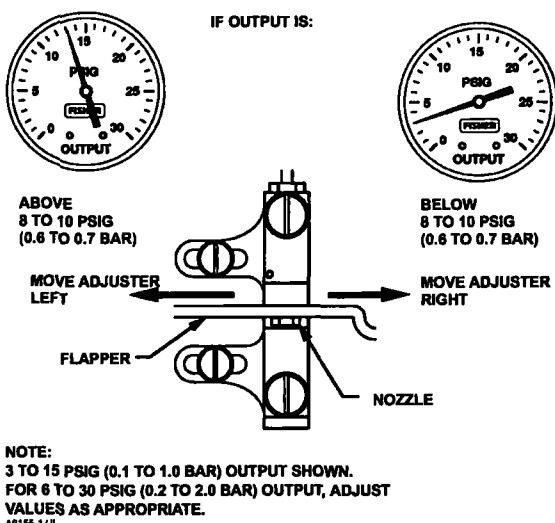


Figure 10. Reverse-Acting Controller Span Adjustment—Proportional-Plus-Reset Controllers

Calibration: Anti-Reset Windup

Controllers with anti-reset windup have a differential relief valve assembly (figure 20). This relief valve is set at the factory to relieve at a 5 psi (0.3 bar) pressure difference between the reset bellows pressure and the proportional bellows pressure. The valve can be adjusted to relieve from 2 to 7 psig (0.14 to 0.4 bar).

The relief valve can relieve on either rising controller output pressure or falling controller output pressure. If the arrow on the relief valve points toward the bottom of the controller case as shown in figure 20, the valve will relieve on falling output pressure. If the arrow points in the opposite direction, the valve will relieve on rising output pressure. The valve can be removed and reinstalled with the arrow pointing in the opposite direction to change the relief action.

Startup: Proportional-Plus-Reset Controllers (General Tuning Guidelines)

Calibrate the controller prior to this procedure.

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.
2. Rotate the pressure-setting knob to the desired set point.
3. Start with a reset setting of 0.05 minutes per repeat (m/r) for fast processes, and 0.5 m/r for slow processes.
4. Set the proportional band adjustment to 100 percent for fast processes (example: liquid pressure or

liquid flow). For a slow process (example: temperature), calculate the percentage from the equation below:

For a slow process, determine the initial proportional band setting in percent from the following equation:

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

For example:

$$\frac{200 \times 2 \text{ psig}}{30 \text{ psig}} \approx 13\%$$

(1.3 proportional band setting)

5. Proportional Action:

Disturb the system by tapping the flapper lightly or change the set point a small amount and check for system cycling. If the system does not cycle then lower the proportional band (raising the gain) and disturb the system again. Continue this procedure until the system cycles. At that point, double the proportional band setting and begin tuning the reset.

6. Reset Action:

Disturb the system. If the system does not cycle then speed up the 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 (3) and slow the reset down to the new value. The reset is now tuned.

This tuning procedure may be too conservative for some systems. The recommended proportional band and reset setting should be checked for stability by introducing a disturbance and monitoring the process as previously described. For some applications, tighter control may be desirable.

Differential Gap Controllers

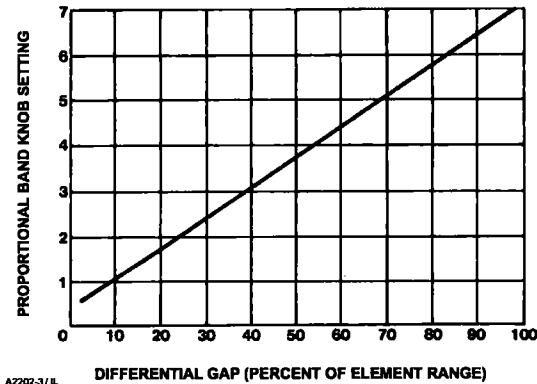
This section describes the adjustments and procedures for calibration and startup. The adjustment locations are shown in figure 5 unless otherwise specified. The output of each controller is checked at the factory before the instrument is shipped.

To convert a differential gap controller to a proportional-only controller or vice versa, refer to the appropriate procedure in the Maintenance section.

If the process pressure can be varied through all or part of the sensing element range or through the two desired switching points, use the process pressure for calibration. If not, provide a pressure source to simulate the process pressure range for calibration procedures.

To better understand the adjustments and overall operation of the controller, refer to the Principle of Operation section in this manual for differential gap controllers and the schematic diagram in figure 14.

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Figure 11. Differential Gap Adjustment for Differential Gap Controllers

Adjustments

Adjustment: Set Point

The position of the pressure-setting knob determines the location of the differential gap within the range of the pressure sensing element. Move the pointer to the desired pressure where the output of the controller should switch from zero to full supply pressure with rising process pressure (direct-acting controllers) or with falling process pressure (reverse-acting controllers).

Adjustment: Proportional Band

The proportional band adjustment shown in figure 5 determines the width of the differential gap. The width of the gap is the difference between the process pressures at which the controller output will switch from zero to full supply pressure, or from full supply pressure to zero. The relationship between the proportional band dial setting and the differential gap is shown in figure 11.

Calibration: Differential Gap Controllers

The output of each controller is checked at the factory before the unit is shipped. Before placing the controller in control of a process loop, check to verify that the controller is calibrated correctly for the application. The controller must be connected open loop (Open loop: The controller output pressure changes must be dead ended into a pressure gauge).

1. Temporarily convert the differential gap controller to a proportional-only controller by disconnecting the proportional tubing (key 104, figure 16) from the mounting base. Reinstall the tubing into the other connection in the mounting base as shown in figure 16. Do not invert the reversing block (key 59, figure 16).

2. Use the calibration procedures for proportional-only controllers.

3. Upon completion of the calibration procedures, re-install the tubing (key 104) in its original location. And, continue with the following procedures.

Note

After reinstalling the tubing (key 104) in step 3 a slight offset of the output pressure will be noticed due to switching from the proportional bellows to the reset bellows. This is because the effective area and spring rate of the two bellows may not match. Performing step 5b below adjusts for this offset.

4. Refer to figure 11 to determine the proportional band dial setting required for the desired differential gap.

For example, assume that a 0 to 100 psig sensing element is being used and the controller is to switch from zero to full supply pressure at a process pressure of 80 psig with rising process pressure and from full supply pressure to zero at 20 psig with falling pressure. (This is for a direct-acting controller.) The differential gap is:

$$\frac{80 \text{ psig} - 20 \text{ psig}}{100 \text{ psig}} \times 100 = 60\%$$

From figure 11, the proportional band dial setting should be approximately 4.5; rotate the proportional band knob to 4.5.

5. Setting the process pressure

For a Direct-Acting Controller:

a. Rotate the pressure-setting knob to the pressure at which the controller output is to switch to the upper switching point (zero to full supply pressure) with rising process pressure. In the above example, this pressure is 80 psig (5.5 bar).

b. Increase pressure to the sensing element while monitoring the output pressure gauge. The controller output pressure should switch from zero to full supply pressure when the upper switching point is reached with rising input pressure.

Note

If the upper switching point is not correct, adjust the nozzle to correct the error. Repeat step 5b until the input pressure and upper switching point are at the desired setting.

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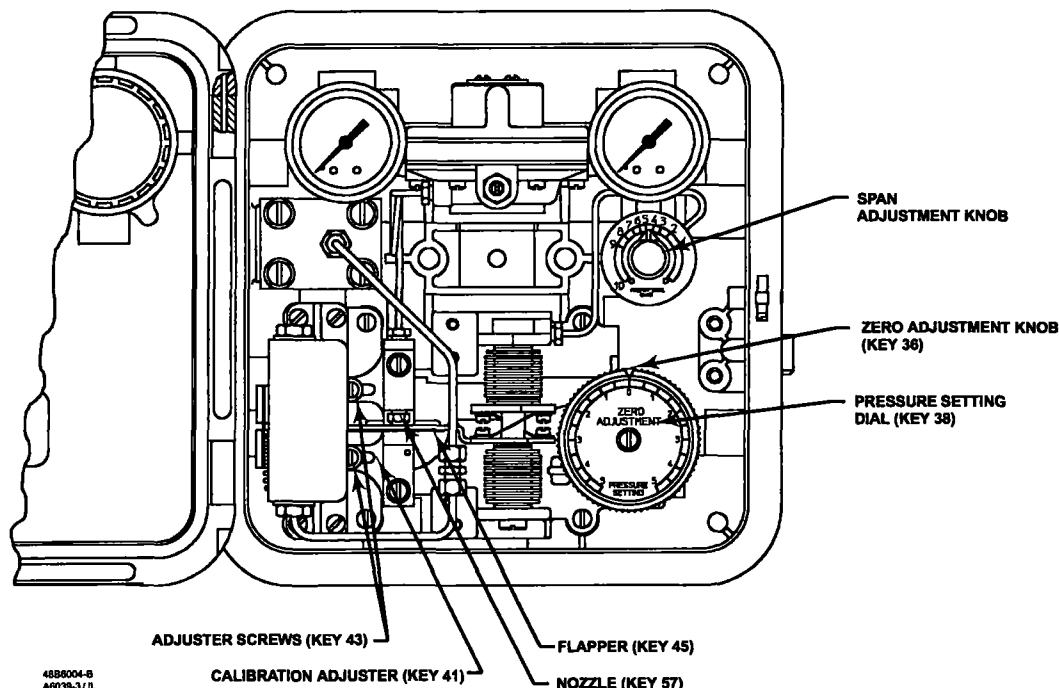


Figure 12. Transmitter Adjustment Locations

c. With falling input pressure, the output should switch from full supply pressure back to zero when the lower switching point is reached.

Reverse-acting controllers produce the opposite response.

6. Vary the process pressure and observe the switching points. Widen or narrow the differential gap by rotating the proportional band knob, then repeat the above steps.

If the output is within the limits stated, refer to the startup procedures in this section. If the output pressure cannot be adjusted within the limits stated, refer to the maintenance procedures.

Startup: Differential Gap Controllers

Calibrate the controller prior to this procedure.

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.
2. Adjust the proportional band knob for the proper differential gap (see figure 11).
3. If the controller is used in conjunction with a control valve, slowly open the upstream and downstream manual shutoff valves, and close the bypass valves.

4. To change the differential gap, perform steps 1 through 4 of the calibration for differential gap controllers procedure.

Transmitter Operation

This section describes the adjustments and procedures for calibration and startup. Refer to figure 12 for the adjustment locations. All adjustments must be made with the cover open. When the adjustments and calibration procedures are complete, close and latch the cover.

To better understand the adjustments and overall operation of the transmitter, refer to the Principle of Operation section in this manual for transmitters. Refer also to the schematic diagram in figure 14.

Adjustments

Adjustment: Zero

The pressure-setting dial is marked ZERO ADJUSTMENT PRESSURE SETTING. Zero is in the center of the dial, and the pressure values increase to the right and left of the center as shown in figure 12. To set the zero, rotate the pointer around the pressure setting

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dial. Rotate the pointer clockwise to increase or counterclockwise to decrease the output depending on transmitter action and desired setting.

For direct-acting transmitters, zero adjustment determines the process pressure at which the transmitter output signal will be at its lower range limit.

The dial (key 38) graduations are approximate indications of the transmitter zero setting. When making adjustments, do not rely solely on the dial setting. Monitor the process pressure and output pressure to be sure the desired settings are attained.

Adjustment: Span

The span adjustment dial is graduated from 0 to 10. A setting of 10 on the dial represents a span setting of 100 percent of the process sensing element range. The transmitter achieves the highest accuracy when the span is 100 percent.

The transmitter span adjustment shown in figure 12 is the same as the controller proportional band adjustment.

Calibration: Transmitters

The output of each transmitter is checked at the factory before the unit is shipped. The transmitter provides an output signal that is proportional to the pressure applied to the sensing element. The output pressure has no direct effect on the process pressure.

The transmitter is calibrated at the factory and should not need additional adjustment. Use the following calibration procedures when the sensing element has been changed or other maintenance procedures have altered the calibration of the transmitter. The following procedures use a 3 to 15 psig (0.1 to 1.0 bar) output pressure range as an example. For other output pressure ranges [such as 6 to 30 psig (0.2 to 2.0 bar)] adjust the values to match the application.

Provide a process pressure source capable of simulating the process pressure range of the transmitter. If an output pressure gauge is not provided, install a suitable pressure gauge for calibration purposes⁽¹⁾. Connect a pressure source to the supply pressure regulator and be sure the regulator is delivering the correct supply pressure to the transmitter.

Unless otherwise indicated, key number locations are shown in figure 12.

1. Complete the above connections and provide a process pressure equal to the sensing element range.
2. Rotate the span adjustment knob to 10 on the dial (100 percent span).
3. Verify that the calibration adjuster screws (key 43) are at mid-position in the calibration adjuster (key 41) slots.

1. For stability, some transmitter applications will require additional volume than just the gauge. Provide a minimum volume of approximately 1.5 in³ (25 cm³) or greater if stability is a problem.

Depending upon the transmitter action, perform one or the other of the following procedures.

For direct-acting transmitters:

4. Rotate the zero adjustment knob to zero.
5. Set the input pressure to zero.
6. Adjust the nozzle (key 57) until the transmitter output pressure is at 3 psig (0.1 bar).
7. Apply an input pressure equal to the sensing element upper range value.

Note

When performing the span adjustment in step 8, loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

8. If the output pressure is not 15 psig, adjust the span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 13.
9. Repeat steps 4 through 8 until no further adjustment is necessary.
10. Proceed to the startup procedure for transmitters.

For reverse-acting transmitters:

4. Rotate the zero adjustment knob to zero.
5. Apply an input pressure equal to the sensing element upper range limit.
6. Adjust the nozzle (key 57) until the transmitter output pressure is at 3 psig (0.1 bar).
7. Set the input pressure equal to zero.

Note

When performing the span adjustment in step 8, loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle

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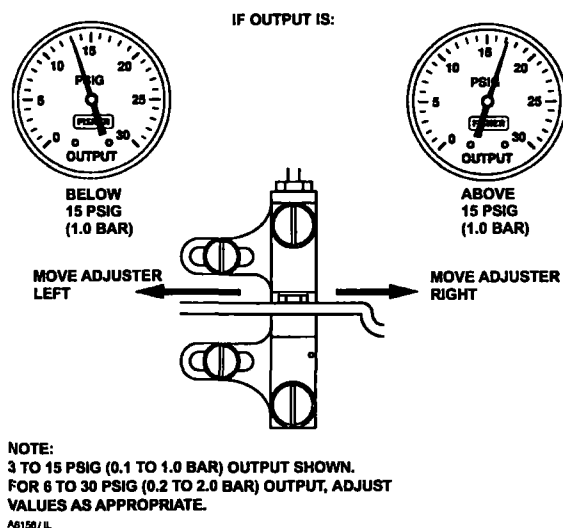


Figure 13. Transmitter Span Adjustment

from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

8. If the output pressure is not 15 psig, adjust the span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 13.
9. Repeat steps 4 through 8 until no further adjustment is necessary.
10. Proceed to the startup procedure for transmitters.

Startup: Transmitters

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the transmitter.
2. Refer to the calibration procedures for the transmitter initial settings.
3. If the transmitter is used in conjunction with a control valve, slowly open the upstream and downstream manual shutoff valves, and close the bypass valves.

Principle of Operation

The following sections describe the operation of a controller or transmitter using a Bourdon tube sensing element. The operation is the same for an instrument using a bellows sensing element (key 71, figure 22) except that movement of the beam is caused by ex-

pansion or contraction of the bellows or differential bellows.

Proportional-Only Controllers

As shown in figure 14, supply pressure enters the relay and bleeds through the fixed orifice before escaping through the nozzle. Nozzle pressure also registers on the large relay diaphragm, and loading pressure (controller output pressure) registers on the small relay diaphragm.

A change in the process pressure moves the beam and flapper with respect to the nozzle by either expanding or contracting the Bourdon tube arc. An increasing process pressure with direct action (or decreasing pressure with reverse action) produces a nozzle-flapper restriction that increases the loading on the large relay diaphragm and opens the relay valve. Additional supply pressure flows through the relay chamber to increase the loading pressure on the control valve actuator. A decreasing process pressure with direct action (or increasing pressure with reverse action) produces a nozzle-flapper opening that bleeds off pressure on the large relay diaphragm and opens the relay valve to exhaust controller output pressure from the actuator.

This controller output pressure change feeds back to the proportional bellows, countering the pressure change in the nozzle and equalizes the relay diaphragm pressure differential. The relay valve maintains a new loading pressure according to the change in sensed pressure.

If the proportional valve is wide open, all of the controller output pressure change feeds back to the proportional bellows. The more the proportional valve is closed, the more the controller output pressure change bleeds out through the proportional valve exhaust and the less there is to feed back to the proportional bellows. A fully open proportional valve results in a proportional band of 100 percent; closing the proportional valve reduces the proportional band.

Proportional-Plus-Reset Controllers

Action of a proportional-plus-reset controller is similar to that of a proportional-only controller except that feedback from the controller output pressure is piped to a reset bellows as well as to the proportional bellows as shown at the right in figure 14.

With an increasing controller output pressure, pressure in the reset bellows increases. Increases in reset bellows pressure moves the beam and flapper closer to the nozzle, starting another increase of pressure throughout the system. Pressure buildup continues until the controlled pressure is brought back to the set point. The reset valve is adjustable to vary the amount of delay in the reset action. Closing the reset valve increases the delay in reset action.

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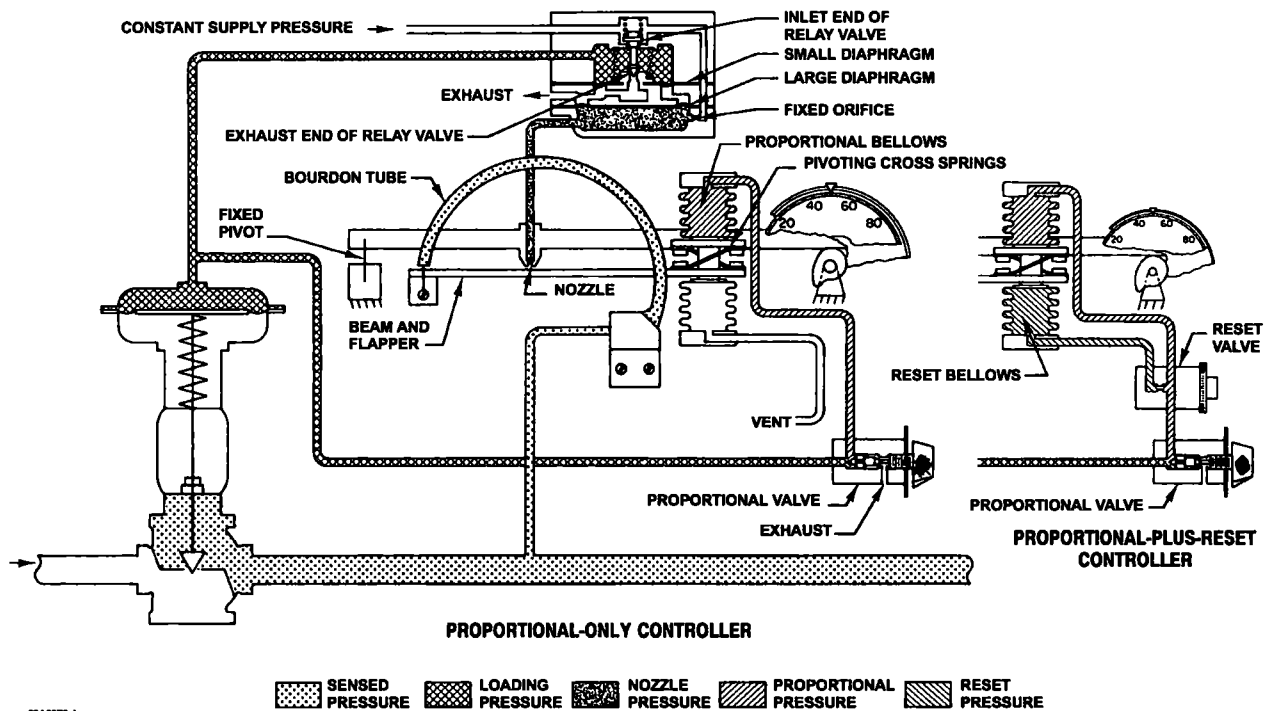


Figure 14. Schematic of Direct-Acting Proportional-Only and Proportional-Plus-Reset Controllers

Controllers with Anti-Reset Windup

During a prolonged difference between set point and the controlled variable, such as encountered with intermittent control applications (e.g., batch temperature control or wide open monitors on pressure control), reset ramps the controller output to either zero or full supply pressure; this condition is reset windup. When the controlled variable crosses the set point, there will be a delay before the controller output responds to the change in controlled variable. Anti-reset windup minimizes this delay and permits returning the controlled variable to set point more quickly with minimal overshoot.

As shown in figure 15 a proportional-plus-reset controller with anti-reset windup includes a differential relief valve. The valve consists of two pressure chambers separated by a spring-loaded diaphragm.

For the controller shown in figure 15, proportional pressure registers rapidly on the spring side of the relief valve diaphragm as well as in the proportional bellows, and reset pressure registers on the opposite side of the relief valve diaphragm. As long as controlled pressure changes are slow enough for normal proportional and reset action, the relief valve spring will keep the relief valve diaphragm from opening. However, a large or rapid decrease in controller pressure will cause the relay to exhaust loading pressure from the control device rapidly, and also from the proportional system and spring side of the relief diaphragm. If this

decrease on the spring side of the diaphragm is greater than the relief valve spring setting, the diaphragm will move off the relief valve orifice and permit the proportional pressure on the opposite side of the relief valve diaphragm to bleed rapidly into the reset bellows. The anti-reset windup action also can be reversed to relieve with an increasing proportional pressure.

Differential Gap Controllers

With a differential gap controller, feedback pressure does not counteract the change in flapper position as it does in a proportional-only controller. Instead, feedback pressure is piped through the proportional valve to the bellows located on the side of the beam and flapper opposite the nozzle (the lower bellows in figure 14 for direct-acting controllers). Then, as controller output pressure increases, feedback pressure moves the flapper closer to the nozzle to again increase controller output pressure. This process continues rapidly until the controller output pressure is at the upper range limit. The action of a differential gap controller is so rapid that output pressure changes from zero to maximum as soon as the switching point is reached. The action is similar with falling output pressure. Lower feedback pressure lowers the bellows pressure, which moves the flapper away from the nozzle. This again reduces the output pressure and continues until the output pressure is zero.

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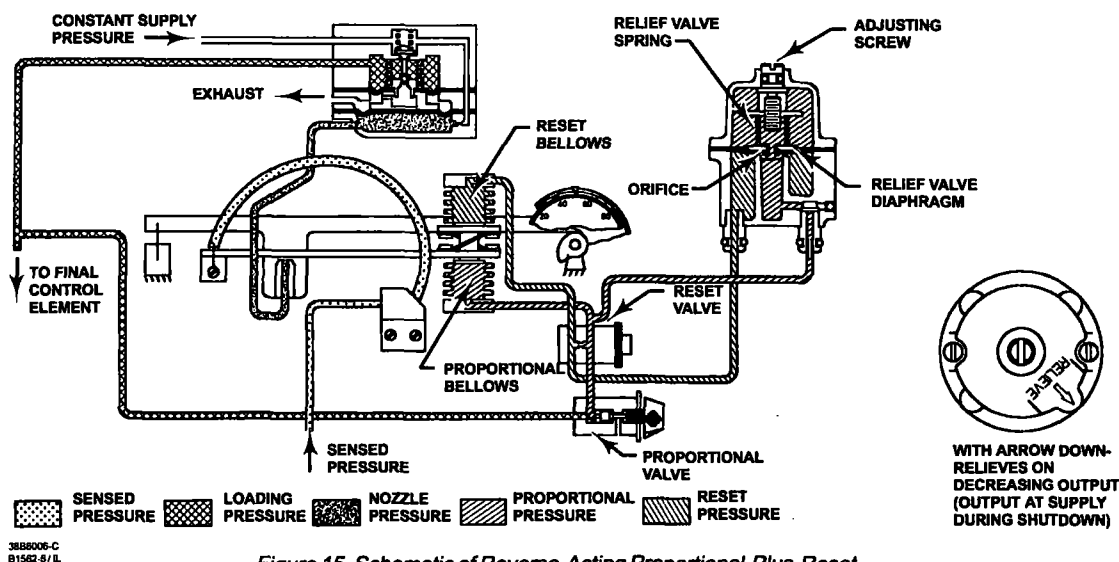


Figure 15. Schematic of Reverse-Acting Proportional-Plus-Reset Controller with Anti-Reset Windup

Transmitters

Action of a pneumatic transmitter is similar to that of a proportional-only controller. Since the output pressure of the transmitter has no effect on the process pressure, transmitter output pressure is a proportional measure of the process pressure. The proportional valve determines the span of the transmitter, and the pressure setting mechanism determines the zero of the transmitter.

Maintenance

If the installation includes a 67 Series filter regulator, periodically open the drain on the filter regulator to drain accumulated moisture. Also, push the cleaner wire on the relay orifice (key 88, figure 23). Check the opening of the vent assembly (key 15, figure 3) or the opening of the remote vent pipe, if one is used. If necessary, clean the openings.

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. Due to the care Fisher takes in meeting all manufacturing requirements (dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher.



WARNING

The following maintenance procedures require taking the controller out of ser-

vice. To avoid personal injury and property damage caused by the release of pressure or process fluid, observe the following before starting maintenance:

- Provide some temporary means of control for the process before taking the controller out of service.
- Provide a means of containing the process fluid before removing any measurement devices from the process.

Replacing Gauges

Refer to figures 19 and 20 for key number locations unless otherwise directed.

Three gauge configurations are available for 4150K and 4160K units.

- Output and supply pressure indications
- Output and process pressure indications
- Output, process, and supply pressure indications

One gauge type (key 13) is used for both output and supply pressure indications when the gauges are installed inside the controller case. Key 13 features a 1/8-inch connecting stem that matches the threaded gauge boss extending from the relay base.

In some cases, a process pressure gauge (key 106) covers the position of the internal supply pressure gauge. The supply pressure gauge has been removed and replaced with a pipe plug (key 108). The pressure control block (key 8) is different to accommodate a different control tubing assembly (key 132) with a

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pressure connection (key 107) for a process pressure gauge. If a supply pressure gauge is required, a gauge with a 1/4-inch connecting stem (key 14) must be mounted on the supply pressure regulator.

CAUTION

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

Note

One gauge type (key 13) is used for either supply pressure indication or output pressure indication when both gauges are installed inside the controller case.

1. Shut off the supply pressure and process lines to the controller or transmitter.
2. Remove the gauge to be replaced:
 - Unscrew the output or supply gauge (key 13) from the relay base.
 - Unscrew the process pressure gauge (key 106) from the process connection (key 107).
 - Unscrew the supply gauge (key 14) from the supply pressure regulator.
3. Coat the threads of the replacement gauge with a sealant.
4. Screw the replacement gauge into the relay base, process connection, or supply pressure regulator.
5. Check for leaks by applying the correct supply pressure with the nozzle capped to produce full output pressure.

Replacing Bourdon Tube

Refer to figure 21 for key number locations unless otherwise directed.

1. Shut off the supply pressure and process lines to the controller or transmitter.
2. Unscrew the machine screw (key 63) to disconnect the link (key 64) and bearing (key 65) from the beam (key 44). Be careful to avoid losing the bearing (key 65). Washer(s) (key 370) for the machine screw (key 63) are at times furnished for insertion at the beam (key 44) connection to ensure alignment of the connecting link (key 64).

3. Disconnect the control tubing (key 132). Unscrew two screws (key 77) and washers (key 76), and remove the Bourdon tube (key 62).
4. Unscrew the machine screw (key 63), and remove the link and bearing (keys 64 and 65) from the Bourdon tube. Be careful to avoid losing the bearing (key 65).
5. Attach the link and bearing to the replacement Bourdon tube.
6. Attach the Bourdon tube with two machine screws and washers (keys 77 and 76).
7. Connect the link and bearing to the beam (key 44).
8. After connecting the link to the beam, make sure the nozzle is centered in the slot in the beam. If not, carefully loosen the machine screw (key 63) enough so that you can slip a washer (key 370) between the bearing (key 65) and beam (key 44). Retighten the machine screw and check the nozzle and beam alignment.
9. Check to be sure that the beam is parallel with the bottom of the case and that the link (key 64) is in tension. If the beam is not parallel with the case, loosen the machine screws (key 77), reposition the Bourdon tube to get the beam parallel, and retighten the screws.
10. If a Bourdon tube with a different range was installed, remove the machine screw and washer (keys 40 and 39) and dial (key 38). Install a new dial having an adjustment range corresponding to the range of the Bourdon tube. If an optional process pressure gauge (key 106, figure 19) is being used, install a new gauge with the appropriate measurement capability.
11. Check all tubing connections for leaks and the Bourdon tube machine screws, tighten as necessary. Perform the appropriate calibration procedures.

Replacing Bellows Sensing Element

Refer to figure 22 for key number locations unless otherwise directed.

1. Shut off the supply pressure and process lines to the controller or transmitter.
2. Disconnect the tubing from the mounting base (key 30) and calibration adjuster (key 41). Disconnect the tubing that connects the pressure block (key 8, figure 19) to the bellows assembly (key 71), at the pressure block end.
3. Unscrew the four machine screws (key 28, figure 19 or 20), and remove the pressure sensing subassembly from the case.
4. Remove the bellows yoke machine screws and washers (keys 75 and 76), and move the bellows yoke to the right to permit access to the link screw.

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5. Disconnect the link (key 71M) and bearing (key 71L) from the beam. Be careful to avoid losing the bearing.
6. Loosen the nuts that secure the bellows assembly (key 71), and remove this assembly from the bellows yoke (key 70).
7. For a gauge-pressure sensing element (only one bellows in the assembly), install the proper bellows spring (key 80) into the bellows assembly if the input signal range is being changed. See the parts list for the correct part number.
8. Install the new bellows assembly into the bellows yoke.
9. Attach the link and bearing to the bellows assembly. Position the bellows yoke (key 70) on the mounting base (key 30), and attach the link and bearing to the beam. Start but do not tighten the four machine screws (key 75) with washers (key 76) that attach the yoke to the mounting base. Slide the yoke up or down as necessary to position the beam horizontally, as shown in figure 22. Tighten the machine screws.
10. Replace the subassembly in the case and secure with the four machine screws (key 28, figure 19 or 20). Reconnect all tubing.
11. If a bellows assembly with a different range is installed, remove the machine screws and washer (keys 40 and 39) and dial (key 38), and install a new dial having an adjustment range corresponding to the range of the bellows. If an optional process pressure gauge (key 106, figure 19) is being used, install a new gauge with the appropriate measurement capability.
12. Check all tubing connections for leaks and the bellows yoke machine screws, tighten as necessary. Perform the appropriate calibration procedures.

Changing Proportional or Reset Valve

1. Disconnect the appropriate tubing and remove the proportional band valve assembly (figure 19 or 20) or the reset restriction valve assembly (figure 20) by unscrewing it from the relay base (key 4, figure 19 or 20). Install the desired replacement assembly.
2. Connect the tubing, check all connections for leaks and perform the appropriate calibration procedures.

Changing Anti-Reset Windup Differential Relief Valve (4160KF)

Refer to figure 20 for key number locations.

1. Note the controller output pressure (zero or supply) when the process is shut down.
2. Remove the differential relief valve assembly.

3. Refer to figure 20. Install the replacement relief valve with the arrow positioned so that the controller output will be as noted in step 1 when the process is shut down.

Changing Action

Proportional-Only to a Differential Gap Controller

A proportional-only controller may be changed to a differential gap controller, or vice versa, by changing the position of the proportional tubing (key 104, figure 16). Refer to figure 16 for key number locations.

1. Isolate the controller from process, control, and supply pressure. Vent any trapped pressure from the controller before proceeding with the following steps.
2. Disconnect the proportional tubing (key 104) from the mounting base (key 30, figure 21 or 22) and reinstall it in the other connection in the mounting base.
3. Do not invert the reversing block unless also changing the controller action.
4. Check all connections for leaks with a soap-and-water solution. Perform the appropriate calibration procedure.

Direct to Reverse Action

Use the numbered steps below to change from direct action (increasing pressure produces increasing output pressure) to reverse action (increasing pressure produces decreasing output pressure), or vice versa. Changing the action is accomplished by reversing the positions of the reversing block and bellows tubing(s). Refer to figure 16 for key number locations unless otherwise directed.

1. Isolate the controller or transmitter from process, control, and supply pressure. Vent any trapped pressure from the controller or transmitter before proceeding with the following steps.
2. Locate the new tubing and reversing block positions for the action desired.
3. Locate the two bellows and the reversing block (key 59, figure 16).
4. Disconnect the tubing:

a. For a proportional-only controller or for a transmitter, disconnect the proportional tubing (key 104) from the mounting base (key 30, figure 21 or 22) and reconnect it in the opposite hole.

b. For a proportional-plus-reset controller, disconnect the proportional tubing (key 104) and reset tubing (key 117) from the mounting base (key 30, fig-

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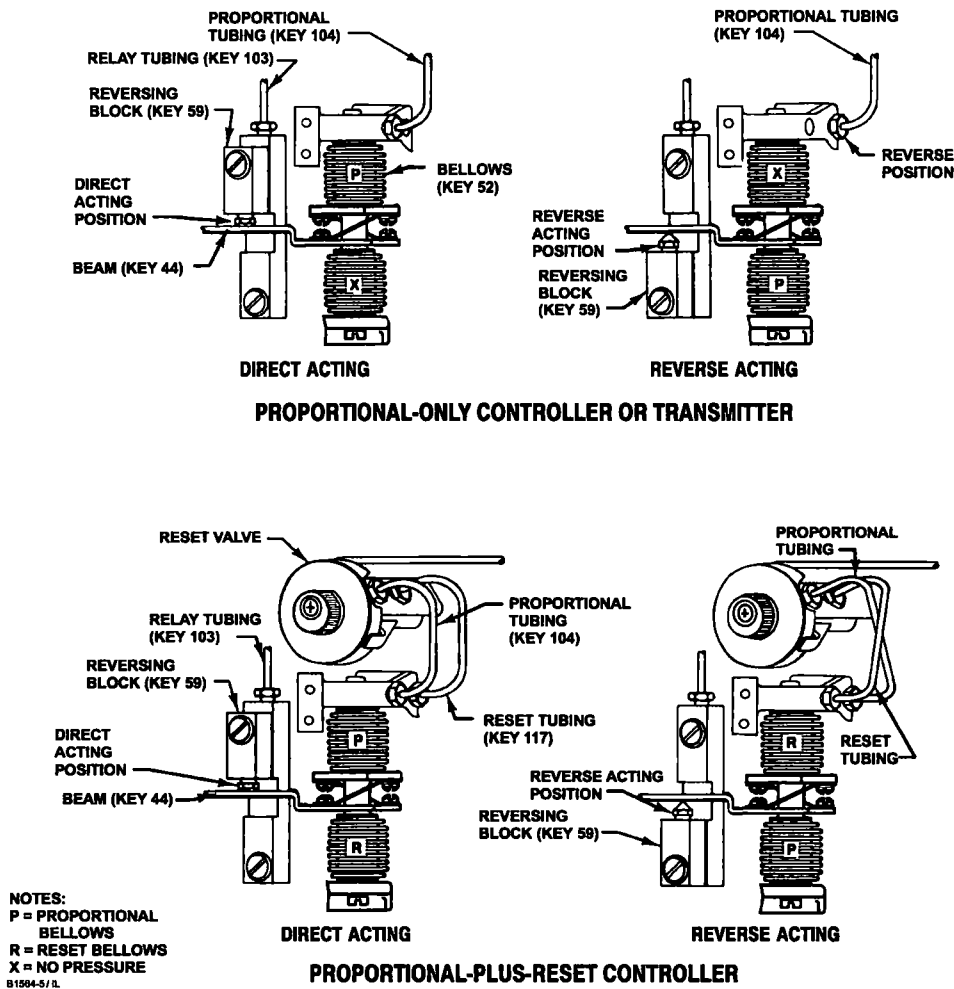


Figure 16. Direct/Reverse Acting Tubing Connections

ure 21 or 22), and reconnect them in the opposite hole.

5. Change the reversing block assembly (key 59):

a. Remove the sealing screw (key 56, figure 21 or 22). Inspect the O-ring (key 55, figure 21 or 22) located in the recessed area under the sealing screw head. Replace the O-ring if necessary.

b. Remove the reversing block screw (key 61, figure 21 or 22) and reversing block assembly (key 59). Inspect the O-rings (key 55) located in the recessed area under the reversing block screw head and between the reversing block assembly and the calibration adjuster (key 41, figure 21 or 22). Replace these O-rings, if necessary.

c. Position the reversing block assembly, with O-ring, on the calibration adjuster (key 41) so that the nozzle is on the opposite side of the beam (key 44, figure 21 or 22) from which it was removed. Properly position the reversing block assembly so that the alignment pin engages the hole in the calibration adjuster. Install the reversing block screw (key 61) with O-ring (key 55).

d. Install the sealing screw (key 56) with O-ring in the hole previously covered by the reversing block assembly.

6. Check all connections for leaks with a soap-and-water solution. Perform the appropriate calibration procedures.

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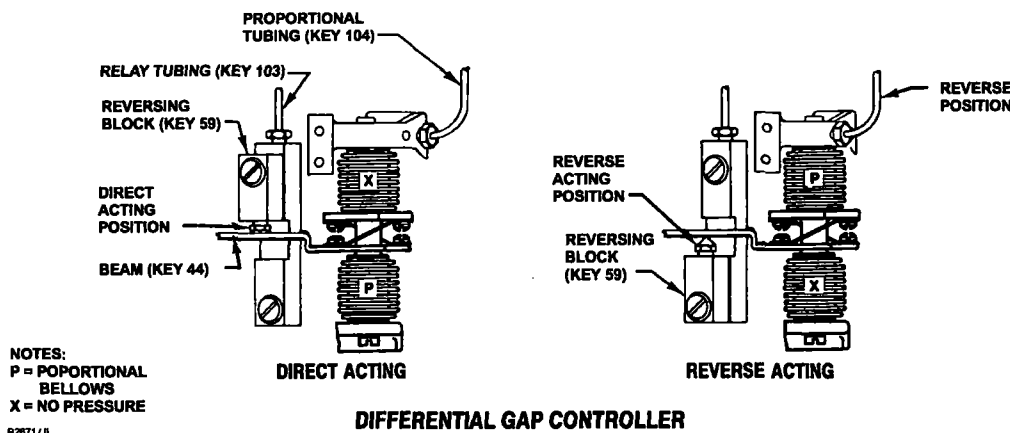


Figure 16. Direct/Reverse Acting Tubing Connections (Continued)

Relay Repair

Replacement

Key numbers used in this procedure are shown in figure 19 or 20 except where indicated.

1. Shut off the supply pressure and process pressure line(s) to the controller or transmitter.
2. Disconnect the tubing (key 103) from the relay.
3. Unscrew the output or supply pressure gauge (key 13).
4. To remove the relay assembly, unscrew two Phillips-head machine screws (key 81, not shown) located behind the relay on the back of the case.
5. Remove the relay gasket (key 7, figure 19).
6. The relay can now be disassembled for cleaning or parts replacement, or a new relay can be installed as a replacement. Refer to the instructions below for relay disassembly. If a new relay is being installed, continue with the next step.
7. Attach the replacement relay and new relay gasket with machine screws inserted through the back of the case. Reinstall the output or supply gauge.
8. Connect the tubing, and check all connections for leaks. Perform the appropriate calibration procedures.

Relay Disassembly

Although the alignment tool shown in figure 17 is not required for assembly of the relay, using the tool will prevent excessive air consumption and dead band. If low air consumption and minimum dead band are required, make or purchase the alignment tool before

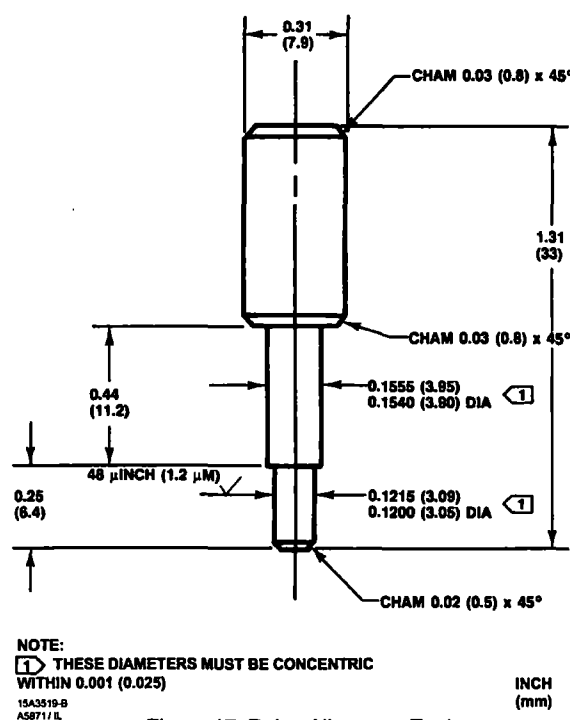


Figure 17. Relay Alignment Tool (Part Number 15A3519 X012)

disassembling the relay. Key numbers are shown in figure 23.

1. Remove the relay from the controller or transmitter case by following steps 1 through 5 of the relay replacement procedure.
2. Unscrew the orifice assembly (key 88). Remove the O-ring (key 90) from the orifice assembly.

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3. Remove the casing screws (key 96), casing assembly (key 85), and top diaphragm (key 91). On a high-temperature relay, also remove the top gasket (key 100) that covers the top diaphragm.

4. Remove the spacer ring (key 84), diaphragm assembly (key 86), and relay spring (key 92) from the relay body (key 83). On a high-temperature relay, also remove the bottom gasket (key 99) from underneath the diaphragm assembly.

5. Remove the screws (key 97), spring plate (key 95), spring plate gasket (key 94), spring (key 93), and valve plug (key 87).

6. Inspect the valve seats for roughness due to corrosion. One seat is located in the diaphragm assembly (key 86), and the other seat is located in the relay body (key 83).

Relay Assembly

1. Replace the diaphragm assembly or relay body if necessary. Inspect the diaphragms and gaskets, and replace them if necessary. Also replace the spring and valve plug if they show signs of corrosion. The lower diaphragm is part of the diaphragm assembly and must be replaced as an assembly. Clean all parts thoroughly before re-assembling.

2. Place the relay spring in the relay body and, on a high-temperature relay, install a bottom gasket. Install the diaphragm assembly, spacer ring, and top diaphragm on the body so that all flow passage holes are lined up. On a high-temperature relay, also install a gasket over the top diaphragm.

3. Put the casing assembly on the top diaphragm so that the lugs on the casing and spacer ring line up and are also lined up with the body lug.

4. Install the casing screws, but do not tighten.

5. If using an optional alignment tool (figure 17), insert the smaller end of the tool into the opening in the relay body. If the tool does not engage the hole in the diaphragm assembly, move the relay parts slightly to reposition the diaphragm assembly so that the alignment tool engages the hole in the diaphragm assembly. Do not remove the alignment tool until the casing screws have been tightened.

6. Tighten the casing screws (key 96) evenly. Remove the alignment tool if one was used.

7. Install the valve plug, spring, gasket, and cover plate (keys 87, 93, 94, and 95). Secure with the machine screws (key 97).

8. Install the O-ring (key 90) on the orifice assembly (key 88), and install the orifice assembly into the relay casing.

9. Install the relay as described in steps 7 and 8 in the relay replacement section.

Changing Output Signal Range

Use the following information and subsequent procedures when changing the output signal range of the controller or transmitter. Use the following procedure:

- **For a controller or transmitter**, use this procedure to change from a 3 to 15 psig (0.2 to 1.0 bar) to a 6 to 30 psig (0.4 to 2.0 bar) output signal range or vice versa.

- **For a differential gap controller**, use this procedure to change from a 0 and 20 psig (0 and 1.0 bar) to a 0 and 35 psig (0 and 2.4 bar) output signal range or vice versa.

- When changing the supply pressure source to a new range, refer to table 5 for supply pressure requirements for the output signal range selected.

Also, make appropriate changes to the nameplate of the controller or transmitter, reflecting the new range selections. Refer to figure 21 or 22 for key number locations unless otherwise directed.

1. Shut off the supply pressure and process lines to the controller or transmitter.

2. Disconnect the tubing from the mounting base (key 30) and calibration adjuster (key 41). Disconnect the tubing that connects the pressure block (key 8, figure 19 or 20) to the Bourdon tube or bellows assembly (key 62 or 71), at the pressure block end.

3. Unscrew the machine screws (key 28, figure 19 or 20), and remove the subassembly from the case.

4. If the controller or transmitter uses a Bourdon tube sensing element, disconnect the Bourdon tube from the beam (key 44) by removing the screw (key 63). Be careful to avoid losing the bearing (key 65). Unscrew the machine screws (key 77), and remove the washers and Bourdon tube (keys 76 and 62).

5. Unscrew the bellows screws (key 54) from each end of the mounting base (key 30). [Note: The bellows screws (key 54) have an O-ring (key 55, figure 18) installed beneath the bellows screw head. Remove the O-ring and obtain a replacement when re-assembling the bellows.]

6. Compress the bellows so that the end of the bellows and beam can be removed from the end of the mounting base (key 30) and unscrewed from the stud (key 51, not shown) that connects the bellows.

7. With the stud that connects the two bellows in place in the spacer (key 50), screw the new bellows onto the stud. Install new gaskets (key 53) on each bellows.

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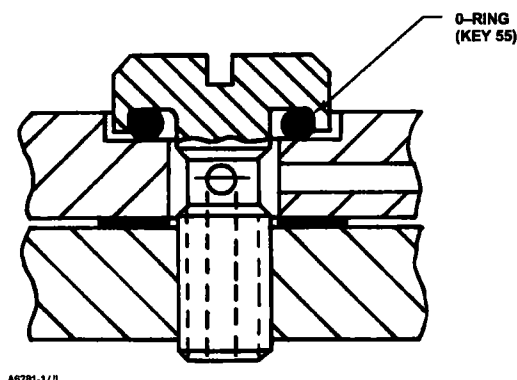


Figure 18. Bellows Screw Detail

Note

The bellows screw (key 54) has an O-ring (key 55) installed beneath the bellows screw head as shown in figure 18. Be sure this O-ring is in place before installing the screw into the mounting base.

8. Compress the bellows, and install them into the mounting base (key 30). With the beam parallel with the mounting base, secure the bellows with the bellows screws (key 54).
9. After tightening the bellows screws, make sure that the nozzle (key 57) is centered on the flapper (key 45).
10. Replace the subassembly in the case and secure with the machine screws (key 28, figure 19 or 20). Install the Bourdon tube if it was removed; refer to the Replacing Bourdon Tube section if needed. Reconnect all tubing.
11. Unscrew the supply and output gauges (key 13, figure 19 or 20) and install new gauges with correct ranges.
12. Check all tubing connections and the bellows machine screws for leaks, tighten as necessary. Perform the appropriate calibration procedures.

Parts Ordering

Whenever corresponding with the sales office or sales representative about this equipment, mention the serial number of the unit. The serial number can be found on the nameplate (key 22, figure 19). When ordering replacement parts, also state the complete 11-character part number of each part required as found in the following parts list.

Parts Kits

Key	Description	Part Number
Controller Repair Kits		
Kit contains keys 5, 9, 10, 21, 24, 45, 46, 53, 55, 56, 57, 58, 59, 60, 61, 63, 64, and 65		
	Standard Temperature	R4150 X00L12
	High Temperature	R4150 X00H22
Relay Repair Kits		
Kit contains keys 7, 85, 86, 87, 88, 90, 91, 92, 93, 94, 99, & 100 (Keys 99 & 100 are included in high temperature relay kits only)		
	Standard Temperature	RRELAYX0L12
	High Temperature	RRELAYX0H12
Relay Replacement Kits		
Kit contains key 7 & 43 and the replacement relay		
	Standard Temperature	RRELAYX0L22
	High Temperature	RRELAYX0H22

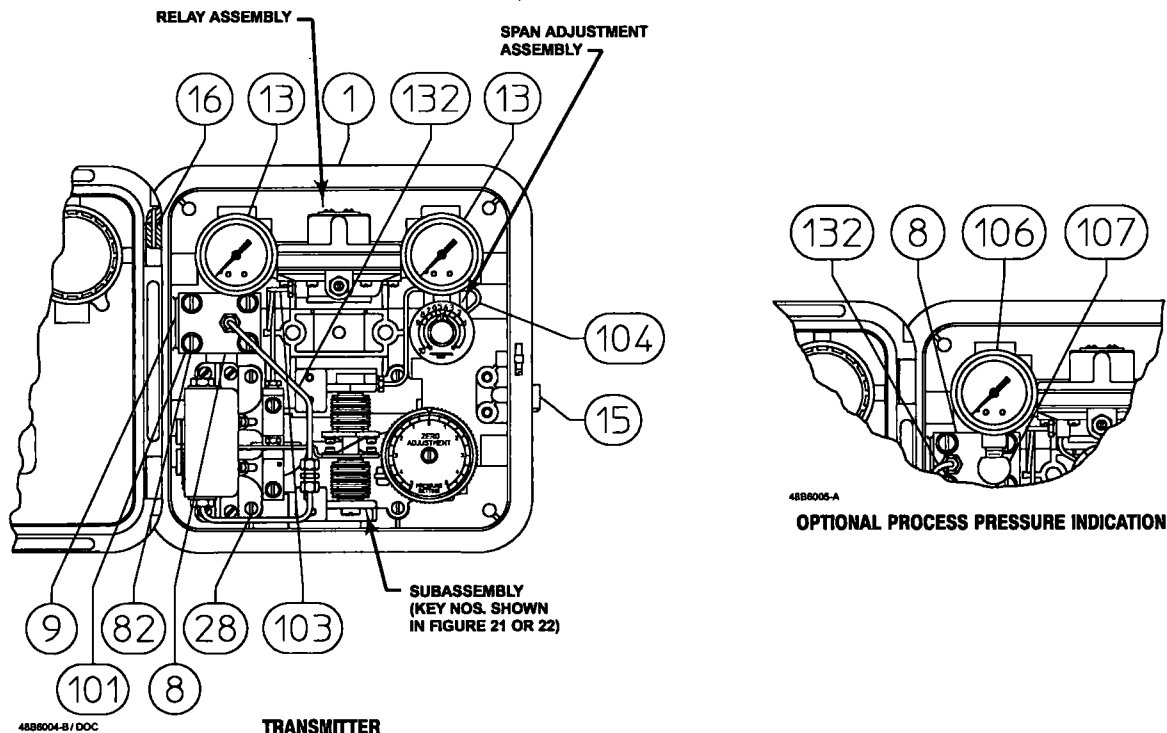
Parts List

Key	Description	Part Number
Assemblies (Figures 19, 20, and 23)		
Case and Cover Assembly, includes keys 1, 2, & 16		
	Std	47B9501 X012
	2 psig (0.14 bar) pressure tested case & cover	47B9501 X022
For converting controllers w/remote set point to new case and cover assembly		
	Type 4151K, 4153K, and 4159K	17B9974 X012
Case and Cover Assembly with anti-reset windup assembly, Use for converting existing Type 4160KF and 4162KF controllers to new anti-reset windup assembly		
includes keys 1, 2, 16, 127, 129, 186, & 367 thru 369		
	-40 to 160° F (-40 to 71° C)	27B9511 X012
	0 to 220° F (-40 to 104° C)	27B9511 X022
Proportional Band Valve or Span Adjustment Assembly		
	Std & High Temperature, aluminum	10A9122 X032
	Stainless steel construction	10A9122 X082
Reset Restriction Valve Assembly		
	Standard Temperature	
	For all except Type 4160KF & 62KF	19A4361 X012
	For Type 4160KF & 62KF	19A4363 X012
Relay Assembly		
(Refer to relay section of list for individual parts)		
	Standard Temperature	22B0463 X012
	High Temp, Type 4150K, 50KS, 52K, 52KS, 57K, 60K, 62K, & 64K	22B0462 X012
	w/sst instrument construction	
	Standard Temp	22B0463 X032
	High Temp, Type 4150K, 50KS, 57K, 60K	22B0462 X022

Common Parts (Figures 19 through 22)

1	Case Ass'y, aluminum	
	For all 4150K and 4160K Series, std or 2 psi (0.14 bar) pressure tested case & cover	47B9513 X012
2	Cover, Ass'y aluminum	
	Std	47B9512 X012
	For 2 psi (0.14 bar) pressure tested case & cover	47B9512 X022
7*	Relay Gasket, for all series	
	Std Temp, neoprene	1C8974 03012
	High Temp, silicone	1N8738 04142

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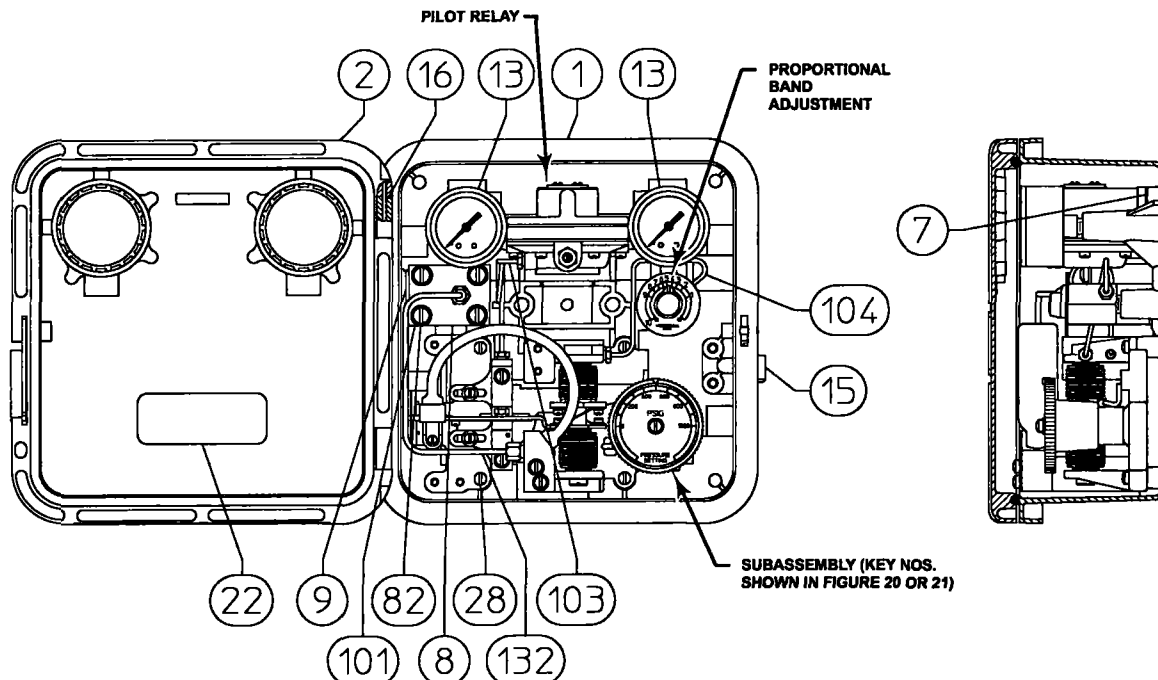
NOTE:
KEYS 10, 81, 105 AND 108
ARE NOT SHOWN

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Figure 19. Typical Direct-Acting 4150K Series Assembly

Key	Description	Part Number	Key	Description	Part Number
8	Control Pressure Block		13*	Output Pressure Gauge, w/process pressure gauge (1/8-inch connecting stem) (1 req'd)	
	For gauge pressure instruments, sst w/o process pressure gauge	16A0979 X012		Triple scale	
	w/process pressure gauge	1J2510 35072		0-30 psig, 0-0.2 MPa, & 0-2.0 bar	11B8577 X012
	For differential pressure instruments, sst	1H6730 35072		0-60 psig, 0-0.4 MPa, & 0-4.0 bar	11B8577 X022
9*	O-Ring, nitrile, for all series	1C3762 06992	14*	Supply Pressure Gauge, w/process pressure gauge (1/4-inch connecting stem), ABS plastic, black enamel/polycarbonate/nitrile	
10*	Gasket, neoprene, for all series	1C3286 03012		Triple scale	
11*	Sealing Washer (not shown) Use w/2 psi (0.14 bar) pressure-tested case & cover (2 req'd)	1J1869 99012		0-30 psig, 0-0.2 MPa, & 0-2.0 bar	11B8579 X022
				0-60 psig, 0-0.4 MPa, & 0-4.0 bar	11B8579 X032
Note			15	Vent Ass'y	27A5516 X012
	Key 13 is used as both a supply gauge and an output gauge on units without a process pressure gauge. A quantity of 2 is required for these units. On units with a process pressure gauge (key 106), key 13 is used for the output gauge. A quantity of 1 is required for these units.		16	Roll Pin, sst (2 req'd)	1H2888 28992
	Use key 14 for supply pressure indication when a process pressure gauge is installed. Key 14 installs on the supply pressure regulator.		22	Plate, Instruction, aluminum	12B6338 X0A2
13*	Supply & Output Pressure Gauge, w/o process pressure gauge (1/8-inch connecting stem), ABS plastic, black enamel/polycarbonate/nitrile (2 req'd)		28	Machine Screw, steel pl (4 req'd)	1E9854 28982
	Dual scale		30	Mounting Base, aluminum	26A7668 X012
	0-30 psig & 0-2.0 kg/cm ²	11B8577 X042	31	Flexure Strip, sst	1C8978 36012
	0-60 psig & 0-4.0 kg/cm ²	11B8577 X052	32	Flexure Strip Washer, steel pl (2 req'd)	16A7671 X012
	Triple scale		33	Machine Screw, steel pl (4 req'd)	14B4995 X012
	0-30 psig, 0-0.2 MPa, & 0-2.0 bar	11B8577 X012	34	Pressure Set Arm, steel pl	36A7669 X012
	0-60 psig, 0-0.4 MPa, & 0-4.0 bar	11B8577 X022	35	Rotary Spring, sst	1J4234 37022
			36	Knob, Rytan	36A7670 X012
			37	Knob Spring, steel pl	1C2215 27022
			38	Dial, aluminum	
				For Bourdon tube controllers	
				0-30 psig	16A7662 X012
				0-60 psig	16A7662 X022
				0-100 psig	16A7662 X032
				0-150 psig	16A7662 X412
				0-200 psig	16A7662 X042
				0-300 psig	16A7662 X052

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NOTE:

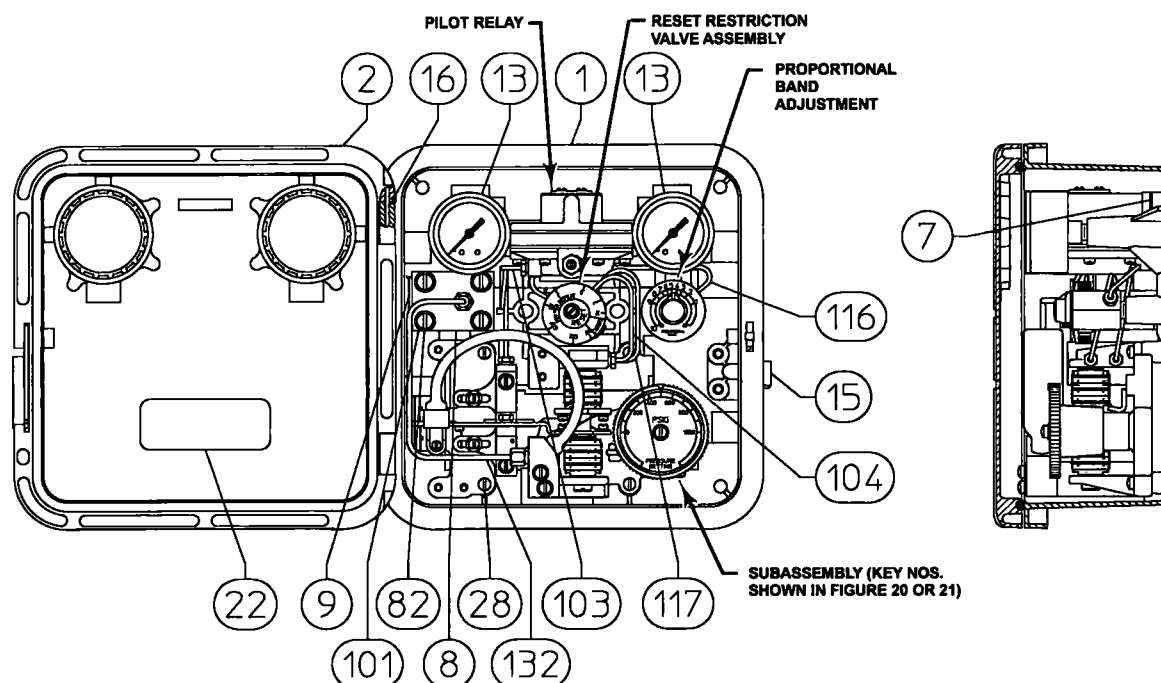
KEYS: 10, 81, 105 NOT SHOWN
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PROPORTIONAL-ONLY CONTROLLER

Figure 19. Typical Direct-Acting 4150K Series Assembly (Continued)

Key	Description	Part Number	Key	Description	Part Number
38	Dial, aluminum		38	Dial, aluminum	
	For Bourdon tube controllers (con't)			For Bourdon tube controllers (con't)	
	0-600 psig	16A7662 X062		0-200 bar	16A7662 X522
	0-1000 psig	16A7662 X072		0-350 bar	16A7662 X532
	0-1500 psig	16A7662 X082		0-550 bar	16A7662 X542
	0-3000 psig	16A7662 X092		0-700 bar	16A7662 X552
	0-5000 psig	16A7662 X102		For bellows sensing element controllers	
	0-8000 psig	16A7662 X112		Gauge pressure	
	0-10,000 psig	16A7662 X122		0-60 inches wc	16A7662 X282
	0-200 kPa	16A7662 X142		0-140 inches wc	16A7662 X292
	0-400 kPa	16A7662 X152		0-5 psig	16A7662 X302
	0-700 kPa	16A7662 X162		0-10 psig	16A7662 X312
	0-1400 kPa	16A7662 X172		0-15 psig	16A7662 X322
	0-2000 kPa	16A7662 X182		0-20 psig	16A7662 X332
	0-4000 kPa	16A7662 X192		0-30 psig	16A7662 X012
	0-7000 kPa	16A7662 X202		0-200 kPa	16A7662 X142
	0-10,000 kPa	16A7662 X212		0-10 inches Hg vacuum	16A7662 X342
	0-20,000 kPa	16A7662 X222		0-30 inches Hg vacuum	16A7662 X352
	0-35,000 kPa	16A7662 X232		30-30 inches wc compound	16A7662 X362
	0-55,000 kPa	16A7662 X242		15 in. Hg vacuum-0-7.5 psig compound	16A7662 X372
	0-70,000 kPa	16A7662 X252		30 in. Hg vacuum-0-15 psig compound	16A7662 X382
	0-100%	16A7662 X272		0-60 inches wc vacuum	16A7662 X392
	0-2 bar	16A7662 X482		Differential pressure	
	0-4 bar	16A7662 X442		0-80 inches wc	16A7662 X402
	0-7 bar	16A7662 X472		0-10 psig	16A7662 X312
	0-14 bar	16A7662 X462		0-20 psig	16A7662 X332
	0-20 bar	16A7662 X492		0-30 psig	16A7662 X012
	0-40 bar	16A7662 X452		0-200 kPa	16A7662 X142
	0-70 bar	16A7662 X502		0-2 bar	16A7662 X482
	0-100 bar	16A7662 X512		For all Type 4155K, 57K, & 58K transmitters	16A7664 X012

4150K and 4160K Series



**PROPORTIONAL-PLUS-RESET CONTROLLER
WITHOUT ANTI-RESET WINDUP**

NOTE:

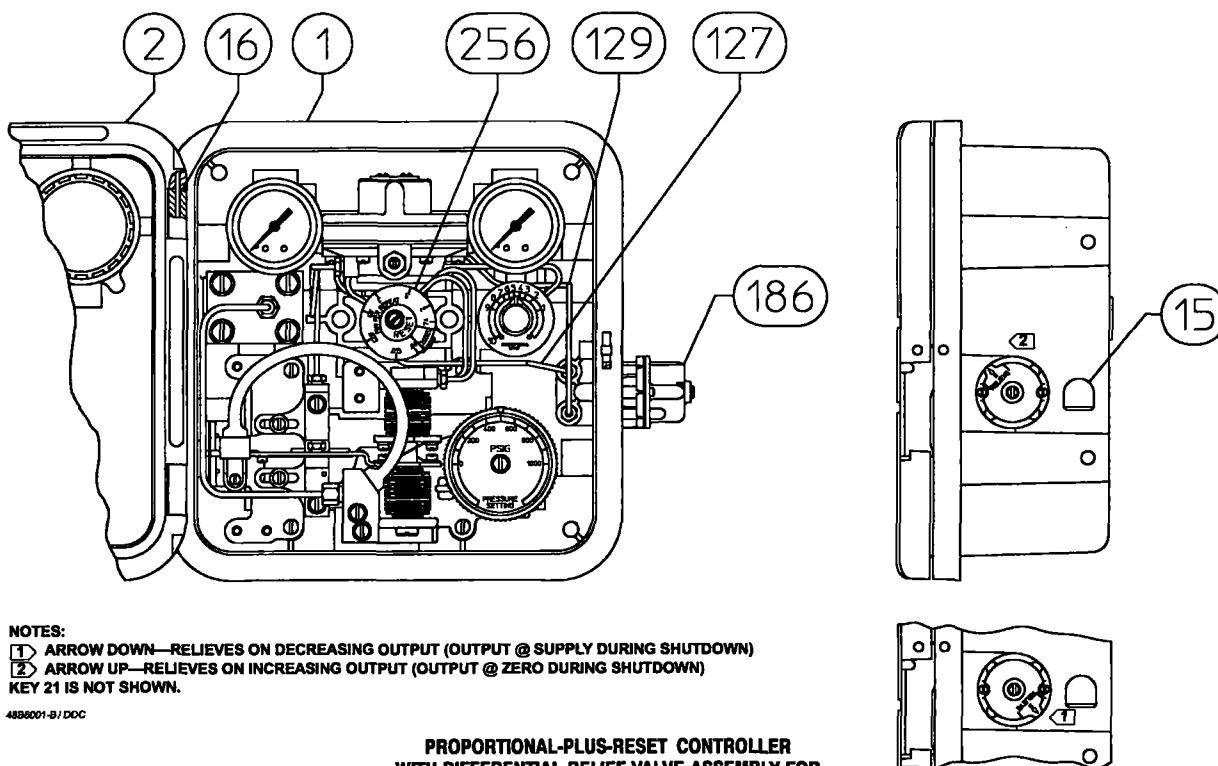
KEYS: 10, 81, 105, 115 NOT SHOWN

4886002-A
B2653-1/1L

Figure 20. Typical Direct-Acting 4160K Series Assembly

Key	Description	Part Number	Key	Description	Part Number
39	Washer, steel pl	1R9820 25072	<p>Note</p> <p>A total of 5 O-rings (key 55) are used. 1 O-ring is used under the sealing screw (key 56), 1 O-ring is used under the reversing blockscrew (key 61), 1 O-ring is used between the reversing block ass'y (key 59) and the calibration adjustor (key 41), and 1 O-ring is used in the recessed area under the head of each of the bellows screws (key 54).</p>		
40	Machine Screw, steel pl	1E1758 28982			
41	Calibration Adjuster, steel pl	2H2662 44012			
42	Washer, steel (2 req'd)	1E8730 28992			
43	Machine Screw, steel pl (2 req'd)	1A5733 X0012			
44	Beam, steel	1H2668 25072	55*	O-Ring,	
45	Flapper, Invar	1H2669 41132		Std Temp, nitrile (5 req'd)	1D6875 06992
46	Machine Screw, steel pl	1B2751 28992		High Temp, fluoroelastomer (5 req'd)	1N4304 06382
47	Cross Spring, sst (2 req'd)	1H2660 37032	56	Sealing Screw, sst	14A5721 X012
48	Washer, steel pl (4 req'd)	1H2671 28982	57*	Nozzle, sst	1U6391 35132
49	Machine Screw, steel pl (4 req'd)	1A3461 28982	58*	Nozzle O-Ring,	
50	Spacer, zinc	1H2659 44012		Std Temp, nitrile	1E2226 06992
51	Bellows Stud, brass (not shown)	1H2658 14012		High Temp, fluoroelastomer	1N8387 06382
52*	Feedback Bellows Ass'y		59	Reversing Block, steel pl	26A0975 X012
	Brass		60	Sleeve, Delrin	16A0976 X012
	3-15 psig (0.2-1.0 bar) (2 req'd)	14A5726 X012	61	Reversing Block Screw, sst	24A5720 X012
	6-30 psig (0.4-2.0 bar) (2 req'd)	14A5726 X032	62*	Bourdon Tube	See following table
	Stainless steel		63	Machine Screw, steel pl	
	3-15 psig (0.2-1.0 bar) (2 req'd)	14A5726 X022		Bourdon tube instruments only (2 req'd)	1A3319 28982
	6-30 psig (0.4-2.0 bar) (2 req'd)	14A5726 X042	64*	Connecting Link, Bourdon tube instruments only	
53*	Gasket			Std., Monel	1L3796 41012
	Std Temp, neoprene (2 req'd)	1D3970 03012		Bourdon tube w/optional travel stop,	
	High Temp, silicone (2 req'd)	1N8736 04142		Stainless steel	1L6112 35022
54	Bellows Screw (2 req'd)		65*	Link Bearing, sst	
	Brass	22B8036 X012		Bourdon tube instruments only (2 req'd)	1L3795 46202
	Stainless steel	22B8036 X022	66	Travel Stop Assembly, steel	
				optional w/Bourdon tube	1H7793 000A2

4150K and 4160K Series



**PROPORTIONAL-PLUS-RESET CONTROLLER
WITH DIFFERENTIAL RELIEF VALVE ASSEMBLY FOR
ANTI-RESET WINDUP**

Figure 20. Typical Direct-Acting 4160K Series Assembly (Continued)

Key	Description	Part Number	Key	Description	Part Number
67	Lockwasher, steel pl (2 req'd) Use w/optional Bourdon tube travel stop	1H2672 28982	71*	Differential-Pressure Bellows (input) Brass 0-80 inches wc (0-200 mbar) 0-10 psi (0-0.7 bar) 0-20 psi (0-1.4 bar) Stainless steel, 0-30 psi (0-2.0 bar)	2L3790 000A2 2L3791 000A2 2L3792 000A2 2L3793 000A2
68	Machine Screw, steel pl (2 req'd) Use w/optional Bourdon tube travel stop	1H2676 28982	71K	Machine Screw, steel pl ⁽³⁾ bellows sensing instruments only (2 req'd)	1A3319 28982
69	Cap Screw, steel pl Use w/optional Bourdon tube travel stop	1H7792 32982	71L*	Bearing ⁽³⁾ bellows sensing instruments only (2 req'd)	1L3795 46202
70	Bellows Yoke, zinc Use w/gauge & differential pressure bellows	2H4538 44012	71M*	Link ⁽³⁾ bellows sensing instruments only	1L3796 41012
71*	Gauge Pressure Bellows (input) ⁽²⁾ Brass 0-60 inches wc (0-150 mbar) positive, 6-60 inches wc (0-150 mbar) vacuum, & 30-0-30 inches wc (75-0-75 mbar) compound	1L3780 000A2	72	Jam Nut, steel pl Gauge pressure bellows instruments only	1A9463 24122
	0-100 inches wc (0-250 mbar) positive, Type 4158K only	1L3788 000A2	73	Washer, steel pl Gauge pressure bellows instruments only	1B8659 28982
	0-5 psig (0-0.35 mbar) positive and for 0-10 inches Hg (0-350 mbar) vacuum	1L3781 000A2	74	Spring Seat, pl brass Gauge pressure bellows instruments only	1H4532 14022
	0-7.5 psig (0-0.5 bar) positive, 4158K only	1L3789 000A2	75	Machine Screw, steel pl Gauge & differential pressure bellows instruments (4 req'd)	1H2676 28982
	0-10 psig (0-0.7 bar) positive	1L3782 000A2	76	Washer, steel pl for Bourdon tube instruments (2 req'd) for bellows sensing instruments (4 req'd)	1H2672 28982 1H2672 28982
	0-15 psig (0-1.0 bar) positive, 0-30 inches Hg (0-1.0 bar) vacuum, & 15-0-7.5 psig (500-0-500 mbar) compound	1L3783 000A2	77	Machine Screw, steel pl Bourdon tube instruments only (2 req'd)	1H2677 28982
	0-20 psig (0-1.4 bar) positive	1L3784 000A2			
	0-30 psig (0-2.0 bar) positive & 30-0-15 psig (1.0-0-1.0 bar) compound	1L3785 000A2			
	Stainless steel, 0-15 psig (0-1.0 bar) positive, 0-30 inches Hg (0-1.0 bar) vacuum, & 15-0-7.5 psig (500-0-500 mbar) compound	1L3786 000A2			
	0-30 psig (0-2.0 bar) positive, 30-0-15 psig (1.0-0-1.0 bar) compound	1L3787 000A2			

*Recommended spare parts

2.If ordering the bellows (key 71) to change the range of a gauge pressure controller, also order the appropriate bellows spring (key 80). Also order keys 72, 73, and 74, if you do not have them.

3.This part is part of the bellows assembly, key 71

4150K and 4160K Series

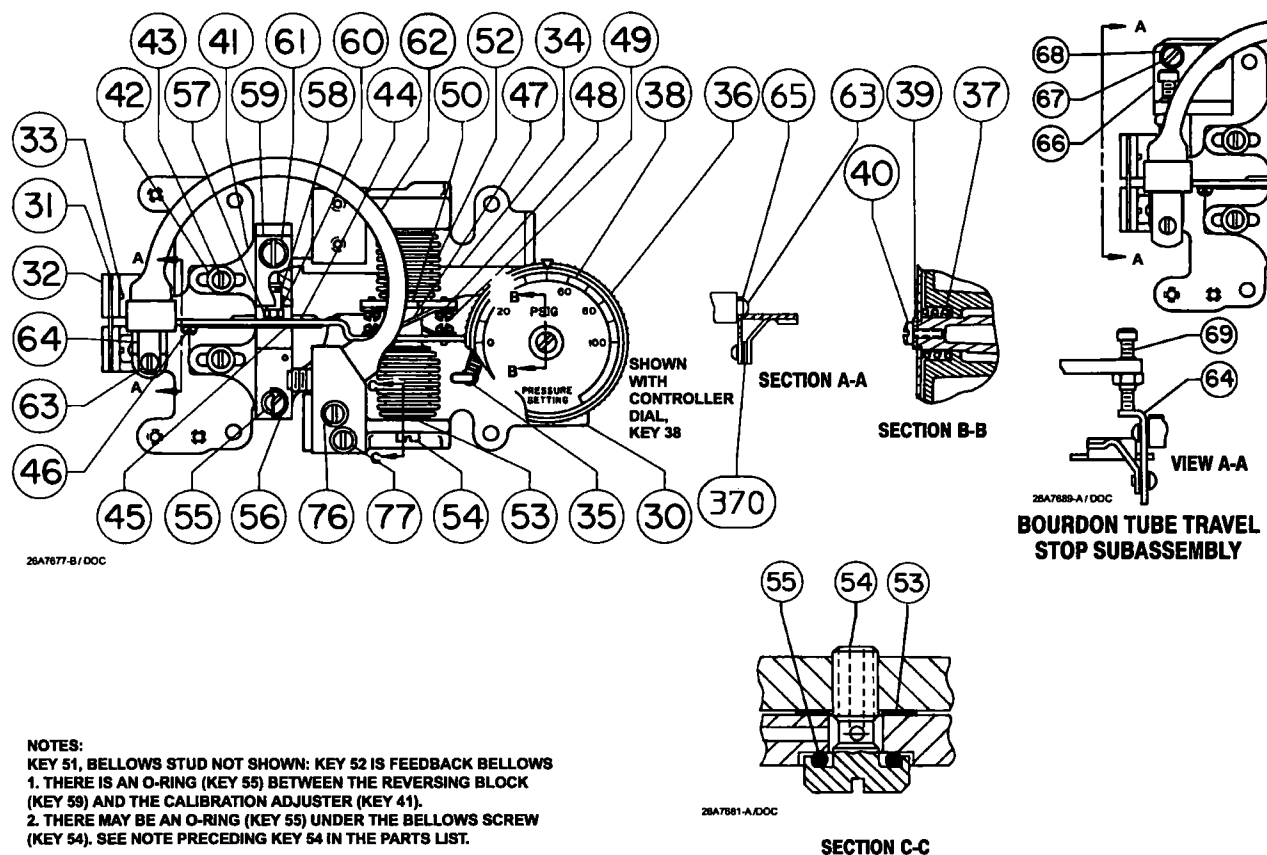


Figure 21. Controller Subassembly with Bourdon Tube Sensing Element

Key	Description	Part Number	Key	Description	Part Number
79	Screw, nylon Transmitters only	1A3461 X0042	80	Spring, gauge pressure bellows instruments only (cont'd)	
80	Spring, gauge pressure bellows instruments only			316 SST	
	Steel pl			0-15 psig (0-1.0 bar) positive,	
	0-60 inches wc (0-150 mbar) positive,			0-30 inches Hg (0-1.0 bar) vacuum,	
	0-60 inches wc (0-150 mbar) vacuum,			15-0-7.5 psig (500-0-500 mbar) compound	1H6411 37012
	30-0-30 inches wc, &			0-30 psig (0-2.0 bar) positive,	
	(75-0-75 mbar) compound	1J7292 27022		30-0-15 psig (1.0-0-1.0 bar) compound	1H6412 37012
	0-100 inches wc (0-250 mbar) positive,		81	Machine Screw, steel pl (not shown) (2 req'd)	1H5271 28982
	0-5 psig (0-0.35 bar) positive, &		82	Machine Screw, steel pl (4 req'd)	1C3333 28982
	0-10 inches Hg (0-350 mbar) vacuum	1H4482 27022	101	Lockwasher, steel pl (4 req'd)	1C2256 28982
	0-7.5 psig (0-0.5 bar) positive	1K5257 27022	103	Relay Tubing Assembly, sst	1H6861 000A2
	0-10 psig (0-0.7 bar) positive	1K4934 27022	104	Compensator Tubing Assembly, sst	
	0-15 psig (0-1.0 bar) positive,			Types 4150K, 50KS, 52K, 52KS,	
	0-30 inches Hg (0-1.0 bar) vacuum,			54K, 55K, 57K, & 58K	1H6864 000A2
	15-0-7.5 psig (500-0-500 mbar) compound	1H4483 27022		Types 4160K, 60KF, 62K, 62KF & 64K	1H6870 000A2
	0-20 psig (0-1.4 bar) positive	1K5259 27022	105	Plug, S31600 (316 SST), (not shown)	
	0-30 psig (0-2.0 bar) positive,			used with gauge pressure only	1A7675 35072
	30-0-15 psig (1.0-0-1.0 bar) compound	p1H4484 27022			

Note

Controllers with bellows sensing element use only the 0 to 30 psig, 0 to 0.2 MPa, & 0 to 2.0 bar triple scale brass and stainless steel process pressure gauges. Differential pressure controllers do not use a process pressure gauge.

4150K and 4160K Series

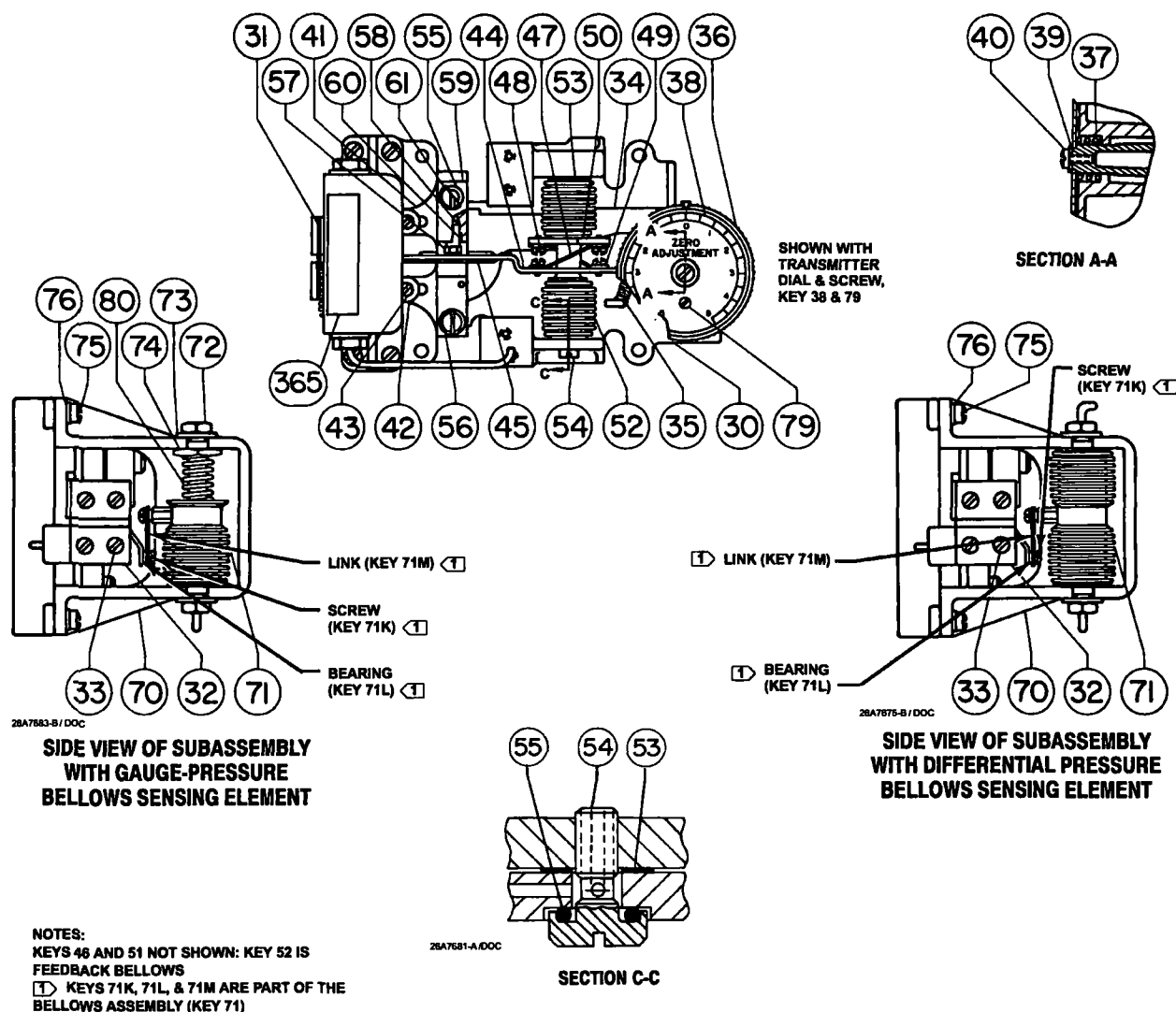


Figure 22. Controller Subassembly with Either Gauge-Pressure Bellows or Differential-Pressure Bellows Sensing Element

Key	Description	Part Number	Key	Description	Part Number
106*	Process Pressure Gauge (use only when specified)		115	Mounting Screw for reset restriction valve	
	Triple scale			Type 4160K, 60KF, 62K, 62KF, & 64K	
	ABS plastic/Brass			1/4-20 UNC, steel pl (not shown)	1H5270 28982
	0-30 psig, 0-0.2 MPa, & 0-2.0 bar	11B8578 X012	116	Reset Tubing Ass'y, sst	
	0-60 psig, 0-0.4 MPa, & 0-4.0 bar	11B8578 X022		Type 4160K, 60KF, 62K, 62KF, & 64K	1H6866 000A2
	0-160 psig, 0-1.1 MPa, & 0-11 bar	11B8578 X032	117	Compensator Tubing Ass'y, sst	1H6868 000A2
	0-300 psig, 0-2.0 MPa, & 0-20 bar	11B8578 X042	127	Tubing Assembly, sst	
	0-600 psig, 0-4.0 MPa, & 0-40 ba	11B8578 X052		Type 4160KF & 4162KF only	27B9975 X012
	0-1000 psig, 0-6.9 MPa, & 0-69 bar	11B8578 X062	129	Tubing Assembly, sst	
	ABS plastic/Stainless steel			Type 4160KF & 4162KF only	27B9976 X012
	0-30 psig, 0-0.2 MPa, & 0-2.0 bar	11B8584 X022	132	Control Tubing Assembly	
	0-300 psig, 0-2.0 MPa, & 0-20 bar	11B8584 X012		For Bourdon tube instruments	
	0-1000 psig, 0-6.9 MPa, & 0-69 bar	11B8584 X032		w/o process pressure gauge	1H3011 000A2
107	Pressure Connection, sst			Stainless steel	1H3011 X0022
	Use w/process gauge	1J2512 35162		K-Monel (not used on Type 4151K)	1J2530 000A2
108	Pipe Plug, steel pl (not shown)			w/process pressure gauge, sst	
	Use w/process gauge,			For gauge-pressure bellows instruments, sst	
	not used w/Bourdon tube protector	1E8231 28982		w/o process pressure gauge	1H4526 000A2
				w/process pressure gauge	1J2553 000A2

4150K and 4160K Series

Key	Description	Part Number
132	Control Tubing Assembly (cont'd) For differential-pressure bellows instruments, sst	1H4526 000A2
133	Control Tubing Assembly, sst For differential-pressure instruments only	1H6732 000A2
167	Label, Use w/2 psi (0.14 bar) pressure-tested case & cover	12A9842 X012
186	Anti-Reset Windup Ass'y For Type 4160KF & 4162KF	21A6447 X0A2
365	Label, bellows sensing instruments only Gauge pressure instruments 0-60 inches wc	11B5655 X062
	0-100 inches wc	11B5655 X272
	0-140 inches wc	11B5655 X082
	0-5 psig	11B5655 X012
365	Label, bellows sensing instruments only Gauge pressure instruments (cont'd) 0-7.5 psig	11B5655 X262
	0-10 psig	11B5655 X022
	0-15 psig	11B5655 X032
	0-20 psig	11B5655 X042
	0-30 psig	11B5655 X052
	Differential pressure instruments 0-80 inches wc	11B5655 X222
	0-10 psi	11B5655 X232
	0-20 psi	11B5655 X242
	0-30 psi	11B5655 X252
366	Pipe Plug, Use w/2 psi (0.14 bar) pressure-tested case & cover (2 req'd)	1P2796 X0012
367*	O-Ring Type 4160KF & 4162KF only (2 req'd)	1C8538 06992
368	Machine Screw Type 4160KF & 4162KF only (2 req'd)	1U8842 X0012
369	Anti-Reset Windup Cover Type 4160KF & 4162KF only (2 req'd)	2V5973 08012
370	Plain Washer, brass	1H3397 18992

Relay Assembly (figure 23)

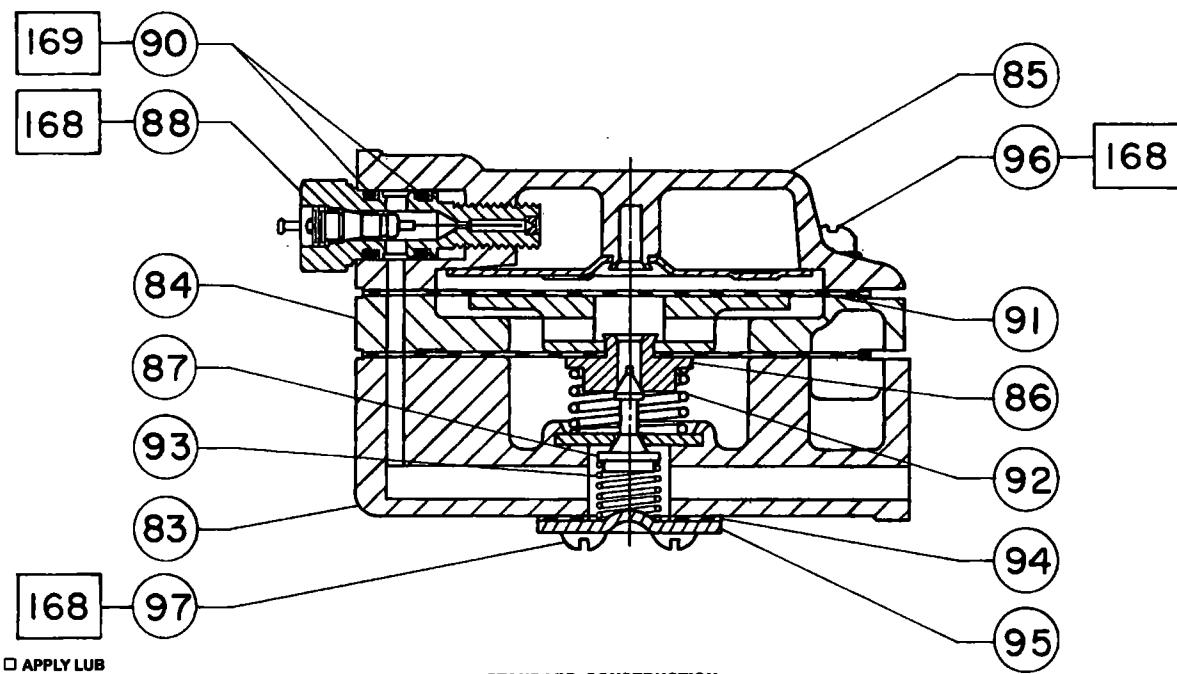
83	Relay Body, Aluminum/brass Use w/sst construction	48A3776 X012 48A3776 X032
84	Spacer Ring, zinc	38A3778 X012
85	Diaphragm Casing Ass'y zinc/steel	12B0460 X012
86*	Diaphragm Ass'y Std Zinc/brass/rubber High Temp Zinc/brass/rubber Std or High Temp w/sst construction Zinc/sst/rubber	18A2451 X012 18A2451 X092 18A2451 X042
87*	Valve Plug Brass (For std or high temp) For use w/sst construction	0Y0617 14012 0Y0617 X0022
88*	Reset Plug and Wire Assembly	12B0468 X012
90*	O-Ring Std Temp, nitrile (2 req'd) High Temp, fluoroelastomer	1D6875 06992 1N4304 06382
91*	Top Diaphragm Std Temp, nitrile High Temp, poly-dacr	1L5556 02042 1K6999 X0012
92	Relay Spring, steel pl	1C8961 27012
Key	Description	Part Number
93	Valve Spring, SST	0X0836 37022
94*	Plate Gasket Std Temp, neoprene High Temp, silicone	1H2696 03012 1K7000 04142
95	Spring Plate, steel pl	1H2697 25072
96	Machine Screw, steel pl (6 req'd)	12B6351 X012

Key	Description	Part Number
97	Machine Screw, steel pl (4 req'd)	1A8664 X00A2
99*	Bottom Gasket, silicone High Temp construction only	1K7001 04142
100*	Top Gasket, silicone High Temp construction only	1K7002 04142
168	Lubricant, Lubriplate, not furnished with controller	
169	Lubricant, DOW Corning 111, not furnished with controller	

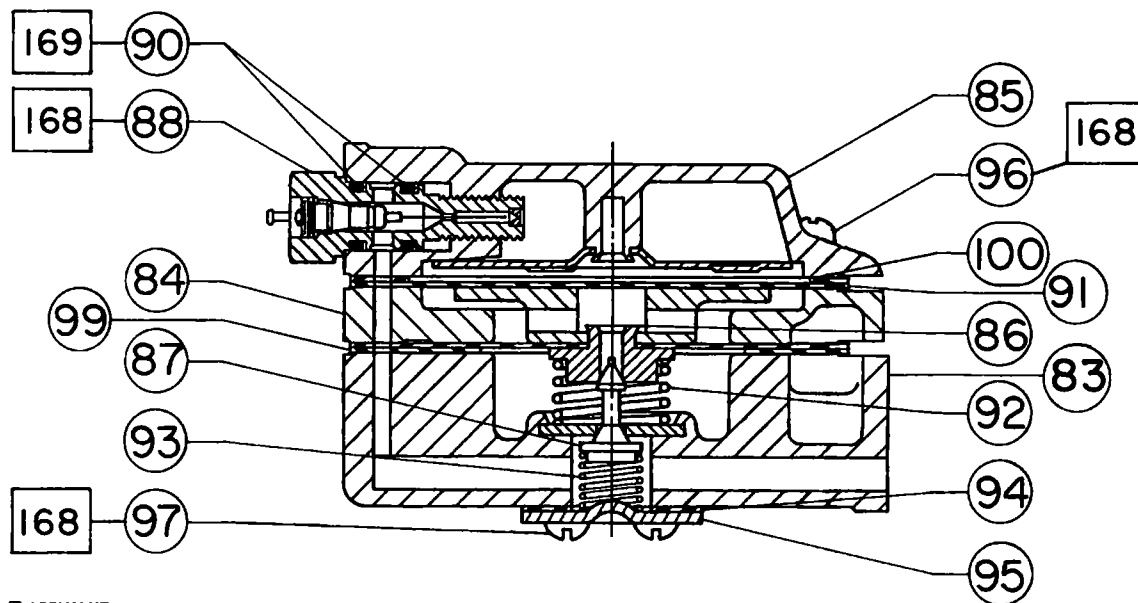
Mounting Parts for Panel, Wall, Pipestand, or Actuator Mounting (Figures 3 and 4)

213	Mounting Plate, steel For yoke mounting on Types 470, 472, 513, 656, 657 & 667 For yoke mounting on Type 480 Vertical Horizontal For yoke mounting on Types 1051 & 1052 Size 40, positions 1 & 3 w/switch and Size 60, position 1 w/switch	1C2218 25022 3L2767 25092 3J8547 25012 23A8891 X012
213	Mounting Plate, steel (cont'd) All others For yoke mounting on Type 1061 Size 30, positions 1 & 3 w/switch and position 1 w/o switch, Size 40, position 1 w/switch and Sizes 80 & 100, position 3 w/o switch All others For pipe stand mounting For mounting on Type 115 For mounting on Type 115C	1C2218 25022 23A8891 X012 1C2218 25022 3N9757 25092 3J7798 25012 2K6548 25022
215	Machine Screw, steel pl (specify quantity req'd) 5/16 UNC X 1 inch 5/16 UNC X 1-1/2 inches 5/16 UNC X 2 inches	1C6391 28982 1H3047 28982 1C6392 28982
216	Hex Nut, steel pl (specify quantity req'd) For casing mounting on Types 126 & 127 and for filter regulator mounting on Types 1051, 1052 & 1061 All other types and mountings	1A3527 24122 1C3328 28982
220	Mounting Bracket, steel pl (not shown) For casing mounting on Types 126, 127, 657, 667, 1051 & 1052 and for casing-mounted filter regulator on Types 1051 & 1052	1F4012 25072 1C2257 28982
221	Lockwasher, steel pl (specify quantity req'd)	
222	Cap Screw, steel pl (specify quantity req'd) 5/16 UNC X 3/4 inch	1A3816 24052
222	Cap Screw, steel pl (con't) 5/16 UNC X 1 inch 5/16 UNC X 1-1/8 inches 5/16 UNC X 1-1/4 inches 5/16 UNC X 1-3/4 inches 5/16 UNC X 2-1/2 inches 5/16 UNC X 3-5/8 inches 3/8 UNF X 1-1/8 inches	1A3526 24052 1C3791 24052 1B7877 24052 1A5534 24052 1C8702 24052 1C3988 24052 1A5828 24052
223	Cap Screw, steel pl Types 1051 & 1052 with either case or yoke mounted regulator and Type 1061 with yoke mounted regulator (2 req'd)	T14109 T0012

4150K and 4160K Series



STANDARD CONSTRUCTION



HIGH TEMPERATURE CONSTRUCTION

Figure 23. Relay Assemblies

Key	Description	Part Number	Key	Description	Part Number
228	Spacer Spool, steel (specify quantity req'd) Types 470, 472, 480, 513, 656, 657, 667, pipe stand 1051, 1052 & 1061 Type 115 W/o regulator or w/one regulator W/two regulators Type 115C	1F9067 24092 1K1534 24092 1K4144 24092 1K6547 24092	229	Cap Screw, steel pl (not shown) (specify quantity req'd) Type 115 W/o regulator or w/one regulator W/two regulators Type 115C Types 126 & 127 Types 1051 & 1052 casing-mounted controller	1F9603 24052 1C8702 24052 1D7704 24052 1B2275 24052 1A5828 24052

4150K and 4160K Series

Key	Description	Part Number	Key	Description	Part Number
230	Cap Screw, steel pl (not shown) Types 126 & 127	1C5958 24052	244	Pipe Nipple, pl galvanized steel (not shown) For mounting on Types 470, 472, 480, 513, 656, 657, panel, pipe stand, 1051, 1052 & 1061 w/nipple-mounted filter regulator	1D2397 26232
231	Pipe Nipple, steel (not shown) (specify quantity req'd) For casing mounting on Types 126 & 127 W/Types 67FR, 67R, 254, 254F & 1301	11A3740 X012	250	Clamp, Steel For pipe stand mounting (2 req'd)	1P4270 28982
232	Pipe Tee, steel (not shown) For casing mounting on Types 126 & 127 W/Types 67R, 254 & 1301	1B8606 X0012	251	Bracket Assembly, steel For panel or wall mounting (2 req'd)	1H2892 000A2
238	Mounting Plate, steel For yoke-mounted filter regulator Types 1051, 1052 & 1062 sizes 40 & 60 Types 1061 size 30	1C2218 25022 23A8891 X012	252	Cap Screw, steel pl For panel or wall mounting (4 req'd)	1B8480 24052
240	Cap Screw, steel For yoke-mounted filter regulator on Types 1051 & 1052 sizes 40 & 60 (2 req'd)	1A5534 24052	Note		
241	Spacer Spool, steel For yoke mounted filter regulators on Types 1051 & 1052 sizes 40 & 60 (2 req'd)	1C5590 24092	Specify quantity of fittings.		
242	Spacer Spool, steel (not shown) For yoke mounting on Types 1051 & 1052 size 40 (2 req'd) Type 1061 sizes 30, 80 & 100 (2 req'd)	1V1026 24092 1J8307 24092	Connector, Brass 1/8 inch NPT X 1/4 inch od tubing 1/4 inch NPT X 1/4 inch od tubing 1/4 inch NPT X 3/8 inch od tubing	1A3959 14012 1A6368 14012 1B8856 18992	
243	Street Elbow, pl galvanized malleable iron (not shown) For mounting on Types 470, 472, 480, 513, 656, 657, 667, panel, pipe stand, 1051, 1052 & 1061 w/nipple-mounted filter regulator	1A9132 21992	Elbow, Brass 1/8 inch NPT X 1/4 inch od tubing 1/4 inch NPT X 1/4 inch od tubing 1/4 inch NPT X 3/8 inch od tubing	1A6850 18992 1A3971 18992 1B8846 18992	

Key 62* Bourdon Tube

PRESSURE RANGE		MATERIAL	
Psig	kPa	Stainless Steel	K-Monel ⁽¹⁾
0-30	0-200	32B1243X012	---
0-60	0-400	32B1243X022	---
0-100	0-700	32B1243X032	---
0-200	0-1400	32B1243X042	---
0-300	0-2000	32B1244X052	---
0-600	0-4000	32B1244X062	32B1244X202
0-1000	0-7000	32B1244X072	32B1244X212
0-1500	0-10,000	32B1245X082	32B1245X222
0-3000	0-20,000	32B1245X092	---
0-5000	0-35,000	32B1245X102	---
0-8000	0-55,000	32B1245X112	---
0-10,000	0-70,000	32B1245X122	---

1. For NACE applications.

A subassembly with Bourdon tube sensing element as shown in figure 21 contains the following key numbers: 30 through 37, 39 through 61, 63, 65, 76, and 77. When ordering the subassembly as indicated by the

table below, one of each of the following key numbered parts must also be ordered to complete the subassembly: dial, key 38; Bourdon tube, key 62; and connecting link, key 64.

Subassemblies with Bourdon Tube Sensing Element

OUTPUT PRESSURE RANGE		FEEDBACK BELLOWS MATERIAL	STANDARD	HIGH TEMPERATURE
Psig	Bar			
3 to 15 or 0 and 20 differential gap	0.2 to 1/0 or 0 and 1.4 differential gap	Brass	26A7677 X012	26A7677 X022
		Stainless steel	26A7677 X052	26A7677 X062
6 to 30 or 0 and 35 differential gap	0.4 to 2.0 or 0 and 2.4 differential gap	Brass	26A7677 X032	26A7677 X042
		Stainless steel	26A7677 X072	26A7677 X082

A subassembly with gauge pressure bellows sensing element as shown in figure 22 contains the following key numbers: 30 through 37, 39 through 61, 71K, and 71L. The machine screws, key 77, quantity of 2, and washers, key 76, quantity of 2, also come with the subassembly. The two washers, key 76, may be used

with the machine screws, key 75, but four washers and machine screws are required so two more washers must be ordered. The machine screws, key 77, are not used on subassemblies with bellows input so they may be discarded. Although two machine screws, key 71K, and two bearings, key 71L, are included with the-

4150K and 4160K Series

subassembly, they are also included with the bellows assembly, key 71. When ordering the subassembly as indicated by the table below, one of each of the following key numbered parts, unless other quantities are indicated, must also be ordered to complete the subassembly: dial, key 38; bellows yoke, key 70; bellows

assembly, key 71; jam nut, key 72; washer, key 73; spring seat, key 74; machine screw, key 75, quantity of 4; washer, key 76, quantity of 2; and spring, key 80. The link, key 71M, is included with the bellows assembly, key 71. If ordering parts for a transmitter, a screw, key 79, must also be ordered.

Subassemblies with Gauge-Pressure Sensing Element

OUTPUT PRESSURE RANGE		FEEDBACK BELLOWS MATERIAL	STANDARD	HIGH TEMPERATURE
Psig	Bar			
3 to 15 or 0 and 20 differential gap	0.2 to 1/0 or 0 and 1.4 differential gap	Brass	26A7677 X012	26A7677 X022
		Stainless steel	26A7677 X052	26A7677 X062
6 to 30 or 0 and 35 differential gap	0.4 to 2.0 or 0 and 2.4 differential gap	Brass	26A7677 X032	26A7677 X042
		Stainless steel	26A7677 X072	26A7677 X082

A subassembly with differential pressure bellows sensing element as shown in figure 22 contains the following key numbers: 30 through 37, 39 through 61, 71K, and 71L. The machine screws, key 77, quantity of 2, and washers, key 76, quantity of 2, also come with the subassembly. The two washers, key 76, may be used with the machine screws, key 75, but four washers and machine screws are required so two more washers must be ordered. the machine screws, key 77, are not used on subassemblies with bellows input so they may be discarded. Although two machine screws, key 71K, and two bearings, key 71L, are included with the

subassembly, they are also included with the bellows assembly, key 71. When ordering the subassembly as indicated by the table below, one of each of the following key numbered parts, unless other quantities are indicated, must also be ordered to complete the subassembly: dial, key 38; bellows yoke, key 70; bellows assembly, key 71; machine screw, key 75, quantity of 4; and washer, key 76, quantity of 2. The link, key 71M, is included with the bellows assembly, key 71. If ordering parts for a transmitter, a screw, key 79, must also be ordered.

Subassemblies with Differential-Pressure Bellows Sensing Element

OUTPUT PRESSURE RANGE		FEEDBACK BELLOWS MATERIAL	STANDARD	HIGH TEMPERATURE
Psig	Bar			
3 to 15 or 0 and 20 differential gap	0.2 to 1/0 or 0 and 1.4 differential gap	Brass	26A7677 X012	26A7677 X022
		Stainless steel	26A7677 X052	26A7677 X062
6 to 30 or 0 and 35 differential gap	0.4 to 2.0 or 0 and 2.4 differential gap	Brass	26A7677 X032	26A7677 X042
		Stainless steel	26A7677 X072	26A7677 X082

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For information, contact Fisher Controls:
Marshalltown, Iowa 50158 USA
Cernay 68700 France
Sao Paulo 05424 Brazil
Singapore 128461



Types 1051 & 1052 with F & G Mounting

Types 1051 & 1052 Styles F & G Size 40, 60 & 70 Rotary Actuators

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Introduction

Scope of Manual

This instruction manual includes installation, adjustment, maintenance, and parts ordering information for the Type 1051 (size 40 and 60) and Type 1052 (Size 40, 60, and 70) pneumatic piston

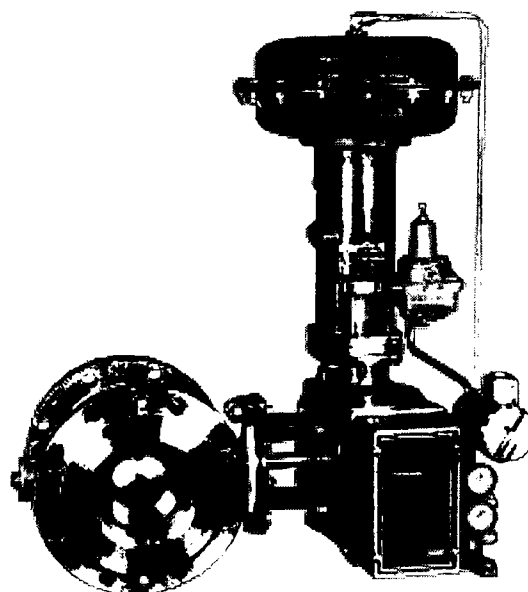


Figure 1. Type 1052 Actuator Mounted on Design V150 Vee-Ball® Valve with a Type 3620J Positioner

rotary actuator with F and G mounting adaptations (see figure 1).

The G mounting adaptation is for Type 7600 and 9500 valves, and the F mounting adaptation is for all other *edisc*® or Vee-Ball® valves. Also, this instruction manual provides information for the optional top-mounted handwheel, up and down travel stops, locking mechanism, and pipe-away vent.

Instructions for the control valve, positioner, accessories, and other sizes of actuators are covered in separate instruction manuals.

Top-Mounted handwheels can be applied for infrequent service as a manual handwheel actuator. Also, an adjustable up travel stop can be added to the actuator to limit its stroke in the upward direction, or an adjustable down travel stop can be added to limit actuator stroke in the downward direction.



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Types 1051 & 1052 with F & G Mounting

Table 1. Type 1051 and 1052 Actuator Specifications

<p>Operation</p> <p>Direct Acting: Increasing loading pressure extends the diaphragm rod out of the spring barrel</p> <p>Service:</p> <p><i>Type 1051:</i> For on-off or throttling service with positioner</p> <p><i>Type 1052:</i> For on-off or throttling service with or without a positioner</p> <p>Actuator Sizes</p> <p>Type 1051: ■ 40 and ■ 60</p> <p>Type 1052: ■ 40, ■ 60, and ■ 70</p> <p>Maximum Diaphragm Sizing Pressure⁽¹⁾</p> <p>Size 40: 4.5 bar (65 psig)</p> <p>Size 60: 2.8 bar (40 psig)</p> <p>Size 70: 3.8 bar (55 psig)</p> <p>Maximum Diaphragm Casing Pressure⁽¹⁾</p> <p>Size 40: 5.2 bar (75 psig)</p> <p>Size 60: 3.4 bar (50 psig)</p> <p>Size 70: 4.5 bar (65 psig)</p> <p>Maximum Valve Shaft Rotation</p> <p>90 degrees rotation (standard) travel stop, or 60 degrees (optional) travel stop for Type 1051 and 1052 actuators, or 75 degrees (optional) travel stop for Type 1052 actuators</p> <p>Valve Shaft Diameters, mm (Inches)</p> <p>Size 40: ■ 12.7 (1/2), ■ 15.9 (5/8), ■ 19.1 (3/4), ■ 22.2 (7/8), ■ 25.4 (1), or ■ 31.8, (1-1/4)</p> <p>Size 60: ■ 19.1 (3/4), ■ 22.2 (7/8), ■ 25.4 (1), ■ 31.8 (1-1/4), ■ 38.1 (1-1/2), ■ 44.5 (1-3/4), or ■ 50.8 (2)</p>	<p>Size 70: ■ 31.8 (1-1/4), ■ 38.1 (1-1/2), ■ 44.5 (1-3/4), or ■ 50.8 (2)</p> <p>Stroking Time</p> <p>Dependent on actuator size, rotation, spring rate, initial spring compression, and supply pressure. If stroking time is critical, consult your Fisher sales office</p> <p>Material Temperature Capabilities</p> <p>Nitrile Diaphragm: -40 to 82°C (-40 to 180°F)</p> <p>Silicone Diaphragm: -40 to 149°C (-40 to 300°F)</p> <p>Nitrile O-Rings: -40 to 82°C (-40 to 180°F), Nitrile O-rings are used in optional top-mounted handwheel, adjustable down travel stop, and adjustable up travel stop assemblies</p> <p>Travel Indication</p> <p>Graduated disk and pointer combination located on actuator end of valve shaft</p> <p>Pressure Connections</p> <p>Standard: 1/4 inch NPT female thread</p> <p>Optional: ■ 1/2 or ■ 3/4-inch NPT female, and ■ 3/4-inch NPT female thread for pipe-away vent</p> <p>Mounting Positions</p> <p>See figure figure 3.</p> <p>Approximate Weights</p> <p>See table 2</p> <p>Additional Specifications</p> <p>For casing pressure ranges and for material identification of the parts, see the <i>Parts List</i></p>
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1. Use this value to determine the maximum torque output allowed. The pressure/temperature limits in this manual and any applicable standard or code limitation for valve should not be exceeded.

Only personnel qualified through training or experience should install, operate, and maintain this actuator. If you have any questions concerning these instructions, contact your Fisher sales office before proceeding.

Description

The Type 1051 and 1052 diaphragm rotary actuators are pneumatic spring-return actuators for use with rotary-shaft control valves. The Type 1051 actuator can be used for on-off service, or it can be used for

throttling service when equipped with a valve positioner. The Type 1052 actuator can be used for on-off service, or it can be used for throttling service when equipped with or without a valve positioner. The Type 1052 actuator spring is adjustable (see figure 2).

Specifications

Specifications are shown in table 1. Specifications for actuator operation, as it originally comes from the factory, are stamped on the nameplate attached to the actuator.

Types 1051 & 1052 with F & G Mounting

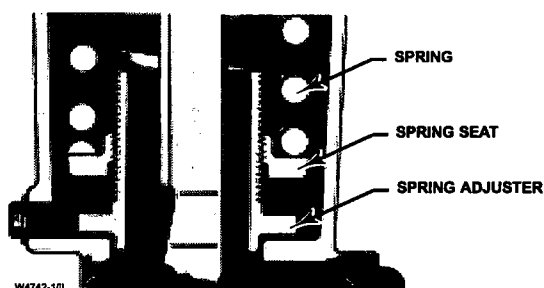


Figure 2. Typical Type 1052 Actuator Adjustable Spring Seat

Installation

When an actuator and valve body are shipped together, the actuator is normally mounted on the valve. Follow the valve body instructions when installing the control valve in the pipeline, and then perform the procedures presented in the *Loading Connection* section. If the actuator is shipped separately or if it is necessary to mount the actuator on the valve, perform the procedures presented in the *Actuator Mounting* section. And, if the actuator requires a pipe-away vent, or if a retrofit pipe-away kit needs to be installed, refer to the *Pipe-Away Vent* section.



WARNING

To avoid personal injury or property damage caused by bursting of pressure-retaining parts, be certain the diaphragm sizing pressure does not exceed the limits listed in table 1. Use pressure-limiting or pressure-relieving devices to prevent the diaphragm sizing pressure from exceeding these limits.

Actuator Mounting

Use the following steps to connect a valve and an actuator. Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.



WARNING

Perform the steps in the **WARNING** at the beginning of the *Maintenance* section to isolate the control valve and actuator.

Table 2. Approximate Actuator Weights

SIZE	TYPE 1051		TYPE 1052		TOP-MOUNTED HANDWHEEL	
	Kg	Lb	Kg	Lb	Kg	Lb
40	43	94	45	99	7.3	16
60	89	197	92	203	11	24
70	---	---	123	272	21	47

1. Unscrew cap screws and washers (keys 34 and 63), and remove cover (key 33).
2. Refer to figure 3 for available mounting styles and positions. When mounting on a Vee-Ball Design V150, V200 or V300 valve, check the valve manual to determine if it is Series B. The actuator is normally positioned vertically with the valve in a horizontal pipeline (see figure 4).

Note

Due to its weight, the Type 1052 size 70 actuator must be externally supported if mounted in the horizontal position.

3. When mounting the actuators, make sure that the bushing (key 67) and valve shaft are in-line so that the bushing will slide onto the valve shaft without damage.
4. Mount the actuator on the valve body and secure it with the valve mounting screws. The torques for 1/2 to 1-inch shafts is 88 N•m (65 lbf•ft); for 1-1/4 to 1-1/2 inch shafts is 136 N•m (100 lbf•ft); for 1-3/4 to 2-inch shafts is 183 N•m (135 lbf•ft).

CAUTION

Exceeding any torque requirement may impair the safe operation of this actuator by causing broken or damaged parts. Refer to table 3 for the bolting torque requirements.

Types 1051 & 1052 with F & G Mounting

Table 3. Recommended Bolting Torques

DESCRIPTION, KEY NUMBER	ACTUATOR SIZE								
	40			60			70		
	Size	N•m	lbf•ft	Size	N•m	lbf•ft	Size	N•m	lbf•ft
Diaphragm Casing, 5	3/8–24	27	20	3/8–24	27	20	3/8–24	27	20
Casing to spring barrel, 7	3/8–16	41	30	3/8–16	41	30	1/2–13	102	75
Diaphragm to rod, 9 (1051)	1/2–13	34	25	3/4–10	102	75	---	102	75
Diaphragm to rod, 9 (1052)	1/2–20	34	25	3/4–16	102	75	3/4–16	102	75
Rod end bearing, 16	1/2–20	34	25	5/8–18	61	45	3/4–16	102	75
Turnbuckle to lever, 18	1/2–13	81	60	5/8–11	163	120	3/4–10	271	200
Spring barrel to housing, 21	5/16–18	23	17	7/16–14	68	50	5/8–18	68	50
Housing to yoke, 23	3/8–16	34	25	1/2–13	81	60	1/2–13	81	60
Travel stop to lever, 28	1/2–13	81	60	5/8–11	163	120	3/4–10	271	200
Side of housing, 34 304/4200/PMV 1076 w/ NAMCO/NAMCO SW	3/8–16	34	25	1/2–13	81	60	1/2–13	81	60
Handwheel top, 54	1/2–20	34	25	5/8–18	34	25	---	34	25
Diaphragm head to rod/Adjustable down travel stop, 54 (1051)	1/2–13	27	20	3/4–10	66	49	---	69	51
Diaphragm head to rod/Adjustable down travel stop, 54 (1052)	1/2–20	27	20	3/4–16	66	49	3/4–16	69	51
Rod end to turnbuckle, 58	3/4–16–LH	102	75	7/8–14–LH	163	120	7/8–14–LH	163	120
Handwheel to actuator, 141	3/8–16	41	30	3/8–16	41	30	1/2–13	81	60

5. Screw the left-hand threaded locknut (key 58) onto the diaphragm rod (key 10) as far as possible.

6. Screw the turnbuckle (key 57) as far as it will go onto the actuator rod.

7. Screw the locknut (key 16) as far as it will go onto the rod end bearing (key 17). Thread this assembly completely into the turnbuckle (key 57).

8. If the lever (key 27) is attached to the rod end bearing, remove the cap screw and hex nut (keys 18 and 19).

9. If the Type 1052 spring adjustment has been changed, complete the Initial Setting portion of the *Type 1052 Spring Adjustment* section before proceeding.

10. Consult the appropriate valve instruction manual's *Installation* section for lever/valve shaft orientation marks, and slide the lever into place (see figure 5). Clamp with the cap screw (key 28).

11. Rotate the lever (key 27) to align with the rod end bearing (key 17). This connection can be aided by moving the actuator off its up travel stop with a regulated air source and adjusting the turnbuckle (key 57) slightly.

12. Apply sealant (key 77) or equivalent thread-locking compound to the threads of the cap screw (key 18).

13. Connect the lever (key 27) and the rod end bearing (key 17) with the cap screw and hex nut (keys 18 and 19). Tighten the cap screw to the recommended bolt torque shown in table 3.

14. Note the valve position and direction of rotation. Position the travel indicator (key 37) accordingly.

a. If no handwheel actuator is to be used, position travel indicator (key 37) according to the valve position just noted. Replace the cover (key 33), and secure with washers and cap screws (keys 34 and 63). If holes in the cover and housing (key 20) do not align, temporarily loosen cap screws (key 23), and shift the housing slightly. Do not stroke the actuator while the cover is off.

b. If a manual handwheel actuator is to be used, refer to the separate handwheel actuator instruction manual for mounting instructions.

15. Replace the cover (key 33), and secure with cap screws and washers (keys 34 and 63). If the holes in the cover and housing (key 20) do not align, use a regulated air source to move the actuator slightly off the up travel stop. If the hole alignment cannot be

Types 1051 & 1052 with F & G Mounting

MOUNTING	ACTION ⁽¹⁾	VALVE SERIES OR DESIGN				VALVE SERIES OR DESIGN		
		BALL/PLUG ROTATION TO CLOSE	V250	V150, V200 & V300	CV500 V500	DISK/BALL ROTATION TO CLOSE	V250	8510B, 8532, 8560 & 9500
Right-Hand	PDTC	CCW	A	A	A	CW	NA	B
	PDTO	CCW	B	B	B	CW	NA	A
Left-Hand	PDTC	CCW	NA	D	D	CW	C	C
	PDTO	CCW	NA	C	C	CW	D	D
Left-Hand (Optional) ⁽²⁾	PDTC	CW	NA	C	NA	NA	NA	NA
	PDTO	CW	NA	D	NA	NA	NA	NA

1. PDTC—Push-down-to-close, and PDTO—Push-down-to-open.
2. A left hand ball will be required for the 3- through 12-inch Series B and the 14- to 20-inch, with or without attenuator.

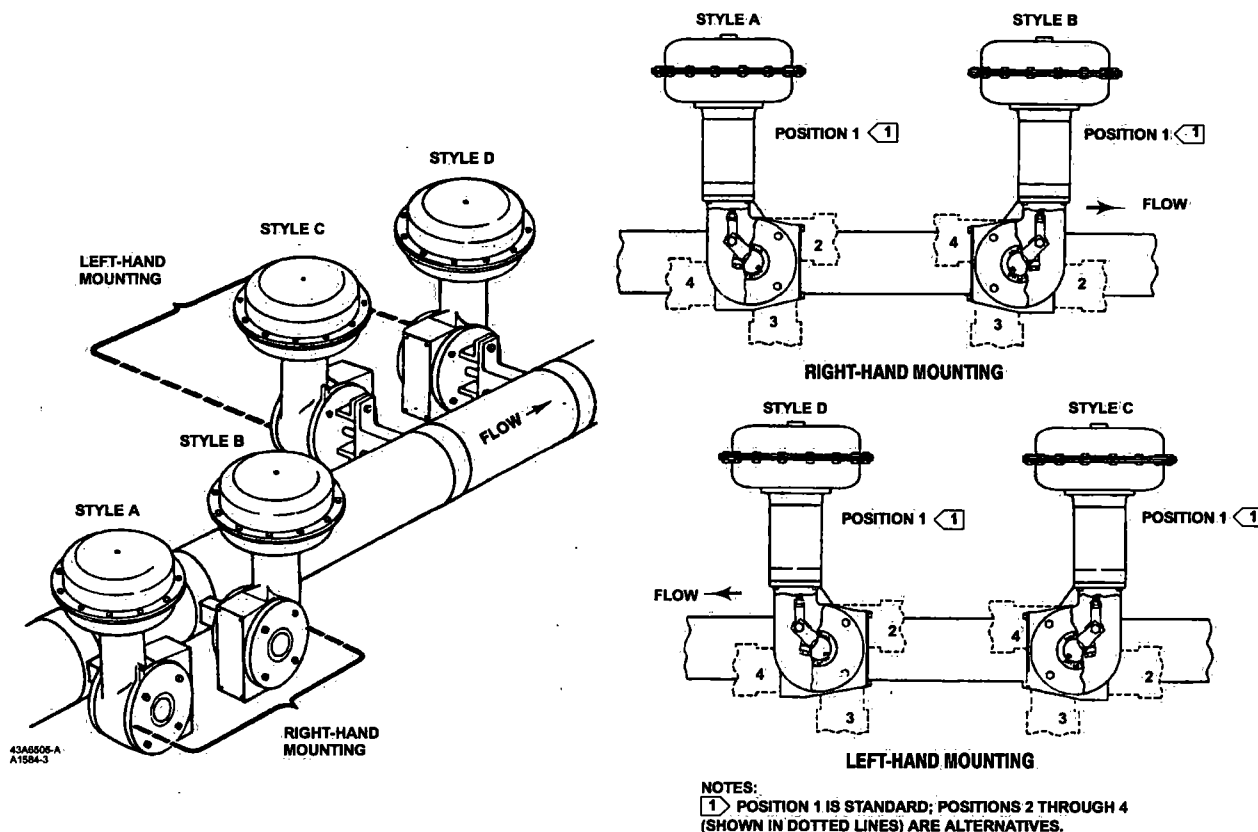


Figure 3. Mounting Styles and Positions for the Type 1051 and 1052 Actuator

obtained in this manner, temporarily loosen the cap screws (key 23), and shift the housing slightly. Do not stroke the actuator while the cover is off.

16. Follow the instructions given in the *Turnbuckle Adjustment* section before proceeding to the *Loading Connection* section.

Valve Flow Direction

Valve construction can change the flow direction for a control valve assembly. It is important to observe the

flow direction in all valve applications **before** installing the valve in the pipeline (see figure 4). Refer to the appropriate valve bulletin.

Note

Observe all warnings and cautions provided in the appropriate valve instruction manual Installation section.

Types 1051 & 1052 with F & G Mounting

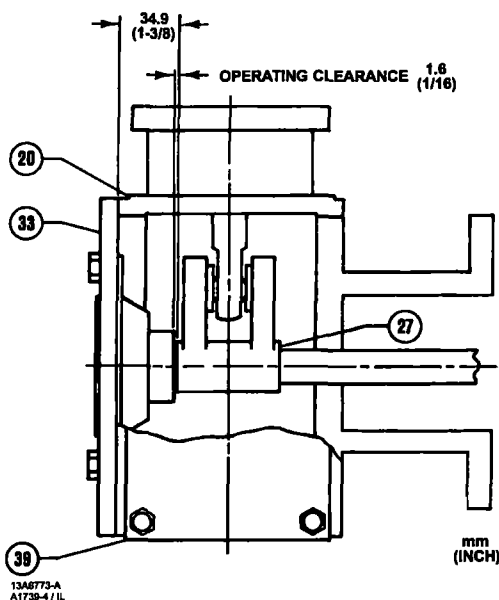


Figure 4. Lever Operating Clearance

Loading Connection

1. Connect the loading pressure piping to the pressure connection in the top of the diaphragm casing.

a. **For size 40 through 60 actuators:** Run either 1/4-inch pipe or 3/8-inch tubing between the 1/4-inch pressure connection and the instrument.

b. **For size 70 actuators:** Run either pipe or tubing between the pressure connection and the instrument. If necessary, remove the 1/4-inch bushing in the pressure connection to increase connection size.

2. Keep the length of pipe or tubing as short as possible to avoid transmission lag in the control signal. If an accessory (such as a volume booster or a valve positioner) is used, be sure that the accessory is properly connected to the actuator. If a valve positioner is part of the assembly, the pressure connection to the actuator will normally be made at the factory.

3. When the control valve is completely installed and connected to the instrument, check for correct action (air-to-open or air-to-close) to match the controlling instrument. For successful operation, the actuator stem and valve shaft must move freely in response to the loading pressure change on the diaphragm.

Adjustment

Turnbuckle Adjustment

Correct turnbuckle adjustment ensures that the valve is correctly closed when the actuator is against its travel stops. The turnbuckle adjustment is the only adjustment necessary on the Type 1051 actuator. Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.

For accurate adjustment to the zero-degree valve disk or ball position, remove valve from pipeline. Refer to the valve instruction manual for instructions.

A regulated air supply will be required to stroke the actuator. Refer to table 4 for the sizes of the three open-end wrenches required for this procedure.

Table 4. Wrench Size Required for Turnbuckle Adjustment, Inches

ACTUATOR		TURN- BUCKLE (KEY 57)	LOWER LOCKNUT (KEY 16)	UPPER LOCKNUT (KEY 58)
Type	Size			
1051 &	40	1-1/8	3/4	1-1/8
1052	60	1-5/16	15/16	1-5/16
1052	70	1-5/16	1-1/8	1-5/16

1. Remove the access plate (key 59). Also remove the machine screws (key 60), if present.

Note

For the most accurate adjustment of the actuator, do not remove cover (key 33) during this procedure.

2. Loosen the lower locknut (key 16).

3. Make sure the actuator housing (key 20) is clear of any tools or other instruments that could obstruct the actuator stroke path. Pressure the diaphragm casing enough to stroke the actuator down so that the left-hand threaded upper locknut (key 58) is accessible through the access opening. Loosen the locknut.

4. Consult the appropriate valve instruction manual for determining the closed position of the valve. Then use one of the following:

a. **Push-down-to-close**—Slowly stroke the actuator to the down travel stop. Adjust the turnbuckle (key 57) until the valve is in the closed position. Lock this adjustment with the left-hand threaded locknut (key 58). Stroke the actuator to the mid-travel position, and tighten the locknut (key 16).

b. **Push-down-to-open**—Release all pressure from the diaphragm casing, making sure the diaphragm is against its up travel stop. Be sure that the optional handwheel is adjusted to its topmost position so that the zero position of the actuator and valve can be reached simultaneously. Check

Types 1051 & 1052 with F & G Mounting

the valve position. Stroke the actuator so the turnbuckle (key 57) is accessible through the access opening. Adjust the linkage. Release pressure to the actuator, and check the new adjustment. Continue this procedure until the valve is in the closed position when the actuator is resting on its up travel stop. Stroke the actuator to the mid-travel position, and tighten locknut (key 16). Stroke the actuator, and tighten left-hand threaded locknut (key 58).

5. Replace the access plate (key 59).

6. Loosen the self-tapping screws (key 38), adjust the travel indicator (key 27), and re-tighten the self-tapping screws.

Type 1052 Spring Adjustment

Initial Setting

The Type 1052 nameplate specifies an initial spring setting, which is the initial setting adjusted into the actuator spring. Initial setting is the casing pressure at which the diaphragm and diaphragm rod begin to move away from the up travel stop **with the actuator disconnected from the valve**. (With the actuator connected to the valve and pressure applied to the valve, a higher pressure will be required to start actuator travel).

The initial setting was selected (based upon the service conditions specified when the actuator was ordered) so that, when the actuator and valve are in service, the valve will seat properly and full travel will be obtained within a diaphragm casing range of 0 to 1.2, 0 to 2.3, 0 to 2.8, or 0 to 3.8 bar (0 to 18, 0 to 33, 0 to 40, or 0 to 55 psig) depending on specific actuator size and construction.

If the actuator has been disassembled or if the spring adjustment was changed, and it is desired to match the initial setting stated on the nameplate, make sure the rod end bearing (key 17, figure 8 or 9) has been disconnected from the lever (key 27, figure 8 or 9). Adjust the spring so that the diaphragm rod just starts to travel at the spring set pressure specified on the nameplate.

Be sure the rod end bearing does not hit the lever as the diaphragm and diaphragm rod move away from the up travel stop. To adjust the spring, insert a round rod into one of the holes in the lower bearing seat (key 73, figure 9). Hole diameter is 9.5 mm (3/8-inch) for size 40 actuators, 15.9 mm (5/8-inch) for size 60 actuators, and 10.1 mm (3/4-inch) for size 70 actuators. Rotate the bearing seat to move it toward the casing to increase initial setting or away from the casing to decrease initial setting (keys 1 and 2, figure 9).

Stroking Range

The initial spring setting listed on the nameplate has been determined to be the optimum setting, and it is not recommended to make spring adjustments that will cause this value to change or be exceeded. For push-down-to-open valve action, the initial spring setting is the maximum allowable to provide the maximum spring closing force. Any increase of this setting will over-stress the spring at full travel. For push-down-to-close valve action, the initial spring set has been determined to be the optimum balance between the air to close and the spring to open breakout torque.

If the Type 1052 actuator is to be changed from one valve action to another (i.e., push-down-to-close to push-down-to-open), first, refer to the table for key 11 in the *Parts List* section to determine the proper initial spring setting; then, adjust the unit according to the procedures in the Initial Settings portion of the *Type 1052 Spring Adjustment* section.

Principle of Operation

The diaphragm rod moves down as loading pressure is increased on top of the diaphragm. As the loading pressure is decreased, the spring forces the diaphragm rod upward.

The spring and diaphragm have been selected to meet the requirements of the application and, in service, the actuator should produce full travel of the valve with the diaphragm pressure as indicated on the nameplate.

Consult the separate positioner instruction manual for actuator principle of operation with positioner.

Maintenance

Actuator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement depends upon the severity of service conditions. Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.

WARNING

Avoid personal injury or property damage from sudden release of process pressure or uncontrolled movement of parts. Before performing any maintenance operations:

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.

- Disconnect any operating lines providing air pressure, electric power, or

Types 1051 & 1052 with F & G Mounting

a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.

- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.

- Vent the power actuator loading pressure and relieve any actuator spring precompression.

- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

- The valve packing box may contain process fluids that are pressurized, even when the valve has been removed from the pipeline. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.

Disassembly

The following procedure describes how to completely disassemble the actuator. When inspecting and replacing parts, perform only those steps necessary to accomplish the repair.

Do not, under ordinary circumstances, remove the cap screws (keys 7, 8, and 21) at this time. Use the following disassembly steps if removal is necessary.

CAUTION

Cap screw (key 18) must be disengaged from the lever (key 27) before removing the diaphragm casing (key 1). Failure to do so will allow the spring precompression to rotate the valve beyond its fully open or closed position. This could cause damage to the valve components and/or seal.

1. Perform the steps in the **WARNING** at the beginning of the *Maintenance* section to isolate the control valve and actuator.
2. Remove the tubing or piping from the top of the actuator.
3. Remove the positioner, if used. If necessary, refer to the positioner instruction manual for removal instructions.

4. Unscrew the cap screws and washers (keys 34 and 63), and remove the cover (key 33).

5. Remove the retaining ring (key 30), and slide the hub (key 29) from the cover. If necessary, remove the travel indicator (key 37) from the hub (key 29).

6. Inspect, and if necessary, replace the cover bushing (key 31). Remove the travel indicator scale (key 35) by removing the self-tapping screws (key 36). Press the bushing out of the cover (key 33).

7. Remove the cap screw and hex nut (keys 18 and 19).

8. Make note of the lever/valve shaft orientation, and then loosen the cap screw (key 28).

CAUTION

When removing the actuator from the valve, do not use a hammer or similar tool to drive the lever (key 27) off the valve shaft. Driving the lever could damage internal valve parts. On some valve types, driving the lever off the shaft could move the valve disk or ball and bearings away from the centered position, causing subsequent damage to valve parts as the valve is operated.

If necessary, use a wheel puller to remove the lever. It is okay to tap the wheel puller screw lightly to loosen the lever, but hitting the screw with excessive force could also damage valve parts or disrupt the centered position of the valve disk and bearings.

9. Rotate the handwheel (if one is used) counterclockwise until the handwheel is not compressing the spring (key 11).



WARNING

To avoid personal injury from pre-compressed spring force suddenly thrusting the upper diaphragm casing (key 1) away from the actuator, relieve Type 1052 spring compression, or carefully remove Type 1051 casing cap screws before proceeding further.

10. To relieve spring compression:

- a. For Type 1051 actuators:

- Loosen, but do not remove, all casing cap screws and hex nuts (keys 5 and 6). Make sure there is no spring force to the upper diaphragm casing.

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- Unscrew and remove the cap screws and hex nuts (keys 5 and 6), and then remove the upper diaphragm casing and the diaphragm (key 3).

b. For Type 1052 actuators:

- Insert a round rod into one of the holes in the lower bearing seat (key 73). Use the rod to rotate the lower bearing seat, and move it away from the actuator casings. Continue rotating the lower bearing seat until spring compression is completely removed. Rod hole diameter is 9.5 mm (3/8 inch) for size 40 actuators, 15.9 mm (5/8 inch) for size 60 actuators, and 19.1 mm (3/4 inch) for size 70 actuators.

- Unscrew and remove the cap screws and hex nuts (keys 5 and 6), and then remove the upper diaphragm casing and the diaphragm (key 3).

11. Removing the diaphragm plate (key 4):

a. For Type 1051 actuators:

- Pull the diaphragm plate (key 4) and attached parts out of the actuator. The spring (key 11), diaphragm rod (key 10), cap screw (key 9), spring seat (key 13), hex nut (key 58), turnbuckle (key 57), hex nut (key 16), and rod end bearing (key 17) will be attached to the diaphragm head assembly.

- The diaphragm plate (key 4) may be wedged against the diaphragm rod (key 10), thereby preventing the spring compression from being relieved as the cap screw (key 9) is loosened.



WARNING

Dislodge the diaphragm plate (key 4) from the diaphragm rod (key 10) before completely removing the cap screw (key 9). Failure to check for this condition could cause personal injury due to the sudden release of spring compression.

- Dislodge the diaphragm plate (key 4) from the diaphragm rod (key 10) by loosening the cap screw (key 9) one full turn and tapping the underside of the diaphragm plate until it follows the cap screw as it is being removed. Failure to check for this condition before completely removing the cap screw (key 9) could cause personal injury due to the sudden release of spring compression.

- Slowly remove the cap screw (key 9) while making sure that the diaphragm head assembly is following the cap screw disassembly. Note—Make sure that spring load is zero before the cap screw is

completely removed. If necessary, separate the remaining parts of the assembly.

b. For Type 1052 actuators:

(1.) Remove the rod end bearing (key 17), the hex nut (key 16), turnbuckle (key 57), and the hex nut (key 58) from the diaphragm rod (key 10).

(2.) Pull the diaphragm plate (key 4) and attached parts out of the actuator. Then remove the cap screw (key 9) to separate the diaphragm plate and the diaphragm rod.

(3.) Proceed as appropriate:

- **For Size 40 and 60 actuators:** Remove the actuator spring (key 11) from the actuator. If it is necessary to remove the adjusting screw (key 74) from the spring barrel during this procedure, heat the base of the adjusting screw to 177°C (350°F) long enough for the thread-locking compound (key 77) to lose its holding strength. Then, unscrew the adjusting screw from the spring barrel. If the spring seat and the lower bearing seat (keys 13 and 73) are to be replaced, unscrew the lower bearing seat from the adjusting screw, and then remove the thrust bearing and the bearing races (keys 71 and 72) from the lower bearing seat.

- **For Size 70 actuators:** Remove the actuator spring (key 11) from the actuator. Remove the cap screws (key 21) then, remove the spring barrel (key 12) from the actuator housing. If it is necessary to remove the spring adjustment parts, loosen the set screw (key 75), and unscrew the spring adjusting screw (key 74) from the spring barrel (key 12).

12. Unscrew the cap screws (key 23), and remove the actuator housing assembly (key 20).

13. Unbolt the mounting yoke (key 22) from the valve.

14. Check the bushing (key 67) in the mounting yoke. Press out and replace the bushing if necessary.

Assembly

This procedure assumes that the actuator was completely disassembled. If the actuator was not completely disassembled, start these instructions at the appropriate step. This procedure also assumes that the valve is removed from the pipeline for ease in actuator assembly and adjustment.

Key numbers are shown in figure 8 for Type 1051 actuators and in figure 9 for Type 1052 actuators.

1. Installing the spring barrel (key 12):

a. **For Type 1051 actuators:** Place the spring barrel onto the housing (key 2). Secure the spring barrel with cap screws (key 21). Tighten the cap screws to the torque value shown in table 3.

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b. *For Type 1052 actuators:* If the spring barrel (key 12) was removed from the housing (key 20), align the spring barrel to the housing as described below to ensure that the offset hole in the base of the spring barrel will be located properly.

- *For Size 40 and 60 actuators:* Note that one of the accessory mounting bosses on the spring barrel is closer to the diaphragm end of the spring barrel. Place the spring barrel onto the housing with the upper boss (the one closer to the diaphragm end) on the same side as the boss located on the housing (see figures 8 and 9). This ensures proper positioning of the offset hole. Secure the spring barrel with cap screws (key 21). On final assembly, tighten the screws to the torque value shown in table 3.

- *For Size 70 actuators:* The spring barrel need not be aligned in any particular position when placing it on the housing.

2. If the bushing (key 67) was removed, press in the new bushing. The end of the bushing should be flush with the bottom of the recess in the mounting yoke (key 22).

3. Slide the mounting yoke over the valve shaft, and secure it to the valve with the valve mounting cap screws.

4. Tighten the valve mounting cap screws to the bolting torque listed in step 6 of the *Installation* procedures. Exceeding any torque requirement may impair the safe operation of the actuator.

5. Refer to figure 4 for the desired orientation of the housing (key 20). Secure the housing to the mounting yoke with cap screws (key 23).

6. Coat with Lubriplate MAG-1 (key 93) or equivalent lubricant on the cap screw threads (key 9), and the tapered end of the diaphragm rod (key 10).

7. Proceed as appropriate:

a. For Type 1051 actuators (see figure 8)

- Assemble the diaphragm rod, spring seat (key 13), spring (key 11), and diaphragm plate (key 4), and secure with the cap screw (key 9). Tightening the cap screw will compress the spring. Be certain the tapered end of the diaphragm rod is seated in the corresponding hole in the diaphragm plate, that the spring is seated in the spring seat, and that the cap screw is tightened to the torque specified in table 3.

- Install the hex nut (key 58), turnbuckle (key 57), hex nut (key 16), and rod end bearing (key 17) onto the diaphragm rod.

- Be certain the travel stops (key 8) are located as shown in figure 5.

- Install the diaphragm plate and attached parts into the actuator.

- Be sure the warning nameplate (key 56) is in place. Install the diaphragm (key 3) and the upper diaphragm casing (key 1). Install the cap screws and hex nuts (keys 5 and 6). Tighten the cap screws evenly in a crisscross pattern to compress the spring and secure the upper diaphragm casing. Refer to table 3 for torque values.

b. For Type 1052 actuators (see figure 9):

- *For actuator designs without a set screw (key 75) in the spring barrel (key 12):* if the adjusting screw and attached parts were removed, first clean and then lubricate the upper threads of the adjusting screw (key 12) with a lubricant (key 76) or equivalent as shown in figure 10. Install the lower bearing seat (key 73), the thrust bearing (key 71), the thrust bearing races (key 72), and the spring seat (key 13) onto the adjusting screw.

- First, clean and then coat the lower end of the adjusting screw with sealant (key 77) or equivalent thread-locking compound as shown in figure 9, and install the entire assembly into the spring barrel (key 12). Let the adjusting screw stand undisturbed for at least two hours after installation to allow the thread-locking compound to cure.

CAUTION

Apply lubricant to the upper threads and thread-locking compound to the lower threads of the adjusting screw. Do not overlap the coat of lubricant with the coat of thread-locking compound since this will adversely affect the performance quality of both substances.

- *For actuator designs with a set screw (key 75),* if the adjusting screw (key 74) and attached parts were removed, lubricate the threads of the adjusting screw with the lubricant (key 76) or equivalent. Install the lower bearing seat (key 73), the thrust bearing (key 71), the thrust bearing races (key 72), and the spring seat (key 13) onto the adjusting screw. Install this assembly into the spring barrel (key 12). Secure the adjusting screw with the set screw (key 75).

8. Coat the tapered end of the diaphragm rod (key 10) and the threads of the cap screw (key 9) with the lubricant (key 76) or equivalent. Bolt the diaphragm plate to the diaphragm rod.

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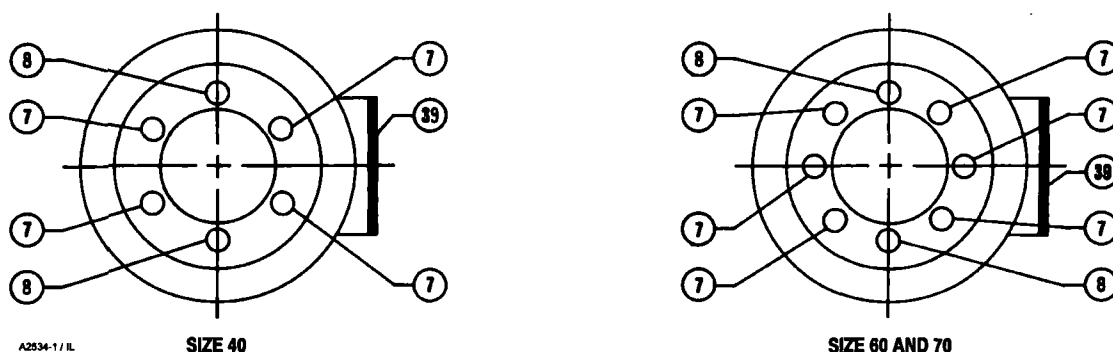


Figure 5. Travel Stop Orientation

9. Be certain the travel stops (key 8) are located as shown in figure 5.

10. Install the spring (key 11) into the spring barrel. Install the diaphragm plate and diaphragm rod into the actuator. Attach the hex nut (key 58), turnbuckle (key 57), hex nut (key 16), and rod end bearing (key 17) to the diaphragm rod.

11. Installing the diaphragm:

- Place the upper diaphragm casing (key 1) onto the lower diaphragm casing (key 2). If necessary, rotate the lower bearing seat (key 73) so that the upper diaphragm casing travel stop will not contact the diaphragm when the casing cap screws and nuts (key 5 and 6) are tightened.

- Secure the upper diaphragm casing with the cap screws and hex nuts (keys 5 and 6). Be sure the warning nameplate is in place on the casing. Tighten the nuts on the cap screws to the torque value shown in table 3.

12. **For Type 1052 actuators**, complete the Initial Setting portion of the *1052 Spring Adjustment* section before proceeding.

13. Refer to the appropriate valve instruction manual for lever/valve shaft orientation marks, and slide the lever (key 27) into place; see figure 5 for correct lever operating clearance. Clamp with the cap screw (key 28, figure 9).

14. Rotate the lever (key 27) to align with the rod end bearing (key 17). This connection can be aided by carefully stroking the actuator off its up travel stop with a regulated air source.

15. Apply sealant (key 77) or equivalent thread-locking compound to the threads of the cap screw (key 18).

16. Connect the lever (key 27) and the rod end bearing (key 17) with the cap screw and hex nut (keys 18 and 19). Tighten the nut on the cap screw (see table 3).

17. Coat the bearing surfaces of the hub (key 29), and cover (key 33) with lubricant (key 76) or equivalent. Install the bushing (key 31) and hub into the cover. Secure with the retaining ring (key 30).

18. Install the travel indicator scale (key 35), and secure it with the self-tapping screws (key 36). Then install the travel indicator (key 37), and secure it with the self-tapping screws (key 38).

19. Note the valve disk or ball position, and direction of rotation. Position the travel indicator (key 37) accordingly.

20. Replace the cover (key 33), and secure with cap screws and washers (keys 34 and 63). If the holes in the cover and housing (key 20) do not align, use a regulated air source to move the actuator slightly off the up travel stop. If hole alignment cannot be obtained in this manner, temporarily loosen cap screws (key 23), and shift the housing slightly. Do not stroke the actuator while the cover is off.

21. If a valve positioner is to be used, consult the separate valve positioner instruction manual for proper positioner installation.

22. Follow the instructions in the *Turnbuckle Adjustment* section.

Changing Actuator Mounting

The actuator is normally positioned vertically in a horizontal pipeline. However, four mounting styles and four positions for each style are possible (see figure 4).

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Note

Due to its weight, the Type 1052, size 70 actuator must be externally supported if mounted in the horizontal position.

Correct lever/valve shaft positioning is important to ensure proper valve action. Consult the appropriate valve instruction manual.

Style A is right-hand mounted, while style D is left-hand mounted. In all other ways, the styles A and D are identical.

Style B is right-hand mounted, while style C is left-hand mounted. In all other ways, the styles B and C are identical.

Use the following procedure along with figures 8 and 9, for key number references, to convert from styles A and D to styles B and C or visa versa or to change the mounting position.

1. Perform the steps in the **WARNING** at the beginning of the *Maintenance* section to isolate the control valve and actuator.
2. Remove the tubing or piping from the top of the actuator.
3. Remove the cover (key 33) by unscrewing and removing the cap screws and washers (keys 34 and 63).
4. Unscrew cap screw (key 18). Loosen cap screw (key 28).

CAUTION

When removing the actuator from the valve body, do not use a hammer or similar tool to drive the lever (key 27) or actuator off the valve shaft. Driving the lever or actuator could damage internal valve parts. On some valve types, driving the lever (key 27) could move the valve disk and bearings away from the centered position causing subsequent damage to valve parts.

If necessary, use a wheel puller to remove the lever. It is okay to tap the wheel puller screw lightly to loosen the lever, but hitting the screw with excessive force could also damage valve parts or disrupt the centered position of the valve disk and bearings.

5. If changing styles,

- Unscrew cap screws (key 23), and remove the actuator housing (key 20) from the mounting yoke (key 22).

- Rotate the housing 180 degrees, maintaining the appropriate position (1, 2, 3, or 4), and place the actuator onto the mounting yoke (key 22).

6. If changing positions, unscrew cap screws (key 23), and rotate the actuator housing to the desired position.

7. Secure actuator housing (key 20) to the mounting yoke (key 22) with cap screws (key 23). Consult table 3 for appropriate bolt torques.

8. Consult the appropriate valve instruction manual for lever/valve shaft orientation marks, and slide the lever (key 27) into place; see figure 5 for correct lever operating clearance. Clamp with the cap screw (key 28).

9. Rotate the lever (key 27) to align with the rod end bearing (key 17). This connection can be aided by stroking the actuator off its up travel stop with a regulated air source.

10. Apply sealant (key 77) or equivalent thread-locking compound to the threads of the cap screw (key 18).

11. Connect the lever (key 27) and the rod end bearing (key 17) with the cap screw and hex nut (keys 18 and 19). Tighten cap screw to the recommended bolt torque shown in table 3. This connection can be aided by stroking the actuator from its up travel stop with a regulated air source.

12. Note the valve position and direction of rotation. Position the travel indicator (key 37) accordingly. Replace the cover (key 33), and secure it with cap screws and washers (keys 34 and 63).

- If the holes in the cover and housing (key 20) do not align, use a regulated air source to move the actuator slightly off the up travel stop.

- If hole alignment cannot be obtained in this manner, temporarily loosen cap screws (key 23) and shift the housing slightly. Do not stroke the actuator while the cover is off.

13. Follow the instructions given in the *Turnbuckle Adjustment* section.

Top-Mounted Handwheels and Adjustable Travel Stops

Principle of Operation for Handwheels

Note

If repeated or daily manual operation is expected or desired, the unit should be equipped with a manual handwheel

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actuator. Refer to the separate manual handwheel actuator instruction manual for mounting instructions.

Top-Mounted Handwheel Assembly is attached to a special upper diaphragm casing (key 1, figures 8 and 9) with cap screws (key 141, figure 10). A hex nut (key 137, figure 11) locks the handwheel in position. Turning the handwheel (key 51, figure 10) clockwise into the upper diaphragm casing forces the pusher (key 135, figure 10) against the diaphragm and diaphragm plate (keys 3 and 4, figures 8 and 9) to compress the spring (key 11, figures 8 and 9) and move the diaphragm rod downward.

Turning the handwheel counterclockwise allows the actuator spring to move the diaphragm rod upward.

- If the valve is push-down-to-close, full opening can be restricted by positioning the handwheel at the desired position.

- If the valve is push-down-to-open, full closing of the valve can be restricted by use of the handwheel.

Adjustable Up Travel Stop (figure 11) limits the actuator stroke in the upward direction. To make adjustments, first relieve actuator loading pressure before removing the closing cap (key 187) as it is a pressure retaining part. Remove the closing cap (key 187). Also, for size 70 actuators, the hex nut (key 137) must be loosened. Then turn the stem (key 133) clockwise into the diaphragm case to move the actuator stem downward or counterclockwise to allow the spring to move the actuator stem upward.

- If the valve has push-down-to-close action, full opening can be restricted by the position of the adjustable travel stop. Or,

- If the valve has push-down-to-open action, full closing can be restricted by the position of the adjustable travel stop.

For size 70, tighten the hex nut and replace the closing cap after adjustment.

Adjustable Down Travel Stop (figure 12) limits the actuator stroke in the downward direction. To make adjustments, first relieve actuator loading pressure before removing the closing cap (key 187) as it is a pressure retaining part. Remove the closing cap (key 187). Loosen the hex jam nut (key 189) and either turn the hex nut (key 63 for size 40 and 70 actuators; or key 54 for size 60 actuators) down on the stem (key 133) to limit travel, or up on the stem to allow more travel. Lock the jam nut against the hex nut, and replace the closing cap after the adjustment has been made.

Handwheel Maintenance and Adjustable Travel Stop

If loading pressure seems to be leaking from either the handwheel or adjustable up stop, the O-rings (key 138 and 139, figures 10 and 11) may need replacement. If the adjustable down stop leaks, the O-ring (key 139, figure 12) may need replacement or possibly the closing cap (key 187, figure 11) is not tight. To tighten the closing cap, apply a good grade of thread sealant to the closing cap threads.

For ease of operation, the stem threads (key 133, figures 10, 11, and 12) may need an occasional application of lubricant (key 241) or equivalent. A grease fitting (key 169, figures 10 and 11) is provided for this purpose in the size 70. The size 70 may also need to have the thrust bearing (key 175, figures 10 and 11) packed with lubricant (key 241) or equivalent. Travel stops for the smaller casings can be lubricated between the stem and pusher (key 135, figures 10 and 11) with the lubricant (key 241) or equivalent.

The following disassembly procedures are separated where appropriate between the top-mounted handwheel and adjustable up travel stop assemblies (figures 10 and 11) and the adjustable down travel stop assembly (figure 12).

1. Perform the steps in the **WARNING** at the beginning of the *Maintenance* section to isolate the control valve and actuator.
2. Remove the tubing or pipe from the handwheel body (key 142, figures 10, 11, and 12).



WARNING

To avoid personal injury from the pre-compressed spring force thrusting the upper diaphragm casing (key 1, figures 8 and 9) away from the actuator, either relieve Type 1052 spring compression, or carefully remove Type 1051 casing cap screws by following the instructions that are referenced in the steps below before removing the casing.

3. Relieve all actuator spring compression by following the procedures presented in the Disassembly portion of the *Maintenance* section. Then, rotate either the handwheel (key 51, figure 10) or the travel stop stem (key 133, figures 11 and 12) counterclockwise until the handwheel or travel stop assembly is no longer compressing the spring.

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CAUTION

For Type 1051 actuators with *ēdisc* valves and push-down-to-open action, the cap screw (key 18, figure 8) should be disengaged from the lever (key 27, figure 9) before removing the diaphragm casing (key 1, figure 8) as specified in the following steps. Failure to do so will allow the spring precompression to rotate the valve beyond its closed position. This could cause damage to the valve seal, seat, or other valve components.

4. Proceed as appropriate:

For Adjustable Up Travel Stops:

- a. Remove the upper diaphragm casing (key 1, figures 8 and 9) by following steps 1, 3, 7, 9, 10, and 11 of the Disassembly portion of the *Maintenance* section.
- b. Remove the cap screws (key 141, figures 10 and 11), and separate the assembly from the upper casing.
- c. Loosen the locknut (key 137, figure 10), or remove the closing cap (key 187, figure 11).
- d. Turn the stem (key 133, figures 10 and 11) clockwise out of the valve body. On handwheel assemblies, the cotter pin and hex nut (keys 247 and 54, figure 10) will have to be removed so that the handwheel (key 51, figure 10) and locknut can be taken off the stem first.
- e. Remove and inspect the O-rings (keys 138 and 139, figures 10 and 11); replace them if necessary.
- f. To complete disassembly:

For sizes 40 and 60: Drive out the groove pin (key 140, figures 10 and 11), and slide the pusher (key 135, figures 10 and 11) off the stem.

For size 70: The pusher unit is held to the stem by a retaining screw (key 174, figures 10, 11 or 12). Removing the retaining screw and pusher exposes the thrust bearing (key 175, figures 10 and 11) for inspection.

For Adjustable Down Travel Stops:

Key numbers are shown in figure 12 unless otherwise noted. For ease of operation, the stem (key 133) threads may need an occasional application of lubricant.

a. Remove the closing cap (key 187), and unscrew the jam nut and hex nut (keys 189 and 63 for size 40 and 70 actuators; or keys 189 and 43 for size 60 actuators) off the stem (key 133).

b. Remove the upper diaphragm casing (key 1, figures 8 and 9) and travel stop body (key 142) by following steps 1, 3, 7, 9, 10, and 11 of the Disassembly portion of the *Actuator Maintenance* section.

c. Unscrew cap screws (key 141), and remove the body from the diaphragm case.

d. Check the condition of the O-ring (key 139), and replace it if necessary.

e. Loosen the hex nut (key 54), and then unscrew the travel stop stem (key 133) out of the actuator stem. The lower diaphragm plate (key 82) can now be removed and the rest of the actuator disassembled.

5. Reassemble by reversing the order of the disassembly steps, being sure to apply lubricant as previously mentioned and as shown by the lubrication boxes (key 241) in figures 10 and 11. For size 70 handwheels or up travel stop assemblies, coat the threads of the retaining screws (key 174, figures 10 and 11) with sealant (key 242) or equivalent thread-locking compound.

6. Readjust the spring to obtain the appropriate travel stop restriction by following the steps in the *Top Mounted Handwheel Assembly* section, and then return the unit to operation.

Locking Mechanism

Refer to figure 6 when installing, operating, and locking the mechanism. Key numbers are shown in figure 6 unless otherwise noted.

Installing the Locking Mechanism

1. Perform the steps in the **WARNING** at the beginning of the *Maintenance* section to isolate the control valve and actuator.
2. To add the locking mechanism to an existing actuator, purchase the required parts from Fisher. The required parts are the locking mechanism and a modified actuator housing.
3. To remove old housing, use the Disassembly procedures in the *Maintenance* section.
4. Attach the mounting plate (key 123) to the modified housing (key 20) as shown in figure 6. Attach it with

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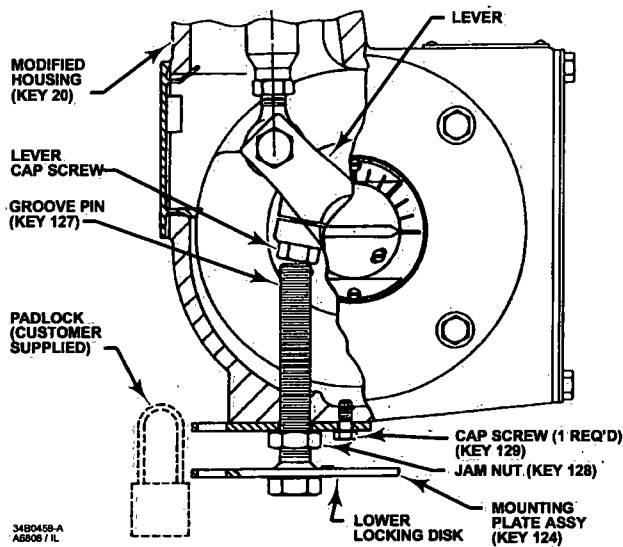


Figure 6. Actuator Locking Mechanism

the cap screw (key 129). Make sure the hole in the center of the mounting plate lines up with the large tapped hole in the housing.

5. Make sure the jam nut (key 128) is threaded onto the threaded bolt before threading it into the housing.

6. After the bolt is threaded into the housing, install the groove pin (key 127) into the end of the bolt. (Note: The groove pin will prevent the threaded bolt from being totally un-threaded from the actuator housing.)

7. Make sure that the bolt is not threaded in so far that it will interfere with re-assembly of the actuator.

8. Reassemble actuator using the Assembly procedure in the *Maintenance* section.

9. Make sure the actuator diaphragm rod is retracted fully. This will be the locked position of the valve. For a push-down-to-close valve and actuator, the valve will be fully open when locked. For a push-down-to-open valve and actuator, the valve will be fully closed when locked.

10. Screw the threaded bolt into the housing until it contacts the head on the lever cap screw (see figure 6).

11. Insert the padlock (not furnished by Fisher) to connect the mounting plate (key 123) with the lower locking disk on the mounting plate assembly (key 124). You might have to back off the lower locking disk a slight amount to line up the holes for the padlock.

Note

In the larger sized actuators, the layers of the mounting plate assembly may be far enough apart that you will need to purchase a padlock with a longer loop. Do not attempt to force the layers closer to fit a small looped padlock.

12. Tighten the jam nut (key 128) against the mounting plate.

Operating the Locking Mechanism

To Unlock the Actuator

1. Remove the padlock. Loosen the jam nut (key 128), and unscrew the threaded bolt until it is stopped by the groove pin (key 127) in the threaded bolt.

Note

For normal operation of the actuator, the threaded bolt must be unscrewed far enough so that the actuator lever will not contact the bolt in normal actuator operation.

2. If you are going to leave the bolt threaded into the housing, lock it by tightening the jam nut (key 128) against the mounting plate so that it cannot be screwed into the housing and interfere with normal actuator operation.

To Lock the Actuator

1. Make sure the actuator diaphragm rod is retracted fully. This will be the locked position of the valve. For a push-down-to-close valve and actuator, the valve will be fully open when locked. For a push-down-to-open valve and actuator, the valve will be fully closed when locked.

2. Make sure the jam nut (key 128) is loose. Screw the threaded bolt into the housing until it contacts the head on the lever cap screw (see figure 6).

3. Rotate the threaded bolt until one of the holes in the lower locking disk (which is welded to the bolt) is in line with the hole in the mounting plate (key 123). Tighten the jam nut against the mounting plate.

4. Lock the plate and disk together with a padlock. (The padlock is not furnished by Fisher.)

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Pipe-Away Vent

Some applications require venting of gas from the rotary actuator housing. The 3610 Series positioners vent into the actuator housing, and from there, the gas has numerous avenues of escape.

Note

This modification is NOT intended to be a leak-proof or pressure-tight design. It is intended to aid in containing the gas that vents from the positioner and allow for connection of piping to carry it away.

Take care that an adequate vent pipe size is used. This is particularly important with the larger size actuators that have fast stroking speed requirements. In these situations, large quantities of gas can be vented very quickly through the positioner, and adequate pipe-away capability must be obtained. Keep the vent piping as short as possible with few bends.

Refer to the *Disassembly and Assembly* steps in the *Maintenance* section to gain access to the following parts. Key numbers are shown in figure 7 unless otherwise noted.

Bushings—Remove the mounting yoke bushing (key 67), and the end plate cover bushing (key 31, figures 8 and 9). Replace them with the pipe-away vent parts, as shown in figure 7. The mounting yoke bushing (key 132) is a two-piece bushing with an O-ring (key 133). The end plate cover completes the assembly with a two-piece bushing (key 134) with an O-ring (key 135).

Travel Indicator—A gasket (key 136) is placed under the travel indicator plate. Remove the indicator plate (key 37, figures 8 and 9), install the gasket (key 136) as shown in figure 7.

Access Plate Assembly—A modified metal access plate assembly (key 137) is provided with a 3/4-inch NPT vent connection as shown in figure 7. If the actuator had a plastic access plate, it will be necessary to drill and tap the actuator housing to install the machine screws (key 138) as shown in figure 7. Use the drilling and tapping pattern shown in figure 7, or use the holes in the access plate as a template to mark holes.

When finished with all maintenance procedures requiring the access plate assembly (key 137) to be removed, use the sealant (key 139, or equivalent) provided with the kit to seal the plate in place.

Housing Vent Plug—A vent is provided in the housing design. To plug this opening, the pipe-away vent kit provides a hex pipe plug (key 140) for this opening, as shown in figure 7. Install the hex plug (key 140) into this opening and tighten it.

Accessories Mounting Boss—If accessories are not installed on the mounting boss, install cap screws (key 143) to plug openings. The location to install the cap screws (key 143) is shown in figure 7. A mounting boss is located on both sides of the spring barrel (key 12, figures 8 and 9).

Type 1052 Spring Barrel Access Cover—For field conversion of Type 1052 actuators, attach the cover (key 141) over the spring barrel adjustment opening with self-tapping screws (key 142). Use key 141 as a drilling template. Drill size is 2.6 mm (A #37 drill) (0.104-inches) by 9.6 mm (0.38-inches) deep.



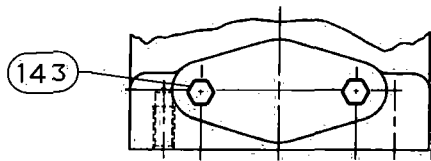
WARNING

If a flammable, toxic, or reactive gas is being used as a supply medium, personal injury, or property damage could result from fire or explosion of accumulated gas. A remote vent pipe cannot be relied upon to vent all gases from the installed location. Provide adequate ventilation for the actuator/positioner assembly. Comply with local and regional codes, and keep the vent pipeline as short as possible with few bends.

Parts Ordering

When corresponding with your Fisher sales office about this equipment, refer to the serial number found on the actuator nameplate (key 41, figures 8 and 10). Also, specify the complete 11-character part number from the following parts list when ordering replacement parts. The Size 70 actuator is available only in Type 1052 actuators.

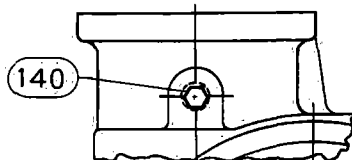
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NOTE:
IF ACCESSORIES ARE NOT INSTALLED ON THE MOUNTING BOSS, INSTALL CAP SCREWS (KEY 143) TO PLUG OPENINGS. A MOUNTING BOSS IS LOCATED ON BOTH SIDES OF THE SPRING BARREL.

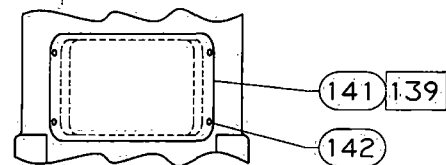
ACCESSORIES MOUNTING BOSS



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NOTE:
INSTALL THE HEX HEAD PLUG (KEY 140) INTO THE VENT OPENING LOCATED IN THE ACTUATOR HOUSING.

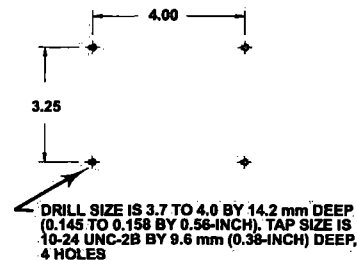
HOUSING VENT PLUG LOCATION



34B4046-B / IL

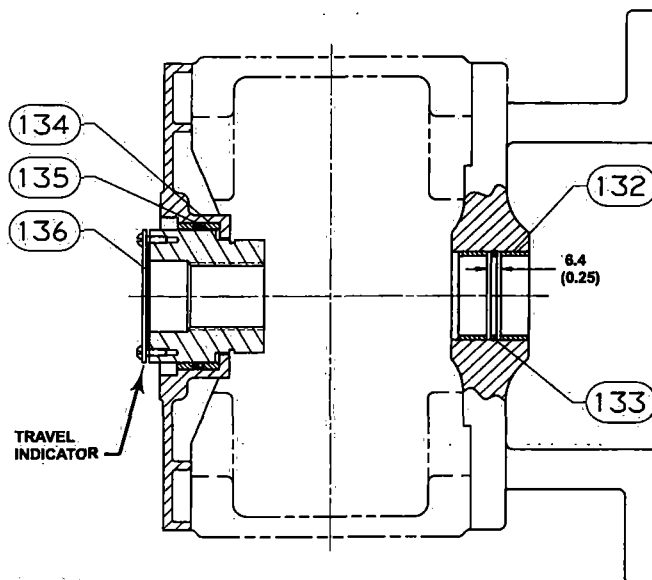
NOTE:
FOR FIELD CONVERSION OF TYPE 1052 ACTUATORS, ATTACH COVER (KEY 141) OVER THE SPRING BARREL ADJUSTMENT OPENING WITH SELF-TAPPING SCREWS (KEY 142). USE KEY 141 AS A DRILLING TEMPLATE. USE DRILL SIZE 2.6 mm (A #37 DRILL) (0.104-INCH) BY 9.6 mm (0.38-INCH) DEEP.
☐ APPLY SEALANT

TYPE 1052 SPRING BARREL ACCESS COVER



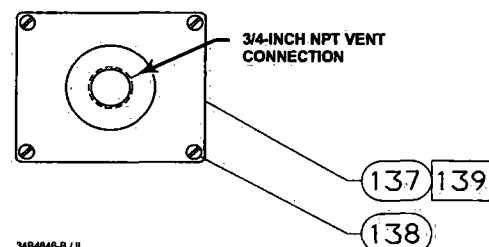
34B4046-B

DRILLING AND TAPPING PATTERN ACCESS PLATE ASSEMBLY



34B4046-B / IL

MOUNTING YOKE AND COVER ASSEMBLY



34B4046-B / IL

NOTE:
FOR FIELD CONVERSION, DRILL AND TAP HOLE PATTERN IF HOUSING HAS A NON-METALLIC ACCESS PLATE. USE KEY 137 AS A DRILLING TEMPLATE IF DESIRED. OR, USE THE DIMENSIONS PROVIDED IN THIS FIGURE FOR DRILLING AND TAPPING.
☐ APPLY SEALANT

ACCESS PLATE ASSEMBLY

mm
(INCH)

Figure 7. Pipe Away Vent Assembly

Types 1051 & 1052 with F & G Mounting

Pipe-Away Vent Retrofit Kit Numbers

SHAFT DIAMETER		TYPE 1051 SIZE	KIT PART NUMBER	TYPE 1052 SIZE	KIT PART NUMBER
mm	Inches				
12.7	1/2	40	34B4646X022	30	34B4646X152
				40	34B4646X162
15.9	5/8	40	34B4646X032	30	34B4646X172
				40	34B4646X182
19.1	3/4	40	34B4646X042	30	34B4646X192
				40	34B4646X202
		60	34B4646X052	60	34B4646X212
22.2	7/8	40	34B4646X062	40	34B4646X222
		60	34B4646X072	60	34B4646X232
25.4	1	40	34B4646X082	40	34B4646X242
		60	34B4646X092	60	34B4646X252
31.8	1-1/4	40	34B4646X102	40	34B4646X262
		60	34B4646X112	60	34B4646X272
				70	34B4646X282
38.1	1-1/2	60	34B4646X122	60	34B4646X292
				70	34B4646X302
44.5	1-3/4	60	34B4646X132	60	34B4646X312
				70	34B4647X322
50.8	2	60	34B4646X142	60	34B4646X332
				70	34B4647X342

Parts Kits

Top-Mounted Handwheel Retrofit Kits

KIT PROVIDES PARTS TO ADD A TOP-MOUNTED HANDWHEEL. KIT NUMBER 1 INCLUDES THE HANDWHEEL ASSEMBLY ONLY. KIT NUMBER 2 INCLUDES KIT NUMBER 1 AND A NEW UPPER CASE (KEY 1) THAT IS REQUIRED TO MOUNT THE HANDWHEEL ASSEMBLY.

Kit Number 1

Key	Description	Part Number	Qty
	SIZE 40	38A1213X032	1
	SIZE 60,	38A1213X062	1
	SIZE 70 TYPE 1052 ONLY	CV8010X0052	1

Kit Number 2

Key	Description	Part Number	Qty
	SIZE 40	38A1213X072	1
	SIZE 60,	38A1213X022	1
	SIZE 70 TYPE 1052 ONLY	CV8010X0062	1

Pipe-Away Vent Retrofit Kit

VENT-AWAY KITS INCLUDES: ACCESS PLATE, TWO-PIECE BUSHING, TWO O-RINGS, GASKET, AND THE APPLICATION OF A SEALANT (SEALANT SUPPLIED WITH RETROFIT KIT). FOR TYPE 1052, AN ADDITIONAL COVER PLATE AND SCREWS ARE REQUIRED FOR THE SPRING ADJUSTMENT ACCESS.

(SEE FIGURE 7).

Types 1051 & 1052 with F & G Mounting

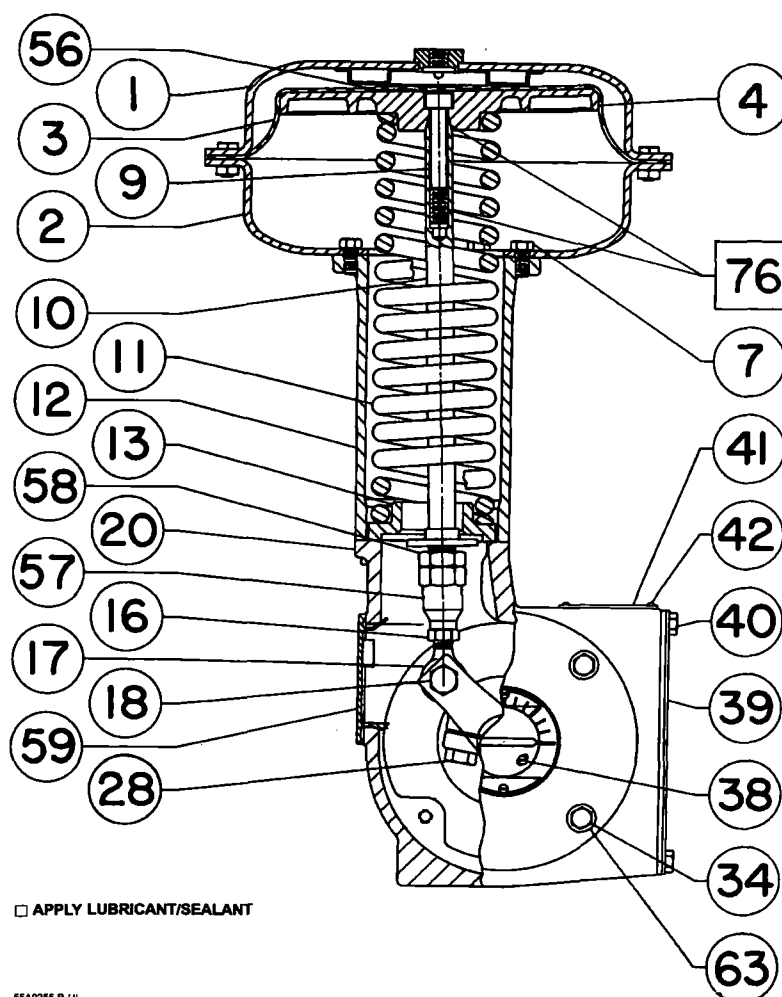


Figure 8. Typical Type 1051 Actuator Assembly

Parts List

Common Parts (Figures 8 and 9)

Key	Description	Part Number	Qty	Key	Description	Part Number	Qty
1	CASING, UPPER			SIZE 60		2E8597X0032	1
2	DIAPHRAGM CASING, LOWER (STEEL ZN PL)			SIZE 70		2N1269X0012	1
3*	DIAPHRAGM, MOLDED (NITRILE/NYLON)			W/ ADJ DOWN STOP			
	STANDARD			SIZE 40		2E6699X0042	1
	W/HANDWHEEL, OR W/ADJ UP STOP			SIZE 60		2E8598X0012	1
	SIZE 40	2E670002202	1	SIZE 70		2N1309X0012	1
	SIZE 60	2E859702202	1				
	SIZE 70	2N126902202	1	4	DIAPHRAGM HEAD		
	W/ADJ DOWN STOP			5	SCREW, CAP, HEX HD		
	SIZE 40	2E669902202	1	6	NUT, HEX		
	SIZE 60	2E859802202	1	7	SCREW, CAP, HEX HD		
	SIZE 70	2N130902202	1	8	STOP, TRAVEL		
	DIAPHRAGM, MOLDED (SILICONE/POLYESTER)			9	SCREW, CAP, HEX SOCKET		
	STANDARD			10	DIAPHRAGM ROD		
	W/HANDWHEEL, OR W/ADJ UP STOP			11	SPRING	SEE FOLLOWING TABLE	
	SIZE 40	2E6700X0012	1	12	SPRING BARREL		
				13	SPRING SEAT	SEE FOLLOWING TABLE	
				16	NUT, HEX		
				17	BEARING ROD END		
				18	SCREW, CAP, HEX HD		
				19	NUT, HEX, JAM		

*Recommended spare parts

Types 1051 & 1052 with F & G Mounting

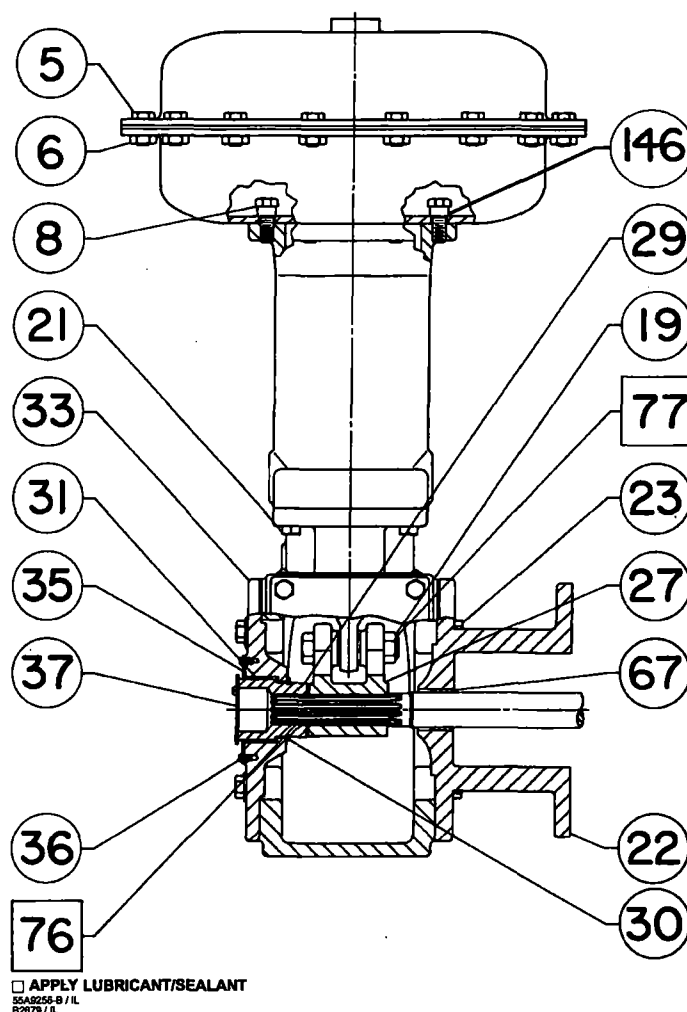


Figure 8. Typical Type 1051 Actuator Assembly (Continued)

Key	Description	Part Number	Qty	Key	Description	Part Number	Qty
20	HOUSING			41	NAMEPLATE		
20	MODIFIED HOUSING			42	SCREW, DRIVE		
21	SCREW, CAP, HEX HD			56	WARNING LABEL		
22	YOKE, MOUNTING			57	TURNBUCKLE		
23	SCREW, CAP, HEX HEAD			58	NUT, HEX, JAM		
27	LEVER			59	PLATE, ACCESS		
28	SCREW, CAP, HEX HD			63	WASHER, PLAIN		
29	HUB			67*	BUSHING		
30	RING, RETAINING, EXT			71	BEARING, THRUST		
31*	BUSHING			72	BEARING RACE		
	SIZE 40	12A9373X012	1	73	BEARING SEAT		
	SIZES 60 & 70	12A9374X012	1	74	SCREW, ADJUSTING		
33	COVER			75	SET SCREW, HEX SOCKET		
34	SCREW, CAP, HEX HD			76	LUBRIPLATE MAG-1, LUBRICANT OR EQUIVALENT		
35	SCALE, INDICATOR			77	LOCTITE 271 SEALANT OR EQUIVALENT		
36	SCREW, SELF TAPPING			78	SCREW, CAP		
37	TRAVEL INDICATOR			82	DIAPHRAGM HEAD, LOWER		
38	SELF-TAPPING SCREW			83	PLUG, PROTECTIVE		
38	MACHINE SCREW			---	PIPE BUSHING (NOT SHOWN)		
39	PLATE, COVER			144	WARNING NAMEPLATE		
40	SCREW, CAP, HEX HD			146	SPACER		

SEE FOLLOWING TABLE

Types 1051 & 1052 with F & G Mounting

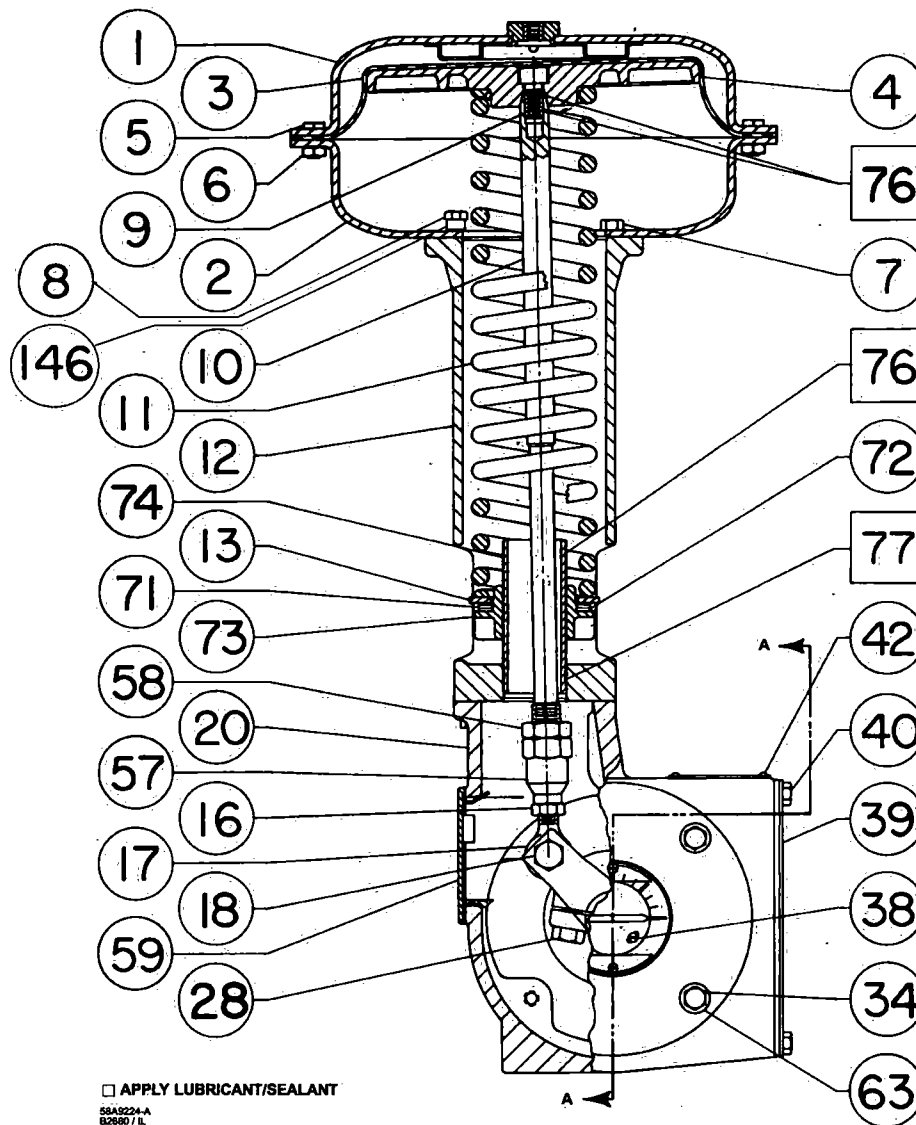


Figure 9. Typical Type 1052 Assembly

Top-Mounted Handwheel (Figure 10)

Key	Description	Part Number	Qty	Key	Description	Part Number	Qty
51	HANDWHEEL			139*	O-RING, (NITRILE) (continued)		
54	NUT, HEX, SLOTTED				SIZE 70	1D269106992	1
133	STEM			140*	PIN, GROOVE,		
135	PLATE, PUSHER				CARBON STEEL-PLATED		
137	NUT, HEX, JAM,				SIZE 40	1F118028992	1
138*	O-RING, (NITRILE)				S31600 (316 SST)		
	SIZE 40	1D237506992	1		SIZE 60	1B627035072	1
	SIZE 60	1B885506992	1	141	SCREW, CAP, HEX HD		
	SIZE 70	1C415706992	1	142	BODY		
139*	O-RING, (NITRILE)			164	BODY EXTENSION		
	SIZE 40	1D267306992	1	169	GREASE FITTING		
	SIZE 60	1D547106992	1	171	WASHER, PLAIN		
				174	RETAINING SCREW		
				175	BEARING, THRUST		

*Recommended spare parts

Types 1051 & 1052 with F & G Mounting

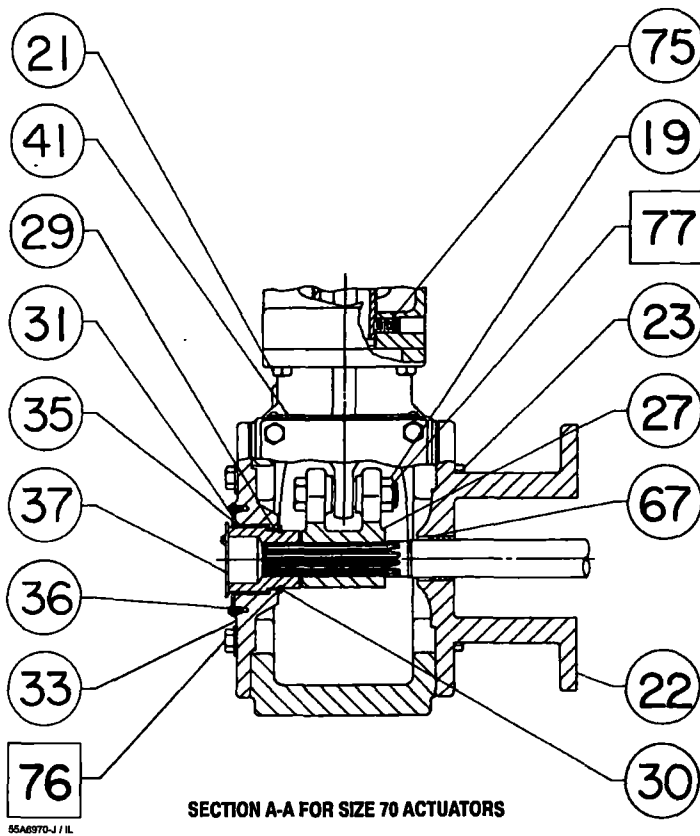
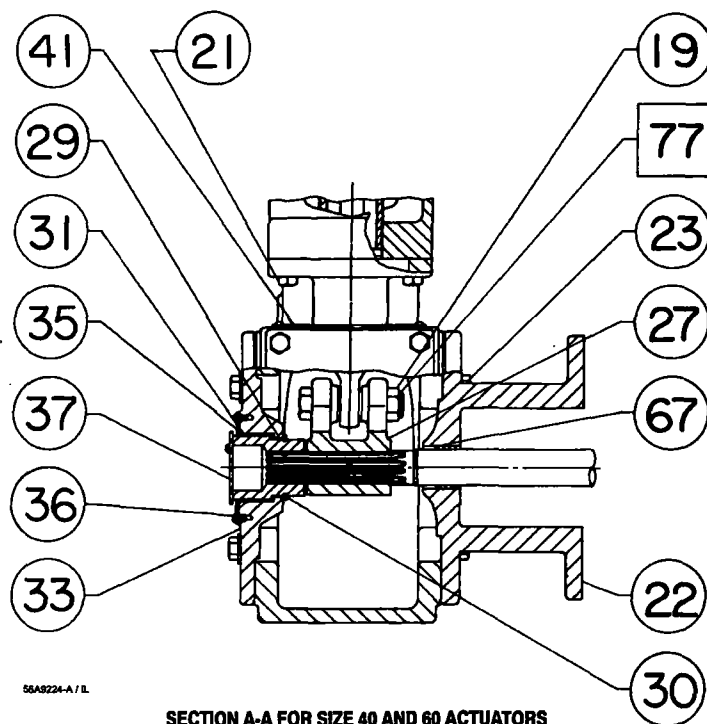
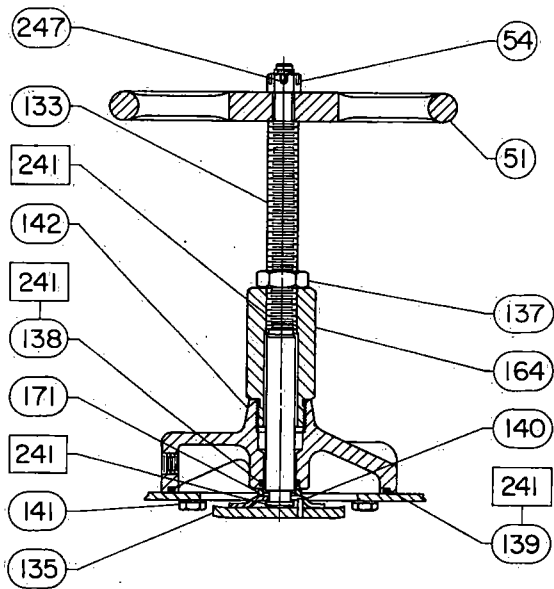


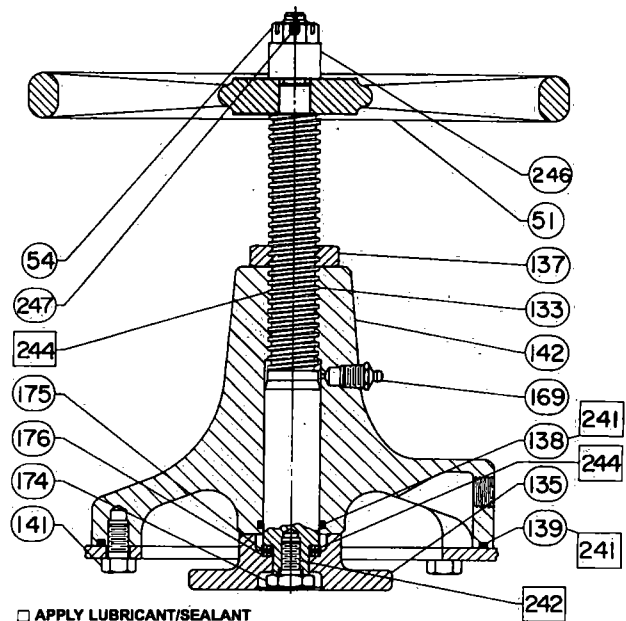
Figure 9. Typical Type 1052 Assembly (continued)

Types 1051 & 1052 with F & G Mounting



□ APPLY LUBRICANT
38A1213-B / IL

**TOP-MOUNTED HANDWHEEL ASSEMBLY FOR
SIZE 30, 40, AND 60 ACTUATORS**



□ APPLY LUBRICANT/SEALANT
CV8010-G / IL

**TOP-MOUNTED HANDWHEEL ASSEMBLY FOR
SIZE 70 ACTUATOR**

Figure 10. Handwheel Assemblies

Key	Description	Part Number	Qty
176	BEARING RACE, THRUST		
241	LUBRIPLATE MAG-1, LUBRICANT OR EQUIVALENT		
242	LOCTITE 271 SEALANT OR EQUIVALENT		
244	NEVER-SEEZ OR EQUIVALENT		
246	SPACER		
247	PIN, COTTER		

Key	Description	Part Number	Qty
174	RETAINING SCREW		
175	BEARING, THRUST		
176	BEARING RACE, THRUST		
187	TRAVEL STOP CAP		
241	LUBRIPLATE MAG-1, LUBRICANT OR EQUIVALENT		
242	LOCTITE 271 SEALANT OR EQUIVALENT		

Adjustable Up Travel Stop (Figure 11)

133	STEM		
135	PLATE, PUSHER		
137	NUT, TRAVEL STOP		
138*	O-RING, (NITRILE)		
	SIZE 40	1D237506992	1
	SIZE 60	1B885506992	1
	SIZE 70	1C415706992	1
139*	O-RING, (NITRILE)		
	SIZE 40	1D267306992	1
	SIZE 60	1D547106992	1
	SIZE 70	1D269106992	1
140*	PIN, GROOVE		
	CARBON STEEL-PLATED		
	SIZE 40	1F118028992	1
	S31600 (316 SST)		
	SIZE 60	1B627035072	1
141	SCREW, CAP, HEX HD		
142	BODY		
164	BODY EXTENSION		
169	GREASE FITTING		
171	SPACER		

Adjustable Down Travel Stop (Figure 12)

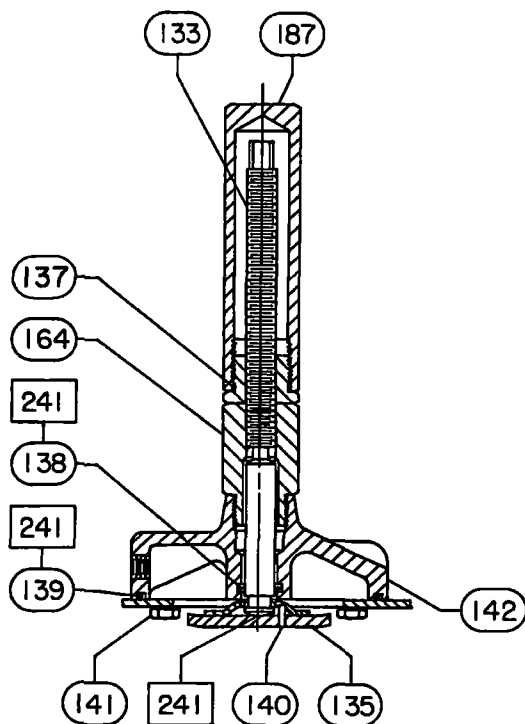
54	NUT, HEX		
63	FLANGE NUT		
133	TRAVEL STOP STEM		
134	WASHER (PLAIN CARBON STEEL)		
139*	O-RING (NITRILE)		
	SIZE 40	1D267306992	1
	SIZE 60	1D547106992	1
	SIZE 70	1D269106992	1
141	SCREW, CAP, HEX HD (STEEL ZN PL)		
142	TRAVEL STOP BODY		
187	TRAVEL STOP CAP		
189	NUT, HEX, JAM		
241	LUBRIPLATE MAG-1, LUBRICANT OR EQUIVALENT		

Locking Assembly (Figure 6) (Size 40, 60, and 70 Actuators)

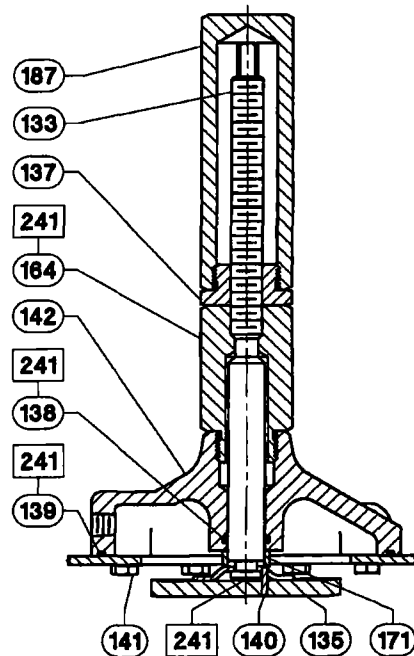
123	MOUNTING PLATE
127	GROOVE PIN
128	JAM NUT
129	CAP SCREW

*Recommended spare parts

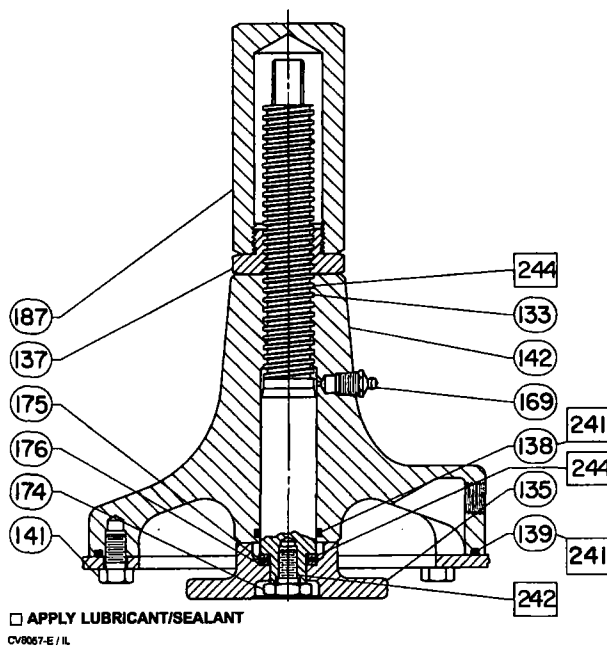
Types 1051 & 1052 with F & G Mounting



**ADJUSTABLE UP TRAVEL STOP FOR
SIZE 40 ACTUATORS**



**ADJUSTABLE UP TRAVEL STOP FOR
SIZE 60 ACTUATORS**



**ADJUSTABLE UP TRAVEL STOP FOR SIZE 70
TYPE 1052 ACTUATORS**

Figure 11. Adjustable Up Travel Stops

Types 1051 & 1052 with F & G Mounting

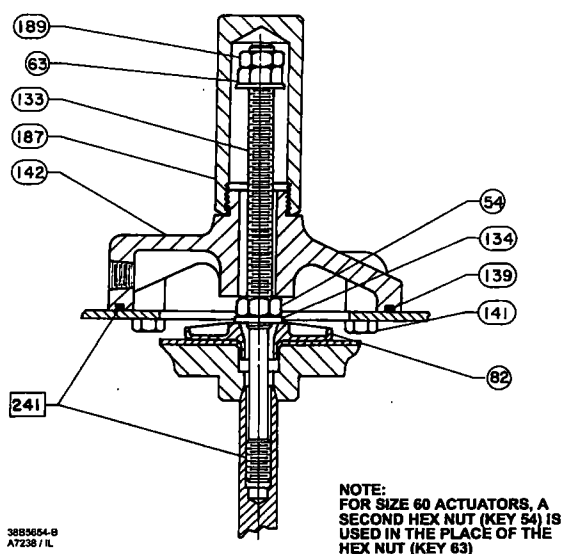


Figure 12. Adjustable Down Travel Stop

Pipe-Away Vent (Figure 7)

COMPLETE RETROFIT KITS ARE LISTED AT THE BEGINNING OF THE PARTS LIST. USE THIS LISTING FOR INDIVIDUAL REPLACEMENT PARTS

Key	Description	Part Number	Qty
132*	LINED BUSHING (STEEL/PTFE) YOKE SIDE		
	12.7 mm (1/2-INCH) DIA. SHAFT	1U902599402	2
	15.9 mm (5/8-INCH) DIA. SHAFT	14B4642X012	2
	19.1 mm (3/4-INCH) DIA. SHAFT	F1918348112	2
	22.2 mm (7/8-INCH) DIA. SHAFT	14B4631X012	2
	25.4 mm (1-INCH) DIA. SHAFT	14B4632X012	2

Key	Description	Part Number	Qty
132*	LINED BUSHING (STEEL/PTFE) YOKE SIDE (continued)		
	31.8 mm (1-1/4 INCH) DIA. SHAFT	14B4633X012	2
	38.1 mm (1-1/2 INCH) DIA. SHAFT	14B4634X012	2
	44.5 mm (1-3/4-INCH) DIA. SHAFT	14B4635X012	2
	50.8 mm (2-INCH) DIA. SHAFT	G1668548112	2
133*	O-RING (NITRILE)		
	12.7 mm (1/2-INCH) DIA. SHAFT	1J4888X0052	1
	15.9 mm (5/8-INCH) DIA. SHAFT	11A8741X052	1
	19.1 mm (3/4-INCH) DIA. SHAFT	1F4636X0032	1
	22.2 mm (7/8-INCH) DIA. SHAFT	10A3805X012	1
	25.4 mm (1-INCH) DIA. SHAFT	10A8217X042	1
	31.8 mm (1-1/4 INCH) DIA. SHAFT	14A6981X012	1
	38.1 mm (1-1/2 INCH) DIA. SHAFT	1F1153X0012	1
	44.5 mm (1-3/4-INCH) DIA. SHAFT	1P1676X0012	1
	50.8 mm (2-INCH) DIA. SHAFT	10A3800X012	1
134*	BUSHING (STEEL/PTFE) HUB SIDE		
	SIZE 30/40		
	12.7 TO 22.2 mm (1/2- TO 7/8-INCH) DIA. SHAFT	14B3503X012	2
	SIZE 40		
	25.4 TO 31.8 mm (1- TO 1-1/4 INCH) DIA. SHAFT	14B3503X012	2
	SIZE 60		
	19.1 TO 50.8 mm (3/4- TO 2-INCH) DIA. SHAFT	14B4310X012	2
135*	O-RING HUB SIDE		
	SIZE 30/40		
	12.7 TO 22.2 mm (1/2- TO 7/8-INCH) DIA. SHAFT	1K594906562	1
	SIZE 40		
	25.4 TO 31.8 mm (1- TO 1-1/4 INCH) DIA. SHAFT	1K594906562	1
	SIZE 60		
	19.1 TO 50.8 mm (3/4- TO 2-INCH) DIA. SHAFT	1U2504X0042	1
136	TRAVEL IND GASKET		
137	ACCESS PLATE ASSEMBLY		
138	MACHINE SCREW		
139	PERMATEX BLUE RTV OR EQUIVALENT		
140	PLUG		
141	SPRING BARREL COVER TYPE 1052 ONLY		
142	SELF-TAPPING SCREW		
143	CAP SCREW		

Types 1051 & 1052 with F & G Mounting

Key 11. Spring⁽¹⁾ for Type 1052 Actuator Only (Steel)

Key 13. Spring Seat⁽¹⁾ for Type 1052 Actuator Only (Steel)

CASING PRESSURE		ACTUATOR SIZE	KEY 11 SPRING PART NUMBER	KEY 13 SPRING SEAT PART NO.
Bar	Psig			
0 to 1.2	0 to 18	40	1L217427042	12A9447X012
		60	1K162727082 1N937327082 1N937327082	12A9450X012 12A9448X012 12A9449X012
0 to 2.3	0 to 33	40	1L217327042 1P637127082	12A9446X012 12A9447X012
		60	1K162827082 1K162827082 1N937327082 1N937327082	12A9448X012 12A9449X012 12A9448X012 12A9449X012
0 to 2.8	0 to 40	40	1L217327042	12A9446X012
		60	1K162827082 1K162829082	12A9448X012 12A9449X012
0 to 3.8	0 to 55	40	1L217327042	12A9446X012
0.2 to 1.0	3 to 15	60	1K162727082	12A9450X012
0.2 to 2.1	3 to 30	40	1L217327042 1P637127082	12A9446X012 12A9447X012
		60	1K162827082 1N937327082	12A9449X012 12A9449X012

Key 11. Spring⁽¹⁾ for Type 1052 Actuators Only (Steel)

CASING PRESSURE		ACTUATOR SIZE	INITIAL SPRING COMPRESSION				KEY 11 SPRING PART NUMBER
			Push-down-to-open		Push-down-to-close		
Bar	Psig		Bar	Psig	Bar	Psig	
0 to 1.2	0 to 18	40	0.2	3.0	0.2	3.0	1L217427042
			0.3	4.3	0.2	3.0	1P637127082
	0 to 18	60	0.3	3.7	0.2	3.0	1K162727082
			0.2	3.5	0.2	3.0	1N937327082
0 to 2.3	0 to 33	40	0.3	4.3	0.3	4.3	1P637127082
			0.4	6.0	0.2	3.0	1L217327042
			0.3	4.4	0.2	3.0	1N844027082
	0 to 33	60	0.2	3.5	0.2	3.5	1N937327082
			0.5	7.0	0.2	3.0	1K162827082
			0.5	6.8	0.2	3.0	1P270227042
	0 to 33	70	0.7	10.1	0.2	3.0	1R676027082
0 to 2.8	0 to 40	40	0.3	4.4	0.2	3.0	1N844027082
			0.4	6.0	0.2	3.0	1L217327042
	0 to 40	60	0.5	6.8	0.2	3.0	1P270227042
			0.5	7.0	0.2	3.1	1K162827082
	0 to 40	70	0.7	10.1	0.2	3.3	1R676027082
0 to 3.8	0 to 55	40	0.3	4.4	0.2	3.5	1N844027082
	0 to 55	70	0.7	10.1	0.7	10.1	1R676027082
0.2 to 1.0	3 to 15	40	---	---	0.2	3.0	1L217427042
	3 to 15	60	0.3	3.7	0.2	3.0	1K162727082
0.2 to 2.1	3 to 30	40	0.3	4.3	0.3	4.3	1P637127082
			0.4	6.0	0.2	3.0	1L217327042
			---	---	0.2	3.0	1N844027082
	3 to 30	60	0.2	3.5	0.2	3.5	1N937327082
			0.5	7.0	0.2	3.0	1K162827082
			---	---	0.2	3.0	1P270227042
	3 to 30	70	0.7	10.1	0.2	3.0	1R676027082

1. For more detailed ordering information concerning spring selection to obtain the torque required by the valve, consult your Fisher sales office.

1. For more detailed ordering information concerning spring selection to obtain the torque required by the valve, consult your Fisher sales office.

Types 1051 & 1052 with F & G Mounting

Keys 22 and 67⁽¹⁾ Mounting Yoke Assembly

VALVE DESIGN	ACTUATOR SIZE	VALVE SHAFT DIAMETER	VALVE SHAFT DIAMETER	KEY 22 YOKE CAST IRON		KEY 67 BUSHING, PTFE
		mm	Inches			
CV500, V100, V150, V200, V250, V300, 8510, 8522, 8532, 8560, and 7800 (2-12 Inch) for F Mounting	40	12.7	1/2	12A9799X0A2	---	1U902599402
		15.9	5/8	12A9799X0B2	---	12A9555X012
		19.1	3/4	12A9799X0C2	---	12A9556X012
	40	22.2	7/8	12A9799X0E2	---	12A9557X012
		25.4	1	12A9799X0G2	---	12A9775X012
		31.8	1-1/4	12A9799X112	---	12A9558X012
	60	19.1	3/4	12A9799X0D2	---	12A9556X012
		22.2	7/8	12A9799X0F2	---	12A9557X012
		25.4	1	12A9799X0H2	---	12A9775X012
	60 and 70	31.8	1-1/4	12A9799X0J2	---	12A9558X012
		38.1	1-1/2	12A9799X0K2	---	12A9559X012
		44.5	1-3/4	12A9799X0L2	---	10A3848X012
		50.8	2	12A9799X0M2	---	12A9715X012
7600 and 9500 for G Mounting	40	12.7	1/2	---	32A9755X012	1U902599402
		15.9	5/8	---	32A9742X012	12A9555X012
		19.1	3/4	---	32A9743X012	12A9556X012
	40	25.4	1	---	32A9757X012	12A9575X012
		31.8	1-1/4	---	32A9746X012	12A9558X012
	60	19.1	3/4	---	32A9750X012	12A9556X012
		25.4	1	---	32A9778X012	12A9775X012
	60 and 70	31.8	1-1/4	---	32A9753X012	12A9558X012
		38.1	1-1/2	---	32A9754X012	12A9559X012
		44.5	1-3/4	---	35A9704X012	12A9560X012
		50.8	2	---	35A9705X012	12A9561X012

1. The yokes in this column are available as yoke-bushing assemblies. However, the bushings are available as replacement parts.

Types 1051 & 1052 with F & G Mounting

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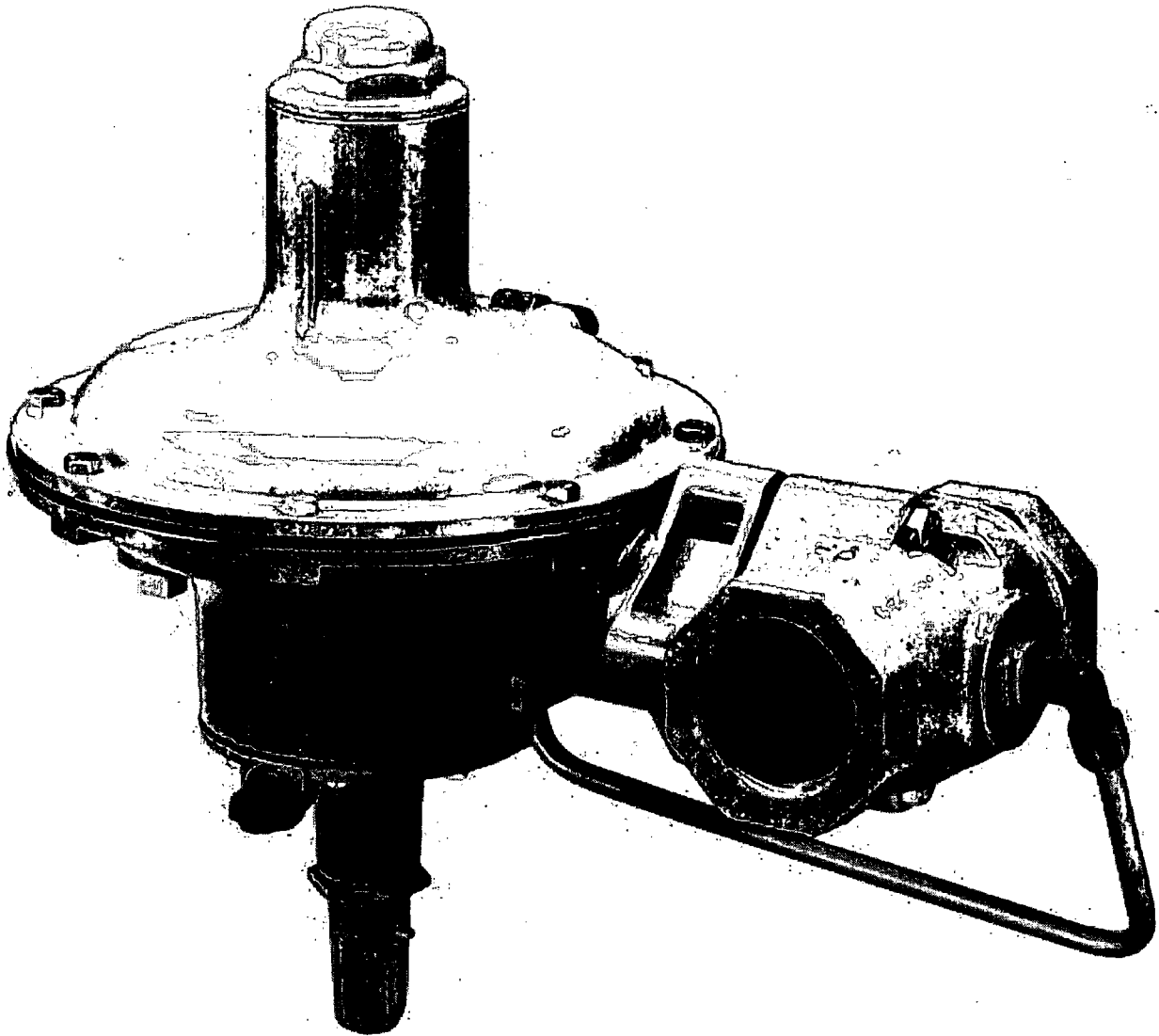
For information, contact Fisher:
Marshalltown, Iowa 50158 USA
Cernay 68700 France
Sao Paulo 05424 Brazil
Singapore 128461



Printed in U.S.A.

FISHER-ROSEMOUNT™

Type 299 Pressure Reducing Regulators



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FISHER

FISHER-ROSEMOUNT™ Managing The Process Better™

Type 299 Pressure Reducing Regulator Features

D Wide Variety of Applications— Natural gas distribution systems, gas supply to industrial boilers, furnaces, ovens, mixers, plant air service.

D Not an adaptation of existing regulators— New design of integrated cases and internal registration ports.

D Accuracy— Keeps constant inlet pressures to downstream equipment by accurately controlling distribution system pressures at widely varying flow rates and supply pressures for maximum efficiency and best operation, or by eliminating the need for pressure-compensating meters by holding a steady pressure to the meter inlet.

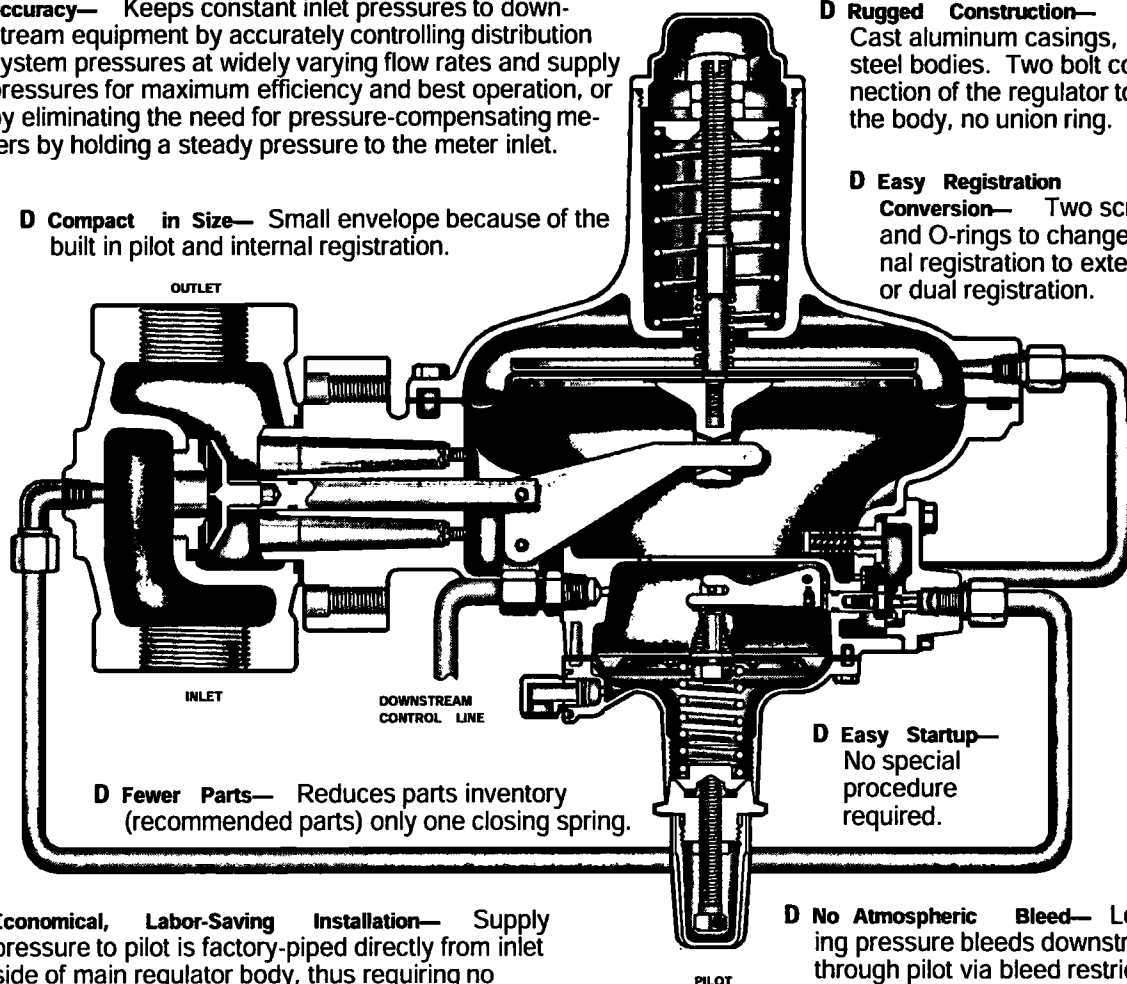
D Compact in Size— Small envelope because of the built in pilot and internal registration.

D High-Capacity Pressure Control— Actuator diaphragm responds quickly to downstream pressure change, causing immediate correction in main valve position. Pilot responds simultaneously and controls final positioning of main valve. This action permits full main valve travel, resulting in higher capacity than could be obtained without a pilot.

D Reusable O-rings At All Servicable Joints— No gaskets.

D Rugged Construction— Cast aluminum casings, steel bodies. Two bolt connection of the regulator to the body, no union ring.

D Easy Registration Conversion— Two screws and O-rings to change internal registration to external or dual registration.



D Fewer Parts— Reduces parts inventory (recommended parts) only one closing spring.

D Easy Startup— No special procedure required.

D Economical, Labor-Saving Installation— Supply pressure to pilot is factory-piped directly from inlet side of main regulator body, thus requiring no upstream pilot supply line on standard installations.

D Easy to Maintain— Main valve disk and orifice can be inspected without removing body from pipeline. Easy access two bolt flange permits quick removal of actuator and pilot from body.

D No Atmospheric Bleed— Loading pressure bleeds downstream through pilot via bleed restriction and downstream control line. No bleed occurs when regulator is shut off.

D Highest Quality— Designed and manufactured to ISO 9001 standards

Specifications

Body Size And End Connection Styles

- 1-1/2-inch, 2-inch NPT screwed or,
- 2-inch ANSI Class 125 and 250 flanged

Orifice Sizes and Maximum Allowable Inlet Pressure⁽¹⁾

1/4 x 3/8-inch	150 psig (10.3 bar)
3/8-inch	150 psig (10.3 bar)
1/2-inch	150 psig (10.3 bar)
3/4-inch	125 psig (8.6 bar)
1-inch	60 psig (4.1 bar)
1-3/16-inch	40 psig (2.8 bar)

Outlet (Control) Pressure Ranges^(1, 2)

See Table 1

Pressure Control Accuracy

+/- 1% of absolute control pressure

Minimum Differential Pressure For Full Stroke

1.5 psi (0.10 bar)

Maximum Emergency Outlet Pressure⁽¹⁾

45 psig (3.1 bar)

Flow Coefficients

See Table 2

Typical Regulating Capacities

See Tables 3 to 5

Construction Materials

Actuator Upper Casing: Aluminum (A03800)

Actuator Lower Casing: Aluminum (A03800)

Pilot Spring Case: Aluminum (A03800)

Actuator Diaphragm: Nitrile

Pilot Diaphragm: Nitrile

Pilot Inlet Screen: 18–8 stainless steel

Valve Body: ■ Cast iron, or ■ steel

Orifice and Valve Stem: Aluminum (A92017)

Disk Holder: Aluminum (A92017)/nitrile

Main Disk Construction: Nitrile

Metal Trim Parts For Pilot: ■ Steel, ■ stainless steel, or ■ aluminum

Pilot Disk Construction: Nitrile

O-Rings: Nitrile

Fittings And Tubing: ■ Steel/stainless steel (std), ■ brass/copper, or ■ stainless steel

Approximate Weight

21 lbs (9.5 kg)

Temperature Capabilities⁽¹⁾

–20° to 150°F (–29° to 65.5°C)

Control Line And Pilot Connections:

See Figure 5

Additional Options:

Three fixed restriction sizes to choose from:

.044-inch (1.12 mm) red (std. gain)

.071-inch (1.80 mm) green (low gain)

.082-inch (2.08 mm) blue (lower gain)

Pressure loading regulator⁽³⁾: A Type 67AF with an internal 40 microns filter

Filter⁽³⁾: A P590 Series filter installed in the pilot supply tubing between main body and pilot

1. The pressure/temperature limits in this bulletin and any applicable standard or code limitation should not be exceeded.

2. For optimum performance, a pilot supply regulator may be installed in the pilot supply tubing between the main valve and pilot.

3. Only one (a pressure loading regulator or a P590 Series filter) may be ordered with the Type 299, but not both.

Table 1. Outlet Pressure Ranges

MAXIMUM RECOMMENDED PILOT SUPPLY PRESSURE	OUTLET (CONTROL) PRESSURE RANGE	PILOT CONTROL SPRING			
		Part Number	Color Code	Free Length Inches (mm)	Wire Diameter Inches (mm)
40 psi ⁽¹⁾ (2.8 bar)	3.5 to 6 inches w.c. (9 to 15 mbar)	T13707T0012	Black	1.86 (47.2)	0.055 (1.4)
	6 to 9 inches w.c. (15 to 22 mbar)	T13589T0012	Yellow	2.05 (52.0)	0.051 (1.3)
	9 to 20 inches w.c. (22 to 49 mbar)	1N3112X0012	Silver	2.18 (55.4)	0.075 (1.9)
	16 to 40 inches w.c. (40 to 99 mbar)	1B413727222	Purple	2.12 (53.8)	0.092 (2.3)
150 psi (10.3 bar)	1 to 3.25 psig (0.07 to 0.14 bar)	T13593T0012	Lt. Blue	2.12 (53.8)	0.105 (2.7)
	3.25 to 6 psig (0.14 to 0.41 bar)	T13671T0012	Orange	2.40 (61.1)	0.120 (3.0)
	6 to 16 psig (0.41 to 1.10 bar)	T13600T0012	Red	2.10 (53.3)	0.142 (3.6)
	16 to 35 psig (1.10 to 2.4 bar)	T13771T0012	Zinc	2.15 (54.6)	0.207 (5.3)

1. Use a pilot supply regulator if actual inlet pressure exceeds 40 psi (2.8 bar).

Table 2. Flow Coefficients and Orifice Diameters

ORIFICE DIAMETER INCH (mm)	FOR RELIEF SIZING WIDE OPEN C _g	REGULATING C _g	C1 ΔP < 10 psi	C1 ΔP ≥ 10 psi
1/4 x 3/8 (6.4 x 9.5)	53	50	26	26
3/8 (9.5)	117	115	30	28
1/2 (12.7)	203	200	30	28
3/4 (19.1)	437	430	32	30
1 (25.4)	725	710	36	34
1-3/16 (30.2)	910	885	37	35

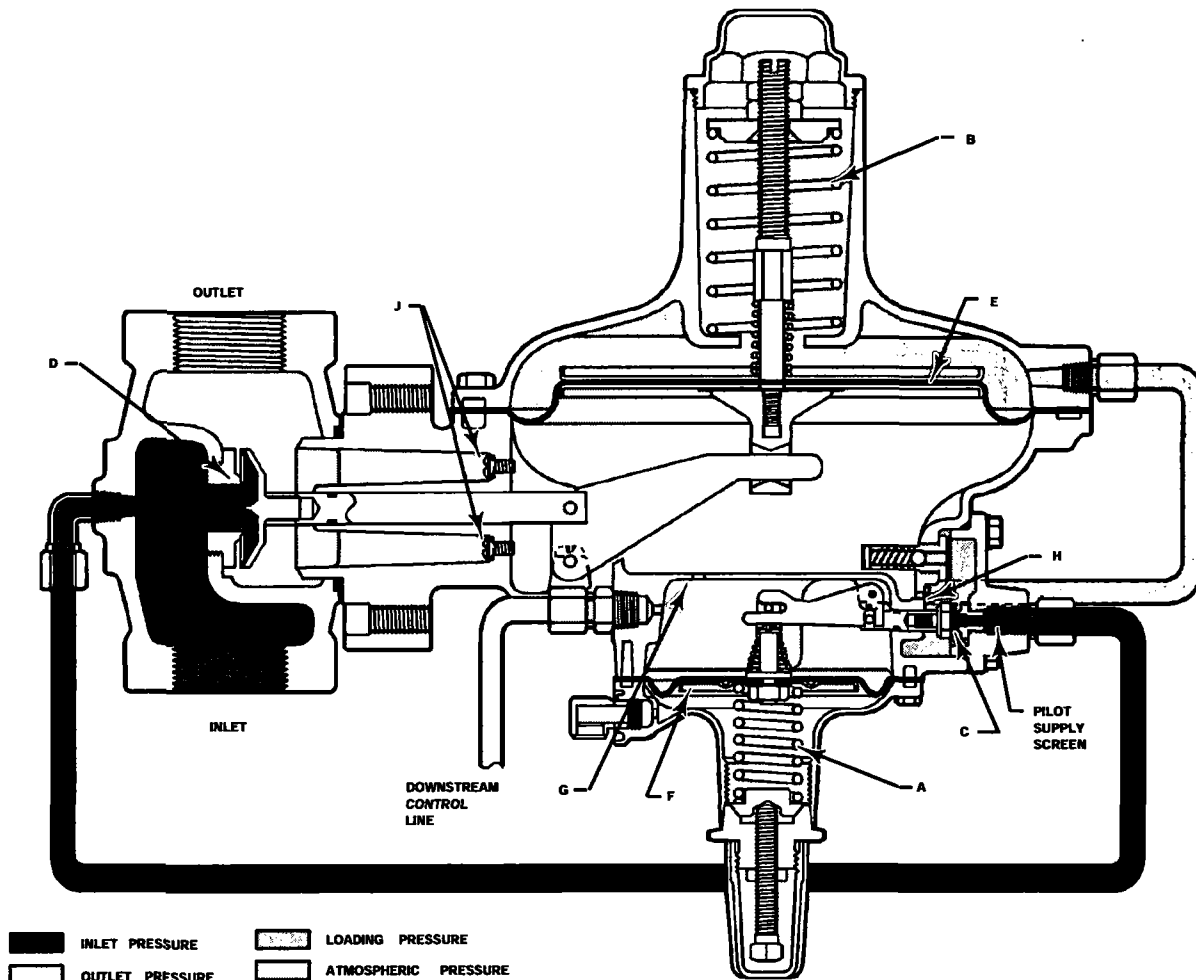


Figure 3. Operational Schematic of Type 299 Regulator (External Registration)

Principle of Operation

Letter keys in this section refers to figure 3 unless otherwise noted. Fast response and accuracy are made possible by the amplifying effect of the pilot and by the two-path control system. The function of the pilot is to sense change in the controlled pressure and amplify it into a larger change in the loading pressure. Any changes in outlet pressure act quickly on both the actuator diaphragm and the loading pilot, thus providing the precise pressure control that is characteristic of a two-path system.

A typical pilot has an approximate gain of 50, which means the outlet pressure needs to droop only 1/50 as much as a self-operated regulator in order to obtain the same pressure differences across the main diaphragm. Advantages of a pilot operated regulator are high accuracy and high capacity.

Upstream or inlet pressure is utilized as the operating medium, which is reduced through pilot operation to load the main diaphragm chamber. Tubing connects the inlet pressure to the pilot. Downstream or outlet pressure registers underneath main diaphragm (E) and on top of pilot diaphragm (F). There are three different versions of registration for the Type 299.

- Internal registration (screws (J) removed)—** Outlet pressure is registered through the throat to the main diaphragm chamber and then through a small port (G) to the top of the pilot diaphragm.
- External registration—** The throat is blocked by screws (J) and a downstream control line is connected to the pilot diaphragm chamber which is connected to the lower main diaphragm chamber by a small port (G).

- c. **Dual registration (screws (J) removed)**—The lower main diaphragm chamber registers outlet pressure through the throat and pilot diaphragm chamber registers downstream pressure by use of a downstream control line. The port (G) between the chambers is blocked by inserting a screw (J).

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

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

When the gas demand in the downstream system has been satisfied, the outlet pressure increases. The increased pressure is transmitted through the downstream control line and acts on top of the pilot diaphragm (F). This pressure exceeds the pilot spring setting and forces the diaphragm down, closing orifice (C). The loading pressure acting on main diaphragm (E) bleeds to the downstream system through a bleed restriction (H).

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

Overpressure Protection

Like most regulators, the Type 299 has outlet pressure ratings lower than the inlet pressure ratings. Complete downstream overpressure protection is needed if the actual inlet pressure exceeds the outlet pressure rating.

Overpressure protection for internal parts is built into the main and pilot diaphragms by means of a small spring on each post. The springs will allow the diaphragms to move farther on the posts avoiding damage to or bending of the valve trim.

Overpressuring any portion of a regulator or associated equipment may cause leakage, part damage, or personal injury due to bursting of pressure-containing parts or explosion of accumulated gas. Regulator operation within ratings does not preclude the possibility of damage from external sources or from debris in the pipeline. A regulator should be in-

spected for damage periodically and after any overpressure condition.

The pilot is provided with a 1/4-inch NPT tapped connection in the spring case.

Monitoring Systems for Safety

Monitoring regulators serve as overpressure protection devices to limit system pressure in the event of open failure of a working regulator feeding the system. A method of using Type 299 regulators in monitoring systems are as follows:

- **Wide Open Monitor**— The control line of the upstream regulator is connected downstream of the second regulator (figure 4), so that during normal operation the monitoring regulator is standing wide open with the reduction to distribution pressure being taken across the working regulator. Only in case of open failure of the working regulator does the wide-open monitoring regulator take control at its slightly higher setting.

The upstream regulator can easily be field converted or ordered with screws and O-rings in the throat (figure 3). This seals off the path that otherwise would let line pressure ahead of the working regulator inlet try to close the wide-open monitoring regulator.

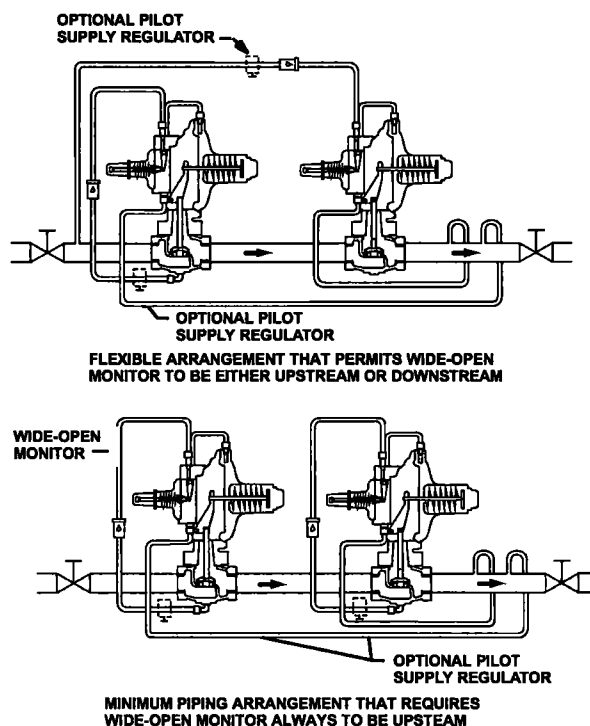


Figure 4. Typical Wide-Open Monitor Installations

Capacity Information

Tables 3 to 5 gives Type 299 natural gas regulating capacities at selected inlet pressures and outlet pressure settings. Flows are in scfh (60°F and 14.7 psia) of 0.6 specific gravity gas at 60°F. To determine equivalent capacities for air, propane, butane, or nitrogen, multiply the table 6 capacity by the following appropriate conversion factor: 0.775 for air, 0.628 for propane, 0.548 for butane, or 0.789 for nitrogen. For gases of other specific gravities, multiply the given capacity by 0.775 and divide by the square root of the appropriate specific gravity. Then, if capacity is desired in normal cubic meters per hour (m³/hr) at 0°C and 1.01325 bar, multiply scfh by 0.0268.

To determine regulating capacities for pressures or constructions not given in tables 3 to 5, or to determine wide-open capacities for relief sizing at any inlet pressure, use the following formula and convert according to the factors in the preceding paragraph if necessary:

$$Q = \sqrt{\frac{520}{GT}} C_g P_1 \sin \left(\frac{3417}{C_1} \sqrt{\frac{\Delta P}{P_1}} \right) \text{ DEG}$$

where:

- C_1 = C_g/C_v (See table 2)
- C_g = Gas sizing coefficient (see table 2)
- G = Gas specific gravity (air = 1.0)
- P_1 = Regulator inlet pressure, psia
- ΔP = Pressure drop across regulator, psi
- Q = Gas flow rate, scfh
- T = Absolute temperature of gas at inlet, degree Rankine

Note

Due to boost, the above formula can not be used to obtain correct regulating capacities for regulators with internal registration.

The published capacities were obtained using inlet and outlet piping the same size as the regulator body size.

Pressure Registration Methods

Internal — use for easiest installation. Capacity is somewhat limited because of droop and /or boost associated with sensing pressure within the body.

External — use for higher capacity and /or upstream regulator in a monitor set. Capacity is increased because of better registration of pipeline pressure when a control line is used. The alternate 1/2-inch NPT con-

trol line connection can be used for piping convenience.

Dual (internal plus external) — use to improve performance over internal pressure registration when there is a low flow rate and high pressure drop and a large orifice (control line must be piped to the primary 1/4-inch NPT connection on the the pilot).

Installation

Although the actuator and pilot can be mounted in 90° increments relative to the body, the normal installation is with the body in a horizontal run of pipe and the pilot hanging vertically from the bottom of the actuator.

Control and vent lines necessary for installation are not supplied with a Type 299 regulator. Control and vent connection locations are shown in figure 5. In many instances good piping practice will require that outlet piping be swaged up above the body size to prevent excessive pressure drop along the outlet line. The piping should be expanded as close to the regulator outlet as possible.

Dimensional information also is given in figure 5.

Ordering Information

To order a particular construction specify the items listed below. In addition, any optional constructions must be specified.

Application

1. Composition and specific gravity of gas (including chemical analysis if possible).
2. Range of temperatures, flowing inlet pressures (maximum, minimum, nominal), and pressure drops.
3. Desired outlet pressure setting.
4. Range of flow rates (minimum controlled, maximum, normal).
5. Piping size(s).
6. Tubing fitting material.
7. Pilot supply regulator or a P590 series filter option.
8. Internal or External registration.
9. Body material.
10. Body end connection.

Construction

Refer to the Specifications on page 3. Carefully review each specification and/or referenced tables, specify the desired selection whenever there is a choice to be made.

Table 3. Regulating Capacities For 1-1/2-inch and 2-inch External/Dual Registration in SCFH (60° F and 14.7 psia) of 0.6 Specific Gravity Natural Gas.

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
3.5 to 8 Inches w.c. (8.8 to 15 mbar) 3-1/2-inch w.c. (8.8 mbar) T13707T0012 Black	2	0.14	760	1560	2700	5490	8170	9940
	5	0.34	1160	2460	4270	8790	13310	16250
	10	0.69	1590	3580	6230	13060	20300	24900
	15	1.0	1920	4410	7670	16480	27210	33910
	20	1.4	2240	5150	8960	19250	31790	39620
	25	1.7	2570	5890	10250	22030	36370	45330
	30	2.1	2890	6640	11540	24800	40950	51040
	40	2.8	3530	8120	14120	30350	50100	62450
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
6 to 9 Inches w.c. (15 to 22 mbar) 7-inch w.c. (17.5 mbar) T13589T0012 Yellow	2	0.14	750	1520	2650	5380	8000	9730
	5	0.34	1160	2440	4240	8730	13220	16130
	10	0.69	1590	3580	6220	13040	20250	24830
	15	1.0	1920	4410	7670	16480	27210	33910
	20	1.4	2240	5150	8960	19250	31790	39620
	25	1.7	2570	5890	10250	22030	36370	45330
	30	2.1	2890	6640	11540	24800	40950	51040
	40	2.8	3530	8120	14120	30350	50100	62450
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
9 to 20 Inches w.c. (22 to 49 mbar) 14-inch w.c. (35 mbar) 1N3112X0012 Silver	2	0.14	700	1430	2480	5040	7480	9090
	5	0.34	1140	2400	4170	8570	12950	15800
	10	0.69	1580	3560	6190	12970	20110	24640
	15	1.0	1920	4410	7670	16480	27210	33910
	20	1.4	2240	5150	8960	19250	31790	39620
	25	1.7	2570	5890	10250	22030	36370	45330
	30	2.1	2890	6640	11540	24800	40950	51040
	40	2.8	3530	8120	14120	30350	50100	62450
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
16 to 40 inches w.c. (40 to 99 mbar) 28-inch w.c. (70 mbar) 1B413727222 Purple	5	0.34	1110	2320	4020	8250	12430	15150
	10	0.69	1570	3530	6140	12830	19830	24290
	15	1.0	1920	4410	7670	16480	27210	33910
	20	1.4	2240	5150	8960	19250	31790	39620
	25	1.7	2570	5890	10250	22030	36370	45330
	30	2.1	2890	6640	11540	24800	40950	51040
	40	2.8	3530	8120	14120	30350	50100	62450
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			

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Table 3. Regulating Capacities For 1-1/2-inch and 2-inch External/Dual Registration in SCFH (60° F and 14.7 psia) of 0.6 Specific Gravity Natural Gas. (continued)

OUTLET PRESSURE RANGE AND SETTING , CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
1.0 to 3.25 psig (0.07 to 0.14 bar) 2 psig (0.13 bar) T13593T0012 Light Blue	5	0.34	1020	2100	3640	7440	11140	13560
	10	0.69	1550	3340	5810	12040	18460	22570
	15	1.0	1920	4360	7580	15990	25050	30760
	20	1.4	2240	5150	8960	19250	31790	39620
	25	1.7	2670	5890	10250	22030	36370	45330
	30	2.1	2890	6640	11540	24800	40950	51040
	40	2.8	3530	8120	14120	30350	50100	62450
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
3.25 to 6 psig (0.14 to 0.41 bar) 5 psig (0.3 bar) T13671T0012 Orange	10	0.69	1390	2910	5050	10350	15600	19030
	15	1.0	1870	4190	7280	15150	23310	28530
	20	1.4	2240	5090	9850	18640	29180	35820
	25	1.7	2570	5890	10250	22030	36370	45330
	30	2.1	2890	6640	11540	24800	40950	51040
	40	2.8	3530	8120	14120	30350	50100	62450
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
6 to 16 psig (0.41 to 1.10 bar) 10 psig (0.7 bar) T13600T0012 Red	15	1.0	1580	3280	5690	11640	17470	21280
	20	1.4	2130	4720	8210	17000	25940	31690
	25	1.7	2540	5710	9940	20790	32220	39490
	30	2.1	2890	6580	11440	24150	37900	46560
	40	2.8	3530	8120	14120	30350	50100	62450
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
6 to 16 psig (0.41 to 1.10 bar) 15 psig (1.0 bar) T13600T0012 Red	20	1.4	1750	3620	6290	12830	19190	23360
	25	1.7	2360	5220	9070	18700	28360	34610
	30	2.1	2820	6290	10940	22790	35050	42890
	40	2.8	3540	8070	14020	29650	46610	57270
	50	3.4	4180	9600	16700	35890	59260	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
16 to 35 psig (1.10 to 2.4 bar) 20 psig (1.4 bar) T13771T0012 Zinc	25	1.7	1920	3930	6840	13930	20800	23510
	30	2.1	2580	5690	9870	20280	30630	37340
	40	2.8	3480	7830	13610	28440	43980	53880
	50	3.4	4180	9550	16610	35140	55310	
	60	4.1	4820	11090	19280	41440	68420	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.6	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			

Table 3. Regulating Capacities For 1-1/2-inch and 2-inch External/Dual Registration in SCFH (60° F and 14.7 psia) of 0.6 Specific Gravity Natural Gas. (continued)

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
16 to 35 psig (1.10 to 2.4 bar) 25 psig (1.7 bar) T13771T0012 Zinc	30	2.1	2070	4230	7360	14980	22310	27140
	40	2.8	3320	7350	12780	23420	40220	49120
	50	3.4	4140	9340	16250	34040	52830	
	60	4.1	4830	11030	19190	40630	64010	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.8	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
16 to 35 psig (1.10 to 2.4 bar) 30 psig (2.1 bar) T13771T0012 Zinc	40	2.8	2980	6520	11330	23190	34790	42370
	50	3.4	4020	8950	15560	32300	49460	
	60	4.1	4800	10850	18870	39600	61630	
	80	5.5	6110	14050	24440	52540		
	100	6.9	7400	17020	29600	63630		
	125	8.8	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			
16 to 35 psig (1.10 to 2.4 bar) 35 psig (2.4 bar) T13771T0012 Zinc	40	2.8	2350	4790	8330	16920	25150	30680
	50	3.4	3770	8300	14430	29690	44890	
	60	4.1	4700	10510	18270	38050	58520	
	80	5.5	6120	14000	24350	51600		
	100	6.9	7400	17020	29600	63630		
	125	8.8	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			

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Table 4. Regulating Capacities For 1-1/2-inch Internal Registration in SCFH (60° F and 14.7 psia) of 0.6 Specific Gravity Natural Gas.

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
3.5 to 6 Inches w.c. (8.8 to 15 mbar) 3-1/2-inch w.c. (8.8 mbar) T13707T0012 Black	2	0.14	760	1560	2700	4050	4310	4540
	5	0.34	1160	2460	4270	7370	8420	8840
	10	0.69	1590	3580	6230	8440	8580	9260
	15	1.0	1920	4410	7670	9540	10300	10020
	20	1.4	2240	5150	8960	10650	10410	10790
	25	1.7	2570	5890	9770	10640	10520	10740
	30	2.1	2890	6640	10360	10640	10620	10690
	40	2.8	3530	8120	12170	10630	10500	10590
	50	3.4	4180	9600	11440	10610	11050	
	60	4.1	4820	11090	10700	10600	11610	
	80	5.5	6110	8760	8640	4500		
	100	6.9	5640	4500	4500	4500		
	125	8.6	5640	4500	4500	4500		
	150	10.3	5620	4500	4500			
6 to 9 Inches w.c. (15 to 22 mbar) 7-inch w.c. (17.5 mbar) T13589T0012 Yellow	2	0.14	750	1520	2650	5380	5610	5790
	5	0.34	1160	2440	4240	7300	7290	7630
	10	0.69	1590	3580	6220	8500	8980	9470
	15	1.0	1920	4410	7670	9700	10670	10240
	20	1.4	2240	5150	8960	10900	10770	11010
	25	1.7	2570	5890	9930	10910	10870	11030
	30	2.1	2890	6640	10750	10920	10970	11060
	40	2.8	3530	8120	12390	10940	10870	11110
	50	3.4	4180	9600	11840	10970	11380	
	60	4.1	4820	11090	11280	10990	11580	
	80	5.5	6110	8980	9020	4500		
	100	6.9	5640	4500	4500	4500		
	125	8.6	5640	4500	4500	4500		
	150	10.3	5640	4500	4500			
9 to 20 Inches w.c. (22 to 49 mbar) 14-inch w.c. (35 mbar) 1N3112X0012 Silver	2	0.14	700	1430	2480	5040	6900	7050
	5	0.34	1140	2400	4170	7230	8170	8430
	10	0.69	1580	3560	6190	8620	9780	9900
	15	1.0	1920	4410	7670	10020	11390	10670
	20	1.4	2240	5150	8960	11410	11480	11440
	25	1.7	2570	5890	10250	11460	11570	11620
	30	2.1	2890	6640	11540	11500	11660	11790
	40	2.8	3530	8120	12820	11580	11620	12140
	50	3.4	4180	9600	12630	11670	12030	
	60	4.1	4820	10890	12400	11750	12200	
	80	5.5	6110	8920	9920	4970		
	100	6.9	5640	4960	4970	4970		
	125	8.6	5640	4960	4970	4970		
	150	10.3	5640	4960	4970			
16 to 40 Inches w.c. (40 to 99 mbar) 28-Inch w.c. (70 mbar) 1B413727222 Purple	5	0.34	1110	2320	4020	6610	9500	9560
	10	0.69	1570	3530	6140	8870	11380	10750
	15	1.0	1920	4410	7670	10650	12850	11530
	20	1.4	2240	5150	8960	12440	12920	12310
	25	1.7	2570	5890	10250	12550	12980	12790
	30	2.1	2890	6640	11540	12650	13050	13260
	40	2.8	3530	8120	13690	12860	13110	14220
	50	3.4	4180	9600	14220	13070	13320	
	60	4.1	4820	10890	14630	13290	13450	
	80	5.5	6110	9070	11560	10670		
	100	6.9	7270	5420	5430	5430		
	125	8.6	6670	5420	5430	5430		
	150	10.3	6830	5420	5630			

Table 4. Regulating Capacities For 1-1/2-inch Internal Registration in SCFH (60° F and 14.7 psia) of 0.6 Specific Gravity Natural Gas. (continued)

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
1.0 to 3.25 psig (0.07 to 0.14 bar) 2 psig (0.13 bar) T13593T0012 Light Blue	5	0.34	1020	2100	3640	7020	10790	10820
	10	.069	1550	3340	5810	8990	12180	11180
	15	1.0	1920	4360	7580	10970	13580	11960
	20	1.4	2240	5150	8960	12950	13630	12750
	25	1.7	2570	5890	10250	13090	13890	13370
	30	2.1	2890	6640	11540	13230	13740	14000
	40	2.8	3530	8120	14120	13500	13850	15250
	50	3.4	4180	9600	15010	13780	13970	
	60	4.1	4820	10890	15740	14050	14080	
	80	5.5	6110	9000	12230	11100		
	100	6.9	7400	5200	5200	5200		
	125	8.6	8170	5040	5200	5200		
	150	10.3	8450	5870	5900			
3.25 to 6 psig (0.14 to 0.41 bar) 5 psig (0.3 bar) T13671T0012 Orange	10	0.69	1390	2910	5050	8470	12010	12190
	15	1.0	1870	4190	7280	11290	14300	12400
	20	1.4	2240	5090	8850	12590	13820	13260
	25	1.7	2570	5890	10250	13210	14550	14310
	30	2.1	2890	6640	11540	13820	15290	15370
	40	2.8	3530	8120	14120	15060	15650	16630
	50	3.4	4180	9600	16700	15400	16010	
	60	4.1	4820	11090	16290	15750	16370	
	80	5.5	6110	14050	14000	13620		
	100	6.9	7400	17020	9020	9220		
	125	8.6	9020	7690	7690	7890		
	150	10.3	10630	6330	6360			
6 to 16 psig (0.41 to 1.10 bar) 10 psig (0.7 bar) T13600T0012 Red	15	1.0	1580	3280	5690	9930	13230	13570
	20	1.4	2130	4720	8210	11990	14130	14100
	25	1.7	2540	5710	9940	13400	15990	15870
	30	2.1	2890	6580	11440	14810	17850	17640
	40	2.8	3530	8120	14120	17640	18630	18920
	50	3.4	4180	9600	16700	18110	19400	
	60	4.1	4820	11090	17200	18580	20170	
	80	5.5	6110	14050	16950	17810		
	100	6.9	7400	17020	15350	15900		
	125	8.6	9020	20730	16740	16270		
	150	10.3	6790	6790	6830			
6 to 16 psig (0.41 to 1.10 bar) 15 psig (1.0 bar) T13771T0012 Zinc	20	1.4	1750	3620	6290	11380	14450	14950
	25	1.7	2360	5220	9070	13590	17440	17430
	30	2.1	2820	6290	10940	15810	20430	19910
	40	2.8	3540	8070	14020	20230	21610	21220
	50	3.4	4180	9600	16700	20820	22800	
	60	4.1	4820	11090	18110	21410	23890	
	80	5.5	6110	14050	19910	22000		
	100	6.9	7400	17020	21710	22600		
	125	8.6	9020	20730	23960	23190		
	150	10.3	10630	24440	26210			
16 to 35 psig (1.10 to 2.4 bar) 20 psig (1.4 bar) T13771T0012 Zinc	25	1.7	1920	3930	6840	12840	15670	16320
	30	2.1	2580	5690	9870	15200	20740	20760
	40	2.8	3480	7830	13610	22820	24600	23510
	50	3.4	4180	9550	16610	20950	23620	
	60	4.1	4820	11090	18080	23330	26120	
	80	5.5	6110	14050	20980	25120		
	100	6.9	7400	17020	23680	26930		
	125	8.6	9020	20730	26980	28020		
	150	10.3	10630	24440	30280			

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Table 4. Regulating Capacities For 1 Internal Registration in SCFH (60°F and 14.7 psia) of 0.6 Specific Gravity Natural Gas. (continued)

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
16 to 35 psig (1.10 to 2.4 bar) 25 psig (1.7 bar) T13771T0012 Zinc	30	2.1	2070	4230	7360	14300	16880	17700
	40	2.8	3320	7350	12780	16810	24040	24090
	50	3.4	4140	9340	16250	21090	24430	
	60	4.1	4830	11030	18050	25240	28260	
	80	5.5	6110	14050	22050	28250		
	100	6.9	7400	17020	25650	31260		
	125	8.6	9020	20730	30000	32840		
	150	10.3	10630	24440	34360			
16 to 35 psig (1.10 to 2.4 bar) 30 psig (2.1 bar) T13771T0012 Zinc	40	2.8	2980	6520	11330	15750	18100	19080
	50	3.4	4020	8950	15560	21220	25240	
	60	4.1	4800	10850	18020	27150	30390	
	80	5.5	6110	14050	23130	31370		
	100	6.9	7400	17020	27630	35690		
	125	8.6	9020	20730	33030	37670		
	150	10.3	10630	24440	38430			
16 to 35 psig (1.10 to 2.4 bar) 35 psig (2.4 bar) T13771T0012 Zinc	40	2.8	2350	4790	8330	13640	19570	20850
	50	3.4	3770	8300	14430	21350	26060	
	60	4.1	4700	10510	18270	29060	32530	
	80	5.5	6120	14000	24350	34490		
	100	6.9	7400	17020	29600	39920		
	125	8.6	9020	20730	36050	42500		
	150	10.3	10630	24440	42500			

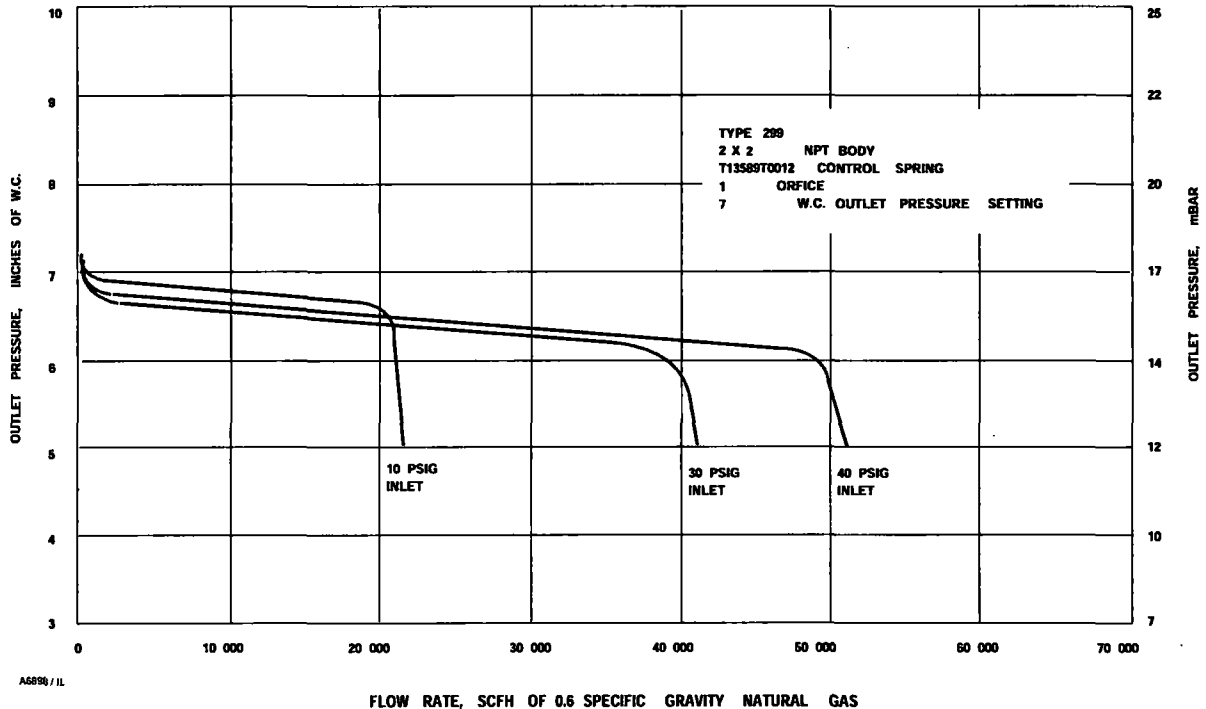


Figure 5. Typical 7 (17 mbar) Water Column Performance Curves

Table 5. Regulating Capacities For 2-inch Internal Registration in SCFH (60° F and 14.7 psia) of 0.6 Specific Gravity Natural Gas.

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
3.5 to 6 Inches w.c. (8.8 to 15 mbar) 3-1/2-inch w.c. (8.8 mbar) T13707T0012 Black	2	0.14	760	1560	2700	4050	5710	6350
	5	0.34	1160	2460	4270	7470	6910	11260
	10	0.69	1590	3580	6230	11230	14780	14900
	15	1.0	1920	4410	7670	14210	17080	17230
	20	1.4	2240	5150	8960	17200	18230	17610
	25	1.7	2570	5890	10250	18290	19220	19040
	30	2.1	2890	6640	11540	19390	19220	20500
	40	2.8	3530	8120	14120	21580	19860	20720
	50	3.4	4180	9600	16700	20170	23010	
	60	4.1	4820	11090	19280	18760	19120	
	80	5.5	6110	14050	24440	5800		
	100	6.9	5640	5640	5640	5800		
	125	8.8	5640	5640	5640	5810		
	150	10.3	5620	5620	5620			
6 to 9 Inches w.c. (15 to 22 mbar) 7-inch w.c. (17.5 mbar) T13589T0012 Yellow	2	0.14	750	1520	2650	5380	6260	6680
	5	0.34	1160	2440	4240	8730	10080	11530
	10	0.69	1590	3580	6220	13040	15700	15600
	15	1.0	1920	4410	7670	16480	18040	18140
	20	1.4	2240	5150	8960	19250	19290	18540
	25	1.7	2570	5890	10250	22030	20420	19880
	30	2.1	2890	6640	11540	24800	20630	21410
	40	2.8	3530	8120	14120	23200	21300	22080
	50	3.4	4180	9600	16700	20310	21830	
	60	4.1	4820	11090	19280	20190	20840	
	80	5.5	6110	14050	24440	5620		
	100	6.9	5640	5640	5640	6000		
	125	8.8	5640	5640	5640	5900		
	150	10.3	5640	5640	5640			
9 to 20 Inches w.c. (22 to 49 mbar) 14-inch w.c. (35 mbar) 1N3112X0012 Silver	2	0.14	700	1430	2480	5040	7440	8460
	5	0.34	1140	2400	4170	8570	13250	11800
	10	0.69	1580	3560	6190	12970	16620	16310
	15	1.0	1920	4410	7670	16480	18990	19050
	20	1.4	2240	5150	8960	19250	20350	19770
	25	1.7	2570	5890	10250	22030	21610	20720
	30	2.1	2890	6640	11540	24800	22040	22330
	40	2.8	3530	8120	14120	24490	22730	23440
	50	3.4	4180	9600	16700	23200	23350	
	60	4.1	4820	11090	19280	22050	22560	
	80	5.5	6110	14050	24440	5620		
	100	6.9	5640	5640	5640	6000		
	125	8.6	5640	5640	5640	6900		
	150	10.3	5640	5640	5640			
16 to 40 inches w.c. (40 to 99 mbar) 28-Inch w.c. (70 mbar) 1B413727222 Purple	5	0.34	1110	2320	4020	8250	9800	12020
	10	0.69	1570	3530	6140	12830	16420	17010
	15	1.0	1920	4410	7670	16480	19950	19960
	20	1.4	2240	5150	8960	19250	21410	20390
	25	1.7	2570	5890	10250	22030	22810	21560
	30	2.1	2890	6640	11540	24800	23450	23250
	40	2.8	3530	8120	14120	25780	24170	24800
	50	3.4	4180	9600	16750	26090	24870	
	60	4.1	4820	11090	19280	23910	24280	
	80	5.5	6110	14050	24260	15560		
	100	6.9	7270	7270	7270	10130		
	125	8.6	6670	6670	6670	9580		
	150	10.3	6830	6830	6830			

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Table 5. Regulating Capacities For 2-inch Internal Registration in SCFH (60° F and 14.7 psia) of 0.6 Specific Gravity Natural Gas. (continued)

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
1.0 to 3.25 psig (0.07 to 0.14 bar) 2 psig (0.13 bar) T13593T0012 Light Blue	5	0.34	1020	2100	3640	7440	10980	13800
	10	0.69	1550	3340	5810	12040	15460	17710
	15	1.0	1920	4360	7580	15990	20900	20670
	20	1.4	2240	5150	8960	19250	22470	21620
	25	1.7	2670	5890	10250	22030	24000	22410
	30	2.1	2890	6640	11540	24800	24860	24170
	40	2.8	3530	8120	14120	27070	25610	26160
	50	3.4	4180	9600	16700	28970	26390	
	60	4.1	4820	11090	19280	25770	26000	
	80	5.5	6110	14050	24440	25500		
	100	6.9	7400	17020	29840	14260		
	125	8.6	8170	12360	17520	13260		
	150	10.3	8450	13750	18580			
3.25 to 6 psig (0.14 to 0.41 bar) 5 psig (0.3 bar) T13671T0012 Orange	10	0.69	1390	2910	5050	10350	13200	16070
	15	1.0	1870	4190	7280	15150	21850	21370
	20	1.4	2240	5090	8850	18640	21350	21390
	25	1.7	2570	5890	10250	21260	24540	22740
	30	2.1	2890	6640	11540	24340	26500	25870
	40	2.8	3530	8120	14120	27670	28300	28930
	50	3.4	4180	9600	16700	30570	29870	
	60	4.1	4820	11090	19280	29390	30390	
	80	5.5	6110	14050	24440	31410		
	100	6.9	7400	17020	29600	22150		
	125	8.6	9020	20730	36050	21590		
	150	10.3	10630	17170	26560			
6 to 16 psig (0.41 to 1.10 bar) 10 psig (0.7 bar) T13600T0012 Red	15	1.0	1580	3280	5690	11640	15420	18340
	20	1.4	2130	4720	8210	17000	19500	21000
	25	1.7	2540	5710	9940	20790	25440	23290
	30	2.1	2890	6580	11440	24150	29250	28700
	40	2.8	3530	8120	14120	28660	32780	33540
	50	3.4	4180	9600	16700	33230	35680	
	60	4.1	4820	11090	19280	35410	37700	
	80	5.5	6110	14050	24440	41270		
	100	6.9	7400	17020	29600	35310		
	125	8.6	9020	20730	36050	35740		
	150	10.3	10630	20590	34530			
6 to 16 psig (0.41 to 1.10 bar) 15 psig (1.0 bar) T13771T0012 Zinc	20	1.4	1750	3620	6290	12830	17640	20610
	25	1.7	2360	5220	9070	18700	26350	23850
	30	2.1	2820	6290	10940	22790	31990	31540
	40	2.8	3540	8070	14020	29650	37270	38150
	50	3.4	4180	9600	16700	35890	41490	
	60	4.1	4820	11090	19280	41440	45020	
	80	5.5	6110	14050	24440	51120		
	100	6.9	7400	17020	29600	48470		
	125	8.6	9020	20730	36050	49780		
	150	10.3	10630	24440	42500			
16 to 35 psig (1.10 to 2.4 bar) 20 psig (1.4 bar) T13771T0012 Zinc	25	1.7	1920	3930	6840	13930	20800	21940
	30	2.1	2580	5680	9870	20280	30630	32630
	40	2.8	3480	7830	13610	28440	33040	35700
	50	3.4	4180	9550	16610	35140	41800	
	60	4.1	4820	11090	19280	41440	47530	
	80	5.5	6110	14050	24440	51240		
	100	6.9	7400	17020	29600	52260		
	125	8.6	9020	20730	36050	56710		
	150	10.3	10630	24440	42500			

Table 5. Regulating Capacities For 2-inch Internal Registration in SCFH (60°F and 14.7 psia) of 0.6 Specific Gravity Natural Gas. (continued)

OUTLET PRESSURE RANGE AND SETTING, CONTROL SPRING NUMBER, & COLOR	INLET PRESSURE		ORIFICE SIZE, Inches (mm)					
	psig	bar	1/4 X 3/8 (6.4 X 9.5)	3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1 (25.4)	1-3/16 (30.2)
16 to 35 psig (1.10 to 2.4 bar) 25 psig (1.7 bar) T13771T0012 Zinc	30	2.1	2070	4230	7360	14980	22310	23270
	40	2.8	3320	7350	12780	23420	40220	33260
	50	3.4	4140	9340	16250	34040	42110	
	60	4.1	4830	11030	19190	40630	50050	
	80	5.5	6110	14050	24440	51360		
	100	6.9	7400	17020	29600	56050		
	125	8.6	9020	20730	36050	63640		
	150	10.3	10630	24440	42500			
16 to 35 psig (1.10 to 2.4 bar) 30 psig (2.1 bar) T13771T0012 Zinc	40	2.8	2980	6520	11330	23190	24580	30810
	50	3.4	4020	8950	15560	32300	42430	
	60	4.1	4800	10850	18870	39600	52560	
	80	5.5	6110	14050	24440	51480		
	100	6.9	7400	17020	29600	59840		
	125	8.8	9020	20730	36050	70570		
	150	10.3	10630	24440	42500			
16 to 35 psig (1.10 to 2.4 bar) 35 psig (2.4 bar) T13771T0012 Zinc	40	2.8	2350	4790	8330	16920	20350	28360
	50	3.4	3770	8300	14430	29690	42740	
	60	4.1	4700	10510	18270	38050	55080	
	80	5.5	6120	14000	24350	51600		
	100	6.9	7400	17020	29600	63630		
	125	8.8	9020	20730	36050	77500		
	150	10.3	10630	24440	42500			

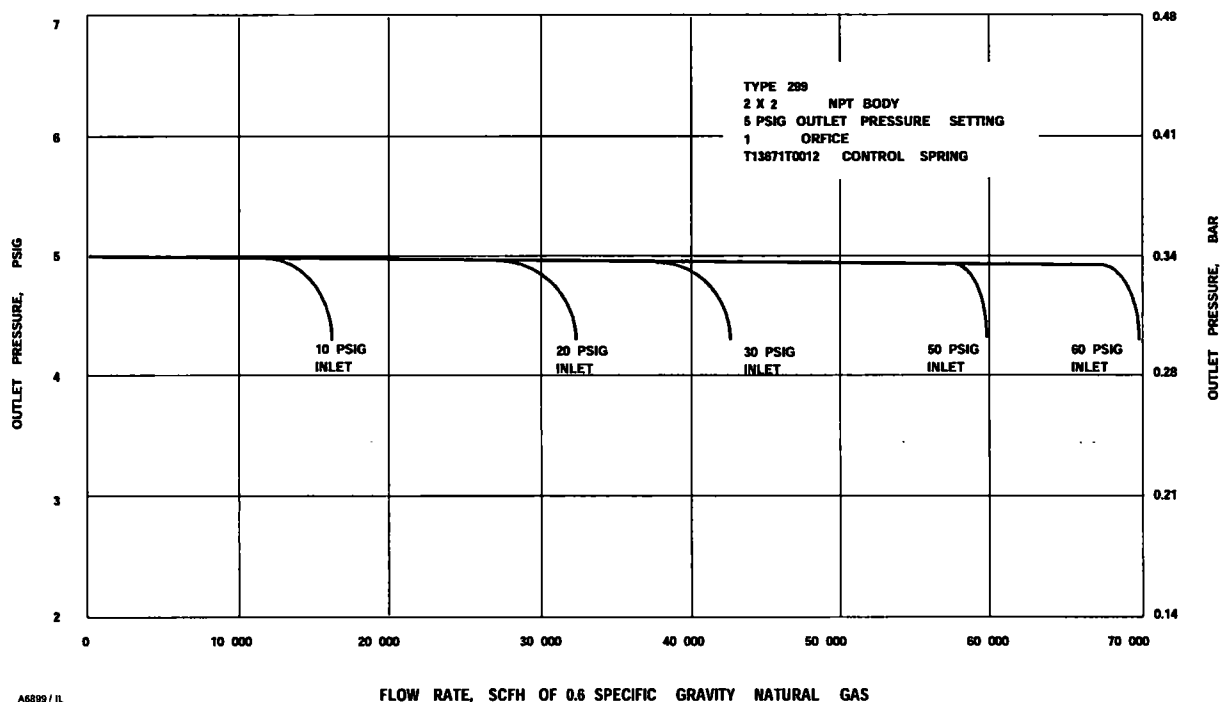


Figure 6. Typical 5 PSIG (0.34 bar) Performance Curve

Bulletin 71.2:299

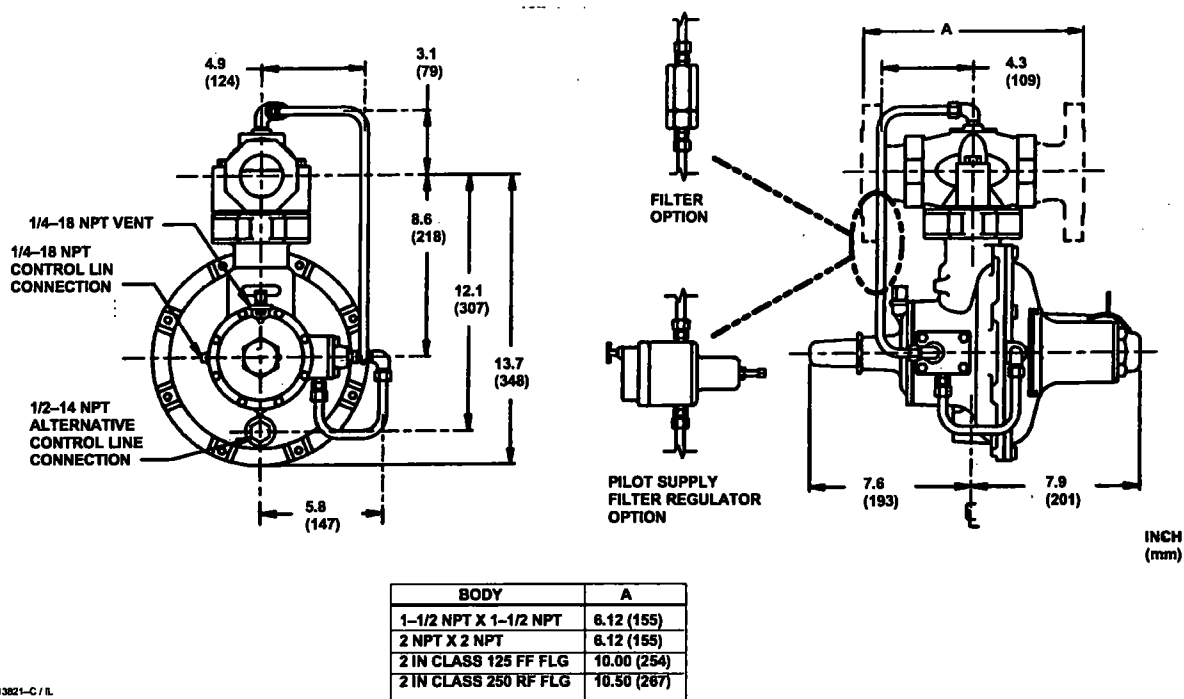


Figure 7. Type 299 Dimensions

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For information, contact Fisher Controls:
 Marshalltown, Iowa 50158 USA
 Cernay 68700 France
 Sao Paulo 05424 Brazil
 Singapore 0512



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