Installation and Operating Instructions
Part Number- 3-9008-555 Revision C
January 2012

Daniel™ Quantity Control Valves

Models 787, 788, 789C

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Process Management

BROOKS INSTRUMENT

INSTRUCTIONS

INSTALLATION AND OPERATING INSTRUCTIONS

BROOKS - Quantity Control Valves
Models 787, 788, 789C
are now manufactured by
Daniel® Measurement and Control, Inc.
and are sold under the Daniel brand of
liquid measurement products.

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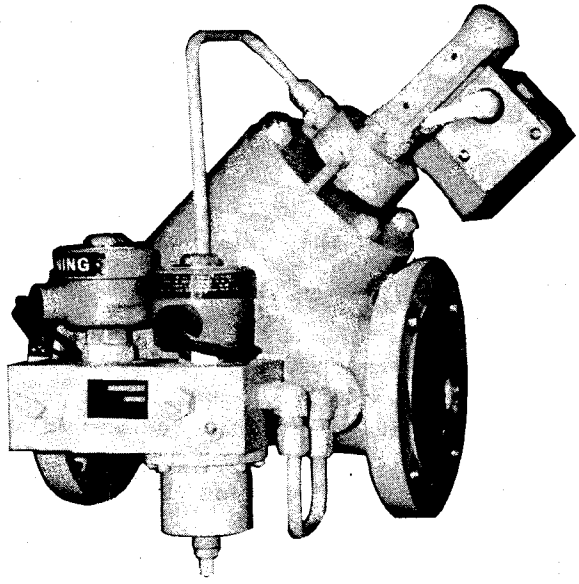
Daniel Measurement and Control
11100 Brittmoore Park Drive
Houston, TX 77041 USA

BROOKS-Quantity Control Valves
Models 787, 788, 789C



WARNING

This publication must be read in its entirety before performing any operation. Failure to understand and follow these instructions could result in serious personal injury and/or damage to the equipment.

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Daniel Part Number 3-9008-555 Rev. C

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Daniel Measurement and Control, Inc.

Daniel™ Quantity Control Valves Models 787, 788, 789C Installation and Operating Instructions

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INSTRUCTION CROSS REFERENCE

251278 . . . . . .Veeder-Root Series 7880 Meter Preset
V1500-21 . . . . . .Cylinder Disassembly - Reassembly Instructions Basic 500-700 Series Valve (125-300 lb.)
V1700-20A . . . . . .Service and Parts List - Basic 700 Series Valve 2" - 12" (125-300 lb.)
Federal Register . . . . . .Occupational Safety and Health Standards, Federal Register No. 202-Pt. 11-1, Subpart 1, Section 1910.132 thru 1910.140

NOTE: Pilot Module photographs and drawing used in this publication are for reference only and may vary in appearance. Operating performance and specifications are identical.

Section 1 INTRODUCTION

1-1 General

This manual describes in detail the installation, operation and service of the Brooks two-stage electric shut-off Quantity Control Valves, hereafter called valves. They are controlled by solenoid pilots which can be actuated by sequencing switches mounted adjacent to the Preset Counter. The pilots can also be actuated by meters of other manufacture or by the use of electronic or computer controlled devices.

This manual does not cover any meter, either Brooks or other manufacturer or any other manufacturers device used to actuate the pilots.

These valves provide a means of reducing the flow rate before final shut-off of a predetermined delivery thus minimizing line surges and shock. This assures a ±0.25 gallon accuracy of total thru-put at final shut-off (2" – 6" only). The valves can also be equipped with an electrical time delay device for two-stage opening.

Maximum safety is accomplished because the valves are fail-safe upon loss of electrical power. Since there is no direct mechanical linkage between the valve and the counter, positive and accurate shut-off is achieved.

1-2 Valve Series

Table 1-1 lists the Valve Series which are referred to in this manual, the Figure Numbers which the Valve Series cover and the Control Functions which each Valve Series performs.

TABLE 1-1 VALVE SERIES TABLE

SERIES	NUMBER	CONTROL FUNCTIONS
787	787B 787C 4787C	Two-Stage shut-off plus maximum flowrate control achieved by sensing differential pressure across a meter or an orifice plate
788	788B 788C 4788C	Two-Stage shut-off only
789	789B 789C 4789C	Two-Stage shut-off plus max. flowrate control achieved by sensing and controlling valve outlet pressure.

Series 787, 788, and 789 valves are available with in-line or right angle bodies. Both in-line and angle valves are capable of performing any of the operations previously described. All parts of angle and in-line designs are interchangeable except for the valve bodies. The angle valve is available in 4" and 6" sizes only.

1-3 Name Plate Data

Each valve is supplied with a name plate attached to the main valve body. This name plate contains information such as Connection Size, Flange rating, Main Valve Piston spring range, Figure number and Maximum Operating Pressure rating.

NOTE: Prefix letters L, M or H appearing before the Figure Number on the name plate refer to a Light, Medium, or Heavy valve spring, respectively.

1-4 Series 787

Series 787 provides maximum flowrate control in addition to the two-stage shut-off function. However, the method of flow control is different in that maximum flowrate control is achieved by using a 1787 pilot which senses the pressure differential across a meter or an orifice plate. Refer to Figures 3-5, 3-6 and 4-2.

1-5 SÉRIES 788

An electrically controlled solenoid pilot (Model 1788) is used on series 788 to close the valve in two stages. The valve is either open, closed, or held in a low-flow state. This valve does not limit the flowrate. Refer to Figures 3-1, 3-2, 3-3 and 3-4.

1-6 Series 789

Series 789 provides maximum flowrate control in addition to the two-stage shut-off function. Maximum flowrate control is achieved by using a 1789 pilot which senses and controls valve outlet pressure. Refer to Fig. 3-7 and 3-8.

TABLE 1-5 PILOT MODULE SPRING RANGES

SPRING RANGE	APPLICATION
0–20 P.S.I.	Standard for 787 (which controls flowrate by sensing differential pressure). Standard for 789 (which controls flowrate by sensing valve outlet pressure; top loading to Atmosphere or similar installation).
10-50 P.S.I.	Standard for 789 delivery to closed system: (Bottom loading)
30-130 P.S.I.	Delivery through 789 to closed system which requires more than 50 P.S.I. outlet pressure for control.

1-7 Specifications

This section contains the specifications for all series 787, 788 and 789 valves.

CAUTION: Do not use the valve in excess of the below SPECIFIED VALUES.

TABLE 1-2 SOLENOID ELECTRICAL DATA – UL LISTED

Voltage	Current (in rush)	Current (holding)
120/60 ac	.7 amps	.33 amps
240/60 ac	.35 amps	.17 amps
Class I - Groups C and D Class II - Groups E, F and G		

TABLE 1-3 PRESET SWITCH ENCLOSURE ELECTRICAL DATA – UL LISTED

Voltage	Current
125 or 250 v ac	15 amps.
Class I – Group D	

TABLE 1-4 MICRO-SWITCH ENCLOSURE ELECTRICAL DATA – UL LISTED

Voltage	Current
125, 250 or 440 v ac	20 amps.
Class I – Groups C and D Class II – Groups E, F and G	

POWER WIRING REQUIREMENTS

Wiring should be in accordance with national electric code, state code or local electric code, if applicable. Wiring conduit connection (1/2" NPT) on all micro-switches, solenoids, and 3/4" N.P.S.M. on preset switch.

MATERIALS OF CONSTRUCTION, PILOT MODULE

Pilot valve body	Steel with Stainless Steel internals
Tubing and fittings	Standard – Steel Optional – Steel; Stainless Steel

RATINGS – MAIN VALVE

Maximum safe working pressure	ANSI 150 lb. Steel Body – 275 PSI (1896.1 kPa) ANSI 300 lb. Steel Body – 720 PSI (4964.2 kPa)
Maximum safe working temperature	Standard – 150°F, 66°C Optional – up to 250°F with selection of proper O-Ring.

RATINGS – PILOT MODULE

Maximum safe working pressure	Steel – 720 PSI (4964.2 kPa)
Maximum safe working temperature	Standard – 150°F, 66°C Optional – Up to 250°F with selection of proper O-Ring.

Section 2 THE QUANTITY CONTROL SYSTEM

2-1 General

The Brooks Quantity Control System generally consists of four pieces of equipment – (1) a flowmeter, (2) a Preset Counter, (3) sequencing switches and (4) a two-stage electric shut-off valve. The meter is the primary flow measuring device. The Preset Counter is the device used to set the predetermined volume of liquid that is to be controlled by the valve. The sequencing switches convert the mechanical motion of the batch controlling mechanism of the Preset Counters, into electrical signals to control the solenoid pilots of the valve. The valve closes, in a two-stage operation to control the predetermined volume of liquid. The first stage closure reduces the flowrate through the valve to approximately 10% to 20% of the rated capacity of the meter. The second stage closes the valve when the predetermined volume of liquid has passed through the meter.

A predetermined amount of liquid for delivery is entered into the system by pushing the proper buttons of the Preset Counter, or other external batch control device. This device can be a meter of another manufacture or some kind of electronic or computer control.

To start delivery an operating handle, located beneath the counter, is actuated by hand. This positions a spring-loaded shut-off ring (located at the base of the Preset Counter) which in-turn moves an actuating lever which actuates the sequencing microswitches and causes the valve to be placed into the valve-open mode (See Fig. 3-1). With the pump on, the valve begins to open until maximum controlled flowrate is achieved, unless the valve is equipped with a time delay circuit for two-stage opening.

When the counter reaches the first stage of shut-off, a cam, located in the Preset trips the shut-off ring which now causes the sequencing switches to place the valve into first stage or low flow shut-off mode (See Fig. 3-3). When the counter reaches zero, the cam trips the shut-off ring again which positions the sequencing switches into the valve-closed or no-flow mode (See Fig. 3-4).

2-2 Meter Preset

The Meter Preset is used to deliver up to 99,999 units of volume of a predetermined quantity of liquid through the meter. The five-digit display is programmed according

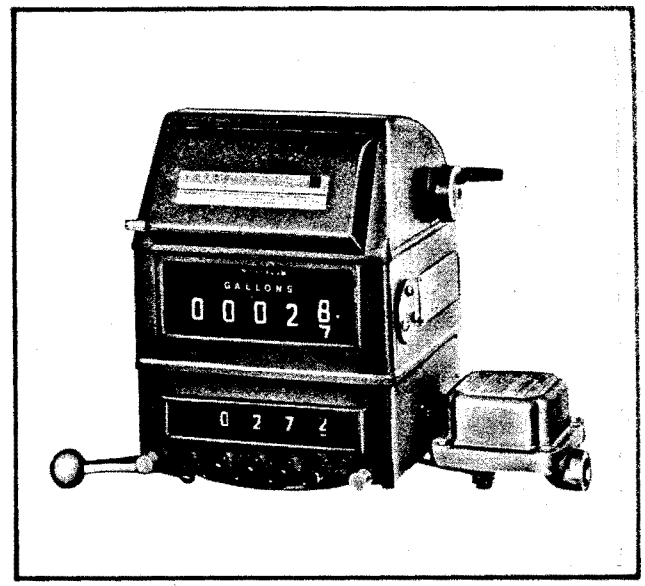


Figure 2-1 Meter Preset with attached Preset Switch Assembly.

to the quantity to be delivered. As the liquid is being delivered, the preset wheels subtract the amount delivered through the meter.

The valve will close to First stage closure according to the customers specifications. This will range from 90 to 3 units of volume. The trip point for First stage closure can be altered in the field by qualified service personnel. With a 1:1 ratio between the input shaft and the right-hand wheel, the maximum input speed of the right-hand wheel is 250 rpm. This is the maximum speed the right-hand wheel (least significant digit) can revolve without premature wear and/or damage occurring to the Preset Register.

NOTE: Variables such as flowrate and minimum volume to be delivered will determine the setting for first stage closure.

Located on the right-hand side of the meter preset is a red "stop" pushbutton which will cause the valve to close if depressed. Located on the left-hand side of the meter preset is a brown "set" pushbutton which must be depressed (latched) before the black "preset buttons" can be actuated. The brown "set" button cannot be depressed if the meter preset is in operation. Therefore, the black "preset buttons" cannot be changed until the meter preset is stopped and the brown "set" button is depressed.

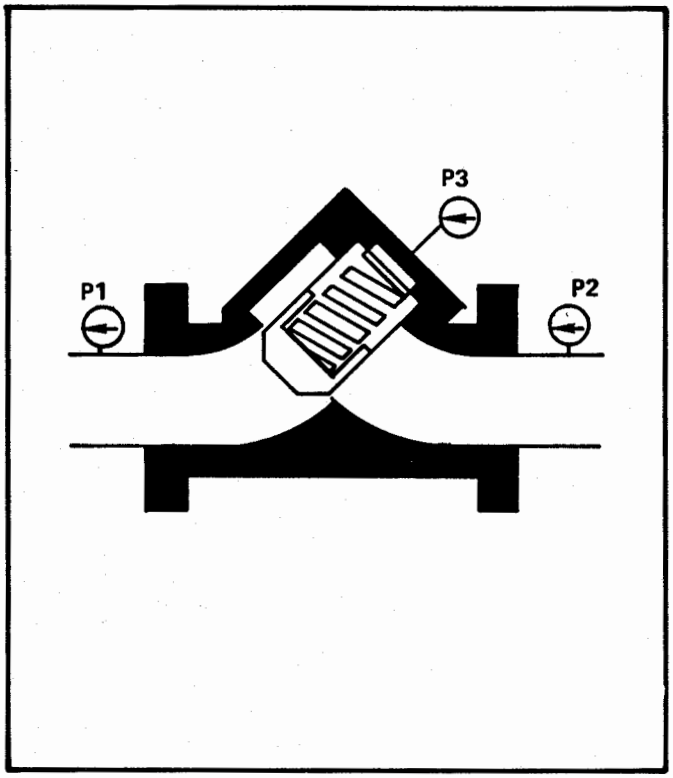
Section 3 PRINCIPLE OF OPERATION

3-1 General

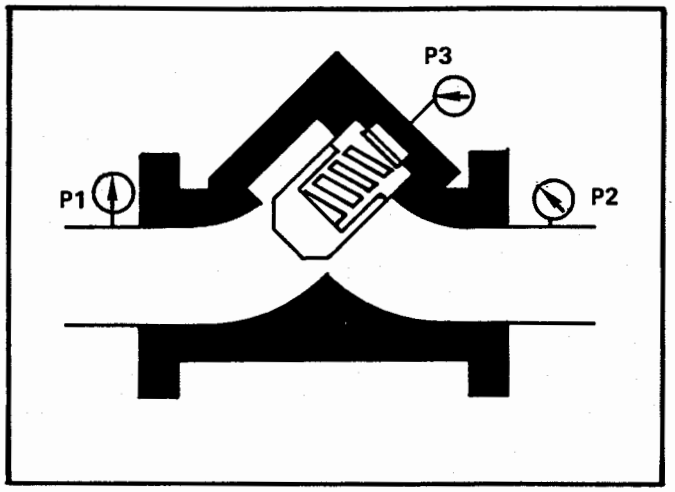
This section contains complete operating instructions for the valve and presents a detailed explanation of the principle of operation.

Before proceeding with a detailed description of the valve, the user will benefit from a basic knowledge of the principle of operation of the balanced piston principle of the Brooks Control Valve. The basic parts of the valve consist of: (1) the valve body, (2) the main valve cylinder, (3) the main valve piston and (4) the valve spring.

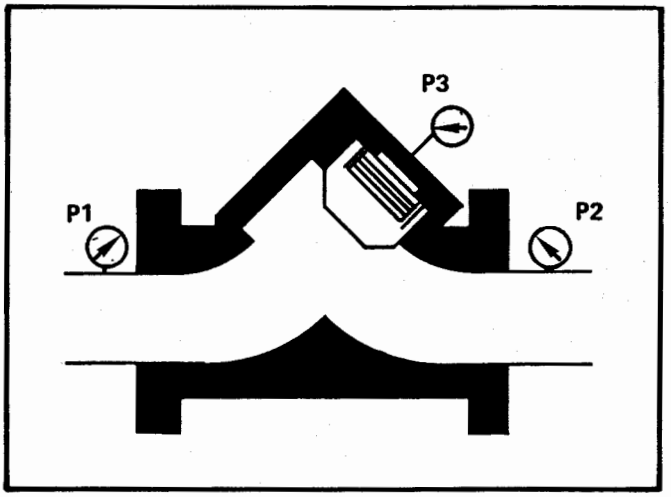
The basic valve operates on a balanced piston principle and is spring biased (loaded). For simplicity of explanation, the sense lines and pilot controls, normally supplied on the valve, have been left off the drawings. Since the area of the nose (P1, as illustrated below) of the main valve piston is exactly the same as the spring side (P3), it is established that the **main valve spring** becomes the force necessary to **control the position of the main valve piston.** As pressure changes, the valve assumes the positions characterized in the following three illustrations.



Closed Position: The valve is closed because (P1 is less than the spring force in the seated position or; (P2) is greater than (P1).



50% Open: The pressure differential across the valve (P1 minus P2) is equal to the spring force in the 50% open position.



Fully Open: The pressure differential across the valve (P1 minus P2) is equal to the spring force in the fully open position.

The Brooks models 787, 788, 789 control valves are two-stage electrical quantity control valves. An electrically operated solenoid controlled pilot module positions the main valve piston by increasing or decreasing the hydraulic pressure exerted against the top of the piston. When pressures on both sides of the valve piston are equalized, a spring (located on top of the piston) acts as a differential force and **closes** the valve. When the pressure against the bottom of the piston exceeds the pressure (plus the force of the spring) exerted against the top of the piston, spring tension is overcome and **opens** the valve. It is through the application of fundamental hydraulic principles utilizing pressure differentials, that the basic control valve functions.

3-2 Model 788 — Principle of Operation

Two Stage shut-off only, no flow control.

Refer to Figures 3-1, 3-2, 3-3 and 3-4 for hydraulic operation, Figure 4-4 and 4-5 for electrical sequencing.

1. Figures 3-1 and 3-4.

   Figure 3-4 shows the valve in its normal no-flow state with both solenoids de-energized. The solenoids are energized in Figure 3-1 opening a flow path (Y to Z) permitting the product on the top of the piston to be vented to the valve outlet and closing a flow path (X to Y) to isolate the top of the piston from valve inlet pressure. Valve inlet pressure on the bottom of the piston overcomes the spring tension and places the valve in a high flow state.

2. Figure 3-2.

   The Preset Counter has just reached its first trip point. Consequently the solenoids are de-energized and return to their normal state. This opens a flow path between valve inlet pressure (X) and the top of the valve piston (Y); and closes Z port to valve outlet pressure. This causes the pressure differential between X and Y (across the valve piston) to decrease and the valve spring starts closing the valve.

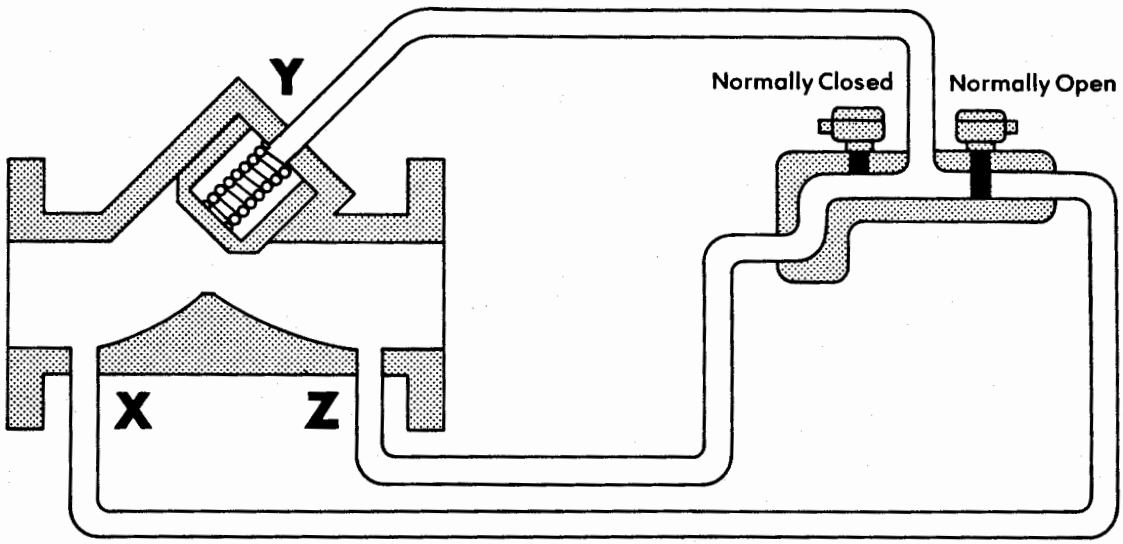


Figure 3-1 High Flow Mode

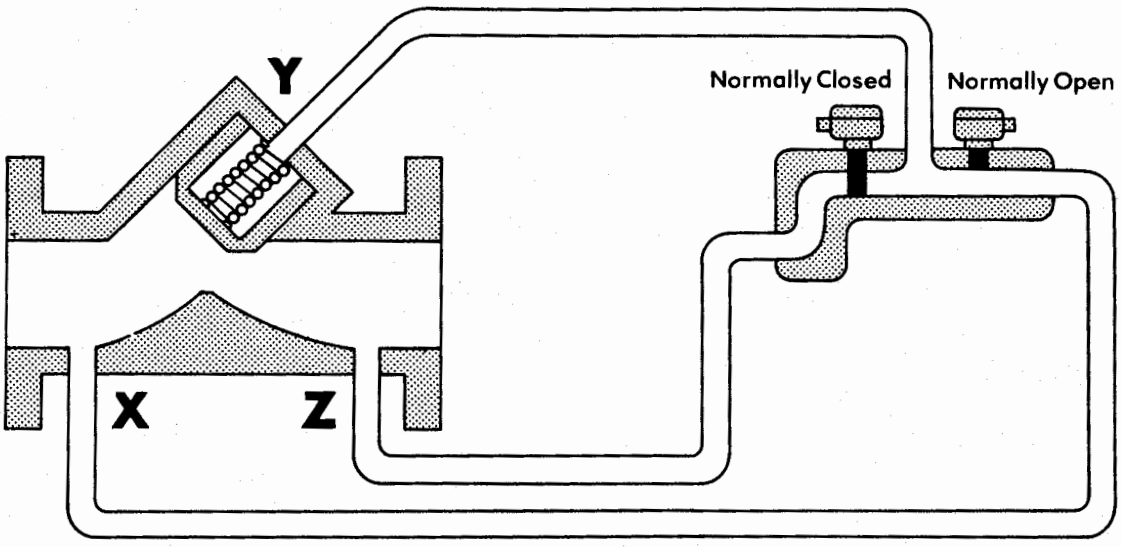


Figure 3-2 Valve Closing Mode

3. Figure 3-3.

The valve closes until the cam on the valve stem closes SW3, (Figure 4-4, Page 17) which energizes the normally open solenoid closing the flow path (X to Y) between the valve inlet pressure and the top of the valve piston. Both solenoids are closed and will not allow any flow to or from the top of the piston. The valve is locked hydraulically in the low flow position.

4. Figure 3-4.

Immediately prior to the completion of the delivery the preset counter opens (S1 Figure 4-4, Page 17) which de-energizes the normally open solenoid. This opens a flow path between the valve inlet pressure and the top of the valve piston through ports X and Y. Valve inlet pressure (X) and pressure at the top of the main valve piston (Y) rapidly equalize allowing the force of the valve spring to close the valve effecting final shut-off.

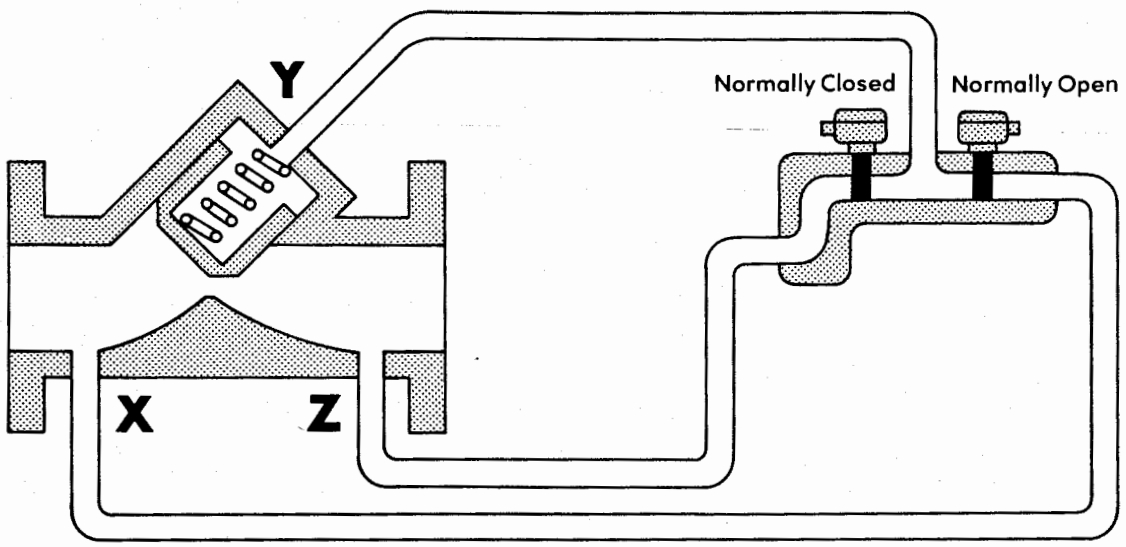


Figure 3-3 Low Flow Mode

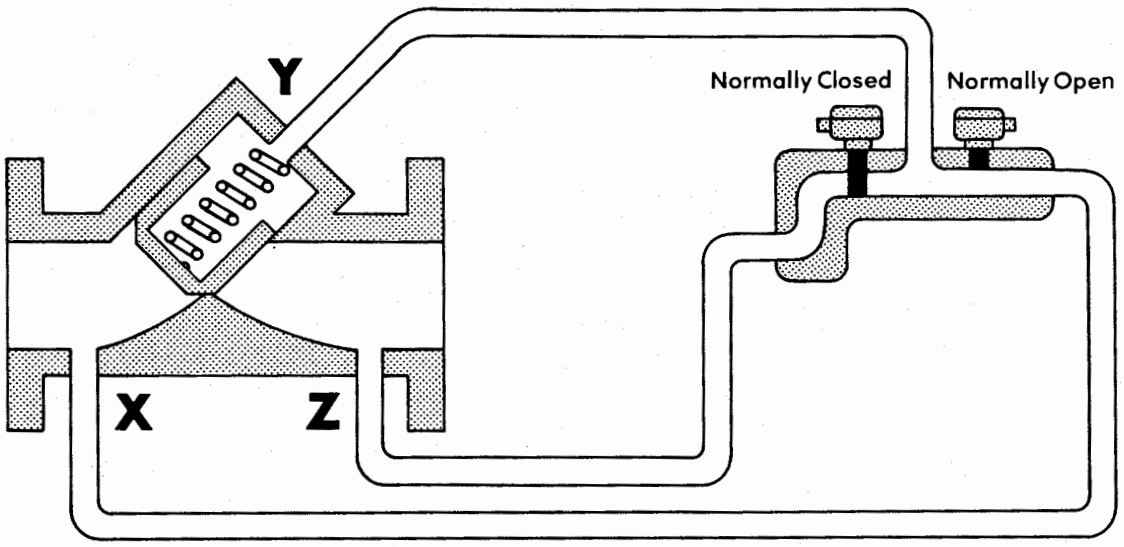


Figure 3-4 No Flow Mode

3-3 Model 787 - Principle of Operation

The 787 valve controls high flowrate by sensing the pressure differential across a meter, an orifice plate or other suitable means that will produce the minimum differential pressure required.

Refer to Figures 3-5 and 3-6. (Two-stage shut-off functions are the same as the Model 788. Refer to figures 3-1, 3-2, 3-3 and 3-4)

1. Figure 3-5

   The main valve is shown in a high-flow state and the pressure differential being sensed is approaching the limit set by the pilot spring. The meter or orifice plate inlet pressure is sensed through port I and the meter or orifice plate outlet pressure is sensed through port O. (Hereafter, the meter inlet and outlet pressure will be referred to as I and O.) Note: Pressure differential is the pressure drop or pressure between two known or given locations in a flowing system and is proportional to the square of the flowrate.

   Eventually the meter inlet pressure, I, minus the meter outlet pressure, O, has sufficient pressure differential to overcome the force applied by the pilot spring.

2. Figure 3-6

   As the pressure differential begins to exceed the force applied by the pilot spring, the pilot spring begins to compress from the movement of the diaphragm. The flow control poppet attached to the diaphragm is proportionally lifted from its seat, opening a parallel variable flow path thru the pilot between the valve inlet pressure (X) and the valve outlet pressure (Z).

3. Figure 3-6

   The parallel variable flow thru the flow control poppet opening exceeds the rate at which the pilot needle valve will let it pass. This produces a pressure increase between X port and Z port. The pressure increase is directed thru the normally closed solenoid pilot (energized open), thru Y port to the top of the valve piston. This causes the differential pressure across the main valve piston to decrease and the valve spring moves the piston down, proportional to the flow increase, to limit maximum flowrate.

4. The additional variable pressure applied to the top of the valve piston is proportional to the position of the flow control pilot poppet and needle valve setting. If flow limiting is not required, the flow control poppet is tightly seated, blocking off the parallel flow path.

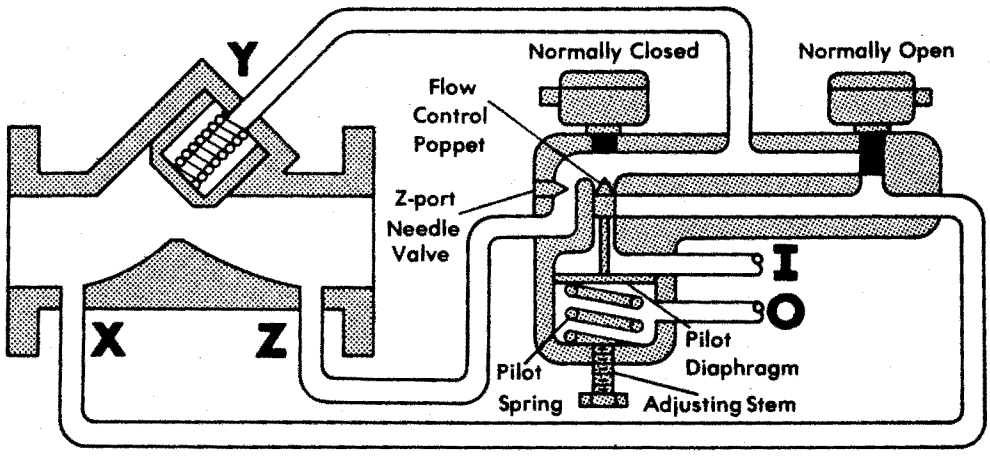


Figure 3-5 Model 787

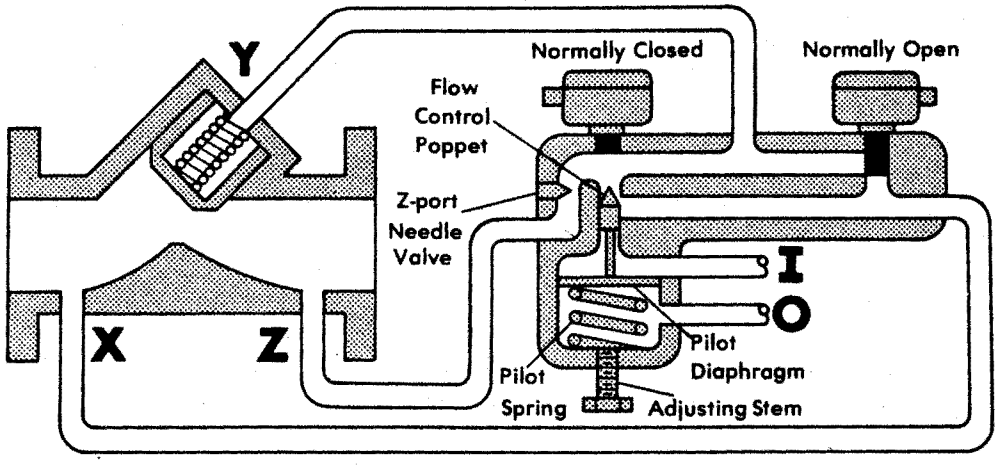


Figure 3-6 Model 787

3-4 Model 789 - Principle of Operation

The model 789 valve controls high flowrate by sensing and controlling the valve outlet pressure.

Refer to Figures 3-7 and 3-8. (Two-stage shut-off functions are the same as the model 788. Refer to Figures 3-1, 3-2, 3-3 and 3-4.

1. Figure 3-7

   The valve is shown in a high-flow state and the valve outlet pressure is approaching the limit set by the pilot spring. Valve outlet pressure is sensed through port Z and directed to the pilot diaphragm.

2. Figure 3-8

   When the valve outlet pressure begins to exceed the force applied by the pilot spring, the movement of the diaphragm begins to compress the spring. The flow control poppet attached to the diaphragm is proportionally lifted from its seat, opening a parallel variable flow path thru the pilot between the valve inlet pressure (X) and the valve outlet pressure (Z).

3. Figure 3-8

   The parallel variable flow thru the flow control poppet opening exceeds the rate at which the pilot needle valve will let it pass. This produces a pressure increase between X port and Z port. The pressure increase is directed thru the normally closed solenoid pilot (energized open), thru Y port to the top of the valve piston. Thus the differential pressure across the valve piston decreases and the valve spring moves the piston down, proportional to the flow increase, to limit maximum flowrate.

4. The additional variable pressure applied to the top of the valve piston is proportional to the position of the flow control pilot poppet and needle valve setting. If flow limiting is not required, the flow control poppet is tightly seated, blocking off the parallel flow path.

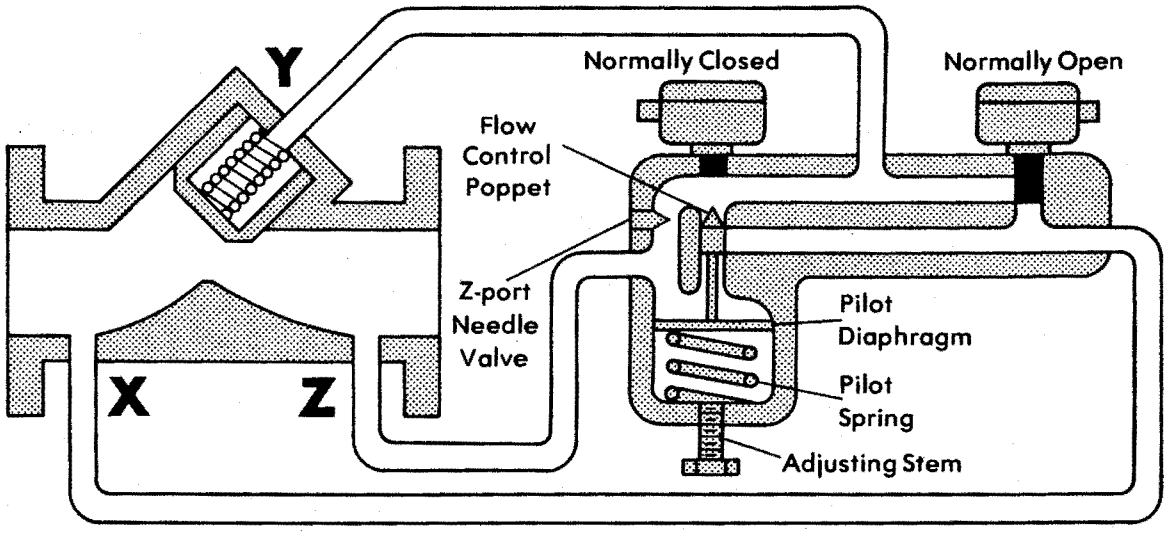


Figure 3-7 Model 789

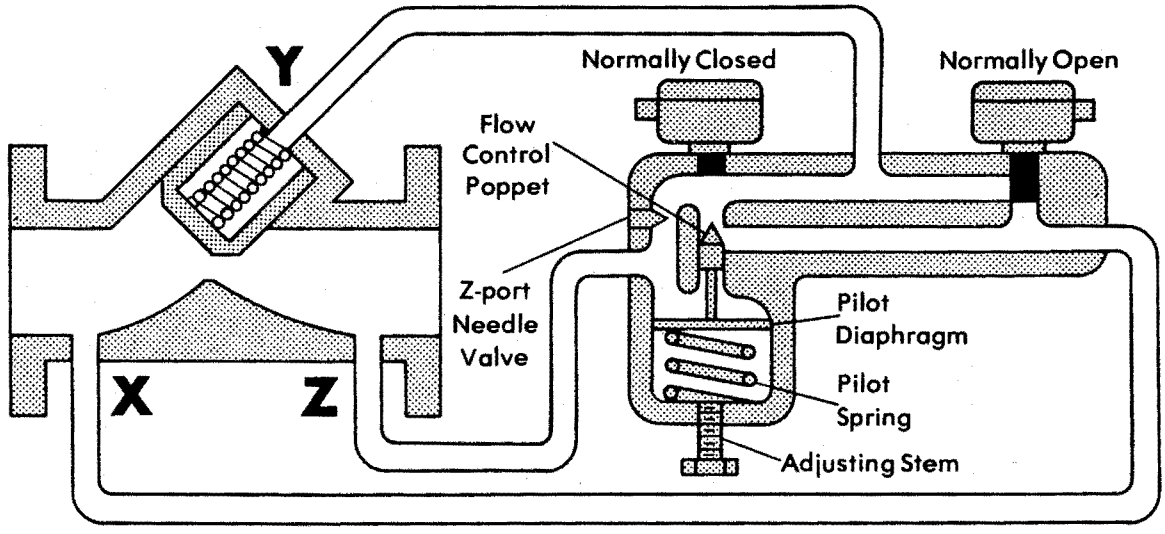


Figure 3-8 Model 789

3-5 Optional Equipment—Principle of Operation

Thermal Relief (Refer to Figure 3-9)
Thermal relief is a pressure differential safety device used to eliminate excessive-pressures caused by thermal expansion. Excessive pressures occur when the line downstream of the valve is closed off without provision for thermal pressure build-up. The spring tension of the relief valve prevents product flow through it from the inlet of the main valve to the outlet of the main valve. The thermal relief valve opens when the outlet pressure of the main valve exceeds that of the inlet pressure of the main valve plus the spring pressure of the thermal relief valve. This relief action prevents rupture of the line downstream of the main valve due to thermal expansion. Normal setting of the spring is 10 to 15 psi. Turning the adjustment screw clockwise increases spring tension, and counterclockwise decreases spring tension.

Manual Override (Refer to Figure 3-9)
The manual override is a device used to by-pass the pilot module and allow the main valve to open by porting directly from the top of the main valve to the valve outlet in the case of a power failure or a malfunction in the pilot module or some other component in the system.

In a manual operating state, the valve is not capable of performing any control functions. Before going back to automatic control, the 3-way manual override valve must be returned to its normal operating position (open normally open to common).

Closing Speed Control (Refer to Figure 3-9)

This device is a combination needle valve and check valve and is used as a closing speed control for the main valve. The closing speed is changed by adjusting the needle valve.

Valves Equipped for Low Flow Start-Up Control

(Time Delay Circuit)

The Time Delay Circuit is used to hold the valve in low-flow for a preset amount of time on the initial opening of the valve. Installation of the time delay circuit is covered in Figure 4-6. Operation of the time delay circuit is as follows: (Refer to Figure 4-7.)

1. Both solenoids are energized and the valve begins to open
2. The valve position indicator stem moves until the upper attached cam actuates SW4, which de-energizes the normally closed solenoid and causes the time delay to begin timing.
3. When the time delay times out, an integral delay switch energizes the normally closed solenoid and allows the valve to continue opening. The time delay is wired in parallel to SW4 and closes upon timing out.
4. The time delay does not enter into the operation of the system again until the counter is reset, for start-up, or an interruption of the circuit occurs which automatically resets the timer.

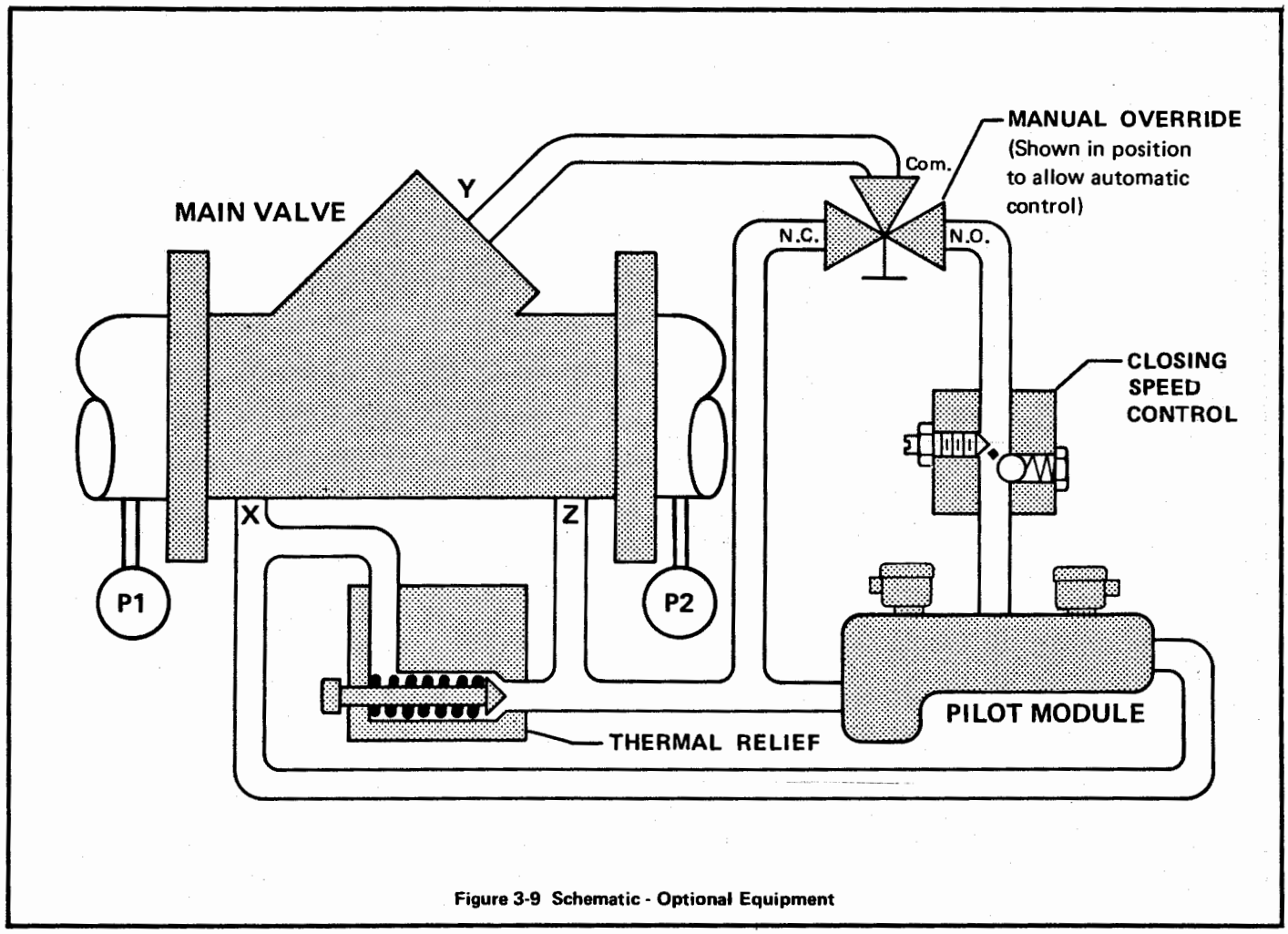


Figure 3-9 Schematic - Optional Equipment

Section 4 INSTALLATION

4-1 General

This section contains the procedures for receipt and installation of the valve. Specific Instructions are provided for accessory equipment.

4-2 General Installation Information

The following instructions are intended as a guide for installing the models 787, 788 and 789 valve and should be carefully complied with if the valve is to be operated as designed.

1. The product line must be completely free of all foreign material before the valve is bolted into the line. This is very important and cannot be over stressed. If it is impractical to flush the line before installing the valve, the valve body may be bolted in and the valve cylinder assembly may then be removed per the disassembly instructions on the basic valve. (Refer to Bulletin V1700-20.) In such case it will be necessary to fabricate a temporary cover for sealing the opening left in the body by removal of the cylinder. (Flushing will not be necessary if the product line and liquid are positively known to be clean.)
2. The inlet flange is marked with the word inlet and should be placed in an upstream position.
3. The valve should be installed downstream of the meter for proper and specified operations.
4. The distance between the valve and the meter is not restrictive on the 788 and 789 models as there are no mechanical connections between the valve and the meter.
5. The 787 model should be installed within twenty-five feet of the meter or orifice plate across which differential pressure is to be sensed. This distance limitation is due to the sense lines which must be run between the pilot and the meter or orifice plate.
6. Two 3/8" sense lines are required, with the 787 model, (Figure 4-2) between the pilot to the inlet and outlet of the meter or orifice plate. This size line is a minimum requirement based on a maximum product viscosity of 500 SSU. A larger size line will be required if the product is in excess of 500 SSU.
7. The solenoid pilot must be operated only at the voltage specified on its name plate. The correct voltage must be verified before the electrical connections are made.
8. It is recommended that a sealing conduit fitting be used in all conduit containing wiring for the solenoids or microswitches in order to prevent water entering the solenoid or microswitch housings through the wiring conduit.
9. WIRING INFORMATION
   Before running any electrical lines, it is important to select the proper wiring diagram. Figure 4-4 is the most common for two-stage closure valves. Figure 4-6 is for valves that incorporate a time delay circuit in the wiring for low flow start-up, plus two-stage closure. In some installations both type valves are required. Low flow start-up valves, if not tagged, can be identified by having two (2) microswitches on the valve position indicator guard. The time delay is not an integral part of the valve.

IN-LINE VALVES

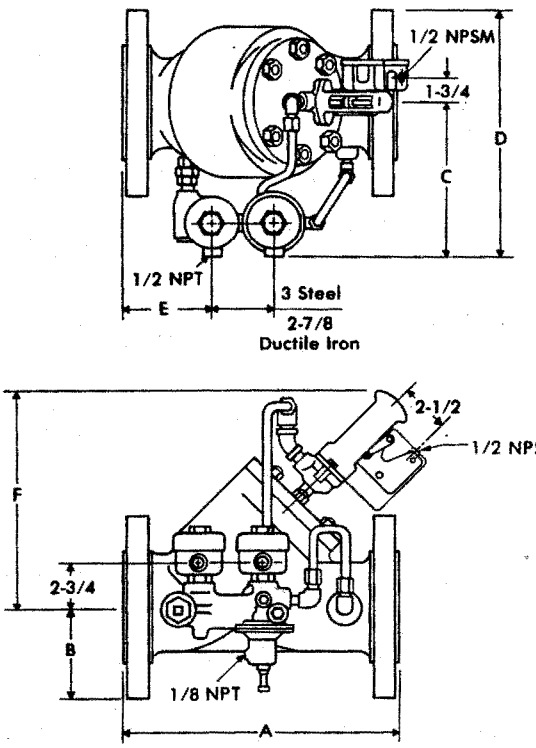


Figure 4-1 Physical Dimensions (In-Line).

Note: Reference page 16 for clearance dimensions required for cylinder removal

Table 4-1
DIMENSIONS — In-Line Valve (For Certified Dimension Prints Consult Factory)

Valve	A (ANSI Flanges				B				C		D		E				F	
	125 & 150 lb.		300 lb.		125 & 150 lb.		300 lb.						125 & 150 lb.		300 lb.			
Size	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
2"	10-1/4	260	10-1/2	267	3	76	3-1/4	83	8-1/8	206	11-3/4	298	3-1/8	298	3-1/8	79	9-5/8	244
3"	11	279	13-1/8	333	3-3/4	95	4-1/8	105	8-1/2	216	12-5/8	321	3-7/16	87	4-3/16	106	10-3/8	263
4"	13	330	14-1/2	368	4-1/2	114	5	127	8-1/2	216	13	330	3-13/16	97	4-9/16	116	10-7/8	276
6"	17	432	17-7/8	454	5-1/2	140	6-1/4	159	10-1/4	260	15-7/8	403	4-1/8	105	4-9/16	116	13-5/8	16
8"	22-1/4	565	23-1/4	590	6-3/4	171	7-1/2	190	11	279	18-1/4	464	4-11/16	119	4-11/16	119	17-1/4	438
10"	26-1/2	673	27-7/8	708	8	203	8-3/4	222	12	305	21-1/8	537	5	127	5	127	17-5/8	448
12"	30-7/8	784	35-5/8	905	9-1/2	241	10-1/4	260	13-1/8	333	23-3/8	594	8-1/16	205	8-1/16	205	22-7/8	581

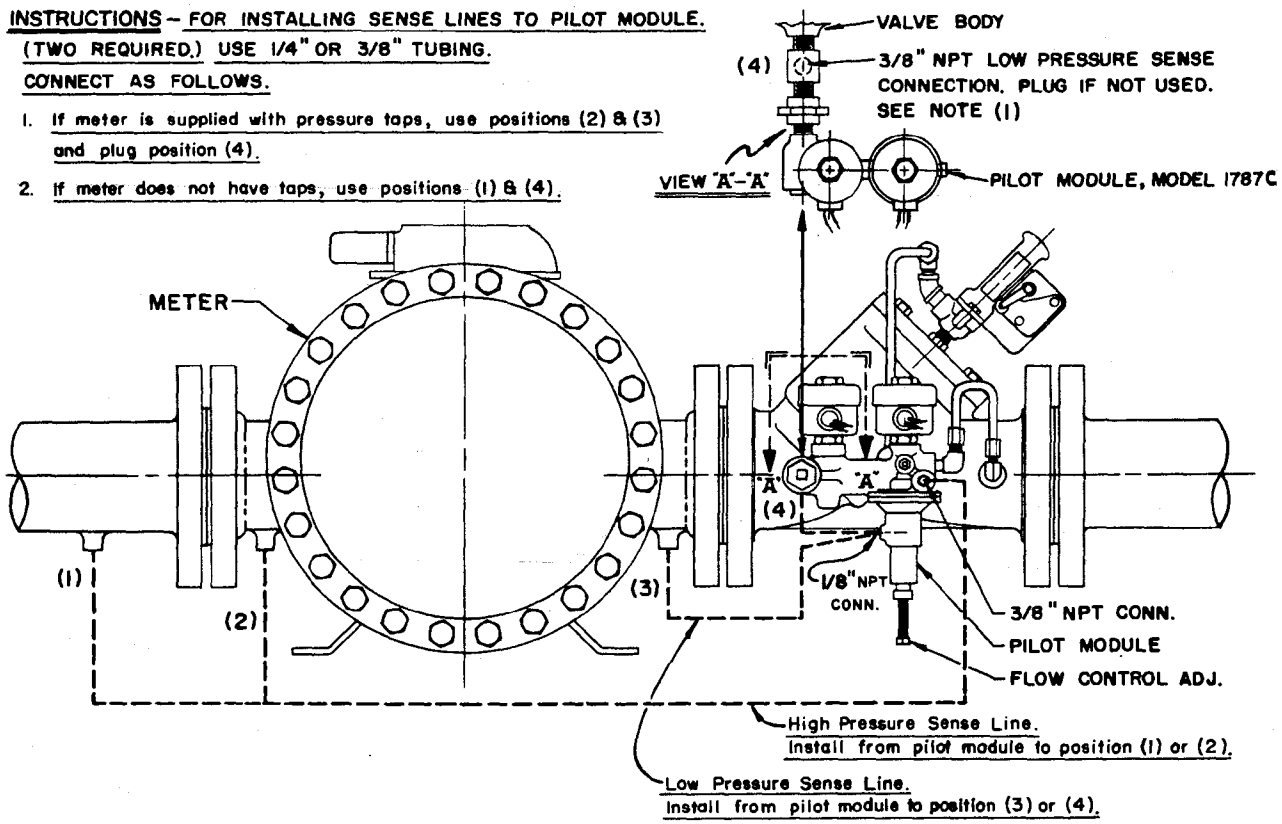


Figure 4-2 Sense Line Connection - Series 787.

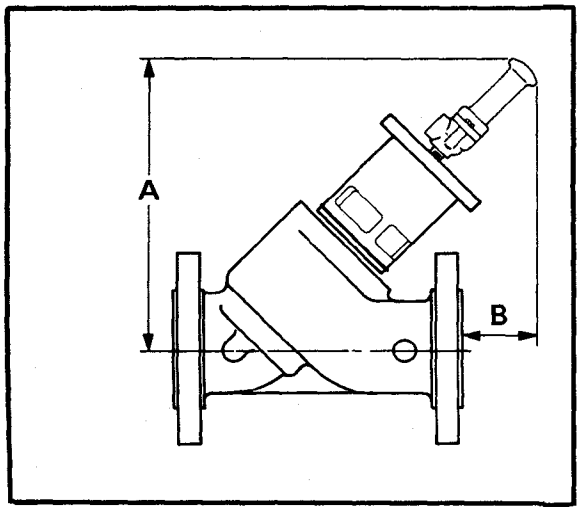


Figure 4-3, Table 4-3 - Clearance Dimensions - Cylinder Removal

Valve Size	A (In-Line)				B (In-Line)			
	125 & 150 lb.		300 lb.		125 & 150 lb.		300 lb.	
	In.	mm	in.	mm	in.	mm	in.	mm
2"	12-5/8	321	15-5/8	397	4-1/16	103	4-3/16	106
3"	14-7/8	378	14-7/8	378	1-9/16	40	4-3/8	111
4"	15-3/4	400	15-3/16	386	4-7/8	124	4-1/8	105
6"	19-3/8	492	19-3/8	492	5-3/4	146	2	51
8"	22-13/16	579	22-13/16	579	4-15/16	24	4-13/16	122
10"	26-1/2	673	26-1/2	673	5-3/16	132	4-1/2	114
12"	27-1/2	698	27-1/2	698	2-5/8	67	1-3/8	35

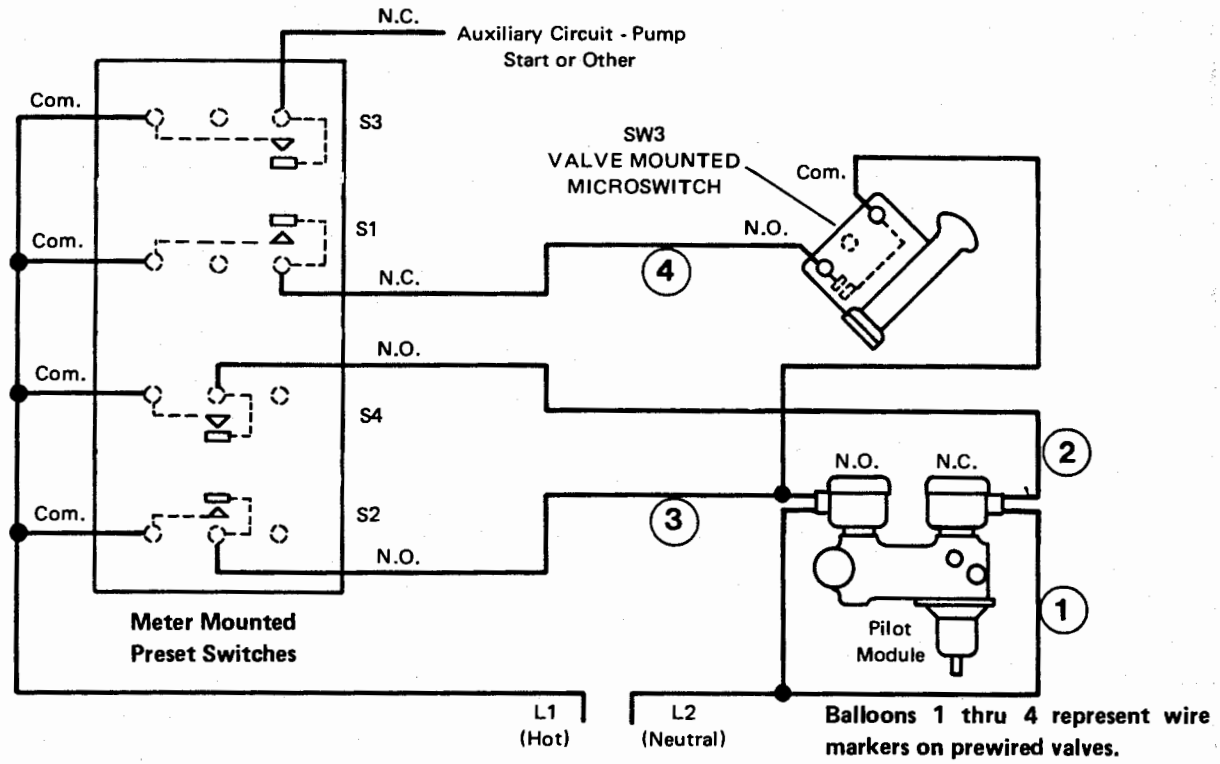


Figure 4-4 Wiring Diagram - All Models without Time Delay Circuit.

VALVE POSITION	SOLENOID PILOTS	SOLENOID PILOT PORTS	MICRO SWITCH CONTACTS		
			S1 & S3	S2 & S4	SW3
START AND HIGH FLOW	N. C. ENERGIZED N. O. ENERGIZED	OPEN CLOSED	CLOSED	CLOSED	OPEN
TRANSITION FROM HIGH TO LOW FLOW	N. C. DEENERGIZED N. O. DEENERGIZED	CLOSED OPEN	CLOSED	OPEN	OPEN
LOW FLOW	N. C. DEENERGIZED N. O. ENERGIZED	CLOSED CLOSED	CLOSED	OPEN	CLOSED
NO FLOW	N. C. DEENERGIZED N. O. DEENERGIZED	CLOSED OPEN	OPEN	OPEN	CLOSED

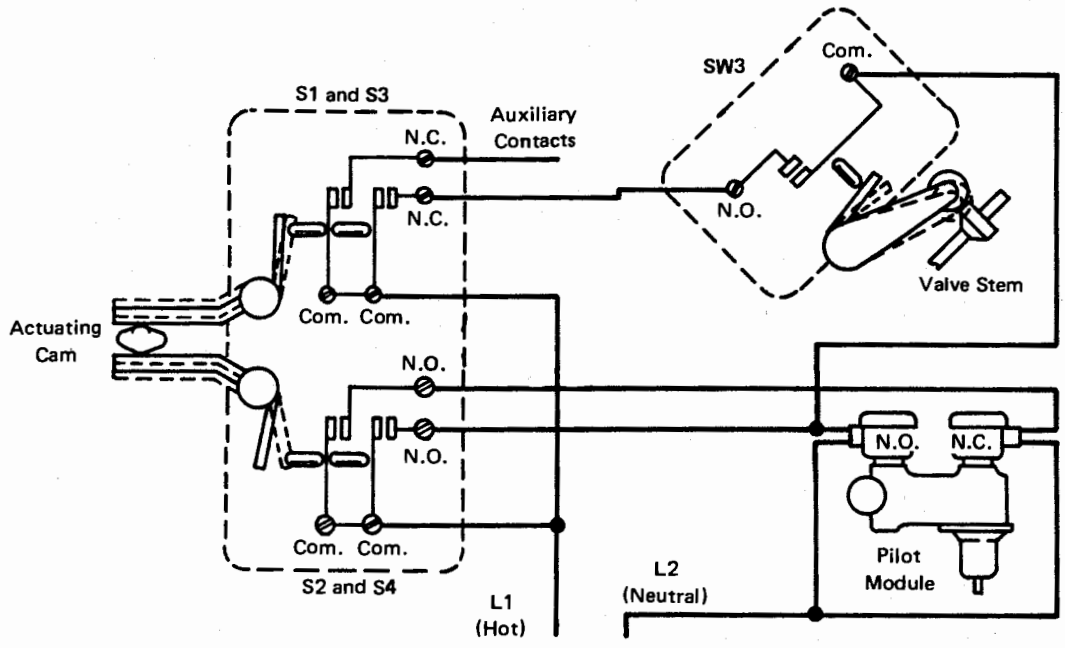


Figure 4-5 Wiring Schematic - All Models without Time Delay Circuit

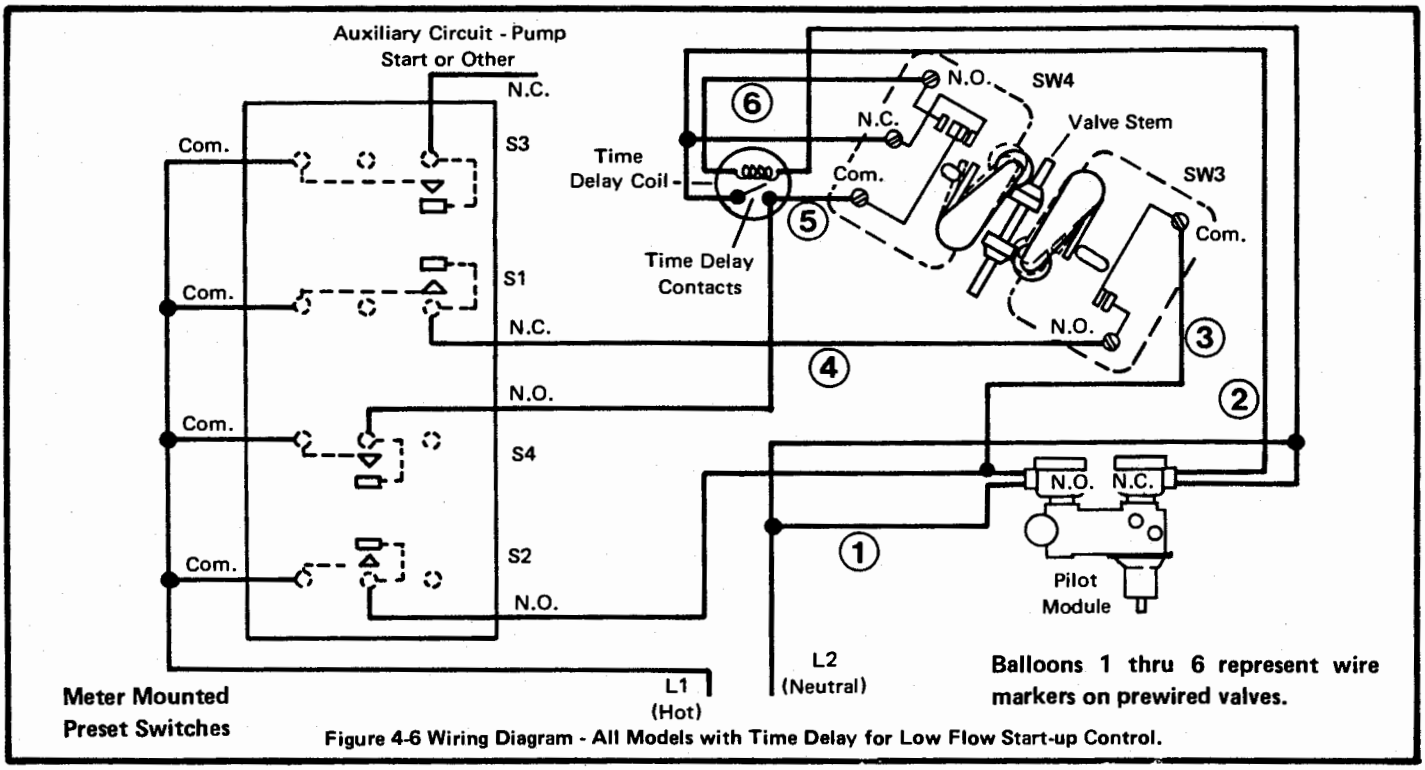


Figure 4-6 Wiring Diagram - All Models with Time Delay for Low Flow Start-up Control.

VALVE POSITION	SOLENOID PILOTS	SOLENOID PILOT PORTS	TIMER		MICRO SWITCH CONTACTS			
			COIL	CONTACTS	S1 & S3	S2 & S4	SW3	SW4
START AND HIGH FLOW	N. C. ENERGIZED N. C. ENERGIZED	OPEN CLOSED	ENERGIZED	CLOSED	CLOSED	CLOSED	OPEN	OPEN
TRANSITION FROM HIGH TO LOW FLOW	N. C. DEENERGIZED N. O. DEENERGIZED	CLOSED OPEN	DEENERGIZED	CLOSED	CLOSED	OPEN	OPEN	OPEN
LOW FLOW	N. C. DEENERGIZED N. O. ENERGIZED	CLOSED CLOSED	DEENERGIZED	OPEN	CLOSED	OPEN	CLOSED	OPEN
NO FLOW	N. C. DEENERGIZED N. O. DEENERGIZED	CLOSED OPEN	DEENERGIZED	OPEN	OPEN	OPEN	CLOSED	CLOSED
LOW FLOW START	N. C. DEENERGIZED N. O. ENERGIZED	CLOSED CLOSED	ENERGIZED	OPEN	CLOSED	CLOSED	CLOSED	OPEN

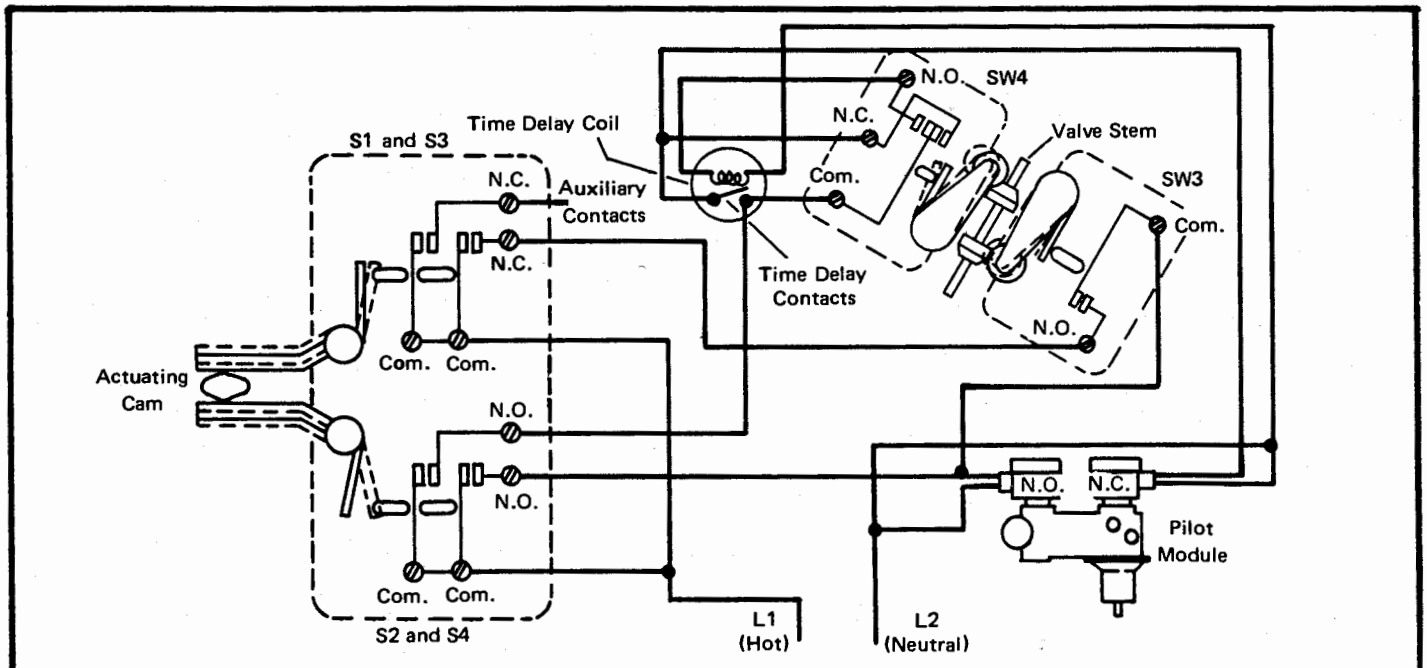


Figure 4-7 Wiring Schematic - All Models with Time Delay for Low Flow Start-up Control.

Section 5 START-UP

5-1 Pre-start checks

1. Make sure wiring is correct (Refer to Figure 4-4 or 4-6).
2. Check to see if electrical system is hooked to properly fused power source.
3. Make sure the solenoid pilot is connected to the voltage specified on its name plate. The correct voltage must be verified before the electrical connections are made.
4. Check electrical connections, with power off, to make sure they are properly installed.
5. Check Series 787 to make sure pressure differential sense lines are installed correctly. (Refer to Figure 4-2 and Paragraph 4.4.)
6. Bleed as much air from system before start-up. If inconvenient to bleed air then start system very slowly. (Reference Figure 5-1).

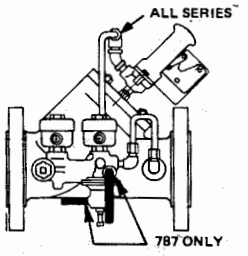


Figure 5-1 Bleed Points

7. Make sure system components are in right sequence in line.
8. Make sure the word inlet (as marked on the inlet flange) is in an up-stream position.
9. Be sure line has been flushed of any and all contaminants.
10. Check dual microswitch adjustments on meter.
11. Check microswitch and cam on valve for proper adjustment.
12. Check pilot needle valve setting.

5-2 Start-up Procedure

CAUTION: Do not operate this valve in excess of Section 1-7 SPECIFICATIONS. For emergency shut-off on initial start-up an operator should be available to immediately depress, the Preset Counter emergency stop button to prevent overflow in case the Preset Counter fails to shut-off at the desired set point or there has been an improper hookup.

It is recommended that these steps be followed for proper and specified operation of the valve.

1. Set Preset Counter to desired delivery.
2. Start pump.
3. Latch Preset Counter into full flow position.
4. The delivery will be completed automatically without any additional operation.
5. Check piping and tubing connections for leakage.
6. Any adjustments required can be made by referring to Section 6, Adjustments.

Section 6 ADJUSTMENTS

6-1 General

The following is a detailed explanation of the correct adjustment procedure for the valve and its accessories.

6-2 Low Flowrate Adjustment (Refer to Figure 6-1.)

The cam position determines the 1st stage low flowrate of the valve, before final shut-off. It is recommended that the low flowrate be adjusted between 10 and 20 percent of the maximum rated capacity of the meter. For Turbine Meters, it may be necessary to adjust for less than 10 percent. **Caution: To avoid damage to the roller arm of of the Microswitch DO NOT ALLOW it to ride over and onto the top side of the cam.**

1. Loosen the two set screws in the cam.
2. Move the cam up to relieve the tension on the microswitch swing arm. The roller on the microswitch swing arm should be approx. 1/16" away from the indicator stem. If necessary, adjust the swing arm per paragraph 6-7 and Figure 6-5.
3. Position the cam precisely as illustrated in Figure 6-1. Make sure the microswitch swing arm roller is on the beveled surface of the cam.
4. Tighten the set screws in the cam.

Note: Do not start the pump to check low flowrate, until all other prestart checks and adjustments have been made.

5. Enter a predetermined batch quantity into the Preset Register. This quantity should be approximately 30 units more than when First stage trip occurs.
6. Position operating handle beneath the Preset Register into the high flow position.
7. Start the pump.
8. Once the First stage trip has occurred, the valve will transfer to low flow rate. Adjust the cam up on the valve position indicator if flowrate is too high or down on the valve position indicator if flowrate is too low. Movement of the cam should be 1/16" increments or less.
9. Repeat steps 5 thru 9 until the desired flowrate is achieved.

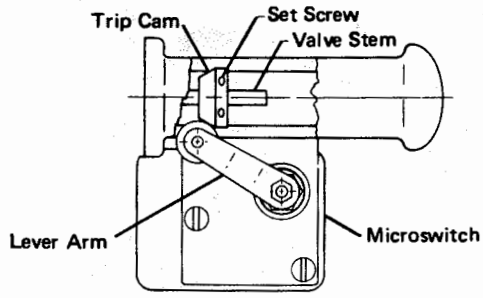


Figure 6-1 Valve Position Indicator Microswitch Trip Cam

6-3 Pilot Needle Valve Adjustment (Ref. Fig. 6-2).

The correct setting of the needle valve varies with valve size. The following Table 6-1 gives a nominal setting before start-up.

TABLE 6-1 NEEDLE VALVE ADJUSTMENT

SIZE	2"	3"	4"	6"	8"
TURNS OPEN	3/4	1	1-1/2	2– 2-1/2	4 – 6

The needle valve serves two functions. Primary function is sensitivity adjustment for flow control (Series 787 and 789 only). Secondary function is opening speed. (Primary function for series 788).

Adjust needle valve as follows:

1. Remove needle valve cap.
2. Set number of turns open from closed position as given in Table 6-1.
3. If valve opening is relatively slow, open needle valve, in one-half turn increments until desired speed is achieved. **Note: It may be necessary to re-adjust needle valve for slower opening if valve is not sensitive enough to flow control (Series 787 and 789 only).**
4. As stated previously, the primary function of the needle valve is related to flow control for series 787 and 789 only. If the main valve is too slow correcting for flow changes, turn the needle valve clockwise in one-half turn increments until desired response is achieved. Normally the nominal settings given for the needle valve result in an acceptable opening speed and good flow control.

Caution: Never completely close the needle valve. It should remain a minimum of one quarter turn open.

6-4 Maximum Flowrate Adjustment of Series 787 & 789 (Refer to Figures 6-2 and 6-3.)

The flowrate setting should be made while the valve is in a high-flow state.

1. To increase the maximum flowrate, turn the adjustment stem in a clockwise direction.
2. To decrease the maximum flowrate, turn the adjustment stem in a counter-clockwise direction.
3. If the valve is too slow on responding to flow control, or will not control the flow, check the pilot needle valve setting. (Refer to paragraph 6-3.)

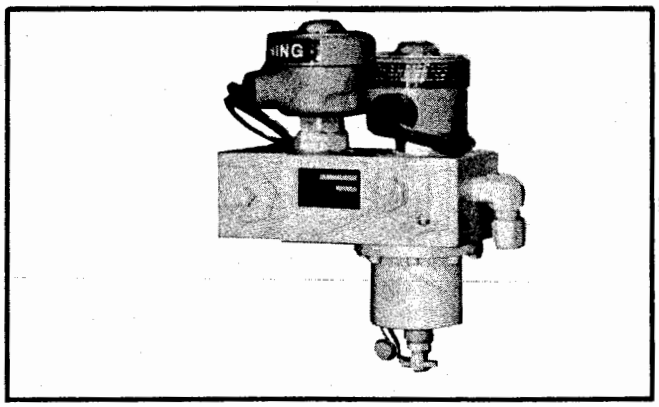


Figure 6-2 Pilot Module - Needle Valve and Adjustment Stem Location.

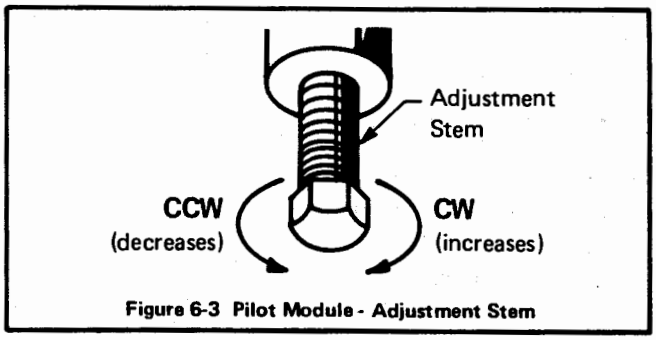


Figure 6-3 Pilot Module - Adjustment Stem

6-5 Adjustment of Thermal Relief (Refer to Figure 3-9)

1. Close the Thermal Relief Valve.
2. Manually engage the microswitches on the counter. This will power the solenoid pilots to place the valve into a high flow position. The line downstream of the valve (generally at the end of the hose) must be closed off so that no flow is permitted through the valve.
3. Start the pump and allow the pump to run until a static pressure is reached at the valve outlet.
4. Press the emergency stop button on the counter. This will cause the solenoid pilots to place the valve into a no-flow position.
5. Stop the pump.
6. Slowly open the Thermal Relief until the reading on pressure gauge P2 is equal to the pressure gauge P1, plus the desired spring setting (10-15 psi).

   EXAMPLE: The valve inlet pressure (P1) is 30 psi and outlet pressure (P2) is 45 psi. This difference is a 15 psid thermal relief spring setting.

   NOTE: In a no-flow state, the N.C. pilot module on the valve is self relieving when the valve outlet pressure (P2) is 25 psi higher than valve inlet pressure (P1). This means the separate thermal relief must be set for less than 25 psid.

6-6 Positioning Preset Switch on the Preset Counter (Refer to Figure 6-4)

The Preset Switch Assembly can be mounted on the right side or left rear of the Preset Counter. If the Preset Switch Assembly is mounted on the side, use the outside mounting hole on the linkage lever and if it is mounted on the rear use the inside hole of the linkage lever.

6-7 Adjusting the Preset Switches

If the internal switches within the Preset Switch Assembly are replaced or disrupted, the lever to actuator distance must be reset in order to obtain proper operation.

The following steps describe the procedures required to position the Internal Switches:

1. With the Preset Switch Assembly attached to the Preset Counter, set the preset ring in the low flow position.
2. Insert feeler gage of proper thickness (Refer to Figure 6-4) between the switch lever and the actuator.

3. Once the proper dimensions between the switch lever and actuator have been set, tighten the switch plate retaining screws securely.

6-8 Adjusting the Preset Counter

1. Positioning Preset Counter on the Meter

The Preset Counter is connected to the adaptor plate on Brooks Meters and can be rotated in eight different positions. To rotate the Preset Counter, remove 1/4 - 28 screws attaching the Preset Counter to the adaptor plate then postion the Preset Counter in the desired postion and install the screws to secure it to the adaptor plate.

NOTE: Mounting screws must not protrude into preset counter case over 0.312" or they will contact internal operating parts.

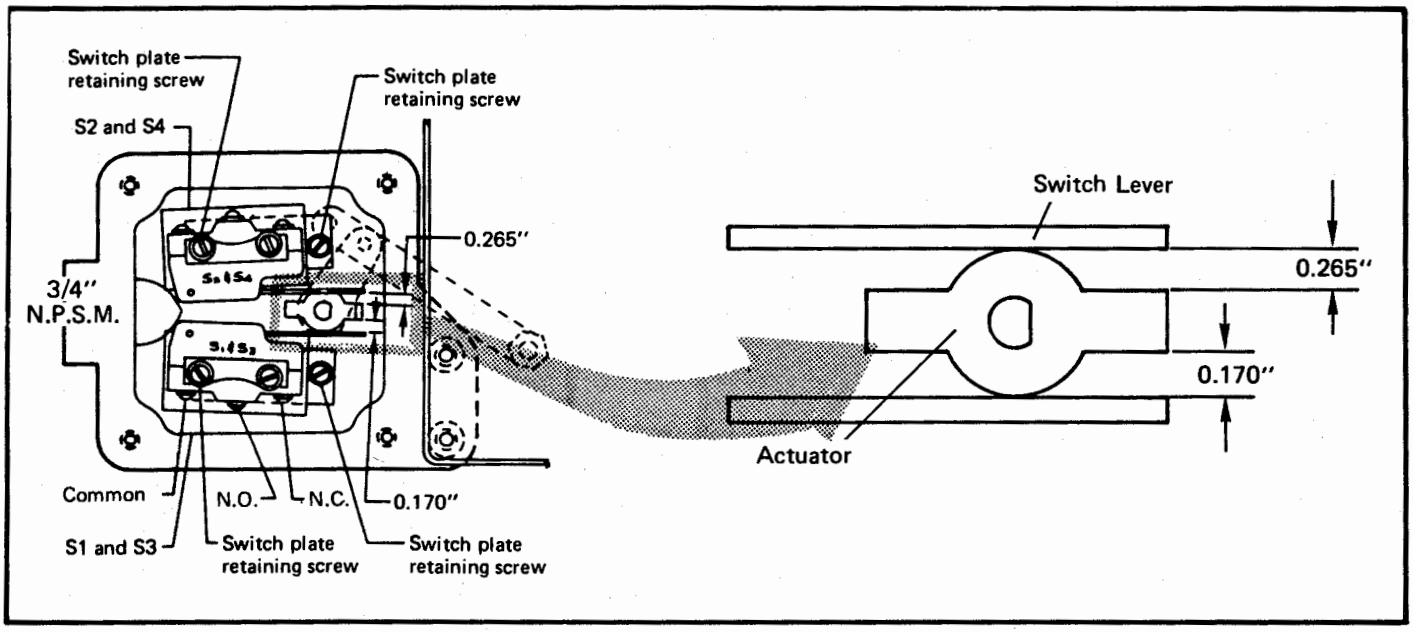


Figure 6-4 Typical Preset Switch Assembly

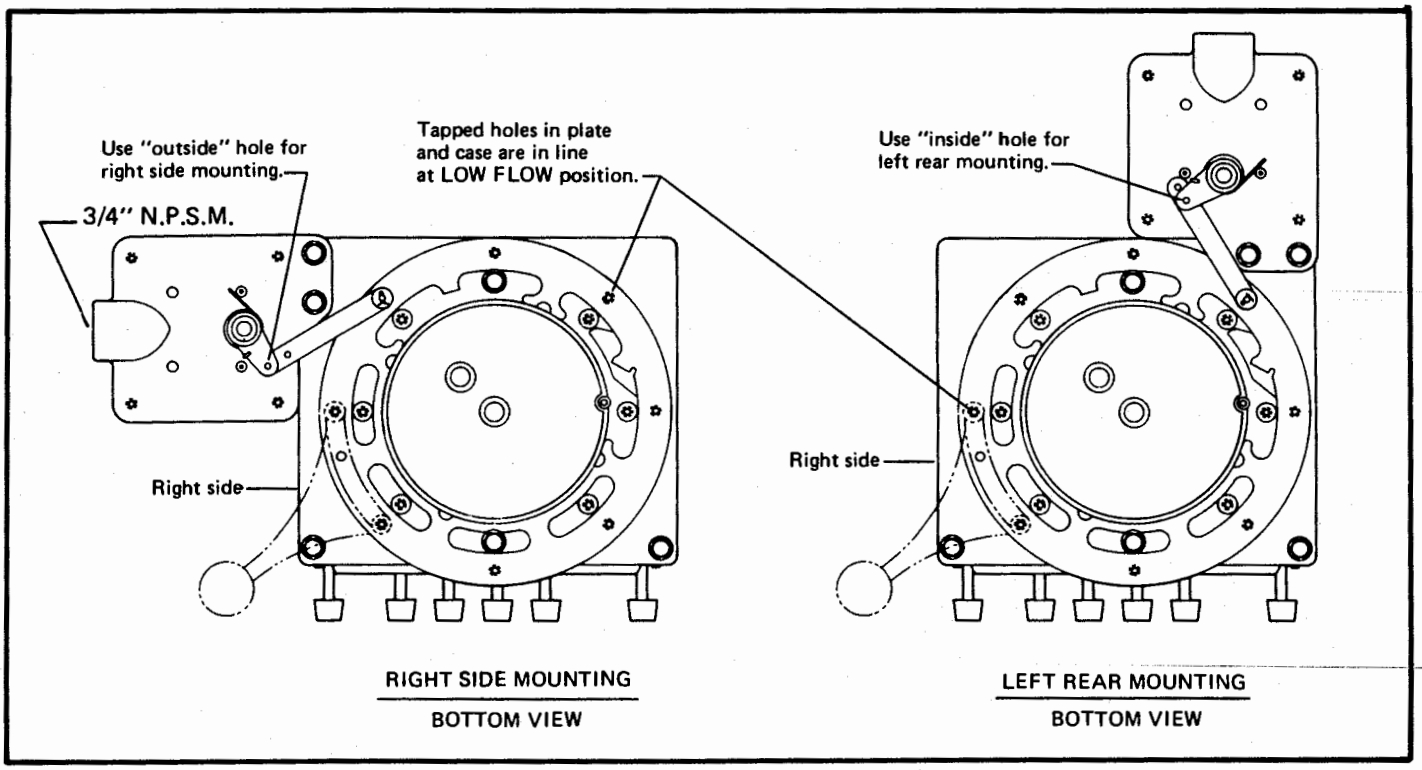


Figure 6-5 Preset Switch Assembly Schematic

2. Setting the Right-Hand Wheel to Zero

If the right-hand wheel does not center at zero in the display window once the preset counter has reached shut-down it must be centered as follows:

A. Make a test run of the meter and determine the quantity of under run or over run which the preset counter has recorded.

B. The brown "set" button must be out during adjusting.

C. Remove the two trim hole plugs located on the right side of the Preset Counter.

D. Insert a screwdriver into each trim hole and into the slots located on the side of the plastic parts (Refer to Figure 6-6). Use the rear screwdriver to hold the gear train stationary. The front screwdriver is used for prying the knock-off cam clockwise or counterclockwise until the zero (0) is centered in the display window on the Preset Counter.

E. Refer to Table 6-2 as a guide in determining the number of clicks or steps to detent the knock-off cam. Each click or step represents a one tenth (1/10) change between numbers on the right-hand wheel of the preset.

NOTE: Adjust the knock-off cam only in the direction indicated in the following steps.

If during adjustment in one direction of rotation a strong resistance is encountered, you have reached the internal stop; rotate the cam in the other direction.

(a.) If the preset counter reaches final shut-down and the right-hand zero (0) stops before it is centered in the display window, move the cam backward (clockwise when looking into the trim hole) only.

EXAMPLE: To correct a reading of 00003, the cam would be rotated 30 clicks clockwise.

(b) If the Preset Counter reaches Final shut-down and the right-hand zero (0) has passed the display window move the cam forward (counterclockwise when looking into the trim hole).

EXAMPLE: To correct a reading of 99998, the cam would be rotated 20 clicks counterclockwise.

3. Changing First Stage Closure on Preset Counters

By altering the notch on the second wheel of the trip cam a change in First stage of closure can be accomplished. The following steps outline the procedures required to alter the First stage of closure.

NOTE: Use care not to damage the first and second stage rake or the Preset Counter will malfunction.

A. Cut and Remove the lockwire that is threaded through the four bolts that hold the register in the Preset Counter. Remove the four bolts.

B. With the Preset Counter in a vertical position lift off the register.

C. Lift the First and Second stage rakes away from the wheels (Refer to Figure 6-7).

D. Using the black "preset" buttons, program the desired First stage of closure number into the display window of the Preset Counter.

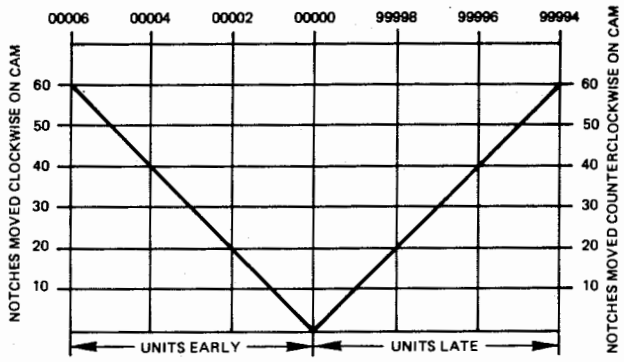
E. The following steps are required if First stage of closure is to be 10, 20, 30, 40, 50, 60, 70, 80, or 90.

(a) With the desired First stage trip number appearing in the display window remove the insert located at the top of the wheel. (Refer to Figure 6-8). Place the insert into the previously open notch or save the insert for future use if there is not an open notch.

F. Lower the First and Second stage rakes.

G. Install register on top of the preset. The two "up-down" shafts protruding from the register should be aligned to mate with the two shafts in the preset before the two units are mounted together. (Refer to Figure 6-9).

TABLE 6-2 DIGIT REGISTRATION ADJUSTMENT CURVE



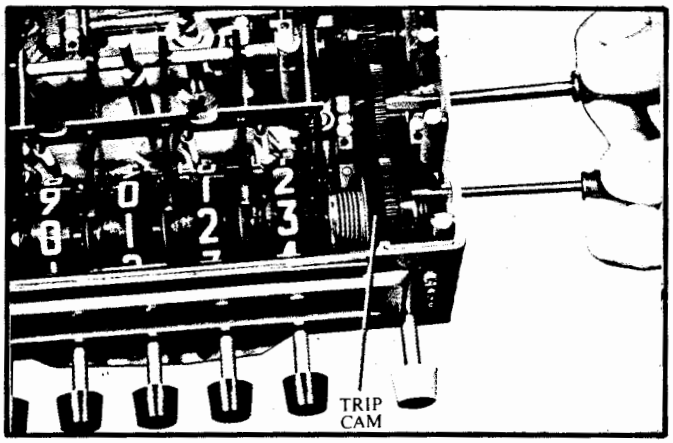


Figure 6-6 Trimming the Right-Hand Wheel.

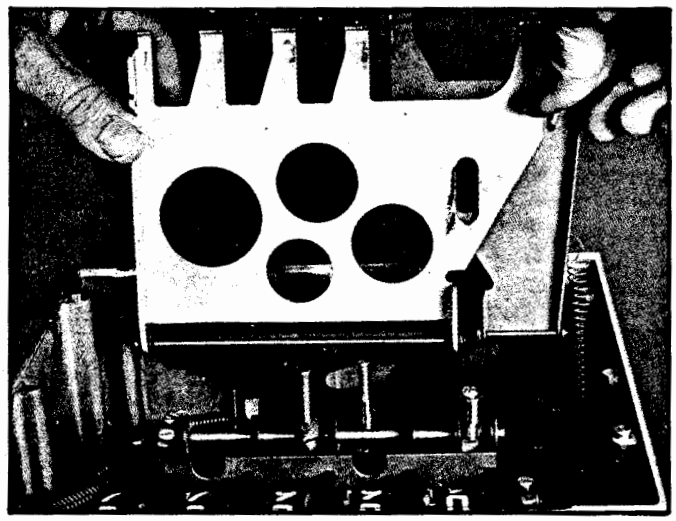


Figure 6-7 Lifting the First and Second Stage Rakes.

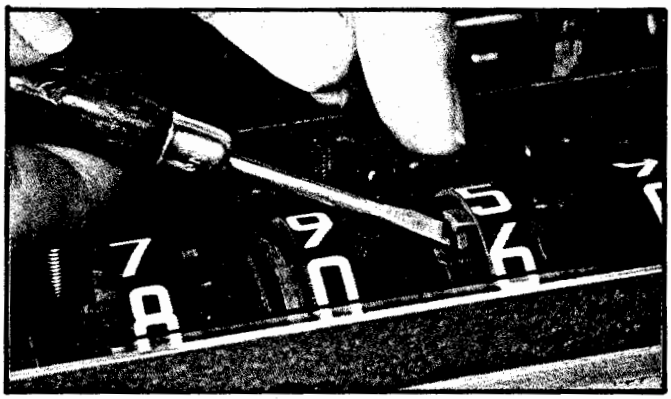


Figure 6-8 Removing Insert from Notch on Second Wheel.

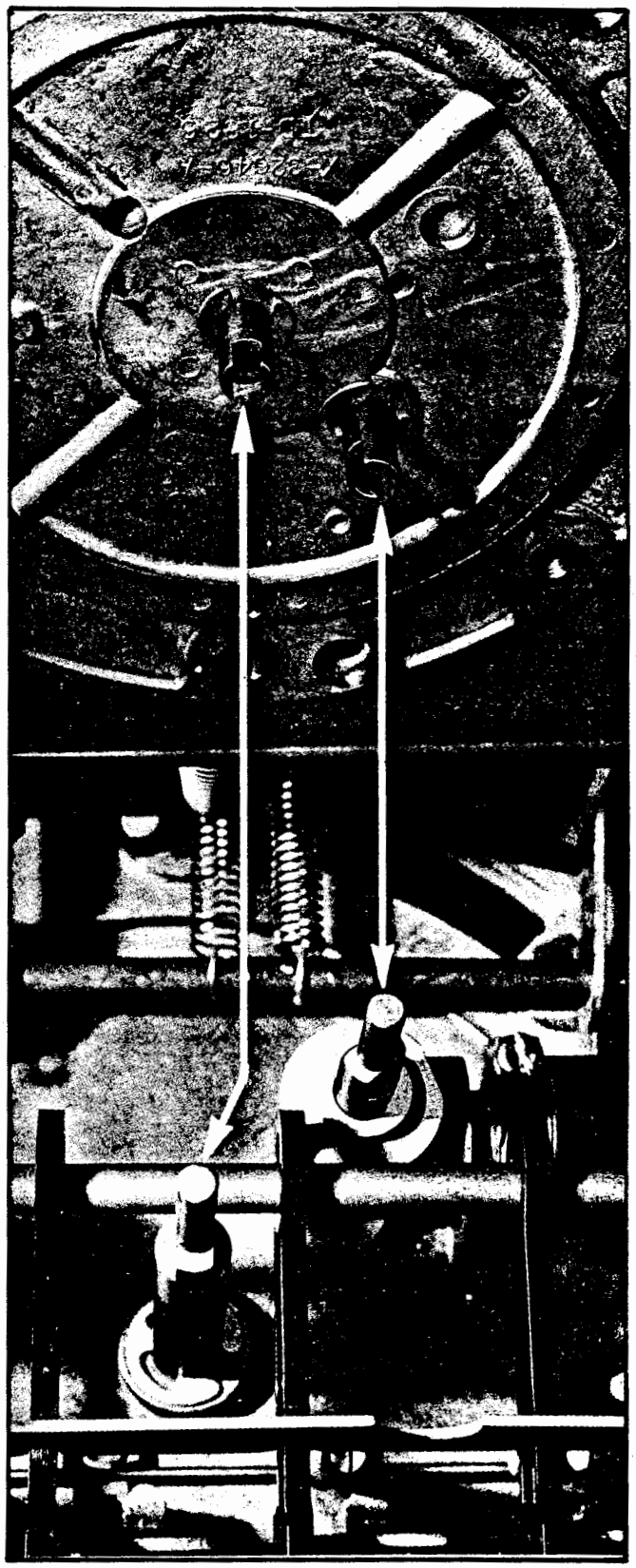


Figure 6-9 Proper Alignment of Shafts on Preset Counter and Coupling on Meter Register.

PRESET COUNTER ADJUSTMENT

Section 7 MAINTENANCE

7-1 General

This section contains disassembly and reassembly instructions for the pilot module. Included in Section 9, is a trouble shooting table to be used as an aid in locating and correcting operational problems which can be handled as general field repairs on the valve. No routine maintenance is normally required for the quantrol system except checking for the accumulation of foreign material.

7-2 Manufacturers Maintenance Recommendations

The following items apply to the valve. Users must give careful consideration to the consequences that may be the result of failure to follow manufacturers recommendations.

a. No attempt should be made by the user to alter any physical dimension of the valve or any component part.
b. Do not use force to assemble or disassemble any component of the valve. All components are machined to exact tolerances.
c. When an unserviceable valve has been returned to the factory for rework, it must be understood that in extreme cases it may be economically impractical to repair the valve.

7-3 Pilot Disassembly

It is not necessary to remove the valve from the pipeline for disassembly. Read the entire procedure for disassembly before making any attempt to disassemble the pilot. Serious personal injury or damage to the pilot can result if it is improperly handled.

Before proceeding with any disassembly, be certain to:

1. Isolate the valve from line pressure or back pressure.
2. If used at elevated temperatures, reduce temperature of valve (including internals) to ambient.
3. Disconnect any electrical lines to or from the valve.
4. If the valve has been used for any corrosive, toxic, or other dangerous liquids, follow the procedures covered in Subpart 1,Sections 1910.132 thru 1910.140 of the Occupational Safety and Health Standards, Federal Register No. 202-Pt II-1, or subsequent changes thereto.
5. Reduce the pressure inside the valve to zero by draining that section of the line which is isolated along with the valve.

Procedure

NEVER USE any gripping tool on any internal component of the pilot. Do not drop any part of the pilot as damage can occur.

If the first digit of the pilot part number suffix is 1 or 2, the pilot is a "B" model.

If the first digit of the pilot part number suffix is 4,5,8, or 9, the pilot is a "C" model.

The disassembly procedures for the 1787-B, 1788-B, and 1789-B are the same as the 1787-C, 1788-C and 1789-C except for step 10 of Disassembly 1788 and step 14 of Disassembly 1789-C which should be deleted for the B model.

PILOT DISASSEMBLY 1787-C

Refer to Figure 8-1 for all disassembly and reassembly.

Follow steps 1-7 under Disassembly 1788-C and steps 8-15 under Disassembly 1789-C, then proceed to step 16 under this heading, Disassembly 1787-C.

16. Remove the adaptor assembly (items 1-6) from the cover (item 9).
17. Remove the adaptor stem (item 5) and O-Ring (item 6).

PILOT DISASSEMBLY 1788C

Refer to Figure 8-1 for all disassembly and reassembly.

1. Disconnect all wiring and piping from pilot module.
2. Loosen caps of both solenoids (items 51 and 53).
3. Remove both solenoids from pilot body with a 1-1/8" open end wrench.
4. Remove core assembly (item 55) and spring (item 54) from normally closed solenoid (item 53). Take care not to lose spring upon removal of solenoid.
5. Pull poppet assembly (items 41-48) out of body. Remove spring (item 49) from normally open solenoid (item 51). Take care not to lose spring upon removal of solenoid.
6. Remove cap (item 35) from the retainer (item 36), then screw retainer and adjustment stem (item 37) out of body.
7. Remove (items 31, 32, 33, and 34) from body. Inspect strainer (item 31) and replace if there is any sign of damage.
8. Remove eight screws (item 28) and the diaphragm plate (item 29) from body.
9. Remove retaining ring (item 17).
10. Pull out on adaptor plug (item 27), until lower guide bushing (item 18) is loose. Remove lower guide bushing (item 18) and O-Ring (item 19).
11. Pull adaptor plug (item 27) and upper guide bushing (item 20) out of body.

PILOT DISASSEMBLY 1789C

Follow steps 1-7 under Disassembly 1788-C then proceed to step 8 under this heading (Disassembly 1789-C).

8. Loosen lock nut (item 2) and adjustment screw (item 1) enough to relieve spring tension.
9. Remove eight screws (item 7), cover (item 9), spring (item 11), and spring guide (item 10) from body.
10. Remove nut (item 12) by screwing it off while holding diaphragm poppet (item 22) by the flats on the end.
11. Remove diaphragm nut (item 13) by screwing it off while holding diaphragm poppet by the flats on the end.
12. Remove diaphragm washers (item 14,16) and diaphragm (item 15).
13. Remove retaining ring (item 17).

14. Pull out on diaphragm poppet (item 22) until lower guide bushing (item 18) is loose. Remove O-Ring (item 19) under lower guide bushing (item 18).
15. Pull diaphragm poppet assembly (item 22) and upper guide bushing (item 20) out of the body.

7-4 Pilot Module Reassembly

To reassemble the pilot module, reverse the disassembly procedure. Before reassembly, be sure to read the following instructions to insure correct reassembly.

1. Clean the body in solvent and check all parts to be sure they are clean.
2. Replace all O-Rings and springs which show any sign of damage or wear.
3. Apply oil or grease to all O-Rings to prevent cutting and for ease of assembly.
4. Replace strainer (item 31) if it is damaged or if foreign matter cannot be removed.
5. When assembling N. C. solenoid to pilot, place spring (item 54) in hole in core assembly (item 55) with tightly wound coils pointing out.
6. When assembling N.O. solenoid to pilot, apply a light silicon-type grease to the spring (item 49) and place spring inside solenoid.
7. When reassembling needle valve assembly (items 35, 36, 37 and 38), screw needle valve (item 37) into retainer (item 36) finger tight. Screw retainer into body securely. Turn needle valve clockwise until it lightly bottoms and back off two turns.
8. **Models 1787 and 1789 only:** When tightening diaphragm nut (item 13) on diaphragm poppet (item 22) hold the poppet across the flats on the end so that the poppet does not turn.

Section 8 PARTS LIST

8-1 General

When ordering, the following information must be furnished:

a. Part number and description.
b. Model number of valve.
c. Serial number of valve.
d. Quantity required.

When ordering items of a special construction or material not indicated in the Parts List, furnish the following information so that the part number of the item can be determined.

a. Item number and description.
b. Specific material of item.
c. Model number of valve.
d. Serial number of valve.
e. Quantity required.

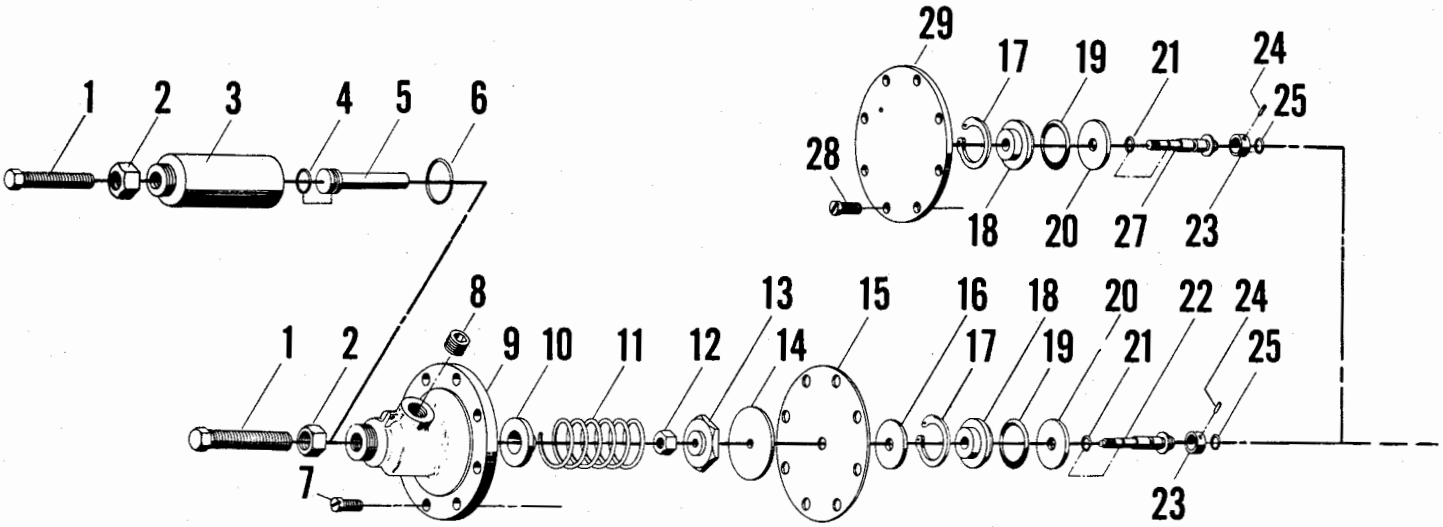
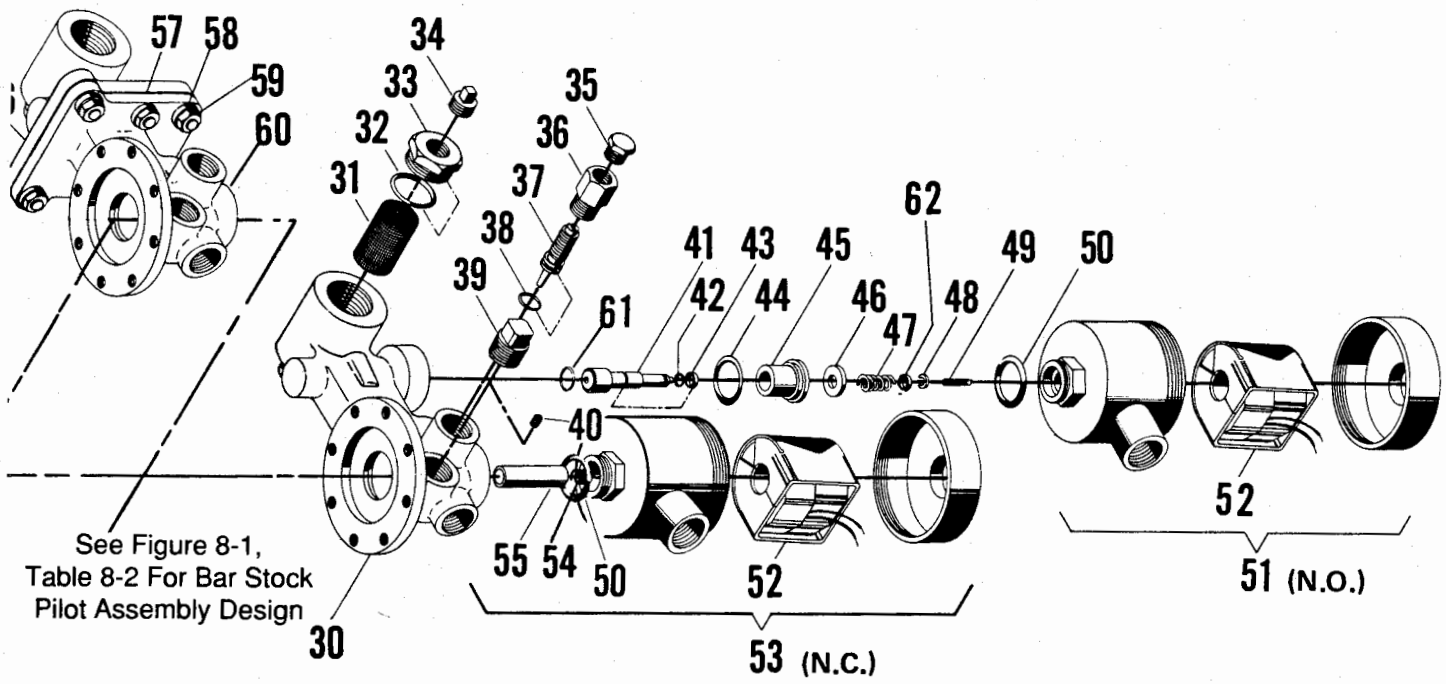


Figure 8-1, Table 8-1 Parts List - Pilot Module

ITEM	DESCRIPTION	NO. REQ.	PART NUMBER 1787	NO. REQ.	PART NUMBER 1788	NO. REQ.	PART NUMBER 1789
1	Adjustment Screw	1	478919	1	—	1	478919
2	Nut	1	SP-1270		—	1	SP-1270
3	Adaptor Bushing	1	478932		—	1	–
4	O-Ring	1	152086		—		–
5	Adaptor Stem	1	478931		—		–
6	O-Ring	1	152048		—		—
7	Screw	8	151030		—	8	151030
8	Vent Plug		—		—	1	460026-500
9	Cover	1	453552-500		—	1	453552-500
10	Spring Guide	1	478908		—	1	478908
11	Spring 0-20 psi (Plain)	1	457223		—	1	457223
	10-50 psi (Blue)	1	457122		—	1	457122
	30-130 psi (Bronze)	1	457123		—	1	457123
12	Nut	1	151533		—	1	151533
13	Diaphragm Nut	1	478903		—	1	478903
14	Diaphragm Washer	1	478904		—	1	478904
15	Diaphragm	1	478902-002		—	1	478902-002
16	Diaphragm Washer	1	478914		—	1	478914
17	Retainer Ring	1	153952	1	153952	1	153952
18	Lower Guide Bushing	1	478918-002	1	478918-002	1	478918-002
19	O-Ring	1	152050	1	152050	1	152050
20	Upper Guide Bushing	1	478918-001	1	478918-001	1	478918-001
21	O-Ring	1	152062-022	1	152062-022	1	152062-022
22	Diaphragm Poppet Assembly	1	478915-502		—	1	478915-502
23	O-Ring Retainer	1	478917	1	478917	1	478917
24	Roll Pin	1	153550	1	153550	1	153550
25	O-Ring	1	152064-022	1	152064-022	1	152064-022
27	Adaptor Plug (includes items 23,24 and 25)		—		478802-502		—
28	Screw		—	8	SP-742		—
29	Diaphragm Plate		—	1	478801		—
30	Pilot Body (Ductile Iron)	1	478940-400	1	478940-400	1	478940-400
31	Strainer	1	460687	1	460687	1	460687

NOTE 1: No parts available for obsolete "B" Model.

NOTE 2: Items 56 & 60 are not available as service items.



Item	Description	No. Req.	Part Number 1787	No. Req.	Part Number 1788	No. Req.	Part Number 1789
32	O-Ring	1	152042	1	152042	1	152042
33	Strainer Cap	1	460682	1	460682	1	460682
34	Pipe Plug	1	154783-024	1	154783-024	1	154783-024
35	Cap	1	460686	1	460686	1	460686
36	Retainer	1	460684	1	460684	1	460684
37	Adjustment Stem	1	460683	1	460683	1	460683
38	O-Ring	1	152067	1	152067	1	152067
39	Pipe Plug	—	—	—	—	1	154716-019
40	Pipe Plug	1	154720	1	154720		
41	Poppet Shaft Assembly	1	456707-001	1	456707-001	1	456707-001
42	O-Ring	1	157068-022	1	157068-022	1	157068-022
43	Glyd Ring	1	157159	1	157159	1	157159
44	O-Ring	1	157093	1	157093	1	157093
45	Sleeve - For Steel Pilot	1	478962	1	478962	1	478962
	Sleeve - For Ductile Iron Pilot	1	478958	1	478958	1	478958
46	Washer	1	478959	1	478959	1	478959
47	Spring	1	456953	1	456953	1	456953
48	Retaining Ring	1	153947-019	1	153947-019	1	153947-019
49	Spring	1	456954	1	456954	1	456954
50	O-Ring	2	157034	2	157034	2	157034
51	N.O. Solenoid (includes item 52)	1	478935-012	1	478935-012	1	478935-012
	Assembly	1	478935-022	1	478935-022	1	478935-022
52	Coil 110/50, 120/60 v ac	2	478938-010	2	478938-010	2	478938-010
	220/50, 240/60 v ac	2	478938-020	2	478938-020	2	478938-020
53	N.C. Solenoid (includes items 52, 54	1	478950-012	1	478950-012	1	478950-012
	Assembly and 55)	1	478950-022	1	478950-022	1	478950-022
54	Spring	1	478954	1	478954	1	478954
55	Core Assembly	1	478953	1	478953	1	478953
56*	Pilot Body (with needle valve)	1	478940-500	1	478940-500	1	478940-500
57*	Gasket	1	478803	1	478803	1	478803
58*	Lockwasher	6	152108	6	152108	6	152108
59*	Socket Head Screw	6	151012	6	151012	6	151012
60*	Pilot Body (with needle valve)	1	478901-501	1	478901-501	1	478901-501
61	O-Ring	1	152067-022	1	152067-022	1	152067-022
62	Washer	1	478922	1	478922	1	478922

*NOTE: For assemblies with steel bar stock body items 56, 57, 58, 59 & 60 have been replaced by one assembly number 478965.

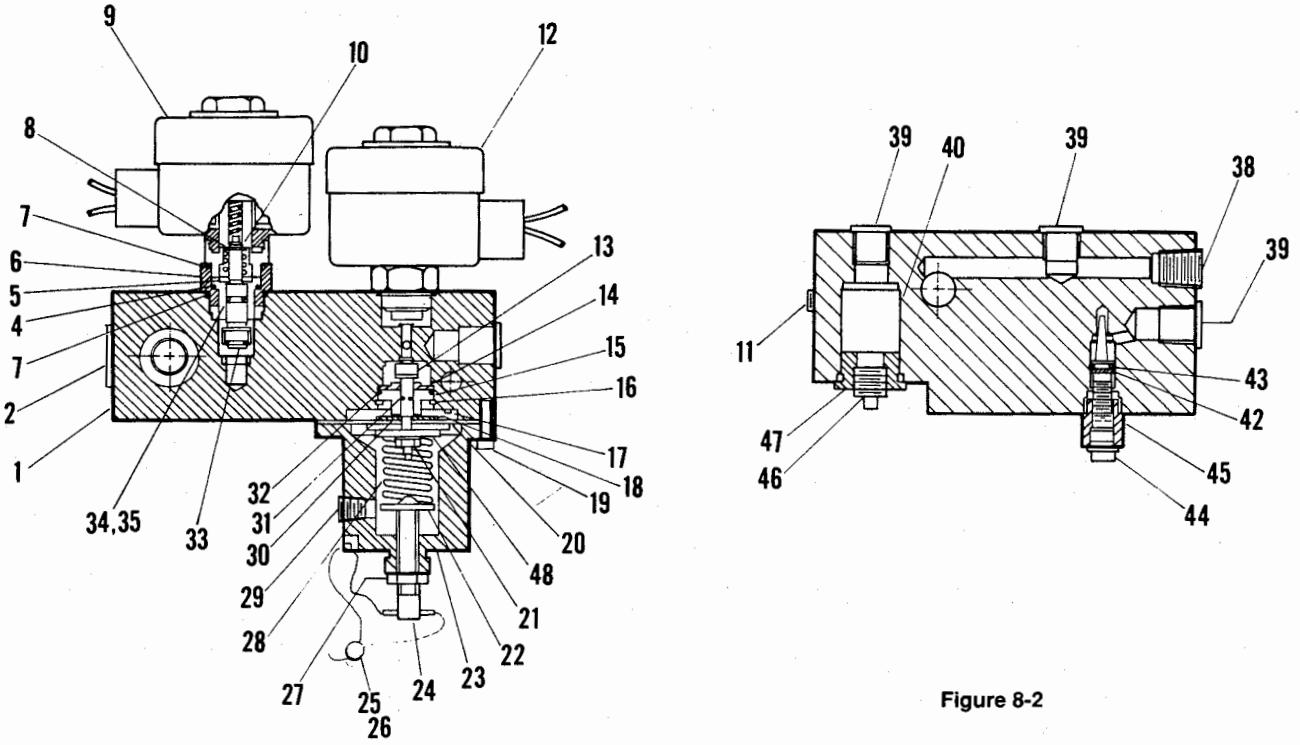


Figure 8-2

Figure 8-2, Table 8-2 Parts List - Pilot Module/Bar Stock Design - All Models

ITEM	DESCRIPTION	PART NUMBER	REQ.	ITEM	DESCRIPTION	PART NO	REQ.
1	Pilot Assembly	478965	1	25	Lead Seal	151831	1
2	Name Plate	478929	1	26	Seal Wire	155051	1
3	Sleeve	478962	1	27	Nut	151627	1
4	O-Ring	157093	1	28	Spring 10-50 PSI	457122	1
5	Washer	478959	1	29	Vent Plug	460026-500	1
6	Stand-off	478964	1	30	Diaphragm Washer	478904	1
7	O-Ring	157034	3	31	O-Ring	152062-022	1
8	Washer	478922	1	32	O-Ring	152050	1
9	N.O. Solenoid Assem.	478935-010	1	33	Poppet Shaft Assem.	456707-001	1
10	Retaining Ring	153947-019	1	34	O-Ring	157068-022	1
11	Pipe Plug	154720	1	35	Glyd-Ring	157159	1
12	N.C. Solenoid Assem.	478950-012	1	36	Pipe Plug	154716-019	2
13	Diaphragm Poppet	478915-502	1	37	Cap Plug	154769	3
14	Guide Bushing	478918-001	1	38	Strainer	460687	1
15	Guide Bushing	478918-002	1	39	O-Ring	152042	1
16	Retaining Ring	153952	1	40	Adjustment Stem	460683	1
17	Screw	150995	1	41	O-Ring	152067	1
18	Diaphragm Washer	878914	1	42	Cap	460686	1
19	Screw	151030	8	43	Retainer	460684	1
20	Diaphragm	478902-002	1	44	Pipe Plug	154783-024	1
21	Nut	151533	1	45	Strainer Cap	460682	1
22	Spring Guide	478908	1	46	Diaphragm Nut	478903	1
23	Cover	453552-500	1				
24	Adjustment Stem	478919	1				

Section 9 TROUBLESHOOTING

9-1 General

The troubleshooting table is presented as an aid in locating and correcting operational problems in the meter. The user must understand that every possible problem could not be listed. However, the table will provide adequate information for general field repairs.

TABLE 9-1 TROUBLESHOOTING

CONDITION	CAUSE	CORRECTION
Valve will not open. (No pressure on inlet.)	1. Upstream block valve is closed. 2. Pump is not operating.	1. Open valve. 2. Start-pump – check for cavitation.
Valve will not open. (Pressure on inlet.)	1. Downstream block valve closed. 2. Pressure is not sufficient (less than 6 psid). 3. No output from power source. 4. Pilot needle valve closed. 5. Preset microswitches not engaging properly. 6. One or both solenoids not functioning. 7. Voltage applied is other than that for which the solenoid is rated. 8. Poppet shaft sticking. 9. Loose wiring connection. 10. Open circuit in wiring. 11. Wired incorrectly.	1. Open valve. (Check coupler on bottom loading units and internal valve in truck.) 2. Check by-pass on pump and strainer in line. 3. Check power source. 4. Adjust needle valve to correct setting. (Refer to paragraph 6-3 and Figures 6-2 and 6-3.) 5. Adjust, repair or replace switch. (Refer to paragraph 6-6 and Figure 6-4.) 6. Check power, wiring, and coils. 7. Check rating, supply correct voltage, and check for damage to solenoids. 8. Disassemble pilot, determine the reason for the sticking and correct. (Refer to paragraphs 7-4 and 7-5 and Figure 8-1.) 9. Tighten connections. 10. Complete the circuit by repairing the break after disconnecting power. 11. Check against wiring diagram. (Refer to Figure 4-4 or 4-6.)
System will not obtain designed maximum flow.	1. Clogged strainer. 2. Insufficient pump pressure. 3. Internal problem in pilot. (Normally open poppet not closing completely or normally closed poppet not opening completely.)	1. Clean strainer. 2. Check pump and correct any problems. 3. Disassemble pilot and correct problem.
Valves open too slowly.	1. Needle valve closed too much. 2. Normally open solenoid pilot not closing completely or normally closed solenoid not opening completely. 3. Valve inlet pressure below normal.	1. Adjust needle valve to correct setting. (Refer to paragraph 6-3 and Figures 6-2 and 6-3.) 2. Check solenoids; if no trouble there, disassemble pilot and check the solenoid poppets. (Refer to paragraph 7-4 and 7-5 and Figure 8-1.) 3. Check line strainer and pump for line obstructions.

Flow control pilot does not regulate properly.	1. Spring out of adjustment. 2. Needle valve open too much. 3. No sense lines installed (787 only) 4. Poppet shaft sticking 5. Hole in diaphragm (will leak to the atmosphere on 1789 pilot). 6. Pressure less than minimum requirement of 3 psid. (787 only) 7. One or both of the sensing lines across the meter blocked.	1. Adjust spring to correct setting. (Refer to paragraph 6-4 and Figure 6-3.) 2. Adjust needle valve to correct setting. (Refer to Figures 6-2 and 6-3 and Paragraph 6-3.) 3. Refer to Figures 4-2 and paragraph 4-4 for proper installation. 4. Disassemble pilot, determine the reason for sticking and correct. 5. Replace diaphram. 6. Increase flow or pressure to obtain required minimum pressure. 7. Check sense lines for obstructions.
By-passes 1st stage trip. (Continues in high flow.)	1. High flow switch (SW2) not dis-engaging. 2. High flow switch (SW2) not functioning internally. 3. Preset counter not operating properly. 4. Mechanical linkage on preset switch assembly sticking. 5. Normally open solenoid stuck in closed position. 6. Incorrect wiring.	1. Make proper adjustment. (Refer to paragraph 6-7 and Figure 6-4.) 2. Repair or replace. (Refer to paragraph 6-7.) 3. Make proper adjustment on cam, or repair or replace counter. 4. Clean and lubricate with silicon-type spray lubricant. 5. Disassemble pilot module. Repair or replace poppet assembly parts as necessary. 6. Recheck all wiring. (Refer to Figure 4-4 or 4-6.)
BY-passes low flow stop position. (Completely closes on transition from high flow.)	1. Valve indicator switch (SW3) damaged or not properly adjusted. 2. Preset low flow switch (SW1) damaged or not properly adjusted. 3. Open circuit in wiring. 4. Loose wiring connection. 5. Incorrect wiring.	1. Replace or adjust. (Refer to paragraph 6-2, 6-7 and Figure 6-4.) 2. Replace or adjust. (Refer to paragraph 6-7 and Figure 6-4.) 3. Complete the circuit by repairing the break after disconnecting power. 4. Tighten connection. 5. Recheck all wiring (Refer to Figure 4-4 or 4-6.)
By-passes 2nd stage trip. (Remains in low flow position and fails to stop.)	1. Preset low flow switch (SW1) damaged or not properly adjusted. 2. Mechanical linkage on preset switch assembly sticking. 3. Preset counter not operating properly.	1. Replace or adjust. (Refer to paragraph 6-6, 6-7 and Figure 6-4.) 2. Clean and lubricate with silicon-sype spray lubricant. 3. Make proper adjustment on cam, or repair or replace counter. (Refer to paragraph 6-8 or 6-10.)

CONDITION	CAUSE	CORRECTION
Valve will not close off tight.	1. Position indicator bent. 2. Foreign material lodged on main valve piston seat. 3. Swollen main valve piston O-Ring. 4. Normally closed solenoid not seating tightly. 5. Main valve piston or seat O-Ring cut or defective.	1. Straighten or replace. 2. Disassemble cylinder assembly and inspect. (Refer to Bulletin V1700-20A.) 3. Disassemble cylinder assembly and replace. (Refer to Bulletin V1700-20A.) 4. Remove normally closed solenoid and inspect poppet and seat. 5. Disassemble cylinder assembly and inspect and replace if necessary. (Refer to Bulletin V1700-20A.)
Valve does not shut-off on "zero". (Closes before "zero".)	1. Preset counter trip cam not properly adjusted. 2. Low flowrate thru valve is too low. 3. Preset counter not operating correctly.	1. Adjust cam for "zero" shut-off. (Refer to paragraph 6-8.) 2. Increase low flow thru valve. (Refer to paragraph 6-2.) 3. Repair or replace preset counter.
Valve does not shut-off on "zero". (Closes after "zero".)	1. Preset counter trip cam not properly adjusted. 2. Low flowrate thru valve is to high. 3. Mechanical linkage on preset switch assembly sticking slightly (delayed action). 4. Main valve closes too slowly. 5. Valve position indicator bent. 6. Air on top of main valve piston. 7. Preset not operating correctly.	1. Adjust cam for "zero" shut-off. (Refer to paragraph 6-8.) 2. Decrease low flow thru valve. (Refer to paragraph 6-2.) 3. Clean and lubricate with silicon-type spray lubricant. 4. Remove cylinder assembly and check piston for freeness. Replace piston O-Ring if necessary. (Refer to V1700-20A.) 5. Straighten or replace. 6. Loosen tubing connection at top of valve cylinder assembly and bleed off all free-air. (Cycle valve open and closed several times using emergency stop on preset. 7. Repair or replace
Valve by-passes low flow start position. (Applies to valves with time delay only.)	1. Low flow start switch (SW4) on valve damaged or not properly adjusted. 2. Incorrect wiring. 3. Normally closed solenoid not being de-energized. 4. Time delay contacts stuck closed. (Should be open on start-up and close on time-out.)	1. Replace or adjust switch. (Refer to paragraph 6-7 and Figure 4-6.) 2. Check wiring. 3. Check wiring. 4. Check operating sequence of time delay contacts and for proper wiring.

DANIEL™ MEASUREMENT AND CONTROL, INC.

RETURNED MATERIAL AUTHORIZATION

REPAIR FORM FOR USED EQUIPMENT INCLUDING DECONTAMINATION/CLEANING STATEMENT

A Return Material Authorization (RMA) number must be obtained prior to returning any equipment for any reason. Download the RMA form from the Support Services web page by selecting the link below.

http://www2.emersonprocess.com/EN-US/BRANDS/DANIEL/SUPPORT-SERVICES/Pages/Support-Services.aspx

1. Return Material Authorization (RMA) Number_____
2. Equipment to be returned:
   Model Number _____Serial Number_____
3. Reason for return:
   _____
   _____
   _____
   _____
   _____

Decontamination/Cleaning Fluids Process

A. List each substance in which the equipment was exposed. Attach additional documents if necessary.

Common Name	CAS# if Available	Used for Hazardous Waste (20 CFR 261)		EPA Waste Code if used for hazardous waste
		[ ] Yes	[ ] No	
		[ ] Yes	[ ] No	
		[ ] Yes	[ ] No	
		[ ] Yes	[ ] No	
		[ ] Yes	[ ] No	
		[ ] Yes	[ ] No	

B. Circle any hazards and/or process fluid types that apply:

Infectious	Radioactive	Explosive	Pryophoric	Poison Gas	
Cyanides	Sulfides	Corrosive	Oxidizer	Flammable	Poison
Carcinogen	Peroxide	Reactive-Air	Reactive-Water	Reactive-Other (list):	

Other Hazard Category (list):

C. Describe decontamination/cleaning process. Include MSDS description for substances used in decontamination and cleaning processes. Attach additional documents if necessary.

Shipping Requirements

Failure to comply with this procedure will result in the shipment being refused.

1. Write the RMA number on the shipping package.
2. Inside the package include one copy of this document and all required Material Safety Data Sheets (MSDS)
3. Outside of the package attach one copy of this document and all required Material Safety Data Sheets (MSDS).

THIS EQUIPMENT, BEING RETURNED "FOR REPAIR," HAS BEEN COMPLETELY DECONTAMINATED AND CLEANED. ALL FOREIGN SUBSTANCES HAVE BEEN DOCUMENTED ABOVE AND MSDS SHEETS ARE ATTACHED.

By_____ _____
(Signature) (Print name)

Title:_____ Date:_____

Company:_____

Phone: _____ Fax:_____

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Daniel Measurement Services, Inc. offers both on-call and contract maintenance service designed to provide single-source responsibility for all Daniel products. The sales and service offices of Daniel Measurement and Control, Inc. are located throughout the United States and in major countries overseas. For the location of the sales or service office nearest you, telephone the number below or visit the Daniel Measurement and Control, Inc. website.

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