

INSTRUCTIONS
FOR
INSTALLATION AND OPERATION

FulTrol[®]
Pilot Temperature Controller
DT-700-A1, A2

Note to Installer: After installing, give this instruction folder to operating personnel or see that it is filed for future reference.



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SECTION I – GENERAL DESCRIPTION

The Fultrol pilot controller provides accurate control of liquid or air temperature when used in conjunction with valves, dampers, etc.

The Fultrol pilot controller may be used to control the operation of various final control elements such as valves, switches, air motors, etc. in pneumatic, or in some cases,

hydraulic control systems. These systems, depending on relative action of pilot and final control element, may control either heating or cooling or both and may be arranged so that valves will either open or close on loss of pilot supply pressure.

SECTION II – SPECIFICATIONS

FulTrol Number		DT-700-A1	DT-700-A2
Control Action (Action readily reversible in the field)		Direct Acting. Controlled air pressure increases with increase in temperature.	Reverse Acting. Controlled air pressure decreases with increase in temperature.
Temperature Ranges	Standard Ranges	-50° F to 150° F, 50° F to 250° F, 150° F to 350° F.	
	Available Ranges	Any 200° F range between -50° F and 350° F. Equivalent 110° C ranges also available.	
Temperature Adjustment		Knob and dial. Dial graduated in ° F with 200° F range of adjustment. Equivalent ° C ranges available on order.	
Overrun Temp. Protection		Unaffected by brief exposure up to 700° F.	
Proportional Band Adjustment		5° F to 25° F (2-1/2 lbs/° F to 1/2 lb/° F).	
Pilot Supply		Air, gas or low viscosity oil. Air Consumption: 12 CFH maximum.	
Pilot Supply Pressure Required		18 to 20 psi normal. Suitable for pressures up to 40 psi.	
Gages (Two Supplied)		Dual Scale graduated 0-30 psi and 0-2.1 kg/cm ² .	
Materials Etc.	Bulb	Type 304 stainless steel welded to stainless steel fitting.	
	Max. Non-Shock Pressure	300 psi at 300° F, 200 psi at 600° F. For higher pressures use Well No. 97181-A1.	
	Pilot Valve	Stainless steel.	
	Body and other Parts	Brass or bronze.	

- Notes:
1. For operation at sub-freezing temperatures, very dry air must be used.
 2. Oil viscosity must not exceed 55 S.S.U. at 40° F.

ACCESSORIES

Control Valves – Suitable for steam, gas, oil, water or other fluids. Valves sizes 1/4" thru 4". Both bellows-actuated and diaphragm-actuated types available.

Booster Relay No. CR-100-A1 – Gives faster response on pneumatic systems requiring substantial air volume. 1/8" pilot inlet; 1/4" supply inlet and outlet. Input-output ratio 1:1 (others on order).

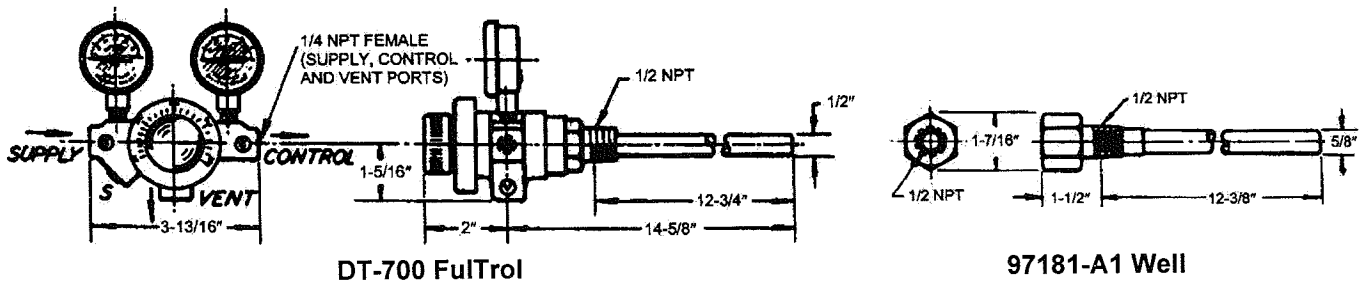
Regulator No. 97478 – Combination regulator, filter and dripwell. Used instead of Nos. 94434 and 97196 for simple installation. 1/4" connections. Has drip cock.

Well No. 97181-A1 – Protects bulb of FulTrol where high pressures are involved. Made of type 304 stainless steel. Maximum non-shock pressure: 1000 psi at 150° F.; 750psi at 350° F. See dimensions below.

SECTION III – INSTALLATION

Bulb is subject to damage which will cause malfunction which could result in complete loss of control of the process. Exercise care in handling. Do not carry by bulb or

apply wrenches or other tools to bulb. When used with hazardous or corrosive media, a separable socket should be used.



LOCATION

FulTrol should be located where the thermal element (bulb) can respond to average temperature to be controlled; where it is not subject to uncontrolled heat or cold sources, and where it is not unduly influenced by heat input. The bulb should be in position of good circulation of the heated (or cooled) medium, and where it will not be subject to mechanical damage. The full length of the bulb must be acted on by the temperature of the controlled medium, otherwise the factory calibration may be affected.

MOUNTING

The position of installation (vertical, horizontal, etc.) is not important except that it is recommended that position be such that the adjustment is readily available and the gages can be easily seen.

When installing, the wrench **MUST** be placed on the bushing between the thermo element and the body casting, **NOT** on the hex section of the body itself. Failure to observe this precaution may result in damage to the instrument.

THERMO ELEMENT: For best temperature response and closest control, use the standard bulb directly in the material under control (without bulb well).

If corrosion, abrasion, or higher pressure conditions require, use stainless steel bulb well No. 97181 A1 (max.

non-shock pressure 1000 psi at 150° F., 750 psi at 350° F.). For best temperature response when well is used, introduce enough copper or aluminum powder into the well to fill the space between bulb and well completely.

Where bulb is installed in a duct, or light sheet metal oven, tank or container, use brass duct flange No. 20762.

PILOT SUPPLY

Connect supply side(s) to a constant supply of clean, filtered air, gas, or fuel oil.

The standard FulTrol is calibrated and set for supply pressure of 20 psi; however, the instrument will operate satisfactorily with supply pressures up to a maximum of 40 psig. Unless **FILTERED** supply at **CONSTANT** pressure is already available, use combination Filter-Dripwell Reducing Valve No. 97478 as shown in Figures 2 through 4.

Filter must be “blown down” periodically to remove accumulated dust, moisture and oil.

Connect output pressure side (O) to the Final Control Element (control valve, etc.). See Figures 2 through 4.

If used on a hydraulic control setup, remove plastic 1/4” pipe plug, and connect a vent line to drain or other return point.

SECTION IV – OPERATION

The bulb is installed at the location where temperature is to be maintained and with the bulb immersed in the medium being controlled.

A change in temperature at the bulb positions the thermal valve which varies the output control pressure applied to the control valve (or other final control device). Control is modulating in action.

The speed of control action is affected by the total volume of the final control element (control valve) etc., and the connecting piping. It is important to keep the air volume of the control system as low as practical.

When set for narrow proportional band, the maximum rate of air (or liquid) input into the control system is lower and therefore the response to temperature rise when using direct-acting FulTrol, or temperature fall when using reverse-acting FulTrol, is slower than the wide proportional band setting.

Faster control action may be achieved on pneumatic system by using a CR-100-A1 volume booster relay in the control system. Its use is recommended wherever long transmission lines are involved or where a larger volume of control air is required, as in the case of two control valves (Fig. 4).

SECTION V – ADJUSTMENTS

Set supply pressure regulator at 18-20 lbs. Turn adjusting screw on top of regulator (while covering "vent" connection on Fultrol with finger) until supply gage reads 18-20 psi. Lock setting of regulator with jam nut.

Turn on supply of heating or cooling medium, etc., so process can start to work under control of the final control element (valve, etc.).

Turn adjustment of Fultrol to desired setting.

Allow process or equipment to operate until action of control system has become consistent.

1. To Correct for Initial "Over-Shoot" or "Under-Run:"

Widen the proportional band as described in Paragraph 5. This will help to eliminate over-shoot or under-run, but will introduce a slightly longer "heat-up" (or "cool-down") time on "batch" processes, etc.

2. To Correct for Continuous "Hunting" or "Cycling:"

This action is due to: (a) thermal lag in controller, control system, or process; and/or (b) too great sensitivity of control system. Wider (longer) proportional band (see Paragraph 5) will make control system more stable and tend to prevent cycling or hunting. Change proportional band setting just enough to eliminate cycling.

3. To Reduce "Offset" (Droop) of Control:

"Offset" or "Droop" from the desired temperature ("setpoint") is the natural result of the change in temperature required to correct for load changes. Narrowing the proportional band (see Paragraph 5) will reduce the amount of "offset."

4. Temperature Adjustment:

To change temperature setting, simply turn the adjusting knob in the direction indicated by the calibrations on the dial. Dial accuracy is dependent upon the setting of the proportional band adjustment (when set for wide proportional band, dial calibrations may not be completely accurate over the full range).

5. Proportional Band Adjustment:

Factory setting of proportional band gives 3 to 15 psi output pressure change on approximately 10° F. temperature change on the "bulb" (at 20 psi constant supply pressure). To decrease (shorten) the proportional band, turn Proportional Band Adjustment Screw (see Figure 5) in clockwise direction. To increase (widen) proportional band, turn adjustment in counterclockwise direction. The setting for a 5° proportional band is found by turning the Proportional Band Adjustment Screw 1/2 turn counterclockwise from the "closed" or "stop" position. This is only an approximation and may require turning the adjusting screw clockwise or counterclockwise in small increments until the 5° proportional band is obtained. Approximately one additional counterclockwise turn gives the full 5 to 25° adjustment of proportional band.

6. To Lock Adjustment:

Tighten adjustment lock screw (Figure 5) with Allen wrench provided. Insert Allen wrench through hole in lower side of dial plate.

7. Calibration Procedure: (For direct-acting type, 50°-250° F. range, 10° F. proportional band).

Mount instrument so that bulb is completely immersed in water, oil, etc. The temperature of this medium should be variable over a suitable range, and should be held fairly constant over the full length of the bulb with thorough agitation or stirring. Place a reliable thermometer near the bulb to measure the temperature of the medium so that an accurate average bulb temperature is shown. Connect pilot supply medium (air, light oil), as in service, and plug the output outlet connection "O." Set supply pressure at 18-20 psi and hold constant during calibration.

- (a) Bring bulb temperature to 150° F. and hold until stable for 2 or 3 minutes.
- (b) Turn adjusting knob slowly until control pressure reads 9 psi.
- (c) Loosen set screw on adjusting knob, reset knob to read 150° F. on dial, and retighten set screw.
- (d) Raise bulb temperature until control pressure reads 15 psi. Hold until stable. Record this temperature.
- (e) Lower bulb temperature until control pressure reads 3 psi. Hold until stable. Record this temperature.
- (f) The temperature difference between (d) and (e) is the proportional band.
- (g) If proportional band is more than 10° F. \pm 1°, turn proportional band adjusting screw (see Figure 5) clockwise. This reduces differential.
- (h) If differential is less than 10° F. \pm 1°, turn adjusting screw counterclockwise. This increases differential.
- (i) After differential is set at 10° F., \pm 1°, return bulb temperature to 150° F.
- (j) Turn adjusting knob until control pressure reads 9 psi.
- (k) Loosen set screw on knob and reset knob at 150° F. on dial. Tighten set screw firmly.

Calibration of reverse-acting type is accomplished exactly the same as with direct-acting type outlined above, except the 15 psi control pressure referred to in step (d) will be attained on lowering bulb temperature. The 3 psi control pressure referred to in step (e) will be attained on rising bulb temperature.

Calibration of the 150° F.—350° F. range Fultrol is carried out exactly as with the 50° F.—250° F. range instrument, except the mid-range calibration should be carried on at 250° F. (with bulb in oil). If preferred, calibration may be done with bulb in water at 200° F., and with adjustment set at 200° F.

8. To Reverse Action In Field:

To change the action of Fultrol Pilot from direct (rising bulb temperature increases control pressure) to reverse, or from reverse (rising bulb temperature decreases control pressure), to direct, follow this procedure:

NOTE: The instrument should be dismantled from operating position. If necessary, the change in action can be made with thermal element installed in pipe, tank, etc.; however, in this case the initial installation must provide pipe unions or copper tube couplings in close proximity to Supply, Control, and Vent connections to the Fultrol.

- (a) Using suitable end wrenches (not pipe wrenches) loosen instrument body from thermal assembly by means of hexagonal surfaces provided.
- (b) Disengage thermal assembly from body, leaving spring and spring seat (Figure 1) in place.

- (c) Remove valve seat and poppet (Figure 1) from valve body, carefully noting position and order of disassembly.
- (d) Invert poppet relative to valve seat by merely turning poppet end for end and reinserting on opposite side of valve seat.
- (e) Replace poppet and valve seat, making sure that the valve seat is oriented in the same relative position as before disassembly. Care should be taken to see that the end of the poppet fits into drilled hole in the end of the stem guide (Figure 1).
- (f) Re-engage thermal assembly with valve body and tighten.
- (g) The calibration should be checked according to instructions found under Calibration Procedure, Paragraph 7, since disassembly in the field will upset the original calibration of the instrument slightly.

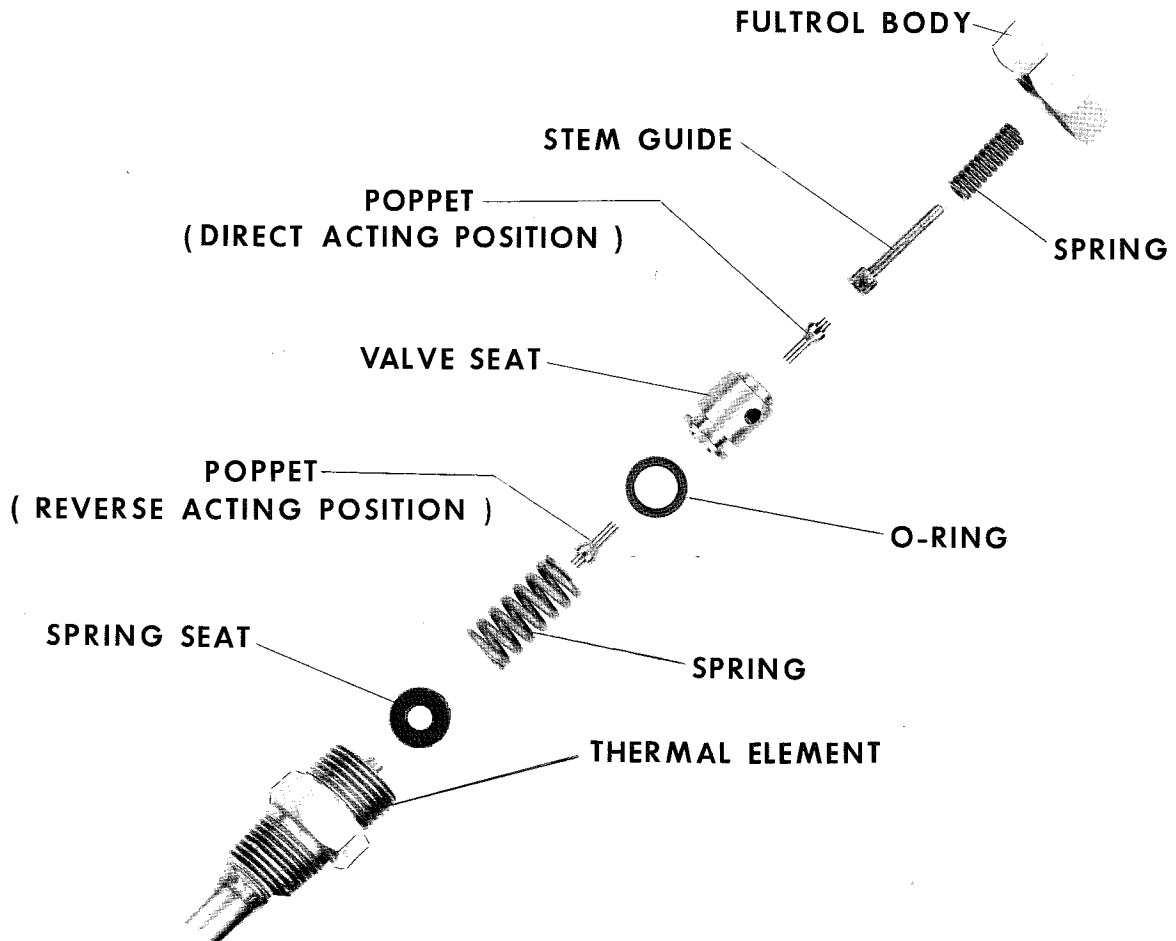


Figure 1

SECTION VI – MAINTENANCE

NORMAL MAINTENANCE

This regulator if properly installed and used should require very little attention or maintenance.

TROUBLE SHOOTING

1. If “supply” gage reads less than 18-20 lbs., clean filter or strainer in supply line. Try readjusting supply pressure regulator.
2. If supply pressure is correct, slowly turn adjusting knob of FulTrol pilot above and below the actual temperature on the bulb. “Output” pressure should increase and decrease thru 0 to 18 lbs. range in response to movement of adjustment.
3. If “output” pressure varies properly as adjustment is moved, trouble lies in pilot supply lines or in the final control element (valve, etc.).

4. If “output” gage reads 0 or low pressure at all times, shut off supply pressure, remove Proportional Band Adjustment Screw (Figure 5), and wipe it off. Turn on supply pressure to blow out accumulated dirt, etc. and replace adjustment screw. If considerable dirt, oil, etc. is found, the FulTrol pilot should be disassembled (as described in Paragraph 8), cleaned out thoroughly and reassembled carefully.
5. If “output” pressure remains high (12-15 lbs.), the pilot valve or the vent hole is probably stopped up (due to excessive dirt, gum, etc.) or there has been an internal failure of the controller mechanism. Disassemble, clean and examine as in 4. above.

NOTE:

When corresponding with the factory concerning this instrument, please refer to the complete instrument number stamped on the dial plate.

SECTION VII – TYPICAL APPLICATIONS

Shown below are a few typical applications of FulTrol. In all cases the temperature sensing element of bulb of FulTrol would be placed in medium whose temperature is being controlled.

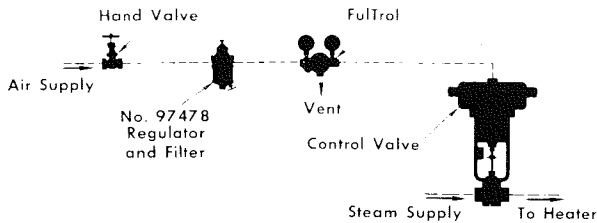


Figure 2, HEATING — Using reverse-acting type FulTrol and reverse-acting control valve.

Control valve closes on temperature rise at FulTrol sensing element. Should pilot air supply fail, valve will close.

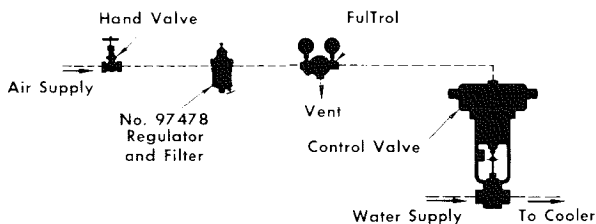


Figure 3, COOLING — Using reverse-acting type FulTrol and direct-acting control valve.

Control valve opens on temperature rise at FulTrol sensing element. Should pilot air supply fail, valve will open.

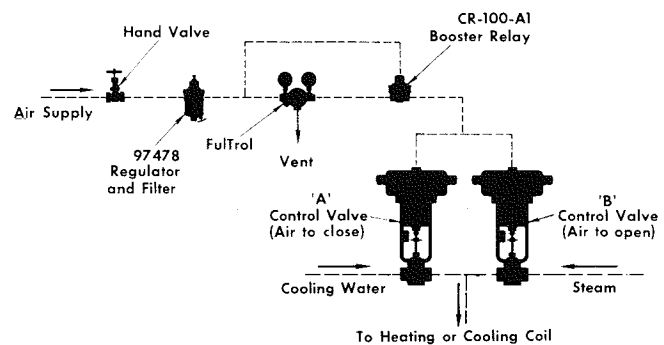


Figure 4, HEATING AND COOLING — Using a direct-acting type FulTrol and one direct-acting (A) and one reverse-acting (B) control valve. Provides temperature control of a solution that must be heated to a certain temperature and then maintained at that temperature by a cooling means. Example: Chrome plating process. Valve (A) closes when temperature of solution at FulTrol sensing element approaches desired temperature. Valve (B) is set to start to open after valve (A) heating control closes and then governs cooling supply to maintain solution at temperature for which FulTrol is set. This control principle can be used for other applications requiring heating and cooling. Numerous FulTrol and valve action combinations can be used to give sequence operations as may be required.

SECTION VIII – PARTS LIST

97234 (0-30 PSI, 0-2.1 Kg/cm²) 97233 (0-30 PSI, 0-2.1 Kg/cm²)

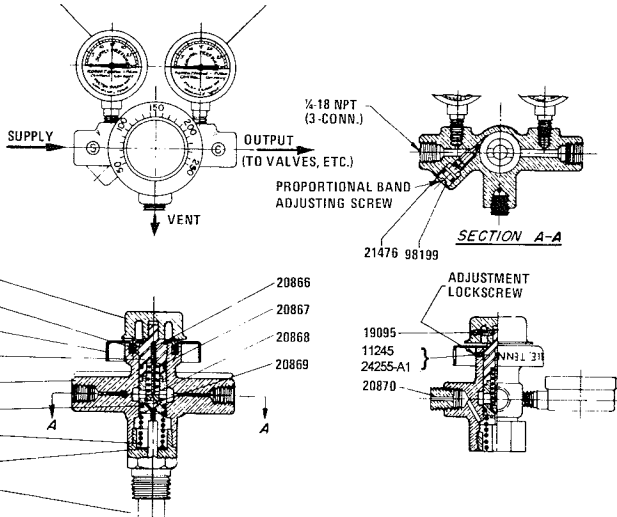


Figure 5

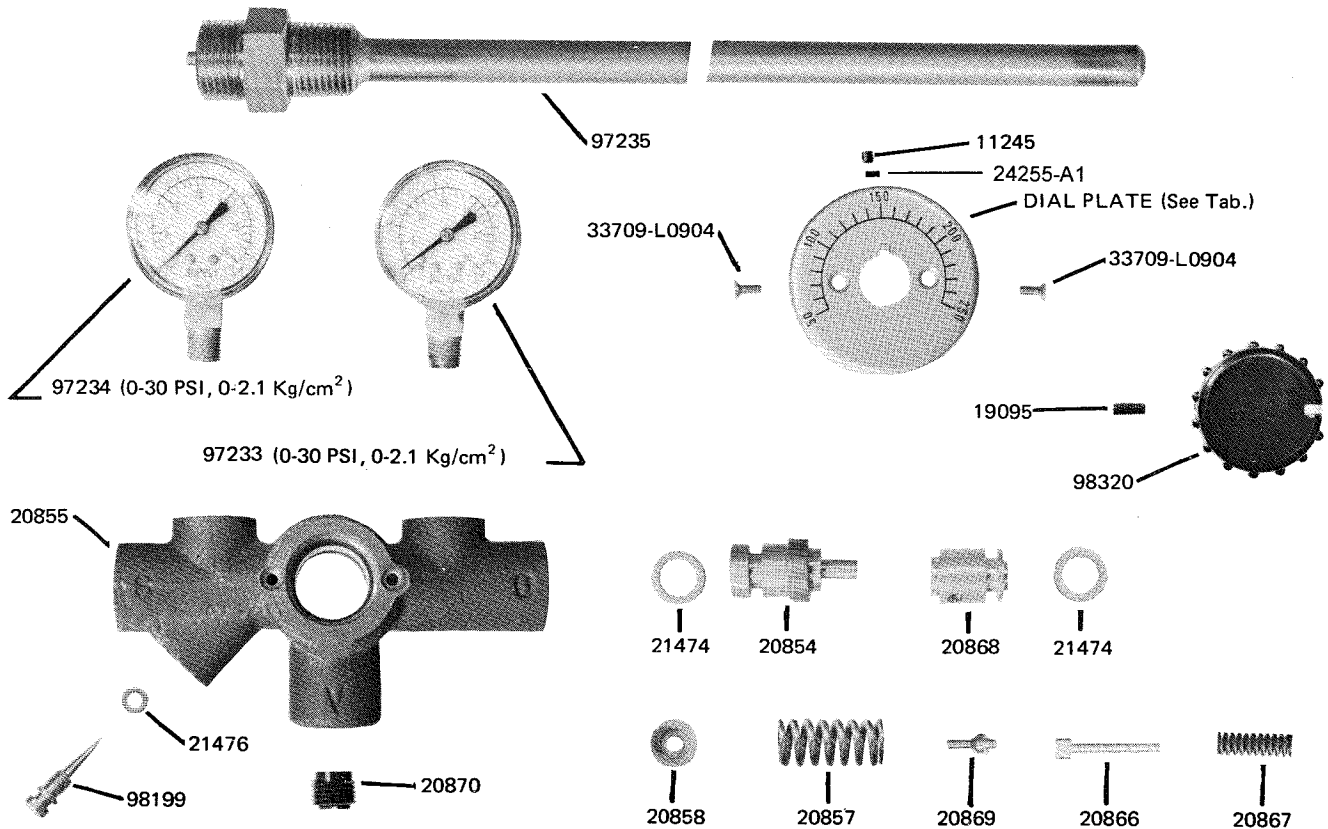
A - SERIES

PART NO.	DESCRIPTION
97234**	Gage, Supply (0-30 psi & 0-2.1 kg/cm ²)
97233**	Gage, Output (0-30 psi & 0-2.1 kg/cm ²)
98320	Knob (includes 19095 Set Screw)
33709-L0904	Machine Screw (2 required)
See Tab.	Dial Plate
20854	Stem
20855	Body
21474**	O-ring (2 required)
20857	Spring
20858	Spring Seat
97235	Bulb Assembly
20866	Guide Stem
20867	Load Spring
20868	Valve Seat
20869	Poppet
21476**	O-ring
98199**	Adjusting Screw
19095	Set Screw
11245	Set Screw
20870	Plug, Vent (with bleed hole)
24255-A1	Disc, Nylon

** Recommended spare parts.

DIAL PLATE

RANGE	PART NO.	RANGE	PART NO.
-50° to 150° F	23128-A3	(___)° F	21366
50° to 250° F	20853	10° to 120° C	23363-A1
150° to 350° F	20893	(___)° C	21366





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