Technical Data

SPENCE ENGINEERING COMPANY, INC. 150 COLDENHAM ROAD, WALDEN, NY 12586-2035

TYPE P60
REDUCED PRESSURE PILOT

SPECIFICATIONS

Process & Air Connections ..... ¼" FNPT
Air Consumption ..... Maximum, 0.2 SCFM
Normal, 0.1 SCFM
Ambient Temperature Limits ..... -40° to 180°F
Weight ..... 8½ lbs.
Proportional Band ..... Adjustable, 2 - 200%
Control Action ..... Reverse or Direct (Adj.)
Control Mode ..... Proportional + Reset (PI)
(P, PD or PID Optional)

OUTPUT

- ☐ 3 - 15 PSIG
- ☐ 3 - 27 PSIG
- ☐ 6 - 30 PSIG
- ☐ 12 - 60 PSIG

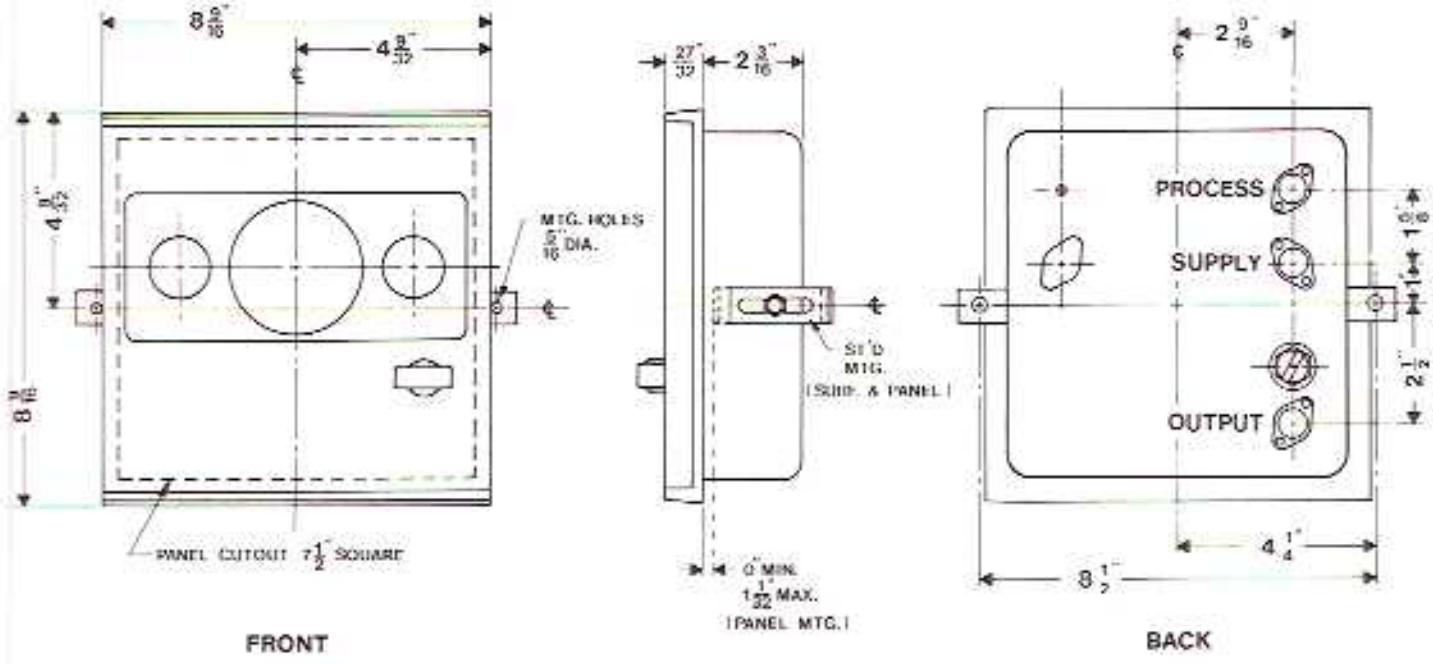
CONTROL RANGE

- ☐ 0 - 15 PSIG
- ☐ 0 - 30 PSIG
- ☐ 0 - 60 PSIG
- ☐ 0 - 100 PSIG
- ☐ _____

The Spence Type P60 pilot is an instrument quality controller which produces a pneumatic output. The standard pilot provides a proportional plus reset control mode with a 3 - 15 PSIG output signal. Other control modes and output ranges are available as shown at left.

The combination of a Type P60 pilot and a Type EA series regulator produces a Spence Type EAP60 series pressure regulator. This regulator will reduce a fixed or varying initial pressure to a constant, adjustable delivery pressure. This pilot is also applicable to Type CA series regulators and Type R and Type G series main valves.

The Type P60 also finds application in switchover (automatic transfer) PRV's, both as a primary controller and as a safety pilot.



FRONT

BACK

SCOPE

This form provides installation, operation and maintenance instructions for Spence Type P60 and Type T60 pilots with proportional plus reset control modes.

NOTICE

Alternate means — safety valves or safety pilots, for example — may be required to protect the system should this pilot malfunction. Consult the local and national governing codes.

RETURN OF EQUIPMENT

If it becomes necessary to return equipment, attach a tag with your return address and a description of the problem.

For returns within the warranty period, ship the unit directly to Spence Engineering Company, Inc., 150 Coldenham Road, Walden, NY 12586. If the unit is out of warranty, ship it directly to Ametek Controls Division, 860 Pennsylvania Boulevard, Feasterville, PA 19047.

INSTALLATION

MOUNTING OF CASE

The instrument should be mounted vertically on a panel or wall where it will be reasonably free from vibration shock and large fluctuations of temperature. Brackets for panel and surface mounting are standard.

OUTPUT CONNECTION

A porous metal output filter is supplied in the output connection of all multi-mode controllers. If the output of the controller is fed directly to a valve, the filter may be discarded. If the output is fed to a valve positioner or to a small valve, the filter should be left in the output as it contributes to control stability at proportional bands greater than 100%. For operation at narrower bands and where speed of response is important, the filter may be removed.

SUPPLY CONNECTION

BEFORE APPLYING SUPPLY AIR, REFER TO PRESSURE LIMIT LABEL ATTACHED TO RELAY.

Instrument requires clean, dry, oil-free air. Each controller should be supplied through a standard instrument dripwell-filter and a reducing regulator with automatic relief valve. The supply pressure must be regulated at:

OUTPUT RANGE (PSIG)	SUPPLY PRESSURE (PSIG)	MIDSPAN OUTPUT (PSIG)
3 - 15	20	9
3 - 27	35	15
6 - 30	35	18
12 - 60	65	36

TABLE 1

Avoid getting dirt, pipe scale, burrs, chips, oil, pipe compound or any foreign matter into supply air lines as these may render instrument inoperative.

PROCESS CONNECTION
P60 PILOT (Pressure Controller)

BEFORE APPLYING PROCESS REFER TO PRESSURE LIMIT LABEL ATTACHED TO INSTRUMENT.

Pressure connection is ¼" NPT (std).

In a pressure controlled process, the pressure tap must be in a representative location and should not tend to become air bound or water logged as these actions will tend to give erratic and erroneous measurement which will in turn cause erratic control. SEE ELEVATION ADJUSTMENT.

PROCESS CONNECTION
T60 PILOT (Temperature Controller)

Install bulb in piping or apparatus at a point where good circulation or agitation is assured. This will keep lags to a minimum and will assure best possible control.

When bulb is of union or separable socket type, install union hub or socket into the equipment first, then insert bulb and lock in place with attached swivel nut. Avoid sharp bends or kinks and never cut connecting tubing.

ELEVATION ADJUSTMENT

INSTRUMENT SHOULD BE FREE OF TRAPPED AIR OR VAPOR BEFORE MAKING ELEVATION ADJUSTMENT.

When a correction is necessary, the process and setting pointers must be moved upscale when the instrument is above the process line and downscale when below until it reads line pressure instead of pressure at instrument level. The correction amounts to 1 PSI for 27.7" H_2O (6,9kPa) and is proportional to the specific gravity of other liquids.

INTERIOR VIEW

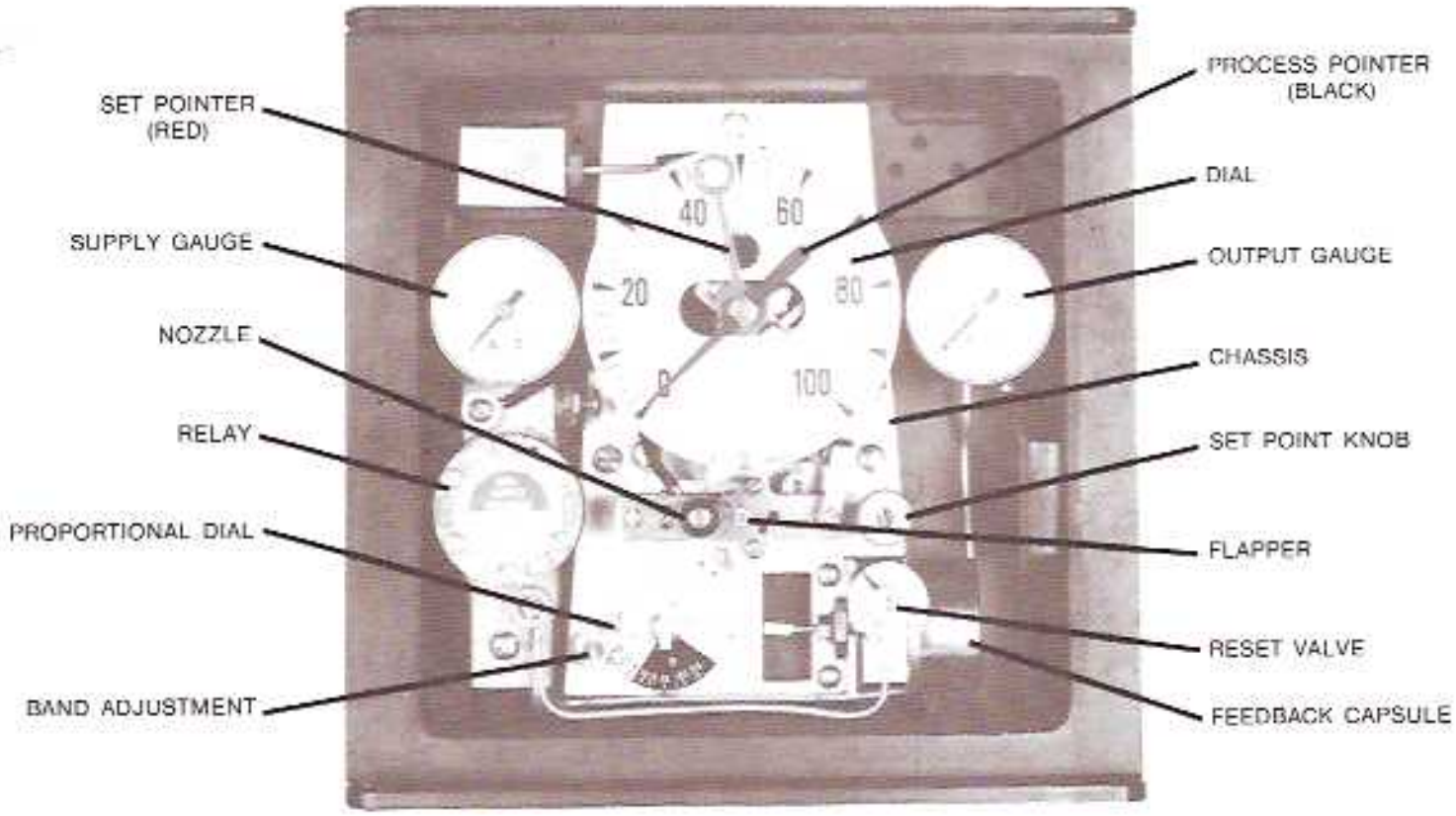


FIGURE 1

CONTROL ACTION

SELECTING ACTION

Determine whether a rise in pressure or temperature should open or close the valve. Position the nozzle as shown in **Table 2** and rotate the proportional dial so that the green pointer is in the "A" or "B" sector for a given controller.

Type EA and Type CA series regulators and Type R series control valves have an air-to-open action. Type G series control valves and air-operated desuperheaters require air-to-close.

REVERSING ACTION

Supply air to controller is necessary for this operation. Loosen nozzle screw one half turn and rotate nozzle until it is pointing squarely at flapper blade. Tighten screw. Turn proportional dial to appropriate zone.

If output gauge does not show full supply pressure when flapper is held against nozzle, readjust nozzle.

IF AN INCREASE IN PRESSURE OR TEMPERATURE MUST	AND THE ACTION OF THE VALVE IS	THEN THE ACTION OF THE CONTROLLER MUST BE	AND THE NOZZLE POSITION MUST BE	AND THE GREEN POINTER IN ZONE
CLOSE VALVE	AIR TO CLOSE	DIRECT		B-BLACK
OPEN VALVE	AIR TO OPEN			
CLOSE VALVE	AIR TO OPEN	REVERSE		A-WHITE
OPEN VALVE	AIR TO CLOSE			

TABLE 2

SCHEMATIC

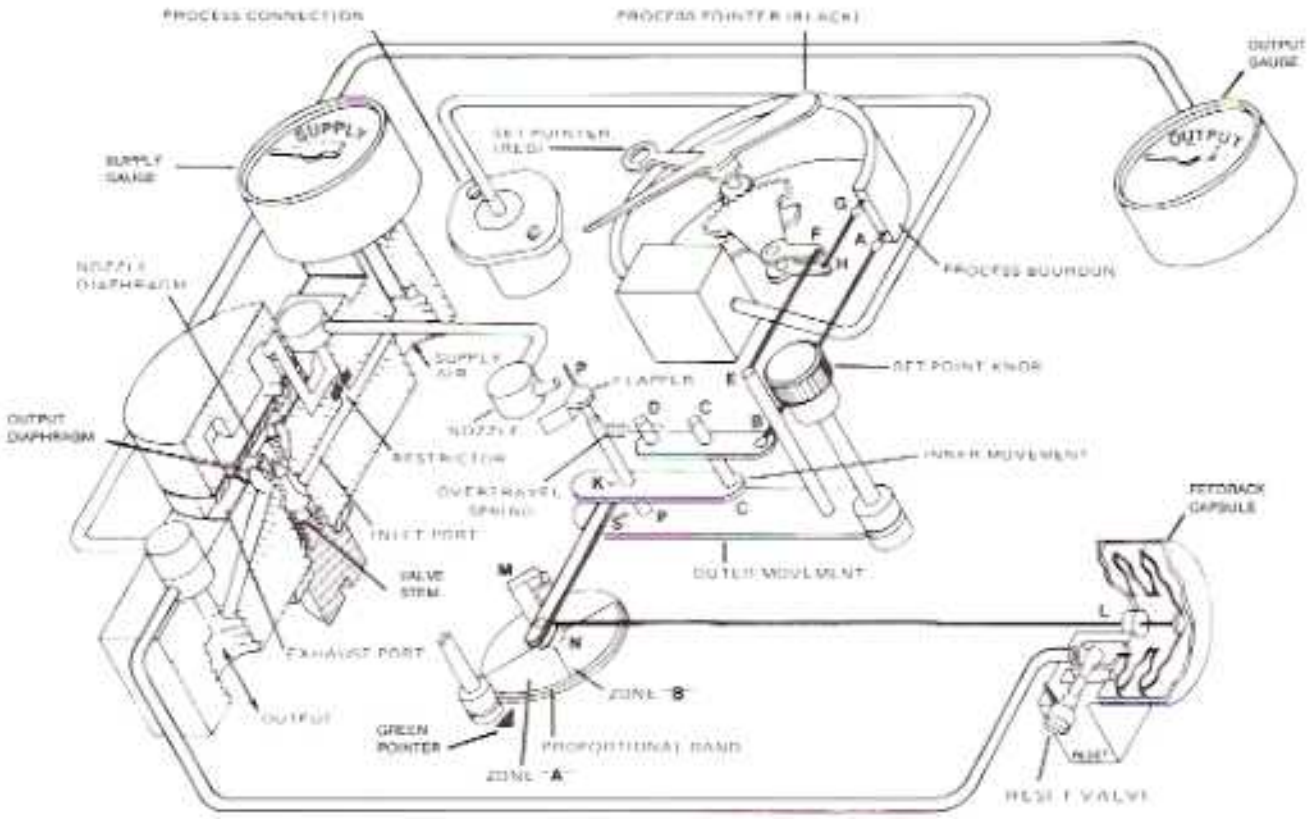


FIGURE 2

PRINCIPLE OF OPERATION

Control point setting is accomplished by turning the set point knob to swing the entire outer movement up or down around pivot **S**. The setting motion is fed to the indicating movement by line **EF** and is shown by set pointer (red).

The low bleed relay is in equilibrium as long as the process is not changing. A change in the process causes a change in the flapper nozzle gap thus producing a change of nozzle back pressure which changes the force exerted by nozzle diaphragm. The resulting force imbalance causes the valve stem to move to a new position either opening the inlet port allowing supply air to enter the output or opening the exhaust port exhausting output air. Either of these changes continue until the force developed by the output diaphragm balances the force of the nozzle diaphragm and equilibrium is restored.

The function of the reset action is to eliminate the proportional offset between the measuring process and the setpoint and to accomplish this in the shortest possible time without creating instability in the proportional control action.

When the reset valve is shut, the reset action is eliminated and the controller operates as a proportional instrument. When the reset valve is set to the proper restriction, the reset restriction and reset chamber form a resistance-capacity network which at first delays the balance across the capsule, but, in a definite time period, produces equilibrium and restores the process to the set point.

With a decrease in process pressure the following occurs:

1 - Process pointer (Black) rotates counterclockwise (ccw) from a downward motion of **GH**.
2 - Lever **BCD** rotates clockwise (cw) from a downward motion of **AB**.
3 - Arbor **PP** rotates ccw causing flapper to restrict nozzle flow.
4 - Supply pressure feeding thru restrictor expands nozzle diaphragm.
5 - Inlet port opens and exhaust port closes.
6 - Output pressure on output gauge increases.
7 - Feedback capsule expands moving link **JL** to the right.
8 - Proportional link **NM** pivoting about **M** causes link **JK** to move upward.
9 - Lever **KC** rotates cw about **P** causing lever **BCD** to rotate ccw about **B** producing flapper motion offsetting input motion.
10 - Equilibrium is reached with the change in output proportional to the change in input.

MANUAL CONTROL AND START UP

Some processes must be brought up to control point manually as the first overshoot on start up may be well beyond permissible limits. In addition, manual operation of process provides a means of diagnosing difficulties in the process which might ordinarily be attributed to the controller.

TO START UP MANUALLY

Open reset valve full by turning reset knob clockwise to stop. Note controller action (direct or reverse). If direct acting, set red pointer well below black pointer and desired value. If reverse acting, set red pointer well above black pointer and desired value. This will cause controller to put out full output pressure. Adjust regulator manually by adjusting air supply regulator. When process is under control, note air output pressure.

TO SWITCH TO AUTOMATIC

Shut reset valve by turning reset knob counterclockwise to stop. Move red pointer back toward desired value until output pressure just drops. Restore full air supply pressure. To correct valve, adjust red pointer to be sure output pressure is brought to exact value noted during manual control.

Tuning procedure for proportional + reset controllers may now be followed. If instrument is already tuned, reset valve may be set at previously determined value.

TUNING CONTROLLER TO PROCESS

Note action of controller (reverse or direct). Set red pointer 30% above black pointer if direct, 30% below black pointer if reverse acting. Open reset valve fully by turning clockwise to stop. Hold for a few seconds, then set reset dial between 0.2 and 0.5 minutes per repeat. Set proportional band at 50% (green pointer).

Turn on supply air. Output of controller should remain zero. Drain dripwell through its drain valve. Adjust regulator to required supply pressure.* Set red pointer to coincide with black pointer. Output will slowly increase. When output reaches mid-span*, quickly turn reset dial counterclockwise to stop. Output should hold at mid-span. Instrument is now operating as a proportional controller. Set red pointer to desired value.

Watch control operation. If controller variable cycles, widen proportional band in steps until stable. Note period of oscillation of controlled variable when red pointer is moved a small amount up or down. The period is the time between two maximum or minimum peaks. If controlled variable is sluggish and wandering, reduce proportional band setting in steps, until controlled variable is jittery or cycles a bit. Note period of cycling in minutes.

Increase proportional band to 2-2½ times the band setting which was obtained by preceding method. Reset valve may be set for the same time as the period of cycling.

The above settings are suggested values and may be varied depending on the specific requirements of the process. For more stability, widen proportional band and/or increase the reset time. If process is too sluggish, reduce proportional band and/or reset time. Note that a little less than optimum reset time may cause cycling while even three to four times optimum may make little difference. This is particularly true for processes with slow load changes.

After process has stabilized, the red and black pointer may not be coincident. To synchronize, hold hex hub of red pointer with 0.25" wrench and turn pointer, pushing it near its center to avoid bending it.

* See Table 1

TROUBLE SHOOTING

PROCESS

When it is indicated that the difficulties are in the process (by manual control method or other diagnosis), a systematic check procedure is suggested.

LOW OUTPUT PROBLEMS

Check leakage in the nozzle line connections at the nozzle and at the relay. If satisfactory, remove flexible tubing from relay and close hole with finger. If pressure increases, the problem is in the nozzle assembly. Remove nozzle assembly. Clean or replace as necessary. If pressure does not increase, the problem is in the relay. SEE MAINTENANCE – RELAY.

HIGH OUTPUT PROBLEMS

Move flapper away from nozzle. If output decreases, check friction in shaft, linkage and overtravel spring. If output does not decrease remove nozzle's flexible tubing at relay. If output decreases, the problem is in the nozzle assembly. Remove nozzle assembly and clean or replace as necessary. If output pressure does not decrease when the nozzle line at the relay is open, the problem is in the relay. SEE MAINTENANCE – RELAY.

OUTPUT CYCLING PROBLEMS

This difficulty will manifest itself by the appearance of process cycling when there had been none before. Before proceeding with any other checks, increase the proportional band setting to determine if this stabilizes the process. If it does, go through the TUNING PROCEDURE. If widening the band does not help, the feedback may be inoperative.

Set the proportional band at approximately 5%. Rapidly change set point around black pointer and observe output motion of the feedback assembly. A clogged tube or broken feedback will show no output motion.

The reset feedback assembly may have a leak in the reset valve which would equalize the pressure between the reset chamber (outside capsule) and the inside of the capsule immobilizing the feedback. To remove and clean the reset valve, see MAINTENANCE – FEEDBACK CAPSULE.

MAINTENANCE

GENERAL

Drain dripwell as required to prevent accumulated water from entering instrument.

At regular intervals:

Push nozzle orifice cleaner button in the side of the relay.

Verify process pointer calibration, as process conditions may cause overranging.

Check connections inside and outside instrument and mounting bolts for tightness, especially under vibration conditions.

RELAY (Fig. 3)

REMOVAL

Disconnect supply and output piping. Remove flexible tubing from nozzle connection and feedback connection.

Also remove flexible tubing from output gauge connection. Remove four mounting screws on back of case.

SERVICING

Should the exhaust or inlet port become fouled with dirt, there will be an audible leak during control. To determine which seat requires attention, move control point to obtain full output. If leak is audible, exhaust port requires attention. If there is no leak, move control point to obtain zero output. If relay leaks, inlet port requires attention.

The inlet port can be serviced by removing the cap nut at back of instrument. Do not lose the small spring in the cap. The valve stem can be removed and cleaned in solvent. The inlet port can be cleaned with a cotton swab dipped in solvent. The exhaust port seat can be serviced by removing the six mounting screws. Separating the diaphragm assembly from the relay may require some force, due to adhesion between the rubber and metal. (Do not damage the rubber diaphragm). Exhaust port can be cleaned with a cotton swab dipped in solvent.

PUSH-BUTTON ORIFICE

Remove from the relay block for cleaning using 0.50" open end wrench. Accumulations of grease, dirt and oil may be removed by soaking in a suitable solvent. When reinstalling, tighten just enough to insure no leakage around metal seat at tip end.

When the relay is reassembled to the instrument, check by opening and closing the nozzle manually. Output should go to full supply value and to zero.

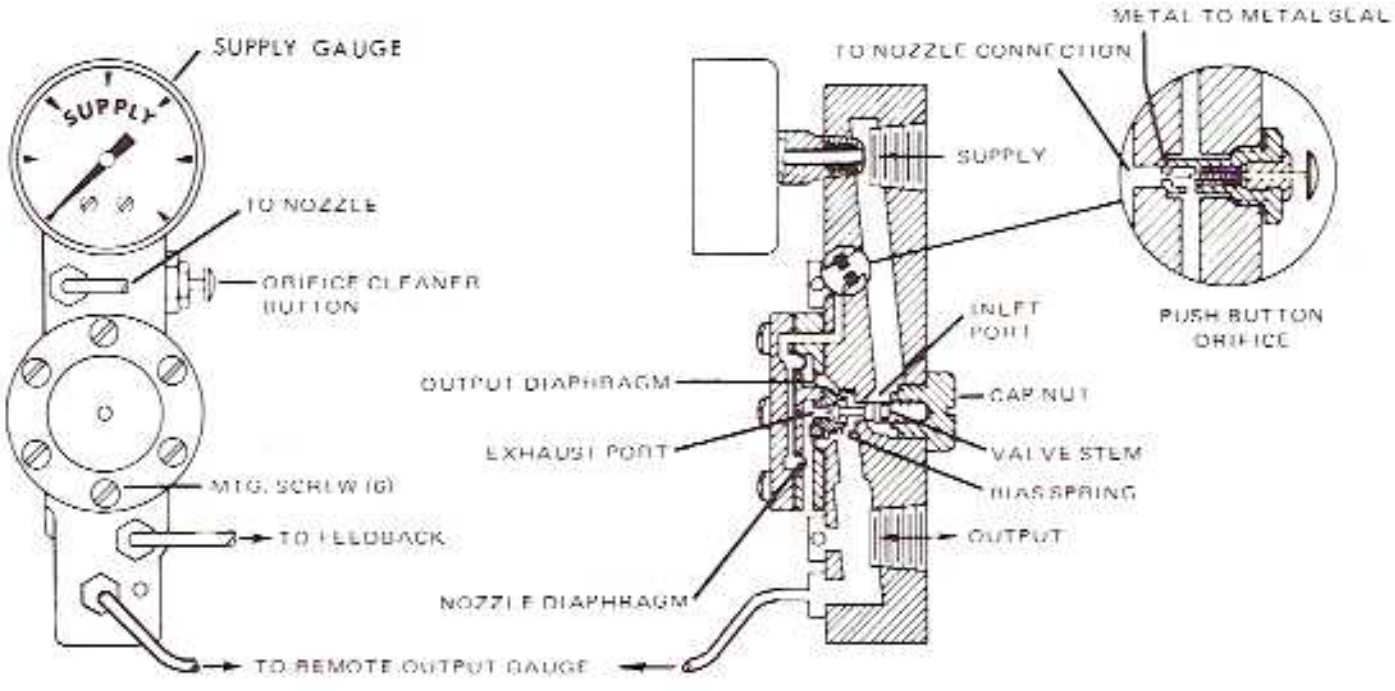


FIGURE 3

FEEDBACK CAPSULE (Fig. 4)

To replace Feedback Capsule – unhook link at proportional band dial. Remove feedback line from relay. Remove two reset block mounting screws. Replace in reverse order. See ALIGNMENT for pointer adjustment.

To replace Valve and Filter – loosen two valve screws (5 turns without removing). Pull up and rotate clockwise until tabs on valve are clear of the screw heads. Remove and replace in the reverse order.

To clean Valve and Filter – remove valve pin by disengaging tension spring from slotted end of pin. Clean seat and pin with suitable solvent. To remove filter, first remove bottom "O" ring. (Do not cut "O" ring on tension spring.) Remove filter and clean with solvent.

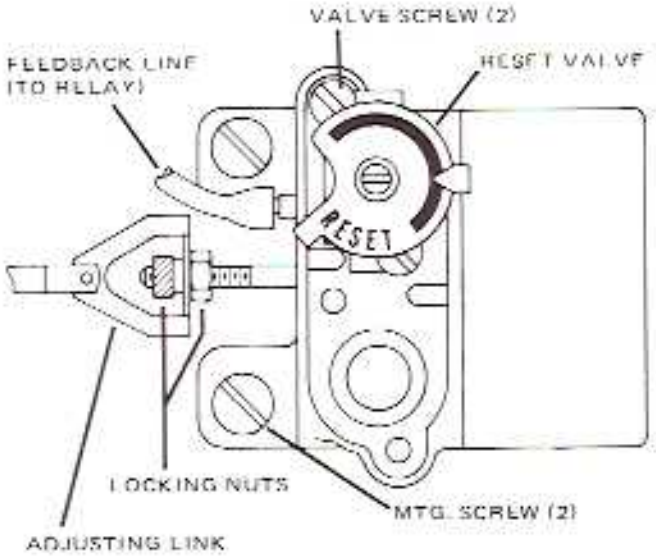


FIGURE 4

Alignment – with all components assembled and supply air on, proceed as follows:

1 - Set proportional band at 10%.

2 - Open reset valve by turning fully clockwise to stop.

3 - Set red pointer for full output.

4 - Reduce supply pressure until mid-span output is obtained.

5 - Shut reset valve by turning full counterclockwise (reset chamber now has mid-span output pressure trapped inside and controller will act like a proportional controller).

6 - Restore supply pressure to correct pressure.

7 - Move red pointer with setting knob until output pressure is at mid-span.

8 - Turn proportional band to maximum setting. Output pressure should not change more than 10% of output span.

9 - To obtain mid-span output pressure, loosen locking nuts and move adjusting link to the left or right. Tighten locking nuts.

10 - Return band to 10%.

11 - Repeat steps 7 thru 10 until output does not vary more than 10% of output span when the proportional band changes.

12 - If red pointer does not coincide with black pointer at mid-span output, hold red pointer hub with 0.25" wrench and turn red pointer until it coincides (apply torque near hub to avoid bending pointer).

MEASURING ELEMENT

All bourdon tube, metal diaphragm and temperature measuring elements are interchangeable.

CALIBRATION AND TRACKING INSTRUCTIONS

All measuring elements are calibrated using the same adjustments on the indicating movement. To make these adjustments, the dial must be removed. The dial can be removed without removing the pointers: (1) Align the red and black pointers using the set knob, (2) Loosen the two dial screws and (3) Manipulate the elliptical center hole over the pointers.

CALIBRATION OF ELEMENT (Figure 5)

1 - Select three pressures or temperatures at or near: the lower end, the center and the upper end of the dial range. For future reference, these will be known as values **Po**, **Pc** and **Pu**.

2 - Disconnect the control link (closest to chassis) at its upper end. Spring the retainer clip open just enough to disengage the ball from bearing hole.

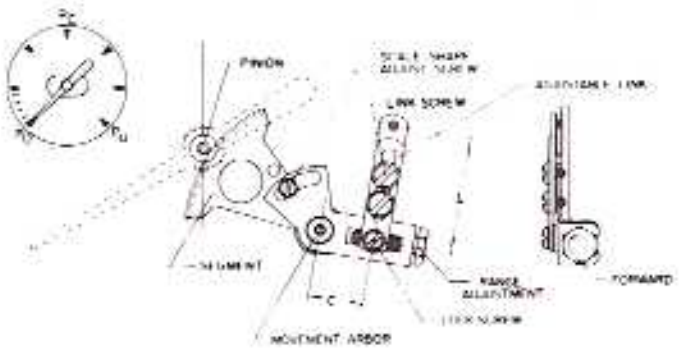
3 - Apply **Po** (lower end of range) to the element and note black pointer reading. If it does not read correctly, hold the hex hub of the pointer with 0.25" wrench and turn pointer to proper value. CAUTION: Apply torque near center of pointer to avoid bending it.

4 - Apply **Pu** (upper value of scale) to element. Note pointer reading. If pointer reads too high, dimension C must be increased. If the pointer reads too low, dimension C must be decreased. Remove dial and make adjustments as follows:

a - To increase C: loosen lock screw 1/4 turn and turn range adjust hex forward. For each percent of error, hex should be turned about 1/4 turn. Make proper adjustment. Tighten lock screw.

b - To decrease C: loosen lock screw 1/4 turn and turn range adjust hex back 1/4 turn for each percent of error. Tighten lock screw.

5 - Replace dial and apply **Po**. Reset black pointer to proper reading, apply **Pu** and note reading. Make adjustments as described in 4 above. Continue adjusting and testing as per 4 and 5 until pointer reads correctly at **Po** and **Pu**.



INDICATOR CALIBRATION

FIGURE 5

6 - With dial in place, apply **Pc** (at center of range) to the element. If pointer reads low, link dimension L must be increased. If pointer reads high, L must be decreased. Remove dial and make adjustments as follows:

CALIBRATION OF ELEMENT (cont.)

a - Loosen link screw and lengthen or shorten link as required. Note resulting black pointer movement. For each percent of error at **Pc**, move black pointer about 90°. Tighten link screws.

b - Now restore black pointer to approximately original position by loosening scale shape adjust screw 1/2 turn and moving the segment. When pointer is back to original position, lock scale shape screw.

7 - Replace dial and apply **Po** to element. Adjust black pointer to read correctly. Apply **Pc** and **Pu**. Note errors.

8 - If error at **Pu** is twice error at **Pc** make only range adjustments (4 and 5). If not, make only scale shape adjustments (6 and 7) until the error at **Pu** is twice the error at **Pc**. Then make range adjustments per 4 and 5.

TRACKING OF POINTERS (Figure 6):

1 - Reconnect control link to element and turn on supply air. Trap mid-span output pressure in the reset chamber as described in TUNING CONTROLLER. Set band at 10% and proceed with steps 2 thru 5.

2 - Set element at **Po**. Move red pointer with knob to obtain mid-span output. Slip red pointer on its hub so that it points to **Po** and is coincident with the black pointer.

3 - Set element at **Pc**. Move red pointer with knob to obtain mid-span output. Note whether red pointer is above or below black pointer. Repeat for **Pu**.

FIGURE 6

4 - If red pointer reads below black pointer at **Pc** and **Pu**, dimension T must be decreased. If above, T must be increased. Remove dial and make adjustments as follows:

a - To decrease T (red pointer reads below black): loosen lock screw on the upper segment 1/4 turn and turn tracking adjust hex backward 1/4 turn per percent of tracking error at **Pu**.

b - To increase T (red pointer reads above black): loosen lock screw 1/4 turn and turn tracking adjust hex forward 1/4 turn per percent of tracking error at **Pu**.

5 - Replace dial. Set element at **Po** and repeat 2, 3 and 4 until red pointer coincides with black at mid-span output for all values of measured variable.

BOURDON ELEMENT (Figure 7)

To remove – remove two screws on back of case holding process connection block. Unhook long control link at its lower end. This is the back link, closest to the chassis. Remove shoulder screw to set point link. Remove three element mounting screws. The upper screw is reached through the dial. Reassemble in reverse order.

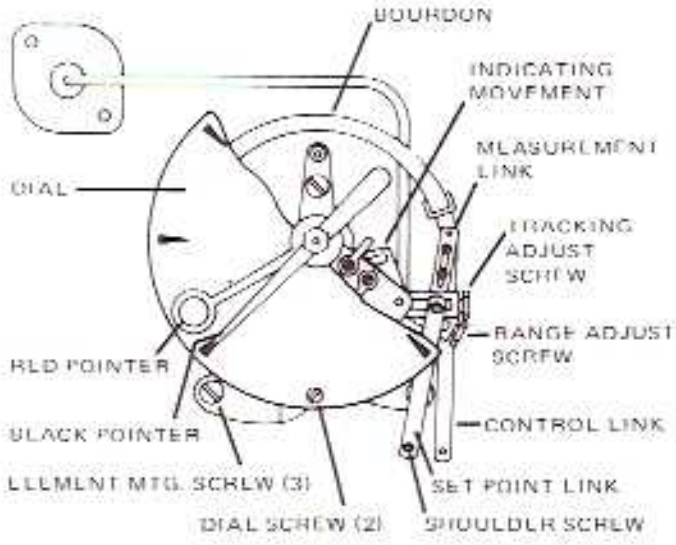


FIGURE 7

To clean – if pointer action is sticky, movement pivots and teeth are probably coated with gummy oil. This can be removed by soaking entire element in suitable solvent. CAUTION: Remove dial before immersing.

To disassemble – if movement is damaged (usually broken or twisted hairspring or worn teeth) it is necessary to disassemble element. Remove dial by loosening two dial screws. Remove movement by unhooking measurement link and loosening two movement mounting screws. If movement can be repaired, do not loosen range adjustment screws as indicator and tracking calibration will be retained thus requiring no calibration. Reassemble in reverse order.

To calibrate – use a test gauge of known accuracy to compare with black pointer readings. A dead weight tester is satisfactory if oil in element is not objectionable. See CALIBRATION AND TRACKING INSTRUCTIONS.