Operating Instruction OI/NAX-EN Rev. C

Models NAA, NAB, NAD
Pneumatic differential pressure transmitters

Deltapi N Series
A complete range of pneumatic pressure transmitters

Power and productivity
for a better world™

CONTENTS

INTRODUCTION

The Deltapi N series models NAA, NAB and NAD pneumatic differential pressure transmitters are designed for measuring the flow, pressure, differential pressure or level of liquids, steam, gas or air. The measured value is transmitted as a 0.2 to 1 Kgf/cm^2 or 3 to 15 lbf/in^2 or 20 to 100 kPa pneumatic signal to remotely mounted receiving equipment such as recorders, indicators or controllers or combinations of these items.
The relative ranges are:

NAA model

a) (3000 to 17000) mm H_2O, with 2 inch diaphragm
b) (500 to 5200) mm H_2O, with 3 inch diaphragm
c) (250 to 750) mm H_2O, with 3 inch diaphragm and with a special feedback bellows.

NAB model

a) (120 to 750) mm H_2O standard version
b) (60 to 120) mm H_2O with a special feedback bellows

NAD model

a) (3000 to 17000) mm H_2O, with 2 inch diaphragm
b) (700 to 5200) mm H_2O, with 3 inch diaphragm

In each of the above case the diaphragm capsule can stand an overload on either side equal to the maximum pressure rating of the transmitter.
The required measurement span, in accordance with the limitations as set down in the specification can be easily set by a screwdriver adjustment; refer to the models specification sheets.

TECHNICAL DESCRIPTION

The Deltapi N series models NAA, NAB and NAD transmitters are basically similar with the exception that different larger diameter diaphragm capsule are used.
The transmission unit is identical for the four types.

General description

For purpose of description the transmitter may be divided into two parts or units: the measuring unit, which detects the measured value and the transmission unit containing the pneumatic transducer.

Measuring Unit (Fig. 1A, 1B and 1C)

This unit comprises a liquid filled diaphragm capsule clamped between two body-half forgings one of which is the positive or upstream chamber and the other the negative or downstream chamber. Both forgings are clamped around the capsule by four or eight bolts, nuts and washers respectively for NAA, NAB and NAD. Each body-half is connection ported on two opposite edges the ports being threaded 1/4 inch NPT female. One port in each half is normally sealed by a plug. A pair of bolt on elliptical connection flanges.
Threaded 1/2 inch NPT female are supplied as standard. In addition each body -half forging contains a vent-valve assembly and drain plug.

The diaphragm capsule (fig. 2) comprises a ring shaped core or annulus (1) to which are welded two flexible metal diaphragms (2) both diaphragms being centrally linked by a tie bar(3) through the core. The capsule is liquid filled normally with silicone oil and sealed. Two "O" rings (4) within the capsule, on each side of the core serve to seal off further liquid flow within the capsule when the limit of diaphragm movement has been reached and thus protect the capsule against overload or underload.
A "U" shaped flexure (5) at the capsule center, within the positive chamber, connects to the transmission bar.
The transmission bar is clamped at its upper end to the fulcrum diaphragm where it joins to force bar of the transmission unit.
The lower end of the transmission bar is clamped to the capsule "U" flexure by a socket nut. The fulcrum diaphragm provides a fulcrum point for the transmission force bar assembly and also a flexible seal between the measuring and transmission units.
The materials used for the measuringunit are selected from the range given in the coding table and are chosen for compatibility with the characteristics of the measured fluid.
A mounting unit, bolted to the measuring unit, provides mounting facility for the transmitter. The unit comprises a drilled plate, "U" bolts shackle and fixing, bolts.

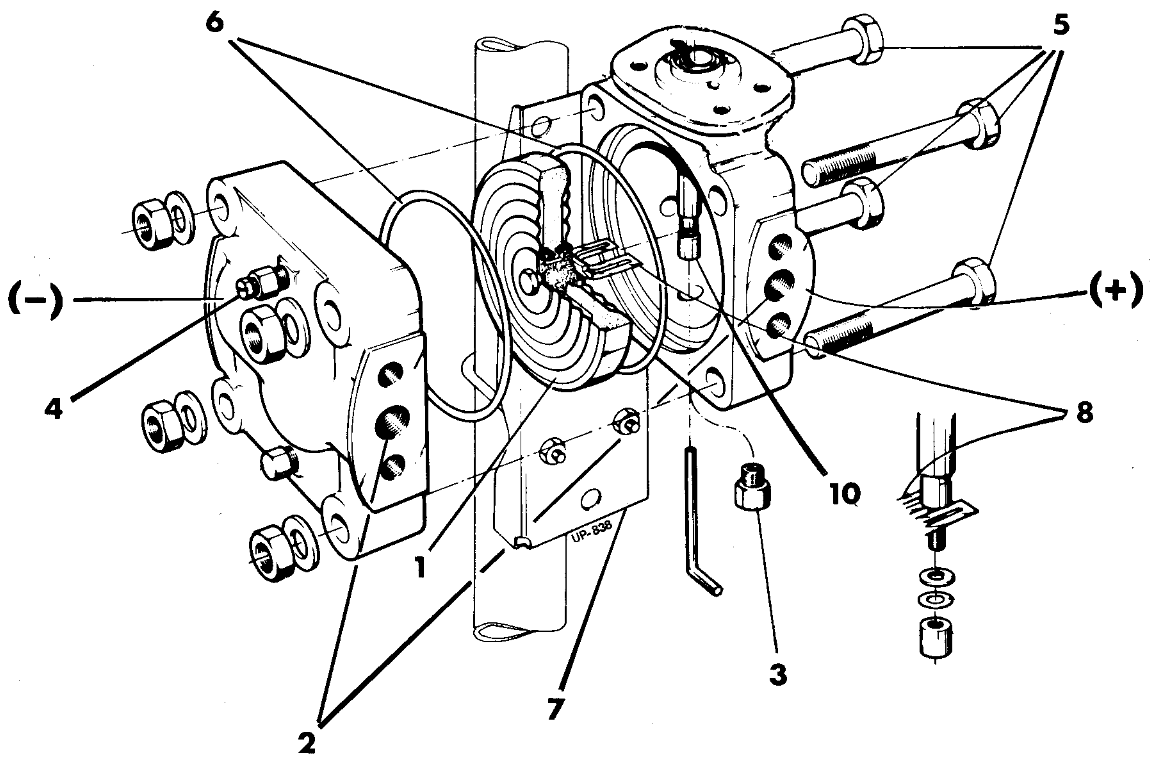


Fig. 1A - NAA model exploded view of measuring element

1 - Diaphragm capsule
2 - Process connections
3 - Drain plug
4 - Vent valve
5 - Clamp bolts
6 - "O" ring seals
7 - Mounting bracket
8 - "U" flexure
9 - Connecting flanges
10 - Force beam

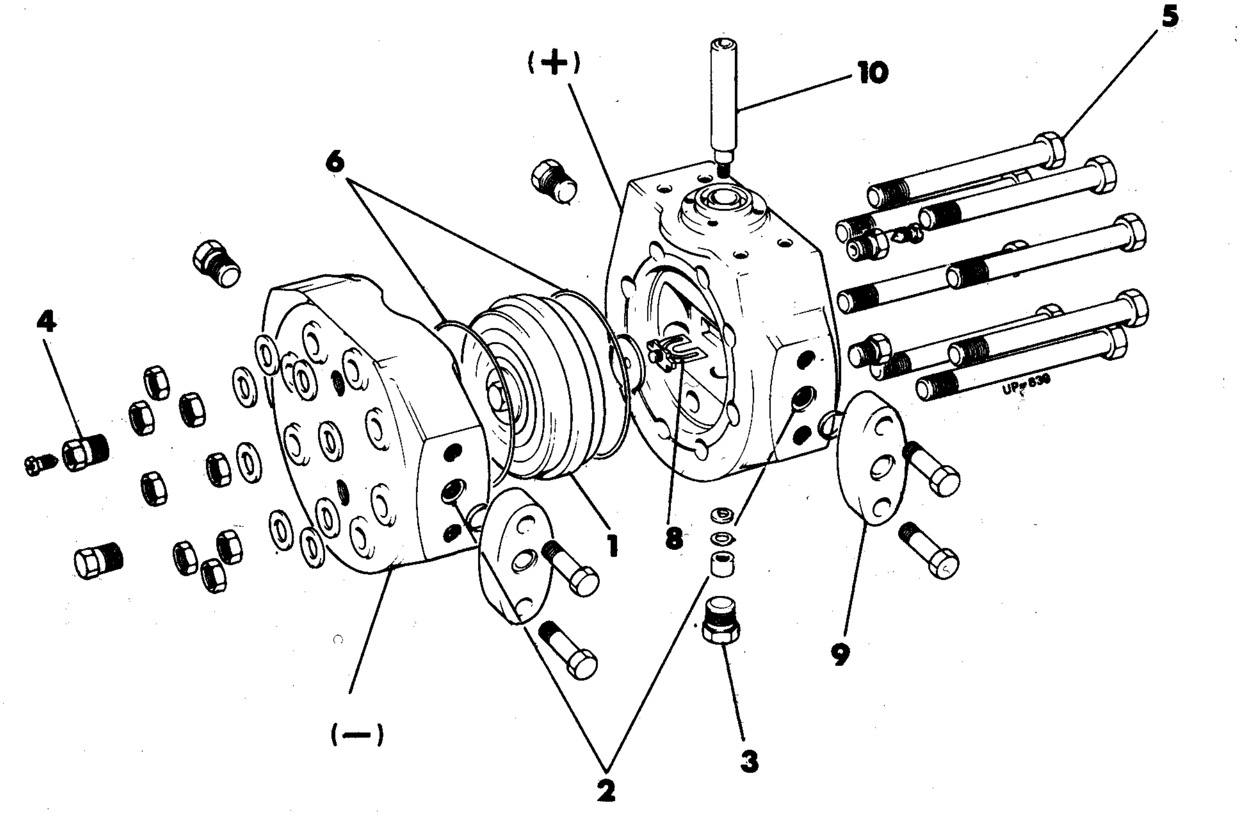


Fig. 1B - NAD model exploded view of measuring element

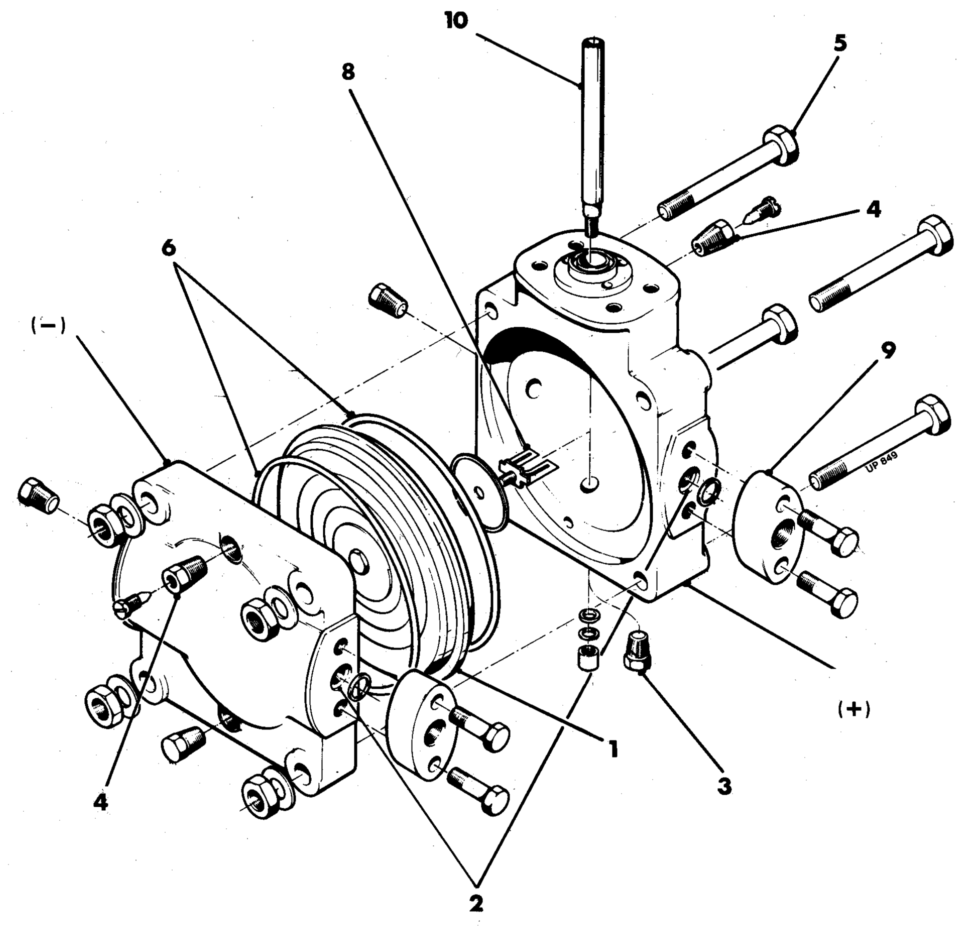


Fig. 1C - NAB model exploded view of measuring unit

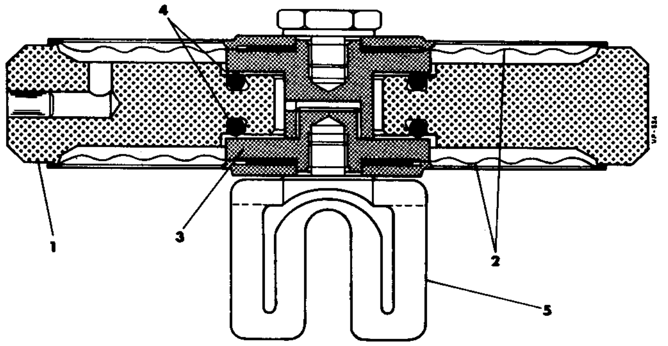


Fig. 2 - Diaphragm capsule

Transmission Unit (Fig. 3)

This unit comprises the following items:
A mounting frame (1) attached directly to the measuring unit body and to which is attached an "A" flexure (2), flapper(3), nozzle (4), feedback bellows (5), span adjustment (6), and zero adjustment mechanisms (7).
A base plate (8) mounted directly to the measuring unit and on which is mounted the air connection block (9), air relay (10) and the transmission unit cover (11). Beneath the base plate is affixed the data plate.
The force bar (12) is attached at its lower end to the transmission bar (measuring unit) and at its upper end to the 'A' flexure.
Also at the upper end of the force bar is the 'T' strap which actuates the flapper; the flapper adjustment screw is also on this strap.

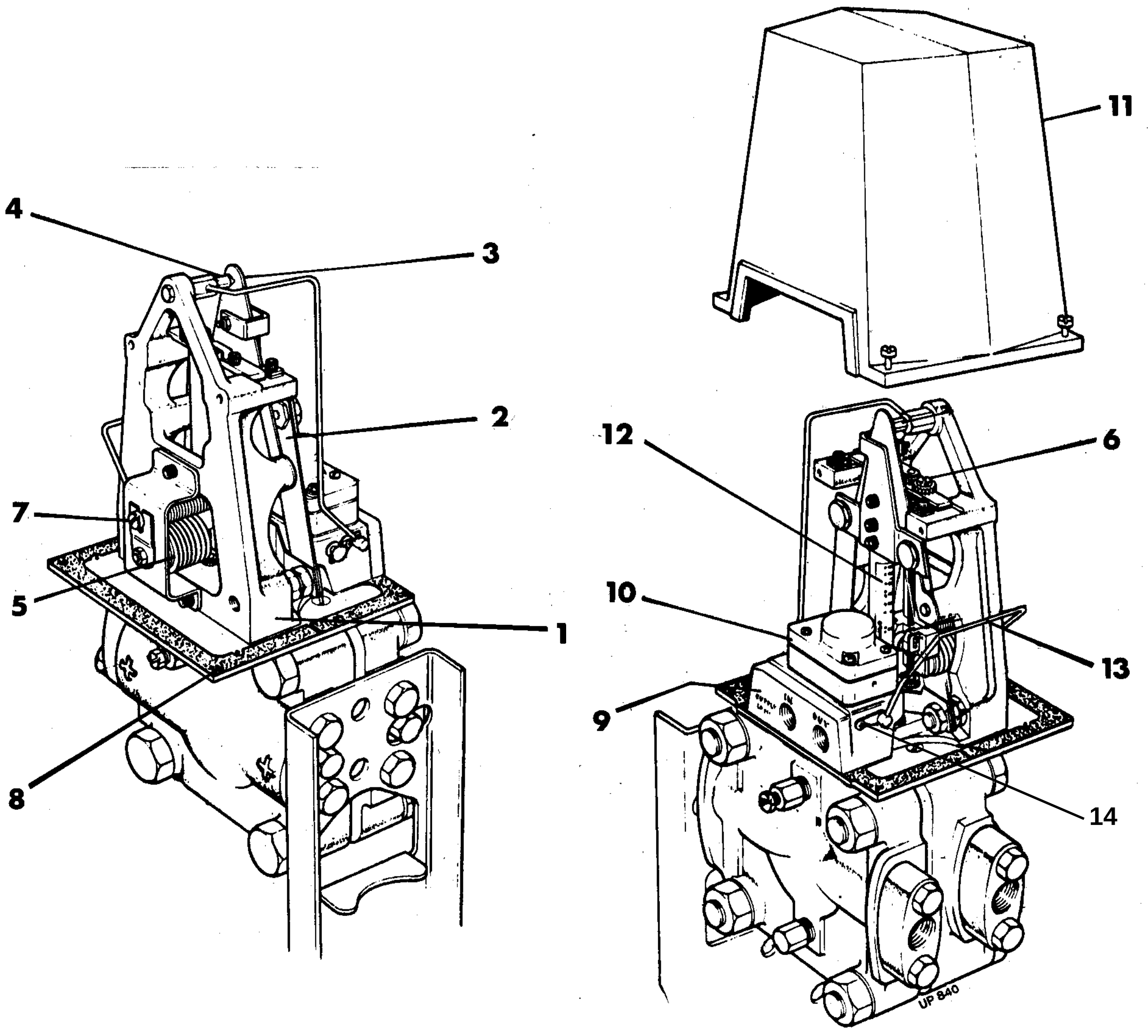


Fig. 3 - Transmission Unit

PRINCIPLE OF OPERATION

The Deltapi N transmitter operates on the force balance principle. The system is depicted schematically in fig. 4. Referring to the diagram, a differential pressure is applied across the diaphragm capsule (A) this generates a force at the capsule in the direction of the arrow "DP measure" and which is applied to the lower end of the transmission bar (B). This force produces a moment relative to the fulcrum point (fulcrum diaphragm) (I) and thus a moment of the force beam about the fulcrum. This movement, in the direction of the arrow "Deltapi measure" varies the distance of the flapper (H) controlled from the upper end of the force beam, relative to the nozzle (G).
Air is supplied to the nozzle via a fixed restriction orifice and discharges to the atmosphere through the flapper nozzle gap and variations of this gap determine the back pressure value at the nozzle.
The nozzle back pressure is sensed by the relay diaphragm which positions the double valve in the relay (F) to allow supply air into the output system of relay. The output pressure from the relay is fed to the feedback bellows (E) (and to the receiving equipment) the pressure rising until the bellows force balances that of the diaphragm capsule; at this point equilibrium is attained and the output pressure is proportional to the differential pressure and thus representative of the differential pressure at the measuring unit.
A reduction of the differential pressure value as sensed by the measuring unit diaphragm capsule will initiate a train of events in opposite direction to that given above.
As the differential pressure falls so the flapper nozzle gap widens because of imbalance of the forces on the force bar. To increase of the flapper nozzle gap causes the output pressure to fall reducing as it does so the bellows feedback force on the force bar until equilibrium is again achieved. The revised output signal will again be proportional to the reduced differential pressure value. As the flapper movement necessary to vary the output pressure throughout its ranges is only 0.0003 inches (0.0005 mm) the force beam remains in a substantially constant position and thus output varies in proportion to the applied forces and thus the applied differential pressure.
The measurement span of the transmitter may be varied by positioning the span rider (C) on the feedback beam. This varies the point at which the feedback force is applied to the force bar and thus the feedback movement of the bellows.
As the rider is moved away from the fulcrum point so will the effect of the feedback bellows force increase thus the measurement span increases as the span rider is moved upwards along the feedback beam.
The transmitter is designed to give a positive output signal pressure (0.2 Kgf/cm^2 or 3 lbf/in^2 or 20 kPa) for the measured zero: to achieve this the feedback bellows is counter balanced by an adjustable spring and adjustment of this spring (D) by a screw anchor is the means of zeroing the transmitter.
The block diagram of fig. 5 shows the operation stages of the transmitter.

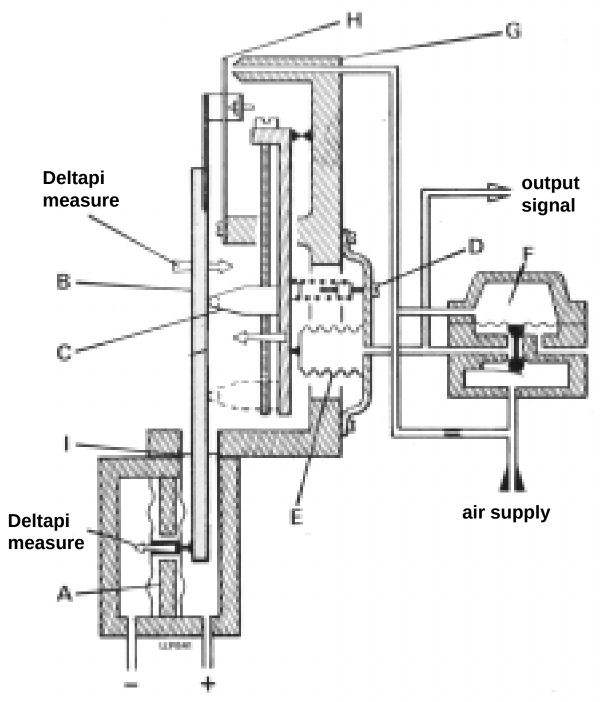


Fig. 4 - Principle of operation

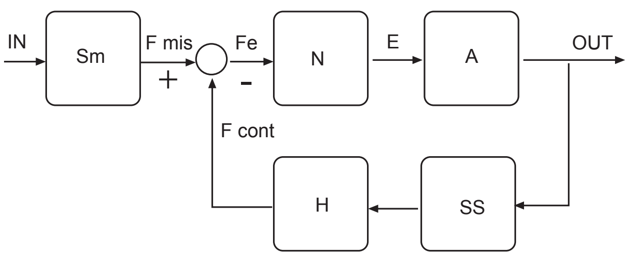


Fig. 5 - Operation stages of the transmitter

IN	=	**Differential pressure**
SM	=	**Diaphragm area**
F mis	=	**Generated force by the input or measured differential pressure**
Fe	=	**Error**
N	=	**Flexibility of the system**
E	=	**Flapper movement**
A	=	**Pneumatic amplifier gain**
OUT	=	**Output**
H	=	**Feedback gain**
Ss	=	**Feedback bellows area**
F cont	=	**Generated force by the output and feedback**

OPTIONAL EXTRA ITEMS

Zero elevation or suppression device (Fig. 6)

A zero elevation or suppression device can be fitted on request. Both devices allow to set the zero of the transmitter to a value (different from the zero) of the process variable. Comprising a spring (A) adjusting screw (C) and mounting screws (B). The bracket is mounted on the mounting frame and the spring on the force bar. The spring is used in tension for zero suppression or in compression for zero elevation. Both devices are assembled to the transmitter as shown in figure 6.

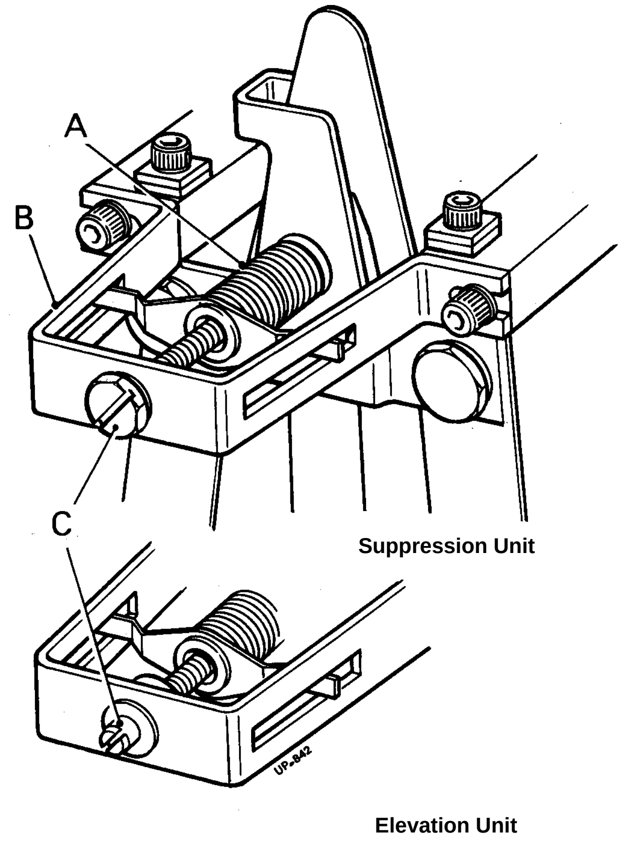


Fig. 6

Oxygen Measurement Service (except for NAD)

The diaphragm capsule is fluorolube filled and the transmitter completely degreased with a special procedure.

Valve Manifold (except for NAD) (fig. 7)

A carbon steel or stainless steel valve manifold is supplied for mounting directly to the measuring unit connection ports (in place of the elliptical flanges). The unit provides upstream and downstream isolation and equalizing facilities at female. Before fitting the manifold remove both elliptical connection flanges (1). Place a PTFE seal (2) into the recess around each of the ports in the rear side of the manifold (3) which fits toward the transmitter. Mount the manifold, with the equalizing valve in the downward position, to the transmitter connection ports. Place a PTFE seal into the recess around each of the ports in the elliptical connection flanges and place the flanges in position. Ensure that the PTFE seals are retained in position and insert the bolts through the flanges and manifold and secure the whole assembly to the transmitter. The process connections are made to the two threaded 1/2 inch NPT connection ports in the connection flanges.

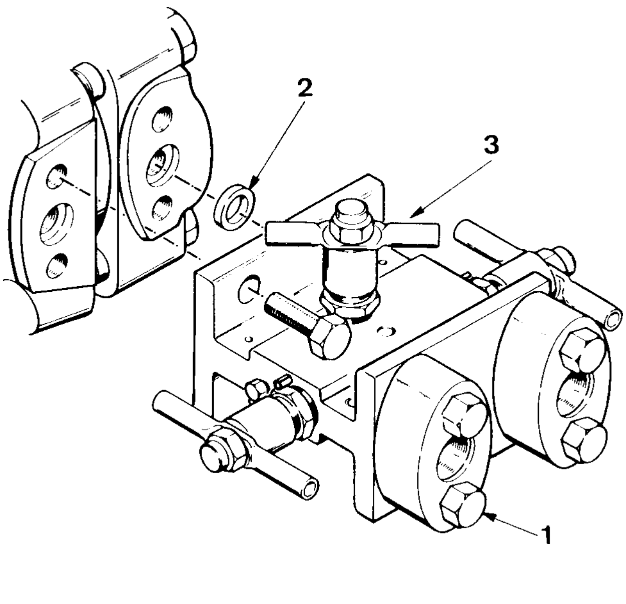


Fig. 7 - Valve manifold

. . . OPTIONAL EXTRA ITEMS

Air filter regulator unit (Fig. 9)

An air filter regulator with a disposal filter element, can be directly mounted on the transmitter, with or without output gauge, and connected with piping and fittings either in stainless steel or copper. The air filter regulator is assembled and connected to the transmitter as shown in Fig. 9.

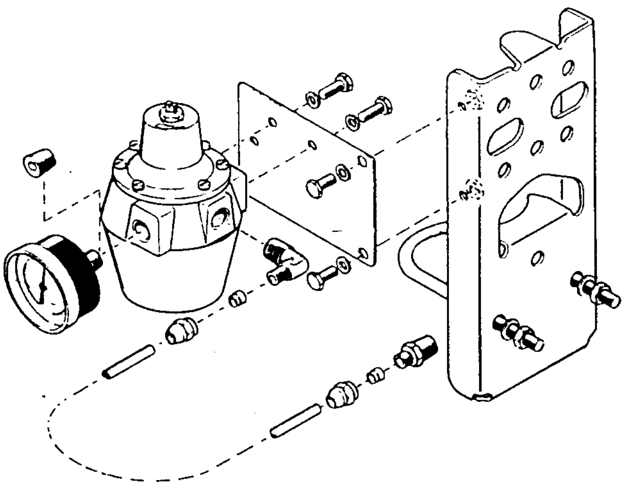


Fig. 9 - Air filter regulator unit

Integral orifice (except for NAD) (Fig. 10)

An orifice plate (1) complete with a by pass carrier (2) is supplied by mounting directly to the measuring unit connection ports (in place of the elliptical flanges) the unit is provided for measuring small rate of flow having the main pipeline connected on both sides of the positive chamber.
The unit is fitted to the outlet process connection and can be removed to change the orifice without dismantling the transmitter. The upstream pressure is fed through the by-pass to the negative chamber.
The process connection is 1/2 inch NPT. If required, the device can be supplied completed with zeroing manifold (3).
Suitable flow-charts and material details are given in the relative specification sheet . The integral orifice assembly is mounted as shown in Fig. 10.

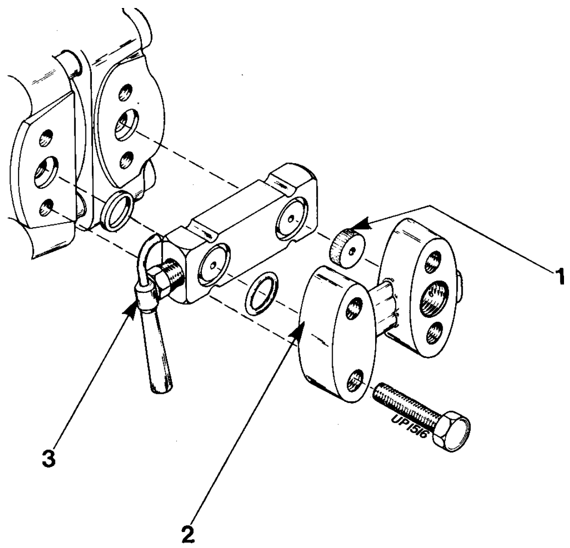


Fig. 10 - Integral orifice

INSTALLATION

Safety Measures

a) Installation is carried out by suitably trained personnel.
b) Before selecting a location and installing the transmitter all the relevant sections of this manual are read and the requirements of all associated equipment considered.
c) Recommended pressures are not exceeded, that all piping and pressure connections are adequate for the duty and are fitted correctly to give reliable pressure tight joints. This is important particularly where compressible fluids (gases) are concerned for these applications a failure under pressure can result in an explosive release of energy.
d) Adequate precautions are taken to prevent excessive pressures being developed through freezing of fluids within the transmitter body or elsewhere within the measured system.
e) Where the instrument has been ordered for oxygen measurement, components in contact with oxygen are carefull degreased in manufacture and it is essential that this condition is maintained.
   Ordinary lubricants are liable to explode in the presence of oxygen. When carrying out instrument maintenance great care must be exercised to avoid contaminating parts in contact with the process fluid. Accurately degrease if in doubt. When replacement of instrument parts are necessary, ensure that new parts are properly degreased before fitting.

Location and mounting

Select a location as close as possible to the detecting element where the ambient temperature range will not exceed the limits -40°C to +120 °C. The location should also be as free as possible from vibration, sufficient space must be allowed above the transmitter to permit removal of the cover. Sufficient space must also be allowed around the valve handles of the valve manifold (if fitted) to permit operation of the valves.
The transmitter is fitted with a 2-way clamp suitable for mounting on either a vertical or horizontal 2 inch I.D. (2-3/8 in O.D.) pipe. For mounting on a vertical pipe the U-clamp must be bolted through the horizontal pair of holes should be used (see Fig. 9).
If necessary, e.g. for reasons of access, the mounting plate can be removed and bolted to the opposite of the body. If this condition exists the position of the connecting flanges must also be reversed and the seal plugs removed from the connection ports and used to seal the ports on the same side as the mounting plate. Ensure that each plug is firmly tightened after changing its position (see Fig. 1A).

Pressure connections and pipework (Fig. 11)

The connection flanges are screwed 1/2 inch NPT female and body ports are screwed 1/4inch NPT female.
The following table gives minimum recommended pipe bores in millimeters of various fluids and transmission distances. These recommendations are in accordance with ISO standard 2186-1973.

Type of Metered fluid	Pressure Signal Transmission Distance		
	0 to 16m	16 to 45m	45 to 90m
Water/steamDry air/gas	7 to 9	10	13
Wet air or gas (i.e. risk of Condensation in pipes	13	13	13
Oils of low to medium viscosity	13	19	25
Very dirty liquids or gases	25	25	38

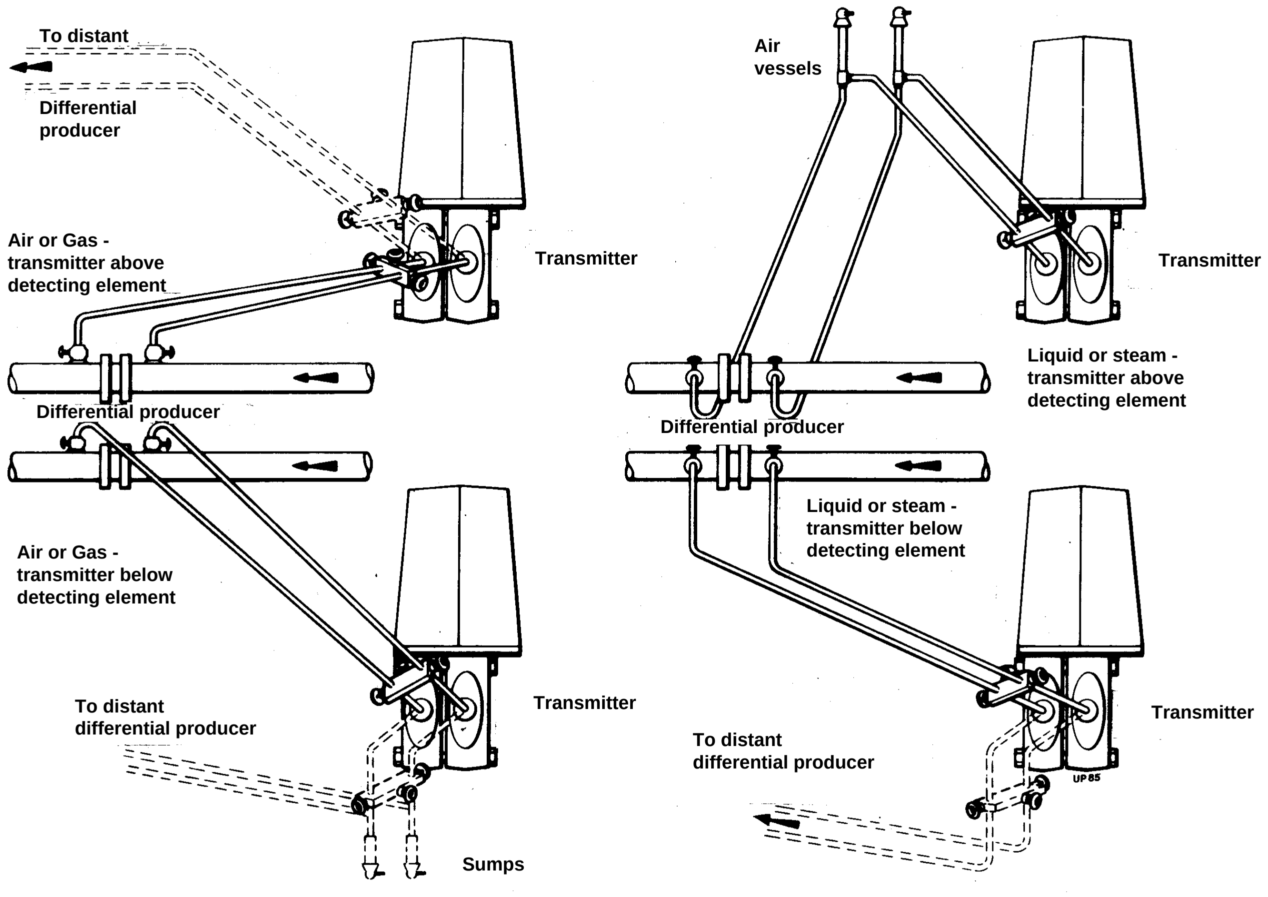


Fig. 11 - Pressure connections and pipework

Fig. 11 gives a typical piping arrangement for the transmitter when used in conjunction with an orifice plate in the flow main. The diagrams show the positions of the high (upstream) and low (downstream) connections in the detecting element. A shut-off valve should be included in each connection to the main and a by-pass (equalizing) valve connected acress the inputs to the transmitter as shown. Alternatively a valve manifold (54 mm or 2.125 inches input centres) may be used.

If the transmitter is used for pressure or level measurement, the connection must be made to the high pressure (+) port and a shut-off valve included in the input pipeline.
The pipes must be routed with a minimum gradient of 1 in 12 after an initial vertical rise (air or gas measurement) or fall (liquid or steam measurement) of approximately 300 mm (1 foot).

. . . INSTALLATION

The pipework must be arranged to ensure that air in a liquid-filled system can be completely vented or that liquid in a gas or air system can be drained. Adeguate protection must be given to prevent the freezing of water in pipes which are exposed to the weather. In installations where the fluid is subject to variations in temperature, expansion loops must be included in the pipework between the detecting element and the converter bodywork caused by these temperature changes. Reference should be made to the instructions for the differential producer for the information regarding cooling chambers or other auxiliary equipment required at the tapping point.

Pneumatic transmission supply/connections (Fig. 12)

The air supply and output signal ports are tapped 1/4 inch NPT female and are identified IN and OUT respectively.
A clean dry and regulated air supply of 1.4 Kgf/cm^2 (20 lbf/in^2) is required for the transmitter. It is recommended that the air is supplied via a filter/regulator unit mounted as close to the transmitter as possible.
The supply pipes and transmission pipes for the transmitter must be a minimum of 3/16 in nominal bore (copper or plastics) and must terminate in connections suitable for the 1/4 inch NPT female ports at the transmitter.
If the pipe length between transmitter and receiver is less than 4 metres (13 feet) the transmitter output signal may become unstable; it is recommended therefore that a reservoir with a capacity of approximately 500 cm^3 is included in the transmission line (Fig. 12).

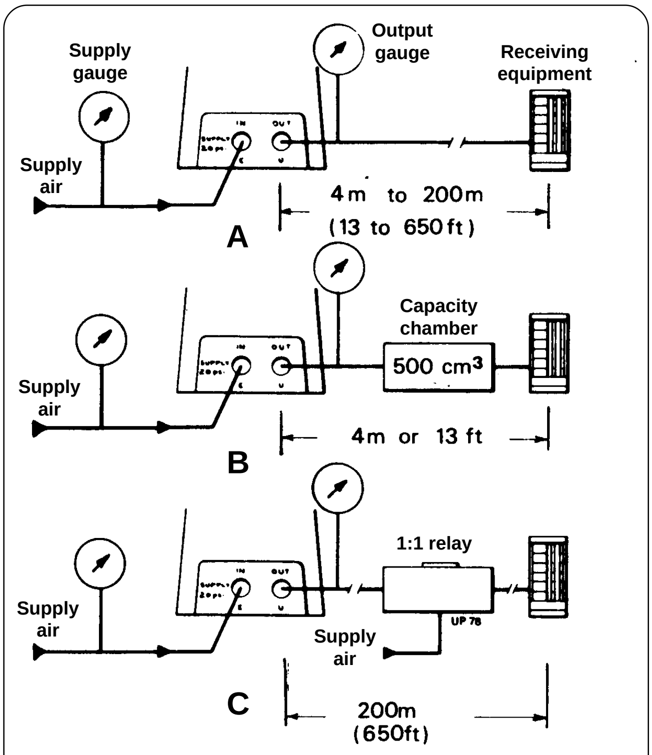


Fig. 12 - Pneumatic transmission supply and connections

If the length of the transmission line exceeds 200 metres (650 feet) a booster relay (1:1) should be included in the line (fig. 12c). To simplify checking and signal monitoring at the transmitter it is recommended that two suitable pressure gauges are included in the pneumatic piping: one in the supply line and the other in the output line. Alternatively a tapping point should be included in each line for gauging purposes.
The pneumatic piping and connections between transmitter and receiving equipment should be completely leak free and should be checked in accordance with paragraph "Leak Test".

SERVICE

Preparation for service

Before the transmitter is put into service it must be mounted and connected in accordance with the foregoing instructions. If not included an output gauge should be connected into the transmission line. Test the transmission line for leaks as follows:

a) Release the four captive screws and remove the transmission unit cover (11) (fig. 3).

Note: Foreign matter must not be allowed to enter the mechanism during the period that the transmission unit cover is removed.

b) Connect an air supply and adjust the pressure to 1.4 Kgf/cm^2 (20 lbf/in^2).
c) Hold the flapper lightly against the nozzle to increase the output pressure to maximum.
d) Retain the output pressure at maximum and (with a soap and water solution) check all joints and connections in the transmission line between the transmitter and receiving equipment for leaks.
e) Eliminate any leaks present.
f) Re-position and secure the transmission unit cover.

Putting into service (Fig. 11)

Ensure that all pipe work connections are correctly made and that all associated equipment is correctly commissioned in accordance with the manifacturers instructions.

Liquid - Filled Systems - Including steam

When the transmitter is used for steam measurement fill the cooling chambers and connecting pipe work with water before proceeding with following instructions. Air expulsion must be conducted very slowly to ensure that steam does not overheat the connection pipes.

a) Ensure that the high (+) and low (-) pressure valves together with any cooling chamber or air collection vessel vent valves are closed.
b) Open by-pass (equalizing) valve.
c) Close both vent valves on the transmitter.
d) Open the valve to the high pressure (+) side.
e) Shut the by-pass (equalizing) valve.
f) Open the valve to the low pressure (-) side.
g) Crack open the low pressure (-) air vent valve on the transmitter until water free of air issues from the vent; close the valve.
h) Crack open the high pressure (+) air vent valve until water free of air issues from the vent; close the valve.
i) Repeat operations (g) and (h) until water free of air issues from the vents.
k) Ensure that the air supply to the transmitter is switched on.

Air gas filled system

a) Check that the transmitter vent valves are closed.
b) Check that the high pressure (+) valve and low pressure (-) valve are closed.
c) Open the equalizing valve and open the low pressure (-) valve.

CALIBRATION

Zero adjustment

With the pneumatic system leak free check, and if necessary, adjust zero as follows:

a) Ensure that all vent valves, drain plugs and pressure connections are pressure tight and that both process connection valves are shut.
b) Fully open the by-pass (equalizing) valve (Fig. 11) and then crack open the valve to the high pressure (upstream) side. For liquid measurement, any air trapped in the measuring unit must be vented via the vent valves.

This applies to zero starting ranges only. Where elevation or suppression facilities are used, the appropriate pressure equivalent to 3 lbf/in^2 (0.2 Kgf/cm^2) output must be applied.

c) Connect an air supply to the transmitter and set the pressure to 1.4 Kgf/cm^2 (20 lbf/in^2).
d) Check that the output gauge indicates, 0.2 Kgf/cm^2 (3 lbf/in^2): if adjustment is necessary proceed as follows:
   i) Rotate the ZERO adjustment flap (positioned on the side of the transmission unit cover) to gain access to the zero adjustment screw.
   ii) By use of a screwdriver rotate the zero adjustment screw in the appropriate direction until the output gauge indicates 0.2 Kgf/cm^2 (3 lbf/in^2).

   Note: Ensure that the receiving equipment is also at zero.
e) Disconnect any gauge or equipment used for test procedure and replace the transmission unit cover in position and secure with the captive screws.

Taking out of service

If the transmitter is part of a control circuit ensure that it is safe to take the transmitter out of service and if necessary that other means of control are in action.

a) Close the isolating valves between the transmitter and tapping point.
b) Open the equalizing valve (if fitted) at the transmitter.
c) Release any pressure trapped in the transmitter body to atmosphere by opening the vent valves in the transmitter body.
d) Switch off the supply air to the transmitter.

Zero and span adjustment

The instrument is despatched with the span, as specifies on ordering, accurately set and no further adjustment is normally required. The span may be set to a new value by adjusting the position of the span carriage this is achieved by rotating the screw, on the span adjustment mechanism, in the appropriate direction until the red pointer indicates the desired span value on the span setting scale. For more accurate setting or for checking calibration the following procedure must be used and for this purpose the following equipment is required.

M_2-a mercury manometer or standard test gauge for the output range 0.2 to 1.0 Kgf/cm^2 (3 to 15 lbf/in^2).
A capacitor chamber 500 cm^3
R_1-M_1-a clean, dry filtered air supply of 1/4 Kgf/cm^2 (20 lbf/in^2).
R_2-a pressure regulator.
M_3-a manometer or test gauge for the measured value span of the transmitter accurate to 0.1% of full scale.
Connecting pipework and unions.

✶ Note: If the transmitter is fitted with input elevation mechanism or suppression mechanism this must be removed (Fig. 6) as follows before span adjustment.
Suppression Mechanism: (Fig. 6) unscrew and remove the adjustment screw C.Remove both bracket mounting screws B (3 mm A.F. socket key) and spring washers; remove the bracket. The suppression spring may remain in position during span adjustment.
Elevation Mechanism: (Fig. 6) remove both bracket mounting screws (3 mm A.F. socket key) and spring washers; remove the bracket. The spring and adjustment mechanism may remain in position during span adjustment.

a) Connect the proceding equipment to the transmitter in accordance with Fig. 13.
b) Rotate the screw on the span adjustment mechanism until the red pointer indicates the desired span value on the span setting scale.
c) Switch on the transmission air supply at the pressure source (Fig. 13) and set the pressure regulator to zero pressure.
d) Switch on the supply air, open the vent valve on the positive body forging and, if necessary, adjust zero by means of the zero adjustment screw 7 (Fig. 3). The signal should now equal 0.2 Kgf/cm^2 or 3 lbf/in^2 at the test gauge M_2 (or manometer if used).
e) Close the vent valve on the positive body forging and via the regulator apply the required maximum differential head, as indicated on the manometer M_3 to the transmitter measuring unit. The output at test gauge M2 should now be 1.0 Kgf/cm^2 or 15 lbf/in^2. If necessary adjust the span carriage via the screw 6 (fig. 3) on the span adjustment mechanism until this conditions is attained.
f) Reduce the air supply via the pressure regulator to zero at manometer M_3 and open the vent valve on the positive body forging. The signal pressure at the test gauge M_2 should be 0.2 Kgf/cm^2 or 3 lbf/in^2. If necessary adjust the zero adjustment screw until this condition is attained.
g) Repeat operations e) and f) until the transmitter is correct at both extremes of the disired span.
h) Check the transmitter at mid-point of the span with an increasing pressure and then a decreasing pressure, to ensure that the transmitter is mechanically free.

Note: If the transmitter is fitted with input elevation mechanism or suppression mechanism this must be re-positioned (Fig. 6) as follows.
Suppression Mechanism: re-position the bracket and secure with the bracket mounting screws (3 mm A.F. socket key) and spring washers; re-position the adjusting screw.
Elevation Mechanism: re-position the bracket and secure with the bracket mounting screws (3 mm A.F. socket key) and spring washers.

If elevation or suppression is to remain the same and the range is as before the transmitter may be returned to service. Otherwise, the transmitter should be set as described in following paragraphs.

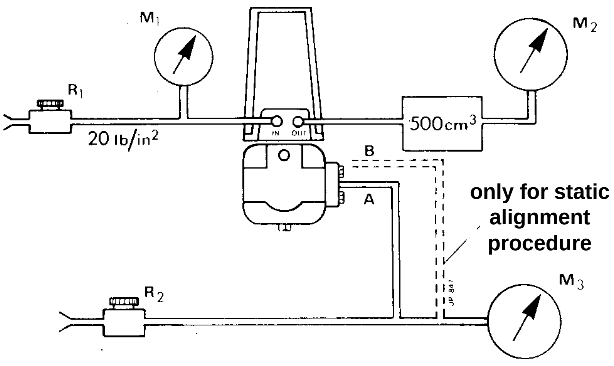


Fig. 13

INPUT SUPPRESSION

Input suppression (if included) (Fig. 6)

a) Set up the transmitter, connect to the test rig (Fig. 13) as described in the previous paragraph, and check calibration.
b) Fit the suppression device.
c) Supply the instrument with a 20 lbf/in^2 signal, obtained adjusting R1 and indicated on M1.
d) Zero the output to 3 lbf/in^2, indicated on M2, by the adjustment of the screw C (Fig. 6).
e) Adjusting R2, feed the positive (+) side with a pneumatic signal equal to the entity to be suppressed (the indication is on M3).
f) The output signal will have obviously been changes: adjust the screw C until the output value (reads on M2) will be again 3 lbf/in^2.
g) Adjusting R2 and reading the relevant indication on M3, feed the positive side (which already contains the pressure equal to the suppression value) with a pneumatic signal equal to the upper limit of the calibration range.
Check that the output, indicated on M2, reaches the 15 lbf/in^2 value. If not, adjust via the screw on the span adjustment mechanism (6) (Fig. 3) in small increments, re-checking at 3 lbf/in^2 after each adjustment until correct calibrations is achieved.

INPUT ELEVATION

Input elevation (if included) (Fig. 6)

a) Set up the transmitter, connect to the test rig (Fig. 13) as described in the previous paragraph, and check calibration.
b) Fit the elevation device.
c) Supply the instrument with a 20 lbf/in^2 signal, obtained adjusting R1 and indicated on M1.
d) Zero the output to 3 lbf/in^2, indicated on M2, by the adjustment of the screw C (Fig. 6).
e) Adjusting R2, feed the negative (-) side with a pneumatic signal equal to the entity to be elevated (the indication is on M3).
f) The output signal will have obviously been changes: adjust the screw C until the output value (M3) will be again 3 lbf/in^2
g) Disconnect R2-M3 from the negative side (-) and connect them to the position side (+) of the transmitter.
h) Adjusting R2 send a pneumatic signal equal to the upper limit of the calibration range. Check that the output signal, indicated on M2, reaches the 15 lbf/in^2 value.
If not, adjust via the screw on the span adjustment mechanism (6) (Fig. 3) in small increments, re-checking at 3 lbf/in^2 after each adjustment until correct calibration is achieved.

OUTPUT SIGNAL REVERSAL

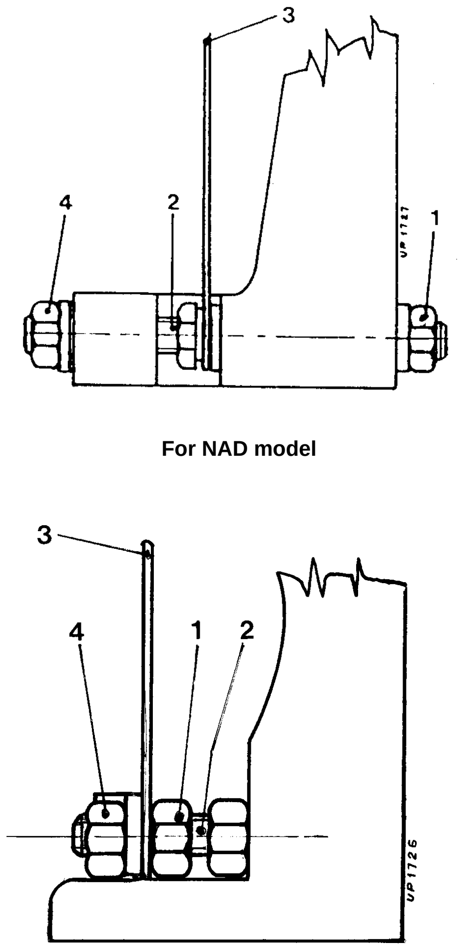
Output signal reversal (Fig. 6) (i.e. 1.0 Kgf/cm^2 or 15 lbf/in^2 output at minimum input span value and 0.2 Kgf/cm2 or 3 lbf/in^2 at maximum input span value) may be obtained by using the input elevation mechanism and reversing the process connections to the transmitter.
Output signal reversal is obtained as follows:

a) Connect the transmitter to the test rig (Fig. 13) and check for calibration. For this check the elevation mechanism must be removed.
b) Fit the elevation mechanism and reverse the pressure connection to the measuring unit (connect pressure to negative chamber).
c) Apply the maximum desired span pressure to the transmitter and adjust the elevation adjustment screw until the output signal is 0.2 Kgf/cm^2 or 3 lbf/in^2.
d) Reduce the pressure to zero and open the vent valve on the negative body forging. The output signal should now be 1.0 Kgf/cm^2 or 15 lbf/in^2. Close the vent valve.
e) If an error exists adjustment must be made to the span in small increments checking and adjusting in accordance with operations (c) and (d) after each adjustment until calibration is correct.
f) Return the transmitter to service, but with reversed process connections at the transmitter.

STATIC ALIGNMENT PROCEDURE

(Fig. 13 and 13a)

a) Connect the transmitter as shown in Fig. 13.
b) Set the red pointer, located on the span carriage, to maximum span by use of the screw on the span adjustment mechanism. Remove the drain plug (3) and slaken the socket-head nut (Fig. 1).
c) Screw in completely the internal nuts (1) and lightly lock the external nuts (4).
d) Set the force bar parallel to the feedback arm by means of the zero adjusting screw.
e) Position the flapper screw to a distance of 0.6 mm $\pm$ 0.1 mm from the flapper then supply the transmitter with a reduced pressure of 10 lbf/in^2 and set zero output to 3 lbf/in^2 via the zero adjusting screw.
f) Tight the socket-head nut on the capsule without altering the parallelism already set: the output pressure should not change more than $\pm$ 0.2 lb/in^2. Increase the supply pressure to 20 lbf/in^2 and adjust the output at 3 lb/in^2.
g) Loose the external nuts (4) and turn internal nuts (1) anticlockwise by one turn and then lock the external nuts again adjusting the output at 3 lbf/in^2.
h) Apply (a pressure equal to 35% of the maximum); on both sides of the capsule; if the output variations exceed the specified limits procees as follows:
i) Shut off the static pressure, repeat the operation (g) turning the internal nut (1).
   - anticlockwise in case of positive error
   - clockwise in case of negative error
   Repeat the operation described under b) until the error falls within the specified limits.



For NAD model

For NAA and NAB models

Fig. 13a

MAINTENANCE

General

If the transmitter forms part of a control loop the plant must be placed under local manual or by pass control while the transmitter is examined, or taken out of service for maintenance or other reasons. It is recommended that any servicing which involves the dismantling of the transmitter be carried out under workshop conditions. If service is to be carried out in the field all precautions must be taken to prevent the ingress of dirt, dust water or other foreign matter into the mechanism.

ROUTINE MAINTENANCE

Under normal working conditions no routine maintenance is required apart from ensuring that the air supply filter is drained periodically in accordance with its own instructions.

POSSIBLE FAULTS

When operating under adverse conditions or after some considerable time under normal conditions the slow accumulation of dirt and deposit may cause faults in the following items which should be cleaned as described.

Flapper nozzle assembly

Under adverse conditions dirt and deposit can built up around the nozzle and flapper in which case the assembly may be cleaned as follows. Great care must be taken not to damage the nozzle in any way or distort or bend the flapper.

a) Shut off the supply air and isolate the process connections.
b) Remove the transmitter cover.
c) Loosen and swing the plate screw 14 (Fig. 13) on the relay block and swing the plate side-ways to release the nozzle supply pipe connection.
d) Hold the pipe entry hexagon at the nozzle steady with a spanner (10 mm AF) and with an 8 mm AF spanner remove the nozzle securing screw. Nozzle and pipe assembly may now be removed.
e) With a clean, lint free, rag moistened in a suitable all dirt and deposit from the flapper.
f) Rinse the nozzle assembly in solvent and if necessary probe the nozzle with a non-ferrous wire not exceeding 1 mm diameter. Blow out the assembly with clean compressed air and throughly dry. Finally examine the 'O' ring on the connection and if necessary replace with a new one.
g) Replace the pipe assembly, holding the nozzle end with a spanner while tightening the set screw so that the pipe is not distorted. If necessary use a smear of silicone grease on the 'O' ring to facilitate entry into the block. Swing the locking plate round to secure the pipe connection and tighten the screw.

Restriction orifice (Fig. 14)

a) Remove the restrictor by loosening the locking plate screw in the relay block and rotating the plate to one side. The restrictor may now be pulled straight out from the relay block. Remove the 'O' rings.
b) Clean by probing with a non-ferrous wire of less than 0.15 mm (0.005 inch) diameter and wash in solvent. Examine the 'O' rings and if necessary replace with new ones.
c) Replace the 'O' rings on the restrictor and smear then with silicone grease.
d) Replace the restrictor and lock with the plate and screw.
e) Check zero and adjust as necessary.

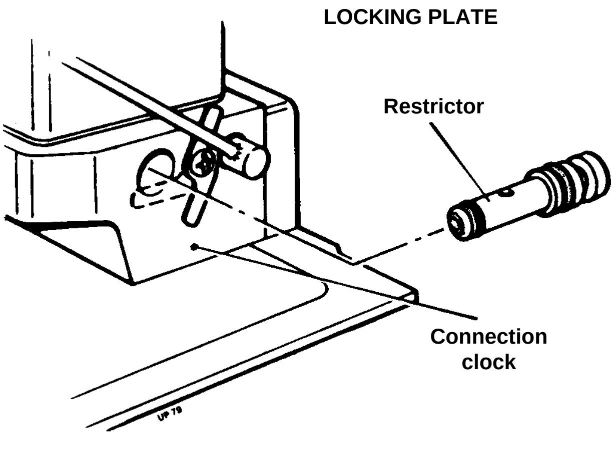


Fig. 14

Relay (Fig. 15)

a) Detach the relay to connection block (3), by removing the two mounting screws (1) and (2) taking care not to damage the gasket (4).
b) Remove the two screws (5) and (6) and separate both halves of the relay taking care not to damage sphere (7) and spacer tube (8) within relay body (9).
c) With solvent such as carbon tetrachloride clean the interior of the relay and dry throughly.
d) Examine: the gaskets (10-11), the diaphragm (12) and the metal foil (13). Replace with new ones if damaged.
e) Reassembled the relay ensuring that both halves are correctly oriented with regards to each other and that the gasket (4) is correctly placed.

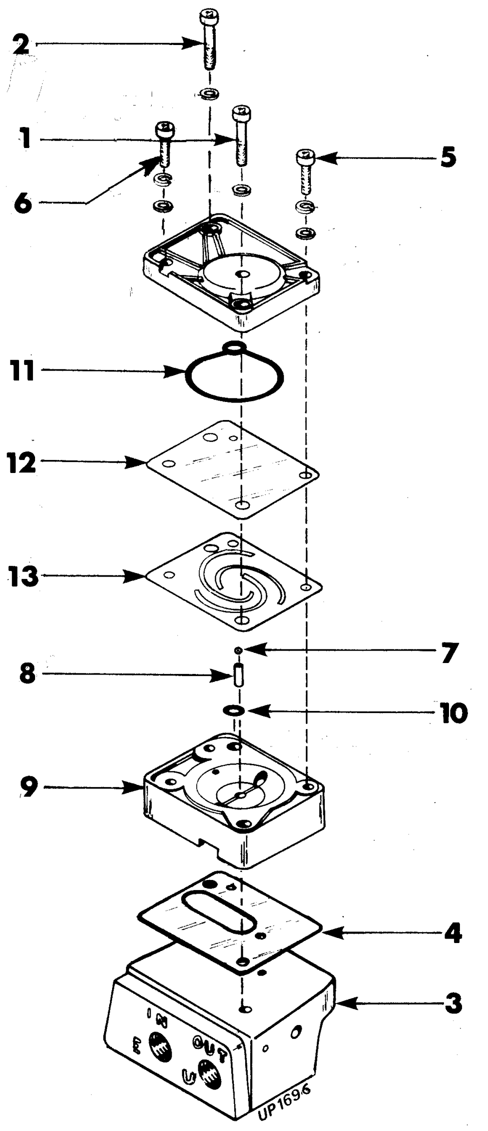


Fig. 15 - Relay

REMOVING AND REFITTING THE DIAPHRAGM CAPSULE

(Figures 1x)
Although the diaphragm capsule may be replaced with the transmitter in situ, it is recommended that this operation be carried out under workshop conditions. If this operation to be carried out in situ it should be born in mind that some considerable force is required to loosen and then subsequently correctly required the four clamping bolts and nuts. Care should therefore be taken not to over-strain the mounting whilst this is being done.

Removal of the capsule

a) Isolate the transmitter from its receiving equipment and also from the process tapping point. If the transmitter forms part of a control loop, place the controller under MANUAL control where appropriate or use an alternative method of control.
b) Equalize the transmitter and close the upstream (+) and downstream (-) valves at the transmitter. Release any pressure from the transmitter via the vent valves.
c) Disconnect the pressure pipes from the transmitter (or alternatively remove the valve manifold). If it is intended to continue the capsule removal and replacement procedure in the workshop, the transmitter should be removed from its mounting.
d) If the transmitter is fitted with input elevation or suppression mechanism remove the mechanism as described in "Calibration and accurate span setting" section.
e) Through the drain plug hole slacken, but do not remove, the socket headed nut securing the transmission bar to the capsule flexure (6 mm AF socket key).
f) Remove both bolts securing the negative (-) body half to the support bracket.
g) Remove the four nuts and bolts clamping the body halves, carefully remove the negative body half and then the capsule taking care not to damage the flexure as the capsule is withdrawn.
   The capsule flexure may be removed by unscrewing from the capsule.

Refitting the capsule

When reassembling the transmitter it is recommended that new capsule 'O' ring seals be used.

a) To reassembled the body unit, place an 'O' ring seal in position in the body capsule-recess of the positive (+) body half. Take the capsule, enter it into the recess and at the same time ensure that the flexure slot engages the threaded portion of the transmission bar with the two washers on the same side as the socket nut. Ensure that the flexure is aligned at 90° to the transmission bar.
b) Place an 'O' ring in the recess of the negative body half and position the body over the capsule, vent valve uppermost, and clamp loosely in position with the four nuts and bolts.
c) Tighten the clamp nuts and bolts in small increments all round, finally using a torque wrench set to 11 Kg/M.
   Replace the two support-bracket bolts and firmly secure.
d) Connect the transmitter to a suitable supply pressure and set the zero screw to 3 lbf/in^2.
e) Through the drain plug hole carefully tighten the transmission bar socket nut (6 mm AF socket key).
   Check the output signal, which should not have varied by more than 0.06 lbf/in^2. If it has, slacken and retighten the nut until the required result is obtained. Replace the drain plug.
f) If a new capsule has been fitted, calibrate in accordance with the instructions given in "Calibration and accurate span setting " section before returning the transmitter to service.
g) If the original capsule is refitted, the transmitter may be returned to service in accordance with the instruction given in "Service" section no recalibration is required. When range suppression or zero elevation is included the mechanism should be refitted, taking care to maintain the original setting; before returning the transmitter to service.

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