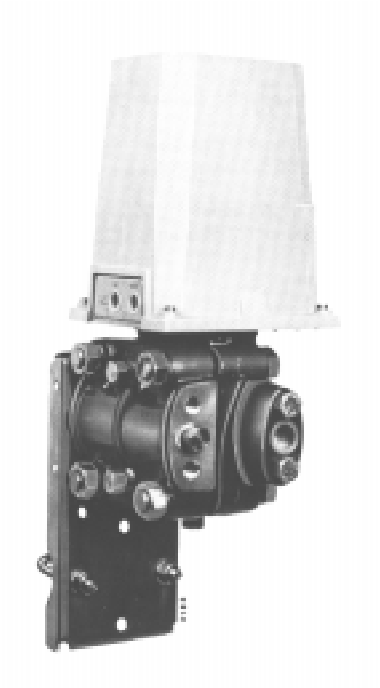
Operating instruction

Deltapi N Series
Pneumatic Transmitters

Models NBC, NBD



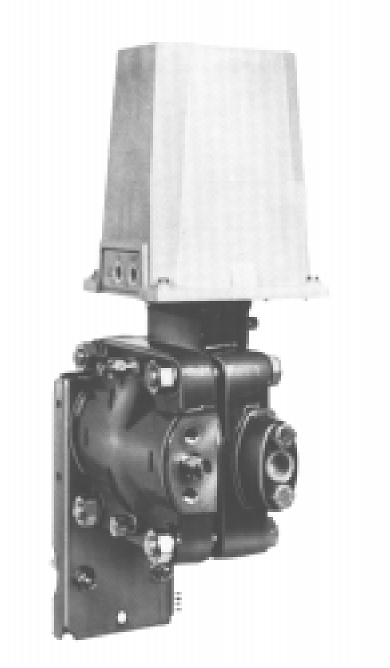


ABB AUTOMATION

The Company

ABB Automation is an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The NAMAS Calibration Laboratory No. 0255(B) is just one of the ten flow calibration plants operated by the Company, and is indicative of ABB Automation's dedication to quality and accuracy.

BS EN ISO 9001

St Neots, U.K. – Cert. No. Q5907
Stonehouse, U.K. – Cert. No. FM 21106

UNI EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

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Use of Instructions

Warning.
An instruction that draws attention to the risk of injury or death.

Caution.
An instruction that draws attention to the risk of damage to the product, process or surroundings.

Note.
Clarification of an instruction or additional information.

Information.
Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS

INTRODUCTION

General

The Deltapi N series models NBC and NBD pneumatic absolute pressure transmitters are designed for measuring the absolute pressure and vacuum. The measured value is transmitted as a 0.2 to 1.0 Kgf/cm^2 , 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 range are:

NBC model

a) 3000 to 17000 mm H2O with 2inch diaphragm
b) 500 to 5200 mm H2O with 3inch diaphragm
c) 250 to 750 mm H2O with 3inch diaphragm and with a special feedback bellows.

NBD model

a) 120 to 750 mm H2O with 5inch diaphragm.

Refer to the relative specification sheets.

TECHNICAL 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)

The measuring unit comprised a sensor membrane or capsule (1) fitted between the two body halves (5).
In these particular versions of the Deltapi series transmitter, the capsule does not have a filling liquid.
The pressure to be measured is applied to the positive chamber via a 1/4 inch NPT female process connection made on the body or via a 1/2 inch NPT female connection made on the eliptical flange (8). The process connection on the negative body half is not utilized.
The measuring sensor (fig. 2) is made up of an annular body 1) having one side smooth and the other side corrugated.
Around the circumference of the latter side is welded the membrane (2) fixed at the centre by the core (3). A vacuum is formed inside the sensor. The convolutions formed on the surface of the annular body (1) match perfectly with those of the measuring membrane for which reason the effect produced by a possible input overpressure will force the membrane towards the body face without it sustaining any damage.
A "U" shaped flexure (4) 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.

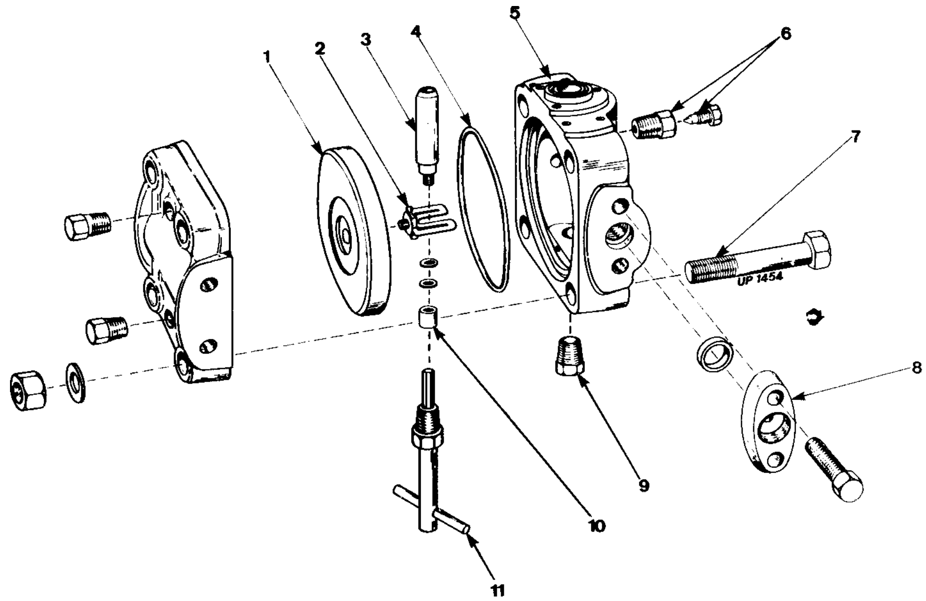


Fig. 1A - NBC model exploded view of measuring element

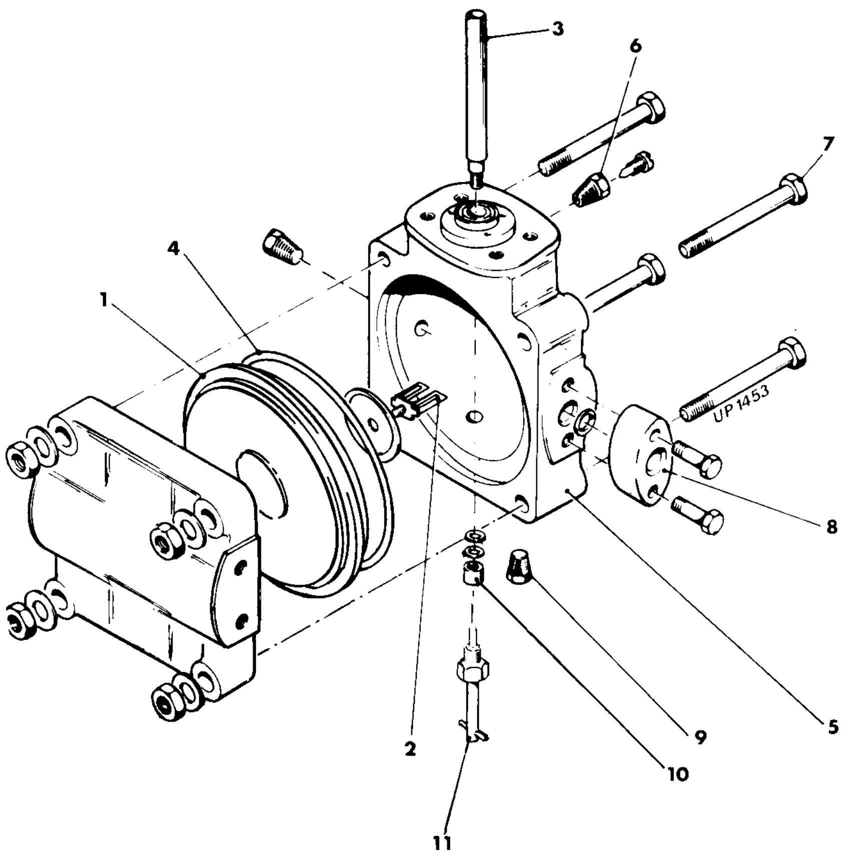


Fig. 1B - NBD model exploded view of measuring element

1 - Diaphragm capsule
2 - "U" flexure
3 - Force beam
4 - "O" ring seals
5 - Body half
6 - Vent valve
7 - Clamp bolts
8 - Eliptical flanges
9 - Drain plug
10 - Socket nut
11 - Special tool

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 measuring unit 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" bolt shackle and fixing, bolts.

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 (14).
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.

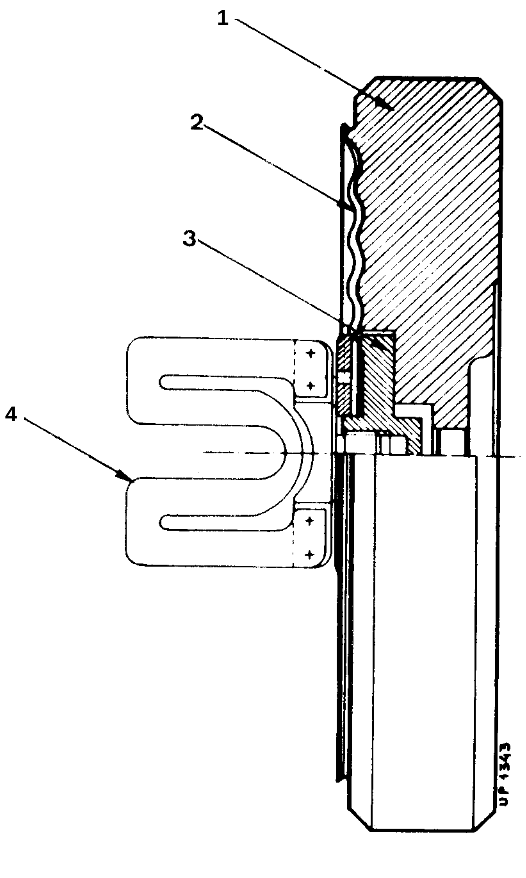


Fig. 2 - Transmission Unit

PRINCIPLE OF OPERATION

The Deltapi N series transmitters models NBC and NBD operate on the principle of equilibrium of the moments produced by the measured value and output signals. The force generated on the membrane (A) by the pressure applied to the positive (+) chamber, produces a moment about the fulcrum (l) which causes the bar (B) to move with this movement the position on the flapper (H) is changed with respect to the nozzle (G), causing an increase in the modulated pressure, in the case that the flapper moves towards the nozzle or a decrease in pressure if it moves away.
The modulated signal is amplified in pressure and flowrate by the continuous venting relay (F), and is simultaneously fed to the feedback bellows and the transmitter output. The pressure acting in the bellows (E) procedures a force which, applied to the bar (B) generates a moment about the fulcrum (l), which opposes the moment generated by the input signal pressure.
The block diagram in figure 5 illustrates the operation of the transmitter. The slider mechanism (C) has been built into the system to allow the span setting to be altered, within the preset limits of the transmitter, without having to make any structural modifications to the instrument.
Infact by changing the position of the slider (C), by means of the micro screw adjuster unit (L), a movement of the feedback beam is obtained and consequently a variation in the force produced by the input pressure, with the effect of re-balancing the system.
The output signal value is a standard 3-15 lb/in^2, 20-100 kPa or 0.2-1 Kg/cm^2.
In the absence of a measured value signal, a pressure of 3 lb/in^2 , 20 kPa or 0.2 Kg/cm^2 is present in the bellows, with the effect of causing the force beam (B) to move in order to avoid any movement, a spring (D) has been added, which effectively cancels the reaction to the pressure. This spring also forms part of the zero adjustment unit, the unit being externally accessible through a cut out in the instrument cover.
The block diagram in figure 5 shows the phases of operation of the transmitter.

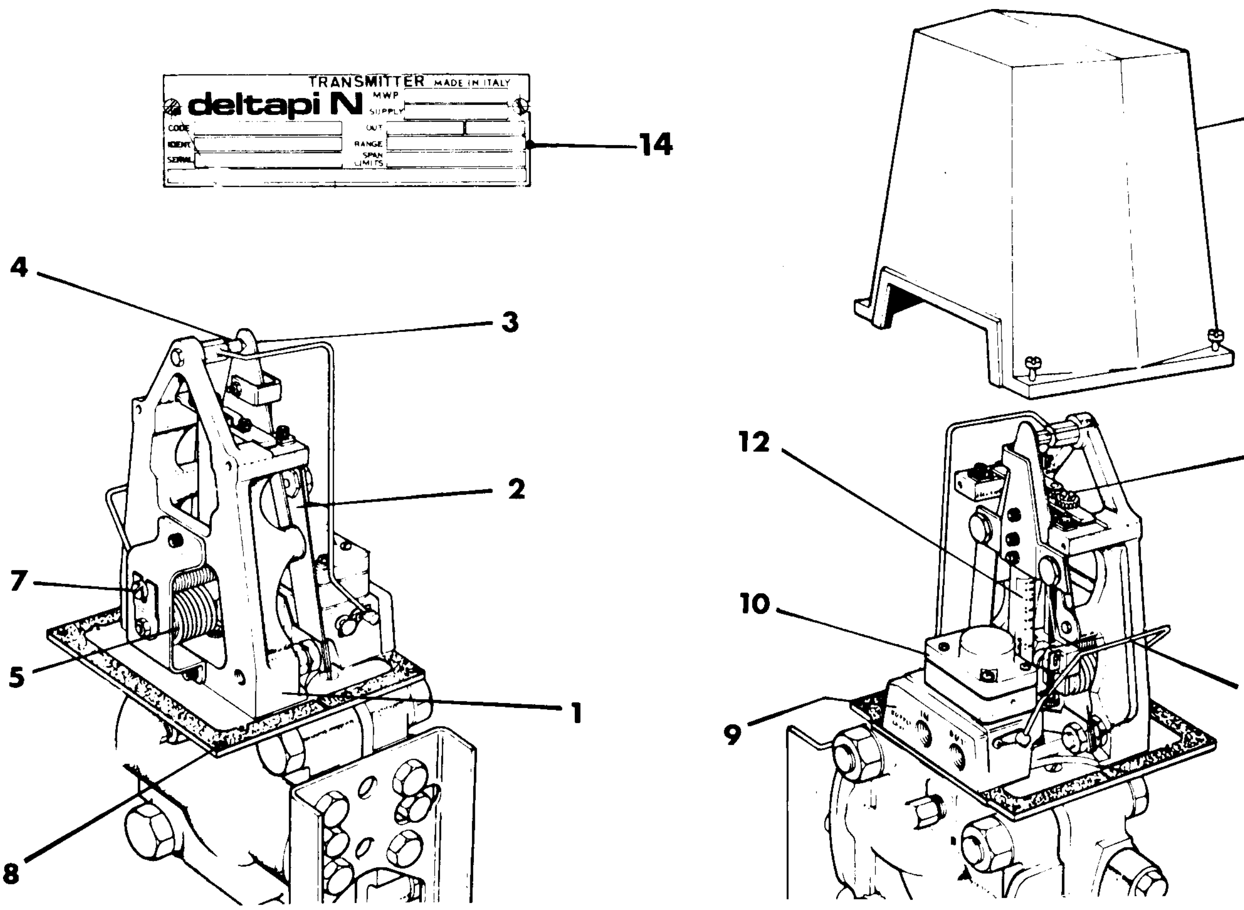


Fig. 3 - Transmission unit

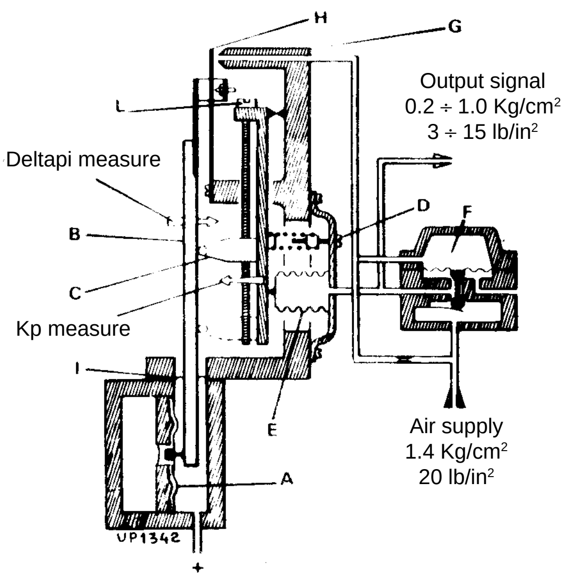
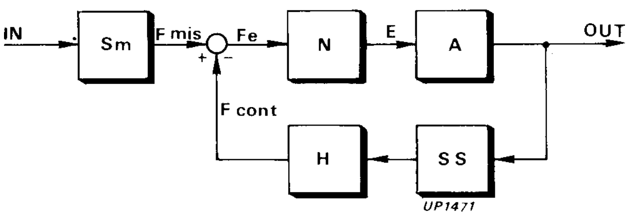


Fig. 4 - Principle of operation



where:

In	=	**Measured 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**
SS	=	**Feedback bellows area**
H	=	**Feedback gain**
F cont	=	**Generated force by the output and feedback**
Out	=	**Output pressure**

Fig. 5

OPTIONAL EXTRA ITEMS

Zero elevation (fig. 6)

A zero elevation device allows to set as a zero of the transmitter a measured variable value different from the absolute zero. Comprising a spring (A) adjusting screw (C) and mounting screws (B).

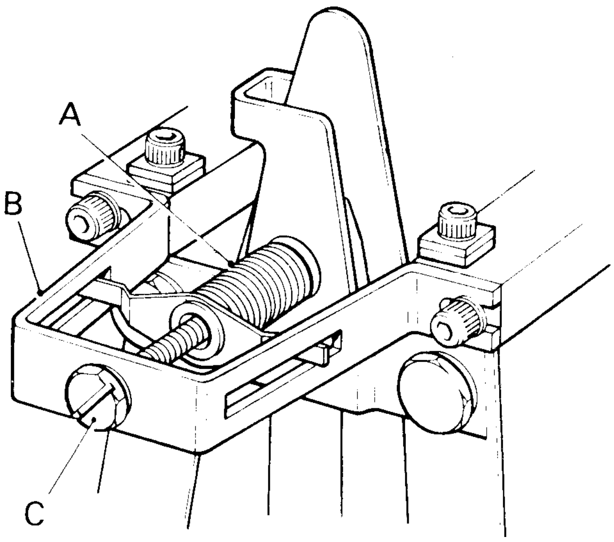


Fig. 6 - Zero elevation

Air filter regulator (fig. 7)

This device can be directly mounted on the transmitter, with or without output gauge, and connected with piping and fittings either in stainless steel or copper.

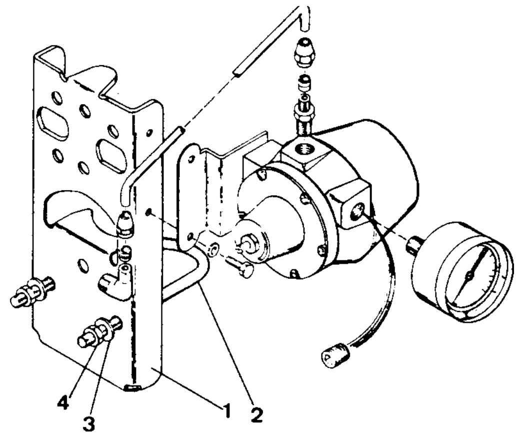


Fig. 7 - Air filter regulator

Oxygen measurement service

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

INSTALLATION

The models NBC and NBD transmitters are suitable for field mounting on a vertical position on a 2 inch diameter stand pipe by means of a mounting bracket.
Before installing the transmitter it is necessary to check that the ambient temperature does not exceed the limits given in the relative technical specification and that the location is not subject to mechanical vibration which would disturb the proper operation of the instrument.
The instrument should be mounted, in accordance with the dimensions given in the specifications relative to each particular model, in a convenient position allowing easy acess and removal, refitting of the cover, proceeding as follows:

- place the mounting bracket (1) against the stand-pipe, locating in the appropriate areas.
- fit the "U" bolts (2), using two flat washers (3) and tightening the two nuts (4), to fix the transmitter in a vertical position.
- make the process and pneumatic connections as described in the following paragraph.

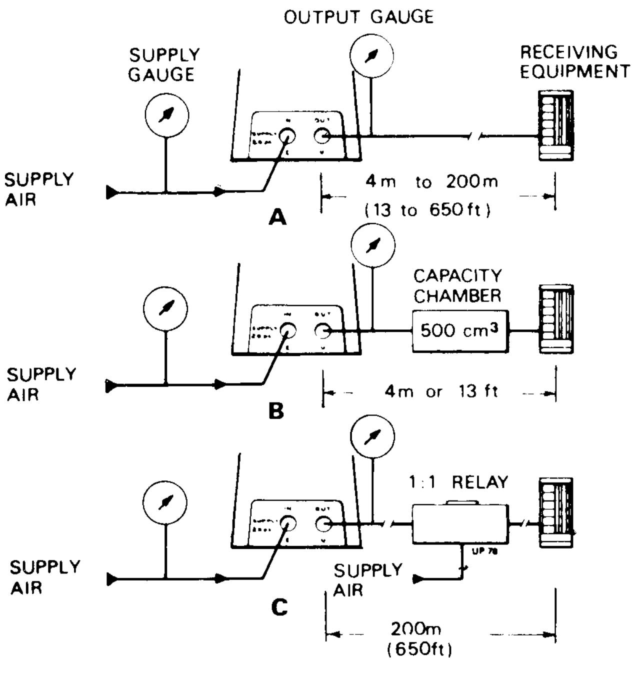


Fig. 9 - Pneuamtic and process connections

PNEUMATIC AND PROCESS CONNECTIONS (fig. 9)

The pneumatic connections should be made using either copper or plastic piping or size 4x6 mm. The process connection adaptor is available as 1/2 inch NPT (in the flange) or as 1/4 inch NPT (in the body).
The air supply and output connections are 1/4 inch NPT.
If the transmission line between the Deltapi and the receiver is less than 4 metres, the transmitter output signal may become unstable and oscillate; to avoid this situation it is recommended that a reservoir be fitted in the line, having a capacity of 500 cm^3. If the distance between the Deltapi and the receiver should exceed 200 metres it is recommended that a booster relay, 1:1 flow rate amplifier, be fitted in the line.
In order that the instrument functions properly the air supply used must be well filtered, dried and completely oil free.
All the piping and connections used for the air supply and transmitter output must be absolutely clean and air tight (a leak test may be carried out using soapy water solution with the output signal at maximum value: this is obtained by supplying the transmitter with air and blocking the nozzle by applying a slight pressure on the flapper).
The instrument should be supplied with air at 20 lb/in^2, preferably by using a pressure regulator and filter, fitted close to the instrument, in addition a pressure gauge should be fitted in the supply line as well as the output line.
Prior to making the connections remove the plastic caps, fitted in the air ports, to prevent the deposition of dust or any other impurity, in the ports and the measuring chamber. Then the air supply and output piping connections may be made and finally the instrument may be supplied at 20 lb/in^2.
The pneumatic connection between the process and the transmitter should be made as shown in fig. 10. The signal to be measured should be fed to the positive chamber of the instrument; the function of the valves A and B is to isolate the instrument from the process and to vent the measuring section during calibration and testing respectively.

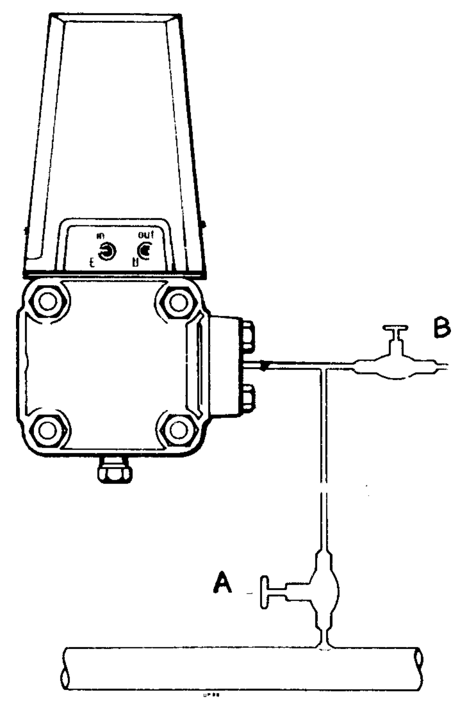


Fig. 10

A transmitter calibration must be carried out every time the instrument has been disassembled for cleaning purpose for the substitution of damaged parts or for a possible variation of the range.
In order to carry out this operation the following equipment is required:
- A vacuum pump (P)
- Two pressure gauges (accuracy 0.2%), to read the air supply M_1 and the output signal M_2
- An absolute pressure gauge M_3
- A capacity of 500 cc
- A pressure regulator R1
- Suitable spanners

The pneumatic circuit should then be connected up as shown in fig. 11.

Zero setting (Fig. 11)

To carry out this operation it is necessary to equalize the vacuum produced in membrane sensor with the vacuum in the positive chamber.
It is also necessary to have available a mercury manometer M_3 (with a scale of 0÷1 m. or 36 in/Hg), an accurate pressure gauge (class 0.2) to measure the output signal of between 3 and 15 lb/in² (0.2 and 1 Kg/cm²), two valves, all to be connected as shown in the test circuit.
Prior to carrying out the test, remove the zero elevation device (if fitted), by completely unscrewing the adjuster screw C (Fig. 6) and check that the circuit is absolutely leak free.
This is checked by opening valve A, closing valve B and using the pump P, produce a vacuum of 0.02 mm Hg read on the mercury manometer M_3.
Then close valve A and check that the indication on the manometer remains steady for at least 5 minutes.
After this operation apply an air supply to the instrument and using the gauge M_2 verify that the output signal is 3 lb/in² (0.2 Kg/cm²).
If this should not be the case adjust the zero screw (7) - Fig. 3 in order to obtain the designed condition.

Determination of the span (Fig. 11)

Carry out the operations described in the "zero setting" section, then proceed as follows:

for vacuum measurements, of values between absolute zero and the maximum span (for the NBD) or atmospheric pressure (for the NBC) proceed as follows:
Close valve B and open valve A.
By means of the vacuum pump, apply a pressure to the positive chamber, read on M_3, equal to the transmitter calibration span value and check that the output signal, read on M_2 is 15 lb/in² (100 kPa, 1 Kg/cm²) should this not be the case, move the adjuster (6) - fig. 3, in order to obtain the said value. Re-check the transmitter zero using the procedure described previously.
Repeat the operations relative to the span and zero settings in order to obtain a satisfactory result within limits of ± 0.06 lb/in² (0.4 kPa, 0.004 Kg/cm²) of the nominal output value.

for absolute pressure measurements (only for NBC), made between atmospheric pressure and the maximum span settable on the instrument (according to the type of measuring sensor fitted).
Make sure that the gauge M_3 used, has a range suited to the calibration span of the transmitter.
Check that the valves A and B are both closed and after having made the connection at T1 open valve C.
By means of the pressure regulator R_1, apply a pressure to the positive chamber, read on M_3, equal to the transmitter calibration span value.
Check that the output signal, read on M_2, is 15 lb/in² (100 kPa, 1 Kg/cm²). If this is not the case move the adjuster (6) - fig. 3, in order to obtain the said value.
Re-check the transmitter zero, proceeding as previously described.
Repeat the operations relative to the zero and span settings in order to obtain a satisfactory result within limits of ± 0.06 lb/in² (0.4 kPa / 0.004 Kg/cm²) of the nominal output value.

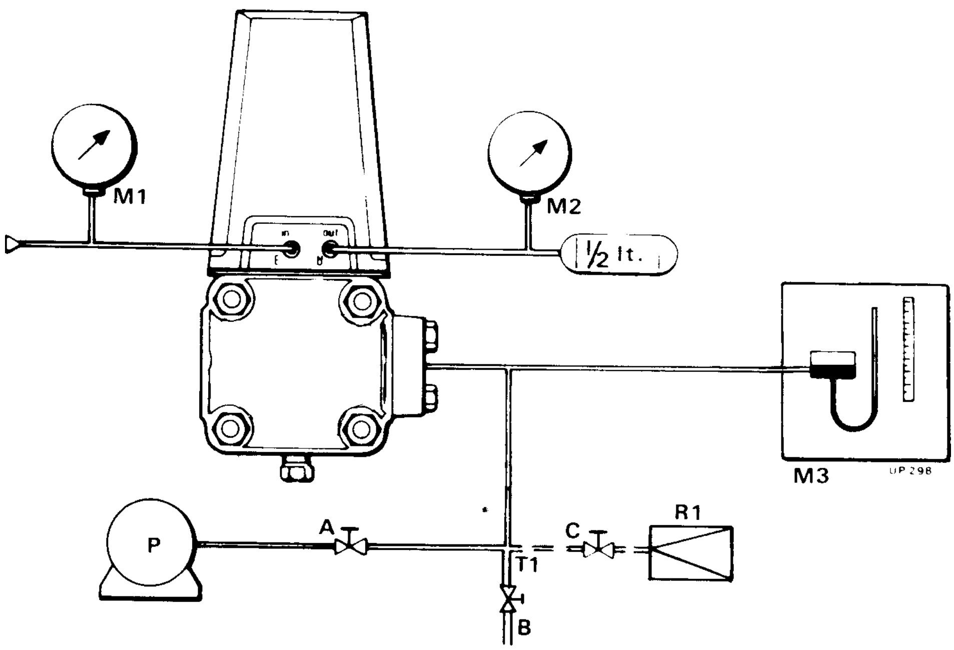


Fig. 11

Zero elevation or range suppression

As already mentioned the zero elevation unit is used in the case that the lower limit of the range of variation of the measured variable is not equal to absolute zero. In which case the instrument calibration span is defined by the difference between the upper and the lower limits of the range of the variable to be measured.

Example:
for measurements made in the scale range between 5200 and 14000 mmH2O, the instrument calibration span is 8800 mmH2O and the amount of zero elevation is 5200 mmH2O.

It is important to remember that the sum of the elevation value (E) added to the span (S) set on the transmitter, should never be greater than the upper limit of the measuring range (M) applicable to the sensor membrane.
By using the values given in table 1, check that the relation: $E + S \leq M$ is respected.

Table 1

MODEL	SENSOR TYPE	VALUE OF M (mmH2O)	MAX ELEVATION (mmH2O)
NBC	ø 2in	17000	14000
	ø 3in	5200	4700
	ø 3in with special bellows	5200	4950
NBD	ø 5in	750	630

After having carried out the procedure for calibration of the transmitter zero and span as detailed in the preceding sections, proceed as follows:
- fit the zero elevation unit to the transmitter as shown in fig. 6.
Check that the manometer M_3 (fig. 11) has a range suited to the value of elevation to be set on the transmitter.
By means of the vacuum pump P, or the regulator R_1, apply a pressure to the positive chamber, equal to the value of elevation to be set. Ensure that the elevation does not exceed the limits previously specified.
By turning the adjuster screw C (fig. 6) in a clock wise direction, bring the value of the output, read on M_2 to 3 lb/in^2 (20 kPa / 0.2 Kg/cm^2).

REMOVING AND REFITTING THE DIAPHRAGM CAPSULE

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 the operation is to be carried out in situ it should be borne in mind that some considerable force is required to loosen and then subsequently retighten the body clamp bolts and nuts. Therefore, care must be taken to ensure that the mounting is not overstrained.

Removal (fig. 1)

a) Isolate the transmitter from its receiving equipment and also from the 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) Release any residual pressure from the transmitter via the vent valve.
c) Disconnect the pressure pipe from the transmitter; if it is intended to remove the transmitter to the workshop for further service, disconnect all the connections and remove the transmitter from its mounting.
If the transmitter is fitted with range elevation mechanism remove the mechanism.
d) Remove the drain plug from the measuring unit body.
e) Insert a 6 mm AF socket key into the drain plug hole and release, but do not remove the socket nut which ensure the "U" flexure to the transmission bar.
f) Remove both bolts securing the positive chamber to the mounting bracket.
g) Remove the four nuts and bolts clamping the body halves, carefully remove the capsule taking care not to damage the "U" flexure.
The "U" flexure is removed by unscrewing it from the diaphragm capsule.

Refitting (Fig. 1)

When reassembling the transmitter it is recommended that a new diaphragm assembly seal be used.
a) To reassemble the body unit, position a diaphragm assembly seal in the recess of the measuring unit body forging. Enter the diaphragm capsule, into the recess ensuring that the "U" flexure-slot engages the transmission bar between the upper of the two washers and the shoulder. Ensure that the "U" flexure is aligned at 90° to the transmission bar axis.
b) Place the negative body half over the capsule and clamp in position with the four nuts and bolts.
c) Before the final locking verify that the transmission rod have not resistance to effect the movement for which it is provided, if this is not so, repeat the previous operations.
d) Tighten the clamp and nuts using a torque wrench set to 11 Kg/m.

. . . REMOVING AND REFITTING THE DIAPHRAGM CAPSULE

Alignment of the measuring membrane (fig. 11)

In order to carry out this operation the following should be done:

a) Build up the circuit as shown in figure 11.
b) Insert the special tool through the drain plug hole, to tighten the socket head screw on the transmission bar.
c) Close the vent valve (6 of fig. 1) and the valve B, open the valve A. By means of the vacuum pump generate the maximum vacuum read on the manometer M_3.
d) Close the valve A and check that the reading on the manometer remains steady for at least 5 minutes.
e) Apply an air supply to the instrument and check that the output is 3 lb/in^2 otherwise adjust the transmitter zero setting.
f) Lock the socket head screw and check that the output value has not changed. If the value has changed either loosen or further the screw until the correct value is obtained.
g) Disconnect the pump from the transmitter, remove the special tool and refit the drain plug.
h) In the case that the membrane (capsule) has been replaced with a new one, before putting the instrument rack into operation it is necessary to recheck the alignment and the calibration according to the "Calibration" section.
i) If the original capsule has been refitted, the instrument may be put back into operation, according to the "INSTALLATION" section without the need to check the calibration. If the instrument is equipped with a zero elevation unit, this unit must be refitted and recalibrated, by following the instructions given in the "Elevation of the transmitter zero section".

TAKING THE TRANSMITTER OUT OF SERVICE

If the transmitter is an integral part of a control system, make sure that taking it out of service does not cause any damage, and where appropriate verify that other measurement or control system have been brought into operation. Close the isolation valve A (Fig. 10) situated between the transmitter and the process. Open valve B and release any pressure built up in the transmitter. Disconnect the transmitter air supply connector.

MAINTENANCE

Under normal working conditions, the Deltapi maintenance is very low. To this purpose, it is recommendable to purge periodically the pressure reducer in order to avoid an excessive deposit of condensed vapour inside the same. Check periodically also the pneumatic and the process seals and make sure that any leaking is quickly eliminated.
However, particularly when the transmitter is working in dusty enviroments or when the supply air is not perfectly clean, a zero displacement may occurr. This might be caused by the depositing of dirt on the flapper, the nozzle, inside the capillary or the relay.
For the right cleaning of these elements, proceed as follows:

Flapper-nozzle group (Fig. 3)

a) Cut off these instrument supply and disconnect it from the process line.
b) Take off the protection cover (11).
c) Disconnect the nozzle-linking tube (13) from the connections block as follows:
   - holding tightly, by means of a 10 mm. spanner, the nozzle support, slacken the nut that locks it, using an 8 mm. spanner.
   - disconnect thus the tube from the connections block.
d) Clean the flapper very lightly and accurately, using alcohol moistened cotton. Make sure not to bend the flapper.
e) Clean the nozzle by pushing inside it a copper or bronze (not steel) wire of 1 mm. thickness max.
   Place then the nozzle in a solvent and then blow it dry with clean air.
f) Grease (or eventually substitute) the O-ring seal of the nozzle supply pipe. Assemble again finally the flapper-nozzle system.

Capillary (Fig. 12)

a) Disconnect the capillary from the connections block and clean it by pushing inside it a wire of 0.15 mm. max. diameter. Such wire is anyhow included in the "tool bag" for Deltapi instruments, ref. N° 4902.0001, of our production.
b) Grease (or eventually substitute) the O-ring seal and connect the capillary again.
c) Check the zero setting and, if necessary, adjust it.

Relay (Fig. 13)

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.

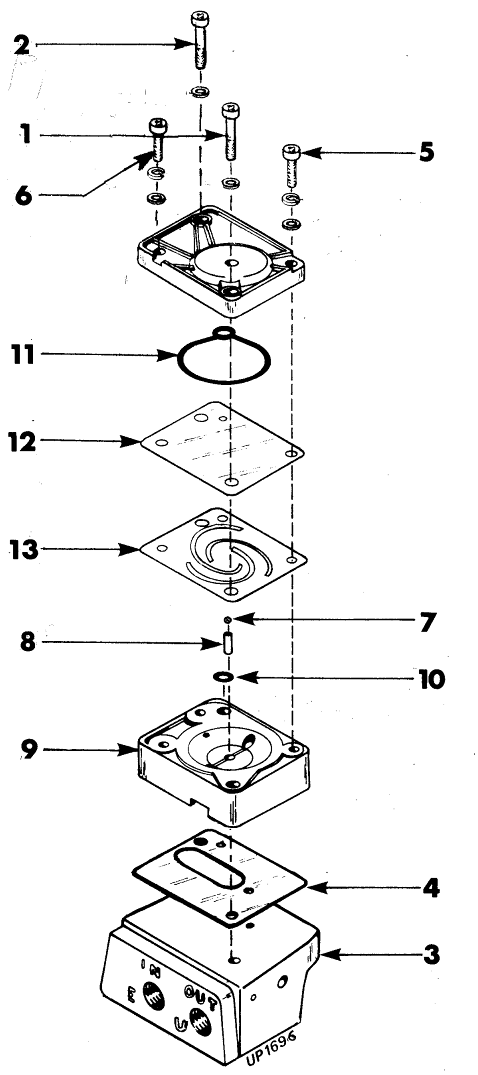


Fig. 13 - Exploded view of relay

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Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition.

In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of operating and maintenance records relating to the alleged faulty unit.

IM/NBC_BD Rev 1

The Company's policy is one of continuous product improvement and the right is reserved to modify the specifications contained herein without notice.

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