

# Pneumatics and Hydraulics

Input, Control and Processing elements part 3

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# Outline

- Pneumatic sensors
- Pneumatic transducers

# Pneumatic Proximity Sensors

- With pneumatic proximity sensors the presence and absence of an object is detected by means of contactless sensing with air jet (Flapper and Nozzle system).
- When an object is present, a signal pressure change occurs, which can be further processed.

## Advantages:

- Operational safety in dusty environments.
- Operational safety with high ambient temperature.
- Can be used in areas of explosion hazard.
- Insensitive to magnetic influences and sound waves.
- Reliable even in extreme ambient brightness and for sensing of light transparent objects where optical proximity sensors may not be suitable.

# Pneumatic Proximity Sensors Disadvantage

Since the price of a complete proximity sensors (Nozzle, pressure amplifier and pressure switch) is generally higher than that of a standard inductive, capacitive or even optical proximity sensors, pneumatic proximity sensors are used preferably for special applications where other proximity sensors are unsuitable.

- Pneumatic Proximity Sensors Types

1. Back pressure sensor (Pilot Tube).
2. Reflex Sensor (Reflection eye) .
3. Air barrier sensor (Air Gate).

# Pneumatic Proximity Sensors

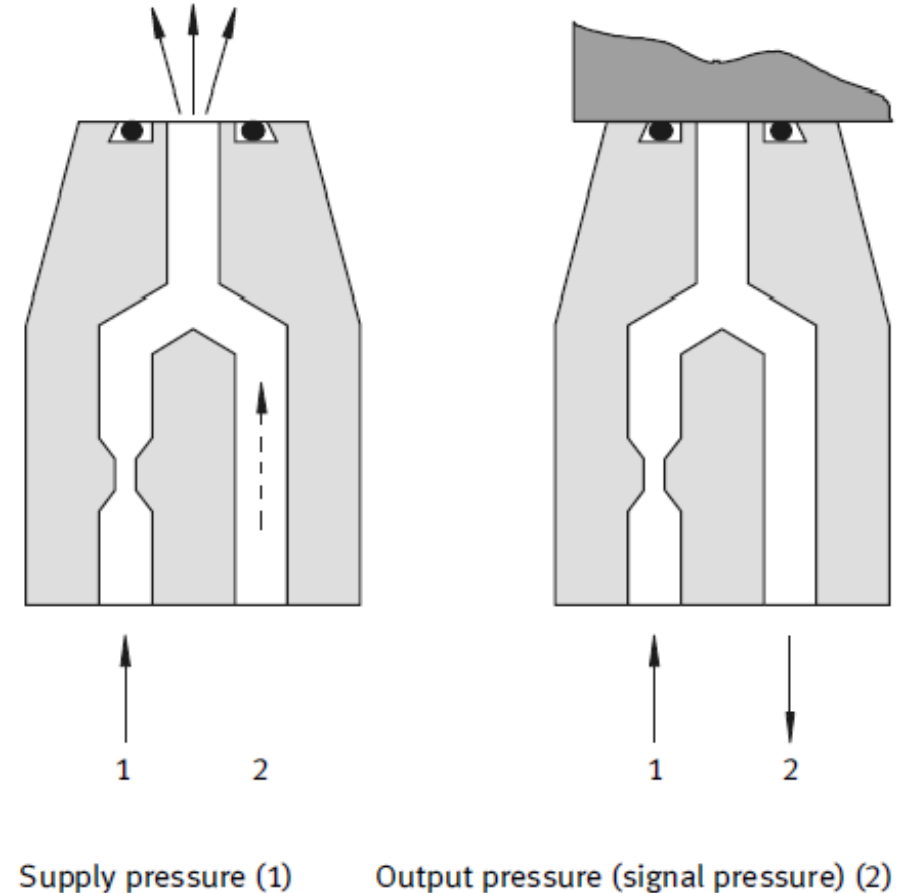
- For all sensors types the signal pressure generated depends on the supply pressure and the distance between the nozzle and the object.
- Detectable distance range from 0 to 100 mm.

## Pneumatic Proximity Sensors Requirements:

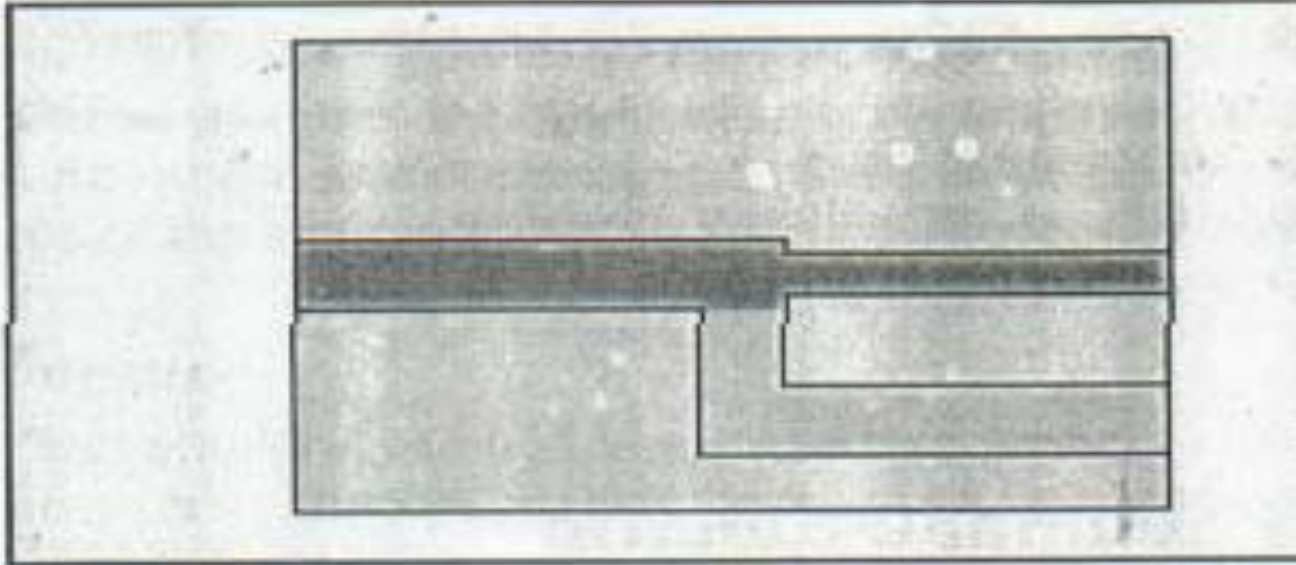
- Reduce the system air pressure to a low-pressure range by using pressure regulator.
- Clean and oil free air is essential.
- As the pneumatic signal is generated too weak for further evaluation, a pressure amplifier needs to be connected downstream.
- A pneumatic proximity sensor with binary electric output signal is created with the help of pneumatic to electrical converters (Electrical pressure switch).

# Back Pressure Sensor (Pilot tube)

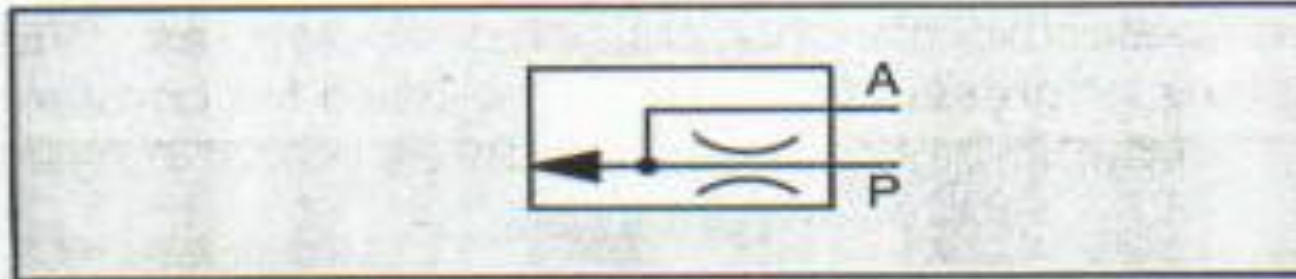
- The obstructing of an air jet (Nozzle) by means of an object to be detected leads to a signal pressure build-up in the control port to the level of the supply pressure.
- When the nozzle is completely covered (full effectiveness obtained), an output pressure will be at the same level with supply pressure.
- By chocking the air supply and by appropriate channel shaping you can use a normal pressure level as supply pressure to the sensor.
- In this case, an amplification of the output is unnecessary, and at the same time, the air consumption is reduced.
- *For this type, the sensing distance is between 0 to 0.5 mm.*



# Back Pressure Sensor (Pilot tube)



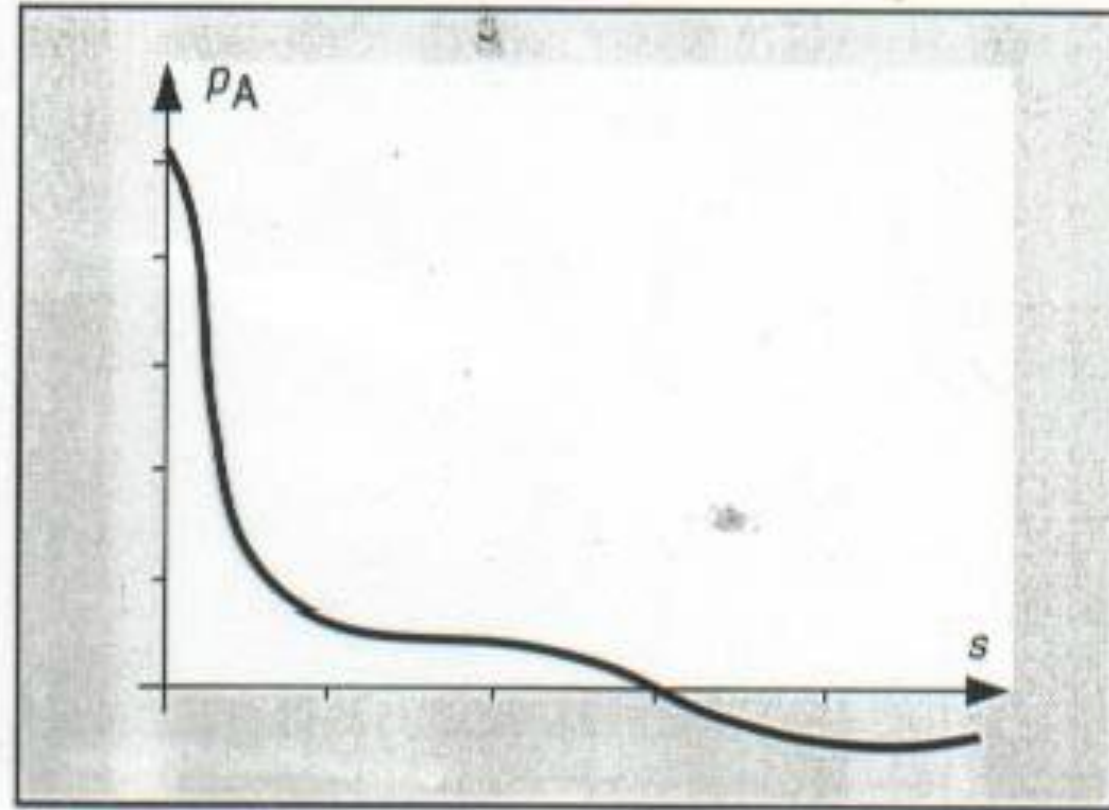
*Pilot tube*



*Graphic symbol*

# Reflex Sensor (Screen Nozzle)

- The reflex type sensor consists of an annular ring jet nozzle (Emitter) and central receiver nozzle arranged concentrically.
- ***Function***: The annular air flow causes a negative pressure in the centrally positioned receiver channel if the air flow is not unobstructed.
- When the object approaches, the pressure becomes positive and reaches the supply value when the nozzle is completely obstructed. The following curve represents the relationship between the output signal and the sensing distance.

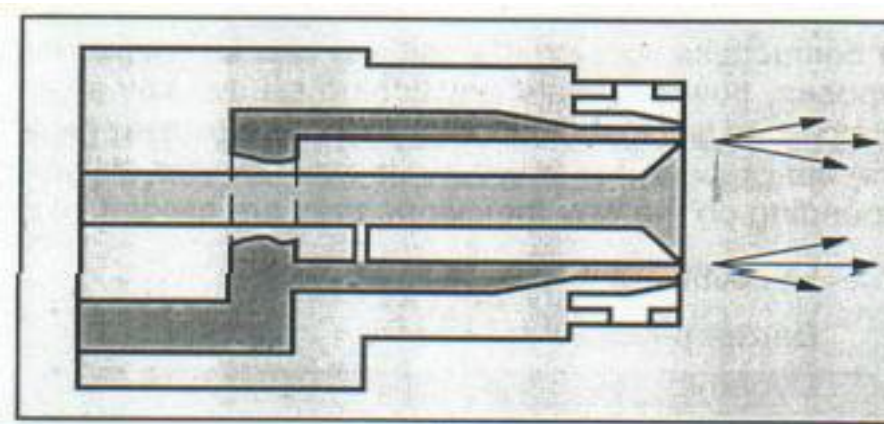


Control pressure vs. sensing distance

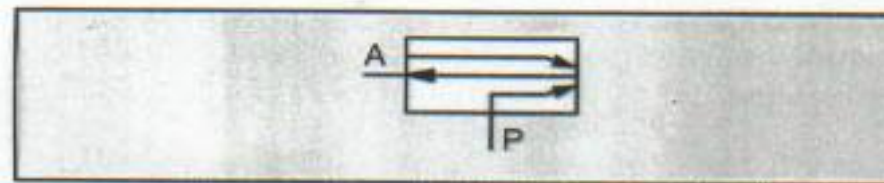


# Reflex Sensor (Screen Nozzle)

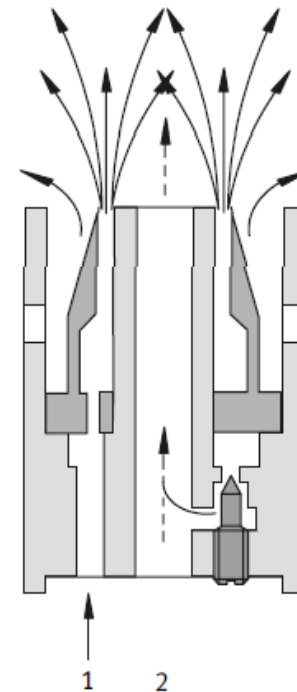
- For this type, the sensing distance is between (2 to 6 mm) up to 15 mm.
- For a supply pressure of (0.1 to 0.5) bar, the usable output signal pressure range is (0.5 to 2) mbar.



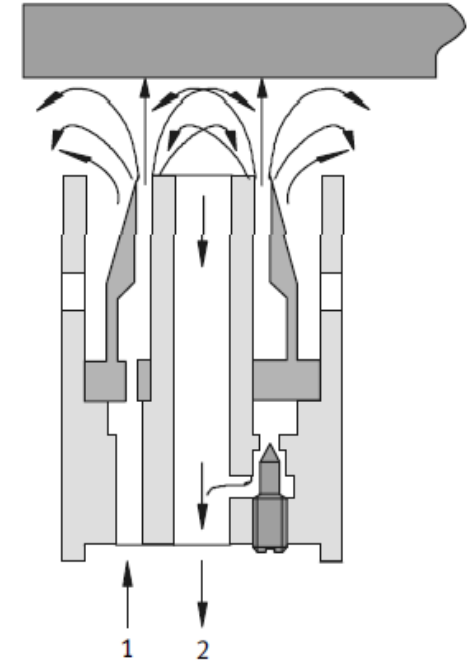
Example of a practical version



Graphic symbol

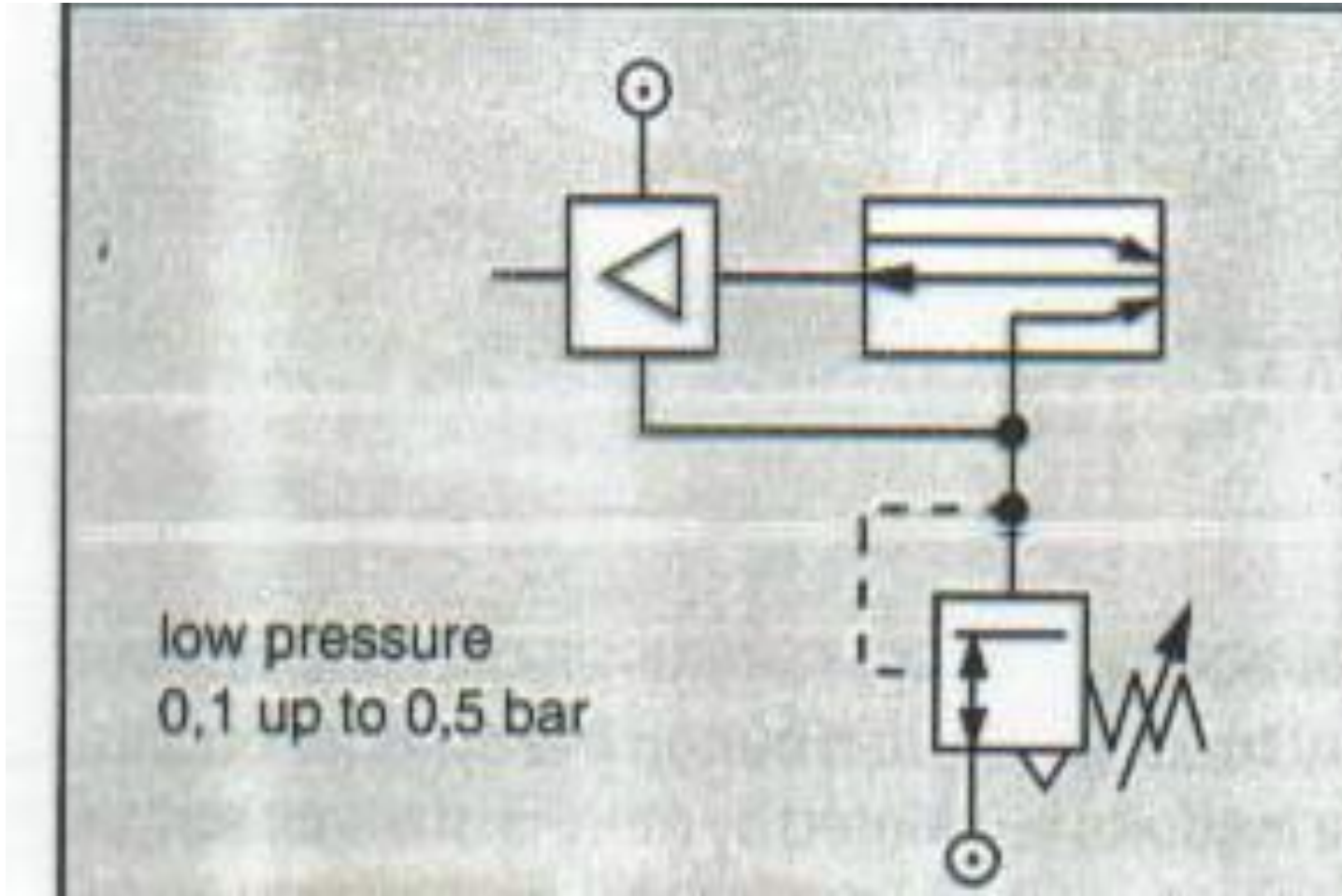


Supply pressure (1)



Output pressure (signal pressure) (2)

# Reflex Sensor Circuit Diagram



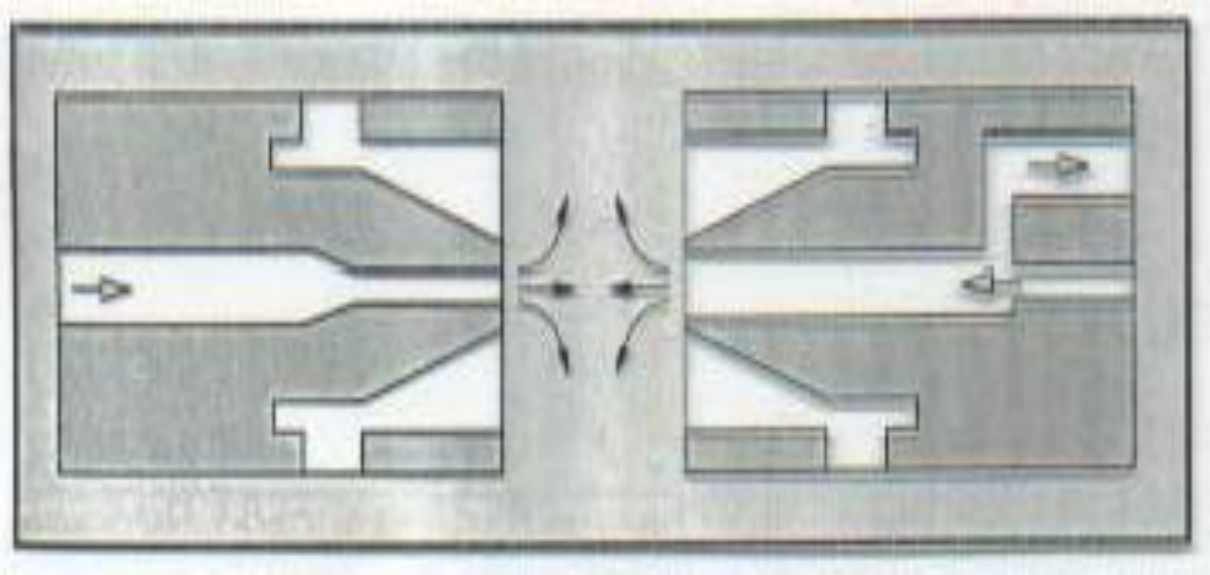
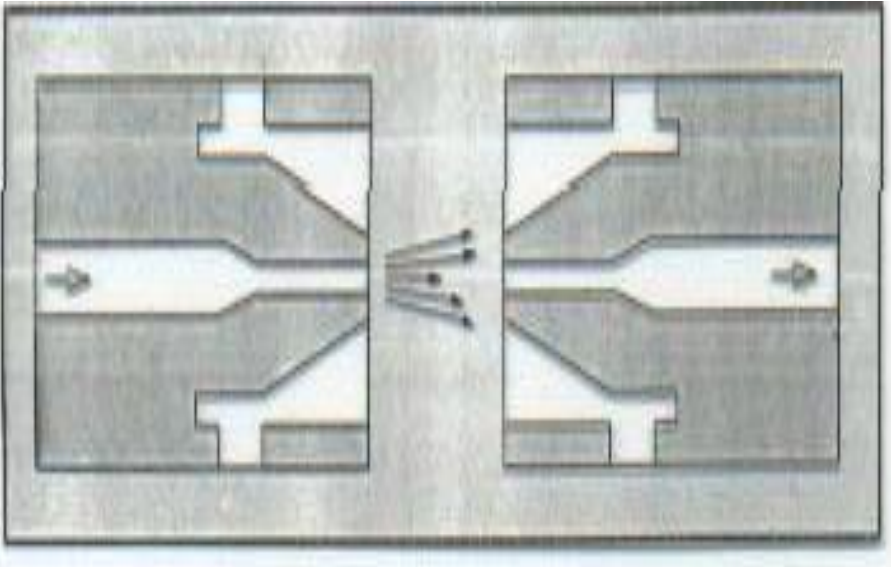
# Air Barrier Sensor

By placing a ring jet nozzle (Emitter) directly opposite a receiver nozzle, it is possible to construct an air barrier which is interrupted by an object.

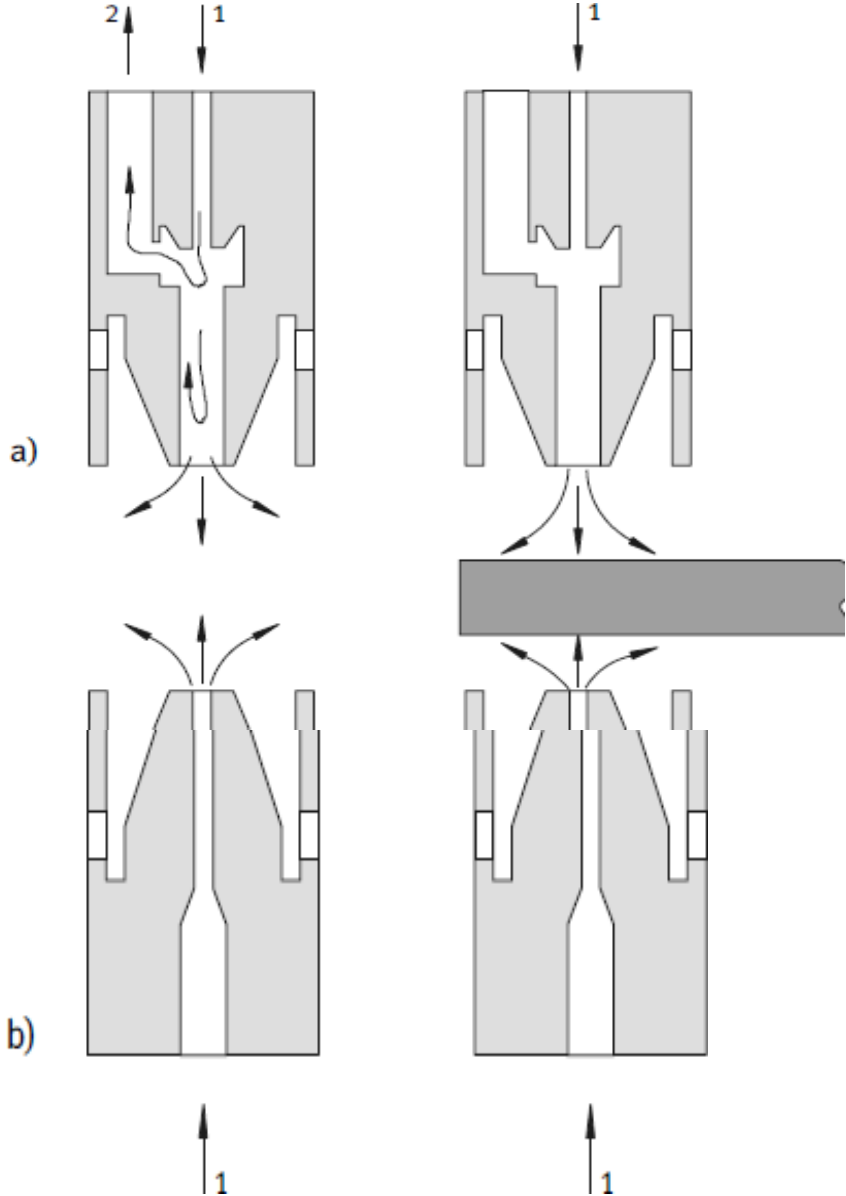
For this type, the sensing distance is up to 100 mm.

- There are two types of air barrier sensor:
  1. **Air barrier without pressure receiver.** Simple construction, consists of: Transmitter nozzle, normal receiver nozzle (with out pressure). **The disadvantage of this type is the sensitivity to external influence (dust)**
  2. **Air barrier with Pressure receiver.** In order to reduce the sensitivity to external influences, the receiver nozzle is pressurized.

# Air Barrier Sensor



# Air Barrier Sensor



supply pressure (1)

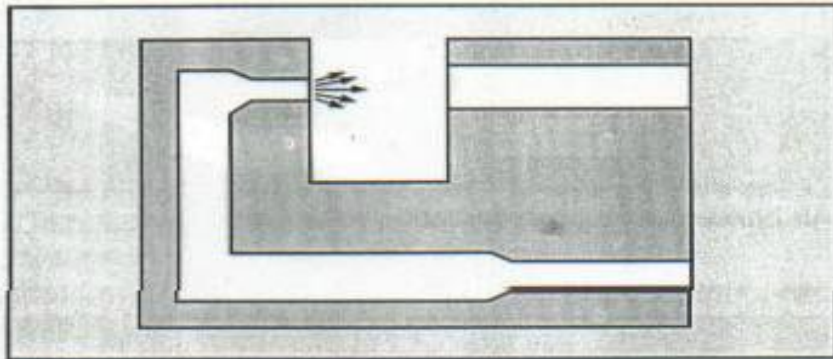
output pressure (signal pressure) (2)

a) Receiver nozzle

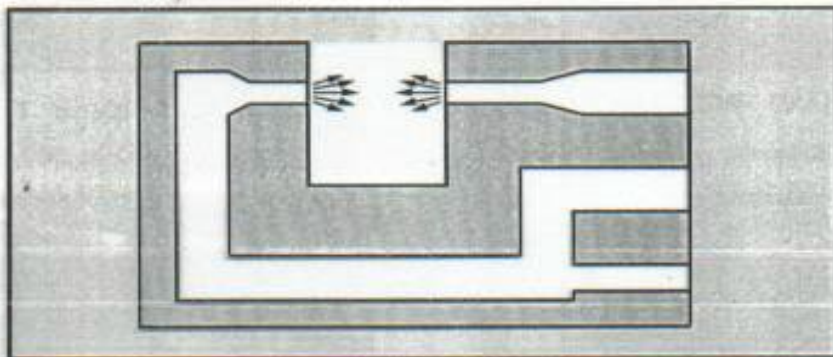
b) Emitter nozzle

# Air Barrier Sensor

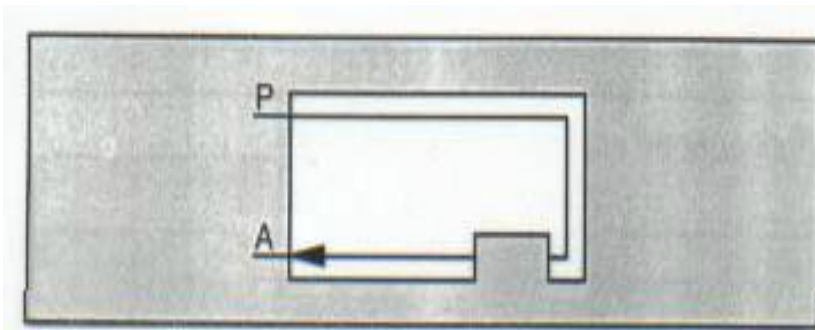
Air barrier are pressurized with low pressure (0.1 to 0.5) bar, in order to obtain a usable output signal pressure from (0.5 to 2) mbar. This signal must be amplified.



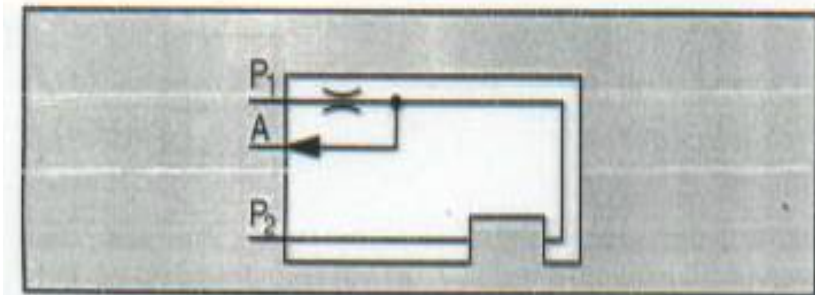
*Fork-shaped air barrier*



*Fork-shaped air barrier with pressurised receiver nozzle*

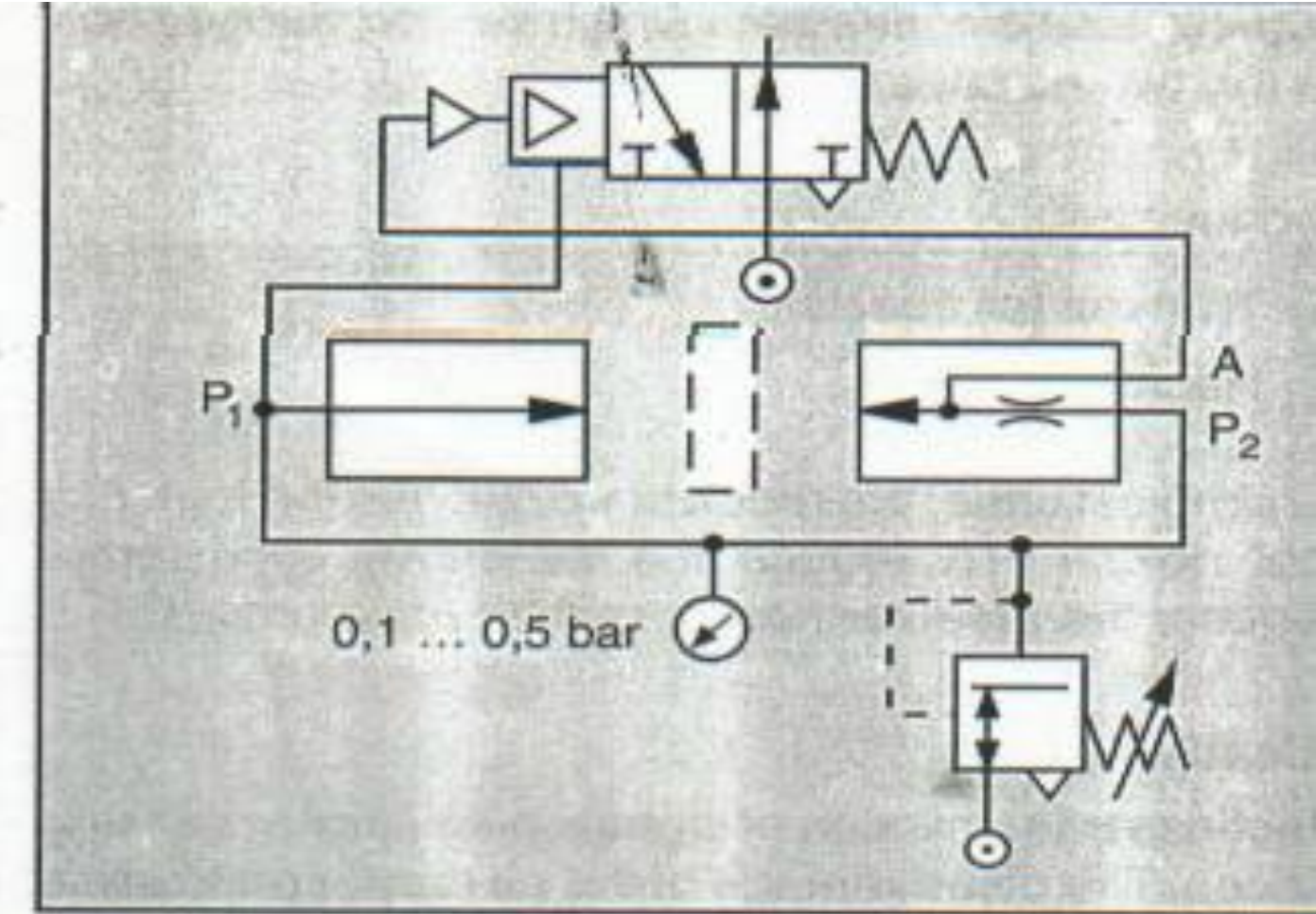


*Gap sensor*



*Gap sensor with pressurised receiver nozzle*

# Air Barrier Sensor



Connection example

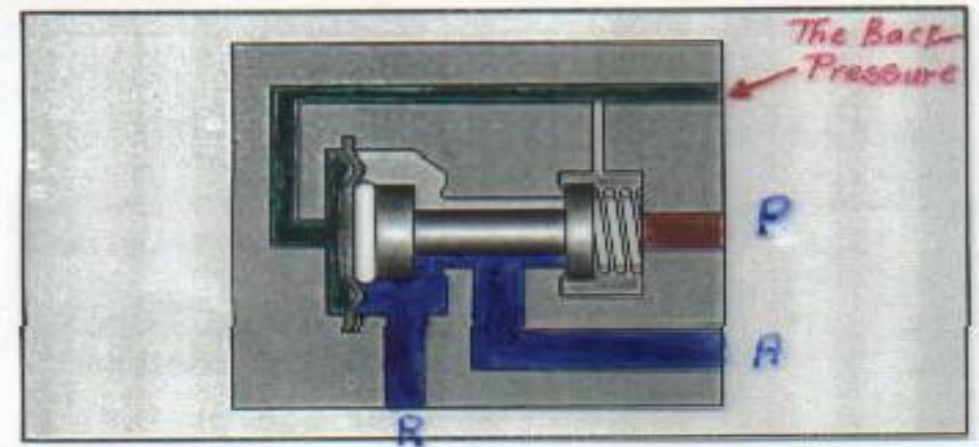
# Dynamic pressure switch

## 2. Dynamic Pressure Switch

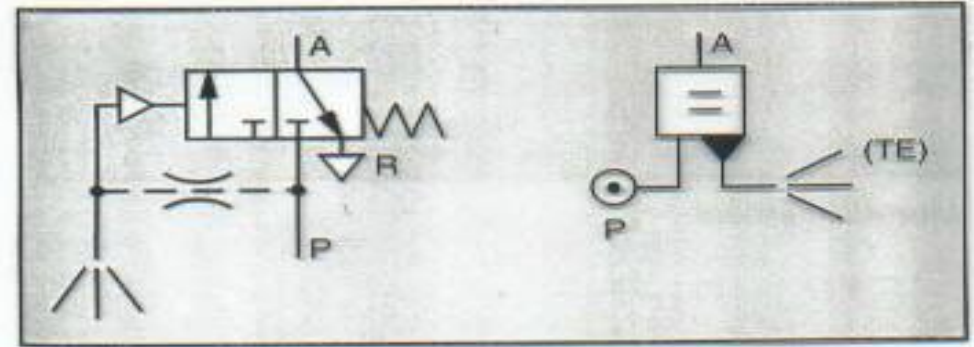
In contrast to the pilot tube, in the dynamic pressure switch the backpressure channel is integrated into a 3-port 2-position directional control valve. In this way the sensing point can be designed as a simple nozzle if it is connected to the dynamic pressure switch via a pipe. The length of the connecting pipes can cause switching delays.

### Properties

The advantage of the dynamic pressure switch is the possibility of using normal supply pressure and, in the case of a covered nozzle, of obtaining an output signal of equal value. A low pressure regulator and amplifier are therefore unnecessary.



Dynamic pressure switch



Graphic symbol



# Pneumatic pressure amplifier

## 7.8 Pneumatic Amplifiers

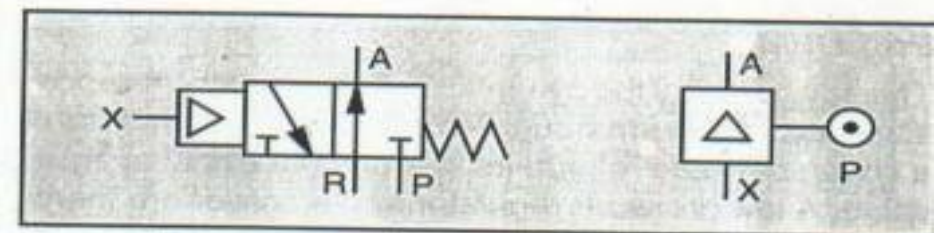
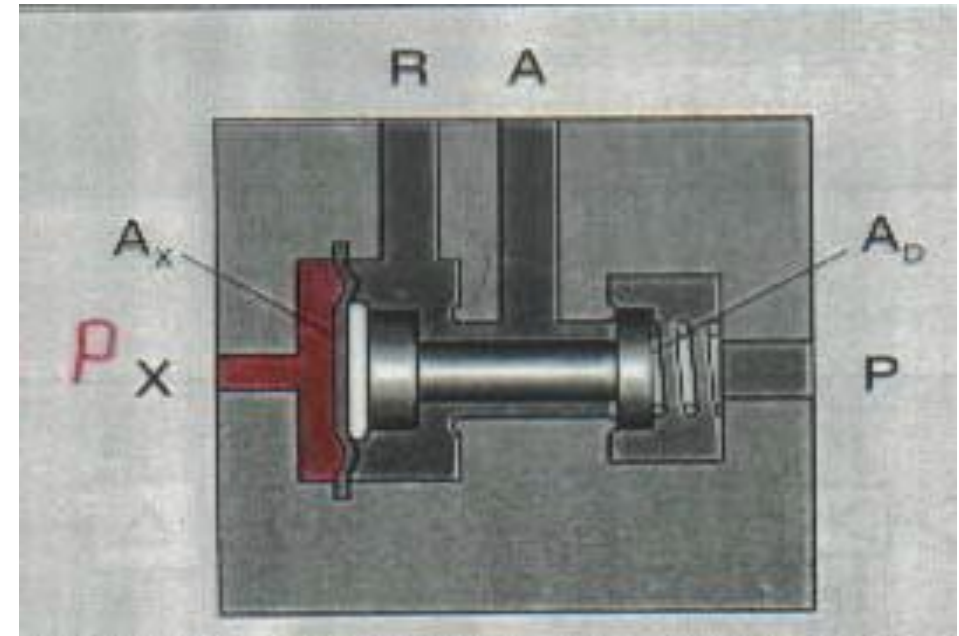
Pneumatic pressure is amplified by changing the areas. Depending on the amplification factor required, single- or two-stage types are used.

The amplification factor  $V$  is the ratio of the output pressure  $p_A$  to the pilot pressure  $p_X$ .

$$V = \frac{p_A}{p_X}$$

### 1. Single Stage Pressure Amplifier

The pilot pressure  $p_X$  acts on the pilot area  $A_X$  generating an actuating force  $F_X$ , opposing the pressure  $p$  and acting on the sealing disc area  $A_D$  and the force of the spring. Depending on the ratio of the areas, an amplification factor as high as 10 can be obtained in practice.



Graphic symbol

# Pneumatic pressure amplifier

## 2. Two-Stage Pressure Amplifier

These are usually designed so that low pressure air is supplied to the first stage, the second stage handling the full pressure.

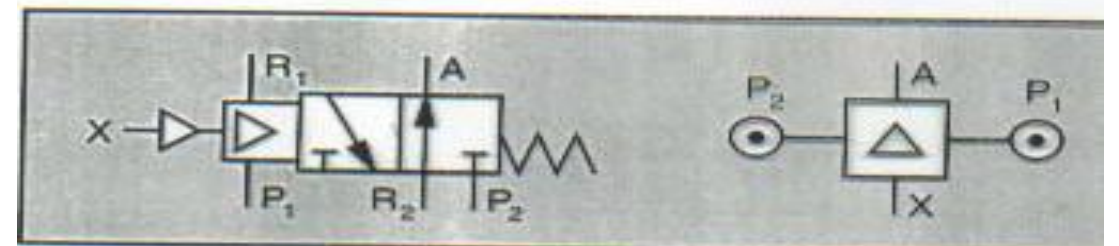
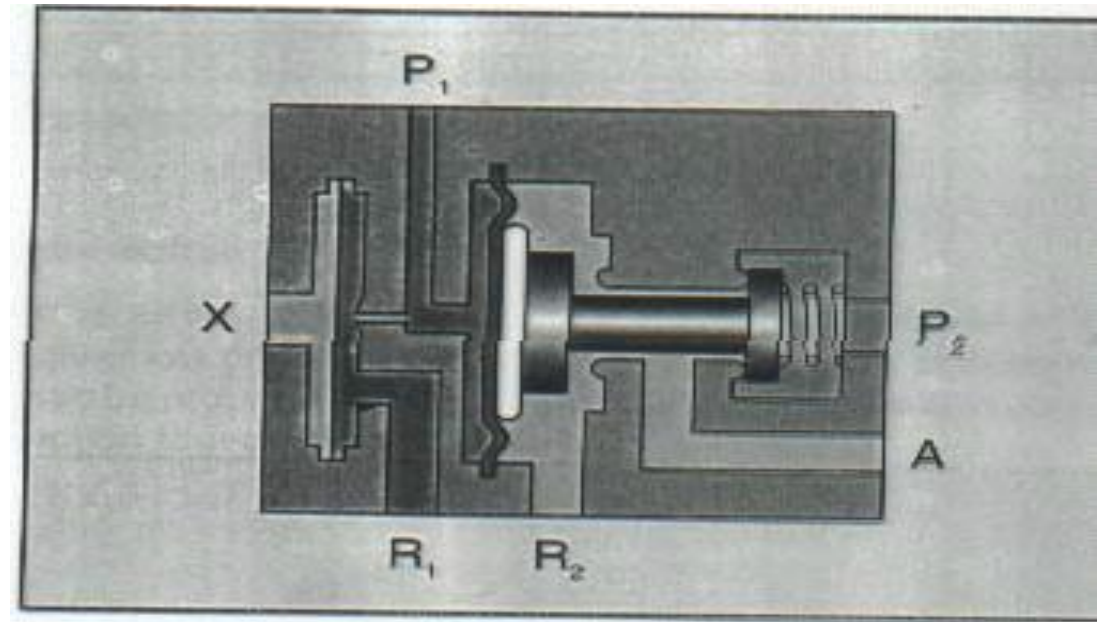
Amplification factors up to **12 000 :1** are possible.

The attainable amplification depends on the design, the supply pressure  $p_1$  and the supply pressure  $p_2$

- Application areas for pneumatic amplifiers are primarily the amplification of output signals of contactless sensors, amplification of pressure measurement data and of pilot tubes operating without covered nozzles.

Amplification by way of area difference

With two-stage amplifiers  
1st stage is supplied with low pressure,  
2nd stage with normal pressure.



# Pneumatic-electric transducers

## 7.9 Pneumatic-Electric Transducers

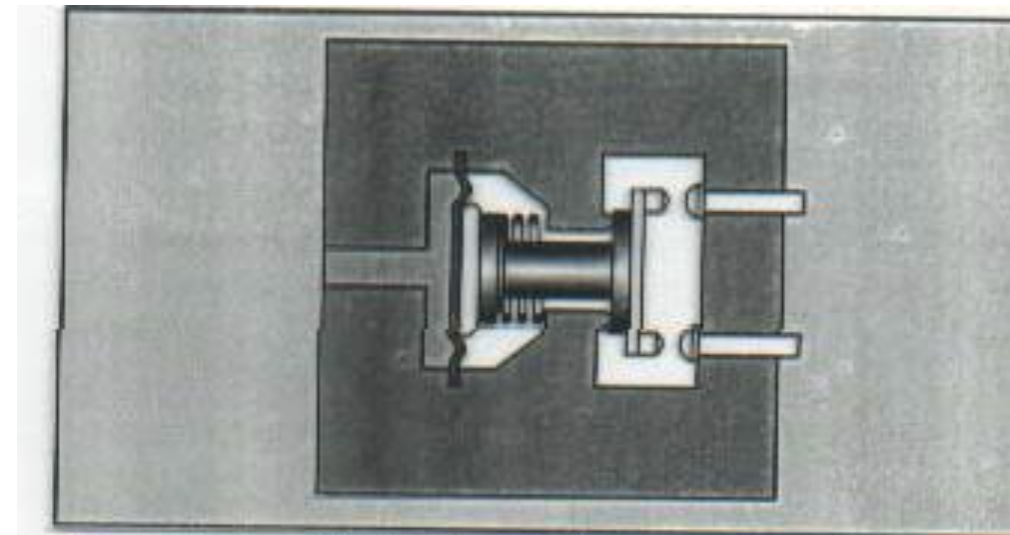
Pneumatic-electric transducers, also known as P/E transducers or pressure switches, are used for converting a pneumatic input signal into an electrical output signal.

### 1. Transducers with Fixed Switching Point

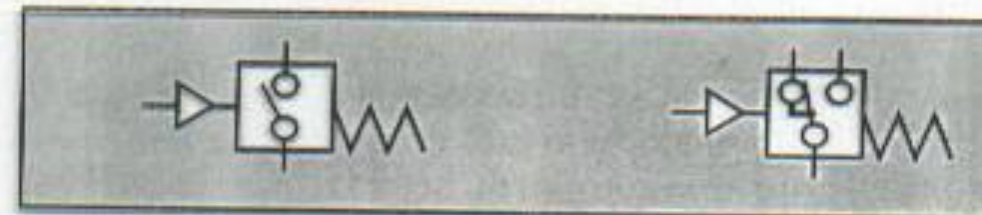
These have a fixed response pressure which depends upon the pressure range used. For transducers in the normal pressure range, it lies usually between 1 and 3 bar.

### Function

A pneumatic drive system (piston, diaphragm) operates an electrical contact. Transducers are often equipped with a manual override to allow the triggering of a switching signal either for testing purposes or in case of an electrical supply failure.



*Transducer with fixed switching point*



*Graphic symbol*

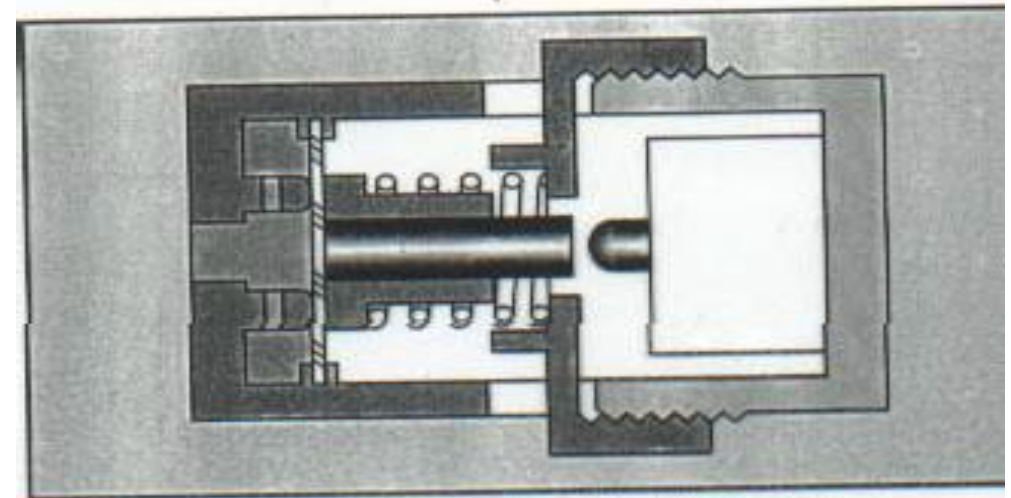
# Pneumatic-electric transducers

## 2. Transducers with Adjustable Switching Point

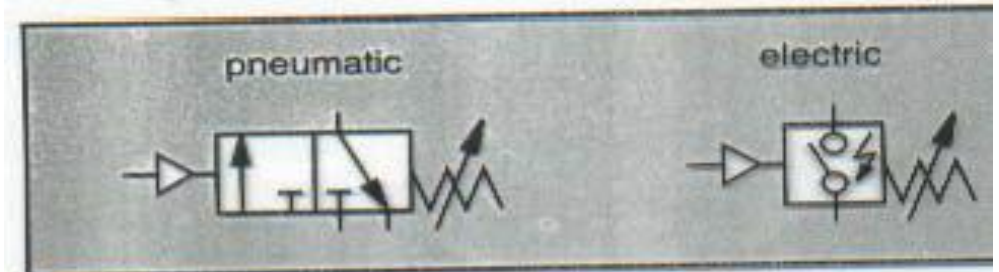
These devices are freely adjustable within a fixed pressure range, and depending on the design and the materials of the equipment, can be used for various media.

### Function

The switching force is generated by a pressure acting on an area in opposition to the force of an adjustable spring.  
If the pressure is greater than the spring force, it actuates one or more switch contacts.



*Transducer with adjustable switching point*



*Graphic symbol*

End

Thank you