PART 2: SECTION 6

CHAPTER 2

PRESSURE GAUGES AND PRESSURE WARNING LIGHTS

Purpose

1. The purposes of fuel, oil, and hydraulic pressure gauges are self-explanatory; those of the remaining pressure gauges and warning lights are explained later in this chapter.

Implementation

2. Instruments for measuring gas and fluid pressures contain a flexible member which is distended by an amount proportional to the pressure difference. This distension, after magnification, is relayed mechanically or electrically to cause a pointer to move over a suitably calibrated scale.

3. There are two basic types of pressure gauge :—

(*a*) Those in which the pressure is applied to a diaphragm, capsule, or bellows.

(*b*) Those in which a Bourdon tube is the flexible member. This tube, which is curved, closed at one end, and oval sectioned, tends to straighten when the pressure inside it increases.

4. Of the above basic types, the former can be made more sensitive and accurate than the latter, but the latter are better suited to the measurement of very high pressures.

5. It is desirable to exclude from the cockpit, as far as possible, pipes containing hazardous liquids under pressure. Leaks or fractures in an instrument or its piping may not only lead to engine failure, but also render the cockpit untenable. This has led to the development of *transmitting* devices in which a sensitive unit is located at the engine or other appropriate part, its movement being relayed hydraulically or electrically to the instrument panel.

6. **Hydraulic Transmitters.** One type (Fig. 1, left) consists of two chambers separated by a diaphragm. The pressure of the oil or fuel in one of the chambers is communicated by the diaphragm to a selected liquid in the other chamber and thence, by capillary tubing, to the instrument. Another type (Fig. 1, right) employs a capsule which is filled with the transmitting fluid (or gas in some instances) and is surrounded by the fuel or oil under pressure.

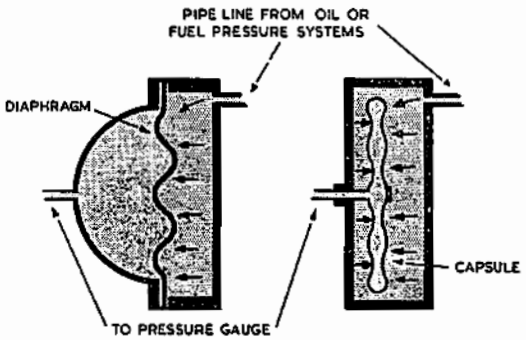


Fig. 1. Diaphragm and Capsule Pressure Transmitters.

7. **Electrical Transmitters—Desynn Type.** The Desynn transmitter (Fig. 2, left) contains a fixed resistance in the form of a continuous circular coil, tapped at three points 120° apart.

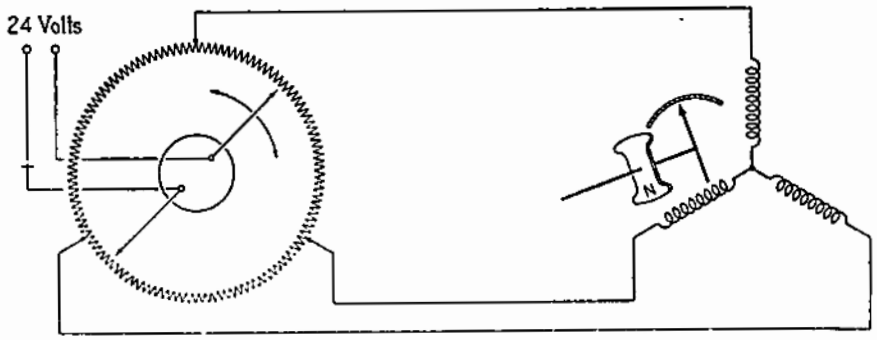


Fig. 2. Desynn Transmitter and Indicator Circuit.

By means of an arm carrying two brushes, current is applied to the resistance at diametrically opposite points, the position of the arm being controlled by a pressure-operated bellows mechanism. Each of the three tappings on the transmitting resistance is connected to one of the outer ends of three coils (Fig. 2, right) on the indicator, which are disposed with their electrical axes also 120° apart. The inner ends of the coils have a common connection. The resultant magnetic field due to the current in the three coils moves therefore in a fixed relationship to the two transmitting brushes. A permanent magnet is suspended within this field on bearings and has a pointer fixed to its shaft. The magnet aligns itself with the direction of the resultant field, and thus the pointer moves in sympathy with the transmitter brushes.

8. There are other types of transmitters, but detailed descriptions of them are beyond the scope of this manual.

CONSTRUCTION AND OPERATION

9. Constructional details of pressure gauges are given in A.P. 1275A. The following descriptions are in broad outline only.

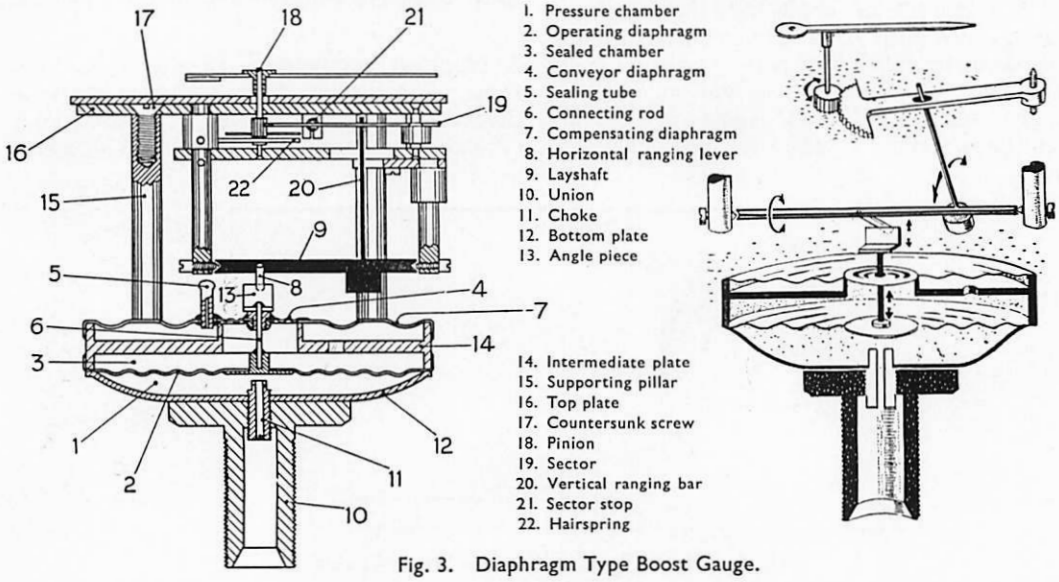
Boost Gauges

10. Boost gauges indicate the pressure in the induction manifold, and thereby in conjunction with engine speed indicators give an indication of engine power. Most R.A.F. boost gauges are calibrated in pounds per square inch above and below standard sea level atmospheric pressure, *i.e.* 14·7 lbs./sq. in. equals zero boost. Thus a gauge reading zero indicates that the induction manifold (or boost) pressure is 14·7 lbs./sq. in. and a gauge reading of +4 indicates a pressure of 18·7 lbs./sq. in. Boost gauges in all American and some British aircraft are calibrated in inches of mercury absolute, on which scale 29·9 inches Hg. equals zero boost.

11. Although a lubber mark is usually fitted to the glass of the instrument to indicate the maximum boost for level flight, pilots should be well acquainted with their engine limitations.

12. **Capsule Type Boost Gauge.** This version, which is very similar to a simple altimeter, has an aneroid movement comprising an evacuated capsule and a magnifying mechanism, the whole being mounted in an air-tight case. A pipe connects the case to the inlet manifold; thus any change in manifold pressure causes the capsule to expand or contract, moving the pointer over the calibrated scale. To safeguard the instrument against backfires a small hole forms a choke in the union between the instrument and the pipeline. A fuel trap is also included in the pipeline and must be kept drained to prevent corrosion of the instrument mechanism. The principal disadvantage of this type of boost gauge is the possibility of errors arising from a leak in the case, due to imperfect seating of the glass or insufficient tightening of the bezel.

13. **Diaphragm Type Boost Gauge.** In this type (Fig. 3) the pressure in the induction system



1. Pressure chamber
2. Operating diaphragm
3. Sealed chamber
4. Conveyor diaphragm
5. Sealing tube
6. Connecting rod
7. Compensating diaphragm
8. Horizontal ranging lever
9. Layshaft
10. Union
11. Choke
12. Bottom plate
13. Angle piece
14. Intermediate plate
15. Supporting pillar
16. Top plate
17. Countersunk screw
18. Pinion
19. Sector
20. Vertical ranging bar
21. Sector stop
22. Hairspring

Fig. 3. Diaphragm Type Boost Gauge.

enters through the union (10) and passes through the choke (11) to the chamber (1) formed by the diaphragm (2) and the bottom plate (12). Movement of the diaphragm is transmitted to the indicating mechanism by the connecting rod (6), which has an angle piece (13) fixed on its end. Attached to the layshaft (9) are the horizontal ranging lever (8), the other end of which rests on the angle piece, and the vertical ranging bar (20), the other end of which engages in a hole in the sector (19). Upward movement of the diaphragm causes the layshaft to turn, the vertical ranging bar and the sector to pivot forward (towards the reader), and the pointer to rotate clockwise. A hairspring (22) is mounted on the pointer spindle to take up play in the mechanism. This gauge provides compensation for changes in external pressure and, by protecting the mechanism from petrol, eliminates the need for a fuel trap. Above the operating diaphragm is a sealed chamber (3), enclosed on the upper side by the annular compensating diaphragm (7) and the small conveyor diaphragm (4). The conveyor diaphragm is there merely to provide a flexible seal for the connecting rod (6). The compensating diaphragm has maximum freedom of movement on a line midway between its inner and outer edges, and this line is used as a pitch circle on which the three mechanism supporting pillars (15) are mounted. Thus a fall in atmospheric pressure causes the whole mechanism to indicate a rise, and there is no movement of the horizontal ranging lever by the angle piece.

Fuel and Oil Pressure Gauges

14. Fuel and oil pressure gauges are usually transmitting types. In some versions the pressure sensitive element is a Bourdon tube, while bellows are used in others. Fig. 4 shows a gauge using a Bourdon tube as the pressure sensitive element. The Bourdon tube (6) is fixed at one end to the assembly plate (12) by a brass stem (8) and either directly or through a hydraulic transmitter is subjected to the pressure in the oil or fuel system. The tendency of the Bourdon tube to straighten is communicated to the sector gear (9) and thus to the pointer (7) by the connecting link (1).

Air and Brake Pressure Gauges

15. An air and brake pressure gauge consists of three direct-acting Bourdon tube gauges mounted in the same case. The largest of the pointers, at the top of the gauge (Fig. 5), shows the air supply pressure, whereas the two lower pointers indicate the pressure to each wheel brake.

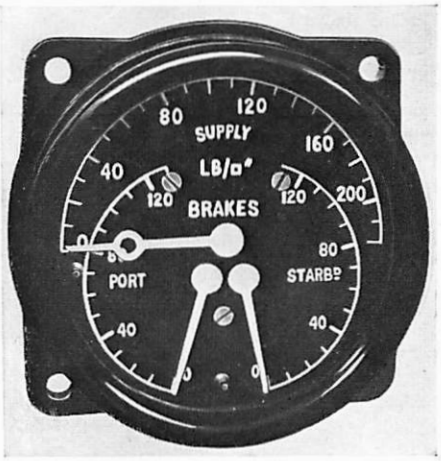
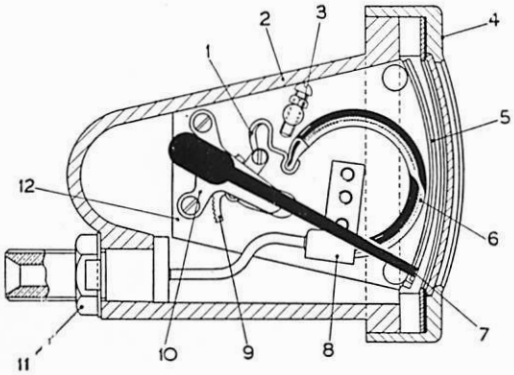


Fig. 5. Air Supply and Brake Pressure Gauge.

Suction Gauges

16. The purpose of a suction gauge is to indicate the degree of suction, in inches of mercury, in the pipelines supplying suction-driven instru-



1. Connecting link
2. Instrument case
3. Overload safety stop
4. Bezel
5. Calibrated scale
6. Bourdon tube
7. Pointer
8. Brass stem
9. Sector gear
10. Sector gear assembly
11. Connection for pressure pipe
12. Assembly plate

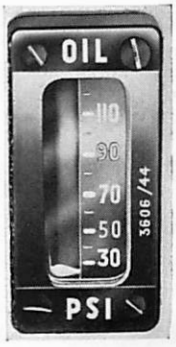


Fig. 4. Bourdon Tube Pressure Gauge.

ments. It may be of the Bourdon tube type, similar to the pressure gauge shown in Fig. 4, or of the capsule type shown in Fig. 6.

Hydraulic Pressure Gauges

17. A gauge of this type is usually a direct-acting Bourdon tube gauge with a circular dial. It is not always located in the pilot's cockpit.

Cabin Altimeters

18. In pressurized aircraft the pilot is provided with a cabin altimeter to indicate the degree of pressurization. The cabin altimeter is a small altimeter, calibrated at 5,000-feet intervals, with its static line opening into the cockpit instead of the outside air. It indicates the altitude at which the atmospheric pressure corresponds to that inside the aircraft.

Differential Pressure Gauges

19. A differential pressure gauge measures the pressure difference between the outside air and the air within the cockpit, and is usually calibrated in pounds per square inch. These gauges may be fitted to some early aircraft with pressure cabins.

Pressure Warning Lights

20. **Fuel Pressure Warning Lights.** Where it is necessary to draw attention to abnormal pressures a light is fitted which, under normal conditions, is off. Such lights are operated by a pressure sensitive switch of the diaphragm type. Should the fuel pressure drop below a predetermined value, movement of the diaphragm closes the switch and completes a circuit which lights the warning lamp.

21. **Cabin Pressure Warning Lights.** A cabin pressure warning light switch, similar in principle to that described above, differs only in that both of the pressures affecting the opposite sides of the diaphragm are variable. The switch closes when the difference in pressure between the air outside and that within the cabin exceeds a certain value.

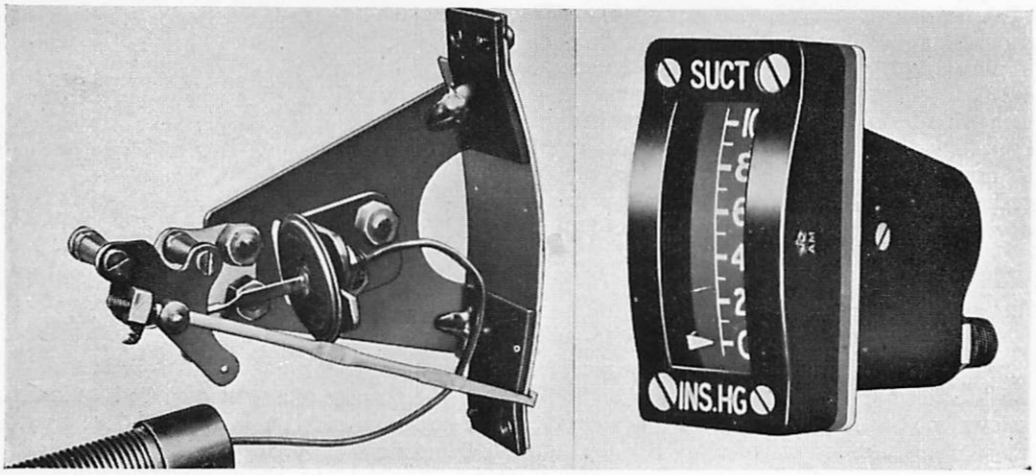


Fig. 6. Capsule Type Suction Gauge.