PART 2 : SECTION 6

CHAPTER 1

TACHOMETERS AND POSITION INDICATORS

TACHOMETERS

Purpose

1. The purpose of a tachometer is to indicate the rotational speed of the engine crankshaft or turbine shaft.

Implementation

2. Tachometers may be either mechanically or electrically operated.

Construction and Operating Principles

3. Constructional details are given in A.P. 1275A (Instrument Manual), and the following paragraphs relate to operating principles only.

4. **Mechanically Operated Tachometers.** A flexible drive is taken from a convenient part of the engine, *e.g.* the end of the camshaft, to the indicator in the cockpit, where it is coupled to a governor-type mechanism (Fig. 1). Rotation of the instrument shaft sets up centrifugal forces in the weighted frame pivoted about the shaft, tending to turn the frame into a horizontal position. This action is resisted by an involute spring, so that for a given speed the frame will turn until the tension in the spring balances the centrifugal force. The higher the speed the more nearly horizontal will the frame become. One end of the frame is linked to a sliding muff or sleeve which is free to move up and down the instrument shaft, so that the higher the speed the higher the sleeve rises. A steel arm, interposed between the flanges of the sleeve, communicates this movement to a toothed sector which causes the pointer pinion and pointer to rotate, pointer movement being shown against a calibrated scale (Fig. 2). A hairspring fitted to the pointer spindle absorbs backlash in the mechanism.

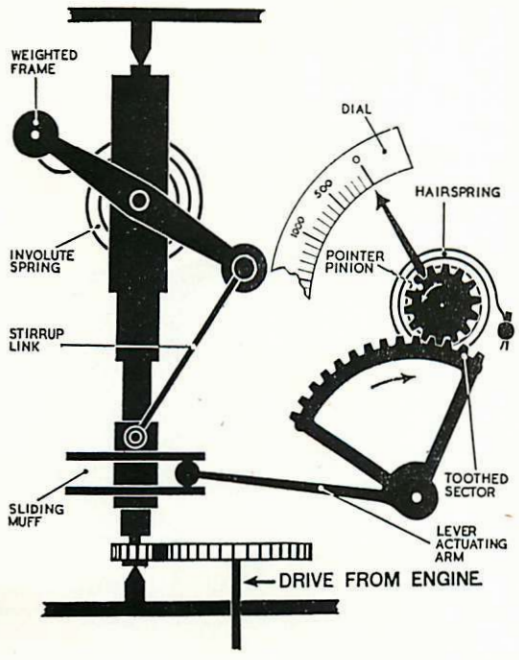

Fig. 1. Principle of the Mechanical Tachometer.

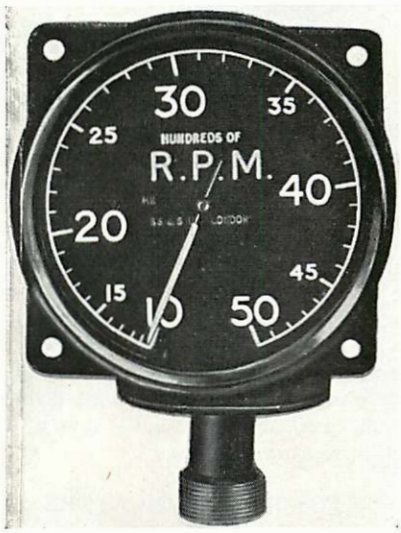

Fig. 2.
Mechanical Tachometer—Presentation.

5. **Electrically Operated Tachometers.** Electrically operated tachometers embody two units; a generator driven by the engine, and an indicator in the cockpit. In early models the generator supplied D.C. (of voltage proportional to the engine speed) to what was in effect a voltmeter calibrated in r.p.m. Present-day versions employ an A.C. generator which drives a motor in the

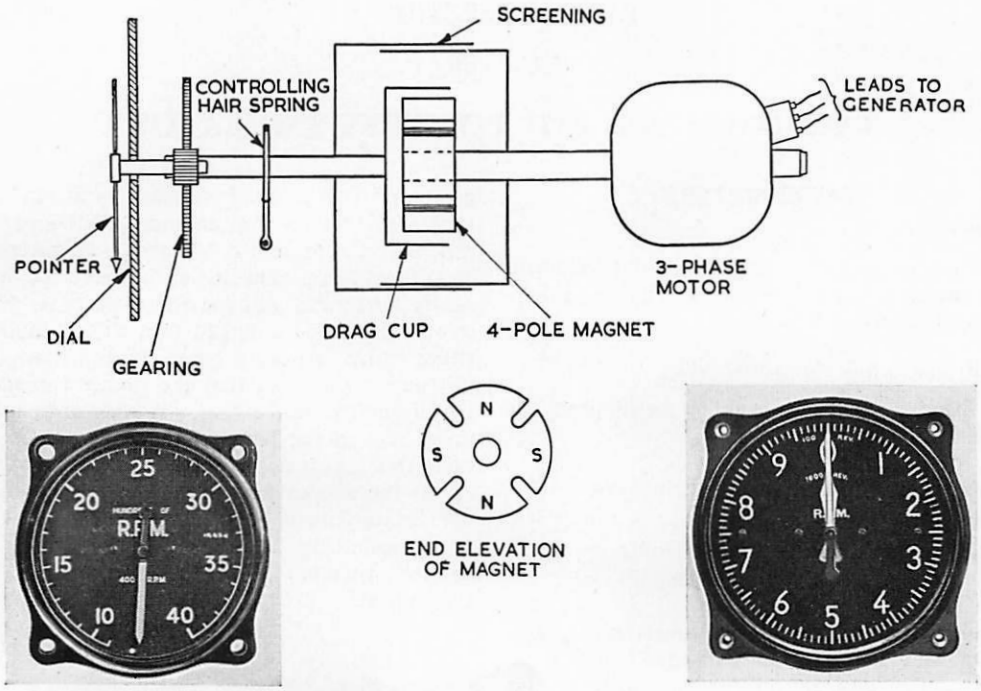

Fig. 3. Electrical Tachometer, Showing Single and Twin Pointer Dials.

indicator. In this type (Fig. 3) a 4-pole permanent magnet mounted on a motor shaft rotates inside a closely fitting drag-cup which, because of the eddy currents set up within it, tends to follow the magnet. Movement of the cup is restrained by a hairspring and magnified by a system of gears to actuate the indicating pointer. Some electric tachometers have two pointers (Fig. 3), the longer of which is geared to the other in the ratio of 10 to 1. Since it is undesirable for the mechanism to rotate at engine speeds (especially where used with turbine engines) the generator is usually driven through reduction gearing.

POSITION INDICATORS

Undercarriage Indicators

6. **Standard Pattern.** Although varying in some details, British undercarriage position indicators (Fig. 4) conform to a standard pattern in which each retractable member of the undercarriage is represented by a red and a green light. These lights, which are normally connected to micro-switches fitted to the undercarriage locks, indicate the position of their respective members thus :—

(*a*) Green light on—locked down.

(*b*) Red light on—between up and down locks.

(*c*) No lights—locked up.

7. **Alternative Bulbs and Changeover Switch.** In the standard undercarriage indicator, the bulbs illuminating the green windows corresponding to each undercarriage member are duplicated. If one or more of these bulbs fails, an alternative bulb or bulbs can be brought into use by operating the push-pull changeover switch knob in the centre of the indicator. In some indicators the bulbs for the red lights are also duplicated, but in these types the bulbs come on together so that if one fails the other continues to give the unlocked indication.

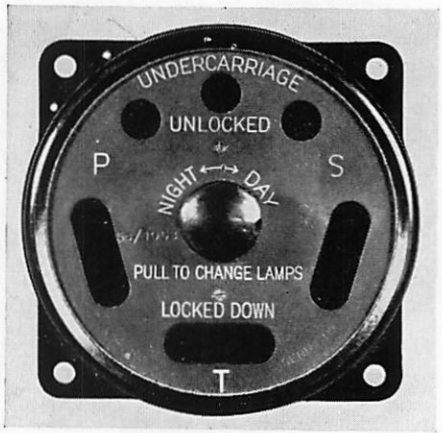

Fig. 4. Undercarriage Position Indicator.

8. **Night Flying—Glare Reduction.** Rotation of the centre knob of the indicator interposes dimmer screens to reduce glare during night flying.

9. **Warning System.** Many aircraft have a warning system operating in conjunction with the indicator. This is actuated whenever the throttle is closed beyond a predetermined point when the undercarriage is locked up (or not locked down on some aircraft). The warning is normally given by a steady or flashing red light from the nose-wheel indicator, but on aircraft on which the undercarriage position indicator is not near the A.S.I. a separate red light window is fitted near this instrument. On some jet aircraft the warning light may remain on continuously during cruising at moderate and high altitudes because the throttles are usually less than one-third open during cruising. On some installations a horn is included in the warning circuit.

10. **Supplementary Indicators.** Mechanical position indicators are provided on some aircraft in addition to standard pattern electrical position indicators. One type consists of small "tell tales" which project from the surfaces of the wing and nose when the undercarriage and nose-wheel are locked down, and retract flush with those surfaces when the undercarriage members are locked up.

Calibrated Indicators

11. Pointer-and-scale type indicators are used to show the position of flaps, trimming surfaces, radiator shutters, cowling gills, and turrets. Some are connected mechanically to the component or its control, but the majority are of the Desynn type (Fig. 5), their construction being fully described in the Instrument Manual.

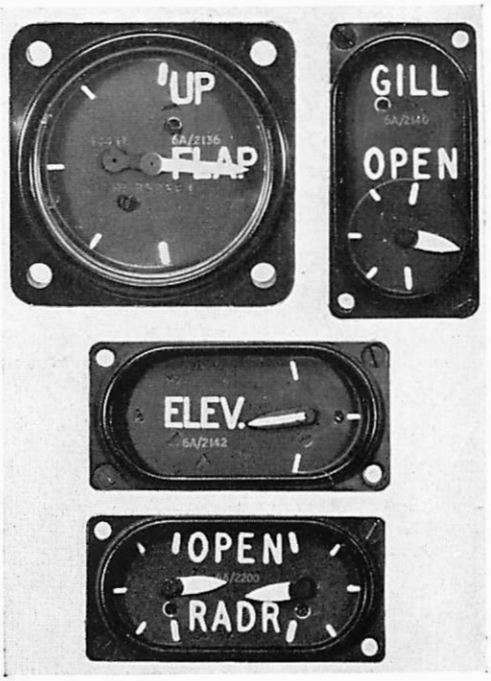

Fig. 5. Desynn Position Indicators.