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PART 2: SECTION 6

CHAPTER 4

FUEL CONTENTS GAUGES AND FUEL-FLOW METERS

FUEL CONTENTS GAUGES

Purpose

1. Fuel contents gauges are installed to provide the pilot with a continuous indication of the amount of fuel remaining in the aircraft, but in some instances, owing to tank shape, design, or manufacturing difficulties, not all the fuel is usable, *i.e.* fuel starvation will stop the engines before the tanks are empty. For this reason the contents gauges of some aircraft are calibrated to register zero when the last of the usable fuel has been drawn off, *i.e.* the fuel gauges register *usable fuel remaining*.

2. In other aircraft in which not all the fuel is usable the gauges show *the total contents including unusable fuel*.

Note: Pilots of aircraft of which part of the fuel is unusable should ascertain from Pilot's Notes for the type whether their fuel contents gauges indicate total fuel remaining or usable fuel remaining.

Implementation

3. In some installations the indications of fuel contents are received through mechanical linkage from a fuel tank float, other systems use a float and electrical transmitters to the indicator, while in others the electrical impedance (resistance) of the fuel remaining (which depends on the *quantity* of fuel present) is used to determine the position of the gauge indicating pointer.

4. Gauges are calibrated to indicate the contents of tanks with the aircraft in the flying attitude and a correction to the reading may be necessary, or a second scale provided, for ground use with tail-wheeled aircraft. Calibration may be in gallons or pounds, the advantage of using pounds being that range and endurance can be related readily to fuel weight and variations in specific gravity of the fuel can be ignored by the pilot. The accuracy of some gauges may not be reliable until they have been switched on for a short time.

Construction and Operation

5. Constructional details of all fuel contents gauges in service use are given in A.P. 1275A, but three representative types are described below in broad outline.

6. **Desynn Type.** In the Desynn type each tank is fitted with a float mechanically coupled through gearing to a Desynn transmitter similar to that described in Chapter 2 of this section. Corresponding indicator units in the cockpit provide continuous readings of each tank's contents.

7. **Simmonds Type.** The principle of operation of the Simmonds type is shown in Fig. 1. The magnetic fields of the two coils A-B and B-C are in opposition. The voltage applied across coil A-B in the indicator is supplied by the aircraft

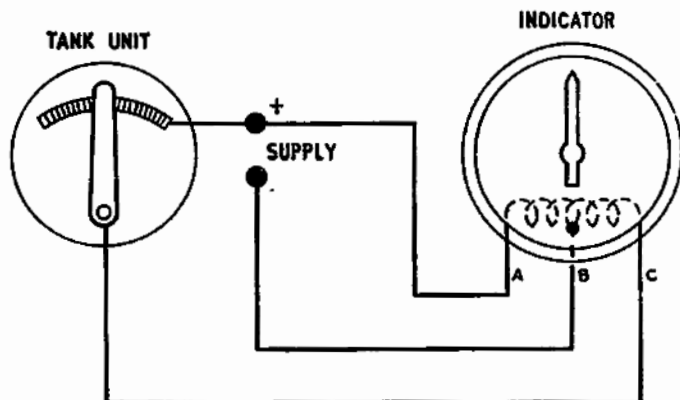


Fig. 1. Simmonds Fuel Contents Gauge—Principle of Operation.

RESTRICTED

RESTRICTED

A.P. 129, VOL. 1, PART 2, SECT. 6, CHAP. 4

battery, while the voltage across coil B-C depends on the position of the sliding contact on a wound resistor in the tank unit, *i.e.* the indicator measures the ratio of these two voltages. Since the sliding contact is actuated by a float in the fuel tank it follows that for a given quantity of fuel, and hence a given position of the float and sliding contact, there exists a definite voltage ratio in the two indicator coils. This causes the indicator armature, which carries a pointer indicating against a scale graduated in gallons, to assume a definite position. The ratio of voltages in the two coils is constant for any position of the sliding contact irrespective of the value of the potential across the ends of the resistance. Accuracy is therefore independent of variations in the supply voltage. Any number of transmitter units can be connected to one indicator through a selector switch, where continuous reading is not required.

8. **Pacitor Type.** The Pacitor type gauge, which gives a continuous reading, differs from those previously described in that the transmitter has no moving parts. The principle involved is that the capacity and therefore the impedance of a condenser varies according to the substance between the plates—the dielectric, as it is called. In this instance each condenser consists of two concentric cylindrical tubes arranged vertically in the tank, the tubes being separated by a small gap which is filled with fuel, air, or both. As the fuel level in the tank falls, the ratio of fuel to air in the gap decreases, thereby altering the impedance of the tank unit. Thus each tank unit serves as a variable condenser, and the strength of an

alternating current applied across it will vary according to the amount of fuel in the tank. It would be possible to feed this current, after rectification, to a millimeter-type fuel contents gauge, but in practice a ratiometer system is used to avoid inaccuracies due to variations in the supply voltage. Taking first the right-hand side of Fig. 2, it is seen that the tank unit varies the current flowing in the transformer primary winding to which it is connected. The corresponding alternating current induced in the secondary winding is converted to direct current by a rectifier and then fed to the deflection coil in the indicator. Meanwhile the same process is taking place in the control circuit on the left, except that, as the control condenser is of fixed value, the current in the control coil remains constant. Variations in A.C. supply voltage affect both circuits, so that the ratio of deflection coil current to coil current remains constant for a given tank unit impedance. Unlike float-operated gauges, the Pacitor maintains an accuracy of ± 5 per cent. for changes in aircraft attitude up to 150° in any direction. This is achieved by the fitting of more than one condenser to each tank (Fig. 3) and connecting them in parallel, so that when the aircraft tilts, the fall in fuel level at one point is compensated by a rise elsewhere and the total capacity of the combination remains reasonably constant.

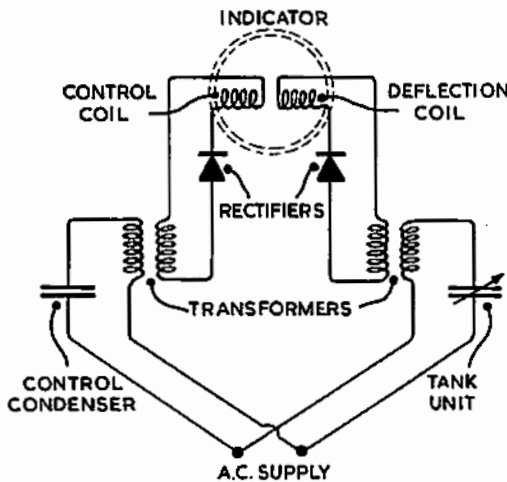


Fig. 2.

Pacitor Fuel Contents Gauge—Circuit Diagram.

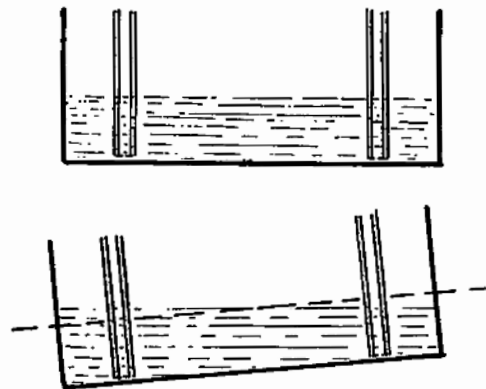


Fig. 3.

Compensation for Tilt in the Pacitor System.

FUEL-FLOW METERS

9. Fuel-flow meters to register fuel consumed are fitted in some aircraft. Each indicator shows continuously the total quantity of fuel passed through the supply lines to which it is fitted.

RESTRICTED

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FUEL CONTENTS GAUGES AND FUEL-FLOW METERS

10. In one version a transmitter actuated by the displacement of a piston in a working chamber sends out an electrical impulse to an indicator (Fig. 4) for each one-tenth gallon passed. The indicator for each tank is a veeder counter which registers each impulse and thus the fuel used up to a total of 999.9 gallons, although both veeder counters may be reset to zero at any time by turning the resetting knob (Fig. 4) anti-clockwise.

11. Some models incorporate a by-pass to the main pipe controlled by a manually or electrically operated cock.

12. On the type illustrated, the Mk. 1, the dial is reversible; one side is marked PORT and STARBOARD for use when the indicator is installed in a twin-engined aircraft, and the other side is marked INNER and OUTER for use when the indicator is connected to the inner and outer tanks of a four-engined aircraft.

13. During idling periods when the flow through the meter is less than ten gallons per hour the indicators may be inaccurate.

14. The veeder counters should be set to zero before starting up, and the booster pumps in use should be switched on when the fuel-flow meters are working, to ensure accurate readings.

15. Later versions of this instrument will show fuel flow in pounds, thus facilitating range and endurance calculations by obviating the necessity to make separate calculations allowing for variations in the specific gravity of the fuel.



Fig. 4. Fuel-Flow Meter, Mk. 1—Indicator.

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