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A Distant Reading Manometer with Particular Application to the Measurement of Small Pressures

By

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of the Aerodynamics Division, N.P.L.

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Summary.—The function of the manometer is to enable small pressure differences to be measured at a distance. The instrument will measure either the difference of two pressures or a single pressure relative to atmosphere.

Introduction.—The accurate measurement of small pressures at a distance remote from the source is not very satisfactory by the orthodox methods using long lengths of tubing. The chief difficulty is that due to lag. This problem became apparent when exploring the wind velocity and direction on the Whirling Arm at the National Physical Laboratory. From the yawmeter to the Chattock gauge, which one normally uses for pressure measurements, the length of tubing required for each lead is of the order of 120 ft. This means that a considerable time must elapse before a reliable reading can be obtained, particularly if the pressure difference is very small. The sensitivity of the manometer described is comparable with that of a 26 in. Chattock gauge and is capable of measuring pressures up to about 3 in. of water.

Description of Instrument. Figs. 1 *and* 1*a*.—The pressures are led to two flexible metal bellows B, which are mounted so that any difference of pressure will deflect the lever L about its cross-spring fulcrum F. One end of this lever carries a soft iron plate P and the other end a counter-balance weight W which is adjusted so that there is zero reading due to centrifugal force when the arm is running. The movement of the lever L causes a change in the gap between the soft iron plate and the coil C, producing an out-of-balance in an induction bridge circuit. Opposing the two pressure bellows is another pair which are interconnected by means of the duct D incorporating the needle valve V. These opposing bellows are filled with thin oil and provide, by adjustment of the needle valve, variable damping. In order to avoid leakage, a packless gland is provided for the needle valve. As the damping system is completely filled and enclosed, provision is made to avoid change in volume on adjustment of the needle valve. This is done by an extension of the valve spindle operating a bellows unit of the same section as the one forming the packless gland; as one extends the other contracts, so keeping the volume unchanged.

The mechanism above described is mounted in some suitable position near the source of pressure and should be boxed in to obviate errors due to draughts.

It has already been noted that a difference of pressure causes a change in gap between the fixed coil C and a soft iron plate producing an out-of-balance in a bridge circuit. This is balanced by the adjustment of a similar gap placed in a convenient position. It is obvious that the accurate determination of this gap gives a measurement of the pressure difference.

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The system is sensitive to a change in gap of the order of 1/10,000 in. so that it is unsatisfactory to measure the gap direct. The mechanism for moving the plate is shown by the photograph in Fig. 2 and diagramatically in Fig. 3. C is the fixed coil and P the plate, which is traversed by means of the micrometer screw S. This micrometer screw is turned, via a high reduction gearing, by means of the small motor M; the direction of rotation may be changed by means of a reversible friction disc drive F. To change the gap 1/1000 in. requires 180 revs. of the motor. The position of the plate relative to the coil is indicated by means of a veeder counter, V, driven by one of the gear shafts.

Fig. 4 is a diagram of the electrical circuit, balance being indicated by a micro-ammeter or a sensitive galvanometer.

The instrument is calibrated against a Chattock gauge or other suitable standard. For very small pressures, instead of using the Veeder counter direct readings may be made on the galvanometer scale.

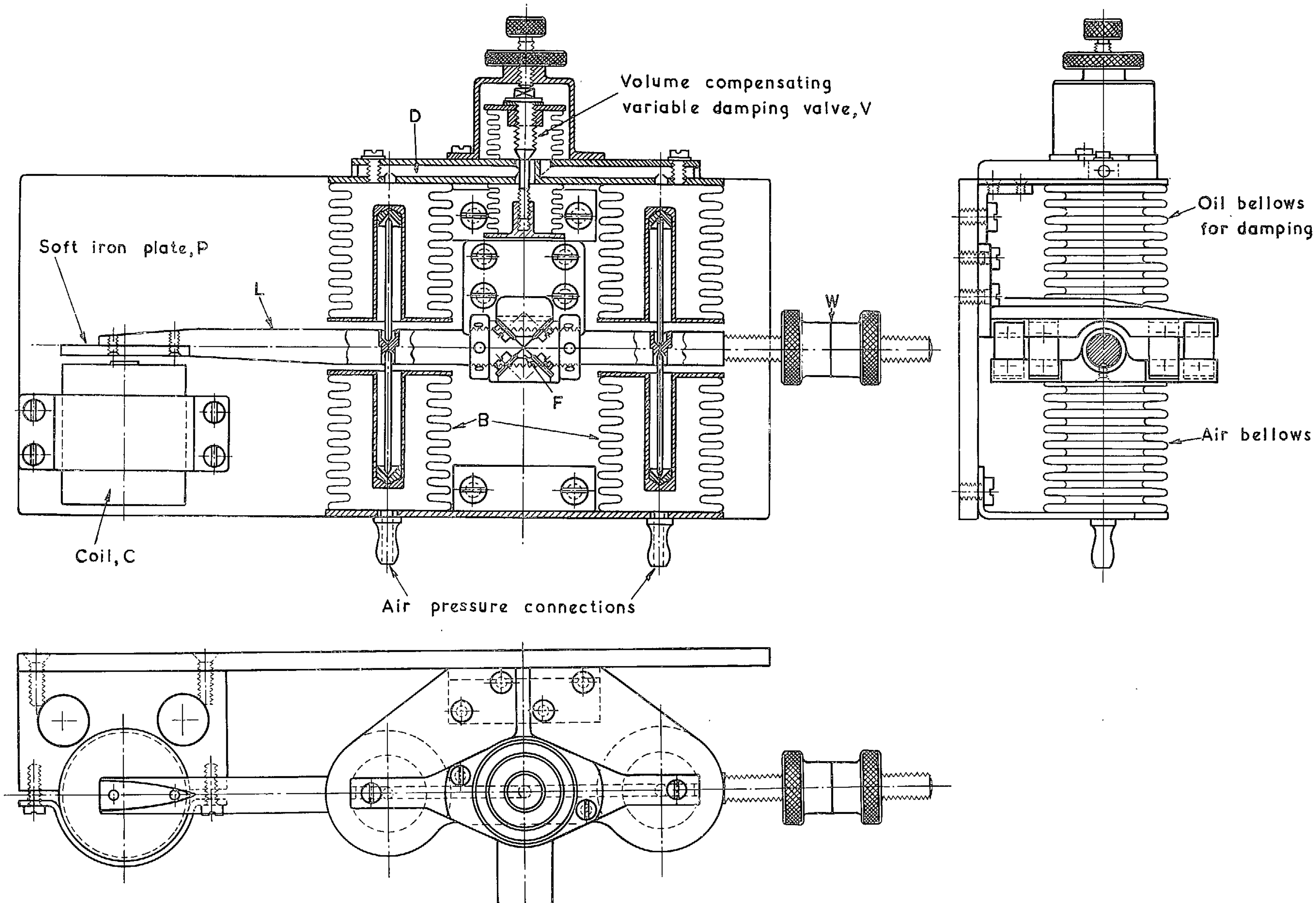


FIG. 1. Distant reading induction bridge pressure gauge.

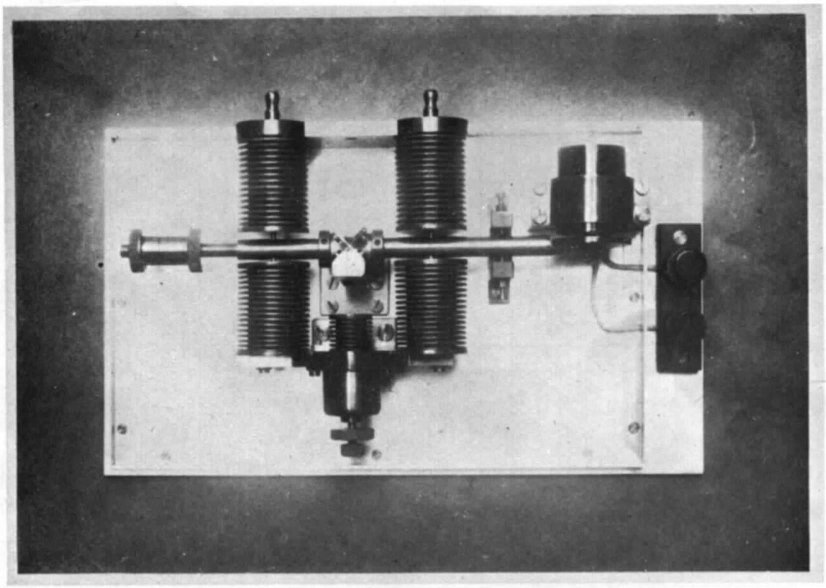


FIG. 1a.

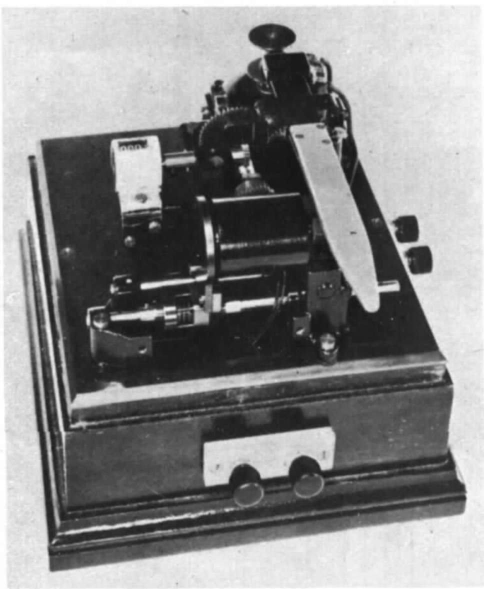


FIG. 2.

(22740) Wt. 15-680 K9 6/52 F. M. & S.

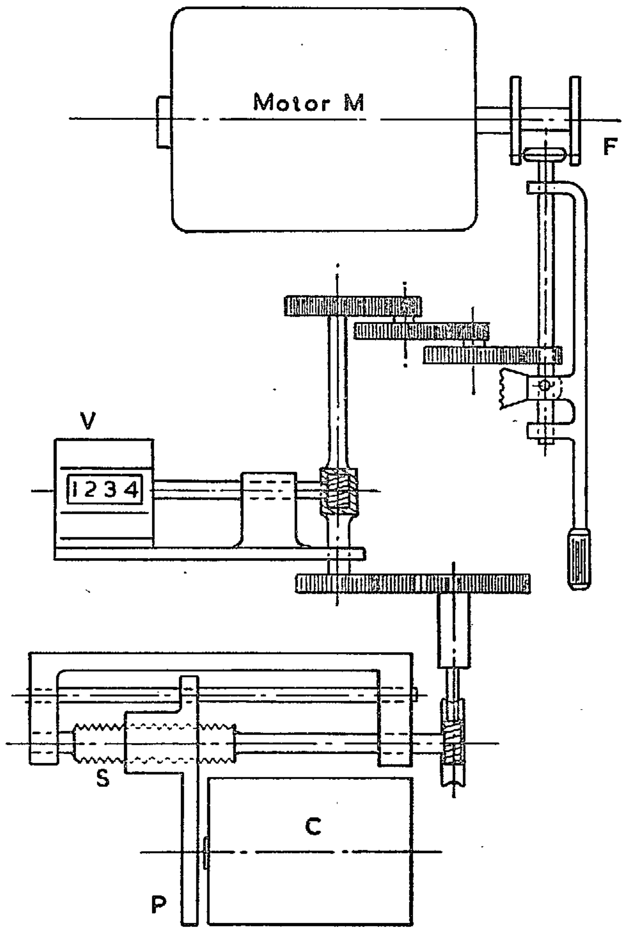
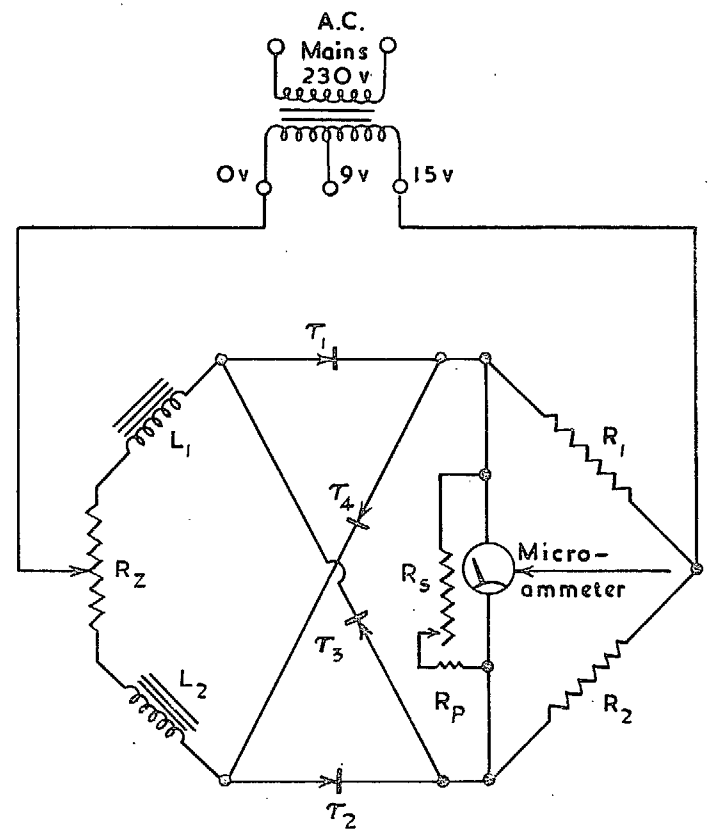


FIG. 3.



L_1 L_2 Micrometer Coils

T_1 T_2 T_3 T_4 Rectifiers Westinghouse Type H.I.(matched)

R_1 R_2 1000 ohm Resistances (matched impedance)

R_S Sensitivity Control (Maximum value of Resistance approximately equal to that of Microammeter)

R_Z Zero Adjuster (20 ohm Wireless type Volume Control)

R_P 10 ohm Resistance

FIG. 4. Balance indicator.

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