were entirely negative. Any specific response of the guinea pig or rabbit to cortisone was also lacking. The effect of cortisone on the rat would, therefore, appear to be unique among the species so far studied. In this respect, it should be recalled that, aside from its action on the mouse which was referred to above, estrogen appears to have no specific effects on all other mammalian species which have been studied so far save the rat(3).

Summary. Varying amounts of cortisone acetate were administered to growing mice, guinea pigs, and rabbits. This hormone in the doses used appears not to have an effect such as has been observed in the rat on the skeletal tissues of these species. Since large amounts led to a retardation in growth, it would seem unlikely that the mouse, guinea pig, or rabbit is less sensitive to the hormone.

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An Improved Recording Rotameter. (19196)

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In many physiological studies it is desirable to obtain continuous measurement and registration of the mean rate of blood flow through a particular blood vessel. An optically recording rotameter which was designed for this purpose(1,2) operated on an electromagnetic principle, and changes in blood flow through the rotameter were detected and translated into proportionate deflections of a light beam reflected from a galvanometer mirror. The use of an electronic circuit involving an oscillator, amplifier, and rectifier made the apparatus relatively difficult to construct and maintain without some degree of technical knowledge. For this reason an attempt was made to simplify and improve the flow metering device without sacrificing sensitivity or accuracy. The construction and performance of the redesigned instrument is reported here.

In Fig. 1 is shown, in sectional view, the metering and detecting portions of the rotameter proper. Construction details are given in the legend. The metering chamber illustrated is designed to cover a flow range of 0-400 cc/min. Other metering chambers which are interchangeably attachable to the detecting portion have been constructed for individual ranges having top flows of 100, 200, 800, 1600, and 3000 cc/min.

The electrical circuit diagrammed in Fig. 2 was constructed from standard parts and assembled in a small control box measuring 3 x 4 x 5 inches.

The entire apparatus is shown in Fig. 3. By viewing the 0-25 microammeter (100 arbitrary scale divisions) the changes in flow through the rotameter could be noted visually. A simple optically recording galvanometer was constructed as follows. The jewel bearings of a 0-200 microammeter were removed, the coil suspended by two nylon filaments and a 3 mm x 3 mm mirror cemented to the counterbalance end of the pointer arm. A rectangular opening was cut in the meter case opposite the mirror and a glass window sealed in place with wax. To provide a stable support, pointed legs were attached to the case through the three mounting holes. A variety of commercially available mirror galvanometers may also be used for recording on sensitized paper or film. The maximum output is approximately 25 μA and 0.1 volt. With supplementary DC amplification, satisfactory records have been made with instruments employing a hot stylus or a pen writer.

Calibrations of the instrument remain con-

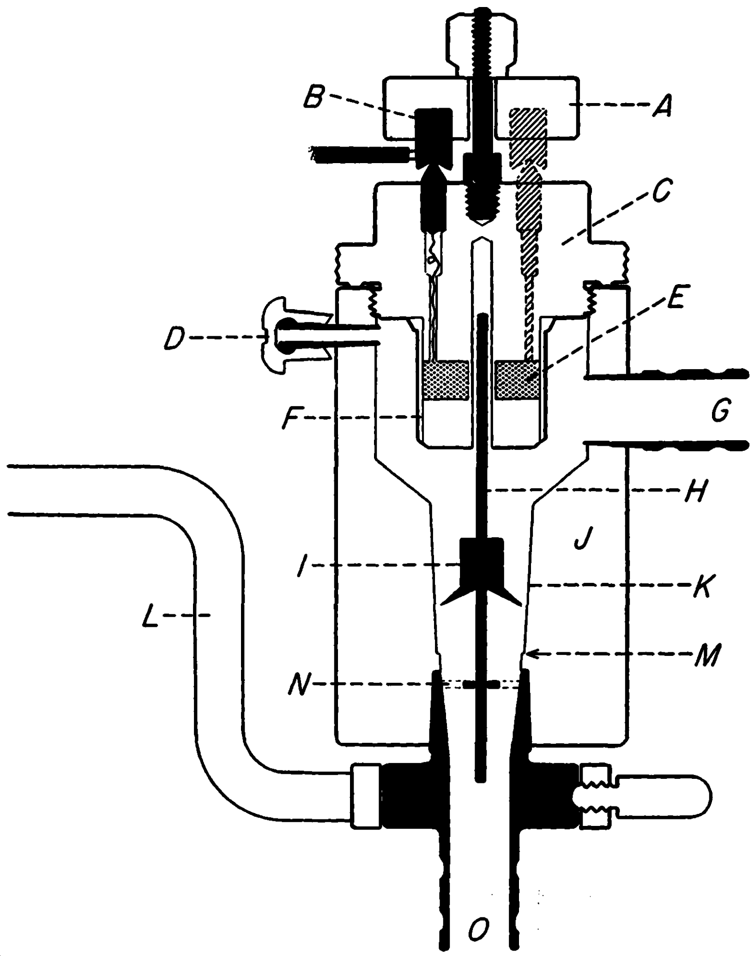

FIG. 1. Full-scale sectional view of 0-400 cc/min rotameter constructed of Lucite or Plexiglass with silver plated brass fittings except where otherwise noted. A: contact holder; B: one of 3 contacts communicating with the 2 terminals and common connection of detecting coil and balancing (non-inductive) coil; C: detecting assembly; D: rubber cap through which air may be removed during filling; E: detecting and balancing coils sealed in wax; F: protecting sleeve; G: outflow spout; H: annealed soft iron silver plated float wire, .051 inch diameter; I: brass float disc. Float is shown in position it would occupy in middle of flow range. Float is 15/32 inch above float rest when at top of flow range. J: detachable metering chamber; K: metering portion, bored with .080 inch per inch taper; L: rotameter support; M: float rest at zero flow; N: float guide; O: inflow spout.

stant within less than 5% variation over 6-8 hours continuous running. Variations in the calibration due to line voltage fluctuations are eliminated by using a constant voltage transformer to supply current to the set. The calibration plots (Fig. 4) are only slightly curved or sigmoid in shape due to the fact that the dimensions and position of the detecting coil and the float wire are adjusted so that the maximum rate of change in reactance occurs in the middle of the flow range. Because of this feature the bridge is not balanced at the lowest float position (zero flow) since the float wire occupies a position partly within the coil. The positive reading on the meter (about $\frac{1}{8}$ full scale) is nullified by turning the zero adjusting screw until the meter reads zero.

Calibration of the rotameter is not greatly affected by changes in viscosity of the blood (Fig. 4). The curves obtained with fluids having different viscosities were not significantly different except at the lower end of the

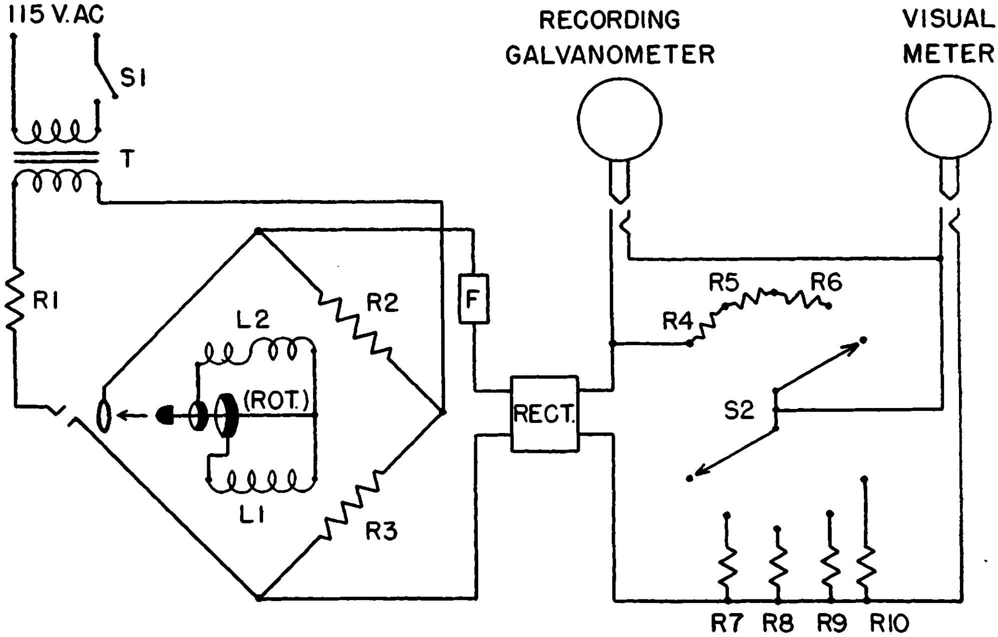

FIG. 2. Wiring diagram of electrical circuit. F: 1/100 amp. fuse; L1: 1600 turns No. 40 enameled copper wire, 110 ohms resistance; L2: 110 ohm, non-inductively wound coil. Resistors: R1, 120-180 ohms, 2 watt; R2 and R3, 400 ohms, Manganin or Advance wire wound, 5 watt; R4, 100 ohms; R5, 330; R6, 750; R7, 20K; R8, 10K; R9, 6800; R10, 5600. Rect.: type M Conant full wave rectifier; Rot.: rotameter detecting assembly with jack; S1: off-on switch; S2: recording galvanometer sensitivity selector switch; T: chime transformer (A.P. Foster), 13V secondary; recording galvanometer, 0-200 μA meter with mirror mounted on hand; visual meter, DC, 0-25 μA meter.

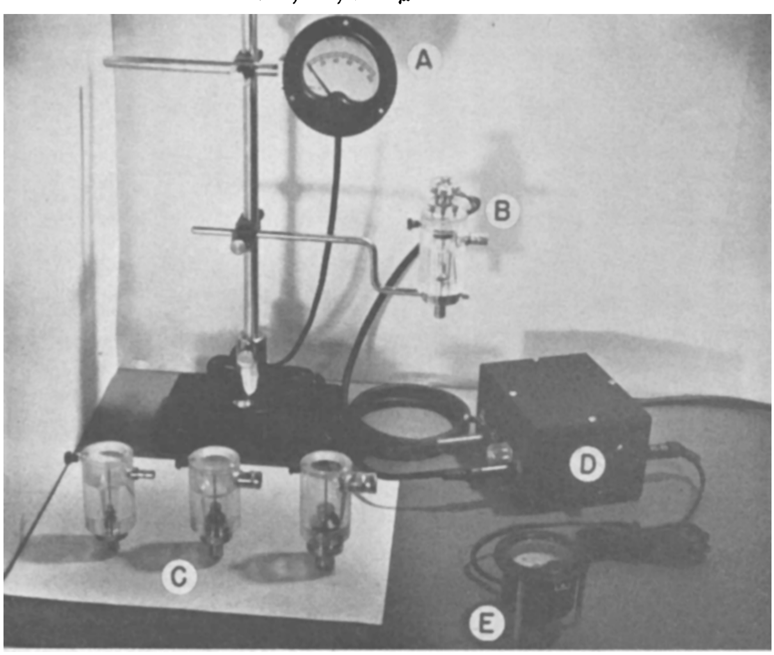

FIG. 3. Photograph of apparatus. A: visual meter; B: rotameter; C: interchangeable metering chambers accommodating different flow ranges; D: control box; E: recording mirror galvanometer.

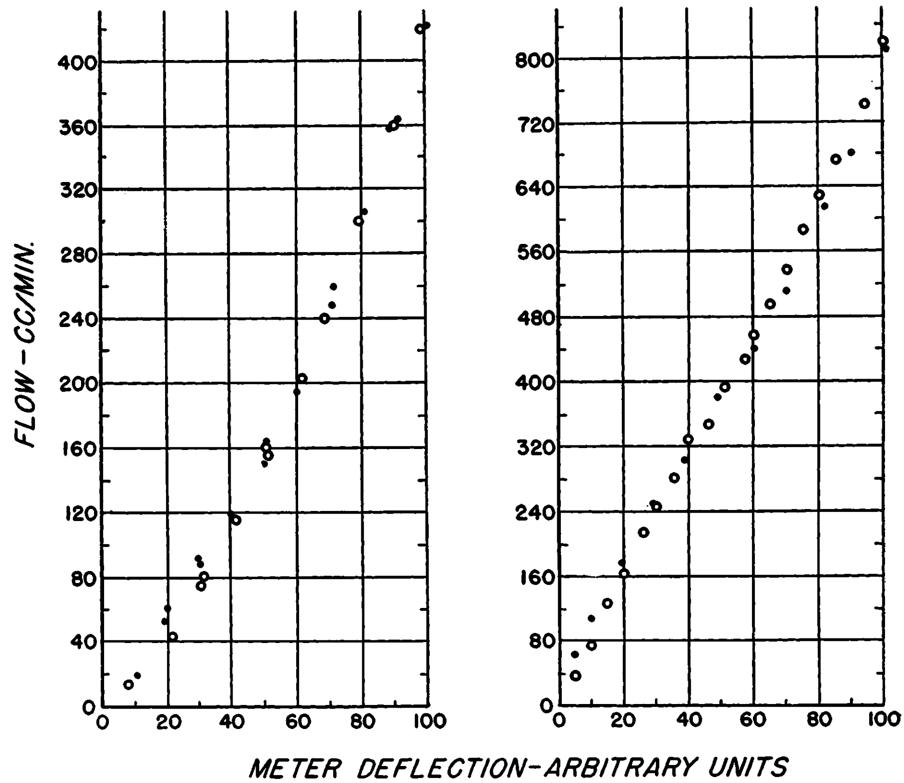

FIG. 4. Calibration curves obtained with fluids having different viscosities. *Left*: metering chamber with range of 0-400 cc/min; dots: calibration points using methyl cellulose solution, specific viscosity 3; open circles: specific viscosity 6.2. *Right*: metering chamber with range of 0-800 cc/min; dots: calibration points using water, specific viscosity 1; open circles: methyl cellulose solution, specific viscosity 4.6.

flow range. The shape of the float disc was copied in part from a design* which was found to eliminate viscosity effects in commercial size rotameters.

Pulsatile flows may be measured accurately within 5%, provided the float does not touch the float rest at its lowest position and its excursion does not exceed the upper limits of the metering area. There is no mechanical dampening of the motion of the float. If the flow pulse is very large, and excessive oscillation of the meter and galvanometer make it difficult to estimate the mean rate of flow, a pulse dampening chamber partly filled with air may be interposed between the source of blood supply and the rotameter.

To minimize pressure drop across the instrument the metering chamber and fittings were made with a large internal diameter, and the float was kept as light as possible for each metering unit. The pressure drop across the rotameter and fittings was measured with each of six metering chambers having different flow ranges. A relatively small pressure head (2-3.5 cm of water) was required to operate the instrument at all rates of flow (see Fig. 5). By increasing the bore of the metering chamber and the diameter of the float the pressure drop could be reduced even further. However, a proportionately larger volume of blood was required to fill the metering chamber, and, in addition, the velocity of the flow through the instrument was reduced to a level where settling of blood cells could occur at low rates of flow.

Since the pressure drop through the entire circuit determines the extent to which flow will be hindered, it is particularly important

* "Ultra-Stabl-Vis," Fischer and Porter Co., Hatboro, Pa.

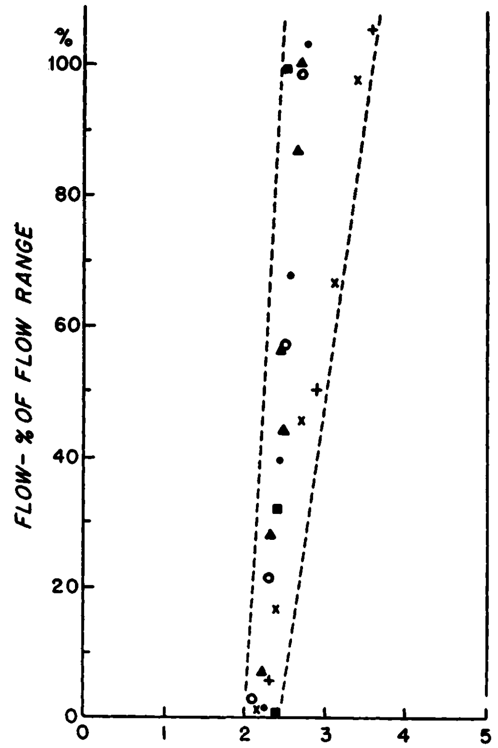

FIG. 5. Pressure drop through rotameter with different metering chambers and at different rates of flow. Ordinate: flow is expressed in terms of percentage of the nominal capacity of each metering chamber. Dots: metering chamber with nominal capacity of 100 cc/min; open circles: 200 cc/min; squares: 400 cc/min; triangles: 800 cc/min; plus signs: 1600 cc/min; X's: 3 liters/min.

that the connecting tubing and cannulas used in association with the rotameter be of maximum bore and minimum length.

In different acute experiments and under a variety of conditions, satisfactory continuous records have been made of the rate of blood flow through carotid, renal, femoral, and coronary arteries and through jugular, vena-caval, renal, femoral, and coronary sinus veins. Illustrations of typical records may be found in other reports(3-6).

Summary. (1) A simplified and improved flow rate meter is described. The instrument is basically a rotameter, the float of which is vertically displaced in proportion to the rate of flow and its position detected electromagnetically. The rate of flow is indicated on a microammeter and a recording galvanometer. The metering chamber and float are designed so that viscosity effects are minimized and the pressure drop through the instrument reduced to less than 3.5 cm of water at any rate of flow. (2) To obtain maximum sensitivity over a given flow range, different metering chambers, with capacities ranging from 100 cc to 3 liters per minute, can be used interchangeably with one detecting unit.

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Prevention of DL-Methionine Toxicity in Rats by Vitamins E, B_{12}, Folacin, Glycine and Arginine.* (19197)

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The toxic effect of high levels of DL-methionine was noted by Earle, Small, and Victor

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