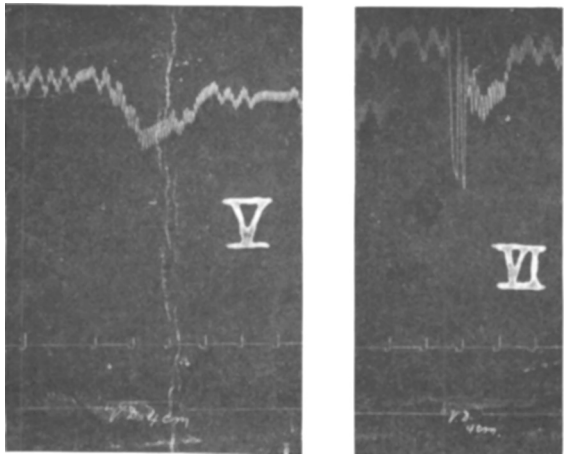

V. Vagus stimulation 1.5 hrs. after the drug.
VI. Vagus stimulation 2.1 hrs. after the drug.

Summary: (1) Solutions of sodium amytal injected intravenously depress the circulation. (2) Such solutions cause prolonged but temporary paralysis of the vagus to the heart. (3) These solutions are stable, and do not show any increase in toxicity within 2 months.

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A Photographic Method of Recording Plethysmograms.

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(Introduced by Charles Sheard.)

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Measuring the change in volume of an organ is done ordinarily by placing the organ under investigation in a plethysmograph and computing the change in volume that occurs in the air space between the organ and the interior wall of the plethysmograph. The change in volume manifests itself by a change in pressure when the plethysmograph is a portion of a closed system so that if, for example, the organ expands, the volume of the system decreases and the pressure increases. Hence by noting the change in pressure it is possible to follow the corresponding change in volume of the organ.

A record of the change in pressure may be made by one of several

methods. A Marey tambour or a piston recorder may be used in conjunction with a kymograph and a tracing made on smoked paper. Besides the possibility of leakage in the tambour or piston, there is always the difficulty of maintaining the proper adjustment of the stylus against the smoked paper. On the other hand, a U-tube containing a liquid may be used satisfactorily as a manometer. Hargis,[3] in his measurements on the changes in volume of the spleen, used a water manometer and followed manually the rise and fall of the meniscus, making a record on smoked paper. Although the latter method of obtaining changes of pressure is satisfactory, the mechanism for recording is only grossly accurate, requires the constant attention of the recorder, and is not capable of registering very rapid fluctuations such as may occur at every heart beat.

We have devised a simple method of recording accurately the fluctuations in the position of the meniscus of a water manometer. If a piece of ordinary glass tube, with a bore of approximately 3 mm., is partly filled with water and held at right angles to the rays

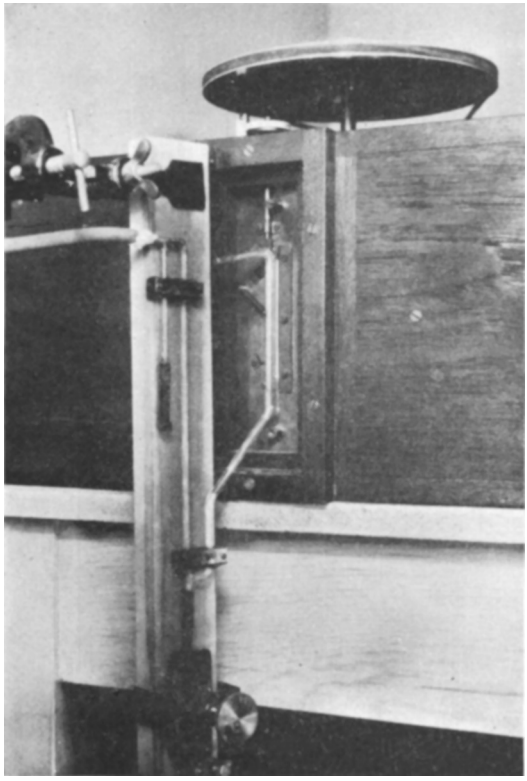

FIG. 1.
The ensemble for the photographic method of recording plethysmograms.

[3] Hargis, E. H., *J. Lab. and Clin. Med.*, 1926, xi, 664.

of light coming from a powerful Mazda lamp a few meters distant, it will be noticed, on placing a piece of paper about 3 mm. behind the glass tube, that the column of water focuses the light sharply on the paper whereas the glass tube alone does not. In other words, the portion of the tube containing water functions as a cylindrical lens and as the water in the tube moves up and down the concentrated beam of light follows accordingly. If, then, the customary cylindrical lens of a recording camera of an electrocardiograph is replaced with one arm of a U-tube partly filled with water, it is possible to photograph changes of pressure by following the elevations or depressions of the meniscus, as evidenced by change in length of the cylindrical lens.

A photograph of the recording apparatus is shown in Fig. 1. A Cambridge electrocardiographic camera using paper 8 cm. (about 3.25 inches) in width is turned on its side and the cylindrical lens in front of the slit removed. The glass tube is shown in front of the slit, whereas in actual use it is pressed firmly against the slit. The height of the meniscus is controlled by pressure on the rubber tube at the bottom of the manometer. Usually the meniscus is kept as high as possible so that a considerable portion of the paper is exposed. A speed of 5 mm. each second has been found satisfactory although this can be varied by changing the pulley ratio between the camera and the Leeds and Northrup constant speed motor which is used for driving the roll of paper in the camera proper. A 250 watt Mazda projection lamp is used as a source of light and, at a distance of about 4 meters, has been found to produce sufficient exposure of the paper.

This apparatus is adapted readily to recording the motion of the shadow of a pointer which is indicative of the motion of the pointer itself. For instance, a Marey tambour may be placed a few centimeters in front of the camera so that the shadow of the pointer falls on that portion of the glass tube which acts as a cylindrical lens. The shadow of a pointer 1 or 2 mm. wide leaves an excellent tracing on the developed photographic record. Besides one or two tambours, a signal magnet and a time marker may be used ordinarily in conjunction with the water manometer, and records of the movements made by each of these may be obtained on paper only 8 cm. wide.

This apparatus was used in the experimentation on the effects of acoustic stimulation on the volume of the spleen and kidney which are presented in other papers.[1, 2]

[1] Corbeille, Catherine, and Baldes, E. J., *Am. J. Physiol.*, 1929.

[2] Corbeille, Catherine, and Baldes, E. J., *Am. J. Physiol.*, 1929.

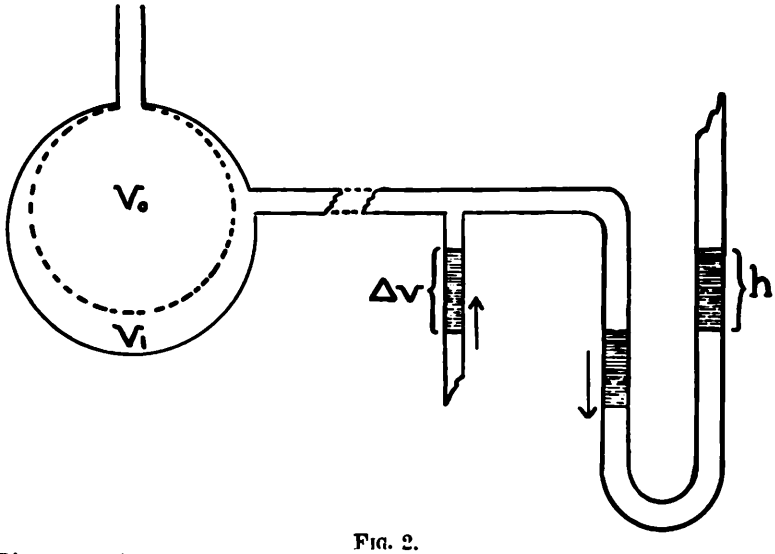

FIG. 2.
Diagrammatic sketch of the plethysmograph and the manometer showing the schematic method of calibrating the manometer.

A method of estimating the percentage changes of volume of an organ is outlined (Fig. 2). The apparatus is calibrated in the usual manner by noting the change in pressure recorded by the water manometer when the volume of the system is changed a known amount.

Let v = volume (cc.) of empty plethysmograph, including the tube leading to the U-tube.

v_0 = volume (cc.) of organ placed in plethysmograph.

v_1 = volume (cc.) of closed system.

Δv_x = decrease in volume (cc.) of closed system controlled by water or mercury in graduated burette.

h_x = increase in pressure (cm. of water) in system when volume is decreased Δv_x.

p = pressure (cm. of water) of atmosphere.

r = radius (cm.) of U-tube.

With the empty plethysmograph attached to the water manometer suppose a decrease in volume, Δv, increases the pressure h.

Then approximately,

$$p\left(\Delta v - \pi r^2 \frac{h}{2}\right) = vh, \text{ or}$$

$$v = \frac{p}{h}\left(\Delta v - \pi r^2 \frac{h}{2}\right)$$

where $\pi r^2 \frac{h}{2}$ is the increase in volume in the U-tube due to decrease in volume Δv with consequent increase of pressure.

With the organ in the plethysmograph and attached to the water

manometer, suppose a decrease in volume Δv_1 increases the pressure h. Then

$$(\Delta v_1 - \pi r^2 \frac{h}{2}) = v_1 h, \text{ or}$$

$$v_1 = \frac{p}{h} (\Delta v_1 - \pi r^2 \frac{h}{2})$$

Therefore the volume of the organ, v_0, is equal to

$$v_0 = v - v_1 = \frac{p}{h} (\Delta v - \Delta v_1)$$

In general, if the increase in volume of the organ causes an increase of pressure h_x, then Δv_x, the increase in volume of the organ, is given by

$$\Delta v_x = \frac{h_x}{h} \Delta v_1$$

and the percentage increase in volume of the organ becomes

$$\frac{100 \Delta v_x}{v_0} = 100 \frac{h_x}{h} \frac{\Delta v_1}{v_0}$$

It is possible to use any liquid, such as alcohol, to increase the sensitivity, or to increase the specific gravity with sodium chloride, so as to indicate changes of pressure directly in units of 1000 dynes for each centimeter.

Summary: A photographic method of recording plethysmograms is described. The use of a U-tube liquid manometer, with its low inertia and low interval friction, furnishes a rapidly acting system for recording small intrinsic changes in pressure. These changes of pressure may be converted into changes in volume by the use of equations.

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Studies on Growth. Growth Factors in Liver.

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Recent investigations have emphasized the value of liver as a dietary supplement in diets apparently adequate with respect to vitamins A and D. No definite information is available, however, concerning the nature of the water soluble substances also present in liver.[1] This is a preliminary report of a study of the nutritional

[1] Osborne, T. B., and Mendel, L. B., *J. Biol. Chem.*, 1917, xxxii, 309; 1923-24, lviii, 363.