

A New Method for the Electrical Recording of Mechanical Deformations.

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Pressure changes or spacial displacements may be recorded by a number of electrical devices,¹⁻¹⁰ based on changes in capacity, resistance or the piezo electric effects. Variations in potential are amplified and recorded photographically. On referring to these methods Green¹¹ states that "while many of them are admirable in concept, their complexity and cost have so far prevented their wide acceptance".

The system about to be described is of low cost, easy to make and of almost universal application. It depends on the variations in resistance occurring in a glass capillary (c) containing equal volumes of alcohol and glycerine; copper wires are inserted into the two ends one of which is fixed (e_2) and the other (e_1) which is movable, being connected to a membrane (m) or any other mechanical device which allows for displacement in space. The fixed electrode (e_2) can be moved in relation to the movable one (e_1) by means

of a screw. The movable electrode should be of small diameter (approximately 0.75 mm) so its mass will have no influence on the experiment. The ends of the electrodes are connected to points a and b of the electric system represented in Fig. 2, consisting of a battery of approximately 10 volts and a switch I_1 , which on closing sends the current through the variable resistance R_1 . The proper voltage is obtained by altering the position of the cursor in this resistance. The

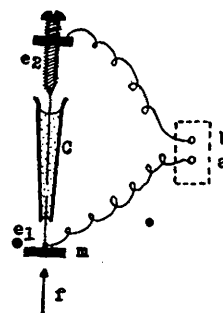


FIG. 1.

A fixed electrode (e_2) and a movable one (e_1) are inserted into the capillary tube C, which contains the electrolyte (alcohol and glycerine). The electrode e_1 is joined to the membrane (m), which is displaced by the force (f). Terminals a and b are connected to points similar to those shown in Fig. 2.

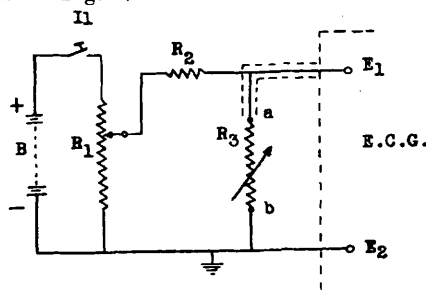


FIG. 2.

The electrical circuit consists of a battery B, a switch I_1 , and resistances R_1 and R_2 , each 250,000 ohms. Variable resistance R_3 corresponds to the capillary system in Fig. 1. The union between a and E_1 is shielded. E_1 and E_2 are entrances to the electrocardiograph (E.C.G.).

¹ Waud, R. A., *J.A.M.A.*, 1924, **82**, 1263.

² Gomez, D. M., *Hémodinamique et Angiocine-tique*. Paris. Hermann et Cie. Edit. 1941.

³ Hampel, A., *Pflüg. Arch. ges. Physiol.*, 1940, **244**, 141.

⁴ Rein, H., Hampel, A., and Heinemann, W., *Pflüg. Arch. ges. Physiol.*, 1940, **243**, 329.

⁵ Macleod, A. C., and Cohn, A. E., *Am. Heart J.*, 1941, **21**, 345.

⁶ Miller, A., and White, P. D., *Am. Heart J.*, 1941, **21**, 504.

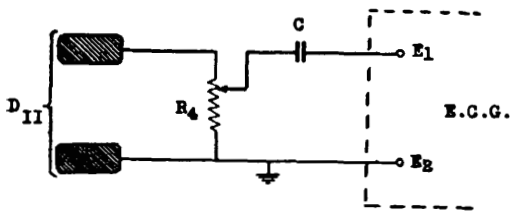
⁷ Dalla Torre, L., *Helv. Physiol. Acta.*, 1943, **1**, C14.

⁸ Grundfest, H., Hay, J. J., and Feitelberg, S., *Science*, 1945, **101**, 255.

⁹ Lambert, E. A., and Wood, E. H., *PROC. SOC. EXP. BIOL. AND MED.*, 1947, **64**, 186.

¹⁰ Motley, H. L., and Cournand, A., *et col.*, *PROC. SOC. EXP. BIOL. AND MED.*, 1947, **64**, 241.

¹¹ Green, H. D., *Circulation, Physical Principles*, in O. Glasser, *Medical Physics*. The Year Book Publ., Inc., Chicago, 1944, p. 227.



D II = lead 2 .

FIG. 3.

Additional circuit for recording of R wave of E.C.G. D₁₁ = lead 2. R₄ = 250,000 ohm variable resistance. C = 0.2 μ F condenser.

potential differences produced at the extremes of R₃ (the capillary's electrolytic resistance) may be amplified through a clinical electrocardiograph (E.C.G.) or another amplifying device, when the movable electrode is displaced.

It has been possible to make an immediate and accurate record of a whole range of mechanical manifestations in the circulation system by means of this apparatus. Suitable capsules are used in each case as fully described elsewhere.

In order to relate the mechanical activities recorded in this way with other manifestations of the heart's activity we have superimposed on the mechanical tracing the R wave of the electrocardiogram by using an additional circuit with a variable resistance and a condenser (Fig. 3).

The different tracings obtained in man are recorded in Fig. 4: carotid pulse (I), jugular pulse (II), venous pulse together with the R wave of the electrocardiogram (III), radial pulse and R wave (IV), and finally the apex beat together with the R wave of the electrocardiogram (V).

Further applications of this method will be described later.

¹² Günther, B., and Concha, J., *Rev. Argent. Cardiol.*, 1948, in press.

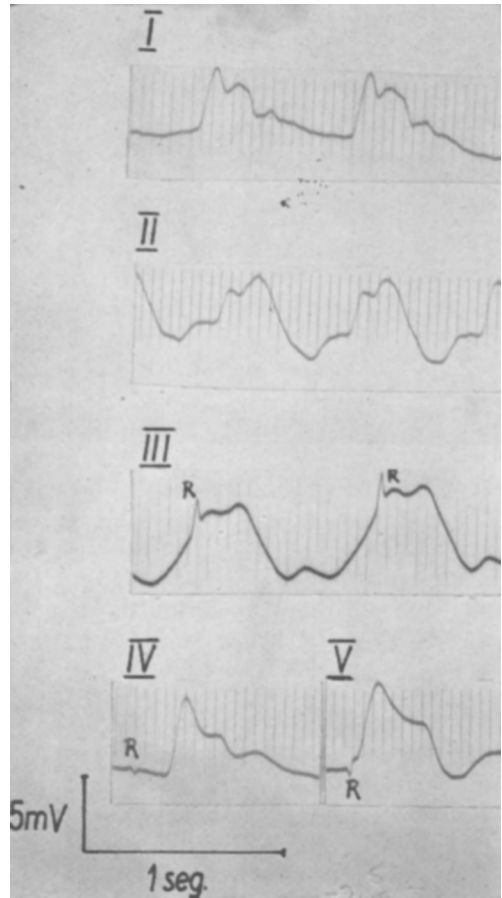


FIG. 4.

Tracings obtained in men: (I) Carotid pulse. (II) Venous pulse (jugular vein). (III) Venous pulse and R wave of the E.C.G. (IV) Radial pulse and R wave. (V) Apex-beat and R wave.

Summary. A new electrical method for recording mechanical variations is described which uses the differences in potential obtained by changes in the electrolytic resistance of a glass capillary filled with alcohol and glycerine. The method is specially useful in the study of mechanical changes in the cardio-vascular system.