IN THE LABORATORY

A Simple Laboratory Apparatus for the Demonstration of Cardiac Ballistics

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While the output of the heart is usually considered at some length in the physiology textbook and in the classroom, there appears to be no simple laboratory experiment in common use through which some of the more outstanding features of cardiac output may be demonstrated to the student. Dilution and foreign gas methods of estimating cardiac output and the direct Fick procedure, because of complexity and other reasons, are seldom practicable in the teaching laboratory. Of the secondary methods which may be used, the ballistocardiograph is of great value in studying changes in heart output. However, because of its rather complicated structure and certain technical difficulties, this device is found in relatively few laboratories.

In the belief that a less elaborate method of recording cardiac ballistics might be of interest, the description of a simple ballistocardiograph is submitted. The parts required for its assembly are readily available and include an ordinary bath scale, a writing lever, and a kymograph. The arrangement is shown in Fig. 1.

The use of a personal scale in the apparatus stems from the observation that the indicators of certain types of such machines show small rhythmic deflections corresponding to the pulse of the subject being weighed.[1] Because of its small size and construction, this type is the most convenient for the present purpose. While several varieties of these scales are available, the Detecto scale,[2] which registers by means of a vertically placed revolving drum, is best suited. When the subject stands upon the platform, the scale mechanism reaches equilibrium rapidly, but the drum does not remain completely stationary. There occurs a series of slight but noticeable oscillations which are found to correspond in frequency to the pulse rate. These oscillations are, in fact, produced by the recoil of the body from the ejection of blood from the heart and the passage of blood through the aorta.

The writing lever is cut from a thin sheet of celluloid in the shape indicated. The movements of the drum, A, are transmitted to the lever by means of a stiff wire, B, which engages in a small hole at C. The location of the fulcrum and the length of the writing arm are determined by the degree of amplification desired.

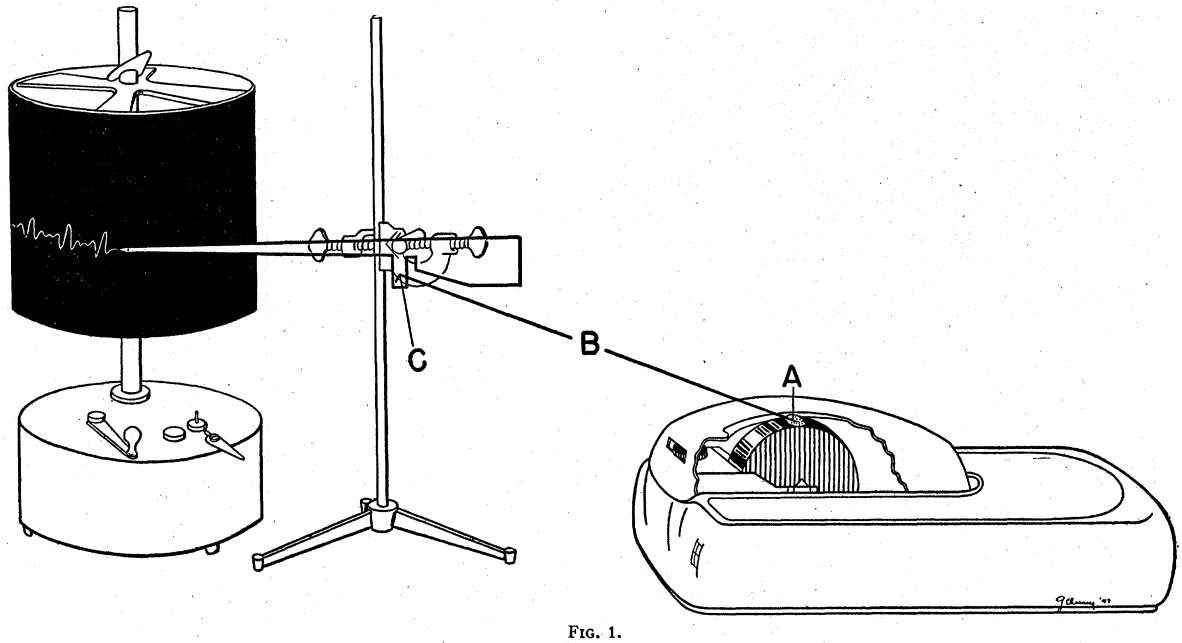

FIG. 1.

The plastic cover of the drum is removed. With the subject standing quietly upon the platform, the wire is attached to the lever at one end and to the drum at the other. The latter is

[1] A similar observation was made 70 years ago on a different type of scale by Gordon (*J. Anat. Physiol.*, 1877, **11**, 533), who recorded these deflections and thus made the first ballistocardiographic tracings.

[2] Detecto Scales, Inc., 1 Main Street, Brooklyn 1, New York.

conveniently done by sticking the flattened end of the wire to the drum's surface with a bit of Tackiwax.[3] Finally, the kymograph drum is brought up to the writing point so that light contact is made. The kymograph is run at a speed which shows the characteristic ballistic waves to best advantage.

Fig. 2(A) shows a typical ballistic wave pattern which was obtained with the apparatus described, the waves being indicated by the customary letters. In some records the L, M, and N waves are indistinct. There is some difference of opinion as to whether these are only a result of after-vibrations or are caused by forced movements. Nevertheless, the first and more important waves appear distinctly. While not intended to give quantitative information concerning the cardiac output, this ballistocardiograph does register changes in that value and may be used to demonstrate to the student some of the factors known to influence the output of the heart. Suggested demonstrations are the effects of exercise, normal and sustained respiration, and drugs upon cardiac output. Fig. 2 (B, C, and D) shows records obtained before and after moderate exercise.

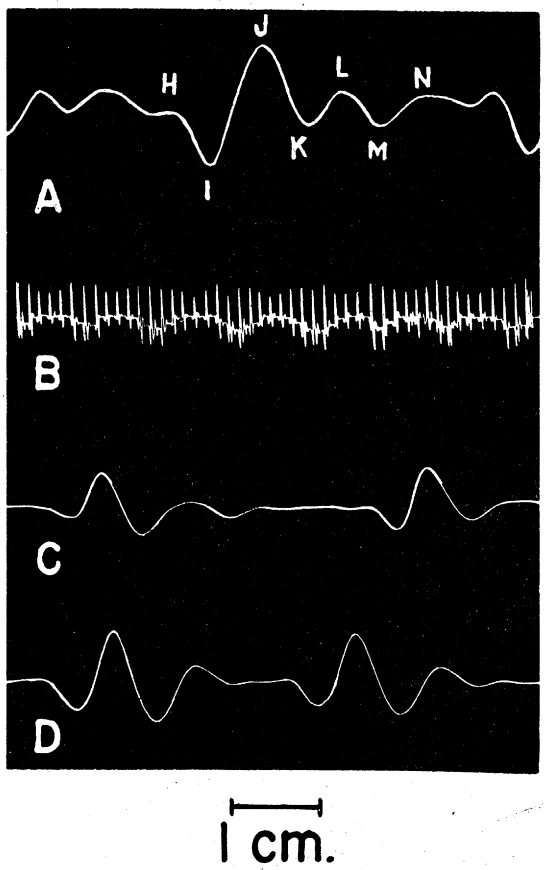

FIG. 2. Tracings obtained with the ballistocardiograph: A, typical pattern with the waves indicated by the customary letters; B, record obtained prior to exercise, with kymograph set at slow speed to show the respiratory waves to best advantage; C, continuation of B with kymograph set at higher speed; D, record of the subject in B and C after moderate exercise. (Note increased I-J distance.)

This ballistocardiograph produces the characteristic pattern of ballistic waves obtained with other, more elaborate instruments. Since the apparatus is inexpensive, is easily assembled, and does not require special training for its successful operation, it may be found useful as a teaching aid in the physiology laboratory.

[3] Cenco-softseal Tackiwax, Central Scientific Company, Chicago, Illinois.

Control of *Nosema* Disease of Potato Tuber Worm, a Host Used in the Mass Production of *Macrocentrus ancylivorus*

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In several laboratories where *Macrocentrus ancylivorus* Roh., an important parasite of the oriental fruit moth, *Grapholitha molesta* (Busck), is being propagated on the potato tuber worm, *Gnorimoschema operculella* (Zell.), serious losses in the production of parasites have been caused by a *Nosema*[1] disease which infects the tuber worm and the parasites reared from it. Infections of 80 per cent or more in the host stocks are not uncommon, and a large portion of the parasites that are produced on even moderately diseased host material may become infected. Diseased parasites are undesirable because they are short-lived and have lowered reproduction capacities.

Nosema disease in potato tuber worm stocks can be controlled by segregating a few pairs of disease-free moths and breeding them through successive generations in a location free of the disease. Although effective, this method is time consuming, and there is also the constant danger of reinfection.

A practical method of controlling *Nosema* disease was developed from suggestions of the junior author. This method takes advantage of the fact that the disease has been found to be transmitted through the host egg. Eggs of the potato tuber worm on paper sheets, which were obtained by the method described by Marvin (*1*), were placed in a water-tight metal envelope and immersed in a hot-water bath at 47° C. for 20 minutes. It was found that the eggs must be heated before being incubated. This treatment proved to be highly successful, reducing infections in the host stocks that developed from the treated eggs, and in the parasites reared from them, by 75 to 90 per cent. In one test the average incidence of *Nosema* disease in the parasites produced in eight trays that had been stocked with heat-treated eggs was only 2 per cent, as compared with 15 per cent in the parasites produced in four trays stocked with untreated eggs. All the eggs used in this test were from stocks that had received heat treatment in preceding generations. In concurrent tests the incidence of the disease was 44 per cent in parasites reared on host stocks, the eggs of which had not received heat treatments in preceding generations. In eggs that were heat treated after being incubated until nearly ready to hatch, only slight reduction in *Nosema* resulted. In experimental series in which complete

[1] Determined by R. R. Kudo, University of Illinois, Urbana.