METHODS

AN APPARATUS FOR RECORDING BALLISTOCARDIOGRAM DISPLACEMENT RATES AND ACCELERATIONS

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(Received January 28, 1957. Presented by V. V. Parin, Member of the Academy of Medical Sciences of the USSR)

The ballistocardiograph, being a valuable diagnostic tool, is being widely introduced into cardiovascular clinics.

There are at present two types of apparatus, in which the ballistocardiogram is recorded indirectly and directly, respectively. Of the indirect the most common are Starr's high frequency table [4] and Nickerson's low frequency table, critically damped [2]. These can record only two parameters of the motion, velocity and displacement, the third – acceleration – not being recorded.

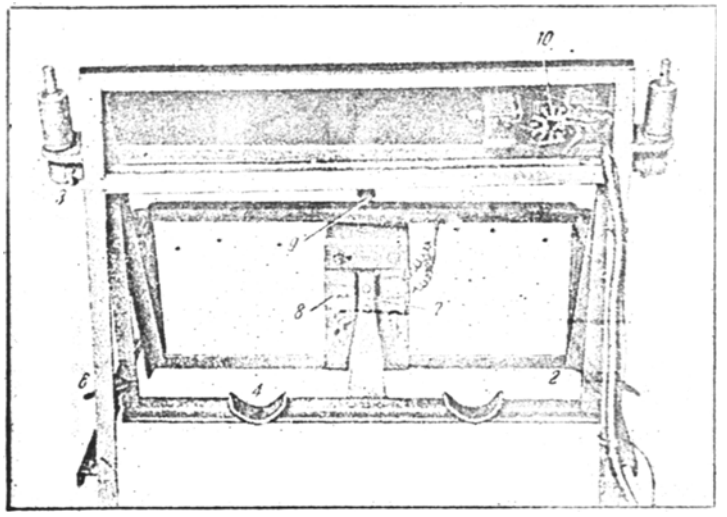

Fig. 1. General view of the ballistocardiogram recording setup. Description in text.

The indirect ballistocardiographs are easily calibrated accurately, which is undoubtedly one of their advantages. But they have also disadvantages, mainly their being cumbrous.

The direct ballistocardiograph was introduced to clinical practice later. Of the very numerous types, Smith's [3] direct ballistocardiograph transducer has been most used, this recording all three parameters simultaneously. This is achieved by integrating and differentiating the electromagnetic transducer output electronically, the transducer sensing the velocity.

A major disadvantage of the direct method is the difficulty or impossibility of calibration, as Kazmeier and Schild state. So in analyzing and evaluating the ballistocardiograms only the qualitative aspects are usually considered.

For recordings to be satisfactory the natural frequency of the platform or transducer must be higher than that of the body, if distortion due to resonance and beats is to be avoided. Starr's table has a satisfactory frequency characteristic but has a second degree of motional freedom, which may affect the curve shapes.

The direct transducers also have this second degree of freedom. Also the various transducers vary in weight and in envelope elasticity, which introduces additional factors into the determination of the frequency characteristics of the transducer plus patient system.

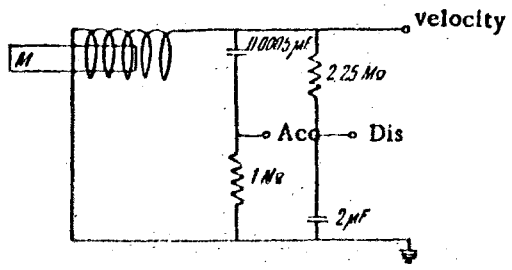

Fig. 2. Circuit of the integrating and differentiating device.
Description in text.

Our ballistocardiograph (Fig. 1) is in essence an attempt to combine the advantages of the indirect mechanical recording system with Smith's direct ballistocardiograph. The mechanical system is based on the free-bob pendulum principle, giving a high natural frequency and simultaneously minimizing the second degree of freedom. The pendulum system is convenient also in being easily calibrated.

The mechanical system is comprised of the following parts:

The angle-iron frame and stand (1) fixed on a solid couch. The bob frame (2) is also of angle-iron, the upper cross-bar being freely supported in ball-bearings fixed to the brackets (3) in the stand. The lower cross-bar carries two shaped rests for the lower parts of the patient's legs, (4). The stand carries two vertical adjustment screws (5) attached to the bob frame to adjust the frame relative to the couch (for leg thickness).

The sides of the stand carry catches (6) to retain the bob frame in the central position. These can also be used for calibration purposes (the catches have gaps within which the frame can be moved over a strictly defined range). The ballistocardiograms can then be calibrated by adjusting the sensitivity.

The electrical circuit comprises a magnet attached to the lower cross-bar in the bob-frame by the brass rod (7) and a coil (8) of 100,000 turns of copper wire 0.08 mm in diameter. The coil, being fixed to stand, can be adjusted vertically by the screw (9) to follow the bob frame, so the magnet moves freely within the coil; the capacitors and resistors (10) for differentiating and integrating the signal (Fig. 2) are mounted in the upper part of the stand.

This ballistocardiograph is simple to build, portable and cheap.

SUMMARY

A new model of ballistocardiograph was suggested, in which the advantage of the mechanical system of indirect recording is used in conjuction with the principle of direct ballistocardiography according to Smith's method. The mechanical system of this apparatus is designed by the principle of a pendulum with a free pendant. This provides high frequency of oscillations of the apparatus and simultaneously it causes the second degree of free movement to come down to a minimum. The system of pendulum is, likewise, convenient since it is easily calibrated.

The ballistocardiograph which is proposed is easily handled, portable and inexpensive.

LITERATURE CITED

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