AN ELECTRONIC HEART-BEAT RECORDER

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Summary

An apparatus permitting to record the heart-beats of working persons is described. The input signal is obtained from a barrier layer photocell and a lamp at the ear-lobe. The signal is amplified by a differential amplifier with symmetrical input and feed-back.

§ 1. *Introduction.* In studies concerning the physiology of work it is sometimes valuable to be informed continuously about the heart-beat frequency of working men. Several instruments to record heart-beats have been developed [1)-4)].

Müller and Reeh [3)] have published a simple method. A small lamp is placed on one side of the ear-lobe of the person studied and on the other side a little selenium photocell is placed. The amount of light falling on the photocell depends on the amount of blood in the ear, which changes with each heart-beat. The small signal obtained in this way is amplified to such a level that a counter can be excited.

It has been found that the amplifier of Müller and Reeh did not work satisfactorily since low frequency disturbances were picked up easily and spontaneous generation could not be avoided.

§ 2. *The apparatus.* Following the same principle, another apparatus has been constructed. The amplifier part is given in fig. 1. In order to eliminate 50 cycles interference and low frequency disturbances, caused by movements of the long connecting cable between photocell and amplifier, a differential amplifier with symmetrical input and feed-back has been used [5)-10)]. A three stage amplification proved to be sufficient to actuate the thyratron

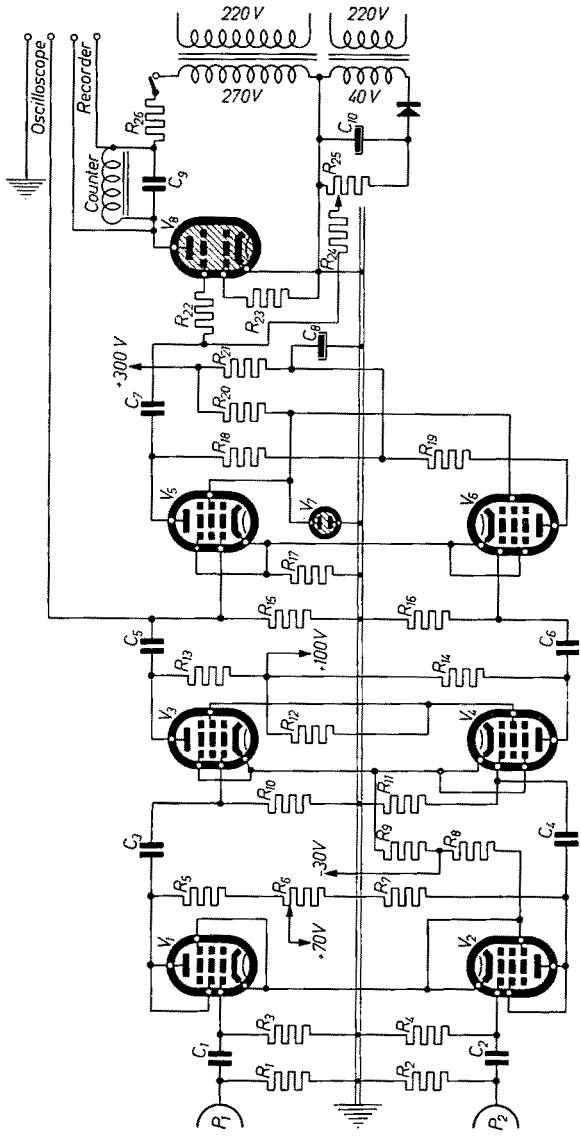

Fig. 1. Circuit-diagram of the heart-beat recorder.

$R_1 = R_2 = 100\ \text{k}\Omega$
$R_3 = R_4 = R_{10} = R_{11} = R_{15} = R_6 = 1\ \text{M}\Omega$
$R_5 = R_6 = R_7 = 50\ \text{k}\Omega$
$R_8 = R_{13} = R_{14} = 100\ \text{k}\Omega$
$R_9 = 40\ \text{k}\Omega$
$R_{12} = 140\ \text{k}\Omega$
$R_{17} = 2.2\ \text{k}\Omega$
$R_{18} = R_{19} = 200\ \text{k}\Omega$
$R_{20} = R_{21} = 20\ \text{k}\Omega$
$R_{22} = R_{23} = 0.1\ \text{M}\Omega$
$R_{24} = 8.2\ \text{M}\Omega$
$R_{25} = 2\ \text{k}\Omega$
$R_{26} = 2.5\ \text{k}\Omega$

$C_1 = C_2 = C_3 = C_4 = 4\ \mu\text{F}$
$C_5 = C_6 = C_9 = 2\mu\text{F}$
$C_7 = 1\ \mu\text{F}$
$C_8 = 50\ \mu\text{F}$
$V_1 = V_2 = V_3 = V_4 = EF\ 37\ A$
$V_5 = V_6 = EF\ 40$
$V_7 = 85\ A\ 1$
$V_8 = 2\ D\ 21$ or $PL\ 21$

P_1 and P_2 are + and — poles of the selenium-cell.

counter unit. The signal at the input of the amplifier is about 200 μV–500 μV and the amplification about 100000. The signal is amplified without considerable distortion and has a saw-toothlike wave form. This simple form of the signal is the reason why recording of heart-beats in the way described is possible.

The power supply of the first two stages must be stabilised within 0,25%. The heater current of the tubes in the first stages and the current through the lamp at the ear-lobe must be stabilized as well.

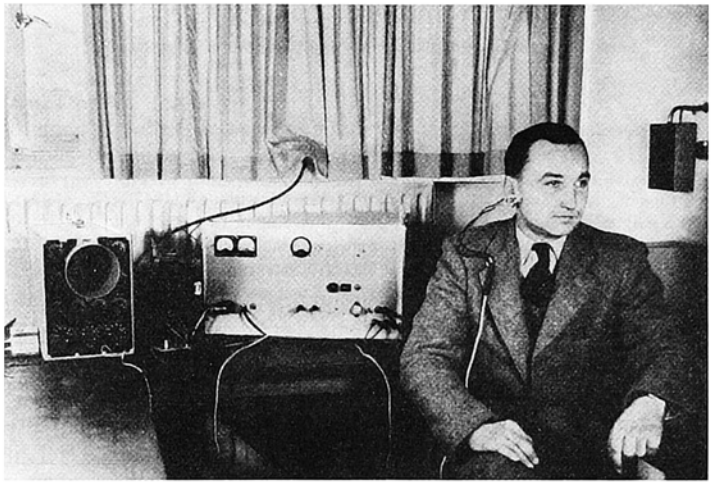

Fig. 2. Photograph of the heart-beat recorder.

In the present apparatus these currents are obtained from a storage battery and the stabilized voltages of the first stages from dry batteries. For the third stage the power supply unit of Müller and Reeh is maintained.

A serious difficulty of the apparatus is the construction of the pick-up. In the first place changes in the relative positions of lamp, ear-lobe, and photocell must be avoided, secondly light from other sources than from the lamp at the ear-lobe must be kept away from the photocell. Although another pick-up than the pick-up described by Müller and Reeh has been used, the details of the construction are not given, since it will be necessary to use different pick-ups under different experimental conditions. Moreover it has been found

that sudden movements of the working person, especially with the head, cause mistakes, owing to a surge of blood in the ear. A photograph of the apparatus and a working person is given in fig. 2.

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