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DEVICE FOR FUNCTIONAL TEST OF ORGANS OF LIVING BODIES

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Fig. 1.

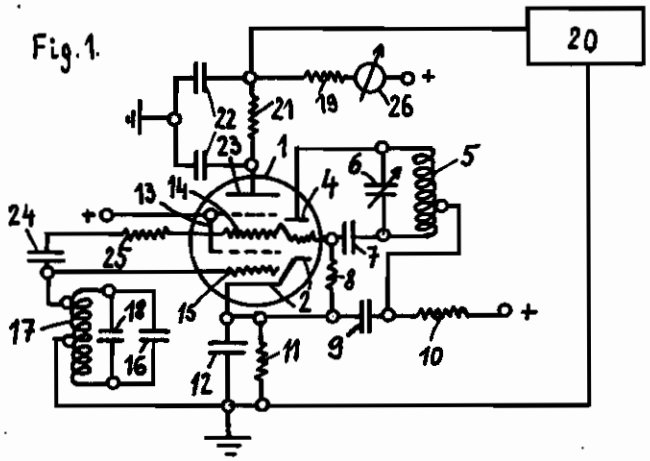


Fig. 2.

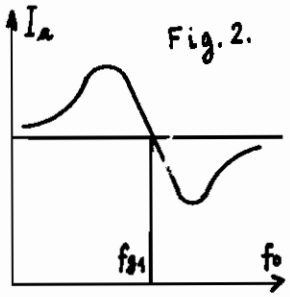
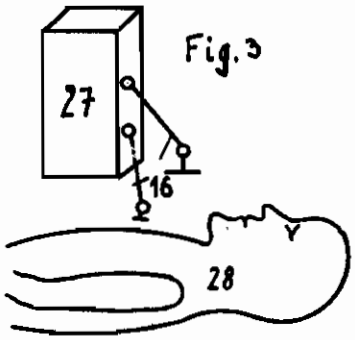


Fig. 3



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DEVICE FOR FUNCTIONAL TEST OF ORGANS OF LIVING BODIES

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The present invention relates to devices for functional test of organs of living bodies (f. i. heart, lungs, veins, muscles etc.) for converting the variations of the resonant frequency and/or damping of a tuned circuit due to the action of the organ to be tested and placed nearby to said tuned circuit into energy having an amplitude proportionately to said frequency and/or said damping variations.

Object of the invention is a device for functional test of organs comprising substantially beside said tuned circuit an electron discharge tube having at least two control electrodes or grids for controlling the space current passing from the cathode to the anode of the tube and one or two generators for alternating potentials preferably of high frequency. Impressing alternating potentials of the same frequency and in nearly quadrature phase relation on said control electrodes, there is produced by mutual intermodulation of the potentials on the electrodes in the anode current of said tube a component having an amplitude varying proportionately to the relative frequency departure of the potentials on the electrodes, which amplitude variations can be observed, recorded, i. e. used for functional test.

Said tube may be preferably of pentagrid-converter or triode-hexode type, in order to avoid the use of a particular oscillator tube. An alternating potential impressed on the first grid near the cathode of said tubes will cause a potential at the frequency of the impressed potential to be induced on the second control grid by unilateral space charge coupling, which is utilized in the case of the pentagrid-converter type. Using a triode-hexode type the space charge coupling is substantially eliminated by means of a condenser connecting the grids. In certain cases, especially very high frequencies, a resistance is advantageously placed in series with the coupling condenser in order to equalize the effect of the transit time of the electrons passing from one grid to the other. If the space charge coupling is neutralized in this manner a new unilateral coupling is produced between the grids in a direction from the second grid towards the first grid.

Figure 1 is a diagram of a circuit adapted for an embodiment of the invention.

Figure 2 is a characteristic curve explanatory of the function of the above circuit.

Figure 3 shows the arrangement for a heart action test.

Referring to Figure 1, item 1 represents a triode-hexode; the cathode 2; the triode grid 3 and the triode anode 4 are connected in the known Hartley circuit to the tuned circuit comprising the inductance coil 5 and the preferebly variable condenser 6 for exciting oscillations. The condenser 7 and the resistance 8 are known coupling elements in the grid circuit, the resistance 9 and the by-pass condenser 10 in the anode circuit, and the resistance 11 and the by-pass condenser 12 in the cathode circuit. Item 13 represents the screen grid of the hexode. The second control grid 14 of the hexode is connected to the grid 3 of the triode within the tube. The space charge coupling directed from the first grid 15 towards the second grid 14 is eliminated by the condenser 24 and resistance 25. By means of the unilateral capacitive coupling directed from the second grid 14 towards the first grid 15 the tuned circuit comprising the inductance coil 17 and the condensers 16 and 18 is excited by the oscillations generated in the tuned circuit 5—6. Nearby to or between the electrodes of the condenser 18 the organ to be tested is to be placed.

In Figure 2 the anode current I_a is plotted as a function of the oscillator frequency f_o. f_{el} represents the natural frequency of the tuned circuit 16—17—18. The working point of the tube (advantageously on the middle, steep portion of the curve) can be tuned in by means of the variable condenser 6 in observing the milliamperemeter 26. The potential variations on the working resistance 19 in the anode 19 circuit feed the amplifier and the recording device 26. The resistance 21 and the by-pass condensers 22 remove the components of high frequency from the anode circuit of the hexode.

In Figure 3, the device 27 contains the coupling elements of Figure 1; the amplifier and the recording apparatus 20 together with the voltage sources will be arranged preferably in a particular container. The one electrode of the condenser 18 is placed above the place of the heart of the patient 28, the action of which is to be tested. The other electrode serves for balance with respect to unwanted influences from without.

Object of the invention is also the balanced arrangement of the electrodes of the condenser 16 referring to "earth." It is also often advantageous to screen the inactive parts of the electrodes and the leads.

Instead of capacitive detuning of the tuned circuit 16—17—18 by means of the condenser 16, inductive detuning by means of the coil 17 ar-

ranged nearby to the organ to be tested can also be applied, or both kinds of detuning can be used at the same time. The damping of said tuned circuit will be varied to some extent in all cases.

Another object of the invention is supplying the feeding voltages for the tube 1 from the mains, the use of at least two consecutive stages of voltage stabilization to remove the fluctuations of the mains voltage from the anode of said tube, whereby at least in one stage, stabilizer tube (tube filled with inert gas) is used, and the other stages can be represented also by stabilizing transformer, motor-generator or special tube circuit. Such a special tube circuit can be provided by adjusting the amplification of the tube 1 in order to balance the fluctuations of the supply voltages of the anode 23 and of the screen grid 13 respectively against another relative to the anode 23.

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