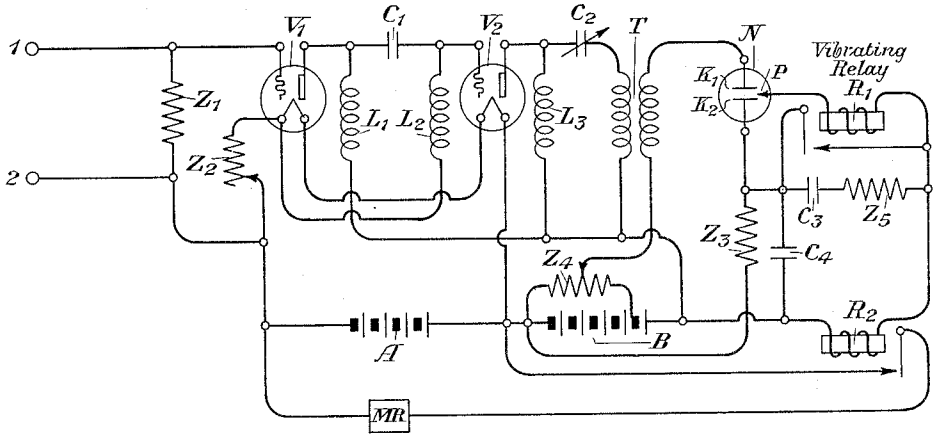
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GAS DISCHARGE TUBE CIRCUITS

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GAS DISCHARGE TUBE CIRCUITS

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This invention relates to gas-filled tubes and to circuits therefor. More particularly, this invention relates to gas-filled tube arrangements adapted to register or record selected types of voltage variations. Still more particularly, this invention is applicable to methods and arrangements for observing and/or recording the heartbeats of man or animal.

The period of the heartbeat of man or animal may be recorded either visually or by the operation of a relay, message register, pen recorder or by other types of recording or alarm arrangements. This statement, however, is based upon the fact that the electromotive forces generated by the heart produce periodic peaks of electromotive force which are of greater amplitude than certain non-periodic electromotive forces generated by muscles and heart, etc.

A simple method for accomplishing this objective consists in the use of an amplifier of high gain to increase the minute voltages produced by the heart to values sufficient to cause operation or ionization of a gas-discharge tube of, for example, the three-element trigger type. An input transformer and condenser may also be employed to tune this circuit to the wave front of the heart voltage peak desired and by virtue of its selective characteristics to exclude other and undesired voltages. The gas-filled trigger tube of the arrangement of this invention is connected to a circuit which causes operation of relays, a message register, pen recorder, etc. Where it is desired that the observations be made only visually, however, only a two-element gas tube need be employed.

It has been determined that the heart produces, among other things, a series of so-called R-waves or voltage peaks at each beat of the heart. The amplitude of these voltage waves is only slightly in excess of other waves produced by the heart which may or may not be periodic. By tuning to the wave front of this R-wave, it is thus possible to obtain increased discrimination between this peak voltage and the undesirable voltages produced, for example, by muscular movement or movements of the heart. By these circuits, as will be shown more clearly hereinafter, the employment of the gas tube arrangement can be made to give a clear-cut distinction between the desired and undesired voltages.

The electromotive forces generated by the heart should be amplified by seventy or eighty decibels. The amplified voltage may be impressed upon the cathodes of a gas-filled or neon tube causing ionization of the gas contained within the tube. The impedance between the electrodes of the tube is thus reduced, causing current to pass in the secondary circuit which includes the relays and registering or recording apparatus.

This invention will be better understood from the further description hereinafter following when read in connection with the accompanying drawing which shows one embodiment of the invention merely for the purpose of illustration.

The terminals 1 and 2 extend to electrodes which may for instance, be brought in contact with a man or animal. These terminals are shunted by a resistor Z_1 which is connected to the grid or input circuit of the tube V_1 through a rheostat Z_2. The output circuit of the tube V_1 includes a coil of inductance L_1 through which is supplied plate current from battery or source of potential B. The voltages that are amplified by the tube V_1 are applied to the grid or input circuit of another amplifying tube V_2 through a condenser C_1. The grid of the latter tube is connected to its filament electrode through a drainage coil L_2 and the filament of the tube V_1. The output circuit of the tube V_2 is connected to the source of plate potential B through another coil L_3. The filaments of both tubes V_1 and V_2 are connected in series with each other and with the rheostat Z_2 and the battery or other source of voltage designated A. The voltages amplified by the second tube V_2 are then transmitted through an input transformer T, the primary of which is connected to the output circuit of the tube V_2 through the adjustable condenser C_2.

The secondary winding of the transformer T is in a circuit which includes the cathodes K_1 and K_2 of a gas-filled discharge tube N, a resistor Z_3 and a potentiometer Z_4, the outer terminals of which are connected across some or all of the source B. The tap of the potentiometer Z_4 may be adjusted so as to bias the cathode K_1 with respect to the cathode K_2 to any desired potential, which may be below the voltage required to sustain ionization between the cathodes K_1 and K_2 or above the sustaining voltage between these electrodes but below the voltage required to initiate gaseous ionization between these electrodes. The anode P of the tube N is connected in a circuit which includes the winding of a relay R_1, the winding of an operating relay R_2, the source B, the resistor Z_3 and the cathode K_2 of the tube N. The relay R_1 has its armature and contact connected between the cathode K_2 and anode P of tube N through its winding. The armature and contact of the relay R_1 are also shunted by a circuit which

includes the resistor Z_5 and the condenser C_3. The left-hand terminal of the winding of the relay R_2 is connected to the armature of the relay R_1 by a condenser C_4. The armature and contact of the relay R_2 are connected in a circuit which includes the source A and a message register or pen recording device or any other recording, registering or indicating device designated MR and this latter device may be located at some remote position.

A foreleg and hind leg of an animal, for instance, may be treated with salt and water around which electrodes may be wrapped. The voltage generated by the animal may be applied to the amplifying circuit including the tubes V_1 and V_2. A predetermined voltage such as that corresponding to the R-wave of the heart may be obtained by adjustment of the condenser C_2 and this voltage may be selectively transmitted to the circuits of the gas-filled tube N to the exclusion of all other waves. The biasing voltage of the tube may be adjusted at the tap of the potentiometer Z_4 to a value which just records glow between the cathodes K_1 and K_2 of the tube N and the relay R_1 will operate in correspondence to the peak voltages of this R-wave.

In the arrangement shown in the drawing, the armature of the relay R_1 will vibrate in accordance with the period of the selected wave. At each closure of the contact of this relay, the potential between the anode P and the cathode K_2 of this tube will be reduced to a practical nullity, the circuit so established including the winding of the relay R_1 which has a comparatively low resistance or impedance. The vibration of the armature of relay R_1 will cause alternate charges and discharges of the condenser C_3 through the impedance Z_5.

During the vibration of the armature of the relay R_1, current will nevertheless flow through the winding of relay R_2. When the armature of the relay R_1 is spaced from its contact, the current which traverses the winding of the relay R_2 will also traverse the winding of relay R_1 as well as the path provided by the anode P and cathode K_2 of the tube N. When the armature of the relay R_1 closes its contact, current will continue to flow through the winding of the relay R_2 over the circuit which includes the armature and contact of the relay R_1 and the resistor Z_3. In other words, the relay R_2 will remain operated as long as the relay R_1 continues to vibrate its armature. During the entire period of operation of the relay R_2 the message register or other recording device MR will be continuously maintained in operation.

It will be observed that the impedance Z_3 is common to the circuit of the cathodes K_1 and K_2 and the circuit of the anode P and cathode K_2 of the tube N. When current flows through this resistor a potential is generated across its terminals which opposes that tapped by potentiometer Z_4 from the source B and reduces the effective voltage between the cathodes K_1 and K_2 to a value well below the voltage required to sustain gaseous ionization between these electrodes. This voltage opposition occurs intermittently, i. e., in accordance with the peak voltage selected by the condenser C_2 and the input transformer T. It is this poriodic voltage opposition which intermittently deionizes the gas between cathodes K_1 and K_2 and therefore allows the gas between these cathodes to become ionized only in accordance with the presence of sufficiently amplified voltage derived from the amplifier V_1—V_2.

The arrangement set forth in the drawing may be employed to record the heartbeats of patients during operations, after operations or when it becomes necessary to observe and record any change in the condition of the heartbeat of the patient. Moist electrodes would be strapped to the arm and leg of the patient and fine wires woud be led to the input of the amplifier. The flashing of the neon lamp N or the operation of the relays and the recording device MR will give beats of the patient's heart. A plurality of circuits each provided for one of the patients may be so arranged that the various neon lamps may be located at a remote point and there observed by a single attendant.

The apparatus of this invention may be employed in operating rooms during the administration of anaesthetics to enable all present to observe the period of the heart, thus relieving the burdensome observation by other methods which involve the use of the stethoscope, pulse, etc. The apparatus may be also used in the case of diabetic patients where dangerous symptoms leading to convulsions or coma are indicated by the increased rate of the heartbeat. Immediate treatment will prevent the occurrence of these conditions if proper drugs are duly administered, the increase of the period in the heartbeat being the warning signal.

If desired, the three electrode device N may be replaced by a two electrode device. Such a device may be bridged across the terminals of the secondary winding of transformer T, preferably through a source of biasing voltage, and it would visually indicate the presence of selected, properly amplified voltages obtained from the apparatus connected thereto.

While this invention has been shown and described in a particular arrangement merely for the purpose of illustration, it should be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a heart voltage measuring apparatus, the combination of a tunable amplifier for amplifying a selected voltage impressed upon said amplifier to the exclusion of all other voltages, a gas-filled discharge tube having three electrodes, two of which are supplied with the voltage amplified by the amplifier, exhibiting apparatus connected between the third electrode and one of the other electrodes of the tube, and means for periodically deionizing the gas between all of the electrodes of the gas-filled tube.

2. In apparatus for measuring heart voltage combination of an amplifier, a gas-filled discharge tube having three electrodes, means for selectively applying only a predetermined voltage to two of the electrodes of the tube, a load circuit connected between the third electrode and one of the other electrodes of the tube, and means for simultaneously deionizing the gas between both pairs of electrodes.

3. Apparatus for observing voltage variations comprising a gas-filled discharge tube having three electrodes, a resistor connected to two of the electrodes, means for selectively applying and magnifying the voltage variations to said two electrodes for producing a glow discharge between said two electrodes of the tube in response to said selected and magnified voltage variations, and means including a circuit connected between the third electrode and one of the other electrodes and including said resistor for intermit-

tently suppressing the glow discharge between the first two electrodes of said tube during the application of said voltage variations.

4. Apparatus for observing and recording the frequency of a selected alternating voltage to the exclusion of all other alternating voltages, comprising a tunable circuit for selecting from numerous applied voltages of different frequencies a voltage of a single frequency substantially to the exclusion of all other frequencies, a gas-filled discharge tube having three electrodes forming two gaps, the selected alternating voltage being applied in magnified form to the electrodes of one of said gaps, exhibiting means connected to the electrodes of the other gap, and means for intermittently deionizing the glow discharge of both gaps.

5. Means for visually indicating the frequency of an alternating voltage to the exclusion of all other voltages, comprising a gas-filled discharge tube having three electrodes, means selectively responsive to said voltage to ionize the gas between two of the tube's electrodes as well as to ionize the gas between the third electrode and one of the other electrodes, and means responsive to the latter ionization to simultaneously deionize the gas between the two pairs of electrodes already referred to.

6. Apparatus for observing feeble voltage effects such as heart beats comprising an amplifier, a tunable circuit connected to the amplifier for selecting predetermined voltage effects, a gas discharge tube of two electrodes connected to said tunable circuit, means responsive to the application of the predetermined voltage effects to said tunable circuit for producing an intermittent glow discharge between the electrodes of said tube for observing the periodicity of the voltage effects, and means responsive to each glow discharge of said tube for producing a voltage for substantially neutralizing the voltage effect impressed by the tunable circuit between the electrodes of the tube.

7. In a heart voltage measuring apparatus, the combination of an adjustable tuned circuit, a gas discharge device having two electrodes coupled to said tuned circuit, a source of voltage connected to said circuit, said device producing intermittent observable glow discharge within said device as the frequency of said tuned circuit is made equal to a frequency of said source and means responsive to each glow discharge of said device for producing a voltage to oppose and substantially neutralize the voltage impressed by said tuned circuit on said device.

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