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APPARATUS FOR RECORDING STEEP WAVE FRONT VOLTAGES OF SHORT DURATION

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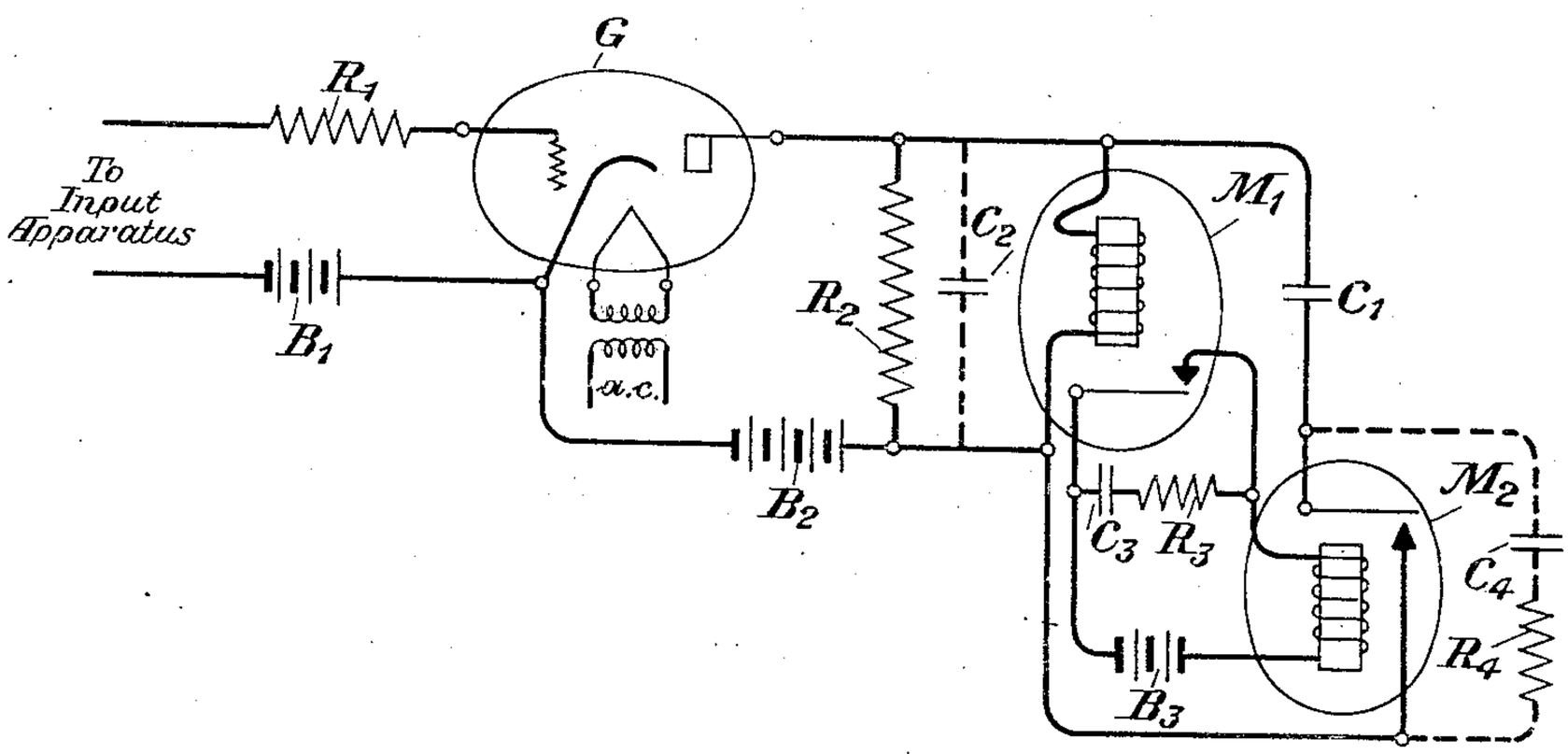

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APPARATUS FOR RECORDING STEEP WAVE FRONT VOLTAGES OF SHORT DURATION

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7 Claims. (Cl. 175—320)

This invention relates to gas-filled tubes and circuits therefor. More particularly, this invention relates to recording systems employing gas-filled tubes and circuits. Still more particularly, this invention relates to arrangements for recording short-lived surges, particularly if of steep wave front.

Where a telephone or other line is exposed to extraneous voltage effects of steep wave front, such effects, if produced by lightning discharges, will be of but short duration. Ordinary recording apparatus for obtaining some picture of the lightning or other such phenomena will ordinarily have a time constant too large to be properly responsive to effects of such brief duration. The arrangements to be described hereinafter and the features and principles employed therein will be useful for the purpose of accurately translating and recording such phenomena.

Where hot cathode tubes as, for example, those of the ionic type, are employed to record steep wave front surges that persist for very short periods of time, an incomplete record will result if the recording mechanism associated with the anode of the tube has an appreciable amount of inductance which is not shunted by resistance or capacity. This is due to the fact that an impulse applied to the grid and cathode at the input of the tube which results in ionization of the gas within the tube may be of too short duration to produce ionization in the anode-cathode circuit. This follows from the lack of sufficient time during the interval that the surge persists on the input terminals to build up sufficient current through the recording mechanism connected in series with the anode and cathode of the gas-filled tube. This difficulty can be overcome by the use of a suitable resistance or a condenser in shunt with the inductive load mechanism. This resistance or condenser must be of such a value as to allow sufficient current to be by-passed around the load mechanism to produce ionization by collision in the work circuit even for very short-lived, steep wave front impulses.

The use of gas tubes requires that a critical minimum value of current be passed between the anode and cathode to produce a "locked-in" condition of the tube. The resistance or condenser must therefore be of suitable value to instantly allow that value of current, or a greater current, to be passed through the work circuit independently of the current supplied to the anode of the tube through the load mechanism.

As it is desired that the recording mechanism be self-restoring and entirely automatic, the size of the condenser shunting the inductive load mechanism must be properly chosen so that the immediate resetting of the tube will not take place until the recording mechanism or message register, of the type well known in the telephone art and employed for recording the number of telephone calls made on a particular telephone line, has had ample time to operate. Hence, to avoid design difficulties it is generally simpler to employ a resistance to shunt the operating mechanism.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing which illustrates certain arrangements for carrying out the principles of this invention.

Referring to the drawing, the reference character G designates a heater type of gas-filled tube, the input or grid-cathode circuit of which is connected to a source of voltage to be recorded through a resistor R_1 and a source of biasing voltage B_1. The output or anode-cathode circuit includes a source of anode voltage B_2 and the winding of an operating relay M_1. The armature and contact of relay M_1 controls the operation of a second relay M_2 which may be a message register or other recording instrument. The winding of the latter relay is in series with a source of potential B_3 which supplies the current required for its operation. The armature and contact of relay M_2 are in series with a condenser C_1 which shunts the winding of relay M_1. A large resistor R_2 permanently shunts the latter winding, but if desired, a condenser C_2 (shown in dotted lines) instead may permanently shunt the winding of relay M_1. A spark killing circuit comprising a resistor R_3 and a condenser C_3 will shunt the armature and contact of relay M_1 and, if desired, a similar arrangement of resistor R_4 and condenser C_4, shown in dotted lines, may be employed to bridge the armature and contact of relay M_2, the latter circuit being employed for a different purpose, as will appear hereinafter.

If the voltage applied in series with resistor R_1 and battery B_1 is of sufficient magnitude and duration, ionization will be produced in the grid-cathode circuit. This ionization will allow an appreciable current to be built up in the anode-cathode circuit. The relay M_1 will then operate and its contacts will cause the message register or recording device M_2 to be operated. Upon operation of device M_2, the condenser C_1 will be connected to shunt the winding of relay M_1 and allow the tube G to reset to normal just as soon as the potential applied to the grid-cathode circuit is withdrawn. Both relays M_1 and M_2, however, will remain operated during the period of application of voltage to the grid-cathode circuit of tube G.

If the condenser C_1 (unless of certain well-chosen value) were connected across the wind-

ing of relay M_1 at all times, it would be possible for the operating relay M_1 and tube G to be reset to normal before the recording mechanism, namely relay M_2, could properly operate. Thus, the apparatus would fail to record very short-lived, steep wave front impulses. Accordingly, the condenser C_1 becomes shunted across the winding of relay M_1 only after operation of relay M_2.

The resistor R_2 or the condenser C_2 is employed to provide for the almost instantaneous passage of current from battery B_2 through the path formed by the anode and cathode of tube G. If both resistor R_2 and condenser C_2 were omitted, however, the current supplied by battery B_2 would have to traverse the winding of relay M_1 and this current would not build up fast enough to a required value to produce ionization by collision of the gas between the anode and cathode of the tube. The delay would be caused by the inductance of the relay winding and hence relay M_1 would fail to operate on the application of very short surges to the input circuit of the tube. The addition of either resistor R_2 or condenser C_2 in shunt with the relay winding permits the current of battery B_2 to rise instantaneously and the ionization of the gas within the tube becomes sufficient so that battery B_2 may transmit current to lock the tube in. Ample time is allowed thereafter to operate relay M_1 by current derived from battery B_2. The addition of condenser C_2 is preferred as against the resistor R_2 because the condenser, cooperating with the winding of relay M_1, provides for the resetting of the tube G. This latter resetting feature is described in the D. T. Osgood application, Serial No. 27,793, filed June 21, 1935.

If no indicating device or message register such as M_2 is connected to the system and it is desired to reset the apparatus immediately after withdrawal of the applied voltage at the input circuit, the condenser C_1 may be shunted around the winding of relay M_1 without the shunting resistor R_2. If desired, a resistance (not shown) may be inserted in series with condenser C_1 in shunt with the winding of relay M_1.

Fast operation and automatic resetting after message register operation can be accomplished by omitting resistor R_2 and adding the resistor R_4 and condenser C_4, as shown in dotted lines. The resistor R_4, however, must be high in value in order that automatic resetting of the tube G may take place only after message register operation.

For good recorder practice, the resistor R_4 and condenser C_4 may be entirely dispensed with and the arrangement shown in full lines, including resistor R_2 and condenser C_1, employed.

The use of resistor R_2 is not necessarily confined to resetting arrangements as shown, but may be employed to shunt any operating or load device connected, for example, between the anode of the tube and the positive terminal of source B_2.

The arrangement of this invention has been shown as applied to a hot cathode type of gas-filled tube. This type of tube is by no means necessary to carry out the principles of this invention. A cold cathode gas-filled discharge tube having but three electrodes and of any well known type may be substituted therefor, two of its electrodes, i. e., its cathodes, being connected to the right-hand terminals of resistor R_1 and source B_1, the third electrode or anode and one of the first-mentioned electrodes or cathodes being connected to the upper terminal of resistor R_2 and the left-hand terminal of source B_2, respectively. The two cathodes will form one discharge gap and the anode and associated cathode will form another discharge gap.

While this invention has been described as embodied in particular arrangements which are deemed desirable, it is to be understood that it is capable of embodiment in many and widely varied forms without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. Apparatus for translating steep wave front voltages of short duration including a gas-filled tube to the input circuit of which said voltages are applied to ionize the gas within the tube, a source of potential, an inductive load connected to the output circuit of the tube in series with said source of potential, and a resistor conductively connected directly in shunt to the inductive load.

2. The combination of a gas-filled tube having input and output circuits, an inductive load operatively associated with the output circuit of said tube, a non-inductive impedance connected in shunt with said load, a capacitor, and means controlled by the load for shunting the capacitor across the load.

3. The combination of a source of voltage, an inductive load, a gas-filled tube interconnecting the source and the load, a non-inductive impedance connected in shunt with the load, a condenser, and means responsive to the transmission of voltage from said source through said tube to the load to shunt the condenser across the load.

4. The combination of a gas-filled tube having an input circuit and an output circuit, an inductive load connected in the output circuit and controlled by voltages applied to the input circuit, the gas within the tube being ionized by the voltages applied to the input circuit of the tube, and a resistor conductively connected directly in shunt with the load.

5. Apparatus for recording steep wave front voltages of short duration comprising a gas-filled tube having an input circuit to which the voltages are applied and an output circuit, a relay having a winding connected in the tube's output circuit, a resistor in shunt with the relay winding, a recording device controlled by the first-mentioned relay, a condenser, and means responsive to the operation of said recording device to shunt the condenser across the winding of the first-mentioned relay.

6. The combination of a gas-filled tube having input and output circuits, an inductive device connected to the output circuit of said tube, a resistor connected in shunt with the inductive device, a capacitor, and means responsive to the ionization of the gas within the tube for shunting the capacitor across the inductive device.

7. The combination of a gas-filled tube having input and output circuits, a relay having a winding connected to the output circuit of the tube and operated in response to ionization of the gas within the tube, a non-inductive device connected in shunt with the relay winding, a condenser, and means responsive to the operation of said relay to shunt said condenser across said relay winding.

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