Sept. 7, 1937. R. S. HOLMES 2,092,373

PROTECTIVE DEVICE

Filed Feb. 28, 1934

Fig. 1.

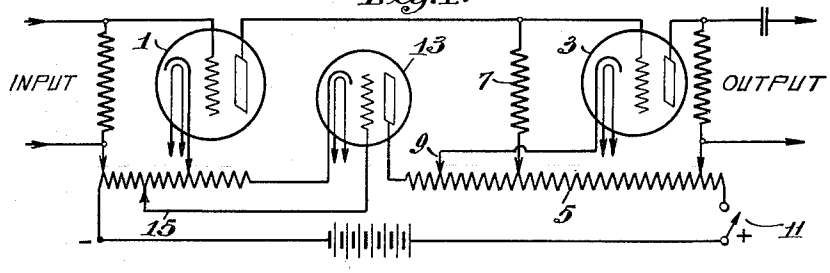


Fig. 2.

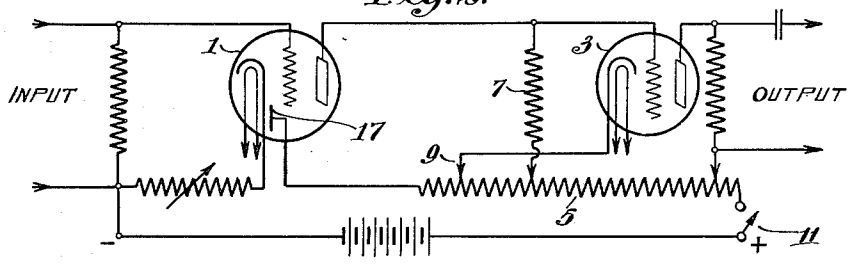
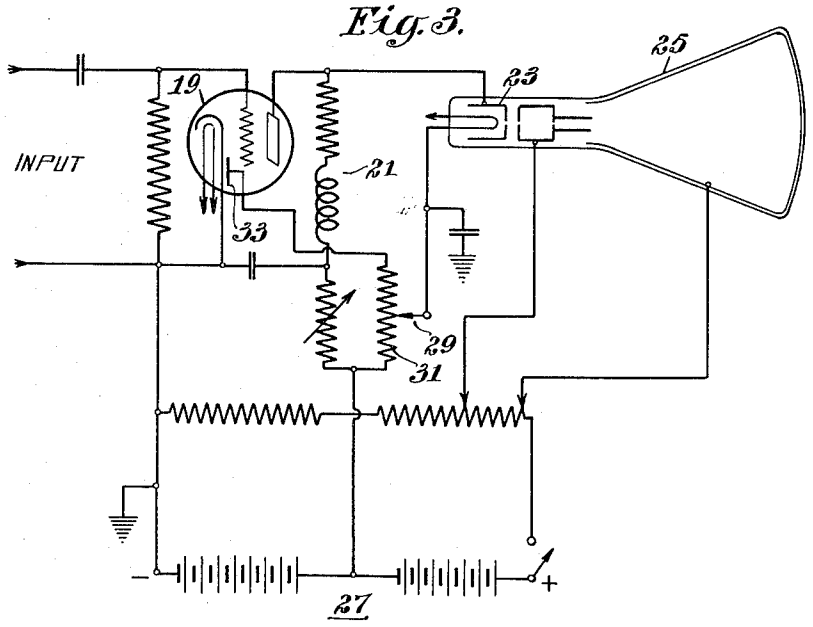


Fig. 3.



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PROTECTIVE DEVICE

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8 Claims. (Cl. 250—27)

My invention relates to protective devices and particularly to devices for preventing destructive currents from flowing in thermionic tubes and the like.

In cascade amplifiers of the so-called direct current type, the grid of one thermionic tube is conductively connected to a resistor included in the output circuit of a preceding tube, the potential developed across the resistor, when the amplifier is in operation, being depended upon to supply a negative bias to the said grid. If the tubes are of the equipotential cathode type, which require a relatively long time to "warm up", the bias on the grid is positive during the warming up period and destructive current is prone to flow therein. The flow of current during the warming up period is particularly harmful to cathode ray tubes, of the type now being utilized in television receivers, since it may spoil the emissivity of the cathode.

It is, accordingly, the principal object of my invention to provide a protective device, for use in connection with direct current amplifiers, that shall function to protect the thermionic tubes against injury, during the "warm up" period and also when one of the tubes is removed from its socket.

At the present time, one of the important fields of usefulness for my invention is in connection with amplifiers of the type wherein all anode and grid-biasing potentials for a plurality of thermionic devices are supplied from a single bleeder resistor connected between the terminals of a source of unidirectional potential. In an amplifier, according to my invention, I interrupt the continuity of the bleeder resistor by interposing between the terminals thereof the space current path in a thermionic device the cathode of which is supplied with heating potential from the same source that supplies the cathodes of the other thermionic devices in the amplifier. The interposed thermionic device will be referred to, hereinafter, as the delay tube.

Preferably, the cathode of the delay tube heats no faster than the cathodes of the amplifier tubes although, as will be pointed out later, it is not detrimental to utilize a cathode that heats at the same rate. By reason of the interposition of the delay tube, current is prevented from flowing in a portion of the bleeder resistor until the amplifier tubes have been supplied with sufficient negative grid-biasing potential to prevent the flow of destructive currents therein.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention tself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment, when read in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic view of a direct coupled amplifier including an embodiment of my invention,

Fig. 2 is a diagrammatic view of a direct coupled amplifier including a modified embodiment of my invention, and

Fig. 3 is a diagrammatic view exemplifying the application of my invention to a television receiver including a cathode ray tube.

Referring now to Fig. 1 of the drawing, the usual direct coupled amplifier includes a plurality of thermionic devices, exemplified in the drawing by the tubes 1 and 3, which are supplied with anode and grid-biasing potentials from a common bleeder resistor 5. From an inspection of the drawing, it will be noted that the tube 3 receives its grid-biasing potential from a resistor 7 included in the output circuit of the tube 1. In view of the fact that such bias, if not compensated, might well be much too negative, an adjustable connection 9 is usually interposed between the cathode of the biased tube and a point on the bleeder resistor more negative than the point to which the bias-supply resistor 7 is connected.

Assume, for the moment, that the continuity of the bleeder resistor 5 is not interrupted when the system is first energized, as by closing a switch 11 in a potential supply lead connected to the positive terminal of the bleeder resistor. During the warming up period, the first tube 1 in the series draws but little anode current and the bias on the grid of the second tube is positive with respect to its cathode. Such being the case, destructive current may possibly flow in the tube 3 unless automatically functioning means are provided to prevent.

According to my invention, therefore, I provide means for preventing excessive current from flowing in the biased tube during the warm-up period such means being constituted by a delay tube 13, the space current path in which is interposed in series with the bleeder resistor. Specifically, I sever the bleeder resistor between the connection thereto of the cathodes of the several tubes and connect the delay tube between the severed portions. For the delay tube I prefer to utilize a diode although a triode may be utilized, as illus-

trated, in which event the grid thereof may be supplied with bias by a connection 15 to the bleeder resistor. If the potential supply to the bleeder resistor is quite variable, the triode offers some advantages in that it tends to hold the current in the second tube constant.

During the warming up period, with the delay tube interposed as illustrated in the drawing, the grid and cathode of the tube 3 are at substantially the same potential and minimum current flows therein until the cathode of the delay tube reaches full emission temperature. By that time, the first tube 1 has also reached emission temperature and, by reason of normal anode current flowing in the output resistor, the protected tube 3 has been supplied with normal negative bias.

It also lies within the scope of my invention to dispense with a separate delay tube and to utilize, instead, a diode plate associated with the cathode of the first tube in the series. Such modification is illustrated in Fig. 2 of the drawing, in which it will be noted that a diode plate 17 has been disposed within the envelope of the first tube 1, adjacent the cathode thereof. Since the operation of the modified protective system is identically the same as that exemplified by Fig. 1, no necessity is seen for going into further detail concerning it. The system shown in Fig. 2 has the still further advantage of affording protection to the second tube 3 in the event that it is necessary to remove the first tube 1 from its socket in case of failure. The reason for this is obvious.

As hereinbefore pointed out, it is highly essential that cathode ray tubes, in television receiving circuits and the like, be adequately protected against excessive beam-currents. The manner in which this may be accomplished according to my invention is illustrated by Fig. 3 of the drawing, wherein is shown a thermionic amplifier tube 19 of the triode-diode type, corresponding to the tube 1 in Fig. 2, having a resistive output circuit 21 directly connected to the ray-control element, or grid 23, in a cathode ray tube 25. As in the other figures, both tubes are shown as being supplied with anode potential from a common potential source 27. Separate sources, of course, may be used. As described in connection with the previous figures, grid biasing potential for the cathode ray tube is supplied from the output circuit of the preceding amplifier tube 19. As a general rule, such potential is much too negative for proper operation of the cathode ray tube if the cathode is directly connected to the positive terminal of the amplifier anode potential source. For that reason I prefer to connect the cathode of the tube to the movable contact element 29 of a potentiometer, the resistor element 31 of which is included in a circuit, shunting that portion of the potential supply source which feeds the anode of the amplifier tube. The shunting circuit must not pass current during the warm up period when the amplifier tube 19 is not taking plate current since this would cause the cathode of the cathode ray tube to become negative with respect to its grid and would permit destructive current to flow. Accordingly, I interpose a space current path in the shunting circuit, the impedance of which changes in accordance with the impedance of the space current path in the amplifier tube. Specifically, such space current path is constituted by the cathode in the amplifier tube and by an extra diode plate 33 therein. Obviously, no current can flow in the shunting circuit until the amplifier tube is passing current by reason of the heating of its cathode and the protective object of my invention is thus accomplished.

From a consideration of the foregoing it will be apparent that I have provided a novel and useful protective system particularly adapted to amplifiers of the direct coupled type. The modifications chosen for purposes of explanation, however, are merely indicative of the many uses to which the invention may be put, and my invention is not to be limited except as necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination a multitube amplifier, a thermionic device having a cathode and an output electrode, a thermionic device having a cathode and an input electrode, a direct conductive connection between the said electrodes, means including a source of power for generating a direct current potential and for supplying it to said electrodes, and a connection between the cathodes of the first mentioned devices, the said connection including the space-current path in a thermionic device.

2. The invention set forth in claim 1 additionally characterized in that the space current path is defined by the cathode in the thermionic device having the output electrode, and a diode plate in the said device.

3. The invention set forth in claim 1 additionally characterized in that the last named connection includes a variable bias source for said second thermionic device.

4. In combination, a thermionic device of the hot cathode type having a grid-electrode, a thermionic amplifier device, also of the hot cathode type, having an anode, a direct connection between the anode of the last mentioned device and the grid of the first mentioned device, a resistor, means for applying potential to said anode through said resistor whereby a plate current flow through said last mentioned device produces a potential drop across said resistor, means for applying said potential drop to said grid-electrode as a negative bias, and protective means for preventing the grid of the first mentioned device from becoming positive with respect to its cathode when energizing potentials are first applied to both devices.

5. The invention set forth in claim 4 wherein the protective means includes a space current path between the cathode and anode in the thermionic amplifier device.

6. The invention set forth in claim 4 additionally characterized in that the cathodes in both of said devices have substantially the same thermal lag.

7. In combination, a thermionic device of the hot cathode type having a grid electrode, a thermionic amplifier device, also of the hot cathode type, having an anode, a direct connection between the anode of the last mentioned device and the grid of the first mentioned device, protective means for preventing the grid of the first mentioned device from becoming positive with respect to its cathode when energizing potentials are first applied to both devices, said protective means including a space current path in said amplifier device between the cathode thereof and a diode-plate therein.

8. In combination, a cathode-ray tube having a control grid and a cathode which is electron emissive when heated, an electric discharge tube having an anode and a cathode which is electron emissive when heated, a direct conductive con-

nection between said anode and said control grid, a resistor, means for applying potential to said anode through said resistor whereby a plate current flow through said electric discharge tube produces a potential drop across said resistor which is applied to said control grid as a negative bias, a device through which current flows readily only when heat is applied thereto, said device having at least as much thermal time lag as the cathode of said discharge device, and a connection between said cathodes which includes said last device.

RALPH S. HOLMES.