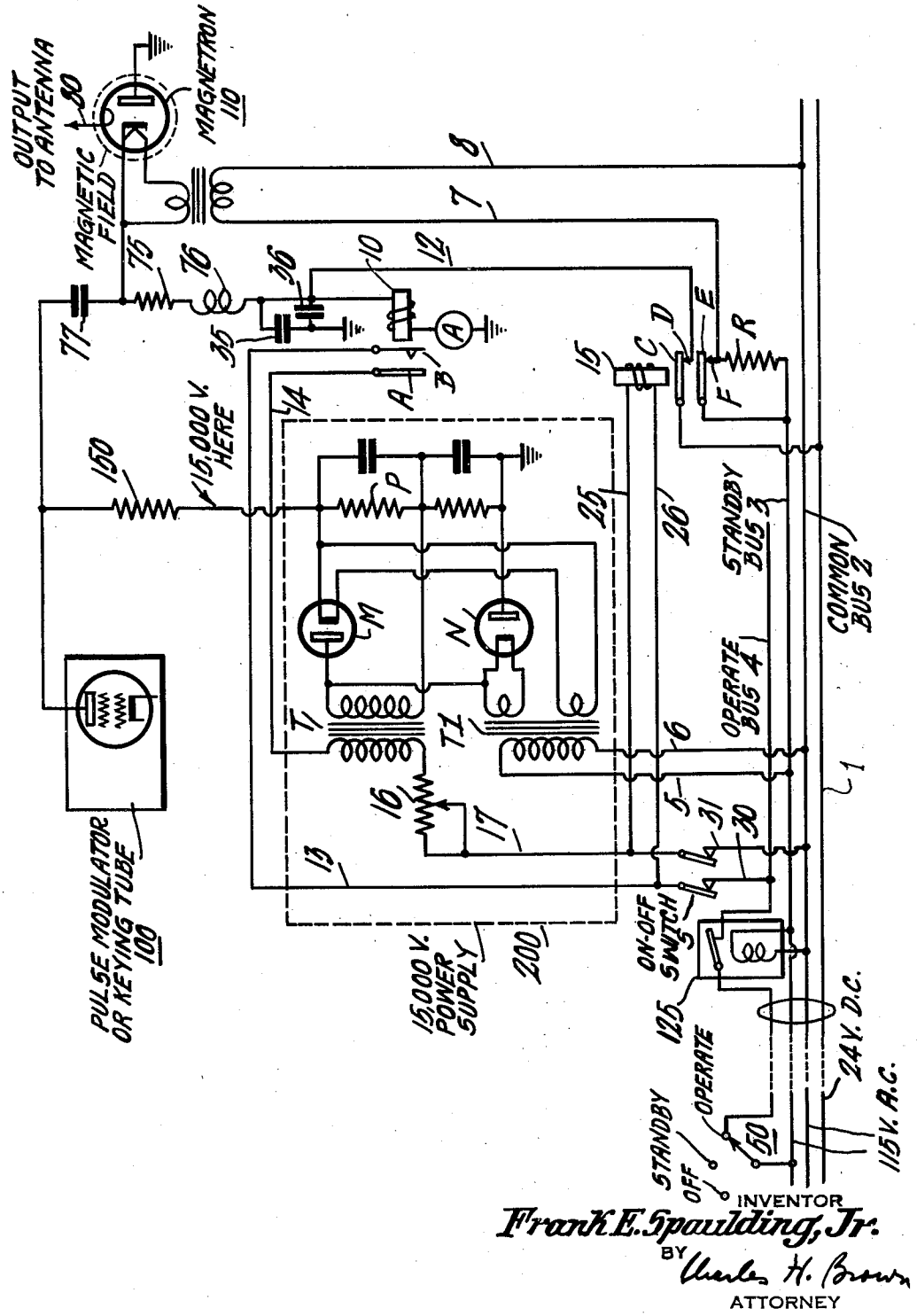
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ELECTRICAL PROTECTIVE SYSTEM

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ELECTRICAL PROTECTIVE SYSTEM

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This invention relates to a protective arrangement for an electron discharge device signalling system.

An object of the present invention is to prevent damage to electron discharge device equipment in a signalling system in the event of arc or flash-over or internal breakdown of the high voltage components.

Another object is to enable the use of an undercurrent relay as a protective device in a high frequency generating system, for preventing damage to the vacuum tubes in the event output current falls below a predetermined value.

A further object is to provide a protective arrangement for an electron discharge device high frequency system in which the system may be controlled or restored to an operating condition from a location which is removed from the electron discharge device apparatus.

A more specific object is to provide an undercurrent relay protective arrangement in a pulse type object locating or radar transmitting system, for disconnecting the high voltage power supply from the main power supply in the event of a reduction in output from the system below a predetermined value.

A detailed description of the invention follows in conjunction with a drawing whose single figure illustrates the protective arrangement of the invention applied to the output stages of an electron discharge device object locating system.

Referring to the drawing, there is shown the pulse modulator or keying tube 100 of the transmitter of an object locating system. The anode of this tube 100 supplies pulses of negative polarity through a coupling condenser to the cathode of a magnetron 110. The magnetron is shown diagrammatically as a tube having a cathode connected to the coupling condenser, an anode connected to ground, and a coupling loop for supplying radio frequency output energy to a suitable antenna via a connection 80, such as a wave guide. In practice, the anode of the magnetron may be a cavity resonator in whose interior the output loop is located.

For supplying high voltage to the anode of the pulsing tube stage 100, there is provided a 15,000 volt power supply 200 whose output is connected to the anode load resistor 150 for the stage 100.

The 15,000 volt power supply 200 includes a pair of rectifiers M and N and a pair of transformers T and T1. The cathode of rectifier M is connected to one terminal of a bleeder resistor P while the anode of rectifier N is connected to the other terminal of bleeder resistor P. The

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midpoint of resistor P is connected to one terminal of the secondary winding of transformer T. The filaments of the rectifiers are heated from current supplied by transformer T1. This is a conventional "voltage doubler" type of rectifier circuit.

One terminal of the primary winding of transformer T is connected through a rheostat 16, lead 17, one side of on-off double-pole switch S and lead 31 to the common bus 2. The other terminal of the primary winding of transformer T is connected to lead 14 and armature A of an undercurrent relay 10. The contact B of this relay is adapted to engage the armature A and is connected through lead 13, the left side of on-off switch S and lead 30 to the "operate" bus 4. It will thus be seen that the circuit through the primary winding of transformer T is controlled by the condition of the undercurrent relay.

Four buses 1, 2, 3 and 4 within a cable extend from the electron discharge device apparatus shown in the drawing to a remote location at which there is positioned the main power switch 50 and the cathode ray tube, not shown. This main power switch has three contacts identified as "off," "standby" and "operate," and a rotary armature adapted to engage any one of these contacts at the will of the operator.

The protective arrangement of the invention includes the undercurrent relay 10, one terminal of which is connected to ground through a meter A and the other terminal of which is connected through a damping choke 76 and a damping resistor 75 to the cathode of the magnetron. In circuit with this last terminal of undercurrent relay 10 is a radio frequency bypass condenser 36 and a time-lag or holdover condenser 35.

Another relay 15 is provided whose operating winding is connected to the power supply side of the on-off switch, as shown, via leads 25 and 26. This relay has two sets of contacts viz: C, D and E, F. Contact D is connected to the upper terminal of undercurrent relay 10 while contact or armature C is connected to the bus 1 to which is supplied 24 volts D. C. auxiliary operating supply for undercurrent relay 10. Contact F is connected through lead 7 to the filament transformer for the magnetron, and also through resistor R to the standby bus 3 to which 115 volts—60 cycle alternating current is connected on some positions of the remote main power switch 50. It should be noted that contacts E and F short circuit or shunt out resistor F in the non-operated position of the relay 15. The filament transformer for the magnetron is also connected

through lead 8 to the common bus 2. Relay 15 serves two purposes; viz: it inserts the current limiting resistor R into the filament circuit of the magnetron 110 when the magnetron is ready to operate, and it removes the 24 volts D. C. auxiliary operating supply from the undercurrent relay 10.

A description of the operation of the protective arrangement of the invention will now be given.

When the main power switch 50 located at the attendant's control point at which the cathode ray tube is found is in the "off" position, all power is removed from the four buses 1, 2, 3 and 4. When this switch 50 is on the "standby" position, a motor generator, not shown, will be started up to produce the 115 volts—60 cycles A. C. which is supplied between buses 2 and 3. This applies when the power source is 115 or 230 volts D. C. When the object location system to which the invention is applied is employed on a ship having 115 volts—60 cycles alternating current supply however, such a motor generator need not be used, and an A. C. contactor, not shown, connects the 115 volt supply to buses 2 and 3. In this condition of switch 50, when its armature is on the "standby" contact, and assuming the on-off switch S to be closed, the system is conditioned for heating all filaments of the different vacuum tubes; also the 24 volt D. C. auxiliary control supply is energized. Thus, the filaments of the rectifiers M and N are heated via leads 5 and 6 which are connected to "standby" bus 3 and common bus 2, and the magnetron filament is heated via leads 7 and 8. In this position of the switch 50, the resistor R is short circuited by virtue of the closed contacts E and F of relay 15 now unenergized. Current is supplied from the 24 volts D. C. auxiliary supply bus 1, over a circuit including contacts C and D, to operate undercurrent relay 10. The operation of relay 10 closes contacts A and B and completes a circuit to the primary winding of the 15,000 volt power supply unit 200, over an obvious path which includes the "operate" bus 4, the left side of switch S, lead 13, contacts B and A of relay 10, lead 14, the primary winding of transformer T, rheostat 16, lead 17, the right side of switch S, to the common bus 2. The 15,000 volt power supply unit 200 is now ready to function when the power switch 50 is turned to the "operate" position. The "standby" position of the main power switch 50 enables the avoidance of excessive wear and tear on expensive tubes if the transmitter is to be left unattended for short periods. It also keeps the equipment ready for instant use after the initial three minute wait time of time delay relay 125 has passed.

When the main power switch 50 is turned to the "operate" position, the 115 volt A. C. "standby" bus is connected to the "operate" bus 4 through the armature and the "operate" contact of switch 50, as a result of which current is supplied to the primary winding of transformer T, and 15,000 volts is supplied by the unit 200 to the anode load resistor 150 for the pulse modulator 100. In this "operate" position of switch 50, relay 15 will operate over an obvious circuit via leads 25 and 26 and will open contacts C, D and E, F. The opening of contacts C, D will remove the 24 volts D. C. auxiliary supply from the winding of relay 10, but this relay 10 will remain operated for a short time interval of the order of ½ second because of the charge built up on capacity 35. During this time interval, the pulse modulator 100 will supply voltage pulses of proper polarity and amplitude to operate the magnetron 110 and thereby to maintain relay 10 operated. The normal operation of the magnetron 110 causes a current to flow through damping resistor 75 and damping choke 76 and the winding of relay 10 to maintain this relay operative. Because of the rapidity of the pulses produced by the pulse modulator (750 or 3,000 per second in accordance with the design of a radar system actually tried out in practice), the undercurrent relay 10 will not fall back in the extremely short time intervals between pulses. The polarity of the pulses appearing on the cathode of the magnetron are negative relative to the ground.

The operation of relay 15 in the "operate" position of the main power switch 50 also opens contacts E and F, this action introducing the resistor R in the filament heating circuit of the magnetron. This resistor enables the magnetron to function on its desired characteristics during pulse operation.

From the foregoing, it will be seen that the filaments of the different tubes are preheated to operating levels before the system is actually set into operation. There is provided a three-minute time delay relay 125 in the "operate" bus 4 circuit in order to prevent the application of 115 volts alternating current to the bus 4 and the 15,000 volt power supply circuit 200 before the passage of three minutes, thus assuring preheating of filaments or heaters to their correct level before the system can be operated as a pulsing transmitter. It should be noted that the winding of the time delay relay 125 is connected across buses 2 and 3, while the contacts of this relay are serially arranged in series with "operate" bus 4.

Should the current in the magnetron be interrupted for more than ½ second for any reason, the undercurrent relay 10 will fall back and open the circuit through the primary winding of transformer T in the 15,000 volt power supply unit 200. This action will remove power from the anode load resistor 150. This action will prevent damage to the magnetron and pulse modulator and the 15,000 volt power supply unit 200 which might otherwise occur. The interruption of the current in the magnetron circuit may be caused by vacuum tube arcing, failure of any one of the rectifier tubes M or N, the absence of suitable trigger pulses in the radar circuit connected to the pulse modulator 100 or failure of any of the high voltage components.

In order to restore the system to the normal operating condition after any undesired interruption of current in the magnetron which causes the undercurrent relay to fall back, the main power switch 50 should be turned to the "standby" position, and afterwards back to the "operate" position. The steps of operation have been described above for these two positions.

An advantage of the present invention over and above the protection afforded to the various elements in the event the magnetron current falls below a predetermined value is that all operating controls may be located at a point removed from the transmitter portion of the equipment. Thus, the main power supply switch 50 can be located at the radar operating position at which the attendant may be stationed.

Although the invention has been particularly described with reference to a radar or object location system, it should be understood that it is not limited to this type of a transmitter and that its application in other electron discharge

device systems will be evident to those skilled in the art.

What is claimed is:

1. In electron discharge transmitting apparatus, a final output stage, a driving stage coupled to said output stage, a high voltage power supply unit for said driving stage, said high voltage supply unit including a transformer having a primary winding adapted to be connected to a main power source, an undercurrent relay coupled to an electrode of said final output stage and responsive to the flow of normal operating current in said output stage, said relay having an armature and a make contact adapted to engage said armature when said relay is operated, said armature and contact being arranged in series relation to said primary winding and said main power source, whereby the reduction of current in said final output stage below a predetermined value causes said relay to fall back and said armature to disengage said contact thereby disconnecting said main power source from said high voltage supply unit.

2. A protective arrangement for electron discharge device transmitting equipment, comprising a final output stage, a driving stage coupled to said output stage, a high voltage power supply unit for said driving stage, said high voltage supply unit including a transformer having a primary winding adapted to be connected to a main power source, an undercurrent relay coupled to an electrode of said final output stage and responsive to the flow of normal operating current in said output stage, said relay having a pair of cooperating contacts which are open when said relay is not operated, a connection from one terminal of said primary winding to one of said contacts, a connection from the other contact to said main power source, whereby said connections and contacts are arranged in series between said primary winding and said main power source, said relay requiring a predetermined minimum value of current therethrough from said final output stage to operatively connect said high voltage supply to said main power source.

3. In electron discharge transmitting apparatus, a final output stage, a driving stage coupled to said output stage, a high voltage power supply unit for said driving stage, said high voltage supply unit including a transformer having a primary winding adapted to be connected to a main power source, an undercurrent relay coupled to an electrode of said final output stage and responsive to the flow of normal operating current in said output stage, said relay having an armature and a make contact adapted to engage said armature when said relay is operated, said armature and contact being arranged in series relation to said primary winding and said main power source, whereby the reduction of current in said final output stage below a predetermined value causes said relay to fall back and said armature to disengage said contact thereby disconnecting said unit main power source from said high voltage supply, another relay having an operating winding coupled to said main power source, a pair of break contacts for said last relay, a resistor having one terminal connected to one of said break contacts and also to one side of the filament circuit for said final output stage, connections between the other terminal of said last resistor and said other break contact and said main power source, whereby said resistor is short-circuited by said break contacts in the unoperated conditions of said last relay, and a connection from the other side of said filament circuit to said main power source, whereby said resistor is inserted into said filament circuit upon the operation of said last relay.

4. In a pulse type transmitter, a pulse modulator tube, a magnetron having a cathode electrode and an anode electrode, a connection between the output of said modulator tube and one of said electrodes of said magnetron, a connection between the other said electrode of said magnetron and a point of reference potential, a high voltage supply unit for said modulator tube, said high voltage supply unit including a rectifier and a transformer for feeding energy thereto, an undercurrent relay connected between said point of reference potential and the output connection from said modulator tube, said relay having a pair of make contacts, a main source of power supply for said high voltage supply unit, and means for connecting the primary winding of said transformer and said pair of make contacts in series relation relative to said main source of supply, whereby the reduction of current in said magnetron below a predetermined value causes said undercurrent relay to fall back thereby opening said make contacts and disconnecting said main power source from said high voltage supply unit.

5. In a pulse type transmitter, a pulse modulator tube, a magnetron having a cathode electrode and an electrode, a connection between the output of said modulator tube and one of said electrodes of said magnetron, a connection between the other said electrode of said magnetron and a point of reference potential, a high voltage supply unit for said modulator tube, said high voltage supply unit including a rectifier and a transformer for feeding energy thereto, an undercurrent relay having one terminal of its operating winding connected to a point of reference potential and the other terminal of its operating winding connected through an inductance coil and a resistor in series to the output connection from said modulator tube, a condenser connected between said last terminal of the relay winding and said point of reference potential, said relay having a pair of make contacts, a main source of power supply for said high voltage supply unit, and means for connecting the primary winding of said transformer and said pair of make contacts in series relation relative to said main source of supply, whereby the reduction of current in said magnetron below a predetermined value causes said undercurrent relay to fall back thereby opening said make contacts and disconnecting said main power source from said high voltage supply unit.

6. In a radio transmitter, a vacuum tube radio frequency oscillation generator, a driving stage coupled by means of a connection to said generator for supplying pulses thereto of such polarity and magnitude as to cause said generator to produce oscillations for a time interval not exceeding the duration of the applied pulse, a high voltage supply unit for said transmitter and including a rectifier and a transformer for feeding energy to said rectifier, an undercurrent relay having one terminal of its operating winding connected to a point of reference potential and the other terminal of its operating winding connected to said connection from said driving stage to said generator, a holdover condenser con-

denser connected between said last terminal of said relay winding and said point of reference potential, said holdover condenser having such value that the charge built up thereon during the application of pulses to said generator by said driving stage will hold said undercurrent relay operated for a predetermined interval of time after the cessation of a driving pulse, said relay having a pair of make contacts, a main source of power supply for said high voltage supply unit, and means for connecting the primary winding of said transformer and said pair of make contacts in series relation relative to said main source of supply, whereby the reduction of current in said generator below a predetermined value causes said undercurrent relay to fall back thereby opening said make contacts and disconnecting said main power source from said high voltage supply unit.

7. In a pulse type transmitter, a vacuum tube radio frequency oscillation generator, a driving stage coupled by means of a connection to said generator for supplying pulses thereto of such polarity and magnitude as to cause said generator to produce oscillations for a time interval not exceeding the duration of the applied pulse, a high voltage supply unit for said transmitter and including a rectifier and a transformer for feeding energy to said rectifier, an undercurrent relay having one terminal of its operating winding connected to a point of reference potential and the other terminal of its operating winding connected through an inductance coil and a resistor in series to said connection from said driving stage to said generator, a holdover condenser connected between said last terminal of said relay winding and said point of reference potential, said holdover condenser having such value that the charge built up thereon during the application of pulses to said generator by said driving stage will hold said undercurrent relay operated for a predetermined interval of time after the cessation of a driving pulse, said relay having a pair of make contacts, a main source of power supply for said high voltage supply unit, and means for connecting the primary winding of said transformer and said pair of make contacts in series relation relative to said main source of supply, whereby the reduction of current in said generator below a predetermined value causes said undercurrent relay to fall back thereby opening said make contacts and disconnecting said main power source from said high voltage supply unit.

8. In a radio transmitter, a final output stage, and a driving stage coupled to said output stage, a high voltage power supply unit coupled to said driving stage, said unit including a rectifier and a transformer for supplying energy to said rectifier, a main power switch having an armature adapted to alternately engage any one of two contacts which may be identified as an "off" contact, and an "operate" contact, a first bus connected to the "operate" contact on said main power switch, a second bus connected to the armature on said main power switch, and a third bus, said second and third buses being connected to a source of low frequency alternating current voltage, an undercurrent relay coupled to an electrode of said final output stage and responsive to the flow of normal operating current in said output stage, said relay having a pair of cooperating make contacts adapted to engage each other in the operated condition of said relay, and means for connecting the primary winding of said transformer across said "operate" bus and said third bus through said make contacts, whereby the reduction of current through said final output stage below a predetermined value causes said relay to fall back and open said make contacts thereby disconnecting said primary winding from said source of low frequency alternating current voltage.

9. In a radio transmitter, a final output stage, and a driving stage coupled to said output stage, a high voltage power supply unit coupled to said driving stage, said unit including a rectifier and a transformer for supplying energy to said rectifier, a main power switch having an armature adapted to engage any one of three contacts which may be identified as an "off" contact, a "standby" contact, and an "operate" contact, a first bus connected to the "operate" contact on said main power switch, a second bus connected to the armature on said main power switch, and a third bus, said second and third buses being connected to a source of low frequency alternating current voltage, an undercurrent relay coupled to an electrode of said final output stage and responsive to the flow of normal operating current in said output stage, said relay having a pair of cooperating make contacts adapted to engage each other in the operated condition of said relay, a lead connecting one terminal of the primary winding of said transformer to one make contact of said relay, another lead connecting the other make contact of said relay to said "operate" bus, and a time delay device located in series with said "operate" bus at a location between said main power switch and the junction of said "operate" bus and said last lead.

10. In a radio transmitter, a final output stage, and a driving stage coupled to said output stage, a high voltage power supply unit coupled to said driving stage, said unit including a rectifier and a transformer for supplying energy to said rectifier, a main power switch having an armature adapted to engage any one of three contacts which may be identified as an "off" contact, a "standby" contact, and an "operate" contact, a first bus connected to the "operate" contact on said main power switch, a second bus connected to the armature on said main power switch, and a third bus, said second and third buses being connected to a source of low frequency alternating current voltage, an undercurrent relay coupled to an electrode of said final output stage and responsive to the flow of normal operating current in said output stage, said relay having a pair of cooperating make contacts adapted to engage each other in the operated condition of said relay, a lead connecting one terminal of the primary winding of said transformer to one make contact of said relay, another lead connecting the other make contact of said relay to said "operate" bus, and a time delay device located in series with said "operate" bus at a location between said main power switch and the junction of said "operate" bus and said last lead, and means for heating the filaments of said rectifier and said final output stage from said second and third buses.

11. In a pulse type transmitter, a vacuum tube radio frequency oscillation generator, a driving stage for said generator, a connection between said driving stage and said generator, a high voltage supply unit for said transmitter and including a rectifier and a transformer for feeding energy to said rectifier, an undercurrent relay having one terminal of its operating winding

connected to a point of reference potential and the other terminal of its operating winding connected through an inductance coil and a resistor in series to said connection from said driving stage to said generator, a holdover condenser connected between said last terminal of said relay winding and said point of reference potential and having such value as to maintain said relay operated for a predetermined interval of time after the cessation of driving current from said driving stage, said relay having a pair of make contacts, a main source of power supply for said high voltage supply unit, means for connecting the primary winding of said transformer and said pair of make contacts in series relation to said main source of supply through a time delay device, whereby the reduction of current through said generator below a predetermined value causes said undercurrent relay to fall back thereby opening said make contacts and disconnecting said main power source from said high voltage supply unit, and means including separate transformers for heating the filaments of said rectifier and said generator from said main power source.

12. In electron discharge transmitting apparatus, a final output stage, a driving stage coupled to said output stage, a high voltage power supply unit for said driving stage, said high voltage supply unit including a transformer having a primary winding adapted to be connected to a main power source, an undercurrent relay coupled to an electrode of said final output stage and responsive to the flow of normal operating current in said output stage, said relay having an

armature and a make contact adapted to engage said armature when said relay is operated, said armature and contact being arranged in series relation to said primary winding and said main power source, whereby the reduction of current in said final output stage below a predetermined value causes said relay to fall back and said armature to disengage said contact thereby disconnecting said main power source from said high voltage supply unit, a second relay having an operating winding coupled to said main power source, a pair of break contacts for said last relay, a connection from one break contact of said last relay to that terminal of the operating winding of said first relay which is connected to the final output stage and a connection from the other break contact of said second relay to a source of unidirectional potential of such magnitude as to enable the operation of said undercurrent relay, and a main power switch for controlling the operative association of said main power source with said high voltage supply unit.

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