

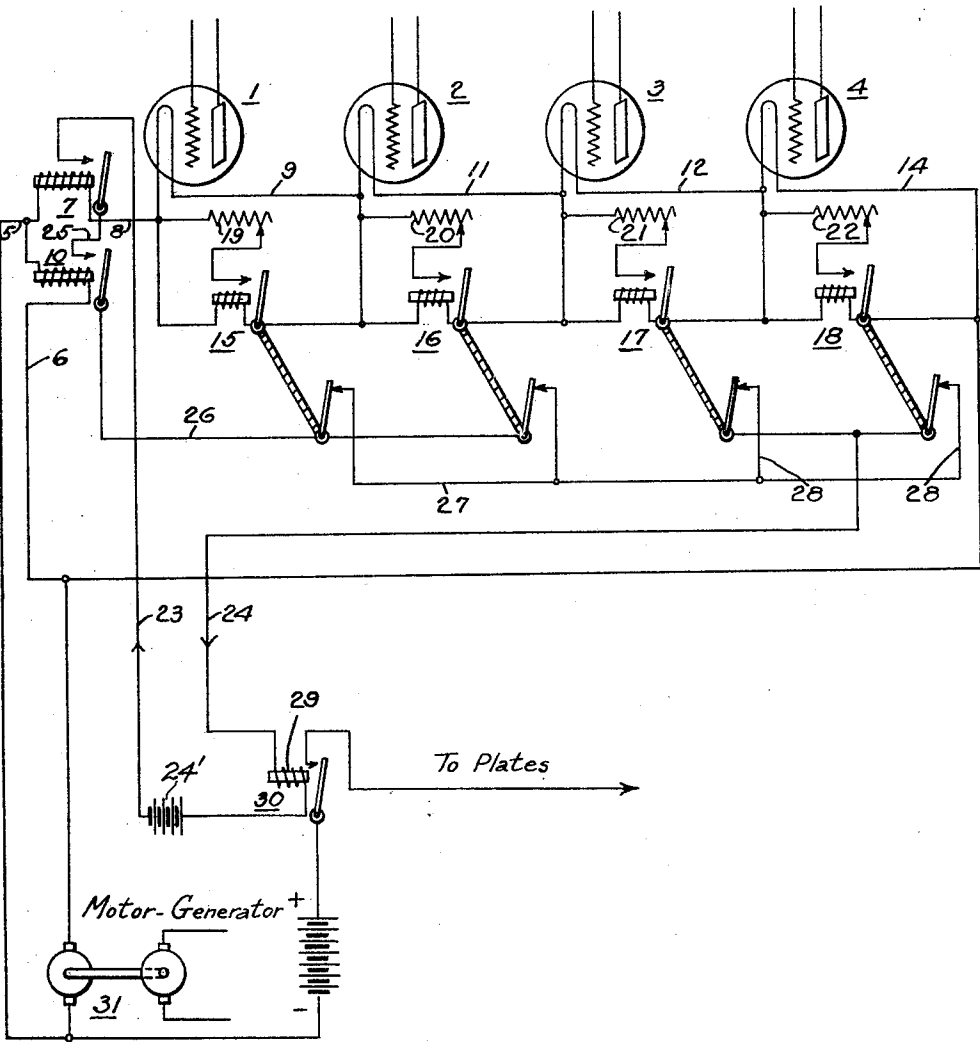
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PROTECTIVE SYSTEM FOR TRIODES

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PROTECTIVE SYSTEM FOR TRIODES

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My invention relates to electrical systems containing electronic devices and particularly to protective means for preventing the complete failure of such systems when portions thereof cease to function.

An object of my invention is to provide a protective relay system for a radio sending apparatus in which a plurality of vacuum tube devices are used connected in groups such as modulators and oscillators, whereby the failure of one or more of said devices will not result in the complete cessation of the modulated radio output, except upon failure of all devices of either group.

Another object of my invention is to provide a relay system in conjunction with a plurality of thermionic discharge devices, which may be triodes or diodes whereby the failure of a filament in one of the devices will cause the actuation of a relay and the introduction of a resistance equivalent to that of the failed filament.

Another object of my invention is to prevent the application of plate current to a triode system before the application of filament current thereto.

Another object of my invention is to provide a relay system in connection with a plurality of thermionic discharge devices, arranged in groups of oscillators and modulators, whereby the destruction of one or more filaments in any group will not result in a complete failure to function of the apparatus until all the filaments of said devices in a single group have failed, and which will disconnect the apparatus from the supply circuits when all the said devices of either group have failed.

In prior art, operation of radio sending systems, such as broadcasting stations, it has been customary for the operator in charge to depend upon visual inspection of the triodes to determine the condition of operation thereof. In most stations this has been reasonably satisfactory when glass bulb triodes were used. The introduction of water-cooled, metal container, tubes has, however, made visual inspection much more difficult and prevents convenient examination. Furthermore, in the operation of a

broadcasting station it is desirable that as consistent operation as possible be maintained.

It is common practice in many stations to use more than a single triode as the oscillator, and more than one triode as modulator, groups of tubes being adapted to perform the respective functions. Under such conditions the destruction of the filament in any one triode need not result in a complete cessation of operation, since it is possible to obtain effective modulation of two oscillators by a single modulator tube. Likewise, it is possible to operate the station with a single oscillator tube and a plurality of modulator tubes. For this reason, it is desirable that means be provided whereby a station can be kept in operation in the event of failure of some of the triodes.

My invention comprises an automatic relay system which maintains the filament current constant in the operating filaments of a triode system in the event of the failure of one or more triodes, so long as one triode in each group remains operative. My system further provides means whereby the failure of the filament of all of the triodes in either group causes the plate current supply to all triodes to be automatically disconnected.

My invention also provides means whereby, when starting, the plate current supply is kept disconnected until the filaments are energized and brought to operating temperature, thereby preventing injury to the triodes by the application of plate potential thereto when the filaments are cold.

Other objects of my invention and structural details thereof will be apparent from the following description when read in connection with the accompanying drawing, wherein:

The single figure is a diagrammatic view of apparatus and circuits embodying a form of my invention as applied to a radio transmitting circuit.

In the figure, modulator triodes 1 and 2 and oscillator triodes 3 and 4 have cathodes, grids, and plates, constructed in the manner common in the prior art. I find it convenient to connect the cathodes of all the triodes in

series relation as shown in the drawing and to supply current thereto from a single source.

The lead wires 5 and 6 are adapted to be connected to a source of filament heating current. The lead 5 is shown as connected to the coil of triode plate circuit control relay 7 which in turn is connected by a conductor 8 to the filament cathode of the triode 1. The second terminal of this filament is connected by conductor 9 to the filament of triode 2 which in turn is connected by conductor 11 to the filament of triode 3 and this in turn by conductor 12 to the filament of triode 4. The conductor 14 connects the other terminal of triode 4 to conductor 6.

The filament of triode 1 is provided with a relay 15 connected across the terminals thereof. The filament of triode 2 is provided with a relay 16 similarly connected thereacross. The filament of triode 3 is provided with a relay 17, similarly connected, and triode 4 is likewise provided with a relay 18, connected in the same manner.

The cathodes of the respective triodes 1, 2, 3 and 4 are also provided with shunting resistors 19, 20, 21 and 22 and equivalent in value thereto. The coils of the respective filament relays 15, 16, 17 and 18 are so designed that their respective relays are inactive when the normal drop in potential across the filaments of their respective triodes is applied to them. The equivalent resistors 19, 20, 21 and 22 are each connected between a terminal of the filament of their respective cathodes and a contact of their respective filament relays, the other contact of which is connected to the other side of the same filament.

Each filament relay is provided with an additional pair of contact members actuated upon operation of the first pair and which serve to open and close a control circuit for the triode plate circuit. This plate control circuit consists of conductors 23 and 24 leading to a magnetically operated contactor 29 in the plate supply circuit of the triodes and includes a potential source 24'. Conductor 23 is connected to one of the contact members of relay 7. Conductor 25 connects the other contact member of relay 7 to one contact of filament voltage relay 10. A conductor 26 connects the other contact of relay 10 to one of the back contacts of each of the relays 15 and 16. Conductor 27 connects the other back contacts of relays 15 and 16 to one of the back contacts of each of the relays 17 and 18, the other back contacts of each of which are connected by conductors 28 to conductor 24.

In the operation of my device, the application of the potential of the filament heating current to conductors 5 and 6 causes current to flow through all of the filaments if the filaments of all the triodes are intact. The current which traverses a circuit, includes the coil of a triode plate circuit con-

trol relay 7, the filament of triode 1, conductor 9, the filament of triode 2, conductor 11, the filament of triode 3, conductor 12, the filament of triode 4, conductor 14 to conductor 6. The flow of this current through the relay 7 causes it to close.

Relays 15, 16, 17 and 18 are designed so that their first pair of contact members will not be closed by the potential of the normal voltage drop through each filament, but they will close when the potential reaches a higher value such as $1\frac{1}{2}$ times the said normal drop of potential value and will then remain closed until the applied voltage drops substantially below the operating value. The second mentioned pair of contact members, to which conductors 26, 27 and 28 are connected, are back contacts of relays 15, 16, 17 and 18 and are closed when the first pair of contact members are open.

Current for the filaments may be supplied from a motor generator set 31, which is left permanently connected to leads 5 and 6. Upon energizing the motor, the voltage of the generator builds up gradually. This is desirable because of the fact that the cold resistance of the tungsten filaments is only 7% to 10% of the resistance when hot, and the application of full voltage to the cold filament would result in an undesirable rush of current through them. This rush of current would produce electro-magnetic stresses which might injure the filament. By the gradual building up of voltage from a motor generator, this rush of current is avoided and the stresses reduced.

Plate circuit control relay 10 is designed to close only when nearly full filament supply voltage is reached, and, it accordingly prevents the application of plate potential until normal conditions of filament voltage and current are reached. The time delay so obtained is a very valuable safety feature.

Upon the closure of relays 10 and 7, as previously described, a circuit is completed extending from the plate current source through conductor 23, contact members of relays 7 and 10, the back contacts of relays 15 and 16 in parallel, the back contacts of relays 17 and 18, in parallel, and conductor 24 to the coil 29 of remote control relay switch 30 operating to close the plate current supply circuit from a source 32. This is the normal operative condition.

In the event of the failure of a filament in any triode, such as may occur by burning out, the relay system will function. For purposes of illustration, it may be considered that the filament of triode 1 has burned out. Under this condition of operation, the entire voltage of the filament supply will be impressed upon relay 15 and since this is more than $1\frac{1}{2}$ times the normal voltage drop across the filament of triode 1, relay 15 will close, closing thereby the circuit through resistor

19. Resistor 19 being equivalent to the resistance to the filament of triode 1, the restored circuit has the same resistance as the original circuit and the proper filament current is supplied to the remaining triodes. Inasmuch as relay 15 will be held closed by the normal operating potential, it remains closed and the system continues to function at slightly reduced activity because of the removal of one triode. The closure of relay 15 opens its back contacts, but inasmuch as relays 15 and 16 have their back contacts connected in parallel, the circuit between conductors 23 and 24 for energizing the triode plates is not opened. The same sequence of operation may occur with either triode 3 or 4 with the result that the system will continue to function at a still further reduced scale.

If, however, the filament of triode 2 fails after the failure of the filament of triode 1, the full filament supply voltage will be impressed across the terminals of relay 16 causing it to close. Its closure, however, opens its back contacts and breaks the second parallel connection between conductor 26 and conductor 27, thereby opening the plate control circuit between conductors 23 and 24 and de-energizing the remote control relay 30 for the plate current supply of the group of triodes. Such action de-energizes the entire system and causes it to cease to function. This cessation takes place, however, only upon the complete failure of all triodes in the same group.

While I have shown only one embodiment of my invention in the accompanying drawings, it is capable of various changes and modifications without departing from the spirit thereof and it is desired, therefore, that only such limitations shall be imposed thereon as are indicated in the prior art or in the appended claims.

I claim as my invention:

1. An electrical system comprising a plurality of groups of triodes each group performing a different function, a source of plate current, means for controlling the current from said source to the triodes, said means including a plurality of relays controlled respectively by the conditions in the triodes and connections controlled by the relays, whereby all the triodes in any one group jointly control said means.

2. In combination, a thermionic device comprising a cathode and an anode, means for heating said cathode, means capable of energizing said anode, and means permitting the energization of said anode only during the continued maintenance of said cathode at its normal operating temperature.

3. In a radio system, a plurality of thermionic devices having filaments normally connected in series, a plate potential circuit associated with said devices, and a control circuit for said plate supply circuit compris-

ing a plurality of relays through certain of which the filament supply current flows, one of said relays being responsive to filament current less than normal and another of said relays being responsive to normal filament voltage.

4. In a radio system, a plurality of thermionic devices, the said devices being arranged in groups, a source of anode voltage for said devices, and means whereby the failure of the filaments of all the devices in any one group serves to disconnect said anode supply from all of said groups.

5. In a signaling system, a thermionic device having a filament and an anode, means for supplying current to said filament, a relay responsive to the current delivered by said means, a relay responsive to the potential developed by said means, a supply-circuit for impressing a potential on said anode, switching means included in said supply circuit, and means whereby said switching means is controlled by the action of said relays.

6. In a signaling system, a thermionic device having a filament and an anode, means for supplying current to said filament, a relay responsive to the current delivered by said means, a relay responsive to the potential developed by said means, a supply-circuit for impressing a potential on said anode, a switching device in said supply circuit, a circuit for actuating said switching device, said circuit being under the control of said relays, and means responsive to a cessation of normal current through said filament for actuating a circuit-opening device in said last mentioned circuit.

In testimony whereof, I have hereunto subscribed my name this 18th day of September, 1924.

ROBERT L. DAVIS.