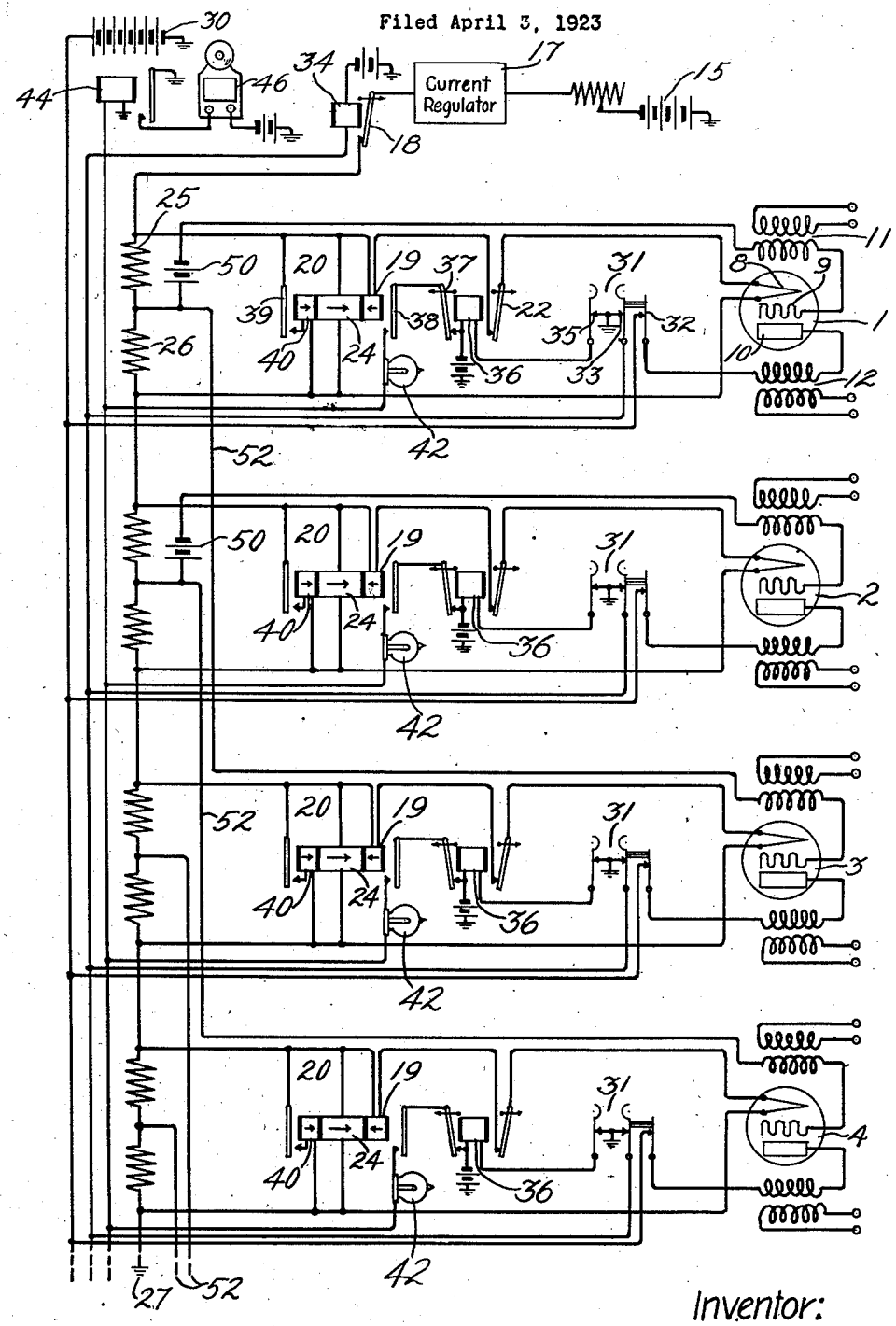
Aug. 5, 1924. 1,503,709

H. M. PRUDEN

VACUUM TUBE CIRCUITS

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HAROLD M. PRUDEN, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

VACUUM-TUBE CIRCUITS.

Application filed April 3, 1923. Serial No. 629,566.

To all whom it may concern:

Be it known that I, HAROLD M. PRUDEN, a citizen of the United States, residing at East Orange, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Vacuum-Tube Circuits, of which the following is a full, clear, concise, and exact description.

This invention relates to circuits for supplying electric energy to vacuum tubes and has for an object to provide for the continuous flow of heating current from a common source through a plurality of vacuum tube cathodes when one or more of the cathodes become broken or otherwise removed from the circuit.

In accordance with the invention the filamentary cathodes of a plurality of vacuum tubes are connected in series with a common battery or other source of potential and a three-winding relay is associated with each of the cathodes. One of the windings which has a high resistance is connected in shunt to the cathode. When the corresponding cathode is burned out or otherwise removed, this winding carries sufficient current to operate an armature connecting in shunt a second winding having approximately the resistance of the filament which it replaces. The magnetic flux produced by the second winding is additive to that produced by the first and insures holding the armature in closed position. A third winding in series with the cathode is so arranged as to produce a flux opposing the flux produced by the first two windings and causes the armature to be released when the filament has been replaced or otherwise reconnected in the circuit.

A further object of the invention is to apply the proper grid or control electrode potentials to a plurality of tubes having a common heating circuit.

The invention will be more fully understood from the following detailed description and claims taken in connection with the accompanying drawing, in which the figure represents schematically a system embodying the invention.

Referring to the drawing by reference numerals the three-electrode vacuum tubes 1, 2, 3 and 4 are representative of a series of detectors which are employed in separate signaling circuits, respectively. Each vacuum tube contains a cathode 8, a grid or control electrode 9, and an anode 10 and has associated therewith an input transformer 11 and an output transformer 12. While in the particular system disclosed the vacuum tubes were employed as detectors, as far as this invention is concerned they might be employed for other well known uses such as that of amplifying alternating currents.

The cathodes 8 when their respective tubes are in operative condition are connected in series with each other and with a battery 15. In one installation the battery 15 was a 24 volt battery such as is commonly employed in a telephone office and eight filaments were connected in series therewith, four only being shown in the drawing. The circuit may be traced as follows: From ground through battery 15, an automatic current regulator 17, the use of which is optional, contact 18, and through a network having three paths in parallel, one comprising the winding 19 of a relay 20, a contact 22, and the cathode 8 of the vacuum tube 1, the second comprising a high resistance, the winding 24 of relay 20, and the third comprising resistances 25 and 26. The resistance of the second and third of these paths is sufficiently high that most of the current flows through the cathode 8, the circuit then continues through similar networks for each of the vacuum tubes 2, 3, 4, etc., to ground at 27.

The anodes 10 of the respective tubes are connected in parallel with a source of potential 30. The energization of the respective tubes is controlled by keys 31, contacts 32 closing the anode circuits. The contacts 33 connect ground through a common relay 34 which in turn closes contact 18. The contact 35 connects ground to relay 36 which closes contact 22 in series with the corresponding vacuum tubes. Relay 36 also closes contact 37 which is in series with contact 38.

When one of the filaments 8 is burned out current ceases to flow in winding 19 and at the same time the current is increased in winding 24 and armature 39 is drawn up connecting the winding 40 in a fourth path in parallel to the three above described. The winding 40 has approximately the resistance of one of the cathodes 8 plus the resistance of the corresponding winding 19 and permits the proper amount of current to flow in the circuit to energize the cathodes which remain in the circuit. Contact 38 is also closed and lights a lamp 42

which is individual to the damaged vacuum tube. A relay 44, which is common to all of the tubes, is actuated by the current for lamp 42 and causes an audible alarm signal to be produced by a suitable device 46. When the damaged tube has been replaced, current again flows in the winding 19 and the currents through windings 24 and 40 are decreased. Contacts 38 and 39 are opened and the circuit is again in the condition shown in the drawing.

When one of the keys 31 is opened for the purpose of deenergizing the corresponding vacuum tube, contact 22 is opened and relay 20 acts as above described to substitute winding 40 for the filament. The lamp 42 and alarm 46, however, are not energized for the reason that contact 37 is open.

Negative grid potential for the tubes 1 and 2 is obtained by means of batteries 50 inserted in series with the secondaries of the input transformers. In one installation employing this circuit, batteries were available in units somewhat larger than the required difference of potential between the negative terminal of the filament and the grid. It was found possible to so proportion the resistances 25 and 26 that the potential of battery 50 minus the drop in resistance 25, gave a suitable grid voltage for each of tubes 1 and 2, and the drop in the filament of tube 2 plus the drop in the resistance 26 associated with tube 1, gave substantially the required voltage to the grid of tube 3. The grid circuits of each tube after the first two, therefore comprise a conductor 52 connected between resistances 25 and 26 of the second preceding tube.

While only one embodiment of the invention has been described, it is apparent that the invention may be used in other circuits and may be applied thereto in a variety of ways within the scope of the appended claims.

The invention claimed is:

1. In combination, a plurality of filaments, means for connecting said filaments in series with a source of heating current, and a relay for substituting a resistance for one of said filaments, said relay having a winding effectively in shunt to said filament and an opposed winding effectively in series with said filament.

2. In combination, a plurality of filaments, means for connecting said filaments in series with a source of heating current, and a three winding relay associated with one of said filaments, one of said windings being effectively in shunt to said filament, another of said windings being opposed to said first winding and being in series with said filament, and the third of said windings being arranged to aid said first winding and having a resistance corresponding to that of said filament, said relay having a contact for closing the circuit of said third winding when the current through said second winding is reduced.

3. In combination, a plurality of filaments, means for connecting said filaments in series with a source of heating current, and a three winding relay, one winding of said relay having a resistance corresponding to the resistance of one of said filaments, said relay having a contact for closing the circuit of said winding when said filament is broken, and a contact for operating an alarm.

4. In combination, a plurality of three electrode vacuum tubes having their filaments connected in series, a resistance path in shunt to one of said filaments, a connection comprising a battery from a point intermediate the terminals of said path to the grid corresponding to said filament and a normally unipotential connection from said point to another control electrode.

In witness whereof, I hereunto subscribe my name this 2nd day of April A. D., 1923.

HAROLD M. PRUDEN.