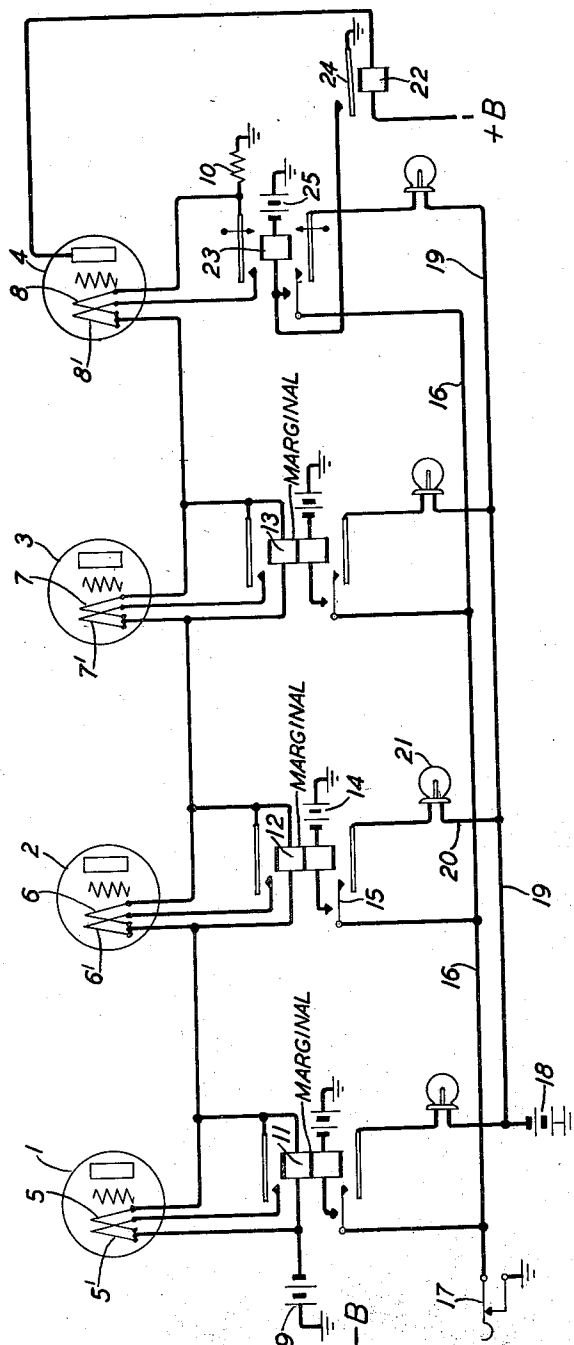


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VACUUM TUBE CIRCUITS
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VACUUM TUBE CIRCUITS

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This invention relates to vacuum tube amplifiers or repeaters and especially to such apparatus using multi-filament vacuum tubes.

Multiple filament vacuum tubes are known in the art. However, so far as applicant is aware, heretofore when for any reason it has become necessary to change from one filament to another, the operation has been manual requiring a definite interval of time and hence the shut down of the apparatus in which the change was made.

The present invention has as an object the automatic substitution of one filament for another in a multi-filament vacuum tube upon the failure of a filament.

Another object of the invention is to insure continuity of operation of a device utilizing multi-filament vacuum tubes when one filament burns out.

These objects are accomplished in one embodiment of the invention involving a series of vacuum tubes by inserting a marginal relay in parallel with the main filament of each of the tubes, the filaments of which are connected in series. The resistance of the winding of this relay is of such value that the plate current of succeeding tubes in the series passes through the winding instead of through the filament. The current, however, is too small to cause the relay to operate. When the main filament is burned out the filament current which formerly passed through the burned out filament now passes through the relay winding and this increase in current is sufficient to operate the relay which cuts in a second filament.

The invention also includes a second method of attaining the objects which consists of inserting a relay in the plate circuit of a tube, which relay controls the operation of a slow-acting relay which, in turn, closes a circuit for a second filament when one is burned out. In this case when the first filament burns out, the plate current ceases to flow and the plate circuit relay becomes deenergized and its armature in falling off closes an energizing circuit for the slow-acting relay. After a definite interval the slow-acting relay cuts in a second filament.

The second arrangement is found desirable in connection with the last stage of a series to conserve filament battery energy and to preclude false operation when there is a slight cessation of plate current flow due to failure of a preceding tube in the series.

The invention will be better understood from the following description and attached drawing showing a schematic diagram involving four tubes, the first three of which are arranged in accordance with the first form of the invention, while the last tube is arranged in accordance with the second form. In either form the invention consists in causing a relay to operate due to a change in current flow in one of the vacuum tube circuits, whereby a second filament is actuated in place of one which has ceased to act.

Referring now to the drawing, four double filament vacuum tubes are indicated at 1, 2, 3 and 4. These tubes may be two, three or four electrode tubes depending upon the type of installation. The two filaments of each tube are shown at 5, 5'—6, 6'—7, 7' and 8, 8'. The main filaments 5, 6, 7 and 8 are connected in series with a grounded battery 9 and through a resistance 10 to ground, for supplying filament-heating current.

Each tube 1, 2 and 3 has associated with it a marginal relay 11, 12 or 13, each relay having two windings, one winding for operating and the second for maintaining the relays operated as will appear hereinafter. The operating winding (upper, as illustrated), of each relay has a sufficiently high resistance to cause most of the filament current to pass through the associated filament, the current which passes through the operating winding is not sufficient to operate the relay. Generally, in installations involving tandem connected tubes having their filaments connected in series, a resistance is placed in shunt to each filament to by-pass the plate current around the filaments. The plate current in the installation illustrated is shunted through the relay winding.

To illustrate the action upon the failure of any filament, assume that filament 6 of tube 2 burns out, the current which passed through filament 6 now passes through the

operating winding of relay 12 causing it to operate. The upper armature closes a circuit through filament 6' actuating it and thereby continuing the operation of the tube 2.

5 The lower armature of relay 12 upon operation closes a holding circuit which may be traced from ground through battery 14, lower relay, winding, contact and contact arm 15, conductor 16, key 17 to ground.

10 A second circuit is also closed by this operation to indicate which tube has failed. This circuit may be traced from ground, battery 18, conductor 19, conductor 20 indicating lamp 21, lower armature and contact arm 15, conductor 16, key 17 to ground.

15 The holding and indicating circuits are maintained closed until key 17 is operated which opens both circuits. However, key 17 is not operated until tube 2 (the defective tube) has been replaced. If key 17 should be accidentally operated and immediately released before the defective tube is replaced, the action which occurred when the filament burned out is repeated. After replacement of
20 the defective tube, key 17 is operated to restore relay 12 to its unoperated condition and the circuit through filament 6 is established.

Another scheme for accomplishing the same purpose, but which has application
30 mainly in tubes where there is no necessity for shunting the plate current away from the filament, is shown in connection with tube 4. In this case a relay 22 is inserted in the plate current supply circuit of the tube. This relay
35 is normally energized or operated and upon deenergization causes the energization of a slow-acting relay 23.

Upon failure of filament 8 of tube 4, plate current from +B through relay 22 will cease
40 to flow. Armature 24 in falling back closes a circuit from ground, battery 25, winding of relay 23, armature 24 to ground.

Relay 23 is thereby operated but is slow-acting for reasons which will appear later.
45 In operating, relay 23 closes the circuit for filament 8' through its upper armature. By the action of its lower armature it closes a holding and an indicating circuit as pointed out in connection with tube 2. These cir-
50 cuits, therefore, need not be traced again.

As soon as filament 8' is heated to the proper temperature plate current again flows through relay 22 causing it to operate there-
55 by breaking the circuit which caused relay 23 to operate and close its holding circuit. Relay 23, however, remains operated over its holding circuit through conductor 16 and key 17, and maintains the circuit of filament 8' closed.

60 Relay 23 is made slow-acting to avoid the interruption of the operation of tube 4 in the event of a failure of any other tube in the series. For example, in the case of the failure of tube 2 as described above, filament cur-
65 rent of all tubes in the series ceases to flow

momentarily until the second filament is cut in. During the cessation of filament current flow, plate current would cease to flow through tube 4 and this would cause the re-
70 lease of relay 22 and the substitution of fila- ment 8' for filament 8 in tube 4.

By making relay 23 slow-acting its con-
75 tacts are kept from closing long enough to permit other relays such as 12 to operate and establish filament current flow again. Relay 23, therefore, does not cause the closure of its contacts, except upon the failure of its asso- ciated tube 4.

When defective tube 4 is replaced, key 17 is operated to establish again the current
80 flow through the main filament 8 of the new tube and to open the circuit of the indicat- ing lamp and the holding circuit of relay 23.

Having described the invention in one of its embodiments it is to be understood that
85 the invention is not to be limited to such an embodiment but only as defined in the ap- ended claims.

What is claimed is:

1. In combination, a plurality of space dis-
90 charge devices each of said devices equipped with a main filament and an auxiliary fila- ment, a relay associated with each of said de-
95 vices having a winding shunted around a portion of the filament current circuit of said devices, and adapted to operate upon change
100 of current flow in said winding, and contacts actuated by the operation of said relay adapt- ed to close the circuit of said auxiliary fila-
105 ment.

2. In combination, a plurality of multi-
110 filament space discharge devices, a relay con- nected in shunt to one filament of each of said devices, circuit control contacts associated
115 with said relay, and means causing said re- lay to operate upon failure of one of said filaments whereby said circuit control con-
120 tacts close the circuit for said second fila- ment.

3. In combination, a multi-filament space
125 discharge device, a relay having a winding thereof connected in shunt to one of said fila- ments, said relay being energized by the flow
130 of filament current through its winding when said filament fails and circuit controlling con- tacts operated upon the energization of said
135 relay to close the circuit of another filament of said device.

4. In combination, a multi-filament space
140 discharge device, a multi-winding relay as- sociated therewith, circuit controlling con- tacts controlled by the operation of said relay,
145 means causing said relay to operate upon the failure of one of said filaments whereby certain of said contacts close the circuit for
150 another of said filaments, certain others of said contacts close a holding circuit through a second winding of said relay and still other
155 contacts close a signal circuit.

5. An electrical system containing multi-

filament space discharge devices, a relay associated with each of said devices, contacts actuated by said relay upon its energization and included in the circuit of a second filament, and means to cause the energization of said relay upon the failure of the first of said filaments, whereby said second filament is actuated.

6. An electrical system according to claim 5 in which said relay is provided with other contacts which upon the energization of said relay maintain it operated, whereby said second filament is maintained actuated.

In witness whereof, I hereunto subscribe my name, this 6th day of March 1931.

HAAKEN I. ROMNES.

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