

May 11, 1943.

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2,318,662

VACUUM TUBE AMPLIFYING APPARATUS

Filed Sept. 17, 1941

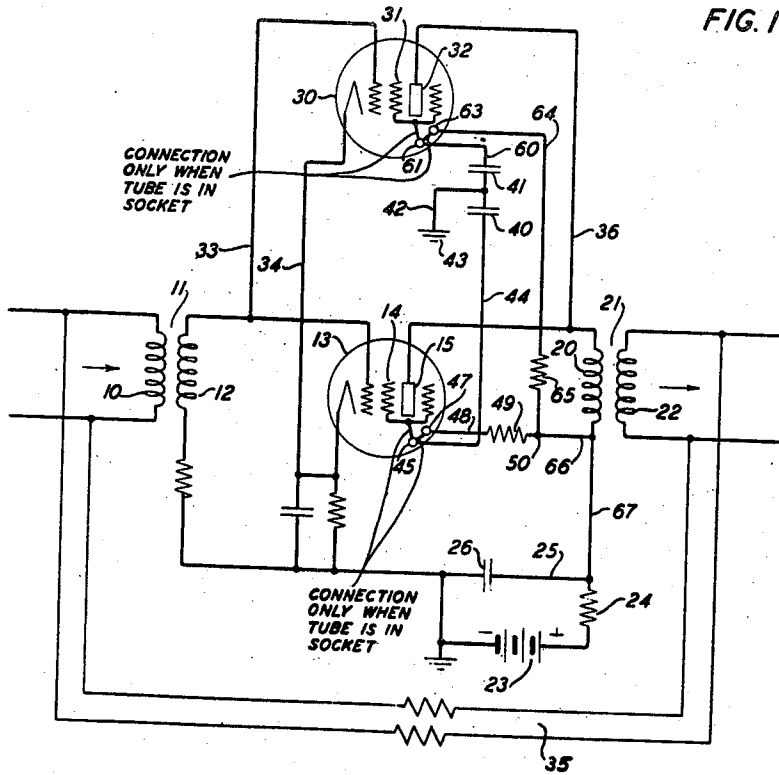


FIG. 2

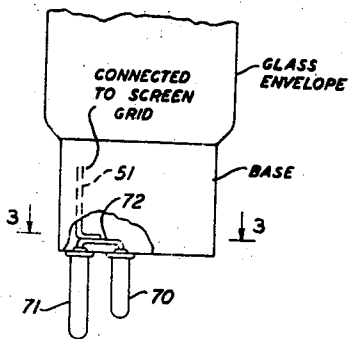
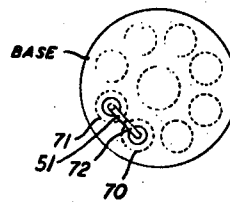


FIG. 3



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2,318,662

VACUUM TUBE AMPLIFYING APPARATUS

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Application September 17, 1941, Serial No. 411,100

7 Claims. (Cl. 179—171)

This invention relates to amplifying apparatus of the vacuum tube type, and more particularly to a device to minimize the occurrence of transients in the output of such apparatus during intervals of changing individual vacuum tubes therein.

Certain multistage amplifying apparatus comprising two vacuum tubes may be arranged such that the sockets for each stage are wired in parallel but only one tube is normally used in one socket while the other socket is vacant. When it is desired to test the one tube used, it is the practice to insert a second tube in the vacant socket and thereafter to withdraw the one tube from its socket. During such tube insertion and withdrawal, it has been found that, when the filaments of individual tubes are hot, transients may be caused to occur in the output of the amplifying apparatus. Where amplifying apparatus of the aforementioned type is utilized in a multichannel carrier telephone system in which at least one channel is arranged for voice frequency carrier telegraph operation, it has been found that such transients are apt to cause "hit." As is well known, "hits" may occasion the false operation of the receiving telegraph apparatus to introduce errors in the telegraph message being received thereby.

Accordingly, the present invention contemplates a device to control amplifying apparatus embodying vacuum tubes such that the tendency to cause transients in the output thereof during the intervals of changing tubes is minimized.

The object of the invention is to minimize the occurrence of "hits" in a voice frequency telegraph circuit operating in one channel of a multichannel telephone carrier system.

A familiar type of negative feedback amplifier apparatus embodying a single vacuum tube in each of one or more stages is disclosed in the patent of H. S. Black, No. 2,102,671 granted December 21, 1937. In certain carrier signaling systems it may be desirable, as previously mentioned, to arrange one or more stages of this amplifying apparatus such that two vacuum tube sockets are connected in parallel but only one tube is normally used in circuit. As is well known, it is necessary from time to time to test the one tube to maintain a minimum tolerable quality of transmission. This may be accomplished by inserting a second vacuum tube in the vacant socket of the circuit and thereafter removing the one tube therefrom. Due to the negative feedback feature of the amplifier apparatus, the over-all steady gain is essentially the

same with one or two vacuum tubes in any one stage. However, as hereinbefore pointed out, such tube insertion and withdrawal may tend to cause transients in the output of the amplifier apparatus.

In a specific embodiment of the present invention, a pair of capacitors is so connected to the screen grids of both vacuum tubes that one terminal of each capacitor is applied to ground potential while the other terminal of each capacitor is applied to both the screen grid of one tube and the positive terminal of the source of direct potential utilized to energize the anode-cathode circuits of both tubes. This is accomplished by inserting two screen grid connector pins of different lengths into two terminals of each socket so that when the second tube is inserted in the vacant socket, the longer pin is effectively connected in circuit in advance of the shorter pin; and when the one tube is withdrawn from its socket, the shorter pin is effectively disconnected from the circuit in advance of the longer pin. As a result, the charges on both capacitors, due to the anode energizing source, serve to apply varying amounts of potential to the screen grids of the respective tubes during the insertion and removal thereof from circuit to minimize the occurrence of transients in the output of the amplifier apparatus.

The invention will be readily understood from the following description taken together with the accompanying drawing in which:

Fig. 1 is a schematic circuit showing a one stage amplifying apparatus embodying the invention;

Fig. 2 is a fragmentary elevational view of a vacuum tube used in Fig. 1, and

Fig. 3 is a plan view taken along the line 3—3 in Fig. 2.

Referring to Fig. 1, a source of signals, not shown, is applied to the primary winding 10 of input transformer 11 whose secondary winding 12 is applied across the control grid-cathode circuit of a multielement vacuum tube 13 which embodies among other elements a screen grid 14 and an anode 15. The anode-cathode circuit of the tube 13 is impressed on the primary winding 20 of output transformer 21 whose secondary winding 22 is connected to a suitable load, not shown. A source 23 of direct potential whose negative terminal is grounded and resistor 24 in series therewith serve to energize the anode-cathode circuit of the tube 13. A lead 25 including a capacitor 26 serves to by-pass the waves in the output winding 20 to ground. A negative feedback path is provided at 35 in accordance

with the Black patent (e. g. Fig. 69 thereof). The foregoing describes essentially a one stage amplifier apparatus embodying one vacuum tube and utilizing negative feedback of the type disclosed in the patent of H. S. Black. Obviously, such apparatus may comprise a plurality of stages, each embodying at least one vacuum tube, and a feedback connection extending from the last to the first stage.

A multielement vacuum tube 30 embodying a screen grid 31 and an anode 32 and otherwise identical with the tube 13 is connected in parallel therewith by means of leads 33, 34 and 36. This means that the control grid-cathode and anode-cathode circuits of the tube 30 are applied to the respective input winding 12 and output winding 20 in parallel with the corresponding circuits of the tube 13. Due to such parallel connection, the source 23, negative feedback path 35 and lead 25 are also effective in the circuit of the tube 30 to accomplish the respective purposes mentioned above in connection with tube 13. It is understood that only the tube 13 is effectively connected in circuit during normal operation and the tube 30 is substituted for the tube 13 in the event that the tube 13 is to be withdrawn for testing or replacement as the circumstance may warrant. In other words, the terminals of the sockets, not shown, for both the tubes 13 and 30 are wired for parallel operation as mentioned above but only one tube, say tube 13 for example, is inserted in one socket and therefore is effectively in circuit while the socket to receive the tube 30 is vacant. It is further understood that one tube 30 is similarly connected in parallel with each tube 13.

In accordance with the invention as shown in Fig. 1, capacitors 40 and 41 have corresponding terminals applied over lead 42 to ground potential 43. The other terminal of the capacitor 40 is connected by lead 44 to terminal 45 of the socket, not shown, associated with the tube 13 which socket also embodies another terminal 47. The latter terminal is connected via a lead 48 and resistor 49 to a common point 50 whose extension will be subsequently pointed out.

The other terminal of the capacitor 41 is extended over lead 60 to terminal 61 included in the socket, not shown, identified with the tube 30 which socket also embodies another terminal 63. This terminal is connected by a lead 64 and resistor 65 to the common point 50 which is extended over leads 66 and 67 to one end of the resistor 24 whose other end is applied to the positive terminal of the direct potential source 23.

Referring to Figs. 2 and 3, each of the tubes 13 and 30 embodies among other pins a short pin 70 and a long pin 71, both of which latter two pins are joined by a strap 72 suitably soldered thereto. A lead 51 and the strap 72 connect the pins 70 and 71 to the screen grids 14 and 31 of the respective tubes 13 and 30.

In the operation of Figs. 1 and 2, it is first assumed that the tube 13 is inserted in the socket therefor while the socket for the tube 30 is vacant, and the feedback amplifier apparatus shown in Fig. 1 is satisfactorily operating in the manner discussed in the patent of H. S. Black, supra. Next, it is assumed that the tube 13 is to be withdrawn from its socket for test purposes. So as not to interrupt transmission through the amplifier, the tube 30 is inserted in the vacant socket. During such insertion, the longer pin 71 engages its associated terminal 61

in the socket for the tube 30 before the shorter pin 70 engages its associated terminal 63 in the same socket. When both pins 70 and 71 are in engagement with the respective socket terminals 63 and 61, the capacitor 41 commences to charge in a circuit comprising positive terminal of the source 23, resistor 24, leads 67 and 66, common point 50, resistor 65, lead 64, socket terminal 63, short pin 70, strap 72, long pin 71, socket terminal 61, lead 60, capacitor 41, lead 42 and ground potential 43.

As the charge is being gradually built up on the capacitor 41 by the source 23, a gradually increasing amount of potential is being effectively applied to the screen grid 31 of the tube 30 over a circuit including ground potential 43, lead 42, capacitor 41, lead 60, socket terminal 61, long pin 71, and lead 51. This means, assuming the filament of the tube 30 to be hot, that the gradually increasing potential being impressed on the screen grid 31 causes the production of a gradually increasing amount of space current in the tube 30. When the capacitor 41 is fully charged, substantially the full amount of the potential of the source 23 is impressed on the screen grid 31 of the tube 30 over a circuit including positive terminal of source 23, resistor 24, leads 67 and 66, common point 50, resistor 65, lead 64, socket terminal 63, both pins 70 and 71 and strap 72, and lead 51.

Inasmuch as, for the moment, both the tubes 13 and 30 are operatively connected in the amplifier apparatus shown in Fig. 1, it is understood that the action of the negative feedback hereinbefore referred to as explained in the patent of H. S. Black, supra, serves to maintain the over-all steady gain substantially identical for the condition of one or two tubes in such apparatus.

As the tube 13 is being removed from its socket, the short pin 70, Fig. 2, is disengaged from the socket terminal 47, Fig. 1, thereby removing the source 23 from the screen grid 14 of the tube 13 from which source a potential was being impressed on the screen grid 14 over a circuit comprising positive terminal of the source 23, resistor 24, leads 67 and 66, common point 50, resistor 49, lead 48, socket terminals 47 and 45, both pins 70 and 71, strap 72, and lead 51. During such withdrawal interval, the long pin 71 being still in engagement with the socket terminal 45, serves to apply the charge on the capacitor 40 to the screen grid 14 of the tube 13 over a circuit including ground potential 43, lead 42, capacitor 40, lead 44, socket terminal 45, long pin 71 and lead 51.

It is understood that the capacitor 40 was initially charged during the interval of the insertion of the tube 13 into its socket in a manner similar to previously described charging of capacitor 41 during the insertion of the tube 30 into its socket. The initial charging circuit for the tube 13 comprises positive terminal of the source 23, resistor 24, leads 67 and 66, common terminal 50, resistor 49, lead 48, socket terminal 47, short pin 70, strap 72, long pin 71, socket terminal 45, lead 44, capacitor 40, lead 42, and ground potential 43.

As the current of the screen grid 14 of tube 13 gradually discharges the capacitor 40 during the previously mentioned withdrawal of the tube 13 from its socket, a gradually decreasing amount of potential is being effectively impressed on the screen grid 14. This causes a gradual

decrease of the amount of space current produced in the tube 13.

Since the space current of the tube 30 is gradually increased during insertion into its associated socket and that of the tube 13 is gradually decreased during withdrawal from its associated socket as distinguished from abrupt changes in space current during such insertion and withdrawal, the effective current in the secondary winding 22 of output transformer 21 is maintained substantially at least at such value that will tend to minimize the occurrence of transients therein. This obviates "hits" on a voice frequency telegraph system operating in a multichannel carrier telephone system.

It is understood that when the tube 13 is inserted into the socket provided therefor and the tube 30 withdrawn from the socket provided therefor the capacitors 40 and 41 function in a direction which is the reverse of that described above so as to repeat the same over-all phenomenon; and that the resistors 24, 49 and 65 serve to effect time delay for charging the capacitors 40 and 41.

From a switching aspect, it may be considered that either the tube 13 or 30 on withdrawal is effectively a "break before break" switch and on insertion is effectively a "make before make" switch in so far as the charging of the capacitors 40 and 41 by the source 23 is concerned. This obviates a use of electromagnetic relays, switching keys, or other necessary electrical apparatus in order to connect the source 23 to and from the capacitors 40 and 41 to accomplish the function hereinbefore mentioned.

In the above description, it is assumed that the socket terminals 45 and 47, and socket terminals 61 and 63 for the respective tubes 13 and 30 are substantially in the same plane so that the different lengths of the pins 70 and 71 will accomplish the action above described; and it is therefore obvious that the same action may be just as expeditiously attained by making the pins 70 and 71 the same length but proportionately changing the contact surfaces of the socket terminals 47 and 63 relative to the respective socket terminals 45 and 61.

What is claimed is:

1. In combination in electrical apparatus, a pair of vacuum tubes, circuit means to connect said tubes in parallel such that only one tube is normally in circuit, each tube embodying a screen grid and an anode, a source of direct potential included in said circuit means to energize said anodes, and means responsive to said source and said tubes during the insertion of a second tube in circuit and the withdrawal of the one tube therefrom to apply varying amounts of potential to the screen grids of the individual tubes.

2. The combination in electrical apparatus according to claim 1 in which said potential applying means applies a decreasing amount of potential to the screen grid of said one tube during said withdrawal thereof from said circuit means.

3. The combination in electrical apparatus according to claim 1 in which said potential applying means applies an increasing amount of potential to the screen grid of said second tube during said insertion thereof in said circuit means.

4. In combination in amplifying apparatus, a pair of vacuum tubes, circuit means to connect said tubes in parallel such that only one tube is

normally in circuit, each tube embodying a screen grid, an anode and two pin connectors applied to the screen grid, a source of direct potential interposed in said circuit means to energize said anodes, and means actuated by said pin connectors and said source to control the magnitude of transient currents produced in the output of individual tubes when a second tube is inserted in said circuit means and said one tube is removed therefrom, including a capacitor individual to each tube and whose charge applies a varying amount of potential to said screen grids during said insertion and withdrawal of the respective second and one tubes.

5. In combination in amplifying apparatus, a pair of vacuum tubes, each embodying a screen grid, an anode and a pair of pin connectors of different lengths connected to said screen grid, circuit means to connect said tubes in parallel such that only one tube is normally in circuit, a source of direct potential to energize said anodes, and means responsive to said tubes and said source to apply a varying amount of potential to said screen grids both during the insertion of a second tube in said circuit means and during the withdrawal of said one tube therefrom, comprising a pair of terminals and a capacitor individual to each tube and arranged such that one terminal of each capacitor is connected to ground potential and the other terminal of each capacitor is connected to one terminal of each of said pairs of terminals and the other terminal of each of said pairs of terminals is connected to the positive terminal of said source, said pair of pin connectors and said pair of terminals individual to each tube cooperating such that during said insertion of said second tube both said pin connectors engage one pair of said pairs of terminals to connect one capacitor in sequence to the screen grid of said second tube and said source to apply effectively a gradually increasing amount of potential to the screen grid of said second tube, and during said withdrawal of said one tube the shorter pin connector is disengaged from said other terminal of a second pair of said pairs of terminals to disconnect effectively said source from the other capacitor and the screen grid of said one tube a certain time before the longer pin connector is disengaged from the one terminal of said second pair of terminals to disconnect the other capacitor from the screen grid of said one tube to apply effectively a gradually decreasing amount of potential to the screen grid of said one tube.

6. A wave amplifying system comprising an input and an output, amplifying means interposed between said input and output, a path supplying waves from said output to said input to control the gain of said system, said amplifying means comprising at least a pair of vacuum tubes connected in parallel such that only one tube is normally in said system, each tube embodying a screen grid, an anode and a pair of pin connectors connected to the screen grid, a source of direct potential to energize said anodes, and means to apply varying amounts of potential to said screen grids when a second tube is inserted in said system and when said one tube is removed therefrom, comprising a pair of capacitors, and circuit means to connect said capacitors and said source to said pin connectors such that one terminal of each capacitor is applied to ground potential and the other terminal of each capacitor is connected to the pin connectors of an individual tube and thereby to the positive terminal

of said source and the screen grid of the individual tube.

7. The wave amplifying system according to claim 6 in which said two pin connectors of each tube have different lengths, and said potential applying means embodies a pair of other terminals individual to each tube, a first terminal of each pair of said other terminals is connected to said one capacitor terminal and a second terminal of each pair of said other terminals is connected to said source so that said second tube on said insertion causes the longer pin connector to

5 be connected to one capacitor a certain time interval before the shorter pin connector applies said source to both said one capacitor and the screen grid of said second tube, and said one tube on withdrawal causes the shorter pin connector to disconnect said source from the other capacitor and the screen grid of said one tube a certain time interval before the longer pin connector causes the other capacitor to be disengaged 10 from the screen grid of said one tube.

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