

Nov. 21, 1933.

J. D. REID

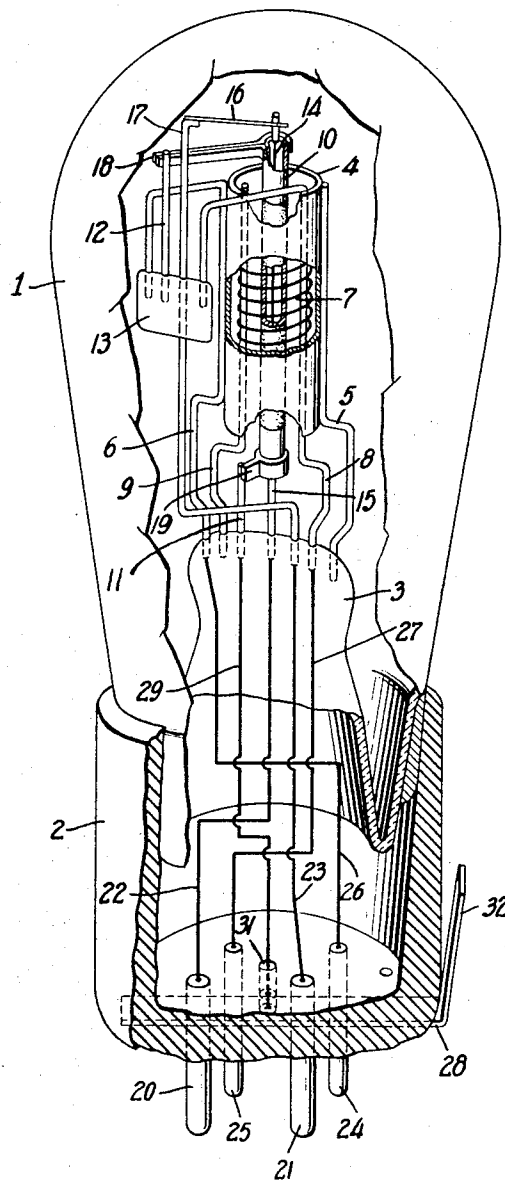
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RADIO APPARATUS

Filed Oct. 16, 1928

3 Sheets-Sheet 1

Fig. 1.



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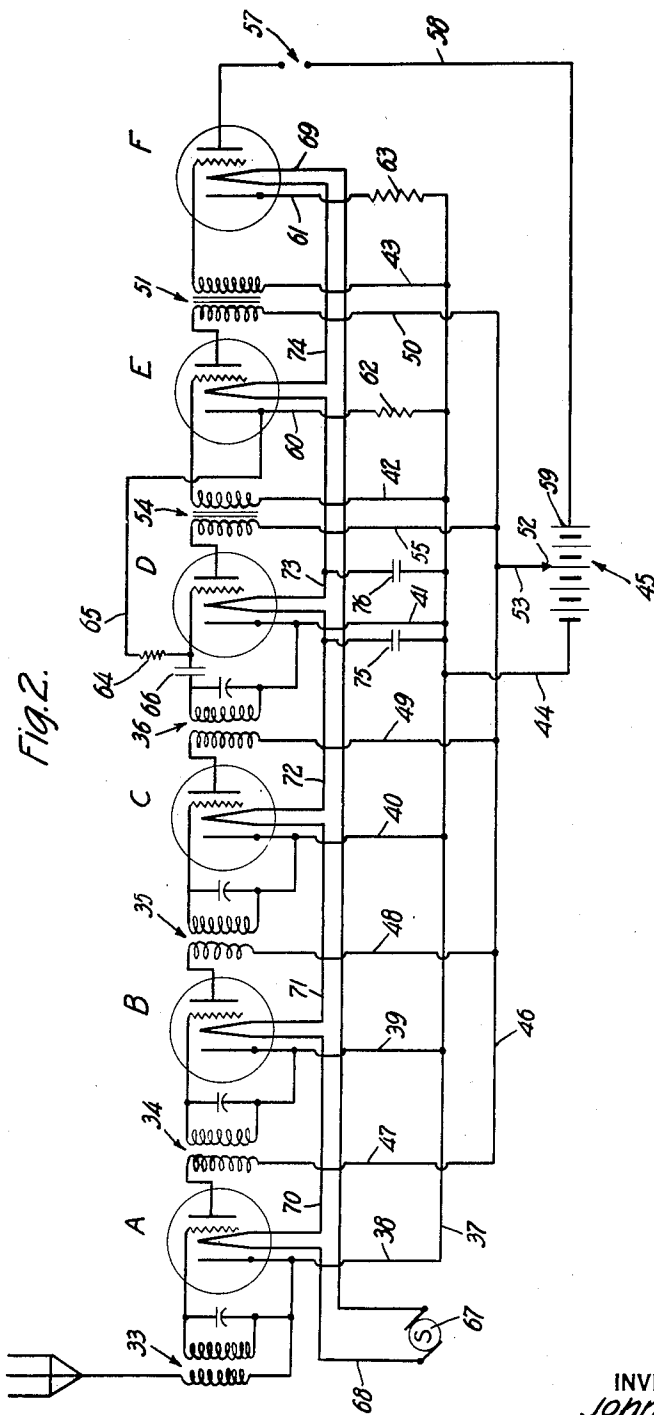
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RADIO APPARATUS

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3 Sheets-Sheet 3

Fig. 3.

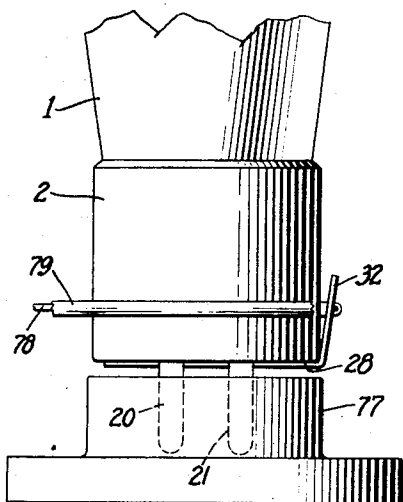


Fig. 5.

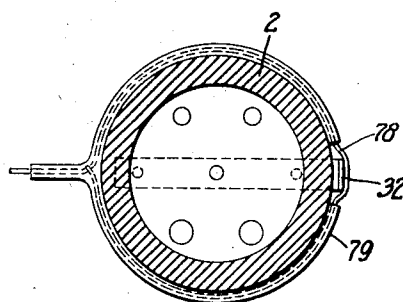


Fig. 4.

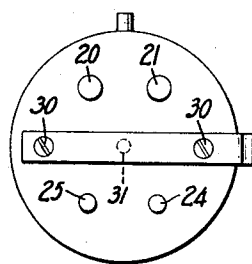
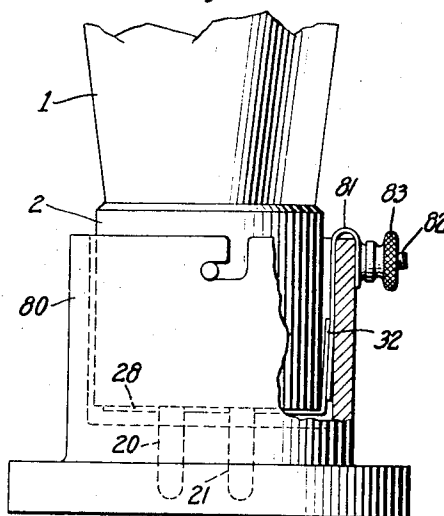


Fig. 6.



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RADIO APPARATUS

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7 Claims. (Cl. 250—27)

This invention relates to radio receiving apparatus, and particularly to apparatus adapted to secure new advantages in the utilization of vacuum tubes of the heater type.

5 In accordance with an important feature of the invention, tubes of the heater type are employed, connected in series to a source of heater current, and provision is made of means for effecting the connection of the heater elements to
10 such current source independently of the electron emitting elements of the tubes.

The series connection of the tubes is highly desirable, particularly where tubes of the heater type are employed. Tubes of this type may be
15 designed to operate to best advantage either with a low voltage drop or a high voltage drop across the heater element, as desired, by selecting in each instance a heater element of appropriate characteristics for installation in the tube. It
20 is accordingly possible by a proper selection of tubes to cause the sum of the normal voltage drops of the heater elements to balance the line voltage, so that the necessity of employing a step-down transformer for alternating current,
25 or a resistance in series with the tubes for direct current, is obviated. Savings in initial cost and in operating cost due to current consumption are, therefore, realized.

Sets employing series connected tubes have
30 always heretofore utilized the electron emitting cathode as a transmission path for the heater current. This has the disadvantage, however, that each cathode is at a potential differing from that of the next succeeding cathode of the series
35 by the amount of the voltage drop across the former. This interferes with securing the maximum amplification per stage, and introduces hum and distortion. Attempts to cope with these objectionable features introduce complications and
40 add to the cost of the set.

With the circuit arrangement of the present invention it has been found unnecessary to provide a grid bias in the radio frequency tubes, since these tubes have been found to operate
45 without perceptible distortion and at maximum efficiency without grid bias. It is also possible to provide negative bias for the grids of the audio frequency tubes by the simple expedient of interposing resistances between the negative terminal
50 of the source of B current supply and the cathodes of such tubes to diminish the negative potentials of such cathodes.

In accordance with a further feature of the invention, the grid of the detector tube is biased
55 positively by connecting it with the cathode of

an audio frequency tube, such cathode being positive with relation to the detector tube cathode because of the interposition of resistance between the former and the negative source of B current.

A further feature of the invention relates to
60 the utilization of the heater circuit of the tubes in a radio set as a ground connection for the set and particularly to effecting the connection in such manner as to greatly reduce, if not altogether eliminate the hum which usually occurs as
65 an incident of connecting a radio set to a source of alternating current.

It is an important object of the invention to provide a radio set which is adaptable without
70 alteration to use with either alternating or direct current.

Other objects and advantages will hereinafter appear.

In the drawings forming part of this specification:
75

Figure 1 is a perspective view of a vacuum tube embodying features of the present invention, parts of the tube being broken away for clearness of illustration;

Figure 2 is a circuit diagram of a radio set
80 adapted to use the tube of Figure 1, and embodying further features of the invention;

Figure 3 is a fragmentary elevation of one form of tube embodying features of the invention, together with a socket in which it is adapted
85 to be inserted;

Figure 4 is a bottom plan view of the base of the tube shown in Figure 3;

Figure 5 is a sectional, plan view through the tube shown in Figure 3, illustrating particularly
90 means for connecting the tube in the circuit; and

Figure 6 is a fragmentary elevation, partly broken away, showing how the tube may be connected in a socket of a different type.

The illustrative tube of Figure 1 comprises an
95 envelope 1 which is mounted on the usual base 2, and encloses a press 3 adapted to support the elements of the tube. Provision is made of a plate or anode 4 supported at two sides thereof by means of the wires 5 and 6 which are sealed in
100 the press 3. A grid or control electrode 7 is supported by wires 8 and 9 which are sealed in the press 3. A tubular cathode 10 coated with a suitable electron emitting substance is connected at its lower end to a wire 11 sealed in the press and
105 at its upper end to a supporting wire 12 which is sealed in a glass bead 13. A filament 14 extends through the tubular cathode 10 and is supported at its lower end by a wire 15 sealed in the press
110 3, and at its upper end by a spring 16. The spring

16 is attached to a wire 17 which is molded in and passes through the bead 13. The wire 17 is sealed in the press 3, and forms a support for the bead 13 as well as for the filament 14.

5 The upper and lower ends of the cathode 10 carry arms 18 and 19, respectively, whereby the cathode is attached to the wires 12 and 11.

10 The filament 14 is always maintained under tension by the spring 16, and therefore does not become slack and sag toward a wall of the cathode when heated, but instead remains always straight and substantially in the axis of the cathode. The utilization of a cathode of small bore is, therefore, practicable.

15 The electrical terminals on the base 2 are connected to the elements described through the press 3. Terminals 20 and 21 are connected by wires 22 and 23, respectively, to wires 15 and 17 of the filament circuit. Terminals 24 and 25 are connected to the plate 4 and the grid 7, respectively, by wires 26 and 27.

20 An additional terminal 28 is connected by a wire 29 to the lower supporting wire 11 of the cathode 10 and forms an electrical connection to the cathode independent of any of the other elements described. The terminal 28 comprises a strip of spring metal which is mounted across the base 2 of the tube and secured to the base in any suitable manner, as by means of screws 30 (see Figure 4). The wire 29 is soldered or otherwise suitably attached to the terminal 28 and is led upward through a hole 31 in the base 2 and connected through the press to the wire 11. The terminal 28 is bent upward at one side of the tube adjacent the side of the base to form a resilient finger 32 adapted to serve as a circuit making, contact piece when the tube is put in place in the radio set.

35 In Figure 2 disclosure is made of a radio set employing the tube just described and disclosing further features of the invention. The set is shown as comprising three radio frequency tubes A, B and C, a detector tube D, and two audio frequency tubes E and F. The grid circuits of the tubes A, B, C and D are connected through radio frequency transformers 33, 34, 35, and 36, respectively, to a common grid connection 37 by means of wires 38, 39, 40, and 41, which wires serve also for connecting the cathodes 10 of said tube to the common lead 37. The grid circuits of the tubes E and F are also connected to the common grid lead 37 by the wires 42 and 43, respectively. The common grid lead 37 is connected by a wire 44 to the negative terminal of the B battery 45.

40 The plate circuits of radio frequency tubes A, B and C and of the audio amplifying tube E are connected to a common plate circuit conductor 46 by wires 47, 48, 49, and 50, respectively, through the radio frequency transformers 33, 34, 35, and 36, and audio frequency transformer 51. This common plate lead 46 is connected to a positive potential 52 on the B battery 45 by a wire 53. The plate circuit of the detector tube D includes the primary coil of the audio frequency transformer 54 which is connected by a wire 55 to a positive potential on the B battery. As illustrated, such connection to the B battery may be effected by connecting the wire 55 to the common B battery lead 46. The plate circuit of the last audio frequency tube F is connected through a translating device 57 by means of a wire 58 to a high potential 59 on the B battery 45.

75 The cathodes for the audio frequency tubes E and F are connected to the common grid lead

37 by wires 60 and 61, respectively, through resistances 62 and 63. These resistances 62 and 63 are employed in the leads forming the cathode connections for the audio frequency tubes to decrease the negative potential of the cathodes, or in other words, to make them more positive than would be the case if the same were connected directly through the lead 37 to the neutral point of the set represented by the negative post of the B battery 45. By making the cathodes of the tubes E and F more positive than the grids of such tubes the same result is obtained as if the grids were maintained at a negative potential by a C battery, and thus the use of a C battery is made unnecessary.

90 In one instance it has been found that the desired result may be obtained by employing a resistance of 600 ohms in the cathode lead of the first audio frequency tube E and a resistance of approximately 2000 ohms in the cathode lead of the second audio frequency tube F.

95 For grid leak and condenser rectification the best results are obtained by providing a positive bias for the grid of the detector tube. Such bias is obtained in the present illustrative embodiment of the invention by connecting the grid of the detector tube D directly through a grid leak 64 by means of a wire 65 to the cathode of the first audio frequency tube E. Since this cathode is more positive than the grid return lead 37, as pointed out above, a positive potential will be placed on the grid of the detector tube. The usual grid condenser 66 is employed in the grid circuit between the radio frequency transformer 36 and the connection to the grid leak 64.

100 The heater circuits for the tubes are connected in series, the first radio frequency tube A having one of its heater terminals connected to a source of alternating current 67 through a wire 68 and the last audio frequency tube F having one of its terminals connected through a wire 69 with the opposite terminal of the source of current 67. The series connection of the tubes is completed by wires 70, 71, 72, 73, and 74.

105 As is well understood, the sum of the voltage drops of the tubes when arranged in series is equal to the total applied voltage of the source 67. For this reason the six tubes employed are preferably adapted to require approximately 15 volts each for their operation, since this gives a total potential of 90 volts required to operate the tubes, which potential approximates that usually delivered by the ordinary house lighting circuit. It has been found that tubes thus designed for a high voltage drop operate in an entirely satisfactory manner in the described apparatus, giving greater amplification per stage than tubes involving less voltage drop, and also operating in a sensitive manner as detectors.

120 Where an antenna of the aerial or condenser type is employed, it is necessary to provide a ground connection for the aerial circuit. In accordance with the present invention, provision is made for grounding the aerial circuit through the circuit which supplies the heating current for the tubes.

125 Difficulty may be experienced in connecting the cathode and grid circuit having the grid lead 37 to the heater circuit in such manner as to avoid the introduction of objectionable fluctuating current into the set if only a single ground connection to the heater circuit is employed. Hence, I have found it desirable to make two connections between the common grid and cathode lead 37 and the heater circuit, one through a condenser 150

75 adjacent one heater terminal of the detector tube and the other through a condenser 76 adjacent the other terminal of the detector tube. I have found that the connections should be made as close to the detector tube as possible, as this materially reduces the tendency to hum. The use of the two condensers one on each side of the detector tube eliminates practically all tendency to hum in the set.

The making of the ground connection in the manner described constitutes a desirable feature, since it saves wiring, and improves the appearance of the set in use by eliminating the usual ground wire.

The set embodying the invention is adapted to be used with either alternating or direct current. If used with alternating current, the necessity for providing a step-down transformer in the heater current supply circuit is obviated, and the efficiency of the set is increased for the reason that all of the current from the power source is used in the heaters of the various tubes, no current being dissipated as heat in the transformer coils. If the set is used with direct current, a substantial saving in power may also be had because of the fact that no resistances are necessary to cut down the line voltage to the operating voltage of the tubes, as would be the case if the tubes were connected in parallel.

While the illustrative set employs six tubes, the number of tubes may be varied by employing tubes whose heater elements are designed to operate upon a greater or less voltage, to maintain the sum of the normally desired voltage drops of the several tubes equal to the voltage of the line circuit. A resistance can, of course, be employed in series with the tubes, if desired, but the set will work more efficiently with the number of tubes balancing the line voltage.

It will be seen that the invention reduces the cost of manufacture of the radio set by eliminating the necessity of a transformer or other voltage-reducing device, and of ground and C battery connections. It reduces to a minimum the hum ordinarily found in a circuit using alternating current for energizing the tubes. It also reduces the cost of operation of the set, as well as the initial cost of accessories because it makes the employment of C batteries, and heater current transformers unnecessary.

In Figures 3 to 6 disclosure is made of means of adapting the tube of Figure 1 for convenient installation in sockets of different types.

If the tube is intended to be used in a shell type metal socket, the socket itself may be used as a connection for the cathode inasmuch as the resilient finger 32 will make contact with the sides of the socket.

If the flat type of socket is used as 77 in Fig. 3 it is desirable to provide a ring of wire 78 which may be connected to the circuit and which is covered with an insulating material 79 extending almost completely around the ring. A portion of the insulating material 79 is removed at one side, as seen in Fig. 5, so that the bare wire 78 may contact with the resilient finger 32 when the base of the tube is inserted in the ring. The ring may be made slightly out of true, so that there will always be some tension between the wire 78 and the resilient finger 32, in order that a good electrical contact will be maintained and the wire will be prevented from slipping out of place.

If the socket is made of insulating material and is of the shell type, as 80 in Fig. 6, a resilient strip of metal 81 may be attached to the side of

the socket by a binding post 82 and terminal nut 83 and be bent over the upper edge of the shell and down against the inner surface, so that when the tube is inserted in the socket the resilient finger 81 will make contact with the strip 32. The strip 81 is made wide enough so that the finger 32 may remain in contact with it throughout the rotary movement of the tube for effecting the bayonet slot connection between the tube and the socket. The binding post 82 and terminal nut 83 may also be used as a convenient means for making the necessary wire connection to the heater circuit.

While I have illustrated and described in detail certain preferred forms of my invention, it is to be understood that changes may be made therein and the invention embodied in other structures. I do not, therefore, desire to limit myself to the specific constructions illustrated, but intend to cover my invention broadly in whatever form its principle may be utilized.

What I claim is:

1. In a current amplifying system, an amplifying circuit having a ground connection, a plurality of heater type vacuum tubes, means to connect the heaters of said tubes in series to a source of current, the sum of the normal operating voltages of said tubes being equal to the voltage across said power source, and means to make the ground connection for the amplifying circuit through the heater circuit.

2. In a radio receiving system, a detector tube, an audio frequency amplifying tube, each of said tubes having an input and an output circuit, means to operatively connect the output circuit of said detector tube to the input circuit of said audio frequency amplifying tube, a heater for each of said tubes, said heaters being connected in series, means for maintaining the cathode of the audio frequency tube at a positive potential with relation to the cathode of the detector tube, a grid leak connected to the grid of said detector tube, and a direct connection between the cathode of said audio frequency amplifying tube and the other end of said grid leak.

3. In a radio circuit, a detector tube, an audio frequency amplifying tube, a heater for each of said tubes, said heaters being connected in series, an input and an output circuit for each of said tubes, means to operatively connect the output circuit of said detector tube to the input circuit of said audio frequency amplifying tube, a grid leak connected to the grid of said detector tube, a direct connection between the other end of said grid leak and the cathode of said audio frequency amplifying tube, means forming a connection between the cathode of the detector tube and the neutral point of the circuit, and means forming a connection of higher resistance between the cathode of said audio frequency amplifying tube and the neutral point of the circuit.

4. In a radio receiving system, a plurality of tubes including a detector tube, heaters for said tubes, said heaters being connected in series with one another and with a source of heater current, an input circuit for said detector tube, including a secondary transformer coil, a primary transformer coil inductively coupled to said secondary coil, means to connect an antenna to one end of said primary coil, means including a condenser for connecting the other end of said primary coil to the heater circuit at a point just in advance of one heater terminal of said detector tube, and means including a second condenser for also connecting said other end of said

primary coil to said heater circuit at a point just following the other heater terminal of said detector tube.

5 5. In a radio receiving set, a plurality of heater
tubes in series to a source of current, one of said
tubes acting as a detector, a common grid cir-
cuit for said tubes, a connection including a con-
10 denser between said grid circuit and said heater
circuit just in advance of one of the heater
terminals on said detector tube, and a second
connection including a condenser between said
grid circuit and said heater circuit just follow-
15 ing the other heater terminal of said detector
tube, said connections and heater circuit acting
as a ground for the circuit.

6. In a radio receiving system, a plurality of
tubes including a detector tube, heaters for said
tubes, said heaters being connected in series with
20 one another and with a source of current, an
input circuit for said detector tube, including a
secondary transformer coil, a primary trans-
former coil inductively coupled to said secondary
coil, means to connect an antenna to one end of
25 said primary coil, means including a condenser for
connecting the other end of said primary coil to
the heater circuit at a point just in advance of one

heater terminal of said detector tube, means in-
cluding a second condenser for also connecting
said other end of said primary coil to said heater
circuit at a point just following the other heater
terminal of said detector tube, and means to
80 maintain a positive potential on the grid of said
detector tube.

7. In a radio receiving set, a plurality of heater
type tubes, means to connect the heaters of said
tubes in series, one of said tubes acting as a de-
85 tector, a common grid circuit for said tubes, a
connection including a condenser between said
grid circuit and said heater circuit adjacent one
of the heater terminals on said detector tube,
a second connection including a condenser be-
90 tween said grid circuit and said heater circuit
adjacent the other heater terminal of said de-
tector tube, said connections acting as the only
ground connections for the circuit, means to
95 maintain the cathode of the tube following the
detector tube at a positive potential, a grid leak
connected to the grid of said detector tube, and
a direct connection between the other end of
said grid leak and the cathode of said tube fol-
100 lowing said detector tube.

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