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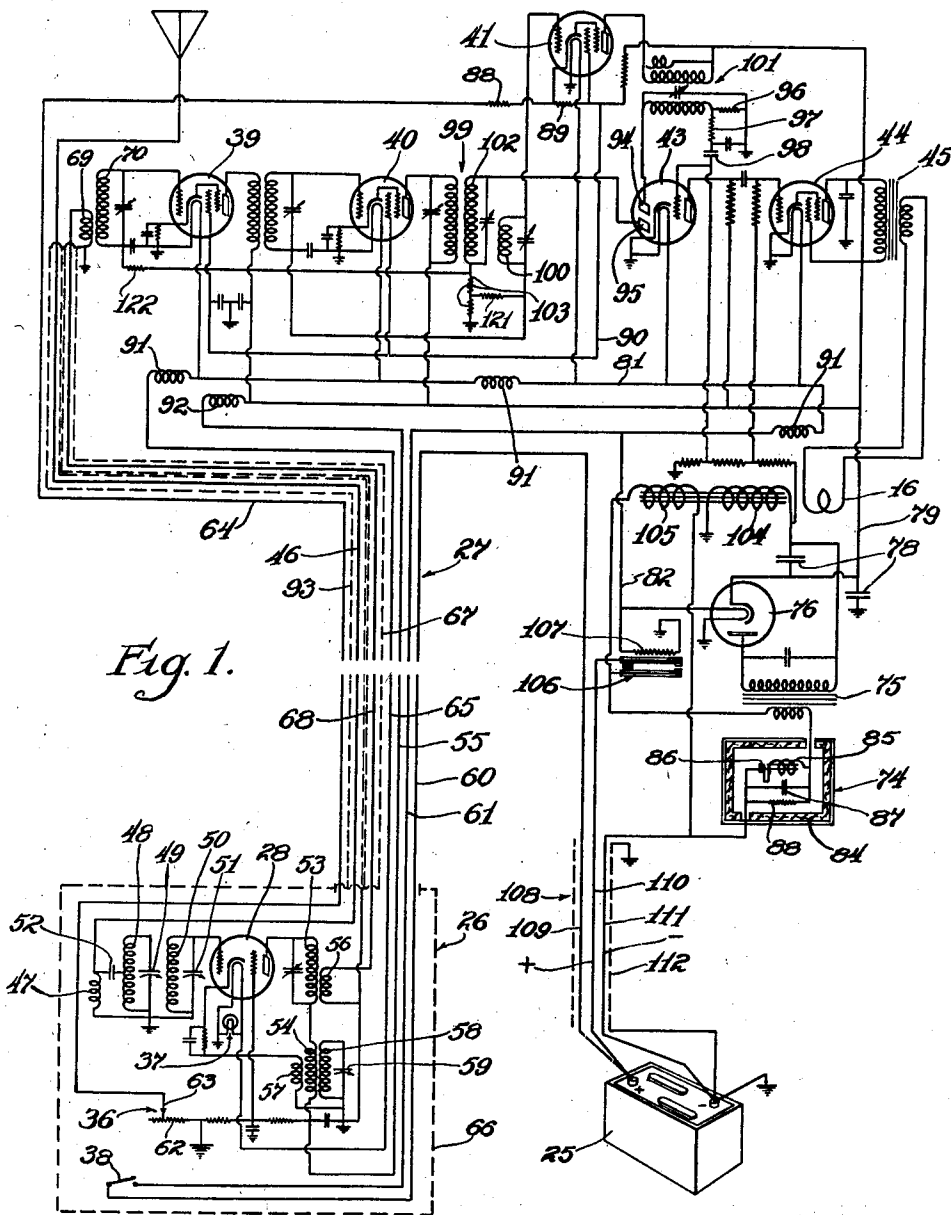
E. F. ANDREWS

2,268,792

RADIO RECEIVER

Original Filed April 8, 1933

3 Sheets-Sheet 1



INVENTOR.
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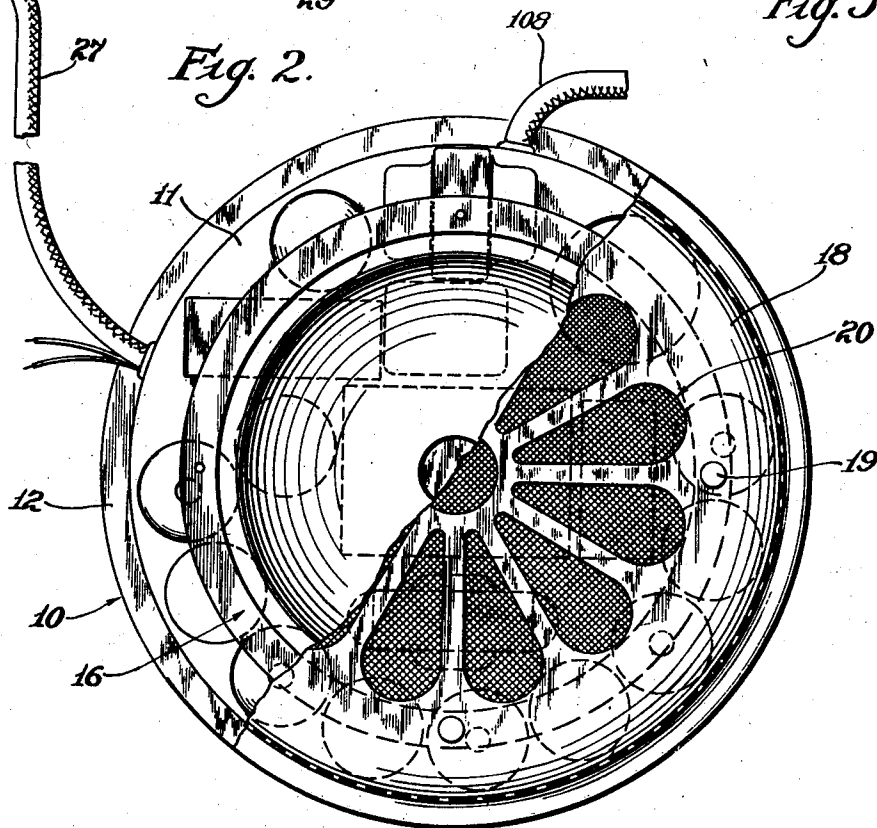
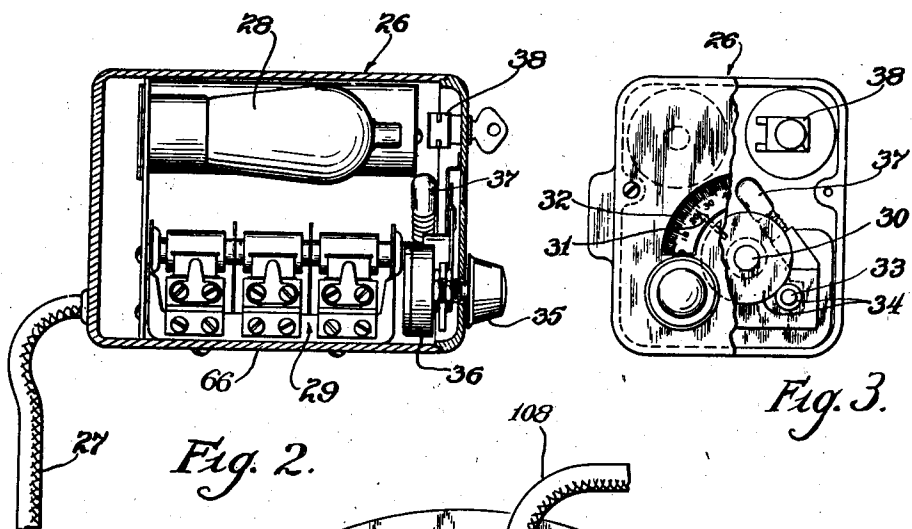
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RADIO RECEIVER

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3 Sheets-Sheet 2



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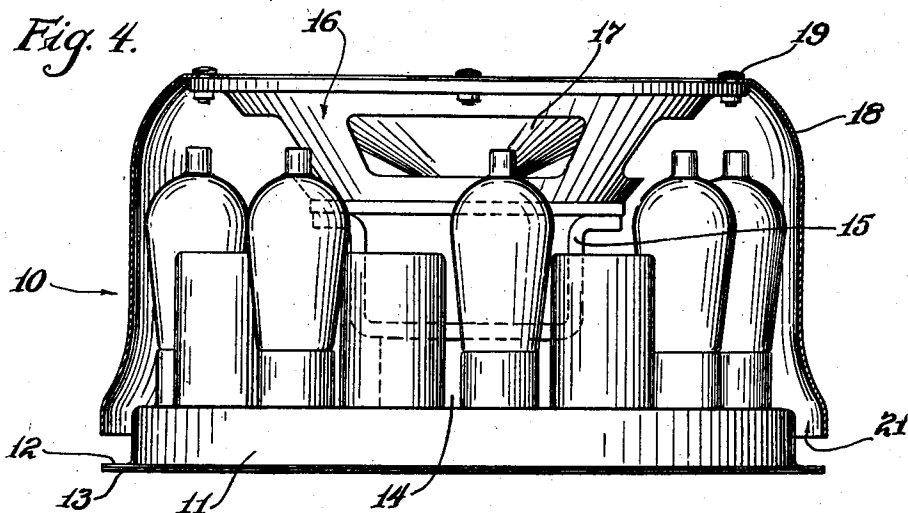
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RADIO RECEIVER

Original Filed April 8, 1933

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,268,792

RADIO RECEIVER

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Original application April 8, 1933, Serial No.
665,074, now Patent No. 2,143,532, dated Janu-
ary 10, 1939. Divided and this application
January 9, 1939, Serial No. 249,909

7 Claims. (Cl. 250—27)

This application is a divisional from my co-
pending application Serial No. 665,074, filed April
8, 1933, and issued on January 10, 1939, as United
States Patent No. 2,143,532.

This invention relates to radio receivers and
has for one of its objects the provision of an im-
proved radio receiver.

Among the other objects of the invention are
to provide a compact radio set with self-contained
power supply devices suitable for deriving fila-
ment and plate current therefor from an auto-
mobile battery or from some other source of low
voltage direct current, and to provide means for
attenuating in the filament circuit of the radio
set the high frequency disturbances occasioned
by the power supply devices and exterior distur-
bances, such as those caused by the ignition system
of an automobile, operated from the storage bat-
tery.

Other objects, advantages, and capabilities of
my invention will appear from the following
description of preferred embodiments thereof,
taken in conjunction with the accompanying
drawings, in which

Fig. 1 is a wiring diagram of one embodiment
of the invention;

Fig. 2 is an illustration of a radio set embody-
ing the invention, the main unit being shown in
plan with its cover partly broken away and the
remote control unit being shown in sectional ele-
vation;

Fig. 3 is an end view of the remote control unit,
with its cover partly broken away; and

Fig. 4 is an elevation of the main unit, the
cover being shown in section in order to display
elements normally obscured thereby.

Referring more particularly to Fig. 2, it is to
be noted that the main unit, which is designated
by the reference numeral 10, is substantially
similar in construction to the set described and
claimed in my co-pending application, Serial No.
639,821, filed October 27, 1932, Patent No.
2,103,135, granted December 21, 1937. This main
unit is also shown in Fig. 4 and comprises a base
11 which may be of inverted dish shape provided
with an outwardly projecting flange 12 to which
is secured a closure plate 13. The space between
the upper face of the base 11 and the closure
plate 13 provides accommodation for wiring and
small radio parts. A block 14 is mounted in
the center of the base 11 to serve as a support
for the pot 15 of a loud speaker 16. The loud
speaker is preferably of the dynamic cone type,
the cone 17 being directed upwardly as shown
in Fig. 4. A cover 18 is supported upon the
speaker, for example, by means of screws 19

which secure it to the edge of the speaker frame
adjacent the periphery of the cone.

The central portion of the cover 18 is provided
with openings 20 for the egress of sound from
the speaker. The cover 18 is preferably of in-
verted dish shape and it extends downwardly to-
wards the base 11. The lowest portion of the
cover 18 is of diameter somewhat larger than
the base 11 so as to provide an annular opening
21 for the egress of sound waves from the lower
side of the speaker cone. The base 11 serves to
provide a mounting for radio apparatus such as
radio tubes, transformers, a vibrator and the
like, which will hereinafter be described in greater
detail. Such radio apparatus is located in a ring
around the pot 15 of the loud speaker, being lo-
cated within the annular space between the loud
speaker and the cover 18. It will readily be un-
derstood that such radio apparatus may be ren-
dered available for adjustment, replacement and
the like by merely removing the cover 18, which
may be done by taking out the screws 19.

Owing to the fact that it is preferred to tune
the receiver in the remote control unit, it is not
necessary to mount a variable condenser in the
main unit as in the case of the aforesaid co-
pending application. The remaining radio appa-
ratus is more convenient to this manner of as-
sembly and the dimensions of the main unit
may be somewhat reduced.

Energy is supplied to the main unit 10 by a
cable 108. The main unit 10 is connected to the
remote control unit 26 by means of a flexible
cable 27 of suitable length. The number and
relation of conductors in this cable depends upon
the wiring system employed and will be discussed
further in relation to the wiring diagrams shown
in Fig. 1.

The remote control unit 26 contains a ther-
mionic tube 28 and a variable condenser 29,
which usually comprises a plurality of units
ganged together. The wiring diagram shown in
Fig. 1 calls for a three-gang condenser. The
condenser shaft 30 carries a pointer 31 which
cooperates with a scale 32. The condenser shaft
30 is actuated from a control shaft 33 by means
of friction wheels 34. At its outer end the con-
denser control shaft 33 carries a manual control
knob (not shown). A manual volume control is
provided in the remote control unit 26. This
control may comprise a knob 35 and a rheostat
or potentiometer 36 actuated thereby. The scale
32 may be provided with suitable indicia and is
preferably translucent. An incandescent lamp
37 is provided to illuminate the scale 32 on the
inside. The remote control also comprises a

switch 38, the function of which will be more readily understood with reference to the wiring diagram shown in Fig. 1.

Referring more particularly to the wiring diagram shown in Fig. 1, the receiver herein illustrated is a superheterodyne set of which the tube 28 in the remote control unit 26 is the oscillator and first detector. The tubes 39, 40 and 41, which are located in the main unit, are intermediate frequency amplifying tubes coupled by transformers tuned to the intermediate frequency. The tube 43 contains two diodes and a triode in the same envelope, all having a common cathode. One diode plate 94 serves as a second detector, the other diode plate 95 serves as a source of automatic volume control potential which is applied to the grid of tube 39, a portion thereof being applied to the grids of the tubes 40 and 41. The triode elements of the tube 43 serve as its first audio amplifier. The last tube 44 is an audio frequency power tube, the output of which is supplied to the voice coil of the loud speaker 16 through an output transformer 45.

The antenna conductor 46 preferably enters the cable 27 in or near the main unit and extends through the cable to the remote control unit 26, being connected therein to a primary coil 47 of the antenna input system which is of lower impedance than would be required to match the antenna employed, in view of the capacity through the cable. The conductor 46 preferably extends through the cable 27 within a grounded metal shield 93, for the purpose of preventing the antenna lead from picking up electrical disturbances. The coil 47 is inductively coupled to a coil 48, which is tuned by a condenser 49, one of the gang of condensers referred to generally by the reference numeral 29 in Figure 2. The coil 47 is connected to a point of the coil 48 comparatively near the grounded end thereof through a condenser 52, for the purpose of maintaining the impedance through the coil 48 lower than the total impedance of the coil. The coil 48 is inductively coupled to a coil 50 which is tuned by a variable condenser 51, also one of the gang of condensers 29.

The coil 50 is connected to the grid of the tube 28 and the plate of the tube 28 is connected in series with coils 53 and 54 and conductor 55 which extends through the cable 27. The coil 53 is coupled with the coil 55, which will be more fully described hereinafter. The coil 54 is coupled with coils 57 and 58. Coil 58 is tuned by condenser 59, which is the third of the gang of condensers designated 29. The output of the tube 28 energizes coils 54 and 58, which in turn energizes feed-back coil 57, causing tube 28 to oscillate. The result of this oscillation, in combination with a signal, is the production of current of intermediate frequency in coil 53, which in turn is communicated to coil 56 for transmission to the main unit.

The switch 38 is connected to conductors 60 and 61 which extend through the cable 27. The volume control 36 comprises a resistance 62, one end of which is grounded, and a conductive arm 63 which cooperates with said resistance. The arm 63 is connected to a conductor 64 which extends through the cable 27. The conductor 64 is connected through a low resistance 88 to the cathode of tube 41. This cathode is also connected through a high resistance 89 to the screen voltage line 90. The cable 27 also includes a conductor 65 which supplies filament current

from the main unit to the tube 28. Conductor 55, previously referred to, supplies "B" current from the main unit to the plate of the tube 28.

The remote control unit is preferably contained within a metallic housing 66 which is conductively connected to a ground conductor 67, which is preferably a metallic shield, extending between the remote control unit 26 and the main unit 10 through the cable 27. This shield contains the conductor 68 which carries the output from the coil 56 to a coil 69 in the main unit. The conductor 68 is connected to one end of the coil 56, the other end of this coil being grounded, preferably through the shield 67. The shield 67 effectively prevents any undesired signals from being picked up by the conductor 68 and introduced into the input of the intermediate frequency amplifying tubes 39, 40 and 41.

The main unit 10 will now be described. The coil 69 is inductively coupled to the coil 70 which is connected to the input of the tube 39. The plate circuit of the tube 39 is coupled with the input of the tube 40. The plate circuit of the tube 40 is coupled with the input of the tube 41. The plate circuit of the tube 41 is coupled to the detector 94. The detector produces a voltage drop across the resistor 96 and this voltage is impressed on the grid of the triode of the tube 43. The plate of the triode is resistance coupled to the grid of the tube 44. The coupling between the tubes 40 and 41 steps down the input to the latter tube. This is done in order to keep the grid swing of the tube 41 within satisfactory limits and to obtain the maximum gain which the permissible grid swing will permit ahead of the last intermediate stage, which is employed mainly for control purposes and additional selectivity.

The plate 95 provides the automatic volume control voltage, being connected by a resistance 103 to ground. This diode circuit includes the winding 102 which receives energy from the plate of the tube 40, being coupled to the primary of the transformer 99. The plate 95 is conductively connected through a part of resistance 103 and through a resistance 121 to the input of the tubes 40 and 41, and through a suitable resistance 122 to the input of the tube 39.

The main unit 10 comprises an interrupter 74, a transformer 75, and a rectifier 76 which is associated with suitable filtering means including condensers 78 for the purpose of ironing out fluctuations in the direct current and potential delivered by conductor 79. This conductor is connected in known manner to the plate circuits of tubes 28, 39, 40, 41, 43 and 44. The filament current for all the tubes is derived from the battery 25 through conductor 109, which passes to the main unit 10, and is connected therein to the conductor 60. When the switch 38 is thrown to made position, the conductor 109 is connected to conductor 61 of the cable 27 and to conductors 81 and 82 in the main unit 10. The current for the filament of tube 28 flows back to the control unit through conductor 65 of the cable 27.

The vibrator or interrupter 74 comprises a casing 84 including sound insulating material, in which is enclosed an electro-magnet 85 which controls points 86 in series with the winding of said magnet so as to cause continual interruption in the current flowing through the primary of the transformer 75. A condenser 87 and high resistance 88 are provided both across the winding 85 and points 86.

It is to be noted that one side of the tube filaments is grounded and the other side of the fila-

ments is connected to the line 81, the filament of tube 28 being connected thereto by line 65 of cable 27, and the filament of tube 76 being connected thereto by line 82. Choke coils 91 are provided in the filament current circuit, being preferably arranged in series in the filament supply circuit, serving with the filament resistances to provide an induction-resistance filter which effectively filters out high frequency disturbances produced by the vibrator 74 and other causes. It will be seen that the filtering effect is greatest towards the input end of the receiving set, where any disturbance present would be amplified to the greatest extent.

The choke coil 92 is connected in series with the lead 55 which supplies plate current to the tube 28. This choke coil prevents oscillation which might be caused by disturbances passing through lead 55, coil 53 and the plate ground capacity of the tube 28.

It is preferred that the rectifying tube 76 passes current when the points 86 make contact, rather than when they break contact. The change from one condition to the other may be effected in many ways, one way being to reverse the connections of the secondary winding of the transformer 75. The set can thus be readily adapted for any automobile, regardless of which pole of the battery is grounded.

The triode elements of tube 43 act to amplify the output of the diode constituted by plate 94 and the cathode at audio frequency. The detected signal appears across the resistance 96 and is impressed upon the grid of the tube 43 through the filter resistor 97 and the capacity 98. The output transformer 99 of the tube 40 steps down the output of that tube and feeds a signal of reduced amplitude to the grid of the tube 41 by means of the winding 100. This winding may be tuned to the intermediate frequency for additional selectivity. Thus there is little or no over-all gain from the last intermediate stage of amplification, including the tube 41. Certain desired results are attained by thus stepping down the output of the tube 40 into the tube 41. In the first place, excessive difference of potential between the diode plates 94 and 95, which might cause oscillation in the tube 41, is avoided. In the second place, the grid swing of the tube 41 is kept relatively small. In the third place, by taking practically all the gain in the first intermediate frequency tubes, substantially the maximum gain is available in the plate circuit of the tube 40, which is the source of automatic volume control energy. Any gain taken in the tube 41 would not add anything to the automatic volume control voltage. The tube 41 is of the variable μ type so that a large variation of the potential difference between the cathode and the grid may be employed to give the desired range of volume control.

Even when a variable μ tube is employed, it is desirable to limit the grid swing to avoid distortion. This is accomplished by impressing a stepped-down signal to the grid of tube 41, as previously described. The signal is then amplified up again to the desired value in the tube 41 and the transformer 101, from which it is impressed upon the diode plate 94, which acts as the second detector. The transformer 99 includes a secondary winding 102 which supplies potential to the diode plate 95 which is rectified and appears across the resistance 103. This

direct current potential is utilized for automatic volume control, as previously described.

The field of the loud speaker comprises two windings 104 and 105. The winding 104 is connected in series with the plate voltage supply from the secondary of the power transformer 75 through the rectifier tube 76. The winding 104 acts as a choke coil to filter the plate supply, as well as supplying part of the energy to the speaker field. Only a part of the speaker field energy is supplied from the plate supply, the remainder for bringing the speaker to the proper sensitivity being supplied directly from the battery to the coil 105. By properly proportioning these coils, the speaker field can be employed as a choke coil and the proper speaker sensitivity attained with a vibrator of moderate output.

To avoid operating the vibrator without a load, it is desirable that the filaments of the tubes should have attained their operating temperature before the vibrator is connected to the battery. A thermostatic relay 106 fulfills this purpose. This relay is adapted to be operated by a heating winding 107 which is connected to conductor 82 and energized upon the closing of the switch 38. The winding 107 is in parallel with the filaments of the tubes and the current therefor is derived from the battery. The thermostatic relay is proportioned to close the vibrator circuit after the cathodes have attained operating temperature. The thermostatic switch is preferably temperature compensated so that its time interval is not excessively affected by changes in atmospheric temperature.

The thermostatic relay serves both as a delayed switch and as a remotely controlled relay. The vibrator current does not pass through cable 27, thus reducing the liability of the introduction of undesirable electrical disturbances into the amplifier tubes, and also avoiding the larger conductors or higher voltage drop which would be occasioned by a higher current through the cable.

The battery cable 108 comprises three leads 109, 110 and 111, surrounded by a shield 112, one end of which connects to the chassis of the main unit, and the other to the grounded terminal of the battery. The conductor 109 is connected to the ungrounded terminal of the battery and leads to the switch 38 for the filament and heating element 107 supply. Conductor 110 is connected to the positive terminal of the battery and leads to one contact of the thermostatic relay 106, through which it is connected in parallel through the primary winding of the transformer 75 and vibrator 74 on the one hand, and through coil 105 on the other hand, to conductor 111 which is connected to the negative terminal of the battery. In Fig. 1 I have shown the negative terminal of the battery to be grounded.

Should the automobile be one in which the positive terminal is grounded, then shield 112 and conductor 110 should be connected to the positive terminal of the battery, and conductors 109 and 111 should be connected to the negative terminal of the battery. It is to be noted that this hook-up follows the nomenclature of the preceding paragraph, according to which shield 112 is grounded and conductor 109 is connected to the ungrounded terminal, and lead 110 is connected to the positive terminal, while lead 111 is connected to the negative terminal.

It should be noted that in the embodiment of

the invention illustrated, the conductors 110 and 111 run to the primary of the transformer 75 and to one side of the vibrating interrupter contacts 86, respectively, thus forming an interrupter circuit. The conductor 109 and the grounded shield 108 connect to the ungrounded and the grounded sides of the filaments respectively, thus forming a filament circuit, which is separate from the interrupter circuit, up to the terminals of the battery 25. The choke coils 91 are in series with the conductor 109, which forms the ungrounded side of the filament circuit. These choke coils serve to attenuate any high frequency disturbances caused by the interruption of the current in the interrupter circuit by the contacts 86 or which may be impressed on the battery from other sources, such, for instance, as the ignition system of the automobile. The complete separation of the filament circuit from the interrupter circuit, apart from the battery, which is common to both circuits, reduces the coupling between the circuits and consequently reduces the introduction of undesired high frequency disturbances into the filament circuit. The choke coils 91 are preferably located in the ungrounded side of the filament circuit between the filaments and the portion of the circuit carrying current from the battery to the interrupter, as shown in Fig. 1. Owing to the low degree of coupling between the filament circuit, on the one hand, and the interrupter and other circuits which may be connected directly to the battery, on the other hand, and owing to the choke coils 91, the amount of disturbance which reaches the filaments is very greatly attenuated, and noise in the loud speaker due to such disturbance may be almost completely eliminated.

The operation is as follows: The switch 33 being closed, the circuits through the filaments and the element 107 are made. By the time the filaments have attained their operating temperature, the thermostatic switch 106 has closed, completing the circuit through the vibrator 74 and the primary of the plate supply transformer 75, as well as through the field coil 105. An interrupted current passes through the primary of the transformer 75. The voltage of this current is stepped up in the secondary of the transformer and is rectified in tube 76 so as to provide "B" voltage by means of conductor 79. The field winding of the speaker 16 is energized and the desired station can be tuned in by actuating the gang of condensers 29. The volume level control 63 adjusts the relative grid bias of tube 41 by making the cathode more or less positive. It is to be noted that this control in the main unit is effected from the control unit by variation of a direct current which is of practically constant value for any particular manual setting of the volume level control 63.

The automatic volume control voltage is applied to the grids of the tubes 39 and 40, which elements are ahead of the source of energy from which the automatic volume control voltage is derived, which source is the plate circuit of the tube 40. Automatic volume control voltage is also applied to the grid of the tube 41, which is after the source of the energy which supplies the automatic volume control voltage which, as has been noted, is the plate of the tube 40. It may here be pointed out that the effective automatic volume control voltage applied to the tubes before the source of the automatic volume control energy is to decrease the gain of these tubes, and hence the automatic volume control voltage

produced, so that these tubes provide only a diminishing corrective effect. However, the application of automatic volume control voltage to the grid of a tube after the source of automatic volume control energy, such as tube 40, produces a reduction of gain without any reduction of the automatic volume control voltage. By tapping in the grid connection of the tube 41 at a suitable point on the resistor 103, signals of substantially uniform strength can be obtained from divers stations with antenna signals of widely different power. Indeed, by suitable adjustment of the connection of the grid 41 to the resistor 103, it is possible to make a stronger antenna signal appear as a weaker audible signal than that derived from a weaker antenna signal.

It is not intended to limit the invention to automobile radio receivers, since it may be applied to home sets and indeed to any manner of radio set.

Although the invention has been described in connection with the specific details of preferred embodiments thereof, it must be understood that such details are not intended to be limitative of the invention, except insofar as set forth in the following claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is:

1. In a battery operated radio receiver, a plurality of thermionic tubes each of which is provided with a filament having a pair of terminals, means for grounding one terminal of each of said filaments, a B-supply transformer having a primary winding and a secondary winding, a low voltage battery having two terminals, an interrupter for rendering the current from said battery transformable connecting said primary winding to said battery to form an interrupter circuit, means for grounding one side of said circuit, a housing in which all of the foregoing elements excepting the battery are located, means for grounding one of said battery terminals, said battery being located externally to said housing, conductive means connecting together the grounded terminals of said filaments, the grounded side of said interrupter circuit, and the grounded terminal of said battery, a conductor extending from the other side of said interrupter circuit to the ungrounded terminal of said battery, a separate conductor extending from the ungrounded terminals of said filaments to the ungrounded terminal of said battery, and a low resistance, high frequency choke coil in said last conductor.

2. In a battery operated radio receiver, a plurality of thermionic tubes having filaments connected in parallel, a B-supply transformer having a primary winding and a secondary winding, a low voltage battery having two terminals, an interrupter for rendering the current from said battery transformable connected to said primary winding to form an interrupter circuit, a housing in which all of the foregoing elements excepting said battery are located, conductive means connecting together one side of said filaments, one side of said interrupter circuit, and one terminal of said battery, a conductor extending from the other side of said interrupter circuit to the other terminal of said battery, a separate conductor connecting all of the other sides of said filaments together and to the last mentioned terminal of said battery, a low resistance, high frequency choke coil in said last named conductor, and at least one low resistance, high frequency choke

coil connected in series with said last named conductor between two of said filaments.

3. In a battery operated radio receiver, a plurality of thermionic tubes having filaments connected together to form a filament circuit, a B-supply transformer having a primary winding and a secondary winding, a vibrating interrupter connected to said primary winding to form an interrupter circuit, a housing in which all of the foregoing elements are located, a pair of terminals adapted to have a low voltage battery connected across them, conductive means connecting together one side of said filament circuit, one side of said interrupter circuit, and one of said pair of terminals, a conductor extending from the other side of said interrupter circuit to the other of said pair of terminals, a separate conductor extending from the other side of said filament circuit to the last mentioned one of said pair of terminals, and a low resistance, high frequency choke coil in said last named conductor, said choke coil being located within said housing.

4. A battery operated radio device comprising a plurality of thermionic tubes having filaments connected together to form a filament circuit, a B-battery transformer having a primary winding, a low voltage battery having two terminals and a secondary winding, an interrupter for rendering the battery current transformable connected to said primary winding to form an interrupter circuit, a housing in which all of the foregoing elements excepting the battery are located, said battery being located externally to said housing, conductive means connecting the two sides of the interrupter circuit to the two terminals of the battery, conductive means separate from said first conductive means connecting the two sides of said filament circuit with the two terminals of the battery, and at least one low resistance, high frequency choke coil in said last named separate conductive means.

5. In battery operated radio receiving apparatus, a plurality of thermionic tubes each of which is provided with a filament having a pair of terminals, means for grounding one terminal of each of said pairs of filament terminals, a B-supply transformer having a primary winding and a secondary winding, a circuit interrupter having a pair of terminals, means for connecting one of said circuit interrupter terminals to one

end of said primary winding, a low voltage battery having a pair of terminals, conductive means for connecting the other of said interrupter terminals to one of said battery terminals, conductive means for connecting the other battery terminal to the other end of said primary winding, a separate conductive means for connecting said last named battery terminal to the ungrounded terminals of said filaments, a shield for said three conductive means, one end of said shield being connected to the grounded terminals of said filaments and the other end of the shield being connected to said first named battery terminal whereby said shield forms part of the battery energizing circuit for said filaments.

6. In a battery operated radio receiver, a thermionic tube provided with a filament having a pair of terminals, means for grounding one of said filament terminals, a B-supply transformer having a primary winding and a secondary winding, a circuit interrupter having a pair of terminals, means for connecting one of said circuit interrupter terminals to one end of said primary winding, a pair of terminals adapted to have a battery connected across them, a shielded cable provided with at least three internal conductors, means connecting one of said conductors between the other of said interrupter terminals and one of said battery terminals, means including another of said conductors for connecting the other battery terminal to the other end of said primary winding and means including the third conductor for connecting said last named battery terminal to the ungrounded terminal of said filament, said last named means including a low resistance-high frequency choke coil in series with said third conductor, and means for connecting the shield of said shielded cable between the grounded terminal of said filament and the first named battery terminal.

7. The arrangement described in the next preceding claim wherein a second thermionic tube is provided, said second tube having a filament provided with a pair of terminals, means for connecting one of said last named terminals to ground, and means including a low resistance-high frequency choke coil for connecting the other terminal of said last named filament to the ungrounded terminal of the first named filament.

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