Nov. 4, 1941. R. B. ALBRIGHT 2,261,203

RADIO RECEIVER

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Fig. 1.

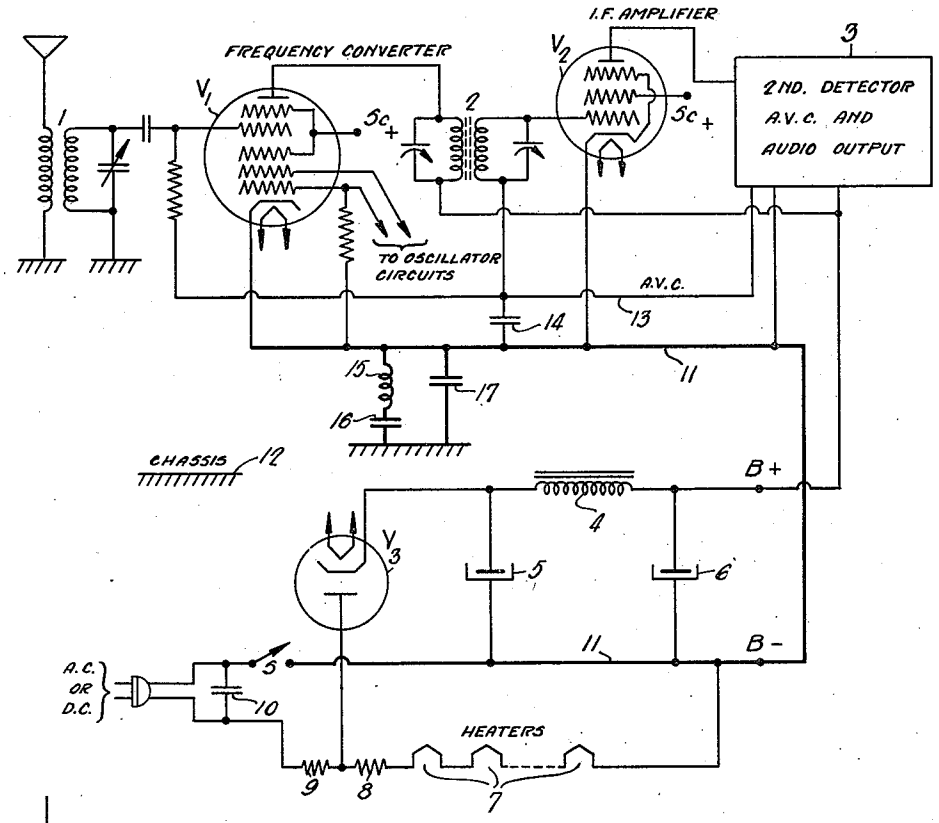
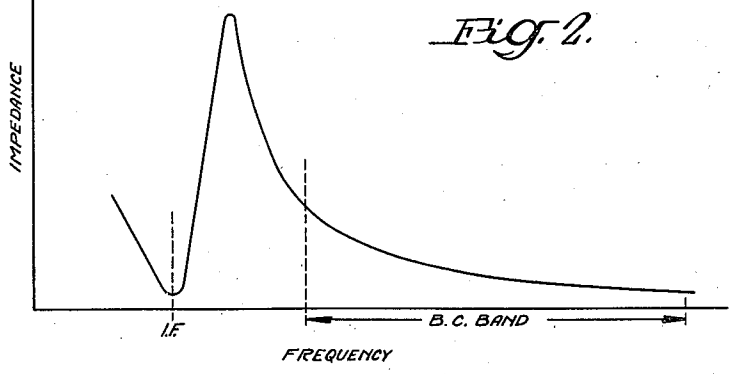


Fig. 2.



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RADIO RECEIVER

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11 Claims. (Cl. 250—27)

This invention relates to improvements in radio receivers, and more particularly to improvements in radio receivers which are adapted to derive their operating power from direct current mains, or from alternating current mains without the employment of an interposed power transformer. Such receivers are often adapted to be energized at will from either type of main and are then known in the art as A. C.—D. C. receivers.

In radio receivers of the class generally referred to above, there is normally a direct or conductive connection between the mains and the vacuum tube circuits, as contrasted with the usual A. C. receiver which employs a transformer for supplying the desired voltage to the rectifier-filter circuits while simultaneously isolating the vacuum tube circuits from the mains. In such transformer-equipped A. C. receivers, it is the usual practice to connect or return certain of the vacuum tube circuits directly to the chassis, which in turn is preferably connected to earth. This practice is impractical, however, in the case of receivers deriving their power by direct connection to the mains, since in such receivers the grounding of the chassis might throw a direct short-circuit on the mains, for one side of the mains is likewise normally grounded. On the other hand, if the receiver chassis were left ungrounded it would constitute a distinct source of hazard to life and property, since the full mains voltage could exist between ground and chassis. Nevertheless, in the interests of receiver efficiency and stability, it is desirable that there be provided a low impedance path between the vacuum tube circuits and the chassis at least for radio frequencies. Accordingly, it has been the practice in some cases to connect a capacitor of relatively high capacity between some common vacuum tube circuit and the chassis. However, if this capacity is made too high it would still be possible for a person to receive a severe and perhaps dangerous shock if he should come in contact with the ungrounded chassis. The severity of the shock would, of course, be proportional to the capacity of the condenser and the line voltage. Hence in the interests of safety it is desirable to limit the maximum capacity employed in this service. However, it has been found that in general the maximum allowable capacity results in altogether too high an impedance, at radio frequencies, between chassis and the vacuum tube circuits, thereby resulting in instability, loss of gain, or a generally erratic receiver performance.

It is therefore an important object of this invention to provide a low impedance path between certain vacuum tube circuits and chassis and/or ground, at high or radio frequencies, while utilizing capacitors which are within allowable or desirable capacity limits.

According to one feature of this invention there is provided a radio receiver which includes a plurality of vacuum tube circuits, means for energizing said circuits directly from the electric supply mains, said means including a conductive connection between said mains and said circuits, a metal housing or chassis upon which various receiver components are mounted, and a frequency discriminating network having relatively small shunt capacity connected between at least some of said vacuum tube circuits and said chassis, said network comprising a plurality of reactive circuit elements constructed and arranged to provide a low impedance path for the high frequency currents extant in said radio receiver, while simultaneously offering a high impedance to direct current and supply mains frequencies.

According to another feature of this invention there is provided a radio receiver which includes a plurality of vacuum tube circuits, means for energizing said circuits directly from the electric supply mains, there being a conductive connection between said mains and said circuits, a metal housing or chassis upon which the various receiver components are mounted, and a frequency discriminatory network connected between at least some of said vacuum tube circuits and said chassis, said network comprising a plurality of dissimilar reactive circuit elements constructed and arranged to provide firstly a high impedance path for direct current and low frequencies, secondly a low impedance path over a relatively narrow frequency range, and thirdly a low impedance path over a broader frequency range, said narrow range lying outside the limits of said broader range.

The invention may best be understood by reference to the accompanying drawing, in which:

Fig. 1 is a schematic diagram of a portion of an A. C.—D. C. radio receiver embodying the present invention, indicating in heavy line representation the elements with which the invention is particularly concerned; and

Fig. 2 is a representative impedance characteristic of a frequency discriminatory network such as might be employed in the circuit of Fig. 1.

In Fig. 1, there is shown a portion of an A. C.—D. C. superheterodyne radio receiver com-

prising a tuned antenna transformer 1, a combined first detector-oscillator, or frequency converter, V_1, a tuned intermediate frequency transformer 2, an intermediate frequency amplifier V_2, and, as indicated generally by the rectangle 3, the usual second detector, automatic volume control means, and audio output system. The power supply means may comprise an alternating current rectifier V_3 and a filter system which may include a series choke 4 and shunt capacitors 5 and 6. When the power supply means is plugged into a D. C. mains outlet, the rectifier V_3 does not function as a rectifier but merely becomes a resistive element in the direct current path. Of course, where power is obtained from D. C. mains, it is necessary to plug in to the mains in the correct polarity sense, for otherwise the rectifier V_3 would constitute an open circuit to the flow of direct current.

The cathode heaters 7 of the various vacuum tubes employed may be serially connected across the mains, including, where necessary, one or more ballast resistors 8 and 9. Similarly the mains voltage may be impressed directly on the rectifier-filter combination, or if desired, one or both sides of this combination may be isolated from the mains by means of a ballast resistor. In the drawing, the resistor 9 is connected between one side of the mains and the anode of the rectifier V_3. A small capacitor 10 may be connected across the mains to by-pass radio frequency currents.

It will be observed that in receivers of the type generally referred to above, there are one or more conductive conditions between certain of the vacuum tube circuits and the supply mains. Normally at least some of these connections will be of low impedance. Thus in Fig. 1 there is a direct connection between the cathodes of the tubes V_1 and V_2 and the common lead 11, which, when the switch S is closed, is directly connected to one side of the mains. Obviously, if desired, the connection between these cathodes and the lead 11 may include the usual cathode biasing resistors and the like, as will be well understood in the art. The plate circuits of the vacuum tubes V_1 and V_2 may be returned to the other side of the mains by way of the filter choke 4 and the rectifier V_3.

In modern radio receivers, it is common practice to mount various receiver components on a metal chassis or housing represented at 12 which provides, at the same time, a member having a common potential to which certain of the receiver circuits may be connected. Thus, in Fig. 1 it will be observed that the primary and secondary windings of the antenna transformer 1 have been returned to the chassis. This chassis may or may not be grounded, i. e., connected to earth. The A. V. C. supply lead 13 is preferably by-passed to the common lead 11 by means of a capacitor 14, as illustrated.

Since it is common practice to ground one side of the electric supply mains, it would obviously be hazardous to connect the common lead 11 directly to the chassis, since it would then be possible for the full mains voltage to exist between the chassis and ground. Moreover if the chassis were grounded, as is preferable, there could exist a direct short circuit across the supply mains. On the other hand, in order to maintain stability and efficiency of receiver operation, it is necessary that a path be provided, between certain of the receiver circuits and the chassis, having a low impedance to the high frequency currents employed in the receiver. Such a low impedance path might be provided by a large capacitor connected between the common lead 11 and the chassis. However because of the restrictions placed upon the maximum capacity between the chassis and the mains, it is impossible to reduce this impedance to the desired level.

In accordance with the present invention there is employed, instead of a simple condenser, a frequency discriminatory network which may comprise a plurality of dissimilar reactive elements arranged to provide a low impedance path for the various high frequency currents employed in the receiver, while offering a high impedance to low frequency and direct currents. In Fig. 1, this network comprises the inductor 15 and the capacitors 16 and 17. Other equivalent networks of similar or greater complexity may obviously be employed if desired. In Fig. 1, the sum of the capacities 16 and 17 should not exceed the maximum allowable chassis-to-mains capacity as determined by considerations hereinbefore referred to.

The impedance characteristic of such a network is illustrated in Fig. 2. The vertical scale is proportional to impedance (without regard to sign), while the horizontal scale represents frequency. In a superheterodyne receiver, the inductor 15 and capacitor 16 are preferably adjusted to give series resonance at the intermediate frequency, thus providing very low impedance at that frequency. The network may be designed to be parallel resonant (anti-resonant) at some frequency not employed or encountered in the particular receiver. In Fig. 2, parallel resonance occurs at a frequency lying between the intermediate frequency and the broadcast band. At higher frequencies, including the broadcast frequencies, the network impedance is again low due to decreasing impedance of the shunt capacitor 17. Below the intermediate frequency, the impedance will rise rapidly, approaching infinity for direct currents.

In superheterodyne receivers, a network such as that described has been found particularly desirable. In these receivers, difficulties due to instability have been traced to feedback at the intermediate and radio frequencies, the former generally being the most troublesome. Such feedback may be due to electrostatic induction occasioned by the difference in radio frequency potential between the chassis and the common lead 11. Moreover where some circuits are connected to the common lead 11 and some to chassis, this radio frequency potential will add to the voltages already present in those circuits which are common to the lead 11 and the chassis 12. Thus in Fig. 1 it will be observed that any voltage between lead 11 and the chassis will be included in the input voltage to the vacuum tube V_1. By making the impedance of the network 15—16—17 small at the high frequencies likely to be encountered, this added undesired voltage can be reduced to a point where it is of no importance.

In an experimental radio receiver employing the present invention, and which had an intermediate frequency of 455 kc. and a broadcast range extending from 540 to 1550 kc., very satisfactory results were obtained employing a frequency discriminatory network in which the values of the elements 15, 16, and 17 were 41.5 microhenries, 0.003 microfarad, and 0.027 microfarad, respectively. The D. C. resistance of the coil 15 was about 2 ohms. Had it been necessary to employ

a 0.03 microfarad capacitor in place of the network disclosed herein, the reactance between the lead 11 and the chassis would have been about 12 ohms at the intermediate frequency, a value entirely too high for optimum receiver performance. By proper design of the network 15—16—17, this impedance may be made much less than 12 ohms. In the experimental receiver referred to above, this impedance was of the order of 3 or 4 ohms at 455 kc.

Although the invention has been described with particular reference to the embodiments of the drawing, it will be understood that the invention is capable of various forms of physical expression, and is not to be limited to the specific examples described herein.

I claim:

1. A radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits directly from electric supply mains, said energizing means including a conductive connection between said mains and said circuits, a metal housing or chassis upon which various receiver components are mounted, and a frequency discriminating network having relatively small shunt capacity connected between said chassis and one side of said mains, said network comprising at least a condenser and an inductance in series and offering a low impedance to currents of high frequency extant in said radio receiver, while simultaneously presenting a high impedance to direct current and to currents of supply mains frequencies.

2. A radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits directly from electric supply mains, said energizing means including a conductive connection between said mains and said circuits, a metal housing or chassis upon which various receiver components are mounted, and a frequency discriminating network having relatively small shunt capacity connected between said chassis and one side of said mains, said network comprising a series combination of inductance and capacity shunted by a capacity, said network offering a low impedance to currents of high frequency extant in said radio receiver, while simultaneously presenting a high impedance to direct current and to currents of supply mains frequencies.

3. A superheterodyne radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits directly from electric supply mains, said energizing means including a conductive connection between said mains and said circuits, a metal housing or chassis upon which various receiver components are mounted, and a frequency discriminating network having relatively small shunt capacity connected between said chassis and one side of said mains, said network comprising serially connected inductive and capacitive elements series resonant at the intermediate frequency of said superheterodyne radio receiver and offering thereby a low impedance to currents of intermediate frequency extant in said radio receiver, while simultaneously presenting a high impedance to direct current and to currents of supply mains frequencies.

4. A superheterodyne radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits directly from electric supply mains, said energizing means including a conductive connection between said mains and said circuits, a metal housing or chassis upon which various receiver components are mounted, and a frequency discriminating network having relatively small shunt capacity connected between said chassis and one side of said mains, said network comprising serially connected inductive and capacitive elements series resonant at the intermediate frequency of said superheterodyne radio receiver and offering thereby a low impedance to currents of intermediate frequency extant in said radio receiver, while simultaneously presenting a high impedance to direct current and to currents of supply mains frequencies, and a condenser of low capacity connected in shunt with said serially connected elements to additionally provide a low impedance path to currents of radio frequencies substantially higher than said intermediate frequency.

5. A radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits directly from electric supply mains, said energizing means including a conductive connection between said mains and said circuits, a metal housing or chassis upon which various receiver components are mounted, and a frequency discriminating network having relatively small shunt capacity connected between said chassis and one side of said mains, said network comprising at least a condenser and an inductance in series and offering a low impedance to currents of high frequency extant in said radio receiver, while simultaneously presenting a high impedance to direct current and to currents of supply mains frequencies, said radio receiver being characterized in that some of the receiver's high frequency circuits are returned to said chassis, while others are returned to said one side of said mains.

6. A radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits directly from electric supply mains, there being a conductive connection between said mains and the cathodes of the vacuum tubes employed in said circuits, a metal housing or chassis upon which the various receiver components are mounted, and an electrical network connected between said chassis and said conductive connection, said network comprising a plurality of dissimilar reactive circuit elements providing firstly a high impedance path for direct current and for currents of low frequencies, secondly a low impedance path for currents having a relatively narrow frequency range, and thirdly a low impedance path for currents having a broader frequency range, said narrow range lying outside the limits of said broader range.

7. A superheterodyne radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits directly from electric supply mains, there being a conductive connection between said mains and the cathodes of the vacuum tubes employed in said circuits, a metal housing or chassis upon which the various receiver components are mounted, and an electrical network connected between said chassis and said conductive connection, said network comprising a plurality of dissimilar reactive circuit elements providing firstly a high impedance path for direct current and for currents of power line frequency, secondly a low impedance path for currents of the receiver's intermediate frequency, and thirdly a low impedance path for currents of received signal frequencies, said last named frequencies being higher than said intermediate frequency.

8. A superheterodyne radio receiver comprising a plurality of vacuum tube circuits, means

for energizing said circuits directly from electric supply mains, there being a conductive connection between said mains and the cathodes of the vacuum tubes employed in said circuits, a metal housing or chassis upon which the various receiver components are mounted, and an electrical network connected between said chassis and said conductive connection, said network comprising a condenser in shunt with a serially connected condenser and inductance, said last-named condenser and inductance being series resonant at the intermediate frequency of said receiver, said network providing firstly a high impedance path for direct currents and for currents of the power line frequency, secondly a low impedance path for currents of the receiver's intermediate frequency, and thirdly a low impedance path for currents of received signal frequencies, said last named frequencies being higher than said intermediate frequency.

9. A radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits from electric supply mains, said receiver being operable on both alternating and direct current mains, said energizing means including a first conductive connection between one side of said mains and the cathodes of at least some of the vacuum tubes in said receiver, and including also a second conductive connection from the other side of said mains through a vacuum tube rectifier to the anodes of at least some of said vacuum tubes, and a frequency discriminating network having a relatively small shunt capacity connected between said chassis and a point on said first conductive connection, said network comprising a plurality of reactive circuit elements offering a low impedance to currents of high frequency extant in said radio receiver, while simultaneously presenting a high impedance to direct current and to currents of supply mains frequencies.

10. A superheterodyne radio receiver comprising a plurality of vacuum tube circuits, means for energizing said circuits from electric supply mains, said receiver being operable on both alternating and direct current mains, said energizing means including a first conductive connection between one side of said mains and the cathodes of at least some of the vacuum tubes in said receiver, and including also a second conductive connection from the other side of said mains through a vacuum tube rectifier to the anodes of at least some of said vacuum tubes, and a frequency discriminating network having a relatively small shunt capacity connected between said chassis and a point on said first conductive connection, said network comprising a plurality of reactive elements connected in series-parallel relation, said network being parallel resonant at a frequency other than those encountered in said receiver, but providing a low impedance path for currents of intermediate and radio frequencies extant in said receiver.

11. A radio tube receiver comprising a plurality of vacuum tube devices, means for supplying space current to said devices directly from alternating current supply mains, said space current supplying means including conductive connections between said mains and said devices, one of said conductive connections including a current rectifying means, a metal structure forming a portion of the mechanical supporting means for at least certain of the components of said radio receiver, said structure being accessible to bodily contact by an operator of said receiver, high frequency signal circuits associated with some of said vacuum tube devices, connections between some of said circuits and said metal structure, and a connection between one of said conductive connections and said metal structure for forming a portion of the high frequency signal paths between said high frequency signal circuits and said vacuum tube devices, said last-named connection comprising a plurality of dissimilar reactive circuit elements for providing between said chassis and said mains a tuned low capacity connection having low impedance to currents of high frequency extant in said receiver, while simultaneously presenting a high impedance to alternating currents of the supply mains frequency, thereby to substantially eliminate the hazard of dangerous shock to the operator.

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