July 11, 1933. W. P. PLACE 1,917,898

RADIO APPARATUS

Filed Aug. 25, 1932

Fig.1.

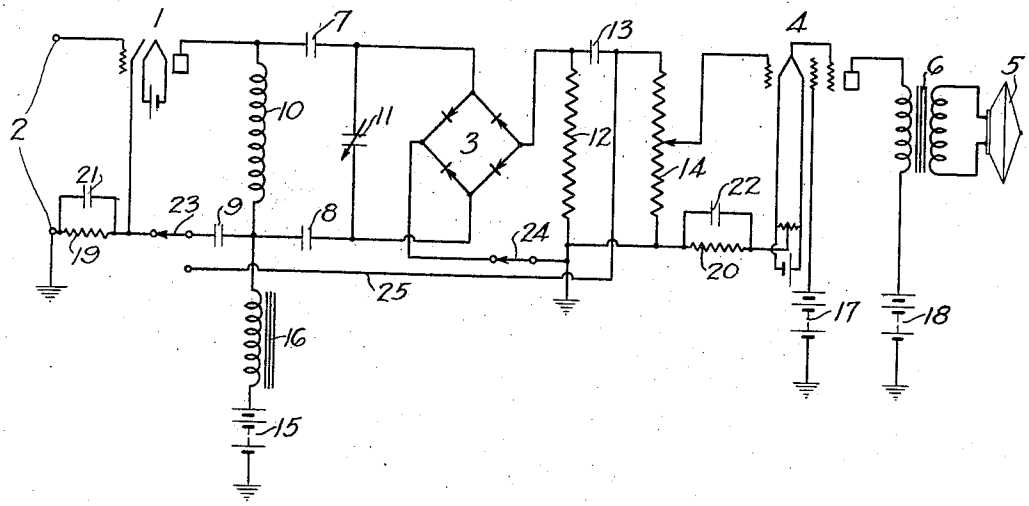
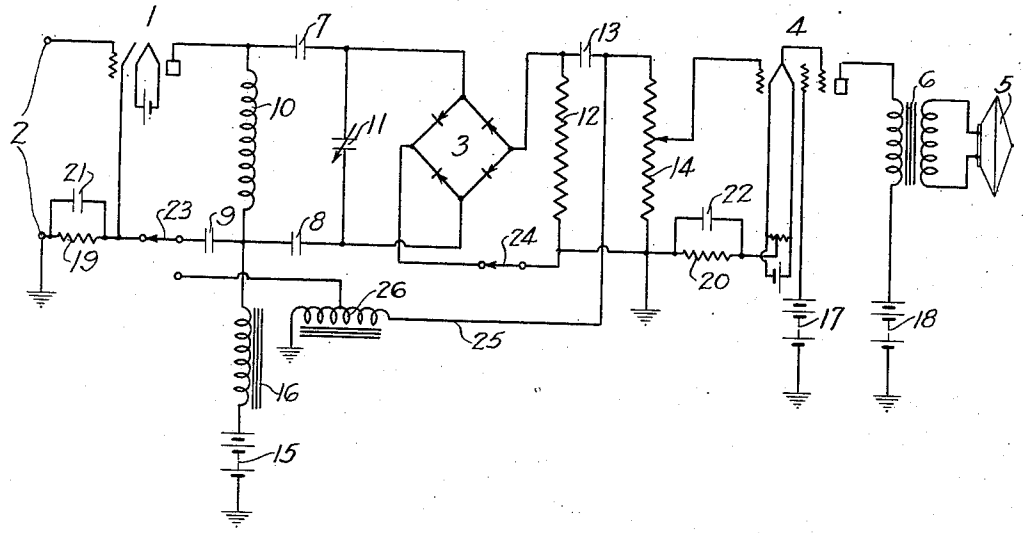


Fig.2.



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UNITED STATES PATENT OFFICE

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RADIO APPARATUS

Application filed August 25, 1932. Serial No. 630,435.

My invention relates to an electrical circuit adapted for optional use either as a radio receiver employing a metal oxide rectifier as a detector or as an amplifying and reproducing unit for attachment to phonographs or the like. The new circuit requires but few elements in addition to those employed during radio reception and may be readily converted from a radio receiver to an amplifier and reproducer for photographs by manipulation of simple throw-over switches.

When it is desired to use elements of the conventional type of radio receiver for amplifying and reproducing a phonograph record, the magnetic pick-up of the phonograph is connected with the detector tube of the receiving circuit so as to cause that tube to operate as an audio frequency amplifier; the amplification effected thereby together with that effected by the usual additional stage of amplification preceding the power tube, providing sufficient amplification for the relatively low voltage delivered by the magnetic pick-up. This method is predicated upon the inclusion of a tube type of detector and of a stage of audio frequency amplification in the radio receiver. Recently there has been developed a new type of radio receiver which utilizes a full wave metal oxide rectifier as a detector and requires no audio frequency stage of amplification; the rectifier preferably feeding directly into a power tube connected to the loud speaker. Thus the usual method above described for converting a radio receiver into an amplifier and reproducer is not applicable to this new type of receiver because there would be insufficient amplification if the magnetic pick-up were connected directly to the input terminals of the power tube. A step-up transformer between the pick-up and power tube, while increasing the volume, would result in a considerable sacrifice in the quality of reproduction and would increase the load on the pick-up with consequent undue record wear.

The circuit of the present invention makes possible the conversion of a radio receiver utilizing a metal-oxide rectifier into an amplifying and reproducing unit for phonographs while insuring sufficient volume of reproduction without loss in quality or undue record wear and without the provision of an additional stage of amplification. In the new circuit the additional audio frequency amplification required for phonographic reproduction is obtained by causing a tube which operates as a radio frequency amplifier during radio reception to be operated as an audio frequency amplifier when the circuit is connected to the magnetic pick-up; the circuit connections being such that the rectifier serves simply as a negligibly small capacity path to ground during phonographic reproduction.

For a better understanding of the invention reference may be had to the accompanying drawings of which:

Fig. 1 represents diagrammatically a radio receiving circuit which, when converted into an amplifying and reproducing unit for phonographs includes a single stage of audio amplification between the phonograph and power tube; and

Fig. 2 represents diagrammatically a circuit substantially similar to that of Fig. 1 but including also a step-up transformer operable when the circuit is used for reproduction to increase the volume of sound delivered by the loud speaker.

The circuit of Fig. 1 includes the amplifier 1, having its control grid and cathode connected across the input terminals 2 of the circuit, the full wave metal oxide rectifier 3 and the power tube 4, the output circuit of which is coupled to the loud speaker 5 by means of a transformer 6. The anode of tube 1 is connected through a capacity 7 with one input terminal of the rectifier; the other input terminal of the rectifier being connected to the cathode of tube 1 through capacities 8 and 9. A radio frequency choke coil 10, offering negligible impedance to currents of audio frequency has one end connected to the plate of tube 1 and its other end connected intermediate capacities 8 and 9. A variable capacity 11, connected across the input terminals of rectifier 3, serves, together with coil 10, to compensate for the inherent capacity of the rectifier.

A resistor 12 grounded at one end, is con-

nected across the output terminals of rectifier 3 to dissipate the steady direct current corresponding to the rectified carrier wave when the circuit is used as a radio receiver. A capacity 13 and a potentiometer resistance 14 are connected in series across resistance 12 to provide a branch for the alternating component of the rectifier output current corresponding to the modulation current. The adjustable tap along potentiometer 14 is connected to the control grid of power tube 4. A battery 15, having its positive terminal connected through an iron cored inductor 16 to the end of inductor 10 connected to capacities 8 and 9 supplies plate voltage to tube 1 and batteries 17 and 18 supply positive potentials to the screen grid and anode respectively of tube 4. Inductor 16 has a negligible direct current resistance and a practically infinite alternating current reactance. Batteries 15, 17 and 18 are each grounded at their negative terminals and the cathodes of each of tubes 1 and 4 are connected to ground through grid biasing resistors 19 and 20 respectively. Capacities 21 and 22 for by-passing high frequency currents bridge resistors 19 and 20, respectively.

When a high frequency voltage corresponding to a modulated carrier wave is impressed across terminals 2, it is amplified by tube 1, operating as a radio frequency amplifier, and delivered to rectifier 3 through the medium of inductance 10 and capacities 7, 11 and 8. The alternating component of pulsating direct current output of the rectifier is conducted by capacity 13 to potentiometer 14. A controllable portion of the voltage across potentiometer 14 is applied to the control grid of the tube 4 for transmission to the loudspeaker 5.

As capacity 9 by-passes inductance 16 by providing an alternative path to ground for the radio frequency currents, inductance 16 has no effect upon the operation of the circuit when used as a radio receiver.

In order to make the above receiving circuit readily convertible into an amplifier and reproducer for phonographs it is only necessary to break the circuit at two points, namely between the cathode of tube 1 and capacity 9 of rectifier 3 and the grounded end of resistor 12 and to connect the ungrounded end of potentiometer 14 with the side of capacity 9 formerly connected to the cathode of tube 1. Switches 23 and 24 and a conductor 25 are provided for effecting these changes. Switch 23, which is a single pole double throw switch, has its movable contact connected to one side of capacity 9, one of its fixed contacts connected to the cathode of tube 1 and the other of its fixed contacts connected to one end of conductor 25; the other end of the conductor 25 being connected to the ungrounded end of potentiometer resistance 14. Switch 24 is inserted in the connection between one output terminal of the rectifier and the grounded end of resistor 12.

When switch 24 is opened and switch 23 thrown to connect conductor 25 with capacity 9, the circuit will operate to amplify audio frequency voltage applied to terminal 2. Thus, with terminal 2 connected to the magnetic pick-up of a phonograph, tube 1 operates as an audio frequency amplifier and the alternating voltage appearing at the anode thereof is applied directly to potentiometer resistence 14 by means of inductor 16 and capacity 9.

Power tube 4 then further amplifies a controllable portion of the voltage across potentiometer 14 and delivers it to the loud-speaker through transformer 6. As inductor 10 offers practically negligible reactance to audio frequency currents, capacity 9 may be considered as if directly connected with the anode of tube 1. The part of the circuit made up of capacities 7, 8 and 11 and of rectifier 3 has no effect upon the remainder of the circuit except to provide a negligibly small capacity path to ground through resistor 12.

The circuit of Fig. 2 differs from that of Fig. 1 only in that an auto-transformer 26 is connected in lead 25; one end of the transformer being connected to the ungrounded end of resistor 14, the other end of the transformer being grounded and the mid point thereof being connected to the fixed contact of switch 23. The secondary inductance of transformer 26 is high enough so that no appreciable loss of audio frequency voltage applied to potentiometer 14 will occur when the circuit is used as a radio receiver. When used as an audio frequency amplifier and reproducer for phonograph transformer 26 serves to step-up the voltage applied to the power tube and hence to increase the available range of audio amplification.

It will be apparent from the above description that a radio receiver utilizing a metal oxide type of rectifier and having no stage of audio frequency amplification preceding the power output tube, in accordance with the invention may be readily converted into an amplifier and reproducer for phonographs by the addition of few elements, namely a pair of switches and an inductor having high alternating current impedance and negligible resistance and, if desired, an auto transformer for increasing the range of amplification; the additional elements being so included in the circuit as not to interfere with the proper operation of the circuit when used as a radio receiver and as to cause a tube normally operating as a radio frequency amplifier to perform as an audio frequency amplifier when the circuit is used for phonographic reproduction.

The new radio receiving circuit disclosed

herein forms the subject matter of other applications filed by me as follows—Serial No. 540348, filed May 27, 1931, Serial No. 566407, filed Oct. 2, 1931, Serial No. 569480, filed Oct. 17, 1931, Serial No. 633273, filed Sept. 15, 1932; the present application being directed to the combination with such receiver of elements which make possible its use either as a receiver or as an amplifying and reproducing unit.

Although I have herein shown and described only two forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. A radio receiver including an amplifier, a full wave metal oxide rectifier coupled to the output circuit of said amplifier and a power tube coupled to the output circuit of said rectifier, and manually operable means in the output circuits of said amplifier and of said rectifier adapted when operated to convert said circuit into an amplifying and reproducing unit for phonographs with said amplifier serving as an audio frequency amplifier and said rectifier effectively by-passed.

2. A radio receiver according to claim 1 wherein the plate circuit of said amplifier includes an inductor of negligible direct current resistance and high alternating current impedance and the output circuit of said amplifier includes a capacity normally providing a by-pass for alternating currents about said inductor, said manually operable means in the amplifier output circuit serving when operated to connect the plate of said amplifier to the input of said power tube through said capacity.

3. An electric circuit adapted for use as a radio receiver and convertible into an amplifier and reproducer for phonographs or the like comprising in combination an amplifying tube, a metal oxide rectifier coupled to the output circuit of said tube, a power tube coupled to the output circuit of said rectifier and a reproducer coupled to the output circuit of said power tube, an inductor in the plate circuit of said amplifying tube and a capacity having one side connected to the low potential side of said inductor and its other side adapted for connection to the cathode of said amplifying tube to by-pass alternating currents about said inductor during operation of said amplifying tube as a radio frequency amplifier and of said circuit as a radio receiver or for connection to the input circuit of said power tube to impress alternating voltages of audio frequency amplified by said amplifying tube upon said power tube during operation of said circuit as an amplifier and reproducer for phonographs, the output circuit of said rectifier being adapted to be opened during operation of said circuits as an amplifier and reproducer.

4. An electric circuit according to claim 3 including an auto transformer connected to the input circuit of said power tube, said capacity when disconnected from the cathode of said amplifier being connected through said transformer with the input circuit of said power tube whereby the alternating voltages amplified by said amplifier are stepped up by said transformer and impressed upon said power tube when the circuit is used as an amplifying and reproducing unit.

5. An electric circuit comprising in combination an amplifier, a metal oxide rectifier having its input terminals coupled to the output circuit of said amplifier, the output circuit of said rectifier being divided into two branches, one for the dissipation of the steady direct current component and one for the alternating current component of the rectifier output corresponding respectively to the carrier current and to the modulation current when a modulated carrier wave is impressed upon said amplifier, a switch in the output circuit of said rectifier adapted when open to disconnect one output terminal of said rectifier from said branches, a power tube, means for impressing upon said power tube a controllable portion of the voltage across said alternating current branch and a reproducer coupled to the output circuit of said power tube, a source of plate potential for said amplifier and two inductors connected in series between said source and the plate of said amplifier, a capacity having one side connected to the plate circuit of said amplifier intermediate said conductors and manually operable means for connecting the other side of said capacity either to the cathode of said amplifier to provide a by-pass for alternating current about one of said inductors or to the said alternating current branch of the rectifier ouput circuit, the rectifier being connected across the other of said inductors whereby when said switch in the rectifier output circuit is closed and said capacity is connected to the cathode of said amplifier the circuit operates as a radio receiver and when said switch is open and said capacity is connected to said alternating current branch said circuit operates as an audio frequency amplifier and reproducer.

In testimony whereof I affix my signature.

WILLARD P. PLACE.