April 10, 1934. W. P. PLACE 1,954,059

RADIO RECEIVING APPARATUS

Original Filed Oct. 17, 1931

FIG. 1.

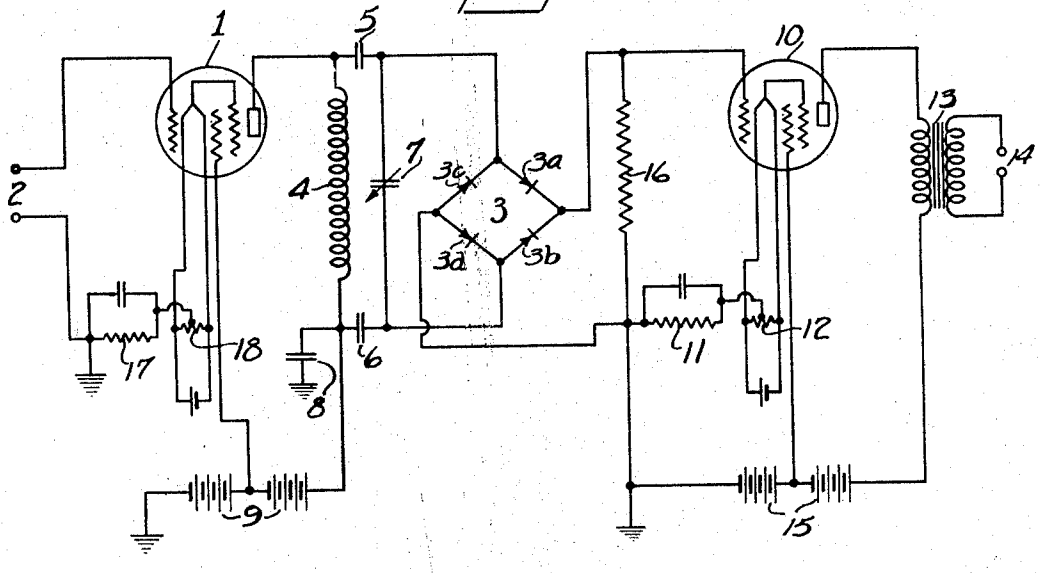
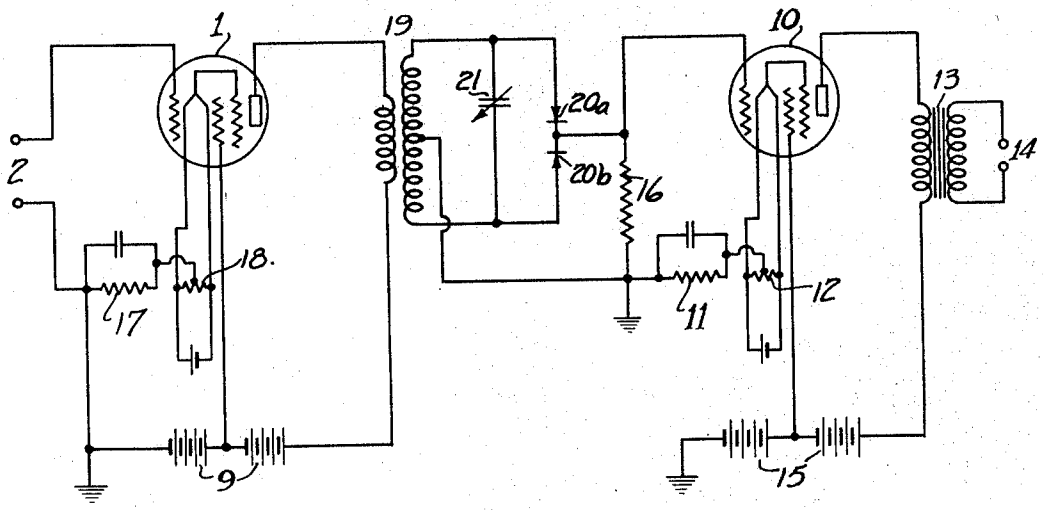


FIG. 2.



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RADIO RECEIVING APPARATUS

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6 Claims. (Cl. 250—30)

My present invention relates to an improved detector circuit for radio receivers adapted to be inserted between a high frequency stage of amplification and the output tube of the receiver, making possible the omission of the usual stage of audio frequency amplification. The circuit of the present invention is in some respects an improvement upon, and in other respects a modification of, detecting circuits described and claimed in my copending applications Serial No. 540,348, filed May 27, 1931, and Serial No. 566,407, filed October 2, 1931.

In the circuit of the present invention as in those described in the applications above referred to, a metal oxide type of rectifier is employed in place of the usual detector tube, the metal oxide rectifier being connected for full wave rectification of the amplified radio frequency wave. The present circuit includes also means for maintaining the effective alternating current resistance of the detecting circuit substantially constant throughout any predetermined range of radio frequency voltages to insure reproduction of the modulation current without distortion.

For an understanding of the invention, reference may be had to the accompanying drawing, of which Fig. 1 is a circuit illustrating the preferred form of the invention in which choke coil coupling to the preceding amplifier is employed, and Fig. 2 illustrates another detecting circuit in which transformer coupling to the preceding rectifier is employed.

In Fig. 1 a radio frequency amplifier is indicated at 1 and shown as connected to input terminals 2 which may be assumed to be connected with preceding radio frequency stages of amplification. In the particular embodiment of the invention illustrated, tube 1 is a five-element tube, but other types of amplifiers could be employed if desired. A metal oxide rectifier 3 comprising elements 3*a*, 3*b*, 3*c* and 3*d* arranged in the form of a Wheatstone bridge network, has the input terminals thereof connected to opposite ends of a choke coil 4 serving to couple the rectifier to the amplifier 1. Capacities 5 and 6 in the leads connecting the rectifier with the choke coil 4 serve to prevent the passage of direct current to the rectifier. A variable capacity 7 bridged across the input terminals of the rectifier 3 serves, together with the inductance of coil 4, to balance out the effective capacity of the rectifier and gives parallel resonance to the output circuit of tube 1. One end of coil 4 is connected to the plate of tube 1 and the other end is grounded through a capacity 8 and connected to the positive terminal of a battery 9 serving as a source of potential for the plate of tube 1 and for the screen grid thereof.

The direct current output terminals of the rectifier 3 are connected across an output tube 10; the high potential side of the rectifier being connected to the control grid of this tube and the low potential side being grounded and connected through an automatic grid biasing resistor 11 and center tapped cathode bridging resistor 12 with the cathode of this tube.

Tube 10 is coupled by a transformer 13 with output terminals 14 of the circuit, which terminals may be connected directly with a loud speaker or other reproducing device. The plate and screen grid of tube 10 are supplied with positive potential by a battery 15 grounded at its negative terminal.

With the circuit so far described, the impedance of the rectifier may be considered as a resistance for the capacity thereof is balanced out by coil 4 and capacity 7. The resistance of the rectifier, however, decreases as the voltage impressed upon tube 1 increases, with the result that if no other resistance were present, there would be a certain amount of distortion in the signal transmitted. To eliminate this distortion a resistor 16 of a value large compared to that of the rectifier is bridged across the output terminals thereof. As the impedance of tube 10, so far as the detector circuit is concerned, may be considered from a practical standpoint as infinite, the provision in the rectifier output circuit of the relatively large resistance 16 eliminates any substantial variation of the resistance of this circuit with change of input voltage and thus insures substantially distortionless reproduction. When a circuit comprised of resistance, inductance and capacity is tuned to parallel resonance, the effective resistance offered to alternating current of resonance frequency is usually very different from any resistance in the circuit which can be measured by direct current. It is this effective alternating current resistance which is maintained substantially constant by the shunting resistor 16.

In operation of the circuit of Fig. 1, tube 1 amplifies the modulated high frequency voltage impressed upon the terminals 2 by the preceding stage or stages of amplification of the receiver. The direct current component of the amplified wave is forced through the choke coil 4 by the capacities 5 and 6 which are of such value as to offer but small impedance to high frequency current while blocking any direct current to the rectifier. Rectifier 3 transforms the high frequency current

impressed thereon to varying direct current of the modulation frequency, and, together with the resistor 16, offers substantially constant resistance thereto. Tube 10 amplifies the modulation current and, through transformer 12, delivers it to the output terminals 14. Resistor 11, which is in the output circuit of tube 10, increases the grid bias of this tube with increase in plate current thereof and thus insures operation of the tube at the best part of its characteristics. The grid bias of tube 1 is similarly automatically adjusted with variation in the magnitude of the direct current output therefrom by a resistor 17 grounded and connected to one input terminal 2 at one end and connected through the center tapped resistor 18 with the cathode of tube 1.

The utility of the shunting resistor 16 is maintaining substantially constant the direct current resistance of the metal oxide rectifier circuit does not depend upon the particular manner in which the rectifier is connected in the circuit with the preceding amplifier. Resistor 16 may be advantageously employed, for example, in the circuit of Fig. 2 in which the metal oxide rectifier is coupled by a transformer 19 to tube 1 and the rectifier, instead of being in the form of a Wheatstone bridge network, comprises but two elements 20*a* and 20*b*, having their input sides connected to opposite ends of the secondary of transformer 19 and their output sides connected to the cathode of tube 10; resistor 16 being connected between the output sides of the rectifier elements and the grounded midpoint of the secondary transformer 19. A variable capacity 21, serving the purpose of capacity 7 of Fig. 1, is bridged across the secondary of transformer 19. The metal oxide rectifier when connected as shown in Fig. 2 operates as a full wave rectifier as during each half of the cycle of the amplified incoming wave one or the other end of the secondary of transformer 19 will be at a high potential relative to the grounded midpoint thereof and will have a low resistance path through one or the other of elements 20*a* and 20*b* to the control grid of tube 10. As in Fig. 1, the negative bias of the control grids of tubes 1 and 10 will be automatically adjusted by the resistors 17 and 11 respectively in a direction to increase the bias on each tube with increase in plate current therefrom. Also, as in Fig. 1, the provision of the shunting resistor 16 of a value relatively large as compared with the resistance offered by the rectifier elements, insures substantially constant effective alternating current resistance of the rectifier circuit with change in voltage of the incoming wave.

In so far as the detector circuit is concerned, the particular arrangement illustrated in Fig. 1 is preferred because direct coupling, as by the coil 4, is apt to be more efficient than transformer coupling and because with the bridge type of rectifier, a lower radio frequency voltage is required for a given output from the rectifier than is the case when the two-legged rectifier of Fig. 2 is employed, and since instability of a radio frequency amplifier is largely caused by electrostatic feedback from the latter stages to the input owing to imperfect shielding, it is advantageous to keep the radio frequency voltage relatively low.

The preferred form of the invention, together with one modification thereof, has now been described. Obviously the invention is not limited to the particular circuits illustrated, as these might be modified considerably without departing from the invention which is primarily directed to the provision of means for insuring substantially constant direct current resistance of a detector circuit of the type employing a metal oxide rectifier in place of the usual tube detector.

The following is claimed:

1. In a detecting circuit for radio receivers of the type employing a metal oxide rectifier in place of the usual tube detector, the combination with the rectifier of a shunting resistor connected across the output circuit of the rectifier and having a resistance relatively high compared to the direct current resistance of the rectifier whereby the input resistance of the rectifier circuit is maintained substantially constant irrespective of the magnitude of the voltage impressed thereupon.

2. A detecting circuit for radio receivers comprising in combination, a radio frequency amplifier, a bridge type metal oxide rectifier coupled thereto, an output tube connected across the direct current terminals of the rectifier and a resistor shunted across the direct current terminals of said rectifier of a value sufficient to maintain the input resistance of the rectifier circuit substantially constant irrespective of the voltage impressed thereupon by said amplifier.

3. A detecting circuit according to claim 2 wherein means are provided between said amplifier and said rectifier for balancing out the inherent capacity of said rectifier and the resistor maintains substantially constant the effective alternating current resistance of the rectifier circuit.

4. A detecting circuit for radio receivers comprising in combination, a radio frequency amplifier, a full wave metal oxide rectifier coupled thereto, an output tube connected across the output terminals of said rectifier, a tunable circuit including a variable capacity connected across the input terminals of said rectifier for balancing out the inherent capacity thereof, a resistor shunted across the output terminals of said rectifier, and means associated with the output circuits of said amplifier and of said tube for automatically adjusting the negative bias of the respective control grids thereof in response to the output currents therefrom.

5. A detecting circuit for radio receivers including in combination, a radio frequency amplifier, a source of plate potential therefor, a choke coil connected between said source and the plate of said amplifier, a bridge type metal oxide rectifier, conductors connecting the input terminals of said rectifier with opposite ends of said coil, a condenser in each of said conductors for preventing the passage of direct current to said rectifier, a variable capacity shunted across the input terminals of said rectifier serving with said coil to balance out the effective capacity of said rectifier, an output tube connected across the direct current output terminals of said rectifier and a resistor connected across the direct current terminals of said rectifier for maintaining the effective alternating current resistance of the rectifier circuit substantially constant during change in the voltage impressed across said coil by said amplifier.

6. A detector circuit for radio receivers comprising in combination, a radio frequency amplifier, a transformer having the primary thereof connected in the output circuit of said amplifier, a rectifier comprising two elements having their input sides connected to opposite ends of the secondary of said transformer, a variable capacity connected across the secondary of said transformer, an output tube having the control

grid thereof connected to the output sides of the elements of said rectifier and the cathode thereof connected to the midpoint of the secondary of said transformer and a resistor connected between the output side of the elements of said rectifier and the midpoint of the secondary of said transformer for maintaining the effective alternating current resistance of the rectifier circuit substantially constant during change in the voltage impressed upon said transformer by said amplifier.

WILLARD P. PLACE.