

Dec. 17, 1935.

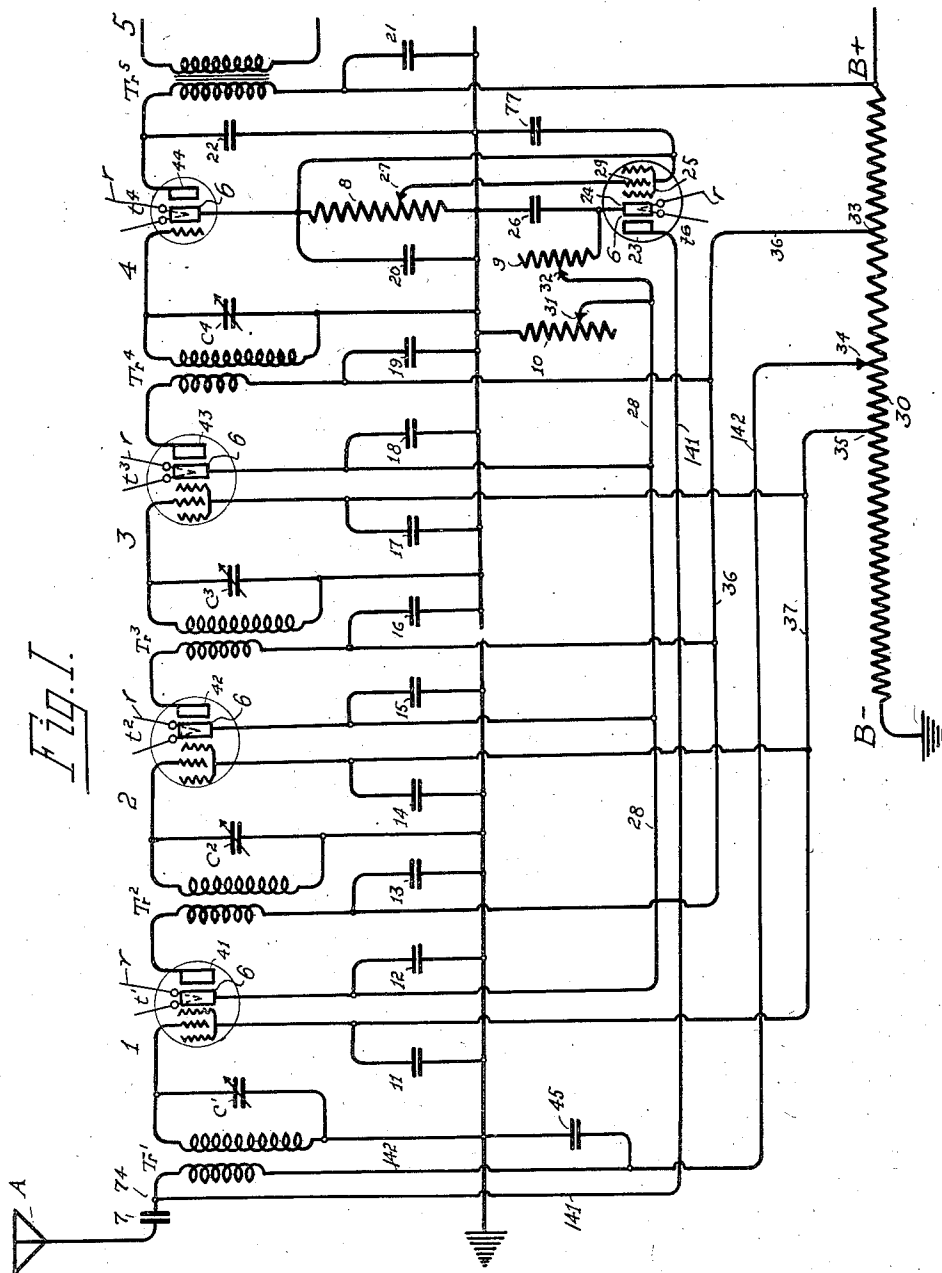
J. H. PHILIPS

2,024,181

RECEIVING SYSTEM

Filed March 3, 1930

2 Sheets-Sheet 1



Inventor
J. H. Philips.
By C. Soper
Attorney

Dec. 17, 1935.

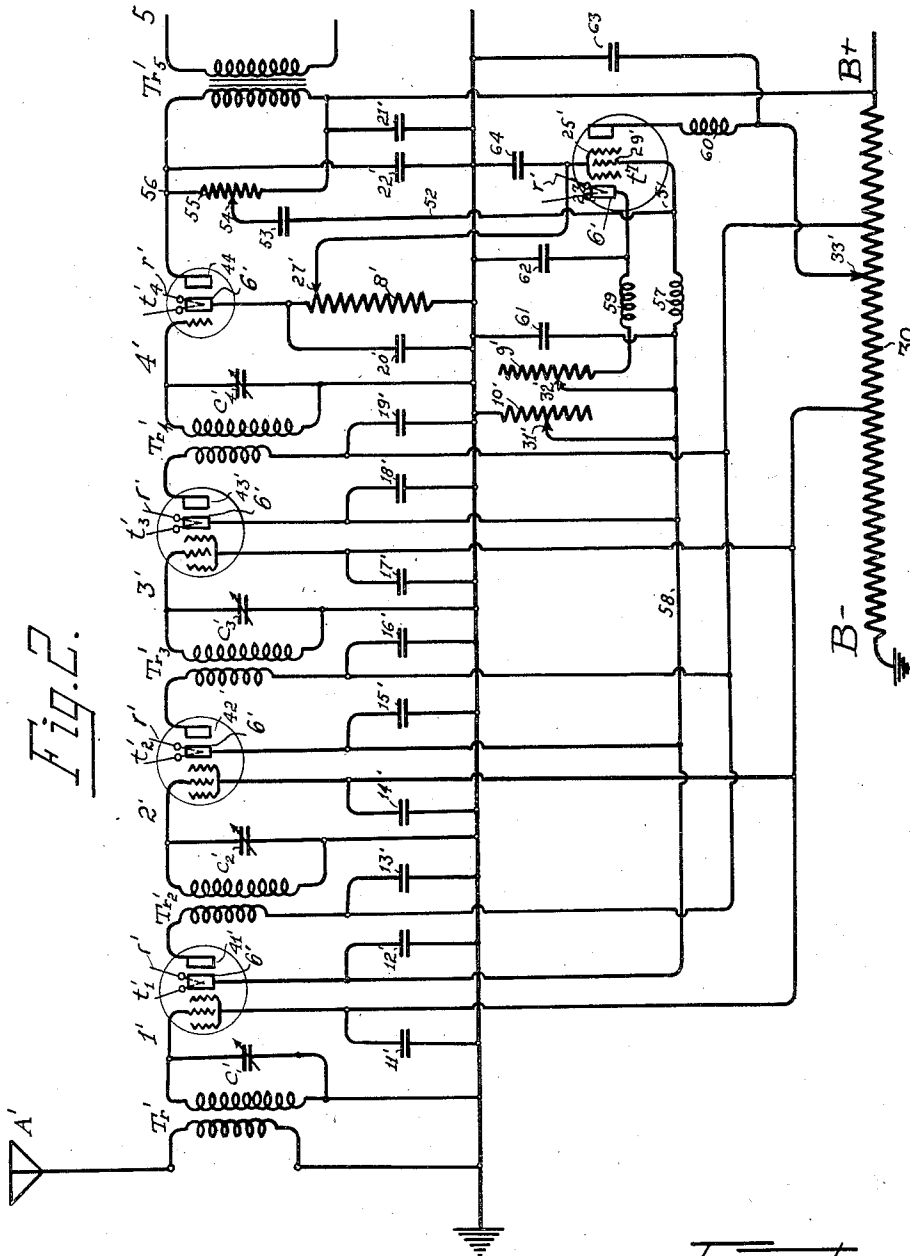
J. H. PHILIPS

2,024,181

RECEIVING SYSTEM

Filed March 3, 1930

2 Sheets-Sheet 2



Inventor
J. H. Philips.
By C. Soper
Attorney.

UNITED STATES PATENT OFFICE

2,024,181

RECEIVING SYSTEM

James Herbert Philips, Oak Park, Ill., assignor to
Kellogg Switchboard and Supply Company,
Chicago, Ill., a corporation of Illinois

Application March 3, 1930, Serial No. 432,661

9 Claims. (Cl. 250—20)

My invention relates to radio receiving circuits and more particularly to an improved system of automatically and manually controlling the output of a radio frequency amplifier.

5 A feature of my invention is the utilization of the variable voltage drop across a resistance in the plate circuit of the detector vacuum tube to control the bias of the preceding radio frequency amplifier tubes through the instrumentality of
10 an auxiliary volume control tube of the type having a shielded grid and an unipotential indirectly heated cathode.

Another feature of my invention is the association of the cathode of the volume control tube with the biasing resistance of the radio frequency amplifier and of the grid and the grid screen of the volume control tube with the detector tube biasing resistance thus rendering the voltage drop across the radio frequency biasing resistance dependent upon the plate current of the detector tube.

Another feature of my invention is the alternative of associating the grid screen of the volume control tube with the detector tube biasing resistance and of the grid of the volume control tube with the plate of the detector tube through the instrumentality of a condenser while the cathode of the volume control remains as before associated with the biasing resistance of the radio frequency amplifier tubes.

Another feature of my invention is the association of the anode of the volume control tube with the antenna in shunt with the primary of the first radio frequency transformer, while
35 its grid and screen remain associated, as aforesaid, with the detector tube biasing resistance thus permitting the volume control tube to shunt a portion of the incoming signal energy the amount shunted being dependent upon the value
40 of the detector tube plate current.

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

45 Fig. 1 illustrates diagrammatically my volume control system as applied to an exemplary radio receiving circuit; and

Fig. 2 represents a modification of my volume control system as applied to an exemplary radio receiving circuit.

50 Referring to Fig. 1, it will be seen that I have illustrated a radio receiving circuit having three radio frequency stages designated respectively 1, 2 and 3, one detector stage designated as 4, and one audio frequency stage 5 of which only the
55 audio transformer Tr^5 is shown in the drawings.

The radio frequency stages 1, 2 and 3 include the vacuum tubes t' , t^2 and t^3 , respectively, said tubes being of the type having a grid screen and an equipotential indirectly heated cathode. They further include the air core coupling transformers
5 Tr' , Tr^2 and Tr^3 associated with the vacuum tubes t' , t^2 and t^3 so as to form a cascade amplifier in the usual manner.

The detector tube t^4 which differs from the preceding tubes by the fact that it has no grid screen,
10 is coupled to the last radio frequency tube t^3 through a similar transformer Tr^4 . The secondary windings of each of the coupling transformers Tr' , Tr^2 , Tr^3 and Tr^4 are shunted by respective variable gang controlled condensers C' , C^2 , C^3 and
15 C^4 for the purpose of tuning. Condensers 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and 21, linking the grid screen, the cathodes and the primaries of the coupling transformers of each of the four stages under consideration, are by-pass con-
20 densers for the purpose of preventing undesirable regeneration. Condenser 22 linking the plate circuit of the detector tube to ground is the usual detector by-pass condenser for the radio frequencies. The cathodes 6 of the tubes t' , t^2 and
25 t^3 of the radio frequency amplifier are linked to ground in addition by their common biasing resistance 10 through the common lead 28 and slide contact 31. The cathode 6 of the detector tube t^4 is linked to ground also by its biasing resist-
30 ance 8. The resistance elements r are connected to a source of electrical current (not shown) and serve as heaters for the cathodes 6.

Proper polarizing or energizing potentials for the electrodes of the vacuum tubes are obtained
35 from the resistance strip 30 between the power supply terminals $B+$ and $B-$, the latter being identical with ground. Thus, tap 33 on the resistance strip 30 energizes the anodes 41, 42 and 43 of the tubes t' , t^2 and t^3 through the primaries of
40 their respective coupling transformers and common lead 36, the anode 44 of the detector tube t^4 being energized directly from the positive terminal $B+$ through the primary of audio transformer Tr^5 . Tap 35 on the resistance strip serves to
45 polarize the grid screens of tubes t' , t^2 and t^3 through common lead 37.

As the operation of a cascade connected amplifier is well known, we shall not enlarge upon it further than to state that after being picked by
50 the antenna A the signal is impressed first upon the first radio frequency transformer Tr' across the condenser 7 whose function will be indicated hereafter.

From the transformer Tr' and the resonating 55

circuit formed by its secondary and condenser C', the signal frequencies are communicated to the grid of the first tube t^1 where their amplitude or volume is increased and from where they are transmitted in the usual manner to tube t^2 across transformer Tr², and further to tube t^3 across transformer Tr³ the volume of the signal increasing in each consecutive stage of the radio frequency amplifier until it reaches the detector tube t^4 where it is rectified and transmitted further in the form of audio frequencies.

Coming now to the volume control system, it will be observed that it includes the vacuum tube t^6 which is of the type provided with a grid screen 25 and an indirectly heated equi-potential cathode 24, the latter communicating with grid 29 across resistances 9 and 10 consecutively through the instrumentality of slide contacts 32 and 31, both of which resistances serve as a biasing resistance for tube t^6 , the second (10) being moreover the common biasing resistance of the radio frequency amplifier tubes as previously indicated. The anode 23 derives its energizing potential from the resistance strip 30 through the instrumentality of slide contact 34, the intermediate connections being formed to lead 141, the primary of first radio frequency transformer Tr' and lead 142. The grid 29 of volume control tube t^6 communicates with the detector biasing resistance 8 through slide contact 27, the grid screen 25 being connected to the positive end of said biasing resistance 8.

To understand the operation of tube t^6 it should be noted that it is adjusted with the help of slide contact 32, varying biasing resistance 9 to furnish plate rectification, as a result of which grid voltage variations would cause a variable unidirectional current to flow in the plate circuit in the direction from cathode 24 to ground across biasing resistances 9 and 10, thus varying the bias of the radio frequency amplifier tubes t^1 , t^2 and t^3 . The grid voltage variations in my system are derived from the current variations in the detector biasing resistance 8, more exactly they are due to the variable voltage drop in the portion of resistance 8 comprised between the position of slide contact 27 and ground. Assuming that the receiver is delivering an output volume of a certain predetermined value, an increase in the amplitude of the signal will result in an increased voltage drop in the detector tube biasing resistance 8 and consequently in an increased unidirectional current in the plate circuit of tube t^6 , as result of which the voltage drop across common biasing resistance 10 will increase thus increasing the negative bias of the radio frequency amplifier tubes t^1 , t^2 and t^3 and reducing their output volume. A decrease in the strength of the signal will in a similar manner have the reverse effect of decreasing the radio frequency amplifier bias and increasing the output volume of the same. Since the grid screen 25 like the grid 29, is connected across the detector biasing resistance 8, its effect upon the plate current of tube t^6 will be similar to that of the grid, only modified by virtue of its greater distance from the cathode and by the fact that it is connected across the whole of the detector biasing resistance 8.

The desired strength of the signal can be predetermined manually by varying common biasing resistance 10 through the instrumentality of slide contact 31. It can also be controlled by moving slide contact 32 over biasing resistance 9 of tube t^6 , or slide contact 27 over detector biasing resistance 8, the effect being that of varying

the bias of tube t^6 , thus varying its plate current and the biasing effect of said plate current upon the radio frequency amplifier tubes. It can be further regulated or adjusted by moving slide contact 34 over the resistance strip 30 thus changing the anode to cathode voltage and the plate current of tube t^6 .

An additional automatic volume control is provided by passing the plate current of tube t^6 through the primary of first radio frequency transformer as previously indicated through lead 141 and tap 74 on the incoming side of the primary. The effect of this connection is that of diverting a portion of the signal energy incoming from the antenna through tube t^6 over lead 141 instead of all of it being impressed upon the transformer Tr'. The amount of energy diverted will vary inversely as the internal resistance of tube t^6 , the latter varying inversely as the grid potential of tube t^6 . Thus, as a greater signal strength will impress a larger positive potential on the grid of tube t^6 , as previously explained it will reduce the resistance of tube t^6 and divert a larger amount of energy from the antenna through tube t^6 thus reducing the input into the amplifier and consequently its output. A diminished signal strength will result in smaller grid voltage variations in tube t^6 and in a smaller amount of energy shunted by said tube.

Condensers 26 and 77 linking the cathode and the grid screen of tube t^6 to ground and condenser 45 linking lead 142 associated with the primary of transformer Tr' to ground, serve to by-pass undesirable radio frequencies and reduce regeneration.

The function of condenser 7 interposed between the antenna A and tap 74 is to prevent the voltage due to connection of tap 34 to the resistance strip 30 from being impressed upon the antenna. It serves also as an antenna compensator.

Referring now to Fig. 2 it will be seen that the amplifier and detector circuits here shown are similar to those of Fig. 1. Its volume control circuit contains a tube t^7 which is of a type similar to tube t^6 in Fig. 1. It will be noted that the grid screen 25' of tube t^7 instead of having a fixed connection across the detector biasing resistance 8', as was the case in Fig. 1, communicates with the latter through slide contact 27', thus being made to perform a function similar to grid 29 in tube t^6 , Fig. 1.

The grid 29' of tube t^7 is associated with the anode of the detector tube through tap 51, lead 52, condenser 53, slide contact 54, resistance 55 and tap 56. Its grid to cathode circuit is made up of choke coil 57, lead 58, slide contact 32', biasing resistance 9', choke coil 59 and cathode 23'. The biasing resistance 9' may be adjusted to furnish plate rectification. As was the case in Fig. 1, the cathode 23' of tube t^7 communicates with ground across biasing resistances 9' and 10', the latter being the common radio frequency amplifier biasing resistance. As result of this arrangement the bias of the amplifier tubes t^1 , t^2 and t^3 can be varied by the plate current of tube t^7 . The purpose of choke coils 57, 59 and 60, included in the plate and grid circuits of tube t^7 , and of the condensers 61 and 62 and 63 linking said circuits to ground is that of filtering out radio frequencies which otherwise may be reintroduced into the amplifier through biasing resistance 10' and common lead 50. Condenser 64 linking the grid screen 25' to ground performs a similar function.

With the connections as described, the opera-

tion of tube t^7 is similar to that of t^6 in Fig. 1. Both audio and radio frequencies are communicated to the grid 29' by virtue of its being linked to the anode of the detector tube through condenser 53 and variable resistance 55 as described. Said resistance 55 shunts the primary of audio transformer Tr' 5. Similarly, audio frequencies are communicated to the grid screen 25' by virtue of it being connected across the detector biasing resistance 8'. These incoming potential variations of the grid and grid screen cause a variable rectified current to flow in the plate circuit of tube t^7 which, as aforesaid, by passing through common biasing resistance 10' imparts an additional bias upon the radio frequency amplifier tubes t^1 , t^2 and t^3 . Consequently any increase or decrease in the amplitude of the signal oscillation will be automatically counteracted by an increase or decrease of the plate current of tube t^7 and of the bias of the radio frequency amplifier tubes.

The manual control of the volume output of the amplifier can be affected either through slide contact 31' associated with common biasing resistance 10', through slide contact 32' associated with the biasing resistance 9' of tube t^7 , through slide contact 54 associated with resistance 55 shunting the primary of the audio frequency transformer, or through slide contact 33' regulating the voltage impressed upon the anode of t^7 .

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

1. In a space discharge system including cascade connected audion tubes, a detector tube, means including resistances in the cathode circuits of some of said tubes, a choke coil associated with said cathode circuits, and an audion tube having grid, plate and cathode elements cooperating with said resistances and said choke coil to link said cathode circuits to the cathode circuit of said detector tube through the instrumentality of another resistance interposed in the plate circuit of said detector tube for varying the current thru the first said resistances and thereby automatically regulate the output volume of said space discharge system, and another resistance for biasing said last audion tube.

2. In an amplification system, audion tubes for amplifying and detecting signal modulated electric waves, a common biasing resistance for certain of said audion tubes, and a second biasing resistance for said detector tube, a volume control tube having control electrodes and a cathode said cathode being associated with said common biasing resistance and said control electrodes associated with said detector tube biasing resistance.

3. A cascade amplifier provided with a plurality of audion amplifiers and an audion detector, a biasing resistance common to said audion amplifiers, an electron tube, means linking the plate circuit of said electron tube with the cathode circuit of the audion amplifier through the instrumentality of said common resistance, grid circuits, a second resistance common to said grid circuits and said plate circuit, and means joining said grid circuits with the plate circuit of the audion detector through the instrumentality of said second resistance to regulate the overall amplification performed by said cascade amplifier.

4. In a receiving system, a plurality of cascade connected audion tubes including a low frequency tube and a plurality of high frequency tubes, a biasing resistance for said low frequency tube, a biasing resistance common to said high frequency tubes, a volume control tube, instrumentalities

including manually controlled means for associating the control electrodes of said control tube with the biasing resistance of said low frequency tube and other instrumentalities including manually controlled means for joining the cathode of said control tube to the biasing resistance of said high frequency amplifier tubes to vary the current through the last named biasing resistance in response to current variations in the first named biasing resistance.

5. In a space discharge system including audion tubes for amplifying incoming signals, transformers associated with said audion tubes, an electron tube having a grid and a grid shield associated on one side with the primary winding of the first of said transformers of said system and on the other side with the plate circuits of one of said audion tubes, a biasing resistance for said one of said audion tubes, said electron tube having its grid connected to the cathode of said one of said audion tubes and thrusaid biasing resistance and having its grid shield connected directly to the cathode of said one of said audion tubes and being arranged to regulate the energy flow into said discharge system in response to current variations in said plate circuit of said one of said audion tubes.

6. An amplifying system including electron tubes, an auxiliary circuit associated with the primary winding of the first transformer of said amplifying system and with the output circuit of one of said electron tubes, a biasing resistance common to certain of said electron tubes, a second biasing resistance for said one of said electron tubes, and an auxiliary electron tube of the shielded grid type in said auxiliary circuit, a biasing resistance for said auxiliary electron tube, said auxiliary tube having its grid connected to said second resistance and its grid shield connected directly to the cathode of said one of said electron tubes and arranged to vary its internal resistance inversely to the variation in the output volume of said amplifying system.

7. In a receiving system, a detector tube, a biasing resistance therefor, a high frequency amplifier, a biasing resistance, transformers for said amplifier, a volume control tube having a grid, and a grid screen, means joining the grid and the grid screen circuits of said volume control tube to the biasing resistance of said detector tube, and means joining the plate circuit of said volume control tube to the primary winding of the first high frequency transformer of the system and the biasing resistance of the high frequency amplifier in series.

8. An amplification system including a plurality of electron tubes, a biasing resistance common to said tubes, a detector tube, a biasing resistance for said detector tube, an auxiliary electron tube having one control electrode associated with the biasing resistance of said detector tube, another control electrode associated with the anode of the detector tube through the instrumentality of a condenser and a cathode associated with the biasing resistance of the high frequency amplifier tubes, said auxiliary electron tube being adapted to vary the current through the said last named biasing resistance in response to current variations in the plate circuit of the detector tube.

9. A discharge system including amplifier tubes, a detector tube, a biasing resistance for said detector tube, a second biasing resistance for said amplifier tubes, an output control tube having a plurality of control electrodes, manually controlled means for connecting one control electrode of said output control tube with the said biasing re-

sistance of said detector tube, a third resistance in parallel with the primary winding of an audio transformer forming a link in the plate circuit of said detector tube, condenser means and manually controlled means connecting another control electrode of said control tube with said third re-

sistance, the cathode of said control tube being associated through manually controlled means with the biasing resistance of a high frequency amplifier tube.

J. HERBERT PHILIPS.