

June 29, 1937.

R. C. SHAW

2,085,125

RADIO TRANSMITTER

Filed June 26, 1935

2 Sheets-Sheet 1

FIG. 1

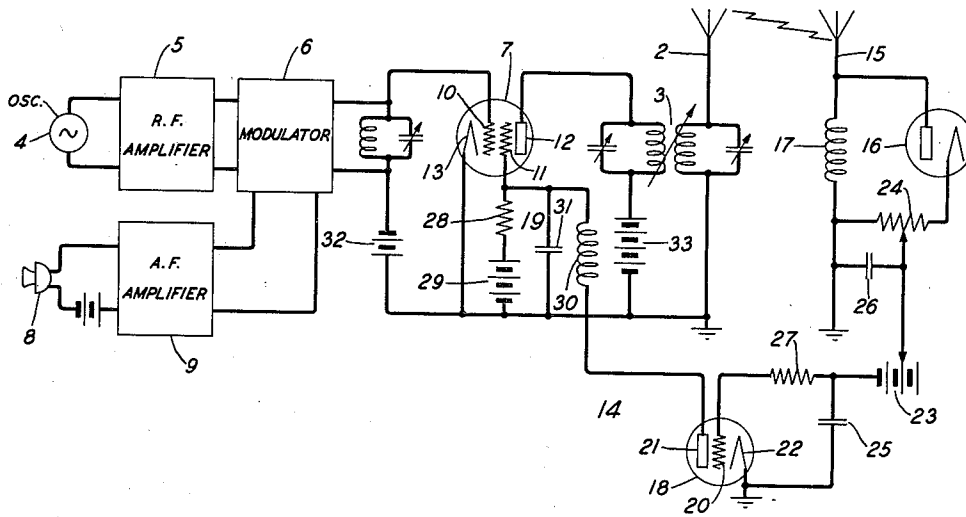
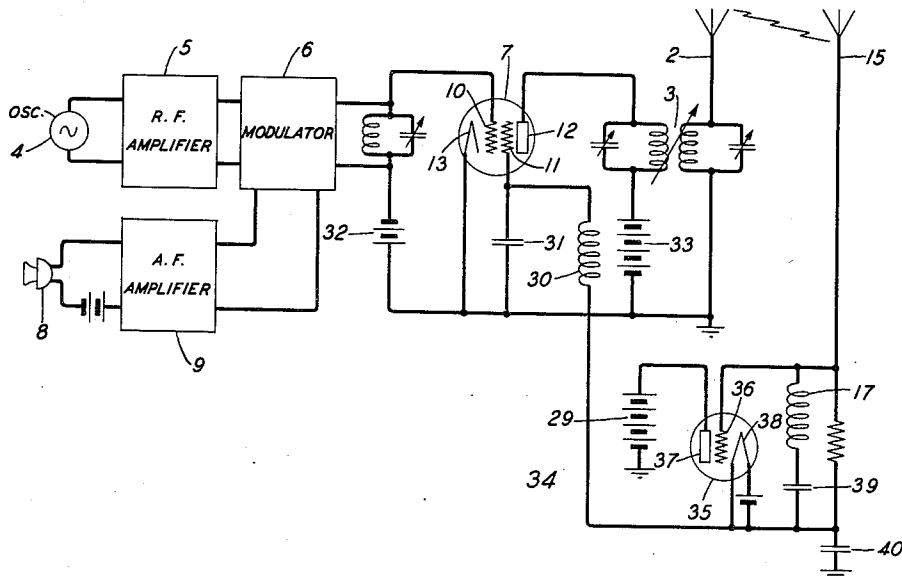


FIG. 2



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2 Sheets-Sheet 2

FIG. 3

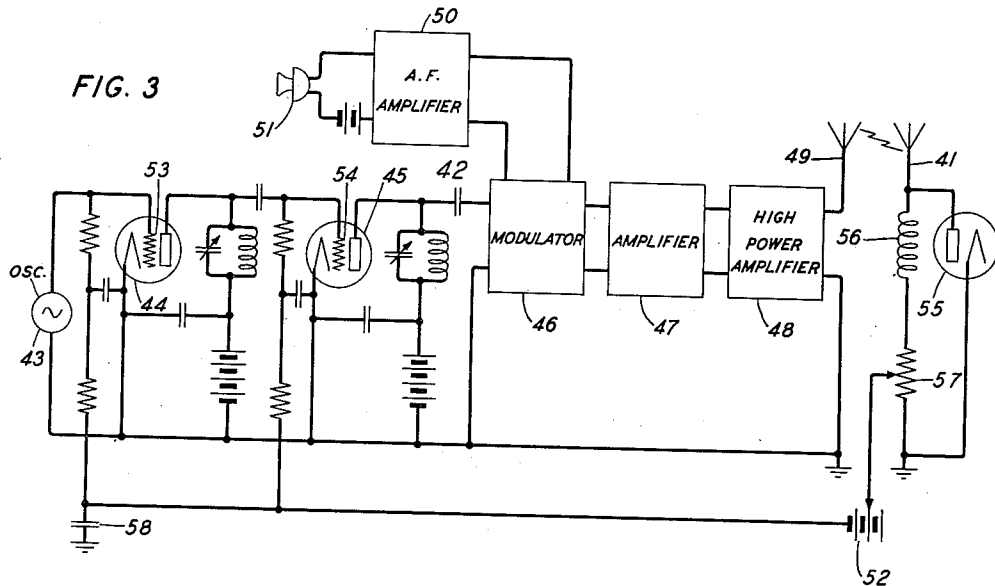
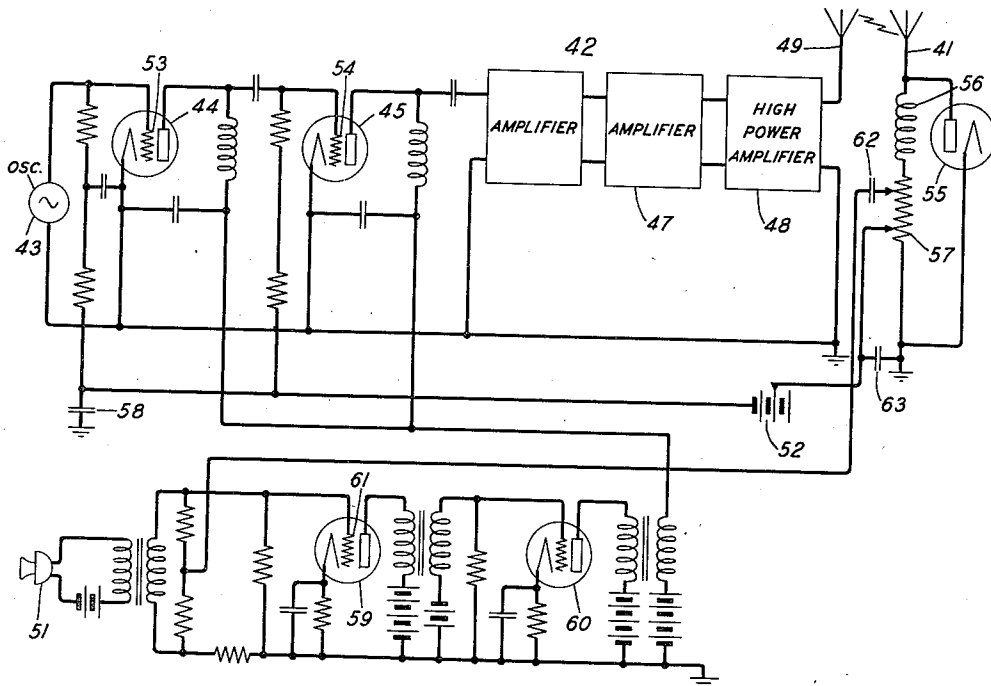


FIG. 4



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RADIO TRANSMITTER

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Application June 26, 1935, Serial No. 28,421

3 Claims. (Cl. 250—17)

This invention relates to radio transmitters and particularly to feed-back circuits for controlling the power radiated by radio transmitters.

One object of the invention is to provide a radio transmitter with a feed-back circuit that shall control the transmitter to maintain the radiated power substantially constant.

Another object of the invention is to provide a radio transmitter with a feed-back circuit that shall control the transmitter to maintain the radiated power substantially constant and with a feed-back circuit for stabilizing the audio frequency stages to improve distortion and noise conditions.

Another object of the invention is to provide a radio transmitter with a feed-back circuit that shall control the transmitter according to the direct current component of the carrier envelope to maintain the radiated power substantially constant.

A further object of the invention is to provide a radio transmitter having radio frequency stages comprising space discharge devices with a feed-back circuit from a pick-up antenna that shall control the grid of a device in a radio frequency stage according to the direct current component of the carrier envelope to maintain the radiated power substantially constant.

In radio telephone transmitters it is desirable to hold the radiated power output at a constant level. Broadcasting stations and ultra short wave systems would be improved in operation and in the quality of the programs radiated if the carrier amplitude variations arising from direct current power changes or from other causes were eliminated. If the radiated power was maintained constant, systems for guiding aircraft, such as blind landing devices and altimeters, which depend upon the absolute value of a transmitted carrier for accuracy, would be made more reliable. The need for constant carrier amplitude in the case of altimeters cannot be over-emphasized. In addition to the above commercial circuits where constant carrier amplitude is desirable, the radiation of a constant amplitude carrier is desirable in making field strength observations, in making studies of fading and in making wave angle tests.

In short wave radio circuits, it is normally desired to hold the transmitter modulation constant for a fixed amplitude of speech level from the speech input equipment. If the radio frequency power varies, the per cent modulation will also vary and usually produce undesirable effects, such as distortion. This distortion will be re-

duced and the modulation percentage will be maintained more constant if the radio frequency power is held constant.

In ultra short wave telephone systems, the radio link should be entirely automatic in operation as in the case of telephone repeaters. In this type of circuit, the ratio of the received power to the transmitted power is constant and the power radiated by the transmitter should also be constant. If the power output from the transmitter is maintained constant regardless of direct current power changes and temperature changes, the resultant effect will be a radio circuit of constant gain.

In accordance with the present invention, a negative feed-back circuit is provided for controlling a radio transmitter to maintain the radiated power substantially constant. In controlling the power output, it is proposed to feed back only the direct current component of the carrier envelope. In one form of the invention, a pick-up antenna is positioned in the vicinity and preferably in the line of fire of a transmitting antenna connected to a radio transmitter having the usual audio frequency stages and radio frequency stages. One of the radio frequency stages comprises a space discharge device having a control grid, an anode, a cathode, and a screen grid. The potential on the screen grid is controlled in accordance with the direct current component of the carrier envelope picked up by the pick-up antenna. A feed-back circuit is connected between the pick-up antenna and the screen grid of the space discharge device in the radio frequency stage. In one form of the invention, the feed-back circuit comprises a rectifier of any suitable type which controls the potential impressed on the grid of a three-element space discharge device. A fixed negative bias is impressed upon the grid of the three-element space discharge device and a variable positive potential is impressed on the grid according to the strength of the carrier wave received by the pick-up antenna. The impedance of the three-element space discharge device forms a part of a potentiometer which is connected to the screen grid of the space discharge device in the radio frequency stage of the transmitter. A filter comprising condensers associated with resistance is included in the feed-back circuit for insuring that speech or syllable frequencies will not control the screen grid of the radio frequency speech discharge device. The time constant of the filter should be of the order of one to ten seconds.

If the amplitude of the carrier envelope ra-

diated by the transmitting antenna is above normal value, the rectified potential from the pick-up antenna which is impressed upon the grid of the three-element space discharge device will be raised to lower the impedance of the three-element space discharge device and decrease the potential impressed on the screen grid of the radio frequency space discharge device. A decrease in the potential on the screen grid will result in lowering the power output from the transmitting antenna.

In another form of the invention, the pick-up antenna which is located in the vicinity of the transmitting antenna may be connected directly to a three-element space discharge device without the interposition of a rectifier. The three-element space discharge device performs the function not only of detection but also of control for the potential impressed on the screen grid of the radio frequency device.

In another form of the invention, a pick-up antenna located in the line of fire of the transmitting antenna and preferably in the vicinity of the transmitting antenna is connected by a feed-back circuit to the control grids of one or more radio frequency devices in a radio transmitter. The feed-back circuit comprises a rectifier of any suitable type connected to the pick-up antenna which impresses potential in a reverse phase upon the control grids of one or more of the radio frequency devices in the transmitter. The radio frequency devices are of the variable mu type. The feed-back circuit, as in the case of the other modifications, is provided with a filter to insure control by the feed-back circuit only in accordance with the direct current component of the carrier envelope.

In still another form of my invention, the pick-up antenna may have two feed-back circuits connected to it. One of the feed-back circuits serves to control the power output radiated from a transmitting antenna and the other feed-back circuit serves to control the audio frequency stages of a transmitter to improve distortion and noise conditions. Filters are provided in the feed-back circuits to insure control by one feed-back circuit only in accordance with the direct current component of the carrier envelope and control of the other feed-back circuit only in accordance with the audio frequency components. Feed-back circuits for controlling the distortion and noise are disclosed in the application of E. B. Ferrell, Serial No. 729,735, filed June 9, 1934.

In the accompanying drawings,

Fig. 1 is a diagrammatic view of a radio transmitter provided with a feed-back circuit constructed in accordance with the invention;

Fig. 2 is a diagrammatic view of a transmitter provided with a modification of the feed-back circuit shown in Fig. 1;

Fig. 3 is a diagrammatic view of a radio transmitter provided with a negative feed-back circuit for governing the control grid of a radio frequency amplifier stage in accordance with the invention; and

Fig. 4 is a diagrammatic view of a radio transmitter provided with a feed-back circuit for controlling the radiated power and a feed-back circuit for controlling an audio frequency stage to prevent distortion and noise.

Referring to Fig. 1 of the drawings, a radio transmitter is shown connected to a transmitting antenna 2 by means of a coupling transformer 3. The transmitter comprises an oscil-

lator 4 of any suitable type, a radio frequency amplifier 5, a modulator 6, and a radio frequency amplifier space discharge device 7 which is shown in detail. A transmitter 8 is connected by suitable audio frequency amplifiers 9 to the modulator 6. The amplifier 7 comprises a control grid 10, a screen grid 11, an anode 12, and a cathode 13. The potential on the screen grid 11 of the device 7 is controlled by a negative feed-back circuit 14 which is connected to a pick-up antenna 15. The pick-up antenna 15 is located in the line of fire of the transmitting antenna 2 and preferably is located in the vicinity of the transmitting antenna 2. The feed-back circuit 14 comprises a rectifier 16 connected around a choke coil 17 in the circuit of the pick-up antenna 15. The rectifier 16 may be of any suitable type and preferably is a two-element space discharge device. The rectified current from the rectifier 16 controls the potential impressed on the grid of a three-element space discharge device 18, the impedance of which forms part of a potentiometer 19 for governing the potential impressed on the screen grid 11 of the device 7.

The three-element space discharge device 18 comprises a control grid 20, an anode 21, and a cathode 22. A battery 23 is provided for impressing a negative bias on the grid 20. A potentiometer 24 included in the circuit of the rectifier 16 impresses a variable positive potential on the grid 20 for controlling the impedance of the device 18. Two condensers 25 and 26 cooperate with the potentiometer 24 and a resistance 27 to have a filtering action and prevent control of the device 18 by speech or syllable frequencies. The time constant of the filter is of the order of one to ten seconds. This filter insures control of the device 18 in accordance with the direct current component of the carrier envelope.

One section of the potentiometer 19 comprises a resistance element 28 and the other section thereof comprises the impedance of the space discharge device 18. A battery 29 is connected to the potentiometer and a choke coil 30 is included in circuit therewith. A condenser 31 serves as a by-pass condenser. Negative bias for the grid 10 of the device 7 is supplied by a battery 32 and plate potential for the anode 12 is supplied by battery 33.

If the power output from the transmitting antenna 2 is raised above normal value, the voltage in the pick-up antenna 15 increases. This increase in voltage in the pick-up antenna increases the potential rectified by the rectifier 16. The rectified potential opposes the bias of the battery 23 which determines the point of operation of the feed-back circuit. The decrease in the negative potential impressed on the grid 20 of the device 18 decreases the impedance of the tube with a resultant decrease in the potential on the screen grid 11. This results in a decrease in the radio frequency power radiated by the transmitting antenna 2. This action continues until the normal value of the carrier amplitude is reached.

If the power radiated by the transmitting antenna 2 decreases, the feed-back effect of the feed-back circuit 14 will be reversed to raise the power output from the transmitting antenna. A decrease of the power output below normal will decrease the potential rectified by the rectifier 16 which will increase the negative potential on the grid 20 of the device 18 which will increase the impedance of the device 18. Increasing the impedance of the device 18 will increase the poten-

tial on the screen grid 11 and increase the radio frequency power radiated from the transmitting antenna 2.

In Fig. 2 of the drawings is shown a modification of the circuit shown in Fig. 1. The radio transmitter in Fig. 2 is exactly the same as the radio transmitter shown in Fig. 1 and similar parts have been indicated by like reference characters. The feed-back circuit 34 shown in Fig. 2 between the pick-up antenna 15 and the screen grid 11 of the space discharge device 7 comprises a three-element space discharge device 35 which has not only the function of detection but also that of control. The device 35 comprises control grid 36, an anode 37, and a cathode 38. The pick-up antenna is directly connected to the control grid 36 and the screen grid 11 of the device 7 is connected through the choke coil 30 to the cathode 38 of the device 35.

The voltage impressed on the screen grid 11 of the device 7 is varied according to the impedance of the control device 35. The output from the space discharge amplifier 7 varies inversely according to the value of the impedance of the device 35. The impedance of the device 35 is dependent on the potential impressed on the grid 36. The choke coil 17 prevents the radio frequency voltage from being by-passed to ground by condenser 39. The grid bias for the device 35 is obtained from the radio frequency carrier which is rectified by grid leak detection in the device 35. Grid bias for normal operation is obtained by varying the amount of radio frequency voltage on the grid 36 of the device 35. If the power output radiated from the transmitting antenna 2 is increased above normal value, the rectified direct current voltage of the device 35 will cause the grid to go more negative and the plate-to-filament resistance thereof will increase. The potential on the screen grid 11 of the device 7 will decrease, causing the carrier output from the transmitting antenna 2 to decrease to normal. The above effect is reversed if the amplitude of the carrier decreases below normal value. Condensers 39 and 40 in the feed-back circuit 34 serve to insure control by the feed-back circuit only in accordance with the direct current component of the carrier envelope.

Referring to Fig. 3 of the drawings, a feed-back circuit from a pick-up antenna 41 is shown for governing the control grids of variable mu tubes in a radio frequency transmitter 42. The transmitter 42 comprises an oscillator 43 connected to a three-element space discharge device 44 of the variable mu type, a space discharge device 45 similar to the device 44, a modulator 46, and radio frequency amplifiers 47 and 48 connected to the transmitting antenna 49. Audio frequency amplifier stages 50 serve to connect a transmitter 51 to the modulator 46. A battery 52 is provided for impressing a negative bias on the grids 53 and 54 of the devices 44 and 45. A rectifier 55 is connected across a choke coil 56 and a potentiometer 57 in the circuit of the pick-up antenna 41. Potential is fed back from the potentiometer 57 for controlling the grids 53 and 54 of the device 44 and 45. A condenser 58 is provided for by-passing low frequency currents and to give the feed-back circuit a time control so that the control of the grids 53 and 54 is effected solely in accordance with the direct current component of the carrier envelope. The circuit shown in Fig. 3 of the drawings operates in the same manner as the circuit shown in Fig. 1 except that the phase control is reversed. With an increase in the ra-

diated power from the transmitting antenna 49, the rectified current supplied by the rectifier 55 increases for supplying negative potential which is impressed on the grids 53 and 54. The negative potential impressed on the grids 53 and 54 lowers the power radiated by the transmitting antenna 49. A reverse operation takes place if the power radiated by the transmitting antenna 49 is lowered below normal value.

Referring to Fig. 4 of the drawings, a radio transmitter similar to the radio transmitter shown in Fig. 3 is illustrated provided, not only with a feed-back circuit for controlling the radiated power as in the circuit shown in Fig. 3, but also with an auxiliary feed-back circuit for controlling the audio frequency stages to correct for noise and distortion. Like parts shown in Fig. 4 to those shown in Fig. 3 will be indicated by similar reference characters. The audio frequency amplifier shown in Fig. 4 comprises two space discharge devices 59 and 60 which are, for example, of the three-element space discharge type. The grid 61 of space discharge device 59 is controlled by a feed-back circuit connected by condenser 62 to the potentiometer 57 in circuit with the rectifier 55. The condenser 62, in combination with the choke coil 56 in the potentiometer 57, insures control of the grid 61 of the device 59 solely in accordance with the audio frequency currents. The condenser 63 connected to the feed-back circuit for controlling the radio frequency devices 44 and 45 serves as a filter to insure against control of the devices 44 and 45 by audio frequency currents or syllable frequency currents. Feed-back circuits for controlling audio frequency devices to correct for distortion and noise are disclosed in the above-mentioned application of E. B. Ferrell, Serial No. 729,735 filed January 9, 1934.

Modifications of the circuits and the arrangement and location of parts may be made within the spirit and scope of the invention. Such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In a radio circuit, a transmitting antenna, a radio transmitter comprising radio frequency stages connected to said antenna and audio frequency stages connected to said radio frequency stages, a pick-up antenna located in the direction of propagation of said transmitting antenna, means comprising a feed-back circuit from said pick-up antenna to a radio frequency stage for controlling said transmitter to maintain the carrier wave amplitude substantially constant, and means comprising a degenerative feed-back for feeding back a wave opposite in phase to the signal wave from said pick-up antenna to an audio frequency stage to control the audio stage by audio frequency currents and reduce noise and distortion of the envelope of the waves radiated from the transmitting antenna.

2. In a radio circuit, a transmitting antenna, a radio transmitter comprising radio frequency stages and audio frequency stages connected to said antenna, a pick-up antenna located in the vicinity of said transmitting antenna, a rectifier connected to said pick-up antenna, means comprising a feed-back circuit from said rectifier to a radio frequency stage for feeding back only the direct current component of the carrier wave to control said radio stage and maintain the carrier wave amplitude substantially constant, and means comprising a degenerative feed-back circuit from the rectifier to an audio frequency stage for controlling said audio frequency stage by

audio frequency currents to reduce envelope distortion of the radiated wave.

3. In a radio circuit, a transmitting antenna, a radio transmitter comprising radio frequency amplifier discharge devices connected to said antenna and audio frequency discharge devices connected to said radio frequency devices for modulating radio frequency currents with audio frequency currents, a pick-up antenna located in the vicinity of said transmitting antenna, a rectifier connected to said pick-up antenna, means comprising a feed-back circuit from said rectifier to

one of said radio frequency amplifier devices for controlling said device to maintain the carrier wave amplitude substantially constant, and means comprising a gain reducing feed-back circuit for feeding back a wave opposite in phase to the signal wave from said rectifier to one of said audio frequency devices to control said audio frequency devices by audio frequency currents and reduce envelope distortion of the modulated wave.

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