

Jan. 3, 1939.

H. J. SCOTT

2,142,335

RADIO TRANSMITTER CONTROL

Filed Dec. 29, 1934

2 Sheets-Sheet 1

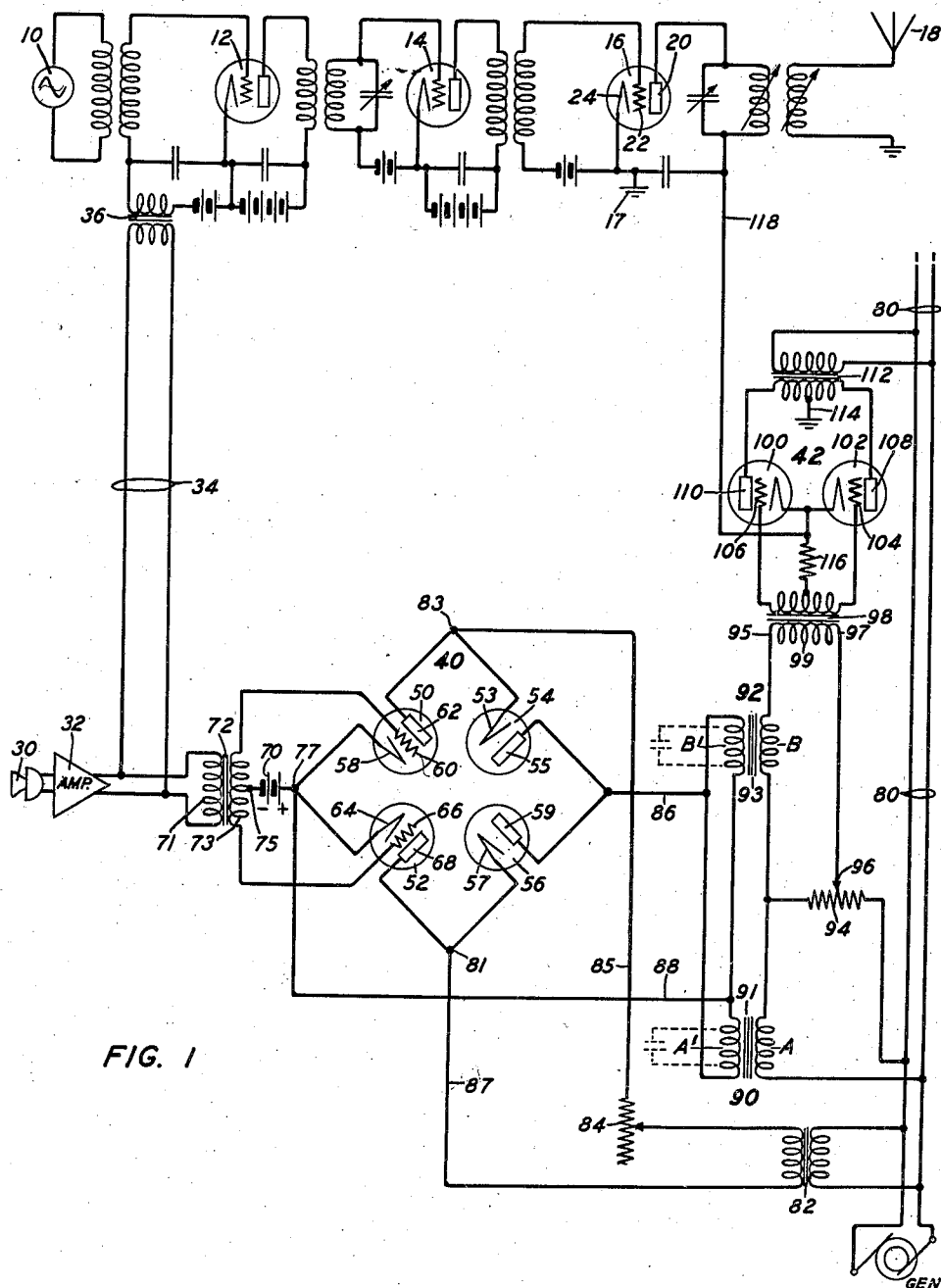


FIG. 1

INVENTOR
H. J. SCOTT
BY
E. V. Griggs
ATTORNEY

Jan. 3, 1939.

H. J. SCOTT

2,142,335

RADIO TRANSMITTER CONTROL

Filed Dec. 29, 1934

2 Sheets-Sheet 2

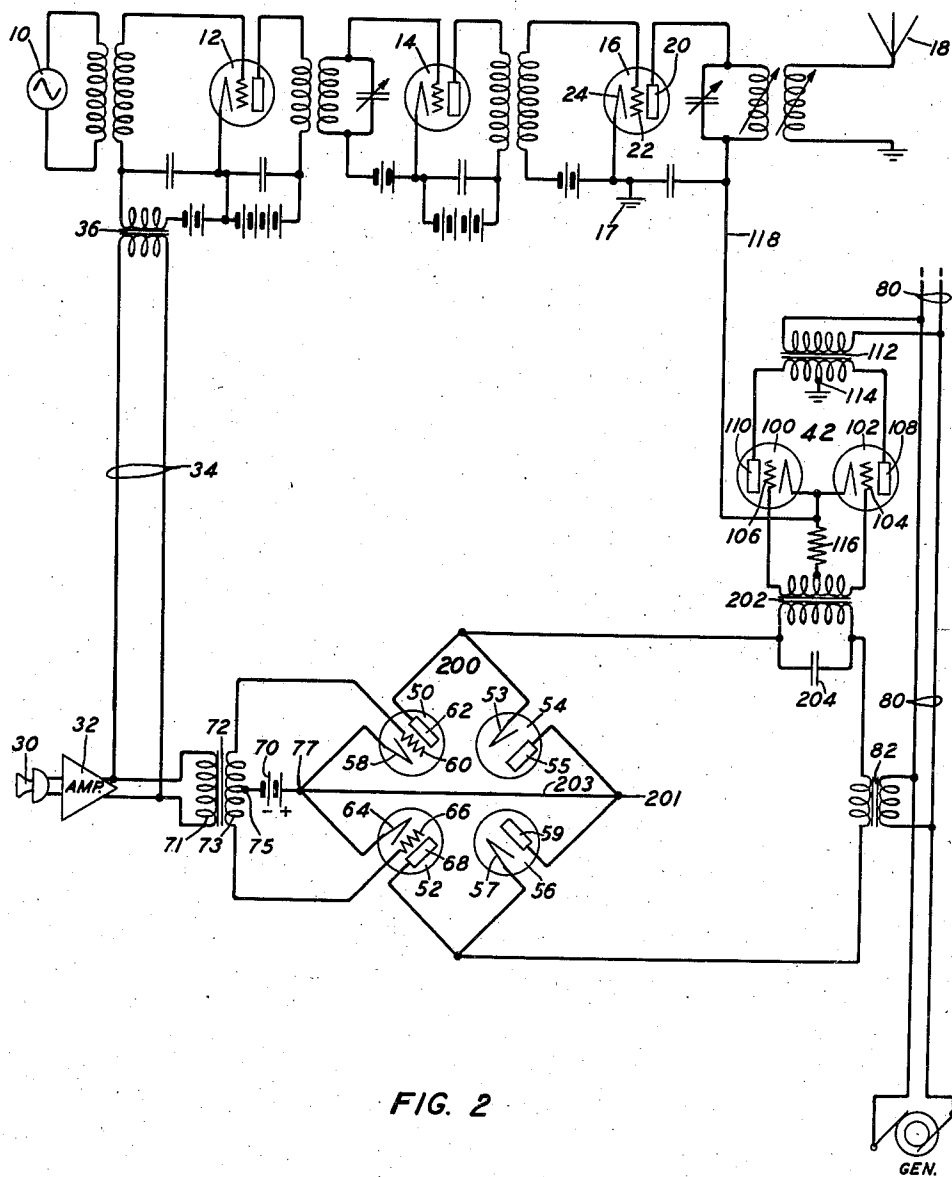


FIG. 2

INVENTOR
H. J. SCOTT
BY
E. V. GIGGS
ATTORNEY

UNITED STATES PATENT OFFICE

2,142,335

RADIO TRANSMITTER CONTROL

Herbert J. Scott, Oakland, Calif., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 29, 1934, Serial No. 759,675

11 Claims. (Cl. 179—171)

This invention relates to radio signaling systems and particularly to apparatus for controlling the power supplied thereto in accordance with speech or other signals.

5 One of the objects of the invention is to conserve energy or power supplied to a radio transmitter and secure improved efficiency of operation thereof.

10 In accordance with this invention, two separate modulations of the radio transmitter carrier wave may be provided. One may be for communication purposes as by speech signaling in the usual manner; the other may be for some other purpose such as improved efficiency of operation. The signaling modulation system for communication purposes may be of the usual type operating to modulate the carrier wave by speech or other sound frequencies, for example, which may vary up to about 3000 cycles or more per second. The efficiency modulation system may operate to conserve power by modulating a 60 cycle, 110 volt power supply by a lower frequency which, in a particular case, may be speech frequency limited to a narrow band in the low frequency portion ordinarily varying from 2 to 20 cycles per second. The efficiency modulation system may also operate to modulate the plate supply of an amplifier tube to control the amplitude of a high frequency carrier wave.

30 Also, in accordance with this invention, the power or energy supplied to the system may be converted from one form to another such as by rectification from alternating current to direct current and simultaneously varied in magnitude in accordance with a characteristic of the signals.

40 This invention further may provide that power from a power source may be supplied to the system from that power source, only when signals are present and that no carrier wave oscillations be supplied to the antenna until signals are present.

45 In accordance with a specific embodiment of this invention, a bridge circuit may be used in connection with speech input thereto to operate a gaseous space discharge rectifier of the so-called "thyatron" tube type controlling the plate voltage of an output stage amplifier tube of a radio transmitter to produce modulation such as low frequency modulation of the carrier wave for the purpose of conserving power supplied to the amplifier tube and for the purpose of keeping the carrier down as low as possible in amplitude and still secure undistorted speech or signal transmission. A saturated iron core inductance may be used to improve the efficiency of operation of the gaseous rectifier tube system. The carrier wave may be separately and simultaneously modulated in the usual manner for signaling purposes.

60 More particularly, the bridge circuit in a par-

ticular form may include two two-element rectifier tubes of usual construction and two three-element vacuum tubes of usual construction and suitable connections with a source of alternating current power supply as a 110 volt, 60 cycle source. The gaseous space discharge rectifier in one of its forms may comprise mercury or other vapor filled tubes of the "thyatron" type each having anode, cathode and grid elements. Signal currents varying in accordance with speech or other signals when impressed on the bridge circuit, change the characteristics of the bridge, and cause phase shifting means to shift the phase of voltage on the grid elements of the thyatron tubes thereby permitting the thyatron rectifier to operate and furnish modulating voltage to an element as the plate element of the power amplifier tube which is adapted to supply energy as carrier wave radio frequency oscillations to a line or load circuit as an antenna. The system may be normally adjusted so that no carrier wave energy is given to the antenna until the thyatron rectifier is operated by signals impressed on the bridge circuit, at which time the thyatron rectifier may operate to supply plate voltage to the amplifier tube and to produce amplitude modulation of the carrier wave at speech frequencies which may be limited to a narrow band in the low frequency portion and ordinarily may vary from 2 to 20 cycles per second. In this manner, power is conserved and the amplitude of the carrier wave is kept down as small as possible consistent with securing undistorted speech or other signal transmission.

Inductance devices of the saturated iron core type may be coupled through suitable circuits to the thyatron rectifiers and to the bridge type rectifier for improving the efficiency of operation of the thyatron tubes which supply voltage to the carrier wave radio frequency oscillator or amplifier. Signal currents impressed on the bridge type rectifier cause direct current to flow to saturate the iron core of the inductance devices thereby changing the value of inductance in the circuit and the phase of the voltage applied to the grid elements of the thyatron rectifiers.

It will be understood that the bridge circuit, the thyatron rectifier, and the iron core inductance means are preferably connected with the same source of alternating current power supply, that the radio transmitter may comprise an oscillator tube alone or such tube followed by one or more tubes as the usual amplifier tubes, and that the invention is adapted for use with any one or all of such tubes.

Among the advantages for this system may be mentioned the following. No carrier wave energy is given to the antenna or load circuit when signals are absent. The carrier is supplied to

the load circuit practically instantaneously and without time delay when signals are present. The system is free from mechanical contact troubles. The operation is practically instantaneous. The carrier is kept as small in amplitude as possible but still sufficient to secure undistorted speech or other signal transmission. No power is supplied to the carrier wave system from the associated power supply when speech or other modulation is not present. The power supply may be controlled by the relatively low frequency signal wave frequencies.

For a clearer understanding of the nature of this invention and the additional features and objects thereof, reference is made to the following description taken in connection with the accompanying drawings, in which

Fig. 1 is a diagram showing a preferred embodiment of my invention; and

Fig. 2 is a diagram showing a modification of the system shown in Fig. 1.

In Fig. 1, a source of carrier waves of the usual type is shown as including a radio frequency oscillation generator 10 followed by a modulator-amplifier 12, a radio frequency amplifier 14, a power amplifier 16 in the output stage of the radio transmitter and an antenna 18. The oscillator 10 and the amplifiers 12, 14 and 16 may be of the usual vacuum tube type. The power amplifier tube 16 disposed in the output stage of the radio transmitter 10 to 18 has a plate electrode 20 as well as a grid electrode 22 and a filament or cathode electrode 24 grounded at 17. Similarly, the oscillator tube of the oscillation generator 10, the modulator tube 12 and the amplifier tube 14 may have three electrodes. Suitable connections as shown including transformers, condensers and sources of voltage may be provided to generate, amplify and transmit carrier waves of radio frequency in a known manner. While there is shown a radio transmitter of a particular type, it will be understood that the radio transmitter need not be limited to the particular system of generating carrier waves as shown, inasmuch as the invention contemplates a radio transmitter of any type including an oscillator alone or an oscillator followed by one or more amplifiers with suitable tuning circuits and antenna.

Apparatus is provided for modulating the carrier waves for communication purposes. Such apparatus may be of the usual construction, as shown, wherein a microphone or telephone transmitter 30 responsive to speech or tone signals is connected through a suitable audio frequency amplifier 32 with the modulator-amplifier 12 by means of a circuit 34 and an audio frequency transformer 36. While there is shown at 30, 32, 34, 36, 12 a particular system for modulating the carrier wave generated by the oscillator 10, it will be understood that signaling for communication purposes may be provided by other systems as any of the known systems of which the one shown is only one type.

The invention contemplates the provision of another and separate modulation system for some other purpose such as improved efficiency or conserving power. For this purpose, I may provide a bridge circuit 40 used in connection with the source of signals 30 to operate upon a rectifier 42 for controlling the potential of the plate 20 of the power amplifier tube 16 disposed in the output stage of the radio transmitter 10 to 18. The rectifier 42, in this instance, is used as a modulating tube system to produce modulation

of the carrier wave at the same time that modulation of the carrier wave due to speech is obtained in the usual fashion through the circuit 34.

The bridge circuit 40 includes two three-element vacuum tubes 50 and 52 of usual construction and two two-element rectifier tubes 54 and 56 of usual construction. The vacuum tube 50 is provided with a cathode 58, a grid electrode 60 and a plate electrode 62. Similarly, the vacuum tube 52 is provided with a cathode 64, a grid electrode 66 and a plate electrode 68.

The rectifier tube 54 is provided with a cathode 53 and a plate electrode 55. Similarly, the rectifier tube 56 is provided with a cathode 57 and a plate electrode 59. While rectifying means in the form of vacuum tubes 54 and 56 are shown, it will be understood that other forms of rectifying means may be employed such as crystal rectifiers or copper oxide rectifiers.

Connections are provided between the tubes 50, 52, 54 and 56. The cathode 58 of tube 50 is connected with the cathode 64 of tube 52, the plate electrode 68 of tube 52 is connected with the cathode 57 of tube 56, the plate electrode 59 of the tube 56 is connected with the plate electrode 55 of the tube 64, and the cathode 53 of the tube 54 is connected with the plate electrode 62 of the tube 50.

A transformer 72 having windings 71 and 73 connects the bridge 40 with the telephone transmitter 30. The winding 73 is connected with the grid electrodes 60 and 66 of the tubes 50 and 52 respectively. A battery 70 has a negative terminal connected with the mid-point 75 of the transformer winding 73 and a positive terminal connected at 77 with the cathodes 58 and 64 of the tubes 50 and 52 respectively. The battery 70 is adapted to bias the grids 60 and 66 of vacuum tubes 50 and 52 highly negatively to shut off all rectifier current from the bridge 40 in the absence of speech input to the transmitter 30. The bridge 40 is connected at 81 and 83 with an alternating current supply circuit or source 80, which may be a sixty cycle source, by a circuit including a transformer 82, a variable resistance 84 and conductors 85 and 87. The resistance 84 may be employed to adjust the amount of power with a given tone. The transformer 82 applies a suitable voltage to the bridge 40.

The two rectifiers 54 and 56 which may be vacuum tubes as shown or crystal rectifiers or copper oxide rectifiers, are adapted to rectify current from the alternating current source 80 and to supply such rectified current through conductors 86 and 88 to the link circuit auxiliary windings A' and B' of the inductance devices 90 and 92. Both halves of such rectified alternating current flow in the same direction in the link circuit windings A' and B'. The inductance devices 90 and 92 may be constructed with sufficient distributed capacity in the windings A' and B' thereof to by-pass the speech frequencies, down to about two hundred cycles, for example, of the signals impressed on the transmitter 30 in order to supply currents corresponding to the lower frequencies only of the signals impressed upon the transmitter 30. The devices 90 and 92 comprise inductance or choke coils A and B which have iron cores 91 and 93 and which are equipped with the auxiliary windings A' and B' referred to, the device 90 having coil A equipped with auxiliary winding A' and the device 92 having coil B equipped with auxiliary winding B'. The windings A' and B' are adapted to vary the

saturation of the iron cores 91 and 93 of the inductances A and B to vary the value of inductance of coils A and B in accordance with speech impressed on the microphone 30.

A phase shifting circuit consisting of a variable resistance 94 and inductance windings A and B is provided. The winding A and the resistance 94 are connected with the alternating current source 80. The winding B and the connection 96 of the variable resistance 94 are connected with the rectifier 42 through a transformer 98.

The rectifier 42 includes two tubes 100 and 102 preferably of the so-called "thyatron" gas-filled type, which here are used as modulating tubes. The grid electrode 104 of the gas-filled tube 102 and the grid electrode 106 of the gas-filled tube 100 are connected to the alternating current supply circuit 80 through the transformer 98, the inductance coils A and B and the resistance 94, 96 of the phase shifting circuit. The plate electrode 108 of the gas-filled tube 102 and the plate electrode 110 of the gas-filled tube 100 are connected through a transformer 112 to the same source of alternating current supply 80. The transformer 112 may be grounded at a mid-point 114. A resistance 116 may be employed to limit the current in the circuits of grids 104 and 106. An output circuit 118 is adapted to supply rectified voltage to the plate 20 of the power amplifier tube 16 which is grounded at 17 to complete the circuit for its rectified plate current supply. The transformers 98 and 112 function to supply potentials of similar frequency from the same source of alternating current 80 respectively to the grids 104 and 106 and to the plates 108 and 110 of the gas-filled tubes 100 and 102. The rectifier tubes 100 and 102 are preferably of the mercury vapor, gas-filled type known in the art, but it will be understood that other types of rectifier tubes may be employed to furnish rectified current in accordance with the phase relation between the potentials impressed on the grids and the plates of the tubes 100 and 102. While I have shown the alternating current source 80 as a sixty cycle 110 volt source, it will be understood that I may use any suitable voltage or any suitable frequency. It is preferable but not necessary that the frequency of the source 80 be higher than that of the lower frequencies of the signals impressed on the transmitter 30.

In the operation of the system shown in Fig. 1, the high frequency wave generated by the oscillator 10 is amplified and radiated by the antenna 18 in the usual manner. The carrier wave so generated is modulated for communication purposes in accordance with signals from the audio transmitter 30 impressed on the modulator amplifier 12 through the circuit 34 including the transformer 36.

The power supply from the alternating current supply circuit 80 through the rectifier 42 to the power tube 16 is controlled by the bridge circuit 40 in response to signals impressed on the audio transmitter 30. Briefly stated, the operation is as follows. When speech is impressed on the microphone 30, the rectifier 40 causes direct current to flow through the windings A' and B' thereby saturating the iron cores 91 and 93 of the inductance coils A and B. This saturating effect changes the values of inductance in the circuit including coils A and B thereby changing the phase of the voltage applied to the grid electrodes 104 and 106 of the tubes 102 and 100 of the rectifier 42 which supplies rectified voltage to the radio frequency amplifier tube 16. More particularly,

referring to the rectifier 42, the gas-filled tubes 100 and 102 thereof, which are here used as rectifiers, control the amount of power and voltage supplied to the plate circuit 118 by controlling the phase of the alternating current voltage of similar frequency applied on the grids 104 and 106 of the gas-filled tubes 102 and 100. If the grid and plate potentials of tubes 100 and 102 are in phase, the amount of rectifier power supplied to the plate circuit 118 will be greater than that which will be supplied with a 90-degree phase shift between such grid and plate potentials, for example; and if the phase relation is 180 degrees, the rectified current in plate circuit 118 will be reduced to zero. The amount of power supplied to the plate circuit 118 of the power amplifier 16 may be varied at a slow rate by varying the phase of the voltage applied to the grids 104 and 106 of the gas-filled tubes 102 and 100 when the rate of variation of phase is a lower rate than the power cyclic rate which, in this instance, is sixty cycles per second. Thus the variations or modulations of the power supply to the plate circuit 118 may be, say five or ten cycles per second, where the frequency of the power supply 80 is sixty cycles per second. The phase shifting circuit embodying the iron core coils A and B and the variable resistance 94, 96 receives the sixty cycle energy from the source 80 and suitably shifts the phase of the potential of that energy and applies it by means of the transformer 98 to the grids 104 and 106 of the tubes 102 and 100. The amount of such phase shift is dependent upon the comparative value of the inductive reactance of coil A with respect to the resistance of resistance 94 and also is dependent upon the comparative value of the inductive reactance of coil B with respect to the effective resistance produced across the terminals 95 and 97 of the input winding 99 of the transformer 98. Any transformer connected with a load has an effective resistance produced across its terminals. If the inductive reactances of both the coils A and B are zero, the phase shift will be zero. If they are large compared to these resistances, the phase shift will approach 180 degrees reaching that value only where the inductive reactances of coils A and B equal infinity ($\omega L = \infty$). More particularly, the phase angle between E and I_2 will be given by the following expression:

$$\alpha = \tan^{-1} \frac{\omega R_1 (L_1 + L_2 + L_3 + \frac{R_3 L_1}{R_1})}{R_1 R_3 - L_1 L_3 \omega^2 - L_1 L_3 \omega^2}$$

where

L_1 = the inductance of coil A.

L_2 = the inductance of coil B.

L_3 = the inductance of transformer 98.

R_1 = the resistance of resistance 94.

R_3 = the effective resistance between the terminals 95 and 97 of transformer 98.

E = the potential of the source 80 applied to the circuit including coil A and resistance 94.

I_2 = the current in the circuit comprising the coil B, the transformer winding 99 and the resistance 94.

$\omega = 2\pi \times$ the frequency.

When L_1 and L_2 are zero, the expression becomes:

$$\alpha' = \tan^{-1} \frac{\omega L_3}{R_3}$$

When ωL_1 and ωL_2 approach infinity or are

very large compared to R_3 , the expression becomes:

$$\alpha'' = \tan^{-1} \frac{\omega R_1 (L_1 + L_2 + L_3 + \frac{R_3}{R_1} L_1)}{-(L_1 L_2 \omega^2 + L_1 L_3 \omega^2)}$$

from which it will be seen that the shift in phase angle may approach 180 degrees.

Accordingly, to modulate the power supplied by the rectifier 42 to the plate circuit 118, the inductances of coils A and B at sixty cycles may be varied at a modulating rate of say about ten cycles per second. Such inductances of coils A and B may be varied by varying the saturation of the iron cores 91 and 93 thereof through the windings A' and B' in response to signals in a manner to be described.

The bridge circuit 40 provided with the two rectifiers 54 and 56 and the two high vacuum tubes 50 and 52 is adapted to rectify both halves of the alternating current supplied from source 80, both halves of such rectified current passing through the windings A' and B' in the same direction. When no speech is impressed upon the transmitter 30, the large value of negative bias supplied from the battery 70 and impressed on the grids 60 and 66 of the tubes 50 and 52 will shut off all such rectified current from the windings A' and B' and the inductances of coils A and B will have a maximum value thereby causing a maximum phase shift in the voltage applied to the grids 104 and 106 of the tubes 102 and 100 and a minimum amount of rectified current in the circuit 118. But, when speech or other signals occur and are impressed upon the transmitter 30, rectified currents will flow through the output circuit 86, 88 of the bridge circuit 40 in the same direction, and if the speech frequencies, for example, those above 200 cycles per second, are by-passed by a suitable distributed capacity of the windings A' and B', a current will flow through the windings A' and B', the magnitude of which will be roughly proportional to the envelope of the speech frequency amplitude. The magnitude of such current affects the magnitude of the effective inductance of the coils A and B and modulations of the power supply 80 will occur at whatever low rate of current variations pass through the windings A' and B' and the high frequency current amplitude in the radio transmitter 10 to 18 will follow. Accordingly, there may be obtained by this system a low frequency modulation of the rectified current in the plate circuit 118 and also a low frequency modulation of high frequency current in the radio transmitter 10 to 18.

Fig. 2 illustrates a modification of the system shown in Fig. 1, particularly in respect to the means for shifting the phase of the alternating current voltage applied to the grids 104 and 106 of the gas-filled tubes 100 and 102, and also in respect to certain parts of the bridge circuit rectifier. In Fig. 2, the radio transmitter shown at 10, 12, 14, 16, 18 is the same as that shown in Fig. 1. Like reference characters correspond to like parts in both figures. Modulation in accordance with signals for the purpose of communication may be obtained through the circuit 34 and the audio transmitter 30 in the same manner as shown in Fig. 1.

A bridge circuit 200 responsive to signals impressed on the transmitter 30 is utilized in connection with a transformer 202 and a condenser 204 connected in parallel circuit relation therewith, to apply voltage as sixty cycle voltage from source 80 to the grids 104 and 106 of the gas-

filled tubes 102 and 100, respectively, for the purpose of producing a phase shift in the sixty cycle voltage in accordance with a characteristic of the signals impressed on the audio transmitter 30.

The gas-filled tubes 100 and 102 also have voltage of suitable magnitude applied from the source 80 by transformer 112 to the plates 110 and 108 thereof. The tubes 100 and 102 accordingly have potentials of similar frequency from a common source 80 applied to the plates 108 and 110 and also to the grids 104 and 106, the grid potentials being supplied through a circuit embodying the transformer 202 and the bridge apparatus 200. The condenser 204 may be used to assist in the phase shift referred to. The bridge 200 may consist of two three-electrode vacuum tubes 50 and 52 of the type shown in Fig. 1, two two-element rectifier tubes 54 and 56 of the type shown in Fig. 1 and suitable connections including a connection 203 between terminals 77 and 201. The bridge 200 will act like a resistance of variable magnitude. The transformer 202 is constructed to act like an inductance and not merely as a true telephone or power transformer. The variation of such resistance of the bridge apparatus 200 with respect to the inductive reactance of the inductance 202 in response to signal current changes in the device 30 will cause a shift in the phase of the alternating voltage and current supplied to the circuit from the source 80 by transformer 82, which shift in phase is transferred by transformer 202 to the grids 104 and 106 of the gas-filled tubes 102 and 100 permitting the rectifier 42 to operate and furnish rectified plate voltage to the power tube 16, which normally may be adjusted so that no power is given to the antenna 18 until the rectifier 42 is operated by speech impressed on the microphone 30. The system will produce a phase modulation in accordance with signals impressed on device 30 since the bridge 200 will act like a resistance of variable magnitude. In other respects, the operation of the system shown in Fig. 2 is the same as that described in connection with Fig. 1.

It will be understood that in the system shown in Figs. 1 and 2 the radio transmitter 10 to 16 may be normally adjusted so that no power is given to the antenna 18 until the bridge circuit 40 of Fig. 1 or 200 of Fig. 2 is operated by signals impressed upon the transmitter 30; that in both species shown, the sixty cycle, 110 volt supply circuit 80 may be modulated by a lower frequency; that modulation in accordance with a characteristic of the signals may be used for the purpose of securing improved efficiency of operation and for conserving energy or power supplied to a radio transmitter; that, in accordance with this invention, two separate modulations of a radio transmitter carrier wave may be provided, one of which may be for communication purposes as by speech signaling in the usual manner and the other of which may be for some other purpose such as improved efficiency of operation and conservation of energy; and that this invention provides an efficient system of supplying rectified current varying in accordance with a characteristic of signals.

Although this invention has been described and illustrated in relation to the specific arrangements, it is to be understood that it is capable of application in other organizations and is, therefore, not to be limited to the particular embodiments disclosed, but only by the scope of the appended claims and the state of the prior art.

What is claimed is:

1. In a radio system, a load circuit, a source of signals, means including a space discharge vacuum tube having a plate electrode for supplying carrier wave radio frequency oscillations to said load circuit, a source of alternating current of frequency less than said radio frequency, rectifier means connected with said source of alternating current and including a gas-filled space discharge tube having anode, cathode and grid electrodes for furnishing rectified voltage to said plate electrode of said space discharge vacuum tube, means including bridge circuit rectifier means connected with said source of alternating current and including two two-element rectifier tubes and two three-element vacuum tubes for shifting the phase of voltage on said grid electrode of said gas-filled tube, and means for impressing currents varying in accordance with said signals upon said bridge circuit to operate said gas-filled tube rectifying means whereby said carrier wave energy is given to said load circuit only in the presence of said signals.

2. In a radio system, a load circuit, a source of signals, means including a space discharge vacuum tube having a plate electrode for supplying carrier wave radio frequency oscillations to said load circuit, a source of alternating current of frequency less than said radio frequency, rectifier means connected with said source of alternating current and including a gas-filled space discharge tube having anode, cathode and grid electrodes for furnishing rectified voltage to said plate electrode of said space discharge vacuum tube, means including inductance apparatus having a saturated iron core and connected with said source of alternating current and with said grid electrode of said gas-filled tube and including also bridge circuit rectifier means connected with said source of alternating current and connected with said inductance means and including two two-element rectifier tubes and two three-element vacuum tubes for shifting the phase of voltage on said grid electrode of said gas-filled tube, and means for impressing currents varying in accordance with said signals upon said bridge circuit to operate said gas-filled tube rectifying means whereby said carrier wave energy is given to said load circuit only in the presence of said signals.

3. A signaling system including a source of carrier waves, a source of signals, means for modulating said carrier waves in accordance with said signals, a power source of constant frequency alternating current, and means connected with said power source of constant frequency alternating current including a bridge circuit rectifier connected with a reactance device having such a capacitance as to by-pass only the frequencies of said signals that are higher than the frequency of said power source for separately modulating said carrier waves in accordance with said signals only at a rate of modulation less than the frequency of said alternating current power source.

4. A signaling system including a source of carrier waves, a source of signals, means for modulating said carrier waves in accordance with said signals, a power source of constant frequency alternating current, and means connected with and modulating said power source of constant frequency alternating current said last-mentioned modulating means including a bridge circuit rectifier connected with an inductance device having such a capacitance as to by-pass the

higher frequencies of said signals for separately modulating said carrier waves in accordance with said signals, and only at a rate of modulation slower than that of said first-mentioned modulating means.

5. A signaling system including a source of carrier waves, a source of signals, means for modulating said carrier waves in accordance with said signals, a constant frequency alternating current power supply source, and means including a bridge circuit rectifier energized from said power source and an inductance device connected with said rectifier and said power source and having such a capacitance as to by-pass the higher frequencies of said signals for shifting the phase of said alternating current source potential and for separately modulating said carrier waves in accordance with the lower frequencies only of said signals.

6. A system including means for producing oscillations, a supply source of constant frequency alternating potential, a signal current circuit, means including a bridge circuit and an inductance device connected with said supply source for shifting the phase of said supply source potential in accordance with said signal current, and means including a rectifying device for rectifying current from said supply source and for varying said oscillations in accordance with said phase shifting of said supply source potential.

7. A power supply system including a source of signal current, an output circuit, an alternating current supply circuit, rectifier means connected with said output circuit and including a tube having a plurality of electrodes, means for supplying voltages to said electrodes from said supply circuit, said voltage supplying means including means for shifting the phase of said voltage on one of said electrodes with respect to the phase of said voltage on another of said electrodes in accordance with said signal current, and said phase shifting means including a bridge circuit and an inductance device connected with said supply circuit.

8. A system including means including a space discharge device for producing radio frequency current, a source of signal current, means including a bridge circuit rectifier for producing flow of direct current in accordance with said signal current from a supply source of constant frequency alternating voltage, means including a resistance device and an inductance device having an iron core for changing the phase of said supply source voltage in accordance with said flow of said direct current, and means including another rectifier comprising a pair of interconnected gas-filled tubes having anode, cathode and grid electrodes for supplying rectified voltage from said supply source to said space discharge device in accordance with said changes of phase of said supply source voltage.

9. A signaling system including a source of carrier waves, a source of signals, means for modulating said carrier waves in accordance with said signals, and means for separately modulating said carrier waves in accordance with said signals including rectifier apparatus comprising a pair of interconnected gas-filled tubes each having grid and plate electrodes, a constant frequency alternating current power supply source connected with said grid and plate electrodes for supplying potentials of similar frequency thereto, a bridge circuit rectifier energized from said power supply source and connected with reactance means varying the phase relation between

said potentials in accordance with said signals for causing said first-mentioned rectifier apparatus to supply rectified voltage from said alternating current supply source in accordance with said signals and means connected with and preventing
5 said bridge circuit rectifier from supplying rectified current to said reactance means in the absence of said signals.

10 10. Apparatus including a radio frequency oscillation producing device, a rectifier connected with said device for supplying rectified voltage from a constant frequency alternating voltage power supply source to said device, said rectifier
15 having grid electrodes, a phase-changing circuit including iron-cored inductances connected with said source and said grid electrodes for changing the phase of said alternating voltage applied to said grid electrodes of said rectifier, a link circuit coupling said inductances, a source of signal current,
20 and a rectifier connected with said link circuit and said signal current source for causing direct current to flow through said link circuit in accordance with said signal current thereby

variably saturating said iron cores of said inductances, changing the value of inductance in said phase-changing circuit, changing said phase of said alternating voltage applied to said grid electrodes, and supplying said rectified voltage to said
5 device in accordance with said signal current.

11. Apparatus for supplying signal-modulated rectified current to a radio system from an alternating current power supply source comprising a rectifier including a pair of gas-filled tubes each
10 having grid and plate electrodes, a circuit connecting said plate electrodes with said power supply source, a circuit including a resistance device and inductance devices connecting said grid
15 electrodes with said source, a link circuit coupling said inductance devices, a bridge circuit rectifier having tubes energized from said power supply source connecting said link circuit with a source
20 of signal currents, and means rendering said bridge circuit rectifier inoperative in the absence of said signal currents.

HERBERT J. SCOTT.