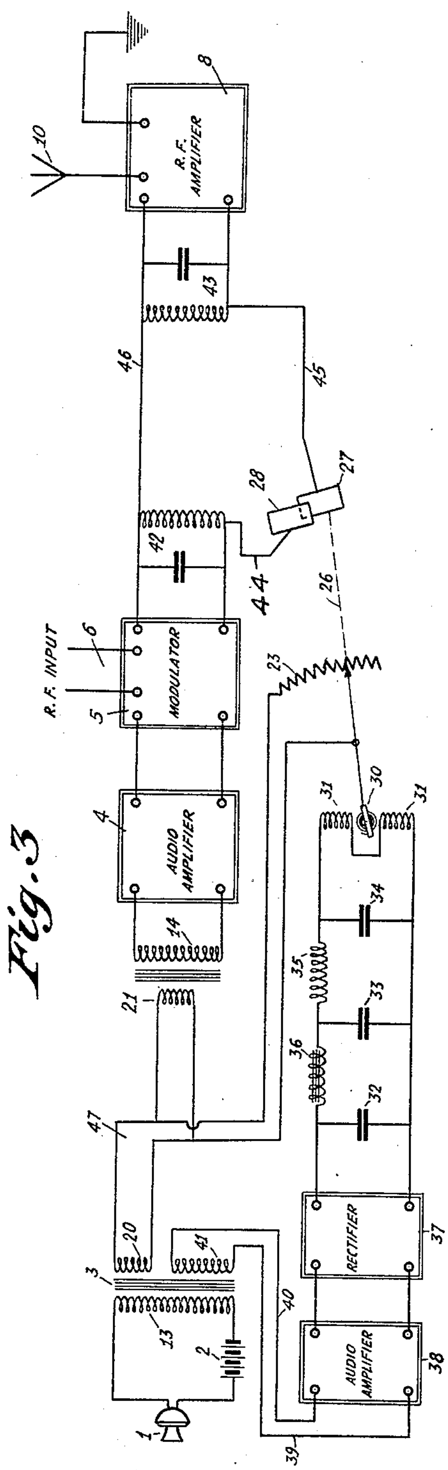
Feb. 14, 1933.

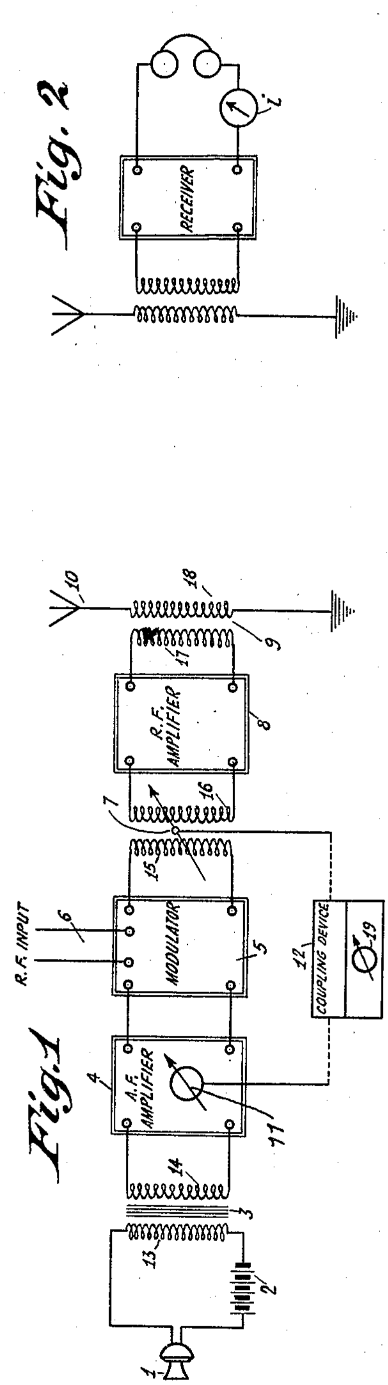
W. VAN B. ROBERTS

1,897,767

WIRELESS SIGNALING DEVICE

Filed April 2, 1929





INVENTOR
WALTER VAN B. ROBERTS
BY [signature]
ATTORNEY

Patented Feb. 14, 1933

1,897,767

UNITED STATES PATENT OFFICE

WALTER VAN B. ROBERTS, OF PRINCETON, NEW JERSEY, ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE

WIRELESS SIGNALING DEVICE

Application filed April 2, 1929. Serial No. 352,037.

This application is a continuation in part of my copending application entitled "Signaling methods and means therefor", Serial No. 310,240, filed October 4, 1928, patented May 17, 1932, No. 1,858,810.

My invention broadly relates to a method of radio transmitting and receiving and, more particularly, to a method of transmitting signals which is especially and admirably adapted for ordinary broadcasting service where absolute freedom from outside disturbances is the great desideratum.

While my invention in its complete aspect particularly relates to ordinary broadcast transmission as understood commercially, the main features of the invention are applicable generally to any type of transmission and receiving systems.

Broadly, the object of my invention is to provide an improved continuous wave system of radio communication in which the percent modulation of the carrier wave is maintained approximately constant by means of varying the intensity of the carrier wave and the audio modulation energy simultaneously.

More particularly, the object of my invention is to provide a novel and improved method of broadcasting.

In its more general aspect, my invention has for one of its objects the provision for so varying the intensity of the carrier wave that, at the receiving end, the effect of strays brought into the receiver by the carrier wave is more or less distributed proportionally according to the intensity of the signal with a result that the effect of static upon the translator device will not be of such intensity that the signal will be completely obliterated.

Another object of my invention is to provide means whereby it is possible, by controlling the energy at the transmitting station, to greatly improve the quality of signal reception at the receiving station.

Still another object of my invention is to provide a device for lessening the effect of strays on the receiving device in radio systems without, in any way, affecting the quality of the received signal.

Still another object of my invention is to provide means for accomplishing all of the above objects automatically.

At the present time, in the usual method of radio transmission it is known that at the receiving end, when customary signals are transmitted, a great deal of outside noises probably in the majority of cases due to strays combining with the carrier wave are heard through the reproducer. These undesired sounds are especially noticeable during the transmission of soft signals, that is to say, signals which are transmitted by means of a carrier wave with a very low percentage of modulation.

Taking, as an example, the transmission of music, a clear illustration of what is meant may be had in the case when what might be termed soft portions of the composition being transmitted are being played. It is known that in such radio transmission devices the customary method of transmitting the signal is to generate a carrier wave which is practically always of constant amplitude. It is seen that, under these conditions, when the percent modulation is small the effect of static on the carrier wave, since the carrier wave is of practically constant intensity, will be the same whether the signal be loud or soft with the result that the effect will be disagreeable to the ear during the so called soft interval of receiving.

For a proper understanding of my invention, it is first desirable to mathematically show the following conditions:

After modulation, the oscillating current amplitude varies in accordance with

$$1+\frac{AE_s}{E_B}\cos\psi t$$

Where E_s represents the voltage developed by the microphone, A the voltage amplification and E_B a constant, $\psi/2\pi$ is a typical audio frequency. The maximum audio frequency volts equals AE_s.

After amplification, the energy, is sent to the antenna, and the radiation may be expressed by the formula:

$$H_c\cos pt\left(1+\frac{AE_s}{E_B}\cos\psi t\right)$$

where H_c is proportional to the carrier wave amplitude and $\rho/2\pi$ is the carrier wave frequency. At the receiving end current of frequency $\frac{\psi}{2\pi}$ is determined by

$$H_C{}^2\frac{AE_s}{E_B}$$

If E_s is very small for an extended period of time, it would be well to increase A so as to keep $\frac{AE_s}{E_B}$ equal to about 50%, and reduce H_c enough so that the received current is not changed. It is evident, reducing H_c reduces the amplification of noise by H_c.

The novel features, which I believe to be characteristic of my invention, are set forth with particularity in the appended claims. The invention itself, however, as to its organization and method of operation, together with further objects and advantages thereof, will be best understood by reference to the following description taken in connection with the accompanying drawing in which I have illustrated diagrammatically a preferred embodiment of my invention.

In said drawing

Figure 1 illustrates a transmitting station incorporating the main features of my invention:

Figure 2 is inserted merely for purposes of explanation and diagrammatically represents any ordinary receiving station: and

Figure 3 illustrates diagrammatically a transmitting station incorporating my invention whereby the desired changes are made automatic.

The system illustrated in Figure 1 comprises the usual microphone circuit with microphone 1 source of current 2 and the primary 13 of an audio transformer 3. The microphone circuit is connected to the input 14 of an audio frequency amplifier 4 through the medium of said audio transformer 3. As will be noted the amount of amplification taking place in amplifier 4 may be controlled by means of device 11 which affects the amplification in any well known manner.

As shown the output of device 4 is coupled to the input of a modulator circuit 5, shown diagrammatically. This modulator device besides being supplied with the amplified audio frequency from devices 1 to 4 has means designated by 6 for receiving radio frequency energy. The modulator device 5 may be of any suitable type and as is apparent and well known in the art serves the purposes of combining the carrier wave with the desired modulations. It is customary to further amplify the resulting modulated radio frequency and for this purpose radio frequency amplifier 8 is shown the input 16 of which is coupled to the output 15 of modulator 5 by means of a variable coupling 7. Coupling device 7 is made variable so that the energy transferred from modulator device 5 to radio frequency amplifier 8 may be varied. The output 17 of radio frequency amplifier 8 is coupled in any well known manner, here shown as coupling device 9, to the usual antenna 10, which is tuned by means of inductance 18. However, antenna 10 may be tuned in any suitable manner.

The operation of the device thus far described is as follows: The signals which are desired to be transmitted are impressed upon microphone 1 whereby a current varying in intensity in accordance with the signals is made to flow around circuit 1, 2 and 13. This varying current is impressed upon the device 4, where it is greatly amplified and then fed to the modulator circuit 5. At this point the amplified audio frequency energy is superimposed on the radio frequency or carrier wave fed to 5 through 6 in a manner well known in the art with the result that a modulated carrier wave is produced in the output of device 5, at which point said modulated carrier wave is transferred by means of a coupling device 7, shown variable, to an additional amplifier and from whence it is transmitted through the medium of antenna 10 as is well known in the art.

It is evident that by means of variable device 7 the amount of energy transferred from circuit 5 to circuit 8 may be varied from practically nothing to a maximum in accordance with the closeness of the variable coupling between 15 and 16. Also, by means of device 11 the amount of amplification resulting in circuit 4 can be regulated in well known manner. It is therefore, conceivable that if the transference of energy through 7 is lessened, the energy at 4 can be sufficiently amplified so that the result as far as the loudness of signals is concerned at the receiving station is the same as it would have been without these changes. Analyzing this procedure it is evident that what has been done is to decrease the intensity or amplitude of the carrier wave and increase the percent modulation. For convenience the two varying elements may be combined so that one control will operate both in such a manner that when one decreases the other one increases sufficiently to compensate for the change and thus cause no disturbance at the receiving end. Such a scheme is illustrated diagrammatically at 12, Figure 1, which device is manually operated through 19 as follows:

During transmission the operator sits by control 19 and either listens to the signals being broadcast or watches a meter which may be arranged in any convenient manner to measure the audio frequency input at 14. When the signal is of a "soft" nature he operates 19 so as to decrease the intensity of the carrier wave and at the same time increase the percent modulation with the result that any static combining with the carrier wave will necessarily be very little amplified thereby.

It is evident from the mathematical consideration (supra) that what is really happening is that the single control device 12 is being used to increase A and decrease H_c sufficiently to keep H^2_cA constant; that is, the operator endeavors to keep AE_s constant by working the control, the effect of this control being only to reduce the noise at the receiver but not change the volume. It is to be noted that the ratio of studio noises to signals is not increased by this adjustment but the ratio of atmospherics to signals is reduced. That is to say, the gain control and the amplifier input are geared together in such a way that the effect is that at the receiving end (see Figure 2) i is not changed by turning the controls provided, of course, the proper ratios are chosen. It is, of course, desirable to accomplish the changes as described above automatically and for this purpose I have devised of the mechanism and circuit shown schematically in Figure 3. In said figure the system comprises the microphone 1, source of current 2, and primary 13 of transformer 3. Coupled to said microphone circuit through the medium of the link circuit 47 is an audio amplifier 4. Link circuit 47 comprises the two transformer windings 20, 21 for coupling the link circuit 47 to 13 and 14 respectively. Audio amplifier 4 is connected to a modulation circuit 4 having radio frequency input 6. Device 5 is similar to the device 5 of Figure 1, its function being to mix the two waves fed therein, whereby the radio frequency wave is modulated according to the signal. As in the case of the mechanism shown in Figure 1, the energy from 5 is fed to a radio frequency amplifier 8 and from there it is transmitted by antenna 10 in any well known manner. Tuned circuits 42 and 43 serve as coupling circuits through the medium of conductors 46, 44 and 45. As shown a condenser device 27 and 28 is interposed between conductors 45, 44 thus the amount of energy transferred from 5 to 8 can be varied. Shunted across link circuit 47 by means of conductors 22, 24 is a variable resistance device 23, 25. Transformer 3 has a second winding or a tap 41 which by means of conductors 39, 40 is connected to audio frequency amplifier 38. Energy therefrom is fed to a rectifying circuit 27 of any well known kind. From thence it is fed to a smoothing out circuit made up of series choke coils 35, 36, and parallel condensers 32, 33, and 34. Connected to the output of the smoothing out circuit is a field coil 31 having a spring controlled permanent magnet 30 operatively connected to arm 24 and adapted to control the movement thereof so as to vary the resistance 23 in well known manner.

As is shown the insulator 26 is attached to arm 25 whereby the coupling effect of the condenser device 28, 27 may be varied simultaneously with the resistance 23.

The device thus far described operates as follows: The signals which are desired to be transmitted are, as in the case of Figure 1, impressed upon microphone 1, whereby a current varying in intensity in accordance with the signals is made to flow around circuit 1, 2, 13. This varying current as stated before is fed to audio amplifier 4 then to modulator 5 where it is made to combine with energy coming in from radio frequency source 6. This results in a modulated radio frequency. This energy is then transferred to the amplified circuit 8 and transmitted through the medium of antenna 10, as is well known. Speech voltage is also amplified by the audio frequency amplifier 38 fed through the second winding 41 of transformer 3 by means of conductors 39 and 40. It is then rectified in device 17 filtered or smoothed out in the filter chain and the resulting direct current, which of course varies with the average volume of the speech input, is allowed to go through the field coil 31 so as to affect the permanent magnet 30 against the spring as shown. The pointer 25 attached to the magnet in any desired manner may preferably dip in a thin trough of mercury as diagrammatically represented by the resistance 23.

From the drawing it can readily be seen that, if the magnet moves the resistance between the moving point and one end of the trough is varied. This variable resistance shunts the low potential large current link circuit 47. When the resistance is great speech voltage is transferred to the upper audio frequency amplifier without substantial reduction. The trough cross section is so varied that whatever the speech input the speech voltage leaving the link is constant. Hence the average speech voltage on the modulator is constant.

As illustrated the moving magnet also moves the condenser plate 28 carried on the insulated arm 26. This varies the capacity coupling from the modulator to the radio frequency amplifier. The shape of the plates on the condenser are such that the coupling is varied in such a manner that the audio output of the receiver varies with speech input to the microphone in the usual manner, although the percent modulation of the radiated wave remains constant on the average.

What I claim is:

1. In a wireless signaling system in which a carrier frequency is modulated by a signal frequency, the combination with a modulator of a source of carrier frequency, a source of signal frequency, both said sources being op-

eratively connected to the modulator, a transmitting antenna system variably coupled to said modulator, a link circuit for coupling said source of signal frequency to said modulator, a rectifying system, an amplifier circuit having its input coupled to said source of signal frequency and its output coupled to the input of said rectifying system, a smoothing out circuit having its input coupled to the output of said rectified system and its output coupled to a field coil device, a resistance shunted across said link circuit and means controlled by said field coil for varying said resistance, said means also being adapted to control the amount of modulated carrier frequency transferred between said modulator and said antenna.

2. In a wireless signaling system in which a carrier frequency is modulated by a signal frequency, the combination with a modulator of a source of carrier frequency, a source of signal frequency both said sources being operatively connected to the modulator, a transmitting antenna system variably coupled to said modulator, an amplifier circuit having its input coupled to said source of signal frequency and its output coupled to the input of a rectifying system and means coupled to the output of the rectifying system including an electrical inertia circuit for controlling the amount of signal energy fed from said source of signal frequency to said modulator and for varying the coupling between said antenna system and said modulator in accordance with the average changes of signal level.

3. In combination, a source of signal energy, a source of carrier energy, means for modulating carrier energy with the signal energy, an antenna circuit, a variable reactance between the antenna circuit and modulating means to control the amount of carrier energy radiated, a direct current circuit including an electrical inertia device and means for producing a flow of direct current therethrough proportional in intensity to the average intensity of the signal energy and means controlled by said flow of direct current for varying said reactance inversely to the intensity thereof.

4. In a radio signaling system, a source of signal energy, a source of carrier energy, means for amplifying in a predetermined manner signals of variable amplitude, means for modulating carrier energy by the amplified signal energy and means for reactively controlling in inverse manner relative to the amplification of the signal energy the amount of modulated carrier energy radiated, said means including a filter circuit coupled through electrical means to said source of signal energy whereby said controlling action operates on average changes in amplitude of said signals and does not respond to rapid changes thereof.

5. In a radio signaling system, a source of variable amplitude signal energy, an amplifying circuit therefor, means for varying the output of said amplifying circuit, a source of carrier energy, means for modulating the carrier energy by amplified signal energy, means for reactively controlling the amount of modulated carrier energy radiated, a direct current source including a filter circuit coupled through electrical means to said signal source and having a current flowing therein proportional in intensity to the amplitude of the signal energy and means controlled by said current flow for controlling said first named means and said last named means in accordance with the intensity of said flow.

WALTER VAN B. ROBERTS.