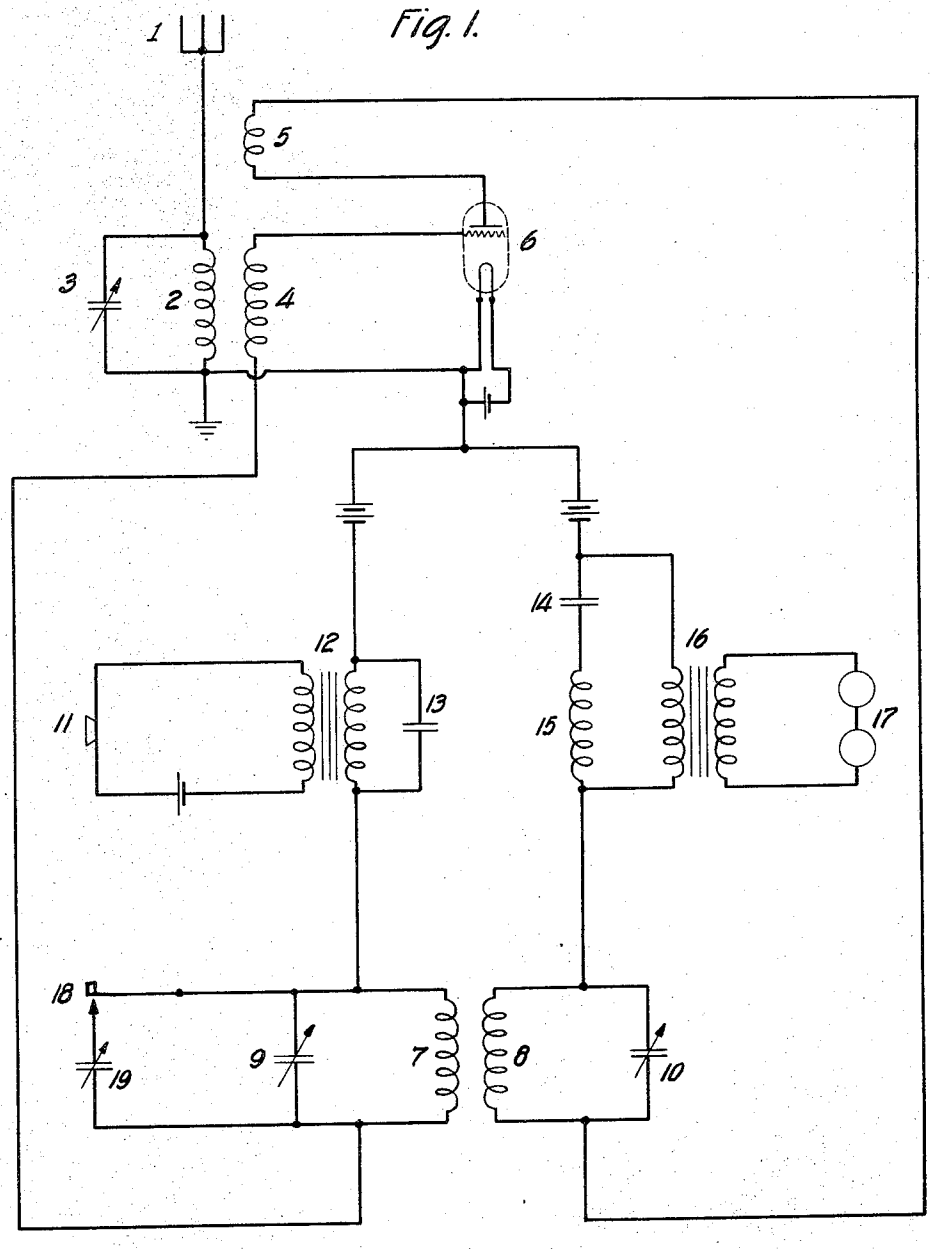
Dec. 17, 1935. E. H. ARMSTRONG 2,024,138

RADIO SIGNALING SYSTEM

Filed Oct. 21, 1930 3 Sheets-Sheet 1

Fig. 1.



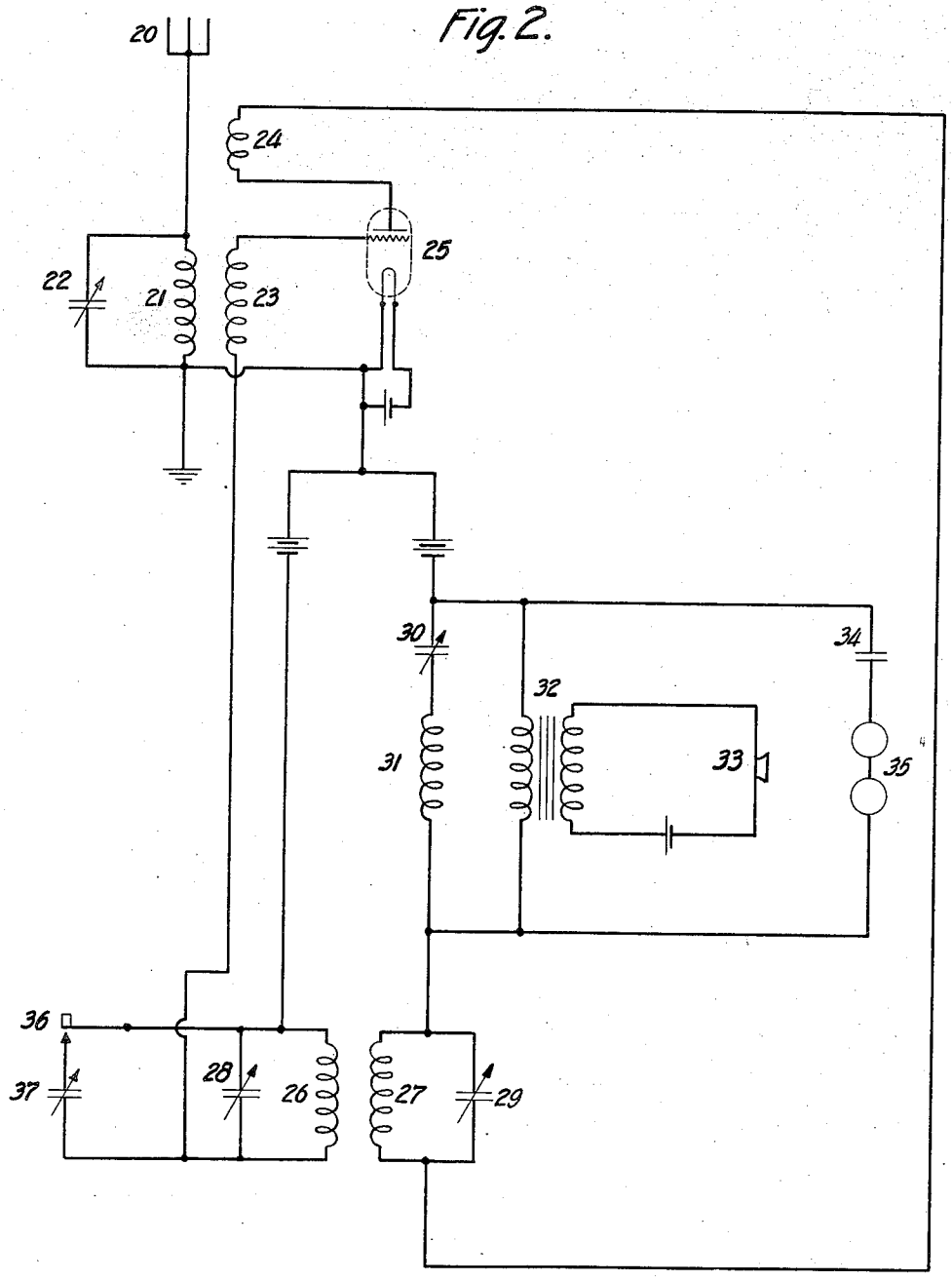
INVENTOR
Edwin H. Armstrong.
BY Moses & Nolte
ATTORNEYS

Dec. 17, 1935. E. H. ARMSTRONG 2,024,138

RADIO SIGNALING SYSTEM

Filed Oct. 21, 1930 3 Sheets-Sheet 2

Fig. 2.



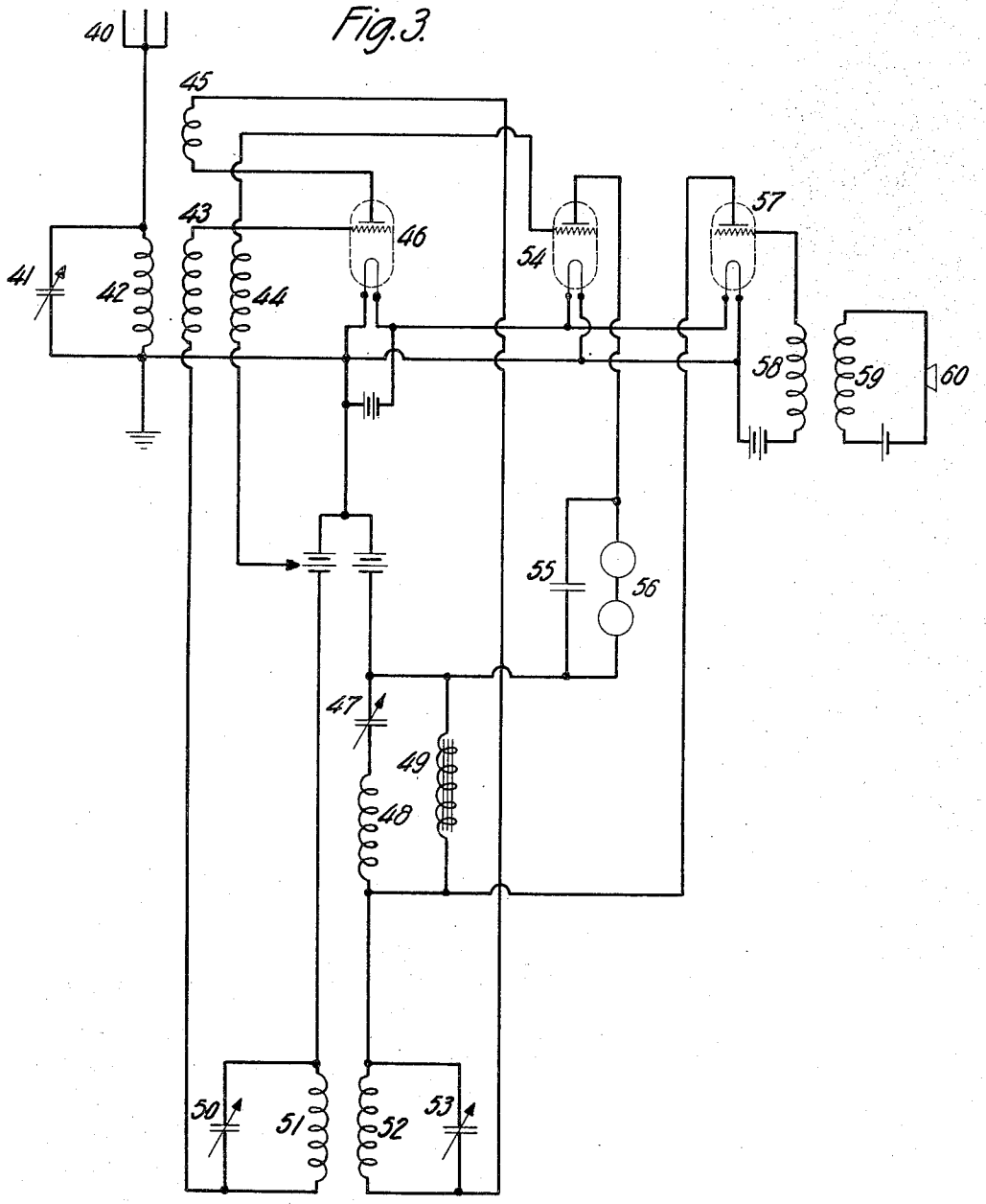
INVENTOR
Edwin H. Armstrong.
BY Moses & Wolte
ATTORNEYS

Dec. 17, 1935. E. H. ARMSTRONG 2,024,138

RADIO SIGNALING SYSTEM

Filed Oct. 21, 1930 3 Sheets-Sheet 3

Fig. 3.



INVENTOR
Edwin H. Armstrong
BY Moses & Nolte
ATTORNEY

Patented Dec. 17, 1935

2,024,138

UNITED STATES PATENT OFFICE

2,024,138

RADIO SIGNALING SYSTEM

Edwin H. Armstrong, New York, N. Y.

Application October 21, 1930, Serial No. 490,129

9 Claims. (Cl. 250—9)

This invention relates to a method of duplex operation in radio signaling systems.

Its object is to provide a simple compact system which is at once capable of acting both as transmitter and receiver.

The invention consists in utilizing the principle of super regeneration in the manner hereinafter described so that the same regenerative system becomes at once a transmitter and receiver.

Figure 1 illustrates the general arrangement of apparatus suitable for carrying out the invention;

Figure 2 illustrates an alternative method; and Figure 3 illustrates an arrangement more suitable for higher powers.

Referring now to Figure 1, 1 represents a receiving antenna, 2 a coil inserted in the antenna, 3 a tuning condenser in parallel with this coil, 4 a coil coupled to the antenna coil 2 and connected to the grid of a vacuum tube 6, in the plate circuit of which a coil 5 is arranged to produce regenerative coupling with the grid coil 4. That is, the parts designated 1 to 6, inclusive, represent an ordinary regenerative system. 7, 8, 9, 10 represents a feed back arrangement for generating the auxiliary frequency for producing super regeneration. 11, 12, 13 represents a voice modulating arrangement inserted in the grid circuit and 16, 17 a telephone transformer and telephone receiver. 14, 15 is a bypass circuit.

The above description represents one end of the circuit. The same apparatus is employed at the other end. The method of operation is as follows. One of the properties of a super-regenerative receiver is that it will oscillate violently with a very small received signal, or in fact, with no received signal at all. Under these conditions the super-regenerative receiver becomes a very effective transmitter radiating, or rather re-radiating a signal of the same character as that which it is receiving. It is therefore, at the same time a sensitive receiver and an effective radiator of electric waves. The amplitude of the radio frequency current in a super-regenerative system will depend upon two things, one, upon the strength of the incoming signal and, two, upon the voltage applied to the plate of the tube. Any variation in the strength of the incoming signal, such as may be imposed upon it by an amplitude modulation, as in telephony, will produce a change in the strength of the high frequency current in the system and hence a response in the telephones corresponding to the variation in the strength of the radio frequency current. Similarly, any variation in the plate voltage of the tube produced by local means will modulate the strength of the signal which is radiated. This is done in the present system by the microphone 11 which modulates through the transformer 12 the grid circuit of the vacuum tube 6. By thus applying a local means of modulation of the plate voltage it is possible to modulate the strength of the radiated wave in the transmitted signal. In other words, the same device is at once a receiver and a transmitter.

There are two methods of operating this system with respect to the values of the intermediate frequencies to be used. Where telephony is employed the auxiliary frequencies will, of course, be above audibility but unless they are synchronous or differ by an amount above audibility a continuous note will be obtained due to the beats between the two modulations. Therefore, the two auxiliary frequencies must be set approximately the same when they will automatically synchronize or so chosen that one, for example, is 30,000 and the other 50,000. In this case the beat frequency will be 20,000 which will not be disturbing. The operation of the system of Figure 1 will be apparent from the foregoing. In transmission the system operates as follows: When no speech is being applied to the microphone 11 the regenerative system 2, 3, 4, 5, 6 is generating a radio-frequency current which is modulated at a super-audible frequency by the auxiliary or oscillating system 7, 8, 9, 10. This wave is radiated from the antenna 1.

When the microphone 11 is spoken into there is induced in the secondary of transformer 12 an electro-motive force of voice frequency which is applied to the grid of tube 6. This modulates the strength of the radiated high frequency current in the manner well understood in the art. There is thus radiated from the antenna a wave which is modulated both at audible and at super-audible frequencies.

The operation of the system as a receiver is as follows: The wave radiated as above described from one station is received at the other station of the duplex system, the manner of its reception and amplification being described in my prior patent dated July 25, 1922, #1,424,065 for Signaling systems. The presence of the super-audible modulation in the received wave will not interfere with the super-regenerative action of the receiver or create undesirable noises, provided the auxiliary frequency of the receiving station is chosen in the manner hereinabove explained, i. e., to be the same as the auxiliary frequency at the

transmitter or to differ therefrom by an amount above audibility, so that the beat produced by reason of the super-audible modulation will be either of substantially zero frequency or of higher than audible frequency.

When it is desired to utilize the system as a duplex telegraph a key 18 controlling a small condenser 19 may be employed to shift the auxiliary frequency at the station which is transmitting so as to bring it within an audible range of the auxiliary frequency used at the other stations. This also furnishes a convenient method of calling when the primary object of the system is telephony.

In Figure 2, 20 represents a receiving antenna, 21 a coil in the antenna, 22 a tuning condenser in parallel with the coil, 23 a coil coupled to the antenna coil 21 and connected to the grid of the vacuum tube 25 in the plate circuit of which a coil 24 is coupled to the grid coil 23 to produce regenerative feed back. In other words, the parts designated 20 to 25, inclusive, represent an ordinary regenerative circuit tuned to the frequency of the incoming signal.

26, 27, 28, 29 represents a feed back arrangement for generating the auxiliary frequency to produce a super-regeneration, 26 and 27 being the coils inserted, respectively, in the grid circuit and the plate circuit of the tube 6, and 28 and 29 being, respectively, the condensers connected across coils 26 and 27, respectively, for the purpose of tuning these circuits to the auxiliary frequency desired. 32, 33 is a modulating system for producing plate modulation. 30, 31 is a bypass system and 35 is the telephone receiver connected in parallel with the secondary of the transformer 32. The operation of the system is substantially the same as that of Figure 1 except that the modulation is accomplished in the plate instead of in the grid circuit. This is carried out by means of the microphone 33 which, through transformer 32, produces a variation of the voltage applied to the plate of the vacuum tube 25 and thereby modulates the strength of the radio frequency signals. The circuit 30—31 connected across the secondary of the transformer 32 is for the purpose of furnishing a path of low impedance for the auxiliary frequency to pass by the high impedance of the secondary.

In Figure 3 the tube 46 is arranged in substantially the same super-regenerative circuit as in Figure 2. A separate tube 54 is used as a detector being coupled to the antenna circuit by coil 44. Modulation is accomplished by a separate tube 57 which varies the plate voltage of the tube 46 by means of the choke coil 49. The condenser 47 and the inductance 48 are a convenient means of bypassing the choke 49. The operation of the system is substantially the same as the operation of the arrangement of Figure 2, the only difference being the accomplishment of detection and modulation by separate tubes.

That is, the function of tube 46 and its associated circuits is wholly to produce super-regeneration. Coupled with the grid coil of this tube is a coil 44 which is connected to a secondary tube 54 which is biased to act as a detector. This tube rectifies the radio frequency signaling currents in the coil 44 and indicates them in the telephone receivers 56. The function of tube 57 is to amplify the current produced by the microphone 60 which controls its grid potential through the transformer 58—59 up to a point where effective modulation of the plate voltage of the tube 46 is secured. This is accomplished by means of the choke coil 49 which is common to the plate circuits of the tubes 46 and 57. That is, the modulation is accomplished in what is commonly referred to as choke coil plate modulation.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. A duplex radio signaling system comprising at each end a super-regenerative receiver for the reception of signals transmitted from the other end, each such receiver comprising means for transmitting a wave of radio frequency, and means associated with the transmitting means of each receiver for impressing signals on the wave transmitted thereby.

2. A duplex radio signaling system comprising at each end a super-regenerative receiver for the reception of signals transmitted from the other end, each such receiver comprising means for generating an auxiliary frequency and means for transmitting a wave of radio frequency, and means associated with the transmitting means of each receiver for impressing signals on the wave radiated thereby, the auxiliary frequency of the one receiver being approximately the same as that of the other receiver.

3. A duplex radio signaling system comprising at each end a super-regenerative receiver for the reception of signals transmitted from the other end, each such receiver comprising means for generating an auxiliary frequency and means for transmitting a wave of radio frequency, and means associated with the transmitting means of each receiver for impressing signals on the wave radiated thereby, the auxiliary frequency of one receiver differing from that of the other receiver by an amount above audibility.

4. The combination with a super-regenerative receiver for incoming signals, comprising means for radiating radio frequencies, of means for producing a modulating current and means for causing said current to modulate the radio frequency radiated by the receiver.

5. The method of simultaneously transmitting and receiving signals over the same circuit which comprises generating oscillations in said circuit; periodically starting and stopping the oscillations; and maintaining a continuous transient condition of the oscillations for the simultaneous transmission and reception of signals.

6. The method of simultaneously transmitting and receiving signals over the same channel and the same circuit which comprises generating oscillations in said circuit; periodically starting and stopping the oscillations in a manner to maintain a continuous transient condition of said oscillations; varying the peak values to which the oscillations are allowed to grow in accordance with signals to be transmitted; and utilizing the transient oscillation for simultaneously receiving signals.

7. The method of simultaneously transmitting and receiving signals over the same circuit which comprises generating regenerative self-oscillations in said circuit; periodically starting and stopping the oscillations in a manner to maintain a continuous transient condition; modulating said oscillations by varying the peak values to which the oscillations are permitted to grow during the starting periods in accord-

ance with signals to be transmitted; and utilizing the transient oscillations for simultaneously receiving signals over the same circuit.

8. In a system of duplex radio communication over the same circuit comprising a resonant circuit; means including a self-oscillating discharge device connected with said circuit for generating carrier oscillations therein; means for periodically starting and stopping said oscillations in a manner to maintain a continuous transient condition of the oscillations; means for varying the peak values to which the oscillations are permitted to grow during the starting periods in accordance with signals to be transmitted; an antenna circuit coupled with said resonant circuit; and means including said oscillating discharge device for translating received signals simultaneously in said circuit.

9. The method of signaling which comprises generating carrier oscillations; periodically starting and stopping said oscillations at a frequency above audibility and in a manner to maintain a continuous transient condition; modulating the carrier oscillations in accordance with signals to be transmitted by varying the peak values with respect to a fixed zero reference line to which the oscillations are permitted to grow and transmitting these modulated signals to a remotely disposed receiving station.

EDWIN H. ARMSTRONG.