

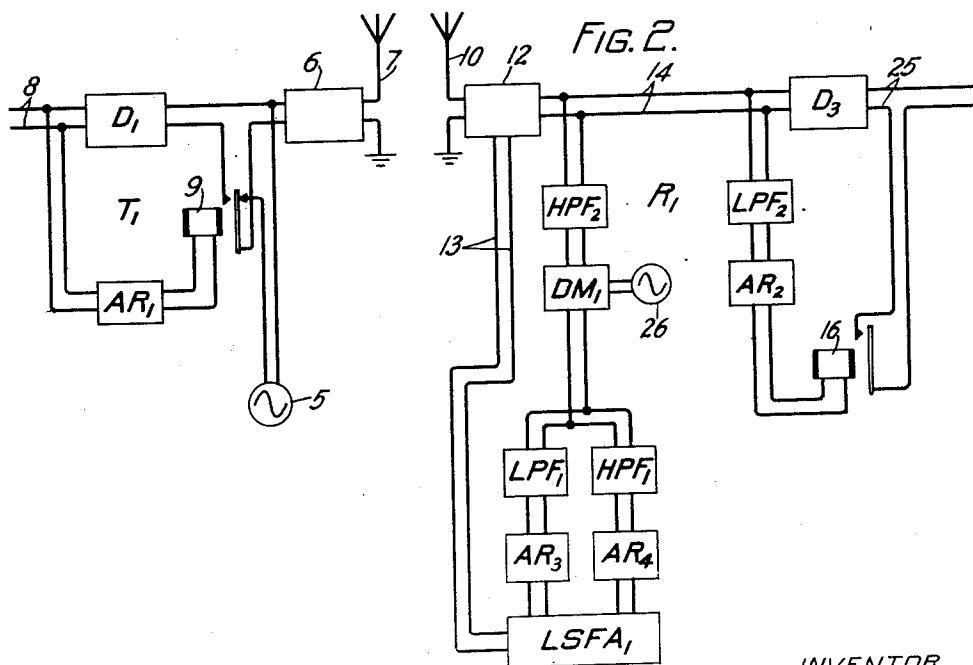
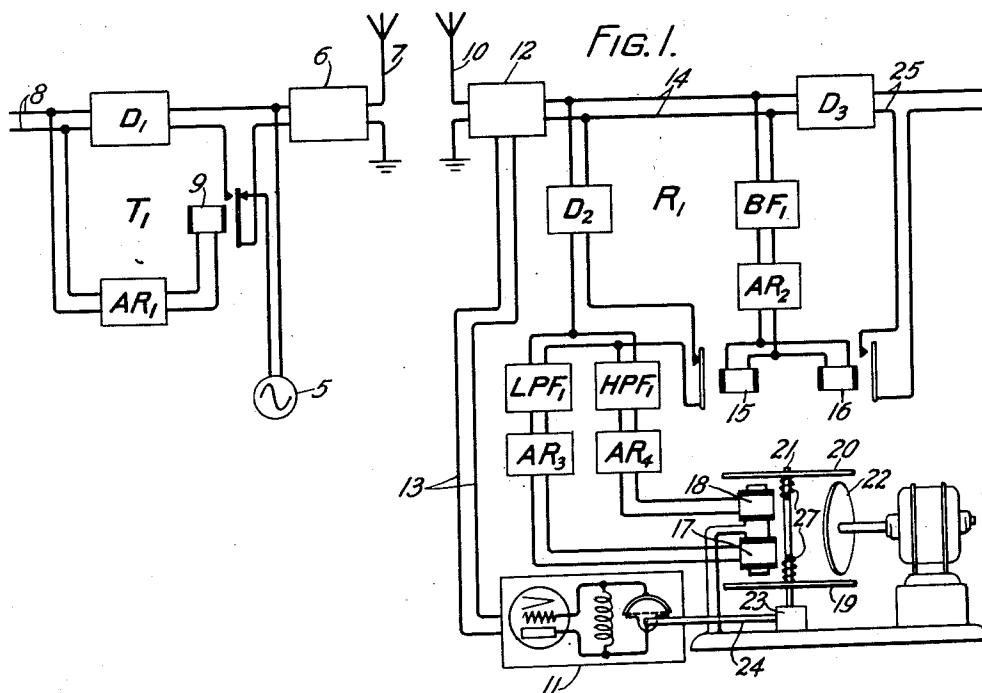
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RADIO COMMUNICATION SYSTEM

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RADIO COMMUNICATION SYSTEM

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This invention relates to carrier signaling systems and more especially to systems of the type in which the unmodulated carrier wave component is suppressed.

5 It is well known that in carrier systems suppression of the unmodulated carrier component results in a very material saving of the power necessary at the transmitting station. Suppression of one side band of the
10 products of modulation results in a further saving of power. However, in either case it is necessary for detection at the receiver that oscillations of carrier frequency or oscillations having a fixed frequency relative to the
15 carrier generated at the transmitting station be introduced to combine with the incoming signal modulated components.

In carrier telephone systems it is especially important to maintain a fixed frequency relation between the transmitting carrier and the introduced oscillations. If the frequency of either the transmitting carrier wave or that of the wave introduced at the receiving station varies from its fixed value,
20 the efficiency of transmission is materially reduced. This inefficiency may be due to the loss of naturalness in the tones transmitted or, in the case of a heterodyne system, to the fact that the resultant intermediate frequency wave differs in frequency from that for
30 which the intermediate frequency amplifiers and circuits are designed whereby a loss in output level is occasioned and distortion of the wave may occur.

35 Considerable difficulty has been experienced in maintaining the oscillations locally produced at the receiver at a fixed frequency with respect to the carrier wave generated at the transmitter. Systems have heretofore
40 been proposed to automatically control the frequency relations between the transmitted carrier wave and the oscillations locally supplied at the receiving station but such systems have not been entirely satisfactory because the control function is only effected
45 when no messages are being transmitted. In all of these systems control of the frequency relation occurs at definite intervals rather widely spaced as to time. With such systems,
50 the relationship between the frequen-

cies supplied at the transmitter and receiver may be correct at the beginning of a message period but before the transmission has been completed, the frequency of one or the other of the supply sources may have varied from its original value to such an extent that the transmission efficiency has been materially reduced. 55

An object of this invention is to provide a method of and means for improving transmission in a carrier signal system. 60

Another object is to cause the frequency control function to be effective automatically and from time to time during a message period. 65

Still another object is to permit frequency control to be effected during individual message periods.

The above objects are accomplished in one embodiment of the invention, by providing means whereby the synchronizing mechanism is brought into operation during momentary pauses in a message period. 70

More specifically, means are provided whereby during a pause between impulses, constituting elements of a message, a control wave is supplied to the transmitter and is transmitted in place of the signals. The control wave may lie either within or outside the audible range. 80

When transmission of the message impulses begins again, the mechanism supplying the control wave is disconnected from the transmitter until the next pause occurs, when it again becomes active to supply the control wave to the transmitter. 85

At the receiving station the control frequency wave is reproduced and if adjustment is necessary, is used to control the actuation of a frequency changing device in the local oscillator circuit. 90

Other features of the invention will be apparent from the following description in connection with the accompanying drawings, Fig. 1 of which shows schematically one embodiment of the invention in which the control wave has a frequency within the audible range, while Fig. 2 is a similar illustration in which the control wave has a frequency at the upper limit or outside the audible range. 100

Referring to Fig. 1, a transmitting station according to this invention is illustrated schematically at T_1 while a cooperating receiving station is illustrated schematically at R_1 . The various component parts of the system are represented by blocks, since the structure of such parts is well known and may vary as to details but will remain within the scope of the invention.

It is also to be understood that whereas the invention is to be described in connection with a radio system, it is not necessarily so limited and may be applied to any system using a carrier wave for transmission purposes whether over wires or not, in which it is necessary to introduce a wave at the receiving station having a frequency fixed relatively to that of the transmitting carrier to enable detection of the signals.

A radio transmitting system 6 associated with antenna 7 is adapted for transmitting messages in the well known manner. For this purpose transmitter 6 comprises the usual high frequency source, modulator, high and low frequency amplifiers and other necessary equipment, the details of which are not essential to an understanding of the present invention.

The synchronizing tone which is assumed to be within the audible range is generated in any desired manner by source 5. For the purposes of the present description, the frequency of the synchronizing wave has been chosen as 1000 cycles.

A time delay circuit D_1 and an amplifier rectifier AR_1 are associated with line wires 8 on which are impressed the speech or other signal waves to be transmitted as modulations of the carrier wave. Relay 9 is associated with amplifier rectifier AR_1 for a purpose and in a manner which will appear hereinafter.

At the receiving station R_1 an antenna 10 is associated with radio receiver apparatus 12 adapted to receive, amplify and detect the incoming wave consisting of a single side band transmitted from T_1 . The local wave essential to detection is generated by source 11 and impressed on receiver 12 over circuit 13. Source 11 may comprise a vacuum tube oscillator of the type disclosed in Hartley Patent 1,356,763, October 26, 1920, having one element of the frequency determining circuit variable to permit of adjustment as will appear hereinafter. The invention however is not to be so limited but any wave source which may be varied as required may be utilized. The output of receiver 12 is impressed upon circuit 14 with which there is associated, as shown, a filter arrangement BF_1 adapted to pass waves of all frequencies except those between 990 cycles and 1010 cycles.

An amplifier rectifier AR_2 is associated

with the filter arrangement BF_1 and has associated with it two relays 15 and 16.

Also associated with circuit 14 is a delay circuit D_2 , the output of which is impressed upon low pass and high pass filters LPF_1 and HPF_1 respectively through armature and contact of relay 15. Each of the filters LPF_1 and HPF_1 has an amplifier rectifier AR_3 and AR_4 respectively associated with it.

Magnets 17 and 18 are connected to the output of amplifier rectifiers AR_3 and AR_4 respectively. Magnets 17 and 18 are associated with discs 19 and 20 which are mounted on shaft 21 so that the discs may slide along the shaft but are keyed to it for rotation. The magnets are supported independently of shaft 21 and may be designed to permit shaft 21 to pass freely through them. If desired the magnets may be mounted adjacent the shaft but offset therefrom. Springs 27 or equivalent means, are provided to return discs 19 and 20 to their normal positions when the associated magnets are deenergized.

A motor M drives constantly rotating disc 22 so positioned in relation to discs 19 and 20 that a slight movement of either disc 19 or 20 will cause it to contact with the edge of disc 22 whereby shaft 21 may be caused to rotate in a direction depending upon which disc contacts with disc 22.

A direction changing and speed reduction gear arrangement 23 connects shaft 21 in power driving relation to shaft 24 which in turn operates a frequency determining element of the local wave source 11.

It is to be understood that the arrangement of magnets, discs, etc. by means of which the outputs of amplifier rectifiers AR_3 and AR_4 control the frequency of the wave generated at 11 is merely indicative and that any other method of accomplishing the same result may be used and still be within the scope of the present invention.

A second delay circuit D_3 is also associated with circuit 14 substantially as shown for a purpose which will appear hereinafter.

Line wires 25 upon which the output of delay circuit D_3 is impressed carry the signals to any desired point for their proper utilization.

The operation of the system of Fig. 1 is as follows:

As shown, relay 9 is in the released or unoperated position and therefore the 1000 cycle synchronizing wave generated by source 5 is impressed on the transmitter 6 over a circuit completed through the armature of relay 9. In transmitter 6 the 1000 cycle wave modulates the carrier wave and there is produced in the transmitter output circuit a single side band of the products of modulation which is impressed on antenna 7.

When speech or other signal waves are impressed on conductors 8, part of their energy

passes through amplifier rectifier AR_1 where the energy is amplified and rectified. The output of AR_1 energizes relay 9 whereupon its armature breaks the synchronizing wave contact and closes the circuit from the delay circuit D_1 to the transmitter 6 where modulation, etc., occurs and a single side band of the products of modulation is impressed on antenna 7.

Delay circuit D_1 functions to delay the transmission of the signals long enough to permit relay 9 to operate so that no part of the message is lost.

When a pause occurs during ordinary conversation or in the transmission of other signals, relay 9 becomes deenergized and the synchronizing wave is again transmitted. This condition continues until conversation is resumed or the sending of signals begins again.

At R_1 considering first the condition when the synchronizing wave is being transmitted, the single side band is received by antenna 10 and impressed on receiver 12 where it is combined with the wave from source 11 and demodulated and the resultant signal wave is impressed on circuit 14.

Band filter BF_1 is adjusted to pass all frequencies except those between 990 cycles and 1010 cycles (synchronizing waves 1000 cycles). Therefore when only the synchronizing wave is being received, relays 15 and 16 remain unoperated and the output of delay circuit D_2 is impressed upon LPF_1 and HPF_1 and the output circuit of delay circuit D_3 remains open.

Delay circuit D_2 passes the demodulated output currents from receiver 12 through armature and contact of relay 15 into LPF_1 and HPF_1 . LPF_1 passes frequencies of 998 cycles and below, while HPF_1 passes frequencies of 1002 cycles and above. If the output of receiver 12 lies between 998 and 1002 cycles, source 11 is generating a wave of a frequency sufficiently close to that desired to warrant no change in its adjustment.

If, however, the frequency of the wave from receiver 12 is below 998 or above 1002 cycles, it indicates that the frequency of the wave from source 11 has varied from its desired value far enough to require adjustment.

Assuming that the lower, or difference, side band is transmitted after modulation with the control wave, consider the case when the frequency is below 998 cycles which indicates that the wave from source 11 is more than 2 cycles below its desired value. This frequency will pass low pass filter LPF_1 and will not pass through HPF_1 .

This wave is amplified and rectified in AR_2 and the rectified energy is impressed on electromagnet 17.

Magnet 17 attracts its associated disc 19 to cause it to contact with constantly rotating disc 22 whereby disc 19 and shaft 21 are

caused to rotate. By means of reduction gear, etc. 23 and shaft 24, the motion of shaft 24 is transferred to a frequency determining element in the tuned circuit of source 11 whereby the source 11 is adjusted to its correct value.

When the correct frequency value of source 11 is attained no energy passes LPF_1 and AR_2 ; hence magnet 17 releases, disc 19 returns to its normal position under the action of springs 27 or equivalent means and shaft 21 ceases to rotate.

The same general action occurs if the output of receiver 12 is above 1002 cycles, in connection with HPF_1 , AR_2 , magnet 18 and disc 20. In this case the rotation of shaft 21 is the reverse of that in the former case and the frequency adjusting element is moved in the opposite direction.

When speech or other signals are sent from T_1 and received at R_1 , signals are impressed on circuit 14. Band filter BF_1 passes all frequencies except those between 990 and 1010 cycles. Some of the signal energy therefore passes BF_1 and is amplified and rectified in AR_2 . The rectified energy energizes relays 15 and 16. The armature of relay 15 is moved from its associated contact to open the circuit of the frequency adjusting means. Any signal frequencies which lie in the band which would cause the operation of the frequency adjusting means are delayed in delay circuit D_2 long enough to permit relay 15 to operate.

When relay 16 operates, its armature makes contact with its associated contact closing the output circuit of delay circuit D_3 through conductors 25. The signals are delayed in D_3 long enough to permit relay 16 to operate.

Conductors 25 may transmit the signal to a central office for distribution to subscribers, etc., or to a local recording or indicating device as desired.

When a pause occurs in the transmission of signals relays 15 and 16 become deenergized and the system returns to the condition for utilizing the synchronizing wave, which condition is maintained until signals are again received.

Fig. 2 illustrates schematically a system similar to that of Fig. 1 but in which the synchronizing wave has a frequency above audibility. The same indices have been applied to like parts in the two figures. In Fig. 2 the operation and construction of T_1 is identical to that of Fig. 1 except that source 5 is assumed to generate a wave of 10,000 cycles.

At R_1 , Fig. 2, delay circuit D_2 is replaced with a high pass filter HPF_2 and a demodulator DM_1 . The band filter BF_1 is replaced with a low pass filter LPF_2 . Relay 15 of Fig. 1 is not required. The local generating source and frequency adjusting apparatus are identical to those shown within the rectangle of Fig. 1 and are indicated by block LSFA.

With a synchronizing wave frequency of 10,000 cycles the high pass filter HPF₂ is arranged to pass waves of frequencies above 9500 cycles. Associated with demodulator DM₁ is an energy source 26 which generates a wave having a frequency of 10,500 cycles, low pass filter LPF₁ passes frequencies below 498, high pass filter HPF₁ passes frequencies above 502 cycles and low pass filter LPF₂ passes frequencies up to 9500 cycles.

The operation of R₁ of Fig. 2 is as follows:

The single side band transmitted from T₁ is received on antenna 10 and impressed on receiver 12 where, by means of the locally generated wave from LSFA₁, the synchronizing wave of 10,000 cycles is detected and impressed on circuit 14.

The 10,000 cycles wave cannot pass filter LPF₂, hence relay 16 remains in the unoperated position and the output circuit of delay circuit D₃ remains open. The synchronizing wave however, does pass HPF₂ and is impressed on demodulator DM₁ where it is combined with a 10,500 cycle wave and the difference frequency is selected.

If the difference frequency is less than 498 cycles it passes LPF₁, if more than 502 cycles, it passes HPF₁. The adjustment of the locally generated wave is accomplished in the same manner as in Fig. 1.

When speech or other signal waves of a frequency less than 10,000 cycles are transmitted and after detection impressed upon circuit 14, they pass LPF₂ and after amplification and rectification in AR₂, energize relay 16. The armature of relay 16 then makes contact with its associated contact to close the output circuit of delay circuit D₃ and the detected signals are transmitted wherever desired over wires 25.

As in Fig. 1, the delay circuit D₃ operates to delay the passage of the waves until relay 16 is operated.

When a pause occurs in the transmission of the signals, no energy is available to retain relay 16 operated and while the synchronizing wave is performing its function, the output circuit of delay circuit D₃ remains open.

It is to be understood that the frequencies given in the above description are not to be considered essential to the operation of the system but that waves of any frequencies may be used in accordance with the principles of the invention.

It is also to be understood that many modifications may be made in the apparatus described and that the invention is to be limited only by the scope of the appended claims.

What is claimed is:

1. In a carrier communication system the method of synchronizing a wave locally generated at the receiving station with the carrier wave generated at the transmitting station which comprises automatically transmitting a control wave during pauses which occur

during message transmission periods, receiving said control wave and utilizing said wave to automatically control the frequency of the wave local to the receiving station.

2. In a carrier communication system comprising a transmitting and a receiving station in which the unmodulated component of the products of modulation is suppressed at the transmitting station, means for introducing at the receiving station a wave used for detection purposes having a frequency definitely related to that of the unmodulated suppressed wave, and means automatically operative during pauses which ordinarily occur during message transmission periods for controlling the frequency of the wave introduced at the receiving station.

3. In a carrier communication system comprising a transmitting and a receiving station, means at the transmitting station for suppressing the unmodulated component of the products of modulation, means at the receiving station for introducing a wave having a definite frequency relation to the suppressed unmodulated component, and means intermittently automatically operative to maintain said frequency relation fixed.

4. A carrier communication system in accordance with claim 3, characterized in this that means are provided whereby said automatically operative means are caused to function during pauses which occur during message transmission periods.

5. In a carrier communication system, a transmitting station and a receiving station, means at the transmitting station for introducing a wave having a definite frequency relation to the suppressed unmodulated component, means at the transmitting station for intermittently transmitting a wave of constant frequency, and means at said receiving station for receiving said constant frequency wave and utilizing it to maintain the frequency relation fixed between the suppressed component and the introduced wave.

6. A carrier communication system in accordance with claim 5, characterized in this that means are provided whereby said constant frequency wave is transmitted during pauses which occur during message transmission periods.

7. A carrier communication system comprising a transmitting station and a receiving station, means at the transmitting station for suppressing the unmodulated component of the products of modulation, means at the receiving station for introducing a wave having a definite frequency relation to the suppressed component, means at the transmitting station for intermittently transmitting a wave of constant frequency, means at the receiving station for receiving and detecting the wave corresponding to said constant frequency wave, and means automatically operative to vary the frequency of said introduced

5 wave in accordance with the variation of the frequency of the detected wave corresponding to said constant frequency wave from the frequency of the transmitted constant frequency wave.

8. A carrier communication system in accordance with claim 7, characterized in this that said automatically operated means functions during pauses which occur during message transmission periods.

10 In witness whereof, I hereunto subscribe my name this 23 day of October, 1929.

EARL G. PORTS.

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