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TELEGRAPH SIGNALING SYSTEM

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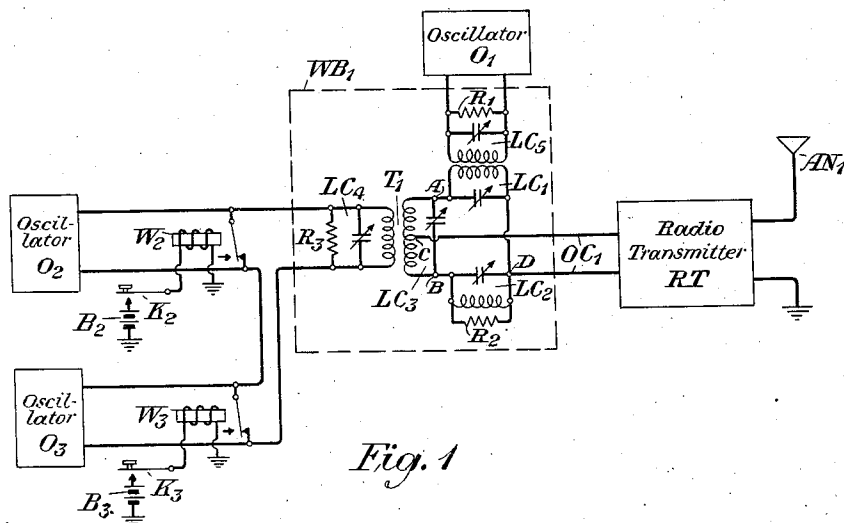


Fig. 1

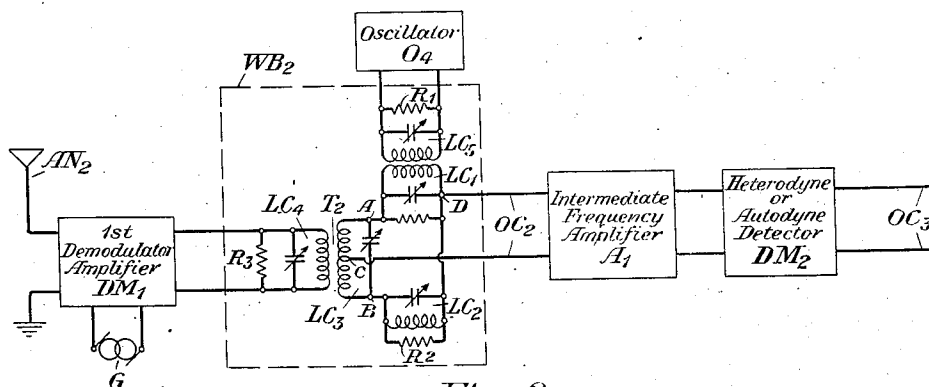


Fig. 2

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TELEGRAPH SIGNALING SYSTEM

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10 Claims. (Cl. 250—8)

This invention relates to signaling systems. More particularly this invention relates to telegraph systems and especially to carrier or radio telegraph systems.

In the carrier or radio telegraph system of this invention, a local oscillator is connected to a source of carrier telegraph signals so that the frequency of the current of the local oscillator is varied so as to equal the frequency of the received carrier current. The local oscillator and the source of carrier telegraph signals are coupled to each other by a balanced or Wheatstone bridge system. The source of the carrier signals is connected to a diagonal of the bridge while the local oscillator is connected to an arm of the bridge. The signal output circuit is connected to the opposite diagonal of the bridge.

In this system the received carrier current is transmitted through the bridge to the local oscillator and causes the local oscillator to change the frequency of its generated current to equal the frequency of the received carrier current. The two alternating currents are thus brought into synchronism with each other. The signal output circuit then receives the current of the local oscillator modulated by the same signals. The modulated current may thereafter be demodulated in any well known manner to reproduce the original signals. By confining the received modulated carrier current and the signals of output circuit to opposite diagonals of the bridge, the two are made conjugate to each other and they are mutually independent of each other except for the effect referred to.

This invention will be better understood from the more detailed description hereinafter following, when read in connection with the accompanying drawing in which Figure 1 represents one form of radio telegraph transmitting system to which the invention may be applied and Fig. 2 represents a form of radio telegraph receiving system to which the invention may also be applied.

Referring to Fig. 1 of the drawing, a Wheatstone bridge system WB_1 is shown interconnecting an oscillator O_1 with one or more oscillators O_2 , O_3 , etc. The tuned circuit LC_1 comprises one of the arms of the bridge, the tuned circuit LC_2 comprises another of the arms of the bridge, and the tuned circuit LC_3 is divided into two parts which may form the remaining two arms of the bridge. The coil of the tuned circuit LC_3 may be the secondary winding of the transformer T_1 , the primary winding of which is part of a tuned circuit LC_4 . The latter tuned circuit may

be connected to either of the oscillators O_2 or O_3 , as will be described hereinafter.

The tuned circuits LC_3 and LC_4 are coupled to each other so as to impress the alternating voltage of either of the oscillators O_2 or O_3 , whenever desired, upon the diagonal A—B of the bridge. The oscillator O_1 is coupled by the tuned circuit LC_5 to the tuned circuit LC_1 of the bridge so as to provide an effective connection of the oscillator O_1 to one of the arms of the bridge as shown. The output circuit OC_1 is connected to the other diagonal C—D of the bridge, this output circuit supplying current to a radio transmitter RT of any well-known type. The radio transmitter RT is connected to an antenna circuit AN_1 of well known type for transmission of signals to a distant point.

A local loop including a battery B_2 , a key K_2 and a relay W_2 may be employed to control the application of current from the oscillator O_2 to the tuned circuit LC_4 and the rest of the bridge WB_1 , to vary the frequency of the oscillator O_1 , as will later be explained. A similar loop including a battery B_3 , a key K_3 and a relay W_3 , may be employed to control the application of current from another oscillator O_3 through the bridge arrangement to the same oscillator O_1 for the same purpose. The relays W_2 and W_3 are normally released as shown so that neither of the oscillators O_2 or O_3 will apply current to the bridge arrangement WB_1 . If one of the keys such as key K_2 is depressed, however, the relay W_2 will become operated so as to remove the shunt around oscillator O_2 provided by the armature and back contact of relay W_2 . In that event the oscillator O_2 may supply current to the bridge WB_1 over a circuit which includes the armature and back contact of relay W_3 and the tuned circuit LC_4 . Similarly when the key K_3 is depressed the relay W_3 will become operated so as to allow the oscillator O_3 to transmit current to the tuned circuit LC_4 connected to the bridge over a circuit which is completed through the armature and back contact of relay W_2 .

Under normal conditions, when the keys K_2 and K_3 are released, the oscillator O_1 will supply current through tuned circuit LC_5 to the arm LC_1 of the bridge and this current will flow in the output circuit OC_1 to the radio transmitter RT. The radio transmitter RT may be employed to modulate this current upon the current of a radio frequency wave in a well known manner for the transmission of the modulated current through the antenna circuit AN_1 to a distant point. The oscillator O_1 may, for example, be a

not too stable generator of sinusoidal current of any well known type. The circuit of oscillator O_1 also may include some kind of keying device for controlling the current of oscillator O_1 in accordance with signals (the keying device not being shown though of well known type).

When key K_2 , for example, is depressed, the oscillator O_2 will apply voltage to the diagonal A—B of the bridge WB_1 to cause the current of oscillator O_2 to flow serially at any instant through the circuits LC_1 , LC_2 and LC_3 and therefore through all four arms of the bridge. The voltage thus generated will send current through the output circuit OC_1 in one direction and at the same time the voltage generated across the tuned circuit LC_2 by the same current of oscillator O_2 will cause current to flow through the output circuit OC_1 in the opposite direction. As the opposing currents in the output circuit OC_1 are of equal magnitude the resultant current through the output circuit OC_1 due to the current supplied by the oscillator O_2 will be practically a nullity.

While oscillator O_2 is supplying current to the bridge WB_1 in response to the closure of key K_2 , the voltage generated by this current across the tuned circuit LC_1 of the bridge will also be applied to the oscillator O_1 . This voltage will act to lock the oscillator O_1 in step with the oscillator O_2 so that the waves of the two oscillators will be in synchronism with each other. The current of the oscillator O_1 will therefore be changed in frequency to be substantially equal to the frequency of the current supplied by oscillator O_2 , but the waves of the two oscillators may differ in phase. The current of the oscillator O_1 , being supplied to the arm LC_1 of the bridge, will then be transmitted to the output circuit OC_1 of the bridge but the frequency of this current in the output circuit OC_1 will be equal to that of the current of oscillator O_2 . The bridge circuit shown and described herein is also shown and described in applicant's copending application, entitled "Signaling apparatus," Serial No. 478,881, filed of even date.

It will be observed that the oscillator O_2 and the output circuit OC_1 are connected in conjugate relationship with each other so that substantially none of the current of oscillator O_2 will traverse the output circuit OC_1 . The oscillator O_1 , however, will alone supply current to the output circuit OC_1 . Although the frequency of the oscillator O_1 continuously follows the frequency of oscillator O_2 , the current supplied by oscillator O_1 to the output circuit OC_1 will have a substantially constant amplitude for all practical purposes.

After key K_2 is released, key K_3 may be thereafter depressed. In that case the oscillator O_3 will then supply current to the bridge WB_1 in a similar manner. This will cause oscillator O_1 to adopt a frequency which is equal to that of oscillator O_3 . The current of oscillator O_1 —now of a frequency which is equal to that of oscillator O_3 —will supply current of this frequency to the output circuit OC_1 and to the radio transmitter RT for transmission to a distant point.

Thus it will be observed that the key K_2 may be operated to transmit signal pulses of current to the output circuit OC_1 and to the radio transmitter RT, the current emanating from oscillator O_1 but being of the frequency of oscillator O_2 . When key K_3 is operated in accordance with signals, pulses of current will be transmitted through the output circuit OC_1 to the radio

transmitter RT, this current similarly emanating from the oscillator O_1 but being of the frequency of oscillator O_3 . Hence the oscillator O_1 is caused to oscillate either at its own frequency unaffected by any external conditions or it may be caused to operate at either the frequencies of the oscillators O_2 or O_3 . Thus the radio transmitter RT will transmit signals of different frequencies in accordance with telegraph signals.

The resistors R_1 , R_2 and R_3 may be added to the circuit if desired in order that the bridge may have equal impedances for currents of all frequencies which may be transmitted there-through. If the arms of the bridge are all tuned to the same frequency and if selected to exhibit like characteristics, the bridge will remain balanced under all conditions of its operation.

Although oscillators O_2 and O_3 and their respective control apparatus W_2 — K_2 and W_3 — K_3 are shown in Fig. 1 in proximity to the bridge arrangement WB_1 , they may be located at points considerably distant from the bridge arrangement WB_1 . The lines between oscillators O_2 and O_3 may be so long as to have induced therein considerable noise and other interference. The arrangement of Fig. 1 may be employed to effectively eliminate such noise and other interference so that the radio transmitter RT may transmit the current of oscillator O_1 unaffected by the noise or interference.

Oscillators O_1 and O_2 have been described as generators of current of different frequencies. These oscillators may have the same frequencies if so desired. Moreover, all three oscillators may be designed to generate currents having frequencies of the same value, although this is by no means essential to the system. Whenever oscillator O_1 is employed to produce current of a frequency which is different from the frequencies of oscillators O_2 and O_3 , the oscillator O_1 may return to its normal frequency upon release of keys K_2 and K_3 .

Fig. 2 illustrates a radio telegraph receiving system which may include an antenna circuit AN_2 , a first demodulator-amplifier DM_1 to which a generator or oscillator G may be connected for demodulating received radio waves into intermediate frequencies in a well known manner; a Wheatstone bridge arrangement WB_2 which is similar to the Wheatstone bridge WB_1 of Fig. 1 for receiving the currents of the intermediate frequencies; an oscillator O_4 which is to supply current of a frequency equal to that of the received carrier current; an amplifier A_1 which is connected to the output circuit OC_2 of the bridge WB_2 ; a demodulator DM_2 which may be of a heterodyne or an autodyne type; and an output circuit OC_3 for receiving the demodulated currents in, for example, the audio frequency range. The oscillator O_4 may be adjusted to produce current of a frequency of, for example, 501 k. c., which is applied through tuned circuit LC_5 to one of the arms LC_1 of the bridge, as already explained. This will cause current emanating from oscillator O_4 to flow through the output circuit OC_2 . The current of oscillator O_4 will be amplified by amplifier A_1 and then demodulated by the demodulator DM_2 so as to produce a zero frequency beating component. Under these conditions the output circuit OC_3 will receive no audible tone.

When the antenna AN_2 receives a radio frequency wave interrupted in accordance with telegraph signals, the intermediate frequency components of the received radio wave obtained from

the demodulator DM₁—which may be of a frequency of 500 k. c.—will be applied to the diagonal A—B of the bridge WB₂. This current will reach the oscillator O₄ as already explained and cause the oscillator O₄ to change its frequency so as to be synchronous with the frequency of the carrier wave supplied by the demodulator DM₁. Thus the oscillator O₄ may now be caused to produce oscillations of a frequency of, for example, 500 k. c. The current of this frequency will be transmitted through the output circuit OC₂ and through the amplifier A₁ to demodulator DM₂. Demodulator DM₂ may, for example, produce its own current of 501 k. c. for demodulating the intermediate frequency current of 500 k. c., thereby producing a beat note of 1,000 cycles. This audible frequency component will be received in the output circuit OC₃.

It will be observed that the demodulator DM₁ and the output circuit OC₂ are in conjugate relationship with each other with respect to the bridge circuit and hence none of the current of the demodulator DM₁ will reach the output circuit OC₂. Because of this conjugacy and also because of the one-way path provided by the amplifier A₁, none of the current of the demodulator DM₂ will be returned to the demodulator DM₁. It will be understood that the oscillator O₄ may be operated either at its own frequency or at any one of several different frequencies which may be applied to it from the demodulator DM₁.

The radio transmitter of Fig. 1 and the radio receiver of Fig. 2 may be operated in independent signaling systems which are unrelated to each other. That is, the radio transmitter of Fig. 1 may be operated in conjunction with any well known radio telegraph receiver and the radio receiver of Fig. 2 may be operated in conjunction with any well known form of radio telegraph transmitter. However, the circuits of Figs. 1 and 2, if desired, may form a complete radio telegraph system, as will be understood by those skilled in the art. Where several different radio frequencies may be received at different times by the receiving antenna AN₂ the frequency of oscillator O₄ will be changed to match and correspond with the carrier wave received by the antenna AN₂ at any instant. The resulting beat note will be of a frequency which corresponds to the particular radio wave received by the system. The output circuit OC₃ may include well known selecting devices (not shown) to distinguish a beat note of one frequency from that of another frequency.

In Figs. 1 and 2 the oscillators O₁ and O₄ are shown connected to tuned circuits LC₅ and LC₁ of the balanced bridge system. It will be understood that either tuned circuit LC₅ or both of these tuned circuits may be incorporated as part of the oscillators O₁ and O₄, as will be apparent to those skilled in the art. As the oscillators O₁ and O₄ may be of any one of many different types, their circuits are not shown in detail because the oscillators themselves do not comprise this invention.

Although Fig. 2 has been described as a radio telegraph receiving system, the same general arrangement may be employed for receiving and detecting frequency modulated signals. If Fig. 2 is used in a frequency modulated system, the intermediate carrier frequency obtained from demodulator DM₁ will swing over a considerable range in accordance with signals. The oscillator O₄ will then be continuously changed in frequency in accordance with the instantaneous val-

ues of the intermediate frequency. Thus the oscillator O₄ will produce current of a frequency which changes in accordance with the received frequency modulated current.

However, the current of oscillator O₄, though responding to the frequency variations of the received carrier wave, will supply current of substantially constant amplitude. Consequently the limiter usually accompanying receiving systems for frequency modulated signals may be omitted. The demodulator DM₂ will necessarily comprise any well known type of detector for converting the frequency variations of the current of oscillator O₄ into audible signals.

Thus the circuit of Fig. 2 may be employed to drive the oscillator O₄ to produce current of a variable frequency to correspond to the frequency variations of received frequency modulated signals. These frequency variations will be detected by the demodulating apparatus DM₂ without a limiter. The bridge circuit WB₂ will operate with oscillator O₄ to substantially reduce noise or other interfering effects.

While this invention has been shown and described in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a signaling system, the combination of a first oscillator, means for interrupting the current of the first oscillator in accordance with signals, a second oscillator of a frequency different from that of the first oscillator, means comprising a balanced bridge circuit coupling said first oscillator with said second oscillator for causing the frequency of the current of the second oscillator to be synchronized with the current of the first oscillator and interrupted by the same signals, and means for deriving the signals from the interrupted current of the second oscillator.

2. In a signaling system, the combination of an oscillator, means for receiving carrier current modulated in accordance with signals, means comprising a balanced bridge circuit coupling said oscillator with said receiving means for applying the received modulated carrier current to said oscillator to vary the frequency of the current generated by said oscillator to continually equal the frequency of the received carrier current, and means for deriving the signals from the current of said oscillator.

3. In a signaling system, the combination of an oscillator of variable frequency, a source of carrier current modulated by signals, a bridge circuit coupling said source and said oscillator so that the frequency of the current obtained from said oscillator will always equal the frequency of said carrier current, and means for obtaining the current of said oscillator and detecting the signals therefrom.

4. In a telegraph signaling system, the combination of first and second oscillators, the current of said first oscillator being interrupted in accordance with signals, a Wheatstone bridge, means for connecting said first and second oscillators to a diagonal and an arm of the bridge, respectively, means for interrupting the current of the second oscillator in accordance with the same signals, said means including said Wheatstone bridge whereby the current of the

second oscillator is synchronized in frequency with the current of the first oscillator and the current of said second oscillator is interrupted by the same signals, and means connected to the other diagonal of the bridge for deriving the signals from the current of the second oscillator.

5. In a radio telegraph signaling system upon which is impressed carrier current interrupted in accordance with signals, means for deriving the signals from said interrupted carrier current, said means including an oscillator, a Wheatstone bridge to which said oscillator is connected as one arm thereof, means for impressing the received interrupted carrier current upon a diagonal of the bridge, and apparatus connected to the other diagonal of the bridge for demodulating and reproducing the signals.

6. In a telegraph system for reproducing the signals present in the form of interruptions of carrier current, the combination of an oscillator, means responsive to the received interrupted carrier current to change the frequency of the current of said oscillator to equal the frequency of the received carrier current while maintaining the amplitude of the current of said oscillator substantially constant, said means including means whereby the current of said oscillator is modulated in accordance with the same signals, and means for deriving the signals from the modulated current of the oscillator.

7. In a signaling system, the combination of an oscillator, a plurality of separate sources of carrier current each interrupted by telegraph signals, means responsive to any one of the received carrier currents for changing the frequency of the oscillator so as to equal that of the received carrier current and interrupting the current of said oscillator in accordance with said signals, said means comprising a balanced bridge circuit coupling said oscillator to said sources of carrier current, and means for detect-

ing the received signals from the current of said oscillator.

8. In a telegraph system, the combination of a plurality of sources of carrier current of different frequencies, means for interrupting the current of any one of said sources in accordance with telegraph signals, an oscillator, means for changing the frequency of the oscillator to equal the frequency of any one of the received interrupted carrier currents, said latter means comprising a balanced bridge circuit coupling said oscillator to said sources of carrier current, and means for observing the oscillator current interrupted in accordance with the same signals.

9. In a telegraph system, the combination of a plurality of sources of carrier current of different frequencies, means for interrupting the currents of said sources in accordance with signals, an oscillator, a Wheatstone bridge system upon one diagonal of which is impressed the current of any one of said sources interrupted by said signals, the oscillator being connected to an arm of said bridge so as to be locked in step with the carrier current received by said bridge diagonal, and a circuit connected to the other diagonal of the bridge for receiving the current of the oscillator interrupted by said signals.

10. In a telegraph system, the combination of a source of signals in the form of a carrier wave interrupted in accordance with the signals, an oscillator, means coupling said oscillator with said source of signals so that the carrier wave of said source will vary and determine the frequency of the oscillator, said means including means for deriving the current of the oscillator interrupted by the same signals, and means for demodulating the current of the oscillator interrupted by said signals to reproduce said signals.

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