



## UNITED STATES PATENT OFFICE

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SIGNALING ARRANGEMENT FOR CARRIER  
FREQUENCY SYSTEMSWolfgang Hagen, Berlin, Germany; vested in the  
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7 Claims. (Cl. 179-4)

Carrier frequency systems are frequently used to establish additional telephone channels on lines already carrying low frequency communications. In such systems it is necessary that the ringing signals be impressed on the carrier of the channel. Methods of distorting the carrier by shifting its frequency in order to transmit ringing signals are well known. Such distortion may be used as long as the shift is not so great as the transmission width of the ringing frequency. German Patent 593,115 is illustrative of such a system.

My invention relates to such systems and will be readily understood when considered in conjunction with the following description and drawing, of which

Fig. 1 shows a block diagram of the terminal apparatus of a known type of carrier frequency system and Figs. 2 and 3 show embodiments applying the features of the invention to modulator stages.

Referring to Fig. 1, M and D are modulator and demodulator stages which are respectively fed by the oscillator T. The transmitting branch comprises a filter F1 adapted to pass the band of speech currents (coming from the line N over the branching network G), the modulator M, amplifier V, and the directional line filter F2. The receiving branch comprises a directional line filter F3 and the demodulator D. Responsive to a ringing signal received over the branching network G, the carrier frequency generated by the oscillator T is intermittently displaced by, say, 500 cycles, at the periodicity of the ringing current source (e. g., 20 cycles per second). This displacement of the carrier frequency is effected by varying the tuning of the oscillatory circuit of the carrier frequency oscillator T. A carrier frequency of 5,800 cycles is thus changed to a higher frequency of 6,300 cycles or to a lower frequency of 5,300 cycles in the rhythm of the ringing signal of, say, 20 cycles. At the receiving terminal the displaced carrier frequency is demodulated (in a demodulator similar to D) by the local carrier frequency source of 5,800 cycles. The demodulation product of 500 cycles interrupted at 20 cycles is detected by a known type of call receiving device such as E.

In many carrier frequency systems the carrier frequency is suppressed and one side-band only is used for signal transmission. The carrier frequency wave is suppressed in a symmetrically designed or balanced modulator. Since the carrier frequency wave does not normally appear in the output of such a modulator, the transmission

of a ringing signal necessarily involves either feeding the displaced carrier frequency directly into the transmitting branch on the output side of the modulator, or distorting the symmetry of the modulator during the periods when the carrier frequency is displaced. Usually both methods necessitate the provision of several relays and the device becomes complicated.

The disclosed invention proposes, for the simplifying of such devices, to use the condenser in the carrier frequency oscillator as a coupling element between the oscillator and transmitter sections of the apparatus when transmitting the call signal by the method employing the displacement of the frequency either side of the carrier.

In such an application the whole as well as only a part of the said condenser can be used, and, furthermore, the same whole or part may also be used with another element as a voltage divider for the call signal frequency. Moreover, in a condition of rest as far as the set is concerned, the condenser which is used to displace the carrier frequency of the oscillating circuit can be employed wholly or partially as a coupling element for the carrier frequency between oscillator and transmitter or receiver as the case may be.

Referring to Fig. 2, the modulator M consists of an input transformer 1, an output transformer 2, and two rectifiers G1 and G2. Impedances R2 and R3 are provided to balance out any unsymmetrical characteristics of the rectifiers G1, G2. The carrier frequency oscillator T consists of a tube L, a transformer U3 for providing regenerative coupling, and two condensers C1 and C2 which when grounded over either contacts .1 or .2 respectively tune the oscillator so as to generate the normal carrier frequency or the displaced carrier frequency which latter is used for the ringing signal. The carrier frequency voltage developed across the lower part of the grid winding of transformer U3 is applied to the modulator M at the mid-point of the secondary winding of transformer 1 and at the junction of the impedances R2 and R3.

The neutral call signal receiving relay R, which responds to the 20-cycle ringing current incoming over the line N, is provided with contacts .1 and .2. In the condition of rest contact .1 and condenser C1 are grounded over the armature of the relay, and condenser C2 is disconnected at contact .2. Condenser C1 tunes the plate circuit to the normal carrier frequency,

In this condition the impedance  $R_1$  is connected magnitude of the impedance  $R_1$  is very much greater than that of the impedance  $R_2$  the symmetry of the modulator  $M$  is substantially undisturbed and the carrier frequency is suppressed from the output.

When transmitting the ringing signal, the contact  $r_1$  is opened and the contact  $r_2$  is closed responsive to the operation of relay  $R$ . The condenser  $C_2$  is connected to ground over contact  $r_2$  in place of condenser  $C_1$  and the displaced carrier frequency is generated. The carrier frequency voltage from the plate winding of transformer  $U_3$  is now applied to the modulator  $M$  over condenser  $C_1$ , impedance  $R_1$  and impedance  $R_2$ , the condenser  $C_1$  functioning purely as a coupling condenser. Since the plate winding voltage applied over this path produces a voltage across impedance  $R_2$  which considerably exceeds the voltage produced across impedance  $R_3$  by the connection from the grid winding of transformer  $U_3$  to the mid-point of the secondary winding of transformer  $1$ , the modulator is unbalanced for the displaced carrier frequency waves, which are therefore transmitted over the outgoing line through the amplifier  $V$ .

In the arrangement shown in Fig. 3, the modulator  $M$  comprises the input and output transformers  $3$  and  $4$  and four rectifiers  $5$ ,  $6$ ,  $7$  and  $8$ . The carrier frequency oscillator  $T$  comprises a tube  $9$ , the plate and grid circuits of which are reactively coupled over the transformer  $10$ . In the rest condition of the ringing relay  $R$ , the condenser  $11$  is grounded over contact  $r_1$  and the plate circuit is tuned to the normal carrier frequency. The alternating voltage at the plate and of the secondary winding of transformer  $10$  is applied across impedance  $R'_2$  over condenser  $12$  and impedance  $R'_1$ , the condenser  $12$  functioning as a coupling condenser. The carrier voltage across  $R'_2$  is applied to the modulator  $M$  at the mid-points of the secondary winding of the transformer  $3$  and the primary winding of transformer  $4$ , in known manner.

When the ringing signal is received, the relay  $R$  responds to the 20-cycle ringing current and intermittently opens contact  $r_1$  and grounds contact  $r_2$ . When the contact  $r_2$  is grounded, the oscillatory plate circuit is tuned by the condenser  $12$  and the oscillator  $T$  generates carrier waves at the displaced frequency. Since the contact  $r_1$  is now ungrounded the full alternating plate voltage found at the upper end of the plate winding of transformer  $10$  is applied over condenser  $11$ , and impedance  $R'_3$  to the mid-point of the secondary winding of output transformer  $4$ , the condenser  $11$  now functioning as a coupling condenser. The displaced carrier frequency wave is thus fed directly into the amplifier  $V$ . It will be seen that during transmission of the displaced carrier waves no carrier voltage is applied to the mid-points of the secondary and primary windings of the transformers  $3$  and  $4$  since these points are grounded over impedance  $R'_1$  and contact  $r_2$ .

What is claimed is:

1. In a carrier wave signaling system, a terminal equipment including a transmitting branch and a receiving branch, a carrier frequency oscillation generator therefor including a frequency determining circuit, two condensers operatively associated with said frequency determining circuit one of said condensers being adapted to tune said circuit to a normal carrier frequency and the other to tune said circuit to

a shifted carrier frequency, and means responsive to a ringing signal for alternately connecting said condensers in tuning relation to said frequency determining circuit and for effecting circuit changes such that at least one of said condensers forms a coupling element between said generator and said transmitting branch for the frequency generated by said generator under the control of the other condenser.

2. A carrier wave signaling system according to claim 1, further comprising a rectifier bridge modulator circuit in said transmitting branch, a coupling circuit for said normal carrier frequency connected between said oscillation generator and symmetrical points of said modulator circuit, and a coupling circuit for said shifted carrier frequency including one of said condensers and connected between said oscillation generator and asymmetrical points of said modulator circuit.

3. A carrier wave signaling system according to claim 1, further comprising a rectifier bridge modulator circuit in said transmitting branch, an output circuit for said modulator, a coupling circuit for said normal carrier frequency connected between said oscillation generator and symmetrical points of said modulator circuit, and a coupling circuit for said shifted carrier frequency including one of said condensers and connected between said oscillation generator and said modulator output circuit.

4. In a carrier wave signaling system, a terminal equipment including a transmitting branch and a receiving branch, a carrier frequency oscillation generator therefor including a frequency determining circuit, two condensers operatively associated with said frequency determining circuit one of said condensers being adapted to tune said circuit to a normal carrier frequency and the other to tune said circuit to a shifted carrier frequency, and means responsive to a ringing signal for alternately connecting said condensers in tuning relation to said frequency determining circuit and for effecting circuit changes such that each condenser forms a coupling element between said generator and said transmitting branch for the frequency generated by said generator under the control of the other condenser.

5. In a carrier wave signaling system, a terminal equipment including a transmitting branch and a receiving branch, a carrier frequency oscillation generator therefor including a frequency determining circuit, means responsive to ringing current for alternately tuning said frequency determining circuit to a normal carrier frequency and to a shifted carrier frequency, a rectifier bridge modulator circuit in said transmitting branch, an output circuit for said modulator circuit, a coupling circuit for said normal carrier frequency connected between said oscillation generator and symmetrical points of said modulator circuit, and a coupling circuit for said shifted carrier frequency connected between said oscillation generator and said modulator output circuit.

6. In a carrier wave signaling system, a terminal equipment including a transmitting branch and a receiving branch, a carrier frequency oscillation generator therefor comprising an electron discharge tube having coupled plate and grid circuits, two condensers, connections from one side of each of said condensers to said plate circuit, a rectifier bridge modulator circuit in said transmitting branch, a relay for responding

to ringing currents including an armature connected to a point of stable potential, front and back contacts for said relay connected respectively to the other side of each of said condensers, means for applying a potential derived from said grid circuit across symmetrically disposed points of said modulator circuit, and means for applying a voltage from said anode circuit to asymmetrically disposed points of said modulator circuit including a connection from one of said contacts to said modulator circuit.

7. In a carrier wave signaling system, a terminal equipment including a transmitting branch and a receiving branch, a carrier frequency oscillation generator therefor comprising an electron discharge tube having coupled plate and grid circuits, two condensers, connections from one side of each of said condensers to said plate

5 circuit, a rectifier bridge modulator circuit in said transmitting branch, an output transformer for said modulator circuit including primary and secondary windings, a relay for responding to ringing currents including an armature connected to a point of stable potential, front and back contacts for said relay connected respectively to the other side of each of said condensers, means including a connection from one of said relay contacts to said modulator circuit for applying a potential derived from said plate circuit across symmetrically disposed points of said modulator circuit, and means including a connection from the other relay contact to a point on said secondary winding for applying a potential derived from said plate circuit across at least a part of said secondary winding.

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