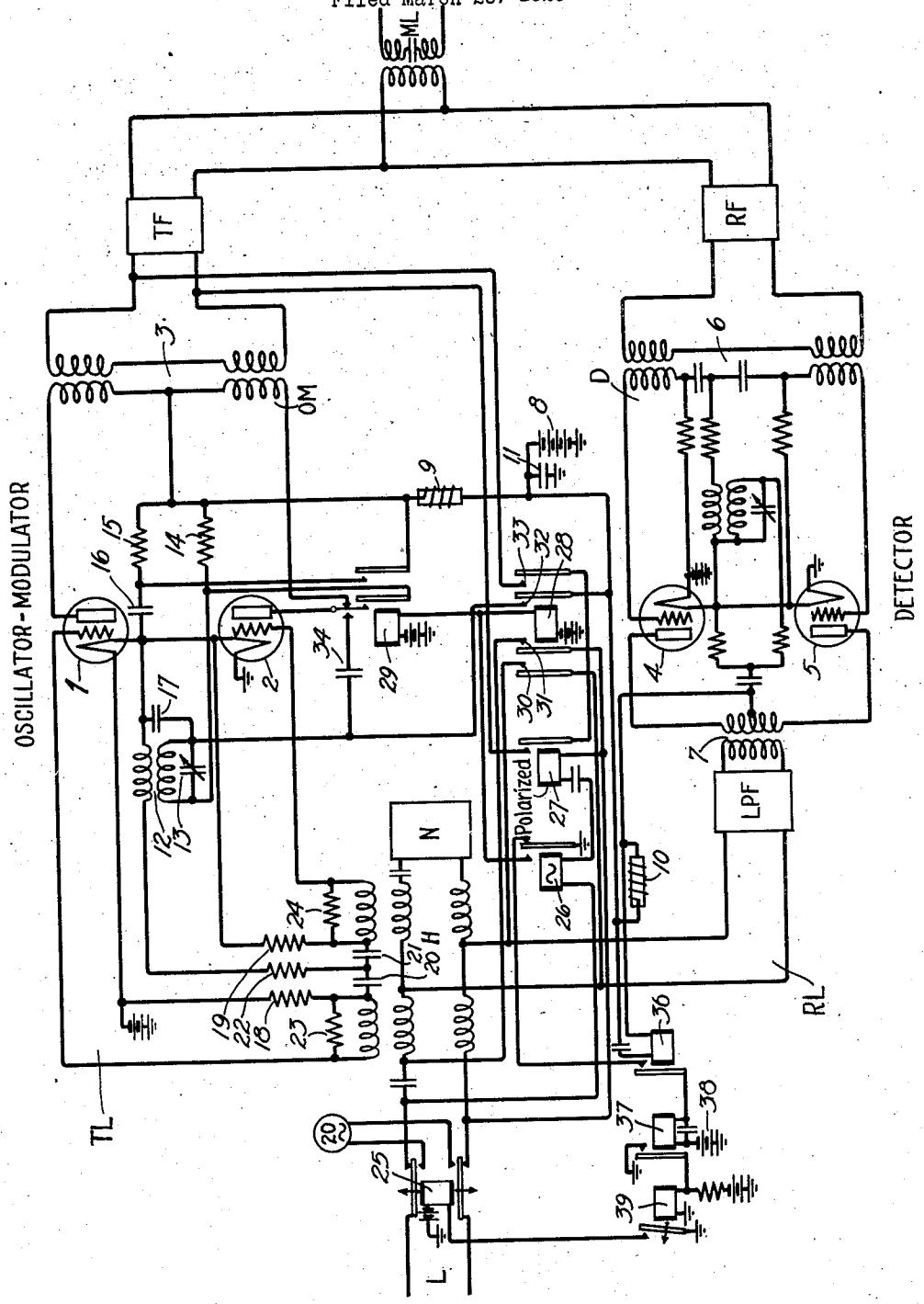
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CARRIER WAVE SIGNALING SYSTEM

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CARRIER-WAVE SIGNALING SYSTEM.

Application filed March 25, 1925. Serial No. 18,125.

This invention relates to carrier wave signaling systems and particularly to ringing circuits therefor.

An object of the invention is to simplify the transmission of ringing signals in carrier wave signaling systems.

A related object of the invention is to transmit a ringing signal by means of a new and improved arrangement for changing the frequency of the carrier wave.

Another object of the invention is to economize in the apparatus employed in systems of this type.

The invention is particularly applicable to carrier wave signaling systems in which the carrier is suppressed at the transmitting terminal, and a side band alone is transmitted.

In systems of this type, difficulty has been encountered in transmitting ringing signals for the reason that the terminal filters are usually so designed as to cause a high attenuation to the unmodulated carrier frequency component, and hence will also impose a very high transmission loss upon frequencies near the carrier frequency. It is therefore very difficult to transmit a side band obtained by modulating the carrier current in accordance with the usual ringing current of 20 cycles or 135 cycles.

This difficulty is overcome in the present invention which provides a ringing circuit for carrier suppression systems in which a 20 cycle ringing current is utilized to convert a balanced oscillator-modulator in the transmitting channel into an oscillator and amplifier adapted to generate and amplify a carrier wave of a frequency which lies within the transmission range of the terminal band filter.

The carrier wave of changed frequency is mechanically modulated by interrupting the output of the converted circuit at the rate of 20 cycles per second. The interrupted wave which is thus freely transmitted through the terminal filter will carry components corresponding to the ringing frequency which may be detected at the receiving station.

The invention will be described in connection with the accompanying drawing which is a diagrammatic illustration of a circuit embodying the invention.

The drawing shows the necessary circuits which would enable one to conduct a complete two-way conversation from low frequency line L over the carrier line ML to a distant station and to transmit and receive ringing signals over the carrier line.

The low frequency line L may be an ordinary subscriber's telephone circuit. A radiating conductor may, of course, be employed in place of the carrier line ML when it is desired to apply the invention to radio systems.

The low frequency line L is associated with the transmitting channel TL and the receiving channel RL of the carrier system through the usual hybrid coil H and associated balancing network N.

The transmitting channel TL includes a balance oscillator-modulator OM and a transmitting band filter TF. The receiving channel RL includes a receiving band filter RF, a balanced detector D and a low-pass filter LPF.

The carrier currents which are utilized for transmitting and receiving signals over the line ML are comprised within mutually exclusive frequency bands. The lower frequencies, for example, may be allotted to the transmitting channel TL and the higher frequencies to the receiving channel RL.

The filters TF and RF serve to separate the respective bands of frequencies to the transmitting and receiving channels. These filters, as well as the low-pass filter LPF, may be designed in accordance with the principles set forth in the U. S. patent to Campbell, No. 1,227,113, issued May 22, 1917.

Oscillator-modulator and detector.

The oscillator-modulator OM and detector D may be of any suitable type, such as that disclosed and claimed in a copending application of H. S. Black, Serial No. 58,744 filed September 26, 1925, consisting of balanced self-oscillating circuits adapted to suppress the carrier.

The oscillator-modulator OM comprises a pair of three-element electron discharge tubes 1 and 2, having their input circuits connected to the series winding of hybrid coil H, and their output circuits connected to the primary winding of output transformer 3.

The detector D comprises a pair of three-

element electron discharge tubes 4 and 5 having their input circuits connected to the secondary winding of input transformer 6, and their output circuits connected to the primary winding of output transformer 7.

Space current is supplied to tubes 1 and 2 of the oscillator-modulator from a battery 8, through choke coil 9, and the primary winding of transformer 3. The battery 8 also supplies space current to tubes 4 and 5 of the detector through choke coil 10 and the primary winding of transformer 7. The condenser 11 serves to reduce the common impedance of the space current supply circuit to a minimum in order to prevent reaction between the oscillator-modulator and detector circuits.

The oscillator-modulator and detector circuits are generally similar in construction, and hence only the elements of the oscillator-modulator will be described in detail.

The tubes 1 and 2 oscillate in parallel at the carrier frequency, the grid voltages on each tube rising and falling in synchronism. The frequency control consists of an oscillating element including an oscillating coil 12 and a variable condenser 13, coupled to the anodes of tubes 1 and 2 by means of a feed-back resistance 14 and the primary windings of output transformer 3.

A biasing resistance 15 is shunted across the feed-back resistance 14 and the oscillating element 12, 13 in order to maintain the external impedance of the output circuits low to the carrier frequency, thereby increasing the load-carrying capacity, stability and output level. The blocking condenser 16 serves to prevent the source of space current 8 from being short-circuited. The blocking condenser 17 provides a low impedance path to the oscillating currents and also prevents the battery 8 from being short-circuited when the oscillator-modulator is converted for ringing purposes, as hereinafter described.

Grid resistances 18 and 19 are employed for the purpose of increasing the stability of the oscillator-modulator, and for the purpose of eliminating the auxiliary batteries which are usually employed to apply the required negative bias to the grids of the tubes. When the tubes 1 and 2 oscillate in parallel, the grids draw current during the periodic intervals when the grids are positive with respect to the cathodes, and hence energy is dissipated in the grid resistances 18 and 19. This energy, which comes from the plate circuit and is but a small portion of the energy dissipated in the plate circuit, is employed to apply a negative bias to each grid, thus elminating the necessity for employing separate grid polarizing sources.

The resistances 18 and 19 are very large and the circuit is so adjusted that any increase or decrease in the plate voltage results in a corresponding change in the grid polarizing voltage. Blocking condensers 20 and 21 are employed in order that equal negative biasing voltages may be applied to the respective grids of tubes 1 and 2.

A grid feed-back resistance 22 is employed in order to make the impedance in the common lead of the oscillator-modulator input circuits high to the impressed voice frequency currents. By regulating the value of this resistance the effect of the voice frequency currents which in practice are found to be present in this part of the circuit, may be rendered negligible. Resistance elements 23 and 24 may be employed to stabilize the input impedance of the oscillator-modulator.

Transmitting telephone signals.

The oscillator-modulator OM normally generates a carrier wave which is utilized for communication purposes. Voice currents originating in the low frequency line L are combined with the carrier wave in the oscillator-modulator, the carrier being suppressed in the usual manner. One of the side bands produced by modulation, for example, the lower side band, is transmitted through the filter TF to the carrier line ML, while the other side band, for example the upper side band is suppressed by the filter TF.

Similarly, the detector D generates a carrier wave which is utilized in the reception of telephonic signals. Voice modulated waves incoming over the line ML are picked up by the band filter RF and are demodulated in the detector D. The voice frequency components of demodulation are transmitted through transformer 7, low pass filter LPF and hybrid coil H to the low frequency line L. High frequency components appearing in the output of the detector are suppressed by the low pass filter LPF.

Ringing.

In transmitting ringing signals over the carrier line ML, it will be evident that if the carrier wave normally generated by the oscillator-modulator OM were directly modulated by a 20-cycle ringing current, the resulting side band would not be efficiently transmitted by the filter TF. That is, the filter TF, which is designed to greatly attenuate the carrier frequency of say 7000 cycles would impose too great a loss upon the 6980-cycle side band.

In accordance with the invention, ringing signals are transmitted over the line ML by converting the balanced oscillator-modulator OM into an oscillator and amplifier adapted to generate and amplify a carrier wave of a frequency which lies within the transmission range of the band filter TF. The wave of

changed frequency is then intermittently interrupted at the rate of 20 cycles per second and impressed upon the line ML.

The operation of the system for transmitting ringing signals is as follows:

The 20-cycle ringing current incoming over the low frequency line L is impressed over the back contacts of relay 25 upon an alternating current relay 26 and a polarized relay 27 connected in series. The relay 26 is thus energized and remains operated as long as the ringing current is transmitted, the relay 27 vibrating at the rate of 20 cycles per second.

Relay 26 in opening its back contact removes ground from a ringing response relay in the receiving circuit, hereinafter more fully described, in order to prevent the operation of relay 25 during the transmission of ringing signals. Relay 26 at its front contact operates relays 28 and 29 over obvious circuits.

Relay 28 at contact 30 short-circuits the receiving channel RL to prevent incoming signals from being transmitted to the line L during the transmission of ringing signals, and at contact 31 short-circuits the hybrid coil H to prevent the 20 cycle ringing current from being transmitted to the channel TL. Relay 28 also closes contacts 32 and 33. At contact 33 this relay closes one branch of a short-circuit across the secondary winding of output transformer 3, so that the output of the transmitting channel TL is intermittently interrupted at the rate of 20 cycles per second by the alternate energization and deenergization of the polarized relay 27.

Relay 29 at its left hand contact opens the plate circuit of the tube 2, thereby unbalancing the oscillator-modulator OM, and connects condenser 34 in the plate circuit of the tube 2. The oscillator-modulator OM is thus converted into an oscillator tube 2 and an amplifier tube 1 connected in tandem. Space current is supplied to the amplifier tube 1 in the same manner as before. Space current, however, is supplied to the oscillator tube 2 from the battery 8, through contact 32 of relay 28, primary winding of oscillating coil 12 and armature and left hand contact of relay 29.

When the circuit is converted in the manner described above, the secondary winding of the oscillating coil 12 is in the grid circuits of both the amplifier tube 1 and the oscillator tube 2. Hence, the output of the oscillator tube 2 which is fed back to its grid circuit is impressed upon the grid circuit of the amplifier tube 1. By including the condenser 34 in the oscillating circuit of the tube 2, the oscillator will generate a carrier wave of a predetermined frequency, for example 5000 cycles, which lies within the transmission range of the band filter TF. The biasing resistance 15 is short-circuited at the right-hand contact of relay 29 and hence the output circuit of the amplifier tube 1 may be traced from the anode, through primary winding of transformer 3, armature and right hand contact of relay 29, condenser 16, to the cathode of tube 1. The carrier currents generated by the oscillator tube 2, which are amplified in the tube 1, are thus transmitted through the transformer 3. The output of transmitting channel TL, as pointed out above, is intermittently short circuited at the rate of 20 cycles per second, so that a carrier wave interrupted at 20 cycles per second, lying well within the transmission range of the filter TF, is impressed upon the high frequency line ML.

The receiving operation is as follows:

The carrier wave interrupted at the rate of 20 cycles per second incoming over the line ML will lie within the transmission range of band filter RF. This wave carries a 20-cycle component which is utilized to actuate a ringing signal in the receiving channel. The interrupted carrier wave which is impressed upon the detector D produces even order modulation components in the common path of the detector output circuits, these even order modulation products including a 20-cycle wave component. The 20-cycle ringing current derived from the common output path of the balanced detector D is impressed upon the relay 36, which is tuned to 20 cycles. The choke coil 10 offers a high impedance to currents of 20 cycles and hence none of the ringing current will be dissipated in the common space current supply circuit.

Relay 36 at its front contact energized relay 37 over a circuit extending from ground, through battery 38, winding of relay 37, armature and front contact of relay 36, back contact and armature of alternating current relay 26, to ground. Hence, if the back contact of relay 26 is open, as it is during the period when the oscillator-modulator OM is converted for the transmission of ringing signals, the relay 37 cannot be energized. The relay 37 is slow acting and is adapted to remain operated only when the relay 36 is intermittently operated at the rate of 20 cycles per second, and hence the relay 37 will not remain operated in response to voice currents or other irregular impulses incoming over the line.

The operation of relay 37, in the manner described above, short-circuits relay 39 which is normally energized over an obvious circuit. Relay 39 is a slow releasing relay and is adapted to close its front contact to actuate relay 25 only when relay 37 remains operated for a predetermined period. Relay 25 in operating connects its armatures to a

ringing source of 20 cycles, thus transmitting ringing current over the low frequency line L.

It will be understood, of course, that the terminal circuits may be arranged to transmit the upper side band for communication purposes in which case the ringing signal would be transmitted by increasing the frequency of the carrier wave in any suitable manner.

The invention is, of course, susceptible of various other modifications and adaptations not specifically referred to but included within the scope of the appended claims.

What is claimed is:

1. In a signaling system, a carrier channel including a source of carrier waves, means in said channel for suppressing a range of frequencies including the carrier and for freely transmitting another range of frequencies, means for shifting the frequency of the waves from said source to a point within said last mentioned range of frequencies, and means for intermittently interrupting the waves of changed frequency.

2. In a signaling system, a transmitting channel including a source of carrier waves, a wave filter for suppressing the carrier and the frequencies lying to one side thereof and for freely transmitting waves of frequencies lying to the other side of the carrier, means for shifting the frequency of the waves generated by said source to a point within the free transmission range of said filter, and means for intermittently interrupting the waves of changed frequency.

3. In a signaling system, a carrier channel connecting a low frequency circuit and a carrier circuit, a source of carrier waves in said channel, a wave filter connected between said source and said carrier circuit and adapted to suppress a range of frequencies including the carrier and to freely transmit another range of frequencies, and means associated with said low frequency circuit to shift the frequency of the waves from said source to a point within the free transmission range of said filter and to intermittently short-circuit said filter.

4. In a signaling system, a balanced oscillator-modulator adapted to generate carrier waves for signaling purposes, and means to convert said oscillator-modulator into an oscillator and amplifier adapted to supply waves of a frequency different from that of the carrier.

5. In a signaling system, a transmission line, a balanced oscillator-modulator associated therewith and adapted to generate carrier waves for signaling purposes, means to convert said oscillator-modulator into an oscillator and amplifier adapted to supply waves of a frequency different from that of the carrier, and means for modulating said waves of different frequency in accordance with a ringing signal.

6. In a signaling system, a carrier channel including a balanced oscillator-modulator adapted to generate carrier waves and upon which signaling waves may be impressed, means in said channel for suppressing a range of frequencies including the carrier and for freely transmitting another range of frequencies, and means to convert said oscillator-modulator into an oscillator and amplifier adapted to generate and amplify waves lying within said last mentioned range of frequencies.

7. In a signaling system, a carrier channel including a balanced oscillator-modulator adapted to generate carrier waves, means to impress signaling waves upon said oscillator-modulator, means in said channel for suppressing a range of frequencies including the carrier and for freely transmitting another range of frequencies, means to convert said oscillator-modulator into an oscillator circuit and an amplifier circuit adapted to generate and amplify waves lying within said last mentioned range of frequencies, and means for intermittently interrupting the waves of changed frequency.

8. In a signaling system, a carrier channel having a source of carrier waves and means for modulating the carrier waves in accordance with voice currents, means for changing the frequency of the waves from said source, and means for intermittently short-circuiting the circuit for said waves of different frequency in accordance with a ringing signal.

9. In a signaling system, a carrier channel having a source of carrier waves and means for modulating the carrier waves in accordance with voice currents, means for changing the frequency of the waves from said source, and means for intermittently interrupting the waves of changed frequency.

10. In a signaling system, a carrier channel having two thermionic tubes serving as a balanced oscillator-modulator to generate carrier waves upon which signal waves may be impressed, means in said channel for suppressing a range of frequencies including the carrier and for freely transmitting another range of frequencies, and means to convert said tubes into an oscillator and amplifier to generate and amplify waves lying within said last-mentioned range of frequencies.

In witness whereof, I hereunto subscribe my name this 12 day of March, A. D. 1925.

HAROLD M. PRUDEN.