Dec. 14, 1926. 1,610,234

M. L. ALMQUIST

CARRIER SIGNALING SYSTEM

Filed July 8, 1924 2 Sheets-Sheet 1

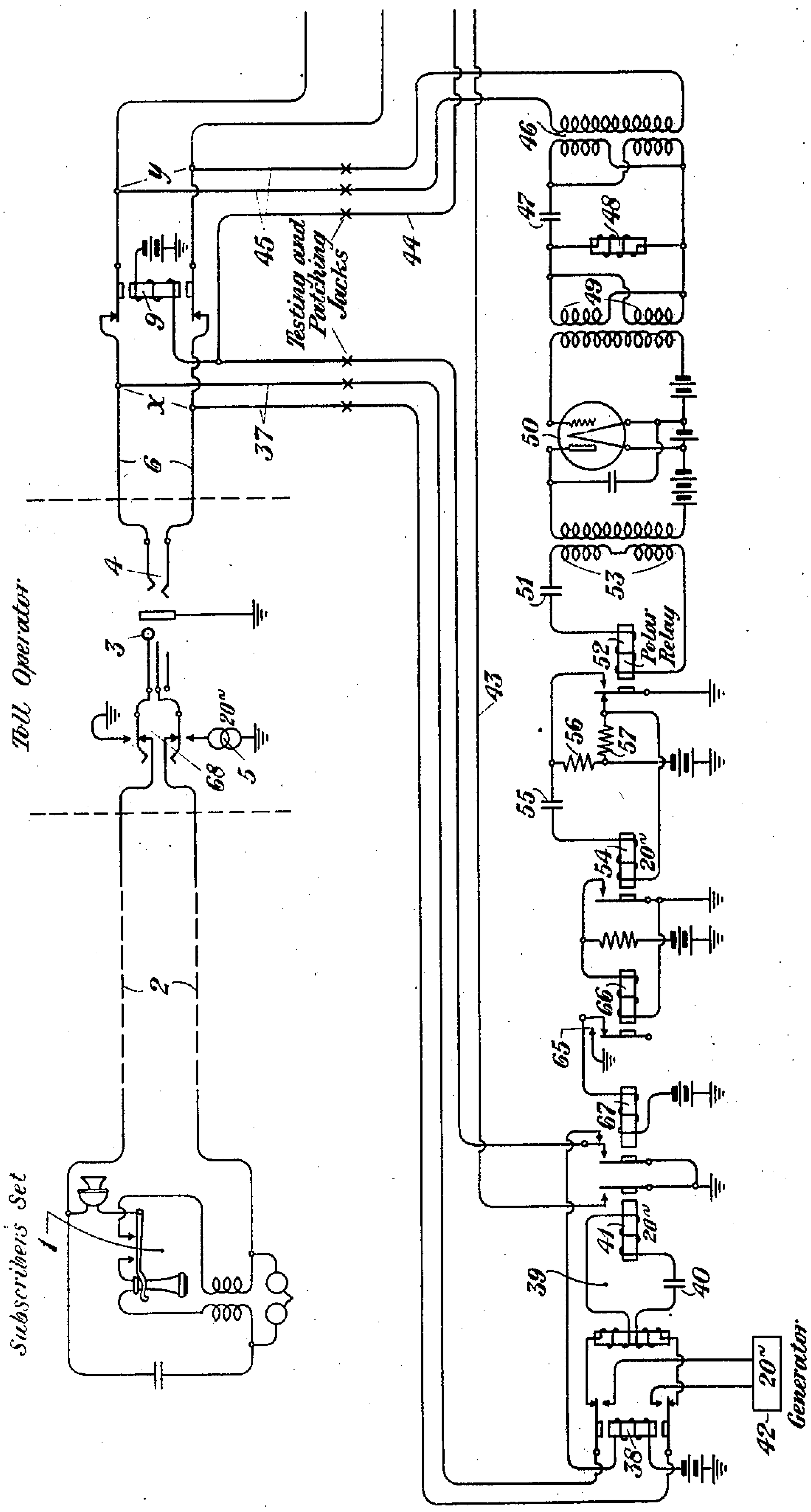

Fig. 1

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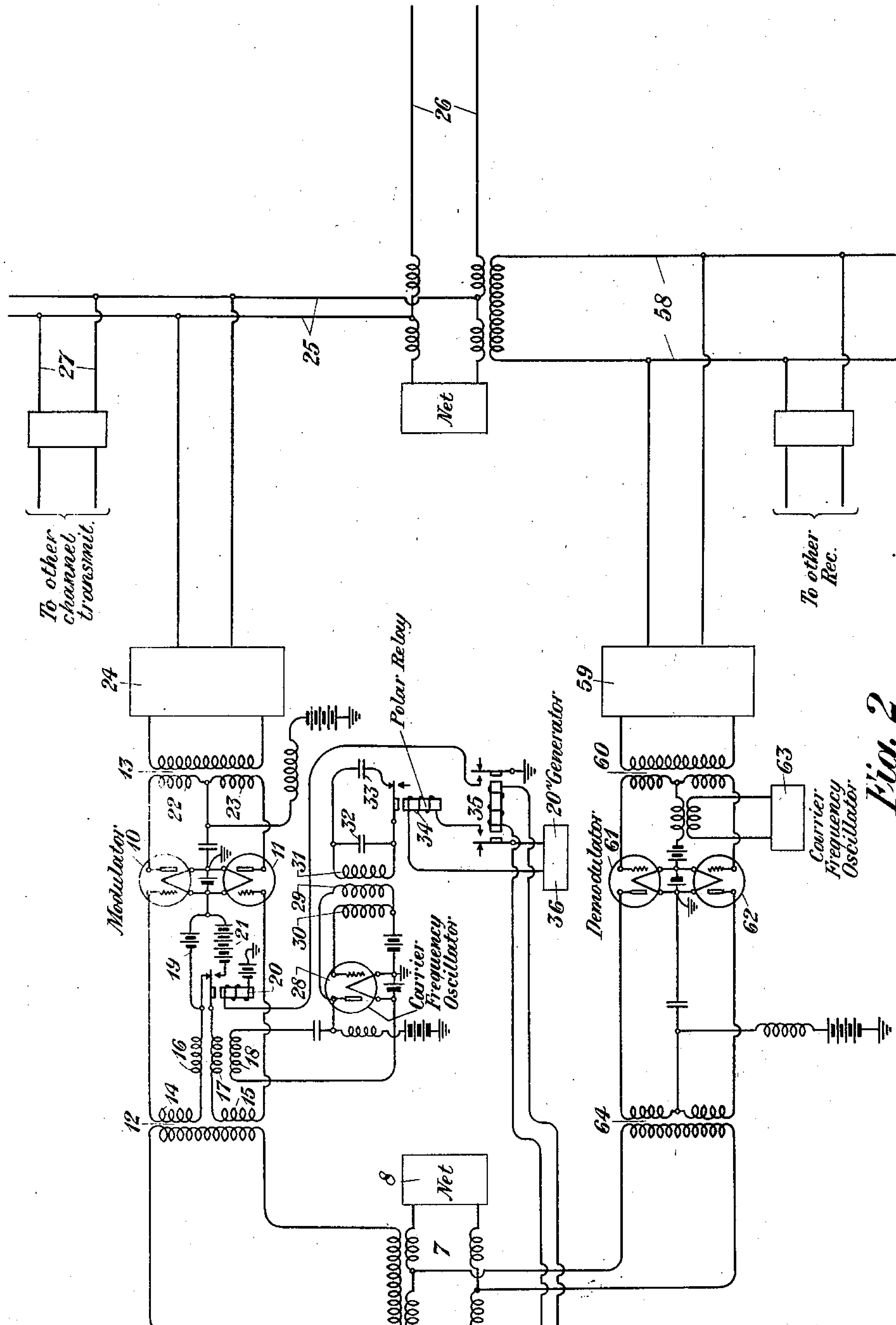

Fig. 2

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UNITED STATES PATENT OFFICE.

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CARRIER-SIGNALING SYSTEM.

Application filed July 8, 1924. Serial No. 724,904.

This invention relates to signaling systems, and particularly to means for signaling upon a carrier telephone system in which the carrier frequency is suppressed.

In a carrier telephone system in which the carrier frequency is transmitted together with one or both of the side bands of frequencies, it is practicable to signal thereover by means of the carrier frequency modulated by a low frequency of the order of 135 cycles, inasmuch as the filters will have a range sufficient to pass such a signaling frequency. In systems in which the carrier and one of the side bands of frequencies are suppressed and only one side band is transmitted, it is impracticable to use the same carrier frequency for signaling as for the speech signals if the signaling frequency is of a low order, such as 135 cycles, because the resulting frequency will not be within the range of the filters for transmitting one of the side bands. In order to signal over such a system the signaling frequency must be brought within the band of frequencies that the filters connected with the system will pass.

Since the speech frequencies range approximately from 200 to 2,000 cycles, it is customary to use a signaling frequency of 1,000 cycles, which signaling frequency modulates the same carrier frequency as is used for the transmission of the voice frequencies, and thus the signal modulated carrier frequency falls within the range of one of the side bands of the speech modulated carrier frequency and will pass through the filters of the system. The use of a signaling frequency of 1,000 cycles or of some other frequency of approximately the same order of magnitude requires a special generator at the terminal stations of the carrier line for the purpose of supplying current of this frequency to the carrier system for signaling thereover. Such generators are relatively expensive, both as to their first cost and also as to their maintenance.

This invention consists in varying the constants of the oscillator in a predetermined manner, which normally supplies the carrier frequency used for the transmission of voice currents so that, during the signaling interval, current of a different frequency will be generated and modulated in a predetermined manner for signaling over the carrier system.

This invention will be clearly understood from the following description when read in connection with the attached drawing, which shows schematically a simple form of embodiment of the invention when the upper end of Figure 1 is placed in juxtaposition to the lower end of Fig. 2.

In the drawing as thus formed, the subscriber's station 1 is connected by the line 2 with a tollboard, terminating thereat in the plug 3. The line 2 is intended to represent not only what is commonly called the subscriber's line but also such trunk circuits as are necessary to connect the subscriber's line with a toll office and also the necessary cord circuits at the intervening and terminating offices. The plug 3, which, in reality, is one of the plugs of the cord circuit at the tollboard, is adapted to be inserted in the jack 4 of the toll line 6, connecting the tollboard with the terminal circuit of the carrier telephone system. Associated with the plug 3 is a source 5 of low frequency current, for example of the order of 20 cycles, used for ringing over the line 6.

The toll line terminates at the carrier terminal in a network 8, shown in Fig. 2, adapted to balance the said line, and it has connected therewith a hybrid coil 7 for connecting the toll line with the four-wire circuit constituting the transmitting and receiving paths of the carrier terminal circuit. A cut-off relay 9 is inserted in the toll line 6 for the purpose of opening the line when ringing current is applied to the line in either direction, the purpose of doing which will be clear from the following description. The transmitting path of the carrier terminal circuit includes a modulator, which is preferably of the balanced type shown in the drawing, comprising two vacuum tubes 10 and 11, and which is connected into the transmitting path by the transformers 12 and 13. The transformer 12 has two secondary windings 14 and 15, the outer terminals of which are connected with the grids of the vacuum tubes 10 and 11 in the manner shown. The inner terminal of winding 14 is connected through winding 16 and battery 19 with the filaments of the said tubes. The junction between winding 16 and battery 19 is connected with the upper contact of relay 20. The inner terminal of winding 15 is connected with the armature of relay 20 which normally touches its upper contact. The grids of the tubes are thus normally connected with the same C-battery 19 so as to have the same negative biasing potential applied thereto, the connection of the grids being made through the armature of the relay 20. Upon the operation of this relay, a C-battery 21 is connected to the grid of the tube 11, which C battery has a different potential from battery 19, thereby destroying the equilibrium existing between the two tubes when both grids are connected with the battery 19. The purpose of using different biasing potentials will be clear from later description. An oscillator is connected by winding 18 with windings 16 and 17.

The plate circuits of the tubes are connected through windings 22 and 23 in the well-known manner to suppress the carrier current in the output circuits and to prevent its transmission to the line. The secondary winding of transformer 13 is connected with a filter 24, the characteristic of which is such as to pass one of the side bands as, for example, the upper one of the speech modulated carrier frequency. The filter 24 is connected with the transmitting branch 25, which in turn is connected across the main transmission line 26. The transmitting branch 25 may have connected therewith a plurality of transmitting channels, such as 27, whereby other carrier terminal circuits may be connected with the main transmission line 26 for the transmission of other channels. Connected to the modulator through the winding 18 is an oscillator comprising a vacuum tube 28, having its output side inductively connected with the input side through the windings 29, 30 and 31. The winding 31 has connected in parallel therewith two condensers 32 and 33, the latter of which may be effectively disconnected by the operation of the polar relay 34, controlled through the relay 35 by 20-cycle current from the source 36. The constants of the inductance 31 and the capacities 32 and 33 are so chosen that the resonant frequency of the circuit, including these elements, is such as to provide the carrier frequency of the desired magnitude for the transmission of the speech currents. When the relay 34 is operated and the capacity 33 is disconnected the resonant circuit will produce a frequency differing from the former by a difinite amount as, for example, by 1,000 cycles.

The relay 35 is controlled by the ringer circuit which will now be described. As is well known to those skilled in the art, the object of a ringer upon a telephone circuit is to effect a translation of frequency, that is to say, when a frequency of a certain magnitude is applied to one side of the ringer, a frequency of different magnitude will be caused to flow from the other side of the ringer. The use of different frequencies arises from the fact that certain frequencies which are used to operate certain apparatus are not readily transmittable over a line as are frequencies of a different order. Having in mind the foregoing description of the general principles upon which ringers are based, the particular arrangement of the applicant's structure will now be described. The low frequency side of the ringer is connected across the circuit 6 at the point x and the high frequency side at the point y. It will be seen that these points of connection are on opposite sides of the point where the cut-off relay 9 is inserted in the line. What may be termed the lower frequency side of the circuit is connected with the ringer by the conductors 37. These conductors are connected with the armatures of relay 38, the outer contacts of which are connected with a circuit 39, tuned to the low frequency which, for the purpose of illustration, we will say is 20 cycles. This circuit is tuned by the condenser 40 and the inductance of the winding of relay 41. The inside contacts of relay 38 are connected with a source 42 of 20-cycle current. When relay 41 operates, it closes its contact, which in turn causes the operation of relays 35 and 9 over conductors 43 and 44.

The high frequency side, which frequency we will assume to be 1,000 cycles, is connected across the circuit 6 by conductors 45, which in turn are connected with the primary winding of transformer 46. The secondary winding of this transformer is connected with a circuit tuned to 1,000 cycles by means of the condenser 47 and the windings 48 and 49. This 1,000-cycle current which sets up oscillations in the tuned circuit just described, is interrupted at a predetermined rate as, for example, 20 times a second. The manner of effecting such interruption will be later described. The secondary winding of transformer 49 is connected with the input side of the detector 50, the output side of which is connected with a circuit tuned to 20 cycles per second, the tuning being effected by condenser 51 and the winding of relay 52 and the secondary winding of transformer 53. Relay 52 is of a type that responds closely to the frequency to which the circuit, including its winding, is resonant. The operation of this relay controls relay 54, which has connected in series with the winding thereof a condenser 55 and resistances 56 and 57. This circuit is so arranged that if relay 52 operates at the rate of 20 times per second, the armature of relay 54 will remain attracted by virtue of the charge and discharge of condenser 55. If, however, relay 52 is operated by some transient non-uniform frequency as, for example, an impulse of the voice frequency, it will fail to operate relay 54. The operation of relay 54 releases relay 66 by establishing a shunt path around its winding and causes the operation of relay 67, which in turn causes the operation of relays 9 and 38, thereby opening the line 6 at the point where the cut-off relay is inserted and applying 20-cycle current to the said line over the inner contacts of relay 38.

The method of operation of this circuit is briefly as follows: Let it be assumed that the subscriber at 1 desires to talk with a subscriber at a distant station connected with the other end of the carrier telephone line. The subscriber's call will be transmitted to the toll operator, who will ring over the line by operating the key 68 connected with the plug 3 of her cord circuit, which will cause the transmission of 20-cycle current over line 6 to the ringer connected with the terminal circuit of the carrier system. This current will continue to flow as long as the key remains operated. The 20-cycle current flowing through the resonant circuit 39 will operate relay 41, thereby causing the operation of relays 9 and 35. The operation of relay 9 prevents the transmission of the 20-cycle current beyond the point where the cut-off relay is inserted in the line, that is to say, it keeps this low frequency current out of the transmitting path of the carrier system. The operation of relay 35 connects the 20-cycle generator 36 with the relay 34, causing this relay to be energized and deenergized at the rate of 20 cycles per second. The operation of relay 35 also causes the operation of relay 20 by grounding the winding of the later relay through the right-hand contact of relay 35. It will, of course, be assumed that the oscillator is functioning to produce oscillations, which oscillations will be applied to the windings 16 and 17 connected with the input side of the modulator. Whenever relay 34 is deenergized, both condensers 32 and 33 will be connected in its resonant circuit, thereby causing the oscillator to produce the carrier frequency upon which speech signals are normally transmitted. When the relay 34 is energized, condenser 33 is disconnected from the circuit and the frequency which the oscillator produces is, for example, 1,000 cycles greater than the carrier frequency for the speech signals. If the grids of the tubes 10 and 11 were biased by equal potentials of the same polarity, a balanced relationship would be established so that regardless of the frequency applied by the winding 18 to the windings 16 and 17 of the modulator, substantially no current would be impressed upon the secondary winding of the transformer 13, that is to say, no carrier current would pass to the line. By the operation of relay 20, the biasing battery 21 is connected to the grid of tube 11, thereby destroying the balance heretofore existing and allowing a certain amount of the carrier frequencies to be transmitted to the circuit connected with the secondary side of transformer 13. For the purpose of illustration let it be assumed that the filter 24 transmits the upper side band of a carrier frequency of 25,000 cycles, modulated by the speech frequencies, that is to say, the band ranging between 25,200 cycles to 27,000 cycles. It will, therefore, be apparent that if the oscillator normally produces 25,000 cycles when the condenser 33 is effectively connected into a circuit and will produce a frequency of 26,000 cycles when this condenser is disconnected, both of these frequencies will appear in the circuit connected with the filter 24 at the rate of 20 times per second. Since the filter cuts off at a frequency of 25,200 cycles, the speech carrier frequency will not be transmitted therethrough but the signal frequency of 26,000 cycles recurring at the rate of 20 times per second will pass through this filter because that frequency lies within the range of the filter. This signaling frequency will continue to flow through the filter 24 and over the circuits 25 and 26 to the distant end of the line as long as the operator continues to apply 20-cycle current to the line 6 by the operation of the key 57; that is to say, the 20-cycle current will keep relay 41 of the ringer operated and this in turn will keep relays 35 and 20 operated. In consequence thereof, relay 34 will be operated at the rate of 20 cycles per second by the source 36. This signaling frequency of 26,000 cycles, interrupted at the rate of 20 times per second, will be transmitted over the line 26 to the distant end and will operate the signal thereat. The mode of operation of such a signal will be clearly understood if we consider that the distant station is transmitting the 26,000-cycle current to the station shown in the figure. This current arriving over the line 26 will be impressed by the transformer upon the receiving circuit 58 and will be passed by the filter 59, which has the range within which this carrier frequency lies. The signaling frequency of 26,000 cycles will be impressed by the transformer 60 upon the input side of the balanced demodulator, which includes the tubes 61 and 62 and will be beaten therein with current of 25,000 cycles from the source 63. The resultant current of the frequency of 1,000 cycles interrupted at the rate of 20 cycles per second will be impressed by the transformer 64 across the hybrid coil 7 and will flow over the line 6 and conductors 45 to the high frequency side of the ringer. This current will be impressed by the transformer 46 upon the circuit coupled therewith tuned to the frequency of 1,000 cycles and will then be impressed by the transformer 49 upon the detector 50. The result of detection is a current of the frequency of 20 cycles per second, which will effect the operation of relay 52 at this rate. This relay will in turn operate relay 54 which by its operation shunts the winding of relay 66, thereby releasing the said relay and causing the operation of relay 67 by the closing of contact 65.

When relay 67 operates it first causes the operation of relay 9 connected in line 6, thereby opening the said line and subsequently causes the operation of relay 38, which connects the source 42 of 20-cycle current with conductors 37 bridged across the line 6 at the point x. This causes the transmission of 20-cycle current over the line 6 and in turn over lines connected therewith to the subscriber's station connected with the distant end of the latter lines, thereby calling the subscriber.

It will be seen that this invention renders unnecessary the use of a 1,000-cycle generator at the terminal of the carrier system for the purpose of providing the modulating current for the transmission of signals. This economy is effected by a novel arrangement of the oscillator which normally supplies the carrier frequency used for the transmission of the speech currents.

While this invention has been disclosed as embodied in a particular form, it is to be understood that it is capable of embodiment in other forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a carrier signaling system, the combination with a normally balanced modulator of the type in which the carrier current is substantially suppressed of an oscillator connected therewith, normally tuned to a definite frequency, means for cyclically changing the frequency of the said oscillator, an means to unbalance said modulator during the period of application of the changed frequency.

2. In a carrier signaling system, the combination with a modulator having a plurality of tubes connected symmetrically therein of an oscillator normally tuned to a definite frequency and connected with the said modulator to apply its potential equally to the grids of both tubes, means for cyclically changing the frequency of the said oscillator, and means to apply a biasing potential to the grid of one tube differing from that applied to the grid of the other tube during the intervals of the changed frequency.

3. In a carrier signaling system, the combination with a modulator of the balanced type in which the carrier frequency applied thereto is substantially suppressed therein of a source of oscillations of a definite carrier frequency, means to change the tuning of the said oscillator to provide a different carrier frequency, means controlled by the tuning-changing means to destroy the balance of the said modulator whenever the oscillator frequency is changed to permit the changed carrier frequency to pass through the said modulator.

4. In a carrier signaling system, the combination with a modulator comprising two vacuum tubes, an input and an output transformer, the input transformer having two secondary windings, each of the secondary windings having its terminals connected with the grid and the filament of a vacuum tube, the primary winding of the output transformer having its outer terminals connected with the plates of the said tubes and having its midpoint connected with the filaments of both tubes, a biasing battery normally connected to apply the same negative potential to both tubes, a second biasing battery of different potential from the said first battery, switching means to connect the said second biasing battery to the grid of one vacuum tube and to leave the other biasing battery connected with the grid of the other tube, a source of carrier current of different frequency connected between the filaments and the secondary windings of the input transformer, the carrier current being applied equally and similarly to the grids of both tubes, and means to change cyclically the frequency of the said oscillator and also to operate the switching mechanism controlling the second biasing battery whenever the frequency of the oscillator is changed.

5. In a carrier signaling system, the combination with a line having a source of speech and a source of signaling current connected therewith of a carrier telephone circuit, a source of carrier current connected with the said carrier circuit to supply current of predetermined frequency thereto to be modulated by the voice current transmitted over the said line, a modulator, a filter connected with said carrier circuit adjusted to transmit only one side band resulting from modulation of the said carrier frequency by the frequencies within the voice range, and means controlled by the source of ringing current connected with the said line to change the frequency of the said carrier current whenever the ringing current is transmitted, the magnitude of the change of the said carrier current being such as to bring it within the range transmitted by the said filter.

6. In a carrier signaling system, the combination with a balanced vacuum tube modulator of a source of carrier oscillations of predetermined frequency, a source of signal frequency to modulate the oscillations of said predetermined frequency, means for changing the tuning of the said source of carrier oscillations to bring the frequency thereof within the range represented by one of the side bands produced by the modulation of the normal carrier by the said signal, means for unbalancing the said modulator,

means for simultaneously operating the said tuning-changing means and the said modulator unbalancing means, and a filter connected with the output of the said modulator adjusted to pass one of the side bands resulting from modulation of the normal carrier frequency by the signal frequency.

7. In a carrier signaling system, the combination with a source of oscillations, the frequency of which is cyclically varied at a predetermined rate, of a line connected therewith for the transmission of the said oscillations, a detector having a source of beating oscillations connected therewith of such frequency as to beat the received oscillations to an intermediate frequency, a second detector to detect the low frequency component of the intermediate frequency, a polar relay connected with the output of the second detector responsive to the low frequency component, a slow acting relay controlled by the polar relay, and signaling means controlled by the slow acting relay.

In testimony whereof, I have signed my name to this specification this 7th day of July, 1924.

MILTON L. ALMQUIST.