May 28, 1940.

E. VROOM

2,202,474

TELEPHONE SYSTEM

Filed Jan. 4, 1939

2 Sheets-Sheet 1

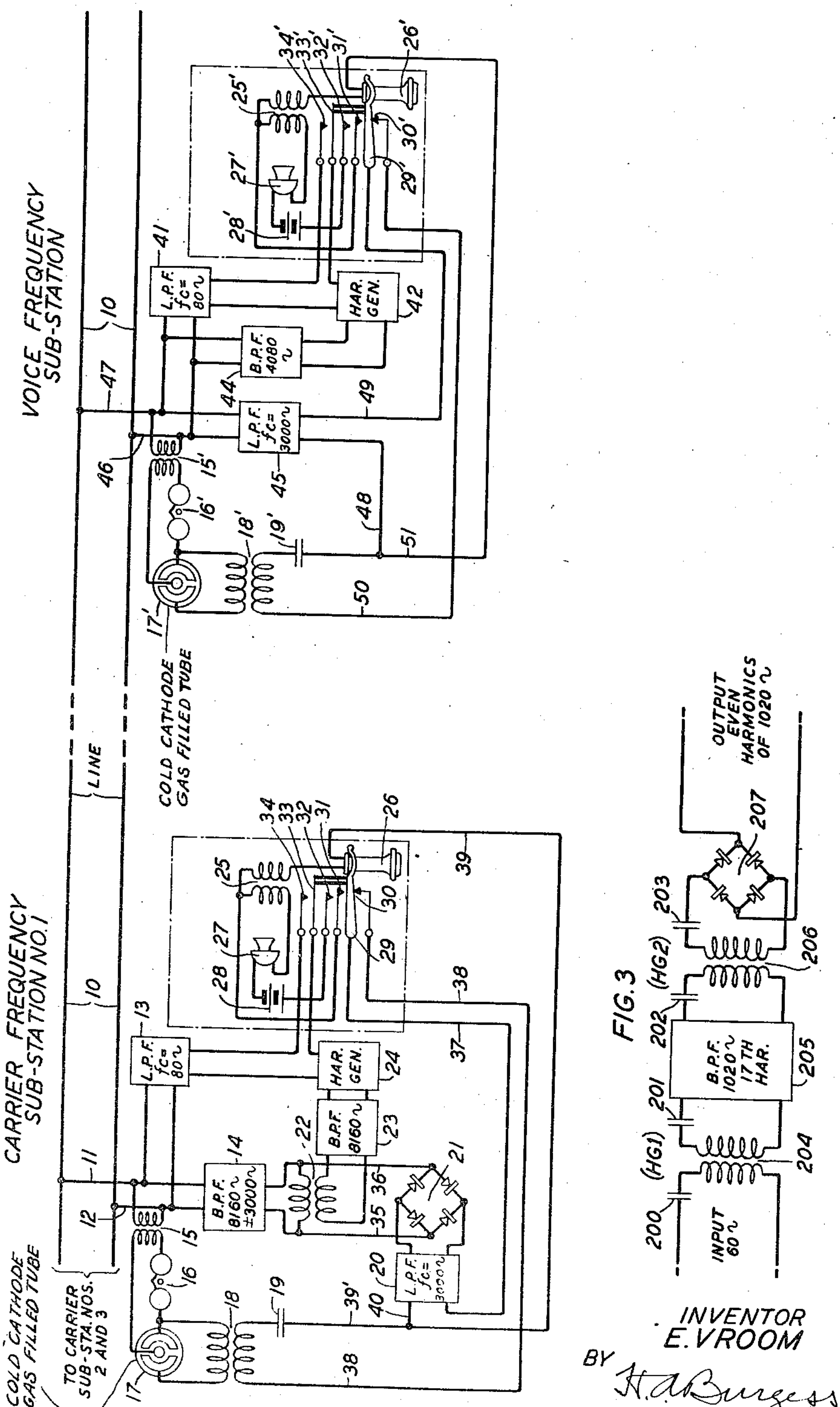

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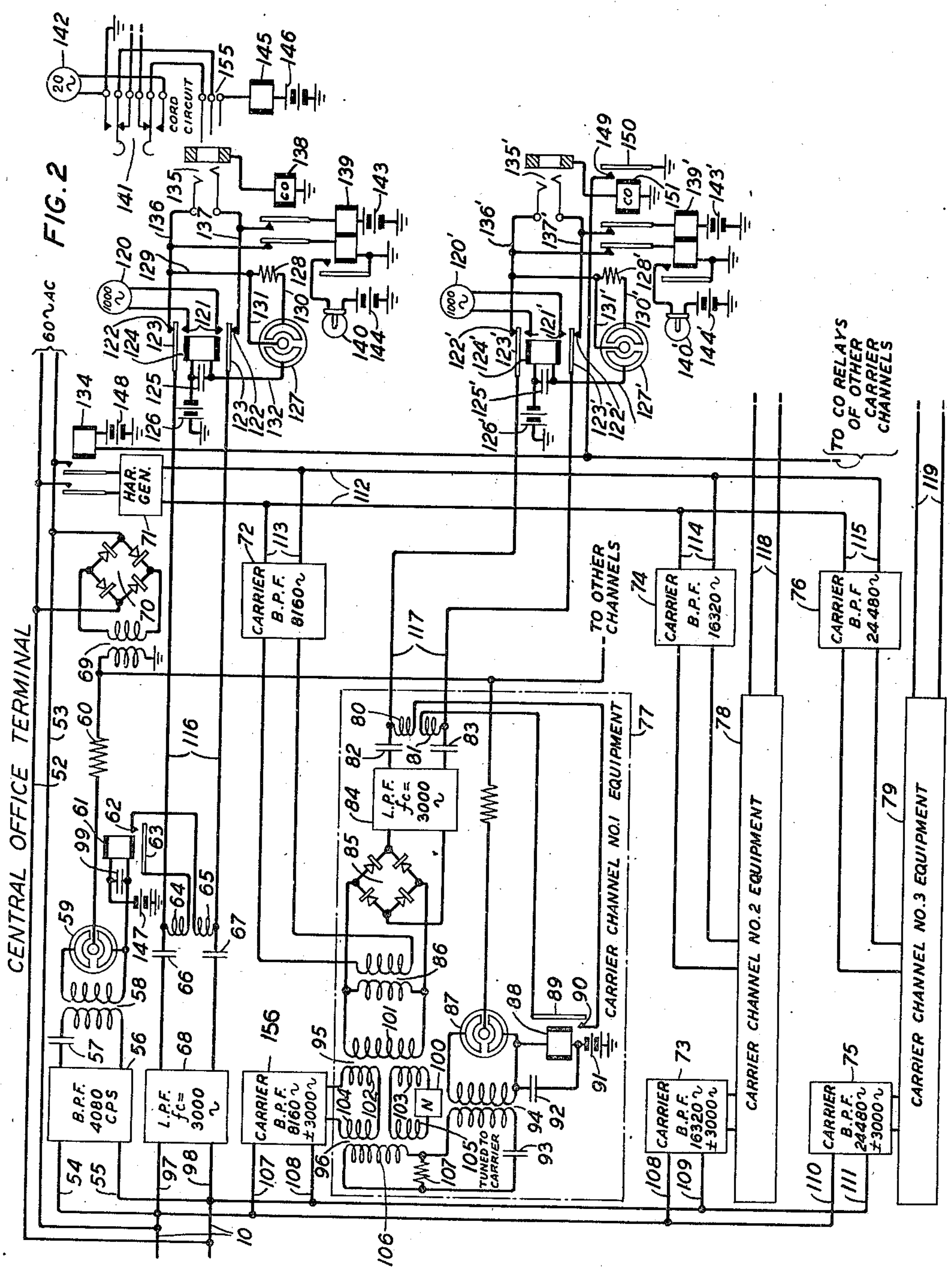
FIG. 2



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2,202,474

TELEPHONE SYSTEM

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14 Claims. (Cl. 179—2.5)

This invention relates to telephone systems and particularly to telephone systems wherein a plurality of telephone messages may be simultaneously transmitted over a single pair of wires. In a yet more limited sense it is concerned with the connections between individual telephone subscribers and their central office, especially where these are party-line connections.

Telephone service to subscribers may be provided on an "individual line" basis or on a "party-line" basis. In the former a separate pair of wires is ordinarily provided from the central office to the subscriber and he has thereby continuous service and complete privacy. A party line may comprise a single line from a central office on which, for example, four separate subscriber stations may be bridged. Selective ringing is ordinarily provided so that a desired one of the four subscriber stations may be rung without signaling the other stations. However, telephone service is available for a given one of four subscribers on a party line only at such times as the line is not in use by one of the other three, and, furthermore, there is no provision to insure that a given conversation by one party-line subscriber shall not be overheard by any or all other subscribers on the same line.

It is an object of this invention to provide party-line subscribers with individual line service.

Another object is to provide additional facilities over a single existing line.

Another object is to provide an improved method of ringing over carrier frequency channels.

Another object is to provide means at a subscriber's station whereby simple and automatic transformation is provided between voice frequency signals and carrier frequency current modulated by those signals.

A further object is to provide means readily adaptable to standard central office equipment whereby voice frequency signals may be readily transformed to and from carrier modulated signals for transmission over a party line.

An additional object is to provide simple means for the automatic derivation of carrier frequencies for use on a telephone line from a commercial low frequency source continuously applied to the said line.

A subscriber may elect party line service on the basis that it is adequate for his needs and preferable by reason of its low cost. In the case of small suburban hamlets, however, there may be need for but two or three telephones. For these stations individual line service may be desirable whereas their distance from a central telephone station may be so great as to make the cost of such service very high. There arises therefore the problem of providing such service in such a way as to avoid the necessity of stringing a separate pair of wires for each subscriber.

An effective method for the provision of multiple transmission channels over a single pair of wires consists in the employment of carrier current. This method is widely employed on long distance lines where the large unit cost of the carrier current equipment may be justified in view of the fact that the great expense involved in the construction of additional long distance line facilities is thereby avoided. Thus whereas the basic cost of the carrier current equipment is large, the cost per circuit mile compares favorably with the cost of additional wires to provide the same number of additional circuits. On the other hand, if this conventional carrier equipment were to be employed in providing additional circuits over the comparatively short line involved in the suburban subscriber loops referred to above, it would be found that the cost per circuit mile of the carrier equipment was so great as to provide little or no advantage.

Not only is the basic cost of the usual carrier equipment too high to justify its use in party line service, but it is also impractical for such service because of the considerable maintenance ordinarily required. Thus maintenance which may be readily provided in a telephone office under expert supervision would present a major, if not economically insuperable, problem if it must be provided on the subscribers' premises. A further consideration is to be found in the fact that the maintenance of carrier equipment is ordinarily provided under the special facilities and personnel associated with the long distance telephone test board. The usual local telephone central office is not and ordinarily could not readily be so equipped.

In order to provide facilities needed and not previously available I have invented a carrier telephone system which by reason of its simplicity both of apparatus and of operation may be employed to provide a number of local telephone subscribers over a single pair of wires all those facilities which are ordinarily provided in individual line service and, moreover, to provide this service at a cost which may be economically justified.

To accomplish these results I employ both at the subscriber's station and in the central office, simple and inexpensive apparatus on which substantially no maintenance is required, which does not involve a continuous absorption of expensively controlled power in its standby or operating condition, which comes automatically into operation for either speech or signal transmission, and which may be simultaneously employed for both voice frequency and carrier frequency transmission. Thus in a specific embodiment 60-cycle alternating current potential from a commercial power source is bridged across a line supplying telephone service to several subscriber stations. When a subscriber takes his receiver off the hook 60-cycle current enters his telephone set and through the medium of a harmonic generator of the type disclosed in Wrathall Patent 2,117,752, May 17, 1938, the high frequency assigned to that particular subscriber's station is generated and selected and goes over the line to the central office where means is provided whereby the line relay associated with the particular subscriber is thereby operated. Thus the operator is signaled and the connection may then be established in the ordinary way.

To call a subscriber the ordinary 20-cycle central office ringing current is translated to 1000-cycle current and the carrier assigned to the particular subscriber station being called is modulated by this 1000-cycle current. The modulated current goes over the line, is accepted by the subscriber's station tuned to receive it, is demodulated in a combined modulator and demodulator of the type disclosed in H. S. Black Patent 1,983,528, December 11, 1934, and conventionally called a Modem, and the 1000-cycle current thus recovered at the subscriber's station operates means which closes the 60-cycle line current through the station bell.

Likewise, the Modem is employed to modulate carrier waves with speech or to demodulate modulated carrier waves into speech. The same carrier wave is used for speech and for ringing or signaling and the frequency thereof is characteristic of the particular subscriber's station.

For a more complete understanding of the nature, objects and operation of the invention as illustrated by particular embodiments, reference is made to the drawings in which:

Figs 1 and 2 when placed side by side with Fig. 1 at the left show in schematic diagram a party line according to the invention in which are shown a voice frequency subscriber's station and a carrier frequency subscriber's station together with the central office termination thereof; and

Fig. 3 is a diagram of a harmonic generator which may be employed to produce the frequencies employed in the specific illustration of Figs 1 and 2.

Referring to Fig. 1, carrier frequency subscriber's station No. 1 is bridged by conductors 11, 12, across party line 10 which is continuously energized with 60-cycle alternating current applied thereto at the central office. Conductors 11, 12 are connected to low-pass filter 13, band-pass filter 14 and transformer 15. A low frequency circuit from the line is established through the low-pass filter 13 into harmonic generator 24 when the receiver 26 is lifted from its hook 29 thus closing contacts 33, 34. The composite output of harmonic generator 24 is reduced to a single carrier frequency by the band-pass filter 23 and supplied through transformer 22 to conductors 35, 36 from which it passes to Modem 21 and also through band-pass filter 14 and conductors 11, 12 to line 10. Band-pass filter 14 is designed to pass carrier plus side-band whereas band-pass filter 23 passes only current of the carrier frequency itself. Lifting receiver 26 from hook 29 also completes the circuit of transmitter 27 through the primary winding of induction coil 25, switchhook contacts 31, 32 and local battery 28 while the secondary circuit of induction coil 25 is closed through receiver 26 and switchhook contacts 29, 31 to speech output leads 37, 39—40 to low-pass filter 20 and then to Modem 21. Condenser 19 is adapted to tune transformer 18 to a frequency of 1000 cycles per second and thus output at that frequency from Modem 21 may pass through low-pass filter 20, conductors 40, 39' and condenser 19 to one primary terminal of transformer 18 and through conductor 37, contacts 29, 30 if the receiver is on its hook and thence through conductor 38 to the other primary terminal of transformer 18. The secondary of transformer 18 is connected across the control gap of the double gap cold cathode ionic tube 17. Such tubes are well known in the art, are ordinarily gas-filled, the particular gas composition determining the breakdown characteristics. For a description of the operating characteristics of a tube of this type reference is made to Holden Patent 2,004,244 June 11, 1935. The main gap circuit of tube 17 is through the bell 16 and the secondary of 60-cycle transformer 15.

A voice frequency subscriber's station is bridged across party line 10 by the conductors 46, 47 to which are connected 60-cycle transformer 15', low-pass filters 41, 45 and band-pass filter 44. With the receiver 26' on its hook 29', as shown, an alternating current of frequency below its cut-off frequency of 3000 cycles may be fed through low-pass filter 45 and then by conductor 48 and condenser 19' and by conductor 49, closed contacts 29', 30' and conductor 50 to the primary of transformer 18'. However, since condenser 19' is adapted to tune transformer 18' to a frequency of 1000 cycles per second, only currents of that frequency will be transformed to appear in substantial amount across the control gap of the cold cathode ionic tube 17'. The main gap circuit of tube 18' is through bell 16' and the secondary of 60-cycle transformer 15'.

When receiver 26' is lifted from its hook 29' contacts 29', 30' are opened. Connection is made between contacts 29', 31', 32' and between contacts 33', 34'. Under this condition current at a frequency below the filter cut-off point of 80 cycles per second may flow through conductors 46, 47 from line 10, through low-pass filter 41 to harmonic generator 42. Output current from harmonic generator 42 flows through band-pass filter 44, conductors 46, 47 and over line 10 to the central station. Likewise, sound waves picked up by transmitter 27' may be with the aid of battery 28' translated into voice frequency currents. These currents may then flow through the induction coil 25' and then through receiver 26' and conductors 49, 51—48 to low-pass filter 45 and thence through conductors 46, 47 to line 10. Similarly voice frequency current traversing line 10 will be conducted through low-pass filter 45 and thence through the conductors 49, 48—51, and the secondary of inductance coil 25' to receiver 26'.

Referring to Fig. 2, the central station termination equipment for a party line giving individual line service is shown for four channels comprising a voice frequency channel and three carrier frequency channels. 60-cycle alternating current power is supplied over conductors 52, 53 to party line 10, to frequency doubler 70, and through the contacts of relay 134 when operated, to harmonic generator 71.

Voice frequency channel equipment is bridged on the party line 10 through conductors 54, 55 and 97, 98. Conductors 54, 55 lead to band-pass filter 56 which passes the carrier frequency associated with the voice channel for signaling purposes. The output of band-pass filter 56 is connected through condenser 57 and transformer 58 to the control gap of double gap cold cathode ionic tube 59. The circuit to the main gap of tube 59 includes battery 147, relay 61, limiting resistance 60 and secondary of transformer 69. The primary of transformer 69 is supplied from the 60-cycle power main through the full-wave rectifier 70 and thus the output from the secondary of transformer 69 has a strong 120-cycle component combined with other even harmonics of 60-cycles. The contacts 62, 63 of the relay 61 when closed form a bridge across conductor 116 through the choke coils 64, 65.

Conductors 97, 98 carry voice frequency transmission through low-pass filter 6 from whence it flows through condensers 66, 67, conductors 116, and normally closed contacts 122, 123, of relay 124 to the tip and ring of jack 135. The front contacts 121 of relay 124 are wired to a source 120 of 1000-cycle alternating current. The talking circuit terminates as conductors 136, 137 at the jack 135. The line relay 139 is bridged across conductors 136, 137 and operates lamp 140 from battery 144 when by the operation of relay 61 a circuit is established bridging the circuit 116 through contacts 62, 63 and chokes 64, 65. The relay 124 is designed to operate when a potential adequate to break down cold cathode ionic tube 127 is applied between conductors 136 and 137, or between conductor 136 and ground.

A portion of a conventional operator's cord circuit is shown to comprise a plug 155, a ringing key 141 to which is wired a ringing source of 20 cycles per second 142, and a relay 145 wired to the sleeve of plug 155. Relay 145 operates with cut-off relay 138 wired to the sleeve of jack 135 when connection is made between plug 155 and jack 135 thus deenergizing line relay 139 in the usual way.

The central office termination of carrier channel No. 1 is bridged across party line 10 to conductors 107, 108 and then through band-pass filter 156 to hybrid coil combination 95, 96 and balancing network 100. Thus waves incoming from line 10 through filter 156 will appear in the secondary 101 and in the secondary 106. Resistance 107 terminates the secondary 106 and allows transformer 94 to be tuned by condenser 93 to the frequency of the carrier assigned to carrier channel No. 1, whereupon the potential of this frequency if present upon the line will appear across the control gap of double gap cold cathode ionic tube 87. The main gap circuit of tube 87 comprises a source of 120-cycle current from transformer 69 and a relay 88 having contacts 89, 90 which, when closed, bridge talking circuit 117 through chokes 80, 81 to allow operation of a line relay 139' as in the case of the voice frequency channel already described.

The secondary 101 is bridged by a carrier coil 86 supplied through band-pass filter 72 from harmonic generator 71 and by a Modem 85 connected through low-pass filter 84 to talking circuit 117 which terminates in jack 135'. The ringing and supervisory equipment for carrier channel No. 1 and also for carrier channels Nos. 2 and 3 which are not shown in detail, is identical with that with which the voice frequency channel referred to above is equipped with the single exception that the cut-off relay 151 has an extra pair of make contacts 149, 150 which close the circuit of relay 134 thus supplying 60-cycle power to harmonic generator 71 whenever the central station operator plugs into jack 135' associated with a carrier frequency channel.

In Fig. 3 are two harmonic generator units which may be of the type disclosed in Wrathall, supra. These are HG1 comprising magnetic cored induction coil 204, condensers 200, 201 and HG2 comprising magnetic cored induction coil 206 and condensers 202, 203. Power at 60 cycles per second is supplied to HG1. From its composite output band-pass filter 205 selects 1020 cycles per second which is the seventeenth harmonic of 60 cycles per second. The output of filter 205 at 1020 cycles per second is applied to HG2 in combination with copper-oxide bridge rectifier 207 from which an output of the even harmonics of 1020 cycles per second is obtained according to Wrathall, supra.

A party-line system such as that shown in schematic diagram in Figs. 1 and 2 might employ as carrier frequencies even harmonics of 4080 cycles per second which is the sixty-eighth harmonic of the 60-cycle current continuously supplied to the line. Thus channel No. 1 might operate on a carrier of 8160 cycles per second, carrier No. 2 on 16,320 cycles per second and channel No. 3 on 24,480 cycles per second. Current at a frequency of 4080 cycles per second may be employed for signaling from the voice frequency subscriber's station.

In such a party system it will ordinarily be advantageous to reverse the order indicated in the diagram of Figs. 1 and 2. Thus, the No. 3 carrier substation would be that electrically nearest the central office, followed in order by carrier substation No. 2, carrier substation No. 1, and last the voice frequency station. Line attenuation may be expected to increase with frequency and this may become important in the application of carrier to circuits ordinarily employed for subscriber loops. Thus, if a carrier of comparatively high frequency is employed it may be necessary to take precautions to hold line attenuation at a minimum value between the central office and a substation employing such carrier whereas these precautions are less important as the frequency of the carrier decreases and are least important at voice frequency. Size and spacing of conductors are factors affecting line attenuation.

In order to make a call from the voice frequency subscriber's station, the receiver 26' is lifted from hook 29' whereupon contacts 29', 30' are opened, connection is made between contacts 29', 31', 32' and contacts 33', 34'. Closing contacts 33', 34' completes connection between line 10 and harmonic generator 42 through low-pass filter 41 which, having a cut-off frequency of 80 cycles per second, passes 60-cycle current from the line 10 to harmonic generator 42. Harmonic generator 42 may be of the type shown in Fig. 3 thus producing even harmonics of 1020 cycles. Band-pass filters 44 then select from the output of generator 42 current of the frequency of the fourth harmonic or 4080 cycles per second and pass it through conductors 46, 47 to line 10.

The line 10 is thus energized with voltage at a frequency of 4080 cycles per second which finds outlet by central office conductors 54, 55 through band-pass filter 56 and tuned transformer 58 to the control gap of cold cathode ionic tube 59. The potential delivered by harmonic generator 42 is so proportioned to the attenuation of line 10 and of band-pass filter 56 and to the transformation ratio of transformer 58 that the potential appearing across the control gap of tube 59 is sufficient to ionize this gap. Under this condition the main gap of tube 59 breaks down under the influence of battery 147 and the 120-cycle output of transformer 69 thus operating relay 61. Operation of relay 61 closing contacts 62, 63 permits the operation from battery 143 of line relay 139 whereupon signal lamp 140 lights from battery 144 thus signaling the operator.

The voice frequency subscriber is called by operating cord circuit key 141, after making connection between plug 155 and jack 135, thus applying 20-cycle ringing power between conductor 136 and ground. The 20-cycle current is rectified by tube 127 and in conjunction with battery 126 operates relay 124 which connects the 1000-cycle source 128 across conductors 116. Condenser 125 smooths out the rectified current applied to relay 124. Current at 1000 cycles per second flows through low-pass filter 68 which is designed to pass all frequencies below 3000 cycles per second thence by conductors 97, 98 to line 10. At the voice frequency subscriber's station the 1000-cycle current passes through low-pass filter 45 and then, since the receiver 26' is assumed to be on its hook 29' thus holding connection between contacts 29', 30', through tuned transformer 18' to the control gap of ionic tube 17'. The control gap is thereby ionized thus permitting 60-cycle current from line 10 to pass through transformer 15' and operate the bell 16' through the main gap of tube 17'.

In answering, receiver 26' is removed from hook 29' thus breaking the connection between contacts 29', 30' and establishing connections 29', 31', 32' and 33', 34' whereupon a voice frequency talking circuit is established from transmitter 27' and receiver 26' through conductors 49, 51—48, low-pass filter 45, conductors 46, 47, line 10, to conductors 97, 98, low-pass filter 68, condensers 66, 67, circuit 116, and jack 135 and thence by plug 155 and operator's cord circuit to the calling station.

A call from carrier frequency subscriber's station No. 1 is made by lifting receiver 26 from its hook 29 thus breaking connections 29, 30 and making connections 29, 31, 32 and 33, 34. Completion of connection 33, 34 admits 60-cycle current from line 10 through conductors 11, 12 and low-pass filter 13 to harmonic generator 24. From the output of generator 24 band-pass filter 23 passes current at a frequency of 8160 cycles per second through transformer 22, band-pass filter 14 and conductors 11, 12 to line 10. This 8160-cycle current is accepted by band-pass filter 156 at the central station and passed into the hybrid coil combination 95, 96 emerging from winding 106 to enter transformer 94 which is tuned to this frequency, whence it appears across the control gap of cold cathode ionic tube 87. From this point the sequence of operation resulting in the lighting of signal lamp 140' is identical with that already described for the voice frequency channel.

The subscriber's station on carrier channel No. 1 is rung by first translating 20-cycle ringing current into 1000-cycle current as in the case of the voice frequency channel. Current at 1000 cycles per second appears on conductor 117, is passed through condensers 82, 83 and low-pass filter 84 which has a cut-off frequency of 3000 cycles per second to Modem 85. Operation of cut-off relay 151 which occurs when connection is made between plug 155 and jack 135' closes contacts 149, 150 thus causing the operation of relay 134 and closing the 60-cycle supply circuit of harmonic generator 71. From the output of generator 71 into high frequency bus 112 the band-pass filter 72 accepts through conductor 113 current of the carrier frequency 8160 cycles per second and this also is applied to Modem 85 through transformer 86. Thus the 8160 cycles per second carrier is modulated with 1000 cycles per second current and this modulated current flows hybrid coil 95, 96, band-pass filter 156 and over line 10 to input leads 11, 12 of the No. 1 carrier frequency subscriber's station whence it is passed through band-pass filter 14 and transformer 22 to Modem 21 where it is demodulated into 1000-cycles current which, flowing through low-pass filter 20 is applied to the control gap of the cold cathode ionic tube 17, the connection to transformer 18 being complete by reason of the fact that receiver 26 is assumed to be on hook 29 thus making contacts 29, 30. The 1000-cycle potential ionizes the control gap of tube 17 and bell 16 is rung through the main gap of tube 17 by 60-cycle current entering from line 10 to transformer 15.

When receiver 26 is removed from hook 29 voice frequency current from transmitter 27 is applied to Modem 21 together with 8160-cycle current from harmonic generator 24, and the modulated product flows through band-pass filter 14 to line 10 and thence to band-pass filter 71 at the central station whence it flows through hybrid coil 95, 96 to Modem 85, is there demodulated and the voice frequency component flows through low-pass filter 84 to jack 135' and then through the cord circuit to the operator or connected subscriber. At the same time, of course, a portion of the carrier frequency component of a transmission from the subscriber's station of carrier channel No. 1 flows through to the transformer 94, maintaining the control gap of ionic tube 87 in ionized condition. Line relay 139' will not operate, however, as long as cut-off relay 151 is operated.

Voice frequency current coming in from the cord circuit through jack 135' passes through low-pass filter 84 to Modem 85 where it modulates the 8160-cycle carrier supplied from harmonic generator 71 through band-pass filter 72 and the modulated wave passes through hybrid 95, 96 and band-pass filter 71 over line 10 to the No. 1 carrier channel subscriber's station. Entering through band-pass filter 14 it is demodulated by Modem 21 and the low frequency demodulation product passes through low-pass filter 20 to receiver 26 if the receiver is off its hook.

In the same way talking and signaling circuits may be established on carrier frequency channel No. 2 employing a carrier frequency of 16,320 cycles per second and over carrier frequency channel No. 3 employing a carrier frequency of 24,480 cycles per second and likewise additional carrier channels might be established at other carrier frequencies.

I have thus shown in detail and by specific illustration an embodiment of my invention whereby the well-known principles of carrier current transmission may be economically and effectively applied to local subscriber loops enabling the establishment over a single pair of wires of the practical equivalent of individual line service to a plurality of subscribers.

It is to be understood that although I have disclosed a preferred embodiment of my invention I am not limited thereby since it is obvious that I may use many modifications and many other arrangements without departing from the spirit of my invention which I have defined in the appended claims.

What is claimed is:

1. A single circuit telephone system comprising a plurality of subscribers' stations connected respectively to a central station through a plurality of channels superposed on said circuit at least one of which is a voice frequency channel and the remainder carrier frequency channels, means at each of said subscribers' stations for producing and transmitting to said circuit a modulated carrier wave for signaling said central station, the carrier channel subscribers' stations including means for modulation and demodulation of voice frequency waves from individual carrier frequencies, a source of 60-cycle waves floating across said single circuit and means for converting said 60-cycle waves into the desired individual carrier frequency.

2. A single circuit telephone system providing private wire service between a telephone central office and a plurality of subscribers comprising at least one voice frequency channel and a plurality of carrier channels superposed on said circuit, said channels being equipped with subscriber sets, means controlled by each subscriber's set for generating and transmitting to said circuit a distinctive modulated carrier wave for signaling said central office, the carrier channel subscriber sets including means for modulation and demodulation of voice frequency waves on individual carrier frequencies and means for automatically producing said individual carrier frequencies in said carrier channel subscriber sets from a 60-cycle supply activating said single circuit.

3. A multiparty telephone system comprising a single pair of wires connecting a central office and a plurality of subscribers' stations, a plurality of channels at least one of which is a voice frequency channel and the remainder carrier frequency channels superposed on said pair of wires thus providing private wire communication to each subscriber's station over a different one of said channels, and means at each of said subscribers' stations including those associated with a voice frequency channel, to generate a distinctive modulated carrier wave for signaling the central office.

4. A multiparty telephone system comprising a plurality of channels one of which is a voice frequency channel and the remainder carrier frequency channels providing individual line communication between a central office and a plurality of subscribers' stations over a single pair of wires, means at each of said subscribers' stations for calling the central office through the medium of locally generated carrier waves of distinctive frequency modulated with a low frequency wave and responsive means at said subscribers' stations whereby said stations may be called through the medium of a low frequency wave transmitted from said central office as a modulation of a distinctive carrier frequency.

5. A multiparty telephone system comprising a plurality of carrier frequency channels connecting a plurality of subscribers' stations to a central office over a single pair of wires and means to provide selective ringing for said subscribers' stations comprising at said central office a source of 20-cycle current, means including a cold cathode tube for translating said 20-cycle current to a 1000-cycle wave and means for modulating a carrier frequency distinctive of the station to be called with said 1000-cycle wave and for transmitting the modulated wave to said pair of wires for transmission thereover, and at said station to be called means for selecting and demodulating the received modulated wave to reproduce the 1000-cycle wave, ringing apparatus and means for utilizing the reproduced 1000-cycle wave to control the operation of said ringing apparatus.

6. A multiparty telephone system comprising a plurality of channels at least one of which is a voice frequency channel and the remainder carrier frequency channels, providing individual line communication between a telephone central office and a plurality of subscribers' stations over a single line, a continuous low frequency supply to said line and means at each of said subscribers' stations to receive said low frequency and to transmit to said line a carrier current derived from said low frequency to call said central office.

7. A multiparty telephone system according to claim 6 in which the last-mentioned means is controlled by switchhook operation.

8. A multiparty telephone system according to claim 6 in which the transmitted carrier current has a frequency which is different for each subscriber station.

9. A multiparty telephone system comprising a plurality of carrier frequency and low frequency channels providing over a single line "individual line" communication between a plurality of subscribers' stations and a central station, a continuous low frequency supply on said line and means including impulse generators operating on magnetic saturation for generating carrier waves of different frequencies for transmission over said channels, from said low frequency supply, said carrier waves being utilized for transmitting call signals.

10. A multiparty telephone system according to claim 9 in which said impulse generators are located at said central station and at said subscribers' stations.

11. A multiparty telephone system according to claim 10, in which said means include modulator-demodulators operating in conjunction with said impulse generators to provide reciprocal transformation between carrier frequencies and voice frequencies.

12. A multiparty telephone system comprising a plurality of communication channels including thereamong a voice frequency channel providing over a single line private communication between a central station and a plurality of subscribers' stations respectively, means at the said central station for calling a carrier subscriber station comprising means for transmitting a carrier wave of the frequency assigned to that subscriber's station modulated with a 1000-cycle wave, means for obtaining said 1000-cycle wave by translation from low frequency ringing current, and means at said subscriber's station for demodulating the said modulated 1000-cycle wave and for translating it to a low frequency current for bell operation, said frequency translating means comprising cold cathode ionic tubes.

13. A multiparty telephone system comprising

a plurality of carrier communication channels providing over a single line private communication between the central station and a plurality of subscribers' stations respectively, a continuous low frequency supply on said line, impulse generators at said stations for generating from the low frequency line supply carrier current of a plurality of frequencies, selective circuits for selecting desired carrier frequencies from the outputs of said impulse generators, modulator-demodulators at said stations for effecting transformation between modulated carrier currents and voice current reciprocally, and a voice frequency channel superposed on said line utilized for carrier frequency supervisory and signaling operations.

14. A carrier frequency signaling system comprising a plurality of stations connected by a carrier line, one of said stations including means for generating carrier waves of selected frequency, means for generating low frequency ringing current, means to translate said ringing current to a higher low frequency current, means to modulate said carrier waves with said higher low frequency current and means to transmit the modulated carrier waves to said line, and another station comprising means to select said modulated carrier waves from said line, means to demodulate the selected waves to reproduce said higher low frequency current, means to translate the reproduced current into low frequency ringing current and ringing apparatus responsive to said low frequency ringing current, the frequency translating means at said one and said other station including a cold cathode ionic tube.

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