

Jan. 20, 1948.

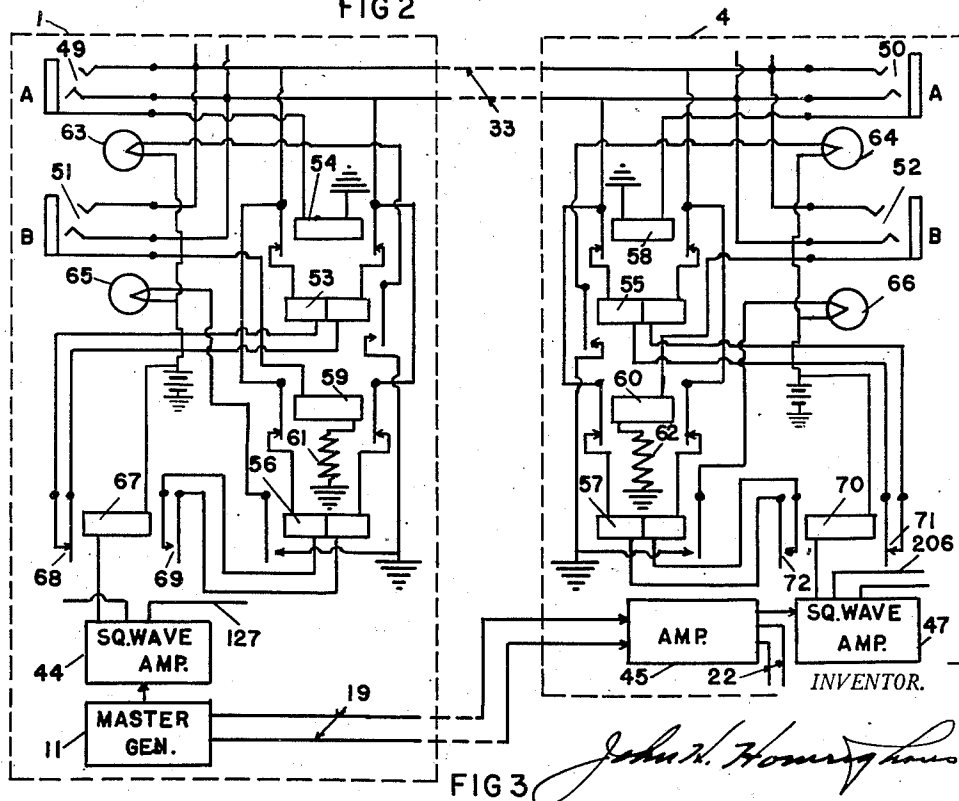
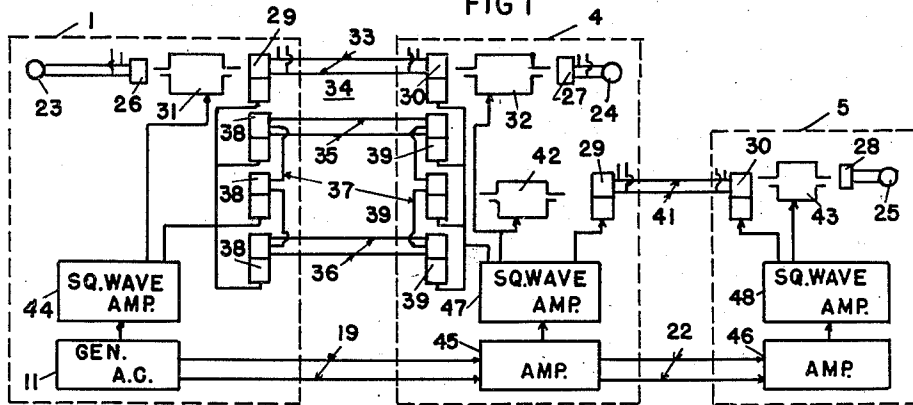
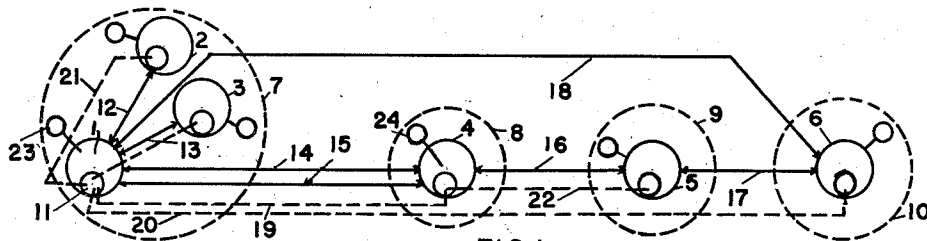
J. H. HOMRIGHOUS

2,434,698

TIME DIVISION MULTIPLEX TELEPHONE SYSTEM

Filed Feb. 15, 1944

3 Sheets-Sheet 1



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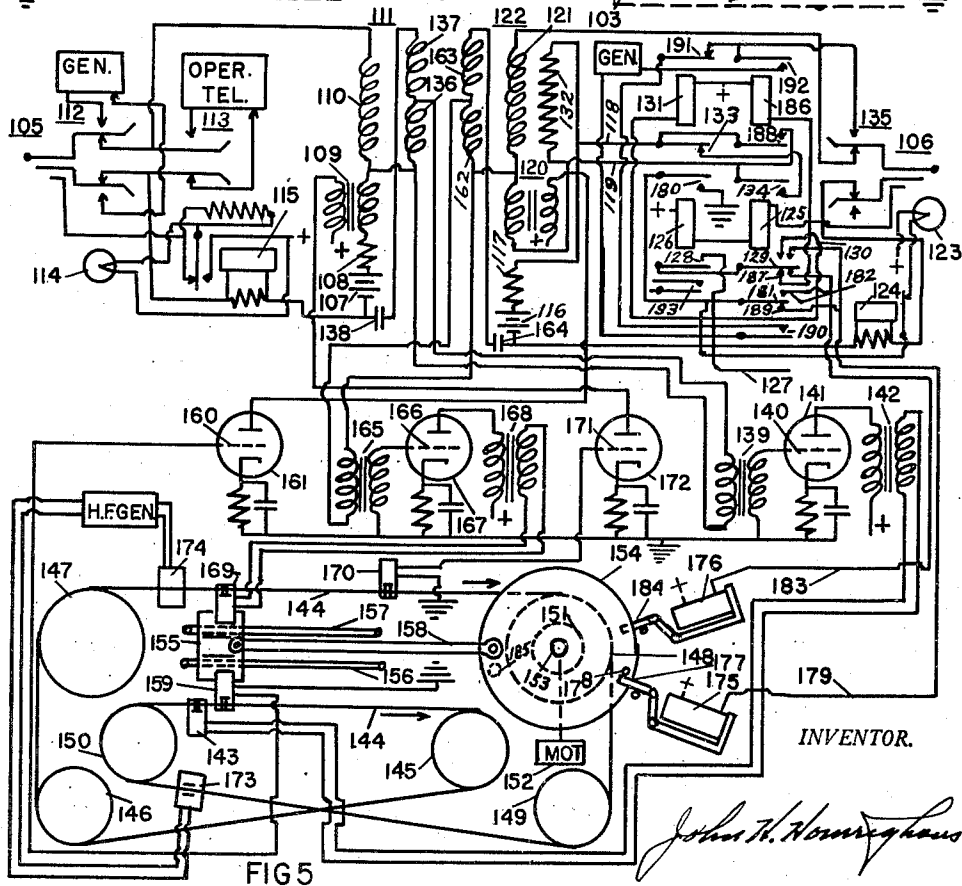
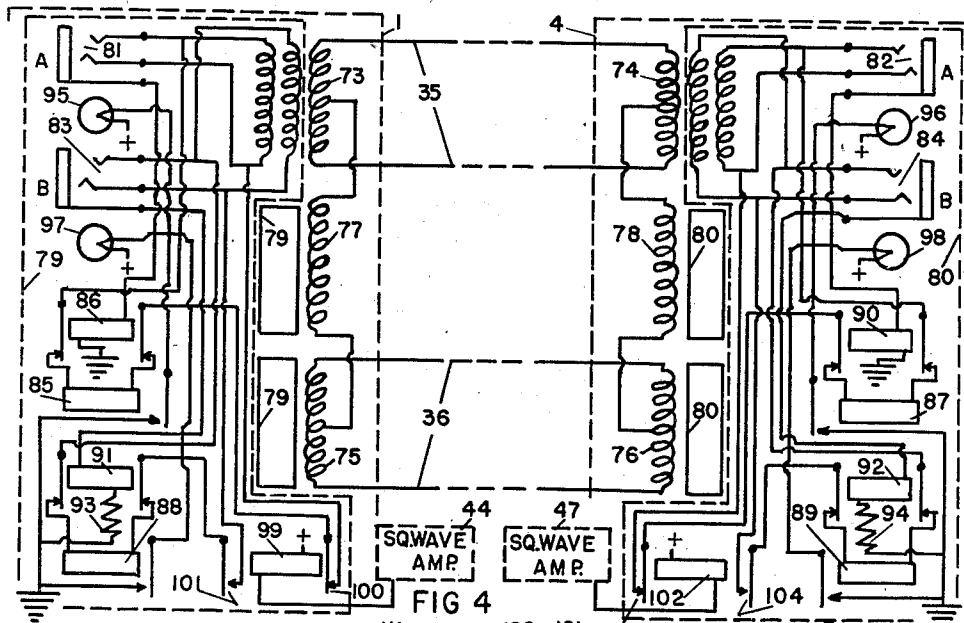
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2,434,698

TIME DIVISION MULTIPLEX TELEPHONE SYSTEM

Filed Feb. 15, 1944

3 Sheets-Sheet 2



INVENTOR.

John H. Homrighous

Jan. 20, 1948.

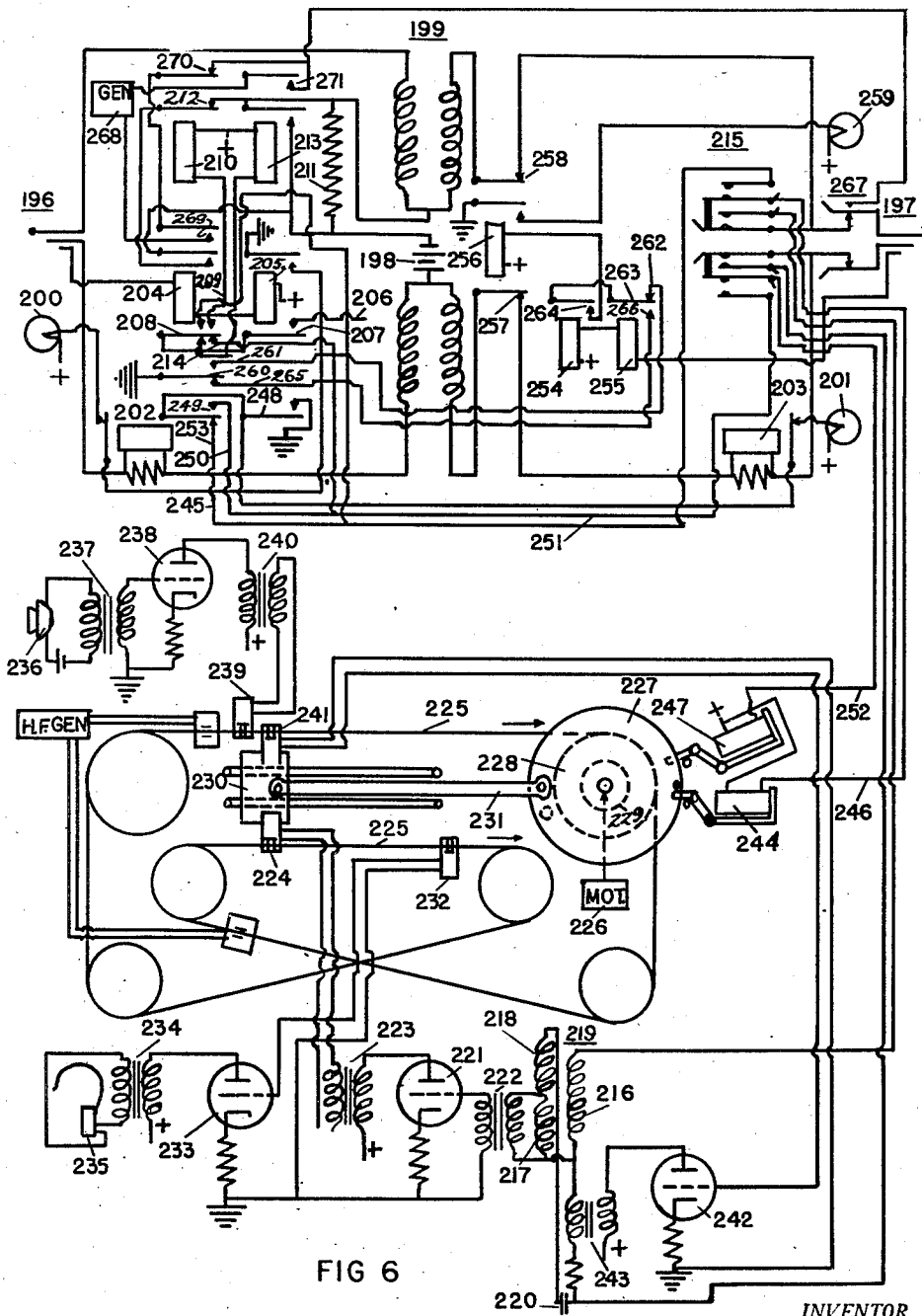
J. H. HOMRIGHOUS

2,434,698

TIME DIVISION MULTIPLEX TELEPHONE SYSTEM

Filed Feb. 15, 1944

3 Sheets-Sheet 3



INVENTOR.

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UNITED STATES PATENT OFFICE

2,434,698

TIME DIVISION MULTIPLEX TELEPHONE
SYSTEM

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Application February 15, 1944, Serial No. 522,475

10 Claims. (Cl. 179—15)

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This invention relates to an improved multiplex telephone system and more particularly to a system for increasing the number of messages that may be transmitted over trunk lines.

One of the objects of my invention is to provide means for transmitting two messages simultaneously over a phantom circuit.

Another object of the instant invention is to provide means for transmitting two messages simultaneously over a phantom circuit, and also for transmitting two messages at the same time over each of the physical trunk lines utilized for the phantom circuit.

Another object of my invention is to provide an improved two message two-way mechanism for reducing and expanding the period of time for small portions or fragments of messages.

Another object of this invention is to provide synchronizing or control signals from a master generator over pilot wire circuits or trunk lines to the various telephone offices in the system, whereby, all the two message two-way mechanisms in the system may be controlled in time relation by the master generator.

Another object of the instant invention is to provide means in a two message two-way transmission trunk line for signaling the operator in either direction independently for either message.

Another object of the instant invention is to provide means in a two message two-way phantom group of trunks for signaling the operator independently for each message in either direction over the two physical trunks, and over the phantom circuit.

Still another object of the instant invention is means for associating the message reducing and expanding mechanism with the operator's cord circuits rather than with the trunk lines.

Several telephone messages may be transmitted simultaneously over a pair of conductors by providing a different carrier wave for each telephone message, or two different messages may be transmitted over a trunk line by reducing the period of time for equal portions of different messages and transmitting these portions by twenty-four volt power and forty-eight volt power in rotation. In the instant invention I separate the sound signals for two messages into equal portions or fragments and reduce the period of time for each portion approximately one half and synchronize the transmission and the reception of different messages in all the telephone offices by control signals developed by a master generator in one office and transmitted over trunk lines to all other offices in the system.

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Other objects will be apparent from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a schematic of a trunking system between telephone offices and cities.

Figure 2 is a block diagram illustrating a circuit arrangement for interconnecting telephone subscribers.

Figure 3 shows a two message two-way transmission trunk line.

Figure 4 shows a multi message two-way transmission phantom trunk group.

Figures 5 and 6 show cord or link circuits for interconnecting trunk lines and subscribers' lines.

Figure 1 represents a telephone trunking arrangement between several telephone offices 1 to 6 inclusive. The telephone offices 1, 2 and 3 may be in the same city 7 while the offices 4, 5 and 6 may be in other towns or cities 8, 9 and 10. The solid lines between these telephone offices represent a group of trunk lines, while the dash lines represent pilot wire or trunk lines for transmitting control signals from the master generator 11 in office 1. The lines 12 and 13 may represent groups of two message two-way transmission trunks. The line 14 and 15 may represent two different types of trunks; 14 may be a group of two message two-way transmission trunks, and 15 may represent phantom groups for multi message two-way transmission. 16 and 17 may be two message two-way transmission groups, while 18 may represent phantom groups similar to 15.

The master generator at 11 may develop control signals of sine wave form, and from this generator the signals of sine wave form may be transmitted over separate trunk lines such as 19, 20 and 21 to the designated offices in the different towns and cities. In office 8 the signals may be amplified and relayed over trunk 22 to another office. The sine wave signals after being amplified in each office are changed to square waves and utilized to synchronize the message reducing and expanding mechanism with the home or originating office.

Figure 2 represents the trunking arrangement and the cord circuits used for interconnecting the subscribers in the telephone offices 1, 4 and 5. The subscribers' telephones 23, 24 and 25 are of a conventional type well known in the art. The numerals 26, 27 and 28 may represent the conventional line and cut off relay and signals associated with the subscribers' lines. The double blocks 29 and 30 represent the apparatus associated with each end of the trunk line, each comprising two jacks, two lamps, two line relays, two cut off re-

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lays, and a signal control relay for the transmissions and reception of two intelligence messages simultaneously. Cord or link circuits 31 and 32 and other similar circuits may be utilized for connecting two subscribers in office 1 to two subscribers in office 4 through the trunk line 33, which may be one trunk in the group 14. The cords 31 and 32 comprise message reducing and expanding mechanism for changing the period of time for successive fragments of the messages.

The phantom groups 34 comprises two pairs of conductors 35 and 36 with a phantom circuit 37 superimposed in conventional manner upon the two pairs of conductors or the two physical circuits. The double blocks 38 and 39 represent the apparatus associated with each trunk circuit, each block comprising two jacks, two lamps, two line relays, two cut off relays, one signal control relay, and associated circuits for the transmission and reception of two messages over each trunk circuit. Cord circuits 31 and 32 may be employed as before to interconnect subscribers in offices 1 and 4. Now suppose that the subscriber at 23 is calling the subscriber 25 in office 5. Then another two message two-way transmission trunk line 41, similar to the trunk line 33, would be employed and a trunk cord circuit 42 would be utilized to extend the connection between the trunk line 41 and the trunk line 33 or a trunk circuit in the phantom group 34 may be employed. The cord circuit 43, similar to cord circuit 32, would be used to complete the call to the subscriber at 25.

The reference numeral 11 represents the master generator in telephone office 1 for developing alternating current signals, preferably twenty cycles per second, although other frequencies may be employed. These signals are supplied to the square wave amplifier 44 where they are changed into spaced square top pulses, and applied to the cord circuit 31 and other similar cord circuits in office 1 for controlling the message reducing and expanding mechanism to be fully explained later. These pulses from the square wave amplifier 44 are also applied to all relay equipments 29 and 38 to control signaling so that lamps will indicate the particular jack into which the cord circuit should be plugged. The alternating current control signals of sine wave form from the generator 11 are transmitted over the trunk 19 to the amplifier 45 in office 4. From the amplifier 45 the signals are relayed over trunk 22 to the amplifier 46 in office 5. In office 4 the signals from the amplifier 45 are also supplied to the square wave amplifier 47 and from this amplifier the square wave signals are applied to the relay equipments 29, 30 and 39 and cords 32 and 42. In office 5 the signals from the amplifier 46 are supplied to the square wave amplifier 48 and from this amplifier the square top waves are applied to relay equipments 30 and cord 43.

In Figure 3 I have shown a pair of conductors 33 extending between two telephone offices 1 and 4 for the transmission and reception of two messages. This trunk may be considered as a two message or two party trunk line, and it is provided at either terminal with a pair of jacks, apparatus, and associated circuits for alternately including a pair of line relays or signal drop relays across the conductors to control each signal of a pair of signals alternately to notify the operator which jack or party should be answered.

In Figure 4, I have shown a phantom group of trunk circuits extending between two telephone offices 1 and 4 which may be used interchangeably with the trunk lines of Figure 3 for the

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transmission and reception of two messages simultaneously over each physical circuit 35 and 36 and two messages simultaneously over the phantom circuit 37. Each trunk circuit may be considered as a two message or two party circuit. The physical circuits and the phantom circuit are provided at either terminal with a pair of jacks, and apparatus for alternately including a pair of signal relays in a circuit inductively connected to the trunk conductors to control signals notifying the operator which jack or party should be answered in the phantom group.

Figures 5 and 6 show cord circuits for interconnecting subscribers' lines and trunk lines. Figure 5 represents a cord circuit for connecting a subscribers' line to a two message two-way transmission trunk circuit such as are shown in Figures 3 and 4. Associated with each cord is a message reducing and expanding mechanism for reducing the period of time for successive fragments of a message outgoing over the trunk, and for expanding the period of time for successive fragments of a message incoming from a trunk line.

Figure 6 represents a cord circuit for connecting to two double purpose trunk lines. This cord is different from the cord in Figure 5 in that the message reducing and expanding mechanism may be common to all the cord circuits in one operator's position rather than being individual to each cord. In other words, since the period of time for the messages transmitted over both connected trunks has been reduced, the reducing and expanding mechanism is only used when the operator talks to either the calling or called party.

With further reference to Figure 3, the trunk conductors 33 terminate in a pair of jacks in parallel at either end for connecting two cord circuits to the same line for the transmission and reception of two different messages simultaneously. Jacks 49 and 50 may be known as the A party jacks and jacks 51 and 52 may be known as the B party jacks. Associated with each jack are line and cut off relays. The line relay 53 associated with jack 49 is adapted to be energized over conductors 33 by battery supplied from a connecting cord circuit at jack 50 and the cut off relay 54 associated with jack 49 is energized through the sleeve conductor of jack 49 from battery in a connecting cord circuit to disconnect the line relay 53. Adapted to be operated in a like manner are the line relays 55, 56 and 57, and the cut off relays 58, 59 and 60, associated with the jacks 50, 51, and 52 respectively. The cut off relays 59 and 60 associated with the B party jacks are energized through resistors 61 and 62 respectively to effect certain changes in the connecting cords, to be explained later. The energization of any line relay 53, 55, 56 or 57 will cause its associated signal lamps 63, 64, 65 or 66 to glow, notifying the operator that a connection is desired.

The master alternating current generator 11 develops an output of sine wave form which is supplied to the square wave amplifier 44; the output from this amplifier may be equally spaced square top pulses which are applied to the signal control relay 67 to alternately energize and deenergize the relay during equal periods of time. The relay 67 in its deenergized position as shown in the drawing maintains a closed circuit through the line relay 53 at the contacts 68, and holds the circuit through line relay 56 open at contacts 69. The relay 67 upon energizing

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holds the circuit through relay 53 open and maintains the circuit through relay 56 closed so that the line relays 53 and 56 are alternately placed in condition for energization over the trunk conductors and for equal periods of time. Therefore the relays 53 and 56 may be energized through the cord circuits connecting jacks 50 and 52 respectively, to be more fully explained hereinafter.

The relay 70 in office 4 will be energized and deenergized in synchronism with the relay 67 in office 1, since the output of the master generator is also supplied over the trunk 19 to the amplifier 45 in office 4. The output from amplifier 45 is supplied to the square wave amplifier 47 to develop spaced square form pulses in synchronism with the pulses from the amplifier 44. These pulses are applied to the signal control relay 70 to thereby open and close the circuits through the line relays 55 and 57 at contacts 71 and 72 during equal periods of time. Therefore, the relays 55 and 57 may be energized through the cord circuits connecting jacks 49 and 51 respectively, to be further explained later.

With further reference to Figure 4 showing a phantom trunk group which may be one group of many between offices 1 and 4. The conductors 35 and 36 are the two physical circuits terminating in transformer or repeating coils windings 73, 74, 75 and 76. The phantom circuit is formed in a conventional manner by connections from the mid points of the repeating coil windings 73, 74, 75 and 76 and terminating at both ends in other repeating coil windings 77 and 78 as shown in Fig. 4.

The terminal equipment 79 and 80 associated with each trunk circuit, comprises at each office terminal a pair of jacks connected to separate repeating coil windings, a pair of line relays, a pair of cut off relays, a signal control relay, and associated circuits for the transmission and reception of two different messages simultaneously over each physical circuit and at the same time two other messages over the phantom circuit, making a maximum of six simultaneous conversations over two pairs of conductors.

Jacks 81 and 82 associated with trunk conductors 35 may be known as the A party jacks, and jacks 83 and 84 may be known as the B party jacks. Associated with each jack are line and cut off relays. The line relay or drop signal 85 associated with the A party jack is adapted to be actuated by alternating current supplied from a connecting cord circuit at the A party jack 82, and the cut off relay 86 associated with jack 81 is energized through the sleeve conductor of jack 81 from battery in a connecting cord circuit to disconnect the relay 85. Adapted to be operated in like manner are the line or drop signal relays 87, 88 and 89, and the cut off relays 90, 91 and 92 associated with the jacks 82, 83 and 84 respectively. The relays 91 and 92 are energized through resistors 93 and 94 to effect certain changes in the connecting cords to be explained later. The energization of any line relay 85, 87, 88 or 89 will cause its associated signal lamp 95, 96, 97 or 98 to glow notifying the operator that a connection is desired. Spaced pulses from the square wave amplifier 44 are applied to the signal control relay 99 to alternately energize and deenergize the relay during equal periods of time. The relay 99 in its deenergized position maintains a closed circuit through the line relay 85 at the contacts 100, and holds the circuit through the line relay 88 open at contacts 101. The relay 99

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upon energizing holds the circuit through relay 85 open, and maintains the circuit through relay 88 closed so that the line relays 85 and 88 are alternately placed in condition to be actuated by ringing current over the trunk conductors 35 for equal periods of time. Therefore, the relays 85 and 88 may be actuated by ringing current from the cord circuits connecting jacks 82 and 84 to be more fully explained later.

The relay 102 in office 4 will be energized and deenergized from spaced pulses supplied from the square wave amplifier 47 in office 4 to open and close the circuits through the line relays 87 and 89 at contacts 103 and 104 during equal periods of time. Therefore, the relays 87 and 89 may be actuated by signal current supplied through jacks 81 and 83. The relay 102 will be energized and deenergized in synchronism with the relays 99 and 67 in office 1 since all control signals are supplied by the master generator 11. Similar terminal apparatus and circuits may be employed for the other physical circuit conductors 36 and also for the phantom circuit as shown in Fig. 4 by the blocks designated 79 and 80.

From the above description it has been shown that an operator may be signaled in either direction for the A and B parties over the phantom trunk group and also over the two conductor trunk.

Figure 5 shows a cord or link circuit for connecting either an individual or party telephone line with a multi party trunk line of Figure 3 or Figure 4 as illustrated in Figure 2 at 31 and 32. The cord circuit includes recording and reproducing mechanism for grouping and separating sound signals so that two cord circuits may be employed at each terminal of the trunk for carrying on two separate and private conversations over the trunk line at the same time.

The plug 105 is a calling or answering plug for the telephone lines, and plug 106 is a calling or answering plug for the trunk lines. Battery at 107 is fed to the telephone line through resistance 108, secondary winding of transformer 109, winding 110 of anti-sidetone transformer 111. The operator may ring on the telephone line through the action of key 112, and she may talk to the subscriber by operating the key 113. The usual disconnect signal is provided at 114, which is caused to glow by the relay 115 returning to normal position when the subscriber on the connected line hangs up his receiver. Battery at 116 is fed over the trunk line through resistance 117, conductors 118 and 119 when certain relays in the cord circuit are operated to be explained later, secondary winding of transformer 120, winding 121 of the anti-sidetone transformer 122, tip of plug 106, trunk conductors of connected trunk line, ring of jack 106, to opposite side of the battery. A disconnect signal is provided at 123 which may be actuated by the relay 124. The relay 124 is marginal and will not operate its armature in series with a line relay in the trunk circuit of Figure 3, but will be completely energized when a second cord circuit is connected to the opposite end of the trunk line of Figure 3, which may be like the cord circuit of Figure 5 except that the battery 116 would be connected opposite to that shown so that the two batteries in the connecting cord circuits would be in series. The disconnect signal 123 and relay 124 would not be used with the phantom group of trunks in Figure 4.

Assume that the plug 106 is connected to the A jack 49 in Figure 3: then relays 54, 125 and

126 would be energized in series over the sleeve conductors. Relay 54 upon energizing clears relay 53 from the trunk line; relays 125 and 126 upon energizing close a circuit from the square wave amplifier 44, conductor 127, Fig. 3, to conductor 127, Fig. 5, springs 128, springs 129 and 130, to relay 131. Therefore relay 131 is energized and deenergized during equal periods of time by the spaced pulses from the amplifier 44. Relay 131 in its normal or deenergized position shorts the very high resistance 132 over conductor 118, springs 133, springs 134, conductor 119. The duration of this condition may be considered one talking period for the A party. Relay 55 in the trunk circuit will be energized during this period or during the time that relays 131 and 70 are deenergized to notify the operator at 64 that a connection is desired. The ringing key 135 is not used with the two conductor trunks. Relay 131 during the period that it is energized opens the contact springs 133 to include the resistance 132 in the battery circuit feeding the trunk line, thereby rendering the cord circuit inoperative or blocked to sound signals, which may be known as a B party talking period. Since the control signals are in synchronism, relays 70 and 131 will be operated in unison and line relay 55 will be cleared from the trunk line during the B party talking period.

In order that two telephone messages may be transmitted over the trunk line, I reduce the interval of portions or fragments of each message by approximately one half and transmit these grouped portions in alternate periods of time. Therefore, by recording the sound signals from the telephone line or the operator's telephone set on a magnetic wire or tape and reproducing the signals by a coil traveling in the opposite direction to that of the wire and at approximately the same speed, the interval for each portion will be reduced or the frequency of the signals will be increased.

The sound signals from a connected telephone line would pass through winding 110 and the alternating current component seeking the path of least resistance would pass through winding 136 and 137 of the anti-sidetone transformer 111, condenser 138 to ring conductor. The primary winding of audio transformer 139 bridged across the winding 136 of the anti-sidetone transformer will vary the potential on grid 140 of the amplifier tube 141 in accordance with sound signals received from the telephone line. The anode output of tube 141 may be applied through the transformer 142 to the stationary recording coil 143 for recording the signals magnetically on the moving wire or tape 144.

In the recording and reproducing mechanism I preferably employ an endless wire 144 of small diameter traveling in the direction indicated by the arrows over the pulleys 145, 146, 147, 148, 149 and 150. The pulley 148 is driven at a uniform speed by a motor 152 through the friction clutch indicated by the dashed circle 151 connected to the shaft 153. Attached to the pulley 148 is a disk of larger diameter 154, driving the member 155 on the slide bars 156 and 157 in a reciprocating motion through the action of the connecting arm 158 attached near the rim of the disk 154 so that the distance traveled right to left by the member 155 is approximately equal to the distance traveled by the wire in one half revolution of the pulley and disk 148 and 154.

The signals recorded on the wire 144 by the coil 143 may be picked up by the reproducing coil

159 traveling from right to left or in a direction reverse to that of the wire so that the signals will be reproduced in the coil 159 in one half of the interval that was required to record them on the wire. The coil 159 traveling from left to right moves very nearly at the same speed and in the same direction as the wire. Therefore the coil 159 would be inactive and as will be shown later the signals would be blocked in the cord circuit during the left to right movement of the coil.

The signals reproduced by the coil 159 are applied to the grid 160 of the amplifier tube 161. The output of tube 161 is applied to the primary winding of transformer 120 to vary the current supplied by battery 116 to the trunk line over a path as previously described. Therefore, it has been shown that the sound signals from the subscriber's line may be separated into small portions, and grouped by the interval being reduced through the reciprocating action of the coil 159, and then transmitted over the trunk line in spaced periods of time. As shown in Figure 2 another cord circuit 32 may be employed in office 4 to connect a telephone line with the A jack 50 of the trunk line. This cord circuit as previously stated may be exactly like the cord circuit of Figure 5 except that the terminals of battery 116 may be reversed. Therefore, signals originating in office 4 and transmitted over the trunk line would also be in spaced groups and the alternating current component would flow through windings 121, 162 and 163 of the anti-sidetone transformer 122, condenser 164 to the opposite side of the line. The primary winding of transformer 165 bridged across the winding 162 will cause the potential on the grid 166 of amplifier 167 to vary in accordance with the sound signals received from the trunk line. The anode output of tube 167 is applied through the audio transformer 168 to the recording coil 169 mounted on the member 155 and traveling forward and backward along the wire 144 to record sound signals thereon during the right to left movement of the coil only. The coil travels left to right in the same direction and approximately the same speed as the wire, therefore no signals would be developed. Furthermore the cord circuit will be blocked during this period by including the resistor 132 in the battery supply circuit. The coil 169 in moving right to left along the wire 144 in a direction opposite to the movement of the wire will cause the signals to be recorded over a length of the wire 144 equal to approximately twice the distance that the coil 169 travels right to left, so that the signals received over the trunk line will be expanded to their normal interval and reproduced in the stationary coil 170 and applied to the grid 171 of the amplifier tube 172. The anode output of the tube 172 may be applied to the primary winding of the transformer 109 to vary the current in the telephone one line over a path as previously described.

The coils 173 and 174 are high frequency erasing coils for restoring or demagnetizing the wire 144 so that further messages may be recorded thereon.

The pole pieces for the recording and reproducing coils are provided with a narrow slot for the wire 144 to travel through.

The A party talking periods over the trunk line are the periods between synchronizing pulses, and the B party talking periods are during the intervals of the synchronizing pulses, which are the same in each two party trunk throughout the

system. In other words, signals originating in office 1 and transmitted over A party trunk would be transmitted during the intervals between control pulses and the answer from a subscriber in office 4 would also be transmitted during the intervals between control pulses.

In order to synchronize the grouping and separating mechanism with the proper party A or B on the trunk line, I provide holding or retarding magnets 175 and 176 for holding the disk 154 so that the member 155 will be held or retarded until a control pulse is received. The magnet 175 may be considered the A party holding magnet and in its nonoperated position as shown in the drawing it holds the disk 154 from rotating by the armature bar 177 engaging the pin 178 in the disk 154. As soon as a control pulse is received over conductor 127, the magnet 175 is energized in parallel with relay 131 through springs 128, 129 and 130, and conductor 179, during the intervals of the control pulses to permit the disk 154 to rotate. The motor is arranged to drive the disk a little faster than one revolution per cycle of the control signals so that the bar 177 will slightly retard the disk just before the control pulse is received. The magnet 176 is continuously energized while the plug 106 is connected to the A party jack through the springs 180, 181 and 182 and conductor 183, to hold its armature bar 184 out of engagement with pin 185.

From the above it has been shown that the member 155 will move from right to left while the relay 131 is deenergized to transmit sound signals during the intervals between control pulses, and that during the intervals of the control signals the cord circuit is blocked by including the resistance 132 in the talking path. As previously explained another cord circuit similar to Figure 5 will be employed in office 4 so that a subscriber in office 1 and a subscriber in office 4 may talk over the A party trunk line. A second subscriber in office 1 may talk to a second subscriber in office 4 at the same time over the B party trunk line. In which case another cord circuit similar to Figure 5 would be connected to the B jack 51 in office 1, and a similar cord circuit would be connected to the B jack 52 in office 4.

Inserting the plug 106 into the B jack 51 will cause relays 59 and 126 to be energized through the resistance 61 over the sleeve conductors, relay 125 is arranged so that its armature will not be operated when the resistor 61 is included in its energizing circuit. Therefore relay 186 will be energized intermittently by the control signals over conductor 127, and through the springs 128, 129 and 187 to the relay 186. Relay 186 during its energized position may be considered the B party talking period and the resistor 132 is shorted at springs 188 during the intervals of the control pulses, and in the intervals between pulses the resistor 132 is included in the talking path to block the signals and to reduce the current drain. Instead of using the resistor 32 the talking path could be opened and closed by the relay 186. The holding magnet 176 will be operated in unison with the relay 186 over conductor 183 and springs 129 and 128, to retard the rotation of the disk 154 by the armature arm 184 engaging the pin 185, which places the member 155 in position to start moving to the left at the instant a control signal is received. Holding magnet 175 is held in its operated position when the cord is used with B party trunk lines, over conductor 179 through springs 189, 181 and 180 to ground. The remainder of the apparatus and associated circuits

in the cord functions as described in connection with the A party.

From the above it has been shown that two private conversations may be carried on over a two conductor trunk line by grouping the signals in alternate spaced periods, and also that the operator may be signaled in either direction. It is also shown that the cord circuit of Figure 5 may be used for either A or B connections.

The cord circuit of Figure 5 may be used with the phantom trunk group of Figure 4 in the same manner as above described except to signal the distant operator. The ringing key 135 would be operated, which causes ringing current to be sent out over the trunk line during a period depending upon which party jack is used. Should plug 106 be inserted in the A jack 81 then ringing current will only be supplied to the trunk line during the A party intervals through springs 190 and 191, and when the plug 106 is connected to B jack 83 ringing current will only be supplied to the trunk during the B party interval through the contacts 192. The motor circuit may be closed by the springs 193 actuated by the relay 126.

The cord circuit for connecting two trunks is illustrated at 42 in Figure 2 and is shown in more detail in Figure 6. The principal difference between this cord circuit and that of Figure 5 is that the signal grouping and separating mechanism in Figure 6 is common to an operator's position in the switchboard rather than being individual to each cord circuit. The operation is very similar to that describing Figure 5.

The plug 196 may be considered the answering plug and the plug 197 may be the calling plug. Battery at 198 is fed through the windings of the repeating coil 199 to the tip and ring conductors of both the answering and calling plugs. Disconnect signals are provided at 200 and 201 adapted to be operated by the relays 202 and 203, when the cord at the opposite terminal of the connected trunks are withdrawn restoring the relays to normal position. The relays will not remain operated in series with a trunk line relay, but may be operated by current from two cord circuit batteries.

Assuming that plug 196 is connected to an A party trunk in answer to a signal then relays 204 and 205 will be energized over the sleeve conductor in series with the associated cut off relay to apply spaced control pulses from the square wave amplifier 47 over conductor 206, springs 207, 208 and 209 to the relay 210. Relay 210 in its nonoperated position which may be considered the talking condition for the A party trunk line, shorts the high resistance 211, and when operated springs 212 are opened to include the resistor 211 in the talking path so that negligible current will flow during the B party trunk line interval. Should the plug 196 be connected to a B party jack the armature of relay 204 would not be operated on account of a resistor in series with the cut off relay in all B party trunks. Therefore relay 213 would be energized by control pulses over conductor 206, springs 207, 208 and 214, which will short the resistor 211 when energized or during the intervals of the control pulses.

From the above it has been shown that the talking periods for the A and B party are the same as described for the cord circuit of Figure 5.

The operator in order to obtain information over the trunk line must operate the key 215 to connect her telephone set with the line which comprises wire recording and reproducing mechanism for separating the grouped signals from

the trunk line and expanding their intervals to normal, and for grouping the signals from the operator's microphone to transmit them over the trunk line.

The path for the grouped sound signals from the trunk line may be over the tip conductor, winding 216, 217 and 218 of the anti-sidetone transformer 219, condenser 220, to the ring conductor. The signals in the coil 217 are applied to the grid of 221 through the transformer 222. The anode output of tube 221 is applied through the transformer 223 to the movable recording coil 224 for recording the sound signals on the wire 225 when the coil is traveling from right to left. The wire 225 travels around the several pulleys as indicated by the arrows and this mechanism is similar to that described in Figure 5. A motor 226 drives the disk 227 and pulley 228 through a friction clutch 229 indicated by the dashed circle. The member 230 is driven in a reciprocating motion through the action of arm 231.

The signals recorded on the wire by coil 224 are picked up by the reproducing coil 232 and applied to the grid of tube 233, the output being applied through transformer 234 to the operator's receiver 235.

The sound signals originating at the operator's microphone 236 are applied through transformer 237 to the grid of tube 238. After suitable amplification in this tube they are applied to the stationary recording coil 239 through the transformer 240. The signals recorded on the wire 225 are picked up by the reproducing coil 241 mounted on member 230 in its movement from right to left opposite to the direction of the moving wire so that the signals are grouped into approximately one-half their normal interval. These grouped signals are applied to the grid of tube 242 to vary the current from the battery 198 through the transformer 243 and winding 216 of the anti-sidetone transformer, and windings of the repeating coil 199.

The control magnet 244 for the A party is intermittently energized by the control signals from conductor 206 through springs 207, and 208, conductors 245 and 246, during the time that key 215 is operated. The control magnet 247 may be energized continuously when the cord circuit is used for the A party from ground through springs 248, 249 and 250, conductors 251 and 252. The control magnet 247 controls the rotation of the disk 227 when the cord circuit is used with a B party jack by the control signals through springs 207, 208 and 214, conductors 251 and 252. Likewise the magnet 244 is continuously energized when the cord circuit is used for the B party from ground through springs 248, 249 and 253, conductors 245 and 246.

Relays 254 and 255 are energized over the sleeve conductor when the cord circuit is connected to the A party jacks and relay 254 only is energized when connected to the B party jack as explained for the opposite end of the cord circuit. Should the operator insert the plug 197 into the wrong party jack the relay 256 will be energized to open the cord circuit at springs 257 and 258 and also light the signal lamp 259 to notify the operator of the mistake. For instance, should plug 197 be inserted in B party jack when plug 196 is connected to an A party jack, then relay 256 would be energized from ground through springs 260 and 261, at relay 204, springs 262, 263 and 264. Should plug 197 be connected to A party jack when plug 196 is in B jack then relay 256 would

be energized from ground through springs 260, 265, 266, 263 and 264.

The operator may ring out over the trunk line in spaced intervals by operating the key 267. The A party ringing current is supplied from the generator 268 through springs 269 and 270 during the deenergization periods of relay 210. The B party ringing current is supplied from the generator 268, springs 271 during the energized periods of relay 213.

From the above it has been shown that two two-party trunk lines may be connected together by two trunk cord circuits for transmitting the sound signals for two private conversations by grouping the signals from both messages in successive rotation.

In the various circuits shown and described I have simplified the drawings by indicating the source of potential by a positive or negative sign. Also I have omitted the heater element from the various tubes.

The embodiments of the invention which have been given herein are illustrations of how the various features may be accomplished and of the principles involved. It is to be understood that the invention contained herein is capable of embodiments in other forms and adaptations, without departing from the spirit of the invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. In a telephone system, a subscriber's line terminating in a jack, a trunk line terminating in a jack, a cord circuit for connecting said subscriber's jack to said trunk jack, and means in said cord circuit for separating electrical signals representative of a telephonic message received from the subscriber's line into equal portions, and for reducing the interval of each portion to transmit over said trunk line.

2. In a telephone system, a subscriber's line terminating in a jack, a trunk line terminating in a jack, a cord circuit for connecting said subscriber's line jack to said trunk line jack, and means in said cord circuit for expanding the interval of spaced portions of electrical signals representative of sound received over said trunk line, and for transmitting successive portions of said expanded signals over said subscriber's line.

3. In a telephone system, a subscriber's line terminating in a jack, a trunk line terminating in a jack, a cord circuit for connecting said subscriber's line jack to said trunk line jack, and frequency changing means in said cord circuit for grouping and expanding electrical signals representative of messages received from said subscriber's line and said trunk line to transmit the grouped signals over said trunk line and to transmit the expanded signals over said subscriber's line.

4. In a telephone system, a subscriber's line terminating in a jack, a trunk line terminating in a jack, a cord circuit for connecting said subscriber's line jack to said trunk line jack, means in said cord circuit to group electrical signals representative of a message received from said subscriber's line, and for transmitting these grouped signals over said trunk line, and means in said cord circuit to expand the interval of spaced portions of electrical signals representative of sound received over said trunk line, and for transmitting the expanded signals over said subscriber's line.

5. In a telephone system, a trunk line, a cord circuit adapted to be removably connected to said line, said cord circuit comprising frequency changing mechanism for grouping and expand-

ing signals representative of messages for the transmission and reception of the signals in spaced periods of time over said line.

6. In a telephone system, a plurality of telephone lines, a two conductor trunk line, a pair of cord circuits adapted to interconnect at least any two of said telephone lines to said trunk line, said cord circuits comprising frequency changing mechanisms for grouping and expanding signals representative of different messages to transmit the signals from the said two telephone lines in successive rotation over the trunk line.

7. In a telephone system, a telephone line, a trunk line, a cord circuit for removably connecting the telephone line with the trunk line, said cord circuit comprising mechanism for recording signals representative of a telephone message received over said telephone line, and for separating, and reproducing the said signals at a higher frequency in spaced groups for transmission over said trunk line.

8. In a telephone system, a first trunk line, and a second trunk line, a plurality of interchangeable cord circuits for electrically interconnecting both trunk lines, mechanism common to said cord circuits for recording spaced groups of message signals received over either of said trunk lines and for reproducing said recorded signals in expanded intervals, and a key in each of the said cord circuits for electrically connecting said mechanism to its associated cord circuit.

9. In a telephone system, a first telephone office, and a second telephone office, subscribers' lines terminating in each of the said offices, a two party trunk line connecting both of said offices, a pair of cord circuits in the first office provided with removable plugs for connecting two subscribers' lines to the trunk line, and a pair of cord circuits in the second office provided with removable plugs for connecting two other subscribers' lines to the trunk line for two simultaneous conversations between subscribers in the first and second offices, each of said cord circuits comprising frequency changing mechanism for grouping signals representative of a telephonic message to transmit the signals over said trunk line in spaced periods of time.

10. In a telephone system, a first trunk line, extending from a first office to a second office, terminating in at least a first and a second jack

in the first office, a subscriber's line terminating in a jack in the first office, means in said first office to produce central impulses, a cord circuit in said first office for connecting said subscriber's line jack to any one of said trunk line jacks, means in said cord circuit under control of said impulses to select portions of electrical signals representative of a telephone message received from said subscriber's line to transmit the signals over said trunk line during certain recurrent periods of time, or during other recurrent periods of time according as the said cord circuit is connected to said first trunk line jack or said second trunk line jack, a second trunk line extending between the first and second offices, means to transmit said control impulses over said second trunk line, a telephone line in the second office, a link circuit in the second office for interconnecting said first trunk line and said telephone line, and means in said link circuit under control of the received control impulses to select said spaced periods to receive the said electrical signals for transmitting the signals over said telephone line.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,048,081	Riggs	July 21, 1936
2,277,516	Henroteau	Mar. 24, 1942
1,573,983	Mathes	Feb. 23, 1926
1,809,070	Schapira	June 9, 1931
2,105,016	Smith	Jan. 11, 1938
1,337,676	Wilbur et al.	Apr. 20, 1920
1,941,618	Nemirovsky	Jan. 2, 1934
1,472,451	Akers	Oct. 30, 1923
1,325,574	Nichols	Dec. 23, 1919
1,624,596	Hartley	Apr. 12, 1927
2,170,751	Gabrilovitch	Aug. 22, 1939
1,655,520	Smythe	Jan. 10, 1928
2,351,621	Light	June 20, 1944
1,567,231	Bowne	Dec. 29, 1925
2,337,878	Espenschied	Dec. 28, 1943
2,031,696	Espenschied et al.	Feb. 25, 1936
2,263,369	Skillman	Nov. 18, 1941