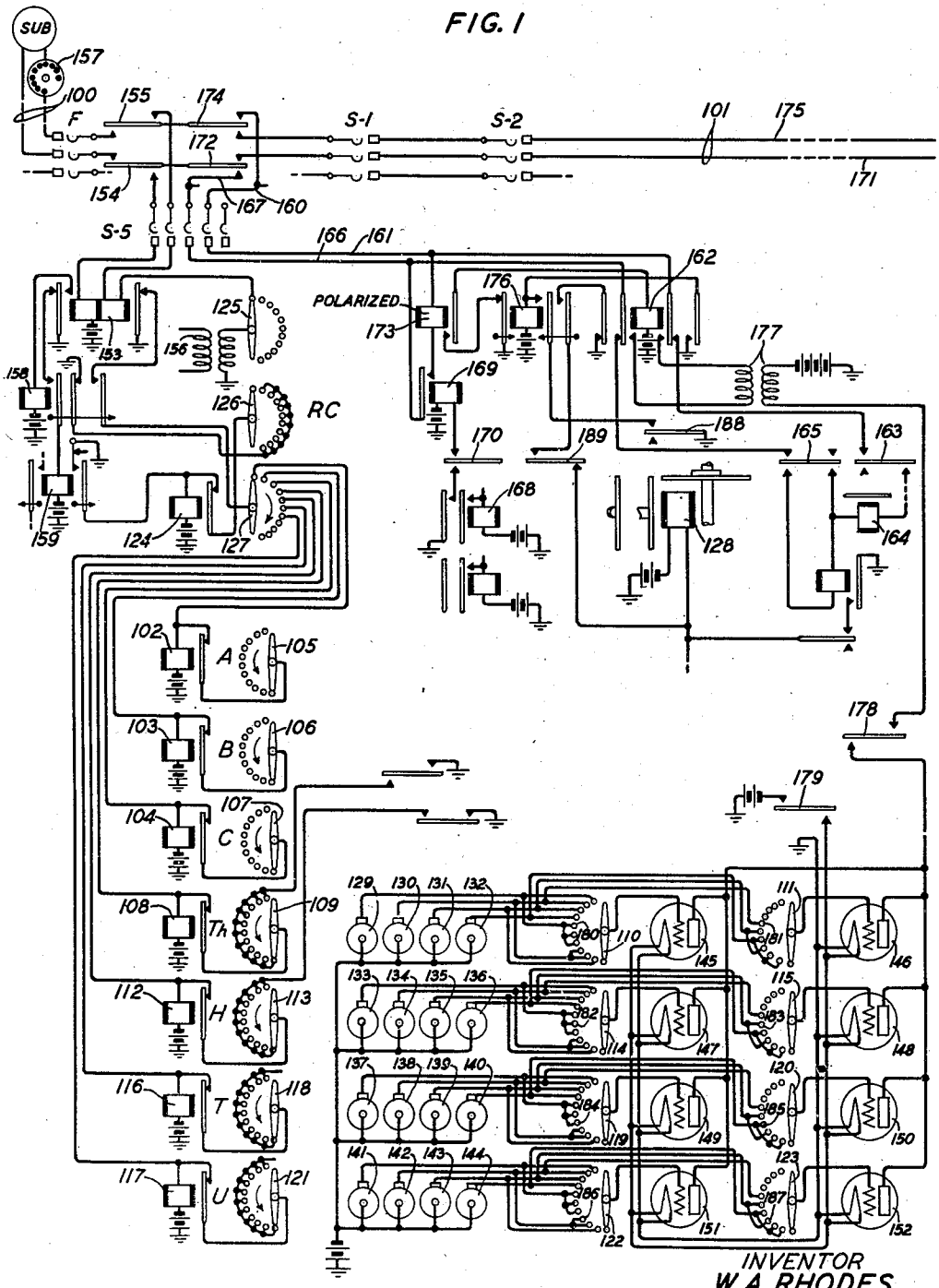
July 2, 1940. W. A. RHODES 2,206,538

TELEPHONE SYSTEM

Filed Sept. 24, 1938 2 Sheets-Sheet 1

FIG. 1



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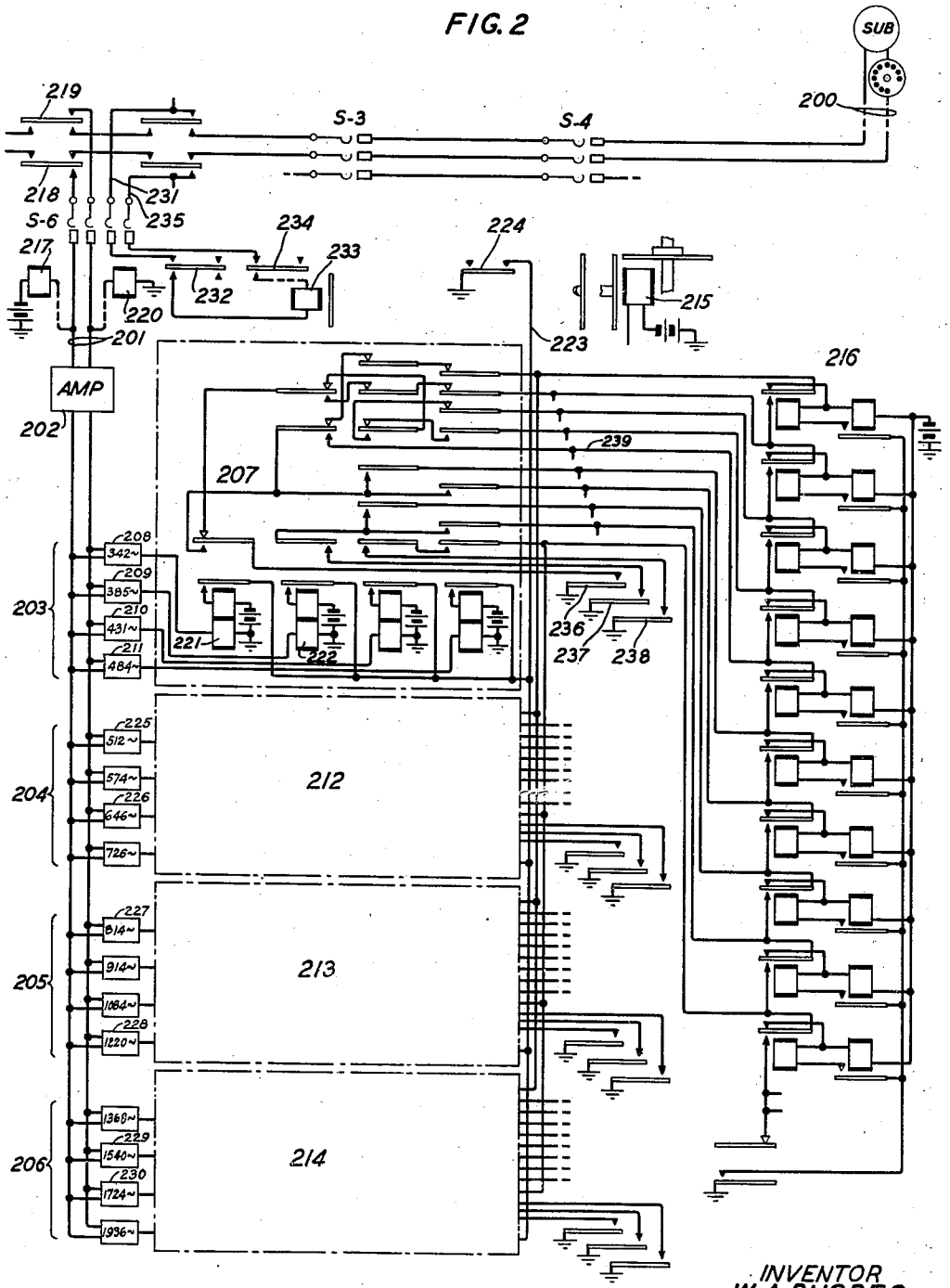
Filed Sept. 24, 1938 2 Sheets-Sheet 2

FIG. 2



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2,206,538

TELEPHONE SYSTEM

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8 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to those in which automatic equipment is used in the establishment of connections.

The objects of the invention are to obtain greater efficiency and increased speed in the transmission of telephone designations; to simplify the operations involved in transferring such designations; and otherwise to improve systems of this kind.

Systems have been proposed heretofore in which telephone designations, such as the numbers of subscribers' lines or the numbers of trunk circuits, are transmitted from one point to another by means of currents of different frequencies, the frequencies singly or in combination serving to characterize different numerals or other characters of the designation. Also, designations have been transferred by means of currents of different polarities and currents of different magnitudes.

In these prior systems it has been the general practice in transferring designations from one point to another to transmit the different digital characters in succession.

According to the present invention advantages are secured over these prior systems by providing mechanism for transferring all digital characters of the designation simultaneously. To accomplish this purpose, the different digital characters of each digital place in the designation are represented by combinations of alternating current frequencies. Where, for example, a four-digit designation is concerned the different characters in the thousands digit place are represented by different combinations of four different frequencies; the different characters in the hundreds digit place are represented by combinations of four other frequencies; and similarly the characters of the tens and units places are represented by combinations of frequencies all of which differ from each other and from those of the thousands and hundreds places. After the designation has been registered and the several frequencies representing the four characters of the designation have been selected, these frequencies are then applied all simultaneously to the transmission line and sent thereover to the distant office. At the distant office they are received and separated by selective circuits, such as filters, and are caused to operate register relays to register the designation thus transmitted.

The foregoing and other features of the invention will be described more fully in detail in the following specification and will also be set forth in the appended claims.

In the drawings Figs. 1 and 2, when taken together, illustrate a telephone exchange system in which interoffice connections are established by way of trunk lines extending between the different offices in the system.

Fig. 1 illustrates an originating office equipped with a register sender for registering the designation of the called line and for transferring the registered information over the interoffice trunk to the distant terminating office; and

Fig. 2 illustrates a terminating office equipped with a register sender for receiving the information from the originating office and for controlling the switches in the terminating office to complete the connection.

The system shown in the drawings is abbreviated to a large extent, all parts not essential to an understanding of the invention being omitted for the sake of clearness and brevity.

The invention is applicable particularly to systems in which the digital information for a call is registered in a common register sender in the central office, part of this information being utilized to control the switches in the office to select a trunk extending in the desired direction, and the remainder of the designation being transferred automatically over the selected trunk to the distant office where it is received and registered in a second common register sender. Here the registered information is utilized to control the local selector switches for completing the connection. Accordingly, the system chosen to illustrate the invention is one in which the central offices are equipped with automatic switches of the well-known panel type. It will be understood, however, that other forms of switches to establish the connections, such as step-by-step switches and cross-bar switches, could be used.

Referring to the drawings, a subscriber's line 100 appears in the contact bank of a line-finder switch F, the line finder F being individual to a first or district selector switch S—1 and also to a sender selector switch S—5. The district selector S—1 has access to office selectors, such as the switch S—2, which in turn have access to outgoing trunks 101 extending to distant central offices.

The sender selector S—5 has access to a number of common register senders, one of which is illustrated in part in Fig. 1. The register sender includes a series of digit registers in the form of single-movement step-by-step switches. There are three of these switches (A, B and C) for the

office code portion of the designation and four switches (TH, H, T and U) for the thousands, hundreds, tens and units digits of the numerical portion of the subscriber's designation. Each switch comprises a stepping magnet and a suitable number of brushes and contact arcs. For example, the first code register A is illustrated by its stepping magnet 102 and a single wiper and contact arc 105. Likewise the other code registers B and C are illustrated by their respective stepping magnets 103 and 104 and by the wipers 106 and 107. Each of these registers may, of course, include other switch wipers. The thousands register comprises a stepping magnet 108 and three contact wipers 109, 110 and 111; the hundreds register H comprises a stepping magnet 112 and three switch wipers 113, 114 and 115. Similarly the tens and units registers comprise stepping magnets 116 and 117 and the corresponding switch wipers 118, 119, 120 and wipers 121, 122, 123.

The code registers A, B and C serve to control the selective operation of the district and office selectors S—1 and S—2 to seize a desired outgoing trunk 101. The four numerical registers register the number of the wanted subscriber's line and serve either one of two purposes. If the call is a local one, these registers control the local incoming and final selectors to complete the connection to the called line. The incoming and final selectors of the local office are not shown. They would, of course, be provided and would correspond to the switches S—3 and S—4 of the office shown in Fig. 2. On the other hand, if the call orignating in the office shown in Fig. 1 is for a subscriber in a distant office, these registers determine the transmission of a code of alternating current frequencies over the selected trunk to the distant office where the number is received in a corresponding sender.

The combination of frequencies for transmitting the thousands digit is obtained from the four alternating current generators 129, 130, 131 and 132. The codes for the hundreds digits are obtained from the four generators 133, 134, 135 and 136. Similarly, the codes for the tens digits and the units digits are obtained from the generators 137, 138, 139, 140 and 141, 142, 143, 144. These generators produce currents of sixteen different frequencies, and they are selected in different combinations by the brushes of the numerical registers. They control the output circuits of the space-discharge tubes 145, 146, 147, 148, 149, 150, 151 and 152 to transmit over the line to the distant office a single impulse of current comprising all of the different frequency components representing the particular numerical designation identifying the called subscriber's line.

During the time the calling subscriber is dialing the digits of the wanted designation his line is associated successively with the code and numerical registers of the sender by means of a register control switch RC including the magnet 124 and the switch wipers 125, 126 and 127.

The register sender also includes numerous relays and a sequence switch 128 for switching the circuits of the sender from one stage of operation to another.

The terminating office illustrated in Fig. 2 includes incoming and final selector switches S—3 and S—4 for extending the incoming connections to the called subscribers' lines, such as line 200. The switches S—3 and S—4 are controlled by common register senders, one of which is illustrated in part. These register senders are selected by a sender selector switch S—6 which is individual to the incoming selector S—3.

The incoming register sender comprises a frequency selective receiving circuit 201, including amplifying means 202 and groups of tuned selective filters or other resonant devices. There are four groups of filters 203, 204, 205 and 206, one for each of the digital places in the numerical designation of a called line. Associated with the thousands group of filters 203 is a corresponding group of register relays 207, including four relays. These relays respond to the currents passing the filters 208, 209, 210 and 211 and operate to register the value of the thousands digit. In a similar manner, groups of register relays 212, 213, and 214 are provided for the three remaining digital places.

The incoming register sender also includes numerous control relays and a sequence switch 215 for controlling the switching operations. The sender further includes a series of counting relays 216 which cooperate with the registers to control the selective operation of the incoming and final switches S—3 and S—4.

As noted above, many details have been omitted in the drawings, such as the structure and circuits of the selective switches, the manner in which the sender selectors seize idle senders in response to incoming calls, the manner in which the sender receives and registers the successive digits transmitted by the calling subscriber's dial, the manner in which the code registers function to control the operation of the selector switches to seize trunks to the desired offices, the manner in which the numerical registers control the selective switches to complete connections to called lines, and in fact numerous other details of operation. For a better understanding of these details, reference may be had to many patents in the prior art relating to systems of this general character and in particular to the following patents: Stearn et al., No. 1,395,977 of November 1, 1921; Stearn, No. 1,505,171 of August 19, 1924; and Raymond et al., No. 1,862,549 of June 14, 1932.

The operation of the system will now be described in detail. Assume for this purpose that the subscriber of line 100 wishes to call the subscriber of line 200 in the distant office and that the designation of line 200 is CHE—5678. When the calling subscriber removes his receiver, the line finder F finds the calling line, and the sender selector switch S—5 is set in motion to select an idle register sender. Thereupon a pulsing circuit is established from battery through the left winding of relay 153 over the contacts of switch S—5, through the contacts of sequence switch spring 154 of the sequence switch associated with the district selector switch S—1, through the brush of the line finder F, thence over the line 100 and returning through the line-finder switch sequence switch spring 155, contacts of sender selector S—5 through the right winding of relay 153, normal contact of wiper 125 through the secondary winding of the tone coil 156 to ground. The calling subscriber hears the dial tone and proceeds to operate his dial 157 to transmit first the three office digits and then the four numerical digits.

When the pulse relay 153 first operated, it closed an obvious circuit for slow-release relay 158. On the first release of relay 153 for the first impulse of the first digit, slow-release relay 159 is operated in a circuit through the contacts

of relays 158 and 153. Also a circuit is closed from ground through the right back contact of relay 153, outer right contact of relay 158, brush 127 (position 1) through the winding of register stepping magnet 102 to battery. Magnet 102 energizes, and, when the impulse ceases and relay 153 reoperates, the magnet again deenergizes and advances the brush 105 and other brushes of the same switch to the first position contacts. For each succeeding impulse in the series the wiper 105 takes an additional step, finally coming to rest in a position corresponding to the first code digit. When relay 159 operated it closed an obvious circuit for the stepping magnet 124 of the control switch RC. At the end of the first series of impulses relay 153 attracts its armatures, and, after an interval, relay 159 releases. Thereupon the magnet 124 releases and steps the brushes 125, 126 and 127 to the next position.

When the next series of impulses are received the stepping circuit is extended over the second position contact of brush 127 to the stepping magnet 103, and magnet 103 advances the brush 106 of the second register in response to these impulses. At the end of the second series of impulses the relay 159 again releases magnet 124, and the switch RC steps to the third position.

Next the third office code impulses are transmitted, and the magnet 104 advances the brush 107 of the third code register to the corresponding position.

In a similar manner the four numerical digits are received and registered on the switches TH, H, T and U, the switch RC advancing from one position to another between successive series of impulses.

Following the registration of the designation the sender sequence switch 128 is advanced through successive positions where the fundamental circuit is completed for controlling the selective operations of the district and office selectors S—1 and S—2 to seize an idle trunk extending to an incoming selector. The fundamental circuit, which is partially illustrated, may be traced from conductor 160 in the district selector over the brush of selector switch S—5, conductor 161, through the inner right back contact of relay 162, contacts of sender sequence switch spring 163, the stepping relay 164, contacts of sequence switch spring 165, inner left back contact of relay 162, conductor 166, contacts of selector switch S—5 to the conductor 167. These selective operations are controlled in the well-known manner by the setting of the three code registers A, B and C.

Had the calling subscriber made a local call, that is, a call for another line in his exchange, the numerical registers TH, H, T and U would now control the incoming and final switches, not shown, in the local office to complete the connection. The assumption is, however, that the calling subscriber wishes to converse with the subscriber of line 200 in the distant office. Accordingly, the district and office selectors S—1 and S—2 have selected an idle trunk 101 extending to the distant office and there terminating in the incoming selector switch S—3. The extension of the call to the incoming selector S—3 causes the sender selector S—6 to seize an idle sender in a manner similar to the operation of the sender selector S—5 in response to the extension of the call to the district selector S—1.

Since the call is one for a distant office, a class relay 168 is operated in the originating sender to identify the class of the call being made. This relay is operated in the well-known manner under the control of the code registers A, B and C. With the class relay 168 operated and the sender sequence switch 128 advanced to the position it assumes upon the extension of the connection to the distant office, a circuit is closed from battery through the winding of relay 169, through the closed contacts of sequence switch spring 170, contact of class relay 168 to ground. As soon thereafter as the incoming sender is seized at the distant office a circuit is completed from battery through the coil 217, contacts of switch S—6, contacts of spring 218 of a sequence switch associated with the selector S—3, thence over trunk conductor 171, brushes of switches S—2 and S—1, closed contacts of sequence switch spring 172, contact of switch S—5, conductor 166, contact of relay 169, polarized relay 173, conductor 161, contacts of switch S—5, closed contacts of sequence switch spring 174, brushes of switches S—1 and S—2, trunk conductor 175, contacts of sequence switch spring 219, contacts of switch S—6 through coil 220 to ground. The current flowing in this circuit is in the proper direction to operate the polarized relay 173. The operation of relay 173 is a signal to the originating sender to the effect that the sender at the distant office has been seized and is now in readiness to receive the single composite frequency signal representing the digits of the called subscriber's number.

When the polar relay 173 operates, it closes a circuit from ground to the left contact of relay 176, closed contact of relay 173 through the winding of relay 162 to battery. Relay 162 operates and connects the secondary winding of the frequency sending transformer 177 to the outgoing trunk. Relay 162 remains operated for a short interval which is measured by the time that slow-operating relay 176 requires to attract its armatures, relay 176 having its circuit closed as soon as relay 162 operates. While the secondary of the tone transformer 177 is connected to the outgoing trunk, the primary winding is connected to the output circuits of the space-discharge tubes 145 to 152, inclusive. The circuit for this purpose may be traced from battery through the primary winding of transformer 177, contacts of sequence switch spring 178 and thence to the plate electrodes of the several space-discharge tubes. At this time the filaments of the several tubes are energized in a circuit from battery through the closed contact of sequence switch spring 179 thence in parallel through the several filaments to ground.

Since the numerical portion of the subscriber's designation was assumed to be 5678 the brushes 110 and 111 of the thousands register are standing on the fifth position terminals 180 and 181; the brushes 114 and 115 of the hundreds register are standing on the sixth position terminals 182 and 183; the brushes 119 and 120 of the tens register are standing on the seventh position terminals 184 and 185; and the brushes 122 and 123 of the units register are standing on the eighth position terminals 186 and 187. The terminals 180 to 187, inclusive, are connected respectively to the generators 129, 130, 133, 135, 137, 140, 142 and 143. Hence, the current flowing in the primary winding of transformer 177 is made up of a plurality of alternating current components which are produced in the anode circuits of the space-discharge tubes 145 to 152, inclusive, under the control of the generators 129, 130, 133, 135, 137, 140, 142 and 143. These alternating cur-

rent components of the composite current flowing in the transformer 177 correspond in frequency to the frequencies of said generators. These components are induced simultaneously in the secondary winding of transformer 177 and are transmitted as a single composite impulse over the trunk line 101 to the distant office where it is delivered to the receiving circuit 201. This composite signal continues to flow for the brief interval required for the operation of the slow-acting relay 176. When this relay operates at the end of the measured interval, it locks to the sequence switch spring 188 and opens the circuit of relay 162. Relay 162 releases immediately, opening the secondary winding of the transformer 177 and terminating the transmission of the composite impulse. Relay 176 in operating also serves to advance the sender sequence switch 128 into a succeeding circuit controlling position. The circuit for this purpose may be traced from ground through the left back contact of relay 162, right front contact of relay 176, sequence switch spring 189 through the winding of the sequence switch magnet 128 to battery.

At the distant office the composite impulse flowing in the receiving circuit 201 may be amplified if necessary by an amplifier 202 which then delivers the amplified currents to the input circuits of the several groups of tuned filters 203, 204, 205, 206. Since the first digit (5) of the number that is being transmitted is represented by the frequencies of generators 129 and 130, these two frequency components are passed selectively by the filters 208 and 209, respectively, and are not passed by any of the other filters. The currents passing the filters 208 and 209 cause the operation of register relays 221 and 222. These relays lock in holding circuits traceable through their upper windings and contacts over holding conductor 223 to ground through the closed contacts of spring 224 of sequence switch 215. In a similar manner the components corresponding to generators 133 and 135, representing the second digit (6), are passed by filters 225 and 226 of the second group 204, causing the operation of corresponding register relays of the group 212. Likewise the components from generators 137 and 140 for the third digit (7) and the components from generators 142 and 143 for the fourth digit (8) are passed by filters 227 and 228 of the third group 205, and by filters 229 and 230 of the fourth group 206, causing in turn the operation of corresponding register relays of the groups 213 and 214, respectively.

In this manner the entire numerical designation for the called subscriber's line 200 is transmitted from the originating office to the terminating office by a single composite impulse of current which requires only a brief interval of time. Following the receipt of the composite impulse and the selective operation of the relay registers 207, 212, 213 and 214, the sequence switch 215 is advanced in the well-known manner to succeeding positions where the fundamental circuit is established for controlling the selective operations of the incoming and final switches S—3 and S—4 in accordance with the settings of these registers. The fundamental circuit is illustrated briefly and may be traced from conductor 231, over a brush of sender selector S—6, through the sequence switch spring 232, through the winding of the stepping relay 233, sequence switch spring 234 thence through a brush of selector S—6 to the conductor 235. During the first, or brush selecting operation for the switch S—3 the stepping relay 233 operates the counting relays 216 in the well-known manner, the number of counting relays being operated depending upon the particular relays of the register 207 that are operated. The drawings show the connection between the contacts of the register relays 207 to the contacts of the counting relays 216. With the sequence switch 215 in the position for the brush selecting operation for switch S—3, its springs 236, 237 and 238 are closed to connect ground to armatures of the relays of the register 207. Accordingly, a circuit is completed from ground through sequence switch spring 236, front contact of register relay 221, front contact of register relay 222, conductor 239 to the corresponding one of the counting relays of the chain 216. In the well-known manner this connection determines the extent of the brush selecting operation for the switch S—3.

Similarly the succeeding selective operations for the switches S—3, S—4 are controlled in turn by the register relays 212, 213 and 214 and the counting relays 216.

Following the selection of the called subscriber's line 200, ringing current is applied to signal the subscriber.

The senders in the originating and terminating offices may be released at any suitable time after they have completed their functions. In the release of the sender in the originating office, the sequence switch 128, the control switch RC, the register switches, and the various controlling relays are restored to normal. The release of the control switch RC is controlled by the wiper 126 which completes a self-interrupting circuit for the stepping magnet 124 through a closed contact of the slow-releasing relay 158. Similarly the release of the several registers A, B and C, TH, H, T and U, is controlled by restoring circuits closed through wipers of these respective switches.

It should be understood that this invention is not limited to the particular embodiment disclosed herein. For instance, other types of automatic switches may be employed in establishing the connections, and in fact the designations may be transmitted to operators' positions where they are displayed on indicating devices. Also various types of designation registers may be used and various types of frequency selective devices for separating the components of the current signals. Moreover, the transmission of the designations in accordance with this invention should not be limited to designations of any particular kind nor to any number of current components for the representation of the different characters. The frequencies to be used for the several components may be chosen to suit the particular conditions involved. It will be noted that specific frequency values are indicated on the filters 203, 204, 205, 206, but these values are, of course, merely illustrative.

What is claimed is:

1. In a communication system in which subscribers are assigned designations each comprising a plurality of separate characters, the combination of a transmission line, a plurality of sources of currents of different characters for representing the separate characters of any subscriber's designation, means for transmitting over said line simultaneously the currents corresponding to the several characters of any desired designation, and means responsive to the currents transmitted.

2. In a telephone system in which the desig-

nations have a plurality of characters, different designations comprising different combinations of characters, sources of current of different frequencies, different characters of said designations being represented by different frequencies, a telephone line, and means for transmitting any telephone designation by applying to said line simultaneously currents of the frequencies representing all of the characters of such designation.

3. In a telephone system in which the designations have a plurality of digital places, the characters in each digital place varying with the different designations, sources of alternating current of a plurality of different frequencies, the different characters of each digital place being distinguished from other characters of the same place and from the characters of other places by different combinations of said frequencies, a line, and means for transmitting all digits of any particular designation over said line together by applying simultaneously to the line currents of all frequencies representing all of the characters in the several digital places of said designation.

4. In a communication system in which each designation has a plurality of characters, different designations comprising different combinations of characters, sources of current of different frequencies, different characters of said designations being represented by different frequencies, a line, means for transmitting any designation over said line by applying thereto simultaneously currents of the frequencies representing all of the characters of such designation, register means for registering the characters of the designation transmitted over said line, and automatic switches controlled by said registers for establishing a connection.

5. In a telephone system in which each telephone designation comprises a plurality of characters, each character of a designation being represented by a different frequency of alternating current, means for producing the different frequency currents necessary to represent the different designations, a telephone line, means for sending over said line a single composite current signal comprising the frequency components representing all of the characters of a desired telephone designation, and means for receiving the transmitted signal and for utilizing the same to establish a telephone connection.

6. In a telephone system in which each telephone designation has a plurality of characters, different designations comprising different combinations of characters, sources of current of different frequencies, each of the characters of a designation being represented by a different combination of said frequencies, a transmission line, means for sending over said line a single composite current signal comprising all the frequencies representing a desired designation, receiving means responsive to the transmitted signal for separating the frequency currents representing the different characters of the designation, automatic switches, and means responsive to the separated frequency currents for selectively controlling the operation of said automatic switches.

7. In a telephone system in which each subscriber's designation is represented by a plurality of digital characters, a plurality of sources of current of different frequencies, the characters in each digital place of a designation being represented by different combinations of said frequencies, an office having registers therein for registering a desired designation, a distant office, a line extending between said offices, means controlled by said registers for selecting the frequency sources representing the desired designation and for transmitting over said line a single impulse of current including the frequency components corresponding to all the characters of said designation, a plurality of digital registers at said distant office, tuned selecting devices at said distant office for receiving said impulse of current and for selectively separating the different frequency components to set said registers in accordance with the characters of the transmitted designation, and automatic switches in said distant office controlled by said registers for establishing a connection corresponding to the transmitted designation.

8. In a telephone system in which subscribers' designations have a plurality of digital places, each place represented by any one of a plurality of numerals, a plurality of sources of current of different frequencies, each of the numerals in each of said digital places being represented by a different combination of said frequencies, a telephone office having automatic switches, registers in said office for registering a desired designation transmitted thereto by a calling subscriber, a distant office, a line extending between said offices, means for controlling the selective operation of said switches in accordance with the setting of said registers to extend the connection over said line to said distant office, means controlled by said registers for selecting the frequency sources representing the designation of the wanted subscriber in said distant office and for transmitting over said line a single impulse of current including the frequency components corresponding to all of the numerals of the designation of the desired line, digital registers in said distant office, tuned selecting devices at said distant office for receiving said impulse of current and for selectively separating the different frequency components thereof to set said last-mentioned registers, and automatic switches in said distant office controlled by said registers for establishing a telephone connection.

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