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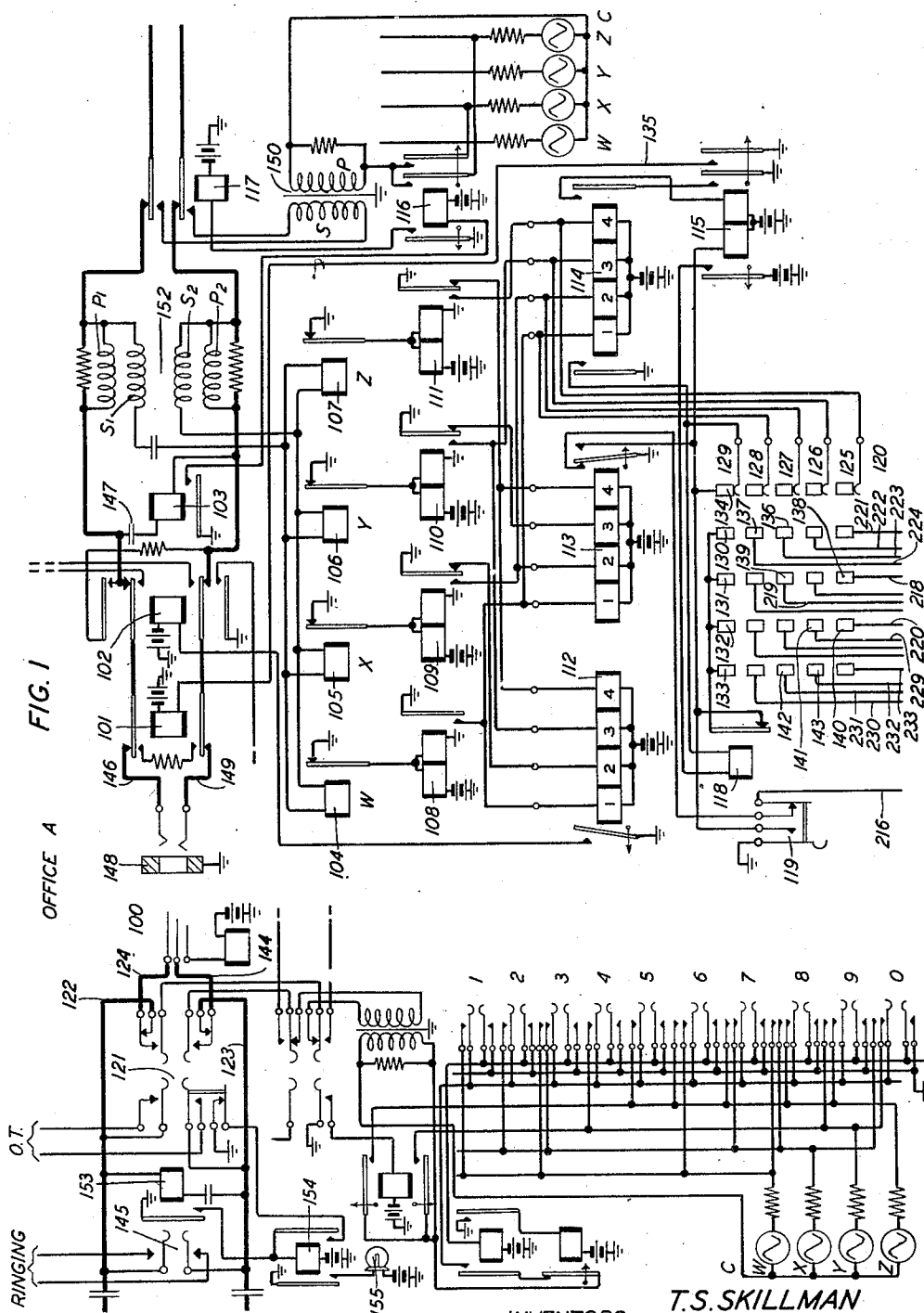
T. S. SKILLMAN ET AL.

1,859,475

CALL INDICATOR SYSTEM

Filed Oct. 15, 1930

3 Sheets-Sheet 1



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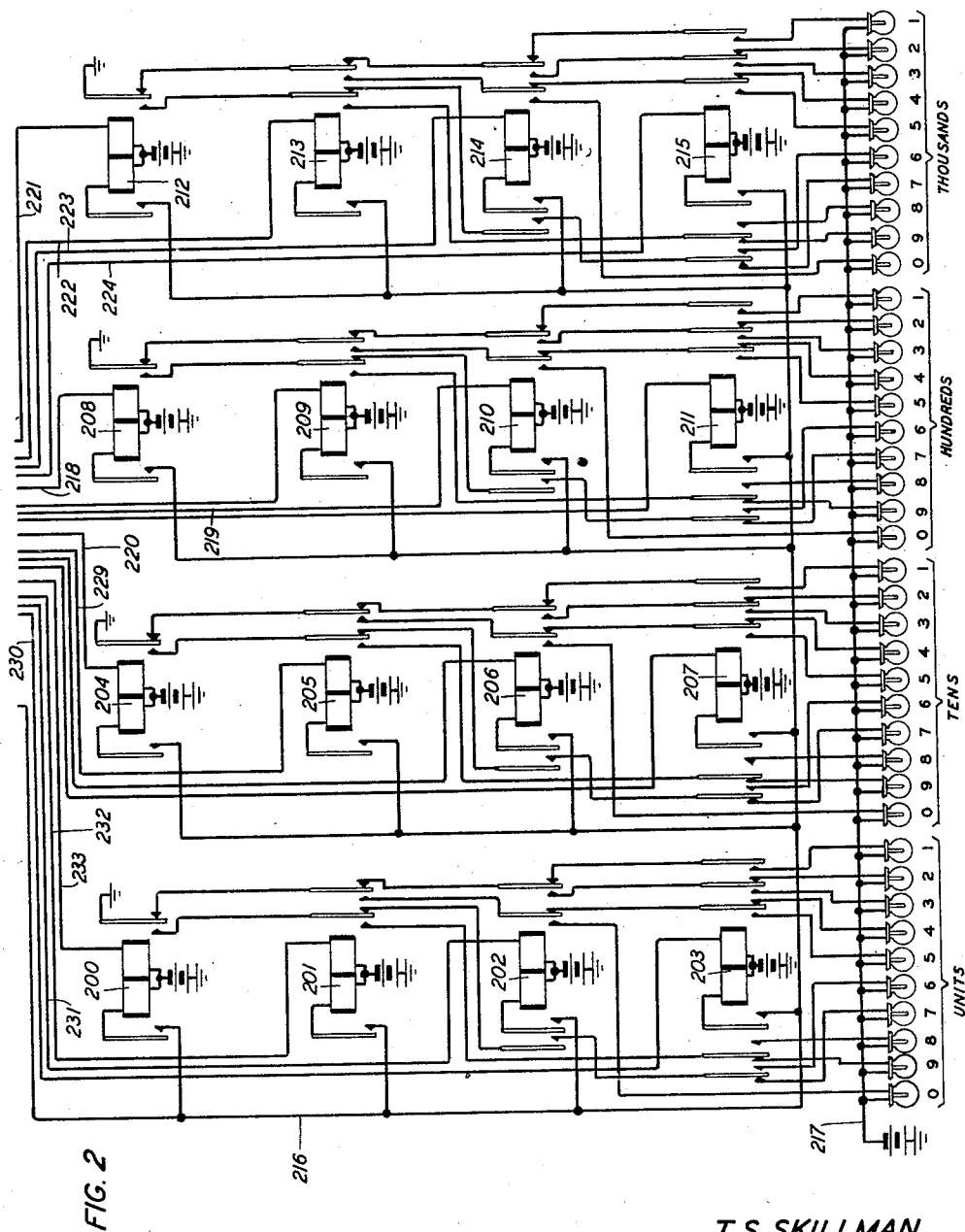
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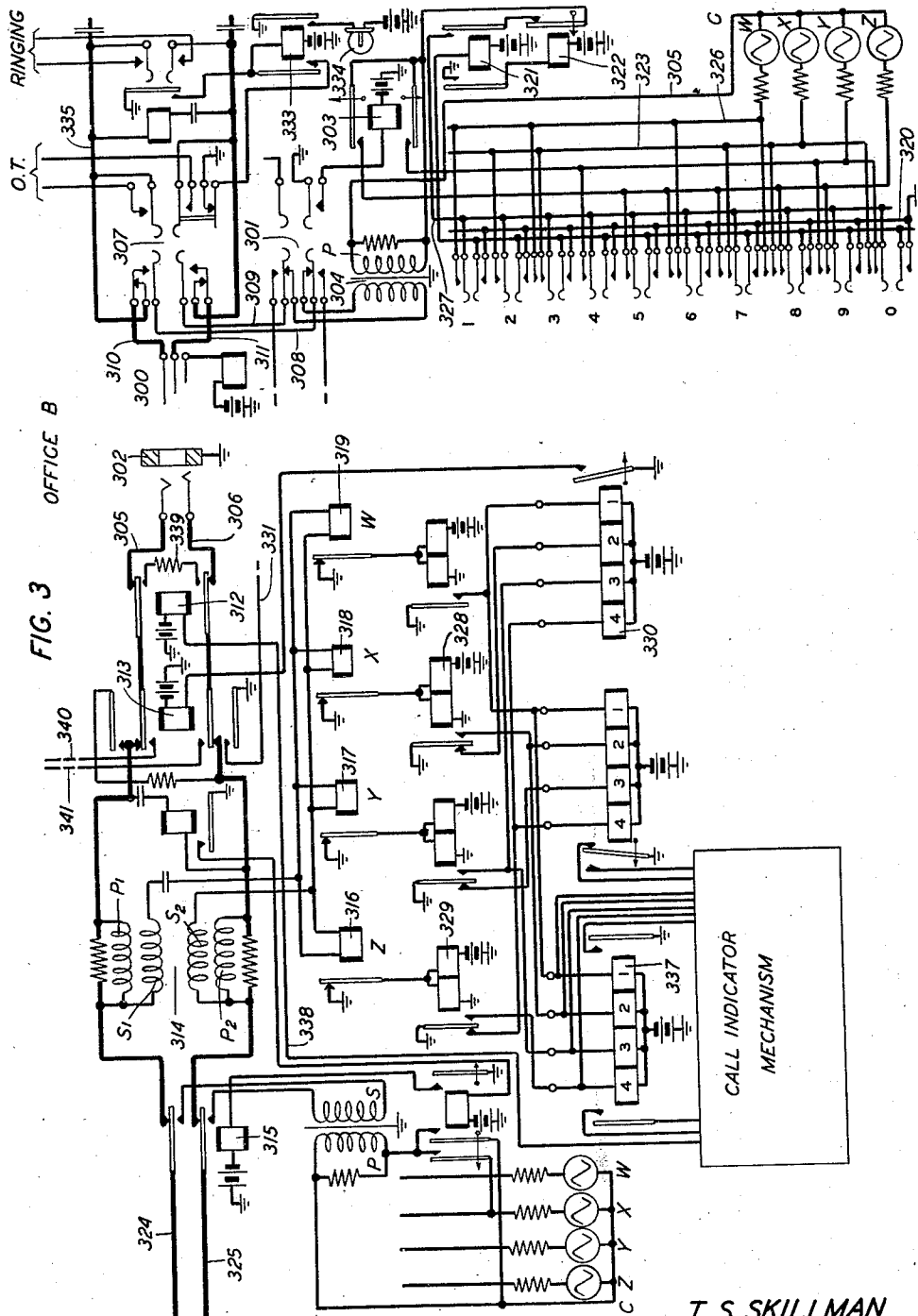
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CALL INDICATOR SYSTEM

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This invention relates to automatic or semiautomatic telephone systems and more particularly to call indicator arrangements whereby the designation of calls may be transmitted over a trunk line from an outgoing office to an incoming office by means of coded impulses of alternating current preferably within the voice frequency range. Its object is to provide an improved method of setting up connections between offices lying in two widely separated areas or between a central office and an outlying satellite or P. B. X. which cannot be reached efficiently by the well known methods of direct current dialing or impulsing.

Heretofore, when extending calls on a toll basis, it has been the practice either to use manual methods by which the operator at the originating office informs the operator at the terminating office of the number of the wanted subscriber or, in some cases, it has been found desirable to employ separate call circuit lines between the two offices for the transmission of the desired information. According to another method, most preferably employed in extending a call line from a terminating office to an outlying manual satellite or P. B. X., direct current code impulses representing the wanted number designation are transmitted to a receiving device at an operator's position at the satellite or P. B. X., from which point the call is then completed in the usual way. All of these methods involve delay, expense, some inaccuracies in the transmission of information and, in the last case mentioned, the transmission of direct current impulses is limited by the electrical characteristics of the line connecting the satellite or P. B. X. with the terminating office and necessarily restricting the application of the direct current impulsing method of transmitting wanted number designations to such terminating telephone centers as are not too distant from the point where the impulses are generated. One of the objects of the present invention, therefore, is to provide improved means for removing the above mentioned difficulties by using alternating current impulses of different frequencies, preferably within the voice fre-

quency range, whereby operators at each end of a toll line can transmit number designations in either direction in an easy and economical manner.

In accordance with the invention, therefore, one specific embodiment of which is disclosed herein by way of illustration, this is accomplished in the following improved manner: A key-set with ten non-locking keys is provided at each of the two outgoing positions from either of which a connection is to be extended. The contacts of each key are connected to voice frequency current sources either separately or in combination at each key. Associated with the key-set is a common pair of relays which, by the operation of a common position key and another key individual to the cord connected with the interconnecting trunk, function to connect the separate key circuits to the trunk line.

To transmit the code impulses of the required number, the operator depresses the individual keys representing the wanted number and each key, when thus depressed, closes the voice frequency circuits connected to its contacts over the two conductors of the trunk line. At the incoming end of the trunk line and connected thereto through a repeating coil is a group of alternating current relays, each of which is tuned to respond to an alternating current of a particular frequency. A call indicator mechanism consisting of a distributor switch whose contacts are connected to a chain of relays controlling a coded call indicator group of registers is adapted to respond to the operation of the said voice frequency relays, there being one call indicator mechanism at each of the two positions and adapted to be connected to the end of the trunk where it is located in response to a signal from the other end that impulses are to be transmitted from said other end. The number of contacts on the distributor switch depends on the number of digits to be displayed and the switch is automatically advanced one step between successive digits. There are as many voice frequency relays as there are voice frequency currents used at the transmitting end so that

each alternating current relay responds to a current of a particular frequency. These relays respond to the impulses set up by the depression of the digit keys at the outgoing end and their response controls local circuits at the incoming position which cause particular brushes of the distributor switch to be grounded by the voice frequency relays which have been operated. These ground connections serve to close circuits which operate the relays of the call indicator circuits directly controlling the lamp circuits corresponding to the digit depressed. When the number is displayed, the operator may, if she chooses, extinguish the lamps by the depression of a key which unlocks the lamp controlling relays and also restores the distributor switch to normal. The display may also be left lighted until the transmission of a new call in which case a voice frequency impulse, generated at the position which is to transmit a new number designation, causes the release of the previous display as well as the return of the distributor switch to normal.

The scope and purpose of the invention will be better understood by a consideration of the following description taken in connection with the attached drawings in which:

Fig. 1 shows the position and trunk circuit equipment together with the associated distributor switch at one office;

Fig. 2 shows the call indicator register and lamps at the position indicated by Fig. 1;

Fig. 3 shows the distant end of the trunk and operator's position thereat together with the necessary conductors communicating with a call indicator mechanism which, being identical with the one disclosed in Figs. 1 and 2 is only schematically indicated herein.

Fig. 2 should be placed directly below Fig. 1 and Fig. 3 to the right of Fig. 1 for a complete disclosure of the present invention.

It is to be understood that while the present embodiment of the invention is disclosed in respect to the transmission of impulses and corresponding display of four digits, it is not to be so limited, and the number of recording relay groups, the lamps to be controlled thereby and the number of separate voice frequency circuits to be utilized will depend, of course, upon the total number of digits to be displayed simultaneously in accordance with the number of digit keys depressed at the outgoing end.

When a trunk line, such as shown in Figs. 1 and 3 and terminating in jack 302 at the outgoing position in office B, is taken into use by an operator at that outgoing position by inserting a cord plug 300 into trunk jack 302, she operates key 307 and momentarily throws to the right the common position key 301. The operation of key 301 causes the operation of slow release relay 303 over an obvious circuit and which, by the closure of its con-

tacts, connects the voice frequency sources Z and Y in parallel to one side of the primary windings P of the repeating coil 304; the other side of the primary winding of the said repeating coil being connected to the common return path C by way of conductor 305. The secondary winding S of repeating coil 304 is closed through the left normal contacts of key 301 to conductors 308 and 309, through the left operated contacts of key 307, cord conductors 310 and 311 to the trunk conductors 305 and 306. The voice frequency circuit is extended to office A by way of the top and bottom back contacts of relay 312, top and bottom inner back contacts of relay 313, windings P₁ and P₂ of repeating coil 314, back contacts of relay 315, trunk conductor 324 and 325, back contacts of relay 117, windings P₁ and P₂ of repeating coil 152, condenser 147 and relay 103. The voice frequency current composed of frequencies Z and Y is repeated through the secondary windings S₁ and S₂ of repeating coil 152 in a circuit including the secondary windings above mentioned and voice frequency responding relays 104, 105, 106 and 107. Relays 106 and 107 operate; the former responding to voice frequency current Y and the latter to voice frequency current Z.

It will be noted that the voice frequency relays 316 and 317, 318 and 319 at office B are connected to secondary windings S₁ and S₂ of repeating coil 314 through the primary windings of which passes the voice frequency current circuit above described. Although the impulse is repeated through the secondary windings S₁ and S₂ of repeating coil 152 at office A causing thereby the response of the proper voice frequency relays, a similar repetition of the impulse current into the secondary windings S₁ and S₂ of repeating coil 314 at office B does not take place due to the fact that the secondary windings of the latter repeating coil are connected to the drop side of the associated primary winding and, consequently, a part of the current traversing the trunk line will traverse the associated secondary winding differentially, the operation being the same for both sets of windings, thereby reducing to a negligible quantity the induced voltage between the two secondary windings and the corresponding flow of current through these windings and the voice frequency relays connected between them. On the other hand the secondary windings S₁ and S₂ of the repeating coil 152 at office A are connected to the high potential side of the line with respect to an incoming signal and, consequently, the impulse current divides between the primary winding P₁ and the associated secondary winding S₁ so that the current through secondary winding has an aiding effect, thereby increasing the induced voltage between the two secondary windings and the corresponding flow of current through these

windings and the voice frequency relays connected between them. It is thus seen that for a voice frequency current transmitted from office B to office A, the current is differential with respect to the secondary windings of the repeating coil on the near side of the line and aiding with respect to the secondary windings of the repeating coil on the far side of the line increasing thereby the sensitivity of the relays on the far side and decreasing that of those located on the near side. An inspection of Figs. 1 and 3 will make clear that the same thing is true with respect to voice frequency current signals transmitted in the opposite direction.

Relays 104, 105, 106 and 107 at office A and relays 316, 317, 318 and 319 at office B are all voice frequency responding relays and each of them respond to a particular voice frequency current as follows:

Relays	Frequency
104 and 319	W
105 and 318	X
106 and 317	Y
107 and 316	Z

The circuit above traced results in the operation of relays 106 and 107 as already noted. Relay 106, in operating, removes the short circuit around the right winding of relay 110 causing this relay to operate over both its windings in series while the operation of relay 107 likewise removes the short circuit around the right winding of relay 111, thus causing this latter relay to operate over both its windings in series. Relay 113 is wired with its No. 3 winding to the back contacts of relay 110 and with its No. 4 winding to the back contacts of relay 111 so that, with relays 110 and 111 normal, relay 113 is operated. When therefore, in response to the outgoing operator's depression of key 301 at office B, relays 106 and 107 are operated, the circuits for the Nos. 3 and 4 windings, respectively, of relay 113 are opened and relay 113 is released. Relay 113 is slow in releasing, however, and will fall back only if the voice frequency relays are operated for a sufficient interval and which interval, in turn, is controlled by the slow releasing characteristics of relay 303, which, it will be recalled, is likewise slow to release. The release of relay 113 opens the locking circuit of all the call indicator relays shown in Fig. 2 by removing ground from conductor 216 and, if any of these relays were left operated by the reception of a previous call and no attempt was made to restore them to normal, they will be released in the first operation of the call indicator apparatus for a subsequent incoming call. Relay 113 also closes a circuit through the left winding of relay 115. This relay operates and connects battery through its left contacts, through the winding of distributor switch magnet 118, brush 129, con-

tact 134 of the normal row of contacts, to ground at the back contacts of relay 113. Switch magnet 118 operates in this circuit but the switch brushes are not advanced thereby. When relay 113 reenergizes as a result of the termination of the impulse, this circuit is opened and the distributor switch advances to the first row of working contacts where brushes 125, 126, 127 and 128 are connected to the first group of recording relays 212, 213, 214 and 215 of the call indicator. If the switch 120 happens to have been left on any group of contacts other than the normal group, a self stepping circuit for magnet 118 is closed from ground through the back contacts of relay 113, interrupter contacts of magnet 118, any of the contacts 130, 131, 132 and 133, brush 129, winding of switch magnet 118 to battery on the left contacts of relay 115. When the switch returns to normal, the previously traced circuit to energize magnet 118 becomes effective and, at the termination of the impulse, advances the switch brushes to the first group of call indicator relays as already described. It is thus seen that the signal sent out from the outgoing position restores the distant call indicator switch to normal if it is off-normal at the time the trunk is taken into use and prepares it for the incoming call by the setting of the switch brushes on the proper group of terminals; the preparing alternating current impulse being sufficiently long to allow for these operations.

The call indicator circuit can also be discharged by operating key 119 at the receiving position. Key 119 closes ground on its inner contact to the left winding of relay 115 causing this relay to operate and also extends this ground by way of the interrupter contacts of magnet 118 and terminals 133, 132, 131 and 130, thereby closing the previously described circuit to restore the distributor switch to normal if the brush 129 is associated with any of these contacts.

In order to illustrate clearly how the code signals are transmitted and received we will assume, for illustration, that the called number is 3790. After the preliminary operations above described have taken place and relay 303 is released, the operator depresses digit key 3. A circuit is now closed from ground on conductor 320, bottom contacts of key 3, winding of relay 321 to battery. Relay 321 operates relay 322 over an obvious circuit. Relay 322, however, is a slow to operate relay so that it does not operate except after an interval of time. During this interval voice frequency source X is connected, over conductor 323, to the top inner contact of key 3. Another path from voice frequency source W is closed over conductor 326 to the top outer contacts of key 3 and paralleled thereat to the path of voice frequency X. These two paths are joined by the de-

pression of key 3 and a circuit is completed from these two voice frequency sources to conductor 327, right contacts of relay 321, contacts of relay 322, primary winding P of repeating coil 304, to conductor 305 of the common return path of all voice frequency sources. This combination voice frequency circuit is maintained over the primary winding of repeating coil 304 so long as relay 322 maintains its back contact. When relay 322 operates, the circuit is opened and the voice frequency circuit is removed from the primary winding of repeating coil 304 even though the operator may still be keeping key 3 depressed. By this means an impulse of definite duration is transmitted to the line regardless of the length of time the operator may keep the numerical key operated. The voice frequency current over the circuit above described, while maintained, is repeated over the secondary S of repeating coil 314 and transmitted to office A over the circuit previously described, including the trunk line and frequency responding relays 104, 105, 106 and 107. Since the voice frequency combination used for digit 3 is WX, relays 104 and 105 operate. Relay 104 operates relay 108 by removing the short circuit around its right winding and relay 105 likewise causes the operation of relay 109 by removing the short circuit around its right winding. Relay 108 closes the circuit of winding No. 1 of relay 112, winding No. 1 of relay 113, winding No. 1 of relay 114 and extends the said ground in parallel to the distributor brush 128. Relay 109 closes the circuit of winding No. 2 of relay 113, winding No. 2 of relay 114 and extends the said ground in parallel to distributor brush 127. Relay 114, which is normally released, operates in the circuits closed as above described. Relay 112, however, is normally operated over windings No. 2 and 4 by ground on the back contacts of relays 109 and 111 respectively, so that, when relay 109 operates as a result of the operation of relay 105, relay 112 does not release since the alternating current impulse transmitted does not affect the circuit of relay 111 which controls, in turn, the circuit over the No. 4 winding. Relay 112 is made slow releasing so as not to fall off during any interval between the opening of the circuit through some of its windings due to the operation of some of the voice frequency relays and the closure of other of its windings due to the operation of other voice frequency relays during the operation of these relays. Relay 113 is likewise normally operated as already described and the closure of circuits through its windings Nos. 1 and 2 does not alter the condition of this relay. The ground on its front contact is connected to conductor 216 which, as already noted, extends to the locking windings of all call indicator relays. Relay 114, when it operates, extends

ground on its left contact through the winding of magnet 118 and, at its right contact closes a locking circuit for relay 115, which relay operates through its left winding over a path extending through the interrupter contacts of magnet 118, switch contact 130, brush 129, to ground on the left contacts of relay 114. Relay 115, on operating, closes a circuit for magnet 118 from ground on the contacts of relay 114, winding of magnet 118, to battery on the left contact of relay 115. Magnet 118 operates, breaks its interrupter contacts and thereby opens the circuit through the left winding of relay 115. This relay, as already noted, is locked from ground on its right inner contacts, right contacts of relay 114 to the right windings of relay 115. As long as relay 114 remains operated, therefore, the switch magnet remains operated and relay 115 remains locked. Relay 115 also closes a circuit for relay 101 from ground on its right outer contacts, conductor 135, winding of relay 101 to battery. This relay operates, disconnects the trunk from the jack at the operator's position at office A and connects a non-inductive loop across the trunk conductors. The disconnection of the trunk from the operator's position at office A is for the purpose of protecting the circuit during the transmission of impulses from office B from any possible interference by the operator at office A who may insert a cord into the trunk jack for the transmission of impulses in the opposite direction, without any knowledge that the trunk is in use for operations in the opposite direction.

Since distributor switch 120 is resting on the first group of working contacts as above described, brush 127 is connected to contact 136 and a circuit is closed from ground on brush 127 connected to contact 136, conductor 223, right winding of relay 214 to battery. Relay 214 operates over its right winding and locks over its left winding and left inner contacts to ground on conductor 216. A circuit is likewise closed from the ground on brush 128 and contact 137, conductor 224, right winding of relay 215 to battery. Relay 215 likewise operates over its right winding and locks over its left winding and left inner contacts to ground on conductor 216. The operation of these two relays closes a circuit for lamp 3 of the thousands group of lamps controlled by relays 212, 213, 214 and 215 from battery on conductor 217 through the lamp No. 3, right middle front contacts of relay 215, right outer front contacts of relay 214, right outer back contacts of relay 213 to ground on the back contacts of relay 212, thus lighting lamp 3 in response to the depression of key 3 at the outgoing end.

When the voice frequency impulse terminates as a result of the operation of relay 322, voice frequency relays 104 and 105 release each of which, by the closure of its back con-

tact, short-circuits the right winding of relays 108 and 109, respectively, thereby causing these relays to release since these relays, as well as relays 110 and 111, are so designed that the normal flow of current through their respective left windings is not sufficient to permit them to remain operated with their right winding short-circuited. The release of relay 108 removes ground from winding No. 1 of relay 112, winding No. 1 of relay 113, winding No. 1 of relay 114, and from the brush 128. Relay 112, however, does not release since it is held energized over winding No. 4 from ground on the back contacts of relay 111. The release of relay 109 disconnects ground from the No. 2 winding of relay 113, the No. 2 winding of relay 114 and from brush 127. Relay 113 does not release as it is held energized over its windings Nos. 3 and 4 by ground from the back contacts of relays 110, and 111 respectively. Relay 114, however, does release and by the opening of ground on its left contact opens the operating circuit of magnet 118 while the opening of its right contact opens the locking circuit of relay 115. Relay 115, however, is slow to release and does not restore during the successive transmission of impulses. The distributor switch magnet 118 releases, thereby advancing the distributor brushes to the next group of working terminals of which terminal 131 is one.

The incoming circuits are now ready to receive the next impulse. The operator at office B depresses key 7. The depression of this key causes the operation of relays 321 and 322 as above described. The two top outer contacts of key 7 are wired to voice frequency sources X and Z so that these two voice frequency sources are closed in parallel to conductor 327 over a path previously described through the primary winding of repeating coil 304 to the common return circuit over conductor 305. An impulse is thus transmitted over the line through the secondary of said repeating coil, consisting of voice frequency currents X and Z and, at the incoming position at office A causes the operation of relays 105 and 107. Relay 105 operates relay 109 and relay 107 operates relay 111 in the described manner. The operation of relay 109 removes ground on its back contact from winding No. 2 of relay 112, but this relay is slow release and holds during the receipt of the impulse. Relay 109 connects ground to winding No. 2 of relay 113, winding No. 2 of relay 114 and to brush 127 of the distributor switch. The operation of relay 111 connects ground to the winding No. 4 of relay 114 and to brush 125 of the distributor switch. Relay 114 operates and closes a previously described circuit for distributor switch magnet 118 and a locking circuit for relay 115. The ground on brush 125 completes a circuit to relay 208 from bat-

tery through its right winding, conductor 218, contact 138, brush 125 to ground on the front contact of relay 111. Ground on brush 127 completes a circuit for relay 210 from battery over its right winding, conductor 219, contact 139 to ground on brush 127. Both of these relays operate over their right windings and lock over their left windings and left innermost contacts to ground on conductor 216. The operation of these two relays and the released condition of the remaining two in the second group of relays causes a circuit to be closed for lamp 7 of the hundreds group of lamps from battery on conductor 217 through lamp 7, left outer back contacts of relay 211, left outer front contacts of relay 210, right inner back contacts of relay 209 to ground on the right front contact of relay 208. When the impulse is terminated, relays 105 and 107 release, thereby causing the release of relays 109 and 111. The release of these relays causes the release of relay 114 and the advance of the distributor switch to the next group of working terminals of which terminal 132 is one.

The operator next depresses key 9 and at its top contacts connects the circuits of voice frequency current sources Z and Y over loops previously described and causes an impulse to be transmitted over the trunk line to the voice frequency relays in the distant office in the described manner. Relays 106 and 107 operate as a result of the impulse of these two frequencies and, in turn, causes the operation of relays 110 and 111 respectively. The operation of these relays operates relays 114 and grounds brushes 125 and 126, the former brush by relay 111 and the latter by relay 110. Brush 125 closes a circuit by way of contact 140, conductor 220, right winding of relay 204 to battery. Brush 126 closes a circuit from ground on brush 126, contact 141, conductor 229 to the right winding of relay 205 to battery. These relays operate over their right windings and lock over their respective left windings and left contacts to ground on conductor 216. A circuit is now closed for lamp 9 in the tens group of lamps from battery on conductor 217, lamp 9, left middle back contacts of relay 207, right inner front contacts of relay 205 to ground on the right front contacts of relay 204. When the impulse is terminated, relays 106 and 107 release, followed by the release of relays 110 and 111, 114 and switch magnet 118. The switch then advances to the last group of working terminals of which terminal 133 is one. The operator now depresses key 0 and causes the transmission of an impulse consisting of voice frequencies X and Y over the line. This impulse causes the operation of relays 105 and 106. The operation of these two relays causes the operation of relays 109 and 110, respectively, in the described manner, operates relay 114, and grounds brushes

127 and 126. Relay 114 operates the switch magnet 118. Ground on brush 127 completes a circuit to relay 202 by way of terminal 142, conductor 231, right winding of relay 202 to battery, and ground on brush 126 completes a circuit to relay 207 by way of terminal 143, conductor 232, right winding of relay 201 to battery. Both of these relays operate, lock over their left windings and left contacts to ground on conductor 216 and close circuits through the lamp 0 in the units group of lamps from battery on conductor 217 through the lamp 0, right inner front contacts of relay 202, right outer front contact of relay 201 to ground on the right back contact of relay 200.

The impulses corresponding to the wanted number 3790 are thus transmitted and a visual display of the number is given to the operator in the incoming position. When the operator has noted the number displayed, she may release the call indicator apparatus and extinguish the lighted lamps by operating key 119. The operation of this key removes ground from conductor 216 thereby unlocking and releasing the lamp relays and which, in turn, open the circuits of the lamps displaying the number. On its inner contacts, key 119 closes a previously described circuit for relay 115 which, in turn, closes another previously described circuit for the magnet 118 through its interrupter contacts, causing it to operate and return the distributor switch brushes to the normal row of contacts. When the last impulse is received, relay 114 releases and opens the locking circuit of relay 115 which, after a time interval, releases and, in turn, releases relay 101 which reconnects the trunk conductors to the trunk jack at office A for immediate use if desired for the transmission of impulses in the opposite direction.

Provision is also made for the condition when the operator at one office wishes to call the operator at the distant office by ringing over the trunk. If, for example, the operator at office A wishes to signal the operator at office B, she inserts the cord plug 100 into trunk jack 148, operates key 145 and connects thereby a ringing current source to the trunk conductors. A circuit is then completed for relay 103 from one side of the ringing circuit, top contacts of key 145, conductor 122, right upper normally made contact of key 121, top cord conductor 124, conductor 146, top back contacts of relay 101, top inner back contacts of relay 102, condenser 147, relay 103, bottom inner back contacts of relay 102, bottom back contacts of relay 101, conductor 149, ring cord conductor 144, right bottom normally made contacts of key 121, conductor 123, bottom contacts of key 145, to the return side of the ringing circuit. Relay 103 operates and closes an obvious circuit for relay

116 which also operates. The cord ringing relay 153 likewise responds to the above described ringing circuit, closes an obvious circuit for relay 154 which operates, locks to ground on the left bottom normal contacts of key 121 and lights lamp 155 as an indication that the operator is ringing. Relay 116, on its left contacts, closes an obvious circuit for relay 117 which operates and, on its right contacts, closes voice frequency current sources X and Z to the primary winding P of repeating coil 150. Relay 117, on operating, disconnects the trunk conductors 324 and 325 from the repeating coil 152 and voice frequency responding apparatus and connects the said conductors to the secondary winding S of repeating coil 150. A voice frequency impulse therefore, consisting of frequencies X and Z, is transmitted over the trunk line to the distant office B; the length of the impulse being governed by the length of time relay 103 is kept operated by the ringing circuit and also by the slow releasing qualities of relay 116. Impulse XZ causes the operation of the relays 318 and 316 and the consequent operation of relays 328 and 329 at office B. The operation of relays 328 and 329 opens the normally made circuits over windings Nos. 2 and 4 of relay 330. Relay 330 releases, closes its contact and operates relay 313. Impulse XZ also operates relay 337 over windings Nos. 2 and 4. Relay 337 at office B is identical with relay 114 at office A and relay 337, on operating, closes a circuit for and operates a relay, not shown, but which is identical with relay 115 at office A. This relay operates, connects ground to conductor 338 and causes thereby the operation of relay 312. Relay 313, on operating, disconnects the trunk conductors from the incoming side of the trunk and connects the top and bottom inner front contacts to conductors 340 and 341. Relays 313 and 312 close a loop including resistance 339, to conductors 340 and 341 to which may be connected any suitable signal for apprising the home operator that the distant operator is ringing. When the calling impulse is over, relays 330, 337, 313 and 312 are released. The operator at office B now inserts the cord in the trunk jack, operates key 307 to the right, thereby connecting the operator's telephone circuit OT, not shown, across the trunk and conversation ensues between them. When the conversation is over, both operators would draw their respective cords and the trunk is ready for use again.

Although the invention has been disclosed as applied to the registration and display of the wanted line number at a distant office under the control of a key-set at an outgoing office it is to be understood that the invention is of broader application and that the registration set up through the operation of an operator's key-set might be employed to

control the setting of automatic switches in a manner well known in the art.

What is claimed is:

1. A telephone exchange system comprising two central offices and an interconnecting line, alternating current sources of different frequencies and a call indicator apparatus at each of said offices, means at each of said offices for selectively applying said alternating current frequency sources to said trunk line to transmit coded impulses thereover, devices at each end of said line responsive to said impulses, and means controlled by said responsive devices for recording said impulses in said call indicator apparatus.

2. In a telephone exchange system comprising two central offices and an interconnecting line, voice frequency current sources at one of said offices, a key-set at said office comprising a plurality of individual keys, the keys of said key-set being variously connected to different ones or combinations of said voice frequency current sources, means including said key-set for selectively applying said voice frequency current sources to said line to form coded voice frequency impulses thereover in accordance with the operation of said key-set, a call indicator apparatus at the other of said offices and means in said trunk line at said other office for responding to said impulses and for setting up said call indicator apparatus in accordance therewith.

3. In a telephone exchange system comprising two central offices and an interconnecting line terminating at an operator's position in each of said offices, a cord circuit and key-set at each of said positions, said key-set comprising a plurality of keys, voice frequency current sources at each of said offices, the keys of said key-set being variously connected to different ones or combinations of said voice frequency current sources, means to operatively associate said key-set with said trunk line through a cord circuit to produce coded voice frequency current impulses thereover in accordance with the depressed key of said key-set, a call indicator apparatus in each of said offices, means in said trunk line responsive to the appropriation of said trunk line at one of said offices for associating said call indicator apparatus to said line at the other of said offices, and means in said trunk line at said other office responsive to said coded voice frequency current impulses produced by the operation of any of said keys of the key-set at the originating office for recording said impulses in said call indicator apparatus at said other office.

4. In a telephone exchange system including a trunk line and a recording apparatus comprising a switch, voice frequency current sources, means to selectively apply said sources to said trunk line to produce voice frequency current impulses thereover, de-

vices in said trunk line responsive to said voice frequency current impulses transmitted over said trunk line and means controlled by said devices when operating in response to said impulses for operating said switch.

5. A telephone exchange system comprising two central offices and a trunk line equipped at each end with means for transmitting thereover coded voice frequency current impulses in accordance with a wanted number designation, devices at each end of said line responsive to said impulses transmitted from distant end of said line, a recording apparatus at each end of said line comprising a switch, and means for stepping said switch in response to one of said devices when operating on impulses corresponding to digits of said wanted number designation.

6. A telephone exchange system comprising two central offices and an interconnecting line, voice frequency current sources at one of said offices, a key-set comprising a plurality of keys at said office, said voice frequency currents being variously connected to the contacts of each of said keys in separate order or combination, means including said key-set for selectively applying said voice frequency current sources to said line to produce coded voice frequency impulses thereover in accordance with the operation of each of said keys of said key-set, a call indicator apparatus at the other of said offices comprising a switch with a plurality of brushes and cooperating contacts, a plurality of registering relays connected to said contacts, a plurality of voice frequency relays operatively connected to said line and responsive to said impulses, and means responsive to said voice frequency relays for operating said registering relays over the brushes of said switch.

7. A telephone exchange system comprising two central offices and an interconnecting line, voice frequency current sources at each of said offices, a key-set comprising a plurality of keys at each of said offices, said voice frequency current sources being variously connected to the contacts of each key of said key-sets in separate order or combination, means at each of said offices including the key-set thereof for selectively applying said voice frequency current sources to said line to produce coded voice frequency impulses thereover in accordance with the operation of each of said keys in said key-set, a call indicator apparatus at each of said offices comprising a switch with a plurality of brushes and cooperating contacts, a plurality of registering relays connected to said contacts, a plurality of alternating current relays operatively connected to each end of said line and responsive to said coded voice current impulses produced at the distant end of said line, and means responsive to said alternating current relays for operating said

registering relays over the brushes of said switch mechanism.

8. A telephone exchange system comprising two central offices and an interconnecting line, voice frequency current sources at one of said offices, a key-set at said office comprising a plurality of keys, said voice frequency current sources being variously connected to the contacts of each key of said key-set in separate order or combination, means including said key-set for selectively applying said voice frequency current sources to said line for producing coded voice frequency current impulses thereover in accordance with the operation of each of said keys in said key-set, a call indicator apparatus at the other of said offices, comprising a switch with a plurality of brushes and cooperating contacts and a plurality of registering relays connected to said contacts, a plurality of alternating current relays operatively connected to said line at said other office and responsive to said impulses, said plurality of registering relays being arranged in a plurality of groups in which each group consists of a similar number of relays as said plurality of alternating current relays, a bank of lamps controlled by each of said groups of registering relays, and means including said switch responsive to the successive operation of said alternating current relays for successive impulses received for operating a corresponding number of said registering relays in each group to light lamps in the banks controlled thereby to designate the numerical values of the impulses.

9. In a telephone exchange system comprising a central office and an interconnecting two way line, voice frequency current sources at each of said offices, a key-set at each of said offices comprising a plurality of keys, each of said voice frequency current sources being variously connected to the contacts of each of said keys in said key-set in separate order or combination, means at each of said offices including said key-set for selectively applying said voice frequency current sources to said line for producing coded voice frequency current impulses thereover in accordance with the operation of each of said keys of said key-set, a call indicator apparatus at each of said offices comprising a switch with a plurality of brushes and cooperating contacts and a plurality of registering relays connected to said contacts, a plurality of alternating current relays connected to said line at each end thereof and responsive to said coded impulses produced at the distant end of said line, said plurality of registering relays being arranged in a plurality of groups in which each group consists of a similar number of relays as said plurality of alternating current relays, a bank of lamps controlled by each of said groups of registering relays, and means including said

switch responsive to the successive operation of said alternating current relays for successive impulses received for operating a corresponding number of said registering relays in each group to light lamps in the banks controlled thereby to designate the numerical value of the impulses.

10. In a telephone exchange system including two central offices and an interconnecting line, means operatively associated at the originating end for producing and transmitting coded voice frequency current impulses thereover for each digit of a wanted number, a voice frequency relay device operatively connected to the terminating end of said line and responsive to said impulses, a number recording apparatus comprising a switching mechanism with a plurality of brushes and cooperating contacts, and means responsive to said voice frequency relay device for advancing said switch brushes one step for each impulse.

11. In a telephone exchange system comprising two central offices and an interconnecting toll line, means operatively associated at one end for producing and transmitting coded voice frequency current impulses thereover for each digit of a wanted number, a plurality of voice frequency relays at the terminating end of said line, each of said voice frequency relays being responsive to a particular frequency of those frequencies of which said impulses are composed, a number recording apparatus comprising a switching mechanism, said switching mechanism having a plurality of contact levels with a cooperating brush for each level and a plurality of groups of registering relays, the corresponding relays of each of said groups being connected to the contacts of a contact level of said switch and means responsive to the operation of any of said voice frequency relays for advancing said switch brushes one step for each impulse and for selectively operating said register relays.

12. A telephone exchange system comprising two central offices and an interconnecting line terminating in an operator's position at each of said offices, voice frequency current sources and a key at one of said offices, a call indicator mechanism at the other of said offices, means for operatively connecting said key to said trunk line, means controlled by said key for selectively applying a plurality of said voice frequency current sources to said line to produce a coded voice frequency current impulse thereover, means for operatively connecting said call indicator mechanism to said line in the other of said offices, and means at said other office responsive to said coded impulse to automatically restore said call indicator mechanism to normal.

13. A telephone exchange comprising two central offices and a two-way interconnecting line terminating at each office in an operator's

position, means capable of being operably associated with each end of said trunk line at each of said positions for transmitting coded voice frequency current impulses over said line means operatively connected to each end of said line responsive to said impulses produced at the distant end of said line, and means at each end of said line for disconnecting said trunk from one of the said operator's positions during the transmission of impulses over said line from other of said operator's positions.

14. In a telephone exchange system an operator's position having a cord circuit, a key-set associable therewith, a trunk line with which said cord circuit may be connected, a called line number displaying apparatus associable with the distant end of said trunk line having a plurality of digit registers, voice frequency current sources, means controlled by said key-set for selectively applying said sources to the outgoing end of said trunk line over said cord circuit to transmit impulses in accordance with the designation of a called line number, and devices responsive to said impulses for setting the registers of said displaying apparatus to cause the display of the wanted line number.

15. In a telephone exchange system, an operator's position having a cord circuit, a key-set associable therewith, a trunk line with which said cord circuit may be connected, a recording apparatus associable with the distant end of said trunk line having a plurality of digit registers, voice frequency current sources, means controlled by said key-set for selectively applying said sources to the outgoing end of said trunk line over the talking conductors of said cord circuit to transmit impulses in accordance with the designation of a called line number, and devices responsive to impulses for setting the registers of said recording apparatus.

In witness whereof, we hereunto subscribe our names this 15th day of September, 1930.

THOMAS SAMUEL SKILLMAN.

LANCELOT GERHARD FREETH.