April 29, 1941. C. E. LOMAX 2,239,825

TELEPHONE APPARATUS

Original Filed April 22, 1938 3 Sheets-Sheet 1

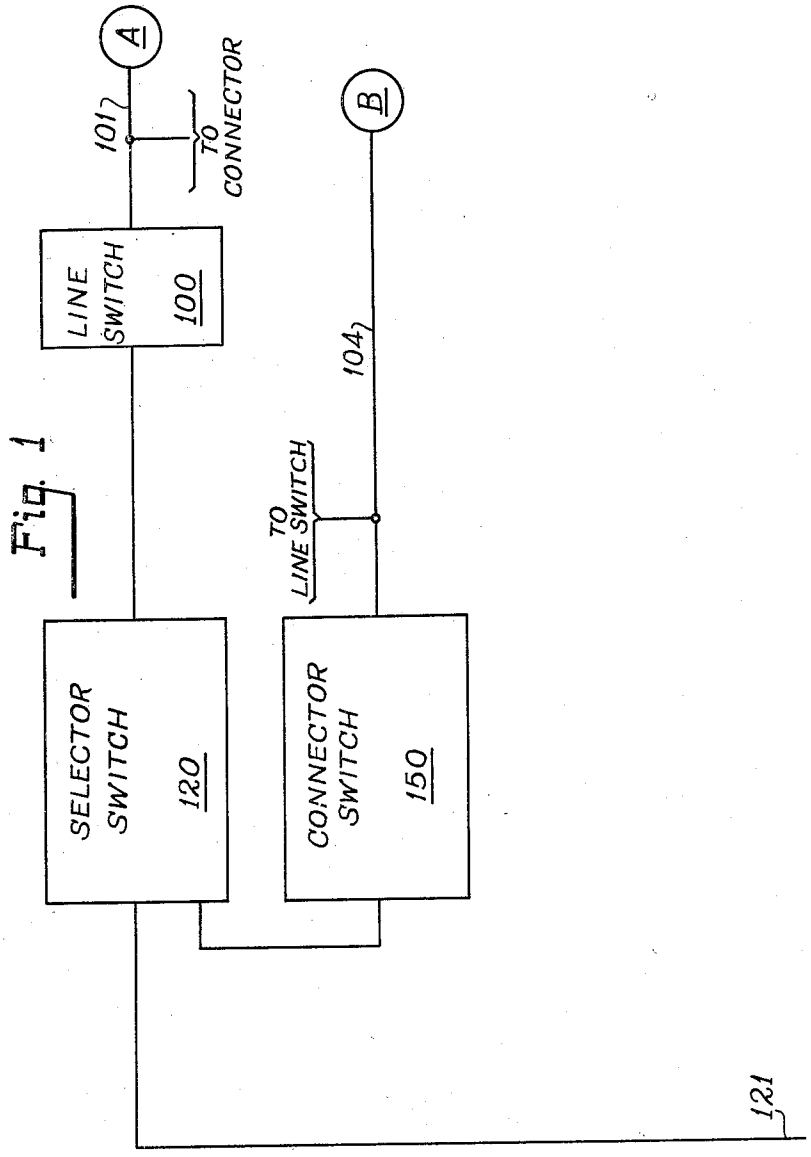


Fig. 1

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TELEPHONE APPARATUS

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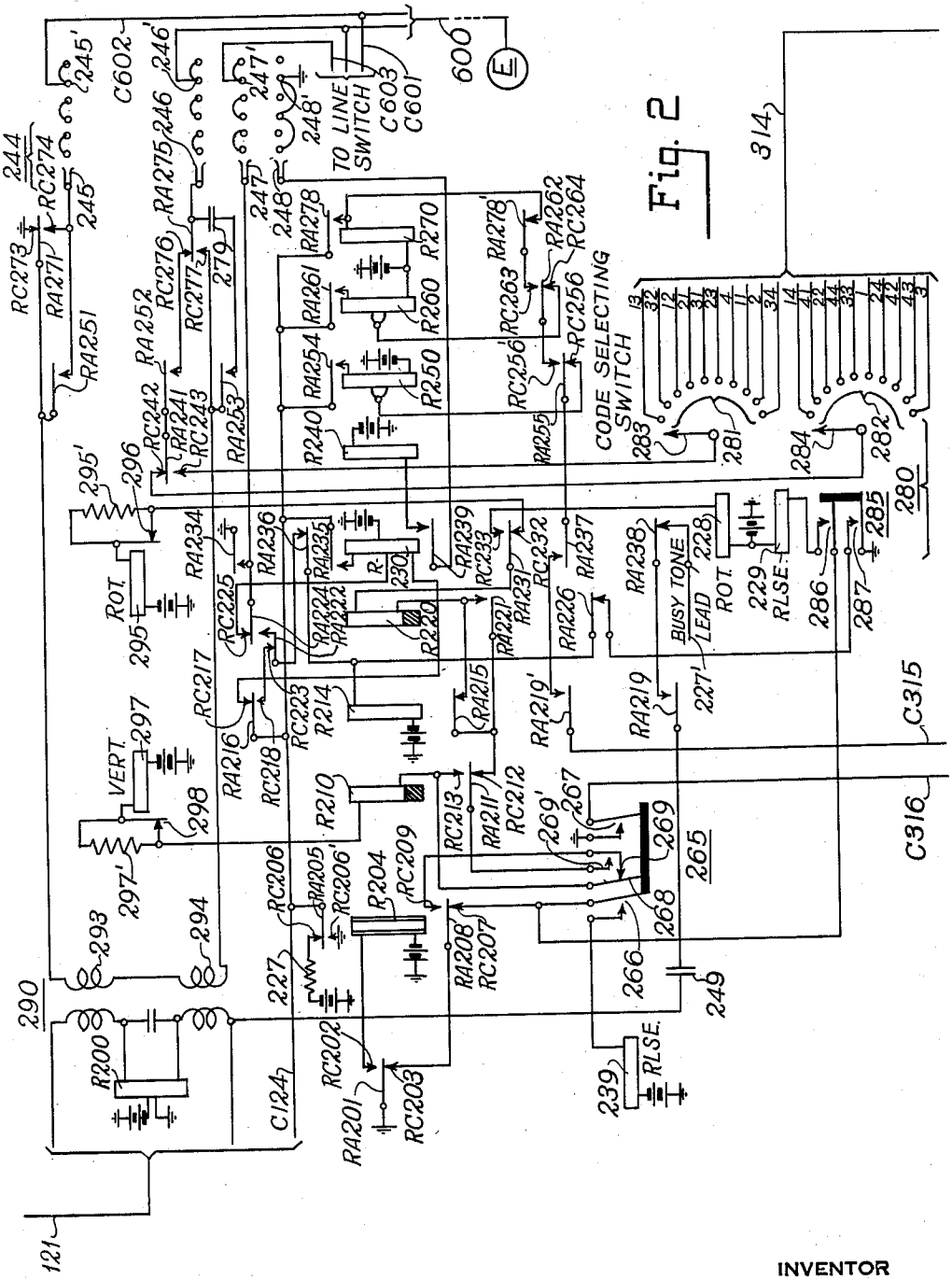


Fig. 2

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Original Filed April 22, 1938 3 Sheets-Sheet 3

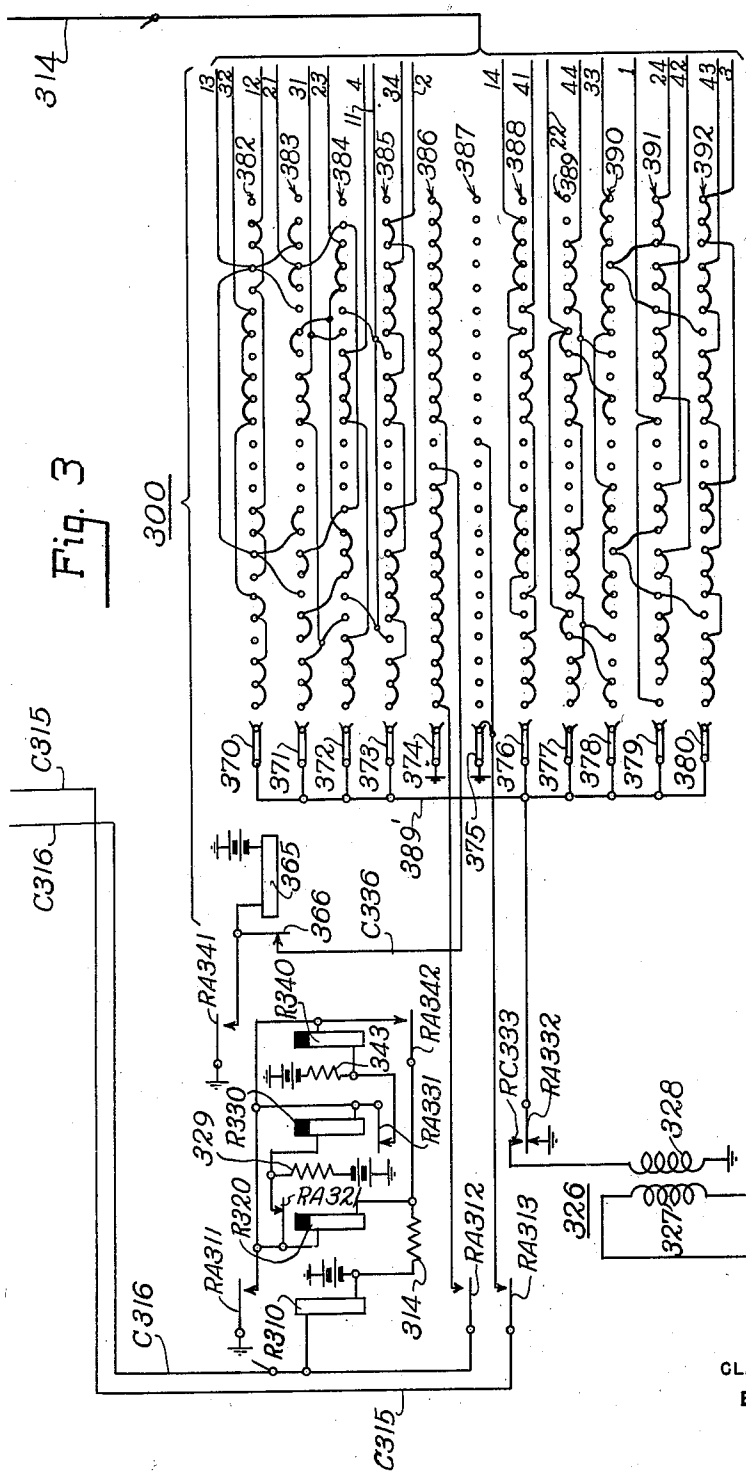


Fig. 3

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Patented Apr. 29, 1941 2,239,825

UNITED STATES PATENT OFFICE

2,239,825

TELEPHONE APPARATUS

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Original application April 22, 1938, Serial No. 203,474. Divided and this application October 23, 1939, Serial No. 300,855

6 Claims. (Cl. 179—17)

The present invention relates to improvements in apparatus for use in automatic telephone systems and, more particularly, to improved apparatus for interrupting the voltage of a ringing current source to provide coded ringing current for signaling over subscribers' lines of the multi-party type. This application is a division of application Serial No. 203,474, filed April 22, 1938, Clarence E. Lomax.

It is an object of the invention to provide an improved and exceedingly simple ringing interrupter switch which utilizes only a small switch contact bank and is so arranged that a large number of different ringing codes are provided.

The invention is illustrated as being incorporated in an automatic telephone system wherein subscriber-controlled impulse responsive automatic switches are utilized for setting up connections between the various lines of the system. Certain of the subscribers' lines included in the system are of the multi-party type and code ringing is utilized for selectively signaling the substations associated with any called subscriber's line of this character. In accordance with one feature of the present invention there is provided an improved ringing interrupter switch for furnishing the various ringing codes. In brief, this switch comprises a plurality of bank contacts arranged in sets, wipers respectively associated with the contact sets and adapted to be connected to a source of ringing current, and motor means for driving the wipers over the contacts of the respective associated sets. The interrupter also comprises a plurality of ringing current conductors which are terminated at the bank contacts of the switch, the number of conductors being greater than the number of the contact sets. A plurality of jumper connections are also provided, which connections extend between certain of the contacts of the different contact sets and are so connected and arranged that at least a portion of the switch wipers are rendered operative to impress the voltage of the ringing current source on at least two of the ringing current conductors during each ringing cycle of the switch.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings in which Figs. 1, 2 and 3 illustrate an automatic telephone system having incorporated therein apparatus constructed and arranged in accordance with the present invention.

Referring now to the drawings, the system there illustrated comprises, in general, an exchange, a plurality of single party subscribers' lines, two of which are illustrated at **101** and **104** extending to the exchange, and a plurality of subscriber-controlled automatic switches including a line switch **100**, a selector switch **120** and a connector switch **150** for setting up connections between the various subscribers' lines. Also extending to the exchange is a group of multi-party subscribers' lines, one of which is illustrated at **600**. The multi-party lines are terminated in the bank contacts of a group of special connector switches, one of which is illustrated in Fig. 2. These special connector switches have associated therewith ringing apparatus as illustrated in Fig. 3 which functions in a manner such that selective code ringing of any desired substation on a selected multi-party line may be achieved.

It will be understood that a plurality of switches of each type, namely, a plurality of line switches, a plurality of selector switches and a plurality of connector switches are provided in the system for performing the usual line switching function. The numerical switches of each type are respectively arranged in groups and in accordance with universally followed practice the number of switches in each group is determined by the maximum volume of traffic the particular switch group is required to handle. Further, in accordance with conventional practice, each of the single party subscribers' lines is multipled to the corresponding bank contacts of a group of connector switches whereby a plurality of switches are available for setting up connections between each line and any other line of the system. The line switches, on the other hand, are individually associated with the respective subscribers' lines.

The end of each subscriber's line remote from the exchange terminates in one or more subscribers' substations, the arrangements of which are different, depending upon whether the line is of the single-party type or is one of the group of multi-party lines. Two substations of the usual automatic type are diagrammatically illustrated at A and B in association with the lines **101** and **104**, respectively. These substations are of the well-known common battery type. The substations associated with the respective multi-party lines, on the other hand, are of the local battery type, one such substation being illustrated at E

in association with the line 600. In brief, each of the substations embodied in the system may comprise the usual hand-set type of transmitter and receiver, a cradle or hook switch, a ringer, and an impulsing device for transmitting the switch controlled impulses by way of the associated line to the automatic switching equipment located in the terminating exchange.

Each of the line switches is preferably of the well-known rotary type, of which there are several commercial embodiments. Each of the selector and connector switches is preferably of the well-known Strowger type having embodied therein a Strowger switching mechanism including a plurality of bank contacts arranged in levels; a wiper carriage structure adapted to be translated vertically to bring the wipers thereof to a position opposite a particular level of bank contacts and then rotated to bring the wipers into engagement with a particular set of contacts in a selected level; vertical, rotary and release magnets; and control relays suitably connected and arranged to control the energization of the various magnets and the line switching in accordance with the particular functions of the particular switch. In all fundamental respects, these switches are similar to the connector switch illustrated in detail in Fig. 2. Obviously, the particular arrangement of the control apparatus embodied in the switches of different type is different in each instance, depending upon the character of the switch.

Neglecting for the present the details of the apparatus terminating the multi-party subscribers' lines and the improved interrupter switch shown in Fig. 3, the system as described above is, in general, entirely conventional in form and its operation is well understood in the art. In brief, when a subscriber, such, for example, as the subscriber at the telephone A, initiates a call over the line 101 to a second subscriber's telephone, such, for example, as the telephone at the station B, by lifting his receiver from its hook, a loop circuit is completed by way of the line 101 for initiating the operation of the line switch 100 to select a trunk line leading to an idle selector switch. Assuming, for example, that the selector switch 120 is the first numerical switch selected for the use of the calling line 101, when the trunk line leading to this selector switch is found, the loop circuit is extended to this switch and the switch is conditioned to respond to the first series of impulses dialed at the calling substation. With the selector switch 120 in this condition, dial tone is returned over the established loop to the calling subscriber to indicate that the dialing operation may be started. When the first digit is dialed at the calling substation, the switch 120 elevates its wipers to a position opposite the level of bank contacts terminating the trunk lines respectively extending to the connector switches having access to the called line 104. Following this operation, the wipers of the switch 120 are automatically stepped over the contacts of the selected level until a trunk line leading to an idle connector switch of the selected group is found. Assuming that the connector switch 150 is the first idle connector switch available, when the wipers of the switch 120 are stepped into engagement with the contacts terminating the trunk line extending to this connector switch, the subscriber's loop circuit is extended thereto, thereby to cause this connector switch to be conditioned to respond to the second and third series of impulses dialed at the calling substation. In response to the dialing of the second digit, the wipers of the connector switch 150 are stepped vertically to a position opposite the level of bank contacts at which are terminated the lines of the ten-line subgroup including the called line 104. Following this series of impulses, the connector switch is conditioned to rotate its wipers step-by-step in accordance with the impulses making up the third and final digit dialed at the calling substation. When the last digit is dialed, the wipers of the switch 150 are stepped into engagement with the set of bank contacts terminating the called line 104. In accordance with conventional practice, suitable provisions are made in the connector switch 150 for testing the called line to determine its idle or busy condition, for returning busy tone over the established loop to the calling subscriber in case the called line is busy and for applying ringing current to the called line in the event this line is idle at the time it is selected. Assuming that the line 104 is idle, the desired conversational connection is completed when the called substation B is answered. Also in accordance with conventional practice, the apparatus is arranged to insure its release when the connection is cleared out at the calling and called substations. Any desired mode of initiating the release of the established switch train may be utilized. For example, the control apparatus embodied in the connector switch 150 may be so arranged that the release of the connection is entirely under the control of the calling party. Alternatively, the apparatus may be so arranged that the release of the connection is under the control of the last party to hang up.

Referring now more particularly to the group of improved connector switches by way of which the regular automatic subscribers' lines gain access to the multi-party lines, it is pointed out that the connector switches of this group may be of identical construction and arrangement. For this reason, only the switch illustrated in Fig. 2 will be described in detail, but it will be understood that each of the multi-party lines is multiplied to the corresponding bank contacts of each of the switches of this group. In brief, the switch shown in Fig. 2 comprises a switching mechanism 244, of the Strowger type, which included a plurality of bank contacts arranged in levels; wipers for engaging the contacts; means comprising a vertical magnet 297 and a ratchet and pawl mechanism, not shown, for translating the wipers to a position opposite a desired level; means comprising a rotary magnet 295 and a ratchet and pawl mechanism, not shown, for thereafter rotating the wipers step by step into engagement with a selected contact set in the selected level; a release magnet 239 for causing the wiper carriage structure to be returned to normal during the release of the switch, vertical off-normal springs 295 and a plurality of control relays for controlling the operation of the three enumerated magnets and the auxiliary functions of the switch. Of these relays, R200 is the usual line or impulsing relay, R204 is the usual hold relay and is of the slow-to-release type, R210 and R220 are slow-to-release pulse circuit control relays, R230 is a ringing control relay, and R214 is the busy test relay. The remaining relays illustrated in Fig. 2, namely, R240, R250, R260 and R270, are provided for controlling the ring cut-off operation and the line switching operation in an improved manner. For the purpose of selectively signalling the various substations associated with the rural subscribers' lines, coded ringing is uti-

lized. To this end, the code selecting switch 280 is provided in the connector switch and is arranged to respond to impulses transmitted thereto by way of a calling line. This code selector switch is of the well-known minor type and comprises two sets of bank contacts 281 and 282 at which are terminated two groups of ringing current conductors, each comprising ten conductors, wipers 283 and 284 respectively associated with the contact sets 281 and 282, an operating magnet 228 for driving the enumerated wipers over the contacts of their respective associated sets, a release magnet 229 operative to restore the switch to normal and off-normal springs 285 for controlling the energization of the release magnet. For the purpose of separating the local battery talking circuits, normally formed when the multi-party rural lines are involved in connections, from the common battery talking circuits used in connections between the regular automatic subscribers' lines, there is provided a repeater 290 which is inserted in and divides into two sections the trunk line incoming to the connector switch illustrated in Fig. 2.

The ringing current conductors terminated at the bank contacts of the code selector switch 280 form a cable 314 extending to the bank contacts of an interrupter switch 300, illustrated in Fig. 3. The switch 300 is of the well-known rotary type and comprises a plurality of sets of bank contacts 382 and 392, inclusive, wipers 370 to 380, inclusive, respectively associated with the bank contact sets, and means comprising an operating magnet 365 and a ratchet and pawl mechanism, not shown, for driving the enumerated wipers over the contacts of their respective associated sets. This switch functions to impress on the respective ringing current conductors the voltage of an alternating current source 325 for predetermined intervals during each cycle of its operation, and the bank wiring of the switch is such that the coded voltage impressed on each conductor during each ringing cycle is different in character from that impressed on each of the other ringing current conductors. More particularly, the voltage of the source 325 is impressed on each of the enumerated wipers of the interrupter switch by way of a transformer 326 having a primary winding 327 connected across the source and a secondary winding 328 having one terminal grounded and the opposite terminal arranged to be connected to the respective wipers. The contact bank of the switch 300 is wired in an improved manner, described more particularly hereinafter, such that the coding of the ringing voltage applied to the several ringing current conductors is different for each conductor. For the purpose of controlling the operation of the interrupter switch there is provided in association therewith a start relay R310 and a group of cyclically operating slow-to-operate relays R320, R330 and R340. Specifically, this group of relays functions to connect the wipers of the interrupter switch to the winding 328 and to energize the operating magnet 365 once during each cycle of their operation.

Operation of the ringing interrupter

The operation of the ringing interrupter is initiated when ground is applied to the start conductor C316 by one of the special connector switches in the group including the switch shown in Fig. 2, to complete an obvious circuit for energizing the start relay R310. The relay R310, upon operating, completes, at RA313, a path for applying a predetermined potential, namely, ground potential, to the pick-up or control conductor C315. At RA312, the relay R310 prepares a circuit, traced hereinafter, for maintaining itself energized independently of its operating circuit as traced above and until the interrupter switch has been operated through a complete cycle. The relay R310 also completes a circuit for energizing the slow-to-operate relay R320, this circuit extending from ground at RA311 by way of the winding of R320 and the resistor 314 to battery.

The relay R320 operates, after an interval, to open, at RA321, a point in the path normally short-circuiting the winding of R330, permitting the latter relay to be energized over a circuit extending from ground at RA311 by way of the winding of R330 and the resistor 329 to battery. The slow-to-operate relay R330 operates, after an interval, to open, at RA331, a point in the path normally short-circuiting the winding of R340, permitting this latter relay to be energized over a circuit extending from ground at RA311 by way of the winding of R340 and the resistor 343 to battery. The slow-to-operate relay R340, in turn, operates, after an interval, to complete, at RA342, an obvious path for short-circuiting the energized winding of R320, causing the last-mentioned relay to restore. When R320 restores, it completes, at RA321, the path for short-circuiting the winding of R330. The relay R330 now restores to complete, at RA331, the above-mentioned path for short-circuiting the winding of R340. When R340 restores, it opens, at RA342, the path short-circuiting the winding of R320, permitting this latter relay to again be energized over its operating circuit as traced above. Thus, a second cycle of operation of the three relays R320, R330 and R340 is initiated. During each operating cycle of these three relays, a circuit is completed for energizing the operating magnet 365 embodied in the interrupter switch 300. Thus, when R340 operates, it completes, at RA341, an obvious circuit for energizing the magnet 365. Assuming the wipers to be standing in the home position as shown in the drawings when this magnet is energized, the magnet, in cooperation with its associated ratchet and pawl mechanism, not shown, operates to step the wipers 370 to 380, inclusive, one step or into engagement with their respective associated second contacts. It is manifest that, for each succeeding cycle of operation of the three relays R320, R330 and R340, the magnet 365 is energized to cause the enumerated wipers to be moved another step. As pointed out immediately hereinafter, movement of the enumerated wipers over the contacts of their respective associated sets results in the coding of the ringing voltage applied to the various ringing current conductors terminating in the bank contacts of the code selector switch 280. This is by virtue of the particular bank wiring arrangement of the interrupter switch illustrated in Fig. 3.

This wiring arrangement is such that voltage of the ringing current source is impressed on the various ringing current conductors for short intervals of equal duration but different in number and with different spacing intervals therebetween. Thus, as the wiper 370 travels over the first twelve contacts of the set 382, it is connected to the ringing current conductor 32 while standing in engagement with its associated second, third, fourth, sixth and seventh contacts. While in engagement with each of these con-

tacts, the voltage developed across the transformer winding 328 is impressed on the conductor 32 for a short interval. Thus, with the wiper 370 standing in engagement with its second contact and when R330 operates during the second cycle of operation of the three relays R320, R330 and R340, a path is completed for connecting the upper terminal of the secondary winding 328 to the jumper connection 389', this path extending by way of RC333 and RA332. The jumper connection noted is multipled between the wipers 370 to 373, inclusive, and between the wipers 376 to 380, inclusive. Hence, the voltage developed across the secondary winding 328 is impressed on those of the ringing current conductors which extend to the respective second contacts associated with the enumerated wipers. Since the second contact of the set 382 is connected to the ringing current conductor 32, this conductor has impressed thereon the voltage of the ringing current source when R330 operates. Similarly, the ringing current conductors 31, 4, 34, 41, 44, 22, 1 and 43 have the voltage of the source impressed thereon with the wipers of the interrupter switch standing in the position noted. When R340 operates, following the operation of R330 in the second cycle of operation of the three relays noted, the magnet 365 is energized to advance the wipers into engagement with their respective associated third contacts. This movement of the wipers, however, does not result in the disconnection of the ringing current conductors from the upper terminal of the secondary winding 328 for the reason that each of the wipers is of the bridging type arranged to bridge two contacts during the transition interval when it is being moved from one contact to another. When R340 operates, however, it causes the rapid sequential restoration of R320 and R330 in the manner pointed out above. The last-mentioned relay, upon restoring, disconnects the jumper conductor 389' from the upper terminal of the winding 328 to remove the potential of the ringing current source from the ringing conductors and to substitute ground thereon. During the third cycle of operation of the three relays R320, R330, and R340, the potential of the source is again impressed on those of the ringing current conductors which are connected to the respective third contacts of the sets associated with the wipers 370 to 373, inclusive, and 376 to 380, inclusive, and, during the fourth cycle of operation of these relays, the potential of the source is impressed on those of the conductors connected to the fourth contacts of the sets respectively associated with the enumerated wipers, and so on. It will be noticed from an inspection of the drawings that the ringing current conductor 32, for example, is not connected to the fifth contact of the set 382. Hence, during the cycle of operation of the three relays R320, R330 and R340 to advance the wipers from engagement with their respective associated fifth contacts and into engagement with their respective associated sixth contacts, the potential of the ringing current source is not impressed on this particular ringing current conductor. A spacing interval is, therefore, provided between the first half of the code and the second half. Since the conductor noted, namely, the conductor 32, is connected to the sixth and seventh contacts of the set 382, this second half of the code cycle comprises two additional short ringing periods. From this point on and until the wiper 370 is advanced into engagement with the fifteenth contact of the set 382, the conductor 32 is held disconnected from the ringing current source.

The arrangement is such that two ringing cycles are completed during movement of the switch wipers over the twenty-five points of the switch. The end of the first cycle is reached when the wipers are advanced into engagement with their respective associated thirteenth contacts, and the wipers are moved to a position to begin the second ringing cycle when they are driven into engagement with their respective associated fourteenth contacts. In order to render the spacing between cycles substantially equal, it is desirable rapidly to move the wipers from engagement with their respective associated thirteenth contacts and into engagement with their respective associated fourteenth contacts. To this end, the thirteenth contact of the set 386 is included in a circuit for energizing the magnet 365 by way of the self-interrupting contacts associated with the armature 366, this circuit being completed when the wiper 374 is advanced into engagement with the thirteenth contact of the set 386 and extending from ground on this wiper by way of C336, the armature 366 and the winding of the magnet 365 to battery. When energized over the above-traced circuit, the magnet 365 operates immediately to advance the wipers into engagement with their respective associated fourteenth contacts independently of the cyclically operating relays R320, R330 and R340. This operation marks the beginning of the second ringing cycle. During this second cycle, the voltage of the ringing current source is impressed on the various ringing current conductors for coded intervals which are identical with those produced during the first ringing cycle. Thus, during the respective intervals when the wiper 370 is standing in engagement with the fifteenth, sixteenth, seventeenth, nineteenth and twentieth contacts of the set 382, the voltage of the source is impressed on the conductor 32 through the operation of the relay R330. During the interval when this wiper stands in engagement with the eighteenth contact of the set 382, the conductor 32 is held disconnected from the source so that a spacing interval is provided which corresponds to that produced when the wiper is moved into engagement with its fifth contact. When the wiper 370 is moved from engagement with the twentieth contact of the set 382, the voltage of the source is held disconnected from the ringing current conductor 32 until this wiper is again moved into engagement with the second contact of the set 382 at the beginning of the third ringing cycle.

As indicated above, the coding of the voltage applied to each of the ringing current conductors during each ringing cycle is different in each instance. Thus, considering the ringing current conductor 13, for example, this conductor has applied thereto the voltage of the source for a short interval, followed by three narrowly spaced short intervals which are relatively widely spaced from the first interval, during each ringing cycle. More particularly, when the wiper 371 is moved into engagement with the seventh contact of the set 383 and when R330 operates, the conductor 13 is connected to the ringing current source. Thereafter and during the interval when the wiper 371 is standing in engagement with the eighth contact of the set 383, the conductor 13 is held disconnected from the source. When, however, the wiper 370 is moved into engagement with the ninth contact of the set 382,

this conductor is connected to the source by way of the wiper 370. Thereafter, and during the intervals when the wiper 371 is standing in engagement with the tenth and eleventh contacts of the set 383, the conductor 13 is connected to the source for short intervals measured by the time required for R330 to operate and restore. By inspection of the bank contact wiring arrangement, it will be apparent that the same coding of the voltage applied to the conductor 13 occurs during the second ringing cycle or during the movement of the wipers over the contacts numbered from 15 to 25, inclusive.

It is believed that the mode of applying the voltage of the ringing current source on the remaining ringing current conductors will be apparent from the wiring arrangement illustrated in the drawings considered in light of the preceding description pertaining to the two conductors 32 and 13. It is pointed out, however, that the number identifying each of the ringing current conductors is indicative of the particular coding of the voltage impressed, respectively, thereon. More particularly, during each ringing cycle, the conductor 12 has impressed thereon the voltage of the source for one short interval, followed by a spacing interval which is succeeded by two successive and closely spaced short ringing intervals. Similarly, the conductor 34 has impressed thereon during each ringing cycle the voltage of the source for three closely spaced short ringing intervals, followed by a spacing interval succeeded by four closely spaced short ringing intervals.

As indicated above, a predetermined potential, namely, ground potential, is impressed on the control conductor C315 for a short interval at the beginning of each ringing cycle. Thus, if the ringing apparatus is started with the interrupter switch standing in the position shown in the drawings, the path for applying ground potential to the conductor noted is completed when R310 operates. This circuit extends from ground as applied to the wiper 375 by way of the first contact of the set 387 and RA313 to C315. Again, when the wipers are driven over their associated contacts to a position where the wiper 375 engages the fourteenth contact of the set 387, this path is again completed. As the switch continues to operate, this path is completed for a short interval at the beginning of each ringing cycle.

The arrangement of the coding switch and its associated apparatus is such that the operation thereof continues until a ringing cycle which has been started is completed, irrespective of whether the operating circuit for the start relay R310 is maintained completed. To this end, an alternative circuit is provided for maintaining the start relay R310 energized independently of its operating circuit. This hold circuit for R310 is prepared at RA312, when R310 operates, is completed when the wiper 374 is moved into engagement with the second contact of the set 386, and is held completed until this wiper is moved into engagement with the thirteenth contact of the set 386. Hence, when the first ringing cycle is started, R310 is held operated until the cycle is completed. Again, when the wiper 374 is moved into engagement with the fifteenth contact of the set 386 to initiate the second ringing cycle, this holding circuit is again completed and is held completed until the wiper noted is again moved into engagement with the first contact of the set 386. By virtue of this arrangement, it is not possible for improperly coded ringing current to be projected over a selected subscriber's line.

The release of the ringing interrupter is brought about by the removal of ground potential from C316 to cause the restoration of the start relay R310. When this relay restores, it opens, at RA311, the circuits over which the cyclically operating relays R320, R330 and R340 are energized, thereby to prevent further operation thereof. At RA312, the relay R310 opens a point in the circuit, just described, for maintaining R310 operated independently of its operating circuit. At RA313, the relay R310 opens a point in the above-traced path for applying ground potential to C315.

From the foregoing description it will be apparent that the jumper connections extending between the contacts of the different contact sets enable the contact bank of the switch 300 to be fully utilized, so that a great number of codes may be obtained with a relatively small switch bank. Thus, the jumper connections extending between the contacts of the sets 382, 383 and 384 are so arranged that the wiper 371 is operative to impress the voltage of the ringing current source on the three ringing current conductors 13, 23 and 31 during each ringing cycle. Again, the conductor 389', which is common to the wipers, is connected by way of the wiper 370 to the ringing conductors 13, 32 and 12 for short intervals of each ringing cycle. It will be noted that the intervals during which the conductor 389' is connected by way of the wiper 370 to the ringing current conductor 13 do not overlap the intervals during which the conductor 389' is connected by way of the wiper 371 to the ringing current conductor 13, but rather that it is a combination of the two connections which produces the desired code. It will be noted further that the number of ringing current conductors, representing different codes, is more than twice the number of contact sets including contacts at which the ringing current conductors are terminated, further demonstrating the utility of the jumper connection arrangement.

Operation of the apparatus to extend a connection to a rural subscriber's substation

Referring now more particularly to the operation of the apparatus to extend a connection from one of the regular automatic subscribers' lines, such, for example, as the line 101, to one of the substations associated with the line 600, and assuming that the line switch 100 operates to extend the connection from the calling substation A to the selector switch 120, when a predetermined digit is dialed at this substation, the selector switch noted is caused to operate automatically to select an idle one of the special connector switches in the group including the switch illustrated in Fig. 2. Assuming the switch illustrated is the first available idle switch of the selected group, when the subscriber's loop circuit is extended by way of the trunk line 121 to this connector switch, the line relay R200 operates to complete, at RA201 and RC202, an obvious circuit for energizing the slow-to-release hold relay R204. The hold relay, upon operating, removes, at RA205 and RC206, battery potential, as extended by way of the resistor 227 to RC206, from the control conductor C124 of the trunk line 121. At RA205 and RC206', ground is applied over an obvious path to the control conductor noted. Through the removal of battery potential from C124 and the substitution of ground potential, the connector switch illustrated is marked as

busy, thereby to prevent its seizure by another of the selector switches on another call to one of the multi-party rural lines. At RA208 and RC209, the relay R204 prepares a point in the pulsing circuit, traced hereinafter, for energizing the slow-to-release relay R210 and the vertical magnet 297 in series. This circuit is completed when R200 restores at the beginning of the first impulse of the second digit dialed at the calling substation A and extends from ground at RA201 by way of RC203, RA208, RC209, the off-normal springs 269 and 268, the winding of R210, the contact springs 298, and through the winding of the magnet 297 to battery. Upon being energized over the above-traced circuit, the magnet 297 attracts its associated operating armature to step the wipers embodied in the switching mechanism 244 one step vertically or to a position opposite the first level of bank contacts. During this first step taken by the wipers, the off-normal springs 265 are moved to the off-normal position to interrupt, at the springs 268 and 269, the above-traced impulsing circuit and to prepare, at the springs 269 and 269', an alternative impulsing circuit. This latter circuit is completed upon the operation of R210, which occurs simultaneously with the operation of the magnet 297. At the springs 267 ground is applied to the ringing interrupter start conductor C316, thereby to initiate the operation of the ringing interrupter in the manner pointed out above. At the beginning of the second impulse dialed at the calling substation A, the above-noted alternative impulsing circuit is again completed. Specifically, this circuit extends from ground at RA201 by way of RC203, RA208, RC209, the off-normal springs 269 and 269', RA211, RC213, the winding of R210, the springs 298 and through the winding of the magnet 297 to battery. When energized over the above-traced circuit, the magnet 297 again attracts its associated operating armature to cause the wipers of the mechanism 244 to be stepped a second step vertically or to a position opposite the second level of bank contacts. Thereafter, the magnet 297 is energized once for each impulse of the second digit dialed at the calling substation so that, at the conclusion of this digit, the switch wipers embodied in the mechanism 244 stand in a position opposite the level of bank contacts terminating the lines of the group including the called line 600. During this series of impulses, the relays R204 and R210 are held energized due to the slow-to-release characteristics thereof. At the end of the second digit dialed at the calling substation, the line relay R200 is held energized for a sufficient time interval to permit R210 to restore. This relay, upon restoring, opens, at RA211 and RC213, a point in the alternative impulsing circuit over which R210 and the magnet 297 were energized in series and prepares, at RA211 and RC212, a circuit for energizing the slow-to-release relay R220 and the rotary magnet 295 in series.

The last-mentioned circuit, namely that over which R220 and the rotary magnet 295 are energized, is completed when the line relay R200 restores at the beginning of the first impulse of the third digit dialed at the calling substation. This circuit extends from ground at RA201 by way of RC203, RA208, RC209, the off-normal springs 269 and 269', RA211, RC212, RA215, the winding of R220, RA231, RC232, the springs 296 and through the winding of the magnet 295 to battery. When energized over the above-traced circuit, the magnet 295 attracts its operating armature to cause the wipers of the mechanism 244 to be stepped from vertical normal into engagement with the first set of contacts in the selected level of bank contacts. The relay R220, upon operating, completes, at RA221, a path short-circuiting the armature RA215 of the busy relay R214, thereby to prevent the above-traced impulsing circuit from being opened when the wipers of the switch mechanism 244 are being moved over contact sets terminating busy lines. At RA224 and RC225, the relay R220 opens a point in the circuit, traced hereinafter, for energizing the ringing relay R230 and, at RA224 and RA222, it prepares a test circuit, traced hereinafter, over which the busy relay R214 may be energized. The rotary magnet 295 is energized once during each additional impulse dialed at the calling substation so that, at the conclusion of the third digit, the wipers of the mechanism 244 are left standing in engagement with the set of contacts terminating the called line 600. As indicated above and pointed out with greater particularity hereinafter, two operating positions are provided for each of the subscribers' lines. Thus, if the wipers 245 to 248, inclusive, are stepped into engagement with either the fifth or sixth set of bank contacts in the level illustrated, the connector switch will have access to the called line 600. Obviously, the one of these two sets selected will depend upon the number of impulses making up the third digit. For example, if the number of impulses in this digit is five, the switch wipers will be rotated into engagement with the contact set including the contacts 245' to 248', inclusive. On the other hand, if this digit comprises six impulses, the switch wipers will be rotated into engagement with the sixth set of contacts. The particular reason for providing two operating positions of the switch for each subscriber's line is pointed out in detail hereinafter.

With the wipers of the mechanism 244 standing in one of the two positions corresponding to the called line 600, the succeeding operation of the apparatus depends upon whether the called line is idle or busy at the time it is selected. Before describing the operation of the apparatus resulting when either of the two conditions noted prevails, reference will be made to the arrangement for eliminating any possibility of false operation on the part of the wipers of the mechanism and for preventing any noise from being introduced into the talking circuit extending by way of these wipers. To this end each of the two operating magnets 295 and 297 is connected and arranged in accordance with the invention disclosed and claimed in the aforementioned copending application so that the speed of the respective associated operating armatures is reduced at the end of each stroke thereof and when they approach their respective oppositely disposed pole faces.

More specifically, with the springs 296 closed the initial energizing path for the magnet 295 is by-passed around the resistor 295'. When the magnet 295 is energized, however, the springs 296 are opened while the operating armature is still moving toward the oppositely disposed pole faces of the associated magnet. When the springs 296 are opened the current through the winding of the magnet 295 is decreased since the resistor 295' is inserted in the circuit. Hence, the force exerted on the operating armature is reduced and the speed of the armature is decreased before the armature completes its stroke.

Thus, the shock incident to the completion of the stroke is materially reduced, thereby eliminating any possibility of the wipers being falsely operated more than one step and minimizing the vibration thereof. An identical arrangement including the contact springs 298 and the resistor 297' is provided in association with the vertical magnet 297 for the same purpose.

By serially including the resistance elements in the respective operating circuits of the two operating magnets 295 and 297 in the manner just described, the currents traversing the respective circuits are materially reduced immediately the respective magnets start to operate. This reduction in the energizing current positively prevents the operating magnets from becoming overheated during operation thereof. Also, the current drawn from the exchange current source is materially reduced during operation of the magnets. While in most instances the current consumption is of no great importance, in certain small exchanges utilizing alternating current rectifiers the maximum power rating of the rectifier may at times tend to be exceeded during periods of heavy traffic. By the arrangement illustrated wherein heavy current consumption occurs only during the initial period of each interval when the magnet is energized, overloading of the current source is minimized. A further advantage of reducing the magnitude of operating currents flowing through the operating magnets, following the initial movement thereof and during each period of energization, resides in the fact that lower resistance windings may be used, thus providing heavy initial operating currents conducive to positive armature operation, followed by holding currents of relatively low values such that the building up of substantial residual magnetic fields in the cores of the magnets is prevented. The prevention of such residual fields materially enhances the speed of restoration of the respective magnet armatures following deenergization of the respective windings and positively eliminates sticking on the part of the armatures.

Continuing now with the operation of the apparatus following the selection of the called line 600, and assuming that the called line is busy at the time it is selected, this condition is indicated by the presence of ground potential on the control conductor C603. When, therefore, the wiper 247 is moved into engagement with the contact 247', a circuit is completed for energizing the busy relay R214, this circuit extending from ground as applied to C603 by way of the contact 247', the wiper 247, RA224, RA222, RA236 and through the winding of R214 to battery. When the busy relay R214 operates, it prepares, at RA216 and RC218, a holding circuit for itself, which circuit is completed upon the subsequent restoration of the slow-to-release relay R220 shortly following the end of the third digit, and extends from ground at RC206' by way of RA205, RA216, RC218, RC223, RA222, RA236 and through the winding of R214 to battery. At RA215, the busy relay opens a point in the operating circuit for R220, thereby to prevent further impulses dialed at the calling substation from effecting any further operation of R220 or the ringing code selecting switch 280. At RA219, the relay R214, upon operating, completes a path for conducting busy tone current by way of the established subscriber's loop circuit through the receiver at the calling substation. This path extends from one side of the busy tone source as connected to C227' by way of RA238, RA219, the condenser 249, one side of the subscriber's loop circuit, the receiver at the calling substation, and back over the other side of the subscriber's loop circuit and the upper winding of R200 to the other terminal of the busy tone current source. The resulting operation of the receiver at the calling substation gives an audible indication identifying the called line as busy. Following the operation of the busy relay R214, no further operation of the apparatus occurs until the partially completed connection is cleared out.

Upon receiving busy tone, the calling subscriber may initiate the release of the operated switch train by restoring his receiver to its hook to cause the restoration of the line relay R200. This relay, upon falling back, opens at RA201 and RC202, a point in the operating circuit for the hold relay R204. When the hold relay restores, after an interval, it removes, at RA205 and RC206', ground from the control conductor C124, thereby to cause the release of the selector switch 120 and the line switch 100 in the usual manner. At RA205 and RC206, battery is substituted for ground on the control conductor C124, to mark the trunk line 121 as idle. The hold relay, upon restoring, also opens, at RA205 and RC206', a point in the previously traced holding circuit for the busy relay R214, causing this relay to restore. At RA208 and RC207, the hold relay completes a circuit for energizing the release magnet 239, this circuit extending from ground at RA201 by way of RC203, RA208, RC207, the off-normal springs 266, and through the winding of the magnet 239 to battery. The resulting operation of the release magnet causes the wiper carriage structure of the switching mechanism 244 to be restored to vertical and horizontal normal in the usual manner. When this occurs, the off-normal springs 265 are moved to the normal position to open, at the springs 266, a point in the operating circuit for the release magnet. At the springs 267 ground is removed from the ringing interrupter start conductor C316, thereby to cause the operation of this switch to be arrested providing none of the other special connector switches associated with the interrupter switch is operated. With the apparatus in this condition, the partially established connection is completely released and the switches involved therein are in readiness for further use.

Assuming now that the called line 600 is idle instead of busy at the time it is selected by the operated connector switch, this condition is identified by the presence of battery on the control conductor C603 thereof, battery potential being applied to the control conductor noted through the winding of the cut-off relay embodied in the line switch to which the line 600 extends. When, therefore, the wiper 247 is operated into engagement with the contact 247' terminating the conductor C603, a circuit is prepared for energizing the relay R230. This circuit is completed upon the subsequent restoration of R220 and extends from ground at RC206' by way of RA205, RA216, RC217, the lower winding of R230, RC225, RA224, the switch wiper 247, and the contact 247' to battery as applied to C603. The relay R230 operates, when its lower winding is energized over the above-traced circuit, and completes, at RA235, a holding circuit for itself, this holding circuit extending from ground on RC206', by way of RA205, C124, RA235 and through the upper winding of R230 to battery. At RA234,

the relay R230 applies ground to the switch wiper 247, thereby to complete a circuit for energizing and causing the partial operation of the cut-off relay provided in the line switch terminating the line 600, in the usual manner. The application of ground to the control conductor C603 of the line 600 serves to mark this line as busy in the bank contacts of the various other connector switches to which it extends.

At RA238, the relay R230, upon operating, opens a point in the above-traced path for applying busy tone current to the loop extending to the calling subscriber's substation and, at RA237, it prepares a circuit, traced hereinafter, for energizing the first relay R250 of the group of ringing control relays R250, R260 and R270. At RA239, the relay R230 completes a circuit for energizing R240, this circuit extending from ground as applied to the bank contact 248' by way of the switch wiper 248, RA239, and through the winding of R240 to battery. The resulting operation of R240 to move RA241 into engagement with RC243 insures that the selected one of the ringing current conductors will be included in the group terminating at the bank contact set 281 of the code selector switch 280. In this connection, it will be understood that, had the wipers of the mechanism 244 been operated into engagement with the sixth set of contacts of the selected level or to the second operating position corresponding to the called line 600, no circuit would have been available for energizing R240 and, hence, this relay would not have been energized following the operation of R230. With R240 deenergized, the ringing current conductor ultimately selected would necessarily be one of the conductors terminating at the contacts forming the set 282 of the switch 280 because, in such case, RA241 would remain in engagement with RC242, which contact is connected to the switch wiper 284.

At RA231 and RC233, the relay R230, upon operating, prepares an impulsing circuit extending to the operating magnet 228 of the switch 280. With the apparatus in this condition, the connector switch is conditioned to respond to the fourth and final digit dialed at the calling substation A. At the beginning of the first impulse of this digit, the above-noted circuit for energizing the operating magnet 228 is completed, this circuit extending from ground at RA201 by way of RC203, RA208, RC209, the off-normal springs 269 and 269', RA211, RC212, RA215, the winding of R220, RA231, RC233, and through the winding of the magnet 228 to battery. The resulting operation of the magnet 228 causes the switch 280 to be conditioned to step the wipers 283 and 284 to the first off-normal position or into engagement with the first contacts of their respective associated sets 281 and 282. When the relay R220 operates, it completes, at RA221, the above-noted path for short-circuiting the armature RA215 of the busy relay R214. At the end of the first impulse and when R200 restores to open the above-traced operating circuit for the magnet 228, the wipers 283 and 284 are stepped to the first off-normal position to select the two ringing conductors terminating at the respective first contacts of the sets 281 and 282. When this first step is taken by the wipers of the switch, the off-normal springs 285 are moved to the off-normal position. At the springs 286, a circuit, traced hereinafter, is prepared for energizing the release magnet 229 and, at the springs 287, a circuit is prepared for energizing the busy relay R214, this latter circuit being traced hereinafter and being held open at the operated armature RA226 of the relay R220. For each succeeding impulse of the fourth digit dialed at the calling substation, the magnet 228 operates to cause the associated wipers 283 and 284 to be stepped one step so that, at the conclusion of the digit, one of the wipers 283 and 284 will be standing in engagement with a contact terminating a ringing current conductor having impressed thereon coded ringing voltage of the particular code which corresponds to the called substation E. As pointed out above, in the particular case under consideration and with R240 operated, the coded ringing current must be conducted to the called line 600 by way of one of the ringing current conductors terminating at the contacts forming the set 281. If it be assumed that the coded signal identifying the substation E corresponds to the code of the ringing voltage applied to the fourth conductor terminating at the contact set 281, the final digit dialed at the calling substation will necessarily comprise four impulses so that, at the conclusion of the digit, the wipers 283 and 284 will be left standing in engagement with their respective associated fourth contacts.

Shortly following the conclusion of the fourth digit dialed at the substation A, the relay R220 restores to open, at RA221, a point in the path short-circuiting the armature RA215 of the busy relay R214 and to complete, at RA226, the above-mentioned circuit for energizing the busy relay. This circuit extends from ground at the lower one of the off-normal springs 287 by way of the upper spring of this set, RA226, and through the winding of R214 to battery. The relay R214, upon operating, opens, at RA215, a point in the circuit for energizing R220 and the magnet 228 in series, thereby to prevent any further operation of the impulsing device provided at the calling substation from effecting further operation of the ringing code selecting switch 280. At RA219, the busy relay prepares a point in the above-traced path for applying busy tone to the loop extending to the calling substation. This path is, however, now open at the operated armature RA238 of the relay R230. At RA219', the relay R214 prepares a circuit for energizing R250, which relay functions to complete a path for applying ringing voltage to the talking conductors of the line extending to the called substation E. The circuit for energizing R250 is completed when the ringing interrupter switch is operated to a position to start a new ringing cycle, at which time a ground pulse is applied to C315. Thus, if R214 operates just prior to the operation of the wipers of the interrupter switch into engagement with their respective associated first contacts, this circuit is completed when the wiper 375 is moved into engagement with its associated first contact and extends from ground at the wiper 375 by way of RA313, C315, RA219', RA237, RA255, RC256 and through the lower winding of R250 to battery. The relay R250 now partially operates to complete a closed circuit for short-circuiting its upper winding, this circuit extending from ground as applied to the control conductor C124 by way of RA254, the upper winding of R250, RC256, RA255, RA237 and RA219' back to ground on C315. When ground is subsequently removed from C315 through the movement of the wipers of the switch 300 out of engagement with their respective associated first contacts, the above-traced short-circuiting path is opened and the two windings of R250 are energized in series,

causing the relay R250 to complete its operation. Upon fully operating, R250 opens, at RA255 and RC256, a point in the above-traced circuit for energizing its lower winding and prepares, at RA255 and RA256', a circuit for energizing the lower winding of R260. At RA251 and RA252, a path is completed for projecting ringing current over the conductors of the called line 600. In the present assumed case, wherein the code identifying the called substation E corresponds to that of the voltage applied to the ringing current conductor 21, the path of this current extends from the upper terminal of the secondary winding 328 by way of RC333, RA332, the switch wiper 371 or the wiper 372, the conductor 21, the wiper 283, RC243, RA241, RA252, RC276, RA275, the wiper 246, the contact 246', the line conductor C601, the signal device at the called substation, C602, the contact 245', the wiper 245, RA251 and RA271 to the grounded terminal of the secondary winding 328 at RC273. It will be understood that portions of this current are by-passed through the signal devices provided at each of the other stations associated with the line 600. Due to the particular coding of the current, however, the subscriber at the substation E is informed that his substation is being called and the other subscribers are informed that the call is not intended for their respective substations. A portion of the ringing current is by-passed by way of the condenser 279, RA253 and through the repeater windings 294 and 293 in series to ground at RC273 to cause ring-back tone current to be impressed on the loop extending to the calling subscriber's substation, thereby to indicate to the calling party that the ringing operation is being performed.

The arrangement of the apparatus is such that ringing current is only applied to the called line for a predetermined number of ringing cycles. Thus, at the beginning of the second ringing cycle, when ground is again applied to C315 by the interrupter switch 300, the relay R260 is caused partially to operate through the energization of its lower winding over a circuit extending from ground on C315 by way of RA219', RA237, RA255, RC256', RA262, RC264, and through the lower winding of R260 to battery. With its lower winding energized over the above-traced circuit, the relay R260 partially operates to complete, at RA261, a closed circuit for short-circuiting its upper winding, this circuit extending from ground on the control conductor C124 by way of RA261, the upper winding of R260, RC264, RA262, RC256', RA255, RA237, and RA219' back to ground on C315. When ground is thereafter removed from C315 through the continued operation of the interrupter switch 300, the above-traced short-circuiting path is interrupted and the relay R260 fully operates to open, at RA262 and RC264, a point in the above-traced circuit for energizing its lower winding and to prepare, at RA262 and RC263, a circuit for energizing R270. This last-mentioned circuit is completed after the second ringing cycle is ended and at the beginning of the third ringing cycle when ground is again applied to the control conductor C315. In this case, the circuit for energizing R270 extends from ground on C315 by way of RA219', RA237, RA255, RC256', RA262, RC263, RA278', and through the winding of R270 to battery. When energized over the above-traced circuit, R270 operates to complete, at RA278, a holding circuit for itself, this circuit extending from ground as applied to C124 by way of RA278 and the winding of R270 to battery. At RA278', the relay R270 open-circuits the pick-up or control lead C315, thereby to permit the ground pulses impressed on this lead to be effective in controlling others of the connector switches in the group including the switch illustrated in Fig. 2. The relay R270 opens, at RA271 and RA275 and their respective associated contacts RC273 and RC276, two points in the above-traced path over which ringing current is projected out over the called line 600 and also two points in the path by way of which ring-back tone current is impressed on the loop extending to the calling subscriber's substation. At RA271 and RA275 and their respective associated contacts RC274 and RC277, the conductors of the trunk line incoming to the connector switch are connected through to the conductor C601 and C602 of the called line, thereby to complete the connection to the called line. More particularly, the talking circuit is completed when the call is answered at the substation E.

The release of a connection as established in the manner described above to the substation E is entirely under the control of the calling party. Thus, if the receiver at the called substation is restored to its hook before the connection is cleared out at the calling substation, the only result effected thereby is the disconnection of this receiver from across the conductors of the line 600. When, however, the calling party restores his receiver to its hook to open the loop circuit by way of which the line relay R200 is held operated, this relay restores to open, at RA201, the operating circuit for the hold relay R204. When R204 restores, ground is removed from the control conductor C124 to cause the restoration of the selector switch 120 and the line switch 100 in the manner pointed out above and to open the respective holding circuits for R230, R250, R260 and R270. Also, when the hold relay restores, the above-traced circuit for energizing the release magnet 239 is completed. The resulting operation of this magnet causes the wiper carriage structure of the switching mechanism 244 to be restored to normal in the manner pointed out above, at which time the off-normal springs 265 are returned to the normal position. When this occurs, the operating circuit for the start relay R310 embodied in the control apparatus for the interrupter switch 300 is opened and, assuming that none of the other special connector switches is operated, this interrupter switch is restored to normal in the manner pointed out above. When the hold relay R204 falls back, a circuit is also completed for energizing the release magnet 229 embodied in the code selector switch 280, this circuit extending from ground at RA201 by way of RC203, RA208, RC207, the off-normal springs 286 and through the winding of the magnet 229 to battery. The resulting operation of this magnet causes the wipers of the switch 280 to be returned to normal, at which time the off-normal springs 285 are restored to normal to open, at the springs 286, the operating circuit for the release magnet 229. When the springs 287 are opened, the operating circuit for R214 is interrupted, causing this relay to restore. Thus, the connector switch is entirely released and is in readiness for further use.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and

it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a ringing interrupter switch comprising, in combination, a plurality of bank contacts arranged in sets, wipers respectively associated with said contact sets, motor means for driving said wipers over the contacts of the respective associated sets, said wipers being adapted to be connected to a source of ringing current, a plurality of ringing current conductors terminating at said bank contacts, the number of said conductors being greater than the number of said contact sets, and jumper connections extending between certain of the contacts of different contact sets which terminate certain of said conductors, said jumper connections and said ringing current conductors being so connected and arranged that at least a portion of said wipers are operative to impress the voltage of said source on at least two of said ringing current conductors during each ringing cycle of said switch and the coded character of the voltage impressed on said conductors is different for each of said conductors.

2. In a telephone system, a ringing interrupter switch comprising, in combination, a plurality of bank contacts arranged in sets, wipers respectively associated with said contact sets, motor means for driving said wipers over the contacts of the respective associated sets, said wipers being adapted to be connected to a source of ringing current, a plurality of ringing current conductors terminating at said bank contacts, the number of said conductors being greater than twice the number of contact sets including contacts at which said conductors are terminated, and jumper connections extending between certain of the contacts of different contact sets which terminate certain of said conductors, said jumper connections and said ringing current conductors being so connected and arranged that at least a portion of said wipers are operative to impress the voltage of said source on at least two of said ringing current conductors during each ringing cycle of said switch and the coded character of the voltage impressed on said conductors is different for each of said conductors.

3. In a telephone system, a ringing interrupter switch comprising, in combination, a plurality of bank contacts arranged in sets, wipers respectively associated with said contact sets, motor means for driving said wipers over the contacts of the respective associated sets, said wipers being adapted to be connected to a source of ringing current, a plurality of ringing current conductors terminating at said bank contacts, the number of said conductors being greater than twice the number of contact sets including contacts at which said conductors are terminated, and jumper connections extending between certain of the contacts of different contact sets which terminate certain of said conductors, said jumper connections and said ringing current conductors being so connected and arranged that at least a portion of said wipers are operative to impress the voltage of said source on at least three of said ringing current conductors during each ringing cycle of said switch and the coded character of the voltage impressed on said conductors is different for each of said conductors.

4. In a telephone system, a ringing interrupter switch comprising, in combination, a plurality of bank contacts arranged in two sets, wipers respectively associated with said contact sets, motor means for driving said wipers over the contacts of the respective associated sets, a conductor connected to said wipers and adapted to be connected to a source of ringing current, at least three ringing current conductors terminating at said bank contacts, and jumper connections extending between certain of the contacts of one of said sets and certain of the contacts of the other of said sets, said jumper connections and said ringing current conductors being so connected and arranged that said first-named conductor is connected by way of one of said wipers to at least a pair of said ringing current conductors for short intervals during each ringing cycle of said switch and the coded character of the voltage impressed on said conductors is different for each of said conductors.

5. In a telephone system, a ringing interrupter switch comprising, in combination, a plurality of bank contacts arranged in two sets, wipers respectively associated with said contact sets, motor means for driving said wipers over the contacts of the respective associated sets, a conductor connected to said wipers and adapted to be connected to a source of ringing current, at least three ringing current conductors terminating at said bank contacts, and jumper connections extending between certain of the contacts of one of said sets and certain of the contacts of the other of said sets, said jumper connections being so connected and arranged that said first-named conductor is connected by way of one of said wipers to at least a pair of said ringing current conductors for short intervals during each ringing cycle of said switch, said first-named conductor is connected by way of the other of said wipers to at least two of said ringing current conductors including at least one of said pair of ringing current conductors for short intervals during each ringing cycle of said switch, and the intervals during which said first-named conductor is connected by way of said one of said wipers to any one of said conductors do not overlap the intervals during which said first-named conductor is connected by way of the other of said wipers to said one conductor.

6. In a telephone system, a ringing interrupter switch comprising, in combination, a plurality of bank contacts arranged in two sets, wipers respectively associated with said contact sets, motor means for driving said wipers over the contacts of the respective associated sets, a conductor connected to said wipers and adapted to be connected to a source of ringing current, at least three ringing current conductors terminating at said bank contacts, and jumper connections extending between certain of the contacts of one of said sets and certain of the contacts of the other of said sets, said jumper connections being so connected and arranged that said first-named conductor is connected by way of one of said wipers to at least three of said ringing current conductors for short intervals during each ringing cycle of said switch, and said first-named conductor is connected by way of the other of said wipers to at least three ringing current conductors including at least one of said last-named three ringing current conductors for short time intervals during each ringing cycle of said switch.

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