Oct. 14, 1941. S. E. PETERSON ET AL 2,258,660

TELEPHONE SYSTEM

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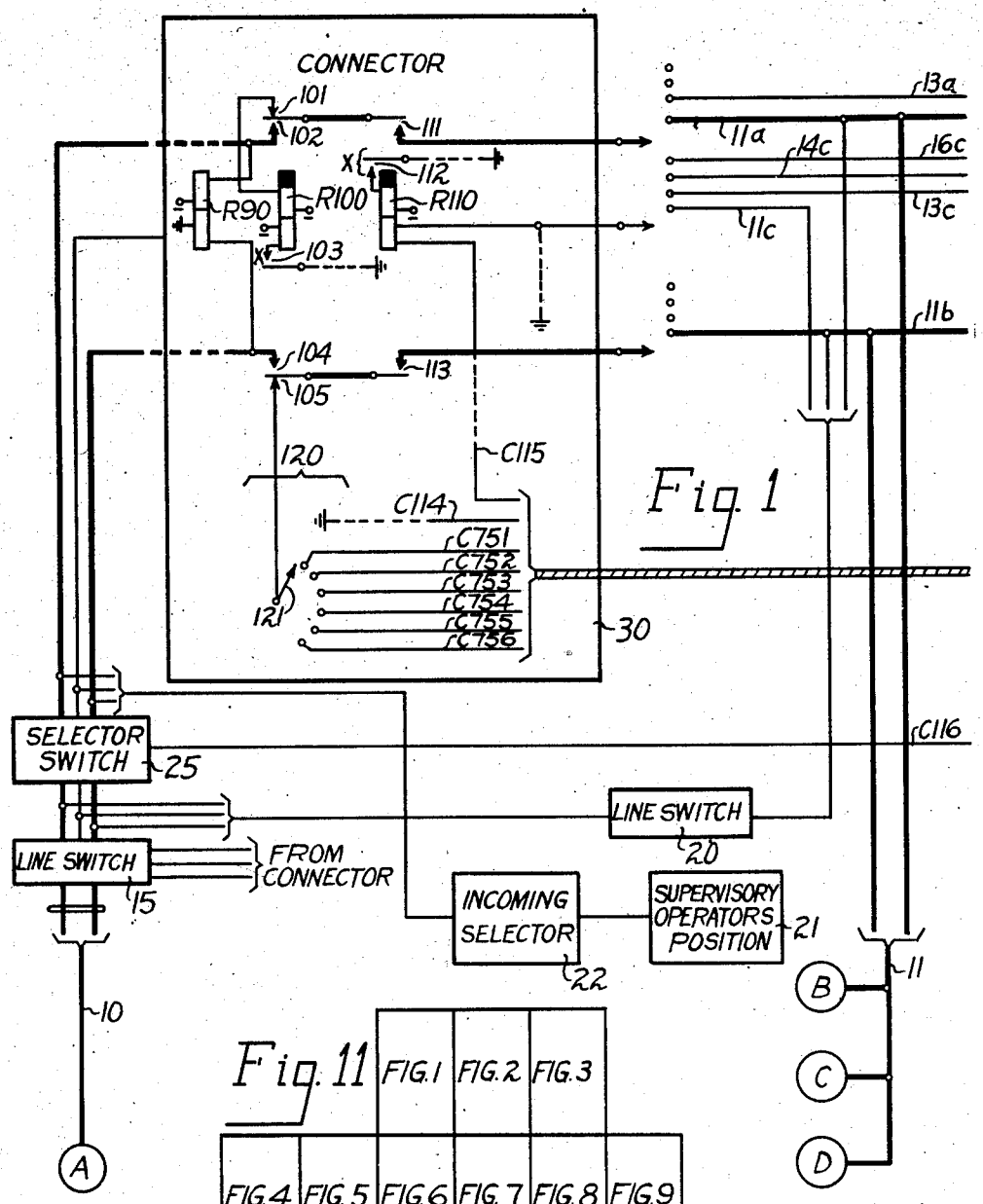

Fig. 1

Fig. 11

		FIG. 1	FIG. 2	FIG. 3	
FIG. 4	FIG. 5	FIG. 6	FIG. 7	FIG. 8	FIG. 9

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TELEPHONE SYSTEM

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Fig. 2

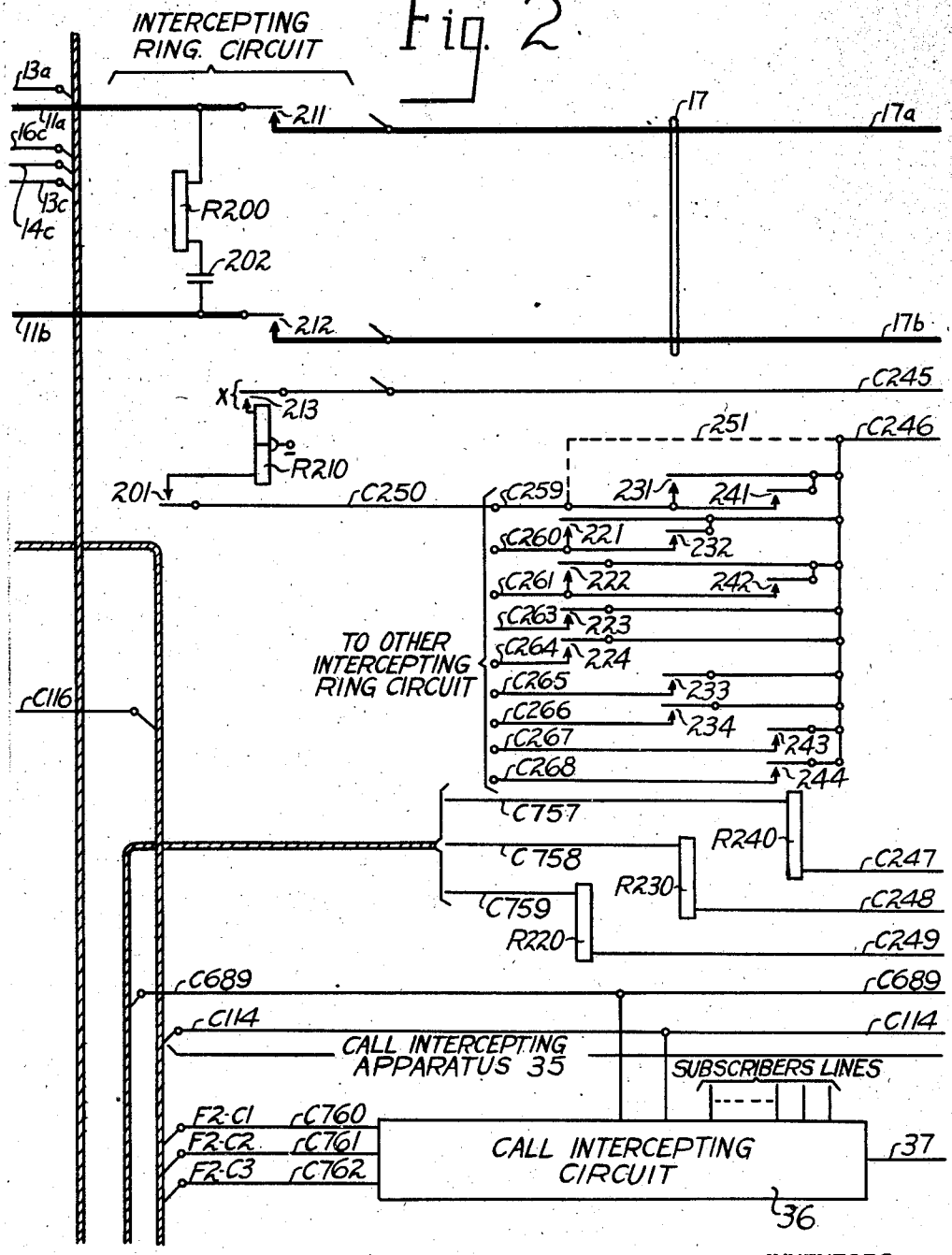

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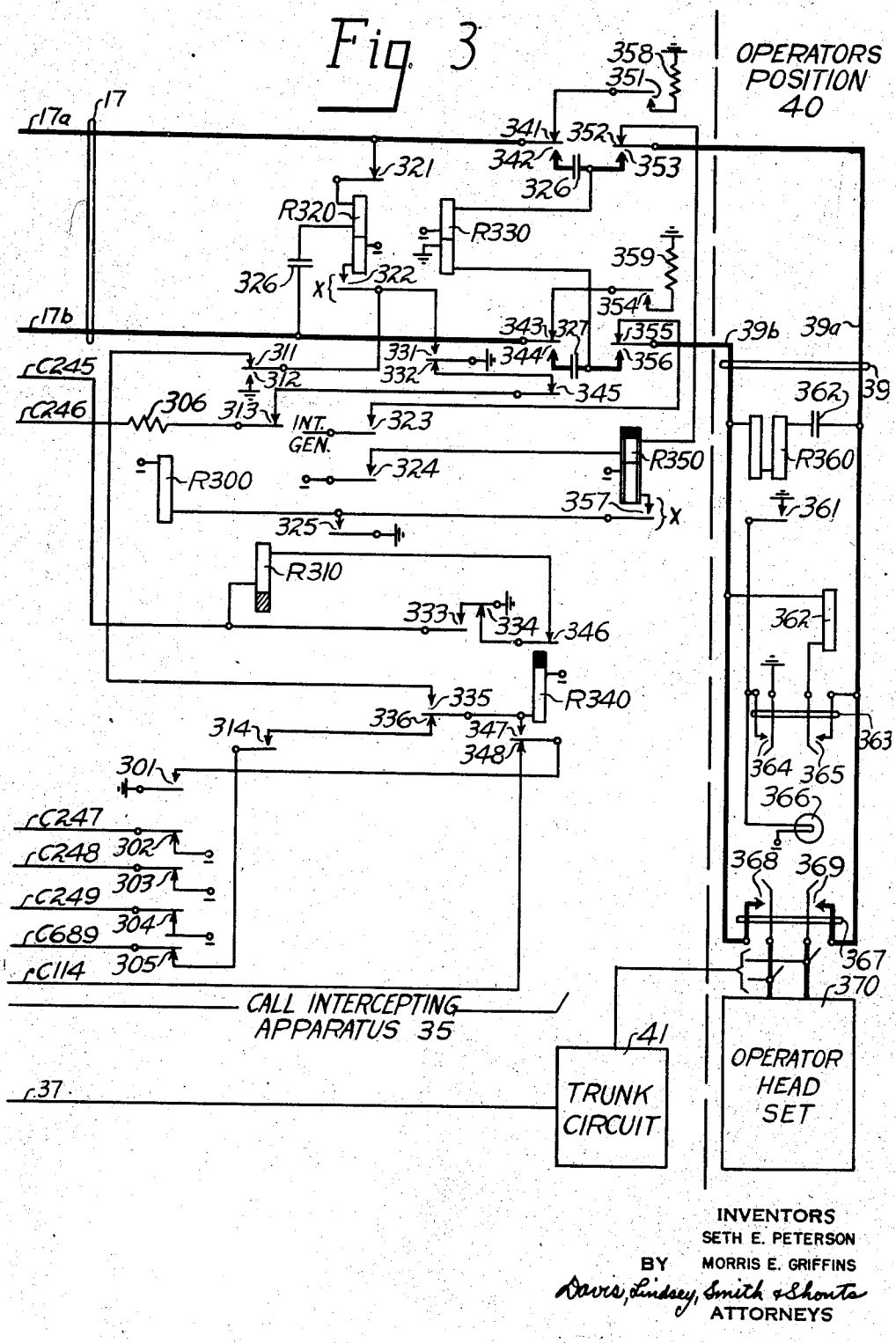
Fig. 3



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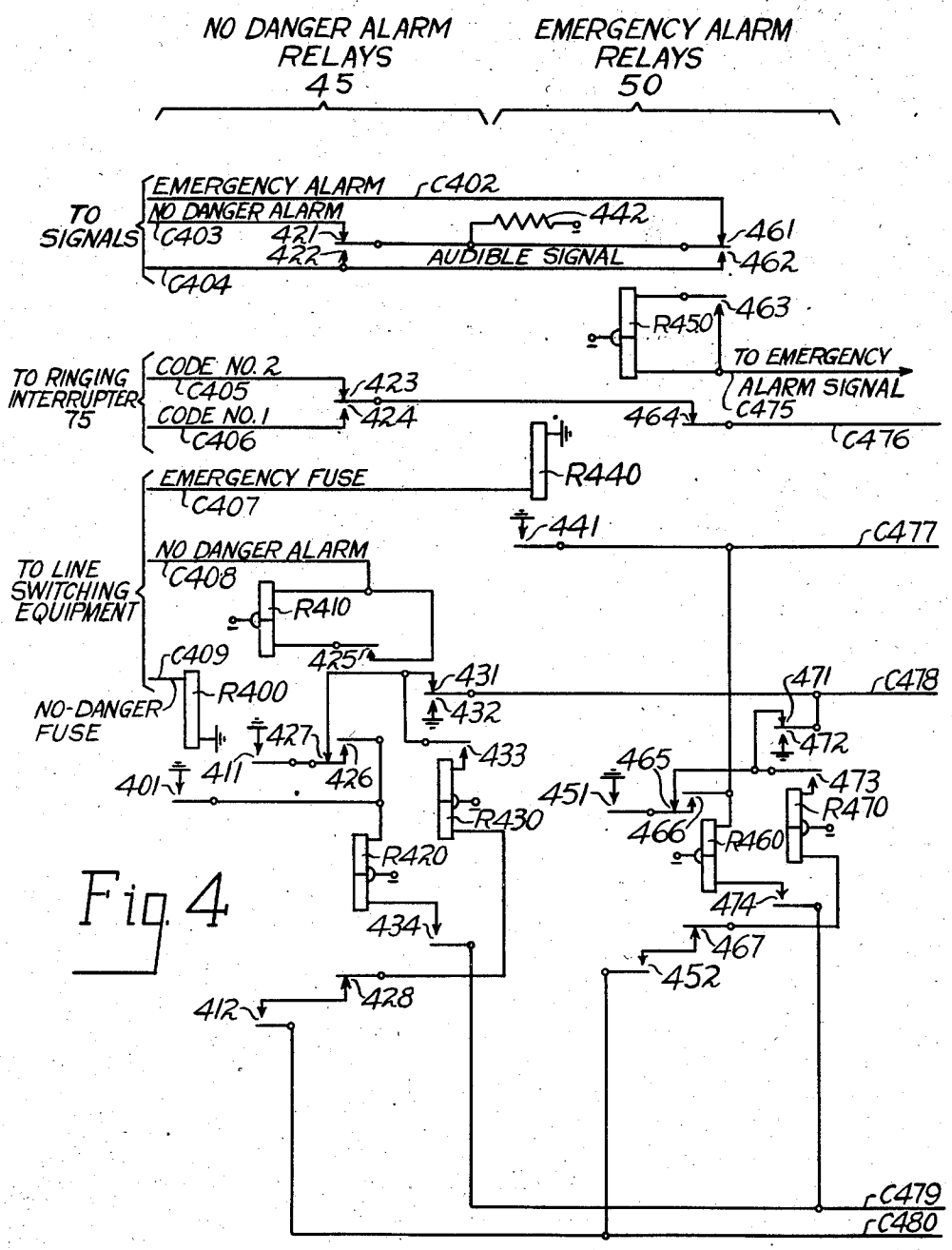

Fig. 4

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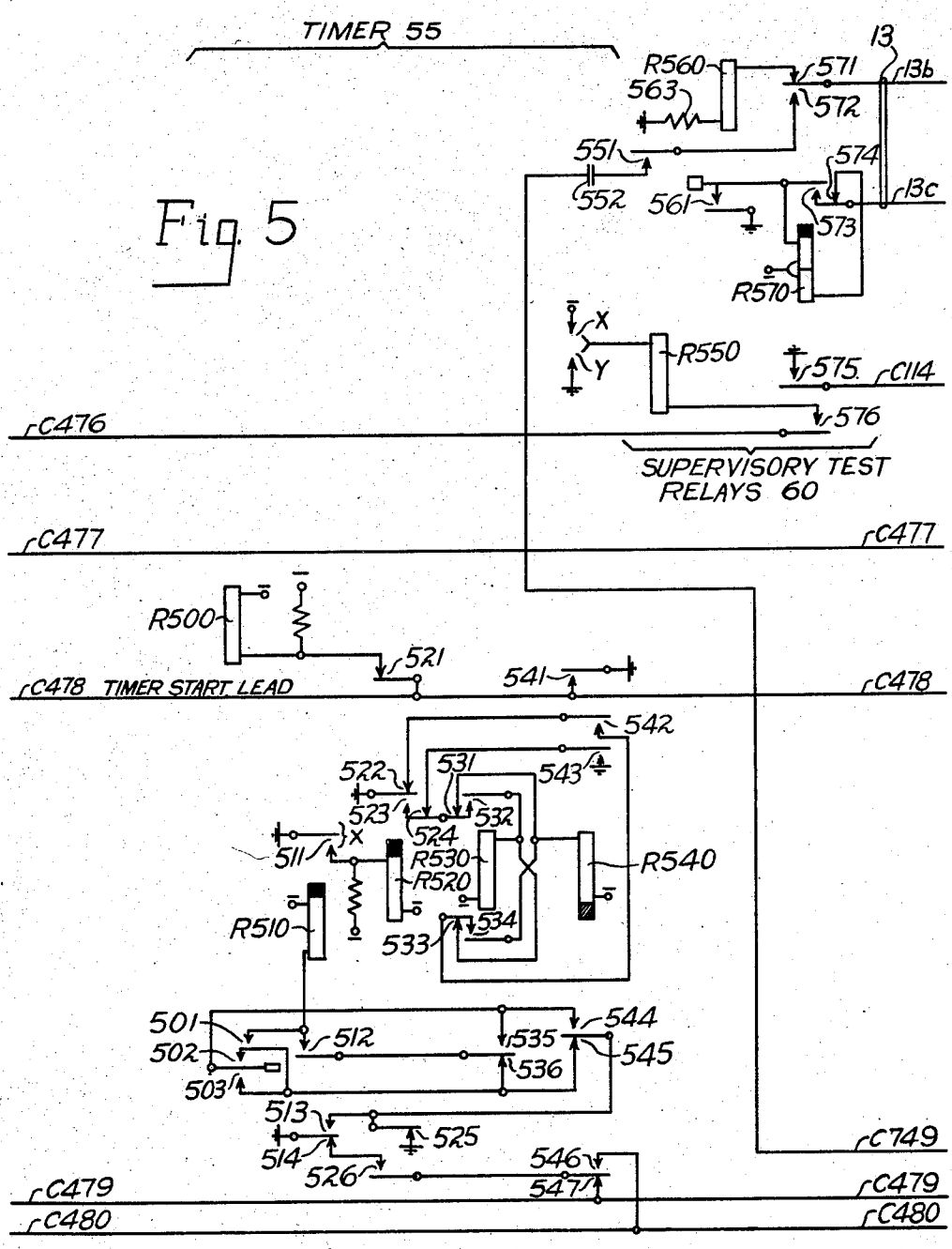
Fig. 5



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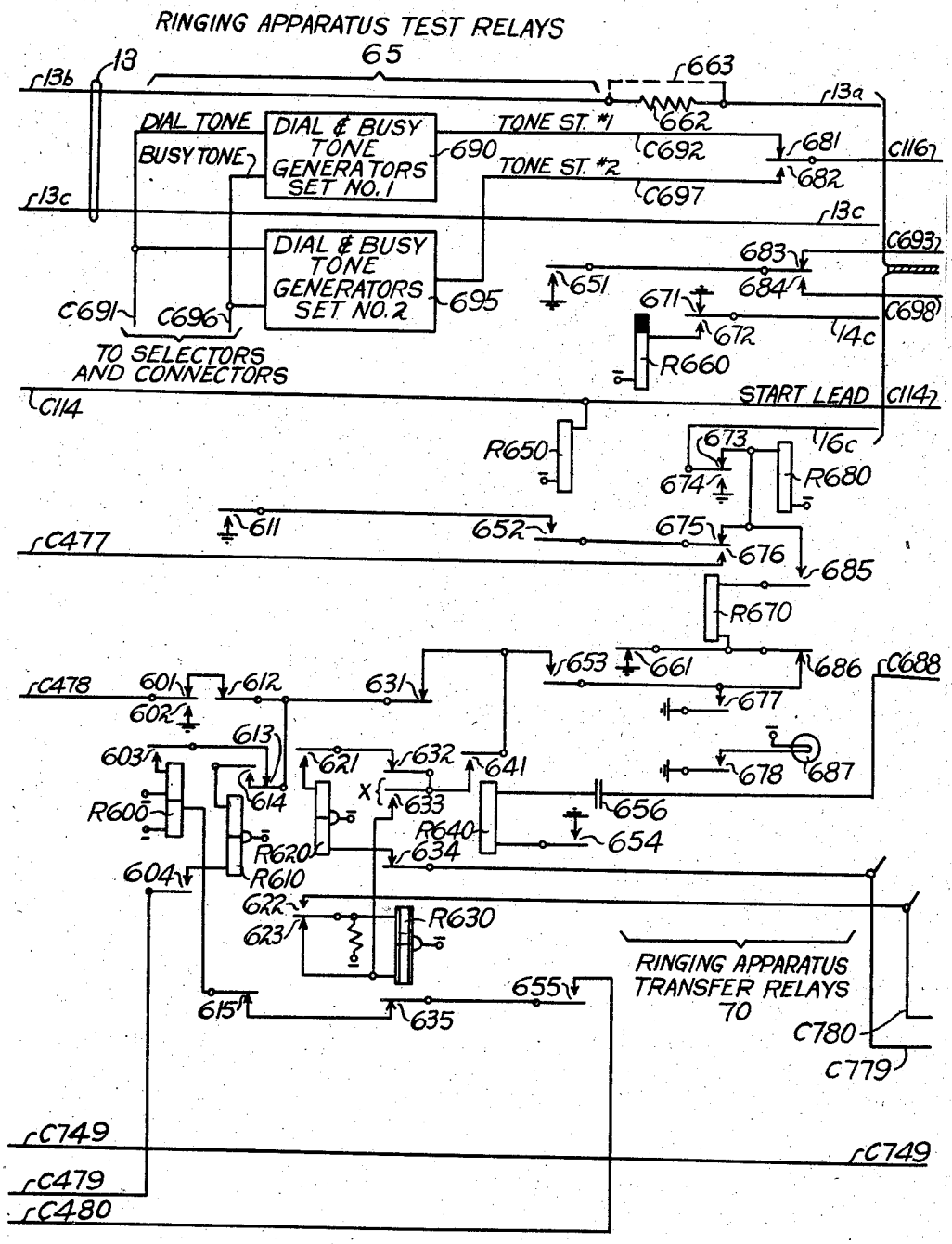

Fig. 6

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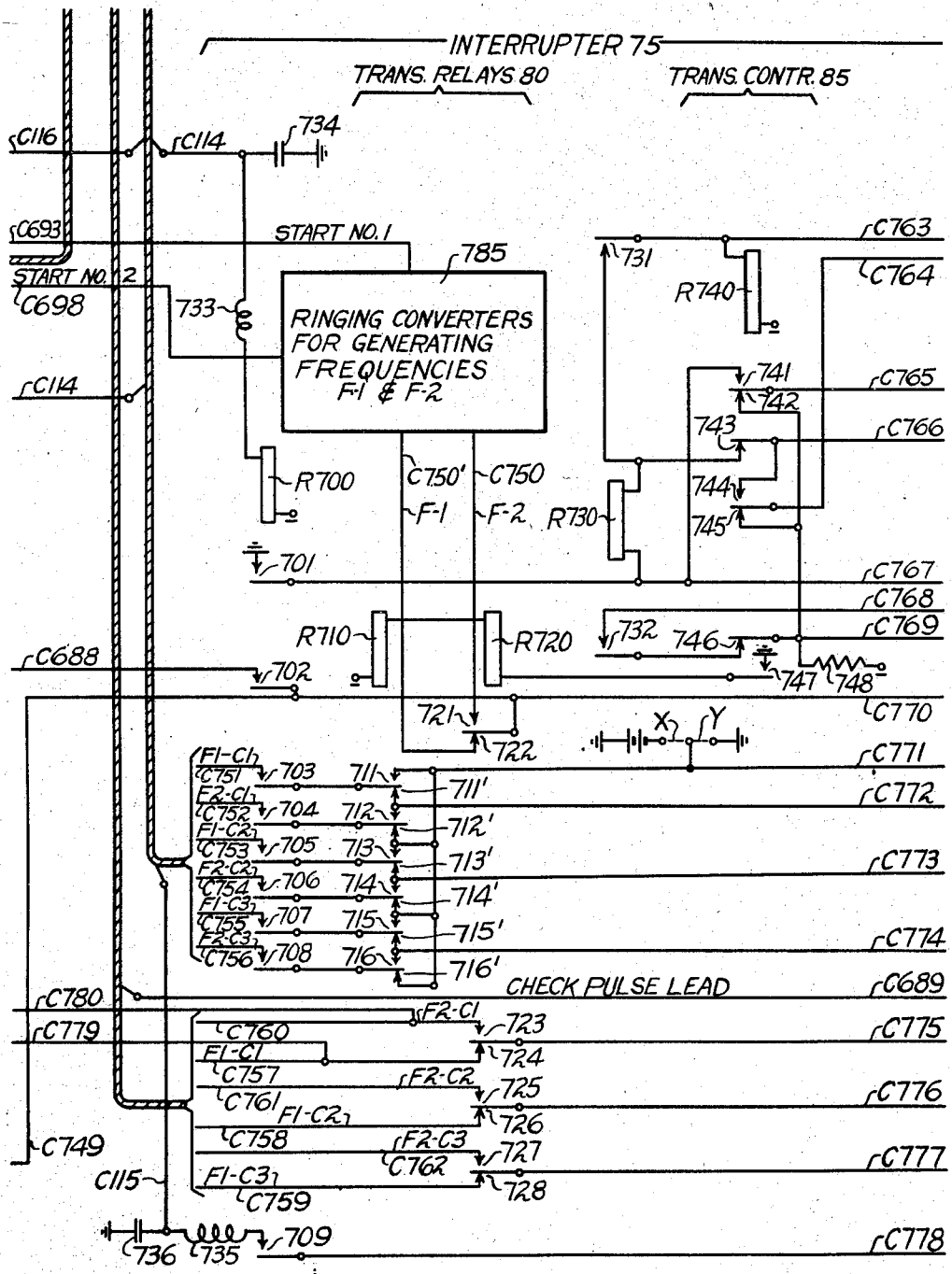

Fig. 7

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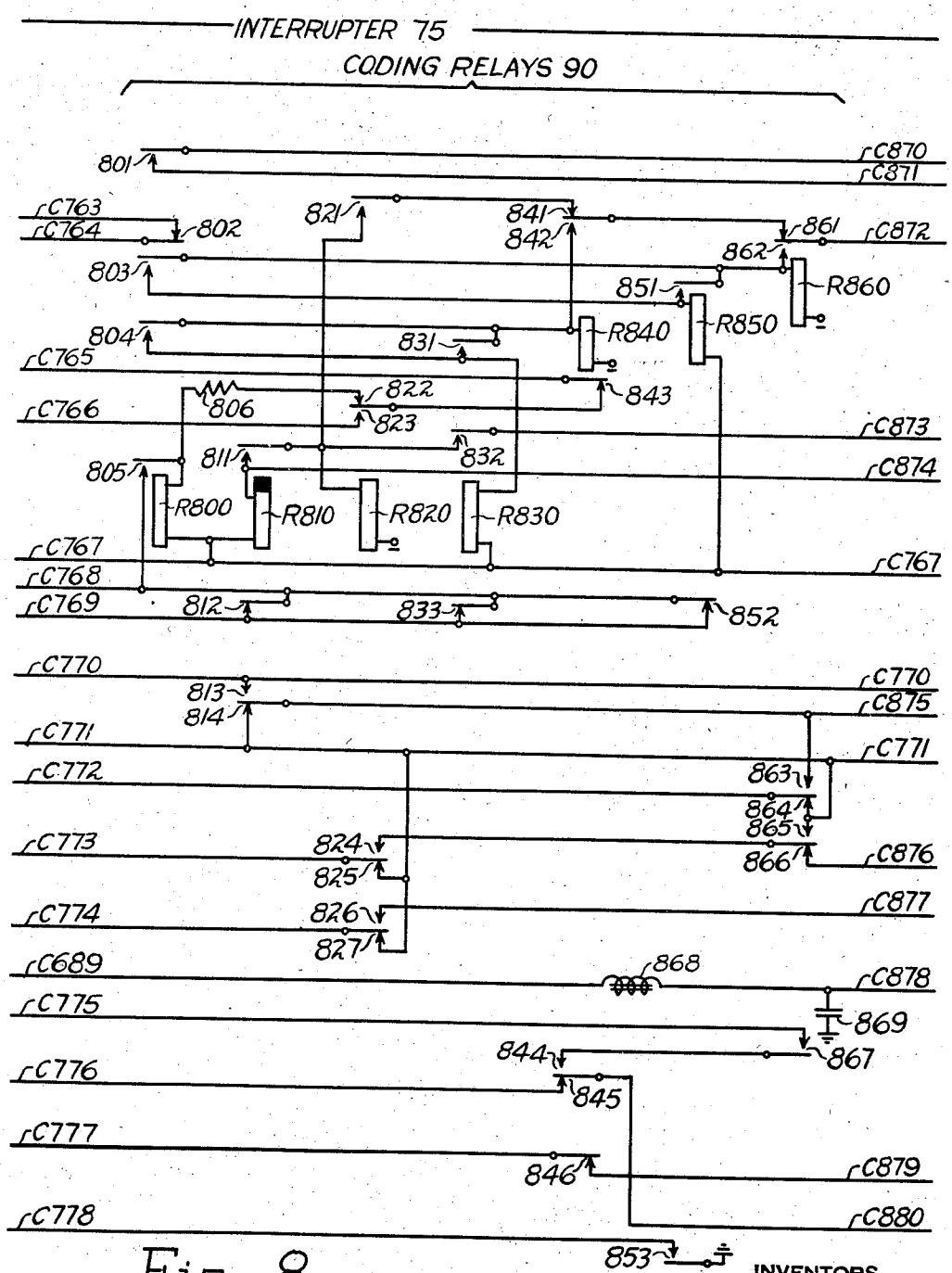

Fig. 8

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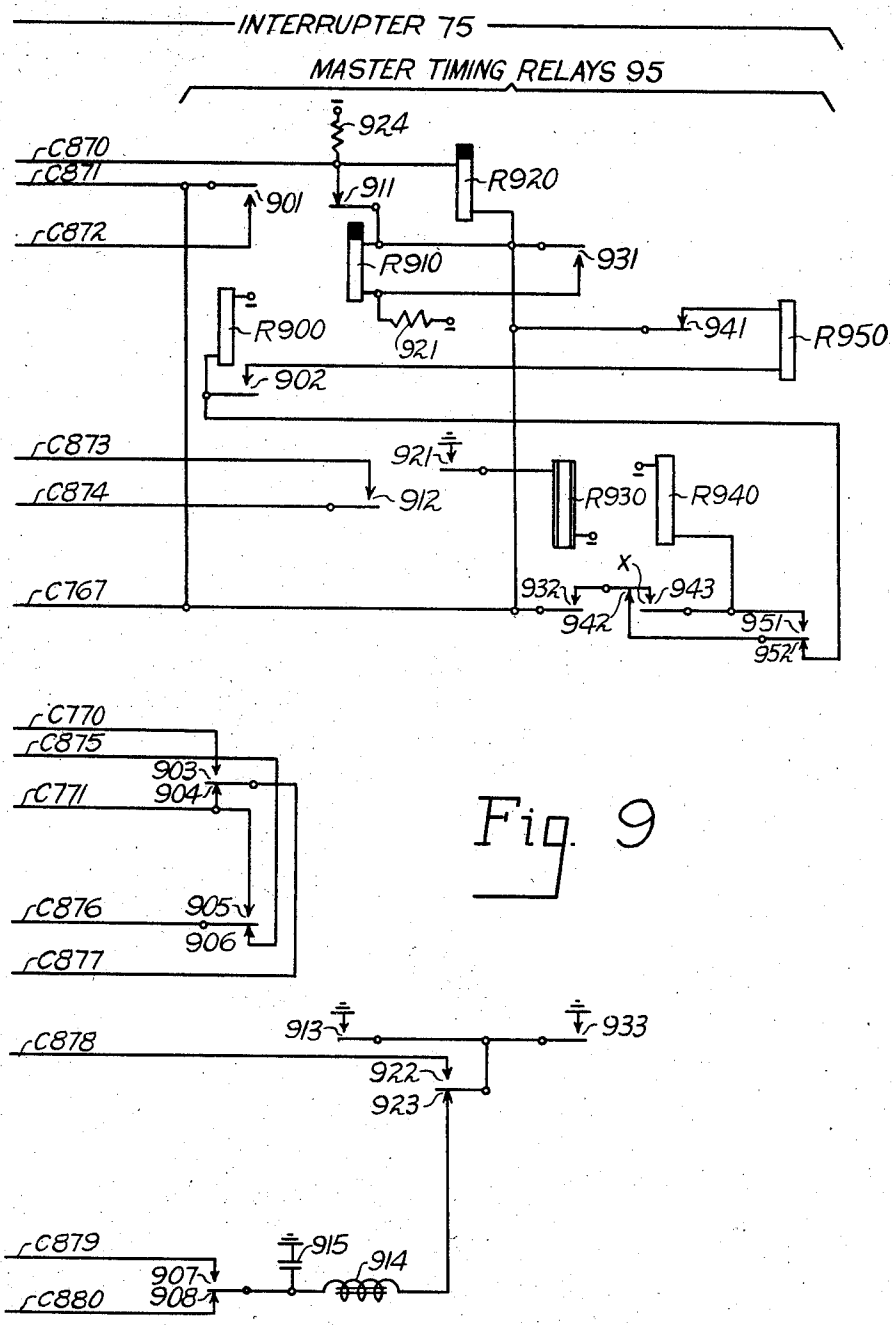

Fig. 9

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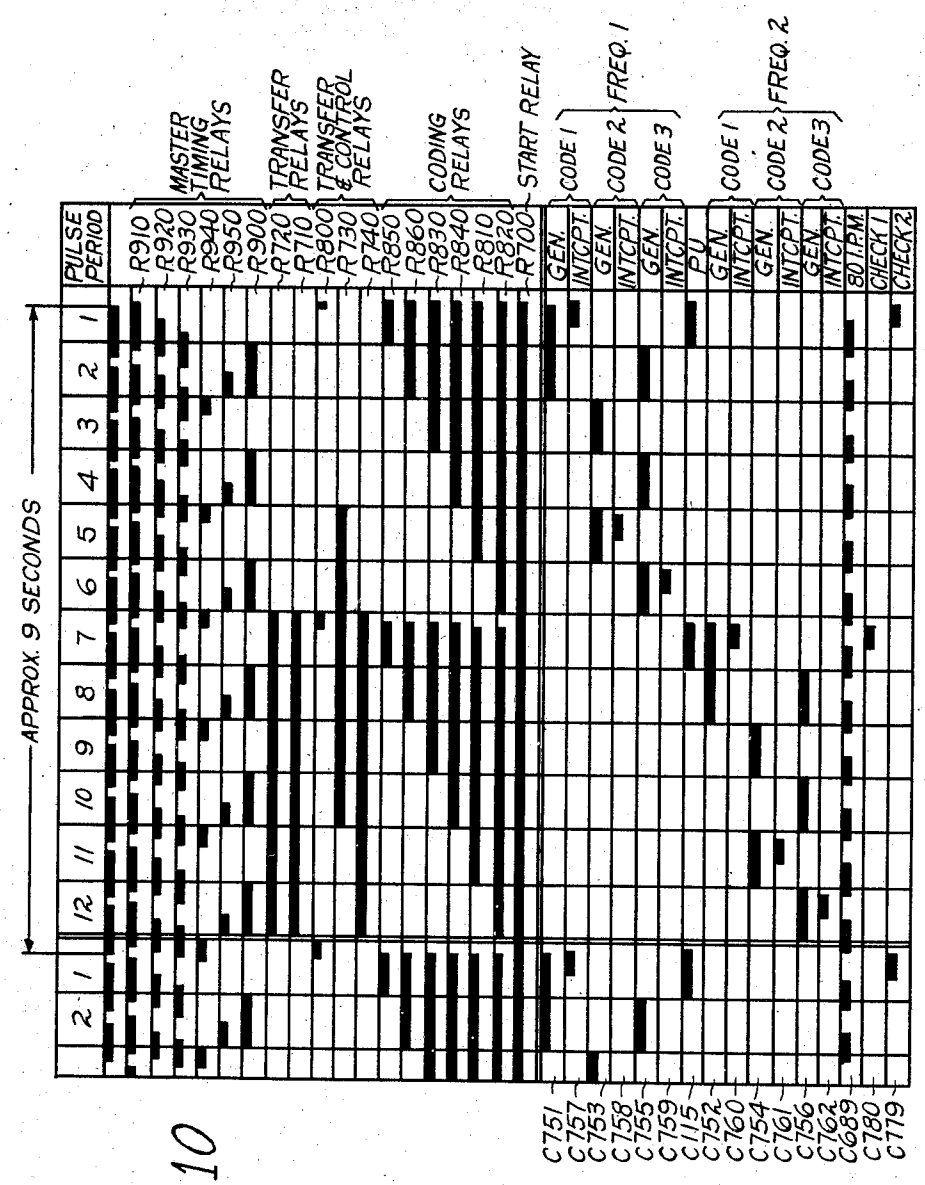

Fig. 10

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UNITED STATES PATENT OFFICE

2,258,660

TELEPHONE SYSTEM

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Application April 11, 1940, Serial No. 329,087

53 Claims. (Cl. 179—27)

The present invention relates to telephone systems, and more particularly to improvements in apparatus for providing call intercepting and supervisory services in conjunction with the use of the lines and automatic switching apparatus of an automatic telephone system.

As explained in Patent No. 1,267,113, Powell, granted May 21, 1918, in telephone systems of the automatic type, when one or more of the substations associated with a multiparty subscribers line is taken out of service or disconnected from the line, it is desirable to provide an arrangement whereby calls intended for the disconnected substation are routed to an operator's position so that the calling subscribers may be informed that the called substation is no longer in service. Call intercepting service of this character is also desirable in other instances when calls to substations actually in service are to be routed to an operator's position.

It is an object of the present invention to provide improved apparatus of the character described, which is of simple and economical arrangement and which functions in a positive and reliable manner to intercept calls to one or more predetermined substations or lines of the system and automatically to route the intercepted calls to an operator's position.

It is another object of the invention to provide improved apparatus of the character described, which is so arranged that the control of the call intercepting apparatus is effected through operation of a ringing interrupter which is common to all of the lines of the system.

It is a further object of the invention to provide improved apparatus of the character described, which is so arranged that the operation thereof to intercept a call intended for a predetermined line or substation must be completed within a predetermined time interval after operation of the apparatus is initiated, and if not completed within this time interval the apparatus is automatically released.

It is still another object of the invention to provide improved call intercepting apparatus of the character described, which is arranged to intercept calls intended for substation designated by ringing currents of different codes and different frequencies and wherein provisions are made for grouping the substations so that the substations arranged for call intercepting service and designated by ringing currents of the same frequency are served by apparatus controlled only by ringing currents of this frequency.

It is a further object of the invention to provide an improved ringing interrupter which is of simple and economical arrangement and which operates in a positive and reliable manner to provide differently coded ringing voltages of different frequencies for use in the selective signaling of called substations associated with the multiparty lines of a telephone system.

It is another object of the invention to provide an improved interrupter switch of the character described, which includes provisons for developing call intercepting impulses individual to the various coded ringing voltages of different frequencies in a predetermined timed relationship with these voltages, and which further includes apparatus for developing check pulses in timed relationship with the intercepting pulses for the purpose of controlling an associated call intercepting circuit to prevent the false operation and lockup of the circuit.

It is still another object of the invention to provide in an automatic telephone system including directively controlled switches for setting up connections between the lines of the system and apparatus for providing supervision of the switching equipment, an improved arrangement whereby on supervisory test calls the backbridge relays of the connector switches in use are prevented from operating.

The invention is illustrated in its embodiment in an automatic telephone system which comprises a plurality of subscribers lines, several of which are of the multiparty type, together with automatic switching equipment for setting up connections between the lines. The system further comprises improved ringing apparatus of the coded ringing type for selectively signaling the substations associated with the multiparty lines of the system. More particularly, this apparatus includes two sources of ringing current of different frequencies and a ringing interrupter switch which functions to interrupt the voltages of the two sources to provide differently coded ringing voltages of the two frequencies. This ringing interrupter includes a plurality of ringing leads, a plurality of call intercepting leads, a check pulse lead, and cyclically operative coding relays for impressing the differently coded ringing voltages upon the ringing leads during each cycle of operation thereof, and for impressing a predetermined potential upon the intercepting leads during predetermined intervals which individually correspond to the different codes. The ringing interrupter further includes a circuit arrangement whereby check pulses are impressed upon the check pulse lead during the

spacing intervals between the intercepting pulses applied to the intercepting leads. More specifically, the arrangement of the cyclically operative coding relays is such that during alternate cycles of operation thereof, ringing voltage of one frequency is coded and applied to the corresponding ringing leads, and during the intervening cycles of operation thereof ringing voltage of the other frequency is coded and applied to the remaining ringing leads.

The arrangement of the system is such that the ringing voltages, intercepting pulses and check pulses developed through operation of the ringing interrupter, are utilized to control a pair of call intercepting circuits which respectively respond to ringing voltages of the two different frequencies to intercept predetermined calls routed to certain of the lines or substations of the system. The operation of each of these two circuits is under the joint control of the ringing voltages applied to the associated lines arranged for call intercepting service and the application of the intercepting pulses to the intercepting leads, the arrangement being such that the application of an intercepting pulse to a predetermined one of the leads must partially overlap the application of ringing voltage to one of the lines arranged for intercepting service before operation of the intercepting circuit is initiated. After operation of an intercepting circuit is initiated, the circuit must complete its operation to intercept the call before a check pulse is impressed upon the check pulse lead. Otherwise, certain of the relays embodied in the intercepting circuit function to release the circuit. By virtue of this arrangement, the intercepting circuits are prevented from being inadvertently locked up due to faulty relay operation or transient voltages impressed upon the lines arranged for intercepting service.

Further features of the invention relate to the particular arrangement of the circuit elements whereby the above and additional operating features of the system are attained.

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 to 9, inclusive, taken together, illustrate an automatic telephone system having embodied therein the features of the invention briefly outlined above; Fig. 10 graphically illustrates the mode of operation of the ringing interrupter forming a part of the system illustrated; and Fig. 11 illustrates the manner of combining Figs. 1 to 9, inclusive, to obtain a unified system.

Referring to the drawings, the system there illustrated comprises an exchange at which are terminated a plurality of single party subscribers lines, one of which is indicated at 10 as extending to the substation A, and a plurality of multiparty subscribers lines, one of which is indicated at 11 as serving the substations B, C and D. For the purpose of setting up connections between the lines of the system automatic switching equipment is provided which includes line switches, a plurality of line switches, two of which are indicated at 15 and 20 respectively, a plurality of selector switches including the switch 25, and a plurality of connector switches including the switch 30. The system further comprises a supervisory operator's position 21 which may be provided in the exchange serving the above described single party and multiparty subscribers lines or in a distant exchange, as desired. This operator's position terminates one end of a trunk which extends to an incoming selector switch 22 having access to the various connector switches of the system. The line switches 15 and 20 and the other similar switches of the system are non-numerical switches in the sense that they are ineffective to perform any line selecting function other than those of selecting idle ones of the selector switches. The selector and connector switches on the other hand, are commonly known as numerical switches in that they are directively controllable from the telephone stations of the system to perform particular line selecting functions. It will be understood that a plurality of switches of each type are provided in the system for performing the various line switching operations. Preferably, each of the line switches 15, 20, etc., is 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 wiper carriage structure adapted to be translated vertically to bring the wipers thereof to a position opposite to 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; and control relays suitably connected and arranged to control the energization of the various magnets and the line switching in accordance with the particular function assigned to the switch. 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.

In order more clearly to explain the operation of certain of the circuits to which the present invention pertains, a portion of the relay equipment embodied in the connector switch 30 has been shown in detail. More particularly, this equipment comprises a slow-to-operate ringing control relay R110, a slow-acting ring cut-off relay R100, a back-bridge or battery reversing relay R90, and a ringing code selecting switch 120. The switch 120 includes a wiper 121 arranged to traverse a set of associated contacts terminating ringing leads having differently coded ringing voltages impressed thereon.

In order to develop the differently coded ringing voltages which are utilized in selectively signaling the subscribers served by the multiparty subscribers lines, there is provided ringing apparatus which includes two sets of ringing converters diagrammatically illustrated at 785 and an improved ringing interrupter 75. Each set of ringing generators comprises a pair of converters, preferably of the well known thump-start vibrating type, for developing ringing voltages having the frequencies F—1 and F—2, respectively. In general, the arrangement of the ringing interrupter 75 is such that three differently coded ringing voltages of each frequency F—1 and F—2 are provided. Briefly described, this interrupter comprises a group of ringing leads, C751 to C756, inclusive, which are labeled according to the frequency and code of the ringing voltages applied thereto; a check pulse lead C389; a group of call intercepting leads C757 to C762, inclusive, which are also labeled according to the frequencies and codes to which they respectively correspond; a group of miscellaneous

supervisory leads including the leads C688, C749, C779 and C780; a pick-up pulse lead C115; and a plurality of control relays for selectively controlling the application of different voltages and potentials to the various enumerated leads. More specifically, the relay equipment of the interrupter 15 comprises a group of coding relays 90, a group of master timing relays 95, and a start relay R700. The coding relays are, when the start relay R700 is energized, operative in a cyclic manner under the control of the cyclic operation of the master timing relays 95, and function during alternate cycles of operation thereof, to impress ringing voltage of the frequency F—1 upon the three leads C751, C753 and C755. At the end of these alternate cycles of operation of the coding relays 90, the ringing circuits are rearranged through operation of a set of transfer relays 80 and a set of transfer control relays 85, so that during the intervening cycles of operation of the coding relays ringing voltage of the frequency F—2 is impressed upon the ringing leads C752, C754 and C756. The transfer and transfer control relays also function to control the intercepting pulse circuits so that intercepting pulses are impressed upon the F—1 intercepting leads C757, C758 and C759 during alternate cycles of operation of the coding relays, and upon the F—2 intercepting leads C760, C761 and C762 during the intervening cycles of operation of these relays.

For the purpose of intercepting calls intended for predetermined lines or substations of the system, there are provided two call intercepting circuits, 35 and 36, which are of identical arrangement and are associated with the lines arranged for intercepting service. These circuits function to route intercepted calls to an intercepting operator's position 40 over the trunks 39 and 37, respectively. Briefly described, the call intercepting circuit 35 comprises a plurality of line connect relays, of which one relay, R210, is shown, which are individually associated with the lines arranged for call intercepting service. The circuit further comprises a plurality of code relays, R220, R230 and R240 which are common to the associated lines and in conjunction with the alternating current ring-up relays, of which one relay, R200, is shown, function selectively to control the energization of the line connect relays. The common relay equipment of the call intercepting circuit 35 also includes a secondary ring-up relay R320, a slow-acting ring cut-off relay R350, a back-bridge relay R330, a pair of control relays R300 and R310, and a slow-to-operate check pulse controlled relay R340. In the arrangement illustrated, the code relays R220, R230 and R240, are individually controlled over the leads C759, C758 and C757 by intercepting pulses corresponding to the coded ringing voltages having the frequency F—1 and the codes 1, 2 and 3, respectively. Accordingly, the circuit 35 is only utilized in intercepting calls to substations designated by ringing voltages having the frequency F—1. The call intercepting circuit 36, on the other hand, is arranged to intercept calls to predetermined substations designated by coded ringing voltages having the frequency F—2, the code relays of this circuit being individually controlled over the three F—2 intercepting leads, C760, C761 and C762. By segregating the control of the intercepting circuits according to frequency in this manner, a more simplified arrangement is obtained which is considerably more reliable in operation.

The trunk circuit 41 terminating the trunk 37 is identical with the apparatus provided at the operator's position 40 to terminate the trunk 39 and is of substantially conventional arrangement. Briefly described, this apparatus comprises an answer key 367 for connecting the operator's telephone set 370 to the trunk 39, a hold key 363, an incoming call signal lamp 366, and a ring-up relay R360 which is bridged across the conductors of the trunk 30 to respond to ringing current transmitted over this trunk and is arranged to control the energization of the signal lamp 366. An impedance element 362 is also provided which functions as a holding bridge across the conductors of the trunk 39 under the control of the hold key 363.

The common equipment provided in conjunction with the automatic switching equipment described above, also includes test and supervisory apparatus for indicating the condition of the power and switching equipment and for enabling a spervisory operator, such, for example, as an operator attending the position 21, to obtain an indication of the condition of this equipment. In general, this supervisory and test apparatus is arranged to provide two classes of signals indicative of faults present in the power and switching equipment of the exchange. These signals have arbitrarily been designated as no-danger alarm signals and emergency alarm signals, a signal of the first type indicating that a fault is present in certain of the apparatus of the exchange which should be corrected but does not require immediate attention, and signals of the second type indicating that a fault is present in the apparatus of the exchange which is extremely serious and a hazard to continued operation of the system. The no-danger alarm signals are under the control of a group of relays 45 which include a no-danger fuse alarm relay R400 and three control relays, R410, R420 and R430. Similarly, the emergency alarm signals are controlled through the provision of a second group of relays 50, which includes an emergency fuse alarm relay R440 and three control relays R450, R460 and R470. Access to the various alarm circuits controlled by the relays just described is obtained through the automatic switching equipment of the exchange, a group of supervisory test relays 60 being accessible to the connector switches of the system over the supervisory trunk 13. This group of supervisory test relays comprises a coding or pulsing relay R550, a pendulum type start relay R560, and a slow-to-operate relay R570 which is provided for the purpose of controlling the pulsing relay R550.

In order to control the condition of the various alarm circuits in accordance with the condition of the ringing apparatus briefly described above, there is provided a group of ringing apparatus test relays 65, which operate through a test cycle each time operation of the associated ringing apparatus is started, and function to set the emergency alarm relays 50 to indicate an emergency alarm condition in any case when the associated ringing equipment becomes faulty. Briefly described, this group of relays comprises an alternating current start relay R640, a pair of check pulse controlled relays R620 and R630, a timer control relay R600, and an alarm circuit control relay R610. In this regard it is pointed out that the alarm relays forming the two groups 40 and 50 are arranged to be controlled by a timer 55 which is of the all-relay type and com-

prises five relays R500, R510, R520, R530 and R540.

As indicated previously, the power and supervisory equipment includes duplicate sets of ringing generators and supervisory tone sources. Thus, the ringing converter equipment 785 was described as including two sets of converters for developing ringing voltages having the frequencies F-1 and F-2, respectively. Similarly, duplicate sets of dial and busy tone generators, respectively indicated at 690 and 695, are provided for developing the dial and busy tone currents. Provisions are made in the common equipment whereby the two sets of tone current sources and the two sets of ringing generators may selectively be conditioned for operation from the supervisory operator's position 21, for example, by the simple expedient of dialing different test numbers respectively designating the two sets of equipment. To this end there is provided a group of transfer relays 70, which comprises a transfer relay R680 and a pair of transfer control relays R670 and R660, the last of which is the slow-to-operate type. These relays not only enable a supervisory operator to condition either set of equipment for operation, but in addition rearrange the control circuits for the ringing apparatus test relays 65 so that these relays will operate to perform their assigned test functions regardless of the set of ringing and tone equipment which is conditioned for use.

Operation of the ringing interrupter 75

In order to facilitate the explanation of the operation of the system as a whole the operation of the ringing interrupter 75 will first be considered. Operation of this apparatus is initiated in response to the appalication of ground potential to the start conductor C114, thereby to energize the start relay R700. It will be understood that this start lead is connected to ground in response to seizure of any one of the final numerical switches of the system. When this lead is connected to ground a circuit extending by way of the choke coil 733 is completed for energizing the start relay R700. This relay in operating connects the F-1 ringing leads, C751, C753 and C755 to the ringing conductors C772, C773 and C774, respectively; and the F-2 ringing leads C752, C754 and C756 to the common ring cut-off conductor C771. Thus, the F-1 ringing lead C751 is connected through the contacts 703 and 711' to the ringing conductor C772 when the start relay R700 operates. Similarly, the second F-1 ringing lead C753 is connected through the contacts 705 and 713' to the second ringing conductor C773; and the third F-1 ringing lead C755 is connected through the contacts 707 and 715' to the third ringing conductor C774. The F-2 ring leads, C752, C754 and C756 are connected to the ring cut-off conductor C771 over obvious paths. This ring cut-off conductor may be connected directly to ground or to the negative terminal on the exchange battery in accordance with the type of switching apparatus utilized in the system. If the final selector switches of the system are arranged for ground imposed ringing, the Y wiring illustrated in Fig. 7 of the drawings will be utilized, whereby the ring cut-off conductor C771 is connected directly to ground. On the other hand, if the final selector switches of the system are arranged for battery imposed ringing, the X wiring shown in Fig. 7 of the drawings will be used whereby the ring cut-off conductor C771 is connected to ground through the exchange battery.

The relay R700, upon operafing also completes at its contact 702, a circuit for energizing the start relay R640, thereby to initiate a cycle of operation of the ringing apparatus test relay group 65 in the manner subsequently explained. At its contacts 709, the relay R700 prepares a circuit for transmitting pick-up pulses over the pick-up lead C115 to the ringing relays conventionally embodied in the final selector switches of the system. At its contact 701, the relay R700 completes an obvious path for grounding the release conductor C767, thereby to energize the relays R800 and R910. The circuit for energizing the relay R800 extends from ground by way of the contacts 701, C767, the winding of R800, the resistor 806, the contacts 822 and 843, C765, the contacts 742 and the resistor 748, to battery. The circuit for energizing the slow-to-operate relay R910 extends by way of the grounded conductor C767, the winding of R910 and the resistor 925, to battery. The relay R910 in operating opens at its contacts 911 the path normally short-circuiting the slow-to-operate relay R920. At its contacts 912, the relay R910 prepares an operating circuit for the relays R810 and R820.

The relay R800 in operating completes at its contacts 805 a holding circuit for itself, this holding circuit extending by way of the grounded conductor C767, the winding of R800, the contacts 805, C768, the contacts 812, 833 and 852 in parallel, C769, and the resistor 748 to battery. At its contacts 801 the relay R800 completes one of the multiple paths for short-circuiting the relay R920 thereby to prevent the latter relay from operating in response to operation of the relay R910. More specifically, this path extends from the upper winding terminal of the relay R920 by way of C870, the contacts 801, and C871, to the lower winding terminal of the indicated relay. At its contacts 802 the relay R800 opens a point in one of the circuits for energizing the relay R740 and a point in one of the paths for short-circuiting the relay R730. At its contacts 803 the relay R800 completes a circuit for energizing the two relays R850 and R860 in series, this circuit extending by way of the grounded conductor C767, the winding of R850, the contacts 803 and the winding of R860 to battery.

At its contacts 804 the relay R800 completes a circuit for energizing the two relays R830 and R840 in series, this circuit extending by way of the grounded conductor C767, the winding of R830, the contacts 804, and the winding of R840 to battery. Thus, the relays R830, R840, R850 and R860 are all caused to operate in response to operation of the start relay R700. The relay R830 in operating, completes at its contacts 831, an obvious holding circuit for itself and the relay R840. At its contacts 832, the relay R830 completes the prepared series operating circuit for the relays R810 and R820, this circuit extending by way of the grounded conductor C767, the winding of R810, C874, the contacts 912, C873, the contacts 832, and the winding of R820 to battery. At its contacts 833, the relay R830 opens one of the above-traced parallel holding circuits for the relay R800. The relay R850 in operating, completes at its contacts 851, an obvious holding circuit for itself and the relay R860. At its contacts 852, the relay R850 opens a second of the multiple holding circuits for the relay R800.

The ringing relay R860, upon operating, opens at its contacts 861 a point in the common portion

of the paths, traced hereinafter, for short-circuiting the relays R810 and R830. At its contacts 862, the relay R860 prepares a path for short-circuiting its associated control relay R850. At the remaining contacts controlled by the ringing relay R860, certain additional circuit control operations are performed, which are described with particularity hereinafter. The ringing relay R840, upon operating, opens at its contacts 841, a further point in the path for short-circuiting the relay R810 and prepares, at its contacts 842, the path for short-circuiting the control relay R830. At its contacts 843, the relay R840 opens a point in the above traced operating circuit for the relay R800. At the remaining contacts controlled by the relay R840, additional circuit control operations are performed which are described in detail hereinafter.

The relay R820, upon operating, further prepares, at its contacts 821, the above-mentioned path for short-circuiting the relay R810 and opens, at its contacts 822, a further point in the operating circuit for the relay R800. At its contacts 823, the relay R820 prepares a circuit for energizing the relay R730. At its remaining contacts the relay R820 performs additional circuit control operations described hereinafter.

Shortly following the operation of the relay R820, the slow-to-operate relay R810 operates to complete a locking circuit for itself and the relay R820, this locking circuit extending by way of the grounded conductor C767, the winding of R810, the contacts 811, and the winding of R820 to battery. At its contacts 812, the relay R810 interrupts the holding circuit for the relay R800, causing the latter relay to release. At its contacts 805, the relay R800 in releasing, opens a further point in its holding circuit. At its contacts 803 and 804, respectively, the relay R800 opens the above-traced operating circuits for the relays R830, R840, R850 and R860. At its contacts 802 the relay R800 reprepares one of the operating circuits for the relay R840. At its contacts 801 the relay R800 interrupts the above-traced path short-circuiting the winding of the relay R920.

The slow-to-operate relay R920 now operates to complete at its contacts 921, an obvious circuit for energizing the slow-to-release relay R930. The relay R930, in operating, completes at its contacts 931, an obvious path for short-circuiting the winding of the relay R910, causing the latter relay to restore. At its contacts 932, the relay R930 completes a circuit for energizing the relay R900, this circuit extending by way of the grounded conductor C767, the contacts 932, 942 and 952, and the winding of R900 to battery.

The operation of the relay R900 marks the end of the first ringing period. This relay in operating, completes at its contacts 901, a holding circuit for the relay R860 and in so doing short-circuits the relay R850. This holding circuit extends by way of the grounded conductor C767, the contacts 901, C872, the contacts 862 and the winding of R860 to battery. Obviously, with this circuit completed, both winding terminals of the relay R850 are grounded so that the relay R850 is short-circuited and restores. The relay R850 in restoring, opens the initially completed holding circuit for itself and the relay R860, and reprepares at its contacts 852, the holding circuit for the relay R800. The relay R900 in operating, also completes a path for short-circuiting the winding of the relay R950, this path extending by way of the grounded conductor C767, the contacts 932, 942, 952 and 902, the winding of R950, and the contacts 941 back to the grounded conductor C767. At its remaining contacts the relay R900 performs certain additional circuit control operations described hereinafter.

The relay R910 is deenergized and restores when its winding is short-circuited by the relay R930. Upon restoring, the relay R910 recompletes the path for short-circuiting the winding of the relay R920, and at its contacts 912 opens the previously traced operating circuit for the relays R810 and R820. The relay R920 restores shortly following the release of the relay R910 and upon restoring, opens the operating circuit for the relay R930. The relay R930 in turn restores after an interval to interrupt, at its contacts 932, the above-traced path, short-circuiting the winding of the relay R950. As a result, the two relays R900 and R950 are energized in series over a circuit extending by way of the grounded conductor C767, the contacts 941, the winding of R950, the contacts 902 and the winding of R900 to battery. The completion of this circuit prevents the release of the relay R900 and results in operation of the relay R950. The relay R950 in operating, opens at its contacts 952, a further point in the operating circuit for the relay R900 and prepares a circuit for energizing the relay R940 at its contacts 951.

The relay R930 in releasing, also opens the path short-circuiting the winding of the relay R910, whereby the latter relay is caused to reoperate and open the path short-circuiting the winding of the relay R920. In reoperating, the relay R910 also completes the initially traced circuit for energizing the relays R820 and R810 in series. Shortly following operation of the relay R910, the relay R920 reoperates to recomplete the operating circuit for the relay R930. The last-mentioned relay in operating, again short-circuits the winding of the relay R910 and completes the above-mentioned circuiting for energizing the relay R940. This circuit extends from ground by way of contacts 701, C767, the contacts 932, 942 and 951, and the winding of R940 to battery. When energized over this circuit the relay R940 operates to complete at the X contacts 943, an obvious locking circuit for itself. After this locking circuit is completed the relay R940 opens its contacts 942 to interrupt its own operating circuit and the operating circuit for the relay R900. At its contacts R941, the relay R940 interrupts the above-traced series holding circuit for the relay R900 and R950, causing both of these relays to restore. The relay R950 in restoring, opens at its contacts 951, a further point in the operating circuit for the relay R940, and reprepares at its contacts 952, the previously traced operating circuit for the relay R900. The relay R900 in releasing, opens the above-traced holding circuit for the ringing relay R860. The ringing relay R860 now restores to open at its contacts 862 a further point in its own holding circuit, and further to prepare, at its contacts 861, the holding circuit for the relay R840 and the path for short-circuiting the winding of the relay R830.

The relay R910 in releasing, initiates the sequential release of the two relays R920 and R930 in the manner explained above. When the relay R930 restores, it again opens the path short-circuiting the winding of the relay R910, and opens, at its contacts 932, the holding circuit for the relay R940. The relay R940 now restores to reprepare the series holding circuit for the two

relays R900 and R950 and the operating circuit for the relay R900. From this point on the master timing relays 95 continue to interact in the exact manner explained above, it being pointed out that the release of the relay R900 marks the end of the second ringing period. Thus, each operation of the relay R900 marks the end of an odd-numbered ringing period and each release of this relay marks the end of an even-numbered ringing period. At the beginning of the fourth ringing period when the relay R900 reoperates, the above-mentioned holding circuit for the relay R840 is completed, this circuit extending by way of the grounded conductor C767, the contacts 901, C872, the contacts 861 and 842, and the winding of R840 to battery. It will be observed that when this circuit is completed the upper and lower winding terminals of the relay R830 are both connected to ground, thus effectively short-circuiting this relay. As a result, the relay R830 is deenergized and restores to open at its contacts 831 the initially completed holding circuit for itself and the relay R840. At its contacts 832 the relay R830 opens the previously traced circuit for energizing the relays R810 and R820 in series. At its contacts 833, the relay R830 prepares a second of the three multiple branches of the holding circuit for the relay R800.

At the end of the fourth ringing period, the relay R900 is deenergized and restores in the manner explained above. This relay in releasing, opens at its contacts 901 the holding circuit for the relay R840. The relay R840 now restores to open, at its contacts 842, a further point in its holding circuit as traced above. At its contacts 841, the relay R840 prepares a further point in one of the holding circuits for the relay R820. At its contacts 843, the relay 840 further prepares the previously traced operating circuit for the relay R800. At its contacts 843 the relay R840 also completes a circuit for energizing the relay R730, this circuit extending from ground by way of the contacts 701, the winding of R730, the contacts 743, C766, the contacts 823 and 843, C765, the contacts 742 and the resistor 748 to battery.

At its contacts 732, the relay R730, upon operating, prepares another multiple branch in the holding circuit for the relay R800. At its contacts 731, the relay R730 completes a holding circuit for itself, this holding circuit extending from ground by way of the contacts 701, the winding of R730, the contacts 731, C763, the contacts 802, C764, the contacts 745 and the resistor 748 to battery. It will be noted that the relay R740 is at this time shunted by the resistor 748. Accordingly, this relay does not operate at this time.

At the end of the fifth ringing period as measured by the fifth cycle of operation of the master timing relays 95, the relay R900 is again energized and operates to complete the above-mentioned holding circuit for the relay R820, this circuit extending by way of the grounded conductor C767, the contacts 901, the conductor C872, the contacts 861, 841 and 821, and the winding of R820 to battery. It will be observed that when this circuit is completed, both winding terminals of the relay R810 are connected to ground and accordingly this relay is deenergized and restores. In releasing, the relay R810 reprepares, at its contacts 812, another multiple branch in the holding circuit for the relay R800. At its contacts 811, the relay R810 opens a further point in the series holding circuit for itself and the relay R820.

At the end of the sixth ringing period as measured by the sixth cycle of operation of the master timing relays 95, the relay R900 is again deenergized and restores to open the above-traced holding circuit for the relay R820. When this circuit is opened, the relay R820 is deenergized and restores to open a further point in its holding circuit. At its contacts 822, the relay R820 completes the previously traced operating circuit for the relay R800. At its contacts 823, the relay R820 opens the previously traced operating circuit for the relay R730.

The relay R800, in reoperating at the end of the sixth ringing period, again completes, at its contacts 801, the previously traced path for short-circuiting the winding of the relay R920. At its contacts 803 and 804, the relay R800 recompletes the circuits for energizing the relays R830, R840, R850 and R860, causing all of these relays to reoperate. At its contacts 805, the relay R800 recompletes the previously traced holding circuit for itself. At its contacts 802, the relay R800 opens the circuit over which the resistor 748 is connected in shunt with the winding of the relay R740, thus permitting the relay R740 to be energized in series with the relay R730 over a circuit which extends from ground by way of the contacts 701, the winding of R730, the contacts 731 and the winding of R740 to battery. The current flow over this circuit is sufficient to hold the relay R730 operated, and to cause the operation of the relay R740. In operating, the relay R740 opens, at its contacts 746, one of the multiple holding circuits for the relay R800. At its contacts 741, the relay R740 prepares a path for connecting the resistor 806 in shunt with the winding of the relay R730. At its contacts 742 and 743, the relay R740 opens a further point in the operating circuit for the relay R730. At its contacts 745, the relay R740 opens a further point in the path including the resistor 748 which normally shunts its own winding. At its contacts 744 the relay R740 further prepares the path for short-circuiting the winding of the relay R730. At its contacts 747, the relay R740 completes an obvious circuit for energizing the two transfer relays R710 and R720 in series. Thus, the two transfer relays R710 and R720 are caused to operate at the end of the sixth ringing period. At its contacts 722, the relay R720 in operating, disconnects the common ringing current conductor C770 from the F—1 ringing converter output lead C750'. At its contacts 721, the relay R720 connects the common ringing current conductor C770 to the F—2 ringing current lead C750 extending to the ringing converter having the output frequency F—2. Thus, a change in the frequency of the ringing voltage impressed upon the conductors C772, C773 and C774 is effected. At its contacts 724, 726 and 728, the relay R720 disconnects the F—1 intercepting pulse leads C757, C758 and C759 from the intercept pulsing conductors C775, C776 and C777. At its contacts 723, 725 and 727, the relay R720 connects the F—2 intercepting leads C760, C761 and C762 to the intercept pulsing conductors C775, C776 and C777, respectively. The transfer relay R710, upon operating, completes, at its contacts 712, 714 and 716, obvious paths for connecting the F—2 ringing leads C752, C754 and C756 to the ringing current conductors C772, C773 and C774 respectively, these leads being disconnected from the ring cut-off

conductor C771 at the contacts 712', 714' and 716' when the relay R710 operates. At its contacts 711', 713' and 715', the relay R710 disconnects the F—1 ringing leads C751, C753 and C755 from the ringing current conductors C772, C773 and C774, respectively. Finally, at its contacts 711, 713 and 715, the relay R710 connects the F—1 ringing leads C751, C753 and C755 to the ring cut-off conductor C771.

The manner in which the coding relays 90 and the master timing relays 95 operate during the seventh to twelfth ringing periods, is exactly the same as set forth above with reference to the operation of these relays during the first to sixth ringing periods, it being noted that during the seventh to twelfth ringing periods, ringing voltage of the frequency F—2 is coded through operation of the coding relays 90 in the manner more fully described hereinafter. At the end of the tenth ringing period, the relay R840 restores to complete an alternative holding circuit for the relay R740, this circuit extending from ground by way of the contacts 701 and 741, C765, the contacts 843 and 823, C766, the contacts 744, C764, the contacts 802, C763, and the winding of R740 to battery. It will be noted that when this circuit is completed, both winding terminals of the relay R730 are connected to ground. Accordingly, the relay R730 is deenergized and restores. Upon restoring, the relay R730 opens, at its contacts 731, a point in the initially completed holding circuit for itself and a point in the circuit for energizing the relay R740. At its contact 732, the relay R730 opens a further point in one branch of the holding circuit for the relay R800. At the end of the twelfth ringing period the relay R820 restores in the manner pointed out above, to open, at its contacts 823, the above-traced alternative holding circuit for the relay R740. The relay R740 now restores to open, at its contacts 744, a further point in its holding circuit, and to recomplete, at its contacts 745, the path including the resistor 748 for short-circuiting its own winding. At its contacts 743, the relay R740 reprepares the operating circuit for the relay R730. At its contacts 741, the relay R740 opens a further point in the above-traced path for short-circuiting the winding of the relay R730. At its contacts 742, the relay R740 reprepares the operating circuit for the relay R800. Finally, at its contacts 747, the relay R740 interrupts the circuit for energizing the relays R710 and R720 in series. The relay R710 in releasing, again connects the F—1 ringing leads C751, C753 and C755 to the ringing current conductors C772, C773 and C774, disconnects the F—2 ringing leads C752, C754 and C756 from the enumerated ringing current conductors, and connects the F—2 ringing leads to the ring cut-off conductor C771. The relay R720 in releasing, disconnects the common ringing current conductor C770 from the F—2 ringing converter lead C750, and reconnects this conductor to the F—1 ringing converter lead C750'. At its contacts 723 to 728, inclusive, the relay R720 disconnects the F—2 intercepting leads C760, C761 and C762 from the intercept pulsing conductors C775, C776 and C777, respectively, and reconnects these conductors to the F—1 intercepting leads C757 to C759, inclusive. From this point on the manner in which the master timing relays 95, the coding relays 90, the transfer control relays 85, and transfer relays 80 operate during succeeding ringing cycles, is exactly the same as described above.

The release of the interrupter 75 is under the control of the start relay R700. More particularly, when the start conductor C114 is disconnected from ground, the relay R700 is deenergized and restores to disconnect the release conductor C767 from ground. In response to this operation any operated ones of the relays R730, R740, R800, R810, R820, R830, R840, R850, R860, R900, R910, R820, R940 and R950, are deenergized and restored. If the relays R710 and R720 are operated at the time the start relay R700 releases, these two transfer relays are deenergized and restore in response to the release of the relay R740. In the event the relay R930 is operated at the time the start relay R700 restores, this master timing relay is deenergized and restores in response to the release of the relay R920.

The ringing circuit control operations effected through operation of the relays embodied in the interrupter 75, in the manner explained above, will best be understood by reference to Fig. 10 of the drawings, wherein the sequence of relay operations and the various circuit control functions effected thereby are plotted for one complete ringing cycle comprising twelve separate and distinct ringing periods. It will be observed from this chart that immediately the start relay R700 and the coding relay R850 operate, a ground pulse is impressed upon the pick-up lead C115 over a path which extends from ground by way of the contacts 853, C778, the contacts 709 and the choke coil 735 to the pick-up lead C115. As indicated by the chart, the pick-up lead is disconnected from ground at the contacts 853 in response to the release of the relay R850, which, it will be recalled, occurs at the end of the first ringing period. From this chart it will also be observed that the pick-up lead C115 is again connected to ground in response to the operation of the relay R850 which occurs during the seventh ringing period and is disconnected from ground through the release of this relay at the end of this period.

Substantially concurrently with the application of ground potential to the pick-up lead C115, the F—1, code 1 intercepting lead C757 and the frequency check lead C779, are connected to ground through operation of the relays R840, R860 and R910, the path for grounding these leads extending by way of the contacts 913 and 923, the choke coil 914, the contacts 908, C880, and the contacts 844 and 867, C775, and the contacts 724. As indicated by the chart, this path is broken at the contacts 923 during the first ringing period in response to the operation of the timing relay R920. Ground potential is also impressed upon the F—1, code 2 intercepting lead C758 for a portion of the fifth ringing period. Thus, when the relay R920 releases during this period, a path is established which extends from ground by way of the contacts 933 and 923, the choke coil 914, the contacts 908, C880, the contacts 845, C776, and the contacts 726 to the intercepting lead C758. This path is momentarily broken when the relay R930 releases during the fifth ringing period to cause the energization and reoperation of the relay R910. The relay R910 upon reoperating, however, completes an obvious alternative path for grounding the lead C758 at its contacts 913. The relay R910 in operating also opens the path short-circuiting the relay R920, causing the latter relay to reoperate and break at its contacts 923, the alternative path over which the lead C758 is connected to ground. Thus, a ground pulse is transmitted over the F—1, code 2 intercepting

lead C758 during the fifth ringing period. As indicated by the chart, the F—1, code 3 intercepting lead C759 is similarly connected to ground for a short time interval during the sixth ringing period. Thus, when the relays R910 and R920 sequentially release during this period, a path is established which extends from ground by way of the operated contacts 933, the contacts 923, the choke coil 914, the contacts 907, C879, the contacts 846, C777, and the contacts 728 to the intercepting lead C759. This path is broken at the contacts 923 in response to the reoperation of the relay R920 which occurs shortly following the release of the relay R930. As explained previously, the transfer relay R720 is operated during the seventh to twelfth ringing periods. Accordingly, ground potential is impressed upon the F—2 intercepting leads C760, C761 and C762 for short intervals during the seventh, eleventh and twelfth ringing periods, respectively, over paths which will be fully apparent in view of the foregoing explanation. It will be observed that the frequency check lead C780 is connected to the F—2, code 1 intercepting lead C760. Accordingly, ground potential is impressed upon this check lead, concurrently with the application of ground potential to the F—2, code 1 intercepting lead C760, for a short time interval during the seventh ringing period.

It will be observed from Fig. 10 of the drawings, that a ground pulse is impressed upon the pulse lead C689 during each cycle of operation of the master timing relays 95. The path over which this pulsing lead is grounded extends by way of the choke coil 868, C878, the contacts 922, and the parallel connected contacts 913 and 933 to ground. This path is obviously completed during each interval when the relay R920 is concurrently operated with either or both of the two relays R910 and R930. It will be understood that the frequency of the pulses impressed upon the pulsing lead C689 depends upon the speed with which the master timing relays 95 sequentially operate. In the preferred arrangement of this interrupter, these timing relays are adjusted so that the pulses impressed upon the lead C689 occur at a rate of approximately 80 impulses per minute.

It will also be observed from the chart illustrated in Fig. 10 of the drawings, that the circuit connections extending between the ringing leads C751 to C756, inclusive, and the two converter leads C750 and C750' are so arranged that the voltage of the F—1 ringing converter is impressed upon the F—1, code 1 ringing lead C751 for the major portion of the first and second ringing intervals. The voltage of this same source is also impressed upon the F—1, code 2 ringing lead C753 throughout the third and fifth ringing periods. The F—1 ringing current source is also connected to the F—1, code 3 ringing lead C755 during each of the second, fourth and sixth ringing periods. More specifically, the circuit for impressing the voltage of the ringing converter having the output frequency F—1, upon the F—1, code 1 ringing lead C751, is completed in response to operation of the relay R810, which occurs shortly following the operation of the start relay R700. This circuit extends from the high potential terminal of the F—1 ringing converter by way of C750', the contacts 722, C770, the contacts 813 and 863, C772, and the contacts 711' and 703 to the lead C751. This circuit is broken at the contacts 863 in response to the release of the ringing relay R860 which occurs at the end of the second ringing period in the manner previously explained. It will be observed that when the relay R860 restores to break this circuit, it completes a path extending by way of the contacts 864 for connecting the ringing lead C751 to the ring cut-off conductor C771. The circuit over which the voltage of the F—1 ringing converter is impressed upon the F—1, code 2 ringing lead C753 is also completed when the ringing relay R860 restores at the end of the second ringing period. This circuit extends by way of the conductor C750', the contacts 722, C770, the contacts 813, C875, the contacts 906, C876, the contacts 866 and 824, C773, and the contacts 713' and 705 to the ringing lead C753. This circuit is interrupted at the contacts 906 when the relay R900 operates at the end of the third ringing period. The relay R900 upon operating at this time also completes, at the contacts 905, a path for connecting the ringing lead C753 to the ring cut-off conductor C771, this path extending by way of the contacts 905, C876, the contacts 866 and 824, C773 and the contacts 713' and 705, to the lead C753. At the beginning of the fifth ringing period, when the relay R900 again restores, the F—1, code 2 ringing lead C753 is again connected to the F—1 ringing converter over the above-traced circuit. Further, at the end of this ringing period, when the relay R900 reoperates, this circuit is broken at the contacts 906 and the lead C753 is again connected to the ring cut-off conductor C771 through the contacts 905. The circuit for connecting the F—1 ringing converter to the F—1, code 3 ringing lead C755 is completed when the relay R900 operates at the beginning of the second ringing period, this circuit extending by way of the conductor C750', the contacts 722, C770, the contacts 903, the conductor C877, the contacts 826, C774, and the contacts 715' and 707 to the ringing lead C755. This circuit is broken at the contacts 903 when the relay R900 restores at the end of the second ringing period in the manner previously explained. The relay R900, in restoring, also completes, at its contacts 904, an obvious path for connecting the ringing lead C755 to the ring cut-off conductor C771. It will be observed that the circuit for connecting this ringing lead to the F—1 ringing converter does not extend through any of the contacts of the coding relays R830, R840, R850 and R860. Accordingly, the circuit is completed during each even-numbered ringing interval when the relays R820 and R900 are operated. Also, this ringing lead is connected to the ring cut-off conductor C771 through the make contacts 826 of the relay R820 and the break contacts 904 of the relay R900 during each odd-numbered ringing period when the relay R900 is restored.

As explained previously, at the end of the sixth ringing period all of the coding relays R810, R820, R830, R840, R850 and R860 are released. With these relays in their respective restored positions it will be observed that the three ringing current conductors C772, C773 and C774 are all connected to the ring cut-off conductor C771 through the back contacts of the coding relays R820 and R860. Thus, a ring cut-off potential is impressed upon all of these conductors during all silent periods. From the foregoing explanation it will be recalled that the transfer relays R710 and R720 are caused to operate at the end of the sixth ringing interval and remain operated until the end of the twelfth ringing period. With these relays operated, the com-

mon ringing current conductor C770 is connected through the operated contacts 721 to the conductor C750 which extends to the high potential terminal of the F—2 ringing converter. Also, the F—1 ringing leads C751, C753 and C755 are connected through the make contacts of the relays R700 and R710 to the ring cut-off conductor C771. Further, the F—2 ringing leads C752, C754 and C756 are connected through the make contacts of the start relay R700 and the make contacts of the transfer relay R710 to the ringing current conductors C772, C773 and C774 respectively. It will be understood, therefore, that during the seventh to twelfth ringing periods the voltage of the F—2 ringing converter is impressed upon the ringing leads C752, C754 and C756 during intervals which respectively correspond to the intervals when the voltage of the F—1 ringing current source was impressed upon the ringing leads C751, C753 and C755, respectively, during the first to sixth ringing periods. Thus, from Fig. 10 of the drawings it will be seen that the voltage of the F—2 ringing converter is impressed upon the F—2, code 1 ringing lead C752 for the major portion of the seventh and eighth ringing periods. Similarly, the voltage of this converter is impressed upon the F—2, code 2 ringing lead C754 for the duration of the ninth and eleventh ringing periods. Finally, the voltage of this converter is impressed upon the F—2, code 3 ringing lead C756 for the duration of the eighth, tenth and twelfth ringing periods. The circuits over which the voltage of this converter is impressed upon the three F—2 ringing leads by the coding relays, are substantially similar to the circuits over which the F—1 ringing converter was connected to the F—1 ringing leads during the first six ringing periods, and will be clearly apparent in view of the foregoing explanation.

Operation of the system

Considering now the operation of the system as a whole, it may be assumed, for example, that a call intended for the substation B, associated with the line 11, is initiated at the telephone station A. When the call is initiated, a connection is extended to one of the selector switches of the system in response to operation of the line switch 15. More specifically, when the usual calling loop circuit is completed by way of the line 10, the line switch 15 operates to select a trunk line leading to an idle selector switch and to mark the calling line 10 as busy in the bank contacts of the connector switches having access thereto. Assuming, for example, that the selector switch 25 is selected by the line switch 15, when the trunk line leading to this selector switch is seized, the calling loop circuit is extended thereto and the selector switch is in condition to respond to the first series of impulses dialed at the calling substation. In response to the seizure of the selector switch 25, certain of the relays embodied therein operate in a well-known manner to impress ground potential upon the tone start lead C116. This start lead is normally connected through the break contacts 681 of the relay R680 to the the start conductor C692 extending to the No. 1 set of dial and busy tone generators 690. As a result, operation of the apparatus 690 is initiated, whereby the usual dial and busy tone signal voltages are impressed upon the conductors C691 and C696, respectively. The dial tone conductor C691 is now connected through a circuit controlled by certain of the relays in the selector switch 25 to the established loop circuit extending between the calling station A and the selector switch whereby the usual dial tone signal is reproduced by the receiver provided at the calling telephone station.

When the first digit is dialed at the calling substation, the switch 25 elevates its wipers to a position opposite the level of bank contacts terminating the trunks leading to the connector switches having access to the desired line 11. Following this operation and during the inter-digit pause between the first and second digits, the wipers of the switch 25 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, for example, that the connector switch 30 is the first available idle connector switch in the selected group, when the wipers of the selector switch 25 are stepped into engagement with the contacts terminating the trunk line extending to this connector switch, the subscribers loop circuit is extended to the switch 30. The connector switch is thus conditioned to respond to the second series of impulses dialed at the calling substation. During the operations just described, the dial tone lead C691 is disconnected from the loop circuit including the calling line 10 whereby the dial tone signal transmitted to the substation A is terminated. When the connector switch 30 is seized in the manner just described, certain of the control relays embodied therein, and more particularly the line and hold relays, operate to complete a path for impressing ground potential upon the ringing apparatus start conductor C114, thereby to initiate operation of the ringing apparatus 785 and the ringing interrupter 75 in the event this apparatus is not already in operation. More specifically when the start lead C114 is grounded, a circuit is completed for energizing the start relay embodied in the apparatus 785 and associated with the No. 1 set of ringing converters. To this end the conductor C114 is included in an obvious operating circuit for the relay R650. Upon operating, the relay R650 completes at its contacts 651 a circuit extending by way of the contacts 683 and the No. 1 start conductor C693 for energizing the start relay associated with the No. 1 set of ringing converters embodied in the apparatus 785. In operating, the relay R650 also performs additional circuit control operations referred to with particularity hereinafter.

In response to the dialing of the second digit at the calling telephone station A, the wipers of the connector switch 30 are stepped vertically to a position opposite the level of bank contacts at which are terminated the lines of the ten-line sub-group including the calling line 11. Following this digit and during the inter-digit pause between the second and third digits, the connector switch 30 is conditioned to rotate its wipers step by step in accordance with the impulses of the third digit dialed at the calling substation. When this third digit is dialed, the wipers of the switch 30 are operated into engagement with the set of bank contacts terminating the called line 11. During the inter-digit pause between the third and fourth digits, circuits are prepared for energizing the operating magnet of the frequency and code selecting switch 120 in accordance with the impulses of the fourth and final digit. This operating magnet responds to the impulses of the fourth digit by operating the wiper 121 into engagement with the contact of the associated con-

tact set, which has impressed thereon ringing voltage of the particular frequency and code designating the called substation B. If it be assumed, for example, that the ringer provided at the called substation B is constructed to respond only to ringing current of the frequency F—1 and further, that the code designating the substation B is the code 2, the fourth digit dialed at the calling telephone station A will necessarily comprise three impulses so that at the conclusion thereof, the wiper 121 will be left standing in engagement with the contact terminating the ringing lead C753. The frequency and code selecting switch 120 is provided with a release magnet, the operating circuit for which is prepared when the wiper 121 is stepped off normal.

In accordance with conventional practice, suitable provisions are made in the connector switch 30 for testing the selected line 11 to determine the idle or busy condition thereof, for returning the usual busy tone signal over the established loop circuit to the calling subscriber in the event the called line is busy, and for projecting ringing current of the selected frequency and code over the called line in the event this line is idle at the time it is selected. In this regard it will be understood that the busy tone current utilized to signal the calling party in the event the called line is found to be busy, is derived from the dial and busy tone generators 690 and is impressed on the calling loop circuit over the busy tone lead C696. Assuming that the called line is idle, a circuit is prepared through operation of certain of the relays embodied in the connector switch 30 for energizing the lower winding of the slow-to-operate ringing control relay R110. This circuit is thereafter completed at the beginning of the next cycle of operation of the coding relays 90 embodied in the ringing interrupter 75 when ground potential is impressed upon the pick-up lead C115. More specifically, when the relay R850 operates, following operation of the connector switch 30 to select the line 11, the ringing relay R110 is energized over a circuit which extends from ground by way of the contacts 853, C778, the contacts 709, the choke coil 735, the pick-up lead C115, certain of the contacts embodied in the relays of the connector switch 30, the private conductor 11c of the selected line and through the winding of the cut-off relay conventionally embodied in the line switch 20 to battery. When this circuit is completed the cut-off relay embodied in the line switch 20 partially operates to disconnect the windings of the line relay embodied in this line switch from the conductors of the called line 11, thereby to clear this line of the shunt impedance represented by the line relay windings. Completion of the circuit just traced also results in the energization and operation of the ringing control relay R110. This relay, upon operating completes, at the X contacts 112, a prepared holding circuit for itself, this holding circuit having previously been prepared through operation of certain of the other relays embodied in the connector switch 30. The relay R110 in operating, also completes a prepared path for impressing ground potential upon the private conductor 11c of the called line, thereby to mark this line as busy in the bank contacts of the other connector switches having access thereto. At its contacts 111 and 113, the relay R110 completes a circuit for transmitting ringing current of the selected frequency and code over the conductors of the line 11. In the present assumed case, the circuit traversed by the ringing current may be traced as extending from the high potential terminal of the operating F–1 ringing converter embodied in the apparatus 785 by way of C750', the contacts 722, C770, the contacts 813, C875, the contacts 906, C876, the contacts 866 and 824, C773, the contacts 713' and 705, the ringing lead C753, the wiper 121, the contacts 105 and 113, the line conductor 11b, the windings of the ringer provided at the substation B, the condenser connected in series with this ringer across the conductors of the line 11, the conductor 11a, the contacts 111 and 101, the upper winding of the ring cut-off relay R100, and the exchange battery to the grounded terminal of the ringing converter in use. It will be understood that in this case, since the ringing voltage is superimposed upon ground, the Y wiring illustrated in Fig. 7 is used in the ringing interrupter 75. Portions of the ringing current transmitted over the line 11 are obviously shunted through the ringers respectively provided at the other substations associated with the line 11. All such ringers, which are tuned to respond to the frequency F-1, operate. Due to the coded character of the ringing voltage impressed upon the ringing lead C753, however, the subscriber at the substation B is signaled that the call is intended for his substation, and the other subscribers served by the line and having ringers which respond to ringing current of the frequency F–1 are informed that the call is not intended for their sub-stations. A portion of the ringing current is also shunted in the usual manner over the calling loop circuit to energize the receiver provided at the calling substation, thereby to indicate to the calling subscriber that the called substation is being signaled. It will be apparent from the foregoing explanation that the code of the ringing current projected over the line 11 is such that two short rings of equal length and separated by a silent interval of the same length, are produced by the ringers associated with the line 11 and tuned to respond to the frequency F–1. This particular code is arbitrarily assumed to designate the substation B. The desired conversational circuit between the calling and called substations is fully completed when the call is answered at the called substation B. More particularly, when the receiver at this substation is removed from its supporting hook or cradle, a direct current conductive bridge is connected across the conductors 11a and 11b of the line 11 to complete a circuit for energizing the upper winding for the slow-acting ring cut-off relay R100. This circuit may be traced as extending from ground by way of the ring cut-off conductor C771, certain of the back contacts of the coding relays 90 or the relay R900, the conductor C773, the contacts 713' and 705, the ringing lead C753, the wiper 121, the contacts 105 and 113, the conductor 11b, the bridge across the conductors of the line 11, the conductor 11a, the contacts 111 and 101, and the upper winding of R100 to battery. When its upper winding is energized over this circuit, the relay R100 operates to close its X contacts 103, thereby to complete a prepared holding circuit for itself. Thereafter, the relay R100, at its contacts 101 and 105, opens two points in its operating circuit and two points in the above-traced circuit for projecting ringing current over the line 11. At its contacts 102 and 104, the relay R100 completes the desired conversational circuit between the calling substation A and the called substation B. When the relay R100 operates it also functions to open the

path, not shown, by way of which ring-back tone current is projected over the calling loop circuit, thereby to terminate the ring-back tone signal in the usual manner. Preferably, the control equipment of the connector switch is so arranged that the release of the operated switch train is entirely under the control of the calling party at the telephone station A. With such an arrangement, when the connection is cleared out at the calling substation, the loop circuit extending through to the operated connector switch 30 is interrupted to cause the release of the line and hold relays conventionally embodied in this switch in the usual manner. When these relays restore, the line and selector switches 15 and 25, respectively, are released and the control apparatus embodied in the connector switch 30 is restored to normal, all in a manner well understood in the art. During the release of the control apparatus embodied in the connector switch 30, the previously described holding circuits for the two relays R100 and R110 are interrupted, causing these relays to restore. Also, ground potential is removed from the private conductor 11c of the called line 11, whereby the cut-off relay embodied in the line switch 20 is released to reconnect the windings of the line relay associated therewith to the conductors 11a and 11b of the line 11. When ground potential is removed from the private conductor of the line 11, battery potential is impressed upon this conductor through the winding of the cut-off relay embodied in the line switch 20, thereby to mark the line as idle in the bank contacts of the connector switches having access thereto. During the release of the control relays embodied in the connector switch 30, a circuit is also completed for energizing the release magnet of the Strowger switch mechanism embodied in this switch, thereby to cause the wiper carriage structure of this mechanism to be restored to rotary an dvertical normal. Similarly, a circuit is completed for energizing the release magnet of the frequency and code selecting switch 120, whereby the wiper 121 of this switch is restored to normal. Thus, the switch train is fully released.

Call interception

Referring now more particularly to the operation of the apparatus 35 to intercept a call routed by way of the connector switch 30 to the line 11, if it be assumed, for example, that for some reason all calls to this line are to be intercepted, the conductor C250 is strapped to the conductor C246 by means of a conductor indicated by the dash line 251. With the circuit arranged in this manner, if ringing current is projected over the line 11, a portion of the current is passed through the condenser 202 and the windings of the relay R200 to energize this relay. In operating, the relay R200 completes at its contacts 201, a circuit for energizing the lower winding of the relay R210, this circuit extending from ground by way of the contacts 332, 345 and 313, the resistor 306, C246, the strap 251, C250, the contacts 201, and the lower winding of R210 to battery. When initially energized over this circuit, the relay R210 operates to complete, at the X contacts 213, a circuit for energizing its upper winding in series with the winding of the slow-to-release relay R310. This series circuit extends from ground by way of the contacts 334 and 346, the winding of R310, C245, the contacts 213 and the upper winding of R210 to battery. When this circuit is completed, the relay R210 is held operated independently of the position of the relay R200. In its operated position the relay R210 connects the conductors 11a and 11b of the line 11 to the link line conductors 17a and 17b, respectively, of the link line 17.

When energized in series with the upper winding of the relay R210, the relay R310 operates to open, at its contacts 313, a point in the above-traced operating circuit for the relay R210 and a point in the common portion of the operating circuits for the other intercepting relays corresponding to the relay R210 and included in the intercepting apparatus 35. At its contacts 312, the relay R310 prepares a holding circuit for the relay R320. At its contacts 314, the relay R310 prepares a circuit for energizing the slow-to-operate relay R340 when a check pulse is impressed upon the check pulse lead C689 by the interrupter 75.

When the relay R210 operates to connect the conductors of the subscribers line 11 to the link line 17, ringing current is passed through the upper winding of the relay R320 in series with the condenser 326 and the contacts 321. When energized in this manner, the relay R320 operates to complete, at its X contacts 322, the prepared holding circuit for itself, this holding circuit extending from ground by way of the contacts 312 and 322, and the lower winding of R320 to battery. After this circuit is completed, the relay R320 completes its operation to open its operating circuit at the contacts 321. At its contacts 325, the relay R320 completes an obvious circuit for energizing the relay R300. At its contacts 323 and 324, the relay R320 prepares a circuit for energizing the upper winding of the ring cut-off relay R350, and in so doing completes a circuit for transmitting ringing current over the trunk 39 to energize the signal control relay R360 provided at the operator's position 40. The circuit traversed by the ringing current may be traced as extending from one of the ringing leads C751 to C756, inclusive, by way of the contacts 323 and 355, the trunk conductor 39b, the windings of the relay R360, the condenser 362, the trunk conductor 39a, the contacts 352, the upper winding of R350, the contacts 324, and the exchange battery to the grounded terminal of the ringing converter in use. The relay R300, upon operating opens, at its contacts 302, 303 and 304, points in the respective operating circuits for the code relays R240, R230 and R220. At its contacts 301, the relay R300 prepares a holding circuit for the relay R340, and completes an obvious multiple path for impressing ground potential upon the ringing apparatus start conductor C114, thereby to insure the continued operation of the ringing apparatus 785 and the interrupter 75, even though the call is abandoned at the calling substation before it is answered at the intercepting operator's position 40. At its contacts 305, the relay R300 opens a point in the above-mentioned circuit for energizing the relay R340 by way of the check pulse lead C689.

The relay R360 operates when ringing current is transmitted through its windings over the circuit traced above, and, upon operating, completes, at its contacts 361, an obvious circuit for energizing the incoming call signal lamp 366. The operator attending the position 40 is thus informed that a call has been intercepted which requires her attention. To answer the call, the operator actuates the answer key 367 to its off-normal position, whereby the contact springs 368 and 369 are respectively operated into engagement to connect the operator's telephone set 370

across the conductors of the trunk 39. A direct current bridge extending through the operator's telephone set is thus established between the conductors of the trunk 39. When this bridging path is completed, the upper winding of the slow-acting ring cut-off relay is energized over a circuit which may be traced as extending from ground by way of one of the ringing leads C751 to C756, inclusive, in use, the contacts 323 and 355, the conductor 39b, the contacts 368, the bridge through the operator's telephone set 370, the contacts 369, the conductor 39a, the contacts 352, the upper winding of R350, and the contacts 324 to battery. When thus energized, the relay R350 partially operates to complete at the X contacts 357, an obvious holding circuit for itself. After this circuit is completed, the relay R350, at its contacts 352 and 355, opens two points in its operating circuit as traced above, and two points in the circuit for transmitting ringing current over the trunk 39. Thus, the relay R360 is caused to restore to open the circuit for energizing the signal lamp 366. At its contacts 353 and 356, the relay R350 further prepares the talking circuit between the calling telephone station and the operator's telephone set 370. At its contacts 351 and 354, the relay R350 connects the link line conductors 17a and 17b to ground through the resistors 358 and 359, respectively, and thus completes a circuit for energizing the ring cut-off relay R100 embodied in the connector switch 30, assuming that the call has been routed to the line 11 through this connector switch. This circuit extends from ground by way of the resistor 358, the contacts 351 and 341, the conductor 17a, the contacts 211, the conductor 11a, the contacts 111 and 101, and the upper winding of the relay R100 to battery. When energized over this circuit, the relay R100 operates to perform the functions described previously, among which is the completion of a circuit including one of the resistance elements 358 and 359 for energizing the back-bridge relay R90 embodied in the connector switch 30. The resistance value of each of these elements is, however, such that the back-bridge relay is insufficiently energized to operate when a circuit including one of these elements and one of the windings of the back-bridge relay, is completed.

At its contacts 353 and 356, the relay R350, in operating, also completes a circuit for energizing the back-bridge relay R330, this circuit extending from ground through the lower winding of R330 and by way of the contacts 356, the conductor 39b, the contacts 368, the bridge through the operator's telephone set 370, the contacts 369, the conductor 39a, the contacts 353, and the upper winding of R330 to battery. The relay R330 now operates to complete, at its contacts 331, an obvious multiple holding circuit for the relay R320. At its contacts 332, the relay R330 opens a further point in the common portion of the operating circuits for the various intercepting relays corresponding to and including the relay R210. At its contacts 333, the relay R330 completes an obvious multiple holding circuit for the relay R210 and momentarily short-circuits the winding of the relay R310. At its contacts 334, the relay R330 opens the initially completed holding circuit for the relay R210, and in so doing interrupts the circuit for energizing the relay R310. At its contacts 336, the relay R330 opens a further point in the above-mentioned circuit for energizing the relay R340 over the check pulse lead C689. At its contacts 335, the relay R330 prepares an alternative circuit for energizing the relay R340. Shortly following the operation of the relay R330, the slow-to-release relay R310 restores to reprepare, at its contacts 313, the operating circuits for the various intercepting relays, and to open, at its contacts 314, a further point in the circuit for energizing the relay R340 over the check pulse lead C689. At its contacts 312, the relay R310 opens the initially completed holding circuit for the relay R320. At its contacts 311, the relay R310 completes the above-mentioned alternative circuit for energizing the relay R340, this alternative circuit extending from ground by way of the contacts 331, 311 and 335, and the winding of R340 to battery. When energized over this circuit, the relay R340 operates after an interval and locks to ground through the contacts 301 and 347. At its contacts 348, the relay R340 opens the above-mentioned multiple path for impressing ground potential upon the ringing apparatus start conductor C114. At its contacts 346, the relay R340 opens a further point in the above-traced circuit for energizing the relay R310 in series with the upper winding of the relay R210. At its contacts 345, the relay R340 opens a further point in the common portion of the operating circuits for the various intercepting relays. At its contacts 341 and 343, the relay R340 disconnects the resistors 358 and 359 from the link line conductors 17a and 17b, respectively, thereby to deenergize the energized winding of the back-bridge relay R90 embodied in the connector switch 30. At its contacts 342 and 344, the relay R340 connects the link line conductors 17a and 17b through the condensers 326 and 327, respectively, to the trunk conductors 39a and 39b, thereby to complete a conversational circuit between the calling subscriber's substation and the operator's telephone set 370.

After answering the call, the operator attending the position 40 may advise the calling subscriber as to the new directory number of the called subscriber in the event the intercepting service is provided for this purpose, or may dispose of the call in any other manner dictated by the purpose for which the intercepting service is provided. If the operator wishes to hold the call while utilizing her telephone set 370 to dispose of another call, she may do so by operating the hold key 363 to its off-normal position, thereby to operate the contact springs 364 and 365 respectively into engagement. At the contact springs 364, an obvious alternative circuit is completed for energizing the signal lamp 366, whereby the operator is informed that a call is present on the trunk 39 which must be attended to. At the contact springs 365, the impedance element 362 is connected across the conductors of the trunk 39 to provide a holding bridge for the back-bridge relay R330. After the key 363 has been operated to its off-normal position, the key 367 may be returned to normal to disconnect the operator's telephone set 370 from the trunk 39, whereby this telephone set is rendered available for use in handling other calls. Obviously, the operator may, by operating the answer key 367 to its off-normal position and releasing the hold key 363, reestablish a connection with the trunk 39 for the purpose of handling the call on this trunk.

The manner in which the operated switch train, including the connector switch 30 and through which the call was routed to the line 11, is released under the control of the calling subscriber, is exactly the same as described above. The release of the call intercepting apparatus 35

is entirely under the control of the operator attending the position 40. More specifically, when the answer key 367 is returned to its normal position, the direct current bridge established through the operator's telephone set 370 and extending between the conductors of the trunk 39, is interrupted at the contacts 368 and 369. When this path is broken the back-bridge relay R330 is deenergized and restores. In releasing, the relay R330 opens, at its contacts 333, the previously traced alternative holding circuit for the intercepting relay R210. At its contacts 331, the relay R330 opens the holding circuit for the relay R320. At its contacts 331 and 335, the relay R330 opens the above-traced operating circuit for the relay R340. The relay R320, in releasing, opens, at its contacts 325, the operating circuit for the relay R300 and the holding circuit for the relay R350, causing both of these relays to restore. The relay R300, in releasing, opens, at its contacts 301, the holding circuit for the relay R340. Thus, all of the relays embodied in the call intercepting apparatus 35 are released and this apparatus is conditioned for further use.

If calls to the line 11 intended only for a substation designated by ringing current of the frequency F—1 and the code 1, are to be intercepted through operation of the apparatus 35, the intercepting lead C250 associated with the intercepting relay R210 individual to the line 11 is cross-connected to one of the two code conductors C267 and C268 which individually correspond to ringing code 1. It will be observed from the ringing code chart illustrated in Fig. 10 of the drawings, that with the apparatus wired in this manner the relays R200 and R240 are concurrently operated to complete the operating circuit for the intercepting relay R210 individual to the line 11 only during the first ringing period of each ringing cycle. More specifically, when ringing current of the No. 1 code is selected through operation of the frequency and code selecting switch 120 of the connector switch 30, for example, ringing current is projected over the selected called line only during the first and second ringing periods of each ringing cycle. Further, ground potential is only impressed upon the intercepting lead C757 by the interrupter 75 during a portion of the first ringing period of each ringing cycle. When ground potential is impressed upon this intercepting lead, the code relay R240 is energized over a circuit which extends by way of this lead, the winding of R240, C247, and the contacts 302, to battery. Since, in the case assumed, the relay R200 is concurrently energized by ringing current projected over the line 11, this relay and the relay R240 are concurrently operated to complete the operating circuit for the relay R210, which, in this case, extends from ground by way of the contacts 332, 345 and 313, the resistor 306, C246, the contacts 243 or 244, C267 or C268, C250, the contacts 201, and the lower winding of R210 to battery. When energized over this circuit the relay R210 locks to ground through the contacts 334 and causes the call to be intercepted and forwarded to the operator's position 40 in the manner explained above.

In a manner similar to that just described, the conductor C250 may be cross-connected to any one of the four conductors C263 to C266 inclusive, so that calls intended for substations designated by the second or third ringing codes and signaled by ringing current of the frequency F—1 projected over the line 11, are intercepted. Thus, with the code relay R230 connected to be energized over the F—1, code 2 intercepting lead C758 and the conductor C250 cross-connected to one of the two leads C265 and C266, the relay R210 will be energized to intercept calls intended for a substation associated with the line 11 which is designated by ringing current of the frequency F—1 and having the code 2. In such case, the relay R230 is energized during the fifth ringing interval of each ringing cycle over a circuit extending by way of the grounded intercepting lead C758, the winding of R230, C248, and the contacts 303 to battery. The resulting operation of this relay is concurrent with the operation of the relay R200, so that an operating circuit for the relay R210 is established which extends from ground by way of the contacts 332, 345 and 313, the resistor 306, C246, the contacts 233 or 234, C265 or C266, C250, the contacts 201, and the lower winding of R210 to battery.

If the conductor C250 is cross-connected to one of the two conductors C263 and C264 and ringing current having the frequency F—1 and interrupted in accordance with the code 3 is transmitted over the line 11, the relays R200 and R220 are concurrently operated during the sixth ringing interval of each ringing period, thereby to complete the operating circuit for the intercepting relay R210. The circuit for energizing the code relay R220 extends by way of the grounded F—1, code 3 intercepting lead C759, the winding of R220, C249, and the contacts 304, to battery. In the last assumed case the operating circuit for the relay R210 extends from ground by way of the contacts 332, 345 and 313, the resistor 306, C246, the contacts 223 or 224, C263 or C264, C250, the contacts 201, and the lower winding of R210 to battery.

If it is desired to intercept calls to two of the substations associated with the line 11 which are designated by the ringing current having the frequency F—1 and the codes 1 and 2, respectively, the conductor C250 is cross-connected to the conductor C259 so that, when either of the two code relays R240 and R230 operates, the operating circuit for the relay R210 is established through the contacts 231 or the contacts 241, depending upon which of the two relays R230 and R240 is operated concurrently with the relay R200. Similarly, if calls to two substations associated with the line 11 which are designated by ringing current having the frequency F—1 and the codes 2 and 3, respectively, are to be intercepted, the conductor C250 is cross-connected to the conductor C260. In this case the operating circuit for the intercepting relay R210 is completed by way of the contacts 221 or 232, when either of the two code relays R220 and R230 operates concurrently with the relay R200. Finally, if calls to two substations served by the line 11 which are designated by ringing current having the frequency F—1 and the codes 1 and 3, respectively, are to be intercepted, the conductor C250 is cross-connected to the conductor C261. In such case the operating circuit for the intercepting relay R210 is completed through the contacts 222 or the contacts 242 when either of the two relays R220 and R240 operates concurrently with the relay R200.

In order to prevent the inadvertent interception of calls to substations for which call intercepting service is not required, and occasioned by sluggish operation of the relay R200 and the other similar relays, provisions are made for energizing the relay R340 over the pulsing lead C689 at the end of each intercepting pulse trans-

mitted over the leads C757, C758 and C759. More specifically, the relay R200, for example, may be slightly slow to release, such that it will remain in its operated position after a predetermined ringing period expires and for a portion of the next succeeding ringing period. This relay may also be energized due to a transient electrical disturbance on the line 11. As a result, the relay R200 may be inadvertently operated simultaneously with one of the coding relays R220, R230 and R240, to complete the operating circuit for the relay R210.

It will be observed that if the operating circuit for the relay R210, for example, is inadvertently completed in this manner, the operation of this relay occurs at a time when ringing current is not being applied to the associated line 11. Accordingly, the relay R320 is not operated and the relays R210 and R310 are locked up in series. As indicated previously, the interrupter 75 operates to impress ground potential upon the check pulse lead C689 at the end of each intercepting pulse. Since, under the conditions assumed, the relay R310 is operated, grounding of the check pulse lead C689 serves to energize the relay R340 over a circuit extending by way of the contacts 305, 314 and 336. The relay R340 in operating, opens, at its contacts 346, the previously traced locking circuit for the two relays R210 and R310, causing both of these relays to release. The relay R310, in releasing, opens the pulsing circuit to the relay R340, whereby the latter relay is released. Thus, the intercepting apparatus 35 is fully restored to normal and the falsely intercepted call is not extended to the operator's position 40.

From the foregoing explanation it will be understood that the intercepting apparatus 35 is, with the wiring apparatus illustrated, utilized only in intercepting calls to substations which are signaled by ringing current having the frequency F—1. It will further be understood that a plurality of intercepting relays corresponding to the illustrated relay R210 and provided in conjunction with others of the subscribers' lines for which intercepting service is required, are included in this apparatus, the link line 17 and the trunk 39 being utilized to forward calls intercepted through operation of any one of these relays to the operator's position 40. By virtue of the lockout arrangement achieved by providing operating circuits for the various intercepting relays which partially parallel each other and are controlled by the relays R310, R340 and R330, only one of the intercepting relays can be operated at any one time. The mode of operation of the duplicate set of intercepting apparatus 36 and the second trunk circuit 41 intercept calls utilizing ringing current having the frequency F—2 for signaling purposes and to extend such calls to the operator's position 40 is exactly the same as described above with reference to the apparatus 35 and the trunk circuit terminating the trunk 39. Although the call intercepting apparatus has been described with reference to the use of only three ringing codes and two ringing frequencies, it will be understood that this apparatus may, by providing additional coding relays and by proper modification of the interrupter 75, be modified to utilize a plurality of ringing frequencies and any desired number of ringing codes.

Operation of timing apparatus 55

Referring now to the operation of the timing appartus 55, it is pointed out that operation of this apparatus is initiated in response to the application of ground potential to the timer start lead C478. When this lead is connected to ground, a circuit extending by way of the contacts 521 is completed for energizing the vibratory relay R500. This relay in operating, attracts its weighted armature to close the contacts 501 and 502 associated therewith. As a result, a circuit is completed for energizing the slow-acting relay R510, this circuit extending from ground by way of the contacts 525, 545 and 501, and the winding of R510 to battery. When thus energized the relay R510 completes, at the X contacts 511, an obvious circuit for energizing the relay R520. At its contacts 512, the relay R510 completes a locking circuit for itself, this locking circuit extending from ground by way of the contacts 513 and 525 in parallel, the contacts 545, 536 and 512, and the winding of R510 to battery. At its contacts 514, the relay R510 opens a point in the common portion of the paths for impressing ground potential upon the time pulse 1 and time pulse 2 leads C480 and C479, respectively. The relay R520 operates after an interval to open, at its contacts 525, one of the multiple holding circuits for the relay R510, and to prepare, at its contacts 526, the above-mentioned paths for impressing ground potential upon the time pulse leads C479 and C480. At its contacts 522, the relay R520 opens a point in one of the circuits for energizing the relay R530. At its contacts 523, the relay R520 completes a circuit for energizing the slow-to-release relay R540, this circuit extending from ground by way of the contacts 523 and 531 and the winding of R540 to battery. At its contacts 521, the relay R520 opens the above-traced circuit for energizing the start relay R500. When the last-mentioned circuit is opened, the weighted armature of the relay R500 is released for vibration, whereby the contacts 503 are closed alternately with the contacts 501 and 502.

The relay R540, in operating, completes, at its contacts 541, an obvious multiple path for grounding the timer start lead C478 and prepares, at its contacts 542, another circuit for energizing the relay R530. At its contacts 543, the relay R540 prepares a holding circuit for itself and a holding circuit for the relay R530. At its contacts 547, the relay R540 opens a point in the path for impressing ground potential upon the time pulse 2 lead C479. At its contacts 546, the relay R540 prepares the path for impressing ground potential upon the time pulse 1 lead C480. At its contacts 545, the relay R540 opens the above-traced holding circuit for the relay R510. Finally, at its contacts 544, the relay R540 prepares an alternative holding circuit for the relay R510, this latter circuit being alternately opened and closed in response to the vibratory movement of the weighted armature controlled by the relay R500. More specifically, this alternative holding circuit extends from ground by way of the contacts 513, 544, 502 and 501, and the winding of R510 to battery. Due to the slow-to-release characteristic of the relay R510, this relay remains operated during the vibratory movement of the weighted armature controlled by the relay R500 until such time as the amplitude of vibration on this armature is diminished to a point where the contacts 501 are no longer moved into engagement. When this occurs, the relay R510 is deenergized for an interval sufficiently long to permit the restoration thereof. In releasing, the relay R510 opens the operating cir-

cuit for the relay R520 at its contacts 511, and at its contacts 513 opens a further point in the above-traced holding circuits for itself. At its contacts 514, the relay R510 completes the path for impressing ground potential upon the time pulse 1 lead C480, this path extending from ground by way of the contacts 514, 526 and 546 to the lead C480.

The relay R520, upon restoring, completes at its contacts 524, the prepared holding circuit for the relay R540, this circuit extending from ground by way of the contacts 543, 524 and 531, and the winding of R540 to battery. After this circuit is completed, the relay R520 opens the operating circuit for the relay R540 at its contacts 523. At its contacts 522, the relay R520 completes the prepared operating circuit for the relay R530, this circuit extending from ground by way of the contacts 522, 542 and 533, and the winding of R530 to battery. At its contacts 525, the relay R520 reprepares the operating circuit for the relay R510. At its contacts 521, the relay R520 recompletes the operating circuit for the relay R500.

The relay R530, upon operating, simultaneously opens, at its contacts 531, the initially traced holding circuit for the relay R540 and completes at its contacts 534 an alternative holding circuit for the relay R540. The last-mentioned circuit extends from ground by way of the contacts 522, 542 and 534, and the winding of R540 to battery. At its contacts 532, the relay R530 completes a holding circuit for itself, this holding circuit extending from ground by way of the contacts 543, 524 and 532, and the winding of R530 to battery. At its contacts 533, the relay R530 opens a point in its operating circuit as traced above. At its contacts 536, the relay R530 opens a point in one of the above-traced holding circuits for the relay R510. At its contacts 535, the relay R530 prepares an alternative holding circuit for the relay R510.

When the relay R500 operates in response to the release of the relay R520, it completes an alternative operating circuit for the relay R510, this alternative circuit extending from ground by way of the contacts 525, 544, 502 and 501, and the winding of R510 to battery. The relay R510, in operating, locks to ground through the contacts 512, 535, 544, 525 and 513. At its contacts 511, the relay R510 recompletes the operating circuit for the relay R520. The relay R520 again operates to open, at its contacts 521, the circuit for energizing the start relay R500, and to open, at its contacts 525, one of the completed holding circuits for the relay R510. At its contacts 522, the relay R520 opens the above-traced alternative holding circuit for the relay R540. At its contacts 523, the relay R520 completes an alternative holding circuit for the relay R530, this alternative circuit extending from ground through the contacts 523 and 532 and the winding of R530 to battery. After this alternative circuit is completed, the initially completed holding circuit for the relay R530 is opened at the contacts 524. When the relay R500 is deenergized, its weighted armature is again released, and vibration thereof is initiated to close the contacts 503 alternately with the contacts 501 and 502. During such vibratory movement of this armature, the relay R510 is held energized over a holding circuit which extends from ground by way of the contacts 513, 545 and 501, and the winding of R510 to battery. Accordingly, the relay R510 remains in its operated position until the amplitude of vibration of the weighted armature carried by the relay R500 is sufficiently decreased to prevent further engagement of the contacts 502. During the vibratory period of the weighted armature carried by the relay R500, the relay R540 releases to open, at its contacts 541, the multiple path for impressing ground potential upon the timer start lead C478, and to open, at its contacts 542, a further point in the operating circuit for the relay R530. At its contacts 543, the relay R540 opens a further point in the holding circuits for itself and the relay R530. At its contacts 546, the relay R540 opens a further point in the above-traced path for grounding the time pulse 1 lead C480. At its contacts 547, the relay R540 prepares a path for grounding the time pulse 2 lead C479. Thereafter, and when the relay R510 restores, the last-mentioned path is completed, this path extending from ground through the contacts 514, 526 and 547 to the lead C479. The relay R510, in releasing, also opens the operating circuit for the relay R520. The relay R520 now restores to interrupt the holding circuit for the relay R530, and to again prepare, at its contacts 521, the operating circuit for the start relay R500. At its contacts 525, the relay R520 reprepares the operating circuit for the relay R510. At its contacts 526, the relay R520 opens the above-traced path for grounding the time pulse 2 lead C479, thereby to terminate the pulse transmitted over this lead. Following the release of the relay R520, all of the relays embodied in the timing apparatus 55 are restored to normal and no further operation thereof occurs unless ground potential is still present upon the timer start lead C478. In the event this lead is still grounded when the relay R520 releases the second time, a second cycle of operation of the timing apparatus 55 is initiated, the relays embodied in this apparatus operating in the exact manner and sequence described above during the second and succeeding cycles of operation of the timing apparatus.

No-danger alarms

As indicated in the introductory portion of the specification, provisions are made for producing alarms of different types when different kinds of faults occur in the system. In general, these alarms fall into two classes, i. e. no-danger alarms and emergency alarms. A fault of the first type may be such that immediate correction of the fault is not required; whereas an emergency alarm indicates a fault requiring immediate correction in order to prevent interruption of service. Thus, if a fuse included in the power supply circuit for one of the automatic switches of the system, such, for example, as the connector switch 30, is blown, due to a fault in the associated switch, circuits are set up for transmitting a no-danger alarm signal to the supervisory operator's position 21. In such case it will be appreciated that the switch may be rendered inoperative without interrupting or interfering with operation of the system as a whole. More specifically, when a fuse of this type is open-circuited to interrupt the power supply circuit to the associated switch, a path is completed therethrough for connecting the no-danger fuse lead C409 to the negative terminal of the exchange battery, thereby to energize the relay R400. When energized, the relay R400 operates to complete, at its contacts 401, an obvious circuit for energizing the upper winding of the relay R420. The relay R420 now operates to open, at its contacts 427 and 428, points in the respective hold-

ing and operating circuits for the relay R430. At its contacts 424, the relay R420 prepares a path for transmitting ground or battery pulses of a particular code to the relay R550. At its contacts 425, the relay R420 connects negative battery through the lower winding of the relay R410 to the no-danger alarm lead C408. At its contacts 427, the relay R420 also opens a point in one of the parallel paths for impressing ground potential upon the timer start lead C478. At its contacts 421, the relay R420 disconnects the negative terminal of the exchange battery from the no-danger alarm lead C403, whereby the no-danger alarm relay normally energized over this lead, but now shown, is caused to restore to initiate the operation of an associated signal device. At its contacts 422, the relay R420 connects the audible signal lead C404 through the resistor 442 to the negative terminal of the exchange battery, thereby to cause the operation of an audible signal device which is not shown, but is connected to be energized over the lead C404. The relays R400 and R420 remain operated until the fuse responsible for the alarm is removed and replaced. The replacement of this fuse may entail the correction of a fault in the associated switch, providing a fault of this character was responsible for the open-circuited condition of the fuse.

If, for any reason, one of the switches such, for example, as the connector switch 30, fails to restore to normal after having been utilized in setting up a connection, a path is completed in a well-known manner for impressing ground potential upon the no-danger alarm lead C408 through the winding of a marginal signal control relay. When this path is completed the upper winding of the relay R410 is energized over an obvious circuit. The relay R410 now operates to complete, at its contacts 411, a path extending by way of the contacts 427 and 431 for grounding the timer start lead C478. At its contacts 412, the relay R410 prepares a circuit for energizing the relay R430. When the timer start lead C478 is grounded, operation of the timing apparatus 55 is initiated in the manner previously explained. During the operation of this apparatus, the prepared circuit for energizing the relay R430, is completed, this circuit extending from ground by way of the contacts 514, 526 and 546, C480, the contacts 412 and 428, and the lower winding of R430 to battery. When energized by the ground pulse transmitted over this circuit from the timing apparatus 55, the relay R430 operates to complete a holding circuit for itself, this holding circuit extending from ground by way of the contacts 411, 427 and 433, and the upper winding of R430 to battery. At its contacts 431, the relay R430 in operating opens the initially completed path for grounding the timer start lead C478. At its contacts 432, the relay R430 completes an obvious alternative path for grounding this start lead. At its contacts 434, the relay R430 prepares a circuit for energizing the relay R420.

In the event the fault which resulted in the grounding of the no-danger alarm lead C408 is not cleared to cause the deenergization and release of the relay R410 prior to the application of ground potential to the time pulse 2 lead C479 through operation of the timing apparatus 55 in the manner explained above, the relay R420 is caused to operate. In this regard it will be understood that if the no-danger alarm lead C408 is disconnected from ground during the interval which elapses between the application of a ground pulse to the time pulse 1 lead C480 and the application of ground potential to the time pulse 2 lead C479, the relay R410 releases to open, at its contacts 411, the holding circuit for the relay R430, whereby the latter relay is caused to release. In releasing, the relay R430 opens, at its contacts 434, the prepared operating circuit for the relay R420, and disconnects the timer start lead C478 from ground at its contacts 432.

Assuming that the relay R410 is not deenergized in the manner just explained, the relay R420 is energized and operates when the timing apparatus 55 functions to transmit a ground pulse over the time pulse 2 lead C479. The circuit for energizing this relay extends from ground by way of the contacts 514, 526 and 547, C479, the contacts 434, and the lower winding of R420 to battery. When energized over this circuit, the relay R420 operates and locks to ground through the contacts 411 and 426. At its contacts 428, the relay 420 opens a point in the above-traced operating circuit for the relay R430. At its contacts 427, the relay R420 opens the previously traced holding circuit for the relay R430, causing the latter relay to restore. At its contacts 424, the relay R420 prepares a circuit including the code pulsing lead C406 for energizing the relay R550. At its contacts 425, the relay R420 includes the low resistance lower winding of the relay R410 in the circuit including the no-danger alarm lead C408. In this regard it is pointed out above that this circuit also serially includes a marginal signal control relay. Further, the upper winding of the relay R410 is of relatively high resistance, whereby the signal control relay initially energized in series therewith does not operate. When, however, the relay R420 operates to connect the low resistance lower winding of the relay R410 in parallel with the high resistance upper winding of this relay, the signal control relay terminating the lead C408 is sufficiently energized to operate and cause the operation of a signal device which indicates the faulty condition of the associated piece of switching equipment.

At its contacts 421, the relay R420 interrupts the above-mentioned normally completed circuit for energizing the no-danger alarm relay which is connected to the no-danger alarm lead C403. At its contacts 422, the relay R420 completes the previously mentioned circuit for energizing the audible signal device associated with the lead C404. When the fault responsible for the energized condition of the relay R410 is cleared, this relay is deenergized and restores to open the locking circuit for the relay R420. The relay R420 accordingly restores, at which time the no-danger alarm relay group 45 is fully restored to normal.

Emergency alarms

When a fuse, which is included in a supply circuit that is common to a large portion of the switching equipment in the exchange, becomes open-circuited, it functions in a well known manner to connect the emergency fuse lead C407 to the negative terminal of the exchange battery, thereby to energize the emergency alarm relay R440. In operating, the relay R440 completes, at its contacts 441, an obvious circuit for energizing the upper winding of the relay R460. When thus energized, the relay R460 operates to open, at its contacts 467, a point in the operating circuit for the relay R470. At its contacts 465 and 466, the relay R460 opens points in certain of the holding

circuits for itself and the relay R470, and also a point in one of the paths for impressing ground potential upon the timer start lead C478. At its contacts 464, the relay R460 opens a point in the circuit for energizing the relay R550. At its contacts 463, the relay R460 completes an obvious path for connecting the two windings of the relay R450 in multiple. At its contacts 461, the relay R460 disconnects the emergency alarm lead C402 from the negative terminal of the exchange battery, whereby the alarm control relay normally energized over this lead is deenergized and restores to complete the operating circuit for an associated signal device. At its contacts 462, the relay R460 completes an obvious alternative path including the resistor 442 for connecting the audible signal lead C404 to the negative terminal of the exchange battery, whereby the audible signal device controlled over this lead is energized in the manner pointed out above. The two relays, R440 and R460, remain operated until the fault is cleared, and the fuse which was open-circuited to connect the lead C407 to the negative terminal of the exchange battery is removed and replaced. When negative battery potential is thus removed from the emergency fuse alarm lead C407, the relay R440 is deenergized and restores to open the circuit for energizing the relay R460. When the relay R460 releases, the emergency alarm relays are fully restored to normal.

When a switch or piece of equipment common to the exchange becomes faulty or fails to operate, the emergency alarm lead C475 is connected to ground in series with a local signal control relay, not shown. In such case, the high resistance lower winding of the relay R450 is energized, and this relay operates to complete, at its contacts 451, a path extending by way of the contacts 465 and 471 for grounding the timer start lead C478, thereby to initiate the operation of the timing apparatus 55 in the manner previously explained. At its contacts 452, the relay R450 prepares a circuit including the time pulse 1 lead C480 for energizing the lower winding of the relay R470. This circuit extends from ground by way of the contacts 514, 526 and 546, C480, the contacts 452 and 467, and the lower winding of R470 to battery, and is completed through operation of the timer 55. When thus energized, the relay R470 locks to ground through the contacts 473, 465 and 451. At its contacts 471, the relay R470 opens the initially completed path for grounding the timer start lead C478. Substantially simultaneously, the relay R470 connects this start lead to ground through its contacts 472. At its contacts 474, the relay R470 prepares a circuit for energizing the relay R460 when the timing apparatus 55 subsequently operates to impress ground potential upon the time pulse 2 lead C479. In the event the fault is cleared to cause the deenergization and release of the relay R450 during the period which elapses between the grounding of the two leads C480 and C479 by the timing apparatus 55, the operating circuit for the relay R470 is interrupted at its contacts 451 and this relay restores to open the prepared circuit for energizing the relay R460. At its contacts 472, the relay R470, in releasing, disconnects the timer start lead C478 from ground. Thus, the relays of the emergency alarm group 50 are restored to normal.

In the event the faulty condition persists, the timing apparatus 55 operates to complete the circuit for energizing the relay R460, this circuit extending from ground by way of the contacts 514, 526 and 547, C479, the contacts 474, and the lower winding of R460, to battery. When thus energized, the relay R460 operates and locks to ground through the contacts 466 and 451. At its contacts 465, the relay R460 interrupts the holding circuit for the relay R470, causing the last-mentioned relay to release. At its contacts 467, the relay R460 opens the prepared operating circuit for the relay R470. At its contacts 464, the relay R460 opens a point in the operating circuit for the relay R550. At its contacts 463, the relay R460 connects the low resistance upper winding of the relay R450 in parallel with the high resistance lower winding of this relay, whereby the signal control relay terminating the conductor C475, and connected in series with the two parallel-connected windings of the relay R450, is caused to operate. At its contacts 461, the relay R460 opens the normally completed circuit for energizing the emergency alarm signal control relay connected to the lead C402. At its contacts 462, the relay R460 completes a circuit including the resistor 442 and the lead C404 for energizing the audible signal device terminating the lead C404. The relay R470, in releasing, opens a further point in its locking circuit, and, at its contacts 472, disconnects the timer start lead C478 from ground.

The relays R450 and R460 remain operated until the fault responsible for the operation thereof is cleared, and the open-circuited fuse is removed and replaced to open the operating circuit for the relay R450. When this relay is deenergized, it restores to open the locking circuit for the relay R460. Thus, all four of the relays in the emergency alarm group 50 are released.

Operation of the ringing machine test and transfer apparatus

As explained previously with reference to the operation of the system as a whole, when the ringing apparatus start conductor C114 is connected to ground, the start relay R650 operates to impress ground potential on one of the two start conductors C693 and C698. Normally, the No. 1 set of ringing converters embodied in the ringing apparatus 785 is used, and accordingly ground potential is normally impressed upon the start lead C693. The relay R650, in operating, also prepares, at its contacts 652, a circuit for energizing the transfer relay R680. At its contacts 653, the relay R650 completes a path for grounding the timer start lead C478, this path extending from ground by way of the contacts 661, 686, 653, 631, 612 and 601 to the conductor C478. At its contacts 653, the relay R650 also prepares holding circuits, traced hereinafter, for the two relays R620 and R630. At its contacts 655, the relay R650 prepares a circuit for energizing the relay R600. At its contacts 654, the relay R650 prepares a circuit for energizing the relay R640. In the event the No. 1 set of ringing converters embodied in the ringing apparatus 785 is in proper working order, ringing voltage is impressed upon the lead C750' to energize the relay R640 over a circuit which extends from this lead by way of the contacts 722, C749, the contacts 702, C688, the condenser 656, the winding of R640, and the contacts 654 to the low potential output terminal of the ringing converter. When energized over this circuit the relay R640 operates further to prepare, at its contacts 641, the holding circuits for the relays R620 and R630.

Shortly following the operation of the relay

R650, the interrupter 75 operates in the manner previously explained to impress ground potential upon the pulse lead C779. When this lead is grounded, the relay R620 is energized over a circuit including its lower winding, the contacts 634, and the lead C779. The relay R620 now operates and locks to ground over a circuit including the contacts 621, 632, 641, 653, 686 and 661. At its contacts 622, the relay R620 prepares a circuit for energizing the slow-acting relay R630. At its contacts 623, the relay R620 opens the path normally short-circuiting the two windings of the relay R630.

As explained previously with reference to the operation of the interrupter 75, after six ringing periods have elapsed during each cycle of operation thereof, the transfer relay R720 operates to connect the ground pulsing conductors C775, C776 and C777 to the intercepting leads C760, C761 and C762. Shortly thereafter, and more specifically during the seventh ringing period of each ringing cycle, a ground pulse is impressed upon the intercepting lead C760 and the check pulse lead C780. When the lead C780 is grounded, the upper winding of the relay R630 is energized over a circuit including this lead and the operated contacts 622. In operating, the relay R630 completes, at its X contacts 633, a locking circuit for itself, this circuit extending from ground by way of the contacts 661, 686, 653, 641, 633 and the lower winding of R630 to battery. At its contacts 635, the relay R630 opens the prepared circuit for the relay R600. At its contacts 632, the relay R630 opens the locking circuit for the relay R620, causing the latter relay to restore. At its contacts 634, the relay R630 opens the prepared operating circuit for the relay R620. At its contacts 631, the relay R630 opens the above-traced path over which the timer start lead C478 is connected to ground. The relay R620 in releasing, opens, at its contacts 621, a further point in its locking circuit, and, at its contacts 622, opens the prepared operating circuit for the relay R630. At its contacts 623, the relay R620 connects the two windings of the relay R630 in parallel. The three relays R650, R640 and R630 remain operated until such time as ground potential is removed from the ringing apparatus start lead C114. When this lead is disconnected from ground, the three relays R650, R640 and R630 restore in the order named and in an obvious manner. Thus, the relays of the ringing apparatus test group 65 are all released.

From the foregoing explanation it will be apparent that the operation of the relay R630, in response to operation of the relay R650, only occurs if the associated ringing apparatus 785 and the interrupter 75 are in proper working order. Thus, if the No. 1 set of converters in the apparatus 785 fails to operate in response to the application of ground potential to the start lead C693, ringing current will not be transmitted over the conductor C688 to energize the relay R640. The relay R630 will thus be prevented from operating. Again, if the interrupter 75 fails to operate properly, the check pulses are not transmitted by way of the two leads C779 and C780 to cause the operation of the relays R620 and R630. Thus, the relay R630 is only operated when the associated ringing equipment is operating in the desired manner. Each time the start relay R650 operates to impress ground potential upon the timer start lead C478, the timing apparatus 55 operates through one cycle. With the ringing equipment operating properly, the relay R630 will be energized and operated before the timing apparatus 55 operates to impress ground potential upon the time pulse 1 lead C480. If, however, a fault is present in this equipment so that the relay R630 is not energized, the timing apparatus 55, upon operating to ground the lead C480, completes a circuit for energizing the lower winding of the relay R600, this circuit extending by way of the grounded conductor C480, the contacts 655, 635 and 615, and the lower winding of R600 to battery. When energized over this circuit, the relay R600 operates and locks to ground through the contacts 603, 613, 631, 653, 686 and 661. At its contacts 601, the relay R600 breaks the initially completed path for grounding the timer start lead C478. At its contacts 602, the relay R600 completes an obvious alternative path for grounding the lead C478. At its contacts 604, the relay R600 prepares a circuit for energizing the relay R610 when the timing apparatus 55 subsequently operates to impress ground potential upon the time pulse 2 lead C479. In the event the relay R630 is caused to operate during the interval which elapses between the application of a ground pulse to the lead C480 and the application of a ground pulse to the lead C479, the holding circuit for the relay R600 is broken at the contact 631, and the operating circuit for this relay is broken at the contacts 635. The relay R600 is thus deenergized and restores to open the prepared operating circuit for the relay R610. On the other hand, if the relay R630 is not operated during the indicated time interval, the relay R610 is energized over a circuit including the contacts 604 and the lead C479, when the timing apparatus 55 operates to impress ground potential upon this lead. Upon operating, the relay R610, at its contacts 615, opens the prepared operating circuit for the relay R600, and at its contacts 614 locks to ground over a path including the contacts 631, 653, 686 and 661. At its contacts 613, the relay R610 opens the holding circuit for the relay R600, causing the last-mentioned relay to restore. At its contacts 612, the relay R600 opens the initially completed path for grounding the timer start lead C478. The relay R600, in releasing, disconnects the timer start lead C478 from ground at the contacts 602, and at its contacts 604, opens the prepared operating circuit for the relay R610.

When the relay R610 operates, it also completes a circuit for energizing the transfer relay R680, this circuit extending from ground by way of the contacts 611, 652 and 675, and the winding of R680 to battery. The relay R680, upon operating, locks to ground through the contacts 685, the winding of R670, and the contacts 661. At its contacts 685, the relay R680 also completes an obvious path for short-circuiting the winding of the relay R670. At its contacts 686, the relay R680 opens a point in the previously traced locking circuits for the relays R600, R610, R620 and R630, thus causing the relay R610 to restore. Upon restoring, the relay R610 reprepares the operating circuit for the relay R600 and opens, at its contacts 611, the path short-circuiting the winding of the relay R670. When this short-circuiting path is broken, the relay R670 is energized in series with the relay R680. In operating, the relay R670 completes, at its contacts 678, an obvious circuit for energizing the signal lamp 687. At its contacts 677, the relay R670 prepares obviously alternative locking circuits for the relays R600, R610, R620 and R630. At its contacts 675, the relay R670 opens a further

point in the operating circuit for the relay R680 and a further point in the path for short-circuiting its own winding. At its contacts 674, the relay R670 connects the supervisory test lead 16c to ground. At its contacts 671 and 672, the relay R670 disconnects the supervisory test lead 14c from ground and connects this lead to battery through the winding of the slow-to-operate relay R660. At its contacts 676, the relay R670 prepares a path for impressing ground potential upon the ringing apparatus alarm conductor C477. When the transfer relay R680 operates in the manner explained above, it disconnects the grounded tone start lead C116 from the start conductor C692 extending to the No. 1 set of dial and busy tone generators 690, whereby operation of these generators is arrested. At its contacts 682, the relay R680 connects the start lead C116 to the start conductor C697, extending to the No. 2 set of dial and busy tone generators 695, whereby operation of these generators is initiated. At its contacts 683, the relay R680 opens the path extending from ground at the contacts 651 for grounding the start conductor C693, extending to the No. 1 set of ringing converters provided in the apparatus 785. At the contacts 684, the relay R680 connects the start conductor C698, individual to the No. 2 set of ringing converters, to ground through the operated contacts 651. Thus, the operation of the No. 1 set of ringing converters is arrested and operation of the No. 2 set of converters is initiated. The two relays, R670 and R680, remain operated until the transfer relay R680 is energized. It will be understood, therefore, that the dial and busy tone apparatus 695 and the No. 2 set of ringing converters embodied in the apparatus 785, are used until operation of the transfer relay R660 is effected.

After operation of the No. 2 set of ringing converters has been initiated in the manner just explained, the ringing apparatus test relays 65 operate in the manner just explained to again test the operation of the ringing equipment. In the event the fault responsible for the transfer to the No. 2 set of ringing converters is present in the No. 1 set of ringing converters, the test relays 65 will operate in the manner explained above to indicate that the ringing equipment is again in proper working order. If, however, the No. 2 set of ringing converters is also defective, or the fault is present in the interrupter 75, the relay R630 of the test relay group will not be energized. Accordingly, after a predetermined time interval, the relay R610 is energized in the manner previously explained, and operates to complete a path extending through the contacts 611, 652 and 676 for impressing ground potential upon the alarm conductor C477. When this conductor is grounded, the relay R460 is energized and operates to perform the functions previously described, among which is the interruption of the prepared circuit for energizing the relay R550. In this case the relay R610 remains operated until the start relay R650 is released.

Supervisory test

If the operator attending the supervisory position 21 desires to ascertain the condition of the power and supervisory apparatus illustrated in Figs. 4 to 9, inclusive, of the drawings, she may do so by initiating a call and dialing the digits of the directory number designating the supervisory trunk comprising the conductors 13a and 13c. Assuming that the call is routed through the incoming selector switch 22 and the connector switch 30 to this supervisory trunk, the wipers of the connector switch 30 are positioned on the contacts terminating the conductors 13a and 13c at the end of the third digit. Normally, negative battery potential is impressed upon the private conductor 13c of the supervisory trunk through the lower winding of the relay R570 and the contacts 574. Accordingly, this trunk will test idle when seized by the connector switch 30. The relay R110 is thus caused to operate to complete a circuit for energizing the relay R560 in series with the upper winding of the ring cut-off relay R100, this circuit extending from ground by way of the resistor 563, the winding of R560, the contacts 571, the conductor 13b, the resistor 662, the conductor 13a, the contacts 111 and 101, and the upper winding of R100 to battery. When energized over this circuit, the relay R100 operates to complete a signaling circuit which extends from the power and supervisory apparatus to the telephone set in use at the supervisory operator's position 21. In operating, the relay R100 also lock to ground through the contacts 103, and at its contacts 102 completes a circuit for energizing the relay R560 in series with the upper winding of the back-bridge relay R90. It is noted that the resistance values of the resistors 563 and 662 included in this circuit are such that the back-bridge relay R90 is insufficiently energized to operate. The relay R560, however, is sufficiently energized to operate. If the arrangement of the system is such that the operation of the back-bridge relay R90 is required on a supervisory call of this character, the resistor 662 may be excluded from the series operating circuit for this relay by providing a short-circuiting strap 663 connected between the conductors 13a and 13b. With the resistor 662 thus effectively removed from the circuit for energizing the relay R90, this relay will be sufficiently energized to operate and perform the functions assigned thereto.

During the operation of the connector switch 30, certain of the relays embodied therein operate in the usual manner to impress ground potential upon the private conductor 13c of the supervisory trunk. When this conductor is grounded, the lower winding of the relay R570 is obviously energized over a circuit including the contacts 574. This lower winding is, however, of exceedingly high resistance and, accordingly, the relay R570 is insufficiently energized to operate. When the relay R560 is energized in series with the ring cut-off relay R100, vibratory movement of the weighted armature controlled thereby is initiated. After a predetermined time interval, this movement is arrested and the contacts 561 settle into resting engagement. An obvious circuit is thus completed for energizing the upper winding of the slow-to-release relay R570. This relay operates after an interval and locks through the contacts 573 to the grounded private conductor 13c. At its contacts 571, the relay R570 opens the circuit for energizing the relay R560. At its contacts 575, the relay R570 completes an obvious multiple circuit for energizing the relay R650. At its contacts 572, the relay R570 prepares a circuit for transmitting ringing current over the established connection to the supervisory operator's position 21. At its contacts 576, the relay R570 prepares or completes a circuit for energizing the relay R550. In this regard it will be recalled from the preceding explanation that, if all of the

switching and power equipment is in proper working order, the conductor C476 is connected to the No. 2 code lead C405. This code lead may be cross-connected to one of the coding conductors of the interrupter 75 so that ground or battery pulses, depending upon the type of ringing in use, will be transmitted thereover so long as the interrupter is operating. Assuming that ground pulses are transmitted by way of the code leads C405 and C406, the X wiring illustrated in Fig. 5 of the drawings is used. On the other hand, if negative battery pulses are transmitted over these two code leads during operation of the interrupter 75, the Y wiring illustrated in Fig. 5 of the drawings is used.

Assuming that all of the apparatus is in proper working order, coded current pulses are transmitted to the relay R550, following operation of the relay R570 over a circuit including the lead C405, the contacts 423 and 464, the conductor C476, and the contacts 576. The relay R550 follows these coded current pulses and repeats the pulses as interrupted ringing current pulses over the established connection extending to the supervisory operator's position 21. More specifically, the path traversed by the ringing current may partially be traced as extending by way of the ringing current conductor C749, the condenser 552, the contacts 551 and 572, the conductors 13b and 13a, to the negative side of the established connection. The coded character of the signals produced by these ringing current pulses, as determined by the coded current pulses transmitted over the lead C405, indicates to the supervisory operator that the equipment is in porper working order.

It will be recalled from the preceding explanation that when a no-danger fault is present in the apparatus, the relay R420 is operated. With this relay operated, current pulses coded in a manner different from the coding of the pulses impressed on the lead C405 are transmitted over the lead C406, through the contacts 424 and 464, over the conductor C476 and through the contacts 576 to cause the operation of the pulsing relay R550. Accordingly, a different coded signal is transmitted to the supervisory operator to indicate that a no-danger fault exists in the apparatus. It will also be recalled from the preceding explanation that when an emergency fault is present in the apparatus, the relay R460 is operated. With this relay operated, the pulsing circuit to the relay R550 is held open at the contacts 464, and hence the relay R550 is not energized at any time in response to operation of the relay R570. In such case, no signal will be transmitted to the supervisory operator, whereby the operator is informed that a fault requiring immediate attetnion is present in the apparatus.

When the supervisory connection is released at the operator's position 21, the selector switch 22 and the connector switch 30 are caused sequentially to release in the order named and in the manner previously explained. During the release of the connector switch 30, the private conductor 13c of the supervisory trunk is disconnected from ground to open the holding circuit for the relay R570, and the operating circuit for the relay R560 is interrupted. The relay R570 now restores to reprepare, at its contacts 571, the operating circuit for the relay R560 and to open, at its contacts 572, the previously traced path for conducting ringing current to the negative side of the established supervisory connection. At its contacts 573, the relay R570 opens a further point in its locking circuit. At its contacts 575, the relay R570 opens the previously traced alternative circuit for energizing the start relay R650. At its contacts 576, the relay R570 opens the above-traced pulsing circuit for the relay R550. Thus, the supervisory test relays are all released.

Transfer of the ringing apparatus from the supervisory operator's position

As indicated previously, provisions are made whereby the supervisory operator attending the position 21 may control the transfer relays 70 to condition either set of ringing and tone apparatus for use in providing signaling currents. Assuming that the tone generators 690 and the No. 1 set of ringing converters in the apparatus 785 are in use, and that the operator desires to cut this equipment out of service and to substitute the tone generators 695 and the No. 2 set of ringing converters therefor, she may do so by initiating a call and dialing the directory number designating the supervisory lead 16c. It will be recalled from the preceding explanation that under these conditions the two relays R670 and R680 occupy their respective restored positions and that in order to effect a transfer operation of the character described, it is necessary to cause the operation of the relay R680. Assuming that the supervisory connection is routed by way of the incoming selector switch 22 and the connector switch 30, when the wipers of this connector switch are positioned on the set of contacts which includes the contact terminating the conductor 16c, the previously described line test operation is performed. Assuming that the two relays R670 and R680 are both restored when the line test is made, the supervisory lead 16c will test idle due to the application of negative battery potential thereto through the winding of the relay R680 and the contacts 673. In this regard it will be apparent that if the two relays R670 and R680 are operated, the lead 16c is connected to ground through the contacts 674 so that it will test busy, with the result that the usual busy tone signal will be returned to the supervisory operator 21. This signal will inform the operator that the tone generators 695 and the No. 2 set of ringing converters are already in use.

Assuming that the lead 16c tests idle, the connector switch 30 operates in the manner previously explained to impress ground potential upon this lead, whereby a circuit including the contacts 673 is completed for energizing the transfer relay R680. This relay, in operating, locks to ground through the contacts 685, the winding of the relay R670 and the contacts 661, and in so doing completes a path including the ground conductor 16c for short-circuiting the winding of the relay R670. At its contacts 686, the relay R680 opens a point in the previously traced holding circuits for the relays R600, R610, R620 and R630, and a point in one of the paths for impressing ground potential upon the timer start lead C478. At its contacts 681 and 682, the relay R680 switches the start conductor C116 from the No. 1 start lead C692 to the No. 2 start lead C697. At its contacts 683 and 684, the relay R680 opens the path for impressing ground potential upon the No. 1 ringing converter start lead C693 and completes the path for impressing ground potential upon the No. 2 ringing converter start lead C698. Thus, the desired transfer operation is effected.

When the supervisory connection extending to the operator's position 21 is released, the connector switch 30 in restoring to normal discon-

nects the supervisory lead 16c from ground, whereby the path short-circuiting the winding of the relay R670 is interrupted. This relay is now energized in series with the relay R680 and operates to prepare, at its contacts 677, alternative holding circuits for the ringing apparatus test relays 65 and an alternative path for grounding the timer start lead C478. At its contacts 679 the relay R670 completes the circuit for energizing the signal lamp 697. At its contacts 675, the relay R670 opens a point in one of the operating circuits for the transfer relay R680. At its contacts 676 the relay R670 prepares one of the paths for impressing ground potential upon the alarm conductor C477. At its contacts 673 and 674, the relay R670 opens a point in the above-traced operating circuit for the relay R680 and connects the supervisory lead 16c to ground. At its contacts 671 and 672, the relay R670 disconnects the supervisory lead 14c from ground and prepares the operating circuit for the slow-to-operate relay R660.

Following the operations described above, if the supervisory operator attending the position 21 desires to effect a second transfer operation to substitute the tone generators 690 for the tone generators 695, and the No. 1 set of ringing converts for the No. 2 set of converters in operation, she may do so by routing a connection to the second supervisory lead 14c. Assuming that the connection is routed through the incoming selector switch 22 and the connector switch 30, the connector switch, upon operating its wipers to engage the contacts of the set including the contact terminating the conductor 14c, will perform a line testing operation in the manner previously pointed out. Under the conditions assumed, the relay R670 is operated so that negative battery potential is impressed upon the supervisory lead 14c through the winding of the relay R660 and the contacts 672. Accordingly, this supervisory lead will test idle. It will be noted, however, that if the relay R670 occupies its restored position at the time the supervisory lead 14c is seized, this lead will test busy due to the application of ground potential thereto through the contacts 671. When the supervisory lead 14c tests idle, the connector switch 30 operates in the manner previously explained to impress ground potential thereon, whereby a circuit extending through the contacts 672 is completed for energizing the slow-to-operate relay R660. This relay, in operating, opens, at its contacts 661, the previously traced series-locking circuit for the two relays R670 and R680, causing both of these relays to restore. When the relay R680 restores, the start circuits are rearranged so that the tone generators 690 and the No. 1 set of ringing converters in the apparatus 785 are conditioned for operation in response to the application of ground potential to the start conductors C116 and C693, respectively. The relay R680, in releasing, also opens a further point in the circuit serially including its own winding and the winding of the relay R670. At its contacts 686, the relay R680 again prepares the previously traced control circuits for the ringing apparatus test relays 65. The relay R670 in releasing, interrupts the operating circuit for the relay R660 and connects the supervisory lead 14c to ground through the contacts 671. At its contacts 674, the relay R670 disconnects the supervisory lead 16c from ground. At its contacts 673, the relay R670 reprepares the operating circuit for the transfer relay R680, and opens, at its contacts 675, the prepared path for impressing ground potential upon the alarm conductor C477. At its contacts 675, the relay R670 reprepares one of the operating circuits for the relay R680. At its contacts 677, the relay R670 opens the prepared control circuits for the ringing apparatus test relays 65. Finally, the relay R670, at its contacts 678, opens the circuit for energizing the signal lamp 697. Thus, the ringing apparatus transfer relays are all restored to normal. Following the release of these relays in the manner just explained, the connection including the selector switch 22 and the connector switch 30, may be released under the control of the supervisory operator attending the position 21.

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 contemplated 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 plurality of lines, means for setting up connections between said lines, means including two sources of ringing current having different frequencies for signaling over said lines, and a pair of call intercepting circuits each common to a group of said lines and respectively controlled by the ringing currents of said different frequencies for intercepting calls routed to certain of said lines.

2. In a telephone system, a plurality of lines, means for setting up connections between said lines, ringing apparatus including two sources of ringing current having different frequencies and a ringing interrupter operative to provide interrupted ringing voltages of said different frequencies, means including said ringing apparatus for signaling over called one of said lines, and a pair of call intercepting circuits each common to a group of said lines and respectively controlled by interrupted ringing currents of said different frequencies for intercepting calls routed to certain of said lines.

3. In a telephone system, a plurality of lines including a group of multiparty lines, means for setting up connections between said lines, means for providing coded ringing voltages of different frequencies, means for selectively impressing said coded ringing voltages of different frequencies upon called ones of said multiparty lines, thereby selectively to signal the substations associated with said multiparty lines, and a plurality of call intercepting circuits respectively controlled by said coded ringing voltages of different frequencies for intercepting predetermined calls routed to certain of said multiparty lines.

4. In a telephone system, a plurality of lines including a group of multiparty lines, means for setting up connections between said lines, ringing apparatus including two sources of ringing current having different frequencies and a ringing interrupter operative to provide differently coded ringing voltages of said different frequencies, means for selectively impressing said coded ringing voltages of different frequencies upon called ones of said multiparty lines, thereby selectively to signal the substations associated with said called lines, and a pair of call intercepting circuits respectively controlled by said coded ringing voltages of different frequencies for intercepting predetermined calls routed to certain of said multiparty lines.

5. In a telephone system, an operator's posi-

tion, a plurality of lines including a group of multiparty lines, means for setting up connections between said lines, means for providing coded ringing voltages of different frequencies, means for selectively impressing said coded ringing voltages of different frequencies upon called ones of said multiparty lines, thereby selectively to signal the substations associated with said called lines, a plurality of call intercepting circuits respectively controlled by said ringing voltages of different frequencies, each of said intercepting circuits including means for discriminating between different ringing codes, whereby only calls intended for predetermined substations associated with said multiparty lines are intercepted thereby, and means including said intercepting circuits for extending to said operator's position calls intended for said predetermined substations.

6. In a telephone system, an operator's position, a plurality of lines including a group of multiparty lines, means for setting up connections between said lines, ringing apparatus including two sources of ringing current having different frequencies and a ringing interrupter operative to provide differently coded ringing voltages of said different frequencies, means for selectively impressing said coded ringing voltages of different frequencies upon called ones of said multiparty lines, thereby selectively to signal the substations associated with said called lines, a pair of call intercepting circuits respectively controlled by said ringing voltages of different frequencies, each of said intercepting circuits including means for discriminating between different ringing codes, whereby only calls intended for predetermined substations associated with said lines are intercepted thereby, and means including said intercepting circuits for extending to said operator's position calls intended for said predetermined substations.

7. In a telephone system, a subscribers line adapted to have a plurality of substations associated therewith, ringing apparatus including a plurality of ringing leads, a plurality of intercepting leads and a ringing interrupter including coding means for impressing differently coded ringing voltages upon said ringing leads and for impressing a predetermined potential upon each of said intercepting leads during an interval at least partially overlapping one of the intervals when ringing voltage is applied to the corresponding ringing lead, means for selectively impressing said coded ringing voltages upon said line, thereby selectively to signal said substations, relays individual to said intercepting leads and each operative in response to the application of said predetermined potential to the corresponding intercepting lead, and means jointly controlled by the operation of one of said relays and the application of ringing voltages of a particular code to said line for intercepting calls intended for the substation designated by said particular code.

8. In a telephone system, a subscribers line adapted to have a plurality of substations associated therewith, ringing apparatus including a plurality of ringing leads, a plurality of intercepting leads and a ringing interrupter including coding means for impressing differently coded ringing voltages upon said ringing leads and for impressing a predetermined potential upon each of said intercepting leads during an interval at least partially overlapping one of the intervals when ringing voltage is applied to the corresponding ringing lead, means for selectively impressing said coded ringing voltages upon said line, thereby selectively to signal said substations, relays individual to said intercepting leads and each operative in response to the application of said predetermined potential to the corresponding intercepting lead, and means operative in response to the application of ringing voltage of a particular code to said line concurrent with the operation of a predetermined one of said relays for intercepting calls intended for the substation designated by said particular code.

9. In a telephone system, a first line, a subscribers line, an automatic switch having access to said subscribers line, said automatic switch including ring cut-off and back-bridge relays and means for impressing ringing voltage upon said subscribers line when said subscribers line is selected thereby, an operator's position, a trunk extending to said operator's position, and a call intercepting circuit terminating one end of said trunk, said circuit including a ringing relay operative to impress ringing voltage upon said trunk, means responsive to the application of ringing voltage to said subscribers line for energizing said ringing relay, a partially common energizing circuit for said ring cut-off and back-bridge relay, means including a second ring cut-off relay controllable from said operator's position for completing said energizing circuit, and means included in said energizing circuit for preventing the operation of said back-bridge relay when said energizing circuit is completed.

10. In a telephone system, a first line, a subscribers line, an automatic switch having access to said subscribers line, said automatic switch including ring cut-off and back-bridge relays and means for impressing ringing voltage upon said subscribers line when said subscribers line is selected thereby, an operator's position, a trunk extending to said operator's position, and a call intercepting circuit terminating one end of said trunk, said circuit including a ringing relay operative to impress ringing voltage upon said trunk, means responsive to the application of ringing voltage to said subscribers line for energizing said ringing relay, a partially common energizing circuit for said ring cut-off and back-bridge relays, means including a second ring cut-off relay controllable from said operator's position for momentarily completing said energizing circuit when a call routed over said trunk is answered at said operator's position, and means comprising a current limiting element included in said energizing circuit for preventing the operation of said back-bridge relay when said energizing circuit is completed.

11. In a telephone system, a line, means for seizing said line on a call routed thereto, a call intercepting circuit, means operative in response to seizure of said line for initiating operation of said circuit to intercept a call routed to said line, and means for releasing said circuit in the event the operation thereof to intercept said call is not completed within a predetermined time interval.

12. In a telephone system, a line, means for impressing ringing voltage upon said line when a call is routed to said line from another line of the system, a call intercepting circuit, means operative in response to the application of ringing voltage to said line for initiating operation of said circuit to intercept the call routed to said line, and means for releasing said circuit in the event the operation thereof to intercept said call

is not completed within a predetermined time interval.

13. In a telephone system, a line, a circuit operative to intercept calls routed to said line from the other lines of the system in response to ringing voltage impressed on said line, means including a ringing interrupter for impressing interrupted ringing voltage upon said line, and means controlled by said interrupter for releasing said circuit in the event the operation thereof to intercept a call is not completed within a predetermined time interval.

14. In a telephone system, a line, means for developing ringing voltage pulses and check pulses in timed relation, means for routing a call to said line from another line of the system and for impressing said ringing voltage pulses upon said line, a call intercepting circuit, means operative in response to a ringing voltage pulse applied to said line for initiating operation of said circuit to intercept the call routed to said line, and means controlled by one of said check pulses for releasing said circuit in the event the operation thereof to intercept said call is not completed within a predetermined time interval.

15. In a telephone system, a line, means for developing intercepting pulses and check pulses, a call intercepting circuit including means controlled by said intercepting pulses for intercepting calls routed to said line from the other lines of the system, and means controlled by said check pulses for releasing said circuit in the event the operation thereof to intercept a call is not completed within a predetermined time interval.

16. In a telephone system, a line, means for developing non-overlapping intercepting and check pulses, a call intercepting circuit including means operative in response to one of said intercepting pulses for initiating operation of said circuit to intercept a call routed to said line from another line of the system, and means operative in response to one of said check pulses following said one intercepting pulse for releasing said circuit in the event operation of said circuit to intercept said call is not completed within a predetermined time interval.

17. In a telephone system, a line, means for developing non-overlapping intercepting and check pulses, a call intercepting circuit including means operative in response to one of said intercepting pulses for initiating operation of said circuit to intercept a call routed to said line from another line of the system, and means operative in response to the check pulse next succeeding said one intercepting pulse for releasing said circuit in the event operation of said circuit to intercept said call is not completed during the period of said one intercepting pulse.

18. In a telephone system, a line, means for impressing ringing voltage upon said line, means for developing intercepting and check pulses, and a call intercepting circuit including a line switching relay operative to connect said line to said circuit, means responsive to the application of ringing voltage to said line and to one of said intercepting pulses for energizing said relay, means including a second relay operative in response to one of said check pulses for deenergizing said line switching relay, thereby to release said circuit, in the event operation of said circuit to intercept the call routed to said line is not completed before said second relay operates, and means normally operative to prevent said second relay from responding to said check pulses.

19. In a telephone system, a line, means for impressing ringing voltage upon said line, means for developing intercepting and check pulses, and a call intercepting circuit including a line switching relay operative to connect said line to said circuit, means responsive to the application of ringing voltage to said line and to one of said intercepting pulses for energizing said relay, means including a second relay operative in response to one of said check pulses for deenergizing said line switching relay, thereby to release said circuit, in the event operation of said circuit to intercept the call routed to said line is not completed before said second relay operates, and means including a third relay energized by ringing current transmitted over said line to said circuit following operation of said line switching relay for preventing said second relay from responding to said check pulses.

20. In a telephone system, a line, ringing apparatus including a ringing interrupter operative to develop ringing voltage pulses, intercepting pulses and check pulses, means for routing a call to said line from another line of the system and for impressing said pulses of ringing voltage upon said line, and a call intercepting circuit including means jointly controlled by one of said intercepting pulses and the application of ringing voltage to said line for initiating the operation of said circuit to intercept said call, and means controlled by one of said check pulses for releasing said circuit in the event operation thereof to intercept said call is not completed within a predetermined time interval.

21. In a telephone system, a line, ringing apparatus including a ringing interrupter operative to develop non-overlapping intercepting and check pulses and ringing voltage pulses certain of which at least partially overlap said intercepting pulses, means for routing a call to said line from another line of the system and for impressing said pulses of ringing voltage upon said line, and a call intercepting circuit including means responsive to the concurrent occurrence of one of said ringing voltage pulses and a predetermined one of said intercepting pulses for initiating operation of said circuit to intercept the call routed to said line, and means operative in response to one of said check pulses following said one intercepting pulse for releasing said circuit in the event operation of said circuit to intercept said call is not completed within a predetermined time interval.

22. In a telephone system, a line, ringing apparatus including a ringing interrupter operative to develop non-overlapping intercepting and check pulses and ringing voltage pulses certain of which at least partially overlap said intercepting pulses, means for routing a call to said line from another line of the system and for impressing said pulses of ringing voltage upon said line, and a call intercepting circuit including means responsive to the concurrent occurrence of one of said ringing voltage pulses and a predetermined one of said intercepting pulses for initiating operation of said circuit to intercept the call routed to said line, and means operative in response to the check pulse next succeeding said one intercepting pulse for releasing said circuit in the event operation of said circuit to intercept said call is not completed during the period of said one intercepting pulse.

23. In a telephone system, a line adapted to have a plurality of substations associated therewith, means for routing calls to said line from

other lines of said system and for selectively signaling said substations, a call intercepting circuit including means operative in response to the routing of a call to said line intended for a predetermined one of said substations for initiating operation of said circuit to intercept said call, and means for releasing said circuit in the event operation of said circuit to intercept said call is not completed within a predetermined time interval.

24. In a telephone system, a line adapted to have a plurality of substations associated therewith, means for providing ringing voltages having a plurality of station selecting characteristics, means for routing calls to said line from the other lines of the system and for selectively impressing said voltages upon said line in order selectively to signal said substations, a call intercepting circuit including means operative in response to the application of a predetermined one of said voltages to said line for initiating operation of said circuit to intercept the call routed to said line, and means for releasing said circuit in the event operation thereof to intercept said call is not completed within a predetermined time interval.

25. In a telephone system, a line adapted to have a plurality of substations associated therewith, ringing apparatus for providing ringing voltages having different station selecting characteristics and including means for providing check pulses, means for routing calls to said line from the other lines of the system and for selectively impressing said voltages upon said line in order selectively to signal said substations, a call intercepting circuit including means operative in response to the application of a predetermined one of said voltages to said line for initiatng operation of said circuit, and means controlled by one of said check pulses for releasing said circuit in the event the operation thereof to intercept the call is not completed within a predetermined time interval.

26. In a telephone system, a line, adapted to have a plurality of substations associated therewith, ringing apparatus including a ringing interrupter operative to provide differently coded ringing voltages, each of said codes corresponding to one of said substations and including one or more voltage pulses, said interrupter including means for developing non-operlapping intercepting and check pulses so timed with respect to said ringing voltage pulses that each of said intercepting pulses as least partially overlaps one of the ringing voltage pulses of a corresponding one of said codes, means for routing calls to said line from the other lines of the system and for selectively impressing said ringing voltages of different codes upon said line, thereby selectively to signal said substations, and a call intercepting circuit including means responsive to the occurrence of a predetermined one of said intercepting pulses at least partially concurrent with the application of a ringing voltage pulse to said line for initiating the operation of said circuit to intercept the call routed to said line, and means operative in response to one of said check pulses following said intercepting pulse for releasing said circuit in the event operation of said circuit to intercept said call is not completed within a predetermined time interval.

27. A ringing interrupter comprising a plurality of ringing leads, a plurality of call supervisory leads, and cyclically operative apparatus for impressing different station designating ringing voltages upon said ringing leads during each cycle of operation thereof and for impressing a predetermined potential upon said supervisory leads during predetermined intervals individually corresponding to said different voltages.

28. A ringing interrupter comprising a plurality of ringing leads, a plurality of call intercepting leads individually corresponding to said ringing leads, and cyclically operative apparatus for impressing differently coded ringing voltages upon said ringing leads during each cycle of operation thereof and for impressing a predetermined potential upon each of said intercepting leads for an interval during each cycle of operation of said apparatus which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

29. A ringing interrupter comprising a plurality of ringing leads, a plurality of call intercepting leads individually corresponding to said ringing leads, a start relay, a plurality of coding relays cyclically operative in response to operation of said start relay, circuits controlled by said coding relays for impressing differently coded ringing voltages upon said ringing leads, and additional circuits controlled by said coding relays for impressing a predetermined potential upon each of said intercepting leads for an interval which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

30. A ringing interrupter comprising a plurality of ringing leads, a plurality of call intercepting leads individually corresponding to said ringing leads, a plurality of coding relays, means comprising a plurality of cyclically operating timing relays for causing the cyclic operation of said coding relays, circuits jointly controlled by said coding relays and said timing relays for impressing differently coded ringing voltages upon said ringing leads, and additional circuits jointly controlled by said coding relays and said timing relays for impressing a predetermined potential upon each of said intercepting leads for an interval which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

31. A ringing interrupter comprising a plurality of ringing leads, a plurality of call intercepting leads individually corresponding to said ringing leads, a start relay, a plurality of coding relays energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods of equal duration, means including said timing relays for sequentially deenergizing said coding relays at the rate of one for each cycle of operation of said timing relays and for again energizing all of said coding relays at the end of a predetermined number of cycles of operation of said timing relays, whereby said coding relays are controlled to operate in a cyclic manner, circuits jointly controlled by said coding relays and said timing relays for impressing differently coded ringing voltages upon said ringing leads during each of predetermined cycles of operation of said coding relays, and additional circuits jointly controlled by said coding relays and said timing relays for impressing a predetermined potential upon each of said intercepting leads for an interval during each of said predetermined cycles of operation of said coding relays which at least partially over-

laps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

32. In combination with first and second ringing current sources having different frequencies, a ringing interrupter comprising first and second sets of ringing leads, call intercepting leads individually corresponding to said ringing leads, cyclically operative coding apparatus for impressing the voltage of said first source upon the ringing leads of said first set during predetermined periods of one cycle of operation of said coding apparatus and for impressing the voltage of said second source upon the ringing leads of said second set during predetermined periods of the next cycle of operation of said coding apparatus, and circuits controlled by said coding apparatus for impressing a predetermined potential upon each of said intercepting leads during an interval which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

33. In combination with first and second ringing current sources having different frequencies, a ringing interrupter comprising first and second sets of ring-leads, call intercepting leads individually corresponding to said ringing leads, cyclically operative coding apparatus, transfer means controlled by said coding apparatus, circuits jointly controlled by said coding apparatus and said transfer means for connecting the ringing leads of said first set to said first ringing current source during predetermined periods of one cycle of operation of said coding apparatus and for connecting the ringing leads of said second set to said second ringing current source during predetermined periods of the next cycle of operation of said coding apparatus, and additional circuits jointly controlled by said coding apparatus and said transfer means for impressing a predetermined potential upon each of said intercepting leads during an interval which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

34. In combination with first and second sets of ringing current sources having different frequencies, a ringing interrupter comprising first and second sets of ringing leads, call intercepting leads individually corresponding to said ringing leads, a plurality of coding relays, means comprising a plurality of cyclically operating timing relays for causing the cyclic operation of said coding relays, transfer relays controlled by said coding relays, circuits jointly controlled by said coding relays, said transfer relays and at least one of said timing relays for connecting the ringing leads of said first set to said first ringing current source during predetermined periods of one cycle of operation of said coding relays and for connecting the ringing leads of said second set to said second ringing current source during predetermined periods of the next cycle of operation of said coding relays, and additional circuits jointly controlled by said coding relays, said transfer relays and said timing relays for impressing a predetermined potential upon each of said intercepting leads during an interval which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

35. In combination with first and second sets of ringing current sources having different frequencies, a ringing interrupter comprising first and second sets of ringing leads, call intercepting leads individually corresponding to said ringing leads, a start relay, a plurality of coding relays energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods of equal duration, means including said timing relays for sequentially deenergizing said coding relays at the rate of one for each cycle of operation of said timing relays and for again energizing all of said coding relays at the end of a predetermined number of cycles of operation of said timing relays, whereby said coding relays are controlled to operate and restore in a cyclic manner, transfer relays controlled by said coding relays, circuits jointly controlled by said coding relays, said transfer relays and at least one of said timing relays for connecting the ringing leads of said first set to said first ringing current source during predetermined periods of one cycle of operation of said coding relays and for connecting the ringing leads of said second set to said second ringing current source during predetermined periods of the next cycle of operation of said coding relays, and additional circuits jointly controlled by said coding relays, said transfer relays and said timing relays for impressing a predetermined potential upon each of said intercepting leads during an interval which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead.

36. Ringing and supervisory apparatus comprising a ringing lead, a call intercepting lead, a check pulse lead, and cyclically operative apparatus including means for impressing ringing voltage pulses upon said ringing lead and intercepting pulses upon said intercepting lead, and means for impressing check pulses upon said check pulse lead in timed relation with said intercepting pulses.

37. Ringing and supervisory apparatus comprising a ringing lead, a call intercepting lead, a check pulse lead, and cyclically operative apparatus including means for impressing ringing voltage pulses upon said ringing lead and intercepting pulses upon said intercepting lead, and means for impressing check pulses upon said check pulse lead during the spacing intervals between said intercepting pulses.

38. Ringing and supervisory apparatus comprising a ringing lead, a call intercepting lead, a check pulse lead, and cyclically operative apparatus including means for impressing ringing voltage pulses upon said ringing lead and intercepting pulses upon said intercepting lead, and means for impressing a check pulse upon said check pulse lead immediately following each of said intercepting pulses.

39. A ringing interrupter comprising a plurality of ringing leads, a plurality of call intercepting leads, a check pulse lead, and cyclically operative apparatus including means for impressing differently coded ringing voltages upon said ringing leads and intercepting pulses upon said intercepting leads during intervals individually corresponding to said codes, and means for impressing check pulses upon said check pulse lead in timed relation with said intercepting pulses.

40. A ringing interrupter comprising a plurality of ringing leads, a plurality of call intercepting leads, a check pulse lead, and cyclically operative apparatus including means for impressing differently coded ringing voltages upon said ringing leads and intercepting pulses upon

said intercepting leads during intervals individually corresponding to said codes, and means for impressing check pulses upon said check pulse lead during the spacing intervals between said intercepting pulses.

41. Ringing and supervisory apparatus comprising a plurality of ringing leads, a plurality of call intercepting leads, individually corresponding to said ringing leads, a check pulse lead, and cyclically operative apparatus including means for impressing differently coded ringing voltages upon said ringing leads, means for impressing an intercepting pulse upon each of said intercepting leads which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead, and means for impressing check pulses upon said check pulse lead in impressing check pulses upon said check pulse lead in timed relation with said intercepting pulses.

42. Ringing and supervisory apparatus comprising a plurality of ringing leads, a plurality of call intercepting leads individually corresponding to said ringing leads, a check pulse lead, and cyclically operative apparatus including means for impressing differently coded ringing voltages upon said ringing leads, means for impressing an intercepting pulse upon each of said intercepting leads which at least partially overlaps one of the intervals when ringing voltage is applied to the corresponding ringing lead, and means for impressing check pulses upon said check pulse lead during the spacing intervals between said intercepting pulses.

43. Ringing apparatus comprising first and second ringing current sources having different frequencies, first and second sets of ringing leads, and cyclically operative coding apparatus for impressing the voltage of said first source upon the leads of said first set during predetermined periods of one cycle of operation of said coding apparatus and for impressing the voltage of said second source upon the leads of said second set during predetermined periods of the next cycle of operation of said coding apparatus.

44. Ringing apparatus comprising first and second ringing current sources having different frequencies, first and second sets of ringing leads, and cyclically operative coding apparatus for impressing the voltage of said first source upon the leads of said first set during predetermined periods of alternate cycles of operation of said coding apparatus and for impressing the voltage of said second source upon the leads of said second set during the intervening cycles of operation of said coding apparatus.

45. Ringing apparatus comprising first and second ringing current sources having different frequencies, first and second sets of ringing leads, cyclically operative coding apparatus, transfer means controlled by said coding apparatus, and circuits controlled by said transfer means and said coding apparatus for connecting the leads of said first set to said first ringing current source during predetermined periods of one cycle of operation of said coding apparatus and for connecting the leads of said second set to said second ringing current source during predetermined periods of the next cycle of operation of said coding apparatus.

46. Ringing apparatus comprising first and second ringing current sources having different frequencies, first and second sets of ringing leads, a plurality of cyclically operative coding relays, transfer relays controlled by said coding relays, and circuits jointly controlled by said coding relays and said transfer relays for connecting the leads of said first set to said first ringing current source during predetermined periods of alternate cycles of operation of said coding relays and for connecting the leads of said second set to said second ringing current source during predetermined periods of the intervening cycles of operation of said coding relays.

47. Ringing apparatus comprising first and second ringing current sources having different frequencies, first and second sets of ringing leads, a plurality of coding relays, means comprising a plurality of cyclically operating timing relays for causing the cyclic operation of said coding relays, transfer relays controlled by said coding relays, and circuits jointly controlled by said coding relays, said transfer relays and at least one of said timing relays for connecting the leads of said first set to said first ringing current source during predetermined periods of alternate cycles of operation of said coding relays and for connecting the leads of said second set to said second ringing current source during predetermined periods of the intervening cycles of operation of said coding relays.

48. Ringing apparatus comprising first and second ringing current sources having different frequncies, first and second sets of ringing leads, a start relay, a plurality of coding relays energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods of equal duration, means including said timing relays for sequentially deenergizing said coding relays at the rate of one coding relay for each cycle of operation of said timing relays and for again energizing all of said coding relays at the end of a predetermined number of cycles of operation of said timing relays, whereby said coding relays are controlled to operate and restore in a cyclic manner, transfer relays controlled by said coding relays to operate at the end of each alternate cycle of operation of said coding relays and to restore at the end of each intervening cycle of operation of said coding relays, and circuits jointly controlled by said coding relays, said transfer relays and at least one of said timing relays for connecting the leads of said first set to said first ringing current source during predetermined ringing periods of alternate cycles of operation of said coding relays and for connecting the leads of said second set to said second ringing current source during predetermined ringing periods of the intervening cycles of operation of said coding relays.

49. Ringing apparatus comprising first and second ringing current sources having different frequencies, a start relay, a plurality of coding relays arranged in series connected pairs and energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods of equal duration, circuits controlled by said timing relays for controlling said coding relays, said circuits being so connected and arranged that predetermined relays of said coding relay pairs are sequentially short-circuited at the ends of alternate cycles of operation of said timing relays, the other coding relays are sequentially deenergized at the ends of the intervening cycles of operation of said timing relays and all of said coding relays are again energized after a predetermined number of cycles of operation of said timing relays, whereby

said coding relays are controlled to operate and restore in a cyclic manner, transfer relays controlled by said coding relays to operate at the end of each alternate cycle of operation of said coding relays and to restore at the end of each intervening cycle of operation of said coding relays, and circuits jointly controlled by said coding relays, said transfer relays and at least one of said timing relays for connecting the leads of said first set to said first ringing current source during predetermined ringing periods of alternate cycles of operation of said coding relays and for connecting the leads of said second set to said second ringing current source during predetermined ringing periods of the intervening cycles of operation of said coding relays.

50. Ringing apparatus comprising a ringing current source, a set of ringing leads, a start relay, a plurality of coding relays energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods, means including said timing relays for sequentially deenergizing said coding relays at the rate of one for each cycle of operation of said timing relays and for again energizing all of said coding relays at the end of a predetermined number of cycles of operation of said timing relays, whereby said coding relays are controlled to operate and restore in a cyclic manner, and circuits controlled by said coding relays for connecting said leads to said source during predetermined ringing periods of predetermined ringing cycles.

51. Ringing apparatus comprising a ringing current source, a set of ringing leads, a start relay, a plurality of coding relays energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods, means including said timing relays for sequentially deenergizing said coding relays at the rate of one for each cycle of operation of said timing relays and for again energizing all of said coding relays at the end of a predetermined number of cycles of operation of said timing relays, whereby said coding relays are controlled to operate and restore in a cyclic manner, circuits controlled by said coding relays for connecting said leads to said source during predetermined ringing periods of predetermined ringing cycles, and paths controlled by said coding relays and individual to said leads for impressing a predetermined ring cut-off potential upon said leads during intervals when said leads are disconnected from said source.

52. Ringing apparatus comprising a ringing current source, a set of ringing leads, a start relay, a plurality of coding relays arranged in series connected pairs and energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods of equal duration, circuits controlled by said timing relays for controlling said coding relays, said circuits being so connected and arranged that predetermined relays of said coding relay pairs are sequentially short-circuited at the ends of alternate cycles of operation of said timing relays, the other coding relays are sequentially deenergized at the ends of the intervening cycles of operation of said timing relays and all of said coding relays are again energized after a predetermined number of cycles of operation of said timing relays, whereby said coding relays are controlled to operate and restore in a cyclic manner, and circuits controlled by said coding relays for connecting said leads to said source during predetermined ringing periods of predetermined ringing cycles.

53. Ringing apparatus comprising a ringing current source, a set of ringing leads, a start relay, a plurality of coding relays arranged in series connected pairs and energized in response to operation of said start relay, timing relays cyclically operative in response to operation of said start relay to define a plurality of ringing periods of equal duration, circuits controlled by said timing relays for controlling said coding relays, said circuits being so connected and arranged that predetermined relays of said coding relay pairs are sequentially short-circuited at the ends of alternate cycles of operation of said timing relays, the other coding relays are sequentially deenergized at the ends of the intervening cycles of operation of said timing relays and all of said coding relays are again energized after a predetermined number of cycles of operation of said timing relays, whereby said coding relays are controlled to operate and restore in a cyclic manner, circuits controlled by said coding relays for connecting said leads to said source during predetermined ringing periods of predetermined ringing cycles, and paths controlled by said coding relays and individual to said leads for impressing a predetermined ring cut-off potential upon said leads during intervals when said leads are disconnected from said source.

SETH E. PETERSON.
MORRIS E. GRIFFINS.

CERTIFICATE OF CORRECTION.

Patent No. 2,258,660. October 14, 1941.

SETH E. PETERSON, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 21, second column, line 40, claim 2, for the word "one" read --ones--; page 24, first column, line 54, claim 26, for "as" read --at--; page 26, first column, lines 18 and 19, claim 41, strike out "impressing check pulses upon said check pulse lead in"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of November, A. D. 1941.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)