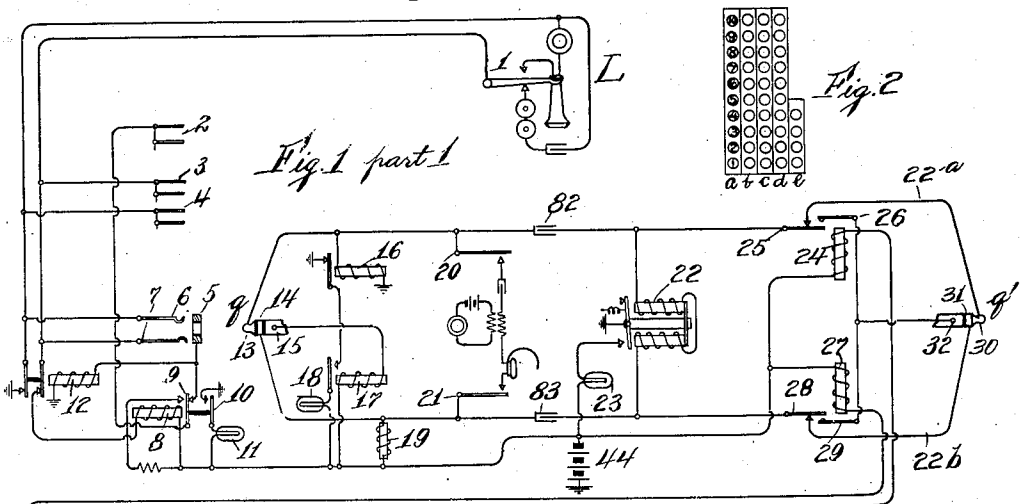
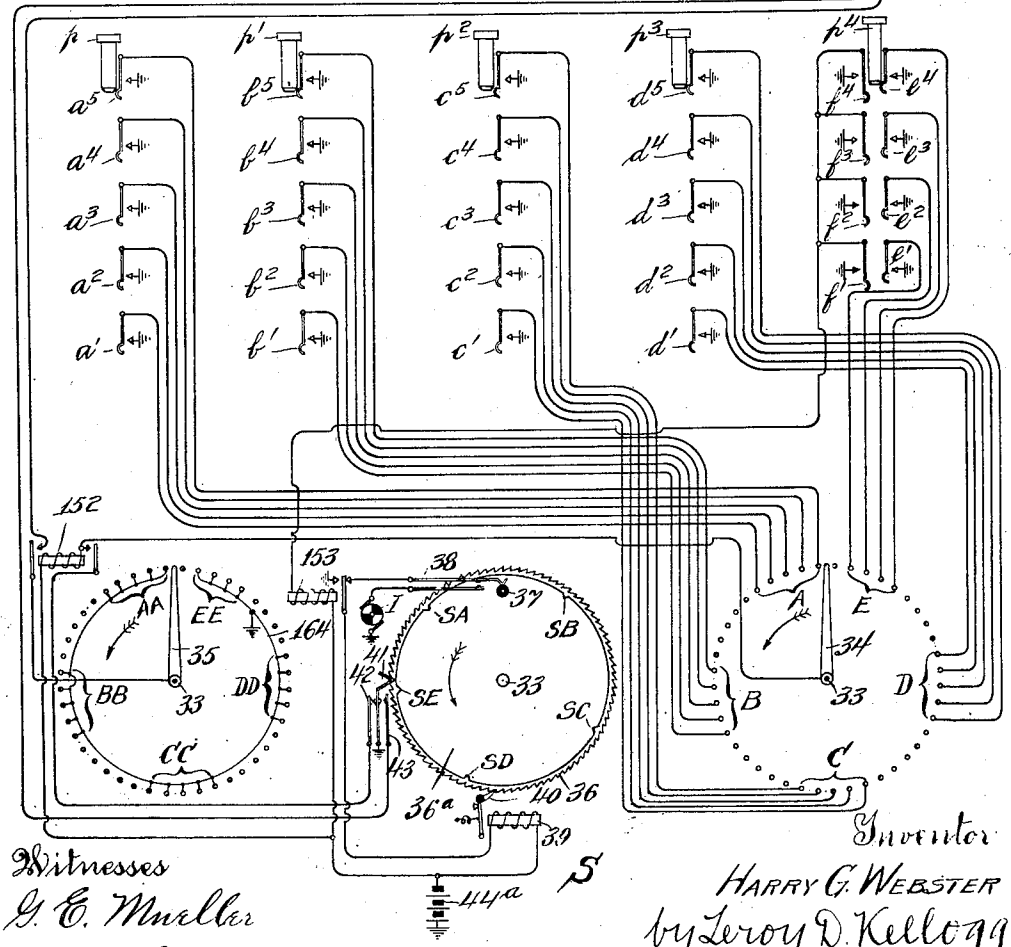
Oct. 27, 1925. 1,559,137

H. G. WEBSTER

TELEPHONE EXCHANGE SYSTEM

Original Filed June 10, 1907 4 Sheets-Sheet 1





Witnesses
G. E. Mueller
J. G. Kellogg

Inventor
Harry G. Webster
by Leroy D. Kellogg
Atty.

Oct. 27, 1925.

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H. G. WEBSTER

TELEPHONE EXCHANGE SYSTEM

Original Filed June 10, 1907 4 Sheets-Sheet 2

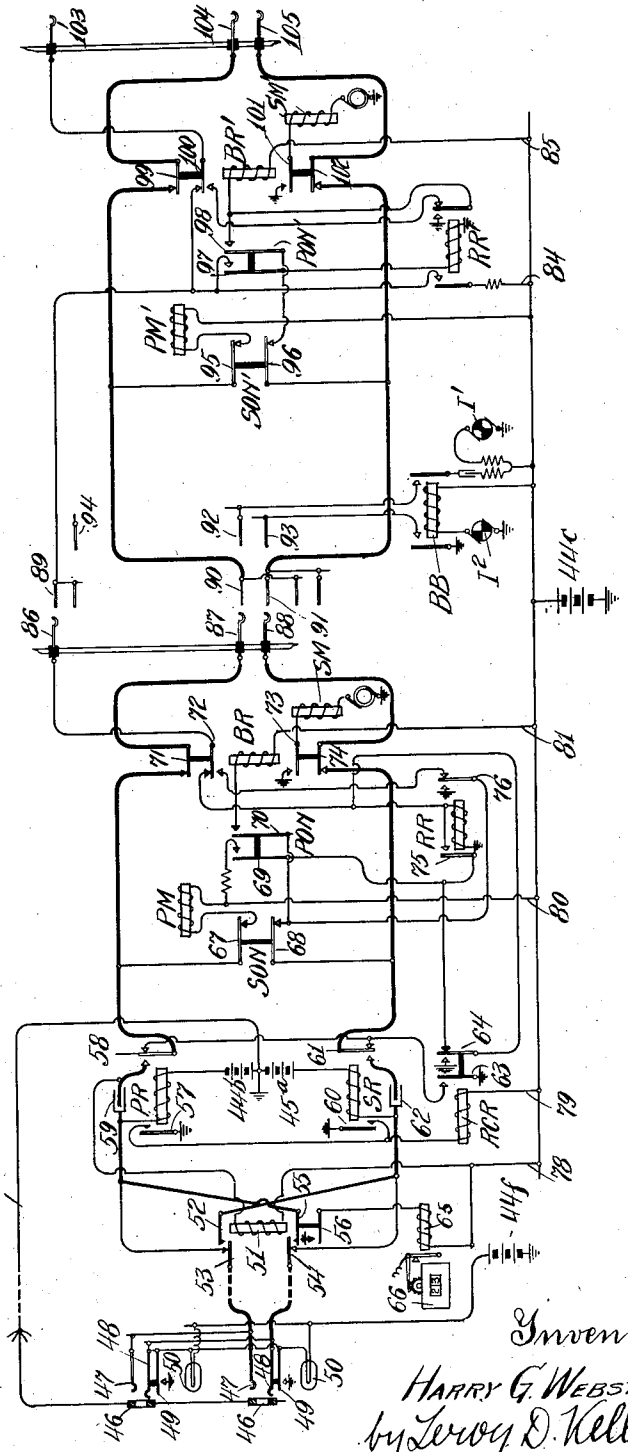

Fig. 1 part 2

Witnesses
G. E. Mueller
J. G. Kellogg

Inventor
Harry G. Webster
by Leroy D. Kellogg
Atty.

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H. G. WEBSTER

TELEPHONE EXCHANGE SYSTEM

Original Filed June 10, 1907 4 Sheets-Sheet 3

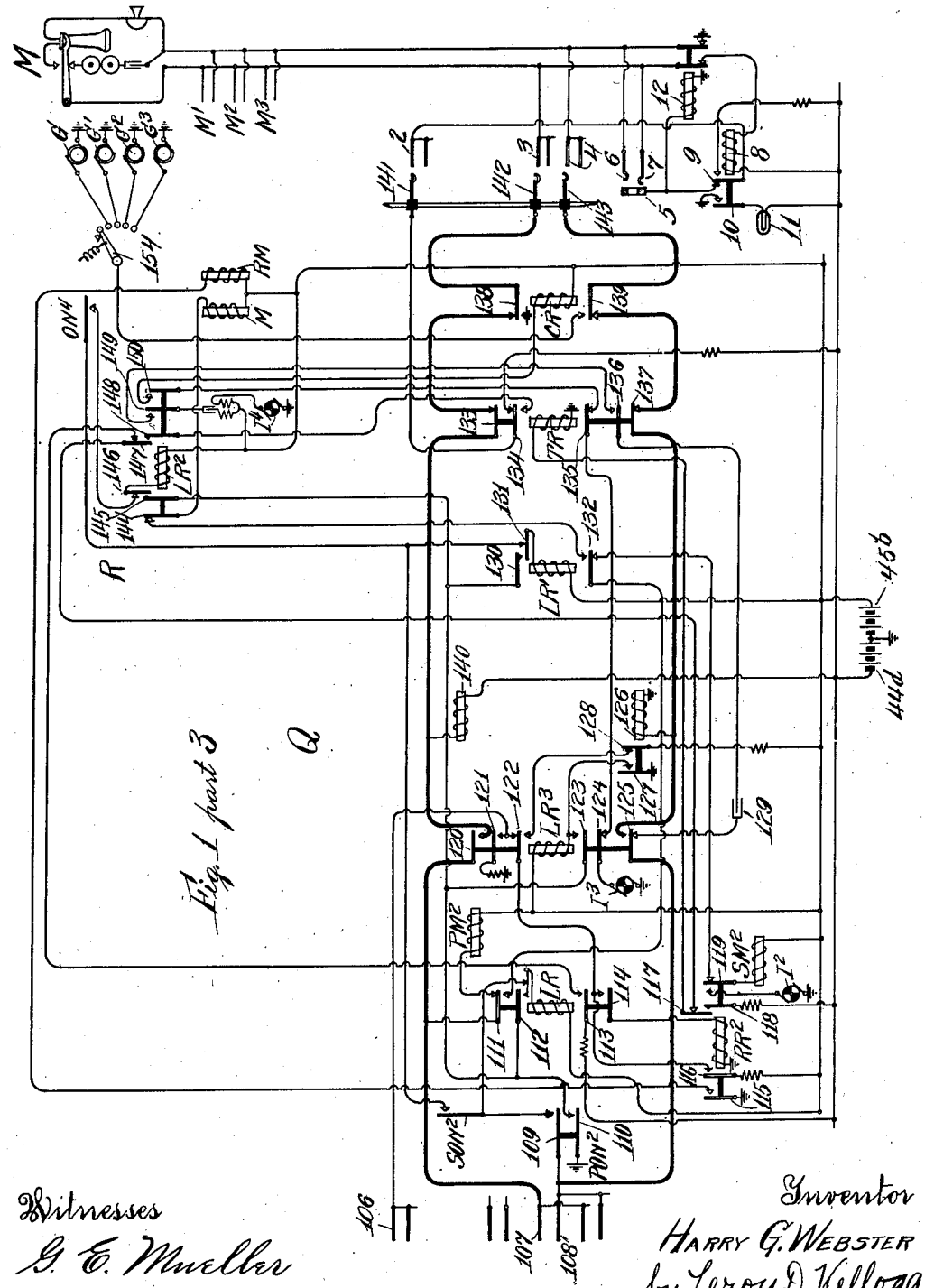

Fig. 1 part 3

Witnesses
G. E. Mueller
J. G. Kellogg

Inventor
Harry G. Webster
by Leroy D. Kellogg
Atty.

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H. G. WEBSTER

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Fig. 6

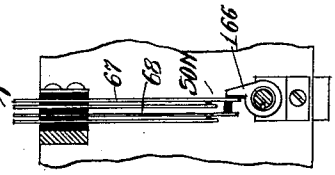


Fig. 5

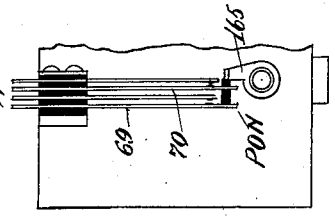


Fig. 8

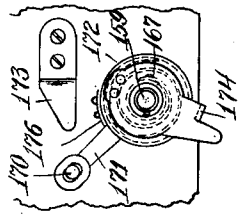


Fig. 7

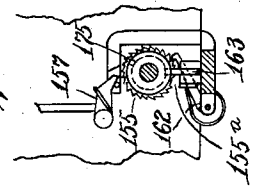


Fig. 4

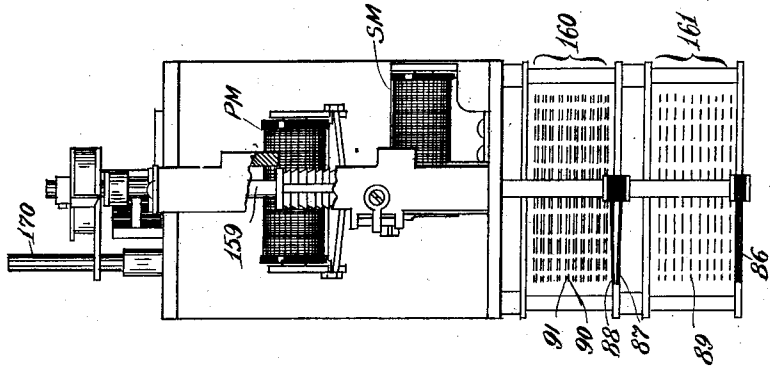
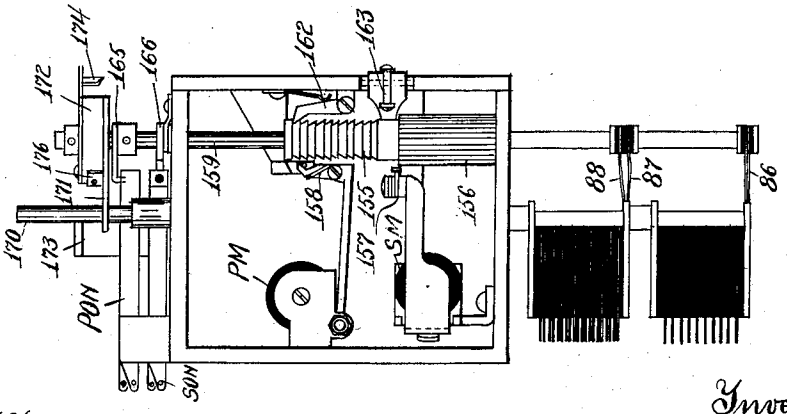


Fig. 3



Witnesses
G. E. Mueller.
J. G. Kellogg.

Inventor
HARRY G. WEBSTER
by Leroy D. Kellogg
atty.

Patented Oct. 27, 1925. 1,559,137

UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

Application filed June 10, 1907, Serial No. 378,184. Renewed October 15, 1918. Serial No. 258,288.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, residing in Chicago, county of Cook, and State of Illinois, have invented new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

I have illustrated my invention in connection with a system wherein a portion of the connections made in putting through a call from a calling subscriber's line to a called subscriber's line is effected by manually operated switching devices at the exchange, the remainder of the connections being made by means of electrically operated step-by-step switching devices. An object of my invention is to provide a simple and reliable operating system wherein the advantages found in the employment of operators at the exchange are preserved, while the extensive and costly multiple spring-jack equipment of subscribers' lines at each section of the switch-board is dispensed with. In this connection, the object of my invention includes further the doing away with the complicated calling devices at the subscribers' stations and the placing of a relatively small number of automatic calling switch mechanisms at the operators' positions, which as far as their manual manipulation is concerned are merely keyboards for counting out the called number. A further object is to provide certain improved arrangements and structures of automatic switching means as hereafter more specifically pointed out in which respects my invention will be defined in the claims in terms applicable to purely automatic systems as well as to the semi-automatic system herein shown and described in detail.

In accordance with my invention, I provide each operator at the exchange with a number of cord-circuits, each including an answering plug and a calling plug, although I do not wish to be limited to this precise structure, the former being adapted for insertion into an answering jack of the calling line in the usual manner, the other being employed to connect with any one of a plurality of multiple springjacks forming terminals of trunk circuits extending to first selector switches in connection with which may be also employed second selectors and connectors.

In connection with each operator's cord-circuit, I further preferably provide a calling device for controlling the sets of electrical impulses to be transmitted to the selectors and connector used in completing the connection from the calling plug to the called subscriber's line. This device may preferably be arranged in the form of a key-board upon which the operator may register the number of the called subscriber, an electromagnetically controlled device being associated with the key-board for then automatically transmitting impulses corresponding to the number registered by the operator. By this arrangement, the operator is not required to continue to give her attention to the call she is putting through, while the sets of impulses are being transmitted, but may as soon as she has registered the number, which act will consist only in counting out the called number by depressing suitable keys on the key-board, turn her attention to other work.

Associated with operators' cord-circuits I have provided the customary supervisory signals, one for the called line and one for the calling line, and have so arranged the structure of my invention that the return to normal of the selective switches employed in a connection is effected by the removal on the part of the operator of the calling plug from the trunk spring-jack. This, and other features of my invention will be at length detailed in the following specific description.

In Fig. 1, including parts 1, 2 and 3, I have illustrated the circuits of a telephone system embodying my invention; in Fig. 2 is shown a plan view of the key-board structure before referred to; Figs. 3 and 4 are respectively side and front elevations of a selective switch adapted for employment in connection with the circuits of Fig. 1; Figs. 5 and 6 are views respectively of a primary off-normal and secondary off-normal switch combination, forming a part of the main switch; Fig. 7 is a detail of the main switch shaft showing the secondary pawl and the retaining dogs, and in Fig. 8 is shown the arrangement of the restoring spring of the switch.

Referring first to Fig. 1, I show at L and M two substations including the usual common battery equipment, each connected by its telephone line to the exchange and there provided with its respective line relay 8

controlling a signal lamp 11, a cut-off relay 12 and an answering spring-jack comprising contacts 5, 6 and 7. Each line is further provided with multiple calling terminals 2, 3 and 4 located in the banks of a suitable number of connectors. As called lines, the lines of the system are grouped according to hundreds, multiple terminals 2, 3 and 4 of the lines of a hundred line group appearing in the banks of a number of connectors of which there may be ten for each group. The contact banks of the connectors may have the contact sets of the lines arranged in groups according to the tens values of the lines, and a customary way which I have followed consists of placing each such group of contact sets upon a different level.

A connector whose circuits are illustrated at Q may comprise the wipers 141—142—143 adapted to be lifted step-by-step in a vertical direction to select the required group of contacts of the lines which it serves, and then rotated to select the particular contacts out of the preliminary selected group. It will be understood that the contacts 2, 3 and 4 are multipled througout the banks of the connectors serving the line to which they pertain.

Assuming an exchange of ten thousand lines, there would be one hundred groups of one hundred lines to each of which groups ten connectors would be assigned, making a total of one thousand connectors.

A second selector of which the circuit is illustrated at P, comprises the adjustable contact wipers 103—104—105 adapted to engage ten levels of multiple contacts 106—107—108 pertaining to ten groups of connectors; the wipers therefore reach in all one hundred connectors assigned by tens to ten different groups of the subscribers' lines. In this operation, the wipers of the second selector are first adjusted vertically to select the group of multiple terminals of the desired connector group (it being understood that the terminals of the connectors are arranged according to their hundreds values in groups of ten at the second selectors), whereupon the wipers of the second selector are rotated to seek out terminals of an idle connector of the preliminary selector group.

For the ten thousand line exchange, one thousand second selectors P would provide sufficient facilities to take care of the business to be expected, and as a second selector serves a group of one thousand lines, on a basis of ten per cent trunking one hundred second selectors would be assigned for connections to the connectors of one thousand lines. Thus the multiple terminals 106—107—108 of the connectors would be multipled before the wipers 103—104—105 of one hundred second selectors.

The first selector of which the circuit is illustrated at O, may include the vertically and rotarily adjustable wipers 86—87—88, and each first selector may have access to terminals 89—90—91 of one hundred second selectors, such terminals being arranged in groups according to the thousands values of the lines served by their second selectors, vertical movements of wipers 86—87—88 being employed to select the group, and rotary movements being employed to select an idle second selector. The second selectors terminate as indicated at O in spring-jacks multipled to the different operators' positions, each spring-jack being provided with a signal lamp 50, the arrangement being such that when a called plug q' is inserted in any multiple jack, all the signal lamps of the jack and its multiples are illumined thus giving a visible busy test at the different operators' positions.

The operator's cord-circuit may comprise the answering plug q in association with which is provided the supervisory signal 18 jointly controlled by the tip relay 16 and sleeve relay 17 in the well known manner. Associated with the calling plug q' is the calling supervisory signal 23 controlled by the polarized relay 22 in permanent bridge of the talking stands of the cord. The said polarized relay is controlled by the called-for party in a manner hereinafter to be described.

It will be understood that three parts of Fig. 1 are to be placed with part 1 to the left, the calling plug q' being approached to the spring-jack of first selector O; part 2 being placed in the middle, while part 3 is placed to the right of part 2, wipers 103—104—105 being approached to the contacts 106—107—108.

From the above it will be understood that the calling subscriber L, by removing his receiver, operates the line relay to signal the operator, who thereupon inserts into the answering jack of this line, the answering plug q. After learning the number of the desired subscriber, she thereupon inserts the calling plug q' into a multiple jack of a first selector O whose signal 50 at her position is unlit. The operator thereupon actuates her calling device to transmit four sets of impulses, or if party line service is employed, which I have included in the system herein illustrated, five sets of impulses will be transmitted. The first set is effective to actuate the first selector O to select a group of second selectors and then an idle switch out of such group assigned for connection to the thousand subscribers' group designated by the first digit of the called subscriber's number. The second set of impulses corresponding to the second digit of the called subscriber's number is effective to cause the second selector P to pick out a group of connectors and then an idle switch

of such group, assigned for connection to the hundred group of subscribers designated by the second digit of the called subscriber's number. The third set of impulses will cause a connector Q to select the tens group of contacts of its bank among which those of the called line are included, the fourth set of contacts then causing the connector to pick out its multiple contacts connected to the called line.

At R is an auxiliary switch for controlling the application of ringing current to the called subscriber's line, four generators G, G′, G² and G³ being shown connected to contacts adapted for engagement by the wiper 154. The fifth set of impulses transmitted by the calling device is effective to step the wiper 154 around to select the generator of proper frequency to ring the bell of the called subscriber, it being understood that the party line signaling system hereindisclosed may be the tuned reed system disclosed in patent to William W. Dean, No. 779,533, dated Jan. 10, 1905.

The selective switches employed are adapted for operation responsive to a series of breaks or openings caused in the circuit of conductor 22ᵃ at the cord-circuit while the calling plug q' is connected to a jack, each break in the circuit of said conductor causing a step of the selective switch, while a break in the circuit of conductor 22ᵇ of the circuit will, under similar circumstances, be effective to produce certain auxiliary circuit changes in the operations of the switches to be hereafter described. It will be noted that the conductors 22ᵃ and 22ᵇ are normally united through the windings of polarized relay 22. The relay 24 by its armature 26 controls the circuit of conductor 22ᵃ, and the said armature, when attracted, first engages the contact 25 and then causes it to leave its normal contact, while relay 27 by its armature 29 similarly controls the circuit of the conductor 22ᵇ. These two relays are the means which I employ for transmitting the switch impulses to the selector switches, and they are in turn controlled by devices associated with the switch shown at S.

The said switch at S may comprise essentially a ratchet 36 fastened to a shaft 33 upon which are mounted the disk 36ᵃ and the two wipers 34 and 35. The magnet 39 for driving the shaft 33, by means of the ratchet 36 and the pawl 40 mounted upon the magnet's armature, is connected in circuit between battery 44ᵃ and the armature of relay 153, which armature is provided with a front contact connected to ground, and a back or normal contact connected to the offnormal switch spring 38 which normally engages a stud 37 upon the disk 36ᵃ. The operation of the switch S is initiated upon the energization of relay 153 which receives a current impulse to cause it to attract and then release its armature in the manner hereinafter described. The said armature then completes a circuit of battery 44ᵃ through magnet 39, said armature and the front contact to ground. Magnet 39 thereupon effects a thrust of pawl 40, turning ratchet 36 a step in a reverse clockwise direction whereupon spring 38 rides down over stud 37 and engages its alternate contact, whereupon when the armature of relay 153 is retracted on the cessation of the momentary impulse referred to, constantly rotating interrupter I comes into play and successive impulses are transmitted through magnet 39 causing ratchet 36, shaft 33, disk 36ᵃ and wipers 34—35 to be moved step-by-step in a rotary direction. Successive impulses will be transmitted through magnet 39 as long as contact 38 continues to engage its associated contact, which it will continue to do until a complete revolution of disk 36ᵃ has been effected, at which time the stud 37 will have been brought around to again engage the spring 38 and lift it free from its contact preventing further actuation of magnet 39, and the switch S will come to a stop. Thus, whenever relay 153 is energized and de-energized, the switch S will be operated until it has completed a revolution.

In actual practice, the arrangement of the calling device will be such as to permit of four series of ten impulses or less each, to be transmitted by the switch S with a suitable time interval between each set of impulses, and in addition to the four sets, a fifth set of impulses for operating the party line switch R. For the sake of simplicity in the drawing however, I have illustrated a device with its associated connections adapted to transmit four sets of impulses, each set of five impulses or less and a fifth set of four impulses. a', a^2, a^3, a^4 and a^5 are contact springs for the transmission of the thousands digit of the called number, in the arrangement shown being arranged to transmit a number of impulses corresponding to their exponents. Each spring is provided with a separate button p of which however one only is shown and that associated with the spring a^5. The buttons p may be arranged and interrelated one to another in a manner similar to that shown in patent to Michael Setter, dated September 5, 1905, No. 799,019, namely such that when a button is depressed by an operator, it remains depressed until the operator depresses another one, at which time the first will be automatically restored by an associated spring to its normal position, in which the button shown at P is illustrated. The springs b', b^2, b^3, b^4 and b^5 are the springs for transmitting the hundreds impulses of the called subscriber's number and each is provided with a button p', one only being shown, each button p' being interre-

lated as described, for the buttons p. Similarly the springs c' to c^5 inclusive are the springs for transmitting the impulses of the tens digit of the called number, each being provided with a suitable button p^2, similarly interrelated as described for the buttons p. The springs d' to d^5 inclusive are the springs for transmitting the units digit of the called number, each being provided with a button p^3, interrelated as described for the buttons p. The springs e', e^2, e^3 and e^4 are for transmitting the impulses to determine the frequency of the ringing current to be impressed upon the called line, and each is provided with a button p^4 which buttons will be interrelated after the manner of the buttons p. The buttons p^4 however, have associated with them respectively the springs f', f^2, f^3 and f^4. When a button p^4 is fully depressed by the operator, it closes its respective spring f momentarily to ground; the button being instantly released by the operator, it is raised by its associated spring to a position where it permits the spring f to disengage its associated grounded contact. The button will not however be raised sufficiently to permit its spring e, shifted when the button is depressed, to again disengage its contact. Thus supposing that the called subscriber's number is 55554, the operator will depress the five buttons illustrated. The button p will cause spring a^5 to engage its contact and remain in engagement therewith and buttons p', p^2, p^3 will also cause their respective springs b^5, c^5 and d^5 to engage their associated grounded contacts and remain in engagement therewith. The spring p^4 when depressed and released will cause spring f^4 to engage its grounded contact, and then allow it to disengage the same and will cause spring e^4 to engage its grounded contact and remain engaging the same. The buttons will of course be depressed by the operator in sequence according to the digits of the called number. Assuming that the number to be called is 55554, the operator by depressing the buttons named will cause the first contact A associated with wiper 34 to be grounded, also the first contact B, the first contact C, the first contact D and the first contact E. Moreover, by the operation of button p^4, an impulse was caused to flow from ground through spring f^4, relay 153 to battery 44^a, energizing and de-energizing relay 153, whereon the switch S starts upon a revolution as before described.

It may be here stated that, the teeth of ratchet 36 are so spaced with respect to the contacts of wipers 34 and 35 that two steps of the ratchet are required to move the wipers from one contact to the next. The first step of the ratchet brings wipers 34 and 35 to engage the first contacts A and AA respectively. Because button p is depressed, wiper 34 finds ground on the first contact A engaged, and therefore closes a circuit from ground through the contact A and relay 152 to battery 44^a, operating relay 152 which is immediately locked to ground through contact 42—41, the spring 41 riding upon the periphery of disk 36^a. As soon as relay 152 is energized, current flows from the grounded conductor 164 through the first contact AA, through the attracted armature of relay 152 and through relay 24 at the cord-circuit to battery 44, energizing and de-energizing relay 24. As switch S continues in its rotation, relay 24 will be energized and de-energized each time wiper 35 engages a contact AA and, as there are five such contacts shown, each connected to the grounded conductor 164, five energizations of relay 24 will be produced and armature 26 will be attracted five times, causing conductor 22^a to have its circuit opened and closed an equal number of times. It will be seen that relay 152 controls the number of impulses transmitted through relay 24, and that the said relay 152 will be energized and locked just as soon as wiper 34 engages a grounded contact A. If the button associated with say spring a^2 has been depressed, wiper 34 would not have found ground until it had reached the next to the last contact A at which time relay 152 would have become energized and locked, and wiper 35 would then have begun transmitting the impulses through relay 24. Similarly, if spring a' has been actuated, but one impulse would have been transmitted and the shifting of spring a^3 or a^4 would have been effective respectively, to produce three and four energizations of relay 24. It will be understood that a device for transmitting a maximum of ten impulses would have ten contacts A, AA, B, BB, etc.

As soon as wiper 35 passes over the last contact AA, the disk 36^a will have been turned to such an extent that the bent portion of spring 41 will drop down into the depression SA, the said spring then disengaging contact 42 to open the locking circuit of relay 152 de-energizing it; the spring 41 then engages contact 43 whereby an impulse of current is caused to flow from ground through contact 41—43, relay 27 to battery 44, energizing and de-energizing said relay, and opening the circuit of conductor 22^b a single time. The impulse through the said relay is momentary only because with the continued travel of switch S, spring 41 passes out of the notch SA to the periphery of the disk, being thereby shifted back to engage the spring 42, but this has no effect upon the relay 152, its armature being retracted. The switch S now rotates wipers 34 and 35, passing over the spaces between the sets of contacts A and B and AA and BB respectively, no effect being produced

upon the relays 24 and 27. This is to allow time for the secondary movements of the switch that is being operated which, having by the impulses transmitted through the relay 24 been caused to select a group, now proceeds responsive to relay 27 to automatically select idle contacts of the group.

As soon as wipers 34 and 35 reach their respective contacts B and BB, wiper 34 will find a ground upon its first contact B at spring b^5; relay 152 is therefore again operated and locked through contact 42—41, and wiper 35 moving over the contacts BB, transmits five impulses from the grounded conductor 164 to relay 24, one impulse for each contact BB engaged by it while relay 152 is operated. If the spring b^2 had been the one operated, relay 152 would not have been operated and locked until wiper 34 had reached the fourth contact B, in which case, only two actuations of relay 24 would have occurred and consequently the circuit of conductor 22^a would have been opened twice only instead of five times. As the wipers 34 and 35 advance beyond the last of their contacts B and BB, spring 41 engages the notch SB, said spring being then shifted to engage contact 43, unlocking the relay 152 and operating the relay 27 over the circuit before described.

The two sets of impulses just described as transmitted were, of course, the thousands and the hundreds digit impulse sets. When the wipers 34 and 35 reach the contact sets C and CC, the tens impulses will be transmitted in manner corresponding to those before described, the secondary impulse being immediately thereafter transmitted by spring 41 engaging the notch SC; similarly, when the wipers reach the contacts D and DD, the unit impulses will be transmitted, followed by an impulse through relay 27 when spring 41 engages the notch SD, and a similar operation takes place with respect to the contacts E and EE followed by an impulse through relay 27 when spring 41 engages a notch SE. Immediately following this engagement, the stud 37 opens the circuit of spring 38 and its contact stopping the switch S. It is thus seen that when the operator has counted out the number of the called subscriber, the switch S proceeds to automatically transmit successive sets of current impulses for controlling the switches, entirely independent of further attention by the operator. It will be understood however, that the employment of the impulses transmitting switch S is not limited to the circuit arrangement in which I have elected to illustrate it, namely, one in which operating relays are associated with a cord-circuit, which relays operate to open the conductors controlling the selectors and connectors, but that it may be employed in various circuit relations, as to transmit impulses directly to the relays or magnets of selective switches or for periodically opening predetermined numbers of times, circuits of relays or magnets of selective switches or other devices, the invention being in this respect of broad scope and capable of varying employment.

In Fig. 2 are shown the tops of a bank of buttons which may conveniently be disposed in the operator's key shelf in alignment with the pair of plugs to which the bank belongs. The numbers 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 in a vertical row indicate the number of impulses which their respective buttons may be supposed to be capable of transmitting, while the letters *a*, *b*, *c*, *d*, and *e* indicate the values of the digit rows, *a* being the thousands, *b* the hundreds, *c* the tens, *d* the units and *e* the generator switch impulse row.

For use in connection with the switch circuits shown at O, P and Q, any preferred form of mechanism may be employed. In Figs. 3 to 8 inclusive, I show a preferred form in which the contacts are arranged in two banks, of which 160, comprising one hundred sets of contact pairs arranged in ten superposed groups of ten contact pairs, a horizontal row of pairs being a group, may include the talking contacts of the switch. The lower bank 161, comprising one hundred single contacts arranged in corresponding groups may be the so-called private contacts. For convenience of reference, the mechanical figures have supplied to them reference characters corresponding to those of the first selector O. Fastened to the shaft 159, suitably journaled to the switch frame, is the wiper 86 adapted to be adjusted by vertical movement of the shaft 159 to a position horizontal with a group of private contacts 89, and then rotated in a clock-wise direction over the contacts to engage any contact of the selected group. The talking wipers 87 and 88 also fastened to the shaft 159 move correspondingly with the wiper 86 to a corresponding located group of contact pairs, and also over the contact pairs of the group. The vertical ratchet 155 is fastened to the shaft, said ratchet being adapted for engagement by the armature driven pawl 158 of primary magnet PM to lift the shaft step-by-step, the vertical retaining pawl 162 engaging successive teeth of the ratchet 155 with the actuations of magnet PM to hold shaft and wipers against back movement. For turning the shaft, the ratchet 156 is provided for engagement by armature driven pawl 157 of secondary magnet SM. The rotary retaining pawl 163 is provided adapted to engage successive ratchet teeth of 156 with the actuations of magnet SM, holding the shaft and wipers against return rotary movement. In addition to the adjustable switch wipers, two

auxiliary switches are provided, one being a primary off-normal switch PON comprising the contacts 69—70 controlled by the arm 165 fastened to shaft 159. The shaft is held in its normal position by a suitable spring 167, Fig. 8, and at such time the arm 165 presses against the primary off-normal switch springs and holds them at normal position; with the first vertical movement of the shaft however, the arm 165 is raised free of the spring 70 and two springs by their tension move to engage their contacts. A rotary off-normal switch is also provided comprising the springs 67—68 controlled by the arm 166. This arm may preferably be keyed to the shaft 159 so as not to partake of the vertical movements thereof. As soon however, as the first rotary step of the shaft is made, the arm 166 is brought free of the spring 67 and the two springs are free by their tension to move to their alternate positions. To restore the switch to normal, additional impulses are caused to pass through magnet SM until on the eleventh impulse, the wipers pass beyond the right edge of the banks, Fig. 4. When this occurs, the vertically extending slot 175 in ratchet 155, shown in Fig. 7, has reached vertical retaining dog 162 and the shaft and wipers are free to drop to their normal level. As they reach this, rotary ratchet 156 is below rotary retaining dog 163 (see Fig. 3) and spring 167 comes into play to rotate the shaft and wipers back to normal, at which times arms 165 and 166 restore switches PON and SON. Spring case 172 fastened rigidly to shaft 159 is connected to one end of spring 167, the other end thereof being fastened to arm 171 at a point adjacent to shaft 159. Said arm 171 has an orifice at each end, one fitting about shaft 159 and the other about the post 170, while arm 176 on case 172 engages arm 171 when the switch is at normal to the end that there may be no pressure of arm 171 upon post 170 while the shaft is being adjusted vertically. To provide for a similar absence of pressure when the shaft is descending to its normal level, the spring arm 174 is carried by case 172 so positioned that on an eleventh rotary step of the shaft it slips over arm 171 to a position like the normal one of arm 176 and so relieves pressure upon post 170. As, however, the shaft completes its descent to normal level, the horizontally extending part of arm 174 impacts on piece 173, whereby arm 174 frees arm 171 by being raised, and spring 167 is effective to rotate the shaft back to normal as described. At 155^a a tooth of ratchet 155 is omitted so that after an eleventh rotary step of the shaft, further actuations of pawl 157 (which continue till the switch is restored) are ineffective to produce further rotary travel.

The remaining features of the system of Fig. 1 will be best understood from the following description of operation in which the line of subscriber L is to be connected to that of subscriber M whose line is assumed to be #55554, the substation bell being attuned to respond to the current of the fourth frequency, that delivered by generator G^3.

Subscriber L in initiating the call, removes his receiver whereupon lever 1 engaging its alternate contact, operates line relay 8 by current from battery 44 through said relay over a limb of the telephone line, through hook-lever 1 and its alternate contact, returning over the other limb of the line to ground at a back contact of cut-off relay 12, operated relay 8 attracting its armatures to display signal lamp 11 and connect battery through armature 9 with the private contacts 2 of the line at the connectors causing the line to test busy as soon as the call is initiated. To answer, the operator inserts the plug q into the answering jack of the line, current then flowing from battery 44 through relay 17, contact 15—5, cut-off relay 12 to ground, which relay attracts its armatures to de-energize relay 8, whereby signal lamp 11 becomes inert. Armature 9 in falling back connects battery from contact 5 to multiple contacts 2 so that they may retain their busy potential. Relay 17 was operated and would cause the display of signal 18 were not relay 16 energized by current from ground to contact 13—6 over the subscriber's line, returning through contact 7—14 to battery through impedance coil 19. The operator having learned the number of the called subscriber, inserts the calling plug q' in a multiple jack of a first selector such as O whose signal 50 is not displayed. On the insertion of the plug, contact 49 engages its associated contact, closing circuit from ground through all the lamps 50 of that switch O at the different operators' positions in parallel to battery 44^f, displaying them as a busy indication. Upon the insertion of the plug, current flows from the negative side of battery 44^b, through primary relay PR at switch O, contact 53, contact 47—30, contact 25 through the windings of polarized relay 22, contact 28, contact 31—48, contact 54, relay SR, to the positive pole of battery 45^a, the batteries 45^a and 44^b being arranged in series. This flow of current is in a direction to operate the armature of relay 22 to close its contact, displaying signal lamp 23 which remains displayed until the called subscriber answers the call. Relays PR and SR being now operated, their armatures close a circut through release control relay RCR to battery 44^c, armature 63 being now attracted to place an operating ground upon the normal contacts of the now attracted armatures 58 and 61, while armature 64 is attracted, placing a short circuit about the winding of the release relay RR.

Having inserted the calling plug, the operator depresses buttons p—p'—p^2—p^3—p^4 and the switch S proceeds to transmit impulses through relays 24 and 27, as before described. The first set of five impulses transmitted through relay 24, de-energizes and energizes relay PR five times, although relays 22 and SR remain unaffected by the opening of the circuit at normal contact 24, since armature 26 before operating spring 24 completes an alternate circuit for said relays, through contact 24—26, contact 32—46 to the negative or grounded side of battery 45^a, and on the retraction of armature 26, the first energizing circuit of relays PR and SR and 22 is re-established before the circuit holding the relays 22 and SR energized is broken. Each time relay PR is de-energized, its armatures are retracted, armature 58 on each retraction transmitting an impulse from ground through armature 63, contact 67, primary magnet PM to battery 44^c, the said magnet PM lifting the wipers 86—87—88 to a position horizontal with their fifth level of contacts, forming terminals of second selectors of the fifth thousand subscriber's group. With the first upward step of the wipers, primary off-normal springs 69 and 70 are shifted, 69 to operatively connect battery 44^c to the normal contact of armature 64, and 70 to operatively connect the busy relay BR to the normal contact of springs 68.

The single impulse transmitted by switch S to operate relay 27, after the fifth impulse has been transmitted through relay 24, attracted and released the armature of 27 whereby circuit is momentarily broken by the opening of conductor 22^b through secondary relay SR of switch O, although relays 22 and PR are not affected since an alternate circuit is completed for them from the negative side of battery 44^b through contact 28—29, contact 32—46 to ground, before the first energizing circuit is broken and on the retraction of armature 29, the initial energizing circuit is recompleted before the substitute one is broken. The armatures of relay SR are momentarily retracted, armature 61 causing an impulse to flow from ground through armature 63, armature 61, switch contacts 68, 70, busy relay BR to battery operating the said relay, whose attracted armature 73 closes a circuit from generator through secondary magnet SM to ground, the said magnet thereon causing a rotary step of the wipers 86—87—88 to engage the first multiple contacts 89—90—91 of the selected group. If these contacts pertain to a busy switch P, contact 89 will be grounded over a circuit extending from a multiple thereof through a wiper 86 of a first selector which has already occupied the switch P, through its normal contact 72 and alternate contact 64 to ground, in which case the busy relay BR of the switch of Fig. 1 will be locked up by current from the grounded contact 89, wiper 86, alternate contact 72, normal contact 76, contact 70, relay BR to battery, and its armature 73 will continue attracted, successive similar locking circuits being established until wiper 86 in its rotation reaches an ungrounded contact 89, whereupon the locking circuit for relay BR will be broken, the relay de-energized and its armatures retracted. Obviously as long as relay BR remained locked, successive impulses flowed through magnets SM advancing the switch step-by-step until relay BR became de-energized when the opening of contact 73 brought the switch to rest. While switch O is moving over multiple contacts of busy second selectors, wipers 87—88 are on open circuit at attracted armatures 71—74. With the first rotary movement of the switch before described, the secondary off-normal switch springs 67—68 were shifted to disconnect magnet PM and relay BR from armatures 58 and 61 respectively, in order that a clear circuit may exist from said armatures through wiper 87 and 88 to the circuits of the selected second selector P as soon as relay BR was de-energized.

The contacts 92—93—94 may be provided as the tenth contact set of the group, in which case there will be but nine selectors P available. The contact 94 is not multipled and wipers 86 will therefore always find it ungrounded, the switch stopping on contacts 94—92—93 if the preceding nine contact sets are already busy. Should this occur, the calling subscriber L will automatically receive a busy signal from interrupter I′ as relay BB is alternately energized and de-energized under the influence of interrupter I^2, the busy current flowing from the interrupter I′ through the right armature of relay BB, contact 92—87, contact 58, condenser 59, contacts 53, 47—30, 25, condenser 82, contact 13—6 over the line and through the receiver, returning over contacts 7—14, 28, 31—48, 54, condenser 62, alternate contact 61, contact 74, contact 88—93 to ground giving the calling subscriber the busy signal whereon he will replace his receiver to display signal 18, due to the consequent de-energization of relay 16, whereon the operator will withdraw the plugs, returning the apparatus to normal as heretofore described.

The switch O having been thus vertically and rotarily adjusted to engage the idle second selector P, the next set of five impulses representing the hundreds digit transmitted through relay 24 effect five de-energizations of relay PR and the transmission, in consequence thereof, of five impulses of current from ground through retracted armature 58, contacts 71, 87—90, 95, magnet

PM′ to battery, magnet PM′ lifting the switch wipers to select the group of contact sets, terminals of the fifth group of connectors, which connectors pertain to the 5500 group of subscribers. On the energization of relay 27 by an impulse following the five through relay 24, relay SR is de-energized momentarily and an impulse transmitted from ground through contacts 63, 61, 74, 88—91, 96, 98, of the primary off-normal switch PON′, (shifted on the first vertical step of the switch) through busy relay BR′, which is energized to close circuit through secondary magnet SM′ whereby the second selector P is caused to automatically pick out the contacts 106—107—108 pertaining to the first idle connector of the group, in a manner similar to that in which the first selector picked out the idle second selectors contacts, the locking circuit for relay BR′ being extended through alternate contact 100, while the talking wipers 104—105 are on open circuit at attracted armatures 99—102, while the switch was rotating. The shifting of contact 97 connected multiple contacts 89 with the winding of release relay RR′ of the second selector. It will be observed that at this time the low resistance circuit to ground at the attracted armature 64 of release control relay RCR at second selector O is extended through normal contact 72 and wiper 86, to multiple contact 89, retaining the second selector P busy, and also to normal contact 100 and wiper 103 to multiple contact 106 of the connector, retaining that switch busy, while the release relays RR and RR′ of the first selector and second selector are shunted by this low resistance circuit so that it is impossible for the said relays to be actuated should other switches whose relays BR were attracted, pass their wipers over the multiples of contacts engaged by the private wipers 86 and 103 of the two switches O and P. In the heretofore proposed systems in which a private wiper has been used for both selecting and releasing purposes, it has been customary to depend upon a proportioning of the resistances of the busy relays and the release relays to prevent premature actuations of the latter, what might be called the "busy ground" at the private wiper of a switch being usually traced through the trunk release relay, and my present system is arranged to obviate the necessity of marginal proportioning of relays hitherto employed.

The third set of impulses representing the tens digits of the called number transmitted through relay 24, effect five de-energizations of relay PR and the transmission of five impulses from ground through armature 63, contact 58, 71, 87—90, 99, 104—107, back contact 111, primary magnet PM^2 to battery 45^b, actuating the magnet PM^2 five times, whereby the shaft of connector Q is raised five steps, bringing the wipers horizontal with the fifth group of line contacts of the one hundred lines served by the connector including the lines numbered 5551 to 5559 inclusive, followed by the line No. 55550, zero being represented by ten impulses in automatic systems. A succeeding energization of relay 27 produced by switch S following the five energizations described, of the relay 24 energizes and de-energizes the secondary relay SR, a current impulse flowing from ground through contact 63, 61, 74, 88—91, 102, 105—108, through contact 109 (primary off-normal, PON^2, switch springs 109 and 110 having been shifted by the first vertical step of the connector) through locking relay LR to battery 45^b, actuating the locking relay which is locked to ground at the spring 110 via armature 112 and its contact. The attraction of armature 113, of relay LR by closing circuit from battery 44^d through contact 113, normal contact 147, normal contact 117, to ground through test relay TR, energizes the said relay in order that the same may be operated while wipers 142, 143 are wiping contacts 3, 4 of lines not wanted and when the test circuit is completed as hereafter described. Armature 114 completes a break in the circuit of release relay RR^2, while armature 111 shifts the connection of contact 107 from primary magnet PM^2 to secondary magnet SM^2, the circuit being traced through alternate contact 111, normal contact 132, normal contact 119, magnet SM^2 to battery 45^b.

When switch S, by operating relay 24, causes the five unit digit impulses to be transmitted from ground through armature 63, they will pass through secondary magnet SM^2 which will be effective to rotate the shaft and wipers 141—142—143 to engage the fifth multiple contacts 2—3—4 of the group horizontal with which the wipers have been adjusted by the tens impulses. The secondary impulse following the five will traverse the before traced path through wiper 105, thence to contact 108, closed contact 109, the now shifted secondary off-normal contact SON^2 through locking relay LR′ to battery 45^b whereby relay LR′ will be energized and locked through contact 131—130 to ground at shifted primary off-normal, PON^2, contact 110. Armature 132 being attracted, the circuit before described from contact 107 is shifted from secondary magnet SM^2 to extend through alternate contact 132, contact 144, through rotating magnet M to battery 45^b so that the fifth set consisting of four impulses transmitted by switch S through the medium of relays 24 and PR will pass through contact 107, alternate contact 111, alternate contact 132, contact 144, magnet M to battery, actuating

magnet M four times which is effective to step the wiper 154 four rotary steps to engage the contact of generator G^3.

It may be stated that magnet M is a driving magnet for the wiper 154, while magnet RM is a release magnet, the former actuating a driving ratchet, the latter being adapted to withdraw a retaining pawl from the ratchet of the wiper to render the restoring spring effective to restore the switch to normal in the well known manner.

The secondary impulse following the four impulses operating the generator switch R will pass through contacts 108, 109, secondary off-normal spring SON^2, off-normal spring ON^4 shifted with the first step of the switch R through normal contact 146, locking relay LR^2 to battery 45^b, relay LR^2 locking itself through contact 145—146 to ground at 110. The attraction of armature 134 on the energization of relay TR, as before described, to engage its alternate contact, closed a contact in a circuit now completed on the attraction of armature 148 of locking relay LR^2 as follows: from wiper 141, alternate contact 134, contact 148—147, contact 117, test relay TR to ground. If at this time the called line is busy, there will be a battery connection at the multiple private contacts 2 which may have been placed there in any one of three ways as follows: If subscriber M has initiated a call that has not been answered, attracted armature 9 will have connected battery 44^d to contact 2 and its multiples. If the call has been answered by the insertion of a plug in the answering jack, battery through relay 17 of the answering cord, contact 15—5 and normal contact 9, has been applied to multiple contact 2. If the line of M is busy as a called line, a battery connection to contact 2 and its multiples will have been extended from the circuits of another connector already applied to a multiple of contact 2 from battery 44^d, to the right, then upward through normal contact 134 and wiper 141 of such other connector. In each of these cases the potential consequently found at the multiple contact 2 of the called line engaged by wiper 141 of switch Q will develop into a current circulating through alternate contact 134 of relay TR of switch Q, contact 148—147, contact 117, relay TR to ground, causing the relay to continue energized whereby busy machine I^4 is operatively associated with the calling subscriber's line, giving the subscriber the customary busy signal over a circuit extending through contact 149, attracted armature 136, condenser 129, normal contact 125, contacts 108—105, 91—88, 48—31, 14—7, over the line limbs of subscriber L and through his receiver, returning through contact 6—13 to ground through relay 16 and PR. The calling subscriber hearing the signal will replace his receiver, de-energizing relay 16 to display lamp 18, and the operator observing the two lamps 18 and 23 both displayed, will remove the plugs from the spring-jacks restoring the line circuit of L to normal, and also restoring the switches O, P and Q in the manner hereafter described.

Assuming however, that the called line is idle, there will be no battery connection to the multiple contacts 2 as will be clearly seen from an inspection of the line circuit of M in its normal or idle condition, shown in Fig. 1. In such case, contact 2 is connected to ground only through cut-off relay 12, and wiper 141 being also connected to ground only through the winding of test relay TR since armature 148 is attracted, the test relay TR necessarily becomes inert and its armatures are retracted, whereof 133 and 137 close contacts in the talking conductors, armature 136 immediately dissociates busy machine I^4 from the calling line so that he does not receive the busy signal, while armature 134 connects the active side of battery 44^d with wiper 141 and multiple contact 2 to render the called line busy, whereby also cut-off relay 12 is operated to disconnect line relay 8 from the called line. Armature 135 now operatively connects interrupter I^3 through normal contact 124, contact 135, closed contact 150, through control relay CR to battery and as interrupter I^3 rotates, relay CR is alternately energized and de-energized, with each energization connecting the generator G^3 through wiper 154, alternate contact 139, to wiper 143 and contact 4 of the called line, the current passing out over the line through condenser and call-bell at the substation notifying the called subscriber that his attention is desired, the current returning through contact 3—142 and through alternate contact 138 to ground, the current being of frequency to ring the bell of subscriber M only, the bells of M', M^2 and M^3 responding to G, G' and G^2 respectively. The called subscriber answering the call removes his receiver and as soon as relay CR is de-energized, current flows from battery 44^d through impedance 140, contact 133, normal contact 138, contact 142—3 over the line through the now raised hook lever at the substation, through receiver and transmitter, returning over the other line limb, contact 4—143, normal contacts 139, 137, relay 126 to ground. This flow of current supplies talking battery to the called subscriber and is also effective by the actuation of armature 127 of relay 126 to energize locking relay LR^3, which, by armature 123 locks itself to ground at 110. Armature 124 now disconnects interrupter I^3 from relay CR so that the relay continues inert and ringing current is henceforth ex-

cluded from the called line. Armatures 120 and 125 complete normally open contacts in the talking circuit, armature 121 places an additional ground upon the private contact 106 because armature 122 in engaging its alternate contact has removed control of release relay RR^2 from the operator's plug switch connection, the connector from now on being controlled as to its release solely by the called subscriber, and if it were not for the ground at 121, the operator might, in withdrawing the plug, before the called subscriber replaced his receiver, disconnect the second selector from the connector, and another second selector wiping contact 106 would stop in connection with connector Q, which would not do as the connector would be still in use being connected to the line of M. Circuit is now closed from battery 44^d through the impedance 140, contact 120, 107—104, 90—87, alternate contact 58, pole changing relay 51 to battery 44^c whereby relay 51 is operated and reverses the connections of batteries 45^a and 44^b to the conductors 22^a and 22^b, whereby reversed current passes through the windings of polarized relay 22 and its armature is shifted to disengage its contact whereby lamp 23 is put out and the operator knows that the subscribers are in conversation. The two subscribers are now in conversation, the talking circuit being traced through the exchange over the heavily marked conductors, condensers 82 and 59 being interposed in one side of the talking circuit, while condensers 83 and 62 are in the other side of the talking circuit, battery being supplied to the calling line through the inductances of relays 16 and 17, and to the called line through the inductances of relay 126 and coil 140.

At the conclusion of conversation, the subscribers replace their receivers, the subscriber L in so doing de-energizes relay 16 and lamp 18 is displayed in the usual manner. When subscriber M replaces his receiver, circuit is opened through relay 126 and its armature 128 falls back to engage its contact, whereby circuit is closed from battery 45^b through said contact, alternate contact 122, armature 114, release relay RR^2 to ground, which relay now attracts its armature 116 to complete a locking circuit for itself, armature 115 to energize release magnet RM at the generator switch R which magnet withdraws a retaining pawl and allows wiper 154 to be snapped back to normal by its associated spring, at which time off-normal spring ON^4 will be restored and locking relay LR^2 de-energized, while armature 118 of release relay RR^2 completes a circuit from battery 44^d through contact 118—117 and test relay TR to energize the said relay to open the circuits of line wipers 142 and 143 at contacts 133—137 so that they may be disconnected while the connector is being rotated over contacts of not wanted lines to the restoring rotary position under the influence of secondary magnet SM^2 whose circuit is now closed by the attraction of armature 119, from battery 45^b through interrupter I^2 to ground. As soon as the eleventh step in a rotary direction is made, the shaft and wipers drop and are thereupon restored rotarily to normal, opening the primary off-normal, PON^2, and secondary off-normal, SON^2, contacts, whereby the locking relays LR, LR^3 and LR′ are de-energized; the deenergization of LR by armature 114 de-energizing release relay RR^2 whose retracted armatures 118—119 respectively de-energize test relay TR and secondary magnet SM^2. Retracted armature 121 of relay LR^3 removes the ground from contact 106, while retracted armature 120 opens the circuit before traced through relay 140 at Q and relay 51 at O, whereby relay 51 is de-energized and its armatures retracted whereupon the connections of batteries 44^b and 45^a to conductors 22^a and 22^b are restored to their initial condition and current through polarized relay 22 is again reversed whereon its armature closes the circuit of supervisory signal 23 and the operator knowing that disconnection is desired, both signals being now displayed, withdraws plugs q and q'. On the withdrawal of q', relay 22 is of course de-energized, and relays PR and SR are de-energized now for the first time since the plug was inserted in the jack of switch O. The de-energizations allow the simultaneous retractions of armatures 57 and 60, and release control relay RCR has its armatures retracted of which 64 completes a circuit from battery 44^c over conductor 80, shifted primary off-normal contact 69, contact 64, the current then dividing, a portion flowing through release relay RR, whose armature 75 immediately locks the relay through spring 69; the remainder of the current flowing through contacts 72, 86—89, contact 97, release relay RR′ to ground, the said relay locking itself by current from battery 44^c over conductor 84, contact 97 to ground. Armature 76 of relay RR closes a circuit through busy relay BR via contact 70 whereby the relay is operated to place wipers 87—88 on open circuit at contact 71—74, while relay BR′ at switch P is operated by the attraction of the right armature of relay RR′. Current impulses now flow through magnets SM and SM′ of the two switches O and P, through the attracted armatures 73 and 101 of relays BR and BR′ respectively, until the switches pass to their extreme rotary positions and are restored. The opening of the primary off-normal switch contacts of switches PON and PON′ is, when the switches are com-

pletely restored, effective to de-energize the operated relays of the switches which are then at normal.

It should be observed that I have associated the call counter 66 with the first selector O, which counter may comprise the usual counting train controlled by the magnet 65 operated responsive to armature 56 of pole changing relay 51, when the called subscriber answers the call whereby the number of completed connections may be registered.

It will be understood that when the operator withdraws the plug, the switch contact 49 of the spring-jack of switch O disengages its contact and the signal lamps 50 cease to be displayed.

Let it be assumed that the called subscriber fails to answer the call, or that the busy signal was extended to the calling subscriber and that under these conditions, the operator withdraws the plug q' from the jack. In such case the circuit operating relay RR′ before described would find a conductive branch via contact 100, contact 103—106, normal contact 122, (because relay LR^3 is only actuated in case the called subscriber answers), through contact 114, and release relay RR^2 to ground. In such case, the three relays RR, RR′ and RR^2 would be energized and locked, and the respective switches with which they are associated would be returned to normal in the manner previously described.

At O, I have shown the conductor 77 and the conductors connecting contacts 47—53 and 48—54 in dotted lines to indicate that they may extend to a distant exchange. In the organization of a system according to my invention including several exchanges, the operators would have accessible to their link-circuits, multiple terminals grouped together for each exchange and connected to trunks leading to first selectors O of each exchange of the system. On receiving the calling subscriber's order, the operator would cause her link-circuit to be connected to multiple terminals of an idle trunk leading to the distant exchange where the called for subscriber's line had its terminals. I prefer to have the conductor 77 a common return conductor for the trunks leading to a particular exchange connected to ground at the distant exchange rather than to a ground conductor local to the exchange where the operator is employed as differences of earth potential are to be expected at different localities included in a system, and such differences would tend to interfere with the proper operation of the switching mechanism. My invention involves therefore the features of trunks, extending from an exchange to various other exchanges, and means at the terminals of the trunks of each exchange for impressing upon the link-circuit a potential equal to that of ground at the exchange to which the trunks lead, the potential varying for the different exchanges.

Should the ground potential at the distant exchange be substantially devoid of fluctuation, the adjustment of the potential of the connection terminals of a set of trunks to the potential of the distant ground may be effected by making the conductor 77 a local conductor leading to a local ground through a source of potential suitable to adjust the potential as required.

However, variations of earth potential are, it is considered, materially less likely to produce troubles in operation than they are in other systems employing earth as a common return for switching purposes. This will be apparent from the following considerations.

In operation, the two operating relays PR and SR are connected in a bridge including battery across the impulse transmitting conductors 22^a and 22^b, which conductors have a second bridge, in the circuit shown including the windings of relay 22, while the impulse transmitting springs 26 and 29 control contacts in the said conductors located intermediate of the two bridges. It will be remembered that when spring 26 is actuated, it completes an alternate circuit to the common return or ground conductor 77 for relay SR before opening the circuit of relay PR; and that on the retraction of spring 26, the original energizing circuit for the two relays PR and SR, having the full voltage of the serially disposed batteries 44^b and 45^a, is re-established for energizing anew the relay PR. With a number of actuations of spring 26, the above would be repeated, and it is clear that the re-energizations of relay PR are effected over the metallic circuit of the impulse transmitting conductors 22^a and 22^b.

When spring 29 is actuated, complementary switching operations for de-energizing relay SR and holding relay PR energized are produced.

In the automatic telephone systems before referred to, a common return or local ground is used for energizing the operating relays, the local grounds being at points distant from the exchange where the relays are. To care for variations in earth potential at such ground connections, or the resistance of the common return, a central battery of relatively high voltage is customarily employed, as the relays must be quickly energized when the conductors, with which they are respectively connected, are applied to the ground or common return. In my present structure, the ground or third conductor being employed only to hold an already operated relay operated, it is apparent that chances of trouble from the

use of the ground or common return are very materially reduced, as it is well known that after a relay is once operated and its armatures are attracted, but a very small per cent of the current originally required for its initial operation is necessary to cause its continued operation.

Having described my invention in a specific manner with reference to one embodiment thereof, it will be understood that it is not my intention to be limited to the specific structures illustrated. It is for instance, well known that selective switches may be employed for the purpose of associating the calling subscribers' lines with operators' link-circuits, and it is not my purpose to limit my invention to the specific plug and jack arrangements shown in certain portions of the specific embodiment of my invention. It will also be understood that the various sources of electrical energy which I have shown at different places in the circuit diagram of Fig. 1, need not be so many individual sources but where identical symbols are indicated, the various sources may be, and preferably are, a single source. Of course where distant exchanges are comprised in a system, each exchange is preferably provided with its individual battery supply. Similarly, the various interrupters marked "I" with different exponents may be a single interrupter. Of course for the furnishing of the different frequencies of current for ringing the tuned bells, different generating devices are preferably employed.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. A telephone system including subscribers' lines, operator controlled selective switches for interconnecting said lines, an operator's impulse transmitter including an electromagnetically adjusted traveling contact member serving to transmit current impulses to operate said switches, and a second electromagnetically adjusted traveling member for said impulse transmitter for controlling the number of impulses transmitted by said first member.

2. A telephone system including subscribers' lines, selective switches for interconnecting said lines, an operator's impulse transmitter provided with a traveling contact member serving to transmit impulses to operate said switches, a second traveling member for said impulse transmitter, a switching device for determining the number of impulses transmitted by said first member, a source of current and a circuit including said second member and said source of current for operating said switching device.

3. A telephone system including telephone lines and selective switches for making connection therewith, controlling mechanism for determining the operation of said switches including an impulse transmitter, an electromagnet for operatively associating when energized, and dissociating when de-energized, said transmitter with and from said switches, a traveling contact member for operating said magnet, an automatic switch for effecting travel of said member, means controlled by said switch at fixed points in its operation for deenergizing said magnet, and manually manipulated switching means for controlling the circuit of said traveling member to control the time of energization of said magnet.

4. A telephone system including telephone lines and selective switches for making connection therewith, a circuit making-and-breaking device for controlling said switches, an automatic switch, a plurality of sets of stationary contacts for said automatic switch, one set for each set of circuit makes-and-breaks to be produced by said device, a plurality of sets of switch contacts, one for each set of stationary contacts, each stationary contact having its corresponding switch contact, manual means for operating selected switch contacts, one of each set to alter the circuits of the corresponding stationary contacts, a travelling member for said automatic switch, and means controlled thereby for operatively associating said device with said selective switches as often as, and when, said member engages a stationary contact whose circuit is altered.

5. A telephone system including telephone lines and selective switches for making connection therewith, a circuit making-and-breaking device for controlling said switches, an automatc switch, a plurality of sets of stationary contacts for said automatic switch, one set for each set of circuit makes-and-breaks to be produced by said device, a plurality of sets of switch contacts, one for each set of stationary contacts, each stationary contact having its corresponding switch contact, manual means for operating selected switch contacts, one of each set to alter the circuits of the corresponding stationary contacts, a travelling member for said automatic switch, means controlled thereby for operatively associating said device with said selective switches as often as, and when, said member engages a stationary contact whose circuit is altered, and mechanism automatically effective at fixed points in the travel of said member to operatively dissociate said device from said selective switches.

6. A telephone system including telephone lines and selective switches for making connection therewith, a circuit making-and-breaking device for controlling said switches, an automatic switch, a plurality of sets of

stationary contacts for said automatic switch, one set for each set of circuit makes-and-breaks to be produced by said device, a plurality of sets of switch contacts, one for each set of stationary contacts, each stationary contact having its corresponding switch contact, manual means for operating selected switch contacts, one of each set to alter the circuits of the corresponding stationary contacts, a travelling member for said automatic switch, means controlled thereby for operatively associating said device with said selective switches as often as, and when, said member engages a stationary contact whose circuit is altered, a manually operated device for initiating travel of said automatic switch, and means for stopping said switch when said member reaches a normal point.

7. A telephone system including telephone lines and selective switches for making connection therewith, a circuit making-and-breaking device for controlling said switches, an automatic switch, a plurality of sets of stationary contacts for said automatic switch, one set for each set of circuit makes-and-breaks to be produced by said device, a plurality of sets of switch contacts, one for each set of stationary contacts, each stationary contact having its corresponding switch contact, manual means for operating selected switch contacts, one of each set to alter the circuits of the corresponding stationary contacts, a travelling member for said automatic switch, means controlled thereby for operatively associating said device with said selective switches as often as, and when, said member engages a stationary contact whose circuit is altered, mechanism automatically effective at fixed points in the travel of said member to operatively dissociate said device from said selective switches, a manually operated device for initiating travel of said automatic switch, and means for stopping said switch when said member reaches a normal point.

8. A telephone system including telephone lines and selective switches for making connection therewith, a circuit making-and-breaking device for controlling said switches, and electromagnet controlling switching mechanism for operatively associating and dissociating said device with and from said switches, an automatic switch, manually operated means for initiating travel thereof, the subsequent travel of said switch to a normal point being automatically controlled, manually controlled switching means for producing energizations of said magnet to operatively associate said device with said selective switches at selected points in the operation of said automatic switch, and switching means automatically controlled by said automatic switch for de-energizing said magnet at fixed points in the operation of said automatic switch to dissociate said device from said selective switches.

9. A telephone system including subscribers' lines, selective switches for use in interconnecting said lines, an operator's impulse transmitter for operating said switches, a traveling contact member for said transmitter, stationary contacts for engagement by said member to co-operate therewith in controlling said switches, a second travelling member for said impulse transmitter provided with stationary contacts, manually operated switching devices for said transmitter for controlling the circuits of said last contacts, a relay for co-operating with said second member, a contact therefor, a manually operated device, and a circuit controlled by said last device including said relay contact for controlling the operative relation of said first member with said switches.

10. A telephone system including subscribers' lines, selective switches for use in interconnecting said lines, an operator's impulse transmitter located at the exchange for operating said switches, a traveling contact member for said transmitter, stationary contacts for engagement thereby one for each number to be transmitted by said transmitter, manually operated keys for operatively altering the electrical condition of said contacts, a controlling relay for effectively completing connection between said transmitter and said switches, and means for operating said relay over a circuit including said traveling member and the first contact engaged thereby whose circuit is altered.

11. A telephone system including subscribers' lines, selective switches for use in interconnecting said lines, an operator's impulse transmitter for operating said switches, a traveling contact member for said impulse transmitter, stationary contacts for engagement thereby one for each number to be transmitted by said transmitter, manually operated buttons for altering the electrical condition of said contacts, a controlling relay for effectively associating said transmitter with said switches, means for operating the said relay over a circuit including said traveling member and the first contact engaged thereby whose electrical condition is altered, and electromagnetically driven means for effecting travel of said member.

12. A telephone system including subscribers' lines, selective switches for use in interconnecting said lines, an operator's impulse transmitter for operating said switches, a traveling contact member for said impulse transmitter, stationary contacts for engagement thereby one for each number to be transmitted by said transmitter, manually operated buttons for altering the elec-

trical condition of said contacts, a controlling relay for effectively associating said transmitter with said switches, means for operating the said relay over a circuit including said traveling member and the first contact engaged thereby whose electrical condition is altered, electromagnetically driven means for effecting travel of said member, manually controlled means for completing the initial operating circuit of said electromagnetic means, an off-normal contact for stopping said electromagnetic means when reaching a normal position, and mechanism controlled by said electromagnetic means effective at certain points of its travel to produce an unoperated condition of said relay.

13. A telephone system including subscribers' lines, selective switches for connecting with called lines, an impulse transmitter for transmitting directive currents to said switches, a key-board for said transmitter having manually actuated switch members, one for each thousands digit, one for each hundreds digit, etc., and a traveling device for said transmitter common to and controlled by said switch members only and effective to produce sets of current impulses corresponding in numbers to the values of the actuated members.

14. A telephone system including subscribers' lines, selective switches for use in completing connections to called lines, an impulse transmitter for transmitting a plurality of sets of directive impulses to said switches, manually operated key members and switching means controlled thereby, one for each digit of each impulse set to be transmitted, and mechanism for said transmitter controlled by said key members and switching means only and controlling the numbers of impulses of said sets according to the values of the actuated members.

15. A telephone system including telephone lines, an electromagnetically controlled connector for connecting to a called line responsive to directive current impulses, contact wipers for said connector including a talking wiper and a test wiper, a test relay controlling a contact in the circuit of said talking wiper, means for holding said relay energized while said talking wiper is engaging lines not wanted whereby said wiper is on open circuit, and a switch for shifting said relay to connection with said test wiper when said talking wiper is engaging the wanted line to render the continued energization of said relay dependent upon the idle or busy condition of said line.

16. A telephone system including telephone lines, an electromagnetically controlled connector for connecting to a called line responsive to directive current impulses, contact wipers for said connector including a talking wiper and a test wiper, a test relay controlling a contact in the circuit of said talking wiper, means for holding said relay energized while said talking wiper is engaging lines not wanted whereby said wiper is on open circuit, test contacts for said lines for engagement by said test wiper, means for altering the normal electrical conditions of said contacts to render them busy, and a switch for shifting said relay to connection with said test wiper when said talking wiper is engaging the wanted line.

17. A telephone system including telephone lines, an electromagnetically controlled connector for connecting to a called line responsive to directive current impulses, contact wipers for said connector including a talking wiper and a test wiper, a test relay controlling a contact in the circuit of said talking wiper, means for holding said relay energized while said talking wiper is engaging lines not wanted whereby said wiper is on open circuit, test contacts for said lines for engagement by said test wiper, and a switch for rendering said test relay sensitive to the idle or busy condition of the test contact of the wanted line on connection made therewith.

18. A telephone system including telephone lines, an electromagnetically controlled connector for connecting to a called line responsive to directive current impulses, contact wipers for said connector including a talking wiper and a test wiper, a test relay controlling a contact in the circuit of said talking wiper, means for holding said relay energized while said talking wiper is engaging lines not wanted whereby said wiper is on open circuit, test contacts for said lines for engagement by said test wiper, a switch for rendering said test relay sensitive to the idle or busy condition of the test contact of the wanted line on connection made therewith, and mechanism controlled by said test relay for extending a busy signal, or completing a portion of a talking circuit according to the idle or busy condition of said contact.

19. A telephone system including telephone lines, a connector for connecting directly with a called line, auxiliary selective switches for successive operation in establishing connection from a calling line to said connector, restoring electromagnets, one for each of said selective switches, a release control circuit extending from switch to switch, a central source of current, branch connections from said control circuit, one for each magnet extending through said magnets to one pole of said source, an additional branch connection from said circuit to said one pole, short-circuiting said magnets while said switches are in use, and means for controlling the continuity of said additional connection to render said magnets operable.

20. A telephone system including telephone lines, a connector for connecting directly with a called line, auxiliary selective switches for successive operation in establishing connection from a calling line to said connector, restoring electromagnets, one for each of said selective switches, a release control circuit extending from switch to switch, a central source of current, branch connections from said control circuit, one for each magnet extending through said magnets to one pole of said source, an additional branch connection from said circuit to said one pole, short-circuiting said magnets while said switches are in use, a release control relay and mechanism therefor controlling the continuity of said additional branch, and means for controlling the operative condition of said relay when disconnection is desired for opening said additional branch to render said magnets operable.

21. A telephone system including telephone lines, a connector for connecting directly with a called line, auxiliary selective switches for successive operation in establishing connection from a calling line to said connector, restoring electromagnets, one for each of said selective switches, a release control circuit extending from switch to switch, a central source of current, branch connections from said control circuit, one for each magnet extending through said magnets to one pole of said source, an additional branch connection from said circuit to said one pole, short-circuiting said magnets while said switches are in use, a release control relay and mechanism therefor controlling the continuity of said additional branch, means for controlling the operative condition of said relay when disconnection is desired for opening said additional branch to render said magnets operable, and apparatus for connecting said source of current to said control circuit to operate said magnets while said additional branch is open when disconnection is desired.

22. A telephone system including telephone lines, a connector for connecting directly with a called line, auxiliary selective switches for successive operation in establishing connection from a calling line to said connector, restoring electromagnets, one for each of said selective switches, a release control circuit extending from switch to switch, a central source of current, branch connections from said control circuit, one for each magnet extending through said magnets to one pole of said source, an additional branch connection from said circuit to said one pole, short-circuiting said magnets while said switches are in use, means for controlling the continuity of said additional connection to render said magnets operable, and apparatus for connecting said source of current to said control circuit to operate said magnets while said additional branch is open when disconnection is desired.

23. A telephone system including subscribers' lines, connector switches for connecting directly to a called line in establishing a connection, auxiliary selective switches for operation in completing connection from a calling line to said connector, an operating relay for transmitting successive sets of directive impulses to the selective switches and the connector switch in establishing a connection, a second operating relay for controlling the circuits of said switches, electromagnets for restoring said switches to normal, one for each switch, a release control relay jointly controlled by said operating relays, a release control circuit extending from switch to switch, a central source of current, branch connections from said circuit through said electromagnets to one side of said source, and a low-resistance branch from said circuit to said one side of said source, said branch being controlled as to its continuity by said release control relay whereby said electromagnets are short-circuited while their operation is not required.

24. A telephone system including subscribers' lines, connector switches for connecting directly to a called line in establishing a connection, auxiliary selective switches for operation in completing connection from a calling line to said connector, an operating relay for transmitting successive sets of directive impulses to the selective switches and the connector switch in establishing a connection, a second operating relay for controlling the circuits of said switches, electromagnets for restoring said switches to normal, one for each switch, a release control relay jointly controlled by said operating relays, a release control circuit extending from switch to switch, a central source of current, branch connections from said circuit through said electromagnets to one side of said source, a low-resistance branch from said circuit to said one side of said source, said branch being controlled as to its continuity by said release control relay whereby said electromagnets are short-circuited while their operation is not required, and means for opening said low-resistance branch and extending a connection to the opposite pole of said source from said release control circuit when disconnection is desired.

25. A telephone system including polystation telephone lines, a connector for operation responsive to directive currents to select a wanted one of said lines, a connection over which said currents are transmitted, an auxiliary switch for said connector comprising a plurality of signaling conductors

carrying current for selectively signaling the various stations of a poly-station line and a contact member for selecting the desired conductor, a locking relay for said connector with means for operating the same, and a switch contact controlled by said relay for shifting said connection from said connector to said auxiliary switch, whereby the latter is rendered responsive to directive currents.

26. A telephone system including an exchange, other exchanges, telephone lines extending from substations to said exchanges, trunk lines extending from said first mentioned exchange to said other exchanges, grounded sources of current at said other exchanges having their ungrounded terminals connected to the trunk lines of their respective exchanges, relays included in the connection between the ungrounded battery terminal and the trunk lines terminals of said trunk lines at said first mentioned exchange, link-circuits for connection to said terminals in establishing desired connections, means associated with the terminals of said trunks for impressing upon a terminal of the link-circuit while in connection with a trunk, an electrical potential corresponding to the electrical potential of the grounded terminal of the source of current at the particular exchange to which the trunk leads, means at said link circuit for impressing said corresponding electrical potential to other terminals of the trunk to operate said relays, and automatic switches controlled by said relays for extending said trunk circuits.

27. A telephone system including an exchange, subscribers' lines terminating at said exchange, operators' link-circuits and means for interchangeably connecting them with calling lines, a distant exchange, trunk circuits extending from said first exchange to said distant exchange and there provided with connection devices for connecting to called lines, multiple terminals for said trunk circuits at said first exchange, the multiple terminals of each trunk including multiple contacts connected to a conductor individual to said trunk and extending to said distant exchange, an additional contact included in each terminal of each trunk, a conductor connecting the additional contacts of the terminals of a plurality of trunks, a source of current at the distant exchange, a connection extending from said conductor to the distant exchange and there connected to one pole of said source, a connection device for an operators' link-circuit for establishing connection to a terminal of a trunk, said device including a switch contact for connecting to each contact of said terminal, a connection from said individual conductor to the opposite pole of said source, and an electromagnet for said link-circuit adapted to be bridged across said first-mentioned contact and said additional contact.

28. A telephone system including an exchange, subscribers' lines terminating at said exchange, operators' link-circuits and means for interchangeably connecting them with calling lines, a distant exchange, trunk-circuits extending from said first exchange to said distant exchange and there provided with connection devices for connecting to called lines, multiple terminals for said trunk-circuits at said first exchange, the multiple terminals of each trunk including multiple contacts connected to a conductor individual to said trunk and extending to said distant exchange, an additional contact included in each terminal of each trunk, a conductor connecting the additional contacts of the terminals of a plurality of trunks, a source of current at the distant exchange, a connection extending from said conductor to the distant exchange and there connected to one pole of said source, a connection device for an operator's link-circuit for establishing connection to a terminal of a trunk, said device including a switch contact for connecting to each contact of said terminal, a third contact for each multiple terminal, a busy or test circuit controlled thereby, means effective on connection made with a terminal to alter the circuit of said third contact to render the trunk busy, a connection from said individual conductor to the opposite pole of said source, and an electromagnet for said link-circuit adapted to be bridged across said first-mentioned contact and said additional contact.

29. A telephone system including an exchange, subscribers' lines terminating at said exchange, operators' link-circuits and means for interchangeably connecting them with calling lines, a distant exchange, trunk-circuits extending from said first exchange to said distant exchange and there provided with connection devices for connecting to called lines, multiple terminals for said trunk-circuits at said first exchange, the multiple terminals of each trunk including multiple contacts connected to a conductor individual to said trunk and extending to said distant exchange, an additional contact included in each terminal of each trunk, a conductor connecting the additional contacts of the terminals of a plurality of trunks, a source of current at the distant exchange, a connection extending from said conductor to the distant exchange and there connected to one pole of said source, a connection device for an operator's link-circuit for establishing connection to a terminal of a trunk, said device including a switch contact for connecting to each contact of said terminal, a connection from said individual conductor to

the opposite pole of said source, an electromagnet for said link-circuit adapted to be bridged across said first-mentioned contact and said additional contact, and a switch included in said link-circuit for opening and closing said bridge.

30. A telephone system including a telephone exchange, other telephone exchanges, two conductor trunk lines extending from said exchange to said other telephone exchanges, multiple terminals, contacts of said conductors at said exchange, a common return conductor from said exchange to each other exchange, a terminal of said common return for each exchange associated with all the terminal contacts of the trunks of its exchange, selective switches at said other exchanges for operation responsive to currents over said trunk lines, subscribers' lines terminating in said exchanges, impulse transmitting relays at said first exchange for transmitting directive currents to said switches over the conductors of said terminals to select called lines, means for operatively associating said relays with the terminal contacts of an idle trunk leading to any of said other exchanges to enable said relays to control the circuits of said conductors in transmitting said currents, a third conductor for said transmitting relays, and means effective on operative association of said relays with any trunk to automatically connect the third conductor of said relays with the common return of the particular exchange to which the trunk extends.

31. A telephone system including a pair of conductors, a selective switch at one end of said conductors, operating relays for said switch bridged across said conductors, a source of current connected with said relays, switch contacts included in said conductors, a common return conductor with connections extending to said contacts, means for operating said relays in series over the metallic circuit of said conductors, actuating devices for said switch contacts for alternative operation, each capable of connecting one of said relays to said common return and thereafter opening the circuit of the other relay, said actuating devices on return movement re-establishing the series circuit of said relays before breaking the connection to said common return whereby the energizations of said relays are produced over the metallic circuit of said conductors.

32. In a telephone system, the combination with trunk lines, of common return conductors, some of said trunk lines having associated with them one such conductor, and others another such conductor, apparatus for selecting and connecting with said trunk lines, said apparatus including means whereby, on connecting to a trunk line, connection is made to the particular associated return conductor.

33. In a telephone system, the combination with trunk lines divided into groups, of common return conductors, one for each group, multiple terminals for said trunk lines, each terminal of a line including a contact connected to the return conductor of the group to which the line belongs, and means adapted to make connection with said terminals.

34. In a telephone system, the combination with relays divided into groups, of trunk lines, one for each relay, common return conductors for said trunk lines, one for the lines of each group of relays, terminals for said trunk lines, each such terminal including a switch contact connected with the return conductor of the appropriate group, an adjustable connector adapted to be connected with any of said terminals, said connector including a contact adapted to register with the switch contact of the terminal to which it is connected.

35. A telephone system including a first selector, a second selector and a connector, a release conductor extending through said selectors and to said connector, release control electro-magnets, one for each of said selectors and said connector, said electromagnets being conductively in circuit with said conductor in parallel connection with each other, and means for altering the potential at a point in the length of said conductor to simultaneously operate said magnets.

36. A telephone system including a first selector, a second selector and a connector, a release conductor extending through said selectors and to said connector, release control electromagnets, one for each of said selectors and said connector, said electromagnets being conductively in circuit with said conductor in parallel connection with each other, an electromagnet controlling said conductor, and means for changing the electrical condition of said last-mentioned magnet to energize said conductor.

37. A calling device for controlling automatic switches comprising traveling contact mechanism adapted for transmitting a variable number of current variations, a set of impulse buttons, circuit connections between said buttons and impulse mechanism for controlling the number of current variations to be transmitted, and means responsive to the operation of any of said buttons to start said impulse mechanism to transmit the corresponding number of current variations.

38. A calling device for controlling automatic switches comprising impulse mechanism normally at rest and adapted for transmitting a variable number of current variations, a set of impulse keys, corre-

sponding to the number of impulse variations, and means responsive to the actuation of any of said buttons to initiate operation of the impulse mechanism to transmit a corresponding number of current variations.

39. A calling device for controlling automatic switches comprising impulse buttons having different digit values, traveling impulse mechanism having operative positions corresponding in number to the number of impulse buttons, and means responsive to the actuation of any of said buttons to initiate travel of said mechanism and to render a number of such positions effective for transmitting impulses, corresponding in digit value to the actuated button.

40. A calling device for controlling automatic switches comprising sets of impulse buttons having different digit values, traveling impulse mechanism having impulse transmitting positions corresponding in number to the number of impulse buttons, means for operating the impulse mechanism, and means responsive to the actuation of a button from each set to initiate travel of said impulse mechanism for transmitting sets of impulses, each set corresponding in digit value to an actuated button.

41. A calling device for controlling automatic switches comprising sets of impulse buttons having different digit values, traveling impulse mechanism having impulse transmitting positions corresponding in number to the number of impulse buttons, and means responsive to the actuation of a button from each set to initiate travel of said mechanism for transmitting sets of impulses, each set corresponding in digit value to an actuated button.

42. A calling device for controlling automatic switches comprising impulse keys adapted for controlling the transmission of sets of impulses of different digit values, and impulse mechanism controlled by said keys having impulse transmitting positions corresponding in number to the number of impulse positions of said keys.

43. An impulse transmitter comprising a key-board having manually actuated switch members, one for each digit to be transmitted, a normally at rest traveling contact maker for said transmitter common to and controlled by said switch members, and means jointly controlled by said traveling member and said switch members to produce sets of impulses corresponding in numbers to the values of the actuated members.

44. A telephone system including a subscriber's telephone line extending to a central exchange, automatic switches, a metallic line circuit, a single impulse maker for generating a plurality of series of directive impulses, each series consisting of a varying number of impulses, a rotary controlling device, a single device controlled by said rotary device for operatively connecting said impulse maker to said metallic circuit to transmit said plurality of series of directive impulses thereover to operate said automatic switches to extend a connection to said subscriber's line, said last device being operative to connect said impulse maker to said metallic circuit for each series of impulses to be transmitted, said impulse maker being connected to said metallic circuit for varying periods of time according to the number of impulses in each series, a plurality of operator controlled keys, and electromagnets controlled thereby for initiating and controlling the operation of said impulse maker.

45. A telephone system including subscriber's lines, operator controlled selective switches for interconnecting said lines, a single impulse generator for making directive impulses, controlling means for dividing up the impulses made by said impulse generator into groups of impulses varying in number for operating said selective switches, said controlling means including a single device for operatively connecting said impulse generator to said selective switches for each series of impulses to be transmitted, said impulse generator being operatively connected to said switches by said single device for varying periods of time according to the number of impulses in the series, a plurality of operator controlled keys, and electromagnets controlled thereby for initiating and controlling the operation of said impulse generator and said controlling means.

46. A telephone system including subscribers' lines extending to a central office, selective switches at said office for interconnecting said lines, an impulse circuit, an operator's impulse transmitter located at said office for transmitting a plurality of series of impulses over one side of said circuit, each series followed by one or more impulses over the opposite side of said circuit to operate said switches, a movable arm, means controlled by said arm for generating the impulses of said different series of impulses, a plurality of operator controlled keys, and electromagnets controlled thereby for initiating the operation of said impulse device.

47. A telephone system including a called subscriber's line, operator controlled selective switches for extending a connection to said line, a central office operator's impulse transmitting device for controlling said switches, operators' keys for controlling said impulse device, electromagnets controlled by said keys, a controlling arm adapted to be operated by said electromagnets, and means controlled by said arm for transmitting impulses according to the digits of the called number.

48. A telephone system including a called

subscriber's line, automatic switches for use in extending connections to said called subscriber's line, an operator's calling device including a plurality of operators' keys, electromagnets controllable thereby, a controlling arm adapted to be operated by said electromagnets, and means controlled by said arm for transmitting a plurality of series of impulses to operate said automatic switches, and means for spacing apart the different series of impulses.

49. A telephone system including subscribers' telephone lines, operator controlled selective switches for interconnecting said lines, a normally at rest operator's calling device including a plurality of operating keys, manual means for associating said device with said switches, electromagnets controlled by said keys, a controlling arm adapted to be operated by said electromagnets, and means controlled by said arm for transmitting a plurality of series of impulses to operate said automatic switches, and means for spacing apart the different series of impulses.

50. A telephone system including subscribers' telephone lines, operator controlled automatic switches, a normally at rest operator's calling device for operating said automatic switches to extend a connection from a calling one of said subscribers' lines to a called one of said subscribers' lines, manual means for associating said device with said switches, a plurality of keys for said calling device, electromagnets controlled thereby, a controlling arm adapted to be operated by said electromagnets, and means controlled by said arm for transmitting impulses to said automatic switches according to the digits of the called number.

51. In a telephone system, subscribers' lines, operator controlled switches for interconnecting the same, an impulse circuit, a normally at rest impulse maker for generating directive impulses located at the central office and controllable by a central office operator, a single controlling device for operatively connecting said impulse maker to said impulse circuit for varying predetermined periods of time, thereby transmitting varying numbers of impulses over said circuit to said switches, a plurality of keys, and electromagnets controlled by said keys for controlling the operations of said impulse maker.

52. A telephone system including subscribers' lines extending to a central exchange, operator controlled automatic switches at said central exchange for interconnecting said lines, an operator's calling device located at the central exchange including a plurality of operators' keys, electromagnets controllable thereby, a controlling arm adapted to be operated by said electromagnets, and means controlled by said arm for transmitting impulses to operate said switches according to the digits of the called numbers.

53. A telephone system including subscribers' telephone lines terminating at a central exchange, automatic switches for interconnecting said lines, a normally at rest operator's calling device located at the central exchange including a plurality of operating keys, electromagnets controlled thereby, a controlling arm adapted to be operated by said electromagnets, means controlled by said arm for transmitting a plurality of series of impulses to operate said switches, and means for spacing apart the different series of impulses.

54. A calling device for controlling automatic switches including a traveling member adapted to generate directive impulses, a set of impulse buttons, electromagnets for dividing up the said directive impulses into different series of impulses varying in number, a single device for operatively associating said impulse maker with said automatic switches, said device being operated for varying periods of time according to the number of impulses in the different series, circuit connections between said keys and said electromagnets for controlling the said traveling member and for initiating the operation of said device.

55. An impulse transmitting device including a keyboard having manually actuated switch members, one for each digit to be called, a normally at rest rotatable traveling member for generating directive impulses, an impulse circuit, a single device for associating said traveling member with said impulse circuit for operatively transmitting a plurality of series of impulses over said impulse circuit, said single device being operated for each series of impulses, said sets of impulses corresponding in numbers to the values of the actuated switch members and varying in numbers.

56. In a telephone system, a line, means for supplying ringing currents of different frequencies, a mechanism for selecting the different frequencies one at a time, means for controlling said mechanism over the two sides of the line in series, and automatic step-by-step-controlled means for extending connection from said line.

57. In a telephone system, a line, means for supplying different kinds of signaling current, a mechanism for selecting the different kinds of current one at a time, means for controlling said mechanism over the two sides of the line in series, and automatic step-by-step-controlled means for extending connection from said line.

58. In a telephone system, a party line, mechanism for selectively signaling on said line, a trunk line, means for controlling said

mechanism over the two sides of the trunk line in series, and automatic step-by-step-controlled means for extending connection from said line.

59. In a telephone system, automatic switching apparatus comprising a connector switch for connecting two lines, a ringer relay in said connector, an energizing circuit for said relay, an intermittent interrupter for controlling said circuit at one point, and a locking relay for controlling the circuit at another point, trunk release apparatus for restoring said switches and for restoring the circuit of the ringer relay to normal.

60. A selector for automatic exchanges including switch wipers and off-normal contacts, an electromagnet adapted to control travel of said wipers, a release control magnet for said selector, a circuit for said first-mentioned magnet having two branches, one branch including a normally open contact of said second magnet and the other including a normally closed contact of said second magnet and an off-normal contact of the selector.

61. A telephone system including telephone lines, an automatic connector switch for connecting to said lines as called lines, an active test contact and an active talking contact for said connector, a relay controlling a contact in the circuit of said talking contact, means for holding said relay energized while said talking contact is engaging lines not wanted, and a switch for shifting said relay into connection with said test contact when said talking contact engages the wanted line to render the continued energization of said relay dependent upon the idle or busy condition of said line.

62. A telephone system including telephone lines, a connector switch for connecting with said lines as called lines, an active test contact and an active talking contact for said connector, a relay, a circuit including said active talking contact controlled by said relay, means for energizing said relay and maintaining the same energized while said talking contact is passing over contacts of lines not wanted, and a switch for then connecting said relay to said test contact, whereby the continued energization of the same is dependent upon the idle or busy condition of the wanted line.

63. In a telephone system, a manual switchboard, an operator's head set at said board, a subscriber's line, an automatic connector switch controllable from said switchboard to connect with said line, means in said switch for automatically preventing the signaling of the substation on said line while the said line is busy and for giving the operator a busy signal, means for automatically signaling said substation when the said line becomes idle, and another signal at the switchboard for indicating when the subscriber responds.

64. In a telephone system, a manual switchboard, an operator's head set at said board, a subscriber's line, a trunk line extending from said switchboard to an automatic connector switch, said switch being operable to connect with said line and controllable over the two sides of said trunk in series, contacts in said switch and means for closing them after the said line has been found to complete connection thereto, means for preventing the closure of said contacts when the said line is busy and until it becomes idle and for giving the operator a busy signal, means for signaling the subscriber when his line becomes idle, and another signal at the switchboard for indicating when the subscriber responds.

65. In a telephone system, a manual switchboard, a subscriber's line, an automatic connector switch operable from said switchboard to connect with said line and controllable over the two sides of a circuit in series, means in said switch for automatically preventing the signaling of the substation on said line while the said line is busy, means for automatically signaling said substation when the said line becomes idle, a signal at said switchboard, and a relay for operating said signal controllable over the subscriber's line.

66. In a telephone system, a manual switchboard, a subscriber's line, a trunk line extending from said switchboard to an automatic connector switch, said switch controllable over said trunk to connect with said line, contacts in said switch and means for closing them after the said line has been found to complete connection thereto, means for preventing the closure of said contacts when the said line is busy and until it becomes idle, a signal at said switchboard, and a relay operated over said trunk line by the subscriber to operate said signal.

67. In a telephone system, a manual switchboard, a subscriber's line, a trunk line extending from said switchboard to an automatic connector switch, a cord circuit at said switchboard having access to said trunk line, means in said cord circuit for operating said connector switch to connect with said line, means in said switch for automatically preventing the completion of such connection while the said line is busy, and means in said switch for automatically completing such connection when the said line becomes idle, and a visual signal at said switchboard for indicating when the called subscriber responds and replaces his receiver.

68. In a telephone system, a calling subscriber's line and a called subscriber's line, connecting means for establishing a continuous metallic talking circuit from the calling to the called line, said means comprising in

serial relation an operator's cord circuit, a plurality of selector switches, and a final connector switch, means controllable over the two sides of a circuit in series for controlling said switches, and subscriber controlled supervisory means for said cord circuit.

69. In a telephone system, a calling subscriber's line and a called subscriber's line, connecting means for establishing a continuous metallic talking circuit from the calling to the called line, said means comprising an operator's cord circuit, a plurality of selector switches, a final connector switch, means controllable over the two sides of a circuit in series for controlling said switches, and subscriber controlled supervisory means for said cord circuit.

70. In a telephone system, subscribers' lines, trunk lines divided into groups, a manual operator's position for extending connection from a calling line to suitable automatic means for completing said connection to a called line, said automatic means including an automatic switch controllable over two sides of a line circuit in series and having vertical motion to select groups and rotary motion to find a line in a selected group, and means at said manual operator's position controlled by the called subscriber for supervising said connection, the supervisory circuit and the switch control circuit coinciding in part.

71. In a telephone system, subscribers' lines, trunk lines divided into groups, a manual operator's position for extending connection from a calling line to suitable automatic means for completing said connection to a called line, said automatic means including an automatic switch controllable over two sides of a line circuit in series and having vertical motion to select groups and rotary motion to find a line in a selected group, and a signal at said operator's position adapted to be displayed when the called line is found and retired when the called subscriber answers, the supervisory circuit and the switch operating circuit coinciding in part.

72. In a telephone system, a manual switchboard, trunk lines, means including said manual board for establishing a talking circuit between a calling manual subscriber and a called automatic subscriber, said talking circuit including a plurality of said trunk lines, an automatic switch individual to each of said trunk lines, means on said board controlled over the two sides of the talking circuit for supervising such connection, and means whereby the automatic switches used in making the call are controllable over the two sides of said talking circuit in series.

73. In a telephone system, subscribers' lines, trunk lines divided into groups, a manual operator's cord circuit and suitable automatic means for extending connection from a calling to a called subscriber's line, said automatic means including an automatic switch having vertical motion to select groups and rotary motion to find a line in a selected group, a magnet individual to said switch for controlling the operation thereof, means for energizing said magnet over two sides of a line circuit in series, a relay bridged across said cord circuit, and a signal controlled by said relay adapted to be displayed when the called line is found and retired when the called subscriber answers.

74. In a telephone system, subscribers' lines, trunk lines divided into groups, a manual operator's position for extending a talking circuit from a calling line to any one of said trunk lines, suitable automatic means associated with each trunk line for completing said connection to a called line, said automatic means including an automatic switch having vertical motion to select groups and rotary motion to find a line in a selected group, a magnet individual to said switch, means for energizing said magnet over two sides of said talking circuit in series to control said switch, and a polarized relay at said manual operator's position responsive to a reversal of flow of current for supervising said connection.

75. In a telephone system, subscribers' lines, suitable automatic means, trunk lines divided into groups, a manual operator's position for extending connection from a calling line to said automatic means for completing said connection to a called line, said automatic means including an automatic switch having vertical motion to select groups and rotary motion to find a line in a selected group, a magnet individual to said switch, means for energizing said magnet over two sides of a line circuit in series to control said switch, and a signal at said operator's position adapted to be displayed when the called line is found and retired when the called subscriber answers.

76. In a telephone system, a cord circuit provided with supervisory signal mechanism, and a relay controlled by the called party for reversing the current in said cord circuit to control said mechanism.

77. In a telephone system, means including a cord circuit and one or more automatic switches for semi-automatically extending a calling connection, supervisory signal mechanism for said cord circuit, and means controlled by the called party for reversing the current in said cord circuit to control said mechanism.

78. In a telephone system, a cord circuit provided with supervisory signal mechanism, a relay controlled by the called party for reversing the current in said cord circuit to control said mechanism, and one or

more central sources of operating and talking current.

79. In a telephone system, means including a cord circuit and one or more automatic switches for semi-automatically extending a calling connection, supervisory signal mechanism for said cord circuit, means controlled by the called party for reversing the current in said cord circuit to control said mechanism, and one or more central sources of operating and talking current.

80. In a telephone system, a set of trunks divided into groups, a combined automatic trunk selector and impulse repeater, and a suitable line over which said selector and repeater are controlled, said selector and repeater having means controlled by a called party for reversing the current in said line, said trunk selector having motion in one plane to select groups and motion in a plane at right-angles thereto to find a trunk in a selected group.

81. In a telephone system, means including a cord circuit and one or more automatic switches for semi-automatically extending a calling connection, supervisory signal mechanism for said cord circuit, and means controlled by the called party for reversing the current in said cord circuit to control said mechanism, said automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a trunk in a selected group.

82. In a telephone system, a plurality of subscribers' lines, means for establishing connection between two of said lines, said means including a cord circuit and one or more automatic switches, electromagnetic means connected to a conductor of one of said automatic switches, a supervisory signal in said cord circuit, means controlled by the response of the called party for energizing said electromagnetic means, and circuit connections controlled by said electromagnetic means upon energizing for reversing the current to control means which controls said supervisory signal.

83. In a telephone system, a plurality of subscribers' lines, means for extending a connection between two of said lines, said means including a cord circuit and one or more automatic switches, a polarized relay in said cord, a supervisory signal controlled by said polarized relay, electromagnetic means connected to a conductor of one of said automatic switches, means for energizing said electromagnetic means upon response of the called subscriber, and means controlled by the energization of said electromagnetic means for reversing the current through said polarized relay to thereby operate said supervisory relay.

84. In a telephone system, means including a cord circuit and one or more automatic switches for semi-automatically extending a calling connection, supervisory signal mechanism for said cord circuit, and means controlled by the called party for reversing the current in said cord circuit to control said mechanism, said automatic switch having a primary motion to select groups and a secondary motion to find a trunk in a selected group.

In witness whereof, I hereunto subscribe my name this 8th day of June, 1907.

HARRY G. WEBSTER.