May 27, 1930. H. M. FRIENDLY 1,760,823

AUTOMATIC TELEPHONE SYSTEM

Filed March 19, 1928 7 Sheets-Sheet 1

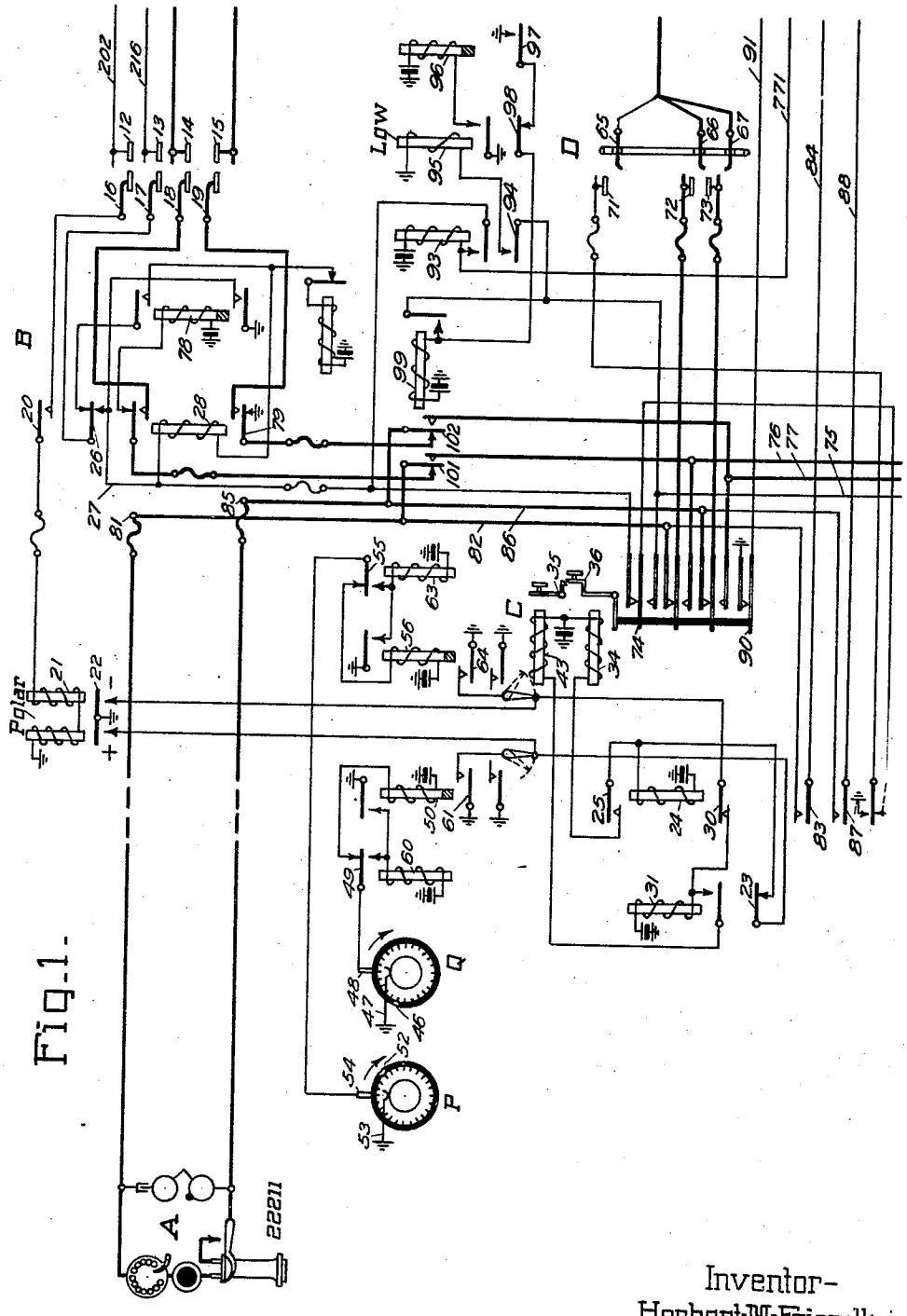


Fig. 1.

Inventor-
Herbert M. Friendly
George E. Muller
Atty.

May 27, 1930. H. M. FRIENDLY 1,760,823

AUTOMATIC TELEPHONE SYSTEM

Filed March 19, 1928 7 Sheets-Sheet 2

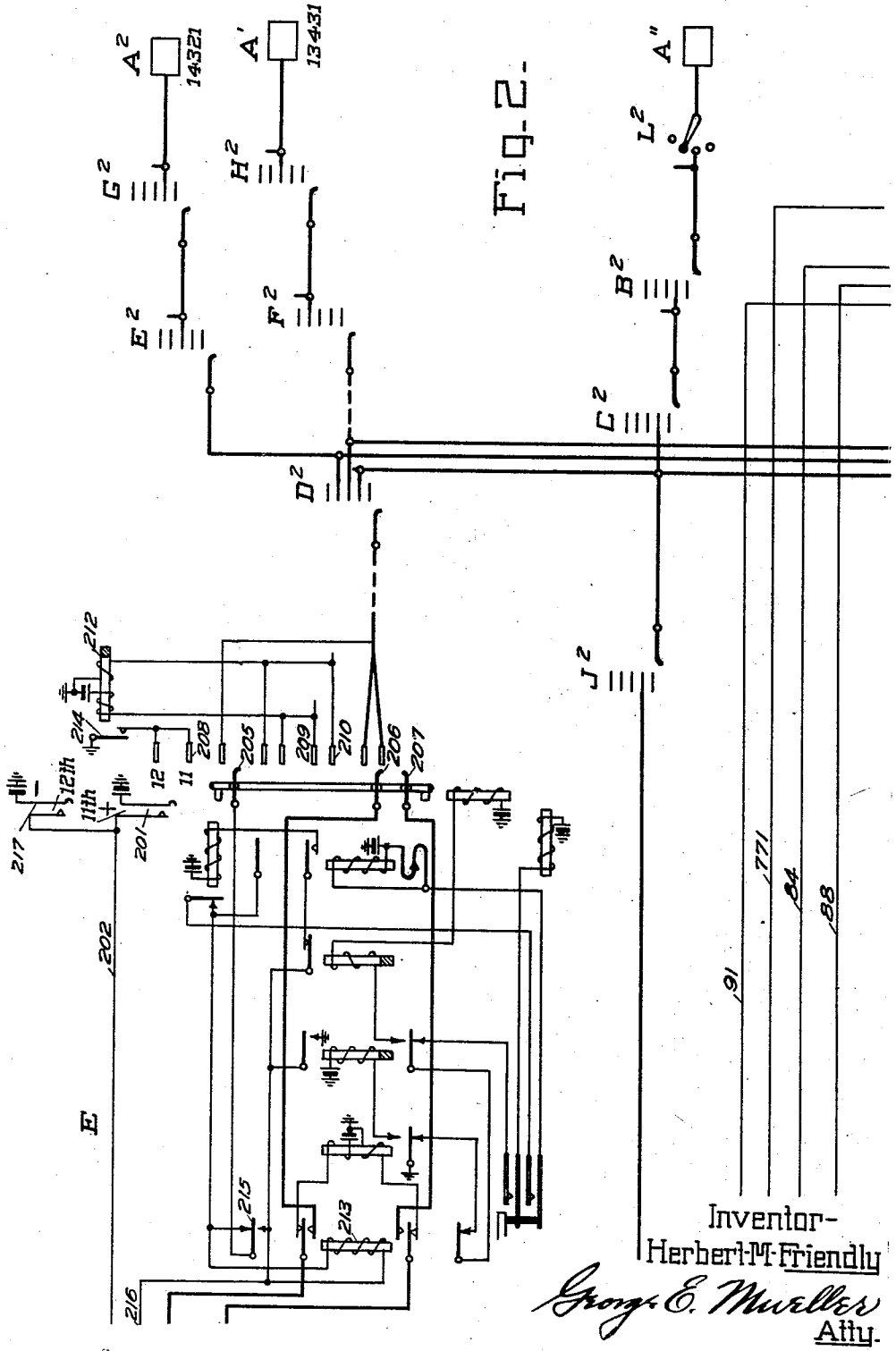


Fig. 2.

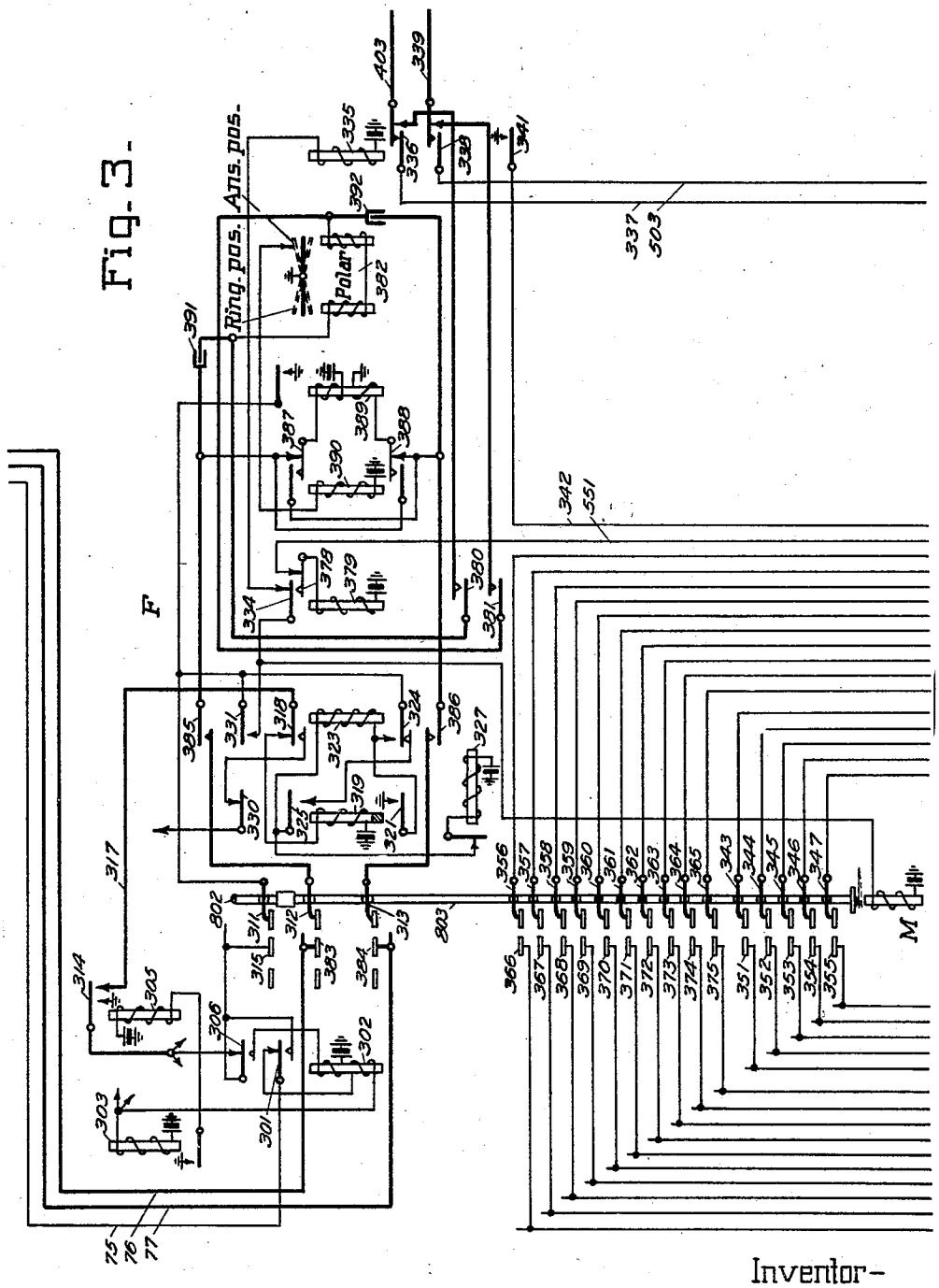
Inventor-
Herbert M. Friendly
George E. Mueller
Atty.

May 27, 1930. H. M. FRIENDLY 1,760,823

AUTOMATIC TELEPHONE SYSTEM

Filed March 19, 1928 7 Sheets-Sheet 3

Fig. 3.



Inventor-
Herbert M. Friendly
George E. Muller
Atty.

May 27, 1930. H. M. FRIENDLY 1,760,823

AUTOMATIC TELEPHONE SYSTEM

Filed March 19, 1928 7 Sheets-Sheet 4

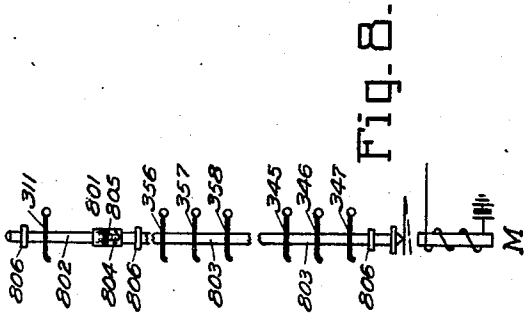


Fig-8.

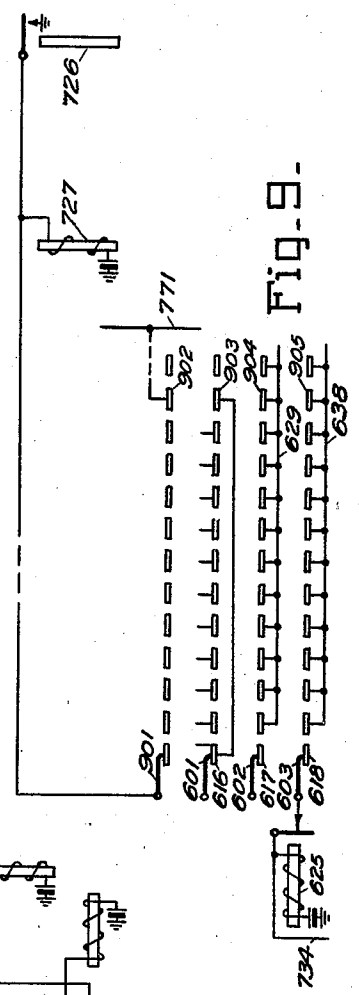


Fig-9.

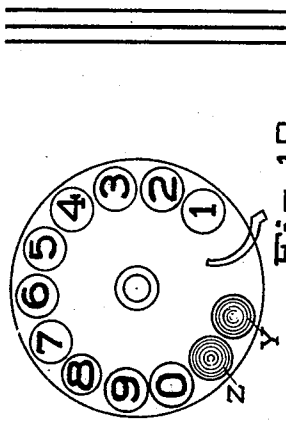


Fig-10.

Fig-4.

Fig-11.

2	4		7
1	3	5	6

Inventor-
Herbert M. Friendly
George E. Mueller
Atty

May 27, 1930. H. M. FRIENDLY 1,760,823

AUTOMATIC TELEPHONE SYSTEM

Filed March 19, 1928 7 Sheets-Sheet 5

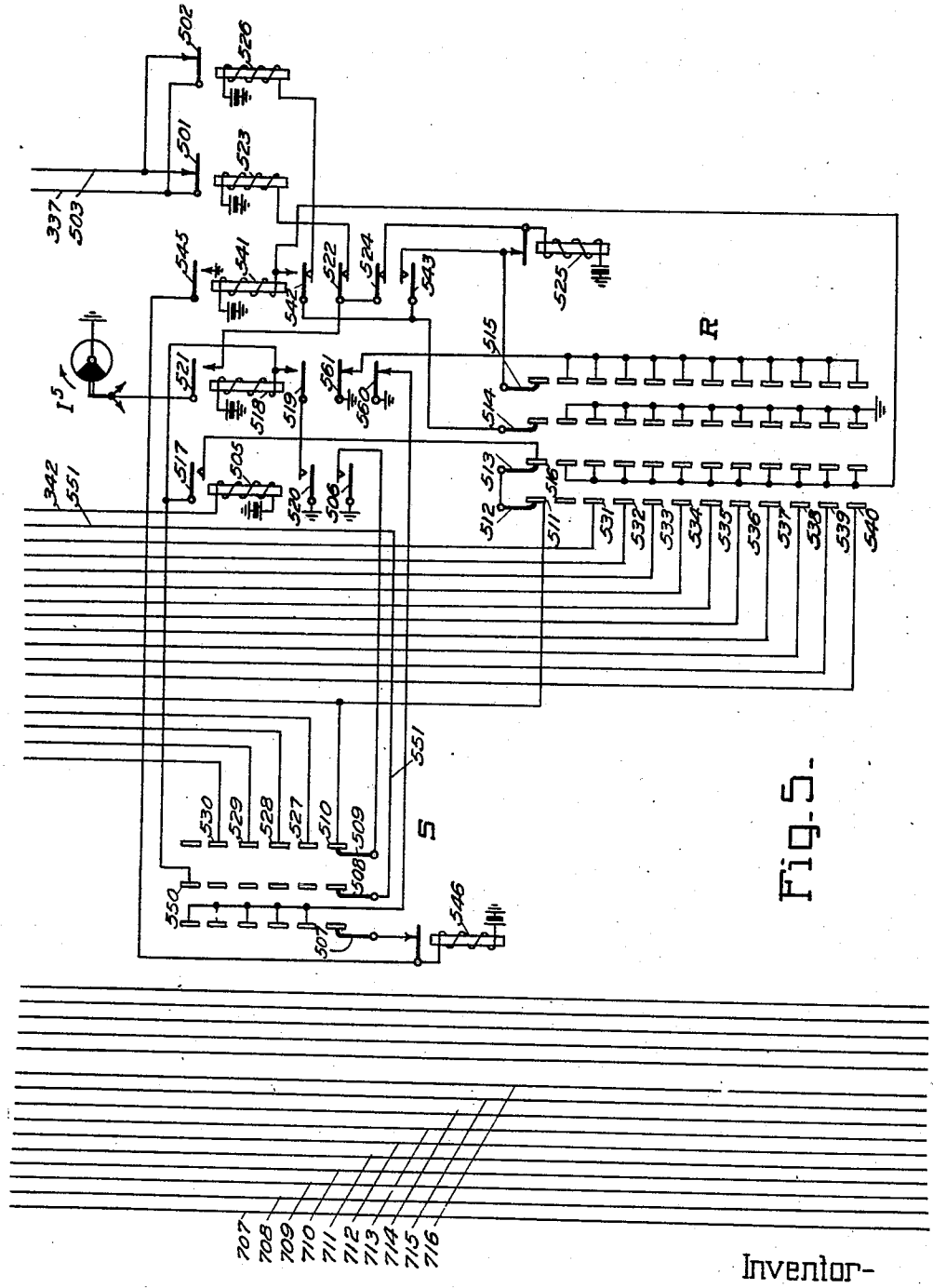


Fig. 5.

Inventor-
Herbert M. Friendly
George E. Mueller
Atty.

May 27, 1930. H. M. FRIENDLY 1,760,823

AUTOMATIC TELEPHONE SYSTEM

Filed March 19, 1928 7 Sheets-Sheet 6

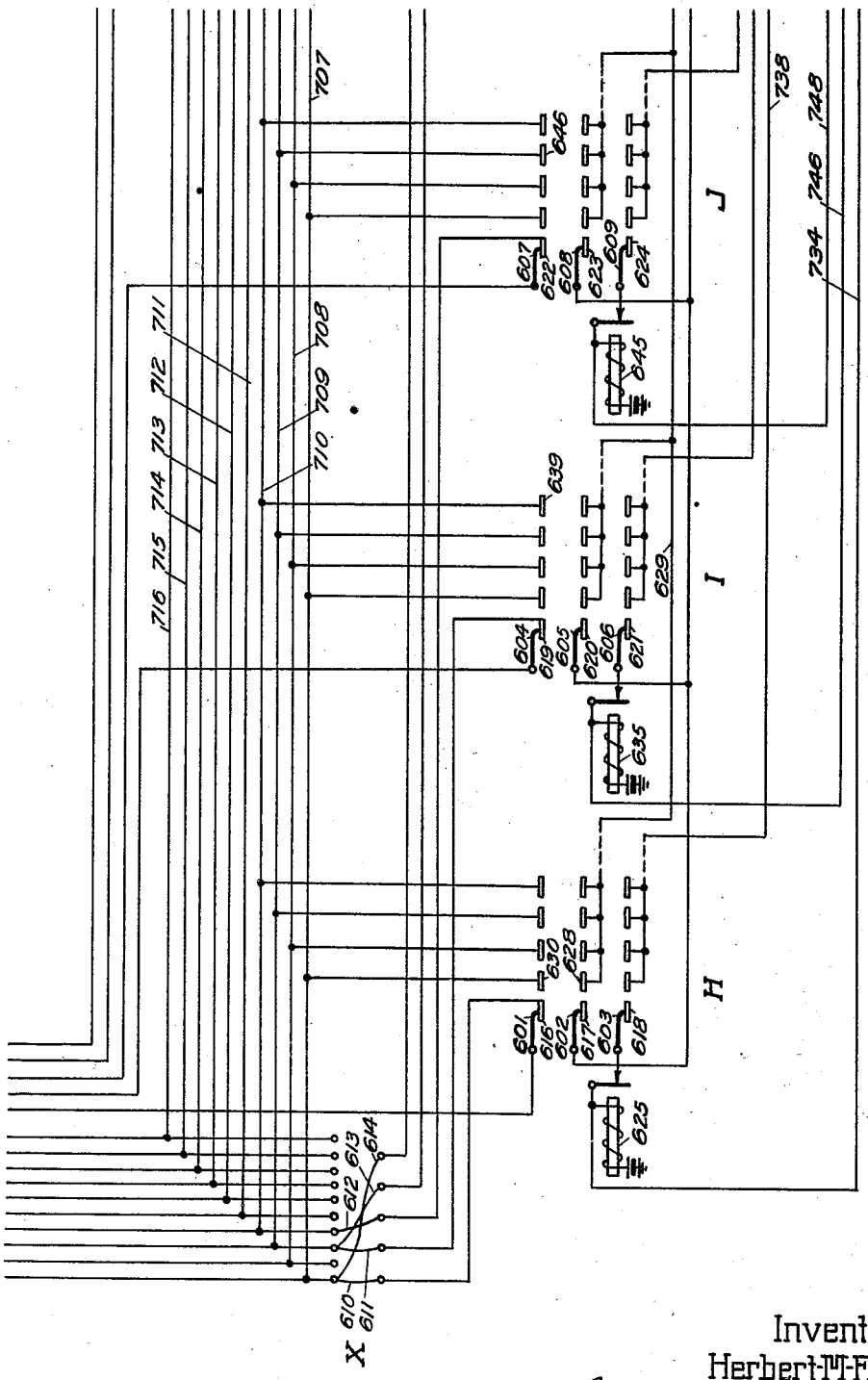


Fig-6.

Inventor-
Herbert M. Friendly
George E. Mueller
Atty.

May 27, 1930. H. M. FRIENDLY 1,760,823

AUTOMATIC TELEPHONE SYSTEM

Filed March 19, 1928 7 Sheets-Sheet 7

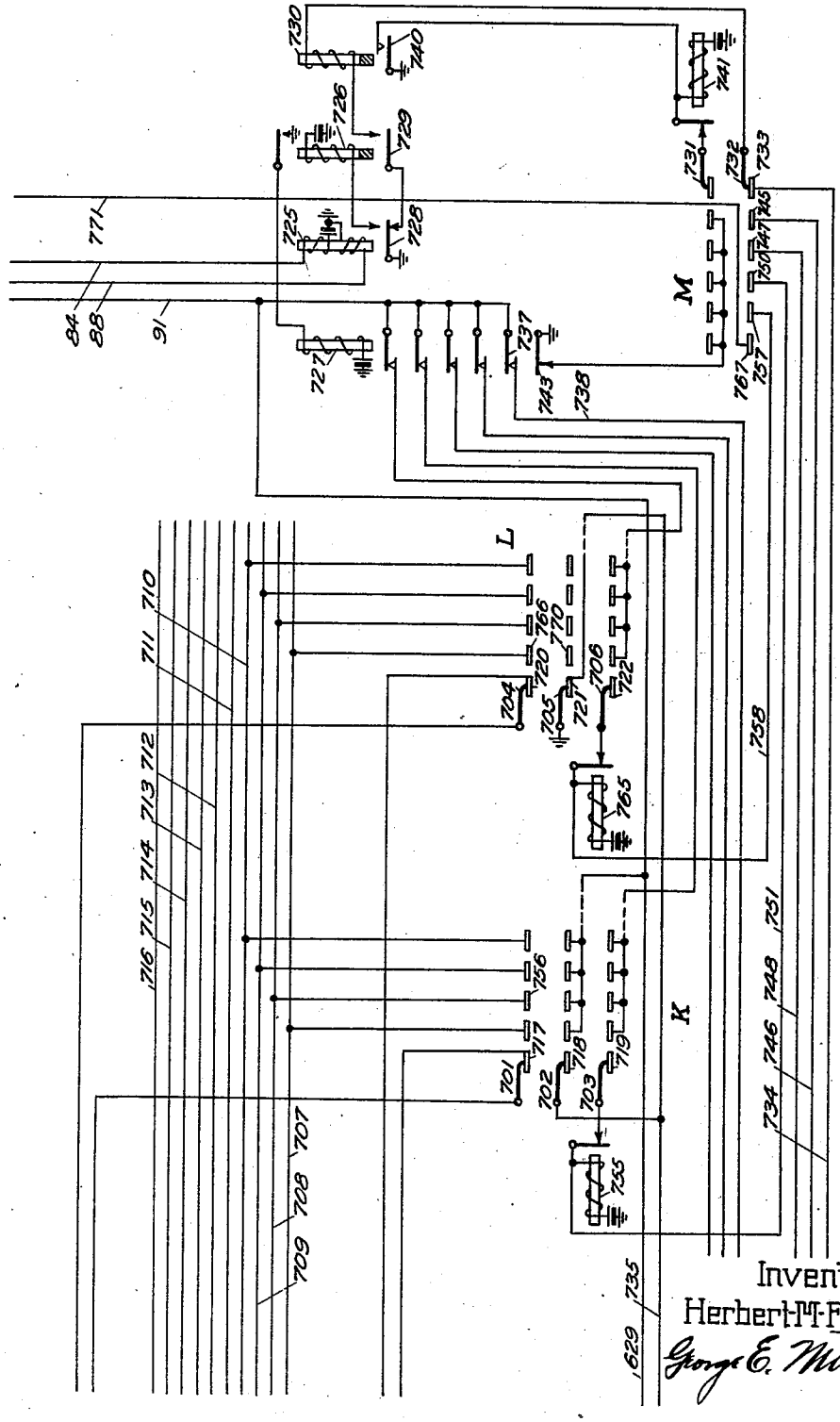


Fig. 7.

Inventor-
Herbert M. Friendly
George E. Mueller
Atty

Patented May 27, 1930 1,760,823

UNITED STATES PATENT OFFICE

HERBERT M. FRIENDLY, OF CHICAGO, ILLINOIS

AUTOMATIC TELEPHONE SYSTEM

Application filed March 19, 1928. Serial No. 262,626.

The present invention relates to telephone systems; more particularly so-called automatic or machine switching telephone systems.

General objects

The general objects of the present invention are to enable a subscriber of the automatic telephone system, who contemplates temporarily leaving the location of his telephone, to directively set central office apparatus or call forwarding equipment associated with his line through the agency of his automatic calling device dial on his telephone so that in case any calls are thereafter directed to his line, the latter said calls will be further extended or forwarded to a predetermined random subscriber's line or other line of the system. That is, for example, a subscriber before leaving the premises may remove the receiver of his telephone as if to initiate a call, and then operate his calling device dial by placing his fore-finger in a specific depression finger-hold of the dial and then draw the dial until his finger encounters the finger-stop, so that when the dial is released it will send a series of eleven open impulses. After the dial has restored, he will restore the receiver, leaving the central office call-forwarding equipment in the set condition.

To unset the said call-forwarding equipment, he will similarly operate the dial from another specific finger-hold depression, so that when it is released it will send a series of twelve open impulses. After the dial has restored, he will restore the receiver, leaving the central office call-forwarding equipment in the normal unset condition.

However, in accordance with the present invention, in the event that the before-mentioned (normally) predetermined line is not the line to which it is in the particular instance desired to have the calls forwarded to, the predetermined line may be directively changed. The latter is accomplished by annexing the telephone number of the line to which it is desired to have calls forwarded to in the particular instance, forthwith after operating the dial to effect the series of eleven open impulses mentioned. The receiver will then be restored to the switch-hook, leaving the set line in condition for forwarding calls directed to it to the specific line indexed by the number annexed after primarily setting the line by the series of eleven open impulses. That is to say, not only is there a normally predetermined line to which calls may be forwarded when a set condition exists on a line called, but this normally predetermined line may be temporarily changed to a random desired line of the exchange.

In connection with the last foregoing, relating to changing from the normally predetermined line to a random desired line to which calls will be forwarded under the set condition, when the subscriber's line is to be unset it is done by removing receiver as in initiating a call thereon, and then sending a series of twelve open impulses. The latter effaces not only the said set condition accomplished responsive to the first said sending of the eleven open impulses, but it also effaces the substituted random desired line and renders the normally predetermined line subject to being called when the subscriber next causes his line to be set by sending the series of eleven open impulses and without annexing any digits.

It will thus be perceived that the present invention is adapted for use in connection with a subscriber's telephone line wherein it may be desired to have calls which may be made thereto, in the absence of the subscriber, forwarded to a desired random line of the exchange as may be predetermined by the subscriber when he sets his line for forwarding calls made thereto. That is, a residence subscriber may leave his residence and go to the residence of some other random subscriber, and desires that all calls made to his telephone be forwarded to the telephone of the subscriber where he will be found. Moreover, a business establishment may wish to have some employee respond to after business hours calls. The line will, therefore, be set to forward calls made to it to any desired telephone of an employee, perhaps a different employee being selected for successive days. That is, there may be a predetermined employee who will be charged with

responding to such calls responsive to the normal setting of the set relay, while this may at will be changed to a random telephone line by simply annexing the number of the latter telephone line, after normally setting the line for forwarding.

The set condition may be at will effaced. It will be effaced at a predetermined time automatically. Of course, a manual setting may be made in the central office, in the event the subscriber neglected to set the line, and a duly authenticated request from him is made for such setting.

General operation

Reference is made to my pending applications for patent Ser. No. 218,605, filed Sept. 10, 1927; Ser. No. 241,793, filed Dec. 22, 1927; Ser. No. 257,480, filed Feb. 27, 1928, and Ser. No. 259,047, filed March 5, 1928. These pending applications are directed to telephone systems and apparatus having objects broadly as set forth in the foregoing statements. The present invention has features believed to be novel but not disclosed in the said cited pending applications. Some of these latter said novel features will be specifically described and pointed out in the present specifications, while other said novel features will be apparent in view of the disclosures specifically set forth in the specifications and drawings.

Among the features of the present invention believed to be novel are:

a. Means whereby after the subscriber has caused his line to set for forwarding calls to the predetermined line by operating the calling device dial in accordance with the setting finger-hold, thereby sending a series of eleven open impulses, he can again operate his calling device dial in accordance with the said finger-hold and thereby cause a connection to be linked from the subscriber's line now set to the said predetermined line. The response on the latter said line will verify the set condition of the subscriber's line. The subscriber can then hang up his receiver, leaving his line in the set condition, the said linked connection being at the same time destroyed.

b. Means whereby after the subscriber has caused his line to be set for forwarding calls to the said predetermined line, he can thereupon operate his calling device with correspondence to the digits of a desired random line of the exchange, and thereby change the primary setting with respect to the said predetermined line to an arbitrary setting for the random line indexed by the digits annexed by the dial after sending the series of eleven open impulses to set the subscriber's line, and he can further thereupon again operate his calling device in accordance with the said setting finger-hold and thereby cause a connection to be linked from his line to the said random line. The response on the latter said line will verify the set condition of the subscriber's line. The subscriber can then hang up his receiver, leaving his line in the set condition, the said linked connection being at the same time destroyed.

c. Means whereby the operation set forth in paragraph "*b*" as to the linking of the call can be alternatively effectuated responsive to sending any digit from 1 to 0 in place of sending the series of eleven open impulses.

d. Means whereby if a connection is caused to be linked from the subscriber's line, as set forth in paragraphs "*a*", "*b*", and "*c*", when the response occurs on the line to which the connection has been linked, and which is the line to which calls made to the subscriber's line will be extended, when the response occurs the direction of current traversing the receiver on the subscriber's line will be reversed in direction. This reversing of current may control supervisory signals or meter or coin-box toll devices, it being old in the art to control such devices by current reversal. However, it is believed that the means disclosed by the present invention for accomplishing this reversal is novel.

e. Means whereby the unsetting of the set condition of the set subscriber's line can be effaced by sending a series of twelve open impulses effectuated by operating a specific finger-hold on the dial of the calling device, which latter said finger-hold is located next to the setting finger-hold for sending a series of eleven open impulses. This means includes off-normal springs on the first selector operated at the eleventh and twelfth levels when the wipers rotate-in on the respective levels. The eleventh level said off-normal springs cause minus battery to be applied over an operating conductor to effect the said set condition. The twelfth level said off-normal springs cause plus battery to be applied over said operating conductor to effect the effacement of the said set condition. The said operating conductor leads through the winding of a polarized relay to ground, so that the armature of the latter said relay will operate to close a ground path to a specific operating conductor for setting and a specific said conductor for unsetting, depending upon if minus or plus battery is applied over the said operating conductor responsive to the operation of the dial for setting or unsetting.

f. An impulse sending mechanism is shown (Fig. 5) that is common to a plurality of subscribers' lines, as distinct from the impulse sending mechanism shown in the last mentioned said pending application which is individual to a subscriber's line.

g. A finder switch (F) is shown which has a plurality of bank-terminal sweeping wipers, but wherein only a single one of said wipers engages co-operative bank terminals with normal connecting pressure. This is to

insure that only the testing wiper will bear appreciably on its co-operating bank terminals to effect conductive relation, while the remaining wipers will either remain out of conductive engagement with co-operative bank terminals or exert only a very slight frictional contact therewith. This is to enable the motor magnet driving the wipers to operate rapidly and with the least applied energy. However, upon the test wiper encountering the line found in the hunting operation a magnet is energized which will exert a tractive force to make the respective wipers bear with sufficient pressure on the co-operative bank terminals of the set found. This device includes a shaft (Fig. 8) with a slip coupling and a magnet for attracting the shaft, and all wipers excepting the said test wiper, endwise wherein the said coupling will permit the shaft to move endwise without affecting the tension between the test wiper and its co-operative bank terminal it is then resting upon.

Drawings

With reference to the accompanying drawings:—

Fig. 1 shows a calling telephone A leading in to a line switch B. It also shows a set relay C for changing the so-termed normal conductors from the line leading to the line switch B to the corresponding terminals accessible from line finder switch F in Fig. 3. The indicated connector D normally has access to the line leading to telephone A.

Fig. 2 shows a first selector E of a group accessible from line switch B. It also indicates a calling telephone A'' leading to a line switch L^2, the latter having access to first selector B^2, second selector C^2, third selector J^2, and connector D in Fig. 1 in sequence, to complete a call from telephone A'' in Fig. 2 to the telephone A in Fig. 1.

Fig. 3 shows a line finder switch F involving auxiliary apparatus, the said switch having access to terminals of a plurality of lines which may be called through connector D in Fig. 1, or random connectors in the exchange office containing connector D wherein contact springs of a set relay similar to relay C are interposed. Each said line accessible from the switch F has a line relay as shown on the left aligned with the relays of the said switch. When the switch F operates and seizes a set of its bank terminals corresponding to a line called, its lower group of fifteen wipers are then co-operative with bank terminals which correspond to the line to which said set relay C belongs. The said switch F has an impulse sending mechanism individual to it and shown in Fig. 5.

Fig. 4 shows a first selector G companion to and individual to the switch F in Fig. 3. The first selector G has access to other switches in common with first selector E in Fig. 2.

Fig. 5 shows an impulse sending mechanism for directing the forwarding of calls. The said impulse sending mechanism is individual to the line finder switch F in Fig. 3.

Fig. 6 shows switches H, I, and J, being the digit setting switches for the first three digits of the number (of five digits) of the line to which calls directed to the line leading to telephone A are to be forwarded to.

Fig. 7 shows switches K and L, being the digit setting switches for the last two digits of the number of the line to which calls directed to the line leading to telephone A are to be forwarded to. Fig. 7 also shows the switch M which distributes to the switches H to L.

Fig. 8 shows the details of the wiper shaft for switch F in Fig. 3, referred to in the foregoing paragraph "*h*".

Fig. 9 shows a preferred modification of the switch H in Fig. 6.

Fig. 10 shows the dial of the sending device of the present invention. This dial is generally like the dial disclosed in Figs. 7 and 8 of my said pending application Ser. No. 218,605, filed Sept. 10, 1927. However, the dial of the present invention has an added finger-hold Y for sending a series of twelve open impulses.

Fig. 11 is a diagram showing the assembly of the seven sheets of accompanying drawings to disclose the circuits employed to exemplify the present invention. The lines extending towards the margins which register are continuations of the same line.

Equipment

The telephone A in Fig. 1 is the well known common battery series type, but is equipped with an automatic calling device and dial as disclosed in Fig. 10. This dial, responsive to operating it in accordance with one of the two finger-hold depressions Z or Y will send a series of eleven or a series of twelve open impulses, respectively, depending upon which finger-hold is operated.

The line switch B is of the well known rotary class as described on page 53 of Hershey's Automatic Telephone Practice, third edition. However, the line switch B has an added wiper for the objects of the present invention.

The connector D in Fig. 1 is of the well known type as shown in Fig. 73 of the fourth edition of the said book.

The first selector E in Fig. 2 is of the well known type sometimes called a Powell selector, and described on pages 59 to 61 of the said third edition of Hershey's book. However, two sets of off-normal springs, which respectively operate on in positions on the eleventh and twelfth bank levels, and connected circuits, have been introduced for the purposes of the present invention. It also has twelve levels of bank terminals.

The first selector G in Fig. 4 is of the well known said Powell type.

The selectors B^2, C^2, D^2, E^2, F^2, and J^2 in Fig. 2 and D^4 in Fig. 4 are like selector G in Fig. 4.

The line switch L^2 in Fig. 2 is like switch B in Fig. 1.

The connectors H^2 and G^2 in Fig. 2 are like connector D in Fig. 1.

The line finder switch F in Fig. 3 is of the class shown and described on pages 55 to 57 of the third edition of Hershey's book. However, it is modified for the purposes of the present invention.

The switch elements R and S in Fig. 5, and the switch elements H, I and J in Fig. 6, and the switch elements K, L and M in Fig. 7, belong to the class of switch B in Fig. 1, modified in accordance with the present invention.

It will be understood that any other suitable switches may be substituted for the said well known switches mentioned, without departing from the spirit of the present invention. Also, that the switches specific to the present invention may be modified by those skilled in the art without departing from the spirit of the present invention, as defined by the subjoined claims.

It will, of course, be understood that in a commercial embodiment of the present invention a plurality of switches in a group will be employed in place of the exemplary single switches used in disclosing the present invention, so that a plurality of calls may be co-existent, the switches in the groups having predetermined order of use with respect to antecedent co-operative switches.

Detailed operation—initiating a call from telephone A to telephone A'

Upon removing the receiver from the switch-hook of telephone A, the line switch B will operate in the well known manner to seize the first idle selector E. The calling party will then operate his calling device in accordance with the five digits 1—3—4—3—1 and thus correspondingly set the selectors E, D^2, and F^2, and connector H^2. The connection may then be released in the well known manner, responsive to the calling party replacing his receiver on the switch-hook. A call to telephone A^2, the telephone number of which is 14321, will be effected in a generally like manner. It will be noted that the telephones A' and A^2 are both located tributary to the "1" office of the exchange, reached through the "1" level of first selector E. Of course, other telephones of the system (not indicated) may be reached through other levels of the selector E, and, therefore, belong to corresponding offices of the exchange. Thus, outgoing calls from telephone A under normal conditions are made in the well known manner, and employ well known switches, with due regard to the special modifications in switches B and E before mentioned, which modifications are not brought into play under normal calling conditions.

Setting the line leading to telephone A so that calls directed to said line will be forwarded to telephone A'

Let it be assumed that the party at telephone A desires to set his line so that calls directed thereto will be forwarded to telephone A'. The party at telephone A will remove his receiver as if to initiate an ordinary call. This will cause the line switch to operate and select a first selector as E. The party at telephone A will then operate his calling device dial, Fig. 10, in accordance with the special finger-hold depression Z to effect a series of eleven open impulses which will step the shaft of selector E vertically in accordance therewith and operate the eleventh vertical off-normal springs 201. The latter operation will cause the indicated plus battery to be applied over conductor 202, bank terminal 12 of set 12 to 15, wiper 16 of set 16 to 19, armature 20, winding of polarized relay 21 to ground, the armature 22 applying ground through armature 23 to the winding of relay 24, the latter said relay actuating. The relay 24 will thus remain actuated as long as the ground is maintained by armature 22.

At the time the off-normal springs 201 operated, the selector E operated in the well known manner to rotate-in and seize by its wipers 205 to 207 the first set of idle bank terminals 208 to 210 on the eleventh level. The latter said set will be the ones corresponding to slow-releasing relay 212. The latter said relay will operate responsive to the seizing by selector E when its relay 213 actuates, and ground from armature 214 will be applied through bank terminal 208, wiper 205, armature 215, release trunk conductor 216, bank terminal 13, wiper 17, armature 26, conductor 27. This ground to the release trunk will, therefore, maintain the relays 213 and 28 actuated as long as the windings of relay 212 are maintained energized through telephone A by the party thereat maintaining his receiver off the switch-hook. The plus battery from springs 201 is similarly maintained to the winding of relay 21 until the shaft of selector E is restored under control of the party at telephone A.

At the time relay 24 actuates, its armature 30 disconnects the winding of relay 31. Armature 25 at the same time applies ground received from armature 22 to the winding of magnet 34 of the set relay C. The latter said magnet will cause the springs of relay C to be operated and the dog 35 latched over the catch 36 to retain the springs of relay C

operated after the winding of magnet 34 has been deenergized.

When the party at telephone A now hangs up his receiver, the relay 212 will deenergize and remove the ground from the release trunk 216, and thus cause the shaft of selector E to be restored and the armature 22 to assume the drawn normal position, free of its co-operating contacts so that the relay 24 will thereupon unlock, the relay C being in its latched or set condition.

In this connection, it will be noted that when relay C is actuated, relay 727 will actuate, and then deactuate when the party at telephone A hangs up, but for no operative purpose. The purpose of relay 725 will appear presently.

Unsetting the line leading to telephone A so that calls thereafter directed to said line will not be forwarded therefrom, the said line then being in normal condition

Let it be assumed that the party at telephone A desires to unset his line, by unlocking the relay C and thus causing the springs thereof to restore to normal condition. The party at telephone A will remove his receiver as if to initiate an ordinary call, having in mind that even if the springs on relay C are operated and locked by the dog 35, outgoing calls from telephone A through the line switch B will be effected normally as if the springs on relay C were not in their operated condition.

The party at telephone A will then operate his calling device dial in accordance with the special finger-hold Y depression to effect a series of twelve open impulses which will step the shaft of selector E vertically in accordance therewith and operate the twelfth vertical off-normal springs 217 and select the relay 212, which relay is, for convenience, connected in multiple with the corresponding vertically aligning sets of the eleventh and twelfth levels. Thus, the relay 212 was selected on the twelfth level in the same manner as it was selected on the eleventh level when the relay C was set. In the present instance current from the indicated minus battery is applied through the spring set 217, conductor 202 to operate relay 21 in the indicated minus direction, the armature 22 applying ground through armature 30 to the winding of relay 31, the latter said relay actuating. This latter energizing circuit will endure until the relay 21 is deenergized by releasing the shaft on selector E.

At the time the relay 31 actuates, its armature 23 disconnects the winding of relay 24. Armature 40 at the same time applies ground from armature 22 to the winding of unlatching magnet 43 of the set relay C. This will operate the latter said magnet to unlatch the dog 35 from the catch 36 and cause the springs on relay C to restore to normal condition.

When the party at telephone A now hangs up his receiver the relay 212 will deenergize and remove the ground from the release trunk 216, and thus cause the shaft of selector E to be restored and the armature 22 to assume the drawn normal position, free of its co-operating contacts so that the relay 31 will thereupon deenergize, the circuits being now at normal.

Relay C is locked and unlocked according to prearranged time schedule

The time controlled circuit grounding device P and Q revolve continuously in the indicated direction at uniform speed, making a revolution in twenty-four hours. The conductive segment 46 applies ground received from brush 47 through brush 48, armature 49 to the winding of slow-releasing relay 50, the latter said relay actuating at 5 p. m. This is assuming that the drawn position of the device Q is at 12 p. m. The conductive segment 52 applies ground received from brush 53 through brush 54, armature 55 to the winding of slow-releasing relay 56, the latter said relay actuating at 9 p. m. This is assuming that the drawn position of the device P is at 12 m.

In view of the indicated direction of revolution of the devices P and Q, the device Q will be the first one to apply ground through its brush 48. This will occur at 9 a. m., as stated. Responsive to relay 50 actuating, relay 60 will actuate and lock to ground on armature 49 until the ground applied through brush 48 is removed because of the segment 46 moving from under the brush 48. When relay 60 actuates, it deenergizes the relay 50, and the latter said relay will then deactuate consistent with its slow-releasing characteristic. Only during the short time that relay 50 is actuated, ground from armature 61 will be applied through armature 23 to the winding of relay 24. The relay 24 will actuate in the manner before described to in turn cause the energization of magnet 34 from the ground applied from armature 61 through armatures 23 and 25, to operate and lock the springs on set relay C.

At 9 a. m. following the operation of relay 50, ground will be applied from brush 54 of device P effective to operate the relay 56. Responsive to relay 56 actuating, relay 63 will actuate and lock to ground on armature 55 until ground applied through brush 54 is removed because of the segment 52 moving from under the brush 54. When relay 63 actuates, it deenergizes the relay 56 and the latter said relay will then deactuate consistent with its slow-releasing characteristic. Only during the short time that relay 56 is actuated, ground from armature 64 will be applied through armature 30 to the winding of relay 31. The relay 31 will actuate in the manner before described to in turn cause the

energization of the magnet 43 from the ground applied from armature 64 through armatures 30 and 40, to disengage the dog 35 so that the springs of relay C will restore to normal condition, and, therefore, the relay C will be in its unset condition.

It will be particularly noted that if, for example, the relay C was in its set condition at the time relay 50 actuated, the relay 24 will be caused to actuate as before described to energize the winding of the magnet 34, but to no effective purpose with respect to the set condition of relay C. In the same manner, if the relay C is at normal and the relay 56 actuated, the relay 31 will be caused to actuate as before described to energize the winding of magnet 43, but to no effective purpose with respect to the unset condition of relay C. It will thus be clear that while applying plus or minus battery over conductor 202 will change the operative condition of relay C, the relays 50 and 56 can only set the relay C or unset it, respectively. Thus, if the party at telephone A has set the relay C at 4:45 p. m., and at 5 p. m. the relay 50 operates, no confusion can occur. In the same manner, if the party at telephone A has unset the relay C at 8:30 a. m. and at 9 a. m. the relay 63 operates, no confusion can occur. However, in the event the subscriber through inadvertance fails to operate his set relay C before leaving for the night, the relay C will be automatically set at 5 p. m.

In this connection it will be understood that there will be as many sets corresponding to P and Q and their individual pair of relays 56 and 63, and 50 and 60, respectively, as there are times of the day when set relays, as C, are to be operated, the various set relays being associated with the proper said device as P and Q depending upon the time of day it is to be automatically set and unset.

It will be noted that no confusion can arise by reason of more than one setting or unsetting operation occuring. That is, by a second party performing a setting or unseting operation. If two or more like operations are made successively, only the first one will be operatively effective to the set relay C.

Call to the line leading to telephone A under normal condition wherein the relay C is not set

Assume that the party at telephone A'' desires to call the telephone A under normal conditions. The dial at telephone A'' will be operated in accordance with digits 2—2—2—1—1 after initiating the call. This will successively operate the selectors B^2, C^2, and J^2, and connector D so that wipers 65, 66, and 67 will seize bank terminals 71, 72, and 73, respectively. Ground from the connector will be applied over private wiper 65, bank terminal 71, spring 74 to the winding of relay 28, the latter said relay operating to disconnect the line relay 78 and the ground on the resting contact of armature 79, in the well known manner. The connector D will now apply signaling current effective to the bell at telephone A, in the well known manner, the effective circuits being those well known from Hershey's book cited.

Call to the line leading to telephone A under the condition that the set relay C is in operated condition

Now assume that at the time the wipers 65 to 67 are set upon the bank terminals 71 to 73, respectively, the set relay C is in its operated and latched condition. Under the latter said condition, the relay 28 will not be energized, since the normal conductors are disconnected from the line leading to telephone A. However, the latter said condition does not prevent the party at telephone A normally extending calls from said telephone.

It will be noted that the conductors leading from bank terminals 71 to 73 disconnected from the line leading to telephone A are now connected to conductors 75 to 77, respectively. Thus, when the connector D seizes the line terminals 71 to 73, ground is applied from the connector over wiper 65, bank terminal 71, spring 74, conductor 75, armature 301, lower winding of relay 302, winding of common relay 303 to grounded battery, the relay 302 actuating and causing the dependent common relay 305 to actuate. Armature 306 on relay 302 will attract from its resting contact to its make contact, while armature 301 remains inert for the time being. This condition causes all the bank terminals accessible from the wiper 311, of the group 311 to 313, to be grounded by the armature 314 of relay 305, excepting the bank terminal 315, corresponding to the relay 302, due to the attracted condition of armature 306. Ground is applied from the armature 314, conductor 317, armature 318 to the winding of slow-releasing relay 319, the latter said relay actuating.

The armature 321 applies ground to the lower terminal of the winding of relay 323, while the ground on the bank terminals successively engaged by wiper 311 is applied through armatures 324 and 325 to the upper terminal of the winding of relay 323. The latter said ground is also applied through the interrupter armature of motor magnet 327 to the winding thereof, the said motor magnet operating to successively step advance the wipers 311 to 313. When wiper 311 encounters bank terminal 315 it will not receive ground because of the attracted condition of armature 306, so that the short-circuit is removed from the winding of relay 323 and the direct ground is removed from the winding of the motor magnet 327. Due to the marginal adjustment of the motor magnet, it will cease operating under the condition, but the

relay 323 will operatively energize under the condition. When relay 323 actuates, ground through armature 321 will be applied through attracted armature 324, wiper 311, bank terminal 315, armature 306, upper winding of relay 302, the latter said relay fully operating. This disconnects the lower winding of the latter said relay 302 at armature 301 and connects ground received from the connector D over conductor 75 through armature 301, bank terminal 315, wiper 311 to armature 324 to maintain the relay 323 locked before the armature 321 has had time to retract. The relays 303 and 305 will now deactuate if there is no other relay like relay 302 with its lower winding energized, due to a waiting call. If the relays 303 to 305 are actuated after relay 302 fully actuates, the ground applied over conductor 317 will be continued through armatures 318 and 330 to the armature corresponding to 318 of the next finder switch like F (not shown) of the group of which switch F is one.

The ground received over conductor 75 is applied through armatures 331 and 334 to the winding of relay 335, the latter said relay actuating. Resultant to the actuation of the relay 335 a circuit path can be traced from grounded battery, upper winding of relay 401, armature 402, conductor 403, armature 336, conductor 337, armatures 501 and 502 in multiple, conductor 503, armature 338, conductor 339, armature 405, lower winding of relay 401 to ground, the latter said relay actuating, followed by slow-releasing release relay 407. Ground will now be applied through armature 408 to release trunk conductor 409.

Ground is applied through armature 341, conductor 342 to the winding of relay 505, the latter said relay actuating. Ground will now be applied from armature 506, wiper 509 of set 507 to 509, bank terminal 510, bank terminal 511, wiper 512 of set 512 to 515, bank terminal 516, armature 517 to the winding of relay 518, the latter said relay actuating and locking through armatures 519 and 520 to ground.

In this connection, it will be noted that the interrupter I^5 revolves at the rate of approximately twelve times per second, so that the next ground impulse applied thereby will be applied through armature 521, armature 522 to the winding of relay 523, and through armature 524 to the winding of motor magnet 525 of switch R, the said relay 523 and magnet 525 coincidently operating. The wipers 512 to 515 will thus be step advanced responsive to the groundings of the interrupter I^5. The armature 501 will attract coincident with the first energization of the motor magnet, the armature 502 of relay 526 will maintain the relay 401 in selector G energized until the wiper 514 encounters ground on the first off-normal bank terminal co-operative therewith, and, thereby, energizes relay 526 over an obvious circuit path, after which time the relay 401 in selector G will be under the sole control of armature 501.

At the time armature 331 attracted, it applied ground to energize the magnet M. The latter said magnet will draw the portion of the shaft carrying all the wipers excepting private wiper 315 so that enough pressure on the engaged bank terminals will be applied to insure proper circuit continuity. Of course, the magnet M may be dispensed with, but under the latter condition a greater turning moment will have to be exerted because under such condition the wipers will have to bear more firmly, offering more frictional resistance. The details of the shaft of switch F is shown in Fig. 8, wherein the sleeve 801 is rigidly fixed to the upper portion of the shaft 802 to which wiper 311 is also rigidly secured, but insulated therefrom. The lower shaft section 803 fits slidably in the sleeve 801 and carries a fixed pin 804 which may move along the slot 805. Thus the wipers on the portion of the shaft 803 rest lightly on the bank terminals as they are rotated by the shaft section 802 with which the motor magnet 327 co-operates. Then when the magnet M is energized the section of the shaft 803 will be drawn towards the magnet M and the pin 804 will change its position accordingly, while all the wipers on the section 803 will rotate with section 802 wherein the pin 804 is a link between the said sections 802 and 803. The shaft is journaled in bearings 806.

Bank terminals 510, 527 to 530 of switch S are respectively tied by conductors to wipers 343 to 347 on the shaft 803 of the switch F. It will also be noted that the latter said wipers are now resting upon bank terminals 351 to 355 which align with bank terminal 315. That is to say, the bank terminals 351 to 355 of switch F are individual to the line leading to telephone A.

The said bank terminals 351 to 355 are respectively tied by conductors to wiper 601 of set 601 to 603 of switch H; wiper 604 of set 604 to 606 of switch I; wiper 607 of set 607 to 609 of switch J; wiper 701 of set 701 to 703 of switch K; wiper 704 of set 704 to 706 of switch L.

Bank terminals 531 to 540 are respectively tied by conductors to wipers 356 to 365 on the shaft 803 of switch F. It will also be noted that the latter said wipers are now resting upon bank terminals 366 to 375 which align with bank terminal 315. That is to say, the bank terminals 366 to 375 are individual to the line leading to telephone A.

Conductors 707 to 716 in Fig. 7 respectively lead to bank terminals 366 to 375, in Fig. 3. Thus, conductors 707 to 713, in the present assumed position of the wipers on the shaft of switch F are respectively conductively connected with bank terminals 531 to 540 of switch R. That is to say, conductors 707 to

716 respectively correspond to bank terminals of switch R which determine the digits 1 to 0. In the same manner, the numerical order bank terminals 510, 527 to 530 of switch S respectively corresponding to wipers 601, 604, 607, 701 and 704 of switches H to L.

It will appear presently that the call in the present instance is to be forwarded to telephone A′, the number of which is 13431, and accordingly, jumpers 610 to 614 in Fig. 6 are run between the cross connecting terminals X to predetermine that the sending mechanism in Fig. 5 will normally send a corresponding train of directive digit impulse series. Thus, circuits can now be traced as follows: Bank terminal 510 of switch S, wiper 343 of switch F, bank terminal 351, wiper 601 of switch H, bank terminal 616 of set 616 to 618, jumper 610, conductor 707, bank terminal 366 of switch F, wiper 356 to bank terminal 531 of switch R; bank terminal 527 of switch S, wiper 344 of switch F bank terminal 352, wiper 604 of switch I, bank terminal 619 of set 619 to 621, jumper 611, conductor 709, bank terminal 368 of switch F wiper 358 to bank terminal 533 of switch R; bank terminal 528 of switch S, wiper 345 of switch F, bank terminal 353, wiper 607 of switch J, bank terminal 622 of set 622 to 624 jumper 612, conductor 710, bank terminal 369 of switch F, wiper 359 to bank terminal 534 of switch R; bank terminal 529 of switch S, wiper 346 of switch F, bank terminal 354, wiper 701 of switch K, bank terminal 717 of set 717 to 719, jumper 613, conductor 709, bank terminal 368 of switch F, wiper 358 to bank terminal 533 of switch R; bank terminal 530 of switch S, wiper 347 of switch F, bank terminal 355, wiper 704 of switch L, bank terminal 720 of set 720 to 722, jumper 614, conductor 707, bank terminal 366 of switch F, wiper 356 to bank terminal 531 of switch R. That is to say, bank terminals 510, 527, 528, 529 and 530 of switch S are, by reason of the position assumed by the wipers of switch F in seizing the terminals corresponding to the line leading to telephone A, connected respectively to bank terminals 531, 533, 534, 533 and 531 of switch R, remembering in this connection, that armature 506 is applying ground through wiper 509 to bank terminal 510.

Going back to the condition wherein the relay 526 actuated responsive to the wiper 514 encountering the first grounded bank terminal, it will be clear that when the relay 526 actuates, the relay 523 by its armature 501 effects the open impulses for directing the extension of the connection to the line leading to telephone A′. The latter said relay will continue to operate its armature 501 responsive to the ground impulses from the interrupter I^5 until the relay 541 is caused to actuate. This occurs responsive to the ground applied from wiper 509 present on bank terminal 531 being encountered by wiper 512, and conducted over wiper 513 and engaged bank terminal to the winding of said relay 541. The relay 541 locks through its armature 542, wiper 514 to the ground on its engaged bank terminal. And, in view of the fact that all the bank terminals co-operative with wiper 514, excepting the one it is shown resting upon, are permanently grounded, the relay 541 will be maintained locked until the wiper 514 is returned to the drawn position. The relay 523 will have energized one time, to effect the impulse for the first digit "1", after relay 526 actuated until wiper 511 encountered bank terminal 531 and thereby caused relay 541 to actuate and disconnect the winding of relay 526 to retract armature 502, so that armature 501 therefore effected one open impulse to the relay 401 for causing the selector G to select an idle trunk on its first bank level leading to second selector D^4, in the well known manner.

The ground derived through wiper 514 is now applied through armature 543 to the interrupter contact on the motor magnet 525, the latter said magnet thereupon operating to restore the wipers of switch R to the drawn normal position, the relay 541 deactuating consistent with its slow-releasing characteristic, the latter being timed to insure sufficient trunk hunting time for the switches operated; the selector G in the present instance.

At the time relay 541 actuated, ground applied through armature 545 energized motor magnet 546, preparatory to causing the wipers of switch S to advance one step responsive to the retraction of the armature 545, at which time ground applied through armature 509 will be extended to bank terminal 533. Relay 541 being deactuated, the paths from the interrupter I^5 to the relay 523 and motor magnet 525 are closed for the initiation of the second digit series of two open impulses corresponding to the digit "3", which said series will terminate when the wiper 512 encounters the latter said bank terminal 533, in the manner as described when the single impulse for the first digit "1" was sent. The relay 541 will operate to effect the said termination of the second digit series and provide the space between the second and third digit series and cause the wipers of the switch S to be advanced one step preparatory to sending the third digit series of four open impulses. The second selector D^4 operated in the well known manner to select the first idle trunk leading to third selecter F^2 responsive to the second digit series.

Ground applied through wiper 509 is now extended to bank terminal 534. The switch R will now operate in the manner as when the first (and second) digit series was sent to cause armature 501 to effect the third series of four open impulses to operate third selector F^2 in the well known manner to select the first idle trunk leading to connector H^2. The

wipers of switch S are thereafter caused to advance one step preparatory to sending the fourth digit series of three open impulses, the wiper 509 then resting upon bank terminal 529, so that ground will now exist on bank terminal 533 of switch R.

The wipers of switch R will now step advance while the fourth digit series corresponding to digit "3" will be sent to operate connector H^2 vertically in the well known manner. The switch R will thereupon restore its wipers to the drawn position and the wipers of the switch S will be advanced one step so that wiper 509 will be resting on bank terminal 530 and ground will then exist on bank terminal 531, preparatory to the sending of the last single open impulse corresponding to digit "1".

The wipers of switch R will now step advance while the fifth digit impulse is being sent effective to rotating the wipers of connector H^2 in the well known manner to seize and ring upon the line leading to telephone A', in the well known manner, after which the wipers of the switch R will restore to the drawn position and relay 541 will deactuate.

At the time relay 541 deactuates following the sending of the open impulse constituting the last digit "1" the wipers of switch S will be advanced one step in the manner as before, this time the ground on bank terminal 550 being applied over wiper 508, conductor 551, make-before-break spring 378 to the winding of relay 379, the latter said relay actuating and locking to the grounded armature 334, the relay 335 deactuating. This will cause relays 505 and 518 to deactuate.

At this time, the line relay in the connector H^2 is energized through a path involving armatures 380 and 381 and the winding of polarized relay 382, in place of the armatures 501 and 502. The relay 382 will tilt its armature clockwise into the indicated "Ring. pos.," however, to no operative effect.

It will be noted at this time, that when the relay 323 first actuated, the windings of the back-bridge relay in connector D thereby became connected through bank terminals 383—384, wiper 312—313, armatures 385—386, make-before-break springs 387—388 and the upper and lower windings of relay 389 to battery and ground, respectively. The back-bridge relay in connector D and relay 389 will not actuate under the condition, because the battery on the upper winding of said back-bridge relay and the battery on the upper winding of relay 389 oppose.

Upon the response at telephone A', wherein the connector H^2 will cause the direction of current traversing the winding of relay 382 to be reversed in direction so that the armature of the latter said relay will be tilted counter clockwise in the indicated "Ans. pos.," under which condition ground from the armature of relay 382 will energize the relay 390, causing obvious circuit changes which will cause the battery on the upper winding of the back-bridge relay in connector D to energize in series with the lower winding of relay 389 in switch F, said back-bridge relay and relay 389 actuating. The actuation of the back-bridge relay in connector D will cause current to be reversed to the calling telephone A''. The talking path between the telephone A^2 and A' will include the condensers 391—392.

It will be understood that any well known or other suitable so-termed repeater may be introduced into the trunk leading-in to selector D^4 from the banks of selector G. This will also apply to the trunk leading-in to selector D^2 from the banks of selector E. The effective operation will be the same as if the said repeaters were not employed, being used for translating from three wires to two wires for the inter-office trunk.

Calling party at telephone A'' abandons call while call is being forwarded

If it is assumed that the calling party at telephone A'' abandons the call while the call is being forwarded from the primarily called line to telephone A', it will be clear that the connector D and antecedent switches will restore to normal, subject to new use. This will remove the ground from conductor 75, so that relays 323 and 335 of switch F will deactuate to render said F subject to new use. Relay 505 will deenergize responsive to the deactuation of relay 335, so that relay 518 will unlock. The armature 560 on relay 518 will now apply ground through wiper 507 to cause the motor magnet 546 to restore the wipers of switch S to the drawn normal position. The armature 561 on relay 518 will now apply ground through wiper 515 to cause the motor magnet 525 to restore the wipers of switch R to the drawn position.

Encountering the line leading to telephone A' busy

Had the line leading to telephone A' been encountered busy, the connector H^2 would have applied busy tone back over the lower talking conductor 339, condenser 392, audible to the calling party at telephone A''.

Releasing connection—called party hangs up first

If it is assumed that the called party at telephone A' hangs up first upon the termination of the conversation, this will reverse the direction of current traversing the winding of polarized relay 382, causing the relay 390 to be deenergized, in turn deenergizing the back-bridge relay in connector D. The connector D will not release its wipers under the present condition. Also, the connector H^2 will not release its wipers under the present condition because the line relay of the latter

said connector is still maintained energized through the winding of the relay 382.

When the calling party at telephone A'' now hangs up his receiver, and in view of the fact that the backbridge relay in connector D is deactuated, the connector D will release its wipers, and the connection from telephone A'' up to and including the connector D will be released to normal, subject to new use. Ground being thus removed from conductor 75, relay 379 will deactuate and open the path including the winding of relay 382, so that the front-bridge relay in the connector H^2 will deactuate and cause the latter said connector to release its wipers and the antecedent selectors F^2, J^2, D^4, and G, the circuits used in the call now being at normal.

Releasing connection—calling party hangs up first

If it is assumed that the calling party at telephone A'' hangs up first upon the termination of the service this will cause the line relay of connector D to deactuate, followed by the release of the antecedent switches J^2, C^2, B^2, and L^2, the connector D remaining in seizure. When the called party at telephone A' hangs up, the current traversing the winding of relay 382 will be reversed, causing the relay 390 to deactuate to deenergize the backbridge relay in connector D so that the latter said relay will deactuate to release the wipers of the latter said connector. When the connector D releases, ground is removed from conductor 75, so that relays 323 and 379 will deactuate to open the circuit path including the winding of relay 382 and cause the line relay in the connector H^2 to deactuate. Since the back-bridge relay in this connector H^2 deactuated responsive to the party at telephone A' hanging up, the wipers of connector H^2 will release, the circuits used in the call being now normal.

Party at telephone A may change the normal prearranged setting for forwarding call to telephone A' to a random desired line

In the foregoing descriptions the wipers of switches H, I, J, K, and L were assumed in the drawn position. The bank terminal 510 of switch S is connected to the wiper 601 of switch H. The four bank terminals 527, 528, 529, and 530 successively following bank terminal 510 are connected to wipers 604, 607, 701 and 704 of switches I, J, K, and L, respectively.

Before the party at telephone A hung up his receiver after causing the set relay C to be actuated and locked, the said party could have changed the setting from that to cause calls to be forwarded to telephone A' as has been described.

Let it be assumed that it is his desire to have calls directed to his line leading to telephone A forwarded to a random desired line A^2, the telephone number of which is 14321. The party at telephone A will operate his dial to annex the digits 1—4—3—2—1, following the sending of the series of eleven open impulses to set the relay C.

It will be noted that under the condition of causing the relay C to be set as assumed, the relay 24 will be in its actuated condition while the party at telephone A maintains his receiver off the switch-hook, so that a circuit can be traced from line terminal 81, conductor 82, attracted armature 83, conductor 84, upper winding of relay 725 to grounded battery. Also, a circuit can be traced from terminal 85, conductor 86, attracted armature 87, conductor 88, lower winding of relay 725 to ground, the latter said relay actuating. The slow-releasing relay 726 actuates, energized in a local circuit of relay 725. Relay 727 then actuates, energized in a local circuit of relay 726.

When the party at telephone A hangs up his receiver after setting relay C forthwith without annexing any digits, the relay 725 will deactuate, its armature 728 applying ground through armature 729, winding of slow-releasing relay 730, wiper 732 of set 731 and 732, bank terminal 733, conductor 734 to the winding of motor magnet 625, the latter said magnet stepping the wipers of switch H one step from the drawn position. Relays 726 and 727 will deactuate consistent with the slow-releasing characteristic of relay 726.

It will be noted that wiper 705 normally grounds conductor 735 and, therefore, similarly grounds wipers 702, 608, 605 and 602. So when the wiper 602 moved to bank terminal 628, this ground is continued over conductor 629, armature 737, conductor 738 to all bank terminals engaged by wiper 603 at off-normal positions. The magnet 625 will operate by interrupter action, so that no upset will occur to the setting relay C to unset the line. It will also be noted that when relay 730 actuated, its armature 740 applied ground to the winding of motor magnet 741 of switch M, so that when relay 730 deactuates following the impulse sent to the motor magnet 625, the armature of the motor magnet 741 will advance the wipers of switch M one step. When the relay 727 deactuates, ground will be applied through armature 743, bank terminals co-operative with wiper 731, interrupter armature of motor magnet 741 to the winding of the latter said motor magnet, causing it to operate and step the wipers of switch M around to the drawn position.

However, in the present assumed instance, the party at telephone A does not hang up his receiver forthwith after setting the relay C, but on the other hand, annexes the five digits 1—4—3—2—1 designating the random telephone A^2, for example. The sending of the digit 1 constituted of one open impulse

will cause the relay 725 to momentarily retract armature 728, so that a ground impulse will be sent from said armature 728, armature 729, winding of relay 730, wiper 732, bank terminal 733, conductor 734 to the winding of motor magnet 625, the wipers of switch H being stepped one step so wiper 601 will rest on bank terminal 630 when the armature of said motor magnet 625 retracts. The armature 740, when retracting, will cause the operation of the motor magnet 741 to advance the wipers of switch M one step, so that wiper 731 will then rest on the bank terminal 745.

The sending of second digit "4" constituted of four open impulses will cause the relay 725 to momentarily retract its armature 728 four times, so that four ground impulses will be sent from the armature 727, armature 729, winding of relay 730, wiper 732, bank terminal 745, conductor 746 to the winding of motor magnet 635, the wipers of switch I being thereby stepped four steps so that wiper 604 will rest on bank terminal 636. The retraction of armature 740 will cause the operation of the motor magnet 741 to advance the wipers of switch M one step, so wiper 732 will rest on bank terminal 747.

The sending of third digit "3" constituted of three open impulses will cause the relay 725 to momentarily retract its armature 728 three times, so that three ground impulses will be sent from the armature 728, armature 729, winding of relay 730, wiper 732, bank terminal 747, conductor 748 to the winding of motor magnet 645, the wipers of switch J being thereby stepped three steps so that wiper 607 will rest on bank terminal 646. The retraction of armature 740 will cause the operation of the motor magnet 645 to advance the wipers of switch M one step so that wiper 732 will rest on bank terminal 750.

The sending of fourth digit "2" constituted of two open impulses will cause the relay 725 to momentarily retract its armature 728 two times, so that two ground impulses will be sent from armature 728, armature 729, winding of relay 730, wiper 732, bank terminal 750, conductor 751 to the winding of motor magnet 755, the wipers of switch K being thereby stepped two steps so that wiper 701 will rest on bank terminal 756. The retraction of armature 740 will cause the operation of the motor magnet 741 to advance the wipers of switch M one step so wiper 732 will rest in bank terminal 757.

The sending of the fifth digit "1" constituted of one open impulse will cause the relay 725 to momentarily retract its armature 728 one time so that one ground impulse will be sent from armature 728, armature 729, winding of relay 730, wiper 732, bank terminal 757, conductor 758 to the winding of motor magnet 765, the wipers of switch L being thereby stepped one step so wiper 704 will rest on bank terminal 766. The retraction of armature 740 will cause the operation of the motor magnet 741 to advance the wipers of switch M one step, so wiper 732 will rest on bank terminal 767.

I twill be noted that under the last foregoing condition the bank terminals 510, 527, 528, 529 and 530 cooperative with wiper 509 are now connected through wipers 601, 604, 607, 701 and 704 over obvious circuit paths to terminals 531, 534, 533, 532, and 531, respectively. Under this condition, it will be clear in view of previous descriptions, that the sending mechanism will be set to send the train of digits 1—4—3—2—1 responsive to the terminals 71 to 73 being seized by connector D.

In this connection, it will be understood that although the jumpers 611 to 614 set the sending mechanism to send the digits 1—3—4—3—1 corresponding to the telephone number of telephone A', when the wipers 601, 604, 607, 701, and 704 are in their drawn normal positions, this same set-up may be attained by directively setting the latter said wipers on the co-operative bank positions corresponding to digits 1—3—4—3—1, respectively. That is to say, it is not necessary to have the jumpers 611 to 614, but to do away with them will make it necessary to always directively set not only relay C, but also the switches H to L in accordance with a telephone number.

Upon the party at telephone A hanging up his receiver, relays 24, 725, 726 and 727 will deactuate; also, the relay 212, the windings of which have been in multiple with the windings of relay 725. The wiper 705 being off the bank terminal 721 it is drawn resting on and is resting on bank terminal 770, when relay 727 deactuates there will be no ground applied through the armatures of this relay from wiper 705, so the wipers of the switches H to L will not be restored at this time. However, when armature 743 retracts, it causes the wipers of switch M to restore to the drawn position by interrupter action of its motor magnet 741.

It will appear presently that responsive to relay 725 deactuating, relay 93 will actuate and cause the lower winding of relay 302 to energize. This operation is only momentary and will not upset the intended operation. Ordinarily, the party setting relay C and the switches H to L will not hang up his receiver at this time, but will operate the dial, as will appear presently, to cause a test to be made of the setting by causing the impulse sending device to send impulses corresponding to the setting to operate the switches to extend a connection from the calling line to the called line corresponding to the setting. He will then hang up his receiver. Of course, moving bank terminal 767 one step to the left, making it necessary to annex two digit series

or other series in place of one would obviate the false operation of relay 93 responsive to hanging up, but the said operation of relay 93 is not seriously objectionable, since it causes no trouble, even if the party neglects to test the setting as intended he should.

If only part of switches H to L are set they will restore

In this connection, it will be noted that if the party at telephone A, when setting the switches H to L had failed to set all of the latter said switches, by leaving off one or more of the five digits, the wiper 705 would then be in the drawn position. So when the relay 727 deactuates responsive to the hanging up of the receiver of telephone A, this ground on wiper 705 would be applied through bank terminal 721 and through those of the wipers 602, 605, 608 and 702 as are in off-normal position in multiple, to conductor 629, and through the multipled armatures on said relay 727 to the resting contacts cooperative with the armatures on the motor magnets of the switches H to K which are off-normal, to restore these switches to the drawn positions, the switch M restoring in the manner before described from armature 743. Under this condition any calls directed to the line leading to telephone A will be forwarded to telephone A′ in accordance with the settings of the switches H to L when in the drawn positions, since only relay C will be set.

Unsetting the relay C and the switches H to L

When the party at telephone A desires to unset his line for forwarding calls directed thereto, he will remove his receiver as if to initiate a call, and thereupon operate his calling device dial in accordance with the finger-hold Y used in sending a series of twelve open impulses. This will cause the relay 31 to operate in the manner before described to unlatch the catch 36 to release the springs of relay C. Ground will now be applied through spring 90, conductor 91, multipled armatures on relay 727, through the interrupter contacts of the motor magnets of switches H to L to restore said switches to the drawn positions, thus effacing the specially set up condition of the switches H to L.

The switches H to L (with the exception of switch H, which has a twelfth bank terminal, as will appear presently) are each drawn with five sets of bank terminals. In a commercial embodiment there would be eleven such sets; a normal position set and one position for each digit from 1 to 0.

The five switches H to L contemplate a train of five digit series. It will be clear that more switches may be added to increase this range, the switch M having corresponding bank positions added.

Party at telephone A after causing relay C to be set may hang up his receiver and initiate a new calll and by his dial direct the call to the number of his own line

The connector D (or any other connector of the group containing connector D) and switch F will operate in the manner described from telephone A to cause the call to be extended to the telephone predetermined by the said setting of relay C. The same will apply if the switches H to L are set for extending calls to a random desired line. The foregoing has in view that the line leading to telephone A is clear of the bank terminals accessible from connector D when the set relay C is in the set condition.

Party at telephone A after causing relay C and the switches H to L to be set may thereupon cause the call to be extended to the random desired line

If the party at telephone A desires to verify the set condition after causing the relay C and the switches H to L to be set for forwarding calls to a random telephone A^2 he may, without first hanging up his receiver, operate his dial in accordance with the finger-hold Z and thereby send a series of eleven open impulses to cause the call to be extended to the line indexed by the set condition of the switches H to L, which in the present assumed instance is to telephone A^2.

The relay 24 under the present assumed condition, is still actuated and energized from armature 22. Thus, the relay 725 will momentarily retract its armature 728 eleven times and send a corresponding number of ground impulses through armature 729, winding of relay 730, wiper 732, bank terminal 767 (it having stepped to the latter said terminal following the setting of the switch L), conductor 771 to the winding of relay 93, the latter said relay actuating and locking to release trunk conductor 27 responsive to the first impulse of said series.

Armature 94 closes the grounded winding of relay 95 to conductor 75, so that the lower winding of relay 302 will energize in series with the winding of relay 95. Slow-releasing relay 96 will be operatively energized in a local circuit of relay 95. Relay 302 will operatively attract only its armature 306 from its resting contact to its make contact in the manner as when connector D applied ground over conductor 75. The finder switch F or one of its group will operate to hunt for and seize the bank terminals corresponding to the line leading to telephone A. When this latter line is found and relay 323 actuates, ground from armature 321 is applied through wiper 311 to conductor 75 as before described. This latter ground will de-

energize the winding of relay 95 and it will therefore deactuate, followed by relay 96.

After relay 95 deactuates and until relay 96 deactuates, ground is applied through armatures 97 and 98 to the winding of relay 99, the latter said relay actuating and locking to conductor 75. Armatures 101 and 102 disconnect the line conductors leading from the telephone A to the line switch B, so that relay 212 will deactuate to remove ground from conductors 202 and 27. Relay 93 will unlock.

Responsive to relay 99 actuating, the windings of relay 389 will energize in series with telephone A, the receiver of which is off the switch-hook. The armature of relay 289 will apply ground to wiper 311 and conductor 75 to maintain the relay 99 locked.

Responsive to the actuation of relay 99 the relay 212 will deactuate to remove the ground from conductor 202 so that the relay 28 of the line switch B will deactuate and first selector E will restore to normal in the obvious manner. Relay 21 will deenergize and relay 24 will deactuate responsive to relay 28 deactuating.

It will be noted, in this connection, that when relay 24 is actuated, the private bank terminal 71 accessible from conductor D will be grounded by the attracted make-before-break armature of relay 24 to guard the line leading to telephone A against seizure before the line is fully set and the party at telephone A has restored his receiver, it being noted that when relay 24 deactuates responsive to relay 212 deactuating, ground to conductor 75 is applied by the armature of relay 389 in switch F before referred to.

Referring to the operation of the finder switch F at the time it finds the line corresponding to telephone A, the private wiper then resting upon the bank terminal 315, it will be clear that the relays 323 and 335 thereupon actuate in the manner before described. This latter operation will cause the impulse sending mechanism in Fig. 5 to transmit a train of digit series to progress the call to telephone A^2 in accordance with the settings of switches H to L in the manner as before described, the connector G^2 applying ringing current to the line leading to telephone A^2. Relay 335 deactuates and relay 379 actuates.

Current derived through the windings of the relay 389 traverses the telephone A in the same direction as when it derived current from the windings of relay 212. However, when the party at telephone A^2 removes his receiver from the switch-hook in responding, the armature of relay 382 will tilt into the indicated "Ans. pos." and cause the relay 390 to actuate for reversing the direction of current applied through telephone A. This reversing of current direction is for operating supervisory devices, call meters and prepayment coin collecting apparatus. Moreover, the reversal effective to relay 382 may be caused by reversing apparatus located intermediate of switch F and connector G^2, and operated by message timing apparatus. The said supervisory devices, call meters and prepayment coin collecting apparatus, and the said reversing apparatus has not been shown, since such has been disclosed in applications of applicant filed heretofore. Moreover, this reversing apparatus may be included in a well known trunk impulse repeater located intermediate of the switches F and G. The party at telephone A is now in talking relation with the party at telephone A^2.

At the time relay 99 actuated and locked and selector E restored its wipers and relay 24 deactuated, relays 725, 726 and 727 deactuated, causing switch M to be restored to the drawn position in the manner before described.

Release of connection—called party hangs up first

If it is assumed that the called party at telephone A^2 hangs up first upon the termination of the conversation, this will reverse the direction of current traversing the winding of relay 382, causing the relay 390 to deactuate and restore the direction of current traversing the telephone A. The connector G^2 will not release its wipers under the condition, since the windings of its line relay are still in series with the winding of relay 382. However, when the party at telephone A hangs up and deenergizes the relay 389, the relay 99 will be thereby unlocked, since ground will then be removed from conductor 75. This also causes relays 323 and 379 to deactuate. This restores the condition of switch F to normal and opens the energizing path for the line relay of connector G^2, so that the connector G^2 and antecedent switches release to normal. However, relay C and switches H to L are in their set position, and this latter has been verified by the response of the party at telephone A^2.

Release of connection—calling party hangs up first

If it is assumed that the calling party at telephone A hangs up first upon the termination of the conversation, this will deenergize the relay 389 so that relay 99 will unlock and remove the ground from conductor 75, causing relays 323, 379 and 390 to deactuate and open the energizing circuit for the line relay of connector G^2. The switches antecedent to said connector will release, but the said connector will remain in seizure. When the party at telephone A^2 hangs up, connector G^2 will release its wipers. However, relay C and switches H to L are in their set position.

Preferred embodiment—party at telephone A after causing only relay C to be set may thereupon cause the call to be extended to telephone A'.

If the party at telephone A desires to verify the set condition after causing only relay C to be set, he may without first hanging up his receiver, operate his dial in accordance with the finger-hold Z, and thereby send a series of eleven open impulses to cause the call to be extended to the line indexed by the jumpers 611 to 614, which is the number of telephone A'.

The switch H is modified in accordance with Fig. 9, wherein another wiper 901 and co-operative tank terminals are added. Also, two sets of bank terminals are added. One set, 902 to 905 have the twelfth bank position, reached by eleven steps of the wipers from normal position. Bank terminals 616 and 903 are in multiple, for the object as will appear presently. Wiper 901 is connected to the upper armature of relay 726. Bank terminal 902 is connected to conductor 771.

In the present instance, the switches H to L are in the drawn positions. The eleven open impulses sent from the dial of telephone A will be sent through wiper 732, which is resting on bank terminal 733, conductor 734 to the winding of motor magnet 625, the latter said magnet operating to set the wipers 901, 601 to 603 on bank terminals 902 to 905, respectively. Wiper 901 has ground received from the upper armature of relay 726, and this ground is now applied through bank terminal 902, conductor 771 to the winding of relay 93, the latter said relay actuating and locking in the before described manner when said conductor 771 was caused to be grounded. The operations responsive to the actuation of relay 93 will be as before described, excepting that the call will be progressed with correspondence to the positions of switches H to L, wherein the wipers of the switch H are on the twelfth set of bank terminals and the other said switches are in their drawn positions. The bank terminals 616 and 903 being in multiple, the circuit relations are the equivalent of wiper 601 being in the drawn position on bank terminal 616.

The wipers of switch M will step to the second bank position at the termination of the latter said series of eleven open impulses, but to no operative purpose, and they will restore to the drawn normal position when the relay 24 deactuates responsive to the calling party replacing his receiver, causing the relays 725, 726 and 727 to deactuate.

It will be noted, in this connection, that in the first instance where relay C was set, and switches H to L were also set, when the relay 93 was caused to actuate, a single open impulse at the dial of telephone A would have caused the same effective operation of relay 93, since it was only necessary to send a single ground impulse through bank terminal 767 to conductor 771. The series of eleven impulses was employed in order to have uniform subscriber operation for the verification of the settings by the actual extension of a call from the calling line in the present instance to the line of the exchange indexed by the setting of the call forwarding mechanism on the said calling line. This operation of verifying the setting will be the same whether or not the switches H to L are set, if the relay C is set.

It is to be understood that the details disclosed in Figs. 8 and 9 are not merely alternative structures or modifications, but on the contrary, are to be understood as belonging to the structure to which they refer. That is to say, they are elements of the main embodiments first described to which they relate. These elements disclosed in part in Figs. 8 and 9 have been so illustrated separately solely to simplify the disclosure as a whole of which they are to be considered a component part.

I claim:

1. In an automatic telephone system, a calling line, called lines, switch mechanism for extending connection from the calling line to a random one of the called lines, a register for receiving impulses, an impulse sending device, means controlled over the calling line for registering the designation of a random one of said called lines to prepare the impulse sending device for thereafter sending impulses to direct the operation of the switch mechanism to complete a connection from the calling line to the random called line, and means controlled over the calling line after the designation has been registered and without initiating a new call for causing the impulse sending device to direct the operation of said switch mechanism in accordance with said registered designation to effect a connection from the calling line to said random called line.

2. In an automatic telephone system, a calling line, called lines, switch mechanism for extending connection from the calling line to a random one of the called lines, a register for receiving impulses, an impulse sending device, means controlled over the calling line for registering the designation of a random one of said called lines to prepare the impulse sending device for thereafter sending impulses to direct the operation of the switch mechanism to complete a connection from the calling line to the random called line, a selective switch having access to the calling line, means for causing the impulse sending device to direct the operation of the switch mechanism to extend a connection from the calling line to said random called line, means operated over the

calling line for rendering last said means effective, and means for rendering next to last said means effective responsive to said selective switch selecting the calling line.

3. In an automatic telephone system, a calling line, called lines, switch mechanism for extending connection from the calling line to one of the called lines, a register, an impulse sending device, means controlled over the calling line for setting said register to prepare the impulse sending device for thereafter sending impulses to direct the operation of the switch mechanism to complete a connection from the calling line to one of said called lines, and means controlled over the calling line after the register has been set and without initiating a new call for causing the impulse sending device to direct the operation of said switch mechanism to effect a connection from the calling line to a predetermined one of said called lines.

4. In an automatic telephone system, a calling line, called lines, switch mechanism for extending connection from the calling line to one of the called lines, a register, an impulse sending device, means controlled over the calling line for setting said register to prepare the impulse sending device for thereafter sending impulses to direct the operation of the switch mechanism to complete a connection from the calling line to one of said called lines, a selective switch having access to the calling line, means for causing the impulse sending device to direct the operation of the switch mechanism to extend a connection from the calling line to a predetermined one of said called lines, means operated over the calling line for rendering last said means effective, and means for rendering next to last said means effective responsive to said selective switch selecting the calling line.

5. In an automatic telephone system, a calling line, called lines, switch mechanism for extending connection from the calling line to one of said called lines, a register, an impulse sending device, means controlled over the calling line for setting said register to prepare the impulse sending device for thereafter sending impulses to direct the operation of the switch mechanism to complete a connection from the calling line to one of said called lines, means operated over the calling line after the register has been set for causing the impulse sending device to direct the operation of said switch mechanism to effect a connection from the calling line to a predetermined one of said called lines, and means operated over the calling line before last said means has been operated but after first said means has been operated for changing the setting of said register so that a different predetermined one of said called lines will be connected to responsive to the operation of next to last said means.

6. In an automatic telephone system, a calling line, called lines, switch mechanism for extending connection from the calling line to one of said called lines, a register, an impulse sending device, means controlled over the calling line for setting said register to prepare the impulse sending device for thereafter sending impulses to direct the operation of the switch mechanism to complete a connection from the calling line to one of said called lines, a selective switch having access to the calling line, means operated over the calling line after the register has been set for causing the impulse sending device to direct the operation of said switch mechanism to effect a connection from the calling line to a predetermined one of said called lines, means operated over the calling line before last said means has been operated but after first said means has been operated for changing the setting of said register so that a different predetermined one of said called lines will be connected to responsive to the operation of said impulse sending device, and means responsive to the operation of said selective switch selecting the calling line for causing said impulse sending device to direct the operation of said switch mechanism to extend a connection from the calling line to said different predetermined one of said called lines.

7. In an automatic telephone system, a first called line, a plurality of other called lines, a set register, first switch mechanism for extending connection to said first called line, second switch mechanism for extending connection from said first line to a random one of said other called lines, means operative over said first line prior to extending connection to said first line by said first switch mechanism for setting said register in accordance with the designation of one of said other lines, means operative over said first line after said register has been set and prior to extending connection to said first line for changing the said setting to the setting of a desired random one of said other lines, means effective due only to the set condition of the register for causing said second switch mechanism to extend a connection from first called line to the particular one of the called lines corresponding to the setting of the register responsive to connection being extended to said first called line by said first switch mechanism, and means controlled over the said first called line after operating first said or second said means for causing said second switch mechanism to extend connection from said first called line to said particular one of said other called lines or to a desired other one of said other called lines, respectively.

8. In an automatic telephone system, calling lines, called lines, a series of automatic switches for extending connection away from a random one of said calling lines to one of said called lines, switch mechanism for ex-

tending connection to said calling line, an impulse storing and sending device common to said calling lines, means controlled over said random one of the calling lines for setting the storing device for causing said impulse sending device to thereafter directively operate said series of switches to extend connection from said random calling line to one of said called lines, and means for causing said set storing device to direct the impulse sending device to operate said series of switches to extend connection from said random calling line to said one of said called lines responsive to said switch mechanism extending connection to said random line.

9. In an automatic telephone system, a calling line, a relay for the calling line, called lines, an impulse storing and sending device, means for operating the relay over the calling line for setting the storing and sending device in accordance with the designation of a random one of said called lines, switch mechanism for extending connection from the calling line to said random line, and means for at will operating said relay after the said storing and sending device has been set for starting the operation of the storing and sending device for thereupon directing the operation of the switch mechanism to extend a connection from the calling line to said random called line.

10. In an automatic telephone system, a calling line, a relay for the calling line, called lines, an impulse storing and sending device, means for operating the relay over the calling line for setting the storing and sending device in accordance with the designation of a random one of said called lines, switch mechanism for extending connection from the calling line to said random line, means for at will operating said relay after the said storing and sending device has been set for starting the operation of the storing and sending device for thereupon directing the operation of the switch mechanism to extend a connection from the calling line to said random called line, a selective switch having access to the calling line, and means responsive to selecting the calling line by the selective switch for thereupon causing the impulse storing and sending device to direct the operation of the said switch mechanism to extend a connection from the calling line to the said random called line without operating the relay.

11. In an automatic telephone system, calling lines, a relay for each of the calling lines, called lines, an impulse storing device individual to each calling line, an impulse sending device common to the calling lines, means for operating the individual relays over the corresponding calling line to set its corresponding storing device in accordance with the designation of one of said called lines, switch mechanism for extending connection from the respective calling lines to the respective called lines, means for at will operating a said relay over its corresponding line after the said storing device has been set for rendering the impulse sending device individual to the said operated relay and for starting the operation of the impulse sending device for thereupon directing the operation of the switch mechanism to extend connection from the calling line to said one called line, and means for thereupon rendering the impulse sending device subject to use with a different calling line while the said extended connection to the said one line still exists.

12. In an automatic telephone system, calling lines, a relay for each of the calling lines, called lines, an impulse storing device individual to each calling line, an impulse sending device common to the calling lines, means for operating the individual relays over the corresponding calling line to set its corresponding storing device in accordance with the designation of one of said called lines, switch mechanism for extending connection from the respective calling lines to the respective called lines, means for at will operating a said relay over its corresponding line after the said storing device has been set for rendering the impulse sending device individual to the said operated relay and for starting the operation of the impulse sending device for thereupon directing the operation of the switch mechanism to extend connection from the calling line to said one called line, means for thereupon rendering the impulse sending device subject to use with a different calling line while the said extended connection to the said one line still exists, selective switch mechanism having access to the calling lines, and means responsive to selecting a calling line by said switch mechanism for causing the said operation caused by the operation of its said relay, but without operating the relay.

13. In an automatic telephone system, calling lines, a relay for each of the calling lines, called lines, an impulse storing device individual to each calling line, an impulse sending device common to the calling lines, means for operating the individual relays over the corresponding calling line to sets its corresponding storing device in accordance with the designation of a random one of said called lines, switch mechanism for extending connection from the respective calling lines to the respective called lines, means for at will operating a said relay over its corresponding line after the said storing device has been set for rendering the impulse sending device individual to the said operated relay and for starting the operation of the impulse sending device for thereupon directing the operation of the switch mechanism to extend connection from the calling line to said random called line, and means for thereupon rendering the

impulse sending device subject to use with a different calling line while the said extended connection to the said random line exists.

14. In a telephone system, a calling line, other lines, a call register which may be variably set, an impulse sending device, switch mechanism for extending connections from the calling line to a random one of said other lines, means responsive to sending impulses over the calling line corresponding to the designation of a random one of said other lines to correspondingly set the register only after first initiating a call on the calling line, and means for thereupon annexing impulses for initiating the operation of the impulse sending device to send impulses in accordance with the specific setting of the register to directively operate the switch mechanism to extend connection from the calling line to the said random one of said lines without effacing the initiated state of the calling line.

15. In a telephone system, a calling line, other lines, a call register which may be variably set, an impulse sending device, switch mechanism for extending connections from the calling line to a random one of said other lines, means responsive to sending impulses over the calling line corresponding to the designation of a random one of said other lines to correspondingly set the register, and means for thereupon annexing impulses as the first following control exercised over the calling line for initiating the operation of the impulse sending device to send impulses in accordance with the specific setting of the register to directively operate the switch mechanism to extend connection from the calling line to said random one of said lines without effacing the initiated state of the calling line.

16. In a telephone system, a calling line, other lines, a call register which may be variably set, an impulse sending device, switch mechanism for extending connections from the calling line to a random one of said other lines, means responsive to sending impulses over the calling line for setting the register in correspondence with a predetermined one of said other lines, means thereafter operated by annexing impulses to first said impulses corresponding to another one of said other lines for changing the said setting to a new setting, means for extending connection to the calling line, and means operated responsive to said connection for causing the register to operate the impulse sending device to further extend the connection to the one of said other lines indexed by the new setting of the register.

17. In a telephone system, a calling line, other lines, a call register which may be variably set, an impulse sending device, switch mechanism for extending connections from the calling line to a random one of said other lines, means responsive to sending impulses over the calling line for setting the register in correspondence with a predetermined one of said other lines, means thereafter operated by annexing impulses to first said impulses corresponding to another one of said other lines for changing the said setting to a new setting, and means operated responsive to again annexing impulses to initiate the operation of the impulse sending device to operate the switch mechanism to extend connection from the calling line to the one of said other lines corresponding to the new setting of the register.

18. In a telephone system, a calling line, other lines, a call register which may be variably set, an impulse sending device, switch mechanism for extending connections from the calling line to a random one of said other lines, means responsive to sending impulses over the calling line for setting the register in correspondence with a predetermined one of said other lines, means thereafter operated by annexing impulses to first said impulses corresponding to another one of said other lines for changing the said setting to a new setting, means operated responsive to again annexing impulses to initiate the operation of the impulse sending device to operate the switch mechanism to extend connection from the calling line to the one of said other lines corresponding to the new setting of the register, and means whereby if last said impulses are sent immediately following first said impulses the connection will be extended from the calling line by said switch mechanism to the specific said other line indexed by first said setting.

19. In a telephone system, a call register having a setting wiper, a normal resting position for said wiper, an impulse device, a start conductor for said impulse device over which conductor the operation of the impulse device can be initiated, a set condition of the register due to the wiper being in said normal position, off-normal positions for the wiper and corresponding other respectively set conditions of the register, and means for setting said wiper in a predetermined off-normal position for setting up the same condition in the register as exists when the wiper is in its said normal position and also for at the same time applying effective control over the start conductor to initiate the operation of the impulse device to effectuate impulses in accordance with said normal setting.

20. In a telephone system, a plurality of lines, a register individual to each of said lines, other lines, means for variably setting the registers over the respectively corresponding line in accordance with the designation of a random one of said other lines, an impulse device common to said plurality of lines, switch means for linking a connection from a random one of said plurality of lines

to a random one of said other lines, and means operated over a random one of said plurality of lines for causing its corresponding register to direct the operation of the impulse device to in turn directively control the switch means to link a connection from said random one of said plurality of lines to said random one of said other lines.

21. In a telephone system, a plurality of lines, a register individual to each of said lines, other lines, means for variably setting the registers over the respectively corresponding line in accordance with the designation of a random one of said other lines, a selective switch and companion impulse device common to said plurality of lines, switch means for linking a connection from a random one of said plurality of lines to a random one of said other lines, means operated over a random one of said plurality of lines for causing the selective switch to find last said line and its corresponding register, and means operated responsive to the finding of last said line for causing the found register to direct the operation of the impulse device to in turn directively control the switch means to link a connection from said random one of said plurality of lines to said random one of said other lines.

22. In a telephone system, a plurality of lines, a register individual to each of said lines, other lines, means for variably setting the registers over the respectively corresponding line in accordance with the designation of a random one of said other lines, a selective switch and companion impulse device common to said plurality of lines, switch means for linking a connection from a random one of said plurality of lines to a random one of said other lines, switch means for connecting to said random one of said plurality of lines, means operated responsive to extending connection to last said random line for causing the selective switch to find last said line and its corresponding register, and means operated responsive to the finding of last said line for causing the found register to direct the operation of the impulse device to in turn directively control the switch means to link a connection from said random one of said plurality of lines to said random one of said other lines.

23. In a telephone system, a calling line, first and second called lines, switch means directively operated over the calling line from the near portion thereof for extending the calling line ahead from the far portion thereof in the direction of said first called line, and means operated in effecting said extension depending upon the directive operation effected for effacing the call extension toward said first called line and for causing the calling line to thereupon directively extend toward said second called line responsive to directive impulses applied from a point beyond the far end of the calling line.

24. In a telephone system, a calling line, first and second called lines, first switch means directively operated over the calling line from the near portion thereof for extending the calling line ahead in the direction of said first called line, second switch means, and means operated in effecting said extension depending upon the directive operation effected for effacing the call extension toward said first called line and for causing the calling line to be thereupon directively extended by said second switch mechanism to said second called line responsive to directive impulses applied to said second switch means from a point beyond the far end of the calling line.

25. In a telephone system, a calling line, first and second called lines, first switch means directively operated over the calling line for extending the calling line ahead in the direction of said first called line, second switch means, and means operated over the extension for setting up a stored condition and for effacing the call extension and for causing the calling line to be thereupon directively extended by said second switch mechanism to said second called line responsive to directive impulses sent responsive to the stored condition and applied to said second switch means from a point beyond the far end of the calling line.

26. In a telephone system, a calling line, first and second called lines, first switch means directively operated over the calling line for extending the calling line ahead in the direction of said first called line, second switch means, and means operated over the calling line for setting up a stored condition and for effacing the call extension and for causing the calling line to be thereupon directively extended by said second switch mechanism to said second called line responsive to directive impulses sent responsive to said stored condition.

In witness whereof, I hereunto subscribe my name this 9th day of March, 1928.

HERBERT M. FRIENDLY.