B. D. WILLIS.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED AUG. 25, 1914.

1,277,675.

Patented Sept. 3, 1918.

3 SHEETS—SHEET 1.

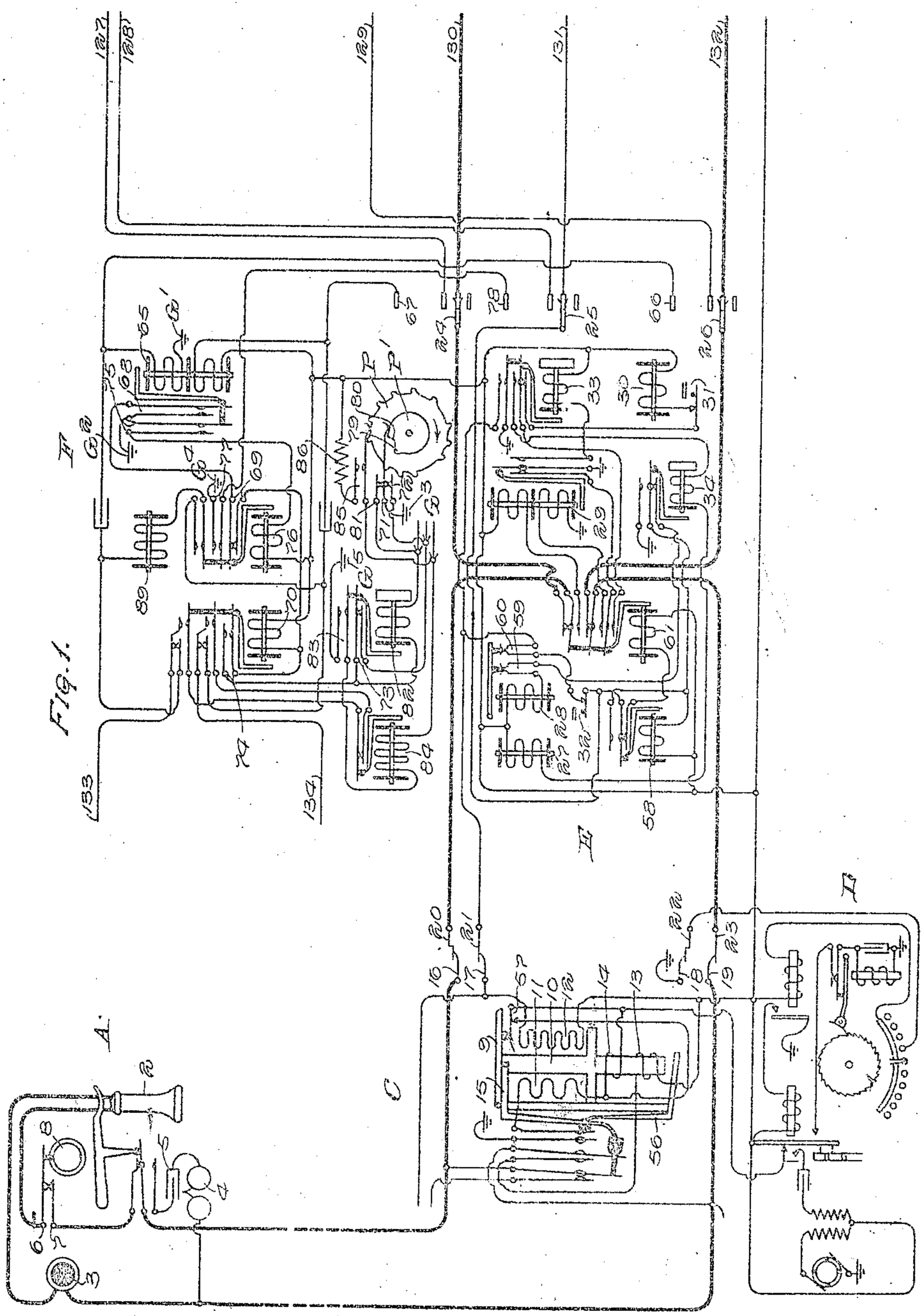

FIG. 1.

WITNESSES

G. Gnadowski

Herbert W. Hacke

INVENTOR.

BERNARD D. WILLIS,

By

Bulkley & Lonnardon

ATTORNEYS.

B. D. WILLIS.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED AUG. 25, 1914.

1,277,675.

Patented Sept. 3, 1918.

3 SHEETS—SHEET 2.

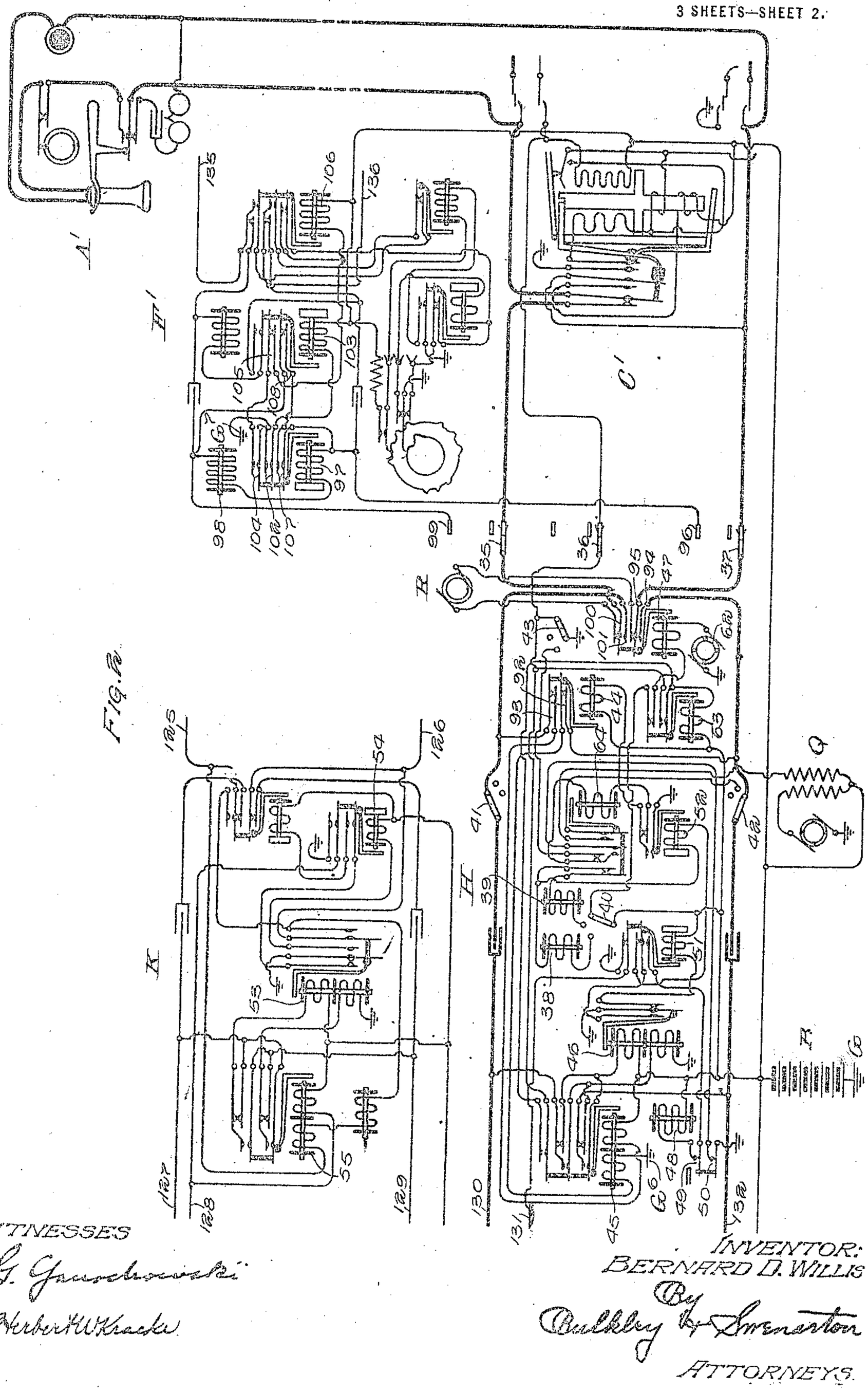

FIG. 2.

WITNESSES

L. Jaschowski

Herbert H. Kracke

INVENTOR:
BERNARD D. WILLIS

By Bulkley & Emerson

ATTORNEYS.

B. D. WILLIS.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED AUG. 25, 1914.

1,277,675.

Patented Sept. 3, 1918.

3 SHEETS—SHEET 3.

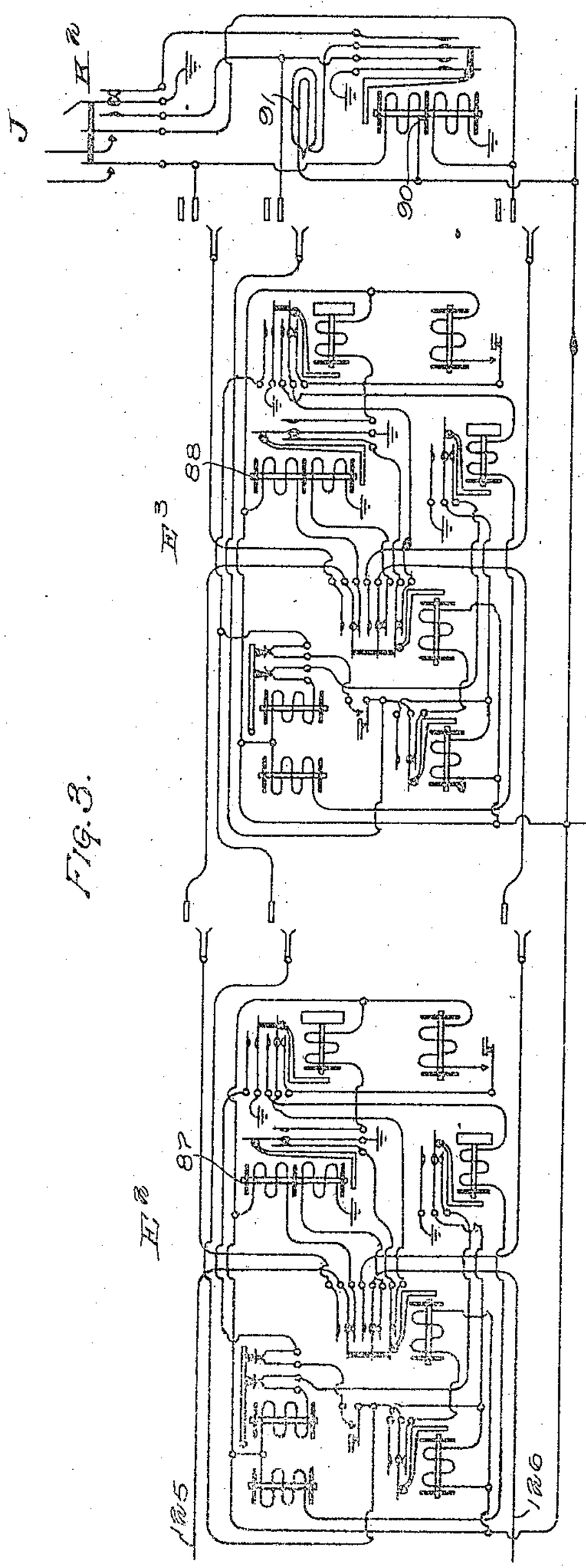

FIG. 3.

WITNESSES

G. Gronbowski

Herbert W. Kracke

INVENTOR:
BERNARD D. WILLIS

By Bulkley & Emerton

ATTORNEYS.

UNITED STATES PATENT OFFICE.

BERNARD D. WILLIS, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,277,675. Specification of Letters Patent. Patented Sept. 3, 1918.

Application filed August 25, 1914. Serial No. 858,480.

To all whom it may concern:

Be it known that I, BERNARD D. WILLIS, a citizen of the United States of America, and resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to improvements in automatic telephone systems, and more particularly to what is known as district systems—that is, systems in which main and branch exchanges are employed.

The objects of my invention are to increase the trunking efficiency from the branch exchange to the main exchange by enabling toll calls, trouble calls and other calls in which it is desired to obtain connection with an operator to be extended over the regular trunks, instead of necessitating the employment of special trunks for this purpose, as has heretofore been customary. By my invention it is necessary to employ but one set of trunks extending from the branch exchange to the main exchange, and all calls can be made over these trunks.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated one embodiment of my invention in connection with automatic switches of well known types.

Figures 1 and 2 show a complete connection in a branch office of an automatic telephone system embodying the principles of my invention.

Fig. 3 shows part of the equipment at the main office.

It has heretofore been customary in a small branch office to have several groups of special service trunks to the main office in addition to the regular outgoing trunks. For instance, it has been necessary to provide a special group of trunks for long distance calls, for trouble calls, for information, for dead levels and for take-outs, etc. It is the object of my present invention to provide an automatic impulse-sending machine of such form that branch exchange calls of the above-mentioned character will be sent in to the main office over the regular out-going trunks. We will assume that the regular outgoing trunks to the main office are accessible from the third level of the first selectors in the branch office, and these outgoing trunks terminate in the main office in incoming second selectors. As is well known, the trunks in the tenth or 0 level of the first selectors of the main office lead to the recording section of the toll board, and in the system disclosed herein it is assumed that the trunks in the sixth level of the special selectors E^3 are multipled with the corresponding trunks in the 0 level of the first selectors.

When a subscriber at the branch office, the subscriber A, for example, desires to call long distance, he removes his receiver and calls the digit 0. The removal of the receiver causes the line switch C to extend the connection to the first selector E. The selector E, upon responding to the impulses for the digit 0, extends the connection to the impulse-sending machine F. The impulse machine F thereupon causes a line switch (not shown, but which is in the same group as the line switch C) to seize a selector (not shown, but which is in the same group as the first selector E), whereupon the impulse machine F delivers three impulses to the first selector (not shown), which causes it to obtain connection with the repeater K, which is associated with a trunk leading to the incoming second selector E^2. The impulse machine F now delivers three impulses to the incoming second selector E^2, which causes it to extend the connection to the special selector E^3. A further set of six impulses from the impulse machine F causes the special selector E^3 to make connection with the answering jack equipment J which is located at the recording position on the toll board. In this way a subscriber in the branch exchange is put in connection with the toll operator by the simple operation on his part of calling the digit 0. At the same time it will be seen that the connection is extended over the regular outgoing trunks to the main office. The remaining calls of the above-mentioned character are made in a manner similar to that of the long distance call, except that the impulses delivered by the impulse machine will be for different digits.

The automatic substation A (Fig. 1) comprises the usual receiver 2, transmitter 3, ringer 4 and condenser 5. Being an automatic substation it is also provided with a suitable call-sending mechanism for controlling the automatic switches, which mecha-

nism is represented diagrammatically by a pair of impulse springs 6 and 7 and an impulse wheel 8, which latter may be controlled by a dial provided with finger holes in such a way that the impulse springs may be momentarily separated a number of times corresponding to the respective digits of the number of the called subscriber.

The subscriber's individual switch C (Fig. 1) is of the general type of subscriber's switch shown in British patent to R. W. James No. 26,301 of 1906, being, however, of the particular type disclosed in British patent to T. G. Martin No. 1419 of 1910. This line switch comprises among other details a plunger (not shown) attached to the end of a so-called plunger arm 9 which is controlled by the magnet 10. The magnet 10 comprises four windings, namely, a pull-down winding 11, a cut-off or holding winding 12, a line winding 13 and an auxiliary winding 14. The core of the magnet 10 is so constructed that the magnetic circuit of the windings 11 and 12 is separate from that of the windings 13 and 14. This magnet also controls the cut-off armature 15. The pull-in winding 11 operates both the plunger arm 9 and the armature 15, while the cut-off or holding winding 12 is strong enough only to operate the cut-off armature 15 and hold the plunger arm 9 in its operated position, when the plunger arm is forced into a bank of contact springs, forcing the springs 16, 17, 18 and 19 into engagement with the springs 20, 21, 22 and 23, respectively. Although only one set of springs (16 to 23, inclusive) is shown, each line switch is provided with a plurality of such sets, each set forming the terminal of a trunk line leading to a selector switch. Each trunk line is connected in multiple with the corresponding springs of all the idle switches of the group which is controlled by the master switch D. The switch C is controlled by the subscriber through the medium of the line winding 13; as will hereinafter be more fully explained.

The master switch D (Fig. 1) is of the same general type as that disclosed in British patent to R. W. James No. 26,301 of 1906, above referred to, being, however, of the particular type disclosed in said British patent to T. G. Martin No. 1419 of 1910. The function of the master switch, as is well known, is to maintain the plungers of all the idle trunk line switches in position to engage the terminal of an idle trunk line.

The selector switch E (Fig. 1) is of the general type of selector switch disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, except that the so-called side switch is omitted, and the circuits are modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series, as shown in British patent to T. G. Martin No. 10,376 of 1912. Among other details the selector E comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 24, 25 and 26 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 27 and a rotary movement controlled by the rotary magnet 28. The operations of the various parts of the switch are controlled through the medium of the double-wound line relay 29. Means for permitting the switch to be restored to normal position are provided in the release magnet 30, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 31 and 32 close only when the switch shaft has been raised one or more steps from its lowest position. The relays 33 and 34 are slow acting—that is, slow to release their armatures upon deënergizing. The selectors E^2 and E^3 are similar in all respects to the selector E.

The connector switch H (Fig. 2) is of the same general type of connector switch as disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits, however, being modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series. Among other details the connector H comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 35, 36 and 37 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 38 and a rotary movement controlled by the rotary magnet 39. The usual side switch comprising the wipers 40, 41, 42 and 43 is controlled by the private magnet 44 in the usual and well-known manner. The operations of the various parts of the switch are controlled through the medium of the double-wound line relay 46, said relay being connected with the line through the reversing springs of a so-called back-ridge relay 45, through the windings of which latter relay the called line is provided with talking current. The ringer relay 47 affords the means by which ringing current is applied to the called line. Means for permitting the switch to be restored to normal position are provided in the release magnet 48, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 49 and 50 close only when the switch shaft has been raised one or more steps from its lowest position. The relays 51 and 52 are slow acting—that is, slow to release their armatures upon deënergizing.

The repeater K (Fig. 2) has a line relay 53, a slow acting relay 54 and a battery-

reversing relay 55. The line relay 53 is normally bridged across the trunk extending to the repeater from the third level of the banks of the first selectors, and is so arranged that when its armature operates in accordance with the impulses from an impulse-sending machine or calling device, it opens and closes the bridge across the trunk extending to the selector E^2 a corresponding number of times. Among the functions of this repeater switch is to receive impulses transmitted by the impulse-sending machine or calling device and repeat them to the switches farther on. Furthermore, it supplies battery current to the calling line and maintains a holding circuit for the switches in front of it, without requiring a third conductor to be included in the trunk line extending to the switches beyond.

The impulse-sending machine F (Fig. 1) consists of a constantly rotating shaft upon which are mounted a pair of impulse cams P and P'. Associated with these impulse cams there may be a number of groups of relays similar to the group shown at F. The function of each of these groups of relays is to supply battery current to the calling line and maintain a holding circuit for the switches in front of it. At the same time means are provided by which a series of impulses corresponding to the notches upon the cam P are sent out to advance the switches ahead to the desired point.

The impulse-sending machine F' is the same in general principle as the machine F.

The called substation A' (Fig. 2) and its individual line switch C' is similar in all respects to the calling substation A and its individual line switch C.

For the purpose of supplying battery current for operating the apparatus and for talking purposes, there are shown the batteries B and B', each having one terminal grounded at G. For the purpose of supplying ringing current there is shown the ringing current generator R. The busy signaling machine Q, as represented herein, comprises an induction coil or transformer, the primary winding of which is included in a local circuit with a battery and an interrupter of high frequency. Through the medium of this interrupter an interrupted current is supplied to the primary winding, which induces an alternating current in the secondary winding, whereby, when said winding is connected with the subscriber's line, a buzzing sound is heard in the receiver.

A general description of the apparatus having been given, it will now be explained how connection can be established between the line of substation A and the line of substation A'. The number of the called substation will be assumed to be 222. Since the automatic switching apparatus disclosed herein is in general well known in the art, and is described in the publications herein referred to, its operation will be explained in a more or less general manner.

When the subscriber at substation A removes his receiver from the switch hook preparatory to making a call, an energizing circuit is closed through the line winding 13 of the line switch C. The armature 56, upon being operated, due to the energizing of the winding 13, closes a circuit through the pull-in winding 11. The pull-in winding 11 upon energizing, attracts both the armature 15 and the plunger arm 9. The plunger arm 9, upon being attracted, forces the plunger which is attached to the end thereof into the bank of trunk terminals to which it has access, forcing the springs 16, 17, 18 and 19 into engagement with the springs 20, 21, 22 and 23, respectively. The engagement of the springs 16 and 19 with the springs 20 and 23, respectively, closes a circuit through the line relay 29 of the first selector E. The relay 29, upon energizing, closes a circuit through the relay 33. The relay 33 in turn, upon energizing, affords a holding circuit for the holding winding 12 of the line switch C, and also places a guarding ground potential upon the connector private bank contact associated with the line switch C. This circuit through the holding winding 12 is closed before the armature 56 falls back after the circuit through the line winding 12 is broken by the attraction of the armature 15. The armature 56 does not fall back immediately upon the attraction of the armature 15, due to the fact that simultaneous with the attraction of the armature 15 is the attraction of the plunger arm 9, which short-circuits the auxiliary winding 14 by closing the springs 57. This short-circuiting of the winding 14 tends to retard the deënergization of the core, and thus the armature 56 is held in an operated position until enough time has elapsed for the circuit through the winding 12 to be closed, whereby the plunger arm 9 is held in an operated position.

The calling subscriber now operates his calling device for the first digit 2 of the called number, whereby the substation impulse springs are separated twice momentarily, each time breaking the circuit of the line relay 29 of the selector E. The relay 33 of the selector being slow acting does not deënergize during the momentary interruptions of its circuit by the relay 29, and consequently each time the latter relay deënergized, an impulse is transmitted through the vertical magnet 27. The vertical magnet receives two impulses and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts, and at the same time the shaft-controlled contacts 31 and 32 are

closed. The slow acting relay 34 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit through the relay 58. The relay 58, upon energizing, forms a locking circuit for itself. Thus, upon the deënergization of the relay 34 after the last impulse has been delivered to the vertical magnet, the relay 58 remains energized and the circuit of the rotary magnet 28 is closed. The rotary magnet, upon energizing, rotates the shaft wipers one step, and by opening the springs 59 and 60 breaks its own circuit and the circuit of the relay 58. If the first trunk line of the second level is idle, the relay 58 deënergizes as soon as the springs 60 are opened. If this trunk line is busy, however, the private wiper 25 finds the contact which it engages provided with a guarding ground potential which is transmitted to the relay 58, thereby preventing it from deënergizing. The rotary magnet, however, deënergizes when the springs 59 are opened, regardless of whether the relay 58 remains energized or not. If the relay 58 remains energized, the circuit of the rotary magnet will be again closed as soon as its armature drops back far enough to close the springs 59 and 60. The rotary magnet will, therefore, operate in a manner similar to that of a buzzer to advance the wipers step by step over the contacts until the non-grounded contact of an idle trunk line is reached by the wiper 25, whereupon the relay 58 deënergizes. The relay 58, upon deenergizing, whether after one or several operations of the rotary magnet, permanently breaks the circuit of the said rotary magnet and closes the circuit of the switching relay 61. The relay 61, upon energizing, disconnects the line relay 29 from the line and extends the line connection over the heavy conductors shown through the wipers 24 and 26 to the connector H. The line relay 46 of the connector thereupon becomes energized and closes the circuit of the relay 51, which in turn, upon energizing, completes a holding circuit for the relay 61 of the selector E and for the winding 12 of the line switch C. This circuit maintains the said relay and winding energized after their original energizing circuit is broken by the relay 33, which deënergizes shortly after the line relay 29 is disconnected from the line.

The calling subscriber now operates his calling device for the second digit 2 of the called number, whereby the substation impulse springs are separated twice momentarily, each time breaking the circuit of the line relay 46 of the connector H. The relay 51 of the connector being slow acting does not deënergize during the momentary interruptions of its circuit by the relay 46, and consequently, each time the latter relay deënergizes, an impulse is transmitted through the vertical magnet. The vertical magnet receives two impulses and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts, and at the same time the shaft-controlled springs 49 and 50 are closed. The slow acting relay 52 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit through the private magnet 44. This circuit is broken when the relay 52 deënergizes after the last impulse has been delivered to the vertical magnet, the breaking of said circuit causing the private magnet 44 to deënergize, thus permitting the side switch to pass to second position. In passing from first to second position the side switch wiper 40 transfers the battery connection from the vertical magnet 38 to the rotary magnet 39.

The calling subscriber now operates his calling device for the last digit 2, in response to which the connector line relay operates to transmit two impulses through the rotary magnet 39, whereby the shaft wipers are rotated onto the contacts of the desired line. The relay 52 operates in response to the impulses for this digit in the same manner as for the previous digit to cause the private magnet 44 to advance the side switch to third position. By the engagement of the side switch wipers 41 and 42 with their third-position contact points, the line connection is completed with the called line. Upon the engagement of the side switch wiper 43 with its third-position contact point, a circuit is completed through the cut-off winding of the line switch C'. The cut-off winding of the line switch C', upon energizing, disconnects the line relay from the called line. The connection of ground with the connector private bank contact associated with the called line prevents the called line from being seized by some other connector switch. By the engagement of the side switch wiper 40 with its third-position contact point, the circuit of the ringer relay 47 is closed. The ringer relay is energized intermittently due to the interrupter 62 and operates to disconnect the calling line from the called line and to bridge the ringing current generator R across the called line to signal the called subscriber. Upon the response of the called subscriber his line is provided with talking current through the windings of the back-bridge relay 45, which relay, upon energizing, closes the circuit of the ringer cut-off relay 63. The ringer cut-off relay, upon energizing, interrupts the circuit of the ringer relay 47 and closes a locking circuit for itself independent of the relay 45. Furthermore, the back-bridge re-

lay 45, upon energizing, operates to reverse the direction of the flow of current in the calling line.

Upon the completion of the conversation, the restoring of the receiver causes the circuit of the line relay 46 of the connector H to be opened. The relay 46, upon deënergizing, opens the circuit of the relay 51, which in turn, upon deënergizing, removes the holding ground from the relay 61 of the selector E and from the winding 12 of the line switch C, and in addition closes the circuit of the release magnet 48. The release magnet 48, upon energizing, operates to withdraw the retaining pawls from the shaft and its own circuit is opened at the springs 49 when the said shaft reaches its lowest position. The relay 61, upon deënergizing, closes the circuit of the release magnet 30. The release magnet 30, upon energizing, withdraws the retaining pawls from the shaft and its own circuit is broken at the springs 31 when the said shaft reaches its lowest position. The winding 12, upon deënergizing, releases the armature 15 and the plunger arm 9, thus allowing the line switch C to return to normal position.

It having been explained how one subscriber establishes connection and releases the same, it will now be explained how a connection is prevented from being made with a busy line. If the called number is busy, there will be a guarding potential upon the connector private bank contact associated with that line, just as explained in connection with the line switch C. The connector private wiper 36, upon engaging this guarded contact and before the side switch has passed to third position, completes an energizing circuit through the relay 64 in series with the private magnet 44. The relay 64, upon energizing, opens the circuit of the rotary magnet 39, and at the same time connects the busy tone from the busy machine Q with the calling line. In addition, the relay 64, upon energizing, forms a locking circuit for itself through the off-normal springs 50. The calling subscriber, upon hearing the busy tone, restores his receiver to the switch hook and the release of the apparatus follows in practically the same manner as previously explained.

It will now be explained how a subscriber at the substation A may obtain connection with a toll operator, the directory number of whom is 0.

When the receiver is removed at the substation A, the line switch C operates to extend the connection to the selector E. Upon the calling subscriber operating his calling device for the digit 0, the wipers of the selector E are brought to rest upon the first idle trunk in the tenth level of its bank, which trunk we will assume leads to the impulse machine F. A circuit may now be traced from ground G^1 through the upper winding of the line relay 65, bank contact 66, line wiper 26 to and through the substation A, line wiper 24, bank contact 67 and the lower winding of the line relay 65 to battery B. Upon the energization of the line relay 65, a circuit is formed from ground G^2 through the springs 68, springs 69 and the relay 70 to battery B. The relay 70, upon energizing, forms a locking circuit for itself from ground G^3 through the springs 71 and 72, springs 73, springs 74 and the relay 70 to battery B. At the time the relay 65 energizes, another circuit is formed from ground G^2 through the springs 75 and the relay 76 to battery B. The relay 76 is slower to energize than the relay 70, otherwise the relay 76 would open the circuit of the relay 70 before said relay had formed its locking circuit. The energization of the relay 76 supplies a holding circuit for the relay 61 of the selector E and for the winding 12 of the line switch C. The said circuit may be traced from ground G^4 through the springs 77, bank contact 78, private wiper 25 and thence through the relay 61 and winding 12 in parallel to battery B. This holding ground is supplied before the original holding ground is removed by the deënergization of the relay 33, which follows shortly after the relay 29 is removed from the line. The trunk conductors 133 and 134 lead to a line switch (not shown) which is similar to the line switch C and is in the same group. When the relay 70 is energized, a bridge is formed across the trunk conductors 133 and 134 which causes the said line switch to be operated and extend the connection to a selector (not shown) which is similar in all respects to the selector E. When the point 79 on the cam P′ engages the spring 71 it causes the said spring to break from the spring 72. A circuit may now be traced from ground G^3 through the springs 71 and 81, relay 82, springs 74 and the relay 70 to battery B. The relay 82, upon energizing, opens the springs 73, so that when the springs 71 and 72 again come into contact, the relay 82 will not be again shunted out. And in addition, by the closure of the springs 83, the circuit for the impulse relay 84 is prepared. Each time a projection on the cam P forces the springs 85 into engagement, a circuit may be traced from ground G^5 through the springs 83, relay 84, springs 85 and the resistance 86 to battery B. Each time the relay 84 energizes it opens the bridge across the trunk conductors 133 and 134 and in this way delivers an impulse over the trunk. The three impulses caused by the first group of projections upon the cam P cause the first selector (not shown) to raise its shaft and wipers to the third level of bank contacts, whereupon the first idle trunk in that level is selected, which we will as-

sume leads to the repeater K. The three impulses delivered by the next group of projections upon the cam P cause the line relay 53 of the repeater K to transmit three impulses over the trunk conductors 125 and 126 to the line relay 87 of the selector E^2, whereupon the wipers of the selector E^2 come to rest upon the first idle trunk in the third level of its bank, which we will assume leads to the selector E^3. The six impulses caused by the next group of projections upon the cam P cause the line relay 53 of the repeater K to transmit six impulses to the line relay 88 of the selector E^3, whereupon the wipers of the selector E^3 come to rest upon the first idle trunk in the sixth level of its bank, which we will assume leads to the jack equipment J. After the last group of projections on the cam P has passed under the springs 85, the depression 80 on the cam P′ passes under the spring 71 and thereby opens the springs 71 and 81. The relay 82 being slow acting does not de-energize immediately, but the relay 70 de-energizes and thereby bridges the coil 89 across the trunk conductors 133 and 134. The impulse-sending machine is now in readiness to extend connection between any other group or groups of relays associated with the said machine (not shown) and the operator at the main exchange. Upon the connection being extended to the answering jack equipment J, the relay 90 becomes energized and in so doing affords a holding ground for the switches in front thereof. At the same time the relay 90 closes a circuit through the signal lamp 91. The operator, upon seeing the lamp 91 lighted, operates the key K^2 to cut her talking set (not shown) across the calling line, whereby she may converse with the calling subscriber. It will be seen that with the key K^2 operated, an additional holding ground is supplied to the switches preceding the answering jack equipment J for the reason that the apparatus will not be released should the calling subscriber hang up before the operator has restored the key K^2. Upon the completion of the conversation, the operator restores the key K^2. The hanging up of the receiver at the calling substation will then bring about the release of the apparatus in a manner similar to that already explained.

When the telephone has been taken out of service it is desirable that any one calling that line be automatically connected with an operator who can then give the information necessary for obtaining connection with the called party. Assuming that the telephone the number of which is 224 has been removed and that that line has been connected in multiple with several others to the impulse machine F′. Then when a subscriber in the branch office calls that number, and the side switch of the connector H steps to third position, a circuit may be traced from ground G^6 through the left-hand winding of the relay 45, springs 92, springs 94 and 95, line wiper 37, bank contact 96, relay 97, coil 98, bank contact 99, line wiper 35, springs 100 and 101, springs 93 and the right-hand winding of the relay 45 to battery B. The relay 45 will not energize over this circuit on account of the high resistance coil 98. The relay 97 will energize, however, and in so doing will close a circuit from ground G^7 through the springs 102 and the relay 103 to battery B. At the same time a circuit will be closed from ground G^7 through the springs 104, springs 105 and the relay 106 to battery B. It will be seen that at the instant between the pulling up of the relay 97 and the pulling up of the relay 103, the high resistance coil 98 and the relay 97 will be short-circuited by means of the springs 107 and 108. This short-circuiting of the coil 98 and the relay 97 will allow sufficient current to flow through the back-bridge relay 45 to operatively energize it for an instant. This will be long enough for it to close the circuit through the ringer cut-off relay 63, but not long enough for the reversal of the current in the calling line to operate a meter therein should there be one. Should the ringer relay 47 be energized when the side switch first steps to third position, the relay 97 will not energize, for, being slow acting, it is not affected by the ringing current. The instant between the energization of the relay 97 and the energization of the relay 103 is sufficient time for the relay 106 to energize, which, upon energizing, forms a locking circuit for itself in the same manner as previously explained in connection with the machine F. The trunk conductors 135 and 136 terminate in a line switch in the same manner as explained in connection with the machine F, and the subsequent operation of the machine F′ is the same as explained in connection with the machine F, except that it produces impulses corresponding to the digits 3—3—4, which cause the connection to be extended to an answering jack equipment before an operator detailed to take care of such calls.

If there should be any unused levels in the first selector E, the bank contacts of this level would be connected with groups of relays (not shown) similar to the group of relays and the impulse machine F, and the operation of the same is similar to the operation of the relays and the impulse machine F hereinbefore described.

It will thus be seen that I have devised a very efficient trunking arrangement between the branch and main office by which it is necessary to employ but a single group of trunks. These trunks can be employed to extend connection to automatic switches

whose operations are controlled from the calling line, or these same trunks can be employed for the purpose of extending connection to an operator's board, such as a trouble operator or a toll operator, such connection being controlled by the automatic impulse sender at the central office.

While I have illustrated and described my invention in connection with automatic switches of well-known types, it will, of course, be understood that different forms of switches could be employed without departing from the scope of my invention, and that various other changes and modifications will readily suggest themselves to those skilled in the art.

What I claim as my invention is:—

1. In a telephone system, a subscriber's line, a trunk line, a plurality of automatic switches, an impulse transmitter on the subscriber's line for transmitting impulses over said trunk to control the operation of said switches, an automatic impulse transmitter at the exchange, and means for connecting said automatic impulse transmitter with said trunk to transmit impulses thereover to control the operation of said switches.

2. In a telephone system, a subscriber's line, a trunk line, a plurality of automatic switches, an impulse transmitter on the subscriber's line for transmitting impulses over said trunk to control the operation of said switches, an automatic impulse transmitter at the exchange, and means controlled from the subscriber's line for connecting said automatic impulse transmitter with said trunk to transmit impulses thereover to control the operation of said switches.

3. In a telephone system, a group of trunks, an automatic selector switch, means for operating said switch to select any one of said trunks, an automatic impulse transmitter, means for operating said selector switch to establish connection with said impulse transmitter, and an automatic switch controlled by said impulse transmitter for selecting any one of the same group of trunks.

4. In a telephone system, a main exchange, a branch exchange, a group of trunk lines extending between said exchanges, means for seizing one of said trunks, a progressively movable wiper at the main exchange individual to each trunk line, a plurality of automatic switches at said main exchange for establishing a connection with a called subscriber's line, a manual toll operator's board at the main exchange, and means for establishing a connection with any one of said automatic switches, or with said toll operator's board, over any one of said trunk lines through the medium of one of said wipers.

5. In a telephone system, a trunk line, an automatic impulse-transmitting device, a calling subscriber's line, means for establishing a connection from said subscriber's line to said impulse-transmitting device, means controlled by the operation of said device for transmitting a plurality of series of impulses over said trunk line, and automatic switches responsive to said impulses.

6. In a telephone system, a trunk line, an automatic impulse-transmitting device, a calling subscriber's line, means for establishing a connection from said subscriber's line to said impulse-transmitting device, means controlled by the operation of said device for transmitting a plurality of series of impulses over said trunk line, automatic switches responsive to said impulses, an impulse-transmitter on the calling line, means for connecting said trunk line with the calling line so that a plurality of operations of said impulse transmitter transmits a plurality of series of impulses over said trunk, and automatic switches responsive thereto for extending connection to a called line.

7. In a telephone system, a main exchange, a branch exchange, a group of trunk lines extending between said exchanges, means for seizing any one of said trunks, a progressively movable wiper individual to each trunk, means for moving said wiper after the trunk is seized for extending regular calls over one of said trunks, and means for extending toll calls and trouble calls over the same group of trunks through the medium of one of said wipers.

8. In an automatic telephone system, a plurality of lines each having for the purpose of being called, a particular numerical designation consisting of a series of digits, automatic switches responsive to impulses corresponding to the various digit combinations for connecting calling and called lines, and a call sending device accessible to calling lines, said device adapted to transmit, each time it is seized by a calling line switch, controlling impulses corresponding to the number of a particular line, whereby such calling line and the particular line may be connected.

9. In an automatic telephone system, a substation and a line therefor, a trunk line to an operator's position, a series of automatic switches responsive to a plurality of digits for extending connection from said line to said trunk line, a calling device at said substation for sending impulses corresponding to the first digit to operate the first switch of the series, and a calling device at the exchange for automatically sending the impulses corresponding to the remaining digits to operate the remaining switches of the series.

10. In an automatic telephone system, subscribers' lines terminating in a central exchange, a trunk line accessible to calling subscribers' lines through the medium of a

series of automatic switches in response to the calling of a particular series of digits, a second trunk line having access to the first switch of said series, a call sender associated therewith and permanently adjusted to send impulses corresponding to the digits of said particular series each time it is operated, and automatic means accessible to calling lines for connecting with said second trunk line.

11. In an automatic telephone system, subscribers' lines terminating in a central exchange, a trunk line accessible to calling subscribers' lines through the medium of a series of automatic switches in response to the calling of a particular series of digits, a second trunk line having access to the first switch of said series, a call sender associated therewith and permanently adjusted to send impulses corresponding to the digits of said particular series each time it is operated, and automatic means responsive to impulses corresponding to a single digit for connecting a calling line with said second trunk line and for initiating the operation of the call sender associated therewith.

12. In an automatic telephone system, a substation and a line therefor, a selector switch accessible to said line, a trunk line accessible to said switch, a second trunk line extending to an operator's position, means comprising a series of impulse controlled switches for extending connection from said first trunk line to said second trunk line, and a calling device associated with said first trunk line adapted when the said first trunk line is seized by said selector switch to send the necessary impulses to operate said series of switches.

13. In an automatic telephone system, a substation and a line therefor, a trunk line, automatic means for connecting said line with said trunk line, a second trunk line extending to an operator's position, means comprising a series of automatic directively controlled switches for extending connection from said first trunk line to said second trunk line, and an automatic controlling device associated with said first trunk line adapted when the said line and first trunk line are connected to control the operation of said series of switches whereby the connection may be automatically extended to the operator's position.

14. In an automatic telephone system, subscribers' lines, an operator's position accessible to calling lines through the medium of a plurality of automatic switches, and an automatic call sending equipment accessible to calling lines, said equipment provided with means adapted to automatically transmit the necessary impulses to operate said plurality of switches.

15. In an automatic telephone system, subscribers' lines, an operator's position ordinarily accessible to calling subscribers' lines through the medium of a plurality of automatic switches responsive to the calling of a plurality of digits, and an automatic call sender accessible to calling lines by calling a lesser number of digits, said call sender adapted when seized by a calling line to send the impulses corresponding to said plurality of digits whereby the connection may be extended to the operator's position.

16. In a telephone system, an automatic switch, a trunk line accessible to said switch, an impulse transmitter and another automatic switch associated with said trunk line, means for operating said first switch to seize said trunk line, and means controlled by said impulse transmitter for operating said second switch.

17. In a telephone system, an automatic switch, a trunk line accessible to said switch, an impulse transmitter and another automatic switch associated with said trunk line, means for operating said first switch to seize said trunk line, said impulse transmitter automatically controlled by the seizure of said trunk line to operate said other automatic switch.

18. In a telephone system, an automatic switch, a plurality of trunk lines accessible to said switch, an automatic switch for each trunk line, an impulse transmitter common to said trunk lines, means for operating said first switch to seize any one of said trunk lines, and means controlled by said impulse transmitter for controlling the automatic switch associated with the seized trunk line.

19. In a telephone system, an automatic switch, a plurality of trunk lines accessible to said switch, an automatic switch for each trunk line, an impulse transmitter common to said trunk lines, means for operating said first switch to seize any one of said trunk lines, said impulse transmitter automatically controlled by the seizure of said trunk line to operate the automatic switch associated with the seized trunk line.

20. In a telephone system, an automatic switch, a trunk line accessible to said switch, a rotary impulse transmitter and another automatic switch associated with said trunk line, means for operating said first switch to seize said trunk line, and means controlled by said impulse transmitter for operating said second switch.

21. In a telephone system, an automatic switch, a plurality of trunk lines accessible to said switch, an automatic switch for each trunk line, a rotary impulse transmitter common to said trunk lines, means for operating said first switch to seize any one of said trunk lines, and means controlled by said impulse transmitter for controlling the automatic switch associated with the seized trunk line.

22. In a telephone system, a caling line, an

impulse transmitter associated therewith, an automatic switch, means for connecting said line with said automatic switch, a trunk line accessible to said switch, another impulse transmitter and another automatic switch associated with said trunk line, means controlled by said first impulse transmitter for operating said first automatic switch to seize said trunk line, and means controlled by said second impulse transmitter for operating said second automatic switch when the trunk is seized.

23. In telephone system, a calling line, an impulse transmitter associated therewith, an automatic switch, means for connecting said line with said automatic switch, a trunk line accessible to said switch, another impulse transmitter and another automatic switch associated with said trunk line, means controlled by said first impulse transmitter for operating said first automatic switch to seize said trunk line, said second impulse transmitter automatically controlled by the seizure of said trunk line to operate said second automatic switch.

24. In a telephone system, a calling and a called line, a trunk line accessible to said calling line, an impulse transmitter associated with said trunk line, means for extending a connection from the calling line to said trunk line, said impulse transmitter controlled by the establishment of the connection with said trunk line to automatically extend said connection to the called line.

25. In a telephone system, an automatic switch, trunk lines accessible to said switch, an impulse transmitter associated with each trunk line, means for operating said switch to select an idle one of said trunk lines, other automatic switches, and means controlled by the impulse transmitter associated with the selected trunk line for operating said other switches.

26. In a telephone system, an automatic switch, trunk lines accessible to said switch, an impulse transmitter associated with each trunk line, means for operating said switch to select an idle one of said trunk lines, other automatic switches, and means controlled by the impulse transmitter associated with the selected trunk line for operating said switches in accordance with the digits of a called subscriber's number.

Signed by me at Chicago, Cook county, Illinois, this 19 day of August, 1914.

BERNARD D. WILLIS.

Witnesses:
GEO. A. YANOCHOWSKI,
HERBERT W. KRACKE.