Aug. 14, 1928. 1,681,039

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AUTOMATIC TELEPHONE TRUNKING SYSTEM

Original Filed Dec. 27, 1919 3 Sheets-Sheet 1

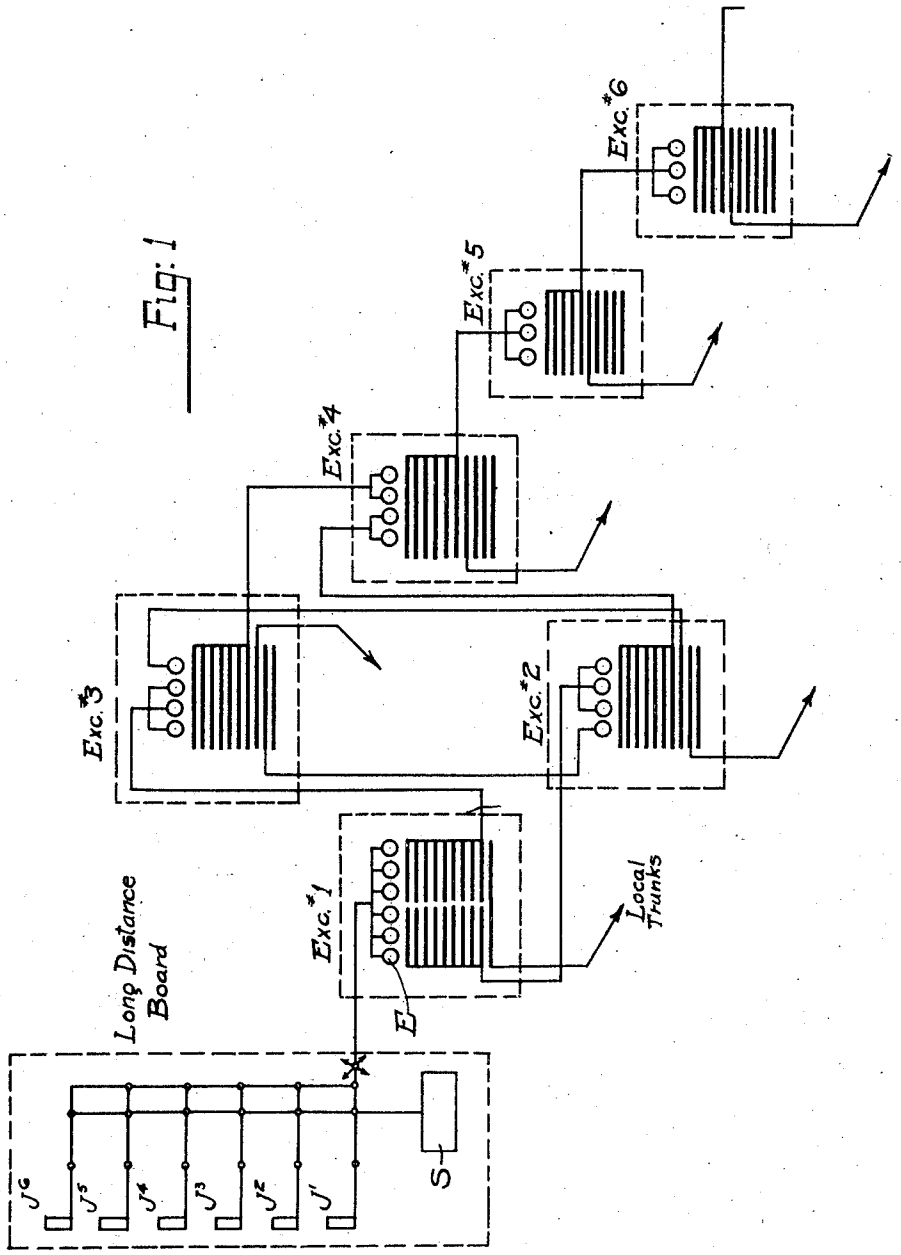


Fig: 1

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AUTOMATIC TELEPHONE TRUNKING SYSTEM

Original Filed Dec. 27, 1919 3 Sheets-Sheet 2

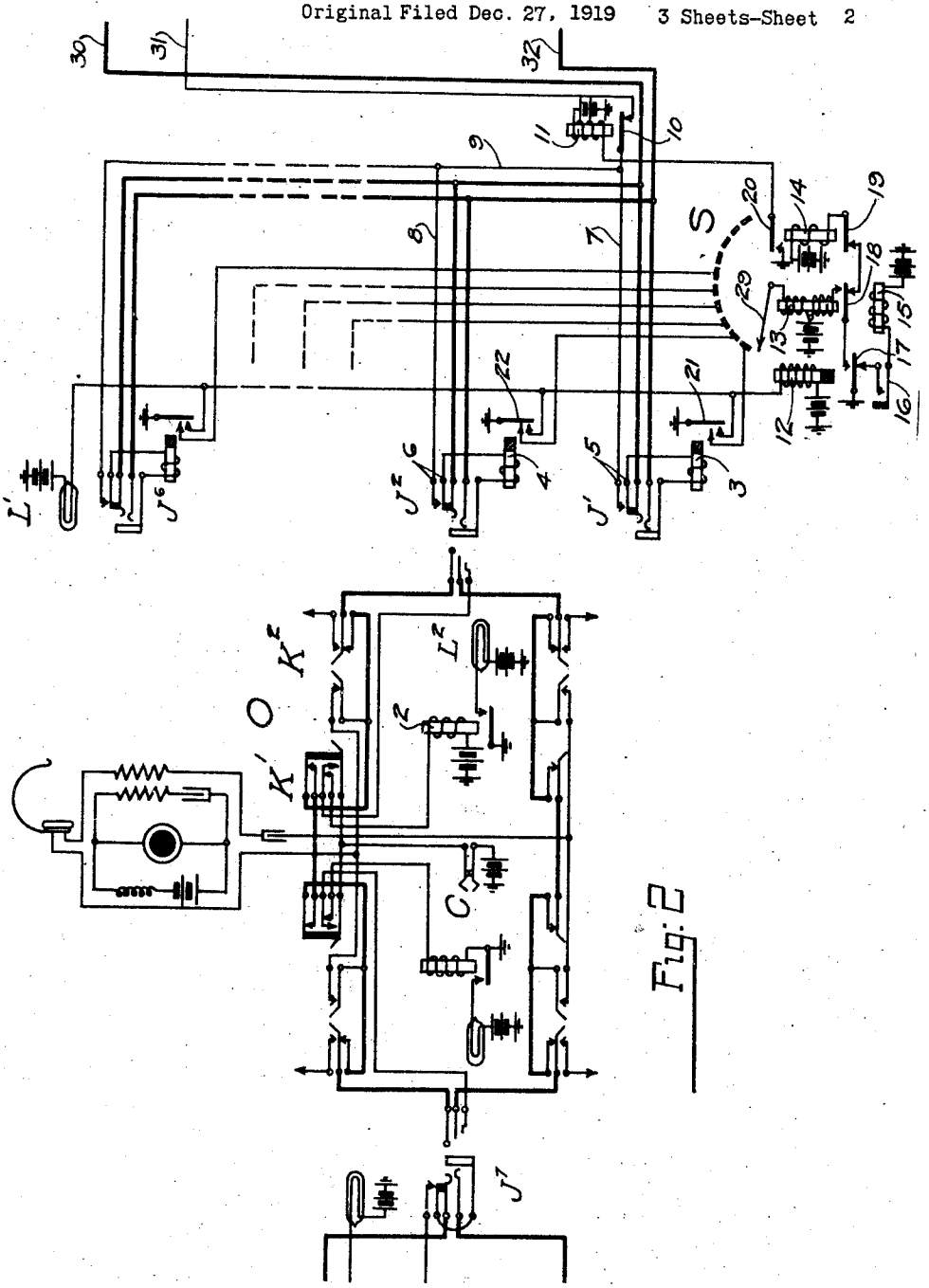


Fig. 2

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Original Filed Dec. 27, 1919 3 Sheets-Sheet 3

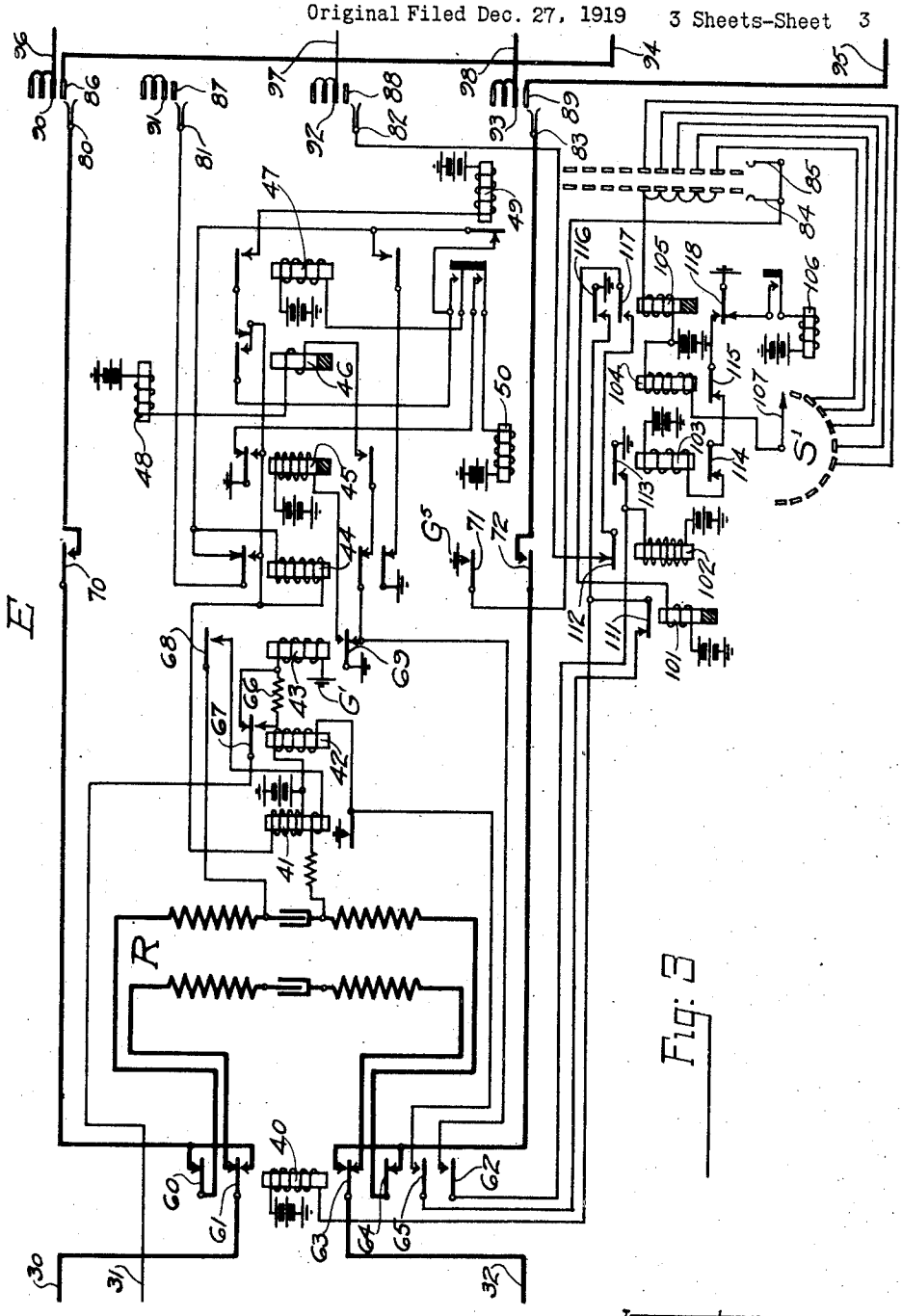


Fig: 3

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# UNITED STATES PATENT OFFICE.

JOHN H. HOMRIGHOUS, OF OAK PARK, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

## AUTOMATIC TELEPHONE TRUNKING SYSTEM.

Application filed December 27, 1919, Serial No. 347,844. Renewed May 18, 1925.

My invention relates in general to automatic telephone trunking systems, but more particularly to such trunking systems as are intended for use by operators in extending connections to desired ones of a plurality of serially related points, and may be considered as a further development of the idea disclosed in my pending application, Serial No. 300,277. More specifically, my invention provides means whereby an operator, generally a long distance operator, is enabled to extend a connection to any one of a plurality of serially related exchanges over serially related trunk or toll lines, and thereafter complete the connection automatically to a called subscriber at the desired exchange, without performing any numerical or selection controlling operations to control the exchange selection other than to pick out the proper terminal over which the connection is initiated. In accomplishing the foregoing each trunk or toll line outgoing from the operator's position is provided with as many connective terminals, or jacks, as there are different exchanges to which the trunk line may be extended; and the operator, in extending a connection to one of these exchanges, simply plugs into the proper jack, whereupon automatic trunking switches are operated independently of the operator to extend the trunk line to the desired exchange.

Other objects are the provision in a trunking system of the above character of means whereby connections to one or more exchanges may be routed via any one of a plurality of intermediate exchanges, the proper route being automatically chosen with reference to the number of trunk lines available either way, and the provision of means whereby connection to either one of two exchanges may be extended direct or via the other exchange.

The foregoing and additional objects are accomplished by appropriate means which will be described in the detailed specification which is to follow, reference being had to the accompanying drawings forming a part thereof.

In the drawings, comprising Figs. 1, 2, and 3, Fig. 1 shows a diagrammatic layout of the system as a whole; Fig. 2 shows a long distance operator's cord circuit, together with the impulse sending mechanism and the jacks associated with an outgoing toll line; while Fig. 3 shows the circuit of the toll selector in which the said trunk line terminates at the first exchange, this exchange being hereinafter designated as the No. 1 exchange. It may be mentioned at this time that each of the other exchanges is provided with similar toll selectors in which the toll lines coming from the direction of the long distance board terminate.

My invention is essentially a system of trunking and contemplates the use of well known types of automatic exchange equipment, and also in so far as it is applicable well known types of automatic toll trunking equipment. In the latter class reference is made to the patent to J. Wicks, #1,315,444 as illustrating the state of the art; and for a disclosure of an automatic telephone exchange system of the so called two wire type, reference is made to the U. S. patent to Newforth, No. 13901, reissued April 13, 1915.

The switches indicated by reference characters S and $S^1$ are simple rotary step by step switches of well known type having each a single wiper and associated bank of 10 contacts as shown. One of these switches is provided for each outgoing toll line at the long distance board, and one for each of the toll selector repeaters such as the selector E, Fig. 3. These latter switches may be similar in general to the toll selectors shown in the above mentioned patent to Wicks, although the circuits are somewhat simplified. Each selector has, however, two rows of vertical contacts and an extra pair of wipers adapted to engage the contacts in the said rows, respectively. These wipers are mounted on the shaft in any suitable manner so that they will sweep the associated contact rows in the vertical movement of the shaft, but will remain stationary during the rotary movement.

It is believed that an explanation of the special apparatus which I use to accomplish the principal object will cause the invention to be readily understood, and I will first describe, therefore, the operation of the equipment shown in Figs. 2 and 3, after which the main aspects of the trunking system as shown in Fig. 1 will be discussed.

Referring to Fig. 2, it will be assumed

that the operator having the cord circuit O has received a toll or long distance call for a subscriber connected to the No. 1 exchange (Fig. 1). She will then proceed to select an idle outgoing trunk or toll line, and observing that the line represented by the series of jacks J′ to J⁶ is idle, as indicated by the unlighted condition of the busy lamp L′, will insert the calling plug of the cord circuit in the jack J′, this jack being the one corresponding to the No. 1 exchange. At the same time the combined listening and ringing key K² is thrown to listening position and the calling device key K′ is actuated. Upon the insertion of the plug a circuit is established for the line relay 43 of the toll selector E at the No. 1 exchange as follows: ground at G′, winding of line relay 43, resting contact of armature 67 and the said armature, conductor 31, resting contact of armature 10 and the said armature, contact springs 5 of jack J′, winding of low resistance slow acting relay 3, sleeve of jack and sleeve of plug in engagement therewith, contact springs of key K′, and the impulse springs of calling device C to battery. The closure of the foregoing circuit causes the line relay 43 to energize, and a circuit is thereby closed for the slow acting release relay 45, which upon energizing, prepares the selector for operation in its vertical movement in the usual manner.

At the operator's position, the relay 3 is energized, whereby ground is placed on the first contact in the bank of the auxiliary step by step switch S, and circuits are closed through the busy lamp L′ and the line relay 12 of switch S in parallel. The busy lamp L′ (and multiple lamps at other positions) is thereupon lighted; and the relay 12 is energized. Upon attracting its armature 17, relay 12 closes a circuit which includes the stepping magnet 14 and its local interrupter 19. The stepping magnet is therefore energized and operates to advanvce the wiper 29 into engagement with the first contact in the bank, whereupon a circuit is completed over wiper 29 which includes the upper winding of the test relay 13. Test relay 13 is therefore energized and by means of its armature 18 breaks the circuit of the stepping magnet and locks itself through its lower winding. The switch S remains in this position throughout the period of the connection. The results produced by its operation will now be considered. When the stepping magnet 14 is energized momentarily as described a circuit is closed for the relay 11 which attracts its armature 10 to produce a momentary interruption in the circuit of the line relay 43 of the toll selector E. The line relay is accordingly deenergized momentarily and transmits an impulse of current through the slow acting series relay 46 and the vertical magnet 48, thereby stepping up the switch shaft one step and raising the wipers 80–83, inclusive, until they stand opposite the first level of bank contacts. When the slow acting relay 46 deenergizes the trunk selecting operation is initiated and the rotary magnet 49 is operated under the control of the stepping relay 47 to advance the wipers 80–83, inclusive, step by step in search of an idle trunk line. This trunk selecting operation is well understood, having been described in publications previously referred to, and need not be explained in detail. Assuming that the trunk line terminating in the contact set comprising bank contacts 86–89, inclusive, is the first idle trunk line, the wipers 80–83, inclusive, will stop on the said contacts, respectively; and the switching relay 44 will be energized in the usual manner. As a result of this operation the right hand windings of the repeating coil R are extended by way of armatures 70 and 72, wipers 80 and 83, and bank contacts 86 and 89 to the trunk conductors 94 and 95, respectively. The trunk conductors 94 and 95 extend to a first selector switch (not shown) which is part of the regular exchange trunking system of the No. 1 exchange, and terminate in the line relay of this switch. It will be seen now that since the line relay 43 of the toll selector E has its armature 68 attracted, the right hand windings of the repeating coil R will constitute a bridge cross the trunk conductors 94 and 95, with the result that the line and release relays of the first selector will be energized and the switch thus made ready for operation.

The operation of the toll selector E just described, by which the connection has been extended to a local first selector in the No. 1 exchange, has been brought about automatically responsive to the insertion of the plug in jack J′ at the long distance board. It should be mentioned that when the toll selector E was operated the wipers 84 and 85 were raised into engagement with the first contacts in the associated rows but since these contacts are dead the operation is without result.

The toll operator may now actuate her calling device C in accordance with the digits in the desired number in the No. 1 exchange. There is nothing unusual about this operation and it need not be explained in detail. As each digit is called a series of interruptions is produced in the circuit of the line relay 43 of the toll selector E, which now operates as a repeater to produce corresponding series of interruptions in the bridge across the trunk conductors 94 and 95. Thus a series of switches in the No. 1 exchange, including the first selector previously referred to, a second selector, and a connector, may be suitably controlled

to complete the connection to the desired line. Having finished dialing the number, the operator will now restore her calling device key K′, thereby substituting the supervisory relay 2 for the calling device. Relay 2 is energized in series with line relay 43 and lights the supervisory lamp $L^2$.

When the called subscriber answers his telephone the connector switch in use reverses the direction of current flow in the trunk conductors 94 and 95, as is usual. This operation is made use of in the present case to control the supervision at the operator's position and the desired result is effected as follows: Included in the bridge across trunk conductors 94 and 95 is the lower winding of the electro-polarized relay 41, the upper winding of which, the polarizing winding, is maintained energized by the release relay 45 while the switch is in use. Until the called subscriber answers, and current flow through the lower winding is reversed, the two windings are in opposition and the relay is inoperative, but as soon as the reversal of current takes place the windings assist each other and the relay operates to close the circuit of relay 42. Upon energizing, relay 42 inserts the resistance 66 in the circuit of the line relay 43. The latter relay remains energized, but the current flow in its circuit is reduced sufficiently to cause the relay 2 in the operator's cord circuit, which is of low resistance and is marginally adjusted, to deenergize and put out the supervisory lamp $L^2$. In case the operator has left the line (by restoring her listening key) she is thus advised that the called party has answered, and will proceed to complete the connection by inserting the left hand plug of her cord circuit in the jack $J^7$ and calling the party who has initiated the call. It is understood that jack $J^7$ may be any line terminal, or it may be the terminal of a series of toll service trunking switches, as shown in the previously mentioned patent to Wicks, by means of which connections are extended to local subscribers in the exchange where the long distance board is located.

When the conversation is finished and the called subscriber hangs up his receiver, the direction of current flow in the lower winding of the electro-polarized relay 42 is reversed back to normal and the said relay is rendered inoperative again, with the result that the circuit of line relay 43 is restored to its original condition. Relay 2 at the cord circuit is therefore energized again, and the lamp $L^2$ is lighted as a disconnect signal. Disconnection and release of the switches is accomplished by simply pulling down the connection. When the plug is removed from jack J′ the circuit of line relay 43 is broken and this relay opens the bridge across the trunk conductors 94 and 95 and also breaks the circuit of the release relay 45. As a result of the former operation the series of switches in the No. 1 exchange are released in the usual manner, while the deenergization of relay 45 causes the toll selector E to be restored by the release magnet 50. The restoration of the rotary switch S is brought about by the deenergization of relay 3, which breaks the circuit of relay 12, which closes the circuit of release magnet 15. In normal position the off normal spring 16 is separated from its working contact and the release magnet circuit is broken.

It will now be assumed that it is desired to extend a connection to a subscriber in the No. 2 exchange, which will require an additional automatic trunking operation under the control of the auxiliary switch S′ which is associated with the toll selector E. In this case the calling plug of the cord circuit is inserted in the jack $J^2$, instead of in jack J′. The circuit of the line relay 43 of the toll selector E is closed as before except that it now includes the relay 4 associated with jack $J^2$. Relay 4 energizes, lights the busy lamp L′, closes the circuit of the relay 12, and places ground on the second contact in the bank of the switch S. The switch S now rotates two steps before it is stopped by the test wiper 29 and produces two interruptions in the circuit of the line relay 43, with the result that the wipers of toll selector E are raised opposite the second bank level instead of the first, as described in the former case. Under control of the rotary magnet 49 the switch wipers are now automatically rotated in search of an idle trunk line extending to the No. 2 exchange. Assuming that the trunk line comprising conductors 96, 97 and 98 is the first one found to be idle, the wipers 80, 81, 82, and 83 will be brought to rest in engagement with bank contacts 90, 91, 92 and 93, respectively.

When the switch wipers 80–83, inclusive, were raised opposite the second level, the wipers 84 and 85 were also raised until they engaged the second contacts in their respective rows. Now when the switching relay 44 is energized ground $G^5$ is extended by way of armature 71 and wiper 85 to the second contact in the bank of the rotary switch S′ and at the same time a circuit is closed by way of wiper 84 for the relay 105 of said rotary switch. The trunk conductors 96, 97, and 98 terminate at the No. 2 exchange in a toll selector similar to selector E, and upon the energization of relay 105 a circuit is completed for the line relay of such selector as follows: from the ungrounded pole of battery by way of the winding of relay 101, armature 117 and its working contact, armature 112 and its resting contact, wiper 82, bank contact 92, conductor 97, and the winding of the line relay

(not shown) of the toll selector in the No. 2 exchange to ground. Upon the closure of the above circuit relay 101 and the line relay of the distant selector are energized, the latter relay energizing the associated slow acting release relay to prepare the switch for operation in the usual manner. As another result of its energization, relay 105 completes at its armature 116 a circuit for the relay 40 of the toll selector E. Upon energizing, relay 40 closes circuits at its armatures 62 and 65 which will be described later, and at its armatures 60, 61, 63 and 64 connects the incoming line conductors 30 and 32 direct to the wipers 80 and 83, respectively, and excludes the reperating coil R from the circuit. Finally, at its armature 118, relay 105 closes the circuit of the stepping magnet 103 of the rotary switch S'. Since the stepping magnet interrupts its own circuit the switch will be operated two steps, when the wiper 107 will engage the second bank contact and the operation of the switch will be stopped by the energization of test relay 104 which opens the rotary magnet circuit at its armature 115. At each energization of the rotary magnet 103 a circuit is closed at armature 113 for the relay 102, which is therefore energized twice momentarily to produce two interruptions in the circuit of the line relay of the distant toll selector at the No. 2 exchange, whose shaft is therefore raised two steps until the wipers stand opposite the second level. At the No. 2 exchange the second bank level of the toll selectors is the level in which the local trunk lines accessible to such selectors terminate, and the wipers are now rotated until an idle local trunk line is found and connection is established therewith.

The operator may now proceed to operate her calling device in accordance with the desired number in the No. 2 exchange. As the first digit is called a series of interruptions is produced in the circuit of the line relay 43 which at each deenergization sends an impulse of current from ground by way of armature 69 and its resting contact, working contact of armature 62 and the said armature, and the winding of relay 102 to battery. Relay 102 responds to these impulses by producing a seres of interruptions in the circuit of the line relay of the distant toll selector, which in turn responds by producing a series of interruptions in the circuit of the line relay of the local first selector. The local first selector is thus operated to select the desired thousand group, and succeeding switches are operated in the same manner until the connection is finally completed to the line of the called subscriber.

When the called subscriber answers responsive to the automatic ringing of his bell, the connector switch will reverse the direction of current flow in the electro-polarized relay of the toll selector in the No. 2 exchange, which is thereby made operative to insert a high resistance in the circuit of the line relay, all as previously described in connection with the toll selector E. The slow acting relay 101, which is of low resistance, is now deenergized and closes a circuit for relay 42 in an obvious manner. Relay 42 accordingly energizes and connects resistance 66 in series with line relay 43, thereby deenergizing relay 2 at the operator's cord circuit and extinguishing the supervisory lamp $L^2$.

The release of the connection is brought about on the termination of the conversation as in the case before described, by simply pulling down the connection at the operator's position. When the line relay 43 is deenergized a circuit is closed again for relay 102 which opens the circuit of the line relay of the distant toll selector. Upon the deenergization of relay 44 the circuit of relay 105 is broken which opens the above circuit at another point and also closes the circuit of release magnet 106. The distant switches in the No. 2 exchange and also the rotary switch S' are thus returned to normal position.

Having described the special equipment required to carry out my invention and explained its operation, its application to a large trunking system will now be readily understood. In Fig. 1 I have shown in diagrammatic form six exchanges, together with a long distance board and a group of trunk or toll lines extending therefrom to the No. 1 exchange.

It should be understood that each trunk line extending from the long distance board to the No. 1 exchange terminates at one end in a series of jacks similar to jacks J' to $J^6$, inclusive, and at the other end in one of the selectors at the No. 1 exchange. Only one of the trunk lines is shown connected to its jacks, the connection of the other trunks with their jacks being indicated by the incompleted branches of the cable shown in the long distance board. From this exchange trunk lines extend to the No. 2 exchange and also to the No. 3 exchange; and each of these latter exchanges has a group of trunk lines extending to the No. 4 exchange. From this point a group of trunk or toll lines extends to the No. 5 exchange, which has a similar group of trunk lines extending to the No. 6 exchange. At each exchange a different level in the incoming toll selectors is assigned to the local trunk lines, and for convenience these levels have been assigned in accordance with the numbers of the exchanges. As for the remaining bank levels of the toll selectors, at each exchange those levels which correspond to exchanges higher in the series, or which are farther away from the long distance board,

are multipled together and form terminals of trunk lines extending to the next exchange; those levels which correspond to exchanges lower in the series are left dead; while any level which corresponds to an exchange of the same position in the series has a group of trunk lines extending direct to such exchange. This arrangement of the bank levels is shown clearly in Fig. 1. In general, the exchanges are in serial relation, and in many cases this would be strictly true, a call for the last exchange being necessarily routed through all the rest. However, in practice it may happen that the location of some exchanges will make it convenient to employ the modification which I have shown in the case of exchanges No. 2 and 3. The outgoing trunk or toll lines at the No. 1 exchange are accessible, as explained already, to all levels above the first level, and are divided into two groups, which extend to the No. 2 and No. 3 exchanges, respectively. The split bank shown in the drawing is intended to illustrate this arrangement, and each group of outgoing trunk lines may be accessible to a different plurality of selectors, as shown, or all selectors may have access to all the trunk lines, which are then divided as desired into two groups. The purpose, obviously, is to divide the traffic between the No. 2 and 3 exchanges, and any suitable arrangement may be used to do this.

The arrangement shown in the drawing distributes the traffic under control of the operator. Thus if the toll operator connects with a jack individual to a selector which has access only to the left hand group of trunk lines, the call will proceed through the No. 2 exchange, while calls made through selectors having access only to the right hand group of trunk lines will always pass through the No. 3 exchange. If all the trunk lines are made accessible to all the selectors, as mentioned, full automatic distribution of traffic is accomplished, and the arrangement may be such that any desired percentage of the traffic will pass through the No. 2 exchange and the remainder through the No. 3 exchange. For instance, if it is desired to approximately equalize the traffic between the exchanges an equal number of trunks are placed in each group and the trunks of the two groups are terminated in the banks of the selectors according to some scheme which will equalize the chances of selecting a trunk in each group. Still another arrangement permits the operator to route the traffic, but provides that if all trunks in the group selected are busy a trunk in the other group is selected, as an over flow trunk. This is accomplished by giving all selectors access to all trunks, the multipling being such, however, that the selectors used by the operator for trunking via the No. 2 exchange hunt over the trunks to such exchange as first choice and have access to the trunks to the No. 3 exchange only if the trunks to the No. 2 exchange are busy. In the same way the selectors assigned for trunking to the No. 3 exchange must hunt over trunks extending to that exchange before they can reach the trunks to the No. 2 exchange.

The process of automatically trunking a connection to the No. 6 exchange may now be briefly explained. The operator will plug into the No. 6 jack of an idle outgoing trunk line, whereupon the rotary switch associated with the line will operate to send six impulses over the line to raise the toll selector in which the line terminates at the No. 1 exchange up six steps, after which the selector will automatically select an idle outgoing trunk line. Assuming that a trunk line extending to the No. 2 exchange has been selected, the rotary switch which is associated with the toll selector at the No. 1 exchange will now send six impulses over the line to step up the toll selector at the No. 2 exchange to the six level, after which the selector will automatically select an idle outgoing trunk line to the No. 4 exchange. The rotary switch associated with the toll selector at the No. 2 exchange will now send six impulses over the line to step up the toll selector at the No. 4 exchange to the sixth level, and the operation will continue in a similar manner automatically until finally the connection is extended to a toll selector in the No. 6 exchange, which is raised automatically to the sixth level. At the No. 6 exchange, local trunk lines are terminated in the sixth level, and also, it should be mentioned, the sixth contacts in the vertical contact rows of the toll selectors are left dead. It follows therefore that when an idle local trunk line is selected in the No. 6 exchange, the rotary switch will not be operated and the toll selector will operate as a local repeater to complete the connection by means of the local selector and connector switches. The above is merely a further extension of the operation described in detail heretofore and will be easily understood.

Suppose now it is desired to extend a connection to the No. 2 exchange. It has already been explained how such connection is established over the direct route, but it may happen that the call is routed by way of the No. 3 exchange. For instance, the toll operator may use a trunk line terminating at the No. 1 exchange in a selector having access only to the right hand group of trunk lines (Fig. 1), which extend to the No. 3 exchange. At the latter exchange the second level has trunk lines terminating therein which extend directly to the No. 2 exchange. Since the plug is inserted in the No. 2 jack two impulses will be sent to control each

trunking operation and the toll selector at the No. 3 exchange will be raised to the second level, resulting in the extension of the connection to the No. 2 exchange where the toll selector in which the trunk line terminates is raised to the second level also. A local trunk line is now selected and the call is completed as before described. Calls to the No. 3 exchange which may happen to be routed by way of the No. 2 exchange are completed in the same general manner.

It will be seen that I have devised a novel and exceedingly useful automatic trunking system, in which connections are extended by a variable plurality of automatic trunking operations to desired exchanges. The system is flexible, and modifications other than the ones shown will no doubt be suggested to persons skilled in the art. I do not, therefore wish to be restricted to the precise arrangement shown, but desire to secure and have protected by Letters Patent all forms of my invention which may hereafter be devised, limited only by the scope of the appended claims.

What I claim as my invention is:

1. In a telephone system, the combination with an operator's position and a series of exchanges, of a trunk line outgoing from said position to the first exchange having a multiple jack for each of said exchanges, an impulse sending device common to said multiple jacks responsive to the insertion of a plug in any jack for transmitting a characteristic series of impulses over said trunk line, a series of switches for extending the said trunk line automatically to the exchange corresponding to the jack in use, the first switch being responsive to the said impulses, and means for automatically repeating a similar series of impulses to each of the other switches.

2. In a telephone system, the combination with a series of exchanges, of a trunk line extending to the first exchange and having a connective terminal for each of said exchanges, means for connecting with any terminal according to the exchange desired, a train of automatic switches responsive to such connection for extending the said trunk line automatically to the desired exchange, an impulse sender common to said terminals for controlling the first of said switches, and an impulse sender associated with each switch except the last for controlling the next switch in the train.

3. In a telephone system, a series of jacks at an operator's position, a common outgoing trunk line, and means including directive automatic switching mechanism and controlling means common to said jacks responsive to the insertion of a plug in said jacks successively for performing different characteristic series of trunking operations to extend said trunk line to different points, the number of trunking operations in each series varying in accordance with the point to which the trunk line is extended.

4. In a telephone system, a series of multiple connective terminals and a common trunk line, means for connecting with said terminals, and means comprising a varying number of directive automatic switches and controlling means common to said terminals responsive to successive connections with different terminals for performing different characteristic series of trunking operations to extend said trunk line to different points.

5. In a telephone system, a trunk line outgoing from an operator's position, a single device for automatically controlling different characteristic series of trunking operations for extending said trunk line to different points, means whereby the operator can initiate the performance of any series by a single selective act, series of directive switches varying in number by means of which the trunking operations are performed, and intermediate controlling means whereby said device is enabled to effect the control of all said switches.

6. In a telephone system, a series of exchanges, a trunk line extending to the first exchange, trunk lines extending from each exchange to the next exchange in the series, as many connective terminals for said first trunk line as there are exchanges, means for connecting with any terminal according to a desired exchange, and means common to said terminals responsive to such connection for automatically extending the connection over a plurality of said trunk lines in series to the desired exchange.

7. In a telephone system, a series of exchanges, trunk lines extending from each exchange to the next in the series, an operator's position, outgoing trunk lines extending from said position to the first exchange in said series, a plurality of connective terminals at said position for each outgoing trunk line, the said terminals in each plurality corresponding to the different exchanges in said series, respectively, means whereby the operator can establish a connection to one of said terminals corresponding to a desired exchange, and means common to said terminals whereby the connection is extended thereafter over a series of said trunk lines to the desired exchange independent of human control.

8. In a telephone system, a plurality of exchanges and connecting trunk lines, means including said trunk lines and directively controlled automatic switches for extending a connection from the first exchange to a called subscriber in any one of the other exchanges, there being a different number of said switches involved in the connection in each case and one of said trunk lines being used in all connections, and a device oper-

ated in all calls over said trunk line for operating certain of said switches automatically, whereby the calling party in the first exchange can call a subscriber in any of the other exchanges by performing the same number of selective operations in each case.

9. In a telephone system, an operator's position and a plurality of exchanges in serial relation thereto, connecting trunk lines and directively controllable automatic switches for extending a connection from said operator's position to a called line in any exchange, each class of connections requiring a different plurality of directively controlled trunking operations, operator's manual equipment for controlling a certain fixed plurality of such trunking operations in each class of connection, and an auxiliary switch common to all classes for controlling a different plurality of such trunking operations in each class of connection, whereby the operator is enabled to extend a connection to a called line in any exchange without varying the number of trunking operations which she has to control.

10. In a telephone system, two exchanges, trunk lines and automatic directively controlled trunking switches for establishing talking connections between calling lines in the first exchange and called lines in the second exchange, a plurality of routes over which such connections are established, there being a different plurality of said switches included in the connections via each of the different routes, and switching mechanism operating automatically responsive to each call to select the route over which the call is to be established.

11. In a telephone system, means comprising automatic switches for connecting calling and called lines, two routes over which such connections may be established, there being a different number of said switches included in the connections in each case, and means for dividing the traffic between said two routes independent of human control.

12. In a telephone system, means comprising automatic switches for connecting calling and called lines, two routes over which such connections may be established, there being a different number of said switches included in the connections in each case, and automatic equipment and circuit arrangements such that calls are divided between the two routes and established without any discriminating acts on the part of the calling parties.

13. In a telephone system, a first and second exchange, two routes by which connections may be extended from the first exchange to the second exchange, one route being by way of direct trunk lines, and the other route being by way of a third exchange, automatic switches in each exchange included in such connections, and means for establishing the same via either route responding to calls from the first exchange independent of choice by the calling parties.

14. In a telephone system, an automatic switch, a plurality of groups of trunk lines accessible to said switch, means for operating said switch by a series of current impulses to select a desired group, automatic means for then operating said switch to select an idle trunk line in the selected group, and mechanism associated with said switch for thereafter transmitting automatically a series of impulses over the selected idle trunk line, the number of impulses in said series being dependent on the extent of movement of said switch.

15. In a telephone system, an automatic switch, a plurality of groups of trunk lines accessible to said switch, means for operating said switch by a series of current impulses to select a desired group, automatic means for then operating said switch to select an idle trunk line in the selected group, and mechanism associated with said switch for thereafter transmitting a variable series of impulses over the selected idle trunk line, the number of impulses transmitted being in all cases determined by the number of impulses received to operate said switch.

16. In a telephone system, an automatic switch, a plurality of groups of trunk lines accessible to said switch, means for operating said switch by a series of current impulses to select a desired group, automatic means for then operating said switch to select an idle trunk line in the selected group, and mechanism associated with said switch for thereafter transmitting automatically a series of impulses over the selected idle trunk line, the number of impulses transmitted being in all cases equal to the number of impulses received to operate said switch.

17. The combination, with a plurality of serially related exchanges and interconnecting trunk lines, of selector switches in each exchange in which the incoming trunk lines terminates, groups of multiply connected contacts accessible to said selectors, said groups corresponding to the numerical designations of said exchanges, local trunk lines at each exchange extending from the contacts of the corresponding group, multiple connections in the selectors at each exchange between the groups of contacts of higher order, and connections from said multiply connected groups to the outgoing trunk lines extending to the next exchange in the series.

18. In a telephone system, a first and second exchange, two routes by which connections may be extended from the first exchange to the second exchange, one route being by way of a third exchange, and the

other route being by way of a fourth exchange, automatic switches in each exchange included in such connections, and means for establishing the same via either route responding to calls from the first exchange independent of choice by the calling parties.

19. In a telephone system, groups of trunk lines, an automatic switch, means for operating said switch primarily to select a group of said trunk lines and secondarily to select an idle trunk line in the selected group, a contact bank and means operated in the primary movement of said switch for placing a potential on a certain contact depending on the extent of the primary movement, an auxiliary switch and means for causing it to hunt over said contact bank to find said certain contact, means operated automatically in the hunting movement of said auxiliary switch to transmit a series of impulses over the selected idle trunk line, and another automatic switch operated responsive to said impulses.

20. In a telephone system, an operator's switchboard, a trunk outgoing from said switchboard, a selector repeater in which said trunk terminates, local trunks accessible to said selector repeater, toll trunks accessible to said selector repeater, means for operating the selector repeater to select either a toll trunk or a local trunk, trunking switches in which the local and toll trunks terminate, loop switch control circuits for the local trunking switches, single wire control circuits for the toll trunking switches, a supervisory relay, a signal at said switchboard controlled by said relay, a polar relay controlled by reverse current over a loop control circuit for controlling said supervisory relay in case a connection is established via a local trunk, and a marginal relay controlled by change in current value in a single wire control circuit for controlling said supervisory relay in case a connection is established via a toll trunk.

21. In a telephone exchange system, a telephone line, a selective switch, a second selective switch, a plurality of switch-controlling registers, means controlled in accordance with the setting of one of said controlling registers for operating said first switch to extend the telephone line to said second switch, and means operated in accordance with the extent of operation of said first switch for controlling the operation of said second switch to further extend the telephone line.

22. In a telephone exchange system, a telephone line, a selective switch, a second selective switch, a plurality of switch-controlling registers, means controlled in accordance with the setting of one of said registers for operating said first switch to extend the telephone line to said second switch, an additional register, means for setting said additional register in accordance with the extent of operation of said first switch, and means controlled in accordance with the setting of said additional register for selectively operating said second switch to further extend the telephone line.

23. In a telephone exchange system, a telephone line, a selective switch, a second selective switch, a plurality of switch-controlling registers, means controlled in accordance with the setting of one of said registers for operating said first switch to extend the telephone line to said second switch, an additional register individual to said first switch, means for setting said additional register in accordance with the extent of operation of said first switch, and means controlled in accordance with the setting of said additional register for selectively operating said second switch to further extend the telephone line.

24. In a telephone system, a first and second exchange, two routes by which connections may be extended from the first exchange to the second exchange, one route being by way of direct trunk lines, and the other route being by way of a third exchange, automatic switches in each exchange included in such connections, and means normally effective for causing such connections to be established via a particular one of said routes but effective in case a group of trunks involved is busy for setting up the connection via the other route.

25. In a telephone system, a first and second exchange, two routes by which connections may be extended from the first exchange to the second exchange, one route being by way of a third exchange, and the other route being by way of a fourth exchange, automatic switches in each exchange included in such connections, and means normally effective for causing such connections to be established via a particular one of said routes but effective in case a group of trunks involved is busy for setting up the connection via the other route.

Signed by me at Chicago, Illinois, this 23d day of December, 1919.

JOHN H. HOMRIGHOUS.