

April 24, 1928.

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E. E. JONES

AUTOMATIC TELEPHONE SYSTEM

Original Filed Feb. 9, 1921

3 Sheets-Sheet 1

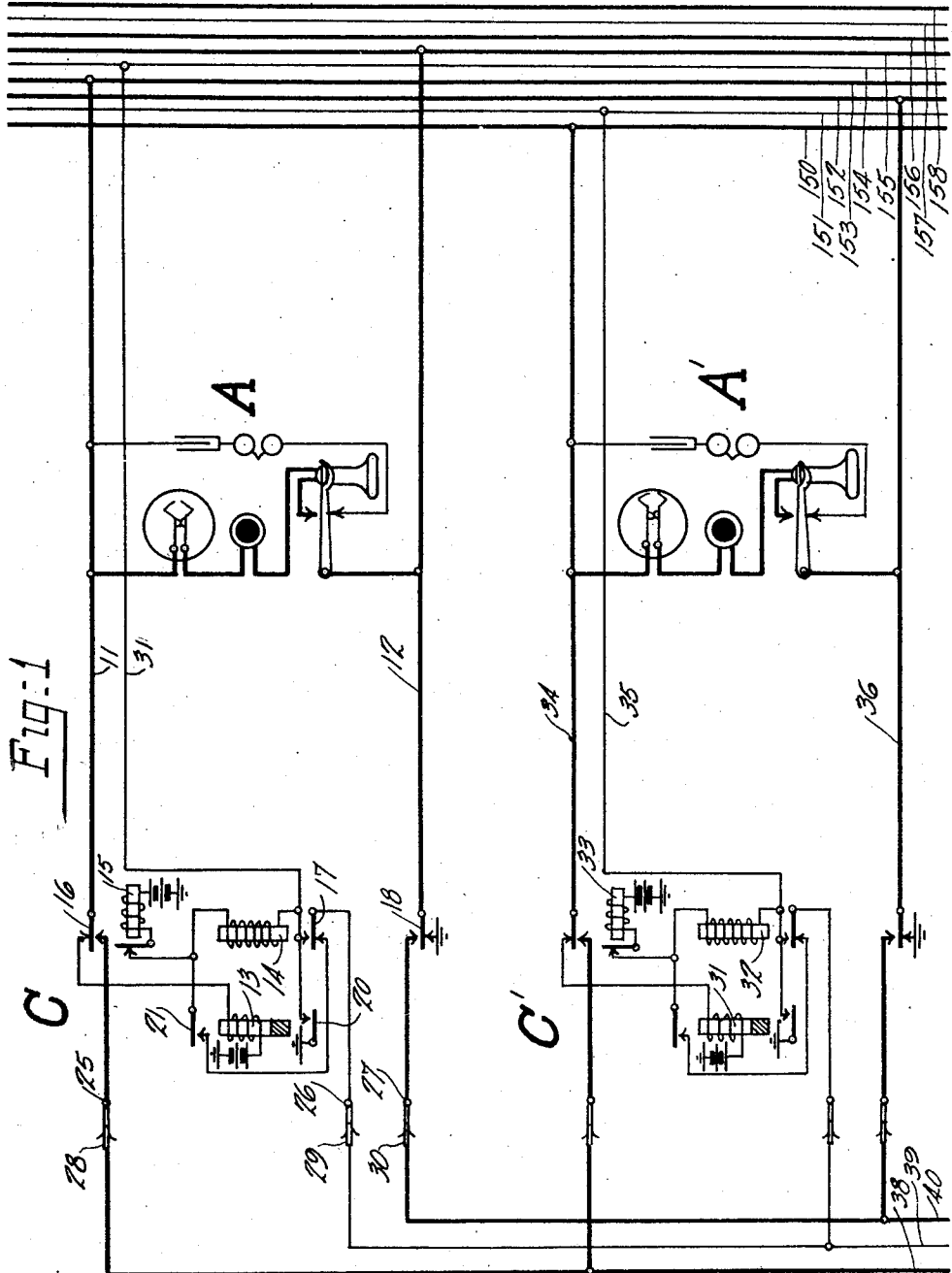


Fig. 1

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3 Sheets-Sheet 2

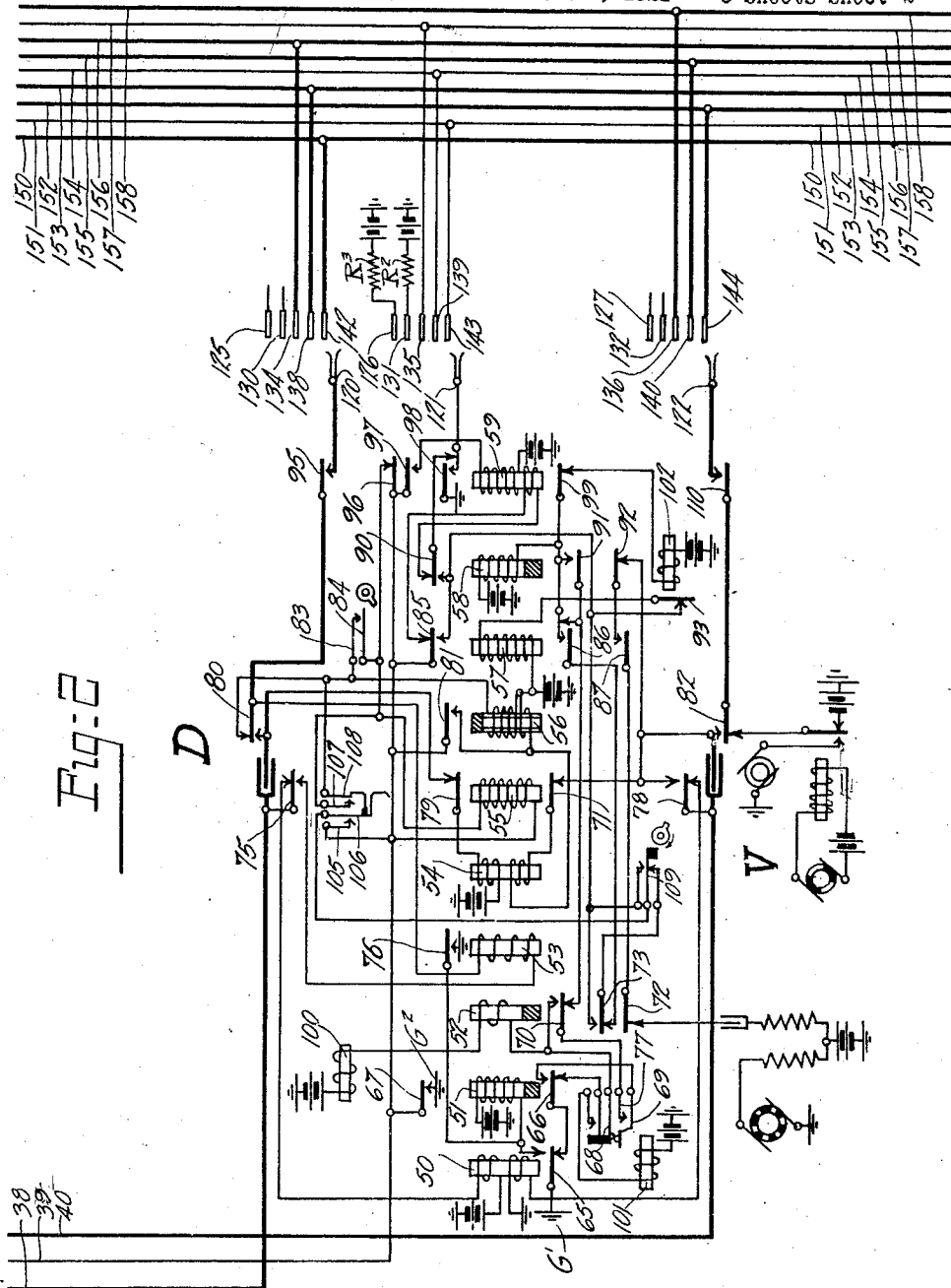


Fig. 2

D

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3 Sheets-Sheet 3

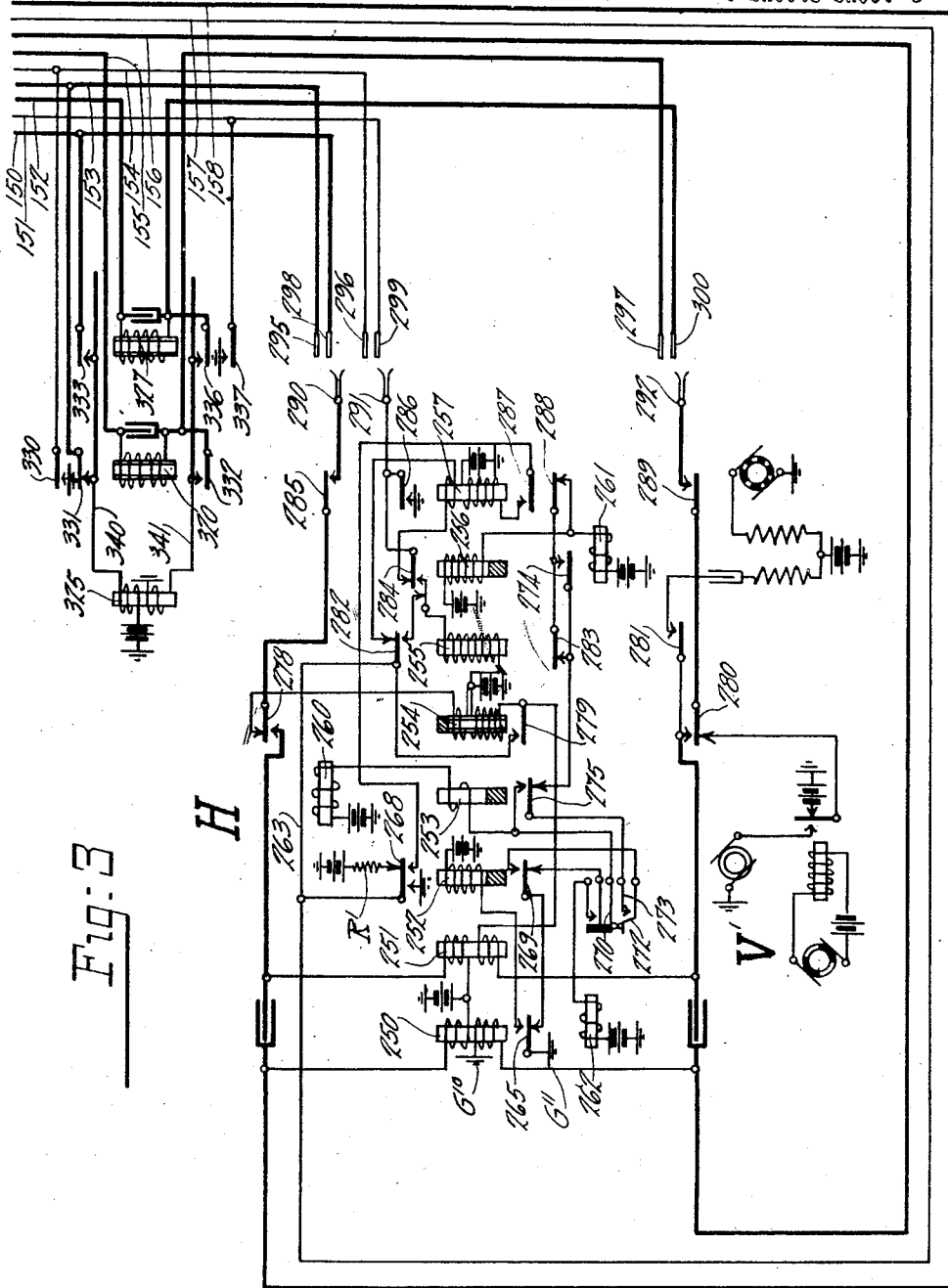


Fig. 3

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# UNITED STATES PATENT OFFICE.

EDWIN E. JONES, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO  
AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELA-  
WARE.

## AUTOMATIC TELEPHONE SYSTEM.

Application filed February 9, 1921, Serial No. 443,654. Renewed June 15, 1927.

The present invention relates to automatic telephone systems but is concerned more particularly with small systems which are commonly known as private automatic exchanges. Exchanges of this nature are usually installed by private concerns and owing to the more exacting requirements of the subscribers in exchanges of this character it is often necessary to provide features which are unnecessary in a public exchange. The present invention is concerned with a feature of this character which is commonly known as conference calling. This is an arrangement to enable an official of a company having a private automatic exchange to talk to a number of his employees simultaneously; in other words a number of telephone lines may be connected together for conference purposes. Hitherto in arrangements of this character it has been necessary to maintain in use trunk lines and switches for each telephone line during the conference. This invention contemplates a scheme of this nature wherein the trunk lines and switches used during a conference are reduced to a minimum.

The particular manner in which this and other results are accomplished will be explained fully hereinafter, reference being had to the accompanying drawings. Referring now to the accompanying drawings comprising Figs. 1 to 3, in order for the drawings to be understood best, Fig. 1 should be placed over Fig. 2, and Fig. 3 should be placed under Fig. 2.

Referring first to Fig. 1, at A and A' are shown two substations of the usual automatic type, each having a rotary line switch of well known construction individual thereto. These line switches are indicated by reference characters C and C', and in common with a plurality of other line switches have access to trunk lines leading to connector switches, one of which is shown at D, Fig. 2. This connector is of the usual Strowger vertical and rotary type and has the usual set of 100 contacts arranged in ten rows or levels. On the first eight levels the switch D and other local switches have the functions of ordinary connectors except in one instance which exception is on the conference number. On the tenth level the switch D operates as an ordinary selector switch. On the ninth level in addition to

the selector function the connector on selecting an idle trunk places ringing current thereon.

A better understanding of the operation of the switch D will be obtained by an explanation of the situation in which the private automatic exchange is used. It will be assumed that the concern using the private automatic exchange under discussion has two factories or other establishments located a short distance apart in a city served by a public manual exchange. One of these factories is supplied with telephone service by the private automatic exchange under discussion while the other factory is supplied with telephone service by another private automatic exchange of the same type. The tenth level in the private automatic exchange in factory No. 1 is reserved for trunk lines leading to the private automatic exchange in factory No. 2, while the ninth level is used for trunk lines extending to the public manual exchange.

From the above description the wiring of the banks of the connector D will be readily understood. Bank contacts 138-140, inclusive, are the terminals of conductors leading to the local substation A, while the bank contacts 142-144, inclusive, are terminals of a line leading to substation A'. Bank contacts 134-136, inclusive, represent the conference number which it will be assumed is the number 60. The conductors leading from this set of bank contacts terminate in an auxiliary connector switch H, Fig. 3. Bank contacts 130-132, inclusive, are terminals of a trunk line leading to the public manual exchange, while contacts 125-127, inclusive, are terminals of a trunk line extending to the private automatic exchange at factory No. 2. All the sets of contacts above described are multiplied in the usual manner into all local connector switches similar to the switch D. The switch H is used only for conference purposes and is an ordinary and well known Strowger connector having access to local subscriber's lines only. The bank contacts in the connector switch H in which the local subscribers' lines terminate are joined to the multiple between the local connectors, but before being so joined one line conductor of each subscriber who is entitled to conference service is passed through the winding of a series relay, these

being represented in the drawings at 320 and 327, which are the relays individual to the lines leading to substations A and A', respectively.

6 Having briefly described the apparatus in the system, a detailed explanation of its operation will now be given. For this purpose it will be assumed that the subscriber at substation A desires to hold a conference.

10 Under these conditions this subscriber will remove his receiver and call the regular local number of the first subscriber desired in the conference, prefixing the digits of the conference number 60. When the receiver is removed at substation A a circuit is closed for the line relay 13 of the line switch C over the line conductors 11 and 12 in series. Upon operating, relay 13 at its armature 20 closes a circuit which includes the switching relay 14 and the stepping magnet 15 in series, and at its armature 21 connects the test wiper 26 to the above circuit at a point midway between the switching relay and the said stepping magnet. The operation now depends upon whether the trunk line with which the wipers of the line switch C are associated is or is not busy. If the trunk line is busy the test contact with which the test wiper 26 is in engagement will be grounded, and as a result the switching relay 14 will be short circuited and the stepping magnet 15, being supplied with direct ground by way of the said test wiper, will operate as a buzzer to advance the switch wipers step by step in search of an idle trunk line. It will be assumed, however, that when the call is initiated the wipers of the line switch C are standing upon the bank contacts shown in the drawings, and it will be further assumed that the trunk line extending from these contacts is idle. Under these circumstances the test contact 29 will have no ground potential on it and when the receiver is removed the energization of the line relay 13 is followed immediately by the energization of the switching relay 14. It may be stated at this point that the switching relay is of very high resistance so as to prevent the operation of the stepping magnet 15 at this time. As a result of the energization of the switching relay 14, the line conductors 11 and 12 are disconnected from the line relay 13 and from ground, respectively, and are extended by way of armatures 16 and 18 and their front contacts, wipers 25 and 27, bank contacts 28 and 30, trunk conductors 38 and 40, armatures 75 and 78 and their back contacts, to the upper and lower windings of the double wound line relay 50 of the local connector D.

60 When the calling line is extended to the switch D as above described the line relay 50 energizes over the line circuit and completes a circuit for the slow acting release relay 51. Upon energizing, relay 51 prepares the operating circuits of the connector

D at its armature 66, and at armature 67 establishes a holding circuit which extends from ground G<sup>2</sup>, front contact and armature 67, release trunk conductor 39, armature 17 and its front contact, and through the winding of the switching relay 14 and the stepping magnet 15 to battery. The above circuit is completed before the slow acting line relay 13 has had time to deenergize and serves to maintain the switching relay 14 energized throughout the connection. Ground is also extended by way of the private normal conductor 31 to multiply connected test contacts in the banks of the connector switches, whereby the said line is protected from intrusion in the ordinary manner.

The calling subscriber may now operate his calling device in accordance with the first digit of the conference number, or the digit 6. Six interruptions are thereby produced in the line circuit of relay 50 which deenergizes a corresponding number of times, each time completing a circuit extending from ground G', armature 65 and its back contact, armature 66 and its front contact, off normal springs 69 and 68, through the winding of the slow acting series relay 52 and the winding of the vertical magnet 100 to battery. The above is the circuit over which the first impulse is transmitted. At the first upward movement of the shaft the off normal springs are shifted and the circuit for the vertical magnet is completed over a new path which is the same as the one previously traced except that it includes the off normal springs 69 and 77, and armature 70 and its front contact, slow acting relay 52 being now in an operated position. By the operation of the vertical magnet 100 the switch wipers 120—122, inclusive, are raised step by step until they are placed opposite the sixth level of bank contacts. The slow acting series relay 52, which is energized in series with the vertical magnet, maintains its armature attracted throughout the vertical movement of the switch and at the end of the vertical operation deenergizes transferring the operating circuit to the rotary magnet 102.

The calling subscriber may now operate his calling device in accordance with the second digit of the conference number namely, the digit 0. Ten interruptions are thereby produced in the circuit of the line relay 50 which operates in response thereto and at each retraction of its armature completes a circuit extending as follows: Ground G', armature 65 and its back contact, armature 66 and its front contact, off normal springs 69 and 77, armature 70 and its back contact, normally closed springs controlled by relay 57, armature 99 and its back contact, and thence through the winding of the rotary magnet 102 to battery. Magnet 102 operates to rotate the wipers 120—122, inclusive, into engagement with the tenth set of con-

tacts in the sixth level which, it will be assumed, are the bank contacts 134-136, inclusive. The slow acting relay 58 is energized in multiple with the rotary magnet and operates to connect the test wiper 121 to the test relay 57. Springs 83 and 84 are cam springs adapted to be shifted into engagement by the cam on the switch shaft when the switch wipers are brought into engagement with the conference number 60. When the springs 83 and 84 are brought into engagement a circuit is completed extending from ground on release trunk conductor 39 by way of armature 96 and its back contact, through springs 84 and 83, and through upper winding of relay 56 to battery. Relay 56 operates to establish a locking circuit for itself at its armature 81 and at armatures 80 and 82 prepares a point in the dialling circuit of the auxiliary connector H. If the line is busy the operation of the springs 83 and 84 will have no function at this time except as above stated. Supposing this to be the case ground will be present on the test contact 135 engaged by the test wiper 121. A circuit will thereby be completed extending from the said grounded test contact by way of test wiper 121, normally closed springs controlled by relay 59, armature 90 and its front contact, back contact and armature 93, and thence through the winding of the test relay 57 to battery. Upon operating, the relay 57 establishes a locking circuit for itself at armature 85, opens the rotary magnet circuit by the operation of armature 86, and at armature 87 places the busy tone upon the lower line conductor of the calling subscriber thereby notifying him that, for the present the conference number is inaccessible. The calling subscriber will therefore replace his receiver upon the switchhook, thereby releasing the switches C and D in a manner to be explained hereinafter.

However, it will be assumed in the present case that the conference number was idle when connection thereto was attempted. Under these circumstances no ground will be present on the test contact 135 and test relay 57 will not be energized. A circuit is then completed upon the deenergization of the slow acting relay 58, extending from ground on release trunk conductor 39, armature 85 and its back contact, through the lower winding of the switching relay 59, back contact and armature 90, normally closed springs controlled by relay 59, test wiper 121, test contact 135, conductor 157, armature 268 and its back contact, and through resistance R' to battery. Relay 59 energizes over this circuit, and establishes a locking circuit for itself at armature 97 and at armatures 95 and 110 prepares another point in the dialling circuit to the auxiliary connector H. Upon energizing, relay 59 at

armature 96 also removes the short circuit around the relay 55. A circuit is then effective extending from ground on release trunk conductor 39, through the winding of relay 55, cam springs 84 and 83, and through the upper winding of relay 56 to battery. Relay 55, upon energizing, completes the dialling circuit to the auxiliary connector H. This circuit includes the line relay 250 which is energized over a circuit extending from ground G<sup>10</sup>, through the lower winding of relay 250, conductor 156, bank contact 134, wiper 120, front contact and armature 95, through the winding of low resistance series relay 53, front contact and armature 75, thence over the line conductor 38 of the substation A, through the transmitter and receiver of the said substation, line conductor 40, armature 78 and its front contact, front contact and armature 82, armature 110 and its front contact, wiper 122, bank contact 136, conductor 158, through the upper winding of the line relay 250 to battery. Relays 53 and 250 energize over this circuit. Relay 53 at its armature 76 maintains the circuit of the slow acting release relay 51 of the local connector D in an operated position thereby preventing the release of the switch D and maintaining the line switch C in an operated position. Relay 250, upon energizing, completes the circuit of the slow acting release relay 252 of the auxiliary connector H.

The calling subscriber at substation A may now call the remaining two digits of the desired local subscriber's number. When the calling device is operated for the first digit of the subscriber's number a series of interruptions is produced in the line circuit of the line relay 250 of the connector H. Relay 250 operates in response thereto and sends a corresponding series of impulses over a circuit extending from ground G'', by way of armature 265 and its back contact, armature 269 and its front contact, off normal springs 272 and 270, through the winding of the slow acting relay 253 and through the vertical magnet 260 to battery. The above is the circuit over which the first impulse is transmitted. Upon the first vertical step of the shaft the off normal springs are shifted and the remaining impulses to the vertical magnet are sent over a different circuit which is the same as the one previously traced except that it includes the off normal springs 272 and 273 and armature 275 and its front contact, relay 253 being now in an operated position. The magnet 260 operates to raise the wipers 290-292, inclusive, step by step until they stand opposite the level of bank contacts in which the desired subscriber's line is located. The slow acting relay 253 is energized in series with the vertical magnet 260, maintains its armature attracted throughout the vertical operation of

the switch, and at the end of the vertical movement of the switch deenergizes and transfers the operating circuit to the rotary magnet 261.

5 When the calling device at substation A is operated for the last digit of the local subscriber's number another series of inter-  
 10 rptions is produced in the line circuit of relay 250. Upon operating, relay 250 sends a  
 15 corresponding series of impulses to the rotary magnet 261 over the following path: Ground G'', armature 265 and its back con-  
 20 tact, armature 269 and its front contact, off normal springs 272 and 273, armature 275  
 25 and its back contact, back contact and armature 283, armature 288 and its back contact, and thence through the winding of the ro-  
 30 tary magnet 261 to battery. Magnet 261 operates to rotate the switch wipers 290-292,  
 35 inclusive, into engagement with the set of bank contacts associated with the line of the desired subscriber, which it will be as-  
 40 sumed are bank contacts 298-300, inclusive, in which the line of the subscriber at sub-  
 45 station A' is terminated. The slow acting relay 256 is energized in multiple with the rotary magnet and operates to connect the  
 50 test wiper 291 to the test relay 255. The further operation of the connector H depends upon whether or not the line of the de-  
 55 sired subscriber is or is not busy. If busy at this time, a ground potential will be present on the test contact 299. A circuit  
 60 is thereby completed extending from the said grounded test contact by way of the test wiper 291, armature 284 and its front con-  
 65 tact, and through the winding of the test relay 255 to battery. Upon energizing, relay 255 establishes a locking circuit for it-  
 self at armature 282 and at armature 281 connects the busy tone to the line of the subscriber at substation A. Upon hearing  
 this tone the calling subscriber will know that the line he desires is busy and he will  
 replace his receiver upon the switchhook, thereby releasing the switches in a manner  
 which will be described fully hereinafter.

Let us assume now that the line of the subscriber at substation A' was idle when  
 connection thereto was attempted. Under these circumstances there will be no ground  
 potential present on the test contact 299 engaged by the test wiper 291. A circuit is  
 thereupon completed following the deenergization of the slow acting relay 256 which  
 extends from ground on release trunk conductor 263 by way of armature 282 and its  
 back contact, upper winding of the switching relay 257, back contact and armature  
 284, test wiper 291, bank contact 299, conductor 151, conductor 35, through the wind-  
 ing of the switching relay 32 of the line switch C' and through the winding of the  
 stepping magnet 33 to battery. Relays 257 and 32 operate over this circuit. Due to a

mechanical interlocking device controlled by the armature of the line relay 31, the switch-  
 ing relay 32 is only operated enough to clear the line of the substation A' from its  
 normal battery and ground connections in the line switch C'. Relay 257, upon operat-  
 ing, establishes a locking circuit for itself at its armature 287, opens the rotary magnet  
 circuit at armature 288, and at armatures 285 and 289 completes the ringing circuit.  
 Ringing current will flow over a circuit ex-  
 tending from the generator V', back con-  
 tact and armature 280, armature 289 and  
 its front contact, wiper 292, bank contact  
 300, through the winding of relay 327, and  
 the condenser associated therewith in mul-  
 tiple, conductor 152, conductor 36, switch-  
 hook springs, ringer and condenser of the  
 substation A', conductor 34, conductor 150,  
 bank contact 298, wiper 290, front contact  
 and armature 285, armature 278 and its  
 back contact, and thence through the upper  
 winding of the ring cut-off relay 254 to  
 battery. Ringing current is intermittently  
 applied to the above traced ringing circuit  
 until the subscriber at substation A' removes  
 his receiver from the switchhook. The re-  
 lays 327 and 254 are so constructed that they  
 do not respond to alternating current and  
 hence will not operate over the ringing  
 circuit.

When the subscriber at substation A' re-  
 moves his receiver a path for direct current  
 is provided over the line circuit thereby  
 energizing the relays 327 and 254. Relay  
 254 upon energizing, establishes a locking  
 circuit for itself at armature 279 and at  
 armatures 278 and 280 opens the ringing  
 circuit and at the front contacts of these  
 armatures completes the talking connection  
 between the subscribers at substations A  
 and A'. Relay 327 operates at armatures 333  
 and 336 and their front contacts to extend  
 the line of the subscriber at substation A'  
 into connection with the conference holding  
 trunk comprising conductors 340 and 341.  
 The calling subscriber at substation A will  
 inform the subscriber at substation A' that  
 a conference is to be held. It will be noticed  
 that while relay 327 is included in the line  
 circuit between the two subscribers its in-  
 clusion will have no effect on the transmis-  
 sion of voice currents because a path for  
 talking current is provided by the condenser  
 associated with relay 327. The calling sub-  
 120 scriptioner will then hang up his receiver there-  
 by openings the line circuit of relay 250 and  
 also the circuit of the series relay 53. Both  
 these relays deenergize thereby opening the  
 circuit of the slow acting release relays 51 and  
 252 in their respective switches, relay 51 upon  
 deenergizing, completing the release magnet  
 circuit of the connector D at the same time  
 removing ground from the holding circuit  
 of the line switch C and relay 252 upon de-  
 130

energizing, completing the circuit for release magnet 262 of the auxiliary connector H. The switches C, D and H are thereby restored to their normal position.

5 The called subscriber at substation A' will not, however, hang up his receiver and it will be seen that he is maintained in connection with the holding trunk by relay 327 which is maintained energized over the line  
10 conductors of the substation A' in series, over the following circuit: Ground through the lower winding of the common talking impedance 325, front contact and armature 336 through the winding of relay 327 and  
15 over the line conductors of the called substation, armature 333 and its front contact, and through the upper winding of the impedance 325 to battery. At armature 337, relay 327 also maintains ground on private  
20 normal conductor 151 of the substation A' thereby protecting the line of the subscriber from intrusion in the ordinary manner and at the same time maintaining the switching  
25 relay 32 of the line switch C' in its operated position.

The calling subscriber at substation A will now remove his receiver and, in identically the same manner as above described, call another local branch exchange subscriber by means of a local connector and the auxiliary connector H. This operation will now be briefly described. When the receiver is removed at substation A the line switch C operates as before described to select an idle trunk terminating in a local connector which it will be assumed is the connector D.

When the calling device at substation A is operated for the digits of the conference number 60 the line relay 50 controls the operation of the vertical magnet 100 in stepping the switch wipers 120-122, inclusive, opposite the sixth level of bank contacts. When the last digit of the conference number is dialed the line relay 50 responds to the interruptions in its line circuit and controls the operation of the rotary magnet 102 in rotating the switch wipers into engagement with the conference number. When  
50 this occurs relays 56, 59 and 55 again energize to complete the circuit of the line relay 250 of the auxiliary connector H.

The calling subscriber may now operate his calling device in accordance with the first digit of the next local subscriber's number. The line relay 250 operates, sending a corresponding series of impulses to the vertical magnet 260 in series with the slow acting relay 253 in the same manner as previously described. Magnet 260 operates to raise the wipers 290-292, inclusive, step by step, until they are placed opposite the level of bank contacts in which the next local subscriber's line is located. The slow acting relay 250 is energized in series with the ver-

tical magnet and maintains its armature attracted throughout the vertical operation of the switch and at the termination of the vertical movement deenergizes thereby transferring the operating circuit to the rotary magnet 261.

When the last digit of the local subscriber's number is called the rotary magnet 261 under the control of the line relay 250 operates to rotate the switch wipers into engagement with the set of bank contacts in which the desired subscriber's line is terminated. If this line is busy the connector H will operate in the usual manner to give the busy tone to the calling subscriber. If the line is idle the switching relay 257 will energize and complete the ringing circuit. Ringing current is then intermittently projected over the line circuit of this subscriber in identically the same manner as was described in the connection with the subscriber at substation A'.

When this called subscriber answers the ring cut off relay 254 and the relay similar to relay 327 in series with the line circuit will be energized, relay 254 establishing a locking circuit for itself and completing the talking connection, the relay similar to 327 being operated to transfer the line of the called subscriber onto the conference holding trunk. After informing this called subscriber that a conference is to be held the calling subscriber will replace his receiver upon the switchhook thereby initiating the release of the switches C, D and H. All the foregoing operations take place in the same manner as was described hereinbefore.

In the above manner the subscriber at substation A will proceed to set up the conference. When he connects with the last party desired, the calling subscriber will not replace his receiver upon the switchhook but will proceed to communicate with all the subscribers in the conference, for the reason that he has now been placed in telephonic connection with the conference holding trunk comprising conductors 340 and 341 by means of the energization of the series relay similar to 327 in the line of the subscriber last called.

When the conference is terminated each subscriber by placing his receiver upon the switchhook severs his connection with the conference holding trunk, the relays 320, 327 and similar relays being deenergized upon the associated called subscribers replacing their receivers upon the switchhook. When the calling subscriber replaces his receiver upon the switchhook he will release the operated switches C, D, and H in a manner before described.

Having described the process of setting up a conference the manner in which a local connection is completed will now be described. For this purpose it will be as-

sumed that the subscriber at substation A desires to call the subscriber at substation A'. When the receiver is removed at substation A the line switch C operates in the usual manner to select an idle trunk terminating in a local connector switch which it will be assumed is the connector D. The line relay 50 of the connector D will be energized over the line circuit completing the circuit of the slow acting release relay 51. Relay 51 energizes preparing the operating circuits of the switch D at armature 66 and at armature 67 establishing a holding circuit for the line switch C.

When the calling device at substation A is operated for the first digit of the desired number of the line relay 50 responds to the interruptions in its line circuit and at each retraction of its armature 65 completes a circuit extending from ground G' by way of armature 65 and its back contact, armature 66 and its front contact, off normal springs 69 and 68, through the winding of the series relay 52, and the winding of the vertical magnet 100 to battery. Upon the first step of the switch the off normal springs are shifted and the impulses are sent to the vertical magnet over a different circuit which includes the off normal springs 69 and 77 and armature 70 and its front contact relay 52 being now in an operated position. Magnet 100 operates to raise the wipers 120-122, inclusive, step by step until they are placed opposite the level of bank contacts in which is located the line of the desired subscriber. The slow acting series relay 52 is energized in series with the vertical magnet and remains so throughout the vertical operation of the switch. At the termination of the vertical movement the slow acting relay 52 deenergizes and transfers the operating circuit to the rotary magnet 102.

When the calling device at substation A is operated in accordance with the last digit of the subscriber's number another series of interruptions is produced in the circuit of relay 50. Relay 50 operating in response thereto sends a series of impulses to the rotary magnet 102 in multiple with the slow acting relay 58. Magnet 102 operates to rotate the switch wipers into engagement with the set of contacts in which are terminated the conductors of the desired subscriber's line and which, we will assume, are the bank contacts 142-144, inclusive. As before, relay 58 being energized in multiple with the rotary magnet 102 operates to connect the test wiper 121 to the test relay 57. If the line of the subscriber at substation A' should happen to be busy at this time a ground potential will be present on the test contact 143.

Supposing this to be the case, a circuit is then completed extending from the said grounded test contact by way of the test wiper 121, normally closed springs con-

trolled by relay 59, armature 90 and its front contact, back contact and armature 93, and through the winding of the test relay 57 to battery. Upon operating, relay 57 establishes a locking circuit for itself at armature 85 and at armature 87 places the busy tone on the calling subscriber's line. The calling subscriber upon hearing this tone will know that the line is busy and will replace his receiver thereby causing the release of the connector D and the line switch C in the usual manner.

It will, however, be assumed that the line of the subscriber at substation A was idle when connection thereto was attempted. Under these circumstances there will be no ground present on test contact 143. A circuit is then completed upon the deenergization of the slow acting relay 58 extending from ground on release trunk conductor 39, armature 85 and its back contact, through the lower winding of the switching relay 59, back contact and armature 90, normally closed springs controlled by relay 59, test wiper 121, test contact 143, conductor 151, conductor 35, and through the winding of the switching relay 32 and the stepping magnet 33 to battery. Relays 32 and 59 operate over this circuit, relay 32 operating, as before, to disconnect the line of the subscriber at substation A' from its normal battery and ground connections in the line switch C'. Relay 59 upon operating, establishes a locking circuit for itself at armature 97, places ground on the private normal conductor 151 at armature 98 and at armatures 95 and 110 completes the ringing circuit. Ringing current is then intermittently applied to the line of the substation A' until the subscriber thereat responds by removing his receiver from the switchhook. When this occurs the ring cut off relay 56 energizes establishing a locking circuit for itself at armature 81 and at armatures 80 and 82 opening the ringing circuit, and at the front contacts of these armatures completing the talking connection. Conversation may now be carried on between the subscribers at substations A and A' battery being supplied to the calling subscriber from the winding of the line relay 50 and to the called subscriber from the windings of the back bridge relay 54. When the conversation is terminated both subscribers will replace their receivers upon the switchhook, the replacement of the receiver at the calling substation A' initiating the release of the line switch C and connector D as previously described.

Having described the process of setting up a local connection, the manner in which a trunk connection to the public manual exchange is completed will now be explained, after which a description will be given of the process of establishing a trunk connec-

tion to a subscriber in the other private automatic exchange which is located at factory No. 2.

As before stated, the trunk lines extending to the main exchange terminate in the ninth level. It follows therefore, that in order to connect with one of these trunk lines the digit 9 must be called. The subscriber at substation A who desires to connect with the main exchange will therefore remove his receiver and operate his calling device in accordance with the digit 9. When the receiver is removed the line switch C operates as before described to extend the associated line to a trunk line terminating in an idle local connector switch. Assuming that the connector D is idle and is selected for use. When connection is extended thereto the line and release relays 50 and 51 operate as previously explained and with the same results.

When the calling device is operated for the digit 9 the switch wipers 120-122, inclusive, are raised step by step by the vertical magnet 100 under control of the line relay 50 and are brought to rest opposite the ninth level, all in the manner previously explained. When the wipers are raised to the ninth level the shaft controlled springs 105 and 106 are brought into engagement by the operation of the shaft. This may be accomplished by any suitable cam arrangement. A convenient way is to mount the spring assembly comprising springs 105-108, inclusive, just above the top of the shaft so that spring 106 will be operated by the cup spring casing mounted at the upper extremity of the switch shaft. When the switch is operated opposite the ninth level the spring 106 will be operated and when the switch shaft is raised opposite the tenth level both springs 106 and 108 will be actuated. To proceed, the slow acting series relay 52 is energized during the vertical operation of the switch and for an instant thereafter and when the ninth and tenth level shaft springs 105 and 106 are closed on the ninth vertical step a circuit is completed extending as follows: Ground on release trunk conductor 39, by way of shaft controlled springs 105 and 106, springs 109, armature 73 and its front contact, back contact and armature 93, and through the winding of the test relay 57 to battery. Upon energizing, relay 57 establishes a locking circuit for itself at armature 85 and at armature 86 prepares the rotary magnet circuit. At the termination of the vertical movement of the shaft the slow acting relay 52 deenergizes and a circuit is thereby completed extending from ground on release trunk conductor 39 by way of shaft controlled springs 105 and 106, springs 109, armature 73 and its back contact, armature 86 and its front contact, armature 99 and its back contact, and through the winding of

the rotary magnet 102 to battery. Relay 58 is energized in multiple with the above circuit of the rotary magnet. Magnet 102 operates to rotate the switch wipers 120-122, inclusive, into engagement with the first set of contacts in the ninth level and also to open the locking circuit of the test relay 57 which deenergizes, opening the circuit of the rotary magnet, which deenergizes also. The further operation of the switch depends upon whether or not the trunk line with which the switch wipers are in engagement is or is not busy. If busy, a ground potential will be present on the test contact engaged by the wiper 121. A circuit is thereby completed extending from the said grounded test contact by way of test wiper 121, normally closed springs controlled by relay 59, armature 90 and its front contact, back contact and armature 93, and through the winding of the test relay 57 to battery. Relay 57 energizes and again completes the rotary magnet circuit. Relay 57 and magnet 102 will operate alternately until an idle trunk line is found which, we will assume, is the trunk line terminating in bank contacts 130-132, inclusive. When the switch wipers are rotated into engagement with this set of bank contacts no ground will be present on test contact 131. Then upon the deenergization of the slow acting relay 58 a circuit is completed extending from ground on release trunk conductor 39, armature 85 and its back contact, lower winding of the switching relay 59, back contact and armature 90, normally closed springs controlled by relay 59, test wiper 121, test contact 131, through resistance R<sup>2</sup> to battery. Relay 59 energized over this circuit and establishes a locking circuit for itself at armature 97 and at armatures 95 and 110 completes a ringing circuit. Ringing current is then automatically projected out over the trunk line the same as in the case of the called local line and the ring down drop or other signalling device at the manual switchboard in the public exchange is operated in the usual manner. When the operator plugs in to answer the call the ring cut off relay 56 is operated, disconnects the ringing current and completes the talking connection. The connection to the desired local station in the main exchange may be completed by the operator through the medium of any suitable means which need not be explained herein.

The operation of the local connector D when used for trunking to the second private automatic exchange is the same as in the case just described in so far as the selection of an idle trunk is concerned, but since the connection in the private automatic exchange must be controlled automatically the circuits of the switch D are altered suitably in order to permit the switch to operate as a series repeater for the purpose of repeating impulses

over the selected trunk line extending to the private automatic exchange at factory No. 2. The operation which takes place when connection is extended to the second private automatic exchange will now be briefly explained.

Since the trunk lines extending to the private automatic exchange at factory No. 2 terminate in the tenth level the digit to be called is the digit 0. Assuming that a subscriber at substation A desires to call a party in the second private automatic exchange, when the receiver is removed the line switch C operates to extend the line of the calling subscriber to an idle connector D. When the calling device is operated for the digit 0, ten interruptions are produced in the line circuit of the relay 50 which deenergizes a corresponding number of times whereby controlling the vertical magnet 100 in raising the switch wipers 120-122, inclusive, step by step until they are placed opposite the tenth level. Upon the tenth vertical step of the switch the springs 105 and 106, and 107 and 108 are shifted into engagement. As before, the slow acting relay 52 is energized in series with the vertical magnet and maintains its armature attracted throughout the vertical movement of the switch and for an instant thereafter. When the springs 105 and 106 are brought into engagement a circuit is thereby completed for the test relay 57 which energizes establishing a locking circuit for itself at armature 85 and preparing the rotary magnet circuit at armature 86. Upon the termination of the vertical movement of the switch relay 52 deenergizes. A circuit is then completed for the rotary magnet 102 in multiple with the slow acting relay 58. Magnet 102 operates to rotate the wipers 120-122, inclusive, into engagement with the first set of contacts in the tenth level and to also break the locking circuit of relay 57. By the operation of springs 107 and 108 a circuit is completed extending from ground on release trunk conductor 39, armature 96 and its back contact, shaft controlled springs 107 and 108, and through the upper winding of the ring cut off relay 56 to battery. Relay 56 operates as before, establishing a locking circuit for itself at its armature 81, and at armatures 80 and 82 preparing a point in the repeating circuit. If the trunk line with which the switch wipers are associated is busy ground will be present on the test contact thereof and the relay 57 will be again energized to complete the rotary magnet circuit. The alternate operation of relay 57 and magnet 102 will continue until an idle trunk line is found which, we will assume, is the trunk line terminating in the bank contacts 125-127, inclusive. When the switch wipers are rotated into engagement with this set of contacts ground will not be present on the test

contact 126 and a circuit is completed extending from ground on release trunk conductor 39 by way of armature 85 and its back contact, lower winding of relay 59, back contact and armature 90, normally closed springs controlled by relay 59, test wiper 121, test contact 131, and thence through resistance R<sup>3</sup> to battery. Relay 59 upon operating, establishes a locking circuit for itself at armature 97, at armatures 95 and 110 prepares another point in the repeating circuit, and at armatures 96 removes short circuit from relay 55. A circuit is then effective extending from ground on release trunk conductor 39 through the winding of relay 55, shaft controlled springs 107 and 108, and through the upper winding of the ring cut off relay 56 to battery. Upon operating, relay 53 completes the repeating circuit in the same manner as was described when the switch D was operated to seize the auxiliary connector H on the conference number. Relay 53 is energized in series with this repeating circuit and operates as before to maintain the slow acting relay 51 in an operated position as long as the calling subscriber at substation A maintains his receiver off the switch-hook. It will be seen that the subscriber at substation A by operating his calling device will produce a series of interruptions in the line relay circuit of the incoming switch in the private automatic exchange at their factory No. 2, and the connection is thereby completed to the subscriber in private automatic exchange No. 2, in the usual manner. It will also be seen that only a two conductor trunk is necessary between the two private automatic exchanges for the reason that the series relay 53 in the connector D maintains the switches C and D in their operated position.

In case a call is attempted by way of either the ninth or the tenth level of the connector D and all the trunks in the called level are busy, the trunk selecting operation of the switch D continues until the wipers 120-122, inclusive, are rotated out of engagement with the last set of bank contacts. This occurs upon the eleventh rotary step and, at this time, a cam on the switch shaft shifts spring 109 out of engagement with its lower contact and into engagement with its upper contact, thereby opening the circuit of the rotary magnet and closing a circuit to maintain busy relay 57 energized so as to give the usual busy signal to the calling subscriber.

Having described the invention what is considered to be new and desired to have protected by Letters Patent will be pointed out in the appended claims.

What I claim as my invention is:

1. In a telephone system, calling and called subscribers' lines, automatic switches,

a holding trunk, means whereby a subscriber on one of said calling lines may establish connections with a number of said called subscribers' lines, a relay individual to the line of each called subscriber, and means controlled by the response of the subscriber on each of said called lines for energizing the associated relay to place the associated called subscriber's line in connection with the said holding trunk.

2. In a telephone system, a calling subscriber's line, automatic switches, a holding trunk, a plurality of called subscriber's lines, means under the control of the subscriber on the said calling line for establishing connections successively with each of said called subscribers' lines, a relay individual to each of said called lines, means for energizing each of said relays upon the response of its subscriber on the associated called line, and means controlled by each relay for connecting its associated called subscriber's line to said holding trunk.

3. In a telephone system, a calling subscriber's line, automatic switches, a holding trunk, a plurality of called subscribers' lines, means under the control of the subscriber on one of said calling lines for establishing connections successively with each of said called subscribers' lines, a relay individual to each called subscriber's line, means for energizing each of said relays upon the response of the subscriber on its associated line, means controlled by each relay for connecting the associated called subscriber's line to the said holding trunk, and means for maintaining each relay energized to maintain the line of the associated called subscriber in connection with the said holding trunk after the subscriber on said calling line replaces his receiver.

4. In a telephone system, a calling subscriber's line, called subscribers' lines, automatic switches under the control of the subscriber on the said calling line for establishing connections with said called subscriber's lines successively, and means controlled by the response of each of said called subscribers for placing his line in connection with the lines previously called independent of said automatic switches.

5. In a telephone system, a calling subscriber's line, automatic switches, called subscribers' lines accessible to said switches, a holding trunk common to all of said called subscribers' lines, means under the control of the subscriber on the said calling line for establishing a connection with a called subscriber's line by way of said automatic switches, and means controlled by the response of the subscriber on the said called line for placing his line in connection with the said holding trunk over a path independent of the said automatic switches.

6. In a telephone system, calling and called subscribers' lines, automatic switches, means whereby a subscriber on one of said calling lines may establish a connection with a called subscriber's line through a series of said automatic switches, a holding trunk, means controlled by the subscriber on said called line for placing his line in connection with the said holding trunk, and means under the control of the subscriber on said calling line for releasing said series of automatic switches while the said called subscriber's line is maintained in connection with the said holding trunk.

7. In a telephone system, a calling subscriber's line, automatic switches, called subscribers' lines accessible thereto, means under the control of the subscriber on the said calling line for establishing connection with one of said called lines by way of a series of said automatic switches, a holding trunk, means controlled by the response of the subscriber on said called line for placing the said line in connection with the said holding trunk, electrical means under the control of the subscriber on said calling line for releasing all of said series of automatic switches while the called subscriber's line is maintained in connection with the said holding trunk, and means controlled by the subscriber on the said called line for disassociating his line from the said holding trunk.

8. In a telephone system, a calling subscriber's line, two automatic connector switches, one of said switches accessible to the other, a called subscriber's line accessible from either connector switch, means whereby the subscriber on said calling line may establish a connection with the said called subscriber's line directly from said first automatic switch, means whereby the subscriber on said calling line may establish a second connection with the said called subscriber's line by way of both connector switches, a relay individual to the line of the said called subscriber, and means for energizing said relay upon the response of the called subscriber in the second connection only.

9. In a telephone system, a calling subscriber's line, a holding trunk, two automatic connector switches one of said switches accessible to the other, a called subscriber's line accessible from either connector switch, means whereby the subscriber on said calling line may establish a connection with the subscriber on said called line directly from said first automatic switch, means whereby the subscriber on the said calling line may establish a second connection with the subscriber on said called line by way of both connector switches, a relay individual to the said called line, means for energizing said relay upon the response of the subscriber on said called line in the second connection,

and means controlled by the said relay for extending said called line into connection with the said holding trunk.

5 10. In a telephone system, two automatic connector switches, a line accessible to both switches, means for establishing a connection with said line by way of either switch, a relay individual to said line, and means for energizing said relay upon the response  
10 of the subscriber on said line when one of said connectors is used for the call, said relay remaining inert upon the response of the subscriber on said line when the other connector is used for the call.

15 11. In a telephone system, two automatic connector switches, a line accessible to both switches, means for establishing a connection with said line by way of either switch, a relay individual to said line, means for energizing said relay upon the response of the  
20 subscriber on said line when one of said connectors is used for the call, said relay remaining inert upon the response of the subscriber on said line when the other connector  
25 is used for the call, a holding trunk, and means controlled by said relay for connecting said line with said holding trunk.

30 12. In a telephone system, a line, two sets of terminals, the conductors of said line being connected to both sets of terminals, a relay, the connection of said line to one set of terminals including said relay in series,  
35 the connection of said line to the other set of terminals excluding said relay, a trunk, and means controlled by said relay for extending a talking connection from said line to said trunk.

13. In a telephone system, a line, a pair

of branches for said line, step by step connector switches for seizing the respective  
40 branches, a relay in series with said line, said relay energized when one of said connectors seizes one of said branches and remaining deenergized when the other of said connectors seizes the other branches.  
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14. In a telephone system, a line, two sets of terminals, the conductors of said line being connected to both sets of terminals, a relay, the connection of said line to one set of terminals including said relay in series, the  
50 connection of said line to the other set of terminals excluding said relay, another line, a trunk, means for connecting said other line, to said trunk, and means controlled by said relay for extending a talking connection  
55 from said trunk to said first line.

15. In a telephone system, a plurality of lines each having two sets of terminals, the conductors of said lines being connected respectively to both sets of terminals, a relay  
60 for each line, the connections of said lines to one set of terminals including said relays in series, the connections of said lines to said other set of terminals excluding said relays, a trunk line, a step by step automatic connector switch having access to said first set  
65 of terminals, means for controlling said connector switch to connect with said terminals, and means controlled by said relay for extending talking connection between  
70 its associated line and said trunk, independent of said connector switch.

Signed by me at Chicago, Illinois this 25th day of January 1921.

EDWIN E. JONES.