Sept. 29, 1925. 1,554,999

J. E. GARDNER

AUTOMATIC TELEPHONE SYSTEM

Filed Oct. 27, 1922 4 Sheets-Sheet 1

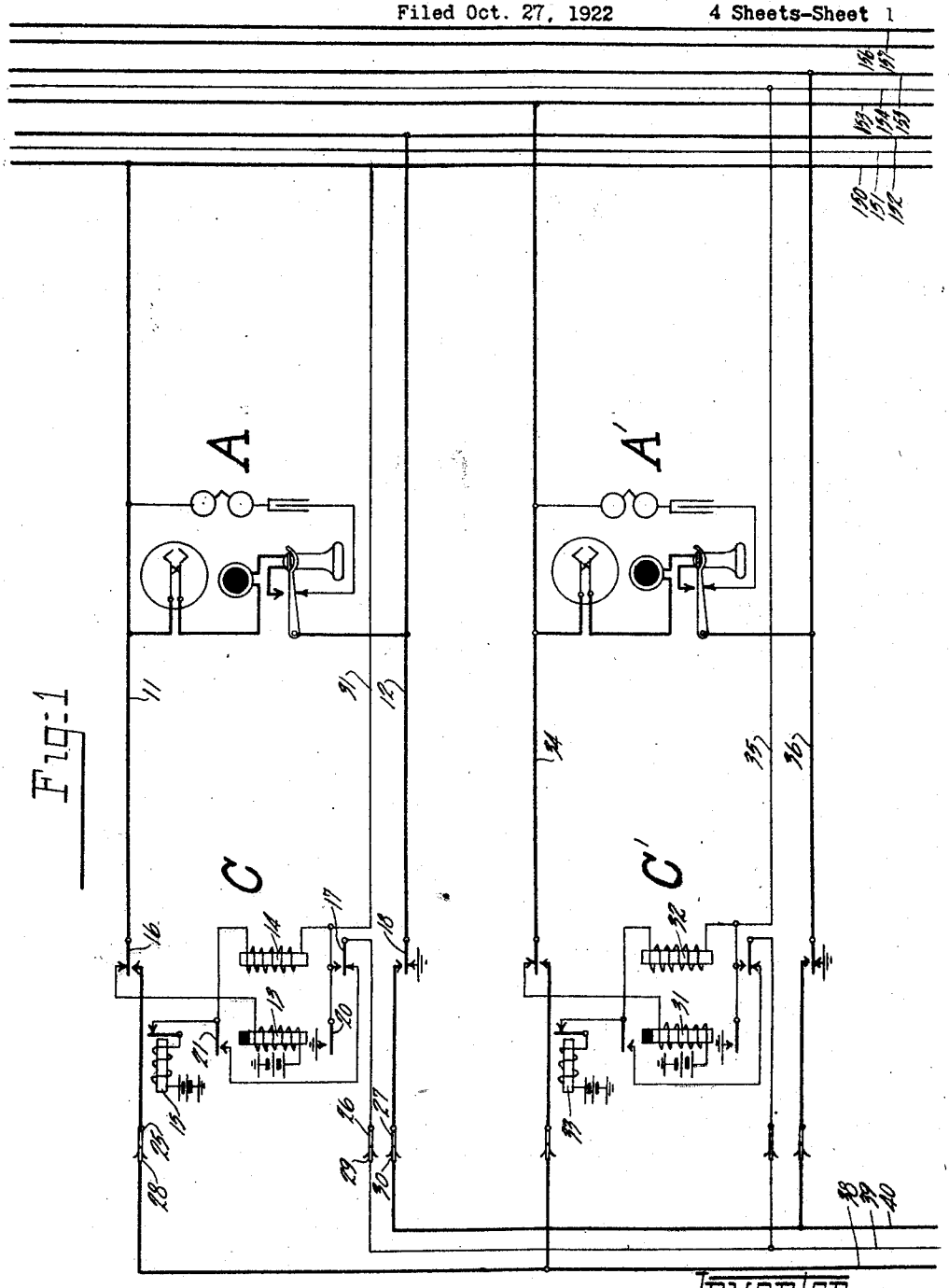

Fig: 1

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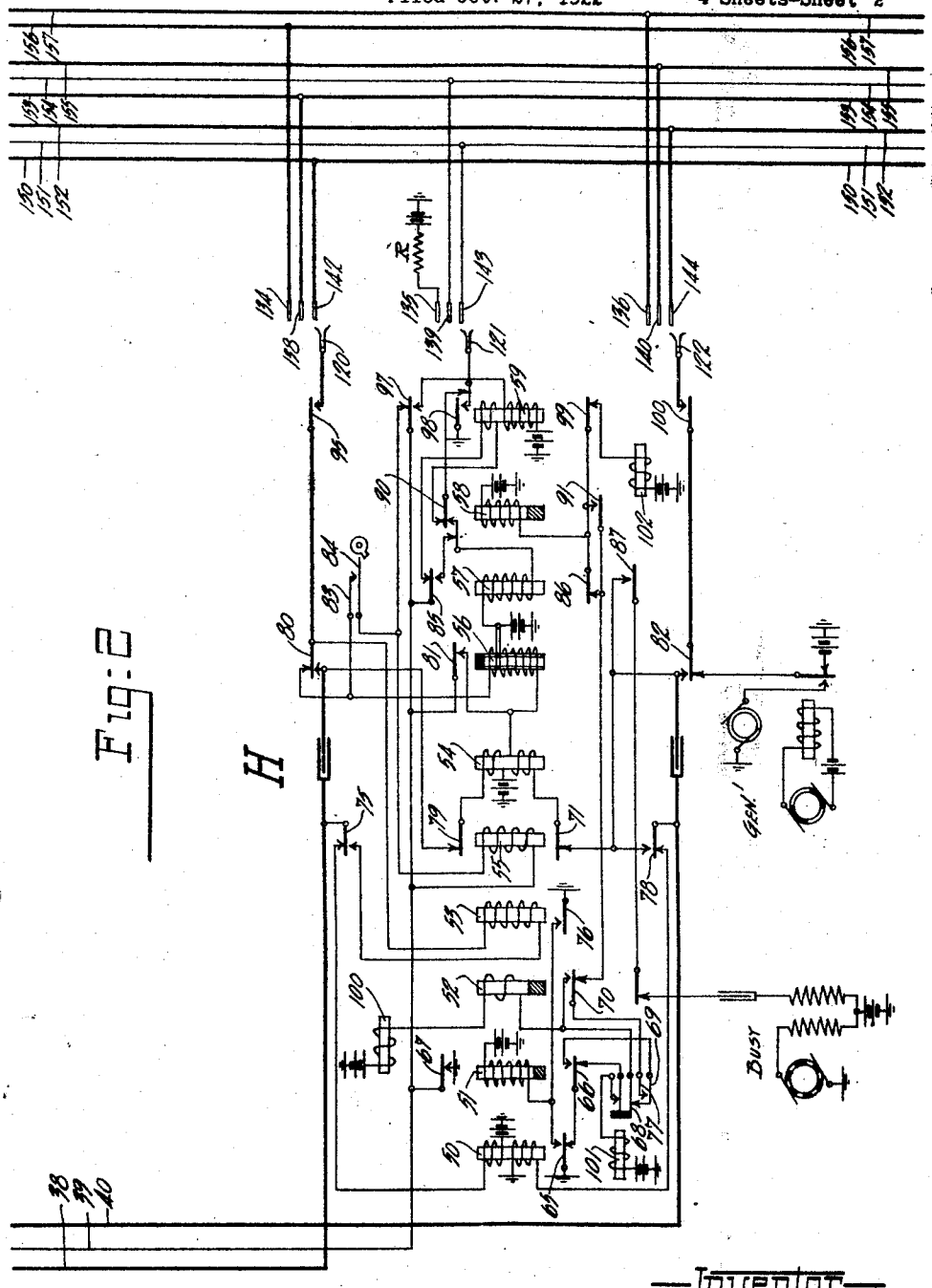

Fig: 2

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AUTOMATIC TELEPHONE SYSTEM

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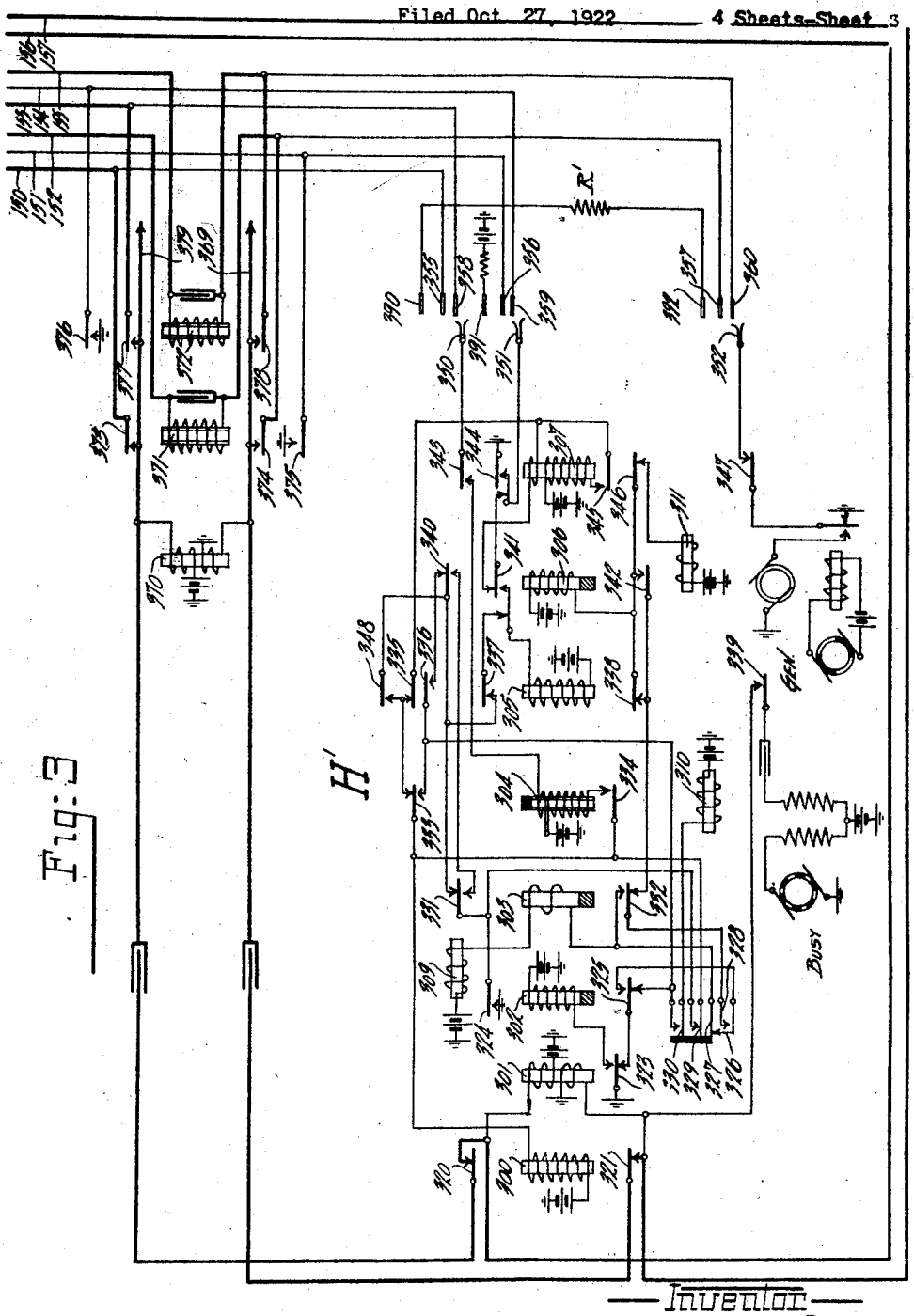

Fig: 3

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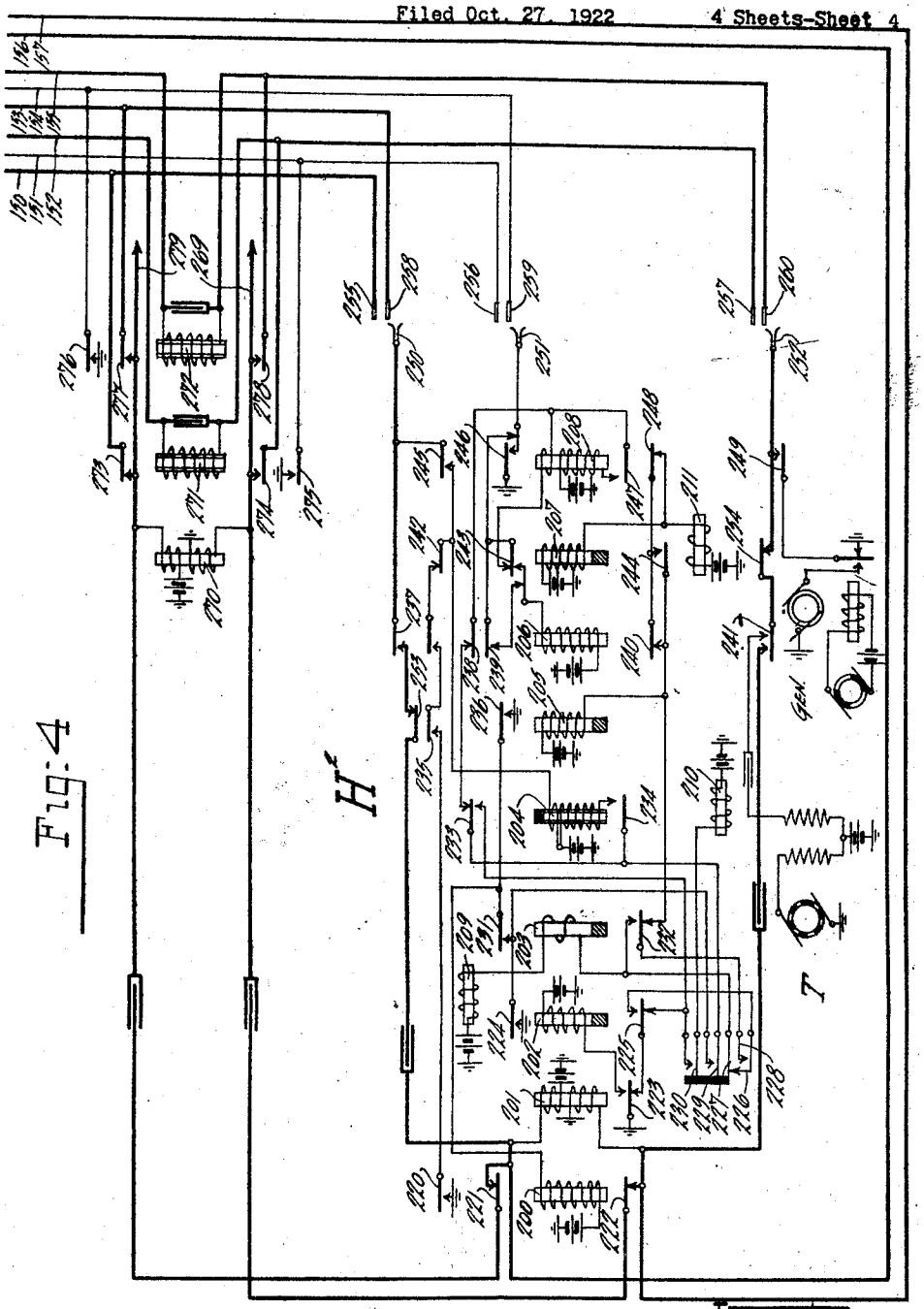

Fig. 4

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Patented Sept. 29, 1925. 1,554,999

UNITED STATES PATENT OFFICE.

JOHN E. GARDNER, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

Application filed October 27, 1922. Serial No. 597,268.

To all whom it may concern:

Be it known that I, JOHN E. GARDNER, a citizen of Canada, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

The present invention relates in general to automatic telephone systems, but is more particularly concerned 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 type, 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 employes simultaneously; in other words, a number of telephone lines may be connected together for conference purposes. Hitherto, in an arrangement of this character, it was possible to establish a conference connection without maintaining a series of switches for each line included in the conference. However, in such system, it was necessary to prefix at least two digits to the called number of each subscriber included in the conference connection. The present invention contemplates a scheme of this nature, wherein the trunk lines and switches used during the conference are reduced to a minimum, and at the same time making it unnecessary to dial more than the ordinary directory number of the subscribers desired, with one exception, this exception being in the case of the subscriber first called when it is necessary to prefix two digits.

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 drawings, Figs. 1, 2, and 3 show by means of the usual circuit diagrams sufficient of the apparatus in the private automatic exchange to enable the invention to be readily explained and understood. Fig. 4 shows a modification of the invention and is adapted to be substituted for Fig. 3.

Referring now more particularly 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 the 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 H, Fig. 2.

The connector H is of the well-known Strowger vertical and rotary type, and has the usual set of 100 bank contacts arranged in ten rows or levels. In all cases the connector H and other local switches function as ordinary connectors, except in one instance, which exception is on the conference number. On the conference number, the local connectors function to switch through in the same manner as a selector switch.

The conference number, as shown in the drawings, has associated with it the bank contacts 134–136, inclusive, accessible to the connector H. The trunk line extending from this set of bank contacts terminates in the special connector H′, Fig. 3. The bank contacts 138–140, inclusive, are the contacts associated with the line of the substation A′ accessible to the connector H. The bank contact set comprising bank contacts 142–144, inclusive, are the terminals of the line of the substation A in the connector H.

The conference connector H′, Fig. 3, is used only for conference purposes and has access to lines of all the subscribers who are entitled to conference service. The bank contacts in the connector 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 is passed through the winding of a relay, these being represented in the drawings at 371 and 372, which are the relays individual to the lines leading to the substations A and A′, respectively.

The modified conference connector H^2, Fig. 4, is quite similar to the connector H′ though the circuits have been somewhat changed to adapt it to operate in a different manner.

The apparatus of the system having been

briefly described, 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. 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 30. 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 13, 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 line relay 50 of the local connector H.

When the calling line is extended to the switch H 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 H at its armature 66, and at armature 67 establishes a holding circuit which extends from ground by way of front contact and armature 67, release trunk conductor 39, bank contact 29, wiper 26, 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 now operates his calling device in accordance with the first digit of the conference number, which is the digit 3. Three 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 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 slow acting series relay 52 and through 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 energized. 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 third 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 movement deenergizes, transferring the operating circuit to the rotary magnet 102.

The calling subscriber now operates 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 by way of armature 65 and its back contact, armature 66 and its front contact, off normal springs 69 and 77, armature 70 and its back contact, back contact and armature 86, 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 contacts in the third 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 30. 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 97 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 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.

Assuming the conference number to be busy, 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, and thence through the winding of the test relay 57 to battery. Upon operating, the relay 57 prepares 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 H in a manner to be explained hereinafter.

However, it will be assumed in the present case that the conference number is idle when connection thereto is attempted by the connector H. Under these circumstances, no ground will be present upon the test contact engaged by test wiper 121 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 upon release trunk conductor 39, armature 85 and its back contact, through the upper winding of the switching relay 59, back contact and armature 90, normally closed springs controlled by armature 98, test wiper 121, test contact 135, and through the resistance R to battery. Relay 59 energizes over this circuit and, upon operating, establishes a locking circuit for itself at armature 97, and at armatures 95 and 100 prepares other points in the dialling circuit extending to the connector switch H′, Fig. 3. A further result of the energization of relay 59 is that at armature 97 the short circuit is removed from relay 55. A circuit is then effective, extending from ground on the 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′ at the same time disconnecting the line relay 50. This dialling circuit includes the line relay 301 of the connector H′ which is energized over a circuit extending from ground through the lower winding of relay 301, conductor 157, bank contact 136, wiper 122, front contact and armature 100, armature 82 and its front contact, front contact and armature 78, conductor 40, bank contact 30, wiper 27, front contact and armature 18, line conductor 12, switchhook springs, receiver, transmitter, and calling device of the substation A, line conductor 11, armature 16 and its front contact, wiper 25, bank contact 28, conductor 38, armature 75 and its front contact, through the winding of the low resistance relay 53, armature 95 and its front contact, wiper 120, bank contact 134, conductor 156, and through the upper winding of line relay 301 of the connector H′ to battery. Relays 53 and 301 energize over this circuit. Relay 53 at its armature 76 maintains the circuit of the slow acting release relay 51 of the local connector H closed so this relay does not retract its armature even though the line relay 50 is deenergized, thereby preventing the release of the switch H and maintaining the line switch C in an operated position. Relay 301, upon energizing, completes the circuit of the slow acting release relay 302 of the auxiliary conference connector H′. The latter relay prepares the switch circuits for operation in the usual manner.

The calling subscriber at substation A may now call the two digits of the desired local subscriber's number. When the calling device is operated for the first digit of the number, a series of interruptions is produced in the circuit of the line relay 301 of the connector H′, and also in the circuit of the low resistance series relay 53 in the connector H. The relay 53 responds by vibrating its armature, but as the relay 51 is slow acting, the connector H and the line switch C are maintained operated by the continued energization of relay 51. In the connector H′, relay 301 operates in response to the interruptions produced in its circuits and sends a corresponding series of impulses to the vertical magnet 309. The first of these impulses traverses a circuit extending from ground by way of armature 323 and its back contact, armature 325 and its front contact, off normal springs 326 and 327, through the winding of the slow acting relay 303, and

through the winding of the vertical magnet 309 to battery. Upon the first vertical step of the switch shaft, the off normal springs are shifted and the remaining impulses to the vertical magnet are sent over a different circuit, which is similar to the one previously traced, except that it includes off normal springs 326 and 328, and armature 332 and its front contact, relay 303 being now in an operated position. The magnet 309 operates to raise the switch shaft carrying the wipers 350—352, inclusive, step by step until the said wipers are brought opposite to the level of bank contacts in which is located the contact set associated with the desired subscriber's line. The slow acting relay 303 is energized in series with the vertical magnet 309, maintains its armature attracted throughout the vertical movement of the switch, and at the termination thereof deenergizes and transfers the operating circuit to the rotary magnet 311. When the off normal springs are operated upon the first vertical movement of the switch shaft, a circuit is completed extending from ground by way of front contact and armature 324, working contact of off normal spring 329 and the said spring, and through the winding of relay 300 to battery. Upon operating, relay 300 at armatures 320 and 321 disconnects the conference trunk comprising conductors 379 and 369 from connection with the conductors 156 and 157. The reason for this operation will appear fully subsequently.

When the calling device at substation A is operated for the next and final digit of the desired party's number, the line circuit of relay 301 is opened a plurality of times. At each deenergization, relay 301 sends an impulse of current over the following circuit: ground by way of armature 323 and its back contact, armature 325 and its front contact, off normal springs 326 and 328, armature 332 and its back contact, back contact and armature 338, armature 346 and its back contact, and through the winding of magnet 311 to battery. Magnet 311 operates to rotate the switch wipers 350—352, inclusive, into engagement with the bank contact set associated with the line of the desired subscriber at substation A′, which, as shown in the drawings, are the bank contacts 358—360, inclusive. The slow acting relay 306 is energized in multiple with the rotary magnet and operates to connect the test wiper 351 to the test relay 305.

Assuming that the desired line is busy at the present time, there will be a ground potential upon the test contact 359 and the test relay 305 will be energized. Upon operating, relay 305 closes a point in its locking circuit, which circuit is completed upon the deenergization of slow acting relay 306, at armature 336 closes a point in the circuit of the release magnet, at armature 335, opens a point in the circuit of switching relay 307 at armature 338, opens a point in the rotary magnet circuit, and at armature 339 connects a lead from the busy signalling machine to conductor 157. Upon the deenergization of slow acting relay 306, a circuit is completed extending from ground by way of front contact and armature 324, armature 331 and its back contact, armature 340 and its back contact, front contact and armature 336, working contact of off normal spring 330 and the said spring, and through the winding of the release magnet 310 to battery. Magnet 310 operates to restore the connector H′ to normal position, its own circuit being opened at the off normal springs when the switch shaft returns to normal. By the opening of the off normal springs, the relay 300 also deenergizes and reconnects the conference trunk with conductors 156 and 157. As a lead from the busy signalling machine is connected to conductor 157, the calling subscriber is given an audible signal in order to inform him that the desired line is busy. There are two courses now open to the subscriber at substation A. He may either replace his receiver and attempt to establish the conference at a later time when the line of the substation A′ becomes idle, or, if he desires, he may call the remaining subscribers desired in the conference successively.

If the subscriber at substation A replaces his receiver, the connection will be released in a manner which will be described hereinafter.

It will be assumed, however, that the line of the substation A′ is idle when the wipers of the connector H are brought into engagement with the bank contacts 358—360, inclusive. Under these conditions, there will be no ground potential upon the test contact 359 and the test relay 305 will not be energized. Then, following the deenergization of the slow acting relay 306, a circuit is completed which may be traced from ground by way of front contact and armature 324, working contact of off normal spring 329 and the said spring, armature 333 and its back contact, back contact and armature 335, through the upper winding of the switching relay 307, back contact and armature 341, normally closed springs controlled by armature 344, test wiper 351, test contact 359, private normal conductor 154, conductor 35, through the winding of the switching relay 32, and through the winding of the rotary magnet 33 to battery. Relays 32 and 307 are energized over this circuit. Upon operating, relay 32 only partially attracts its armatures, enough to disconnect the line of the substation A′ from its normal battery and ground connections in the line switch C′. This partial operation is

due to a mechanical inter-locking device which is controlled by the armature of the line relay 31 which is now normal.

In the connector H′, relay 307, upon energizing, at armature 345 closes a locking circuit for itself, at armature 344 places direct ground upon the test contact 359, at armature 346 opens the rotary magnet circuit, and at armatures 343 and 347 completes the ringing circuit. Signalling current from the generator Gen is now intermittently projected out on the called line until an answer is obtained. It will be noted that the relay 372 is in the line circuit of the substation A′. However, due to the fact that its winding is shunted by a condenser and also because it is constructed so as not to respond to ringing current, it is not actuated at the present time.

When the called subscriber responds, a circuit is completed for the ring-cut-off relay 304 in the connector H in series with the individual relay 372. Relay 372, upon operating, at armature 376 places ground upon the private normal conductor 154 in order to maintain the line of the substation A′ busy, and at armatures 377 and 378 connects the line of the substation A′ with the conference trunk comprising conductors 379 and 369.

Relay 304 at armature 334 closes a locking circuit for itself and at armature 333 completes a circuit for the release magnet 310, at the same time opening the locking and energizing circuit for the switching relay 307. Relay 307 immediately deenergizes to disconnect the signalling current and to restore certain other circuits to normal. Magnet 310 operates to release the switch in the usual manner. When the off normal springs are operated at the time the switch shaft reaches normal, the locking circuit of the ring-cut-off relay 304 is opened and also the circuit relay 300. The circuit of the release magnet is also opened at the off normal springs. By the release of the connector H′ the original energizing circuit of the relay 372 is opened. However, this relay is maintained energized over the line circuit of the substation A′, battery being supplied from the windings of the conference trunk relay 370. The subscriber at substation A may now converse with the subscriber at substation A′, the talking circuit extending over the heavy conductors in the drawing and over the conference trunk. The subscriber at substation A will inform the called party that a conference is to be held and for him to hold the line.

The calling subscriber will now operate his calling device in accordance with the two digits of the next party's number. By these operations the connector H′ is again operated in the same manner as before until its wipers are brought into engagement with the bank contacts of the wanted subscriber's line. The relay 300 is, of course, energized upon the first vertical step of the switch shaft, and operates to disconnect the conference trunk from the conductors 156 and 157. This operation occurs so as to prevent the subscriber at substation A′ hearing any disagreeable noises due to the interruptions produced by the calling device at substation A. When the connection is made with the line of the desired party, the relay 307 is energized, assuming that the line is idle, ringing current is applied to the called line. When the called subscriber answers, the ring-cut-off relay 304 in the connector H′ is energized as is the relay in series with the called line. The relay in series with the called line operates to associate that line with the conference trunk in the same manner as has already been described. The relay 304 in the connector H′ brings about the release of this switch in the same manner as before. The calling subscriber at substation A can now converse with this party over the conference trunk and inform him that a conference is being held.

In the above manner all the parties desired may be included in the conference, and no switches will be held up except the connection from the substation A to the conference number. It will be remembered that when the connection was first extended to the line of the substation A′ that it was assumed that this line was busy, and it was pointed out at that time that the subscriber at substation A, if he so desired, could immediately call the remaining parties in the conference. This operation will now be briefly described. As the connector switch H′ is now in normal position, it will be operated in the same manner as has been previously described responsive to the two digits of the called subscriber's number. When the slow acting relay 303 is energized in series with the vertical magnet 309, the locking circuit of the test relay 305 is opened, and this relay deenergizes to remove the busy tone from conductor 157 and to restore certain other circuits to normal. The remaining operations of the connector H′ take place in a manner already described.

It will now be assumed that during the establishment of the conference connection, the last line desired by the calling party is busy. Under these conditions, the connector H′ will be released and a busy tone will be applied to conductor 157. The subscriber at substation A may still desire to confer with the parties already called even though he cannot obtain the party last called. In order to remove the busy tone, the subscriber at substation A will call a special number provided for that purpose. When this number is called, the connector H′ re-

sponds in the usual manner and raises its wipers and then rotates them into engagement with the contact set associated with this number, which it will be assumed are the bank contacts 390—392, inclusive. When engagement is made with this set of bank contacts, relay 307 is energized and also the relay 304, as the resistance R′ is bridged across the bank contacts 390 and 392. Relay 304 energizes to bring about the release of the connector H′ in the ordinary manner. By the above operation, the busy tone is removed from the conductor 157 and the connector H′ is left so that if it develops during the conference that another subscriber is desired, that subscriber may be called by dialling his directory number in the usual manner.

When the conference is terminated, the subscribers called will replace their receivers as will the subscriber at substation A. The replacement of the receiver at substation A brings about the deenergization of the line relay 301 of the connector H′ and also the relay 53 of the connector H. Relay 301, upon deenergizing, opens the circuit of the slow acting relay 302. The latter relay, upon retracting its armatures, brings about the release of the connector H′. The deenergization of relay 53 in the connector H opens the circuit of the slow acting relay 51 which also deenergizes. Upon retracting its armatures, relay 51 opens the circuit of certain relays in the connector H, and also closes the circuit of the release magnet 101. In this manner, the connector H is restored to normal. By the removal of ground from release trunk conductor 39 by the relay 51 deenergizing, the holding circuit of the switching relay 14 in the line switch C is opened and this relay deenergizes to restore the line switch circuits to normal. Each subscriber associated with the conference trunk by replacing his receiver upon the switch-hook, severs his connection with the conference trunk, the relay such as 372 being deenergized as soon as its associated subscriber replaces his receivers. In the above manner the connection is released.

The operation of the invention when the connector H′ is used having been described, the operation of the modification shown in Fig. 4 will now be briefly explained. For this purpose, it will be assumed that in the original connection when the subscriber at substation A′ is called, that the connector H^2 is the one connected to. Immediately upon the connection being extended to the connector H^2, the line relay 201 thereof is energized and closes a circuit for the slow acting relay 202. The latter relay operates to prepare the operating circuits of the switch in the usual manner.

In response to the next operation of the calling device at substation A, a series of interruptions is produced in the line relay circuit, and a corresponding series of impulses is sent to the vertical magnet 209. Magnet 209 operates to raise the switch wipers 250—252, inclusive, step by step until these wipers are placed opposite the level of bank contacts in which is located a contact set associated with the line of the substation A′. The slow acting relay 203 is energized in series with magnet 209 and operates its armature 231 to close the circuit of relay 200, and its armature 232 to preserve the vertical magnet circuit when the off normal springs are shifted upon the first vertical movement of the switch. At the termination of the vertical operation, the slow acting relay 203 deenergizes and transfers the impulsing circuit to the rotary magnet 211 at armature 232, and opens the circuit of the relay 200 at armature 231. The operation of relay 200 serves to disconnect the conference trunk comprising conductors 279 and 269 from the trunk conductors 156 and 157 while impulses are being sent.

Responsive to the next operation of the calling device at substation A, relay 201 sends a plurality of impulses to the rotary magnet 211. Magnet 211 operates to rotate the switch wipers into engagement with the bank contact set associated with the line of substation A′, which, as shown in the drawings, are the bank contacts 258—260, inclusive. The slow acting relays 205 and 207 are energized in multiple with the rotary magnet. Relay 205 operates to close the circuit of relay 200 at armature 236, and at armature 253 operates to open a point in the talking circuit. The operation of armature 235 is without particular function at the present time because the slow acting relay 207 is also energized. Relay 207, upon operating, at armature 242 opens a point in the circuit of the upper winding of relay 204, connects the test wiper 251 to the test relay 206 at armature 243, and at armature 244 short circuits the contact springs comprising armature 240 and its back contact on the test relay 206, in order to provide against the opening of the rotary magnet circuit should the test relay 206 become energized by the switch wipers being rotated over bank contact sets associated with busy telephone lines. A further result of the energization of relay 207 is that at armature 254 the connection of the lower wiper 252 with the conductor of the switch is opened.

Assuming first that the line of the substation A is idle, there will be no ground potential upon the test contact 259 and the test relay 206 will not be energized. Then, upon the deenergization of the slow acting relay 207, a circuit is completed extending from ground by way of front contact and armature 224, working contact of off normal spring 229 and the said spring, armature 233

and its back contact, back contact and armature 238, through the upper winding of relay 208, back contact and armature 243, normally closed springs controlled by armature 246, test wiper 251, test contact 259, private normal conductors 154 and 35, through the winding of switching relay 32 of line switch C', and through the winding of motor magnet 33 to battery. Relays 208 and 32 are energized. Relay 32 operates as before to disconnect the normal battery and ground connections from the called lines.

In the connector H^2, relay 208, upon energizing, at armature 247 establishes a locking circuit for itself, places direct ground upon the test contact 259 at armature 246, opens the rotary magnet circuit at armature 248, and at armatures 245 and 249 completes the signalling circuit. Ringing current is now intermittently projected out on the called line until an answer is obtained. Relay 272, which is included in series with the conductor 155, is not energized for the same reason as was stated in the previous explanation in connection with relay 272.

When the called subscriber responds, relays 272 and 204 are energized. Relay 272 operates to associate the called subscriber's line with the conference trunk and also places ground upon the private normal conductor. Relay 204, upon operating, closes a locking circuit for itself at armature 234, at armature 233 opens the circuit of relay 208, and at the front contact of this armature completes the circuit of the release magnet 210. The deenergization of relay 208 brings about the disconnection of ringing current and the restoration of certain circuits to normal in the connector H^2. When the switch shaft returns to normal, the release magnet 210 as well as the relay 204 is deenergized. The calling and called subscribers may now converse, the talking circuit being similar to the one already traced in the previous description of the connector H'. The subsequent operations of establishing a conference connection will proceed in substantially the same manner as has been before described.

When the conference is finally terminated, the release of the connection is brought about by each subscriber replacing his receiver upon his associated switchhook. By the replacement of the receiver at substation A, the release of the switches C, H, and H^2 occur in the usual manner. Each subscriber included in the conference in replacing his receiver disconnects his line from the conference trunk.

In the establishment of the above conference connection, if the wipers of the connector H^2 are rotated into engagement with a bank contact set associated with a busy line, the test relay 206 will be energized in the ordinary manner. Relay 206, upon operating, prepares a point in its locking circuit, which includes the test wiper 251, at armature 239, at armature 240 opens a point in the rotary magnet circuit, and at armature 238 opens a point in the circuit of relay 208. Further results of the operation of relay 206 are that at armatures 237 and 241 the wipers of the switch are connected up and at the same time a low tone from the tone machine T is placed upon the line. As the line connected with is busy, this tone will serve to inform the subscribers in the busy connection that their line has been connected with by the conference connector. The calling subscriber at substation A will now converse with the parties and inform the one he desires that a conference is being held, and ask the busy subscriber to terminate his present connection as soon as possible. To terminate this connection, both busy subscribers will replace their receivers, thereby removing the guarding potential from the test contact associated with the test wiper 251. As the test relay 206 is maintained locked by this guarding potential, it will now deenergize. The energization of relay 206 closes the circuit of the switching relay 208. The subsequent operations wherein the called subscriber is signalled and the manner in which he is connected to the conference trunk all take place as before described.

It may happen that when a busy line is connected to by the conference connector H^2, that the conversation is so important that it is undesirable to abruptly terminate it. Upon the calling subscriber at substation A being informed of this fact, he will operate his calling device for the digit 1. By this operation the line relay 201 deenergizes momentarily and sends an impulse of current to the slow acting relay 205. Upon operating, relay 205 at armature 236 closes a circuit for the relay 200, and at armature 235 prepares a circuit for relay 204. Upon energizing, relay 200, in addition to disconnecting the conference trunk, completes a circuit for relay 204. Relay 204, upon energizing, brings about the release of the connector H^2, in the same manner as if the desired party had answered. By this release, the test relay 206 is deenergized and the lead from the tone machine T disconnected.

Having described the manner in which conference connections are established, it will now be briefly explained how the subscriber at substation A may connect with the subscriber at substation A^2 in an ordinary connection. In this case, in response to the two digits of the desired subscriber's number, the connector H will be operated in substantially the same manner as before described, though, instead of the wipers 120—122, inclusive being operated into engagement with the contacts 134—136, in-

clusive, they will be operated into engagement with bank contacts 138—140, inclusive. Another difference is that as the cam springs 83 and 84 are not in engagement with each other, neither the relay 55 or 56 will be operated. The relay 59 is energized in series with the switching relay 32 in the line switch C′ in the usual manner. Relay 32, of course, operates to disconnect the called line from its normal battery and ground connections. Upon operating, relay 59 closes a locking circuit for itself at armature 97, places direct ground upon test contact 139 at armature 98, and at armatures 95 and 100 closes the signalling circuit. Ringing current from the generator Gen′. is now connected to the called line. When the called subscriber answers, the ring-cut-off relay 56 is energized and operates at armature 81 to establish a locking circuit for itself, to open the ringing circuit at armatures 80 and 82 and at the front contacts of these armatures to complete the talking circuit. Talking current is supplied to the calling subscriber from the windings of the line relay 50, and to the called subscriber from the windings of the back bridge relay 54.

When the conversation is terminated, the replacement of the receiver at substation A brings about the release of the connection in the usual manner.

Should the line of the substation A′ have been busy when called as above described, the calling subscriber is given a busy tone in a manner similar to that before described.

The features of the invention, having been described and ascertained, 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 is:

1. In a telephone system, telephone lines, two directively controlled automatic switches operated successively from a calling one of said telephone lines for establishing a connection with a called one of said lines, a holding trunk, and means controlled by the response of the subscriber on said called line for connecting such line to said holding trunk and for releasing the last operated switch.

2. In a telephone system, telephone lines, an automatic switch, a holding trunk associated with said automatic switch, means controlled from a calling one of said lines for extending a connection to said switch, means for then operating said switch to connect with a called one of said telephone lines, a source of signalling current, means for automatically applying said source to said line, and means controlled by the response of the subscriber on the said called line for disconnecting said signalling current and for establishing a talking connection with said calling line independent of said switch but including said holding trunk.

3. In a telephone system, an automatic switch, telephone lines, a holding trunk associated with said switch, means controlled by a subscriber on a calling one of said lines for operating said automatic switch to signal a station on a called one of said lines, and means responsive to the removal of the receiver at said called station for establishing a talking connection with said calling line independent of said switch but including said holding trunk.

4. In a telephone system, telephone lines, an automatic switch controlled from a calling one of said lines for extending a connection to a called one of said lines, means for making said called line busy, means in said switch responsive to such busy condition for releasing only said switch and for applying a tone to said calling line, and means whereby said calling subscriber may reoperate said switch to connect with another of said lines while maintaining the receiver at the calling substation off the switch hook.

5. In a telephone system, telephone lines, an automatic switch, a holding trunk, means for making some of said lines busy, a calling device on a calling one of said lines for operating said switch to extend a connection to a busy or idle one of said lines, means operative upon the response of a subscriber for connecting the line called with said holding trunk, release means in said switch operative in case a busy line is encountered for releasing said switch and for connecting said tone to said calling line, and means operative responsive to the first subsequent operation of said calling device to disconnect said tone.

6. In a telephone system, telephone lines, an automatic switch, means for making some of said lines busy, means controlled from a calling one of said lines for extending a connection to a busy or idle one of said lines by operating said automatic switch, said switch operative to extend a talking connection to the called line only in case such line is busy.

7. In a telephone system, telephone lines, an automatic switch, a holding trunk associated therewith, means controlled from a calling one of said lines for extending a connection to a called one of said lines by way of said automatic switch, means responsive to the operation of said switch for disconnecting said holding trunk from said switch, means responsive to the response of the subscriber on the said called line for associating said line with said holding trunk and for releasing said automatic switch, and means responsive to such release for again associating said holding trunk with said switch.

8. In a telephone system, subscribers' lines, a conference trunk, an automatic

switch for extending connections to any one of said lines either busy or idle, means in said switch operative if the line is busy for informing the calling subscriber of the busy condition of the line called and for permitting the calling subscriber to converse with the called subscriber regardless of this fact, means in said switch for causing the called subscriber's line signal to be operated automatically if the called line is idle, and means automatically responsive to the removal of the receiver at the station of the called line for connecting said line to the conference trunk and for effecting the release of said automatic switch.

9. In a telephone system, subscribers' lines, a conference trunk, an automatic switch for connecting a plurality of said lines with said trunk, means in said switch for automatically signalling a called station in case the line called is idle, means automatically operative upon the response of the subscriber called for effecting the connection of the called line with the conference trunk and for effecting the release of said switch, and means operative in case the line called is busy for establishing a talking connection therewith without effecting the release of said switch.

10. In a telephone system, subscribers' lines, a conference trunk, an automatic switch for extending connections to any desired ones of said lines, means in said switch for automatically signalling a called station in case the line called is idle, means automatically operative upon the response of the subscriber called for effecting the connection of the called line with the conference trunk and for effecting the release of said switch, means for making said lines busy, and means in said switch permitting the same to extend talking connections to busy lines, said last means also effective to permit said first means to function as soon as the called busy line becomes idle.

11. In a telephone system, a conference trunk, subscribers' lines, a directively controlled automatic switch for extending connections to any one of said lines, means associated with each line for causing the same to be connected to the conference trunk when the subscriber called responds, means effective upon such response for effecting the release of said automatic switch to render the same operative to extend a connection to a second called line, and circuit arrangements such that said switch may be operated and automatically released repeatedly to cause other of said lines to be connected to said conference trunk.

12. In a telephone system, subscribers' lines, a conference trunk, an automatic switch for connecting with and for then transmitting signalling current to said lines, means controlled by the response of subscribers called via said switch for establishing a direct talking connection between the calling and called line via said trunk, means for making certain of said lines busy, and means operative when a busy line is connected with for establishing a talking connection via said automatic switch.

In witness whereof, I hereunto subscribe my name this 24th day of October A. D., 1922.

JOHN E. GARDNER.