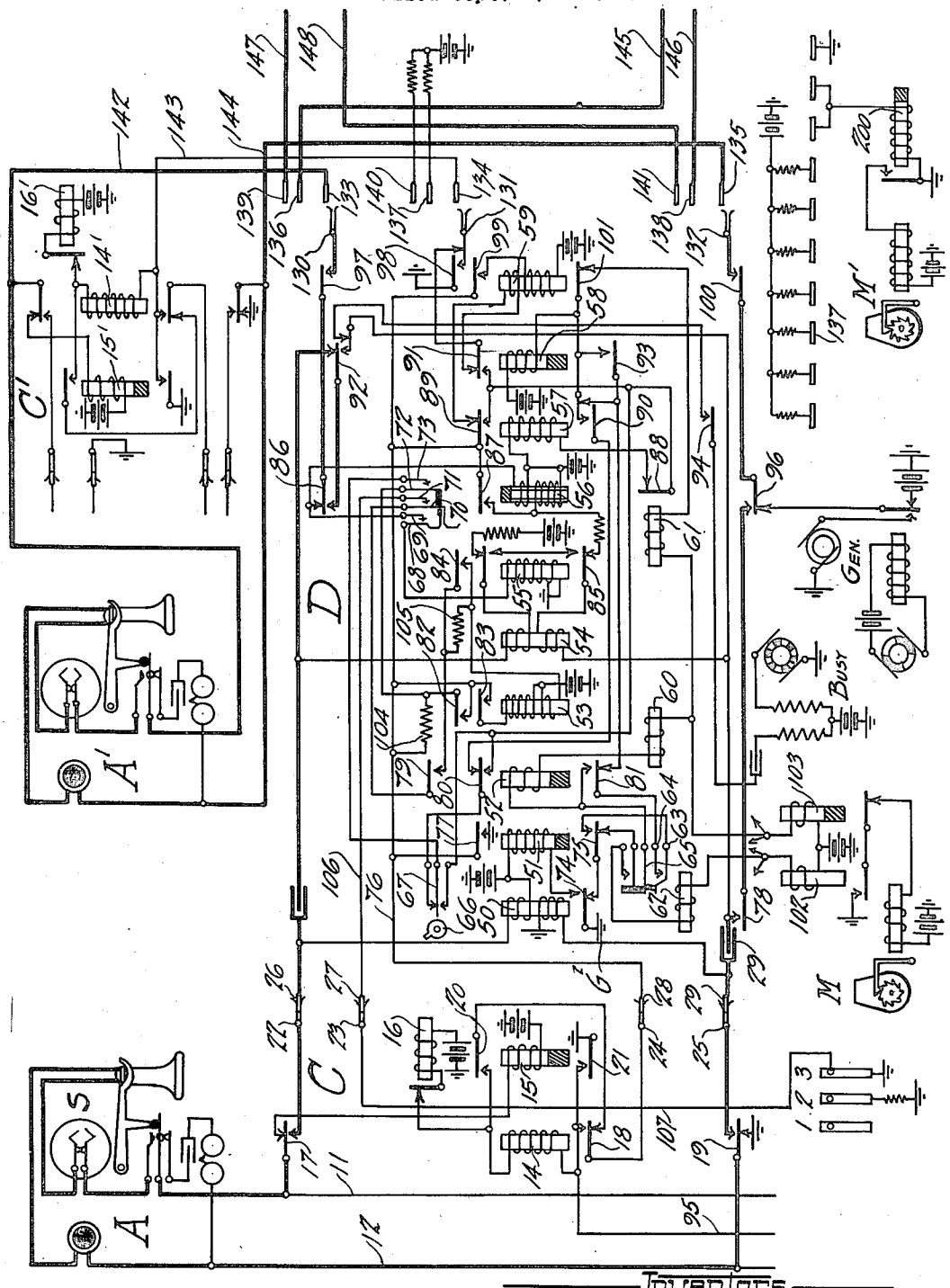
Sept. 18, 1923. 1,468,078

A. J. RAY ET AL

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 3, 1920



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Patented Sept. 18, 1923. 1,468,078

UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed September 3, 1920. Serial No. 408,061.

To all whom it may concern:

Be it known that we, ARTHUR J. RAY and WILLIAM A. CHAPIN, both citizens of the United States of America, and both residents of Chicago, Cook County, Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

Our invention relates in general to automatic telephone systems, but more especially to automatic systems of relatively small size, intended for use in furnishing telephone service between the various departments of a large commercial or manufacturing establishment. A system of this kind is commonly known as a private automatic exchange, or P. A. X.

In a system of the above character it has often been found desirable to provide means for classifying the subscribers with a view to restricting the service of one class of subscribers so as to prevent such subscribers from establishing connections of a certain kind. Heretofore, however, so far as is known such restricted service systems have been limited to two classes of subscribers. The object of the present invention is to provide new and improved restricted service arrangements, whereby the subscribers in the system are divided into three classes in accordance with the different kinds of service they are entitled to, and to provide means for accomplishing this in a novel and efficient manner.

The improved connector switch disclosed herein and the metering arrangement associated with the connectors are not part of the present invention, but are claimed in the pending application of Ray, S. N. 410,596, filed September 16, 1920.

Referring to the drawing, which comprises a single sheet, sufficient apparatus is shown therein to enable the invention to be readily understood. The reference character A indicates an automatic telephone substation of the usual type having the usual talking instrumentalities and a calling device S for controlling the central office switches. The line conductors 11 and 12 extend to a central point where the switching mechanism or exchange is located and there terminate in the individual line or trunk selecting switch C. The line switch C is of the well known rotary type, with wipers moving in a forward direction only and having no normal position, and has the function of extending the line of substation A, when the receiver is removed, to a trunk line terminating in an idle selector connector repeater.

One of these trunk lines which is accessible to the line switch C and other similar line switches is shown in the drawing and terminates in the selector connector repeater indicated by reference character D. The switch D is of the well known Strowger type having one hundred contact sets arranged in ten rows or levels. The first eight levels are reserved for local traffic within the P. A. X. and when working on these levels the switch D has the functions of an ordinary connector switch. The two top levels, or the ninth and tenth levels, are reserved for trunk lines. On these two levels the switch D has the functions of a selector switch, that is, when raised to either the ninth or tenth level the switch will operate to select an idle trunk line automatically. The trunk lines terminating in one level, say the tenth, extend to another private automatic exchange, and on this level the switch D has the functions of an automatic impulse repeater.

The arrangement of the different bank levels may be better understood from a more detailed consideration of the situation in which the P. A. X. is used. It is assumed that the concern using the P. A. X. has two factories or other establishments located a short distance apart in a city served by a public manual exchange. One of the factories is supplied with telephone service by the P. A. X. 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 selector connector repeaters in the P. A. X. at factory No. 1 is reserved for the private trunk lines extending to the P. A. X. at factory No. 2, while the ninth level is used for trunk lines extending to the public manual exchange.

From this explanation the wiring of the banks of the switch D will be readily understood. The conductors 142 and 144 are the conductors of a local line terminating in the first level and extending to substation A' which is in all respects similar to substation A. Conductors 147 and 148 are conductors

of a private trunk line terminating in the tenth level and extending to the P. A. X. switchboard at the No. 2 factory, where the trunk line terminates in a line switch or an incoming connector. Conductors 145 and 146 are conductors of a trunk line terminating in the ninth level and extending to the public manual exchange, where the trunk line may terminate in an ordinary drop and jack. It is understood that there are or may be a plurality of trunk lines in each of the ninth and tenth levels similar to the ones described.

The operation of the system may now be described, it being assumed first that the subscriber at substation A desires to obtain connection with the subscriber at substation A'.

When the receiver is removed at substation A a circuit is completed over the line conductors 11 and 12 for the line relay 15 of the line switch C. Upon energizing, the line relay 15 closes at its armature 21 a circuit which includes the switching relay 14 and the stepping magnet 16 in series, and at its armature 20 connects the test wiper 24 to the above circuit at a point midway between the switching relay and the said magnet. The operation now depends upon whether the trunk line with which the wipers of the line switch C are associated, is busy or is not busy. If the trunk line is busy the test contact with which the test wiper 24 is in engagement will be grounded, and as a result the switching relay 14 will be short circuited and the stepping magnet 16, being supplied with direct ground by way of the test wiper, will operate as a buzzer to advance the switch wipers step by step in search of an idle trunk line. It may 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 drawing, and it may be assumed furthermore that the trunk line extending from these bank contacts is idle. Under these circumstances the test contact 28 will have no ground potential upon it and when the receiver is removed the energization of the line relay 15 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 16 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 15 and from ground, respectively, and are extended by way of armatures 17 and 19, wipers 22 and 25, and bank contacts 26 and 29 to the upper and lower windings of the double wound line relay 50 of the selector connector repeater D.

When the calling line is extended to the switch D as above described, the line relay 50 is energized over the line circuit in the usual manner and completes a circuit for the slow acting release relay 51. Upon energizing, the latter relay prepares a circuit for the vertical magnet 60 at armature 75, and at armature 77 connects ground to the release trunk conductor 76, thereby closing a holding circuit for the line switch C which extends by way of the test contact 28, test wiper 24, armature 18 and its working contact, winding of the switching relay 14, and the winding of the stepping magnet 16 to battery. The above circuit is completed before the slow-acting line relay 15 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 95 to multiply connected test contacts in the banks of the selector connector repeaters which have access to the line of substation A, whereby the said line is made busy.

The calling subscriber at substation A may now proceed to operate his calling device S in accordance with the digits in the local telephone number of substation A'. When the calling device is operated for the first digit a series of interruptions is produced in the line circuit, to which the line relay 50 responds by deenergizing a corresponding plurality of times. At the first deenergization the line relay transmits a current impulse to the vertical magnet 60 over the following path: ground at G^2, armature 74 and its resting contact, armature 75 and its working contact, off normal springs 63 and 65, winding of the slow acting series relay 52, winding of the vertical magnet 60, and the winding of the common relay 103 to battery. The above is the circuit over which the first impulse is transmitted. At the first upward movement of the shaft the normal springs are shifted and the circuit is completed over a new path which is the same as the one previously traced except that it includes the off normal springs 63 and 64 and armature 81 of the series relay 52 and its working contact, the said series relay being now in operated position. By the operation of the vertical magnet 60 the wipers 130—132, inclusive, are raised step by step until they stand opposite the level of bank contacts in which is located the set of contacts associated with the line of substation A'. The slow acting series relay 52, which is energized in series with the vertical magnet, maintains its armatures attracted throughout the vertical operation of the switch, and at the end of the vertical movement deenergizes and transfers the operating circuit to the rotary magnet 61.

The calling subscriber may now operate

his calling device in accordance with the second and final digit in the desired number. As before, a series of interruptions is produced in the line circuit to which the line relay 50 again responds by transmitting a series of impulses to the rotary magnet 61 over the following path: ground at G^2, armature 74 and its resting contact, armature 75 and its working contact, off normal springs 63 and 64, armature 81 and its resting contact, normally closed contacts controlled by armature 90 of relay 57, armature 101 and its resting contact, winding of the rotary magnet 61, and the winding of the common relay 103 to battery. Responsive to these impulses the rotary magnet is operated to rotate the switch wipers into engagement with the particular set of bank contacts in which the line of substation A' terminates, these bank contacts being indicated in the drawing by reference characters 133, 134, and 135. The slow acting relay 58 is energized in parallel with the rotary magnet and remains in operated position while the switch wipers are being rotated. At its armature 91, relay 58 connects the test wiper 131 to the winding of the test relay 57, and at its armature 93 relay 58 closes the operating circuit for the rotary magnet over a path which is independent of the contacts controlled by armature 90 of the test relay 57. This latter operation is to guard against the possibility of the test relay being energized while the test wiper 131 is passing over busy test contacts. Assuming first, that the line of substation A' is busy when connection thereto is established as just described, when the test wiper 131 comes to rest in engagement with the test contact 134 it will find a ground potential thereon and the test relay 57 will be operated. Upon energizing, the test relay establishes a locking circuit for itself at its armature 89 and at its armature 94 connects a lead from the busy signalling machine to the lower heavy talking conductor. By this means the calling subscriber is given an audible busy signal, and being advised thereby that the desired line is for the time being inaccessible, he will hang up his receiver and release the connection.

Having described the operations which take place when the called line is busy, it will now be assumed that the called line is idle when the connection is attempted. Under these circumstances, when the test wiper 131 comes to rest in engagement with test contact 134 it will find no ground potential and the test relay 57 will not be energized. Then when the slow acting relay 58 deenergizes at the end of the rotary movement of the switch a circuit will be completed for the switching relay 59 as follows: from the grounded release trunk conductor 76, by way of armature 89 and its resting contact, upper winding of switching relay 59, resting contact of armature 91 and the said armature, normally closed contact springs controlled by armature 98, test wiper 131, test contact 134, private normal conductor 143, winding of the switching relay 14', and the winding of the stepping magnet 16' to battery. Upon the closure of the above circuit relays 59 and 14' are energized in series, and the latter relay is operated to clear the line of substation A' of its normal battery and ground connections in the line switch C'. It is noted that relay 14' operates only about half way, due to the fact that the line relay 15' has not been energized, and the line conductors are not connected through to the wipers of the line switch. At the selector connector repeater D when the switching relay 59 is energized the said relay establishes a locking circuit for itself at its armature 99, connects direct ground to the test wiper 131 at armature 98, opens the rotary magnet circuit at armature 101, and at armatures 97 and 100 connects up the line wipers 130 and 132.

The connection having been finally completed, ringing current from the generator Gen. is projected intermittently out over the line of substation A' in the usual manner to operate the bridged ringer at the substation. It will be understood that the return path for the ringing current includes the upper winding of the ring cut off relay 56 and when the called subscriber responds by removing his receiver the ring cut off relay is energized and establishes a locking circuit for itself at its armature 87. The ring cut off relay also opens the ringing circuit at its armatures 86 and 96, and at the working contacts of these armatures finally completes the talking connection.

The desired connection has now been established. The transmitter at the calling substation A is supplied with talking battery through the windings of the line relay 50, while the transmitter at substation A' is supplied with talking battery through the windings of the double wound back bridge impedance coil 54. The voice currents take the path shown in heavy lines which will be understood without further explanation.

When the subscribers are through talking they will both replace their receivers, and the replacement of the receiver at substation A causes the line switch C and the selector connector repeater D to be released in the following manner: When the line circuit is broken by the replacement of the receiver the line and release relays 50 and 51 are both deenergized, and a circuit is completed for the release magnet 62 which operates to restore the connector D to normal position in the well understood manner. Relay 51 also disconnects ground from the release trunk conductor 76 thereby permitting the

switching relay 14 of the line switch C to deenergize. By the deenergization of relay 14 the line switch C is restored to normal condition ready for another call. It will be noted that the circuit of the release magnet 62 includes the common relay 102. Relays 102 and 103 are low resistance relays which are connected in series with the battery feed conductors for the release magnets and operating magnets, respectively, of the selector connector repeaters, and have the function of controlling the operation of the meter M which is provided for the purpose of registering the total number of completed connections which are established in the P. A. X. Whenever the switch D or any other similar switch in the P. A. X. is released, the relay 102 is energized in series with the release magnet and closes a circuit for the operating magnet of the meter M in order to register the connection, providing of course that the relay 103 is not energized at the same time. Under the circumstances just described, when the switch D is released at the termination of a successful connection, relay 103 will not be operated and the call will be registered on the meter M. But if the switch D should be released prematurely, that is, before it has been completely operated, either the vertical magnet 60 or the rotary magnet 61 will be energized just before the release magnet 62 is energized and it follows therefore that the relay 103 will also be operated. Relay 103 is made slow acting so that it will retain its armature attracted after the circuit of the operating magnet has been broken and until the switch has been completely restored in order to prevent the relay 102 from closing the circuit of the meter operating magnet to register the call. Thus no connection will be registered when the switch is released after being only partially operated.

Having described the process of setting up a local connection we will now explain the manner in which a trunk connection to the main exchange is established, after which a description will be given of the process of establishing a trunk connection to a subscriber in the other private automatic exchange which is located at factory No. 2. Before proceeding it will be convenient to explain a little more fully certain details concerning the restricted service feature, particularly with regard to the means for classifying the P. A. X. subscribers in accordance with the class of service to which they are entitled. As before stated, the subscribers are divided into three classes. The subscribers in class No. 1 are given local service only, that is, they can call neither the manual main exchange nor the other private automatic exchange. The subscribers in class No. 2 can establish local connections and also are able to establish trunk connections to the other private automatic exchange, but not to the main exchange. The subscribers in class No. 3 have no restriction imposed on their service and can establish local connection and both kinds of trunk connections. In order to differentiate between the different classes of subscribers automatically each individual line switch is provided with an extra wiper and bank of contacts and the truck line extending to each of the selector connector repeaters is provided with an extra conductor, there being four conductors in each such trunk line. This arrangement is clearly shown in the drawing in which the line switch C is shown as having an extra wiper 23 which has access to the fourth conductors of the several trunk lines extending to the selector connector repeaters, one of which conductors is the conductor 106. When used in connection with a restricted service system this fourth conductor is commonly referred to as a discriminating trunk. The class of service to which any subscriber is entitled is determined by the manner in which the extra wiper of each individual line switch is connected. Three bus-bars are provided at the line switchboard which may be numbered 1, 2, and 3 as shown in the drawing. Bus-bar No. 3 is permanently connected to ground, bus-bar No. 2 is connected to ground through a resistance of about 500 ohms, while bus-bar No. 1 has no ground connection at all. The extra wipers of the several line switches are connected to these three bus-bars in accordance with the class of service which is to be given to the different subscribers. For example, the extra wiper 23 of line switch C is connected to bus-bar No. 3 and it follows therefore that the subscriber at substation A belongs to the third class and is given unrestricted service.

The explanation of the manner in which a trunk connection to the main exchange is established may now be proceeded with. 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 S 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 selector connector repeater. Assuming that the selector connector repeater D is idle and is selected for use, when connection is extended thereto the line and release relays 50 and 51 are energized as previously explained and with the same results. When the calling device is operated the switch wipers 130—132,

inclusive, are raised step by step by the vertical magnet 60 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 70 and 72 are brought into engagement with springs 71 and 73, respectively, 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 68—73, inclusive, just above the top of the shaft so that springs 68 and 70 may be actuated by the circular cup spring casing which is mounted at the upper extremity of the switch shaft. 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 level shaft springs are closed on the ninth vertical step two circuits are completed which will now be pointed out. The first of these circuits serves to energize the test relay 57 and may be traced as follows: from the grounded release trunk conductor 76 by way of resistance 104, shaft springs 72 and 73, rotary off normal spring 67 and its resting contact, armature 80 and its working contact, interrupter contact 88 of the rotary magnet, and the winding of the test relay 57 to battery. Upon energizing, the test relay 57 locks itself at its armature 89 and prepares a circuit for the rotary magnet at its armature 90. The second circuit referred to extends to the discriminating relay 53 as follows: from grounded bus-bar No. 3 at the line switchboard by way of conductor 107, wiper 23, bank contact 27, discriminating trunk conductor 106, shaft springs 71 and 70, armature 79 and its working contact, resistance 105, and the lower winding of relay 53 to battery. Since direct ground is supplied to the discriminating trunk conductor 106, relay 53 is energized notwithstanding the fact that resistance 105 is included in this circuit, and establishes a locking circuit for itself at armature 83. Relay 53 also short circuits resistance 104 at its armature 82.

When the vertical movement of the switch is completed and the slow acting relay 52 is deenergized a circuit is completed for the rotary magnet 61 which extends as follows: from the grounded release trunk conductor 76, by way of the working contact of armature 82 and the said armature, shaft springs 72 and 73, rotary off normal spring 67 and its resting contact (this rotary off normal spring is not shifted until the eleventh rotary step), armature 80 and its resting contact, armature 90 and its working contact, armature 101 and its resting contact, and the winding of the rotary magnet 61 to battery by way of the common relay 103.

When the above circuit is closed the rotary magnet 61 is energized and rotates the switch shaft to advance the wipers 130—132, inclusive, into engagement with the first set of bank contacts in the ninth level. In operating, the rotary magnet breaks the interrupter contact at its armature 88 which is included in the locking circuit of the test relay 57, and this relay is accordingly deenergized to break the circuit of the rotary magnet, which then deenergizes also and again closes its interrupter contact. The operation now depends upon whether the first trunk line in the ninth level is busy or idle. If this trunk line is busy, the test contact with which the test wiper 131 is in engagement will have a ground potential upon it and since the said test wiper has been connected to the test relay 57 by the operation of the slow acting relay 58 (relay 58 is energized in parallel with the rotary magnet, as before explained), the test relay 57 will again be energized and will reestablish its locking circuit and the energizing circuit of the rotary magnet 61. In this manner the wipers are advanced into engagement with the second set of contacts, and the same operation is repeated rapidly until an idle trunk line is reached. Assuming that the trunk line shown in the drawing and comprising conductors 145 and 146 is the first idle trunk line, when the test wiper 131 arrives at test contact 137 it will find no ground potential and the test relay 57 will not again be energized. It follows then that no further rotary movement will take place. The slow acting relay 58 is now deenergized and completes a circuit for the switching relay 59 which is energized as in the case previously described and with the same results.

The desired connection has now been established. Ringing current is 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 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 restricted service devices may now be explained a little more fully. It will have been noted that the circuit of the rotary magnet 61 when the same was used in the trunk hunting operation includes armature 82 of the discriminating relay 53. This relay is energized over the discriminating trunk conductor 106 at the end of the vertical movement of the switch, provided that the calling subscriber is a

subscriber in class No. 3, for when any subscriber in this class calls the discriminating trunk conductor will be connected with solid ground by the extra wiper of the calling line switch. However, if a subscriber in class No. 2 is calling, ground will be connected to the discriminating trunk conductor through 500 ohms resistance and the discriminating relay 53 consequently will not energize. It follows therefore, that resistance 104 is not short circuited and when the rotary magnet circuit is completed this resistance is included in the circuit. As a result, neither the rotary magnet 61 nor the slow acting relay 58 which is connected in parallel therewith is energized, and the test relay 57 being now in operated position, the calling subscriber is given a busy signal to warn him that the desired connection cannot be obtained. The result obtained by the subscribers in class No. 1 when calling for main office trunk lines will obviously be the same as described above for the subscribers of class No. 2.

The operation of the selector connector repeater 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 line is concerned, but since the connection in the private automatic exchange must be completed automatically the circuits of the switch D are altered suitably in order to permit the switch to operate as a repeater for the purpose of repeating impulses over the selected trunk line. The operations which take place when the connection is extended to the second private automatic exchange will now be briefly explained. Since the trunk lines extending to the second P. A. X. terminate in the tenth level, the digit to be called is the digit O. Assuming the same conditions as before, the calling subscriber being the subscriber at substation A, when the calling device is operated for this digit the wipers of the selector connector repeater D will be raised to the tenth level. By this operation the ninth level shaft springs are closed as in the previous case and also the tenth level shaft springs 68 and 69 are closed. By the closure of the tenth level shaft springs a circuit is completed for relay 55 in series with the upper winding of the ring cut off relay 56. Both these relays are energized and the latter relay disconnects the ringing current and locks itself as usual. When the slow acting relay 52 deenergizes at the end of the vertical movement of the switch the automatic trunk selecting movement is initiated as before explained, and the switch wipers are rotated step by step under control of the test relay 57 in search of an idle trunk line. Assuming that the first idle trunk line is the trunk line comprising conductors 147 and 148, when the wipers 130—132, inclusive, arrive at bank contacts 139—141, inclusive, the test wiper 131 will find no ground potential on test contact 140 and the rotation of the switch will cease. The switching relay 59 is now energized in the usual manner and the connection with the trunk line is thereby completed. Since relay 55 is now in operated position the two windings of the impedance coil 54 will be bridged across the trunk line in an obvious manner and a circuit will be completed for energizing the line relay of the connector switch in which the trunk line terminates at the second private automatic exchange. The calling subscriber may now operate his dial in accordance with the digits in the desired number at the second P. A. X. When the first digit is called the line relay 50 is deenergized a plurality of times and at each deenergization said line relay opens the bridge across the trunk line conductors 147 and 148 at its armature 78, thus repeating the interruptions produced by the calling device at the calling substation into the circuit of the line relay of the connector switch at the No. 2 P. A. X. At the same time line relay 50 sends a series of impulses through the slow acting relay 58, and this relay completes the bridge across the trunk line conductors 147 and 148 over a direct path which excludes the windings of the impedance coil 54 but includes the armature 78 of relay 50. This circuit change is accomplished at armature 92 of relay 58. The connector at the No. 2 P. A. X. is operated in the usual manner in response to the received impulses to select a desired level and when the next digit is called it is further operated to complete the desired connection. It will be clear that the trunk lines leading to the second P. A. X. may terminate in line switches instead of incoming connectors if desired, or if the second P. A. X. is of large size they may terminate in selector switches, the exact trunking arrangement used being unimportant.

With reference to the restricted service feature, it will be understood that subscribers in class No. 2 also can connect with trunk lines on the tenth level, for when the switch is raised to this level relay 55 short circuits resistance 105 and thus permits the discriminating relay 53 to be operated by a 500 ohm ground on the discriminating trunk. Relay 53 will operate in series with this 500 ohm ground or in series with resistance 105, but will not operate in series with both these resistances.

Although not shown in the drawing it will be understood of course that suitable arrangements are provided for handling incoming calls from the manual main exchange and from the second private branch exchange to the private branch exchange

under consideration. The trunk lines shown may be made "two-way" by the use of well known expedients, or separate trunk lines may be provided which terminate in incoming connectors at the first private automatic exchange, the banks of these incoming connectors being provided with a multiple of all the local lines. But since nothing new is involved in these provisions for handling incoming traffic the circuits have not been shown and need not be considered herein.

We will now explain briefly a feature which consists in the provision of means for registering the total number of calls which are attempted to be established over a group of trunk lines and which fail because all of the trunk lines in the group are busy. The means for accomplishing this is shown at the lower right hand corner of the drawing and comprises the meter M' and relay 200 together with suitable circuit arrangements whereby the relay is operated at suitable times to control the meter. It will be assumed that this metering arrangement is applied to the group of trunk lines extending to the manual main exchange and which terminate in the ninth level of the selector connector repeaters. Assuming that there are 7 of these trunk lines in the group, they will be assigned to the first 7 contact sets in the bank. This is indicated clearly in the drawing which shows the ten test contacts of the ninth level and their connections. The eighth and ninth test contacts are connected in multiple to the relay 200 while the last test contact is permanently grounded. Assume now that a call is attempted when all of the seven trunk lines are busy, the selector connector repeater D being used to set up the connection. When the trunk hunting movement is initiated the test wiper 131 will find the first seven test contacts grounded and the switch will be rotated past the first seven contact sets in the well understood manner. Since the eighth and ninth test contacts are also grounded through the winding of relay 200, the rotary movement will be continued past the eighth and ninth contact sets in the same manner. The tenth contact set is permanently connected to ground and the switch therefore will not stop at this point either but the rotary movement will continue until the wipers are rotated entirely off the bank. This occurs on the eleventh rotary step at which time the rotary cam 66 shifts the rotary off normal spring 67 from its resting to its working contact. By this operation the circuit of the rotary magnet 61 is broken and the rotation of the switch is stopped. When the contact spring 67 comes into engagement with its working contact an energizing circuit is completed for the test relay 57 and this relay is held up until the connection is released. As soon as the slow acting relay 58 deenergizes the subscriber is given an audible busy signal in the manner previously explained. The unsuccessful trunk hunting movement described above causes the meter M' to be operated once to register the unsuccessful attempt at setting up a connection. When the test wiper 131 passes over the eighth and ninth test contacts the test relay 57 energizes in series with the meter control relay 200. This relay is slow acting and pulls up its armature once in response to the two current impulses received in order to operate the meter M'. It will be seen that by means of a metering arrangement of this kind lost calls due to insufficient trunking capacity which might otherwise not be noticed will be called to the attention of the management, and the scheme is thus of great assistance in keeping a check on traffic conditions.

Having described our invention, what we consider to be new and desire to have protected by Letters Patent will be pointed out in the appended claims.

What we claim as our invention is:

1. In a telephone system, three exchanges, one of said exchanges being a private automatic exchange, trunk lines extending from said exchange to each of the other exchanges, and restricted service arrangements at the switchboard in said private automatic exchange dividing the subscribers thereof into three classes, the subscribers of one class being restricted to local calls, the subscribers in another class being restricted to local calls and trunked calls to one of said other exchanges only, while the third class of subscribers have unrestricted service to local lines and both of said other exchanges.

2. In a telephone system, three exchanges, trunk lines extending from the first of said exchanges to the other two, automatic switches in the first exchange for completing local calls and for connecting calling local lines with said trunk lines, and service restricting means in said switches dividing the subscribers into three classes, the subscribers of one class being restricted to local calls, the subscribers of another class being restricted to local calls and trunked calls to one of said other exchanges only, while the third class of subscribers have unrestricted service to local lines and both of said other exchanges.

3. In a telephone system, three exchanges, trunk lines extending from the first of said exchanges to the other two, automatic switches in the first exchange for completing local calls and for connecting calling local lines with said trunk lines, and service restricting means in each of said switches cooperating with means individual to each subscriber's line for dividing the subscribers

into three classes, the subscribers of one class being denied access to the trunk lines extending to both of said other exchanges, the subscribers of another class being denied access to the trunk lines extending to one of said other exchanges only, while the subscribers of the third class have unrestricted service over the trunk lines extending to both of said other exchanges.

4. In a telephone system, an automatic switch for establishing connections of different kinds, service restricting means in said switch including a locking relay whereby certain of the subscribers having access to said switch are prevented from establishing connections of a certain kind, a discriminating trunk conductor included in the trunk line leading to said switch, and means for momentarily connecting said conductor with said relay when the said switch is operated.

5. In a telephone system, an automatic switch for establishing connections of different kinds, service restricting means associated with said switch whereby certain of the subscribers having access to said switch are prevented from establishing connections of a certain kind, a discriminating trunk conductor included in the trunk line leading to said switch and adapted for use in controlling said restricted service means, and a resistance for inclusion in the circuit of said conductor, the said resistance being common to all of the said subscribers whose service is restricted.

6. In a telephone system, an automatic switch, a conductor terminating therein, two groups of lines accessible to said switch, circuit controlling means associated with said conductor for rendering said switch operable to connect with any line in either of said groups, means for impressing a potential on said conductor which is sufficient to operate said circuit controlling means when said switch attempts to connect with any one of said lines, other means for placing a potential on said conductor which is insufficient to operate said circuit controlling means when said switch attempts to connect with a line in one group, and means for rendering said circuit controlling means responsive to the last named potential when said switch attempts to connect with a line in the other group.

7. In a telephone system, an automatic switch, two groups of lines accessible thereto, a conductor terminating in said switch, means for placing a potential on said conductor sufficient to permit said switch to connect with a line in the first group but insufficient to permit said switch to connect with a line in the second group, and other means for placing a potential on said conductor sufficient to permit said switch to connect with a line in either group.

8. In a telephone system, calling lines divided into two classes, an automatic switch accessible to said lines in common, two groups of lines accessible to said switch, a conductor individual to said switch, a relay and a resistance at said switch, means operable when a line of one class is calling for impressing a potential on said conductor high enough to operate said relay in series with said resistance, means operable when a line of the second class is calling for impressing upon said conductor a potential which is high enough to operate said relay but not high enough to operate said relay in series with said resistance, circuit connections controlled by said relay for permitting said switch to connect with a line in the desired group, means for connecting said conductor to said relay in series with said resistance when a line in one group is being called, and means for connecting said conductor to said relay over a path exclusive of said resistance when a line in the other group is being called.

9. In a telephone system, three classes of calling subscribers' lines, three groups of called lines, automatic switching mechanism for establishing connections between said calling and called lines, the subscribers of one class being able to operate said switching mechanism to connect with called lines in any group, and service restricting arrangements included in said switching mechanism at the exchange limiting the number of possible connections which may be established by subscribers of the other two classes, the subscribers of one of said last mentioned classes being denied service to lines in two of said groups, while the subscribers in the other of said last mentioned classes are denied service to lines in only one of said groups.

10. In a telephone system, three classes of subscribers' lines, two groups of trunk lines, automatic switching mechanism for connecting calling subscribers' lines with called subscribers' lines or with said trunk lines, the subscribers of one class being able to operate said switching mechanism to connect with any idle subscriber's line or trunk line, and service restricting arrangements included in said switching mechanism at the exchange limiting the number of possible connections which may be established by the subscribers of the other two classes, the subscribers in one of said other classes being denied service to both groups of trunk lines, while the subscribers in the second of said other classes are denied service to only one of said groups of trunk lines.

Signed by us at Chicago, Cook County, Illinois, this 26th day of August, 1920.

ARTHUR J. RAY.
WILLIAM A. CHAPIN.