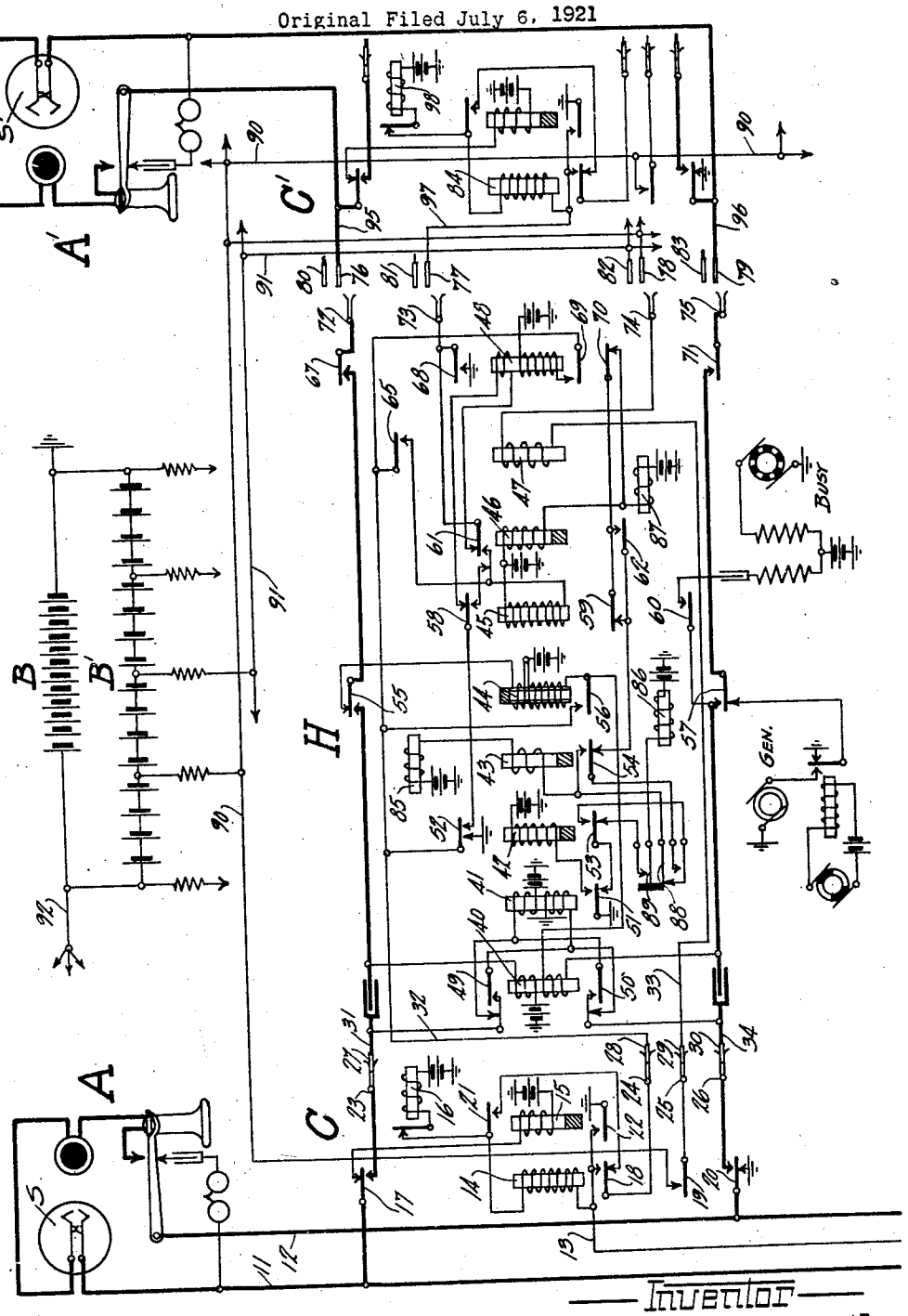
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AUTOMATIC TELEPHONE SYSTEM

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AUTOMATIC TELEPHONE SYSTEM.

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The present invention relates to automatic telephone systems in general, but is concerned more particularly with such systems as are commonly called private automatic exchanges; and the object broadly stated is the provision of improved circuit arrangements whereby a plurality of small private automatic exchanges may be combined into one system using common trunk lines and associated apparatus, while the different groups of lines are maintained isolated from each other so that a subscriber whose line terminates in one group cannot call a subscriber whose line terminates in another group.

Other objects have to do with the carrying out of the invention as above set forth so as to make the same more efficient and practical.

Referring now to the drawings which comprise a single sheet, there is illustrated therein by means of the usual circuit diagrams sufficient of the apparatus in a system embodying the principles of the invention to enable the same to be thoroughly understood.

The automatic substations A and A′, shown therein, which are assumed to be substations of the same group or belonging to the same private automatic exchange, are ordinary automatic substations having the usual talking and signalling instrumentalities and having in addition the calling devices S and S′, respectively, for the purpose of controlling the automatic switches.

The line of substation A terminates at the exchange in the individual line switch C and the line of substation A′ terminates at the exchange in the individual line switch C′. These line switches are of the well known rotary type and accordingly the wipers have no normal position and move in a forward direction only.

The line switches C and C′, together with the other line switches of the system, have common access to a plurality of connector switches of which the connector H is one. The connector H is mechanically of the well known vertical and rotary type and accordingly has its bank contacts arranged in horizontal rows or levels. The circuit of the said connector is shown complete and will be described fully hereinafter.

The battery indicated by the reference character B is assumed to be the exchange storage battery which is usually composed of a plurality of lead cells connected in series, the number of cells being immaterial but in practice the number must be great enough to give a potential high enough for satisfactory operation of the exchange switches. In the line switches C and C′ and the connector H, a plurality of batteries are shown, but it is to be understood that they are shown for convenience only and that the lead 92 of the battery B is wired to each point where a battery is shown.

The battery B′ which is shown connected in multiple with the battery B, or in other terms "floated" on the latter, is composed of dry cells and is used so as not to subject the battery B to an unbalanced load condition that would tend to exhaust some cells more quickly than the others. It is to be understood that the battery B′ is not necessarily floated on or connected in multiple with the battery B, but is shown that way in the present drawings because of the fact that when connected in this way the dry cells do not run down or become exhausted quickly as they would otherwise.

It is apparent that if more taps are needed than can be taken out of the battery B′, the said battery B′ may be entirely disconnected from the battery B and more cells added, or as an alternative arrangement more cells may be connected on at either or both ends of the battery B′, thereby affording more individual battery taps.

If we assume that we have only two groups of lines in a given system, the battery B′ may be eliminated entirely, and the conductors 90 and 91 or the corresponding conductors in that case, may be made battery and ground, respectively. Or if there are more than two, a corresponding number of taps may be taken out of the battery B itself, provided of course that it is not considered objectionable to subject some cells to a slightly higher rate of discharge than the others. With the present arrangement there obviously is no chance for any cells of the storage battery to be discharged at a higher rate than the others; and so far as the dry cells are concerned this does not make so

much difference, as the individual dry cells may be replaced at a comparatively low cost as often as may be necessary.

The method used in the present case for preventing a subscriber in one group from calling a subscriber whose line terminates in a separate group may be outlined about as follows: Each group of lines is given an individual battery tap such as the conductor 90. This conductor is carried forward through the calling line switch, through a so called discriminating relay in the connector, and thence to a wiper which at the termination of the operating impulses always engages with a contact which is connected with the battery tap of the called line. Now if the subscriber is calling another subscriber in the same group there is obviously no current flow through the discriminating relay for the reason that it will be connected with the same battery tap at each end, but when a subscriber calls a line belonging to another group, the discriminating relay which is connected at one end to the battery tap of his own group is connected with a contact which is connected to a battery tap of a different group and consequently of a different potential, and accordingly the discriminating relay operates with the final result that connection is denied and a busy tone is placed on the calling line.

It is to be understood that many variations may be made from the present arrangement, such as using an alternating current discriminating relay in each of the connectors in connection with a transformer with a plurality of taps brought out of its secondary winding. These and many other changes that may suggest themselves to the minds of those skilled in the art may be made without departing from the spirit of the invention.

The system, having been described in general, will now be described in connection with a detailed description of its operation. For this purpose it will be assumed that the subscriber at substation A desires to call the subscriber at substation A′, whose line as has been mentioned before terminates in the same group as that of the calling subscriber. When the receiver is removed at substation A, a circuit is closed over the line conductors 11 and 12 for the line relay 15 of the line switch C. Upon energizing, line relay 15 closes at armature 22 a circuit for the switching relay 14 and stepping magnet 16 in series, and at armature 21 connects the test wiper 24 to the above circuit at a point between the switching relay and stepping magnet. The operation now depends upon whether the trunk line, upon which the wipers of the line switch are standing, is busy or idle. If it is busy, switching relay 14 is short circuited and stepping magnet 16, which interrupts its own circuit, is operated in the manner of a buzzer to advance the switch wipers in search of an idle trunk line. In the present case, however, we may assume that the trunk line upon which the wipers of the line switch are standing is idle when the call is initiated. That being the case there is no ground potential on the test contact 28 and switching relay 14 is not short circuited, and stepping magnet 16 is not operated because of the high resistance of switching relay 14. Upon energizing, switching relay 14 disconnects the line conductors 11 and 12 from the winding of line relay 15 and ground, respectively, and extends them by way of line wipers 23 and 26, bank contacts 27 and 30, trunk conductors 31 and 34, and normally closed contacts controlled by armatures 49 and 50 to the upper and lower windings of line relay 41 of the connector H. Line relay 41, upon energizing over the calling subscriber's loop, closes a circuit for release relay 42 at armature 51. Upon energizing, release relay 42 opens a point in the circuit of the release magnet 86 and prepares a circuit for the operating magnets of the connector H at armature 53, while at armature 42 it places ground on the release trunk conductor 32, thereby establishing a holding circuit for the switching relay 14 of the line switch C by way of test contact 28, test wiper 24, and armature 18 and its working contact. This holding circuit, it may be said, is established before the slow acting line relay 15 has time to deenergize. By means of a ground potential on test contact 28 and its multiples in the banks of the other line switches, the seized trunk line is caused to test busy to the switches having access to it. A ground potential extends by way of private normal conductor 13 to multiple test contacts in the banks of the connectors, thereby guarding the calling line against intrusion in the usual manner.

The calling subscriber now operates his calling device S in accordance with the first digit of the desired number, thereby producing a corresponding number of interruptions in the circuit of line relay 41 of the connector H. Each time line relay 41 deenergizes in response to one of these interruptions, it closes at armature 51 the following circuit: from ground by way of armature 51 and its resting contact, armature 53 and its working contact, contact of off normal spring 88 and the said spring, slow acting series relay 43, and vertical magnet 85 to battery. By the operation of the vertical magnet the shaft and wipers of the connector H are raised step by step until the latter stand opposite the desired level of bank contacts which is the level in which the

line of substation A′ terminates. Slow acting series relay 43 is maintained energized throughout the series of interruptions and at its armature 54 serves to hold the circuit of the vertical magnet 85 intact after the off normal springs have shifted as they do upon the first vertical step. At the end of the vertical movement relay 43 deenergizes and transfers the impulsing circuit from the vertical to the rotary magnet.

The calling subscriber now manipulates his calling device in accordance with the next and last digit of the desired number, whereupon the line relay 41 is deenergized a corresponding number of times and upon each deenergization completes the following circuit: from ground by way of a previously traced circuit to armature 54 and thence by way of the resting contact of the said armature, resting contact of armature 59 and said armature, armature 70 and its resting contact, and rotary magnet 87 to battery. By the operation of the rotary magnet the switch shaft and wipers 72—75, inclusive, are rotated step by step until the latter come to rest upon the contacts 76—79, inclusive, which are the ones in which the line of substation A′ terminates. Relay 46 is energized in multiple with the rotary magnet and being slow acting retains its armature attracted throughout the rotary movement. At armature 61, relay 46 disconnects the test wiper 73 from the upper winding of switching relay 48 and connects it to the winding of busy relay 45 and at armature 62 places a shunt around armature 59 and its resting contact so as to maintain the circuit of the rotary magnet intact even though the busy relay 45 happens to energize while the test wiper 73 is passing over grounded test contacts.

As soon as the wipers of connector H land on the contacts of the called line the battery tap of the calling line is connected to the battery tap of the called line by way of the following circuit: from conductor 90, by way of the working contact of armature 19 and said armature, wiper 25, bank contact 29, conductor 33, discriminating relay 47, wiper 74, and bank contact 78, to conductor 90 again. Since this circuit, in this particular case starts from and finally returns to the same conductor without having passed through any source of current, discriminating relay 47 is obviously not energized and therefore the said relay does not affect the operation of the connector H in any way, at this time.

From this point the operation depends upon whether the line of substation A′ is busy or idle. Assuming first, that it is busy, there is a ground potential upon test contact 77 and busy relay 45 energizes as soon as the test wiper 73 arrives upon the said contact. Upon energizing, busy relay 45 prepares a locking circuit for itself at armature 58 and at armature 59 opens a point in the circuit of the rotary magnet so as to prevent any further operation of the calling device from effecting any movement of the wipers of the connector H. In this case, slow acting relay 46, upon deenergizing, opens a point in its own circuit and consequently in the circuit of the rotary magnet at armature 62 and at the normally closed contacts controlled by armature 61 completes a locking circuit for the busy relay 45. As a further result of the operation of the busy relay 45, it connects at armature 60 a lead from the busy signalling machine to the lower heavy talking conductor. By this operation the calling subscriber is informed that the desired line is for the time being inaccessible.

Assuming now that the line of substation A′ is idle when called, as above described, there is no ground potential on the test contact 77 and consequently busy relay 45 fails to energize and slow acting relay 46, upon deenergizing, completes at armature 61, the following circuit: from ground by way of the working contact of armature 52, armature 58 and its resting contact, upper winding of switching relay 48, resting contact of armature 61 and said armature, test wiper 73, test contact 77, private normal conductor 97, switching relay 84, and stepping magnet 98 to battery. The two switching relays 48 and 84 energize in series over the above traced circuit and the latter, upon energizing, clears the called line of its normal battery and ground connections, but, owing to a mechanical interlocking device (not shown) between the armatures of switching relay 84 and the associated line relay, the wipers of the line switch C′ are not connected up.

In the connector H switching relay 48, upon energizing, closes at armature 69 a locking circuit for its lower winding; opens the circuit of the rotary magnet 87 and slow acting relay 46 at armature 70; places direct ground on test wiper 73 at armature 68, and at armatures 67 and 71 connects up the line wipers 72 and 75. Ringing current is now intermittently sent out from the interrupted generator Gen. to ring the bridged bell at the called substation.

When the called party answers, a direct current circuit is closed over the line conductors 93 and 96 for the upper winding of ring cut off relay 44 and the said relay, upon energizing, closes a locking circuit for itself at armature 56, and at armatures 55 and 57 disconnects the line wipers 72 and 75 from the interrupted generator lead and its own upper winding and connects them to the upper and lower windings of back bridge relay 40. Back bridge relay 40, upon energizing, reverses the trunk conductors 31 and 34 as regards their connection

with the upper and lower windings of line relay 41 at armatures 49 and 50. This operation, however, has nothing in particular to do with the present invention but is made use of in other cases to operate meters, supervisory signals, and the like.

The calling and called subscribers may now converse with each other as desired, the talking circuits being outlined by the heavy conductors, and when the conversation is finished they both replace their receivers.

When the receiver is replaced at substation A, the circuit of line relay 41 is opened and the said relay, upon deenergizing, opens the circuit of release relay 42. Upon deenergizing, release relay 42 removes ground from the release trunk conductor 32 at armature 52, thereby allowing the line switch C to assume normal condition and unlocking the ring cut off relay 44 and switching relay 48. Upon deenergizing, switching relay 48 removes the ground potential from the private normal conductor 97 thus allowing the called line switch C′ to assume normal condition. As a further result of the deenergization of release relay 42 it closes the circuit of the release magnet 86 at armature 53. By the operation of the release magnet, the shaft and wipers of the connector H are restored to normal position, the circuit of the release magnet being broken at the off normal springs 89 by the switch shaft when it reaches normal position. The entire connection is now released and the apparatus is ready for another call.

We shall assume now that the subscriber at substation A, either by intent or by accident, calls a number belonging to a line which terminates in another group. In this case the operation of the line switch C and the connector H are the same as they were in the previous call except of course that, since different digits have been called, the wipers of the connector land upon different contacts at the end of the second and last digit. Assuming that the wipers of the connector H land upon the contacts 80—82, in which a line of another group terminates, the following circuit is closed for the discriminating relay 47: from conductor 90 by way of a previously traced circuit to the lower winding of discriminating relay 47 and thence by way of wiper 74, contact 82, conductor 91, and a portion of the battery B′ to conductor 90. Upon energizing, discriminating relay 47, closes a circuit for busy relay 45 at armature 65 as follows: from ground by way of release trunk conductor 32, armature 65 and its working contact, and busy relay 45 to battery. Busy relay 45, upon energizing, prepares the usual locking circuit for itself at armature 58 and upon the falling back of slow relay 46 becomes locked up in the usual manner. The calling subscriber is now given the usual busy signal to inform him that he cannot obtain connection with the called line.

The calling subscriber now replaces his receiver, whereupon the connection is released in the usual manner.

It is to be understood that selector switches of any well known or preferred type may be inserted between the line switch C and the connector H in case the number of lines served by the private automatic exchange is greater than can be served by a single group of connectors. In this case the only change that need be made in the selectors is that the extra conductor or the one which finally extends to the discriminating relay 47 in the present case must be carried through a pair of contacts on the switching relay of the selector and through an extra wiper in much the same manner as it is carried through the line switch C.

In case it is so desired the present system may be arranged so that the subscribers may call main exchange numbers. This can be accomplished by altering the connector H so as to rotate automatically on one level, the tenth for example, and to switch through when an idle trunk line is found; or when viewed from another angle a connector of any suitable type may be substituted for the connector H, provided such connector is furnished with a suitable discriminating relay and wiper together with the necessary circuit connections.

Having described my invention, what I consider to be new and desire 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, a plurality of groups of subscribers' lines, individual line switches for said lines, automatic switching mechanism for connecting lines accessible to all of said line switches in common, and isolating means preventing inter-group connections originating at any group.

2. In a telephone system, a plurality of groups of subscribers' lines, automatic connector switches accessible to all of said lines and having access to all of said lines, and isolating means whereby any connector which is in use by a calling line in one group is prevented from connecting with a called line in any other group.

3. In a telephone system, a plurality of private automatic exchange systems, each comprising a number of telephone lines, an automatic switchboard giving service to all of said systems, and means for preventing the establishment of all connections between lines belonging to different systems.

4. In a telephone system, a plurality of groups of subscribers' lines, an automatic

switchboard for use by all of said lines in common, a battery, a battery tap individual to each of said groups, each tap differing in potential from the others, and testing means controlled over said battery taps whereby the subscribers in each group are prevented from calling subscribers in other groups.

5. In a telephone system, a plurality of groups of lines, line switches individual to said lines, directive switches, trunk lines extending from the banks of said line switches to said directive switches, bank connections for said directive switches over which access may be had to the lines in all of said groups, means whereby the subscriber on a calling line in any group can establish a talking connection with any line in the same group by way of his line switch and one of said directive switches, and means in each directive switch responsive to prevent the establishment of the connection whenever the associated switch is used by a subscriber in one group in an attempt to call a subscriber in a different group.

6. In a telephone system, a plurality of groups of subscribers' lines, an automatic switch accessible to all of said groups of lines and having access to a plurality of said groups of lines, means whereby the subscriber on a calling line in any group to which said switch has access can operate said switch to connect with any other line in the same group, and means for preventing the said subscriber from operating said switch to connect with any line in a different group.

7. In a telephone exchange, a plurality of groups of subscribers' lines, trunk lines local to the exchange, automatic connectors local to the exchange and accessible to all said groups of lines in common over said trunk lines, and isolating means whereby a connector switch which is in use by any calling line is prevented from connecting with any other line except those lines which are in the same group with the calling line.

8. In a telephone system, a plurality of groups of lines, a connector accessible to and having access to all the lines of the groups, means in the connector jointly dependent upon the group number of the calling line and the group number of the called line for preventing the establishment of a talking connection between lines of different groups.

9. In a telephone system, a plurality of groups of lines, line switches individual one to each line, connector bank terminals at which the respective lines terminate, a connector accessible to any of said line switches for setting up a connection to any of said connector bank terminals, and means in the connector controlled jointly over the line-switch and over a connector bank terminal for rendering the called line inaccessible.

10. In a telephone system, a plurality of groups of lines, each line having an incoming branch and an outgoing branch, a device common to said lines for setting up a connection between lines, and means in said device controlled in conformity with the condition of the incoming branch of the called line and the outgoing branch of the calling line for preventing the establishment of a connection between lines of different groups.

11. In a telephone system, a plurality of groups of lines, each line having an incoming branch and an outgoing branch, both branches of all of the lines in the same group having certain related characteristics, said characteristics being different for the different groups, a device for setting up a connection between any two lines, and means in the device effective if the calling and the called lines do not have said certain related characteristics for preventing the establishment of talking connections between said lines.

12. In a telephone system, a plurality of groups of lines, a connector accessible to and having access to all the lines of the groups, means for operating the connector to select any desired line, a busy relay in the connector effective if the selected line is busy to prevent the establishment of a talking connection to the line, an additional relay in the connector, means for rendering the second named relay effective if the selected line is of a different group than is the calling line, and means controlled by said second named relay for rendering the first named relay effective independent of the busy or idle condition of the called line.

In witness whereof, I hereunto subscribe my name this 30th day of June, A. D., 1921.

ARTHUR BESSEY SMITH.