MACHINE SWITCHING TELEPHONE SYSTEM

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Fig. 11.
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Fig. 17
MACHINE SWITCHING TELEPHONE SYSTEM

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To all whom it may concern:

Be it known that I, Fritz Aldendorff, 32 Mannheimerstrasse, Wilmersdorf, Berlin, Germany, engineer, have invented certain new and useful Improvements in Machine-Switching Telephone Systems, of which the following is a clear specification.

This invention relates in general to electro-mechanically controlled telephone systems and more particularly to systems of this kind in which the numerical switches set by the selecting or dialing impulses of the calling parties are placed in "branch paths" or "by-paths" as distinguished from the "main paths" or conversational circuits or trunks through which the talking currents are conducted from one talking party to another. By-path systems of various kinds are known, one kind of such system being shown in my United States Patent No. 1221793. This invention relates amongst other features to certain features which, while partly shown in said patent, are not claimed therein. The numerical switches i. e. the switches set by dialing impulses, of the system claimed herein, after being sent onto a certain bank contact or set of bank contacts, do not execute any subsequent hunting operation for the purpose of finding an idle trunk, this operation being performed by purely non-numerical switches, said as switches or mechanisms that are not set by the subscribers' dialing impulses, but only by automatic arrangements that operate independently of the dialing or numerical impulses determined by the calling party.

The new features and combinations will appear in the following description, drawings and claims.

The invention is illustrated in the drawing in which Fig. 1 shows the general outlay of a system in which the establishing of each connection involves one group-selecting act.

Figs. 2 and 3 show the outlay of a system in which two group selecting acts are involved in each connection and Figs. 4 and 5 show a system requiring three group-selecting acts in the establishing of a talking connection.

Figs. 6 to 12 illustrate the details of the switches of a system according to Fig. 1. Fig. 7 should be placed at the right side of Fig. 6, Fig. 7 above Fig. 7, Fig. 8 beside Fig. 7, Fig. 9 beside Fig. 8, Fig. 10 beside Fig. 9, Fig. 11 beneath Fig. 8 and Fig. 12 beneath Fig. 9.

Fig. 13 illustrates the identifying means of the secondary trunk finders.

Fig. 14 shows a system in which secondary trunk finders are omitted.

Figs. 15 and 16 indicate how the trunking efficiency of a system without secondary finders may be improved.

Figs. 17 and 18 illustrate methods of reducing the number of finders employed in systems according to Figs. 1 to 13.

Fig. 18 shows diagrammatically the trunk hunting switches which extend connections from the trunks of Fig. 18.

Fig. 19 shows an application of the invention to a system without group selectors and Figs. 20 and 211 illustrate how forwardly-acting primary trunk finders may be used instead of reversibly-acting primary trunk finders.

A general idea of the new system may be imparted with the aid of Fig. 1. In this figure three groups of subscribers or switches are indicated. The subscribers' stations 1, 2, 3 of the first group are connected to quick-acting finders 4, 5, 6 to "calling line connectors" 20, 22 and to the fixed contacts of "wanted line connectors" 23, 25, 30. The subscribers' stations 11, 21, 31 of the second group and the stations 111, 211, 311 of the third group are connected like the first group to four different groups of switches. In addition to these switches each subscribers' group may have a set of calling-line-connector-findners 11, 12 (whose office it is to connect an idle quick-acting finder to an idle calling line connector) a set of group selectors 13, 14, a set of group selector connectors 9, 10, a set of primary trunk finders 18, 19, 20 a set of secondary trunk finders 16, 17 and a set of wanted-line-selector-connectors 24, 25. Similar switches in the different subscribers' groups are denoted by similar reference numerals which
have exponents that correspond to their particular groups.

The general method of connecting a calling line to a wanted line will now be explained—Suppose a subscriber 2 of the first group establishes a connection with a subscriber 311 of the third group. The switches of the system operate as follows: When the calling subscriber 2 removes his receiver from the hook a quick-acting finder, for example 7, moves its movable contacts into connection with the calling line 102 and causes a connection to be established between the calling subscriber and an idle group selector, e.g., 131, through a calling line connector finder, e.g., 111 and a group selector connector 9. The calling line connector finders 11, 12 are arranged so that they are caused to hunt for a new idle calling line connector as soon as their quick-acting finders 7, 8 have completed their function of setting a calling line connector onto a calling line and the group selector connectors 9, 10 are arranged so that when their functions in connection with a certain call are complete they start hunting for a calling line connector 4, 5 or 6 to which a calling line connector finder has already connected itself. The calling line connectors are arranged so that they start moving as soon as a quick-acting finder that happens to be connected to them makes connection with a calling line. Thus a calling line connector 5 to which a finder 7 is connected will start moving as soon as the finder 7 reaches a calling line and will then also put its brushes into connection with the calling line. Should the calling subscriber 2 start sending in his selecting impulses before the connector 5 has reached his line the selecting impulses will flow through 7, 11, 9 to the group selector 13. But as soon as the connector 5 reaches the line 102 the path through 11 and 7 is interrupted by the finder 11 connecting its quick-acting finder 7 to some other idle calling line connector, e.g., 6. The selecting impulses from the calling subscriber then flow through 5, 9 to the group selector 13. Since the calling subscriber 2 desires to connect to a subscriber 311 of the third group, he sends in a number of group selecting impulses that causes the group selector 13 to select the selecting wire 36 that leads to the motor magnets 2111, 2211, 2311 of the primary trunk finders 1811, 1911, 2011 of the desired third group.

It will be seen from Fig. 1 that for each group of secondary trunk finders 15, 16, 17, 18, 19, 20, 21, 22, 23, there is a set of trunks 37, 38, 39 and 31, 311, 3211, 33, 3311 and 3711, 3811, 3911 respectively and that all these sets of trunks are connected to all of the primary trunk finders 18, 19, 20 and 1811, 1911, 2011, 2011 respectively. The primary trunk finders are arranged so that all the idle finders of a selected group, e.g. 1811, 1911, 2011 of the third group are caused to move together as soon as a group selector, e.g. 131 is caused to move. The range of the group selector 13 will thus cause the primary trunk finders 1811, 1911, 2011 to start hunting and these finders will then continue to move until one of them finds an idle trunk, 37, 38 or 39 that leads to the calling group. The primary trunk finders are so arranged that they only test such primary trunks as lead to a group in which there is a calling line waiting for extension to a desired group. Thus if there are no group selecters 131, 141, 151, 161 in the second and third groups that have been caused to select the group of primary trunk finders 1811, 1911, 2011 these finders will only test the trunks 37, 38 and 39. The moment one of these finders, e.g. 1911 finds an idle trunk, e.g. 38, it stops and the secondary trunk finder 16, which belongs to the trunk 38 is now started and moves its brushes onto the secondary trunk which is connected to the calling line connector, 5, which has connected to the calling line 2. All the primary trunk finders except the one 1911 which found the free trunk 38 continue moving until they regain their normal positions, where they stop until they are started again by another call.

The secondary trunk finders 15, 16, 17—151, 161, 171—151, 161, 171 are arranged so that they always find the proper secondary trunk from which the call came that was passed on to them, so that wrong connections in the case of several calls being simultaneously passed to different groups are prevented with certainty. This means for preventing wrong connections is explained in subsequent paragraphs.

After a primary trunk finder 1911 and a secondary trunk finder 16 have operated in the manner described, the calling subscriber 2 will be connected through 5, 16, 41, 38, 1911, to the final trunk 4411. The wanted-line-selector-connectors 2411, 2511 will then be started and an idle wanted-line-selector, e.g. 2711, will be connected by its connector 2511 to the trunk 4411. The calling subscriber 2 now sends his selecting impulses through 5, 32, 16, 41, 38, 1911, 2511 to the selector 2711 of the selected group and sets this selector onto the line 303 of the wanted subscriber 311. As soon as this is done the "wanted-line-connector" 2911 associated with 4411 is started and its movable contacts travel until they reach the wanted line that has been designated by the selector 2711 where they stop. Identifying means are provided for preventing wrong connections in case two or more connectors are started at the same time.
A ringing current is now sent from the wanted line connector 29 to the wanted subscriber 23. When the wanted line connector connects to the wanted subscriber the wanted line selector connector and the wanted line selector are restored to their normal positions. The ringing current is sent automatically from the connector 29 to the wanted subscriber until this subscriber responds. When the wanted subscriber raises his receiver from the hook, the ringing current is stopped and the talking connection is recorded by a current path that traverses the connector and which is independent of the wanted line selector 27.

At the end of the conversation the trunk finder 19 restored to its normal position. The calling line connector 5 the wanted line connector 29 and the trunk finder 19 are not restored to definite normal positions, although they could be so arranged.

It will be seen from Fig. 1 that from each of the primary trunk finders of each group 18, 19, 20-18, 19, 20-18, 19, 20 the one trunk leads to any one calling group. From the finder 18 of the first group for example only one trunk 37, 40, leads to the finder 17 of the first group; from the finder 19 only one trunk 38, 41, leads to the finder 16 of the first group and from the finder 20 only one trunk 39, 42, leads to the finder 15 of the first group. The primary trunk finders of the other groups are similarly each provided with only one trunk to each of the different calling groups. Hence it will be clear that if a primary trunk finder e. g. 18, finds that its trunk e. g. 37, that leads to a certain calling group is engaged, a connection between the group of this primary finder and the particular calling group will only be possible through other finders 19, 20 of the same called group. For this reason it is important that when a call is passed on to a certain wanted group several primary finders are started simultaneously; should one finder be unable to take up the call on account of its trunk being engaged, some other trunk finder will take it up whose trunk is disengaged. The primary trunks will preferably be so connected to the primary trunk finders that the trunk finders of a group, e. g. 18, 19, 20 will not simultaneously reach a plurality of trunks leading to the same calling group, e. g. the trunks 37, 38, 39 but that the finders will reach such trunks one after the other. In order that the brushes of these finders are each at a different distance from the said trunks when they are started these finders are preferably arranged to start from a definite normal position.

In Fig. 1 a system is outlined in which only one group selecting function occurs in the establishing of each connection between two subscribers and which would be suitable for comparatively small exchanges having a capacity for say 1000 lines.

In Figs. 2 and 3 a system is shown that would be suitable for 10000 lines and in which two group selecting functions occur in the establishing of a connection between two subscribers.

The subscribers' stations are shown in Fig. 2 at the left and are marked with the reference signs CS. The stations that have the exponent "I" associated with the letter C of their reference signs belong to the first major group or to the first thousand, the stations with the exponent "II" belong to the second thousand and so forth. Each major group or thousand group is composed of a plurality of minor groups or hundred groups. The signs of reference of the subscribers and switches of the first hundred group in each thousand group have an index "I" appended to them, whilst the corresponding parts of the second and third hundred groups in Fig. 2 are denoted by the indexes "II" and "III." For calls or connections that originate in the first thousand group and that are to be extended to, or to be established with, other subscribers of the first thousand group, a group of primary trunk finders P1 F1, P2 F2 is provided, whilst a second group of primary trunk finders P3 F3, P4 F4 is provided for calls that originate in the second thousand group and that are to be extended to subscribers of the first thousand group. In this way a special set of primary trunk finders is provided for connections from each different thousand to the subscribers of the first thousand, so that if the exchange comprises ten different thousand groups there will be ten groups of primary trunk finders for calls that are extended to the subscribers of the first thousand group.

Similarly for calls to the second thousand a special group of primary trunk finders will also be provided for each different major or thousand group.

In Fig. 2 only two of these groups of switches P1 F1, P2 F2, and P3 F3, P4 F4 are indicated. The various groups of primary trunk finders that extend the connections from the different thousand groups to certain thousand groups are each connected by sets of trunks to further groups of switches by means of which the desired minor or hundred group in the selected thousand is selected. Thus the two illustrated groups of primary trunk finders that extend connections to the second thousand group are connected by the sets of trunks 2S F1, to 2S F2, to 2S F3, to 2S F4, Fig. 3, to the bank contacts of trunk finders 2S F1, 2S F2, 2S F3, 2S F4. The connections intended for the second thousand and that originate in the first thousand...
group are extended through the group of trunk finders 2S°F, 2S°F, 2SF°F, whilst the connections intended for the second thousand group that originate in the second thousand group are extended through the group of switches 2SF°F, 2SF°F, 2SF°F. Calls originating in the various thousand groups and that are extended to the first hundred of the second thousand are established by the group of trunk finders 2P°F, 2P°F, 2P°F, whilst the calls to the second or third hundred group of the second thousand pass through the finder groups 2P°F, 2P°F, 2P°F and 2P°F, 2P°F, 2P°F respectively. From these latter finder groups sets of trunks F°F, F°F, F°F, F°F, F°F, F°F, F°F extend to the groups of selectors 2SF°F, 2SF°F, 2SF°F, Fig. 2. The connectors FS and the quick acting finders FQ extend calls or connections in two directions.

To elucidate the path of a connection or call through a system for say 10,000 lines according to Figs. 2 and 3 it will be assumed that a subscriber CS°F is in the second hundred group of the first thousand establishes a connection with a subscriber CS°F in the third hundred of the second thousand.

The first thing that happens when the subscriber CS°F removes his receiver from his switchhook is that an idle quick acting switch or finder, e.g. 1FQ°F, places its movable contacts into connection with the calling line and connects this line through a calling line connecting finder IQ°F and a group selector connector S°C°F to an idle group selector G’S°F similarly as explained in connection with Fig. 1. As the calling subscriber desires a connection with a subscriber of the second thousand he will send selecting impulses that cause the group selector G’S°F to move its wipers onto the selecting wire that leads to the second thousand and this in turn will cause the idle finders of finder group P°F, P°F, to start hunting. This hunting action will continue until a free trunk e.g. P°F°F, leading to the calling group is found by one of the finders P°F°F, whereupon the secondary trunk finder S°F°F belonging to P°F°F will also start in search of the trunk S°F°F to which the calling subscriber CS°F is connected. In the meantime the calling line connector 1FS°F will have moved its brushes onto the calling line C’S°F which was marked by the quick acting finder 1FQ°F and the seizure of the calling line by the connector 1FS°F will have resulted in the quick-acting finder being separated from the connection and being connected to some other idle calling line connector, e.g. 1FS°F which may be a two-way switch.

The moment the secondary trunk finder S°F°F finds the secondary trunk S°F°F to which the calling subscriber CS°F is connected, the group selector G’S°F will be connected by its group selector connector S°C°F to a trunk e.g. S°F°F which has been seized by a calling line connector finder e.g. 1Q°F. The calling subscriber CS°F is now connected through 1FS°F, S°F°F, S°F°F, P°F°F, 2P°F°F, 2SF°F to the fixed contacts of the group of finders 2S°F°F, 2S°F°F, 2S°F°F. An idle second group selector, e.g. 2G’S°F, will now be connected by its group selector connector 2G’S°F to the trunk 2S°F°F. The calling subscriber then sends his hundreds selecting impulses into the group selector 2G’S°F, and causes the selector to place its movable contacts into connection with the selecting wire 2SW°F, that leads to the desired hundred group. This results in the starting of the free finders of this group, e.g. 2P°F°F, 2P°F°F. The moment one of these finders, e.g. 2P°F°F, finds a free trunk 2P°F°F, the finder 2P°F°F belonging to this trunk is started and caused to make connection with the trunk 2S°F°F. When the trunks 2S°F°F is thus extended to the trunk F°F°F the group selector 2G’S°F is separated from the connection by its connector 2G’S°F and reverts to common use. The calling subscriber CS°F is now connected through 1FS°F, S°F°F, S°F°F, P°F°F, 2P°F°F, 2S°F°F, 2P°F°F, 2P°F°F to the trunk F°F°F which leads to the third hundred group of the second thousand and thus also to the fixed contacts of the calling line connector finders 2Q°F, 2Q°F. The calling line connector finders are so arranged that those that do not happen to be engaged for calls that have originated in the selected group are started hunting and continue moving until a quick-acting finder, e.g. 2G°C°F, is connected by a connector finder to the trunk F°F°F. Circuit changes now take place in the quick-acting finder 2Q°F which cause it to act as a wanted line selector. The calling subscriber now sends selecting impulses into the compound selector switch 2FQ°F, which acts both as a quick-acting finder and as a wanted line selector, and this selects the wanted line C’S°F, whereupon the calling line connector 2FS°F°F makes connection with the wanted line marked by the switch 2FQ°F so that the calling line connector 2FS°F°F on account of its acting also as a wanted line connector, may be called a two-way connector or compound connector switch. When the two-way connector 2FS°F°F has made connection with the wanted line the compound selector switch 2FQ°F°F is separated from the connection and reverts to common use, and a ringing current is sent to the wanted station C’S°F from the two-way connector 2FS°F°F. When the called subscriber responds the ringing current is stopped, the connection is re-
corded by a recording device and the connection between the calling and called subscribers is then established as follows:

- from C5S, through 1FS,n, SFS,n, 2FS,n, P1T,n, P2F,n, 2ST,n, SF,n, PT2, P2F2, 2ST2, 2SF2, 2P1T, 2PF2, F2T, 2FS, to CSf,n.

When the called subscriber replaces his receiver at the end of the conversation the primary trunk finders P1F2 and 2P2F2 that were used for the connection are restored to their normal positions. The connection is also broken in the switches 1FS,n, SFS,n and 2FS,n; but these are not restored to definite normal positions. When the called subscriber replaces his receiver the connection is also interrupted in the compound connector switch 2FSf,n.

If the called subscriber C5S,n is the first to replace his receiver the connection is first broken in the compound connector switch 2FSf,n and in the secondary trunk finders 2STf, SFf, and the primary trunk finders P1F2 and 2P2F2 are simultaneously restored to their normal positions. Upon the calling subscriber replacing his receiver the connection is also interrupted in the compound connector switch 1FSf,n.

In an exchange or system for 100000 subscribers ten groups are formed for 10000 subscribers each and each of these groups is divided into ten minor groups for 1000 subscribers each. Each minor group is divided into ten sub-groups each having 100 subscribers and ten trunk finders. In Figs. 4 and 5 a system for 100000 subscribers is represented. In the first major group of 10000 two minor groups I, II for 1000 lines each and in the second major group two other minor groups XI, XII are illustrated.

The ten different hundred groups of the first thousand are each provided with a set of trunk finders 1, 1, 1.—11, 11, 11.—111, 111, 111 and the ten different hundred groups of the second thousand are similarly provided with ten sets of trunk finders 2, 2, 2.—22, 22, 22.—222, 222. In the same way each of the hundred groups in the second ten thousand group and in the other ten thousand groups has a set of finders 11, 11, 11.—11, 111, 111, 111 etc. Each set of finders 1, 1, 1, is connected to a set of trunks, e.g. 14, to which are connected the bank contacts of sets of finders 17, 17, 17.—18, 18, 18, each of these sets leading to a different trunk group.

Each set, e.g. 17, 17, 17 is connected by a set of trunks, e.g. 19, 19, 19, to the fixed contacts of another set of finders 20, 20, 20 in the particular trunk group. Each of these other sets of finders 20, 20, 20 is connected to a set of trunks 21 that are joined to the fixed contacts of finder groups 22, 22, 22.—23, 23, 23. Each of which leads to a different thousand group. Each of the finder groups 22, 22, 22 etc. is connected to a further set of finders 24, 24, 24 that is connected to a set of trunks 25 which in turn is joined in multiple to the fixed contacts of sets of finders 26, 26, 26.—27, 27, 27.—28, 28, 28. Each of the sets of finders 26, 26, 26.—27, 27, 27.—28, 28, 28 belongs to a different hundred group of its thousand and is connected to trunks, e.g. 29, that lead to the connectors 30, 30, 30 of a certain hundred.

The sets of finders 1, 1, 1.—20, 20, 20.—24, 24, 24 are secondary trunk finders in the sense of Fig. 1 and the sets of finders 17, 17, 17.—22, 22, 22.—26, 26, 26 are primary trunk finders in this sense. Associated with each set of primary trunk finders is a set of group selectors 31, 31 although all the group selectors are not represented in the drawing. The general connecting path in establishing connections between two subscribers in a system for 100000 subscribers will be readily traced with the aid of Figs. 4 and 5 without further explanation. It will be clear from Figs. 4 and 5 that the number of sets of finders 17, 17, 17.—18, 18, 18 provided for each thousand group will be equal to the number of major groups or ten-thousand-groups that may be selected by the thousand group. Thus in an exchange for 100000 subscribers ten such sets of finders will be provided for each thousand, this making one hundred sets of these finders for each ten thousand group. For selecting the various thousand groups of a ten thousand group each ten thousand group has ten sets of finders 22, 22, 22.—23, 23, 23. For the calls coming from the various ten thousand groups there will be in each ten thousand group altogether 100 of these latter sets of finders. Finally each thousand group has ten sets of finders such as 26, 26, 26.—27, 27, 27.—28, 28, 28 for connections with the different hundred groups of the particular thousand.

It having now been explained how an exchange for 10000 lines may be extended to 10000 lines and how a 1000 line exchange may be increased for a capacity of 100000 lines, further extensions will be understood without additional description.

The circuit details of a system according to Fig. 1 will now be described. These details are illustrated in Figs. 6 to 13.

In Fig. 6 the quick-acting finders RI, RII and "calling line connectors" VI, VII of a hundred group are shown. Fig. 7 shows the calling-line connector-finders VS1, VSI. Fig. 7 the group selectors GW1, GWII and the group-selector-connectors GVI, GVII of a hundred group.

In Fig. 8 three secondary trunk finders ZVI, ZVII, ZVIII of a hundred group and in Fig. 9 three primary trunk finders EVI, EVII, EVIII, are illustrated.

LWI, LWII in Fig. 10 represent two wanted line selectors of a hundred group.
LVII, LVII are two wanted-line-selector-connectors and SV is a wanted-line-con
nector.

Figs. 11 and 12 illustrate a set of sec-
ondary trunk finders ZE1, ZE2, ZE3 and a set of primary trunk finders E1, E2, E3 that belong to a second hundred group.

The operation of the various switches shown in Figs. 6 to 12 will be understood
from the following detail description of a connection between a calling and called sub-
scriber.

Each subscriber T is connected to the ex-
change by two wires 11, 12 and has three
wires 1, 2, 3 in the exchange by which his
line and cut-off relay 16 is connected to the
fixed contacts of calling line connectors VI,
VII and of wanted line connectors SV of his
hundred group. The wire 3 that leads to
the cut-off relay 16 is also connected to the
quick-acting finders RI, RII and to the
wanted line selectors LWI, LWII, Fig. 10.
Each subscriber T has a conversation re-
corder 17 which is connected by a wire 4 to
the contacts of the calling line connectors
VI, VII. Three additional wires 5, 6, 7 are
provided for each subscriber in the ex-
change which are multiple connected to the
contacts of the quick-acting finders of the
subscribers' hundred group. Finally each
subscriber has two identifying wires 8, 9 or
as many identifying wires as there are
quick-acting finders in his hundred group.
Each identifying wire leads to one quick-
acting finder only but is connected in mul-
tiple to the contacts of the calling line con-
nectors.

When a group selector GWI or GWII has
been caused to select a desired group the
primary trunk finders EVI, EVII, EVIII
in the selected group are made to hunt for
an idle primary trunk E1, E2, E3 leading to
the calling group. When an idle trunk
has been found the secondary trunk finder,
c. g. ZVII, belonging thereto is set in mo-
tion and caused to find the secondary trunk, c. g. Z' to which the calling subscriber is
already connected.

Each of the trunks E1, E2, E3 of every
hundred group is connected to a set of bank
contacts of a primary trunk finder in each of
the different hundred groups as indicated in Fig. 1.

It will now be assumed that a subscriber
T establishes a connection with the sub-
scriber No. 134.

When the calling subscriber T removes
his receiver from its hook a current flows
from earth through a relay 14, which is
common to all the subscribers of the calling
subscribers' hundred group, through the
bus bar 16, thence through 10, 18, 12, T, 11,
20, 21 to the negative pole of the exchange
battery. The common relay 14 is energized
and its armature contact closes the circuits
of the motor magnets 22 and 23 of the
quick-acting finders RI and RII. The cur-
rent through the magnet 22 flows from the
earth through 15, 24, 25, 26, 29 inter-
rupter 28 to the negative pole, whilst the im-
ulses through the motor magnet 23 flow
from the earth through 15, 24, 25, 27, in-
terrupter 28 to the negative pole. It will be
seen that at a moment when the magnet 23
receives a current impulse the other motor
magnet 22 will be deenergized. By this
means the movable contacts or brushes of the
one quick-acting finder RI are always caused
to reach new sets of contacts before these
sets can be reached by the brushes of the
other quick-acting finder. Hence it will not
happen that two quick-acting finders are set
onto the bank contacts of the same sub-
group of subscribers' lines at the same in-
stant and that one and the same subscriber's
line is hereby extended to two different
trunks ZI, ZII.

The quick-acting finder RI has a group
test relay 30 and the quick-acting finder RII
is equipped with a similar group test rel-
ay 31. The quick-acting finders are also
equipped with a set of individual test relays
32, 33, 34 and 35, 36, 37 respectively.

At each new current impulse through the
motor magnets of the quick-acting finders
the sets of brushes s1, s2, t1, t2, d1-c2,
s2, t2, d2-c3, s3, t3, s3, d3 and e4, s4,
t4, b4-c5, s5, t5, b5-c6, s6, t6, s6, b6,
s6 respectively are moved onto another
group of three subscribers and at each step
the brushes s1, s2, s3 and s4, s5, s6 test three
different subscribers' lines in order to ascer-
tain whether they are in a calling condi-
tion. The moment a test brush, c. g. s1,
reaches the wire 38 of a calling line a cur-
rent flows through the group test relay 30 of
the particular quick-acting finder which may be traced from the negative pole
through 39, 40, 41, 30, 42, s1, 38, 20, 11, T,
12, 18, 16, 14 to earth. The group test
relay 30 is energized and opens the circuit
of the motor magnet 22 at 25 so that the
brush sets of the finder RI stop travelling.
At the same time the contacts 42, 43, 44
are opened so as to disconnect the branch
115 circuits from the test brushes s1, s2, s3.
By contact 45 a locking circuit is closed for
the group test relay 30. By the closure of
contact 46 the group test relay causes the
energization of a relay 50 and this relay
then opens its contact 24 and thus interrupts
the circuit of the motor magnet 23 of the
second quick-acting finder, so that the sec-
ond quick-acting finder is stopped even if
other subscribers happen to be calling at
that moment. This stopping of the second
quick-acting finder lasts until the calling
substracter T is extended by quick-acting
finder RI to a trunk in the manner presently
described. In this way the danger is avoid.
ed of a brush of the second quick-acting finder being also moved onto the line of the calling subscriber T at the next step or one of the subsequent steps taken by the second finder RI before the said subscriber's line is extended through the first finder RI and before the calling condition is removed from this line. The extension of the calling line after it has been found by a quick-acting finder takes place almost immediately so that the stoppage of the second quick-acting finder only lasts a fraction of a second.

By its contact 51 the group test relay 30 connects earth to the relay 54 whilst the negative pole of the battery is connected through the contacts 52 and 48 and through the interrupter 28 alternatively to the wires 37, 58. Upon the closure of the contacts 51, 52 and 48 a current impulse first flows through the relay 54 and then further impulses flow through the relays 55, 56 in succession. The first impulse that flows through the relay 54 may be traced from the negative pole through 28, 26, 52, 55, 54, 51 to earth. This energizes the relay 54 and causes it to close a locking circuit for itself that extends from the negative pole through 60, 51 to earth. By the energization of the relay 54 a circuit through 55 is prepared at the contact 61 and as soon as the interrupter 28 connects the negative pole to the wire 27 a current flows from the negative pole through 28, 27, 48, 62, 55, 61 to earth. This energizes the relay 55 which closes a locking circuit for itself that extends from the earth through 61, 55, 63 to the negative pole. An energizing circuit is then prepared at contact 64 for the relay 56 and as soon as the interrupter 28 connects the negative pole to the wire 29 a current flows from the negative pole through 29, 26, 52, 67, 64 to earth. This energizes the relay 56 which closes an own locking circuit extending from the negative pole through 68, 64 to earth. The energizations of the relays 54, 55, 56 in rapid succession in the manner described causes the negative pole to be connected in rapid succession through a contact 53 to the test wires 69, 70 and 71. When the relay 54 is energized the application of the negative pole takes places through 53, 75, 66, 69 and upon the energization of the relay 55 the negative pole is applied through 53, 73, 65 to 70, and finally when the relay 56 is energized the negative pole is connected through 53, 72 to the wire 71.

It will thus be seen from the preceding paragraphs that when the group test relay 30 is energized the negative pole is connected at rapidly succeeding intervals to the test coils 74, 75 and 76. But the application of the negative pole to all of these coils will only happen if the third set of brushes, or the test brush s3, happens to strike the contacts of the calling line. If it were the test brush s2 of the second set of brushes that struck the calling line only the two relays 54, 55 would be energized. But if test brush s1 of the first set of brushes strikes the calling line the energizations of the chain of relays 54, 55, 56 will be stopped immediately the first relay 54 is excited. This is accomplished by the simultaneous energization of a relay 77 at the moment a relay 32, 33 or 34 is excited causing the opening of the circuit of relay 30 at the contact 39 and the interruption of the current impulses at 52 and 48 that flow from the interrupter 28 to the relays 54, 55 and 56.

The moment the relay 54 is energized as previously described an initial test current path is closed extending from the negative pole through 53, 73, 66, winding 74 of the individual test relay 32, contact 78, brush s1, to the test wire 38. If the subscriber to whom the test wire 38 belongs happens to be calling the test current path just traced will extend further through 70, 11, 1, 12, 18, 16, common relay 14 to earth and the test relay 32 will be energized. This relay then closes the contacts 79, 80, 81 and 82. By the closure of contact 79 a new circuit is completed which extends from earth through 83, Fig. 7, 77, upper winding of relay 32, 79, e1, 84, cut off relay 16 to the negative pole. The relay 77 is energized and at its contact 39 it opens the circuit of the group test relay 30 so that this relay lets its armature drop back and prevents the energizations of the relays 55 and 56 and the applications of the negative pole to the relays 33 and 34. If the test brush s2 of the second set of brushes had struck the calling line the relay 33 would have been energized in series with the relay 77 and energizations of the relays 54, 55, 56 would have progressed until the second relay 55 was energized.

The energization of the relays 77 and 32 is accompanied by the energization of the cut-off relay or line extending relay 16, and the calling line 11, 12 is thus extended to 115 the brushes, a1, b1 of the connector finder VSI, the path from 11 being through 85, 86, a2, 81, 87 to a1 and from 12 through 19, 91, b1, 82, 88 to b1.

At the moment the group test relay 30 was de-energized, the relay 50 was also de-energized by the opening of the contact 46, so that now, if other subscribers happen to be calling and to be energizing the common relay 14, current impulses will flow from the negative pole through the interrupter 28 and through 27 to the motor magnet 23 of the second quick-acting finder. This finder will then again commence moving its brushes until one or several of them strike
upon a calling line or lines. The group test relay 31 will then be energized and will stop the operation of the motor magnet and the lines that the sets of brushes are contacting with will be tested one after the other by the relays 91, 92, 93 and 35, 36, 37 until an individual calling line has been found. By the described arrangement of the quick-acting finders RI, RII according to which the brush sets of the various finders are each caused to reach a group of subscribers before this same group can be reached by the brushes of another finder and by which the individual lines upon which the brush sets of a finder stop are tested one after the other, the danger is obviated of one and the same calling line being extended to two different connector finders and of several calling lines being extended through one quick-acting finder to the same connector finder.

The danger of several calling lines being extended through the various brush sets of one and the same quick-acting finder to the same numerical switch or to the same connector finder may also be prevented by arranging the circuits of the locking windings of the test relays in such a manner that the test relay of the series cuts off the battery connection from the locking windings of the following test relays in the series.

With this arrangement the energization of the first test relay of the series would prevent the energization of the locking winding of the second and any succeeding relays.

The energization of the second test relay would prevent the energization of the locking winding of the third and any succeeding relays and so forth. This can be accomplished by providing each test relay with an extra front and back contact, by connecting the movable contact spring of the one test relay to the fixed contact of the next and by connecting the movable spring of each relay that is normally insulated to the locking winding of its particular relay. With test relays arranged in this manner the extra set of relays by which the test potential is applied to the test relays one after the other may be omitted.

As soon as the calling subscriber T is extended in the manner described to a calling line connector finder VSI an impulse relay, e.g. 94, in a group selector is energized. It has already been mentioned that each time a quick-acting finder has completed its functions in connection with a call it is immediately connected by its calling line connector-finder to another idle calling line connector, or to the trunk belonging to this connector and that a group selector is therewith also connected to this connector or trunk. The circuits and devices for accomplishing this will be explained later. For the time being it may be assumed that the brushes of the connector-finder VSI and those of the group selector connector GVII have seized the second trunk Z8 or the calling line connector VII. This being so a current will flow, when the calling line 11, 12 is extended as described, from the negative pole of the battery through 94, 95, 101, 102, 111, 112, 117, 121, 128, 131, 135, 137, 138. The calling subscriber is thus connected to the group selector GVII and as he desires a connection with the subscriber No. 134 he will cause his impulse transmitter to produce a single interruption of the circuit of the relay 94 in order to select the first hundred group. Since the relay 115 is energized by a circuit extending from earth through 49, Fig. 6, 289, 119, 120, 121, 110, 99, 115, 118 to the negative pole and as the contact 116 is thus closed, each interruption of the current flowing through the relay 94 will result in a current impulse flowing from the earth through 49, 119, 120, 121, 110, 99, 123, 116, motor magnet 124 of the group selector to the negative pole.

At each impulse the brushes 125, 128, 127, 128 of the group selector GVII are moved a step forwards onto another set of fixed contacts. As the desired number of the contacts in this case is No. 134 the calling subscriber causes only one interruption of the current flow through the relay 94 so as to shift the brushes 125, 128, 127, 128 one step forwards onto the selecting wires leading to the first hundred group. These selecting wires comprise the wires 129, 130, 131, 132 and 132'. After the calling subscriber has caused the brushes of the group selector to select the desired group as described an interval issues during which the change-over relay 129 is steadily short-circuited by the contact 118 so that it allows its armature to drop back and close the contacts 134, 135, 136, 137 and 138. Current impulses then flow from earth through the interrupter, 139, 143, 235, 125, 129, Figs. 8 and 9, 141, 142, 143 through the contacts 144, 145, 146 and through the motor magnets 147, 148, 149 of the primary trunk finders EVI, EVII, EVIII of the first hundred group. Simultaneously with the sending of current impulses through the motor magnets 147, 148, 149, the positive battery pole is applied to the contacts 153, 154, 155 of the primary trunk finders EVI, EVII, EVIII and the negative pole is applied to 150, 151, 152. These contacts correspond to the first hundred group of subscribers. If the call had come from the second hundred group the energizations of the motor magnets 147, 148, 149 would have been accompanied by the connection of the negative pole to the contacts 156, 157, 158 and of the positive pole to the contacts 159, 160, 161. When calls proceed from the third hundred group the negative pole is connected to the contacts 130.
162, 163, 164 and the positive pole to the contacts 165, 166, 167. By this means the primary trunk finders are always tested only the particular set of primary trunks that leads to the group of the calling subscriber. No testing operations occur when the brushes of the primary trunk finders wipe over the contacts of trunks that lead to non-calling groups, so that these finders never stop upon trunks which lead to a non-calling group. Thus the primary trunk finders possess the faculty of distinguishing between trunks that lead to calling groups and non-calling groups.

15 The application of the negative pole to the contacts 150, 151, 152 takes place when the change over relay 122 is deenergized as described and the path through which the negative pole is connected may be traced from the negative pole through 137, 163, Fig. 7, 128, 131 to the contacts 150, 151, 152, whilst the application of the positive pole takes place over a path extending from the earth through 169, 138, 139, Fig. 8 resistances 170, 171, 172, through the contacts 174, 178, 182 and through the wires 185, 186 and 187. The primary trunk finders EVI, EVII, EVIII whose motor magnets 147, 148, 149 are energized by current impulses from the interrupter 139, Fig. 7, and which are each equipped with a front set of seven brushes and a rear set of four brushes, now move their brushes over their fixed contact sets. The front and rear sets of brushes reach opposite sets of fixed contact sets simultaneously. Thus the front set of brushes of EVI passes over the front contacts 190, 191, 192, 193, 194, 195, 196, 197, 198 corresponding rear set of brushes wipes across the contacts 150, 196, 197, 198. The brush sets of the various primary trunk finders of each group occupy different positions with respect to the primary trunks of each group, so that the brushes of a group of finders reach the primary trunks of a trunk group one after the other. Thus the primary trunk finder EVI will reach the primary trunk E1 that leads to calling group and at the next step taken by the finder the primary trunk finder EVII will reach another trunk E1, leading to the same group. The primary trunk finder EVIII will reach the third trunk E1 when the finders execute their third steps. By this means the seizure of more than one trunk for one call is prevented. The primary trunk finders are arranged so that as soon as the one finder reaches an idle trunk leading to the calling group it stops on this trunk whilst the other finders of the group continue traveling until they regain their normal positions. These operations will now be described in detail.

It has already been explained that at the moment the primary trunk finders are started the contacts 150, 151, 152 and 153, 154, 155 that correspond to the calling group are connected to the negative and positive battery poles respectively. It will be assumed that the primary trunk E1 is busy. When the test brushes 204 and 203 reach their corresponding contacts 153 and 150 respectively a test current flows from the contact 150 that is connected to the negative pole through 204, 206, test relay 200, test brush 204, to the contact 153 that is connected to the positive pole. But as the first primary trunk E1 is busy the potential on the test contact 153 will be so low that the test relay 200 will not be energized. The primary trunk finder EVI will therefore continue moving its brushes reaching the primary trunks leading to the second, third, fourth and other hundred groups of the exchange one after the other. After the brushes of the first primary trunk finder EVI have passed the contact set of the primary trunk E1, the brushes 207, 208, 209, 210, 211, 212, 213 will reach the contacts 154, 214, 215, 216, 217, 218, 219 of the trunk E1. It will be assumed that this trunk is idle. A current will flow from the contact 151 that is connected to the negative pole through 220, 224, test relay 201, test brush 207, test contact 154, 156, 178 resistance 171, 138, 139, 138, 169 to earth or to the positive pole. This current will energize the relay 201 because the potential on the test contact of the idle trunk will be high enough to do so. The relay 201 opens the circuit of the motor magnet 148 at 143 so that the brushes of the primary trunk finder are stopped. By its contact 228 it closes a circuit that extends from the negative pole through 228, 221, 131, 127, 222, relay 234, 130 to the positive pole. The current in this circuit energizes the relay 234 and causes it to close a locking circuit for itself that extends from the negative pole through 136, 234, 236 to the positive pole of the battery. At its contact 235 the relay 234 opens the path of the current impulses from the interrupter 139 through 134, 235, 129 to the wire 129 so that the motor magnets of the primary trunk finders EVI, EVII, EVIII can no longer be energized through this current path. By opening its contact 128 the relay 234 also interrupts the connection between the negative pole and the wire 130 and the contacts 150, 151, 152 so that after the primary trunk finder EVII has seized an idle primary trunk, no further tests of primary trunks leading to the calling group will be executed by the other trunk finders. These other trunk finders EVI, EVIII now receive moving impulses from an interruptor 236 to the lead 237 of which their motor magnets are connected by their auxiliary switches 238, 239 the moment their brushes are moved away from their normal positions. As soon as these brushes regain their
normal positions the switches 238, 239 break the connections between the motor magnets 147, 149 and the wire 237 and re-establish their connections with the wire 131. But as this wire is disconnected from the interrupter 139, Fig. 7, the motor magnets 147, 149 will not receive further impulses and the primary trunk finders EVI, EVII will remain in their normal positions.

10. The test relay 201 of the primary trunk finder EVII that has seized the trunk E', completes a circuit by its contact 231 that extends from the negative pole of the battery through 239, 231, 212, 244, motor magnet 238 of the secondary trunk finder ZVII to earth. By this means the brushes 246, 247, 248, 249, 250, 251, 252 are set in motion and this motion continues until the brushes of this secondary trunk finder reach the secondary trunk ZII to which the particular calling subscriber is connected (through the quick-acting finder RI or through the calling line connector VII) whose call was passed in the manner described above through the group selector GWII and through the primary trunk finder EVII to the secondary trunk finder ZVII. An identifying means is provided by which the secondary trunk finder is able to pick out the correct calling line amongst any number of calling lines. In other words a secondary trunk finder that is started moving as a result of a call from a certain subscriber will always move its brushes onto the trunk to which this subscriber is connected but never onto any other trunk which might also happen to be connected to a calling subscriber. The identifying means by which this is accomplished includes the identifying wires 132, 132—253, 253'. Figs. 7 and 8—254, 254'. Each group selector has a separate identifying wire leading to each group of primary trunk finders. Thus the group selector GWI has its own identifying wire 132 leading to the primary trunk finder EVI, EVII, EVIII and the group selector GWII also has its own identifying wire 132 leading to the first group of finders EVI, EVII, EVIII. A separate set of identifying wires leads from the bank contacts of the secondary trunk finders ZVI, ZVII, ZVIII to each group selector connector GVI, GVI'. Thus identifying wires 253, 254 are provided that lead only to the bank contacts of the group selector connector GVI and there is a second set of identifying wires 253', 254' that leads from the banks contacts of the secondary trunk finders ZVI, ZVII, ZVIII only to the bank contacts of the group selector connector GVI'. Only when a group selector GWII is set onto a set of selecting wires 129, 130, 131, 132, 133' the identifying wire 132 belonging to this set of wires is connected to the negative pole through 126, 135. At the same moment one of the identifying wires 253 or 254 that correspond to the group selector connector GVII will be connected to the positive pole through 100 and 95. If the group selector connector GVII is connected to the second trunk Z2 the wire 254 will be connected to the positive pole. Another important point is that the identifying relay 255 in the primary trunk finder is connected in such a way that it will, in the case of GVII having seized Z2, only be excited and be caused to open the circuit of the motor magnet 238 of the secondary trunk finder ZVII if the one end of its winding is connected to the wire 132 and the other end to the wire 254. Thus as soon as the brush 248 of the secondary trunk finder reaches the contact of the wire 254, a current flows from the negative pole through 133, 126, 132, 242 lower winding 226, 210, 216, 242, 179, 248, 254, 109, 100, 95 to earth.

The identifying relay 255 is energized and opens its contacts 224, 220 whilst closing its contacts 227, 223, 225 and 233. If finding its contacts 226, 227 the relay 255 completes a locking circuit for which itself at first extends from the negative pole through 226, upper winding of 255, 227, 207, 154, 168, 178, 138, 169 to earth. By closing contact 225 the relay 255 switches the relay 201 into a locking circuit which at first extends from the negative pole through 225, 201, 207, 154, 168, 178, 171, 138, 260 to earth. At the contact 239 the current which flows from the negative pole through 238, 231, 212, 218, 244, 246 and energizes the motor magnet 238 of the secondary trunk finder ZVII is interrupted so that the brushes of this finder stop on the contacts of the trunk ZII. At the same moment the closure of contact 253 completes a circuit that extends from the negative pole through 253, 213, 219, 245, 246, 256, 106, 102, relay 257 to earth. The relay 257 is energized and by closing its contact 258 it excites the differential relay 259. This relay opens its contacts 95, 53 and closes its contacts 96, 98. By the closure of the contact 98 a locking circuit is completed for the relay 257 which extends from the earth through 257, 261, 98 to the negative pole. Through contact 96 a current is caused to flow from the negative pole through 96, the motor magnet 260, interrupter 139 to earth and this results in brushes of the group selector connector being set in motion. But, before this motion begins a circuit is completed by the closure of the contact 262 by relay 267 which extends from the earth through 262, 104, 105, 263, 249, 263 relay 265 to the negative pole, so that before the group selector connector is started the relay 265 is caused to open the contacts 130, 179, 178, 264 and to close the contacts 177, 265' 267. The relay 265 closes a locking circuit for itself, which includes 265, 250, 266, 269 and goes through 269' to earth, and from 130.
that moment the locking circuits of the relays 255 and 201 Fig. 9 no longer extend through the contact 178 and resistance 171, and through 138, 169 to earth, but through 177, 250, 268, 269 to earth.

The line of the calling subscriber is now extended through the contacts 266 and 267 to the primary trunk finder EVII.

It must now be pointed out that at the moment the line of the calling subscriber T was extended through the quick-acting finder RI to the "calling line connector finder" VSI, the relay 77, Fig. 6 was energized and completed the circuit of the motor magnet 270 of the calling line connector VII by its contact 49. The calling line connector was thus started in its operation of finding the calling line marked by the quick-acting finder or "calling line marking switch" RI, before the calling subscriber commenced sending his selecting impulses to the group selector GWII. According to the position of the contact set in the contact bank of the calling line connector VII its brushes will take a shorter or longer time to reach the calling subscriber's contacts. In some cases these brushes will reach the calling line before the selecting operation of the group selector is connected. But it may also happen that the calling line connector reaches the calling line whilst the selecting operation of the group selector is progressing. The moment the brushes of the calling line connector reach the calling line the connection of this line through the quick-acting finder is broken and is substituted by another connection through brushes of the calling line connector VII. Thus when the brushes ε, δ̄, ε, δ̄, δ̄, δ̄, δ̄, reach the fixed contacts of the calling subscriber a current flows from the negative pole through the identifying wire δ̄, Fig. 7 89, δ̄, identifying wire 271, brush δ̄, identifying wire 8, brush ε̄, 90 to the positive pole. The relay 271 is thus energized and at its contact 272 it opens the circuit of the motor magnet 270 causing the brushes of the calling line connector to stop. At the same time a circuit including the relay 279 is completed by contact 273 this circuit extending from the negative pole through 273, 279, 120, 119, 49 to the positive pole. The relay 279 opens its contact 276 and closes its contacts 274, 275, 277, 288. A new circuit is completed by contact 275 for the relay 279, this circuit extending from the negative pole through the cut-off relay 16 and through 3, ε, 275, 120, 269 to the positive pole. A starting circuit for the calling line connector finder VSI is closed by the contact 274 which may be traced from the negative pole through 274, 283, 280 right winding of the starting relay 283 to the positive pole. The relay 283 is thus energized and closes its contacts 90, 284 whilst opening its contacts 285, 83, 286, 87, 88 and 89. Through contact 284 a new circuit is closed including the right winding of relay 283 which extends from the positive pole through 284, 281, 287, 288 to the negative pole. At contact 90 the circuit of the motor magnet 280 is closed and also a circuit including the left winding of the relay 283. At each current impulse from the interrupter 291 the motor magnet 289 steps the brushes of the connector finder onto another set of contacts or onto another secondary trunk. These operations continue until the brush 281 strikes a wire similar to the wire 287 that has no connection with the negative pole.

The wires 287 of busy trunks, or of trunks that have already been seized by calling line connector finders, will be connected to the negative battery pole and this connection will be made either through a contact 288 of a release relay 114 or through a contact 286 of a starting relay. The moment the brush 284 of the connector finder finds an idle and unseized trunk and when the current impulse sent from the interrupter 291 and the left winding of the relay 283 ceases, the relay 283 lets its armature drop back and thus opens the circuit of the motor magnet 289 which results in the brushes of the calling line connector finder stopping on the contacts of an idle and unseized secondary trunk. When the relay 283 was energized the circuit including the relay 77, the upper winding of relay 32, contact 79 and the cut-off relay was opened, so that the relays 77 and 32 were de-energized. The cut-off relay 16, was, however, not energized but is kept excited by a current that flows from the earth through 269, 120, 279, 275, ε, 3, 16 to the negative pole. When the connector finder VSI seizes an idle unseized trunk it connects the negative pole to the wire 293 or 293¹ through 289, 285, 282 and thus prepares a stopping circuit for started group selector connectors. When the brush 202 of a group selector connector reaches the contact of a wire 293¹ that is connected to the negative pole a current flows through the left winding of the differential relay 259 of the particular group selector connector. The circuit of the current will extend from the earth through the left winding of relay 259, 102, 107, 293, brush 259, contact 285, contact 289 to the negative pole. In order to prevent a continuous flow of current in this circuit a relay may be inserted between the contacts 285 and 289 which is energized the moment this circuit is closed and which then opens the locking circuit of a second relay that was previously closed by the aid of relay 77. This second relay will then be deenergized and will open the connection.
between the negative pole and the brush 282 so that other group selector connectors will not stop on a seized trunk.

The current that flows through the left winding of the differential relay 259 neutralizes the magnetization produced by the right winding so that the relay 259 lets its armature drop back. The locking circuit of the relay 257 and the circuit of the motor magnet 260 are then opened at the contacts 98 and 96 respectively. The relay 257 is de-energized and opens the contacts 258, 261 and 262. The quick-acting finder RI is thus connected to an idle unsaddled secondary trunk and the group selector connector that was started when the secondary trunk finder ZVII reached the secondary trunk to which the calling subscriber is connected, is caused to move its brushes onto the trunk seized by the connector finder VSI.

The moment the relay 279 was energized a circuit was closed through the calling station T as follows: From earth through 114, 113, 278, b7, 2, 12, T, 11, 1, a7, 277, 112, 205, 209, 251, 266, 241, 215, 209, 300, 301 to the negative pole. This circuit is closed for a brief interval only and is opened the moment a free wanted line selector connector LV, Fig. 10 moves its brushes onto the final trunk SVII.

When the brushes 207, 208, 209, 210, 211, 219, 213 of the primary trunk finder EVII seized the primary trunk EVI, the energization of the test relay 201 resulted in the closure of a starting circuit for the idle line selector connectors LVI, LVII at contact 227. If both line selector connectors are idle a current flows from the negative pole through 227, Fig. 9, 320, 321, contacts 324, 325, motor magnets 322, 323, contacts 326, 327 to earth. The magnets 322, 323 move the brush sets 338, 339, 340, 341, 342—343, 344, 345, 346, 347 over their bank contacts. As soon as these brushes leave their normal positions the magnets 322, 323 are switched by switches 350, 351 and through contacts 354, 359 into circuits that do not depend upon the starting circuit 321. The said magnets now cause their brushes to travel over the contacts of the final trunks SV until a test brush 342 or 347 reaches the wire 353 that is connected by the contact 230 of the test relay 201 of the primary trunk finder EVII to earth. Assuming that the test brush 342 reaches the wire 353 first, a current will flow from the negative pole through the test relay 354, 341, 342, 353, 354, 355, 350 to earth. The test relay 354 is energized and closes a locking circuit for itself through 352 and 356. Through its contact 350 it also closes a circuit which extends from the earth through 330, 341, 357, 358, relay 350 to the negative pole and energizes the relay 359. This relay closes a locking circuit for itself which extends from the negative pole through 360, 297, 154, 186, 177, 250, 265, 260 to the positive pole. At contact 334 the relay 360 opens the test current path through the wire 353 so that other "wanted line selector connectors" cannot seize the final trunk SVII. At its contact 300 the relay 359 severs the connection between the negative pole and the wire 360, but it simultaneously establishes a new connection between the negative pole and the wire 361 through the contact 362, wire 363, brush 340, 329, 364, current impulse relay 365, negative pole of battery. The calling subscriber is now connected to the selecting impulse relay 365 of the wanted line selector LVI and current flows through this relay and the calling station T through the following circuit: battery B, 365, 364, 329, 340, 363, 362, 361, 200, 215, 241, 266, 251, 269, 295, 112, 277, a7, 1, 11, T, 12, 2, 57, 278, 113, release control relay 114 to earth.

It must now be mentioned that after the wanted line selector connector LVI has seized the final trunk SVII to which the calling subscriber is connected the other wanted line selector connectors LVII etc. either seize other calling final trunks or, if there are no other calling final trunks, are kept moving by their magnets 323 etc. until the switch 351 opens the contact 349 and thus breaks the circuit of the magnet 323. This happens the moment the brushes 343, 344, 345, 346, 347 reach their normal position.

When the brushes 338, 339, 340, 341, 342 of the wanted line selector connector LVI left their normal position a contact 356 was closed by the switch 350 and a circuit was completed from the earth through 356, contact 370, relay 371 to the negative pole. This relay 371 was energized and opened the contacts 372, 373, 374 and 398. The moment the connection between the calling subscriber and the selecting impulse relay 365 is completed in the manner described above the relay 365 is energized and a short circuit about the relay 375 is removed at 370 whilst the relay 371 is short circuited at 376. Thus the relay 375 is energized whilst the relay 371 is de-energized. By the energization of relay 375 a circuit is prepared at 367 for the lifting magnet 377 of the wanted line selector. At 378 a circuit is prepared for the change-over relay 379. As the calling subscriber desires No. 134 he will cause three breaks of the circuit including the selecting impulse relay 365 in order to select the third tens group in the selected hundreds group. The relay 365 lets its armature drop back three times in quick succession. The relays 371, 375 are kept energized during these oscillations and three impulses are sent through the lifting magnet 377 of the wanted line selector LVI.
which flow from the earth through 356, 380, 367, 381, 377, to the negative pole. The lifting magnet 377 lifts the brushes 382, 383 of the selector to the third contact level. A short pause now ensues during which the calling subscriber sends no selecting impulses and during which the relay 365 keeps its armature steadily pulled up and closes the contact 376. The relay 371 now allows its armature to drop back and a current flows from the negative pole through 373, 378, switch 384, which is closed upon the flowing of the first lifting impulse, 385, 379 to earth. The circuit changing relay 379 is thus energized and closes a locking circuit for itself which extends from the negative pole through 379, 386, 356, to earth. The relay 379 separates the selecting impulse wire 387 from the lifting magnet and connects it to the turning magnet 389 which is arranged to move the brushes 388, 389 along the contact levels of the selector. To select the desired line in the third contact level the calling subscriber now causes four interruptions of the selecting circuit which results in the selecting relay 365 allowing its armature to drop back four times. Four impulses then flow from the positive pole through 356, 380, 367, 390, 389 to the negative pole and the magnet 389 shifts the brushes 388, 389 onto the fourth set of contacts 391, 392 in the third contact level. At the end of the series of four interruptions of the selecting circuit the relay 365 again steadily attracts its armature and causes the deenergization of the relay 371, whilst the relay 375 is kept energized. The earth is thus connected through 373, 378 to the test relay 393 of the selector. If the wanted line is busy the potential on the test wire 3\textsuperscript{i} of this line will be so low that the relay 393 will not be energized. The result of this will be that a busy signal current will flow from the busy signal machine 395, through 396, contact 397 that was closed when the brushes 383, 382 were moved by the magnet 389, contact 396, brushes 340, 363, through the selecting circuit to the calling subscriber. On hearing the busy signal the subscriber replaces his receiver on his instrument and thereby causes the switches used for the connection to return to their normal positions. These restoring operations will be described in subsequent paragraphs.

If the wanted subscriber is free the test relay 393 is energized by a current that flows from the earth through 373, 378, 393, test wire 3\textsuperscript{o} of the desired line and through this wire to the relay of the wanted line that corresponds to the relay 16, Fig. 6, of the calling subscriber and to the negative pole. By the energization of the relay 393 a circuit is closed at contact 400 which extends from earth through 400, 372, 388, 401, 402, 403, motor magnet 404 of the wanted-line connector SV, to the negative pole. The motor magnet of the wanted-line connector now sets the set of brushes 405, 406, 407, a10, a10 in motion and this motion continues until the identifying relay 408 is energized by a current that flows through the identifying wire 409. This flow of current occurs as soon as the identifying brush 407 reaches the identifying wire 409. A circuit is then closed from the positive pole through 374, 383, 392, 409, 407 lower winding of the identifying relay 408, 410, 339, 411 to the negative pole. The relays 408 and 411 are thus energized simultaneously. The relay 408 opens the contact 403 and thus breaks the circuit of the motor magnet 404. The brushes of the wanted line connector are thus stopped on the line of the subscriber No. 134.

When the relay 411 is energized its contact 412 closes a circuit which extends from the earth through 412, 413, relay 414 to the negative pole. The relay 414 closes a locking circuit for itself which may be traced from the negative pole through 414, 415, 356 to the earth. Relay 414 opens its contact 364 and thus breaks the circuit of the selecting relay 365 causing its armature to fall back and to short circuit the releasing relay 375 by its contact 370. After a brief interval the release relay lets its armature drop back and its armature contact 366 connects the interrupter 416 to the magnet 389. The magnet 389 now receives current impulses which flow from the earth through 416, 417, 366, 390, 389 to the positive pole and moves the brushes 382, 383 forward to the end of the third contact row where they drop and move back to their normal position.

When the relay 411 is energized the locking circuit of relay 354 is opened at the contact 356. The armature of this relay closes the circuit of the motor magnet 322 through contact 326, 322, 348 and the motor magnet then moves the brushes of the selector connector LVI forward until it reaches its normal position, in which the contact 348 is opened and the circuit of the motor magnet 322 is broken. At the same time the locking circuit of the relays 379, 414 is broken by the opening of the contact 356 so that these relays allow their armatures to drop back.

When the relay 408 opened the circuit of the motor magnet 404 at contact 403 it also closed the circuit of a relay 421 (earth 420, 422, 421, negative pole) by its contacts 420. The relay 421 connected itself to the wire 207 through contact 425, the wire 207 being connected to earth through the contacts 209 of the relay 114, Fig. 7. The relay 421 thus closed a locking circuit for itself. At the same time it substitutes the connection be-
between the wire 363 and the negative pole that is disrupted at the contact 364 of relay 414 by a connection through the contact 492, 433 to the negative pole. The connection between the negative pole and the wire 363 is required to maintain the energization of the release relay 114, Fig. 7.

The relay 421 substitutes a connection between the earth and the wire 3 in through contact 426 and the brush 405 for the connection through the relay 393 and the contacts 378, 373 that is disrupted by the restoration of the selector LWI. As the test wire 3 is now directly connected to earth, no test relays 393 that may hereafter be connected to this wire will be energized. The busy condition of the desired line is established the moment the test relay 393 of the wanted-line selector is energized due to the test relay 393 short-circuiting a part of its winding and thus lowering the test potential on the wire 3.

By closing its contacts 427, 428 the relay 421 establishes a ringing circuit and a ringing current then flows from the ringing machine 429 through the interrupter 430, relay 431, contact 432, 438, brush 810, wire 2 of the desired line to the desired subscriber, back through wire 1, 810, 427, 433 to the ringing machine 429. When the called subscriber responds by removing his receiver from its hook the ringing current flowing through the relay 431 is strengthened sufficiently to enable this relay to attract its armature and to close its contacts 435, 436.

The contact 435 connects the wire 363 to earth and the contact 436 closes the circuit of the relay 437. This relay then connects itself to the wires 363, 364 by its contacts 488, 489, while the connection of the positive pole through 485 to the wire 363 results in the relay 440, Fig. 7, being energized by the following circuit: earth, 435, 308, 305, 208, 214, 420, 267, 262, 270, 295, 440, negative pole. The relay 440 opens its contacts 298, 297 and closes its contacts 206, 295 and by so doing switches itself into a new circuit that extends from the negative pole through 440, 206, 112, 277, 871, 171, 12, 2, 57, 278, 113, 114 to earth. By the energization of the relay 440 the meter circuit is completed, this circuit extending from the negative pole through 229, 441, 271, 4, meter 17 to earth. The connection established between the calling and called subscribers is thus registered. By the energization of the relay 437 the circuit of the ringing cut-off relay 451 is completed at contact 450 which circuit may be traced from earth through 450, 492, 451, to the negative pole. A new circuit is then closed for relay 437 which extends from earth through the right winding of 437, 439, 459, 458, 428, 810, 2, called station, wire 1, 810, 427, 434, 438 to the negative pole. The relay 427 is slow-acting and therefore the opening of the contact 436 by the disconnection of the relay 431 from the called line at the contacts 492, 433 will not result in the immediate falling back of the armature 437 and this is kept attracted until the contacts 434, 435 are properly closed and until the described circuit through the windings of the relay 437 and the station of the called subscriber is established. The opening of the contacts 433, 432 which is caused by the de-energization of the relay 451 results in the de-energization of the relay 431 and in the disconnection of the ringing machine 492 from the called line. The transmitter of the called station is now supplied with current through the windings of the relay 437, whilst the calling subscriber receives current through the windings of the relays 114 and 440. The calling and called lines are now connected to each other through the following talking current circuit: calling station T, 11, 1, 877, 112, condenser 470, 269, 291, 266, 241, 215, 209, 362, 363, 434, 427, 810, limb 1 of the wanted line No. 134, station No. 134, return limb 25, 810, 428, 433, 369, 303, 208, 214, 420, 267, 262, 270, 297, 471, 113, 278, 87, 1, 2, 12, calling station T.

When the calling subscriber T replaces his receiver at the end of the conversation he interrupts the current flowing through the relays 114, 440, Fig. 7 and this causes the connection between the wire 120 or 268 and earth to be broken by contact 268. Since the relays 279, 16, 265, 359, 301, 255, 421, 451 receive their current from earth through the wire 120 or 268 the disconnection of this connection by the de-energization of the relay 114 results in the de-energization of all the said relays. By the retraction of the armature of 201 the primary trunk finder EVIT is caused to return to its position because of the completion of the circuit of the motor magnet 148 at 145. The brushes of the other switches remain in the positions in which they happen to be, but the talking circuit is opened in these switches by the relays just mentioned.

The breaking down of the talking connection may also be brought about by the called subscriber replacing his receiver. This could be accomplished by supplying the current from earth through contact 269 to the wires 120, 268 through a resistance and by short-circuiting the relays in the various switches by causing the relay 437 to connect the negative pole to the wires 120, 268 when it is de-energized by the called subscriber replacing his receiver and opening his line loop.

The means by which the secondary trunk finders are enabled to identify the trunk that is connected to the correct calling line amongst a number of lines which are also in the calling condition have already been briefly described, but a more detailed de-
scription will now be given with the aid of Fig. 13. This figure represents the primary and secondary trunk finders of two different hundred groups. The sets of group selectors and group selector connectors belonging to these hundred groups are also shown. The various switches of Fig. 13 are marked with the same reference characters as the corresponding switches of Figs. 7, 8, 9, 11 and 12. Only the circuits or current paths of these switches that form parts of the identifying means by which the secondary trunk finders are enabled to always identify and stop upon the correct trunk Z1, Z2—z1, z2 are shown. In order that the task which the identifying circuits have to fulfill may be perfectly understood it will now be restated. Suppose a subscriber A that wishes to connect his line to the another line in the first hundred makes a call. He will first be connected in the manner previously described to a secondary trunk, e.g. Z1, which has been seized by GVI.

The calling subscriber A now selects the selecting wires leading to the desired first hundred group by the aid of the group selector GVI and starts the idle primary trunk finders EVI, EVII, EVIII of the first hundred group as previously described. One of these finders, e.g. EVII, will now seize a primary trunk E2 and the secondary trunk finder ZVII belonging thereto will then be started. This secondary trunk finder must stop its brushes on the contacts that are connected to the secondary trunk Z1 to which the calling subscriber A and the group selector connector GVI are connected. It may happen that whilst these operations are progressing another subscriber B makes a call who wishes to be connected to a subscriber in the second hundred group and who has been connected to a secondary trunk Z2 which is seized by the group selector connector GVII. The calling subscriber B moves the brushes of the group selector GWII onto the selecting wire leading to the second hundred group and thus causes the primary trunk finders EVI, EVII, EVIII to start hunting. One of these finders, e.g. EVIII, will seize an idle trunk E3, and the secondary trunk finder ZVIII belonging this trunk will be started. The secondary trunk finder ZVII started by the subscriber A (who desires the first hundred group) and the secondary trunk finder ZVIII started by the calling subscriber B (who desires the second hundred group) now move simultaneously over the contacts of the secondary trunks Z1, Z2. If the secondary trunk finder ZVIII were to stop on the trunk Z1 the calling subscriber A, who wishes to be connected to the first hundred group would be connected to the second hundred group, and if the secondary trunk finder ZVII were to stop on the trunk Z2 the calling subscriber B, who wishes to be connected to the second hundred group, would be connected to the first hundred group. To prevent wrong connections of this kind, the identifying circuits are provided which are illustrated in Fig. 13, and which always cause the secondary trunk finders to identify or distinguish the proper calling line or the secondary trunk connected to the proper calling line. It will be seen that from each group selector a separate wire (i.e. a wire connected to the particular group selector only and not to a plurality of group selectors) leads to each group of primary trunk finders. Thus a separate identifying wire 132 leads from the group selector G VI to the primary trunk finder EVI, EVII, EVIII of the first hundred group and a separate identifying wire 132 leads from the group selector GWII to the primary trunk finders of the first hundred group. In a similar manner a separate identifying wire 133 leads from the group selector G VI to the second hundred group and a separate wire 133 leads from the group selector GWII to this group.

In the same way separate identifying wires 532, 532 extend from the group selectors gw1, gw2 to the first hundred group and a separate wire from each group selector gw1, gw2 to the second hundred group. Each group selector connector also has separate identifying wires leading from its contacts to the contacts of the secondary trunk finders. Thus the group selector connector G VI has a separate set of identifying wires 253, 254, 653 and the group selector connector GVII has a separate set of identifying wires 253, 254, 653. The upper brushes e1, e2, e3 of the secondary trunk finders ZVI, ZVII, ZVIII wipe over the contacts of the identifying wires of the group selector connector G VI only, and on tracing the connections of the brushes e1, e2, e3 through the wires f1, f2, f3 and through the connections that cooperate with these wires through the brushes, 210, 210, 210 and the wires 132, 132 and through the brushes 710, 710, 710 and the wires 533, 533; it will be evident that a current through a brush e1, e2 or e3 can only flow from the positive pole connected to the brush of the group selector connector G VI to the negative pole connected to the brush 132 of the group selector G VI, which latter brush wipes over the identifying wires 132, 133. In a similar manner a circuit through the lower brushes k1, k2, k3 can only be closed by way of the brushes of the group selector connector GVII and of the corresponding group selector GWII. Therefore if a group selector CWII is set onto the wire 132 it will only be possible for a cir-
cuit to be closed through a brush $e^1$, $e^2$ or $e^3$ that comes into contact with a wire 253', 254', 653' which is connected by the corresponding group selector connector GVI to the positive pole. But as only one of these wires can be connected to the positive pole at a time the brush of the particular secondary trunk finder, e.g. the brush $e^3$ will only be able to close a circuit when it reaches the wire, e.g. 253' onto which the group selector connector GVI is set. If the secondary trunk finder ZVI is used for the talking connection the primary trunk finder EVII will have set its brushes onto the primary trunk B', and the moment the brush $e^2$ reaches the wire 253' a current will flow from the positive pole connected to the brush of GVI through 253', $e^2$, $f^2$, 210 lower windings of 255, 222, 225, 132', brush 126' of the group selector GWI to the negative pole. The relay 255' is thus energized and stops the brushes of the secondary trunk finder ZVII in the manner described in connection with Fig. 9. If the brushes of the secondary trunk finder were to contact with a secondary trunk that is connected to a group selector connector GVI' no circuit could be closed through the brush $e^2$ or $k^2$ of the secondary trunk finder ZVII because the brush 126' of the group selector GWII connects the negative pole through a brush 715', 716', or 717' only to a brush $k^1$ or $k^3$ of one of the other secondary trunk finders ZVI or ZVIII. The connecting of two primary trunk finders to one and the same secondary trunk finder, e.g. ZVII, is prevented by the testing devices of the primary trunk finders previously described.

The stopping of a secondary trunk finder that is started as the result of a call from a subscriber A upon a secondary trunk which is connected to a calling subscriber B is only possible if the two subscribers A and B select the same group. But in a case like this the identification of the subscribers by the secondary trunk finder is unnecessary. The reason why no identification takes place (nor need take place) in a case like this is that the identifying wires of the same hundred group, e.g. 132', 132, may both be connected to the negative pole at the same time. The two brushes $e$ and $k$ of the travelling secondary trunk finders will then be simultaneously connected to the negative pole and as soon as the brush $e$ or $k$ contacts with a wire connected to the positive pole, e.g. 253', 255', the upper or lower winding of the particular identifying relay, e.g. 255', will be energized and the particular secondary trunk finder ZVIII will be stopped. The simultaneous connection of the brushes $e$ and $k$ of a secondary trunk finder is, as has already been said, only possible when the group selectors GWI, GWII of a calling group are caused to select the same hundred group and if, in a case like this, the secondary trunk finder started by a calling subscriber A stops on a trunk that is connected to the other calling subscriber B, or on the trunk that is connected to A, it will make no difference since both subscribers A and B wish to be extended to the same group. The identifying means used in the calling-line connectors and in the wanted-line connectors to enable these switches to identify the correct calling or called line are based on the same inventive idea as the identifying means used in the group selectors and secondary trunk finders, so that they will be understood without any further explanations by referring to the drawings.

In the preceding paragraphs the secondary trunk finders, e.g. 15, 16, 17, Fig. 1 have been described as a revertively-acting finders. Instead of these finders forwardly acting finders could be used whose movable contacts are connected to the trunks 31, 32, 33 and whose fixed contacts are multiplied connected to the trunks 40, 41, 42.

Fig. 14 illustrates how the number of trunk finders may be reduced by omitting the secondary trunk finders. In this figure the quick-acting finders R, the calling line connectors V, the group selectors GW etc. are marked with same signs of reference as in Figs. 6 to 12. The front fixed contacts of the trunk finders EV, EV are directly connected to the trunks Zl, Zl instead of to secondary trunk finders.

The operation of this system is as follows: On a calling subscriber's receiver being removed a quick-acting finder, e.g. RI moves its brushes onto the calling line, e.g. 2, as explained in Figs. 6 and 7. The calling subscriber then causes a group selector, e.g. GW, to select the wanted group, e.g. the first group as described in Fig. 6, whereupon current impulses flow from the positive pole through the interrupter 139', brush 125', wire 129', motor magnets 147' of the idle trunk finders EVI, EVII etc. of the first group to the negative pole. If the group selector connector GVI has its brushes resting on the trunk Zl the identifying relay 253' of the finder EVI will be energized as soon as the brush 211' reaches the identifying wire 517' of the trunk Zl. The energizing current will flow from the negative pole through 190', 132', 223' upper windings of 255', 211', 217, brush 100' of the group selector connector GVI to the positive pole. The identifying relay 255' closes its contacts 300, 301 and by the closure of 301 relay 302 is energized which de-energizes the motor magnet 147' and thus stops the finder. The closure of contact 300 results in the starting of further group selector connectors or wanted-line selector connectors in the manner represented in Figs. 9 and 10 so as to connect the trunk SVI to another group selector or wanted.
line selector. When the relay 309 is energized the talking wires of the trunk Z1 are extended to the trunk SVI. By this means the calling subscriber's line 1 is also extended to the next group selector or to the wanted-line selector. In the meantime the connector VI belonging to the trunk Z1 will have moved its brushes into contact with the calling line 2 in the manner described in Fig. 6 so that the calling subscriber 2 will now be connected through the connector VI and the trunk finder EVI to the trunk SVI leading to the wanted group of lines. Many details and operations are omitted in Fig. 14 because the switches R, VS, V, EV and GW operate similarly to the corresponding switches of Figs. 6 and 7.

A drawback is involved in the system shown in Fig. 14 which will now be explained: Suppose a group selector connector GVI has set its brushes onto a trunk Z1. The trunk finder EVI or EV11 corresponding to this trunk will then have to be idle in the group selected by the calling subscriber or else the calling subscriber will not be extended to a trunk SVI in the desired group. The reason of this is that there are no further connecting paths through the fixed contact sets of the other finders EVII, EVIII or E2, E3 leading to the trunk Z1. The finder EVI thus accords the only possible connection between the selected group and the trunk Z1. But it may happen that at the moment the subscriber 2, who is connected through a quick-acting finder R and a connector-finder to a trunk Z1, selects the first group, the finder EVI that accords the only possible connection between the trunk Z1 and wanted group is being used for a connection from some other calling group. The calling subscriber in the first group would then obtain no connection even if other trunks Z2 or Z3 are still idle. This drawback can be removed by connecting each of the trunks Z1, Z2, Z3 to several finders EVI, EVII, EVIII as shown in Fig. 15 instead of connecting each to one finder only.

It will be seen from Fig. 15 that each of the trunks, e.g. Z2, Z3 are connected to the fixed contacts of two finders EVI, EVII of the first group and to two finders, EV1, EV2 of the second group. Thus each of the trunks Z2, Z3 may be extended by several trunk finders in each group to a free trunk SVI, SVII or SV1, SV2. If the connecting of the trunks Z1, Z2, etc., z1, z2, etc., to several trunk finders in each group is followed to its ultimate consequences each trunk finder EVI, EVII, etc., EV1, EV2, etc., would be provided with as many sets of bank contacts as the total number of trunks E11, E21, - E2, E2, and these trunks would be simply connected in multiple to the bank contacts of the trunk finders. On each trunk finder a contact segment would be arranged for each identifying wire from the group selectors GWI, GWII, gw1, gw2 so that the number of contact segments in each set of segments would be equal to the number of group selectors in the calling group to which the set of segments corresponds as indicated in Fig. 16. In this figure only the identifying wires and the group selectors, group selector connectors and trunk finders of two subscribers' groups are shown. A representation of the other switching paraphernalia is unnecessary because this can be inserted with the aid of the foregoing description and the Fig. 16 by anyone skilled in the art.

Another method by which the poor trunking efficiency of Fig. 14 can be removed is shown in Fig. 17. In this figure the switching devices of two subscribers' groups are represented. The subscriber T belongs to one group and the subscriber T1 to another. When a subscriber calls he is connected by a finder RI or RII to an idle group selector GWI or GWII. The finders RI, RII are preferably made quick-acting. For the sake of simpler explanation they are shown as ordinary finders in Fig. 17. When a calling subscriber T is connected to a group selector, e.g. GWI, he sets the brushes of this selector onto the desired group, e.g. the first hundred group. After the brushes of the group selector have reached the desired group a set of trunk finders EVI, EVII, EVIII in this group is started. Each of these finders has only one trunk leading to the calling group. When one of the finders has seized a free trunk, e.g. Z1, the connector VI is caused to move its brushes on to the calling line which is marked by the identifying wire connected to the quick-acting finder which took up the call. The moment the connector VI reaches the line of the calling subscriber T this line is extended through the connector VI and the particular trunk finder EVI to the trunk VLI. This leads in the manner shown in Figs. 6 to 12 to a final selector, a wanted line connector, or to another group selector as shown in Figs. 4, 5.

The detailed group selecting operations in the system shown in Fig. 17 are as follows:—When the calling subscriber T raises his receiver a current flows from the positive pole through the common relay 1, 2, 7, T, 9, 11 resistance 11 to the negative pole. The relay 1 closes contact 12 and completes the circuits of the motor magnets 13 and 20 of the finders RI, RII and these move their brushes over the subscribers' contacts. As soon as the brush 21 of a finder, e.g. RI, reaches the earthed contact 6 of the calling subscriber a current flows from the negative pole through contact 17 of the relay 22, upper winding of this relay, brush 21, 6, contact
9 of relay 50, T, 7, 2, relay 1 to the positive pole. The relay 22 of the finder RI opens the circuit through its upper winding and at its contact 18 it closes another circuit extending from the positive pole through contact 23 of the relay 51, lower winding of relay 22, brush of RI, 3, relay 60 to the negative pole. The circuit of the motor magnet 13 is opened at contact 14 so that the brushes of the finder RI stop on the bank contacts of the calling line. At the same time the relay 50 is energized and the subscriber's station T is extended through 8, 4, 16 and through 10, 5, 18 to the selecting impulse relay 37 of the group selector GWI. Another simultaneous function is the closure of the contact 10 of the relay 22 of RI by which the negative pole is connected to identifying wire e1 of the subscriber T and a stopping circuit is prepared for a subsequently operated connector.

The selecting relay 27 is energized by a current which flows through the calling subscriber's loop. By closing its contact 28 it energizes the release relay 35 in a circuit extending from the negative pole through 28, 35 to earth. The relay 35 closes its contacts 39, 40 and opens the contact 41 of the release circuit. By closing contact 39 the relay 35 completes an auxiliary locking circuit extending from the negative pole through resistance 42, 39, 35 to earth. This auxiliary locking circuit keeps the releasing relay energized until the relay 27 is steadily de-energized when the release relay will be steadily short-circuited. The closure of the contact 40 results in the energization of the relay 34 by a current flowing from the negative pole through 43, 40, 34 to earth. The change-over relay 34 opens the contacts 36, 37, 38 and thus disconnects the negative pole from the brushes of the group selector. If the relay 27 is kept steadily energized the change-over relay will be de-energized by a short-circuit from earth through 30 which will take all the current from the negative pole through 43 and 30. When the calling subscriber sends in his selecting impulses by causing openings of his loop the armature of the relay 27 falls back at each such opening. If the calling subscriber wants the first group he will cause one opening of his loop so that the armature of 27 falls back once and is then pulled up again. This causes a current impulse to flow from the negative pole through 43, 31, motor magnet 32 to the positive pole which steps the brushes of the group selector forward one step so that they engage with the selecting wire LI. The relay 34 which was energized by the opening of the contact 30 when the armature of 27 fell back lets its armature drop back again when the relay 27 is excited continually and then connects the negative pole to the three brushes of the group selector through 90, 37, 38. This energizes the motor magnets of the trunk finders EVI, EVII, EVIII of the desired group and starts them. Since these finders are all similarly arranged it is only necessary to show the circuits of one of them, e.g. EVI. When the group selector brushes 81, 82, 83 have been moved on to the desired group as described the motor magnet of this trunk finder is energized by a current flowing from the negative pole through 36, 81, starting wire 84, 63, 65 to the positive pole. The motor magnets of the other finders EVII, EVIII will be simultaneously energized in a similar manner. The group distinguishing contacts 85, 86, 87 of the finders are connected to the negative pole through the wire 88 and through brush 82 and contact 37. Hence the test relays 62 of each finder EVI, EVII, EVIII will each test a trunk Z1, Z2 and Z3 respectively when the contacts 85, 86 and 87 are reached by the brushes 89, 91 and 91 respectively, but no testing of the trunks leading to other non-calling groups will take place. It will be assumed that the trunks Z2, Z3 are busy and that the trunk Z1 is free. This being so a current will flow when the brush 80 reaches the contact 85, from the negative pole through 87, 82, 88, 58, 61, test relay 62, brush 92, wire 98 of the trunk Z1, 100, relay 101 to the positive pole. The test relay 62 is energized and short-circuits a part of its winding, whilst opening its back contact 61 and closing a new energizing circuit for itself through a front contact. This causes a strengthening of the current that flows through the relay 101 so that this relay pulls up its armature and closes the circuit of the motor magnet 102 of the connector VI. The brushes of the connector VI now travel over the contact sets of the subscribers' lines in the calling subscribers' group until the identifying brush e3, which corresponds to the identifying wire e1 of the group selector GWI or of the finder RI, reaches the identifying wire e1. The identifying relay er will then be energized by a current which flows from the positive pole through relay 24, contact 19 of the relay 22, resistance 103, lower brush of RI, e1, e3, upper winding er, wire 104, Z1, brush 97, brush 105, wire 108, brush 83 of GWI, 38 to the negative pole. If the calling subscriber had been connected by a different quick-acting finder RII to a different group selector GWII the identifying relay er would have been energized by a current that flowed through the identifying wire e2 of the second finder RII and through e4, 105, 96, 106, 108 and brush 109 of the group selector GWII.

When the relay er is energized the circuit of the relay 101 and of the motor magnet 102 is broken. Simultaneously the contact 110 of relay er is closed and a relay 111 is thus
energized which closes its contacts 112, 113, 114 and extends the line a, b, of the calling subscriber to the trunk Z1. A current then flows from earth through the release relay 116, 113, b, T, a, 112, 117, 118, 94, back contact 119 of the relay 72 of the finder EVI, resistance 115 to the negative pole.

The energization of the identifying relay was accompanied by the energization of the relay 24 of the finder RI. The latter relay opens its contact 23 and breaks the circuit including the lower winding of relay 22 and the relay 50. The relay 24 short-circuits itself by its contact 24 so that it slowly lets its armature drop back. In the meantime the relay 116 will have attracted its armature and completed a new circuit for relay 50 (through 120, 121, bottom brush of VI, 3, 50 negative pole) which is only dependent on the release relay 116.

By the de-energization of 22 the connection between the calling line and the relay 27 is disrupted. The relay 27 is thus de-energized and the contact 29 steadily closed so that the release relay of the group selector GWI is deenergized and the circuit of the release magnet 33 is closed at 41. The brushes of the group selector GWI are then restored to their normal position.

During the operations that took place after the finding of the trunk Z1 a second group selector connector, which will have been started by the closure of contact 68 of the relay 79, will have been caused, by similar means to those shewn in Fig. 10, to make connection which the trunk VLI which is put into the calling condition by the closure of contact 69. The moment this trunk is reached by the second group selector connector or wanted-line selector connector (not shown) a relay 72 is energized and this connects itself to the brush 95 and the earthed wire 121 by closing its contact 74. On the energization of relay 72 the calling line a, b is extended through the contacts 76, 78 to the trunk VLI. The remaining operations in establishing the connection with the wanted-line are similar to those of Figs. 9 and 10 which have already been described.

It will be seen that if the number of subscribers in a group is large an appreciable time might elapse before a subscriber, whose call is passed on through a quick-acting finder R to a group selector, is ultimately extended through a connector V to the desired group. If there are 100 subscribers T in a group it may happen that the brushes of the connector used will have to pass over 99 sets of contacts before reaching the calling line. In order to enable the calling subscriber T to send in the next series of selecting impulses, after the operation of the first group selector, as soon as possible it is desirable that the calling line be extended to the next numerical switch (group selector, wanted line selector) as rapidly as possible. This can be accomplished in different ways.

First, the connectors may be made quick-acting like the quick-acting finders of Fig. 6. Secondly, connectors may be used having a number of bank contact levels instead of one level only each level containing a subgroup of the whole group of lines. The brushes of the connectors will then execute a few steps to reach the sub-group or contact level of a calling line and will then execute a few more steps to reach the particular calling in the contact level. Thirdly, the circuits may be arranged so that when a group selector has operated and a free trunk has been found by a trunk finder EV the next series of impulses are sent through the brushes of the group selector to the next group selector or wanted-line selector that is connected to the particular trunk VI, so that the calling subscriber need not wait till a connector V has reached his line before sending the next series of selecting impulses.

A fourth method is to provide each subscriber's line with a forwardly-acting connector, which is started when an idle trunk Z is reached by a trunk finder EV and is then also caused to move its brushes onto the idle trunk Z found by the trunk finder EV. This fourth method is illustrated in Fig. 18 in which the switching devices of one group are represented. The trunk finders EV, the group selectors GW and the quick-acting finders R are similar to the corresponding switches of Fig. 17. But the connectors differ in that one connector V is provided for each subscriber's line whose brushes are connected to the subscriber's line. These brushes move over bank contact sets that are connected in multiple and to the trunks Z1, Z2 etc. of the subscriber's group as indicated. The trunks Z1, Z2 etc. lead to fixed contacts of different groups of trunk finders Ec. Ec in the manner shewn in Fig. 17.

When a subscriber T of Fig. 18 calls, a common relay 1 is energized and this closes the circuits of motor magnets 2 of quick-acting finders RI, RII as in Fig. 17. The brushes of the quick-acting finders are then moved over the bank contacts of the subscribers' lines until a brush set of one of the finders, for example RI, reaches the contact set of the calling subscriber T. Relays 3 and 4 are then energized and the calling subscriber is connected as in Fig. 17 to a group selector GWI. The calling subscriber now sends selecting impulses through the selecting relay 5 and thus moves the brushes of the group selector onto the selecting line, e. g. L1, that leads to the desired group. The idle trunk finders in this group, e. g. EVI, EVII are then started hunting for an idle trunk. Up to this point the operations of Fig. 18 are similar to those of Fig. 17 as previously described. When a
trunk finder, e.g. EWI, has found a free trunk Z1 its test relay 8 attracts its armature and closes a contact 10 which is absent in Fig. 7. A current flows through this contact from the negative pole through 10, 11, 12, 13, 14, relay 15, 23 to the positive pole. The relay 15 of the quick-acting finder is thus energized and closes a circuit which extends from the positive pole through 18, 19, 20, 21, 25, motor magnet 22 to the negative pole. The brushes of the connector VI of the calling subscriber are now moved and they continue to travel until a circuit is closed through the identifying wire e1 that corresponds to the quick-acting finder RI. This circuit extends from the positive pole at the group selector, through 26, 27, e3, e29, 29, 30, 31, lower winder of relay 32, e1, 33, 35, relay 34 to the negative pole.

If the other quick-acting finder RII had seized the calling line T another stopping circuit instead of the circuit just described would have been closed, and this circuit would have included the identifying wire e2, that corresponds to the quick-acting finder RII, and the wire e4 and the upper winding of the relay 32.

The circuit described in the second last paragraph energizes the relay 34 and by opening its contact 19 it breaks the circuit of the motor magnet 22 so that the brushes of VI stop on the contacts of the trunk Z1. During the motion of the brushes of VI the connection between the battery B1 and the brushes 39, 40 or 35, 36 is disrupted at the contacts 37, 38 of relay 15 and during the interval of disruption the relay 5 is kept energized by a current through the resistance 41 in order to prevent the release of the group selector GWI which would result from the de-energization of 5.

But the moment the relay 34 is energized in the manner described by a current flowing through the identifying wire, the circuit of the relay 15 is opened at 23. The relay 3 is simultaneously de-energized by the opening of 42 and by the energization of the relay 32 the relay 48 is energized through 44 and this relay closes its contacts 25, 46, 47 and opens contact 48. By the closure of contacts 46, 47 a circuit is completed from earth through the relay 49, 47, 36, T, T, 35, 46, 50, 51, 52, resistance 53 to the negative pole. The relay 49 connects earth or the positive pole to the wire 56 and the energization of the relay 4 is thus maintained by a current flowing from the negative pole through 55, 56, 54 to earth. In order that the opening of the contact 60, which happens almost immediately the relay 34 is energized, may not be followed by the immediate de-energization of the relay 4, a short-circuiting contact 21 is provided on the relay 34 which causes this relay to fall back sluggish and also causes the positive pole to remain connected through 61, 62 to the wire 63 and the relay 4 until the relay 49 has connected the positive pole through 54. In order to prevent the sure energization of the relay 32 being endangered by the quick opening of the contact 35 this relay may also be kept shunted by connection to the negative pole as long as the slowly-retracting relay keeps its armature attracted.

The de-energization of the relays 3 and 34 is followed by the deenergization of relay 5 and the restoration of the group selector GWI. By the energization of the relay 48 the calling subscriber's line is extended to the trunk VII. At the end of the conversation the connection is broken down by the de-energization of the relay 49.

Fig. 19 illustrates an application of the invention to an exchange in which no group selectors are used. RI, RII represent quick-acting finders LWI, LWII are wanted-line selectors, Vs1, Vs2, Vs3 are calling-line connectors and Vs1, Vs2, Vs3 are wanted-line connectors.

When a subscriber T calls a common relay 1 is energized in the same manner as in previous figures and this relay closes the circuits of motor magnets 2, 2' of the finders RI, RII. The moment the brushes of a finder, e.g. RI, reach the calling line the subscriber's line is extended as in the previous systems to a numerical switch, the numerical switch in Fig. 19 being a wanted-line selector LWI. The wanted-line selector is then set by selecting impulses from the calling subscriber T onto the wanted line, say the line of the subscriber T1. If this line is free the contacts 3, 4, 5 in the wanted-line selector are closed. By the closure of contact 3 the negative pole of the battery is connected to the identifying wire e3 whilst the closure of contact 4 connects the negative pole through a resistance 6 to a test wire 7. By the closure of contact 5 the circuits of the motor magnets 8, 9, 10 of the connectors Vs1, Vs2, Vs3 are completed and these magnets cause the brushes of the connectors to travel over the bank contacts of the subscribers' lines. As soon as the brushes of a connector, e.g. Vs2, reach the line selected by the selector LWI the test relay 16 of the connector is energized by a current that flows from the positive pole through the relay 16, brush 11, wire 7, brush 12, 14, resistance 6 to the negative pole. The relay 18 closes its contacts 14, 15, 16, 17 and opens its contact 18. By the closure of the contact 18 the potential on the wire 7 is reduced in a known manner, so that other connectors Vs are no longer able to seize the line of the wanted subscriber T1. By the opening of contact 18 the connector magnet 9 is de-energized so that the brushes of the connector Vs2 stop on the line of the subscriber T1. The closure of the contact 17 causes the energization of
the motor magnet 19 of the connector V2 so that the brushes of this connector are made to travel over the bank contacts of the subscribers. Since the contacts 14, 15 are closed by the relay 16 and the identifying wire e is connected by 3 to the negative pole, the upper winding of the identifying relay ev will be energized the moment the brush 20 reaches the identifying wire e that is connected to the positive pole by contact 21 and that corresponds to the finder RI or the wanted-line selector LWL. The motor magnet 19 will thus be de-energized and the calling line will be connected to the desired line T through the connectors V2, V2.

The circuits could also be arranged so that at the moment the wanted-line selector is set onto the wanted line T1 a free connector V2 is caused to connect to the calling line, whereupon the connector V2 belonging to the connector V2 is caused to find the called line by means of identifying wires.

The system will preferably be arranged (as in Figs. 17 and 18) so that when a connection between a calling and called subscriber T and T1 is established the switches R, LW revert to common use.

The connectors V2 may also be made to act as forwardly acting finders instead of revertively-acting finders as shown in Fig. 10. Each subscriber's line would then have its own connector.

In Figs. 1 to 13 the primary trunk finders, i.e. the switches 18, 19, 20 of Fig. 1 for example are shown as revertively-acting finders. They may however, be made to act as forwardly-acting finders, if a different grouping and arrangement of the trunks and of the system is employed. This system is shown in Figs. 29 and 29. In these figures three subscribers' groups, SC1, SC2, SC3—CS'2, CS'2, CS'1 are illustrated. The first group has a set of primary trunk finders FF1, FF2, FF3, a set of secondary trunk finders SF1, SF2, SF3, SF4, a set of connectors F1, F2, F3, a set of group selectors GS a set of group selectors SC and a set of wanted line selectors LW1, LW2, LW3. The other groups of subscribers are provided with sets of switches that correspond to those of the first group. The upper bank contacts of the primary trunk finders FF are connected so that each contact set of each finder leads to a wanted line selector in a different group. The lower bank contacts of the primary trunk finders FF of a group all lead to contacts of group selectors of the same (calling) subscribers' group. When a subscriber, say CS1 calls, he is first connected to a group selector GS1 and he then sets this selector onto a selecting line, e.g. 8, which leads to the desired group. A circuit is then closed through the wire 5 which includes the motor magnets d1, d2, etc., of the primary trunk finders FF1, FF2, FF3 of the wanted group so that these finders are all started. As soon as the identifying brush, e.g. b, of a primary trunk finder FF1 reaches the wire 5, which is connected through 6, 1, 9 to the negative pole, a relay f1 that corresponds to the motor magnet d1 will be energized provided that the test brush t' simultaneously contacts with a free line 510 leading to a final selector LW1 of the wanted group. At the same time an identifying wire 18 is simultaneously connected to the negative pole and a stopping circuit is thus prepared for a secondary trunk finder SF. A relay 6 in the group selector GS, is energized simultaneously with the relay f1 and this causes the energization of a motor magnet 7 of a secondary trunk finder SF, through a contact 9 and brush 11. The brushes of the secondary trunk finder are now moved until the relay 26 is energized by a current from the positive pole through 15, right winding of 26, wire 18, winding 19, contact 514 to the negative pole. The calling subscriber is now connected through a finder F1 and through the secondary trunk finder SF1 and the primary trunk finder FF1 to a final selector in the desired group. The other operations in the establishing of a connection are similar to those described in the preceding pages.

It will of course, be understood that one or more common batteries may be employed in any exchange arranged according to this invention.

It will be further mentioned that modified types of switches may be used instead of the quick-acting finders shown in Figure 6. Thus instead of driving all the sets of brushes of a quick-acting finder by a single driving device, the quick-acting finder may be split up into a number of small switches, each having one set of brushes and an individual driving mechanism. Upon a subscriber, making a call, the set of brushes that travels over the sets of bank contacts amongst which the calling subscriber's bank contacts are contained, will be set in motion and will stop on the said bank contacts, whereupon the calling line will be extended to a connection finder, group selector or wanted line selector as the case may be. Of course, the circuits will be arranged similarly to those previously described so as to prevent several calling subscribers being simultaneously extended to the same trunk.

Each quick-acting finder of Fig. 6 could also be replaced by a series of relays containing one relay for each calling line. Thus if two quick-acting switches are to be provided as in Fig. 6, and if there are 100 calling lines there would be two series of 100 relays each. The circuits of these series
of relays are so arranged that when a subscriber calls, the relay which is associated with his line in the series of relays representing the idle quick-acting switch will be energized and will extend his line to a free trunk.

I claim:

1. In a telephone system, a switch with groups of bank contacts, telephone lines connected to the groups of bank contacts, sets of brushes on the switch adapted to be shifted onto the said groups of bank contacts in succession, a link circuit coordinated to the said brushes, a group testing relay for testing each group of lines onto which the sets of brushes are set, and individual test relays for testing a line through one set of brushes and extending a free line to the said circuit.

2. In a telephone system, telephone lines, stationary contacts connected to the said telephone lines, a plurality of simultaneously moved brushes adapted to cooperate with the said stationary contacts, a link circuit, means for extending a said line through a said brush to the link circuit, and a switch for also automatically extending the said line to the said link circuit.

3. In a telephone system, talking circuits, a switch with groups of bank contacts connected to the said talking circuits, means for establishing a busy condition on each said circuit when it is taken into use, a set of brushes cooperating with the said bank contacts, a group testing means for testing a group of said talking circuits, and a testing means for testing each said talking circuit individually.

4. In a telephone system, telephone lines, means for testing said lines in groups, means for testing the lines of a group individually, a link circuit, means for connecting a free line to the link circuit with the aid of the said testing means, switches, and means for controlling the said switches by currents flowing through a telephone line and the said link circuit.

5. In a telephone system, telephone lines, a link circuit, a finder with sets of simultaneously hunting brushes, a test relay associated with each said set of brushes, means for connecting a telephone line through a set of brushes and a test relay to the link circuit, and another finder for connecting the telephone line to the said link circuit.

6. In a telephone system, telephone lines, calling means associated with the said lines, line finders with bank contacts connected to the said lines, a finder starting relay common to the said telephone lines, an energizing circuit extending through the finder starting relay and directly through any said telephone line, means for setting a said finder onto a line when it calls, and means for opening the energizing circuit when the finder is set onto the said calling line.

7. In a telephone system, telephone lines, calling means associated with the said lines, line finders with bank contacts connected to the said lines, a finder starting relay common to the said telephone lines, an energizing circuit extending through the finder starting relay and directly through any said telephone line, means for setting a said finder onto a line when it calls, and a relay associated with each line for opening the said energizing circuit when the finder is set onto the said calling line.

8. In a telephone system, subscribers' stations, numerical impulse transmitters associated with the said stations, outgoing conversational circuits, intermediate conversational link circuits between the subscribers' stations and the said outgoing conversational circuits, selectors with circuit selecting contacts that always move in the same plane and are affected only in response to said impulse transmitters, and means for automatically extending a calling subscriber's station through a free intermediate conversational link circuit to a free outgoing conversational circuit after a said selector has been set by numerical impulses from a said numerical impulse transmitter.

9. In a telephone system, subscribers' stations, numerical impulse transmitters associated with the said stations, outgoing conversational circuits, intermediate conversational link circuits between the subscribers' stations and the said outgoing conversational circuits, selectors with circuit selecting contacts that always move in the same plane and are affected only in response to said impulse transmitters, means for automatically extending a calling subscriber's station through a free intermediate conversational link circuit to a free outgoing conversational circuit after a said selector has been set by numerical impulses from a said numerical impulse transmitter, and means for disengaging a selector after a calling subscriber's station has been extended.

10. In a telephone system, subscribers' stations, numerical impulse transmitters associated with the said stations, outgoing conversational circuits, intermediate conversational link circuits between the subscribers' stations and the said outgoing conversational circuits, by-paths associated with, and fewer than, the intermediate conversational link circuits, means for connecting any free by-path to a calling subscriber's station when a subscriber makes a call, non-hunting selectors with movable contacts that always remain in one and the same plane connected in the said by-paths, and means for automatically extending a calling subscriber's station through a free intermediate conversational link circuit to a free out.
going conversational circuit after a said selector has been set by numerical impulses from a said numerical impulse transmitter.

11. In a telephone system, subscribers' stations, numerical impulse transmitters associated with the said stations, outgoing conversational circuits, intermediate conversational link circuits between the subscribers' stations and the said outgoing conversational circuits, by-paths associated with, and fewer than, the intermediate conversational link circuits, means for connecting any free by-path to a calling subscriber's station when a subscriber makes a call, non-hunting selectors with movable contacts that always remain in one and the same plane connected in the said by-paths, means for automatically extending a calling subscriber's station through a free intermediate conversational link circuit to a free outgoing conversational circuit after a said selector has been set by numerical impulses from a said numerical impulse transmitter, and means for disengaging a selector after a calling subscriber's station has been extended.

12. In a telephone system, subscribers' stations, numerical impulse transmitters associated with the said stations, outgoing conversational circuits, intermediate conversational link circuits between the subscribers' stations and the said outgoing conversational circuits, non-hunting selectors with movable contacts that always remain in one and the same plane and adapted to be set by the impulse transmitters, means for automatically extending a calling subscriber's station through a free intermediate conversational link circuit to a free outgoing conversational circuit after a said selector has been set by numerical impulses from a said numerical impulse transmitter.

13. In a telephone system, subscribers' stations, numerical impulse transmitters associated with the said stations, outgoing conversational circuits, intermediate conversational link circuits between the subscribers' stations and the said outgoing conversational circuits, non-hunting selectors with movable contacts that always remain in one and the same plane and adapted to be set by the impulse transmitters, means for automatically extending a calling subscriber's station through a free intermediate conversational link circuit to a free outgoing conversational circuit after a said selector has been set by numerical impulses from a said numerical impulse transmitter, and means for disengaging a selector after a calling subscriber's station has been extended.

14. In a telephone system, calling lines, wanted lines, a plurality of sets of conversational trunks, a plurality of numerical selecting devices with movable contacts that always remain in one and the same plane, numerical impulse transmitters associated with the calling lines, conductors for conducting a series of numerical impulses from a calling line into a first said numerical selecting device, means for subsequently conducting a second series of numerical impulses through a plurality of conversational trunks into a second numerical selecting device, and means for subsequently interconnecting a calling and called line through a number of the said conversational trunks in tandem.

15. In combination with a telephone system, an automatic switch with series of bank contacts and a plurality of sets of wipers adapted to move from one series of bank contacts to the next without passing a number of individual contacts of a series, a testing means for testing a whole series of bank contacts at a time, and means for testing each bank contact of a series separately.

16. In combination with a telephone system, a group of automatic switches each provided with series of bank contacts and a plurality of sets of wipers adapted to move from one series of bank contacts to the next without passing a number of individual contacts of a series, a testing means for testing a whole series of bank contacts at a time, means for testing each bank contact of a series separately, means for operating a plurality of these said switches simultaneously, and means for preventing mutual interference of simultaneously operating switches when connections are extended through them.

17. In combination with a telephone system, an automatic switch with series of bank contacts sets and a plurality of sets of wipers adapted to move from one series of bank contacts to the next series, a testing means for testing a whole series of bank contacts at a time, and means for testing each bank contact of a series separately.

18. In combination with a telephone system, an automatic switch with series of bank contact sets and a plurality of sets of wipers adapted to move from one series of bank contacts to the next without passing a number of individual contacts of a series, a testing means for testing a whole series of bank contacts at a time, and means for testing each bank contact of a series separately.
testing each bank contact of a series separately.

20. In combination with a telephone system, a rotary automatic switch comprising a plurality of series of bank contacts arranged in different planes, a plurality of sets of wipers adapted to move from one series of bank contacts to the next without passing a number of individual contacts of a series, a driving device for driving the said wipers from one series of bank contacts to another in succession, a testing relay for testing a whole series of bank contacts at a time, and testing relays for testing each bank contact of a series separately.

21. In an automatic telephone system, automatic line finder switches with fixed bank contacts and movable contacts cooperating with the bank contacts, a plurality of trunks of a certain character each connected to the movable contacts of a different finder switch, a plurality of trunks of a different character each connected to the movable contacts of others of the said finder switches, and calling lines connected to the multiples of all of the contact banks of the said finder switches.

22. In an automatic telephone system, automatic line finder switches with fixed bank contacts and movable contacts cooperating with the bank contacts, a plurality of trunks of a certain character each connected to the movable contacts of a different finder switch, a plurality of trunks of a different character each connected to the movable contacts of others of the said finder switches, calling lines connected to the multiples of all of the contact banks of the said finder switches, telephone instruments associated with the calling lines, and means by which a calling line is always connected to a trunk of a certain character when the telephone receiver is raised from the instrument belonging to the calling line.

23. In an electromechanically controlled telephone system, the combination of a group of trunks, a group of subscriber's lines, a plurality greater than two of sets of intermediate lines for effecting connections between the subscriber's lines and the trunks non-numerical switches, numerical switches with movable contacts that always remain in the same plane and means including a said non-numerical switch for establishing the said connections through lines of all the sets in series.

24. In an electromechanically controlled telephone system, the combination of a group of trunks, a group of subscriber's lines, a plurality greater than two of sets of intermediate lines for effecting connections between the subscriber's lines and the trunks, non-numerical switches, numerical switches with movable contacts that always remain in the same plane; means including a said non-numerical switch and a numerical switch for establishing the said connections through lines of all the sets in series, and means for preventing any line of two of the said sets of intermediate lines from being taken into engagement unless it can form part of a completed connection.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRITZ ALDENDORFF.

Witnesses:

WOLDEMANN HAUPF.
HENRY HASPER.