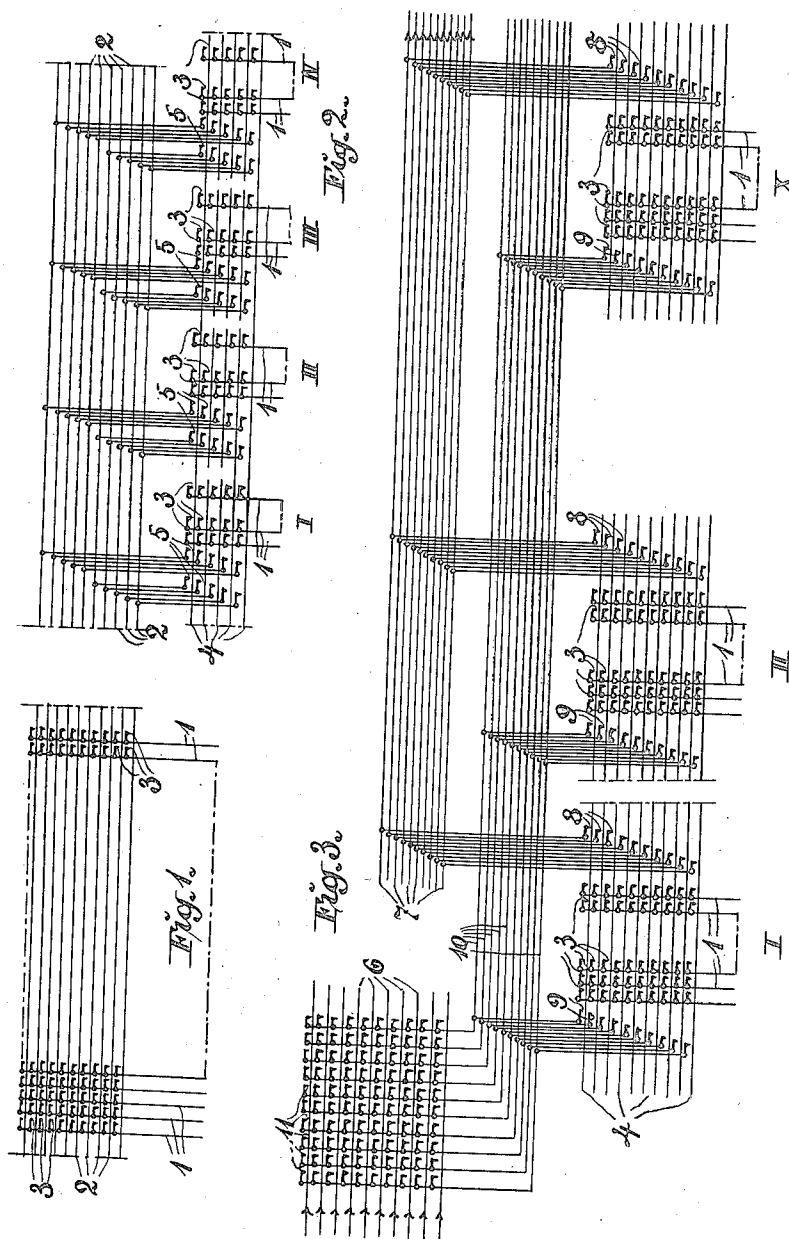


G. A. BETULANDER & N. G. PALMGREN.
 AUTOMATIC OR SEMI-AUTOMATIC TELEPHONE EXCHANGE SYSTEM.
 APPLICATION FILED APR. 17, 1914.

1,234,610.

Patented July 24, 1917.
 6 SHEETS—SHEET 1.

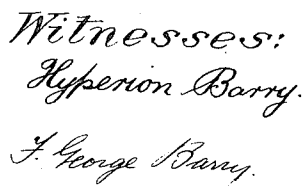


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1,234,610.

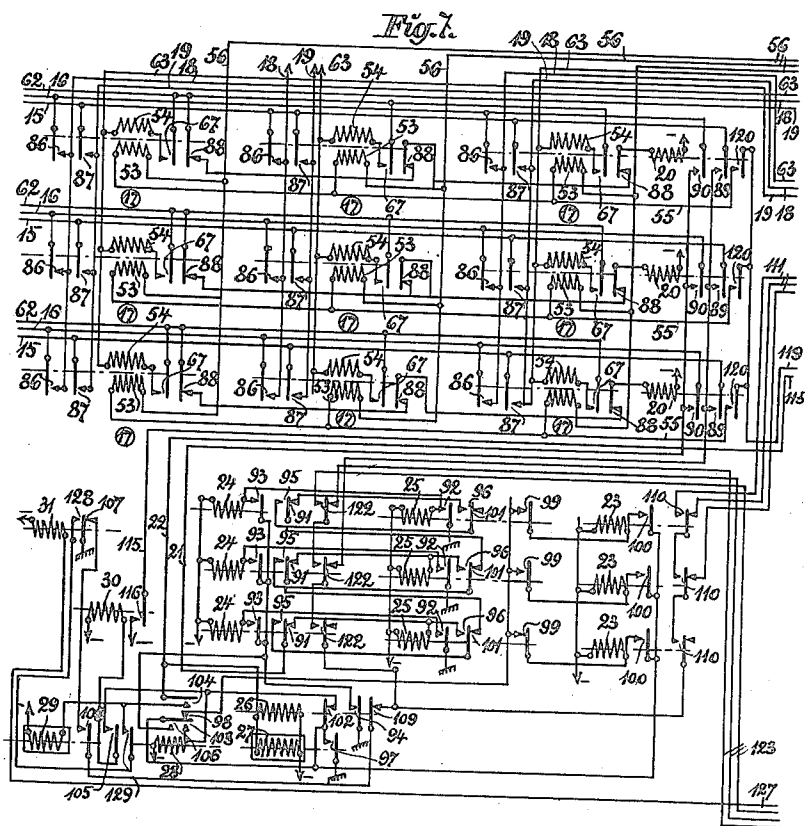
6 SHEETS—SHEET 2.



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6 SHEETS—SHEET 3.

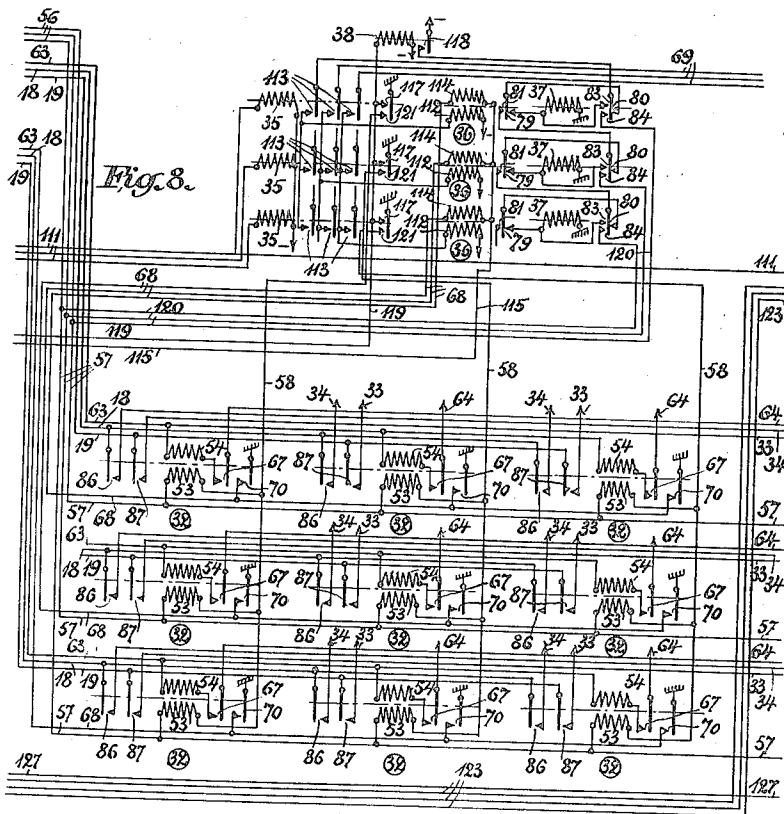


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1,234,610.

6 SHEETS--SHEET 4.



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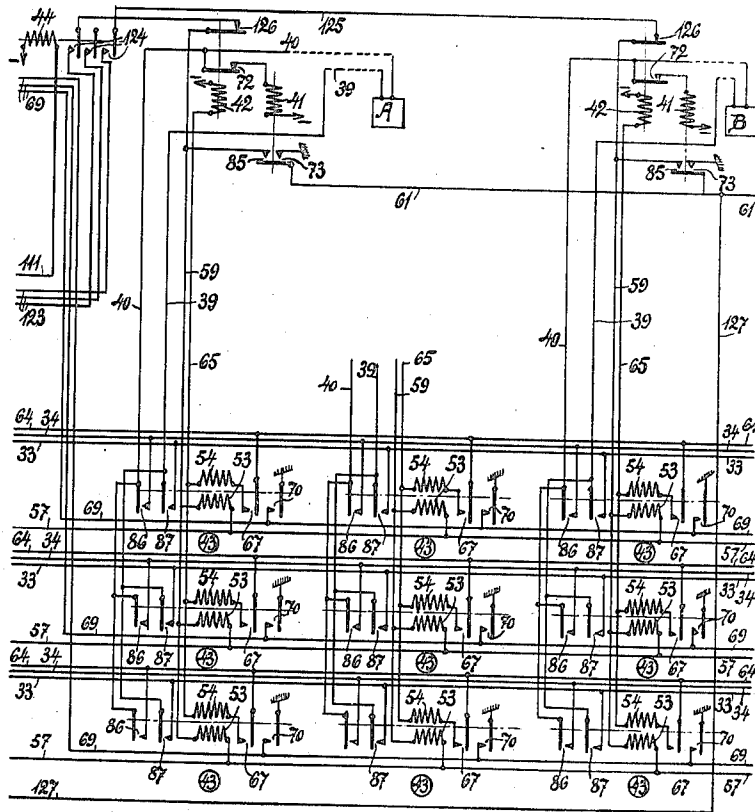
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6 SHEETS—SHEET 5.

Fig. 9



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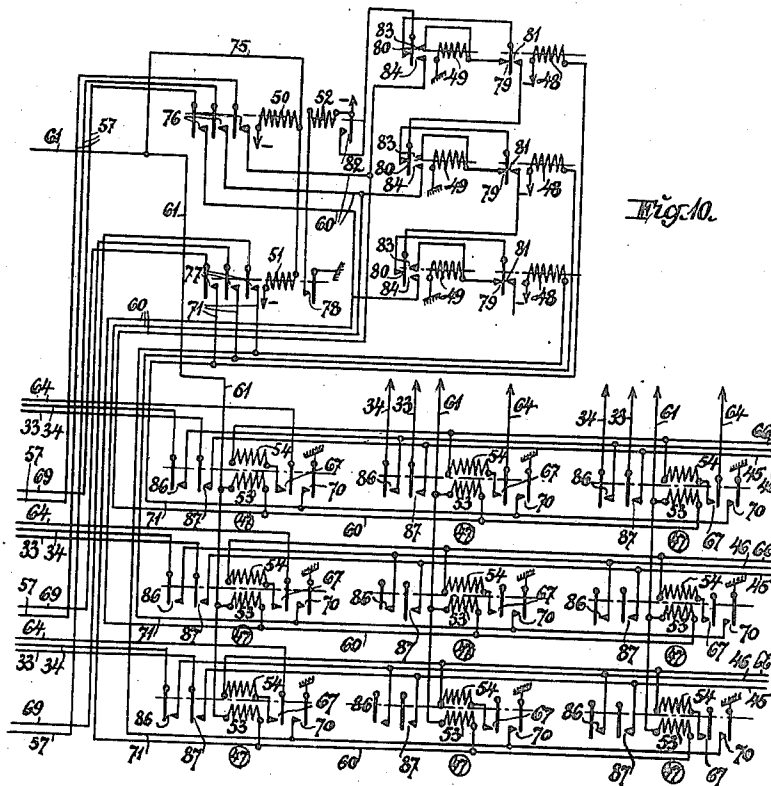
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G. A. BETULANDER & N. G. PALMGREN.
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1,234,610.

Patented July 24, 1917.
 6 SHEETS—SHEET 6.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC OR SEMI-AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

1,234,610.

Specification of Letters Patent.

Patented July 24, 1917.

Application filed April 17, 1914. Serial No. 832,471.

To all whom it may concern:

Be it known that we, GOTTHILF ANSGARIUS BETULANDER, a subject of the King of Sweden, and resident of Villa Castor, Södertörns Villastad, in the Kingdom of Sweden, and NILS GUNNAR PALMGREN, a subject of the King of Sweden, and resident of Marconi House, Strand, London, W. C., in the Kingdom of Great Britain, have invented certain new and useful Improvements in Automatic or Semi-Automatic Telephone-Exchange Systems, of which the following is a specification, reference being had therein to the accompanying drawings.

The invention relates to automatic or semi-automatic telephone exchange systems in which connections are to be established between a group of subscribers' lines at one side and the incoming and outgoing junction lines common to said subscribers' lines at the other side. The object of the invention is to reduce the number of contacts necessary for the connecting of the said lines and thus to simplify the connecting devices or to reduce the number of the same. According to the present invention the said object is gained by the said group of subscribers' lines being divided into a number of sub-groups each having at its disposal a number of intermediate lines adapted to mediate connections with any incoming as well as with any outgoing junction line.

The invention is independent of the construction of the connecting devices. It involves the greatest advantages in systems of that class in which the connections are effected exclusively by means of relays but the invention also involves considerable simplifications when selectors are used for the connecting of the lines.

The accompanying drawings show different forms of the invention. Figures 1 to 6 inclusive are simplified diagrams adapted to illustrate the principle of the invention. Fig. 1 shows a line arrangement of the hitherto ordinary type, and Fig. 2 a corresponding arrangement according to this invention. Fig. 3 shows the invention adapted to a group of subscribers' lines and the incoming and outgoing junction lines common to the said group. Figs. 4 to 6 inclusive show modifications of the arrangement shown in Fig. 3. Figs. 7 to 10 inclusive are diagrams

of circuits corresponding to the general scheme of Fig. 3.

1, Fig. 1, designates an arbitrary number of lines, for instance 100 lines, which may each be connected with any of a second group of lines 2, including for instance 10 lines. This fact may, independently of the construction of the used connecting devices, be denoted in the manner, shown in the drawings, by contacts 3 normally open and adapted to be closed by means of the said connecting devices. For instance, the contacts 3 of each line 1 may comprise the stationary contacts of a selector, allotted to the line 1, and the movable contact arm of the selector, or relay contacts, the number of the relays being the same as the number of contacts 3. The number of said contacts may now be considerably reduced by means of a line arrangement according to Fig. 2, in which the number of the lines 1 and 2 is assumed to be the same as in Fig. 1.

For that purpose the lines 1 are divided into a number of groups, four groups I, II, III, IV in the example shown in Fig. 2, each comprising 25 lines. Each of the said groups has at its disposal a number of intermediate lines 4, through which the lines 1 may be put into connection with the lines 2 each of the lines 1 being adapted to be connected with any of the intermediate lines 4 by means of contacts 3 and each of the intermediate lines 4 to be connected with two or more lines 2 by means of contacts 5. The possibility of reducing the number of the contacts is based upon the fact that the number of intermediate lines can be less than the number of lines 2 as will be explained below. In the shown example each group comprises five intermediate lines. Consequently, to each line 1 belong five contacts 3, while the contacts 5 are common to all the lines 1. The number of intermediate lines is preferably so adapted that the number of intermediate lines 4 is an aliquot of the number of lines 2, in order that the contacts 5 may be equally distributed on the intermediate lines. Thus, in the arrangement shown in Fig. 2 there are two contacts 5 for each intermediate line. The advantages in practical respect gained by the said reduction of the contacts are obvious in such systems, where the

connection is effected by means of relays and, consequently, where each contact represents one relay. In systems based upon the use of selectors the advantage of the number of stationary sets of contacts or the number of selectors being reduced is generally gained, which is of special importance in such systems, where selectors individually allotted to the subscribers' lines are used for effecting connections with incoming and outgoing junction lines, as will be explained more in detail below.

Fig. 3 shows an arrangement according to the invention for the effecting of connections between a group of 100 subscribers' lines 1 and ten incoming and ten outgoing junction lines 6 and 7 respectively common to the said lines 1 the said lines 6 and 7 corresponding substantially to the lines 2 of Fig. 2. The subscribers' lines 1 are divided into ten subgroups I, II . . . X each comprising ten lines. Each of the said groups has at its disposal ten primary intermediate lines 4 which may each be connected with the outgoing junction lines 7 respectively through contacts 8 and with ten secondary intermediate lines 10 respectively through contacts 9. Each of the lines last mentioned may be connected with anyone of the incoming junction lines 6 through contacts 11. Consequently, the primary intermediate lines 4 are used for incoming as well as for outgoing interconnections.

At first it may be assumed that the connection of the different lines is effected by means of relays only. A call outgoing from the group of subscribers' lines then first causes a searching device common to all subscribers of the group, to operate which device also may consist of relays. By testing simultaneously the intermediate lines 4 as well as the outgoing lines 7 the searching device selects a junction line 7 at the time available and then sends out a current impulse which effects the energizing of the relays corresponding to the contacts 3 and 8 in question through which the calling subscriber's line is thus directly connected to a selected free junction line. At an incoming call the connection between the calling incoming junction line 6 and the wanted subscriber's line may be effected in the following manner. The calling junction line 6 is first connected with a line-selector common to all the said lines 6, which selects the desired subscriber's line and then effects a testing of the primary intermediate lines 4 of the wanted subscriber's group as well as the secondary intermediate lines 10 thereby selecting a free intermediate line 4 corresponding to a free intermediate line 10. Immediately thereafter a current impulse is sent out which effects the energizing of the relays corresponding to the contacts 3, 9 and 11 in question. The line-selector is immediately

after ready to be set for a new connection.

When selectors are used a pre-selector may be allotted to each subscriber's line said pre-selector being adapted to select a free intermediate line 4. The contacts 8 and 9 are closed by means of relays. Moreover, either a selector is allotted to each incoming junction line 6, which selector is then adapted to select an available intermediate line 10, or a selector is allotted to each intermediate line 10 the selector then operating to find the calling junction line 6. An outgoing call causes in known manner the starting of the corresponding pre-selector. In this instance the intermediate lines are marked as engaged both if they are themselves already engaged by an outgoing or incoming conversation and if only the corresponding outgoing junction line 7 is engaged. At an incoming call the calling junction line 6 is first connected with a common line-selector, as before, which selects the wanted subscriber's line and then effects a testing of the intermediate lines 4 and 10 for the selecting and marking of an available line 4 and a corresponding free line 10. Immediately after the selectors above mentioned are started to establish the connection through the intermediate lines selected.

The number of primary intermediate lines 4 of each group I, II . . . X may at least be equal to the largest number of telephonic interconnections existing simultaneously in such a group. The said number, however, is always less than the sum of the incoming and outgoing junction lines 6 and 7 as the number of the latter is adapted for the largest number of telephonic interconnections existing simultaneously in the whole hundreds group. This forms the main advantage of the present invention. If namely the subscribers' lines should be connected with the incoming or outgoing junction lines directly without the use of intermediate lines either 20 relays must be allotted to each subscriber's line, viz, one relay for each line 6 and 7, or two selectors must be allotted to each subscriber's line one operating for outgoing calls and the other for incoming calls. Consequently, through the adopting of the present arrangement the number of relays for each subscriber's line may be considerably reduced in the first case and in the second case one and the same pre-selector may be used for outgoing as well as for incoming connections without the increasing of the number of contact sets of the selector.

The number of contacts 3, 8 and 9 and consequently the number of relays may be reduced still more by dividing the hundred subscribers into a still larger number of groups as shown in Fig. 4. In the said figure the subscribers' lines are divided into 20 groups I, II . . . XX, each comprising five

lines. Each group has at its disposal five primary intermediate lines 4 each of which is adapted to be connected with two secondary intermediate lines 10 through contacts 9 and with two outgoing junction lines 7 through contacts 8. If the relays for connecting the junction lines 6 and the intermediate lines 10 are not taken into consideration there are in an arrangement according to Fig. 3 twelve relays for each subscriber's line and in an arrangement according to Fig. 4 on the other hand only nine relays for each subscriber's line.

Figs. 5 and 6 show the manner in which also the number of contacts 11 and consequently the number of relays between the incoming junction lines 6 and the intermediate lines 10 may be considerably reduced through a similar dividing of the lines into groups and through the provision of intermediate lines. Thus in Fig. 5 the intermediate lines 10 are divided into two groups I, II the lines of each group having at their disposal five other (tertiary) intermediate lines 12 through which connection can be effected by means of contacts 13 and 14 in the same manner as through the intermediate lines in Fig. 4. In Fig. 6, on the other hand, the junction lines 6 are divided into two groups I, II. Each line 6 may be connected, in the same manner as in Fig. 5, with any intermediate line 12 belonging to the corresponding group, through contacts 13 while each intermediate line 12 may be connected with two intermediate lines 10 through contacts 14.

Figs. 7 to 10 inclusive show as an example a practical form of execution in accordance with the diagram shown in Fig. 3 the connections being effected by means of relays only. Fig. 7 shows the connecting arrangement between the lines 6 and 10 in Fig. 3 and a line-selector common to all incoming junction lines. Fig. 8 shows the arrangement between the lines 10 and the corresponding ends of the intermediate lines 4 and, further, a searching device for incoming calls, Fig. 9 shows the arrangement between a group of subscribers' lines 1 and the corresponding intermediate lines 4, and Fig. 10 shows the arrangement between the outgoing junction lines 7 and the corresponding ends of the intermediate lines 4 and, further, a searching device for outgoing calls.

For the sake of simplicity only three of the incoming junction lines 15, 16, Fig. 7, are shown. Each of the said lines may be connected with any of the secondary intermediate lines 18, 19, only three of which are shown, by means of a corresponding number of relays 17, and by means of relay 20 with a line 21, 22 extending to the line-selector. The said line-selector consists of relays only.

It comprises ten tens relays 23, ten unit

relays 24 and ten auxiliary relays 25. For the sake of simplicity only three relays of each type are shown. The circuits of the selector are controlled by a number of relays 26, 27, 28, 29, 30 and 31.

Each secondary intermediate line 18, 19 may be connected by means of a corresponding number of relays 32, Fig. 8, with any of ten primary intermediate lines 33, 34 only three of which are shown. The primary intermediate lines 33, 34 corresponding to a secondary intermediate line 18, 19 are distributed among the different tens groups of subscribers' lines, as shown most clearly in Fig. 3. The searcher shown uppermost in Fig. 8 is adapted to select a primary intermediate line 33, 34 of the tens group marked by the line-selector, and a corresponding secondary intermediate line 18, 19 through which connection can be effected between the calling junction line 15, 16 and the wanted subscriber's line, and to close the circuits necessary for the operating of the corresponding connecting relays. The searcher comprises ten group-relays 35 corresponding to the different tens groups of subscribers' lines, ten testing relays 36 and ten switching relays 37. For the sake of simplicity only three relays of each type are shown. The said searcher also comprises a current emitting relay 38 which closes the circuits determined by the relays 35, 36, 37 said circuits including the connecting relays corresponding to the selected free intermediate lines.

In Fig. 9 only three of the ten subscribers' lines 39, 40 belonging to the same group are shown. Each subscriber's line is provided with a line relay 41 and a cut-off relay 42 and may be put into connection with any one of ten primary intermediate lines 33, 34 by means of relays 43, three lines 33, 34 only being shown. A group-relay 44 belongs to each group of ten subscribers' lines which relay is operated from the line selector.

Each outgoing junction line 45, 46, Fig. 10, may be connected with any of ten primary intermediate lines 33, 34 only three of which are shown by means of relays 47. The ten primary intermediate lines belonging to each special outgoing junction line are distributed among the different tens groups of subscribers' lines as shown most clearly in Fig. 3. The searcher shown uppermost in Fig. 10 is adapted for outgoing calls and operates to select a free outgoing junction line 45 46 corresponding to a free primary intermediate line 33, 34 of the group from where the call originates. The said searcher comprises ten testing relays 48 and ten switching relays 49. Only three relays of each type are shown. The said searcher also comprises two group relays 50 and 51 and a current emitting relay 52.

The means shown in Figs. 7 to 10 inclusive are, as already stated, adapted for

a group of 100 subscribers. If the telephone exchange does not comprise more than 100 subscribers the outgoing junction lines 45, 46, Fig. 10, are connected directly with the different incoming junction lines 15, 16 respectively, Fig. 7. If the telephone exchange comprises several hundreds groups connecting means are provided in known manner between the outgoing and the incoming junction lines for the selection of the hundreds groups, thousands groups, etc., into which the subscribers' lines are divided.

The connecting relays 17, 32, 43 and 47 are provided with two windings 53, 54. The winding 53 is adapted to effect the attraction of the armature and the other winding 54 is adapted to lock the said armature in attracted position. The said windings 53, which may be called operating windings, are connected at their one end with lines extending along the different horizontal rows of relays, and at their other end with lines extending along the different vertical rows of relays. Thus in Fig. 7 the operating windings 53 for each horizontal row of relays 17 are connected at one side in parallel with a corresponding horizontal line 55, while the windings 53 of each vertical row are connected at the opposite side in parallel with a corresponding vertical line 56. The said relays 17 may be considered as interposed in the cross-points of the different horizontal and vertical lines 55 and 56 and are rendered current carrying by the connecting of the corresponding horizontal and vertical lines with the opposite poles of a connecting battery.

The operating windings 53 of the relays 32, Fig. 8, are connected in a similar manner with horizontal and vertical lines 57, 58 respectively. The relays 43, Fig. 9, have the same horizontal lines 57 as the relays 32, Fig. 8, as the lines last mentioned extend into the corresponding horizontal rows of the relays 43 but special vertical lines 59 corresponding to the different subscribers' lines 39, 40. The operating windings 53 of the relays 47, Fig. 10 are connected in the same manner with horizontal and vertical lines 60 and 61 respectively.

Parallel to the two branches of the different junction lines, intermediate lines and subscribers' lines third lines 62 and 63 (Fig. 7), 64 (Fig. 8), 65 (Fig. 9) and 66 (Fig. 10) respectively extend which may be called locking lines owing to the fact that the locking windings 54, which are to be connected in series between the said lines through the contacts 67 at the corresponding connecting relays, are kept current carrying through the said lines as long as the interconnection is maintained.

Test lines 68, 69 respectively are allotted to the intermediate lines 18, 19 and 33, 34,

Figs. 8 and 9, which test lines, when the corresponding intermediate lines are engaged, are connected with earth through a contact 70 at the corresponding connecting relay 32 and 43 respectively. The outgoing junction lines 45, 46 are provided with similar test lines 71.

Current for connecting purposes is supplied by a battery the positive pole of which is connected with earth. The said battery is not shown but pole indications (minus and earth respectively) are shown at the ends of the lines respectively.

With reference to the designations it may be observed, that similar relays and lines of the same group of relays and, further, relay contacts and lines corresponding to one another have the same designations. For the distinguishing of the relays having the same designations the relays located in the same vertical row are called "the upper," "the middle" and "the lower" relay and the relays located in the same horizontal row are called "the first," "the second" and "the third" respectively counted from the left to the right. Thus, for instance, the third connecting relay 17, counted from the left in the middle horizontal row, Fig. 1, is called "the third middle" relay 17.

It may be presumed that a subscriber A, Fig. 9, wants a conversation with a subscriber B which, for the sake of simplicity, may belong to the same hundreds group and the same tens group.

After the subscriber A has set his instrument he takes off the receiver the two line branches 39 and 40 being then first connected with earth at the sub-station. Owing to the said fact the line-relay 41 becomes current carrying through the line branch 40 and the contact 72 of the cut-off relay 42. The relay 41 attracts its armature and closes a circuit from earth through contact 73, line 61, line 75, Fig. 10, and, further, parallelly through relays 50 and 51 to the negative pole of the battery. The relay 50, upon operating, connects the horizontal lines 57 with the corresponding horizontal lines 60 through contacts 76. The relay 51 connects the test lines 69 with the corresponding test lines 71 through contacts 77. At the same time it closes the contact 78 so that the relay 52 is energized. Before the said relay has attracted its armature the testing relays 48 corresponding to engaged intermediate lines 33, 34 and junction lines 45, 46 have attracted their armatures as they have been supplied with current through a contact 70 and a test line 71 or 69 or both the test lines thereby having cut out the corresponding switching relays 49 by opening the contact 79. Presuming that only the middle outgoing junction line 45, 46 and the intermediate line 33, 34 corresponding to the

same are free simultaneously, so that only the middle relay 48 is not current carrying, a circuit is now closed from earth at the middle switching relay 49 through its winding, contact 79 of the corresponding testing relay 48, contact 80 at the relay 49 just mentioned, contact 81 of the upper testing relay 48, contact 80 of the upper switching relay 49 and contact 82 of the relay 52 to the negative pole of the battery. The middle switching relay 49, upon operating, puts itself in a locking circuit through its contact 83. At the same time a circuit is closed from earth at the line relay 41 of the calling subscriber, Fig. 9, through contact 73 and further in parallel partly through the line 61 common to the whole tens group in question, winding 53 of the first middle connecting relay 47, Fig. 10, the corresponding horizontal line 60, contact 84 of the middle switching relay 49 and contacts 81, 80 and 82 to the negative pole of the battery, partly through contact 85 of the line relay 41 in question, Fig. 9, the coördinate line 59 of the calling subscriber, winding 53 of the first middle connecting relay 43, corresponding horizontal line 57, corresponding contact 76 and line 60, Fig. 10, contact 84 of the middle switching relay 49 and contacts 81, 80 and 82 to the negative pole of the battery. The first middle connecting relay 43, Fig. 9, and the first middle connecting relay 47, Fig. 10, operate upon the closure of the said circuit the calling subscriber's line being thereby connected through contacts 86 and 87 of the relay 43 to the middle primary intermediate line 33, 34 which in its turn is connected through similar contacts 86 and 87 of the relay 47 with the corresponding outgoing junction lines 45, 46. As the branches of the subscriber's line are connected with earth at the sub-station a set of transmitting relays (not shown), connected with the outgoing junction line 45, 46 is now operated in such manner that the corresponding locking line 66, Fig. 10, is immediately connected with earth, so that a flow of current passes from earth through the said line 66, locking winding 54 of the first middle connecting relay 47, corresponding contact 67 and locking line 64, winding 54 of the first intermediate connecting relay 43, Fig. 9, corresponding contact 67 and locking line 65 and cut-off relay 42 of the calling subscriber to the negative pole of the battery. The armatures of the two connecting relays 43 and 47 are therefore maintained in attracted position as long as connection with earth is maintained at the locking line 66, Fig. 10, which is the case as long as the calling subscriber keeps his receiver in taken-off position. As the cut-off relay 42, Fig. 9, attracted its armature the circuit of the line relay 42 was

broken so that the flow of current hitherto maintained through the contact 73, ceased and the relays 50, 51, 52, 48 and 49 released their armatures.

The connecting operation is then continued in a manner immaterial to this invention, until the calling subscriber has been connected with one of the incoming junction lines 15, 16, Fig. 7, for instance the upper one. Then, at first, a flow of current passes from earth at the set of transmitting relays mentioned above through locking line 62, contact 88 of the first upper connecting relay 17, corresponding contact 88 of the two next upper relays 17 and the upper relay 20 to the negative pole of the battery. The junction line 15, 16 in question is therefore connected through contacts 89, 90 with the line 21, 22 extending to the line selector. By the action of the number switch of the calling subscriber the two line branches 15, 16 are then immediately connected with earth so that a flow of current passes partly through line branch 16, contact 90, line branch 22 and the two relays 26 and 27, connected in parallel, partly through line branch 15, contact 89, line branch 21, contact 91 at the first unit relay 24 and the corresponding auxiliary relay 25 to the negative pole of the battery. The said relays 26 and 27 attract their armatures, at first however without any effect. The relay 25 cuts in the first unit relay 24 through the contact 92 and the relay last mentioned puts itself in a locking circuit through its contact 93 and the contact 94 of the relay 26. The relay 25 is further locked through contact 95 of the relay 24 and its own contact 96. At the same time a flow of current passes from earth at the relay 27, through contact 97, contact 98 of relay 28, contact 99 of the first auxiliary relay and the first tens relay 23 to the negative pole of the battery. The relay last mentioned, upon operating, puts itself in a locking circuit through its contact 100. Through the operation at the sub-station the current through the line branch 15 is then broken a certain number of times while the line branch 16 remains current carrying. If it be assumed that the wanted subscriber belongs to the third tens group three interruptions of the current will be effected. At the first interruption the first auxiliary relay 25 releases its armature. Consequently, the next impulse in the branch 21 passes through contact 95 of the first unit relay 24, contact 101 of the corresponding auxiliary relay 25, contact 91 of the second unit relay 24 and the corresponding auxiliary relay 25 to the negative pole of the battery, the second relays 25, 24, 23 being thereby operated successively in the same manner as just described with reference to the corresponding first relays. The third

current impulse actuates in the same manner the third relays 25, 24, 23. The current is then broken for a moment in both line branches 15 and 16 whereby the third auxiliary relay 25 and the relay 26 release their armatures. Consequently, the relays 24 also release their armatures. The relay 27 is slow acting and therefore it still keeps its armature in attracted position. A circuit is therefore closed from earth at the relay 27 through contacts 97 and 102 and relay 28 to the negative pole of the battery. The relay last mentioned operates upon the closure of that circuit thereby putting itself in a locking circuit through its own contact 103 and the contact 97. When the line branches 15, 16 are immediately after again connected with earth the relay 29 is supplied with current through the line branch 22 and the contact 104 of the relay 28. The relay 29 in its turn cuts in the relay 30 through contacts 105, 103 and 97. Three interruptions of the current in the line branch 15 are now effected (it being assumed that the wanted subscriber B is the third of the tens group in question). Consequently, the three first unit-relays 24 are again cut in in the same manner as before. Upon the third interruption in the line branch 15 the current is also broken in the line branch 16 whereby the relay 26 releases its armature while the relay 27 still keeps its armature attracted for a moment. The relay 29 is slow acting and, consequently, still keeps its armature attracted for a moment so that the relay 30 is also still energized. The unit relays 24 are now supplied with current through contacts 93, contact 106 of relay 28 and contact 97 of relay 27.

When the relay 26 releases its armature a circuit is closed extending from earth at relay 31 through contacts 107, 108, 109, contacts 110 of the three tens relays 23, line 111 and, further, parallelly partly through the third group-relay 35, Fig. 8, partly through the group-relay 44, Fig. 9, of the third tens-group to the negative pole of the battery. The relay 35, Fig. 8, operates upon the closure of that circuit thereby connecting each of the windings 112 of the different testing relays 36 through contacts 113 with the test lines 69 of the primary intermediate lines 33, 34. Such windings 112 which are thereby connected with earthed test lines 69 corresponding to engaged intermediate lines are now traversed with current so that the corresponding test relays 36 attract their armatures. In this case the middle primary intermediate line 33, 34 is engaged by the subscriber A and therefore the middle test relay 36 is energized. The other windings 114 are at one side connected through line 115 and contact 116 of the relay 30, Fig. 7, with the negative pole of the battery and at the other side with each of the test lines 68

of the intermediate lines 18, 19. If it be assumed that the first of these intermediate lines is engaged the upper test relay has, consequently, also attracted its armature. When the upper group-relay 35 attracted its armature the current emitting relay 38 was cut in through contact 117. When the last mentioned relay operates a circuit is closed from earth at the lower switching relay 37 through its winding, contact 79 of the corresponding testing relay 36, contact 80 of the lower switching relay 37, contacts 81, 80, 81, 80 of the second testing relay 36 and switching relay 37 and contact 118 of the relay 38 to the negative pole of the battery. The lower switching relay 37 operates upon the closure of that circuit thereby cutting itself in a locking circuit through its contact 83. At the same time the following three circuits are closed, viz:

(1) From earth at the upper group-relay 35 through contact 117, line 119, contact 120 of the upper relay 20, Fig. 7, corresponding line 55, winding 53 of the third upper connecting relay 17, corresponding line 56, line 120, Fig. 8, and contacts 84, 81, 80, 81, 80 and 118 to the negative pole of the battery.

(2) From earth at the upper group-relay 35 through contact 121, corresponding line 58, winding 53 of the first lower connecting relay 32 corresponding line 57, line 120 and contacts 84, 81, 80, 81, 80 and 118 to the negative pole of the battery.

(3) From earth at relay 31, Fig. 7, contacts 107, 108 and 109, contacts 122 of the three unit relays 24, line 123, contact 124 of the group relay 44, Fig. 9, line 125, contact 126 of the cut-off relay 42 of the called subscriber B, line 59, winding 53 of the third lower connecting relay 43, corresponding line 57, line 120, Fig. 8, and contacts 84, 81, 80, 81, 80 and 118 to the negative pole of the battery.

The corresponding currents effect the energization of the third upper connecting relay 17, Fig. 7, the first lower connecting relay 32, Fig. 8, and the third lower connecting relay 43, Fig. 9, the first incoming junction line 15, 16, Fig. 7, being thereby connected with the line 39, 40, Fig. 9, of the wanted subscriber through the third secondary intermediate line 18, 19 and the third primary intermediate line 33, 34. At the same time a locking circuit for said connecting relays is closed from earth at the wire 62, Fig. 7, through the locking windings of said relays, corresponding lines 63, 64 and 65 and the cut-off relay 42 of the calling subscriber to the negative pole of the battery. Immediately after the relays 27 and 29, Fig. 7, release their armatures, whereby the relays of the selector and of the searcher are restored to normal position. When the connecting relay 17 attracted its armature the circuit of the cor-

responding relay 20 was broken at the contact 88 whereby the connection between the line 15, 16 and the selector was severed. The latter as well as the searcher are therefore now free and are immediately available for a subsequent call.

If the called subscriber be engaged the contact 126 of the cut-off relay 42, Fig. 9, of said subscriber is broken, and, consequently, the operating circuit of the connecting relay 43 cannot be closed. The connecting relays 17 and 32 operated will therefore be unable to keep their armatures attracted for a longer time than for the duration of the operating impulse as no locking circuit can be closed.

The relay 31, Fig. 7, has for its object to prevent the final connection with the wanted subscriber from being effected simultaneously with the selecting of an outgoing junction line in the same group. During the selection of an outgoing junction line the contact 73 of the line relay 41, Fig. 9, of the subscriber in question is closed so that a flow of current is maintained through a line 127 and the said relay 31, Fig. 7. Its contact 107 will therefore be broken until the subscriber's line in question has been connected with an outgoing junction line, the line relay 41, Fig. 9, of the subscriber being then cut off by the appertaining relay 42. In the meantime the line selector is maintained in shifted position on account of the fact that the relay 29 is kept current-carrying through contact 128 of the relay 31 and contact 129 and the relays 26 and 27 through contacts 128, 129 and 104. The current impulse initiating the selecting of intermediate lines is, consequently, not emitted until the relay 31 releases its armature and closes its contact 107.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A telephone exchange system comprising subscribers' lines divided in groups, incoming junction lines adapted to have calls to subscribers' lines effected over them and to have connections maintained over them, outgoing junction lines adapted to have calls from subscribers' lines effected over them and to have connections maintained over them, said incoming and outgoing junction lines being common to said subscribers' line, intermediate lines allotted in common to each of said groups of subscribers' lines, electrically operated connecting means for effecting connections between the subscribers' lines and the intermediate lines, electrically operated connecting means for effecting connections between the intermediate lines and the incoming junction lines and electrically operated connecting means for effecting connections between the intermediate lines and the outgoing junction lines.

2. A telephone exchange system comprising subscribers' lines divided in groups, incoming junction lines adapted to have calls to subscribers' lines effected over them, and to have connections maintained over them, outgoing junction lines adapted to have calls from subscribers' lines effected over them and to have connections maintained over them, said incoming and outgoing junction lines being common to said subscribers' lines, primary intermediate lines allotted in common to each of said groups of subscribers' lines, secondary intermediate lines interposed between the primary intermediate lines and the incoming junction lines and connecting means for effecting connections between the subscribers' lines and the outgoing junction lines through the mediation of said primary intermediate lines and between the subscribers' lines and the incoming junction lines through the mediation of said primary and secondary intermediate lines.

3. A telephone exchange system comprising subscribers' lines divided in groups, incoming junction lines adapted to have calls to subscribers' lines effected over them and to have connections maintained over them, outgoing junction lines adapted to have calls from subscribers' lines effected over them and to have connections maintained over them, said incoming and outgoing junction lines being common to said subscribers' lines, primary intermediate lines allotted in common to each of said groups of subscribers' lines, secondary intermediate lines divided in groups, tertiary intermediate lines allotted in common to each of said groups of secondary intermediate lines and connecting means for effecting connections between the subscribers' lines and the outgoing junction lines through the mediation of said primary intermediate lines and between the subscribers' lines and the incoming junction lines through the mediation of said primary, secondary and tertiary intermediate lines.

4. A telephone exchange system comprising subscribers' lines divided in groups, incoming and outgoing junction lines common to said subscribers' lines, intermediate lines allotted in common to each of said groups of subscribers' lines, connecting relays for effecting connections between the subscribers' lines and the incoming and outgoing junction lines through the mediation of said intermediate lines, locking circuits for said connecting relays, cut-off relays individually allotted to the subscribers and adapted, upon being energized, to be included in said locking circuits thereby marking the corresponding subscribers as engaged during the duration of the telephonic interconnection.

5. A telephone exchange system comprising subscribers' lines divided in groups, in-

coming and outgoing junction lines common to said subscribers' lines, intermediate lines allotted in common to each of said groups of subscribers' lines, connecting relays for effecting connections between the subscribers' lines and the incoming and outgoing junction lines through the mediation of said intermediate lines, operating circuits for said connecting relays and cut-off relays individually allotted to the subscribers and adapted, upon being energized, to open a contact included in the operating circuit of the connecting relays pertaining to the corresponding subscriber's line.

6. A telephone exchange system comprising subscribers' lines divided in groups, incoming junction lines adapted to have calls to subscribers' lines effected over them and to have connections maintained over them, outgoing junction lines adapted to have calls from subscribers' lines effected over them and to have connections maintained over them, said incoming and outgoing junction lines being common to said subscribers' lines, intermediate lines allotted in common to each of said groups of subscribers' lines, connecting means for effecting connections between the subscribers' lines and the intermediate lines and between the intermediate lines and the incoming and outgoing junction lines, said connections being effected simultaneously, and means adapted to prevent the completion of a connection with a subscriber's line during the establishing of a connection with an outgoing junction line.

7. A telephone exchange system comprising subscribers' lines, incoming junction lines adapted to have calls to subscribers' lines effected over them and to have connections maintained over them, outgoing junction lines adapted to have calls from sub-

scribers' lines effected over them and to have connections maintained over them, said incoming and outgoing junction lines being common to said subscribers' lines, primary intermediate lines adapted to mediate connections between the subscribers' lines and the incoming as well as the outgoing junction lines, secondary intermediate lines adapted to mediate connections between the primary intermediate lines and the incoming junction lines and automatic switches allotted individually to the subscribers' lines and the incoming junction lines.

8. A telephone exchange system comprising subscribers' lines, incoming junction lines adapted to have calls to subscribers' lines effected over them and to have connections maintained over them, outgoing junction lines adapted to have calls from subscribers' lines effected over them and to have connections maintained over them, said incoming and outgoing junction lines being common to said subscribers' lines, primary intermediate lines adapted to mediate connections between the subscribers' lines and the incoming as well as the outgoing junction lines, secondary intermediate lines adapted to mediate connections between the primary intermediate lines and the incoming junction lines and automatic switches allotted individually to the subscribers' lines and the secondary intermediate lines.

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

GOTHILF ANSGARIUS BETULANDER.
NILS GUNNAR PALMGREN.

Witnesses:

OSCAR GRAHN,
HALMER JANSON.