C. A. W. HULTMAN.

SEMIAUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED DEC. 23, 1918.

1,431,116.

Patented Oct. 3, 1922.

12 SHEETS—SHEET 1.

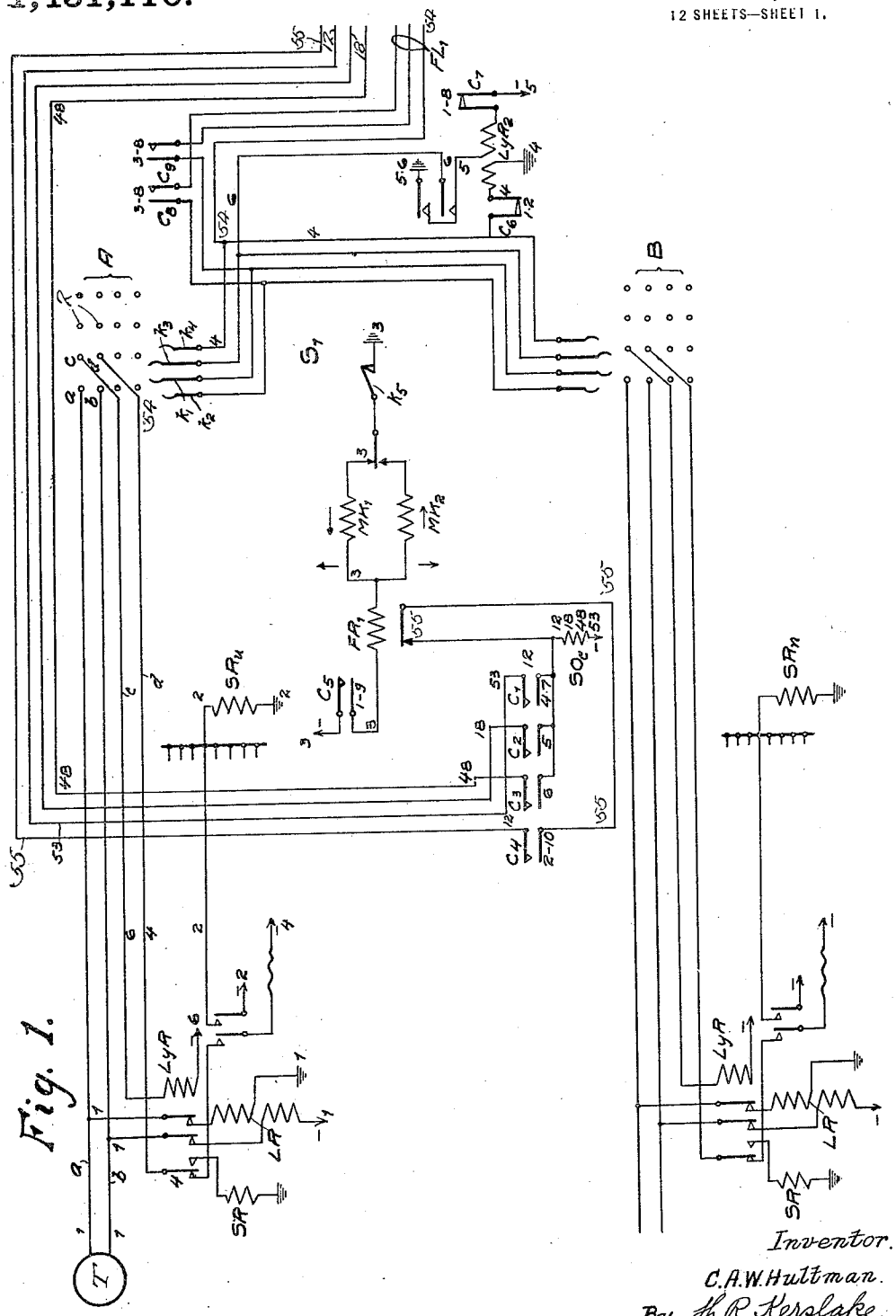

Fig. 1.

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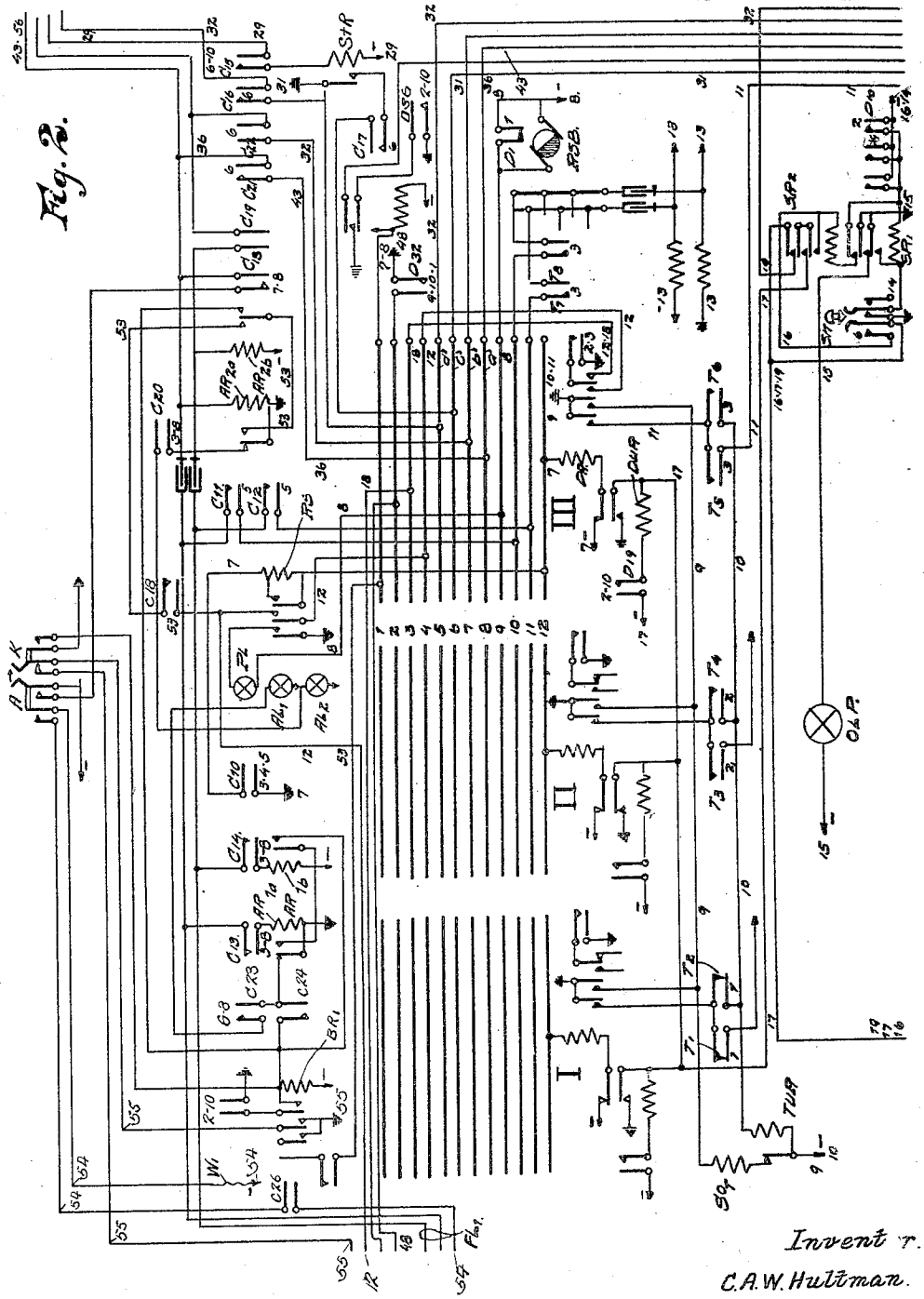
12 SHEETS—SHEET 2.

Fig. 2.



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12 SHEETS—SHEET 3.

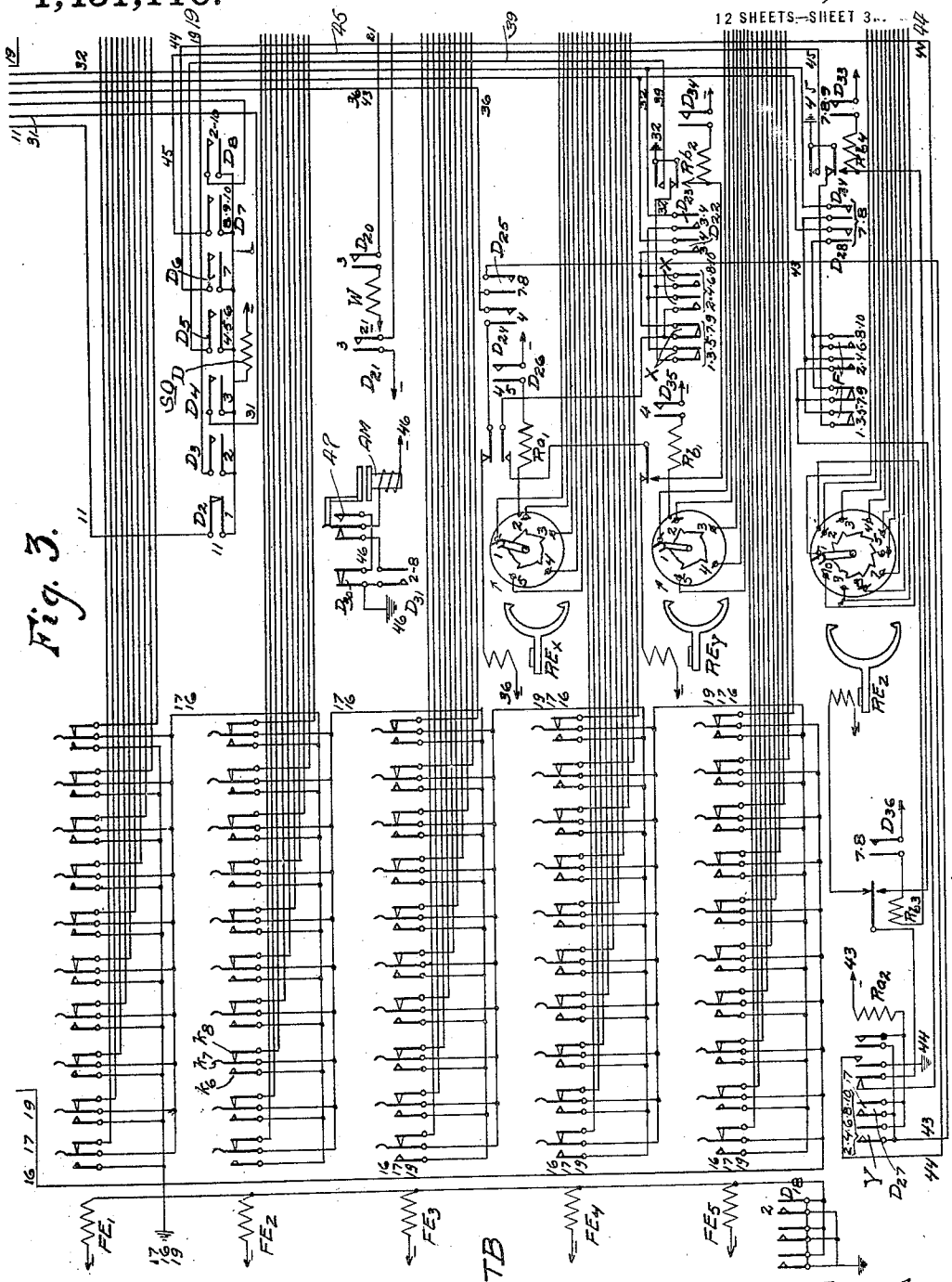

Fig. 3.

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12 SHEETS—SHEET 4.

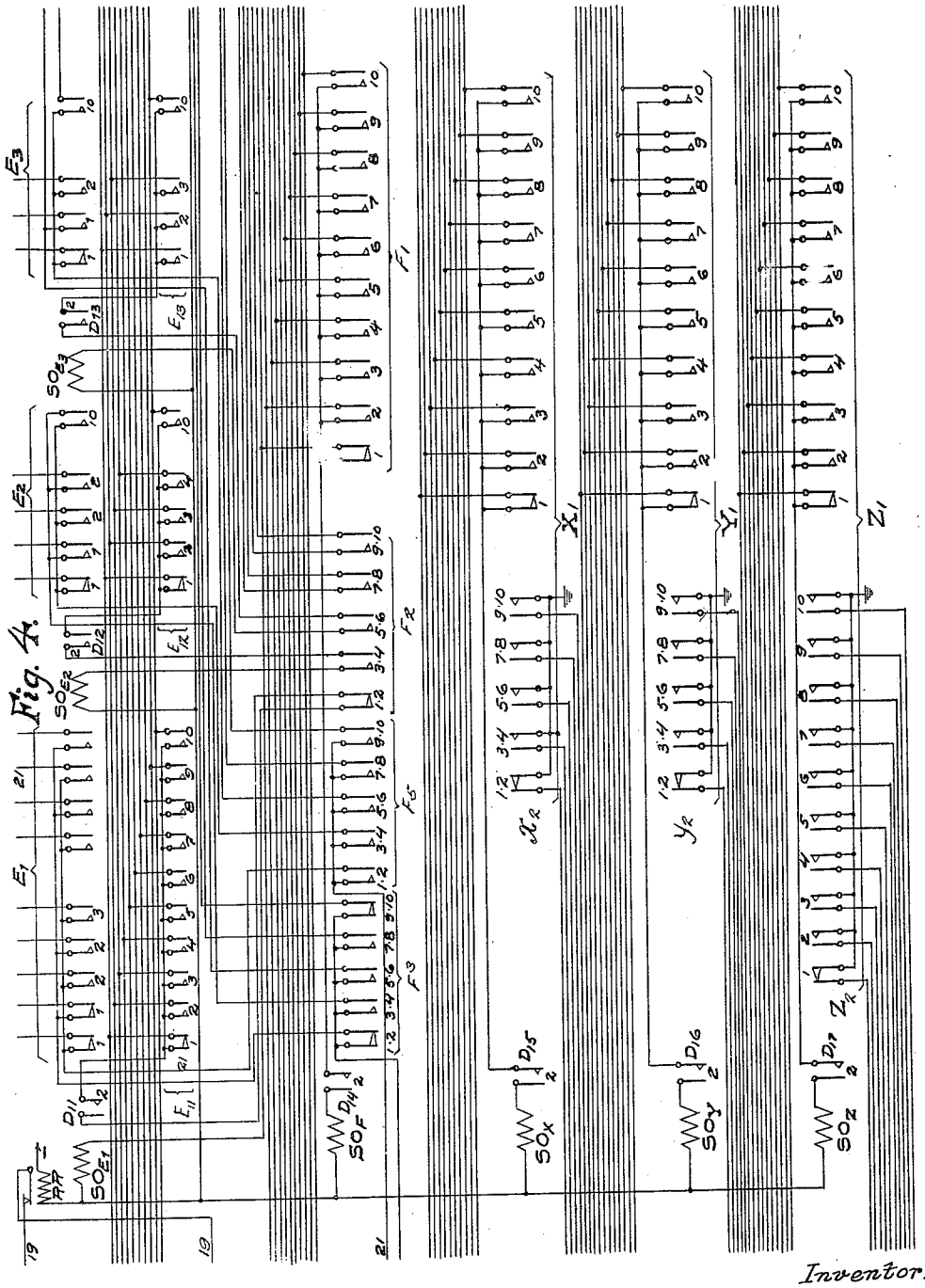

Fig. 4.

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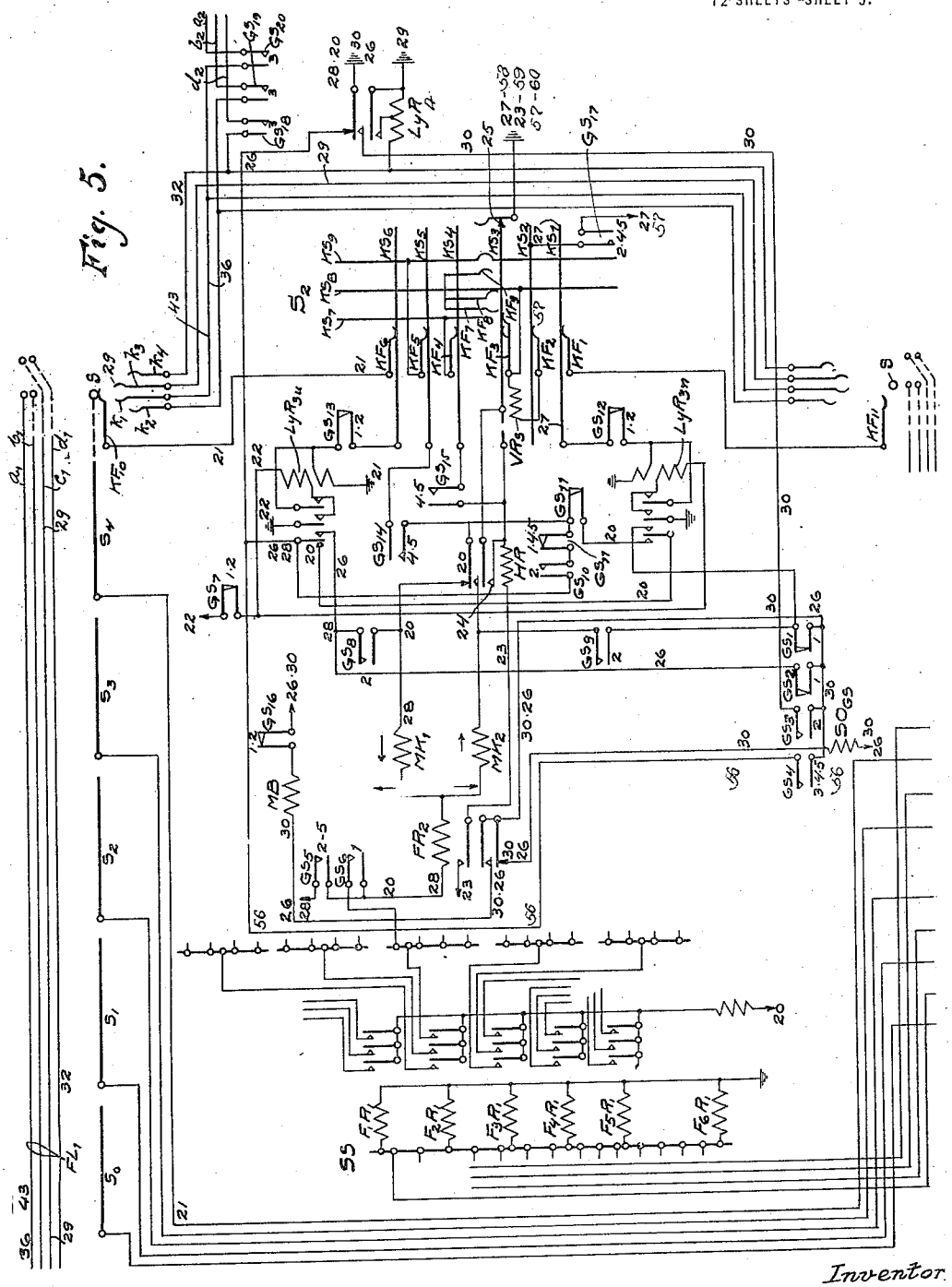
12 SHEETS-SHEET 5.

Fig. 5.



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12 SHEETS—SHEET 6.

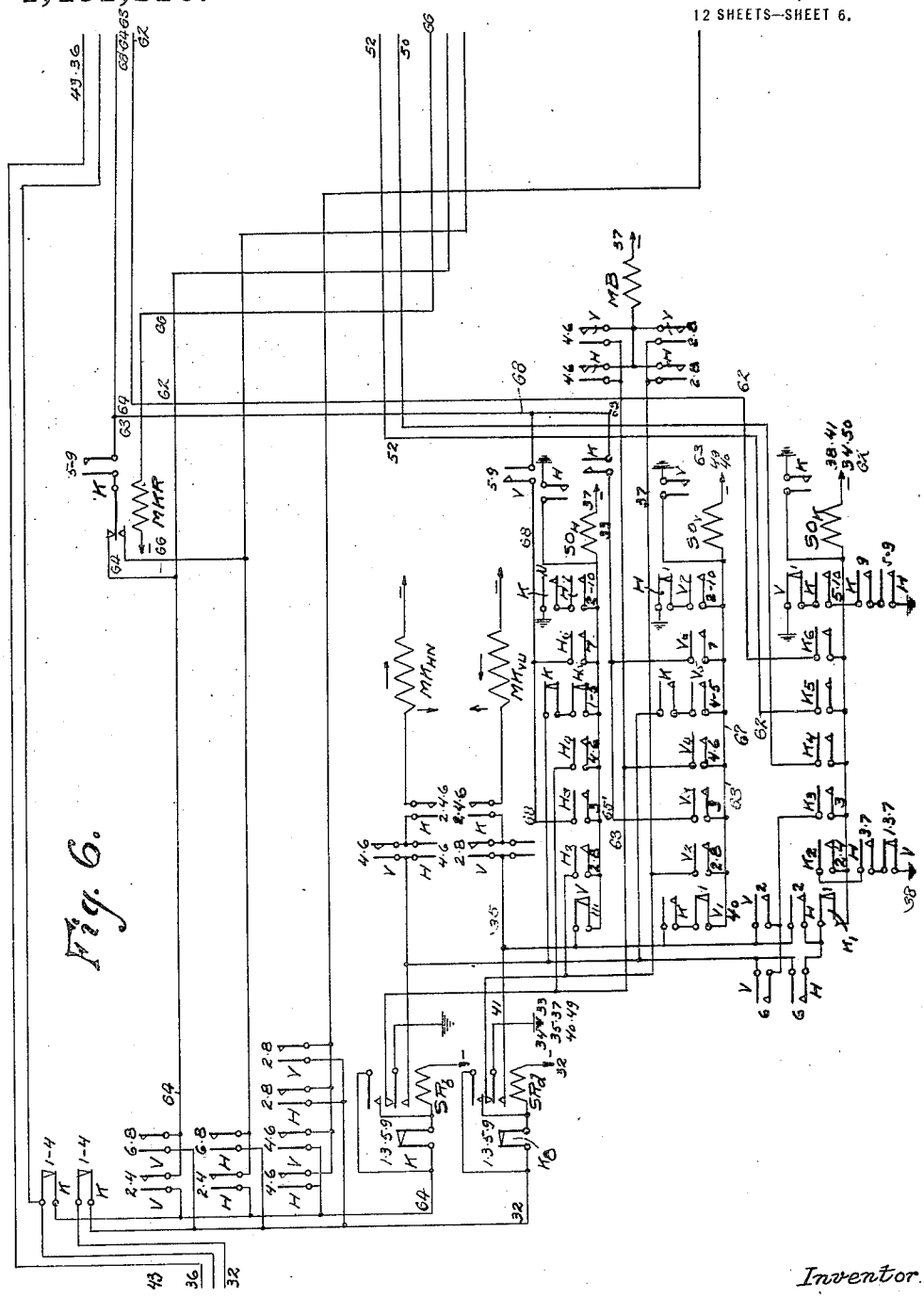

Fig. 6.

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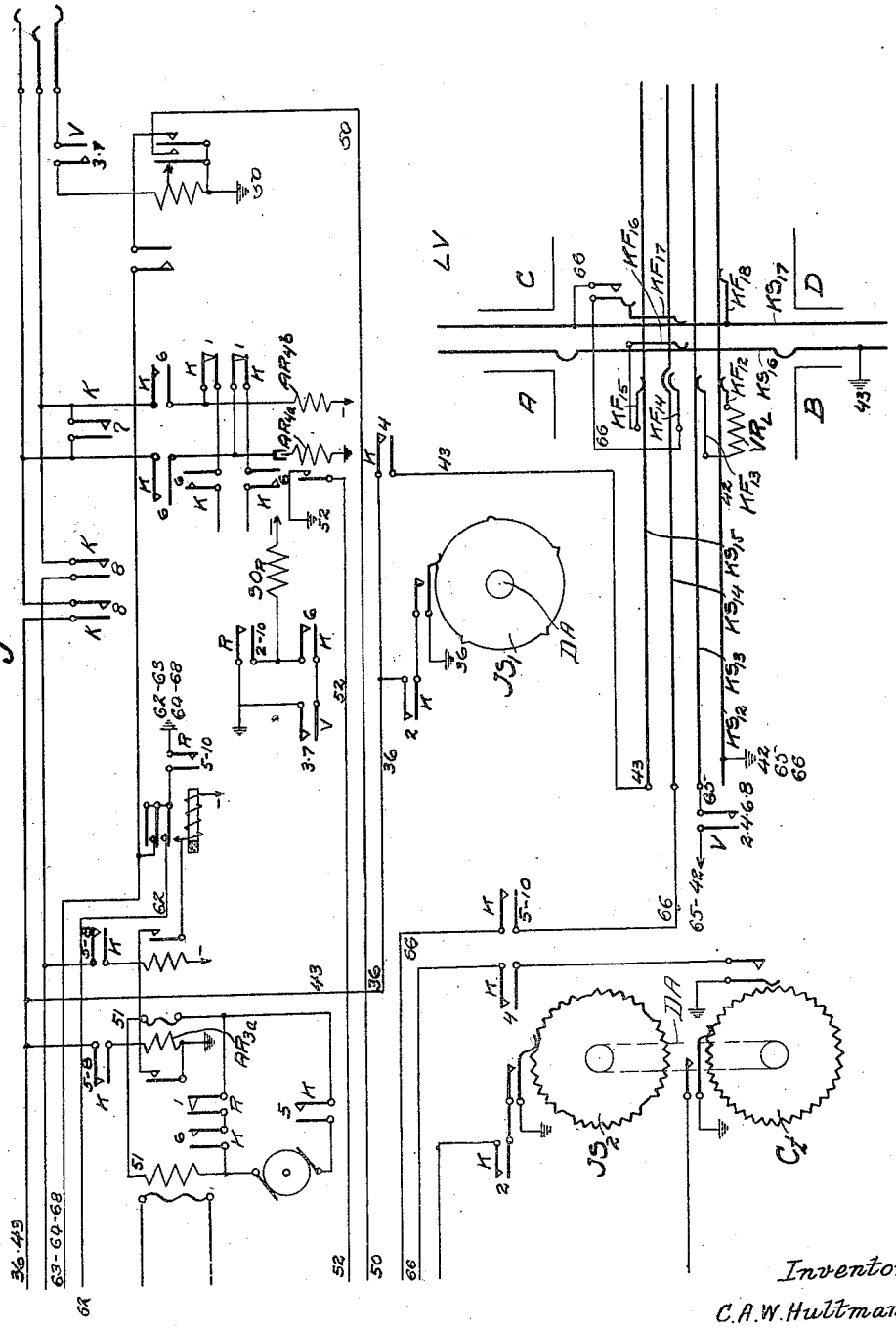
12 SHEETS—SHEET 7.

Fig. 7.



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12 SHEETS—SHEET 8.

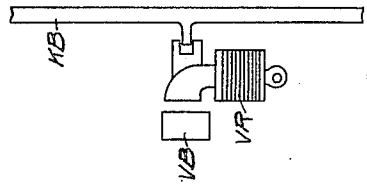

Fig. 9.

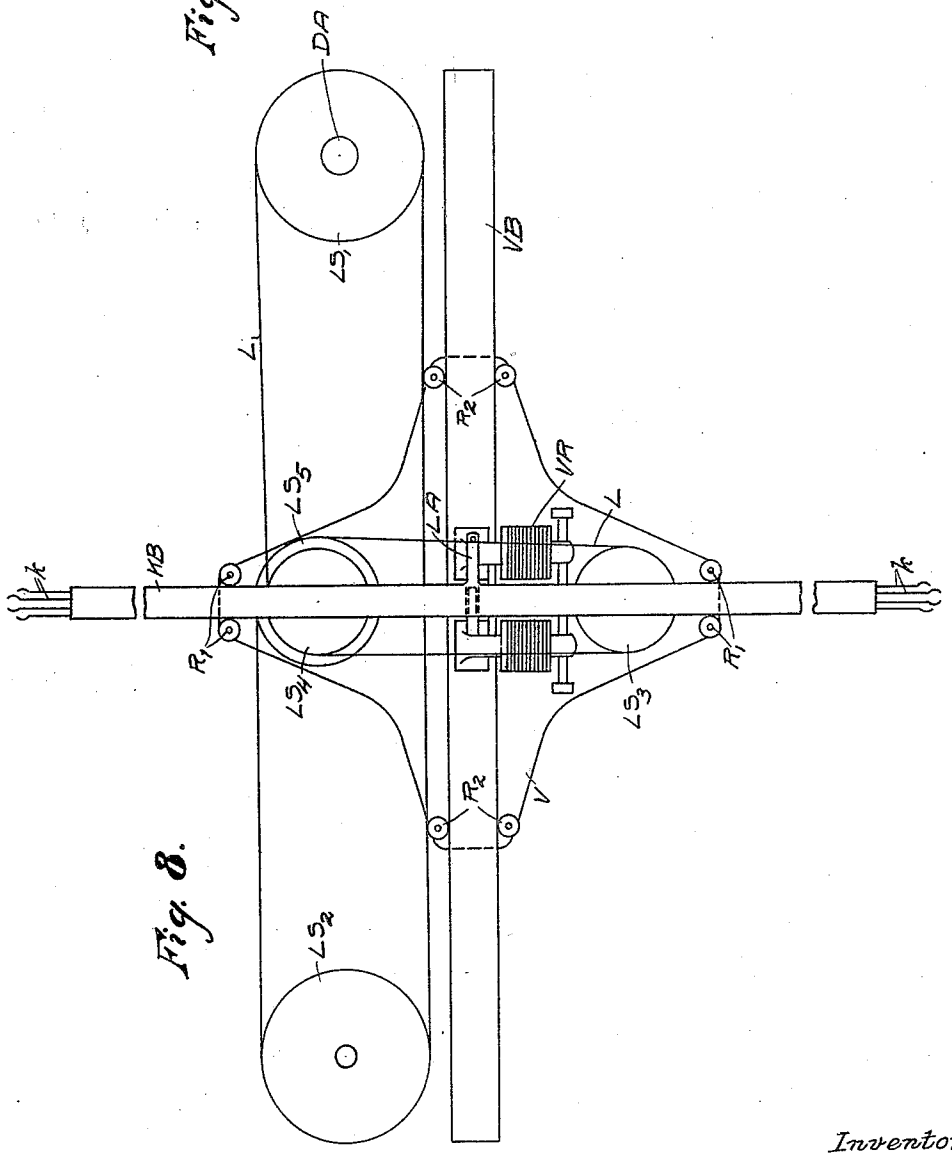

Fig. 8.

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12 SHEETS--SHEET 9.

Fig. 10.

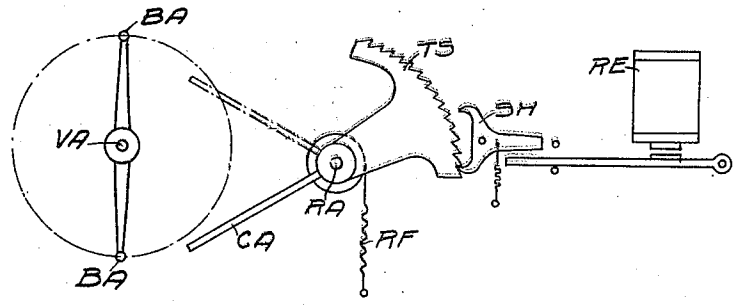

Fig. 14.

Fig. 1.	Fig. 2.	Fig. 5.	Fig. 6.	Fig. 7.
	Fig. 3.	Fig. 4.		

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12 SHEETS—SHEET 10.

Fig. 11.

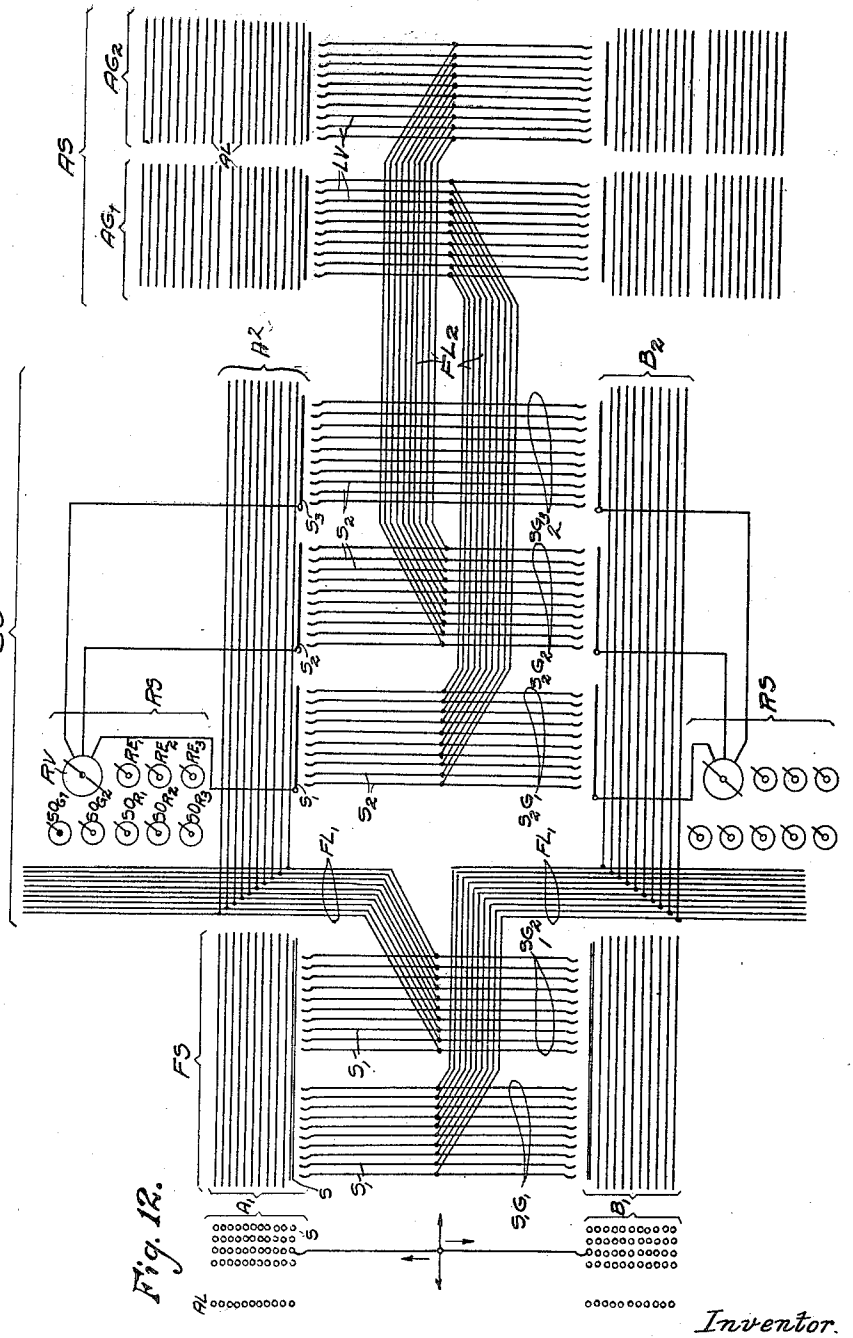

Fig. 12.

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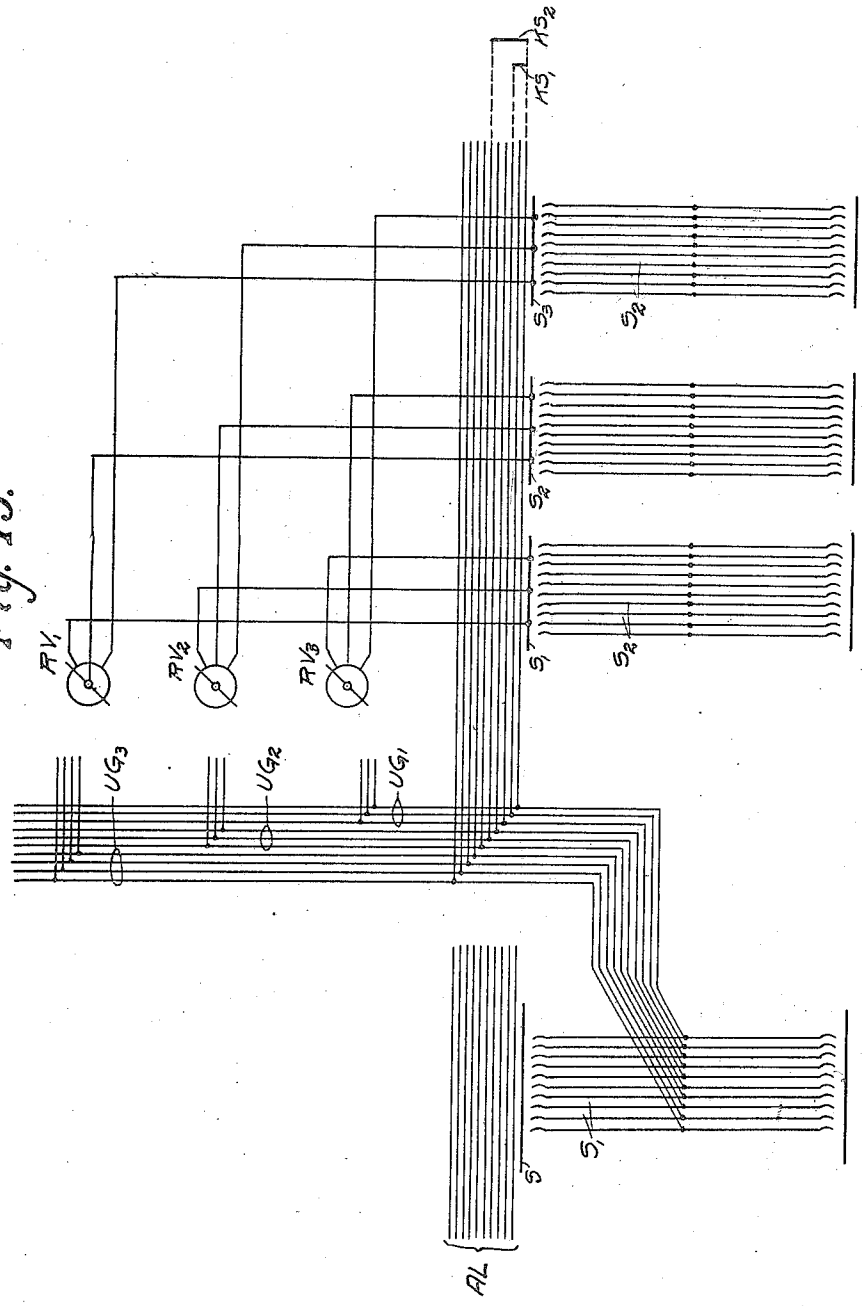
12 SHEETS—SHEET 11.

Fig. 13.



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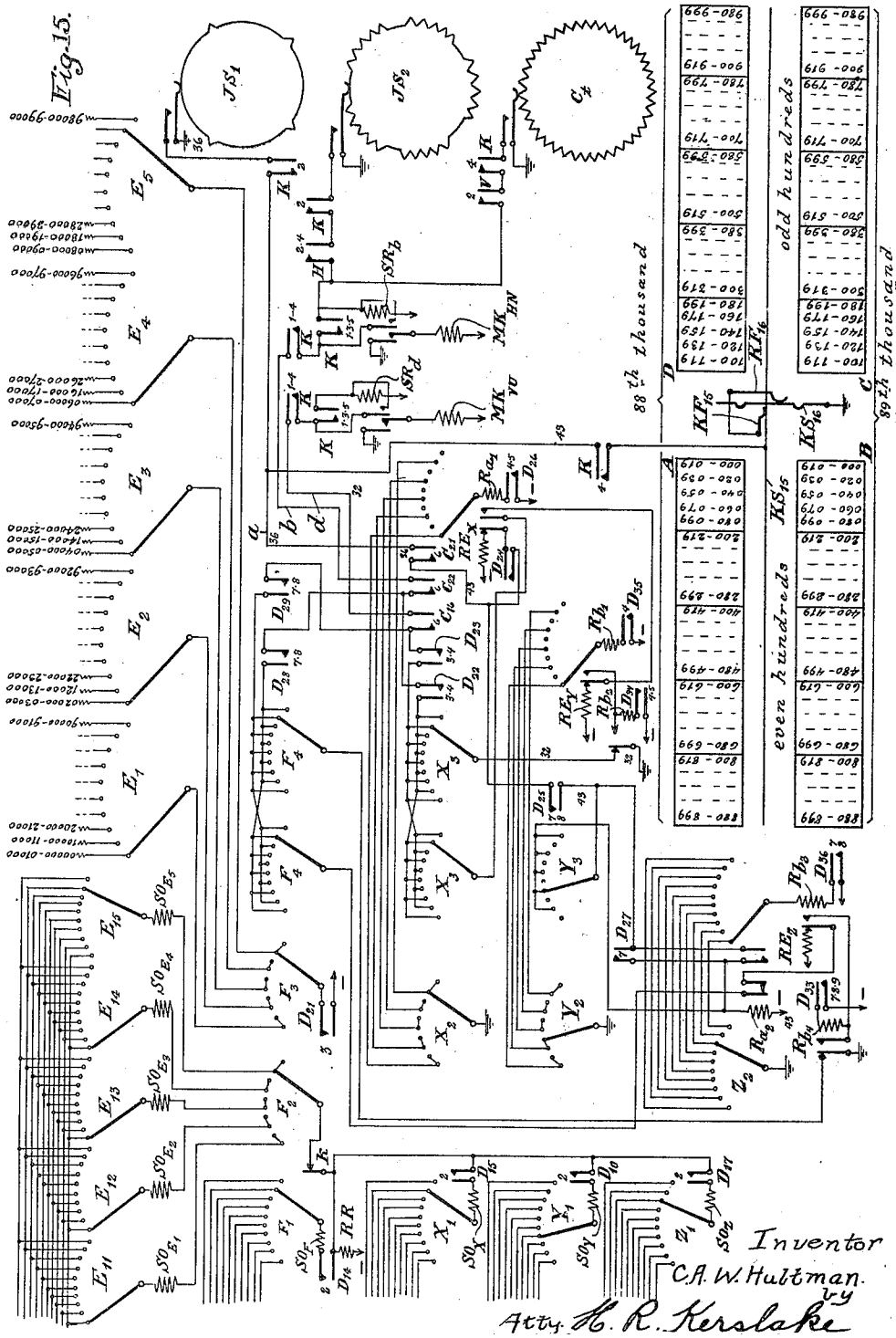
12 SHEETS—SHEET 12.

Fig. 15.



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UNITED STATES PATENT OFFICE.

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SEMIAUTOMATIC TELEPHONE SYSTEM.

Application filed December 23, 1918. Serial No. 268,069.

To all whom it may concern:

Be it known that I, CARL AXEL WILHELM HULTMAN, subject of the King of Sweden, residing at Stockholm, Sweden, have invented certain new and useful Improvements in Semiautomatic Telephone Systems, of which the following is a specification.

This invention relates to automatic and semiautomatic telephone systems in which switches of great capacity, for instance one or more thousand lines, are used for establishing the talking connections. More particularly, the invention relates to the group-switching stages of systems of this kind in which the connections are established by means of switches of the line finder type associated with the outgoing lines of a group-switching stage, while the numerical selection is effected by means of separate group selectors or equivalent means associated with the incoming lines and arranged in common to groups of lines.

The principal object of the invention is to simplify the switch operations in the group-switching stages of such systems particularly with a view to prevent wrong connections. To this end, according to one feature of the invention, the fixed contacts of each finder switch are arranged in groups or rows each comprising the terminals of a different group of incoming lines.

This grouping of the incoming lines and the terminals of the finder switches lends itself conveniently to obtaining a simple control system, so as to prevent interference in case there are two or more simultaneous calls into different numerical groups. As in such a case finder switches belonging to different numerical groups would be simultaneously searching for the calling lines, there would be a risk of the calling line being connected through to a wrong numerical group. To prevent this the group selectors are adapted, according to the invention, to mark the appertaining group of incoming lines only in the finder switches belonging to the numerical group selected.

The finder switches of each numerical group will then, evidently be unable, in searching for calling lines, to establish connection with other incoming lines than those which are seeking connection in the particular group in question. Thus, according to the invention, each group of incoming lines is provided with separate test contacts in the different numerical groups of finder switches and these group marking contacts are connected up to the group selector of the corresponding group of incoming lines in such a manner that, after the group selector has been set, a test potential is applied only to the test contacts of the finder switches belonging to the numerical group selected.

Immediately after the group selection a number of line finder switches is started to search for the calling line. That one, which first finds the marked group containing the calling line moves into the corresponding row of contacts to complete the connection whereas all other finder switches are prevented from entering the corresponding row by the first finder switch applying a test potential whereby said row is barred to the other finder switches.

In the arrangement so far described the instance is not taken into account, when there are two or more incoming lines of the same group calling simultaneously to different numerical groups. To prevent wrong connections also in such cases means are provided, according to the invention, to prevent more than one call from entering each group of incoming lines at a time, for instance by marking all lines of a group as engaged as soon as a call occurs on one line and as long as the switching operation is going on.

The invention, and the objects to be obtained in its use, resides in the certain new and novel arrangement of circuits and parts as will be hereinafter more fully described, set forth in the appended claims, and illustrated in the accompanying drawings, in which:—

Figures 1–7 show the circuit diagrams for a talking connection in a semiautomatic telephone exchange according to the invention, adapted for a number of subscribers corresponding to numbers with five digits,

Figure 8 is a schematical view of the driving device of the line finders,

Figure 9 shows a detail of said driving device,

Figure 10 shows a detail of the construction of the register switches,

Figure 11 shows schematically the arrangement of the junctions and the connecting switches in an exchange according to Figures 1–7,

Figure 12 shows diagrammatically a cross

section through a line finder according to Figure 11,

Figure 13 shows a modification of the arrangement according to Figure 11,

Figure 14 shows, how the different Figures 1–7 are to be put together to obtain a continuous circuit diagram, and,

Figure 15 is a diagram of the principal circuits of the system.

The principal features of the invention will first be described with reference to Figs. 11, 12 and 13. In these figures all lines are shown as consisting of single wires although, actually, they comprise two or more wires. In Fig. 11 the subscribers' lines AL are connected at the incoming side of the exchange to the contact fields of preselecting line finders S_1 and at the outgoing side to the contact field of connectors LV. The connections between the preselecting line finders S_1 and the connectors LV are effected by means of group selectors S_2, to the contact fields of which the conductors of the trunks FL_1 leading from the preselecting line finders S_1 are connected, and each of which is connected, at the other side, to a connector over trunks FL_2. The preselecting line finders S_1 constitute the pre-selecting section FS, the group selectors S_2 constitute the group selecting section GS and the connectors LV the line selecting section AS.

The preselecting line finders and the group selector switches S_1 and S_2 are machine driven apparatus of the kind described in my copending patent application Serial No. 268,068, filed December 23, 1918. They each have a capacity of 1000 lines or multiples thereof, leading therefrom and which are divided into two main groups A_1 and B_1, forming parallelopipedical bundles of bare wires arranged in 50 vertical rows each containing 10 lines. Provided between the two groups are the movable contact arms of the switch, as S_1, or S_2, which are adapted to be set forwards and backwards in a horizontal direction perpendicularly to the bundles of wire and, further, up or down into one or the other of said bundles. The bundles of wire are arranged in common to a plurality of such switches.

The connectors are of the kind described in the Patent No. 1,250,885, granted to me on December 18, 1917, and have a capacity of 2000 lines. The construction of the connectors is different from that of the preselecting line finders and the group selectors comprising the switches S_1, and S_2, chiefly, and only in that the trunk lines leading from the latter and connecting the subscribers' lines are divided in four bundles, the contact arms being normally arranged centrally with regard to these bundles and adapted to be set to one or the other side from the normal position. Each bundle comprises 25 vertical rows of 20 lines each.

The preselecting line finders S_1 are divided in groups of ten finders and the trunks FL_1 leading from each of said groups are connected to the wires of a vertical row of the contact field of the group selectors S_2. Fig. 11 shows two different groups S_1 G_1 and S_1 G_2 connected to an upper and a lower bundle of wires in the group selectors S_2. For each pair of bundles A_2 and B_2 there is provided a number of groups S_2 G_1, S_2 G_2, S_2 G_3 etc. of junction finders S_2, said groups corresponding to different numerical groups of subscribers' lines AG_1, AG_2 etc., i. e. different 2-thousands.

Associated with each group of ten lines of the trunks FL_1 is a set of registers RS common to all of said lines and comprising five machine driven register switches SO_{G1}, SO_{G2}, SO_{R1}, SO_{R2}, SO_{R3}, which correspond to different digits of the subscribers' numbers and which are set in accordance with the wanted number either from the subscribers' station in full automatic systems or from the keyboard in semiautomatic systems. The register set also comprises a machine driven group selector RV and three electromagnetically driven register switches RE_1, RE_2 and RE_3 for controlling the setting of the connector.

The switching operation is principally the following. Upon a call, a plurality of preselecting line finders S_1 are started simultaneously the said finders then moving forwards and backwards in horizontal direction while making contact with test wires s for the different vertical rows of contacts. The preselecting line finder, which first finds the vertical row containing the line of the calling subscriber, is stopped in its horizontal movement and is immediately after started upwards or downwards, the latter movement ceasing when the contact arms make contact with the calling line. When the particular preselecting line finder locates the vertical row in question, the latter is seized and marked as engaged with respect to the other of the preselecting line finders, so that only one of them can be started vertically. At the same time the group of ten line finders to which said particular preselecting line finder belongs, is marked as engaged, which indication is maintained till the connection is completed. Thus, only one call can be received and effectuated at a time in each group of ten preselecting line finders S_1.

The trunk FL_1, to which the calling subscriber's line is thus connected, is now marked as calling at the operator's position in question. The operator receives the number wanted, marks it out on the keyboard and depresses a starting button, whereby the register switches SO_{G1}, SO_{G2}, SO_{R1}, SO_{R2}, SO_{R3} are set in accordance with the different digits of the subscriber's number. The register switches SO_{G1} and SO_{G2} mark

out the corresponding tens group and units contact of the group selector RV, the latter being then set in a corresponding position. The group selector has as many contact positions as there are 2-thousands groups of subscribers' lines, and these contacts are connected to test wires s_1, s_2, s_3 etc., of groups of S_2G_1, S_2G_2, S_2G_3, etc., of group selectors S_2 corresponding to the different 2-thousands. The group selector has as many contact positions as there are 2-thousands groups of subscribers' lines, and is provided with contacts connected to test wires s_1, s_2, s_3 etc. of different numerical groups S_2G_1, S_2G_2, S_2G_3, etc., of junction finders S_2 corresponding to the different 2-thousands. These test wires identify that vertical row of the finders which contains the calling trunk FL_1 and are therefore located immediately below one and the same row the wires of which extend through a plurality of groups of switches S_2. The identification is effected by a potential being applied to one of said test wires, viz that one which extends through the switches of the numerical group S_2G selected. Similarly another group of trunk lines FL_1 connected to another vertical row is identified by another set of test wires s_1, s_2, etc., connected to the contacts of another group selector, viz that one associated with said other group of trunk lines. The selection and starting of the numerical group of selector switches S_2 in question is effected by means of the same group selector RV but over contacts and circuits not shown in Figure 11.

At the same time as the test wire thus selected is given a certain potential, the corresponding set of group selectors S_2 is started and connection is established between the calling trunk FL_1 and one of said group selectors in the same way as in the pre-selecting section. Wrong connections which might occur, in case several calls are made simultaneously in the same marked vertical row of the contact field of the group selectors S_2, are prevented by all lines of a vertical row being marked as engaged, as soon as a call occurs on one of them. This is effected as soon as a lead of the trunk FL_1 is taken into engagement by the calling subscriber when, not only this particular lead, but also all other leads of the same group S_1G_1 or S_1G_2, etc., are marked as engaged so that the whole group is barred for further calls during the establishing of the connection. The setting of the connector LV belonging to the group selectors S_2 is then effected in known manner by means of impulses sent from the connector to the register switches RE_1, RE_2, RE_3.

The invention is, of course, not limited to the use of only one group switching section, if for instance the different groups of subscribers are distributed on different exchanges, it may be necessary to arrange a first group switching section on one exchange and a second group switching section on another exchange. It is only essential to the invention that in such cases one or the other or both group switching sections is equipped for multi-digit group selection, i. e. that each section forms a combination of two or more single digit switching sections, the connection being effected in one step without intervening numerical selection, in which case the latter precedes the connection.

The invention does not exclude the use of double line finders according to the principle of double pre-selection, and this arrangement may in this case be applied to the group selecting section as well as to the pre-selecting section.

In the arrangement according to Fig. 11 the particular group selector may, of course, be dispensed with, if instead of it the register switches SO_{G1} and SO_{G2} are so devised that the group in question is marked directly by the setting of the said register switches. Even the latter as well as the switches SO_{R1}, SO_{R2} and SO_{R3} may be dispensed with if the marking of the test wires s_1, s_2 and the contacts of the switches RE is effected directly from a keyboard.

Besides the capacity of the preselecting line finder switches and the connectors may, of course, be varied without departing from the spirit and scope of the invention.

In order to reduce the number of disengaged preselecting line finders, which are marked as engaged for each call, said line finders may be divided in smaller groups in which case, for the purpose of preventing interference in case two or more calls occur simultaneously in the same vertical row of the group selectors S_2, and arrangement according to Fig. 13 may be used.

Each group of ten preselecting line finders S_1 corresponding to a vertical row in the group selector S_2, is divided in three sub-groups, viz two groups UG_1 and UG_2 each containing three selectors, and one group UG_3, comprising four selectors, each of said groups having allotted to it a set of registers of which only the group selectors RV_1, RV_2 and RV_3 are shown. Upon a call only those preselecting line finders S_1 belonging to the corresponding sub-group, are marked as engaged. The group selectors S_2 are each provided with two contact bars KS_1 and KS_2 which, for the purpose of illustrating their function, are shown in the drawing as provided at one side of the contact field of the group selectors S_2. The contact bar KS_1 is of a height corresponding to the three first lines of the contact field, and the bar KS_2 is of a height corresponding to the six first lines. On a call in the group UG_2 the corresponding group selector marks

the test wire s as well as the contact bar KS_1, whereby the group selector is caused to pass the three first lines of the vertical row and to search only among the other lines. If a call occurs in the third group UG_3 the contact bar KS_2 is marked in a similar manner, whereby the group selector is caused to search only in the third group.

The invention is not limited to the use of selecting switches of the kind above described and does not exclude the use of switches connected to the incoming instead of to the outgoing lines or trunks of the group switching section.

Before the complete course of operation for establishing the talking connection is described more particularly, the essential features of the construction of the finder and selector switches will be explained with reference to Figs. 8 and 9, which show the driving mechanism.

The movable contact wipers k are provided at the upper and the lower ends of a contact carrier KB, which is guided between rollers R_1, on a carriage V, the latter being in turn guided in a horizontal direction on a beam VB by means of rollers R_2. The contact carrier KB is carried by an endless cord or rope L fastened to a laterally projecting arm LA. The cord or rope is carried round two rope pulleys LS_1 and LS_2 arranged on shafts rotating in stationary bearings and over three pulleys LS_3, LS_4 and LS_5 mounted on the carriage, the two latter pulleys being loosely mounted on a common shaft. These two pulleys have actually the same diameter but are shown unequal on the drawing in order that the arrangement of the cord or rope may be indicated. The cord or rope runs from the pulley LS_1 over the pulley LS_4 and further over the pulleys LS_3, LS_5 and LS_2 back to LS_1. The pulley LS_1 is keyed to a shaft DA, which by means of electromagnetic clutches MK_1 and MK_2 (Figures 1 and 5) may be coupled to a driving shaft (not shown) continuously rotating in the same direction, and in such a manner that in one case the pulley LS_1 is rotated to the left and in another case to the right. The contact carrier is normally locked to the carriage by means of a magnet VR provided on the carriage as shown in Fig. 9. If the clutch MK_1 is operated, while the magnet VR remains unoperated, the shaft DA rotates to the left, the carriage V being then also moved to the left as the rope in this case is locked to the carriage by the magnet VR and the contact carrier. In a similar way the carriage is caused to move to the right, if the clutch MK_2 is energized, while the magnet VR remains unoperated. If, on the other hand, the magnet last mentioned is energized simultaneously with the clutch MK_1 or MK_2 respectively the swingably mounted magnet VR is attracted to the beam VB, the carriage being then locked and the contact carrier released. The latter will therefore be moved upwards, if the clutch MK_1 is operated, or downwards, if the clutch MK_2 is operated.

Figure 1 shows diagrammatically the principal parts of the preselecting line finder S_1 and the appertaining circuits. In this figure only the principal circuits are shown, as the circuit diagram for this line finder is the same as for the group selector S_2, the complete diagram of which is shown in Fig. 5, and which is identical with and operates in the same way as the line finder S_1. As seen in Figure 1, the subscriber's telephone T has its conductors a, b connected to the wires A forming the contact field of the preselecting line finders. The contact field also contains two wires c and d, which together with the wires a and b form a bundle so arranged that the wipers k_1, k_2, k_3 and k_4 mounted on the contact carrier make contact with the wires a, b, c and d respectively, when the wipers enter between the wires in the contact field.

The movements of the preselecting line finders are controlled by a machine driven sequence switch SO_C of any known construction, the contacts of which are designated C_1, C_2, etc. The figures shown close to the contact indicate the positions of the sequence switch in which the corresponding contact is closed.

Figures 2, 3 and 4 show the arrangement at the operator's position. Allotted to each operator's position is a keyboard TB, Figure 3, and three sets of registers provided with three groups I, II, III of bus-bars 1–12, through which the three corresponding groups of leads of the trunks FL_1 can be connected to the corresponding switch of the registers. Only that one of the sets of registers which belongs to the group III, is shown in the drawing. Each set of registers comprises five machine driven register switches SO_{E1}—SO_{E5} (only three of which are shown, Figure 4) which correspond to the first digit of the subscribers' numbers, and a register switch SO_F, SO_X, SO_Y and SO_Z respectively for each of the other digits. Further, there are three electromagnetic register switches RE_X, RE_Y and RE_Z for controlling the setting of the connector, and a register switch SO_D for controlling the switching operations.

The machine driven register switches are of the kind which are coupled to a permanently rotating shaft by means of a magnetic clutch and which are provided with contacts which are broken and closed in different positions of the switch. The set of contacts belonging to the different register switches are designated E_1, E_2, E_3, F, X, Y, Z and the various contacts are closed in the

positions indicated by the figures. The construction of the electro-magnetical register switches appears from Figure 10. Loosely mounted on a common shaft RA are three toothed segments TS, (only one being shown), the same being actuated in one direction by a spring RF. A ratchet pawl SH actuated by a spring engages the toothed segment and is operated by the armature of the electromagnet RE of the register switch in such a manner that the segment is moved for the distance of a tooth for each current impulse through the electromagnet. All segments are restored at the time at the end of the switching operation by one or the other of two rotatable arms BA extending parallelly with the shaft RA and rotatably mounted on a shaft VA, said arms rotating half a revolution upon the shaft VA being coupled to a permanently rotating shaft by means of a magnetic clutch AM, Figure 3, and then carrying with it the segments by actuating arms CA projecting from the segments.

Figure 5 shows the group selector S_2. On the horizontally movable carriage a number of contact wipers KF_1—KF_6 are provided, which during the movement of the carriage make contact with a corresponding number of stationary contact bars KS_1—KS_6. Provided on the carriage are, further, three contact bars KS_7, KS_8 and KS_9 cooperating with contact wipers KF_7, KF_8 and KF_9 respectively moving with the contact carrier KB, Fig. 8. The carriage also carries two test wipers KF_{10} and KF_{11}, which during the movement of the finder in the horizontal direction make contact with test wires s for testing the different rows of contacts.

The movements of the group selector are controlled by a sequence switch SO_{GS}, the contacts of which are designated GS_1, GS_2, etc.

Figures 6 and 7 show the arrangements at the connector. The contact field is here divided in four groups A, B, C, D and the contact carrier normally takes up a position centrally with respect to said groups. The starting of the connector LV to the left or to the right, upwards or downwards is controlled, as in the finder switches, by means of two electromagnetical clutches MK_{HN} and MK_{VU}, Figure 6, and the shifting magnet VR_L, Fig. 7, mounted on the carriage. The switching operation is also controlled by sequence switches SO_H, SO_V, SO_K, Figure 6, and the ringing is controlled by a rotating switch SO_R, Fig. 7, the contacts of said switches SO_H, SO_V, and SO_K being designated H_1 to H_7, V_1 to V_7, and K_1 to K_7, respectively.

The connector is provided with four stationary contact bars KS_{12}, KS_{13}, KS_{14} and KS_{15} which make contact with four contact wipers KF_{12}, KF_{13}, KF_{14} and KF_{15} respectively provided on the carriage. The carriage also carries two contact bars KS_{16} and KS_{17} co-operating with two contact wipers KF_{16} and KF_{17} moving with the contact carrier. The contact bar KS_{17} is permanently in contact with the contact bar KS_{12} by means of a wiper KF_{18}. Keyed to the driving shaft DA of the connector are two impulse disks JS_1 and JS_2, from which impulses are set out for controlling the setting of the connector, and the centering disk Ct for controlling the adjustment of the movable contacts in the proper position.

The numerical wiring of the register switches and the connectors as well as the principal circuits for selecting the trunk line finders and operating the connector will appear from the diagram of Figure 15. For the sake of clear representation the registers are shown as consisting each of a set of ordinary switches having rotating arms and ten contact positions the same reference letters being used as in Figures 1–7 to facilitate comparison. The contacts E_{11}—E_{15} of the switches SO_{E1}—SO_{E5} are connected in multiple to the first row of buttons of the keyboard TB, Figure 3.

Similarly the contacts F_1, X_1, Y_1 and Z_1 of the other switches SO_F, SO_X, SO_Y and SO_Z are connected to the buttons of the corresponding rows of the keyboard.

The switch arms are shown in positions corresponding to the subscriber's number 88837. Thus, the switches SO_{E5}, SO_F and SO_X are set in their ninth positions (the first position corresponding to the figure 0), whereas SO_Y is set in its fourth and SO_Z in its eighth position.

Only the switch SO_{E5} out of the five switches SO_{E1}—SO_{E5} is operated owing to these switches being controlled over contacts F_2 of SO_F. Each of the switches SO_{E1}—SO_{E5} has a set of contacts E_1, E_2, E_3, E_4 and E_5, respectively over which the circuits of the starting relays FR of the different 2-thousand groups of selectors S_2 are carried. These circuits are further controlled at contacts F_3 of SO_F so that any one of the 50 2-thousand groups may be selected by setting the switches SO_E and SO_F in accordance with the two first digits of the subscriber's number. The numerical wiring is indicated by the numbers opposite to the contacts E_1—E_5. The contacts X_2, Y_2 and Z_2 control the setting of the switches RE_X RE_Y and RE_Z respectively. The contacts F_4, X_3 and Y_3 control the circuits for setting the connector. The numerical wiring of the connector will appear from the numbers inserted in the vertical contact rows of the connector field diagrammatically represented at the bottom of Figure 15. The connector is connected to the registers over the trunk lines a, b, d. The clutch MK_{VU} couples the connector for movement to the left and upwards and the

clutch MK_{HN} for movement to the right and downwards. The circuits of these clutches are controlled by relays SR_d and SR_b operated over the *d*- and *b*-wire respectively.

The course of operation will first be described in its main features with reference to Figure 15. After a calling subscriber has been connected by a line finder to an operator the latter depresses the buttons of the keyboard corresponding to the wanted number whereby the circuits of the clutch magnets of the register switches SO_F, SO_X, SO_Y and SO_Z are closed through a common relay RR and over the contacts F_1, X_1, Y_1 and Z_1 respectively the sequence switch D being then in its second position. The switches thus rotate till they reach the contact corresponding to the depressed button when said circuits are opened and the switches stopped. SO_F, on de-energizing closes at a contact *k* the circuit of the particular switch SO_E, corresponding to the position of SO_F, and this switch SO_E is now set in accordance with the first digit of the subscriber's number. The sequence switch D is then moved into its third position in which the circuit of the relays FR of the 2-thousand groups of trunk line finders selected is closed over a contact F_3 said trunk line finders being thereby started to hunt for the line engaged by the calling subscriber. One of said line finders establishes the connection and the appertaining connector is thus connected to said line and over that one to the registers through contacts C_{16}, C_{21}, C_{22} of the sequence switch C which is now in its sixth position.

The connector is now to be set in accordance with the positions taken up by the register switches SO_X, SO_Y and SO_Z. Thus, SO_X determines partly (at contacts X_3) if the connector shall be started to the left (even hundreds) or to the right (odd hundreds) partly (at contacts X_2) in which hundreds the switching operation shall take place. SO_Y then determines (at contacts Y_2) which group of 20 subscribers, i. e. which contact row, the connector shall have to search for, and SO_Z (at contacts Z_2) together with SO_Y (at contacts Y_3) finally determine the subscriber in question to be searched for. SO_F also determines (at contacts F_4) whether the connector, after having been set in the horizontal direction, shall move upwards (even thousands) or downwards (odd thousands).

For the movement of the connector to the left as also afterwards for the upward movement it is required that the *d* wire shall be connected to earth, while current impulses are sent on the *a* and *b* wires (or only the latter), and for the movement to the right as also downwards the *b* wire shall be connected to earth, while current impulses are being sent on the *a* and *b* wires (or only the latter).

If the wanted number is 88837 as presumed above one connector is selected, as previously described, out of those containing the subscriber's lines within the 88th and 89th thousands. This connector will then send out four impulses on the *a* wire, before the last hundreds to the left is reached, and then two impulses on the *b* wire in order to reach the second group of 20 within the hundreds in question. The connector will then move upwards (even thousands) while first sending an impulse on the *a* wire, which is maintained while the ten first subscribers 20–29 are past, and then 8 impulses on the *b* wire, whereby the 37th line is reached.

It will be seen that in the present case the register switch RE_X has obtained earth connection at its fifth contact by SO_X and that RE_Y has obtained earth connection at its second contact by SO_Y while RE_Z has obtained earth connection at its eighth contact by SO_Z.

Upon the completion of the connection with the connector the sequence switch D was moved into its fourth position and a circuit 32 was closed through the relay SR_d which energizes and connects itself in a locking circuit. Immediately thereupon the sequence switches SO_K and SO_H are moved into their second positions in which they remain during the horizontal movement of the connector. The clutch magnet MK_{VU} operates and the connector starts to the left sending out four impulses over the *a* wire by means of the impulse disc JS_1 which controls the impulse circuit 36 of the register switch RE_X. The impulse disc JS_2 is then inoperative as the impulse circuit over the *b* wire is then open at a contact of the relay R_{a1}. When RE_X reaches its fifth position which is connected to earth at a contact X_2, R_{a1} energizes and disconnects RE_X which is thus stopped. At the same time the said impulse circuit over the *b* wire is prepared at R_{a1}. As the connector continues to move to the left JS_2 now sends impulses over the *b* wire through RE_Y which is moved into its second position. In this position the relay R_{b1} receives current over a contact Y_2, whereby RE_Y is disconnected and stopped. At the same time the relay R_{b2} is connected to the *b* wire and this relay will therefore be operated by the next impulse on the *b* wire. R_{b2} then connects itself in a holding circuit and opens the circuit 32 of the relay SR_d whereby the horizontal movement of the connector is stopped. The sequence switches SO_H and SO_K are now moved into their third positions in which the relays SR_b and SR_d are again connected to the *b* and *d* wires. Further, the sequence switch SO_D is moved into its seventh position. A circuit is therefore closed through the relay SR_d over the *d* wire and immediately after the

sequence switches SO_V and SO_K move into their second and fourth positions respectively. SO_K then disconnects the relays SR_b and SR_d the latter, however, remaining energized over a holding contact. The clutch magnet MK_{VU} is therefore again operated (together with the shifting magnet VR_L) and the connector is started upwards. By the sequence switch SO_K entering its fourth position the *a* wire was connected to the contact bar KS_{15} of the connector. This causes a circuit 43 to be closed through the relay R_{a2} which locks itself over a holding contact and immediately after SO_D is moved into its eighth position. During the upward movement of the connector the impulse circuit for RE_Z over the *b* wire is at first maintained open at a contact of said relay R_{a2}. When the contact wipers of the connector reach the contact field the circuit 43 of the relay R_{a2} is transiently opened whereby R_{a2} is caused to release its armature. As the connector moves on, however, said circuit will again be closed over a contact Y_3 as SO_Y is in its fourth position and, consequently, R_{a2} will keep the circuit of RE_Z open as long as the connector wipers passes over the first ten contacts of the vertical row in question. When leaving the tenth contact the circuit 43 is opened at the upper end of the contact bar KS_{16} of the connector as this contact bar extends only over half the length of the vertical row. R_{a2} therefore de-energizes and prepares the circuit of RE_Z which now receives impulses over the *b* wire from the impulse disc *Ct*. By the seventh impulse RE_Z reaches its eighth position in which R_{b3} receives current over the corresponding contact Z_2. RE_2 is thus disconnected and at the same time the relay R_{b4} is connected in circuit. The latter is operated by the following eighth impulse on the *b* wire, which corresponds to the last figure of the subscriber's number, and consequently the circuit of the relay SR_d will be opened and the connector stopped in the eighteenth vertical position. The setting of the connector is thereby completed.

The switching operations for establishing a talking connection will now be described in detail with reference to Figures 1 to 7.

When the calling subscriber removes his receiver, a circuit 1, Figure 1, is closed over the two line branches *a*, *b* and through the line relay LR. The latter completes a circuit 2 through a starting relay SR_u (or SR_n if the subscriber's line is connected to the lower group B of wires) common to ten subscribers. Relay SR_u closes in a manner which will be more closely described in connection with Figure 5, the starting circuit 3 for a number (for instance 60) of pre-selecting line finders S_1, which are started at one time in the horizontal direction. The pre-selecting line finder which first finds the contact row to which the calling subscriber's line is connected, is caused to stop in a manner which will be more closely described in connection with Figure 5 by a test relay opening a contact k_5 in the circuit 3. At the same time all other pre-selecting finders of the appertaining group of the ten finders are marked as engaged, so that no further call can be received in this group during the switching operation, as described in connection with Figure 11. When the starting circuit 3 is opened, a relay FR_1 included in said circuit de-energizes, the sequence switch SO_c then receiving a current impulse whereby it is moved into its second position, in which the shifting magnet VR, Figure 8, and one or the other of the clutches MK_1 and MK_2 are put in circuit. The pre-selecting line finder is then started upwards or downwards respectively. When the pre-selecting line finder finds the line of the calling subscriber, a circuit 4 is completed through one winding of a test relay $Ly R_2$ which energizes and closes a locking circuit 5 through the other winding and a circuit 6 through the cut-off relay *Ly*R of the subscriber. The latter disconnects the line relay LR which in turn opens the circuit of the relay SR_u all of the said line finders which are still moving being then stopped. When the test relay $Ly R_2$ energizes, the circuits for the clutch MK_1 over MK_2 and the shifting magnet VR, Figure 8, are opened, whereby the pre-selecting line finder is stopped. At the same time the sequence switch SO_c is operated, which now enters into its fourth position passing the third position. In the third position the line branches *a*, *b* are connected through the contacts C_3 and C_6 to the trunk FL_1. The subscriber is thereby connected up to an operator's position, Figure 2.

The microphon circuit of the subscriber is now closed through the clearing relays AR_{1a} and AR_{1b}, which attract their armatures. In the third position of the sequence switch SO_c a circuit 7 for a call relay R_s and a relay DR was closed. The former attracts its armature then shortcircuiting the greater part of its winding, whereby the bus-bar 12 is marked as engaged, so that no other relay R_s can be operated. At the same time a circuit 8 for a call-lamp PL is closed after the relay R_s has been shortcircuited, the relay DR is operated, whereby the circuit 9 for a sequence switch SO_T is closed. The latter is started and moves, till it reaches its third position, corresponding the group III, to which the calling line belongs. In this position the relay TUR is operated over the circuit 10, whereby the sequence switch is disconnected. When SO_T is stopped, the sequence switch SO_D, Figure 3, receives current over the circuit 11 and passes into its second position. In this position the contact D_1 is opened,

whereby the call-lamp PL shows a flashing light, its circuit being closed and opened by a rotating interrupter RSB. At the same time calls may have entered into the two other groups, when the corresponding call-lamps are lighted, but only that one corresponding to the subscriber connected through to the operator shows a flashing light. When SO_D enters its second position, SO_C, Figure 1, receives current over the circuit 12, whereby it is moved into the fifth position. In this position the line branches *a*, *b* are connected to the talking circuit 13, Figure 2, of the operator over the contacts C_{11}, C_{12} and T_7, T_8. Further, a circuit 14 for a relay SR_1 is closed which in turn closes the circuit 15 for a supervisory lamp OLP.

After the operator has answered and received the number wanted, she marks it down on the keyboard TB, Figure 3, by depressing the corresponding buttons. For each button there are three contact springs k_6, k_7, k_8, the middle one being operated by the button, so that the contact k_6, k_7 is closed and k_7, k_8 is opened. The buttons are arranged as usual in five rows corresponding to the different digits of the subscribers' numbers. After the buttons have been depressed they are retained in their position by holding magnets FE_1—FE_5, which receive current over a contact D_{18}, as long as SO_D is in its second position.

Upon depressing the buttons the different machine driven register switches are moved successively into the positions corresponding to the depressed buttons, their coupling magnets receiving currents through a common relay RR, Figure 4, contacts of the corresponding register switch, contacts k_7, k_8 at the buttons of the appertaining row, which are not depressed, Fig. 3, the contact k_7, k_6 at the operated button of the same row and the contact k_7, k_6 at one or more preceding rows of contacts. It is to be noticed that the register switch SO_E in question is not started, until the switch SO_F has stopped, when the latter determines which of the former shall be brought into operation, as SO_{E_1} corresponds to the first two positions of SO_F, SO_{E_2} to the two next positions and so on. After the last button has been depressed, the operator actuates the starting button SK, whereby a circuit 16 is closed extending from earth at the first contact row over the contacts k_6, k_7 in the different rows of buttons, connected in series, and through a relay SR_2, Figure 2, which energizes and puts itself in a holding circuit independent of the starting button. The relay SR_2 closes a circuit 17 for a relay DUR, which energizes and is locked independently of the keyboard. The circuit of DR and RS is then opened. As long as DR is disconnected, the corresponding group is barred for further calls. When DR deenergizes, the sequence switch SO_C, Figure 1, receives current over the circuit 18, whereby it is moved into its sixth position.

When SR_2 attracted its armature the sequence switch SO_D received current over the circuit 19, whereby it was moved into its third position provided that the relay RR, Fig. 4, is deenergized, i. e. that all register switches have stopped moving. In the third position of SO_D said register switches are disconnected. Further, the circuits of the relay SR_1 and SR_2 are opened and also the circuit of the holding magnets FE_1—FE_6, Figure 3, is opened, whereby the buttons of the keyboard are restored to their normal position. When DR, Figure 2, was deenergized, the circuit of the relay TUR was opened, whereby the sequence switch SO_T was disengaged, so that it now may hunt for another group, where a call has entered.

When SO_D enters its third position the negative pole of the battery is connected through the resistance W, Figure 3, over certain contacts in SO_F and the switch SO_E in question to the test wire *s*, Figure 5, of the group of ten preselecting line finders S_1 in the group of group selectors S_2 corresponding to the selected 2-thousands. In a similar manner the negative pole of the battery is connected over a contact D_{21}, Figure 3, and contacts on the switches SO_F and SO_E to a bus-bar SS, Figure 5, for said group of selectors S_2, whereby a number of starting relays F_1R_1—F_6R_1 are energized. The latter close the starting circuits 20 for said selectors, which are then started at one time in the horizontal direction. The group selector, which first finds the vertical row, to which the calling line or trunk FL_1 is connected, closes a circuit 21 through one winding of the appertaining test relay $Ly R_{3U}$ and the test wiper KF_{1Q}. The test relay energizes and connects its second winding into a locking circuit 22. At the same time the contact row in question is barred to other finders by the test wire *s* in question obtaining direct earth connection over contacts of the test relay $Ly R_{3U}$.

As the starting circuits 20 contain the clutch magnet MK_1, all group selectors are started to the left. If the group selectors should not find the contact row in question during their movement to the left, the movement is automatically reversed, when the carriage reaches its outer left position, the contact spring KF_3 then closing a circuit 23 through a shifting relay HR, which connects the magnet MK_2 in circuit. The relay HR is then locked over its contact 24 and the relay will therefore remain current carrying, till the relay FR_2 deenergizes or till a contact 25 is opened in the opposite end position of the carriage.

When the test relay $Ly R_{3N}$ attracts its

armature, a circuit 20 is opened and the horizontal movement of the group selectors cease, and at the same time the relay FR_3 included in said circuit deenergizes and closes the circuit 26 partly through a brake magnet MB and partly through the sequence switch SO_{GS}, the latter then entering its second position in which said circuit 26 is open at the contact GS_2. In its second position the sequence switch closes a circuit 27 for the vertical magnet VR_3 and a circuit 28 for the clutch magnet MK_1, whereby the preselecting line finder is started upwards.

When the group selector finds the calling trunk line, a circuit 29 is closed through the test relay $Ly R_1$, c_1—wire and a relay StR, Figure 2, which was connected in circuit when SO_C entered its sixth position. The circuit 28 is therefore opened at the relay $Ly R_4$ and the group selector is stopped. When $Ly R_4$ energizes, it short circuits the greater part of its resistance, whereby the trunk FL_1 is marked as engaged. Further, the brake magnet MB and the sequence switch SO_{GS} receive current over the circuit 30, whereby the sequence switch is moved into its third position, in which the contact GS_{13} is opened, so that the marking of the contact row in question as engaged ceases. In the third position also the a_1- b_1- and d_1- wires are connected to the corresponding wires a_2-b_2- and d_2 in the connector at the contacts GS_{20}, GS_{10} and GS_{12}, respectively. When StR Figure 2, energizes, the sequence switch SO_D, Fig. 3, receives current over the circuit 31, whereby it is moved into its fourth position, in which the contacts D_{20} and D_{21}, Figure 3, are opened, whereby the group selectors which are still moving are caused to stop and the marking of the test wire s ceases. In this position the bus-bar a', Figure 2, is connected to the register switch RE_X, Fig. 3, and the bar b' or d' respectively over contacts of SO_X to RE_Y or to earth, according to the position of SO_X.

After a connector LV appertaining to the 2-thousands group to which the wanted subscriber belongs, has been selected by the setting of the register switches SE_E and SO_F, the connector is now to be set in accordance with the positions taken up by the register switches SO_X, SO_Y and SO_Z. Thus, the position of SO_X determines partly if the connector shall be started to the left—even hundreds—or to the right—odd hundreds—, partly in which hundreds the switching operation shall take place. SO_Y then determines which group of 20 subscribers, i. e. which contact row, the connector shall have to search for, and SO_Z together with SO_Y finally determines the subscriber's line of the group of twenty subscribers in question to be searched for. SO_F also determines whether the connector, after having been set in the horizontal direction, shall move upwards—even thousands—or downwards—odd thousands.

For the movement of the connector to the left as also afterwards for the upward movement it is required that the d-wire shall be connected to earth, while current impulses are sent on the a- and b-wires—or only the latter—, and for the movement to the right as also downwards the b-wire shall be connected to earth, while current impulses are being sent on the a- and b-wires—or only the latter.

If the wanted number is assumed to be 88837, one connector LV is selected, as previously described, out of those containing the subscribers' lines within the 88th and 89th thousands. This connector will then send out four impulses on the a-wire, before the last hundreds to the left is reached, and then two impulses on the b-wire in order to reach the second group of 20 within the hundreds in question. The connector will then move upwards—even thousands—while first sending an impulse on the a-wire, which is maintained while the ten first subscribers 20–29 are past, and then 8 impulses on the b-wire, whereby the 37th line is reached.

Assuming still that the wanted number is 88837, it appears from Figures 3 and 4 that the register switch RE_X has obtained earth connection at its fifth contact by SO_X, and that RE_Y has obtained earth connection at its second contact by SO_Y, while RE_Z has obtained earth connection at its eighth contact by SO_Z.

At the same moment, when the wires d_1 and d_2, Figure 5, are connected together on the sequence switch SO_{GS} passing into its third position, a circuit 32 was completed from earth through a contact of the relay Rb_2, Fig. 3, a contact of the sequence switch SO_X in its ninth position, the contact D_{23} the bus-bar d Figure 2, and d-wire through the relay SR_d, Figure 6. SR_d energizes and closes a circuit 33 through the sequence switch SO_H, which then enters its second position. SO_K then receives current over 34, whereby this sequence switch is moved into its second position. Owing thereto SR_b and SR_s are disconnected from the b- and d-wires respectively, but SR_d remains energized owing to the fact that the contact K_s of the sequence switch SO_K is bridged by a contact of the relay SR_d. As both SO_H and SO_K have been moved into the second position, the coupling MK_{VU} receives current over 35 and the movement is started to the left.

During this movement the b-wire is first connected to earth five times by the impulse disk JS_2, however without any effect, as the b-wire is broken at relay R_{a1}, Figure 3. The impulse disk JS_1 then sends an impulse over 36 through the a-wire and RE_X, Fig.

3, whereby the latter is moved one step. After the impulse on the *a*-wire five earth connections on the *b*-wire follow, as before without any effect, and then another impulse on the *a*-wire, whereby RE_X is moved another step. In this way the switching operation is continued, till RE_X has been moved four steps, when the contact arm of this register switch makes contact with the fifth contact. As the latter is connected to earth over a contact of SO_X, the relay at R_{a_1} is now energized whereby RE_X is disconnected and the *b*-wire is connected to RE_Y. The following impulses on the *b*-wire will therefore pass through RE_Y. By the first impulse RE_Y is moved into the second position, in which the contact arm connects the second contact, which in this case is connected to earth, to the relay R_{b_1}, which then energizes and disconnects RE_Y and also connects R_{b_2} to the *b*-wire. The next impulse on the *b*-wire therefore operates R_{b_2}, which energizes and receives holding current. The earth connection of *d*-wire is then broken, and owing thereto SR_d, Figure 6, deenergizes. It is, however, to be noted that SR_d keeps its armature attracted, till the contact is broken at the centering disk C*t*.

When SR_d deenergizes, the current through MK_{VU} is interrupted and the connector is stopped. At the same time a circuit 37 is completed partly through the brake magnet MB and partly through SO_H, whereby the latter is moved into its third position. In this position of SO_H SO_K receives current over 38, whereby SO_K is moved into its third position, in which the relays SR_b and SR_d are again connected to the *b*- and *d*-wires.

When R_{b_2} at the register set, Figure 3, attracted its armature, SO_D received current over 39, SO_D then passing from its fourth into its seventh position. In this position the *a*-wire is connected to R_{a_2}, Figure 3, over the contacts D_{25} and D_{27} and the *b*-wire to RE_Z over contacts R_{b_3}, Figure 3, R_{a_2}, SO_F and SO_D and the *d*-wire to earth over contacts of SO_D, SO_F and R_{b_4}. When therefore the *d*-wire is connected to earth, the relay SR_d, Figure 6, is again operated now closing a circuit 40 through the sequence switch SO_V, which is moved to its second position. In this position SO_K is connected in circuit over 41, whereby it is moved into its fourth position, in which it disconnects SR_b and SR_d from the *b*- and *d*-wires. SR_d, however, remains energized as before over a holding contact. When SO_V is in its second and SO_K in its fourth position, MK_{VU} receives current. SO_V in its second position closes a circuit 42 through the magnet VR_L, Figure 7. When SO_K entered its fourth position, the *a*-wire was connected to the bar KS_{15} in the connector, and R_{a_2} in the register set, Figure 3, then received current over the circuit 43. R_{a_2} energizes and is locked up. At the same time it closes a circuit 44 through SO_D, which then enters its eighth position.

As now MK_{VU} and VR_L, Figure 7, are current carrying, the connector is moved upwards, the *b*-wire being then repeatedly connected to earth at the impulse disk C*t*. These earth connections, however, have no effect on the register switch RE_Z, as the relay R_{a_2} is energized. When the movable contacts of the connector reach the contact field, the circuit 43 is interrupted by the contact wiper KF_{16} registering with a recess in the contact bar KS_{16}. Owing thereto the relay R_{a_2}, Figure 3, deenergizes. During the continual movement of the connector the relay R_{a_2} will again energize, as SO_Y is in its fourth position for the subscriber's number chosen in this instance, and, consequently, also the following-ten-impulses on the *b*-wire will have no effect on RE_Z. When the movable contacts have passed the ten first subscribers' lines in the row in question, the contact wiper KF_{16} leaves the bar KS_{16}, whereby the current through the *a*-wire is interrupted and R_{a_2} deenergizes. The following impulses on the *b*-wire now operate RE_Z whereby the latter is moved forwards step by step. By the seventh impulse the contact arm of the register switch reaches the contact connected to earth, when R_{b_3} receives current and energizes. The eighth impulse, corresponding to the Figure 7 in the wanted number, will therefore operate the relay R_{b_4}, the latter closes the circuit 45 for the sequence switch SO_D, whereby the latter is returned to its initial position. When SO_D passes the ninth position a circuit 46 for the restoring magnet AM of the register switches RE_X, RE_Y and RE_Z is closed, whereby all these register switches are returned at one time through the initial position, as described in connection with Figure 10. The circuit 46 was prepared, when SO_D entered its second position, the restoring arm being then moved one step, thereby closing the contact 47 in said circuit 46. When SO_D passes into its initial position, the current through the relay DUR, Figure 2, is interrupted, whereby the relay DR is again connected in circuit, so that the group III in question may now receive another call.

When SO_D passed through the positions 8-10, a circuit 48 was completed through the sequence switch SO_C at the call finder, Figure 1, whereby the latter was moved into its seventh position—the speaking position—. In this position the *a*- and *b*-wires are connected through at the contacts C_{18} and C_{19}, Figure 2, to complete the talking connection.

When the relay R_{b_4} at the register set, Figure 3, released its armature, the connection of the *d*-wire with earth was interrupted, whereby also the relay SR_d, Figure

6, was caused to deenergize. Owing thereto a circuit 49 is closed through SO_V which then enters its third position. At the same time the current through MK_{VU} and VR_L is interrupted and the connector is stopped after having been centered.

If the subscriber is disengaged, the relay LyR_{LR} is energized over the *c*-wire and the cut-off relay LyR, Figure 1. The sequence switch SO_V in its third position closes the circuit 38 for SO_K which then is moved into its fifth position. In this position a circuit 50 for SO_K is closed, as LyR_{LR} is energized owing to the subscriber being disengaged, the sequence switch SO_K being then moved into its sixth position—the ringing position—. In this position the ringing machine—not shown—is connected to the subscriber's line and at the same time a rotating sequence switch SO_R serving to regulate the length of the ringing intervals is started. The ringing period corresponds to the first position of this switch and the ringing causes correspond to the positions 2–10. The rotating sequence switch SO_R regulates a hummer circuit 51, inductively connected with the current feeding coil AR_{3a}, whereby the calling subscriber can hear the outgoing signal.

When the subscriber answers, the temporary current feeding coils AR_{4a} and AR_{4b} are operated, whereby a circuit 52 is closed through SO_K, which then moves into its eighth position—the speaking position—. When SO_K leaves its sixth position, the ringing current is cut off and SO_R returns to its initial position. In the eighth position of SO_K the current feeding coils AR_{2a} and AR_{2b} are connected to the subscriber's line, whereby they are energized. At the same time the current feeding coils AR_{2a} and AR_{2b}, Figure 2, are operated, whereby the clearing lamp AL_2 is disconnected. At the same time a circuit 53 for the sequence switch SO_C, Figure 1, is closed, whereby the latter is moved into its eighth position.

The connection is now fully completed for conversation between the subscribers.

When the subcribers after having finished the conversation replace their receivers the feeding coils or clearing relays AR_{1a}, AR_{1b}, AR_{2a}, AR_{2b} become currentless and release their armatures. As a consequence the clearing lamps AL_1 and AL_2 are lighted. The operator then depresses the disconnecting key AK whereby a back relay BR_1 is energized and then locked. At the same time the *d* wire leading to the line finder, Figure 1, is connected to battery over a resistance W_1, whereby a circuit 54 is closed for the meter SR, Figure 1, and the conversation is registered. When the operator then releases the disconnecting key AK a circuit 55 is completed through the sequence switch SO_C, Figure 1, which is then moved from its eighth position. In the ninth position of this switch a circuit is closed for the shifting magnet VR of the line finder and for one or the other of the clutch magnets MK_1 and MK_2 and the relay FR_1 in a manner not illustrated in Figure 1. FR_1 energizes and opens the circuit 55 of the sequence switch SO_C so that the latter is stopped in its ninth position. When MK_1 or MK_2 operates the line finder is started upwards or downwards. This movement continues till the switch reaches its normal vertical position in which position said circuit for the clutch magnet is automatically opened as will be described below in connection with Figure 5. Upon FR_1 de-energizing the circuit 55 is again closed whereby the sequence switch SO_C is returned to its initial position in which the circuit of the shifting magnet VR and that of the back relay BR_1 are opened. The pre-selecting line finder is thus completely restored and may now be taken into engagement for a new call.

When SO_C enters its initial position the circuit 29 of the relay StR, Figure 2, and LyR_4, Figure 5, is opened. The latter, when de-energizing, closes a circuit 56 through SO_{GS} which now leaves its third position. In the fourth position of this switch a circuit 57 is closed through the shifting magnet VR_S of the selector and, as the latter stands in the upper bank of contacts, a circuit 58 is closed through FR_2. The latter upon energizing closes a circuit 59 for the shifting relay HR_1 which in turn connects up the clutch magnet MK_2 in a circuit 60 whereby the selector is started downwards. At the same time FR_2 opens the circuit 56 so that SO_{GS} is stopped in its fourth position. When the selector reaches its normal vertical position the circuit 60 for the clutch magnet is opened and the finder is stopped. At the same time FR_2 de-energizes and recloses the circuit 56 for the sequence switch SO_{GS} which is now returned to its initial position. The selector is thereby completely restored to normal and may be taken into engagement for another call.

When the disconnecting key AK was operated, battery was connected to the *a* wire and, as a consequence, the relay AR_{3a} at the connector, Figure 7, was energized, whereas the relay AR_{3b} remained unoperated. A circuit 61 is therefore closed through a slow acting back relay BR_2 which locks itself and sends a current through SO_K over a circuit 62 whereby SO_K is moved into its ninth position. In this position of SO_K current is sent through SO_V over a circuit 63 whereby SO_V is moved into fourth position LyR_{LV} is then disconnected from the test wire and the called subscriber's line is thus set free. BR_2 also closes a circuit 64 through the relay SR_b, Figure 6, whereby the clutch magnet MK_{HN} is energized. As

already the shifting magnet VR_L, Figure 7, has been energized in the circuit 65 the connector will not move downwards. When the connector reaches its normal vertical position a circuit 66 is completed through a relay MKR, Figure 6, which disconnects SR_b and causes the vertical movement to be stopped. When SR_b deenergizes a circuit 67 is closed through SO_v, which is then moved into its fifth position in which SO_H receives a current over 68. SO_H is then moved into its fourth position in which SR_b is again energized, this time, however over the front contact of relay MKR. The clutch magnet is therefore energized once more, however, as the shifting magnet VR_L is now de-energized the connector moves to the right. When, finally, the connector reaches its normal horizontal position the circuit 66 of the relay MKR, Figure 6, is opened, when the latter de-energizes and disconnects SR_b so that the movement is stopped. SR_b when de-energizing, sends a current through SO_H which is then moved into its fifth position in which SO_K is operated and caused to enter its tenth position. When SO_K is in this position, SO_H is moved into its first position in which SO_v is operated and moved into its first position. Finally, when SO_v is returned to its first position, SO_K is also returned to its initial position when BR_2 de-energizes. The connector is, thus, completely restored to normal and can be taken into engagement for another call.

Having now fully described and ascertained the nature of my said invention I declare that what I claim is:—

1. In a telephone exchange system, the combination of trunks leading into a group selecting section and divided into groups, group selecting devices arranged in common to all trunks of each of said groups, trunk finders associated with the individual outgoing trunks of the group selecting section and having access to the plurality of said groups of incoming trunks and fixed contacts in said trunk finders arranged in rows each of which comprises the terminals of a different group of incoming trunks.

2. In a telephone exchange system according to claim 1, the provision of separate marking contacts in different numerical groups of the trunk finders.

3. In a telephone exchange system, the combination of trunks leading into a group selecting section and divided into groups, group selecting devices arranged in common to all trunks of each of said groups, trunk finders associated with the individual outgoing trunks of the group selecting section and having access to the plurality of said groups of incoming trunks, fixed contacts in said trunk finders arranged in rows each of which comprises the terminals of a different group of incoming trunks, separate marking contacts in different numerical groups of the trunk finders, and means for preventing more than one connection to be effected in each group of incoming trunks at the same time.

4. In a telephone exchange system according to claim 3, means for marking all trunks of a group of incoming trunks as engaged as soon as a call occurs on one of the trunks of said group, and means for removing said marking of the trunks at the end of a switching operation.

5. In a telephone exchange system according to claim 1, the provision of means for marking a row of contacts in a number of trunk finders as engaged upon one of the trunk finders finding the group of trunks including the calling trunk.

6. In a telephone exchange system according to claim 1, the provision of means for removing the marking of a group of trunks as engaged upon the trunk finding the calling trunk.

7. In a telephone exchange system, the combination of trunks leading into a group selecting section and divided into groups, group selecting devices arranged in common to all trunks of each of said groups, trunk finders associated with the individual outgoing trunks of the group selecting sections and having access of the plurality of said groups of incoming trunks, fixed contacts in said trunk finders arranged in rows each of which comprises the trunks of a different group of incoming trunks, separate marking contacts in different numerical groups of the trunk finders, each group of incoming trunks being divided into a number of sub-groups, the trunk finders being provided with marking contacts which may be electrically distinguished from the group selecting devices so that the trunk finders are caused to search only in a corresponding sub-group.

In testimony whereof I affix my signature in presence of two witnesses.

CARL AXEL WILHELM HULTMAN.

Witnesses:
JACOB BAGGE,
CHARLES H. SAFELY.