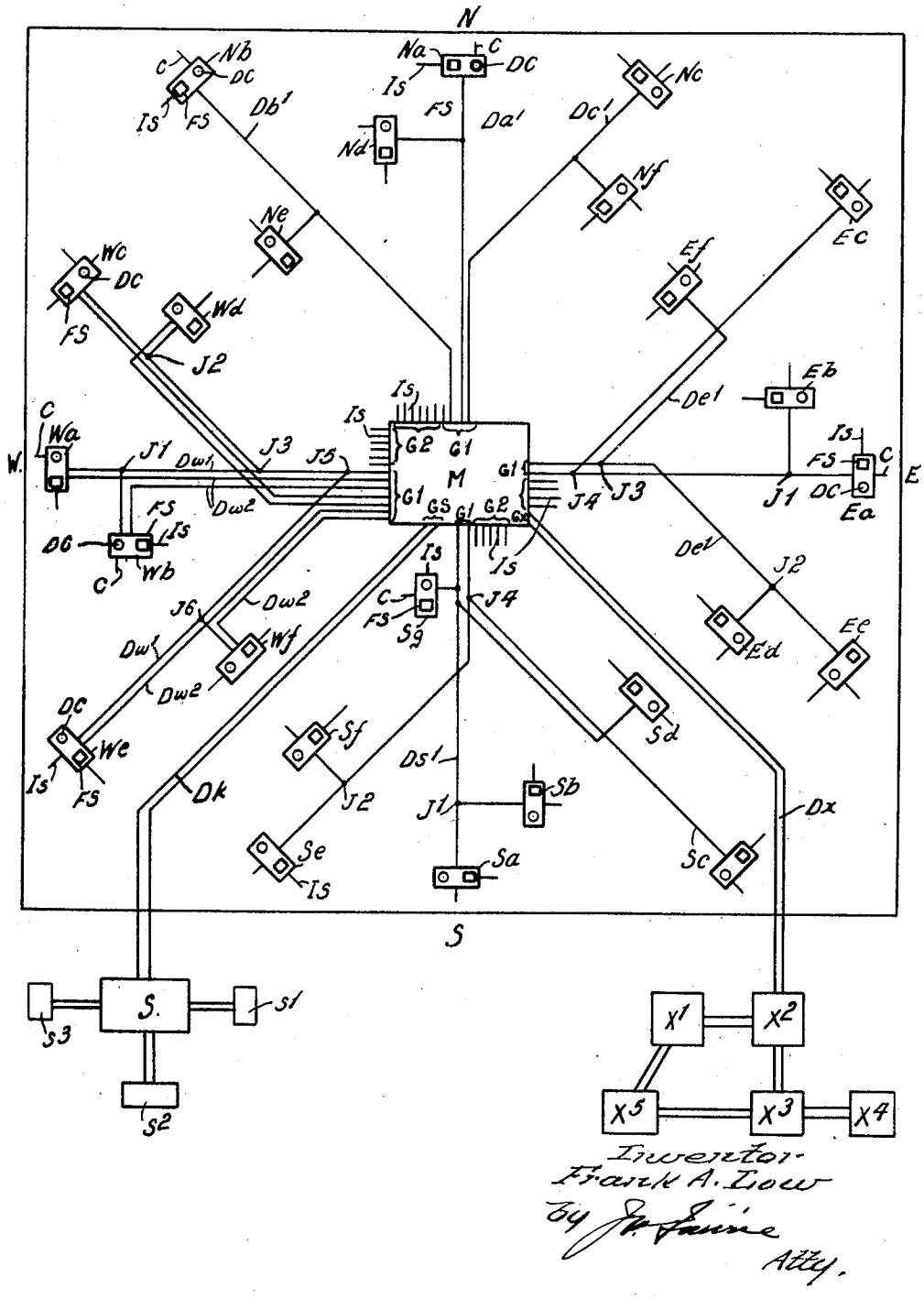
Nov. 2, 1943. F. A. LOW 2,333,324

AUTOMATIC TELEPHONE SYSTEM

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FIG. 1.



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FIG. 2.

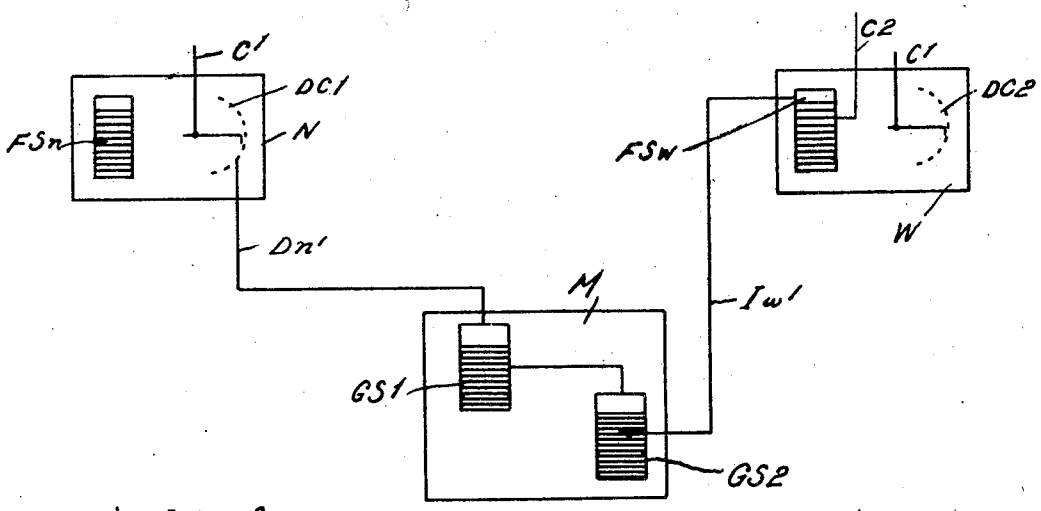


FIG. 3.

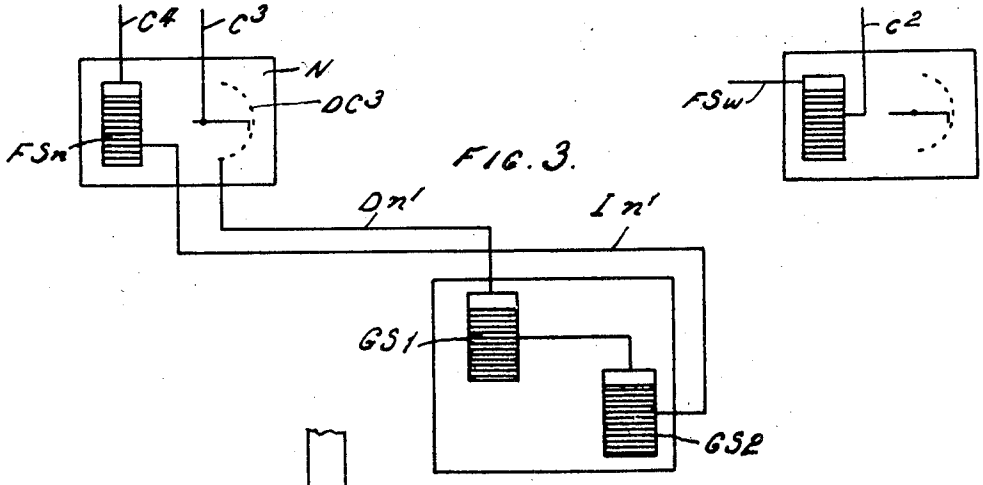


FIG. 7.

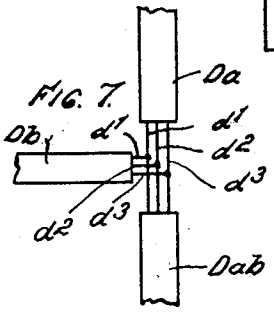
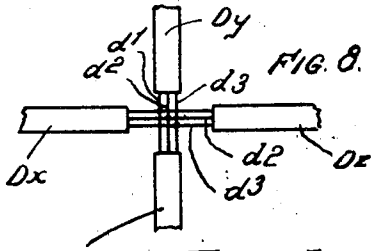


FIG. 8.



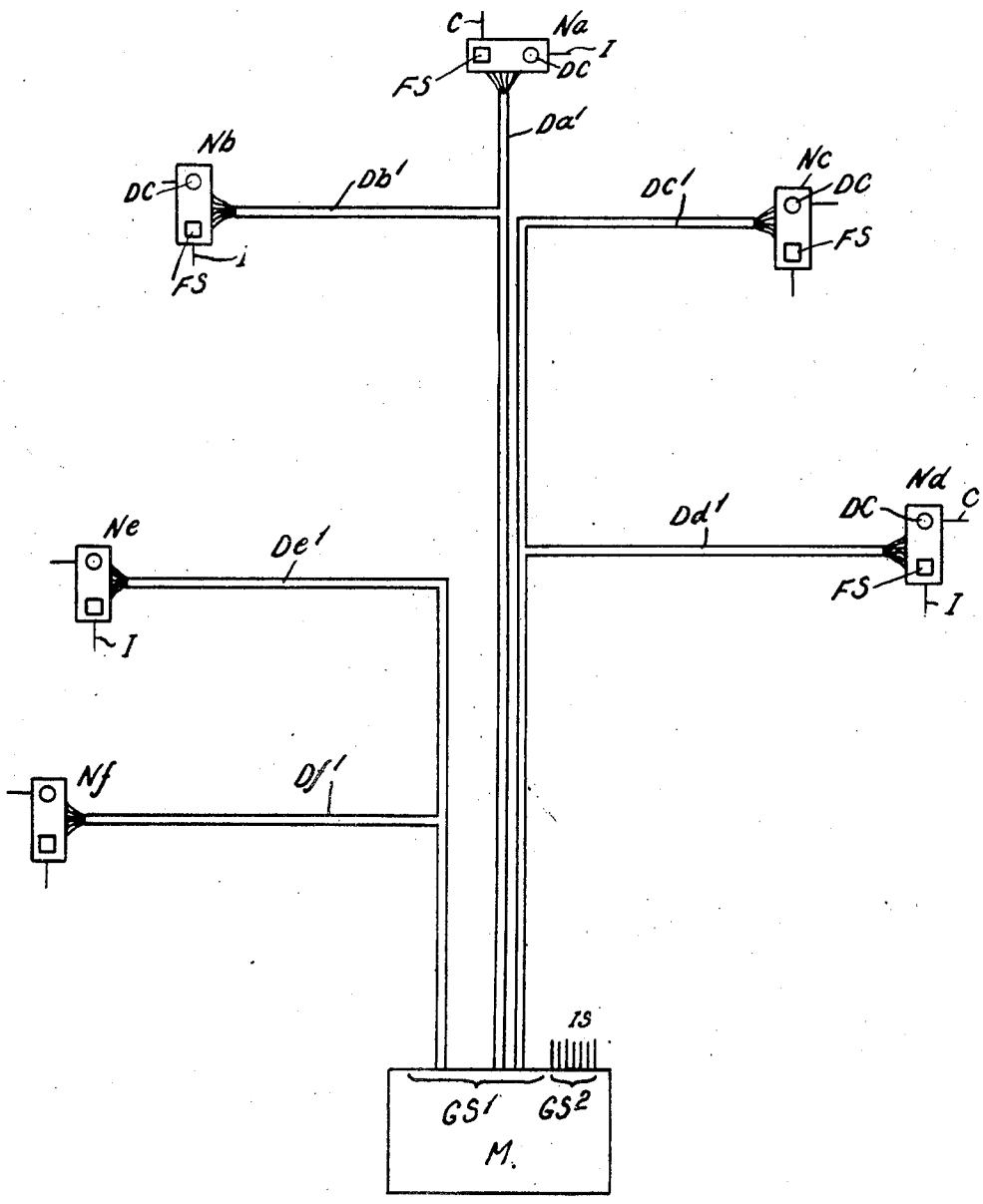
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FIG. 4.



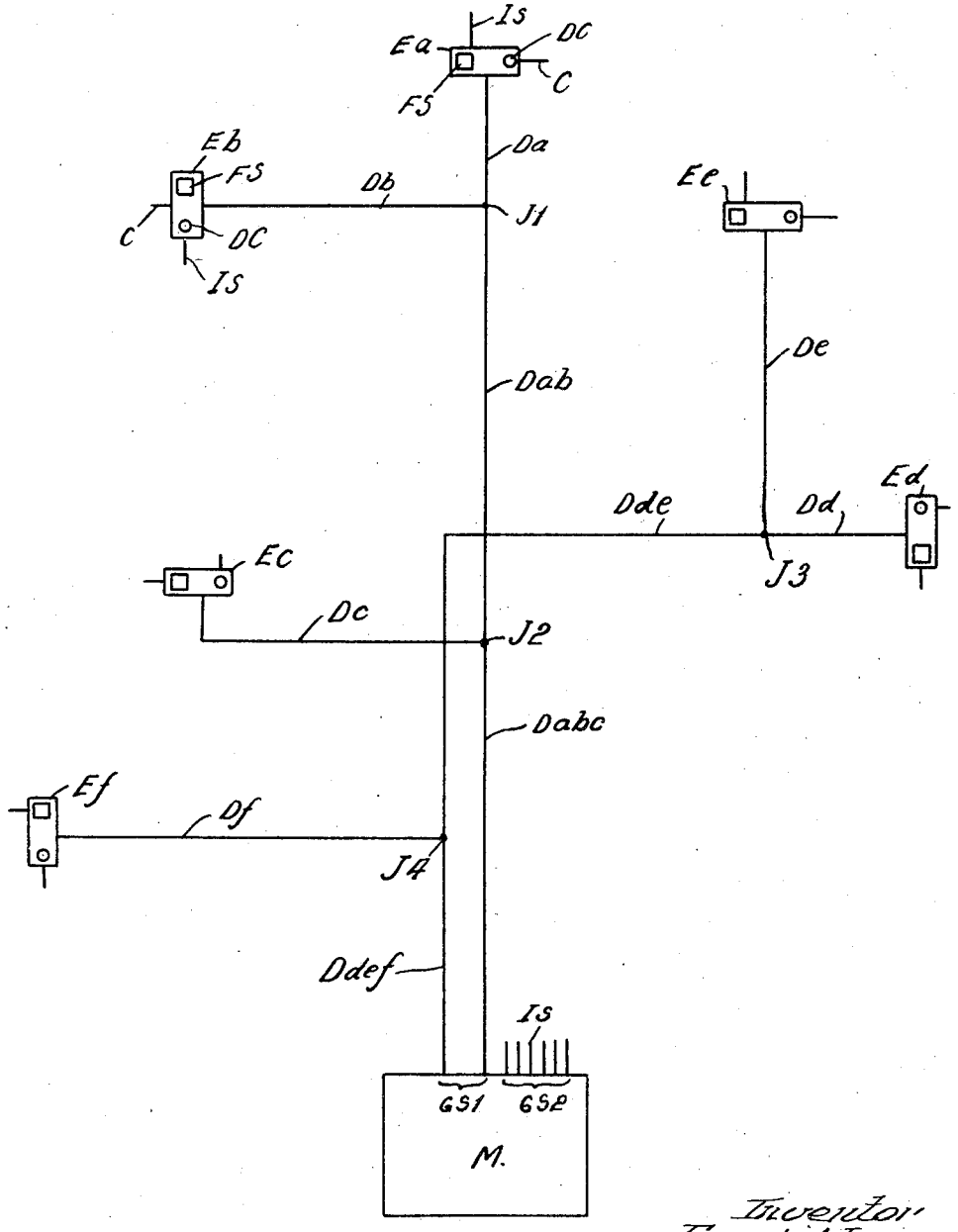
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FIG. 5.



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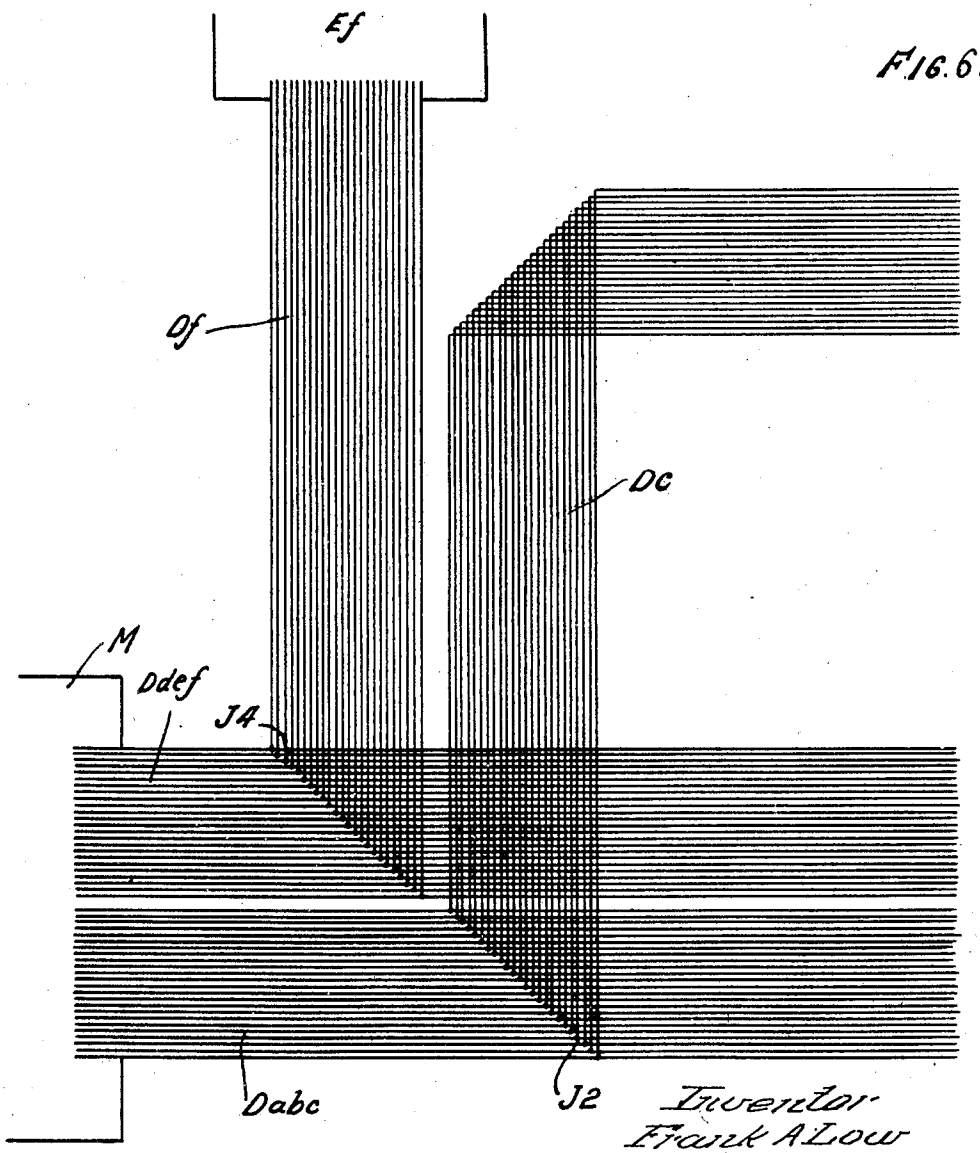


FIG. 6A

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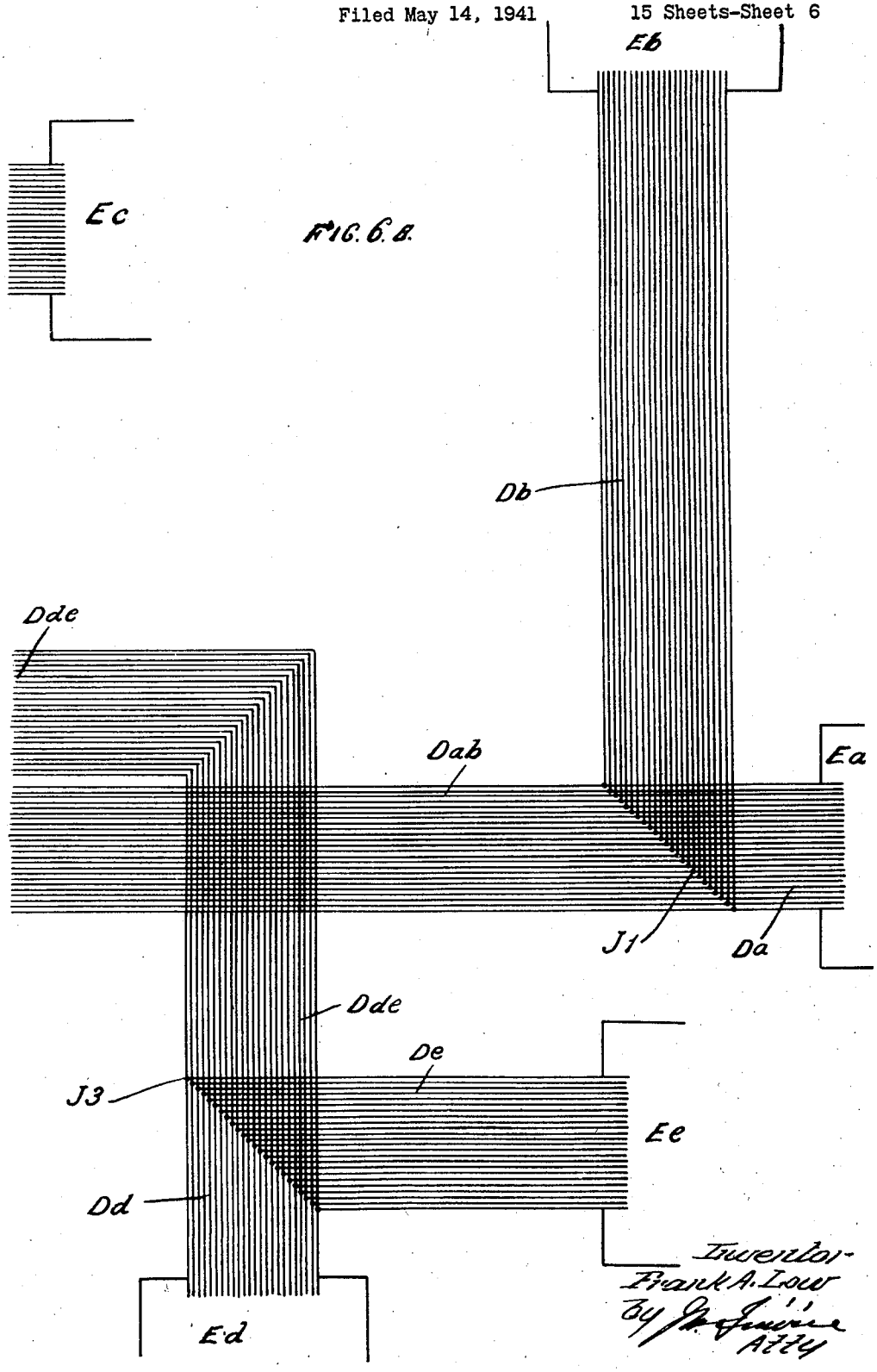


FIG. 6. B.

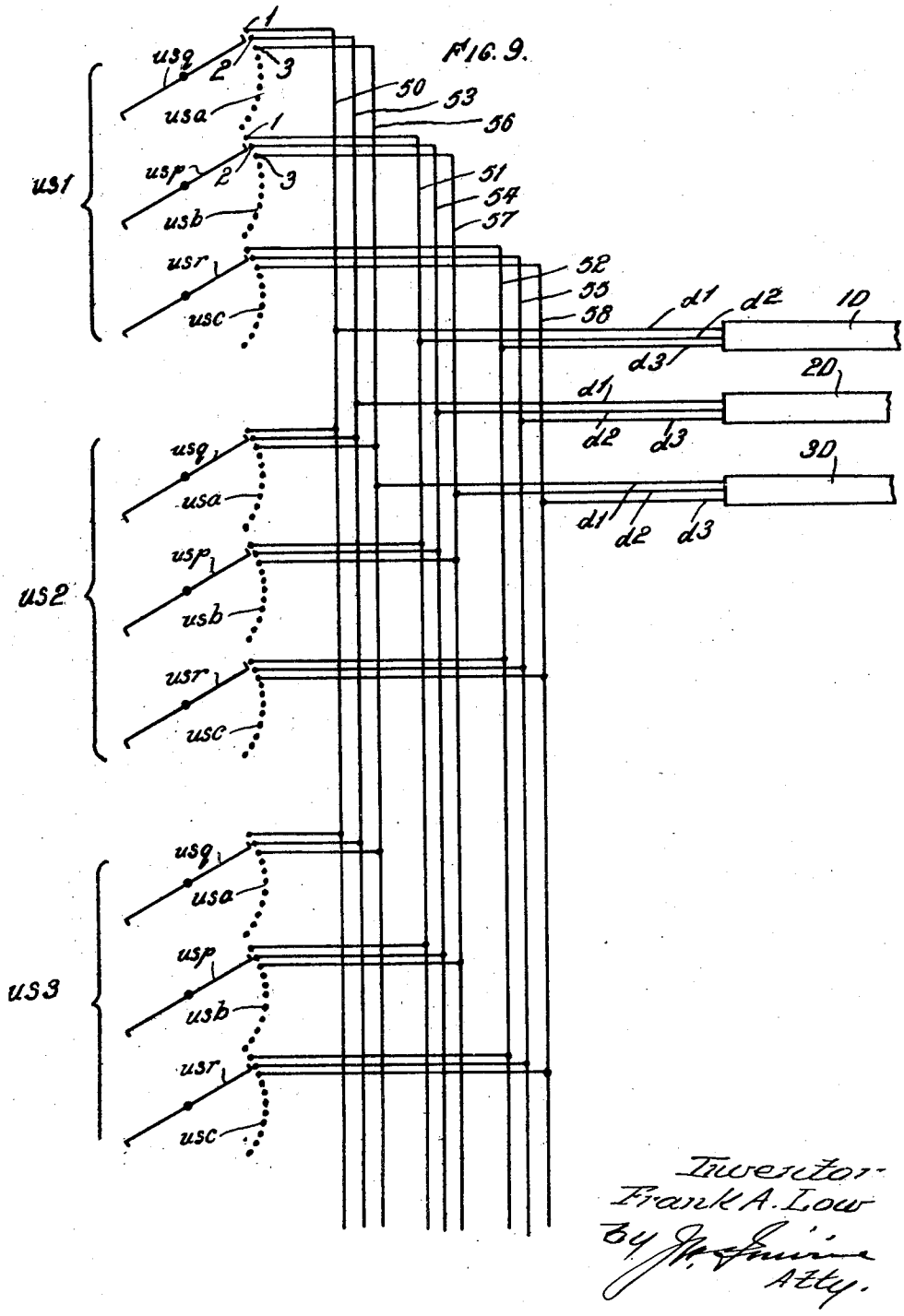
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FIG. 9.



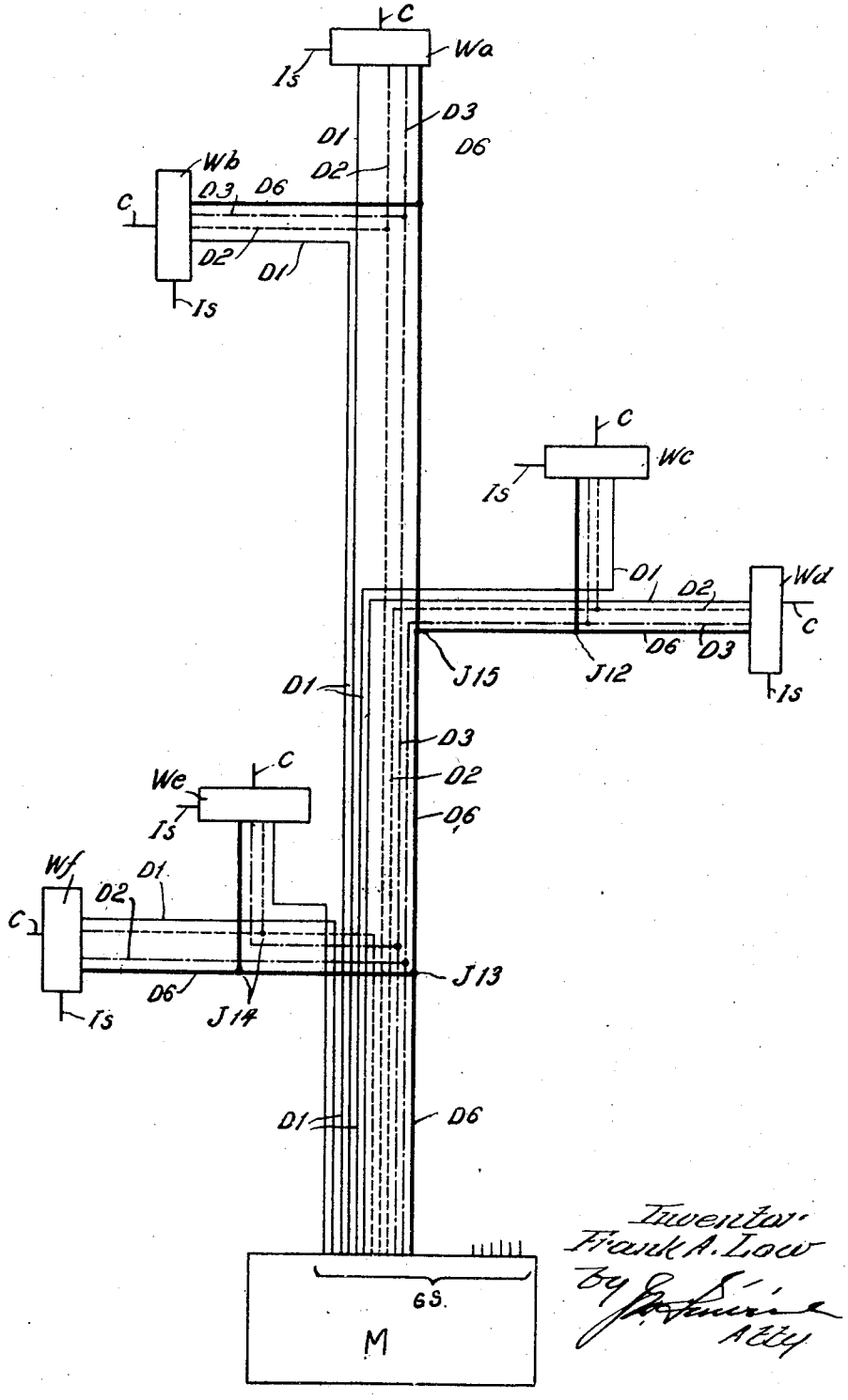
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FIG. 10.



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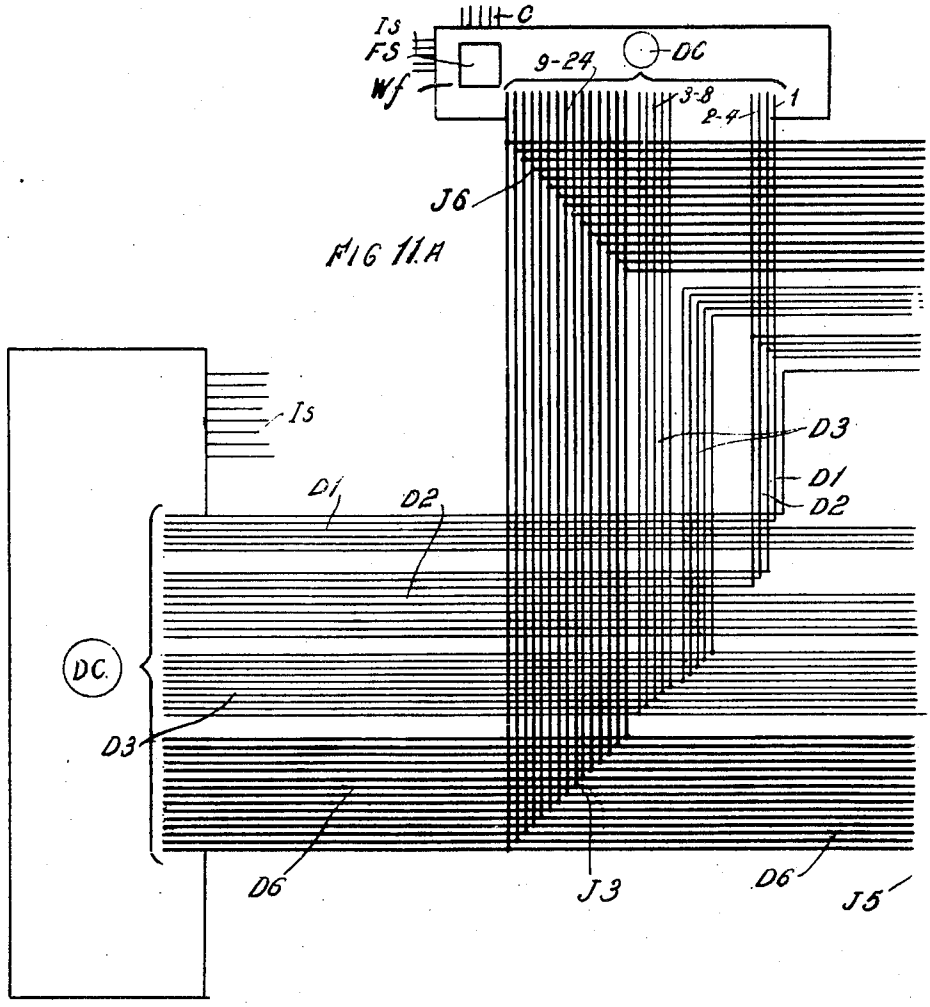


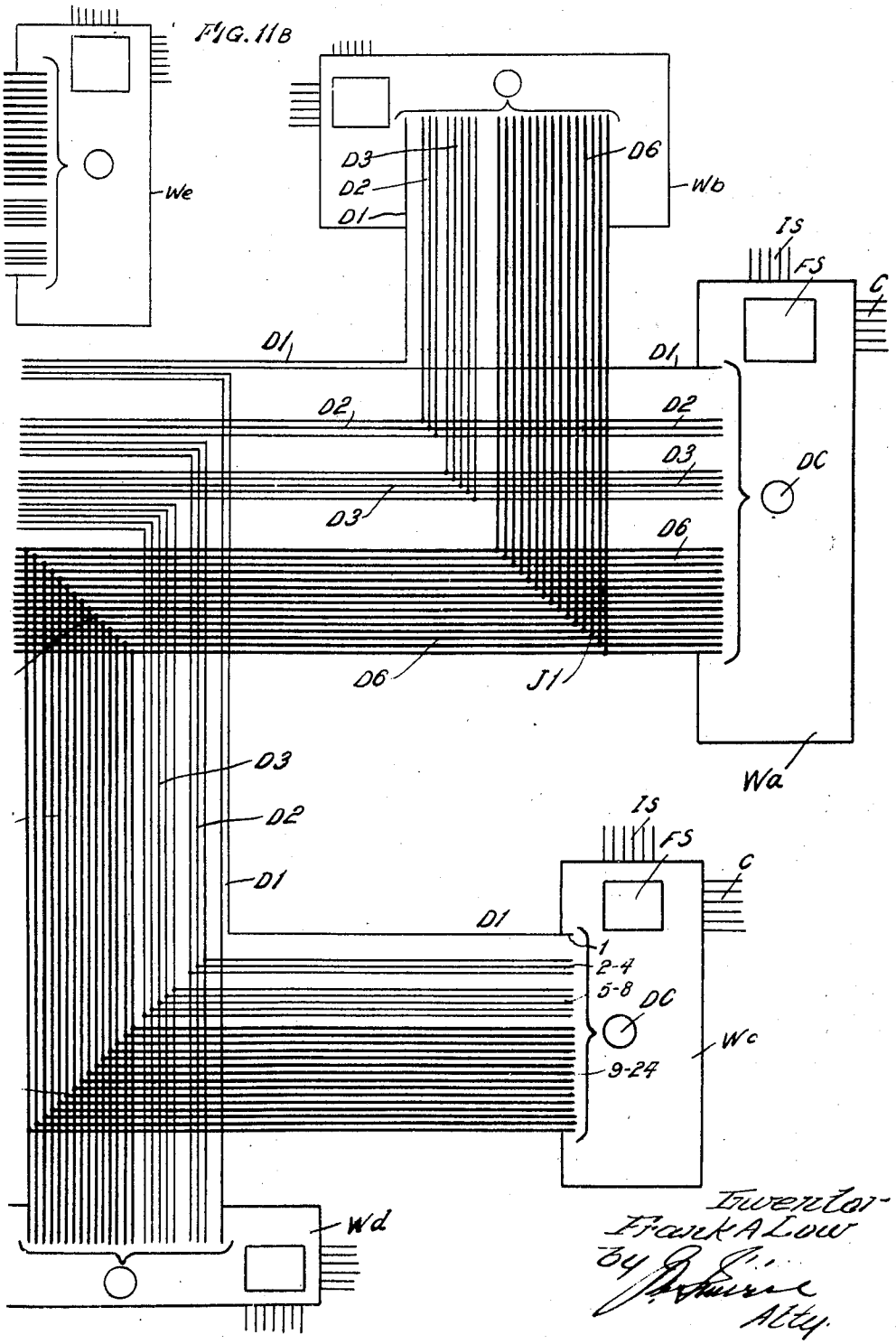
FIG 11.A

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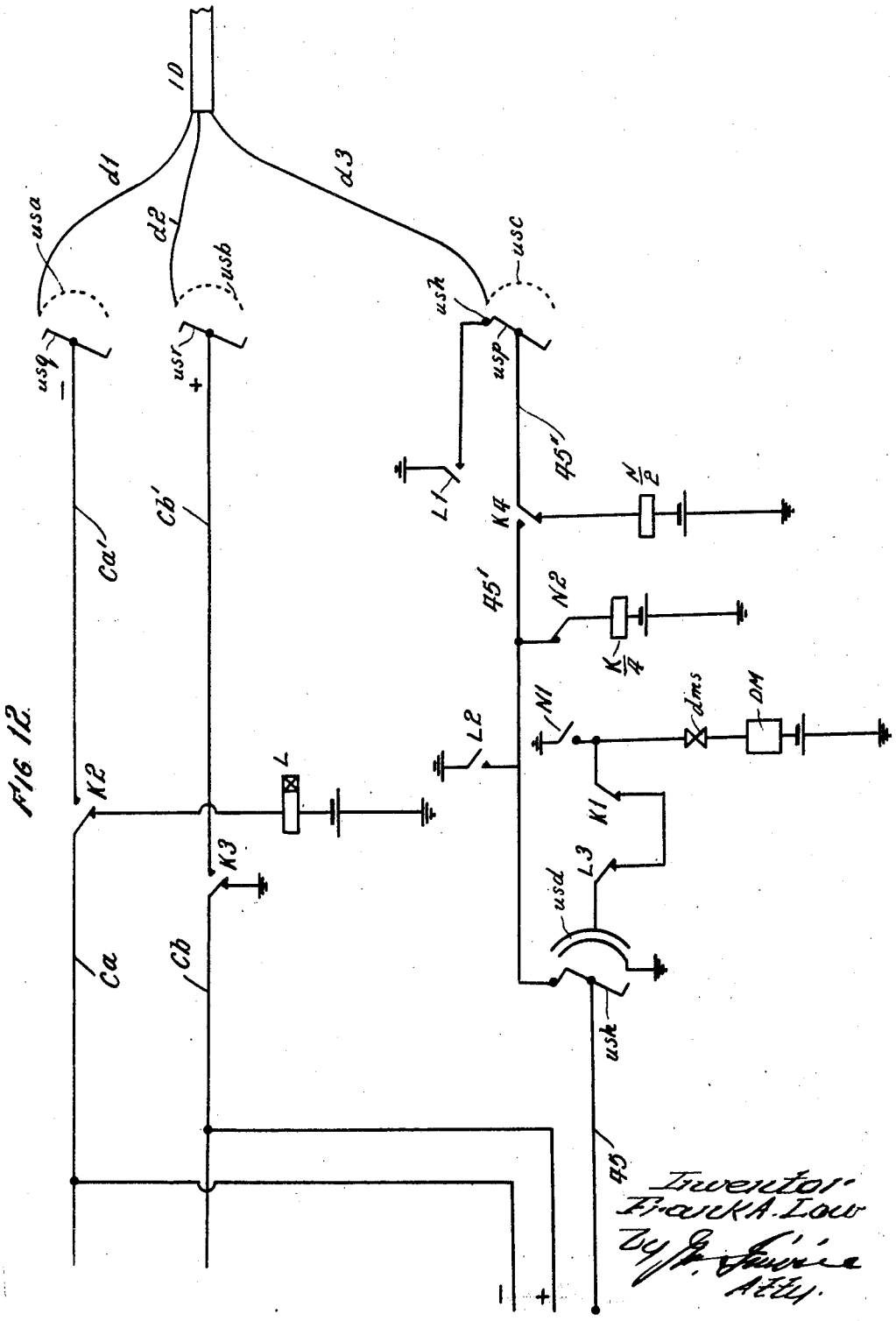


FIG 12.

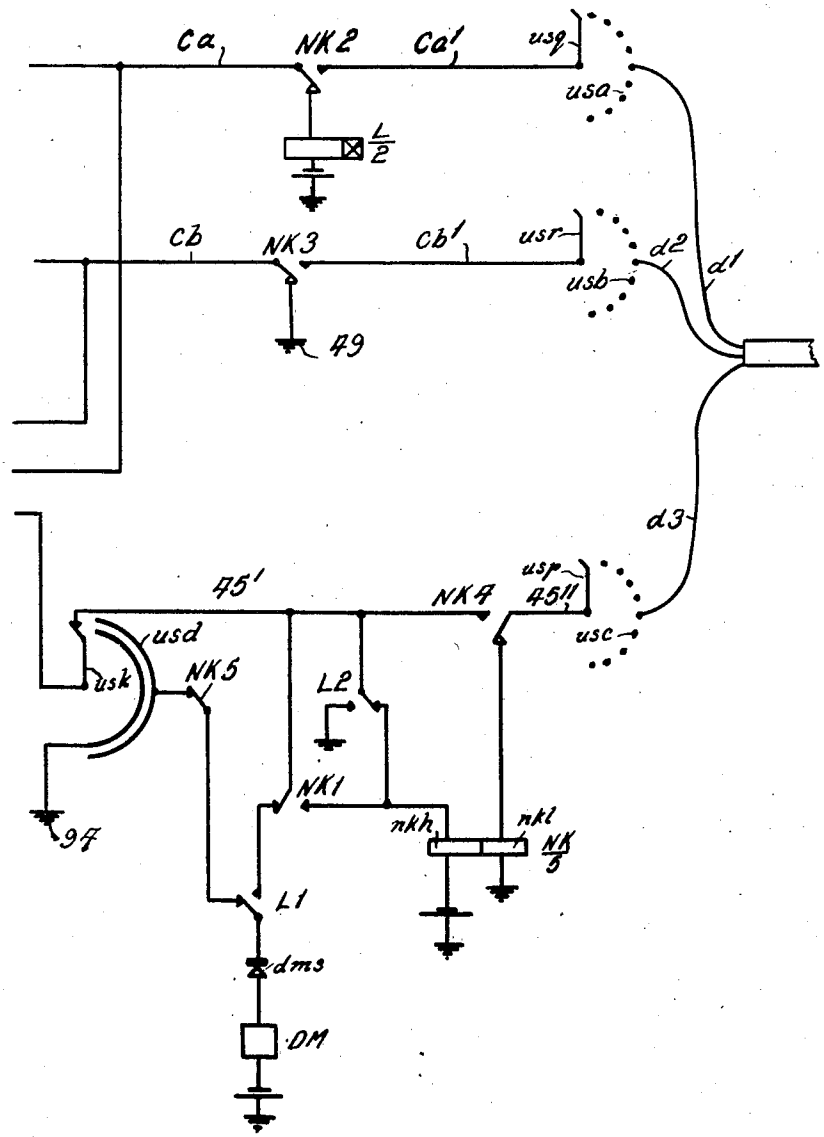
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FIG. 13.



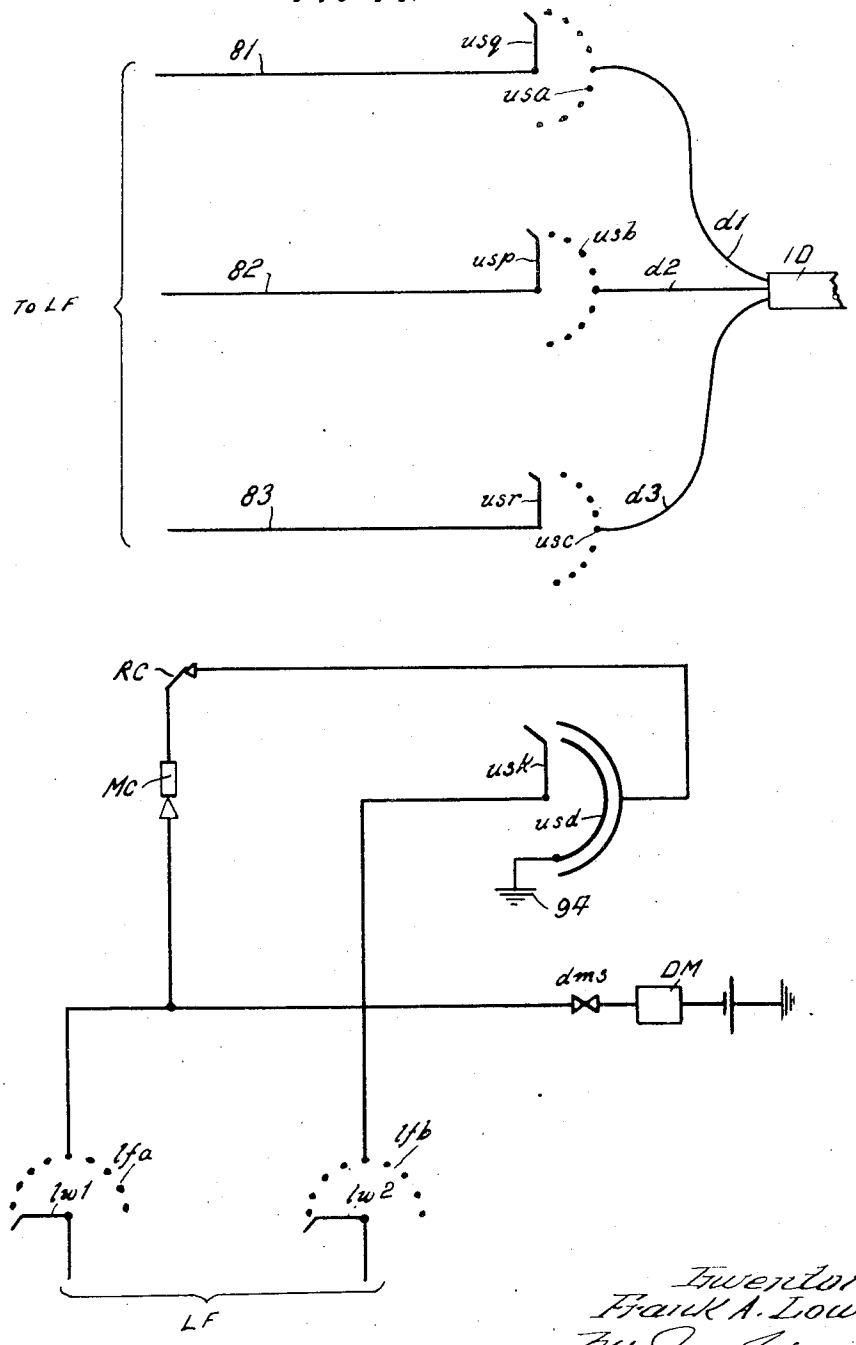
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AUTOMATIC TELEPHONE SYSTEM

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FIG. 14.



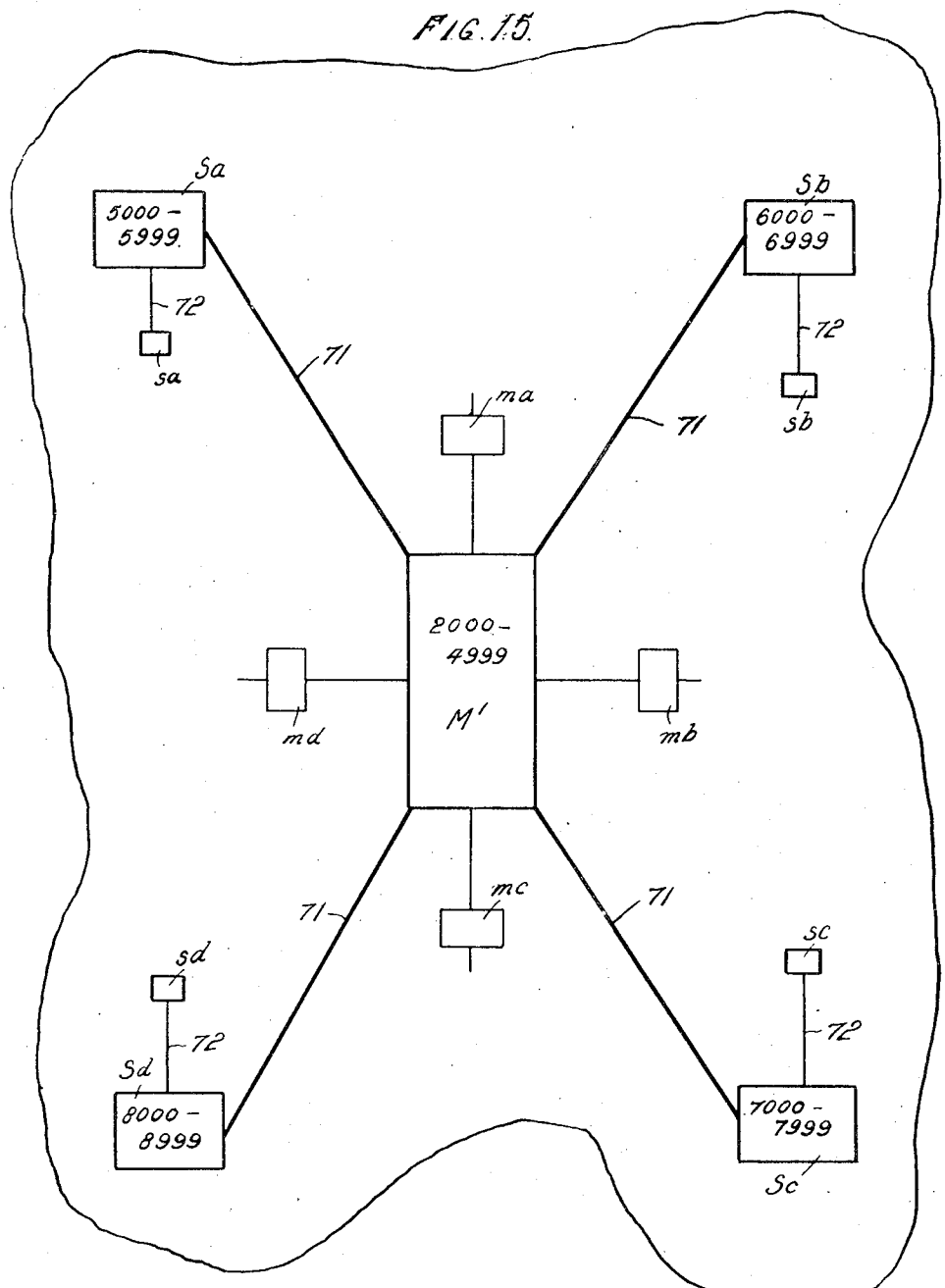
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FIG. 15.



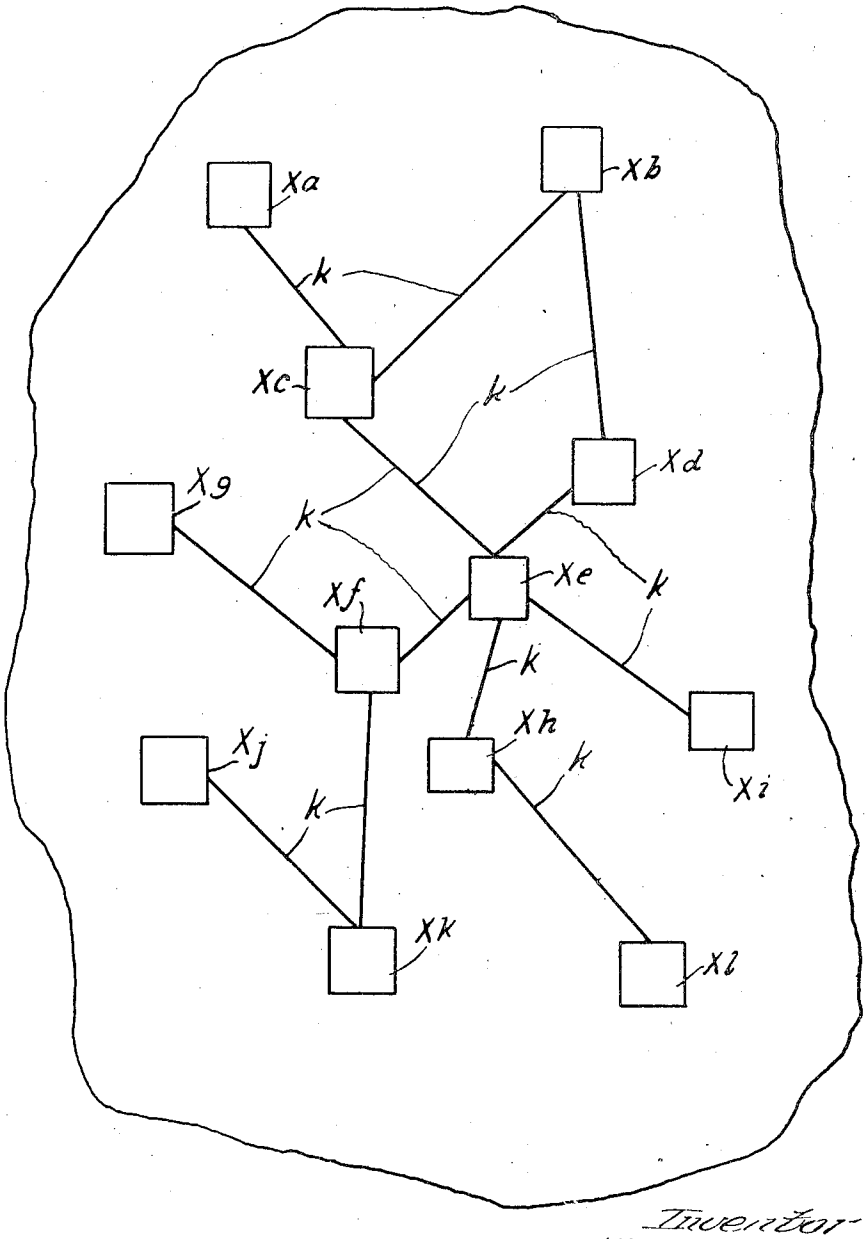
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FIG. 16.



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Patented Nov. 2, 1943

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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SYSTEM

Frank Arthur Low, Southport, England

Application May 14, 1941, Serial No. 393,433
In Great Britain May 25, 1940

6 Claims. (Cl. 179—18)

This invention relates to automatic telephone systems of the type comprising one or more sub-exchanges to each of which a number of subscribers are connected, and a main exchange to which each of the sub-exchanges is connected by a number of connecting lines fewer in number than the number of subscribers' lines connected to the sub-exchanges, and the object is to improve and cheapen this type of automatic telephone system.

I have, by way of example, illustrated my invention in the accompanying drawings which are mainly diagrams of connections.

In the drawings—

Figure 1 is a diagrammatic view of the general arrangement. In Figure 1 the area to be served is divided into four districts, north, south, east, west, and four different ways in which the outgoers may, according to the invention, be arranged are shown in these four sections respectively,

Figure 2 shows the connections which are made when calling and called subscribers are connected to different sub-exchanges,

Figure 3 is a similar view of the connections when the calling and called subscribers are connected to the same sub-exchange,

Figure 4 shows, to an enlarged scale, the mode of connection illustrated in the north section of Figure 1,

Figure 5 shows, to an enlarged scale, the mode of connection illustrated in the east section of Figure 1,

Figure 6^b and Figure 6^a together show a more detailed view or the connections shown in Figure 5,

Figure 7 shows with more detail than can conveniently be shown in Figure 6 how the commoning between the respective three conductors of two commoned outgoers is effected,

Figure 8 is a similar view but dealing with three commoned outgoers,

Figure 9 shows how the connection of outgoer trunks to subscribers' uniselectors are made,

Figure 10 shows the preferred arrangement of the connections between the sub-exchanges and the main exchange,

Figure 11^b and Figure 11^a shows with more detail the arrangement of Figure 6,

Figure 12 shows a modification of the arrangement of the usual construction of a uniselector, when this type of line-finder is used to connect a calling subscriber to a disengaged outgoer trunk of a group of outgoer trunks,

Figure 13 shows a further modification in the construction of uniselector,

Figure 14 shows a modification made in the usual construction of line-finder and outgoer trunk hunter when this type is used to hunt for the line of the calling subscriber and to find a disengaged outgoer trunk of a group of outgoer trunks.

Figure 15 shows the application of the invention to a non-director multi-exchange system with satellite exchanges,

Figure 16 shows the application of the invention to a director system of automatic exchanges.

Referring first to Figures 1, 2 and 3, the area to be served has a main exchange M, and in the example selected is divided into four sections, north, south, east and west; three of the sections, north, east and west are each divided into six sub-districts, the south section being divided into seven sub-districts; each sub-district has about one hundred potential subscribers and a sub-exchange is located in each sub-district; there are, therefore, twenty-five sub-exchanges divided into four groups, three of six and one of seven sub-exchanges. Each sub-exchange is connected by the requite number of separate lines C (one only of which is shown in Figure 1) to the respective subscribers in its sub-district, and is also connected to the main exchange by a suitable number of sub-exchange incomer trunks *Is*. Each outgoer trunk and incomer trunk has multiple conductors, the outgoer trunk usually three, and the incomer either two or three. In the drawings unless the contrary is stated, D, followed by a distinguishing letter or numeral, represents a group of the separate outgoer trunks to its associated sub-exchange, each of which outgoer trunks consists of three insulated conductors *d1*, *d2*, *d3* (see Figure 7 and Figure 9). *Is* represents a group of incomers to its associated sub-exchange; the ends only of incomers *Is*, at the main and sub-exchanges respectively, are shown, the intermediate parts being, to simplify the diagram, omitted.

The sub-exchanges are of the completely unattended type of automatic exchange. The equipment of a sub-exchange to carry out the present invention consists (see Figures 2 and 3) of disengaged outgoer trunk connectors DC and final selectors FS. The disengaged outgoer trunk connectors may be of any of the well known organization adapted to be associated with a number of subscribers' lines connected to the

sub-exchanges, and a number of outgoer trunks from the sub-exchange to the main exchange, which, when a subscriber lifts his receiver from its rest, connects the subscriber's line to an unengaged outgoer trunk; these may be uniselectors of known construction modified as described in connection with Figure 12 or Figure 13, in which case there would be one for each subscriber, or there may be a group of line finders with associated outgoer trunk hunters, the number required depending upon the traffic requirements of the sub-exchange. The final selectors FS may be of any of the well known designs operated by the dialling of the final two digits of the called subscriber's number and giving the usual facilities. There would be one final selector for each incomer trunk to the sub-exchange, and each when operated would connect its associated incomer trunk to the line of the called subscriber. The whole of the equipment would be housed in one or more air-tight cabinets. Normally the sub-exchanges would be identical in construction and would not be designed individually. Preferably they would be equipped for 100 subscribers' lines with facilities for expansion to 200 lines.

A main exchange M for the area served is provided, and to carry out the present invention has a group selector for each outgoer trunk from the sub-exchanges which enters the main exchange, and each group selector is associated with one of said outgoer trunks: in a four-digit numbering system each group selector comprises a 1st (GS1) and a 2nd (GS2) associated numerical selectors (see Figures 2 and 3), in which one 1st and 2nd group selector only is shown. Any of the well known construction of group selectors may be employed: when the sub-exchange outgoer trunk connected to the group selector GS1 is connected at a sub-exchange to a calling subscriber's line, and the first digit of the called number is dialled, the 1st selector GS1 moves vertically to the appropriate level and then, by angular movement, selects a disengaged connector, at that level, to the 2nd selector, and the latter, when the second digit is dialled, moves vertically to the appropriate level and, by angular movement, selects a disengaged incomer trunk to the sub-exchange to which the called subscriber is connected. When the two last digits are dialled the final selector FS associated with the connected incomer trunk connects the latter to the called subscriber's line.

The main exchange is equipped to act primarily as a switching centre for the sub-exchanges, it is, however, fitted with the usual well known apparatus for connection to a manual board: for producing and testing of tones and the like; and, where desired, for obtaining access to other automatic exchanges.

Such a combination of a main and twenty-five sub-exchanges would be capable of dealing with two-thousand-five-hundred subscribers in the area, a four-digit system of numbering being adopted.

All sub-exchanges are similarly equipped, and suitably connected to subscribers and to the main exchange, and in what follows each of the several modifications will be described with reference to a single group; the connections in each modification would, in practice, be followed in respect to each sub-exchange.

The sub-exchanges in the north section group are indicated by N*a*, N*b*, N*c*, N*d*, N*e*, N*f*. The other groups are correspondingly designated.

S is a satellite exchange with sub-exchanges *s*1, *s*2, *s*3; and X—X5 are exchanges of a director system, associated with the main exchange M.

The connections made when a calling subscribed associated with one sub-exchange N calls a subscriber in another sub-exchange W are shown in Figure 2. When the calling subscriber lifts his receiver from the rest his line C is connected by the disengaged-out-goer-connector DC to the free outgoer trunk D*n* from the sub-exchange N to the 1st group selector GS1 in the main exchange; and when the 1st and 2nd group selectors have been actuated, by dialling the first two digits of the called subscriber's number, the outgoer trunk D*n* will be connected to the incomer trunk I*w* and by the latter to the final selector FS*w* in the sub-exchange W, which final selector will connect the incomer trunk I*w* to the called subscriber's line C2. In Figure 3 the calling and called subscribers are both connected to the same sub-exchange N.

Of the three conductors (see Figures 7 and 9) *d*1, *d*2 and *d*3 of each outgoer trunk, two, *d*1 and *d*2, are the speaking lines, and *d*3 is a line which is automatically "earthed" when the outgoer trunk with which it is associated is in use. A calling subscriber has, of course, to be connected to a disengaged outgoer, and accordingly when he lifts his receiver he operates switches which make battery and relay circuits which, in well known manner, cause the actuating magnet of the subscriber's disengaged-outgoer-trunk-connector to move wipers (including its "private" wiper) in succession over the respective sets of contacts connected to the respective outgoer trunks until it finds a set with an associated wire *d*3 which is not "earthed," and therefore is a disengaged outgoer trunk.

In order to reduce the length of cable required for, and therefore the cost of, outgoer trunks which are usually laid in the streets en route between the sub-exchanges and the main exchange the sets of outgoer trunks are commoned at junction points located in the line of route between a group of sub-exchanges and the main exchange, said junction points are usually enclosed in weather-tight underground chambers, the positions of which coincide with the points where the routes from the several sub-exchanges of the group approach close together or intersect; for example, where the routes from two remote sub-exchanges of a group to the main exchange approach near together or intersect a junction point is formed at which the corresponding conductors of the two sets of outgoer trunks from the said two sub-exchanges are connected together as hereinafter described. There would be a set of outgoer trunks leaving each sub-exchange, the number of outgoer trunks in a set depending upon traffic requirements; usually a set would, for average traffic, comprise twenty to thirty outgoers, each outgoer trunk having conductors for speech transmission and a testing conductor; the number of sets of outgoers leaving a junction is always less than the number of sets of outgoer trunks entering it. For example, the number of sets of outgoer trunks leaving each junction point may be (see the east section of Figure 1 and Figures 5 and 6) reduced to one-half the number entering the junction, or where three sets of outgoer trunks meet at a junction point, is reduced to one-third of those entering; in Figure 6 it will be seen that though 24 outgoer

trunks leave each of six sub-exchanges of the east section, that is 144 outgoer trunks, only 48 outgoer trunks enter the main exchange. It must be understood that the number of sub-exchanges in a group, which share a particular set of outgoer trunks to the main exchange, is determined by the traffic requirements of the sub-exchanges; in Figures 5 and 6 there are three sub-exchanges per group. In this example normal average traffic has been assumed. The comparisons given above apply when all the outgoer trunks in a group are commoned at each junction point; in some cases, however, certain of the outgoer trunks from each sub-exchange pass directly to the main exchange, and some are commoned at some of the junction points only (as shown in the west section of Figure 1 and in more detail in Figures 10 and 11); in the latter arrangement the number of outgoer trunks leaving a two-to-one, or a three-to-one junction point are respectively more than one-half or one-third of those entering as the case may be. Examples of these respective modes of commoning are described with more detail later herein.

In the modification illustrated as applied to the grouped sub-exchanges in the east section, Figure 1 and in Figures 5 and 6, each sub-exchange is connected to the main exchange by a group of incomer trunks Is, the ends only of which at the sub-exchange and main exchange are shown. There would usually be 12 such incomer trunks for an exchange of 100 subscribers. The arrangement of the outgoer trunks is as follows:

For an exchange of 100 subscribers there would usually be 24 outgoer trunks; the outgoers D*a* and D*b* (see Figures 5 and 6) from sub-exchanges E*a* and E*b* are commoned at the two-to-one junction point J1, the junction point J1 is connected to the line D*ab* of 24 outgoer trunks to the junction point J2 where the outgoer trunks from sub-exchange E*c* would be commoned, the line D*abc* of 24 outgoer trunks enter the main exchange M, each connected (with great saving in length of cable required) to each of the three sub-exchanges E*a*, E*b* and E*c*.

In like manner the outgoer trunks D*d* and D*e* from sub-exchanges E*d* and E*e* are commoned at junction point J3 which is connected by the 24 outgoer line D*de* to junction point J4 where the outgoer trunks D*f* from sub-exchange E*f* are commoned; the line D*def* of 24 outgoers enters the main exchange.

By "commoning" is meant that the corresponding conductors of each outgoer in a set of outgoer trunks are connected to the corresponding conductors of the outgoer trunks in the other set; for example, at each of the commoning points indicated by a dot in Figure 6, the three conductors (see Figures 7 and 9) *d*1, *d*2 and *d*3 of each one of the commoned outgoer trunks would respectively be electrically connected to the conductors *d*1, *d*2 and *d*3 of each one of the other set of outgoer trunks, and the joints insulated.

An example of the mode of construction is that shown in Figure 7 where the conductors *d*1, *d*2 and *d*3 of the respective outgoer trunks D*a* and D*b* are commoned at *d*1, *d*2 and *d*3 of the outgoer trunk line D*ab*. Figure 8 shows the mode of commoning where three sets of outgoer trunks are commoned at a junction point; the conductors *d*1, *d*2 and *d*3 of the outgoer trunks D*x*, D*y* and D*z* are connected to the conductors *d*1, *d*2 and *d*3 or the outgoer line D*xyz*.

The junction points J1, J2, J3 and J4 would be located at points where the routes from the corresponding respective sub-exchanges to the main exchange approach close together or intersect.

The respective incomer trunks of the six sets of incomers Is to the respective sub-exchanges are, at the sub-exchange, each connected to a final selector, and at the main exchange end are connected either directly or indirectly to the banks of the 2nd group selectors GC2 (see Figures 2 and 3).

In Figure 5 each of the lines in the diagram represents a group of outgoer trunks; in Figure 6 the mode in which the individual outgoer trunks are commoned at the junctions is shown to a larger scale; the connections will readily be followed as the same letters of reference are employed in both Figures 5 and 6.

It will be seen, in the arrangement of outgoer trunks last described, that for each group of three sub-exchanges twenty-four outgoer trunks, each with its 3 conductors, enter the main exchange M. These would each be connected to a group selector GS1. A group selector connected to, say outgoer trunk numbered 1, would, therefore, be connected to each of the three sub-exchanges, thus the line 1 would be made an engaged line if selected by a subscriber at any one of the three sub-exchanges; the remainder of the outgoer trunks would be similar in this respect. Thus there would be no grading and the early choices will be in almost continuous use, the later choices being only used when the traffic offered from the three sub-exchanges reaches a peak value.

To equalize the traffic on all choices and thus reduce the total number of outgoer trunks required, in the preferred arrangement according to the present invention, the outgoer trunks are graded by directly connecting some and by commoning others, so that an early choice outgoer trunk is shared by subscribers to one sub-exchange only, the later choices being shared by the subscribers to two, three or more sub-exchanges. This arrangement is described in greater detail later.

Figure 9 shows the mode in which the three conductors of each of the respective outgoer trunks are connected to the bank of disengaged outgoer trunk connectors in the respective sub-exchanges. It will be assumed that the disengaged-outgoer-connectors are uniselectors US1, US2—US24, one for each of say 100 subscribers connected to each sub-exchange. Each uniselector has three sets *usa*, *usb* and *usc* of twenty-four concentrically arranged contacts corresponding with twenty-four outgoer trunks 1D, 2D, 3D—24D connected to the sub-exchange. *usq* and *usr* are the respective wipers for connecting the calling subscriber's line to the speaking lines *d*1 and *d*2 of an outgoer trunk, and *usp* is the private wiper which is used in testing for a disengaged line. There would be as many uniselectors as there are subscribers but three only, US1, US2, US3, are shown and there would be 24 outgoer trunks, three only, 1D, 2D, 3D, are shown in the diagram.

In Figure 9 *usa*, *usb* and *usc* are the three sets of 24 contacts fitted to each uniselector and *usq*, *usr* and *usp* are respective wipers therefor. The conductors *d*1 and *d*2 are for speech transfer, and *d*3 for testing of outgoer trunk 1D; these conductors are connected to contact 1 of the respective *usa*, *usb* and *usc* of uniselector US1 and all contacts 1 of the sets *usa* of each of the uniselectors are connected together by the conductor 59, similarly all contacts 1 of sets *usb* of each of the uniselectors are connected by the conductor

51, and contacts 1 of the sets *usc* are connected by the conductor 52, and so on; conductors 53, 54 and 55, 56, 57 and 58 connecting the corresponding contacts of all the uniselectors. The three conductors *d1*, *d2* and *d3* of outgoer trunk 2D are respectively connected to contacts 2 of sets *usa*, *usb* and *usc* of all the uniselectors, similarly the conductors *d1*, *d2* and *d3* of outgoer 3D are connected to contacts 3 of sets *usa*, *usb* and *usc* of all the uniselectors, and so on in well known manner.

Assuming that a subscriber associated with the uniselector US1 is making an outward call, the three wipers *usq*, *usr* and *usp* move over the respective sets of contacts. If outgoer trunk 1D is engaged its conductor *d3* and therefore wiper *usp* would be automatically earthed, and the wipers would, by their driving magnet, pass on to contacts 2; if outgoer trunk 2D were disengaged the wipers would remain on contact 2 until the subscriber released the connection. This is the usual action of the uniselector.

In order to reduce the total number of outgoer trunks required by equalising the traffic carried by early- and late-choice outgoer trunks, it is preferred to connect the outgoers from the sub-exchanges to the main exchange so as to provide a graded system of outgoer trunks as shown in the western section of Figure 1 and in Figures 10 and 11.

In Figure 10 the connecting lines D2, D3, D4 represent groups of outgoer trunks; in Figure 11 the lines represent single outgoer trunks to show the mode of commoning at the respective junction points; the same reference letters are employed to designate similar parts in both Figures 10 and 11. In this case there are four kinds of outgoer trunks per set; D1 (shown in fine full line) are outgoer trunks which connect the sub-exchange with which it is associated directly to the main exchange; D2 are outgoer trunks (shown in heavier lines) which are connected to two sub-exchanges by being commoned at a junction point J11; D3 are outgoer trunks (indicated by still heavier lines) which are connected to three sub-exchanges by being commoned at junction points J11 and J13; and D6 are outgoer trunks (indicated by heavy lines) which are connected to all sub-exchanges by being commoned at junction points J11, J12, J13, J14 and J15. The mode in which the several outgoer trunks are commoned at the junctions is illustrated in Figure 11 from which it will be seen that of outgoers entering the main exchange M some are connected to one sub-exchange only, some to 2 sub-exchanges, some to 3 sub-exchanges and some to 6 sub-exchanges. The wipers of the uniselector of a calling subscriber contacting with contacts 1 of the uniselector to which the directly connected outgoer D1 is connected, would find a disengaged line unless another subscriber in the same sub-exchange had already appropriated it. On the wiper moving over contacts 2, 3, 4 a disengaged line would be obtained unless these numbers were appropriated by a subscriber in the calling sub-exchange or in the other associated sub-exchange. On passing the contacts 5 to 8 the outgoer trunk would be engaged if it had been called up by a subscriber in the calling sub-exchange or either of the other two sub-exchanges; whilst on moving from contacts 9 to 24 an outgoer would be engaged if in use by any one of the 6 sub-exchanges. These conditions are typical of grading and by distributing the calls evenly over the various outgoer trunks each one has maximum efficiency and so renders it possible to reduce the number of them to a minimum for given traffic requirements.

The conductor *d3* of an outgoer trunk is earthed at the sub-exchange by which it is engaged; and it will be seen that if the conductor *d3* of an outgoer trunk be earthed at a sub-exchange near to the main exchange by a call originating in that sub-exchange, and be tested for earth by a uniselector at a remote sub-exchange, a long length of conductor will intervene between the private wiper *usp* at the remote exchange and the "earth" at the near exchange; and that this resistance would be varied according to the distance of the two said sub-exchanges. As this resistance may have a maximum of several hundreds of ohms the usual arrangement of a uniselector would prove unsatisfactory if employed with the usual standard battery voltage, relays and the like. It is, thereore, preferred to modify the usual form of uniselector in the manner illustrated in Figure 12.

In Figure 12, L is the line relay having three contact units L1, L2 and L3 and K is the switching relay having four contacts K1, K2, K3 and K4. In addition to the relays L and K there is provided a testing relay N having two contacts N1, N2. Of the relay contacts L1 and L2, the former is arranged to make contact before L2, these two contacts are of the "make" type; L3 is a "break" contact unit; the respective functions of L2 and L3 are to "earth" the private wire 45' and to control the homing circuit. The line relay has a slow-to-release feature. L1 provides an operating circuit for the testing relay N by earthing the home contact *ush*. The relay N is of the type which releases quickly, and when operated will hold in series with several hundreds of ohms resistance; and N1 and N2 are "make" and "break" contact units respectively; the energising of the switching relay K disconnects the N relay. The testing relay N completes and controls the driving magnet circuit, controls the switching relay K and tests the contacts in the uniselector bank. The uniselector mechanism may be of normal design and consists of four wipers *usq*, *usr*, *usp* and *usk* which are angularly moved, as one unit over a corresponding number of semi-circular arcs of contacts *usa*, *usb*, *usc* and concentric segments *usd* known as the uniselector bank, by a pawl and ratchet arrangement actuated by an armature. The motive power is supplied by the driving electro-magnet DM. The interrupter springs *dms* are arranged as usual so that they disconnect the operating circuit of DM when the armature is operated.

The two conductors Ca and Cb connect the subscriber's line to the moving springs of contact units K2 and K3 of the line relay K. K2 connects conductor Ca to one end of the L relay coil. K3 connects conductor Cb to earth. The other end of L relay coil is connected to negative of earthed battery. The operating circuit for L is completed when the subscriber takes his receiver off the rest. Contacts L2 and L3 respectively "earth" conductor 45', and disconnect the homing circuit through *usd* and *usk* respectively. L1 connects the home contact *ush* of arc *usc* to earth, wiper *usp* normally resting on this contact and being connected to negative of earthed battery. Hence when precedent acting contact L1 is closed, relay N is operated. N2 then connects K relay coil to conductor 45' and

provides an operating circuit for this relay when N relay releases, N1 closes and the circuit of the driving magnet DM and interrupter contacts *dms* is completed; the driving magnet DM will be energised over this circuit and the wipers will be rotated until they rest on a free outlet, whereupon the relay N will release as there will be no "earth" on the private wiper to complete its circuit. N1 contact in releasing disconnects the circuit of DM and thus prevents further rotation; N2 contact in releasing connects K relay coil to conductor **45'** and thence through relay contacts L2 to "earth"; K relay then operates; K1 disconnects the homing circuit; K2 disconnects conductor *Ca* from relay coil L, and connects it through conductor *Ca'* to wiper *usq* and so to the subsequent selector; K3 disconnects conductor *Cb* from "earth" and connects it through *Cb'* to wiper *usr* and so to the subsequent selector. K4 disconnects conductor **45''** from the relay N and connects it to conductor **45'**; thus extending conductor **45** through wiper *usk* to the subsequent selector. The operating circuit for relay L is now broken and it starts to release; the "earth" providing the holding circuit for relay K is maintained on conductor **45'** at L2 during the slow-to-release period of relay L until a holding "earth" has been returned on wire **45** from the subsequent selector. K relay remains operated until the holding "earth" is removed from conductor **45** due to the calling subscriber hanging up his receiver. The release of K restores everything to normal, in preparation for another call, by completing the homing circuit at K1 and re-connecting wires *Ca* and *Cb* to the line relay L and "earth" respectively, an "earth" being connected to the driving magnet circuit by means of wiper *usk* through the homing arc *usd*, contact L3 and contact K1.

When this invention is applied to systems of telephony in which the "engaged" indicating conductor *d3* is connected to negative battery, the free condition of an outgoer trunk being indicated by such connection, and the "engaged" condition being indicated as usual by connecting the said conductor to "earth," further modifications are required to the subscriber's uniselector to make the testing relay operate instead of releasing when a free outgoer trunk is reached.

One arrangement of the said modification is shown in Figure 13; as the diagram Figure 13 is similar in many respects to Figure 12, the same nomenclature has been used where possible. The modification consists in combining the testing relay N and switching relay K of Figure 12 into one relay NK (see Figure 13) which combines the functions of both relays N and K, this combination being rendered possible inasmuch as the testing wire, in the case of a free outgoer trunk, is energised by connection to negative battery.

NK relay is a double coiled relay with one high resistance winding *nkh* and one low resistance winding *nkl;* it has 5 contact units NK1, NK2, NK3, NK4 and NK5; NK1 operates when winding *nkl* is energised and before the other NK relay contact units. The line relay L is of the usual construction and has the usual functions. Its operation causes the uniselector wipers *usq, usr, usp, usk* to rotate over the arcs *usa, usb, usc, usd* until a negative battery on *d3* of a free outgoer trunk completes a circuit for the low resistance coil *nkl* of relay NK via wiper *usp,* to "earth." The energising of this coil causes the operation of NK1 contact. NK1 contact thus operated disconnects the circuit of the driving magnet DM and contacts *dms* and completes the operating circuit for the high resistance coil *nkh* of NK relay, which completely operates the relay, and through contacts NK2, NK3, NK4 switches the subscriber's line connections *Ca* and *Cb* through to the uniselector banks. NK relay holds on as in a normal switching relay, releasing upon the termination of the call.

If, instead of using subscribers' uniselectors as disengaged outgoer trunk connectors, subscribers' two-motion line-finders with directly associated outgoer trunk hunters are used, the difficulty of testing for a free outgoer trunk, referred to above, does not exist with a testing relay used for this purpose, in which the wipers are not returned to the home position upon release; but there remains a difficulty when used in the arrangement shown in the W section of Figure 1 and Figures 10 and 11, where in order to obtain the advantages of grading it is necessary, that the outgoer trunks should be tested in the same order (1 to 24) each time. To do this it is necessary, in order to apply such outgoer hunters to the present invention, for the wipers of the outgoer trunk hunter to return to a normal or home position when not in use, and also that the associated line-finder shall be prevented from being taken into use while this homing action is occurring.

One method of accomplishing the object is shown in the arrangement of Figure 14 in which, instead of reproducing all the connections of the line-finder, line-finder allotter, control relay sets and other equipment in which no change is made, only those parts are shown which are directly concerned with the modification, which parts are a uniselector mechanism US3 of normal design, a relay operated contact unit Rc, a mechanically operated contact unit Mc and two of the uniselector line allotter arcs *lfa* and *lfb,* and wipers *lw1* and *lw2,* associated with a line-finder allotter.

When the outgoer trunk hunter is taken into use an "earth" is transmitted from the line-finder allotter circuit via wiper *lw1* to complete a self-interrupted drive circuit for the driving magnet DM; thus the wipers *usq, usr* and *usp* pass over their associated arcs and connect to the three conductors *d1, d2* and *d3* of each outgoer trunk in turn; this circuit is broken in a known manner by the operation of a testing relay (not shown) in the line-finder allotter circuit when a free outgoer trunk is connected to wiper *usp.* At the same time, as the outgoer trunk hunter is taken into use, its associated line-finder is taken into use also; as soon as this occurs the relay-operated contact unit Rc breaks the homing circuit of the driving magnet DM; as the wipers of the line-finder step off normal in a vertical direction the mechanically operated contact unit Mc operates, further breaking the homing circuit in preparation for relay contact unit Rc making contact again when the line-finder is stepping in a rotary direction. When the line-finder wipers finally rest on the calling subscriber's line, contact unit Rc breaks again and does not "make" until the connection is released by the calling subscriber replacing his receiver on the rest. The line-finder wipers are restored to their normal position at this time, and the mechanically operated contact unit Mc makes contact again, thus completing the following self-interrupted drive homing circuit for the driving magnet DM; the wiper

usk connects the arc *usd* to "earth," which arc is connected via contact units Rc and Mc to the driving magnet DM and its associated interrupted springs *dms*, the circuit being completed by its associated negative battery. The wipers *usq*, *usr*, *usp* and *usk* will be stepped over their associated arcs, therefore, until the homing circuit is broken by wiper *usk* leaving arc *usd* and disconnecting the earth 94, all the wipers being now in the home position. While the outgoer hunter is being restored to the home position the earth 94 is connected via wiper *usk* to the appropriate contact on arc *lfb* of the line-finder allotter, to prevent the outgoer trunk hunter and its associated line-finder from being taken into use while the outgoer trunk hunter is at normal.

Figure 15 shows one way of applying the invention to a non-director multi-exchange area. In the diagram M1 represents a central exchange having sub-exchanges *ma*, *mb*, *mc* and *md*; S*a*, S*b*, Sc and S*d* represent four satellite exchanges (having sub-exchanges such as *sa*—*sd*) and these five exchanges form main exchanges for the sub-exchanges in their respective areas. 71 are groups of lines connecting the satellite exchanges S*a*—S*d* to the central exchange M, and 72 are lines connecting the satellite exchanges to their sub-exchanges.

In the arrangement illustrated in Figure 15 the subscribers' numbers in the area of the central exchange range from 2,000 to 4,999, hence 30 sub-exchanges are connected to the central exchange by one of the methods shown in Figure 1; the sub-exchange outgoers are connected to 1st numerical selectors at the central exchange, which would also contain 2nd numerical selectors for connecting callers to the incomers to sub-exchanges in the central exchange area; the incoming junctions from the satellite exchanges are also connected to 1st numerical selectors. When 5, 6, 7 or 8 is dialled on a 1st numerical selector, connection is made over a junction to a 2nd numerical selector at one of the satellite exchanges S*a*, S*b*, Sc or S*d* respectively, the second digit dialled connects the caller to the appropriate incomer trunk by stepping the 2nd numerical selector.

For the system illustrated in Figure 15 the numbering schemes of the satellite exchanges are as follows:

S*a* exchange 5000–5999, S*b* exchange 6000–6999, Sc exchange 7000–7999, S*d* exchange 8000–8999; thus there are 10 sub-exchanges connected to each satellite exchange. The sub-exchange outgoers are connected to discriminating selector repeaters with associated outgoer trunk hunters, which in a well known manner, connect the outgoer trunk to the central exchange and the satellite exchange before dialling, and discriminates to which exchange the call must pass after the first digit is dialled. For example, in exchange S*a* when 5 is dialled the connection to the central exchange is released and the remaining digits dialled pass through exchange S*a*, the discriminating selector then acting as a 2nd numerical selector.

Thus when the invention is applied to a non-director multi-exchange area the only modification required lies in the type of selector to which the outgoer trunk is connected at the satellite exchanges, that is to say a discriminating selector repeated instead of a 1st numerical selector.

Figure 16 shows the application of the invention to a director system of exchangers XA, XB, XC, XD, XE, XF, XG, XH, XI, XJ, XK and XL. Ks indicates the group of incomer trunks and outgoer trunks linking the exchanges to enable calls to pass from one to the other; each of the exchanges XA—XL has up to 100 sub-exchanges connected to it by one of the methods shown in Figure 1 and as hereinbefore described.

Each outgoer trunk is terminated on a selector of usual design which, in a well known manner, provides facilities for storing 7 digits dialled and translating the first 3 digits into a code of 1 or more digits in order to route the call to the correct exchange. For example, when a caller in an exchange area makes a call to a subscriber in the same area, the 3 digits are translated into 1 code digit; if, however, the call is to a subscriber in exchange XL the first 3 digits are translated into 4 code digits, one to determine the route in each exchange passed through.

Each of the exchanges X contains selectors with associated equipment and 1st and 2nd numerical selectors; the latter would connect callers to the incomer trunks to the sub-exchanges. Thus it will be seen that the modification required for applying the improved system to a director exchange is only in the type of selector to which the outgoer trunk is connected at the main exchange.

I claim:

1. In an automatic telephone system in combination, a main exchange, sub-district sub-exchanges, line connections from subscribers in the respective sub-districts to the corresponding sub-exchange, outgoers from each sub-exchange to the main exchange, incomers to each sub-exchange from the main exchange, a disengaged outgoer connecting organisation in each sub-exchange which, when a subscriber puts a call through to his sub-exchange automatically connects his line to a disengaged outgoer, switching mechanism of the group selector type in the main exchange, associated with the outgoers and incomers, which, when the calling subscriber is connected to an outgoer and dials in succession all the digits, except the last two, of the number of the subscriber re is calling, automatically connects the said outgoer to an incomer to the sub-exchange to which the called subscriber is connected, final selectors in each sub-exchange respectively connected to the incomers to the sub-exchange which, when the two final digits of the called number are dialled through the connected incomer, connects the latter to the line of the called subscriber, a number of junction points located at points where the routes from the respective sub-exchanges of a group of sub-exchanges to the main exchange approach close together or intersect, means at the junction points by which the corresponding conductors of corresponding outgoers entering the junction point from a plurality of sub-exchanges of the said group are connected together and to a single outgoer leaving the junction point en route for the main exchange.

2. An automatic telephone system in accordance with claim 1, in which the disengaged outgoer connector organisation is a uniselector, one for each subscriber's line, the combination with the driving magnet energising circuit and the usual line and switching relays of the uniselector of a relay the winding of which is normally connected, in series with an earthed battery, through a contact unit of the switching relay, to the private wiper of the uniselector, said testing relay having two contact units one, normally closed, in the driving magnet energising circuit,

and one, normally open, in the winding circuit of the switching relay, the first mentioned of said two contact units being opened and the second mentioned being closed when the testing relay winding is de-energised by movement of the private wiper onto a contact which is not earthed.

3. An automatic telephone system as claimed in claim 1, in which the testing wires of the outgoers are, when disengaged, connected to a battery negative, and when engaged are earth-connected, and in which the disengaged outgoer connector organisation is a uniselector, one for each subscriber's line, the combination with the elements of the uniselector of a combined switching and testing relay having two windings, one of high resistance and the other of low resistance, the latter normally connecting the private wiper of the uniselector to "earth" and when the said wiper moves into contact with a test wire at negative potential, being energised, and when energised opening a relay contact unit in the energising circuit of the driving magnet and closing a relay contact unit in the circuit of the high resistance winding, whereupon relay contact units of the uniselector are operated to connect the subscriber's line to a disengaged outgoer.

4. An automatic telephone system as claimed in claim 1, in which the disengaged outgoer connector organisation is a combined line-finder and outgoer hunter, the combination with the elements of such organisation of two relay contact units arranged in series in the circuit including the driving magnet energising winding, the line allotter arcs and the wipers therefor, one of the said contact units being that of an electrically controlled relay associated with the line finding circuits of the said organisation, and the other contact unit being mechanically controlled relay operated by the wiper of the two motion finders of the said organisation, the combined action of the two relay contact units, upon release of the said organisation, causing the return movement of the hunter wipers to the home position, and preventing, during said return movement, the line-finder part of said organisation being taken into use.

5. The combination with an automatic telephone system as claimed in claim 1 of at least one satellite exchange system comprising a satellite central exchange and a number of sub-district satellite sub-exchanges, the central exchange being connected by sets of outgoers and incomers to the main exchange, and the satellite sub-exchanges being connected to the subscribers in the associated sub-district, and being connected by outgoers and incomers to the central exchange.

6. The combination with an automatic telephone system as claimed in claim 1 of a plurality of additional exchanges which, together with the main exchange of the said system, are interconnected on the director system.

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