

Nov. 3, 1936.

J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

Filed Nov. 30, 1934

16 Sheets-Sheet 1

FIG. 1

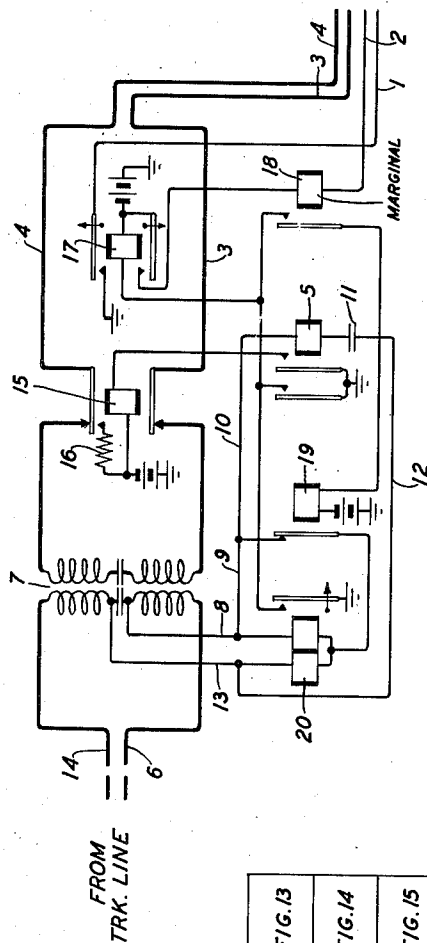


FIG. 1A

FIG. 1	FIG. 2	FIG. 5	FIG. 9	FIG. 13
	FIG. 3	FIG. 6	FIG. 10	FIG. 14
	FIG. 4	FIG. 7	FIG. 11	FIG. 15
		FIG. 8	FIG. 12	FIG. 16

INVENTOR
J. MESZAR

BY
H. H. Kugman
ATTORNEY

Nov. 3, 1936.

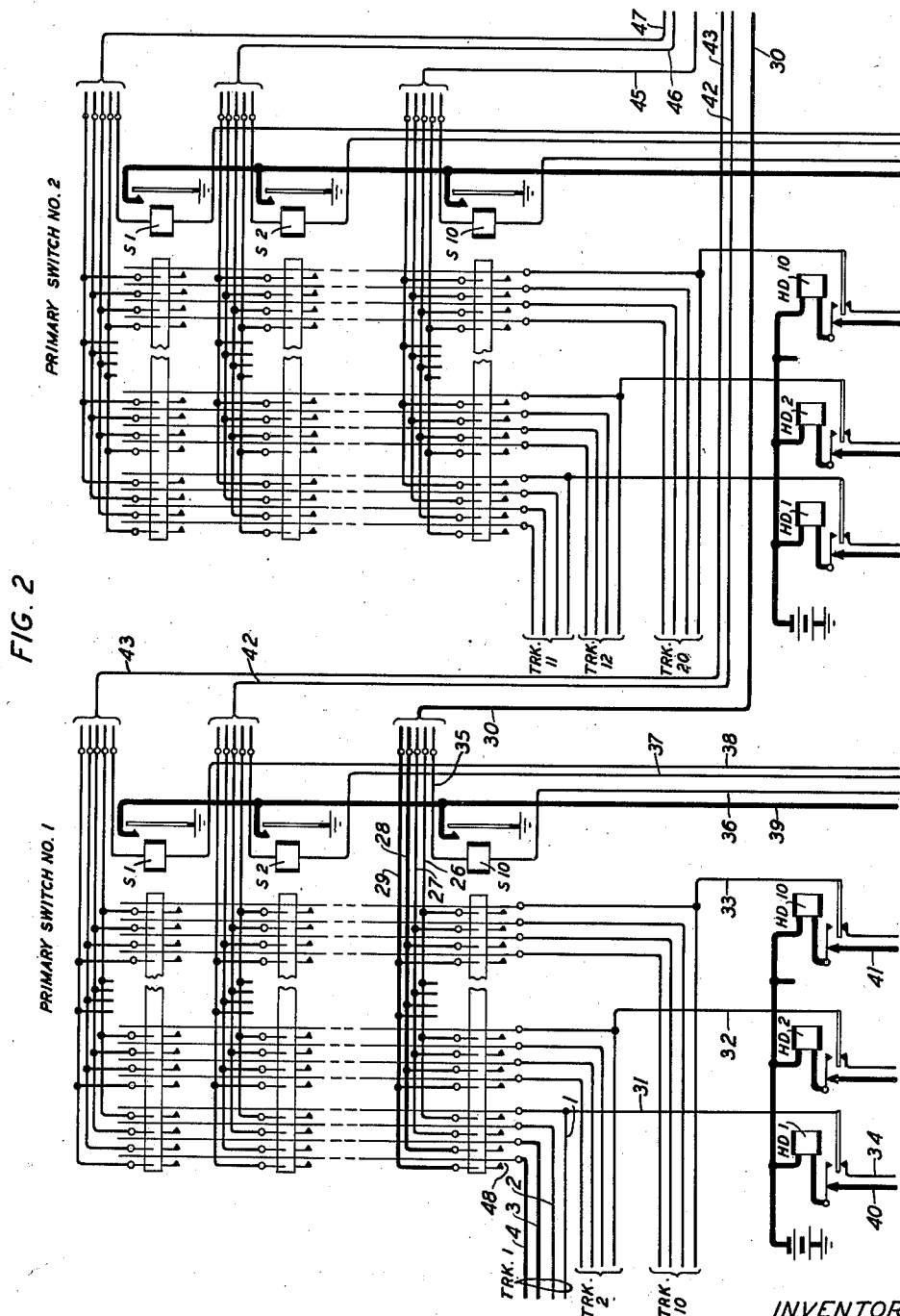
J. MESZAR

2,059,596

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16 Sheets-Sheet 2



INVENTOR
J. MESZAR

BY
J. G. Krigman
ATTORNEY

Nov. 3, 1936.

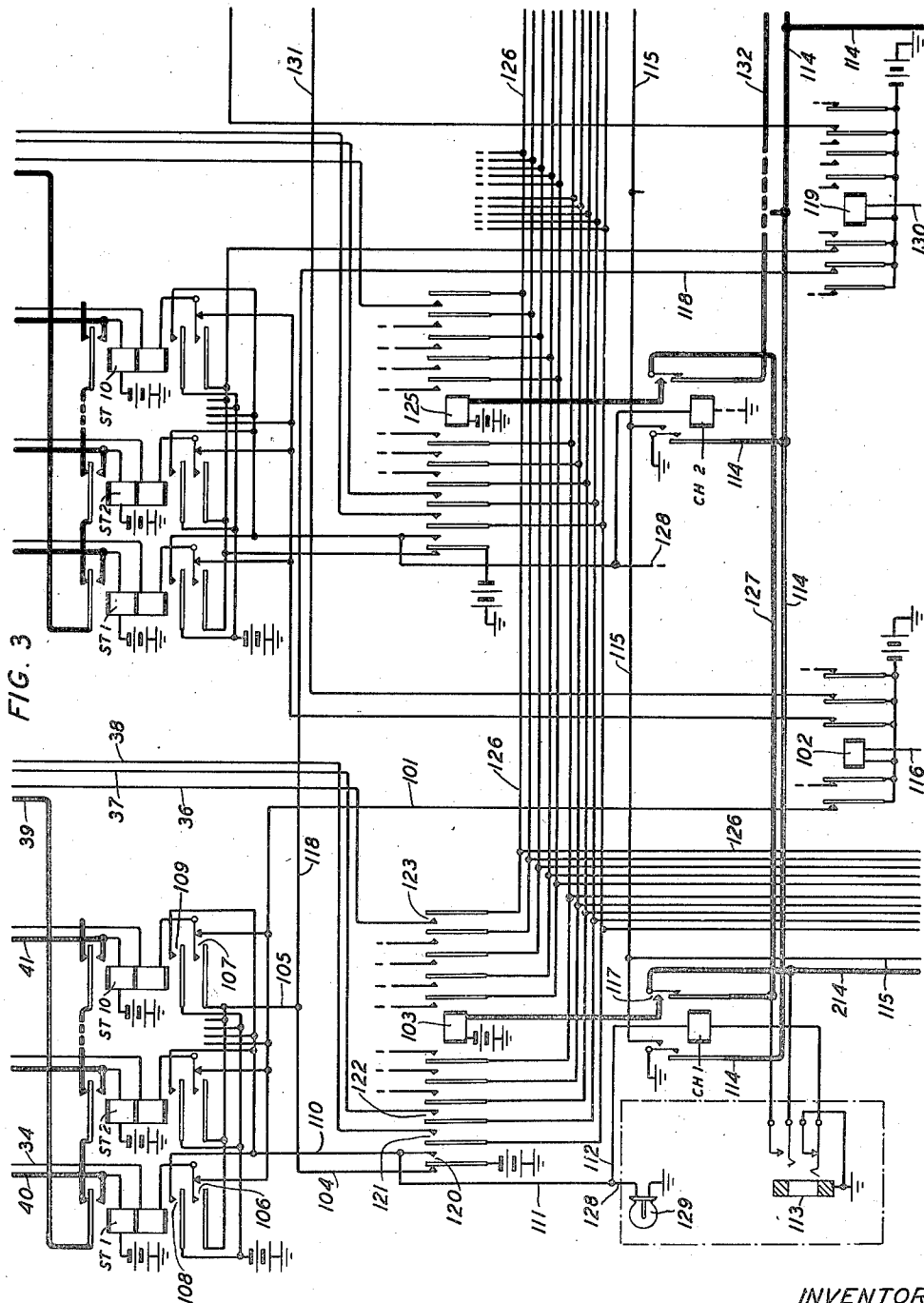
J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

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16 Sheets-Sheet 3



INVENTOR
J. MESZAR

BY
H. J. Kingman
ATTORNEY

Nov. 3, 1936.

J. MESZAR

2,059,596

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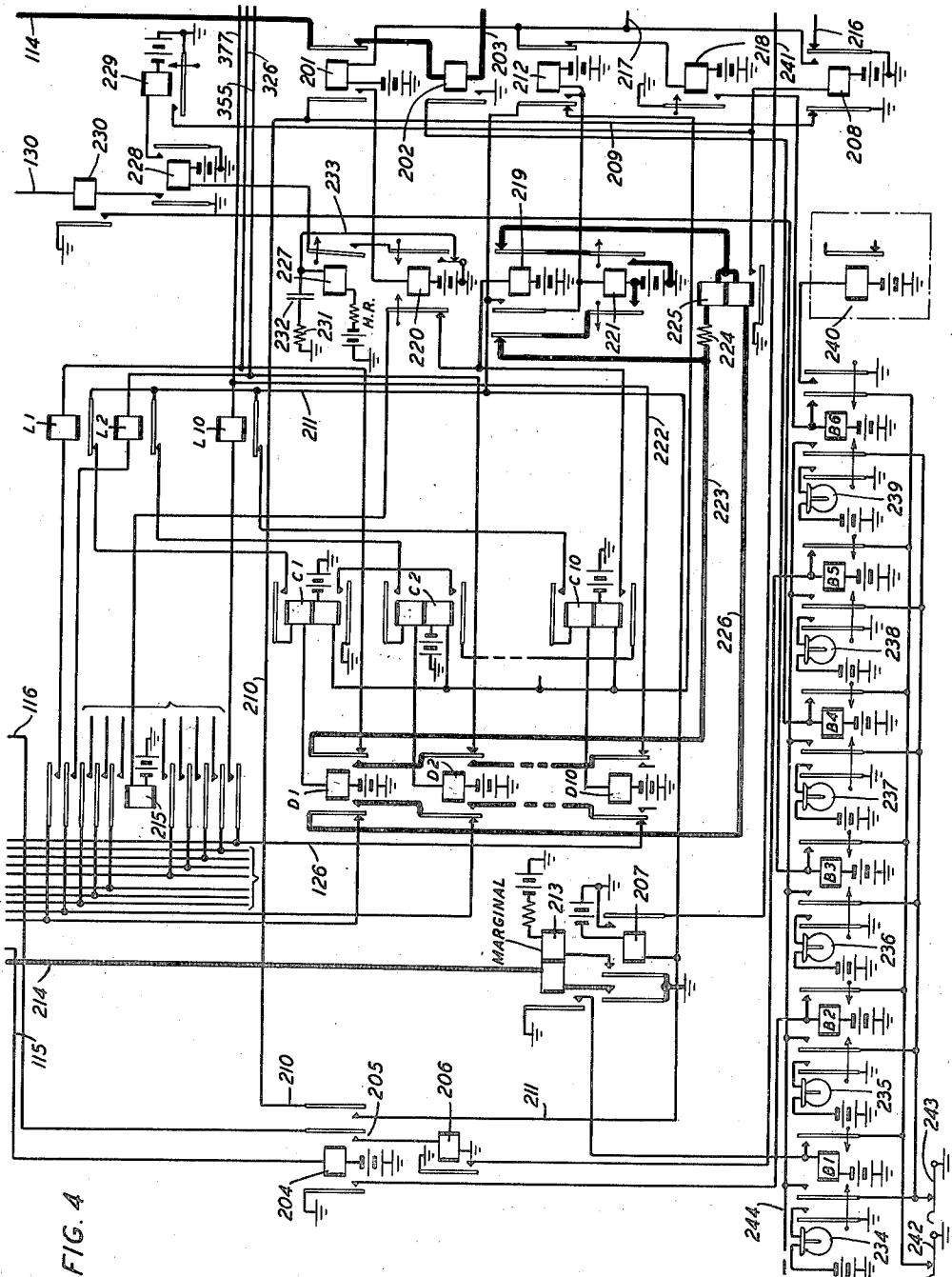


FIG. 4

INVENTOR
J. MESZAR

BY
Al. Kugman
ATTORNEY

Nov. 3, 1936.

J. MESZAR

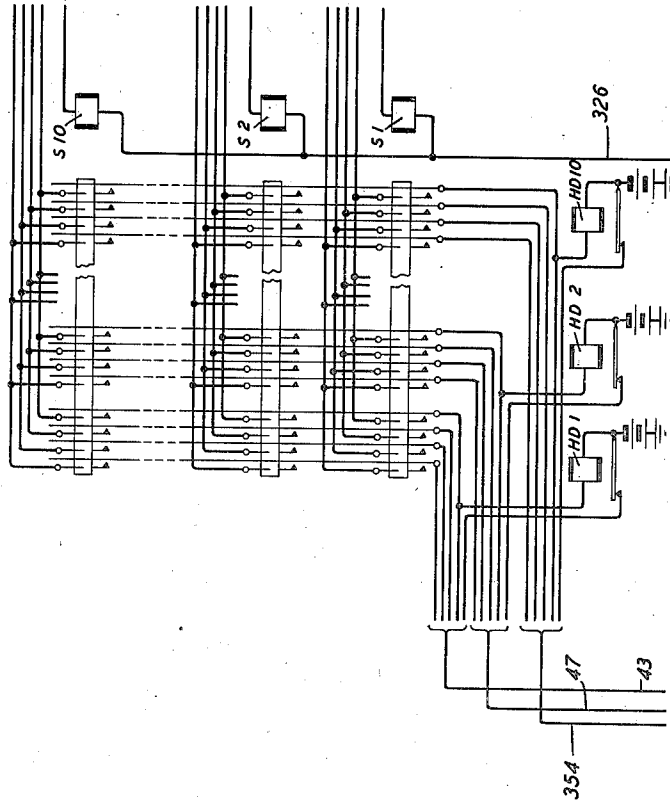
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FIG. 5
SECONDARY SWITCH NO. 10



INVENTOR
J. MESZAR

BY

A. G. Kingman

ATTORNEY

Nov. 3, 1936.

J. MESZAR

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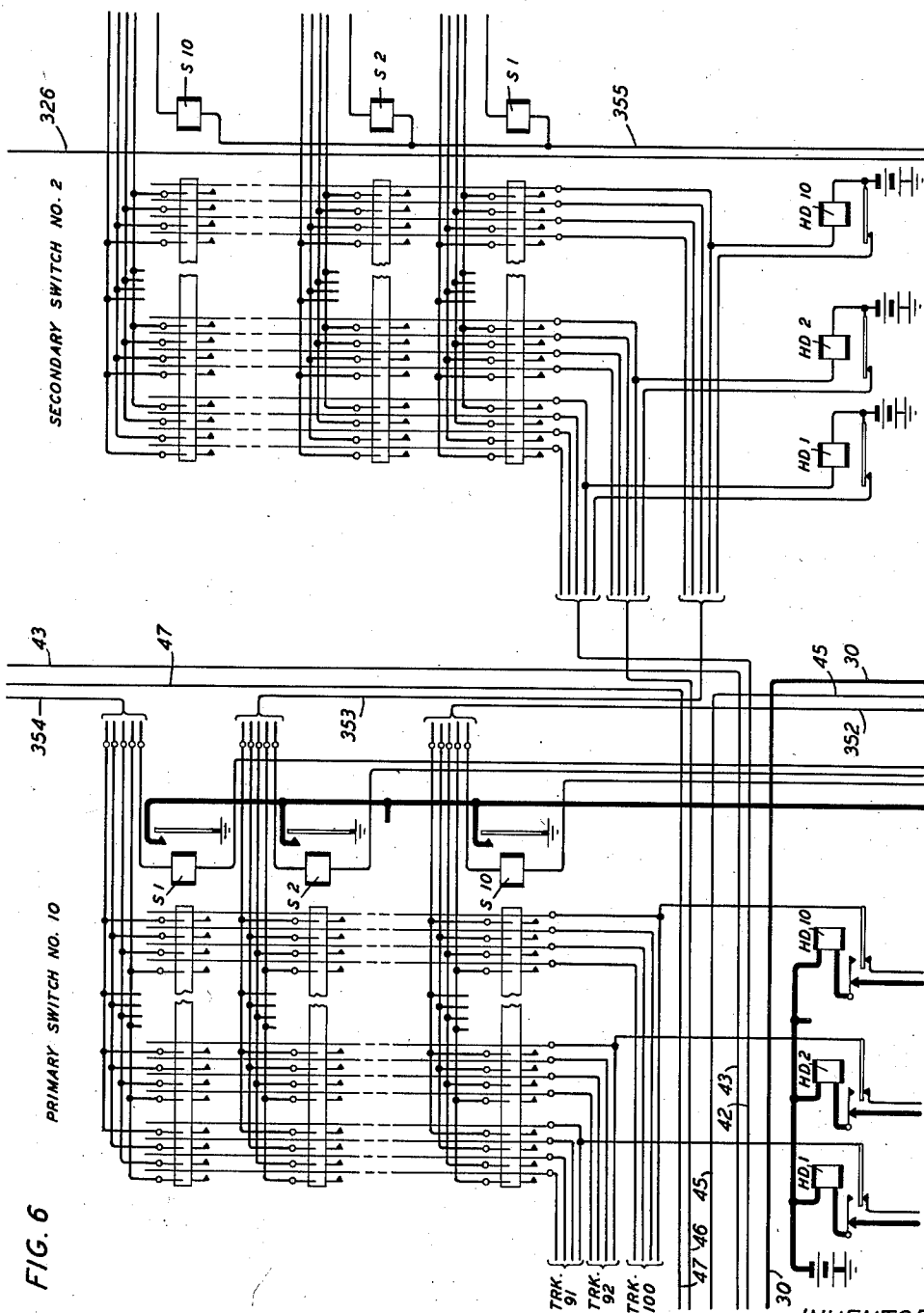


FIG. 6

INVENTOR
J. MESZAR

BY
A. G. Ferguson
ATTORNEY

Nov. 3, 1936.

J. MESZAR

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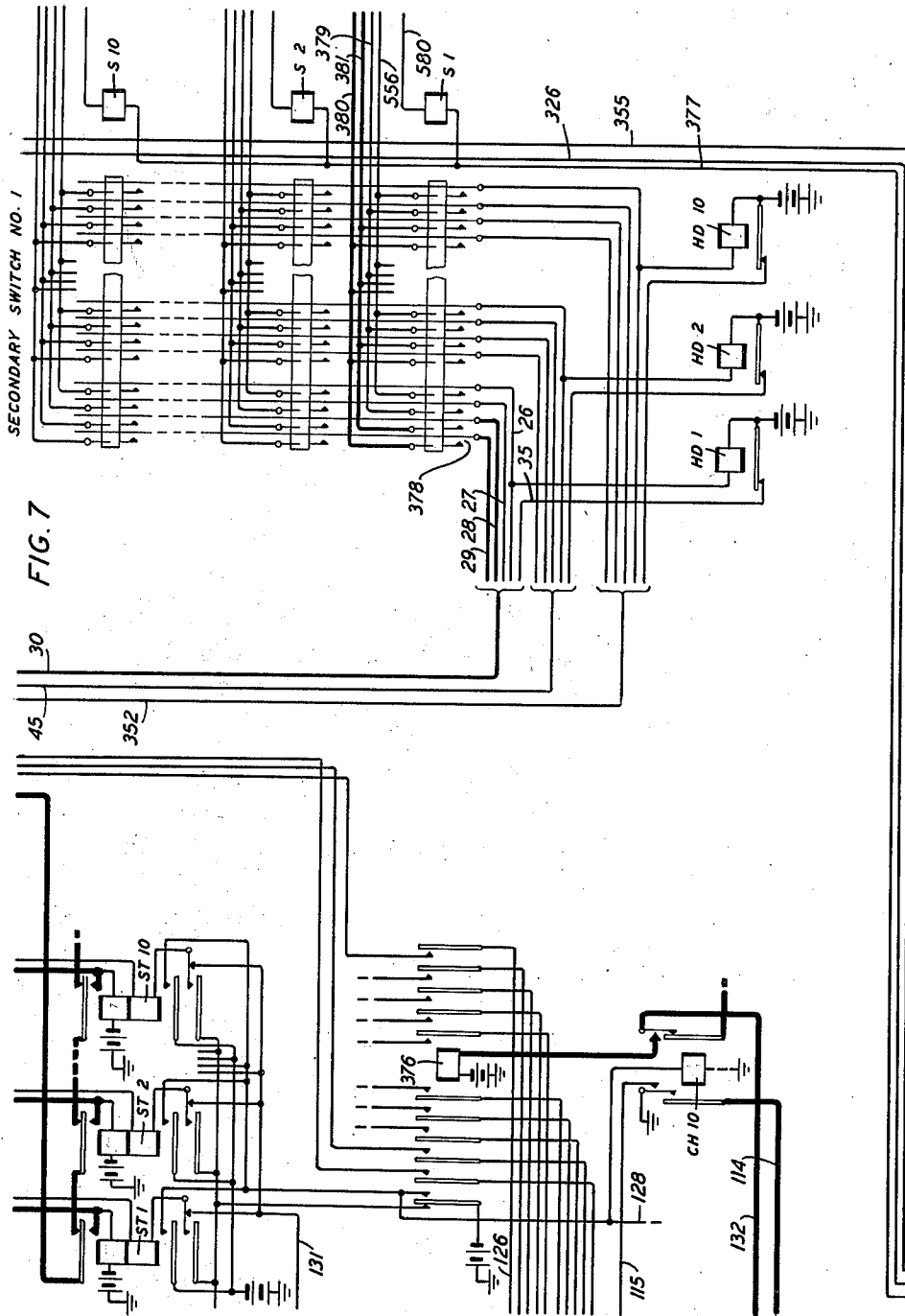


FIG. 7

INVENTOR
J. MESZAR

BY
A. J. Kingman
ATTORNEY

Nov. 3, 1936.

J. MESZAR

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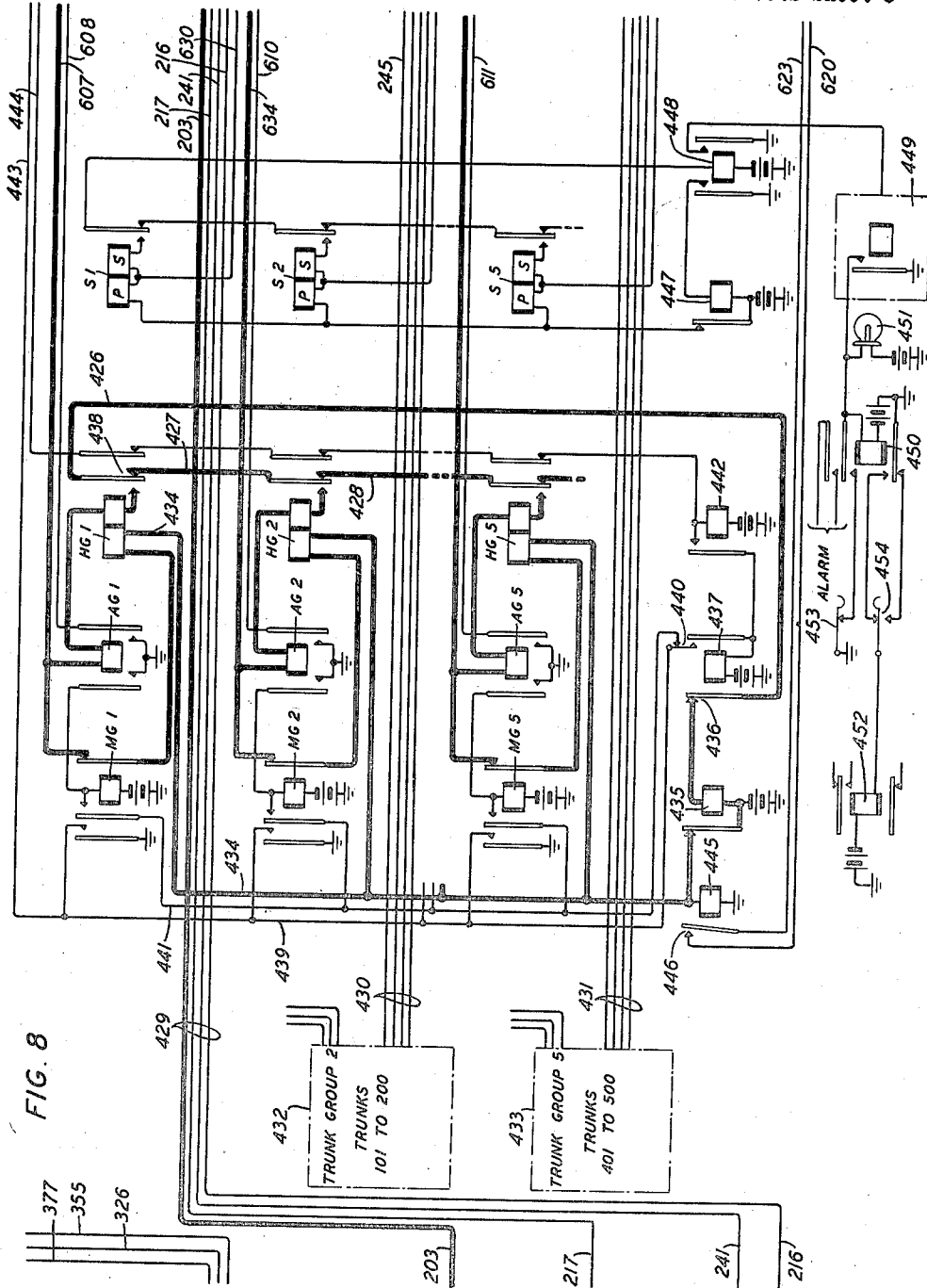


FIG. 8

INVENTOR
J. MESZAR

BY
A. J. Krugman
ATTORNEY

Nov. 3, 1936.

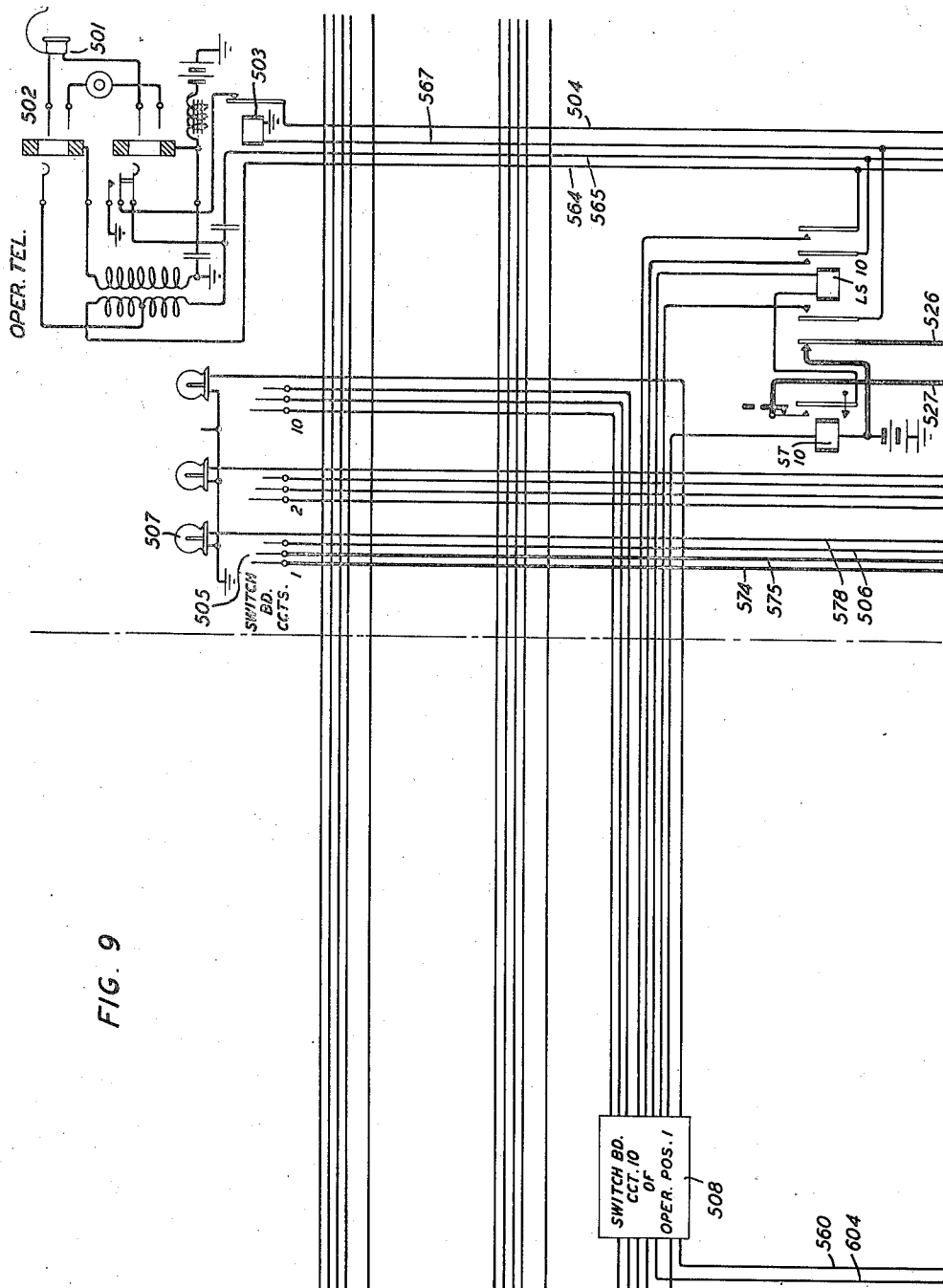
J. MESZAR

2,059,596

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INVENTOR
J. MESZAR

BY

ATTORNEY

Nov. 3, 1936.

J. MESZAR

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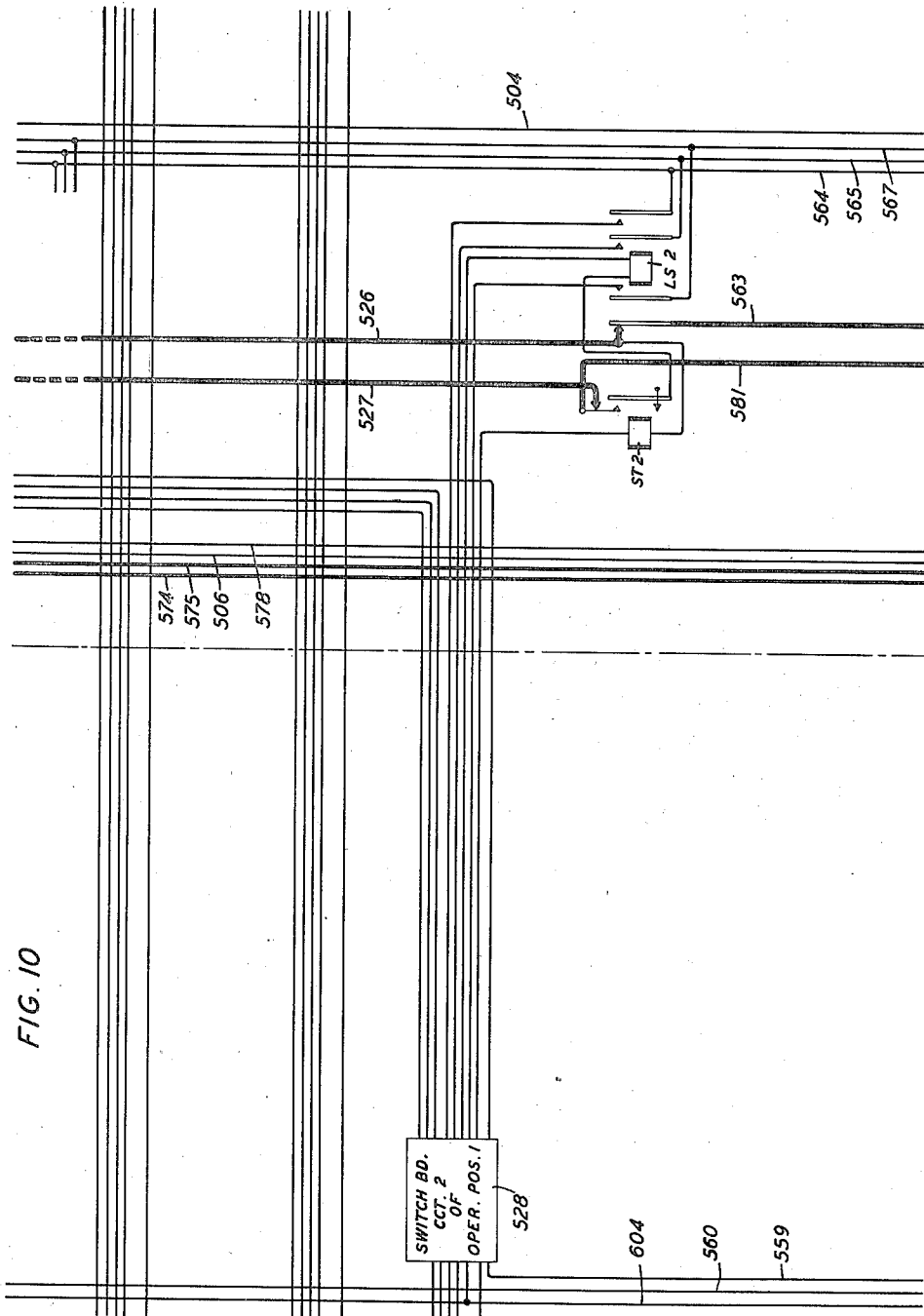


FIG. 10

INVENTOR
J. MESZAR

BY

H. J. Pinzman
ATTORNEY

Nov. 3, 1936.

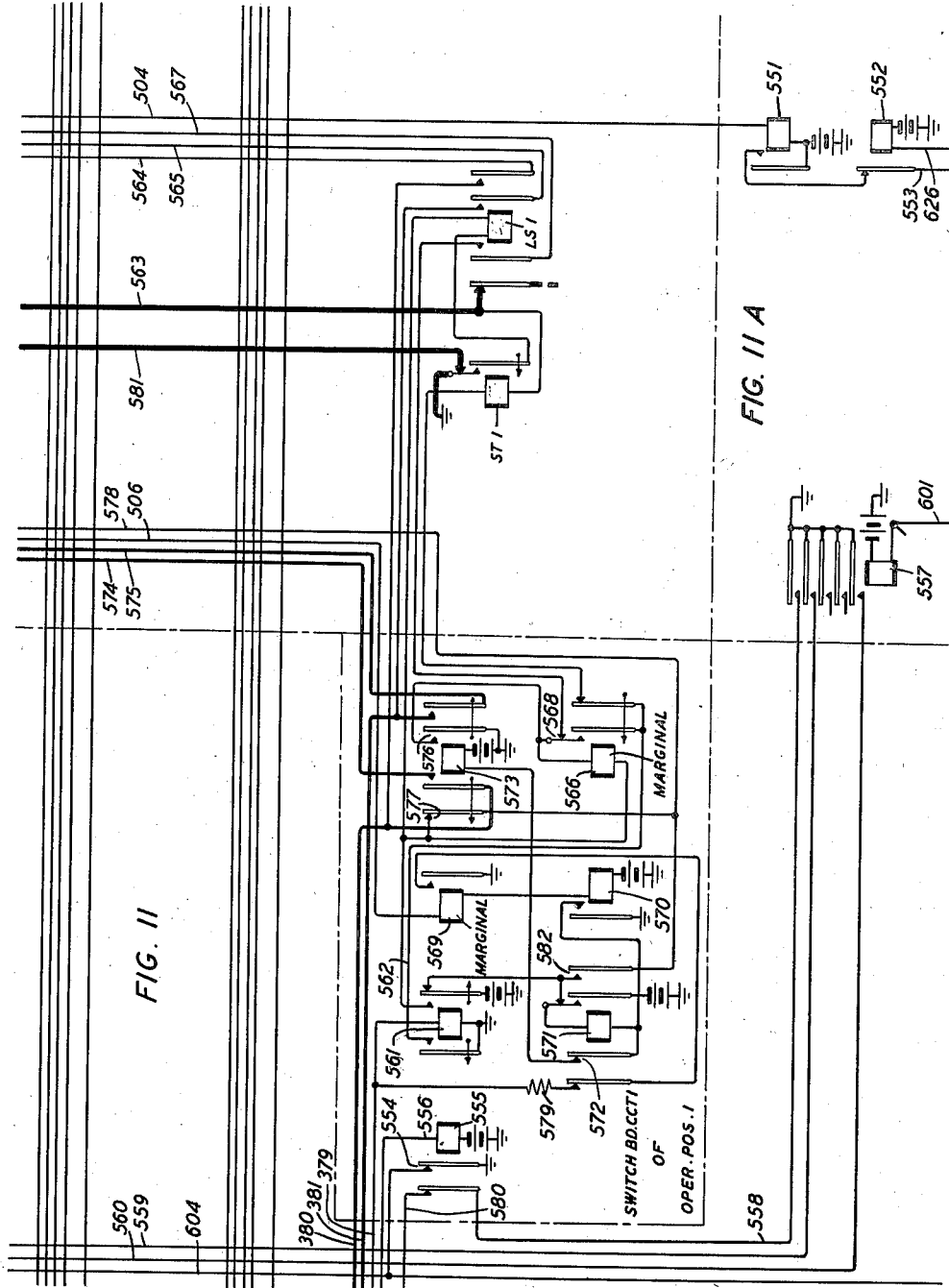
J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

Filed Nov. 30, 1934

16 Sheets-Sheet 11



INVENTOR
J. MESZAR

BY

A. H. Kugman
ATTORNEY

Nov. 3, 1936.

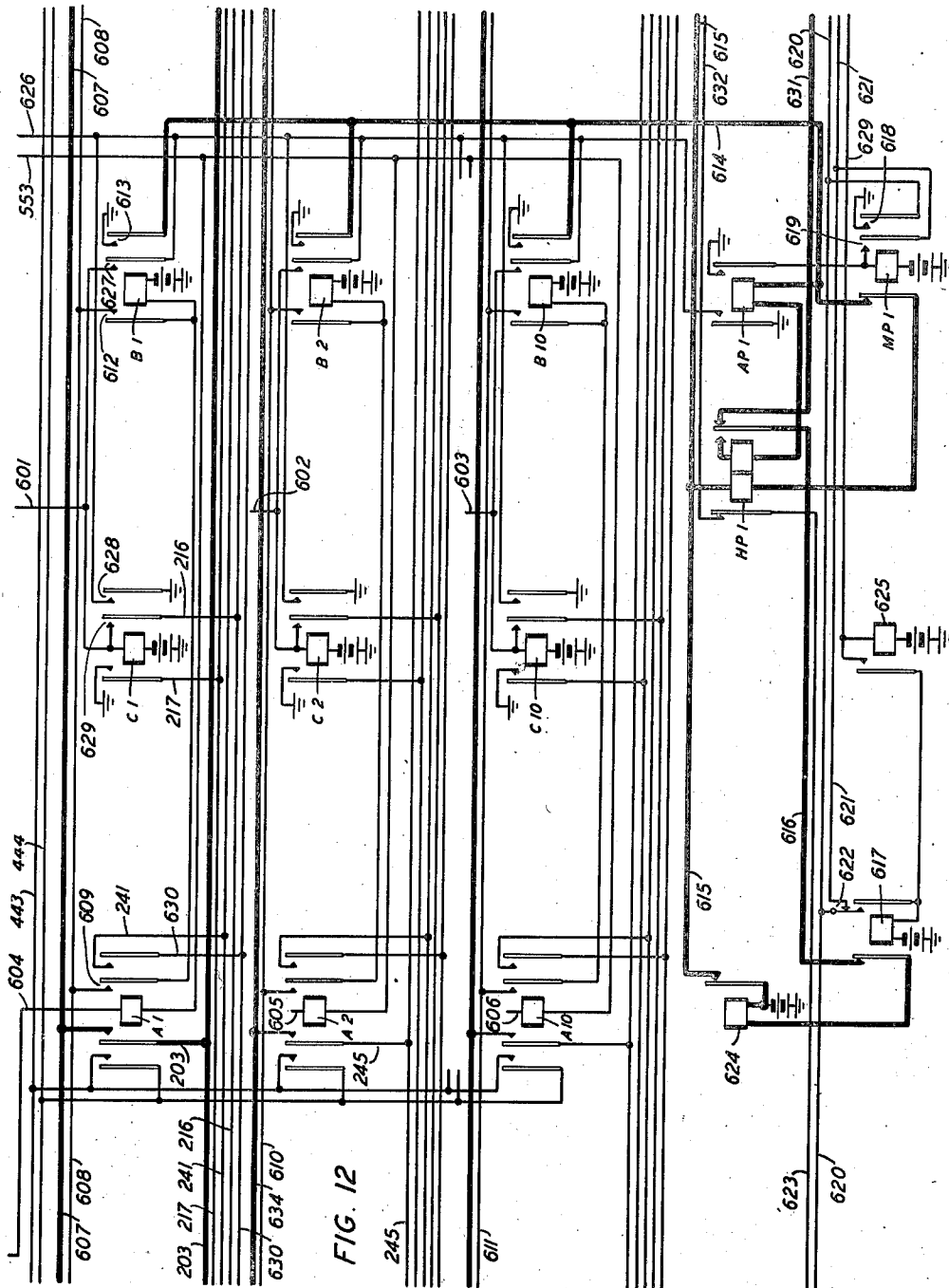
J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

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16 Sheets-Sheet 12



INVENTOR
J. MESZAR

BY
Attorney
ATTORNEY

Nov. 3, 1936.

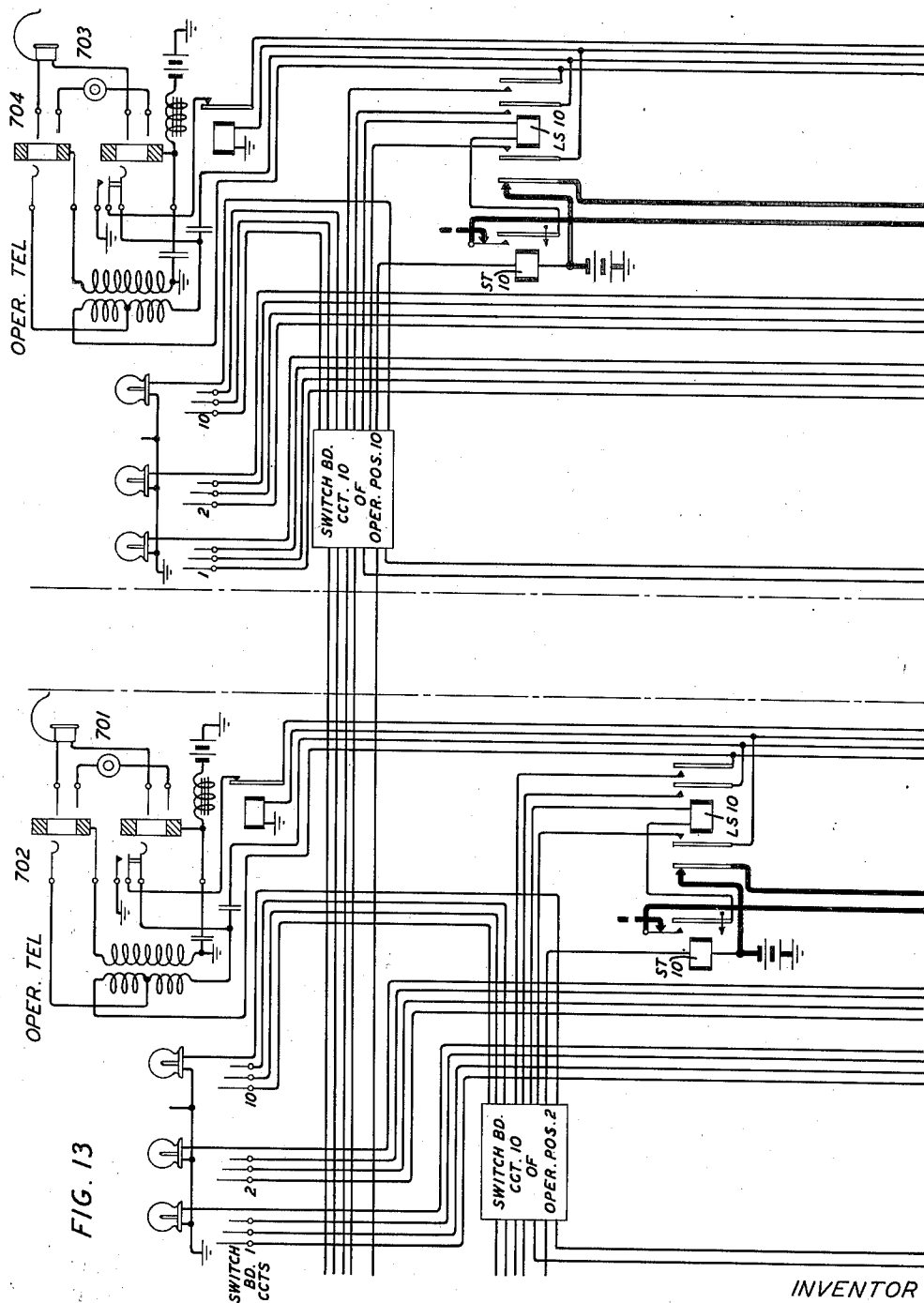
J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

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INVENTOR
J. MESZAR

BY
A. J. Fingman
ATTORNEY

Nov. 3, 1936.

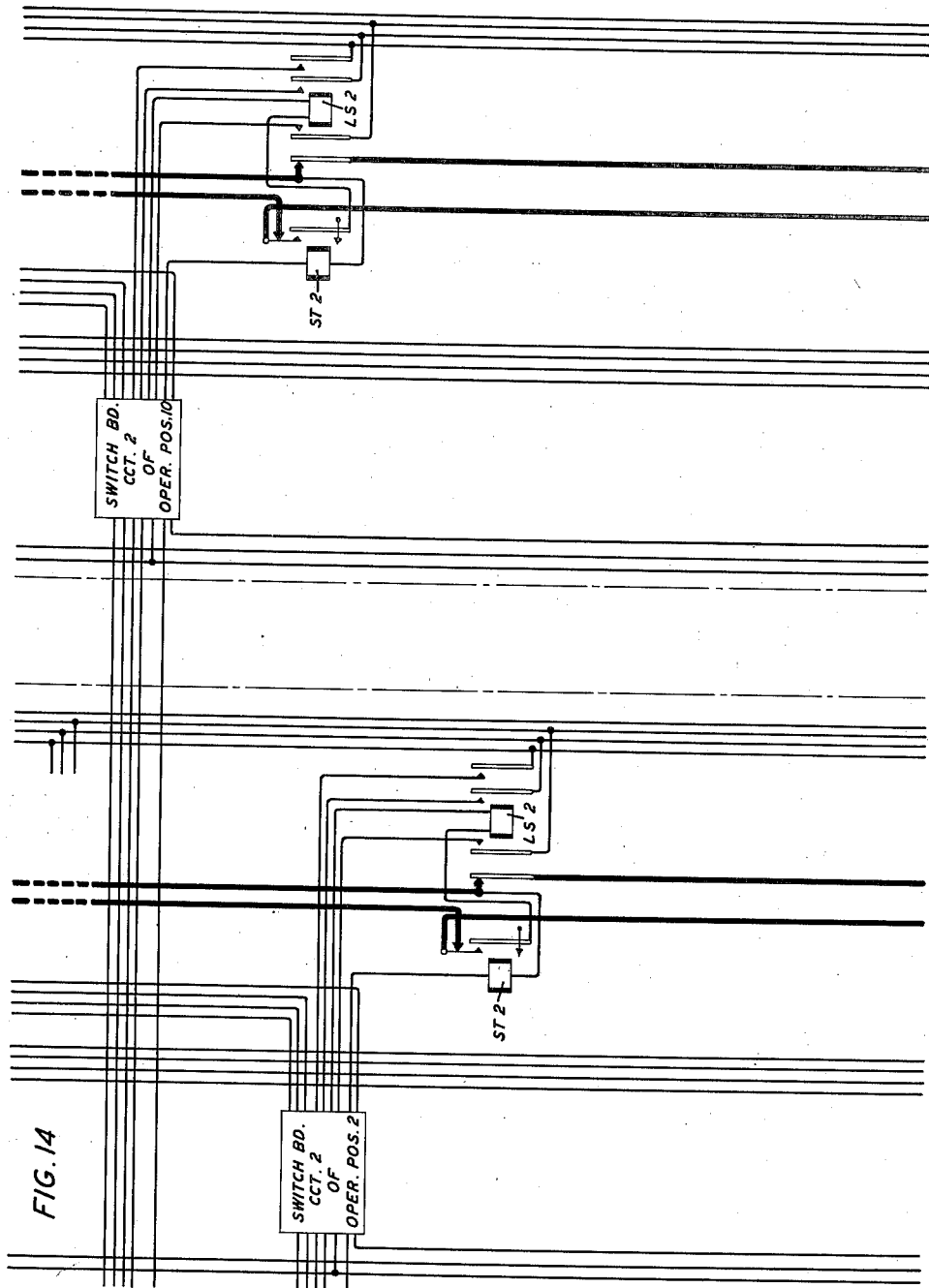
J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

Filed Nov. 30, 1934

16 Sheets-Sheet 14



INVENTOR
J. MESZAR

BY
H. P. Ingman
ATTORNEY

Nov. 3, 1936.

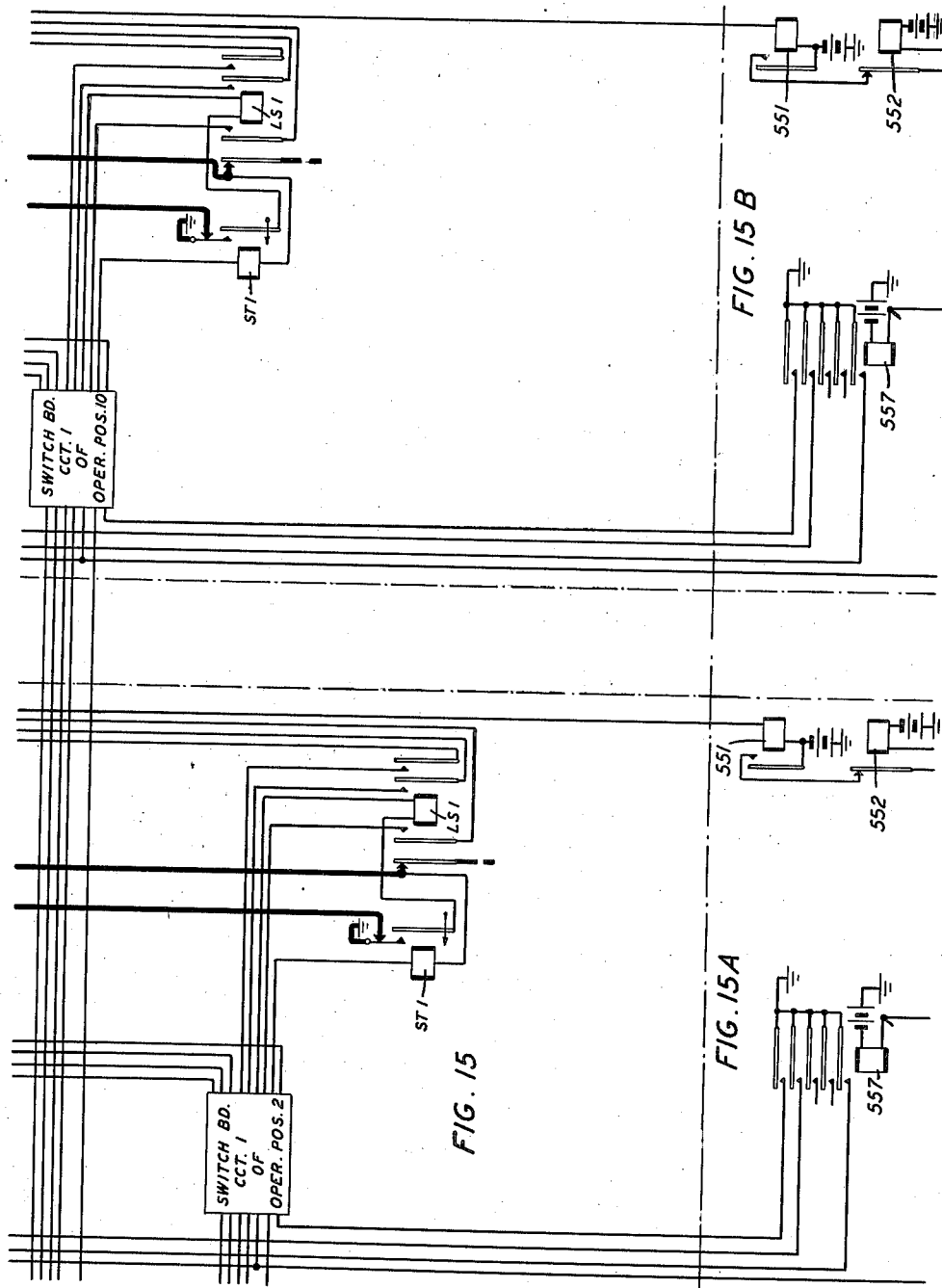
J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

Filed Nov. 30, 1934

16 Sheets-Sheet 15



INVENTOR

J. MESZAR

BY

H. G. Kingman
ATTORNEY

Nov. 3, 1936.

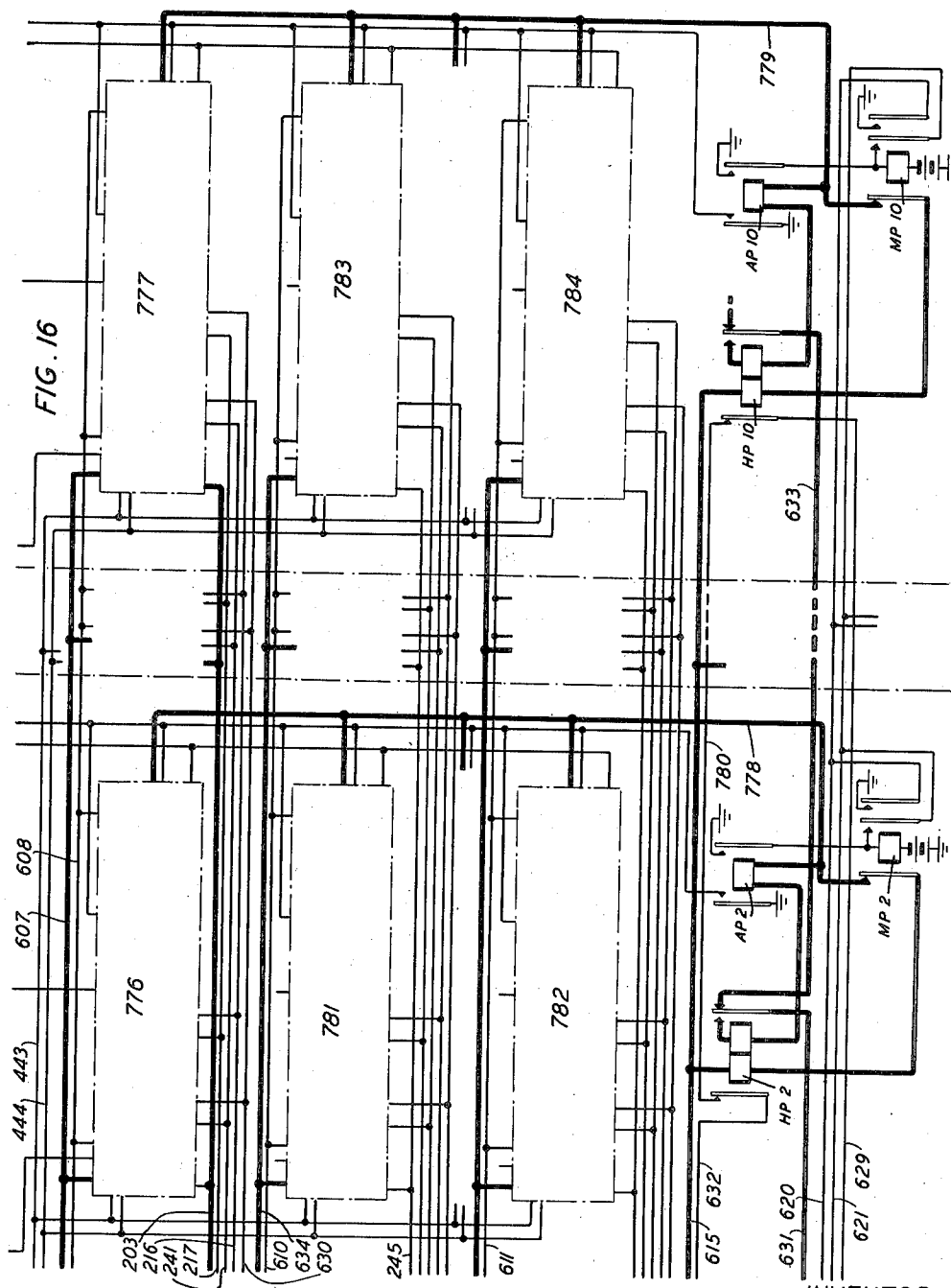
J. MESZAR

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

Filed Nov. 30, 1934

16 Sheets-Sheet 16



INVENTOR
J. MESZAR

BY
A. H. Kugman
ATTORNEY

UNITED STATES PATENT OFFICE

2,059,596

TELEPHONE CALL DISTRIBUTING SYSTEM

John Meszar, Bogota, N. J., assignor to Bell
Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application November 30, 1934, Serial No. 755,340

10 Claims. (Cl. 179—27)

This invention relates to telephone systems and more particularly to what are known as call distributing systems whereby calling lines are automatically routed to idle operators.

An object of the invention is to extend an incoming calling line as, for example, a trunk circuit or toll line, to an occupied switchboard position at which the operator is free to answer the call.

A feature of the invention whereby the foregoing object is attained, resides in dividing the calling lines into groups, terminating the lines of each group in contacts of a primary cross-bar switch individual to the group, extending a plurality of link circuits from each primary switch to a group of secondary cross-bar switches, terminating each link circuit in contacts of one of the secondary switches, extending a plurality of circuits from each secondary switch to and distributing them among a plurality of operators' positions and there terminated in answering terminals and, in an arrangement whereby a calling line causes certain circuit operations to take place including the following:

(1) Mark the calling line at the primary switch;

(2) Locks out subsequent calls after the system has started working on one or more calls until all the calls on which it is working have been connected to switchboard circuits;

(3) Tests a predetermined first choice switchboard position to (a) determine if the position is occupied, (b) determine whether the operator is idle, (c) determine whether the position has an idle answering terminal available to one of the secondary switches associated with the primary switch in which the calling line terminates and if no idle terminal is found continues testing until a second, third, etc. choice position is found in which an idle terminal appears to which the call can be routed;

(4) Causes the position to initiate a hunting operation to find the calling line and connect it, by means of the primary switch, to the lowest numbered idle link circuit extending to a secondary switch having access to an idle connecting terminal appearing in the chosen position and to cause the secondary switch to connect the link circuit thereto.

Other features include the following:

The link circuits from two or more primary switches can be multiplied thereby reducing the number of link circuits available for extending a given group of calling lines. In like manner the outgoing switchboard circuits from two or

more secondary switches can be multiplied thereby effecting further economy by reducing the number of answering terminals available to the calling line group.

The foregoing is possible due to the fact that in the present system both the link circuit and the answering terminal (switchboard, plug or jack circuit) are common equipment with respect to the calling line and reduction by means of multiplying can be carried out until only sufficient link circuits and answering terminals are available for satisfactory service.

In any group of calling lines served by a corresponding group of link and switchboard circuits, only one calling line is hunted for at a time.

Calling lines are hunted for in their numerical order in the group, i. e., the lowest numbered is answered first, the next higher numbered next, etc.

If a calling line has been hunting but cannot be connected through to the switchboard due to an "all links busy" condition or for some other reason, a timing arrangement causes the system to drop working on the call and pass on to the next. Under this condition, the dropped call is not given attention until the system has passed through its cycle and again reaches the line in its regular order of sequence.

All idle positions are notified when a call arrives. One position is assigned to take the call and all others are released at once even though more than one call has come in. If simultaneous calls had arrived, the operators will return after they have tested other groups.

A position will not be assigned to hunt for two successive calls unless it is the only position free to do so.

The preferred embodiment of the system of the invention in which the foregoing and other objects are attained employs cross-bar switches in a primary secondary switch arrangement. As shown in the accompanying drawings in which Figs. 1 to 16, inclusive, when placed together as indicated in Fig. 1A illustrate the method of extending a calling toll line or trunk to an available plug circuit before an idle toll operator. For clearness in reading, the description which following the talking circuit of a typical calling trunk and its extension is shown by medium heavy lines and the numerous series relay control circuits are shown by heavy black lines.

The calling toll line or trunk shown in Fig. 1 represents one of one hundred similar trunks each connected to a vertical row of contact springs of one primary cross-bar switch 1 unit, 55

shown in Fig. 2. Within the switch, each set of vertical springs may be connected to any one of ten horizontal sets of springs. The horizontal springs of each primary switch unit are directly connected to a vertical row of contact springs on each of ten secondary cross-bar switch units shown in Figs. 5, 6 and 7. Within each secondary switch unit, each set of vertical springs may be connected to any one of ten horizontal sets of springs, each of which are connected to switchboard circuit shown or indicated in Figs. 9, 10, 11 and ending in ten plugs shown in Figs. 9 and 13 before each of ten operators. Every group of one hundred incoming trunks thus requires ten primary switch units of which the first, second and tenth are shown in Figs. 2 and 6 mounted on what is generally termed a primary bay. According to the embodiment of this invention, the simple case is taken for illustration of providing one hundred links between a primary and its associated secondary bay. A group of one hundred switchboard circuits are also provided for serving the secondary bay if the traffic ratio is 1:1. A 2:1 reduction between a group of incoming trunks and switchboard circuits may be made by connecting one primary bay in multiple with another primary bay. The second bay in this case is called a supplementary primary bay. The switchboard circuits likewise may be connected to the horizontal springs of switches of a second, third, etc. secondary bay to obtain various ratio reductions between links and switchboard circuits. These bays are referred to as multiplied secondary bays. By the use of supplementary primary bays and multiplied secondary bays, a group of one hundred switchboard circuits may serve, according to traffic requirements, any number of incoming trunk circuits in multiples of one hundred. Odd ratios between incoming circuits and switchboard circuits may also be obtained by connecting less than one hundred incoming circuits to a primary bay or less than one hundred switchboard circuits to a secondary bay.

The cross-bar switches illustrated in Figs. 2, 5, 6 and 7 are of a well-known type and the specific structure and maintenance thereof is described in detail in the copending application of J. N. Reynolds Case 76, Serial No. 702,453 filed December 15, 1933. For purposes of this invention, it is sufficient to remember that the connection between any vertical and any horizontal contact spring is determined by the operation of the corresponding hold magnet HD when one of the selecting magnets S is energized, the latter magnet being thereafter released.

The system of this invention employs a line finder method of connecting an incoming trunk circuit to a switchboard circuit, that is, through the medium of group and position allotter circuits a number of switchboard circuits are selected capable of being connected to corresponding link circuits. A link allotter circuit then allots an idle link for connecting one of the switchboard circuits to the incoming trunk circuit. In order to start this selective action, restrict selection to the group of incoming trunk circuits that are next to be served, and control the hold and selecting magnets of the cross-bar switches, it is necessary to provide control relays and allotter circuits consisting principally of relays with series wiring. For example, incoming trunk circuits such as shown in Fig. 1 are connected in groups of ten to primary switch units such as shown in Fig. 2 with a group of ST control relays

for each switch unit as shown in Figs. 3 and 7. These relays serve to determine the order of handling calls originating in a given unit one at a time. Another set of CH control relays with series wiring leads 214, 127 and 132 serve to determine the order of handling calls originating from the ten different switch units one at a time. Therefore, out of all calls originating at a time in a given group of one hundred trunks only one at a time can be connected to a switchboard circuit and operator. The function of the link allotter circuit, shown in Fig. 4, is therefore to take these incoming calls and by means of the L, C and D control relays with series wiring in leads 223 and 226, determine and allot one of the link circuits through the primary and secondary cross-bar switches for connecting the incoming trunk with a switchboard circuit and operator.

The group allotter circuit, shown in Fig. 8 with series wiring leads 426, 427 and 428, determine the order in which incoming calls from different trunk groups such as 429, 430 and 431 are to be served. The position allotter circuit shown at the bottom of Figs. 12 and 16 with series wiring leads 616, 631 and 653 determines the order in which the operator positions are assigned to handle incoming calls. Groups of A, B and C control relays are shown in top portion of Fig. 12 and serve as signaling means between the group allotter, position allotter and switchboard circuits for position 1. Control relays wired identically as shown in Fig. 12 are indicated by squares 776, 781 and 782 of Fig. 16 for position 2 and by squares 777, 783 and 784 for position 10. A typical switchboard circuit for position 1 is shown in Fig. 11 with similar circuits indicated by small squares such as 508 in Fig. 9 and 528 in Fig. 10. Switchboard circuits of other positions 2 to 10 are indicated by similar squares in Figs. 13, 14 and 15. A set of control relays ST and LS associated with each switchboard circuit of the chosen operator's position, shown in Figs. 9, 10 and 11, serves to insure that only one switchboard circuit at a time in the position will be connected to the operator's telephone. Normally, the allotter and control circuits would prevent more than one call reaching an operator at a time but there are times when the operator receives a rering on an existing connection just at the moment her position is selected by an incoming call.

The primary and secondary cross-bar switches shown on the drawings and the link allotter circuit of Fig. 4 represents sufficient equipment to care for one group of one hundred incoming trunk circuits. Similar cross-bar switch equipment, although not shown, is assumed for the purpose of this description for four other groups of one hundred trunks as indicated by the squares 432 and 433 in Fig. 8. Referring to Fig. 12, it will be noted that leads 601 and 604 connect with the switchboard circuits shown in Figs. 9, 10, 11 and 11A for position 1. It is to be assumed that position 1 would have ten more plugs connected to switchboard circuits to care for the second group of one hundred incoming trunks, all wired and connected same as shown in detail for the first group. Leads 602 and 605 of Fig. 12 would, therefore, connect to similar points in the second group as shown for leads 601 and 604. Similarly for a fifth group of one hundred incoming trunks, a fifth set of ten switchboard plugs would be placed in position 1 with leads 603 and 606 of Fig. 12 connected to similar points as shown for leads 601 and 604. In like manner, positions 2 to 10 would have additional plugs so that it may be

assumed in this description that the ten positions will each have five groups of ten switchboard circuits and plugs. For the purposes of this description, this 1:1 ratio of links to switchboard circuits is the simple case but it will be readily understood that this ratio is entirely flexible and dependent on the traffic requirements for a particular office. Since five groups of ten switchboard circuits per position are assumed for this description, there will be five sets of A, B and C relays per position, shown or indicated in Figs. 12 and 16. Since each set controls its respective switchboard circuits, a group allotter circuit shown in Fig. 8 is provided which will allow only one of the above A, B, C relay sets to function at a time on a given call. The wiring of the group allotter circuit, as will later be described, functions also to see that one call out of each group of one hundred incoming trunks is served before permitting a second call in any group to be served. In this way all groups of trunks have an equal chance at reaching an operator.

A call originating in the first trunk group operates the corresponding AG₁, MG₁ and HG₁ relays of Fig. 8 as will later be described so that if calls are also originating in other trunk groups the group allotter circuit will cause the calls to be handled in a definite sequence, one at a time. The position allotter relays HP, MP and AP of Figs. 12 and 16 then determine which position is to take the incoming call. If, for example, all positions were idle then position 1 would be chosen due to the series circuit over leads 616 and 631 through the contacts of the HP relays as will later be explained. The idle switchboard circuits of the chosen position are then grounded or marked by the operation of relay 557 of Fig. 11A common to position 1, except those that are busy which have their relays 555 operated. Grounding the switchboard circuits makes it possible for the link allotter circuit of Fig. 4 to operate any one of the corresponding S magnets on the secondary cross-bar switch, thus extending an idle switchboard circuit over an available link such as 30 in Fig. 7 to the primary switch bays serving the group of one hundred incoming trunks in which the call has originated. Thus, it will be evident that any one of ten of the idle switchboard circuits of the chosen position may receive the incoming call, depending on which link is available. It is further obvious that several trunks in this particular group of one hundred may be calling at the same time so that the ST and CH series relay control circuits are provided for sorting out and marking a definite order, to the link allotter circuit of Fig. 4, in which the calls are to be handled.

According to the foregoing general description, only one calling trunk at a time is capable of being extended by the link allotter circuit of Fig. 4 to any one of a number of idle switchboard circuits in the chosen position. One function of the link allotter circuit, therefore, is to select an idle path or link between the primary and secondary cross-bar switches. That is, it must match one of the idle switchboard circuits with an available link. In Figs. 5, 6 and 7, for example, any one of ten links represented by lines 30, 42 and 43 may connect with any one of switchboard circuits 1 to 10 of position 1 and in the event no match is found, this circuit temporarily shelves the call, allowing other waiting calls in the group to be served. This allotter circuit allows only one match to be made at a time between an idle switchboard circuit and an available link. The

primary secondary switch circuit is further controlled by the allotter circuit at relay 102 of Fig. 3 to admit all waiting calls to preferential service at the finish of the last call in the preferential group. Thereafter, all new calls must wait until the preferential calls have been served. The link allotter circuit further acts to control and time the cutting through of the incoming trunk call to an idle cord in the chosen operator's position and to bring in an alarm in case of failure of any of the common leads or of the allotter itself.

The manner in which the system is organized will appear from the description of its operation which now follows. Let it be assumed that the incoming trunk 1 of Fig. 1 is originating the call, in which case the calling operator at the distant office is sending out ringing current over the trunk in the usual manner, causing ring-up relay 5 to operate in a loop circuit traced from lead 6 through winding of repeating coil 7 over leads 8, 9 and 10, winding of relay 5 in series with condenser 11, leads 12 and 13, upper winding of repeating coil 7, and back over lead 14 to the incoming trunk. Relay 5 closes two circuits, one from ground at its inner make contact through winding of relay 15 to battery which causes the latter to operate but which has no function at this time. The other make contact on relay 5 connects ground to winding of relay 17 to battery, causing the latter to operate and prepare one path from battery on the lower contact, through winding of relay 18 and lead 2, leading to primary cross-bar switch 1 of Fig. 2 for supervision purposes; and another path from ground on the upper contact over lead 1 to the primary switch 1 of Fig. 2 for starting purposes as will presently be described. No further operation of the trunk in Fig. 1 occurs now until the trunk is connected to an operator.

Let it further be assumed that the incoming trunk connected to the leads designated trunk 10 of Fig. 2 is also originating a call at this time. Ground over leads 1 and 31 and over leads 32 and 33 will then operate relays ST₁ and ST₁₀ of Fig. 3. Relay ST₁ is operated over lower break contact of hold magnet HD₁ and lead 34 of Fig. 2, thence over lead 34 of Fig. 3, lower winding and lower break contact of relay ST₁, common lead 101 and break contact on relay 102 to battery. Relay ST₁₀ is operated over a similar path to the same common lead 101 and battery on the break contact of relay 102. Both ST relays being operated, substitute battery through left break contact of relay 103, leads 104 and 105, and contacts 106 and 107, for the battery over common lead 101. Thus, calls coming in on other trunks in the same unit are prevented from operating their ST relays until the two calls being traced have reached an operator. The upper break make contacts on the ST₁ and ST₁₀ relays are now operated but have no function at this time since none of the selecting magnets S have as yet operated.

Both ST₁ and ST₁₀ relays at contacts 108 and 109 now feed battery to common lead 110 which continues over leads 111 and 112 for operating relay CH₁ to ground at test jack 113. As previously referred to, all ten CH relays have their right-hand set of contacts connected in a series circuit arrangement over leads 127 and 132 which serves to determine the order in which the preferential calls in different cross-bar switch units are served. For purposes of this description, therefore, it is assumed that a third call on trunk 91 in primary switch 10 of Fig. 6 also came in with the two calls in primary switch 1 and that its

respective CH₁₀ relay also operates in unison with relay CH₁. Both relays at their left contacts connect ground to two different circuits; one over multiple lead 114 which causes the group and position allotter circuits to ground or mark all idle switchboard circuits in a chosen position as will later be described; the other over multiple lead 115 of Fig. 3, winding of relay 204 of Fig. 4, to battery causes the latter relay to operate and at its left make contact operate relay B₂ for alarm purposes. At contact 205, relay 204 connects a path from ground through relay 206 to lead 116 and winding relay 102 of Fig. 3 to battery. Relay 206 of Fig. 4 operating, operates relay B₅ for alarm purposes and relay 102 of Fig. 3 operating, removes battery from lead 101 and those leads corresponding to lead 101 of each primary switch unit. In this manner, the further operation of any ST relay in other cross-bar switch units is prevented until the three trunk calls being traced have reached an operator.

Going back to relay 204 of Fig. 4, this relay also closes a circuit at its outer right make contact for operating relay 207 and all of the C₁ to C₁₀ relays. This path is traced from ground at left back contact relay 208 in lower right corner of Fig. 4, thence over leads 209 and 210, left make contact relay 204 to battery through winding relay 207 and also over lead 211, lower back contact relay 212, to battery through the C₁ and C₁₀ lower relay windings to battery. Relay 207 operating, closes ground to left winding relay 213, thence on lead 214 and because relay CH₁ of Fig. 3 is operated at this time, the circuit is closed at contact 117 and through winding relay 103 to battery. Relay CH₁₀ of Fig. 7 is also energized at this time but its associated relay 376 cannot operate on account of the series circuit through the CH relay contacts. Relay 213 of Fig. 4 functions only as an alarm relay while relay 103 of Fig. 3 has three functions. In the first place, at its left break contact it removes battery from multiple leads 104 and 105. This does not, however, release the ST relays associated with primary switch 1 because normally battery is also fed to lead 105 over lead 118 and back contact relay 119. As will later be explained, relay 119 operates only when the link allotter cannot match an idle switchboard circuit with an idle link or when calls from all one hundred incoming trunks are blocked. Secondly, at contact 120 it supplements the battery already on lead 111 and winding relay CH₁, making holding of relay CH₁, independent of relays ST₁ and ST₁₀. Lastly, at contacts 121 to 123, it prepares ten different paths for the operation of the selecting magnets on primary switch 1 of all ten connecting circuits called links.

One path through selecting magnet S₁₀ in Fig. 2 for example, may be traced from battery through back contact of holding magnet HD₁ of secondary switch 1, shown in Fig. 7, thence over lead 35 to selecting magnet S₁₀ of primary cross-bar switch 1 of Fig. 2. Passing through winding S₁₀, the path is further traced over lead 36 to contact 123 on relay 103 of Fig. 3, thence over common lead 126 to lower make contact of relay 215 of Fig. 4 and left break contact of relay D₁₀. The other paths may be traced in a similar manner, each one starting from battery at the break contact of the holding magnets HD of secondary switch units of Figs. 5, 6 and 7. Whenever a link such as 42, for example, is in use, its corresponding holding magnets HD₁ of Fig. 6 is operated as will later be described, so that battery is removed from lead 351 of Fig. 6, leading over

link 42 to the corresponding selecting magnet S₂ of the primary switch 1 of Fig. 2, thus making the link busy.

The description thus far has assumed that three calls have originated simultaneously; one from the incoming trunk of Fig. 1; one from the incoming trunk 10 indicated in Fig. 2 and one from trunk 91 indicated in Fig. 6. Because of the series circuit through the right contact springs of the CH relays over leads 127 and 132 it is obvious that although both relays CH₁ and CH₁₀ may be operated, still only the first of the relays 103, 125 of Fig. 3 and relay 376 of Fig. 7 can be operated as above described. This relay 103, therefore, connects ten common leads of Fig. 4 such as 126 to primary switch unit 1, thereby eliminating for the moment the call on trunk 91. The choice of a link leading to a secondary switch unit is further restricted to the incoming trunk of Fig. 1 by the ST relay series of Fig. 3. Thus, when ground from the front contact of whatever selecting magnet is energized is later connected to lead 39 in Fig. 2 and Fig. 3, the holding magnet HD₁ will be energized through the top front contact of relay ST₁ and the call on trunk 10 whose ST₁₀ relay is also operated will have to wait until the first call is connected to an operator. The relays involved in this set-up that have functions as described therefore remain operated until the group allotter circuit of Fig. 8 and the position allotter of Figs. 12 and 16 function to pick out or mark the idle switchboard circuits of a chosen operator position and the link allotter of Fig. 4 functions to match one of the switchboard circuits with an available link which will connect with the incoming trunk of Fig. 1 at primary switch 1 of Fig. 2.

The following description will serve to show more clearly how the group allotter circuit of Fig. 8 and position allotter circuit of Figs. 12 and 16 function. These circuits are so arranged that the operator telephone sets 501 of Fig. 9 and 701 and 703 of Fig. 13 are required to be plugged into the position jacks 502, 702 and 704 in order to make the switchboard circuits of the positions selectable. Tracing, for example, from ground on the make contact of telephone jack 502 of Fig. 9 through break contact on relay 503, lead 504 of Figs. 9, 10 and 11, through relay 551 of Fig. 11A to battery, a path is completed for operating relay 551 which in turn connects battery through break contact on relay 552 to lead 553 of Figs. 11 and 12 connected to the windings of every A relay corresponding to each group of one hundred incoming trunk circuits. A further requirement for making an operator position selectable is that there be some switchboard circuit available for receiving a trunk call. This is provided for by connecting ground to lead 604 of Fig. 12 for the A relay to operate over the path previously traced to battery. Ground to lead 604 of Figs. 9, 10, 11 and 12 is supplied at back contact 554 on relay 555 of Fig. 11 and corresponding contacts on similar relays not shown in Figs. 9 and 10. Relay 555 remains operated whenever the switchboard circuit is busy, due to its winding being connected over lead 556 to secondary switch 10 of Fig. 7, lead 26 to primary switch 1 of Fig. 2, lead 1 and ground at incoming trunk of Fig. 1. The topmost A relay of Fig. 12, therefore, will not operate if all the switchboard circuits that answer calls in the first group of one hundred incoming trunks are busy. Assuming, however, that switchboard circuits are

available and that all operators are idle, awaiting a call, then all A relays, one for each trunk group for each operator will be in a normally operated position.

5 When the chain relay CH₁ of Fig. 3 operated, it not only operated relay 204 of Fig. 4 to start the link allotter to functioning as described in the previous paragraph, but connected ground to the multiple lead 114 traced through right break
10 contact on relay 201 of Fig. 4, winding of relay 202, multiple lead 203, running through Figs. 8, 12 and 16. Since all A relays are operated, the ground path just traced continues through the left make contact of the A relays and back over
15 multiple lead 607, to the group allotter of Fig. 8 where the path may be further traced through left winding on relay HG₁ thence over multiple lead 434 to battery at back contact of common relay 435.
20 Allotter relay HG₁ of Fig. 8 and series low resistance relay 202 of Fig. 4 both operate in the above circuit. The latter relay serves only for alarm purposes but relay HG₁ operates to break the series leads 426 and 427 at contact 438 and
25 prepare a holding path for itself traced from battery through common relay 435, contact 436 on relay 437, lead 426, inner armature and front contact on relay HG₁ right winding of same relay, through winding of relay AG₁, thence over
30 lead 607 and through left inner contacts in multiple of all A relays of Figs. 12 and 16 to ground on lead 203 from the link allotter circuit of Fig. 4 previously traced. Relay 435 operating in this path serves to remove battery from multiple lead
35 434 thereby releasing all other HG relays that may have operated. Assuming by way of illustration that relays HG₂ and HG₃ had operated at this moment due to incoming calls originating in trunk groups 2 and 5, it will be evident that
40 battery through relay 435 on lead 426 will connect only to righthand winding of the HG₁ relay, due to the opening of contact 438 in the circuit to lead 427. Thus only the AG₁ and HG₁ relays receive current, giving the call in the first group preference over calls in the lower groups. Since
45 the AG₁ relay connects ground to lead 608 for operating the B₁ relays of all A, B and C control relays associated with the group allotter relays of Fig. 8 it is evident that only the top set
50 of B and C relays in Fig. 12 and those indicated in squares 776 and 777 of Fig. 16 can function at this time.

Relay AG₁ at its left make contact also connects ground to the winding of relay MG₁ to
55 battery. The latter relay locks to ground supplied from its own left outer armature, thence over multiple lead 439, contact 440 on relay 437, multiple lead 441 and left inner make contact of relay MG₁. The MG₁ relay at its right break
60 contact serves to open the left winding of relay HG₁ leaving the AG₁ and HG₁ relays normally dependent for their release on ground being removed from lead 203 in the link allotter of Fig. 4 as will later be described. The MG₁ relay now
65 cannot release until relay 437 is operated and the latter relay cannot operate until all HG relays have released as will later be explained. Thus the MG₁ relay at its right break contact also serves to prevent its associated HG₁ relay from re-
70 operating after it has once functioned on one call and prevents other calls which might be waiting in trunk group 1 from being served until one call in each of the lower trunk groups has been served as would be indicated by the asso-
75 ciated HG relay having operated, operating re-

lays AG and MG and then AG and HG relays being released by the link allotter of Fig. 4. This allotter circuit therefore prevents the calls bunched in one trunk group from taking preference over calls in other trunk groups.

5 Having shown how the call from trunk group No. 1 is given preference over calls from trunk groups 2 and 5, the manner in which one of the idle operator positions is chosen to serve this call will now be described. The ground placed
10 on multiple lead 608 by relay AG₁ of Fig. 8 may be traced in Fig. 12 through contact 609 on relay A₁ to winding and battery of relay B₁ and similarly in Fig. 16 through a path for operator positions 2 to 10. Thus the B₁ relays of all idle
15 operators in the first or top sets of A, B, C control relays operate and lock at contact 612 of relay B₁ of Fig. 12 and corresponding contacts, to lead 608. This results in ground being connected at contact 613 to lead 614, and in a similar
20 manner to corresponding leads 778 and 779 of Fig. 16, for starting the position allotter circuit at the bottom of Figs. 12 and 16 to functioning. This allotter is constructed on the same
25 principle used in the group allotter circuit as will appear from the description in the following paragraphs. In this case however the function of the AP, HP and MP, relays is to prevent
30 a position from being selected a second time as long as there is some idle position that has not received a call.

Since all the operators are assumed to be idle for the purposes of this description, ground on
leads 614, 778 and 779 as previously described causes the operation of all HP relays. Ground
35 on lead 614 by way of example is further traced through left break contact on MP₁ relays, thence through left-hand winding of relay HP₁ to battery connected to multiple lead 615 at back contact
40 on relay 624 of Fig. 12. It will be observed that each HP relay at its right front contact, therefore, establishes a circuit through its own right-hand winding and winding of its corresponding AP relay in series to ground on lead
45 614 and in Fig. 16 to leads 778 and 779. Due, however, to the series circuit through the HP relays over leads 616, 631 and 633 only one AP relay can energize. The path for the relay in this illustration may be traced from ground on
50 lead 614 of Fig. 12, winding of relay AP₁, right-hand winding of relay HP₁, front contact and armature over lead 616, left back contact relay 617, and battery through winding of relay 624. Both relays AP₁ and 624 operate. Relay 624 in
55 operating removes battery from lead 615 which releases all HP relays that were operated except HP₁ and prevents any other HP relay from operating as might sometimes be the case where a position happened to come idle at that particular
60 moment. Relay AP₁ in operating at its right contact operates relay MP₁ which opens the circuit through the left-hand winding of HP₁ relay but the latter does not release because of the right-hand winding being included in the operating path of the AP₁ relay. The MP₁ relay locks
65 itself operated through its own contacts 618 and 619 over leads 620 and 621 and contact 622 of common relay 617 thus preventing the reclosing of the circuit through the left-hand winding of relay HP₁ until the remaining positions have
70 each answered a call. When this occurs all HP relays will be deenergized and the MP relays of all positions that have handled a call will be locked to contact 622 on relay 617. In the case of an uncovered position the relay corresponding to relay 75

551, in Fig. 11A, would not be operated so that no A relays could operate and therefore the HP relay for that position would remain unoperated even though the MP relay were normal. In this manner the incoming trunk calls are distributed uniformly over all positions that are covered by an operator.

Referring again to the operation of relay AP₁ ground at its left make contact is connected to lead 626 causing relay 552 of Fig. 11A to operate and immediately make the position test busy to all other calls. Ground on lead 626 in Fig. 12 through contact 627 of relay B₁ also operates relay C₁ and over lead 601 it operates relay 557 of Fig. 11A. The latter relay marks all idle switchboard circuits of position 1 that are capable of receiving the call from Fig. 1 over an available link circuit. The group allotter relays working in conjunction with the position allotter relays HP₁, MP₁, and AP₁ having now allotted position 1 for handling the call on the incoming trunk of Fig. 1, proceeds to release so that a call in the second group of one hundred trunks may be served without waiting for the call in the first group to reach the operator of position 1. The manner in which this release is accomplished will be found in a following paragraph. For the present it will be assumed that control relays A₁ and V₁ of group 1 in position 1 shown at top of Fig. 12 have released and that relay C₁ alone remains locked through its contact 629 back over common lead 216 to the right back contact of relay 208 of Fig. 4 to ground. Also the relays 201 and 218 of Fig. 4 have been operated due to ground at left make contact of C₁ relay of Fig. 12 over common lead 217.

As stated above, all idle switchboard circuits capable of serving the first group of trunks of position 1 have now been grounded through the operation of relay 557 of Fig. 11A. These ground paths include for example lead 558 to which ground is connected by relay 557. Said path being further traced through left outer contact of switchboard relay 555, to lead 580 and winding of selecting magnet S₁ on secondary switch 1. In a similar manner the grounded leads 559 and 560 connect to selecting magnets S₂ of secondary switch 2 and secondary switch 10 respectively. The other side of these selecting magnets connect respectively to lead 377 of Fig. 7, lead 355 of Fig. 6 and lead 326 of Fig. 5 and all go direct to the winding of relays L₁₀, L₂ and L₁ respectively as shown in link allotter circuit of Fig. 4. These circuits representing ten selecting magnets correspond to the ten links represented in Fig. 2 by lines 30, 42 and 43 respectively. The call on the trunk of Fig. 1 therefore can be connected over any one of these links that is idle.

The function of the link allotter circuit of Fig. 4 of selecting one of the above links which is idle will now be further described. As previously stated, when a switchboard circuit is busy its relay 555 or one corresponding to it will remain operated. Therefore the link to which it is connected will also be busy and the circuits to the secondary switch selecting magnets in Figures 5, 6 or 7 will be open at the left outer contacts of relays 555. In this manner ground through a secondary switch selecting magnet will be connected to the windings of relays L₁ to L₁₀ only when the corresponding link is idle. For purposes of illustration in tracing the call for the trunk in Fig. 1 it will be assumed that only relay L₁₀ has ground connected to its winding over lead 377 as previously traced. That is to say switch-

board circuits 2 to 10 in position 1 are busy. Going back now to the first part of the description where relay 204 operated and closed a circuit for the C₁ to C₁₀ relays it was observed that these relays all operated in multiple on their lower windings to battery. Each C relay at its top make contact therefore closed an individual circuit traced from battery through the winding of its corresponding D relay top winding and front contact of the C relay, and back contact in the corresponding L relay to ground on lead 211. As a result, all ten D relays operated and the corresponding C relay windings being in the same circuits, locked in their operated position. When all C relays had operated, a ground path was established through the lower make contacts in series for operating relay 219 and also through the left break contact on slow operate relay 220 for operating relay 215. Relay 219 at its left inner contact closed ground from lead 211 to relays 212 and 221. Relay 212 operated and locked at its left make contact back to ground on lead 211 and at its left break contact it opened the original operating path through the lower windings of the C relays. Relays 221 although operated is not as yet effective because its contacts are in series and are open by virtue of relay 219 being operated.

The above described condition of the link allotter circuit therefore is present when ground through S₁ magnet of secondary switch 1 is returned over lead 377 to the winding of the L₁₀ relay. Since switchboard circuits 2 to 10 were assumed to be busy, the windings of the L₁ to L₉ relays are open so that they cannot operate. Accordingly relays C₁ to C₉ and D₁ to D₉ remain operated. Ground through S₁ magnet on winding of relay L₁₀, however, causes the latter to operate over a path traced through the bottom make contact on relay 215 thence over lead 126 to Fig. 3 and through make contact 123 on relay 103, lead 36, through selecting magnet S₁₀ of primary switch 1 and thence over lead 35 to battery at back contact on hold magnet HD₁ of secondary switch 1 of Fig. 7 as previously described. The operation of relay L₁₀ at its break contact opens the circuit of the C₁₀ and D₁₀ relays permitting them to release thereby closing another circuit substantially in parallel with the winding of the L₁₀ relay. This path is traced from ground through S₁ magnet of secondary switch 1 on lead 377 of Figs. 7, 8 and 4, thence over lead 222, right back contact relay D₁₀, and right front make contacts of relays D₉ to D₁ in series, lead 223, resistance 224 and two windings of relay 225 in series, back over lead 226 and left front make contacts of relays D₁ to D₉ in series, thence through left break contact relay D₁₀ and bottom make contact relay 215 to the other side of relay L₁₀. Relay 225 in this circuit being differential does not operate at this time. It is pertinent to remember at this point that relay 201 operated when the position 1 was chosen and the idle switchboard circuit shown in detail in Fig. 11 was grounded. Therefore relay 220 of Fig. 4 started to receive energy over a path traced from ground at left back contact relay 208, left make contact relay 201 to battery through winding of relay 220. The latter relay being slow to operate has therefore given sufficient time for the L, C and D relay combinations to be established so that its proceeding to operate at this time, opens the circuit at its left break contact; of the relays 215 and 219. Relay 215 releasing opens the circuit of the L₁₀ relay and thus re-

moves the shunt on the parallel circuit connected through leads 223 and 226 and windings of relay 225 traced above. The release of relay 219 then establishes two paths for operating the selecting magnet S_{10} of the primary switch 1 and the selecting magnet S_1 of the secondary switch 1 in order to close switchboard circuit 1 through the link represented by line 30 in Figs. 2, 6 and 7 to the incoming trunk of Fig. 1.

It will now be shown how the two paths for operating the above selecting magnets are organized to cut the call through to the switchboard circuit, with a provision for making a test to make sure that the call actually cuts through. For this purpose relay 225 functions as a differential relay. The top winding it will be observed is connected directly across battery and ground from the contacts of relay 221. The bottom winding, however, connected in lead 226 carried the current for operating the selecting magnet S_{10} of primary switch 1 which overpowers the top winding and prevents relay 225 from operating. At the same time relay 219 also connects battery to lead 223 for operating selecting magnet S_1 of secondary switch 1. The operation of selecting magnet S_{10} of primary switch 1 in addition to operating the selecting fingers (not shown) on the switch also connects ground to lead 39 of Fig. 2 and Fig. 3. Since both relays ST_1 and ST_{10} are still operated this ground continues over lead 40 to energize hold magnet HD_1 of Fig. 2. Contact springs 48 therefore operate and connect leads 1, 2, 3, 4 to leads 26, 27, 28, 29, represented by line 30. Ground being already present on lead 1 and therefore on lead 26, causes the hold magnet HD_1 of secondary switch 1 in Fig. 7 to operate. Since selecting magnet S_1 of this switch has already operated the selecting fingers for the bottom row of horizontal contacts, the operation of the hold magnet therefore operates contact springs 378 of Fig. 7. It also removes battery from lead 35 to which the selecting magnet S_{10} of primary switch 1 is connected, thus opening the circuit over lead 226 through the lower winding of relay 225 and thereby permitting the top winding to operate relay 225 as an indication that the connection has been established between the calling trunk of Fig. 1 and switchboard circuit 1 of position 1 shown in Figs. 9 and 11.

The link allotter circuit now restores to normal due to the operation of relay 208 by ground on make contact of relay 225. Relay 208 at its right back contact removes ground from multiple lead 216 traced through Figs. 8 and 12 thereby releasing the relay C_1 corresponding to position 1 which up to this time has remained operated. Relay 208 at its right front contact supplements the ground placed on lead 217 by the above mentioned C_1 relay, causing relay 201 to remain operated and prevent the group and position allotter relays of Figs. 8 and 12 from functioning on a new call until the link allotter of Fig. 4 is fully restored to normal. Relay 208 of Fig. 4 at its left back contact removes ground from lead 209 causing relays 207, 212, 220, 221 and the nine sets of C and D relays of Fig. 4 to release. Relay 221 is slow releasing to insure complete cut through of the call and when it does release it releases relay 225 which in turn releases relay 208. Relay 201 then releases and the link allotter circuit is ready for another call.

The above description of tracing a call from trunk 1 of Fig. 1 made the assumption that an-

other call had come in on trunk 10 and had operated the ST_{10} relay of Fig. 3 at the same time that relay ST_1 operated. The call on trunk 10 will therefore be the next one to be handled. This is due to the fact that relay ST_{10} continues to hold battery on lead 111 which prevents relay CH_1 from releasing, in turn preventing relay 204 of Fig. 4 from releasing. Hence the release of the relay 208 on the previous call acts at once to reoperate relay 207 and the system proceeds to connect the second call on trunk 10 to an operator in a similar manner as described for the first call on trunk 1.

This description has also assumed that a call on trunk 91 in primary switch 10 unit of Fig. 6 originated along with the calls on trunks 1 and 10 of primary switch 1 unit. Therefore upon the completion of allotting a link for the second call described in the preceding paragraph, the call on trunk 91 will be the next to be handled. Since both ST_1 and ST_{10} relays of Fig. 3 have now released due to the operation of their respective hold magnets HD_1 and HD_{10} battery has been removed from lead 111 thus in turn releasing relay CH_1 . Lead 214 is thereby extended through the right back contact of the CH_1 relay, thence over lead 127 and back contact on relay CH_2 , through other CH relay contacts in series and over lead 132 to contact 128 on relay CH_{10} . Hence the release of the relay 208 on the previous call acts at once to reoperate relay 207 causing relay 376 of Fig. 7 to operate. The system then proceeds to connect the third call to an operator in the same manner as described for the first call from the trunk of Fig. 1. After the relay 208 releases on this call it will be observed that all relays of the CH chain in Figs. 3 and 7 have now released, so that ground is removed from lead 115 of Fig. 4 causing relay 204 to release. Release of relay 204 in turn releases relay 132 of Fig. 3 so that all calls that have in the meantime originated in the first group of 100 trunks will now operate their respective ST and CH relays and they will then be connected to an operator in the same manner as described above. In this way all new calls must wait until the preferential calls have been served.

It has been shown how link indicated by line 30 in Figs. 2, 6 and 7 has connected switchboard circuit 1 of position 1 and incoming trunk of Fig. 1. Ground on lead 1 of Fig. 2 holds primary cross-bar switch magnet HD_1 operated to maintain contacts 48 closed and ground on the extension of same lead i. e. lead 26 of Fig. 7 holds the secondary cross-bar switch magnet HD_1 operated to maintain contacts 378 closed. Since lead 27 is also an extension of lead 2 of Fig. 1 battery may be traced from the bottom armature and front contact of relay 17 through winding of relay 18 lead 2 and contacts 48, lead 27 of Fig. 2, thence over link 10 indicated by line 30 to lead 27 of Fig. 7, contacts 378 to lead 379 and ground through relay 561 of Fig. 11. Relay 18 of Fig. 1 being marginal does not operate at this time. Relay 561 of Fig. 11, at its right front contact connects battery through contact 577 on relay 573 to lead 578 running through Figs. 9, 10, 11 which lights lamp 507 in Fig. 9 and informs the operator of the plug she is connected with. Relay 561 also connects ground at its left make contact to lead 562 thence through right outer back contact relay 566 to winding relay ST_1 , thence over lead 563 to left armature of relay LS_2 of Fig. 10, continuing through the back contact to lead 526 to left armature of relay LS_{10} of Fig. 9, thence through back contact to battery. As previously stated the ST

and LS relays of each switchboard circuit serve to make sure that only one call is connected to an operator at a time. For purposes of this description it is assumed that switchboard circuits 2 to 10 are busy so that their corresponding ST and LS relays are normal. Operation of relay ST₁ of Fig. 11 therefore connects ground through the winding of relay LS thence to battery at the front make contact of relay 561 previously operated.

The operation of relay LS₁ thus extends temporarily the talking leads 380 and 381 of the switchboard circuit 1 through its right make contacts to operator's telephone set of position 1 shown in Fig. 9 over leads 564 and 565. Relay LS₁ at its left outside break contact would prevent any succeeding ST relay of another switchboard circuit from operating while at its left inner contact a circuit is closed through contact and winding of relay 566 for making the position test busy. This path may be traced from ground through relay 503 of Fig. 9, lead 567, left inner make contact of relay LS of Fig. 11, contact 568 on relay 566, winding of relay 566 to battery at right front contact relay 561 previously operated. The operation of relay 503 of Fig. 9 in the above path opens the circuit over lead 504 for relay 551 of Fig. 11A which makes the position test busy as previously described. Relay 566 in the above path is marginal and does not operate under this condition.

The operator receiving the number of the wanted party inserts plug 505 of Fig. 9 into the called line which results in ground being connected to the sleeve lead 506, thence to battery through relays 569 and 570 of Fig. 11. Relay 569 later functions to pass back supervision signals to the incoming trunk by connecting ground through left outer contact on relay 571, low resistance 579 to lead 379. This path being in parallel with the ground path through high resistance relay 561 lowers the resistance of lead 379 to ground sufficient to operate marginal relay 18 of Fig. 1. This in turn operates relay 19 which opens a shunt around right winding of relay 20. Relay 570 at its make contact connects ground to winding relay 571 and also at contact 572 of the latter relay it grounds the winding of relay 573 connected to battery. Relay 573 operated extends the talking leads 380 and 381 of the cross-bar switch to the leads 574 and 575 of the switchboard plug circuit. Relay 573 at contact 576 connects direct ground to winding of relay 566, thus shunting out the path to ground through relay 503 previously traced. Relay 566 operating opens the circuit through winding of relay ST restoring both the ST and LS relays to normal. In this manner the operator is automatically cut off of the connection. Relay 573 at contact 577 opens the circuit over lead 578 for putting the trunk lamp 507 of Fig. 9 out during conversation. The series circuit through break contacts on the ST relays over leads 581 and 527 serves to insure one connection at a time to the operator telephone set.

After the conversation over trunk 1 and plug 1 has terminated the calling trunk 1 at the distant end disconnects which releases supervisory relay 20 of Fig. 1 thereby removing ground from windings of relays 17 and 19. Relay 17 releasing at its top contacts removes ground from leads 1 and 26 thus releasing holding magnets HD₁ of both the primary cross-bar switch and the secondary cross-bar switch causing contact springs 48 and 378 respectively to restore to normal. The release of the link circuit indicated by line 30 thus causes relays 555 and 561 to release. The latter relay at its right back contact

connects battery to winding of relay 571 causing it to operate and lock to ground at front contact of relay 570. The operation of relay 571 at contact 582 connects battery from relay 551 to lead 578 and lights lamp 507 of Fig. 9 as a disconnect signal to the operator who then pulls down plug 505 releasing relay 570 and in turn relay 571 thus restoring the link and switchboard circuits to normal.

Returning now to that point in the above description where the group allotter circuit in Fig. 8 is assumed to release and permit a call in the second group of incoming trunks indicated by square 432 to be served, without waiting for the call in the first group to actually reach the operator of position 1. This release is brought about by the operation of the corresponding C₁ relay for position 1 which previously operated in a circuit through contact 627 on relay B₁ of Fig. 12 thence to ground on lead 626 placed there by relay AP₁. Relay C₁ at contact 628 supplements the ground already on lead 626 in order to make position 1 continue to test busy when relay AP₁ releases. Relay C₁ at contact 629 locks over common lead 216 to the right back contact of relay 203 of the link allotter circuit of Fig. 4. Relay C₁ is thus not permitted to release until the link allotter has completed its function of connecting the trunk call from Fig. 1 to operator position 1 and relay 203 has operated to restore the link allotter to normal. Relay C at its left contact, however, immediately connects ground to the common lead 217 which then operates relay 201 of Fig. 4. The latter relay at its right break contact opens the path over multiple lead 203 running through Figs. 8, 12 and 16. Opening of this path causes group allotter relays AG₁ and HG₁ to release, thereby releasing all B relays associated with these relays. The A₁ relay of Fig. 12 for group 1 already released when the relay 552 of Fig. 11A first operated as previously described. The release of the B₁ relay of Fig. 12 for position 1 thus opens the holding circuit through the AP₁ relay winding, S winding of HP₁ relay, front contact and armature of relay HP₁, lead 616, left back contact relay 617, to battery through relay 624. Relays AP₁, HP₁ and 624 all release, thus putting both group and position allotter circuits in condition to serve the call that is assumed to be waiting in trunk group 2.

The call that has originated in trunk group 2, it must be remembered, is being handled by its own link allotter circuit similar in all respects to the link allotter of Fig. 4 so that ground will be present on multiple lead 245 of Figs. 8, 12 and 16. The first relay A₂ of position 1 is released because position 1 has just been made busy by the call from trunk 1 of Fig. 1, but the A₂ relays of succeeding positions are operated due to the positions being idle and to switchboard circuits being available. Therefore the ground path on lead 245 may be further traced through the A₂ relays of positions 2 to 10 and back on lead 634 through relay HG₂ to battery on lead 434 of the group allotter circuit of Fig. 8. Relay HG₂ operates and the call in this trunk group progresses the same in all respects as traced for the call from the trunk of Fig. 1. In a similar manner the call in trunk group 5 will be handled and the group allotter relays of Fig. 8 function.

The group allotter circuit of Fig. 8 prevents more than one call in a group of trunks being served as long as calls are waiting in other

groups, as indicated by the corresponding HG relay being operated. This is accomplished by providing a locking circuit for each MG relay that operates. Said locking circuit includes contact 440 on relay 437 and the latter relay is dependent for operation on relay 442 before the MG relays can be released. The path for operating relay 442 may be traced from ground through the left make contacts of whatever MG relays are operated, to multiple leads 439 and 443, left make contacts on any A relay of the relay control circuits shown in Figs. 12 and 16, thence back over lead 444 and through the right break contact on all HG relays of Fig. 8 to winding relay 442 and battery. When all MG relays have released relay 442 will release, releasing relay 437 thus placing the allotter in position to serve another batch of calls. Since the MG relays prevent their corresponding HG relays from reoperating once they have operated and released on a call, it will be evident that calls in one group of trunks cannot lock out calls in other groups.

The position allotter circuit at bottom of Figs. 12 and 16 has fundamentally the same circuit functions as the group allotter circuit except in this case it allots a call to every idle operator before giving any one operator a second call. This is accomplished by making each MP relay lock to a contact on relay 617 so that once an operator has received a call and the HP and AP relays have released, it will be impossible for them to again operate until relay 625 operates relay 617. But relay 625 cannot operate except all HP relays are deenergized which means that the position has had a call. In this connection the HP relay for one or more idle positions might be deenergized because no call is waiting in which case relay 445 of the group allotter circuit of Fig. 8 would be continuously operated to battery at left break contact on relay 435 thereby holding contact 446 open and preventing relay 625 of Fig. 12 from operating.

Referring again to the functioning of the link allotter circuit as described in the first part of this specification, it will be remembered that a statement was made that the link allotter might not be able to match up an idle link with an idle switchboard circuit. This may occur occasionally if the ratio of links to switchboard circuits is too close to the actual traffic ratio, so that the link allotter must be designed to release under this condition and start serving another incoming call. For this purpose relays 227, 228, 229 and 230 are provided for operating relay 119 of Fig. 3 for releasing the ST relays of all primary switch units in the group of one hundred incoming trunk circuits, thus making the link allotter circuit start over again to serve another call. Normally of course, this does not occur because a time delay is introduced in Fig. 4 by relay 227, resistance 231, capacity 232 in which relay 227 is made slow enough releasing to give the link allotter time to function. When the group and position allotter circuits of Figs. 8, 12 and 16 cause relay 201 of Fig. 4 to operate as previously described, relay 220 in turn operating and starting the link allotter to functioning also removes ground at its right break contact from lead 233. This starts relay 227 to releasing but it does not release as long as an idle link can be matched to an idle switchboard circuit. If, however, no match is found so that the allotter takes more time than it should, then relay 227 finally releasing will operate relay 228. Relay 228 then

operates slow operate relay 229 and also relay 230 and relay 119 of Fig. 3 in series over lead 130. The contact on relay 230 then operates the alarm relay B₄. The contact on relay 229 operates relay 208 which causes the link allotter circuit to restore to normal ready to serve the next call as previously described. The operation of relay 119 of Fig. 3 at its individual back contacts opens battery that supplies the lower holding windings of all ST relays that may have operated, thus making them release and later come in on the allotter circuit as a new group of preferential calls. During the restoration of the allotter to normal relay 220 of Fig. 4 releases thus restoring ground to winding of relay 227 whereupon relays 228, 229 and 230 releases. Relay 228 also releases relay 119 of Fig. 3 and the link allotter is again ready to serve the new preferential group of calls. In the event of some trouble condition in the allotter, relays 227, 228, 229, 230 and 119 of Fig. 3 would function in the same manner as above and would indicate this condition by operating slow operate relay B-4 to light lamp 237.

The underlying characteristics of the system of this invention necessarily involve the use of control circuits common to the exchange. Provision is therefore made for the rather elaborate use of alarm equipment, some of which is automatic in character. In connection with the CH relay chain circuit of Figs. 3 and 7 for example a lamp 129 is connected to ground and to lead 128 to indicate to the attendant that a CH relay is operated and that some trunk has not yet reached an operator. The test jack 113 connected in the ground side of the CH relay winding provides means for testing and clearing trouble on the series leads 127 and 132.

Alarm circuits covering the link allotter of Fig. 4 are arranged to give visual signals, and for any trouble condition that ties up the allotter, a spare allotter is cut into use. Slow operate relay B₁ operates if relay 213 operates which happens if lead 214 is open or grounded. This condition is indicated by alarm lamp 234. Relay B₂ which is slow to operate operates only if relay 204 remains operated too long indicating a grounded common lead 115. This condition is indicated by alarm lamp 235. Slow operate relay B₃ operates and lights lamp 236 in the event that relay 202 remains operated too long which would result for example if relay 201 upon operating failed to open its right back contact. Slow operate relay B₅ will operate if relay 206 remains operated abnormally long indicating, for example, the failure of contact 205 on relay 204 to open when the latter is supposed to release. This condition is indicated by lamp 238. Slow operate relay B₆ is operated by relay 218 if relay 212 does not operate at the proper time indicating that the link allotter is not functioning properly. This condition is shown by lighting of lamp 239 and furthermore ground at right front contact operates relay 240 to cut in a spare or emergency link allotter circuit the same in all respects as that of Fig. 4. The latter relay, although not showing the details, is wired into all the leads entering and leaving Fig. 4, and when it operates, it merely acts to transfer these leads to a spare link allotter as indicated. Key 242 serves to unlock any alarm relay that may have been operated or key 243 may be used to shut off the audible alarm feature connected to lead 244.

An automatic alarm feature is also shown in Fig. 8 for the group and position allotter circuits.

One S relay is provided for each trunk group and corresponds to the HG relay of that group. When, therefore, a call comes in on one of the trunks of a group, such as group 1, for example, for which there is a free operator with available switchboard circuits, the lead 241 of the group is grounded by relay 237 of the link allotter circuit of Fig. 4. This condition on multiple lead 241 through the outside right make contacts on all operated control relays A₁ associated with the corresponding HG₁ relays causes relay S₁ of Fig. 8 to operate over multiple lead 630 and through P winding of relay S₁ to battery at break contact on relay 447. In like manner, calls in other trunk groups operate their respective S relays of Fig. 8. Only the S₁ relay, however, locks through its S winding to battery through relay 448. The operation of relay 448 in this path causes relay 447 to operate and remove battery from the P windings of all S relays, thus leaving only the S₁ relay operated. Relay 448 at its right make contact connects ground to a timing circuit indicated at 449. If the incoming calls are being handled by the group and position allotter circuits at a normal rate, the associated relay 450 will not operate, but if trouble develops in these circuits and the rate at which calls are handled drops, then the timing circuit at 449 will cause lamp 451 to light and relay 450 to operate. Relay 450 operating causes relay 452 to operate and thereby automatically connect in a spare set of group and position allotter relays, not shown. This relay locks to alarm key 453 and brings in an audible alarm. Provision is also made to shift over to the spare allotter relays manually when desired by operating key 454.

What is claimed is:

1. In a call distributing system, calling lines, a plurality of primary cross-bar switches terminating said lines, a plurality of secondary cross-bar switches, link circuits extending between said primary and secondary switches and so arranged that each primary switch has a link circuit extending to each secondary switch, a plurality of operators' positions, a switchboard circuit extending from each secondary switch to each position, means for predetermining the order in which idle ones of said positions shall have calling lines extended thereto and means for preventing any one of said positions from having a second line extended thereto until each of the remaining idle positions have been assigned in the predetermined order.

2. In a call distributing system, calling lines, a plurality of operators' positions, a plurality of primary cross-bar switches terminating said lines, a plurality of secondary cross-bar switches, link circuits extending between said primary and secondary switches and so arranged that each primary switch has a link circuit extending to each secondary switch, switchboard circuits extending from each secondary switch to each position, means for allotting, in a predetermined order, a different idle position to which successive calls shall be extended and means responsive to a call on one of said lines for selecting a link circuit accessible thereto which has access to an idle switchboard circuit and which terminates in the position allotted to that call, said means also being effective to extend the line to the allotted position.

3. In a call distributing system, a plurality of groups of lines, calling lines waiting in certain of said groups, a plurality of operators' positions,

switching means including primary and secondary cross-bar switches for extending said lines to said positions, and means for successively initiating the extension, in a predetermined order, of one calling line from each group.

4. In a call distributing system, a plurality of groups of lines, calling lines waiting in certain of said groups, a plurality of operators' positions, switching means including primary and secondary cross-bar switches for extending said lines to said positions, means for successively initiating the extension, in a predetermined order, of one calling line from each group and means for insuring the extension of all waiting calls in any group before any subsequent calling lines in the same group are served.

5. In a call distributing system, a plurality of groups of lines, each of said groups being divided into a plurality of subgroups, calling lines waiting in certain of said groups, a plurality of operators' positions, switching means including primary and secondary cross-bar switches for extending said line to said positions, and means for successively initiating the extension, in a predetermined order, of one calling line from each group, and means for insuring that waiting calls in different subgroups of any main group will be served in a predetermined sequential order.

6. In a call distributing system, calling lines, a plurality of operators' positions, a plurality of primary cross-bar switches terminating said lines, a plurality of secondary cross-bar switches, link circuits extending between said primary and secondary switches and so arranged that each primary switch has a link circuit extending to each secondary switch, switchboard circuits extending from each secondary switch to each position, means for allotting in a predetermined order the idle positions to which successive calls shall be extended and for selecting the switchboard circuit to be used, means responsive to a call on one of said lines for selecting a link circuit accessible thereto for extending that line and which has access to the selected switchboard circuit, a magnet individual to each line for operating the associated primary switch to connect the line with any one of the accessible link circuits and a magnet individual to each link for operating the associated secondary switch to connect the link to any one of the accessible switchboard circuits, means responsive to the selection of one of said switchboard circuits giving access to the allotted position for energizing the respective primary and secondary magnets, giving the calling line access to the selected link and the selected link access to the selected switchboard circuit, and means for preventing a second set of magnets extending another calling line until the first calling line has been extended to the first allotted position.

7. In a call distributing system, calling lines, a plurality of operators' positions, a plurality of primary cross-bar switches terminating said lines, a plurality of secondary cross-bar switches, link circuits extending between said primary and secondary switches and so arranged that each primary switch has a link circuit extending to each secondary switch, switchboard circuits extending from each secondary switch to each position, means for allotting, in a predetermined order, the idle positions to which successive calls shall be extended, means responsive to a call on one of said lines for selecting a link circuit accessible thereto and which has access to an idle switchboard circuit terminating in the position

allotted to that call, said means also being effective to extend the line to the allotted position and means actuated upon failure of said calling line to be extended to the allotted position within a predetermined interval of time to automatically restore all of said extending means to normal.

8. In a call distributing system, a plurality of lines divided into groups, each group being further divided into a plurality of subgroups, a plurality of operators' positions, a plurality of switchboard circuits individual to and terminating at each of said positions, a plurality of link circuits for extending said lines to said switchboard circuits, said link circuits being divided into groups, each of said groups of links being individual to and accessible to a different one of said subgroups of lines, and also having access to a switchboard circuit terminating at each position, an allotter common to the groups of lines and adapted, responsive to calls on said lines to successively allot, in a predetermined order, the groups which may have calling lines extended to said switchboard circuits, a position allotter common to said positions also responsive to calls on said lines and so arranged as to assign, in a predetermined order, an idle one of said positions to which may be extended a calling line in the group determined by the group allotter and a link selector responsive to the joint operation of said group and position allotters arranged to select one of said link circuits, over which the calling line may be extended, that is accessible to the subgroup first in order in the group as determined by the group allotter and that has access to an idle switchboard circuit extending to the position assigned by the position allotter.

9. In a call distributing system, the combination with a plurality of lines, a plurality of operator's positions, means for extending calling ones of said lines in a predetermined order to predetermined ones of said positions, said means including link circuits and cross-bar switches, a relay arrangement common to said switches and link circuits for controlling the extension of said lines to said positions, an auxiliary relay arrangement adapted to be substituted for said first arrangement and means responsive to the failure of the first relay arrangement to complete its prescribed function within a predetermined time interval, due to trouble therein, to substitute said auxiliary arrangement therefor.

10. In a call distributing system, a primary cross-bar switch, lines terminating therein, a plurality of secondary cross-bar switches, a link circuit between the primary switch and each of the secondary switches, a plurality of operators' positions, means for preallotting the positions one at a time and in a predetermined order to serve calling ones of said lines, answering terminals at each position, switchboard circuits from each secondary switch to and terminating in an answering terminal at each position, means responsive to a call on one of said lines to render available all idle switchboard circuits terminating at an idle allotted position and to select one of said circuits for extending the calling line to the allotted position and other means initiated by the selection of said switchboard circuits to cause said primary and secondary switches to connect the calling line over an available link to the selected switchboard circuit.

JOHN MESZAR.