

Dec. 3, 1929.

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1,738,302

TELEPHONE SYSTEM

Filed Aug. 28, 1926

7 Sheets-Sheet 1

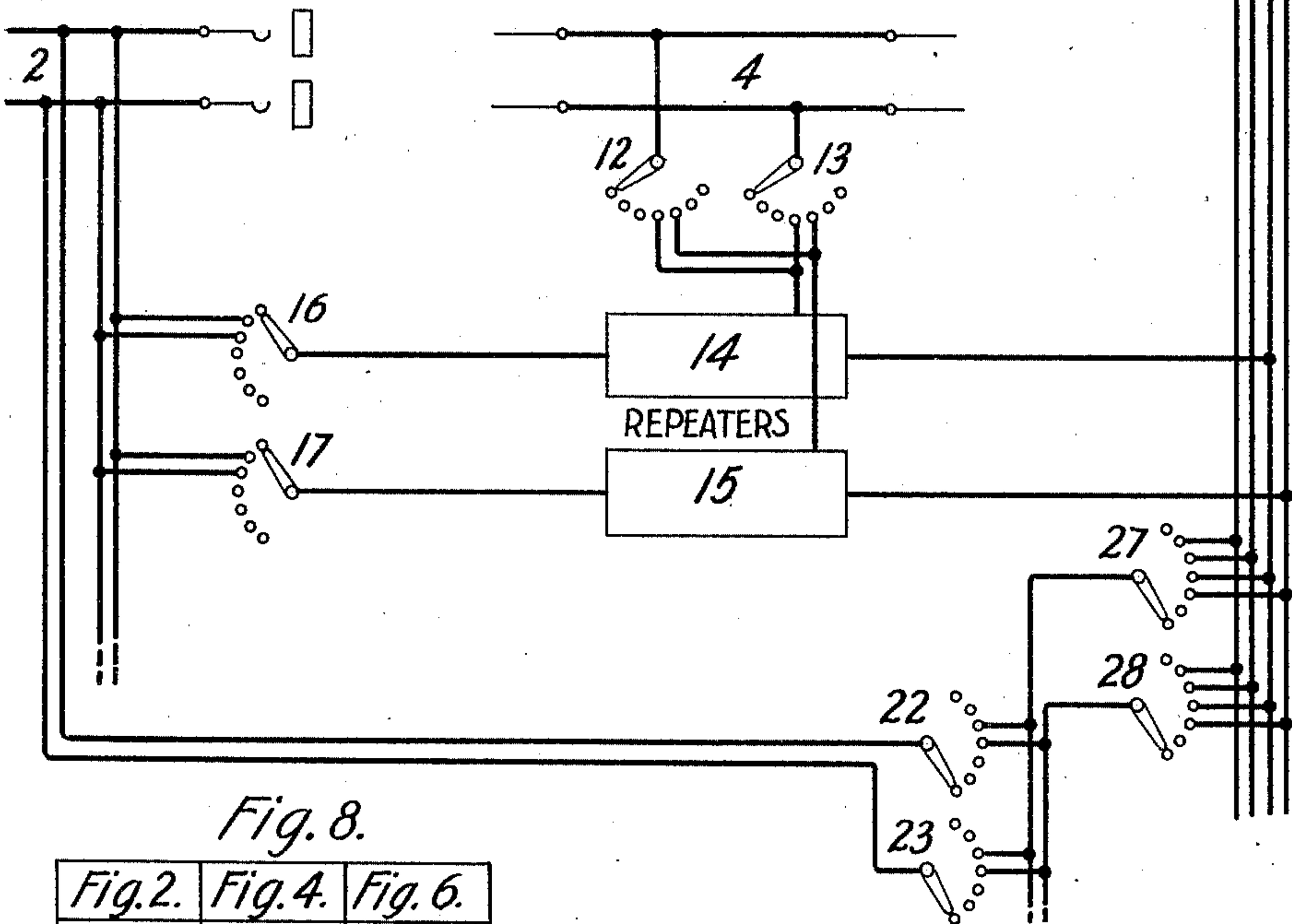
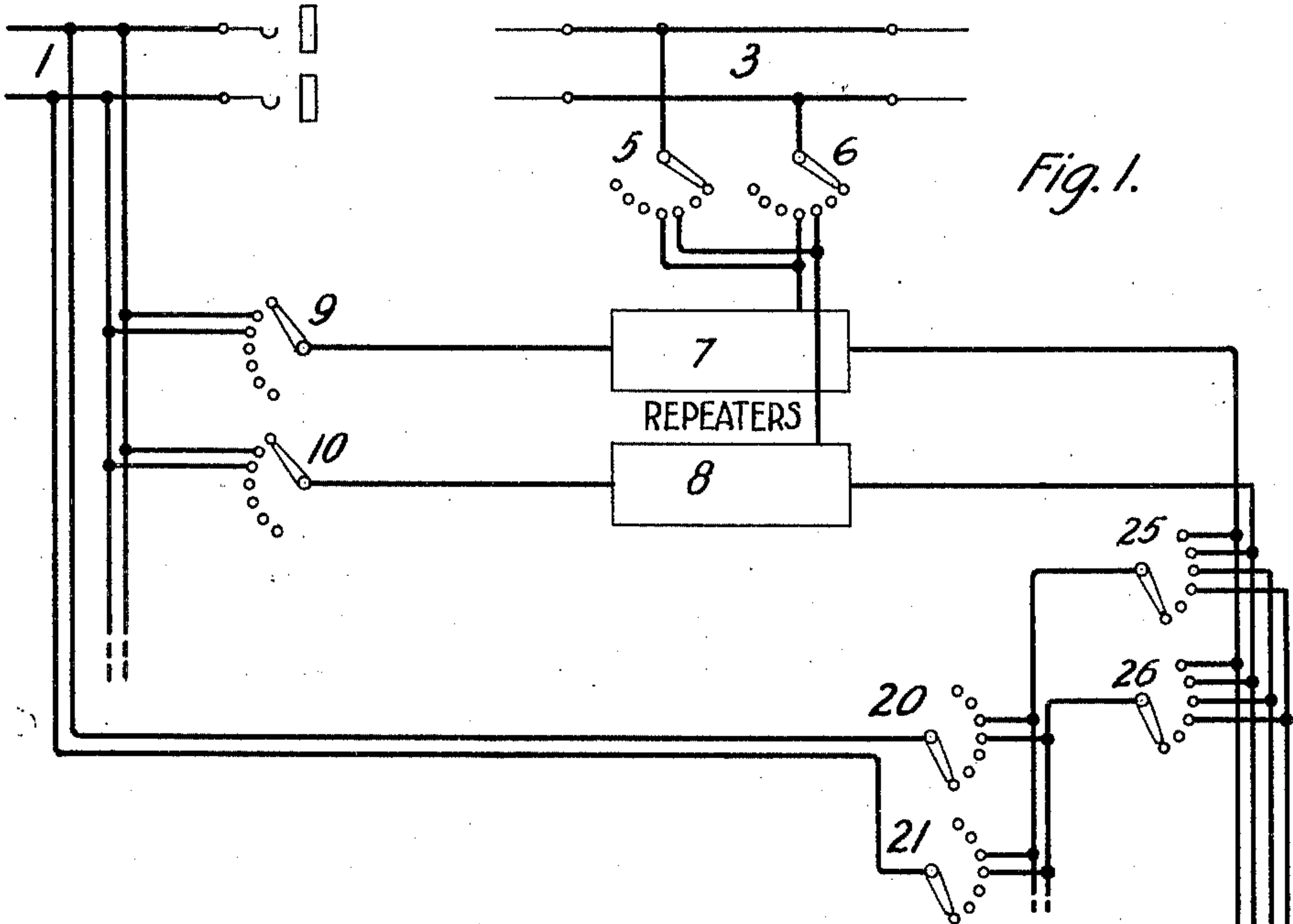


Fig. 2.	Fig. 4.	Fig. 6.
Fig. 3.	Fig. 5.	Fig. 7.

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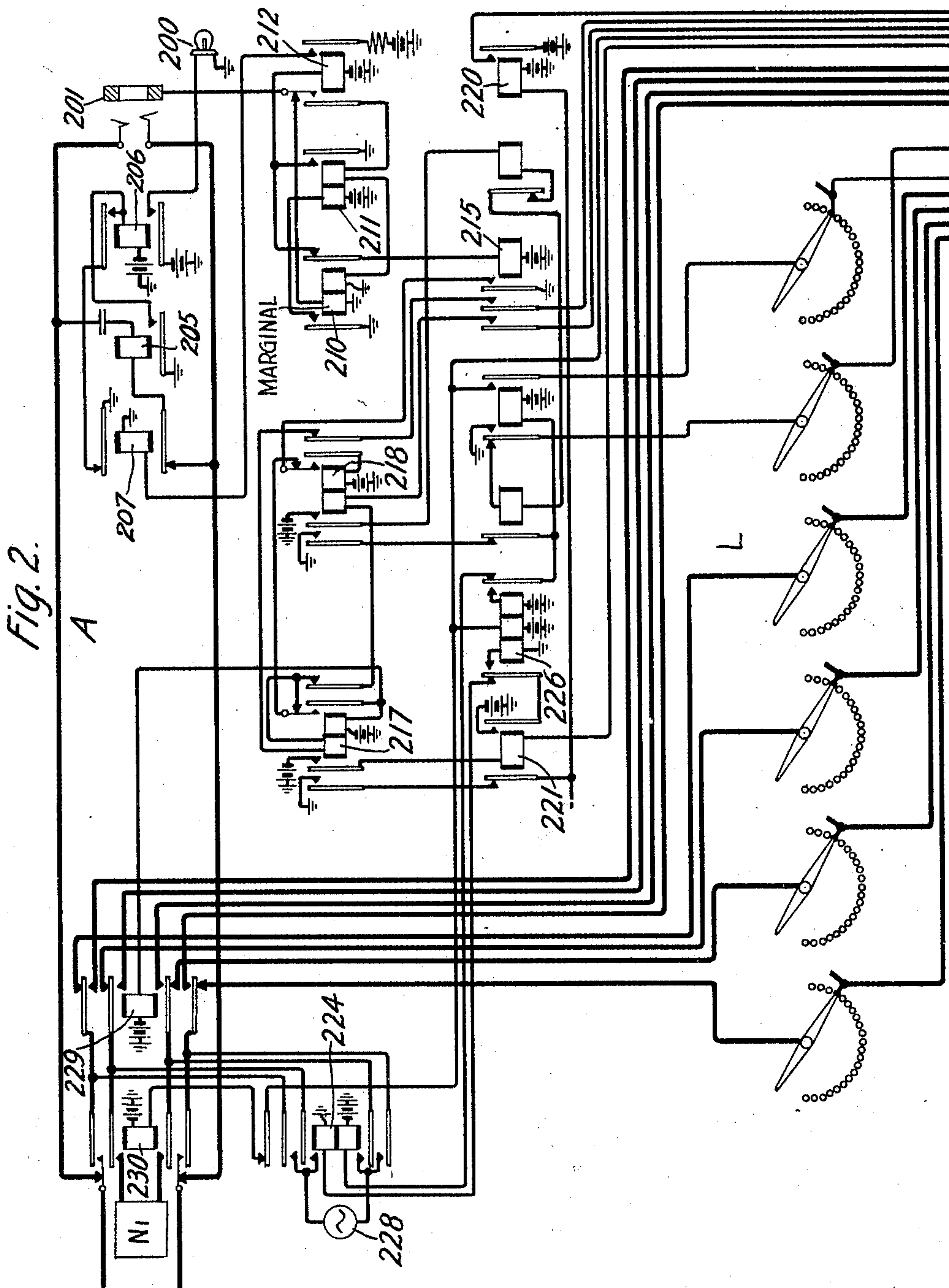
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Filed Aug. 28, 1926

7 Sheets-Sheet 2



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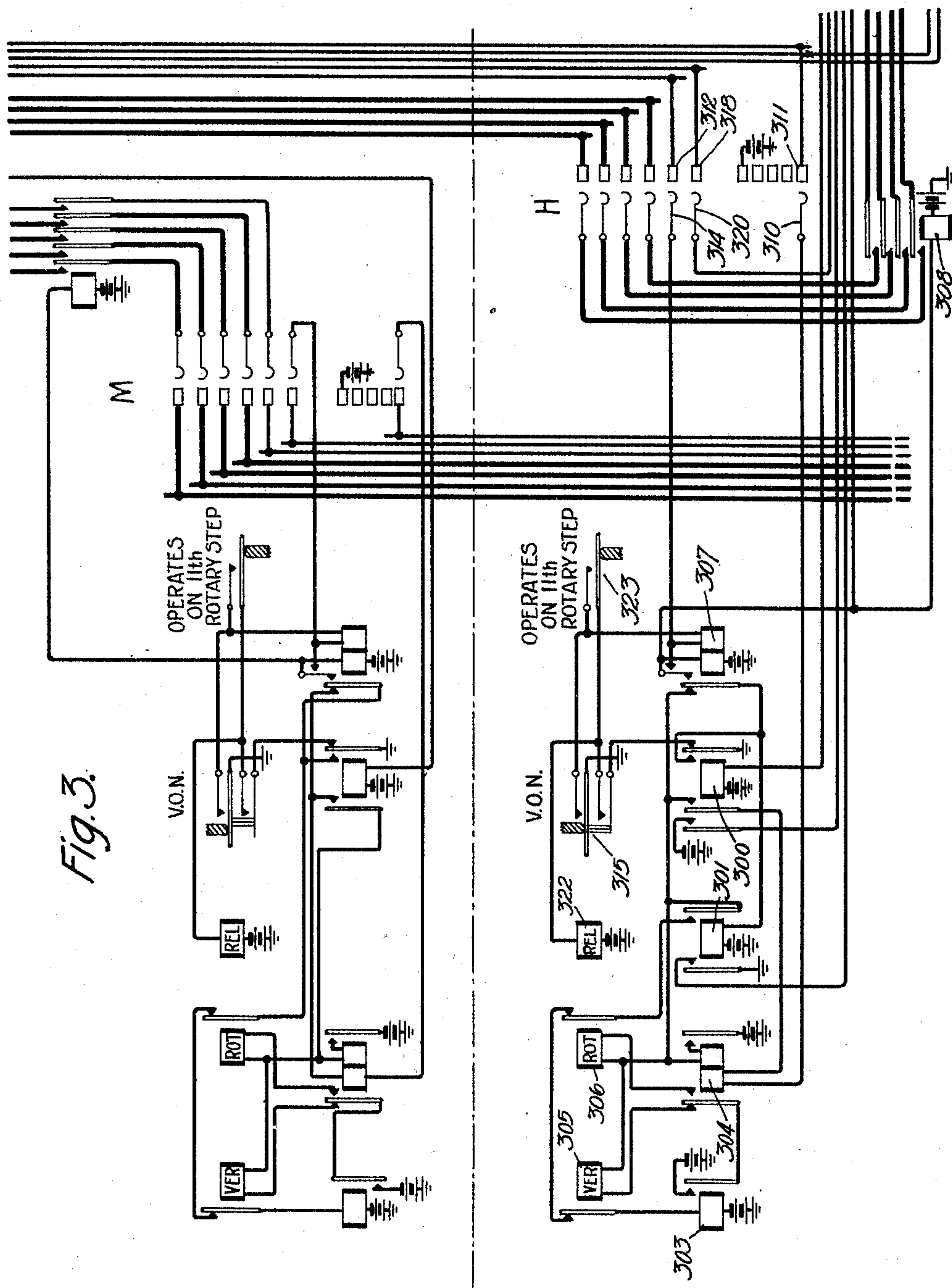
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1,738,302

TELEPHONE SYSTEM

Filed Aug. 28, 1926

7 Sheets-Sheet 3



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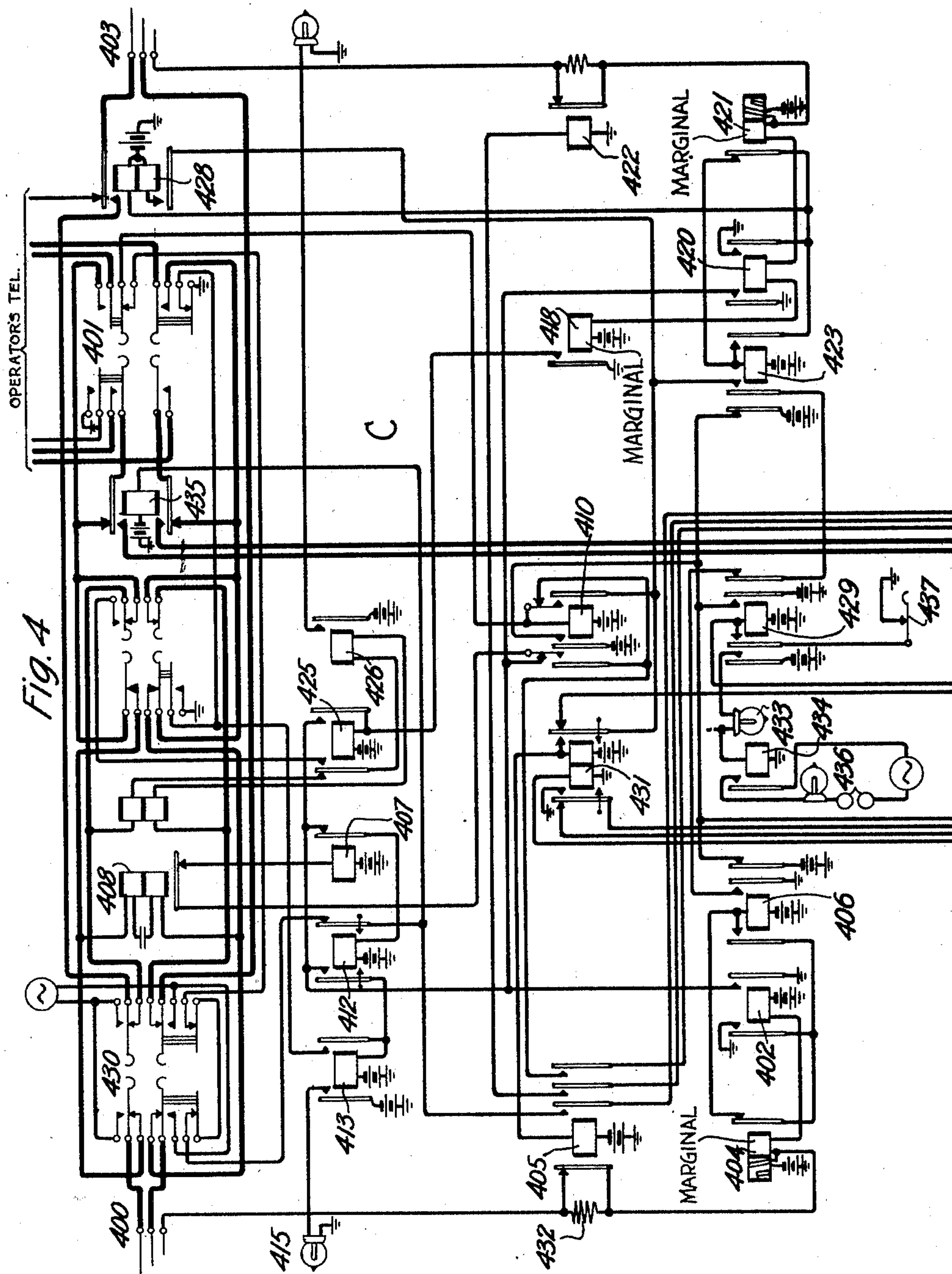
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1,738,302

TELEPHONE SYSTEM

Filed Aug. 28, 1926

7 Sheets-Sheet 4



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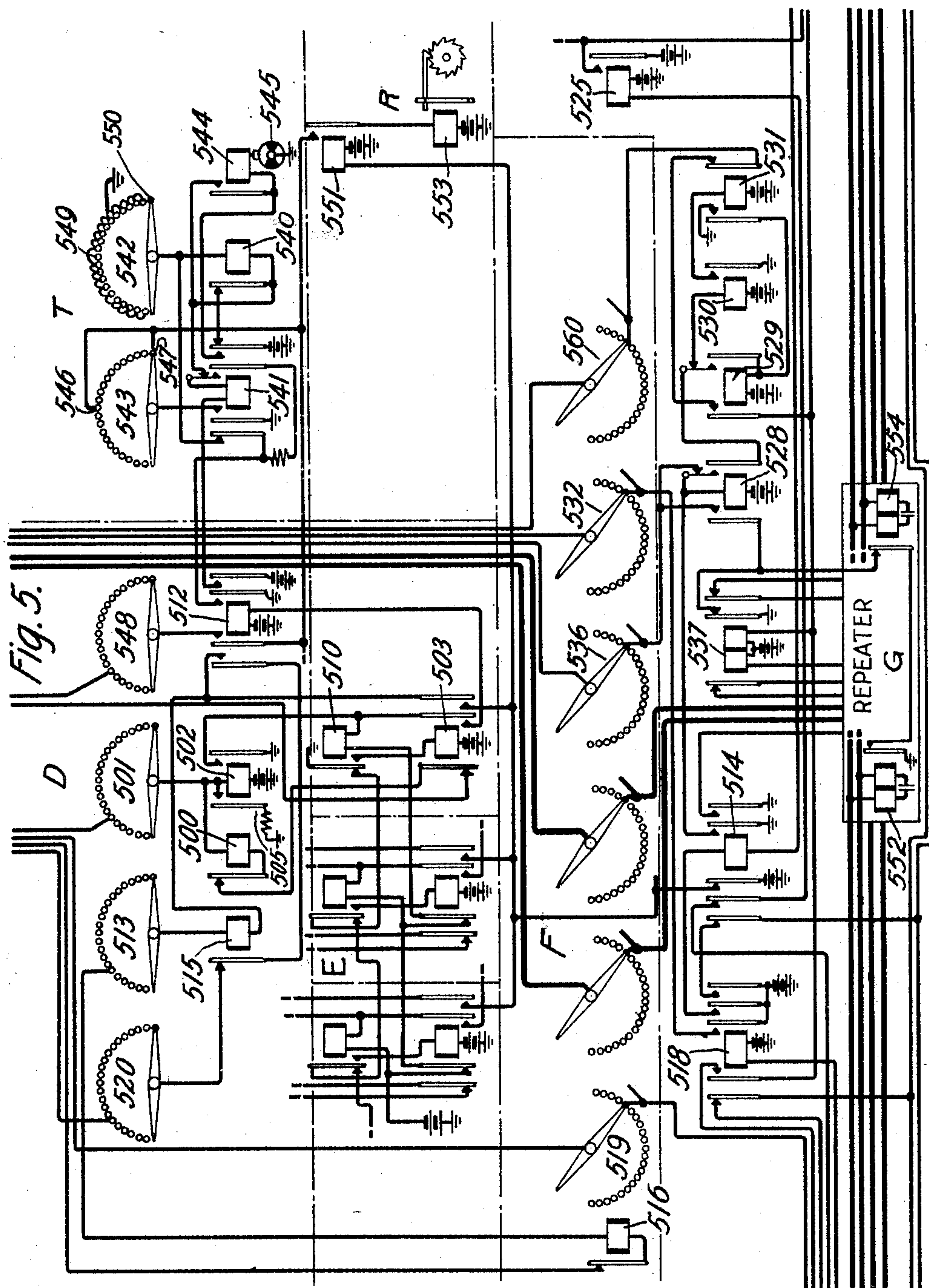
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1,738,302

TELEPHONE SYSTEM

Filed Aug. 28, 1926

7 Sheets-Sheet 5



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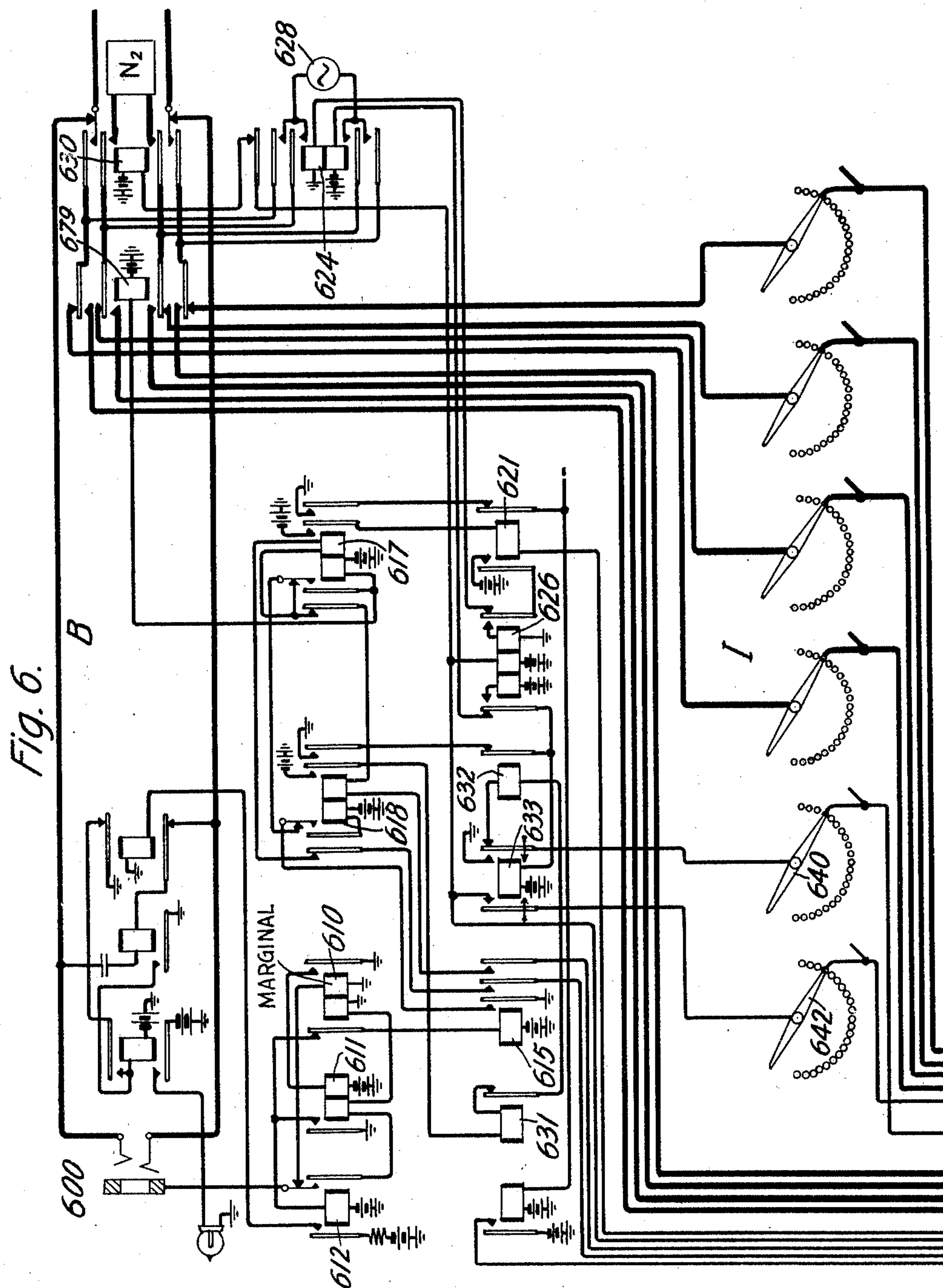
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1,738,302

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Filed Aug. 28, 1926

7 Sheets-Sheet 6



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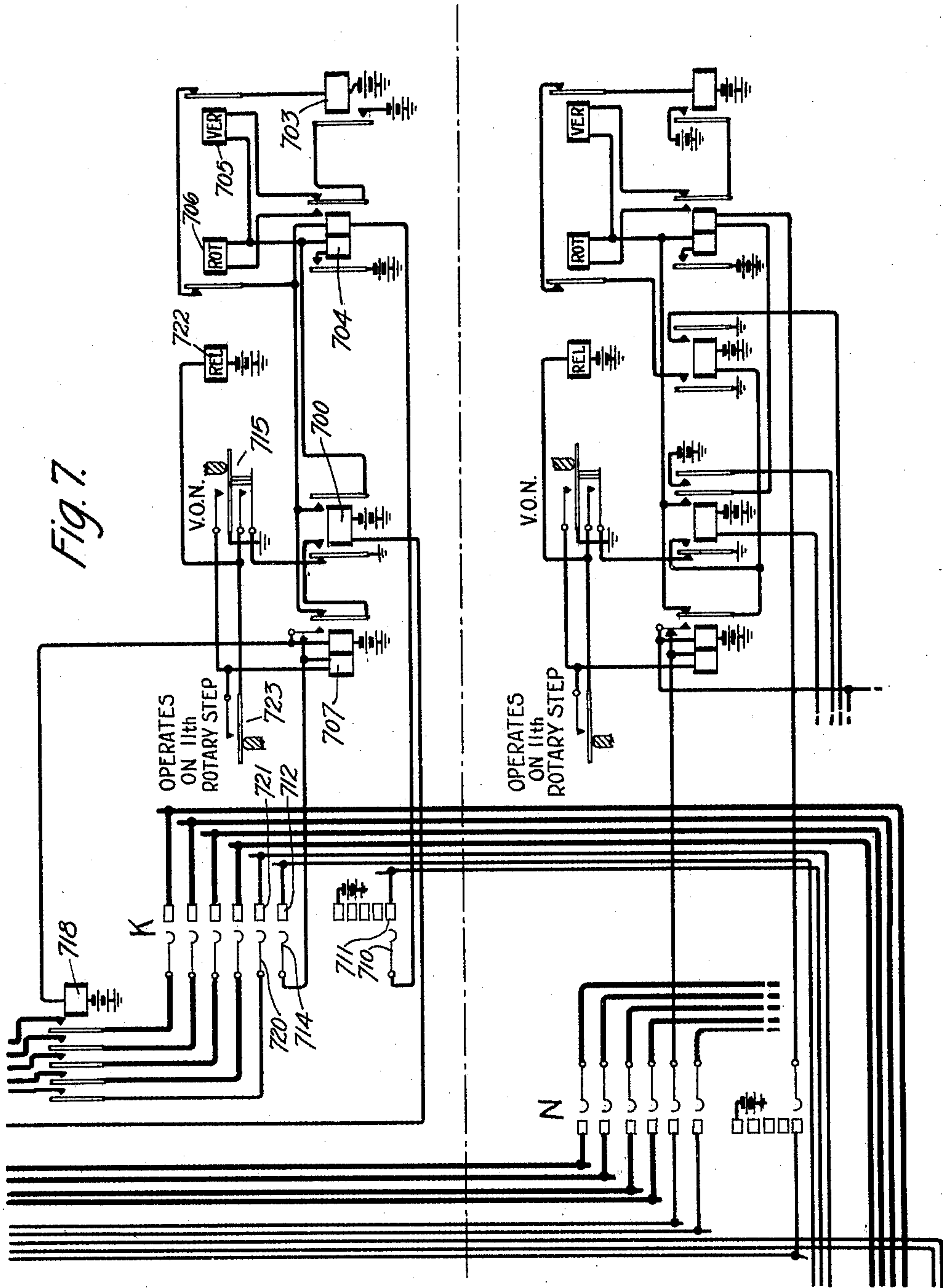
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1,738,302

TELEPHONE SYSTEM

Filed Aug. 28, 1926

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed August 28, 1926. Serial No. 132,105.

This invention relates to telephone exchange switching systems, and more particularly to the automatic selection of speech amplifying and repeating apparatus and the insertion of the same in toll connections.

Heretofore systems such as those disclosed in the Patent No. 1,647,796, issued to L. L. Glezen, S. P. Shackleton and E. Vroom, November 1, 1927, and the application of E. Vroom and F. S. Entz, Serial No. 129,682, filed Aug. 17, 1926, have been designed for the selection of repeaters and the inclusion of the same in toll lines. In general the arrangements in these systems are such that the automatic actions are started on the interconnection of two lines by means of a cord circuit. An idle repeater is first selected and then connected between the two lines by means of various kinds of switching apparatus.

The present invention is embodied in an arrangement in which one end of an automatically selected repeater is connected, by means of an individual line finder, with the call originating line, while a trunk finder individual to the called line operates to select the other end of the repeater, thereby effecting an interconnection of an idle repeater between these two lines.

Furthermore the present invention contemplates a grouping of the toll lines and repeaters such that the repeaters of any group serve, not only for toll connections involving two lines in their own group, but for connections involving one line in their own group and another line in any other group.

In large exchanges, toll line traffic may be conveniently arranged so that certain groups of lines will always be answered by certain groups of cords. Taking advantage of this arrangement, the system of grouping in accordance with this invention is such that each group of cords will have a definite group of repeaters assigned to it. Each repeater is connected at its incoming end with a line finder having direct access to all the lines in the group that may be answered by cords having access to the corresponding group of repeaters. On the other hand, the outgoing end of each repeater in each group may be reached by having the lines in each

group individually terminating in a trunk finder having access to a plurality of trunks that are common to the trunk finders for each group of lines. Each of these trunks terminates in a repeater finder having access to all of the repeaters of all groups.

It should be understood that the expression "incoming or outgoing end" of a repeater is merely used for convenience in distinguishing between the two ends of repeaters from which connections are made to lines or to which connections are made from lines and does not refer to the transmission characteristics of the repeaters.

This invention has been illustrated in the accompanying drawings in which Fig. 1 is a diagrammatic representation of a typical grouping arrangement, in accordance with this invention, of toll lines, cord circuits and repeaters and the automatic switches for interconnecting the same.

Figs. 2 to 7 show the detail circuit arrangement of an incoming line and an outgoing line, a cord circuit and the various switching mechanisms required for the establishing of a connection between said lines through a repeater.

Fig. 2 shows an incoming line and its associated trunk finder.

Fig. 3 shows a repeater finder in which a trunk from the trunk finder shown in Fig. 2 terminates and a line finder having access to the incoming line shown in Fig. 2.

Figs. 4 and 5 illustrate a cord circuit of the group serving the group of lines of which the line shown in Fig. 2 is one and the associated repeater selector and a repeater, the repeater being merely indicated by means of an enclosure. These two figures also show various common circuits and switching arrangements for preventing more than one interconnection of toll lines from taking place at any one time, this common equipment being similar to the equipments for the same purpose shown in the above mentioned copending applications.

Fig. 6 illustrates the incoming end of another line requiring the addition of a repeater and the associated trunk selector, while Fig. 7 illustrates a repeater finder as-

sociated with a trunk from the trunk finder shown in Fig. 6, and a line finder having access to the group of lines over which the line shown in Fig. 6 is one.

Fig. 8 shows the arrangement of the various drawings forming part of this application.

The general grouping arrangement of the various equipments for carrying out this invention may take the form shown in Fig. 1. For example, the toll lines of the system may be divided into groups two of which 1 and 2 of one hundred lines each have been indicated. Each of these groups of lines may be answered by a group of cords, the group 3 being used for answering calls incoming over lines in group 1 and the group 4 being used for calls incoming over the lines of group 2. The cords in group 3 are each provided with a repeater selector, such as 5 and 6 having access to repeaters, such as 7 and 8, of a group of approximately twenty repeaters. The incoming ends of these repeaters terminate in line finders, such as 9 and 10 having access to all of the lines in group 1. The cord circuits of group 4 are each provided with a repeater selector, such as 12 and 13 having access to repeaters, such as 14 and 15 of a group of approximately twenty repeaters. The incoming ends of these repeaters are connected to line finders, such as 16 and 17 having access to all of the lines in group 2. Each of the lines in groups 1 and 2 is provided with a trunk finder, such as 20, 21, 22 and 23. Each of these trunk finders has access to approximately twenty trunks terminating in repeater finders, such as 25, 26, 27 and 28, all of which have access to the outgoing ends of all of the forty repeaters in the two groups shown. A connection between two lines in these groups to include a repeater, may be established by inserting for example the left-hand end of a plug from a cord in group 3 into a jack of a line of group 1 and inserting the right-hand plug of said cord into a jack of a line of either group 1 or group 2 depending on where the wanted line is located. The connection of two lines in this manner will cause an idle repeater to be selected by a repeater selector, such as 5 or 6. When this selection has taken place a line finder, such as 9 or 10, associated with the incoming end of the selected repeater finds the calling line and connects it to the selected repeater. A trunk finder of a wanted line then selects an idle trunk and the repeater finder connected to the selected idle trunk finds the outgoing end of the selected repeater. A connection will now be established, for example, as follows: From a line in group 1 through a line finder, such as 9, a repeater, such as 7, a repeater finder, such as 25, a trunk finder, such as 20, and the associated line in group 1 or from the repeater 7 through a repeater finder, such as 27, a trunk finder,

such as 22, and the associated line in group 2. When this connection is completed the talking conductors of the cord circuit employed are opened and a talking connection through the repeater is established.

Referring now to Figs. 2 to 7, the general scheme of interconnecting toll lines and inserting repeaters into these connections in accordance with this invention will be outlined as follows: Let it be assumed that the toll line A is to be connected through a repeater with the toll line B and that cord circuit C is to be used for the establishing of this connection. In accordance with well-known practice, a call incoming over line A causes a lamp, such as 200, to be lighted at the toll boards. An operator having charge of cord circuits, such as C, in answering this call inserts plug 400 into jack 201 and operates the talking key 401 to connect her telephone set to line A for the purpose of communicating with the operator at the distant end to ascertain the destination of the desired connection. After having received the desired information, the operator inserts plug 403 into jack 600 of line B and restores the talking key 401.

As both lines A and B require the inclusion of a repeater, these lines have special electrical characteristics in their sleeve circuits that will initiate, when the toll lines are connected to the cord circuit, automatic operations for the insertion of the repeater in the connection. For this purpose, there is provided a so-called lockout selector switch or cord finder, one of which is indicated at D. Each cord finder is common to a group of cords. The cord finder D will now start to find the cord C and when found, the cord finder remains associated with the cord until the operations for inserting the repeater in the connection are completed. This is in order to prevent any other cord circuit in this group from starting its operations until cord C is released. As soon as cord finder D finds the cord circuit C, operations are started to actuate the secondary lockout circuit or position finder indicated at E. This finder is common to all groups of cords in the system. The position finder E remains associated with the cord circuit C until the complete sequence of operations for the insertion of the repeater into the connection has been effected and functions to prevent any other cord circuit in any other group from starting the selection of a repeater until the cord circuit C has completed its functions in this respect. The actuation of the position finder takes place immediately, provided no other cord in the system is going through the process of inserting a repeater in a connection. The reason for the provision of a cord finder for each group of cords and a position finder for all the groups of cords in the system is to insure that only one connection of a re-

peater between two toll lines may take place at any one time. In order however not to delay the connection of repeaters any longer than is necessary, the cord finders of the different groups of cords may operate to find
 5 cords interconnecting toll lines independently and simultaneously and prepare the associated circuits to the point where the common position finder begins to operate to
 10 permit one cord circuit at a time to complete the repeater selecting and connecting functions.

Once the cord circuit C has assumed control over the position finder E, it starts its
 15 repeater selector indicated at F to hunt for a repeater. One repeater has been indicated at G merely by means of an enclosure with all the leads from the line finder connected to the incoming end of the repeater and with
 20 all the leads from the repeater finders having access to the outgoing end of the repeater and all the leads from the repeater selector F shown leading into this enclosure. As the repeater itself forms no part of the invention and as any repeater of any well-known type
 25 may be used, it is thought that this representation will be sufficient. The repeater selectors and cord finder switching units may be of any well-known type having a series
 30 of terminal banks with the brushes arranged to travel thereover in steps under the control of stepping mechanisms. These selectors and finders have no home positions.

When the repeater selector F finds an idle
 35 repeater, certain electrical conditions are established for the sleeve circuits of lines A and B to cause these lines to be connected together through the selected repeater. First, the line A is connected through the
 40 line finder H to the incoming end of repeater G and then line B is connected through the trunk finder I and a repeater finder, such as K, to the outgoing end of repeater G. In addition to line finder H for finding line A,
 45 there has also been shown a line finder L individual to this line A and a repeater finder M, the brushes of which are connected through a trunk terminating in the banks of the line finder L. This repeater finder
 50 having access to the outgoing ends of all of the repeaters in the various groups, it should be noted that a similar showing has been made for line B, that is, a line finder N from the incoming end of a repeater has been
 55 shown. This line finder has access to the group in which the line B is located. This showing has been made in order to clearly bring out the fact that these lines can be reached through switches, such as H or N, and may find the outgoing ends of repeaters through such switches as L and M or I and K. The construction of the trunk finders L and I may be of any well-known type having
 60 a series of terminal banks with brushes arranged to travel thereover in steps under con-

trol of stepping magnet mechanisms. These selectors have no home positions. The construction of the repeater finders M and K and line finders H and N may be of any well-known Strowger type, having terminal
 65 banks arranged in horizontal layers with brushes traveling in a vertical followed by a horizontal step-by-step movement.

As soon as the lines have been connected with the repeater, the cord finder and the
 70 position finder are released so that the cord finder becomes available for other cords in the group to which the cord C belongs and so that the position finder becomes available for this or any other group of cords. Circuit changes will now take place to separate
 75 the two lines from the cord C and connect them to the repeater in the manner above mentioned, and at the same time, connect the networks N₁ and N₂ to balance the lines and
 80 also to remove certain short circuits in the selected repeater to make it operative. Transmission may then take place through the repeater while the connection through the
 85 cord circuit is opened.

Arrangements are also made whereby when the talking key of the cord circuit is operated, the repeater is cut out from the connection, which under these circumstances will extend
 90 through the cord circuit. Monitoring keys are also provided whereby connections from the repeater to the operator's telephone set may be established through the repeater selector.

If either one of the plugs of cord C is withdrawn from the line jack, the repeater is released from the connection. The repeater selector brushes, the cord finder brushes, and the trunk finder brushes will remain in the
 95 position in which they were last used, while the line finder and repeater finder are returned to normal position. The sleeve circuit of the line still connected to the cord remains in busy condition until both plugs are removed, when the entire equipment is restored to normal condition.

For the purpose of providing for failure of any part of the system during the establishing of a connection involving a repeater, the
 100 time alarm circuit indicated by T is used. Each connection is allowed a certain time, for example, five seconds in which to be completed. If completed within this time, the time alarm circuit is restored to normal, but
 105 if it is not completed in the allotted time, the time alarm circuit functions to give an alarm indicating which cord circuit is involved and also to cause the release of the cord finder involved to allow connections through another
 110 cord to take place. Cord circuits, such as C, are also arranged for interconnecting ordinary toll lines that do not require addition of repeaters. However, the invention is essentially concerned with the inclusion of repeaters in toll line connections and the following
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detailed description will therefore be confined to a description of functions taking place under such conditions.

As stated, when a call comes in over line A the operator at the toll board observes the lighted lamp 200. This lamp is lighted by a signal incoming over line A to operate relay 205 which closes an obvious circuit for the operation of relay 206, that in operating locks up through its upper armature and front contact to the ground at the upper armature and back contact of relay 207. Relay 206 in operating also closes an obvious circuit for the lighting of lamp 200. The operator at C answers this call by inserting the plug 400 into jack 201 and by connecting her telephone set through cord C to line A for the purpose of communicating with the operator at the distant end of the line A to ascertain the destination of the desired connection. The first effect after the insertion of plug 400 into jack 201 and before key 401 is operated will be the extinguishing of lamp 200. A circuit is completed through the sleeve terminals of jack 201 and plug 400 as follows: Battery, winding of relay 402, right-hand winding of relay 404, left-hand armature and back contact of relay 405, sleeve terminals of plug 400 and jack 201, left-hand winding of marginal relay 210 to ground. This circuit causes the operation of relays 210 and 402. The operation of relay 210 closes an obvious circuit for the relay 211, which in turn, closes an obvious circuit for relay 212. The operation of relay 212 opens the original energizing circuit for relay 210 and closes at its left-hand armature and front contact a connection from the sleeve through the right-hand windings of relays 211 and 210 in series to ground, thus holding these two relays operated. The operation of relay 212 also closes an obvious circuit for the operation of relay 207, which in operating, opens the holding circuit for relay 206 and also the circuit for relay 205. Relay 206 in releasing causes the lamp 200 to be extinguished.

When relay 402 operates a circuit is closed for the operation of relay 406 as follows: Battery, winding of relay 406, right-hand armature and back contact of relay 404, left-hand armature and front contact of relay 402 to ground. Relay 406 provides a locking circuit for itself directly through its left-hand armature and front contact to the ground at the left-hand armature and front contact of relay 402, independent of the original energizing circuit through the armature and back contact of relay 404. Relay 404 being marginal does not operate as long as the sleeve circuit extends through the left-hand winding of marginal relay 210. As soon as the sleeve circuit is changed to extend through the right-hand windings of relays 211 and 210 in series, the resistance of the

circuit is changed, as the resistance of the right-hand windings of relays 211 and 210 is low as compared with the resistance of the left-hand winding of relay 210. Hence, when relay 212 operates, this change in the resistance of the sleeve circuit causes relay 404 to operate to open the original energizing circuit for relay 406. The operation of relay 402 closes a circuit for the operation of relay 407 as follows: Battery, winding of relay 407, armature and back contact of relay 408, left-hand make-before-break contact of relay 410, right-hand armature and front contact of relay 402 to ground. It should be noted that this circuit extends through armature and back contact of relay 407 to the winding of relay 412 and battery, but as relay 412 is slow in operating as compared with relay 407, it will not have time to operate before the circuit for this relay is broken by the operation of relay 407. The non-operation of relay 412 prevents relay 413 from operating and consequently prevents the lighting of lamps 415.

The operator will now actuate the talking key 401 to associate her telephone set with cord circuit C. After ascertaining from the operator at the distant end of toll line A the destination of the desired connection, the operator will now insert the plug 403 into jack 600 of line B. The effect of this connection is similar to the effect of inserting plug 400 into jack 201. That is, a circuit is completed from battery, winding of relays 418, 420 and 421 in series, armature and back contact of relay 422, sleeve terminals of plug 403 and jack 600, make-before-break contacts of relay 612, right-hand winding of marginal relay 610 to ground. The immediate effect of this circuit will be to cause the operation of relays 420 and 610. The operation of relay 420 causes an obvious circuit to be closed for the operation of relay 423, which relay, in operating, closes a locking circuit for itself through its right-hand armature and front contact directly to the ground at the right-hand armature and front contact of relay 420. The operation of relay 610 closes an obvious circuit for the operation of relay 611, and relay 611, in operating, closes an obvious circuit for the operation of relay 612. Relay 612, in operating, opens at its make-before-break contacts the circuit through the right-hand winding of relay 610 and extends the sleeve circuit, through the right-hand armature and front contact of relay 612, through the left-hand windings of relays 611 and 610 in series to ground. The resistance of the circuit through these windings is low as compared with the resistance of the right-hand winding of relay 610, so that on the operation of relay 612, the resistance characteristics of the sleeve circuit change to cause the relays 418 and 421 to operate. The operation of relay 421 causes the original energizing circuit

for relay 423 to be opened and the operation of relay 418 closes an obvious circuit for the operation of relay 425 to transfer the relay 426 to a different bridge circuit across the talking conductors of the cord circuit C for establishing conditions relating to the supervision of the connection as will hereinafter become apparent. The operation of relay 420 also closes an obvious circuit for the operation of relay 428, which relay in operating closes a locking circuit for itself through the inner left-hand armature and front contact of relay 423, outer right-hand armature and back contact of relay 429, inner right-hand armature and front contact of relay 406 to ground. Relay 428 closes through the tip conductor to the tip terminals of plug 403 and jack 600 of cord circuit C.

The cord finder D will now be actuated to find the cord C. The terminal of cord circuit C on bank 501 will be marked by the absence of battery as it will be seen that the operation of relays 406 and 423 removes battery connections to this terminal. The starting magnet 500 for cord finder D will also start to operate the brushes of the cord finder D over a circuit as follows: Battery, from relays corresponding to relays 406, 410 and 423 of idle or busy cords, through the corresponding terminals and brush of bank 501, winding of stepping magnet 500, through its armature and back contact, through the left-hand armature and back contact of relay 503 of the position finder E, right-hand armature and back contact of relay 431, inner left-hand armature and front contact of relay 423, outer right-hand armature and back contact of relay 429, inner right-hand armature and front contact of relay 406 to ground. As the stepping magnet 500 breaks its own circuit, it will continue to operate until the terminal of the bank 501 from which battery has been removed is found. This terminal is associated, as stated, with the cord circuit C and when the stepping magnet stops its operation, relay 502 will operate. Relay 502 has a high resistance winding and operates in series with the stepping magnet without causing the stepping magnet to operate.

Relay 502, in operating, locks through a resistance 505 and its left-hand armature and front contact to ground and remains in this condition until it is released, as will hereinafter be described. The operation of relay 502 closes a circuit for the operation of relay 510 as follows: Battery, through the inner left-hand armatures and back contacts of relays corresponding to relay 503 that are individual to other groups of cords in the position finder E, through the winding of relay 510, right-hand armature and front contact of relay 502 to ground. Relays 510 and 503 of the position finder are individual to the group of cord circuits of which cord C

is one. The individual relays, for each group of cord circuits, corresponding to relays 510 and 503 are connected in a manner similar to these relays. Two sets of such relays is shown to the left of the two relays individual to this group of cord circuits. On the operation of relay 510 an obvious circuit is closed for relay 503 which by operating its left-hand armature opens the connection for the stepping magnet 500. Thus no other cord in this group can cause cord finder D to operate until the release of cord circuit C in the manner to be hereinafter described. Similarly, the operation of relay 510 by attracting its armature removes ground normally connected in a chain circuit through the armatures of other relays corresponding to relay 510 in other groups so that none of the relays corresponding to relay 503 can be operated while relay 510 is actuated. Connections from cord circuits in other groups are therefore prevented from going through the position finder until the functions of the cord circuit C are completed.

On the operation of relay 503 a circuit is closed for relay 512 as follows: Battery, winding of relay 512, inner right-hand armature and front contact of relay 503, right-hand armature and front contact of relay 502 to ground. The operation of relay 503 closes a circuit to battery through bank 513, through the cord circuit C to cause the operation of the repeater finder F. This circuit may be traced as follows: Battery, inner left-hand armature and back contact of relay 514, outer right-hand armature and front contact of relay 503, winding of relay 515, brush and a selected terminal of bank 513, winding and armature and back contact of stepping magnet 516 of the repeater finder F, left-hand armature and back contact of relay 431 to the brush of bank 519 of the repeater finder F. If the brushes of the repeater finder happen to rest on the terminals of a busy repeater, which is indicated by the fact that a ground is connected to a corresponding terminal of bank 519, the stepping magnet 516 will start to operate and advance the brushes of repeater finder F until an idle repeater is found which is indicated by the absence of ground on the corresponding terminal of bank 519, or as in this case, the presence of battery on this terminal. In other words, if a busy repeater is encountered, ground will be connected through brush 519 to a corresponding multiple contact of the repeater finder connected to the busy repeater. This ground will be supplied from the left-hand armature and front contact of the relay corresponding to relay 431 in the engaged cord circuits. It will be noted that a circuit is established for relay 431 at the same time that a circuit is established for relay 515. The circuit for relay 431 may be traced as

follows: Battery, inner left-hand armature and back contact of relay 514, outer right-hand armature and front contact of relay 503, outer left-hand armature and front contact of relay 512, armature and back contact of relay 515, to brush and corresponding terminal of bank 520, left-hand winding of relay 531 to ground. Relay 515 in the above mentioned circuit is a fast operating relay as compared to relay 431 which is slow to operate. The operation of relay 515 will therefore prevent relay 431 from operating at this time although a circuit for relay 431 is completed through the armature and back contact of relay 515. The stepping magnet 516 will continue to operate until an idle repeater is found, that is, one that has no ground on its multiple terminal of the bank 519. This circuit through the relay 515 and the stepping magnet 516 will therefore be opened, that is, when no ground is found on the corresponding terminal of bank 519 the release of relay 515 and the stopping of magnet 516 takes place, so that the brushes of the repeater finder F will now rest on the terminals of the first idle repeater. When this takes place, the previously traced circuit for relay 431 will be completed through the armature and back contact of relay 515 so that relay 431 will now be energized and apply ground to its left-hand armature and front contact through the brush 519, thus making the repeater G busy to other cord circuits.

Relay 431, in operating, provides a locking circuit for itself through its right-hand armature and front contact, left inner contact and armature of relay 423, right outer normal contact and armature of relay 429, to the ground at the inner right-hand armature and front contact of relay 406. The operation of relay 431 also closes a circuit for the operation of relay 405 as follows: Battery, winding of relay 405, right-hand armature and front contact of relay 431 to the ground at the inner right-hand armature and front contact of relay 406. The operation of relay 405 by opening the connection through its left-hand armature and back contact for the sleeve circuit for plug 400 and jack 201 causes a resistance 432 to be inserted in the sleeve circuit. The effect of the insertion of this resistance is that the marginal relay 210 will be released. Relay 210 in releasing closes a circuit for the operation of relay 215 as follows: Battery, winding of relay 215, right-hand armature and back contact of relay 210, armature and front contact of relay 211 to ground. The operation of relay 215 closes a connection to ground at its inner left-hand armature and front contact for circuit changes to take place to mark the level on the line finder H in which the terminals of line A are located. It will be noted that on the operation of relay 431, relay 300

of line finder H is operated over a circuit as follows: Battery, winding of relay 300, a terminal and the brush of bank 519, left-hand armature and front contact of relay 431 to ground. The operation of this relay and relay 215 above mentioned will therefore close a circuit for the operation of relay 217 as follows: Battery, outer left-hand armature and front contact of relay 300, outer left-hand armature and back contact of relay 518, middle left-hand armature and front contact of relay 215, outer right-hand armature and back contact of relay 218, left-hand winding of relay 217, make-before-break contacts of this relay, make-before-break contacts of relay 218, inner left-hand armature and front contact of relay 215 to ground. The operation of relay 217 opens the circuit from ground at the inner left-hand armature and front contact of relay 215 through the make-before-break contacts of relay 217 and extends this circuit through the inner right-hand armature and front contact and the right-hand winding of relay 217 to battery to lock relay 217 under the control of relay 215. While a circuit is partially completed for relay 218 on the operation of relay 215 this relay 218 will not operate due to the fact that line A is the call originating line. It will be explained in the description relating to the association of lines B with the outgoing end of the repeater G how a relay corresponding to relay 218, namely relay 618, in the circuit for line B will be operated, while a relay 617 in this circuit corresponding to relay 217 in the circuit for line A will not be operated due to the fact that line B is the wanted line. Thus, by the operation and non-operation of these relays, discrimination between an incoming line and an outgoing line is determined. The operation of relay 217 closes a circuit for relay 220 as follows: Battery, winding of relay 220, left-hand armature and back contact of relay 221, outer left-hand armature and front contact of relay 217 to ground. Relay 220 is common to all of the lines of the group of which line A is one that terminate in the same level of line finder H as line A. The operation of relay 220 by closing its armature and front contact to battery will mark the level of line finder H in which line A is located.

Upon the operation of relay 300 an obvious circuit is closed for the operation of relay 301. The operation of relay 301 closes the circuit for the operation of relay 303 as follows: Battery, winding of relay 303, armature and back contacts of vertical magnet 305 and rotary magnet 306, right-hand armature and front contact of relay 301, armature and back contact of relay 307, right-hand armature and front contact of relay 300 to ground. The operation of relay 303 closes a circuit for the operation of the vertical magnet 305 as follows: Battery,

armature and front contact of relay 303, left-hand armature and back contact of relay 304, winding of vertical magnet 305, armature and back contact of relay 307 and right-hand armature and front contact of relay 300 to ground. As the vertical magnet 305 operates the circuit for relay 303 is opened. The release of relay 303 opens the circuit for the vertical magnet which in releasing again closes the circuit for relay 303 to reoperate the vertical magnet 305. Thus the alternate operation and release of vertical magnet 305 causes the brushes of switch H to travel in a vertical direction until the brush 310 finds the terminal 311 which marks by a battery from relay 220 the level in which the terminals of line A are located. A circuit will now be completed from the battery at the armature and front contact of relay 220, terminal 311, brush 310, left-hand winding of relay 304, inner left-hand armature and front contact of relay 300, armature and back contact of relay 307 to ground at the right-hand armature and front contact of relay 300.

The operation of relay 304 opens the circuit for the vertical magnet 305 which now ceases its operations and the circuit from battery at the armature and front contact of relay 303 is transferred to close the circuit for the rotary magnet 306 as follows: Battery, armature and front contact of relay 303, left-hand armature and front contact of relay 304, winding of rotary magnet 306, armature and back contact of relay 307, right-hand armature and front contact of relay 300 to ground. The alternate operation and release of rotary magnet 306 and relay 303 take place in the same manner as during the operations of the vertical magnet 305. It will be noted that when the terminal 312 of line A is reached by the brush 314 of finder H, battery will be supplied from the inner left-hand armature and front contact of relay 217 for the operation of relay 307 over a circuit as follows: Battery, inner left-hand armature and front contact of relay 217, winding of relay 221, terminal 312, brush 314, right-hand winding of relay 307 and upper vertical off normal contacts 315 to ground. This circuit causes the operation of relays 221 and 307. The operation of relay 307 opens the energizing circuit for rotary magnet 306 and relay 303 causing the brushes of finder H to stop on the terminals of line A. Relay 307 is locked up to the ground at the right-hand armature and front contact of relay 300 over the armature and front contact of relay 307. The operation of relay 307 also closes a circuit for the operation of relay 308 as follows: Battery, winding of relay 308, armature and front contact of relay 307 to ground at the right-hand armature and front contact of relay 300. The operation of relay 308 closes the connection between the conductors from line A through to the incoming end of repeater G. A circuit

for relay 518 is also closed by the operation of relay 307 as follows: Battery, winding of relay 518, armature and front contact of relay 307, right-hand armature and front contact of relay 300 to ground. The purpose of the operation of relay 518 will be explained hereinafter. The operation of relay 221 causes a circuit to be closed for the operation of relay 224 as follows: Battery, right-hand armature and front contact of relay 221, left-hand armature and back contact of relay 226, upper winding of relay 224 to ground. The operation of relay 224 applies ringing current from source 228 to the conductors of line A leading to the incoming end of the repeater G through the armatures and front contacts of this relay and the armatures and front contacts of relay 229. It should be noted that relay 229 was operated upon the operation of relay 217 over a circuit as follows: Battery, winding of relay 229, inner right-hand armature and front contact of relay 217, make-before-break contact of relay 218, inner left-hand armature and front contact of relay 215 to ground. The purpose of applying ringing current to the conductors from line A to the incoming end of repeater G is to "burn out" the terminals and brush connections between the line finder H and the conductors of line A.

Relay 518 in operating closes a circuit for the operation of relay 422 as follows: Battery, inner right-hand armature and front contact of relay 518, brush and a terminal of bank 532, middle right-hand armature and front contact of relay 405, winding of relay 422 to ground. Relay 422 in operating changes the resistance characteristics of the sleeve circuit for plug 403 and jack 600 which causes the marginal relay 610 to release. The release of relay 610 causes a circuit to be closed for the operation of relay 615 as follows: Battery, winding of relay 615, left-hand armature and back contact of relay 610, armature and front contact of relay 611 to ground. The operation of relay 615 closes a circuit for the operation of relay 618 as follows: Battery, outer right-hand armature and front contact of relay 518, outer left-hand armature and back contact of relay 514, outer right-hand armature and front contact of relay 615, right-hand winding of relay 618, outer left-hand armature and back contact and make-before-break contacts of relay 617, make-before-break contact of relay 618, inner right-hand armature and front contact of relay 615 to ground. Relay 618 in operating closes a locking circuit for itself through its left-hand winding and inner left-hand armature and front contact to the ground at the inner right-hand armature and front contact of relay 615. A circuit may now be closed by the operation of relay 618 for the operation of the stepping magnet 631 in series with the relay 632 for the operation of the trunk selector I.

If the brushes of this selector are resting on terminals of a busy trunk the stepping magnet 631 will operate and a circuit will be closed for this magnet and the relay 632 as follows: From battery, inner right-hand armature and front contact of relay 618, winding, armature and back contact of stepping magnet 631, winding of relay 632, right-hand armature and back contact of relay 633 brush of bank 640 of switch I to the terminal of the busy trunk at this bank and a corresponding brush of a busy trunk selector such as I, to ground at the right-hand armature and front contact of a relay of the busy line corresponding to relay 633 of this line. It will be noted that a circuit is also closed by the operation of relay 618 for relay 633 from battery through the winding of relay 633 through the armature and back contact of relay 632 to ground at the outer right-hand armature and front contact of relay 618. But as relay 632 is faster in operating than relay 633 the circuit for this latter relay will be opened as long as relay 632 is operated and stepping magnet 631 is alternately operated to advance the brushes of switch I until they come in contact with the terminals of an idle trunk. At this time the brush of bank 640 encounters battery on the corresponding terminal and consequently relay 632 and magnet 631 will be released. When this takes place the above mentioned circuit for relay 633 is completed and this relay will now operate to apply at its right-hand armature and front contact a ground to make the selected trunk busy to other trunk finders such as I. The release of relay 632 closes a circuit for the operation of relay 624 over a circuit as follows: Battery, lower winding of relay 624, left-hand armature and back contact of relay 626, armature and back contact of relay 632 to ground at the outer right-hand armature and front contact of relay 618. Relay 624 in operating applies ringing current from source 628 to the conductors of line B leading through switch I the selected brush and switch K to the outgoing end of the repeater jack to "burn out" the contacts of these switches as is well known in the art. It should be understood, however, that the ringing current will not be needed until switch K has found the outgoing end of repeater G.

The operation of repeater finder K will now be explained. It will be noted that on the operation of relay 633 relay 700 of repeater finder K will operate over a circuit as follows: Battery, winding of relay 700, a corresponding terminal and the brush of bank 640 of switch I, left-hand armature and front contact of relay 633 to ground. The operation of relay 700 closes a circuit for the operation of relay 703 as follows: Battery winding of relay 703 armatures and back contacts of vertical magnet 705 and rotary magnet 706,

armature and back contact of relay 707, left-hand armature and front contact of relay 700 to ground. The operation of relay 703 provides, by the operation of its armature, battery for the operation of the vertical magnet 705 as follows: Battery, armature and front contact of relay 703, right-hand armature and back contact of relay 704, winding of vertical magnet 705, right-hand armature and front contact of relay 700, armature and back contact of relay 707, left-hand armature and front contact of relay 700 to ground. The operation of vertical magnet 705 opens the circuit for relay 703 which in releasing opens the circuit for the vertical magnet 705. Thus this relay 703 and vertical magnet 705 will alternately operate and release to advance the brushes of repeater finder K to the horizontal level in which the terminals of the outgoing end of repeater G are located. It will be noted that this level is marked by a battery applied from the armature and front contact of relay 525 to terminal 711. Hence, when the brush 710 finds this terminal a circuit is closed for the operation of relay 704 as follows: Battery, armature and front contact of relay 525, terminal 711, brush 710, right-hand winding of relay 704, armature and back contact of relay 707, left-hand armature and front contact of relay 700 to ground. Relay 704 in operating transfers the battery at the armature and front contact of relay 703 from the vertical magnet to the rotary magnet.

The circuit for the rotary magnet may be traced from this battery, right-hand armature and front contact of relay 704, winding of rotary magnet 706, right-hand armature and front contact of relay 700, armature and back contact of relay 707, left-hand armature and front contact of relay 700 to ground. Relay 703 and rotary magnet 706 will now alternately operate and release until the brushes of repeater finder K find the outgoing terminals of repeater G. It will be noted that terminal 712 has been marked by a battery on the operation of relay 518 so that when brush 714 finds this terminal a circuit is completed for the operation of relays 707 and 514 as follows: Battery, middle right-hand armature and front contact of relay 518, winding of relay 514, terminal 712, brush 714, left-hand winding of relay 707, vertical off normal contacts 715 to ground. Relay 707 in operating opens the circuit for the rotary magnet 706 at its armature and back contact and closes through its armature and the corresponding front contact a locking circuit for itself to the ground at the left-hand armature and front contact of relay 700. A circuit is also completed by the operation of relay 707 for the operation of relay 718 which joins the selected trunk conductors to the brushes of repeater finder K. At this time the ringing current from source 628 is passed through

the brushes and terminals of switches I and K to burn them out.

Relay 514 in operating opens at its outer left-hand armature and back contact the original energizing circuit for relay 618 which, however, remains operated as hereinbefore described. This relay also opens a circuit for relay 525 which releases to remove the marking battery from the terminal 711.

It might be explained here that if during the vertical movements of the line finders H or K the marking of the terminals such as 311 or 711 should for some reason not be identified by the brushes 310 and 710, the vertical magnets 305 or 705 would continue to step the brushes up until the 10th level is reached at which time relays 304 or 704 would operate from the battery supplied at the 10th level through brushes 310 or 710. In this case the rotary magnets 306 or 706 would operate to step the brushes over the 10th level until the 11th rotary step is reached for the operation of the 11th step rotary contacts 323 or 723. The operation of these contacts would cause the operation of release magnets 322 or 722 over obvious circuits so that these switches would be restored to their normal positions. In view of the fact that relays 300 and 700 are still operated on the return of the switches to normal, the switches will repeat their vertical and rotary operations until the brushes 310 or 710 find the marked terminals 311 or 711 or until the alarm circuit T functions to restore the connections to normal.

It should be noted that the operation of relay 514 also, by opening the connection through its inner left-hand armature and back contact, removes the common battery from the position finder E. The operation of relay 514 also closes a circuit to ground for the operation of relay 528 as follows: Battery, winding of relay 528, inner right-hand armature and front contact of relay 514 to ground. However before relay 528 has time to operate a circuit is completed through its make-before-break contacts for the operation of relay 410 as follows: Battery, winding of relay 410, right-hand make-before-break contacts of this relay, outer right-hand armature and front contact of relay 405, brush and the corresponding terminal of bank 536, make-before-break contacts of relay 528 to the ground at the inner right-hand armature and front contact of relay 514. Relay 410 in operating provides a locking circuit for itself through its right-hand armature and front contact to the ground at the right-hand armature and front contact of relay 406. While this ground from the inner right-hand armature and front contact of relay 514 is removed from the terminal and brush of bank 536 at the make-before-break contact of relay 528 when it operates, a substitute ground is provided for the brush of this bank from the inner right-hand armature and back contact of relay 537

through the left-hand armature and front contact of relay 538 and this ground is now applied, due to the operation of relay 410, to another circuit as will be hereinafter explained.

It should be noted that relay 410 in operating opens the circuit for relay 407 extending through its left-hand make-before-break contacts and transfers this circuit through the outer left-hand armature and front contact to the ground connected at the inner right-hand armature and back contact of relay 537. Thus the control of relay 407 is transferred to the repeater G for supervisory purposes. It will be noted that there is another connection to ground from the left-hand armature of relay 528 into the repeater G through the armatures and back contacts of the ringing relays 552 and 554. As relay 537 is operated, over a circuit which will hereinafter be traced, to insert a repeater in a connection by opening its left-hand armature and back contact to remove the short-circuit across the repeater, the ground at the inner right-hand armature and back contact of relay 537 will be removed. Hence the ground in the repeater will have control over the operation and release of relay 407. If supervisory signals are incoming to the repeater G from either line A or B to operate either of the ringing relays 552 and 554 this above mentioned ground will be removed to cause the release of relay 407. Relay 407 in releasing will permit the operation of relay 412 over an obvious circuit. Relay 412 in operating will close an obvious circuit for the operation of relay 413 which in turn closes a circuit for lighting of lamp 415. Hence the operation of relay 528 transfers the supervisory control to the repeater from the cord circuit when the lines are connected through a repeater.

Another function performed by the operated relay 528 is to close a circuit for the operation of relay 530 as follows: Battery, winding of relay 530, make-before-break contact of relay 529, right-hand armature and front contact of relay 528 to the ground at the inner right-hand armature and front contact of relay 514. Relay 530 in operating closes an obvious circuit for the operation of relay 531 which in operating closes an obvious circuit for the operation of relay 529. Relay 529 in operating opens the circuit for relay 530 and relay 530 opens the circuit for relay 531. The relay 529 in operating closes a locking circuit through its right-hand armature and front contact to the ground at relay 514, so that this relay will remain operated while relays 530 and 531 are released. This sequence of operation will take a certain period of time sufficient for the ringing currents from sources 228 and 628 to "burn out" the brush and terminal contacts as hereinbefore described. On the release of relay 531 a connection will be completed for the opera-

tion of relay 537 over a circuit as follows: Battery, right-hand winding of relay 537, left-hand armature and front contact of relay 529, right-hand armature and back contact of relay 531, a corresponding contact and brush of bank 560, inner right-hand armature and front contact of relay 405, right-hand armature and back contact of relay 412, lower normal springs of ringing keys 430, upper inner right-hand normal contacts of talking key 401, right-hand armature and front contact of relay 410, inner left-hand armature and front contact of relay 423, outer right-hand armature and back contact of relay 429, inner right-hand armature and front contact of relay 406, to ground. Relay 537 in operating opens, at its left-hand and outer right-hand armatures and back contacts, the usual short-circuiting bridge for the repeater G making it operative and places lamp 415 under the control of relays 552 and 554 as hereinbefore described. The same circuit that operated relay 537 also extends through relays 435, 226 and 626. The circuit for relay 435 is obvious and this relay in operating connects the monitoring leads from repeater G to the talking and monitoring key 401 so that if the operator desired to monitor the connection she may actuate this key towards the left and thus connect her telephone set to the repeater. The circuit for relay 226 may be traced as follows: Battery, middle winding of relay 226, terminal 318, brush 320 of line finder H, inner left-hand armature and front contact of relay 518 through the left-hand armature and front contact of relay 529 to the ground as previously traced at relay 406. The circuit for relay 626 may be traced from battery, middle winding of relay 626, left-hand armature and front contact of relay 633, brush and corresponding terminal of bank 642, outer left-hand armature and front contact of relay 718, brush 720, terminal 721 to the left-hand armature and front contact of relay 529 and then to the ground at relay 406. Relay 226 in operating closes a locking circuit for itself through its left-hand winding, armature and front contact to the battery at the right-hand armature and front contact of relay 221, and by the operation of this left-hand armature the circuit for relay 224 is broken to release this relay and remove the ringing current from the conductor of line A. It will now be noted that the circuit from the ground at relay 406 will extend through the winding of relay 230 through the upper outer armature and back contact of relay 224 so that this relay 230 will operate and disconnect the line A from the tip and ring terminal of jack 201 and connect it and a network N1 through to the incoming end of repeater G. It seems unnecessary to trace the circuit from line A and network N1 to the incoming

end of repeater G as it is clear from the drawing how this connection is completed.

On the operation of relay 626 a locking circuit is provided for this relay through its left-hand winding and left-hand armature and front contact through the armature and back contact of relay 632 to the ground at the outer right-hand armature and front contact of relay 618. It will be noted that on the operation of relay 626 the circuit for relay 624 is broken at the left-hand armature and back contact of this relay so that relay 624 is released and removes ringing current from the conductors of line B leading to the outgoing end of the repeater G. When relay 624 releases the circuit from ground at relay 406 is extended through the upper outer armature and back contact of this relay 624 through the winding of relay 630 which now operates. This relay in operating disconnects the line B from the tip and ring conductors of jack 600 and extends it and the associated network N2 through the trunk selector I and the repeater finder K to the outgoing end of repeater G. As this connection from toll line B to the outgoing end of repeater G is also clearly traceable on the drawing it seems unnecessary to specifically describe it. A transmission connection is now therefore completed from line A to B that includes a repeater and conversation over this connection may now begin.

As the toll lines A and B are now connected through the repeater G it is no longer necessary to prevent other cord circuits in other groups for establishing connections. It will be noted that on the operation of relay 410, battery was connected at the inner left-hand armature and front contact of this relay to the corresponding terminal and brush of bank 501 and this has the effect of shunting the winding of relay 502 to cause the release of this relay. Relay 502 in releasing causes the release of relay 510 which in turn causes the release of relay 503 and the release of relays 502 and 503 causes the release of relay 512. By the release of relays 510 and 503 other cord circuits in this group or cord circuits in any other group that have been associated with corresponding cord finders, will be permitted to extend the connections through the relays corresponding to relays 510 and 503 of the position finder E. It should be understood that only one cord circuit at the time will be permitted to complete a connection.

The time alarm circuit T operates as follows: On the operation of relay 512 a circuit is provided for the operation of stepping magnet 540 as follows: Battery, outer right-hand armature and back contact of relay 541, armature and back contact and winding of stepping magnet 540, outer left-hand armature and back contact of relay 541, inner right-hand armature and front contact of re-

lay 512 to ground. When the stepping magnet 540 operates to move the brushes of banks 542 and 543 one step, the brush of bank 542 connects with the first terminal which is connected to ground. This causes a circuit to be closed for relay 541 as follows: Battery, outer right-hand armature and front contact of relay 512, winding of relay 541, make-before-break contacts of relay 541, winding of stepping magnet 540 to ground at the strapped terminals of bank 542. Relay 541 locks up to ground at the inner right-hand armature and front contact of relay 512 through its inner right-hand armature and front contact. Relay 541 in operating opens the original energizing circuit for magnet 540 and provides a circuit for the operation of relay 544 through interrupter 545. Relay 544 in operating closes a secondary circuit for the operation of stepping magnet 540 as follows: Battery, outer right-hand armature and front contact of relay 541, armature and front contact of relay 544, winding of stepping magnet 540, brush of bank 542 to ground at the bank terminals. The interrupter 545 causes relay 544 to be intermittently operated to apply battery over its armature and front contact to the circuit for the stepping magnet 540. The stepping magnet 540 consequently is alternately operated and released to advance the brushes of banks 542 and 543 step-by-step under control of interrupter 545. If this condition prevails for a certain period, for example, 5 seconds, the brushes will have been advanced to a predetermined position. An alarm will then be given and the position finder and cord finder will be released to prevent holding up the system. If, for example, for some reason the system has failed to function in this period the brush of the bank 543 will be advanced to terminal 546. In this position ground from the inner left-hand armature and front contact of relay 541 will be connected through terminal 546, inner left-hand armature and front contact of relay 512, the brush of bank 548 through the winding of relay 429 to battery. Relay 429 operates and locks under control of the key 437 and causes the release of the position finder E as it places battery from its inner right-hand armature and front contact on the brush of bank 501 to release relay 502 and thus cause the release of relays 510, 503 and 512 in succession to release the position finder E as hereinbefore described. The operation of relay 429 also closes a circuit at its outer left-hand armature and front contact from battery through lamp 433 to ground through the winding of relay 434. Lamp 433 lights and indicates to the operator that the circuit has failed to function properly and the operation of relay 434 closes a circuit for an alarm circuit 436 which is common to the office in which the toll operator is located. The operation of key 437 restores the circuit to normal

condition. Assuming however, that the repeater is inserted in the connection within the allotted time, the time alarm circuit will not function to give an alarm due to the release of relay 512. Relay 512 in releasing at the proper time causes the release of relay 541 which closes a circuit from battery through stepping magnet 540 to ground on the terminals of bank 542. The brushes of banks 542 and 543 are thus advanced to the next position marked by terminals 546 or 547. Since relay 541 has been released the alarm circuit cannot be established in these terminal positions. When the brush of bank 542 arrives at the terminals 549 or 550 no ground is found on these terminals and consequently the stepping magnet 540 will step with the brushes in either of these positions.

In case all of the repeaters are busy battery through bank 513 of the cord finder such as D, will not be available as all relays such as 514, will be actuated. However, battery through the winding of relay 551 of the common meter circuit R will be available. The resistance of the winding of relay 551 will prevent relays, such as 431 and the stepping magnet 516 from becoming operated but will allow the operation of relay 551 as follows: Battery, winding of relay 551, outer right-hand armature and front contact of a relay such as 503, outer left-hand armature and back contact of a relay such as 512, armature and back contact of a relay such as 515, a bank such as 520, winding of a relay such as 431 to ground. The operation of relay 551 causes the operation of a meter magnet 553 over a circuit as follows: Battery, winding of meter magnet 553, armature and front contact of relay 551, through the contact 546 or 547 of the time circuit when the brush 543 is advanced to this point and to ground at the inner left-hand armature and front contact of relay 541. Thus the operation of meter magnet 553 indicates the number of times repeaters were required and not available. It should be understood that if a repeater becomes idle before the timing device operates the circuit arrangement is such that this repeater will be selected in the manner as hereinbefore described.

If the operator has occasion to actuate the talking key 401, after repeater G has been connected with lines A and B relays 230, 630 and 537 will be released. The release of relay 537 short-circuits the bridging points of the repeater G and the release of relays 230 and 630, disconnects lines A and B and the respective networks N1 and N2 from the repeater G and connects them through the cord circuit and to the operator's telephone set.

In case supervisory signals come in while the repeater is inserted between lines A or B either the ringing relay 552 or 554 is operated to remove the ground applied through the left-hand armature and front contact of

relay 528 to relay 407 which in releasing causes the lighting of lamp 415.

When for example, plug 400, is removed from toll line A the circuit connections will be restored to normal. That is, in line A relays 211 and 212 release to cause the release of relays 215 and 207 which in turn causes the release of relays 217, 221 and 226. In the cord circuit the release of relays 404, 402 and 406 causes the opening of the common holding ground through the inner right-hand armature and front contact of relay 406. Hence all the relays in the circuits that are held operated from this ground may be released. It should be noted that on the release of relay 431, relay 300 of switch H is released to cause the return of this switch to normal. On the release of relay 300 a ground is connected at its right-hand armature and back contact for the operation of release magnet 322. On the release of relay 307, relay 518 is released thus causing the release of relay 514. The release of relay 514 causes the release of relays 528 and 529. The release of relay 518 also causes the release of relay 422 which in turn causes the operation of relay 610. Relay 610 in operating releases relay 615. Relay 615 causes the release of relay 618 and this relay causes the release of relay 633. The release of relay 633 causes the release of relay 700 which permits the operation of the release magnet 722, which now returns switch K to normal position.

Although the present invention has been illustrated and described particularly in connection with toll systems it may be applied to switching systems not operated on the toll basis.

What is claimed is:

1. In a telephone system, lines, repeaters arranged for interconnection between two of said lines, means for designating said two lines, means to designate a repeater for selection, line selecting apparatus individual to said repeaters, repeater selecting apparatus individual to said lines, and means for actuating line selecting apparatus in response to the designation of a repeater and repeater selecting apparatus in response to the designation of a line to interconnect said repeater between two of said lines.

2. In a telephone system, lines, repeaters arranged for interconnection between two of said lines, means to designate a repeater for selection, line selecting apparatus individual to one end of said repeaters, repeater selecting apparatus individual to said lines, and means for controlling the line selecting apparatus of a designated repeater to connect the one end of said repeater to a line and for controlling the repeater selecting apparatus of another line to connect said other line to the other end of said repeater.

3. In a telephone system, lines, repeaters arranged for interconnection between two of

said lines, cord circuits, line selecting apparatus individual to said repeaters, repeater selecting apparatus individual to said lines, and means responsive to the connection of a cord circuit between two of said lines for controlling the line selecting apparatus of a repeater to connect one end of said repeater to one of said lines, and for controlling the repeater selecting apparatus of another line to connect said other line to the other end of said repeater.

4. In a telephone system, lines, repeaters arranged for interconnection between two of said lines, cord circuits, line selectors individual to said repeaters, repeater selectors individual to said lines, and means responsive to the connection of one of said cord circuits between two of said lines for controlling the line selecting apparatus of a repeater to connect one end of said repeater to said first mentioned line and for controlling the repeater selecting apparatus of said second mentioned line to connect such line to the other end of said repeater.

5. In a telephone system, lines, repeaters arranged for interconnection between two of said lines, line selecting apparatus comprising a line finder switch associated with one end of each repeater for finding a line and connecting it with the corresponding repeater, repeater selecting apparatus comprising a trunk finder switch associated with each line, a plurality of trunks selectable by any one of said trunk finders and a repeater finder switch associated with each of said trunks having access to the other end of any one of said repeaters, means for controlling the line finder switch of a repeater to find one of said lines and connect it to said repeater, and means for controlling the trunk finder of another line to find an idle trunk and connect it to said other line and for controlling the repeater finder associated with the selected idle trunk to find said repeater and connect said trunk therewith.

6. In a telephone system, groups of lines, groups of repeaters, means to designate a repeater in a particular group for selection, line selecting apparatus associated with each repeater, the line selecting apparatus of each repeater having access to a certain group of lines, repeater selecting apparatus individual to said lines and having access to any one of the repeaters in any one of the groups, and means for controlling the line selecting apparatus of a designated repeater to select a line in the assigned group and for controlling the repeater selecting apparatus of any one of the lines in any of the groups to select said designated repeater and interconnect it between the two lines involved.

7. In a telephone system, groups of lines, a group of cord circuits for each group of lines arranged for answering calls from the associated group of lines and for extending a

connection to any line in any of the groups, a group of repeaters assigned to each group of cords, line selecting apparatus associated with each repeater, the line selecting apparatus of the repeaters in each group having access to the corresponding group of lines, a group of repeater selecting apparatus assigned to each group of lines having access to any one of the repeaters in any group, and means responsive to the connection of a cord circuit between a calling line and another line for actuating the line selecting apparatus of a repeater assigned to the group of cords to which the connected cord circuit belongs to connect said repeater with the calling line and for actuating the repeater selecting apparatus of the other line to connect said other line to said repeater.

8. In a telephone system, groups of lines, a group of cord circuits for each group of lines arranged for answering calls from the associated group of lines and for extending a connection to any line in any of the groups, a group of repeaters assigned to each group of cords, line selecting apparatus associated with each repeater, the line selecting apparatus of the repeaters in each group having access to the corresponding group of lines, a group of repeater selecting apparatus assigned to each group of lines having access to any one of the repeaters in any group, means responsive to the connection of a cord circuit between a calling line and another line for actuating the line selecting apparatus of a repeater assigned to the group of cords to which the connected cord circuit belongs to connect said repeater with the calling line and for actuating the repeater selecting apparatus of the other line to connect said other line to said repeater, and means responsive to the connection of said repeater between said two lines for opening the connection between said two lines established by said cord circuit.

9. In a telephone system, groups of lines, a group of cord circuits for each group of lines arranged for answering calls from the associated group of lines and for extending connections to any of the lines in any of the groups, a group of repeaters assigned to each group of cord circuits, line selecting apparatus associated with each repeater, the line selecting apparatus of the repeaters in each group having access to the lines answerable by a particular group of cord circuits, repeater selecting apparatus comprising a trunk finder for each line, trunks each connected at one end with stationary terminals of a plurality of said trunk finders, repeater finder switches having movable brushes connected to the other end of said trunks and stationary terminals connected to the repeaters of all groups, all of said repeater finders thus having access to any repeater in any group, means responsive to the connection of a cord

circuit between a calling line and another line for selecting an idle repeater in the group associated with the calling line for actuating the corresponding line finder, to find the calling line and connect it to the selected repeater and means for actuating the trunk finder of the other line to select an idle trunk to actuate the associated repeater finder to find the selected repeater and connect it to said other line.

10. In a telephone system, incoming lines, outgoing lines, groups of repeaters, a line finder for each repeater for finding an incoming line over which a call has been initiated, a repeater finder for connecting an outgoing line to a repeater of any group, and means for actuating a line finder and a repeater finder for interconnecting an idle repeater between an incoming and an outgoing line.

11. In a telephone system, incoming lines, outgoing lines, groups of repeaters, means to designate a repeater in one of said groups for use between said lines, a line finder associated with the designated repeater for finding the incoming line, a repeater finder associated with the outgoing line for finding the designated repeater, and means for actuating said line finder and repeater finder thereby connecting said designated repeater between said incoming and outgoing lines.

12. In a telephone system, incoming and outgoing lines, said lines varying in transmission characteristics, automatically operable means to distinguish the character of an incoming and an outgoing line to determine whether the addition of a repeater is required, line selecting apparatus individual to said repeaters, repeater selecting apparatus individual to said lines, and means responsive to said distinguishing means for actuating the line selecting apparatus of a repeater and the repeater selecting apparatus of a line to interconnect said repeater between said incoming and outgoing lines.

13. In a telephone system, lines arranged for incoming or outgoing telephone traffic, repeaters arranged for interconnection between an incoming and an outgoing line, line selecting apparatus for said repeaters operable for selecting lines used for incoming traffic, repeater selecting apparatus for said lines operable when a line is used for outgoing traffic, and means for actuating the line selecting apparatus of a repeater and a repeater selecting apparatus of a line to interconnect said repeater between an incoming and an outgoing line.

14. In a telephone system, lines, repeaters arranged for interconnection between a line over which a call is initiated and a line to which said call is extended, line selecting apparatus for one end of said repeaters for selecting a line over which a call is initiated, repeater selecting apparatus associated with

said lines, and means for controlling the line selecting apparatus of a repeater to connect one end of said repeater to a line over which a call is initiated and for controlling the repeater selector apparatus of a line to which said call is extended for connecting said last line to the other end of said repeater.

15. In a telephone exchange system, in combination, lines divided into groups, repeaters divided into groups according to the line grouping, means to seize two of said lines for a telephone connection, means to seize an idle repeater, line finders operable by the seizure of a repeater for selecting a seized line in a particular line group, and repeater finders in said lines operable in response to the seizure of a line for finding a seized repeater in any of said groups.

16. In a telephone exchange system, in combination, lines divided into groups, repeaters divided into groups according to the line grouping, line finders divided into groups according to the repeater grouping for serving the repeaters for connecting a repeater with a line in a particular line group, repeater finders in said lines for connecting any line with a repeater in any group, means for designating two lines for connection with a repeater, and means responsive to said designation for actuating one of said line finders and one of said repeater finders.

In witness whereof, I hereunto subscribe my name this 26th day of August, A. D. 1926.

JOSEPH A. KRECEK.