

Aug. 6, 1940.

T. L. DIMOND  
TELEPHONE SYSTEM

2,210,068

Filed Aug. 4, 1939

5 Sheets-Sheet 1

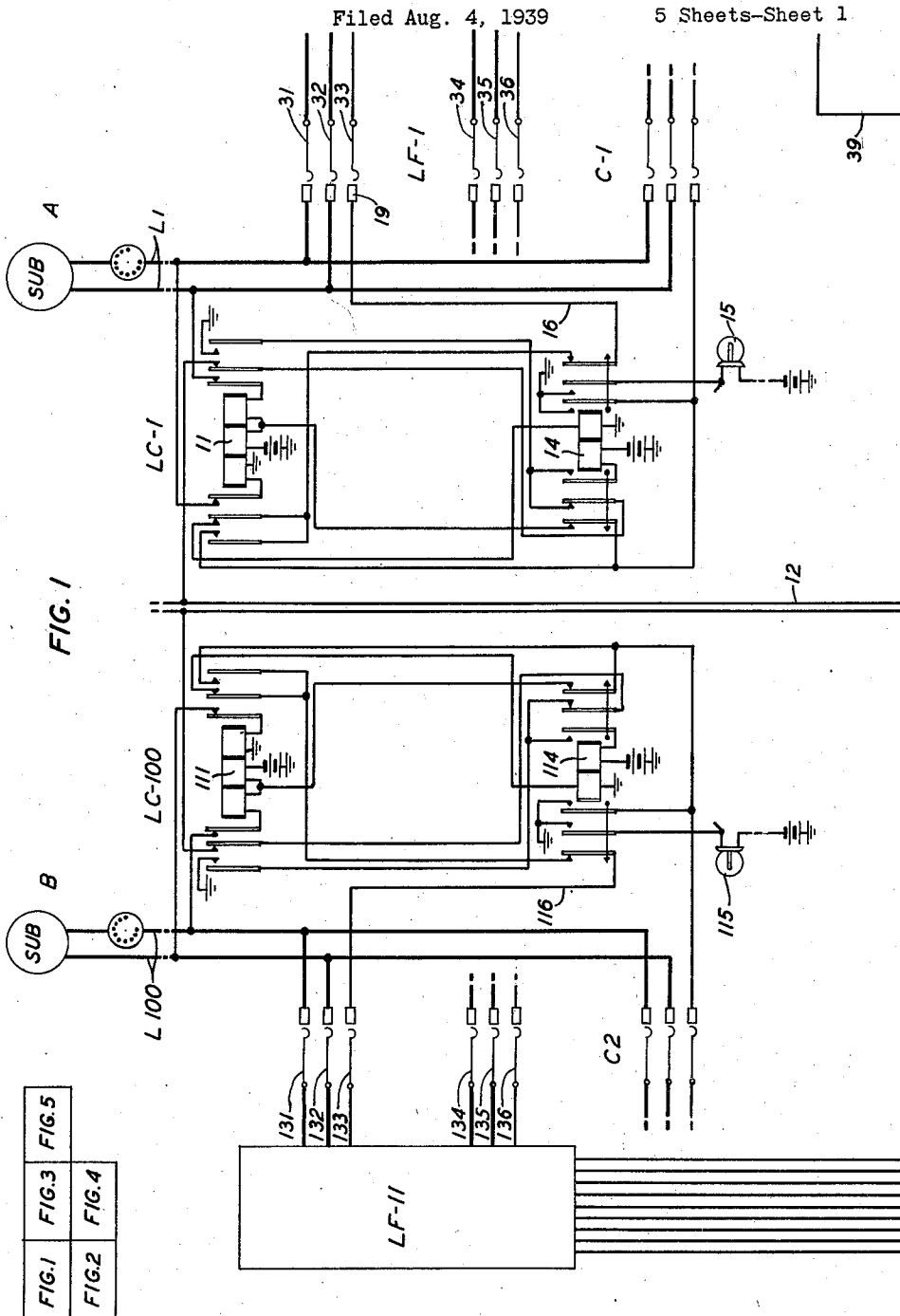


FIG. 6

|        |        |        |
|--------|--------|--------|
| FIG. 1 | FIG. 3 | FIG. 5 |
| FIG. 2 | FIG. 4 |        |

INVENTOR  
T. L. DIMOND  
BY *M. J. McVerry*  
ATTORNEY

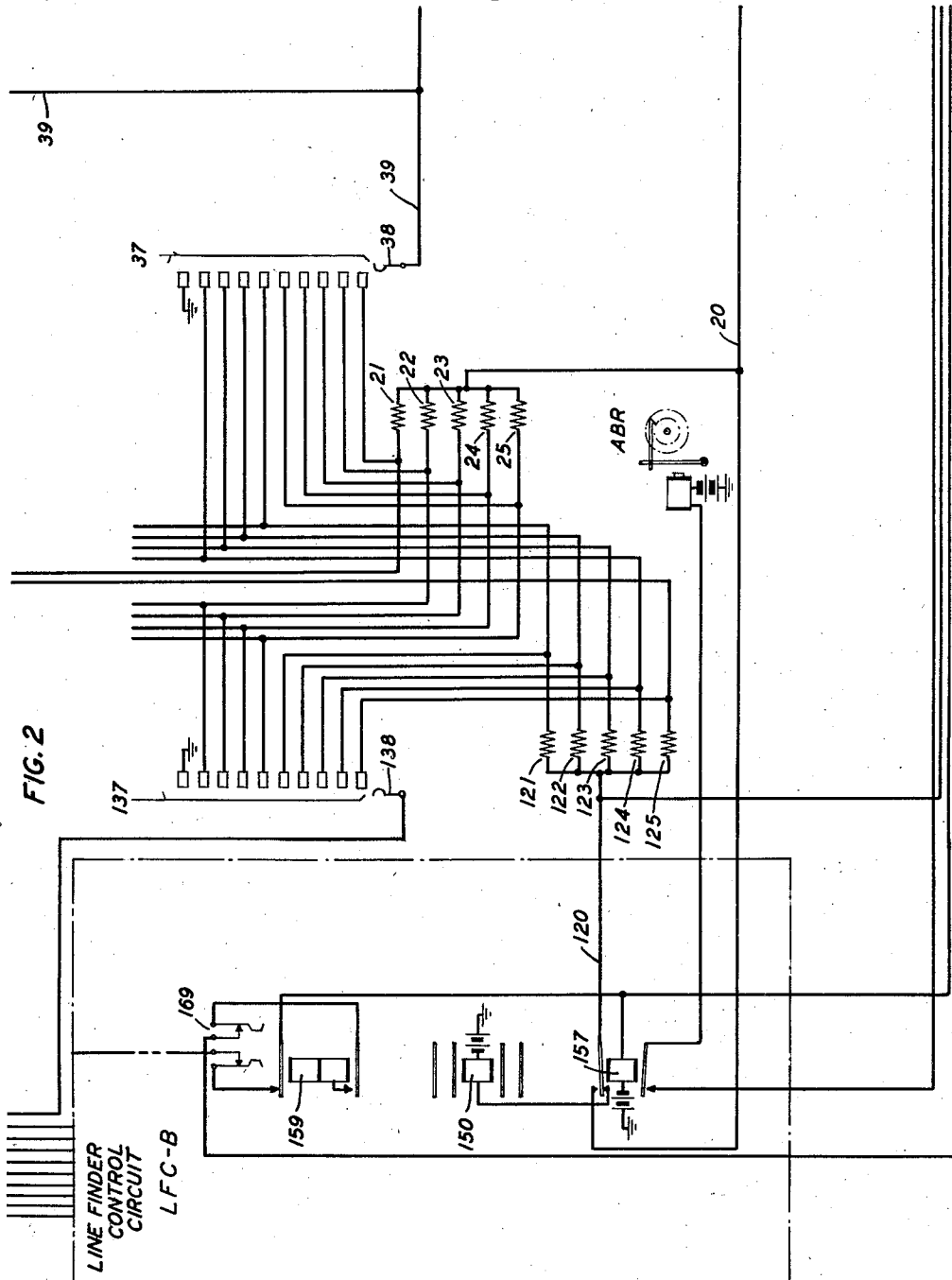
Aug. 6, 1940.

T. L. DIMOND  
TELEPHONE SYSTEM

2,210,068

Filed Aug. 4, 1939

5 Sheets-Sheet 2



INVENTOR  
T. L. DIMOND  
BY *M. J. McKeeney*  
ATTORNEY

Aug. 6, 1940.

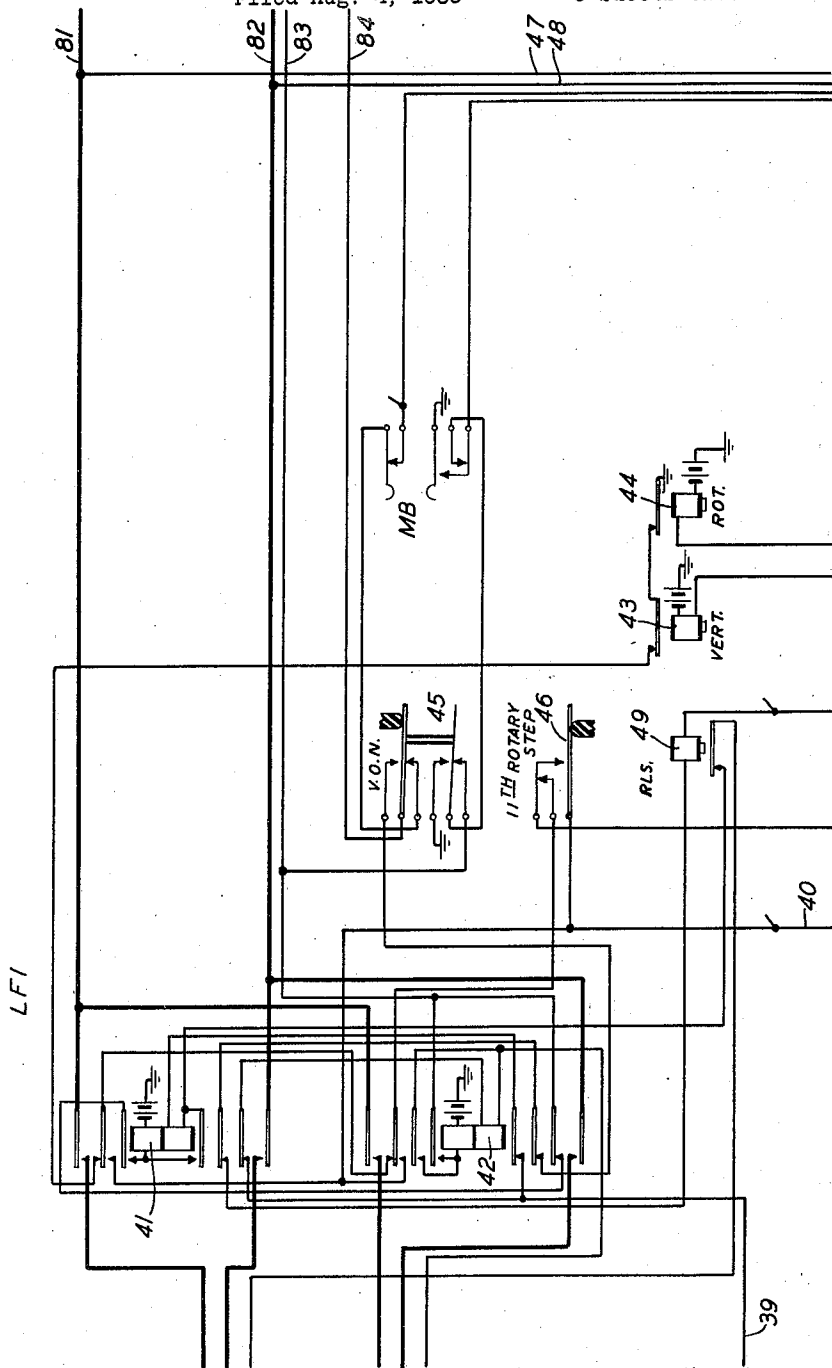
T. L. DIMOND  
TELEPHONE SYSTEM

2,210,068

Filed Aug. 4, 1939

5 Sheets-Sheet 3

FIG. 3



INVENTOR  
T. L. DIMOND  
BY *Wm. M. Kenney*  
ATTORNEY

Aug. 6, 1940.

T. L. DIMOND

2,210,068

TELEPHONE SYSTEM

Filed Aug. 4, 1939

5 Sheets-Sheet 4

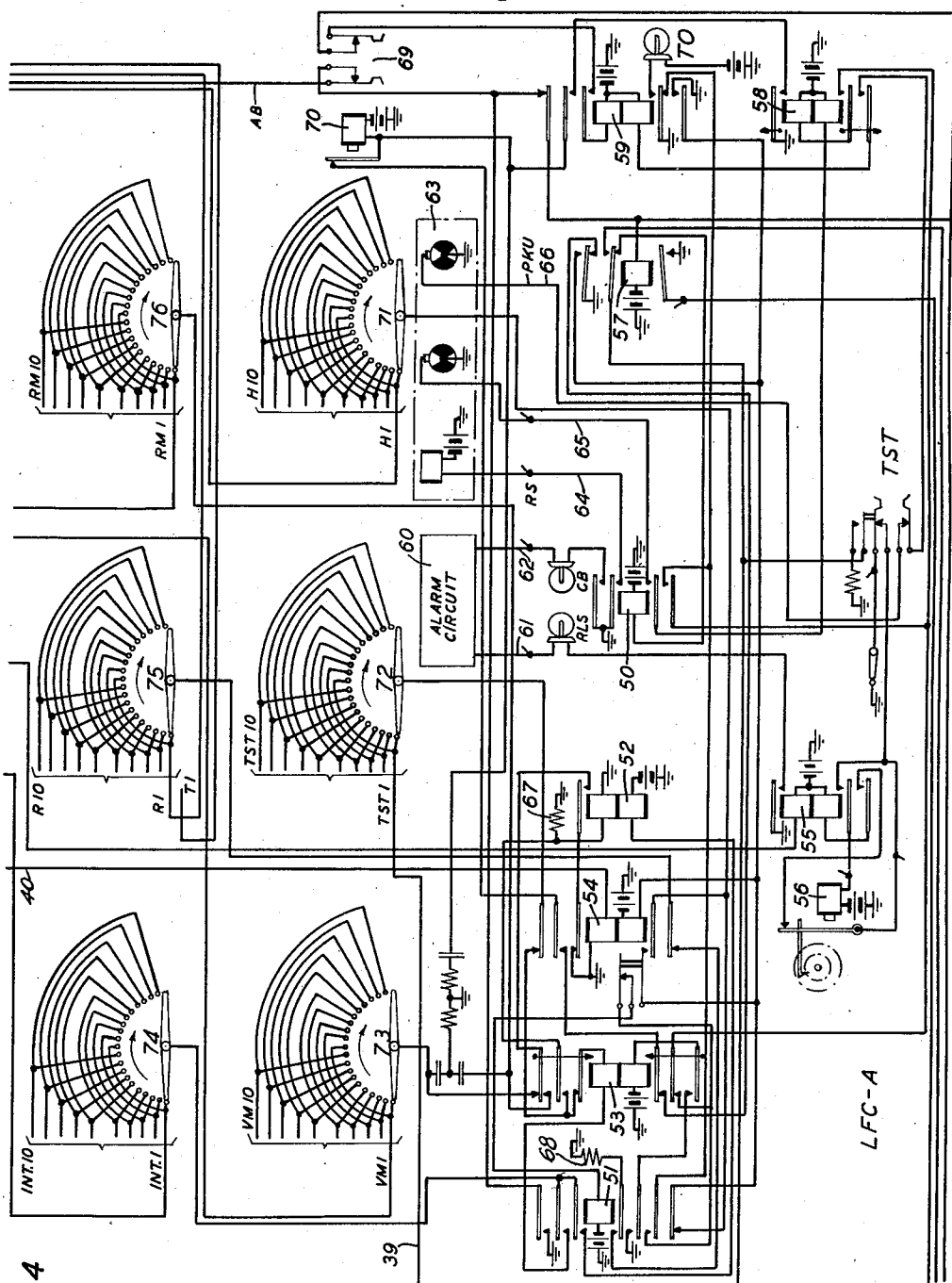


FIG. 4

INVENTOR  
T. L. DIMOND

BY

*Wm. H. Kenney*

ATTORNEY

Aug. 6, 1940.

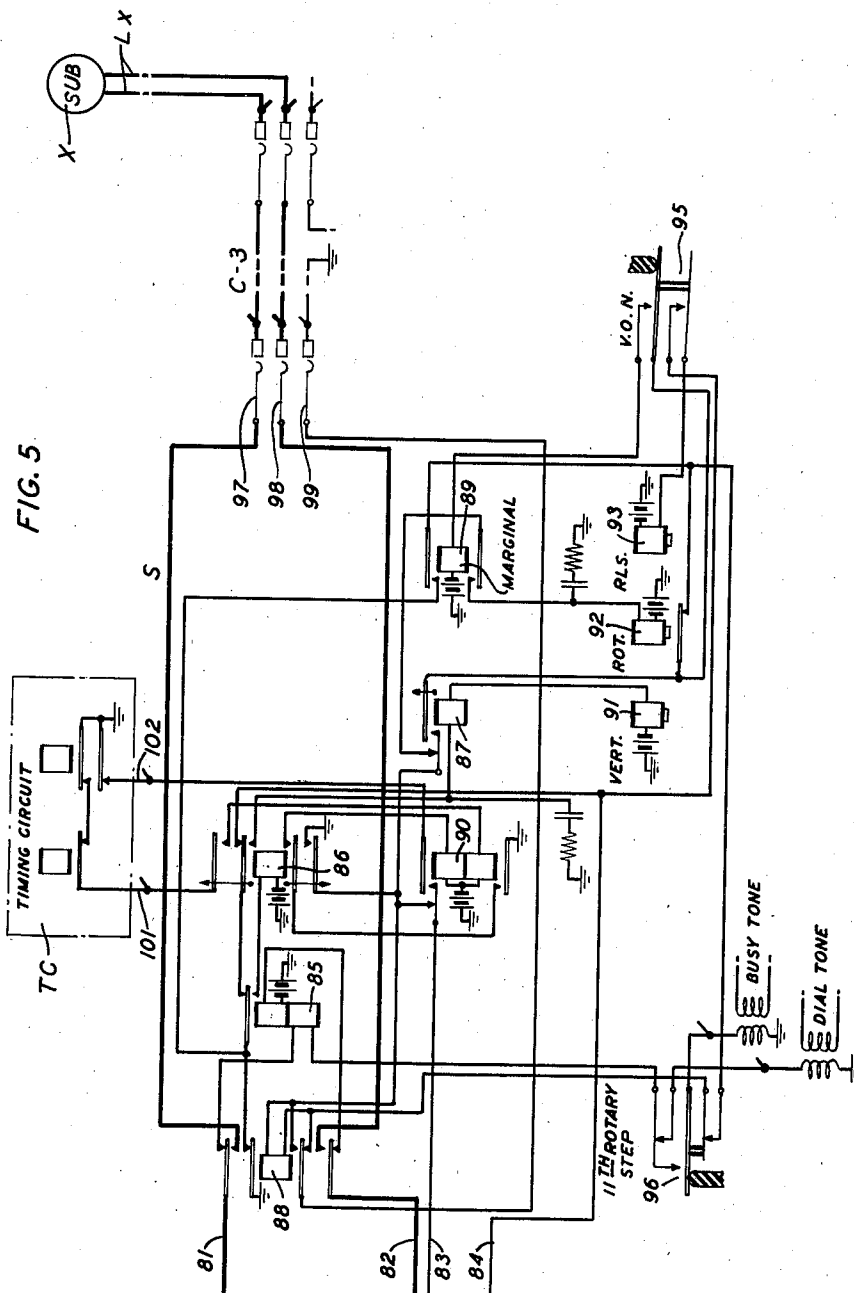
T. L. DIMOND

2,210,068

TELEPHONE SYSTEM

Filed Aug. 4, 1939

5 Sheets-Sheet 5



INVENTOR  
T. L. DIMOND  
BY  
*M. T. McEnney*  
ATTORNEY

## UNITED STATES PATENT OFFICE

2,210,068

## TELEPHONE SYSTEM

Thomas L. Dimond, Rutherford, N. J., assignor  
to Bell Telephone Laboratories, Incorporated,  
New York, N. Y., a corporation of New York

Application August 4, 1939, Serial No. 288,289

5 Claims. (Cl. 179-18)

This invention relates to telephone systems and particularly to systems comprising automatic switches for finding and connecting with calling subscribers' lines.

Objects of the invention are a more efficient use of automatic switching equipment for connecting with calling lines and an increase in the reliability of operation of such equipment.

The invention is an automatic telephone system comprising subscribers' lines, step-by-step line-finder switches and a new and improved control equipment for successively allotting the line finders in a group and for controlling the operation of an allotted finder switch to establish connection with a calling line. According to a feature of the invention, a common control equipment for a group of step-by-step line-finder switches comprises means for allotting each of said finder switches in succession and a stepping relay for operatively controlling the stepping magnets of said finder switches, the advance of the brushes of an allotted finder being arrested when the brushes engage the terminals of a calling line by the closure of a circuit through the test brush so as to hold the stepping relay operated.

According to another feature of the invention a circuit is closed when the test brush of an allotted line-finder switch engages the terminals of a calling line to energize the operating winding of a cut-through relay of the finder switch in series with a holding winding of the stepping relay in the common line-finder allotter and control equipment so as to prevent further operation of the stepping magnet of the finder switch until the cut-through relay operates. Such a circuit arrangement makes it unnecessary to provide a fast-operate, expensive cut-through relay.

A further feature is the operation of the line and release relays of the selector switch associated with an allotted line-finder switch immediately upon operation of the start relay of the common line-finder allotter and control equipment upon initiation of a call at a subscriber's station, thereby connecting a holding ground potential to a conductor of the line finder to lock the cut-through relay of the line finder as soon as the cut-through relay is energized upon engagement of the brushes of the line finder with the terminals of a calling line.

A clear and complete understanding of the invention will be facilitated by considering a telephone system arranged in accordance with the above-mentioned features. One such system is represented schematically in the drawings which

form a part of this specification. The invention is, however, not limited in its application to the particular system disclosed but is generally applicable to all telephone systems comprising line-finder switches for connecting with calling lines.

Referring to the drawings:

Fig. 1 shows two subscribers' stations A and B, lines L-1 and L-100, line circuits LC-1 and LC-100, two sets of brushes and two sets of terminals of the bank of each of two line-finder switches LF-1 and LF-11, and the brushes and a set of terminals of each of two connector switches C-1 and C-2;

Fig. 2 shows the vertical commutators 37 and 137 and commutator brushes 38 and 138 of the line finders LF-1 and LF-11, resistors 21 to 25, inclusive, and 121 to 125, inclusive, one for each level of the banks of the line-finder switches, and a line-finder control unit LFC-B;

Fig. 3 shows the electromagnets and other apparatus of the line-finder LF-1;

Fig. 4 shows a line-finder control unit LFC-A;

Fig. 5 shows a first selector switch S permanently associated with the line finder LF-1 of Fig. 3, a timing circuit TC, a connector switch C-3, a subscriber's station X; and

Fig. 6 shows the relative position of Figs. 1 to 5 to form an operative arrangement.

The subscribers' stations are of the usual type employed in common battery automatic telephone systems and each includes a dial or other impulse sending device for controlling the numerical switches through which connections with other subscribers' lines are established. The line circuit LC-1 comprises a combined line and cut-off relay 11 and a permanent signal lock-out relay 14. Line circuit LC-100 comprises similar relays 111 and 114.

The line-finder switches LF-1 and LF-11, selector switch S, and connector switches C-1, C-2 and C-3 are of the well-known two-motion step-by-step type. A clear and complete description of the structure of such switches is found in "Automatic Telephony" by Smith and Campbell, 2nd edition, pages 53 to 67, inclusive. The bank of each of the line-finder switches is represented in the drawings by two sets of terminals and the banks of the selector and connector switches are each represented by a single set of terminals. The line finder LF-1 and selector S are shown in detail but the line finder LF-11 and connector switches C-1, C-2 and C-3 are represented by the brushes and the one or two sets of terminals.

Each of the line finders in a group has access

to a group of two hundred lines, one hundred through each set of brushes. The lines and line finders are divided into subgroups A and B. The lines in subgroup A are multiplied to the lower five levels of the banks of finders in subgroup A and to the upper five levels of the banks of finders in subgroup B; and the lines in subgroup B are multiplied to the lower five levels of the banks of finders in subgroup B and to the upper five levels of the banks of finders in subgroup A. More specifically, the ten lines connected to the first level of finders in subgroup A are connected to the tenth level of the finders in subgroup B; the ten lines connected to the second level of finders in subgroup A are connected to the ninth level of the finders in subgroup B; the ten lines connected to the third level of finders in subgroup A are connected to the eighth level of finders in subgroup B; the ten lines connected to the fourth level of finders in subgroup A are connected to the seventh level of finders in subgroup B; and the ten lines connected to the fifth level of finders in subgroup A are connected to the sixth level of finders in subgroup B. Furthermore, the order in which the lines are connected in a level of the finders of one of the subgroups may be inverted with respect to the order in which these lines are connected in a level of the other subgroup. The finders in subgroup A, of which the finder LF—1 is one, are allotted and controlled by the line-finder control unit LFC—A; and the finders in subgroup B, of which the finder LF—11 is one, are allotted and controlled by the line-finder control unit LFC—B. The line-finder control unit LFC—A which is shown in detail comprises a single motion step-by-step allotter switch having a stepping magnet 70, a set of brushes 71 to 76, inclusive, and an associated bank of terminals. The unit LFC—A also comprises a start relay 50, an auxiliary start relay 51, a stepping relay 52, a switching relay 53 for transferring the stepping relay from control of the vertical stepping of any finder switch to control of the rotary stepping of the finder, a relay 54 for controlling the operation of the stepping magnet 70 of the allotter switch and a set of transfer relays 57, 58 and 59 for shifting the start lead 20 from the control unit LFC—A to the control unit LFC—B when necessary. A relay 55 supplies current to the release magnets of the finders in subgroup A and controls a peg count register 56.

The line-finder control unit LFC—B is similar to the unit LFC—A and is represented by the start relay 159 and transfer relays 157 and 159. An all-finders busy register ABR is associated with the two line-finder control units.

The allotter switch of each of the control units is of the preselecting type and its brushes normally engage the terminals of an idle finder. When a line in subgroup A becomes a calling line, the preselected finder in subgroup A is started in operation to find the line and, similarly, when a line in subgroup B becomes a calling line, the preselected finder in subgroup B is started. If all of the finders in either subgroup are busy and a call originates in that subgroup of lines, a finder in the other subgroup is started. And if for any reason an allotted finder in either subgroup fails to find the calling line within an allowed interval of time, a finder in the other subgroup is started if there is such a finder available. After an allotted finder has found the calling line, the allotter switch advances to select the next idle finder in the subgroup. When a calling

line is found by a finder switch, the operation of the cut-through relay associated with the set of brushes which finds the calling line extends the line to the associated first selector. When the calling subscriber dials the number of the station with which connection is desired, the first selector S, intermediate selectors, if any, (none shown) and a connector switch C—3 are operatively controlled to complete the desired connection.

To further describe the system shown, assume that the subscriber at station A removes the receiver to originate a call thereby closing a circuit, for operating line relay 11, from battery through the middle and right windings of relay 11, over line L—1 and through station A, and through the inner left back contact and left winding of relay 11 to ground. The right winding of relay 11 has a high resistance and, therefore, relay 11 is only partially energized by the current in this circuit. Relay 11 closes its outer right front contact, connecting ground over conductor 12 to mark the commutator segments of the level in which the line terminates in the banks of the finders of both subgroups. (Ground is permanently connected to the top commutator segment of each line finder so that a finder will always stop on the top level, if not before.) The ground connected to conductor 12 is further extended through resistor 21 (which is common to the twenty lines connected to the first level of the finders in subgroup A) to start conductor 20. As long as there is an idle finder in subgroup A, relay 57 is held operated in a circuit which includes the upper back contact of relay 59, left contact of make-busy key 59, upper contacts of the make-busy key MB of each finder in subgroup A, upper back contact of the vertical off-normal springs 45 of each idle finder in the subgroup, thence over conductors 84, through back contacts of relays 86, 85 and 88 of each associated idle first selector, to ground. Assuming that there is an idle finder in subgroup A so that relay 57 is operated, the connection of ground to conductor 20 causes the operation of start relay 50.

Relay 50, in operating, connects ground to conductor 64 to start the ringing interrupter and connects ground to conductor 62 leading to the alarm circuit 60 for the purpose of effecting an alarm in case relay 50 remains operated due to some trouble condition. Relay 50 closes a circuit, for operating relay 51, from battery through the winding of relay 51, a lower back contact of relay 54, a lower back contact of relay 53, lowermost front contact of relay 50, to ground at the lower back contact of relay 59. Relay 51 locks through its lowermost front contact under the control of relays 54 and 59 and closes a circuit for operating the line relay of the selector associated with the allotted line finder. As shown in the drawings, the brushes 71 to 76 of the line-finder allotter switch are in engagement with the first set of terminals, which terminals are connected to the line finder LF—1 shown in Fig. 3. The circuit closed by relay 51 for operating the line relay 85 of the associated selector S of Fig. 5 is traced from ground through resistor 68, inner lower front contact of relay 51, lowermost back contact of relay 54, through brush 75 and terminal 1, conductors 48 and 82, lowermost back contact of relay 88 of selector S, through the upper winding of relay 85 to battery. In operating, relay 85 closes a circuit for operating the slow-to-release relay 86. Relay 86 connects

ground through its lowermost front contact and the back contact of relay 90 to conductor 83, and closes a circuit through the lower winding of relay 90 and through conductor 101, to ground in the permanent signal timing circuit TC. Relay 90 operates, locks through its upper winding under control of relay 86, and connects conductor 83, through conductor 102, to ground in the timing circuit TC. The connection of ground to conductor 83, due to the operation of relay 85, is in preparation for the finding of the calling line as hereinafter described. Relay 51 connects ground through its uppermost front contact to hold relay 57 operated during the operation of the allotted finder to find the calling line in case this line finder is the only idle finder in the group. Relay 51 also closes a circuit, for operating the stepping relay 52, from battery through the lower winding of relay 52, inner upper front contact of relay 51, brush and terminal 1 of bank 74 of the allotter switch, back contact of the 11th rotary step springs 46, upper back contact of relay 42, upper back contact of relay 41, through the back contacts of the vertical stepping magnet 43 and rotary stepping magnet 44 to ground. The stepping relay 52 closes a circuit from ground at a back contact of relay 54, front contact of relay 52, uppermost back contact of relay 53, brush and terminal 1 of bank 73 of the allotter switch, through the winding of the vertical stepping magnet 43 to battery. Magnet 43 operates stepping the brushes of finder LF—1 up to the first level. The vertical off-normal springs 45 are actuated when the shaft on which the brushes are mounted moves out of normal position. The operation of magnet 43 opens the operating circuit of relay 52 but, if the calling line is connected to terminals in the first level of the line-finder bank, relay 52 is held operated to prevent reoperation of magnet 43. The circuit for holding relay 52 operated is traced from battery through the lower winding of relay 52, inner and middle front contacts of relay 51, upper winding and inner upper back contact of relay 53, uppermost back contact of relay 54, brush 72 and terminal 1 of the allotter switch, conductor 39, commutator brush 38 and first segment of commutator 37, through conductor 12 to ground in the line circuit LC—1. If, however, the calling line is connected to terminals in some other level of the bank, relay 53 does not operate when brush 38 engages the first commutator segment and in this case relay 52 releases when magnet 43 operates; the release of relay 52 causes the release of magnet 43; and the release of magnet 43 again closes the circuit for operating relay 52. The described cycle of operations of relay 52 and magnet 43 is repeated to raise the brushes step by step until the brushes reach the level of the terminals of the calling line at which time relay 52 is held operated in the circuit through brush 38. Relay 53 is partially operated by the energization of its upper winding in this circuit to close its lowermost front contact and thereby operatively energize its lower, locking winding under control of relay 51. The complete operation of relay 53, due to the energization of its locking winding, opens the circuit through its upper winding, opens the operating circuit of stepping magnet 43 and closes a circuit for operating the rotary stepping magnet 44. Relay 53 is slow in operating so that the brushes of the line finder will stop vibrating before the circuit is closed for operating the rotary stepping magnet. The circuit for operating the rotary stepping magnet 44

is traced from battery through its winding, terminal 1 and brush 76 of the allotter switch, uppermost front contact of relay 53, front contact of relay 52 to ground at a back contact of relay 54. The operation of magnet 44 steps the brushes of the line-finder switch into engagement with the first set of terminals in the level to which the brushes were advanced by the operation of magnet 43. The operation of magnet 44 opens the operating circuit through the lower winding of relay 52 and relay 52 releases unless the calling line is connected to the terminals engaged by the upper set of brushes 31, 32 and 33 or to the terminals engaged by the lower set of brushes 34, 35 and 36. If neither of the lines connected to the terminals engaged by the brushes of line finder LF—1 is a calling line awaiting connection to a first selector, relay 52 releases when the circuit through its lower winding is opened by the operation of magnet 44. The release of relay 52 causes the release of stepping magnet 44. The release of stepping magnet 44 again closes the operating circuit for relay 52. Relay 52 and stepping magnet 44 are thus alternately operated and released to advance the brushes of the line finder step by step until the one or the other of the two sets of brushes engages the terminals of the calling line; whereupon relay 52 is held operated and one or the other of relays 41 or 42 are operated. If the calling line is found by brushes 31, 32 and 33, a circuit is closed for holding the stepping relay 52 operated and for operating relay 41. This circuit is traced from ground through the upper winding of relay 52, the inner upper front contact of relay 53, uppermost back contact of relay 54, brush 72 and terminal 1 of the allotter switch, conductor 39, lowermost back contact of relay 42, lower winding of relay 41, back contact of the release magnet 49, test brush 33 and terminal 19, conductor 16, right back contact of relay 14, left front contact of relay 11, outer left back contact of relay 14, through the middle winding of relay 11 to battery. The non-inductive resistor 67 connected across the upper winding of relay 52 makes this relay somewhat slow in releasing so as to prevent its release if the brushes are momentarily advanced beyond the terminals of the calling line; it also prevents the release of relay 52 while the current is building up in the circuit through the test brush and terminal of the calling line. In addition to holding relay 52 operated, the current in this circuit is effective to complete the operation of relay 11 and to energize the lower winding of relay 41 and thereby partially operate relay 41. Relay 41 closes its inner upper front contact, thereby completing a circuit from battery through its upper winding, and the lowermost back contact of relay 42, over conductor 83, to ground at the lowermost front contact of relay 86 of selector S or, if relay 90 is operated, to ground in the timing circuit TC. With relay 41 completely operated by its upper winding, the line L—1 is connected through brushes 31 and 32, the outer front contacts of relay 41, conductors 81 and 82, outer back contacts of relay 88, to the windings of the line relay 85 of selector S. The complete operation of relay 41 also disconnects the lower winding of relay 42 from conductor 39; disconnects the release magnet 49 from conductor 84; disconnects the lower winding of relay 52 from the contacts of magnets 43 and 44; and closes a circuit, for holding relay 52 and operating relay 54. This circuit is traced from battery through the lower winding of relay 52, inner upper front contact of relay 51,



brush 74 and terminal 1, back contact of the 11th rotary step springs, upper back contact of relay 42, middle upper front contact of relay 41, conductor 40, through the upper winding of relay 54, to ground. With relay 41 operated, the complete operation of the line and cut-off relay 11 by its middle winding is assured by its connection through conductor 16, brush 33, back contact of magnet 49, inner front contacts of relay 41, lowermost back contact of relay 42, and conductor 83 of selector S to the holding ground potential already connected to this conductor as above described.

If a calling line is connected to the set of terminals engaged by the brushes 34, 35 and 36, a circuit is closed through the upper winding of relay 52, front contact of relay 53, back contact of relay 54, brush 72, conductor 39, the lowermost back contact of relay 41, the lower winding of relay 42 and brush 36, to the winding of the line relay of the calling line. Relay 52 is held operated by its upper winding and relay 42 is partially operated by its lower winding. Relay 42 closes its inner upper front contact closing a circuit through its upper winding and conductor 83 to ground. Relay 42 is thereby completely operated, connecting the calling line to selector S. Relay 42 also disconnects the lower winding of relay 41 from conductor 39 and disconnects the locking contact of relay 41 from conductor 83 so that if relay 41 has also operated due to brushes 31, 32 and 33 engaging the terminals of a calling line, relay 41 will release and only the line engaged by brushes 34, 35 and 36 will be connected to selector S. Relay 42 also disconnects release magnet 49 from conductor 84, disconnects the lower winding of relay 52 from the back contacts of magnets 43 and 44; and closes a circuit, for holding relay 52 and for operating relay 54. This circuit is traced from battery through the lower winding of relay 52, inner upper front contact of relay 51, brush 74 and terminal 1, normally-closed contact of the 11th rotary step springs, next-to-the-outer upper front contact of relay 42, conductor 40, and through the upper winding of relay 54 to ground. Relay 42 also connects the test brush 36 directly to conductor 83 to insure the complete operation of the line and cut-off relay of the calling line.

It is particularly to be noted that further rotary stepping of the line finder is prevented due to the holding of stepping relay 52 by the energization of its upper winding in the circuit for operating the switching relay 41 or 42 of the line finder and completing the operation of the line and cut-off relay of the subscriber's line circuit. It is also to be particularly noted that the switching relays 41 and 42 do not need to be fast in operating to prevent advance beyond the terminals of a calling line because the stepping relay 52 is held operated. Relay 52 being held to prevent further stepping, no further action can take place until the lower operating winding of relay 41 or 42 has become sufficiently energized to close the locking circuit through its upper winding.

With relay 54 operated, due either to the operation of relay 41 or to the operation of relay 42, a circuit is closed through the lower winding and lower front contact of relay 54, through brush 71 of the allotter switch, lower back contact of the make-busy key MB, to ground at the lower front contact of the vertical off-normal springs 45. In operating, relay 54 disconnects ground from the contact of the stepping relay 52 to prevent fur-

ther operation of the rotary stepping magnet 44; opens the circuit path through brush 75 and conductor 48 to the upper winding of the line relay 85 of selector S; opens the circuit through the upper winding of relay 52 and brush 72 of the allotter switch; and causes the release of relay 51. The release of relay 51 opens the circuit through the lower winding of relay 52, brush 74 and the upper winding of relay 54, thereby causing the release of relay 52. The release of relay 51 also opens the circuit for holding relay 57 operated and causes the release of relay 53. Relay 57 remains operated if one or more of the finders in subgroup A is idle at the time that relay 51 releases. In releasing, relay 53 closes a circuit, for operating the stepping magnet 70 of the allotter switch, from battery through the winding and interrupter contact of stepping magnet 70, upper front contact of relay 54, inner lower back contact of relay 53, to ground at the uppermost front contact of relay 57. The operation and release of magnet 70 steps the brushes of the allotter switch to the next set of terminals. If the line finder connected to this set of terminals is busy, relay 54 is held operated by its lower winding in a circuit through brush 71 of the allotter switch to ground at the vertical off-normal springs of the busy finder. Since brush 71 makes contact with each terminal before it breaks contact with the circuit for the preceding terminal, relay 54 is held operated and the stepping magnet 70 is alternately operated and released to advance the brushes of the allotter switch, step by step, until brush 71 encounters a terminal connected to an idle line finder. When an idle finder is encountered, relay 54 releases and stops the allotter. The control circuit LFC-A is then ready to operate in response to another call.

Returning now to the selector S, the connection of the calling line through conductors 81 and 82 to the winding of relay 85 of selector S is effective to maintain the operation of relays 85 and 86. Dial tone is transmitted to the calling subscriber and, when the subscriber dials the first digit of the number of the subscriber with whom conversation is desired, relay 85 is alternately released and reoperated by each of the impulses in the train. The release of relay 85 in response to the first impulse closes a circuit from battery through the winding of the vertical stepping magnet 91, winding of change-over relay 87, inner upper front contact of relay 86, through back contacts of relays 85 and 88, to ground. The operation of magnet 91 raises the brushes 97, 98 and 99 to the first level of the bank. As soon as the shaft and brushes of switch S are moved out of normal position, the vertical off-normal springs 95 are actuated, closing a circuit for operating relay 89. This circuit includes the upper front contact of springs 95, the front contact of relay 87 and the lowermost front contact of relay 86. Relay 89 locks in a circuit which includes the back contact of the rotary stepping magnet 92, the upper front contact of relay 89 and the inner upper back contact of relay 88. When relay 85 reoperates at the end of the first impulse, the vertical stepping magnet 91 releases. Relay 86 is slow in releasing and remains operated while relay 85 is responding to dial impulses. Relay 37 is also slow in releasing and remains operated until all of the impulses in the series have been received by relay 35. The vertical stepping magnet 91 is reoperated by the release of relay 85 in response to each of the succeeding impulses of the train, thereby stepping the

brushes up to the level corresponding to the digit dialed. When relay 87 releases after the last impulse of the train has been received, it closes a circuit from battery through the winding of the rotary stepping magnet 92, lower front contact of relay 89, back contact of relay 87 to ground at a front contact of relay 86. The operation of magnet 92 advances the brushes into engagement with the first set of the terminals in the selected level. The operation of magnet 92 also causes the release of relay 89 and the release of relay 89 causes the release of magnet 92. If the trunk or switch connected to the first set of terminals is busy, the test brush 99 encounters a ground potential which is effective to cause the reoperation of relay 89. The circuit path between the winding of relay 89 and brush 99 includes the upper front contact of springs 95, back contact of magnet 92, lower back contact of the 11th rotary step springs 96, and the inner lower back contact of relay 88. Relay 89 recloses the circuit for operating the rotary stepping magnet 92 and the brushes are thereby advanced to the next set of terminals. Relay 89 and magnet 92 thus cooperate to advance the brushes step by step until an idle set of terminals is encountered, whereupon relay 88 is operated in a circuit traced from battery through the winding of relay 89, upper front contact of springs 95, back contact of magnet 92, lower back contact of the 11th rotary step springs 96, winding of relay 88 to ground at the lowermost front contact of relay 86. Being marginal, relay 89 is not operated in this circuit. Relay 88 disconnects the winding of relay 85 from conductors 81 and 82 and connects these conductors through its outer front contacts and brushes 97 and 98 to the selected trunk or switch. The release of relay 85 causes the release of relays 86 and 90. Ground is momentarily extended from the lowermost front contact of relay 86, through the inner lower front contact of relay 88 and brush 99 to the test terminal of the selected set to mark the selected trunk busy until holding ground potential is connected to the test terminal by the seized trunk or switch in the usual manner.

The impulses created by the dialing of the succeeding digits of the called subscriber's number effect the operation of intermediate selectors, if any, and the operation of a connector C) to complete the connection with the called subscriber's line. The line relay (not shown) of the connector C-3 effects the connection of holding ground potential to the terminal engaged by the test brush 99 to hold the cut-through relay 88 of selector S. The holding ground is further extended through the inner lower front contact of relay 88 and back contact of relay 90 to conductor 83 to hold the cut-through relay 41 or 42 of the line finder and the line and cut-off relay 11 of the calling line. If the called line is idle, a ringing current source (not shown) is connected to the line. If the call is answered, the talking circuit is closed in usual and well known manner.

When the calling subscriber replaces the receiver, the release of the line relay (not shown) of the connector C-3 causes the disconnection of the holding ground potential thereby causing the release of relay 88 of the selector S, the release of the cut-through relay 41 or 42 of the line finder, and the release of the line and cut-off relay 11 of the calling line. The release of relay 88 closes a circuit for operating the release magnet 93 of selector S, thereby effecting the return of selector

S to normal. The release of relay 88 and the release of the cut-through relay 41 or 42 close a circuit for operating the release magnet 49 of the line finder LF-1. This circuit is traced from battery through the upper winding of relay 55 of control circuit LFC-A, through the winding of release magnet 49 of line finder LF-1, back contacts of relays 41 and 42, upper front contact of the VON springs 45, conductor 84, through back contacts of relays 86, 85 and 88 of selector S, to ground. Relay 55 locks through its lower windings until the peg count register 56 operates. Relay 55 also connects ground through lamp RLS and conductor 61 to the alarm circuit to cause an alarm in usual manner in case the line finder fails to release within a predetermined interval of time. When the shaft of the line finder reaches normal, the VON springs 45 are restored to normal, releasing magnet 49 and relay 55. The release of relay 55 releases the register 56.

If a calling subscriber fails to commence dialing within a predetermined interval of time after the connection of the subscriber's line to a selector S, ground is disconnected from conductor 83 to cause the release of the line finder and the operation of the lock-out relay 14 of the calling line. Reference may be had to the application of G. V. King and P. W. Swenson Ser. No. 289,148, filed on even date herewith for a detailed description of the operation of the permanent signal timing circuit and permanent signal lock-out feature.

If all of the finders in subgroup A are busy, relay 57 releases, thereby connecting start conductor 20 of subgroup A to start conductor 120 of subgroup B so as to effect the starting of a finder in subgroup B in search for a calling line in subgroup A. The release of relay 57 prevents the operation of stepping magnet 70 to prevent the advance of the allotter switch when there is no idle finder in the subgroup. Relay 57 also closes a circuit for operatively energizing the lower winding of relay 54 so that the allotter will be advanced as soon as a finder in the subgroup becomes idle. Relay 57 reoperates as soon as one or more of the line finders in subgroup A becomes idle. If all of the finders in subgroup B are busy the release of relay 157 connects start conductor 120 of subgroup B to start conductor 20 of subgroup A so as to start a line finder in subgroup A in search for a calling line in subgroup B. If all of the finders in both subgroups are busy, both of relays 57 and 157 will be released and neither of the start relays 50 and 150 will operate. In this case a circuit is closed for operating the all-finders-busy register ABR.

If any trouble occurs which prevents a line from being connected to a first selector, the continued operation of the start relay of either subgroup causes the starting of a finder in the other subgroup and causes the advance of the allotter switch of the group in question to the next finder. With start relay 50 operated and the ringing interrupter started by the connection of ground to conductor 64, ground is thereafter connected to conductors 65 and 66 at recurring intervals. As soon after relay 50 operates as ground is connected to conductor 65, the lower winding of relay 58 is operatively energized. Relay 58 closes a locking circuit through its upper winding and inner lower front contact, lowermost front contact of relay 50 to ground at a back contact of relay 59. If the calling line is found without unusual delay, the release of relay 50 causes the

release of relay 58. But if, due to some trouble condition in the control circuit LFC—A or in the allotted line finder, relays 50 and 58 remain operated until ground is connected to conductor 66, a predetermined interval of time after the connection of ground to conductor 65, relay 59 is operated by the energization of its lower winding. Relay 59 connects its upper locking winding in parallel with the winding of relay 157 of the line-finder control circuit LFC—B and is held operated if there is an idle finder in subgroup B. Relay 59 closes a circuit for lighting the time-out lamp TO and causes the release of relay 51. Relay 59 also closes a circuit for operatively energizing the lower winding of relay 54, closes a circuit for operating magnet 70, and causes the release of relays 57 and 58. The release of relay 58 causes the release of magnet 70, thereby stepping the brushes of the allotter switch to the next set of terminals. Calls in subgroup A will be served by finders in subgroup B until key 69 is operated by a maintenance attendant to cause the release of relay 59 or until relay 59 releases due to all of the finders in subgroup B becoming busy. The release of relay 59 causes the reoperation of relay 57 if there are any idle finders in subgroup A. If the finder connected to the terminals with which the brushes of the allotter are then engaged is idle, the release of relay 59 and reoperation of relay 57 causes the release of relay 54; but if this finder is busy the magnet 70 is operated under the control of relay 54 to advance the brushes to an idle finder. If relay 59 releases immediately after its operation due to all finders in the other subgroup being busy, the continued operation of relay 50 in case the calling line is not found by the second allotted finder causes the time-out operation to be repeated with an advance of the allotter to again allot another finder. If this condition persists for a long enough time, the alarm circuit 60 will be operated due to the continued connection of ground to conductor 62 to operate a maintenance alarm.

The operation of make-busy key MB of the line finder LF—I is effective to mark the finder busy in the bank of the allotter and to disconnect conductor 84 of the associated selector from the winding of relay 57 of the allotter.

The operation of key 69 effects the release of relay 59, if operated, for the purpose described above and also effects the release of relay 57 so that the calls in subgroup A will be served by finders in subgroup B. The operation of key 169 of allotter circuit B effects the release of relay 159 so that all calls in subgroup B will be served by finders in subgroup A.

The operation of the test key TST of the allotter circuit effects the operation of start relay 50, each of the finders being successively allotted and operated to the tenth level and to the 11th rotary step position. When the brushes of the finder LF—I are advanced to the 11th rotary position, due to the operation of key TST or for any other reason, the actuation of springs 46 connects the upper winding of relay 54 in series with the lower winding of relay 52 to hold relay 52 and operate relay 54 and thereby cause advance of the allotter to the next finder as hereinbefore described.

What is claimed is:

1. In a telephone system, line-finder switches, each of said finder switches comprising a set of brushes, a cut-through relay, and a stepping magnet, lines, each line connected to a set of terminals in the bank of each of said switches, means for allotting said finders, control means

common to said finder switches, said control means comprising a start relay operatively responsive to the origination of a call over any of said lines and comprising a stepping relay for controlling the operation of the stepping magnet of an allotted finder switch, and means comprising a circuit closed by the test brush of an allotted finder switch upon engagement with a terminal of a calling line for operating the cut-through relay of said finder switch and for holding said stepping relay operated.

2. In a telephone system, line-finder switches, each of said finder switches comprising a set of brushes, a bank of terminals, a cut-through relay and a stepping magnet for advancing the brushes, lines, each line connected to a set of terminals in the bank of each of said line-finder switches, means for allotting said finder switches, control means common to said finder switches, said control means comprising a start relay operatively responsive to the origination of a call over any one of said lines and a stepping relay for controlling the operation of the stepping magnet of an allotted finder switch, and means comprising a circuit closed by the engagement of one of the brushes of an allotted finder switch with a terminal of a calling line for operating said cut-through relay and for holding said stepping relay operated to prevent the further operation of said magnet.

3. In a telephone system, line-finder switches, selectors, one for each of said finder switches, each of said finder switches comprising a set of brushes, a bank of terminals, a cut-through relay and a stepping magnet for advancing the brushes, lines, each line connected to a set of terminals in the bank of each of said finder switches, means for allotting said finder switches, control means common to said finder switches, said control means comprising a start relay operatively responsive to the origination of a call over any one of said lines and a stepping relay for controlling the operation of the stepping magnet of an allotted finder switch, means comprising a circuit closed by the engagement of one of the brushes of an allotted finder switch with a terminal of a calling line for operating said cut-through relay and for holding said stepping relay operated to prevent the further operation of said magnet, and means in the selector associated with an allotted finder switch for locking said cut-through relay, said last-mentioned means rendered operatively effective by the operation of said start relay.

4. In a telephone system comprising subscribers' lines, line-finder switches for connecting with calling lines, control means common to said switches, and preselecting means for connecting said control means to an idle finder switch, each of said finder switches comprising a set of brushes, vertical and rotary stepping magnets and a cut-through relay, said control means comprising a starting relay energized in response to the initiation of a call over any one of said lines, a stepping relay for cooperation with the stepping magnets of said finder switches, a switching relay the operation of which shifts said stepping relay from the vertical stepping magnet to the rotary stepping magnet of an allotted finder switch, means comprising a circuit closed when the brushes of an allotted finder switch are advanced to a level in which the terminals of a calling line are located for operating said switching relay and for temporarily holding said stepping relay, and means comprising a circuit closed through the test brush

of an allotted finder switch upon engagement with a terminal of a calling line for operating the cut-through relay of said finder switch and for energizing a holding winding of said stepping relay.

5 5. In a telephone system according to claim 4, selectors, one for each of said finder switches, and

means in each of said selectors operatively responsive to the operation of said starting relay for connecting ground to the normally open locking contact of the cut-through relay of the associated finder switch.

THOMAS L. DIMOND.

5