Jan. 14, 1936. H. M. BASCOM ET AL 2,027,463

TELEPHONE SYSTEM

Filed Oct. 7, 1933 3 Sheets-Sheet 1

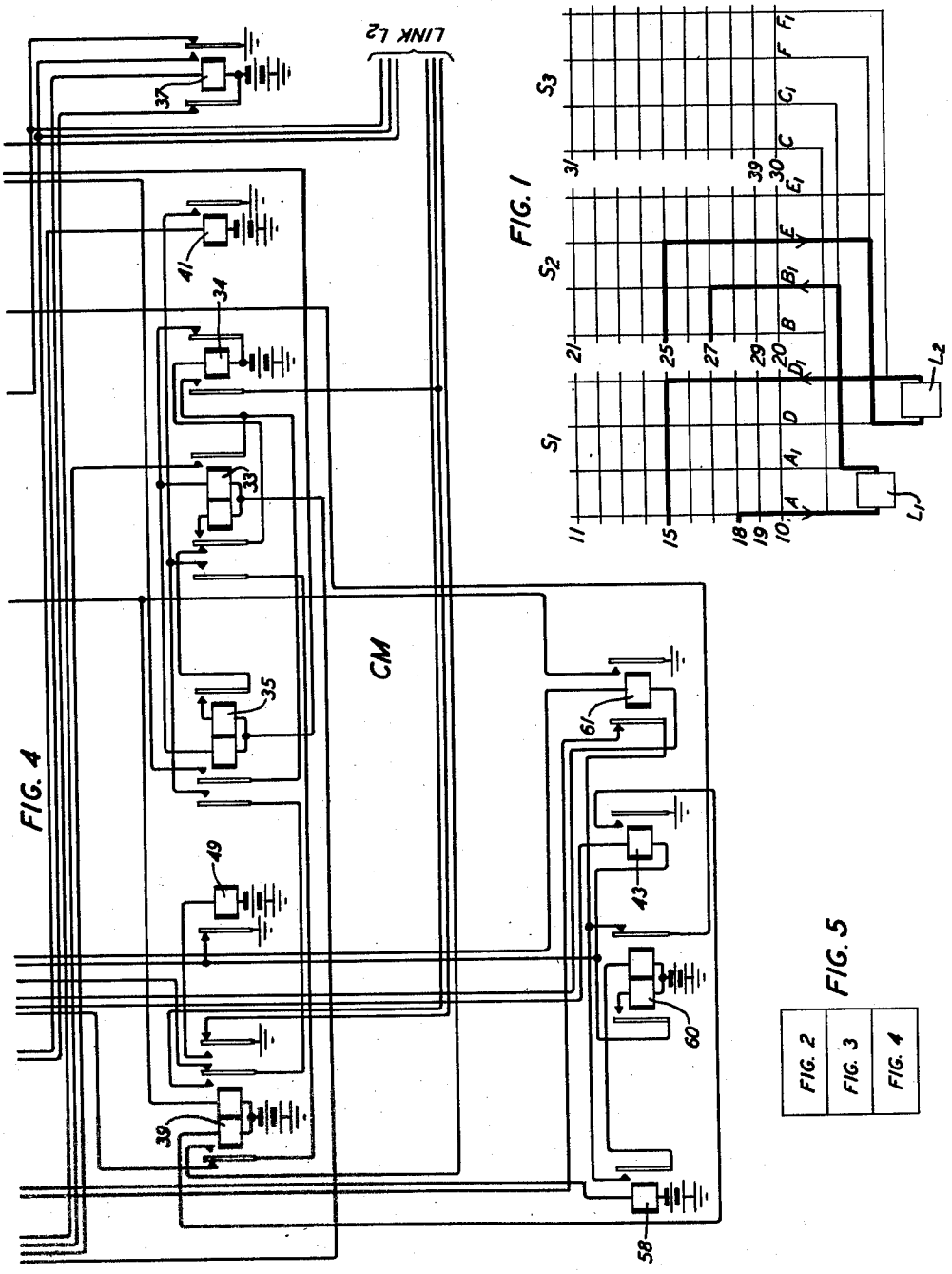


FIG. 4

FIG. 1

FIG. 5

FIG. 2	FIG. 3	FIG. 4

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TELEPHONE SYSTEM

Filed Oct. 7, 1933 3 Sheets-Sheet 2

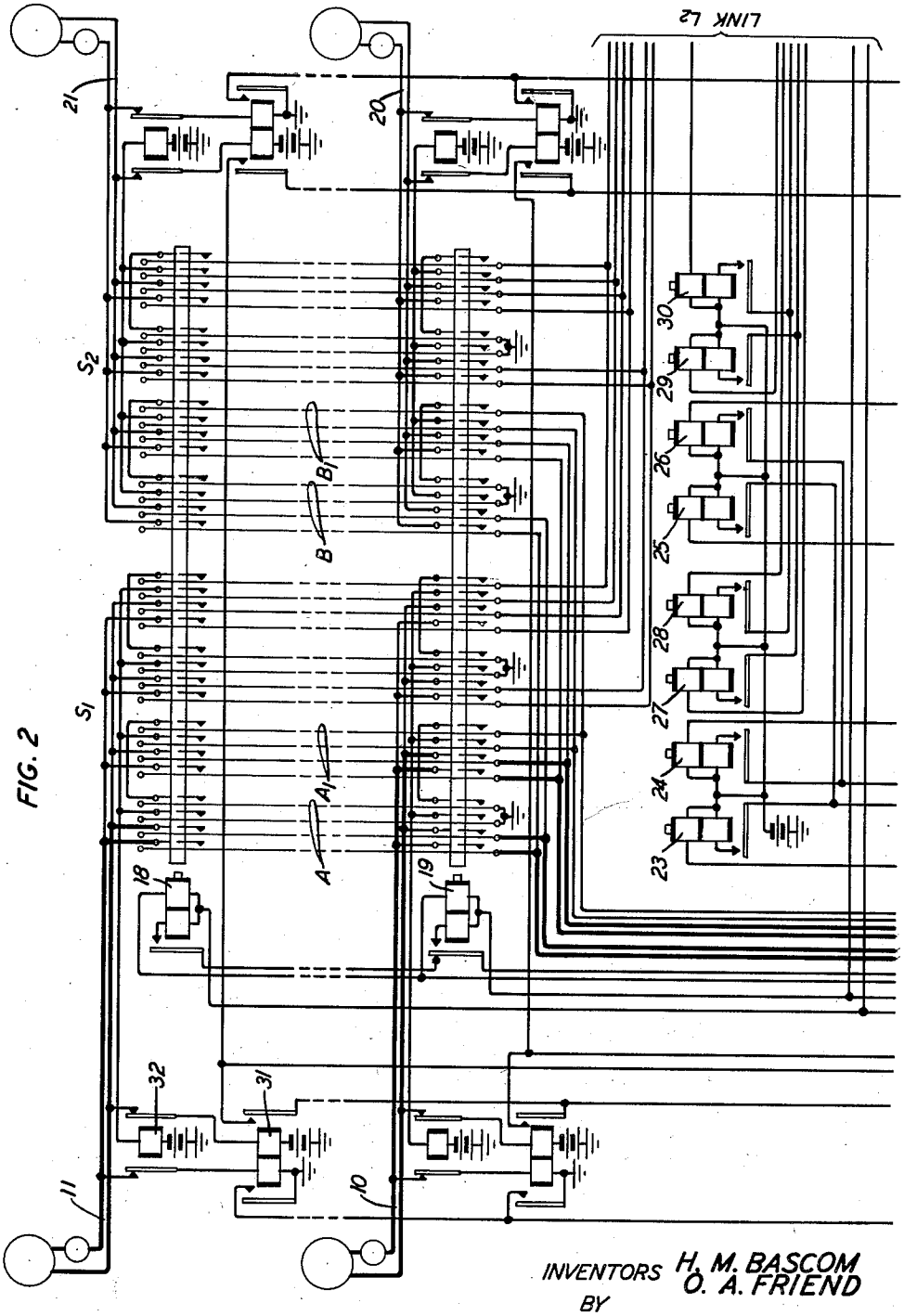


FIG. 2

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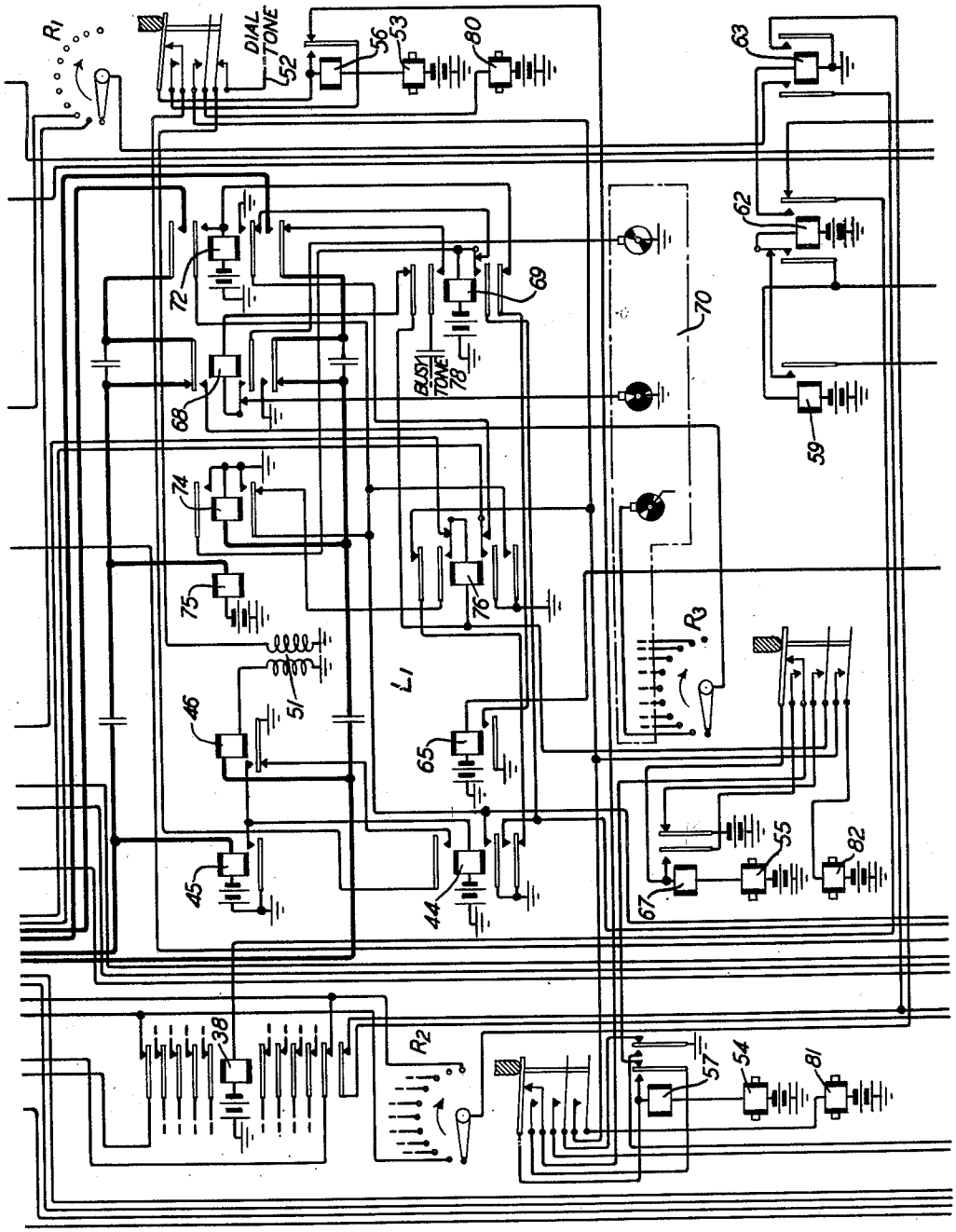


FIG. 3

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Patented Jan. 14, 1936 2,027,463

UNITED STATES PATENT OFFICE

2,027,463

TELEPHONE SYSTEM

Henry Melvin Bascom, Brooklyn, and Otto Albert Friend, New York, N. Y., assignors to American Telephone and Telegraph Company, a corporation of New York

Application October 7, 1933, Serial No. 692,676

14 Claims. (Cl. 179—22)

This invention relates to telephone systems and particularly to small capacity automatic telephone systems.

An object of the invention is to provide improved and economically arranged systems for automatically establishing connections between telephone lines by means of switching units of the cross-bar type.

Another object of the invention is to improve the flexibility of systems of this type whereby additional lines might be added without materially increasing the cost of the system.

Heretofore systems have been provided in which a connection may be established from any line to any other line in a single cross-bar switch. Systems of this kind have been shown in a patent to L. R. Waller 1,567,309 of December 29, 1925, and in a copending application of W. W. Carpenter and E. H. Clark, Serial No. 693,287, filed Oct. 12, 1933, now Patent No. 1,991,193, of Feb. 12, 1935. Other systems have been provided in which lines have been divided in groups with one group accessible to a particular cross-bar switch and in which link connecting means have been used with the incoming end of each link individual to a particular cross-bar switch while the outgoing end of each link is multipled to appear in a plurality of cross-bar switches for connecting to any called line in any cross-bar switch. A system of this kind is shown in a patent to S. B. Williams, Jr. 1,672,970 of January 12, 1928. In still other systems provisions have been made in which lines have been divided in groups accessible in the same cross-bar switch through linking arrangements whereby any line in any group may be connected to any other line in any group. In these systems an incoming end of one idle link may be seized by any calling line by connections made at two points in the switch through an intermediate link and any other called line may be connected to an outgoing end of said link by connections made at two other points in the switch through another intermediate link. A system of this kind is disclosed in a patent to E. E. Hinrichsen 1,567,265 of December 29, 1925.

A feature of the present invention is a system of these general types in which lines divided in groups are accessible in the same cross-bar switch through links whereby any line in any group is connectible to any other line in any group directly through an idle link with a calling line connected directly to an incoming or calling branch of the link at a single point and the called line connected directly to an outgoing or called branch of said link at a single point.

Other features of this invention relate to arrangements whereby one call may be originated before a preceding call is completed and whereby interference between the originating and completing of calls in progress at the same time is avoided. The arrangements in this respect are as follows:

A second call may be initiated as soon as the connection for a first call has advanced to the stage where the calling line is connected to a calling branch of an idle link.

Said second call may be initiated and the connection therefore advanced to the stage where the second calling line is connected to a calling branch of another idle link until the time that the connection for the first call is advanced to the stage where the called line has been selected for connection to a called branch of the chosen link.

If such a second call is being made and the first call connection is ready to be completed to the chosen link, said connection for said second call is permitted to advance to the stage where the second calling line is connected to a calling branch of another idle link at which time the first call connection may proceed to be completed after which the second call connection may proceed to be completed.

If two calls are in progress at the same time intended for completion to the same subscriber, the call that is first extended to the called line is permitted to complete the call while the other call is permitted to be extended to the same subscriber's line but the calling subscriber in this case receives a busy signal.

If two calls are in progress at the same time intended for completion to subscribers in different groups but whose lines are so located in the switch, namely, in the same horizontal row, as to require the operation of the same horizontal magnet to complete the connections, said connections are permitted to be completed. In this case the arrangement is such that the connection for the one call which advances first to the stage where the called line has been selected for connection to a called branch of the chosen link is given the preference while the other connection for the second call is delayed until the horizontal magnet is released from use with the prior connection.

The invention has been illustrated in the accompanying drawings in which:

Figure 1 shows in diagrammatic form the ar-

rangement in three groups of lines and two links in the same cross-bar switch;

Figs. 2, 3, and 4 arranged as shown in Fig. 5 show the details of the circuit arrangement for the lines of two groups and one link in a single cross-bar switch.

An ordinary cross-bar switch of the type disclosed in Patent 1,168,419 of January 18, 1916 to J. N. Reynolds may be employed and has been shown in Fig. 2 in diagrammatic form for two groups of lines at S1 and S2 respectively. This switch may be arranged for ten lines in group S1 such as lines 11 to 10 terminate at cross-points in contact sets for connection to link branches arranged in four vertical rows and in group S2 such as lines 21 to 20 terminate at cross-points in contact sets for connection to link branches arranged in four vertical rows. Of the lines in group S1 only 11 and 10 have been shown and of the lines in group S2 only 21 and 20 have been shown. The circuits for the first link L1 only has been shown completely. The calling branches of this link have been shown in group S1 at A and in group S2 at B while the corresponding called branches of this link have been shown at A1 in group S1 and at B1 in group S2. The part of the circuit equipment common to a number of links is shown at CM in Fig. 4 and the circuit arrangement and apparatus individual to the first link has been shown at L1, Fig. 3. The line magnets for lines 11 and 21 and 10 and 20 have been shown at 18 and 19, respectively. That is, one line magnet serves two lines in the same horizontal row of the two groups. The link magnets for link L1 have been shown in group S1 at 23 for connecting the calling branch A of the link to a calling line in this group and at 24 for connecting the called branch A1 of the link to a called line in this group, and in group S2 at 25 for connecting the calling branch B of this link to a calling line in this second group and at 26 for connecting the called branch B1 to a called line in this second group. Corresponding link magnets for a second link have been shown at 27 and 28 for group S1 and at 29 and 30 for group S2.

Referring now specifically to Fig. 1, which shows three groups S1, S2, and S3 with links L1 and L2 in the same cross-bar switch. The calling branches of the link L1 terminate in all three groups at cross-points arranged in vertical rows. In group S1 the calling branch is marked A, in group S2, B, and in group S3, C, while the called branches of link L1 terminate in all three groups and are marked in groups S1, A1 in group S2, B1 and in group S3, C1. Similarly for link L2, the calling branches have been marked D, E, and F, in groups S1, S2, and S3, respectively, and the called branches have been marked D1, E1, and F1 in groups S1, S2, and S3, respectively. In this figure thirty lines have been shown, lines 11 to 10 in group S1, 21 to 20 in group S2 and 31 to 30 in group S3. Certain of these branches have been indicated with heavy lines and marked with arrow points to designate calls, for example, the link L1 is shown as having established a connection from line 18 over the calling branch A in group S1 through the called branch B1 of group S2 to line 27. Link L2 has been shown as having established a connection from line 25 in group S2 over the calling branch E1 and the called branch D1 to line 15 of the group S1, thus indicating that any line in any group may establish a connection to any other line in any group through any link. The links are arranged so that the link L1 has the preference and when this link becomes busy, the link L2 will be used.

A description will now be made of the circuit operations for a call originating with line 11 as the calling line and terminating in line 10 as the called line using link L1. The various lines are equipped with the usual cut-off and line relays so that when line 11 is seized by a calling subscriber, the line relay 31 is operated over a circuit from battery and ground, both of its windings, contacts of the cut-off relay 32 and the loop of line 11. The operation of relay 31 closes a circuit for the operation of the guard relay 33 for lines 11 to 10 in the common equipment CM. The circuit for this relay is controlled by a relay 34 in such a manner that when relay 34 is operated, relay 33 can not operate. Similarly a corresponding relay 35 for lines 21 to 20 can not operate if relay 34 is operated so that if a call from any of the lines 21 to 20 comes in during the setting up of a connection from line 11, this connection has to wait until line 11 has completed a connection. In the same manner any line in the group 11 to 10 if calling would be prevented from establishing a connection or disturbing the call by line 11 as long as relays 34 and 33 are operated. Relay 34 operates due to the operation of relay 33 to contacts closed through a second winding of relay 33 and thus remove the battery from the first winding of relay 33 as well as relay 35. Relays 33 and 34 are locked to ground at contacts of relay 31. Relay 31 in operating also closes a circuit for the operation of the proper line magnet, in this case line magnet 18. The circuit for this magnet may be traced from battery, contacts of relay 37, one winding of magnet 18, contacts of relays 38, contacts of relay 31, contacts of relays 33 and 34 to ground at the contact of relay 39 of the common equipment CM. The magnet 18 in operating closes an obvious circuit for the operation of relay 37 to remove the battery from the other magnets and this relay is locked in series with the second winding of magnet 18 to ground at relay 39. Thus no interference for the establishing of one connection may be caused by any other line calling. The operation of relay 37 closes an obvious circuit for the operation of relay 41 and this relay in turn closes a circuit for the operation of the link magnet 23 for the calling branch A of link L1 from battery through the winding of this magnet, contact of relay 39, relays 33 and 41 to ground. The operation of this magnet and the magnet 18 now therefore causes the connection to be established between the calling line, tip, ring and sleeve conductors to the tip, ring and sleeve conductors of the calling branch A of the link L1.

It should be noted that at each cross point a fourth connection is made to ground for the two branches of a link. The purpose of this connection will become apparent in connection with the following description hereinafter related to revertive calling from party lines. It should be noted also that the sleeve conductor of the calling branch of link L1 is connected to ground and consequently this now causes the operation of the cut-off relay 32 of line 1 which in turn causes the release of the line relay 31 of this line. This line relay in turn causes the release of relays 33 and 34, line magnet 18 and relay 37. Relay 37 causes the release of relay 41 to open the original energizing circuit for the link magnet 23, but this magnet is held operated through its locking winding and operated contacts over a circuit extend-

ing through the winding of relay 43 to ground at contacts of relay 44.

It should be noted that this relay by this time will be operated due to the operation of relays 45 and 46 from the calling subscriber's loop over the tip and ring conductors and the calling branch of link L1 through the windings of these relays to battery and ground, respectively. These relays in operating close a circuit for relay 44. The locking circuit just traced for magnet 23 as stated extended through the winding of relay 43 so that this relay will now also operate and close an obvious circuit for the operation of relay 39. Relay 39 closes an obvious circuit for the operation of relay 49. Relay 49 in operating removes a ground from the locking circuit for the magnet 23 which may be provided in case relay 44 does not operate in time before the original energizing circuit for magnet 23 is opened. Relay 39 in operating transfers the connections for the link magnets for the calling branches A and B to the corresponding link magnets of the second link. Therefore if a second call is made and link L1 is busy the connections from relays 33 or 35 will be extended through the operated contacts of relay 39 to the calling magnets of the second link through contacts of a relay corresponding to relay 39.

When the tip conductor circuit is closed to the calling subscriber's line a connection is established through a repeating coil 51 to a dial tone source 52 and off normal contacts of a stepping switch R1 so that a dial tone will now be transmitted to the calling subscriber indicating that the switches are ready for the reception of impulses. In the equipment for the link L1 as well as the succeeding link L2 there is provided three separate switches R1, R2 and R3 of the single bank step-by-step type. The stepping magnet for switch R1 is 53, for R2 54, and for R3 55. The stepping switch R1 is for the purpose of selecting the link magnet for the called branch in the group S1 or S2 depending on what group the calling line is located and the step-by-step switch R2 is for the purpose of selecting a line magnet, while step-by-step switch R3 is for the purpose of selecting the ringing code. If now the calling subscriber dials 1 or 2 impulses to select the group of lines 11 to 10 or 21 to 20 relays 45 and 46 will operate and release in accordance with these impulses. Relay 45 may or may not release as it does not necessarily follow the impulses. The purpose of these two relays is to provide a longer holding time for relay 44 so that this relay may be maintained operated during pulsing. Relay 46 is the relay that controls the pulsing and on the first release of this relay a circuit is completed for the operation of the stepping magnet 53 of switch R1 and relay 56 over a circuit from battery through the windings of magnet 53 and relay 56 and the off-normal contacts of the switch R1 through contacts of relays 44 and 46 to ground. Relay 56 is operated and maintained operated during the pulsing. After the first step of the switch R1 the off-normal contacts operate to establish a circuit to the stepping circuit of magnet 53 and relay 56, over contacts of relay 56, off-normal contacts operated by the first step of the switch to the ground at relay 46 so that the succeeding impulses will maintain relay 56 operated due to its slow release characteristics. At the end of this series of impulses relay 56 releases and a connection is established through its armature and back contact for the magnet 54 of switch R2 and relay 57 so that the next series of impulses will operate the magnet 54 of switch R2 and maintain relay 57 operated during dialing over a circuit which may be traced from battery through the windings of magnet 54 and relays 57, off-normal contacts of switch R2, armature and back contact of relay 56, off-normal contacts of switch R1 to contacts of relays 44 and 46, the off-normal contacts of switch R2 operating the same as those of switch R1 to transfer the stepping circuit through contacts of relays 57. The second series of impulses selects the desired line in the group selected by the first series of impulses. Relay 57 in operating closes an obvious circuit for the operation of relay 58. The purpose of this relay will become apparent as the description proceeds.

At the end of the second series of impulses, relay 57 releases and a circuit is completed for the operation of relay 59 from battery through the winding of this relay, contacts of relay 60, contact of relay 61, off-normal contacts of switch R2, and contacts of relay 57 to ground. Relay 59 in operating closes a circuit for the operation of relay 62 from battery, make-before-break contacts of relay 62, contacts of relay 59, to the ground at relay 37. Relay 62 closes a circuit for the operation of relay 63 and 38 from battery through the winding of relay 36, contacts of relay 62, winding of relay 63 to ground. Relay 38 in operating opens the circuits for all the ten line magnets, such as 18 and 19, leading to the line relays of the two groups of lines so that any line calling can not now operate any corresponding line magnet on the operation of its line relay while this selection is taking place. The operation of relay 63 closes a circuit from ground through its contacts, the brush of switch R2, the tenth terminal and the tenth line magnet 19 to battery at the contacts of relay 37. Magnet 19 in operating closes an obvious circuit for the operation of relay 37 and the magnet and the relays are held operated from ground at contacts of relay 63. The operation of relay 37 closes a connection from the operation of the magnet for the connector branch of link L1 as the first digit was 0 indicating the first group of ten lines. This circuit may be traced as follows: Battery, winding of link magnet 24, the first terminal and brush of switch R1, contacts of relay 63, contacts of relay 37 to ground. Magnet 24 is locked over a circuit through its second winding. This circuit extends through the winding of relay 61 which operates in series with the locking winding of magnet 24, ground for this circuit being supplied by contacts of relay 44. As the called line was located in group S1 magnet 24 was operated. Had the called line been located in group S2, the link magnet of the connector branch of link L1 in group S2 would have been operated, that is magnet 26. Relay 61 in operating closes a circuit for the operation of relay 65 from battery through the winding of relay 65, contacts of relay 61 to ground and relay 65 causes the operation of relay 72, which locks to relay 44. The purpose of the operation of these relays will become apparent hereinafter. The operation of relay 61 also closes another circuit for the maintaining of relay 39 operated and opens the circuit for relays 59 and 62. The release of relay 62 causes the release of relays 63 and 38 and the release of relay 63 causes the release of magnet 19 and relay 37. A third series of impulses are now transmitted for operating the switch R3 to select a ringing code. This digit is necessary for all lines regardless of whether they are party

lines or not. The release of relay 57 completed the pulsing circuit for the stepping magnet 55 and the relay 67 so that the next series of impulses causes the stepping magnet 55 to operate the switch R3 and maintain the relay 67 operated during pulsing. At the end of the pulsing, relay 67 releases and a circuit is completed for the operation of relay 68 from battery through a contact of relay 67, off-normal contact of switch R3, contacts of relay 69, winding of relay 68, make-before-break contact of relay 68, the pick-up contacts of the ringing interrupter 70 to ground. Relay 68 in operating closes a holding circuit for itself through its own front contact to the holding cam to ground of the ringing interrupter 70. The operation of this relay therefore now connects the ringing code to the called line from the ringing source and a code cam in the interrupter 70 through its contacts, the selected terminal and brush of the switch R3, contacts of relay 68, contacts of relay 72, ring conductor of the link through the called subscriber's set, back over the tip conductor, contacts of relay 72, contacts of relay 68 to ground. Relay 69 is maintained operated for each ringing period. At the end of each series it releases so that if the called subscriber has answered at that time, a circuit is completed through the called subscriber's loop, winding of relay 74 and inductance 75. Relay 74 operates and closes a circuit for the operation of relay 69 which is locked up to contacts of relay 44 and thus prevents the further ringing. The circuits are now in condition for conversation. Talking battery for the calling subscriber is supplied through the windings of relays 45 and 46 and talking battery for the called subscriber through the windings of the relays 74 and inductance 75.

In case the called line is busy when the connection is made, ground would be present on the sleeve lead thereof. This ground would then cause the operation of the busy test relay 69 from battery through the make-before-break contact of this relay, contact of relay 72, contacts of relay 76, to ground at the sleeve of the connector branch of the link L1. Relay 69 would then in operating provide a locking circuit for itself through the ground at the contacts of relay 44 and apply a busy tone from the source at 78 over the tip conductors to the calling line.

When the calling party replaces his receiver on the switchhook, relays 45 and 46 release causing the release of relay 44. This relay in turn causes the release of the connection through the switch S1 by the release of magnets 23 and 24. Relays 43 and 61 also release and in turn cause the release of relays 39, 49, and 65. The release of relay 44 also operates the various release magnets 80, 81, and 82 for the switches R1, R2, and R3 through the off-normal contacts of these switches, respectively.

In case of a revertive call, the busy tone is disregarded and relay 76 is operated from battery at the armature and back contact of relays 67 and the off-normal contacts of switch R3, winding of relay 76, make-before-break contacts of this relay, the revertive call lead through switch S1 and the revertive lead of branches of the link used to ground. The revertive call relay 76 in operating provides a locking circuit for itself to ground at contacts of relay 76 through contacts of relay 74. In the meantime the calling subscriber knowing that a revertive call is being made is instructed to hang up his receiver. This causes the release of relays 45 and 46 and 44. Relay 44 in releasing causes the release of magnet 23 of the line finder branch and the calling line is thereby released from the link, but the cut-off relay 32 of the calling line is maintained operated over a circuit from battery through the winding of this relay, the sleeve lead through the connector branch of the link L1 and the sleeve circuit to ground at contacts of relay 76. Relay 44 causes the release of relay 69 and this in turn causes the operation of the relay 72 from battery through the winding of this relay, contact of relay 69, contact of relay 65 to ground and relay 72 is locked in operated position through its own contacts and ground at contacts of the revertive call relay 76. The fact that relay 76 is operated prevents the operation of the release magnets 80, 81, and 82 of the switches R1, R2, and R3, respectively, so that the ringing code may now be transmitted from the ringing code equipment 70 through the proper contacts of switch R3 to the line over the connector branch of the link L1. When the called subscriber answers, ringing relay 68 when it releases, permits relay 74 to operate to provide talking battery for the calling and called subscriber. The operation of relay 74 opens the holding circuit for the revertive call relay 76, which is thereby released so that the link is in the same condition as when held by a called subscriber after hanging up of the calling subscriber. When conversation is finished over this revertive call connection, the hanging up of the subscribers' receivers releases the link as previously described.

Descriptions will now be made relating to the arrangements whereby one call may be initiated before a preceding call is completed and whereby interference is avoided between the originating and completing of calls in progress at the same time.

A second call may be initiated as soon as the connection for a first call has advanced to the stage where the calling line is connected to the calling branch of an idle link such as line branch A in the present case. At this stage it will be remembered that cut-off relay 32 is operated which releases relay 31. This relay in turn releases relays 33 and 34. Relay 34 in releasing restores battery to the circuit for relay 33 so that when a second call is now made the line relay of the calling line, corresponding to line relay 31, may be operated to initiate the second call.

It should be noted that such a second call may be initiated and the connection therefor advanced to the stage where the second calling line is connected to a calling branch of another idle link, from the time on as mentioned above until such time that the connection for the first call is advanced to the stage where the called line has been selected for connection to the calling branch of the chosen link, that is, when the dialing has been completed as at this time relay 38 is operated to prevent the operation from this time on of the line magnet of any second calling line.

Should such a second call be in progress and the first call connection has in the meantime become ready to be completed to the chosen link, that is, if dialing has been completed for such a first call, such second call is permitted to advance to the state where the second calling line is connected to a calling branch of another line idle link before the first call connection is allowed to proceed further. The reason for this is that relay 38 cannot be operated due to the fact that if a second line magnet is operated relay 37 is

immediately operated which prevents the circuit for relay **62** from being completed and this latter relay in turn is prevented from operating relay **38** in series with relay **63**. Relay **63** is the relay that controls the completion of the first call connection to the calling branch of the link chosen by the first call.

It should be further observed that if two calls are in progress at the same time for completion to the same subscriber the call that is first to be extended to the called line is permitted to complete the call while the other call is permitted to be extended to the same subscriber's line but the calling subscriber in this case receives the busy signal by the operation of relay **69**, as hereinbefore described in connection with calls to a busy subscriber.

In case two calls are in progress at the same time intended for completion to subscribers in different groups but whose lines are so located in the switch, namely, in the same horizontal row as to require the operation of the same horizontal magnet to complete the connection, said connections are permitted to be completed. In this case the arrangement is such that the connection for the call which advances first to the stage where the calling line has been selected by the operation of the line magnet for connection to a called branch of the chosen link is given preference while the other connection for the second call is delayed in the manner described hereinbefore until the line magnet is released from use with the prior connection.

What is claimed is:

1. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, and means for originating one call through said switch before another is completed, and means for preventing interference in said switch between calls in progress at the same time.

2. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch with one line in each group appearing in the same horizontal row, a line magnet for each set of lines in the same row, links having a calling branch and a called branch appearing in each section in vertical rows, a magnet for each branch, means for connecting a calling line to a called line through an idle link including the operation temporarily of the line magnet of the calling line and the operation permanently of the magnet for the calling branch of said link in the section where the calling line appears to connect the calling line to said branch at a single connecting point of said switch and including the operation temporarily of the line magnet of the called line and the operation permanently of the magnet for the called branch of said link in the section where the called line appears to connect the called line to said called branch at a single connecting point of the switch, and means for originating one call through said switch before another is completed without interfering with the use of the line magnets in originating the first call and completing the second call.

3. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, and means for originating a second call connection through said switch as soon as the first call connection has advanced through said switch to the stage where the first calling line has been connected to a calling branch of an idle link.

4. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, a relay, means for operating said relay when a calling line is originating a call through said switch, means for releasing said relay when said calling line has been connected to a calling branch of an idle link, and means controlled by said relay for permitting a second call through the switch to be originated when said relay is released.

5. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, and means for originating a second call connection through said switch from the time a preceding call connection has been extended to a calling branch of an idle link until the time said preceding call connection has been advanced to the stage where the called line has been selected for connection with a called branch of the chosen link.

6. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, a relay, means for operating said relay when a first call connection has advanced to the stage where a called line has been selected for connection to a called branch of the chosen link, means for originating a second call connection while said first call connection is in progress through the switch any time after the said first call connection has advanced to the stage where said first calling line has been connected to a calling branch of the idle link until said relay is operated.

7. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected direct-

ly to a called branch of said link at two connecting points only of said switch, and means for originating a second call connection while the first call connection is in progress through the switch and for preventing completion of the first call connection until the second call connection has advanced to the stage where the second calling line has been connected to a calling branch of a second idle link.

8. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, means for originating a second call connection while the first call connection is in progress through the switch if said first call connection has been advanced to the stage where it has been extended to a calling branch of an idle link, a relay, means for operating said relay when a second call connection is originated through the switch, means for releasing said relay when said second call connection has been extended to a calling branch of a second idle link, and means for preventing completion of the first call connection while said relay is operated.

9. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, and means for originating a second call connection before a preceding call connection is completed to the same called line, means for completing both call connections in the order in which they are originated, and means for transmitting a busy signal to the second calling line on the completion of the second call connection to the same called line.

10. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, one line in each group appearing in the same horizontal row, a line magnet for each set of lines in the same row, links having a calling branch and a called branch appearing in each section, means for connecting a calling line to a called line through an idle link including the temporary operation of the line magnet of the calling line and of the called line with the calling line connected to a calling branch of an idle link directly at a single connecting point of said switch and with the called line connected to a called branch of the chosen link directly at a single connecting point of said switch, means for originating a second call connection to said switch before the first call connection is completed to the same called line, and means for operating the line magnet of said called line, once to complete the first call connection and a second time to complete the second call connection to the same called line, and means for transmitting a busy signal to the second calling line on the completion of the second call connection to the same called line.

11. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch with one line in each group appearing in the same horizontal row, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch, and means for originating one call while a preceding call is in progress through the switch for called lines appearing in the same horizontal row, and means for completing said calls in the order in which they are originated without interference.

12. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch with one line in each group appearing in the same horizontal row, a line magnet for each set of lines in the same horizontal row, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link including the temporary operation of the corresponding line magnet as line magnets with a calling line connected at a single connecting point in the switch to a calling branch of an idle link and a called line connected at a single connecting point in the switch to a called branch of the chosen link, means for originating one call while another is in progress for called lines appearing in the same horizontal row, and means for operating the corresponding line magnet once for completing the first originating connection and a second time for the completion of the later originated connection without interference.

13. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch, links having a calling branch and a called branch appearing in each section of said switch, means for connecting a calling line to a called line through an idle link with the calling line connected directly to a calling branch of said link and the called line connected directly to a called branch of said link at two connecting points only of said switch.

14. In a telephone system, a cross-bar switch, lines appearing in groups in separate sections of said switch with one line in each group appearing in the same horizontal row, a line magnet for each set of lines in the same row, links having a calling branch and a called branch appearing in each section in vertical rows, a magnet for each branch, means for connecting a calling line to a called line through an idle link including the operation temporarily of the line magnet of the calling line and the operation permanently of the magnet for the calling branch of said link in the section where the calling line appears to connect the calling line to said branch at a single connecting point of said switch and including the operation temporarily of the line magnet of the called line and the operation permanently of the magnet for the called branch of said link in the section where the called line appears to connect the called line to said called branch at a single connecting point of the switch.

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