

**June 3, 1941.**

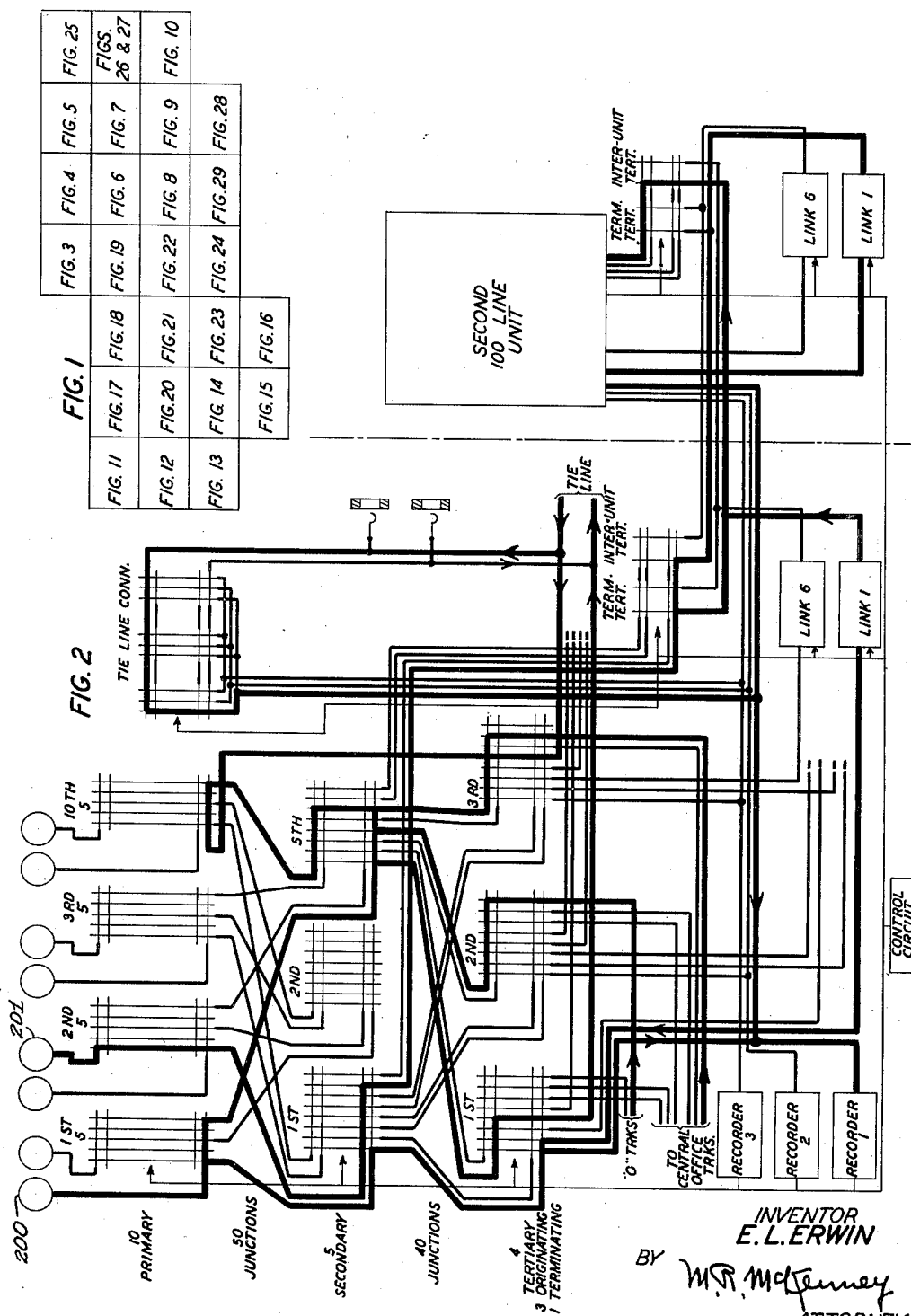
E. L. ERWIN

**2,244,004**

## TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 1



June 3, 1941.

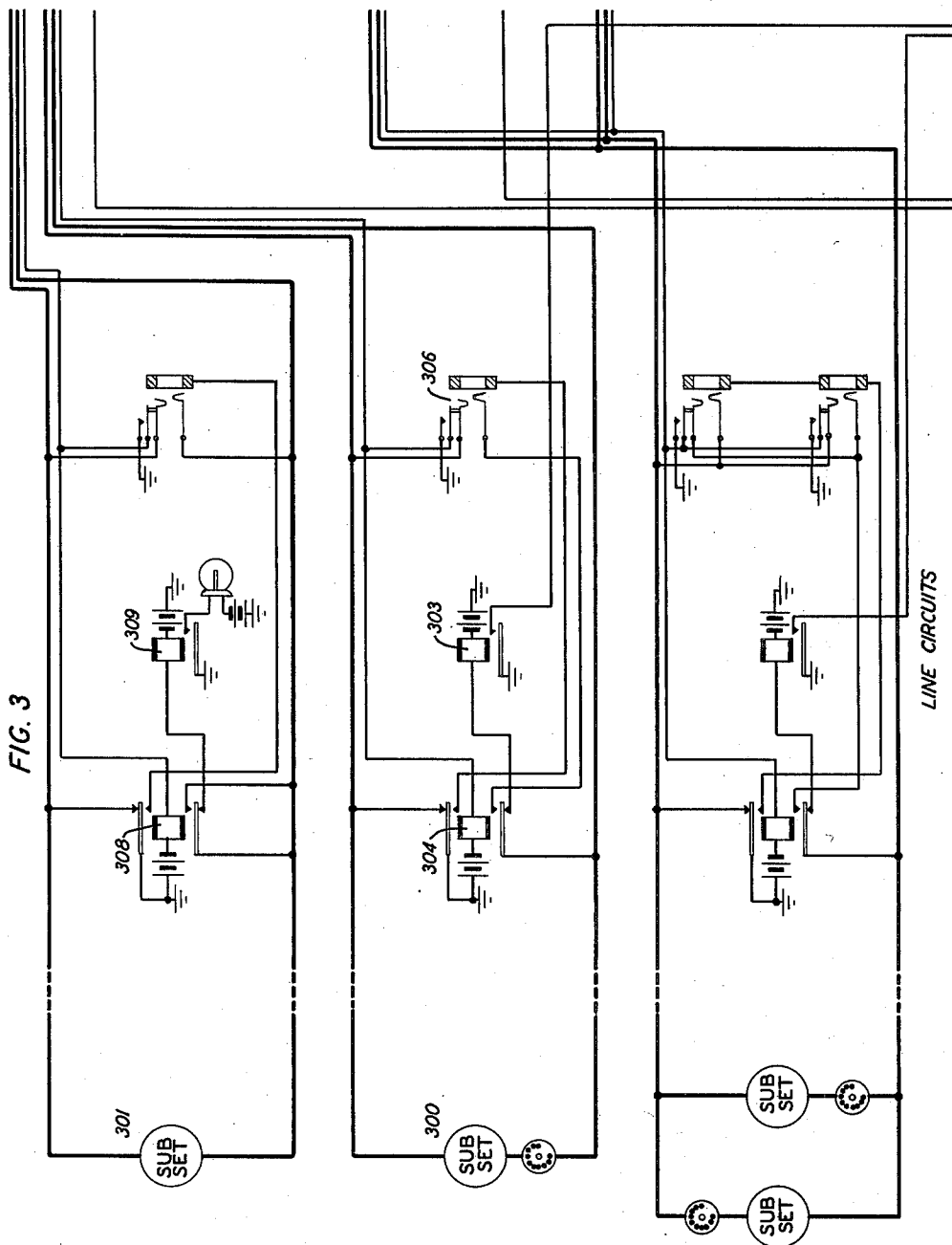
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 2



INVENTOR  
E. L. ERWIN

BY

*W. J. McFadden*

ATTORNEY

June 3, 1941.

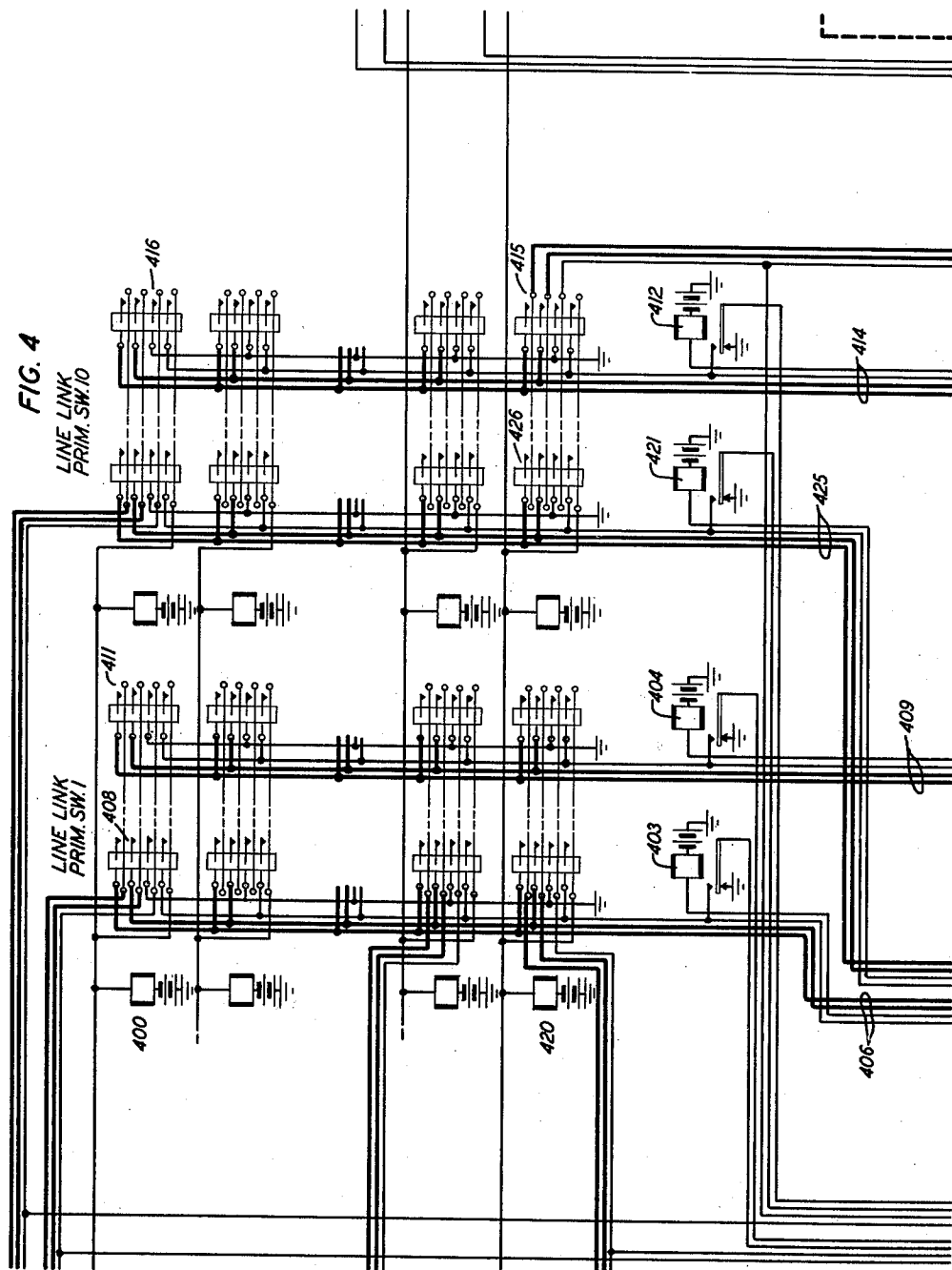
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 3



INVENTOR  
E. L. ERWIN  
BY *W. H. McFerry*  
ATTORNEY

June 3, 1941.

E. L. ERWIN

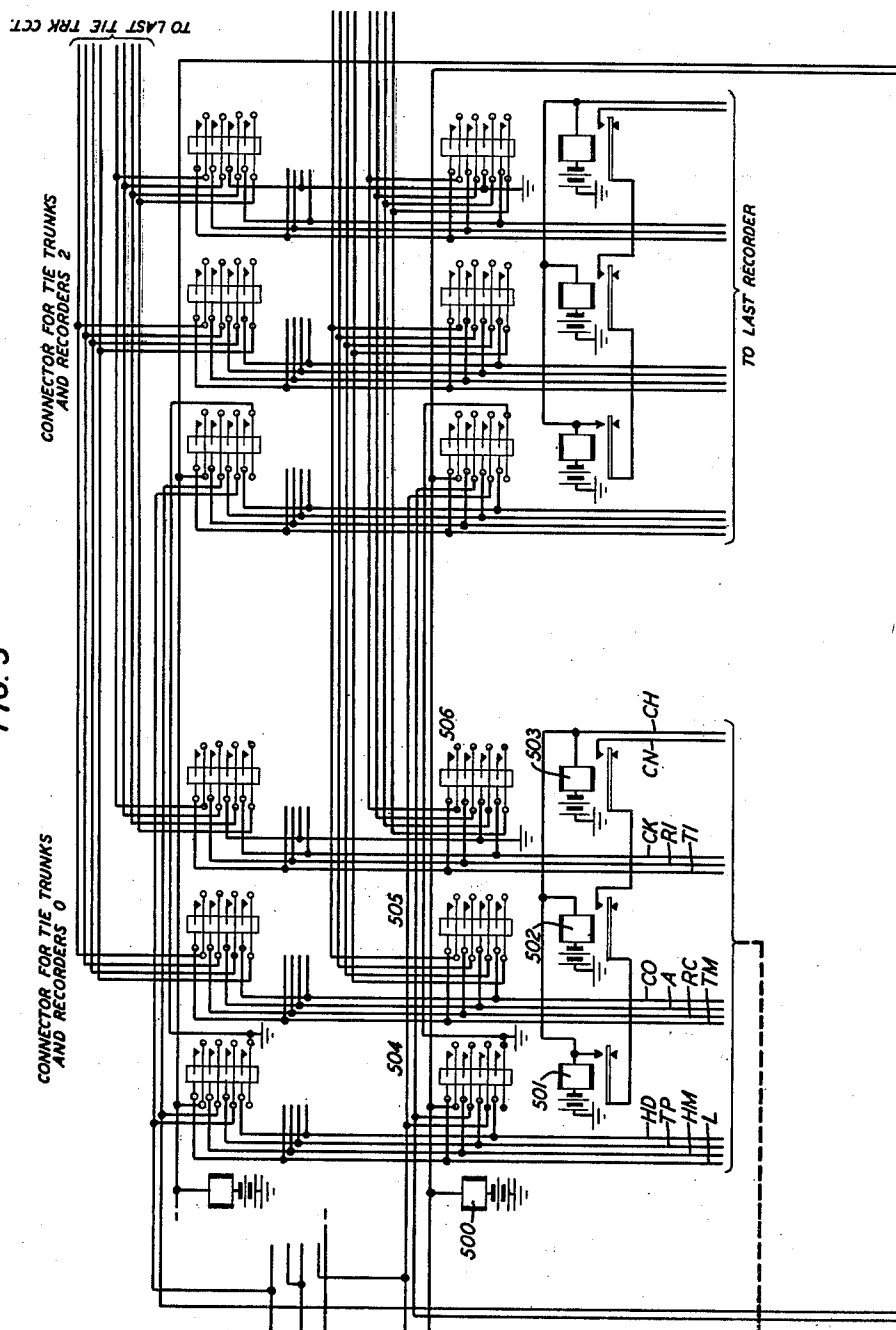
2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 4

FIG. 5



INVENTOR  
E. L. ERWIN  
BY *W. T. McJannet*  
ATTORNEY

June 3, 1941.

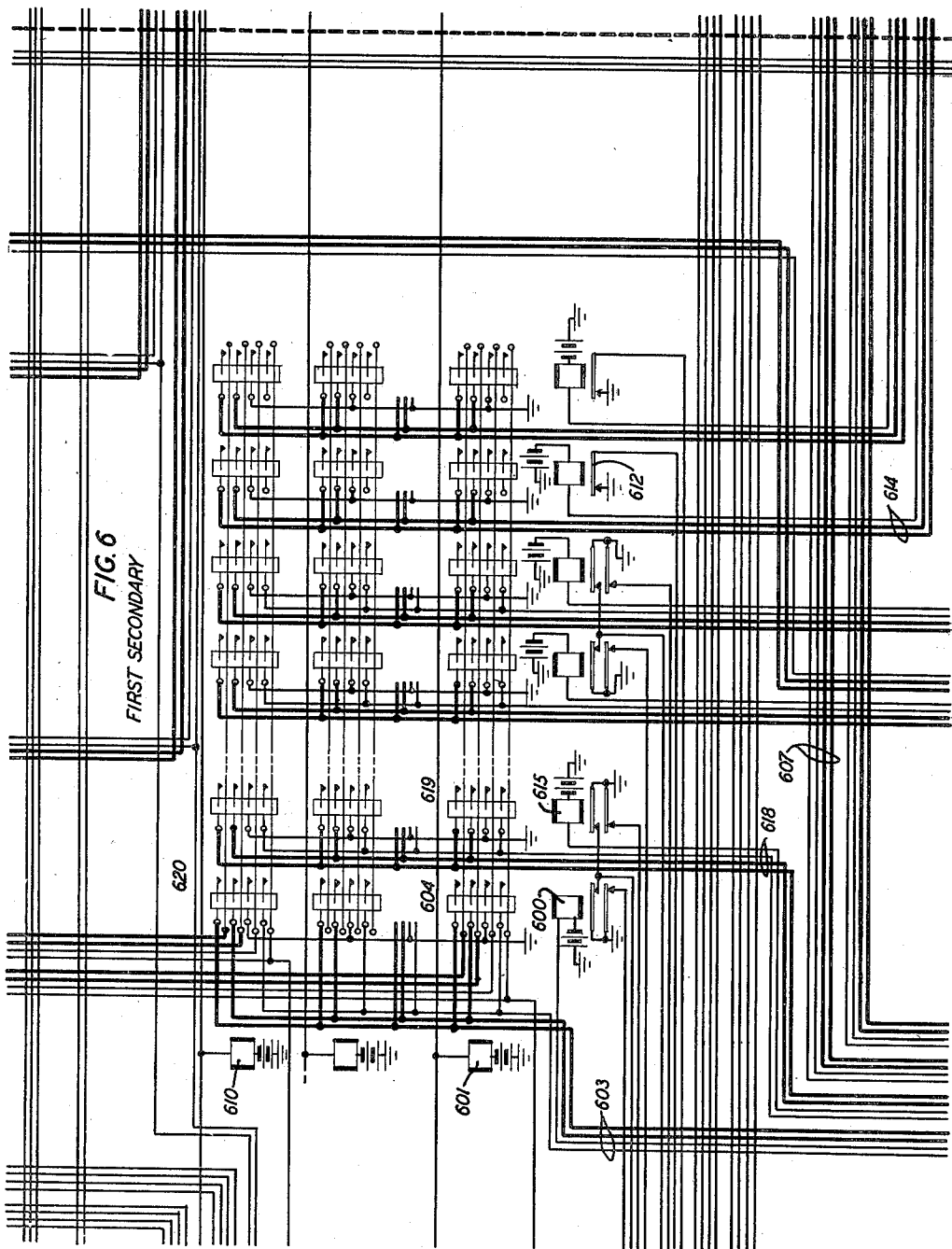
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1933

27 Sheets-Sheet 5



INVENTOR  
E. L. ERWIN  
BY *W. H. McFenney*  
ATTORNEY

June 3, 1941.

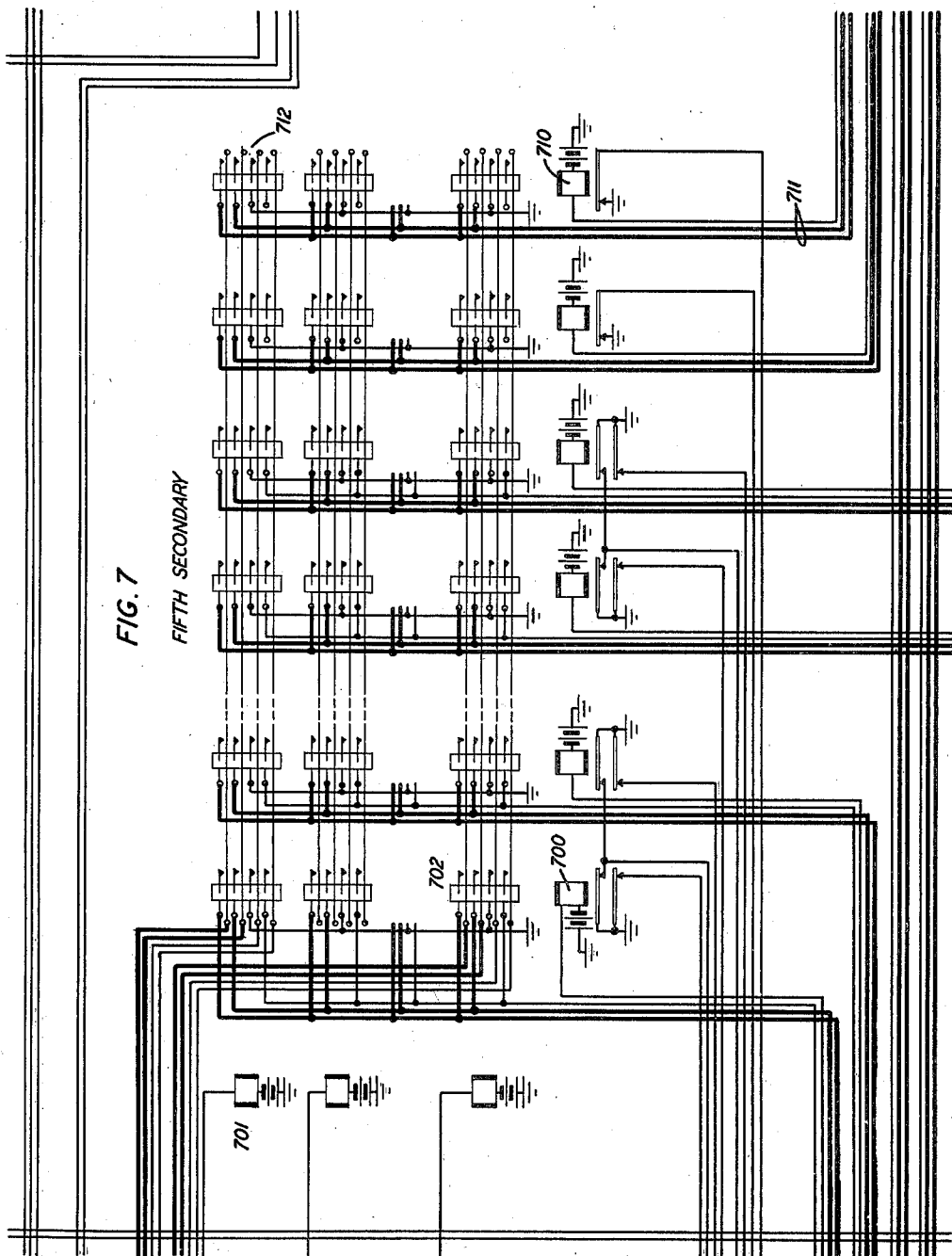
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 6



INVENTOR  
E. L. ERWIN

BY *W. H. McFarney*  
ATTORNEY

June 3, 1941.

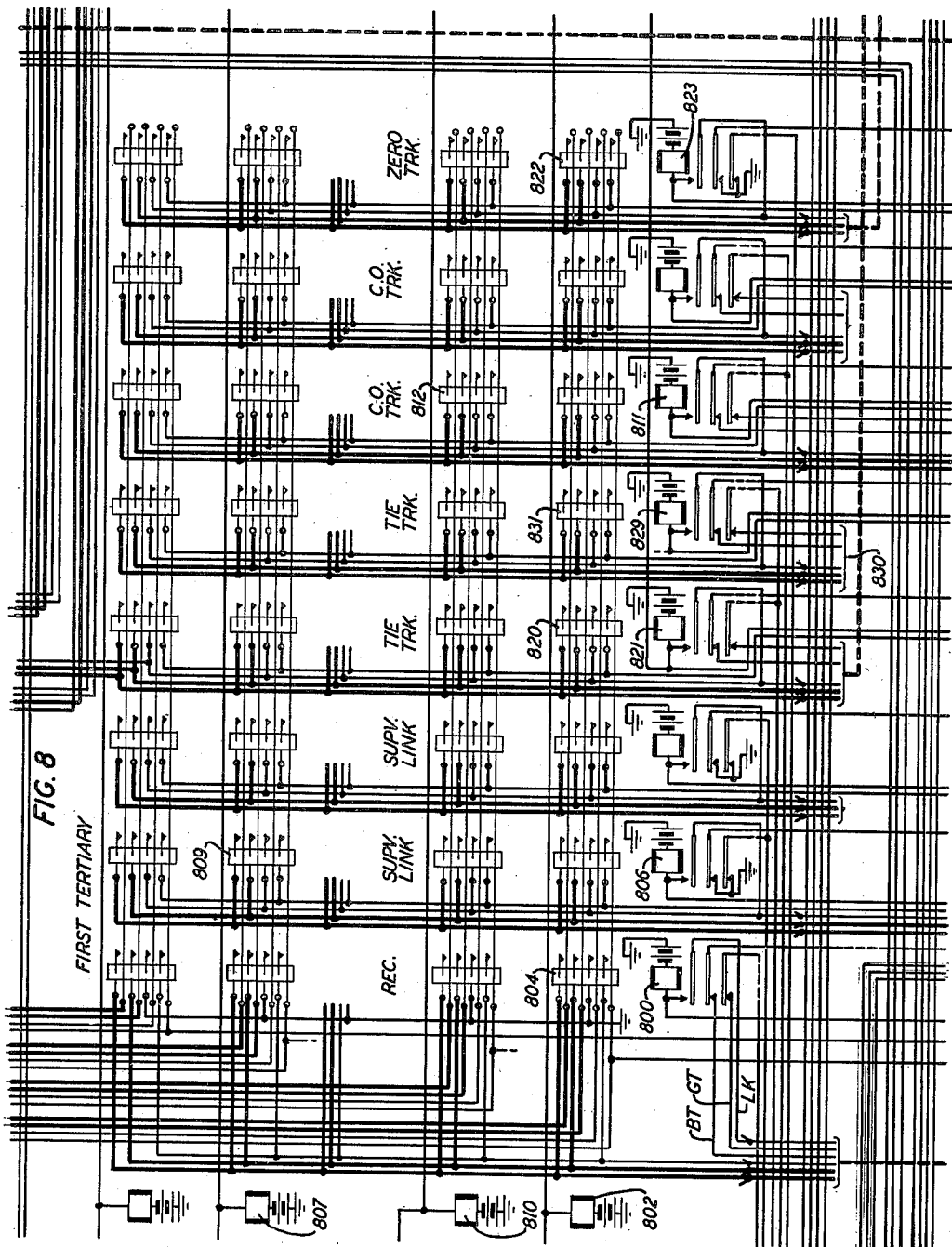
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 7



INVENTOR  
E. L. ERWIN  
BY *Wm. McJannet*  
ATTORNEY

June 3, 1941.

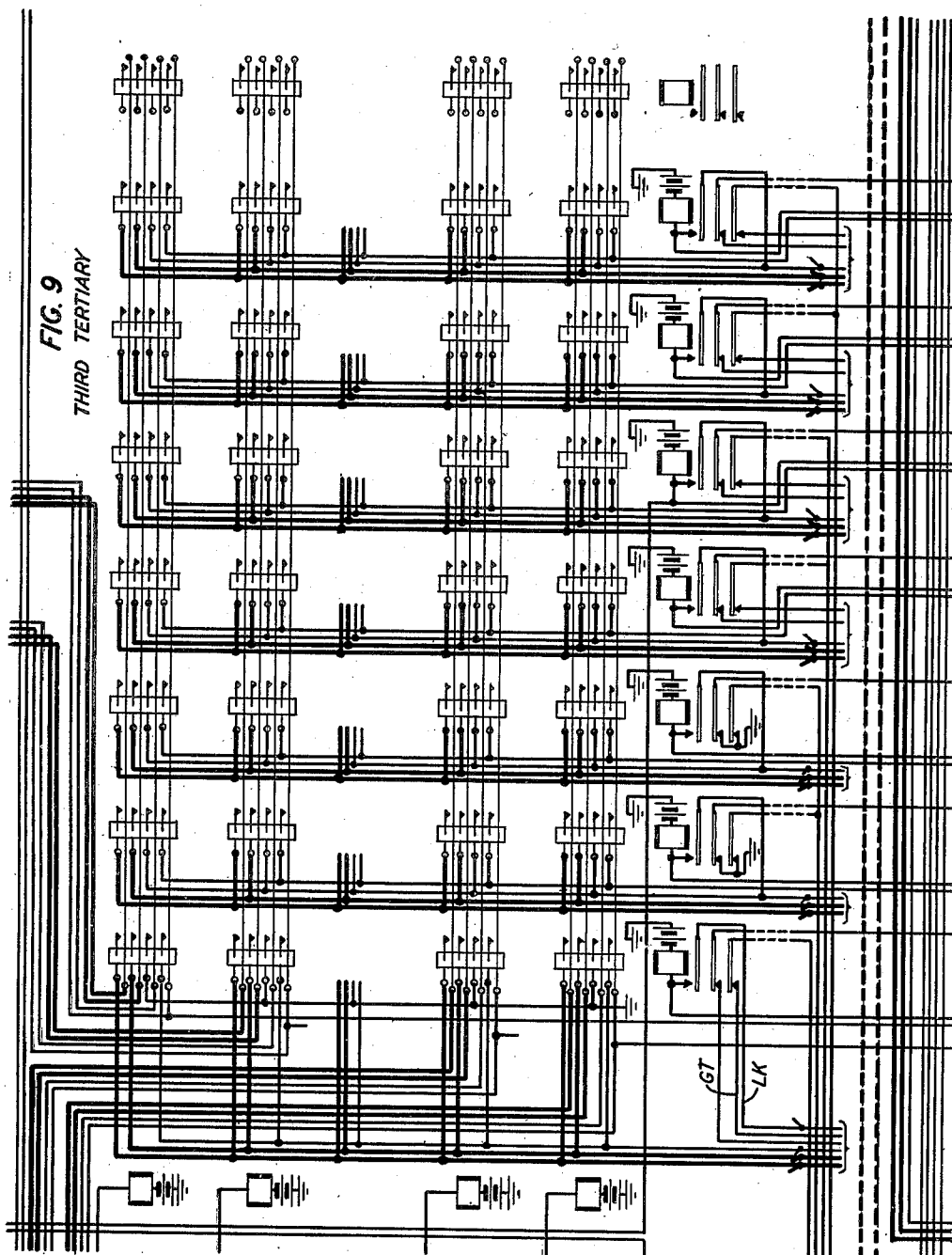
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 8



INVENTOR  
E. L. ERWIN  
BY *M. M. M. M. M.*  
ATTORNEY



June 3, 1941.

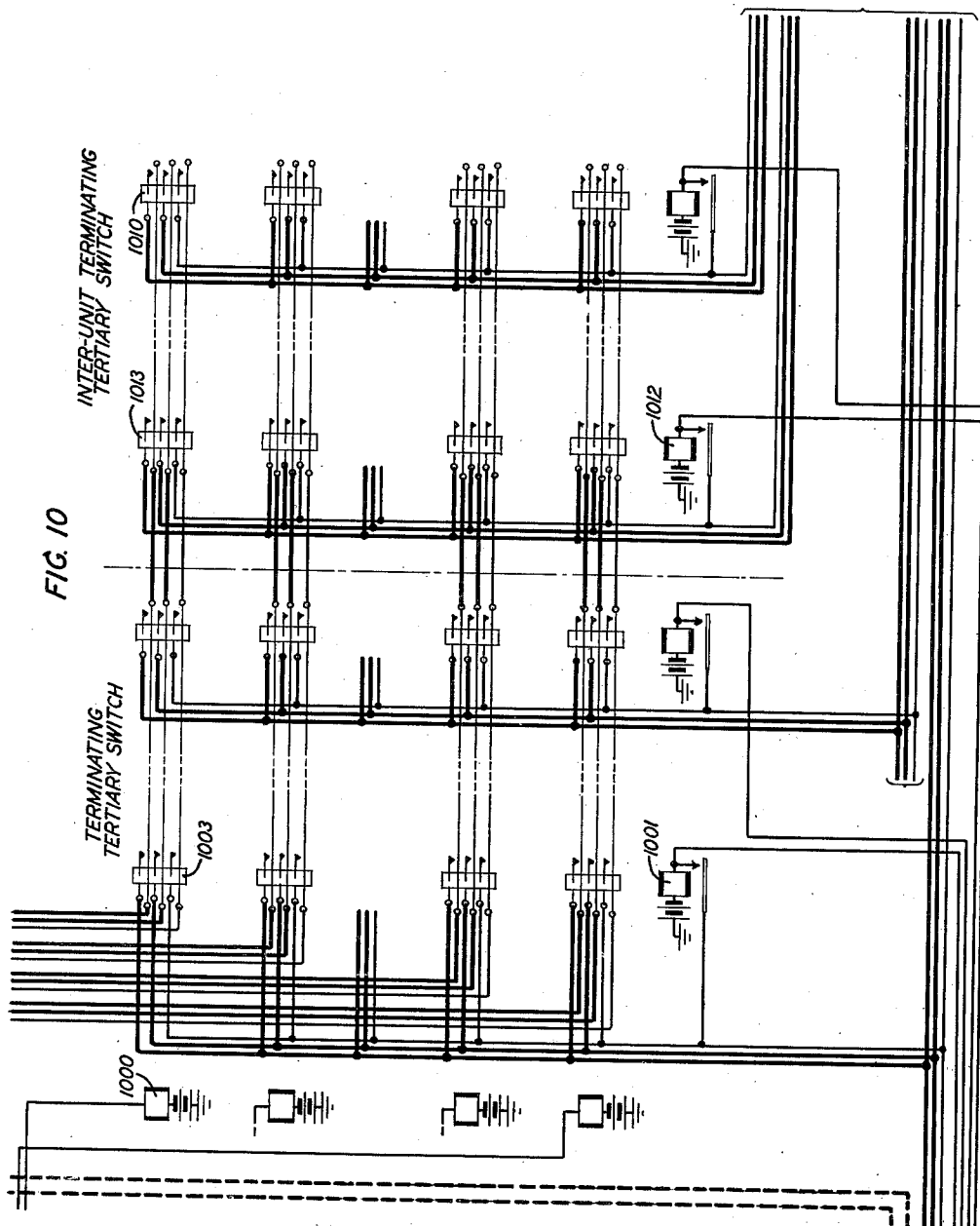
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 9



INVENTOR  
E. L. ERWIN  
BY *M. P. M. J. J. J.*  
ATTORNEY

June 3, 1941.

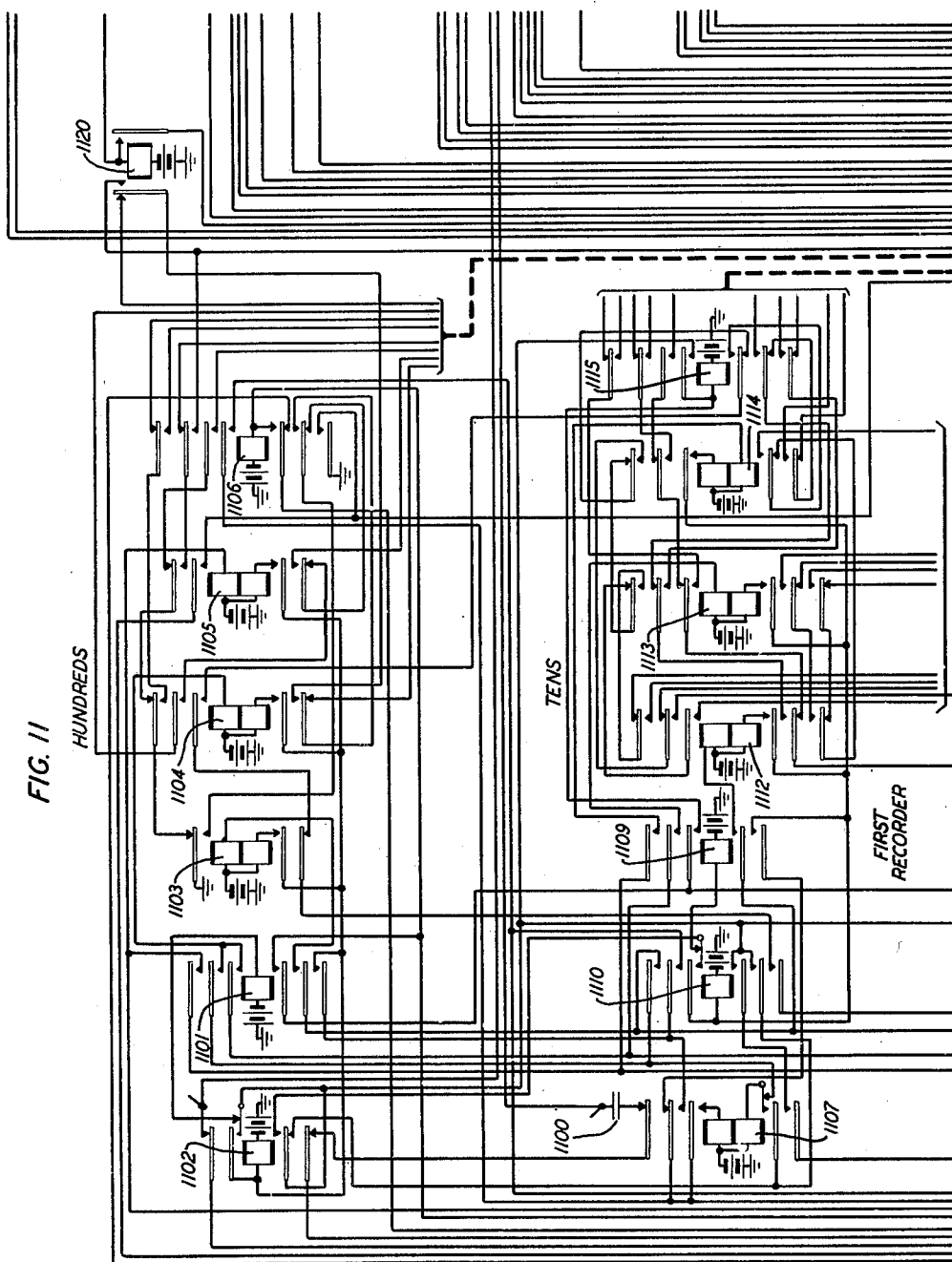
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 10



INVENTOR  
E. L. ERWIN  
BY *M. J. McJannet*  
ATTORNEY

June 3, 1941.

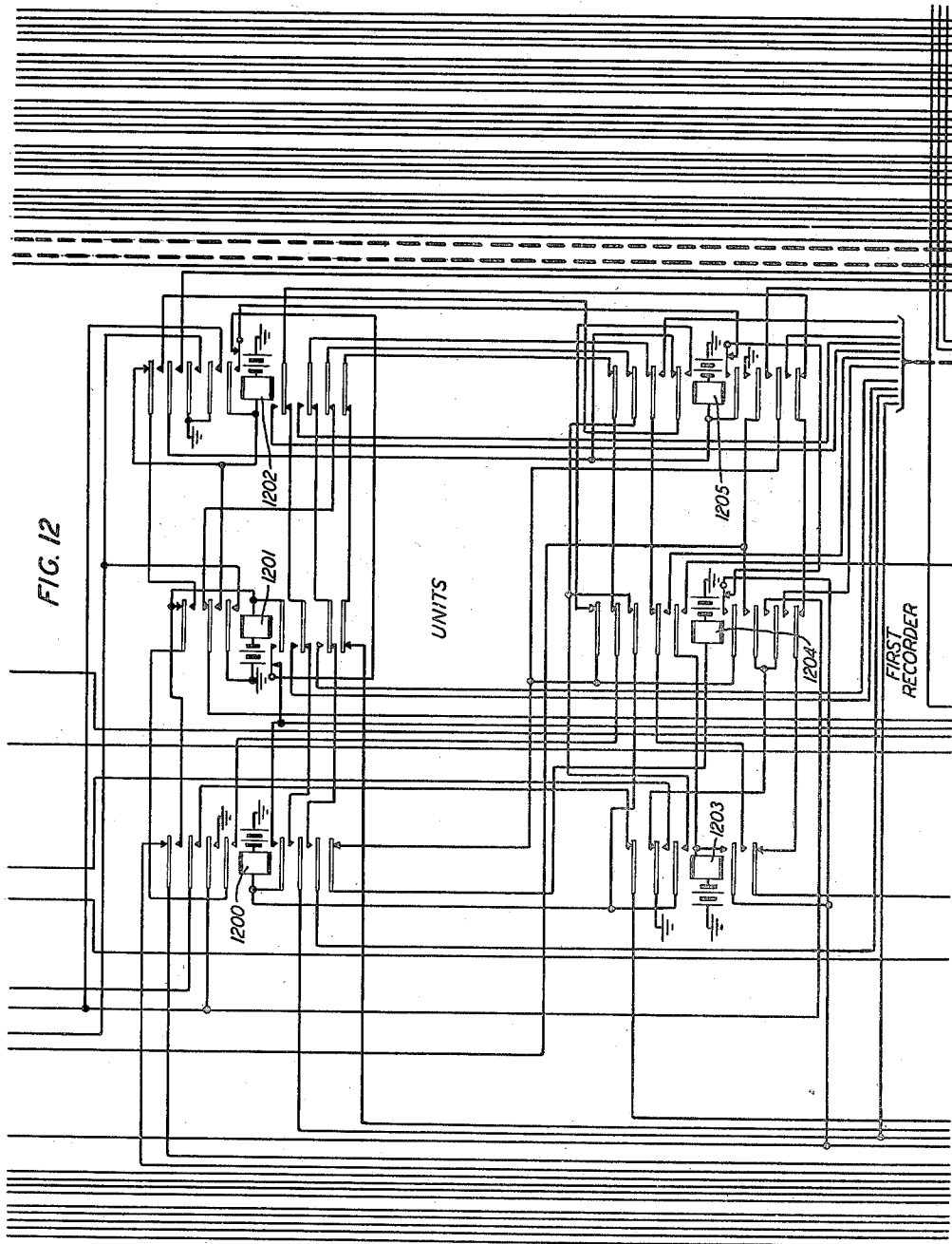
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 11



INVENTOR  
E. L. ERWIN  
BY *W. M. McJannet*  
ATTORNEY

June 3, 1941.

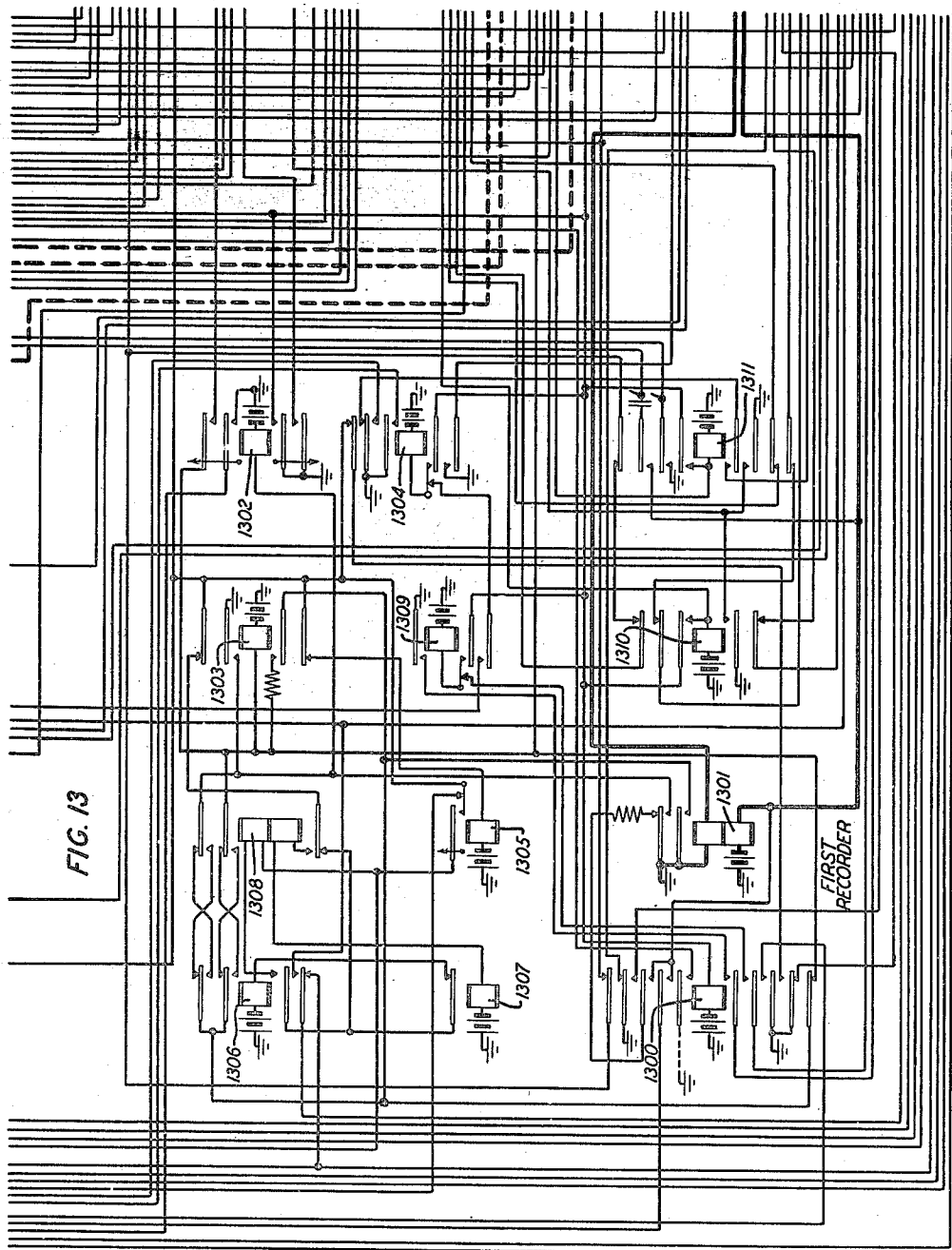
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 12



INVENTOR  
E. L. ERWIN  
BY *W. T. McFerry*  
ATTORNEY

June 3, 1941.

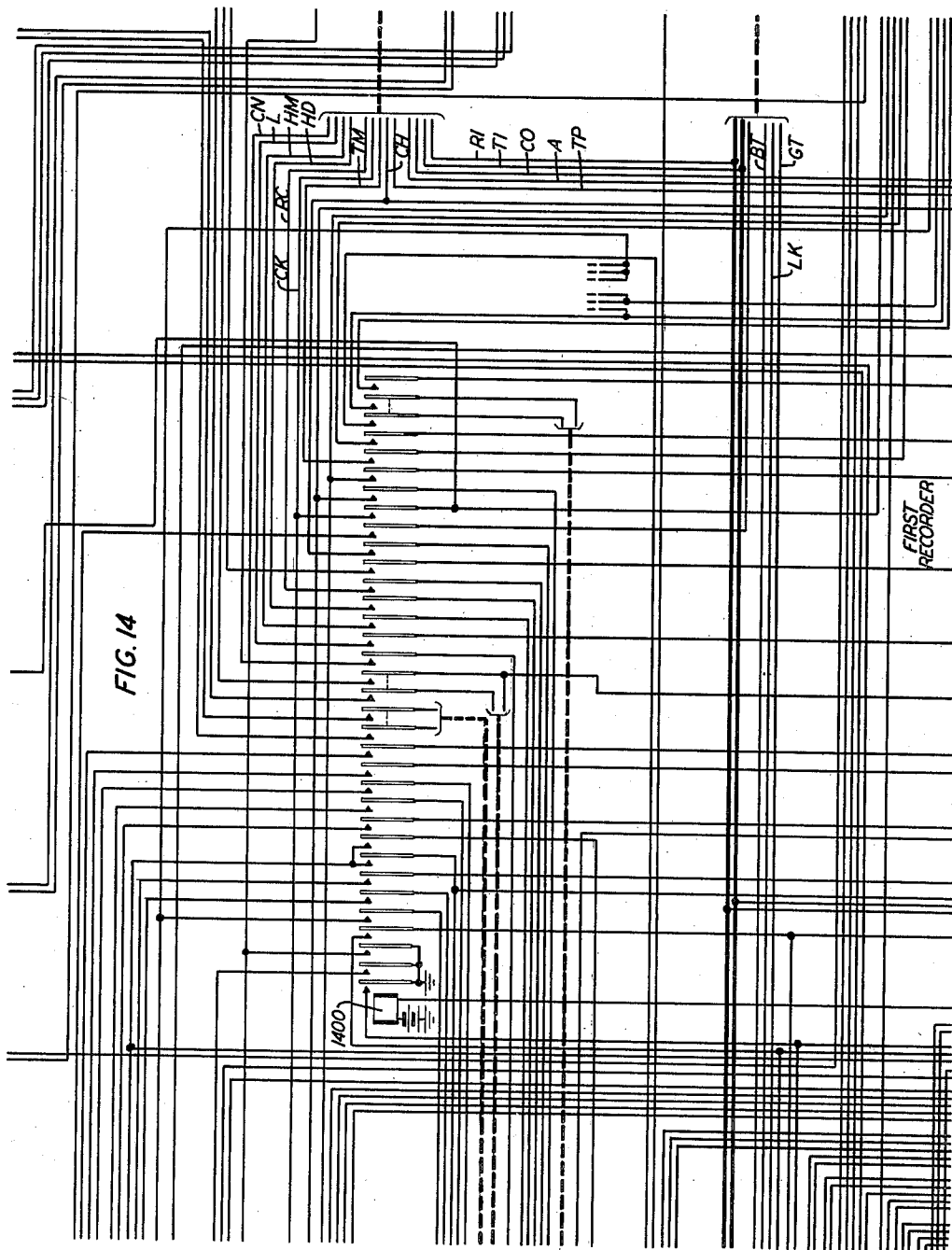
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 13



INVENTOR  
E. L. ERWIN

BY *W. P. McJannet*  
ATTORNEY

June 3, 1941.

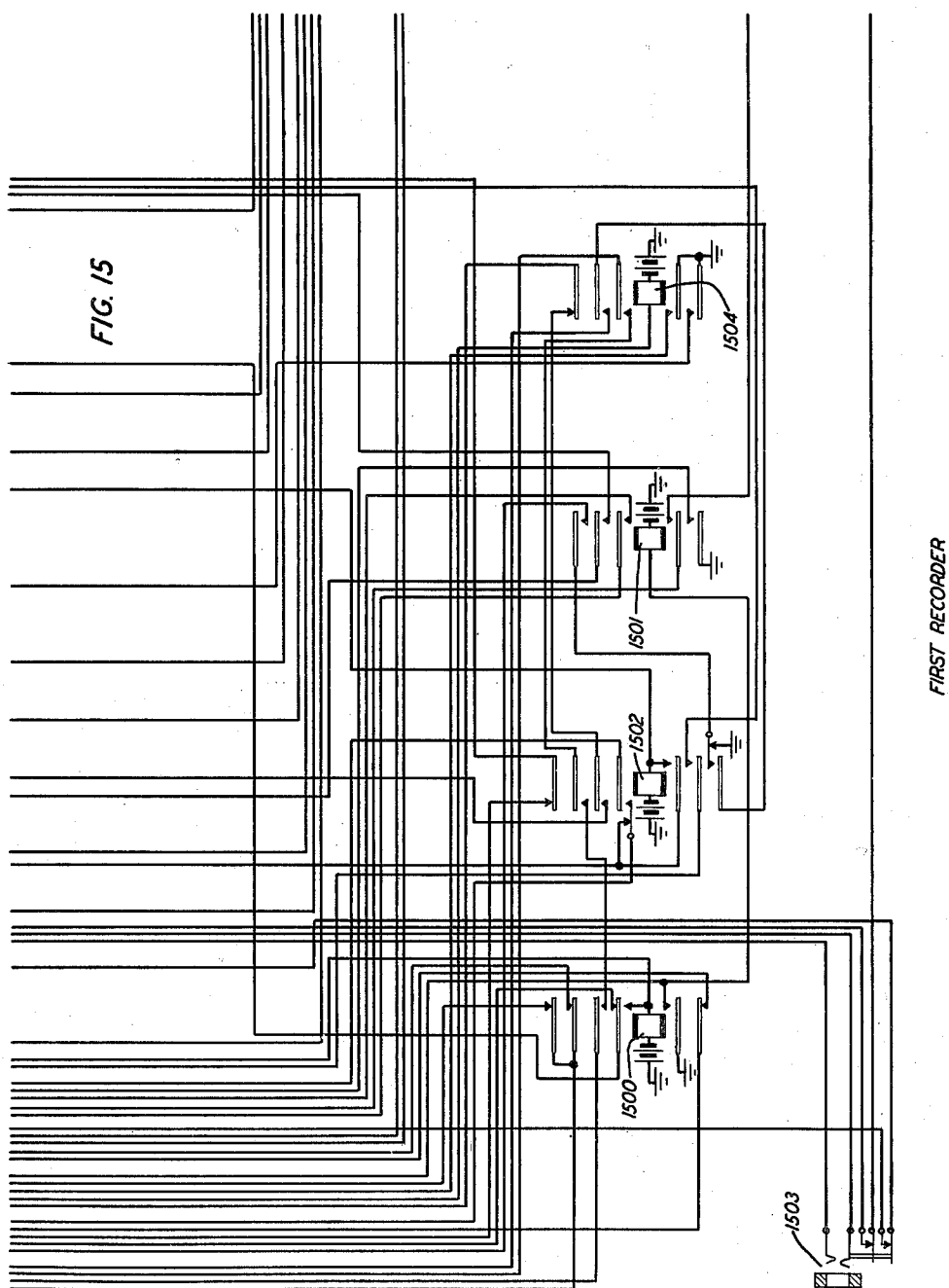
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 14



INVENTOR  
E. L. ERWIN

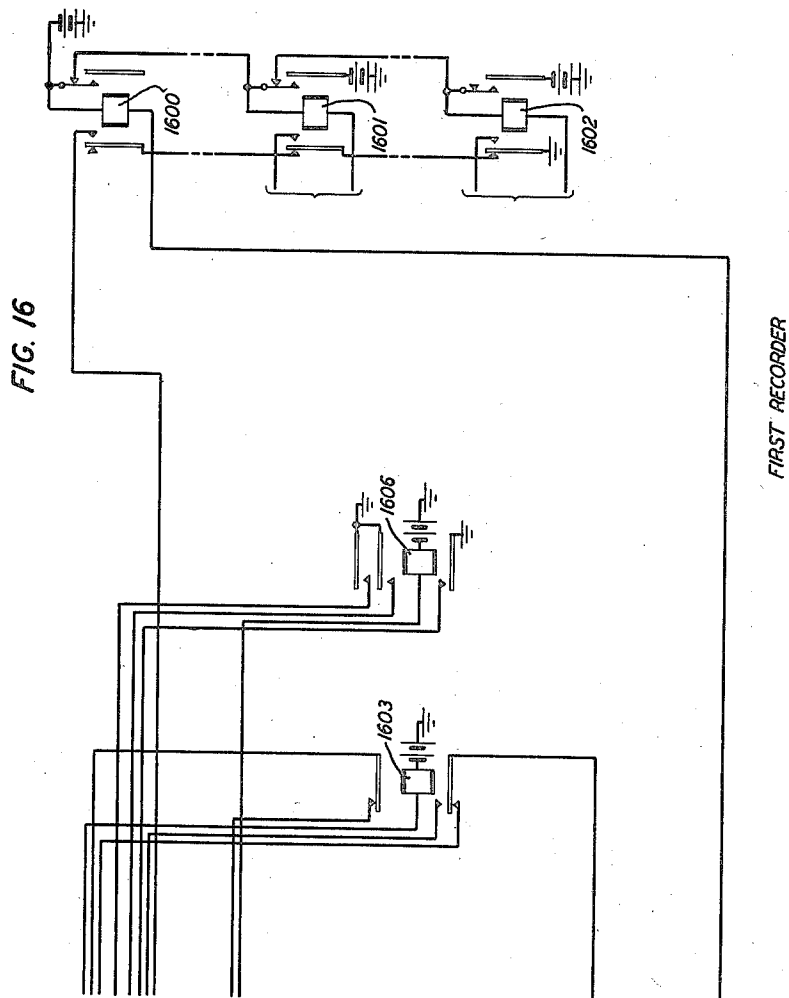
BY *W. J. McFarney*  
ATTORNEY

June 3, 1941.

E. L. ERWIN  
TELEPHONE SYSTEM  
Filed Feb. 11, 1938

2,244,004

27 Sheets-Sheet 15



INVENTOR  
E. L. ERWIN

BY *W. J. McFadden*  
ATTORNEY

June 3, 1941.

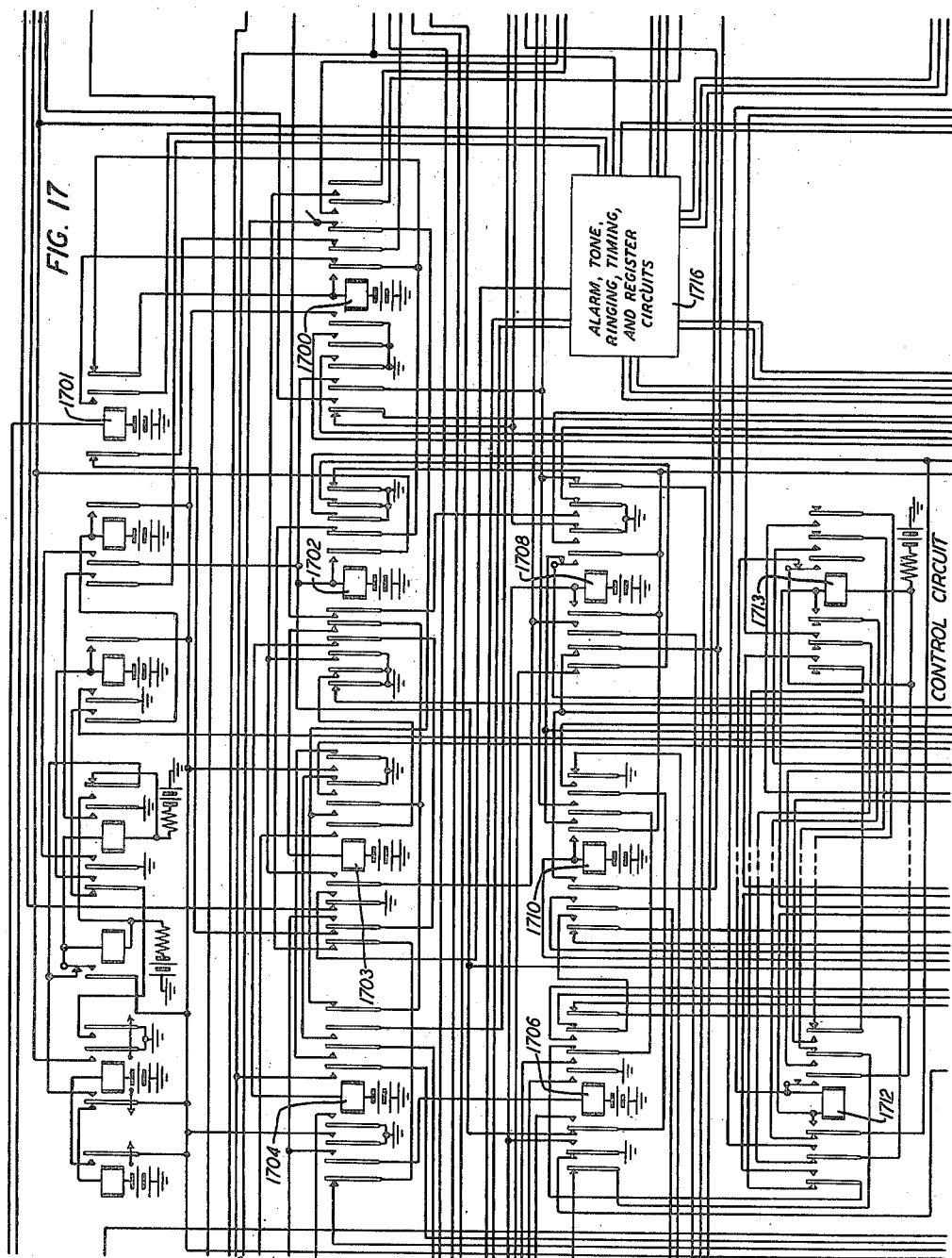
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 16



INVENTOR  
E. L. ERWIN

BY *W. T. McJannet*  
ATTORNEY



June 3, 1941.

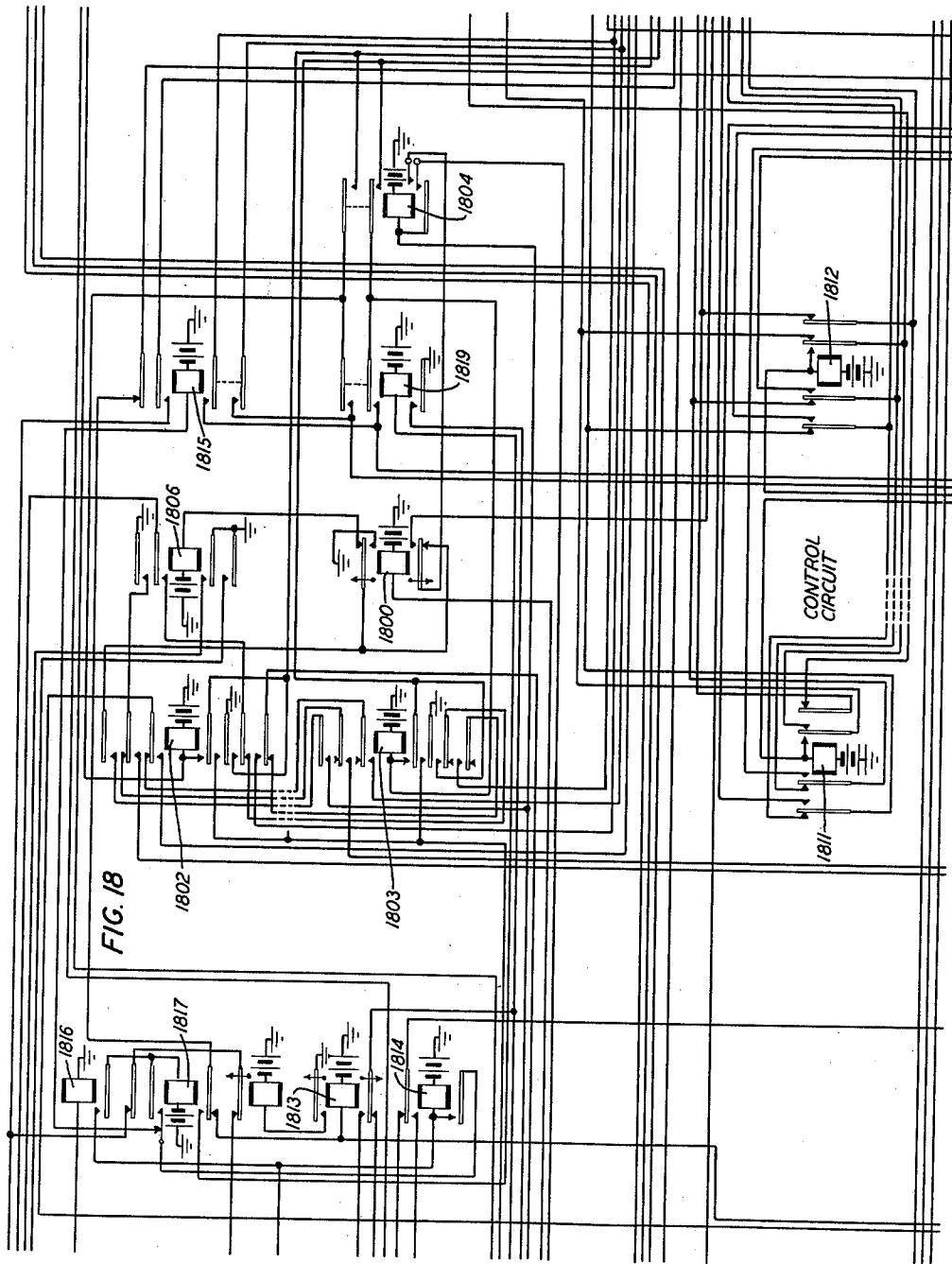
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 17



INVENTOR  
E. L. ERWIN

BY *W. J. McInerney*  
ATTORNEY

June 3, 1941.

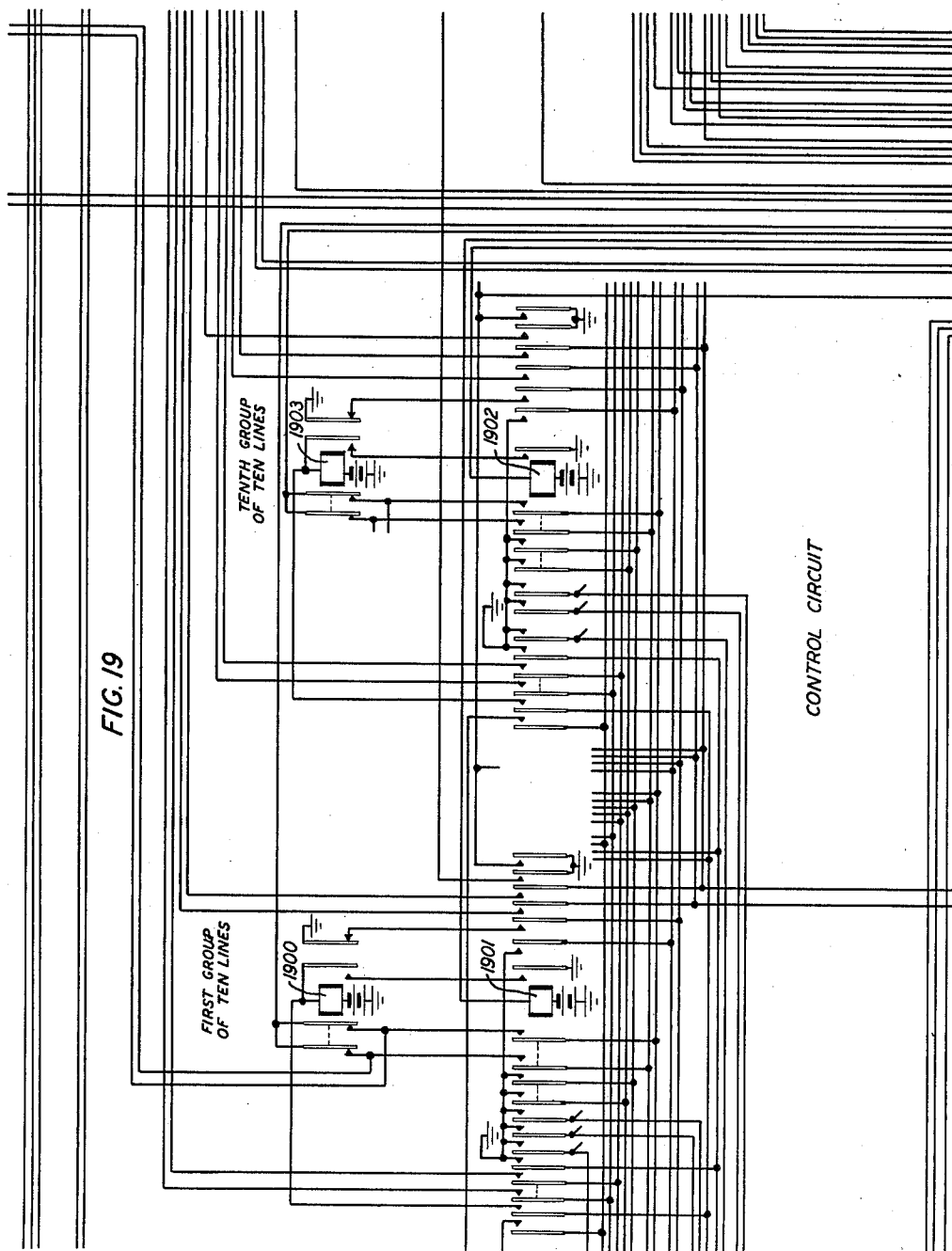
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 18



INVENTOR  
E. L. ERWIN

BY *W. F. McJannet*  
ATTORNEY

June 3, 1941.

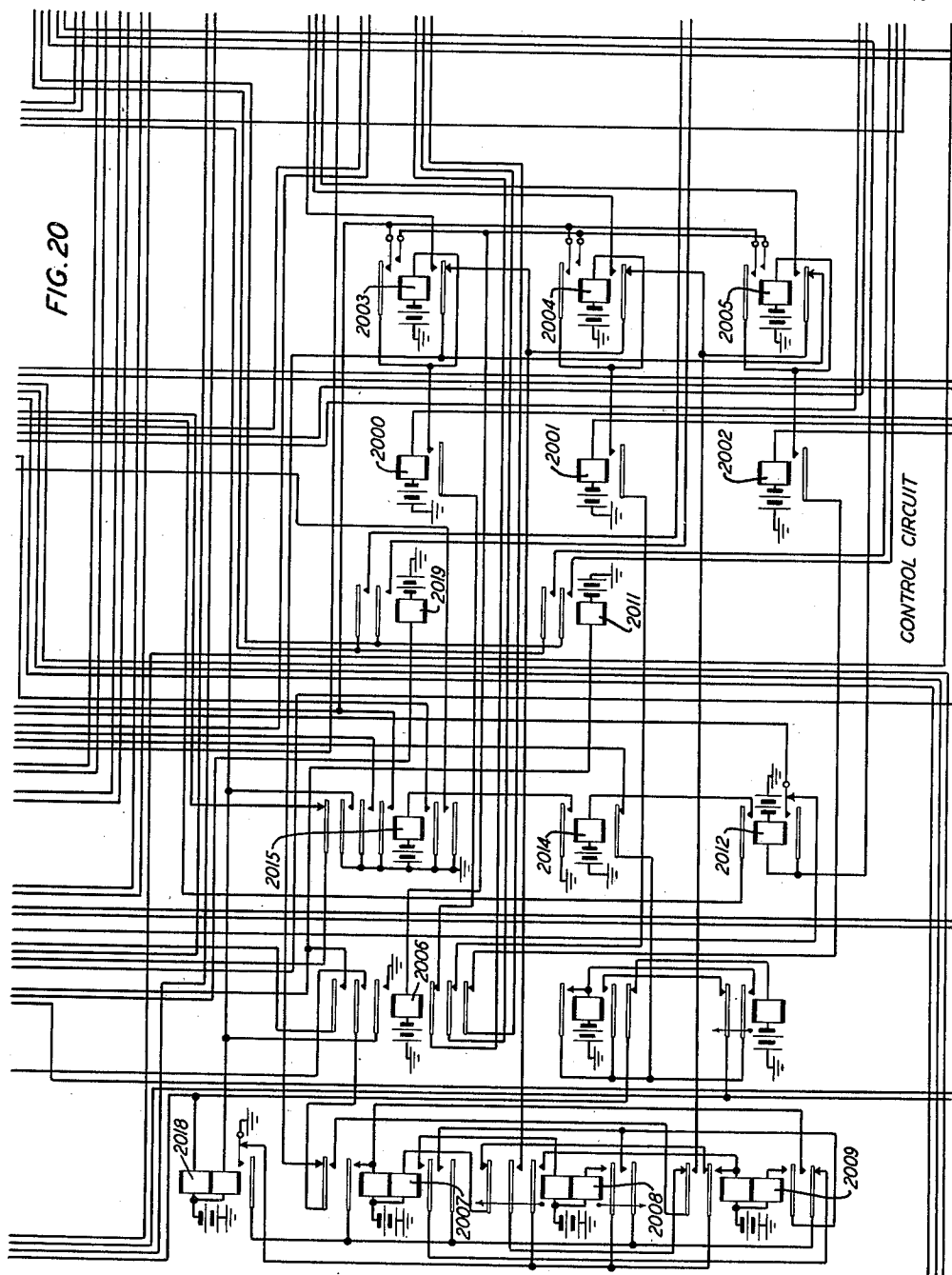
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 19



INVENTOR  
E. L. ERWIN

BY *M. J. McJannet*  
ATTORNEY

June 3, 1941.

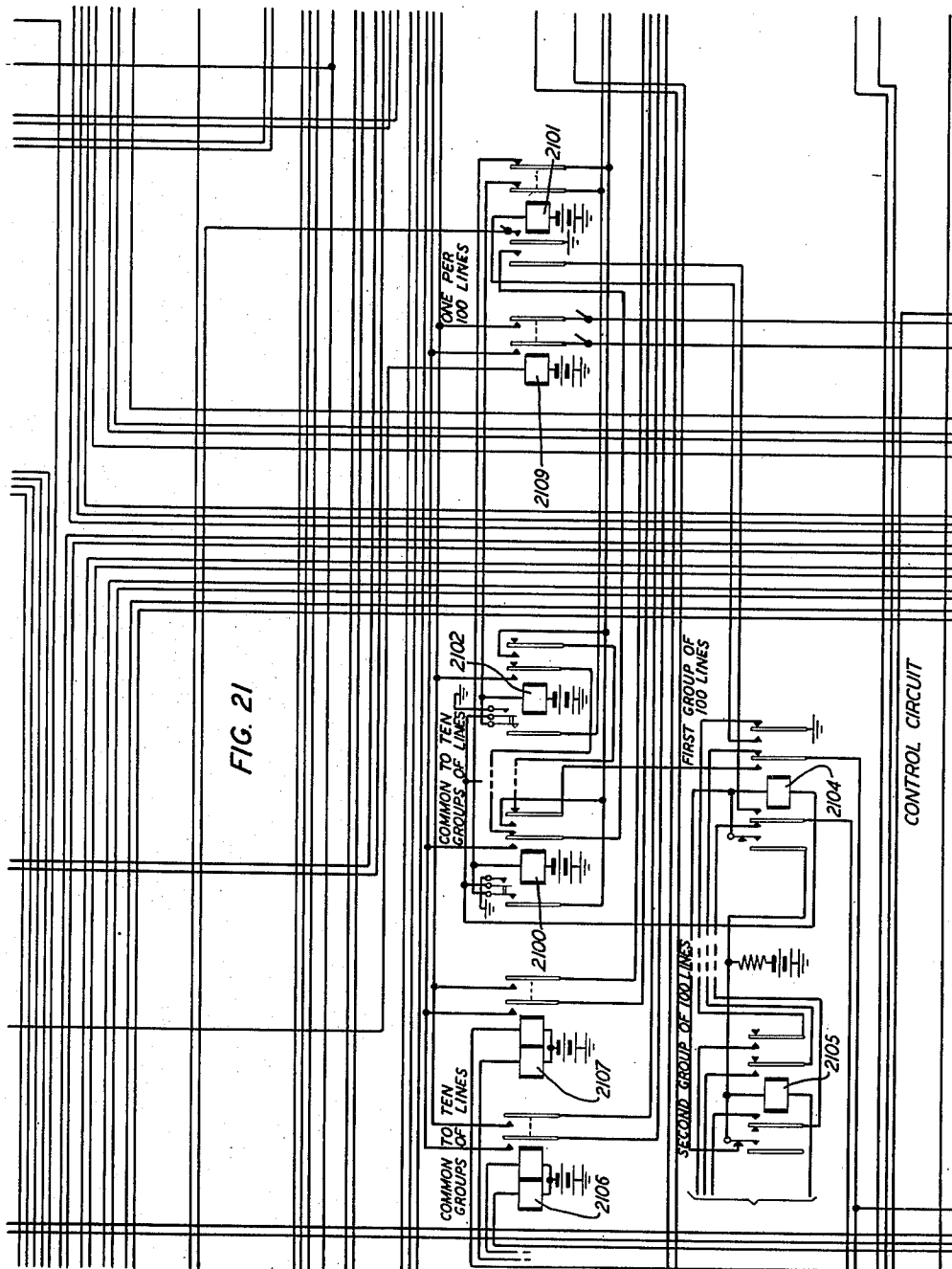
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 20



INVENTOR  
E. L. ERWIN

BY *W. M. Kenney*  
ATTORNEY

June 3, 1941.

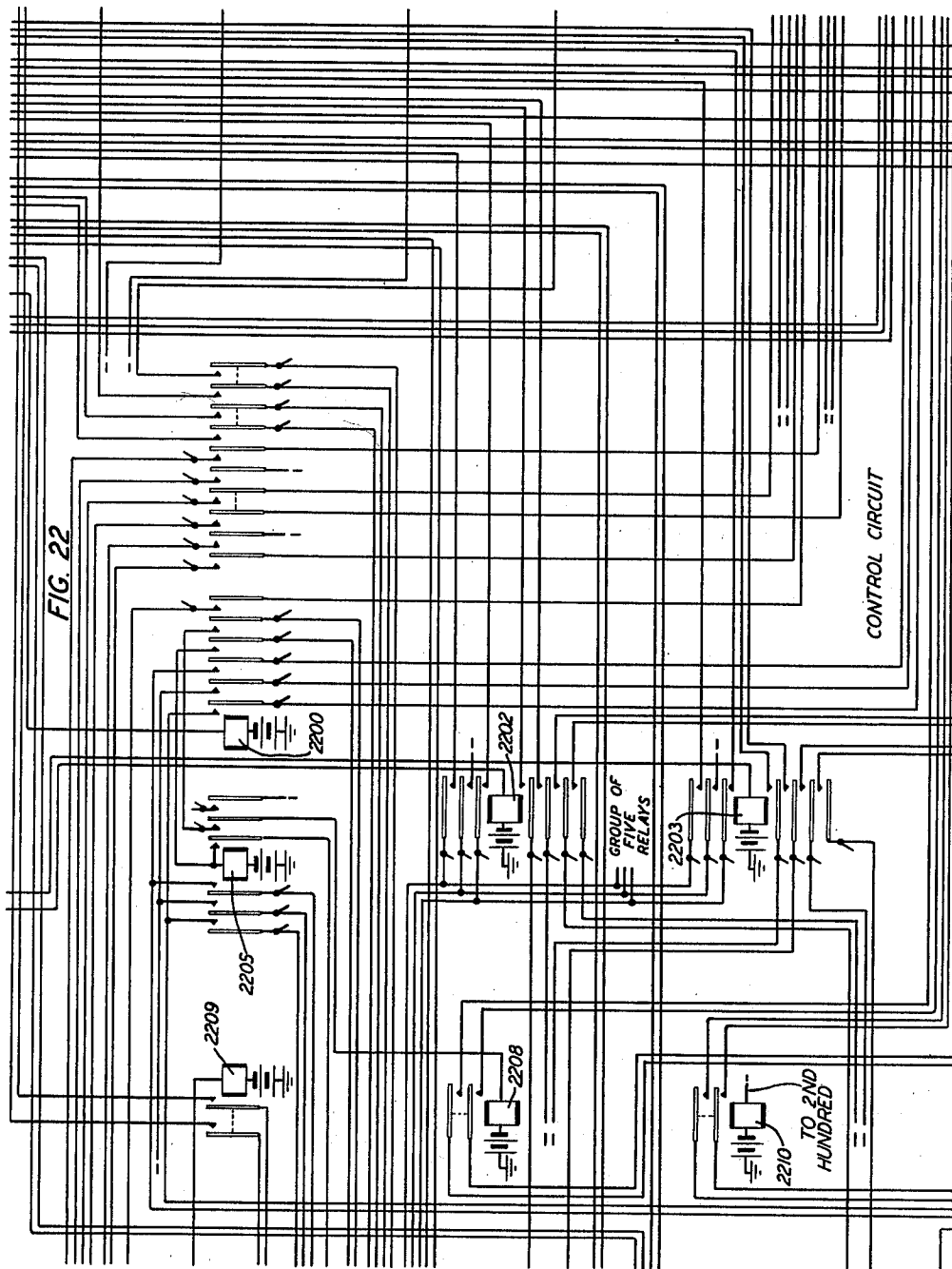
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 21



INVENTOR  
E. L. ERWIN

BY *W. M. McFerry*  
ATTORNEY

June 3, 1941.

E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 22

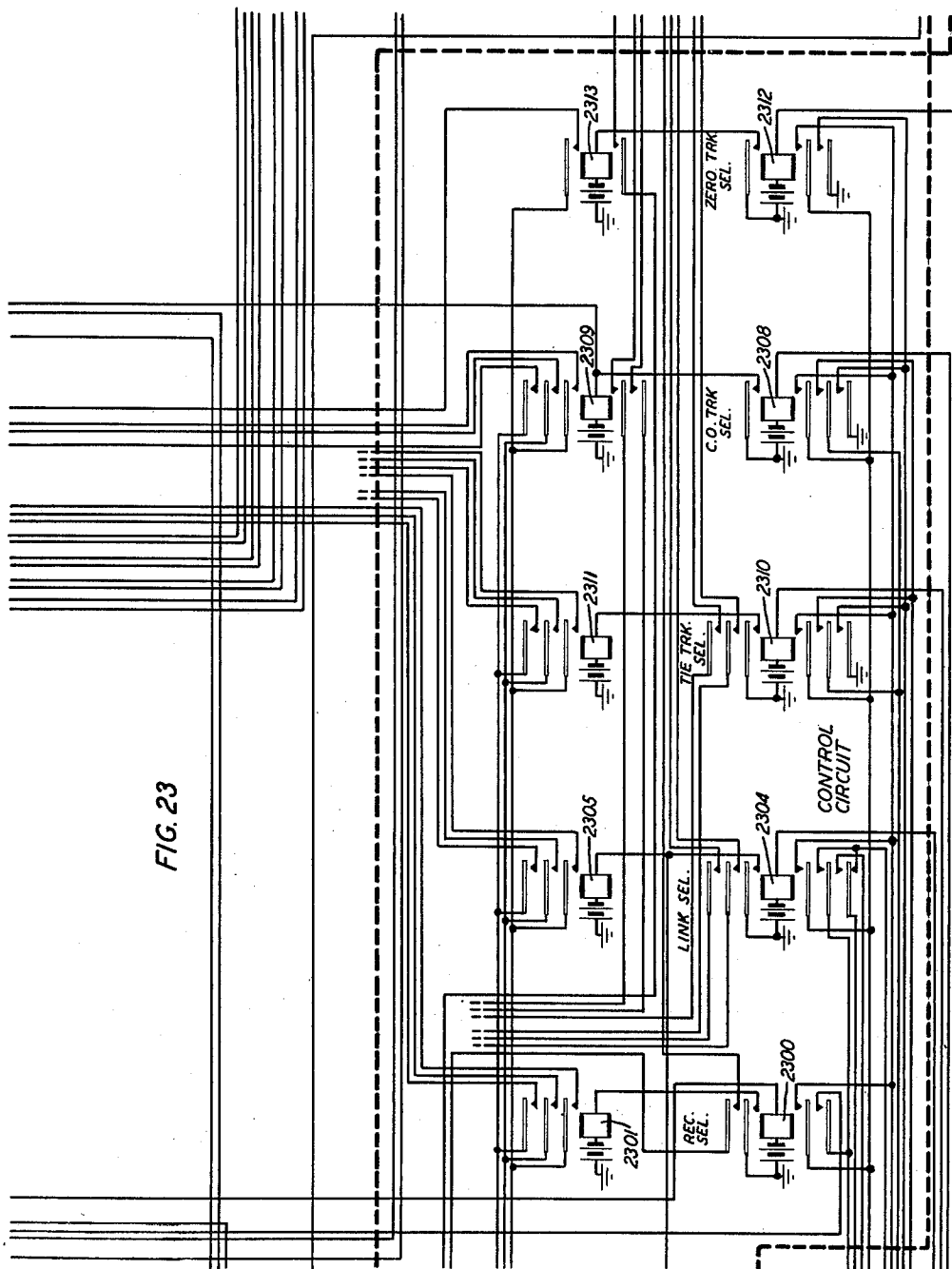


FIG. 23

INVENTOR  
E. L. ERWIN  
BY *Wm. H. Hume*  
ATTORNEY

June 3, 1941.

E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 23

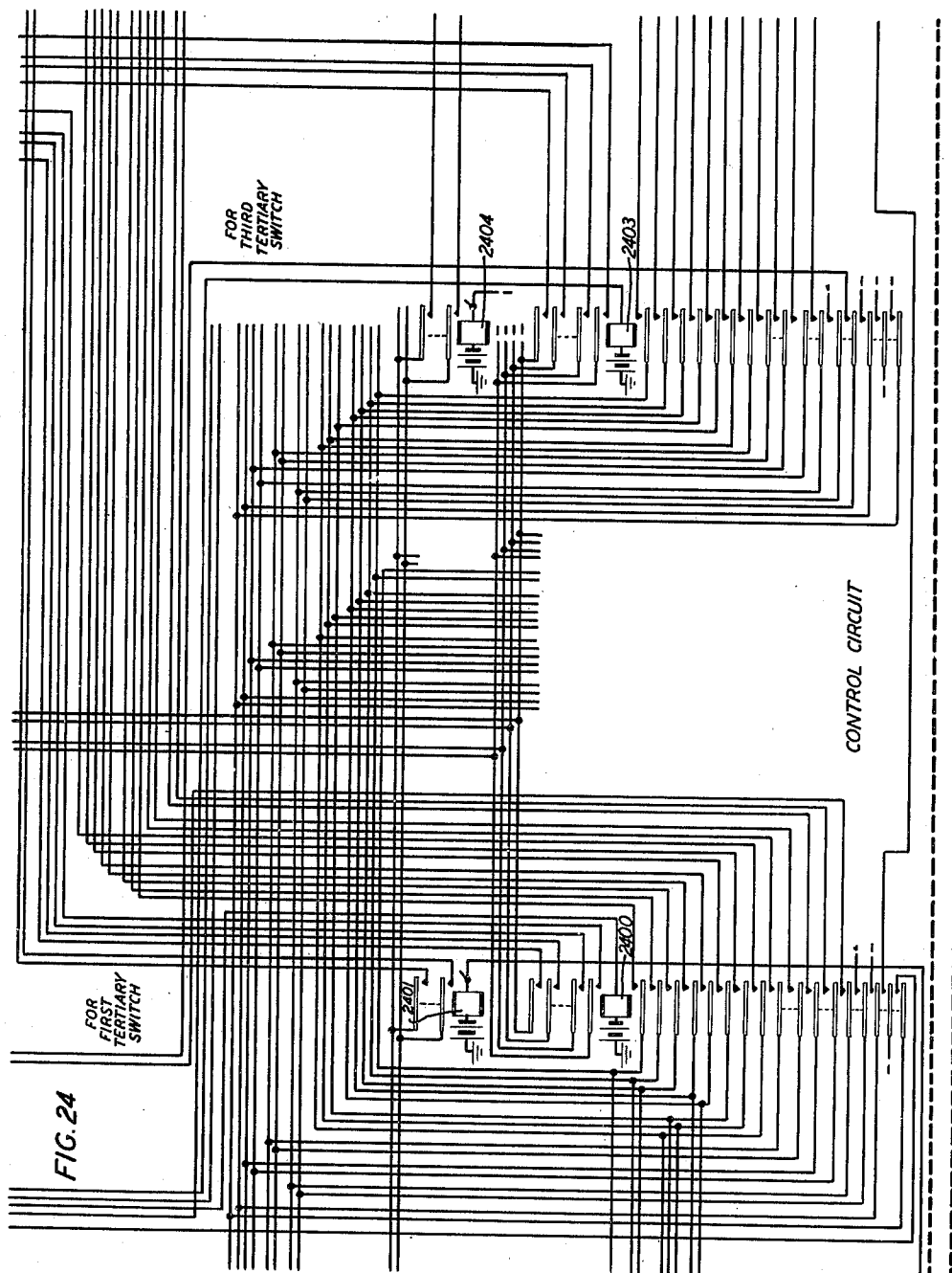


FIG. 24

INVENTOR  
E. L. ERWIN  
BY *W. M. McJannet*  
ATTORNEY

June 3, 1941.

E. L. ERWIN

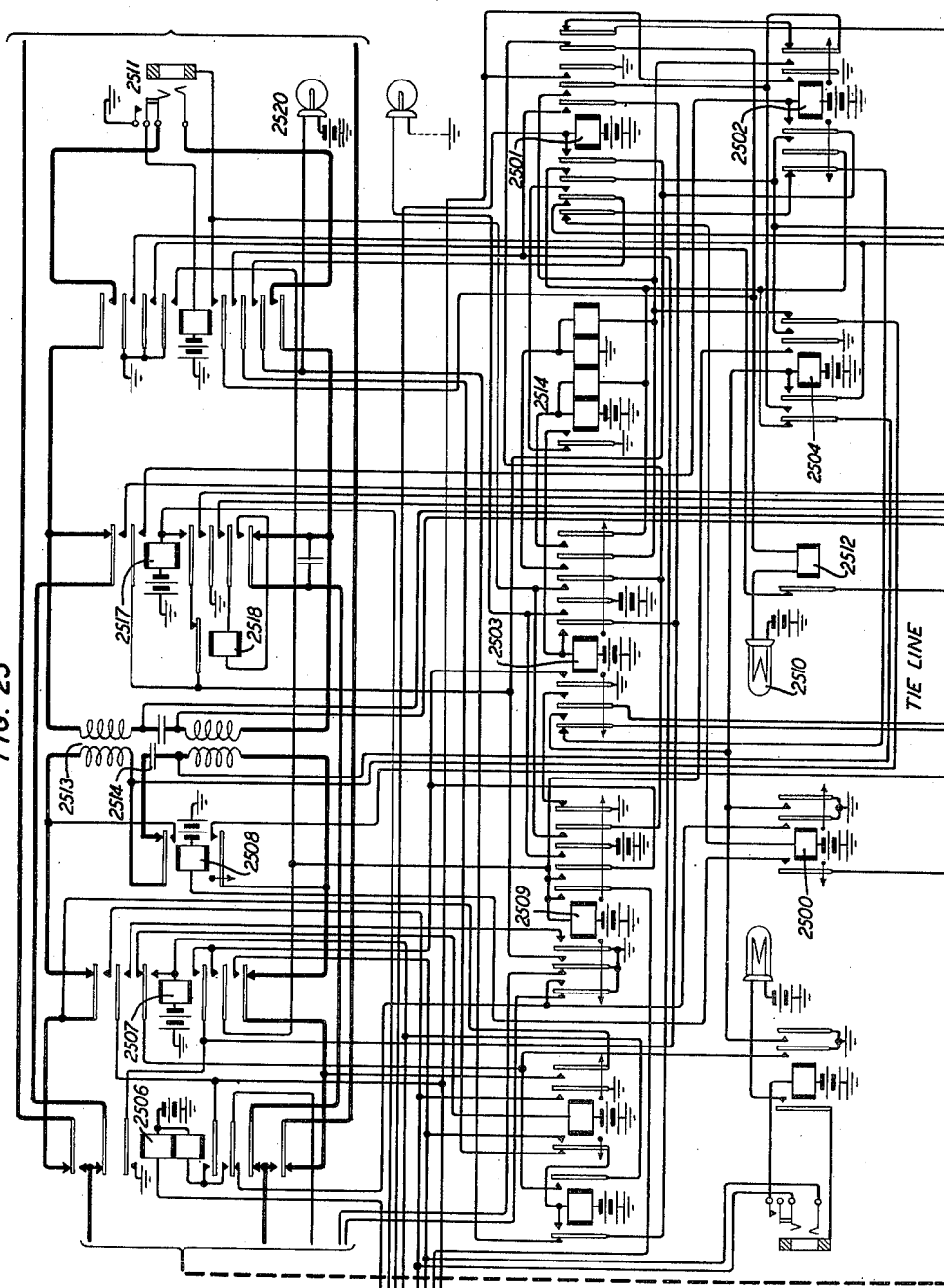
2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 24

FIG. 25



INVENTOR  
E. L. ERWIN

BY

*W. McKenney*

ATTORNEY



June 3, 1941.

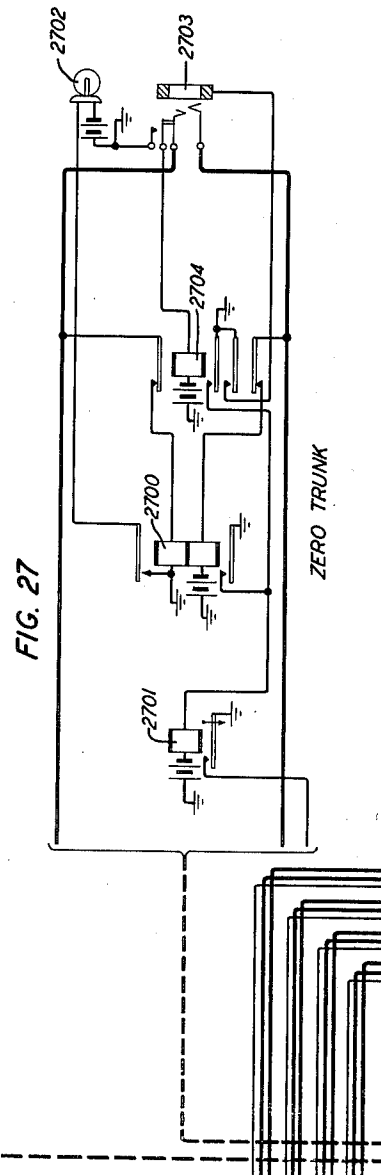
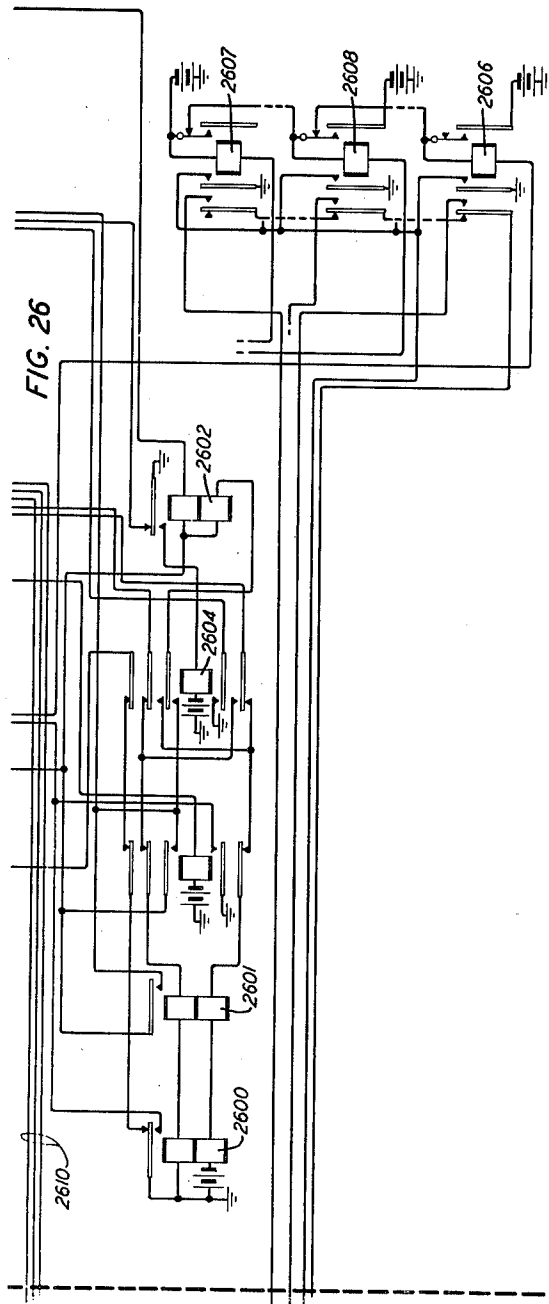
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1933

27 Sheets-Sheet 25



INVENTOR  
E. L. ERWIN

BY *M. J. McFadden*  
ATTORNEY

June 3, 1941.

E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1938

27 Sheets-Sheet 26

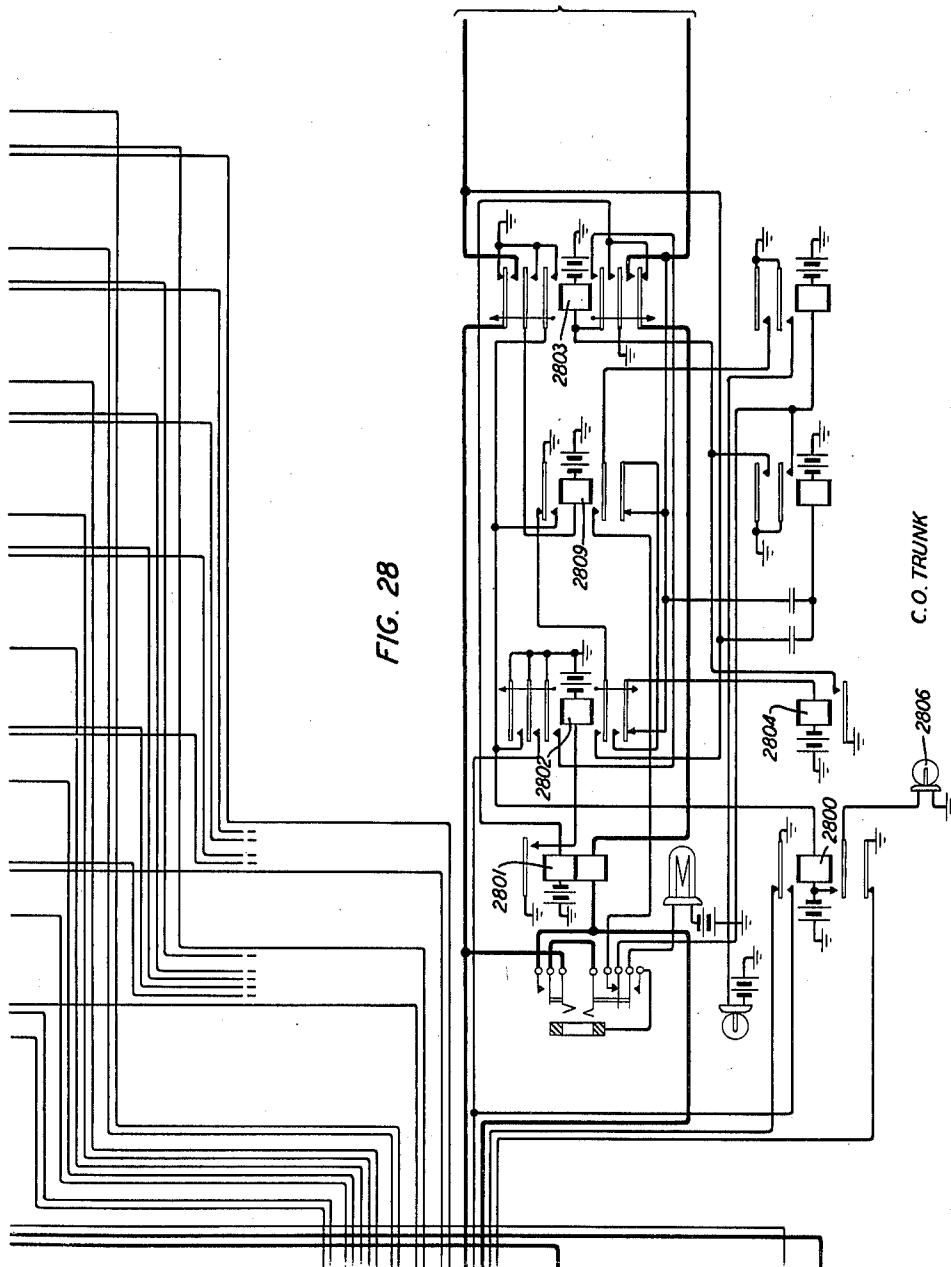


FIG. 28

INVENTOR  
E. L. ERWIN

BY *M. T. McKenney*  
ATTORNEY

June 3, 1941.

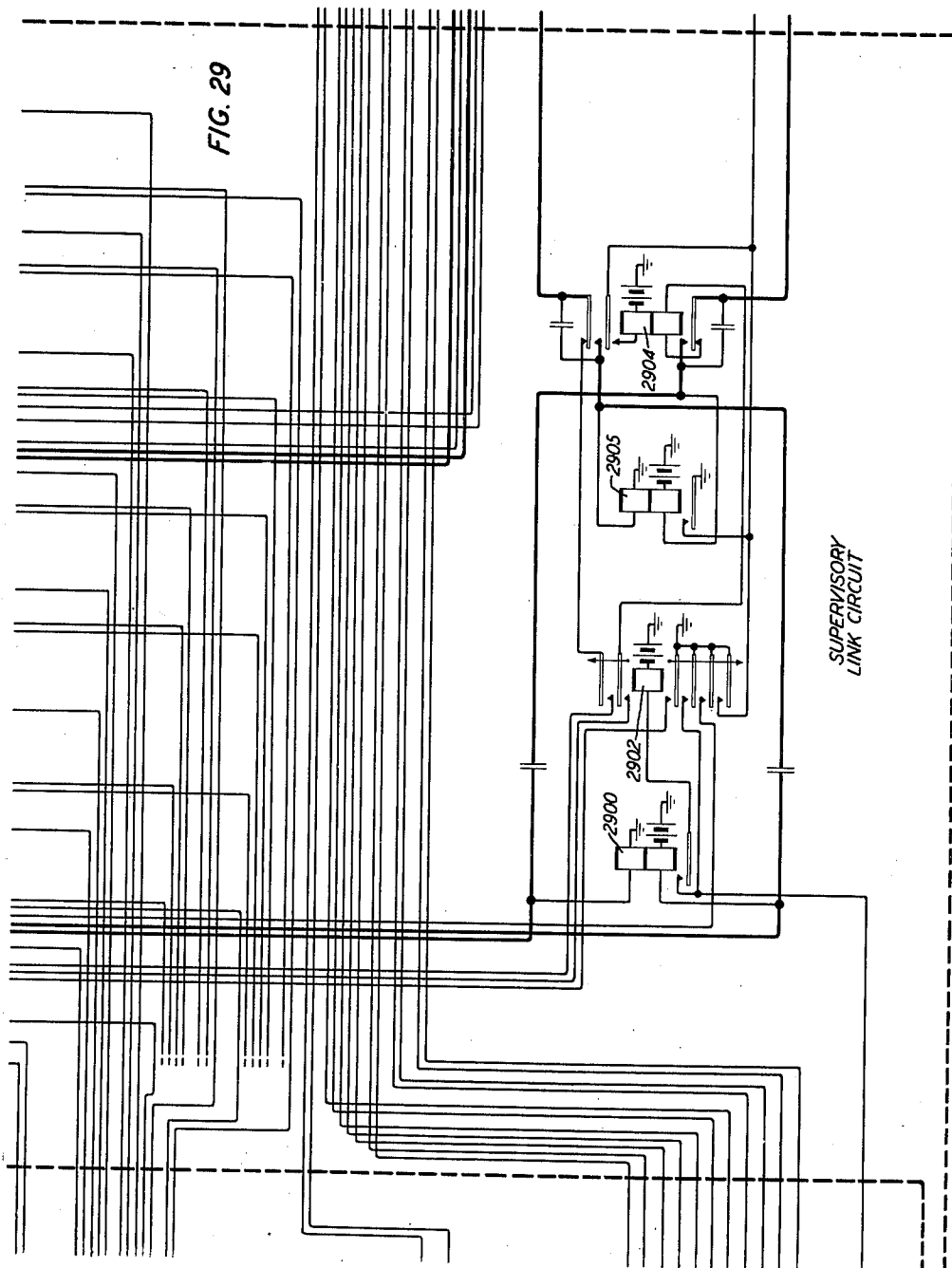
E. L. ERWIN

2,244,004

TELEPHONE SYSTEM

Filed Feb. 11, 1933

27 Sheets-Sheet 27



INVENTOR  
E. L. ERWIN

BY *W. R. McKenney*  
ATTORNEY

## UNITED STATES PATENT OFFICE

2,244,004

## TELEPHONE SYSTEM

Edson L. Erwin, Towaco, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application February 11, 1938, Serial No. 189,940

## 11 Claims. (Cl. 179—18)

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

An object of the invention is to provide a system of this kind that is economically constructed, simple in operation and easily maintained.

Another object is to provide a system in which the capacity of one installation may readily be increased with the least possible alteration in existing installations and with a minimum of added equipment.

The applicant's invention is applicable to systems of the kind in which original small capacity units for establishing connections between lines and trunks may be enlarged by adding thereto other units for other lines and trunks that may be required. The arrangement may be such that certain equipments existing in the original units are designed to serve for the establishing of connections between lines and trunks of all the units, for example, a limited number of recording devices at a common control circuit installed in the original unit may be made available in other units with the least possible interconnections between the units and with the addition of but a single switching device for each unit.

In the system illustrated cross-bar switches are employed as switching units and a feature in this respect is an arrangement whereby a recorder may be connected over a series of switches to calling subscriber's lines for the control over the establishing of independent connections over the same or other switches from one end of a link connection to the calling subscriber's line and from the other end of this link connection to the called subscriber's line and whereby when this connection is completed the connection through the switches for the recorder is released.

Another feature is the arrangement whereby connections may be established to trunks by first seizing a recorder over these switches, then establishing an independent connection over the switches from a trunk to the calling subscriber's line, and finally releasing the recorder, and whereby tie-lines may appear in some switches for seizure on outgoing calls from a subscriber's line in a unit, may appear in another switch for connections to recorders, and in still another switch as an outgoing terminal for tandem connections from other tie-lines incoming to the unit.

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

Fig. 1 shows a plan for arranging the various figures to read the circuits;

Fig. 2 shows a general schematic layout of a

private branch exchange system arranged in accordance with the present invention while the remaining Figs. 3 to 29 show detail circuit arrangements primarily of a unit of 100 lines in this private branch exchange system. Of these figures,

Fig. 3 shows typical subscribers' line circuits;

Figs. 4 to 10 show the various cross-bar switches used in establishing connections. These are shown in diagrammatic form;

Figs. 11 to 16 show a number of relays and circuits that may be called a recorder employed in setting up, or record the number of a desired connection; a plurality of these may be used in the system;

Figs. 17 to 24 show a number of relays and circuits that may be termed a control circuit the major portion of which is common to a plurality of units of 100 lines each;

Figs. 25 and 26 show one of a plurality of tie-lines;

Fig. 27 shows a zero trunk line;

Fig. 28 shows one of a plurality of central office trunk lines; and

Fig. 29 shows one of a plurality of supervisory link circuits used in establishing connections. Figs. 25 to 29 show these various circuits mentioned available to one unit of 100 lines.

Referring now particularly to Fig. 2 which shows a general schematic layout of the P. B. X. system, the general arrangement is as follows. The layout shown on the left-hand side of the dash-dotted line represents equipment employed in an originally installed switching unit which takes care of the establishing of connections for one-hundred subscribers and the layout at the right-hand side of this group of lines shows the equipment used for a second unit of 100 lines. It should be understood that several other units of one-hundred subscribers' lines may be added from time to time as required. Connections as to the lines in the original unit may be made through ten primary, five secondary and four tertiary switches. In the unit of one-hundred subscribers' lines, the lines themselves are divided in ten groups of ten each. Each group terminates in a separate primary switch. Each group has access to five junctions outgoing to five separate secondary switches. Four of the primary switches have been illustrated in this figure. There will consequently be fifty outgoing junctions which terminate in the five secondary switches with ten junctions terminating in a separate secondary switch. Three of these secondary switches have

been shown. The junctions from the primary to the secondary switches are divided in five groups of ten each. Each group has access to eight junctions outgoing from the secondary switches and terminating in tertiary switches. There will consequently be forty junctions between the secondary and tertiary switches. These may be arranged as follows: For example, the first two junctions from the first secondary switch will terminate in the first tertiary switch and the succeeding first two junctions in the succeeding five secondary switches will also terminate in the first tertiary switch. Similarly, the second group of two junctions from the five secondary switches will terminate in a second tertiary switch, and so on. All four tertiary switches have been shown. It should be observed that only eight connections are provided outgoing from each of the first three tertiary switches. These may be arranged in different manners but in general the arrangement may be as follows: There are provided three recorders 1, 2 and 3, recorder 1 terminating in the first tertiary switch, recorder 2 terminating in the secondary tertiary switch and recorder 3 terminating in the third tertiary switch. Six links 1 to 6 may be provided, the incoming branches of the first and fourth links terminate in the first tertiary switch, the incoming branches of the second and fifth links terminate in the second switch, and the incoming branches of the third and sixth terminate in the third switch. Six tie-lines 1 to 6 and six central office trunks may be provided terminating in these tertiary switches in the same manner as the incoming branches of the six links. Three zero trunks 1 to 3 may be provided to terminate one in each of the first three tertiary switches. The outgoing branches of these six links terminate in the fourth, or so-called terminating tertiary switch. There is also provided an inter-unit tertiary switch in this unit of 100 lines in which the links 1 to 6 of the second hundred lines unit terminate, while in the second hundred lines unit corresponding switches are provided in which the links 1 to 6 of the first unit terminate. These last-mentioned switches are provided for establishing connections between calling subscribers in one unit and called subscribers in another unit. There is also provided a tie-line connector switch for the six tie-lines in which connection from the three recorders may be established. It should be observed that the tie-line 6 also terminates in the last primary switch for tandem connections. A common control circuit is employed in establishing connections through these units and has been shown diagrammatically in this figure by the thinnest lines and arrows connecting the various units.

It should be understood that, while in the above description the switches have been described as individual switches in the light of the functions or use to which they are put, these switches from the point of view of construction may be arranged into other combinations. For example, the primary switches may comprise five individual switches having ten vertical and ten horizontal bars; each switch thus containing twenty subscribers' lines terminating in the ten horizontals and ten junctions to secondary switches terminating in the ten verticals. The secondary switches may comprise five individual switches for the five secondary switches, each with ten horizontal bars for ten junctions to primary switches and eight vertical bars for eight junctions to

tertiary switches. The tertiary switches may comprise four individual switches. The first, second and third switches, each consists of ten horizontal bars for ten junctions from secondary switches and eight vertical bars for eight outlets to recorders, link and trunks, while the fourth switch consists of ten horizontal bars for junctions to secondary switches and two groups of vertical bars, one group for links in the first 100 line unit and the other group for links in the second hundred line unit. The tie-line connecting switch may comprise a single switch with six horizontal bars for six tie-lines and nine vertical bars, three for each recorder.

The cross-bar switches disclosed herein may be of the type shown in the patent to Reynolds No. 2,021,329 of November 19, 1935.

A description will now be made of the various types of calls that may be established in this system. In case of a line-to-line call in a unit such as the one shown at the left of the dash-dotted line, a calling line 200 will establish a connection through the first primary switch over any idle one of the five junctions extending from this switch to a corresponding secondary switch and from there through any idle one of the first six junctions terminating in any one of the three first tertiary switches. From the tertiary switch the call is extended to the recorder that happens to be terminated in the tertiary switch to which a connection has been made and this recorder is then seized. Simultaneously to the connection of the recorder, the common control circuit equipment is appropriated for controlling the establishing of connections. A path to the first recorder has been marked in heavy lines as extending from the subscriber at 200 over the first junction between the first primary and first secondary switches, and the first junction between the first secondary and the first tertiary switches to the first recorder. When this connection has been established the calling subscriber dials the number of the desired subscribers' line into the recorder while the control circuit is temporarily released. After dialing is completed the control circuit is again appropriated for the control of the establishing of the connection to the called line. The control circuit selects an idle supervisory link and causes, for example, if link 1 has been chosen, the incoming branch of link 1 to be extended over tertiary, secondary and first primary switches to the calling subscriber's line. A path for this connection has been shown in heavy lines as extending from the incoming branch of link 1 over the first tertiary switch, the fifth secondary switch and the first primary switch. The recorder will then control the control circuit to cause a connection to be established over a path from the outgoing branch of this link over the terminating tertiary switch, a secondary switch and a primary switch to a called subscriber's line, for example, subscriber's line 201 in the secondary primary switch. The path through these switches is also marked in heavy lines as extending over the terminating tertiary switch to the first secondary switch and the second primary switch to the subscriber 201. Tests to determine these various paths are made by the control circuit and when the connections are established and the called subscriber has been rung and answered, the connection from subscriber 200 to the recorder through the switches is released and the recorder and the control circuit are restored to normal and released. Conver-

sation between the two subscribers 200 and 201 may then take place.

If a connection is desired from the subscriber's line 200 to a central office trunk, tie-line or zero trunk, the line is first connected as heretofore described to a recorder. The calling subscriber in this case dials a certain digit, for example, 8 or 9 for central office trunks, 6 or 7 for tie-lines, or 0 for zero trunks. A connection from an idle central office trunk, tie-line, or zero trunk is thereby established to the calling subscriber's line over one of the first three tertiary switches, a secondary and a primary switch and the recorder and control circuit are then released. Paths to the calling line 200 for these types of connections have been marked in heavy lines. For example, for the central office trunk 1 the connection extends over the third tertiary switch, the fifth secondary switch and the first primary switch. A connection from the sixth tie-line extends over the third tertiary switch to the fifth secondary and the first primary switches and a connection from zero trunk 1 extends over the second tertiary switch over the same path as tie-line 6 to the calling subscriber 200 over the secondary and primary switches.

In case of a connection from a tie-line to a called subscriber, such as 200 in this unit, a connection is established first through the special tie-line connector switch to a recorder, the number of the called subscriber's line is then registered in this recorder and by the aid of the control circuit a connection is established over tertiary, secondary and primary switches from this tie-line to the called subscriber's line 200. Such a connection is marked in heavy lines and extends from tie-line 6 over the tie-line connector switch to the recorder 1 and from tie-trunk 6 over the third tertiary switch, the fifth secondary and first primary switches to the subscriber 200. When the connection has been established to the subscriber at 200, the recorder and the control circuits are released as usual.

In case of a connection from one tie-line to another in tandem through this unit, the tie-line 6, for example, may be specially arranged for this type of call by terminating in a primary switch in the same manner as a subscriber's line. When this tie-line seizes the recorder 1 over the tie-line connector switch and the number of the tie-line in another exchange is registered, a connection is established to the calling tie-line in the tenth primary switch from a called tie-line in the same manner as any subscriber's line is connected to a called tie-line. This type of connection is marked in heavy lines and may extend from tie-line 6, through the tie-line connector switch to the recorder 1 and from the tie-line 1 through the first tertiary switch, the fifth secondary switch and tenth primary switch to tie-line 6.

In case a connection is desired from a subscriber in the first unit at the left-hand of the dotted line to a subscriber in the second unit at the right of the dotted line, the connection may be established, for example, from subscriber 200 to a recorder. After the desired subscriber's number has been dialed, the recorder and the control circuit establish a connection from the incoming branch of a link to the calling line over a tertiary, secondary and primary switch and from the outgoing branch of a link over the inter-unit tertiary switch in the second unit and from there through a secondary and a pri-

mary switch in this second unit to the desired subscriber's line. This connection is marked in heavy lines and extends from subscriber 200 to recorder 1 and from link 1 over the incoming branch back through tertiary, secondary and primary switches to the calling subscriber 200 and from the outgoing branch of this link through the inter-unit tertiary switch of the second hundred unit through a secondary and a primary switch in this unit to the desired subscriber's line in the same manner as has been shown in heavy lines from link 1 through a secondary and primary switch in the first unit. In the case of a connection from the second unit to a subscriber in the first unit, the connection is established from the calling subscriber through a primary, secondary and tertiary switch in the second unit to one of the recorders in the first unit and then a link in the second unit is seized. The incoming branch of this link is then connected to the calling subscriber's line in the usual manner through a tertiary, secondary and primary switch in the second unit while the outgoing branch of this link is connected through the inter-unit tertiary switch in the first unit and from there through a secondary and primary switch in the first unit to the called subscriber's line. It will therefore be seen that the recorders and the control circuits in the first unit are employed in all connections between a subscriber in any unit, while a link in the unit in which the call originates is always used.

A detailed description will now be made of the various calls mentioned above using the Figs. 3 to 29. The first call to be described is one from a calling subscriber 300 to another subscriber in the same unit, for example, subscriber 301. When the subscriber at 300 removes his receiver from the switchhook, relay 303 operates over the tip and ring conductors and contacts of relay 304. Relay 303 in operating applies a connection to ground for the operation of relay 2100 from battery, winding of this relay, contacts of relays 2101, 1900 and 303 to ground. Relay 2100 is one out of a group of ten relays each common to ten lines terminating in a separate primary switch and is the first one in the group, as the calling subscriber's line 300 terminates in the first primary switch. Only one of the remaining nine relays has been shown, that for the ten lines in the tenth primary switch. This latter relay is marked 2102. In other words, relay 2100 will operate when any one of the ten lines in the first primary switch is calling and similarly other relays in this group will operate when subscribers in the corresponding succeeding primary switches are calling. Thus, relay 2100 identifies the group of ten lines in which the calling line is located. This relay 2100 now closes the circuit for the operation of relay 2104, which is individual to this unit of 100 lines. There is a similar relay for every succeeding unit of 100 lines. The relay 2105 of the next unit of 100 lines has been shown. This relay 2104 is locked to ground at relay 2100 and acts as a lock-out relay against other groups of 100 lines seizing the control circuit. Relay 2104 closes a circuit for the operating relay 2101 to prevent the operation of other relays, such as 2102, should calls be started in other groups of ten lines.

The operation of relay 2101 closes a circuit for the operation of relay 1700 from battery, winding of this relay, contacts of relay 1701, 1702, 1703, 1704, 1201 to ground. It should be noted that relay 1700 will not operate if the common

control circuit is already in use, since the operating circuit for relay 1700 is connected through break contacts of relays 1703 and 1704 either one of which may be operated during such use. The relay 2300 will now operate from battery, winding of this relay, contacts of relay 1700 to ground, and relay 2100 is locked to the same ground. Relay 2300 closes an obvious circuit for the operation of relay 2301. These two relays are provided for the selection of a recorder, as will hereinafter be described. There are other similar relays in this Fig. 23 that serve similar purposes for link selections, tie-line selections, central office trunk selections and zero trunk selections. Relay 1700 also operates relay 1901 from battery through the winding of this relay, contacts of relays 2100, 2101, 2104 and 1700 to ground. Relay 1901 is one of ten relays provided with one relay for each group of ten lines terminating in a separate primary switch. Only the first and last relays of this group have been shown, the last relay being numbered 1902. Relay 1901 causes the operation of relay 2200 over an obvious circuit and also closes the circuit for the operation of the slow-to-release relay 1800 from battery, winding of this relay, contacts of relays 1700, 1901 and 1900 to ground. Relay 2200 closes a circuit for the operation of relay 2205 from battery, winding of this relay, contacts of relay 2200 and 1708 to ground. Relay 1901 furnishes ground connections for the operation of a group of relays 1802 and 1903, which represents the first and the last of a group of ten relays. The circuit for these relays 1802 and 1803 and intermediate relays, extend from the windings of these relays through contacts of the relays 1804 and 1901 through contacts of relay 1900 to ground at relay 303. As only two of these relays have been shown, only the corresponding contacts of through-relays 1901 and 1910 have been shown. When all of these ten relays have operated, a circuit is closed for the operation of relay 1804 from battery to the winding of this relay, series contacts through these relays 1803 and 1802 and intermediate relays, relay 1800 to ground. Relay 1804 locks through its lower armature and front contacts through contacts of relays 1700 and 1702 to ground, and opens the operating circuits for relays 1802, 1803 and intermediate relays, and also furnishes ground for the operation of relay 1900 from battery, winding of this relay, contacts of relays 1901, 1800, 1804 to ground at relay 1702. There are ten of these relays like 1900, the first of which is the relay 1900 and the last is numbered relay 1903, the intermediate relays being omitted. Each of these relays represents a group of ten lines. Relay 1900 also opens the operating paths for the ten relays 1802, etc., permitting all of them to release except the one corresponding to the calling lines. In this case, relay 1803 remains operated as this relay represents the calling line, its locking circuit extending through its cross contacts, contacts of relays 1900 and 303 to ground. Relay 1900 also opens the circuit for relay 1800, which releases and closes a circuit for the operation of relay 1806 from battery, winding of this relay, contacts of relays 1800, 1804, 1700 and 1702, to ground. Relay 1806 furnishes ground over the operated relay 1803 for the operation of the primary switch selecting magnet corresponding to the level in which the calling line is located on the primary switches. In this case, the line from the subscriber 300 is located in the upper or tenth level of the first

primary switch. Hence, the selecting magnet 400 is operated over a circuit from battery, winding of this magnet, contacts of relays 2200 and 1803, contacts of intermediate relays, relay 1802 to ground at contacts of relay 1806.

The operation of relay 1901 which corresponded to the group of ten lines in which the calling line is located also closes circuits from ground at contacts of the holding magnets of the five junctions which serve the first group of ten lines to the windings of five relays, the first and the last of which have been shown. The first of these relays is numbered 2202 and the last 2203, the intermediate relays being omitted. Each of these five relays will operate provided its corresponding junction between this primary switch and secondary switches is idle, each of these relays representing a separate junction. The circuits for these relays may be traced from battery through the windings thereof, contacts of relay 1901 to ground at the holding magnets of the first primary switch. Two of these holding magnets have been shown. The first is marked 403 and the second 404. There are three relays marked respectively, 2000, 2004 and 2002 corresponding to the three tertiary switches. When there is an idle recorder or recorders available on a particular tertiary switch, the corresponding relay 2000, 2001 or 2002 associated with that switch will operate. For example, if the first recorder which has been shown in detail in this circuit is idle and is available over the first tertiary switch, relay 2000 will operate over a circuit from battery, winding of this relay, contacts of relays 2301 and 2200, contacts of the first holding magnet 800 on the first tertiary switch over the GT lead to ground at relay 1300 in the recorder. If the recorders available over the second and third tertiary switches are idle, the corresponding relays 2001 and 2002 will operate over similar circuits. The relays 2000, 2001 and 2002 close circuits for three other relays 2003, 2004, and 2005 from ground at the contacts of holding magnets for the secondary switches. Each relay represents a separate secondary switch and five groups of two junctions each, between the secondary and tertiary switches, for example, relay 2003, receives ground from holding magnets for the first and second junctions between the first to fifth secondary switches to the first tertiary switch, while relay 2004 receives ground from holding magnets for the third and fourth junctions between the first to fifth secondary switches to the second tertiary switch, etc.

If all of these junctions are available, all three relays will operate. For example, relay 2003 will operate from battery, winding of this relay, contacts of relays 2000, 2006, 2202 to ground at the contacts of the first and second holding magnets 600 and 615 of the first secondary switch. The other relays 2004 and 2005 will operate over similar circuits. If there is an idle junction from the first primary switch to the first secondary switch and from this first secondary switch to the first tertiary switch, relay 2003 in operating may operate relay 2400 from battery, winding of this relay, contacts of relays 2205, 2003, 2007 and 2006 to ground at relay 1706. As noted, only one recorder is shown available from each tertiary switch. In case more than one recorder is idle, only one recorder will, of course, be chosen. This is determined by relays 2007, 2008 and 2009 that operate to rotate the choice of idle recorders between the three tertiary switches. If re-

lay 2007 is released, relay 2400 will operate as described. If relays 2007 and 2008 are operated, the recorder available in the second tertiary switch will be chosen by the operation of a relay corresponding to relay 2400, not shown, and if relays 2007 and 2009 are operated the recorder available with three tertiary switches will be chosen by the operation of relay 2403. Each time relay 2018 changes its position, a shift in the relays 2007, 2008 and 2009 occurs, which permits the rotation of operation of relay 2400, an intermediate relay and relay 2403. If it is assumed, then, that the recorder shown in the drawings is idle, it is chosen on the operation of relay 2003 as soon as this has caused the operation of relay 2006 from battery through the winding of this relay, contacts of relay 2003 to ground at relay 1702, as the above circuit for relay 2400 is then closed. It should be noted that relay 2006 in operating opens the circuits for testing for idle junctions between secondary and tertiary switches and operates relay 2018 over an obvious circuit. Relay 2018 shifts the relays 2007, 2008 and 2009 to control the choice of idle recorders. Relay 2006 also closes a circuit for relay 2011 from battery through the winding of this relay, contacts of relays 2006, 1710, 2012 and 1708 to ground at relay 1901.

Relay 2011 closes circuits for the windings of a group of ten relays, two of which have been shown, 1811 and 1812, through contacts of relays 2011, 2202 and 2203 and intermediate relays, contacts of relay 2400 to ground at contacts of the ten holding magnets of the secondary switches corresponding to the junctions between these switches and the first tertiary switch selected by the relay 2003 for the connection to the recorder in this switch. The operation of any or all of the relays of this group indicates that there are paths available from the calling line over junctions to the secondary switch associated with the relay or relays operated. If relay 1811 operates, it shows that the first junction between the first primary and the first secondary switch is idle. Relays 1811 and 1812 and the intermediate relays are so wired that when more than one of them operates, only one is effective. Any one of these relays may be in a preferred position, depending upon which one of the ten relays 1901, etc., is operated. If relay 1811 is operated from the ground at contacts of the hold magnet 600, this causes the operation of the tertiary selecting magnet, corresponding to the junction between the first secondary switch and the first tertiary switch associated with this relay and holding magnet. In this case therefore the tertiary selecting magnet 802 is operated from battery through the winding of this magnet, contacts of relays 2400 and 1811 to ground at relay 1901. It should be noted that the secondary switch selecting magnet corresponding to the group of ten lines in which the calling line is located and the level in which the junctions originating in the first primary switch terminate in the secondary switches will operate on the operation of relay 1901. In this case the selecting magnet 601 will operate, as the first junction between the first primary and first secondary switches is the one employed as part of the path to the recorder. The circuit for this magnet may be traced from battery, winding thereof, contacts of relay 1901 to ground.

The operation of relay 2400 also closes circuits through contacts of holding magnets of the tertiary switch for connecting recorders

through these switches, through the windings of ten relays and other relays, of which 1712 and 1713 only have been shown. These relays are wired in a chain circuit and perform the function of connecting the particular recorder to be used on this call. As the first recorder has been chosen by the choice of the first tertiary switch, the relay 1712 will operate from battery through contacts of relay 1713, winding of relay 1712, contacts of relays 2300 and 2400, contacts of holding magnet 800, the BT lead to ground at relay 1500. Relay 1712 locks to ground at relay 1702 and operates relay 1120 from battery, winding of this relay, contacts of relays 2401, 1712, 1706, 2300, 1802, etc. to ground at relay 1901. Returning same to the operation of relay 1811 it should be observed that this relay causes the operation of relay 2012 from battery, winding of this relay, contacts of relays 1901, 1811, 2011, 2202 and 2400, contacts of holding magnet 600 to ground. Relay 2012 closes a circuit for relay 2014 from battery, winding of this relay, contacts of relays 2012, 1700 and 1708 to ground. Relay 2014 closes an obvious circuit for relay 2015. The operation of this last two-mentioned relay is for the purpose of providing a proper time interval between the operation of the selecting magnets and the holding magnets. Relay 2015 operates the holding magnet 800 of the first tertiary switch from battery, winding of this magnet, contacts of relays 2400, 1712, 1708 and 2015 to ground. This contacts the recorder at the cross-connecting point 804 of the first tertiary switch to the junction 603 between this switch and the first secondary switch. A circuit is now completed over the sleeve of this junction 603 for the operation of the holding magnet 600 of the first secondary switch. This magnet operates from battery winding of this magnet over the sleeve circuit of junction 603 to ground at the cross-connecting point 804 of the first tertiary switch. A connection is then established between this junction 603 and junction 406 between the first secondary switch and the first primary switch over a connection at the cross-connecting point 604. On the establishing of this connection a circuit is completed for the holding magnet 403 for the first junction 406 of the first primary switch to the calling subscriber's line at the cross-connecting point 408. The circuit for this holding magnet 403 may be traced from battery through the winding of this magnet to ground at the cross-connecting point 604. The tip and ring conductor of the calling line are now extended through the first primary, first secondary and first tertiary switches to the first recorder. Relay 304 is now operated over the sleeve connection through the cross-connecting point 408 to ground and this releases relay 303. Relay 304 in operating extends the connection from the calling subscriber's line to a jack 306, to which an operator may make a connection in case she wants to monitor on the calling subscriber's line. This sleeve circuit is also extended for the operation of a release relay that will release the control circuit as this circuit is not required further until the number of the desired subscriber's line has been recorded. This relay is marked 1702 and the circuit may be traced from battery through the winding of this magnet, contacts of relay 1700, contacts of relay 1802, intermediate relay and relay 1803, contacts of 1901, cross-connecting point 408 of the first primary switch to ground.

The operation of relay 1702 causes the re-



lease of the control circuit, but the cross-connecting points through the switches mentioned are held from ground in the recorder circuit over a lead LK. However, before the recorder circuit can furnish this ground on lead LK for holding the switches operated, the line relay 1301 in the recorder circuit must operate over the tip and ring conductors of the subscriber's line which takes place on the establishing of the connection from the recorder to the other subscriber's line. Relay 1301 operates relay 1302 which completes the connection to ground for the LK lead, over contacts of relays 1502 and 1310. In order to insure that the control circuit does not remove the operating ground from the holding magnet 800 before this locking ground is available, the control circuit maintains the operating ground until the slow-release relays 2014 and 2015 have released. The release of the relays operated in the control circuit now takes place in approximately the following order: 1804, 1806, 1803 and the primary selecting magnet 400. Also in the series beginning with the release of relay 1700, 2100, 2104, 2101, 2300, 2301, 2000, 1901, 1811, 2200, 2205, 2202, etc. and 1900, secondary selecting magnet 601 and tertiary selecting magnet 802, relays 2012, 2014, 2015, 2003, 1712, 2006, 1702 and 2400. The connection from the calling subscriber's line to the recorder is now therefore completed.

When the recorder has been seized and the line relays 1301 and 1302 are operated, relay 1303 is also operated from battery, winding of this relay, contact of relays 1300 and 1301 to ground. Relay 1300 also operates over a circuit to ground at relay 1302. The operation of relay 1302 connects, as mentioned, the ground to the LK lead for locking the operated holding magnet in the tertiary switch and closes a circuit for the operation of relay 1101 from battery, winding of this relay, contacts of relays 1102 and 1304 to ground at relay 1300. Relay 1300 opens the operating circuit for relay 1303 which, however, locks over its own contacts directly to ground at relay 1301. Relay 1302 closes the circuit for transmitting dial tone to the tip conductor of the calling line through condenser 1100 from the tone ringing and pulsing circuits at 1716 which is started over the ST lead operating the 1309 relay which closes a circuit to ground over the PU1 lead to the circuit 1716. The operation of relay 1101 prepares a path for storing the first or hundred digit to be dialed on the storing relays 1103, 1104, 1105 and 1106.

The subscriber may now dial the hundred digit and relay 1301 follows the dial pulses. When relay 1301 first releases, it causes the release of relay 1303 while relay 1302 which is slow in releasing remains operated during dialing. The release of relay 1303 operates the relays 1305 and 1306 in a circuit from battery, winding of relay 1305, contacts of relay 1303 to ground at relay 1300, and from battery winding of relay 1306, contacts of relays 1307, 1308, 1303 and 1304 to ground at relay 1300. The operation of relay 1305 prepares ground for locking the counting relays 1200 to 1205 and the pulsing relays 1306, 1307 and 1308. The operation of relay 1306 closes a path for locking in series with relay 1308 and closes a path for reoperation of relay 1303 when relay 1301 again operates and also prepares a locking path for relay 1303. At the end of the first impulse relay 1301 operates and as relay 1306 has already operated, relay 1303 will reoperate from bat-

tery winding of this relay, contacts of relays 1308, 1306 and 1301 to ground. The operation of relay 1303 opens the circuit for the operation of relay 1305 and removes the short circuit for the primary winding of relay 1308. Relay 1308 then operates in series with relay 1306 from battery, winding of relay 1306, contacts of relay 1307, contacts of relay 1306, upper winding of relay 1308, contacts of relays 1305 and 1304 to ground at 1300. Before relay 1305 releases, when relay 1308 operates it is locked with relay 1305. When relay 1301 again releases at the beginning of the second impulse relay 1303 again releases. The release of relay 1303 again closes the circuit for relay 1305 and a circuit for the operation of relay 1307 from battery, winding of this relay, lower winding of relay 1308 and its lower armature and front contact, contacts of relays 1303 and 1304 to ground at relay 1300. Relay 1308 therefore remains operated while on the operation of relay 1307, relay 1306 releases and prepares a path for the reoperation of relay 1303, when relay 1301 again operates and prepares a locking path for relay 1303. At the end of the second impulse relay 1301 reoperates, causing the reoperation of relay 1303, which opens the circuit for relay 1305 and causes the release of relays 1307 and 1308. Subsequent odd and even pulses causes relays 1306, 1308 and 1307 to operate as described, relay 1306 operating on each odd pulse and releasing on each even pulse. Relay 1302 is slowly released and maintained operated during the sending of the pulses of this digit. The relay 1305 is also slow to release and operates at the beginning of the digit and holds until the end of the digit.

The operation of these relays causes alternate impulses to be transmitted over the odd and even lead for the operation of the counting relays 1200 to 1205. When relay 1306 operates on the first dial pulse, it causes the operation of relay 1200 over the odd lead as follows: From battery, winding of relay 1200, contacts of relays 1204, 1205, 1202, 1201, 1306, 1501 to ground at 1502. Relay 1200 locks over a chain circuit through its lower inner armature and front contact and contacts of relays 1201, 1202, 1205, 1204, 1305 and 1304 to ground at 1300. Relay 1200 prepares an operating path for the relay 1201. When relay 1306 releases on the second impulse, it causes the operation of relays 1201 and 1107. Relay 1201 operates from battery through the winding of this relay, contacts of relays 1200, 1306, 1501 to ground at 1502. The circuit for relay 1107 extends from battery through the winding of this relay and its make-before-break contacts, contacts of relay 1101 to ground at relay 1201. The operation of relay 1107 disconnects dial tone from the ring conductor on the calling subscriber's line. It closes a locking circuit for its primary winding under control of relay 1102 to ground at relay 1300 and prepares a locking circuit for its upper winding under control of relay 1305. Relay 1201 locks under control of relay 1305 over the same chain circuit as relay 1200 was operated which now releases and relay 1201 prepares a path for the operation of relay 1202. In like manner on the third, fourth and fifth pulses the relays 1202, 1205 and 1204 operate. As each of these relays operates, it releases the preceding relay and prepares the operating path for the succeeding relay. When relay 1306 releases on the sixth impulse, it causes the operation of relay 1203 over

a circuit from battery, winding of this relay, contacts of relay 1204, contacts of relays 1500, 1200, 1306, 1501 to ground at 1502. Relay 1203 locks under control of relay 1305 and prepares a circuit for the operation of relay 1200. When relay 1306 operates on the seventh impulse, it causes the operation of relay 1200, which prepares a locking circuit for itself, causes the release of relay 1204 and closes a path for the operation of relay 1201. The release of relay 1204 closes a locking circuit for relay 1200. On the eighth, ninth and tenth impulses the relays 1201, 1202 and 1205 operate in the same manner as described for the second, third and fourth impulses.

As the counting relays 1200 and 1205 operate in this manner on the first digit, ground is connected to cause the operation of relays 1103, and 1106. Relay 1103 operates on the operation of relay 1200 over a circuit from battery to the upper winding of this relay, contacts of relay 1101, contacts of relay 1200 to ground. Relay 1104 operates on the operation of relay 1201. Relay 1105 operates on the operation of relay 1205. Relay 1106 operates on the operation of relay 1203. Relays 1103 and 1104 operate on the operation of relay 1202. Relays 1103 and 1105 operate on the operation of relay 1204. Hence, combination of these relays 1103 to 1106 operate in different manner, depending on the number of impulses transmitted in the first digit. At the end of this first digit relay 1305 releases and closes a connection to ground for locking whichever of these storing relays 1103 to 1105 are operated and for the operation of relay 1102. This circuit may be traced from battery, windings of relays 1102, 1103, 1104, 1105, contacts of relays 1101, 1100, 1305, 1304 to ground at 1300. Relay 1102 closes a locking circuit for itself and the operated storing relays, and causes the release of relay 1101 and the operation of relay 1109 from battery winding of this relay, contacts of relays 1110 and 1102 to the locking circuit to ground at relay 1300.

When relay 1305 operates at the beginning of the second or tens digit, it releases relay 1107 which prepares a path for operating relay 1110 at the end of the second digit. The operation and release of the counting relays in response to the second digit causes the operation of the storing relays 1112, 1113, 1114 and 1115 in combinations similar to the operations of relays 1103 to 1106. For example, relay 1112 is operated over a circuit from battery through its upper winding, contacts of relay 1109 to ground at relay 1200. Similarly, relay 1113 operates on the operation of relay 1201; relay 1114 on the operation of relay 1205; relay 1115 on the operation of relay 1203, relays 1112 and 1113 on the operation of relay 1202, and relays 1114 and 1112 on the operation of relay 1204. If relay 1115 operates on the operation of relay 1203, it immediately locks up under control of relay 1300. At the end of the digit when relay 1305 releases, it provides ground for locking whichever combinations of the relays 1112 to 1115 may be operated and for the operation of relay 1110 from battery, winding of this relay, contacts of relays 1109, 1107, 1305 and 1304 to ground at 1300.

The operation of relay 1110 closes a locking circuit for itself and for whichever relays of the group 1112 to 1115 are operated and causes the release of relay 1109. This prepares a path

for the operation of relay 1107 at the beginning of the third digit.

When the counting relays 1200 to 1205 operate in response to the third or unit digit, relay 1107 operates immediately on the first impulse on the operation of relay 1200. The circuit for relay 1107 in this case extends from battery, lower winding of this relay and its make-before-break contacts, contacts of relay 1110, contacts of relay 1200 to ground. It should be noted that in this case relay 1107 operated on the first impulse, whereas during the dialing of the previous digits, it operated on the second impulse. Relay 1107 locks to ground on relay 1300 and provides a path independent of relay 1305 for locking the counting relays through its lower outer armature and front contacts, contacts of relays 1110 and 1504 to ground at 1300. Therefore, in this case the last or third digit is registered on the counting relays 1200 to 1205. At the end of this digit when relay 1305 releases, relay 1500 operates over a circuit from battery, winding of this relay, contacts of relays 1110, 1107 and 1304 to ground at 1300. Relay 1500 closes an obvious circuit for relay 1501.

As the dialing is now completed and relays 1500 and 1501 are operated and the control circuit is now idle, relay 1703 operates over a circuit from battery, winding of this relay, contacts of relays 1702, 1704 and 1700 over the start lead, contacts of jack 1503, contacts of relays 1310, 1311 and 1501 to ground. This relay closes a circuit for the operation of relay 1600 from battery to the winding of this relay, contacts of jacks 1503, 1310, 1311, 1501 and 1106 to ground at relay 1300. Relay 1600 prevents other recorders from seizing the control circuit. It should be mentioned at this time that the storing relay 1106 will not be operated in this case as of the hundred digits that may be dialed for the selection of a subscriber's line in a 100 line unit only digit 2, 3, 4 or 5 may be dialed as the system is designed for an ultimate capacity of only four-hundred lines. Relay 1600 closes a circuit for the operation of relay 1400 from battery, winding of this relay, contacts of relays 1600, 1601 and 1602 to ground. Relay 1400 closes a circuit for the operation of relay 2401 from battery, winding of this relay, contacts of relays 1400, 1708 and 1702 to ground. Relay 2401 operates as this relay corresponds to the first tertiary switches over which the first recorder is accessible. In case another recorder has been chosen, the relay corresponding to the tertiary switches over which this other recorder is accessible would have been operated, such as for example, relay 2404 for the third group of tertiary switches. Relays 2304 and 2305 are now operated to initiate the selection of an idle link such as is shown in Fig. 29 for connecting, first, the calling subscriber's line to the incoming end of the idle link through a primary, secondary and tertiary switch, and then the outgoing end of this link to the called subscriber's line through the terminating tertiary switch, a secondary and a primary switch. The operating circuit for relay 2304 extends from battery, winding of relay 2304, contacts of relays 1400, 1603, 1501 and 1106 to ground at 1300. Relay 2304 closes a circuit for relay 2305. To initiate the connection of the incoming end of a link to the calling subscriber's line over a path for the switches, the primary selecting magnet 400 is again operated over a circuit from battery, winding of

magnet 400, connection at points 408, 604 and 804, contacts of relays 1400 and 1710 to ground.

In response to the operation of relay 2401 one of the relays 2106 to 2107 is also operated. There are five of these relays common to the ten groups of lines. The relay 2106 will in this case operate from battery, left-hand winding of relay 2106, contacts of relay 2401 through cross-connecting point 804 over the sleeve lead contacts of relays 1400 and 1710 to ground, as this relay represents the first two levels of junctions terminating on the tertiary switches. As relay 2106 operates, it closes the circuit for relay 1901, which is common to the first group of ten lines. This circuit may be traced from battery, winding of relay 1901, contacts of relay 1206, the cross-connecting points 604 and 804, contacts of relays 1400 and 1710 to ground. Relay 2200 now operates over an obvious circuit and all of the relays in the group 2202 and 2203 and intermediate relays except relay 2202, as this relay will find no ground at the holding magnet of a primary switch as the first holding magnet 403 is operated, as the first junction between the first primary switch and the first secondary switch is occupied by the connection to the first recorder. If all other relays in this group operate, it indicates that all the other junctions to the other four secondary switches are idle. The circuit for these relays have already been traced. These relays therefore test for both junctions between primary and secondary switches. Relay 1901 also closes an obvious circuit for the operation of the selecting magnet 601 of the secondary switches. Relays 2000, 2001 and 2002 now test for an idle link in the same manner as they tested for a recorder. If it is assumed that the first link in the first tertiary switch is idle, relay 2000 will operate from battery, winding of this relay, contacts of relays 2305 and 2200 over the first link lead through contacts of the holding magnet 806 to ground. The incoming end of this link will therefore be the one chosen for establishing a connection to the calling line. Relay 2200 also operates relay 2205 over a circuit already traced. The corresponding relay 2003 now operates from the relay 2000 depending on which of the relays 2202, intermediate relays or relay 2203 are operated, as grounds will be supplied over contacts of those operated. These grounds are as hereinbefore described, in connection with the selection of a recorder, at contacts of holding magnets of the secondary switches and indicate whether or not there are any idle junctions between the first tertiary switch and the secondary switches. As soon as relay 2003 is operated, relay 2006 operates from battery, winding of this relay, contacts of relay 2003 to ground at relay 1702. Relay 2011 is now operated from ground at contacts of relay 2400, as heretofore described.

Some of the relays in the group 1812, intermediate relays and relays 1813 will now operate. If the relay 2202 is not operated due to the first junction between the first primary and first secondary switches being occupied, relay 1812 will not operate, nor can the next relay in this group operate even though a ground is furnished at the contacts of the holding magnet for the second junction between the first secondary and the first tertiary switches. Consequently, this junction will not be used as there is only one junction available between the first secondary and first primary. Therefore some junction between the

first tertiary and any one of the remaining secondary switches must be chosen, and this choice depends in turn on whether or not there is any other junction available between the first primary and any one of the remaining secondary switches. If it is assumed that only the fifth junction from the first primary is available, relay 2203 only can operate and consequently as this junction terminates in the fifth secondary switch, one of the pairs of junctions between the first tertiary and the fifth secondary switches must be chosen. If, for example, the ninth junction from the first tertiary switch terminating in the fifth secondary switch is idle, the ninth relay in the group 1812, etc., will operate from battery through the winding of this relay, contacts of relay 2011, contacts of relays 2203 and 2401, contacts of the holding magnet 700 to ground. This relay operating, therefore, causes the ninth select magnet in the first tertiary switch to operate. This select magnet is marked 807 and a circuit therefore may be traced from battery through the winding of this magnet, contacts of relay 2200, contacts of the relay in group 1812, etc. and back contacts of the intermediate relay and the back contacts of relay 1812 to ground at relay 1901. One of the relays in the group 1712 to 1713 will now operate and the one representing the first link will operate over a circuit from battery through contacts of relay 1713, intermediate relays and the windings of the relay in this group representing the first link which will be the second relay after relay 1712 and from there over the contacts of relays 2304 and 2400 to ground at the holding magnet 806 of the first link. The ninth relay in the group of relays 1811, etc. also operates relay 2012 by ground at the inner right-hand armature and front contact and relays 2014 and 2015 are then operated as heretofore described, as well as the tertiary holding magnet 806 from battery, winding of this magnet through contacts of relay 2400, one of the relays in the group 1712, etc. corresponding to the first link, that is, the relay next to relay 1712, contacts of relays 1708 and 2015 to ground. The corresponding secondary holding magnet 700 is now operated from battery through the winding of this magnet through contacts 809 to ground. The corresponding primary holding magnet 404 is now operated from battery, winding of this magnet, contacts 702 to ground. The calling subscriber's line is now connected to the incoming end of the supervisory link over the junction 409 between the first primary switch and the fifth secondary switch and over the junction 607 from the fifth secondary switch and the first tertiary switch over the cross-connecting points 411, 702 and 809.

As the connection through the switches is now set up from the calling subscriber to the incoming end of the link, a ground is provided for the operation of relay 1708 from battery through the winding of this relay, contacts of relays 2304 and 1706, the relay in the group 1712 to 1713 that is operated and relay 2400, cross-connecting points 809, 702, 411, 408 and 604 to ground. Relay 1708 locks to relay 1702. The operation of relay 1708 opens the circuit for the release of relays 2401, 2106, 1901 and 2200, selecting magnet 601 of the first secondary switch, selecting magnet 807 of the first tertiary switch, the relays operated in the group 2202 to 2203, and relays 2000, 2003, 2012, 2006, 2011 and the relay that is operated in the group 1812 to 1813, as well as relays 2014 and 2015. On the release of relay 2015 the relay 1710 is operated from battery, winding of this

relay, contacts of relay 2015 and 1708 to ground. Relay 1710 closes a circuit for the operation of relay 2209 from battery, winding of this relay, contacts of relay 1710 and 2304 to ground. Relay 1710 also opens the circuit for the selecting magnet 400 of the first primary switch. Returning now to the operation of relay 1708, relay 1814 is operated from battery, winding of this relay, contacts of relay 1702 to 1708 to ground. Relay 1804 closes the circuit for the operation of relay 2109. This relay is provided for the first unit of 100 lines and similar relays are provided for succeeding units. The circuit for relay 2109 may be traced from battery, winding of this relay, contacts of relay 1814 and 1400 through contacts of the storing relays for the one hundreds digit, in this case over contacts of relays 1106 and 1104 to ground at 1103. It should be observed at this time that the storing relays for the one hundreds digit may be operated in response to the various digits dialed. In this particular system the digits 2, 3, 4 and 5 are dialed for the selection of different units of 100 lines each. If the called subscriber in this case is located in the first unit shown in the drawings, the digit 2 would be dialed and relay 1104 operated as heretofore described. Hence the connection for relay 2109 will extend as just traced.

It is assumed that the called subscriber's line is located in the tenth group of ten lines and hence may be connected through the tenth primary switch. The second digit is therefore zero and the storing relays 1114 and 1115 operated. Relay 1902 will therefore operate over a circuit from battery, winding of this relay, contacts of relay 2109 through the storing relays for the second digit, in this case over the contacts of relays 1115, and 1114, contacts of relay 1400, 1708, 1804, 1700 and 1702 to ground. Relay 1902 when operating closes a circuit for the selecting magnet 610 for the first secondary switch as the junctions from the tenth primary switch to the secondary switches terminate in the tenth levels of the secondary switches. It should be noted that magnet 610 has been connected in series with other magnets in all the secondary switches for this row and all of these magnets operate in parallel. For example, for the fifth secondary switch the magnet 701 has been shown. The circuit for these magnets may be traced from battery through the windings thereof to ground at relay 1902. Relay 1902 also closes a circuit for the operation of relay 2200 already traced. Another relay operating in response to the operation of relay 1902 is relay 1502 from battery, winding of this relay, contacts of relay 1400, 1815 and 1902 to ground. It should be observed, however, that this relay does not operate until relay 1815 is operated, which will be described hereinafter. Relay 2208 also operates on the operation of relay 1902 from battery through the winding of this relay, contacts of relay 2205, 2200 and 1710 to ground. Relay 2017 operates from battery through the winding of this relay, contacts of relays 1706, 1710, 2012, 1710 and 1902 to ground. It should also be observed that on the operation of relay 1902 relay 2202, intermediate relays and relay 2203 of the group of five relays are operated to determine if there are any idle junctions between the tenth primary and the secondary switches. These relays are operated from grounds at the holding magnets of this primary switch. For example, if the junction 414 is idle, ground will be supplied at the holding magnet 412 for the operation of relay 2203. 75

Returning now to the operation of relay 1814, relay 1815 is operated from battery, winding of this relay, contacts of relays 1817, 1814 and 1702 to ground at 1708. It is at this time that the circuit for relay 1502 is closed as hereinbefore described. Relay 1815 connects the sleeves of the group of ten lines in which the called line is located in the tenth primary switch. This is for the purpose of testing whether the called line is idle or not. Relay 1815 causes the release of relays 1813. If the unit digit was also zero the counting relays 1205 and 1203 will be operated. If now, therefore, the called line is idle, relay 1816 will operate in series with the cut-off relay 308 of a called subscriber's line, from battery, winding of relay 308 over the test lead for this subscriber, contacts of relays 1902, 1815 and 1400 through the continuation of this zero test lead through contacts of the unit relays 1205, 1204, 1203, 1504, 1502, 1400, 1813, 1400, 1311, 1400 and 1816 to ground. Relay 308 in operating disconnects relay 309 from the tip of ring conductor of the called subscriber's line. Relay 1816 closes a circuit for the operation of relay 1817 from battery through the winding of this relay, contacts of relays 1816 and 1702 to ground at 1708. Relay 1817 opens the circuit for the relay 1815 which now releases. This in turn causes the release of relay 1816. Relay 1812, intermediate relays and relay 1813 will now operate to indicate whether there are idle junctions between the secondary switches and the terminating tertiary switch from the outgoing end of the link.

If relay 1813 operates, its circuit may be traced from battery through the winding of this relay, contacts of relays 2019 and 2202 to ground at the contacts of the holding magnet 710, indicating that the junction controlled by this holding magnet is idle. In this case it would be junction 711 between the fifth secondary switch and the terminating tertiary switch which is used exclusively for establishing connections between the outgoing end of links to call the subscribers' lines in this unit of one-hundred subscribers. The operation of relay 1813 now closes a circuit for the selecting magnet 1000 in the terminating tertiary switch which represents the tenth level of this switch in which junction 711 terminates and extends through the fifth secondary switch. Relay 2012 is now also operated from battery, winding of this relay, contacts of relay 1902, contacts of relays 1813, 2019 and 2203 to ground at the holding magnet 711. Relay 2012 provides a locking circuit for itself to ground to contacts of relays 7010 and 1902. Relay 2019 is then released due to the operation of relay 2012. It should be observed that relay 1819 is operated from battery through the winding of this relay through the contacts of this relay 1817 and on the release of relay 1815 through the contacts of this relay to ground at contacts of relay 1703. This relay now closes a circuit for the operation of relay 1803 from battery, winding of this relay, contacts of relay 1819 over part of the same test lead which was used for determining whether the called subscriber's line was idle through contacts of relay 1400, 1205, 1204, 1203, 1504, 1502 and 1400 to ground at relay 1819. Relay 1803 closes a circuit for the primary selecting magnet 400 and its associated magnets for the other primary switches, such as 415 from battery through the winding of these magnets, contacts of relays 2200 and 1803, intermediate relays and relay 1802 to ground at relay 1806. Relay 2014 is now again operated from battery, winding of this relay,

contacts of relay 2012, 1700, 1803 to ground. Relay 2014 operates relay 2015. This in turn now causes the operation of the holding magnets for the chosen junctions to the called subscriber's line and the outgoing end of the link. The holding magnet 1001 for the terminating tertiary switch is operated from battery through the winding of this magnet, contacts of relays 2208, 2400, 1712, 1706, 1710 and 2015 to ground. Holding magnet 1001 closes the connection between the junction 711 and the outgoing end of the link at the point 1003 and the ground that operated the holding magnet 1001 is extended through its contacts over the sleeve connection through the point 1003 for the operation of the holding magnet 710, which closes a connection at the point 712 for the junction 414 to the tenth primary switch. The holding magnet 412 in the tenth primary switch now operates over a connection from battery through the winding of this magnet through the cross-connecting point at 712 to ground. Holding magnet 412 establishes a connection at the point 416 to the called subscriber's line. As this connection is established, the ground is connected through the sleeve at the cross-connecting point 416 for holding relay 308 operated. This ground is now extended also for the operation of the release relay 1702 in the control circuit from the battery to winding of this relay, contacts of relays 1706, 1710 and 1802 and intermediate relays through the operated relays 1803 and 1902 through ground to point 416. When relay 1702 operates a circuit is also established for the operation of relay 2902 from battery, winding of this relay to contacts of relays 2700 and 2403, the relay in the group 1712 to 1713 representing the link used, and 1712, 1706, 2304 to ground as the sleeve provided for relay 1702. Relay 2902 provides ground for holding magnets 1001 and 806 and a ground for holding itself operated through contacts of relay 2900 and also supplies ringing current from the source at 1716 for the tip and ring conductors through contacts of relay 2904. This ringing continues until the called subscriber answers, at which time the ring and tip conductor of relay 2904 operates. This relay locks through its upper winding to the sleeve circuit and disconnects the ringing, and connects the outgoing end of the link to battery and ground through the relay 2905, which provides substitute ground for the sleeve lead for holding magnet 1001. Talking over the link may now take place and when the calling and called subscribers restore their receivers on the switch-hook, relays 2900 and 2905 release, causing the release of the holding magnets and restoring of the switches to normal.

The operation of relay 1702 releases the recorder and the control circuit by releasing relays 1901, 1804, 1814, 1817, 1806, primary select magnets 400, 1703, 1819, 2203, 2205, 1600, 1400, the hold magnets 800, 600 and 403 releasing the recorder connection to the calling line, also 2109, 2310, 2311 and 2000, also 2012, 1811, 2203, 2200, 2208, secondary select magnet 701, tertiary select magnet 1000, also 2014, 2015, 2006, 1710, one of the group 1712 to 1713, 2003, and 1708, and also 1702 and 2400.

The connection to a central office trunk from a calling subscriber's line 301 will now be described. The operations of the circuits are the same as hereinbefore described as far as connecting the calling subscriber to a recorder. The circuits are so arranged that the central office trunks may be dialed by dialing the numbers

8 or 9, that is, only one digit is used. If it is assumed that the digit 8 was dialed, this will operate storing relays for the first digit numbered 1104 and 1106 and when this digit has been dialed, relay 1305 will release. The release of this relay causes the operation of relay 1500 from battery through the winding of this relay and contacts of storing relay 1106, contacts of relay 1304 to ground at relay 1300. Relay 1500 operates relay 1501 and this in turn causes the operation of relay 1703 over the circuits as hereinbefore described. Relay 1703 closes the circuit for the operation of relay 1600. This relay in turn causes the operation of relays 1813, 1804 and 1806. Relay 1600 also causes the operation of relay 1400. Relay 1400 closes a circuit for the operation of relay 2401 and also closes a circuit for the primary select magnet 400 of the level in which the calling subscriber's line is located. The circuit in this case will extend from battery through the winding of this magnet through the connecting point 408, 604, 804, contacts of relays 1400 and 1710 to ground.

Relay 2308 which is provided for central office trunk selection is now operated from battery, winding of this relay, contacts of relays 1400, 1106, 1104 to ground at 1103. Relay 2308 closes an obvious circuit for the operation of relay 2309. The operation of relay 2401 closes a circuit for one of the relays 2106 or 2107 or intermediate relays, depending on the junctions to the switches selected by the calling line to the recorder. In this case if the junctions 406 and 603 were selected, relay 2106 will operate from battery through the left-hand winding of this relay, contacts of relay 2401 through the cross-connecting points 804 to ground at 1710. The corresponding relay 1901 which represents the first group of ten lines in which a calling subscriber's line is located will now operate from battery, winding of this magnet, contacts of relay 2106, cross-connecting points 604 to ground at 1710. Relay 1901 closes a circuit for the operation of relays 2200 and 2205 and the testing of the junctions available from a calling subscriber to a central office trunk will now begin.

As many of the relays 2202 and 2203 will operate as there are available junctions between the primary switch in which the calling subscriber's line is terminating to the secondary switches. The junction 406 used by the calling subscriber's line to the recorder is also testing idle so that this junction can be chosen in case no other junction is available. In this case if no other junction is available the circuit for operating relay 2202 which is the first relay in the group will extend from battery, winding of this relay, contacts of relay 1901, contacts of holding magnet 403 to ground at relay 1710 as hereinbefore described. If other junctions are available other relays in the group will be operated. If it is assumed that this junction is the only one testing idle it should be noted that it terminates in the first level of the first secondary switch. Consequently the select magnet 601 will operate due to the operation of relay 1901.

A test will now be made to determine whether or not the desired trunk is idle. If the trunk shown in Fig. 28 is idle, there will be a ground on contacts of relays 2800 through contacts of the holding magnet 810, contacts of relays 2200, 2309, winding of relay 2000 to battery. The operation of relay 2000 now closes an obvious circuit for the associated relay 2003 from battery through the winding of relay 2003, contacts of

relays 2000, 2006 and 2202 to ground at the holding magnet 615 as relay 2202 is operated. Relay 2003 closes a circuit for the operation of relay 2006 from battery through the winding of this relay, contacts of relay 2003 to ground at relay 1702. Relay 2003 is locked through its own contacts to ground at 1702. As the trunk is located in the first tertiary switch relay 2400 will now operate from battery, winding of this relay, contacts of relays 2205, 2002, 2007, 2006, 1706 to ground provided relay 2007 is not operated. Relays 2007 to 2009 are operated in rotation as hereinbefore described. The operation of relay 2006 operates relay 2018 which shifts the operations of these relays 2007, 2008 and 2009. Relay 2011 is now operated from battery, winding of this relay, contacts of relays 2006, 1710, 2012, 1710 to ground at 1901 and one of the relays of the group 1712 to 1713 would also operate. In this case a relay between 1712 and 1713 such as the eighth relay from the common battery through the make-before-break contacts of relay 1713 and of intermediate relays through the winding of this relay, through the lead marked 8 in Fig. 23, contacts of relay 2309, holding magnet 810 in the first tertiary switch to ground at relay 2800. As relay 2202 is operated, the relay next to 1812 of the group 1812, intermediate relays and relay 1813 will operate from battery, winding of this relay, contacts of relays 2011, 2202, 2400 to ground at the holding magnet 615 and consequently select magnet 810 for the first level in the first tertiary switch will now operate for the connection of the trunk to the link 603. This circuit may be traced from battery winding of magnet 802, contacts of relay 2200, the next relay in the group 1812, etc., to ground at relay 1901.

Relay 2012 will operate as soon as the relay next to relay 1812 operates over a front contact of this relay and cause the release of relay 2011 and the operation of relays 2014 and 2015. The tertiary select magnet 811 will now operate from battery through the winding of this magnet over contacts of relay 2400 through the sixth relay of the group 1712, etc., contacts of relays 1708 to ground at relay 2015, thus closing a connection between the trunk and the second junction 618 at the cross-connecting point 812. The corresponding hold magnet 615 is then operated over contacts of hold magnet 810, and as the holding magnet of the first secondary switch is already operated as well as the hold magnet 403 for the junction 406 the trunk is now connected through the point 619 to the calling subscriber's line. Relay 1702 now operates. This causes the release of relays 1804, 1806, 1703, 2205, 1600 and 1400, the recorder holding magnet 800 (releasing the recorder), the primary select magnet 400, relays 2308, 2309, 2000, 2401, 2106, 1901, the relay next to 1812, relays 2200, 2202, secondary select magnet 601, tertiary select magnet 810, also relays 2012, 2014, 2015, 2003, sixth relay of the group 1712 to 1713, 2006, 1702 and 2400. When the connection between the calling subscriber and the trunk circuit is established over the tip and ring conductors, relay 2801 is operated and closes a circuit for the operation of relay 2802. Relay 2802 closes a circuit for 2800. Relay 2802 also closes a circuit for the sleeve for holding the connection to the calling subscriber and another circuit to ground for holding relay 2803, and connects battery through the winding of relay 2804 to the tip conductor of a trunk to the central office. The operation of relay 2800 opens the

ground connections to make the trunk busy and causes the operation of busy lamp 2806 and also produces a holding ground for the sleeve to hold the connection through the switches. When the central office picks up this trunk it establishes a ground connection on the tip lead to operate relay 2804 which operates relay 2803 which locks under control of relay 2802. The operation of relay 2803 opens the original operating circuit for relay 2801 and closes another operating circuit for relay 2801 and an operating circuit for relay 2809 and also connects the tip and ring conductors between the calling subscriber's line and the central office. Relay 2809 opens a circuit for relay 2804 which releases. Conversation between the calling subscriber's line and the central office may now proceed.

In establishing a connection to a tie-line such as is shown in Figs. 25 and 26, the operations are practically identical with those required for establishing a connection of a central office trunk. The circuits have been arranged for tie-lines to be seized by dialing the digits 6 or 7. The only difference in the operations of the circuits is that when a tie-line is selected, relays 2310 and 2311 are operated, on the operation of relay 1400 from ground, provided by the operation in case of the dialing of 6 of relay 1106 and in the case of the dialing of 7 by the operation of relays 1103 and 1106 to provide a ground for the operation of relay 2310 through contacts of relay 1400, and the operation of relays in the group of relays 1712, etc. The operation of the sixth or seventh relays in this group selects the corresponding tie-line in the first tertiary switch and a connection is established through this switch from the calling subscriber's line to the selected tie-line. If a connection is established for tie-line 6, the connection may be made through any of the junctions leading to the secondary switches in the same manner as when a central office trunk is selected, for example, through the point 820 over junction 603 and from there through any of the links terminating in the first primary switch if the calling subscriber's number is 300, in this case, over junction 406 and point 408.

When the tie-line shown in Figs. 25 and 26 is seized in this manner, relays 2600 and 2601 are operated over the connection through the tip and ring conductors. The operation of relay 2600 closes an operating circuit for relay 2500 from battery, winding of this relay, contacts of relays 2501, 2502 and 2503 to ground at relay 2600. Relay 2500 closes an obvious circuit for the operation of relay 2504. The operation of relay 2504 closes a bridge across the tip and ring conductors of the tie-line through contacts of relays 2506, 2507, 2508 and 2504 and over the tip conductor through the outer right-hand armature of relay 2504, through contacts of relay 2601 through the upper winding of relay 2602, contacts of relays 2501 and 2502, through the outer left-hand armature and front contact of relay 2504 to the ring conductor as traced. This P. B. X. call indicates that a call has originated over this type trunk.

The operation of relay 2500 provides ground for the sleeve conductor to hold the holding magnet 821 of a first tertiary switch to maintain the connection through the switches. Relay 2500 also operates relay 2509 over an obvious circuit. This relay removes ground from the BT and GT leads to make the trunk busy and closes a supplementary ground for the sleeve lead. It also provides a connection from the busy lamp 2510



to the sleeve of the jack 2511 to make this local connection busy. This connection extends from battery, lamp 2510, windings of relay 2512, contacts of relays 2501 and 2509 to the sleeve of jack 2511. The tie-line is now in condition for dialing by the calling subscriber of a desired line in the distant P. B. X., wherein calls are received over the tie-line and relay 2601 responds to the impulses. Relay 2601 opens and closes the bridge across the tip and ring conductors and causes the selection to take place at the distant P. B. X. Relay 2600 follows the dial pulses, but relay 2500 is slow in releasing and will remain operated during the dialing of each digit.

Relay 2508 operates on the first release of relay 2600 and remains operated until the train of impulses has been sent. The operation of relay 2508 which is repeated for each digit dialed opens the transmission circuit through the repeating coil 2518 and the condenser 2514 and short-circuits the upper winding of relay 2600 for all except the first impulse of each digit dialed. When the call is answered at the distant P. B. X. the battery is reversed over the tip and ring conductors, causing relay 2602 to operate. Relay 2602 closes an obvious circuit for relay 2604. Relay 2604 closes the lower winding of relay 2602 in parallel with the contacts of relay 2601 and opens the operating circuit for relay 2508 and reverses the battery and ground connection over the tip and ring conductors toward the calling subscriber's line for supervision.

The selection of the zero trunk is exactly the same as in the establishing of a connection to a central office trunk or to a tie-line, except that in this case the relays 2312 and 2313 are operated in the control circuit and the zero trunk is connected in the first tertiary switch at the last horizontal cross-connections which may be made, for example, at the point 822 to the junction 603 to the calling subscriber in the same manner as a tie-line or central office trunk. When this zero trunk is seized, which is illustrated in Fig. 27, relay 2700 is operated, which in turn operates relay 2701 which provides ground on the sleeve conductor to hold the holding magnet 823 operated. Relay 2700 also lights the lamp 2702 and when the operator answers this call by inserting a plug in jack 2703, relay 2704 is operated. Relay 2704 provides a holding circuit for relay 2701 and a ground connection for the sleeve of jack 2703.

When a call is incoming to the P. B. X. from a tie-line such as the one shown in Figs. 25 and 26 seizing of the tip and ring conductors at the distant P. B. X. closes a loop across the tip and ring conductors, causing the operation of relay 2514 from battery and ground through the windings of this relay, contacts of relay 2504, left-hand windings of repeating coil 2513, contacts of relays 2507 and 2506 over the tip and ring conductor. Relay 2514 closes a circuit for relay 2503 which then closes a circuit for relay 2606 from battery to the chain circuit over contacts of relays 2607 and 2608 for other tie-lines, winding of relay 2606, contacts of relays 2503 to ground at relay 2509. Relay 2606 in operating closes a circuit to ground for the ST lead for the operation of relay 1704 to seize the central circuit from battery through the winding of this relay, contacts of relays 1702, 1703, 1701 and 1700 to ground at 2606. Relay 1704 closes a circuit for relay 1600 to seize the first idle recorder from battery through the winding of this relay, contacts of jack 1503, relays 1310, 1311, 1300 and

1704 to ground at 1703. Relay 1600 closes the circuit heretofore traced for relay 1400 and this relay operates relay 1603. A circuit is now closed for the primary select magnet 500 of the special tie-line connecting switch shown in Fig. 5 for the association of an idle recorder with the calling tie-line. Primary select magnet 500 is operated as this particular tie-line is connected in the horizontals of the switch shown in Fig. 5. The circuit for the primary select magnet 500 extends from battery through the winding of this magnet, contacts of relays 2606 and 1704 to ground at 1703. If it is assumed that the recorder shown in the drawings is the one that is idle at this time due to the operation of relay 1600 the holding magnets 501, 502 and 503 for connecting the tie-line to the first recorder are operated from battery through the winding of these magnets over the CH lead, contacts of relay 1400 to ground at the relay 1704. The hold magnets lock over a circuit over the CN lead through contacts of relay 1400 and later through contacts of relay 1302. This establishes connections between the recorder shown and the tie-line at the cross-connecting points 504, 505 and 506. A ground is now applied for the lead HD which causes the operation of relay 1303 from battery, winding of this relay, contacts of relay 1400 to ground over this lead at point 504. Relay 1303 closes a circuit for the operation of relay 1302 and this relay in turn closes a circuit for the operation of relay 1300. The operation of relay 1300 closes a connection to ground for the lead CO over point 505 through the winding of relay 2507 to battery causing relay 2507 to operate. Relay 2507 removes battery and ground through the windings of relay 2514 from the tip and ring conductors of the trunk and extends the tip and ring conductors to battery and ground through the windings of relay 1301 over the two pulsing leads. Relay 1301, 1302 and 1303 operate as usual. Relay 2507 also causes the operation of relay 2509 from battery through the winding of this relay, contacts of relays 2507 to ground at relay 2503 and the circuits are now ready for dialing the subscriber's number for this P. B. X. The operation of relay 2509 causes the release of the control circuit by establishing a connection to ground at this time through contacts of relay 2507 over the lead CK through the point 506, contacts of relay 1400, winding of relay 1702 to battery. Relay 1702 on operating releases relay 1704 which in turn releases relay 1600 and the primary select magnet 500. Relay 1600 releases relay 1400 which in turn releases relay 1702. Dial tone is transmitted to the trunk and the subscriber at the distant end may now dial the number of the desired subscriber's line in this P. B. X.

Dialing of the number to operate the various register and holding relays in the recorder is the same as heretofore described in connection with the dialing of the subscriber's line in this exchange from another subscriber as hereinbefore described. When the dialing of the called subscriber's line has been completed and the number recorded on the relays in the recorder, the relays 1500 and 1501 are operated and the control circuit is thereby called in by the operation of relay 1703 from battery through the winding of contacts of relays 1702, 1704, 1700, contacts of jack 1503, contacts of relays 1310 and 1311, to ground at relay 1501. Relays 1813, 1804 and 1806 are then operated over circuits as hereinbefore described. Relays 1600 and 1400 are also oper-

ated over circuits described. Relay 1704 is then operated from battery through the winding of this relay, contacts of relays 1702, 1703, 1400, 1603, 1501, 1106, to ground at 1300.

It should be noted that relay 1106, which is one of the recording relays for the hundred digit, will not be operated as the first digit of the number dialed will be 2, indicating that the call is in the first hundred unit. Relay 1706 is now therefore operated from battery, winding of relay 1704 to the ground at relay 1300 for the circuit described for the operation of relay 1703. This closes a circuit for the operation of relay 1708 from battery, winding of this relay, to ground at relay 1706. Relay 1710 is then operated from battery, winding of this relay to contacts of relay 2015, to ground at relay 1708. Relay 1814 is also operated from battery through the winding of this relay to contacts of relay 1702, to ground at relay 1708.

The recorder now furnishes information concerning the position of the called line, causing the operation of relay 2109, which indicates that the call is in this first hundred unit. The circuit for this relay may be traced from battery through the winding thereof, contacts of relays 1814, 1400, 1106, 1104, to ground at 1103 as relay 1104 is operated by the first digit 2. This operates the relay 1901 if it is assumed that the tens digit was 1 indicating that the called subscriber's line is located in the first group of ten lines. The circuit for this relay may be traced from battery through its winding, contacts of relay 2109, 1400, 1114, 1115, 1113, 1112, 1400, 1708, 1703, to ground at 1702, as the only relay of the recording release for the tens digit that is operated is 1112. Relay 1901 in operating closes a circuit for the select magnet in the secondary switches in which junctions between the first primary switch and the secondary switches terminate. In this case the select magnet 601 operates over a circuit to ground at relay 1901. Relays 1502 and 2011 are also operated by relay 1901, relay 1502, from battery, winding of this relay, contacts of relays 1400, 1815, 1901 to ground and relay 2011 from battery, winding of this relay, contacts of relays 1706, 1710, 2012, 1710, 1901 to ground. The testing for junctions available between the tertiary switch in which the calling tie-line terminates in this case, the first tertiary switch and between the secondary and primary switches is now made. The operation of relay 1901, which indicated that the called line is located in the first primary switch, indicates the junctions between this primary switch that must be chosen for the connection to the tie-line. There are five such junctions available, one for each secondary switch. Now if all of these are idle, all of the relays in the group 2202, etc., will operate from battery through the windings of these relays, contacts of relay 1901 to ground on the holding magnets for these junctions in the first primary switch. The leads for two of these connections have been shown with the corresponding holding magnets 403 and 405 of the first and the last junction. As relay 2200 operates as usual on the operation of relay 1901, the relay 2400 will now operate over a circuit from battery through the winding of this relay, contacts of relay 2200, contacts at point 504 of the tie-line switch shown in Fig. 5, over the lead TP contacts of relays 1501, 1400, to ground at relay 1706. The reason why this particular relay was

operated as noted was determined by the tie-line calling.

Junctions from the first tertiary switch through secondary switches must be employed for the establishing of the connection from the tie-line to the called line. There are ten such junctions available from this first tertiary switch to the five secondary switches with two junctions to each secondary switch. Now if all of these junctions are idle, all of the ten relays of the group 1811, etc., will operate through contacts of the ten relays 2202, etc., from grounds on contacts of the holding magnets corresponding to these junctions in the secondary switches. For example, grounds will be supplied from contacts of holding magnets 600 and 615 in the first secondary switch through contacts of relay 2400 to 2202, 2011, through the winding of relay 1811 and the next intermediate relay of this group to battery, but as only relay 1901 is operated, the select magnet for one level of the first tertiary switch will be operated. In this case the select magnet 802 will be operated from battery through the winding of this magnet, contacts of relay 2200, relay 1811 to ground at relay 1901. This will select the first junction 603 between the first tertiary switch and the first secondary switch as part of the path for connecting the tie-line to the called subscriber's line. Had this junction been busy, the next select magnet 810 would have been operated and thus cause the selection of the second junction 618 between the first tertiary switch and the first secondary. The circuit in this case would have extended from battery through the winding of select magnet 810 through the contacts of relays 2200, contacts of the second relay of the group 1812 through a back contact of relay 1812 to ground at relay 1901. Consequently the first idle junction will be chosen regardless of how many subsequent junctions are idle.

When any one of the relays 1812 intermediate relays and relay 1813 operates, a circuit is closed for the operation of relay 2012 from battery through the winding of this relay, contacts of relay 1901, right-hand armature and front contact of relay 1812 if this relay is operated to the ground traced for the operation of this relay. If this relay is not operated the connection passes through this armature and back contact through a right-hand armature and front contact of any of the other relays in the group that is operated to ground. Relay 2012 opens the circuit for relay 2011 which now releases. Returning now to the operation of relay 1814, a busy test will be made on the called line, and this test will be initiated by the operation of relay 1815 over a circuit from battery, winding of this relay, contacts of relays 1817, 1814, to the ground that caused the operation of relay 1814 as heretofore described. The operation of relay 1815 first releases relay 1813 and if the line is idle, relays 1816 and 1817 are operated, whereupon relay 1815 is released, causing the release of relay 1816. On the release of relay 1815, relay 1819 is operated from battery through the winding of this relay, the contacts of relays 1817, 1815, and 1703 to ground. This relay causes the operation of the relay in the group 1802 to 1803 corresponding to the location of the called line in the first primary switch. If it may be assumed that the unit digit 0 is the one dialed, relay 1803 will operate from battery, winding of this relay, contacts of relays 1819, 1400, 1202, 1205, 1204, 1203, 1504, 1502, 1400,



1704 to ground. This causes the operation of the select magnet in the primary switch for the level in which the called line is selected, in this case magnet 400, over a circuit from battery, winding of this magnet, contacts of relays 2200, 1803, intermediate relays, relays 1802, 1806 to ground. A circuit is now closed for the operation of relay 2014, which in turn operates relay 2015. The holding magnet in the first tertiary switch for establishing connection between the calling tie-line and the chosen junction to the first secondary switch will now be operated. In this case holding magnet 821 and the circuit therefor may be traced from battery through its winding, point 504 over the HM lead, contacts of relays 1400, 1706, 1710, 2015 to ground. The holding magnet 600 is now operated for establishing a connection between the junctions 603 and 406 at the cross-point 604, from ground at the cross-point 820 applied over the sleeve through contacts of relays 2506 and 2507. The operation of this magnet closes the cross-point at 604, which causes the operation of holding magnet 403 from the ground connected at point 604, so that the calling subscriber's line is now connected directly to the switches to the calling tie-line.

It should be noted that on the operation of relay 1502 the circuit for relay 2507 in the tie-line was opened at the outer armature and back contact. The release of relay 2507 discontinues the tip ring leads of the trunk from the pulsing leads and connects them to the windings of the relay 2514, causing the reoperation of this relay to hold relays 2503 and 2504. Now when the connection is established through the switches to the called subscriber's line, there is a circuit completed for the operation of relay 2517 over the RC lead through contacts of relays 1400, 1706, 1710 to ground at relay 2015. Relay 2517 locks under control of relay 2518 and 2509 and removes the transmission battery supply through the windings of relays 2600 and 2601 and the repeating coil 2513 through the tip and ring leads of the line and closes ringing connections over the leads 2610 to start the ringing of the called line and this relay also closes the circuit for the operation of relay 2502 from battery to the winding of this relay, contacts of relay 2517 to ground at relay 2509. Relay 2502 closes connection with ground for the lead CK, which causes the operation of the release relay 1702 from battery through the winding of this relay, the contacts of relay 1400 over the CK lead to ground at relay 2502. The recorder and control circuit are now released as hereinbefore described and the release of the recorder restores the tie-line connecting switch to normal. The connection for the holding magnet 821 to maintain the connection is extended to contacts of this magnet over the sleeve lead of the tie-line to ground at relay 2509.

When the subscriber at the called station 300 answers this call by removing his receiver from the switchhook, relay 2518 operates causing the release of relay 2517 to discontinue the ringing. Relay 2517 also closes the connection from battery through the windings of relays 2600 and 1601 and the repeating coil 2513 to the called subscriber's line. Relay 2502 is also released. Relays 2600 and 2601 operate. Relay 2601 in operating performs no useful function at this time but relay 2600 closes the circuit for the operation of relay 2504 from battery through the winding of this relay, contacts of relay 2503 to

ground at contacts of relay 2600. Relay 2504 reverses the battery and ground over the tip and ring conductor to signal the distant P. B. X. that the called subscriber has answered.

In case the calling subscriber decides to flash the distant P. B. X., the switchhook is operated, causing the release operation of relays 2600 and 2601. Relay 2000 alternately releases and operates relay 2504 to battery and ground for the tip ring conductor on the trunk, causing the release and operation of a supervisory relay at the distant P. B. X. to flash the supervisory lamp.

In case a tandem connection is desired through this P. B. X. from one tie-line to another, a connection is established from the originating tie-line, for example, the one shown in Figs. 25 and 26 which is specially equipped for this purpose, to a recorder in the same manner as any incoming calls from a tie-line hereinbefore described. After the recorder has been seized, the operator at the distant end of the calling tie-line dials the number of the desired tie-line connection to a distant P. B. X. The circuits in this P. B. X. have been wired as hereinbefore described so that the operator may dial the digit 6 or 7 for connecting to a tie-line. In this case she would dial 7 as the number of her tie-line is 6. Then, when the number has been dialed, relay 1606 operates from battery, winding of relay 1606, contacts of storing relay 1206 to ground. The relays 1500, 1501, 1703, 1813, 1804, 1806, 1600 and 1400 are then operated as usual. It should be noted that the tie-line shown in Figs. 25 and 26 terminates at the cross-connecting point 415 in the tenth primary switch. Information will therefore now be furnished to the control circuit that this is the case. Hence on the operation of relay 1400 relay 2109 will operate from battery through the winding of this relay, contacts of relays 1814, 1400 and 1606 to ground. The relays 2310 and 2311 are also operated by the dialing of digit 7. Relay 2310 is operated from battery through the winding of relay 2310, contacts of relays 1400, 1105, 1106 and 1103 to ground and relay 2311 from relay 2310. The primary select magnet 420 is now operated, which represents the level in which the calling tie-line is located in the primary switches. This connection may extend from battery through the winding of the primary select magnet 420 through the cross-connecting point 504 over the lead L to ground through contacts of relays 1400 and 1606. On the operation of relay 2109 a circuit is closed for the operation of relay 1902, which indicates that the calling tie-line is located in the tenth primary switch. The circuit for the relay 1902 will now therefore extend from battery through the winding of this relay, contacts of relays 2109 and 1400 to ground at 1606. Relay 1702 operates relay 2200, and this relay in turn operates relay 2205.

If all junctions from the tenth primary switch to secondary switches are idle, all five of the relays 2202, etc., will operate through contacts of relay 1902 to ground at the holding magnets 421 and 412 and intermediate magnets. The secondary select magnet 610 is now also operated from battery to the winding of this magnet, contacts of relay 1902 to ground, as the junctions between the primary and secondary switches terminate in the tenth level which is controlled by this select magnet. If, now, all of the tie-lines outgoing from this exchange are idle, the first idle one will be selected. The tertiary switch

will be selected in the usual manner for extending the connection from the call originating tie-line to a called tie-line. Hence, if tie-lines are idle in any of these tertiary switches, ground will be found on contacts of the corresponding holding magnets on the BT leads at the relays corresponding to relay 2509 to operate the corresponding relays 2000, 2001, or 2002. If relay 2000 operates, the corresponding relay 2003 will operate over contacts of relay 2206 and contacts of relays in the group 2202 and 2203 to ground on the holding magnets of idle junctions between secondary and tertiary switches. Relay 2203 closes a circuit for relay 2006 and this relay causes the operation of relay 2011. As relay 2003 was operated, the corresponding relay 2400 will operate from battery, winding of relay 2400 and contacts of relay 2205 and 2003 through contacts of relays 2007 and 2006 to ground at relay 1706. This will indicate that there is an idle tie-line that terminates in the first tertiary switch. Now the first idle tie-line in this switch will cause the operation of a corresponding one of the relays in the group 1712 and 1713 from battery, through the winding of one of these relays, contacts of relay 2400 to contacts of the holding magnet of the first idle tie-line over the GT lead to ground on relay corresponding to relay 2509. One of the relays 1812 or 1813 will now also operate, depending on what level in the tertiary switch a connection will be made to the idle tie-line through a junction to a secondary switch and the operation of this relay depends on the idle conditions of these junctions, for example, from battery, winding of relay 1812, contacts of relay 2011, contacts of relays 2202 and 2203 to ground on the holding magnets of the idle junctions in secondary switches over which connections may be made. If relay 1812 is operated, the first select magnet 802 for the first level of the first tertiary switch will operate from battery through the winding of this magnet, contacts of relays 2200 and 1812, through back contacts of the other relays in the group to ground at relay 1902.

Relay 2012 is now also operated from battery through the winding of this relay, contacts of relay 1902 through back contacts of intermediate relays in the group 1811 to 1812 through a front contact of relay 1811 to ground just traced for the operation of this relay 2012. Relay 2011 is released and relays 2014 and 2015 are operated. Now the holding magnet for this first idle tie-line in the first tertiary switch will be operated. It may be assumed that it is holding magnet 829 and the circuit for it may be traced from battery, winding of this magnet through contacts of relays 2400 and 2310, contacts of relays in the group 1712, etc., contacts of relays 1708 back to ground at relay 2015. A connection will now be established therefore from the tie-line, which terminates at 830, at the cross-connecting point 831 to the junction 603 in the first secondary switch. This causes the operation of the holding magnet 600 from battery, winding of this magnet, point 830, contacts of magnet 829 to ground just traced for the operation of this holding magnet at relay 2015. This connects junction 603 to junction 425, which leads to the tenth primary switch and the holding magnet 421 in this switch is then operated from ground at the point 620. This causes a connection at the cross-connecting point 426 to the calling tie-line and connects ground at this cross-point to the sleeve lead of the calling tie-line, through contacts of relays 1902,

1802, 1708, 2310 and 1400, TM lead through the winding of relay 2506 to battery, causing the operation of this relay.

Relay 2506 in operating locks to the same ground directly over the sleeve at the point 426 and provides at its lower inner armature and front contact this ground connection to lead CK, which extends through contacts of relay 1400 through winding of the relay 1702 to battery, causing the operation of this relay and the release of the recorder and the control circuits. Relay 2506 also closes the locking circuit for relay 2503 and opens the operating circuit for relay 2514, causing the release of this relay. Relay 2506 also opens the connection from the left-hand windings of the repeating coil 2513 to the tip and ring conductors of the calling tie-line and extends at its outer upper and lower armatures and front contacts the connection from the distant P. B. X. over the tie-line through the outgoing tie-line over the connection through the switches as traced. This causes the operation of relays corresponding to relays 2600 and 2601 in the terminating tie-line and the relay corresponding relay 2600 operates the relay corresponding to relay 2500 and this closes a ground connection over the sleeve from this terminating tie-line back to the sleeve in the tie-line shown in Figs. 25 and 26 to hold relay 2506 operated.

The operation of relay corresponding to relay 2601 closes a low-resistance bridge involving upper winding of the relay corresponding to relay 2602 and this bridge causes the operation of relays corresponding to relays 2503 and 2514 in the distant P. B. X. in which the tie-line outgoing from this exchange terminates and the operation of the relay corresponding to relay 2503 causes the recorder in the distant exchange to be seized and a dial tone will be transmitted back over the tie-lines to the calling tie-line for the dialing of the desired subscriber's line in this distant P. B. X.

To establish connections from a subscriber in one 100 line unit to call a subscriber in another hundred line unit, the arrangement is such that the recorders and the control circuit provided for the first 100 unit will be used, while a link individual to the hundred unit in which the calling subscriber's line is located will be used for the establishing of this type of connection. There are, however, certain relays and circuit arrangements shown in the control circuit in the drawings that are individual to each 100 line unit as follows: All of the relays shown in Figs. 19, 21, 22 and 24 are individual to each 100 line unit. It should be noted that in Fig. 21 the relay 2105 of the second 100 line unit corresponding to relay 2104 of the first 100 line unit has been shown. In the following description of a call from a subscriber in the second unit to a subscriber in the first unit, the majority of the individual circuits for the relays involved will not be traced completely as it is thought that the previous detailed tracing of circuits in the description of calls in the first unit will suffice in this respect and reference to such description may be made wherever required. As only the detail circuits for the first unit have been shown in the drawings, taps have been shown with explanations for such circuits that lead also to the second unit and it is believed that with such taps and legends the following description will readily be understood.

If it is assumed that a subscriber in a second 100 line unit adjacent to the one shown in the

drawings calls a subscriber in the first 100 line unit shown in the drawings, this subscriber in this second unit will, when he removes his receiver from the switchhook, appropriate a recorder in the first 100 line unit and the common control circuit. In this second unit a relay corresponding to the group in which the calling subscriber's line is located, will operate; for example, the relay corresponding to relay 2100, which indicates that the calling subscriber is located in the first primary switch. Relay 2105 then operates and this causes the operation of the relay corresponding to relay 2101. The relay 1700 in the control circuit then operates, causing the operation of a relay in the second group corresponding to relay 1901 and this in turn causes the operation of relays corresponding to relays 2200 and 2205. The relay corresponding to relay 2205 locks to ground at 1703. All of the relays corresponding to relays 2202, etc., are then operated as well as one of the relays in the group 1802, etc., causing the operation of relays 1800, 1804, and the relay corresponding to the relay 1900, whereupon relay 1800 releases causing the operation of relay 1806 which operates a primary select magnet in the second unit, corresponding to, for example, the select magnet 400 in the first hundred unit. Operation of the relay corresponding to 1901 also closes the circuit for a select magnet for a level in the secondary switches of the second unit in which the junctions from a primary switch terminates. That is, the primary switch in which the calling subscriber's line is located. The relays 2300 and 2301 will operate on the operation of relay 1700, which indicates to the control circuit that a recorder is to be selected. Depending now on the idle condition of the recorders, one at least of the relays 2000, 2001 or 2002 will operate. If 2000 is operated relay 2003 will operate causing the operation of relay 2006 and this causes the operation of the relay corresponding to relay 2400 in the second unit, which indicates that the recorder terminates in the first tertiary switch of this second unit. This relay causes the operation of relay 2011 and relays in the group 1812, etc.; and relay 1712 will operate to indicate free junctions between the chosen recorder and the calling subscriber's line and relay 1120 operates due to operation of relay 1712 as hereinbefore described.

Relay 2012 is then operated as usual and a tertiary select magnet in the first tertiary switch of the second unit is operated, corresponding, for example, to the tertiary select magnet 802 in the first tertiary switch of the first unit. The operation of relay 2012 causes the release of relay 2011 and the operation of relays 2014 and 2015 so that a tertiary holding magnet in the first tertiary switch of the second unit will operate, corresponding, for example, to the holding magnet 800 in the first unit. The operation of this magnet causes the operation of holding magnets in a secondary switch and in the first primary switch of the second unit to establish a connection to the calling subscriber's line from the recorder. This causes the operation of the cut-off relay in the calling subscriber's line and also the operation of the release relays 1702 in the control circuit, which now releases. When this connection is established relays 1300, 1301 and 1302 operate as usual in the recorder.

The subscriber will now dial the number of the desired subscriber in the first unit. The hundred digit for this unit may be 2 while the

tens and unit digits may be any numbers decided. When the digits have been dialed relay 1305 releases and relays 1500 and 1501 operate for the seizure of the control circuit to secure an idle link in the second unit, and to connect the incoming end of this link to the calling subscriber's line and the outgoing end to the called subscriber's line. To initiate these operations relay 1703 operates on the operation of relay 1501 and this relay causes the operation of relays 1813, 1804, 1806, 1600 and 1400 as usual. The relay in the second unit corresponding to relay 2401 is then operated although it should be observed that relay 2401 also operates, but the operation of this latter relay performs no function at this time. The relays 2304 and 2305 are then operated to initiate the link selection and the primary select magnet in the primary switch in the second unit corresponding to the level in which the calling subscriber's line is located will also operate through contacts of the relay corresponding to relay 2401 in that unit. When the relay corresponding to relay 2401 operates, the relay corresponding to relay 2106 in the second unit will operate, indicating the group of ten lines in which the calling subscriber's line is located. This in turn causes the operation of the relay corresponding to relay 1901, which represents the first group of ten lines in which the calling subscriber's line is located. The relay corresponding to relay 2200 is then also operated and the relays in the group 2202, etc., as well as the corresponding secondary select magnet in the second unit due to the operation of the relay corresponding to relay 1901. The operation of the relay corresponding to relay 2200 closes the circuit for the operation of the relay corresponding to relay 2205 and if a link terminating in the first tertiary switch in the second unit is idle, relay 2000 operates. This in turn closes the circuit for the operation of relay 2003, which then closes the circuit for relay 2006 and the relay corresponding to relay 2400 in the second unit. This relay closes the circuit for relay 2011 and one of the relays in the group 1811, etc., and relay 1712 are operated as usual, causing the operation of relay 2012 and the tertiary select magnet in the level in which idle junctions from secondary switches terminate in the first tertiary switch of the second unit. For example, a select magnet corresponding to select magnet 807 in the first unit. Relay 2011 is then released and relays 2014 and 2015 operate, whereupon a tertiary holding magnet in the first tertiary switch of the second unit corresponding to holding magnet 806 operates, causing the corresponding holding magnets in the secondary switch in the first primary switch in the second unit to operate to connect the calling subscriber's line with the incoming end of the idle link.

This now causes the operation of relay 1708, which locks the relay corresponding to relay 2205 and causes the release of relays 2014, 2015, causing the operation of relay 1710 and the release of the primary select magnet in the second unit; relay 2012; the relays operate in the group 1812, etc.; the relays in the second unit corresponding to relays 2401, 2106, 1901, 2204, and 2205; also the secondary and tertiary select magnets in the second units corresponding to select magnets 601 and 807 respectively; also the relays 2202, etc.; the relay corresponding to relay 2200 and the relays 2000, 2003, 2006, 2012 and 2011.

Relay 1814 now operates on the operation of relay 1708, causing the operation of relay 1815,

which causes the release of relay 1813. If the called line in the first unit is idle, relay 1816 operates, which in turn operates relay 1817 and this in turn causes the release of relays 1815 and 1816. Returning now to the operation of relay 1814, relay 2109 operates, due to the dialing of the digit 2, indicating that the called subscriber's line is located in the first unit. If the called subscriber's line is located in the first group of ten lines in this unit, the relay 1901 operates, causing the operation of relays 2202, etc., a secondary select magnet and relays 2200 and 1502. Relay 2200 operates relays 2202, etc., and these operate relay 2019. This in turn causes relays in the group 1812, etc., to operate, indicating idle paths between tertiary and secondary switches in the first unit for the outgoing end of the idle link in the second unit. Relay 2200 now operates relay 2210 from battery, winding of relay 2210, contacts of relay corresponding to relay 2205 in the second unit, contacts of relay 2200 to ground at contacts of relay 1710.

In Fig. 10 there has been shown a special inter-unit terminating tertiary switch 1010 in which idle links from the second unit terminate for establishing a connection through a secondary and a primary switch to the called subscriber's line in the first unit. As a relay in the group 1811, etc., operates it causes the operation of relay 2012 and a tertiary select magnet such as 1000 in this special switch indicating the level in which an idle junction between this tertiary switch and the secondary switches terminate. Relay 2012 releases relay 2019. Relay 1819 now operates, which in turn causes the operation of relays in the group 1802, etc., indicating the level in which the called subscriber's line is located, causing the operation of the corresponding primary select magnet and also relays 2014 and 2015. The tertiary holding magnet of the outgoing end of the link from the second unit will now operate. This holding magnet is marked 1012 and its circuit may be traced from battery through the winding of this magnet, through contacts of relay 2210, a relay corresponding to relay 2400 in the second unit, contacts of the relay operated in the group 1712, relays 1706, 1710 and to ground at 2015. The operation of this magnet closes the circuit for a secondary holding magnet which in turn closes the circuit for a primary holding magnet to establish the connection from the outgoing end of the link used to the called subscriber, for example, through points 1013, 712 and 416. Relay 1702 is then operated and the recorder and control circuits are released in the usual manner.

What is claimed is:

1. In a telephone system, a plurality of switching units, lines in each unit, links in each unit, common control means for all units, a special switch for each unit, means including a temporary connection through the switches of the unit in which a calling line is located between said calling line and the common control means for the establishing of an independent connection over a link from the calling line to a called line in any unit over switches of the units involved and the special switch associated with the unit in which the called line is located.

2. In a telephone system, a plurality of switching units, lines in each unit, links in each unit, each link having one end terminating in the corresponding unit and having other ends terminating in all the units, a recorder in one of said

units, means for establishing a connection from a calling line in any unit to a recorder over switches in the corresponding unit, and means controlled by said recorder for establishing a connection from said calling line through the switches of the corresponding unit to one end of a link in said unit and to a called line in any unit over another end of said link terminating in the unit in which the called line is located over switches in said unit and for thereafter releasing said recorder.

3. In a telephone system, a first switching unit comprising cross-bar switches, lines, links, recorders, means for establishing a connection from a calling line to a recorder over said switches, means controlled by said seized recorder for establishing a connection between one end of a link and the calling line and between any other end of this link to a called line over said switches and for thereafter releasing the recorder, a second switching unit comprising cross-bar switches, lines, links, means for establishing a connection from a calling line in the second unit to a recorder in said first unit, means controlled by said seized recorder for establishing a connection between one end of a link in the second unit and the calling line in the second unit and between another end of said link and a called line in said second unit over switches in said second unit, and for thereafter releasing the recorder, additional cross-bar switches, and means controlled by a recorder seized by a calling line in either unit for establishing a connection between one end of a link and said calling line and between another end of said link to a called line in the other unit over switches in both units and one of said additional switches.

4. In a telephone system, primary, secondary and tertiary groups of cross-bar switches, lines terminating in the primary group of switches, paths between the primary group of switches and the secondary group of switches and between the secondary group of switches and the tertiary group of switches, recorders accessible through the tertiary switches, links accessible through tertiary switches, means for establishing a connection from a calling line to recorders over a path extending from a primary switch to a secondary switch and from said secondary switch to a tertiary switch, means for recording the number of the called line on the selected recorder over said path between the calling line and said recorder, and means thereafter controlled by said recorder in accordance with the number recorded for selecting a link and establishing a connection between one end of said link and the calling line and another end of said link to a called line over paths between said three groups of switches and for thereafter releasing the selected recorder.

5. In a telephone system, cross-bar switches, lines, links, recorders, means for establishing a connection from a calling line to a recorder over said switches, means controlled by said selected recorder for selecting a link and for establishing a connection from one end of the selected link to the calling line and from the other end of said selected link to a called line over said switches and for thereafter releasing the first-mentioned connection for releasing said recorder.

6. In a telephone system, cross-bar switches, lines, links, recorders, means for establishing a connection from a calling line to a recorder over said switches, means responsive to impulses received from a calling line over said connection

to the recorder for selecting a link and for establishing a connection from one end of the selected link to the calling line and from the other end of said selected link to a called line over said switches and for thereafter releasing the first-mentioned connection for releasing said recorder.

7. In a telephone system, primary, secondary and tertiary cross-bar switches, a plurality of paths between the primary and secondary switches and between the secondary and tertiary switches, lines appearing in said primary switches, trunks appearing in said tertiary switches, recorders connectable through said tertiary switches, means for establishing a connection from a calling line to a recorder over paths between a primary switch, a secondary switch and a tertiary switch, means controlled by said selected recorder for selecting a trunk and for establishing a connection from said selected trunk to said called line over paths including connections through a primary, a secondary and a tertiary switch and for thereafter releasing the connection between the calling line and the recorder.

8. In a telephone system, primary, secondary and tertiary cross-bar switches, connecting paths between primary and secondary switches and between secondary and tertiary switches, lines terminating in said primary switches, a tie line connector cross-bar switch, recorders terminating in said connector switch, tie-lines terminating in said primary, tertiary and connector switches, means responsive to the seizure of a tie line for establishing a connection between said tie line and a recorder through said connector switch, means controlled by said seized recorder for establishing a connection from said calling tie line to a called tie line through a primary, a secondary and tertiary switch and for thereafter releasing the connection between said connector and said calling tie line.

9. In a telephone system, primary, secondary, tertiary and connector cross-bar switches, paths

between primary and secondary switches and between secondary and tertiary switches, lines appearing in said primary switches, tie lines appearing in primary switches, tertiary switches and in the connector switch, recorders appearing in said connector switch, means responsive to the seizure of a tie line for selecting a recorder over a connection through the connector switch, means controlled by said selected recorder for establishing a connection from said calling tie line to a line over a path through said primary, secondary and tertiary switches or to a called tie line over a path extending from the calling tie line through a tertiary switch, a secondary switch and a primary switch to the called tie line and for releasing the connection through the connector switch for the recorder when either type of connection is completed.

10. In a telephone system, cross-bar switches, lines, links, recorders, means for establishing a connection from a calling line to a recorder over said switches, means controlled by said selected recorder for selecting a link and for establishing a connection from one end of the selected link to the calling line and from the other end of said selected link to a called line over said switches and means thereafter operating for releasing the connection over said switches from the calling line to the recorder.

11. In a telephone system, cross-bar switches, lines, links, recorders, means for establishing a connection from a calling line to a recorder over said switches, means responsive to impulses received from a calling line over said connection to the recorder for selecting a link and for establishing a connection from one end of the selected link to the calling line and from the other end of said selected link to a called line over said switches and means thereafter operating for releasing the recorder by the release of the switches over which the connection from the calling line to the recorder was established.

EDSON L. ERWIN.