Oct. 1, 1946. W. A. MALTHANER 2,408,433

TELEPHONE SYSTEM

Filed Feb. 13, 1943 14 Sheets-Sheet 1

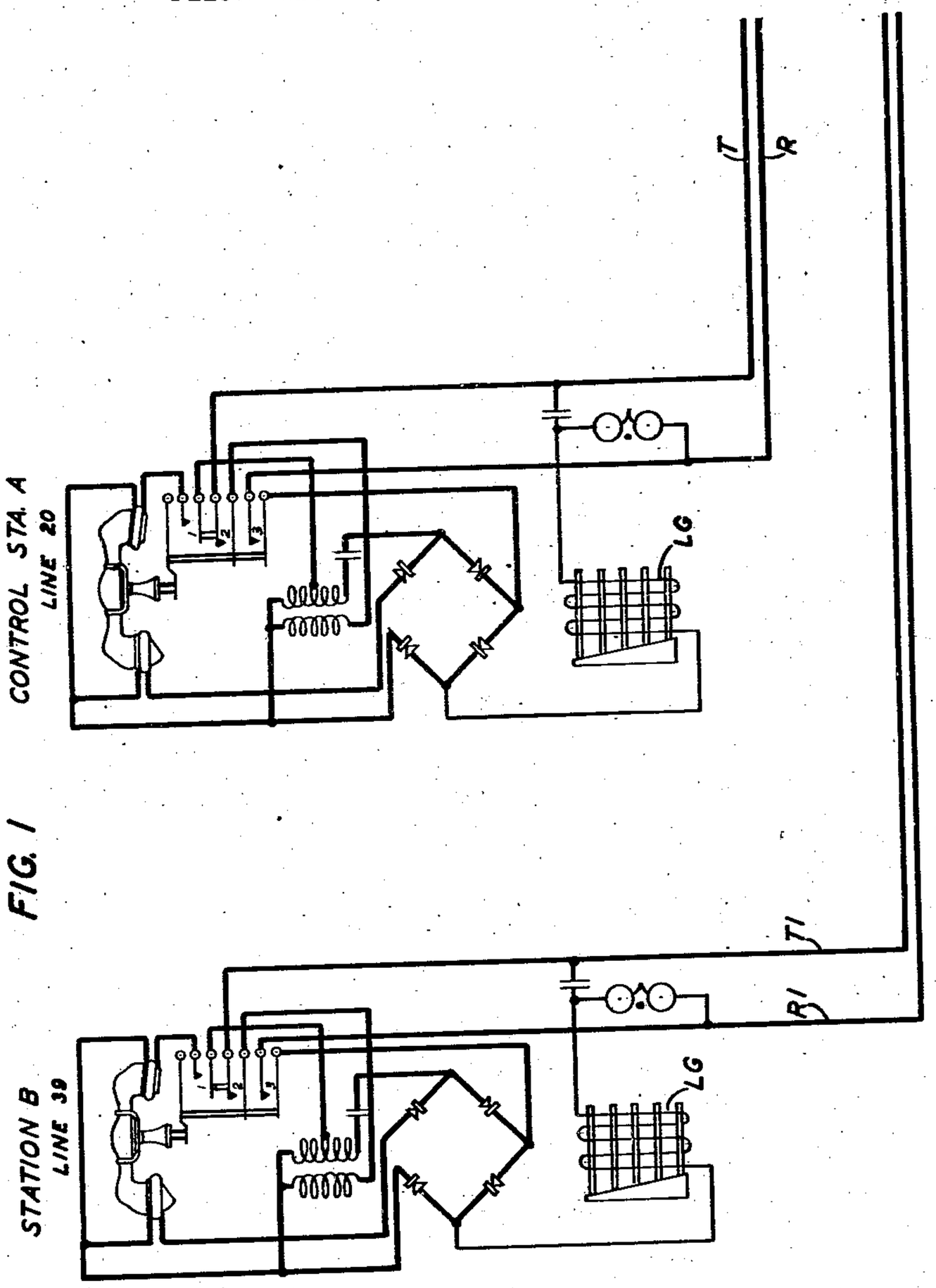

FIG. 1

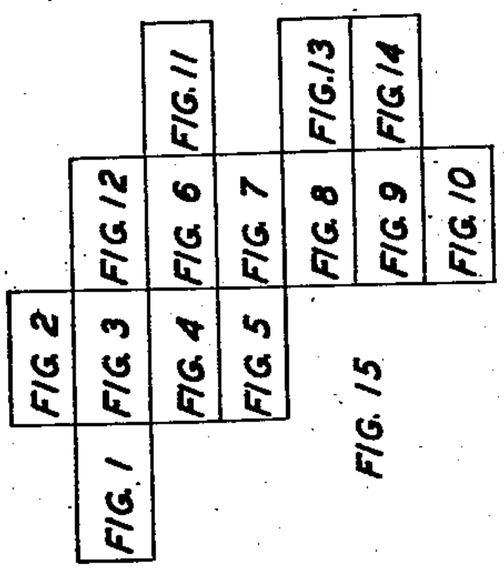

FIG. 15

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TELEPHONE SYSTEM

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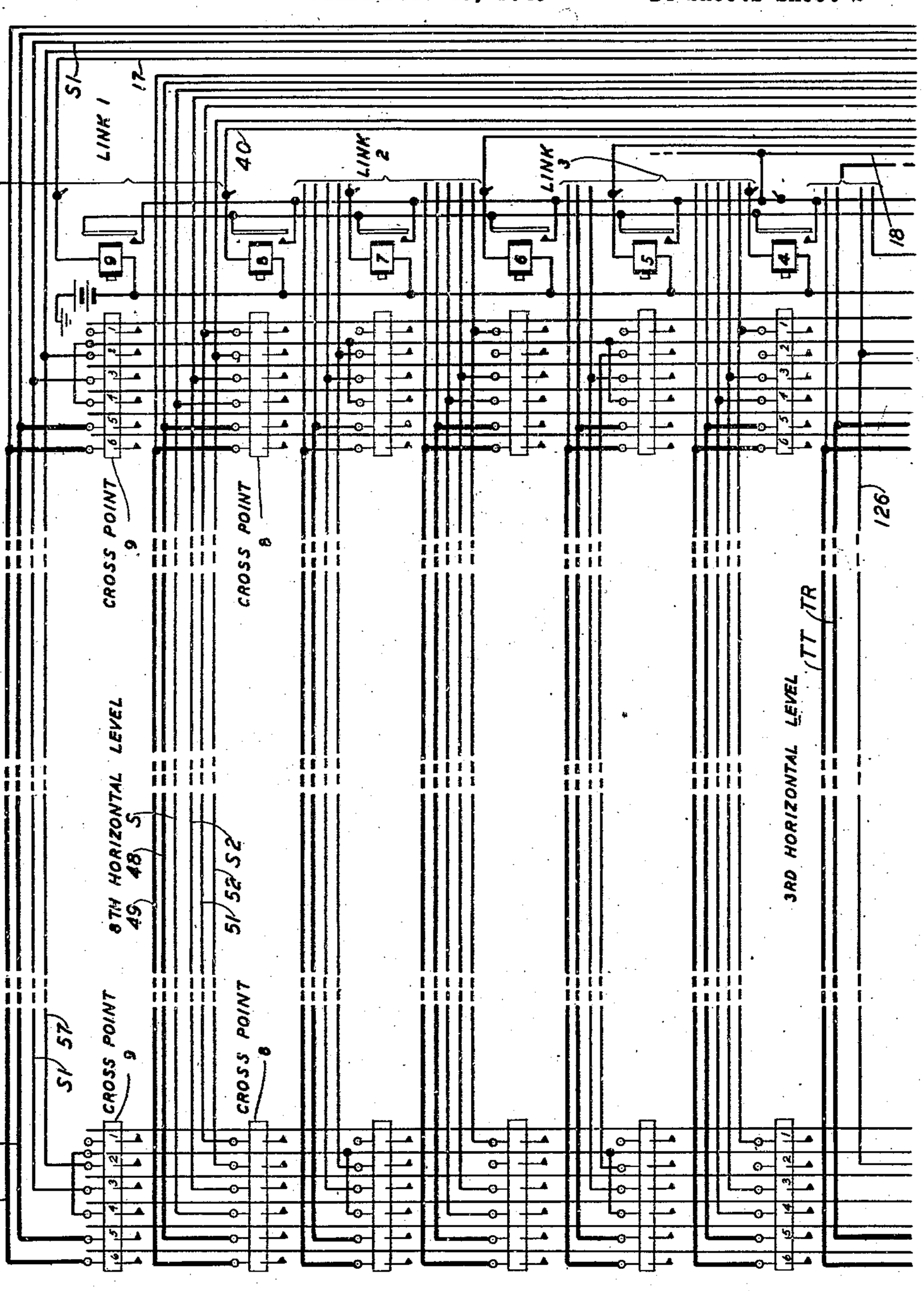

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TELEPHONE SYSTEM

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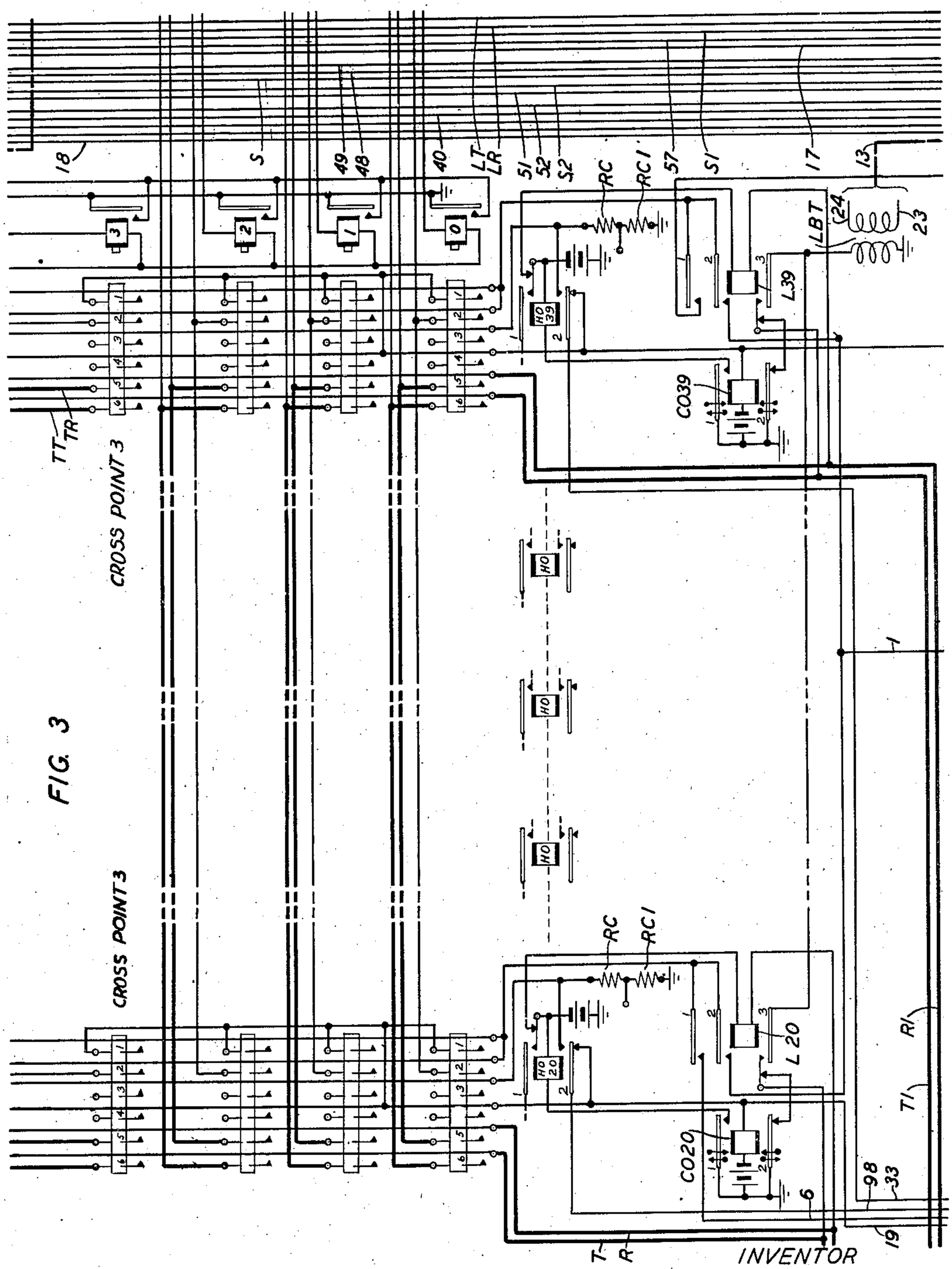

FIG. 3

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TELEPHONE SYSTEM

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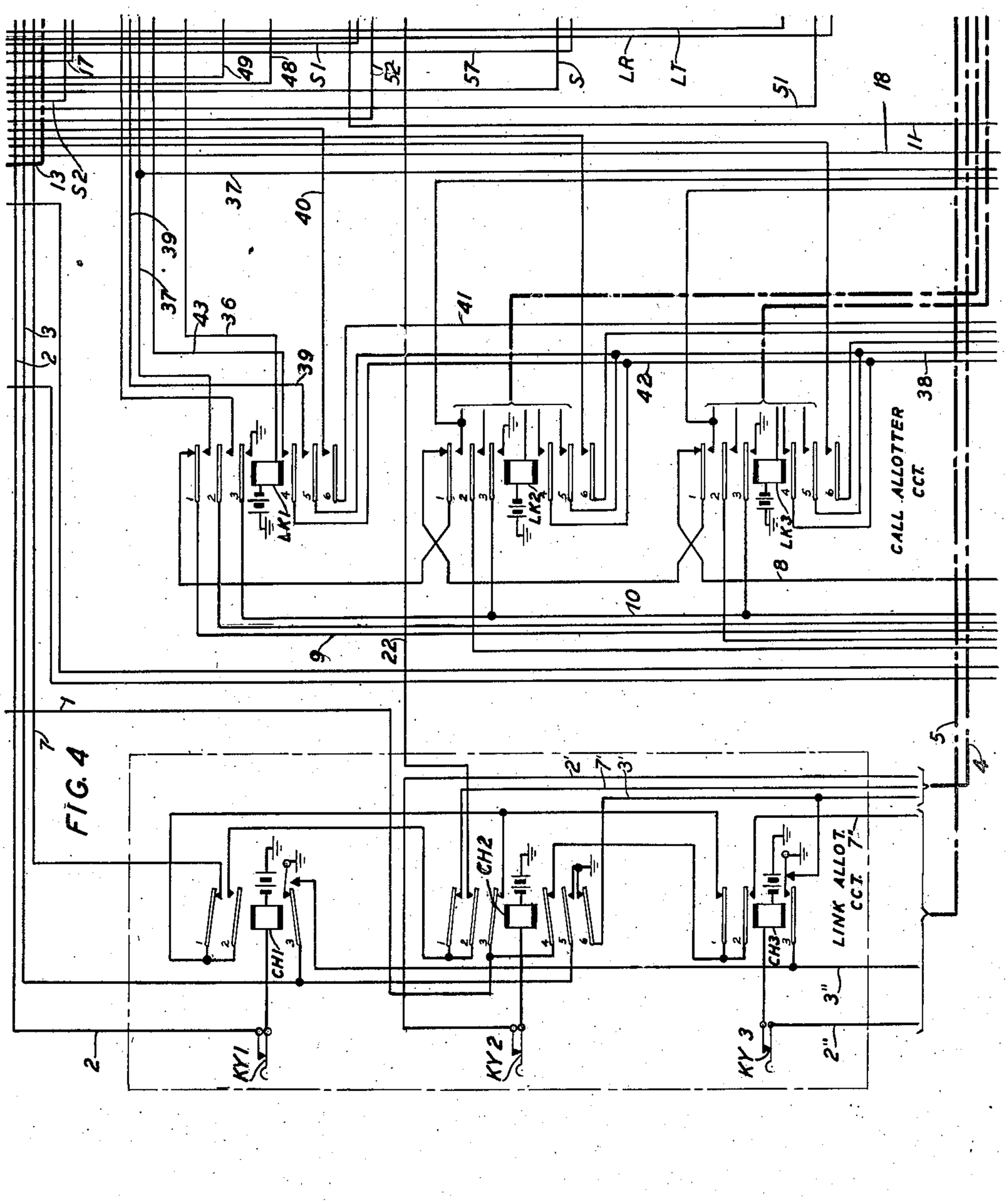

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TELEPHONE SYSTEM

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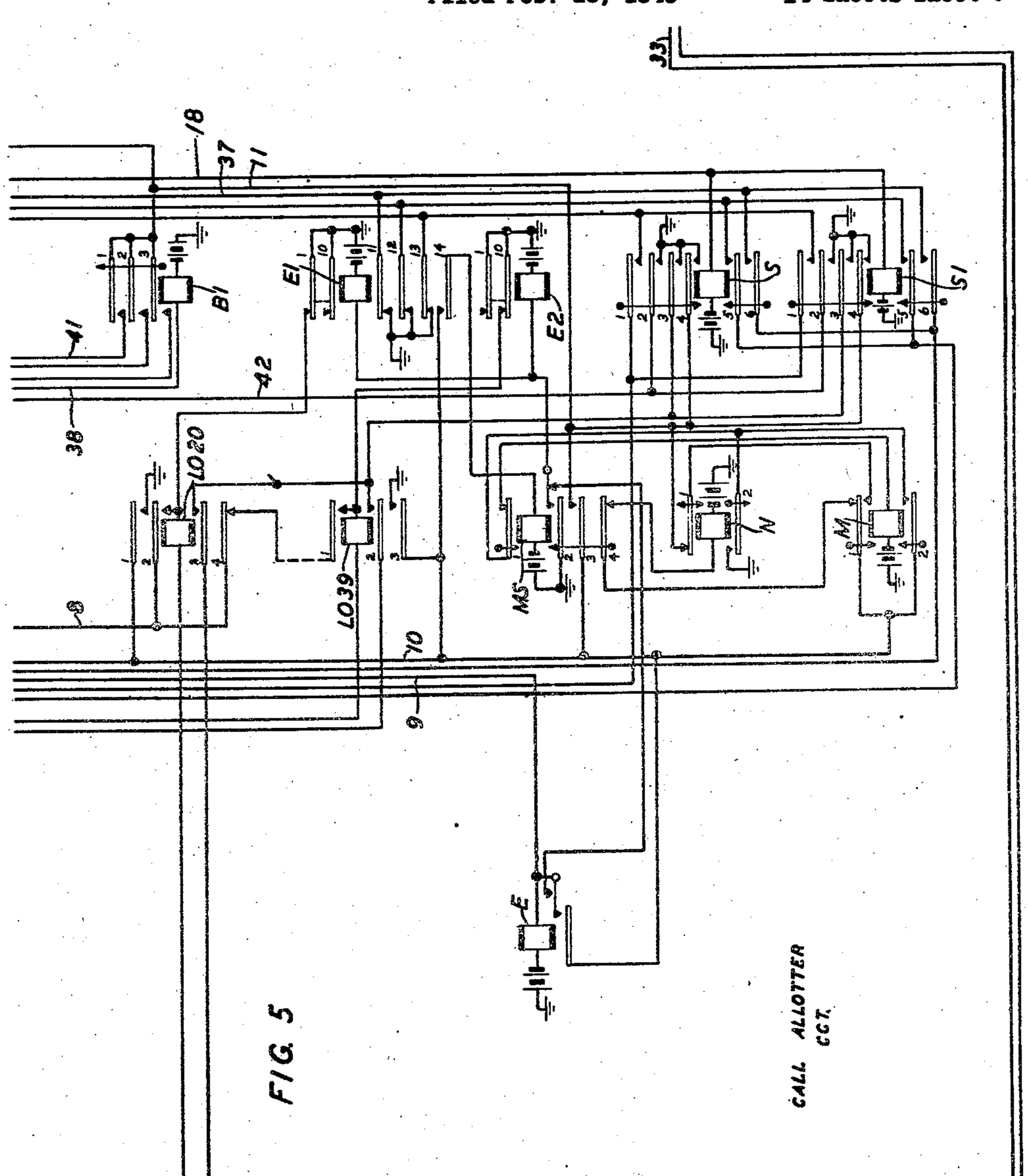

FIG 5

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TELEPHONE SYSTEM

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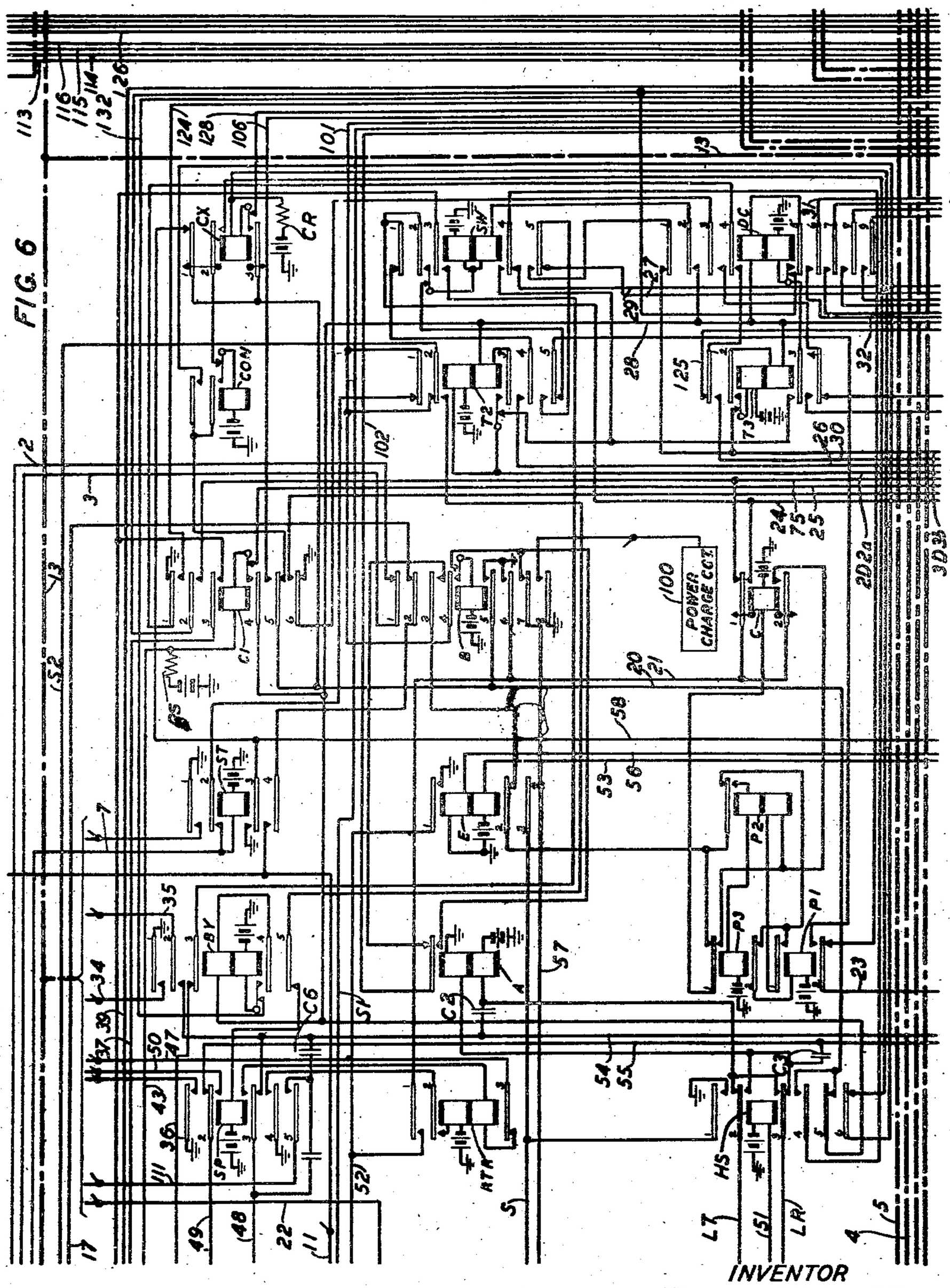
FIG. 6



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TELEPHONE SYSTEM

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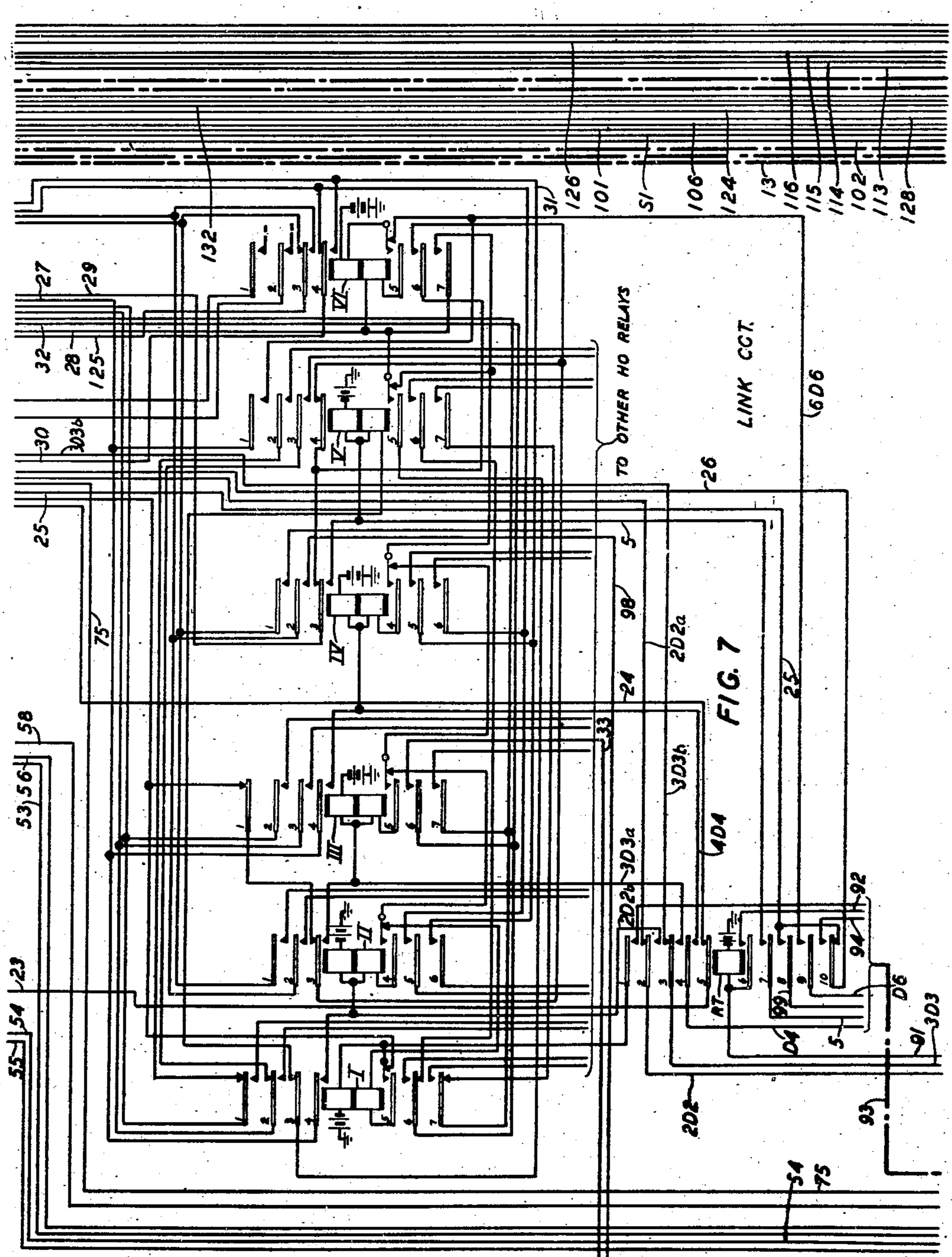

FIG. 7

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TELEPHONE SYSTEM

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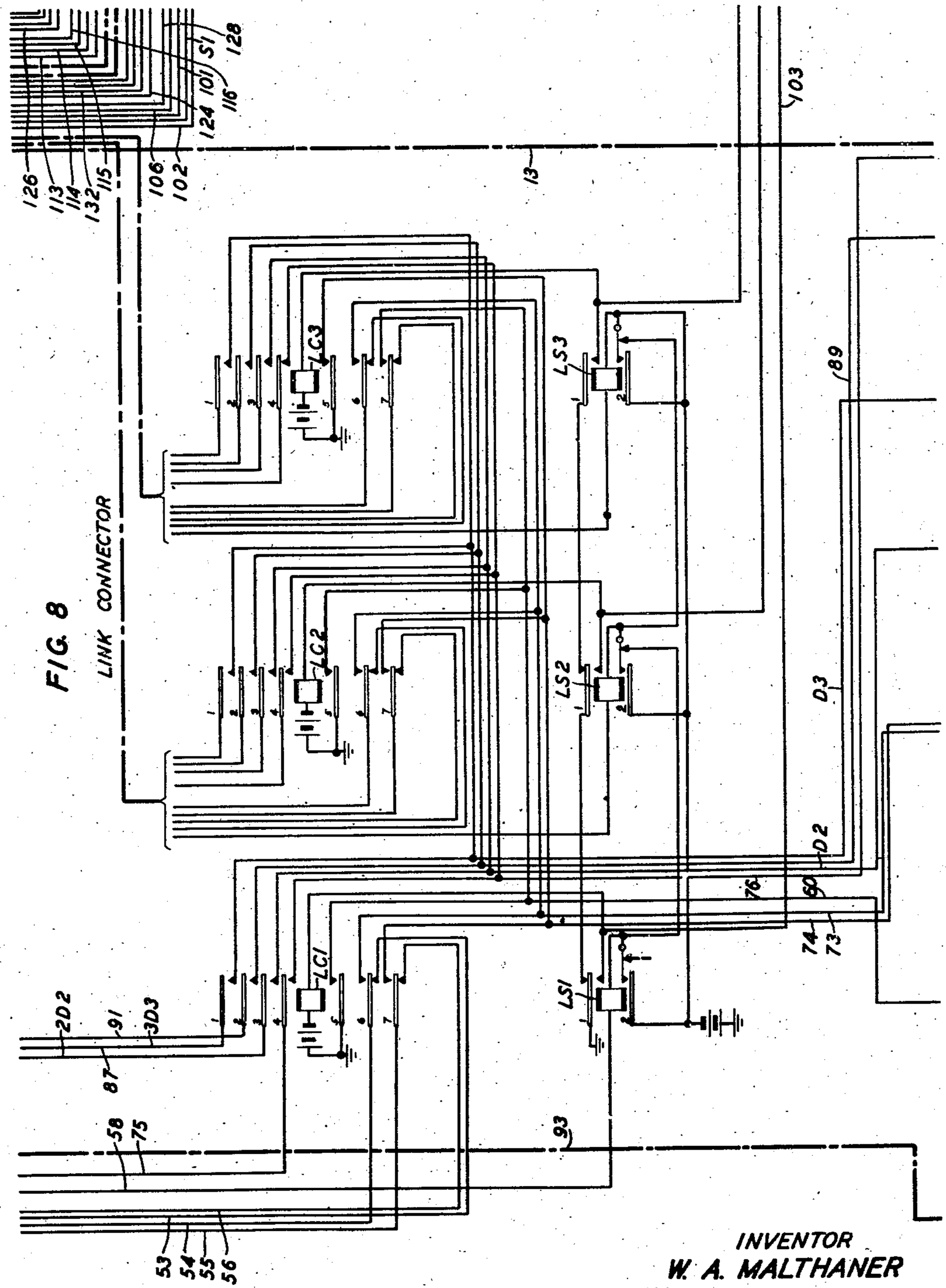

FIG. 8

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TELEPHONE SYSTEM

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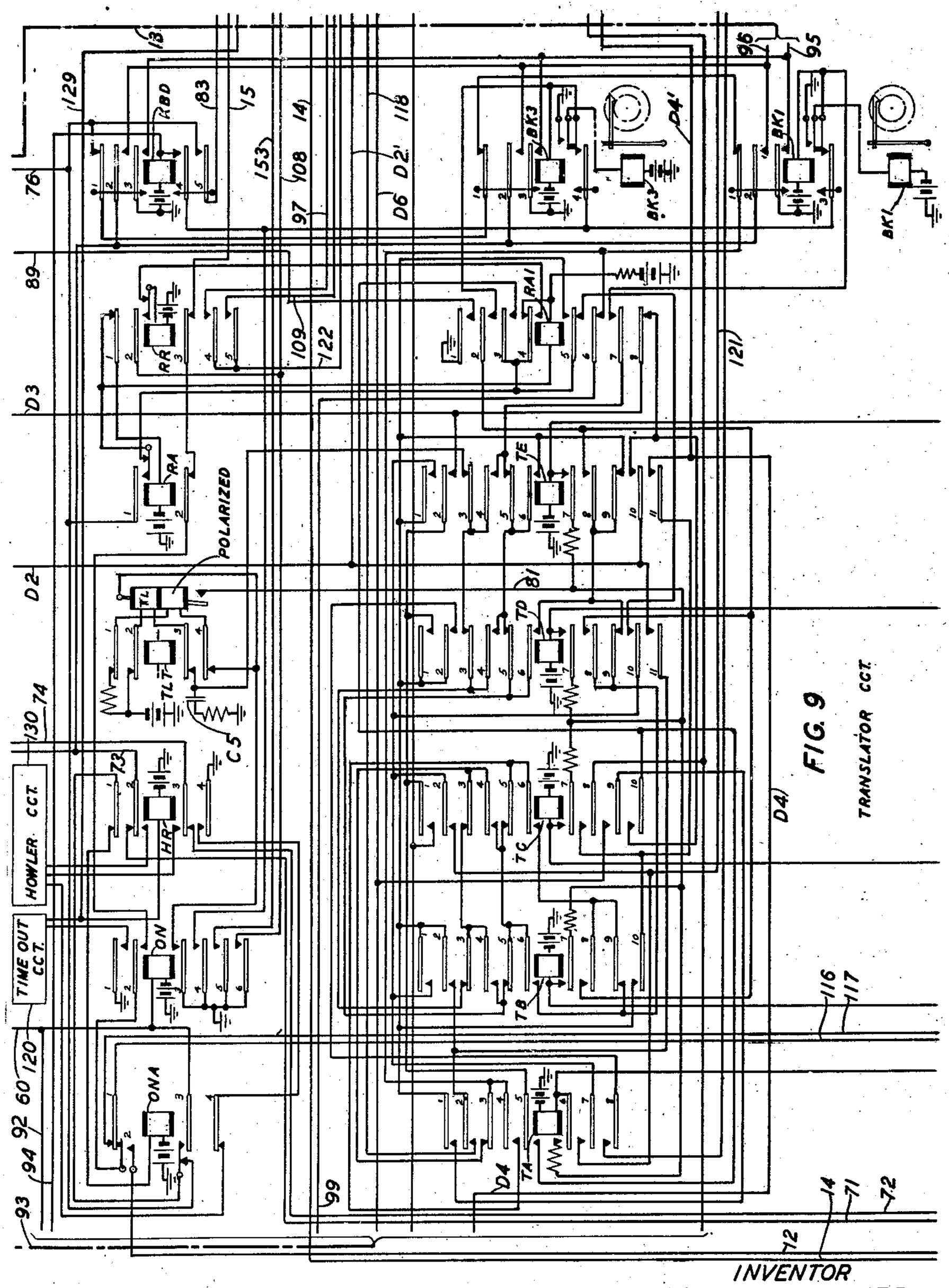

FIG. 9

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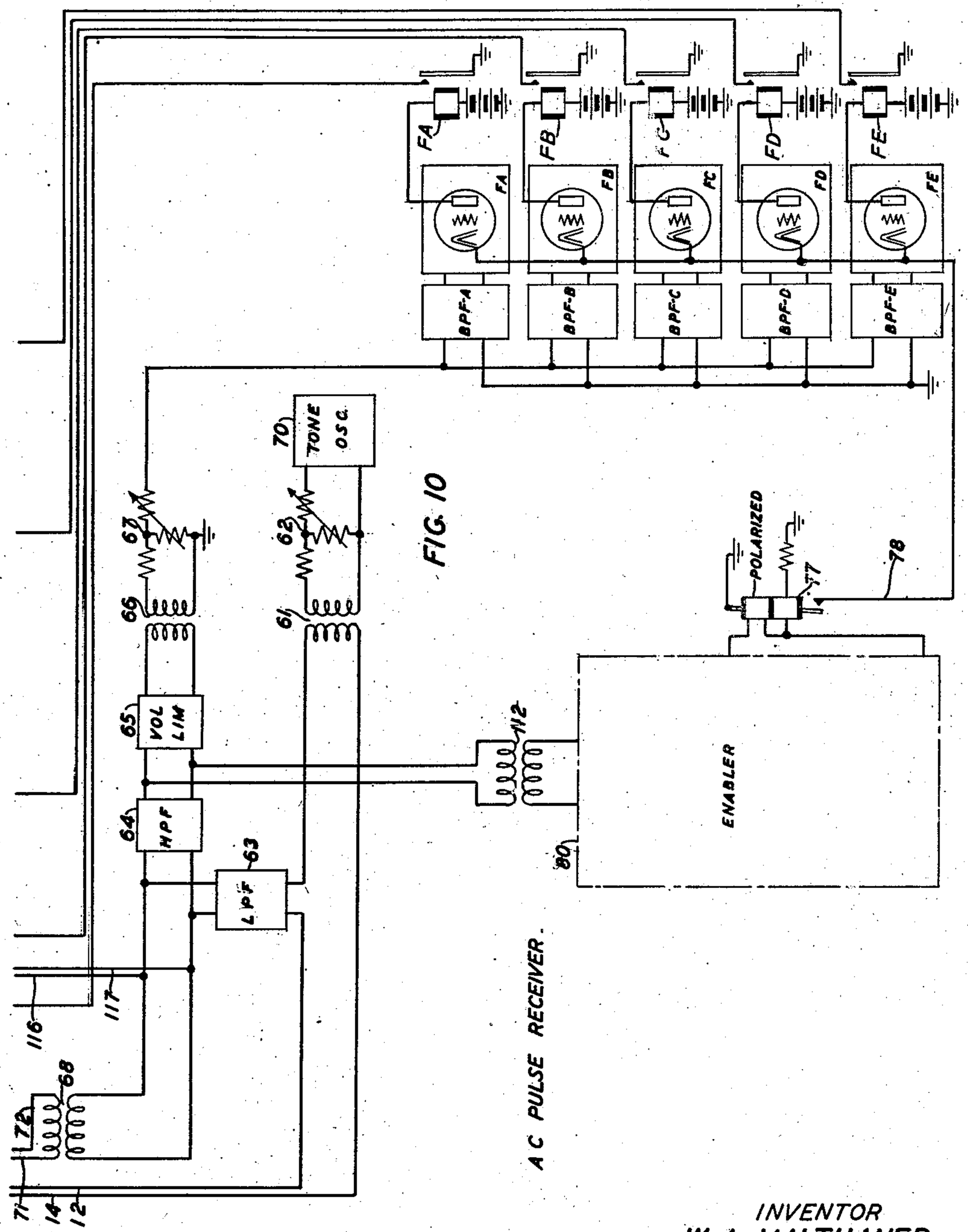

FIG. 10

A C PULSE RECEIVER.

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TELEPHONE SYSTEM

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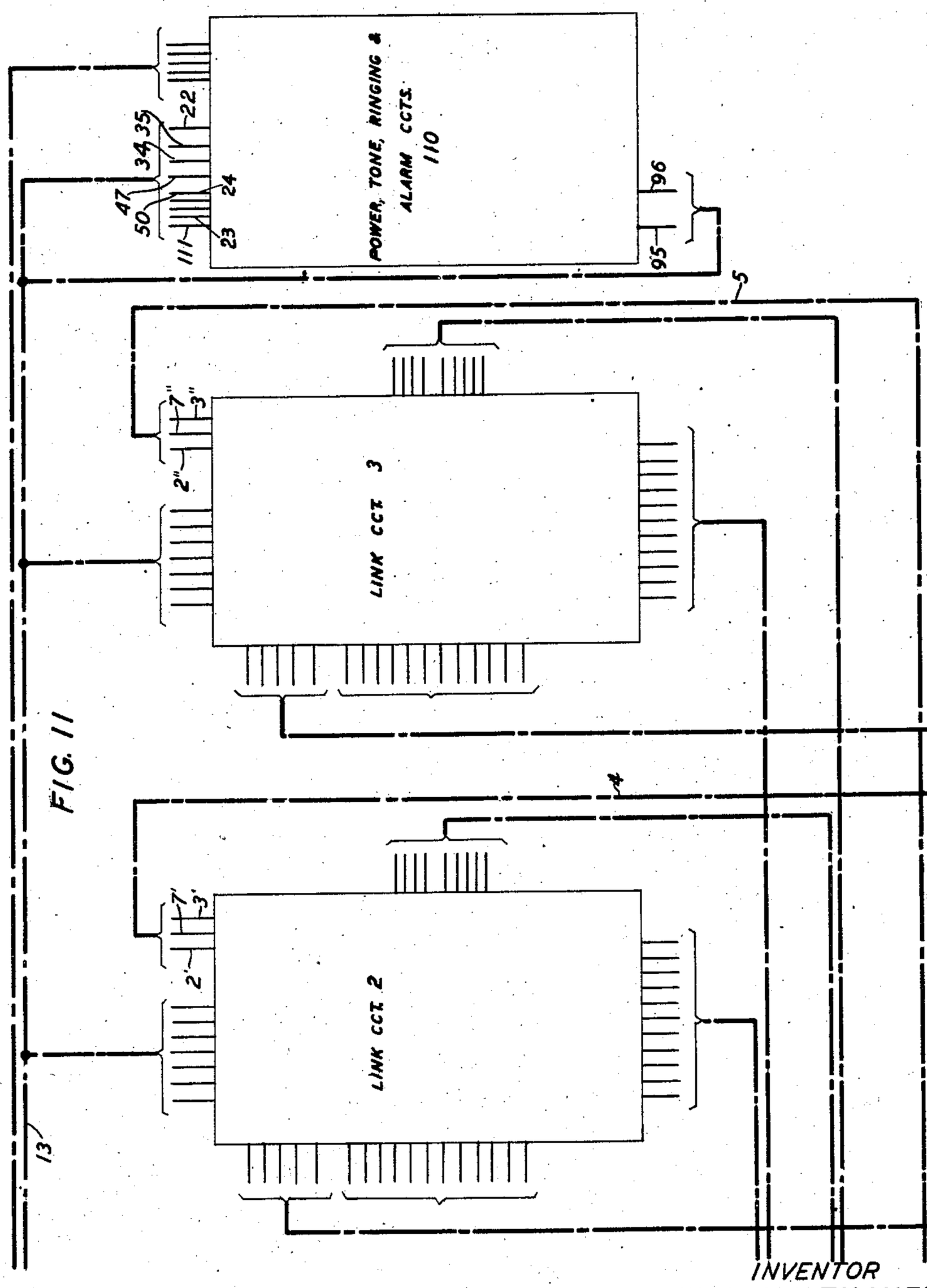

FIG. 11

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TELEPHONE SYSTEM

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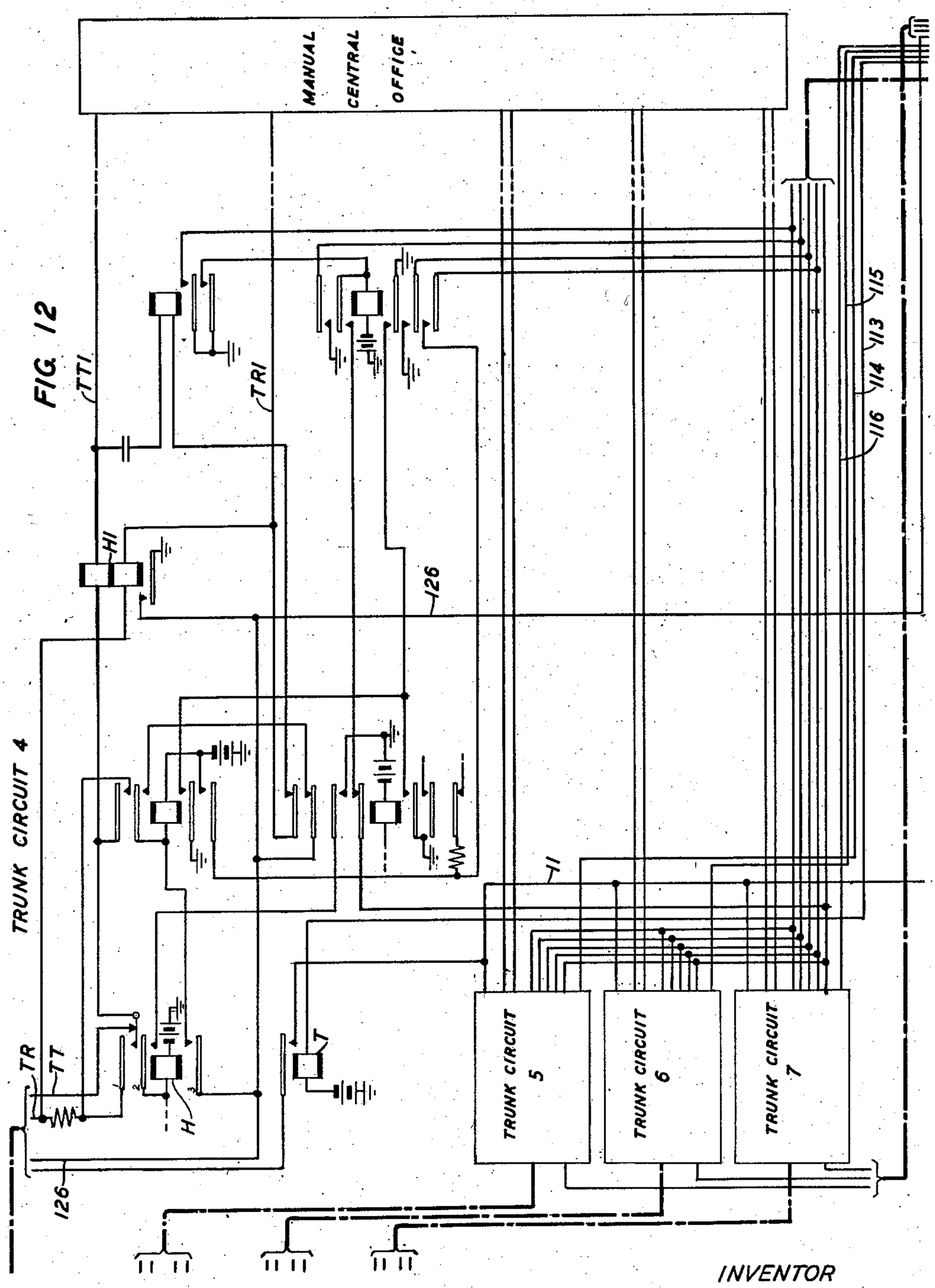
FIG 12



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TELEPHONE SYSTEM

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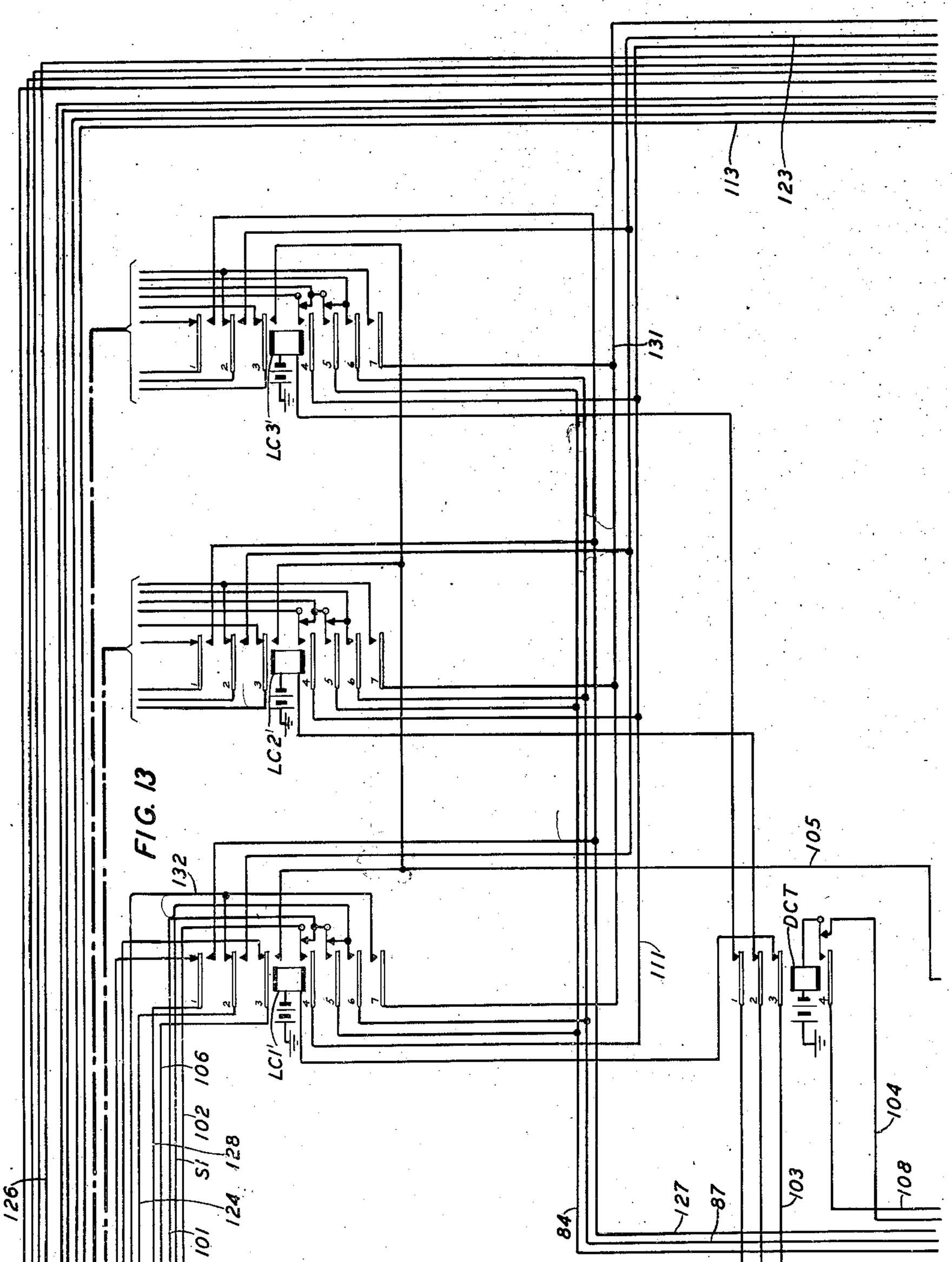

FIG. 13

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TELEPHONE SYSTEM

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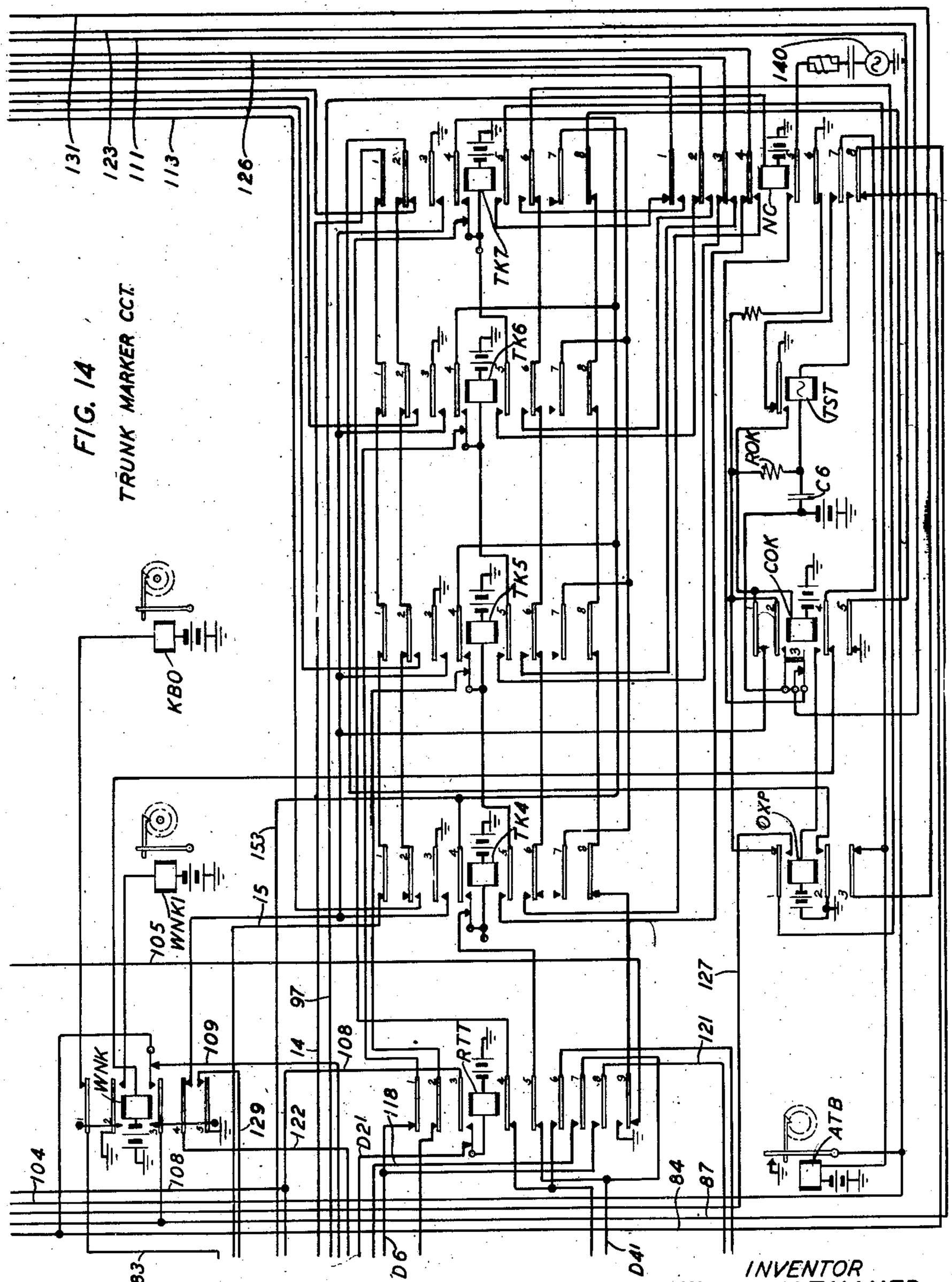

FIG. 14

TRUNK MARKER CCT.

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Patented Oct. 1, 1946 2,408,433

UNITED STATES PATENT OFFICE

2,408,433

TELEPHONE SYSTEM

William A. Malthaner, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application February 13, 1943, Serial No. 475,745

12 Claims. (Cl. 179—18)

1

This invention relates to telephone systems and more particularly to small capacity telephone systems of the private branch exchange type (P. B. X) in which cross bar switches are employed having telephone lines, links and trunks terminating thereon, each of said telephone lines being equipped with an alternating current generating device for producing and transmitting pulses of different combinations of frequencies designating wanted lines or trunks which can be reached over the links.

According to the present invention means are provided whereby a link connected to a calling line, in response to a trunk designation and the calling line designation, functions to extend the line to the wanted trunk and thereafter returns to normal.

Another feature of the invention is a number checking circuit which operates to verify the calling line number as keyed therefrom, and if found to agree with the numerical designation of said line as registered in the link, causes said link to extend the line to the wanted trunk; otherwise it causes said link to dismiss the connection and apprise the subscriber by a distinct tone to restore the telephone instrument and attempt once again to establish the connection.

Still another feature of the invention is a number checking circuit which, in combination, with an electrical condition individual to each line, is adapted to discriminate, when checking the calling line number, between a line that is entitled to trunking service and one that is not, causing the link to establish the connection to a trunk if the call has originated on a line entitled to trunk service and causing it to dismiss the connection if the call has originated on a line which is not entitled to trunk service.

Yet another feature of the invention is a trunk marker which is available in common to all the links, which controls the assignment of an available trunk to a link which is taken into use by a calling line if the trunk digit is keyed before the digits of the calling line number and which is disconnected from the link immediately if the first digit keyed is not the trunk digit.

These and other features of the invention will be better understood from the following detailed description and accompanying drawings in which:

Fig. 1 shows two of the twenty stations in the P. B. X, station A having a line designation of 20 and station B having a line designation of 39;

Figs. 2 and 3 show, diagrammatically, a cross bar switch frame of known construction having

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twenty vertical and ten horizontal outlets. To each of the vertical outlets a station is connected, station A being connected to vertical 20, station B being connected to vertical 39 and the other eighteen stations, in the order of their respective numerical designations, being connected to verticals 21 to 38, inclusive. Of the ten horizontal outlets, or levels, the uppermost six are reserved for three links and the lowermost four are reserved for four trunks which may extend either to one main central office or to as many different central offices;

Fig. 4 in the left portion thereof shows a link allotter circuit, while the rest of this figure, together with Fig. 5, shows the call allotter circuit;

Figs. 6 and 7 show the details of the link circuit;

Figs. 8 and 13 show the link connector and trunk marker connector, respectively;

Figs. 9 and 10 show the common translator and alternating current receiver, respectively;

Fig. 11 shows, in diagrammatic form, two other links and a power generating, tone and alarm circuit;

Fig. 12 shows in detail one of the four trunks extending between the P. B. X and the central office, the other three trunks extending to the same central office being conventionally indicated;

Fig. 14 shows the trunk marker; while

Fig. 15 shows the manner in which Figs. 1 to 14, inclusive, are to be arranged with respect to each other to completely disclose the invention.

Before describing the detailed operation of the invention it is desirable to call attention to the fact that the invention has been illustrated in connection with the circuits and equipment completely disclosed and described in Patent 2,300,951 issued to me on November 3, 1941, the equipment and circuits shown in said patent having been modified and adapted to carry out the new functions and features constituting the essence of the present invention, including their adoption for cooperative action with circuits and equipment not shown therein. Reference, therefore, is made to said patent for an understanding for such operations as are not described here, for example, the establishment of local connections; that is, connections between stations in the P. B. X.

Referring, now, to Fig. 4, there are shown therein three relays, namely, relays CH1, CH2 and CH3, which form a link allotter circuit. Relays CH1 and CH2 are shown in the operated position, while relay CH3 is shown in the un-

operated position. These three relays control the sequential allotment of an available link to a calling line, and the function of the relays CH1 and CH2 in the positions shown is to route the start conductor 1 to the first available link in the office. As stated before, in the present embodiment of the invention it is assumed that the quantity of traffic from and between the various lines of the office, including trunk service to the central manual office, may be adequately handled by the use of only three links so that the relays CH1, CH2 and CH3 serve to route a calling line to one of the three links depending upon which one of them is free in the order of allotment. The operated condition of relay CH1 indicates that the link to which it provides access is in the idle condition, the relay remaining locked until said link is taken into use, the locking circuit of said relay extending from battery, through the winding thereof, contacts of key KY1, conductor 2, No. 1 back contacts of relay B of link No. 1 (Fig. 6), conductor 3, No. 3 front contacts of relay CH1 to ground. The locking circuit of relay CH2, which controls access to link No. 2, is traced over a path which extends from battery through the winding of said relay, contacts of key KY2, conductor 2' in the bracket line 4, the No. 1 back contacts of relay B in link No. 2 (said link being conventionally indicated in Fig. 11), conductor 3' in the bracket line 4, No. 6 contacts of relay CH2 to ground.

On the other hand, the operating circuit of relay CH3, which provides access to link No. 3, while traceable over the contacts of its associated key KY3, conductor 2'' within the bracket line 5, through the No. 1 back contact of relay B of link No. 3 (said link being conventionally indicated in Fig. 11), and conductor 3'' within the bracket line 5, terminates in the No. 3 normal contacts of relay CH3 and also in the No. 3 open contacts of relay CH1.

In other words, for a calling line to have accessibility to link No. 1, relays CH1 and CH2 must be operated and relay CH3 must be normal. It will be shown that as each link is allotted in rotation, the circuits of relay CH1, CH2 and CH3 are changed to provide for the advancement of start conductor 1 from one link to the next in the order designated by the numerical indication of each of the three links.

Bearing in mind that relays CH1, CH2 are assumed to be operated and that relay CH3 is assumed to be normal, it may now be further assumed that a call is originated at station A (line 20) for a trunk connection to the manual central office. As before stated, the present invention is in the nature of an improvement over the small capacity office disclosed in my Patent 2,300,951, in which the stations thereof are equipped either with a dial device or an alternating current generating device, and in which links are provided whereby local connections between the several lines may be established over said links by the dialing or keying the number of the wanted station. In the present invention, each of the stations is assumed to be provided with an alternating current device LG and that local connections between the several stations in the office may be established over the links in the manner described in said patent. Although the link circuit herein shown and used has been modified in some respects over the link in said patent to provide for the performance of functions essential to the operation of the features of the present invention, its structure, is so far as it pertains to the establishment of local connections, remains substantially unaltered. The operation of the link, therefore, with respect to the establishment of local connections is not described herein, reference being made to the above patent for a description of said operation.

We may now assume that station A desires to establish a connection to the manual central office. To do so the station attendant removes the telephone instrument from its cradle and then waits for "key" tone upon receiving which he keys an arbitrarily assigned digit indicative of the trunk connected and, thereafter, keys his own station line number, that is, 20. The removal of the telephone instrument from the cradle completes a circuit for line relay L20 which extends from battery, over the No. 1 normal contacts of the hold magnet HO20 associated with vertical 20, winding of relay L20, ring conductor R, over the station loop, tip conductor T, No. 3 normally made contacts of relay L20 to ground on the No. 2 contacts of cut-off relay CO20. Relay L20 operates. Over its No. 3 front contacts, the ground terminal of its circuit is switched from solid ground on the No. 2 contacts of relay CO20 to ground through the secondary winding of transformer LBT to the primary winding of which is connected a source of distinctive tone which, as will be shortly described, is transmitted to the calling line in the event that no link is available for completing the connection.

Over its No. 1 and No. 2 contacts, relay L20 causes a circuit to be completed for relay LO20 of the call allotter circuit (there being one relay LO— for each line) and relay ST of link No. 1 which, since relays CH1 and CH2 of the link allotter are assumed to be operated and relay CH3 is assumed to be normal, is the preferred link in the order of selection. The circuit for the relays ST and LO20 is traced as follows: ground through the No. 1 contacts of relay E1, winding of relay LO20, conductor 6, No. 1 and No. 2 contacts of relay LO20, start conductor 1, No. 3 contacts of relay CH2, No. 1 contacts of relay CH1, conductor 7, winding of relay ST to battery. Both relays LO20 and ST operate in this circuit. Relay LO20, upon operating, completes a circuit for relay N, the path of which may be traced from ground on the No. 1 contacts of relay LO20, conductor 10, No. 1 back contacts of relay M, No. 4 contacts of relay MS, winding of relay N to battery. Relay N operates and completes a circuit for relay M which extends from ground on the No. 2 contacts of relay N, No. 1 contacts of relay MS, winding of relay M to battery. Relay M operates, opens the circuit of relay N at its No. 1 back contacts and causes the latter relay to release. The release of relay N opens the operating circuit of relay M but this latter relay, however, remains locked to ground on conductor 10 under the control of the No. 1 contacts of relay MS and its own No. 2 contacts. When relay MS operates, as described below, relay M releases. This cycle for operating relays M and N ordinarily performs no useful function, but will perform an emergency function which will be explained in due course. At the same time, relay LO20 completes a circuit for relay E which may be traced from ground on the No. 1 contact of relay E1, No. 2 contacts of relay LO20, conductor 8, serially through the No. 1 back contacts of the individual link relays LK3, LK2 and LK1 in the call allotter, conductor 9, winding of relay E to battery. Upon operating, relay E locks to ground on the No. 1 contacts of relay LO20 and,

at the same time, closes a circuit for relays E1 and E2 from ground on its contacts traced therethrough from the No. 1 contacts of relay LO20, No. 2 normally made contacts of relay MS, the windings of relay E1 and E2 in parallel to battery. Relays E1 and E2 operate but relay LO20, which operated from ground on the No. 1 contacts of relay E1, now holds locked to ground on its own No. 1 contacts from battery through relay ST of the selected link, as previously traced to conductor 6, winding of relay LO20 and its No. 2 contacts, conductor 8 as traced to conductor 9, contacts of relay E to ground on the No. 1 contacts of relay LO20. Hence, with the operation and locking of relay LO20 individual to the calling station A and with the operation of relay E1 and E2, all other lines may not receive service if calls are initiated thereat during the time when station A is having a link assigned to its since, with relays E1 and E2 operated, no ground is available for completing the circuit of any other relay LO— individual to a calling line.

When relay E1 operates, it completes a circuit for relay MS, said circuit being traced from ground on conductor 10, No. 14 contacts of relay E1, winding of relay MS to battery. Since relay MS has slow-operating characteristics, it operates after an interval, at which time it opens the locking path of relay N, supplies holding ground over its No. 2 contacts for relays E1 and E2 and, over its No. 3 contacts, applies ground on conductor 10 to conductor 11. Ground on conductor 11 is used to complete the circuit of the link select magnet 9 in virtue of operations which will be shortly described and which have been taking place in the link as the result of the operation of relay ST therein.

In the event that, due to some trouble condition, relay E of the call allotter fails to operate, relay MS cannot operate and ground will not be applied to conductor 11 over its No. 3 contacts. If possible under these circumstances, it is desirable to complete the connection and so emergency means are provided for applying ground to conductor 11 when relay MS fails to operate. It will be remembered that, upon the operation of relay LO20, a circuit was completed for relay N, and that prior to the operation of relay MS, relay N caused the operation of relay M. Now, when relay M operates, it opens the circuit of relay N, but relay M remains locked over its No. 2 contacts to ground on conductor 10, and it will be observed that, with relay N normal and relay M operated, ground on conductor 10 is applied to conductor 11 via the No. 1 front contacts of relay M and the No. 1 contacts of relay N.

Returning, now, to the operation of relay ST of the allotted link No. 1, a circuit is completed for select magnet 9, the path of which may be traced from battery, through the winding of said magnet, conductor 17, No. 2 contacts of relay B, No. 4 contacts of relay ST, conductor 11, to the aforetraced ground thereon. Select magnet 9 operates and conditions the group of cross-points in the ninth horizontal level for selection, including cross-point 9 on vertical 20 through which the calling loop will be extended into the link, as shown hereinafter. Select magnet 9, upon operating, completes a circuit from ground over its contact and paralleled conductor 18, to the common windings of relays S and S1, causing said relays to operate and complete a circuit for cut-off relay CO20, the circuit of said relay being traced from ground on the No. 3 contacts

of relays S and S1, No. 3 contacts of relay LO20, conductor 19, winding of relay CO20 to battery. Relay CO20, upon operating, closes an obvious circuit for hold magnet HO20 of the vertical 20 to which line 20 (station A) is connected and, because select magnet 9 is operated, cross-point 9 on vertical 20 is also operated. This cross-point 9 remains operated after the circuit of select magnet 9 has been opened, and since this is standard cross bar switch operation, it will not be amplified any further. When hold magnet HO20 operates, it releases line relay L20 which, in turn, releases relay LO20 and the latter, upon releasing, opens the circuit of CO20 and further disconnects ground from start conductor 1 which caused the operation of relay ST. Relay CO20 (as well as every other relay CO—) is slow release and slow operate and will hold up for the nonce until a holding circuit therefor will have been completed in the link as described hereinafter. Also, while conductor 1 is now opened, the fact that cross-point 9 on vertical 20 is closed, relay ST will not release, it having a locking circuit through a cross-point contact, which circuit may be traced over the No. 2 contacts of said relay, No. 1 contacts of relay T2, conductor 101, No. 5 normally made contacts of relay LC1', conductor S1, No. 3 contacts of cross-point 9 on vertical 20, resistors RC and RC1 to ground.

Since cross-point 9 on vertical 20 is closed, the line tip and ring conductors T and R are joined to the link tip and ring conductors LT and LR, respectively, over the No. 6 and No. 5 contacts of the operated cross-point 9, respectively, and this joining of conductors completes an operating path for relay A of the link, which circuit may be traced from battery, through the lower winding of said relay, No. 2 back contacts of relay HS, conductor LT, No. 6 contacts of cross-point 9 on vertical 20, line conductor T, over the calling line loop, ring conductor R, No. 5 contacts of cross-point 9 on vertical 20, conductor LR of the link, No. 3 back contacts of relay HS, upper winding of relay A to ground. Relay A operates and completes a circuit for relay B which extends from ground on conductor S1, No. 5 and No. 4 normally made continuity contacts on relay LC1', conductor 102, front contacts of relay A, No. 4 normally made continuity contacts of relay B, winding of relay B to battery. Relay B operates and locks over its No. 4 front contacts, conductor 101, No. 5 normally made continuity contacts on relay LC1', to ground on conductor S1. At its No. 7 contacts relay B now completes a holding circuit for CO20 which traces from battery through the winding of said relay CO20, No. 4 and No. 2 contacts in series of cross-point 9 in vertical 20, conductor 57, No. 7 contacts of relay B, front contacts of relay A, conductor 102 and thence as traced to ground on conductor S1. Relay CO20 thus holds operated, in turn holding magnet HO20 which keeps cross-point 9 closed. At its No. 2 contacts, relay B opens conductor 17, thereby causing the release of select magnet 9. However, since the hold magnet HO20 is being held, cross-point 9 on vertical 20 will likewise be held. Relay B further completes a circuit from ground over its No. 8 contacts to a relay (not shown) in the power charge circuit 100 by means of which, when the relay is operated, circuits are closed thereby that will increase the charging rate to the link power supply during the time that the link is being used and, over its No. 5 and No. 6

contacts, relay B further applies ground to hold conductors 20 and 21, respectively, for holding and operating certain other relays as noted below. Over its No. 1 contacts, relay B opens the locking circuit of relay CH1 in the allotter circuit, which, upon releasing, advances the common start conductor 1 over the No. 3 contacts of relay CH2, No. 2 contacts of relay CH1, No. 1 contacts of relay CH2 to conductor 7' which further extends to relay ST of link No. 2 (conventionally indicated in Fig. 11).

It is now evident that if, at the time a call is initiated at station A (or any other station) link 1 is busy or is otherwise made unavailable, its relay CH1 in the link allotter circuit would be normal and the start conductor 1, with ground applied thereto, would be connected to conductor 7' of link 2 to cause the operation therein of relay ST in the manner described for relay ST of link 1. On the other hand, if both links 1 and 2 are busy or otherwise made unavailable, relay CH2 as well as relay CH1 will be normal since their respective locking circuits will be opened at the No. 1 contacts of relay B of their respective links.

However, as soon as these relays are both normal, a circuit is completed for relay CH3 which extends from battery through its winding, contacts of key KY3, conductor 2'' within bracket line 5, No. 1 contacts of relay B of link 3 (conventionally indicated in Fig. 11), conductor 3'' to ground over the No. 1 normally made contacts of relay CH1. Relay CH3 operates and, with relays CH1 and CH2 normal, represents the condition in which links 1 and 2 are unavailable but link 3 is available. If, now, a call is initiated at a line station, as for example, station A, ground on start conductor 1 is extended to conductor 7'' which is connected to the winding of relay ST of link 3, the path being from ground on conductor 1 as applied thereto from conductor 6 through the No. 2 and No. 3 contacts of relay L20, No. 4 contacts of relay CH2, No. 2 contacts of relay CH3, conductor 7'', to the winding of relay ST of said link, causing the operation of said relay and the connection of the associated link 3 to the calling line.

If all three links are unavailable, relay CH3 will be normal along with relays CH1 and CH2. The initiation of a call under these circumstances will cause ground on the start conductor 1 to be applied to conductor 22 via the No. 4 contacts of relay CH2, No. 1 contacts of relay CH3, No. 2 contacts of relay CH1, No. 2 contacts of relay CH2, to conductor 22. This conductor extends (within bracket line 13) to the power tone and alarm circuit 110 and completes a circuit therein which causes a distinct "Link busy tone" to be applied to conductors 23 and 24 which are connected to primary winding terminals of busy tone transformer LBT. Since the secondary winding of this transformer is connected to ground and is completed into a circuit over the winding of the line relay L— to battery on the upper normally made contacts of the hold magnet HO—, the subscriber at the calling station will hear the tone as an indication that, due to unavailable links, the connection cannot be established.

As soon as a link becomes available, say link 1, a circuit is completed for relay CH1 which extends from battery through its winding, thence as traced to conductor 3, No. 5 contacts of relay CH2 to ground. Relay CH1 operates and locks to ground over its No. 3 front contacts to reestablish the path of start conductor 1 to the winding of relay ST of link 1 in readiness for seizure on

the next call. If link 2 becomes available, relay CH2 operates over a circuit traceable from battery, through its winding, thence as traced to conductor 3' to ground on the No. 3 normally made contacts of relay CH3.

Returning, now, to the operation of relay ST of link 1, assumed to have been taken into use as a result of a call having been initiated at station A, ground on the No. 3 contacts of said relay completes a circuit for relay LS1 of its private link connector and this circuit is traced from ground on said contacts, conductor 58, winding of relay LS1, serially through the No. 2 normally made continuity contacts of relay LS2 and LS3 (the former being individual to link 2 and the latter individual to link 3), to battery. Relay LS1 operates, connects operating battery to its winding through its own No. 2 front contacts and, over its No. 1 front contacts, closes two circuits, the first extending from ground, winding of relay LC1 to battery, and the second extending from the same ground, conductor 103, No. 3 contacts of relay DCT, winding of relay LC1' to battery. Both relays LC1 and LC1' operate, the former to connect the translator and alternating current receiver shown in Figs. 9 and 10, respectively, to the link and the latter to connect the trunk marker of Fig. 14 to the link.

In connection with the circuit for operating relay LC1' (or LC2' or LC3'), it should be observed that the link is designed to control the setting up of two types of connections, namely, a local connection between two local stations as, for instance, between stations A and B, and a trunk connection between a local station as, for instance, station A and a trunk extending to the desired central office. In the case of a local connection no trunk is required and, therefore, the services of the trunk marker (Fig. 14) may be dispensed with whereas, on a trunk connection, its services are required and, therefore, connection of the trunk marker to the link is necessary. Discrimination between the two types of connections is achieved by the first digit that will be keyed by the calling subscriber. Since, in the present embodiment of the invention, the private branch exchange is limited to twenty lines with each line having a numerical designation from 20 to 39 depending upon the cross bar vertical in the cross bar switch to which the designated line is connected, and since for the establishment of a local connection the calling subscriber merely keys the digits of the wanted number as set forth in my above-mentioned patent, whereas, for a trunk connection, he keys the trunk digit ahead of the digits of his own station designation, it is obvious that if the first digit keyed by a subscriber is a 2 or 3 and such digits are not used for trunk digit designations, said digits may be used to apprise the link that the connection will be local and, therefore, that the use of the trunk marker can be dispensed with. As described in my above-mentioned patent, the keying of a digit 2 or 3 as the first digit will cause the operation of relay T2 of the link or relay T3 (if digit 3 is keyed) followed by relay T2 (if digit 3 is keyed), for registering therein the digit 2 or 3, respectively, whichever digit it may be. Relay T2 completes a circuit for relay C1 (as set forth in said patent) and the latter, upon operation, completes a circuit for relay DCT of the trunk marker connector. This circuit may be traced as follows: Battery through the winding of relay DCT, No. 4 normally made continuity contacts of said relay, conductor 104, serially through the

No. 8 contacts of the individual trunk relays TK7, TK6, TK5, and TK4 (assuming that four trunks are provided between the private branch exchange and the central office), No. 9 back contacts of relay RTT, conductor 105, No. 3 front contacts of relay LC1', conductor 106, No. 5 contacts of relay C1, to ground on the No. 5 contacts of relay B. Relay DCT operates over the above circuit, locks over its No. 4 front contacts, conductor 108, to ground on the No. 6 contacts of relay ON which is operated at this time as will be shown, and opens the circuit of relay LC1' which releases and, in so doing, disconnects the trunk marker from the link.

In the event of a trunk connection, however, the subscriber first keys the trunk digit designation 4 and, thereafter, follows this digit by keying in succession the two digits of his own number which, in the case of station A, would be a 2 and 0. Under these circumstances, relay T2 will not be operated until the digit 2 is keyed, and in the interval between the keying of the trunk digit and the keying of the tens digit of the calling line, the trunk marker remains connected to the link.

The operation of relay LC1' transfers the holding circuit of relay B from ground on conductor S1 and conductor 101 as traced thereto over the normally made continuity contacts of relay LC1', to the same conductor S1 as traced thereto from conductor 101, No. 5 front contacts of relay LC1', conductor 84, No. 8 back contacts of relay NC, conductor 87, No. 6 front contacts of relay LC1' to conductor S1. It also transfers over its No. 4 front contacts the holding ground for cut off relay CO20 which now holds over conductor 111 to ground on the No. 5 contacts of relay COK. Relay LC1' (or relay LC2' or relay LC3' depending upon which of the relays LS1, LS2 or LS3 is operated) also performs certain other functions in the progressive establishment of the connection which are best described when these functions come into play.

Relay LC1 closes a circuit from ground on its No. 5 contacts over conductor 60 to the winding of relay ON which operates to complete a circuit over its No. 1 contacts to a relay (not shown) in the "Time out" circuit 120, and applies ground over its Nos. 3 to 6 contacts, inclusive, to the connected conductors for controlling certain relays of the circuit as described hereinafter. With the operation of relay ON, a circuit is also completed for relay ONA extending from battery through the winding of said relay, No. 1 contacts of relay HR, No. 3 normally made continuity contacts of relay ONA, conductor 76, No. 4 contacts of relay LC1, conductor 75, No. 1 back contacts of relay C, conductor 21 to ground on the No. 6 contacts of relay B. Relay ONA operates, locks over its No. 3 front contacts under the control of the No. 1 contacts of relay HR to ground on conductor 60 and, at the appropriate time, performs certain functions which are noted below. The operation of the relay in the "Time out" circuit 120 initiates the operation of a group of relays or similar instrumentalities by means of which a predetermined time interval is measured, which interval is the time allowed the calling subscriber to complete keying the wanted number which, in this case, is the trunk digit and the two digits of his own number. When that interval is terminated, a circuit is completed for relay HR which operates to perform certain functions best described in connection with the keying of the wanted trunk or called number as the case may be.

The object of operating relay LS1 and, locally therefrom, relays LC1 and LC1' is, as before stated, to connect to the link when taken into use to the common alternating current pulse receiver and translator shown in Figs. 9 and 10 and to the trunk marker shown in Fig. 14. When these circuits are connected to the link (the signal for which is the operation of relay LS1), the receiver and the trunk marker must be made unavailable to the other two links. This is done by removing the operating ground for relays LC2, LC3, LC2' and LC3' at the No. 1 back contacts of relay LS1 so that, if either relay LS2 or LS3 should have its operating circuit established by relay ST of links 2 and 3, respectively, the circuit of relays LC2 and LC2' or LC3 and LC3' will be cut off at the No. 1 back contacts of relay LS1. On the other hand, if the link taken into use happens to be link 2 or 3, then the corresponding operation of relay LS2 or LS3, respectively, will cut off the operating circuit of relay LS1 at their respective No. 2 normally made continuity contacts so that if link 1 is seized thereafter, the failure of relay LS1 to operate will prevent the operation of relays LC1 and LC1' and thereby prevent the connection of the common alternating current receiver, translator and trunk marker simultaneously to two calling links.

The alternating current receiver of Fig. 10 is adapted to receive alternating current impulses from a calling station which, as said before, is equipped with an alternating current generating device LG, and this receiver as well as the translator and trunk marker must be connected to the link before the calling subscriber can be advised, by an appropriate warning tone, to transmit the called line or trunk designation. Accordingly, when relay ONA operates, it closes the primary circuit of a low frequency tone derived from the tone oscillator 70 through adjustable resistance pad 62 and transformer 61. The path is traced as follows: from the lower terminal of the secondary winding of transformer 61, conductor 14, serially through the No. 1 contacts of relays TK7–TK4, inclusive in the order named, conductor 15, No. 3 contacts of relay RR, No. 2 contacts of relay RA, No. 2 contacts of relay ON, No. 2 contacts of relay ONA, conductor 12, through the low-pass filter 63 to the upper terminal of the secondary winding of transformer 61. The tone frequencies produced by the oscillator 70 are thus induced over the circuit above traced.

Through a transformer arrangement (not shown) in the low-pass filter 63, the low frequencies are induced in the closed circuit comprising the transformer 68, a transformer in said low-pass filter 63 and a transformer in high-pass filter 64. Beyond the secondary winding of the transformer (not shown) in the filter 64 are connected suitable filter networks (not shown) which are designed to pass only frequencies within the signal frequency band of the frequencies that are produced by the station generator LG when operated. Hence the tone frequencies produced by oscillator 70 will not pass into the volume limiter 65 or into the enabler 80. They will, however, be induced into the secondary winding of transformer 68 if said secondary winding forms part of a closed electrical system, which it is, because conductors 71 and 72 are but extensions of the line conductors T and R into the link and alternating current receiver connected thereto. The path of this circuit is traced as follows: From the left side of the secondary winding of

transformer **68**, conductor **71**, No. 2 back contacts of relay HR, conductor **73**, No. 6 front contacts of relay LC1, conductor **54**, condenser C2, No. 2 back contacts of relay HS, conductor LT, No. 6 contacts of cross-point **9** on vertical **20**, conductor T, over the loop of station A, conductor R, No. 5 contacts of cross point **9** on vertical **20**, conductor LR, No. 3 back contacts of relay HS, condenser C3, conductor **55**, No. 7 front contacts of relay LC1, conductor **74**, No. 3 back contacts of relay HR, conductor **72** to the right terminal of the secondary winding of transformer **68**. Inasmuch as the receiver of the telephone instrument of station A is included in the above-closed circuit, the tone induced thereover is heard by the subscriber, which he understands as a signal to proceed with keying the number of the wanted subscriber or trunk.

If the subscriber fails to key the wanted number or trunk (including the digits of his own number) in the time taken for relay HR to operate as above set forth, it is presumed that the connection so far set up was due to the telephone instrument at the station being accidentally removed from its cradle and not restored. In any event, the fact that but three links are provided to serve twenty lines makes it imperative that no link be unduly kept out of service after key tone is transmitted to the calling line without performing the necessary connection-completing functions that follow the transmission of the wanted number designation. Hence if the subscriber fails to transmit the number by the time relay HR operates, relay ONA is unlocked, a circuit is completed from ground over the No. 4 contacts of relay HR, No. 4 contacts of relay ONA to a relay (not shown) in the howler circuit **130** which operates to complete a sharp howler tone which is applied over the No. 2 and No. 3 front contacts of relay HR to conductors **73** and **74**, both of said conductors extending over the calling loop (as previously traced) including the station telephone instrument. The tone is sufficiently loud to be heard at a distance from the receiver and is intended to apprise the subscriber that the telephone instrument should be restored, an occurrence that will cause the link to be disconnected and restored to normal as described hereinafter.

Assuming, however, that relay HR has not operated, the subscriber, upon hearing key tone, operates the device LG to transmit the wanted designation which, since the connection desired is to a trunk extending to the manual central office, will consist of the arbitrary digit "4" indicating a trunk to said central office, followed by the subscriber's own number "20." He does this by first operating a key in the device LG bearing the numeral "4" thereon and then, in succession, similar keys bearing the numerals "2" and "0," respectively. The depression of each key causes two out of five reeds to be plucked according to a code combination individual to the numeral indicated, and the reeds are set into vibration to produce two alternating currents of specific frequencies which are now transmitted over a circuit which may be traced as previously to conductors **73** and **74** at the No. 2 and No. 3 back contacts, respectively, of relay HR and, thereafter, to conductors **71** and **72**, respectively, connecting with the secondary winding of transformer **68**. These frequencies are induced into the circuit comprising the primary winding of said transformer and the high-pass filter **64**.

The alternating current pulse receiver shown in Fig. 10 is a conventional disclosure of the receiver shown in Patent 2,269,022 issued to G. Hecht and A. A. Lundstrom on January 6, 1942. It comprises the channel composed of transformer **68**, the high-pass filter **64**, the volume limiter **65**, the transformer **66**, the adjustable pad **67**, five detector amplifiers *f*A–*f*E with relays FA–FE in the respective anode circuits thereof and a suitable filter BPF— intermediate the pad **67** and each one of the detector amplifier tubes *f*A–*f*E, each of said filters being designed to pass only the frequency intended for the particular channel in which the filter is included. Between the high-pass filter **64** and the volume limiter **65** is bridged the primary winding of transformer **112** to the secondary winding of which is connected the enabler **80**. This enabler is identical to that disclosed and described in the above-mentioned patent to G. Hecht and A. A. Lundstrom and is shown only in conventional form except for polarized relay **77**. The enabler responds to a portion of the energy in each of the signal pulses that pass through the high-pass filter **64** and functions to operate polarized relay **77** after a predetermined interval. Relay **77** grounds conductor **78** which is connected to the cathode of each of the detector tubes *f*A–*f*E thereby activating them to respond to the portion of the signal energy that passes through the volume limiter **65**. Since the operation of the enabler **80** is completely described in the above-mentioned patent to G. Hecht and A. A. Lundstrom, reference is made to said patent for a complete description thereof, only so much of said description being supplied herein as will be necessary to an understanding of the present invention.

It will further be noted that the No. 1 contacts of relay ONA are bridged across the high-pass filter **64** (through conductors **116** and **117**) to short-circuit said filter when the relay is normal. This is a safety measure to insure that if, at the time the subscriber initiates the call, the Nos. 5 and 6 contacts of cross-point **9** on vertical **20** close last, and should close after the alternating current receiver is connected to the link, the impulse produced over the line loop will not find a passage into the high-pass filter. For if it does and this pulse contains frequency components within the signal frequency band, these frequencies would falsely operate one or more of the signal channels. By the time relay ONA has operated, however, the pulse will have been dissipated, the short circuit is removed and the receiver is connected to the line as above described.

As said before, each detector amplifier tube *f*A–*f*E is preceded by a filter BPF which passes only the frequency intended for the channel in which the tube therein is to operate on the energy carried by said frequency. It is assumed that the device LG is capable of producing five different frequencies which, for convenience, may be designated A–E, inclusive, and that, in accordance with the operation of the receiver as described in the above-mentioned patent to G. Hecht and A. A. Lundstrom, frequency A will cause the operation of tube *f*A, frequency B will cause the operation of tube *f*B and so on up to and including frequency E which will cause the operation of tube *f*E.

As already mentioned, each detector amplifier tube has a relay F— connected in its anode circuit, and a front contact of this relay is further connected to the winding of one of the five re-

lays TA–TE in the translator circuit shown in Fig. 9. Relay FA in the anode circuit of the first channel which responds to frequency A has its front contact connected to the winding of relay TA, while relay FB of the second channel, responding to frequency B, is connected to the winding of relay TB and so on up to and including relay FE in the anode circuit of the fifth channel which responds to frequency E, the front contact of which relay is connected to relay TE. Hence the operation of any combination of detector amplifier tubes *f*A–*f*E will cause a corresponding operation of the register relays in the translator circuit of Fig. 9.

The combination of frequencies for each of the digits which may be keyed from the calling station, the operation of the channels and translator relays operated thereby are as follows:

Digit keyed	Channels operated	Translator relays operated
1	*f*A, *f*D	TA, TD
2	*f*B, *f*D	TB, TD
3	*f*D, *f*E	TD, TE
4	*f*B, *f*E	TB, TE
5	*f*C, *f*D	TC, TD
6	*f*A, *f*C	TA, TC
7	*f*B, *f*C	TB, TC
8	*f*C, *f*E	TC, TE
9	*f*A, *f*E	TA, TE
0	*f*A, *f*B	TA, TB

When, therefore, the subscriber keys the first or trunk digit 4, frequencies B and E are generated and these frequencies are transmitted over the previously described loop, including a winding of transformer **68**, whence they pass through high-pass filter **64** from the output of which the energy thereof divides, part of it passing through transformer **112** to operate the enabler **80** and part of it passing through the volume limiter **65**, transformer **66**, resistance pad **67**, the filters preceding the tubes *f*B and *f*E to the grids of said tubes. Since the operation of the receiver has been amply described in the above-mentioned patent to G. Hecht and A. A. Lundstrom and to which reference is made for a complete description thereof, it may be stated that a definite time interval is consumed in the operation of enabler **80** subsequent to which relay **77** operates to apply ground to conductor **78**. Since this conductor is connected to the cathode of each of the tubes *f*A . . . *f*E, those detectors will respond through whose channels the filters have caused the passage of the frequencies in the signal to be passed. Hence for the digit 4 for which the frequencies B and E are produced to cause the response of channels *f*B and *f*E, relays FB and FE will be operated and they, in turn, close obvious circuits for operating relays TB and TE which, upon operating, lock over conductor **81** under the control of polarized relay TL to ground on the No. 3 contacts of relay ON; relay TL having operated in the meanwhile (before the operation of relays TB and TE) over a circuit which may be traced from battery, the No. 2 contacts of relay TLT, serially through the upper winding of relay TL, No. 3 contacts of relay TLT, No. 3 contacts of relays TE, TD, TB, TC and TA, No. 1 contacts of relays BK**1**, BK**3** and KBD, conductor **76** and ground previously traced thereto. Relay TL also has a circuit through its lower winding, which may be traced from ground on the No. 3 contacts of relay ON, No. 4 contacts of relay TLT, lower winding of relay TL, No. 1 contacts of relay TLT to resistance battery. Now

the current flowing through the upper winding of relay TLT is in a direction to cause its armature to engage the stationary contact while that flowing through the lower winding is in a direction to do the opposite. The strength of the current through the lower winding, however, is not sufficient, by itself, to overcome the effect of the current flowing through the upper winding so that, when both windings are energized, the armature will engage its contact and provide locking ground for relays TB and TE (or any other combination of relays TA–TE) as above described.

It will be noted that the ground which forms a part of the circuit of the upper winding of relay TL also keeps condenser C**5** short-circuited. However, the operation of any one of the register relays TA . . . TE removes this ground, and a charging circuit is established for the condenser through the circuit of the upper winding of relay TL. Relay TL continues to hold for a short interval until the charging current through the condenser dies down after which, being then solely responsive to the current through its lower winding, the relay will release and unlock the register relays TB and TE. However, the interval in which relays TB and TE (or other register relays in the translator) are locked is sufficient to operate or release relay RA as described hereunder and to cause the number indicated by relays TB and TE to be transferred to the direct current pulse register of the link (Fig. 7) if said number is a digit of a local station number, or to the trunk marker if it is the code of the wanted trunk to the central office. Since those operations of the link which have to do with the establishment of local connections are not involved in the present invention, reference being made to my above-mentioned patent for a description of the same, the digit 4 registered by the operation of relays TB and TE is immediately transferred to the register of the trunk marker. In other words, during the time or immediately upon the operation of relays TB and TE and during the interval that the same are locked to the contacts of relay TL, a circuit is completed for relay TK**4** over the following path; battery through the winding of relay TK**4**, No. 4 normally made continuity contacts of said relay TK**4**, No. 5 contacts of relay RTT, conductor D**4**′ (which is in parallel with conductor D**4**), No. 11 contacts of relay TE, No. 10 contacts of relay TB, No. 6 contacts of relay TE, No. 5 contacts of relay TD, No. 4 contacts of relay TB, No. 3 contacts of relay TC, No. 3 contacts of relay TA, No. 1 contacts of relay BK**1**, No. 1 contacts of relay BK**3**, No. 1 contacts of relay KBD, to aforetraced ground on conductor **76**. Relay TK**4** operates over this circuit and, among other functions to be described in due course, locks over its No. 4 front contacts and conductor **153** to ground on the No. 5 contacts of relay ON, causes key tone to be cut off to the line by opening its No. 1 contacts and thereby opens the secondary path of the circuit of oscillator **70**. The ground above traced to conductor D**4**′ is also applied to conductor D**4** which, within bracket line **93** and over the No. 4 contacts of relay RT extends to the upper winding of the link digit register relay IV. However, due to the fact that relay RT is normal at this time, ground on said conductor D**4** will have no effect.

The subscriber, after keying the trunk digit 4, proceeds to key the two digits of his own number which, as said before, is 20. The keying of

the tens digit 2 causes the operation of relays TB and TD of the translator, whereupon a circuit is completed for relay T2 of the link, said circuit extending from aforetraced ground on the No. 1 contacts of relay BK1, No. 3 contacts of relay TA, No. 3 contacts of relay TC, No. 4 contacts of relay TB, No. 6 contacts of relay TD, No. 9 contacts of relay TE, No. 2 contacts of relay TB, No. 11 contacts of relay TD, conductor D2, No. 3 contacts of relay LC1, conductor 2D2, No. 2 contacts of relay RT, conductor 2D2*a*, upper winding of relay T2 to battery. Relay T2 operates, locks over a circuit traced from battery through both of its windings and No. 2 front contacts, conductor 28, No. 5 contacts of relay HS, conductor 20, to ground on the No. 5 contacts of relay B, and unlocks relay ST which releases. Relay LS1, however, does not release on this account, it having a holding circuit over the No. 1 contacts of relay CX to ground on conductor 20. Relay T2 registers the tens digit 2 in the link.

Had the tens digit of the calling subscriber's number been a 3 instead of a 2, then relays TD and TE would have been operated and, under such circumstances, a circuit would have been completed for relay T3 instead of T2, said circuit being traced from aforetraced ground on the No. 1 contacts of relay BK1, No. 3 contacts of relay TA, No. 3 contacts of relay TC, No. 3 contacts of relay TB, No. 4 contacts of relay TD, No. 6 contacts of relay TE, No. 1 contacts of relay TD, No. 2 contacts of relay TE, conductor D3, No. 1 contacts of relay LC1, conductor 3D3, No. 3 back contacts of relay RT, conductor 3D3*b*, No. 2 normally made continuity contacts of relay T3, upper winding of relay T3, to battery. Relay T3 operates and locks over its No. 2 front contacts in series with both windings, conductor 28, to aforetraced ground on the No. 5 contacts of relay B. Relay T3 by its operation and locking registers the tens digit 3 in the link. At the same time a circuit is completed for relay T2 extending from aforetraced ground on the No. 1 contacts of relay B*k*1, No. 3 contacts of relay TA, No. 3 contacts of relays TC and TB, No. 4 contacts of relay TD, No. 6 contacts of relay TE, No. 1 contacts of relay TD, No. 2 contacts of relay TE, No. 8 contacts of relay RA1, No. 10 contacts of relay TE, conductor D2 and thence as traced to the upper winding of relay T2 which now operates and locks as previously described. Note that for either digit ground is applied to conductor D2′ which is joined to conductor D2. Therefore, upon the keying of the tens digit of the calling line number regardless of whether it is a 2 or *a* 3, a path is completed for relay RTT through its normally made No. 3 contacts. Relay RTT operates, locks over its No. 3 front contacts to ground on conductor 108 and performs certain functions to be noted in due course.

Simultaneously with the operation of the register relays TB and TD in response to the keying of the tens digit 2, or with the operation of relays TD and TE in response to the keying of the digit 3, a circuit is completed for relay RA. For either digit, the ground on conductor 76 may be traced to the common terminal of the No. 6 and No. 9 contacts of relay TE. These paths are through a network of contacts which extends over certain contact sets of relays TA–TE in order to insure that exactly two of these relays are operated before grounding any of the link register relays. From the common terminal of this network at the Nos. 6 and 9 contacts of relay TE, the circuit for relay RA may further

be traced through either No. 1 contacts of relay TE, or No. 1 contacts of relay TB, No. 10 contacts of relay TD, No. 5 back contacts of relay RA1, No. 1 normally made continuity contacts of relay RA, No. 1 contacts of relay RR, winding of relay RA to battery. Relay RA operates and, by the closure of its No. 1 front contacts, applies ground on conductor 76 to one terminal of the winding of the relay RA1, the other terminal being grounded over the No. 4 back contacts of said relay to the same ground. When the translator register relays TB and TD release upon the release of relay TL, ground is removed from the conductor which completed the circuit for relay RA (said relay, however, locking up over its front contacts to ground on conductor 76 via the No. 1 contacts of relay RR) and since, by the operation of said relay RA, ground on conductor 76 is now applied over its No. 1 front contacts of one side of the winding of relay RA1, said relay operates and closes a circuit for relay RT, the path of which extends from ground on the No. 1 contacts of relay RA1, conductor 89, No. 2 contacts of relay LC1, conductor 91, winding of relay RT to battery. Relay RT operates, locks over its No. 6 contacts, conductor 92 within bracket line 93, to ground on conductor 60, and connects the windings of the link units register relays I–VI with the contact network of the translator relays TA–TE so that the operation of any two of the latter relays in accordance with the digit code for the alternating current transmission of the units designation of the calling number, will result in the operation of the appropriate one or two relays therein for the registration of said units digit. Relay RT further completes a partial path for relay KBD that traces from battery through the winding of relay KBD, conductor 94 within bracket line 93, No. 10 front contacts of relay RT, conductor 26, No. 4 contacts of relay T2, No. 1 contacts of relay SW to the No. 1 front contact of relay C. Now, if the subscriber should by accident flash the switchhook after having keyed the tens digit, the release of relay A in consequence of the momentary opening of the line will cause the operation of relay C over a circuit completed from aforetraced ground on conductor 102, back contacts of relay A, No. 3 contacts of relay B, No. 2 contacts of relay E, back contacts of relay P3, winding of relay C to battery. Relay C operates, and by applying ground on conductor 102 over its front contacts, completes the aforetraced circuit for relay KBD which now operates and applies ground over its No. 3 contacts to conductor 95 within bracket line 13 which extends to a relay (not shown) in the power, tone and alarm circuit 110 that controls the production of a distinctive source of tone. This tone is applied to conductor 96 which, over the No. 2 contacts of relay KBD, connects with conductor 73 and thence as previously traced over the calling subscriber's loop, lower winding of relay A to battery. This tone warns the subscriber that the connection will not be completed, and that he should restore the telephone instrument and try once more to establish the connection. In the event that the subscriber ignores the tone and proceeds to key the units digit, the same will not be registered since, with relay KBD operated, the ground on conductor 76 used for operating the units register relays I–VI of the link from the setting of the translator relays TA–TE, will not be available, said ground now being opened at the No. 1 contacts of said relay

KBD. Relay KBD further completes a circuit for message register KBO over a circuit extending from ground on conductor 76, No. 5 contacts of relay KBD, conductor 83, No. 1 back contacts of relay WNK, winding of register KBO to battery. The operation of this register furnishes the traffic division of the operating company with information as to how often subscribers flash after keying the tens digit.

When the calling subscriber depresses a key of the device LG for the second or units digit of his own number, the receiver of Fig. 9 responds to the two frequencies supplied to operate whichever two channels are tuned to said frequencies. Thus, if the units digit is 0, as assumed, channel relays FA and FB are operated, followed by the operation of translator relays TA and TB, respectively, which lock to ground on the contacts of relay TL as before. Since relay RA1 is now operated, a circuit path is completed for relay RR which extends from battery through the winding of said relay and its No. 2 normally made continuity contacts, No. 4 front contacts of relay RA1, No. 5 contacts of relay RA1, No. 9 contacts of relay TE, No. 9 contacts of relay TD, No. 6 contacts of relay TB, No. 5 contacts of relay TC, No. 4 contacts of relay TA, No. 1 contacts of relays BK1 to aforetraced ground thereon. Relay RR operates, locks to ground on conductor 108, releases relay RA and applies ground to conductor 101 to hold relay B over the following path: ground on the No. 3 contacts of relay TK4, No. 4 contacts of relay WNK, conductor 122, No. 5 contacts of relay RR, conductor 109, No. 3 normally made continuity contacts of relay WNK, conductor 84, No. 5 front contacts of relay LC1′ to conductor 101. Relay RR further completes a circuit for relay NC which extends from aforetraced ground on conductor 122, No. 4 contacts of relay RR, conductor 97, winding of relay NC to battery. Relay NC operates to perform functions noted hereinafter. On the release of relay RA, relay RA1 will not release, it being held over the No. 1 continuity contacts of relay RA and No. 4 front contacts of relay RA1 to the same ground which caused the operation of relay RR. Relay RA1 now remains locked during the interval in which translator relays TA and TB remain operated; that is, until relay TL releases.

Relays I–VI of the link units register are operated as follows to register each of the ten numerals of the units digits:

Digit	Translator relays	Units register relays
1	TA, TD	I
2	TB, TD	II
3	TD, TE	III
4	TB, TE	IV
5	TC, TD	V
6	TA, TC	V, VI
7	TB, TC	VI, I
8	TC, TE	VI, II
9	TA, TE	VI, III
0	TA, TB	VI, IV

Since the digit 0 requires the operation of relays IV and VI, the operation of relays TA and TB completes the following two circuits for relays IV and VI: Aforetraced ground on No. 1 contacts of relay BK1, No. 4 contacts of relay TA, No. 5 contacts of relay TC, No. 6 contacts of relay TB, No. 9 contacts of relay TD, No. 9 contacts of relay TE, No. 2 contacts of relay TB, No. 2 contacts of relay TA, conductor 118, No. 7 contacts of relay RTT, conductor D4′, conductor

D4 within bracket line 93, thence as traced to the No. 4 contacts of relay RT, conductor 4D4, upper winding of relay IV to battery. Relay IV operates and then locks to ground over both of its windings in series, its No. 4 front contacts, No. 5 normally made continuity contacts of relay V, conductor 28, No. 5 contacts of relay HS, conductor 20, to ground on the No. 5 contacts of relay B. The circuit path for relay VI traces from ground on the No. 1 contacts of relay BK1, No. 4 contacts of relay TA, No. 5 contacts of relay TC, No. 6 contacts of relay TB, No. 9 contacts of relay TD, No. 9 contacts of relay TE, No. 1 contacts of relay TB, No. 7 contacts of relay TA, conductor 121, No. 8 contacts of relay RTT, conductor D6 within bracket line 93, No. 9 contacts of relay RT, conductor 6D6, No. 5 normally made continuity contacts of relay VI, upper winding of relay VI to battery. Relay VI operates and locks through both windings in series and its No. 5 front contacts to ground on conductor 28.

In the same way, if the units digit of the calling line were to be any other digit from 1 to 9, inclusive, circuits to the appropriate relays I–VI in accordance with the above table may be traced from aforetraced ground on the No. 1 contacts of relay BK1 through the various contact combinations of the translator relays TA–TE including, for some digits, combinations on relay RA1 and relay RTT, to conductors within bracket line 93 extending to the windings of the respective relays I–VI which then operate and lock to register the indicated digit. Since the tracing of these circuits may be easily followed from the above example in conjunction with the above table setting forth the relays in the translator and in the units register of the link which are to operate for the various units digits indicated in said table, these circuits are not traced.

After the calling line number has been registered in the link, the tens digit 2 by the operation of relay T2 and the units digit 0 by the operation of relays IV and VI, the link proceeds to check or verify the calling line number before extending the calling line to the trunk. This operation is necessary for two reasons. In the first place, it is desirable not to disrupt an existing connection in the event that a station calling for a trunk, keys the trunk digit and thereafter, instead of keying the digits of his own number keys those of another who, at the time, might be engaged in a local connection with some other station. In the second place, if the lines of the private branch exchange are divided into one group of lines which are accorded outside trunk service and another group which are denied this service, it will be necessary, on a trunk call, to ascertain, of course, whether or not this call has been placed by a line having access to this service. Obviously a check of the calling line will prevent the disturbance of an existing connection in the event that a number is keyed at the calling station which is different from the number of said station, and will prevent the establishment of the connection if the trunk call has been placed from a station to which this service is denied.

It has been stated that after the registration of the units digit of the calling number, relay C1 is operated. Remembering that after the registration of said digit relay RA1 is released, the path over which relay C1 is operated traces as follows: Battery through resistance RS, winding of relay C1, No. 4 normally made continuity con-

tacts of said relay, conductor 25, No. 8 contacts of relay RT, conductor 99 within bracket line 93, No. 6 contacts of relay RA1, to aforetraced ground on the No. 1 contacts of relay BK1. Relay C1 operates and locks over its No. 4 front contacts to ground on conductor 20. A circuit is now completed for relay DC which may be traced as follows: Battery through the lower winding of said relay, No. 5 normally made contacts of said relay, No. 2 contacts of relay C1, No. 1 back contacts of relay C, to ground on conductor 21. Relay DC operates over said circuit and then locks through its No. 5 front contacts and both of its windings in series to aforetraced ground on conductor 28. A circuit is now closed for relay SW extending from battery through both windings in series, No. 2 contacts of relay DC to ground on conductor 28. Relay SW operates and completes a circuit for relay LK1 which extends from battery through the winding of said relay, conductor 36, No. 3 contacts of relay BY, No. 3 contacts of relay SW, No. 3 contacts of relay C1, conductor 37 to ground on the No. 11 contacts of relay E1. Relay LK1 operates and opens the serial locking path of all relays LO— which, if any of them have been operated in response to the initiation of a call during the time that a link is setting up the terminating of a connection (which, in the adaptation of the link to this invention, means extending the calling line to the central office trunk), the same will be prevented from locking at the time relays E1 and E2 operate in the manner previously described. The failure of relay LO— to lock will then prevent ground from being applied to conductor 11 over the contacts of relay MS. In this manner, a line which calls during the setting up of a connection will be prevented from interfering and, of course, will also be denied service until the previous connection has been set up. Relay LK1 also completes a circuit for relay E of the call allotter which may be traced from battery through the winding of said relay, conductor 9, No. 1 front contacts of relay LK, conductor 37, to ground on the No. 11 contacts of relay E1. Relay E now operates relays E1, E2 and MS as previously described and, when the latter relay operates, ground is applied to conductor 11 which, as will be shown, is used to complete the circuit of the trunk select magnet after the link has checked the calling line number through circuit functions which have taken place following the operation of relays C1 and DC as described below.

After the operation of relays C1 and DC, and remembering that relays TK1 and NC in the trunk marker are operated, the link, in cooperation with the trunk marker, proceeds to make a check of the calling line number.

It proceeds to do this by applying an alternating current over a path which includes conductor S1 individual to the line which has initiated the call. This alternating current circuit path is as follows: One branch extends from ground through the alternating current source 140 and impedance network in series therewith, No. 5 contacts of relay NC, No. 3 contacts of relay COK, conductor 123, No. 2 front contacts of relay LC1', conductor 124, No. 1 front contacts of relay C1, No. 4 front contacts of relay DC, No. 1 back contacts of relay T3, conductor 125, No. 3 front contacts of relay VI, No. 2 contacts of relay IV, conductor 98, No. 2 front contacts to hold magnet HO20, resistances RC and RC1 to ground; the second branch extends from grounded battery through

condenser C6, winding of relay TST, No. 8 front contacts of relay NC, conductor 87, No. 6 front contacts of relay LC1', conductor S1, and thence as traced to resistances RC and RC1 in series to ground. It will be observed that both of these paths have resistances RC and RC1 to ground in common and that, so far as number checking is concerned, the resistances to ground is entirely unnecessary since the direct path between generator 140 and the relay TST, once established at the terminal of said resistances, will be sufficient to cause the operation of relay TST. With respect to the alternating current supply 140, however, resistances RC and RC1 to ground and relay TST, condenser C6 to battery may be considered as parallel branches of a circuit of which the alternating current supply 140 and the impedance in series therewith is the common branch. The quantity of alternating current which flows into the branch circuit including relay TST will depend, therefore, upon the resistance values of resistors RC and RC1. Now, for lines entitled to trunking service, resistors RC and RC1 are comparatively high so that most of the current will take the circuit path including relay TST and cause said relay to operate on that account. For lines not entitled to trunking service, on the other hand, resistors RC and RC1 are comparatively low so that most of the current will flow to ground through said resistors, leaving an insufficient quantity of the total current to flow through the parallel path which includes relay TST thereby causing said relay not to operate. Hence the discrimination between lines entitled to trunking service and lines not entitled to trunking service is achieved purely by the value of the discriminating resistors RC and RC1. As a matter of convenience, these two resistors may be made, if desired, into a single unit (as shown) divided into two series elements each preferably though not necessarily of equal ohmic value, and the conductor extending to the No. 2 front contact of the hold magnet HO— and to the No. 3 vertical wire of the involved cross bar vertical, may then be connected to the upper terminal of the two elements to include in the above-described circuit the two elements in series for a line entitled to trunking service and to the middle terminal of the unit to include the lower element only for a line not entitled to trunking service. Hence, if a line is entitled to trunking service, relay TST is caused to operate; if a line is not entitled to trunking service, relay TST is caused not to operate.

It will now also be evident why if, after keying the trunking digit, the subscriber at the calling station should key a number other than his own, the check circuit will fail to complete the above parallel circuits and, therefore, will cause a failure of relay TST to operate. For, under such circumstances, that branch of the circuit which has been traced from the alternating current source 140 to resistors RC and RC1, will be closed over the path including a conductor corresponding to conductor 98 as determined by the setting of the tens relays T2 and T3 and the units relays I–VI for the number erroneously keyed. The other branch of the circuit including relay TST, however, cannot be completed since conductor S1, being individual to each link, can have no access to resistors RC and RC1 of the number erroneously called through any other link except the one of which it is an integral part, and the link of which it is an integral part is connected to the line originating the trunk call and not to

the one which has been erroneously keyed. Under these circumstances, the path of relay TST not being closed, said relay will not operate and, of course, the check circuit will not clear the link for succeeding operations.

Thus, for example, assume that station A erroneously keys the number 39 after the trunk digit 4. The tens digit 3 will be registered by the operation and locking of relays T2 and T3, and the units digit 9 will be registered by the operation and locking of relays VI and III. Now, if station B (line 39) is normal, no link will be connected to the vertical thereof and the alternating current path from source 140 will be closed to the No. 1 front contacts of relay T3 as previously traced thereto, conductor 30, No. 4 front contacts of relay VI, conductor 31, No. 6 contacts of relay DC, conductor 32, No. 6 contacts of relay III, conductor 33, No. 2 back contacts of hold magnet HO39, winding of relay CO39 to battery. However, since relay CO39 is slow operate, the alternating current flowing through it will not affect the relay and, therefore, the hold magnet HO39 will not be disturbed from its normal condition. The branch of the check circuit which includes relay TST remains as previously traced to ground via resistors RC and RC1 of line 20. However, since the alternating current branch of the circuit now is not joined to these resistors, and since condenser C6 intermediate the battery and the winding of relay TST prevents the flow of direct current through the circuit traced between this relay and ground through resistors RC and RC1, said relay will not operate.

Again, consider that station B (line 39) is in a local connection with some other station over link 2, for example, and that station A (line 20) erroneously keys 39 after keying the trunk digit. Since relay CO39 and hold magnet HO39 are operated in this case to hold one end of link 2 connected to station B, the check path from source 140 through link 1 is now completed to ground through resistors RC and RC1 associated with vertical 39, exactly as it would be if the check path had been routed to ground through resistors RC and RC1 associated with vertical 20 had the subscriber at station 20 keyed his own number 20 instead of 39. However, the other branch of the check circuit (the one including relay TST) is now traced as before to conductor S1 of link 1, but since link 1 is connected to vertical 20 instead of vertical 39, said path will be completed to ground through resistors RC and RC1 associated with vertical 20. Under these circumstances, the two paths are not joined at the terminal of a common set of resistors RC and RC1, and since condenser C6 blocks the flow of direct current in the circuit path between relay TST and the resistors RC and RC1 associated with vertical 20, relay TST will fail to operate. In either case, the check circuit, by failing to identify the number of the calling station, signals the link as described hereinafter to return an appropriate tone to the calling station that the call may not be established.

Assuming, now, that the calling station A has keyed its own number 20 and that relay TST has operated in consequence thereof, an obvious circuit is closed for relay COK which operates and then locks over its No. 1 contacts to ground on the No. 3 contacts of relay TK4. Relay COK completes a locking circuit for relay TST from battery through the No. 2 contacts of relay COK, resistance ROK, winding of relay TST, No. 8 front contacts of relay NC, conductor 87 and thence

as previously traced via conductor S1 to ground through resistors RC and RC1. By breaking its No. 3 contacts, relay COK opens the alternating current branch of the circuit from the source 140, and by breaking its No. 5 contacts it opens the holding circuit of cut-off relay CO20 which, prior to the operation of relay LC1' held to ground on conductor S1 and subsequent to the operation of said relay held to ground on the No. 5 contacts of relay COK via conductor 111, the No. 4 front contacts of relay LC1' and conductor 102. The release of relay CO20 causes the release of magnet HO20 which, in turn, opens cross-point 9 on vertical 20 and thereby opens the holding circuit of relay TST which now releases. The opening of the cross-point also releases the link relay A which was being held operated over the line loop, but since relay B is held locked to ground on the No. 3 contacts of relay TK4 via the No. 5 contacts of relay LC1', conductor 84, No. 3 normally made continuity contacts of relay WNK, conductor 109, No. 5 contacts of relay RR, conductor 122 and No. 4 contacts of relay WNK, the release of relay A has no effect at this time upon the operated condition of relay B. The release of relay TST, however, completes a circuit for relay OXP extending from battery through the winding of said relay, No. 4 front contacts of relay COK, No. 7 contacts of relay NC, to ground on the back contacts of relay TST. This relay operates and completes a circuit for relay T of trunk 4 (marked by relay TK4) which extends from ground on the No. 2 contacts of relay OXP, serially through the No. 2 back contacts of relays TK7, TK6, and TK5, No. 2 front contacts of relay TK4, conductor 113, winding of relay T to battery. Relay T operates and extends ground on conductor 11 over its contacts to complete the circuit of selector magnet 3 which operates to condition the cross-points on the third horizontal level for selection and locking in order now to connect the calling line to the trunk. The operation of selector magnet 3 closes the circuit of relays S and S1 (the circuit of these relays being closed by the operation of any selector magnet) and, upon their operation, ground is applied to the common terminal of resistance RS and relay C1, the path for this ground tracing from ground on the No. 2 contacts of either relay S or relay S1, conductor 42, No. 4 contacts of relay LK1, conductor 43 to said common terminal. Relay C1 is thereby shunted and caused to release, subsequent to which a circuit is then closed for relay CO20 extending from ground on the No. 1 back contacts of relay C1, No. 4 contacts of relay DC, No. 1 back contacts of relay T3, conductor 125, No. 3 front contacts of relay VI, No. 2 contacts of relay IV, conductor 98, No. 2 back contacts of the hold magnet HO20, winding of relay CO20 to battery. Relay CO20 operates and closes the circuit of said hold magnet which, upon operating, and in view of the fact that selector magnet 3 is still operated, closes cross-point 3 on vertical 20 and thereby extends the calling line to the trunk. The closure of contacts 6 and 5 on said cross-point effects a juncture of the line conductors T and R with the trunk conductor TT and TR, respectively, the latter two conductors extending to the central office over the following path: conductor H, No. 1 normally made contacts of relay TT, upper winding of relay H1, conductor TT1 which extends to the central office and is in series thereat with a signal responsive device, a battery and conductor TR1, lower winding of relay H1, to conductor TR. Since the line loop beyond conductors TR and TT

is closed by the calling station as previously traced, the signal device at the central office operates to indicate to the operator that service is demanded upon the trunk, and relay H1 operates to provide locking ground for various relays that function on incoming calls with which this invention is not involved and, therefore, not described; also, to provide holding ground for the cut-off relay CO20 over conductor 126, No. 2 contacts on cross-point 3 of vertical 20, the common vertical wire, No. 1 contacts on said cross-point, the common vertical wire, winding of relay CO20 to battery. Relay CO20 is thus maintained operated, in turn maintaining the hold magnet HO20 operated and the cross-point 3 closed. A branch of conductor 126 completes a circuit for relay CX in the link through the operated relay TK4 in the marker corresponding to the trunk assigned (similar paths being available from other trunks through their corresponding marking relay in the trunk marker). This path is as follows: Ground on conductor 126, No. 4 front contacts of relay NC, No. 6 contacts of relay TK4, serially through the No. 6 back contacts of relays TK5–TK7 inclusive, No. 1 front contacts of relay XOP, conductor 127, No. 1 front contacts of relay LC1', conductor 128, No. 3 normally made contacts of relay CX, resistance CR to battery. Relay CX operates, locks over its No. 3 front contacts to ground on conductor 20 and, its No. 1 contacts, opens the circuit of relay LS1, causing it to release and, in turn, release relays LC1 and LC1', the former disconnecting the translator and alternating current receiver from the link and the latter disconnecting the trunk marker from the link, thus causing them both to be available for service with another link. The release of relay LC1 of the link connector releases relay ON in the translator, and since all operated relays therein are locked to ground on its Nos. 3–6 contacts, said relays, including relays RR and TK4, release, the latter in turn releasing all relays holding to ground on its No. 3 contacts. The release of relay RR opens the circuit of relay NC which, upon releasing, restores the number checking paths of the trunk marker. The release of relay LC1 further rejoins conductor 101 to conductor S1. However, since the link is no longer connected to the line, conductor S1 does not have ground thereon. Relay B, therefore, will release and disconnect ground from conductors 20 and 21 thereby releasing all link relays holding thereto and restoring the link to normal.

The trunk connection now holds over cross-point 3 on vertical 20 under the control of ground from the trunk relay H1. When the calling station disconnects, relay H1 is released, relay CO20 releases in consequence thereof and hold magnet HO20 also releases and opens the cross-point. Both line and trunk are thus restored to normal.

Having described the operation of the invention with respect to above functions which have to do with the normal set-up of the call, on the assumption that the calling number is correctly checked by the link and on the further assumption that one trunk only interconnects the central office with the P. B. X, the operation of the invention will now be further described with respect to a failure to check the calling line number and with respect to the utilization of more than one trunk interconnecting the central office with the P. B. X.

In the event that the link fails to check the calling line number, relay WNK is operated. It will be observed that relay WNK is slow operate

and that its circuit path traces through the No. 4 back contacts of relay COK, No. 7 contacts of relay NC to ground on the back contacts of relay TST. Now when relay NC is operated and the check circuit, including relay TST, is connected to the terminal of resistors RC and RC1 individual to the calling line, the circuit of relay WNK is also closed. Since relay WNK is slow operate, sufficient time is thus allowed for operating relay TST, if the number is correctly checked, before relay WNK is allowed sufficient time to operate. If the number does not check, relay TST remains normal and relay WNK operates. This relay now completes a circuit for relay HR over conductor 129 to ground on its No. 5 contacts, closes an obvious circuit over its No. 2 contacts for meter WNK1 to register the fact that a wrong number was keyed, and opens its No. 4 contacts. The opening of these contacts disconnects ground on the No. 3 contacts of relay TK4 from conductor 122 causing the release of relay NC and the disconnection of the number checking circuit. Ground is also thereby disconnected from conductor 109 over which, it will be recalled, relay B of the link is maintained locked. However, due to the fact that the No. 3 contacts of relay WNK are continuity contacts, conductor S1 is immediately joined to conductor 101, via conductor 87, thereby transferring the holding circuit of relay B to ground on conductor S1 through the front contacts of relay A.

The operation of relay HR now causes the application of the howler circuit 130 to conductors 73 and 74 and, therefore, to the calling line loop. The tone from said howler circuit will indicate to the calling subscriber that he should restore the receiver and key the number over again. The link now holds over the loop, and when the subscriber restores, relays A and B release and cause the restoration of the link as well as the translator, receiver and trunk marker.

The number of trunks which may interconnect the P. B. X with the central office will, of course, vary with the needs of the traffic and the capacity of the switch. In the present embodiment of the invention wherein a twenty line switch with ten horizontal outlets is utilized, the needs of three links for local traffic leaves four horizontal outlets which may be used for as many trunks. Assuming, therefore, that a maximum of four trunks is provided between the P. B. X and the central office, each trunk is marked by its own relay TK— in the trunk marker. Thus, relay TK4 marks the trunks whose circuit is shown in detail in Fig. 12, while relays TK5, TK6 and TK7 mark the trunks designated trunk 5, 6 and 7, respectively, in said figure. When the subscriber keys the trunk digit 4, the trunk marker immediately assigns a trunk, if one is available. The trunks are arranged in a numerical order of preference so that trunk 4, marked by relay TK4, will be first choice. Should this trunk be busy, the next idle trunk in the order of preference will be selected.

It will be recalled that as soon as a trunk is taken into use and relay H1 operates, ground is applied to conductor 126 individual to the trunk. Now when a subscriber keys the trunk digit 4 and the trunk marker is connected to the link, relay TK4 operates in the manner described. However, if the trunk marked by this relay is busy, ground will be present in its conductor 126 and a circuit will be closed thereby for relay TK5 if the trunk marked by this relay is free. The circuit of said relay TK5 traces from aforetraced ground on conductor 126, No. 4 back con-

tacts of relay NC, No. 5 contacts of relay TK4, winding of relay TK5 to battery. Relay TK5 operates and then functions, at the proper time, to complete the circuit of relay T of trunk 5, operations thereafter proceeding as already described in connection with trunk 4. Should trunk 5 also be busy, ground will be present on the conductor corresponding to conductor 126 and connected to the stationary spring of the No. 5 contacts of relay TK5, so that, with relay TK4 operated by the trunk marker and relay TK5 operated by ground on conductor 126, a circuit will be completed for relay TK6 from ground extended from trunk 5 to the No. 5 contacts of relay TK5, winding of relay TK6 to battery. Relay TK6 now assigns the idle trunk and performs and controls the same operations which have been described for trunk 4.

If all the four trunks are busy, relays TK4–TK7 inclusive, will all be operated by the ground on private conductor 126 individual to the preceding trunk, and a circuit will be closed for the all-trunks-busy meter ATB extending from battery through the winding of the meter coil ATB, No. 5 contacts of relay TK7, No. 7 back contacts of relay NC to ground on the private conductor (not shown) of trunk 7. The operating ground for the meter ATB is further applied through the No. 3 contacts of relay OXP, conductor 131, No. 7 contacts of relay LC1', conductor 132, No. 4 normally made contacts of relay BY, lower winding of relay BY to battery. Relay BY operates, locks through its No. 4 front contacts in series with its upper winding, No. 5 contacts of relay HS to ground on conductor 20. Relay BY applies ground through its No. 1 contacts to conductor 34 extending to the power, tone and alarm circuit 110 whereby circuits are closed therein to apply a "busy" tone source to conductor 35. This conductor extends over the No. 2 contacts of relay BY, to one side of condenser C2 through which the tone current passes over the No. 2 back contacts of relay HS, conductor LT, over the calling loop to conductor LR, No. 3 back contacts of relay HS, upper winding of relay A to ground. The busy tone thus furnished the calling line indicates to him that no trunk is available.

Upon the operation of meter ATB, ground is applied to conductor 104, thereby completing the circuit of relay DCT which operates, locks to off-normal ground on conductor 108 and opens the paths to the three relays LC1', LC2' and LC3'. Relay LC1' releases and puts the control of relay B again under the control of ground on conductor S1 through the front contacts of relay A, thereby making the release of the link dependent upon the restoration of the calling subscriber.

While I have described my invention in connection with a specific application thereof, it is understood that various other applications and embodiments thereof may be made by those skilled in the art without departing from the spirit of the invention as defined within the scope of the appended claims. For example, different trunks may extend to different central offices instead of one central office, and the same may then be keyed by a digit individual to each trunk. The relay which marks the trunk is then operated by the translator in response to the digit that marks the wanted office, in the same manner as relay TK4 is operated, a different digit other than a 2 or 3 being needed, of course, for each trunk.

What is claimed is:

1. In a telephone system, a calling line, line

extending means, line settable means, and a circuit for verifying the number of said line comprising one branch established by said line extending means and another branch established by said line settable means when set from said calling line in accordance with the number thereof.

2. In a telephone system, a calling line, a terminal individual to said line, line extending means, line settable means, and a circuit for verifying the number of said line comprising one branch established from said terminal by said line extending means and another branch established from said terminal by said line settable means when set from said calling line in accordance with the number thereof.

3. In a telephone system, a calling line, a terminal individual to said line, line extending means, line settable means, and means for verifying the number of said line comprising a source of power connected to said terminal by said line settable means when set from said calling line, and a responsive device connected to said terminal by said line extending means when said line settable means are set in accordance with the number of said calling line.

4. In a telephone system, a calling line, a terminal individual to said line, line extending means, line settable means, and means for verifying the number of said line comprising a source of alternating current connected to said terminal by said line settable means when set from said calling line in accordance with the number thereof, and a responsive device connected to said terminal by said line extending means, whereby upon the establishment of both of said connections, said responsive device operates.

5. In a telephone system, a calling line, a link having a first element for extending said line, and a second element for registering the number of said line, and a circuit for verifying the number of said line comprising one branch established by said first element of said link and another branch established by said second element of said link when set in accordance with the number of said line.

6. In a telephone system, a calling line, a terminal individual to said line, a link having a first element for extending said line and a second element for registering the number of said line, and a circuit for verifying the number of said line comprising one branch established from said terminal by the first element of said link and another branch established from said terminal by the second element of said link when set in accordance with the number of said line from said line.

7. A telephone system comprising a plurality of stations each having an individual terminal, a plurality of links available to said stations, a plurality of trunks for connection to said stations, means responsive to one of said lines initiating a call for connecting one of said links thereto, means in said link for registering the designation of a trunk connection and the designation of said calling station, means responsive to the registration of both of said designations for connecting a source of alternating current to the terminal individual to the calling line through said line registering means, and a signal responsive device connected to said terminal through the link extension of said calling line whereby said signal responsive device is operated by the current supplied through said source of alternating current.

8. A telephone system comprising a plurality of stations each having an individual terminal, a plurality of links available to said stations, a plurality of trunks for connection to said stations, means responsive to one of said stations initiating a call for connecting one of said links thereto, means in said link for registering the designation of a trunk connection and the designation of calling station, means responsive to the registration of both of said designations in the order named for connecting a source of alternating current to the terminal individual to said calling line through said link registering means, and a signal responsive device connected to said terminal through the link extension of said calling line whereby said signal responsive device is operated by the current supplied from said source of alternating current.

9. A telephone system comprising a cross bar switch, lines connected to the verticals of said switch, each of said lines including a terminal individual thereto, a plurality of links connected to a number of the horizontals of said switch for access to all of said lines, a plurality of trunks connected to another number of the horizontals of said switch for connection to all of said lines, means responsive to one of said lines initiating a call for connecting one of said links to said line through the common cross-point of said line and said link on said switch, means in said link for registering the designation of a trunk connection, other means in said link for registering the designation of the calling line number, means responsive to the registration of both of said designations in the order named for connecting a source of alternating current to the terminal individual to the calling line through the line registering means of said link, and a signal responsive device connected to said terminal through the cross-point connecting said line with the link whereby said signal responsive device is operated by the current supplied from said source of alternating current.

10. A circuit for discriminating between telephone lines entitled to two different classes of service comprising a network having a first branch individual to each line, the impedance of said first branch having one value for a line entitled to one class of service and a higher value for a line entitled to the other class of service, a second branch connectable to said first branch, and a third branch including a signal responsive device connectable to both of said branches, whereby said signal responsive device operates if the first branch has the higher impedance value and does not operate if it has the lower impedance value.

11. A telephone system comprising a plurality of stations divided into two groups each entitled to a different class of service, a resistance element for each line, the resistance elements of the lines

entitled to one class of service being of a higher ohmic value than the resistance elements of the lines entitled to the other class of service, a plurality of links available to said lines, a plurality of trunks for connection to said lines, means responsive to one of said lines initiating a call for connecting one of said links thereto, means in said link for registering the designation of a trunk connection, other means in said link for registering the designation of said calling line, means responsive to the registration of both of said designations for connecting a source of alternating current to a terminal of the resistance element individual to said calling line through the line registering means of said link, a signal responsive device connected to said terminal through the link extension of said line whereby said signal responsive device operates on current supplied through said source of alternating current if the resistance element individual to the line has the higher ohmic value, and does not operate if said resistance element has the lower ohmic value, and means responsive to the operation of said signal responsive device for extending said calling line to one of said trunks.

12. A telephone system comprising a plurality of stations divided into two groups, one of said groups being entitled to trunking service and the other of said groups being entitled to local service only, a resistance element for each line, the resistance elements of the lines entitled to trunking service being of higher ohmic value than the resistance elements of the lines entitled to local service only, a plurality of links available to said lines, a plurality of trunks for connection to said lines, means responsive to one of said lines initiating a call for connecting one of said links thereto, means in said link for registering the designation of a trunk connection, other means in said link for registering the designation of said calling line, means responsive to the registration of both of said registrations in the order named for connecting a source of alternating current to a terminal of the resistance element individual to said calling line through the line registering means of said link, a signal responsive device connected to said terminal through the link extension of said line, whereby said signal responsive device operates on current supplied through said source of alternating current if the resistance element individual to the line has the higher ohmic value, and does not operate if said resistance element has the lower ohmic value, means in said link responsive to the operation of said signal responsive device for extending said calling line to one of said trunks, and means in said link responsive to the extension of said calling line to one of said trunks for disconnecting said link from said line and restoring it to normal.

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