Sept. 15, 1936. G. KINER 2,054,702

TELEPHONE SYSTEM

Filed Jan. 27, 1933 5 Sheets-Sheet 1

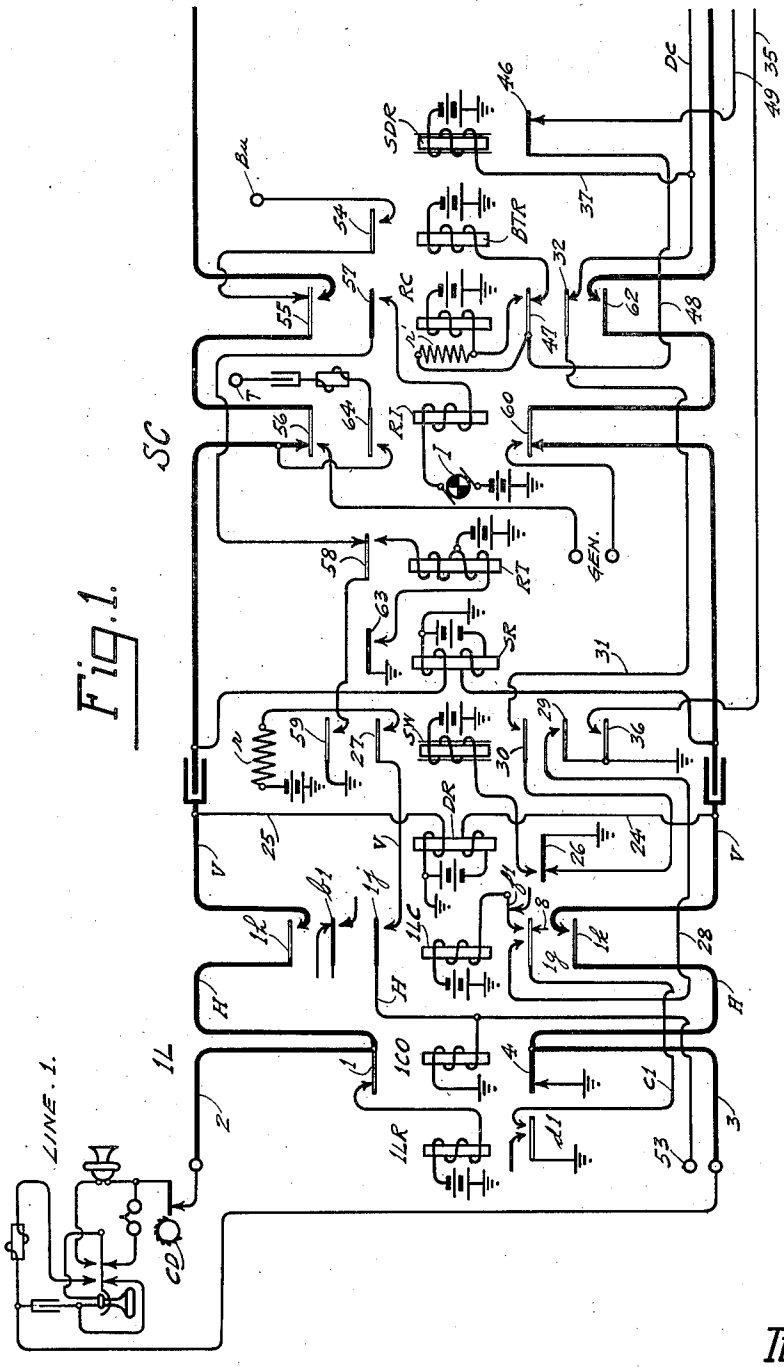

Fig. 1.

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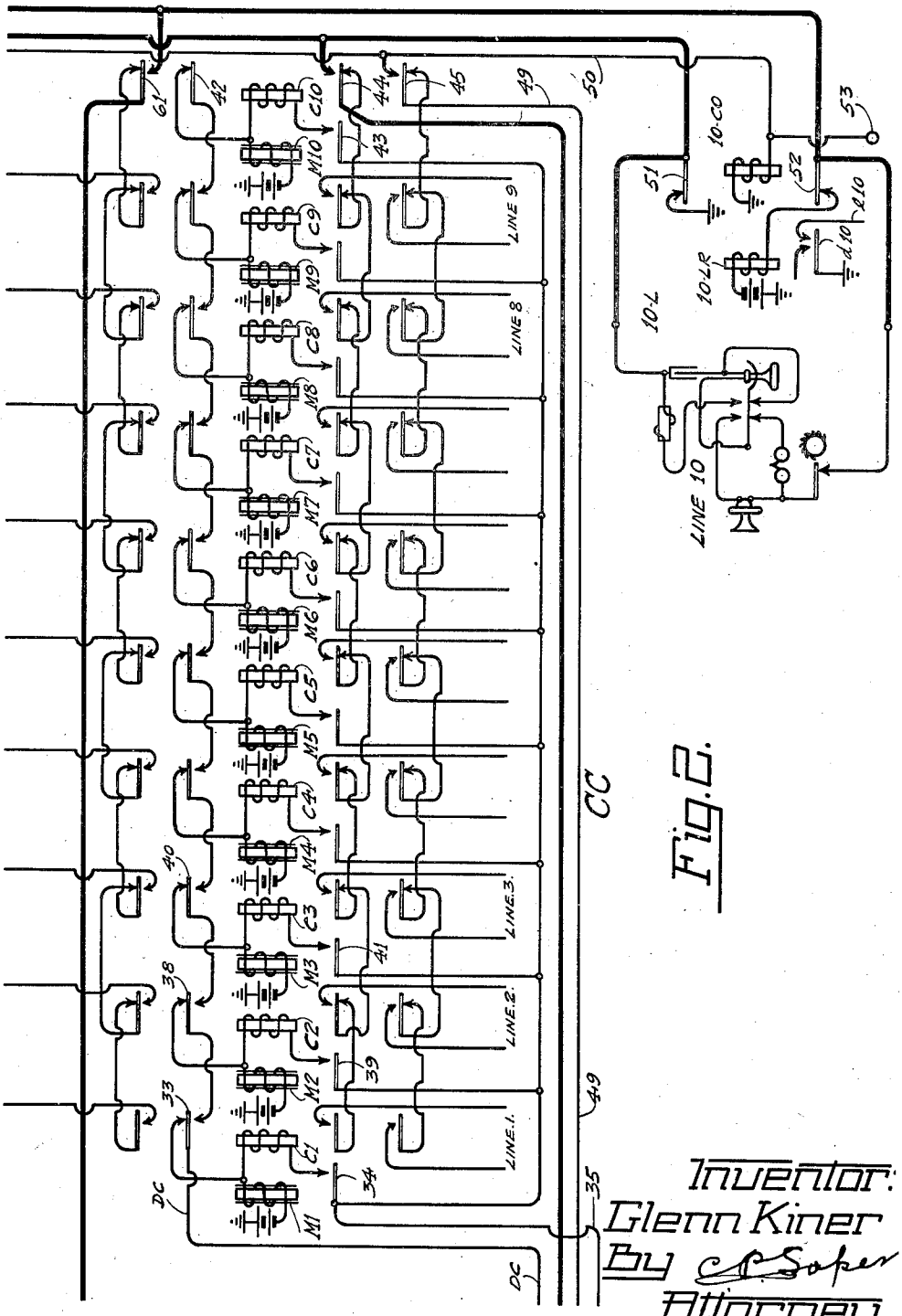

Fig. 2.

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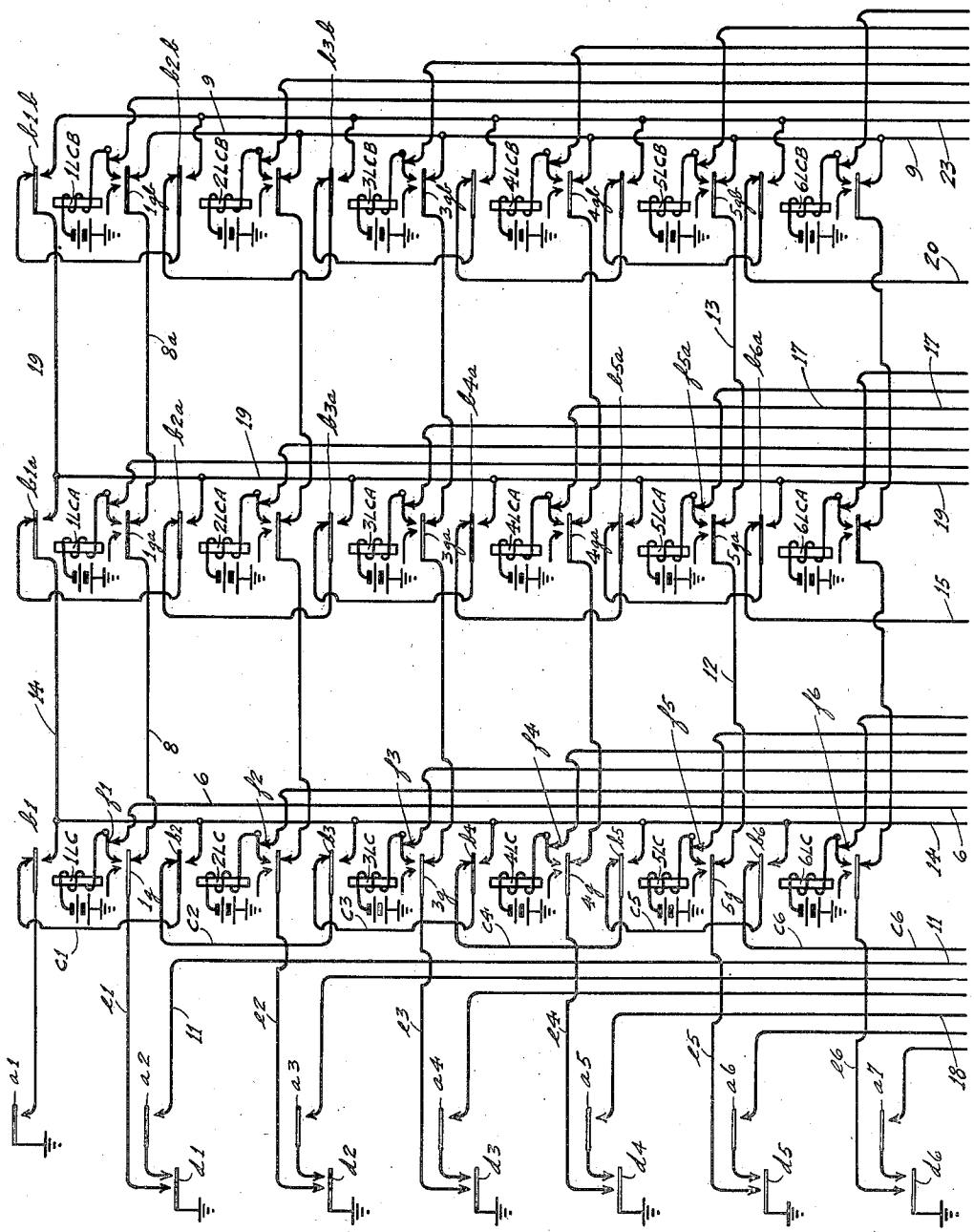

Fig. 3.

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TELEPHONE SYSTEM

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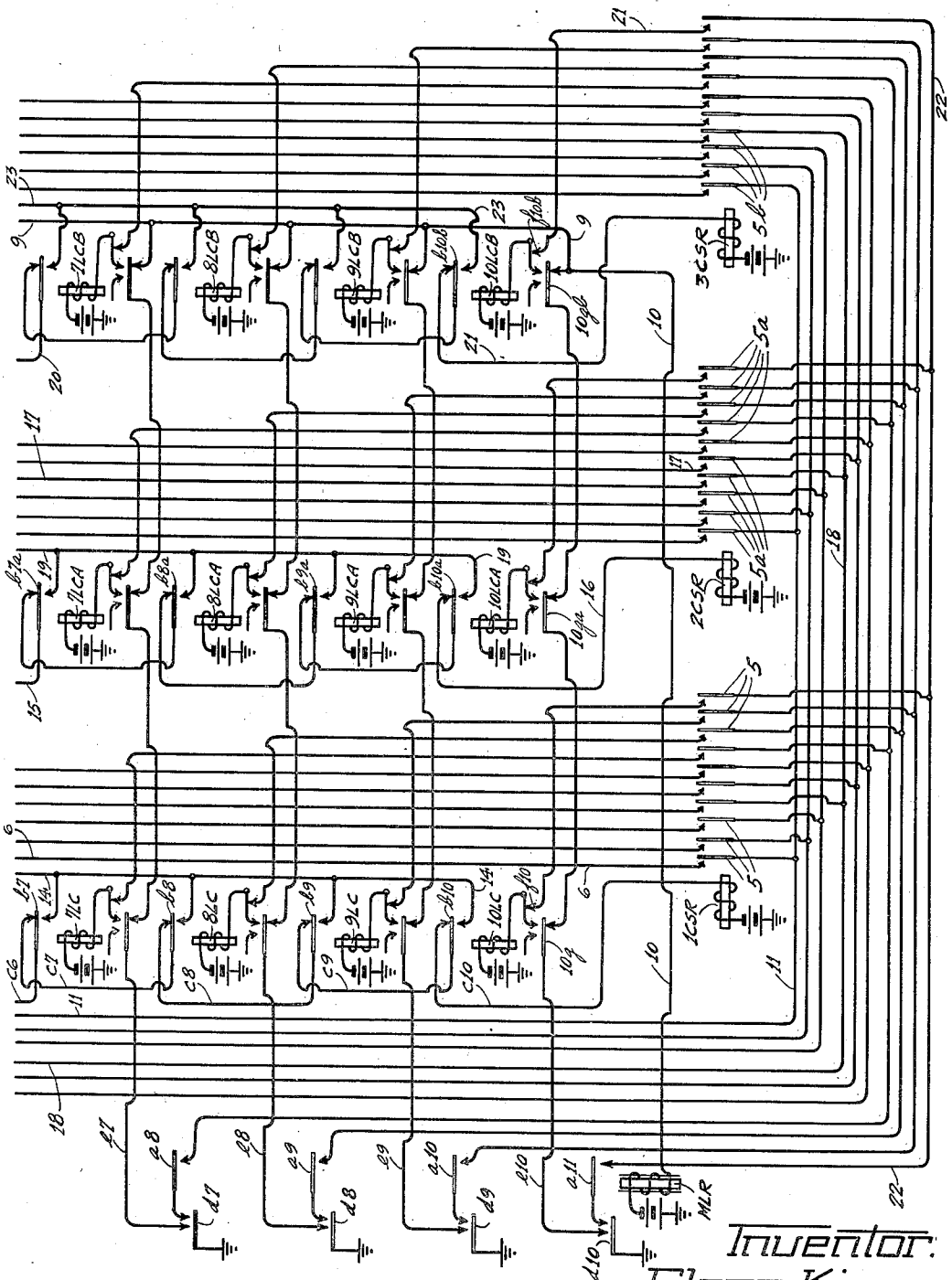

Fig. 4.

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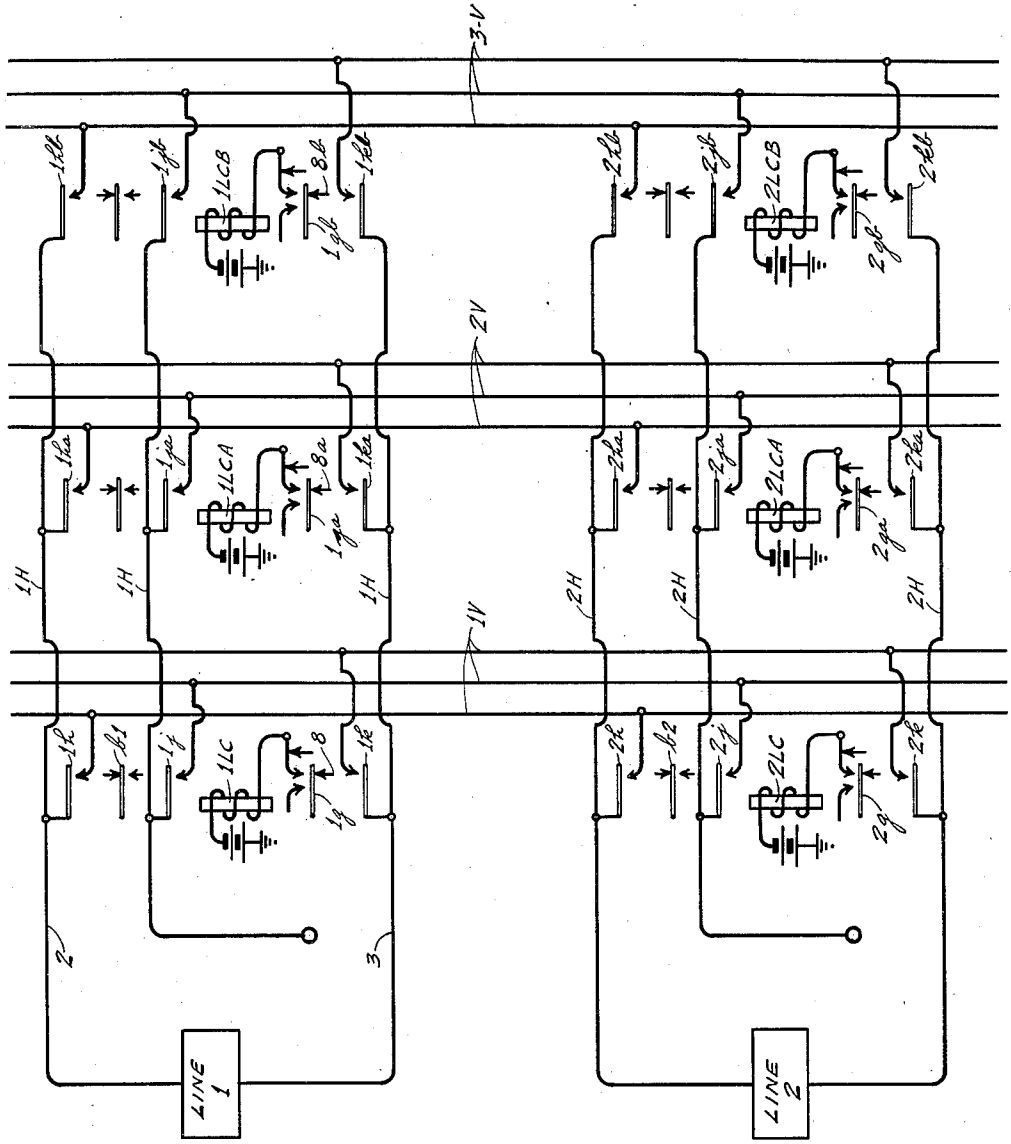
Fig. 5.



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UNITED STATES PATENT OFFICE

2,054,702

TELEPHONE SYSTEM

Glenn Kiner, Park Ridge, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill., a corporation of Illinois

Application January 27, 1933, Serial No. 653,773

15 Claims. (Cl. 179—16)

My invention relates to automatic telephone systems and more particularly to an automatic private branch exchange of the full relay type.

A feature of my invention is the provision in a telephone system of the type described of a plurality of channels for interconnecting subscribers' lines at the exchange.

Another feature of my invention is the provision in such a telephone system of relay means controlled by the calling subscriber for selecting an idle channel.

A further feature of my invention is the provision of relay means associated with the selected channel for connecting the calling subscriber's line to the line of the called subscriber provided the said called line is idle.

Other features will be disclosed from time to time as the description of the invention progresses.

In the accompanying drawings like reference characters indicate like parts and

Fig. 1 is a schematic drawing of the apparatus comprising the line and selector circuit;

Fig. 2 shows the connector circuit;

Figs. 3 and 4 show the channel selecting apparatus; and

Fig. 5 shows a portion of the channel selecting apparatus in detail.

When Fig. 2 is placed to the right of Fig. 1 and Fig. 3 is placed above Fig. 4 the entire circuit arrangement is disclosed.

The present invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming a part of this specification, with the understanding, however, that the invention is not confined to any strict conformity with the showing of the drawings but may be changed or modified so long as such changes and modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

The system of my invention is shown in the drawings as a 10-party exchange provided with three channels for interconnecting the subscribers. Of course, the system may be enlarged indefinitely by having a second, third, etc. channel selector, that is, have one channel lead to other channel selecting means and then to still another. Referring particularly to Fig. 1 of the drawings the line conductors 2 and 3 at the left of the drawings lead to a subscriber's station, line 1, which is equipped with the usual automatic substation equipment and terminates at the private branch exchange in the line circuit 1L which comprises line relay 1LR and the cut-off relay 1CO. Each of the subscriber's stations terminate at the exchange in a similar line circuit. A line channel relay 1LC connects the line circuit 1L to the selector circuit SC, also shown in Fig. 1, which leads to a connector circuit CC, shown in Fig. 2, and thence to the subscriber's station line 10 of Fig. 2, through a line circuit 10L which is similar to the line circuit 1L.

In Fig. 5 is shown the line channel relay 1LC which is the same one shown in Figs. 1 and 3.

Associated with the line 1 are three line channel relays 1LC, 1LCA and 1LCB, which serve to connect the horizontal commons 1H to the vertical commons 1V, 2V or 3V, which lead to respective selector circuits and connector circuits each of which comprises a channel. If the line 1 institutes a call and all the channels are idle the first link channel relay 1LC will operate to connect the line to the commons 1V of the first channel. If the first channel is busy the second link channel relay 1LCA will operate to connect the horizontal commons 1H to the vertical commons 2V of the second channel and if the first two channels are busy the third relay 1LCB will connect the line 1 to the third channel thru the vertical commons 3V. In other words the calling line will be connected to the first idle channel in the exchange. It is to be understood that the terms "horizontal commons" and "vertical commons" are used only for the purpose of facilitating the description of the invention and refer only to the drawings to distinguish between the commons for the lines and the commons for the channels. In practice the commons may be neither vertical nor horizontal but may proceed in any direction.

In Figs. 3 and 4 I show the full channel selecting mechanism necessary in a 10 line exchange. The link channel relays 1LC, 2LC, etc. are shown minus the contacts necessary to connect the horizontal and vertical commons which are shown in Figs. 1 and 5. The link channel relays 1LCA, 2LCA to 10LCA are associated with the second channel and the link channel relays 1LCB to 10LCB are associated with the third channel. The contacts shown at the extreme left of Figs. 3 and 4, marked $d1$, $d2$ to $d10$ are associated with line relays such as 1LR of Fig. 1 of the respective subscriber's lines and are controlled by the switchhook at the subscriber's station in the well known manner. Should a calling subscriber operate his switchhook the line relay is operated and the contact $d1$ to $d10$ associated with his line is operated to connect ground thru the contact of his associated link channel relay LC of the first channel.

Should this channel be idle the channel selecting relay ICSR is operated to establish a circuit for the link channel relay LC which connects the horizontal commons associated with the calling line to the vertical commons leading to the selected channel.

A better understanding of the invention can be obtained by tracing a call from a calling subscriber such as line 1 to a called subscriber such as line 10. The operation is as follows. The calling subscriber at line 1 removes his receiver from the switchhook. This establishes an operating circuit for the line relay 1LR which is operated by current flowing from grounded battery thru winding of 1LR, normal contact 1, line conductor 2, thru the closed switchhook contacts at subscriber's station line 1, line conductor 3, normal contact 4 to ground. The relay 1LR operates over this circuit and closes its alternate contact *d1* which places ground upon the conductor *e1*.

Referring now particularly to Fig. 3, the ground upon the conductor *e1* establishes an operating circuit for the master line relay MLR of Fig. 4. This circuit can be traced from grounded contact *d1*, conductor *e1*, contact *1g*, conductor 8, contact *1ga*, conductor *8a*, contact *1gb*, conductors 9 and 10 thru the coil of master line relay MLR to grounded battery. The relay MLR operates and attracts its contacts A1, A2 to A11. The closure of contact A1 establishes an energizing circuit for the channel selecting relay ICSR. This energizing circuit can be traced from grounded battery thru the relay ICSR, normal contacts *b10*, *b9*, *b8*, *b7* to *b1* and ground at alternate contact *a1*. The relay ICSR operates and attracts its contacts 5 which establishes an operating circuit for the link channel relay 1LC associated with the calling line #1. This circuit can be traced from grounded battery thru the winding of the relay 1LC, its make-before-break contact *f1*, conductor 6, alternate contact 5, conductor 11, alternate contacts *a2*, and *d1* to ground. A locking circuit for the link channel relay 1LC is closed thru its alternate contact *1g* to ground at alternate contact *d1*. The relay 1LC attracts its contacts *1h*, *1j* and *1k* to connect the horizontal commons 1H to the vertical commons 1V associated with the first channel. Upon the operation of the link channel relay 1LC the energizing circuits of the relays MLR and ICSR are broken and the same restored to normal.

If a second call is instituted, while the first is still unfinished, by a line such as line 4 (not shown) the line relay associated with the line circuit of that line will operate to close its alternate contact *d4* shown in Fig. 3.

The grounding of contact *d4* causes the operation of the master line relay MLR, the circuit being traced from alternate contact *d4*, normal contacts *4g*, *4ga* and *4gb*, conductors 9 and 10. The relay MLR attracts its contacts *a1* to all and extends ground thru its alternate contact *a1* to alternate contact *b1* of the link channel relay 1LC, which is holding the first connection, conductor 14, normal contact *b1a* of 1LCA, normal contact *b2a*, *b3a*, *b4a*, *b5a*, *b6a*, conductor 15, *b7a*, and so on to conductor 16 and relay 2CSR which operates and attracts its armatures *5a* which closes an energizing circuit for the link channel relay 4LCA associated with the calling line 4. This circuit can be traced from grounded battery, the winding of 4LCA, conductor 17, alternate contact *5a*, conductor 18, alternate contacts *a5* and *d4* to ground. The relay 4LCA operates similarly to relay 1LC and connects the horizontal commons 1H associated with line 4 to the vertical commons 2V which lead to the second channel.

Should a third call be instituted by line 10 while the first two calls are still being carried on, the line relay LR will close its alternate contact *d10* to ground the conductor *e10* which leads thru normal contacts *10g*, *10ga*, *10gb* and conductor 10 to the master line relay MLR which operates as above explained to close its alternate contact *a1* to extend ground thru alternate contact *b1* of 1LC, which operated to establish the first call, conductor 14, normal contacts *b1a*, *b2a*, *b3a*, and alternate contact *b4a* of link channel relay 4LCA, which operated to establish the second call, conductor 19, normal contacts *b1b* to *b10b*, and relay 3CSR which thereupon operates to attract its contacts *5b* which closes an energizing circuit for the link channel relay 10LCB which operated by current flowing from grounded battery thru the winding of the relay, normal contact *f10b*, conductor 21, alternate contact *5b*, conductor 22, alternate contacts *a11* and *d10* to ground. The relay 10LCB thereupon operates and connects the line 10 to the vertical commons 3V which lead to the third channel.

If another line, such as line 3, desires to institute a call while the other three calls are still in progress its line relay will close its alternate contact *b3* which will furnish ground for the master line relay MLR, as above explained, which will energize to supply ground thru its contact *a1*, alternate contact *b1*, normal contacts *b1a*, etc. to alternate contact *b4a*, conductor 19, normal contacts *b1b*, etc. to alternate contact *b10b* and conductor 23 with no result as all the channels are busy.

Referring again to Fig. 1 and the original call instituted by line 1 the energization of the link channel relay 1LC above described connected the horizontal commons H to the vertical commons V which lead to the channel comprising the selector SC and the connector CC closed energizing circuit for the dialing relay DR which circuit can be traced from grounded battery thru the lower winding of the dial relay DR, conductor 24, alternate contact *1k*, horizontal common H, the line conductor 3, the closed switchhook contacts at line 1, line conductor 2, horizontal common H, alternate contact *1h*, conductor 25, thru the upper winding of dialing relay DR to ground. The operation of the dialing relay DR causes the attraction of alternate contact 26 which closes an obvious energizing circuit for the switching relay SW which closes alternate contact 27 to establish an energizing circuit for the cut-off relay ICO which is operated by current flowing from grounded battery thru resistance *r*, alternate contact 27 of SW, vertical common V, alternate contact *1j* of 1LC, horizontal common H, thru the winding of ICO to ground. Relay ICO operates to interrupt the circuit of line relay 1LR which deenergizes and opens the energizing circuit of relay 1LC but before this circuit is broken a locking circuit for 1LC is established which can be traced from grounded battery, relay 1LC, contacts *f1* and *1g*, conductor 28 to ground at alternate contact 29 of SW. The subscriber at line 1 next operates his dialing device CD to signal the line 10, the one to which he desires to be connected. The first interruption causes the deenergization of the dialing relay DR which restores its contact 26 to normal. This opens the

energizing circuit of the switching relay SW but due to its slow-to-release construction the said relay remains energized and ground is supplied to the dialing conductor DC which causes the operation of the electromagnet M1 by current flowing from grounded battery thru the winding of the electromagnet M1, normal contact 33, dialing conductor DC, normal contact 32 of RC, conductor 31, alternate contact 30 of SW, normal contact 26 of DR. The relay M1 energizes and attracts its alternate contact 34. After the first interruption by the dial CD the relay DR is again energized to attract its contact 26 and again establish an energizing circuit for the switching relay SW which has not restored due to its construction and the opening of contact 26 breaks the energizing circuit of the relay M1 but as it is also of slow-to-release construction its alternate contact 34 is maintained in its operated position until an energizing circuit for the relay C1 and a holding circuit for M1 is established. This circuit can be traced from grounded battery, the winding of relay M1, relay C1, alternate contact 34 of M1, conductor 35, alternate contact 36 of SW to ground. The relay C1 operates over this circuit and attracts its contact 33 to remove the relay M1 from the dialing conductor DC. The second interruption of the line conductors 2 and 3 by the dial D again deenergizes the relay DR which restores its contact 26 to normal to place ground upon the dialing conductor DC as above explained which thereupon causes the energization of the relay M2 current flowing from grounded battery thru the winding of the relay M2, normal contact 38, alternate contact 33 of C1, to the grounded dialing conductor DC. Upon the reenergization of dialing relay DR the energizing circuit of the relay M2 is interrupted but an energizing circuit for the relay C2 thru the alternate contact 39 of M2 is established over the previously traced circuit so that upon the next interruption of the line conductors and the subsequent deenergization of the dialing relay DR the grounded dialing conductor DC is extended to the next set of relays with the same result as heretofore explained. This is repeated until upon the last interruption of the line the relays M10 and C10 are operated to connect the calling subscriber to the desired line. The relays M10 and C10 are maintained energized by current flowing from grounded battery thru the winding of M10, the winding of relay C10, alternate contact 43 of M10, conductor 35, and alternate contact 36 of SW to ground.

Upon the first restoration of the dialing relay DE the slow dialing relay SDR was operated by current flowing from grounded battery thru the winding of SDR to ground at normal contact 26 of DR. Due to the slow-to-release construction of this relay it remains in its energized position until after the last interruption of the calling line and the subsequent energization of the dialing relay DR at which time it restores its contact 46 to normal thereby establishing energizing circuits for the cut-off relay 10CO of the called line and either the ringing control relay RC or busy test relay BTR depending upon the busy or idle condition of the called line. The three conductors leading to each line from the contacts of relays C1 to C10 are multipled between the connector circuits of the channels.

If the line is busy the busy test relay BTR will be operated by current flowing from grounded battery thru the winding of BTR, normal contact 47 of RC, conductor 48, normal contact 46 of SR, conductor 49, alternate contact 45 of C10, conductor 50, the winding of cut-off relay 10CO to ground. The busy test relay BTR operates to connect a busy tone BU to the calling line which informs the calling subscriber that the desired line is busy at this time. The circuit for this tone can be traced from BU, alternate contacts 54 of BTR, normal contact 55 of RC, normal contact 56 of IR, over the heavily marked conductors to the calling subscriber's line 1.

If the called line is idle the ringing control relay RCR will operate before the busy test relay BTR can do so and will attract its armature 47 to disconnect the busy test relay BTR and prevent its energization to give a false busy test to the calling subscriber. The attraction of contact 47 of RC shunts out the high resistance winding R' and allows the energization of the cut-off relay associated with the line of the called party which relay 10CO operates and attracts its contacts 51 and 52 to disconnect the line relay 10LR from the line conductors. The energization of ringing control relay RC provides an energizing circuit for the ringing relay RI which circuit can be traced from grounded battery thru a constantly rotating interrupter I, winding of ringing relay RI, alternate contact 57 of RC, normal contact 58 of RT, alternate contact 59 of SW to ground. The ringing relay RI is thus alternately energized and deenergized to connect ringing current supplied from the generator Gen. to signal the subscriber at line 10. The path for the ringing current can be traced from the generator Gen., alternate contact 56 of RI, alternate contact 55 of RC, over the heavily marked conductor, alternate contact 61 of C10, thru the call bell at line 10, back thru alternate contact 44 of C10, alternate contact 62 of RC, and alternate contact 60 of RI to the generator.

A ringing tone is supplied the calling subscriber from the tone punching T, alternate contact 64 of RI over the heavily marked conductors to the calling station.

The subscriber at line 10 removes his receiver from the switchhook in answer to the signal and thereby closes an energizing circuit for the supervisory relay SR which attracts its contacts 63 to establish an obvious energizing circuit for the ringing trip relay RT which closes its alternate contact 58 to establish a locking circuit for itself and to also interrupt the energizing circuit of the ringing relay RI which restores and disconnects ringing current from the called line and completes the conversational circuit by the restoration of its contacts 56 and 60.

Upon the termination of conversation the calling subscriber replaces his receiver upon its switchhook and thereby causes the interruption of the dialing relay DR which restores its contact 26 to normal and thereby opens the energizing circuit of the switching relay SW which restores its contact 59 to interrupt the locking circuit of the ringing trip relay RT and restores its alternate contact 36 to interrupt the locking circuit of the relays M10 and C10 which restore to normal and disconnect the connector circuit from the line circuit at contacts 61 and 44. The replacement of the called subscriber's receiver interrupts the energizing circuit of the supervisory relay SR which also restores to normal. The restoration of contact 29 of SW to normal breaks the locking circuit of the link channel relay 1LC which releases the first channel and prepares it for subsequent seizure by another calling line.

Having described my invention, what I claim is new and desire to secure by United States Letters Patent is:

1. An automatic telephone system comprising a plurality of subscribers' lines, a plurality of channels for interconnecting any two of said lines, horizontal commons connected to relay contacts in each channel, vertical commons for each channel connected to other contacts of the said relays, channel selecting means consisting of relays exclusively for automatically selecting an idle channel and connecting a calling line thereto through the medium of said relay contacts.

2. An automatic telephone system comprising a plurality of subscribers' lines, a plurality of channels for interconnecting any two of said lines, horizontal commons connected to relay contacts in each channel, vertical commons for each channel connected to other contacts of the said relays, channel selecting means consisting of relays exclusively for automatically selecting an idle channel and connecting a calling line thereto through the medium of said relay contacts, and means for rendering busy said selected channel.

3. An all-relay telephone system comprising subscribers' lines, a plurality of channels each comprising a connector circuit and a selector circuit for interconnecting said lines, horizontal commons associated with individual calling lines, vertical commons associated with individual channels and means for connecting said horizontal and vertical commons.

4. An all-relay telephone system comprising subscribers' lines, a plurality of channels, a connector circuit and a selector circuit for each channel for interconnecting said subscribers' lines, horizontal commons associated with individual calling subscriber's lines and all the channels, vertical commons associated with individual channels and all the lines and means for connecting said horizontal and vertical commons.

5. An all-relay telephone system comprising subscribers' lines, a plurality of channels, a connector circuit and a selector circuit for each channel for interconnecting said subscribers' lines, horizontal commons for each line associated with all the channels, vertical commons for each channel associated with all the lines, a line channel relay for each line operable to connect the horizontal commons for that line to a set of vertical commons and a channel selecting relay for each channel controlling said line channel relay.

6. An all-relay telephone system comprising subscribers' lines, a plurality of channels for interconnecting said subscribers' lines, channel selecting means operable upon the initiation of a call comprising a line channel relay for each line in each channel, a channel selecting relay for each channel, the channel selecting relay of the first idle channel operable upon the initiation of a call to operate the line channel relay associated with the calling line to connect the said line to said idle channel.

7. An all-relay telephone system comprising subscribers' lines, a plurality of channels for interconnecting said lines, horizontal commons extending each line to each channel, vertical commons for each channel associated with each of said lines, a relay operable to connect the horizontal commons of a calling line to the vertical commons of an idle channel, and relay means controlling said relay.

8. An all-relay telephone system comprising calling and called lines, a plurality of channels for interconnecting said lines, horizontal commons for each line for associating each line with each channel and vertical commons for associating each channel with each line, a connector circuit and a selector circuit for each channel, relay means operative upon the initiation of a call to select an idle channel, dialing means at said calling line, and means responsive to said dialing means to connect said calling line to a called line.

9. An all-relay telephone system comprising calling and called lines, a plurality of channels for interconnecting said lines, horizontal commons for each line for associating each line with each channel and vertical commons for associating each channel with each line, a connector circuit and a selector circuit for each channel, relay means operative upon the initiation of a call to select an idle channel, dialing means at said calling line, means responsive to said dialing means to connect said calling line to a called line, and means preventing said connection if said called line is busy.

10. An all-relay telephone system comprising calling and called lines, a plurality of channels for interconnecting said lines, commons associated with individual channels, channel selecting means comprising a line channel relay for each line located in the respective channels.

11. An all-relay telephone system comprising calling and called lines, a plurality of channels for interconnecting said lines, commons connecting each line to each channel and each channel with each line, channel selecting means comprising a line channel relay for each line located in the respective channels, and a channel selecting relay individual to a channel controlling the line channel relays in the channel.

12. An automatic telephone system comprising subscribers' lines, a plurality of channels for interconnecting two of said lines, horizontal commons individual to the lines, vertical commons individual to the channels, a line channel relay for each line in each channel, operable to connect the horizontal and vertical commons, a channel selecting relay in each channel controlling the said line channel relays in the respective channels, and circuit connections for said relays whereby the channel selecting relay in the first idle channel operates the line channel relay in that channel associated with the calling line.

13. An automatic telephone system comprising subscribers' lines, a plurality of channels for interconnecting two of said lines, horizontal commons individual to the lines, vertical commons individual to the channels, a line channel relay for each line in each channel, operable to connect the horizontal and vertical commons, a channel selecting relay in each channel controlling the said line channel relays in the respective channels, circuit connections for said relays whereby the channel selecting relay in the first idle channel operates the line channel relay in that channel associated with the calling line, and means for extending another call to the next channel.

14. An automatic telephone system comprising subscribers' lines, a plurality of channels for interconnecting two of said lines, horizontal commons individual to the lines, vertical commons individual to the channels, a line channel relay for each line in each channel, operable to connect the horizontal and vertical commons, a channel selecting relay in each channel control-

ling the said line channel relays in the respective channels, circuit connections for said relays whereby the channel selecting relay in the first idle channel operates the line channel relay in that channel associated with the calling line, and means preventing the operation of the channel selecting relay associated with a busy channel.

15. An automatic telephone system comprising a calling line and a called line, a plurality of channels for interconnecting said lines, channel selecting means operable upon the initiation of a call to select an idle channel, said channel selecting means comprising a line channel relay in each channel connected to individual respective lines by horizontal commons, vertical commons for each channel extending from contacts of one line channel relay to contacts of another line channel relay and relay means operable to operate the line channel relay associated with a calling line to connect the horizontal and vertical commons at that point.

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