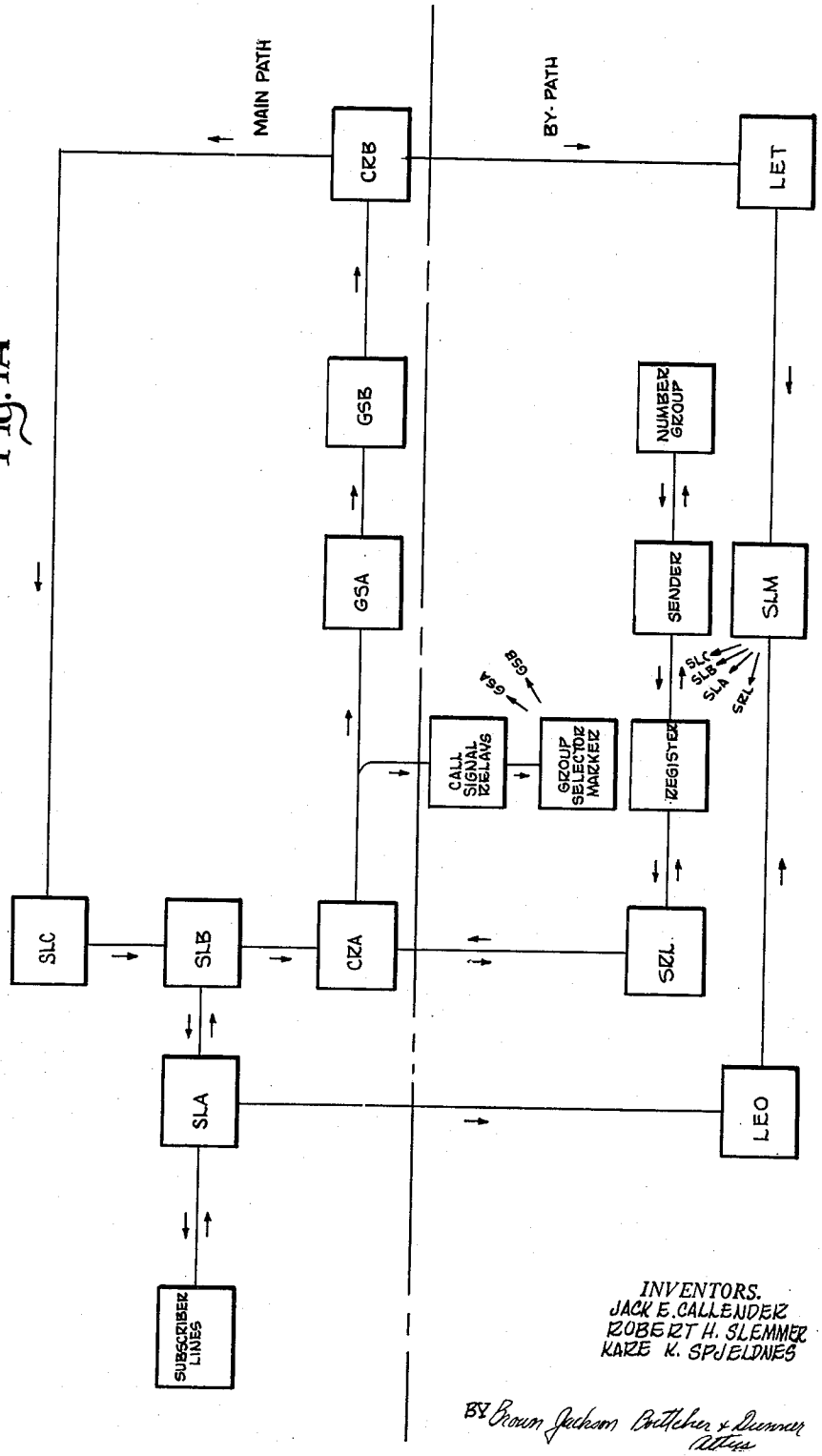
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Fig. 1A



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JACK E. CALLENDER
ROBERT H. SLEMMER
KAZE K. SPJELDNES

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Attys

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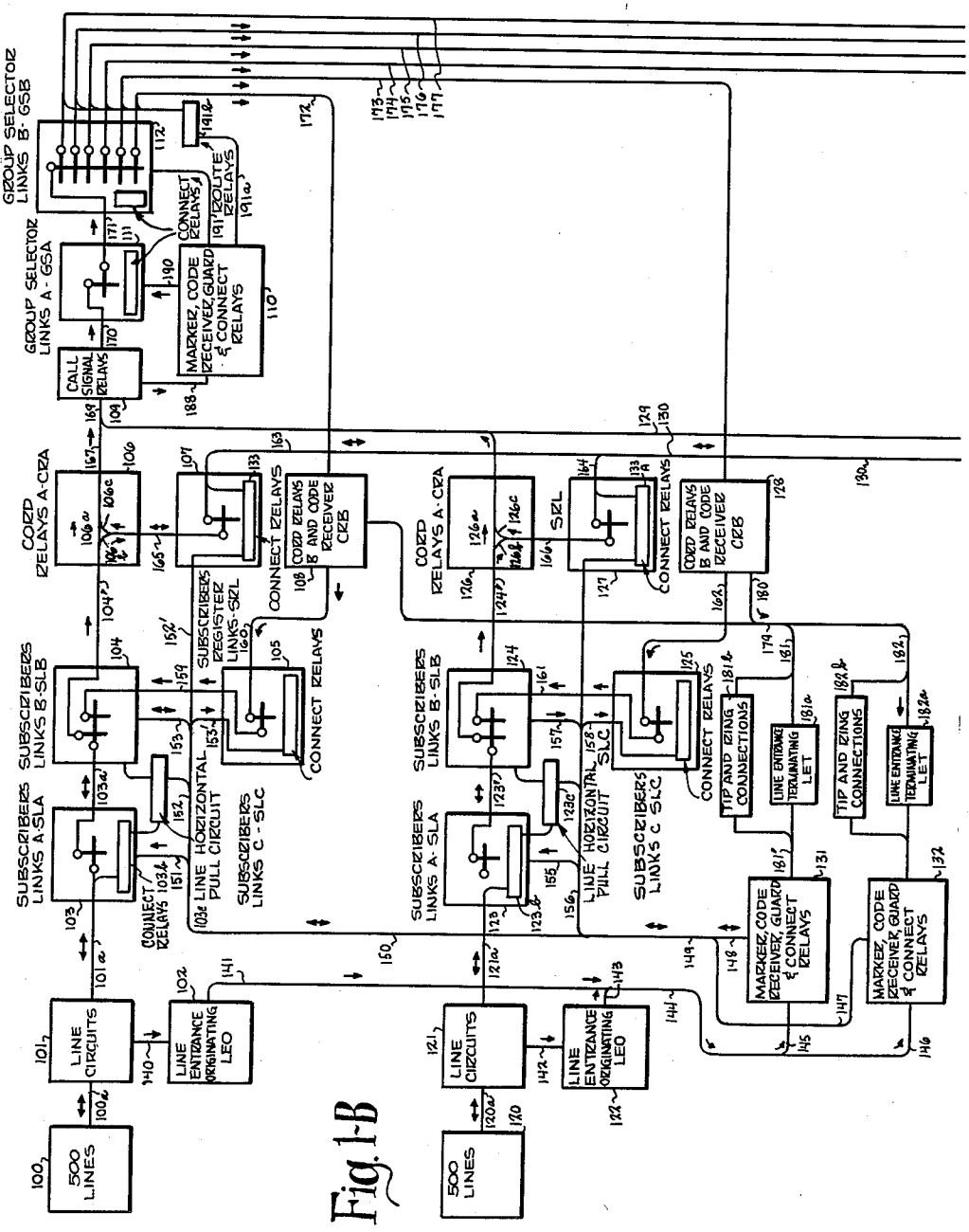


Fig. 1-B

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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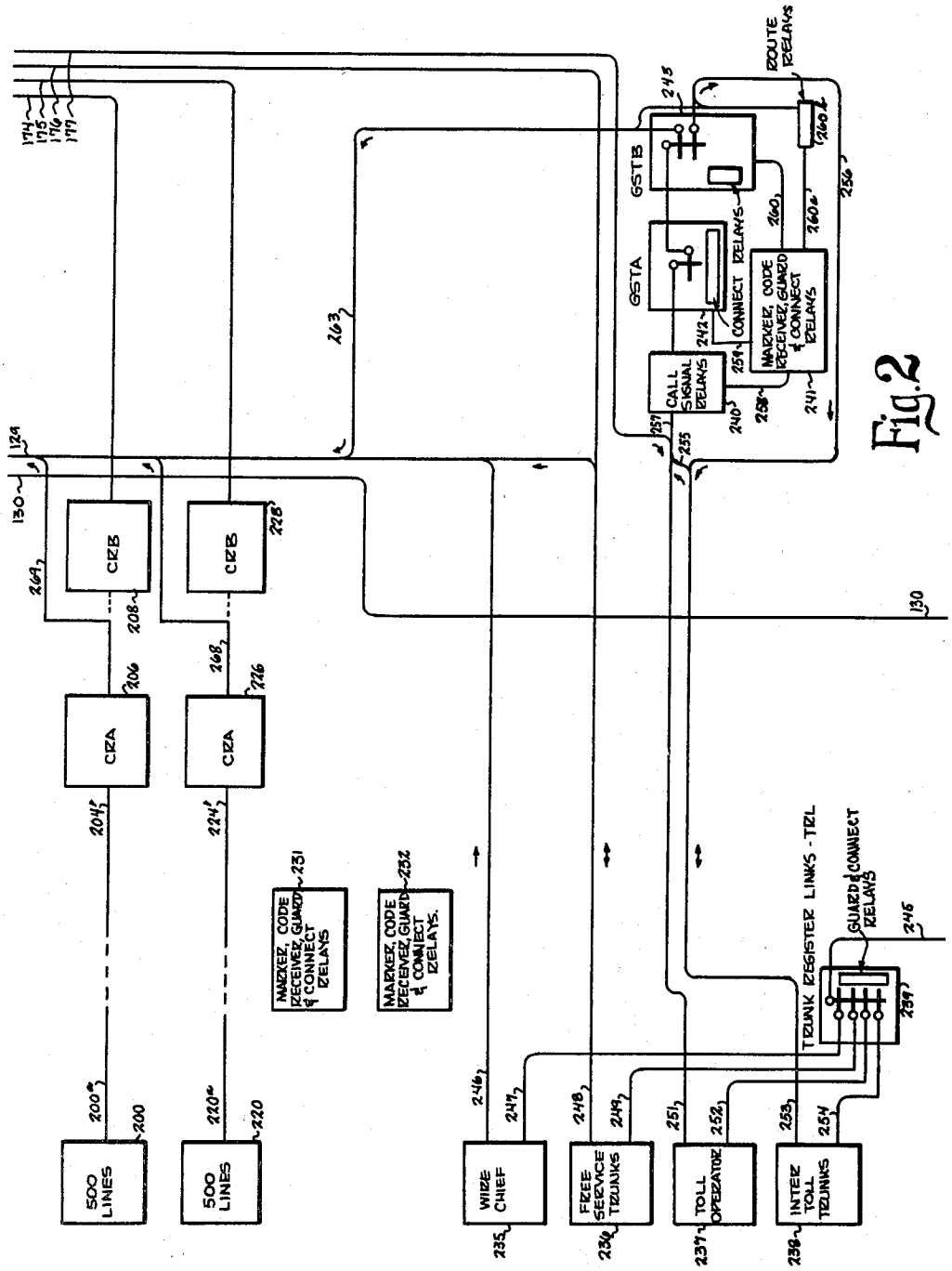


Fig. 2

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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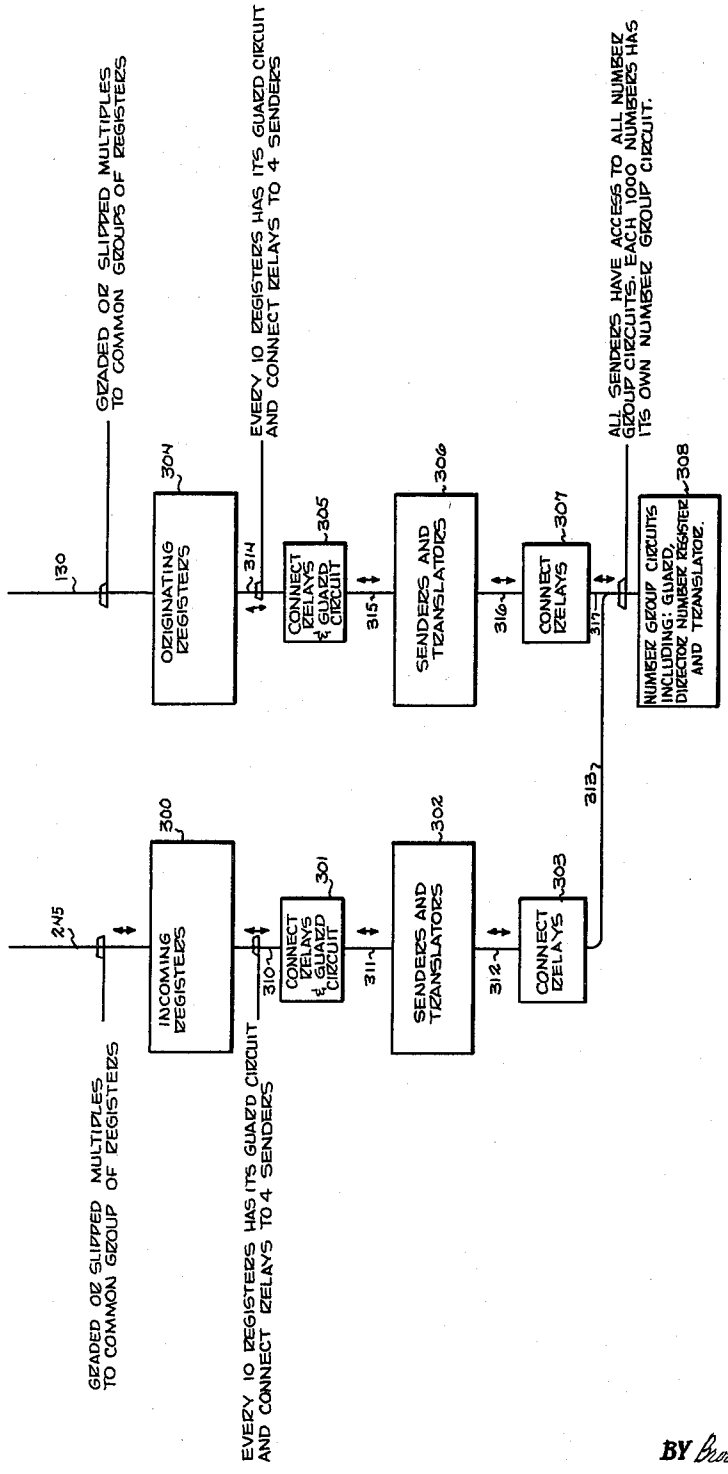


Fig. 3

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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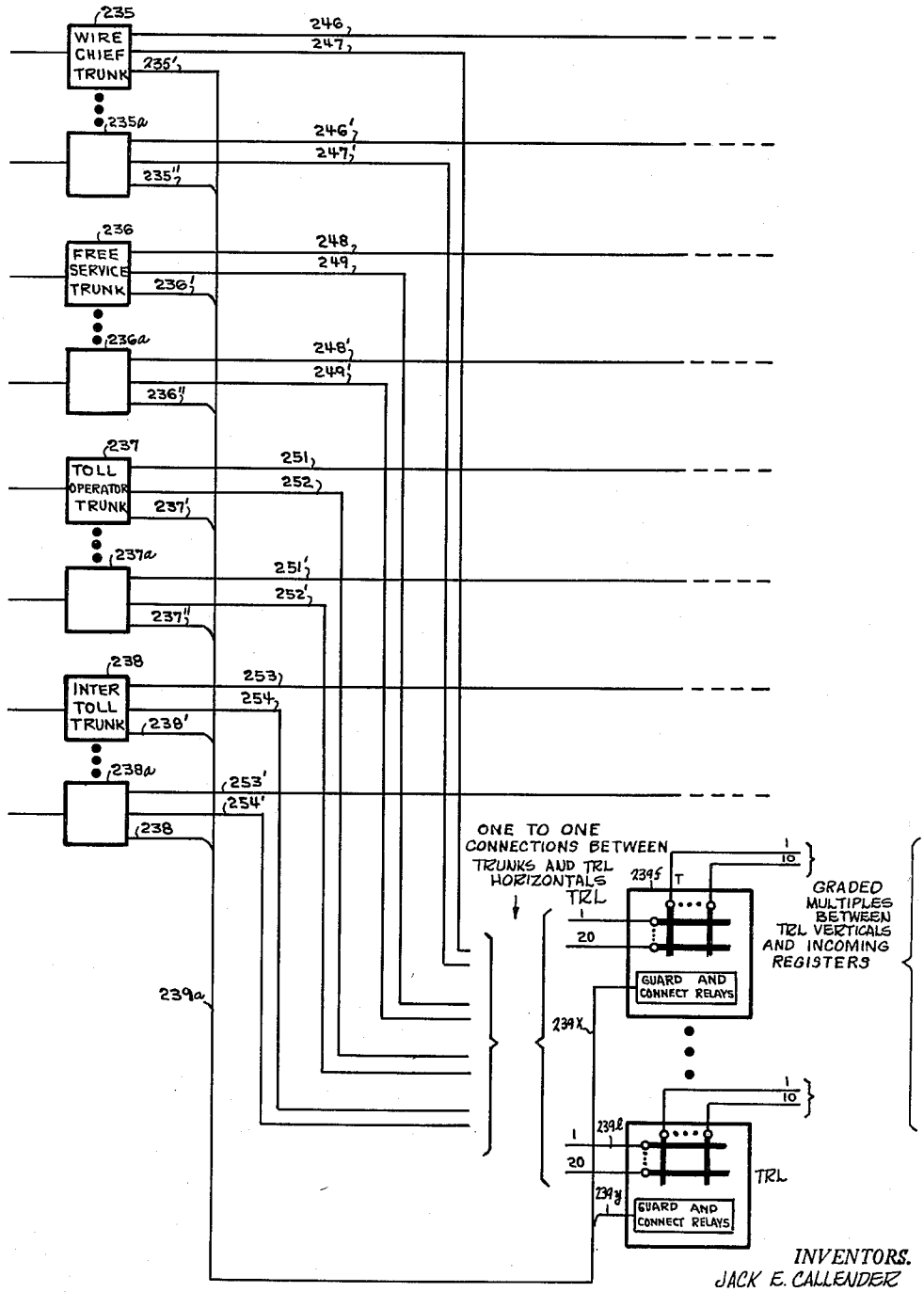


Fig. 4

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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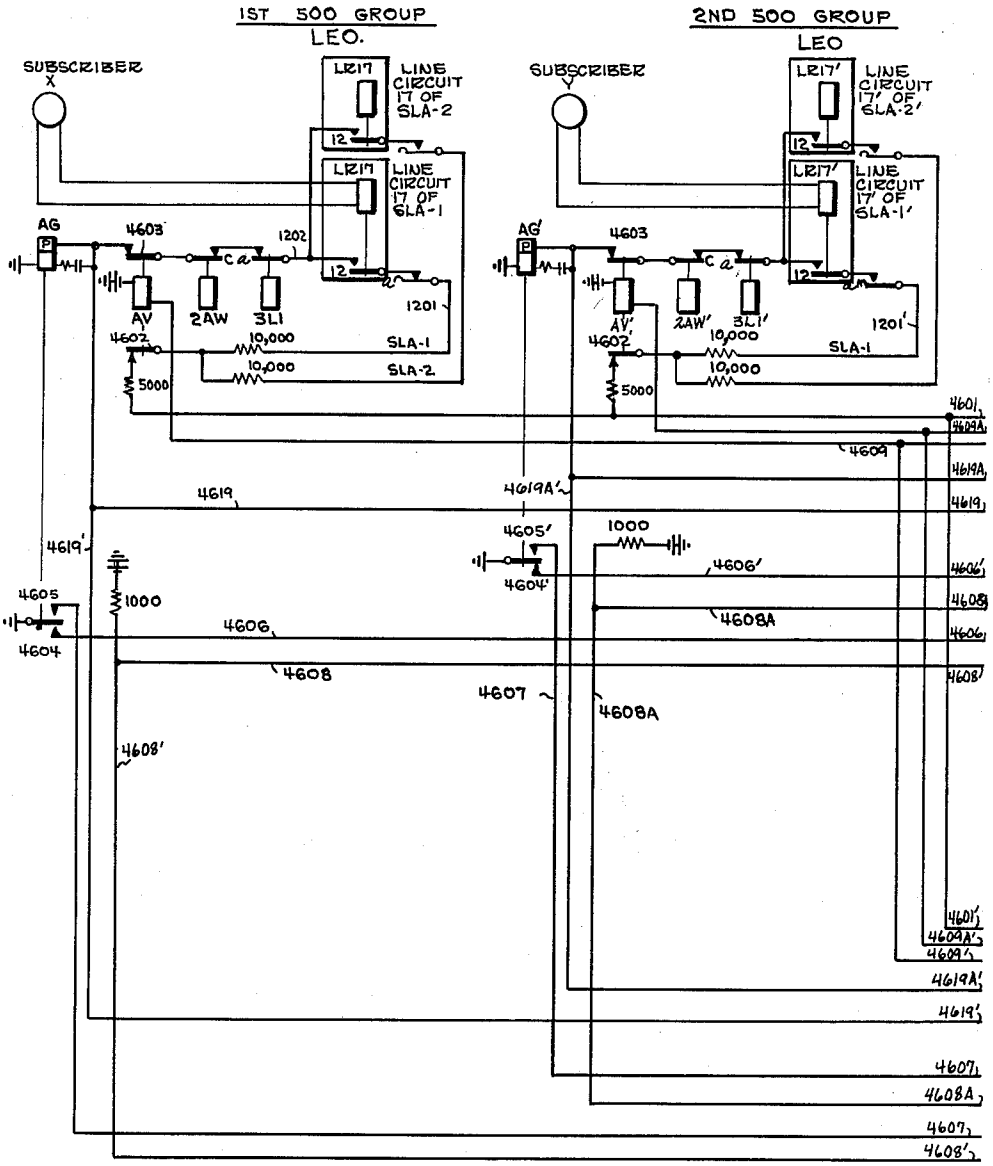


Fig. 5

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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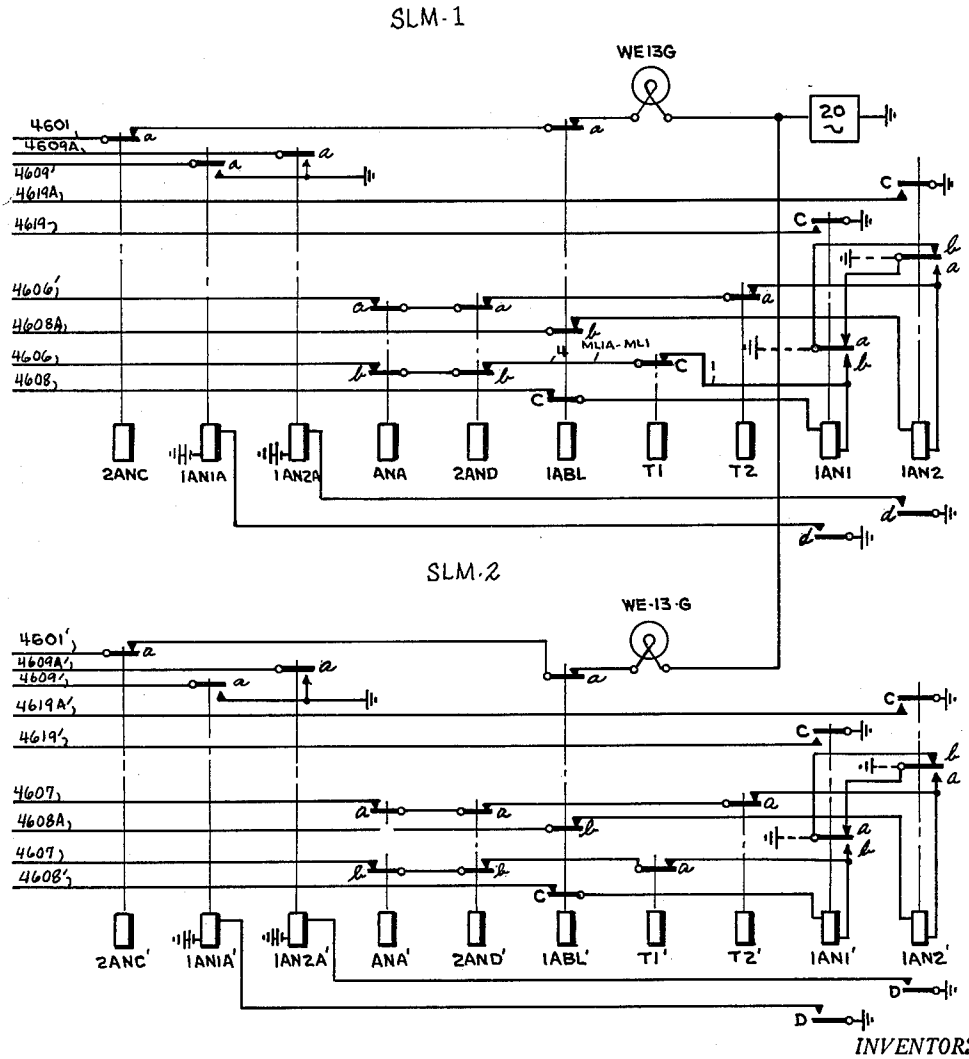


Fig. 6

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES
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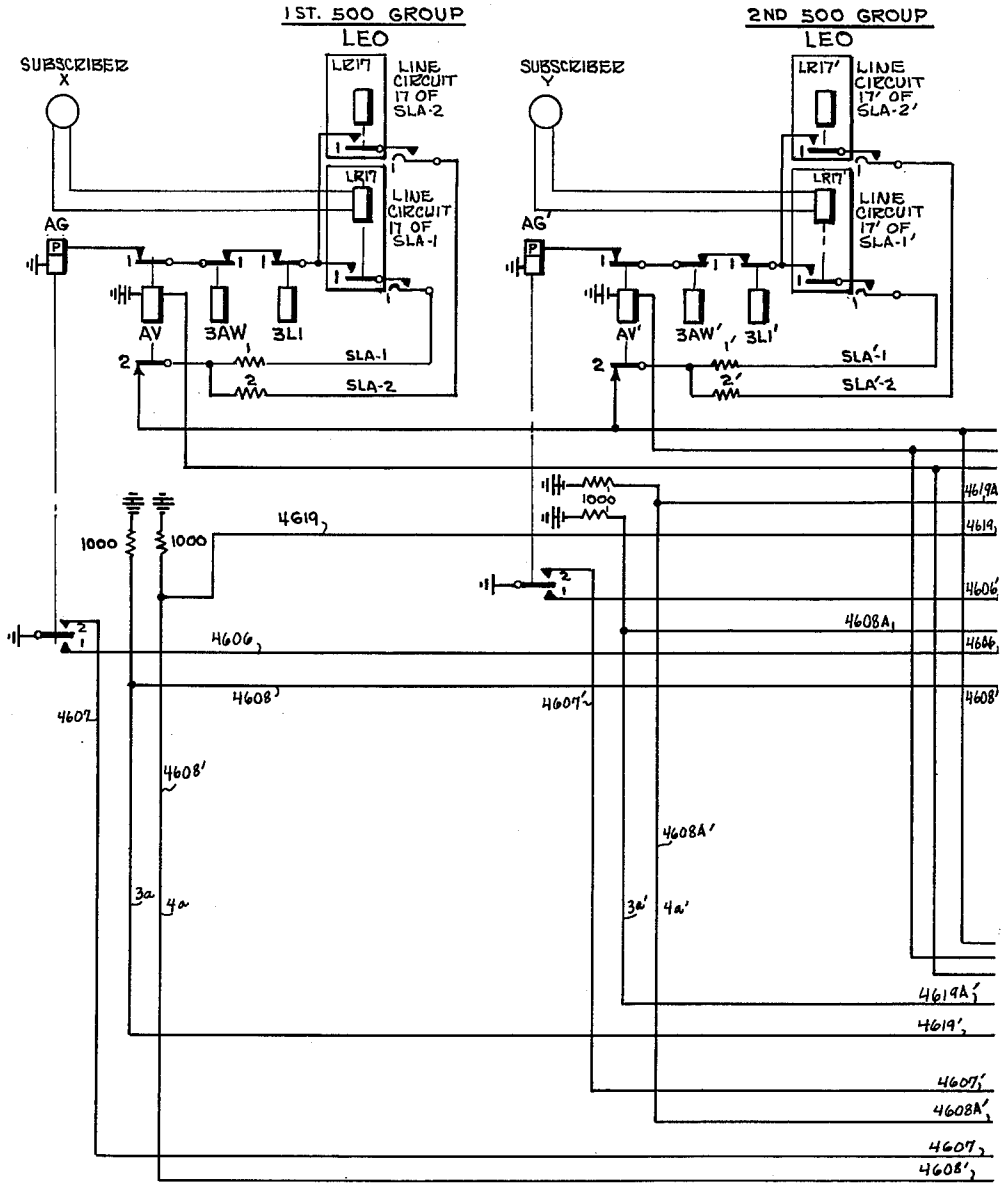


Fig. 7

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES
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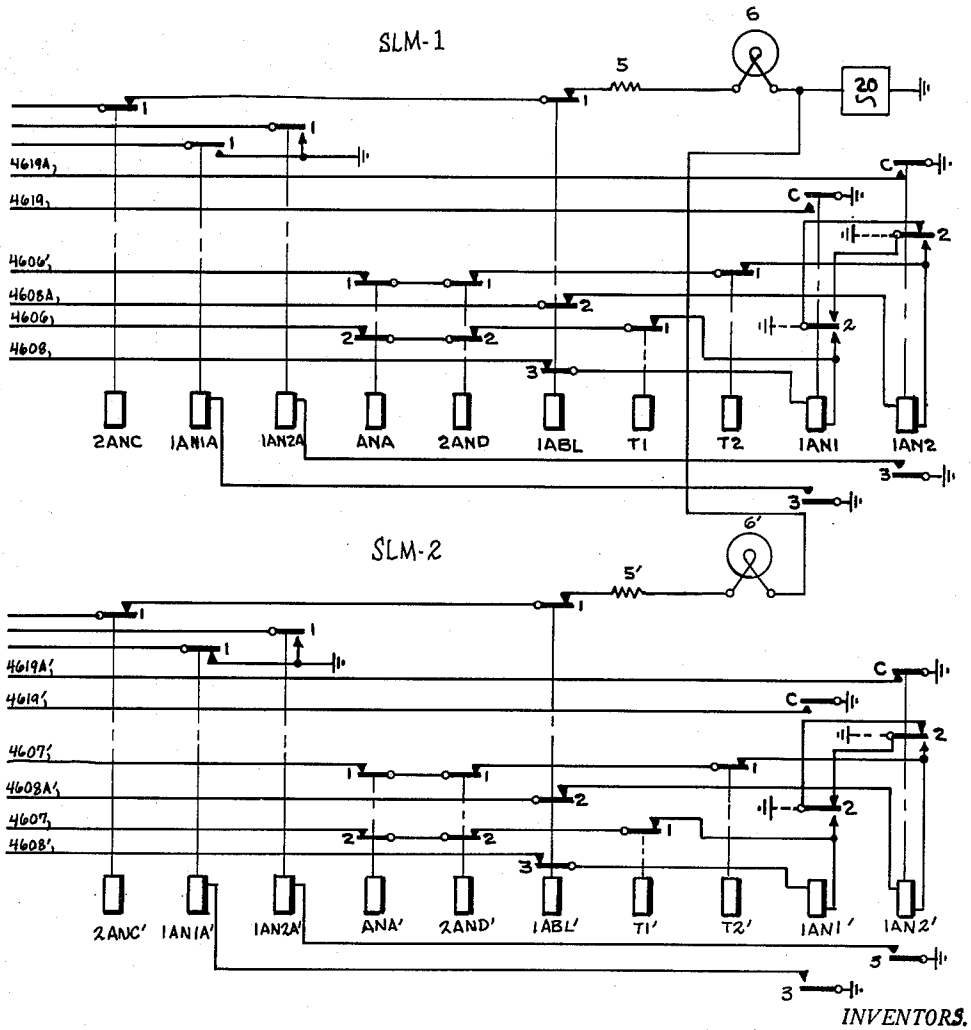


Fig. 8

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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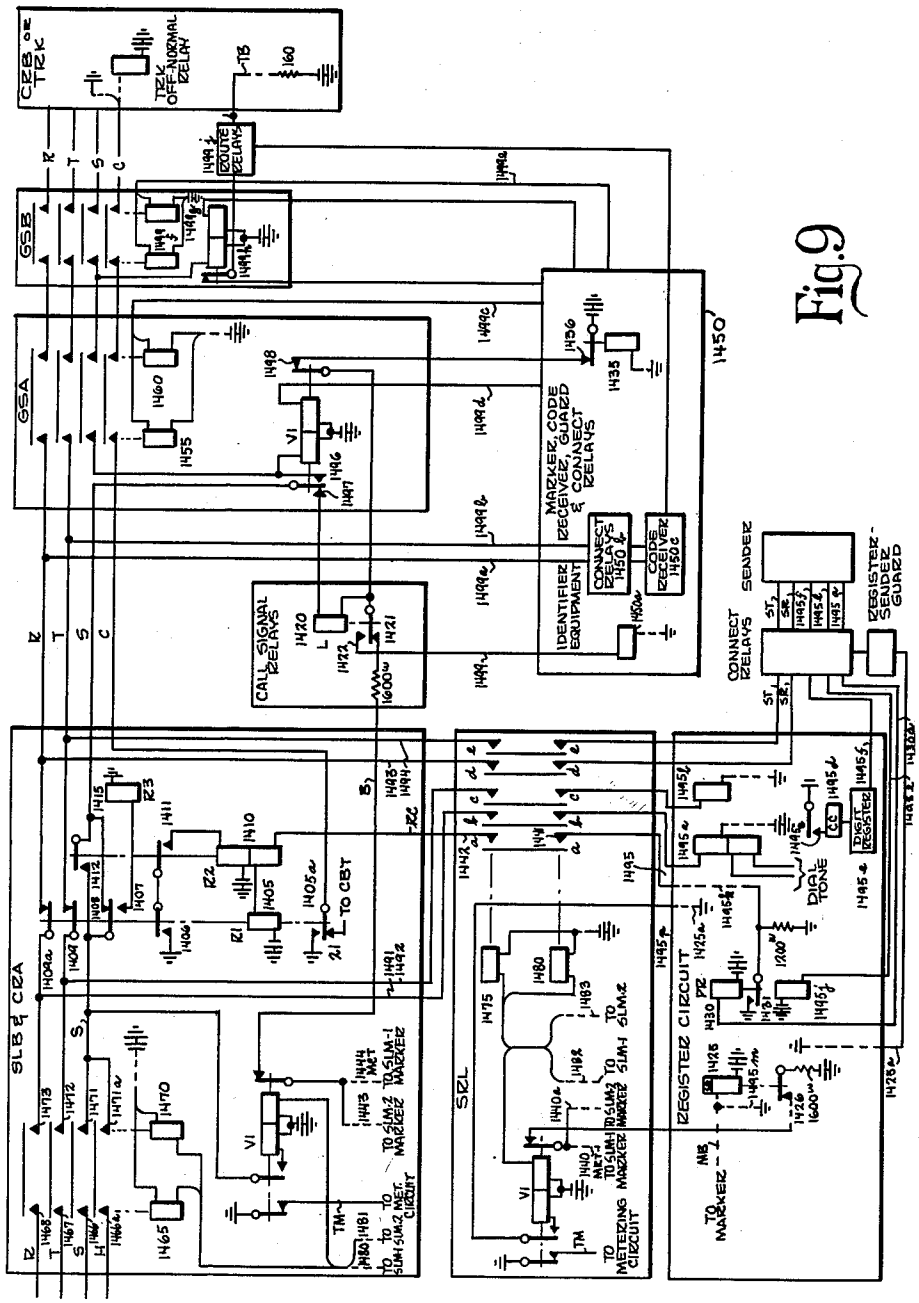


Fig. 9

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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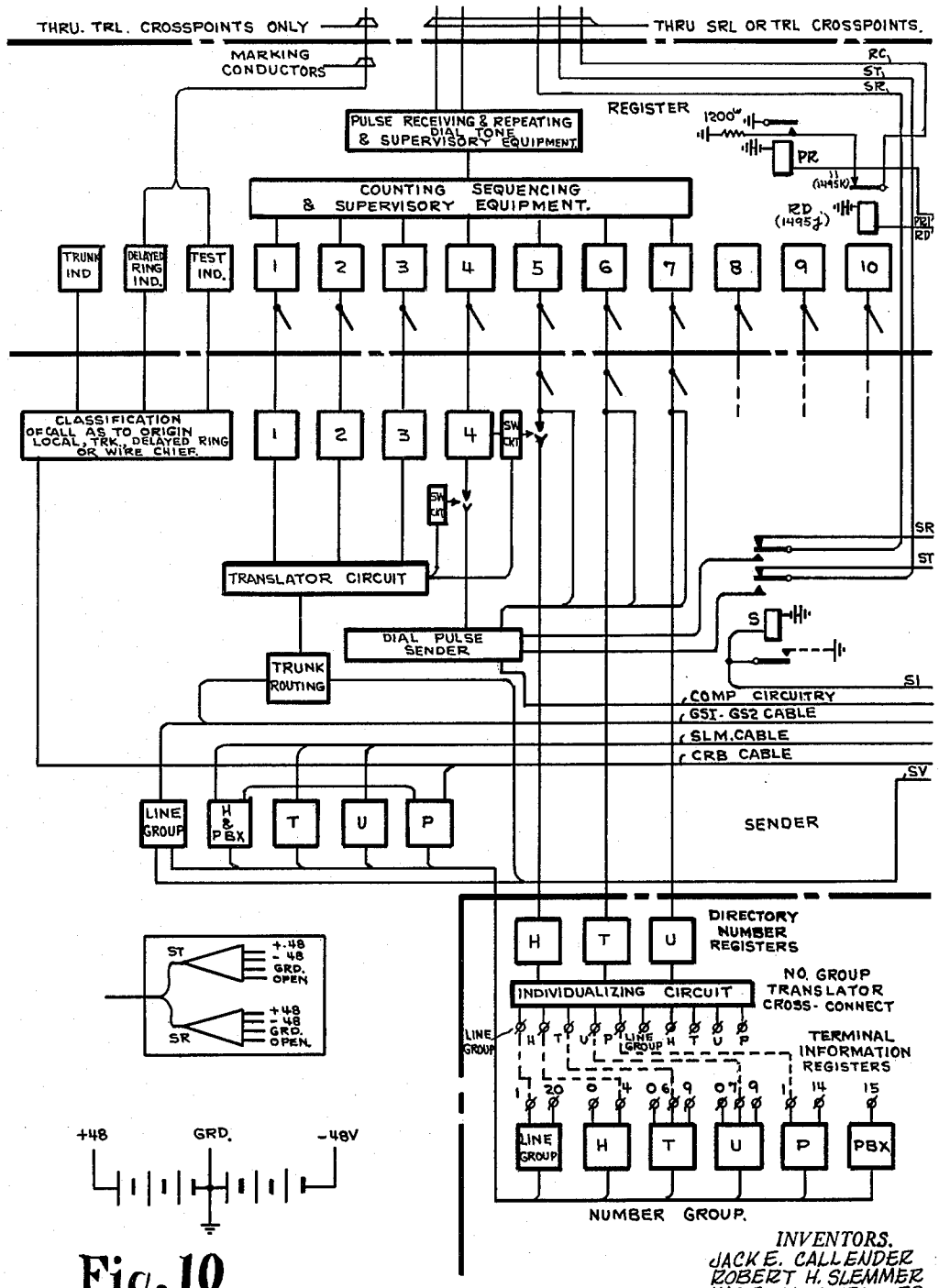


Fig. 10

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

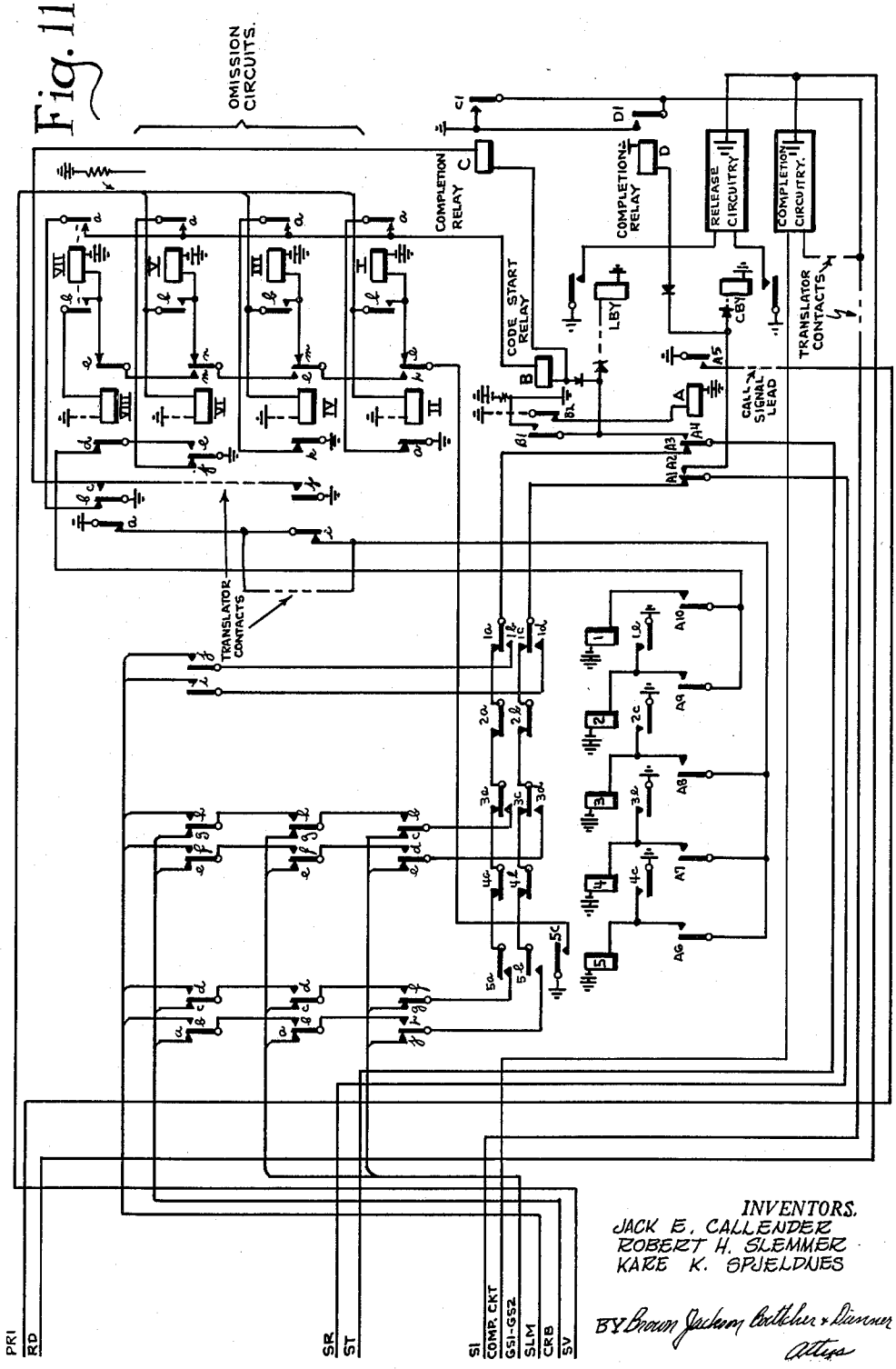
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Fig. 11



INVENTORS.
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ROBERT H. SLEMMER
KARE K. SPJELDNES

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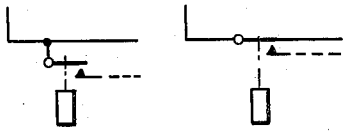


Fig. 12-A

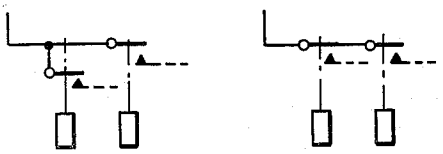


Fig. 12-B

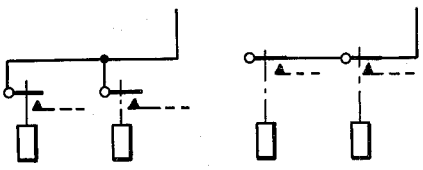


Fig. 12-C



Fig. 12-D

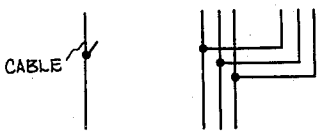


Fig. 12-E

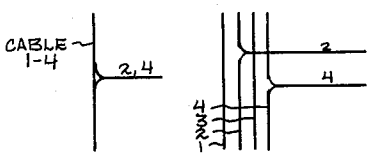


Fig. 12-F

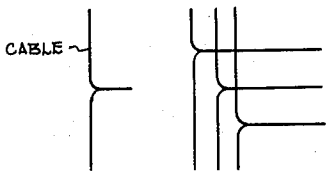


Fig. 12-G

INVENTORS.
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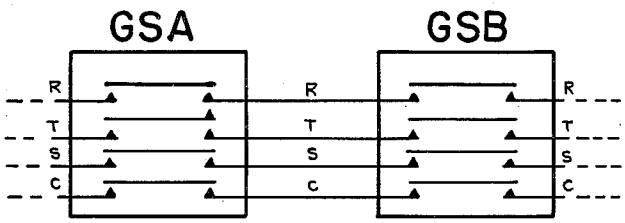


Fig.13-A

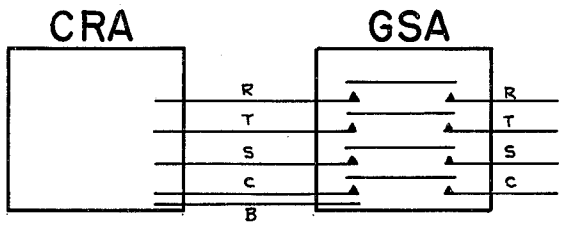


Fig.13-B

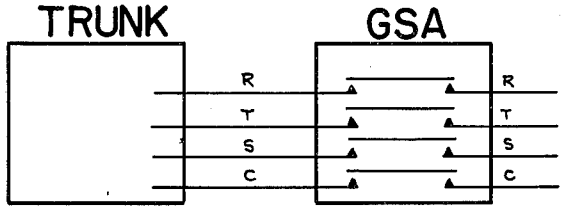


Fig.13-C

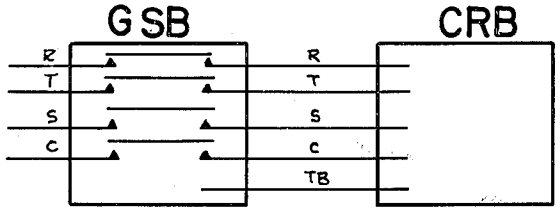


Fig.13-D

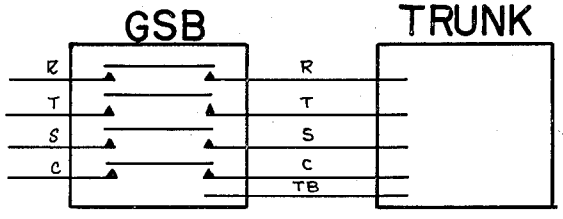
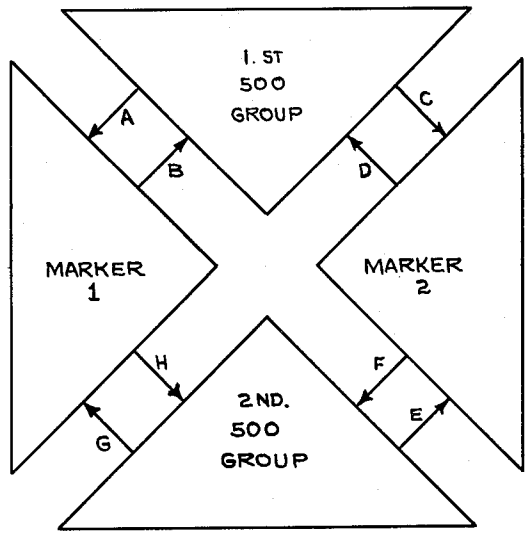


Fig.13-E

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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Attys



ORIGINATING CONNECTIONS A, C, E, G,
TERMINATING CONNECTIONS B, D, F, H.

Fig. 14

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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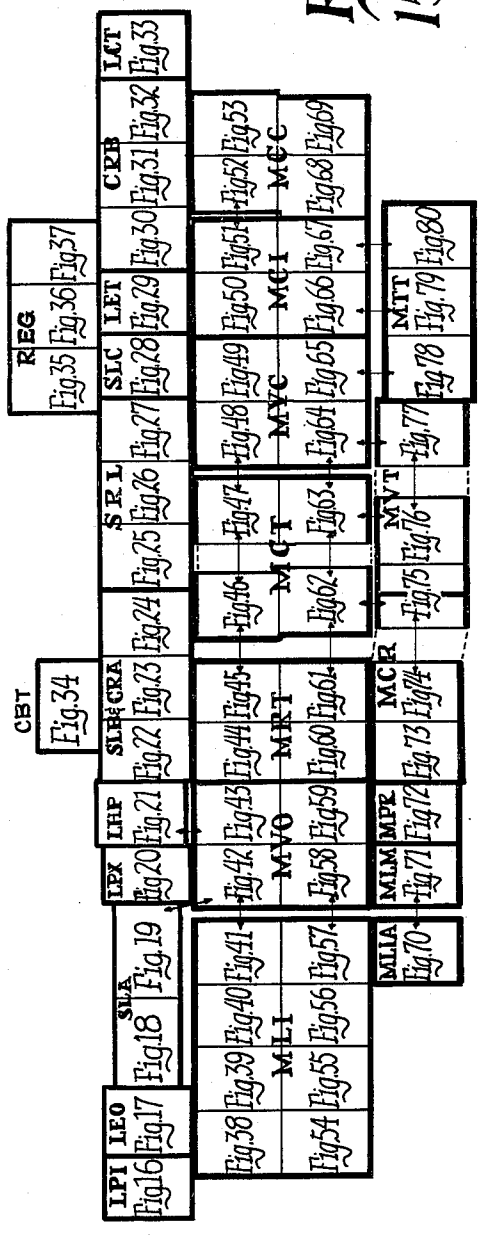


Fig. 15-A

Note:
(↔) denotes presence of wiring between separated figures.

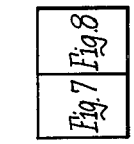


Fig. 15-D

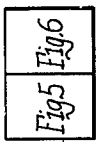


Fig. 15-C

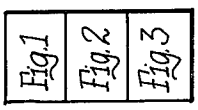


Fig. 15-B

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE. K. SRJELDNES

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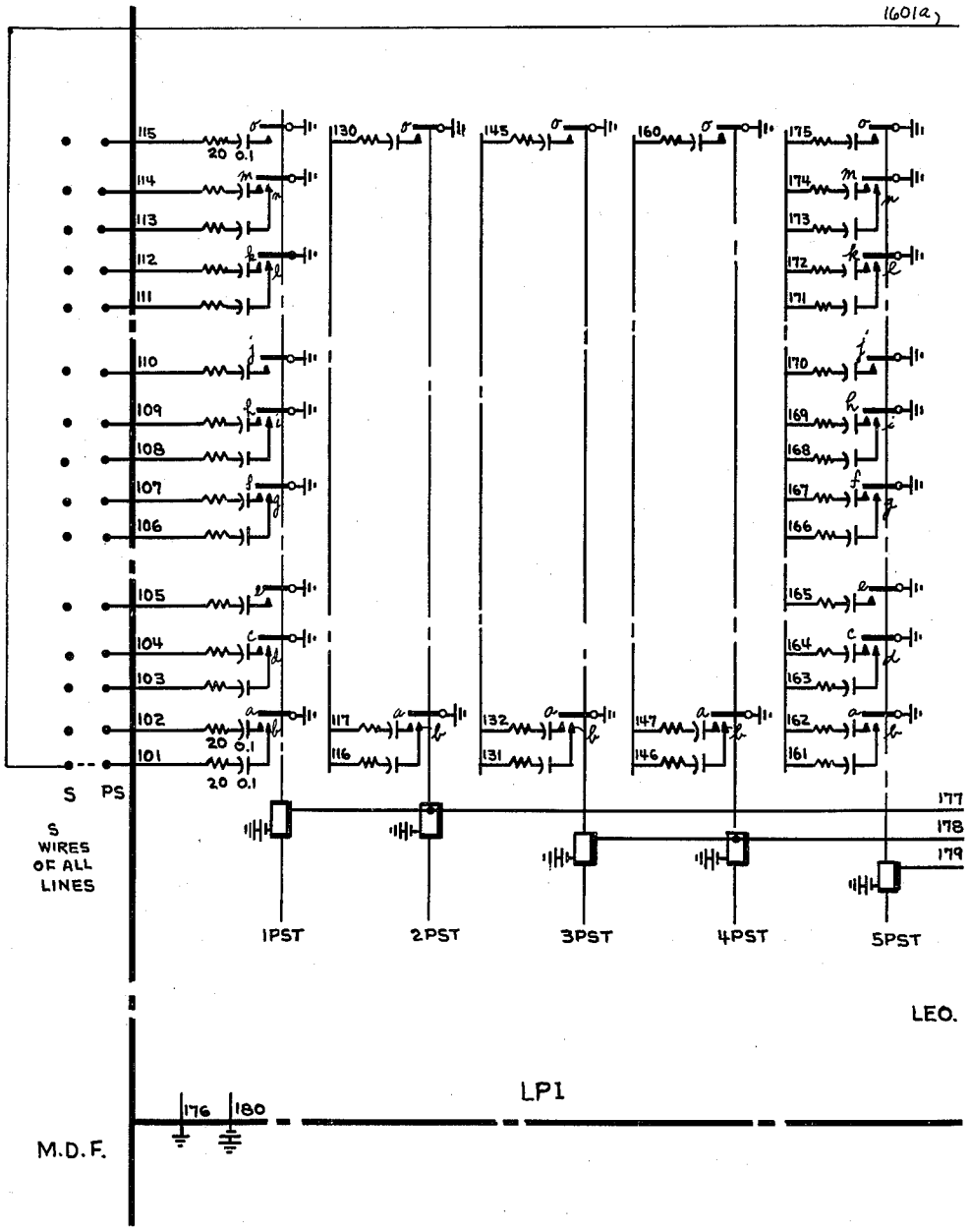


Fig. 16

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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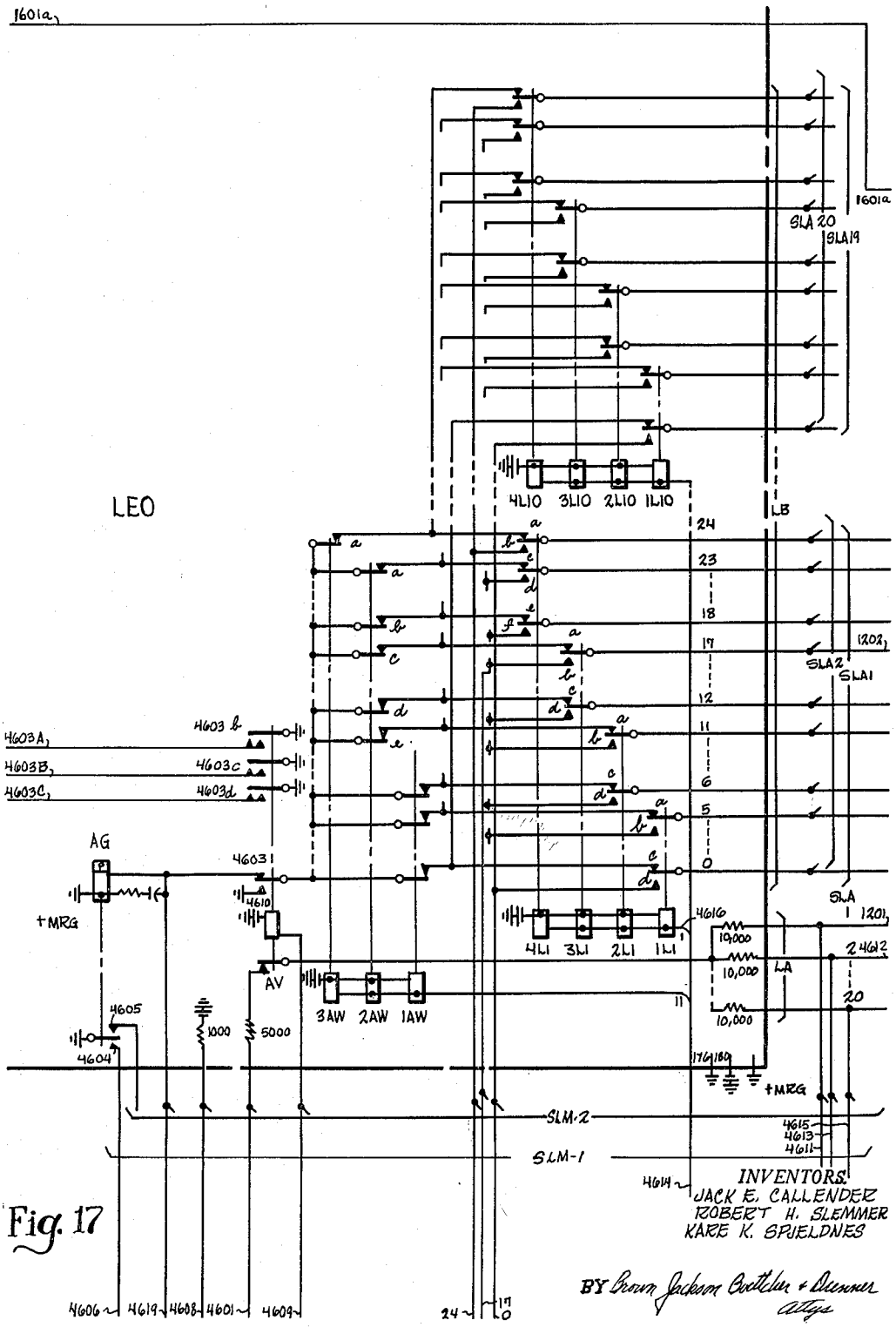


Fig. 17

INVENTORS
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

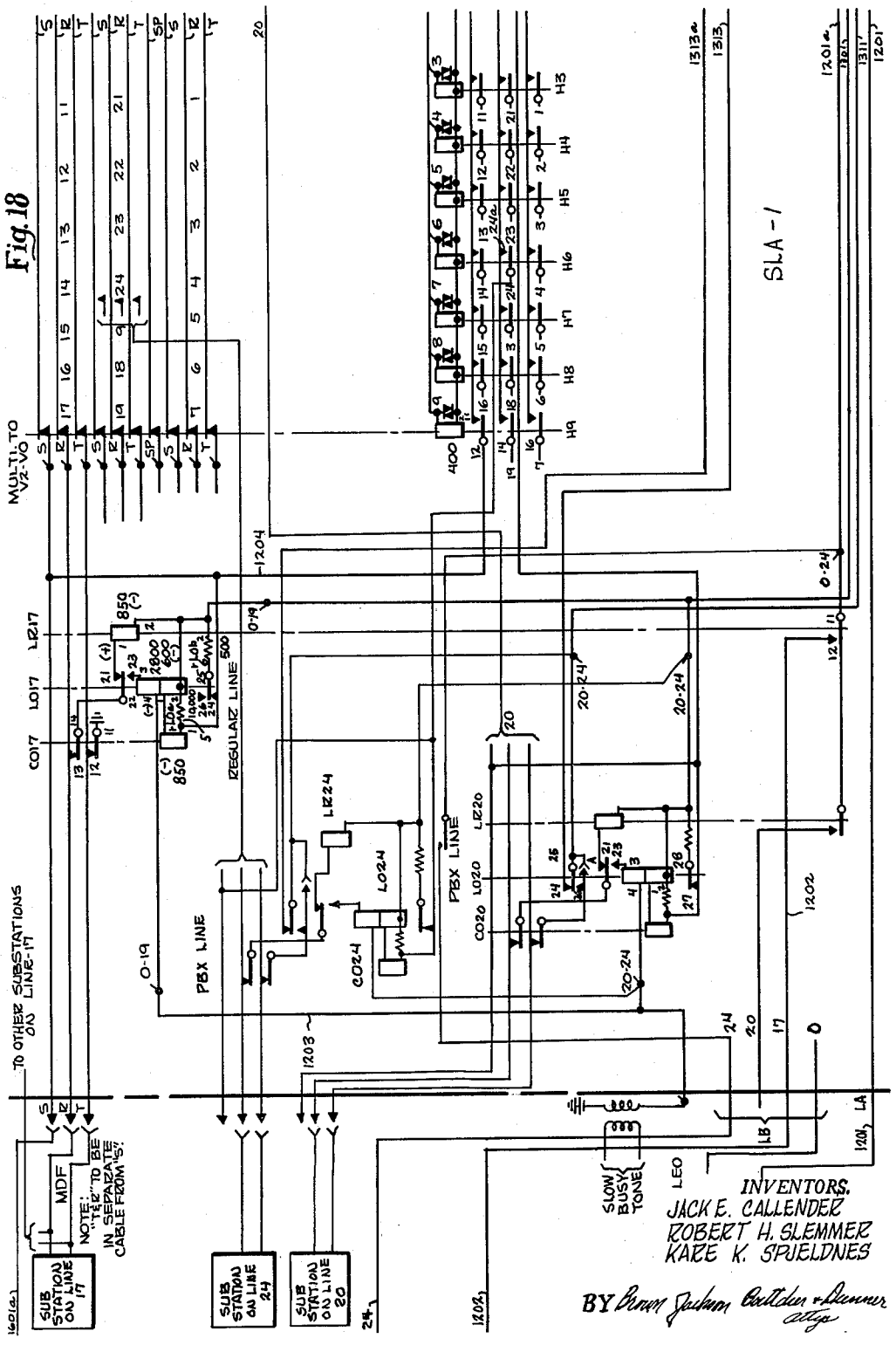
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Fig. 18



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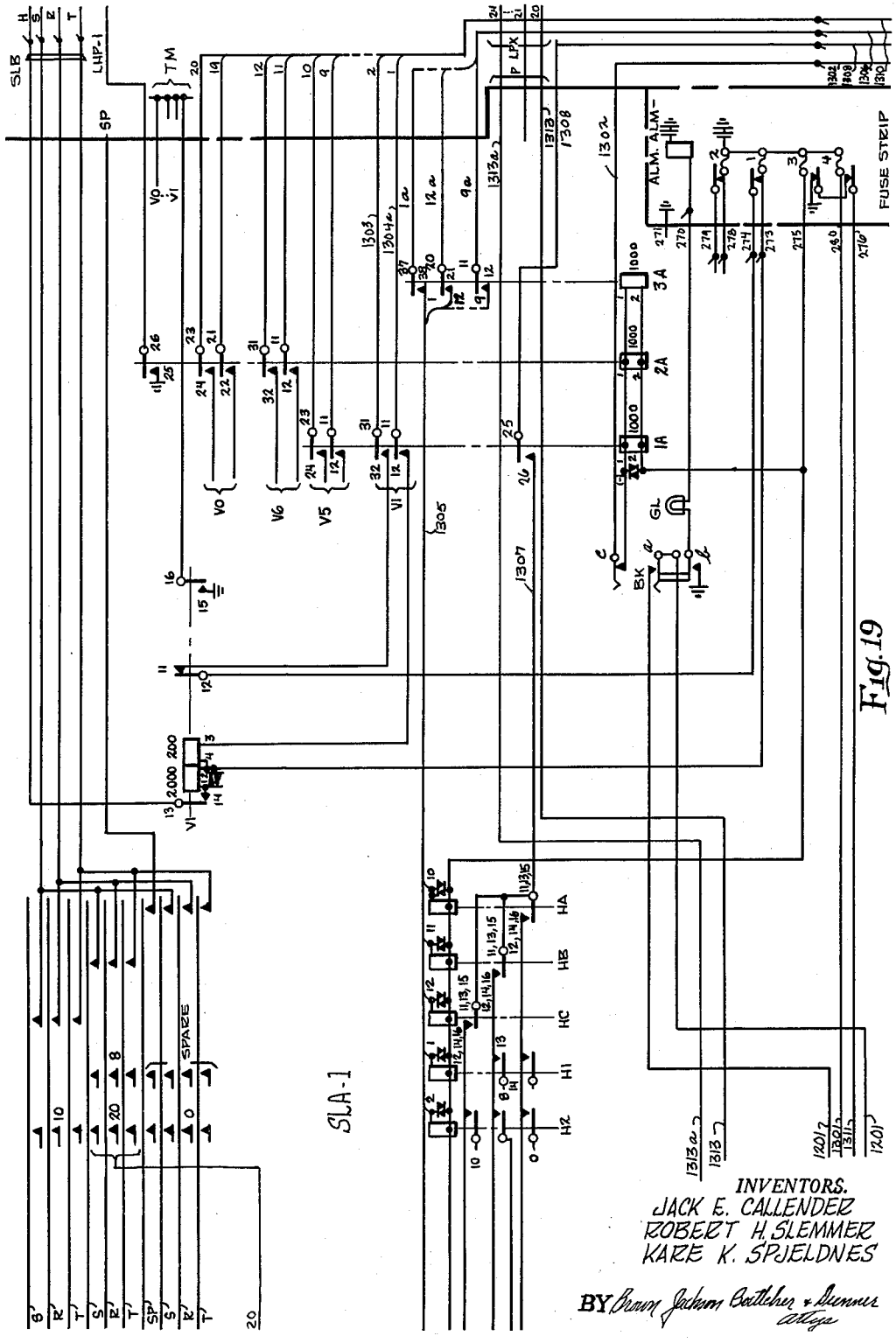


Fig. 19

INVENTORS.
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ROBERT H. SLEMMER
KARE K. SPJELDNES

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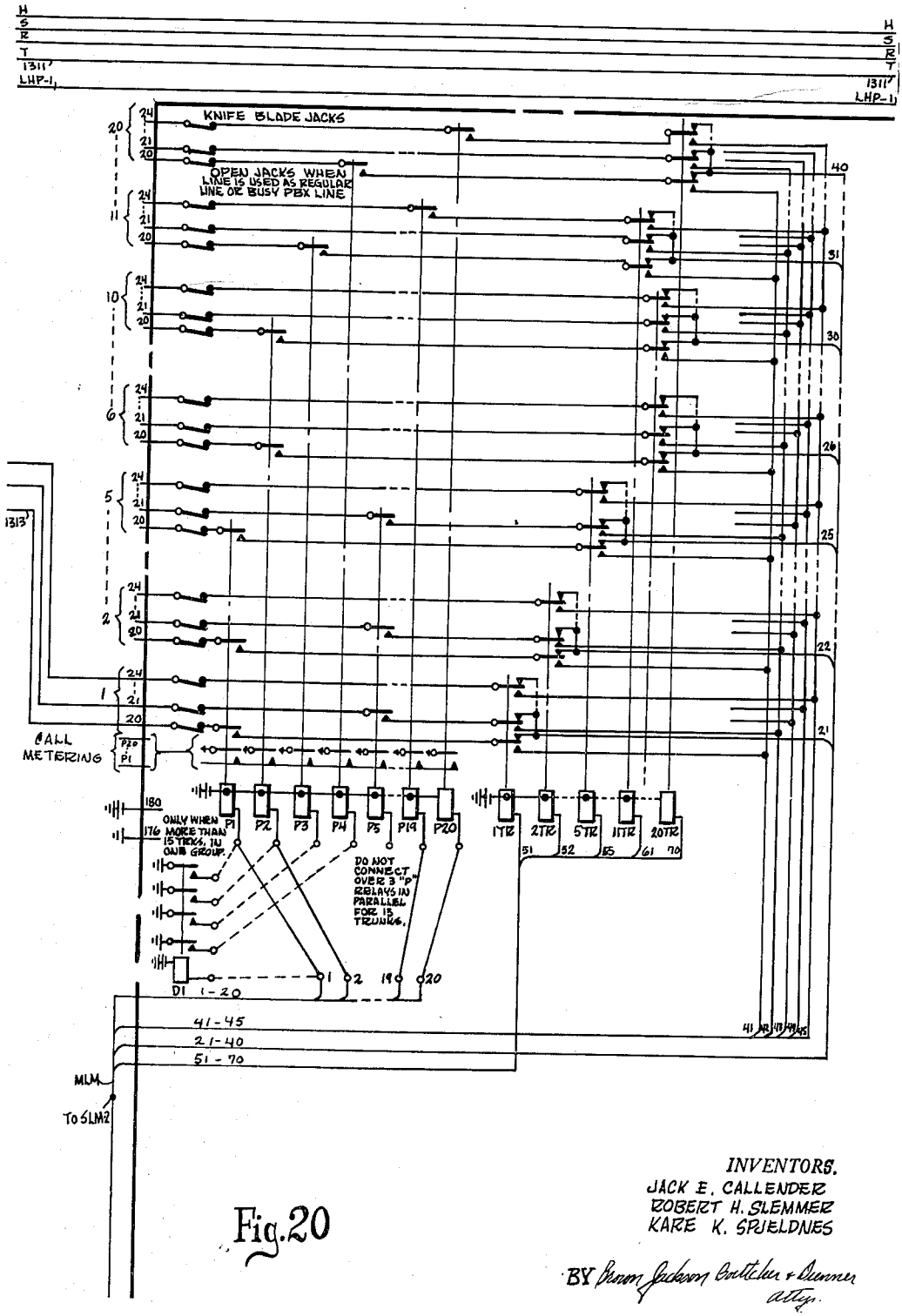


Fig. 20

INVENTORS.
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KARE K. SPJELDNES

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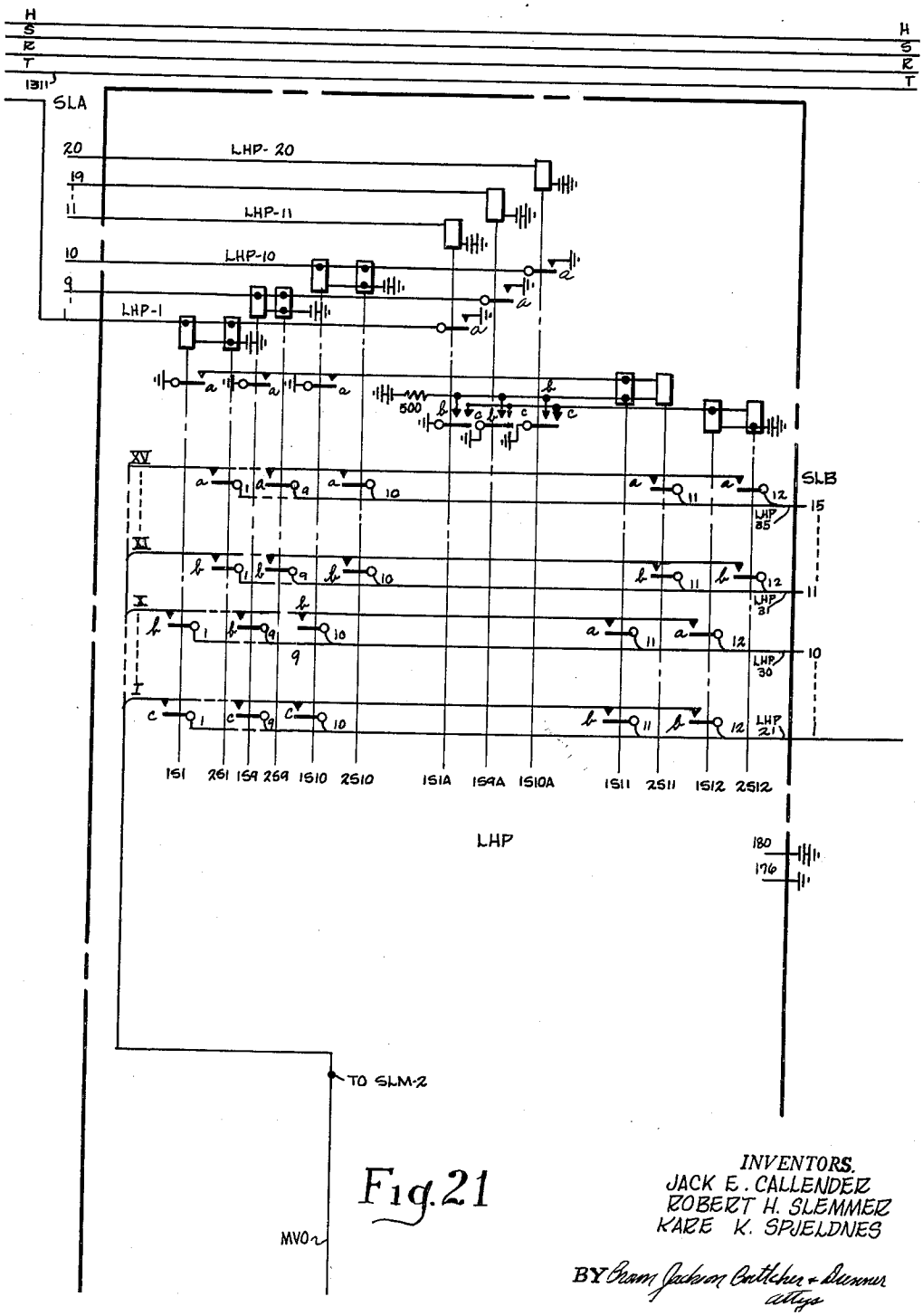


Fig. 21

INVENTORS.
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KARE K. SPJELDNES

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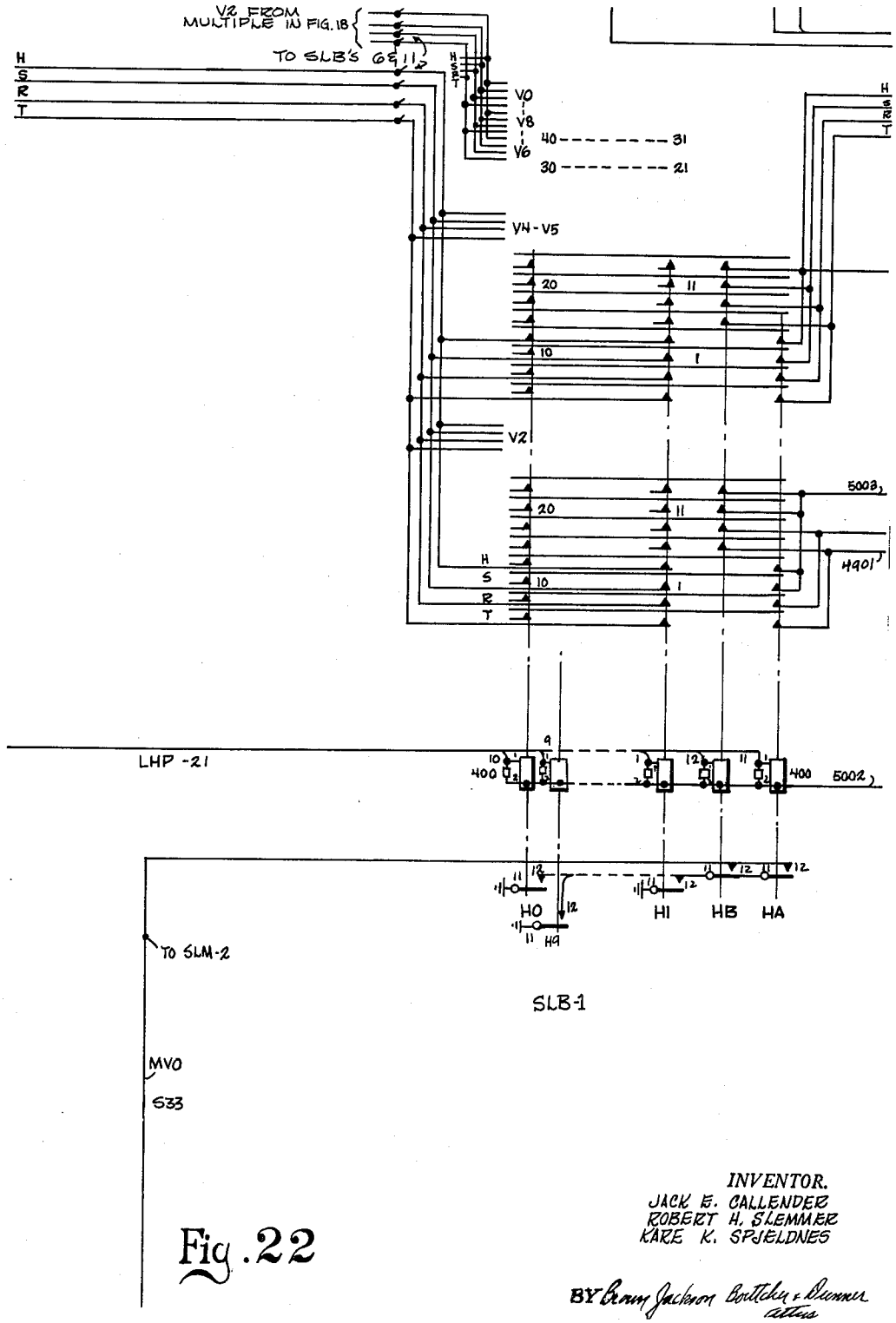


Fig. 22

INVENTOR.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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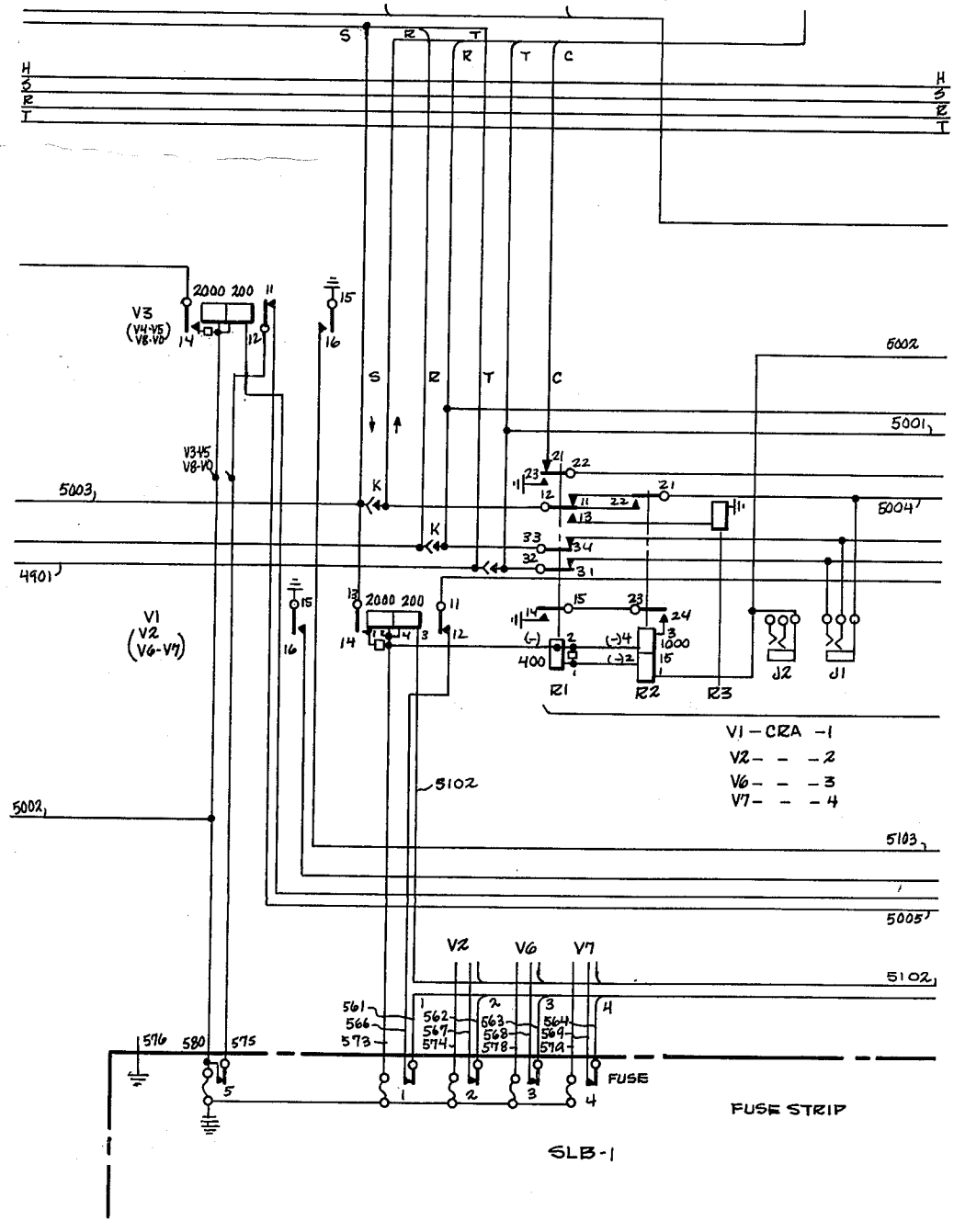


Fig. 23

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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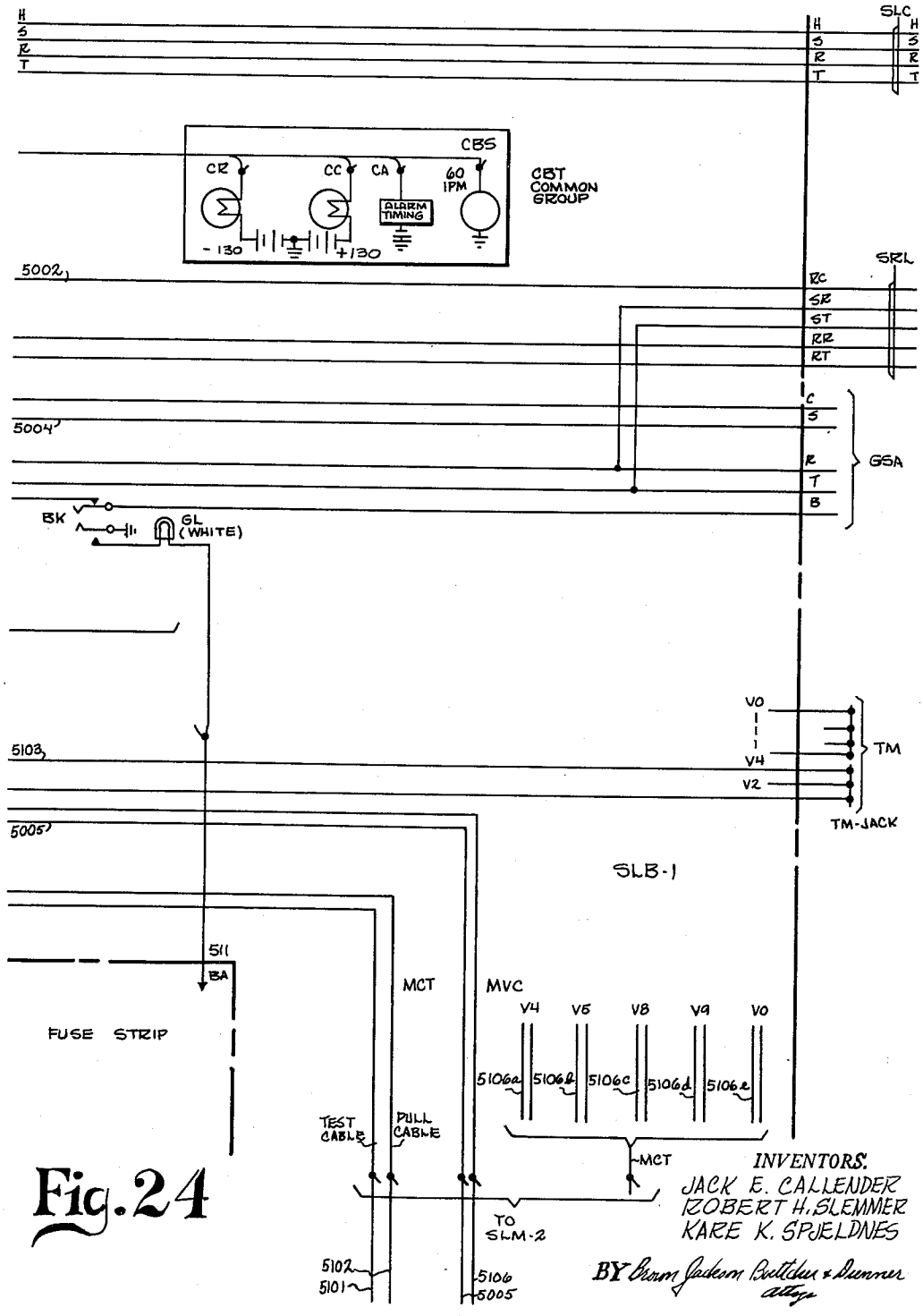


Fig. 24

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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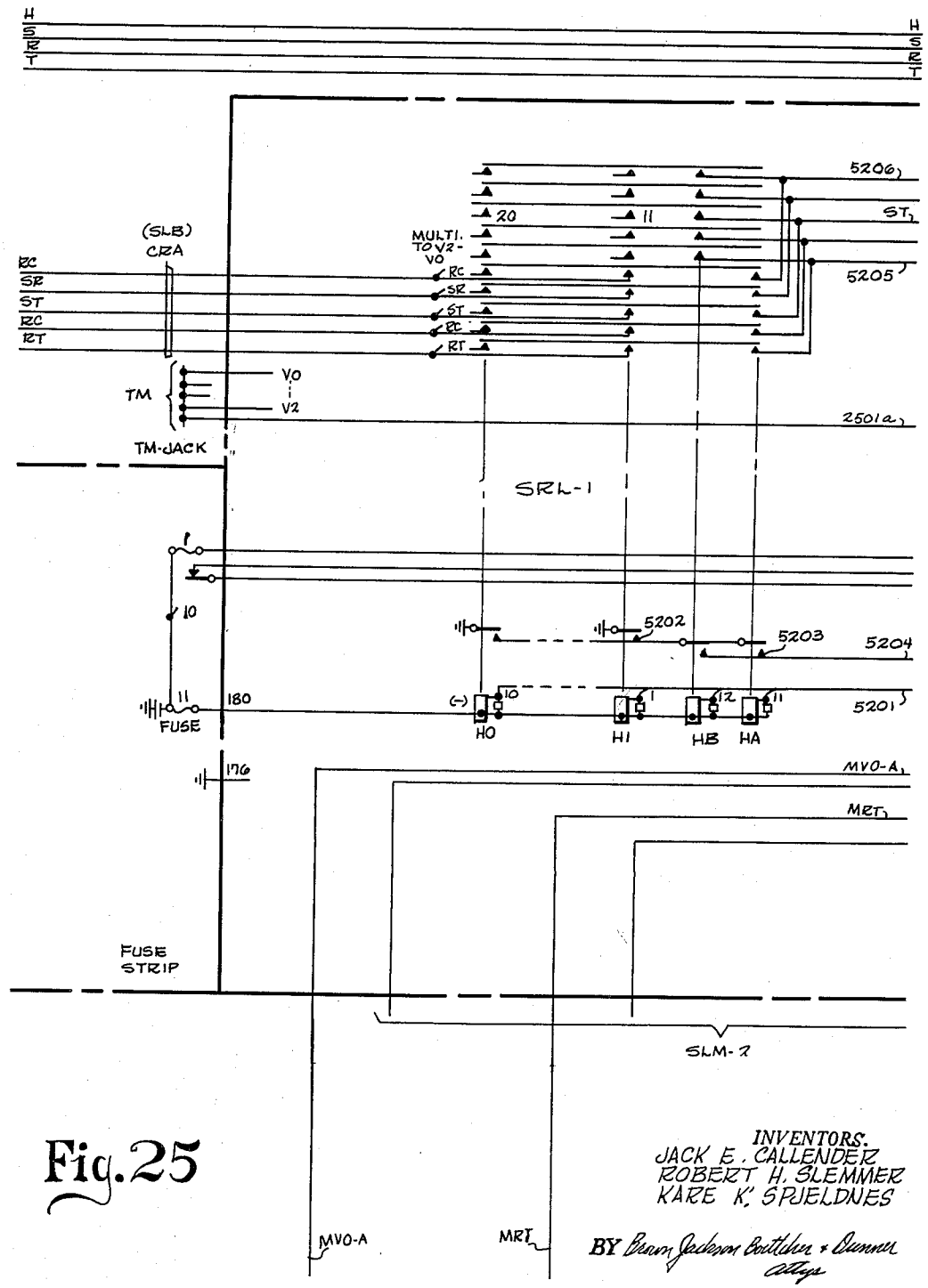


Fig. 25

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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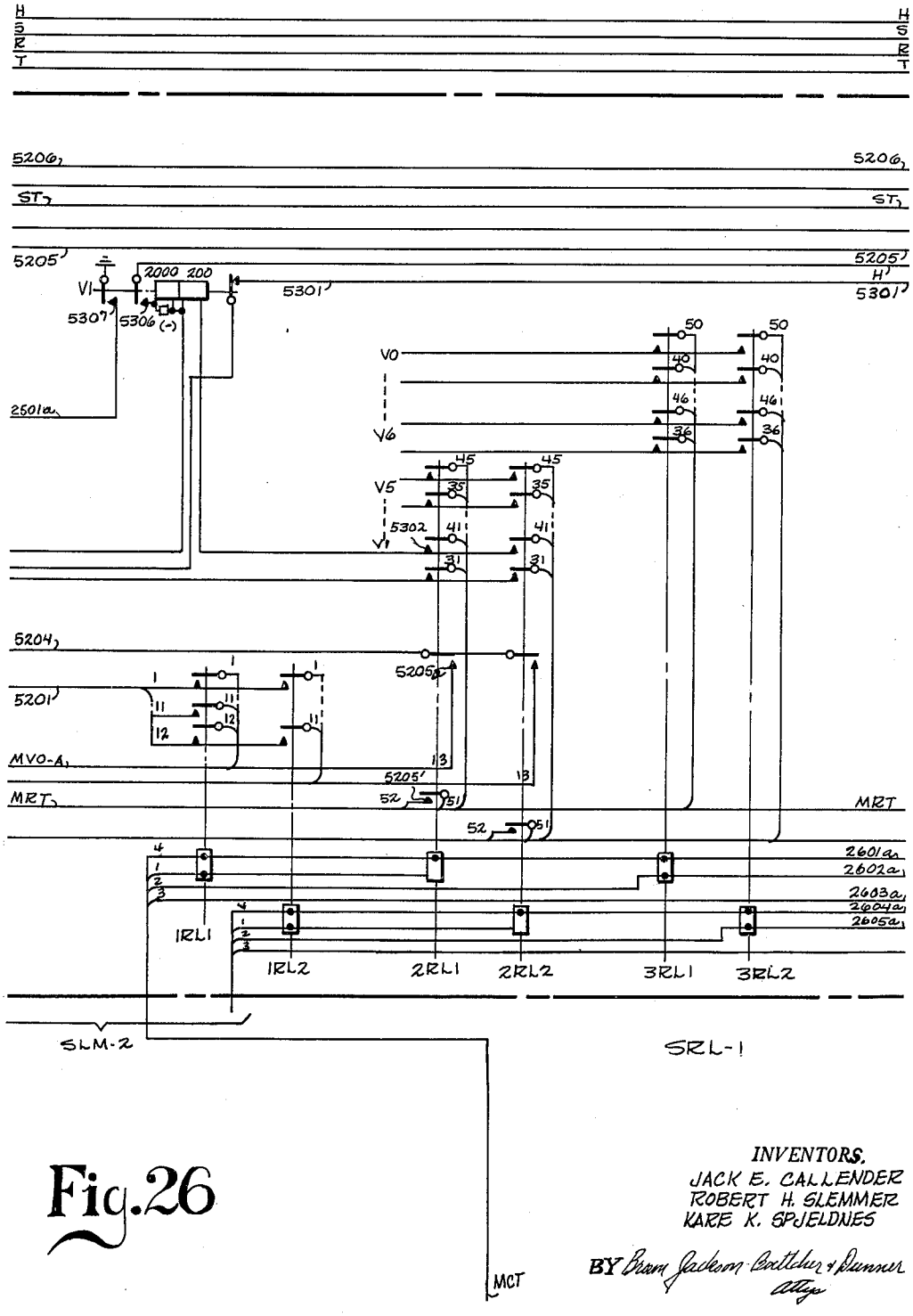


Fig. 26

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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Attys

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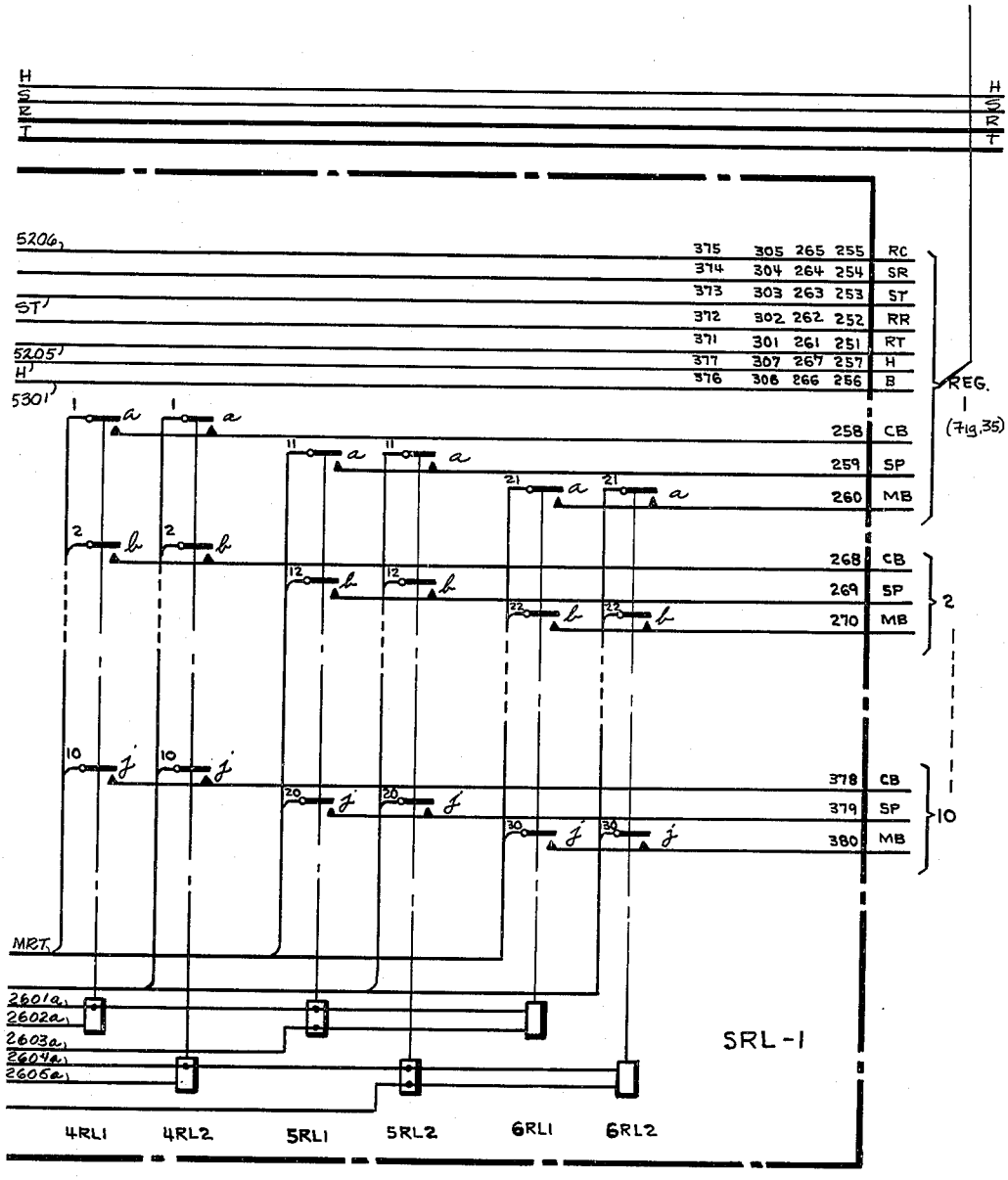


Fig. 27

INVENTORS.
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ROBERT H. SLEMMER
KARE K. SPJELDNES

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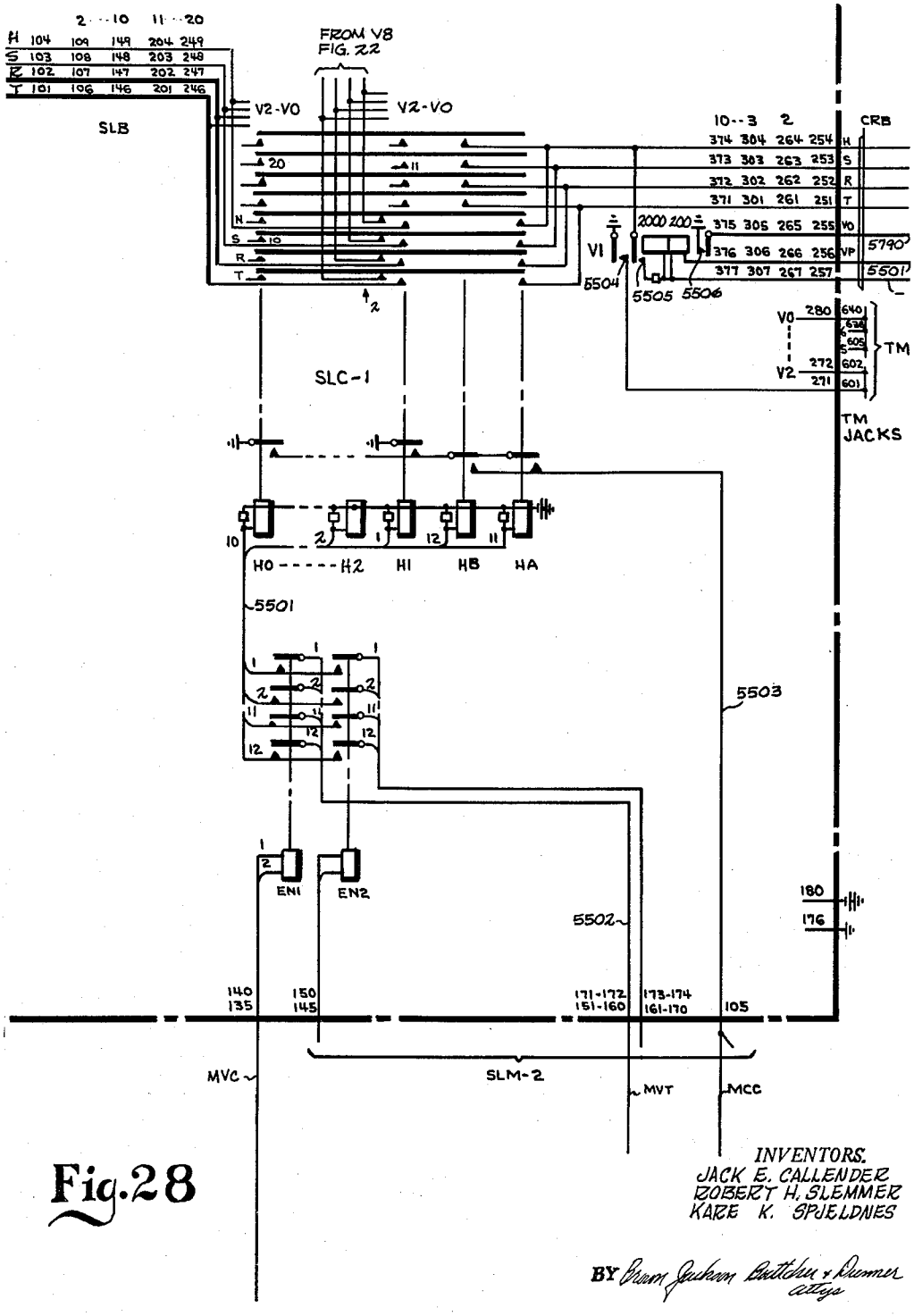


Fig. 28

INVENTORS.
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KARE K. SPJELDNES

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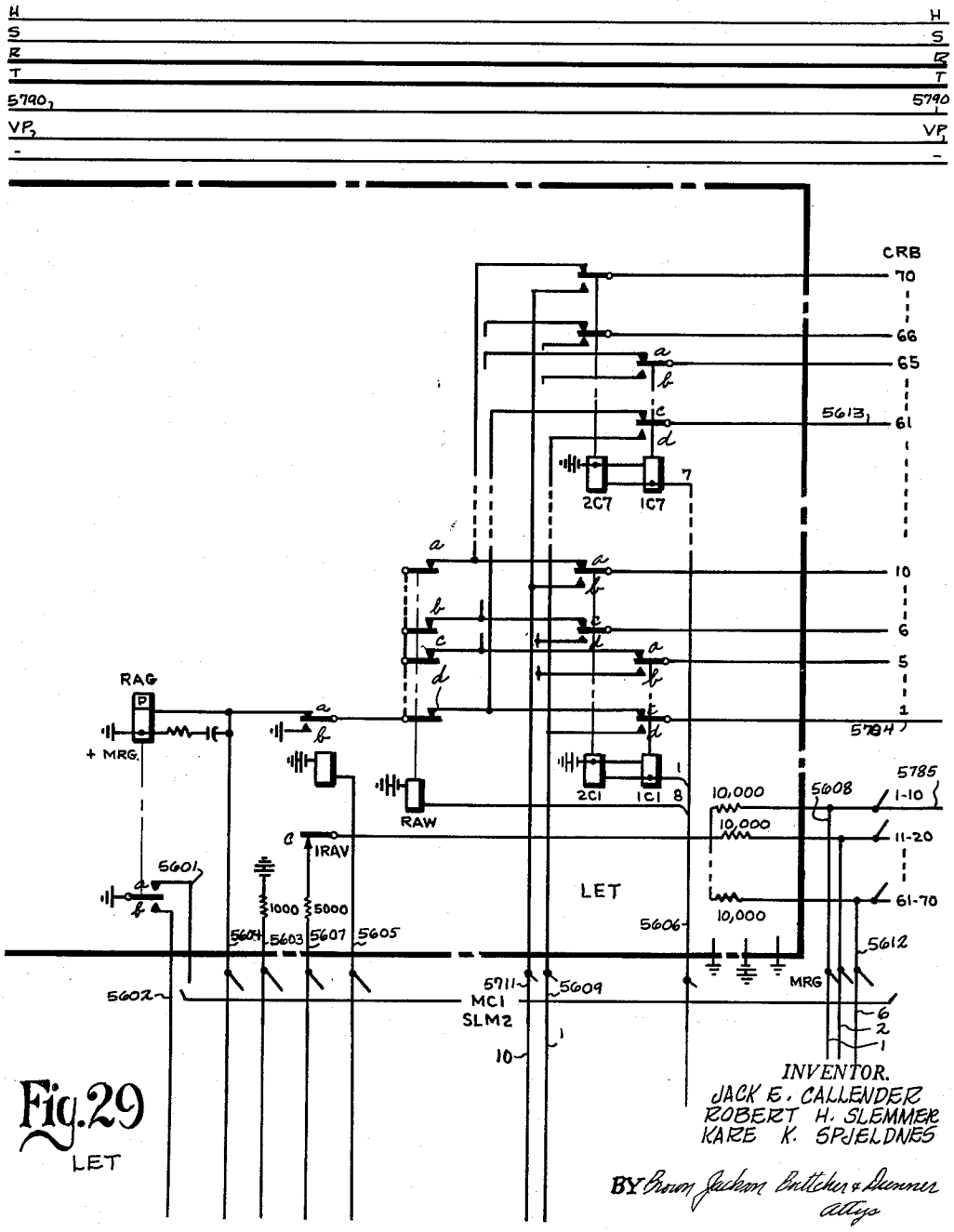


Fig. 29
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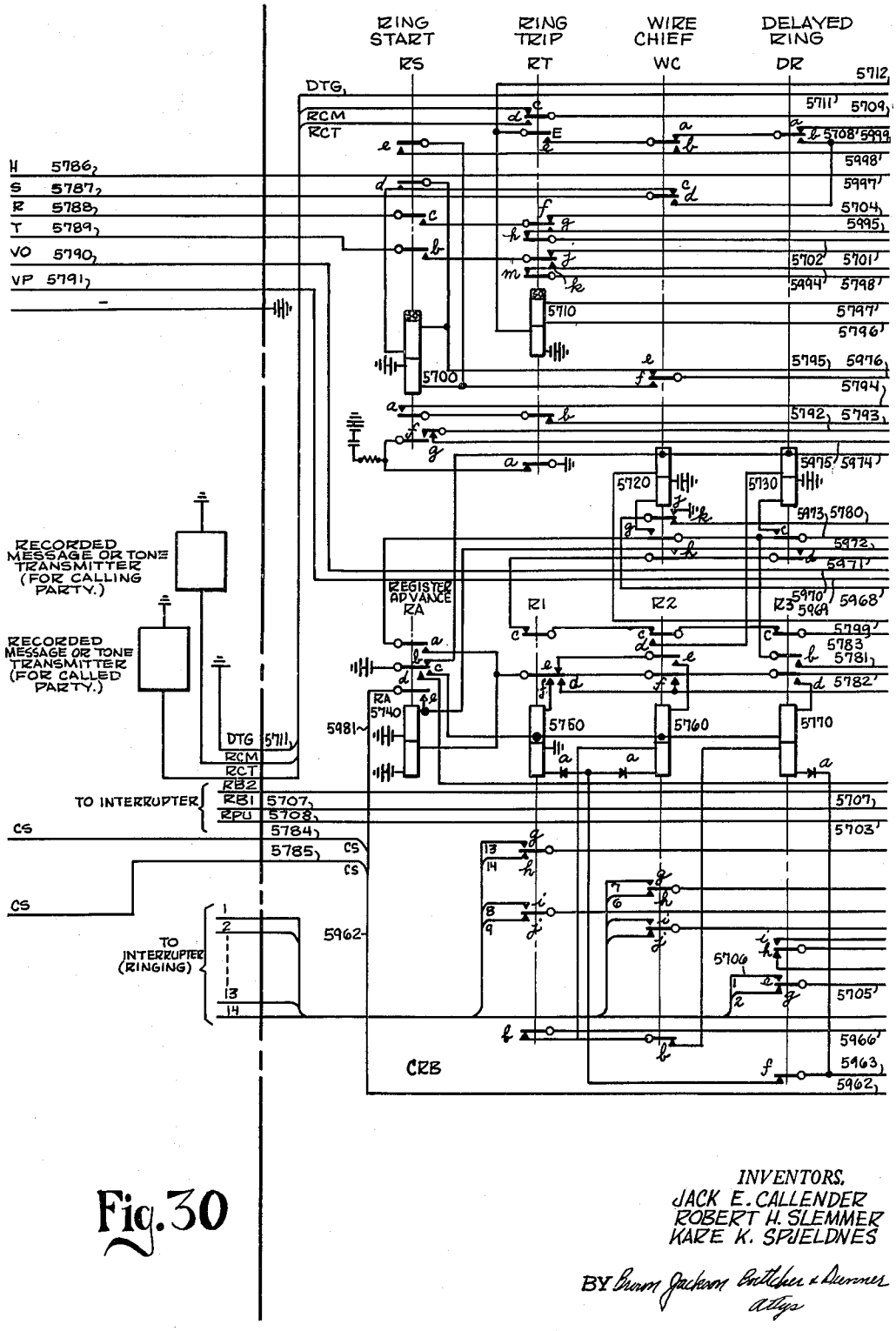


Fig. 30

INVENTORS.
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ROBERT H. SLEMMER
KARE K. SPJELDNES

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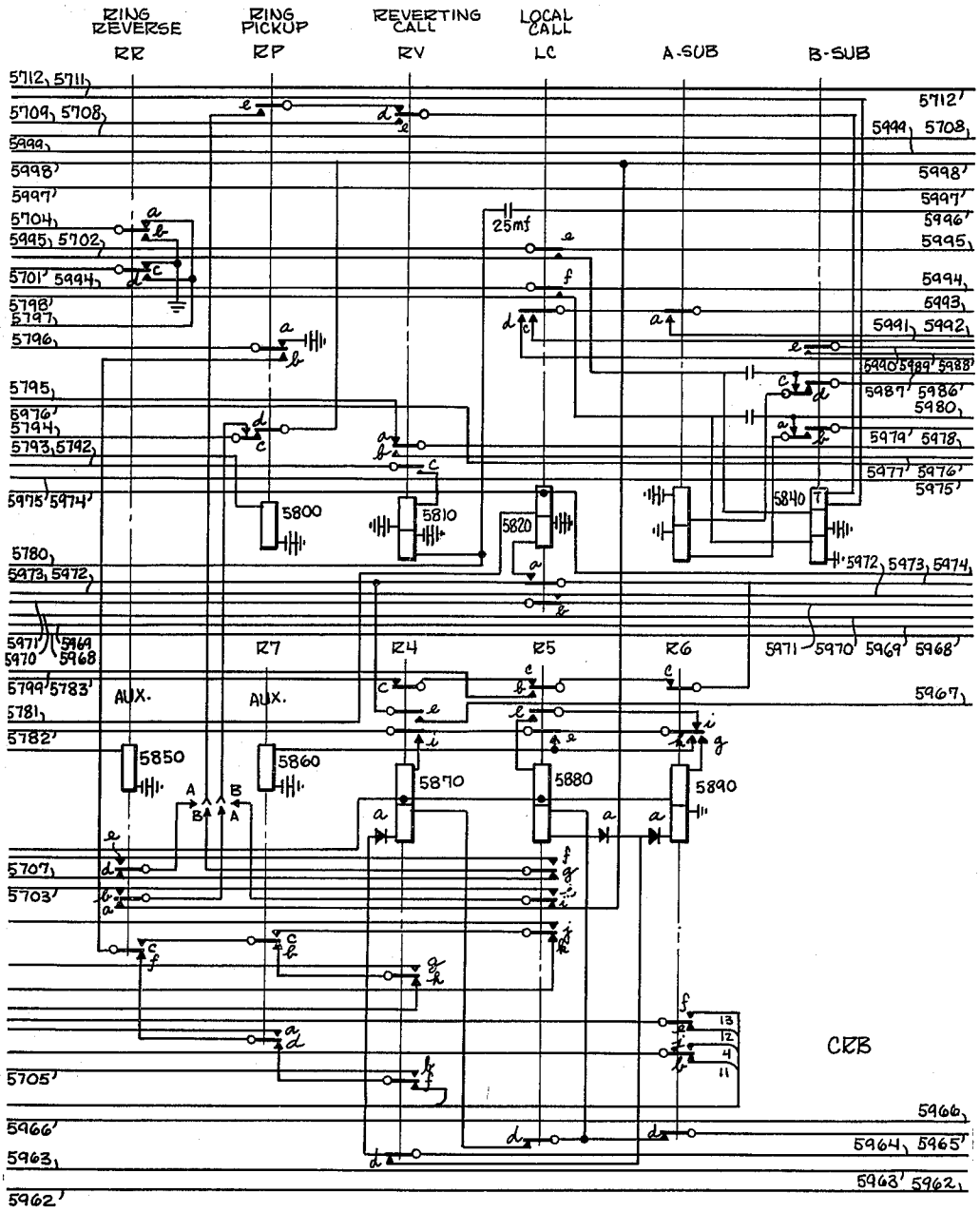


Fig. 31

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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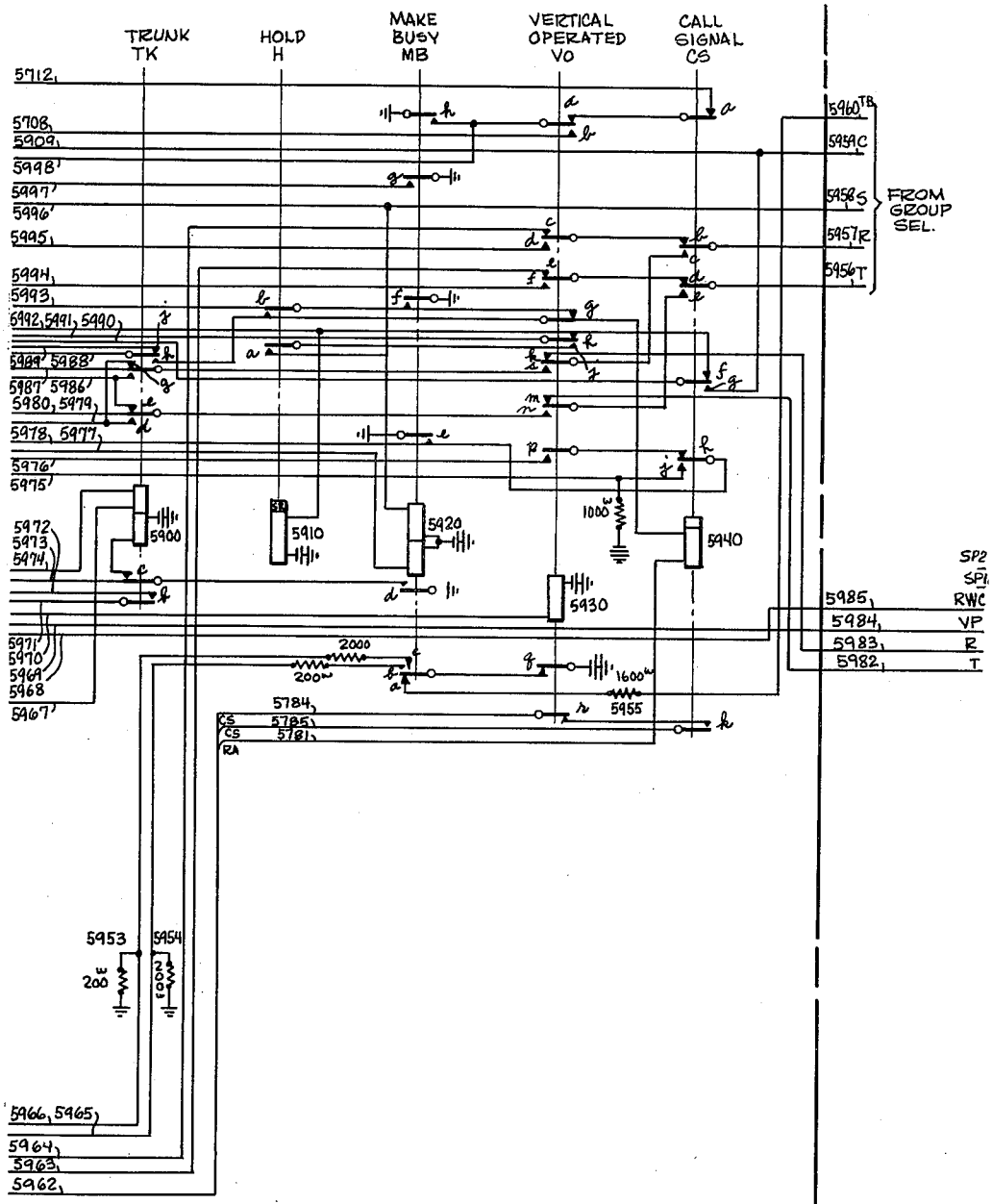


Fig. 32

INVENTORS.
JACK E. CALLENDER
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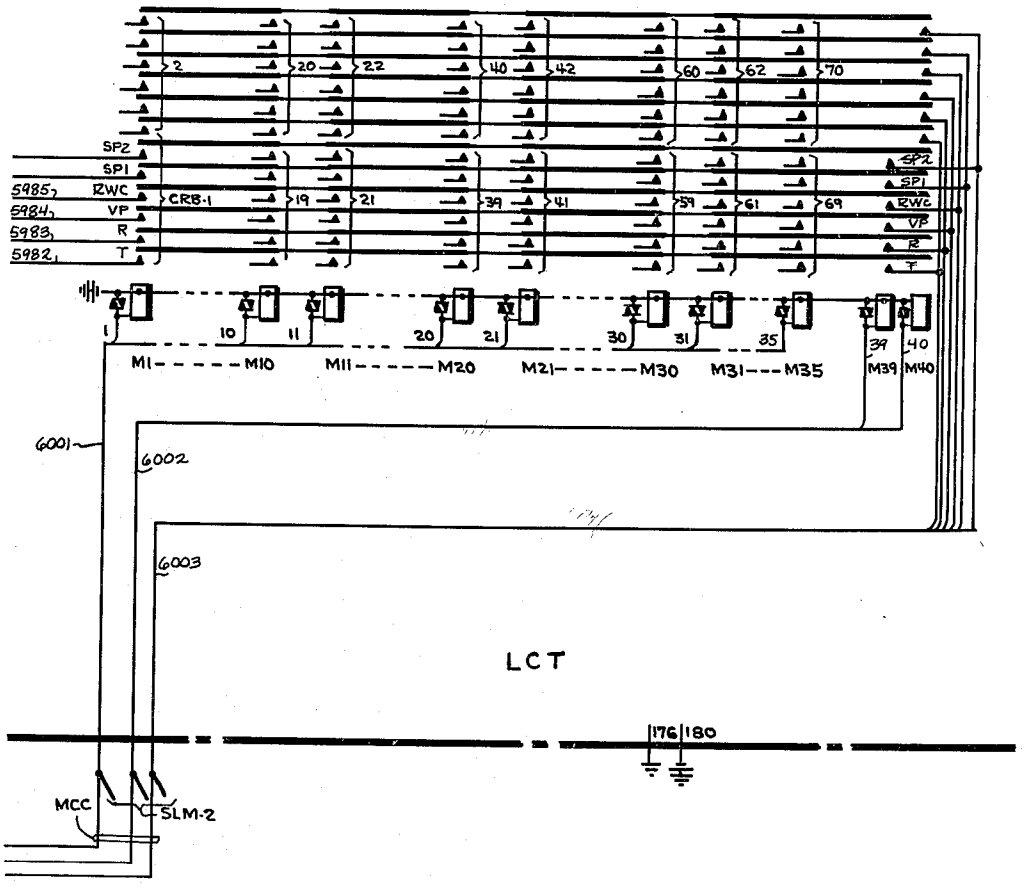


Fig. 33

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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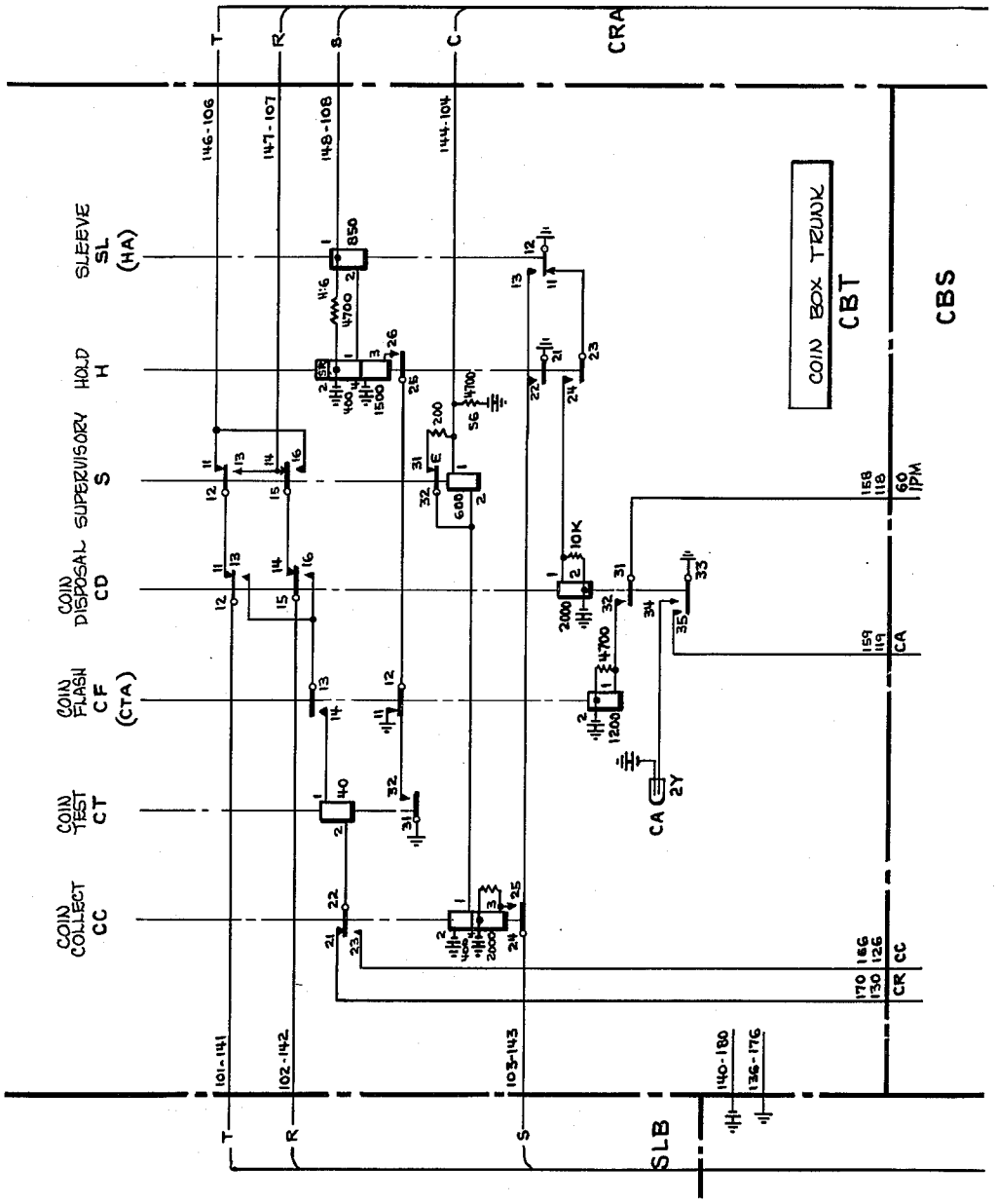


Fig. 34

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INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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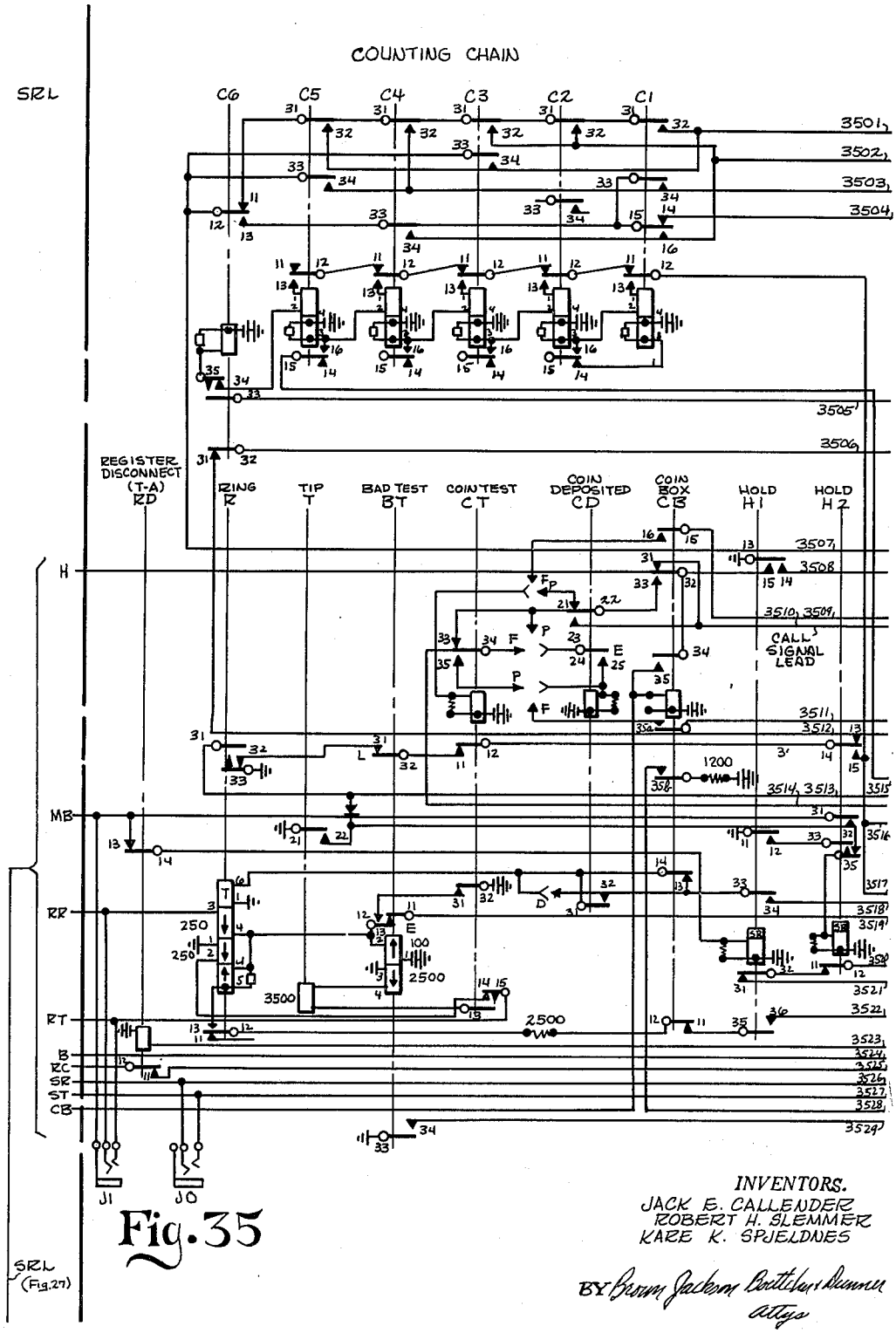


Fig. 35

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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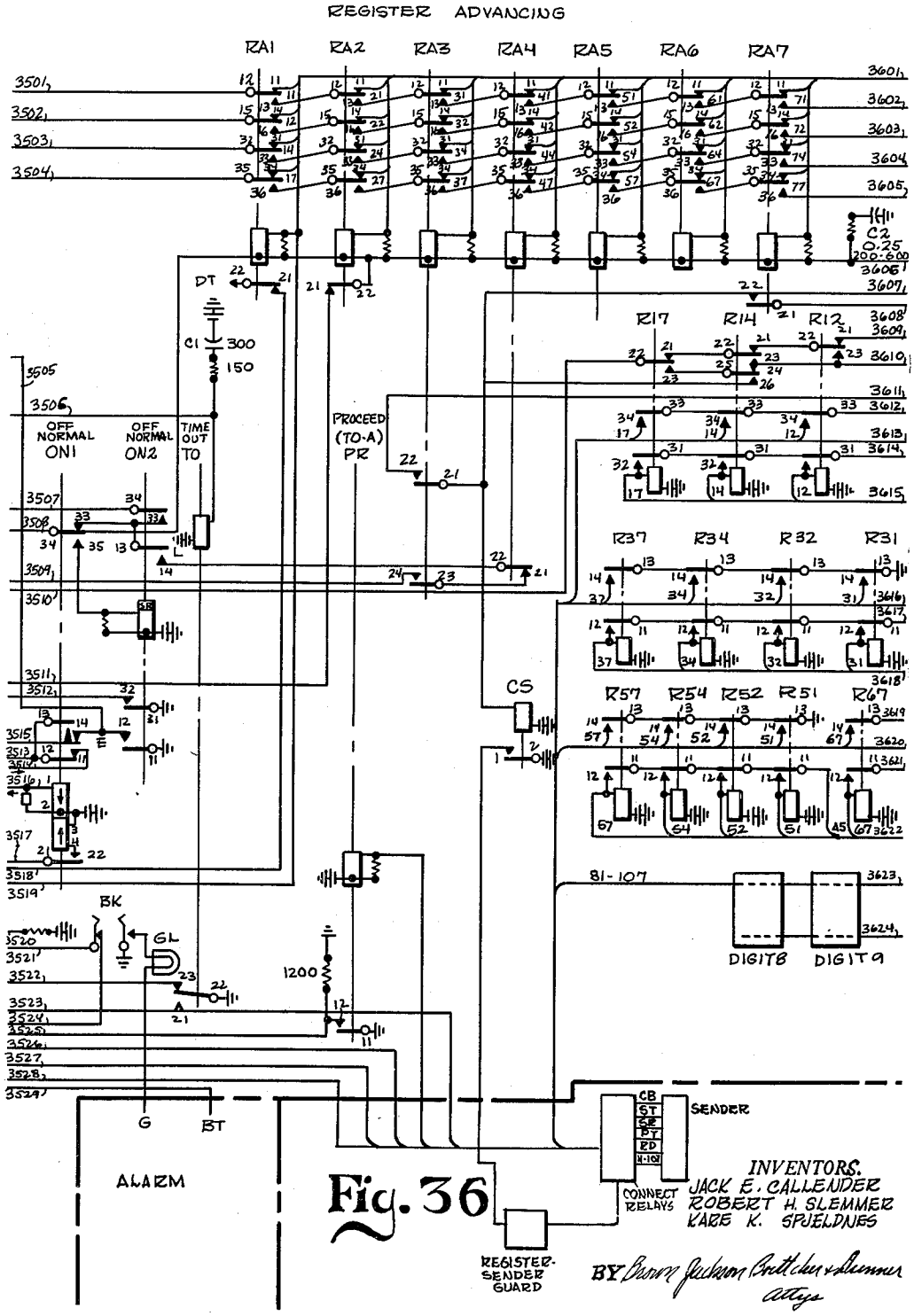


Fig. 36

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPIELDNES

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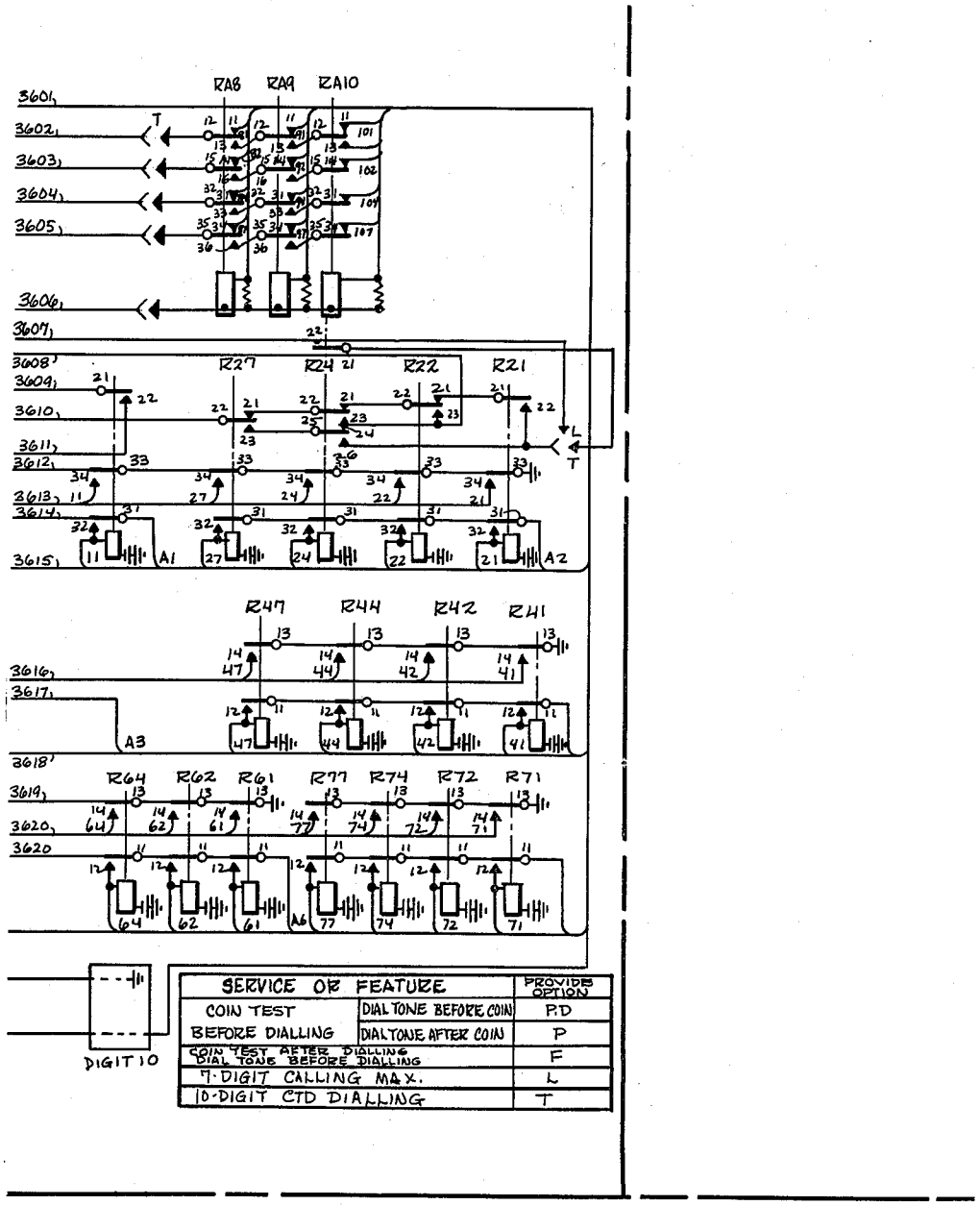


Fig. 37

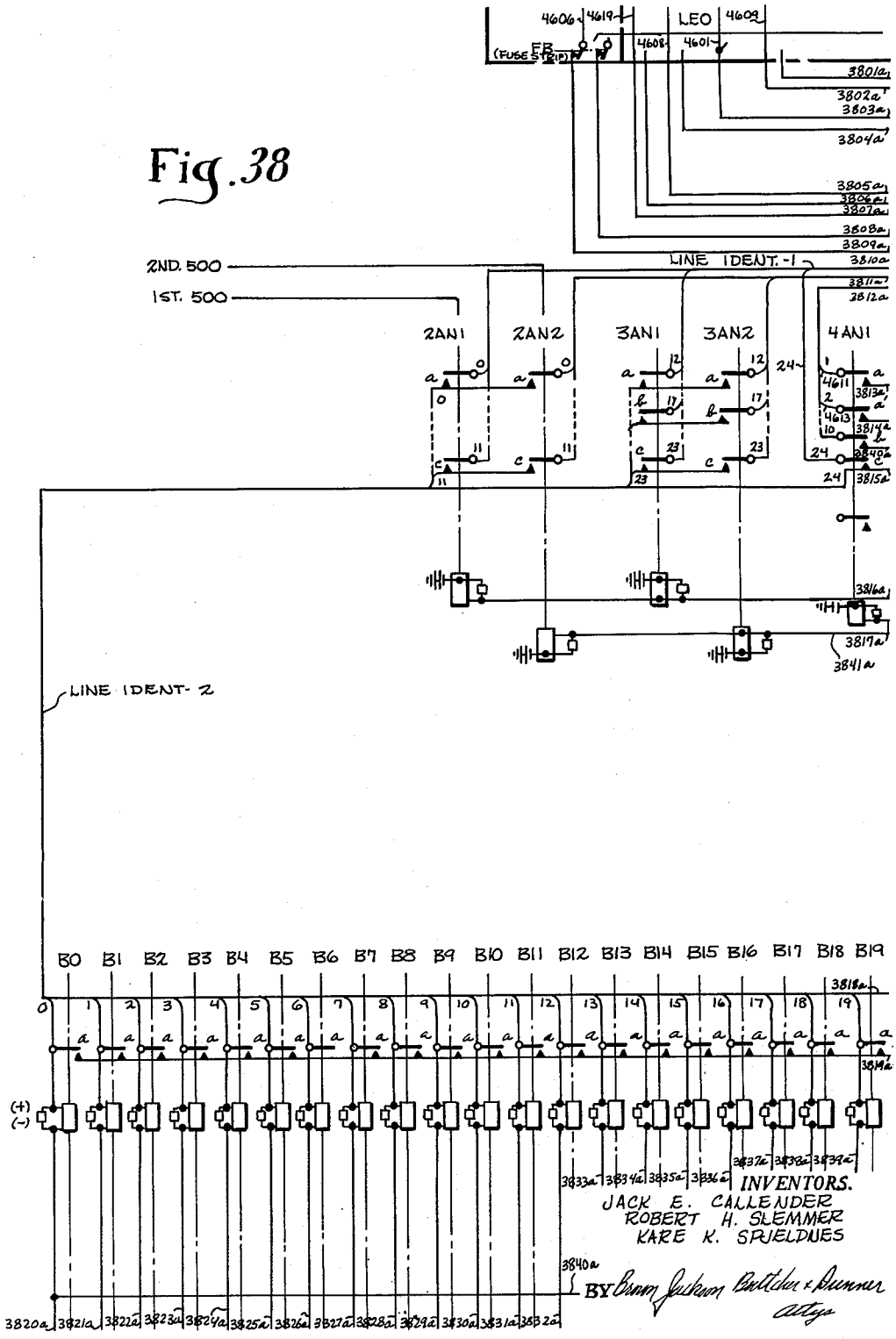
INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES
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Fig. 38



INVENTORS.
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ROBERT H. SLEMMER
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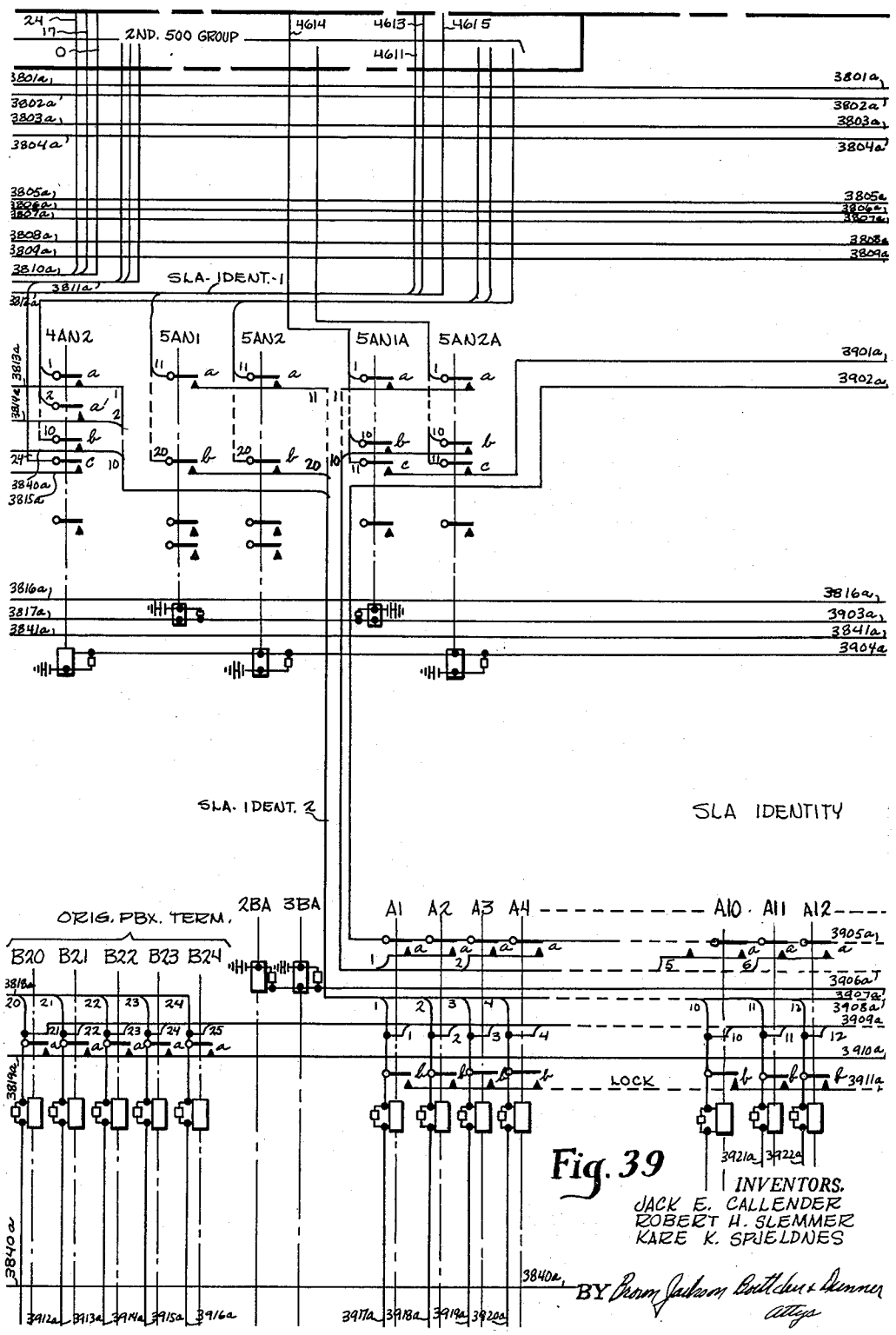


Fig. 39

INVENTORS.
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ROBERT H. SLEMMER
KARE K. SPJELDNES

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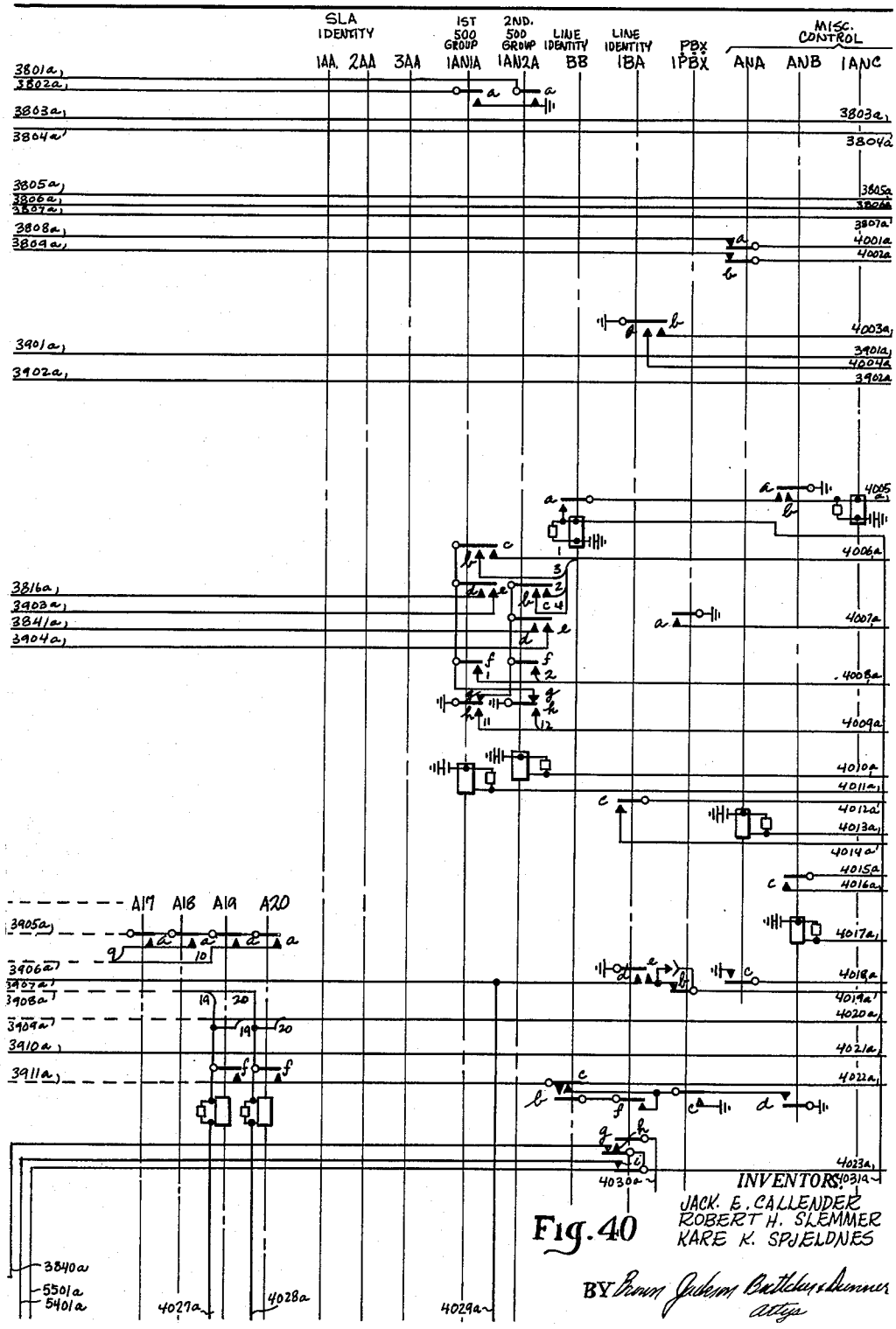


Fig. 40

INVENTORS:
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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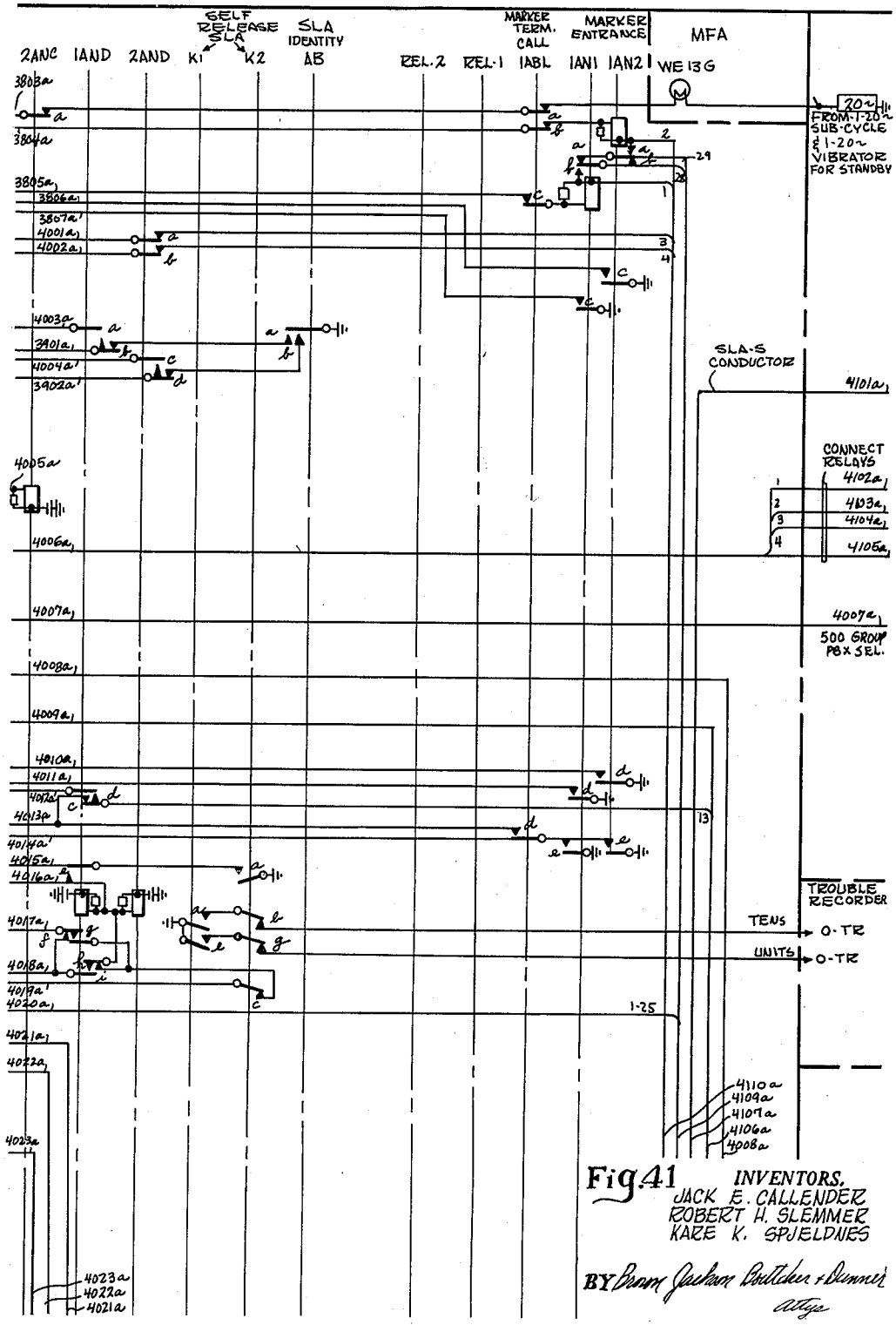


Fig 41

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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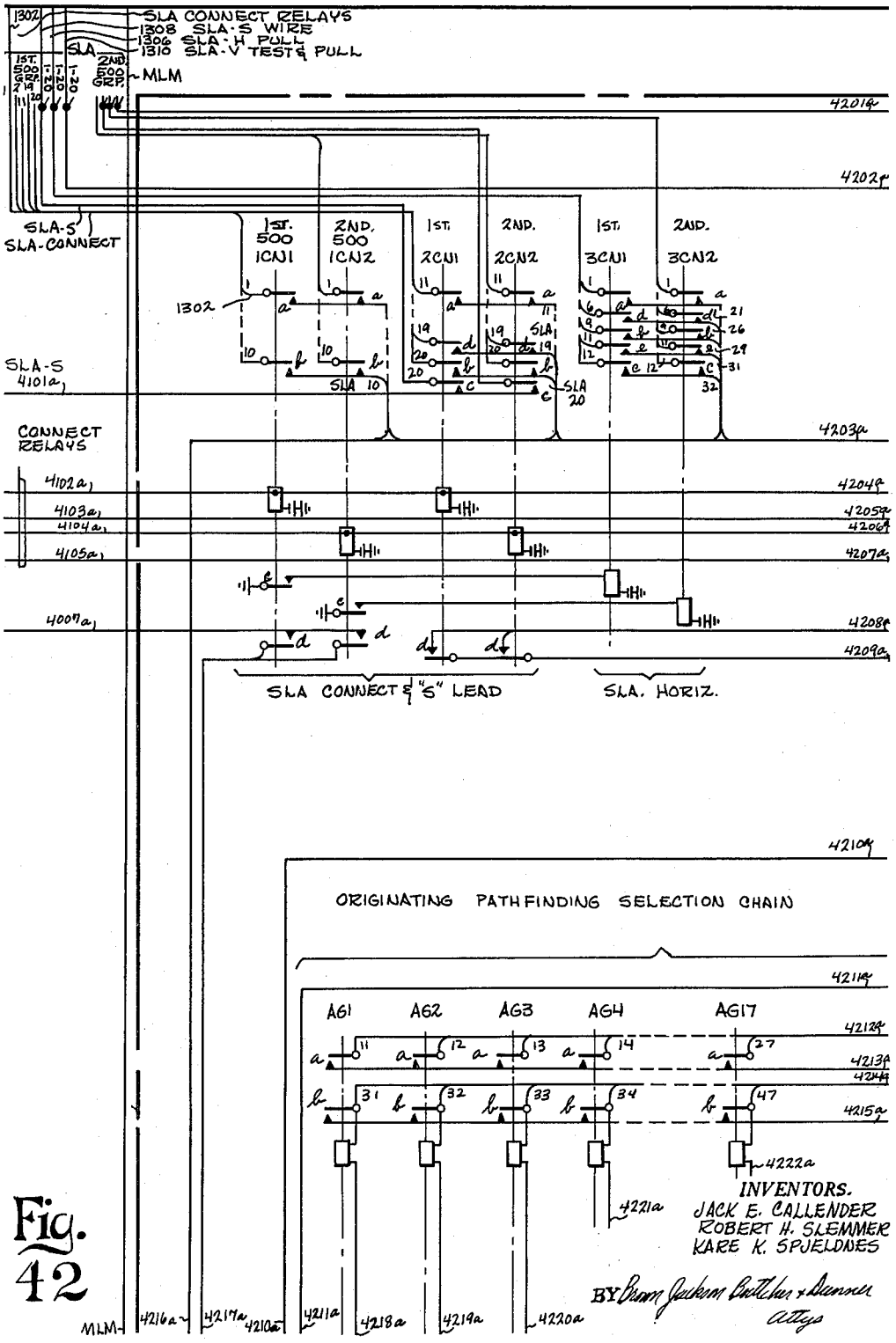


Fig. 42

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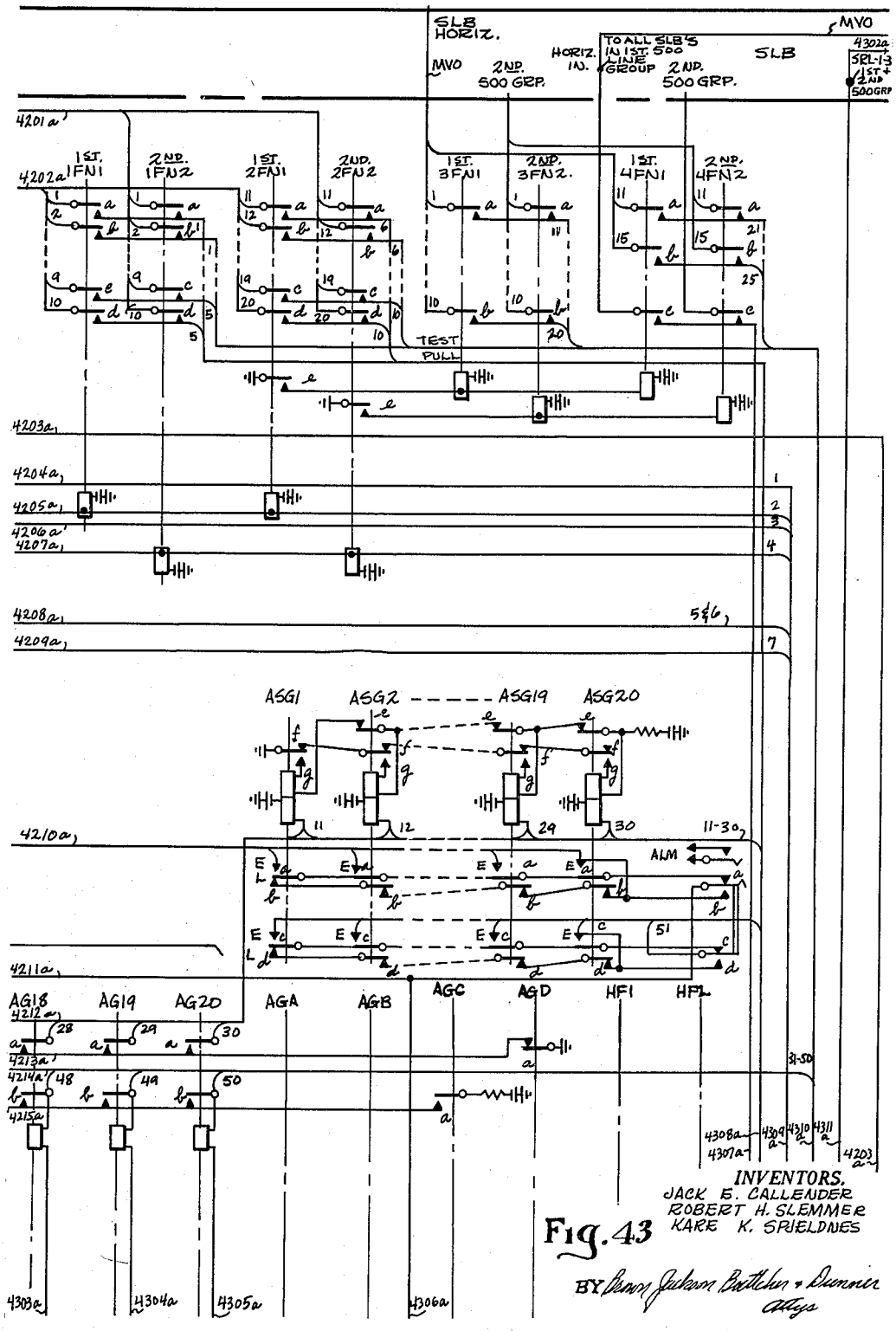


Fig. 43

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPIELDNES

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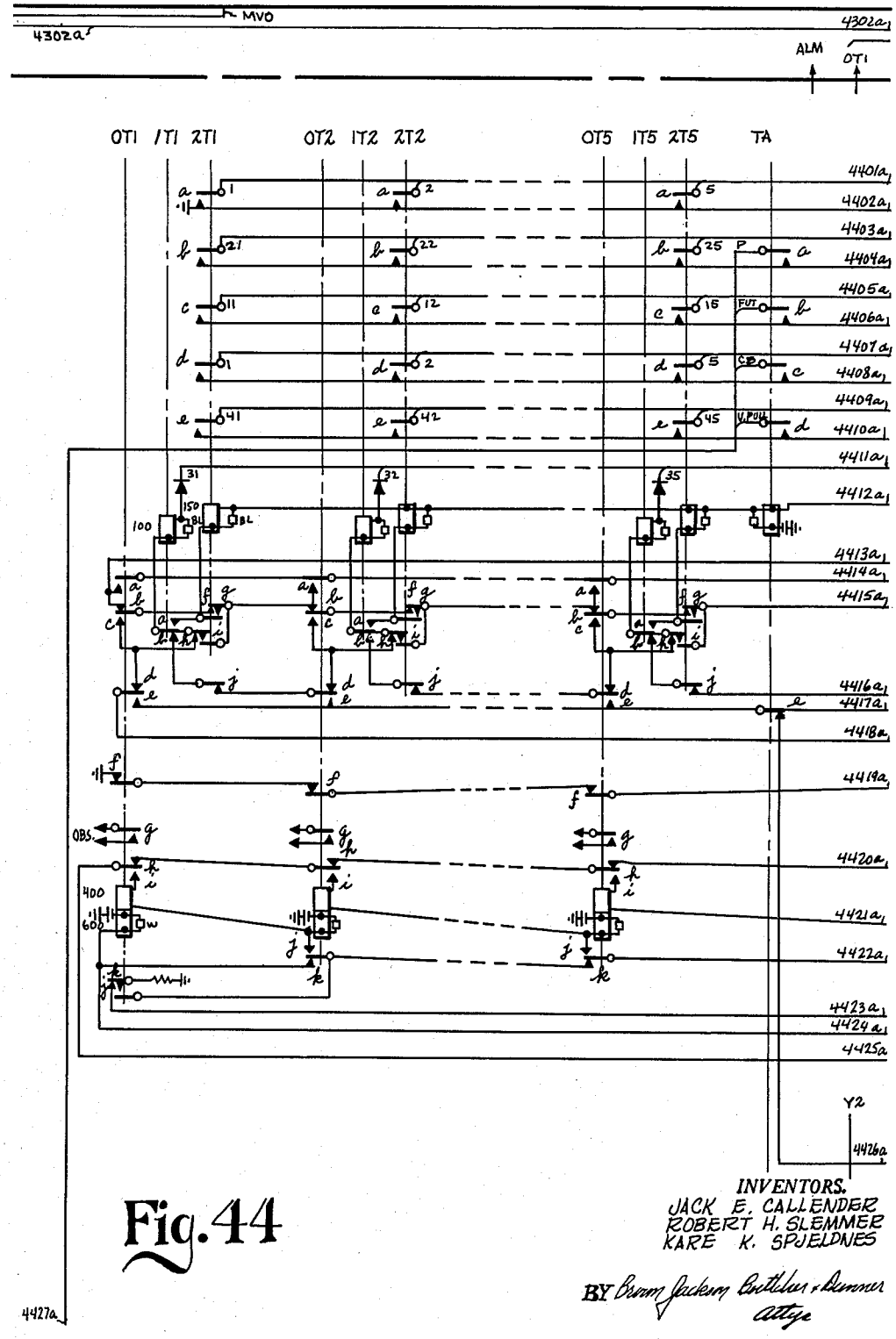


Fig. 44

INVENTORS.
JACK E. CALLENDER
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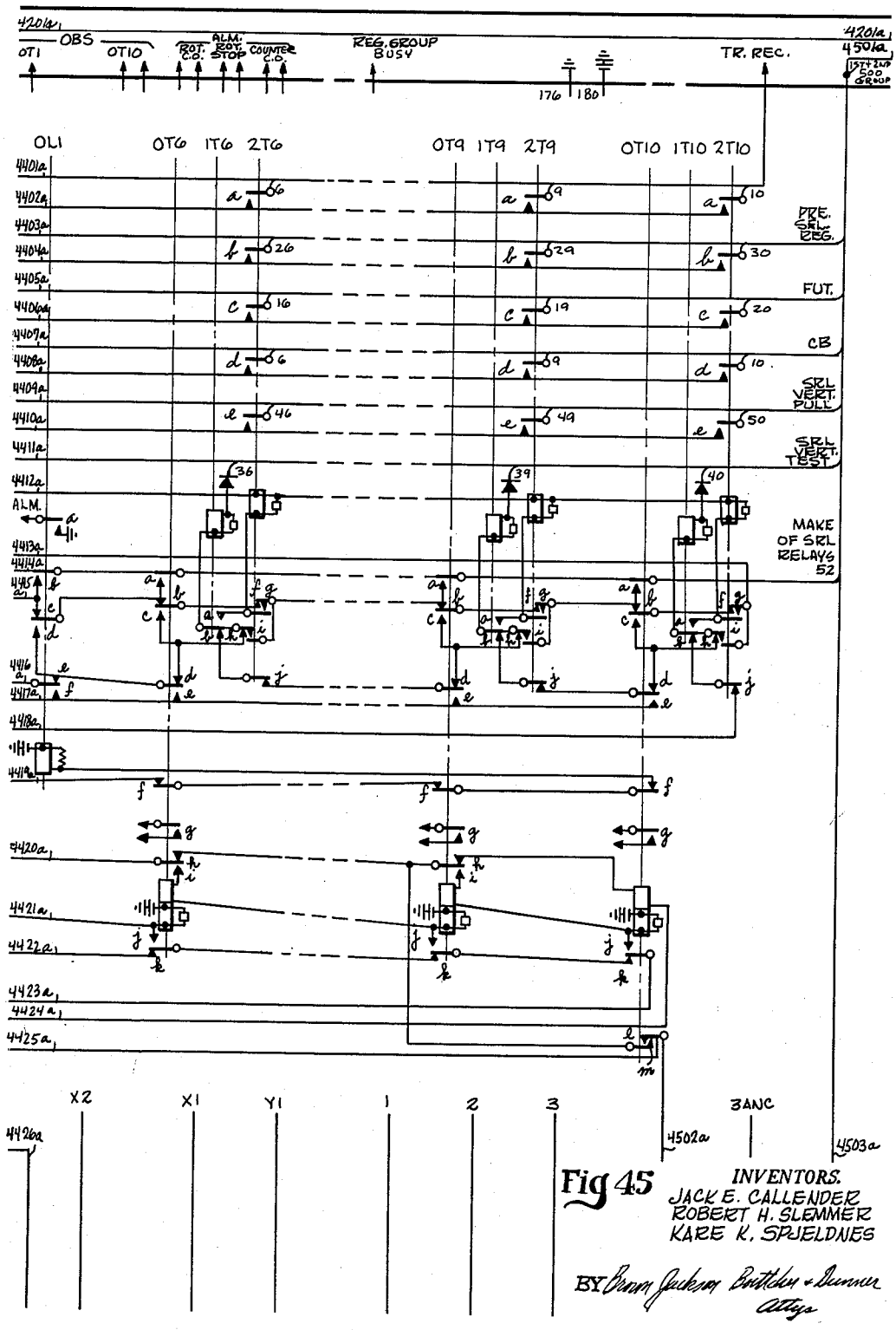


Fig 45

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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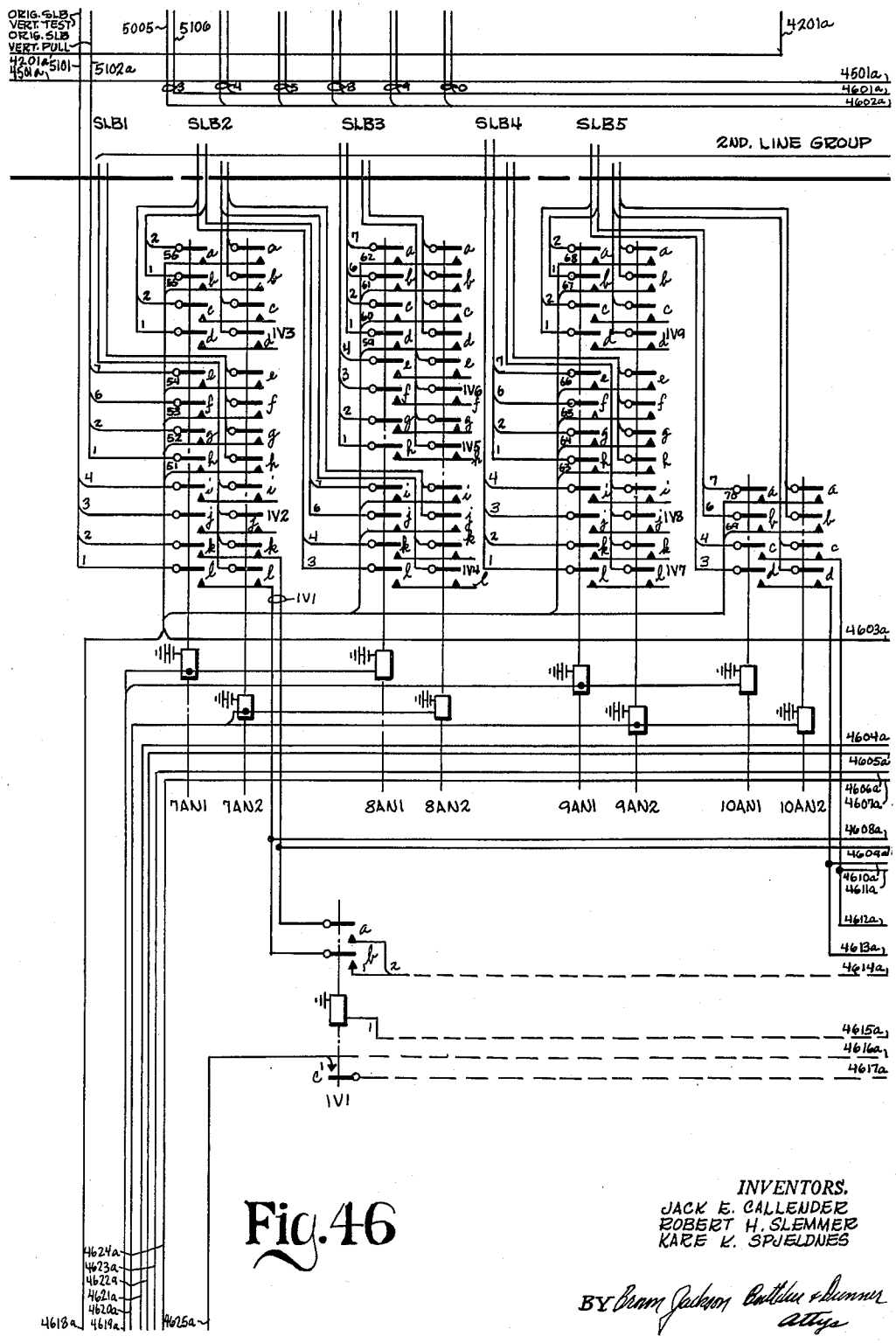


Fig. 46

INVENTORS.
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ROBERT H. SLEMMER
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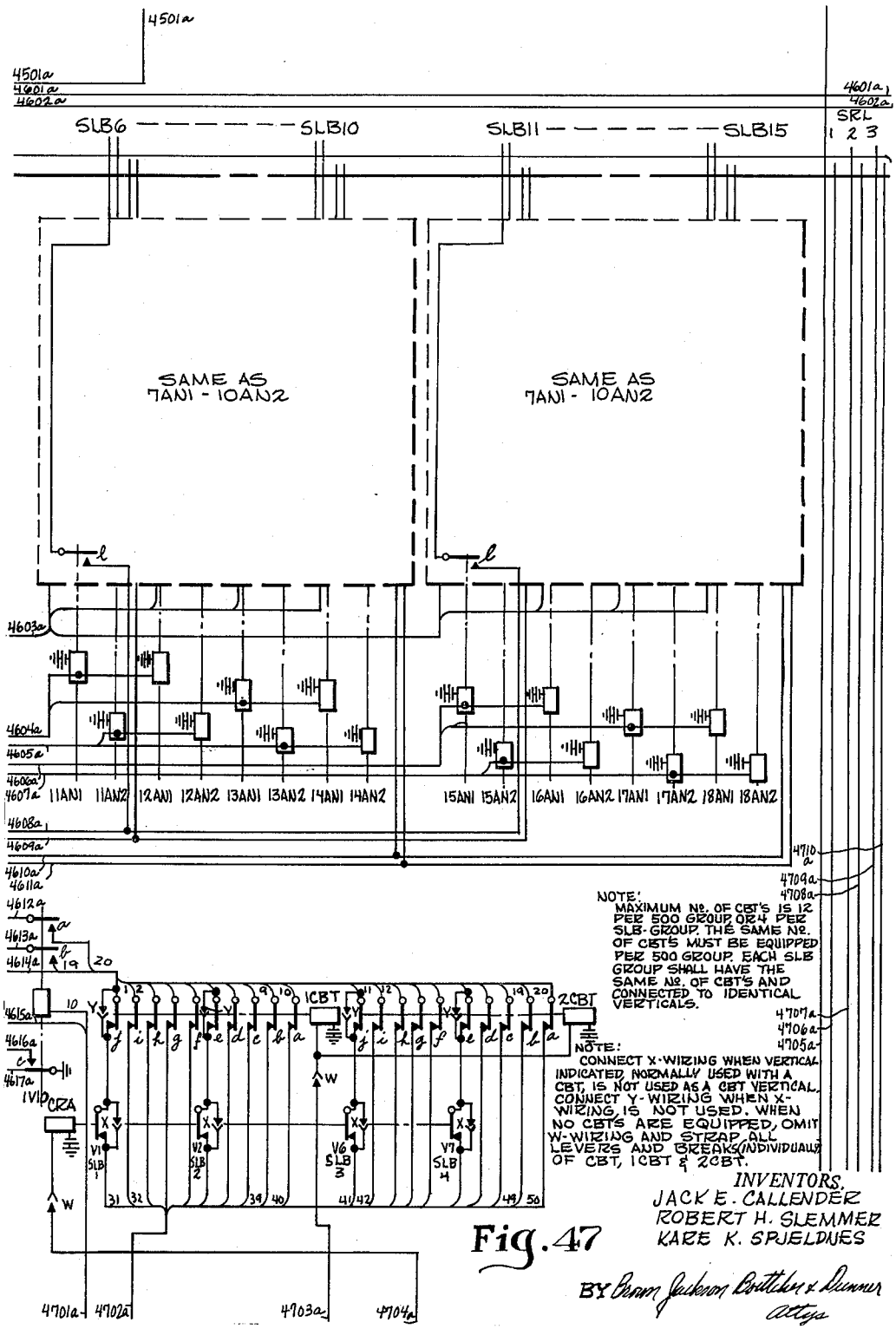


Fig. 47

INVENTORS,
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ROBERT H. SLEMMER
KARE K. SRJELDNES

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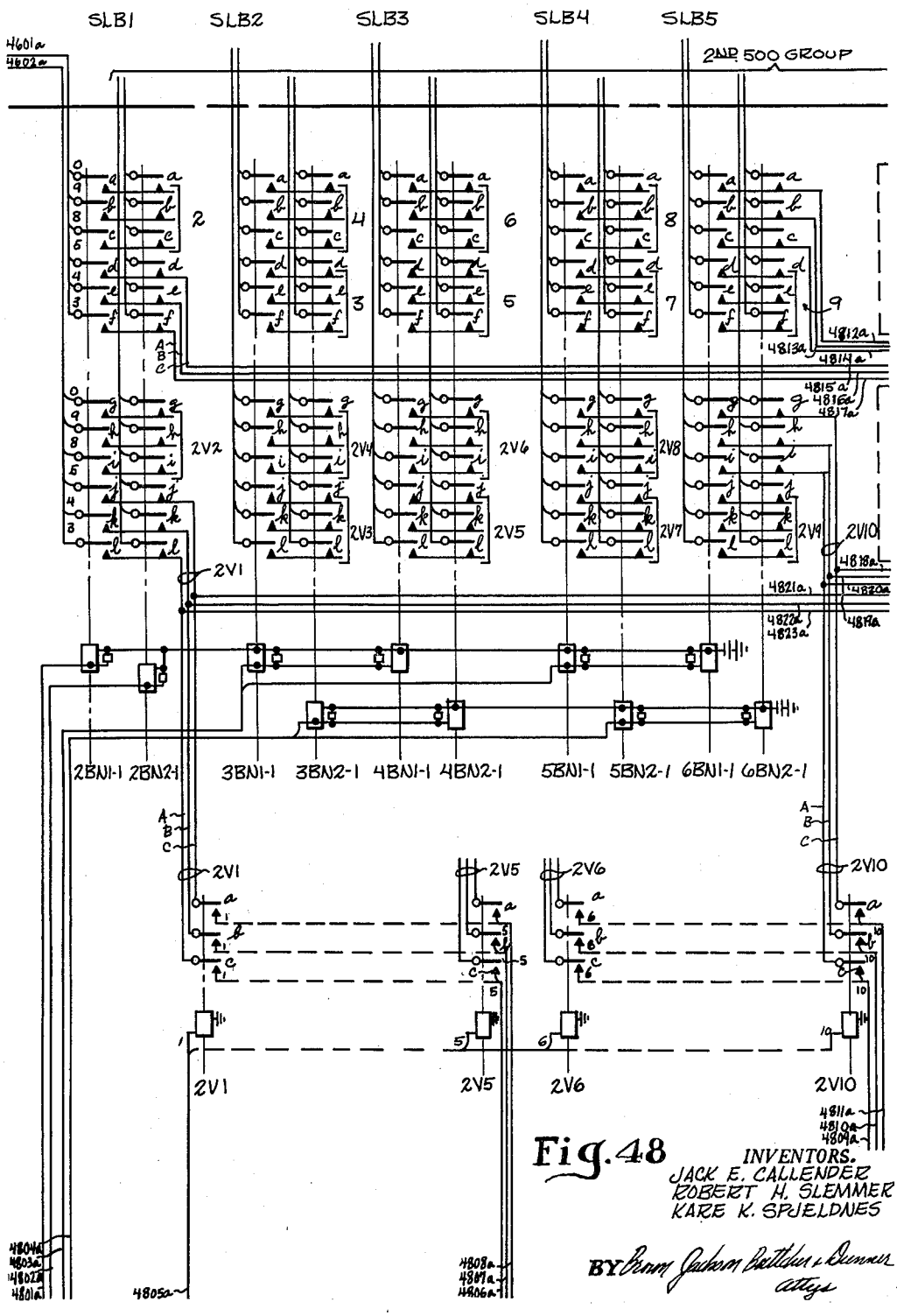


Fig. 48

INVENTORS.
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ROBERT H. SLEMMER
KARE K. SPJELDNES

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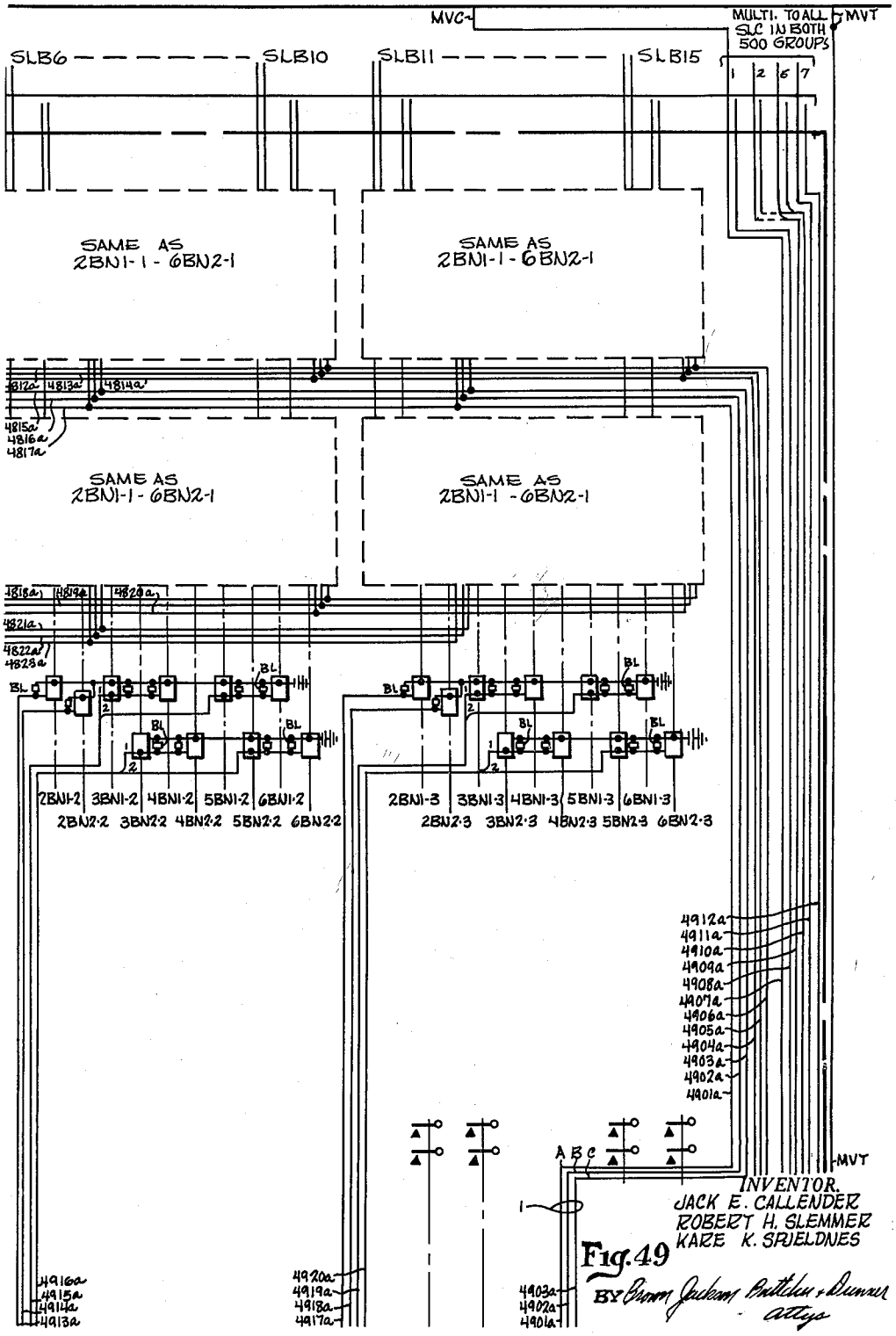


Fig. 49

INVENTOR.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SRIELDNES

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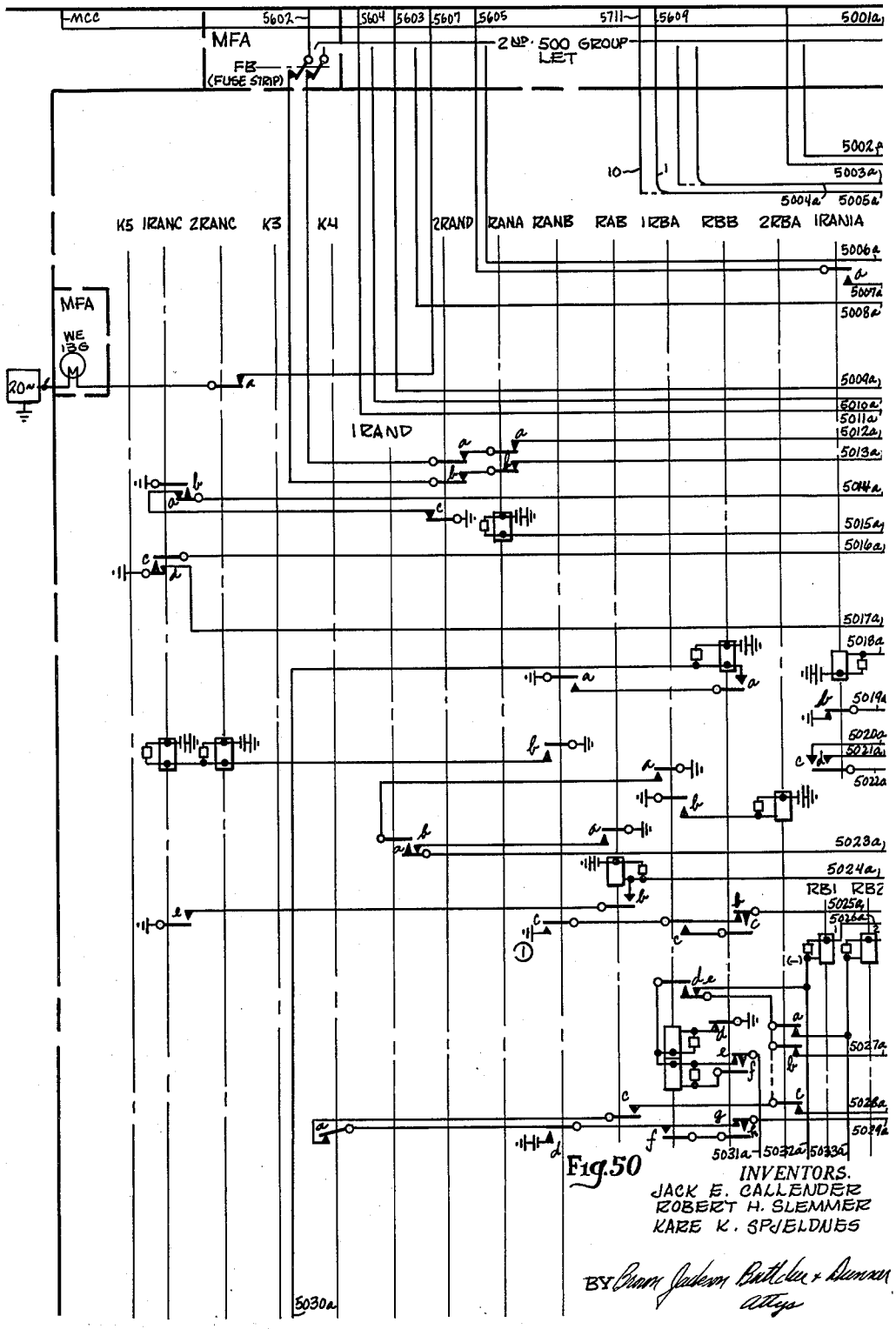


Fig. 50

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPIELDNES

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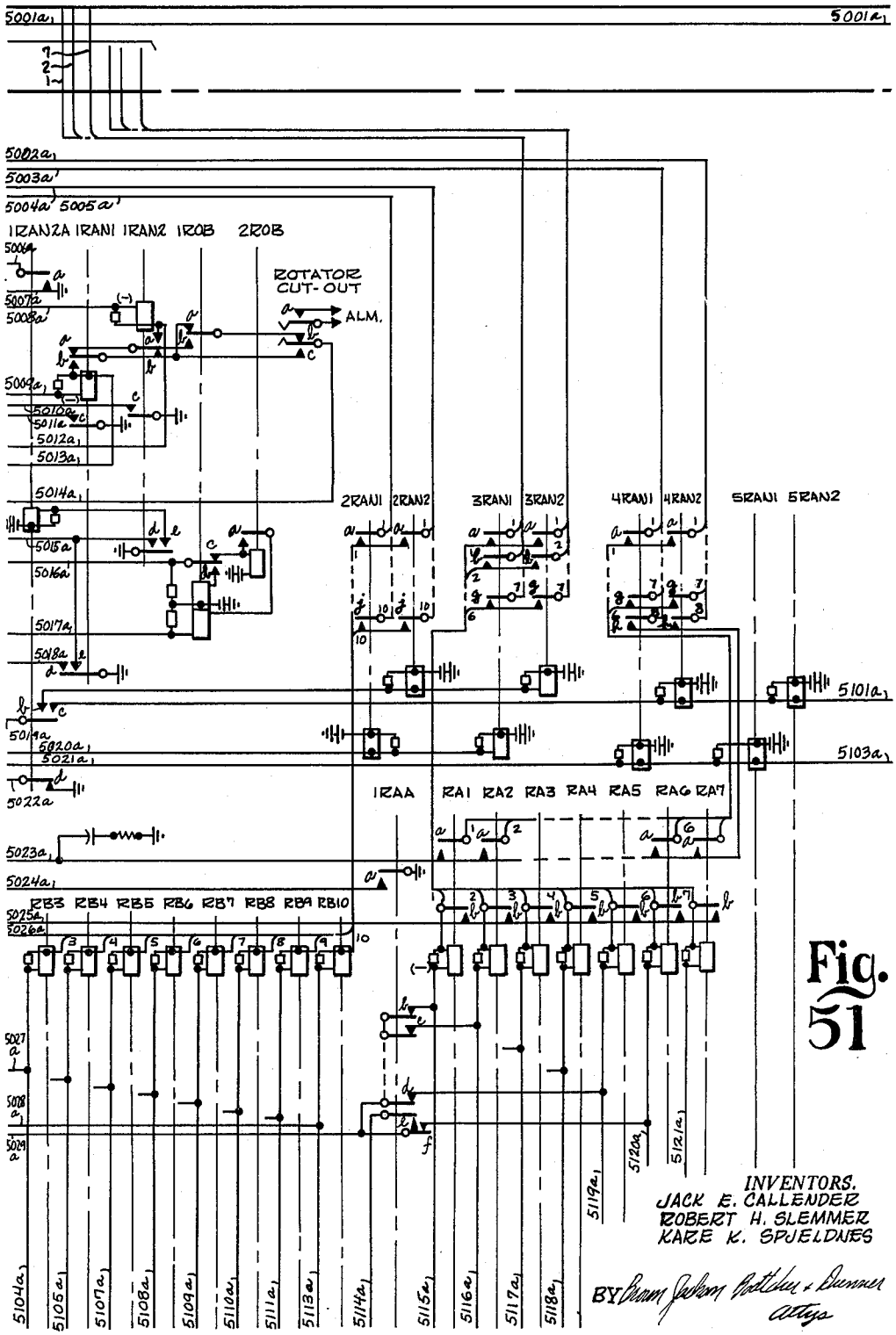


Fig. 51

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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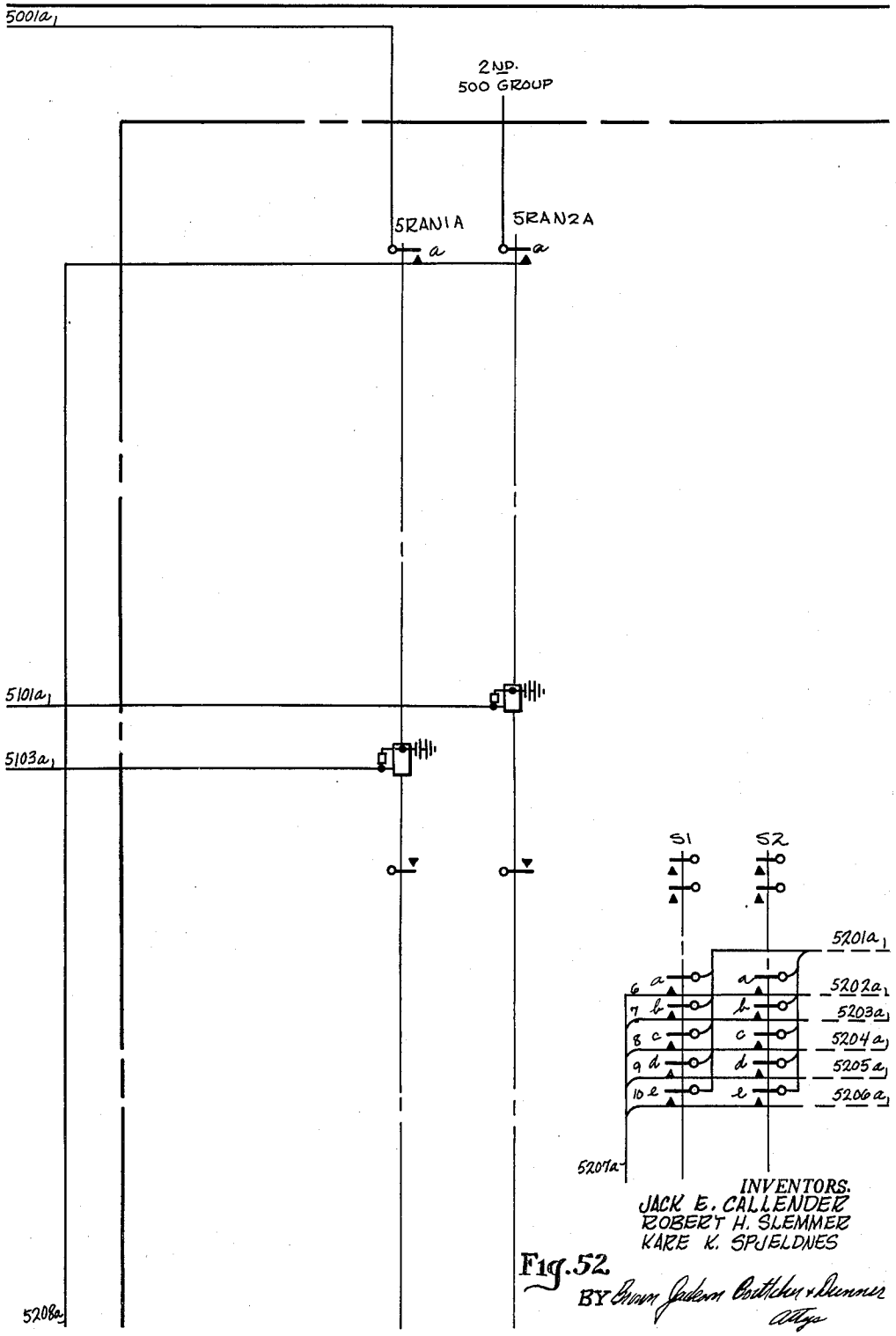


Fig. 52.

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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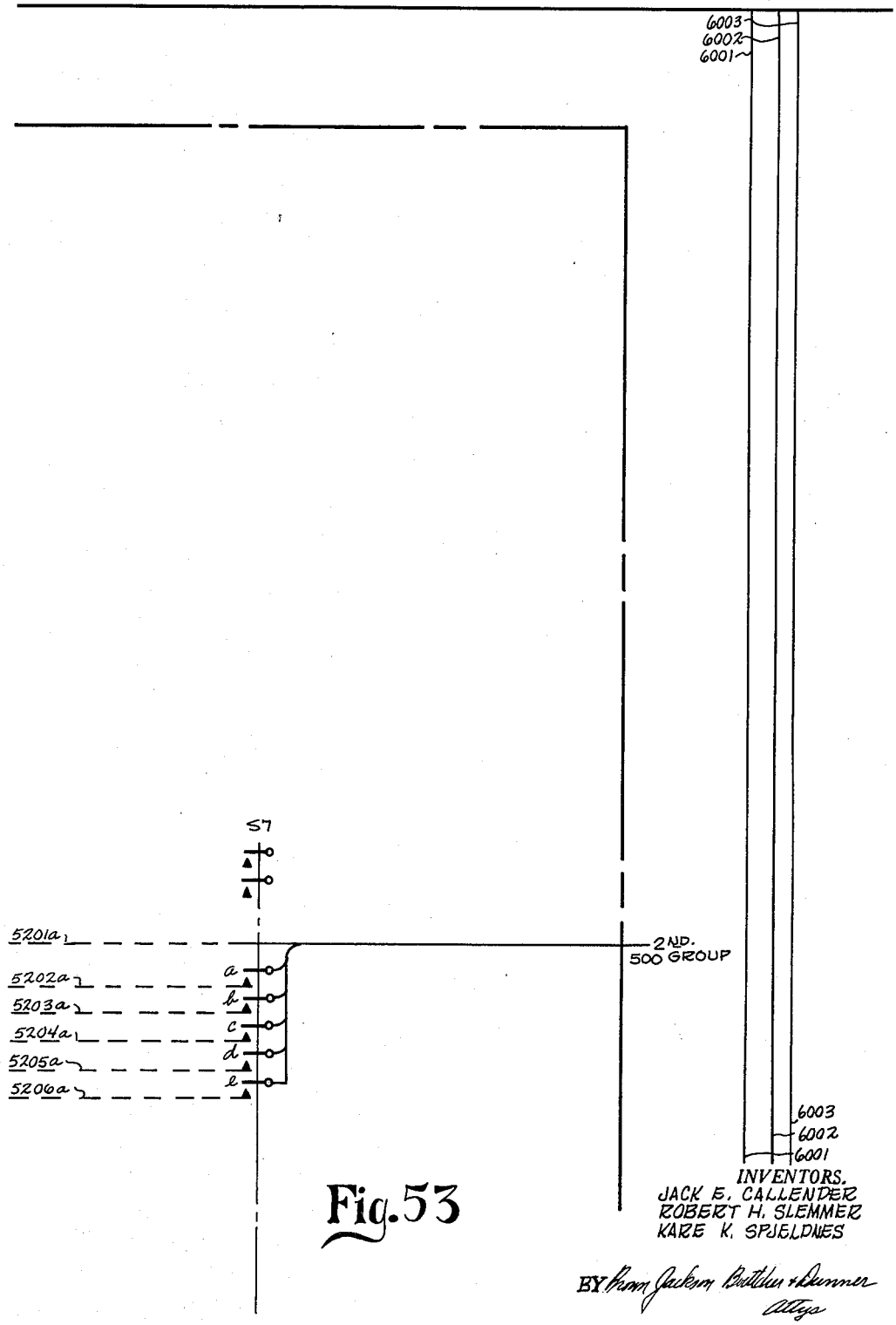


Fig. 53

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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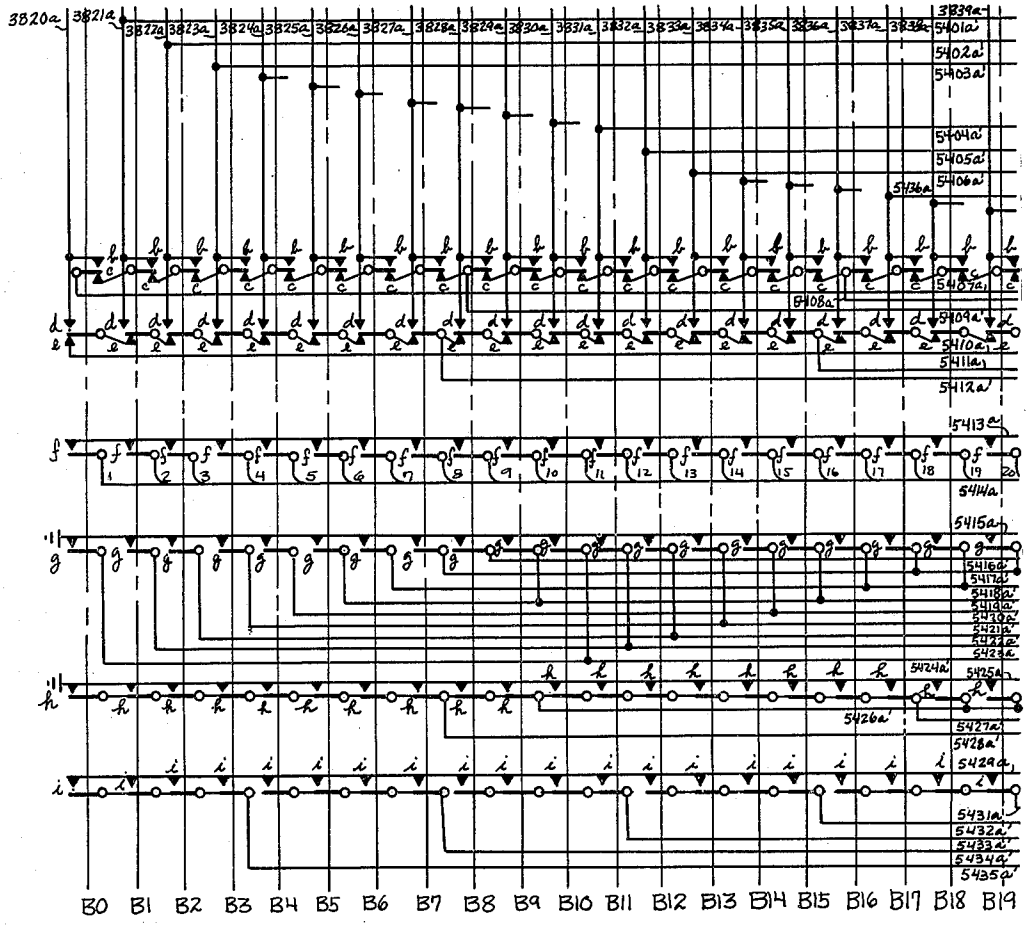


Fig. 54

INVENTORS.
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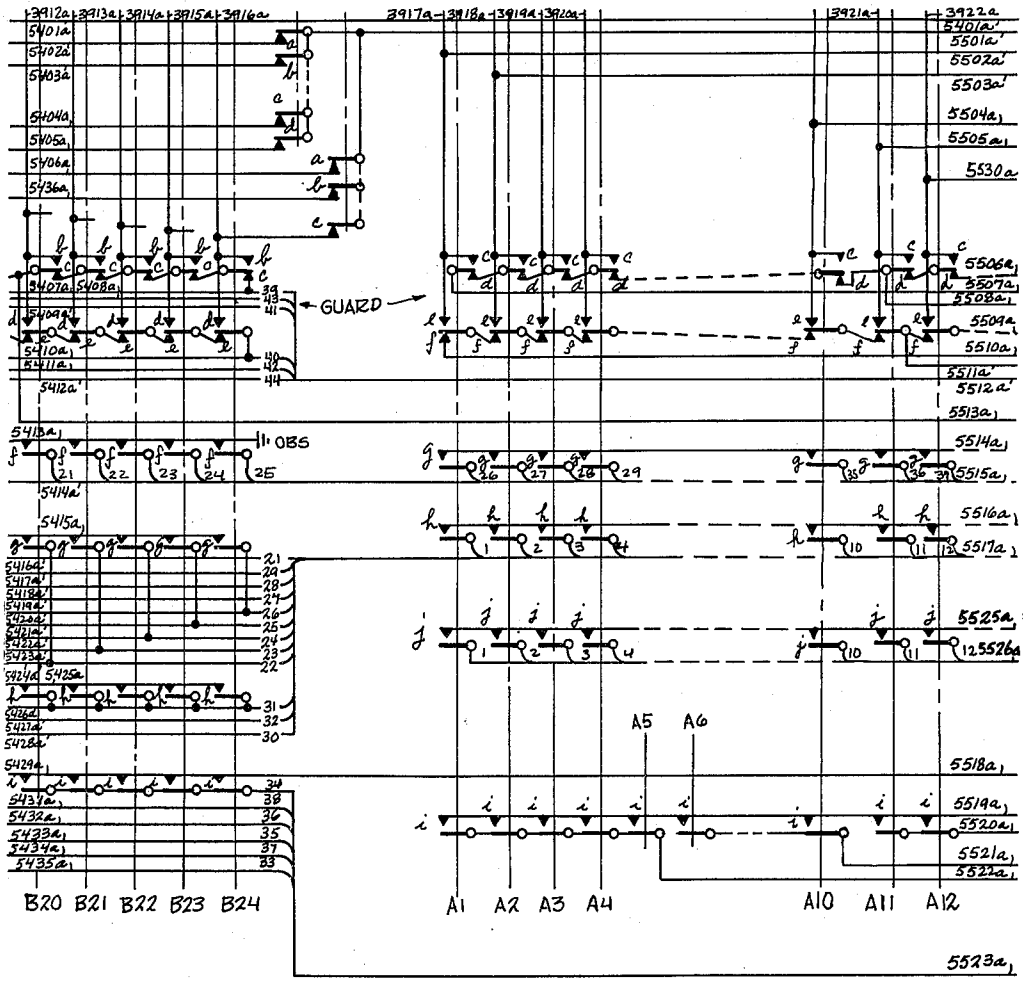


Fig. 55

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES
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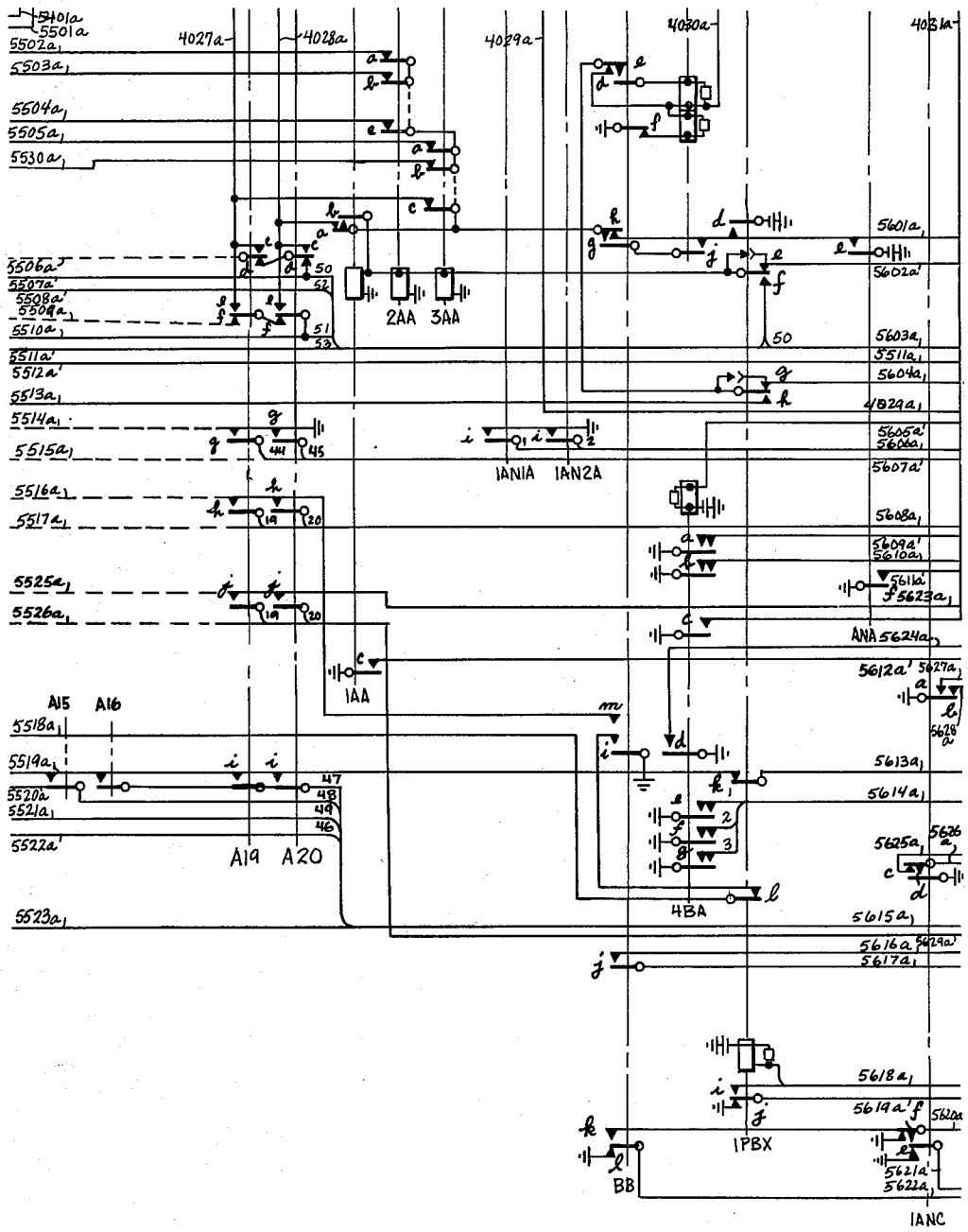


Fig. 56

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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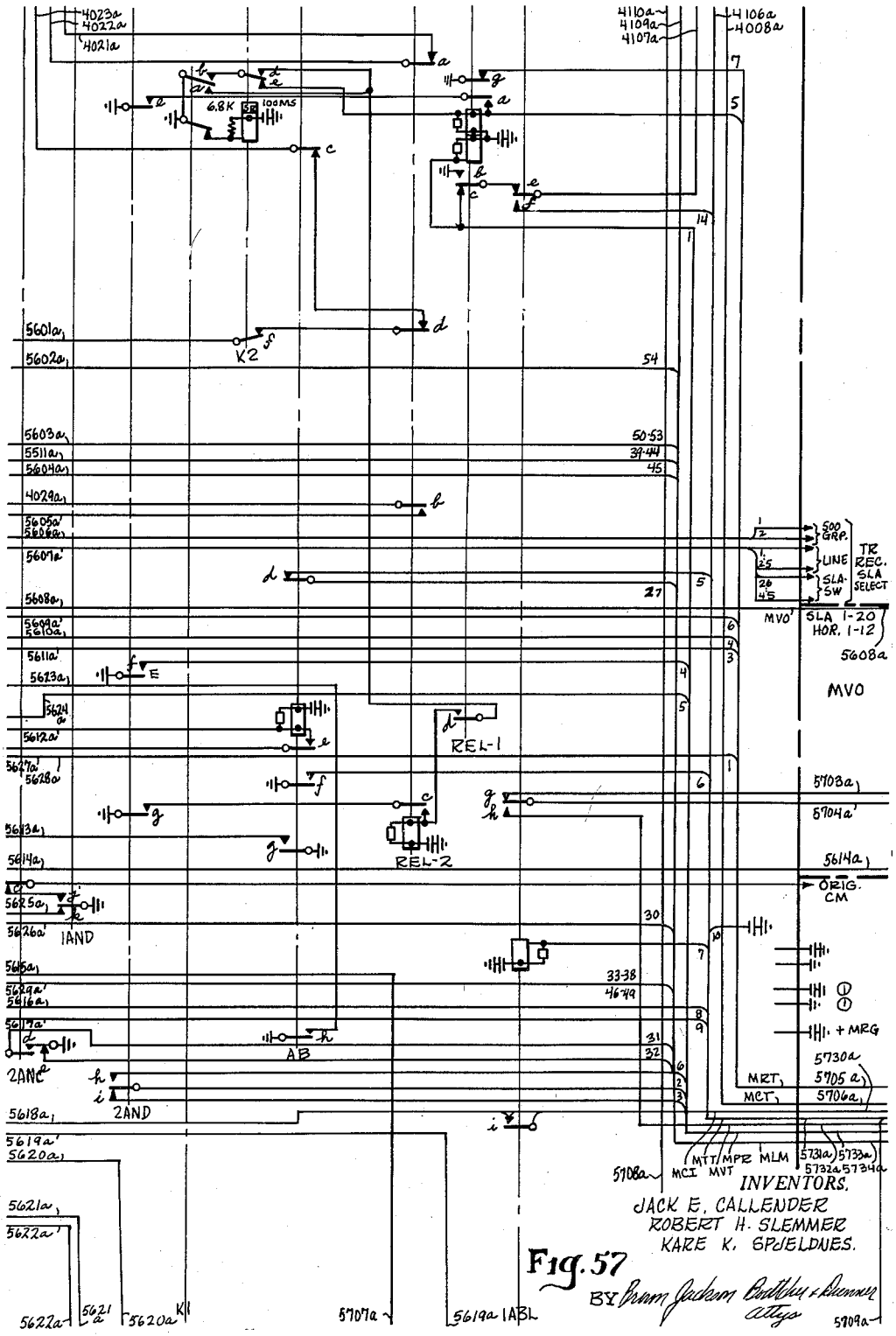


Fig. 57

INVENTORS.
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ROBERT H. SLEMMER
KARE K. GRJELDNES.

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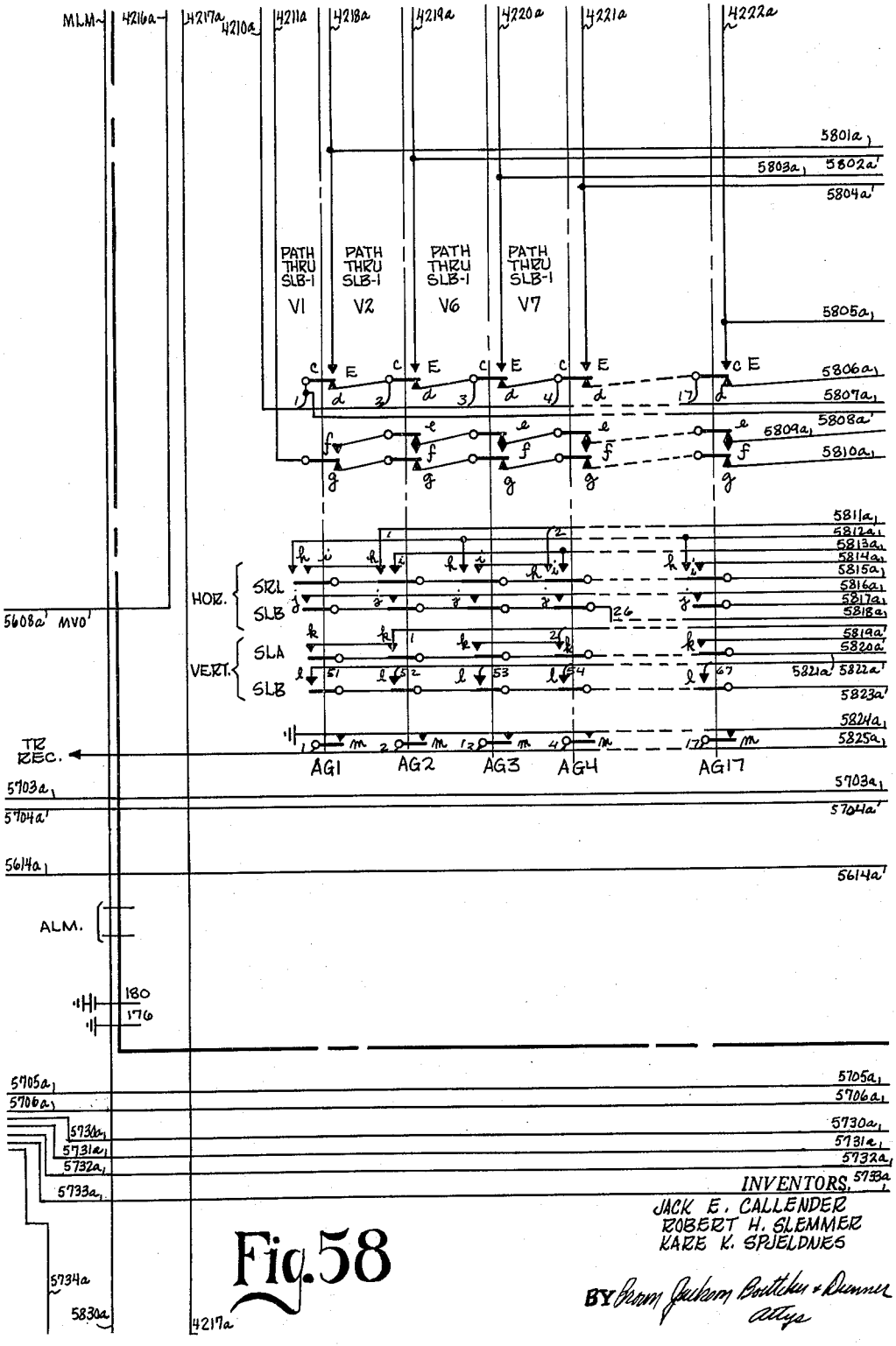


Fig. 58

INVENTORS,
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KARE K. SPJELDNES

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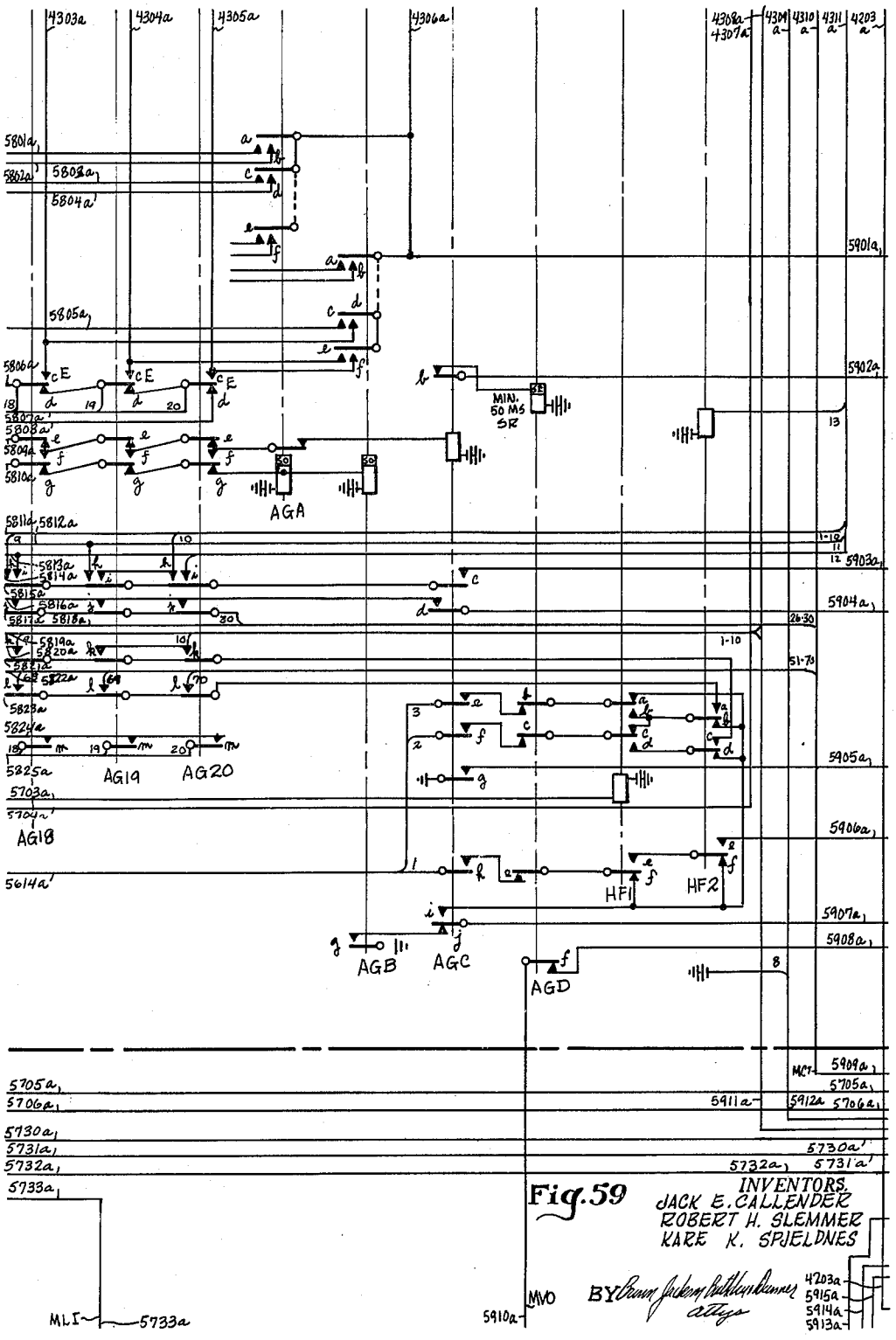


Fig. 59

INVENTORS
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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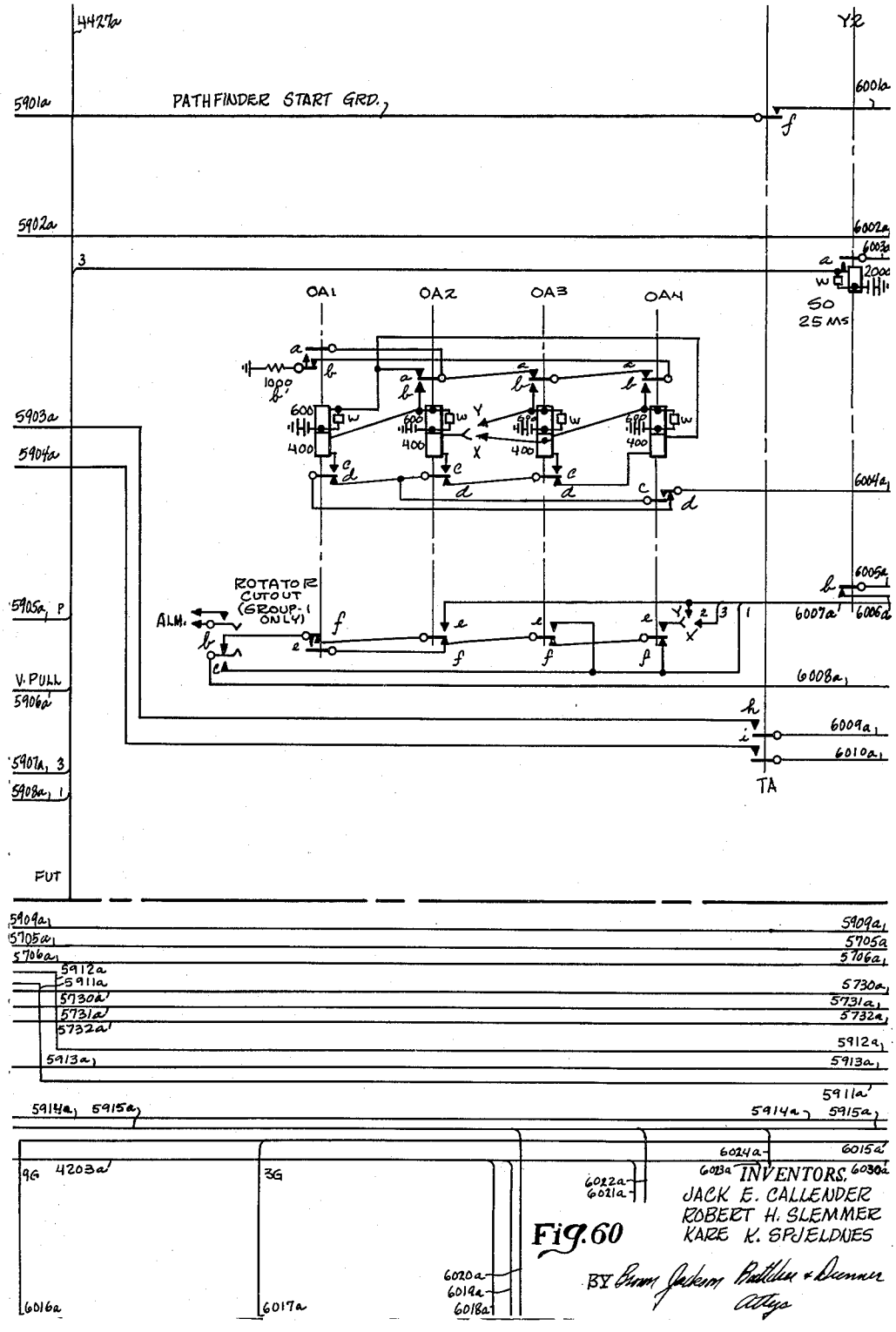


Fig. 60

INVENTORS,
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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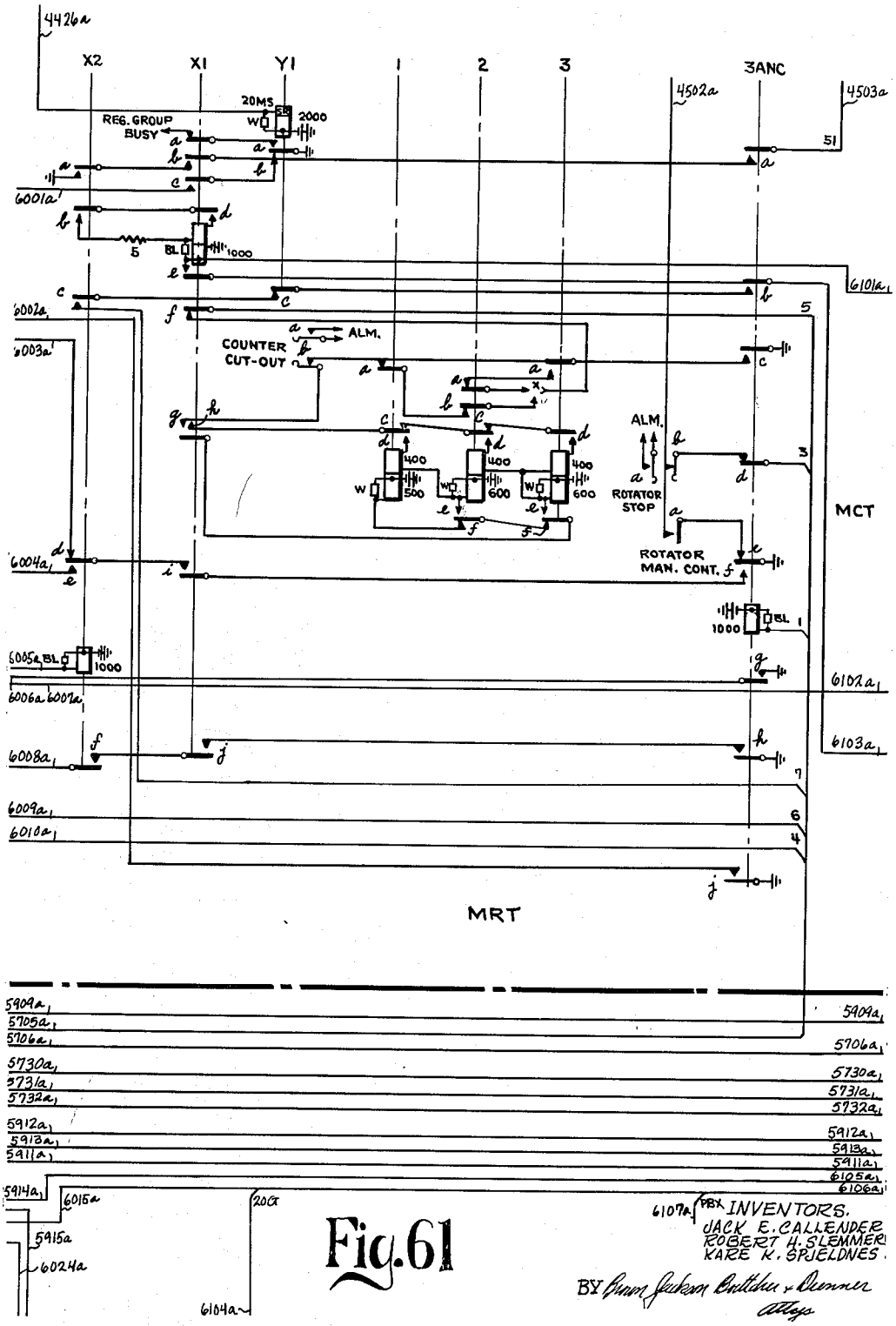


Fig.61

INVENTORS.
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ROBERT H. SLEMMER
KARE K. SPJELDNES

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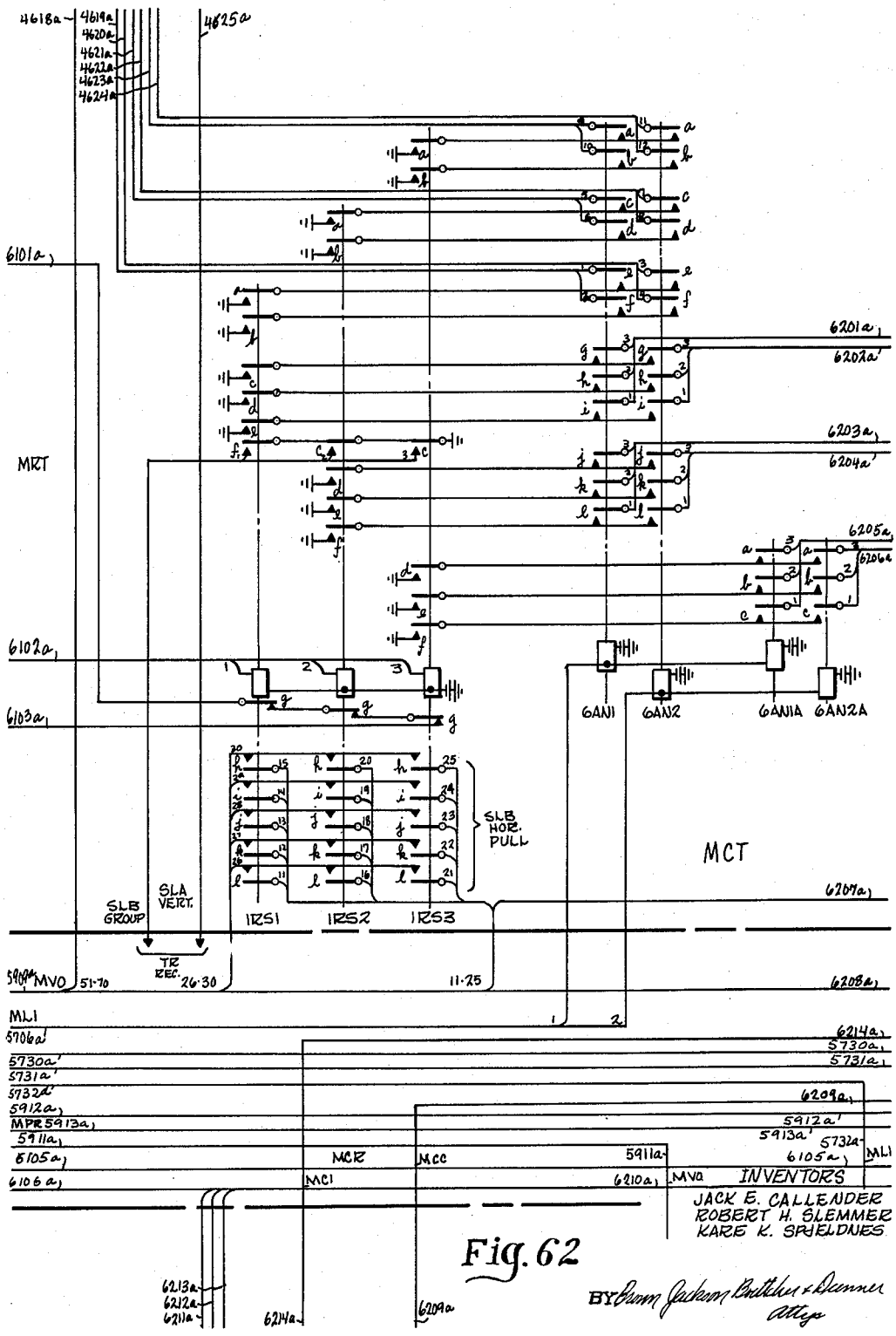


Fig. 62

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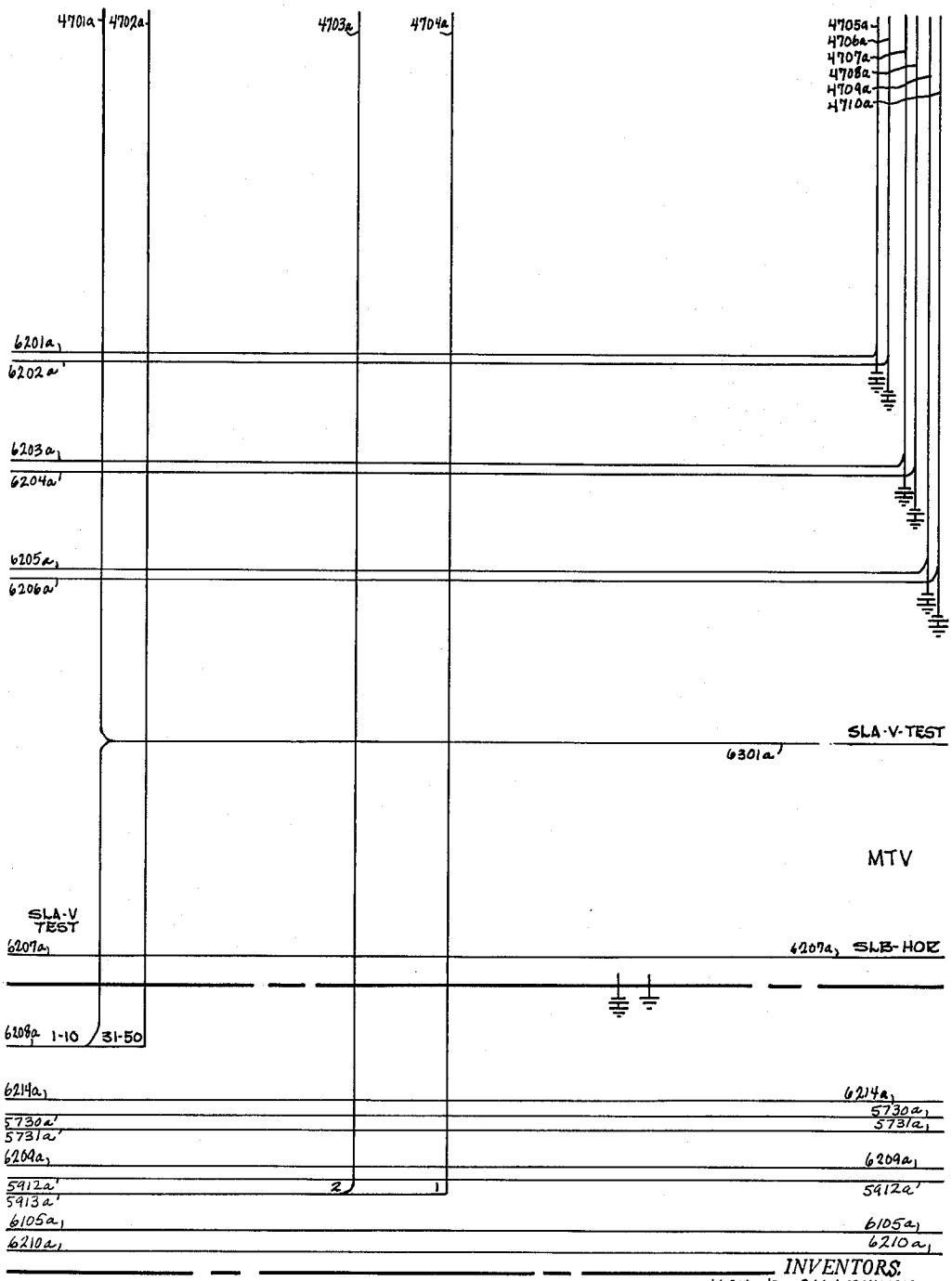


Fig. 63

INVENTORS.
JACK E. CALLENDER
ROBERT H. SLEMMER
KARE K. SPJELDNES

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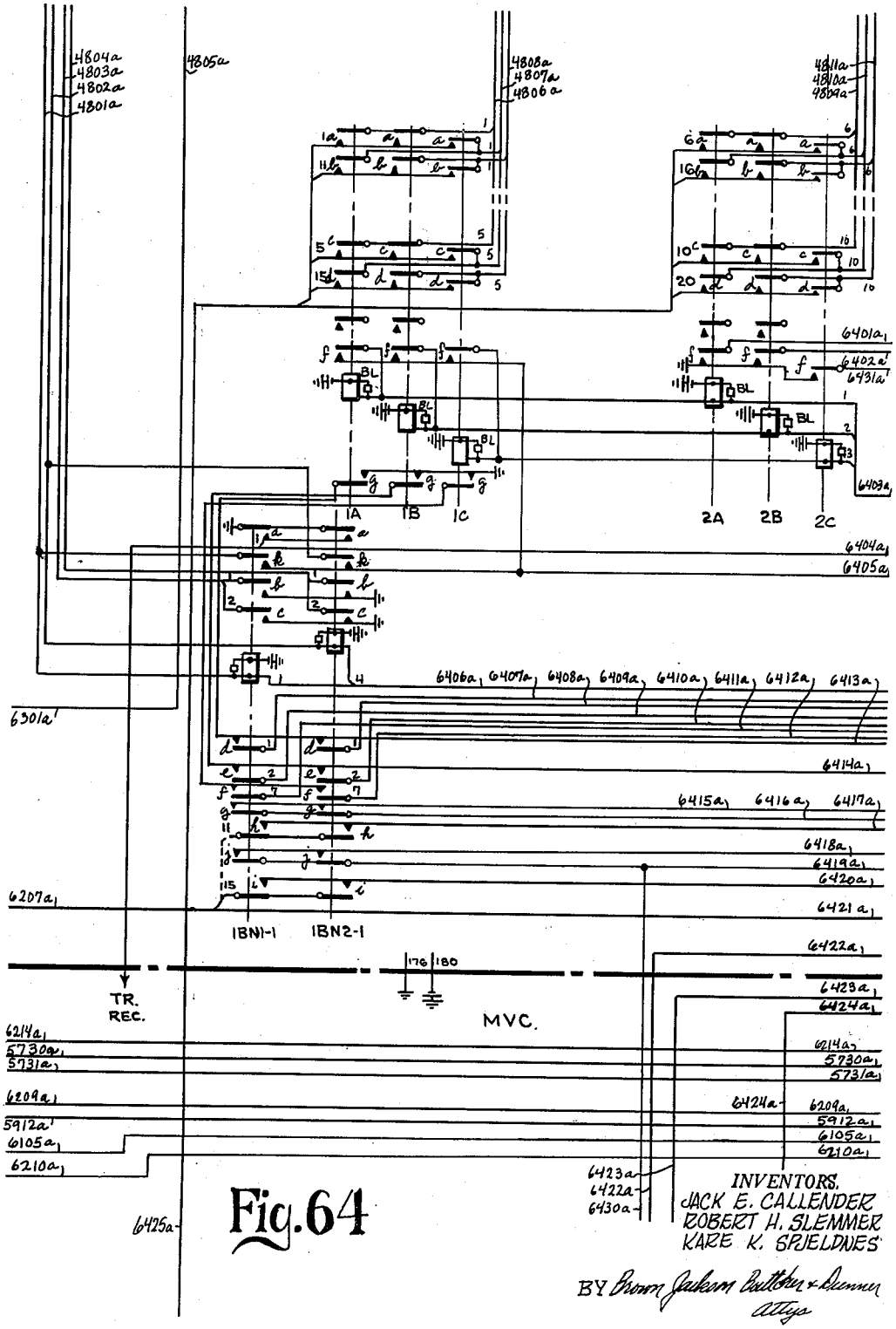


Fig. 64

INVENTORS.
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ROBERT H. SLEMMER
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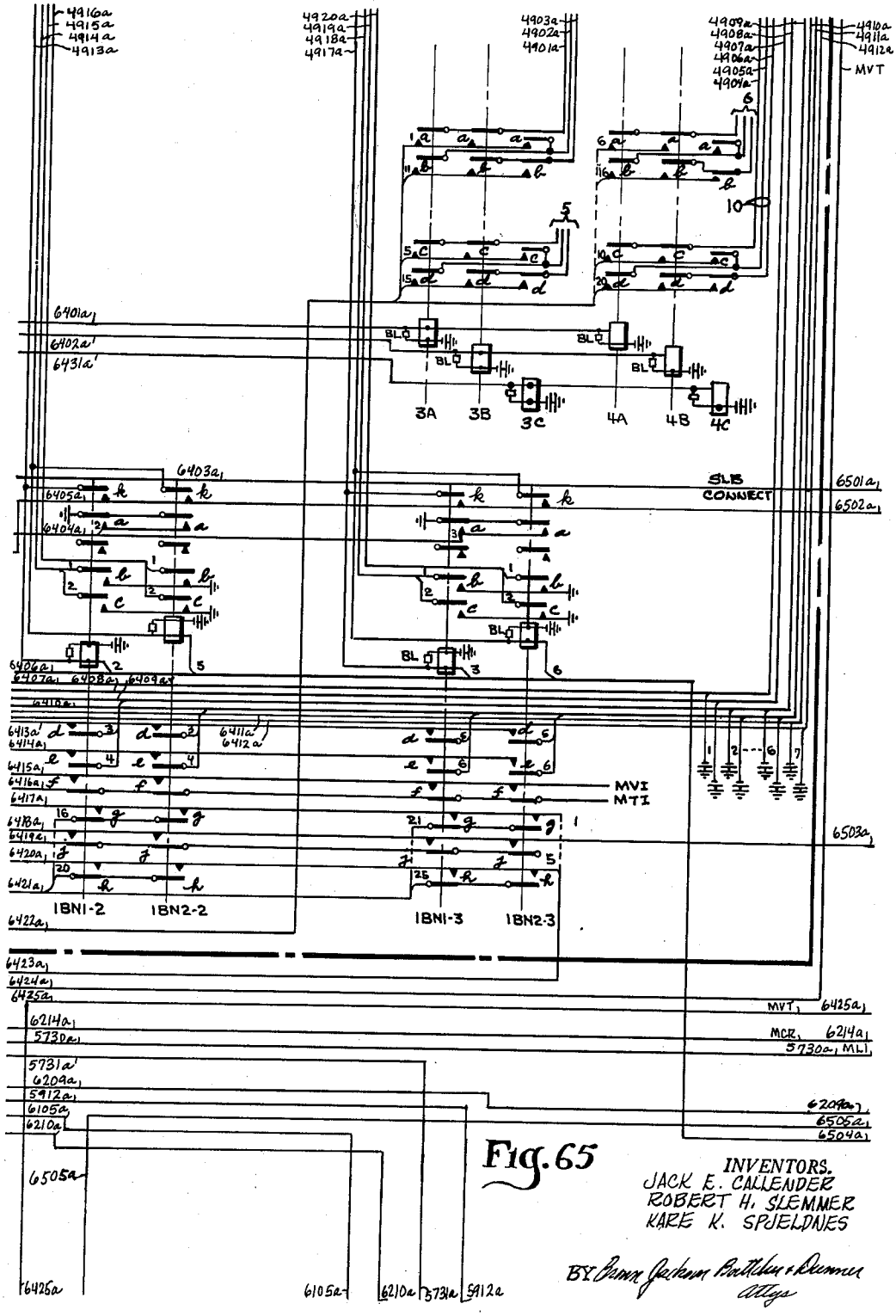


FIG. 65

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Oct. 31, 1961 J. E. CALLENDER ET AL 3,007,006

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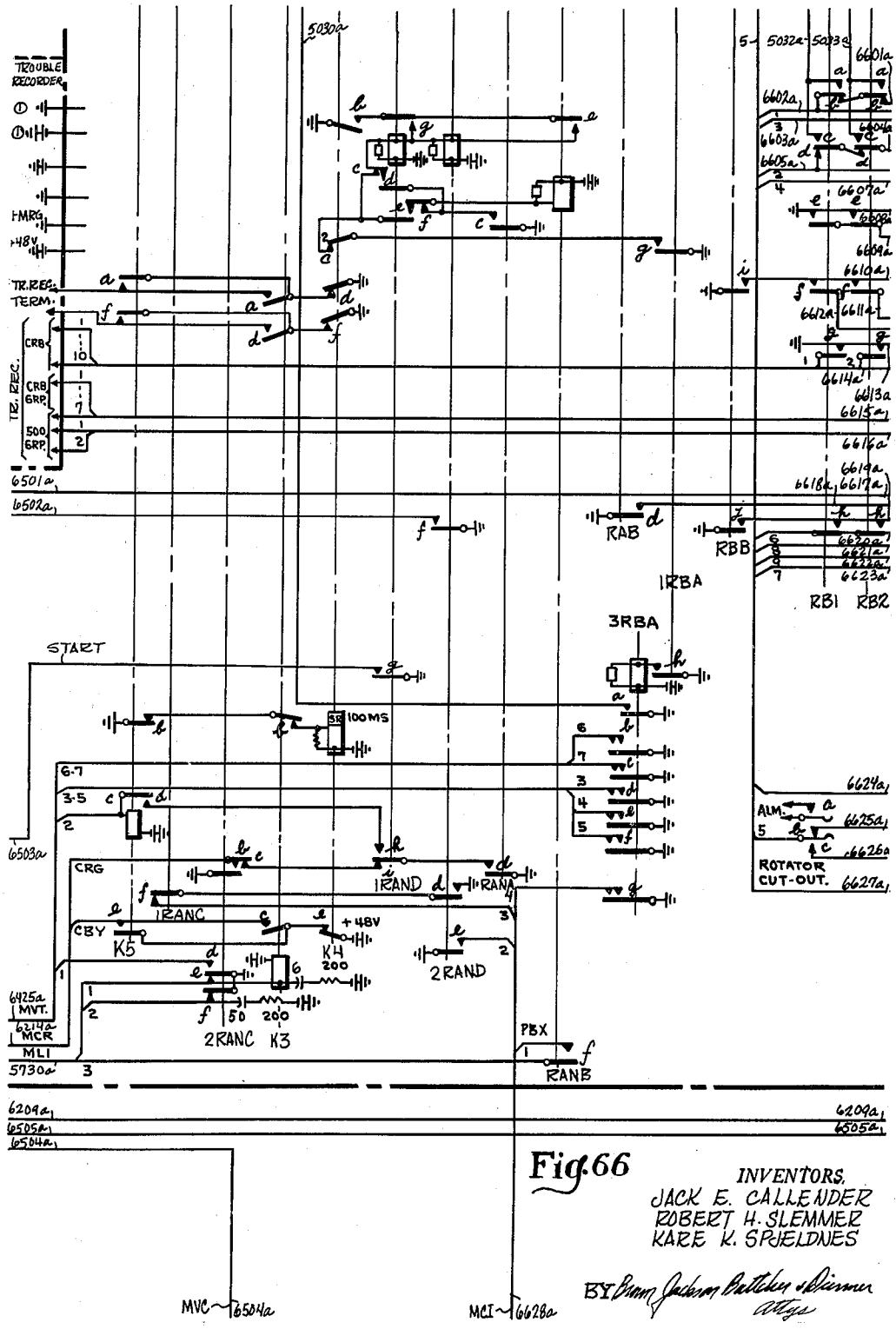


Fig. 66

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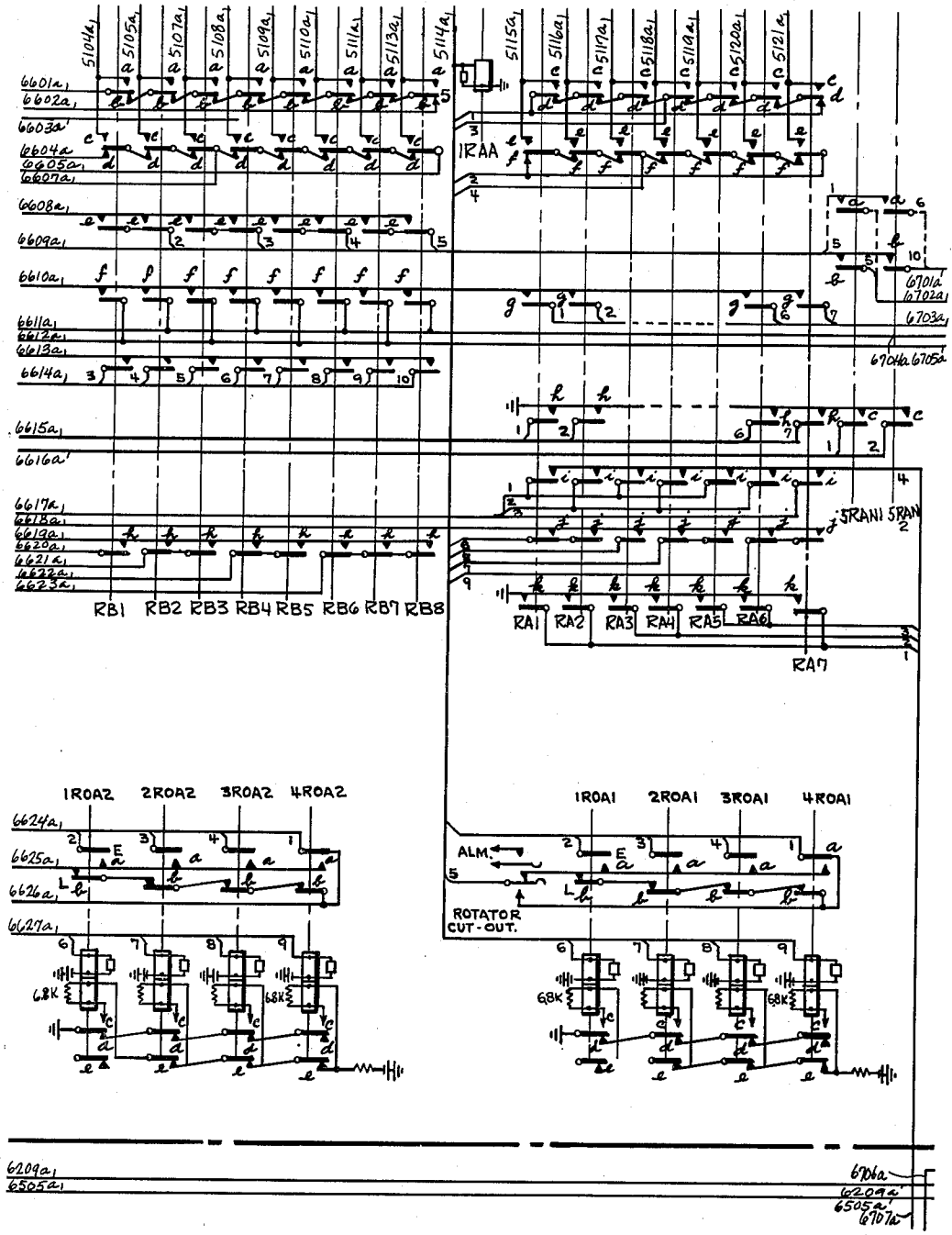


Fig. 67

INVENTORS.
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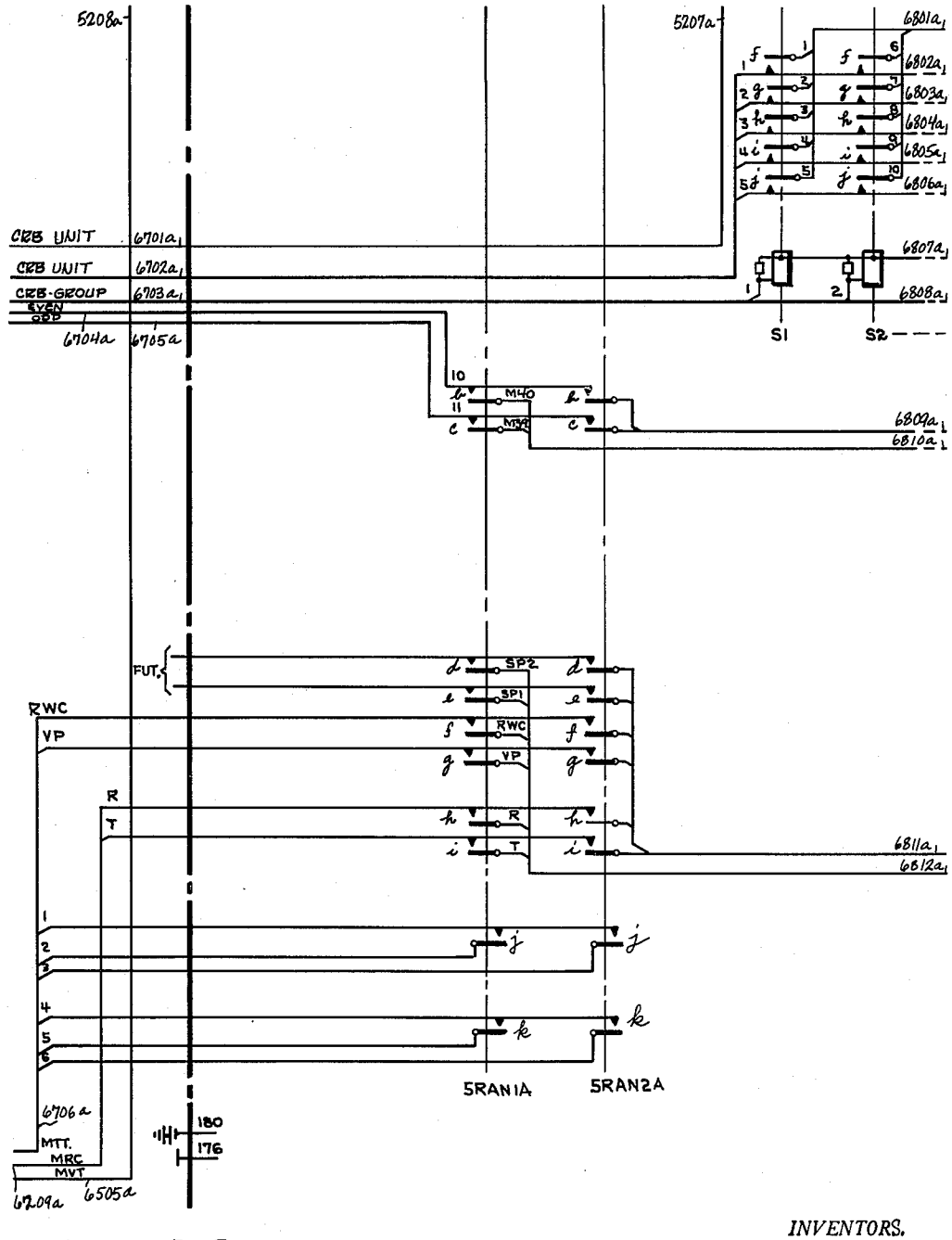


Fig. 68

INVENTORS.
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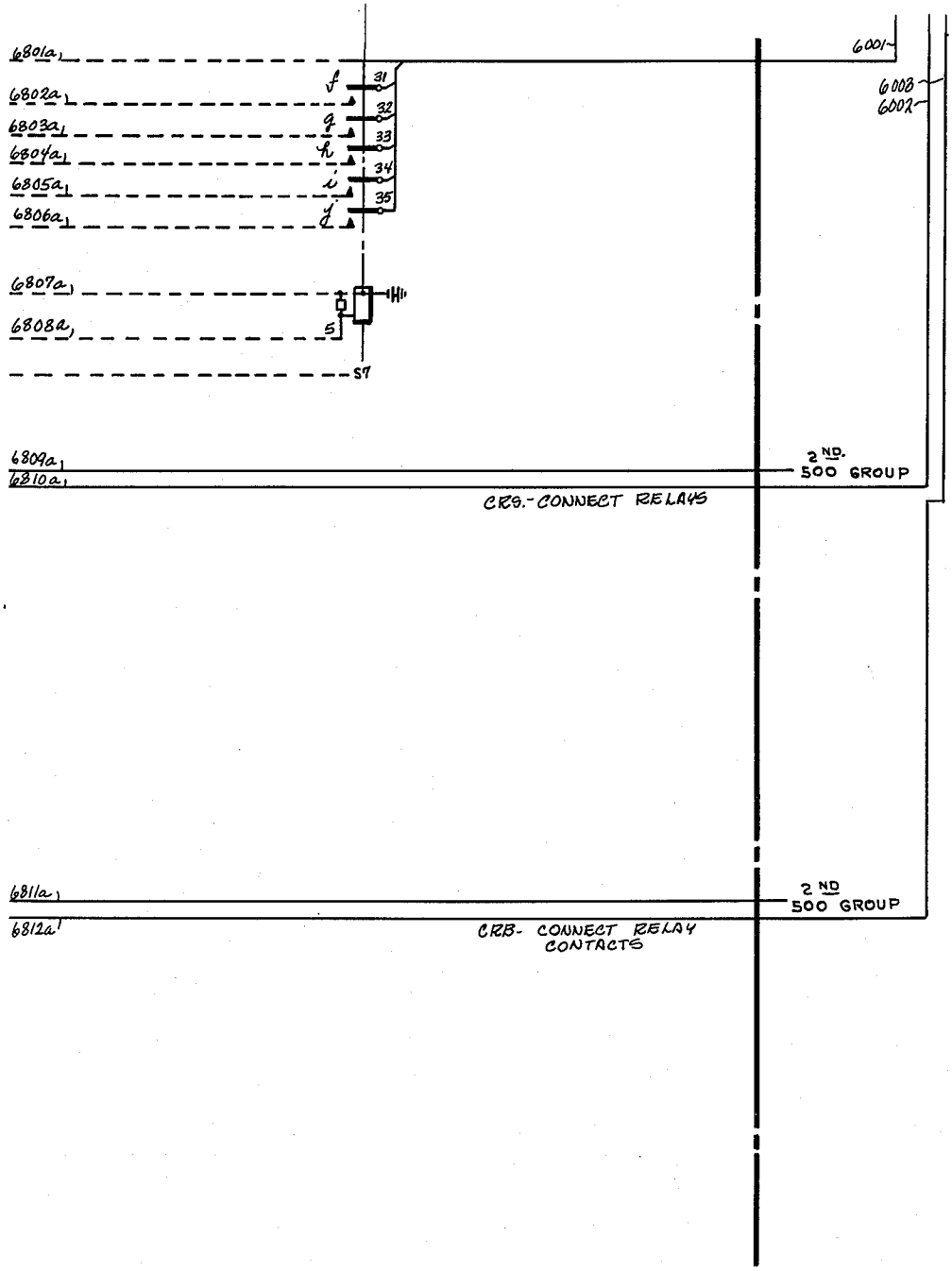


Fig. 69

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Oct. 31, 1961 J. E. CALLENDER ET AL 3,007,006

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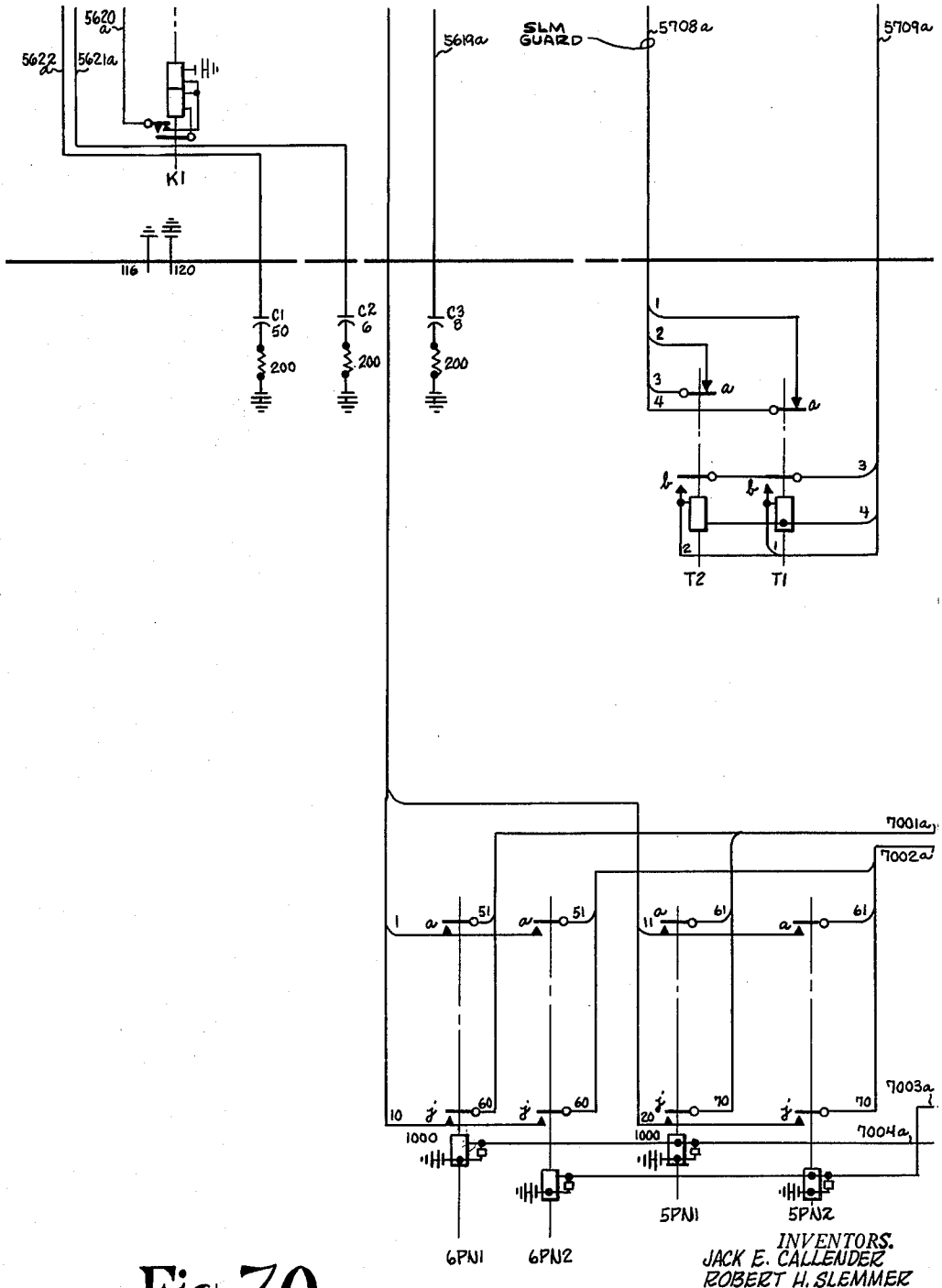


Fig. 70

INVENTORS.
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AUTOMATIC TELEPHONE SYSTEM

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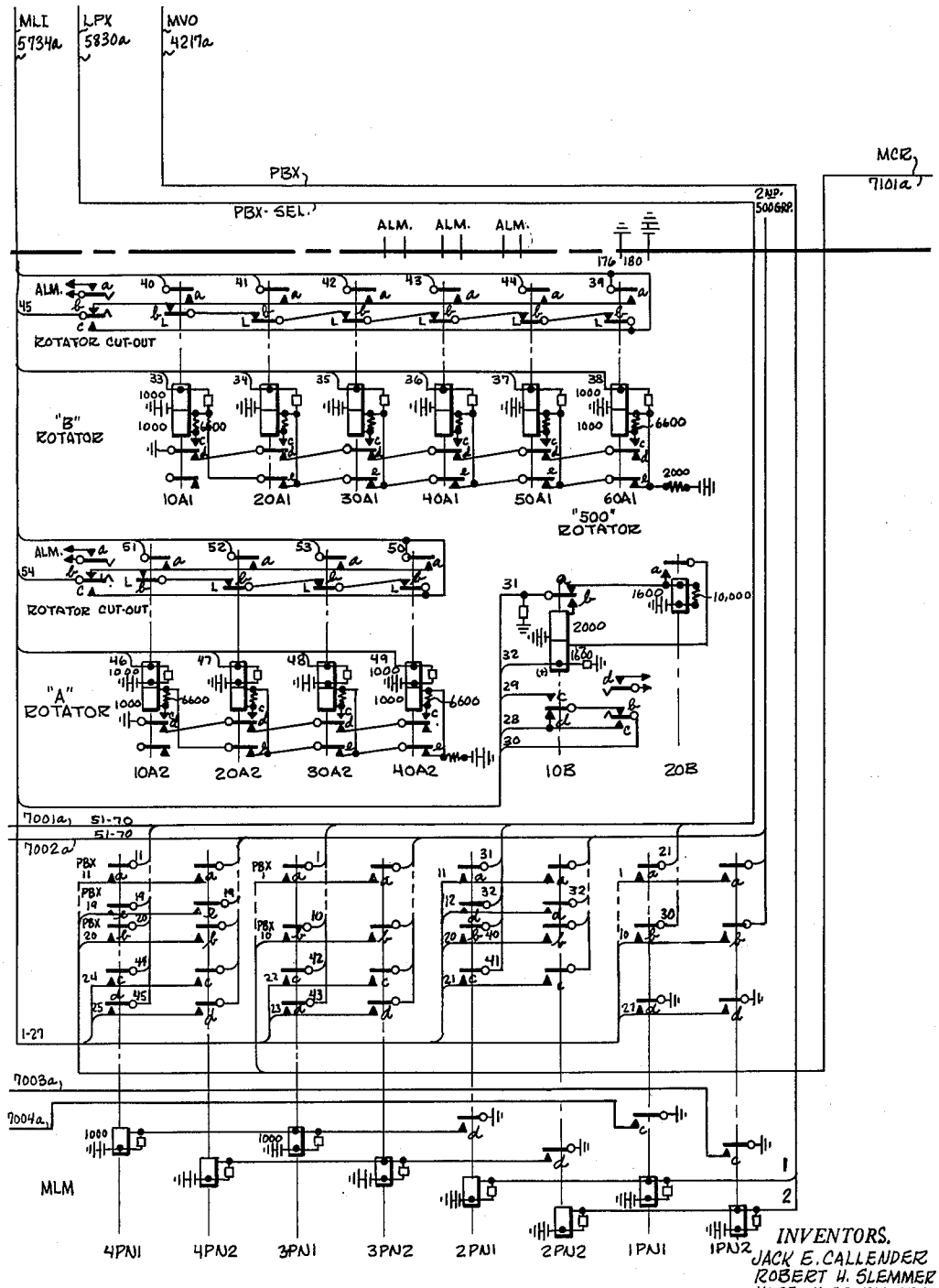


Fig. 71

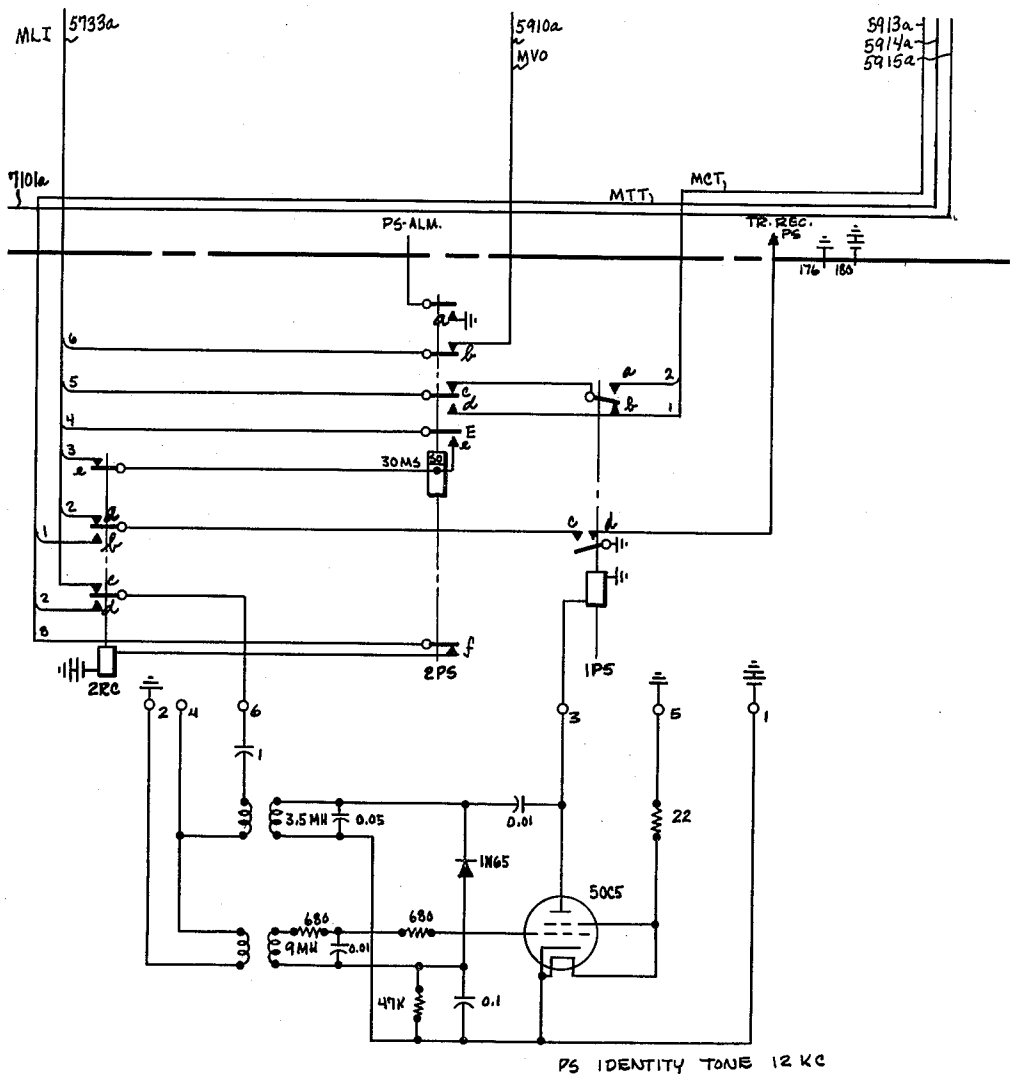
INVENTORS.
JACK E. CALLENDER
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MPR

Fig. 72

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Oct. 31, 1961 J. E. CALLENDER ET AL 3,007,006

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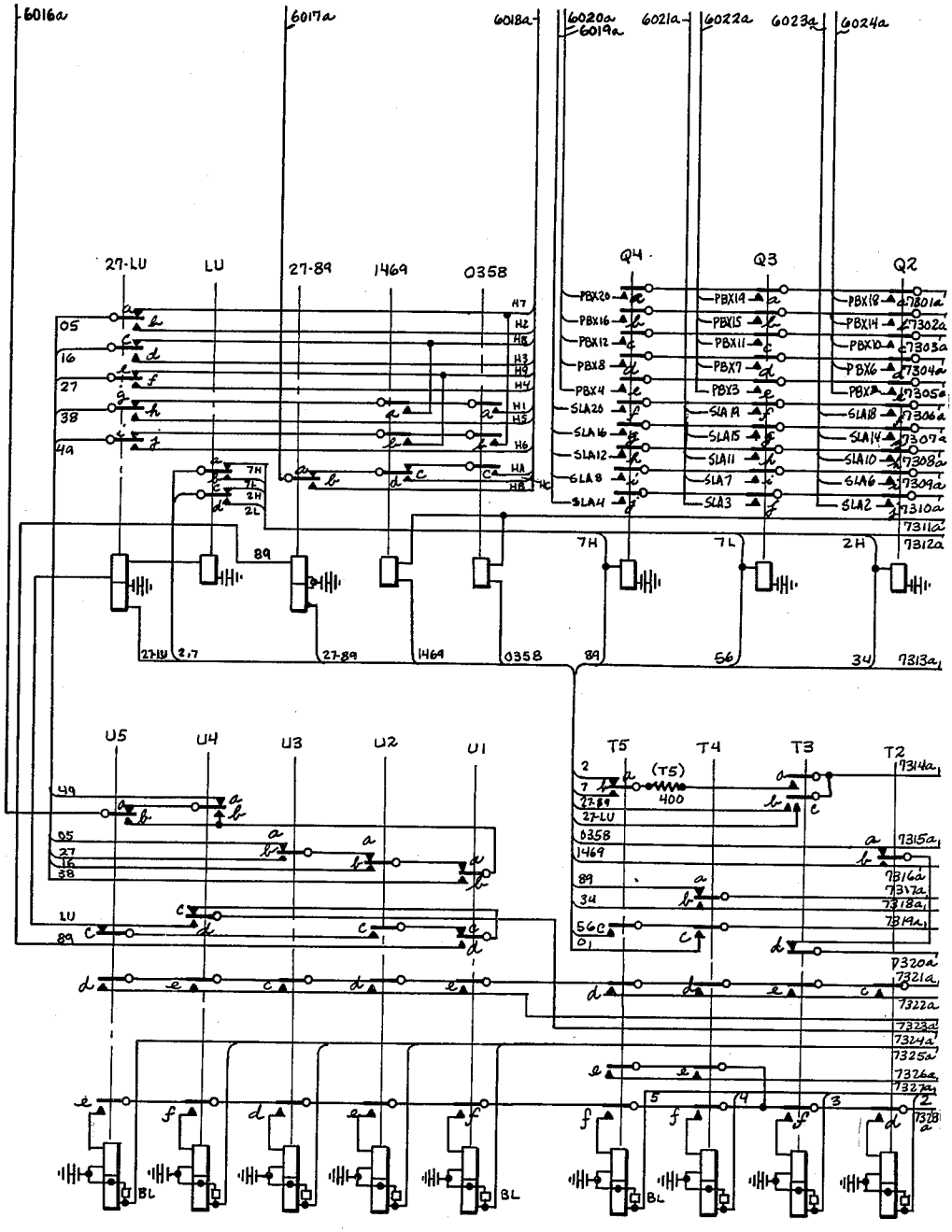


Fig. 73

INVENTORS.
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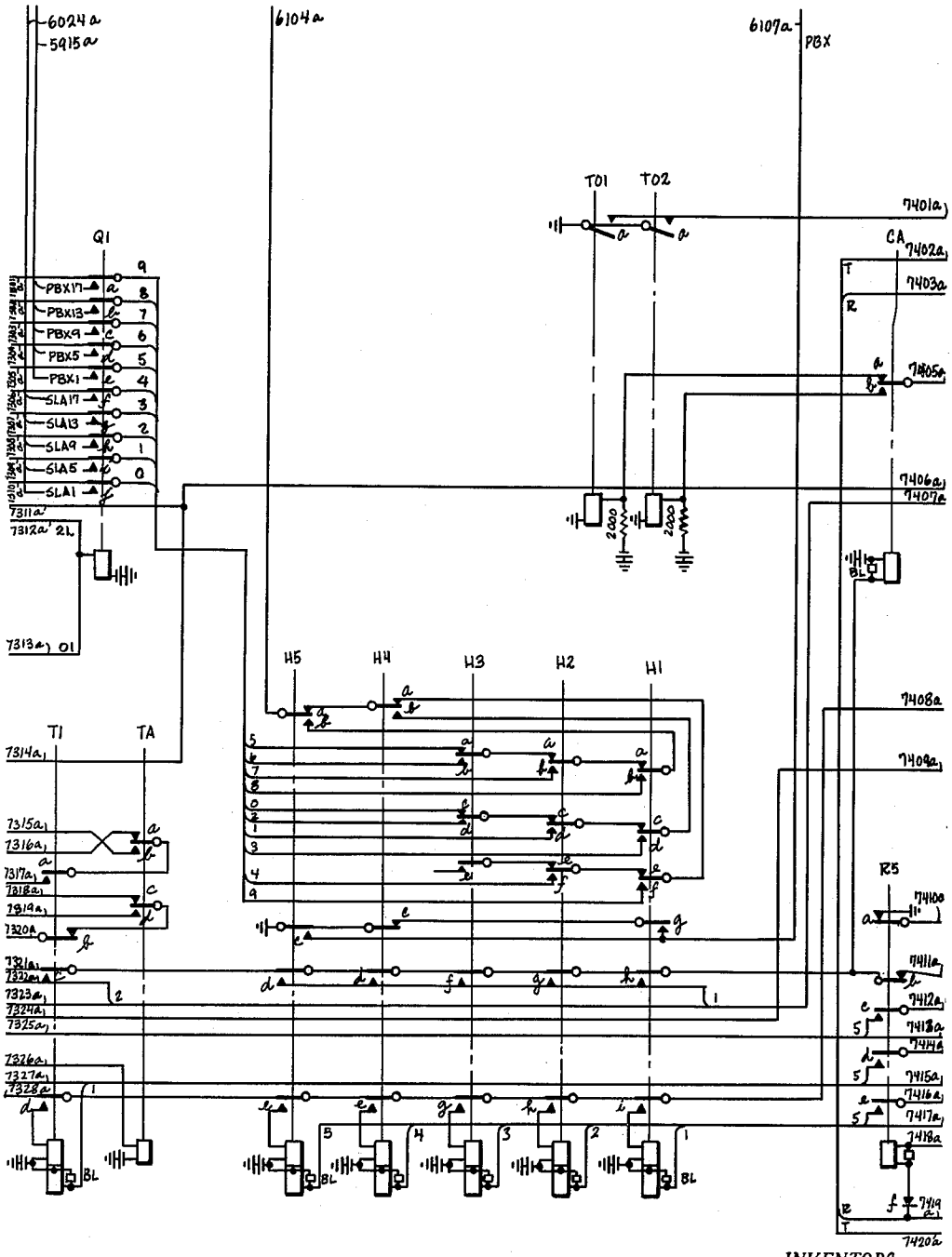


Fig. 74

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Filed Jan. 27, 1956 83 Sheets-Sheet 76

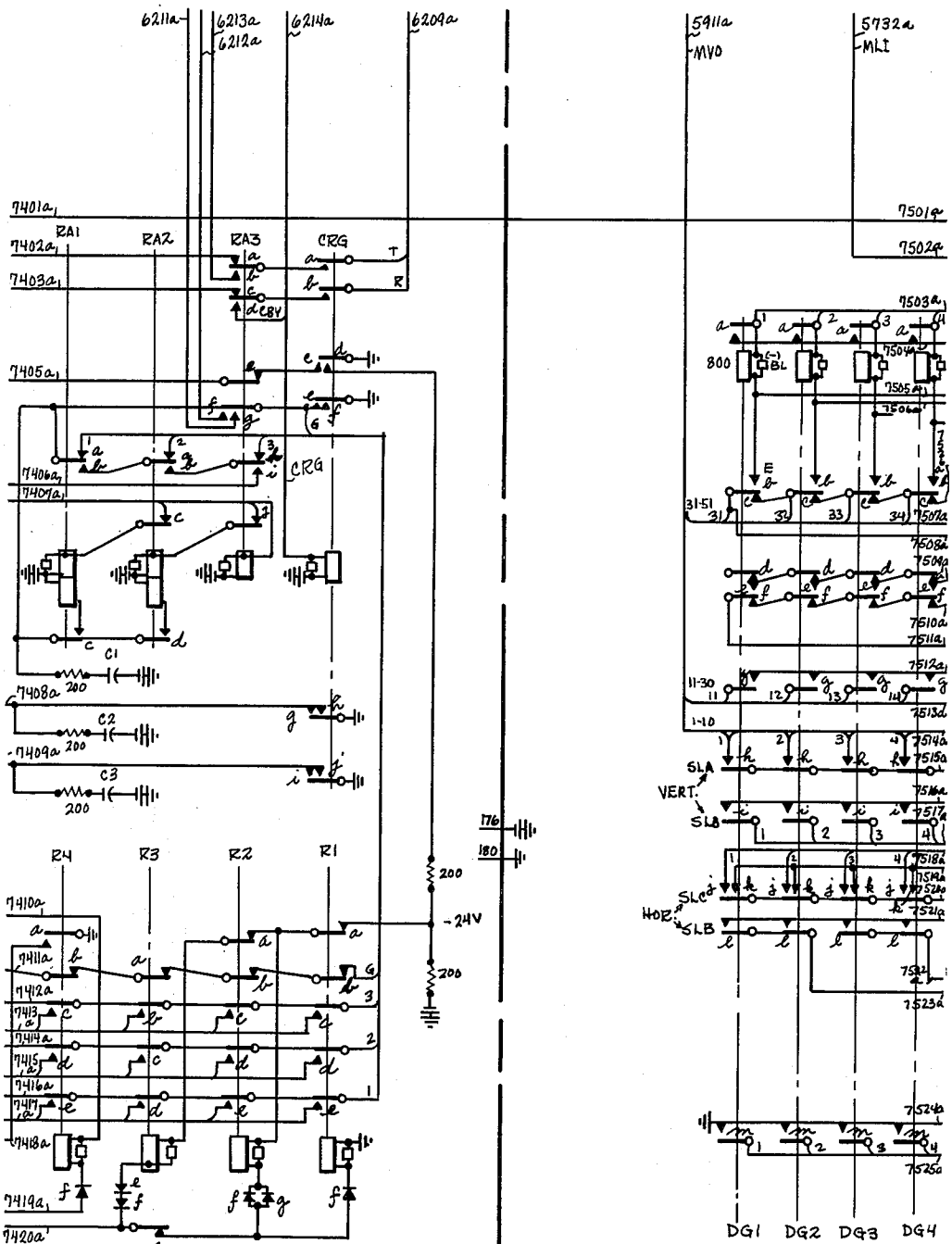


Fig. 75

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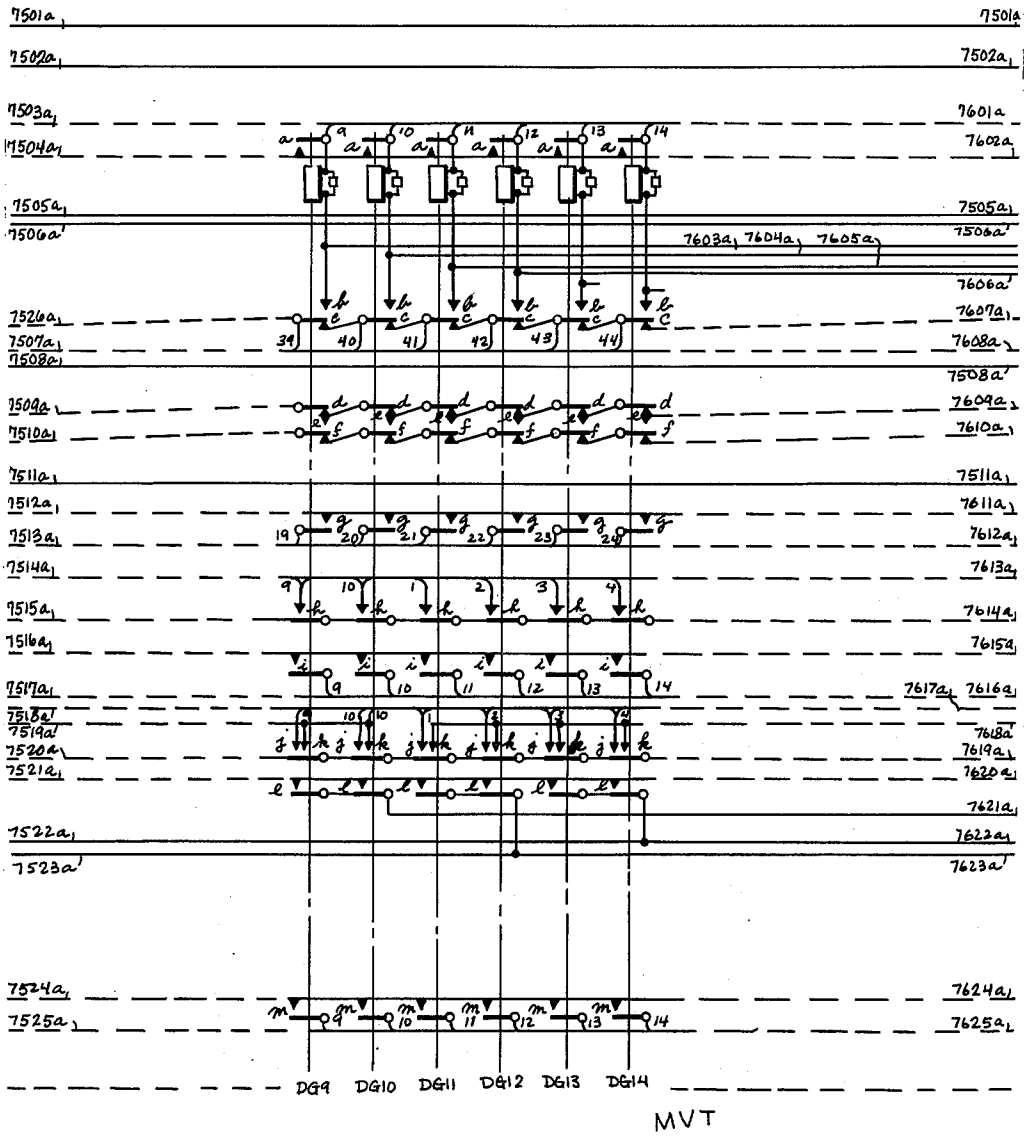


Fig. 76

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Filed Jan. 27, 1956 83 Sheets-Sheet 78

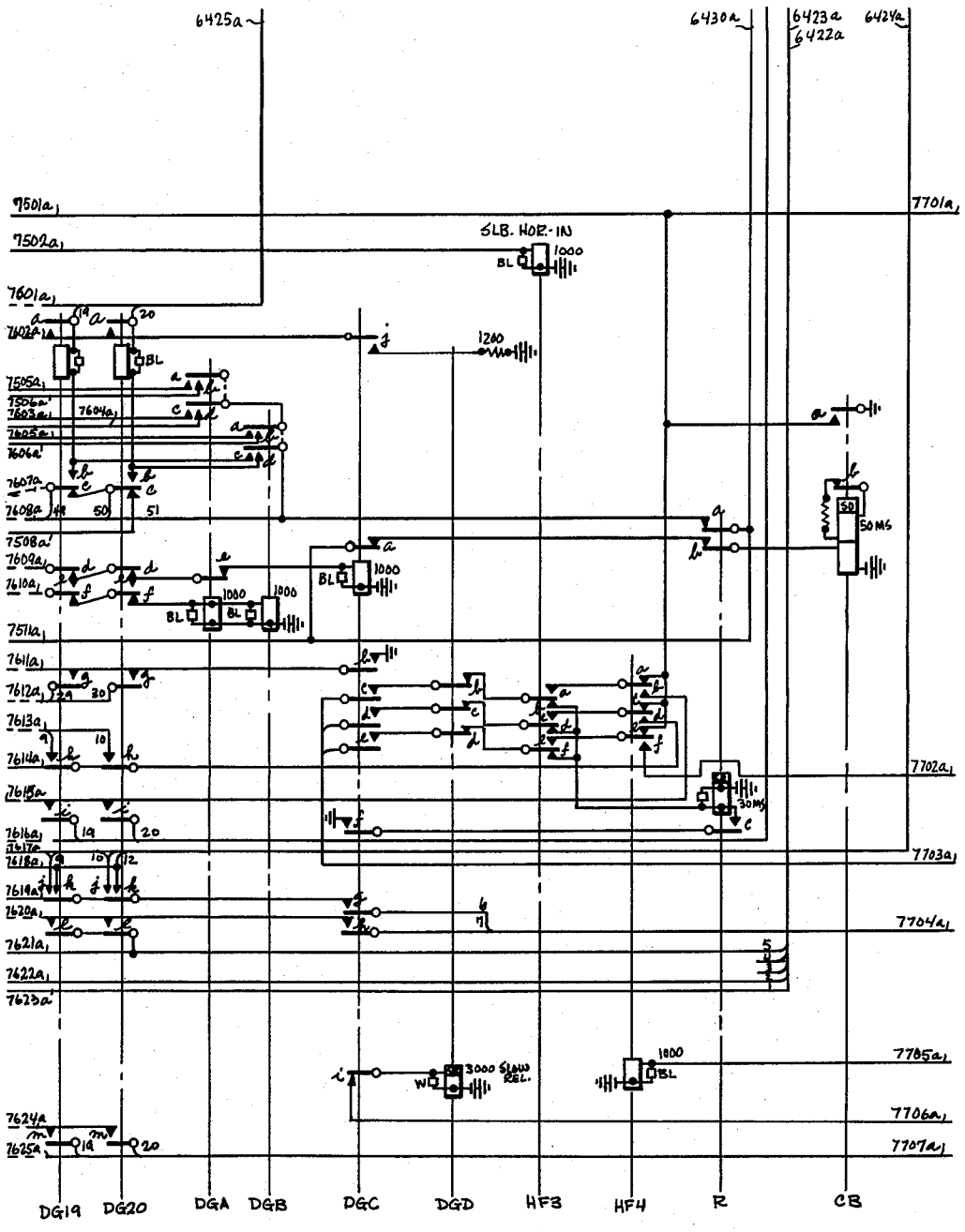


Fig.77

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AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 27, 1956 83 Sheets-Sheet 79

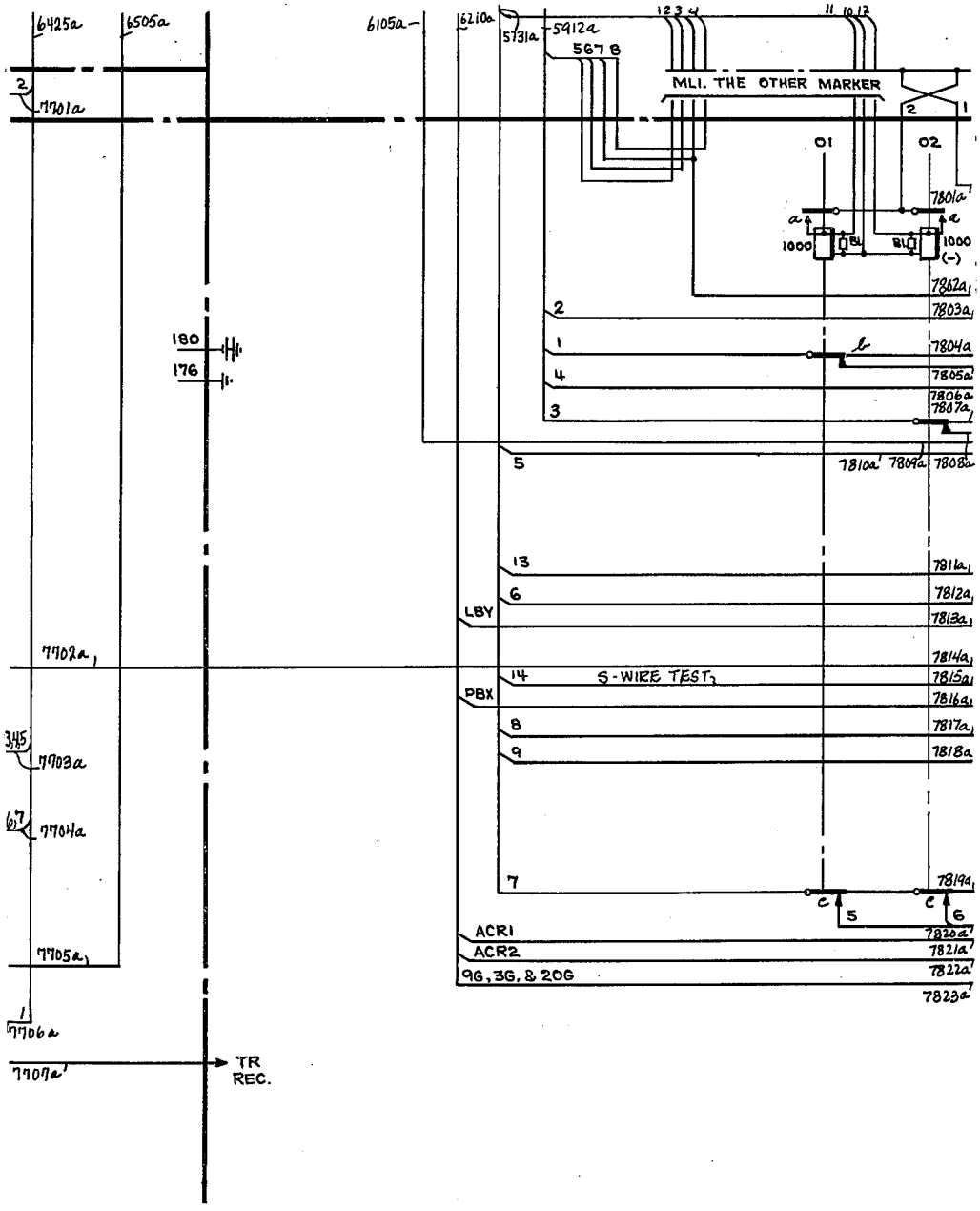


Fig. 78

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Filed Jan. 27, 1956 83 Sheets-Sheet 80

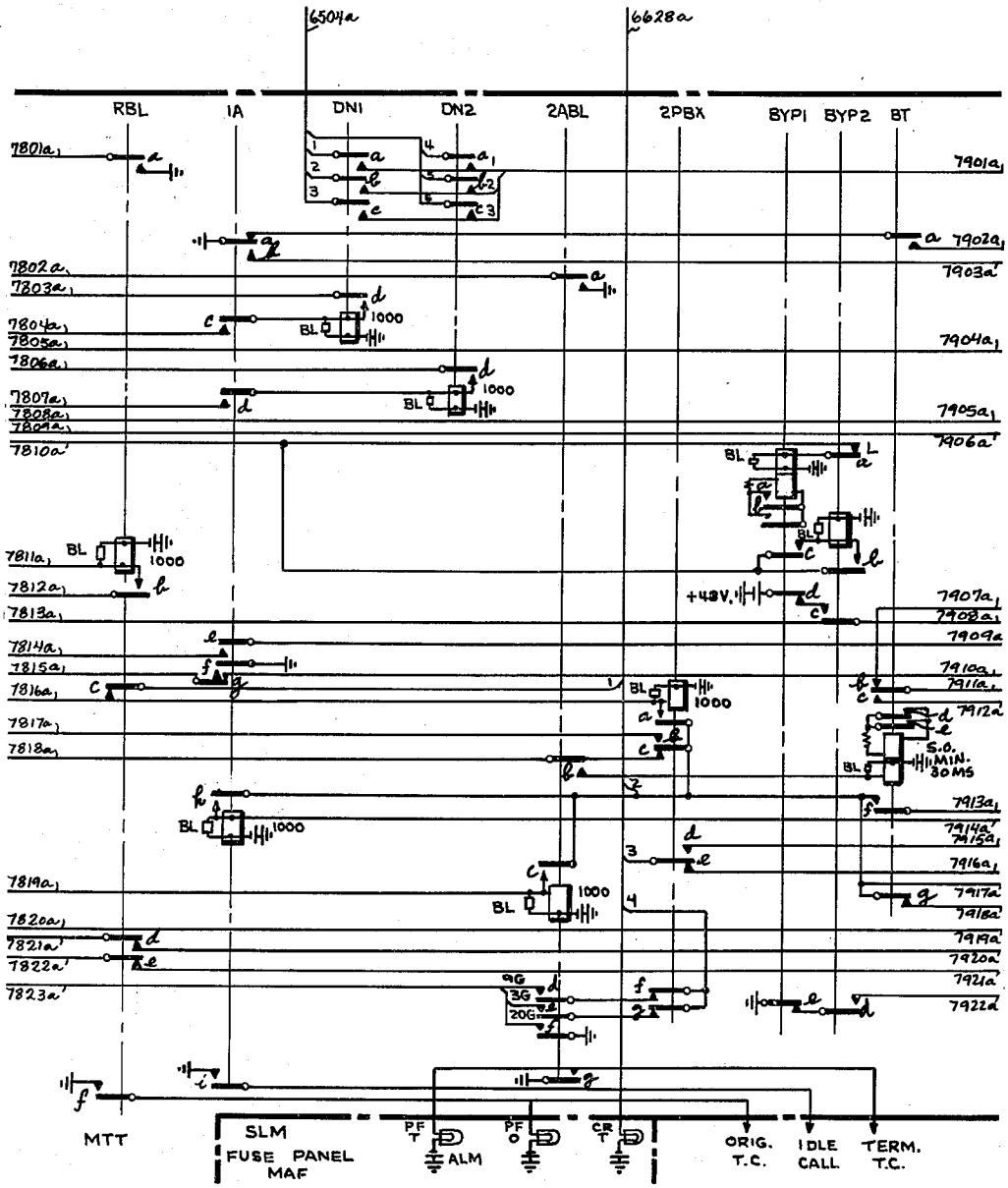


Fig. 79

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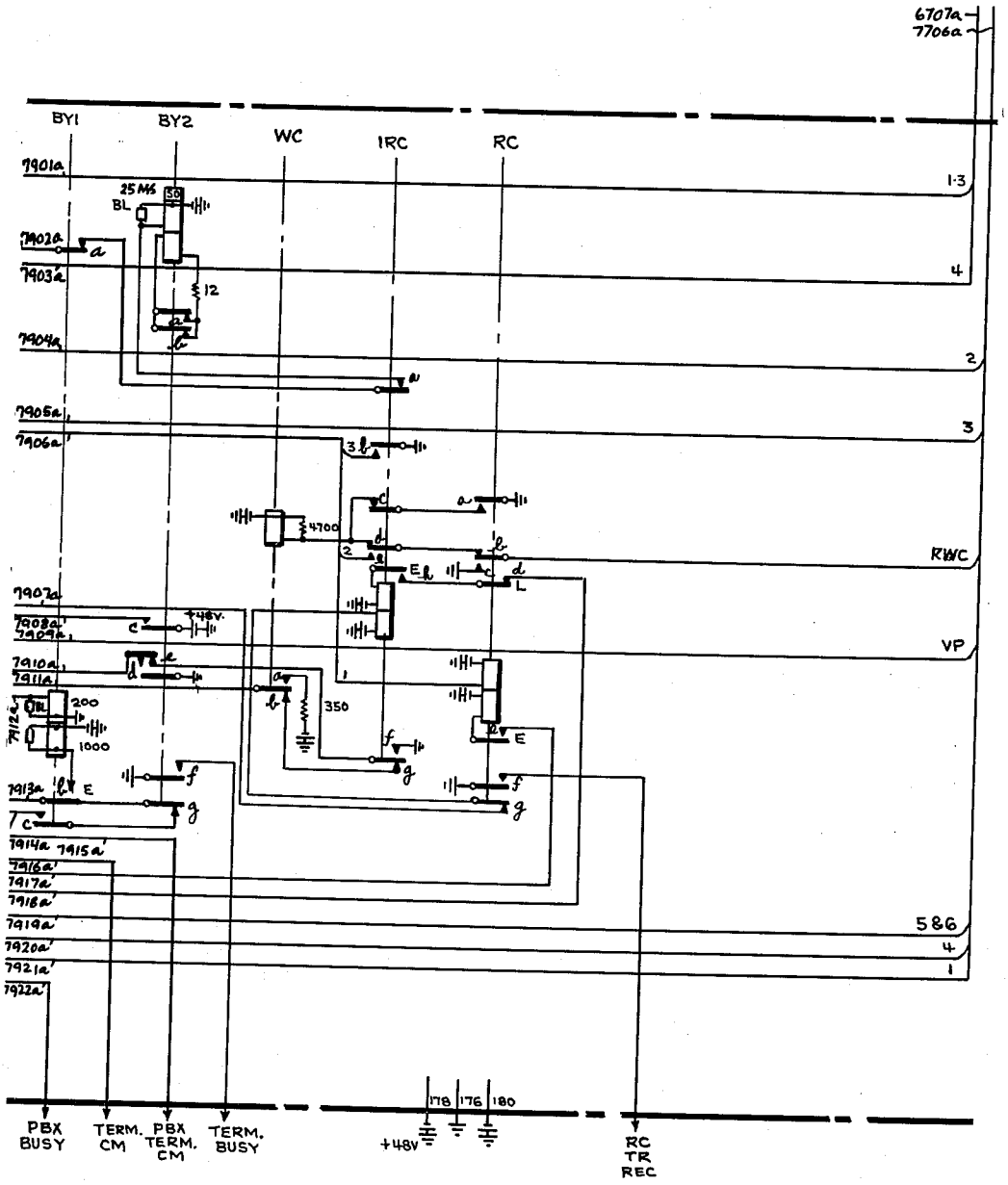


Fig 80

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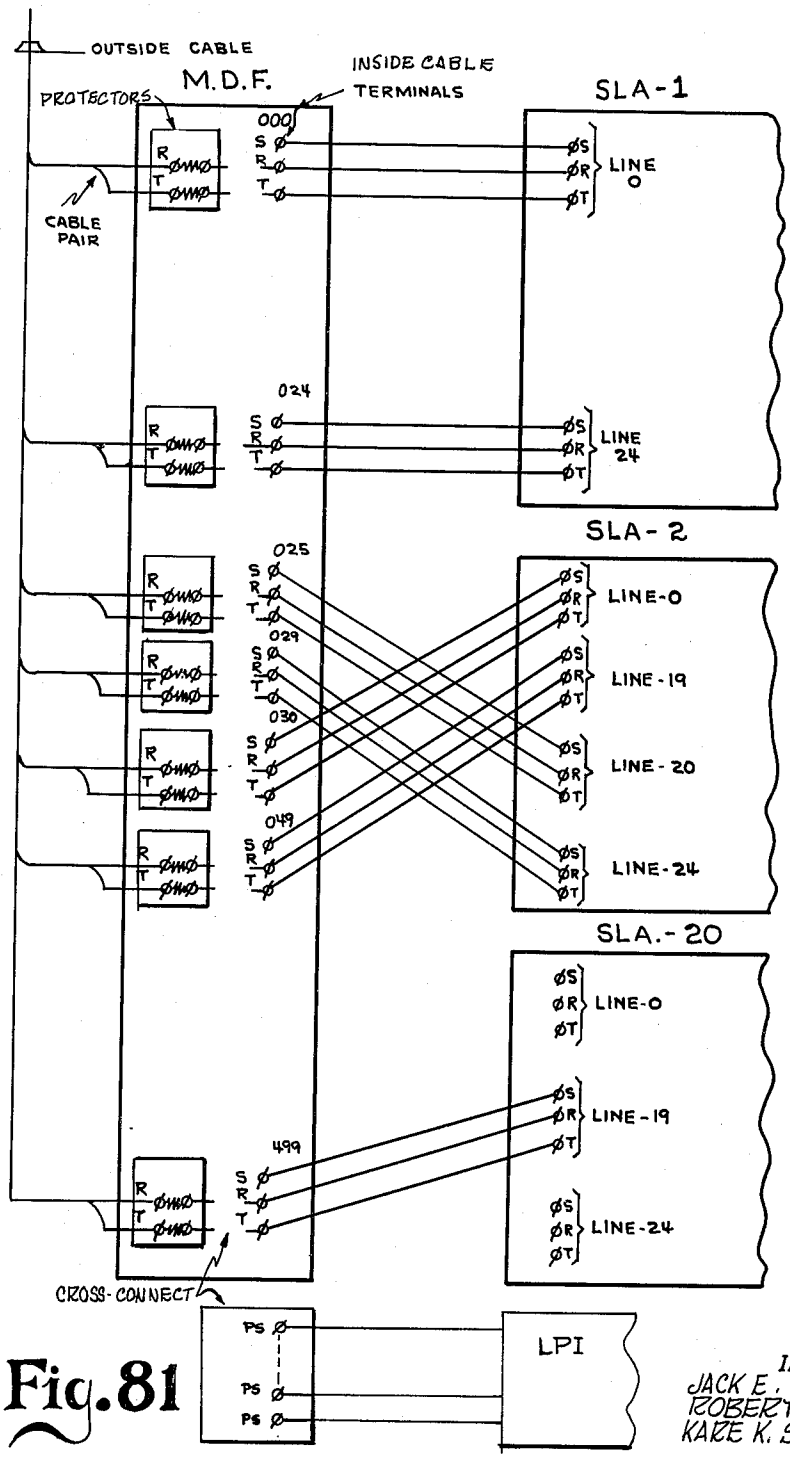


Fig. 81

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AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 27, 1956 83 Sheets-Sheet 83

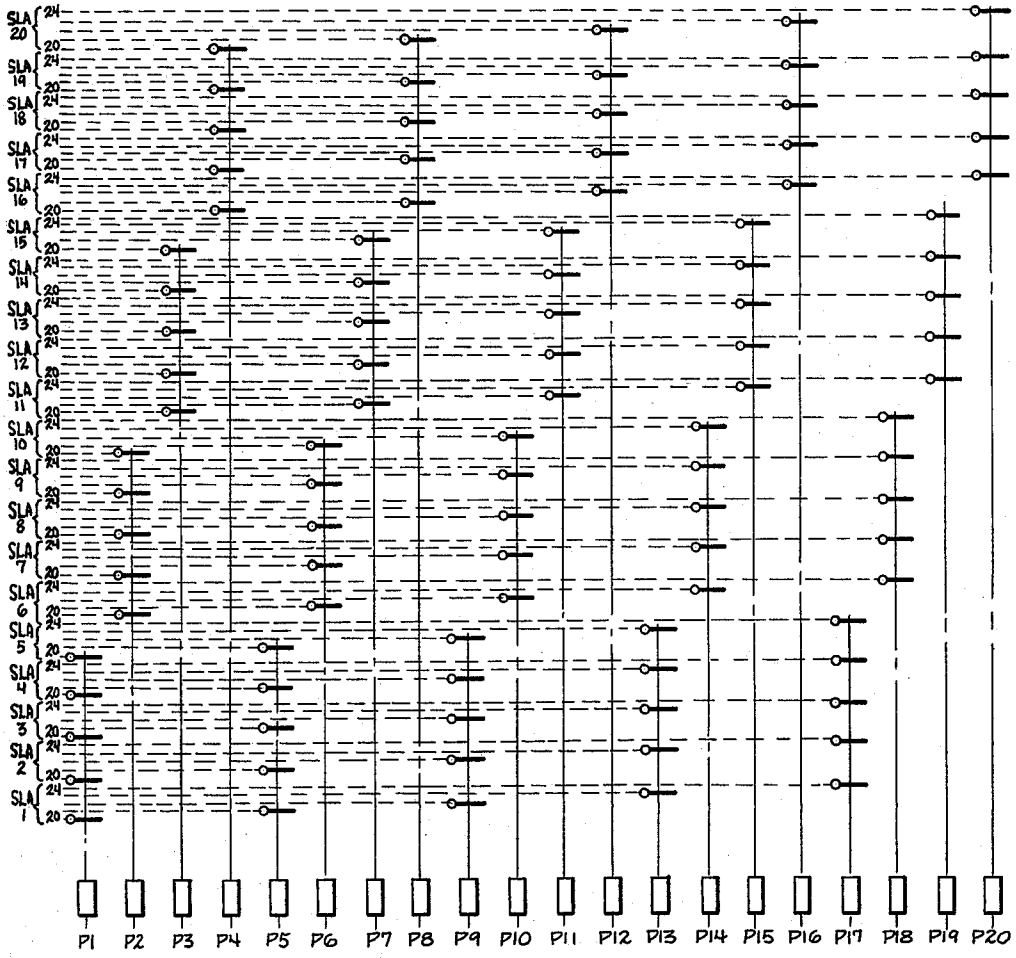


Fig. 82

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United States Patent Office 3,007,006
Patented Oct. 31, 1961

3,007,006

AUTOMATIC TELEPHONE SYSTEM

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Filed Jan. 27, 1956, Ser. No. 561,975
32 Claims. (Cl. 179—17)

The present application relates to automatic telephone systems in general, and more particularly to automatic telephone systems of the crossbar type.

The invention particularly relates to a novel crossbar system utilizing the "by-path" principle in the extension of connections between subscribers. It is a primary object of the present invention to provide an advanced system of this general type which is economically feasible for use in exchanges of all sizes; which incorporates in its equipment speed and accuracy in all of the switching stages, reliability of operation with a minimum of maintenance, ease of installation and expansion, and a higher ratio of completed calls utilizing this improved switching equipment.

The switching equipment is basically comprised of a plurality of crossbar switches certain of which are utilized for terminating the subscriber lines, each terminating crossbar switch in the disclosed embodiment being arranged to terminate twenty-five lines. When a call originates, line relay equipment associated with the subscriber line signals marker equipment and indicates to the marker the terminal location in the terminating crossbar switch associated therewith. The marker tests for and selects an idle register and tests for and selects an idle path to the calling line. Thereafter, the marker establishes a connection from the calling line through certain crossbar switches including a register selection crossbar switch to a register circuit, which returns dial tone to the telephone subscriber. The marker is then released for subsequent use in the establishment of connections.

The subscriber now dials the directory number of the desired party, which information is stored in the memory equipment in the register circuit.

The register seizes the sender which in turn connects to a number group for the purpose of securing routing information necessary for the extension of the call. In the event that the call is local in nature, the number group indicates to the sender the terminal location of the called station, and the party ring code. In the event of a toll call, the sender provides routing information and necessary signals without seizing the number group.

The sender then effects seizure of the group selector marker and transmits signals to the group selector marker to inform same of the called level. The group selector marker tests for and selects an idle path on such level, and extends the main path through the group selector crossbar switches over the selected path. The group selector marker is then released.

Information regarding the class of service and the designation of the party on the line is transmitted by the sender over the tip and ring to the terminating relay group.

The terminating relay group calls in a subscriber line marker and extends tip and ring connections into the marker over which the sender transmits three signals to the marker indicative of the terminal location of the called line. The marker then makes a by-path test to the called line sleeve wire. If the called line is busy, all connections are released to place the calling line on lockout, and the calling line receives busy tone through the line circuit. If the called line is idle, the marker establishes connections over main path crossbar switches and the marker and the sender are released. Ringing current is applied to the line through the terminating relay group in accordance with the information which has been previously supplied thereto by the sender.

As the called party answers, the ringing is tripped and battery feed for both the called and calling party substation sets is provided by the terminating relay group.

A crossbar system of this general type inherently is advantageous in operation in that markers are used to test a number of possible routings for a call. Additionally, as an available path is seized the markers are immediately dropped out within a fraction of a second for use in the extension of other calls. Another advantage lies in the manner in which the talking circuits are not extended until the path has been selected, whereby a substantial reduction in main path equipment is accomplished. The time during which the equipment is held, in the event that a busy line condition is encountered, is reduced to a minimum in that the equipment in the present arrangement automatically abandons the call, releasing all equipment except the calling line circuit. Such operation is accomplished by placing the calling line on lockout, whereby busy tone is transmitted to the calling line over the line circuit. Such operation also occurs in the event that a congestion busy condition is encountered.

In one of the preferred embodiments, the crossbar system is designed on a block-built-jack-in principle utilizing crossbar switches and relay units. In the illustrated system, arrangement is in groups having a capacity of 500 lines each, and is expandable within any 500 group, 25 lines at a time by mounting and jacking any assembled units. However the system should not be considered limited to line groups of 500 lines. In installation, all wire connections to the jacked-in units are completed in the matter of seconds by the use of heavy duty jacks which may be locked in position by hand pressure.

Additionally, the arrangement provides for two markers per 1000 group both of which are accessible to both 500 groups of the 1000 line group, and accordingly any line can have access to two subscriber line markers. Further, these markers are utilized both for originating and terminating subscriber calls. The provision of multiple subscriber line markers provides a safeguard against the inadvertent blocking of calls if trouble should develop in one of the markers.

The novel crossbar system includes means for establishing reverting calls between subscribers on a calling line. According to a feature of the invention, an electronic feed-back test path is utilized in the establishment of the reverting call. Such arrangement insures reliable extension of reverting calls between subscribers. The unusual aspect of the reverting call arrangement is the manner in which the calling party is informed by a recorded announcement of the fact that he is making a reverting call along with a suggestion that his receiver be restored for the purpose of making it possible for the equipment to ring the common line for the parties. Of course, a distinctive tone could be used instead of the recorded announcement. Additionally, as the called party answers, further equipment effects the transmission of a recorded announcement or a distinctive tone to the calling party to inform him of the fact that a reverting call is being attempted, and that his receiver should therefore be retained off the hook to afford the calling party an opportunity to re-remove the calling receiver from his associated substation set.

The crossbar system of the disclosure also includes a novel paystation identification arrangement which utilizes the electronic tone generator common with the reverting call test arrangement in an electronic feed-back test path.

A feature of the invention is the manner in which the equipment is provided with subscriber originating relay groups both with and without associated paystation

trunks, and the novel method of selectively engaging the same. The exchange equipment is operative to provide calls from paystations to official lines without charge. The exchange equipment is also operative to provide calls to special service trunks from prepay paystations without requiring coin deposit providing a convenience not common to conventional telephone systems.

Other features of the inventions include the manner in which senders are operative to transmit hundreds digits which are upgraded by a value of five for selection of PBX groups, and the manner in which originating call identifier relays are utilized to select PBX lines on calls to PBX groups. Further features include the manner in which sequential register group testing is effected in the subscriber line marker; the manner in which path finding is accomplished in originating and terminating calls by a one step method; a novel testing arrangement which is used in testing the sleeve wire of the called line; and the plural manner in which a control wire is used for trunk off-normal control for control of the called line sleeve on test calls, and for answer supervision, which in turn selectively provides for paystation call or refund; and more specifically, the novel manner in which dual signals are utilized over a common path extending between the subscriber's terminating relay circuit and the marker to signal a call of test origin to the marker in one case, and a reverting call to the subscriber's terminating relay group in the other case.

Other objects, features and advantages of the novel crossbar system in the disclosure will become apparent with reference to the specification, claims and drawings which appear hereinafter.

II. DESCRIPTION OF DRAWINGS

FIGURE 1A is an abbreviated local call box diagram showing main path and by-path connections.

FIGURES 1B, 2, and 3 constitute a block diagram of the crossbar system of the switch components of this application.

FIGURE 4 constitutes a block diagram illustrating more explicitly certain connections between trunks, trunk register links, and incoming registers.

FIGURES 5 and 6 constitute one detailed embodiment of landing circuitry by means of which either of two calling 500 line groups gains entrance to either of two subscriber line markers.

FIGURES 7 and 8 constitute an alternative detailed embodiment of landing circuitry.

FIGURE 9 is an illustration of certain test, seizure and signaling circuits.

FIGURES 10 and 11 illustrate certain register, sender, and number group arrangements and relationships.

FIGURES 12A–12G illustrate certain symbolism used; FIGURES 12A–12C illustrating certain alternative symbolisms relative to connections to relay contacts; FIGURE 12D illustrating alternative symbolisms for conductor multiples; FIGURES 12E and 12G illustrating certain alternative symbolisms for cable multiples wherein every conductor in a cable is individually multipled and FIGURE 12F illustrating alternative symbolisms for indicating multipling in which one or more of the individual conductors of a cable are multipled but not all.

FIGURES 13A–13E illustrate certain crosspoint connections.

FIGURE 14 gives a "bird's-eye" view of marker and line group relationships.

FIGURE 15A constitutes an assembly diagram for FIGURES 16–80 of the marker and certain associated main path switches, FIGURE 15B constitutes an assembly diagram for FIGURES 1–3, FIGURE 15C constitutes an assembly diagram for FIGURES 5–6, and FIGURE 15D constitutes an assembly diagram for FIGURES 7–8.

FIGURE 16 is the line paystation identity circuit (LPI).

FIGURE 17 is the line entrance originating circuit (LEO) through which an SLA engages a subscriber's line marker.

FIGURES 18 and 19 constitute the subscriber's primary line switch circuit (SLA).

FIGURE 20 constitutes the line PBX terminating circuit (LPX).

FIGURE 21 constitutes the line horizontal pull circuit (HP).

FIGURES 22, 23, and 24 constitute the subscriber's line switch secondary switch circuit (SLB) the crossbar switch verticals of which are associated with subscriber's originating cord relays (CRA). Certain common control circuitry, for CBT circuits is shown in FIGURE 24 for convenience but is not actually a part thereof.

FIGURES 25, 26, and 27 constitute the subscriber's register link circuit (SRL) through which access to registers is had over the path from calling lines SLA, SLB, SRL to registers.

FIGURE 28 constitutes the subscriber's tertiary line switch circuit over which terminating connections to called lines is had over the path from CRB, SLC, SLB, SLB to called lines.

FIGURE 29 is the line entrance terminating circuit through which a CRB circuit engages a subscriber's line marker.

FIGURES 30, 31 and 32 constitute the subscriber's terminating cord relays (CRB) including the calling and called subscriber battery feed relays on local calls; and means for ringing the called party.

FIGURE 33 is the line connecting terminating circuit (LCT) through which certain conductors including tip, ring, marking and control conductors from the CRB are routed into the marker.

FIGURE 34 sets forth the coin box trunk circuit (CBT).

FIGURES 35, 36, and 37 constitute the register circuit (REG) into which the calling party dials the called number.

FIGURES 30–80 constitute the subscriber's line marker proper (SLM).

FIGURES 38–41 and 54–57 constitute the marker line identifier (MLI).

FIGURE 70 constitutes the marker line identifier auxiliary circuit (MLIA) in the lower part of which certain circuitry of the MPR circuit is shown because of the adjacent space available.

FIGURE 71 which overflows into FIGURE 70 constitutes the marker line miscellaneous circuit (MLM).

FIGURE 72 constitutes the marker paystation and reverting call electronic feedback tone test circuit (MPR).

FIGURES 44, 45, 60, and 61 constitute the marker register test circuit (MRT).

FIGURES 78 to 80 constitute the marker terminating test circuit (MTT).

FIGURES 48, 49, 64, and 65 constitute the marker vertical connecting circuit (MVC).

FIGURES 42, 43, 58, and 59 constitute the marker vertical originating circuit (MVO).

FIGURES 75 to 77 constitute the marker vertical test circuit (MVT).

FIGURE 81 illustrates certain MDF to SLA and MDF to LPI connection arrangements.

FIGURE 82 illustrates relationships between relays P1–P20 and lines 20–24 of SLA's 1–20.

An outline is included herewith for the purpose of facilitating the location in the various sections of the description.

Outline

I. Introduction
II. Description of drawings
III. General description of system involving marker
IV. Marker relay groups and individual relays
V. Idle condition

VI. Originating call
- A. Call extension to subscriber line marker
  - 1. Both markers idle
    - (1) Call from first 500 line group
      - (I) Landing in first marker
      - (II) Landing in second marker
    - (2) Call from second 500 line group
      - (I) Landing in first marker
      - (II) Landing in second marker
    - (3) Simultaneous calls from both 500 line groups
      - (I) First 500 line group landing in first marker and second 500 line group landing in second marker
      - (II) First 500 line group landing in second marker and second 500 line group landing in first marker
  - 2. First marker idle; second marker busy
    - (1) Call from first 500 line group
      - (I) Landing in first marker with second marker busy due to originating or terminating call in second 500 line group
      - (II) Blocked from landing in first marker due to second marker being engaged with terminating call to first 500 line group
    - (2) Call from second 500 line group
      - (I) Landing in first marker with second marker busy due to originating or terminating call in first 500 line group
      - (II) Blocked from landing in first marker due to second marker being engaged with terminating call to second 500 line group
    - (3) Simultaneous call from both 500 line groups
      - (I) First 500 line group landing in first marker with second marker busy due to terminating call in second 500 line group
      - (II) Second 500 line group landing in first marker with second marker busy due to terminating call in first 500 line group
  - 3. First marker busy; second marker idle
    - (1) Call from first 500 line group
      - (I) Landing in second marker with first marker busy due to originating or terminating call in second 500 line group
      - (II) Blocked from landing in second marker due to first marker being engaged with terminating call to first 500 line group
    - (2) Call from second 500 line group
      - (I) Landing in second marker with first marker busy due to originating or terminating call in first 200 line group
      - (II) Blocked from landing in second marker due to first marker being engaged with terminating call to second 500 line group
    - (3) Simultaneous calls from both 500 line groups
      - (I) First 500 line group landing in second marker with first busy due to terminating call in second 500 line group
      - (II) Second 500 line group landing in second marker with first marker busy due to terminating call in first 500 line group
  - 4. Both markers busy
  - 5. Alternative arrangement
- B. Line group identity
- C. SLA identity
- D. Line identity—SLA horizontal operation
- E. Coin box (paystation) identity
- F. Register selection and path finding (by-path)
  - 1. Marker rotator set with starting point at register group
    - (1) Register group #1 available; idle path thereto
    - (2) Register group #1 available; no idle path thereto; register group #2 available; idle path thereto
    - (3) Register group #1 available; no idle path thereto; register group #2 available; no idle path thereto; register group #3 available; idle path thereto
    - (4) Register group #1 available; no idle path thereto; register group #2 available; no idle path thereto; register group #3 available; no idle path thereto; release
    - (5) Register group #1 not available; register group #2 available; idle path thereto
    - (6) Register group #1 not available; register group #2 not available; register group #3 available; idle path thereto
    - (7) Register group #1 not available; register group #2 not available; register group #3 available; no idle path thereto; release
    - (8) Register group #1 not available; register group #2 not available; register group #3 not available; release

VI. Originating call—Continued
- F. Register selection, etc.—Continued
  - 2. Marker rotator set with starting point at register group #2
  - 3. Marker rotator set with starting point at register group #3
- G. Path establishment
  - 1. Horizontal closure—SLB, SRL
  - 2. Vertical closure—SLA, SLB, SRL
- H. Marker release
  - 1. Normal release
  - 2. Timed-out release
    - (1) If line has not been properly identified
    - (2) If line has been properly identified
  - 3. Release under other circumstances
- I. Subsequent operation

VII. Terminating call
- A. Seizure of marker
- B. Line group identity
- C. CRB group identity
- D. CRB identity
- E. Information received by marker code receiver from sender
- F. Call for marker (path-finder portion thereof)
  - 1. Marker seizure
  - 2. Marker seizure prevented due to an originating call in same line group
- G. Selection of SLA
- H. Operation of SLA horizontals—Test of called line
  - 1. Called line idle
  - 2. Called line on lockout
  - 3. Called line busy
    - (1) Reverting call test
      - (A) Idle signal to marker and reverting call signal to CRB
- I. Release on called line busy or lockout condition
- J. Called line idle
  - 1. Path-finding from CRB to idle line (by-path)
    - (1) No idle path
      - (A) Congestion busy signal to sender
    - (2) Idle path
      - (A) Horizontal closure—SLB, SLC
      - (B) Vertical closure—SLA, SLB, SLC
      - (C) Release
- K. Reverting call
- L. Call to PBX group
- M. Terminating call from wire chief or busy verification trunk

VIII. Miscellaneous
- A. Originating call self release
- B. Terminating call self release
- C. Terminating call preference
- D. Congestion busy and other miscellaneous released

IX. Claims

III. GENERAL DESCRIPTION OF SYSTEM INVOLVING MARKER

As shown in abbreviated box diagram form in FIGURE 1A, the invention is directed to a cross-bar system in which conversation channels are established over crossbar switches comprising the "main-path" and in which idle paths through the crossbar system are determined according to the by-path principle.

More specifically, as the calling subscriber lifts his receiver an associated line relay in the associated SLA crossbar switch unit operates to close a loop to the line entrance originating circuit (LEO) which engages a subscriber line marker (SLM) by means of which the location of the calling line in the SLA switch is ascertained.

The subscriber line marker next tests for and selects an idle register, and tests for and selects an idle path between the calling line and the register. As a result thereof the marker sets crossbar switches in the SLA, SLB, and SRL circuits, extending the calling line over SLA, SLB, CRA, and SRL circuits into the selected register, the calling line receiving dial tone from the register at this time. When the SRL crosspoints close, resistance ground in the register operates a relay in the CRA circuit which places ground on the incoming test wire which extends to the subscriber's line marker and signals the marker to release.

As the calling party now dials the directory digits of the called number, the number is registered in the register which then engages a sender. If the call is to a party in the local exchange, the sender engages a number group circuit. The number group circuit translates the directory number into terminal location indicia which is returned to the sender, and as the sender has received this information from the number group, it signals the CRA circuit which extends a connection to the call signal relays which engage a group selector marker.

The code receiver in the group selector marker signals

the sender that it is ready to receive, whereupon the sender sequentially transmits two digit information bearing signals to the code receiver in the group selector marker informing the group selector marker as to the required level over which the called connection should be extended.

As a result thereof, the group selector marker tests for and selects an idle outlet on this level, tests for and selects an idle path thereto, and sets the crossbar switches of the GSA and GSB circuits (a two-stage group selection stage) extending a path to an idle subscriber terminating relay group (CRB).

When the code receiver in the selected CRB circuit is ready to receive, it signals the sender which sequentially transmits two information bearing signals thereto, the first signal indicating the type of origin of the call and the second signal indicating the party on the line.

The CRB circuit now closes a loop to the line entrance terminating circuit (LET) which engages a subscriber's line marker for terminating call purposes.

When the code receiver in the subscriber's line marker is ready to receive, it signals the sender which sequentially transmits three digit information bearing signals thereto to inform the marker of the terminal location of the called line.

The subscriber's line marker extends a test connection through the SLA circuit to the called line test wire over the horizontal magnets off-normal contacts, and a test is made of the condition of test wire to determine the idle, busy, or lockout condition of the called line.

If the line is busy or on lockout, the marker signals the sender which dismisses all connections, placing the calling line on lockout and, the calling line receives busy tone through the line circuit.

If the called line is idle, the marker tests for and selects an idle path between the calling CRB and the called line, and sets the crossbar switches in the SLC, SLB, and SLA switches, extending the main path from the CRB to the called line.

When the SLC switch is set, a signal from vertical magnet off-normal contacts thereof signals the CRB circuit.

Thereupon the CRB circuit opens its loop to the subscriber's line marker, causing it to release; also the CRB circuit signals the sender which effects the release of itself and the register. The CRB circuit then rings the called line.

When the called party answers the CRB circuit trips the ring and a conversation path can be traced from the box "Subscribers Lines," through an SLA, SLB, CRA, GSA, GSB, CRB, SLC, SLB, SLA back to the box "Subscribers Lines." It should be observed that different SLA's and SLB's or else different verticals in the same SLA and SLB are involved for the originating and terminating ends of this call.

It should also be observed in summary that the circuits involving crossbar switches are: SLA, SLB, SRL, SLC, GSA and GSB.

On the initiation of the call, crossbar switches SLA, SLB and SRL are involved to route the calling connection into a register. Crossbar switches GSA and GSB represent the group selection stage. Crossbar switches SLC, SLB, and SLA are involved in extending the terminating end of the connection to the called line.

Referring now more specifically to the block diagram of FIGURES 1B, 2, and 3, it will be assumed that a subscriber on the line in the five hundred line group designated by the block **100** originates a call by lifting the receiver from his substation set. The associated line circuit in the group of line circuits **101** is actuated over the path **100***a*, and signals the line entrance originating circuit **102** over path **140**.

The line entrance originating circuit **102** over path **141**, **144**, and **145** or **146** calls in one of the subscriber line marker circuits **131** and **132**, each comprising marker, code receiver, and connect relays groups, and indicates to the seized marker the twenty five line group origin of the calling line (i.e. the particular subscriber's crossbar switch or link SLA designated **103** to which the calling line is connected), and also extends signaling circuits into the seized marker by means of which the marker identifies the calling line. In the present example, it will be assumed that marker **131** is seized.

Marker **131** by "by-path" principles examines and seizes a register in the group indicated as **304** over paths indicated as **148**, **149**, **150**, **152**, and **152'**; test, guard and connect relays indicated as **133** in subscribers' register link SRL, a group of which is indicated as **107**; and paths **163** and **130**. The seized register of the group **304** is connected to the vertical of the seized one of a plurality of subscribers' register links, indicated generally as **107**.

The calling subscriber's line is connected to the horizontal of the SLA switch assigned to the twenty five line group containing the calling subscriber's line, which SLA switches are indicated generally as **103** in the present example. For conciseness hereinafter, the group symbols are used when referring to a member of a group.

The marker accordingly has the problem of connecting the horizontal of the calling switch **103** with the vertical of the SRL switch **107** associated with the seized register.

It should be observed at this point that in effect each subscriber's line is connected to a particular horizontal of a single SLA switch, each five hundred group of lines having twenty SLA switches. Each SLA switch has in effect ten verticals which are in effect connected in a certain pattern to the horizontals of a plurality of subscribers' links B (SLB) indicated generally at **104**. The number of SLB switches is determined by traffic considerations. Each SLB switch has ten verticals, four of which are connected to cord relays A circuits (CRA) indicated generally as **106**, and six of which are connected to horizontals of subscriber link C circuits (SLC), indicated generally as **105**. Each CRA is connected to a vertical in a group of group selector switches (GSA) indicated generally as **111**. It should also be observed that each CRA circuit is connected in effect to a horizontal of a subscriber's register links (SRL) of a plurality of such crossbar links indicated generally as **107**. Accordingly a CRA circuit is represented by a vertical in an SLB crossbar switch, a vertical in a GSA crossbar switch, and a horizontal in an SRL crossbar switch.

The marker **131** now tests as to whether the calling SLA switch has an idle vertical or verticals leading to the SLB switches, the tested verticals being represented in effect by certain horizontals in the SLB switches. The marker also tests for an idle CRA for connection to an idle SLB horizontal and an idle SRL vertical. Since the SLA horizontal magnet has been operated at an earlier stage, the marker now operates the SLB and SRL horizontal magnets, and the operation of the vertical magnets of the SLA, SLB, and SRL switches is effected thereafter. It should be understood that the horizontal magnets are "select" magnets and that the vertical magnets are "hold" magnets. After the hold magnets are operated the select magnets are released. The testing and circuit operations above described are accomplished over paths **148**, **149**, **150**, **151**, **152**, **153**, and **153'**. It should also be understood that leads entering a box such as **107** may have connections inside the box other than those specifically shown.

At this stage of operations, the calling line is extended over path **100***a* and **101***a*, an SLA switch **103** (primary crossbar switch), path **103***a*, an SLB switch **104** (secondary crossbar switch), path **104'**, through path **106***b* of a CRA circuit **106**, path **165**, and SRL switch **107**, and paths **163** and **130** over a graded or slipped multiple to a register of a group of registers indicated generally as **304**.

Relationships between the SRL switches and registers

will be further described hereinafter, as well as in the copending application which was filed on July 15, 1955, and received Serial No. 522,233 and which was assigned to the assignee of this invention.

Upon connection of a register **304** to a CRA **106**, a signal to the CRA operates a control relay in the CRA which holds open the tip and ring circuits, represented by path **106***a*, between the CRA and the GSA switch **111**. This control relay also connects ground to a third wire "S" to operate the calling line cut-off relay and lockout relay, and holds the vertical magnets of the SLA and SLB switches when the marker subsequently releases. The marker **131** is now dismissed.

The calling subscriber then receives dial tone from the originating register **304** and dials the 2–5 directory number into the register over the described path including circuit **106***b* in the CRA. This 2–5 number comprises a three digit exchange code plus a four digit called number. However in the event of a call to an area other than the area of the calling subscriber, a preliminary three digit area code may also be dialed into the register.

After the register has received all of the dialed digits, it signals a guard circuit **305** which connects the register through connect relays in **305** to one of a group of sender-translators indicated as **306**, there being a lesser number of senders than registers. The register then forwards the first four digits to the seized sender-translator **306**, which analyzes the first three digits to determine whether the call is an inter-office or intra-office call.

If the call is an intra-office call, the sender operates in accordance with the value of the fourth (thousands) digit received to seize the number group circuit **308** associated with the indicated directory thousands group. The circuit is specifically seized via connect relays **307** and a sender-finder arrangement in the number group circuit **308** which establishes connections between the originating register, sender, and the number group circuit. The number group circuit then translates the hundreds, tens, and units directory digits received into five pieces of information which are fed back into other registers in the sender-translator circuit, these five pieces of information being: (1) the five hundred group of the called subscriber, (2) the equipment hundreds digit location of the called subscriber, (3) the equipment tens digit location of the called subscriber, (4) the equipment units digit location of the called subscriber, and (5) the party-on-the-line designation of the called subscriber, or in the case of private branch exchange lines the fact that the called subscriber is associated with private branch exchange lines. It should be noted that all senders have access to all number groups.

If the call is an inter-office call, the sender does not engage a number group circuit. In the case of an inter-office call the sender is set-up in preparation to outpulse part or all (if necessary) of the first three exchange code digits received (also area code under certain circumstances) and to prefix a tandem routing digit or digits if necessary.

When the sender is ready to send, it signals the CRA, circuit **106**, operating a second relay in CRA which forwards the "S" wire ground over path **106***c*, **167**, and **169** actuating a call signal relay associated with the calling CRA in the group **109** which, over path **188**, engages a group selector marker circuit **110** comprising marker, code receiver, guard and connect relays. When the sender has received a 24 volt negative battery "dial start" signal on the tip lead from the marker **110** upon engagement of the marker, the sender sends routing signals via the tip and ring conductors over path **106***c*, **167**, **169**, and **188** to the code receiver in marker **110**. (These routing signals are for the purpose of enabling the group marker **110** to set the primary group selector crossbar switch **111** and the secondary group selector crossbar switch **112** to extend the call to a CRB in a local line group or to an outgoing trunk.)

These signals comprise the application of positive 48 volt battery, negative 48 volt battery, ground, or nothing to the tip conductor; and simultaneously, positive 48 volt battery, negative 48 volt battery, or nothing to the ring conductor; wherein zero volts is ground. Two such signals are sent to represent the tens and units decimal digits. Thus with the various combinations of two of such digits, any one of one hundred values can be selected by two rapid signal applications. Twenty of these combinations can be used to represent the various called five hundred groups and trunk groups. Others of these combinations can be used for alternate trunk routing.

On a local call, as a result of the two signals transmitted from the sender **306** to the group marker **110**, the group selector marker over a "by-path" examines the possible idle routes from the calling CRA to an idle CRB in the called line group and over "by-path" connections **190** and **191** actuates first the horizontal select magnets and then vertical hold magnets of switches **111** and **112** to extend a connection from the calling CRA through a primary group selector crossbar switch **111** and a secondary group selector crossbar switch **112** to an idle cord relay B circuit (CRB) such as **108**, **128**, **208** or **228** in the called five hundred line group.

On a trunk call, as a result of the two signals transmitted from the sender to the group selector marker **110**, the marker similarly extends a connection through crossbar switches **111** and **112** to an idle trunk in the required outgoing group of trunks, such as for example, trunk groups **236** and **237**. As shown such trunk groups may include free service trunks, toll operators trunks inter-toll trunks, etc.

The group selector marker **110** then releases. If outpulsing over the selected trunk is indicated by the senders translation of the first three digits, the sender out-pulses to repeat exchange or area digits and to route through tandem points if necessary.

In the case of a local call, the seized CRB circuit such as **108**, for example, transmits a negative 24 volt battery signal over the tip conductor connection to the sender which then sends two signals to the code receiver in the seized CRB circuit, which signals comprise positive 48 volt potential, negative 48 volt potential, ground, or absence of a signal on the tip conductor, and like signals on the ring conductor, the signals being applied to the two conductors in different combinations. The first of these signals indicates, according to the combination of the signal, any one of four possibilities as to the origin of the call and one possibility as to the destination of the call and the adjustment in the CRB necessitated thereby. Thus according to one combination, if the call is of local origin, the CRB is conditioned to insert calling and called battery feed coils and condenser bridge. If another combination indicates that the call is of trunk origin, the CRB is conditioned to cut the tip and ring conductors through metallic in which case the battery feed coils are located in the calling trunk circuit. If another combination indicates that the call requires a delayed ring feature, the CRB pre-trips the ring for delayed ring, the operator reclosing the ring trip relay over the "C" wire. Also if the call is of wire chief or test origin, the CRB is conditioned to cause the subscriber's line marker, such as **131** or **132**, on a terminating call to disregard the busy condition of a called line, to pre-trip the ring, and to disable the CRB sleeve test in disregard of an open sleeve or grounded sleeve. The wire chief can then proceed with his tests.

The second signal to the CRB takes any one of fourteen combinations to condition the CRB in preparation to ring any one of fourteen ringing combinations of frequencies and codes on the called line to signal the called subscriber station phone which may be any of a plurality of stations on the called line.

After these signals have been received by the CRB and are properly registered, the CRB, such as **108**, ex-

tends a call signal over paths **178**, **179** and **181** or **182** to seize the code receiver of one of the two markers such as **131** and **132**. It should be understood that the code receiver of a given marker can be receiving the signals incident to a terminating call simultaneously with the use of the marker in the establishment of an originating call.

After the code receiver of a line group marker, such as **131**, has been seized and the tip and ring conductors extended thereto, the line group marker **131** applies negative 24 volt battery supervision to the tip lead of the sender to cause same to initiate sending.

The sender thereupon sends three coded signals to the line group marker code receiver in a manner similar to that effected in the sending of signals to the group selector marker code receiver and CRB code receivers. Each of these signals can have ten decimal values according to the particular combinations used.

The first signal can have any one of five values to indicate the decimal hundreds value of the equipment location of the called line. The first signal can have any one of five other values to indicate the decimal hundreds value of the equipment location of the called line, and additionally the fact that the called line is in a multiple selection group, such as a PBX group.

The second signal can have any one of ten values to indicate the decimal tens value of the equipment location of the called line.

The third signal can have any one of ten values to indicate the decimal units value of the equipment location of the called line.

Upon receiving the three signals, the marker code receiver seizes its associated marker which operates connecting relays in the desired SLA switch, and operates the horizontal magnets on the SLA switch over paths **147** or **148** according to which marker was seized, **149**, **150** and **151** thereby getting an indication as to the busy, idle, or lockout condition of the called line. If the called line is busy, the line group marker then determines whether or not the called line is identical to the calling line, that is, a reverting call. Such test consists of testing the continuity of the sleeve wire by means of a tone oscillator. If the call is of a reverting nature, the line group marker establishes connections from CRB **108** through crossbar switches SLC, indicated generally as **105**, SLB, and SLA over paths **160**, **159**, **103***a*, **101***a*, and **100***a* to the called line. At the same time, a signal is sent to the CRB from the line group marker, indicating to the CRB that the call is a reverting call. If the call is not of a reverting nature, the line group marker does not complete the connections from the CRB **108** to the called line through switches SLC, SLB, and SLA, but instead sends a signal to the sender **306** which releases. The release of the sender causes the release of the two relays in the CRA, removing ground from the "S" lead, thereby releasing all switches which have been used in establishing the connection, and placing the calling line on lockout. This gives busy tone to the calling subscriber until he replaces his receiver.

If the called line is on lockout, the line group marker determines this fact by making a marginal test on the sleeve wire of the called line, and immediately sends a busy signal to the sender **306** (except in the case of wire chief test call), which then releases as described in the case of a non-reverting busy line.

If the called line is idle, the line group marker establishes connection thereto from CRB **108** over a crossbar switch SLC of the group **105** and over connections of the same or other SLB and SLA switches to the called line. The SLA and SLB switches are bi-directional and are used for both originating and terminating calls.

The CRB then gives normal battery feed signals over the tip and ring to the sender-translator **306** which causes the sender-translator to release, in turn causing the release of the register **304**, the subscribers register link, such as **107**, and the dropping of the first mentioned relay in the CRA circuit **106** which extends the calling loop into the CRB over the path **106***a*.

After the called connections have been extended into the CRB circuit, the marker dismisses itself, and all connections are held by ground on the "S" wire in the CRB relay group **108** which is under the control of the calling line loop.

The CRB circuit **108** then rings the called party over tip and ring and the calling party receives ring-back tone over tip and ring.

When the called party answers, the ring trip relay operates in the CRB to connect the calling and called tip and ring to battery feed relays so that conversation can then ensue.

Assuming the calling and called parties to be in the same five hundred group of lines: the loop now extends from the handset of the calling party in line group **100**, paths **100***a* and **101***a*, SLA primary crossbar switch of group **103**, path **103***a*, SLB secondary crossbar switch of group **104**, path **104'**, CRA path **106***a*, paths **167**, **169** and **170**, GSA group selector primary crossbar switch of the group **111**, path **171**, GSB group selector secondary crossbar switch of group **105** used in terminating calls only, path **159**, SLB crossbar switch of group **104**, path **103***a*, SLA crossbar switch of group **103**, paths **101***a* and **100***a* (which comprise distinct calling and called tip and ring circuits), to the called party in the line group **100**.

If the called party had been in the five hundred line group **120** this path would be completed from the GSB switch **112** as follows: path **173**, CRB circuit of the group **128**, path **162**, SLC switch of the group **125**, path **161**, SLB switch of the group **124**, path **123'**, SLA switch of the group **123**, and paths **121***a* and **120***a* to the called party in the line group **120**.

Other five hundred line groups, such as **200** and **220**, (FIG. 2), originate calls respectively over paths **204'** and **224'**, CRA's **206** and **226**, paths **269** and **268**, and paths **129** and **169** into the call signal relays **109** (FIG. 1). These 500 line groups receive calls from the group selector GSB switches such as **112** respectively over paths **174** and **175**, and CRB's **208** and **228**. Additionally these 500 line groups are served by subscriber line markers **231** and **232**.

Wire chief circuits, such as **235**; toll operator circuits, such as **237**; free service trunks, such as **236**; and inter-toll trunks, such as **238** have access via trunk register links (TRL) designated **239** and path **245** to incoming registers **300** (FIG. 3), which in turn have access over path **310**, connect relays **301** and path **311** to sender and translator circuits, designated **302**, and thence over path **312** and connect relays **303** to the various number group circuits designated **308**, over paths **313** and **318** to which the sender-translators **306** also have access as previously described. For convenience the term sender includes translator whether mentioned or not.

Senders **302** seize and send via wire chief circuit **235**, paths **246**, **129**, and **169**; via free service trunks **236**, paths **248**, **129**, and **169**; via toll operators circuits **237** and paths **251**, **257**; and via inter-toll trunks **238** and paths **253**, **255**, and **257**.

Thus the wire chief and free service trunks complete connections over regular GSA switches **111** and GSB switches **112**, while toll operators and inter-toll trunks complete connections by means of call signal relays **240**, group selector marker **241**, GSTA group selector primary crossbar switches **242** and GSTB group selector secondary crossbar switches **243**.

Out of secondary switches **243**, toll operators and inter-toll trunks have access over paths **263**, **129**, call signal relays **109**, and regular group selector crossbar switches **111** and **112** to the various outlets from switches **112**.

Intertoll Trunks and toll operators have access from outlets of switches **243** and paths **256** and **253** to Inter-

toll Trunks 238 which may comprise several groups of trunks extending to and from various toll exchanges.

Referring now to FIGURE 4, a more detailed showing of trunk arrangements is set forth.

The group of wire chief trunks 235 and 235*a* of FIGURE 4 correspond to the box 235 in FIGURE 2.

The group of free service trunks 235 and 236*a* of FIGURE 4 correspond to the box 236 in FIGURE 2.

The group of toll operator trunks 237 and 237*a* of FIGURE 4 correspond to the box 237 of FIGURE 2.

The group of inter-toll trunks 238 and 238*a* of FIGURE 4 correspond to the box 238 of FIGURE 2.

Paths 246, 247, 248, 249, 251, 252, 253, and 254 correspond to the same numbered paths in FIGURE 2.

Paths 246′ and 247′ are corresponding paths associated with trunk 235*a*; paths 248′ and 249′ are corresponding paths associated with trunk 236*a*; paths 251′ and 252′ are corresponding paths associated with trunk 237*a*′ and paths 253′ and 254′ are corresponding paths associated with trunk 238*a*.

It should be observed that paths 247, 247′, 249, 252, 252′, 254, and 254′ enter a group of trunk register link circuits (TRL) designated 239*f* to 239*l* corresponding to box 239 of FIGURE 2, via a graded or slipped multiple between these paths and the horizontals of the crossbar switches thereof, there being one crossbar switch for each TRL circuit.

The ten verticals of each TRL crossbar switch enter incoming registers via a graded or slipped multiple between TRL verticals by tens groups to the incoming registers.

Each trunk has its control connections to guard and connect relays in the TRL circuits as follows: trunk 235 via path 235′; trunk 235*a* via path 235″; trunk 236 via path 236′; trunk 236*a* via path 236″; etc.

These paths enter the composite path or cable 238*a* and emerge via paths such as 239*x* and 239*y* to guard and connect relays in the TRL circuits by means of which the proper horizontal and vertical magnets are operated in the proper TRL crossbar switches to extend the calling trunk to an idle incoming register. It should be noted that the guard relays reflect the idle or busy condition of the associated incoming registers.

The following comments are included at this point to indicate generally the arrangement and number of switch members used under different traffic conditions:

(1) Each line group marker 131 and 132 can serve originating and terminating calls in both five hundred groups 100 and 120. Calls are alternated at random between line group markers.

(2) There may be one or a plurality of group selector markers, such as 110 in each group selector.

(3) The maximum number of SLA switches per five hundred line group is twenty, but a lesser number may be originally equipped. As additional lines are needed, SLA switches may be added up to the maximum.

(4) The number of SLB switches per five hundred line group is determined by the amount of originating and terminating traffic.

(5) The number of GSB switches is determined to a great extent by the number of outlets.

(6) The number of GSA switches is determined by the amount of originating traffic.

(7) Each SRL crossbar switch has access to ten registers.

(8) Each five hundred line group has access to three SRL switches maximum and accordingly to thirty registers.

(9) A graded or slipped multiple exists between the various groups of thirty outlets from SRL switches and a common group of registers.

(10) Every ten registers has its guard and connect relay circuit for access to four sender-translators.

(11) The crossbar switching arrangement indicated by box 239 (TRL) is illustrated in more detail in FIGURE 6, and specifically the manner in which groups of ten trunks have access to ten registers. Additionally it should be observed that a slip multiple exists between outlets from the TRL switches and a common group of incoming registers. As in the case of originating registers, each ten incoming registers has its guard circuit and connect relays whereby it has access to four sender-translators.

(12) Each 1000 called directory numbers had its associated number group circuit. Large systems having over 10,000 directory numbers usually have number groups accommodating 2,000 directory numbers each.

(13) All sender-translators have access to all number group circuits; sender translators of the group 306 through connect relays 307 and sender translators of the group 302 through connect relays 303.

(14) On local to local calls, the battery feed for calling and called lines are in the CRB circuit.

(15) On local to trunk or trunk to local calls, the subscribers line battery feed is located in the trunk.

(16) On trunk to trunk calls the incoming trunk presents a loop condition to the outgoing trunk.

(17) Busy signals are returned from the marker to the sender which signals the trunk. The register, sender, and marker are then released, and the trunk is placed in a lockout condition.

IV. MARKER RELAY GROUPS AND INDIVIDUAL RELAYS

This circuit includes a polar relay AG, connected for operation by 20 cycle alternating current to permit originating call entrance to one of two markers, when contacts LR12 of line relay LR17 in the SLA plug-in unit of FIGURES 18 and 19 are closed. After a marker is seized, the 20 cycle A.C. is cut off by relay AV which feeds direct ground through the contacts of relay LR into the marker for SLA selection. Transfer relays 1L1–4L1 etc. are used to switch from SLA selection to line selection. Relays 1AW–3AW are cut-off relays which are not released until the marker is released.

The line entrance originating circuit comprises the following relays:

AF: Polarized relay which operates from 20 cycle alternating current for selecting one of two markers.

AV: Operates after marker seizure to cut-off A.C. supply and to provide ground for SLA-group selection in the marker (see relays A1–A20 in the marker MLI circuit comprising FIGURES 38–41 and 54–57). Also operates relays in the line pay-station identification circuit LP1 comprising FIGURE 16 to facilitate placing of ground through RC (i.e. resistance-capacitance) network to the sleeve of paystation lines on originating calls only.

1AW–3AW: Operates as soon as SLA group is established to cut-off original ground to relays A1–A20 of MLI.

1L1–4L1 to 1L10–4L10: Operates as soon as SLA–group is established to transfer the ground windings of relays A1–A20 to operate line identity relays B0–B24 of MLI. These relays prevent the identifying of a line that does not want the marker, in all cases except certain related lines in adjacent SLA groups such as 1–2, 3–4, etc.; the possibility of occurrence of such condition and double selection as a result thereof is so negligible as to be tolerated in the interest of economy.

Marker line identifier circuit (MLI) (see FIGURES 38–41 and 54–57)

This circuit provides connecting relays for working with two 500 groups and also identity relays for the SLA groups and lines within the group.

A group of miscellaneous relays are utilized for marker entrance and release functions.

This circuit comprises the following relays:

1AN1–5AN1, 1AN1A, 5AN1A: Connecting relays for the 1st 500 group of lines.

1AN2–5AN2, 1AN2A, 5AN2A: Connecting relays for the 2nd 500 group of lines.

A1–A20: SLA group identifying relay. Many may operate, only one will lock.

B0–B24: Line (in SLA group) identifying relay. Many may operate, only one will lock.

1AA, 2AA, 3AA: Operate after A1–A20 to open original operating battery to A1–A20.

AB: Operates from 1AA, 2AA, 3AA. Timing permits only one up of A1–A20.

1BA, 2BA, 3BA: Operate after B0–B24 to open original operating battery to B0–B24.

4BA: Closes ground for vertical and horizontal control circuits.

BB: Operates from 4BA. Timing permits only one up of B0–B24.

1ABL: Operates from MTT circuit to prevent use of marker for original calls when a term call is in progress.

1PBX: Indicates a terminating PBX call and arranges for selection of B20–B24 and A1–A20 on PBX calls.

K1: Normally operated and releases only if trouble is encountered, to signal and seize the trouble recorder.

K2: A 100 millisecond slow release relay to release the signal to the trouble recorder.

REL1: Operates at same time trouble recorder is seized to operate cut-off relay CO of line, preparatory to putting line on lockout.

REL2: Releases locked up relays of groups B0–B24 and A1–A20 when congestion is encountered, also operates line cutoff relay CO.

ANA: Operates when 500 line group is identified to open original marker selection leads.

ANB: Provides ground and battery circuits for relay chains comprising relay groups B0–B24 and A1–A20.

1ANC, 2ANC: Provides for shifting 500 line alternator; start register selection, open 20 cycle A.C. and perform other miscellaneous control functions.

1AND, 2AND: Shift original locking circuits of ANA and ANB to effect release. Provides for "holding" grounds to marker and opens original seizure circuits.

It should be noted that relays G0–B24, A1–A20 and PBX are used on terminating calls to provide PBX selection.

Marker line identifier auxiliary circuit (MLIA)

This circuit is purely an auxiliary strip for MLI and contains blocking relays to prevent marker entrance, if a terminal call to the same 500 group is being placed in the companion marker. Also capacitors are provided to regulate two release cycles for marker occupancy.

This circuit comprises the following relays (see FIGURE 70):

T1: Guard relay indicating call to first 500 group on terminating call by companion marker.

T2: Guard relay indicating call to second 500 group on terminating call by companion marker.

Marker line miscellaneous circuit (MLM)

This circuit contains two "jump rotators" (explained hereafter) for use with MLI and one alternator for 500 group preference. Also, connecting relays for PBX selection are included in this plug-in strip.

This circuit comprises the following relays (see FIGURE 71):

10A1–60A1: Rotator relays for supplying hold circuit for relays B0–B24 (MLI).

10A2–40A2: Rotator relays for supplying hold circuit for relays A1–A20 (MLI).

10B–20B: Rotator relays for supplying hold circuit for relays 1AN1, 1AN2 (MLI).

1PN1–4PN1: Connecting relays for effecting PBX calls to first 500 group.

1PN2–4PN2: Connecting relays for effecting PBX calls to second 500 group.

Marker pay stations circuit (MPR)

This circuit contains relays and a 12 kilocycle oscillator for identifying calling paystations and routing them to a CRA associated with a Coin Box Trunk (CBT). See FIGURE 72. This same oscillator is used to detect reverting calls for terminating service.

This circuit comprises the following relays:

1PS: Releases when a paystation originating call is made or a reverting terminating call is made.

2PS: Operates when 1PS releases and marker is not in use. Re-routes paystation calls to CRS's without CBT's and makes reverting calls ineffective.

2RD: Operates to facilitate reverting call test.

Line horizontal pull circuit (LHP)

This circuit provides connecting relays for horizontal magnets of the SLB switches and is controlled from the SLA switches and the SLB vertical path finder chain.

This circuit comprises the following relays (see FIGURE 21):

S1, 2S1, to 1S10, 2S10: SLB horizontal connect relays controlled from SLA's 1–10, SLA 11–20.

1S11, 2S11: SLB horizontal connect relays controlled from SLA's 1–10.

1S12, 2S12: SLB horizontal connect relays controlled from SLA's 11–20.

Marker vertical originating circuit (MVO)

This circuit has 500 group connecting relays for testing into the SLA and SLB switches; a path finder chain for testing over 20 SLB verticals at one time; and also a "jump rotator" for use with originating and terminating path-finder chains.

Certain miscellaneous relays are also provided to effect path-finder chain operation and also horizontal and vertical pulling circuits.

This circuit comprises the following relays (see FIGURES 42, 43, 58 and 59):

1CN1–3CN1: First 500 group connect relays for SLA 1–20 selection and SLA horizontal magnets and horizontal S wire test circuits.

1CN2–3CN2: Second 500 group connect relays for SLA 1–20 selection and SLA horizontal magnets and horizontal S-wire test circuits.

1FN1–4FN1: First 500 group connect relays for SLA 1–20 vertical magnets and test circuits and SLB horizontal magnets.

1FN2–4FN2: Second 500 group connect relays for SLA 1–20 vertical magnets and test circuits and SLB horizontal magnets.

ASG1–ASG20: Rotator for originating and terminating path finders.

AG1–AG20: Originating path finder selection chain.

AGA, AGB: Originating path finder ground starting relays.

AGC: "One up" path finder relay for horizontal control.

AGD: Originating vertical control.

HF1 and HF2: SLB and SRL horizontal operated supervisory relays.

Marker CRA test circuit (MCT)

This circuit has 500 group connecting relays for testing over three groups of SLB verticals per 500 group.

SLA vertical test relays are also a part of this circuit as well as relays for indicating a paystation call or a non-paystation call, which open certain SLB vertical test circuits, as required.

This circuit comprises the following relays (see FIGURES 46, 47, 62 and 63):

7AN1–10AN1, 11AN1–14AN1, 15AN1–18AN1: First

500 group vertical test and pull circuits for SLB groups 1–3.

7AN2–10AN2–14AN2, 15AN2–18AN2: Second 500 group vertical test and pull circuits for SLB groups 1–3.

1V1–1V10: SLA vertical test relays carrying SLB vertical test circuits.

1CRA–3CRA: SLB vertical test blocking relays. Operate on non-paystation originating calls to open CRA with CBT test verticals. All breaks are strapped when no paystations are in the 500 groups associated with this marker.

1PCRA–3PCRA: SLB vertical test blocking relays. Operate on paystation originating calls to open CRA without CBT test verticals. All breaks are strapped when no paystations are in the 500 groups associated with this marker.

Note: CBT's must be always the same in each of two 500 groups and associated with the same CRA's in each 500 group.

6AN1, 6AN1A: First 500 group connecting relays for controlling SLB groups 1, 2, 3.

6AN2, 6AN2A: Second 500 group connecting relays for controlling SLB groups 1, 2, 3.

1RS1, 1RS2, 1RS3: Primary control relays for testing to registers associated with SLB groups 1, 2, and 3.

Marker register test circuit (MRT)

This circuit is used for testing for one to ten idle registers and selecting one. Register group hunting relays are also provided to hunt over 3 groups of ten registers.

A rotator and a counting chain are provided for proper functioning of both circuits.

This circuit comprises the following relays (see FIGURES 44, 45, 60 and 61):

0T1–0T10: Register selection rotator relays for changing register preference.

1T1–1T10: Parallel test relays to 1600 ohm battery for register selection.

2T1–2T10: Slave relays of 1T1–1T10 to guard against more than one register selection.

X1, Y1: Register group stepping relays.

X2, Y2: Pathfinder group stepping relays.

1, 2, 3: Counting chain to register maximum number of register groups to be tested before release.

3ANC: Slave of 1ANC (MLI), to start register selection.

0A1 to 0A4: Pre-set register group selection rotator. Hunting for three groups will be 0A1, 0A2, 0A4; 0A2, 0A4, 0A1; 0A4, 0A1, 0A2. Hunting for two groups will be 0A1, 0A2; 0A2, 0A3; 0A3, 0A4; 0A4, 0A1; 0A1, 0A2', etc.

Subscribers' line A circuit (SLA)

This circuit provides for 25 line equipments, marker connecting relays and one crossbar switch. Ten verticals are provided, which are connected to SLB horizontals. This circuit is used on both originating and terminating calls.

This circuit comprises the following relays (see FIGURES 18 and 19):

1A–3A: Connecting relays for horizontal magnets, vertical magnets and vertical and S-wire test circuits operate.

LR: Operates when call is made, and releases after an idle register is selected.

CO: Operates when an idle register is seized or when a terminating call is made.

LO: Operates when an idle register is seized or when a terminating call is made. Also holds when ground is removed from S-wire with the subscriber loop closed for a lockout indication.

In each SLA circuit twenty-five lines are connected to the horizontals; and the ten verticals are connected to SLB horizontals for use on originating and terminating calls.

Subscribers' link B circuit (SLB)

This circuit provides for four CRA's (maximum 60 CRS's per 500 group) which are used on originating calls only to provide a path to an idle register and subsequently to a CRB or trunk, via the group selectors.

One crossbar switch of 10 verticals (four for originating calls, six for terminating calls) is provided, the horizontals of which are connected to SLA verticals. The four originating verticals are arranged for connecting to a coin box trunk (CBT) from certain SLB circuits. When no coin box trunk is connected, K-wiring is used. This circuit is used for both originating and terminating calls.

This circuit comprises the following relays (see FIGURES 22, 23 and 24):

R1: Operates when register is seized to provide holding grounds forward and backward and to disconnect the calling tip and ring from the sender tip and ring.

R2: Operates after all digits are dialed to apply ground forward on "S" lead to seize the group selector marker.

R3: Low would retard coil which presents a high impedance to 12,000 cycle tone from the reverting call test circuit.

In each SLB switch the horizontals are split and twenty SLB horizontals have access to the first five verticals V1–V5 and 20 horizontals have access to the last five verticals V6–V10. These forty SLB horizontals are connected in a predetermined pattern to forty SLA verticals. Four SLB verticals are connected to four CRA's and group selector inlets and SRL horizontals for originating traffic (V1, V2, V6, V7).

Six SLB verticals are connected to SLC horizontals (V3, V4, V5, V8, V9, V10), for terminating traffic.

Subscribers' register link circuit (SRL)

This circuit provides a path from a CRA (shown on SLB circuit) to one of 10 registers. One crossbar switch is equipped with 10 verticals connected to the registers. The horizontals are connected to 20 CRA's.

Connecting relays are provided to connect the switch to one of two markers, this circuit being used for originating calls only.

This circuit comprises the following relays (see FIGURES 25, 26, 27):

1R11–6RL1: Connecting relays to first subscriber line marker (SLM–1).

1R11–6RL2: Connecting relays to second subscriber line marker (SLM–2).

In each SRL switch twenty horizontals are connected to the four verticals V1, V2, V6, and V7 and to the associated CRA's of five SLB switches.

The ten verticals of each SRL are connected to a local originating register.

Subscribers' line C circuit (SLC)

This circuit provides a path from a CRB (on SLC vertical) to the verticals to the SLB switches and comprises the following relays (see FIGURE 28):

EN1: Connecting relays to first subscribers line marker.

EN2: Connecting relays to second subscribers line marker.

In each SLC switch twenty horizontals are connected to various verticals V3, V4, V5, V8, V9 and V10 of five predetermined SLB switches.

Each of the ten verticals is connected to a CRB.

Line (CRB) entrance terminating circuit (LET)

This circuit provides for operation of a polar relay from twenty-cycle alternating current to permit terminating call entrance to one of two code receiver registers (MCR) when contacts of the CRB are closed.

After a MCR is seized, the twenty-cycle A.C. is cut off by relay RAV which feeds direct ground through contacts in the CRB circuit into the MCI circuit for CRB identifi-

cation. Transfer relays 1C1, 2C1, etc., are used to switch from CRB group identity to CRB individual identity. Relay RAW is a cut-off relay, which is not released until the marker is released.

This circuit comprises the following relays (see FIGURE 29):

RAG: Polarized relay which operates from 20 cycle alternating current for selecting one of two markers.

RAV: Operates after marker seizure to cut-off 20 cycle A.C. and to provide ground for CRB group selection in the marker (relay RA1–RA6 in the MCI circuit).

RAW: Operates as soon as SLB group is established to cut off original ground to relays RA1–RA6 of the MCI circuit.

1C1, 2C1 to 1C6, 2C6: Operate as soon as CRB group is established to transfer the ground windings of relays RA1–RA10 to operate CRB identity relays RB1–RB10 of MCI.

These relays prevent the identification of a CRB that is not in the process of calling for a marker.

Marker CRB identifier circuit (MCI)

This circuit provides connecting relays for working with two 500 line groups of CRB's and also identity relays for CRB groups of ten each and CRB's within the group.

A group of miscellaneous relays are supplied for code receiver entrance and release functions.

Two "jump rotators" and one alternator for 500 group preference are provided.

This circuit comprises the following relays (see FIGURES 50, 51, 66 and 67):

1RAN1–5RAN1, 1RAN1A: Connecting relays for CRB's associated with the first line group (maximum of seventy shown).

1RAN2–5RAN2, 1RAN2A: Connecting relays for CRB's associated with the second line group (maximum of seventy shown).

RA1–RA7: CRB group identifying relays. Many may operate, only one will lock.

RB1–RB10: CRB (in CRB group) identifying relay. Many may operate, only one will lock.

1RAA: Operates after RA1–RA6 to open original operation battery to RA1–RA6.

RAB: Operates from 1RAA. Timing permits only one up of RA1–RA6.

1RBA, 2RBA: Operate after RB1–RB10 to open original operating battery to RB1–RB10.

3RBA: Closes ground for horizontal and vertical contact circuits.

RBB: Operates from 1RBA. Timing permits only one up of RB1–RB10.

K3: Normally operated. Releases only if trouble is encountered, to signal and seize the trouble recorder.

K4: A 100 millisecond slow release relay to release the signal to the trouble recorder.

K5: Congestion busy or marker code receiver failure relay.

RANA: Operates when 500 group is identifier to open original marker selection leads.

RANB: Provides ground and battery circuits for RA and RB relay chains.

1RANC, 2RANC: Provide for shifting 500 line alternator, opens 20 cycle A.C. and perform miscellaneous control functions.

1RAND, 2RAND: Shift original locking circuits of RANB to effect release. Provide for "holding" grounds to marker and open original seizure circuits.

1ROA1–4ROA1: Rotator relays for supplying hold circuit for relays RA1–RA6.

1ROB, 2ROB: Rotator relays for supplying hold circuit for relays 1RAN1 and 1RAN2.

Line connecting terminating circuit (LCT)

This circuit consists of relays for effecting selective connection of each of a plurality of CRB's to the MCR and MTT circuits and is used for terminating calls only.

This circuit comprises the following multiple relays (see FIGURE 33):

M1–M10: Connecting relays for CRB's 1–20.
M11–M20: Connecting relays for CRB's 21–40.
M21–M30: Connecting relays for CRB's 41–60.
M31–M40: of which M31–M35 comprise connecting relays for CRB's 61–70; M39 comprises a connecting relay for odd CRB's; and M40 comprises a connecting relay for even CRB's.

Marker vertical (test) terminating circuit (MVT)

This circuit has a pathfinder chain for testing over 20 SLB verticals at one time and is used for terminating calls only.

Certain miscellaneous relays are provided to effect pathfinder chains operation and also horizontal and vertical pulling circuits.

The circuit comprises the following relays (see FIGURES 75, 76 and 77):

DG1–DG20: Terminating pathfinder selection chain.
DGA, DGB: Terminating pathfinder ground starting relays.
DGC: "One up" pathfinder relay for horizontal control.
DGD: Terminating vertical control.
HF3, HF4: SLB and SLC horizontal operated supervisory relays.
R: Release and reselect if horizontals do not operate.
CB: Terminating call, "no path" relay.

Marker vertical connecting circuit (MVC)

This circuit has 500-group connecting relays for testing into the SLA and SLB switches. SLA vertical test relays are also a part of this circuit.

Connecting relays are also provided for establishing connections to the proper SLC switch. This is used for terminating calls only.

This circuit comprises the following relays (see FIGURES 48, 49, 64, and 65):

1BN1–1 to 6BN1–1: SLB group-1 vertical and horizontal control circuits connecting relays for the first 500 group.

1BN2–1 to 6BN2–1: SLB group-1 vertical and horizontal control circuits connecting relays for the second 500 group.

1BN1–2 to 6BN1–2: SLB group-2 vertical and horizontal control circuits connecting relays for the first 200 group.

1BN1–3 to 6BN1–3: SLB group-3 vertical and horizontal control circuits connecting relays for the first 500 group.

1BN2–3 to 6BN2–3: SLB group-3 vertical and horizontal control circuits connecting relays for the second 500 group.

2V1 to 2V10: SLA vertical test relays.

1A–3A, 1B–3B, 1C–3C: SLB vertical test and pull connect relays (work with path-finder chain).

Marker CRB connecting circuit (MCC)

This circuit is used in conjunction with circuit LCT to provide for operating circuits in the LCT. Also 500-group connecting relays are provided to carry certain control wires from the LCT to other circuits. This circuit is used on terminating calls only.

This circuit comprises the following relays (see FIGURES 52, 53 68 and 69):

5RAN1: CRB control circuit connecting relays for the first 500 group.

5RAN2: CRB control circuit connecting relays for the second 500 group.

S1–S7: CRB group connecting relays control circuits for both 500 groups. Relays S1–S7 are associated with the seven groups of CRB's respectively: **1–10; 11–20; 21–30; 31–40; 41–50; 51–60; 61–70.**

Marker terminating test circuit (MTT)

This circuit is provided for testing the called lines "S" wire to determine idle, busy, or reverting call conditions. Other connecting and guard relays are provided to determine the 500-group to be used.

This circuit comprises the following relays (see FIGURES 78, 79 and 80):

O1: Blocking relay when an originating call in the first 500 group is progressing through the companion marker.
O2: Blocking relay when an originating call in the second 500 group is progressing through the companion marker.
RBL: Blocking relay when an originating call is progressing through the marker.
2ABL: Blocking relay when a terminating call is progressing through the marker.
2PBX: Marking relay when a terminating PBX call is being made.
BY1, IA: Idle line indicating relays.
DN1, DN2: SLB connect relay control for first and second 500-groups.
BYP1, BYP2: PBX group busy relays.
BT: "S" wire control relay.
BY2: Line busy relay.
WC: Wire chief test or busy verification relay; also used to establish reverting call circuit.
1RC: Indicates ground on the "S" wire to set up reverting call test.
RC: Reverting call indicating relay.

Line PBX terminating circuit (LPX)

This circuit receives information from the MCR circuit for PBX calls and controls connection of a calling line to the first idle PBX line of a PBX group. Twenty groups or less of PBX lines, totaling a maximum of 100 lines may be used. Only five lines (**20–24**) of each SLA switch are available for PBX service.

This circuit comprises the following relays (see FIGURE 20):

P1–P20: PBX group selection relays for a maximum number of 20 PBX groups of five trunks each. These relays may be operated in parallel, or from relay D1 to form any number of PBX trunks in one group (maximum 100). Knife blade jacks are used to facilitate the use of normally reserved PBX lines as regular lines; and to also "busy" any PBX trunk as required for maintenance.
11RT–20TR: Control relays operated by relays A1–A20 respectively in the marker.
D1: Slave relay to provide for parallel operation of several relays P1–P20 as required.

Coin box trunk circuit (CBT)

This circuit is used with a CRA (see SLB) to provide for collect and refund voltages on pre-pay paystations. Time disconnect of conversation is provided if desired.

This circuit comprises the following relays (see FIGURE 34):

CC: Coin collect.
CT: Coin test.
CF: Coin flash.
CD: Coin disposal.
S: Supervisory.
H: Hold.
SL: Sleeve.

Marker code receiver circuit (MCR)

This circuit provides for receiving the hundreds, tens and units signals (terminating number) from the sender and also certain information to access PBX trunk groups.

This circuit comprises the following relays (see FIGURES 73, 74):

R1–R5: Code receiver relays.
H1–H5: "Hundreds" register relays.
TA, T1–T5: "Tens" register relays.
U1–U5: "Units" register relays.
CRG: Code receiver ground supply relay.
RA1–RA3: Register sequence relays.
CA: Timing switching relay.
TO1, TO2: Timing relays.
Q1–Q4: SLA and PBX group identity relays.
27–LU, LU, 27–89, 1469, 0358: SLA horizontal determination relays.

Cord relay-B circuit (CRB)

This circuit provides for receiving codes indicative of called party ringing from the sender; codes from the sender indicative of origin such as local call, trunk call, toll call (delayed ring), test call; and a code indicative of fact that a call is in progress to a charge-free phone.

This circuit also has the talking bridge which is bypassed for all trunk and test calls and is accessed from the group selectors by 500-groups with a maximum of 70 per group shown.

Cord relay B circuit comprises the following relays (see FIGURES 30–32):

RS: Ring start.
RT: Ring trip.
WC: Wire chief.
DR: Delayed ring.
RR: Ring reverse.
RP: Ring pickup.
RV: Revert call.
LC: Local call.
A: Calling subscriber battery feed.
B: Called subscriber battery feed.
TK: Trunk call.
H: Hold.
MB: Make busy.
VO: Vertical operated.
CS: Call signal.
RA: Ring selection auxiliary.
R1: Ring selection.
R2: Ring selection.
R3: Ring selection.
R0: Ring selection.
R4: Ring selection.
R5: Ring selection.
R6: Ring selection.

Line pay station identity circuit (LPI)

This circuit consists of 75 resistor-capacitor networks and the necessary connecting relays for use with a maximum of 75 paystations per 500 line group.

LPI comprises the following relays (see FIGURE 16):

1PST–5PST: Relays operated from LEO circuit to place RC ground on "S" wire of paystation lines to provide a feed-back path for the 12 kc. oscillator of circuit MPR to identify paystation lines.

Register circuit (REG)

This circuit provides registers for receiving the dialed digits; means for paystation control, etc.

The register circuit comprises the following relays (see Figures 35–37):

RD—Register disconnect.
R—Ring conductor.
T—Tip conductor.
BT—Bad test.
CT—Coin test.
CD—Coin deposited.

CB—Coin box (i.e. paystation).
H1—Hold.
H1—Hold.
ON1—Off-normal.
ON2—Off-normal.
TO—Time out.
RC—Register control.
PR—Proceed.
CS—Call signal.
C1 to C6—Counting chain.
RA1–RA10—Register advancing relays associated with digits.
R11–R17—1st register (digit 1).
R21–R27—2nd register (digit 2).
R31–R37—3rd register (digit 3).
R41–R47—4th register (digit 4).
R51–R57—5th register (digit 5).
R61–R67—6th register (digit 6).
R71–R77—7th register (digit 7).
Box "digit 8"—8th register (digit 8).
Box "digit 9"—9th register (digit 9).
Box "digit 10"—10th register (digit 10).

V. IDLE CONDITION

In the idle condition with no calls passing through the markers, relays K1 and K2 in MLI, 10A1 for example, and 10A2 for example in MLM, 1PS in MPR, 0T1 and 0A1 for example in MRT, may be in the operated condition. The following relays in the terminating end of the marker may also be normally operated: relays K3, K4, 4ROA1, 4ROA2 in MCI. Relays 10B and 20B in MLM may or may not be in the operated condition as they are both operated on one call, both released on the next, etc. Relays 1ROB and 2ROB in MCI may or may not be operated.

The operating circuits for these relays are as follows.

Relay K1 (FIGURE 41) initially operates from battery over its upper winding, break contacts *e*, of relay K1 and break contacts *e* of relay 1ANC to ground; and locks from battery over its upper and lower windings in series, make contacts *b* of relay K1, and break contacts 3 of relay 1ANC to ground. Relay K1 operates slow release relay K2 (FIGURE 41) from battery through the winding of relay K2, a 6800 resistor, and make contacts *d* of relay K1 to ground.

Relays K1 and K2 control signaling to a trouble recorder and the release of the marker.

Relay 10A1 (FIGURE 71), for example, a rotator relay for supplying a holding circuit for relays B0–B23, is operated initially over the circuit from battery through the upper winding of relay 10A1, conductor 33, cable to MLI, cable 33–38, conductor 33, make contacts *i* of any relay B0–B3 (when it operated previously), make contacts *i* of relay BB, to ground; and locks over the circuit from ground, make contacts *c* of relay 10A1, lower winding of relay 10A1, break contacts 3 of relays 20A1–60A1 in series, and 2000 ohm resistor to battery. With relay 10A1 operated and locked, ground through break contacts *b* of relay BB, the lower winding of relay 1BA, break contacts *d* of relay BB, break contacts *g* of relay 1PBX, conductor 45, cable to MLM, conductor 45, break contacts *b* of rotator cut-out key, make contacts *a* of relay 10A1, conductor 40, cable to MLI, cable 39–44 and conductor 40 enters the lower locking chain of relays B0–B24 between the break contacts *e* of relay B0 and the lever associated with contacts *d* and *e* of relay B24 whereby relay B24 takes precedence in locking over relays B0–B23; relay B23 takes precedence in locking over relays B0–B22; etc.

Relay 10A2 (FIGURE 71), for example, a rotator relay for supplying a holding circuit for relays A1–A20 is operated initially over the circuit from battery through the upper winding of 10A2, conductor 46, cable to MLI, cable 46–49, make contacts *i* of any relay A1–A5, make contacts *g* of relay AB to ground; and locks over the circuit from ground, make contacts *c* of relay 10A2, lower winding of relay 10A2, break contacts *e* of relays 20A2–40A2, and 2000 ohm resistor to battery. With relay 10A2 operated and locked, ground through the winding of relays 1AA, 2AA, and 3AA of MLI in parallel, break contacts *e* of relay 1PBX, conductor 54, cable to MLM, conductor 54, break contacts *b* of rotator cutout key, make contacts *a* of relay 10A2, conductor 51, cable to MLI, cable 50–53, and conductor 51 enters the lower locking chain of relays A1–A20 between break contact *f* of relay A1 and the lever associated with contacts *e* and *f* of relay A20, whereby relay A20 takes precedence in locking over relays A1–A19; relay A19 takes precedence in locking over relays A1 to A18; etc.

Relay 20B (FIGURE 71) operates initially from battery through the winding of relay 20B, break contacts *a* of relay 10B, conductor 31, cable to MLI, conductor 31, and make contacts *d* of relay 2ANC to ground; and locks from battery through the winding of relay 20B, make contacts *a* of relay 20B, lower winding of relay 10B, conductor 32, cable to MLI, conductor 32, and break contacts *e* of relay 2ANC (FIGURE 41) to ground, when relay 2ANC releases operating relay 10B. It should be noted that relay 20B is shunted by a 10,000 ohm resistor whereby it is made slow to release so that it does not release during the transfer of relay 2ANC. Ground through break contacts *k* of relay 1AND, break contacts *c* of relay 1ANC, conductor 30, cable to MLM, conductor 30, closed break contacts *b* of the manual key, make contacts *c* of relay 10B, conductor 29, cable to MLI, conductor 29, to the locking lever of relay 1AN2 gives relay 1AN2 priority in locking over relay 1AN1, and accordingly gives the second 500 line group priority in seizing the marker if both should attempt to seize the marker simultaneously.

On the next operation of relay 2ANC (FIGURE 41), relay 20B is released due to the removal of holding ground from conductor 32, but relay 10B holds from battery through the upper winding of relay 10B, make contacts *b* of relay 10B, conductor 31, cable to MLI, conductor 31, and make contacts *d* of relay 2ANC to ground. When relay 2ANC releases, relay 10B is dropped. Ground through break contacts *j* of relay 1AND, break contacts *c* of relay 1ANC, conductor 30, cable to MLM, conductor 30, closed break contacts *b* of manual key, break contacts *d* of relay 10B, conductor 28, cable to MLI, conductor 28, to the locking lever of relay 1AN1 gives relay 1AN1 priority in locking over relay 1AN2, and accordingly gives the first 500 line group priority in seizing the marker if both should attempt to seize the marker simultaneously.

Relay 1PS (FIGURE 72) is operated over the circuit from ground, through the winding of relay 1PS, through the anode-cathode space path of 50C5 tube which is in the conducting state, to negative battery. The operation of relay 1PS holds ground off its signalling contacts *c* and *d*; and closes its contacts *b* to normally prepare for a non-paystation call.

Referring now to the MRT circuit, relays 0T1–0T10 (FIGURES 44–45) constitute an originating register preference chain. Relay 0T1, for example, may be operated and locked, giving register 1 first preference. Relay 0T1 operates from battery through its lower winding and break contacts *k* of relays 0T2–0T10, break contacts *j* of 0T1, and resistor *j*, to ground; and locks over the circuit from battery through its lower winding, break contacts *k* of relay 0T2, make contacts *k* of relay 0T1, and resistor *j'* to ground, disconnecting this ground from the levers of the other relays. Relay 0T1 prepares a circuit for relay 0T2 from battery through the lower winding of relay 0T2, upper winding of relay 0T1, make contacts *i* of relay 0T1, break contacts *m* of relay 0T10, break contacts *b* of manual rotator stop key, break contacts *d* of relay 3ANC, conductor 3, cable to MLI, conductor 3, make contacts *f* of relay ANB to ground. When relay

ANB (FIGURE 40) operates, relay 0T2 operates and relay 0T1 holds. When relay ANB releases, relay 0T1 is released and relay 0T2 holds from battery through the lower winding of relay 0T2, make contacts *j* of relay 0T2, break contacts *k* of relays 0T3–0T10, break contacts *j* of relay 0T1, and resistor *j*, to ground. Relay 0T2 gives register 2 preference on the next call.

Referring now to relays 0A1–0A4 (FIGURE 60) in the MRT circuit, relay 0A1, for example, is a rotator relay and may be operated and locked, giving the first subscribers line register group circuit (SRL–1) first preference. Relay 0A1 is initially operated over the circuit from battery through the 600 ohm upper winding of relay 0A1, break contacts *a* of relays 0A2–0A4, break contacts *b* of relay 0A1, and 1000 ohm resistor *b'* to ground; and holds from battery through its upper 600 ohm winding, break contacts *a* of relay 0A2, make contacts *a* of relay 0A1, through the 1000 ohm resistor to ground, disconnecting the 1000 ohm ground from relays 0A3 and 0A4. Relay 0A1 prepares a circuit for 0A2 from battery through the upper winding of relay 0A2, lower 400 ohm winding of relay 0A1, make contacts *c* of relay 0A1, break contacts *d* of relay 0A4, to open make contacts *e* of relay X2. With relay 0A1 operated, relay 1RS1 (MCT circuit) is prepared for operation.

Relay K3 (MCI) is normally operated over the path from battery through the winding of relay K3, and contacts 2RANC–*e* to ground.

Relay K4 (MCI) is normally operated over the path from battery through the winding of relay K4, contacts K3–*b*, and K5–*b* to ground.

Relay 4ROA1 (MCI) is normally locked over the path from battery, through a resistor, the lower winding of relay 4ROA1, contacts 4ROA1–*c*, and break contacts *d* of relays 3ROA1–1ROA1, to ground, the relay having been operated on a previous call from ground placed on lead 9 by the marker. If none of these relays had as yet been operated by the marker, it should be observed that a path exists from conductor 5 through their break contacts *b* in series to conductor 1 which gives the same effect as though relay 4ROA1 were operated.

Relay 4ROA2 (MCI) is normally locked over the path from battery, through a resistor, the lower winding of relay 4ROA2, contacts 4ROA2–*c*, and break contacts *d* of relays 3ROA2–1ROA2 to ground, having been operated on a previous call from ground placed on lead 9 by the marker. If none of these relays had as yet been operated by the marker, it should be observed that a path exists from conductor 5 through their break contacts *b* in series to conductor 1 which gives the same effect as though relay 4ROA2 were operated.

Relays 1ROB and 2ROB (MLI) are normally both up at the beginning of one call and both down at the beginning of the next call, alternating on successive calls, and are operated by contacts *c* and *d* of relay 1RANC in similar fashion to the operation of relays 10B and 20B of the MLM circuit by contacts *d* and *e* of relay 2ANC of the MLI circuit.

VI. ORIGINATING CALL

As hereinbefore described, a subscriber line marker is used to originate a call and is then dismissed; and a subscriber line marker is called in and used on the termination of a call. Two such markers are provided for two line groups such as 500 line groups; and both markers are used for originating and terminating calls. The same marker which is used on the origination of a call is not necessarily the one used to establish the terminating connection of a call, although it may be.

Accordingly, we shall describe the operation of the marker for an originating call in this section of the description, and its operation for a terminating call in a subsequent section.

A. *Call for subscriber line marker*

Referring now to FIGURES 5 and 6, we shall describe first the operation of the system in seizing either of two subscribers line markers from either of two subscribers line groups.

Relays AG, AV, 3AW, and 3LI (FIGURE 5) are line entrance relays associated with the first 500 line group; relays AG', AV', 3AW' and 3LI' with the second 500 line group.

Relays 2ANC, 1AN1A, 1AN2A, ANA, 2AND, 1ABL, T1, T2, 1AN1, and 1AN2 (FIGURE 6) are subscribers' line marker relays associated with the first marker; relays 2ANC', 1AN1A', 1AN2A', ANA8, 2AND', 1ABL8, T1', T2', 1AN1' and 1AN2' with the second marker.

1. Both markers idle

(1) Call from first 500 line group

(I) Landing in first marker

Assuming that as shown in FIGURES 5 and 6, a calling subscriber on line 17 of the first group of twenty-five lines in the first 500 group of lines, that is, the group of lines terminating on the first SLA switch (SLA–1), lifts his receiver, a circuit is closed over the calling line loop to operate associated line relay LR17 on SLA–1.

Relay LR17 of SLA–1 operates and at its make contacts 12 closes a circuit to operate polarized relay AG as follows: ground through the winding of relay AG, break contacts 4603 of relay AV, break contacts C of 2AW, break contacts A of relay 3LI, conductor 1202 make contacts 12 of relay LR17, close contacts A of SLA–1 manual switch BK, conductor 1201, 10,000 ohm resistor, break contacts 4602 of AV and a 5000 ohm resistor, conductor 4601, in parallel through similar circuits in each subscriber's line marker. In SLM–1 this circuit is as follows: break contacts *a* of relay 2ANC, break contacts *a* of relay 1ABL, lamp WE13G, twenty cycle current source to ground. In SLM–2 this circuit is as follows: break contacts *a* of 2ANC', break contacts *a* of relay 1ABL', lamp WE13G', through the twenty cycle current source to ground.

Relay AG responds to the 20 cycle alternating current, closing its contacts 4604 or 4605 according to the phase of the current, it being understood that this lever is in the center position when relay AG is non-energized.

In its lever lower position, contacts 4604 close a circuit to relay 1AN1 in marker SLM–1 from ground through contacts 4604, conductor 4606, closed fuse contacts, break contacts *b* of relay ANA, break contacts *b* of relay 2AND, conductor 4, cable MLIA–MLI, contacts of relay T1 (MLIA) conductor 1, cable MLIA–MLI, conductor 1, winding of relay 1AN1, break contacts C of relay 1ABL, conductor 4608, 1,000 ohm resistor to battery.

In its lever upper position, contacts 4605 of relay AG close a circuit to relay 1AN1' in marker SLM–2 from ground through contacts 4605 of relay AG, conductor 4607, break contacts *b* of relay ANA', break contacts *b* of relay 2AND', break contacts A of relay T1', winding of relay AN1' break contacts *c* of relay 1ABL', conductor 4608', 1,000 ohm resistor to battery.

The lever of relay AG may operate one of these relays 1AN1 or 1AN1' upon its first engagement with associated contacts 4604 or 4605 or it may go through one or more cycles before one of these relays operates, depending upon the valve of the circuit constants.

Either of these relays shunts relay AG as follows:

Relay 1AN1 shunts relay AG over the circuit from ground, through make contacts C of relay 1AN1 and conductor 4619.

Relay 1AN1' shunts relay AG over the circuit from ground, through make contacts *c* of relay 1AN1', conductor 4619'.

Relay 1AN1 locks to ground over make contacts *f* or relay 1AN1 or over make contacts *b* of relay 1AN1

and break contacts *b* of relay 1AN2, indicating to marker SLM–1 that the calling line is in the first 500 line group.

Relay 1AN1′ locks to ground over make contacts *b* of relay 1AN1′ or over make contacts *b* of relay 1AN1′ and break contacts *b* of relay 1AN2′, indicating to marker SLM–2 that the calling line is in the first 500 line group.

It will be noted that relays 1AN1 and 1AN1′ operate through a common 1000 ohm resistor and that when one of these relays succeeds in closing its locking circuit, the current drain is such as to prevent the other operating.

Accordingly if both relay try to operate during oscillation of the lever of relay AG, the relay 1AN1 or 1AN1′ which succeeds in locking, causes the other to be non-operated.

Assuming that relay 1AN1 operates and locks, a circuit is completed from ground through make contacts *d* of relay 1AN1, and the winding of relay 1AN1A to battery, operating this relay.

Relay 1AN1A operates and at its contacts *a* extends ground over conductor 4609, and the winding of relay AV to battery.

Relay AV opens its break contacts 4602 and 4603, disconnecting the 20 cycle alternating current from polarized relay AG. The lever of AG assumes its middle position, opening the original operating circuit of relay 1AN1.

(II) Landing in second marker

Assuming that relay 1AN1′ in marker SLM–2 operates and locks as before described, a circuit is completed from ground through make contacts *d* of relay 1AN1′ and the winding of relay 1AN1A′ to battery, operating this relay.

Relay 1AN1A′ operates relay AV from ground through contacts *a* of relay 1AN1A′, conductor 4609′, and the winding of relay AV to battery.

As before stated, relay AV opens its break contacts 4602 and 4503, disconnecting 20 cycle alternating current from polarized relay AG, the lever of which assumes its middle position, opening the original operating circuits of relay 1AN1′.

(2) Call from second 500 line group
(I) Landing in first marker

Assuming that a calling subscriber Y on line LR17′ of the first group of twenty-five lines, in the second 500 group of lines, that is the group of lines terminating on the first SLA switch (SLA–1), lifts his receiver, a circuit is closed over the calling line loop to operate associated line relay LR17′ on SLA′–1.

Relay LR17′ of SLA′–1 operates and at its make contacts closes a circuit to operate polarized relay AG′ as follows: ground through the winding of relay AG′, break contacts 4603′ contacts *c* of relay 2AW′, contacts *a* of relay 3L1′, make contacts 12 of relay LR17′ contact *a* of SLA′–1 manual switch, 10,000 ohm resistor, break contact 4602′, and 5,000 ohm resistor in parallel through similar circuits in each subscriber's line marker as traced before.

Relay AG′ responds to the 20 cycle alternating current, operating its contact lever to a first position, closing contacts 4604′ or to a second position closing contacts 4605′ according to the phase of the current.

In its lever lower position, contacts 4604′ close a circuit to relay 1AN2 in marker SLM–1 from ground through contacts 4604′, contacts *a* of relay ANA, contacts *a* of relay 2AND, contacts *a* of relay T2, winding of relay 1AN2, contacts *b* of relay 1ABL, conductor 4608A, and 1,000 ohm resistor to battery.

In its upper position, contacts 4605′ close a circuit to relay 1AN2′ in marker SLM–2 from ground through contacts 4605′, contacts *a* of relay ANA′, contacts *a* of relay 2AND′, contacts *a* of relay T2′, winding of 1AN2′, contacts *b* of relay 1ABL′, conductor 4608A′, 1,000 ohm resistor to battery.

The lever of relay AG′ may operate one of these relays 1AN2 or 1AN2′ upon its first engagement with associated contacts 4604′ and 4605′ or it may go through one or more cycles before one of these relays operates, depending upon circuit constants.

Either of these relays shunts relay AG′ as follows:

Relay 1AN2 shunts relay AG′ over the circuit from ground, through make contacts *c* of relay 1AN2, and conductor 4619A.

Relay 1AN2′ shunts relay AG′ over the circuit from ground, through contacts *c* of relay 1AN2′ and conductor 4619A′.

Relay 1AN2 locks to ground over make contacts *a* of relay 1AN2 or over make contacts *a* of relay 1AN2 and break contacts *a* of relay 1AN1, indicating to marker SLM–1 that the calling line is in the second 500 line group.

Relay 1AN2′ locks to ground over make contacts *a* of relay 1AN2′, or over make contacts *a* of relay 1AN2′ and break contacts *a* of relay 1AN1′, indicating to marker SLM–2 that the calling line is in the second 500 line group.

It will be noted that relays 1AN2 and 1AN2′ operate through a common 1,000 ohm resistor and that when one of these relays succeeds in closing its locking circuit, the current drain is such as to prevent the other locking.

Accordingly, if both relays try to operate during oscillation of the lever of relay AG′, the relay 1AN2 or 1AN2′ which succeeds in locking, cause the other to be non-operated.

Assuming now that relay 1AN2 operates and locks, a circuit is completed from ground through make contacts *d* of relay 1AN2, and the winding of relay 1AN2A to battery, operating this relay.

Relay 1AN2A operates relay AV′ from ground through make contacts *a* of relay 1AN2A, conductor 4609A and the winding of relay AV′ to battery.

Relay AV′ opens it break contacts 4602 and 4603, disconnecting the 20 cycle alternating current from polarized relay AG. The lever of AG assumes its middle position, opening the original operating circuit of relay 1AN2.

(II) Landing in second marker

Assuming that relay 1ANA′ in marker SLM–2 operates and locks as before described, a circuit is completed from ground through make contacts *d* of relay 1AN2′ and the winding of relay 1AN2A′ to battery, operating this relay.

Relay 1AN2A′ operates relay AV′ from ground through contacts *a* of relay 1AN2A′, conductor 4609A′ and the winding of relay AV′ to battery.

As before stated, relay AV′ opens its break contacts 4602 and 4603, disconnecting 20 cycle alternating current from polarized relay AG′, the lever of which assumes its middle position, opening the original operating circuit of relay 1AN2′.

(3) Simultaneous calls from both 500 line groups
(I) First 500 line group landing in first marker and second 500 line group
Landing in second marker

Let us assume for example that both markers are idle and that line relay LR17 of SLA–1 of the first 500 line group and LR17′ of SLA′–1 of the second 500 line group operate simultaneously.

Four paths then exist for twenty cycle current from the markers to polarized relays AG and AG′ as follows:

Ground, winding of relay AG, contacts 4603, break contacts *c* of relay 2AW, break contacts *a* of relay 3L1, conductor 1202, make contacts 12 of relay LR17, closed contacts *a* of manual key, 1000 ohm resistor, break contacts 4602 of relay AV, 5000 ohm resistor, conductor

4601, break contacts *a* of relay 2ANC, break contacts *a* of relay 1ABL, lamp WE13G, source of 20 cycle alternating current to ground.

Ground, winding of relay AG, contacts 4603, break contacts *c* of relay 2AW, break contacts *a* of relay 4L1, conductor 1202, make contacts 12 of relay LR17, closed contacts *a* of manual key, 10000 resistor, break contacts 4602 of relay AV, 5000 ohm resistor, conductor 4601', break contacts *a* of relay 2ANC', break contacts *a* of relay 1ABL', lamp WE13G, source of 20 cycle alternating current to ground.

Ground, winding of relay AG', contacts 4603', contacts *c* of relay 2AW', contacts *a* of relay 3L1', make contacts 12 of relay LR17', closed contacts *a* of manual key, resistor 10000 ohm, contacts 4602', conductor 4601, break contacts *a* of relay 2ANC, break contacts *a* of relay 1ABL, lamp WE13G and source of 20 cycle alternating current to ground.

Ground, winding of relay AG', contacts 4603', contacts *c* of relay 2AW', contacts *a* of relay 3L1' make contacts 12 of relay LR17', closed contacts *a* of manual key, 10000 ohm resistor, contacts 4602', conductor 4601', break contacts *a* of relay 2ANC', break contacts *a* of relay 1ABL', lamp WE13G, source of 20 cycle alternating current, to ground.

Polarized relays AG and AG' both respond, actuating their levers according to the phase of the 20 cycle A.C.

We shall consider four different combinations of positions of levers of AG and AG'.

If contacts 4604 and 4604' are closed simultaneously, both 1AN1 and 1AN2 may operate (over circuits previously described).

Relays 1AN1 and 1AN2 both try to lock over their make contacts. It should be observed however that ground is placed on one or the other of the locking levers of relays 1AN1 and 1AN2 at different times by a rotator (10B–20B, FIGURE 71) described more in detail hereinafter. Accordingly, if the ground obtains on the locking lever of relay 1AN1, relay 1AN1 locks over its make contacts *b* to this ground. Relay 1AN2 also tries to lock to this ground over make contacts *a* of relay 1AN2 and break contacts *a* of relay 1AN1, but relay 1AN1 has opened this circuit and accordingly relay 1AN2 releases. (If the rotator had placed the locking ground on the locking lever of relay 1AN2 instead of relay 1AN1, relay 1AN2 would lock instead of relay 1AN1, the alternate procedure being obvious by analogous reasoning from what follows. However in this case the second 500 line group would land in marker SLM–1 and the first 500 line group in marker SLM–2.)

Relay 1AN1 operates relay 1AN1A which operates relay AV which releases relay AG.

With relay 1AN1 operated and locked, marker SLM–1 is seized by the first 500 line group and the marker is so signalled.

Inasmuch as relay AV' is not operated, relay AG' continues vibrating its lever and the second 500 line group lands in the second subscribers line marker as becomes apparent by a consideration of the case wherein the lever of relay AG initially engages contacts 4605 and the lever of AG' contacts 4604'.

In this case, relay 1AN1 operates, in turn operating relay 1AN1A which operates relay AV, releasing relay AG. Also relay 1AN2' operates, in turn operating relay 1AN2A' which operates relay AV', releasing relay AG'. With relay 1AN1 operated and locked, the first 500 line group has landed in marker SLM–1 and the marker is so signalled; and with relay 1AN2' operated and locked the second 500 line group has landed in marker SLM–2 and the marker is so signalled.

It should be noted that relay 1AN1 places a shunt on relay AG to prevent 1AN1' from operating and locking and that with relay 1AN1' nonoperated, relay 1AN2' can lock, regardless of whether the associated locking ground rotator has ground on the #2 lever of relay 1AN1' or relay 1AN2'.

(II) First 500 line group landing in second marker and second 500 line
Group landing in first marker

Let us assume that the lever of relay AG closes contacts 4605 and that the lever of AG' closes contacts 4605' and that accordingly relays 1AN1' and 1AN2' both operate simultaneously over paths previously traced.

Relays 1AN1' and 1AN2' both try to lock over their #2 make contacts. Here, again, the rotator by controlling locking ground determines whether relay 1AN1' or relay 1AN2' locks.

Assuming that relay 1AN1' locks, it operates relay 1AN1A' which operates relay AV which releases relay AG. (If the rotator had caused relay 1AN2' to be locked instead of relay 1AN1', the second 500 line group would land in marker SLM–2 and the first 500 line group is SLM–1.)

With relay 1AN1' operated and locked, marker SLM–2 is seized by the first 500 line group and the marker is so signalled.

Inasmuch as relay AV' is not operated, relay AG' continues vibrating its lever and the second 500 line group lands in the first subscribers line marker, as becomes apparent by a consideration of the case wherein the lever of relay AG initially engages contacts 4605 and the lever of relay AG' initially engages contacts 4604'.

In this case, relay 1AN2 operates, in turn operating relay 1AN2A which operates relay AV', releasing relay AG'; and relay 1AN1' operates, in turn operating relay 1AN1A' which operates relay AV, releasing relay AG. With relay 1AN2 operated and locked, the second 500 line group has landed in marker SLM–2 and the marker is so signalled; and with relay 1AN1' operated and locked, the first 500 line group has landed in marker SLM–2 and the marker is so signalled.

2. First marker idle; second marker busy
(I) Call from first 500 line group
(I) Landing in first marker with second marker busy due to originating or terminating call in second 500 line group

With the second marker (SML–2) busy, one circuit for twenty cycle alternating current through lamp WE13G will be opened, break contacts *a* of relay 1ABL' being open if the marker is engaged for use in a terminating call, or break contacts *b* of relay 2ANC being open if the marker is engaged for use in an originating call. However, with the first marker (SML–1) idle, twenty cycle A.C. through lamp WE13G, closed break contacts *a* of relay 1ABL, closed break contacts *a* of relay 2ANC, 5000 ohm resistor, closed break contacts of relay AV, etc. operates relay AG.

If relay AG closes contacts 4605, relay 1AN1' is prevented from operating by open contacts *c* of relay 1ABL' is SLM–2 is engaged with a terminating call; or if SLM–2 if engaged with an originating call by open contacts *b* of relay ANA' and open contacts *b* of relay 2AND'.

Relay AG continues to vibrate its lever, closing contacts 4604, whereupon relay 1AN1 operates over a path previously traced and the first 500 line group lands in SLM–1. The result is the same as though contacts 4604 closed originally instead of 4605.

(II) Blocked from landing in first marker due to second marker being engaged with terminating call to first 500 line group

The manner in which landing of the first 500 line group in the busy marker SLM–2 is prevented has been described above. Although the first marker SLM-1 may not be engaged with an originating or a terminating call, the landing of the first 500 line group in this marker may be prevented due to the second marker SLM–2 being en-

gaged with a terminating call to the first 500 line group. This is to prevent interference in the crossbar switches and in the markers and is accomplished as follows.

If marker SLM–2 is engaged with a terminating call to the first 500 line group, relay T1 in the first marker SLM–1 is operated and opens the circuit of relay 1AN1 at its open contacts *a*. Accordingly, when contacts 4604 try to operate relay 1AN1, the circuit of relay 1AN1 is found open at open contacts *a* of relay T1.

If the marker SLM–2 had been engaged with a terminating call to the second 500 line group, relay T2 would be operated in the first marker but this would not interfere with the operation of relay 1AN1 by relay AG.

(2) Call from second 500 line group

(I) Landing in first marker with second marker busy due to originating or terminating call in first 500 line group

With the second marker busy, the circuit for 20 cycle A.C. through lamp WE13G will be opened as previously explained, but twenty cycle A.C, through lamp WE13G, and contacts *a* of relay 1ABL, contacts *a* of relay 2ANC, contacts 4602′ etc., operates relay AG′.

If the contacts 4605′ close while SLM–2 is engaged with a terminating call, relay 1AN2′ is prevented from operating by open contacts *b* of relay 1ABL′ or by open contacts *a* of relay ANA′. If SLM–2 is engaged with an originating call, relay 1AN2′ is prevented from operating at contacts *a* of relay 2AND′.

Relay AG′ in the continued vibration of its lever now closes contacts 4604′, whereupon relay 1AN2 operates over a path previously traced and the second 500 line group lands in SLM–1. This is the same as though contacts 4604′ closed originally instead of 4605′.

(II) Blocked from landing in first marker due to second marker being engaged with terminating call to second 500 line group

The manner in which landing of the second 500 line group in the busy marker SLM–2 is prevented was described above.

However, even though the first marker SLM–1 may not be engaged with an originating or a terminating call, if the second marker SLM-2 is engaged with a terminating call to the second 500 line group, the landing of the second 500 line group in this marker will be prevented. This is to prevent interference in the crossbar switches and in the markers and is accomplished as follows.

If marker SLM–2 is engaged with a terminating call to the second 500 line group, relay T2 in the first marker SLM–1 is operated and at its contacts *a* opens the circuit of relay 1AN2.

Accordingly, when contacts 4604′ try to operate relay 1AN2, the circuit of relay 1AN2 is found open at contacts *a* of relay T2.

If the marker SLM–2 had been engaged with a terminating call to the first 500 line group, relay T1 would be operated in the first marker but this would not interfere with the operation of relay 1AN2 by relay AG′.

(3) Simultaneous calls from both 500 line groups

(I) First 500 line group landing in first marker with second marker busy due to terminating call in second 500 line group

Twenty cycle A.C. through lamp WE13G, contacts *a* of relay 1ABL and contacts *a* of relay 2ANC, etc. operates relays AG and AG′.

Relay 1AN1′ and 1AN2′ are prevented from operating by operated relay 1ABL′.

Relay 1AN2 is prevented from operating by operated relay T2.

Consequently only relay 1AN1 can possibly be operated by the vibrating levers of relays AG and AG′, which relay operates over a path as described hereinbefore and locks over its #2 make contacts.

If ground is placed by the rotator on the lever associated with the locking contacts of 1AN1, relay 1AN1 locks independent of relay 1AN2. If, however, the ground is placed by the rotator on the lever associated with the locking contacts of 1AN2, relay 1AN1 locks over contacts *b* of relay 1AN1 and contacts *b* of relay 1AN2 to ground.

(II) Second 500 line group landing in first marker with second marker busy due to terminating call in first 500 line group

Twenty cycle A.C. through lamp WE13G, contacts *a* of relay 1ABL and contacts *a* of relay 2ANC, etc., operates relays AG and AG′.

Relays 1AN1′ and 1AN2′ are prevented from operating by operated relay 1ABL′.

Relay 1AN1 is prevented from operating by operated relay T1.

Consequently, only relay 1AN2 can be operated by the vibrating levers of relays AG and AG′. Relay 1AN2 operates over the path as described hereinbefore and locks over its #2 make contacts.

3. First marker busy; second marker idle

(1) Call from first 500 line group

(I) Landing in second marker with first marker busy due to originating or terminating call in second 500 line group

Twenty cycle current through lamp WE13G, break contacts *a* of relay 1ABL′, and break contacts *a* of relay 2ANC′, etc., operates relay AG.

Relay 1AN1 is prevented from operating by open contacts *c* of operated relay 1ABL; or by open contacts *b* of relay ANA and by open contacts *f* of relay 2AND of operated relays ANA and 2AND respectively.

Ground through contacts 4605, contacts *f* of relay ANA′, contacts *b* of relay 2AND′, contacts *a* of relay T1, winding of relay 1AN1′, contacts *c* of relay 1ABL′, conductor 4608′, 1000 ohm resistor, to battery, operates relay 1AN1′ which locks over its make contacts *b*. Thereby the first 500 line group lands in SLM–2 and marker SLM–2 is informed of such operation.

(II) Blocked from landing in second marker due to first marker being engaged with terminating call to first 500 line group

Twenty cycle A.C. potential through lamp WE13G, contacts *a* of relay 1ABL′, contacts *a* of relay 2ANC′, etc., operates relay AG.

Relay 1AN1 is prevented from operating by open contacts *a* of relay 1ABL.

Relay 1AN1′ is prevented from operating by open contacts *a* of relay T1′.

(2) Call from second 500 line group

(I) Landing in second marker with first marker busy due to originating or terminating call in first 500 line group

Twenty cycle A.C. potential through lamp WE13G, break contacts *a* of relay 1ABL′, break contacts *a* of relay 2ANC′, etc., operates relay AG′.

Relay 1AN2 is prevented from operating by open contacts *c* of relay 1ABL, or by open contacts *a* of relay ANA and *a* of relay 2AND.

Relay 1AN2′ operates from ground through contacts 4605′, contacts *a* of relay ANA′, contacts *a* of relay 2AND′, contacts *a* of relay T2′, winding of relay 1AN2′, contacts *b* of relay 1ABL′, conductor 4608A, 1000 ohm resistor, to battery. Relay 1AN2′ locks over contacts *a* of relay 1AN2′, whereby the second 500 line group is landed in marker SLM–2 and this marker is so informed.

(II) Blocked from landing in second marker due to first marker being engaged with terminating call to second 500 line group

Twenty cycle A.C. potential through lamp WE13G,

contacts *a* of relay 1ABL', contacts *a* of relay 2ANC', etc., operates relay AG'.

Relay 1AN2 is prevented from operating by open contacts *b* of relay 1ABL.

Relay 1AN*a*' is prevented from operating by open contacts *a* of relay T2'.

(3) Simultaneous calls from both 500 line groups

(I) First 500 line group landing in second marker with first marker busy due to terminating call in second 500 line group

Twenty cycle A.C. potential through lamp WE13G, contacts *a* of relay 1ABL' and contacts *a* of relay 2ANC', etc., operates relays AG and AG'.

Relays 1AN1 and 1AN2 are prevented from operating by operated relay 1ABL.

Relay 1AN2' is prevented from operating by operated relay T2'.

Consequently, relay 1AN1' is the only relay which is conditioned for the operation by the vibrating levers of AG and AG', which relay now operates over a path as described hereinbefore and locks over its make contacts *b*.

(II) Second 500 line group landing in second marker with first marker busy due to terminating call in first 500 line group

Twenty cycle A.C. potential through lamp WE13G, contacts *a* of relay 1ABL', and contacts of relay 2ANC', etc., operates relays AG and AG'.

Relays 1AN1 and 1AN2 are prevented from operating by operated relay 1ABL.

Relay 1AN1' is prevented from operating by operated relay T1'.

Consequently, relay 1AN2' is the only relay which the vibrating levers of relay AG and AG' can operate, and relay 1AN2' therefore operates over a path as described hereinbefore and locks over its make contacts *a*.

4. Both markers busy

If both markers are busy, twenty cycle A.C. potential through lamp WE13G is disconnected by open contacts *a* of relay 1ABL or open contacts *a* of relay 2ANC; open contacts *a* of relay 1ABL' or open contacts *a* of relay 2ANC'.

Consequently, neither relay AG nor relay AG' can operate and the calling 500 group or groups must wait until a marker is available. As markers are normally held for less than a second, no apparent waiting is experienced by the calling party.

5. Alternative arrangement

According to an alternative arrangement of FIGURES 7 and 8, relays 1AN1, 1AN1', 1AN2, and 1AN2' operate through individual 1000 ohm resistors to battery and these relays at their make contacts *c* perform a shunting action which is somewhat different than that described hereinbefore.

Whereas the marker relay 1AN1 at its contacts *c* hereinbefore shunted polarized relay AG, in the alternative arrangement ground through the make contacts *c* of relay 1AN1, conductor 4619 connects to the 1000 ohm battery feed circuit conductor 4608' of relay 1AN1' whereby sufficient current is detracted from relay 1AN1' to cause it to non-operate or release. Accordingly, both of these relays may operate, but the one which succeeds in locking shunts the other down.

Similarly, whereas make contacts *c* of relay 1AN1' shunted relay AG, in this alternative arrangement, ground through make contacts *c* of relay 1AN1', conductor 4619', connects to the 1000 ohm battery feed circuit conductor 4608 of relay 1AN1, shunting this relay.

Similarly, ground through make contacts *c* of relay 1AN2 shunts relay 1AN2'.

Similarly, ground through make contacts *c* of relay 1AN2' shunts relay 1AN2.

B. *Line group identity*

Referring now to FIGURES 16 to 80, let us assume that the line entrance originating circuit LEO of FIGURE 17 is that associated with the first 500 lines and that the marker of FIGURES 38 to 80 is the first marker, i.e., SLM–1.

Let us assume again that the calling party on line 17 (FIGURE 19) of the first SLA unit of the first 500 line group lifts his receiver. The following circuit then is established for the associated line relay LR17: ground, break contacts 12 of relay CO17, conductor T, calling line loop, conductor R, break contacts 1S of relay CO17, break contacts 21 of relay LO17, winding of relay LR17, conductor 1301, fuse 4, to battery.

Relay LR17 operates and closes a circuit from ground through the winding of polarized relay AG (FIGURE 17), break contacts 4603 of relay AV, break contacts *c* of relay 2AW, break contacts *a* of relay 3L1, conductor 1202, make contacts 12 of relay LR17, closed contacts *a* of manual key, conductor 1201, 10,000 ohm resistor, break contacts 4602 of relay AV, 5000 ohm resistor, conductor 4601, break contacts *a* of relay 2ANC, break contacts *a* of relay 1ABL, WE13G lamp, and a source of 20 cycle A.C. to ground.

Relay AG vibrates its lever according to the phases of the 20 cycle A.C. At this point the equipment operates to select an idle one of the markers and identifies the calling five hundred line group in the selected marker. The marker then connects itself to the calling line group.

Assuming that the first five hundred line group shown lands in the first marker shown in the manner described above, relay 1AN1 operates over a circuit extending from ground through the lower make contacts 4604 of relay AG, conductor 4606, fuse contacts, C3809*a*, break contacts *b* of relay ANA, break contacts *b* of relay 2AND, conductor 4, cable to MLIA, conductor 4, break contacts *a* of relay T1, conductor 1 of cable 4110*a* to MLI, conductor 1, winding of relay 1AN1, break contacts *c* of relay 1ABL, conductor 4608, 1000 ohm resistor to battery.

Relay 1AN1 operates to indicate that the first five hundred line group has succeeded in seizing the marker. It is noted that if the second five hundred line group had seized the marker, relay 1AN2 would have been operated. Assuming that the rotator comprising relays 10B and 20B (see MLM) is in the position with relays 10B and 20B non-operated, relay 1AN1 locks over the circuit from battery through the 1000 ohm resistor, conductor 4608, break contacts *c* of relay 1ABL, winding of relay 1AN1, make contacts *b* of relay 1AN1, conductor 28, cable to MLM, conductor 28, break contacts *d* of relay 10B, break contacts *b* of manual key, conductor 30, cable to MLI, conductor 30, break contacts *c* of relay 1ANC, and break contacts *k* of relay 1AND to ground. When relay 1ANC subsequently operates, this holding ground comes through the make contacts *d* of relay 1ANC to conductor 30. If the rotator is in the position with relays 10B and 20B operated, the locking circuit of relay 1AN1 passes through the make contacts *b* of relay 1AN1, break contacts *b* of relay 1AN2, conductor 29, cable to MLM, conductor 29, make contacts *c* of relay 10B, closed contacts *b* of the manual key, and conductor 30 to the aforedescribed ground.

Relay 1AN1 at its contacts *d* extends ground to the winding of relay 1AN1A and battery.

Relay 1AN1A operates to extend ground through make contacts *a* of relay 1AN1A, over conductor 4609, and the winding of relay AV to battery.

Relay AV (FIGURE 17) operates and at its break contacts 4602 and 4603 opens the circuit of relay AG; and at its make contacts 4603*f* closes ground over conductor 4603A through the windings of relays 1PST and 2PST in parallel to battery (circuit LPI); at its make contacts 4603*c* closes ground over conductor 4603B through the windings of relays 3PST and 4PST in parallel

to battery; and at its contacts 4603*d* closes ground over conductor 4603C through the winding of relay 5PST to battery. Relays 1PST–5PST and circuit LPI are only equipped in 500 line groups containing paystations, as will be brought out subsequently in connection with the description of the paystation identification circuits.

Relay 1AN1 also closes a circuit from ground through make contacts *e* of relay 1AN1, break contacts *d* of relay 1ABL, through the winding of relay ANA to battery; and at its make contacts *e* of relay 1AN1 closes a circuit from ground over break contacts *d* of relay 1ABL, break contacts *c* of relay 1AND, conductor 13, cable to MTT, conductor 13, and winding of relay RBL to battery. Relay ANA and relay RBL operate. Relay RBL prepares a locking circuit from battery through its winding, make contacts *b* of relay RBL, conductor 6, cable to MLI, conductor 6, and make contacts *f* of relay AB to ground, which circuit is completed as relay AB subsequently operates.

Relay ANA (FIGURE 40) at its break contacts *b* opens the original marker selection circuit for relay 1AN1 which then holds over the aforedescribed holding circuit. On calls from the second five hundred group, relay ANA at its break contacts *a* also opens the circuit of relay 1AN2. Additionally relay ANA at its contacts *c* operates relay ANB over a circuit extending from battery through the winding of relay ANB, break contacts *f* of relay 1AND and make contacts *c* of relay ANA to ground.

Relay RBL (FIGURE 79) prevents the path-finding portion from being seized by the associated code receiver for call termination purposes in a manner to be described hereinafter.

Relay 1AN1A (FIGURE 40) operates to complete energizing circuits for the following relays for the purpose of connecting the first five hundred group into the marker: relays 2AN1, 3AN1, 4AN1, 5AN1, 5AN1A, 1CN1, 2CN1, 1FN1, 2FN1, 6AN1, and relay O1 in the companion marker.

Relays 2AN1 and 3AN1 (FIGURE 39) operate from battery through their windings in parallel, make contacts *d* of relay 1AN1A, break contacts *g* of relay 1AN2A to ground.

Relay 4AN1 and 5AN1 and 5AN1A (FIGURE 39) operate from battery through their windings in parallel, make contacts *e* of relay 1AN1A, break contacts *g* of relay 1AN2A to ground. These relays connect circuits from the line entrance origination circuit LEO into the first marker SLM–1.

Relays 1CN1 and 2CN1 (FIGURE 42) operate from battery through their windings in parallel, conductor 1 through cable 1234, conductor 1, make contacts *c* of relay 1AN1A, break contacts *g* of 1AN2A to ground.

Relay 1CN1 at its contacts *c* completes an operating circuit for relay 3CN1 which extends from battery through the winding of relay 3CN1 and make contacts *c* of relay 1CN1 to ground.

Relays 1FN1 and 2FN1 (FIGURE 43) operate from battery through their windings in parallel, conductor 2, cable 1234, conductor 2, make contacts *b* of 1AN1A, break contacts *g* of relay 1AN2A, to ground. Relay 2FN1 operates relay 3FN1 and 4FN1 from battery through the windings of relays 3FN1 and 4FN1 in parallel and make contacts *e* of relay 2FN1 to ground. These relays connect leads from the 20 SLA's to the marker. It might be noted at this point that relay 1CN1 connects SLA leads from the first 500 group into the marker whereas 1CN2 connects leads from the second five hundred group into the marker. This same scheme of notation is found in many places in the marker.

Relay 1AN1A (FIGURE 40) at its contacts *f* completes operating circuits for relays 6AN1 and 6AN1A (FIGURE 62) which extend from battery over the windings of 6AN1 and 6AN1A in parallel, conductor 1, cable MLI to MCT, conductor 1, make contacts *f* of relay 1AN1A, break contacts *g* of relay 1AN2A to ground. These relays control circuits of the first 500 group for making register tests and SLB vertical tests for the three groups of SLB switches.

Relay O1 (FIGURE 78) associated with the first five hundred group is in the companion marker, but the circuit thereof can be traced by reference to the marker shown as follows: Battery (MLI), conductor 10, cable to MTT, conductor 10, winding of relay O1, conductor 11, cable to MLI, conductor 11, make contact *h* of relay 1AN1A to ground.

Relay O1 in the companion marker locks over its make contacts *a*, conductor 2, to conductor 1 in the instant marker and make contacts of RBL to ground in the instant marker. Assuming that the instant call is progressing from the first five hundred group relay 1AN1A operates relay O1 in the companion marker, which blocks a terminating call through the companion marker to the first five hundred group.

It should be observed that if relays 1AN1A and 1AN2A should both be operated by some freak condition, the connecting relays for neither five hundred line group can operate because break contacts 1AN1A–*g* and 1AN2A–*g* open the operating ground to opposite connecting relays. In other words, the operation of connecting relays for either five hundred line group is based upon the supposition that one relay 1AN1A or 1AN2A is operated and the other is non-operated. For example, the circuit of relay 2AN1 passes through make *d* of relay 1AN1A and break *g* of relay 1AN2A.

Relay ANB operates and at its contacts *f* completes an operating circuit for relay 0T2 (FIGURE 44) which extends from battery through the lower winding of relay 0T2, upper winding of relay 0T1, make contacts *i* of relay 0T1, break contacts *m* of relay 0T10, break contacts *b* of the alarm key, break contacts *d* of relay 3ANC, conductor 3, cable to MLI, conductor 3 and make contacts *f* of relay ANB to ground. This prepares for shifting the marker register preference as will be appreciated more clearly hereinafter. If the marker had been sitting with 0T10 operated instead of 0T1, this ground would cause relay 0T1 to operate in series with 0T10, and would prepare to shift the marker preference accordingly.

Additionally relay ANB at its contacts *b* completes operating circuits for relays 1ANC and 2ANC which extend from battery through the winding of these relays in parallel and make contacts *b* of relay ANB to ground.

Relay 1ANC at its break contacts *e* disconnects ground from the holding circuit of relay K1 and connects this circuit over its make contacts *f* to 2200 ohm battery. A circuit then obtains from battery through the upper winding of relay K1 through the lower winding of relay K1, through make contacts *f* of relay K1 and make contacts *f* of relay 1ANC through 2200 ohms and a 6 mf. capacitor to battery, and the condenser discharge makes K1 slow to release. It should be recalled that relay K1 is normally operated and releases only if trouble is encountered. Accordingly relay K1 at this time is providing a timing period.

Assuming relays 10B and 20B (MLM) (FIGURE 71) non-operated prior to this call, when relay 2ANC operates, ground through make contacts *d* of relay 2ANC, conductor 31, cable to MLM, conductor 31, break contacts *a* of relay 10B, winding of relay 20B to ground operates relay 20B which prepares to lock over its make contacts *a* and the lower winding of relay 10B.

Additionally relay 1ANC operates slave relay 3ANC (FIGURE 61) over the following circuit: battery through the winding of relay 3ANC, conductor 1, cable to MLI, conductor 1 and make contacts *b* of relay 1ANC to ground. Relay 3ANC operates to start register selection as will be discussed hereinafter.

At this time the five hundred line group has been

identified in the marker and the marker has connected itself to the identified five hundred line group.

C. *SLA identity*

At this point it should be observed that two sequences of relay operations are occurring simultaneously in the marker, which consist of selecting an idle register; and of identifying to the marker the calling one of the twenty SLA's and the identity of the particular line which has initiated the call. We shall discuss first the sequence of SLA and line identity and in a subsequent section that of register selection.

Returning to a prior point in this description, the joint operation of relays AV and ANB effect operation of relay A1 (FIGURE 39) over the following circuit: ground through make contacts 4603 of relay AV, break contacts *c* of relay 2AW, break contacts *a* of relay 3L1, conductor 1202 associated with line 17, make contacts 12 of relay LR17, break contacts *a* of the manual key, conductor 1201, associated with SLA1, conductor 4611 (otherwise indicated as conductor 1 associated with SLA–1), cable SLA-IDENT–1, conductor 1, make contacts *a* of relay 4AN1, conductor 1, cable SLA–IDENT–2 conductor 1, winding of relay A1, break contacts *a* of relay 2AA, break contacts *h* of relay BB, make contacts *e* of relay ANB to battery. Relay A1 immediately closes the following locking ground for itself independent of line relay LR17 and the LEO circuit: ground through make contacts *d* of relay ANB, break contacts *c* of relay BB, make contacts *b* of relay A1 to the winding of relay A.

Relay A1 then operates relays 1AA, 2AA and 3AA (FIGURE 40) from ground through the windings of these relays in parallel, break contacts *e* of relay 1PBX, conductor 54, cable to MLM, conductor 54, break contacts *b* of the manual key, make contacts *a* of relay 10A2 assuming relay 10A2 operated as heretofore described, conductor 51, cable to MLI, conductor 51, break contacts *f* of relays A20 to A2 in series, make contacts *e* of relay A1, the break contacts *a* of relay 2AA, break contacts *h* of relay BB, and make contacts *e* of relay ANB to battery. Relay 1AA operates and at its make contacts *b* closes a circuit from battery through make contacts *e* of relay ANB, break contacts *h* of relay BB, make contacts *b* of relay 1AA through the windings of relays 1AA, 2AA and 3AA in parallel to ground. This same battery circuit extends to relay A1. It should be observed that the break contacts of relays 1AA, 2AA and 3AA open after the make contacts *b* of relay 1AA close. Thus a battery circuit is maintained to the SLA identity relay A1–A20. In particular, relay A1 then holds over the following circuit: ground through make contacts *d* of relay ANB, break contacts *c* of relay BB, make contacts *b* of relay A1, winding of relay A1, make contacts *e* of relay A1, break contacts *f* of relays A2–A20 in series, conductor 51, cable to MLM, conductor 51, contacts *a* of relay 10A2, contacts *b* of the manual key, conductor 54, cable to MLI, conductor 54, break contacts *e* of relay 1PBX, make contacts *b* of relay 1AA, break contacts *h* of relay BB, make contacts *e* of relay ANB to battery.

Relay 1AA at contacts *c* completes an operating circuit for relay AB (MLI) (FIGURE 57) which extends from battery through the winding of relay AB, and make contacts *c* of relay 1AA to ground. Relay AB at its contacts *a* then operates relays 3AW, 2AW and 1AW (LEO) (FIGURE 17) from battery through their windings in parallel, conductor 4615 (otherwise designated 11), cable 4614, conductor 11, make contacts *e* of relay 5ANIA, break contacts *b* of relay 1AND a nd make contacts *a* of relay AB to ground.

Relay AB at its contacts *b* effects operation of relays 4L1, 3L1, 2L1 and 1L1 (FIGURE 17), over a circuit which extends from battery through their windings in parallel, conductor 4616 (otherwise designated 1), cable 4614, conductor 1, make contacts *a* of relay 5AN1A, conductor 1, make contacts *a* of relay A1, break contacts *d* of relay 2AND and make contacts *b* of relay AB to ground.

Relay 2AW and 3L1 operate to open the original operating ground from relay A1.

Relay AB provides ground through its make contacts *g* to the contacts *i* of the relays A1 to A20 (FIGURE 39), which relays advance the rotator comprising relays 10A2 to 40A2 (FIGURE 71). More specifically, when relay AB operates, the before mentioned ground through contacts of any relay A1 to A5, conductor 46, cable 46 to 49, cable to MLM, conductor 46, upper winding of relay 10A2 to battery operates relay 10A2, which operates and at its contacts *c* locks over a circuit extending from ground over make contacts *c* of relay 10A2, lower winding of relay 10A2, break contacts *e* of relays 20A2, 30A2, 40A2, 2,000 ohm resistor to battery, and opens the similar locking circuit for any other relay such as 20A2 to 40A2 which may have been operated.

Considering a similar situation when relay AB operates, ground through its make contacts *g* and make contacts *i* of any relay A6 to A10 which might be operated instead of A1 to A5, conductor 49, cable 46 to 49, cable to MLM, conductor 49, upper winding of relay 40A2 to battery operates relay 40A2. Relay 40A2 operates and at its break contacts *e* opens the aforedescribed holding circuit for 10A2 and locks over the circuit which extends from ground through break contacts *d* of relay 10A2, 20A2, 30A2 and make contacts *c* of relay 40A2, lower winding of relay 40A2, 2,000 ohm resistor to battery.

Considering a similar situation when AB operates, ground through make contacts *g* of relay AB through contacts *i* of any relay A11 to A15 which might have operated instead of the other relays A1 to A10, conductor 48, cable to MLM, conductor 48, upper winding of relay 30A2 to battery will operate relay 30A2.

Relay 30A2 opens the aforedescribed locking circuit of relay 40A2 at break contacts *e* of relay 30A2 and locks over the circuit from ground through the break contacts *d* of relay 10A2, 20A2 and make contacts *c* of 30A2, winding of relay 30A2, break contacts *e* of relay 40A2, 2,000 ohms to battery.

Similarly ground through make contacts *g* of relay AB and make contacts *i*, any relay A16 to A20 which might have operated instead of the other relays A1 to A15, conductor 47, cable 46 to 49, cable to conductor 47, upper winding of relay 20A2 to battery operates this relay.

Relay 20A2 opens the aforedescribed locking circuit of relay 30A2 and locks over the circuit from ground through the break contacts *d* of relay 10A2, make contacts *e* of relay 20A2, lower winding of relay 20A2, break contacts *e* of relay 30A2 and 40A2 through the 2,000 ohm resistor to battery. As calls come into the marker from SLA's at random these relays, 10A2 to 40A2, operate at random and release any other such relay which is operated. The result of this arrangement is such that battery through the make contacts *e* of relay ANB, break contacts *h* of relay BB, make contacts *b* of relay 1AA, break contacts *e* of 1PBX, conductor 54, cable to MLM, conductor 54, break contacts *b* of the manual key to the contacts *a* of the various relays 10A2 to 40A2 is selectively placed by the make contacts *a* of the operated relay on conductor 51, 52, 53, or 50 which through cable to MLI and cable 50 to 53 enters the locking circuits of the relays A1 to A20 at different points, so as to give a priority in locking to a particular relay A1 to A20 even though two or more may operate simultaneously.

For example if ground obtains on lead 50, such ground enters the upper locking chain of contacts between the lever of A1 and the break contact *d* of relay A20. Accordingly, the operation of A1 disconnects the locking circuit of all relays A2 to A20; the locking circuit of relay A2 disconnects the locking circuits of all relays A3 to A20 etc., giving a priority in locking of these relays wherein A1 has the highest priority and A20 the lowest

priority. Similarly if ground obtains on lead 52 instead of 51 relay A11 has priority in locking and opens all the other locking circuits of relays A12 to A20 and around to A10, giving A11 priority over all the other A relays.

By similar reasoning A12 would open the locking circuits of all relays A14 to A20 and then around to A10.

Similarly if ground obtains on lead 51 to the lower locking chain relay A20 has priority in locking and opens the locking circuits of all relays A19 down to A1. Relay A19 opens the locking circuits of all relays A18 down to A1 etc.

If ground obtains on lead 53 entering the lower locking chain between the lever of relay A10 and the break contacts *f* of relay A11, then relay A10 has priority in locking and opens the locking circuits of all relays A9 to A1 and around to A11.

Relay 9 opens the locking circuits of all relays A9 to A1 and around to relay A11.

Accordingly though several A1 relays may operate simultaneously, only one can lock to locking battery. We shall designate the rotator comprising relays 10A2 to 40A2*a* "jump rotator."

Accordingly when a call originates, any relay 10A2 to 40A2 may be in the operated position, predisposing certain of the relays A1 to A20 to have priority over others. Thus the operated one of the relays A1 to A20 identifies the calling SLA which has succeeded in seizing the marker.

B. *Line identity—SLA horizontal operation*

The equipment now identifies in the marker, the calling line of the lines associated with the identified SLA. When relay 3L1 operates, a circuit is completed for line identity relay B17 which extends from battery through make contacts *e* of relay ANB, make contacts *f* of relay K2, break contacts *d* of relay REL2, make contacts *c* of relay AB, break contacts *b* of relay 3BA, winding of relay B17, conductor 17, cable LINE–IDENT–2, conductor 17, make contacts *b* of relay 3AN1, conductor 17, cable LINE–IDENT–1, conductor 17, make contacts *b* of 3L1, conductor 1202 associated with line 17, make contacts 12 of relay LR17 conductor 1201A, closed contacts *a* of manual key, conductor 1201 associated with SLA1, conductor 4611, cable SLA–IDENT–1, conductor 4611 (otherwise designated conductor 1), make contacts *a* of relay 4AN1, conductor 1, cable SLA–IDENT–2, conductor 1, make contacts *b* of relay A1, break contacts *c* of relay BB and make contacts *d* of relay ANB to ground. Relay B17 immediately closes a ground circuit independent of the line relay LR17 as follows: ground through make contacts *d* of relay ANB, break contacts *c* of relay BB, break contacts *a* of relay REL2, make contacts *a* of relay B17 to the winding of relay B17.

Relays B0 to B24 are controlled in their locking by a "jump rotator" comprising relays 10A1 to 60A1. The operation of the "jump rotator" is set forth briefly hereat.

Relay 10A1 operates from battery through the upper winding of relay 10A1, conductor 33, cable to MLI, conductor 33, cable 33 to 38, conductor 33 and through the make contacts *i* of the one of the relays B0 to B3 which is operated and make contacts *i* of relay BB to ground, such operation being effected in response to the subsequent operation of relay BB.

Relay 20A1 operates incident to the operation of any relay B20 to B24. Similarly relay 30A1 operates incident to the operation of any relay B8 to B11.

Similarly relay 40A1 operates incident to the operation of any relay B12 to B15, and

Relay 50A1 operates incident to the operation of any relay B3 to B7, and relay 60A1 operates incident to the operation of any relay B16 to B19. The operation of the jump rotator in other connections will be obvious from such description.

Returning from the digression, relay B17 then operates relay 1BA over the following circuit: ground through break contacts *f* of relay BB, lower winding of relay 1BA, break contacts *d* of relay BB, break contacts *g* of relay 1PBX, conductor 45, cable to MLM, conductor 45, close contacts *b* of the manual key, through the operated contacts *a* of one of the relays of the jump rotator such as 10A1 and conductor 40, cable to MLI, cable 39 to 44, conductor 40, break contacts *e* of relays B24 down to B18 in series and make contacts *d* of B17, break contacts *b* of relay 3BA, make contacts *c* of relay AB, break contacts *d* of relay REL2, make contacts *f* of relay K2 and make contacts *e* of ANB to battery.

Relay 1BA may be thus operated in parallel over the make contacts of several B relays which may operate simultaneously.

Relay 1BA locks over the circuit from ground through break contacts *f* of relay BB, lower winding of relay 1BA, make contacts *h* of relay 1BA, make contacts *c* of relay AB, break contacts *d* of relay REL2, make contacts *f* of relay K2 and make contacts *e* of relay ANB to battery.

Relay 1BA then operates relays 2BA, 3BA, and 4BA over the following circuits: battery through the windings of relays 2BA and 3BA in parallel and make contacts *d* of relay 1BA to ground; also battery through the winding of relay 4BA (lower portion of MLI), break contacts *b* of relay REL2 and make contacts *d* of relay 1BA to ground.

Relays 1BA, 2BA and 3BA open the original battery circuits to relays B0 to B24 so that a test is made over their locking circuits to determine which of the relays B0 to B24 shall lock if more than one had operated at the same time.

As noted above with the operation of the jump rotator 10A1–60A1 and the locking circuits of relays B0–B24, after relays 1BA to 3BA operate, only one relay B0 to B24 can hold.

Relay 4BA operates relay BB from battery through the winding of relay BB and make contacts *c* of 4BA to ground, relay BB locking through its make contacts *a* and make contacts *a* of relay ANB to ground. Also, relay 4BA operates relay 1CRA (see MCT circuit), over the circuit from battery through the winding of relay 1CRA, conductor 1, cable to MPR, conductor 1, make contacts *b* of relay 1PS, break contacts *c* of relay 2PS, conductor 5, cable to MLI, conductor 5 through make contacts *d* of relay 4BA to ground. Relay 1CRA operates on non-paystation originated calls to prevent connection to CRA's with coin box trunk verticals, as will be understood better hereinafter.

The operation of relay BB re-routes the locking ground for the operated relay B17 of the group B0–B24, and the operated relay A1 of the group A1–A20, over make contacts *f* of relay 1BA and make contacts *b* of relay BB which close before its contacts *c* open; and also re-routes the locking battery for the operated relay B17 of the group B0–B24 and the operated relay A1 of the group A1–A20 and relays 1BA, 1AA, 2AA, and 3AA over make contacts *j* of relay 1BA and make contacts *g* of relay BB which close before its contacts *h* open. With relay B17 operated, the marker is informed that line 17 of the lines 0–24 associated with the calling SLA has initiated the call.

At the same time that relay 1BA operated relays 2BA, 3BA and 4BA, it operated relays 1AND and 2AND from battery through the windings of these relays in parallel, breaks contacts *i* of relay 1AND, make contacts *c* of relay K2, break contacts *b* of relay PBX, and make contacts *e* of relay 1BA to ground. Relay 1AND, at its contacts *h* establishes a circuit to ground for these relays through make contacts *c* of relay ANA before it opens its break contacts *i* to disrupt the circuit just traced.

At its break contacts *a* and *b*, relay 2AND opens the original circuits of 1AN2 and 1AN1 respectively. At its make-before-break contacts *d*, relay 1AND routes the operating circuit of relay RBL through make contacts *c* of relay 1BA to ground through make contacts *e* of relay 1AN1. It should be observed that relay RBL additionally has a locking circuit from battery through the winding

of relay RBL, make contacts *b* of relay RBL, conductor 6, cable to MLI, conductor 6, make contacts *f* of relay AB to ground.

At its make contacts *g*, which operate before the associated break contacts *f* open, relay 1AND establishes a holding circuit for relay ANB from battery through the winding of relay ANB, make contacts *g* of relay 1AND, normal make contacts *c* of relay K2, break contacts *b* of relay 1PBX, and make contacts *e* of relay 1BA to ground in preparation for release.

At its make contacts *a*, which operate before the associated contacts *b* open, relay 1AND transfers the circuit of relays 3AW, 2AW and 1AW in the LEO circuit from ground through make contacts *a* of relay AB to ground through make contacts *b* of relay 1BA. Also, at its make contacts *c* which close before the associated break contacts *d* open, relay 2AND transfers the circuit of relay 4L1, 3L1, 2L1, and 1L1 of the LEO circuit from ground through make contacts *b* of relay AB to ground through make contacts *a* of relay 1BA.

It should be observed that if the marker has advanced to the point where relay BB operates, battery through 200 ohms resistance and a 50 mf. capacitor which is normally charged to ground through break contacts *l* of relay BB, is connected in series through make contacts *k* of relay BB and make contacts *f* of relay K1 to the winding of relay K1 in parallel to the circuit from battery through 200 ohms and a 6 mf. capacitor which was connected to the winding of relay K1 when relay 1ANC operated, whereby an additional circulating current is inserted in the circuit of relay K1 to give the marker an increased time to continue its performance.

It should be observed also that when relay BB operates with the calling line being line 17, ground to the make contact *i* of relay BB, make contacts *i* of relay B17, conductor 38, cable to MLM, conductor 38 through the upper winding of relay 60A1 to battery, operates "jump rotator" relay 60A1 whereby the priority of locking of relays B0 to B24 is shifted.

Additionally when relay BB operated a circuit was completed to operate relays 1A, 2A, and 3A in switch SLA–1 over the following circuit: battery through fuse 3, windings of relays 1A, 2A and 3A in parallel, closed contacts *c* of the manual key, conductor 1302, cable SLA-CONNECT, conductor 1302, otherwise designated conductor 1, make contacts *a* of relay 1CN1, conductor 1, cable MLI–MVO, conductor 1, make contacts *k* of relay A1 representing SLA–1, and make contacts 1 of relay BB to ground.

Ground through make contacts 2 of relay B17 on conductor 29 and ground through make contacts *h* of relay B17 on conductor 32, both of which conductors enter cable SLA-HORIZ, emerge as cables H9 and HC otherwise designated 29 and 32 respectively and pass through make contacts *b* and *c* respectively of operated relay 3AN1 into conductors 9 and 12 respectively and thence into SLA cable 1306 emerging as conductors 9A and 12A in the SLA switch and passing through contacts 12 and 21 respectively of operated relay 3A into cable 1305, emerging as conductors 9 and 12 respectively, passing through windings of coils H9 and HC respectively, through fuse 3 to battery. Horizontal magnets H9 and HC accordingly operate, and as described more fully hereinafter, extend the test conductor "S" of the calling line into the marker to permit testing thereat by the marker to determine whether or not the calling line is a paystation line.

Additionally when relays 1A and 2A of SLA–1 are operated vertical test and pull circuits comprising leads 1–20 of cable 1310 are extended into the marker for the purpose of informing the marker of the SLA verticals which are available to extend the *a* path from the calling line in the direction of a register. More specifically, the odd leads of the group 1–20 are pull circuits and the even leads are test circuits. As an example, a circuit is prepared for vertical magnet V1 of the seized SLA vertical magnet from battery through fuse 1,200 ohm winding of magnet V1, contacts 12 of relay 1A, conductor 1304*a*, otherwise designated conductor 1, cable 1310, conductor 1, contacts *a* of relay 1FN1, pull cable, conductor 1, to open contacts *k* of relays AG1 and AG2 associated with two SLB verticals, i.e., two of twenty paths between each group of five SLB's and the associated SRL circuit.

Also a circuit is closed as follows to operate relay 1V1 (see MRT) assuming vertical V1 of SLA–1 idle: battery (SLA–1), fuse 1, associated fuse contacts, closed break contacts 11 of magnet V1, contacts 32 of relay 1A, conductor 1303 (other wise designated 2), cable 1310, conductor 2, contacts *f* of relay 1FN1, conductor 1, test cable MCT–MVO, cable 1–10, conductor 1, winding of relay 1V1 to ground.

Conductors 1–20 entering relays 1FN1 and 2FN1 from SLA's of the first 500 group and those emerging to contacts of relays AG1–AG20 of MVO circuit and to coils of relays 1V1 to 1V10 of the MCT circuit are as follows:

Conductors From SLA's	Emerging Conductors to Pull Cable	Emerging Conductors To Test Cable	To MVO Relay Contacts	To MCT Relay Coils
1	1		K of AG1 and AG2.	
2		1		1V1
3	2		K of AG3 and AG4.	
4		2		1V2
5	3		K of AG5 and AG6.	
6		3		1V3
7	4		K of AG7 and AG8.	
8		4		1V4
9	5		K of AG9 and AG10.	
10		5		1V5
11	6		K of AG11 and AG12.	
12		6		1V6
13	7		K of AG13 and AG14.	
14		7		1V7
15	8		K of AG15 and AG16.	
16		8		1V8
17	9		K of AG17 and AG18.	
18		9		1V9
19	10		K of AG19 and AG20.	
20		10		1V10

Accordingly in the marker a relay of the group 1V1–1V10 will be operated for each idle vertical of the calling SLA to indicate the verticals which are presently available.

A corresponding pattern holds for relays 1FN2 and 2FN2 for the second five hundred group.

Relay 2A of the SLA–1 switch operates relays 1S1 and 2S1 of the line horizontal pull circuit from battery through the windings of these relays in parallel, conductor LHP and make contacts 25 of relay 2A to ground.

Relay 1S1 operates relays 1S11 and 2S11 from battery, through a 500 ohm resistor, through the windings of these relays in parallel, and make contacts *a* of relay 1S1 to ground.

Accordingly relay 1S1 extends a circuit from battery through fuse 5, conductor 5002, through the winding of horizontal relay H1 of the SLB switch circuit #1 (SLB–1) shown, through conductor 1, cable LHP–21, into the line horizontal pull circuit (LHP), conductor 1 emerging and passing through make contacts *c* of relay 1S1 into conductor I associated with SLB–1, into cable MVO to the marker.

Also relay 1S11 extends the circuit from battery through fuse 5, conductor 5002, winding of relay HA of SLB–1, conductor 11, cable LHP–2, conductor 11, make contacts *b* of relay 1S11 into conductor I into cable MVO to the marker.

Similarly at others of their make contacts, relays 1S1

and 2S1 extend circuits from magnets H1 of SLB's 2–15 to conductors II to XV associated respectively with SLB's 2–15 and thence into cable MVO to the marker.

Accordingly with SLA–1 calling and having effected the operation of relays 1S1, 2S1, 1S11 and 1S12, as will be discussed in more detail subsequently, circuits have been prepared for the marker to operate magnets H1 and HA in any of the SLB's 1–15 by selectively placing ground on conductors I to XV of cable MVO for the purpose of further extending the calling line in the direction of a register. Possible routings are now described.

If the marker extends connections through the vertical V1 of SLA–1 (on an originating or terminating call) it operates H1 and HA in SLB–1, SLB–6, or SLB–11 by placing ground on conductor I, VI, or XI and also operates vertical magnet V1, V2, V3, V4 or V5 in SLB–1, SLB–6, or SLB–11.

If the marker extends connections through vertical V2 of SLA–1, it operates H1 and HA in SLB–1, SLB–6, or SLB–11 by placing ground on conductor I, VI, or XI of cable MVO and also operates vertical magnet V6, V7, V8, V9, or V10 in SLB–1, SLB–6, or SLB–11.

If the marker extends connections through vertical V3 of SLA–1, it operates magnets H1 and HA in SLB–2, SLB–7, or SLB–12 by placing ground on conductor II, VII, or XII of cable MVO, and also operates vertical magnet V1, V2, V3, V4, or V5 in SLB–2, SLB–7 or SLB–12.

If the marker extends connections through vertical V4 of SLA–1, it operates magnets H1 and HA in SLB–2, SLB–7, or SLB–12 by placing ground on conductor II, VII or XII of cable MVO, and also operates vertical magnet V6, V7, V8, V9, or V0 in SLB–2, SLB–7, or SLB–12, etc.

If the calling SLA is SLA–2, a set of relays 1S2 and 2S2 (not shown) are operated in the LHP circuit and operate relays 1S11 and 2S11 and extend connections from magnets H2 and HA of SLB's 1–15 to conductors I to XV respectively of cable MVO.

The following chart summarizes the relays of the LHP circuit operated and the circuits of SLB's 1–15 prepared as SLA's 1–20 are engaged upon originating or terminating calls. Reference should also be made to the SLA–SLB–SRL–SLC diagram of FIGURE 9 in the copending application.

SLA	LHP Relays Operated	SLB Circuits Prepared
1	1S1, 2S1, 1S11, 1S12	H1, HA in SLB's 1–15.
2	1S2, 2S2, 1S11, 1S12	H2, HA in SLB's 1–15.
3	1S3, 2S3, 1S11, 1S12	H3, HA in SLB's 1–15.
4	1S4, 2S4, 1S11, 1S12	H4, HA in SLB's 1–15.
5	1S5, 2S5, 1S11, 1S12	H5, HA in SLB's 1–15.
6	1S6, 2S6, 1S11, 1S12	H6, HA in SLB's 1–15.
7	1S7, 2S7, 1S11, 1S12	H7, HA in SLB's 1–15.
8	1S8, 2S8, 1S11, 1S12	H8, HA in SLB's 1–15.
9	1S9, 2S9, 1S11, 1S12	H9, HA in SLB's 1–15.
10	1S10, 2S10, 1S11, 1S12	H0, HA in SLB's 1–15.
11	1S1A, 1S1, 2S1, 1S12, 1S12	H1, HB in SLB's 1–15.
12	1S2A, 1S2, 2S2, 1S12, 1S12	H2, HB in SLB's 1–15.
13	1S3A, 1S3, 2S3, 1S12, 1S12	H3, HB in SLB's 1–15.
14	1S4A, 1S4, 2S4, 1S12, 1S12	H4, HB in SLB's 1–15.
15	1S5A, 1S5, 2S5, 1S12, 1S12	H5, HB in SLB's 1–15.
16	1S6A, 1S6, 2S6, 1S12, 1S12	H6, HB in SLB's 1–15.
17	1S7A, 1S7, 2S7, 1S12, 1S12	H7, HB in SLB's 1–15.
18	1S8A, 1S8, 2S8, 1S12, 1S12	H8, HB in SLB's 1–15.
19	1S9A, 1S9, 2S9, 1S12, 1S12	H9, HB in SLB's 1–15.
20	1S10A, 1S10, 2S10, 1S12, 1S12	H0, HB in SLB's 1–15.

It should be observed that SLA–11 operates relay 1S1A from ground through make contacts 25 of relay 2A in SLA–11, conductor LHP–11, winding of relay 1S1A to battery. Relay 1S1A operates relays 1S1 and 2S1 from ground through make contacts *a* of relay 1S1A, windings of relays 1S1 and 2S1 in parallel to battery. Relay 1S1 closes the aforedescribed ground circuit to relays 1S11 and 2S11 but these relays do not operate being shunted by ground on the other side of their windings over the circuit from ground through make contacts *b* of relay 1S1A to the windings of relays 1S11 and 1S12. However, ground through make contacts *c* of relay 1S1A through the windings of relays 1S12 and 2S12 in parallel to battery operates these relays. Accordingly, with relays 1S1A, 1S1, 1S2, 1S12 and 2S12 operated, the circuit of magnet H1 of SLB–1 is extended through contacts *c* of relay 1S1 to conductor I of cable MVO as previously described and the circuit of magnet HB is extended to conductor I over the circuit from battery, fuse 5, conductor 5002, magnet coil HB, conductor 12, cable LHP–21, conductor 12, contacts *b* of relay 1S12, conductor I to cable MVO and thence to the marker. Thus, if the marker places ground on conductor I with SLA–11 involved in the connection (one either on originating or on terminating call) relays H1 and HB of SLB–1 operate. Similarly, if the marker places ground on conductor II with SLA–11 involved in the connection, relays H1 and HB in SLB–2 operate. It is believed unnecessary to describe other LHP circuits.

Summarily the LHP circuit in its operation has selectively prepared circuits between the marker and the SLB for the purpose of further extending the calling line toward the register. Thus, at this point the marker has "asked" the SLA and the SLB for a report as to the verticals which are available for use in extending path from the calling line in the direction of a selected register, and the SLA and SLB have supplied the test information to the marker.

E. Coin box (paystation) identity

The equipment is operative during this same period to test the calling line for the purpose of determining whether or not the calling line is a paystation line. It is noted that the paystation lines are strapped for purposes of identification, the strap for such lines being connected between the S terminal associated with the line and the paystation conductor PS of the LP1 circuit (see FIGURE 16 and FIGURE 81).

Referring now to FIGURE 72 (MPR), the circuit of this figure provides a means for detecting originating calls from paystations as well as for detecting reverting calls. This circuit comprises an electronic tube which is commercially available as a 50C5 having a plate, a cathode, a control grid and a screen grid therein. The plate is connected over a .01 mf. condenser to an LC circuit comprising a 3.5 mh. coil and a .05 mf. capacitor. Additionally the plate is connected through the winding of relay 1PS to ground, i.e. positive potential.

The output of the LC circuit is arranged to be selectively and inductively connected to the control grid cathode circuit of the electronic tube over a circuit comprising a 9 mh. coil, an .01 capacitor and a 680 ohm resistor. A 4700 ohm resistor and a .1 mf. capacitor are connected in the tube grid return circuit. A rectifier which may be of the type commercially available as a 1N65 is connected between the output of the tube and the control grid cathode circuit thereof. The screen grid of the tube is connected to positive battery through a 22 ohm resistor in conventional manner. The tube is heated by a filament over a circuit from ground through the 22 ohm resistor filament to battery. The cathode of the circuit is connected to battery.

The control relay 1PS is connected in the output circuit of the electronic tube and is operatively controlled thereby.

Second and third control relays 2PS and 2RC are operative in cooperation with relay 1PS to make the above mentioned tests and to indicate certain alarm conditions. With no bias on the control grid, the tube is normally conducting and relay 1PS is operated from ground, its winding, the anode of the tube, through the space anode cathode path to negative battery, the tube conducting 30 to 40 milliamperes.

With relay 1PS normally operated, ground is withheld from lead PS to a trouble recorder by open contacts *d* and from lead 2 through break contacts *d* of relay 2RC by open contacts *c* of relay 1PS. At its make contacts *b*, relay 1PS connects conductor 1 from cable MCT–MPR through its contacts *b* and break contacts *c* of

relay 2PS to conductor 5 of cable ML1–MPR and at its break contacts holds open conductor 1 from cable MCT–MPR.

Earlier in the description it was stated that relay AV operates relays 1PST to 5PST (LPI, FIGURE 16). Accordingly if line 17 had been a paystation line, a strap would be connected between the S terminal associated with line 17 of the LPI circuit to lead PS of the LPI circuit and the following circuit would be completed upon the operation of horizontal magnets HC and H9 in the SLA–1 circuit: Ground through make contacts of relay 1PST through a .1 mf. condenser through a 20 ohm resistor, through the strap between terminal PS and S, to the S wire of line 17, through make contacts 11 of magnet H9 and make contacts of relay HC, then through the make contacts 26 of relay 1A, conductor 1308, SLA–A conductor otherwise labeled 21, through make contacts *c* of relay 2CN1, SLA–S conductor, through break contacts *e* of relay 1ABL, break contacts *c* of relay REL1 into conductor 1 and cable MPS to MLI, conductor 1, through break contacts *c* of reverting call test relay 2RC, through a 1 mf. capacitor and the 3.4 mh. coil through the 9 mh. coil, to ground, thus completing an alternating current return path between the secondary windings of the 3.5 mh. coil and the 9 mh. coils. Accordingly the output from the electronic tube is fed back to the input causing the tube to oscillate at a frequency of about 12 kc. The oscillating voltage is rectified by rectifier 1N65 which impresses a negative bias voltage through the primary of the 9 mh. coil and the 680 ohm resistor on the control grid causing the tube to reduce its conduction to approximately 3 or 4 milliamperes and thereby to effect the restoration of the control relay 1PS which is connected in the plate circuit thereof.

Relay 1PS connects ground through break contacts *d* to lead PS of the trouble recorder which indication is only effective if the marker calls in a trouble recorder. Relay 1PS also places ground through break contacts *c* of relay 1PS and break contacts *a* of relay 2RC, conductor 2, cable MLI to MPR, conductor 2, make contacts *h* of relay 2AND, conductor 6, cable MPR to MLI, conductor 6, break contacts *b* of relay 2PS, conductor to MVO, to a lever of relay AGD, preparatory to notification of the originating register through further circuitry that the calling line is a paystation call so that the originating register may require coin deposit therefor.

It should be recalled that relay 4BA operated relays 1CR. When relay 1PS releases, it opens the circuits of this relay and completes the circuit for relays 1CBT and 2CBT instead thereof. This circuit may be traced from battery through the windings in parallel of these relays, conductor 2, cable to MPR, conductor 2, break contacts *a* of relay 1PS, break contacts *c* of relay 2PS, conductor 5, cable to MLI, conductor 5 and make contacts *d* of relay 4BA to ground.

With the operation of relays 1CBT and 2CBT and the release of relay 1CRA, the paystation call has been identified in the marker. Further significance of these relays will become apparent hereinafter.

F. Register selection and path finding "by-path"

It should be recalled that with operation of relay 3ANC (see MRT circuit), the selection of an idle register and finding of a path from the calling line to the selected register was initiated. It should be appreciated that register selection has been proceeding simultaneously with line selection, but that both must be completed before path finding is initiated. The marker equipment first seeks a register group having an idle register therein.

More specifically, relay 3ANC at its contacts *d* opens the holding circuit of relay 0T2 in series with the upper winding of relay 0T1, whereby relay 0T1 is released. It should be observed that a holding circuit exists for relay 0T2 from battery through the lower winding of relay 0T2, make contacts *j* of relay 0T2, and make contacts *k* of relay 0T1, through resistor *j* to ground; and that as relay 0T1 releases and disrupts this holding circuit, a holding circuit for relay 0T2 exists from battery through the lower winding of relay 0T2, make contacts *j* of relay 0T2 and break contacts *k* of relays 0T3 to 0T10 (certain of which are shown and others of which are indicated), and break contacts *j* of relay 0T1 and resistor *j* to battery, this transfer being effected over make-before-break contacts of relay 0T1.

Relay 0T2 at its make contacts *i* prepares a circuit in series with relay 0T3 (not shown but indicated) extending from battery through the lower winding of relay 0T3, upper winding of relay 0T2, make contacts *i* of relay 0T2, break contacts *h* of relay 0T1, break contacts *m* of relay 0T10, closed contacts *b* of manual key, to open break contacts *d* of relay 3ANC, this circuit becoming effective on the next call through the marker. In this fashion the advance rotator comprising relays 0T1 to 2T10 advances as calls pass through the marker, these relays being operative in a continuous circle.

Relay 3ANC also operates relay X2 over the circuit from battery through the winding of relay X2, through break contacts *b* of relay Y2, through make contacts *g* of relay 3ANC to ground. Relay X2 operates relay X1 from battery through the lower winding of relay X1, conductor X1, break contacts 6 of relays 1RS1, 1RS2 and 1RS3 of the MCT circuit in series, through make contacts *b* of relay 3ANC, break contacts *c* of relay Y1 and make contacts *c* of relay X2 to ground.

Brief consideration is given to the MRT circuit (FIGURES 44, 45, 60 and 61) at this point. Relays 0T1–0T10 constitute an advance rotator which shifts the priority of register selection in register groups. When circuit MRT is ready to make a register test in the first group of registers predetermined, relay Y1 operates and opens the circuit of relay X1. If a register is found, within a predetermined time, relay Y1 releases before X1 has time to release, and reestablishes the circuit of relay X1.

Referring now to relays 1T1 to 1T10, these relays operate from idle indication battery in the respective registers through the respective rectifiers. If a plurality of registers are idle, a plurality of corresponding relays of the group 1T1–1T10 operate simultaneously but only one can lock as determined by the rotational setting of relays 0T1–0T10. The relay of this group which locks indicates in the marker the particular register group which has been asigned for use in the call.

Referring to the group of relays 2T1 to 2T10, the individual relays of this group are operated by the corresponding relays of the group 1T1–1T10.

Furthermore, if a register is found, relay TA operates and relay Y1 releases. With relays X1 and relay TA operated and relay Y1 released a circuit to the MVO circuit effects the operation of originating pathfinder ground start relays AGA and AGB. If a path is found, relay AGC operates and prevents ground through make contact *g* of AGB and break contact *j* of relay AGC from extending into the MRT circuit and operating relay Y2. However, if a path is not found, this ground through the make contact *g* of relay AGB, through break contact *j* of AGC, conductor 3, cable MRT to MVO, conductor 3 and winding of relay Y2 to battery, operates relay Y2. Relay Y2 releases relay X2, and register selection is attempted again in the next group of registers.

Relays 0A1 to 0A4 constitute an advance rotator, the position of which determines which group of registers shall be the starting point of the search.

Relays 1, 2 and 3 constitute a counting chain so that if three different tests of register groups is made, the marker is advised to stop its searching for an idle register.

1. Marker rotator set with starting point at register group #1

(1) Register group #1 available; idle path thereto

The manner in which the selection of an idle register

of group 1 is made is now set forth. By way of review, it is noted that relay 3ANC (FIGURE 61) operated relay X2 which in turn operated relay X1. Relay X1 locked from battery through the lower winding of relay X1, through make contacts *e* of relay X1, through make contacts *b* of relay 3ANC independent of the MCT circuit, through break contacts *c* of relay Y1, through make contacts *c* of relay X2 to ground.

It can be seen that a circuit exists through the upper winding of relay X1, make contacts *d* of relay X1, make contacts *b* of relay X2, through a 5 ohm resistor and back to the upper winding of relay X1 whereby with X2 operated, X1 is made slow to release.

Relay X1 operates relay 1 from battery through the lower winding of relay 1 through break contacts *b* of relay 2, break contacts *b* of relay 3, make contacts *g* of relay X1, closed contacts *b* of the manual key, and make contacts *c* of relay 3ANC to ground.

Relay 1 prepares a circuit in series with relay 2 from battery through the lower winding of relay 2, through the upper winding of relay 1, through make contacts *d* of relay 1 to open contacts *h* of relay X1.

Relay X1 also operates relay 0A2 from battery through the upper winding of relay 0A2, through the lower winding of relay 0A1, make contacts *c* of relay 0A1, through break contacts *d* of relay 0A4, through make contacts *e* of relay X2, through make contacts *i* of relay X1 and make contacts *f* of relay 3ANC to ground.

Relay 0A2 opens the original locking circuit of 0A1 from battery through the upper winding of relay 0A1, through break contacts *a* of relay 0A2, make contacts *a* of relay 0A1 and 1000 ohm resistor ground; and prepares a locking circuit for itself from battery through the upper winding 0A2, through make contacts *b* of relay 0A2 and break contacts *a* of relay 0A3 and 0A4 in series in preparation for the release of relay 0A1, at which time this circuit passes through the break contacts *b* of relay 0A1 through 1000 ohms to ground, when subsequently 0A1 releases.

Additionally relay X1 operates relay 1RS1 (see MCT circuit) from battery through the winding of relay 1RS1, conductor 1, cable MRT–MCT, conductor 1, break contacts *b* of relays 0A4 and 0A3 in series, make contacts *e* of relay 0A1, closed contacts *f* of manual key, make contacts *f* of relay X2, make contacts *j* of relay X1, make contacts *h* of relay 3ANC to ground.

Relay 1RS1 operates relays 7AN1 and 8AN1 from battery through the winding of these relays in parallel, conductor 1, cable A, conductor 1, make contacts *e* of relay 6AN1 and make contacts *a* of relay 1RS1 to ground. Similarly relay 1RS1 operates relays 9AN1 and 10AN1 from battery through the winding of these relays in parallel, conductor 2 through cable A, conductor 2, through make contacts *b* of relay 6AN1 and make contacts *b* of relay 1RS1 to ground.

Relay 1RS1 operates relays 1RL1 and 2RL1 in the SRL–1 circuit from battery through conductor 4 in circuit MCT, cable to SRL, conductor 4, windings of relays 1RL1 and 2RL1 in parallel, conductor 1, cable to MCT, conductor 1, make contacts *i* of relay 6AN1, make contacts *e* of relay 1RSL to ground.

Relay 1RS1 operates relays 3RL1 and 4RL1 in the SRL–1 circuit from battery through conductor 4, cable to SRL, conductor 4, windings of relays 3RL1 and 4RL1 in parallel, conductor 2, cable to MCT, conductor 2, make contacts *h* of relay 6AN1, and make contacts *d* of relay 1RS1 to ground.

Relay 1RS1 also operates relays 5RL1 and 6RL1 from battery, conductor 4, cable to SRL, conductor 4, windings of relays 5RL1 and 6RL1 in parallel, conductor 3, cable to MCT, conductor 3, make contacts *g* of relay 6AN1 and make contacts *c* of relay 1RS1 to ground.

It should be observed that if relay 6AN2 had been operated instead of relay 6AN1 as a result of the calling five hundred line group being the second group instead of the first group, relays 7AN2, 8AN2, 9AN2, and 10AN2 would have been operated instead of relays 7AN1 to 10AN1, and similarly if relay 6AN2 had been operated instead of relay 6AN1 relays 1RL1 to 6RL1 in the SRL circuit associated with the second five hundred group of lines would have been operated instead of those in the SRL associated with the first 500 group of lines.

Additionally it should be noted that if this marker had been the second subscriber's line marker, relays in the SRL circuit would have operated relays 1RL2 to 6RL2 instead of relays 1RL1 to 6RL1 thereby making certain connections between the SRL–1 circuit and the second subscriber's line marker instead of the first.

Relay 2RL1 operates 20 millisecond slow release relay Y1 over the circuit from battery through the winding of relay Y1, break contacts *e* of relay TA, make contacts *e* of relay 0T2, contacts *j* of relay 2T1, contacts *f* of relay 1T1, contacts *h* of relay 2T1, contacts *d* of relay 0T1, contacts *j* of relay 2T10, contacts *b* of relay 1T10, contacts *h* of relay 2T10, contacts *d* of relay 0T10, contacts *j* of relay 2T9, contacts *b* of relay 1T9, contacts *h* of relay 2T9, contacts *d* of relay 0T9, similar contacts not shown of intervening relays, contacts *j* of relay 2T6, contacts *b* of relay 1T6, contacts *h* of relay 2T6, contacts *d* of relay 0T6, contacts *e* of relay 0L1, contacts *j* of relay 2T5, contacts *b* of relay 1T5, contacts *h* of relay 2T5, contacts *d* of relay 0T5, similar contacts not shown of intervening relays, contacts *j* of relay 2T2, contacts *b* of relay 1T2, contacts *h* of relay 2T2, contacts *e* of relay 0T2, contacts *f* of relay 2T2, contacts of intervening relays, contacts *b* of relay 0T5, contacts *f* of relay 2T5, contacts *c* of relay 0L1, contacts *b* of relay 0T6, contacts *f* of relay 2T6, contacts of intervening relays, contacts *b* of relay 0T9, contacts *f* of relay 2T9, contacts *b* of relay 0T10, contacts *f* of relay 2T10 around to break contacts *b* of relay 0T1, contacts *f* of relay 2T1, make contacts *a* of relay 0T2, conductor 52, cable to SRL, conductor 52, make contacts 5305′ of relay 2RL1, conductor 51, cable to MRT, conductor 51, make contacts *a* of relay 3ANC, make contacts *b* of relay X1, make contacts *a* of relay X2 to ground.

At this time relay Y1 opens the circuit of slow to release relay X1 at contacts *c* of relay Y1 to begin a timing interval for selecting a register in the first group of registers tested.

When relays 1RL1–6RL1 of the SRL–1 circuit operate, conductor B from each register of the group of ten registers reached from SRL–1 is connected through a rectifier to an associated relay 1T1–1T10 in the MRT circuit, and if the register is available, 1600 ohm battery via conductor B is connected to one side of the associated relay. Although all relays of the group 1T1–1T10 which correspond to idle registers attempt to operate, only one of these relays of the group 1T1–1T10 can lock, as determined by the priority chain 0T1–0T10, the relay which locks being the one closest ground provided by chain 0T1–0T10. The relay which locks opens the ground circuit to the other relays of the group 1T1–1T10.

For example, assuming register #1 (see FIGURES 35 to 37) to be idle, battery in the register through break contacts 11 of register relay H2, break contacts 31 of register relay H1, closed contacts of manual key, conductor B, cable to SRL–1, conductor B otherwise designated 5301, break contacts of relay B1 associated with conductor 5301 through fuse switch contacts associated with fuse 1, through make contacts of relay 2RL1, associated with conductor 31, conductor 31, through a cable into a cable to MRT, out of the said cable into the vertical test cable "VERT TEST," out of that cable through conductor 31, through the rectifier in the correct direction, through the winding of relay 1T1, through break contacts *h* of relay 2T1, through break contacts *d* of relay 0T1, around to break contacts *j* of relay 2T10, through break contacts *b* of relay 1T10, to break contacts *h* of relay 2T10, to break contacts *d* of relay 0T10,

break contacts *j* of relay 2T9, contacts *b* of relay 1T9, contacts *h* of relay 2T9, contacts *d* of relay 0T9, similar intervening contacts, contacts *j* of relay 2T6, contacts *b* of relay 1T6, contacts *h* of relay 2T6, contacts *d* of relay 0T6, contacts *e* of relay 0L1, contacts *j* of relay 2T5, contacts *b* of relay 1T5, contacts *h* of relay 2T5, contacts *d* of relay 0T5, similar intervening contacts, contacts *j* of relay 2T2, contacts *b* of relay 1T2, contacts *h* of relay 2T2, make contacts *c* of relay 0T2, break contacts *f* of relay 2T2, similar intervening contacts, break contacts *b* of relay 0T5, break contacts *f* of relay 2T5, break contacts *c* of relay 0L1, break contacts *b* of relay 0T6, break contacts *f* of relay 2T6, similar intervening contacts, break contacts *b* of relay 0T9, break contacts *f* of relay 2T9, contacts *b* of relay 0T10, contacts *f* of relay 2T10, and around through break contacts *b* of relay 0T1, break contacts *f* of relay 2T1, make contacts *a* of relay 0T2, conductor 52, cable to SRL–1, conductor 52, closed make contacts of relay 2RL1, conductor 51, cable to MRT, conductor 51, make contacts *a* of relay 3ANC, make contacts *b* of relay X1, and make contacts *a* of relay X2 to ground, operates relay 1T1.

It should be noted that if register 1 is idle, 1600 ohm battery is on the B lead from the register, but that if the register is busy, the B lead will be found open.

Additionally if a register is busy, the vertical magnet associated with this register such as V1 of the SRL circuit such as SRL–1 will be operated and the B lead circuit will be opened at break contacts of this relay. For example, in the circuit of the relay just described, the B lead from the register which becomes lead 5301 would be opened at break contacts of relay V1 associated with this lead.

Assuming for example that register 6 is also idle, relay 1T6 attempts to operate over the following circuit: 1600 ohm battery on the B lead from the register, through break contacts of a relay V6 not shown, an associated conductor therefrom, make contacts of relay 3RL1, conductor 36, a sub-cable into a cable to MRT, vertical test cable "VERT TEST" emerging therefrom, conductor 36, rectifier in the correct direction, winding of relay 1T6, contacts *h* of 2T6, contacts *d* of 0T6, contacts *e* of 0L1, contacts *j* of 2T5, contacts *b* of relay 1T5, contacts *h* of relay 0T5, similar intervening contacts. contacts *j* of relay 2T2, contacts *b* of 1T2, contacts *h* of 1T2, make contacts *e* of 0T2, break contacts *f* of 2T2, similar intervening contacts, contacts *b* of relay 0T5, contacts *f* of relay 2T5, contacts *c* of relay 0L1, contacts *b* of relay 0T6, contacts *f* of relay 2T6, similar intervening contacts, contacts *b* of relay 0T9, contacts *f* of 2T9, contacts *f* of relay 0T10, contacts *f* of relay 2T10 around through break contacts *b* of relay 0T1, break contacts *f* of relay 2T1, make contacts *a* of relay 0T2, conductor 52, to ground traced hereinbefore.

Also, assuming that register 2 is idle, relay 1T2 also attempts to operate over the following circuit: 1600 ohm battery on the B lead from the register, through break contacts of a relay V2 not shown, an associated conductor therefrom, make contacts of relay 2RL1, conductor 32, a cable into cable to MRT vertical test cable "VERT TEST" emerging therefrom, conductor 32, rectifier in the correct direction, winding of relay 1T2. contacts *h* of relay 2T2, contacts *e* of relay 0T2, contacts *f* of relay 2T2, intervening contacts, contacts *b* of relay 0T5, contacts *f* of relay 2T5, contacts *c* of relay 0L1, contacts *b* of relay 0T6, contacts *f* of relay 2T6, intervening contacts, contacts *b* of relay 0T9, contacts *f* of relay 2T9, contacts *b* of relay 0T10, contacts *f* of relay 2T10, contacts *b* of relay 0T1, contacts *f* of relay 2T1, contacts *a* of relay 0T2, conductor 52 to ground previously traced.

It is also noted that contacts *b* of relay 1T2 open the aforedescribed circuits of relays 1T1 and 1T6, but that the circuit of 1T2 (with 0T2 operated) does not pass through contacts of relays 1T1 and 1T6. Accordingly, if registers #1, #2 and #6 are all idle with priority relay 0T2 operated, only relay 1T2 can remain operated. With relay 0T2 operated a priority in locking exists from 1T2 to 1T10 with relay 1T1 having lowest priority.

Relay 1T1 has first priority if relay 0T1 is operated and a decreasing priority exists from 1T2–1T10. Relay 1T3 has first priority if relay 0T3 is operated and a decreasing priority exists from 1T4–1T10–1T1–1T2.

In order to be more concise the following terminology will be employed extensively hereinafter. For example:

Contacts *i* of relay 2T1=2T1–*i*
Contacts *h* of relay 2T1=2T1–*h*
Winding of relay 2T1=2T1

For purposes of illustration let us assume that relay 0T1 is operated and accordingly that relay 1T1 operates, a circuit is completed to operate associated relay 2T1 and relay TA from battery, TA, 2T1, 1T1–*a*, 2T1–*h*, 0T1–*c*, 2T1–*f*, 0T2–*b*, 2T2–*f*, intervening contacts, 0T5–*b*, 2T5–*f*, 0L1–*c*, 026–*b*, 2T6–*f*, intervening contacts, 0T9–*b*, 2T9–*f*, 0T10–*b*, 2T10–*f*, 0T1–*a*, conductor 52, to ground previously traced. Relay 1T1 opens the ground circuits to relays 1T2–1T10.

Relay 2T1 locks itself and relay TA over the circuit from battery, TA, 2T1, 2T1–*g*, 0T2–*b*, 2T2–*f*, intervening contacts 0T5–*b*, 2T5–*f*, 0L1–*c*, 0T6–*b*, 2T6–*f*, intervening contacts, 0T9–*b*, 2T9–*f*, 0T10–*b*, 2T10–*f*, 0T1–*a*, to ground on conductor 52. Relay 1T1 also locks over contacts 1T1–*a*, 2T1–*g* to ground as just traced. Since the circuit over 2T1–*g* is closed before the circuit over 2T1–*f* is opened, and relays 1T1, 2T1 and TA are held thereover.

It should be recalled that a slipped or graded multiple exists between SRL's of the whole exchange and the common group of registers, and accordingly, if the marker in a different 1000 line group should operate relays 1RL2–6RL2 in an SRL in the different 1000 line group and should test the #1 register B conductor, the current drain through relay 1T1 of the instant marker would prevent relay 1T1 in the other marker from operating.

Relay 2T1 closes a circuit from ground through 2T1–*a* to the trouble recorder and prepares circuits from MVO to SRL–1. Relay TA also prepares these circuits from MVO to SRL–1.

Relay 1T1 at its contacts *b*, relay 2T1 at its contacts *h* and relay TA at its contacts *e* open the circuit of 20 millisecond slow relase relay Y1, which releases in time to reclose the circuit of relay X1 at Y1–*c* before X1 releases.

Relay 0L1 (see MRT circuit) operates if, for any reason all relays 0T1–0T10 should be non-operated, and takes over the functions of relay 0T6, thus giving the same priorities as though 0T6 had been operated. The circuit which operates relay 0L1 may be traced from battery through the winding of relay 0L1, and break contacts *f* of all relays 0T1–0T10 in series to ground.

Additionally, relay 0L1 places ground through 0L1–*a* on alarm terminal ALM.

At this time the marker controls the equipment to initiate the path finding operation. That is, with relay TA operated indicating that a register has been selected; with relay X1 operated, indicating that a register was selected within the required time; and with relay Y1 also released after the proper interval, a circuit is completed from ground, Y1–*b*, X1–*c*, TA–*b*, to the pathfinder start lead "PF Start," thence to the MVO circuit, through break contacts *g* in series of all originating pathfinding selection relays AG1–AG20, through the windings in parallel of originating pathfinding ground start relays AGA and AGB to battery, operating these relays which are of the slow operate type to allow relays 1CRA and 1CBT and 2CBT of the MCT circuit time to respond to the paystation identification and settle down before actual pathfinding begins.

When relays AGA and AGB operate, the pathfinder start ground on lead "PF Start" is connected to one side of each relay AG1–AG20 through contacts of relays AGA

and AGB. For example, ground through Y1–*b*, X1–*c*, TA–*f*, AGA–*a* is connected to the lower side of the winding of relay AG1. The connection of battery to the other side of the relays AG1–AG20 depends upon which relays 1V1–1V10 are operated as a result of corresponding idle verticals V1–V10 in the calling SLA switch; and upon which verticals V1, V2, V6, and V7 are idle in SLB's 1–5. It should be recalled that relays 7AN1–10AN1 associated with SLB's 1–5 were operated as a result of relay 1RS1 having been operated which in turn was operated as a result of the rotator 0A1–0A4 of the MRT circuit being in the position of having relays 0A1–0A2 operated to start register selection in the first group of registers, and as a result of a register having been found idle in the first group of registers associated with SRL–1 associated with SLB's 1–5.

For example, with relay 1V1 (see MCT circuit) operated and with vertical V1 of SLB–1 idle, battery is connected to the other side of relay AG1 (see MVO circuit) and this relay operates over the circuit from ground through Y1–*b*, X1–*c*, TA–*f*, AGA–*a*, AG1, conductor 31, cable 31–50, cable to MCT, cable 31–50, conductor 31, break contacts V1 of relay 1CRA if the call is a paystation call or X-wiring if the call is a non-paystation call with CRA operated but no CBT associated with CRA–1, break contacts 1CBT–*f* if the call is a non-paystation call or Y-wiring if the call is a paystation call with a CBT associated with CRA–1, conductor 1, contacts 1V1–*b*, conductor 1, 7AN1–1, conductor 1, cable 1–2–3–4 (otherwise labeled 5101) from MCT to SLB–1, fuse contacts 1, off-normal break contacts 12 of vertical magnet V1, closed contacts of manual key BK, conductor B (see now also FIGURE 9 and trace therein), 1600 ohm resistor, contacts 1421 of call signal relay 1420, off-normal break contacts 1498 of associated vertical magnet V1 of the group selector crossbar GSA switch, break contacts 1436 of relay 1435 in the group selector marker 1450 to battery.

Similar circuits may obtain for each relay AG2–AG20.

Thus, if all verticals V1–V10 of SLA–1 are idle, and all twenty verticals comprising V1, V2, V6, V7 of SLB's 1–5 (associated with corresponding twenty CRA's) are idle, all relays AG1–AG20 operate.

If vertical V1 of SLA–1 is busy as for example by another originating or terminating call, relay 1V1 will be non-operated, and relays AG1 and AG2 cannot operate, even though verticals V1 and V2 of SLB–1 are idle. Also if vertical V1 of SLA–1 is idle relay 1V1 will be operated. If vertical V1 of SLB–1 is idle, relay AG1 will operate; but if vertical V2 of SLB–1 is busy, relay AG2 will not operate with the off-normal break test contacts of magnet V2 of SLB–1 open.

Accordingly only those relays AG1–AG20 operate which represent an idle path from an SLA vertical to an SRL–1 horizontal.

Referring to FIGURE 9 of the copending application, the twenty possible paths are as follows:

Path	SLA Vertical	SLB	SLB Horizontal	SLB Vertical	SRL–1 Horizontal	Relays
1	V1	1	1 (left)	V1	1	AG1
2	V1	1	1 (left)	V2	11	AG2
3	V2	1	1 (right)	V6	2	AG3
4	V2	1	1 (right)	V7	12	AG4
5	V3	2	1 (left)	V1	3	AG5
6	V3	2	1 (left)	V2	13	AG6
7	V4	2	1 (right)	V6	4	AG7
8	V4	2	1 (right)	V7	14	AG8
9	V5	3	1 (left)	V1	5	AG9
10	V5	3	1 (left)	V2	15	AG10
11	V6	3	1 (right)	V6	6	AG11
12	V6	3	1 (right)	V7	16	AG12
13	V7	4	1 (left)	V1	7	AG13
14	V7	4	1 (left)	V2	17	AG14
15	V8	4	1 (right)	V6	8	AG15
16	V8	4	1 (right)	V7	18	AG16
17	V9	5	1 (left)	V1	9	AG17
18	V9	5	1 (left)	V2	19	AG18
19	V10	5	1 (right)	V6	10	AG19
20	V10	5	1 (right)	V7	20	AG20

The operated relays AG1–AG20 try to lock over their *c* contacts but only one can succeed in locking as determined by the position of the jump rotator ASG1–ASG20.

Thus, if jump rotator relay ASG20 is in the operated position, ground on the pathfinder start lead "PF START," through contacts *a* of the alarm key, ASG20–*a*, conductor 1, cable, to conductor 1, gives relay AG1 priority in locking over relays AG2–AG20 when relays AGA and AGB subsequently operate, opening the original operating ground from relays AG1–AG20. It can be seen that with relay AG1 operated and locked through its *c* contacts, the *c* contacts locking circuit of relays AG2–AG20 are opened at open contacts *d* of relay AG1. Similarly, if AG1 is non-operated and AG2 operated, relay AG2 has a locking circuit over AG2–*c*, AG1–*d* to ground on conductor 1 and the *c* contacts locking circuits of relays AG3–AG20 are opened at the open *d* contacts of relay AG3–AG20, etc. Thus with ground on conductor 1 the relays AG1–AG20 have decreasing priority from AG1–AG20.

Digressing, if "Jump rotator" relay ASG1 is in the operated condition instead of relay ASG20, locking ground will be found on conductor 2 instead of conductor 1, and relays AG1–AG20 will have decreasing priority of locking from AG2 to AG20 to AG1.

The operation of any relay or relays AG1–AG20 opens the circuit of relays AGA and AGB. For example, relay AG1 at its open contacts *g*, opens the circuit of relays AGA and AGB which are slow release relays.

When relays AGA and AGB release, the initial operating ground is removed from relays AG1–AG20 and only one of these relays remains operated. We shall assume that relay AG1 has succeeded in locking with locking ground on conductor 1.

With relay AG1 operated and relay AGA released, a circuit is completed to operate relay AGC as follows: battery, AGC, AGA–*g*, break contacts *e* in series of relays AG20 to AG2, AG1–*f*, to ground on lead "PF START."

At its contacts *a*, relay AGC closes battery through a resistor to the *b* contacts in parallel of relays AG1–AG20, whereby AG1 holds when the original operating battery on conductor 31 is removed by the operation of vertical magnet V1 of SLB–1.

At its contacts *j*, relay AGC disrupts the following circuit which was closed when relay AGB operated: ground, AGB–*g*, AGC–*j*, C3, cable, C3, Y2, battery. It should be noted that relay Y1 is a 35 ms. slow operate relay and normally will not have operated when relay AGC opens this circuit.

At its contacts *g*, relay AGC closes a circuit from ground, AGC–*g*, conductor P, cable, conductor P, TA–*a*, 2T1–*b*, C21, cable PRE. SEL. REG., cable SRL–MRT, C21, 6RL1–*a*, conductor MB, cable REG–O–SRL–1, conductor MB, break contacts 13 of relay RD in register #1, winding of slow release relay H1, to battery, operating relay H1 which places ground through its make contacts 15 on the H lead to prepare a holding circuit for the SRL–1 vertical magnet which subsequently operates. Relay H1 at its contacts 32 disconnects resistance battery from the B lead, releasing relay 1T1 in the marker.

At its contacts *b*, relay AGC opens the following circuit for 50 ms. slow release relay AGD which was closed, operating relay AGD when relay 3ANC operated: battery, AGD, AGC–*b*, conductor "VERT. CONT.," 3AANC–*j* to ground.

It is noted that the description of the initiated call continues at Section G–Path Establishment, and that for continuity the reader should advance to such point in the description. At this point, the description digresses to set forth various register and path seeking operations which differ with the condition of the equipment wherein it is assumed that the equipment includes three groups of registers equipped with X-wirings.

It is first noted that whenever an originating call has

progressed to the point of seeking a register and path, relay 3ANC of the MRT circuit operates as described hereinbefore. Relay 3ANC operates relay X2 over the circuit from ground, through contacts 3ANC–*g*, Y2–*b*, winding of relay X2 to battery.

Relay X2 operates relay X1 over the circuit from battery through the lower winding of relay X1, conductor X1, break contacts *g* in series of each relay 1RS1, 1RS2, and 1RS3, contacts 3ANC–*b*, Y1–*c*, X2–*c*, conductor 7, cable to the MLI circuit, conductor 7, and contacts REL1–*g* to ground. Relay X1 locks over the circuit which extends from battery through its lower winding, contacts X1–*e*, 3ANC–*b*, Y1–*c*, X2–*c*, etc., and over the path just traced, independent of relays 1RS1, 1RS2, and 1RS3. With relays X2 and X1 both operated, a circuit through the upper winding of relay X1, contacts X1–*d*, X2–*b*, resistor 5 back to the upper winding of relay X1 makes relay X1 slow to release.

Relay X1 operates relay 1 of the chain 1–3; and assuming relay 0A1 to have been normally operated, relay X1 operates relay 0A2 in series with 0A1; and operates relay 1RS1 of the group 1RS1, 1RS2, 1RS3. Relay 1RS1 in turn operates relays 7AN1–10AN1 in the marker and relays 1RL1–6RL1 in the associated SRL–1. With relay 2RL1 in the selected SRL operated, ground through contacts X2–*a*, X1–*b*, 3ANC–*a*, conductor 51, cable to SRL, contacts 5205 of 2RL1, conductor 52, cable to MRT, through contacts of relays 0T1–2T10, contacts TA–*e*, through the winding of relay Y1 to battery, operates relay Y1.

Accordingly, relays X2, X1, and Y1 are all operated.

It should be observed that relay X1 at its contacts X1–*c* prepares the pathfinder start lead, but that relay Y1 at its contacts Y1–*b* and relay TA at its contacts TA–*b* holds this lead open. Accordingly, path-finding cannot start unless an idle register is found.

Relay Y1 at its contacts Y1–*c* opens the holding circuit of relay X1 but relay X1 is slow to release and will not release at this time unless no register is found.

When a register is found, relay TA operates, opening the circuit of slow release relay Y1 which releases after an interval, preventing the release of relay X1. With relays TA and X1 operated and relay Y1 released, ground is placed on the path-finder start lead.

However, if a register is not found, relay TA does not operate. Accordingly, relay Y1 does not release. Accordingly, the circuit of relay X1 is held open, and after an interval as determined by its slow release, relay X1 releases. With relays TA and X1 released and Y1 operated, ground is withheld from the path-finder start lead.

Relay X1 in releasing releases relays 0A1 and 1RS1 and operates relay 2. The release of 1RS1 releases relays 7AN1–10AN1 and 1RL1–6RL1 in SRL–1. The release of 2RL1 releases relay Y1 which reoperates relay X1. The reoperation of relay X1 operates relay 0A4, releases relay 1, and operates relay 1RS2 in the group 1RS1–1RS3 which operates relays 11AN1–14AN1 in the marker and relays 1RL1–6RL1 in the associated SRL–2 which reoperates relay Y1. If a register is found, relay TA operates, relay Y1 releases, and the path-finder start lead is grounded. If a register is not found, relay TA does not operate, relay Y1 does not release, and relay X1 releases.

The release of relay X1 releases relays 0A1 and 1RS2 and operates relay 3. The release of relay 1RS2 releases relays 11AN1–14AN1 in the marker and relays 1RL1–6RL1 in SRL–2 which releases relay Y1 which reoperates relay X1.

Relay X1 operates relay 0A1, releases relay 2, and operates relay 1RS3. Relay 1RS3 operates relays 15AN1–18AN1 in the marker and relays 1RL1–6RL1 in SRL–3 which reoperates relay Y1. If a register is found relay TA operates relay Y1 releases and the pathfinder start lead is grounded. If a register is not found, relay X1 releases, in turn releasing relays 0A4 and 1RS3. The release of relay 1RS3 releases relays 15N1–18AN1 in the marker and relays 1RL1–6RL1 in SRL–3. The release of relay X1 holds relay 3 until relay 3ANC subsequently releases.

The release of relay X1 closes a circuit from ground through contacts 3ANC–*c*, 3–*a*, 2–*b*, *X*–wiring, X–*f*, conductor 5, cable to the MLI circuit, conductor 5, upper winding of relay REL2 to battery, operating relay REL1, which locks from battery through its upper winding, early contacts REL1–*a*, and 2RAND–*e* to ground.

Relay REL1 operates relay REL2 over the circuit from battery through the winding of relay REL2, contacts REL1–*d*, K1–*c* to ground. At its contacts REL2–*a* relay REL2 opens the operating and holding ground from the operated relay of the group B0–B24 (such as B17) which effects the release of the marker.

It should be observed that relays 1RL1–6RL1 extend test paths from the registers to the test relays 1T1–1T10 in the upper part of MRT. Thus with relay 1RS1 operated and relays 1RL1–6RL1 operated in SRL–1, test paths from the registers associated with SRL–1 (i.e., the first group of registers) are extended to relays 1T1–1T10. With relay 1RS2 operated and relays 1RL1–6RL1 operated in SRL–2, test paths from the registers associated with SRL–2 (i.e., the second group of registers) are extended to relays 1T1–1T10. With relay 1RS3 operated and relays 1RL1–6RL1 operated in SRL–3, test paths from the registers associated with SRL–3 (i.e., the third group of registers) are extended to relays 1T1–1T10.

In any register test of the three possible tests, if a register is found one of the relays 1T1–1T10 will be operated, and will operate an associated relay of the group 2T1–2T10 in series with relay TA.

Accordingly, on the successful register test, relay Y1 will release and hold relay X1. Ground through contacts Y1–*b*, X1–*c*, TA–*b* will then obtain on the pathfinder start lead to operate relays AGA and AGB in the MVO circuit. Ground through contacts AGB–*g*, AGC–*j*, conductor 3 cable, conductor 3, and the 2000 ohm winding of 25 millisecond slow operate relay Y2 to battery energizes this relay, which does not immediately move its armature and contacts.

If no path is found and accordingly relay AGC in the MVO circuit does not operate, this ground is maintained on conductor 3 to relay Y2 and after its 25 millisecond slow operate period has expired, relay Y2 operates.

At its contacts Y2–*b*, relay Y2 opens the circuit of relay X2 which releases. Relay Y2 then locks over the circuit from battery through the winding of relay Y2, contacts Y2–*a*, X2–*d*, X1–*i*, and 3ANC–*f* to ground. The release of relay X2 opens the holding circuit of relay X1 at contacts X2–*c* and opens the circuit of the upper winding of relay X1 at contacts XZ–*b*. Accordingly, relay X1 releases fast. The release of relay X2 releases a relay of the chain 0A1–0A4. For example, if relay 0A1 was normally operated and relay 0A2, 1RS1 and relay 1 operated upon the operation of relay X1 on the first register test, the present release of relay X2 releases relay 0A1 and 1RS1 at contacts X2–*e* and X2–*f* respectively and the release of relay X1 further opens these circuits and operates relay 2 in series with 1. Also the release of relay X1 opens its locking circuit at contacts X1–*e*; removes the pathfinder start ground at contacts X1–*c*, releasing relays AGA and AGB which removes ground from conductor 3 releasing relay Y2.

The release of relay Y2 recloses the circuit of relay X2, reoperating relay X2.

Relay X1 reoperates over break contacts of relays 1RS1–1RS3, contacts 3ANC–*b*, Y1–*c*, X2–*c* to ground previously traced.

Relay X1 operates a relay of the group 0A1–0A4 (relay 0A2 for example), operates a relay of the group 1RS1–1RS3 (1RS2 for example), and releases relay 1 for example.

The operated relay of the group 1RS1–1RS3 (relay 1RS2 for example) operates relays 1RL1–1RL6 in the

selected SRL (SLL–2 for example) and a set of relays such as 11AN1–14AN1 for example.

A new register test is then made.

However, if pathfinding is successful, one of the relays AG1–AG20 will be operated and locked, releasing relays AGA and AGB, and operating relay AGC. The operation of relay AGC disconnects ground from lead 3 to relay Y2 and the release of AGB further opens this circuit.

It should be noticed that relay AGD was operated by relay 3ANC over the circuit from battery through the winding of relay AGD, contacts AGC–*b*, and 3ANC–*j* to ground. When relay AGC operates, the circuit of relay AGC is opened but relay AGD requires 50 milliseconds to release. Normally relays HF1 and HF2 will be operated before the release of relay AGD as a result of the SLB and SRL horizontal magnets operating. If such is the case ground will be kept off conductor 3 and thus will be withheld from relay Y2 at contacts *a*, *c*, and *f* of relay HF1 and contacts *b*, *d*, and *f* of relay HF2. Reviewing, relays X2, X1, and Y1 are initially operated. If a register is found relay Y1 releases. Then if a path is found nothing further occurs as far as relays Y2, X2, X1, and Y1 are concerned until release of the marker. However, if relay HF1 has not operated by the time relay AGD releases, indicating that the SLB horizontal magnets have not operated, ground will be found connected to conductor 3 over three paths to operate relay Y2. These three paths are as follows: ground, 4BA–*e*, conductor 1, cable from MLI to MVO, conductor 1, contacts AGC–*h*, AGD–*e*, HF1–*f*, AGC–*i*, to conductor 3 ground, 4BA–*f*, conductor 2, cable from MLI to MVO, conductor 2, contacts AGC–*f*, AGD–*c*, HF1–*c*, AGC–*i* to conductor 3. Ground 4BA–*g*, conductor 3, cable from MLI to MVO, conductor 3, contacts AGC–*e*, AGD–*b*, HF1–*a*, AGC–*i* to conductor 3.

Also if HF1 has operated, indicating that the SLB horizontal magnets have operated but HF2 has not operated by the time AGD releases, indicating that the SRL horizontals have not operated, three ground paths will obtain to conductor 3 comprising contacts HF1–*b* and HF2*b*; HF1–*d* and HF2–*d*; HF1–*e* and HF2–*f*.

Accordingly, even though pathfinding has been successful, unless SLB and SRL horizontal magnets are all operated and have operated HF1 and HF2 by the time AGD releases, relay Y2 in the MRT circuit will be operated to signal an unsuccessful pathfinding to the MRT circuit and relay Y2 will cause the MRT circuit to shift to another register group unless the operation of chain 1–3 indicates that three register groups have been tested in which case relays REL1 and REL2 in the MLI circuit are operated to release the marker.

Let us consider the chain 0A1–0A4 in further detail with X-wiring for three register groups. It should be observed that when the marker comes to rest after a call, one relay of the chain 0A1–0A4 will be in the operated condition locked to the 1000 ohm ground over its upper winding and break contacts of at least the next relay in the chain in the circle 0A1, 0A2, 0A4, 0A1 (assume X-wiring for 3 register groups). It should be observed also that the position to which the chain was driven by the last call determines which relay will be normally in the operated condition when the next call engages the marker. Let us assume that relay 0A1 is operated as a result of a prior call.

When the next originating call engages the marker and relays 3ANC, X2, and X1 have all operated, ground through contacts 3ANC–*h*, X1–*j*, X2–*f*, closed contacts *b* of the manual key, contacts 0A1–*e*, 0A2–*f*, 0A3–*f*, 0A4–*f*, conductor 1, cable to the MCT circuit, conductor 1, winding of relay 1RS1 to battery operates 1RS1. It should be noted that this circuit is independent of the imminent operation of relay 0A2. Ground through contacts 3ANC–*f*, X1–*i*, X2–*e*, 0A4–*d*, 0A1–*c*, the lower winding of relay 0A1, and the upper winding of relay 0A2 to battery operates relay 0A2. Relay 0A2 locks over the circuit from battery through the upper winding of relay 0A2, contacts 0A2–*b*, 0A1–*a*, and a 1000 ohm resistor to ground.

When relay X1 (or X2) next releases, the circuit through the lower winding of relay 0A1 is opened at contacts X1–*i* (or X2–*e*). With the upper winding circuit of relay 0A1 opened at contacts 0A2–*a*, relay 0A1 releases. During the release of 0A1, contacts *b* of relay 0A1 close before contacts *a* open holding relay 0A2 over the path from battery through the upper winding of 0A2, contacts 0A2–*b*, 0A3–*a*, 0A4–*a*, 0A1–*b*, 1000 ohm resistor to ground. Also when X1 releases (or X2), the circuit of relay 1RS1 is opened at contacts X–*j* (or X2–*f*) and relay 1RS1 releases. With relay 0A1 released, a circuit is prepared through contacts 0A1–*f* and 0A2–*e* to lead 2 for relay 1RS2.

When relay X1 next operates, a circuit is completed to operate relay 1RS2 over the path from ground, 3ANC–*h*, X1–*j*, X2–*f*, closed contacts *b* of manual key, contacts 0A1–*f*, 0A2–*e*, conductor 2, cable to MCT, winding of relay 1RS2 to battery. Also when X1 next operates, a circuit is completed to operate relay 0A4 in series with 0A2 over the path from battery through the upper winding of relay 4, X-wiring through the lower winding of relay 0A2, contacts 0A2–*c*, 0A1–*d*, 0A4–*d*, X2–*e*, X1–*i*, and 3ANC–*e*, to ground. At its contacts *c* which make before contacts *d* open, relay 0A4 transfers this circuit independent of relay 0A1 over the circuit from battery through the upper winding of relay 0A4, X-wiring, lower winding of relay 0A2, contacts 0A2–*c*, contacts 0A4–*c*, X2–*e*, X1–*i*, 3ANC–*f*, to ground. Relay 0A4 locks over the path from battery through the upper winding of relay 0A4, contacts 0A4–*b*, 0A1–*b*, 1000 ohm resistor to ground, disabling the upper winding holding circuit of relay 0A2.

When relay X1 (or X2) next releases, the holding circuit of relay 0A2 is opened and relay 0A2 releases. Also the circuit of relay 1RS2 is opened and this relay releases. A circuit is then prepared for relay 1RS3 over break contacts *f* of relays 0A1, 0A2, 0A3 and make contacts *e* of relay 0A4 and X-wiring to conductor 3.

When relay X1 next operates, relay 0A1 operates in series with relay 0A4 over the path from battery through the upper winding of relay 0A1, lower winding of relay 0A4, contacts 0A3–*d*, 0A2–*d*, contacts 0A4–*c*, X2–*e*,X1–*i*, and 3ANC–*f* to ground. Relay 0A1 locks over its contacts *a* which close before its contacts *b* open over the circuit from battery through the upper winding of relay 0A1, contacts 0A2–*a*, 0A1–*a*, 1000 ohm resistor to ground. At its contacts 0A1–*b*, relay 0A1 opens the upper winding holding circuit of relay 0A4. When relay X1 operates a circuit is completed for relay 1RS3 over the path from ground through contacts 3ANC–*h*, X1–*j*, X2–*f*, manual key, contacts 0A1–*f*, 0A2–*f*, 0A3–*f*, 0A4–*e*, X-wiring, conductor 3, cable to MCT, conductor 3, winding of relay 1RS3 to battery. As relay 0A1 operates, the circuit to relay 1RS3 is maintained over contacts *e* of relay 0A1 which close before contacts *f* open and then through contacts 0A3–*f*, holding relay 1RS3.

When relay X1 (or X2) next releases, the holding circuit of relay 0A4 is opened and relay OA4 releases. Also the circuit of relay 1RS3 is opened and relay 1RS3 releases. Upon the release of relay 0A4, a circuit is prepared for relay 1RS1 over contacts 0A1–*e*, 0A3–*f* and 0A4–*f* to conductor 1.

Accordingly with relay 0A1 normally operated a complete cycle of the chain is completed and subsequent calls advance the chain in like manner.

Let us also consider the chain 1–3 with X-wiring for three register groups in further detail. All the relays of this chain are normally non-operated when the marker comes to rest after the passage of a call through the marker, any operated relays being released when relay 3ANC releases. This chain counts the number of register tests in the attempt to advance a call, and with

X-wiring, causes marker release when three tests have been made and a register has not been found; or if a register has been found on the third test, if an idle path is not found to this register, or if the SLB or SRL horizontal magnets fail to operate relays HF1 and HF2.

When relay X1 first operates after an originating call has engaged the marker, relay 1 operates over the path from ground through contacts 3ANC–*c*, closed contacts of the manual key, contacts X1–*g*, 3–*f*, 2–*f*, and the lower winding of relay 1 to battery. Relay 1 prepares a circuit in series with relay 2 at contacts 1–*d*.

When relay X1 next releases, relay 2 operates in series with relay 1 over the circuit from battery through the lower winding of relay 2, the upper winding of relay 1, contacts 1–*d*, X1–*h*, manual key, contacts 3ANC–*c* to ground. At its contacts *e*, relay 2 prepares a holding circuit for itself and at its contacts *f* disconnects the lower winding circuit of relay 1.

When relay X1 next operates, the upper winding circuit of relay 1 is opened at contacts X1–*h* and relay 1 releases, preparing a circuit for relay 3 at contacts 3–*c*.

When relay X1 next releases, relay 3 operates in series with relay 2 over the path from battery through the lower winding of relay 3, upper winding of relay 2, contacts 2–*d*, 1–*c*, X1–*h*, manual key, and contacts 3ANC–*c* to ground. Relay 3 opens the lower winding holding circuit of relay 2 at contacts 3–*f* and prepares a holding circuit for itself at contacts 3–*e*.

When relay X1 next operates it opens the upper winding circuit of relay 2 at contacts X1–*b* and relay 2 releases. Relay 3 then holds over the circuit from battery through the lower winding of relay 3, contacts 3–*e*, X1–*g*, manual key, and contacts 3ANC–*c* to ground.

When relay X1 next releases, relay 3 holds over the circuit from battery through the lower winding of relay 3 through the upper winding of relay 3, contacts 3–*d*, 2–*c*, 1–*c*, X1–*h*, manual key, and contacts 3ANC–*c* to ground until relay 3ANC subsequently releases.

Relay REL1 in the MLI circuit then operates over a path previously traced in turn operating relay REL2 which opens the circuit of the operated relay of the group B0–B24 affecting the release of the marker. When relay 3ANS releases, the circuit of relay 3 is opened and relay 3 releases, opening the original energizing circuit of relay REL1, but relay REL1 has locked over its upper winding, contacts REL1–*a*, and 2AND–*e* to ground and accordingly is released when relay 2AND subsequently releases. The chain 1–3 is thus returned to normal.

In the event that a register and path are found, the circuit for relay REL1 is not established over the path just described, and the chain stops in some intermediate position. In this case, when relay R1 in the CRA circuit operates, ground through the impedance coil R3 is applied to the originating S-wire and through K-wiring for example (or its CBT equivalent), conductor 5003, SLB crosspoints, SLA crosspoints, to the S-wire of the line circuit (line 17 for example), conductor 1204, H9–11, contacts 12, 14, 16 of magnet HC, conductor 1307, contacts 1A–26, conductor 1308, to the MVD circuit, contacts 2CN1–*c*, "SLA–S" conductor, to the MLI circuit, contacts 1ABL–*e*, REL1–*c*, lower winding of relay REL1 to battery, operates relay REL1. Relay REL1 closes its contacts *a* before its contacts *c* open, locking through contacts 2AND–*e* to ground. Relay REL1 operates relay REL2 which opens the operating and holding circuit of the operated relay B0–B24 (for example B17) which effects the release of the marker. Relay 3ANC releases, in turn releasing any relays of the group 1–3 which are operated.

It should be observed that when a path was found, relay Y1 was released, Y2 did not operate, and relays X2 and X1 remained operated. When relay 3ANC releases, it in turn releases relay X2 at contacts 3ANC–*g*, relay X1 at contacts 3ANC–*b*, and the operated relay of the group 1RS1–1RS3 at contacts 3ANC–*h*.

These relationships might be illustrated in the following sequence chart in which a noncircled designation indicates an operation and a circled designation indicates a release.

CHAIN OPERATION WITH X-WIRING FOR 3 REGISTER GROUPS
[(0A1, 0A2, 0A4) (1, 2, 3)]

Normal — 0A1

X1 — 0A2
— 1RSL
— 1

[X1] — [0A1]
— [1RS1]
— 2

X1 — 0A4
— 1RS2
— [1]

[X1] — [0A2]
— [1RS2]
— 3

X1 — 0A1
— 1RS3
— [2]

[X1] — [0A4]
— [1RS3]
— Holds 3 until 3ANC releases
— REL1–REL2—Release of marker

As an illustration of the operation with relay 0A2 normally operated when a call engages the marker, the following sequence chart is provided. It should be noted that whereas in the previous chart the first operation of relay X1 operates relays 0A2 and 1, in this chart the first operation of relay X1 operates relays 0A4 and 1.

CHAIN OPERATION WITH X-WIRING FOR 3 REGISTER GROUPS
[(0A1, 0A2, 0A4) (1, 2, 3)]

Normal — 0A2

X1 — 0A4
— 1RS2
— 1

[X1] — [0A2]
— [1RS2]
— 2

X1 — 0A1
— 1RS3
— [1]

[X1] — [0A4]
— [1RS3]
— 3

X1 — 0A2
— 1RS1
— [2]

X1 — Holds 3 until 3ANC releases
— REL1–REL2—Release of marker

The following chart illustrates the operation of relays

0A1–0A4 with Y-wiring for two register groups only equipped.

CHAIN 0A1-0A4 (WITH Y-WIRING FOR 2 REGISTER GROUPS)
[(0A1, 0A2, 0A3, 0A4)]

Normal — 0A1

X1 — 0A2
— 1RS1

[X1] — [0A1]
— [1RS1]

X1 — 0A3
— 1RS2

[X1] — [0A2]
— [1RS2]

X1 — 0A4
— 1RS1

[X1] — [0A3]
— [1RS1]

X1 — 0A1
— 1RS2

[X1] — [0A4]
— [1RS2]

The following chart illustrates the operation of the chain 1–3 with Y-wiring for two register groups only equipped.

CHAIN 1-3 (WITH Y-WIRING FOR 2 REGISTER GROUPS)
[(1, 2, 3)]

Normal — All down

X1 — 1

[X1] — 2

X1 — [1]

[X1] — 3 and holds 3 in series with 2 until 3ANC releases
— REL1–REL2—Release of marker

The following chart illustrates the combined operation of the chains with Y-wiring for two register groups only.

CHAIN OPERATION WITH X-WIRING FOR 2 REGISTER GROUPS
[(0A1, 0A2, 0A3, 0A4) (1, 2, 3)]

Normal — 0A1

X1 — 0A2
— 1RS1
— 1

[X1] — [0A1]
— [1RS1]
— 2

X1 — 0A3
— 1RS2
— [1]

[X1] — [0A2]
— [1RS2]
— 3 and holds 3 in series with 2 until 3ANC releases
— REL1–REL2—Release of marker

Normal — 0A3

X1 — 0A4
— 1RS1
— 1

[X1] — [0A3]
— [1RS1]
— 2

X1 — 0A1
— 1RS2
— [1]

[X1] — [0A4]
— [1RS2]
— 3 and holds 3 in series with 2 until 3ANC releases
— REL1–REL2—Release of marker

(2) Register group #1 available; no idle path thereto
Register group #2 available; idle path thereto

(1) Relay 3ANC operates as described hereinbefore when the marker is ready to start register testing and pathfinding
(2) 3ANC operates X2
(3) X2 operates X1
(4) X1 operates 0A2, 1, and 1RS1
(5) 1RS1 operates 7AN1–10AN1 and 1RL1–6RL1 in SRL–1
(6) 1RL1–6RL1 operate Y1 and 1T1 (for example)
(7) Y1 opens the circuit of X1; 1T1 operates 2T1 and TA
(8) TA releases Y1 holding X1
(9) Y1 operates AGA and AGB
(10) AGB operates Y2
(11) Y2 releases X2
(12) X2 releases 1T1, 2T1, TA, 0A1, X1, and 1RS1
(13) X1 operates 2; X1 and TA release AGA and AGB; 1RS1 releases 7AN1–10AN1 and 1RL1–6RL1 in SRL–1
(14) AGB releases Y2
(15) Y2 operates X2
(16) X2 operates X1
(17) X1 operates 0A2, releases 1, and operates 1RS2
(18) 1RS2 operates 11AN1–14AN1 and 1RL1–6RL1 in SRL–2
(19) 1RL1–6RL1 operate Y1 and 1T1 (for example)
(20) Y1 opens the circuit of X1; 1T1 operates 2T1 and TA
(21) TA releases Y1, holding X1
(22) Y1 operates AGA and AGB
(23) AGA–AGB operates AG1 for example
(24) AG1 releases AGA and AGB
(25) AGA operates AGC; AGB opens the circuit of Y2 which does not operate

(3) Register group #1 available; no idle path thereto
Register group #2 available; no idle path thereto
Register group #3 available; idle path thereto

(1–22) Same as (2) 1–22
(23) AGB operates Y2
(24) Y2 releases X2
(25) X2 releases 1T1, 2T1, TA, 0A2, X1, and 1RS2
(26) X1 operates 3; X1 and TA releases AGA and AGB; 1RS2 releases 11AN1–14AN1 and 1RL1–6RL1 in SRL–2
(27) AGB releases Y2
(28) Y2 operates X2
(29) X2 operates X1
(30) X1 operates OA4, releases 2, and operates 1RS3
(31) 1RS3 operates 15AN1–18AN1 and 1RL1–6RL1 in SRL–3
(32) 1RL1–6RL1 operates Y1 and 1T1 (for example)

(33) Y1 opens the circuit of X1; 1T1 operates 2T1 and TA
(34) TA releases Y1 holding X1
(35) Y1 operates AGA and AGB
(36) AGA–AGB operate AG1 for example
(37) AG1 releases AGA and AGB
(38) AGA operates AGC; AGB opens the circuit of Y2 which does operate

(4) *Register group #1 available; no idle path thereto*
Register group #2 available; no idle path thereto
Register group #3 available; no idle path thereto
Release

(1–22) Same as (2) 1–22
(23–35) Same as (3) 23–35
(36) AGB operates Y2
(37) Y2 releases X2
(38) X2 releases 1T1, 2T1, TA, 0A4, X1, and 1RS3
(39) X1 releases AGA, AGB and operates REL1; 1RS3 releases 15AN1–18AN1 and 1RL1–6RL1 in SRL–3
(40) REL1 operates REL2 and CO17 (for example)
(41) REL2 and CO17 release B17 (for example), 1BA, and 4BA
(42) B17, 1BA, and 4BA effect release of the marker

(5) *Register group #1 not available*
Register group #2 available; idle path thereto

(1) Relay 3ANC operates as described hereinbefore when the marker is ready to start register testing and pathfinding
(2) 3ANC operates X2
(3) X2 operates X1
(4) X1 operates 0A2, 1, and 1RS1
(5) 1RS1 operates 7AN1–10AN1 and 1RL1–6RL1 in SRL–1.
(6) 1RL–6RL1 operate Y1
(7) Y1 opens the circuit of X1 which releases
(8) X1 releases OA1, operates 2, releases 1RS1, and releases Y1
(9) 1RS1 releases 7AN1–10AN1 and 1RL1–6RL1 of SRL–1; Y1 reoperates X1
(10) X1 operates 0A4, releases 1, and operates 1RS2
(11) 1RS2 operates 11AN1–14AN1 and 1RL1–6RL1 of SRL–2
(12) 1RL1–6RL1 operate Y1 and 1T1 (for example)
(13) Y1 opens the circuit of X1; 1T1 operates 2T1 and TA
(14) TA releases Y1, holding X1
(15) Y1 operates AGA and AGB
(16) AGA–AGB operate AG1 (for example)
(17) AG1 releases AGA and AGB
(18) AGA operates AGC; AGB opens the circuit of Y2 which does not operate

(6) *Register group #1 not available*
Register group #2 not available
Register group #3 available; idle path thereto

(1–11) Same as (5) 1–11
(12) 1RL1–6RL1 operate Y1
(13) Y1 releases X1
(14) X1 operates 0A2 and 3; and releases 1RS2 and Y1
(15) 1RS2 releases 11AN1–14AN1 and 1RL1–6RL1 of SRL–2; Y1 operates X1
(16) X1 operates 0A1, releases A, and operates 1RS3
(17) 1RS3 operates 15AN1–18AN1 and 1RL1–1RL6 of SRL–3
(18) 1RL1–6RL1 operate Y1 and 1T1 (for example)
(19) Y1 opens the circuit of X1; 1T1 operates 2T1 and TA
(20) TA releases Y1, holding X1
(21) Y1 operates AGA and AGB
(22) AGA–AGB operate AG1 (for example)
(23) AG1 releases AGA and AGB
(24) AGA operates AGC; AGB opens the circuit of Y2 which does not operate

(7) *Register group #1 not available*
Register group #2 not available
Register group #3 available; no idle path thereto
Release

(1–11) Same as (5) 1–11
(12–21) Same as (6) 12–21
(22–28) Same as (4) 36–42

(8) *Register group #1 not available*
Register group #2 not available
Register group #3 not available
Release

(1–11) Same as (5) 1–11
(12–17) Same as (6) 12–17
(18) 1RL1–6RL1 operate Y1
(19) Y1 releases X1
(20) X1 releases 0A4, releases Y1, releases 1RS3, and operates REL1
(21) 1RS3 releases 15AN1–18AN1 and 1RL1–6RL1 of SRL–3; REL1 operates REL2 and CO17 (for example)
(22) REL 2 and CO17 release B17 (for example), 1BA, and 4BA
(23) B17, 1BA, and 4BA effect release of the marker

In these various register and path tests it should be appreciated that when relays 1A, 2A and 3A in a selected SLA operate (SLA–1 for example), relays of the group 1V1–1V10 operate representative of the idle verticals V1–V10 of the selected SLA (SLA–1 for example). When relay 1RS1 operates relays 1RL1–6RL1 in SRL–1 and relays 7AN1–10AN1, test paths for verticals V1–V10 of SRL–1 are extended to the windings of relays 1T1–1T10 by relays 1RL1–6RL1 and according to the setting of the priority chain 0T1–0T10 and the verticals which are idle, one of these relays operates and locks (for example 1T1) and in turn operates 2T1 and TA. Thereby the marker knows which SRL vertical magnet to operate if a path is available to the SRL switch containing this vertical. By the operation of relays 7AN1–10AN1, test paths from verticals V1, V2, V6, and V7 of the five SLB switches associated with SRL–1 (through which paths extend to SRL–1), are extended over contacts of relays 1V1–1V10 to relays AG1–AG20, and according to the setting of the jump rotator ASG1–ASG20 and the idle paths available, one of these relays operates and locks. Thereby the marker knows which SLA vertical magnet, which SLB horizontal and vertical magnets, and which SRL horizontal magnets to operate.

It should be appreciated that with relay 1RS1 operated, horizontals and verticals of SRL–1 (as distinguished from SRL–2 or SRL–3) are determined, the available register as evidenced by the operation of one of the relays 1T1–1T10 (and 2T1–2T10 and TA) determining which particular vertical magnet in SRL–1 will be operated; and the particular path as evidenced by the operation of one of the relays AG1–AG20 determining which particular horizontal select and combination magnets in SRL–1 will be operated. Examples of these various paths have been traced hereinbefore. It should be appreciated that all twenty paths through SLB's 1–5 reach all ten registers of the first group of registers through SRL–1. The extension of any of the twenty paths into the SRL–1 switch is determined by the operation of the appropriate horizontal select and combination magnets of SRL–1 and this incoming path is switched to any of the tens registers associated with SRL–1 by the operation of the appropriate vertical magnet of SRL–1.

With relay 1RS2 and accordingly relays 11AN1–14AN1 and relays 1RL1–6RL1 in SLC–2 operated test paths from verticals V1, V2, V6, and V7 of SLB's 6–10 are extended over contacts of relays 1V1–1V10 to the windings of relays AG1–AG20; by relays 11AN1–14AN1 and test paths from the verticals V1–V10 of SLC–2 are extended to the windings of relays 1V1–1V10.

To further clarify, the circuit from the winding of

relay AG1, conductor 31, cable 31–50, cable to MCT, cable 31–50, cable 31, X-wiring on contacts GRA–V1, Y-wiring or contacts 1CBT–*j*, conductor 1, contacts 1V1–*b*, to a multiple point is traced hereat. If relays 7AN1–10AN1 are operated, this path extends from this multiple point over contacts 7AN–1, conductor 1, test cable 5101, fuse contacts associated with fuse 1, break contacts 12 of vertical magnet V1, closed contacts of manual key, conductor B (now see FIG. 9), 1600 ohm resistor, contacts 1421, 1498, and 1436 to battery if vertical V1 of SLB–1 is idle. However, if relays 11AN1–14AN1 had been operated instead of relays 7AN1–10AN1, this path extends from this multiple point, over conductor 4608*a*, contacts 11AN1–1 and over a similar circuit through break contacts 12 of vertical magnet V1 of SLB–6 of the second group of SLB's associated with SLC–2. If relays 15AN1–18AN1 had been operated instead, this path would have extended from the multiple point over conductor 4608*a*, contacts 15AN1–1 and over a similar circuit through break contacts 12 of vertical magnet V1 of SLB–11 of the third group of SLB's associated with SLC–3. This further clarifies the point that if relay 1RS1 is operated, and accordingly relays 7AM–10AN1, test paths are extended from appropriate SLB verticals of the group SLB's 1–5 to relays AG1–AG20; if 1RS2 is operated and accordingly relays 11AN1–14AN1, test paths are extended from appropriate SLB verticals of the group SLB's 6–10 to relays AG1–AG20; and if 1RS3 is operated and accordingly relays 15AN1–18AN1, test paths are extended from appropriate SLB verticals of the group SLB's 11–15 to relays AG1–AG20. Similar paths may be traced for relays AG2–AG20.

Reference is also made to the circuit extending from register test relay 1T1, the rectifier connected in the conducting direction, conductor 31, SRL Vert Test Cable, and cable to the multiple designated SRL–1–3. If relay 1RS1 and accordingly relays 1RL1–6RL1 in SRL–1 are operated, this path extends over cable MRT to SRL–1, conductor 31, make contacts of relay 2RL1, fuse contacts associated with fuse 1, break contacts associated with vertical magnet V1 of SRL–1, conductor 5301 which is conductor B to register 1, cable to register 1, conductor B, closed contacts of manual key, contacts H1–31, H2–11, and 1600 ohm resistor to battery. However, if relay 1RS2 and accordingly relays 1RL1–6RL1 in SRL–2 are operated instead of SRL–1, this path extends from the multiple, into SRL–2 and over a similar path through make contacts of relay 2RL1 in SRL–2 and break contacts associated with vertical magnet V1 of SRL–2 and conductor B through 1600 ohms to battery in register 1 associated with SRL–2. Also, if relay 1RS3 and accordingly relays 1RL1–6RL1 in SRL–3 are operated instead, this path extends from the multiple into SRL–3 and over a similar path through make contacts of relay 2RL1 in SRL–3 and break contacts associated with vertical magnet V1 of SRL–3 and conductor B through 1600 ohms to battery in register 1 associated with SRL–3. Similar paths may be traced for the other relays 1T2–1T10.

Thus if relay 1RS1 is operated, registers 1–10 of the first group of registers are tested and if at least one of these registers is available, a path-finding test is made of twenty possible paths to these registers, SRL–1, being the common meeting point. The paths are represented by horizontal of SRL–1 and the registers by verticals. By the proper operation of horizontal and vertical magnets, any path of the twenty can connect with any of the ten registers. The path-finding is concerned with finding a path from the calling SLA to a particular SRL. Any line in the SLA can be extended over the path found to any register reached from the SRL. In other words an SLA switch is the common meeting point between lines and paths, and an SRL is the common meeting point between registers and paths.

Relays 1RS2 and 1RS3 are similarly arranged.

G. Path establishment

1. *Horizontal closure—SLE, SRL*

It will be recalled that the SLC horizontal magnets were previously operated to test the "S" wire to determine whether a paystation was making the call. These magnets have been held operated. Following such test, register selection and path finding were indicated, and the equipment is now ready to establish the connection over the path which has been selected to the register selected by operating the pertinent horizontal and vertical magnet of the appropriate cross bar switches.

More specifically, relay AGC at its contact *d* completes the following circuit to operate horizontal relays H1 and HA in SLB–1: battery in SLB–1, fuse 5, conductor 5002, windings in parallel of horizontal magnets H1 and HA, conductors 1 and 11 respectively, cable LHP–21, conductors 1 and 11, contacts 1S1–*c* and 1S11–*b* respectively, conductor I, cable to MVO, conductor 1 which is a continuation of conductor I, 3FN1–*a*, cable, cable to MCT, cable 11–25, conductor 11 which is the extension of conductor 1, 1RS1–26, conductor 26, cable 26–30, cable to MVO, cable 26–30, conductor 26, AG1–*j*, AGC–*d*, conductor between MVO and MRT, TA–*i*, conductor 4, cable to MLI, conductor 4, 4BA–*b*, to ground. It should be observed that if relay AG2, AG3, or AG4 were operated, representative of paths 2, 3, 4 (see previous chart), relays H1 and HA would operate over contacts *j* of these relays. It should be recalled that paths 1, 2, 3, and 4 pass over the #1 horizontal of SLB–1 and verticals V1, V2, V6, and V7 of SLB–1.

At its contacts *c*, relay AGC extends ground to operate horizontal magnets H1 and HA in the SRL–1 circuit. This ground originates in MLI, passes through 4BA–*a*, conductor 6, cable to MRT, conductor 6, TA–*h*, conductor between MRT and MVO, AGC–*c*, to the lever associated with contacts *h* and *i* of relay AG1, through contacts *h* and *i* of relay AG1 to conductors 1 and 11 respectively, through cable "SRL HOR." to SRL–1, emerging conductors 1 and 11 respectively, through cable 5201, emerging conductors 1 and 11 respectively, through the windings of horizontal relays H1 and HA respectively, through fuse 11 to battery, operating horizontal magnets H1 and HA. It should be observed that if path 2 were involved with relay AG2 operated, this ground would be placed on conductors 1 and 12 through contacts *h* and *i* respectively of relay AG2 and horizontal magnets H1 and H12 of SRL–1 would operate.

The operation of any combination of horizontal magnets of SLB–1 results in relay HF1 (see MVO) being operated. For example with horizontal magnets H1 and H11 operated, ground through contacts 12 of magnet H1, contacts 12 of magnet HA, conductor to MVO, 4FN1–*c*, 1ABL–*g*, HF1, to battery, operates relay HF1.

Also, operation of any combination of horizontal magnets of SRL–1 results in relay HF2 (see MVO) being operated. For example with horizontal magnets H1 and H11 operated, ground through contacts 5202 of magnet H1, contacts 5203 of HA, conductor 5204, contacts 5205 of relay 2RL1, conductor, cable MVO–A from SRL–1 to MVO, conductor 13, HF2, to battery, operates relay HF2.

Slow release relay AGD releases after all of the aforedescribed functions are completed.

At its *a* contacts, relay AGD closes a circuit from ground through AGD–*a*, AG1–*a*, conductor 11, lower winding of "jump rotator," relay ASG1, to battery. Relay ASG1 operates and locks over its upper winding, in turn releasing relay ASG20. With ASG1 operated, locking ground for relays AG1–AG20 is placed on conductor 2 thus shifting the priority of locking of relays AG1–AG20 so that AG2 has highest priority, with decreasing priority to AG20, and with AG1 having lowest priority on the next call. On the present call, relay AG1 holds however over AG1–*c*, and break contacts *d* of relays

AG20–AG2, conductor 2, ASG1–*a*, break contacts *a* of the manual key to ground still on the "PF Start" conductor. It should be observed that contacts ASG1–*a* close before contacts ASG20–*a* open maintaining ground on conductor 1 until ground is placed on conductor 2 and thus maintaining AG1 operated during the transfer. It should be observed that initially if no relays ASG1–ASG20 of the "jump rotator" are operated, ground on the "PF start" conductor, through contacts *a* of the manual key, and break contacts *b* of relays ASG1–ASG20 is connected to conductor 1, furnishing a locking ground and giving first priority to AG1. When one of these relays operates, ASG1 for example, contacts ASG1–*a* close before contacts ASG1–*b* open thus connecting ground to conductor 2 before ground is removed from conductor 1, thus maintaining a holding circuit for the operated relay AG1–AG20. Thus in the drawings the capital letter E by the *a* contacts designates the contacts as "early" contacts and the capital letter L by the *b* contacts designated them "late" contacts. (A similar arrangement obtains for the "jump rotators" of the MLM circuit.)

2. Vertical closure—SLA, SLB, SRL

With the release of relay AGD, the SLA, SLB, and SRL vertical magnets are operated to effect extension of the calling connection "main path" to the register in preparation for dialing.

It is assumed that the calling connection involves vertical V1 of SLA–1, vertical V1 of SLB–1, and vertical V1 of SRL–1.

At its contacts *c*, relay AGD closes the following circuit to operate vertical magnet V1 of SLA–1: battery in SLA–1, fuse 1, 200 ohm winding of vertical magnet V1, 1A–12, conductor 1304*a* (otherwise labeled conductor 1), cable 1310, conductor 1, 1FN1–*a*, conductor 1, pull cable, conductor 1, AG1–*k*, HF2–*c*, HF1–*d*, AGD–*c*, AGC–*f*, conductor 2, "PULL VERT" cable from MVO to MLI, conductor 2, 4BA–*f*, to ground. It should be observed that odd numbered conductors entering the contacts of relays 1FN1, LFN2, 2FN2, 2FN1 and 2FN2 from SLA's are vertical pull conductors and that even numbered conductors are test conductors. The odd conductors enter the Pull cable and emerge to contacts *k* of relays AG1–AG20 as conductors 1–10 as follows:

Entering Pull Cable	Emerging from Pull Cable
1	1
3	2
5	3
7	4
9	5
11	6
13	7
15	8
17	9
19	10

Similarly the even conductors enter the Test cable and emerge to the windings of relays 1V1–1V10 of the MCT circuit as conductors 1–10 as follows:

Entering Test Cable	Emerging from Test Cable
2	1
4	2
6	3
8	4
10	5
12	6
14	7
16	8
18	9
20	10

At its contacts *b*, relay AGD closes the following circuit to operate vertical magnet V1 of SLB–1: battery, fuse 1, 200 ohm winding of vertical magnet V1, conductor 5102, cable 5102*a* to the MCT circuit, conductor 1, 7AN1–*h*, conductor 51, cable 51–70, cable from MCT to MVO, cable 51–70, conductor 41, AG1–1, HF2–*a*, HF1–*b*, AGD–*b*, AGC–*e*, conductor 3, "PULL VERT" cable from MVO to MLI, conductor 3, 4BA–*g*, to ground.

It should be observed that test circuits from the off-normal break contacts of vertical magnets V1, V2, V6 and V7 of SLB–1 pass through the Test cable and enter the contacts of relay 7AN1 (see MCT) as conductors 1, 2, 3, and 4 respectively and that the pulling circuits of vertical magnets V1, V2, V6 and V7 of SLB–1 pass through the Pull Cable and enter the contacts of relay 7AN1 as conductors 1, 2, 6 and 7 respectively. The other vertical test and pull circuits from SLB's 1–5 to the contacts of relays 7AN1–10AN1 of the first 500 line group and relays 7AN2–10AN2 of the second 500 group; the vertical test and pull circuits from SLB's 6–10 to the contacts (indicated as a box) of relays 11AN1–14AN1 for the first 500 group and relays 11AN2–14AN2 for the second 500 group; and the vertical test and pull circuits from SLB's 11–15 to the contacts (indicated as a box) of relays 15AN1–18AN1 for the first 500 group and relays 15AN2–18AN2 for the second 500 group are similarly analyzed.

Furthermore, it should be observed that the test circuits emerge from contacts of these relays 7AN1–18AN2 and pass through contacts of horizontal vertical test relays 1VI–1V10, pass through contacts of relays CRA and 1CBT or 2CBT and X or Y wiring as the case may be, and enter the windings of SLB vertical test relays AG1–AG20. Also, it should be observed that the pull circuits emerge from contacts of relays 7AN1–18AN2 and are connected to contacts 1 of relays AG1–AG20. Thus relays AG1–AG20 are associated by their windings with the test circuits of SLB verticals and by their contacts 1 with the pull circuits of SLB verticals as per the preceding table.

Relay AGD at its contacts closes the following circuit to operate vertical magnet V1 of SRL–1: battery, fuse 1, 200 ohm winding of vertical magnet V1, contacts 5302 of relays 2RL1, conductor 41, cable SRL Vert. Test Pull & Reg. to MRT circuit, SRL Vert. Pull cable, conductor 41, 2T1–*e*, TA–*d*, cable from MRT to MVO, SRL Vert. Pull cable, HF2–*e*, HF1–*e*, AGD–*e*, AGC–*h*, conductor 1, Pull Vert. cable to MLI, conductor 1, 4BA–*e*, to ground. Vertical magnet V1 then locks over the circuit from battery, through fuse 1, 2000 ohm winding of V1, locking contacts 5306, conductor H, cable to register 1, conductor H, H1–15, to ground.

Relay AGD at its contacts *f* completes the following circuit to operate relay CB in the selected register (i.e. register-1) if the calling line is a coin box with the MPR circuit conditioned accordingly: battery, CB, conductor CB, cable to SRL–1 circuit, conductor CB, 4RL1–*a*, conductor 1, cable to MRT circuit, conductor CB, 2T1–*d*, TA–*c*, conductor CB, cable to MVO circuit, conductor CB, AGD–*f*, conductor to MPR circuit, 2PS–*b*, conductor 6, cable to MLI circuit, conductor 6, 2AND–*h*, conductor 2, cable to MPR circuit, conductor 2, 2RC–*a*, 1PS–*c*, to ground.

With F-wiring (for dialtone before dialing and coin test after dialing) connected in the register, relay CD in the register operates over the circuit from battery, through the winding of relay CD, F-wiring, contacts 35*a* of relay CD, RA2–21, H1–14 to ground.

Brief indication is given to the function of relays CRA; and relays 1CBT and 2CBT, of the MCT circuit at this time which control the SLB test paths so that on non-paystation calls a CRA circuit having one associated coin box trunk (CBT) will be selected and on paystation calls a CRA circuit so equipped will be selected.

It should be observed that CRA's (see FIGURE 23) may have K-wiring connected therein with no coin box trunk circuit (CBT) connected thereto or may have K-wiring disconnected therein with coin box trunks (CBT's;

see FIGURE 34) connected thereto instead. The SLB vertical test paths, associated with CRA's, pass through contacts of relays CRA, 1CB7, and 2CBT in the MCT circuit which assume that paths 1, 6, 11, and 16 of the group of paths 1–20 are associated with CRA's connected to CBT's with Y-wiring; and that all other paths of the group of paths 1–20 are associated with CRA's not connected to CBT's. Also if X-wiring instead of Y-wiring is connected in any path, the assumption is that the CRA of that path does not have an associated CBT.

Thus, when relays CRA operates on non-coin-box originated calls, the contacts of relay CRA open the test paths having associated CBT's. With Y-wiring accordingly, the circuits of relays AG1, AG6, AG11, and AG16 are opened so that the calling line does not get connected to a CRA having an associated CBT circuit. However, if the SLB test path is not associated with a CBT circuit, X-wiring is connected for that path instead of Y-wiring. Accordingly the associated contact of relay CRA is strapped so that a test path can obtain to the associated relay of the group AG1–AG20.

Also, when relays 1CBT and 2CBT operate on coin box originated calls, the contacts of relays 1CBT and 2CBT open the paths which do not have associated CBT's and the circuits of associated relays of the group AG1–AG20 so that the calling coin box line will not be connected to a CRA without an associated CBT. It should be observed that if a test path has a CBT circuit associated therewith, the associated contact of relays 1CBT and 2CBT is strapped so that a test path can obtain to the associated relay of the group AG1–AG20 even with 1CBT and 2CBT operated.

Vertical magnet V1 of SLA–1 operates as before described and at its off-normal contacts 11 opens the circuit of relay 1V1 (see MCT circuits), which releases. Relays 1V1–1V10 selectively ground conductors 1–10 to the Trouble Recorder at their *g* contacts, and relay 1V1 accordingly has grounded conductor 1 to the Trouble Recorder during its operated period. At this time such ground is removed.

As vertical magnets V1 of SLA–1, V1 of SLB–1, and V1 of SRL–1 operate, the crossbar cross-point contacts prepared by the horizontal magnets H1 and HA in SLA–1, H1 and HA in SLB–1, and H1 and HA in SRL–1 are closed. Reference should be made at this point to U.S. patent application bearing Serial Number 522,233 filed July 15, 1955, assigned to the assignee of this application.

When these crosspoints close, a circuit is completed to relay R1 of the CRA circuit in the SLB–1 circuit over the path from battery, fuse 1, winding of relay R1 (400 ohms), lower winding of relay R2 (15 ohms), conductor 5002, crosspoint contacts of horizontal magnet H1 in vertical V1 of the SRL–1 circuit, vertical conductor bar (it should be understood that on the detailed schematic diagrams, verticals are turned 90° for convenience and hence lie horizontally in the drawing), crosspoint contacts of horizontal magnet HA in vertical V1 of SRL–1 circuit, conductor 5206 which is conductor RC entering the cable to register 1, cable from SRL–1 to register 1, conductor RC emerging, break contacts 11 of register relay RD, 1200 ohm registor, to ground. Relay R1 in the CRA circuit operates but relay R2 does not due to the low resistance of its lower winding.

Also with the closing of the crossbar crosspoints, the calling line loop is extended into the register. This circuit may be traced as follows: calling substation on line 17 for example, ring and tip conductors, H9 crosspoint contacts, "vertical" conducting bars and HC cross point contacts of vertical V1 in SLA–1, ring and tip conductors to the SLB–1 circuit, H1 crosspoint contacts, "vertical" conducting bars and HA crosspoint contacts of vertical V1 in SLB–1, ring and tip conductors through K-wiring (in a non-coin-box CRA) or through a coin-box-trunk circuit (via a coin box CRA without K-wiring), ring and tip conductors RR and RT respectively to the SRL–1 circuit, H1 crosspoint contacts, "vertical" conducting bars and HA crosspoint contacts of vertical V1 of SRL1, ring and tip conductors RR and RT to the register 1 cable, through the register 1 cable to register 1, emerging as conductors RR and RT in register 1. Conductor RR can be traced through the second winding from the top of relay R, through break contacts 12 of relay BT and break contacts 31 of relay CT to battery. Conductor RT can be traced through break contacts 14 of relay CT, through the third winding from the top of relay R to ground.

It is noted that wtih a CBT involved and hence no K-wiring connected, the ring and tip conductors can be traced from the CRA circuit through the cable incoming to CBT, out of this cable in the CBT circuit, through break contacts 14 and 11 respectively of relay CD, break contacts 14 and 11 of respectively of relay S, to the ring and tip conductors leaving the CBT through the outgoing cable from the CBT circuit to the CRA circuit, connecting respectively to conductors RR and RT to the SRL circuit, and to levers 33 and 32 respectively of relay R1 in the CRA circuit.

The calling party then receives dial tone from the register circuit over a path which extends through the tone winding T of relay R over the path from ground over the winding of relay R, break contacts 13 of relay CB or make contacts 32 of relay CD, contacts 34 of relay H1, break contacts 21 of relay RA1, through the dial tone source DT to ground. Tone induced into middle windings of relay R passes over the line loop to the calling subscriber, informing him that dialing may begin.

Register relay R operates in this circuit over the calling line loop, in turn operating register slow release relay H2 over the circuit from battery H2, H2–35, rectifier in the correct direction, R–32, to ground. A holding circuit for register slow release relay H1 is then provided over the circuit from battery, H1, RD–13, H2–32, rectifier in the correct direction, R–32, to ground. It should be recalled that relay H1 provides a holding circuit for vertical magnet V1 of SRL–1 over the circuit from battery, fuse 1, 2000 ohm winding of vertical magnet V1, contacts 5306, H conductor, cable to register 1, H conductor, H1–15, to ground.

Relay R1 in the CRA-1 circuit of SRL–1 at its contacts 14 prepares a holding circuit for relay R2 in CRA–1, which circuit is rendered effective when relay R2 subsequently operates.

At its contacts 23, relay R1 connects ground to conductor C to the group selector stage comprising GSA and GSB switches.

At its open contacts 31 and 34, relay R1 disconnects the calling subscribers tip and ring conductors from the tip and ring conductors SR and ST and the outgoing tip and ring conductors R and T in preparation for pulsing into register 1.

At its contacts 13, relay R1 connects ground through the winding of impedance coil R3, through contacts R–13, K-wiring (on a non-coin-box call) to conductor 5003 and over off-normal make contacts 14 of vertical magnet V1 of SLB–1, winding of relay V1, through fuse 1, to battery to hold relay V1 operated. Such ground is also connected in parallel through crosspoints of magnets HA, and H1 to conductors H and S to the SLA–1 circuit.

H. Marker release

1. Normal release

Release of the marker is basically initiated as the crosspoints of the selector SRL are closed. More specifically, the register signals the CRA circuit which places impedance ground on the S-conductor through crosspoints of magnets HC and H9 of SLA–1 through the windings of line cutoff relay CO17 and line lockout relay LO17 in series, and fuse 4 to battery operates relays CO17 and LO17, which releases line relay LR17 opening the

loop circuit to the marker, thus opening one circuit of relay B17.

It is recalled that if the CRA–1 circuit associated with vertical 1 of SLB–1 has an associated CBT circuit, the coin box tone test indicates that the call is being made from a coin box line resulting in relay 1PS releasing and in turn relay 1CRA releasing and relays 1CBT and 2OBT, operating. When relay AGA and AGB (which are slow enough operating to allow relay 1CRA to release and relays 1CBT and 2CBT to operate) operate relay AG1 operates over Y-wiring and break contacts V1 of relay 1CRA. Assuming that path 1 is selected, the operation of the circuit is essentially the same as described up to the point of operation of relay R1 in SLB–1 from 1200 ohm battery in the selected register when the SRL cross-points close.

Upon the operation of relay R1 in SLB–1, relay R1 performs the same functions described before but ground through impedance coil R37 make contacts 13 of relay R1, the S-conductor into the cable, S-conductor, winding of relay SL in the CBT circuit upper winding of relay H to battery, operates relays SL and H in series, relay H locks from battery through its lower winding, contacts H–26 and contacts CF–11 to ground. Relay SL at its contacts SL–13 and relay H at its contacts H–22 place ground on the S-wire of the CBT circuit which is connected to conductor 5003 and performs the functions of holding the SLA switch and operating the line cut-off and lockout relays as previously described.

Ground on the S-wire of line 17 through H9–11, make contacts 12, 14, 16 of magnet HC, conductor 1307, 1A–26, conductor 1308 to SLM–1, which becomes conductor 21 in the marker, 2CN1–*c*, conductor to MLI, 1ABL–*e*, REL1–*c*, lower winding of REL1, to battery, operates relay REL1. Relay REL1 at its early contacts *a* closes a locking circuit for itself from battery through its upper winding, REL1–*a*, 2AND–*e*, to ground before its contacts *c* open. At its contacts *b*, relay REL1 connects ground to the S-wire just traced.

Relay REL1 at its contacts *g* opens the circuit of relay X1 (MRT circuit). After its slow release period has expired relay X1 releases, opening the pathfinder start conductor at contacts X1–*c*, releasing relays AG1 and AGC.

Relay REL1 operates relay REL2 over the circuit from battery through the winding of relay REL2, REL–*d*, K1–*c*, to ground. Relay REL2 opens the circuit of relay 4BA at REL2–*b*; opens the operating and holding ground circuit of relay B17 at REL1–*a* and the battery circuit of relay B17 at contacts REL1–*d*. As relay 1BA is held in series with relay B17, relay 1BA is also released. Relay 1BA at its contacts *d* releases relays 2BA and 3BA. Relay 4BA also releases.

When relay 4BA releases, it disconnects the original operating circuits of horizontal magnets H1 and HA and vertical magnet V1 in the SLB–1 circuit and the original operating circuits of horizontal magnets H1 and HA and vertical magnet V1 in the SRL–1 circuit and the original operating circuit of vertical magnet V1 in SLA–1. The horizontal magnets release but the vertical magnets remain held. The release of horizontal magnets H1 and HA in SLB–1 opens the circuit of relay HF1 which releases. Also, the release of horizontal magnets H1 and HA in SRL–1 opens the circuit of relay HF1 which releases. At its contacts *d*, relay 4RBA releases relays 1CBT and 2CBT.

With relays CO17 and LO17 operated (see SLA), the circuit of line relay LR17 is opened and this relay releases. It should be appreciated that relay REL2 prior to its operation has provided a circuit independent of the line relay so that flashing by the calling subscriber would have no effect on relay B17.

At its contacts *g* and *h*, relay B17 releases horizontal magnets H9 and HC respectively of SLA–1, at which time the aforedescribed feedback path over the S-wire of line 17 for the tone oscillator of the MPR circuit is opened; the grid rises in voltage to zero; the tube conducts approximately 40 milliamperes; and relay 1PS re-operates. As relay 4BA has released, the shifting of contacts *a* and *b* of relay 1PS has no effect on relay 1CRA and relays 1CBT and 2CBT. The release of relay 1PS also removes ground from lead PS to the trouble recorder at contacts *d* and opens the original operating circuit of register relay CB in the register which has locked independently as will be explained hereinafter.

At its contacts *i*, relay B17 opens the operating circuit of "jump rotator" relay 20A1 which remains operated over its locking circuit.

Relay 1BA at its contacts *f* and *j* releases relay A1; and at its contacts *j* releases relays 1AA, 2AA, and 3AA; at its contacts *a* releases relays 1L1–4L1 (LEO); at its contacts *b* releases relays 1AW–3AW (LEO); and at its contacts *e* releases relay ANB.

Relay A1 at its contacts *h* releases relays 1A, 2A, and 3A (SLA); and at its contacts *i* opens the original energizing circuit of "jump rotator" relay 20A2 which remains operated over its locking circuit. The release of relays 1A, 2A and 3A opens contacts in the test circuits of all relays 1V1–1V10 and any of these relays which have remained operated are released. Also the release of relay 2A opens the circuit of relays 1S1 and 2S1 (LHP) which release, in turn releases relays 1S11 and 2S11.

Relay ANB at its contacts *a* releases relay BB; at its contacts *b* releases relays 1ANC and 2ANC; and at other of its contacts *b* releases relays 1ANC and 2ANC; and at other of its contacts opens other circuits.

The release of relay 1ANC connects ground to the holding circuit of relay K1 over contacts 1ANC–*e* which close before contacts 1ANC–*f* open, thus preventing the release of relay K1.

The release of relay 2ANC at its contacts *d* removes ground from conductor 31 and places ground over its contacts *e* on conductor 32 which causes the 500 group rotator comprising relays 10B and 20B to step as described hereinbefore. Contacts *d* close before contacts *e* open.

Relay 1ANC at its contacts *b* releases relay 3ANC (MRT).

Relay 1ANC at its contacts *a* releases relay AB, which opens the holding circuit of relay RBL in the MTT circuit. As the operating circuit of relay RBL is opened by contacts *c* of relay 1BA, relay RBL releases, making the pathfinding portion of marker available for seizure by terminating calls, allowing the terminating end to operate 1ABL to block the originating end. (It should be appreciated that a terminating call may have already placed its information in the code receiver of this marker.)

Relay 1ANC at its contacts *d* opens the holding circuit of relay 1ANL, releasing same.

Relay 1AN1 at its contacts *d* releases 1AN1A; at its contacts *e* releases relay ANA. With the original energizing circuit of relay O1 (in the MTT circuit of the companion marker) opened by contacts *h* of relay 1AN1A and with the holding circuit of the said relay O1 opened at contacts *a* of relay RBL, the said relay O1 releases, thus allowing a terminating call to the first 500 group to proceed in the companion marker.

Relay 3ANC at its contacts *h* releases relay 1RS1; at its contacts *a* releases relays TA, and 2T1 (MRT); at its contacts *f* releases relay 0A1 (relay 0A2 then holding from battery over its upper winding, 0A2–*b*, 0A3–*a*, 0A4–*a*, 0A1–*b*, and resistor *b'* to ground, contacts 0A1–*b* closing before contacts 0A1–*a* open thus guarding against the release of 0A2 during transfer); at its contacts *c* opens the holding circuit of relay 1 which releases; at its contacts *g* opens the circuit of relay X2 which releases; relay X2 also opens the slow to release circuit of relay X1 at contacts X2–*b*, but relay X1 has already been released.

Relay 1AN1A at its contacts *c* releases relays 1CN1 and 2CN1 which releases relay 3CN1 (MVO); at its contacts *b* releases 1FN1 and 2FN1 which releases relays 3FN1 and 4FN1 (MVO); at its contacts *d* releases relays 2AN1 and 3AN1 (MLI); at its contacts *e* releases relays 4AN1, 5AN1, and 5AN1A; at its contacts *f* releases relays 6AN1 and 6AN1A (MCT); and at its contacts *a* releases relay AV in the LEO circuit.

Relay 1RS1 at its contacts *a* and *b* releases relays 7AN1, 8AN1, 9AN1, and 10AN1; and at its contacts *c*, *d*, and *e* releases relays 1RL1–6RL1 in the SRL–1 circuit.

Relay ANA at its contacts *c* releases relays 1AND and 2AND.

Relay 2AND at its contacts *e* releases relay REL1; and at its contacts *g* opens the locking circuit of relay REL2. Relay REL2 accordingly releases.

3. Release under other circumstances

In order to economize on relays in the LEO circuit, relay 1L1–4L1 are provided common to two SLA's; that is, SLA's 1 and 2 have a common set of such relays: SLA's 3 and 4 have another common set of such relays; etc. As a result, the wrong line may be selected on rare occasions, but will not be extended to the called party. Since such safeguards are provided, the condition is tolerated.

More specifically, let us suppose that line 17 of SLA–1 and lines 17 and 24 of SLA–2 of the same 500 group of lines all initiate calls simultaneously. Relay AG in the LEO circuit for the said 500 group of lines operates over make contacts of line relay LR–17 of SLA–1 as hereinbefore described. A parallel circuit is also completed over make contacts of line relay LR–24 in SLA–2 from ground through the winding of relay AG, contacts 4603, 3AW–*a*, 4L1–*a*, conductor 24, multiple to SLA–2, through make contacts 12 of LR–24, closed contacts *a* of manuel key, a conductor 4612 (otherwise labeled 2) in SLA–2 corresponding to conductor 1201 shown in SLA–1, 10,000 ohm resistor, contacts 4602, 5000 ohm resistor, conductor 4601, contacts 2ANC–*a*, 1ABL–*a*, lamp WE136, through a source of 20 cycle alternating current to ground. A similar parallel circuit obtains for line 17 of SLA–2.

Relay AG selects a marker as previously described. Relay AV operates; and at this time circuits can be traced for SLA identity relay A1 of ML1 over the path previously traced involving contacts LR17–12 of line relay LR17 of SLA–1, and for relay A2 from ground through contacts 4610, 3AW–*a*, conductor 24, multiple to SLA–2, contacts 12 of line relay LR24 in SLA–2, conductor 4612 in SLA–2 corresponding to conductor 1201, conductor 4613, cable MLI, conductor 4613 (otherwise labeled 2), contacts 4AN1–*a'*, conductor 2, SLA–IDENT–2 cable, conductor 2, winding of relay A2, contacts 2AA–*b*, BB–*h*, ANB–3, to battery. A similar circuit for relay A2 can be traced from ground through contacts 4610, 2AW–*c*, 3L1–*a*, conductor 17, multiple to SLA–2, a conductor in SLA–2 corresponding to 1202, contacts 12 of relay LR17 in SLA–2, closed contacts *a* of a manual switch in SLA–2 a conductor 4612 in SLA–2 corresponding to conductor 1201 in SLA–1, conductor 4613, etc., as traced above through the winding of relay A1 to battery.

It is assumed for explanatory purposes that locking ground obtains on conductor 50 to the upper locking chain of relays A1–A20, and accordingly that relay A1 is locked, and relay A2 released.

Relays 1AW–3AW and 1L1–4L1 operate as before described.

Thereupon relay B17 is operated over the path described hereinbefor. Relay B24 also operates over a circuit extending from ground through ANB–*d*, A1–*b*, conductor 1, cable SLA–IDENT–2, conductor 1, 4AN1–*a*, conductor 4611, cable SLA–IDENT–1, conductor 4611, conductor 1201, closed contacts of manual key, conductor 1201*a*, multiple ⟍ through closed contacts 12 of line relay LR17 in SLA–1, conductor 1202 back through the multiple ⟍ into a conductor of SLA–2 corresponding to conductor 1202 of SLA–1, contacts 12 of line relay LR17 in SLA–2, back through the multiple ⟍ in SLA–2 through contacts 12 of LR24 in SLA–2, to conductor 24, 4L1–*b*, conductor 24, cable LINE–IDENT–1, conductor 24, 4AN1–C, cable LINE–IDENT–2, conductor 24, B24, 3BA–*c*, AB–*c*, K2–F, ANB–*e*, to battery.

Assuming now that locking battery for relays BO–B24 is on lead 40 to the lower locking chain of contacts, when relays 2BA and 3BA operate, relay B24 takes priority in locking over relay B17 which releases. Accordingly horizontal magnets H6 and HB for line 24 are operated in SLA–1 instead of for the calling line 17 in SLA–1.

If line 24 of SLA–1 is a busy line, ground on the S–wire through off-normal make contacts 24*a* of magnet H6, conductor 1307, 1A–26, conductor 1308, SLA–S cable, conductor 21, contacts 2CN1–*c*, SLA–S conductor, 1ABL–*e*, REL1–*c*, lower winding of relay REL1 to battery operates relay REL1. Relay REL1 locks from battery over its upper winding, REL1–*a*, and 2AND–*e*, to ground; and in turn grounds the said S-wire from ground, REL1–*b*, 1ABL–*e*, etc.

Relay REL1 operates relay REL2 from battery through the winding of REL2, REL1–*d*, 2AND–*e*, to ground. Relay REL2 locks over its *c* contacts to ground through 2AND–*g*.

At its contacts *d*, relay REL2 opens the holding battery of relays B24 and 1BA, releasing these relays. Also relay REL2 releases relay 4BA at contacts REL2–*b*. Relay 1BA releases relays 2BA and 3BA. With relays B24, 1BA, 2BA, and 3BA released, release of the marker takes place.

If line 24 is not a busy line, the line is switched into a register over the SLA, SLB, and SRL crossbar switches, as described hereinbefore and in the copending application referred to. When the SRL crosspoints operate and relay R1 in the CRA circuit operates, ground through impedance coil R3 is placed on the S-wire operating relay REL1 and in turn REL2, effecting the release of the marker. As no dialing takes place in the register, the timeout relay TO in the register releases the register which releases remaining connections. If the same call immediately comes in again, the chances are good that the shift of the "jump rotators" has interrupted the spurious condition. If not and the call comes in again, the spurious condition is broken up with a second re-entrance.

I. Subsequent operation

At this point in the call, the calling subscriber actuates his dial to dial the directory number of the called subscriber which we shall assume contains seven digits (i.e. a 2–5 number).

As this number is dialed, relay R in the register circuit (FIGURE 35) pulses in response to each of the dial pulses, releasing when the loop is opened, and reoperating when the loop is reclosed.

In general it may be said that relay R operates the off-normal relay ON1 and drives the counting chain C1–C6 and that at the end of each digit, the registration on the counting chain is transferred to the seven digit registers through the register advancing relays RA1–RA7. These seven digit registers are as follows:

1st digit—relays R11–R17
2nd digit—relays R21–R27
3rd digit—relays R31–R37
4th digit—relays R41–R47
5th digit—relays R51–R57
6th digit—relays R61–R67
7th digit—relays R71–R77

In order to show the full operation of the counting chain it is assumed that ten pulses occur, the description being concerned with a random digit in the sequence of digits.

On the first release of relay R, ground through R–32,

BT–31, CT–11, H2–15, through the upper winding of relay ON1 to battery, operates relay ON1. Relay ON1 closes its contacts 22 so that the above traced ground also incidentally passes through ON1–22 through the lower winding of relay ON1 to battery. The windings are opposed but the upper winding is of much higher ampere turns than the lower winding and predominates. (With this arrangement, relay ON1 is fast operating but when ground is subsequently removed from this relay, the two windings of the relay are in series and a circulating current flows in aiding relationship through these windings, making the relay slow to release.)

On the subsequent reoperation of relay R, ground through R–33, ON1–15, and break contacts 14 in series of relays C5–C1, through the lower winding of relay C1 to battery, operates relay C1. The slow release of relay ON1 prevents its release between pulses. Relay ON1 oprates slow release relay ON2 from ground through contacts H1–14, ON1–35, winding of relay ON2, to battery.

On the second release of relay R, ground through R–32, BT–31, CT–11, H2–15, C1–13, upper winding of relay C1, lower winding of relay C2, to battery operates C2 in series with relay C1. It should be observed that contacts R–32 close to ground before the ground connection between contacts 33 and lever 31 is opened, thus establishing the holding circuit of relay C1 before the original operating circuit is opened. At contacts C2–14 the original energizing circuit of relay C1 is opened.

On the subsequent reoperation of relay R the circuit for C2 in series with C1 is opened at contacts R–32 and relay C1 releases but relay C2 holds from battery through its lower winding, C2–16, break contacts 14 of relays C3–C5, ON1–15, R–33, to ground.

On the third release of relay R, relay C3 operates in series with relay C2 from battery, through the lower winding of relay C3, upper winding of relay C2, C2–13, C1–11, H2–15, C3–11, C4–31, R–32 to ground. At C3–14, relay C3 opens the original operating circuit of relay C2 through its lower winding.

On the subsequent reoperation of relay R, the circuit for C3 in series with C2 is opened at R–32 and relay C2 releases, but relay C3 holds from battery through its lower winding, C3–16, C4–14, C15–14, ON1–15, R–33, to ground.

On the fourth release of relay R, relay C4 operates.

On the subsequent reoperation of relay R, relay C3 releases, and on the fifth release of relay R, relay C5 operates.

On the subsequent reoperation of relay R, relay C4 releases, but relay C5 holds from battery through its lower winding, C5–16, ON1–15, R–33, to ground.

On the sixth release of relay R, relay C6 operates over the circuit from battery through the winding of relay C6, through contacts 35 and 34 of relay C6, upper winding of relay C5, C5–13, and break contacts 11 of relays C4 to C1, H2–15, CT–11, BT–31, R–32, to ground. When lever 33 of relay C6 operates, relay C6 holds from battery through the winding of relay C6, C6–35, ON2–12, to ground. Connection is made between lever 33 and contacts 35 of relay C6 before contacts 35 and 34 thereof separate, thus holding relay C6 over make-before-break contacts. When contacts 35 and 34 of relay C6 separate, the initial circuit for relay C6 in series with relay C5 is opened and relay C5 releases.

The subsequent reoperation of relay R operates relay C1 over the path originally traced for the first operation of relay C1.

On the seventh release of relay R, relay C2 operates in series with relay C1 over the path aforedescribed.

On the subsequent reoperation of relay R, relay C1 is released, as aforedescribed.

On the eighth release of relay R, relay C3 is operated over the path aforedescribed.

On the subsequent reoperation of relay R relay C2 is released as aforedescribed.

On the ninth release of relay R, relay C4 is operated over the path aforedescribed.

On the subsequent reoperation of relay R, relay C3 is released as aforedescribed.

On the tenth release of relay R, relay C5 is operated over the path aforedescribed.

On the subsequent reoperation of relay R, relay C4 is released as aforedescribed.

With R reoperated at the conclusion of the digit and with no further pulsing of the digit, the original energizing circuit of ON1 is opened. Circulating current through the two windings in series in aiding relation holds relay ON1 operated for an interval after which it releases. At its contacts 35 relay ON1 opens the original energizing circuit of slow release relay ON2 which releases after an interval as determined by its slow to release characteristics.

Let us assume now that the dialed directory number is ME7–2000 which is the same as dialing 637–2000. The digit-representing impulses are extended to the register for storage on the register thereat.

At the end of the first digit (6) with relays C1 and C6 operated, circuits can be traced upon the release of relay ON1 to operate relays R12 and R14 of the first digit register relay group as follows: Battery, R12, conductor 12, cable, conductor 12, RA1–14, C1–16, C6–13, ON2–33, ON1–33, H1–14, to ground. Battery, R14, conductor 14, cable, conductor 14, RA1–31, C1–34, C6–13, ON2–33, ON1–33, H1–14, to ground. At this time relay RA1 is shunted over the path from ground, H1–14, winding of relay RA1, conductor A1, cable, conductor A1, contacts of 32 of relays R12 and R14, conductors 12 and 14 to the operating ground of relays 12 and 14. It should be observed that the release of relay ON1 transfers the circuit of relay C1 over make-before-break contacts to relay ON2 over the circuit from battery through the lower winding of relay C1, break contacts 14 of relays C2–C5, contacts 15 to 14 of relay ON1, ON2–12, to ground.

When relay ON2 releases, relays C1 and C6 are released and the operating grounds of relays R12 and R14 are opened at ON2–33. Relay RA1 operates in series with relays R12 and R14 over the circuit from ground, H1–14, winding of relay RA1, conductor A1, cable, conductor A1, in parallel through make contacts 32 of relays 12 and 14, windings of relays R12 and R14 to battery. The digit six is thus registered on the first digit register.

At the end of the second digit (3) relay C3 is operated and circuits can be traced upon the release of relay ON1 to operate relays R21 and R22 of the second digit register relay group as follows: Battery, R21, conductor 21, cable, conductor 21, RA2–11, RA1–13, C3–34, ON2–33, ON1–33, H1–14, to ground. Battery, R22, conductor 22, cable, conductor 22, RA2–41, RA1–16, C3–32, C6–11, ON2–33, ON1–33, H1–14, to ground.

At this time RA2 is shunted by the operating ground of relays R21 and R22. It should be observed that relay C3 is held over the circuit from battery through the lower winding of relay C3, C3–16, C4–14, C5–14, contacts 15 to 14 of relay ON1, ON2–12, to ground.

When relay ON2 releases, relay C3 is released and the operating grounds of relays R21 and R22 are opened. With the shunt removed from relay RA2, this relay operates in series with relays R21 and R22. The digit three is thus registered on the second digit register.

At the end of the third digit (7) with relays C2 and C6 operated, a circuit can be traced to operate relay R37 of the third digit register relay group. When relay ON2 releases, relays C2 and C6 release and relay RA3 operates in series with relay R37 to complete registration of the digit "7" on the third digit register.

At the end of the fourth digit (2), with relay C2 operated, a circuit can be traced to operate relay R42 of the digit-4 register relay group. When relay ON2 releases, relay C2 is released and relay RA4 operates in

series with relay R42 to effect registration of the digit "2" on the fourth digit register.

At the end of the fifth digit (0), with relays C5 and C6 operated, circuits can be traced to operate relays R54 and R57 of the digit-5 register group. When relay ON2 releases, relays C5 and C6 are released, and relay RA5 operates in series with relays R54 and R57 to effect registration of the digit "0" on the fifth digit register.

At the end of the sixth digit (0) with relays C5 and C6 operated, circuits can be traced to operate relays R64 and R67 of the digit-6 register relay group. When relay ON2 releases, relays C5 and C6 are released, and relay RA6 operates in series with relays R64 and R67 to effect registration of the digit "0" on the sixth digit register.

At the end of the seventh digit (0) with relays C5 and C6 operated, circuits can be traced to operate relays R74 and R77 of the digit-7 register relay group.

When relay ON2 releases, relays C5 and C6 are released and relay RA7 operates in series with relays R74 and R77 to effect registration of the digit "0" on the seventh digit register.

It will be recalled that at the end of the fourth digit when relay ON1 releases, relay CT operates if relay CB has been operated previously as the indication to the register that the call is originating at a coin box. Relay CT operates over the circuit from battery through the winding of relay CT, F-wiring, CB–16, RA3–24, RA4–21, ON2–14, ON1–33, H1–14, to ground.

Relay CT sets up a test to determine whether the calling party has deposited a coin in the coin box as follows: At its contacts CT–31, it removes its battery circuit from the Ring winding of relay R, making effective the circuit from battery through the upper winding of bad test relay relay BT to the Ring winding of relay R. At its contacts 14 and 15 it transfers the Tip side of the line over make-before-break contacts from the Tip winding of relay R via contacts CT–14, over contacts CT–15 through the winding of relay T and the lower winding of relay BT to ground.

Although the calling party at a coin box receives dial tone immediately upon removing the receiver, insertion of the minimum charge coin in the coin box before dialing is required.

If the calling party at the calling coin box has inserted the said coin in the coin box, the coin box places 1000 ohm ground on the Tip conductor which (with CT operated at the end of the fourth digit for coin test) holds relay R operated over the path from battery, through the upper winding (in the order of 100 ohms) of relay BD, through the winding second from the top of relay R, conductor RR and intervening circuitry to the coin box, through the coin box to the Tip conductor, 1000 ohm resistor to ground. Relay BT does not operate under these conditions and it is immaterial whether relay T operates or does not operate.

If, however, the calling subscriber at the calling coin box has not inserted the said coin in the coin box, the aforedescribed 1000 ohm ground will not be connected to the Tip conductor and sufficient current will not flow through the second from the top winding of relay R and relay R will release. Relay T (in the order of 3500 ohms) operates in this circuit but relay BT does not operate.

It should be observed that with F-wiring connected, relay CD operates initially over the circuit closed when CB operates on coin box indication from the marker over the path from battery through the winding of relay CB, F-wiring, contacts 35*a* of relay CB, RA2–21, H1–14, to ground. Relay CD locks over the path from battery, through the winding of relay CD, CD–25, F-wiring, CT–33, CB–33, H–15, to ground so that after relay RA2 opens the original operating circuit after the second digit, relay CD holds over this locking circuit. When relay CT operates to initiate the coin test, relay CD holds over the circuit from battery, through the winding of relay CD, CD–25, F-wiring, ON1–11, R–35, to ground.

Accordingly, if R remains operated during the coin test as a result of the coin having been deposited, relay CD remains operated; but if relay R releases as a result of the coin not having been deposited, the holding circuit of relay CD is open at the lever 31 of relay R and CD releases.

If relay CD remains operated, ground through H1–15, CB–33, and CD–23 is on the call signal lead in preparation to operate the call signal relay CS. However, if relay CD is released, this ground circuit to the call signal lead is open at CD–23. It should be observed that on a non-coin-box call, ground through H1–15 and CB–31 obtains on the call signal lead in preparation to operate the call signal relay CS.

Moreover, if the Tip or Ring conductor at the coin box is grounded for any reason, as for example, by attempted fraud, relay BT operates from battery through the upper winding of relay BT, the second from the top winding of relay R to ground on the loop at the coin box station. Relay R holds in this circuit but relay T and the lower winding of relay BT are shunted. Relay BT locks from battery through its upper winding, BT–13, winding of relay RA1, H1–14, to ground. With relay BT operated, the circuit from ground through R–32 to the counting chain and to relay ON1 is opened. Subsequent digits dialed do not operate the counting chain, ON1, ON2, and do not advance the register relays. Alternatively break contacts 31 of relay BT could be placed in the call signal lead to disable the circuit of the call signal relay.

When relay ON2 releases, the circuit of relay CT is opened at ON2–14. When relay RA4 operates this circuit is further opened at RA4–21.

When relay CT releases, the normal pulsing circuit involving relay R is re-established.

(With P-wiring option, and the normal R relay holding circuit of relay H1 disabled through the operation of relay CT, a holding circuit for relay H1 is established. That is, during the time that relays CT and T are operated and relay R released, with no coin having been deposited, ground through T–21, H2–32, RD–13, holds relay H1 operated.

(It is necessary to hold relay H1 operated until coin deposit in order to prevent the release of the register.)

At the end of the seventh digit, as before stated, relays ON1 and ON2 release after sequential intervals; the seventh digit register is actuated (except in the case wherein the BT relay has operated); the counting chain is released; and relay RA7 operates.

If ground is on the call signal lead, this ground through the following contacts associated with the first digit:

Digit 2—R17–21, R14–21, R12–23
Digit 3—Same
Digit 4—R17–21, R14–23
Digit 5—Same
Digit 6—Same
Digit 7—R17–23, R14–24
Digit 8—Same
Digit 9—Same

the following contacts associated with the second digit

Digit 2—R27–21, R24–21, R22–23
Digit 3—Same
Digit 4—R27–21, R24–23
Digit 5—Same
Digit 6—Same
Digit 7—R27–23, R24–24
Digit 8—Same
Digit 9—Same

and make contacts 22 of relay RA7, through the winding of call signal relay CS to battery, operates relay CS.

Relay CS places battery through its make contacts on

the call signal lead CS to the register-sender guard circuit (ground through contacts 1425*a* to the register-sender guard circuit of FIGURE 14 of the copending patent application) which causes the guard circuit to operate the connect relays to switch certain leads (CB, ST, SR, PT, RD, CS) and a cable containing conductors **11–107** into the sender. It should be understood that conductors **81–107** are from digit-8 register, digit-9 register, and digit 10 register relay groups when equipped with T-wiring for a maximum of 10 digit dialing, L-wiring being used for a maximum of seven digit dialing. These paths compare with those of FIGURE 14 in the above identified copending application as follows:

Present Application	Fig. of Copending Application
CB	not shown on Fig. 14. (See Fig. 54, however.)
ST	ST.
SR	SR.
PT	1430*a*.
RD	1495*l*.
CS	1430*c*.
11–107	1495*b*

Leads **11–107** also correspond to connections between register and sender 4–13 from left to right in FIGURE 18 of the copending application.

It should be understood that the markings on the leads are combinational markings for the digit values 1–0. For example, with reference to the digit-1 register in the register circuit the digit registered, the relays operated, and the lead grounded are as follows:

Digit	Relays Operated	Leads Grounded
1	R11	11.
2	R12	12.
3	R11 and R12	11 and 12.
4	R14	14.
5	R11 and R14	11 and 14.
6	R11 and R14	12 and 14.
7	R17	17.
8	R11 and R17	11 and 17.
9	R12 and R17	12 and 17.
10	R14 and R17	14 and 17.

It should be observed that with relay CB operated, battery through a 1200 ohm resistor, and make contacts **35***b* of relay CB extends over lead CB to the sender, apprising the sender of the fact that the call originates at a coin box (this has significance on a call to an operator as will be explained further hereinafter).

Also it should be observed that each register relay which is operated connects ground to an associated conductor of cable **11–107** to apprise the sender of this fact. For example, if register relay **R11** is operated, ground through **R11–34**, conductor **11** through cable **11–107** to the sender apprises the sender of the fact that this relay is operated.

Thereupon the sender analyzes the first three digits as per indications on leads **11–17**; **21–27**; **31–37** to determine whether the call is to a trunk or special service group or to a local subscriber; and to identify the called trunk groups and special service numbers.

If the first three digits indicate that the call is to a local subscriber, the sender determines from the fourth digit as per indications on leads **41–47** what thousands number group to seize and seizes the same through connect and guard relays.

Thereupon indications on lead **51–57**; **61–67**; and **71–77** which have been switched into the correct number group circuit, enable the number group circuit to analyze the hundreds, tens and units directory digits indicated thereby and to translate them into five bits of information relative to the called party, the five bits of information being: (1) the five hundred line group (1–20) in which the called line is located; (2) a hundreds digit (0–4) indicative of the called equipment line location in the said 500 group; (3) a tens digit (0–9) indicative of the called line equipment location in the said 500 group; (4) a units digit (0–9) indicative of the called line equipment location in the said 500 group; and (5) the party (1–14) on the line or an indication (15) that the call is to a PBX line.

These five bits of information are relayed from the number group circuit back to the sender, the PBX indication from the number group to the sender resulting in the sender in an altered hundreds digit (i.e. the hundreds digit raise by 5; for example, if the hundreds digit had been 2 it is altered to become 7); and in a standard party 1 indication.

When the sender has received this information back from the number group it places ground on lead PT which operates relay PR in the register. Relay PR places direct ground on lead RC which causes relay R2 in the CRA circuit to operate.

Relay R2 (see FIGURE 23) locks from battery through fuse **1**, upper winding of relay **R2**, **R2–24**, **R1–14**, to ground. At its contacts **R2–22**, relay R2 extends ground through impedance coil **R3**, **R1–13**, **R22** to the S-wire leading to the group selector stage.

By reference to FIGURE 9 and the text and FIGURE 14 of the copending patent application, it can be seen that this ground calls in a group selector marker **1450** and the ring and tip connections SR and ST are extended from the sender, through the register, through the SRL crosspoints, and leads R and T into the code receiver **1450***c* of this group selector marker.

The group selector marker then places 24 volt negative battery on the tip conductor as a start signal to the sender, operating relay B (FIGURE 11 corresponding to FIGURE 19 of the copending application) in the sender.

Thereupon the sender sequentially transmits two digit information bearing signals to the code receiver in the group selector marker whereby the group selector marker ascertains the level off the GSB crossbar switches to the desired 500 group of lines, and according to the by-path principle closes a path through the GSA and GSB crossbar switches to an idle CRB circuit, extending a four wire connection comprising C, S, R, and T conductors from the CRA circuit to the CRA circuit. Ground on the S-wire operates relay MB in the CRB circuit. At contacts *g*, relay MB connects ground to the terminating H-wire from the CRB circuit in preparation to hold terminating connections. It should be noted however that at this time relay R1 holds the ring and tip conductors open. The four wire connection can be traced from the SLB–CRA circuit (FIGURES 22 and 24 of the present application) to the GSA switch; thence by reference to FIGURE 13A through the GSA and GSB crosspoints; thence by FIGURE 13D to the CRB circuit; and thence by FIGURE 32 into the CRB circuit.

Thereupon the code receiver in the CRB circuit places 24 volt negative battery on the tip conductor as a start signal to the sender and the sender sequentially transmits two digit information bearing signals to the code receiver in the CRB circuit as to the type of origin of the call and as to the party on the called line. If the call is to a PBX group, the CRB receives a party 1 ringing signal from the sender comprising —48 volt battery on the tip conductor T and —48 volt battery on the ring conductor R.

Although a more detailed description of the operation of the marker in establishing the terminating connections for calls follows in section VII, a brief account of the completion of the call is given at this point, to preserve the continuity of description of the CBT circuit and the register circuit.

The CRB circuit then applies for a subscriber's line marker code receiver.

When the calling CRB has been identified and a subscriber's line marker code receiver has been seized, the tip and ring connections are switched into the said code receiver and the said code receiver places 24 volt negative battery on the tip conductor as a start signal to the sender

and the sender sequentially transmits three digit information bearing signals as to the terminal location of the called line to the subscriber line marker code receiver.

If the call is to a PBX group the hundreds digit received is altered to have a value 5 higher than otherwise. Thus if the hundreds digit signal for a regular call indicates 4, the hundreds digit signal for a call to a PBX group indicates 9.

After receiving is completed, the code receiver of the subscriber line marker seizes the path-finding part of the marker when it is available for call completion.

The marker first operates the SLA horizontals to test the S-wire of the called line for a busy or lockout condition. If the called line is found to be busy, the marker makes a reverting call test. If the called line is found to be busy but not from reverting call, it signals the sender by placing +48 volts on the tip conductor and the sender places ground on lead RD to the register. If the called line is found idle, the marker tests for an idle path from the calling CRB to the called line. If no idle path can be found the marker signals the sender by placing +48 volts on the ring conductor and the sender places ground on lead RD to the register.

If the marker finds an idle line it places ground on the called S-wire operating line relays CO17 and LO17. If it also finds an idle path it closes the SLA, SLB, and SLC crosspoints. The closure of the SLC vertical magnet signals the CRB circuit by operating relay VO therein. Relay VO retains ground to the originating connections and places —48 volts on the ring conductor to the sender.

The —48 volt signal on the ring to the sender also actuates the sender to place ground on the RD lead to the register.

Ground on the RD lead through the winding of register disconnect relay RD to battery operates this relay (this relay is the same as relay **1495***j* in FIGURE 14 of the copending application).

Relay RD opens the RC lead at its contacts RD–**11**, allowing relay R1 in the CRA circuit to release. Relay R1 releases relay R2. With R1 releasing, the continuity of the S-lead from the CRB circuit to the originating connections is maintained. On a successful call this circuit can be traced from ground in the CRB circuit, MB–*f*, LC–*c*, VO–*j*, H–*a*, S-wire, FIGURE 13D, through the GSB crosspoints, FIGURE 13A, through the GSA crosspoints, FIGURE 13B, to the CRA circuit, tracing them in FIGURES 24, 25, etc., through contacts R2–**22** and then R1–**11**, after R1 releases, K-wiring (or ground from the CBT circuit), conductor **5003** via the H-wire over the circuit traced before to hold V1 of SLA–**1** and via the S-wire over the circuit traced before to hold the line cut off relay CO17 and lockout relay LO17. This ground on the S-wire makes the calling line busy to other calls, holds magnet V1 in SLB–**1**; V1 in the GSA switch; and vertical magnet **1499***h* in the GSB switch.

Magnet V1 in the SLA–**1** switch holds from battery through fuse **1**, **2000** through winding, contacts V1–**14**, to ground on the H-wire.

Magnet V1 in the SLB–**1** switch holds from battery, fuse **5**, 2000 ohm winding of magnet V1, contacts V1–**14** to ground on the S-wire.

Magnet V1 in the GSA switch holds from battery through the left 2000 ohm winding of magnet V1, to ground on the S-wire from the GSA S-wire crosspoints.

Vertical magnet **1499***h* in the GSB switch holds from battery through the left winding of magnet **1499***h* to ground on the S-wire through the GSB S-wire crosspoints.

Relay RD also opens the circuit of relay H1 at its contacts RD–**13**. After an interval as determined by its slow to release characteristics, relay H1 releases, removing its ground circuit from the H-lead at its contacts H–**15** (contacts **1425***a* in FIGURE 14 of the copending application), releasing vertical magnet V1 in SRL–**1**, in turn opening the SRL crosspoints, in turn releasing register relay R.

Relay H1 also at its contacts H1–**15** releases relays CB, CD, and CS; at its contacts **14** releases the operated register advance relays and the operated digit register relays; and at its contacts H1–**12** opens the holding circuit of relay H2 which releases after an interval as determined by its slow to release characteristics. Before relay H2 releases, the call signal relay CS releases removing ground from the call signal lead, releasing the sender, the release of which opens the circuits of register relays PR and RD, releasing these relays.

Finally H2 releases, re-establishing 1600 ohm battery to conductor B, making the register eligible for seizure by another call.

If, upon coin test, no coin was found deposited, relay R falls, releasing relay CD which opens a point in the operating circuit of CS at CD–**23**, so that CS cannot operate (on a non-coin box call, of course, ground through H1–**15** and CB–**31** prepares for CS to operate, no coin test being made). With CS non-operated, no sender is called in; and after ON2 releases for the last time, the circuit of relay TO is opened. It should be appreciated that when relay R operated, it opened the original operating circuit of relay TO, relay TO being normally operated from battery through the winding of relay TO, C6–**31**, H2–**13**, CT–**13**, BT–**31**, and R32 to ground. This operating circuit is also further opened by relays H2 and C6. This operating circuit has charged the condenser C1 through the 150 ohms, the condenser C1 to battery, and whenever the operating circuit is opened the condenser C1 begins discharging through relay TO. After about 20 seconds relay TO releases. However, with relay ON2 operated ground through relay ON2–**32** is connected to this operating circuit. Accordingly relay TO establishes a timing interval of 20 seconds in which dialing must begin or it will fall. Also relay TO establishes a timing interval of 20 seconds between digits during which the next digit must be dialed or it will fall. Also when relay ON2 releases at the end of dialing, with no coin deposited on a coin box call, CS does not operate, and no sender is called in. After 20 seconds, relay TO releases, completing a circuit from battery through the winding of relay RD, TO–**21** to ground, operating relay RD which releases connections. Whenever TO releases under any circumstances, relay RD operates and connections are released. After H2 releases, the original energizing circuit of relay TO is established and relay TO reoperates.

When the subscribers line marker has closed the SLC, SLB, and SLA crosspoints, it releases. It should be observed that either marker may be used on origination of the call after which the marker used releases and either marker may be used for the completion of the terminating end of the call after which the marker releases, removing its ground circuit from the called S-wire allowing relay RS in the CRB circuit to operate over its upper winding in series with the called line relays CO17 and LO17 to battery. This circuit can be traced from ground through contacts **5920**–*e*, conductor **5978**, **5810**–*a*, upper winding of relay RS (**5700**), contacts **5720**–*c*, over SLC–**1**, SLB–**1**, and SLA–**19** crosspoints through the winding of lockout relay LO17, the winding of relay CO17, fuse **4** to battery. Relay RS then holds over the circuit from battery through its lower winding, contacts **5700**–*e*, conductor **5998**, and contacts **5920**–*h* to ground. Ground through contacts **5920**–*e*, conductor **5978**, contacts **5810**–*a*, conductor **5795**, contacts **5700**–*d*, **5720**–*c*, to conductor **5787** which is the called S-wire holds called line relays CO17 and LO17 and keeps the called line busy.

The CRB circuit then rings the called party and when the called party answers, ring trip relay RT and in turn B in the CRB circuits operate. Ground placed on the C-conductor by the CRB circuit operates relays CC and S in the CBT circuit on a coin box call. This circuit may be traced from ground, through MB–*b* (in the

CRB circuit of FIGURES 30–32), conductor 5993, LC–*d*, conductor 5988, break contacts of relay TK, conductor 5989, B–*e*, conductor 5990, CS–*g*, conductor 5959 which is conductor C (refer now to FIGURE 13D), to the GSB switch, through the GSB crosspoints (refer now to FIGURE 13A), to the GSA switch through the GSA crosspoints (refer now to FIGURES 24 and 23, R1–21'), conductor C through the cable to the CBT circuit, conductor C, winding of relay S, upper winding of relay CC to battery. A major portion of this C–wire circuit also may be traced on FIGURE 9 which corresponds to FIGURE 14 of the copending application. Relay S is slow to operate. Upon its operation it opens its contacts S–31, removing the 200 ohm shunt from across its winding, thus allowing fast release when its circuit is subsequently opened. At its other contacts it reverses the tip and ring connections to the calling paystation. Thereupon the tip connector T, incoming to the CBT circuit from the coin box, can be traced through CD–11, S–13, to the ring connection outgoing from the CBT circuit. Similarly the incoming ring conductor R may be traced through CD–14, S–16, to the T conductor outgoing from the CBT circuit. This battery reversal in the coin box nullifies the battery reversal which occurs in the CRB circuit upon answer in order to properly adjust the tip and ring to prepay paystations relative to the 1000 ohm ground placed on the tip by coin deposit at the coin box. This is done for the purpose of maintaining battery on the ring conductor to the coin box telephone so that the CRB can recognize a disconnect signal from the coin box subscriber in the event said coin box subscriber should hang up while an answered condition exists. It should also be observed that relay CC locks from battery, through its lower winding, CC–25 to ground on the S-wire at its lever 22 relay CC transfers from the CR circuit lead to the CC circuit lead in preparation to collect instead of refund on hang-up, the CR-lead being connected to a source of −130 volt battery through a lamp and the CC lead being connected to a source of +130 volt battery through a lamp.

A conversation path can now be traced via tip and ring connections from the calling line to the called line. If the called party hangs up first, relay B (sub.) in the CRB circuit releases, reversing the ring and tip back to normal in the CRB circuit. At contacts B–*e*, relay B (sub.) opens the C-conductor ground, releasing relay S in the CBT circuit, which reverses the ring and tip in the CBT back to normal, thus nullifying the effect of the CRB reversal. It should be recalled that relay CC in the CBT circuit is locked and hence the removal of ground from the C-conductor does not affect it.

When the calling party hangs up, the CRB circuit removes ground from the S-conductor and the C-conductor as taught in detail in the copending patent application. The removal of ground from the C-conductor releases relay S, but relay CC holds to ground on the incoming S-wire. It can be seen by reference to FIGURE 9, and also to other figures that removal of ground from the S-wire releases the GSB vertical magnet which has been held over its left winding thereto, the GSA vertical magnet which has been held over its left winding thereto, the SLB vertical magnet which has been held over its left winding and make contacts of V1 thereto (on a non-coin box call), the SLA vertical magnet which has been held over its left winding and make contacts thereof (on a non-coin box call), the line cut-off relay CO17, and line lockout relay LO17. Switches SLA, SLB, GSA and GSB accordingly releases. The removal of this S-wire ground also un-busies the calling line. If a CBT were involved in the connection, the removal of ground from the S-wire by the CRB circuit releases relay SL, in the CBT circuit as well as switches GSA and GSB. The release of relay SL, removes its ground circuit from the incoming S-wire at SL–13, but relay H is locked to ground through CF–11, maintaining ground on the incoming S-wire which holds the SLA, and SLB switches and the line cut-off and lockout relays.

The release of relay SL operates relay CD from ground, SL–11, H–24, winding of relay CD to battery.

Relay CD connects relay CF to the 60 i.p.m. ground lead. Relay CD lights the lamp CA over an obvious circuit and places ground on the CA conductor which passes through the cable to the CBT Common Group equipment (FIG. 24), through an alarm timing circuit to battery which causes an alarm to be sounded if the attempts to dispose of the coins persist beyond a predetermined time. Relay CD also disconnects the ring and tip circuits incoming to the CBT from the ring and tip circuits leaving the CBT at its contacts 14 and 11 respectively and joins the incoming ring and tip circuits and routes them in common to lever 13 of relay CF. When ground obtains on the 60 i.p.m. lead, relay CF operates over the circuit from battery through the winding of relay CF, CD–32, 60 i.p.m. conductor, cable from CBT circuit to CBT Common Group equipment, 60 i.p.m. conductor, through the grounded segment of the interrupter to ground. Of course, any kind of a 60 i.p.m. interrupter could be used, such as an all relay interrupter.

When relay CF is operated, a circuit is closed to operate relay CT in series with the polarized coin magnet in the coin box. This circuit can be traced as follows: ground, negative pole of 130 volt battery, 130 volt battery, positive pole of 130 volt battery lamp, conductor CC, cable to the CBT circuit, conductor CC, CC–23, winding of relay CT, CF–14, in parallel through contacts 16 and 13 respectively to the ring conductor R and the tip conductor T, cable, conductors R and T, back through the SLB and SLA crosspoints, over the ring and tip line conductors to the coin box, both ring and tip conductors merging and passing through contacts closed by the passage of the deposited coin, through the winding of the 1000 ohm polarized coin magnet to ground. The polarized coin magnet in the coin box responds to the +130 volts on tip to operate the vane to route the coin through the collect chute in the coin box.

Relay CT closes ground through contacts CT–32 and H–26, through the lower winding of relay H to battery to hold relay H, the slow release feature of relay H preventing this relay from releasing in the interval between the operation of relay CF, upon which the ground to relay H through F–11 is opened, and the operation of CT.

Following this, relay CF releases during the open period of the 60 i.p.m. ground circuit.

Relay CF in releasing, holds relay H. Also relay CF opens the circuit of relay CT and the coin magnet in the coin box, releasing these. Relay CT opens its holding circuit to relay H.

When relay CF operates on the next grounded period of the 60 i.p.m. ground circuit, relay CT does not reoperate provided the coins have been properly disposed of in the coin box telephone and accordingly the circuit of slow release relay H is opened and relay H releases. At its contacts 24, relay H opens the circuit of relay CD which releases relay CD. At its contacts 32, relay CD disconnects relay CF which releases.

When relay H released, it also removed ground from the incoming S-wire at H–22, releasing relay CC, vertical magnet V1 of SLB–1, and V1 of SLA–1, and line relays LO17, and CO17, as well as unbusying the calling line S-wire. With the release of the vertical magnets of the SLA and SLB switches, the associated cross-points release.

If a coin gets stuck during the sequence of relay operation in the CBT circuit, when relay CF reoperates, relay CT reoperates holding relay H operated, which holds relays CC and CD operated. The 60 i.p.m. ground then intermittently operates relay CF, which intermittently attempts to apply the +130 volts or −130 volts as the case may be to tip and ring in an effort to dispose of the coins.

On a call to a special service trunk which is reached by

dialing three digits, such as 113 for example, the operation of the system is essentially the same as that described just previously up to the third digit.

When relay ON2 in the register releases at the end of the third digit and relay RA3 operates in series with digit register relays R31 and R32, the call signal relay CS operates over the circuit from battery through the winding of relay CS, RA3–22, R11–22, R12–21, R14–21, R17–21, CB–31, H1–15, to ground, operating relay CS.

Relative to a call from a coin box, as the coin check is designed to follow the fourth digit on a call from a coin box, no coin check has as yet been made at the end of the third digit. It should be recalled that relay CB in the register was operated prior to dialing, and that with F-wiring and relay CB operated, relay CD was operated and locked. Accordingly, under these circumstances the circuit of relay CS can be traced from R17–21 through CD–23, CB–33, and H1–15 to ground; and relay CS operates.

Relay CS places battery on the call signal lead CS which through guard and connect relays connects the register to a sender.

The sender ascertains from ground on leads 11, 21, 31, and 32 that the dialed digit was 113, operates register relay PR over lead PT, engaging a group selector marker and routes the call to the operator over certain predetermined trunks. In the case of calls to service trunks, the sender, of course, interprets the first three digits, and does not call in a number group circuit. The sender transmits two digit information signals sequentially to the group marker code receiver (see FIGURE 9) whereby the group marker code receiver operates the proper route relay of the group indicated generally by the box 1499*j* to route the TB leads of the special service trunks of the group through off-normal break contacts of the associated vertical GSB magnets into the group selector marker whereby the marker ascertains the idle or busy condition of the trunk. If a trunk is idle, battery through 1600 ohms on the TB lead, through contacts of the Route Relays, through the off-normal break contacts of the associated GSB vertical magnet to the group selector marker circuit apprises the marker of this fact. If the trunk is busy, this 1600 ohm battery is absent from the TB lead. (A similar situation holds for testing CRB's on calls to local subscribers.) The group selector marker accordingly chooses an idle trunk, finds an idle path (if available) and closes first the particular horizontal magnets, then the particular vertical magnets of the GSA and GSB switches to route the calling CRA to the selected idle trunk (a similar situation holds routing a CRA to a CRB). It should be recalled that relays R1 and R2 are both operated when the GSA and GSB crosspoints close. Ground through make contacts 1405*a* of relay R1, the C-conductor through GSA and GSB crosspoints to the trunk circuit operates the trunk off-normal relay. Additionally, ground through impedance coil R3 (1415), contacts 1407 and 1412 on the S-conductor, through the GSA and GSB crosspoints obtains on the S-conductor to the trunk. (On calls to CRB's, ground forward on the S-conductor but not on the C-conductor is significant but, as has been explained, in the case of calls from coin boxes, ground placed on the C-conductor by the CRB on answer to the CBT is significant.)

When the sender has finished sending and the GSA and GSB crosspoints have closed, —48 volt battery will be found on the ring conductor from the trunk circuit causing tthe sender to release the register, which releases, the sender and relays R1 and R2 in the CRA circuit.

When the operator answers, no reverse battery supervision is given on the ring and tip, and ground is not placed on the C-conductor. Accordingly, if a coin box is involved, relays CC and S in the CBT circuit do not operate.

When the calling party at a coin box hangs up, with relay CC non-operated, relay SL releases and releases switches forward of CBT. Relay CD operates. Relay CF operates, and —130 volt battery (the positive side of which is grounded), through the lamp, conductor CR, cable to CBT circuit, conductor CR, CC–21, winding of relay CT, CF–14, in parallel through contacts CD–13 and CD–16 over the calling connection to the coin box through the polarized coin magnet to ground operates the coin magnet which tips the associated vane to route any coin which the calling party may have inserted, through the refund chute. Of course, it was not necessary for the calling party to deposit a coin on a call to special service trunks.

On a call to a "dial 0" operator trunk, the operation of the system is essentially the same as that described up to the dialing of the first digit.

When relay ON2 in the register releases at the end of the first and only digit (i.e. "0"), and relay RA1 operates in series with digit register relays R14 and R17, the call signal relay CS operates over the circuit from battery through the winding of relay CS, R14–26, R17–23, CB–31, H–15, to ground. On a call from a coin box with relay CB operated and relay CD operated with F-wiring, this circuit may be traced from R17–23, through CD–23, CB–33, and H–15 to ground.

The sender analyzes this first digit "0," does not engage a number group circuit, operates register relay PR over lead PT, which operates relay R2 in the CRA circuit engaging a group selector marker, and sends two digit information bearing signals sequentially to the group selector marker enabling the marker to extend connections through the GSA and GSB switches to the "dial 0" trunks which are tested and one of which is selected, whereupon C-conductor ground and S-conductor ground are extended into the selected "dial 0" operator trunk of a predetermined trunk group. If the call originated at a coin box with register relay CB operated, the sender receives 1200 ohm battery through contacts 35*b* of relay CB via the CB lead; and apprised by this information, routes the call to the operator over other predetermined trunks, whereby the operator knows that the call originated at a coin box rather than at a non-coin-box subscriber station. The sender signals the register to release by placing ground on lead RD thereby causing the operation of relay RD in the register. The register and sender release, and relays R1 and R2 in the CRA circuit release.

When the operator answers on a call from a pre-pay coin box telephone, the tip and ring conductors are reversed and ground is placed on the C-conductor by the operator trunk (see FIGURE 9). This ground on the C-conductor through the GSB and GSA crosspoints, contacts 21 of relay R1 (now see FIGURE 23), conductor C into the cable to the CBT circuit, conductor C, winding of relay S, upper winding of relay CC to battery, operates relays S and CC in the CBT circuit in preparation for collect on hang-up.

However, the operator trunk momentarily applies 130 volt negative potential to the tip and ring circuits which causes the polarized coin magnet in the coin box to refund any coin which the calling party may have inserted (unnecessarily with F-wiring) to reach the operator.

The operator ascertains the desired called party destination from the calling party and advises the calling party what coins to deposit. The operator by tone signals over the conversation tip and ring channel ascertains in conventional manner if the required coins are deposited and extends the connection to the called party.

When conversation has been completed and the calling and called parties have replaced their receivers, the operator places 130 volt positive potential on the ring and tip conductors to the coin box telephone which operates the polarized coin magnet in the paystation to collect the coins. However, provision is made to collect these coins automatically if the operator forgets to apply the collect potential.

More specifically, it should be understood that on calls to trunks, the ring and tip connections are extended into the trunk and cause the trunk to apply ground to the S-conductor which ground back through the GSB and GSA crosspoints obtains on the S-conductor before the register releases CRA relays R1 and R2. The applied ground holds the GSA and GSB vertical magnets; through contacts 22 of R2 (FIGURE 23) holds the SLB and SLA switches; holds the line cut-off relay CO17 and lockout relay LO17 operated; and on a coin box call holds relays SL and H operated.

When this S-wire ground is removed by the "dial 0" operator trunk, the whole connection collapses, with the exception that on a coin box call the connections from the calling coin box to the CBT circuit are temporarily held by the CBT circuit.

As explained previously with relays CC and S in the CBT circuit operated at this time the CBT circuit goes through an operation before final release to place +130 volts positive potential on ring and tip to actuate the polarized coin magnet in the coin box to collect the deposited coins.

It is recalled that on seven digit calls the circuit of the call signal relay passed through RA7–22, thus giving the register the signal to seize a sender after the seventh digit.

The cases in which the first digit is "1" and third "3" for example; in which the first digit is "0"; and in which the first digit is anything from "2" to "9" have been considered.

In the event the subscriber has dialed "110," the operation of the system is essentially the same as that set forth relative to response of the equipment to the first three digits of a call to a local subscriber.

When relay ON2 in the register releases at the end of the third digit and relay RA3 operates in series with the digit register relays R34 and R37, the call signal relay CS operates over the circuit from battery through the winding of relay CS, RA3–22, R11–22, R–12–21, R14–21, R17–21, CB–31, H1–15, to ground, operating relay CS.

Since the coin check is designed to follow the fourth digit on a call from a coin box, no coin check has as yet been made at the end of the third digit. It should be recalled that relay CB in the register was operated prior to dialing, and that with F-wiring and relay CB operated, relay CD was operated and locked. Accordingly, under these circumstances the circuit of relay CS can be traced from R17–21 through CD–23, CB–33, and H1–15 to ground; and relay CS operates.

Relay CS places battery on the call signal lead CS which through guard and connect relays connects the register to a sender.

The sender ascertains from ground on leads 11, 21, 34, and 37 that the dialed digits were 110, operator register relay PR over lead PT, engaging a group selector marker and routes the call to the operator over certain predetermined trunks. If the call originated at a coin box with register relay CB operated, the sender receives 1200 ohm battery through contacts 35*b* of relay CB via the CB lead; and responsive to such information, routes the call to the operator over other predetermined trunks, whereby the operator knows that the call originated at a coin box telephone rather than at a non-coin-box telephone. In the case of calls to 110 trunks, the sender, of course, interprets the first three digits and does not call in a number group circuit. The sender transmits two digit information signals sequentially to the group selector marker code receiver whereby the said marker routes the call to the operator trunk.

From here on, the action of the circuitry is the same as that for a call to a "dial 0" operator trunk.

Referring to the register circuit, with L-wiring, if the second digit dialed is 1 or 0 (which indicates an area toll ticketing code) with any first digit 2–9, the call signal relay CS is operated upon the operation of the second digit register relay or relays whether the call originated at a coin box or not.

For example, if the first two digits dialed are 21 and the call is a non-coin-box call, the circuit for the call signal relay may be traced from battery, through the winding of the call signal CS, L-wiring, R21–22, R22–21, R24–21, R27–21, R12–23, R14–21, R17–21, CB–31, H–15, to ground.

Also for example if the first two digits dialed are 70 or 90 and the call is a coin box call, the circuit for the call signal relay may be traced from battery, through the winding of the call signal relay CS, L-wiring, R24–26, R27–23, R14–24, R17–23, CD–23, CB–33, H1–15, to ground.

The call signal relay places battery through its make contacts on the call signal relay CS which calls in a sender. The sender determines from the markings on the leads of the group 11–107 which are unique to the first and second digit registers that the call requires intercept and routes the call to the intercept operator.

With T-wiring connected for ten digit dialing, the first three digits representing the area, the next three the office, and the last four the called party directory number, the dialing of the second digit "1" or "0" does not operate the call signal relay to route the call to an intercept operator. Rather, if the second digit dialed is "1" or "0," the requirement is made that the tenth digit be dialed before the call signal can be operated. For example, if the first two digits dialed are 21 and the call is a non-coin-box call, a circuit for the call signal relay CS is completed at the end of the tenth digit over the circuit from battery through the winding of relay CS, RA10–22, T-wiring, R21–22, R22–21, R24–21, R27–21, R12–23, R14–21, R17–21, CB–31, H1–15, to ground.

Of course, if the second digit dialed is other than 1 or 0, the circuit through RA7–22 is effective and the call signal relay CS is operated after the seventh digit instead of the tenth.

VII. TERMINATING CALL

The condition of the marker in the idle condition was described in section V.

A. *Seizure of marker*

Referring now to FIGURES 33 and 38–80, it is assumed that the line entrance terminating circuit LET of FIGURE 33 is that associated with the CRB's of the first 500 group of lines and that the marker of FIGURES 38 to 80 is the first marker, i.e. SLM–1. It should be appreciated that on the termination of a call, circuit LET corresponds to circuit LEO on the origination of a call. It is further assumed that the CRB circuit through which a call is proceeding is the first CRB (i.e. CRB–1). When relay CS in the CRB circuit operates (see copending application S.N. 522,233), a path is completed to operate polarized relay RAG in the LET circuit, which path may be traced from ground through the winding of relay RAG, 1RAV–*a*, RAW–*d*, 1C1–*c*, call signal conductor 5784, cable 5962 through FIGURES 30 and 31 into FIGURE 32, conductor 5784, contacts 5930–*r*, 5940–*k*, conductor 5786, cable through FIGURES 32 and 31, into FIGURE 30, conductor 5785, 10,000 ohm resistor, 1RAV–*c*, 5000 ohm resistor, conductor 5607, 2RANC–*a*, WE13G lamp, source of 20 cycle alternating current to ground, causing the lever of relay RAG to oscillate.

Contacts RAG–*a* are arranged to extend ground to seize subscribers line marker #2 (SLM–2); contacts RAG–*b*, subscribers line marker #1 (SLM–1); in a manner similar to that described for the operation of relay AG on an originating call.

B. *Line group identity*

The equipment first operates to indicate to the marker the identity of the five hundred line group which includes the called subscriber substation set.

Assuming that relay RAG closes its contacts RAG–*b* to engage SLM–1, ground through contacts RAG–*b*, conductor 5602, fuse contacts, 2RAND–*b*, RANA–*b*, winding of relay 1RAN1 associated with the first 500 line group conductor 5603, 1000 ohm resistor to battery, operates relay 1RAN1.

Relay 1RAN1 at its contacts *b* locks to ground independent of ground through contacts RAG–*b*. This locking circuit is similar to that described for relay 1AN1 on an originating call. That is, relay 1RAN1 pertains to the first 500 line group having access to SLM–1 and relay 1RAN2 to the second 500 line group. Relays 1ROB and 2ROB are rotator relays which are both operated and both released on successive calls, shifting the priority of locking of relays 1RAN1 and 1RAN2 thus giving the first 500 line group or the second 500 line group priority in seizing the subscribers line marker, there being two LET circuits, one for each 500 line group, which we shall designate LET–1 and LET–2 for the first and second 500 line groups respectively and two markers SLM–1 and SLM–2.

Assuming relays 1ROB and 2ROB non-operated, relay 1RAN1 locks to ground over the path through 1RAN1–*b*, 1ROB–*a*, contacts *b* of the manual key, 1RANC–*a*, 2RAND–*c*, to ground, opening the locking circuit of 1RAN2 at 1RAN1–*a*, to indicate in the marker that the CRB which has seized the marker serves the first five hundred line group.

Relay 1RAN1 at its contacts *c* places a shunt on relay RAG over the path from the right side of the winding of relay RAG, conductor 5603, 1RAN1–*c* to ground to immediately stop the oscillation of the lever of relay RAG; at its contacts *d* operates relay 1RAN1A over the path which extends from battery through the winding of relay 1RAN1A, 1RAN1–*d*, to ground; and at its contacts *e* operates relay RANA over the path from battery through the winding of relay RANA, 1RAN1–*e*, to ground.

Relay 1RAN1A at its contacts *a* closes the following circuit to operate relay 1RAV in the LET circuit: battery, winding of relay 1RAV, conductor 5605, 1RAN1A–*a* to ground; at its contacts *c* operates relays 2RAN1 and 3RAN1 over the path from battery through the windings of these relays in parallel, 1RAN1A–*c*, 1RAN2A–*d*, to ground; and at its contacts *d* operates relays 4RAN1, 5RAN1, and 5RAN1A over the path from battery through the windings of these relays in parallel, 1RAN1A–*d*, 2RAN1A–*d*, to ground.

Relay RANA at its contacts *b* and *a* opens the circuits from the LET circuits to relays 1RAN1 and 1RAN2, but relay 1RAN1, which operated, has locked; at its contacts *c* operates relay RANB over the circuit from battery through the winding of relay RANB, 1RAND–*f*, RANA–*c*, to ground; and at its contacts *d* operates relay CRG in the marker code receiver (FIGURES 73 to 75) over the path from battery through the winding of relay CRG, conductor from MCR to MCI, 2RANC–*c*, 1RAND–*h*, RANA–*d*, to ground.

Relay RANB at its contacts *b* operates relays 1RANC and 2RANC over the circuit from battery through the windings of these relays in parallel, RANB–*b*, to ground.

Relay RANB at its contacts *d* provides operating battery for CRB group identity relays RA1–RA7 and CRB individual identity relays RB1–RB10; and at its contacts *c* provides ground for relays RA1–RA7, independent of the LET circuit. Relay RANB closes certain other contacts also, the purpose of which will become more meaningful hereinafter.

C. *CRB group identity*

Recalling that it was assumed that the calling CRB is the first CRB in the first group of CRB's, the equipment now operates to inform the marker as to which group the seizing CRB is assigned, and the number of the CRB in the group. Relay RA1 operates over the circuit from battery through contacts RANB–*d*, RBB–*g*, 1RAA–*b*, winding of relay RA1, conductor 1, cable, conductor 1, 3RAN1–*a*, cable from MCI to LET, conductor 1 otherwise designated 5608, conductor 5785 to the CRB circuit, cable, conductor 5785, contacts 5940–*h*, 5930–*r*, conductor 5784, cable, conductor 5784 to the LET circuit, contacts 1C1–*c*, RAW–*d*, IRAV–*b*, to ground to indicate to the marker that the seizing CRB is in the first group of CRB's.

Relay RA1 extends its operating battery to sequence relay 1RAA so that this relay operates over the circuit from ground through the winding of relay 1RAA, conductor 5, cable to rotator relays, conductor 5, contacts *b* of manual key, contacts 1ROA4–*a* (assuming that relay 1ROA4 is the rotator relay operated), conductor 1, cable, conductor 1, make contacts *c* of relay RA1, contacts IRAA–*b*, RBB–*g*, and RANB–*d* to battery. Relay 1RAA locks over its contacts *g* to this battery over the circuit from ground through the winding of relay 1RAA, 1RAA–*g*, RBB–*g*, RANB–*d*, to battery. After contacts *g* of relay 1RAA have closed, contacts *b*, *c*, *d*, *e*, *f* and other similar contacts of 1RAA open. Relay RA1 then holds operated over the circuit from ground through contacts RANB–*c*, RBB–*b*, RA1–*b*, winding of relay RA1, RA1–*c*, conductor 1, cable to the rotator, conductor 1, 1ROA4–*a*, contacts *b* of the manual key, conductor 5, cable, conductor 5, 1RAA–*g*, RBB–*g*, RANB–*d*, to battery in parallel with relay 1RAA.

It should be understood that relays 1ROA1–4ROA1 constitute a "jump rotator" for shifting the priority of locking of relays RA1–RA7 through conductors 1 and 3 to the upper locking chain of relays RA1–RA7 and through conductors 2 and 4 to the locking chain of relays RA1–RA7 in similar fashion to that described for relays A1–A20 of the MLI circuit, so that, though more than one of the relays RA1–RA7 can operate simultaneously, only one can lock.

As relay 2RANC operates, the circuit of timing relay K3, which is normally operated, is opened at contacts 2RANC–*e* and relay K3 is held operated for an interval by circulating current over the path from battery through the winding of relay K, condenser B, 200 ohm resistor to battery.

Relay 1RANC closes ground to operate rotator relay 2ROB over the circuit from ground, 1RANC–*c*, 1ROB–*c*, winding of relay 2ROB, to battery. Relay 2ROB at its contacts *a* prepares to lock in series with relay 1ROB when 1RANC releases.

Relay 1RANC at its contacts *a* disconnects ground on 2RAND–*c* from the holding circuit of relay 1RAN1 and connects ground through 1RANC–*b* thereto in preparation for release.

Relay 2RANC at its contacts *c* disconnects ground through RANA–*d* from relay CRG, and connects ground through 2RANC–*b* thereto.

Also relay 2RANC at its contacts *d* operates terminating control relay DGD in the MVT circuit over the path from battery through the winding of this relay, break contacts DGC–*i*, conductor 1, cable through MVC circuit to MCI circuit, conductor 1, 2RANC–*d*, to ground.

As relay 1RAA operated, relay 1RAA at its contacts *a* operates relay RAB over the circuit from battery through the winding of relay RAB, 1RAA–*a*, to ground.

Relay RAB locks over the circuit from battery through the winding of relay RAB, RAB–*b*, 1RANC–*e*, to ground.

Relay RAB at its contacts *a* operates relay RAW, 2C1 and 1C1 in the LET circuit. The path for operating RAW can be traced from battery through the winding of relay RAW, conductor 8, cable to MCI circuit, conductor 8, 4AN1–*g*, 1RAND–*b*, RAB–*a*, to ground. The circuit for operating relays 2C1 and 1C1 can be traced from battery through these relays in parallel, conductor 1, cable to MCI circuit, conductor 1, 4AN1–*a*, cable, conductor 1, RA1–*a*, 1RAND–*b*, RAB–*a*, to ground. It should be noted that if relay RA2 were operated, relays 2C2 and 1C2 (not shown) in the LET circuit would be operated;

and that if relay RA7 were operated, relays 2C7 and 1C7 in the LET circuit would be operated.

Relay RAB at its contacts *d* steps the "jump rotator" by operating relay 1ROA1 over the circuit from battery through the upper winding of relay 1ROA1, conductor 6, cable, conductor 6, RA1–*j*, RAB–*d*, to ground. Relay 1ROA1 locks and releases relay 4ROA1.

D. *CRB identity*

Relay RAB at its contacts *c* also provides battery to the individual CRB identity relays RB1–RB10 for the purpose of indicating to the marker the particular CRB in the first group which has seized the marker. Assuming the first CRB of the first group has seized the marker relay RB1 operates over the circuit from ground through contacts RANB–*c*, RBB–*b*, RA1–*b*, conductor 1, cable, conductor 1, 3RAN1–*a*, conductor 1, cable to LET circuit, conductor 1 (otherwise designated 5608), conductor 5785, cable, conductor 5785, contacts 5940–*h*, 5930–*r*, conductor 5784, cable, conductor 5784, contacts 1C1–*d*, conductor 5609 to MCI circuit, cable, conductor 1, contacts 2RAN1–*a*, conductor 1, cable, conductor 1, winding of relay RB1, contacts 1RBA–*e*, RAB–*c*, K4–*a*, and RANB–*d*, to battery.

Relay RB1 extends its battery circuit to relay 1RBA, operating this relay. For example, with rotator relay 4ROA2 initially in the operated position, relay 1RBA operates over the circuit from ground through contacts RBB–*d*, upper winding of relay 1RBA, contacts RBB–*e*, conductor 5, cable, conductor 5, contacts of manual key, 4ROA2–*a*, conductor 1, RB1–*a*, 1RBA–*e*, RAB–*c*, K4–*a*, RANB–*d*, to battery. Relay 1RBA locks over its upper winding via the path from ground, RBB–*d*, upper winding of relay 1RBA, 1RBA–*d*, RAB–*c*, K4–*a*, RANB–*d*, to battery. At this time relay RB1 holds over a circuit from ground previously traced to conductor 1, winding of relay RB1, RB1–*a*, conductor 1, cable, conductor 1, 4ROA2–*a*, contacts *b* of manual key, conductor 5, cable, conductor 5, RBB–*e*, 1RBA–*d*, RAB–*c*, R4–*a*, RANB–*d*, battery.

Relay 1RBA operates relays 2RBA and 3RBA over obvious circuits.

Relay 2RBA opens the original battery feed circuits to the other relays RB2–RB10.

Relay 1RBA also operates relays 1RAND and 2RAND over the circuit from battery through the windings of these relays in parallel, 1RAND–*c*, K4–*c*, 1RBA–*g*, to ground. Relay 1RAND locks itself and relay 2RAND over make-before-break contacts over the path from battery through the windings of these relays in parallel, 1RAND–*d*, RANA–*c*, to ground and shifts the circuit of relay RANB over make-before-break contacts to ground over the circuit from battery through the winding of relay RANB, 1RAND–*e*, K4–*c*, 1RBA, to ground. It can be seen that relay RANB prepares a circuit to operate relays 1RAND and 2RAND to ground through R4–*b* if K4 should release and that relay 1RAND parallels this circuit through its make contacts *g* when relay 1RAND operates. Relay 1RAND prepares start wire ground at contacts 1RAND–*g*.

Relay 3RBA operates sequence relay RBB over the path from battery through the winding of relay RBB, 3RBA–*a*, to ground.

Relay RBB locks to ground through RBB–*a* and RANB–*a*. Relay RBB shifts the ground circuit for relays RA1–RA7 and RB1–RB10 over make-before-break contacts to the circuit from ground through RANB–*e*, 1RBA–*c*, RBB–*c*, etc. Relay RBB also at its contacts *d* opens the circuit from ground to the upper winding of relay 1RBA. Relay RBB steps the "jump rotator" 1ROA2–4ROA2 by operating relay 1ROA2 over the path from ground, RB1–*h*, conductor 6, cable, conductor 6, upper winding of relay 1ROA2 to battery. Contacts 1ROA2–*a* close. Relay 1ROA2 releases relay 4ROA2 which opens its contacts 4ROA2–*a*.

Relay RBB also, over make-before-break contacts, establishes a path from battery, RANB–*d*, K4–*a*, RAB–*c*, 1RBA–*d*, lower winding of relay 1RBA, RBB–*f*, conductor 5, cable, conductor 5, contacts *b* of the manual key, contacts 4ROA2–*a*, conductor 1, cable, conductor 1, RB1–*a*, winding of relay RB1, conductor 1, cable, conductor 1, 2RAN1–*a*, conductor 1, cable, conductor 1, contacts 1C1–*d* in the LET circuit, conductor 5784, cable, conductor 5784, contacts 5930r, 5940*k*, conductor 5785, cable, conductor 5785, conductor 5608, cable to MCI circuit, conductor 5608 otherwise designated 1, 3RAN1–*a*, conductor 1, cable, conductor 1, RA1–*b*, RBB–*c*, 1RBA–*c*, RANB–*c*, to ground. When relay 1ROA2 operates this circuit extends from battery, RANB–*d*, K4–*a*, RAB–*c*, 1RBA–*d*, lower winding of relay 1RBA, RBB–*f*, conductor 5, cable, conductor 5, contacts *b* of manual key, 1ROA2–*a*, conductor 2, cable, conductor 2, contacts *d* in series of relays RB10 to RB2, RB1–*c*, winding of RB1, etc.

It should be understood that relays 1ROA2–4ROA2 constitute a "jump rotator" for shifting the locking circuit and thereby the priority of relays RB1–RB10 in locking via upper and lower locking chains so that, although several of these relays operate, only one can lock and that locking occurs according to the priority provided at the setting of the jump rotator. This technique has been discussed heretofore and in the above identified copending application.

Relay RBB also operates relay S1 in the MCC circuit over the path from battery through the winding of relay S1, conductor 1, cable to the MCI circuit, conductor 1, contacts RA1–*g* and RBB–*i*, to ground.

Relay RBB also operates magnet M39 of the multiple relay comprising magnets M31–M40 in the LCT circuit over the path from battery through the winding of combination magnet M39, conductor 39, cable 6002 to the MCC circuit, conductor M39, contacts 5RAN1A–*c*, odd conductor 11 to the MCI circuit, contacts RB1–*f*, and RBB–*i* to ground.

Relay S1 completes a circuit to operate selection magnet M1 of the multiple relay M1–M10 in the LCT circuit over the path from battery through the winding of magnet M1, conductor 1, cable 6001 to the MCC circuit, conductor 1, contacts S1–*f*, conductor 1, cable to the MCI circuit, conductor 1, contacts 5RAN1–*a*, condutor 1, contacts RB1–*e* to ground. It should be noted that the operation of relays S1–S7 is selectively determined by the operated CRB group relay of the group RA1–RA7; that combination magnet M39 is operated if the CRB is an odd numbered CRB as determined by the operated odd numbered individual CRB relays of the group RB1–RB10; that combination magnet M40 is operated if the CRB is an even numbered CRB as determined by the operated even numbered individual CRB relays of the group RB1–RB10; that the circuits of magnets M1–M35 are selectively extended in groups of ten by the relays of group S1–S7 to contacts of the relay group RB1–RB10; that relay S1 extends the circuits of magnets M1–M10 of the first multiple relay to contacts of the group RB1–RB10; that relay S2 extends the circuits of magnets M11–M20; etc.; that magnet M1 is operated by either relay RB1 or RB2 but that the leads of CRB–1 or CRB–2 are extended into the marker accordingly as magnet M39 or M40 respectively is operated, M39 being operated by relay RB1 and M40 being operated by RB2. It should be appreciated that operation of relays S1–S7 and M39–M40 is controlled by the operation of relay RBB which operates only after the relay groups RA1–RA7 and RB1–RB7 have settled down. Also, that the individual magnets M1–M35 are operated through make contacts of relays S1–S7. Accordingly, a guard is provided against switching the leads of more than one CRB into the marker due to several CRB's applying simultaneously for a marker and more than one of the relays of the group

RA1–RA7 being operated simultaneously and/or more than one of the relays RB1–RB10 being operated simultaneously.

With select magnet M1 and combination magnet M39 operated, leads T, R, VP, and RWC of the first CRB (i.e. CRB–1), assumed to be the one shown for example, are switched into the selected marker SLM–1 shown.

The tip conductor T can be traced from ground in the sender of FIGURE 11 corresponding to FIGURE 19 of the above identified copending application through contacts *f* of relay VIII, contacts *a* of relay VII, winding of relay B, through the rectifier, contacts A4 of relay A, tip lead ST, break contacts of relay S (FIGURE 10), tip lead ST through path 315 of block diagram FIGURE 3 corresponding to FIGURE 3 of the copending patent application, through connect and guard relays 305, through path 314 into the originating register 304 (FIGURE 3) via the ST lead of schematic FIGURE 35 of the register, (see also FIGURE 10), through the register into cable SRL to FIGURE 27, lead ST, through crosspoints associated with horizontal magnet HA (FIGURE 25) and vertical magnet V1 (FIGURE 26), through crosspoints associated with horizontal magnet H1 (FIGURE 25) and vertical magnet V1 (FIGURE 26), lead ST, to lead T leading to the group selector (now see FIGURE 13A), through crosspoint contacts of the GSA switch, through crosspoint contacts of the GSB switch, (now see FIGURE 13D) to the CRB circuit (now see schematic FIGURE 32 of the CRB), contacts 5940–*e*, 5930–*m*, conductor 5982 which is the T conductor to multiple relay M1–M10, through make contacts associated with magnet M1, through the corresponding conducting bars of the multiple relays in series, through contacts associated with magnet M39, into a Tip conductor common to these contacts of magnet M39 and the corresponding contacts of magnet M40, cable 6003 to the MCC circuit, conductor T emerging from this cable and passing through contacts 5RAN1A–*i*, Tip conductor, cable to MCR circuit, Tip conductor, CRG–22, RA3–31, tip conductor T, cable, tip conductor T, contacts R3–11 through the two 13F rectifiers in parallel, winding of code receiver relay R2, contacts R1–11 to the —24 volt point on the voltage divider composed of the circuit from —48 volt battery through a 200 ohm resistor, —24 volt point, another 200 ohm resistor, and contacts CRG–33, to ground. The resistance of relay B in the sender is such that code receiver relay R2 does not operate at this time. Relay B in the sender operates, however, as a dial start signal received from the marker code receiver to advise the sender to start sending.

Similarly, the ring conductor R can be traced from ground in the sender through the winding of relay D, rectifier, contacts A2 of relay A, conductor SR, etc., through CRG–*b*, RA3–*c*, cable, ring conductor R, rectifier winding of relay R4, R5–*a*, to ground.

Also at this time the circuit of vertical magnet V1 of SLC–1 is partially completed over the circuit from battery in the CRB circuit over a conductor through FIGURE 29 to the 200 ohm winding of magnet V1 in FIGURE 28, thence over conductor VP which becomes conductor 5791 in the CRB, which becomes conductor 5969, which becomes conductor 5984, which becomes conductor VP, through contacts of magnet M1 and corresponding conducting bars of the other multiple relays (FIGURE 33), through contacts of magnet M39, conductor VP, cable 6003, conductor VP, 5RAN1A–*g*, conductor VP, cable to MTT circuit, conductor VP, to the lever associated with contacts *e* of relay 1A, in preparation to operate magnet V1 of the SLC circuit.

Additionally, a circuit extends from the lever of relay WC (5720) of FIGURE 30 associated with contacts *j* and *k* of relay 5720, conductor 5968, which becomes conductor 5985, which becomes conductor RWC, contacts of magnet M1, conducting bars in series (FIGURE 33), contacts of magnet M29, conductor RWC, cable 6003 to the MCC circuit, conductor RWC, contacts 5RAN1A–*f*, conductor RWC, cable to MTT circuit, conductor RWC, contacts RC–*b*, 1RC–*d*, winding of relay WC to battery. If relay WC (5720) in the CRB circuit is in the operated condition due to a call from a wire chief trunk or a busy vertification trunk (see above identified copending application), ground through contacts *j* of relay 5720 on the associated lever, over the circuit traced operates relay WC in the MTT circuit to apprise the marker of the fact that a wire chief or busy verification call is progressing so that the marker can disregard the busy condition of a called line. If a reverting call is being made instead, relay WC (5820) in the CRB circuit will be in the non-operated condition, and at the proper time a back signal ground on the RWC lead from the MTT circuit through contacts 5720*k* in the CRB, conductor 5780, and the lower winding of reverting call relay RV (5810) to battery, operates this relay to apprise the CRB of the fact that a reverting call is in progress (see copending application for CRB operation).

E. *Information received by marker code receiver from Sender*

Thereupon, having received the dial start signal of —24 volts on the tip conductor, the sender connects ground to the tip conductor and nothing on the ring conductor as the hundreds digit 4 signal. This ground on the tip conductor T through R3–*g*, the two 13F rectifiers in parallel and the winding of relay R2 to the —24 volt potential connection on the voltage divider, operates relay R2. (On a call to a PBX group hundreds digit 4 would be altered to 9 which would be received by the marker code receiver as +48 volts on the tip conductor T and nothing on the ring conductor R, operating relays R1 and R2 and hundreds register relays H1 and H2.)

Relay R2 at its contacts R2–*e* operates hundreds register relay H2 from battery through the lower winding of relay H2, conductor 2, cable, conductor 2, contacts R2–*e*, conductor 1, cable 2030, conductor 1, RA1–*a*, and contacts *e*, *f* of relay CRG to ground. Relay H2 locks over the circuit from battery through the upper winding of relay H2, contacts H2–*h*, conductor 2053 and contacts *g*, *h* of relay CRG to ground.

When the sender removes ground from the tip conductor T, relay R2 releases and sequence relay RA1 is operated over the circuit from battery through the upper winding of relay RA1, contacts RA2–*c*, conductor 1, cable 2057, conductor 1, contacts H2–*g*, break contacts R5B, R4B, R3A, R2B and R1B in series of the code receiver relays R5–R1, conductor G, cable 2030, conductor G, contacts *e*, *f* of relay CRG, to ground. Relay RA1 locks over the circuit from battery through its lower winding, contacts RA1–*c*, and contacts *e*, *f* of relay CRG, to ground.

The sender then connects ground to the tip conductor T and 48 volt positive potential on the ring conductor R which constitutes the signal for tens digit 6.

Relay R2 operates over the circuit before traced. Relay R5 operates from positive 48 volts on the ring conductor R, the 13F rectifier in the proper direction, and winding of relay R5 to ground through R4–11. Relay R5 operates relay TA over the circuit from battery through the winding of relay TA, T5–36, conductor 2053 and contacts *g*, *h* of relay CRG to ground.

As a result thereof, relay T2 operates over the circuit from battery through the lower winding of relay T2, conductor 2, cable, conductor 2, R2–26, conductor 2, cable 2030, conductor 2, RA2–21, RA1–23, and contacts *e*, *f* of relay CRG to ground. Relay T2 locks over the circuit from battery through the upper winding of relay T2, T2–*d*, conductor 2053, and contacts *g*, *h* of relay CFG to ground.

Relay T5 operates over the circuit from battery over the lower winding of relay T5, conductor 5, cable, con-

ductor 5, R5–*d*, conductor 2, cable 2030, conductor 2, RA2–*a*, RA1–*b*, and contacts *e*, *f* of relay CRG to ground.

When the sender removes the signals from the tip and ring, relays R2 and R5 release and sequence relay RA2 operates from battery through the upper winding of relay RA2, RA3–*j*, conductor 2, cable 2057, conductor 2, T2–*c* and T5–*d* in parallel, break contacts R5B, R4B, R3A, R2B and R1B in series of relays R5–R1, conductor G, cable 2030, conductor G, and contacts *e*, *f* of relay CRG to ground. Relay RA2 locks over the path from battery through the lower winding of relay RA2, RA2–*d*, and contacts *e*, *f* of relay CRG, to ground.

When the sender connects negative 48 volt battery to the tip conductor and positive 48 volt battery to the ring conductor as the signal for units digit 7, relays R3 and R5 operate.

Relay R3 operates over the circuit from —48 volts on the tip conductor T, the 13F rectifier in the proper direction, winding of relay R3, R2–*a*, R1–*a*, to the —24 volt point on the voltage divider.

Relay R5 operates over the circuit from +48 volts on the ring conductor R, the 13F rectifier in the proper direction, winding of relay R5, R4–*a*, to ground.

As a result thereof relay V3 operates over the circuit from battery through the lower winding of relay V3, conductor 3, cable, conductor 3, R3–*b*, conductor 3, cable 2030, conductor 3, RA3–*h*, RA2–*b*, RA1–*b*, and contacts *e*, *f* of relay CRG to ground. Relay U3 locks over the circuit from battery through the upper winding of relay U3, U3–*d*, conductor 2053*a*, and contacts *i*, *j* of relay CRG to ground.

Also relay U5 operates over the circuit from battery, lower winding of relay U5, conductor 5, cable, conductor 5, R5–*c*, conductor 3, cable 2030, conductor 3, RA3–*h*, RA2–*b*, RA1–*b*, and contacts *e*, *f* of relay CRG to ground. Relay U5 locks over the circuit from battery through the upper winding of relay U5, U5–*e*, conductor 2053*a*, and contacts *i*, *j* of relay CRG to ground.

When the sender removes the signaling potentials from the tip and ring conductors T and R, relays R3 and R5 release, operating sequence relay RA3 over the circuit from battery through the winding of relay RA3, conductor 3, cable 2057, conductor 3, U3–*c*, and U5–*d* in parallel, break contacts R5B, R4B, R3A, R2B and R1B in series of relays R5–R1, conductor G, cable 2030, conductor G, and contacts *e*, *f* of relay CRG to ground.

Sequence relay RA3 at its contacts *b* extends a circuit from the line busy lead issuing from the MTT cable, to the sender via the tip conductor T over contacts RA3–*b* and CRG–*a* in preparation for a line busy signal; at its contacts *d* extends a circuit from the congestion busy lead issuing from the MCI cable, to the sender via the ring conductor R over contacts RA3–*d*, and CRG–*b* in preparation for a congestion busy signal; at its contacts *f* and *g* connects ground to leads ACR1 (all codes received lead #1) and ACR2 (all codes received lead #2) to the MTT cable; at its contacts *e* opens the ground circuit through CRG–*c* to the time-out relays TO1 and TO2 which will be described more fully hereinafter; at its contacts *h* opens another point the original operating circuit of relays U3 and U5; at its contacts *j* opens the original operating circuit of relay RA2; and at its contacts *i* extends a circuit from ground through contacts *e*, *f* of relay CRG, RA1–*b*, RA2–*b*, RA3–*i*, conductor 1–MCR, winding of relay 1469, conductor 1469, cable, conductor 1469, T2–*b*, T3–*d*, T1–*b*, TA–*d*, T5–*e*, conductor 56, cable, conductor 56, and winding of relay X3 to battery, operating relays 1469 and Q3.

The following three circuits are then extended in preparation to operate the connect relays of SLA–19, the horizontal select magnet H9 of SLA–19, and the horizontal combination magnet HC of SLA–19: (1) cable MTT, lead 20G, H–*a*, H4–*a*, H1–*e*, H2–*f*, conductor 4, cable, conductor 4, Q3–*f*, SLA–19 conductor, cable, cable to MVO; (2) cable MTT, conductor 3G, contacts *a* of relay 27–89, contacts *d* of relay 1469, conductor HC, cable, cable to MVO; and (3) cable MTT, conductor 9G, U5–*b* U1–*a*, U2–*a*, U3–*b*, conductor 27, cable, conductor 27, contacts *e* of relay 27–LU, conductor H9, cable, cable to MVO. It should be understood that at the appropriate time the MTT circuit places ground on conductors 20G, 3G, and 9G.

It should be appreciated that according to the various configurations of relays operated, various SLA's, various horizontal select magnets, and various horizontal combination magnets are marked for operation by the action of the subscribers line marker code receiver.

Relays TO1 and TO2 have not been discussed thus far. It should be appreciated that these relays are normally operated; relay TO1 over the circuit from ground through the winding of relay TO1, 2000 ohm resistor to ground; and relay TO2 over the circuit from ground through the winding of relay TO2, 2000 ohm resistor to battery.

At open contacts TO1–*a*, and TO2–*a* these relays hold ground off conductor CRF to the MVT circuit.

When relay CRG was operated upon seizure of the marker code receiver, ground through CRG–*c*, RA3–*e*, CA–*a*, winding of relay TO1, to ground short circuited relay TO1 placing it in a condition for slow release (the release period being about 200 milliseconds).

Immediately, however, relay CRG operated relay CA over the circuit from battery through the winding of relay CA, break contacts 21, R5B, R4B, R3A, R2B, R1B in series of relays R5–R1, conductor G, cable 2030, conductor G, contacts *e*, *f* of relay CRG, to ground. Relay CA removes the short circuiting circuit from relay TO1 and connects ground through CRG–*c*, RA3–*c*, CA–*b*, and the winding of relay TO2 to ground, short circuiting relay TO2 (which has a release period of about 200 milliseconds).

The operation of relay CRG placed ground on the voltage divider through contacts CRG–*d*, giving the start signal to the sender which transmitted the first code, operating one or more of the relays R1–R5 which opened the circuit of relay CA which releases, transferring the short circuiting circuit of relays TO1 and TO2 back to TO1.

At the end of the first code, relays R1–R5 are all released and relay CA reoperates.

The same action occurs during the second and third codes from the sender to the marker code receiver.

At the end of receiving the third code, relay RA3 operated, disconnecting the short circuiting ground from relays TO1 and TO2 at RA3–*e*.

As the signals from the sender are on for about 25 milliseconds and off for about 25 milliseconds, relays TO1 and TO2 do not release for the normal passage of a call.

If, however, any action of the system keeps one of the relays TO1 or TO2 shunted for more than 200 milliseconds, as for example, by a stalling of the sender, relay TO1 or TO2 releases. Ground through TO1–*a*, or TO2–*a* on lead CRF to the MVT circuit passes through the MVT circuit and enters the cable to the MCI circuit as conductor 2, emerging from the cable in the MCI circuit and passing through the winding of relay K5 to battery.

Relay K5 in the MCI circuit locks over the circuit from battery through the winding of relay K5, K5–*d*, 1RAND–*g*, and RANA–*d*, to ground. By the operation of K5–*e* +48 volts is placed on the ring conductor back to the sender as a congestion busy signal, which releases all connections, placing the calling line on lockout.

F. *Call for marker (path-finder portion thereof)*

When relay RA3 in the subscriber line marker code receiver operates, all codes have been received and the code receiving relays R1–R5 have released.

At this time the subscriber line marker code receiver signals the pathfinding portion of the marker that a terminating call is ready to be extended.

1. Marker seizure

More specifically, when relay RA3 operates, ground through RA3–25, conductor ACR1, cable to the MTT circuit, conductor ACR1, RBL–*d* (assuming that the marker is not engaged by an originating call), conductor 4, cable to the MCC circuit, conductor 4, 5RAN1A–*k*, conductor 5, cable to the MTT circuit, cables 5 and 6, conductor 5, contacts *c* of relay O1 (assuming that the associated marker is not engaged by an originating call in the first five hundred line group to which we assumed the instant terminating call is directed), branches two ways in parallel, one way comprising conductor 7, cable, cable to MLI circuit, conductor 7, winding of relay 1ABL, to battery, operates relay 1ABL in the MLI circuit. The other branch of the parallel circuit referred to passes through the winding of relay 2ABL in the MTT circuit, to battery, operating relay 2ABL. Relay 1ABL blocks the marker from being seized by an originating call while the path-finding portion thereof is serving a terminating call; closes a point in the extension of the called S-wire into the marker as will be described in greater detail hereinafter; and further extends the holding time of relay K3 in the MCI circuit by connecting an additional condenser circuit thereto so that condenser 30 can create an additional current through relay K3 over the path from battery, through the winding of relay K3, conductor 1, cable to the MLI circuit, conductor 1, contacts *i* of relay 1ABL (MLI circuit), conductor 2, cable to MCI circuit, condenser 30, 200 ohm resistor, to battery.

Relay 2ABL at its contacts *c* locks to ground over the circuit comprising conductor 2, cable to MCI circuit, conductor 2 and RAND–*e* to ground, and energizes 30 milliseconds slow operate relay BT in the MTT circuit over the circuit from battery through the lower winding of relay BT, 2ABL–*b*, 2PBX–*c*, conductor 2, cable to MCI circuit, conductor 2, 2RAND–*e* to ground.

Also when RA3 operates, ground through CRG–24, conductor ACR2, cable to the MTT circuit, conductor ACR2, RBL–*e* (if an originating call has not seized the marker), conductor 1, cable to the MCC circuit, conductor 1, 5RAN1A–*j*, conductor 2, cable to MTT circuit, conductor 2, contacts *b* of relay O1 (if an originating call in the first 500 line group has not seized the associated marker), conductor 1, cable to the MVO circuit, conductor 1, windings of relays 1CN1 and 2CN1 in parallel to battery, operates these relays.

Relay 1CN1 operates relay 3CN1 over an obvious circuit.

Relays 1CN1, 2CN1, and 3CN1 prepare circuits which will be better understood hereinafter.

When relay 2CN1 in the MVO circuit operates, a circuit is completed to operate relay T1 in the ML1A circuit of the companion marker SLM–2 which indicates to the originating end of the companion marker SLM–2 that a terminating call is being made to the first 500 line group by the marker SLM–1. This circuit can be traced from ground through contacts 2ABL–*a* in circuit MTT of SLM–1, conductor 7, cable, cable to the MVO circuit, conductor 7, 2CN1–*d*, conductor 5, cable, cable to MTT circuit, conductor 5, across to conductor 1 in the MTT circuit of the companion marker SLM–2 (shown across a gap on the MTT schematic of SLM–1 by which device, circuitry of SLM–1 may be used in an illustrative way to trace in SLM–2), cable, cable to MLI (and ML1A), cable 1–4 to the ML1A circuit, conductor 1, winding of relay T1, conductor 4, cable, cable to MTT circuit, conductor 4, across to conductor 8 of the MTT circuit of SLM–1, cable, cable to MVO circuit, conductor 8, battery. Relay T1 locks over contacts T1–*b*, conductor 3, cable, cable to MTT circuit, conductor 3, across to ground through 2ABL–*a* in the MTT circuit of SLM–1. At its contacts *a*, relay T1 of SLM–2 holds the circuit of relay 1AN1 of SLM–2 open so that a call from the first 500 line group cannot seize SLM–2 while a call is in progress to the first 500 line group through SLM–1. (A call to the second 500 line group through SLM–1 would operate relay T2 in MLIA instead of T1 and open the circuit of relay 1AN2.)

2. Marker seizure prevented due to an originating call in same line group

The seizure of the path-finding portion of the marker by the code receiver may be defined as the operation of relays 1ABL and 2ABL by relay RA3.

If an originating call is progressing in the same 500 line group (i.e. the first 500 line group in the instant example), this originating call may be in SLM–1 or SLM–2. If it is in SLM–1, relay RBL will be operated, and the circuits of relays 1ABL and 2ABL will be open at RBL–*d*. If the originating call is in SLM–2, SLM–2 has operated relay O1 in the MTT circuit of SLM–1 and the circuits of relays 1ABL and 2ABL are open at contacts *c* of relay O1.

At this point is inserted a résumé of guards between the two 500 line groups and the two markers of a thousand line group.

Referring to FIGURE 14, the upper and lower segments represent the first and second 500 line groups respectively; while the left and right segments represent SLM–1 and SLM–2 respectively. The arrows farthest removed from the center (A, C, E, and G) represent originating connections between the line groups and the markers; while the arrows nearest the center (B, D, F, H) represent terminating connections between the line groups and markers.

Referring now to chart A, in the left column are found connections found as arrows in FIGURE 14; in the second column from the left is found certain relays in the originating end of SLM–1; in the third column from the left, certain relays in the terminating end of SLM–1; in the fourth column from the left certain relays in the originating end of SLM–2; and in the fifth column from the left, certain relays in the terminating end of SLM–2. These relays are guard relays relative to the paths represented in column 1.

CHART A.—GUARDS

Connections A, B, C, D, E, F, G, H	Marker 1		Marker 2	
	Orig. End	Term. End	Orig. End	Term. End
AB	1ABL	RBL		
AC	1AN1		1AN1	
AD	T1			O1.
AE				
AF				
AG	A1N1, 1AN2			
AH	1ABL	RBL		
BC		O1	T1	
BD		1RAN1		1RAN1.
BE				
BF				
BG	1ABL	RBL		
BH		1RAN1, 1RAN2.		
CD			1ABL	RBL.
CE			1AN1, 1AN2.	
CF			1ABL	RBL.
CG				
CH				
DE			1ABL	RBL.
DF				1RAN1, 1RAN2.
DG				
DH				
EF			1ABL	RBL.
EG	1AN2		1AN2	
EH		O2	T2	
FG	T2			O2.
FH		1RAN2		1RAN2.
GH	1ABL	RBL		
ABC	1ABL, 1AN1.	RBL, O1	T1, 1AN1.	
A–H				

Thus on the line of path A no relays are found, indicating that if the system is attempting to set up connec-

tion A, no refereeing is required between simultaneous connections.

However, on the line of paths AB (which means path A and path B), we find relay 1ABL in the originating end of SLM–1 and relay RBL in the terminating end of SLM–1. Thus if an attempt is made to seize the path-finding portion of SLM–1 simultaneously by an originating call and by the code receiver of the marker on a terminating call, the originating call tends to operate relay RBL in the terminating end and the terminating call tends to operate relay 1ABL in the originating end. As the path of relay RBL passes through break contacts of relay 1ABL and as the path of relay 1ABL passes through break contacts of relay RBL, the relay which operates first disables the other. Thus if relay RBL operates, the originating call has succeeded in seizing SLM–1; but if 1ABL operates, the terminating call has succeeded in seizing SLM–1.

On the line of paths AC (which means A and C), we find relay 1AN1 in the originating end of SLM–1 and relay 1AN1 in the originating end of SLM–2. Thus if one or more calls are originated from the first 500 line group simultaneously, the lever of relay AG in the LEO circuit of the first 500 line group oscillates. Which ever relay 1AN1 operates according to one embodiment (illustrated in FIGURES 7 and 8) shunts the other; or according to another embodiment of FIGURES 5 and 6 shunts polarized relay AG, stopping its oscillation.

Similarly, line BD illustrates the principle that when a LET circuit is engaged and calls for a marker, relay 1RAN1 in the terminating end of SLM–1 and 1RAN1 in the terminating end of SLM–2 determine which marker is seized.

It should be understood that a terminating arrangement corresponding to FIGURES 7 and 8 of the originating arrangements could be employed and should be considered a part of this specification.

G. *Selection of SLA*

NOTE.—In the copending application it was assumed arbitrarily that dialing hundreds digit 0, tens digit 0, and units digit 0 into the register resulted in a number group translation giving line group 1, hundreds group 4, tens group 6, units group 7, and party 1; resulting in the selection of line 19 of SLA–1 and the ringing of party 1 on this line.

In the present application it is assumed that dialing hundreds digit 0, tens digit 0, and units digit 0 into the register results in a number group translation giving line group 1, hundreds group 4, tens group 6, units group 7, and party 1; resulting in the selection of line 17 of SLA–19 and the ringing of party 1 on this line.

It should be understood that if desired hundreds group 4, tens group 6, and units group 7 in the marker could be used to reach any line of any SLA in the 500 line group, as for example, line 19 of SLA–1 as assumed in the prior application.

However, the pattern of connections in the marker illustrated exhibit an economical arrangement and are normally to be preferred.

When relays 1CN1, 2CN1, and 3CN1 of the MVO circuit operate, a circuit is completed to operate relays 1A, 2A, and 3A in SLA–19. This circuit may be traced over the path from ground through contacts 2ABL–*f* in the MTT circuit, conductor 20G, cable 9G, 3G, and 20G, cable to MCR circuit, conductor 20G, contacts H5–*a*, H4–*a*, H1–*e*, H2–*f*, conductor 4, cable, conductor 4, contacts Q3–*f*, conductor SLA–19, cable, cable to MVO circuit, cable to contacts of relays 2CN1 and 2CN2, conductor SLA–19, contacts 2CN1–*d*, conductor 19, cable, conductor 19 to SLA–19.

H. *Operation of SLA horizontal—Test of called line*

With relays 1A, 2A, and 3A in SLA–19 operated, circuits are completed to operate horizontal magnets HC and H9 of SLA–19 over the following circuits.

The circuit of horizontal combination magnet H9 may be traced from ground through contacts 3RBA–*g* in MCI, conductor 4, cable to MTT, conductor 41 contacts 2PBX–*g*, contacts 2ABL–*e*, conductor 3G, cable 9G, 3G, and 20G, cable to MCR circuit, conductor 3G, contacts *a* of relay 27–89, contacts *d* of relay 1469, conductor HC, cable, cable to the MVO circuit, cable to contacts of relays 3CN1 and 3CN2, conductor HC, contacts 3CN1–*c*, conductor 12, cable, branching cable to SLA–19 similar to cable 1306 to SLA–1. It should be understood that conductor 12 through which horizontal magnet HC is operated is in branching multiple through the various branching cables to SLA's 1–20, to operate HC in the particular SLA which has its relays 1A, 2A, and 3A operated. Similarly for conductors which operate other horizontal magnets. Similarly for vertical magnet operating circuits. Similarly for test circuits to the various SLA's. Inasmuch as SLA–1 is shown, for purposes of tracing we shall continue tracing the circuit of magnet HC involving conductor 12 through cable 1306 to SLA–1 instead of through a corresponding cable to SLA–19. From cable 1306 conductor 12 emerges as conductor 12*a*, passes through contacts 21 of relay 3A, emerging therefrom as conductor 12, passing through cable 1305, emerging as conductor 12, passing through the winding of relay HC, fuse 3, to battery. Relay HC operates over this circuit.

The circuit of horizontal select magnet H9 may be traced from ground through contacts 3RBA–*g* in MCI, conductor 4, cable MTT, conductor 4, contacts 2PBX–*f* in the MTT circuit, contacts 2ABL–*d*, conductor 9G, cable 9G, 3G, and 20G, cable to MCR circuit, conductor 9G, contacts U5–*b*, U1–*a*, U2–*a*, U3–*b*, conductor 27, cable conductor 27, contacts *e* of relay 27–LU, conductor H9, cable, cable to MVO circuit, cable to contacts of relays 3CN1 and 3CN2, conductor 29 which corresponds to H9, contacts 3CN1–*f*, conductor 9, cable to the multiple where cables branch to the various SLA's, but we shall trace via cable 1306 to SLA–1 for convenience in tracing instead of through the cable to SLA–19 (not shown), conductor 9*a* emerging from cable 1306, contacts 12 of relay 3A, conductor 9, cable 1305, conductor 9, winding of magnet H9, fuse 3, to battery, operating magnet H9.

When relay 2A of SLA–19 operates, a circuit is completed (tracing in SLA–1 for example) from ground through contacts 2A–25, a conductor LHP–19 corresponding to LHP–1, through the winding of relay 1S9A in the LHP circuit, to battery, operating relay 1S9A. Relay 1S9A closes circuit from ground through make contacts *a* of relay 1S9A, windings of relays 1S9 and 2S9 in parallel to battery, operating relays 1S9 and 2S9. Relay 1S9 at its contacts *a* tries to operate relays 1S11 and 2S11 but relay 1S9A has these relays shunted by its contacts *b* and they do not operate. Relay 1S9A at its contacts *c* closes an obvious circuit to operate relays 1S12 and 2S12. Thereby, circuits are extended from horizontal magnets HB and H9 of each SLB circuit to SLM–1. The circuit of horizontal magnet HB of SLB–1, for example, extends from battery in SLB–1, fuse 5, conductor 5002, winding of magnet HB, conductor 12 cable LHP–21, conductor 12, contacts 1S12–*b*, conductor I, cable to the MVO circuit, conductor 1 which is an extension of conductor I to contacts *a* of relay 3FN1 which have not been closed yet. The circuit of horizontal magnet H9 of SLB–1 for example, extends from battery through fuse 5, conductor 5002, winding of magnet H9, conductor 9, cable LHP–21, conductor 9, contacts *c* of relay 1S9, conductor I, cable to the MVO circuit, conductor 1 which is an extension of conductor I, to contacts *a* of relay 3FN1 which have not closed yet.

In the meantime "Busy Test" relay BT in the MTT circuit, which controls the called line S-wire test, is "soaping."

1. Called line idle

If the called line is idle, an approximately 360 ohm battery from the called line circuit will be found on the called S-wire. In the assumed example the called line is line 17 of SLA–19 but, inasmuch as SLA–19 is not shown, we shall trace the S-wire circuit of line 17 of SLA–1 assuming that it is line 17 of SLA–19 and showing where the difference occurs. Accordingly, a circuit will be traced from battery through fuse 4, conductor 1301, through three parallel circuits to the S-wire conductor 1204, the first of these parallel circuits comprising 500 ohm resister LO*b*, and contacts LO17–24, the second of these parallel circuits comprising the 10,000 ohm resistor, and the third of these parallel circuits comprising the 600 ohm lower winding of relay LO17, and the 850 ohm winding of relay CO17, over conductor 1204, contacts H9–11, contacts 12, 14, 16 of horizontal combination magnet HC, conductor 1307, contacts 1A–26, conductor 1308 associated with SLA–1 which we have used for convenience in tracing to the multiple point showing where corresponding leads from the other SLA's of the group of twenty connect in parallel so that we can understand that if relays 1A, 2A, and 3A in SLA–19 instead of SLA–1 are operated, an S-wire circuit the same as we have traced will enter from SLA–19 at this point, the SLA–S conductor, contacts 2CN1–*c*, the SLA–S conductor, to the MLI circuit, contacts 1ABL–*f*, conductor 14, cable to the MTT circuit, conductor 14 which is the S-wire conductor, contacts 1A–*g*, BY2–*e*, Irc–*g* WC–*b*, BT–*b*, RC–*g*, and lower winding of relay 1RC to battery. Relay 1RC does not operate under these circumstances.

When relay BT operates at the end of its 30 millisecond slow to operate period it closes a circuit from ground through contacts IA–*a*, BT–*a*, BY1–*a*, 1RC–*a*, and the upper winding of relay BY2 which is a 25 millisecond slow to operate relay. Also the 360 ohm battery on the S-wire circuit is switched through contacts BT–*c* and the upper 200 ohm winding of line idle relay BY1 to battery, operating this relay.

Relay BY1 locks over the circuit from battery through the lower winding of relay BY1, contacts BY1–*b* which close before contacts BY1–*c*, contacts BT–*f*, conductor 2, cable to MCI circuit, conductor 2, contacts 2RAND–*e*, to ground; and opens the circuit of relay BY2 at contacts BY1–*a*. Also relay BY1 closes the following circuit to operate relay IA: battery winding of relay IA, contacts BY1–*c*, BY2–*g*, BT–*f*, to the ground on conductor 2 which was traced before and which we shall call "master ground." Relay IA operates and further opens the circuit of BY2.

With relays BY1 and IA operated and relay BY2 non-operated, the MTT circuit is marked to indicate that the called line is idle.

2. Called line on lockout

If the called line is on lockout, relay LO17 is operated. Battery through fuse 4 and conductor 1301 reaches the S-wire over two parallel paths, one path comprising the 10,000 ohm resistor, and the other path comprising the 600 ohm lower winding of relay LO17 and the 850 ohm winding of relay CO17 giving approximately 1260 ohms battery (approx. 1200 ohms), on the S-wire. This approximately 1200 ohm battery over the S-wire path to the MTT circuit previously traced passes through the lower winding of relay 1RC to battery shunting relay 1RC which does not operate.

When relay BT operates, this approximately 1200 ohm battery through contacts BT–*c* and the upper winding of relay BY1 to ground does not provide sufficient current to operate relay BY1.

Accordingly with relay BY1 non-operated, relay BY2 becomes operated and relay IA remains non-operated.

With relay BY2 operated and relays BY1 and IA non-operated, the called line is marked in the MTT circuit as being on lockout and the further response of the subscriber's line marker is the same as that to be described following an S-wire test of a non-reverting busy line.

3. Called line busy

However, if the called line is busy, direct ground will be found on the S-wire of the called line. An illustrative path over which this ground reaches the S-wire of the called line will be traced hereinafter and will not be traced at this point in the description. Starting with ground on the S-wire of the called line and following the circuit described previously to the lower winding of relay 1RC and therethrough to battery, it should be understood that relay 1RC operates. Relay 1RC locks over the circuit from battery through its upper winding, contacts 1RC–*h*, RC–*d*, BT–*g*, conductor, 2, cable to MCI circuit, conductor 2, and contacts 2RAND–*e*, to ground. However, a called line may be busy under two circumstances: (1) when it is a different line than the calling line; and (2) when it is the same line as the calling line. Accordingly whenever a busy line is encountered it is necessary to make a reverting call test to distinguish.

1. Reverting call test

Relay 1RC at its contacts *g* directly disconnects its lower winding from the called S-wire and grounds the called S-wire at contacts 1RC–*f*; at its contacts *a* opens the circuit of relay BY2; at its contacts *c* opens a point in the operating circuit of relay WC; at its contacts *c* and *d* opens points in the ground path from the subscribers line marker to the CRB circuit via lead RWC; at its contacts *b* operates relay 2RC in the MPR circuit over the path from ground through contacts *b*, conductor 3, cable to the MPR circuit, conductor 3, contacts 2PS–*f*, winding of relay 2RC to battery, which relay prepares for making the reverting call test by holding the circuit of relay 2PS open at 2RC–*e*, transfers a signaling circuit from MLI at its contacts 2RC–*a* to MTT at its contacts 2RC–*b*, and transfers the 50C5 electronic tube feedback path from MLI at its contacts 2RC–1 to MTT at its contacts 2RC–*d;* and at its contacts 1RC–*f* and *e* closes a circuit to provide a feed-back path for the 50C5 tube of the MPR circuit.

Let us assume first that the called line is the same as the calling line, that is line 17 of SLA–19 (i.e. that a reverting call is in progress). This feedback path by means of which the tube 50C5 oscillates may be traced over the calling connections over the circuit beginning at MPR from ground through the left hand winding of the 9 mh. coil, through the left hand winding of the 3.5 mh. coil, condenser 1, contacts 2RC–*d*, conductor 2, cable to the MTT circuit, conductor 2, contacts 1RC–*e*, RC–*b*, conductor RWC, cable to MCC circuit, conductor RWC, contacts 5RAN1*a*–*f*, conductor RWC, cable 6003 to the LCT circuit, conductor RWC, closed contacts associated with magnet M39, conduction bars in series of the multiple relays, contacts associated with magnet M1, the RWC conductor otherwise labeled 5985 which becomes 5968, contacts 5720–*k*, conductor 5780, .25 mf. condenser, conductor 5996, which becomes 5958 and the S conductor to the GSB crosspoints (see FIGURE 13D), through the GSB switch crosspoints to the GSA switch (see FIGURE 13A), through the GSA crosspoints to the CRA circuit (see FIGURE 13B), S-wire conductor 5004 of detailed schematic FIGURE 24, contacts R2–22, K-wiring, conductor 5003, crosspoint contacts associated with horizontal magnet HA in vertical V2 (for example) of the SLB–1 switch, conducting bar, crosspoint contacts associated with horizontal magnet H1 of vertical V2 of the same switch, conductor S, to the SLA–19 switch, crosspoint contacts associated with horizontal magnet HC in vertical V1 of the 3LA–19 switch, conducting bar, crosspoint contacts associated with hori-

zontal magnet H9 of vertical V1 of the same switch, conductor corresponding to 1204, contacts H9–11, contacts 12, 14, 16 of magnet HC, conductor corersponding to 1307, contacts 1A–26, conductor corresponding to 1308, cable SLA–S, contacts 2CN1–*c*, SLA–S conductor, contacts 1ABL–*f*, conductor 14, cable to the MTT circuit, conductor 14, contacts IA–*g*, BY2–*e*, and IRC–*f*, to ground. It should be observed that ground through impedance coil R3 (FIGURE 23) through contacts R1–13 on conductor 5003, i.e. the S-wire, holds connections but offers such high impedance as to not affect the reverting call test.

As the result of this feedback path the tube oscillates at a frequency of about 12 kilocycles; and oscillating voltage is rectified by the 1N48 rectifier, producing a grid bias that reduces the plate current to three or four milliamperes, so that relay 1PS releases.

The release of relay 1PS connects ground over contacts 1PS–*d* to lead PS of the trouble recorder; transfers its *a*–*b* contacts which has no significance on a terminating call; and completes a circuit from ground through contacts 1PS–*c*, 2RC–*b*, conductor 1, cable to the MTT circuit, conductor 1, and the upper winding of relay RC to battery, operating reverting call relay RC which locks over the circuit from battery through its lower winding, contacts RC–*e*, to "master ground."

(A) *Idle signal to marker and reverting call signal to CRB*

Relay RC at its contacts *f* connects ground to the trouble recorder; completes a circuit from ground through contacts RC–*c*, conductor RWC, cable to the MCC circuit, conductor RWC, contacts 5RAN1*a*–*f*, cable to the LCT circuit, conductor RWC, contacts associated with magnet M39, conducting bars in series, contacts associated with magnet M1, conductor RWC which becomes conductor 5985 which becomes conductor 5968, contacts 5720–*k*, conductor 5780, lower winding of relay RV (5810) to battery, operating relay RV to inform the CRB circuit that the call is of the reverting nature. Also relay RC opens the holding circuit of relay 1RC at its contacts RC–*d* (it should be observed that contacts *e* of relay RC close before contacts *d* of relay RC open as indicated by the legends E and L respectively near the contacts which mean "Early" and "Late"); opens the circuit to the lower winding of relay 1RC at its contacts RC–*g*; and at its contacts RC–*a* prepares to operate relay WC.

When relay 1RC releases, a circuit is completed to operate relay WC over the circuit from ground through contacts RC–*a*, 1RC–*a*, and the winding of relay WC to battery.

When BT operates, or if it has already operated, battery through the 350 ohm resistor, contacts WC–*a*, BT–*c*, and the upper winding of relay BY1 to ground operates relay BY1. Relay BT, at its contacts *d* and *e* removes shunts on its second winding, so that it can subsequently release fast.

Relay BY1 locks over a circuit before described, opens another point in the circuit of relay BY2, and operates relay IA over a circuit previously described.

With relays BY1, IA, WC, and RC in the subscribers line marker operated and relay RV in the CRB circuit operated, circuits are marked for a reverting call as will be described further hereinafter.

It should be observed that in the given example in which the calling line 17 of SLA–1 is extending a connection to line 17 of SLA–19, as relay 1RC operates and a feedback path for the 50C5 tube is attempted, ground through the left winding of the 9 mh. coil (MPR circuit), the left winding of the 3.5 mh. coil, contacts 2RC–*d*, conductor 2, cable to MTT circuit, and the circuit through MCC, LCT, CRB, GSA, GSB, SLB–1, to the S-wire of line 17 are interrupted by open contacts 11 on magnet H9 in the example given wherein the calling line is line 17 of SLA–1 (on a call from line 17 of SLA–1 to line 17 of SLA–19).

However if the calling and called lines were in the same SLA–19 switch, with the calling line, line 17, and the called line, line 19, and magnets H9 and HB operated on the terminating operation, the calling S-wire would pass through closed contacts H9–11 to open contacts 12, 14, 16 of relay HC; the called S-wire would pass through closed contacts H9–11 to open contacts 12, 14, 16 of relay HC; the called S-wire would pass through closed contacts H9–13 and closed contacts 12, 14, 16 of relay HB, and there is no continuous A.C. circuit to ground through contacts RC–*f* in the MTT circuit. If the call line were 17 and the calling line 10, the S-wire circuit of line 17 would be open at open contacts 11 of magnet H9 inasmuch as magnet H2 would be operated on the terminating operation for line 10 instead of magnet H9.

Accordingly on a non-reverting busy line call when relay 1RC operates, no alternating current loop is completed for effecting oscillation of the 50C5 tube, and relay 1PS does not release, and relay RC does not operate, and relay WC does not operate.

When relay BT operates at the end of its 30 millisecond slow operate period, the S-wire ground circuit is transferred from the lower winding of relay 1RC at contacts BT–*b* through the upper winding of relay BY1 to ground at its contacts BT–*c*, shunting relay BY1, which does not operate; the holding circuit of relay 1RC is opened at contacts BT–*g* and relay 1RC releases and the circuit of relay BY2 is completed at contacts BT–*a*.

However in the case of a non-reverting call to a busy line, at the end of its 25 millisecond slow operate period, relay BY2 operates. At its contacts *a* and *b*, relay BY2 opens the shunts across its second winding so that it can subsequently release fast.

With relay BY2 operated and relays IA, BY1, WC, and RC released, the subscribers line marker is marked to indicate that the called line is busy.

The following chart (chart B) summarizes the marking relays in the MTT circuit operated at the end of the busy test for various conditions. It should be understood that relay 1RC operates and releases on each call to a busy line including reverting calls.

CHART B

	IA	BY1	BY2	WC	RC
Idle	X	X			
Lockout			X		
Busy			X		
Reverting	X	X		X	X

I. *Release on called line busy or lockout condition*

When relay BY2 operates as the result of the called line S-wire busy test, whether due to a busy line or a line on lockout, relay BY2 at its contacts BY2–*c* places +48 volts on the tip conductor to the sender, operating relay LBY in the sender as the signal to release the entire connection, placing the calling line on lockout whereby it receives busy tone from the line circuit until hang up.

More specifically, the operating circuit for relay LBY in the sender may be traced over the path from +48 volt battery through contacts BY2–*c*, LBY conductor, cable to MCR circuit, LBY conductor, contacts RA3–*b*, CRG–*a*, conductor T, cable to the MCC circuit, conductor T, contacts 5RAN1A–*i*, cable to the LCT circuit (it should be noted that corresponding conductors from SLM–2 merge with conductors from SLM–1 as indicated by the multiple sign +; for example conductor T from SLM–1 and corresponding conductor T from SLM–

2 merge and pass as a single conductor T through cable 6003, cable 6003, conductor T, contacts associated with magnet M39, conducting bars in series, contacts associated with magnet M1, conductor T which is also designated 5982 to the CRB circuit, contacts 5930–*m*, 5940–*e*, conductor 5956 which is the T conductor to contacts of the GSB switch (see FIGURE 13D), through GSB crosspoints to the GSA switch (see FIGURE 13A), through GSA crosspoints to the CRA circuit (see FIGURE 13B); (see also FIGURES 9, 10 and 11 corresponding to FIGURES 14, 18, 18A and 19 of the copending application; and detailed schematic FIGURE 24), conductor RT through SRL–1 crosspoints associated with horizontal magnet H1, conducting bar, and horizontal magnet HA, conductor ST, through the cable REG–1 to the register, conductor ST through the register–1 circuit to the RSL circuit designated "connect relays" on FIGURE 9 corresponding to FIGURE 14 of the copending application to the sender. Referring now to FIGURE 9, it can be seen that the lead ST from the register passes through the connect relays into the sender circuit. Referring now to FIGURES 10 and 11 corresponding to FIGURES 18, 18A, and 19 of the copending application wherein for purposes of these circuits the guard relays were not shown, we find the ST lead from the SRL crosspoints passing through the register into the sender, through break contacts of relay S, make contacts A4 of relay A, rectifier in the proper direction, winding of line busy relay LBY to ground, operating line busy relay LBY. At its make contacts relay LBY connects ground to release circuitry which places ground on lead RD (FIGURES 10 and 11; which is the same as lead 14951 on FIGURE 9), which passes through contacts of the connect relays represented by a box between the sender and register (see FIGURE 9) and relay RD (see FIGURES 10 and 11) which is the same as relay 1495*j* on FIGURE 9 to battery, operating this relay.

Relay RD opens its contacts 11 (FIGURE 10) which is the same as contacts 1495*k* (FIGURE 9), releasing relays R1 and R2 (FIGURES 9, 23). At its contacts 13 (see detailed schematic FIGURE 35) relay RD releases relay H1 (which is the same as relay 1425 (FIGURE 9)), which removes ground from the H-wire at its contacts 15 releasing vertical magnet V1 of the SRL–1 circuit, releasing the SRL crosspoints. The operation of relay RD also releases the register–1 circuit. It should be observed that relay H1 is a slow release relay and releases the SRL circuit after relays RL and R2 have released.

Inasmuch as the CRB circuit has not yet connected ground to the S-wire to hold connections, the release of relays R1 and R2, remove ground through impedance coil R3 from the S-wire, releasing vertical magnet V1 of SLA–1, V1 of SLB–1, and the line 17 cut off-relay CO17, vertical magnet V1 of the GSA switch, vertical magnet 1499*h* of the GSB switch and make busy relay MB (5920) of the GRB circuit. Thereupon the associated circuits are released. Relay LO17 holds over the circuit from ground, contacts CO–12, calling line loop, contacts CO–15, contacts LO17–23, upper winding of relay LO17, conductor 1203, secondary winding of tone transformer to battery, whereby busy tone from the tone transformer primary is induced into the calling line which is on lockout. It should be appeciated that contacts CO17–12 and CO17–13 close before contacts LO17–23 open whereby lockout relay LO17 can be held over the loop if the loop is established when ground is removed from the S-wire.

When relay MB (5920) of the CRB–1 circuit releases, the circuit of relay C5 (5940) is opened and relay CS releases, in turn opening the loop to the SLM–1 circuit at contacts 5940–*h*, releasing relays RB1 and 1RBA in the MCI circuit. At its contacts *c*, relay 1RBA releases relays RA1 and 1RAA. At its contacts *b*, relay 1RBA releases relay 2RBA. At its contacts *h*, relay 1RBA releases relay 3RBA. At its contacts *a*, relay 3RBA opens the original operating circuit of relay RBB. At its contacts *g*, relay 1RBA releases relay RANB. At its contacts *a*, relay 1RBA releases relays 1C1, 2C1, and RAW in the LET circuit. At its contacts *c* and *f*, relay 1RBA removes holding battery and ground supplies for the relays RB1–RB10 and RA1–RA7. Relay RANB at its contacts *a* releases relay RBB, and at its contacts *b* releases relays 1RANC and 2RANC.

At its contacts *b*, relay 1RANC releases relay 1RAN1; at its contacts *d* holds relay 1ROB in series with 2ROB. At its contacts *a*, relay 2RANC prepares the 20 cycle A.C. circuit. At its contacts *e*, relay 1RANC releases relay RAB.

Relay 1RAN1 releases its shunt circuit on relay RAG at its contacts *c*; at its contacts *d* releases relay 1RAN1A; and at its contacts *e* releases relay RANA.

Relay 1RAN1A at its contacts *a* releases relay 1RAV in the LET circuit; at its contacts *c* and *d* releases relays 2RAN1, 3RAN1, 4RAN1, 5RAN1, and 5RAN1A.

At its contacts *c*, relay RANA releases relays 1RAND and 2RAND. Further releasing takes place in the marker completely releasing the marker but enough has been described it is believed at this point to indicate how release is initiated, more detail of marker release becoming evident in the subsequent description of marker release in connection with release after an established call.

J. *Called line idle*

1. Path-finding from CRB to idle line (by-path)

Relay IA at its contacts *c* operates relay DN1 over the circuit from battery through the winding of relay DN1, contacts IA–*c*, O1–*b*, conductor 2, cable to MCC circuit, conductor 2 , contacts 5RAN1A–*j*, conductor 1, cable to MTT circuit, conductor 1, contacts RBL–*e*, conductor ACR2, cable to MCR circuit, conductor ACR2, contacts RAC–*f* and contacts *e–f* of relay CRG to ground.

At it contacts *b*, relay IA operates relays 1A and 2A in the MVC circuit over the circuit from ground through contacts IA–*b*, conductor 4, cable to the MCI circuit, conductor 4, contacts RA1–*i*, conductor 1, cable to the MVC circuit, conductor 1, windings of relays 1A and 2A in parallel to battery. Relay 1A provides a holding circuit for itself and relay 2A over the path from battery through the windings of these relays in parallel, contacts 1A–*f*, conductor 6405*a*, 6502*a*, and contacts 2RAND–*f* to ground.

Relay 2A operates relays 3A and 4A over the circuit from ground, contacts 2A–*f*, windings of relays 3A and 4A to battery.

It should be appreciated that relays 1A–4A correspond to SLC–1, SLC–3 and SLC–5; relays 1B–4B to SLC–2, SLC–4, and SLC–6; and relays 1C–4C to SLC–7; also that DN1 is associated with the first 500 line group and DN2 with the second 500 line group.

Relay DN1 operates relays 1BN1–1 and 2BN1–1 in the MVC circuit over the path from battery through the windings of these relays in parallel, conductor, 1, cable to the MTT circuit, conductor 1, contacts DN1–*a*, conductor 1, cable to the MC1 circuit, conductor 1, contacts RA1 to ground. Relay 1BN1–1 provides a holding circuit for itself and relay 2BN1–1 over the path from battery through the windings of these relays in parallel, contacts *k* of relay BN1–1, conductor 6405*a*, 6502*a* and contacts 2RAND–*f* to ground. It should be observed that the operation of relay RA1, RA2, or RA7 will operate relays 1BN1–1 and 2BN1–1 which are associated with the first group of SLB's; that the operation of relay RA3 or RA4 will operate relays 1BN1–2 and 2BN1–2 which are associated with the second group of SLB's; and that relay RA5 and RA6 will operate relays 1BN1–3 and 2BN1–3 which are associated with the third group of SLB's. A summary of relationships is shown in chart C.

CHART C

CRB	SLC	SLB	MCI Group Ident. Relays	MVC Relays
1–10	1	1	RA1	1A–4A; 1BN1–1 to 6BN1–1.
11–20	2	1	RA2	1B–4B; 1BN1–1 to 6BN1–1.
21–30	3	2	RA3	1C–4C; 1BN1–2 to 6BN1–2.
31–40	4	2	RA4	1A–4A; 1BN1–2 to 6BN1–2.
41–50	5	3	RA5	1B–4B; 1BN1–3 to 6BN1–3.
51–60	6	3	RA6	1C–4C; 1BN1–3 to 6BN1–3.
61–70	7	1	RA7	1A–4A; 1BN1–1 to 6BN1–1.

Relay LBN1–1 operates relays 3BN1–1, 4BN1–1, 5BN1–1, and 6BN1–1 over the circuits (1) from battery through the windings of relays 3BN1–1 and 4BN1–1 in parallel, conductor 1, cable, conductor 1, and contacts 1BN1–1–*b* to ground; and (2) from battery through the windings of relays 5BN1–1 and 6BN1–1 in parallel, conductor 2, cable conductor 2, contacts 1BN1–1–*c* to ground.

Relay DN1 also operates relays 1FN1 and 2FN1 in the MVO circuit over the path from battery through the windings of these relays in parallel, conductor 2, cable to the MTT circuit, conductor 2, contacts DN1–*d*, IA–*c*, O1–*b*, conductor 2, cable to the MCC circuit, conductor 2, contacts 5RAN1A–*j*, conductor 1, cable to MTT circuit conductor 1, contacts RBL–*e*, conductor ACR2, cable to MCR circuit, conductor ACR2, contacts RA3–*f*, and contacts *e*–*f* of relay CRG to ground. Relay 2FN1 operates relays 3FN1 and 4FN1 over the circuit from ground through contacts 2FN1–*e*, through the windings of relays 3FN1 and 4FN1 in parallel to battery.

Relay 1BN1–1 also operates relay EN1 in the SLC–1 circuit over the path from ground through contacts 1A–6 in the MVC circuit, contacts *d* of relay 1BN1–1, conductor 1, cable to the SLC–1 circuit, conductor 1, winding of relay EN1, conductor 2, cable to the MVC circuit of SLM–1, conductor 2, to battery. (It should be observed that a similar circuit to the corresponding relay EN1 in the second 500 group through contacts 1BN2–1 obtains on a similar call to the second 500 line group).

Also relay 1BN1–1 operates terminating pathfinder ground starting relays DGA and DGB in the MVT circuit over the path from battery through the windings of these relays in parallel, break contacts *f* in series of all terminating pathfinder selection chain relays DG20–DG1, Start conductor to the MVC circuit, contacts *j* of relay 1BN1–1, Start Conductor to the MCI circuit, contacts 1RAND–*g* to ground.

When relays 1FN1 and 2FN1 in the MVO circuit operate, circuits are extended from the off-normal test contacts of the ten vertical magnets V1–V0 of the SLA containing the called line (i.e. SLA–19 in the example given) to the windings of the SLA vertical test magnets 2V1–2V10 in the MVC circuit. Each idle vertical in the calling SLA switch results in a corresponding test relay in the MVC circuit being operated. For example, if vertical V1 of SLA–19 is idle, battery in the SLA–19 circuit through fuse 1, fuse contacts, contacts V1–11, 1A–32, conductor 1303 otherwise labeled conductor 2, cable 1310 to the multiple where corresponding test leads from the other of the twenty SLA's merge in parallel, cable to contacts of relays 1FN1 and 2FN1, conductor 2, contacts 1FN1–*b*, test conductor 1, test cable to the MCT circuit, test cable 1–10. At this point it should be understood that test conductor 1 branches in parallel, one test conductor 1 reaching test magnet 1V1 in the MCT circuit pertinent on originating calls and the other test conductor 1 passing through the SLA–*v* Test cable into the MVC circuit, emerging a conductor 1, to the winding of test magnet 2V1 in the MVC circuit pertinent on terminating calls, which circuit through the winding of magnet 2V1 to ground operates this relay. Although test magnet

1V1 in the MCT circuit also operates, the open contacts of relays 7AN1–10AN2 prevent extension of circuits. (Also, though 2V1 may operate on an originating call, open contacts of relays 2BN1–1 to 6BN2–1 prevent extension of circuits.) With provision of extra relays only the operation of relays 1V1–1V10 on originating calls and the operation of relays 2V1–2V10 on terminating calls could be effected.

Referring now to FIGURE 9 of the copending application, between any CRB as represented by a vertical on an SLC switch and any called line as represented by a horizontal on an SLA switch, there are twenty possible paths.

For example, if we consider CRB–1 as represented by vertical V1 on the SLC–1 switch as the CRB through which the call is progressing and horizontal 1 on SLA-1 as the called line, the first path between these would be traced as follows: horizontal 1 of SLC–1 to vertical V3 of SLB–1, left horizontal 1 of SLB–1 to vertical V1 of SLA–1. It should be understood that a horizontal on one switch is associated with a vertical on another switch, the two constituting a path segment which is tested over the off-normal test contacts of the vertical magnet, not the horizontal. Thus, in the path just described two segments were involved, a first segment comprising horizontal 1 of SLC–1 and vertical V3 of SLB–1, and the other segment comprising left horizontal 1 of SLB–1 and vertical V1 of SLA1. It should be observed that there are twenty first segments and ten second segments; one second segment being common to two first segments. Accordingly a path tests idle only if both of the two verticals, one in each segment, test idle.

CHART D.—CALLED PATHS FROM CRB's 1–10 OF SLC–1 TO HORIZONTALS 1–25 OF SLA–1

Path 1:
1st segment—Horizontal 1 of SLC–1 and V3 of SLB–1
2nd segment—Left horizontal 1 of SLB–1 and V1 of SLA–1

Path 2:
1st segment—Horizontal 2 of SLC–1 and V8 of SLB–1
2nd segment—Right horizontal 1 of SLB–1 and V2 of SLA–1

Path 3:
1st segment—Horizontal 3 of SLC–1 and V3 of SLB–2
2nd segment—Left horizontal 1 of SLB–2 and V3 of SLA–1

Path 4:
1st segment—Horizontal 4 of SLC–1 and V8 of SLB–2
2nd segment—Right horizontal 1 of SLB–2 and V4 of SLA–1

Path 5:
1st segment—Horizontal 5 of SLC–1 and V3 of SLB–3
2nd segment—Left horizontal 1 of SLB–3 and V5 of SLA–1

Path 6:
1st segment—Horizontal 6 of SLC–1 and V8 of SLB–3
2nd segment—Right horizontal 1 of SLB–3 and V6 of SLA–1

Path 7:
1st segment—Horizontal 7 of SLC–1 and V3 of SLB–4
2nd segment—Left horizontal 1 of SLB–4 and V7 of SLA–1

Path 8:
1st segment—Horizontal 8 of SLC–1 and V8 of SLB–4
2nd segment—Right horizontal 1 of SLB–4 and V8 of SLA–1

Path 9:
1st segment—Horizontal 9 of SLC–1 and V3 of SLB–5
2nd segment—Left horizontal 1 of SLB–5 and V9 of SLA–1

Path 10:
1st segment—Horizontal 10 of SLC–1 and V8 of SLB–5
2nd segment—Right horizontal 1 of SLB–5 and V10 of SLA–1

Path 11:
1st segment—Horizontal 11 of SLC–1 and V4 of SLB–1
2nd segment—Left horizontal 1 of SLB–1 and V1 of SLA–1

Path 12:
1st segment—Horizontal 12 of SLC–1 and V9 of SLB–1
2nd segment—Right horizontal 1 of SLB–1 and V2 of SLA–1

Path 13:
1st segment—Horizontal 13 of SLC–1 and V4 of SLB–2
2nd segment—Left horizontal 1 of SLB–2 and V3 of SLA–1

CHART D—Continued

Path 14:
1st segment—Horizontal 14 of SLC–1 and V9 of SLB–2
2nd segment—Right horizontal 1 of SLB–2 and V4 of SLA–1
Path 15:
1st segment—Horizontal 15 of SLC–1 and V4 of SLB–3
2nd segment—Left horizontal 1 of SLB–3 and V5 of SLA–1
Path 16:
1st segment—Horizontal 16 of SLC–1 and V9 of SLB–3
2nd segment—Right horizontal 1 of SLB–3 and V6 of SLA–1
Path 17:
1st segment—Horizontal 17 of SLC–1 and V4 of SLB–4
2nd segment—Left horizontal 1 of SLB–4 and V7 of SLA–1
Path 18:
1st segment—Horizontal 18 of SLC–1 and V9 of SLB–4
2nd segment—Right horizontal 1 of SLB–4 and V8 of SLA–1
Path 19:
1st segment—Horizontal 19 of SLC–1 and V4 of SLB–5
2nd segment—Left horizontal 1 of SLB–5 and V9 of SLA–1
Path 20:
1st segment—Horizontal 20 of SLC–1 and V9 of SLB–5
2nd segment—Right horizontal 1 of SLB–5 and V10 of SLA–1

It should be observed now that these same twenty paths are possible between any CRB (1–10) of SLC–1 and any horizontal (1–25) of SLA–1.

In the assumed example of a terminating call however, we assume that the terminating call is progressing through CRB–1 to line 17 (horizontal 17) of SLA–19. Accordingly, twenty possible paths exist, the first of which may be traced from CRB–1 as represented by the vertical V1 of SLC–1, horizontal 1 of SLC–1, vertical V3 of SLB–1, left horizontal 17 (not shown, but assumed by inference) of SLB–1, to vertical V1 of SLA–19 (not shown, but assumed by inference), to horizontal 17 representing line 17 (not shown, but assumed by inference) of SLA–19.

The twenty possible paths between the ten CRB's of SLC–1 and the twenty-five lines of SLA–19 are given in chart E. It should be appreciated that the first segments of the paths in chart E are the same as those in chart D, but that the second segments, are different.

CHART E.—CALLED PATHS FROM CRB'S 1–10 OF SLC–1 AND HORIZONTALS 1–25 OF SLA–19

Path 1:
1st segment—Horizontal 1 of SLC–1 and V3 of SLB–1
2nd segment—Left horizontal 19 of SLB–1 and V1 of SLA–19
Path 2:
1st segment—Horizontal 2 of SLC–1 and V8 of SLB–1
2nd segment—Right horizontal 19 of SLB–1 and V2 of SLA–19
Path 3:
1st segment—Horizontal 3 of SLC–1 and V3 of SLB–2
2nd segment—Left horizontal 19 of SLB–2 and V3 of SLA–19
Path 4:
1st segment—Horizontal 4 of SLC–1 and V8 of SLB–2
2nd segment—Right horizontal 19 of SLB–2 and V4 of SLA–19
Path 5:
1st segment—Horizontal 5 of SLC–1 and V3 of SLB–3
2nd segment—Left horizontal 19 of SLB–3 and V5 of SLA–19
Path 6:
1st segment—Horizontal 6 of SLC–1 and V8 of SLB–3
2nd segment—Right horizontal 19 of SLB–3 and V6 of SLA–19
Path 7:
1st segment—Horizontal 7 of SLC–1 and V3 of SLB–4
2nd segment—Left horizontal 19 of SLB–4 and V7 of SLA–19
Path 8:
1st segment—Horizontal 8 of SLC–1 and V8 of SLB–4
2nd segment—Right horizontal 19 of SLB–4 and V8 of SLA–19
Path 9:
1st segment—Horizontal 9 of SLC–1 and V3 of SLB–5
2nd segment—Left horizontal 19 of SLB–5 and V9 of SLA–19
Path 10:
1st segment—Horizontal 10 of SLC–1 and V8 of SLB–5
2nd segment—Right horizontal 19 of SLB–5 and V10 of SLA–19

CHART E—Continued

Path 11:
1st segment—Horizontal 11 of SLC–1 and V4 of SLB–1
2nd segment—Left horizontal 19 of SLB–1 and V1 of SLA–19
Path 12:
1st segment—Horizontal 12 of SLC–1 and V9 of SLB–1
2nd segment—Right horizontal 19 of SLB–1 and V2 of SLA–19
Path 13:
1st segment—Horizontal 13 of SLC–1 and V4 of SLB–2
2nd segment—Left horizontal 19 of SLB–2 and V3 of SLA–19
Path 14:
1st segment—Horizontal 14 of SLC–1 and V9 of SLB–2
2nd segment—Right horizontal 19 of SLB–2 and V4 of SLA–19
Path 15:
1st segment—Horizontal 15 of SLC–1 and V4 of SLB–3
2nd segment—Left horizontal 19 of SLB–3 and V5 of SLA–19
Path 16:
1st segment—Horizontal 16 of SLC–1 and V9 of SLB–3
2nd segment—Right horizontal 19 of SLB–3 and V6 of SLA–19
Path 17:
1st segment—Horizontal 17 of SLC–1 and V4 of SLB–4
2nd segment—Left horizontal 19 of SLB–4 and V7 of SLA–19
Path 18:
1st segment—Horizontal 18 of SLC–1 and V9 of SLB–4
2nd segment—Right horizontal 19 of SLB–4 and V8 of SLA–19
Path 19:
1st segment—Horizontal 19 of SLC–1 and V4 of SLB–5
2nd segment—Left horizontal 19 of SLB–5 and V9 of SLA–19
Path 20:
1st segment—Horizontal 20 of SLC–1 and V9 of SLB–5
2nd segment—Right horizontal 19 of SLB–5 and V10 of SLA–19

Furthermore, with reference to FIGURE 9, of the copending application, it should be appreciated that in a 500 line group; in the first column there are 20 SLA's (1–20) although only one SLA–1 is shown; in the second column there are three groups of 5 SLB's in each group although only one group (1–5) is shown; in the third column there are shown 2 equipped SLC's (1 and 2) and one future SLC (7) but there are also two more equipped SLC's (3 and 4) and one future SLC (8) associated with the second group of SLB's (6–10) and two more equipped SLC's (5 and 6) and one future SLC (9) associated with the third group of SLB's (11–15). In the detailed schematics, however, only SLC's 1–7 are shown.

Thus in a given 500 line group, all SLA's have access to all SLB's; the SLB's 1–5 have access to SLC's 1, 2, and 7; the SLB's 6–10 have access to SLC's 3, 4 and 8; and SLB's 11–15 have access to SLC's 5, 6, and 9. With this arrangement all SLA's have access to all SLC's and accordingly each calling line has access to each CRB. It should be understood that the connection of SLC's 2, 3 and 8 to the SLB's 6–10 is the same as the connection of SLC's 1, 2, and 7 to SLB's 1–5; and that the connection of SLC's 5, 6, and 9 to SLB's 11–15 is the same as the connection of SLC's 1, 2, and 7 to SLB's 1–5.

Referring now to the detailed schematics, with relays 1A, 2A, and 3A in SLA–19 operated and relays 1FN1 and 2FN1 in the MVO circuit operated relays 2V1–2V10 in the MVC circuit are operated corresponding to the idle verticals of SLA–19, constituting the "second segment" test of the twenty possible paths between SLC–1 and SLA–19.

The "first segment" test involves verticals V3, V4, V8, and V9 of each of the SLB's 1–5.

Inasmuch as both a first and a second segment of a path must be idle to constitute an idle path, the "first segment" test paths (i.e. the test paths from verticals V3, V4, V8 and V9 of SLB's 1–5 are run through make contacts of relays 2V1–2V10 associated with the "second segment" test paths. Thus, unless a "second segment" is idle, the idle "first segments" are disregarded.

The test path for vertical V3 if it is idle of SLB–1

(see path 1 in chart E) may be traced from battery through fuse 5 and fuse contacts 5, contacts V3–11, conductor 5005 otherwise designated conductor 3, cable to the MVC circuit, conductor 3, contacts 1 of relay 2BN1–1, contacts 2V1–*c*, conductor 1, cable, contacts 1A–*a* (if vertical V1 of SLA–19 is idle), conductor 1, cable to MVT circuit, conductor 1, winding of relay DG1, contacts DGA–*a*, R–*a*, Start conductor to the MVC circuit, contacts *j* of relay 1BN1–1, Start conductor to MCI circuit, contacts LRAND–*g* to ground. It should be noted that if vertical V1 of SLA–19 is idle and vertical V3 of SLB–1 is idle, relay DG1 operates to indicate in the marker that path 1 is idle. It should also be noted that if vertical V3 of SLB–1 is idle but vertical V1 of SLA–19 is busy, relay DG1 will not operate. It should also be noted that if vertical V1 of SLA–19 is idle but vertical V3 of SLB–1 is busy, relay DG1 will not operate. Also that if V1 of SLA–19 and V3 of SLB–1 are both busy, relay DG1 will not operate.

The test path for vertical V4 not shown on detailed schematic (if it is idle) of SLB–1 (see path 11 of chart E) may be traced from battery through fuse 5, fuse contacts, multiple to contacts 11 of vertical magnet V4, conductor 5106*a* otherwise designated 4, cable to the MVC circuit, conductor 4, contacts *k* of relay 2BN1–1, contacts 2V1–*b*, conductor 1, cable, conductor 1, contacts 1A–*b*, conductor 11, cable to MVT circuit, conductor 11, winding of relay DG11, contacts DGB–*a*, R–*a*, to Start lead ground previously traced.

The test path if it is idle for vertical V5 (not shown) of SLB–1 (not on chart E because there is no path from SLC–1 involving vertical V5 of SLB–1, this vertical being pertinent as part of a path from SLC–2 and SLC–7 instead of SLC–1), may be traced, from battery through fuse 5, fuse contacts, multiple to contacts 11 of vertical magnet V5 (not shown), conductor 5106*b* otherwise designated 5, cable to the MVC circuit, conductor 5, contacts *j* of relay 2BN1–1, 2V1–*k*, conductor 1, cable, conductor 1, to contacts of relays 1B and 1C but not 1A inasmuch as V5 of SLB–1 is pertinent to paths from SLC–2 (as represented by relay 1B) and SLC–7 (as represented by relay 1C), but not pertinent to paths from SLC–1 (as represented by relay 1A). Digressing, on a call from SLC–2 or SLC–7, this path would continue over contacts of relay 1B or 1C to conductor 11, cable to MVT circuit, conductor 11, to the winding of relay DG11 and thence to ground previously traced, as part of path 11. However, path 11 from SLC–1, over which DG11 is operated if the path is idle, involved vertical V4 of SLB–1 as previously shown (see FIGURE 9 of the copending application).

Returning, the test path for vertical V8 (not shown) if it is idle, of SLB–1 (see path 2 in chart E) may be traced from battery through fuse 5 and fuse contacts 5, multiple to contacts 11 of vertical magnet V8, conductor 5106–*c* otherwise designated 8, cable to the MVC circuit, conductor 8, contacts *i* of relay 2BN1–1, conductor A to contacts *c* (not shown but implied) of relay 2V2 (not shown but indicated), cable A, conductor 2 (not shown but implied), contacts of relay 1A, conductor 2, cable to MVT circuit, conductor 2, winding of relay DG2, contacts DGA–*b*, R–*a*, to Start wire ground.

The test path for vertical 9 (not shown), if it is idle, of SLB–1 (see path 12 of chart E) may be traced from battery through fuse 5 and fuse contacts 5, multiple to contacts 11 of vertical magnet V9, conductor 5106*d* otherwise designated 9, cable to the MVC circuit, conductor 9, contacts *h* of relay 2BN1–1, conductor B (indicated), contacts *b* (not shown but implied) of relay 2V2 (not shown but indicated), cable B, conductor 12 (not shown but implied), contacts (not shown but indicated) of relay 1A, conductor 12, cable to MVT circuit, winding of relay DG12, contacts DGB–*d*, R–*a*, to Start wire ground.

The test path for vertical V10 not shown (if it is idle) of SLB–1 (not on chart E because there is no path from SLC–1 involving vertical V10 of SLB–1), this vertical being pertinent as part of a path from SLC–2 and SLC–7 instead of SLC–1, may be traced, from battery through fuse 5, fuse contacts, multiple to contacts 11 of vertical magnet V10 (not shown), conductor 5106*e* otherwise designated 0, cable to the MVC circuit, conductor 0, contacts *g* of relay 2BN1–1, conductor *c* to contacts *a* of relay 2V2 (not shown but indicated) conductor 2, cable C, conductor 2 (not shown but implied), to contacts of relays 1B and 1C but not 1A. Digressing, on a call from SLC–2 or SLC–7, this path would continue over contacts of relays 1B or 1C to conductor 12, cable to MVT circuit, conductor 12, to the winding of relay DG12 and thence to ground previously traced as part of path 12. However path 12 from SLC–1, over which DG12 is operated if the path is idle, involved vertical V9 of SLB–1 as previously shown.

Chart F is included to indicate the test paths of SLB verticals on calls from SLC–1.

CHART F.—SLB VERTICAL TEST PATHS ON CALLS FROM SLC-1

Path	SLB	SLB Vertical	Contacts of Relays 2BN1-1 to 6BN2-1	Conductor	Contacts of relays 2V1-2V10	Conductor	Cable	Conductor	Contacts of which relay 1A-2C	Conductor	Winding of which relay DG1-DG20
1	1	V3	*l* of 2BN1-1	A	2V1-*c*	1	A	1	1A	1	DG1
2	1	V8	*i* of 2BN1-1	A	2V2-*c*	2	A	2	1A	2	DG2
3	2	V3	*l* of 3BN1-1	A	2V3-*c*	3	A	3	1A	3	DG3
4	2	V8	*i* of 3BN1-1	A	2V4-*c*	4	A	4	1A	4	DG4
5	3	V3	*l* of 4BN1-1	A	2V5-*c*	5	A	5	1A	5	DG5
6	3	V8	*i* of 4BN1-1	A	2V6-*c*	6	A	6	2A	6	DG6
7	4	V3	*l* of 5BN1-1	A	2V7-*c*	7	A	7	2A	7	DG7
8	4	V8	*i* of 5BN1-1	A	2V8-*c*	8	A	8	2A	8	DG8
9	5	V3	*l* of 6BN1-1	A	2V9-*c*	9	A	9	2A	9	DG9
10	5	V8	*i* of 6BN1-1	A	2V10-*c*	10	A	10	2A	10	DG10
11	1	V4	*k* of 2BN1-1	B	2V1-*b*	1	B	1	1A	11	DG11
12	1	V9	*h* of 2BN1-1	B	2V2-*b*	2	B	2	1A	12	DG12
13	2	V4	*k* of 3BN1-1	B	2V3-*b*	3	B	3	1A	13	DG13
14	2	V9	*h* of 3BN-1	B	2V4-*b*	4	B	4	1A	14	DG14
15	3	V4	*k* of 4BN1-1	B	2V5-*b*	5	B	5	1A	15	DG15
16	3	V9	*h* of 4BN1-1	B	2V6-*b*	6	B	6	2A	16	DG16
17	4	V4	*k* of 5BN1-1	B	2V7-*b*	7	B	7	2A	17	DG17
18	4	V9	*h* of 5BN1-1	B	2V8-*b*	8	B	8	2A	18	DG18
19	5	V4	*k* of 6BN1-1	B	2V9-*b*	9	B	9	2A	19	DG19
20	5	V9	*h* of 6BN1-1	B	2V10-*b*	10	B	10	2A	20	DG20

Following is a chart (chart G) indicating SLB vertical test paths on calls from SLC–2.

CHART G.—SLB VERTICAL TEST PATHS ON CALLS FROM SLC-2

Path	SLB	SLB Vertical	Contacts of Relays 2BN1–1 to 6BN2–1	Conductor	Contacts of relays 2V1–2V10	Conductor	Cable	Conductor	Contacts of which relay 1A–2C	Conductor	Winding of which relay DG1–DG20
1	1	V3	*l* of 2BN1–1	A	2V1–*c*	1	A	1	1B	1	DG1
2	1	V8	*i* of 2BN1–1	A	2V2–*c*	2	A	2	1B	2	DG2
3	2	V3	*l* of 3BN1–1	A	2V3–*c*	3	A	3	1B	3	DG3
4	2	V8	*i* of 3BN1–1	A	2V4–*c*	4	A	4	1B	4	DG4
5	3	V3	*l* of 4BN1–1	A	2V5–*c*	5	A	5	1B	5	DG5
6	3	V8	*l* of 4BN1–1	A	2V6–*c*	6	A	6	2B	6	DG6
7	4	V3	*l* of 5BN1–1	A	2V7–*c*	7	A	7	2B	7	DG7
8	4	V8	*l* of 5BN1–1	A	2V8–*c*	8	A	8	2B	8	DG8
9	5	V3	*l* of 6BN1–1	A	2V9–*c*	9	A	9	2B	9	DG9
10	5	V8	*i* of 6BN1–1	A	2V10–*c*	10	A	10	2B	10	DG10
11	1	V5	*j* of 2BN1–1	C	2V1–*a*	1	C	1	1B	11	DG11
12	1	V10	*g* of 2BN1–1	C	2V2–*a*	2	C	2	1B	12	DG12
13	2	V5	*j* of 3BN1–1	C	2V3–*a*	3	C	3	1B	13	DG13
14	2	V10	*g* of 3BN1–1	C	2V4–*a*	4	C	4	1B	14	DG14
15	3	V5	*j* of 4BN1–1	C	2V5–*a*	5	C	5	1B	15	DG15
16	3	V10	*g* of 4BN1–1	C	2V6–*a*	6	C	6	2B	16	DG16
17	4	V5	*j* of 5BN1–1	C	2V7–*a*	7	C	7	2B	17	DG17
18	4	V10	*g* of 5BN1–1	C	2V8–*a*	8	C	8	2B	18	DG18
19	5	V5	*j* of 6BN1–1	C	2V9–*a*	9	C	9	2B	19	DG19
20	5	V10	*g* of 6BN1–1	C	2V10–*a*	10	C	10	2B	20	DG20

Following is a chart (chart H) indicating SLB vertical test paths on calls from SLC–7 (i.e. the third in the group).

CHART H.—SLB VERTICAL TEST PATHS ON CALLS FROM SLC-7

Path	SLB	SLB Vertical	Contacts of Relays 2BN1–1 to 6BN2–1	Conductor	Contacts of relays 2V1–2V10	Conductor	Cable	Conductor	Contacts of which relay 1A–2C	Conductor
1	1	V4	*k* of 2BN1–1	B	2V1–*b*	1	B	1	1C	1
2	1	V9	*h* of 2BN1–1	B	2V2–*b*	2	B	2	1C	2
3	2	V4	*k* of 3BN1–1	B	2V3–*b*	3	B	3	1C	3
4	2	V9	*h* of 3BN1–1	B	2V4–*b*	4	B	4	1C	4
5	3	V4	*k* of 4BN1–1	B	2V5–*b*	5	B	5	1C	5
6	3	V9	*h* of 4BN1–1	B	2V6–*b*	6	B	6	2C	6
7	4	V4	*k* of 5BN1–1	B	2V7–*b*	7	B	7	2C	7
8	4	V9	*h* of 5BN1–1	B	2V8–*b*	8	B	8	2C	8
9	5	V4	*k* of 6BN1–1	B	2V9–*b*	9	B	9	2C	9
10	5	V9	*h* of 6BN1–1	B	2V10–*b*	10	B	10	2C	10
11	1	V5	*j* of 2BN1–1	C	2V1–*a*	1	C	1	1C	11
12	1	V10	*g* of 2BN1–1	C	2V2–*a*	2	C	2	1C	12
13	2	V5	*j* of 3BN1–1	C	2V3–*a*	3	C	3	1C	13
14	2	V10	*g* of 3BN1–1	C	2V4–*a*	4	C	4	1C	14
15	3	V5	*j* of 4BN1–1	C	2V5–*a*	5	C	5	1C	15
16	3	V10	*g* of 4BN1–1	C	2V6–*a*	6	C	6	2C	16
17	4	V5	*j* of 5BN1–1	C	2V7–*a*	7	C	7	2C	17
18	4	V10	*g* of 5BN1–1	C	2V8–*a*	8	C	8	2C	18
19	5	V5	*j* of 6BN1–1	C	2V9–*a*	9	C	9	2C	19
20	5	V10	*g* of 6BN1–1	C	2V01–*a*	10	C	10	2C	20

Of course, if the call was from a CRB in the groups 21–30 or 31–40 served by SLC–3 and SL–4 respectively of the first 500 line group relays **1BN1–2** to **6BN1–2** would be operated and corresponding SLB vertical test circuits from SLB's **6–10** would pass through contacts of SLA vertical test relays **2V1–2V10**. For simplicity the contacts of relays **2BN1–2** to **6BN1–2** have been shown in block form above the relays and connections have been indicated to the SLB's, the relays **2V1–2V10**, and to the other circuitry for the first 500 line group. For the second 500 line group relays **1BN2–2** to **6BN2–2** are involved.

Similarly, if the call was from a CRB in the groups 41–50 and 51–60 served by SLC–5 and SLC–6 in the first 500 line group respectively, relays **2BN1–3** to **6BN1–3** would be operated and corresponding SLB vertical test circuits from SLB's **6–10** would pass through contacts of SLA vertical test relays **2V1–2V10**. For simplicity the contacts of relays **2BN1–3** to **96BN1–3** have been shown in block form above the relays and connections have been indicated to the SLB's, the relays **2V1–2V10** and to other circuitry. For the second 500 line group relays **2BN2–3—6BN2–3** would be involved.

It should be appreciated that if the call is terminating in the second 500 line group, relays **1FN2** and **2FN2** extend corresponding SLA vertical test circuits to relays **2V1–2V10**.

It should be appreciated also that if the call is terminating in the second 500 line group, relays **1BN2–1** to **6BN2–1** operate to extend corresponding SLB circuit for the SLB's in the first group of SLB's; relays **1BN2–2** to **6BN2–2** to extend corresponding SLB circuits for the SLB's in the second group of SLB's and relays **1BN2–3** to **6BN2–3** to extend corresponding SLB circuits for the SLB's in the third group of SLB's.

Accordingly a relay of the group **DG1–DG20** is operated for each idle path. If all paths are idle, all twenty of these relays may operate. Only one can lock, however. The order of preference in locking is determined by the associated preference chain of contacts *b* and *c* of these relays.

Referring now to the jump rotator comprising relays ASG1 to ASG20 shown in the MVO circuit, if relay ASG1 is operated and locked, and all twenty relays DGL–DG20 operate, a preference arrangement is provided as follows. Ground on the Start lead of the MVT circuit, through contacts R–*a*, conductor **51**, cable **31–51**, cable to the MVO circuit, cable **31–51**, conductor **51**, contacts *c* of the manual key, contacts ASG1–C, conductor **32**, cable **31–51**, cable to the MVT circuit, conductor **32**, contacts DG2–*b*, to the winding of relay **DG2**, gives relay DG2

priority over all the other relays of the chain DG1–DG20 and the other relays of this chain will release when the original operating ground circuit is opened. However, if relay ASG20 is operated instead of ASG1 locking ground will obtain on conductor 31 instead of 32 and relay DG1 will have preference over the other relays of the chain DG1–DG20 and when the original operating ground circuit is opened, the other relays of the chain will release and the first path will be chosen. If no relay of the jump rotator is operated, ground on conductor 51 through contacts *c* of the manual key, and break contacts *d* in series of relays ASG1 to ASG20 through a strap to conductor 31 will obtain on conductor 31 and will give relay DG1 first reference in locking. Of course if relay DG13 for example should be the only relay operated it could lock to the ground on conductor 31 over break contacts of other relays of the chain DG1–DG20, etc. We shall assume that this first path is the one chosen.

When any relay in the chain DG1–DG20 operates it opens the circuit of relays DGA and DGB which release, removing the original operating ground from relays DG1–DG20. Thereupon the preference locking takes place.

With relay DGA released and only one relay on the chain DG1–DG20 operated, assume DG1 for example, a path is completed to operate relay DGC over the circuit from battery through the winding of relay DGC, break contacts DGA–*e*, break contacts *d* in series of relays DG20 to DG–2, make contacts DG1–*e*, to ground on the Start conductor.

Relay DGC at its contacts *j* provides a locking battery for any operated relay or relays, of the group DG1–DG20. For example, relay DG1 locks from battery through the contacts DGC–*j*, contacts DG1–*a*, winding of relay DG1 to ground previously traced.

Relay DGC at its contacts *f* closes a circuit to step the jump rotator ASG1–ASG20. For example with relay DG1 operated, ground through contacts DGC–*b*, DG1–*g*, conductor 11, cable 11–30, cable to the MVO circuit, cable 11–30, conductor 11, lower winding of relay ASG1, to battery operates this relay, if it is not already operated. Relay ASG1 releases relay ASG20 (assuming that it was the one operated), by opening its holding circuit at ASG1–*f* and locks over the circuit from ground through contacts ASG1–*g*, upper winding of relay ASG1, break contacts *e* of relays ASG2–ASG20, resistor to battery. The operation of relay ASG1 changes the locking reference of originating pathfinder chain relays AG1–AG20 at its *a–b* contacts, and changes the locking preference of the terminating pathfinder chain relays DGL–DG2 at its *c–d* contacts. It should be observed that ground is placed on conductor 32 which holds relay DG1 before ground is removed from conductor 31; also that the circuit to conductor 2 through ASG1–*a* is closed before the circuit to conductor 1 through ASG20–*a* is opened. The circuit over which DG1 holds may be traced from ground on conductor 32, break contacts *c* of relays DG2–DG20, back around through contacts DG1–*b* to the winding of relay DG1.

Relay DGC at its contacts *i* opens the circuit of relay DGD. It should be observed that relay DGC at its contacts *c, d,* and *e,* prepares certain circuits which relay DGD holds open at its contacts *b, c,* and *d* until it releases.

(1) No idle path

(A) Congestion busy signal to sender

Relay DGC at its contacts DGC–*a* opens the following circuit which was closed when ground appeared on the Start conductor: ground on the Start Conductor, contacts DGC–*a*, R–*b*, lower winding of relay CB, to battery. Fifty millisecond slow operate relay CB operates if no path is found as evidenced by the nonoperation of relay DGC and connects ground over contacts CB–*a* to conductor 2 which passes through a cable to the MVT circuit, emerging on cable 2, and passing through the winding of relay K5 to battery, operating relay K5, which places ground on congestion busy lead to the sender which releases connections, placing the calling line on lockout, whereby the calling line receives busy tone. Relay CB opens its contacts *b* to allow itself to release fast when its circuit is opened. With relay DGC operated, the circuit of relay CB is opened and a congestion busy signal is prevented.

Relay DGC closes other circuits the significance of which becomes clearer hereinafter.

(2) Idle path

Path I involving called SLA–19 comprises horizontal 19 of SLB–1 (determined by horizontal magnets H9 and HB of SLB–1) and horizontal 1 of SLC–1 (determined by horizontal magnets H1 and HA of SLC–1). It should be recalled that the horizontal magnets H9 and HC of SLA–19 were operated to test the S-wire of line 17 and have remained operated. Also it should be appreciated that horizontal magnets of a switch are operated before vertical magnets.

(A) *Horizontal closure—SLB, SLC*

Accordingly, relay DGC at this time operates horizontal magnets H9 and HB of SLB–1 and H1 and HA of SLC–1.

The operating circuit of magnet H9 of SLB–1 may be traced from battery in SLB–1, fuse 5, conductor 5002, winding of magnet H9, conductor 9, cable LHP–21, contacts *c* of relay 1S9, conductor I, cable to the MVO circuit, conductor 1 which is an extension of conductor I, contacts 3FN1–*a*, conductor 11, cable 11–20, cable to the MCT circuit, cable 11–25, the individual conductors of which branch in parallel to contacts of relays 1RS1–1RS3 for originating calls and to contacts of relays 1BN1–1 to 1BN2–3 in the MVC circuit for terminating calls. Conductor 11 emerges from cable 11–15, passes through contacts *h* of relay 1BN1–1 into conductor 1, cable 1–5 to the MVT circuit, conductor 1, contacts 1 of relay DG1, DGC–*n*, conductor 7, cable 6–7, cable to the MCI circuit, cable 6–7 conductor 7, and contacts *c* of relay 3RBA to ground.

The operating circuit of relay HB in SLB–1 may be traced from battery through fuse 5, conductor 5002, winding of relay HB, conductor 12, cable LHP–21, conductor 12, contacts 1S12–*b*, conductor I to ground selectively placed on conductor I over the circuit just traced.

The following charts show ground paths for SLB horizontals operation as controlled by the subscribers line marker.

CHART I WITH RELAY 1BN1–1 OPERATED, INDICATING SLB's 1–5

Path	Contacts	Conductors Issuing from DG–relay contacts	Conductors Issuing from 1BN1–1 relay contacts	Conductors to LHP circuit	Horizontal Pull Ground For—
1	DG1–*l*	1	11	I	SLB–1
2	DG2–*l*	1	11	I	SLB–1
3	DG3–*l*	2	12	II	SLB–2
4	DG4–*l*	2	12	II	SLB–2
5	DG5–*l*	3	13	III	SLB–3
6	DG6–*l*	3	13	III	SLB–3
7	DG7–*l*	4	14	IV	SLB–4
8	DG8–*l*	4	14	IV	SLB–4
9	DG9–*l*	5	15	V	SLB–5
10	DG10–*l*	5	15	V	SLB–5
11	DG11–*l*	1	11	I	SLB–1
12	DG12–*l*	1	11	I	SLB–1
13	DG13–*l*	2	12	II	SLB–2
14	DG14–*l*	2	12	II	SLB–2
15	DG15–*l*	3	13	III	SLB–3
16	DG16–*l*	3	13	III	SLB–3
17	DG17–*l*	4	14	IV	SLB–4
18	DG18–*l*	4	14	IV	SLB–4
19	DG19–*l*	5	15	V	SLB–5
20	DG20–*l*	5	15	V	SLB–5

CHART J WITH RELAY 1BN1–2 OPERATED, INDICATING SLB's 6–10

Path	Contacts	Conductors Issuing from DG-relay contacts	Conductors Issuing from 1BN1-2 relay contacts	Conductors to LHP circuit	Horizontal Pull Ground For—
1	DG1-*l*	1	16	VI	SLB-6
2	DG2-*l*	1	16	VI	SLB-6
3	DG3-*l*	2	17	VII	SLB-7
4	DG4-*l*	2	17	VII	SLB-7
5	DG5-*l*	3	18	VIII	SLB-8
6	DG6-*l*	3	18	VIII	SLB-8
7	DG7-*l*	4	19	IX	SLB-9
8	DG8-*l*	4	19	IX	SLB-9
9	DG9-*l*	5	20	X	SLB-10
10	DG10-*l*	5	20	X	SLB-10
11	DG11-*l*	1	16	VI	SLB-6
12	DG12-*l*	1	16	VI	SLB-6
13	DG13-*l*	2	17	VII	SLB-7
14	DG14-*l*	2	17	VII	SLB-7
15	DG15-*l*	3	18	VIII	SLB-8
16	DG16-*l*	3	18	VIII	SLB-8
17	DG17-*l*	4	19	IX	SLB-9
18	DG18-*l*	4	19	IX	SLB-9
19	DG19-*l*	5	20	X	SLB-10
20	DG20-*l*	5	20	X	SLB-10

CHART K WITH RELAY 1BN1–3 OPERATED, INDICATING SLB's 11–15

Path	Contacts	Conductors Issuing from DG-relay contacts	Conductors Issuing from 1BN1-3 relay contacts	Conductors to LHP circuit	Horizontal Pull Ground For—
1	DG1-*l*	1	21	XI	SLB-11
2	DG2-*l*	1	21	XI	SLB-11
3	DG3-*l*	2	22	XII	SLB-12
4	DG4-*l*	2	22	XII	SLB-12
5	DG5-*l*	3	23	XIII	SLB-13
6	DG6-*l*	3	23	XIII	SLB-13
7	DG7-*l*	4	24	XIV	SLB-14
8	DG8-*l*	4	24	XIV	SLB-14
9	DG9-*l*	5	25	XV	SLB-15
10	DG10-*l*	5	25	XV	SLB-15
11	DG11-*l*	1	21	XI	SLB-11
12	DG12-*l*	1	21	XI	SLB-11
13	DG13-*l*	2	22	XII	SLB-12
14	DG14-*l*	2	22	XII	SLB-12
15	DG15-*l*	3	23	XIII	SLB-13
16	DG16-*l*	3	23	XIII	SLB-13
17	DG17-*l*	4	24	XIV	SLB-14
18	DG18-*l*	4	24	XIV	SLB-14
19	DG19-*l*	5	25	XV	SLB-15
20	DG20-*l*	5	25	XV	SLB-15

Reviewing, with relay **1BN1–1** operated, indicating the first group of SLB's, relay **DG1** at its contacts **1** completes a circuit for horizontal pull ground to conductor I of the LHP circuit for SLB–**1**. With relays **1S9, 2S9,** and 1S9A operated by SLA–**19**, the ground on conductor I is directed to the windings of horizontal magnets **H9** and HB of SLB–**1** operating the same whereby leads from SLA–**19** are directed into SLB–**1** when subsequently an SLB–**1** vertical is operated.

Relay **DG1** in operating also completes a circuit to energize horizontal magnets **H1** and HA of SLC–**1**.

The circuit of magnet **H1** of SLC–**1** may be traced from battery through the winding of magnet **H1**, conductor **1**, cable **5501**, conductor **1**, contacts of relay **EN1**, conductor **1**, cable **5502** to the point where similar conductors **1** from all SLC's in both 500 line groups merge into a single conductor **1** in the cable, cable, conductor **1**, contacts DG1–*j*, DGC–*g*, conductor **6**, cable **6–7**, cable to the MCI circuit, cable **6–7**, conductor **6**, contacts *b* of relay **3RBA**, to ground.

The circuit of magnet HA of SLC–**1** may be traced from battery through the winding of relay HA, conductor **11**, cable, cable **5501**, conductor **11**, contacts of relay **EN1**, conductor **11**, cable **5502** to the point where similar conductors **11** from all SLC's in both 500 line groups merge into a single conductor **11** in the cable, cable **5502**, conductor **11**, contacts DG1–*k*, DGC–*g*, conductor **6**, cable **6–7**, cable to MCI circuit, cable **6–7**, conductor **6**, contacts **3RBA**–*b*, to ground.

Chart L indicates the contacts on the relays **DG1–DG20** which operate horizontal magnets **H1–H10** and HA–HB in all SLC's.

CHART L

Path	Contacts	Select Conductor	Combination Conductor	H1-H10	HA-HB
1	DG1-*j*	1		H1	
	DG1-*k*		11		HA
2	DG2-*j*	2		H2	
	DG2-*k*		11		HA
3	DG3-*j*	3		H3	
	DG3-*k*		11		HA
4	DG4-*j*	4		H4	
	DG4-*k*		11		HA
5	DG5-*j*	5		H5	
	DG5-*k*		11		HA
6	DG6-*j*	6		H6	
	DG6-*k*		11		HA
7	DG7-*j*	7		H7	
	DG7-*k*		11		HA
8	DG8-*j*	8		H8	
	DG8-*k*		11		HA
9	DG9-*j*	9		H9	
	DG9-*k*		11		HA
10	DG10-*j*	10		H10	
	DG10-*k*		11		HA
11	DG11-*j*	1		H1	
	DG11-*k*		12		HB
12	DG12-*j*	2		H2	
	DG12-*k*		12		HB
13	DG13-*j*	3		H3	
	DG13-*k*		12		HB
14	DG14-*j*	4		H4	
	DG14-*k*		12		HB
15	DG15-*j*	5		H5	
	DG15-*k*		12		HB
16	DG16-*j*	6		H6	
	DG16-*k*		12		HB
17	DG17-*j*	7		H7	
	DG17-*k*		12		HB
18	DG18-*j*	8		H8	
	DG18-*k*		12		HB
19	DG19-*j*	9		H9	
	DG19-*k*		12		HB
20	DG20-*j*	10		H10	
	DG20-*k*		12		HB

It should be further observed that although subscribers line marker #**1** places ground on the said conductors leading to contacts of relays **EN1** in all the SLC's of both 500 line groups, these ground circuits can only operate the relays **H1–H10** and HA–HB in the SLC which has its relay **EN1** operated (in the case of subscribers line marker #**2**, the **EN2** relay).

It should also be observed that guards are provided so that both markers do not complete calls in the same 500 group simultaneously and accordingly relay **EN1** and **EN2** in any given SLC are never operated simultaneously.

It should also be observed for example that relay **EN1** in SLC–**1** of the first 500 line group is operated through contacts *d* of relay **1BN1–1** and that relay **EN1** in SLC–**1** of the second 500 line group is operated through contacts *d* of relay **1BN2–1** and that only the one of these relays is operated as determined by which relay **1RAN1** or **1RAN2** is operated.

Accordingly, only one relay **EN1** or **EN2** of all such relays in a 500 line group can operate at once. Accordingly, the horizontal pulling leads can only effect the operation of the horizontal SLC magnets in the SLC determined by the operated relay **EN1** or **EN2** (in the present example **EN1** of SLC–**1**), although corresponding pulling leads are multipled.

As an indication to the MVT circuit that the SLB horizontals have operated, ground through contacts **H9–12, HB–12**, through conductor MVO to the MVO circuit where corresponding conductors from all SLB's in the first 500 line group merge metallically, contacts **4FN1**–*c*, conductor to the MLI circuit, contacts **1ABL**–*h*, conductor to the MVT circuit, through the winding of relay **HF3** to battery, operates relay **HF3**. It should be appreciated that this metallic multiple is possible because only one terminating connection in a 500 line group is set up at

a time and horizontal magnets on established connections are released, the crosspoints being held operated by the vertical magnets.

Also, as an indication to the MVT circuit that the SLC horizontals have operated, ground through make contacts of magnet H1 of SLC–1 circuit, make contacts of magnet HA, conductor 5505 to the MCC circuit, contacts 5RAN1A–*a*, conductor to the MVT circuit, through the winding of relay HF–4 to battery operates this relay. It should be observed that reporting leads such as 5505 of all SLC's in the same 500 line group are metallically tied together and metallically branch to SLM–1 and SLM–2.

Presently, slow release relay DGD, the circuit of which was opened by relay DGC, releases. If test relay HF3 is operated (indicating that the SLB horizontal magnets have both operated) and test relay HF4 is non-operated (indicating that the SLC horizontals have not both operated), a circuit is completed to operate relay K5 in the MCI circuit, whereby a congestion busy signal is transmitted to the sender and all connections are released, placing the calling line on lockout, and thus giving it busy tone.

The operating circuit of relay K5 may be traced from battery through the winding of relay K5, conductor 2, cable the MCT circuit, conductor 2, break contacts *a*, *c*, and *e* of relay HF4, make contacts *a*, *c*, *e* of relay HF3, break contacts *b*, *c*, and *d* of relay DGD, make contacts *c*, *d*, and *e* of relay DGC, conductors 4, 5, and 3 respectively, cable 3, 4, 5, cable to the MCI circuit, cable 3–5, conductors 4, 5, and 3 respectively, contacts *e*, *f*, and *d* respectively of relay 3RBA, to ground.

If, however relay HF3 is non-operated, relay R operates over the path from battery through the winding of relay R, break contacts *b*, *d*, and *f* of relay HF3, break contacts *b*, *c*, and *d* of relay DGD, make contacts *c*, *d*, and *e* of relay DGC to ground previously traced. Relay R locks to relay DGC over the path from battery through the winding of relay R, contacts R–*c*, contacts DGC–*f* to ground. Relay R at its contacts R–*b* further opens the energizing circuit of relay CB and at its contacts R–*a* opens the holding ground circuit for the relays DG1–DG20 and particularly for the operated relay DG1 in the assumed example, releasing relay DG1. The release of relay DG1 effects the release of relay DGC and the SLC horizontal magnets, and re-establishes the circuits of relays DGA and DGB. The release of relay DGC releases 30 millisecond slow release relay R, which re-establishes locking ground for the relay group DG1–DG20. As the jump rotator has shifted the locking ground entrance point to the chain DG1–DG20, when relays DGA and DGB reoperate, relays of the group DG1–DG20 operate according to the idle paths and one locks. Relay DGC reoperates and circuits are completed to the SLB and SLC horizontals. This process is repeated until relay HF3 operates or time-out occurs by the release of relays K3 and K4 in the MCI circuit.

(B) *Vertical closure—SLA, SLB, SLC*

With relays HF3 and HF4 both operated, indicating that both horizontal magnets in the selected SLB circuit and both horizontal magnets in the SLC circuit involved have operated, circuits are completed to operate the vertical magnet V1 associated with the calling CRB (i.e. CRB–1), and the vertical magnets associated with selected path 1 between SLC–1 and SLA–19 (i.e. vertical magnet V3 of SLB–1 and vertical magnet V1 of SLA–19). These circuits may be traced as follows.

Vertical magnet V1 of SLA–19 operates over the path from battery in SLA–19 (tracing in SLA–1 shown for convenience), fuse 1, 200 ohm winding of vertical magnet V1, contacts 1A–12, conductor in SLA–19 corresponding to 1304*a*, conductor in SLA–19 corresponding to 1, cable from SLA–19 corresponding to 1310, to the multiple point where corresponding conductors from SLA's 1–20 individually merge in parallel metallically and extend to contacts of relays 1FN1 and 2FN1, conductor 1, contacts 1FN1–*a*, conductor 1. Pull cable to the MVT circuit, conductor 1, contacts DG1–*h*, HF4–*d*, HF3–*c*, DGD–*c*, DGC–*d*, conductor 5, cable 3, 4, 5, cable to the MCI circuit, cable 3–5, conductor 5, and contacts *f* of relay 3RBA to ground. Vertical magnet V1 locks over the circuit from battery through fuse 1, 2000 ohm winding of magnet V1, contacts V1–14, to ground on the H-wire.

It should be observed that a metallic multiple of the vertical V1 pull lead exists to all SLA's in a 500 line group and to each marker, SLM–1 and SLM–2.

Vertical magnet V3 of SLB–1 operates over the path from battery in SLB–1, fuse 5, the 200 ohm winding of magnet V3, conductor 5106 also designated conductor 3, cable to the MVC circuit, conductor 3, contacts *f* of relay 2BN1–1, conductor A, contacts 3A–*a*, conductor 1, cable to MVT circuit, conductor 1, contacts DG1–*i*, HF–*b*, HF3–*a*, DGD–*b*, DGC–*c*, conductor 4, cable 3, 4, 5, cable to MCI circuit, cable 3–5, conductor 4, contacts 3RDA–*e* to ground. Vertical magnet V3 of SLB–1 locks over the circuit from battery through fuse 5, 2000 ohm winding of magnet V3, contacts V–14, to ground on the H-wire.

The pattern of contacts on relays 3A–4C corresponds to that on relays 1A–2C. Whereas a particular contact on relays 1A–2C provides an operating path for a particular relay DG1–DG20 as determined by an SLB horizontal magnet test circuit, the corresponding contact on relays 3A–4C provides an operating path for the tested SLB vertical magnet.

Vertical magnet V1 of SLC–1 operates over the path from battery from the associated CRB circuit over lead "—" through the 200 ohm winding of magnet V1, conductor VP to the associated CRB circuit, through the CRB circuit as conductor 5969 and then 5984, becoming conductor VP to the LCT circuit, contacts associated with magnet M1 of multiple relay M1–M10, VP conducting bars in series of multiple relays M1–M10, M11–M20, M21–M30, and M31–M40, contacts associated with magnet M39 of multiple relay M31–M40, conductor VP, cable 6003 to the MCC circuit (it should be observed that the conductors of this cable are multiplied to SLM–2 but that guards referred to hereinbefore prevent SLM–1 and SLM–2 from both completing calls in the same 500 line group simultaneously), conductor VP, contacts 5RAN1A–6, conductor VP, cable to the MTT circuit, conductor VP, contacts IA–*e*, conductor to the MVT circuit, contacts HF4–*f*, HF3–*e*, DGD–*d*, DGC–3, conductor 3, cable 3–4–5–, cable to the MCI circuit, cable 3–5, conductor 3, contacts *d* of relay 3RBA to ground. Magnet V1 of SLC–1 locks over the circuit from battery in the associated CRB–1 circuit, conductor "—," 2000 ohm winding of magnet V1, to ground on the H-wire. It should be observed that vertical 1 of SLB is connected with CRB–1, that CRB–1 was identified in the marker and the marker operated magnets M1 and M39 in the LCT circuit and relay 5RAN1A to extend circuits from CRB–1 into the marker. Accordingly, the path to vertical magnet V1 of SLC–1 associated with CRB–1 is through CRB–1.

C. *Release*

When vertical magnet V1 in SLA–19 operates it opens its contacts V1–11, releasing relay 2V1 in the MVC circuit.

When vertical magnet V3 in SLB–1 operates it opens its contacts V3–11, which open the original energizing battery circuit of relay DG1 which does not immediately release but holds to battery through DGC–*j*.

When vertical magnet V1 in SLC–1 operates, ground through contacts 5506 of vertical magnet V1 over the VO conductor 5790 which becomes 5970, through the

winding of vertical operated (VO) relay **5930** in the CRB circuit, to battery operates this relay.

Relay VO (**5930**) in the CRB circuit closes a circuit from ground through contacts **5920***b*, conductor **5993**, contacts **5820**–*c*, conductor **5991**, contacts **5930**–*j*, **5910**–*a*, to conductor **5998** which is the incoming S-conductor, through GSB switch S-wire crosspoints, through GSA switch S-wire crosspoints, to the S-wire of figure which is conductor **5004**. This ground through contacts **R1–11**, K-wiring (or the CBT circuit equivalent) on conductor **5003**, through HA crosspoints of vertical **V1** of SLB–**1**, S-wire conducting bar, **H1** crosspoints of vertical **V1**, S-wire to the SLA–**1** circuit, HA crosspoints of vertical **V1** of SLA–**1**, S-wire conducting bar, **H9** crosspoints, to the S-wire of calling line **17** of SLA–**1** through the 600 ohm winding of relay **LO17** and the winding of relay **CO17**, conductor **1301**, fuse **4**, to battery, holds relays **LO17** and **C917** operated. Also this ground holds verticals of SLA, SLB, GSA, and GSB. At its contacts *r*, relay **5930** opens the CRB loop circuit to the marker, releasing relays **RB1** and **1RBA** in the MCI circuit.

Relay **RB1** at its contacts **RB1**–*e*, releases magnet **M1** in the LCT circuit; at its contacts **RB1**–*f* releases magnet **M39** in the LCT circuit; and at its contacts *h* opens the original operating circuit of "jump rotator" relay **1ROA2** which is locked over its second winding.

Relay **1RBA** at its contacts *b* releases relay **2RBA**; at its contacts *h* releases relay **3RBA**; at its contacts *c* and *f* releases relays **RA1** and **1RAA**; at its contacts *g* releases relay **RANB**; at its contacts *a* releases relay **RAW** in the LET circuit.

When relay **3RBA** releases the original energizing circuits of the horizontal magnets in SLB–**1** and SLC–**1** are opened and these magnets release; also the original 200 ohm winding energizing circuits for the vertical magnets in these circuits and in SLA–**1** are opened but the selected vertical magnets hold over their 2000 ohm winding to the H-wire ground. The release of the SLB–**1** horizontal magnets release relay **HF3** and the release of the SLC–**1** horizontal magnets release relay **HF4**.

Relay **RA1** at its contacts *g* releases relay **S1** in the MCC circuit.

Relay **RA1** at its contacts *j* opens the original operating circuit of "jump rotator" relay **1ROA1** which remains locked over its second winding.

Relay **RANB** at its contacts *a* releases relay **RBB**; at its contacts *b* releases relays **1RANC** and **2RANC**; and at its contacts *c* and *d* removes the ground and battery supply for relays **RA1–RA7**, **RB1–RB10** and relay **1RBA**.

Relay **1RANC** at its contacts *b* releases relay **1RAN1**; at its contacts *d* which close before contacts *c* open, operates relay **1ROB** over its lower winding in series with relay **2ROB**; at its contacts *e* releases relay **RAB**; at its contacts *f* closes a circuit from ground through contacts **2RAND**–*d*, **1RANC**–*f*, conductor **3**, cable to the MTT circuit, cable **3** through a lamp to battery on the SLM Fuse Panel MFA and through contacts **2PBX**–*e* to the Terminating Call Meter indicated.

Relay **2RANC** at its contacts *e* reestablishes an obvious circuit to hold relay **K3**.

Relay **2RANC** at its contacts *b* releases relay **CRG** in the MCR circuit; relay **CRG** at its contacts *e*, *f* releasing relay **RAL**, **RA2**, **RA3**, **Q3**, **1469**, **DN1**, **1CN1** and **2CN1** which releases relay **3CN1**, **1FN1** and **2FN1** which releases relays **3FN1** and **4FN1**; relay **CRG** at its contacts **15**, **16** releasing relays **H2** (which releases relays **1A**, **2A**, and **3A** in SLA–**19** which release relays **1S9**, **2S9**, and **1S9A**), **T2**, and **T5**; relays **CRG** at its contacts **12**, **13** releasing relays **U3** and **U5**. With relays **1CN1–3CN1** and relays **1A**, **2A** and **3A** in SLA–**19** released, horizontal magnets **H9** and **HC** of SLA–**19** are released and the vertical test paths from SLA–**19** to relays **2V1–2V10** are opened releasing any such relays which might be operated.

Relay **1RAN1** in releasing, at its contacts *d* releases relay **1RAN1A**; at its contacts *e* releases relay **RANA**; and at its contacts *c* removes the shunt from relay **RAG** in the LET circuit.

Relay **1RAN1A** at its contacts *a* releases relay **1RAV** in the LET circuit; at its contacts *c* releases relays **2RAN1** and **3RAN1**; and at its contacts *d* releases relay **4RAN1**, **5RAN1**, and **5RAN1A**.

Relay **RANA** at its contacts *c* releases relays **1RAND** and **2RAND**.

Relay **2RAND** at its contacts *e* removes ground from conductor **2** which is the "master ground" for the MTT circuit. As a result thereof, any relays so held in the MTT circuit release, including relays **2ABL**, **BT**, **IA**, and **BY1**. The circuit of relay **1ABL** in the MLI circuit passes through contacts *c* of relay **2ABL** to the "master ground" circuit and accordingly, relay **1ABL** releases.

Relay **2RAND** at its contacts *f* releases relays **1BN1–1**, **2BN1–1**, **3BN1–1**, **4BN1–1**, **5BN1–1**, **6BN1–1**, **1A** and **2A**. Relay **2A** releases relays **3A** and **4A**. With relays **1BN1–1** and **1A** released, the circuit of relay **EN1** in the SLC circuit is opened and this relay releases.

Relay **1RAND** at its contacts *g* releases relays **DG1** and **DGC**.

Relay **2ABL** at its contacts *a* releases the locking circuit of relay **T1** in the companion marker.

As before mentioned, when the marker removes its ground circuit from the called S-wire, the shunt is removed from relay **RS** (**5700**) in the CRB circuit and this relay operates, initiating the ringing of the called party.

When the called party answers, the ring trip relay **RT** (**5710**) in the CRB circuit operates, and a conversation path can then be traced between the calling line and the called line.

K. *Reverting call*

The procedure in making a reverting call is the same as that in making a regular local "calling to called party" call to the point of busy testing the called line. It should be recalled that when all codes were received in the marker, relay **RA3** operated, completing a circuit to energize busy test relay **BT** which is slow operating.

As a result of the busy test of the called line S-wire, the called line is found busy from ground placed on the originating S-wire from the SRB circuit on the calling S-wire which is also the called S-wire, operating relay **1RC** in the MTT circuit.

However, to determine that the called line is the same as the calling line, a feedback path for the electronic tube of the MPR circuit is set up which comprises calling and called S-wires in series. If the calling and called S-wires are the same the feedback path is completed and the tube oscillates, as a result of which relay **1PS** in the MRT circuit releases, in turn operating relay **RC** in the MTT circuit.

Relay **RC** operates relay **RV** in the CRB circuit over conductor **RWC** and releases relay **1RC** which operates relay **WC**.

When relay **BT** (which has been soaking) operates, or if it has already operated, relay **BY1** operates, in turn operating relay **IA**.

With relays **BY1**, **IA**, **WC**, and **RC** operated in the marker and relay **RV** operated in the CRB circuit, circuits are marked for a reverting call, disregarding the busy condition of the called line. Relay **RV** in the CRB circuit opens the ring-back tone path at its contacts *d*; and completes a path from ground through the Recorded Message or Tone Transmitter, conductor **RCM**, cable, conductor **RCM**, contacts **5710**–*c*, conductor **5709**, contacts **5810**–*e*, tone winding of relay **5840**, conductor **5711** which is the DTG conductor, cable, conductor DTG, to ground, whereby a recorded message or tone is induced into the called line, advising the calling party that he is making a reverting call and that he should hang up his receiver so that the called party will be rung. Relay

RV (5810) holds relay MB (5920) over the circuit from battery through the lower winding of relay 5920, conductor 5977, contacts 5810–*b*, conductor 5978, and contacts 5920–*e* to ground. Relay MB (5920) provides ground through contacts 5920–*g* to the terminating H conductor from the CRB to hold the called switches.

Also, the marker disregarding the busy condition of the called line, operates the SLB and SLC horizontal magnets, and then the SLA, SLB, and SLC vertical magnets, which hold to the H-wire ground provided by relay MB in the CRB circuit.

Referring now to FIGURE 18 corresponding to FIGURE 12 of the copending application, the connection may comprise the path from line 17 of SLA–19 represented by horizontal 17, vertical V2 of SLA–19 and associated right horizontal 1 of SLB–1, vertical V6 of SLB–1 through the associated CRA circuit (see other drawings), through the GSA–1 switch the GSB–1 switch, CRB–1, vertical V1 of SLC–1, vertical V3 of SLB–1, left horizontal 1 of SLB–1 and associated vertical V1 of SLA–19 to horizontal 17 of SLA–19 to line 17.

Accordingly the marker relay DG1 would have been operated, and the corresponding horizontal and vertical magnets operated for path 1 relative to SLC–1. Of course, other paths might have been chosen from SLC–1; and if a different CRB were employed a different originating path and a different terminating path chosen.

When vertical V1 of SLC–1 operates, a circuit is completed which operates relay VO in the CRB–1 circuit; relay VO connects the two windings of relay A (5840) to the incoming ring and conductors, such that the negative battery winding is connected to the ring conductor R and operates relay D in the sender (see FIGURE 11); and such that the positive battery winding is connected to the ring conductor; operating relay A. Relay A operates relay H (5910); and ground is placed on the incoming sleeve conductor S, holding the calling connections; similar to a regular call. The operation of relay D, through certain contacts in the translator, causes first the release of the two relays in the CRA, and subsequently the release of the originating register, the sender, and the SRL switch.

When the calling party hangs up, the calling line loop is opened, releasing relay A (5840) in the CRB circuit. Relay A at its contacts 5830 (*a*) opens the circuit of slow release relay H (5910) which releases after an interval. The release of relay H (5910) at its contacts 5910*a* removes ground from the S-wire incoming to CRB which releases the incoming connections, involving vertical V2 of SLA–19, vertical V6 of SLB–1, particular vertical involved of the GSA switch; the particular vertical involved of the GSB switch; and relays LO17 and CO17 of SLA–19. The release of relay H (5910) at its contacts *b* opens the circuit of call signal relay CS (5940) which is a slow release relay and releases after an interval.

Upon the release of relay CS (5940), ground through contacts 5920–*e*, 5940–*h*, 5930–*p*, conductor 5976, contacts 5720–*e*, upper winding of relay 5700, contacts 5720–*c*, and the called S-wire through the closed SLC–1, SLB–1 and SLA–1 crosspoints, through the winding of cut-off relay CO17, the lower 600 ohm winding of lockout relay LO17, fuse 4 to battery, reoperates these relays in series with relay RS which operates; and this ground re-busies the called line.

At the proper time in the ringing cycle, relay RP operates which causes ringing of the called telephone.

When the called party answers, ring trip relay RT operates, in turn operating relay B which operates relay H.

When ring trip relay RT operates, relay RV holds tor about five seconds by means of its upper winding over the circuit from battery over the upper winding of relay RV, contacts RV–*c*, conductor 5792, contacts RS–*f*, resistor and condenser in series to battery.

During the interval between the operation of relay RT and the release of relay RV, the called party receives a recorded message or tone advising him that he has answered a reverting call and that he should keep his receiver removed until the calling party again removes his receiver.

The path for this message may be traced from ground through the Recorded Message or Tone Transmitter for the Called Party, conductor RCT, cable, conductor RCT, contacts 5710–*d*, conductor 5709, contacts 5810–*e*, tone winding of relay 5840, conductor 5711 otherwise labeled DTG, cable, conductor DTG, to ground. Thereby the message or tone is induced into the called loop.

When the calling party again removes his receiver, a conversation path obtains between calling and called substations, both of which use relay B as battery feed.

The tip conductor can be traced from line 17 of SLA–19, H9 crosspoints of SLA–19 vertical V1 (indicated), tip conducting bar, HC crosspoints of SLA–19 vertical V2, H9 crosspoints of SLB–1 vertical V3 (indicated), tip conducting bar, HB crosspoints of SLB–1 vertical V3, H1 crosspoints of vertical V1 of SLC–1, tip conducting bar, HA crosspoints of vertical V1 of SLC–1, tip conductor T which becomes conductor 5789 to CRB–1, contacts RS–*b*, RT–*k*, conductor 599*e*, contacts LC–*b*, lower winding of relay (5840) to ground.

The ring conductor can be traced over a corresponding path, through contacts RS–*c*, RT–*g*, conductor 5995, contacts LC–*e*, through the middle winding of relay B (5840) to battery.

When both parties replace their receivers, relay B releases, in turn releasing slow release relay H, which releases relay MB, which removes holding ground for any operated relays in the CRB except relay VO, and removes ground from the terminating S-wire at contacts MB–*e* and the terminating H-wire at contacts MB–*g*.

Removal of ground from the S-wire releases relays CO17 and LO17 of line 17 in SLA–19. Removal of ground from the H-wire releases vertical magnet V1 of SLA–1, V3 of SLB–1, and V1 of SLC–1.

Release of vertical magnet V1 of SLC–1 releases relay VO in the CRB circuit.

The release of relay VO reestablishes the circuit from battery through contacts VO–*q*, MB–*a*, 1600 ohm resistor, to incoming lead TB whereby CRB–1 tests idle to another call from the group selector.

Marker release in the case of a reverting call is initiated, as it is on a regular call by the operation of relay VO in the CRB (as a result of vertical magnet V1 closing its contacts 5506), which at its contacts VO–*r* opens the calling loop from CRB–1 to SLM–1, releasing relays RB1 and 1RBA in SLM–1.

L. Call to PBX group

In order to illustrate a call to a PBX group, let us assume that the calling party on line 17 of SLA–1 lifts his receiver and dials ME7–2000, which we shall assume is the directory number of a PBX group instead of line 17 of SLA–19 as assumed hereinbefore.

We shall assume that the action of the telephone system in selecting a register and connecting the calling line to the selected register, in registering the dialed digits, in engaging a sender and a number group circuit, and in the action of the register, sender, and number group circuits is the same as that described hereinbefore up to the point of number group translation.

Referring now to FIGURE 10 corresponding to FIGURE 18 of the copending application, the five terminals reached from the Individualizing Circuit as a result of the registration of the digits "0," "0" and "0" in the directory number registers H, T, and U respectively of the number group circuit are cross-connected as shown for a regular subscriber destination with the exception that individual terminal P is cross-connected to terminal 15 leading to Terminal Information Register PBX instead of to terminal 1 of the group of terminals 1–14 leading to the party register P.

As has been explained, this results in a signal to sender register P that a call to a PBX group is in progress. Sender register P over conductor **2010** signals the register "H & PBX" to raise the value of the hundreds digit by 5. Sender register P adjusts its contact fans in preparation for the sender to transmit a party 1 signal.

Accordingly, whereas the sender registers were conditioned for a call to a regular subscriber with a line group registration of 1 in the "Line Group" register, a hundreds registration of 4 in the register "H & PBX," a tens registration of 6 in the register "T," a units registration of 7 in the register "U," and a party registration of 1 in the register "P"; in accordance with the changed number group strapping the registrations are the same in all these registers except in register "H & PBX" in which the registration is 9 instead of 5.

It should be understood that if the party strapping had been for party 14, for example, instead of for party 1 on the regular call, the register "P" in the number group would have registered therein party 14 and would have transmitted this party 14 registration to register "P" in the sender; but if the party strapping is connected to terminal **15** leading to register "PBX" in the number group, this register transmits the PBX signal to register "P" in the sender and register P always under "PBX" circumstances adjusts its contact fans in preparation for the sender to transmit the same party signal such as for example the party 1 signal.

We shall assume that the sender transmits two signals to the code receiver marker of the group selecter as already described to cause the operation of GSA and GSB crossbar switches to extend connections to the first 500 line group, and that the connections are extended into CRB–**1**.

We shall also assume that the sender transmits two signals to the CRB–**1** circuit as already described, the first signal indicating a normal or regular call as the source of origin, and the second signal indicating party **1** as to the ringing signal to be transmitted by the CRB to the called line at the appropriate time.

We shall also assume that the CRB–**1** circuit seizes SLM–**1** and extends connections into the SLM–**1** marker code receiver and that the sender transmits hundreds digit 9, tens digit 6, and units digit 7 to the marker code receiver.

To represent hundreds digit 9, the sender places +48 volts on the Tip conductor. Referring to the MCR circuit, +48 volts on the tip conductor T from the sender, through contacts CRG–**22**, RA**3**–**31**, conductor T, cable, conductor T, contacts R**3**–**11**, branches in parallel through the windings of relay R**1** and R**2** via rectifiers in the conducting direction. Through relay R**1** this path is completed to ground, operating relay R**1**. Through relay R**2** this circuit passes through contacts R**1**–**11** to the 24 volt point on the voltage divider comprising the circuit from battery through the 200 ohm resistor, another 200 ohm resistor, and contacts CRG–**33** to ground, operating relay R**2**.

Thereupon relay H**1** operates over the circuit from battery through the lower 800 ohm winding of relay H**1**, conductor **1**, cable, conductor **1**, contacts R**1**–**28**, conductor **1**, cable, conductor **1**, contacts RA**1**–**21**, and contacts **35**, **36** of relay CRG to ground. Relay H**1** locks over the circuit from battery through the upper 2000 ohm winding, contacts H**1**–**32**, and contacts **15**, **61** of relay CRG to ground. Ground through contacts H**4**–**11**, H**1**–**25**, conductor PBX to the MTT circuit through the winding of relay **2**PBX to battery operates this relay, which locks to "master ground" through contacts **2**PBX–*a*, extending the following circiut to operate relay **1**PBX in the MLI circuit: battery through the winding of relay **1**PBX, conductor **3**, cable to the MCI circuit, conductor **3**, contacts RANB–*f*, conductor **1**, cable to the MTT circuit, conductor **1** contacts RBL–*c*, **2**PBX–*a* to "Master ground." At its contacts *i*, relay **1**PBX connects battery through a 200 ohm resistor, condenser C**3** (which has been charged to ground through contacts **1**PBX–*j*) to conductor **2**, in the cable to MCI. At its contacts a relay **1**PBX prepares to operate a circuit, relays **1**PN**1** and **2**PN**1**, effective when subsequently relay **1**CN**1** operates. Other functioning of the relay **1**PBX will be described hereinafter. At its contacts *c*, relay **2**PBX disconnects the normal circuit to relay BT and at its contacts *b* prepares a circuit to operate relay BT from battery through the lower winding of relay BT, **2**ABL–*b*, conductor **9**, cable to the MLI circuit, conductor **9**, contacts BB–*j*, conductor **8**, cable to MTT circuit, contacts **2**PBX–*b*, to master ground, which circuit is effective to energize the lower winding of relay BT when relays **2**ABL and BB are both operated. At its contacts *d*, relay **2**PBX prepares a circuit to the PBX terminating call meter. At its contacts *f* and *g*, relay **2**PBX opens the ground supply circuits for leads **9**G and **3**G.

Relay H**2** operates and locks over circuits previously traced.

Contacts R**1**–**11** and R**2**–**11** then open and relay R**2** releases but relay R**1** remains operated until the sender removes the +48 volt signal from the tip conductor T. Relay RA**1** operates and locks.

It should be understood that code receiver relays R**1**–R**5** operate through contacts of each other to avoid detaining the relays in their release when the sender removes the signals, due to circulating current.

To represent the tens digit 6, the sender places ground on conductor T and +48 volts on conductor R operating relays R**2** and R**5**, in turn effecting the operation of relays T**2** and T**5** which lock as before described. Relay TA operates over the circuit from battery through the winding of relay TA, contacts T**5**–**36** to the holding ground of relays T**2** and T**5**. The sender removes the signals and the code receiver relays release. Relay RA**2** operates and locks.

To represent the units digit 7, the sender places −48 volts on conductor T and +48 volts on conductor R resulting in relays R**3** and R**5** operating in turn operating relays U**3** and U**5** which lock. The sender removes the signals and the code receiver relays release. Relay RA**3** operates.

Relay RA**3** connects ground to conductors ACR**1** which operates relays **1**ABL and **2**ABL; and to conductor ACR**2** which operates relays **1**CN**1** and **2**CN**1**. Relay **1**CN**1** at its contacts *c* operates relays **3**CN**1** over in obvious circuit; and its contacts *d* operates relays **1**PN**1** and **2**PN**1** over the path from battery through the windings of these relays in parallel, conductor **1**, cable to the MVO circuit, contacts **1**CN**1**–*d*, conductor to the MLI circuit, and contacts **1**PBX–*a* to ground. Relay **2**PN**1** operates relays **3**PN**1**, **4**PN**1**, **5**PN**1** and **6**PN**1** from battery through the windings of these relays in parallel through contacts **2**PN**1**–*d* to ground.

With the operation of relay **1**ABL, the circuit of timing relay K**3** is connected from battery through the winding of relay K**3**, conductor **1**, cable to MLI, contacts **1**ABL–*i*, in parallel over two circuits one of which passes through contacts **1**PBX–*j* and condenser C**3** and a 200 ohm resistor to battery and the other of which passes as conductor **2** into cable to the MCI circuit, conductor **2**, through condenser **30** and 200 ohm resistor to battery thus increasing the holding time of relay K**3**, one timing period having been initiated when relay **2**RANC operated.

With the operation of relays **2**ABL and **4**PN**1**, ground through contacts **2**ABL–*g*, conductor **20**G, cable **9**G, **3**G, and **20**G, cable to the MCR circuit, conductor **20**G, contacts H**5**–**11**, H**4**–**13**, H**1**–**23**, conductor **9**, cable, conductor **9**, contacts of relay Q**3** associated with PBX–**19** group, conductor PBX–**19**, cable, cable to the MLM circuit, conductor PBX–**19**, contacts **4**PN**1**–*e*, conductor **19**, cable to the LPX circuit, conductor **19**, terminal **19**, cross-

connect to terminal 19, through relay P19, to battery, operates this relay.

Relay P19 controls the PBX group comprising line 24 in SLA–11, line 24 in SLA–12, line 24 in SLA–13, line 24, in SLA–14 and line 24 in SLA–15.

We shall assume that all of these lines are idle. Accordingly, when relay P19 operates, circuits are completed to operate relays A11, A12, A13, A14 and A15 in SLM–1. More specifically, the circuit of relay A11 extends from battery through contacts 1PBX–*d* (in the MLI circuit), contacts BB–*h*, contacts 3AA–*a*, winding of relay A11, conductor 11 into the PBX cable 1–25, cable to the MLM circuit, conductor 11, contacts 2PNL–*a*, conductor 31, cable to the LPX circuit, cable 21–40, conductor 31, break contacts of relay 11TR (which break contacts are associated with line 24 of SLA–11; as SLA–11 is not shown we shall trace the similar conductor for line 24 of SLA–1 shown), conductor 1313*a*, break contacts 24 of relay LO24, conductor 1311, fuse contacts associated with fuse 4, fuse contacts associated with fuse 3, to ground.

The circuit of relay A12 extends from battery through contacts 1PBX–*d*, BB–*h*, 3AA–*b*, winding of relay A12 (not shown), conductor 12 into the PBX cable 1–25, cable to the MLM circuit, conductor 12, contacts *d* of relay 2PN1, conductor 32, cable to the LPX circuit, cable 21–40, conductor 32, break contacts of relay 12TR (which break contacts are associated with line 24 of SLA–12; and as SLA–11 is not shown this circuit may be traced similarly via conductor 1313*a* of SLA–1 to ground as traced above).

Similar circuits may be traced for relays A13, A14 and A15.

When relays A11–A15 close their contacts *b* and *c* other circuits are established. Relay A11 establishes a locking circuit for itself independent of the subsequent operation of relay 11TR from ground through contacts 1PBX–*c*, BB–*c*, A11–*b*, winding of relay A11, contacts 3AA–*a*, BB–*h*, and 1PBX–*d*, to ground. Relay A11 operates relays 1AA, 2AA, and 3AA over the path from battery through contacts 1PBX–*d*, BB–*h*, 3AA–*a*, contacts A11–*c*, break contacts *d* of relays A10–A1, conductor 50, contacts 1PBX–*f*, windings of relays 1AA, 2AA and 3AA in parallel to ground. Relays A13 establishes a similar locking circuit for itself but does not close a similar circuit for relays 1AA, 2AA, and 3AA as can be appreciated by tracing the circuit from battery, contacts 1PBX–*d*, BB–*h*, 3AA–*b*, and A13–*c* to open contacts A11–*d*. Similarly for relays A13, A14, and A15.

When relays 1AA, 2AA, and 3AA operate, relay 1AA at its contacts *b* which close before other contacts shown above relay 1AA, 2AA and 3AA open, establishes a locking circuit for relays 1AA, 2AA, and 3AA over the path from ground through the windings of these relays in parallel, contacts 1AA–*b*, BB–*h*, and 1PBX–*d* to battery. When these other contacts shown above relays 1AA, 2AA and 3AA open, the original battery circuits to relays A11–A15 are disconnected, and relays A12–A15 release (if they had been operated). Relay A11 however, being the lowest numbered of the relays A11–A15 locks over the path from ground, contacts 1PBX–*c*, A11–*b*, A11–*c*, break contacts *d* of relays A10–A1, conductor 50, contacts 1PBX–*f*, 1AA–*b*, BB–*h*, and 1PBX–*d*, to battery. After relays 1BA and BB have subsequently operated, this path extends from ground through contacts 1PBX–*c*, 1BA–*f*, BB–*b*, etc., BB–*g*, 1BA–*j*, and 1PBX–*d* to battery in preparation for release.

If relays A12–A15 had operated as a result of lines 24 in SLA's 12–15 being idle, relays A12–A15 would operate but only relay A12 would remain locked, having opened the locking circuits of relay A13–A15 at contacts A12–*d*. This provides an automatic step-up rotation for PBX lines of a group. Thus for PBX group 19 the lines will be taken for use by the automatic switchboard in the order line 24 of SLA–11, line 24 of SLA–12, line 24 of SLA–13, line 24 of SLA–14, and line 24 of SLA–15. (Hereinafter when larger PBX groups up to a maximum of 100 PBX lines to a group are described, it should be appreciated that the locking circuits of relays A1–A20 through their *c* and *d* contacts to lead 50 are such that relay A1 opens the locking circuits of relays A2–A20, relay A2 opens the locking circuits of relays A3–A20, etc. given a decreasing priority from A1 to A20.)

It should be appreciated also that at contacts 1PBX–*e*, the circuit from battery through contacts 1AA–*b* is disconnected from lead 54 to the jump rotator 10A2–40A2 and consequently is withheld from leads 50–53 over the path through the jump rotator; but that through contacts 1PBX–*f* the circuit from battery through contacts 1AA–*b* is connected to lead 50 which gives priority in locking in the order A1–A20.

It should also be observed that break contacts *k* of relay 1PBX prevent relays A1–A20 from stepping the jump rotator 10A2–40A2.

Relay 1PBX at its contacts *b* opened a circuit to prevent the operation of relays 1AND and 2AND.

For purposes of illustration we shall assume that relay A11 remains operated and relays A12–A15 release.

Relay 1AA operates relay AB over the circuit from battery through the winding of relay AB, contacts 1AA–*c* to ground.

When relay AB operates, a circuit prepared by relay A11 is completed for relay 11TR associated with SLA–11, which circuit may be traced from ground through contacts AB–*h*, A11–*j*, conductor 11, cable to the MLM circuit, cable 11–20, conductor 11, contacts 5NP1–*a*, conductor 61, cable 51–70, cable to the LPX circuit, cable 51–70, conductor 61, winding of relay 11TR to battery, operating relay 11TR.

Relay 11TR in operating, transfers the ground circuit from line circuit 24 of SLA–11 which was on conductor 31 to conductor 45, operating relay B24 in the ML1 circuit. The circuit over which relay B24 operates may be traced from battery through contacts 1PBX–*d*, K2–*f*, AB–*c*, 3BA–*c*, winding of relay B24, conductor 25 into the PBX cable 1–25, cable to the MLM circuit, cable 1–27, conductor 25, contacts 4PN1–*d*, conductor 45, cable to the LPX circuit, cable 41–45, conductor 45, make contacts of relay 11TR, to ground on the conductor from break contacts of the line circuit 24 of SLA–11. Relay B24 locks over the path from ground, contacts 1PBX–*c*, BB–*c*, REL2–*a*, B24–*a*, winding of relay B24, contacts 3BA–*c*, AB–*c*, REL2–*d*, K2–*f* and 1PBX–*d* to battery.

Relay 1BA operates relays 2BA, 3BA, and 4BA.

Relay B24 operates relay 1BA over the circuit from battery, contacts 1PBX–*d*, K2–*f*, REL2–*d*, AB–*c*, 3BA–*c*, B24–*b*, B23–*c*, B22–*c*, B21–*c*, B20–*c*, 1PBX–*h*, BB–*d* lower winding of relay 1BA and contacts BB–*f* to ground.

Relay 1BA locks over the path from battery through contacts 1PBX–*d*, K2–*f*, REL2–*d*, AB–*c*, 1BA–*h*, lower winding of relay 1BA, and contacts BB–*f* to ground.

After relay 3BA operates and the original battery circuit to relay B24 is opened at contacts 3BA–*c*, relay B24 holds over the circuit from ground through contacts 1PBX–*c*, BB–*c*, REL2–*a*, B24–*c*, winding of relay B24, make contacts B24–*b*, break B23–*c*, B22–*c*, B21–*c* and B20–*c*, contacts 1PBX–*h*, BB–*d*, 1BA–*h*, AB–*c*, REL2–*d*, K2–*f*, and LPBX–*d* to battery. After relay BB operates, relay B24 holds over the circuit from ground through contacts 1PBX–*c*, 1BA–*f*, BB–*b*, REL2–*a*, B24–*c*, winding of relay B24, contacts B24–*b*, B23–*c*, B22–*c*, B21–*c*, B20–*c*, 1PBX–*h*, BB–*e*, upper winding of relay 1BA, contacts 1BA–*h*, AB–*c*, REL2–*d*, K2–*f*, and 1PBX–*d* to battery. (It should be observed that on regular calls in which relay B0 or B1 locks over contacts 1BA–*h*, that contacts 1BA–*h* close before contacts 1BA–*g* open, thus holding relay B0 or B1 as the case may be.)

This is a good point to note that with regard to larger PBX groups described subsequently and containing more

than one line in a given SLA, two or more of the relays B20–B24 may operate simultaneously but that the locking circuits of these relays through their *h* and *c* contacts are such that only one of these relays can remain operated after relay 3BA opens the original battery circuits and that relay B20 has first priority in locking, B21 next priority, etc. to relay B24 which has last priority.

Accordingly in a large PBX group involving lines in different SLA's the relay A1–A20 which remains locked determines the lowest numbered sub group of PBX lines containing an idle line and the operation of the relay B20–B24 determines the lowest numbered idle line in the subgroup.

It should be observed that relay 1PBX at its contacts *g* disconnects lead 45 to the jump rotator 10A1–60A1 so that no battery circuits through the jump rotator obtains on leads 39–44 to contacts of relays B0–B24 and accordingly locking of relays B20–B24 is governed entirely through contacts 1PBX–*h*.

It should also be noted that ground to operate jump rotator relays 10A1 to 60A1 is opened at contacts 1PBX–*l* so that the operation of relays B20–B24 cannot step the said jump rotator.

Relays A11 and B24 operate and lock through contacts of relay 1PBX instead of relay ANB.

Relay 4BA operates relay BB over a circuit previously traced.

Relay BB at its contacts *j* closes the before traced circuit to energize relay BT (which is a 30 millisecond slow to operate relay) in the MTT circuit; and at its contacts 1, closes a circuit to operate connect relays 1A, 2A and 3A in SLA–11 from battery SLA–11 (as SLA–11 is not shown we shall trace in SLA–1 which is wired the same as SLA–1), fuse 3, windings of relays 1A, 2A, and 3A in parallel, closed contacts *c* of the manual key, a conductor of SLA–11 corresponding to 1302, SLA-CONNECT cable, conductor 11, contacts 2CN1–*a*, cable to the MLI circuit, contacts A11–*h* and BB–1 to ground.

Relay 2A in SLA–11 closes a circuit from ground through contacts 2A–25, an LHP–11 conductor corresponding to LHP–1 shown, winding of relay 1S1A to battery, operating this relay. Relay 1S1A operates relays 1S1, 2S1, 1S12, and 2S12, and shunts relays 1S11 and 2S11.

When relays 1A, 2A, and 3A in SLA–11 operate, circuits are completed to operate horizontal magnets H6 and HB in SLA–11. The circuit for magnet H6 may be traced from battery through fuse 3 (in SLA–11), winding of magnet H6, conductor 6, cable corresponding to 1305, contacts of relay 3A, cable corresponding to 1306, conductor 6, contacts 3CN1–*d*, conductor 26, cable to MLI circuit, conductor 26, contacts B24–*g* to ground, operating relay H6. A similar circuit can be traced through contacts B24–*h* to operate relay HB.

Thereupon the S-wire of line 24 of SLA–11 is extended to the lower winding of relay 1RC for the S-wire test. Line 24 of SLA–19 has already tested idle during the selection of the PBX line. Accordingly, the S-wire test provides a double check and is used also to cause the call to progress through the marker (i.e. is used to continue the sequence of the marker). It is not believed necessary to trace this path inasmuch as a similar path was traced before. With line 24 of SLA–11 idle, relay 1RC does not operate.

After its slow operate period has elapsed, relay BT in the MTT circuit operates, and transfers the S-wire to the upper winding of relay BY1.

Relay BY1 operates from 360 ohm battery on the S-wire, upper winding of relay BY1 to ground and locks over the circuit from battery through the lower winding of BY1, make before break contacts BY1–*b*, contacts BT–*f*, to "master ground."

Relay BY1 operates relay IA which operates relays DN1, 1A, and 2A; relay 2A operating relays 3A and 4A.

Relay DN1 operates relays 1BN1, 2BN1, 1FN1, and 2FN1.

Relay 1BN1 operates relays 3BN1, 4BN1, 5BN1, 6BN1, EN1, DGA, and DGB.

Relay 2FN1 operates relays 3FN1 and 4FN1, with relays 1FN1 and 2FN1 operated, test circuits of the verticals of SLA–11 are extended to relays 2V1–2V10 of the MVC circuit, each idle vertical effecting the operation of a corresponding relay of the group 2V1–2V10.

With the operation of relays of the group 2V1–2V10, test circuits of the associated SLB verticals (in SLB's 1–5, assuming the call to be through CRB–1) are extended to pathfinding relays of the group DG1–DG20.

Assuming for illustration that all paths are idle, all relays 2V1–2V10 will operate and all relays DG1–DG20 will operate.

The operation of any relay releases relays DGA and DGB. Accordingly these relays release.

When relays DGA and DGB release, only one of the relays DG1–DG20 remain operated; and accordingly relay DGC operates.

Relay DGC opens the circuit of slow-to-release relay DGD; operates one of the relays ASG1–ASG20 (ASG1 assuming DG1 remains operated); operates horizontal magnets H1 and HB of SLB–1 and H1 and HA of SLC1.

The operation of the SLB horizontals operates relay HF3; and the operation of the SLC horizontals operates relay HF4. This occurs before the release of relay DGD.

The release of relay DGD operates vertical magnet V1 of SLA–11 which releases relay 2V1; vertical magnet V3 of SLB–1; and vertical magnet V1 of SLC–1 which operates relay VO in the CRB–1 circuit.

The operation of relay VO in the CRB–1 circuit opens the CRB calling loop to the marker, releasing relays RB1 and 1RBA.

The release of relay RB1 releases multiple relay magnets M1 and M39 in the LCT circuit.

With relay 1RBA released, the following relays are released: 2RBA, 3RBA, RA1, 1RAA, RANB. Relay 3RBA releases horizontal magnets H1 and HB of SLB–1, horizontal magnets H1 and HA of SLC–1. Also the original operating circuits of vertical magnets V1 of SLA–11, V3 of SLB–1, and V1 of SLC–1 are opened, but these magnets remain locked to H-wire ground.

Relay RA1 releases relay S1 in the UCC circuit. With relay RANB released, the following relays are releases: RBB, 1PBX, 1RANC, and 2RANC.

With relay 1PBX released, the following relays are released: 1PN1, 2PN1, B24, 1BA, A11, 1AA, 2AA and 3AA. With relay 1PN1 released, relays 5PN1 and 6PN1 are released. With relay 2NP1 released, relays 3PN1 and 4PN1 are released. With B24 released, horizontal magnets H6 and HB are released. With relay 1BA released, relays 2BA, 3BA, 4BA, and BB are released. With relay A11 released, re'ays 11TR and relays 1A, 2A, and 3A (in SLA–11) are released. With relays 1A, 2A, and 3A in SLA–11 released, relay 1S1A in the LHP circuit is released. With relay 1S1A released, relays 1S1, 2S1, 1S12 and 2S12 are released.

With relay 2RANC released, relay CRG is released. With relay CRG released, the following relays are released: 1CN1, 2CN1, 1FN1, 2FN1 and in turn 3CN1, 3FN1, and 4FN1 in the MVO circuit; relays H1, H2, T2, T5, TA, U3, U5, RA1, RA2, and RA3 in the MCR circuit and relay DN1 in the MTT circuit. With relays 4PN1 in the MVO circuit and relay H1 in the MCR circuit released, two points are opened in the circuit of relay P19 in the LPX circuit, and relay P19 releases. With relay 2FN1 in the MVO circuit and relays 1A, 2A, and 3A in SLA–11 released, two points in each of the operating circuits of relays 2V1–2V10 of the MVC circuit (and of relays 1V1–1V10 in the MCT circuit) are opened and any of these relays which have been operated, release.

With relay 1RANC released, the following relays are released: 1RAN1, RAB. With the release of relay 1RANC, the ground shunt is removed from relay 1ROB, and this relay operates. Also, the energizing circuits of "jump rotator" relays 2ROA1 and 2ROA2 are removed, but these relays remain locked in their operated position.

With relay 1RAN1 released, the following relays are released: 1RAN1A and RANA.

With relay 1RAN1A released, the following relays are released: 2RAN1, 3RAN1, 4RAN1, 5RAN1, 5RAN1A, and 1RAV.

With relay RANA released, the following relays are released: 1RAND and 2RAND.

With relay 2RAND released, the following relays are released: 1ABL, 2ABL, IA, 2PBX, BT, BY1, 1BN1–1 to 6BN1–1, and relays 1A and 2A in the MVC circuit.

With relay 2ABL released, relay T1 in the companion marker is released.

With relay 2A in the MVC circuit released, relays 3A and 4A in the MVC circuit are released.

With relays 1BN1–1 and 2A in the MVC circuit released, relay EN1 in the SLC circuit is released.

With relay 1RAND released, relays DG1 and DGC are released.

Referring again to the LPX circuit, it should be observed that lines 20, 21, 22, 23, and 24 in each SLA circuit of the twenty SLA's of the 500 line group are arranged to be used as PBX lines, giving a maximum of 100 PBX lines per 500 line group.

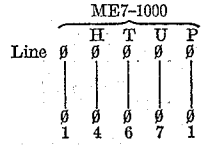
Each conductor entering the left of the LPX circuit has a circuit extending from ground through fuse contacts associated with fuses 3 and 4 in the associated SLA, break contacts 24 of the associated lockout relay, through the associated knife blade contact of the LPX circuit, through contacts one of the relays P1–P20 associated with a PBX group, to a lever of one of the relays 1TR–20TR associated with a particular SLA, first over break contacts to a conductor 21–40 associated with a particular SLA; and subsequently, after the particular relay 1TR–20TR operates, over make contacts to one of the conductors 41–45 associated with the line number 20–24.

Leads 1–20 emerge from the MLM cable to respective terminals 1–20, of which 1, 2, 19, and 20 are shown. The windings of relays P1–P20, of which P1, P2, P3, P4, P5, P19 and P20 are shown, terminate in associated terminals. Relay D1 is an example of an auxiliary relay, of which there may be none, one, or more. The winding of relay D1 terminates in an associated terminal. Each make contact of relay D1 terminates in an associated terminal. These terminals are for the purpose of cross-connection.

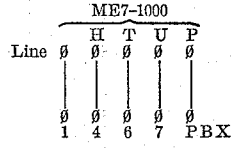
If there are five or less PBX lines in each group of PBX lines, and all groups are connected, and the groups are in consecutive order, cross-connections would be arranged with terminal 1 of cable 1–20 connected to the terminal associated with relay P1; terminal 2 of cable 1–20 connected to the terminal associated with relay P2; etc.; with terminal 19 of cable 1–20 connected to the terminal associated with relay P19 and terminal 20 of cable 1–20 connected to the terminal associated with relay P20. With this arrangement, if a marker places ground on conductor 1 of cable 1–20 relay P1 operates selecting the associated PBX group #1 and extending circuits to marker relays A1–A5, one of which locks; and when subsequently, one of the corresponding relays 1TR–5TR operates in turn operating one of the marker relays B20–B24, as a result thereof an idle PBX line in the selected PBX group #1 is selected. Similarly, if the marker places ground on conductor 2 of cable 1–20, relay P2 operates selecting the associated PBX group #2 and extending circuits to marker relays A6–A10, one of which locks and when subsequently one of the corresponding relays 6TR–10TR operates in turn operating one of the marker relays B20–B24, as a result thereof an idle PBX line in the selected PBX group #2 is selected. Similarly for the other relays P3–P20.

FIGURE 81 illustrates schematically in a systematic way the lines in the various SLA's which are controlled by relays P1–P20, being an amplified illustration in connection with FIGURE 20.

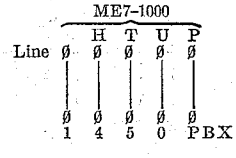
In the example of a call to a regular line number already given, it was shown that by dialing ME7–1000, party 1 on line 17 of SLA–19 in first 500 line group could be reached by cross-connecting the terminals associated with directory digits 000 in number group 1 as follows:



In the example of a call to a PBX group already given, it was shown that by dialing ME7–1000, PBX group 19 in the first 500 line group could be reached by alternatively cross-connecting the terminals associated with directory digits 000 in number group 1 as follows:

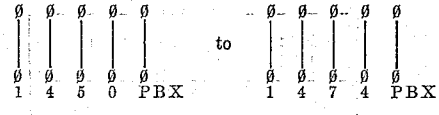


Ordinarily, however, PBX group 19 in the first 500 line group would be reached by cross-connecting the terminals of the directory number assigned to it in any number group as follows:



using hundreds, tens and units digits 450 instead of 467.

This serves to illustrate the fact that any cross-connection from



that is, any cross-connection involving hundreds, tens and units digits from 450–474 can be used to select PBX group 19. Digits 450–474 are MDF (main distributor frame) terminal numbers associated with the lines of SLA–19. If the party jumper in the number group is cross-connected to a ring terminal 1–14 a line in SLA–19 is selected and rung, but if the party jumper is cross-

connected to the terminal PBX, the PBX group #19 is selected.

At this point we shall digress to consider the relationships between number cross-connections, sender transmissions, marker code receiver relays, SLA magnets and lines, and MDF terminals for calls to regular lines, calls to PBX groups, and calls to PBX lines by dialing night numbers. After this digression we shall consider the combining of the lines in individual PBX groups to form larger PBX groups.

The following chart shows which line terminals 0–24 of each individual SLA switch are determined by the operation of the horizontal combination and select magnets.

CHART

Horizontal Combination Magnet	Horizontal Select Magnet	Line No.
HA	H1	26 (spare)
HA	H2	0
HA	H3	1
HA	H4	2
HA	H5	3
HA	H6	4
HA	H7	5
HA	H8	6
HA	H9	7
HB	H1	8
HB	H2	20
HB	H3	21
HB	H4	22
HB	H5	23
HB	H6	24
HB	H7	9
HB	H8	18
HB	H9	19
HC	H1	(Inconsistent)
HC	H2	10
HC	H3	11
HC	H4	12
HC	H5	13
HC	H6	14
HC	H7	15
HC	H8	16
HC	H9	17

Referring now to FIGURE 81, therein is shown the outside cable containing 500 cable pairs, each pair terminating on the outer side of the MDF in two terminals R and T, only certain representative sets being shown. On the inner side of the MDF are 500 sets of terminals numbered 000–499, each set comprising three terminals S, R, and T, only certain representative sets being shown. Cross-connection jumpers run from outer R and T terminals to inner R and T terminals of the MDF in the manner shown. Twenty SLA's (of which only SLA–1, SLA–2, and SLA–20 are shown) each having twenty sets of line terminals 0–24 are indicated to the right side of the drawing. Cross-connections are shown between corresponding terminals S, R, and T of MDF set 000 and SLA–1 set for line 0; etc. as follows:

MDF terminals	SLA terminals
000	Line 0 of SLA–1.
024	Line 24 of SLA–1.
025	Line 0 of SLA–2.
029	Line 24 of SLA–2.
030	Line 0 of SLA–2.
049	Line 19 of SLA–2.
499	Line 19 of SLA–20.

The relationships between MDF terminals and SLA terminals are shown in the following chart.

CHART

MDF Terminals (Also these are Digits Transmitted by Sender to SLM Code Receiver)	Corresponding Individual SLA Lines	SLA
000–009	0–9	1
101–019	10–19	1
020–024	20–24	1
025–029	20–24	2
030–039	0–9	2
040–049	10–19	2
050–059	0–9	3
060–069	10–19	3
070–074	20–24	3
075–079	20–24	4
080–089	0–9	4
090–099	10–19	4
100–109	0–9	5
110–119	10–19	5
120–124	20–24	5
125–129	20–24	6
130–139	0–9	6
140–149	10–19	6
150–159	0–9	7
160–169	10–19	7
170–174	20–24	7
175–179	20–24	8
180–189	0–9	8
190–199	10–19	8
200–209	0–9	9
210–219	10–19	9
220–224	20–24	9
225–229	20–24	10
230–239	0–9	10
240–249	10–19	10
250–259	0–9	11
260–269	10–19	11
270–274	20–24	11
275–279	20–24	12
280–289	0–9	12
290–299	10–19	12
300–309	0–9	13
310–319	10–19	13
320–324	20–24	13
325–329	20–24	14
330–339	0–9	14
340–349	10–19	14
350–359	0–9	15
360–369	10–19	15
370–374	20–24	15
375–379	20–24	16
380–389	0–9	16
390–399	10–19	16
400–409	0–9	17
410–419	10–19	17
420–424	20–24	17
425–429	20–24	18
430–439	0–9	18
440–449	10–19	18
450–459	0–9	19
460–469	10–19	19
470–474	20–24	19
475–479	20–24	20
480–489	0–9	20
490–499	10–19	20

In the following chart is shown the reaction of the marker code receiver in response to the various hundreds, tens, and units digits transmitted to it from the sender. In the column farthest to the left is listed the digit values 0–9 which may be received from the sender. In the next two columns to the right of the digit value column are given the potential signals on the tip and ring conductors for the various digital values. In the next five columns is given the operation of the code receiver relays in response to the digital values. In the next five columns is given the operation of the hundreds register relays H1–H5 in response to receipt of the various hundreds digits 0–9 received by the code receiver relays R1–R5. In the next six columns is given the operation of the tens register relays T1–TA in response to receipt of the various tens digital values 0–9 by the code receiver relays R1–R5. In the next five columns is given the operation of the units register relays U1–U5 in response to receipt of the various units digital values 0–9 by the code receiver relays R1–R5. In the next column is given the results of the operation of the hundreds register relays. In the next column is given the relays operated as a result of the operation of the tens register relays only. In the next column is given the relays operated as a result of the operation of the units register relays only. In the last column is given

CHART.—CODE RECEIVER IN SLM

Digit	Tip	Ring	Common Code Receiver					Hundreds Register				
			R1	R2	R3	R4	R5	H1	H2	H3	H4	H5
0		−48				X					X	
1	Grd	−48		X		X			X		X	
2	−48	−48			X	X				X	X	
3	+48	−48	X	X		X		X	X		X	
4	Grd			X					X			
5		+48					X					X
6	Grd	+48		X			X		X			X
7	−48	+48			X		X			X		X
8	+48	+48	X	X			X	X	X			X
9	+48		X	X				X	X			

Digit	Tens Register						Units Register					Result of Hund. Digit Grd. on Lead	Result of Tens Digit Relays Operated
	T1	T2	T3	T4	T5	T A	U1	U2	U3	U4	U5		
0				X		X				X		0	Q1, 0358.
1		X		X		X		X		X		1	Q1, 1469.
2			X	X		X			X	X		2	27–LU, 27–89.
3	X	X		X		X	X	X		X		3	Q2, 0358.
4		X						X				4	Q2, 1469.
5					X	X					X	5	Q3, 0358.
6		X			X	X		X			X	6	Q3, 1469.
7			X		X	X			X		X	7	27–LU, 27–89.
8	X	X			X	X	X	X			X	8	Q4, 0358.
9	X	X					X	X				9	Q4, 1469.

Digit	Result of Units Digit Relays Operated	Result of Combination of Tens and Units Digit Relays Operated
0	LU, 27–LU	
1	LU, 27–LU	
2	LU, 27–LU	{Q1 if tens digit is 2 and units digit is low (i.e. 0, 1, 2, 3, 4). Q2 if tens digit is 2 and units digit is high (i.e. 5, 6, 7, 8, 9).
3	LU, 27–LU	
4	LU, 27–LU	
5		
6		
7		{Q3 if tens digit is 7 and units digit is low (i.e. 0, 1, 2, 3, 4). Q4 if tens digit is 7 and units digit is high (i.e. 5, 6, 7, 8, 9).
8	27–89	
9	27–89	

the relays operated as a result of the operation of both the tens register relays and the units register relays.

In the following chart is given the number group cross-connections, the hundreds, tens, and units digital values transmitted by the sender to reach individual lines, the marker code receiver relays operated thereby, the SLA horizontal magnets determined thereby, the SLA lines 0–24 determined thereby, and the MDF terminals reached thereby.

It should be appreciated that seeming oddity in numbering lines in the SLA circuit is occasioned at least in part by the fact that MDF terminals are on a decimal basis and SLA lines are arranged relative to horizontal magnets on a 9 x 3 basis.

CHART.—INDIVIDUAL LINE SELECTION

Number Group Cross Connections (Also Digits Sender Transmits to SLM code Receiver HTU	H1	H2	H3	H4	H5	T1	T2	T3	T4	T5	TA
000				X					X		X
001				X					X		X
002				X					X		X
003				X					X		X
004				X					X		X
005				X					X		X
006				X					X		X
007				X					X		X
008				X					X		X
009				X					X		X
010				X			X		X		X
011				X			X		X		X
012				X			X		X		X
013				X			X		X		X
014				X			X		X		X
015				X			X		X		X
016				X			X		X		X
017				X			X		X		X
018				X			X		X		X

CHART.—INDIVIDUAL LINE SELECTION—Continued

Number Group Cross Connections (Also Digits Sender Transmits to SLM code Receiver HTU	H1	H2	H3	H4	H5	T1	T2	T3	T4	T5	TA
019				X			X		X		X
020				X				X	X		X
021				X				X	X		X
022				X				X	X		X
023				X				X	X		X
024				X				X	X		X
025				X				X	X		X
026				X				X	X		X
027				X				X	X		X
028				X				X	X		X
029				X				X	X		X
030				X		X	X		X		X
031				X		X	X		X		X
032				X		X	X		X		X
033				X		X	X		X		X
034				X		X	X		X		X
035				X		X	X		X		X
036				X		X	X		X		X
037				X		X	X		X		X
038				X		X	X		X		X
039				X		X	X		X		X
040				X			X				
041				X			X				
042				X			X				
043				X			X				
044				X			X				
045				X			X				
046				X			X				
047				X			X				
048				X			X				
049				X			X				
050				X						X	X
051				X						X	X
052				X						X	X
053				X						X	X
054				X						X	X
055				X						X	X
056				X						X	X
057				X						X	X
058				X						X	X

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CHART.—INDIVIDUAL LINE SELECTION—Continued

Number Group Cross Connections (Also Digits Sender Transmits to SLM code Receiver HTU	H1	H2	H3	H4	H5	T1	T2	T3	T4	T5	TA
059				X			X			X	X
060				X			X			X	X
061				X			X			X	X
062				X			X			X	X
063				X			X			X	X
064				X			X			X	X
065				X			X			X	X
066				X			X			X	X
067				X			X			X	X
068				X			X			X	X
069				X			X			X	X
070				X				X		X	X
071				X				X		X	X
072				X				X		X	X
073				X				X		X	X
074				X				X		X	X
075				X				X		X	X
076				X				X		X	X
077				X				X		X	X
078				X				X		X	X
079				X				X		X	X
080				X		X	X			X	X
081				X		X	X			X	X
082				X		X	X			X	X
083				X		X	X			X	X
084				X		X	X			X	X
085				X		X	X			X	X
086				X		X	X			X	X
087				X		X	X			X	X
088				X		X	X			X	X
089				X		X	X			X	X
090				X		X	X				

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CHART.—INDIVIDUAL LINE SELECTION—Continued

Number Group Cross Connections (Also Digits Sender Transmits to SLM code Receiver HTU	H1	H2	H3	H4	H5	T1	T2	T3	T4	T5	TA
091				X		X	X				
092				X		X	X				
093				X		X	X				
094				X		X	X				
095				X		X	X				
096				X		X	X				
097				X		X	X				
098				X		X	X				
099				X		X	X				
100		X		X					X		X
101		X		X					X		X
102		X		X					X		X
103		X		X					X		X
104		X		X					X		X
105		X		X					X		X
106		X		X					X		X
107		X		X					X		X
108		X		X					X		X
109		X		X					X		X
467		X					X			X	X
490		X				X	X				
491		X				X	X				
492		X				X	X				
493		X				X	X				
494		X				X	X				
495		X				X	X				
496		X				X	X				
497		X				X	X				
498		X				X	X				
499		X				X	X				

U1	U2	U3	U4	U5	Q1	Q2	Q3	Q4	T 0358	T 1469	TU 27-89	LU	TU 27-LU
	X		X		X				X			X	X
			X		X				X			X	X
X		X	X		X				X			X	X
	X				X				X			X	X
				X	X				X				
	X			X	X				X				
X		X		X	X				X				
X	X			X	X				X		X		
			X		X					X		X	X
	X		X		X					X		X	X
X		X	X		X					X		X	X
	X		X		X					X		X	X
				X	X								
	X			X	X								
X		X		X	X						X		
X	X			X	X						X		
			X		X					X	X	X	X
	X		X		X					X	X	X	X
X		X	X		X					X	X	X	X
	X		X		X					X	X	X	X
				X	X				X			X	X
	X			X	X				X			X	X
X		X		X	X				X		X		
X	X			X	X				X		X		
			X		X	X	X			X		X	X
	X		X		X	X	X			X		X	X
X		X	X		X	X	X			X		X	X
	X		X		X	X	X			X		X	X
				X	X	X	X						
	X			X	X	X	X						
X		X		X	X	X	X				X		
X	X			X	X	X	X				X		
			X		X	X	X			X		X	X
	X		X		X	X	X			X		X	X
X		X	X		X	X	X			X		X	X
	X		X		X	X	X			X		X	X
				X	X	X	X						
	X			X	X	X	X						
X		X		X	X	X	X				X		
X	X			X	X	X	X				X		
			X		X	X	X			X		X	X
	X		X		X	X	X			X		X	X
	X												

U1	U2	U3	U4	U5	Q1	Q2	Q3	Q4	T 0358	T 1469	TU 27–89	LU	TU 27–LU
----	---	X	X	---	---	-----	X	-----	-----	X	-----	X	X
X	X	---	X	---	---	-----	X	-----	-----	X	-----	X	X
----	X	---	---	---	---	-----	X	-----	-----	X	-----	X	X
----	---	---	---	X	---	-----	X	-----	-----	X	-----	---	-----
----	X	---	---	X	---	-----	X	-----	-----	X	-----	---	-----
----	---	X	---	X	---	-----	X	-----	-----	X	-----	---	-----
X	X	---	---	X	---	-----	X	-----	-----	X	X	---	-----
X	X	---	---	---	---	-----	X	-----	-----	X	X	---	-----
----	---	---	X	---	---	-----	X	-----	-----	-----	X	X	X
----	X	---	X	---	---	-----	X	-----	-----	-----	X	X	X
X	X	X	X	---	---	-----	X	-----	-----	-----	X	X	X
----	X	---	---	---	---	-----	X	-----	-----	-----	X	X	X
----	---	---	---	X	---	-----	-----	X	-----	-----	X	X	X
----	X	---	---	X	---	-----	-----	X	-----	-----	X	X	X
X	X	X	---	X	---	-----	-----	X	-----	-----	X	X	X
X	X	---	---	X	---	-----	-----	X	-----	-----	X	X	X
----	---	---	X	---	---	-----	-----	X	X	-----	X	X	X
----	X	---	X	---	---	-----	-----	X	X	-----	X	X	X
----	X	X	X	---	---	-----	-----	X	X	-----	X	X	X
X	X	---	X	---	---	-----	-----	X	X	-----	X	X	X
----	---	---	---	X	---	-----	-----	X	X	-----	-----	---	-----
----	---	---	---	X	---	-----	-----	X	X	-----	-----	---	-----
----	X	X	---	X	---	-----	-----	X	X	-----	-----	---	-----
X	X	---	---	X	---	-----	-----	X	X	-----	X	---	-----
X	X	---	---	X	---	-----	-----	X	X	-----	X	---	-----
----	---	---	X	---	X	-----	-----	-----	X	-----	-----	X	X
----	X	---	X	---	X	-----	-----	-----	X	-----	-----	X	X
----	---	X	X	---	X	-----	-----	-----	X	-----	-----	X	X
----	X	---	X	---	X	-----	-----	-----	X	-----	-----	X	X
----	---	---	---	X	X	-----	-----	-----	X	-----	-----	---	-----
----	X	---	---	X	X	-----	-----	-----	X	-----	-----	---	-----
----	---	X	---	X	X	-----	-----	-----	X	-----	-----	---	-----
X	X	---	---	X	X	-----	-----	-----	X	-----	X	---	-----
X	X	---	---	---	X	-----	-----	-----	X	-----	X	---	-----
----	---	X	---	X	---	-----	X	-----	-----	X	-----	X	X
----	X	---	X	---	---	-----	-----	X	-----	X	-----	X	X
----	---	X	X	---	---	-----	-----	X	-----	X	-----	X	X
X	X	---	X	---	---	-----	-----	X	-----	X	-----	X	X
----	X	---	---	---	---	-----	-----	X	-----	X	-----	X	X
----	---	---	---	X	---	-----	-----	X	-----	X	-----	---	-----
----	X	---	---	X	---	-----	-----	X	-----	X	-----	---	-----
----	---	X	---	X	---	-----	-----	X	-----	X	-----	---	-----
X	X	---	---	X	---	-----	-----	X	-----	X	X	---	-----
X	X	---	---	---	---	-----	-----	X	-----	X	X	---	-----

Corresponding Individual SLA Number	SLA Combination	SLA Select	SLA Line	MDG Terminal Sets Reached Thereby
1	HA	H2	0	000
1	HA	H3	1	001
1	HA	H4	2	002
1	HA	H5	3	003
1	HA	H6	4	004
1	HA	H7	5	005
1	HA	H8	6	006
1	HA	H9	7	007
1	HB	H1	8	008
1	HB	H7	9	009
1	HC	H2	10	010
1	HC	H3	11	011
1	HC	H4	12	012
1	HC	H5	13	013
1	HC	H6	14	014
1	HC	H7	15	015
1	HC	H8	16	016
1	HC	H9	17	017
1	HB	H8	18	018
1	HB	H9	19	019
1	HB	H2	20	020
1	HB	H3	21	021
1	HB	H4	22	022
1	HB	H5	23	023
1	HB	H6	24	024
2	HB	H2	20	025
2	HB	H3	21	026
2	HB	H4	22	027
2	HB	H5	23	028
2	HB	H6	24	029
2	HA	H2	0	030
2	HA	H3	1	031
2	HA	H4	2	032
2	HA	H5	3	033
2	HA	H6	4	034
2	HA	H7	5	035
2	HA	H8	6	036
2	HA	H9	7	037

Corresponding Individual SLA Number	SLA Combination	SLA Select	SLA Line	MDG Terminal Sets Reached Thereby
2	HB	H1	8	038
2	HB	H7	9	039
2	HC	H2	10	040
2	HC	H3	11	041
2	HC	H4	12	042
2	HC	H5	13	043
2	HC	H6	14	044
2	HC	H7	15	045
2	HC	H8	16	046
2	HC	H9	17	047
2	HB	H8	18	048
2	HB	H9	19	049
3	HA	H2	0	050
3	HA	H3	1	051
3	HA	H4	2	052
3	HA	H5	3	053
3	HA	H6	4	054
3	HA	H7	5	055
3	HA	H8	6	056
3	HA	H9	7	057
3	HB	H1	8	058
3	HB	H7	9	059
3	NC	H2	10	060
3	HC	H3	11	061
3	HC	H4	12	062
3	HC	H5	13	063
3	HC	H6	14	064
3	HC	H7	15	065
3	HC	H8	16	066
3	HC	H9	17	067
3	HB	H8	18	068
3	HB	H9	19	069
3	HB	H2	20	070
3	HB	H3	21	071
3	HB	H4	22	072
3	HB	H5	23	073
3	HB	H6	24	074
4	HB	H2	20	075

Corresponding Individual SLA Number	SLA Combination	SLA Select	SLA Line	MDG Terminal Sets Reached Thereby
4	HB	H3	21	076
4	HB	H4	22	077
4	HB	H5	23	078
4	HB	H6	24	079
4	HA	H2	0	080
4	HA	H3	1	081
4	HA	H4	2	082
4	HA	H5	3	083
4	HA	H6	4	084
4	HA	H7	5	085
4	HA	H8	6	086
4	HA	H9	7	087
4	HB	H1	8	088
4	HB	H7	9	089
4	HC	H2	10	090
4	HC	H3	11	091
4	HC	H4	12	092
4	HC	H5	13	093
4	HC	H6	14	094
4	HC	H7	15	095
4	HC	H8	16	096
4	HC	H9	17	097
4	HB	H8	18	098
5	HB	H9	19	099
5	HA	H2	0	100
5	HA	H3	1	101
5	HA	H4	2	102
5	HA	H5	3	103
5	HA	H6	4	104
5	HA	H7	5	105
5	HA	H8	6	106
5	HA	H9	7	107
5	HB	H1	8	108
5	HB	H7	9	109
19	HC	H9	17	467
20	HC	H2	10	490
20	HC	H3	11	491
20	HC	H4	12	492
20	HC	H5	13	493
20	HC	H6	14	494
20	HC	H7	15	495
20	HC	H8	16	496
20	HC	H9	17	497
20	HB	H8	18	498
20	HB	H9	19	499

Returning now from the digression, in the following chart is given the number group cross-connections, the sender transmissions, and relays operated in the marker code receiver, LPX circuit, and SLA circuits, the PBX group and lines and finally the MDF terminals reached thereby.

PBX.—TWENTY INDIVIDUAL GROUPS CONSECUTIVELY ARRANGED

Number Group Cross Connections		Digits Sent By Sender to SLM Code Receiver	H1	H2	H3	H4	H5	T1	T2	T3	T4	T5	TA
HTU	P												
000	PBX	500					X				X		X
025	PBX	525					X			X	X		X
050	PBX	550					X					X	X
075	PBX	575					X			X		X	X
100	PBX	600		X			X				X		X
125	PBX	625		X			X			X	X		X
150	PBX	650		X			X					X	X
175	PBX	675		X			X			X		X	X
200	PBX	700			X		X				X		X
225	PBX	725			X		X			X	X		X
250	PBX	750			X		X					X	X
275	PBX	775			X		X			X		X	X
300	PBX	800	X	X			X				X		X
325	PBX	825	X	X			X			X	X		X
350	PBX	850	X	X			X					X	X
375	PBX	875	X	X			X			X		X	X
400	PBX	900	X	X							X		X
425	PBX	925	X	X						X	X		X
450	PBX	950	X	X								X	X
475	PBX	975	X	X						X		X	X
467	PBX	967	X	X					X			X	X

U1	U2	U3	U4	U5	Q1	Q2	Q3	Q4	T 0358	T 1469	T U 27–89	LU	T U 27–LU	Relay P in LPX Ckt.
			X		X				X			X	X	P1
				X		X					X		X	P2
			X				X		X			X	X	P3
				X				X			X		X	P4
			X		X				X			X	X	P5
				X		X					X		X	P6
			X				X		X			X	X	P7
				X				X			X		X	P8
			X		X				X			X	X	P9
				X		X					X		X	P10
			X				X		X			X	X	P11
				X				X			X		X	P12
			X		X				X			X	X	P13
				X		X					X		X	P14
			X				X		X			X	X	P15
				X				X			X		X	P16
			X		X				X			X	X	P17
				X		X					X		X	P18
			X				X		X			X	X	P19
				X				X			X		X	P20
		X		X			X			X				P19

	Individual SLA Lines Determined Thereby	In SLA	Transfer Relay Associated With SLA	MDF Terminal Reached Thereby	PBX Group
P1	20	1	1TR	020	1
	20	2	2TR	025	
	20	3	3TR	070	
	20	4	4TR	075	
	20	5	5TR	120	
P2	20	6	6TR	125	2
	20	7	7TR	170	
	20	8	8TR	175	
	20	9	9TR	220	
	20	10	10TR	225	
P3	20	11	11TR	270	3
	20	12	12TR	275	
	20	13	13TR	320	
	20	14	14TR	325	
	20	15	15TR	370	
P4	20	16	16TR	375	4
	20	17	17TR	420	
	20	18	18TR	425	
	20	19	19TR	470	
	20	20	20TR	475	
P5	21	1	1TR	021	5
	21	2	2TR	026	
	21	3	3TR	071	
	21	4	4TR	076	
	21	5	5TR	021	
P6	21	6	6TR	126	6
	21	7	7TR	171	
	21	8	8TR	176	
	21	9	9TR	221	
	21	10	10TR	226	
P7	21	11	11TR	271	7
	21	12	12TR	276	
	21	13	13TR	321	
	21	14	14TR	326	
	21	15	15TR	371	
P8	21	16	16TR	376	8
	21	17	17TR	421	
	21	18	18TR	426	
	21	19	19TR	471	
	21	20	20TR	476	
P9	22	1	1TR	022	9
	22	2	2TR	027	
	22	3	3TR	072	
	22	4	4TR	077	
	22	5	5TR	122	
P10	22	6	6TR	127	10
	22	7	7TR	172	
	22	8	8TR	177	
	22	9	9TR	222	
	22	10	10TR	227	
P11	22	11	11TR	272	11
	22	12	12TR	277	
	22	13	13TR	322	
	22	14	14TR	327	
	22	15	15TR	372	
P12	22	16	16TR	377	12
	22	17	17TR	422	
	22	18	18TR	427	
	22	19	19TR	472	
	22	20	20TR	477	
P13	23	1	1TR	023	13
	23	2	2TR	028	
	23	3	3TR	073	
	23	4	4TR	078	
	23	5	5TR	023	
P14	23	6	6TR	128	14
	23	7	7TR	173	
	23	8	8TR	178	
	23	9	9TR	223	
	23	10	10TR	228	
P15	23	11	11TR	273	15
	23	12	12TR	278	
	23	13	13TR	323	
	23	14	14TR	328	
	23	15	15TR	373	
P16	23	16	16TR	378	16
	23	17	17TR	423	
	23	18	18TR	428	
	23	19	19TR	473	
	23	20	20TR	478	
P17	24	1	1TR	024	17
	24	2	2TR	029	
	24	3	3TR	074	
	24	4	4TR	079	
	24	5	5TR	124	
P18	24	6	6TR	129	18
	24	7	7TR	174	
	24	8	8TR	179	
	24	9	9TR	224	
	24	10	10TR	229	
P19	24	11	11TR	274	19
	24	12	12TR	279	
	24	13	13TR	324	
	24	14	14TR	329	
	24	15	15TR	374	
P20	24	16	16TR	379	20
	24	17	17TR	424	
	24	18	18TR	429	
	24	19	19TR	474	
	24	20	20TR	479	

Perhaps a word of explanation relative to certain terminology in the marker code receiver would facilitate an understanding thereof. Ground on lead **20G** selectively routed through the marker code receiver operates the relays **1A**, **2A**, or **3A** in any of the 20 SLA switches; and selectively routed differently through the marker code receiver operates any relay **P1–P20** in the LPX circuit. Ground on lead **9G** selectively routed through the marker code receiver operates any of the horizontal select magnets **H1–H9** in the selected SLA. Ground on lead **3G** selectively routed through the marker code receiver operates any of the horizontal select magnets HA, HB, and HC in the selected SLA. On PBX calls by dialing PBX directory group code codes, ground is found on lead **20G** but not on **9G** and **3G**.

Leads **0–9** out of the hundreds register are selectively grounded from the **20G** ground through the hundreds register as a result of the hundreds digit; leads **0–4** in conjunction with relays Q1–Q4 selecting SLA's and leads **5–9** in conjunction with relays Q1–Q4 selecting relays **P1–P20** relays in the LPX circuit.

Relay **Q1** is operated by ground on lead **01** as a result of tens digit 0 or 1; or by ground on lead **2L** as a result of tens digit 2 and a "lower" units digit (0–4). It can be seen that the lead designation refers to the digit situation as a result of which relay is operated.

Relay **Q2** is operated by ground on lead **34** as a result of tens digit 3 or 4; or by ground on lead 2H as a result of tens digit 2 and 2 "higher" units digit (5–9).

Relay **Q3** is operated by ground on lead **56** as a result of tens digit 5 or 6; or by ground on lead 7L as a result of tens digit 7 and a "lower" units digit (0–4).

Relay **Q4** is operated by ground on lead **8** or **9**; or by ground on lead 7H as a result of tens digit 7 and a "higher" units digit (5–9).

Relay **0358** is operated by ground on lead **0358** as a result of a tens digit 0, 3, 5, or 8.

Relay **1469** is operated by ground on lead **1469** as a result of a tens digit 1, 4, 6, or 9.

Relay **27–89** is operated as a result of a tens digit 2 or 7; or as a result of a units digit 8 or 9.

Relay **LU** is operated as a result of a lower units digit (0–4).

Relay **27–LU** is operated as a result of a tens digit 2 or 7; or as a result of a lower units digit (0–4).

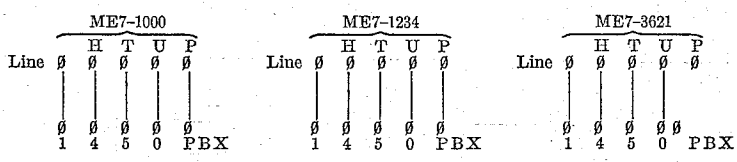
Although ground is on lead **20G** and not on leads **9G** and **3G** for a PBX group call, the tens and units digits are employed to operate the correct relays Q1–Q4 in conjunction with leads **0–9** to direct the **20G** ground selectively to any one of the relays **P1–P20** in the LPX circuit.

Referring to the LPX circuit of FIGURE 20, the knife switch of each PBX line should be closed to give PBX service to that line.

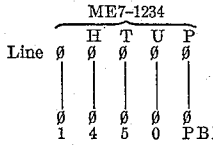
However, if it is desired to busy out a PBX line, the knife switch should be opened. Thereby when the associated relay **P1–P20** operates, ground from the PBX line circuit is prevented from operating one of the relays **A1–A20**; and when the associated relay **1TR–20TR** operates, this ground is prevented from operating one of the relays **B20–B24**.

It should be understood that any individual set of terminals associated with any of the 1000 dialed directory numbers of any number group can be cross-connected to

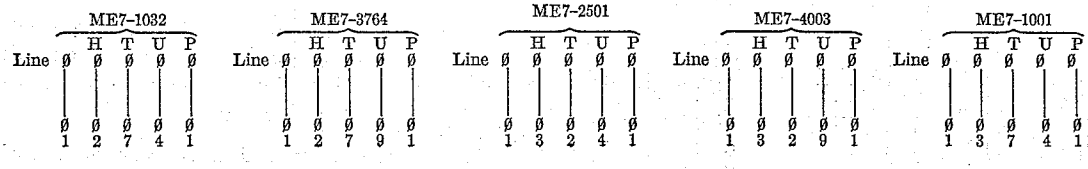
select the desired PBX group. Thus, to select PBX group 19 the following example is given:



Now to make night numbers of PBX lines, any directory numbers, not otherwise used, may be assigned to the lines of the PBX group. For example, in the case already given wherein the following cross-connection (see below) in the number group for the first thousand directory numbers was used to reach PBX group 19,



giving access to PBX lines of PBX group 19 on MDF terminals 274, 279, 324, 329, and 374; the following directory numbers, for example, can be assigned to the individual lines and the following cross-connection can be made in the number group circuits of various thousands of directory numbers:



Accordingly, by dialing the assigned directory number, any one of the PBX lines of the group can be selected in exactly the same manner as the selection of a regular subscriber line. A common party designation however will always be used for PBX lines, party 1 for example. Accordingly, the following chart summarizes the results:

Directory Number Dialed	Line of SLA	SLA	In PBX Group	Line of PBX Group	MDF Terminal Reached
ME7-1032	24	11	19	1	274
ME7-3764	24	12	19	2	279
ME7-2501	24	13	19	3	324
ME7-4003	24	14	19	4	329
ME7-1001	24	15	19	5	374

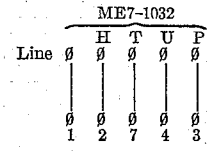
If, in busying out a PBX line its associated knife switch is opened, it is also desired to disable the night number of the line, one, two, three, or four of its number group jumpers may be disconnected, leaving at least one connected, which causes an incomplete code to be received by the sender from the number group circuit. As a result thereof, the sender routes the call to an intercept operator. (This device of disconnecting jumpers can be used with regular lines also to route them to an intercept operator. Furthermore, if no jumpers are connected for a directory number, the sender receiving no codes from the number group is apprised of the fact that an unequipped directory number has been dialed and routes the call to an automatic intercept circuit whereby the calling party receives a recorded message advising him that he has dialed a non-equipped number.)

If it is desired to use any line or lines of PBX group 19 for example as a non-PBX regular subscriber line:

1st: Open the associated knife switch in the LPX circuit.

2nd: Connect the "P" jumper in the number group to an appropriate party terminal.

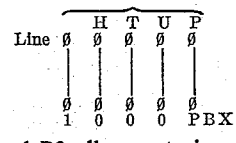
For example, line 24 of SLA–11 may be so arranged as follows:



Thus party 3 on the line on MDF terminal 274 would be rung by dialing ME7–1032. Of course, terminals 1, 2, 7, 4, 3 just shown could be cross-connected to the individual terminals of a different directory number, so that this line could be reached by dialing a different directory number.

Referring again to the LPX circuit of FIGURE 20, if it is desired to include more than five PBX lines in a common group by dialing a single directory number, this may be accomplished as follows.

For example, suppose that it is desired to include fifteen PBX trunks in PBX group 1. This may be accomplished by running jumpers between terminal 1 associated with conductor 1 of cable 1–20 and terminals associated with relays P1, P2 and P3. Thereby when the marker places ground on conductor 1 to select PBX group 1 as a result of the following cross-connections (see below) in the number group circuit,



relays P1, P2, and P3 all operate in parallel to battery. By reference to FIGURE 82, it can be seen that by the operation of relays P1, P2, and P3, ground test circuits from lines 20 in SLA's 1–15 are extended into the LPX circuit. Ground from the associated line circuits of idle PBX lines, through contacts of relays P1, P2, and P3, and break contacts of relays 1TR–15TR, operate relays of the group A1–A15 according to the lines which are idle. If all lines are idle, relays A1–A15 in the marker MLI circuit all operate. Only one of the relays A1–A15 lock, however, namely the lowest numbered. Accordingly, relay A1 locks, and relays A2–A15 release. Relay A1 operates relay 1TR and the test ground circuit from line 20 of SLA–1 is transferred by contacts of relay 1TR to conductor 41 of cable 41–45 whereby relay B20 in the marker MLI circuit. Thereby line 20 of SLA–1 is determined for selection.

If, for example, lines 20 of only SLA's 6, 13, 14, and 15 are idle, relays A6, A13, A14, and A15 operate but only relay A6 locks, as it is the lowest numbered resulting in the operation of relay 6TR. Thereby the test ground from line 20 of SLA–6 is extended conductor 1

of cable 41–45 operating relay B20 which results in line 20 of SLA–6 being selected.

Let us assume another example. Suppose it is desired to include eighteen lines in the same PBX group. This is accomplished by cross-connecting terminal 1 associated with lead 1 of cable 1–20 to the terminal associated with and leading to the winding of relay D1 to battery. Thus when the marker responsive to the before described cross-connections in the number group circuit, places ground on conductor 1 of cable 1–20, relay D1 operates. Four separate make contacts of relay D1 are connected to associated cross-connect terminals. These four terminals are cross-connected to the terminals associated with relays P1, P2, P3, and P4. The associated levers of relay D1 are grounded. Accordingly when relay D1 operates, ground through the four make contacts referred to operates relays P1, P2, P3, and P4. Let us suppose that the last two PBX lines associated with relay P4 are not used as PBX lines but as regular subscriber lines and accordingly their knife switches are opened and appropriate cross-connections are made in the number group circuits to reach them as regular lines.

When relays P1, P2, P3, and P4 operate, ground circuits from the associated PBX lines are extended into the marker. If all eighteen PBX lines are idle, ground circuits from lines 20 of SLA's 1–18 are extended to marker relays A1–A18 but only A1 locks. When the associated relay 1TR operates as a result of the operation of relay A1, the test ground from line 20 of SLA–1 is extended into the marker operating relay B20 resulting in the selection of line 20 of SLA–1. If all lines are busy except lines 20 of SLA's 17 and 18, relays A17 and A18 operate and only relay A17 would lock. When relay 17TR operated as a result thereof, the test ground from line 20 of SLA–17 is extended into the marker over conductor 1 operating relay B20 in the marker. With relay A17 and B20 operated, selection of line 20 of SLA–17 is determined.

It should be observed that the operation of relays P1–P20 control the operation of relays A1–A20 which control the operation of relays 1TR–20TR

P1	A1–A5	1TR–5TR.
P2	A6–A10	6TR–10TR.
P3	A11–A15	11TR–15TR.
P4	A16–A20	16TR–20TR.
P5	A1–A5	1TR–5TR.
P6	A6–A10	6TR–10TR.
P7	A11–A15	11TR–15TR.
P8	A16–A20	16TR–20TR.
P9	A1–A5	1TR–5TR.
P10	A6–A10	6TR–10TR.
P11	A11–A15	11TR–15TR.
P12	A16–A20	16TR–20TR.
P13	A1–A5	1TR–5TR.
P14	A6–A10	6TR–10TR.
P15	A11–A15	11TR–15TR.
P16	A16–A20	16TR–20TR.
P17	A1–A5	1TR–5TR.
P18	A6–A10	6TR–10TR.
P19	A11–A15	11TR–15TR.
P20	A16–A20	16TR–20TR.

Each relay 1TR can control relays B20–B25, but if marker relay A1 is operated by test ground from line 20 of SLA–1 as for example by the operation of relay P1, then the operation of relay 1TR extends this test ground to operate relay B20. If relay A1 is operated from test ground from line 21 of SLA–1, as for example by the operation of relays P5, then the operation of relay 1TR extends this test ground via conductor 42 of cable 41–45 to operate relay B21.

Of course, relay D1 can be connected to operate relays P1, P2, P3, P4, and P5 if desired, to give access to a PBX group of twenty-five lines. In this case if lines 20 and 21 of SLA–1 are both idle, test ground from line 20 of SLA–1 through make contacts of relay P1 and break contacts of relay 1TR; and test ground from line 21 of SLA–1 through make contacts of relay P5 and other break contacts of relay 1TR; converge via conductor 21 of cable 21–40 to operate relay A1. The operation of relay A1 results in the operation of relay 1TR, where upon test ground from line 20 of SLA–1 is extended over make contacts of relay P1 and 1TR to conductor 41 of cable 41–45; and test ground from line 21 of SLA–1 is extended over make contacts of relay P5 and 1TR to conductor 42 of cable 41–45 operating both of the relays B20 and B21, the lower of which B20 locks. Relay B21 releases.

Relays A20–A25 and B20–B24 have preference in locking from highest preference for relay A20 to the lowest preference for relay A25 and the highest preference for relay B20 to the lowest preference for relay B24. Thus if the first line, i.e., line 20 in a selected SLA is idle relay B20 will operate. If line 20 is busy but line 21 is idle, relay B21 will operate. If lines 20 and 21 are busy and line 22 is idle, relay B22 will operate, etc.

Let us consider the extreme case in which all 100 PBX lines of the 500 line group are included in a single PBX group. In this case terminal 1, for example, associated with conductor 1 of cable 1–20 may be cross-connected to the terminal associated with relay D1 and also to the terminal of another such relay not shown which we shall designate D2. Terminals associated with the make contacts of relay D may be cross-connected respectively relays P1–P10 and terminals associated with make contacts of relays D2 may be cross-connected respectively to relays P11–P20.

Accordingly, when the marker connects ground to conductor 1 of cable 1–20 to select the PBX group; relays D1 and D2 both operate, in turn operating relays P1–P20.

Assuming all PBX lines idle, test ground from lines 20–24 of SLA's 1–20 pass through associated closed knife switches, make contacts of relays P1–P20 and break contacts of relays 1TR–20TR to leads 21–40 of cable 21–40, operating all relays A1–A20, the first of which, A1, locks. Relay A1 operates relay 1TR whereupon test ground from lines 20–24 of SLA–1, through make contacts of relay 1TR on leads 41–45 of cable 41–45 operates relays B20–B24, one of which, B20 locks. Accordingly line 20 of SLA–1 is selected.

Accordingly SLA–1 has first priority but if all lines in SLA–1 are in use SLA–2 has next priority, etc. Also in any SLA, line 20 has first priority but if line 20 is in use line 21 has next priority, etc.

The flexibility of the system is illustrated by the fact that any terminal 1–20 of cable 1–20 can be connected to any terminals associated with relays P1–P20. Also any terminal 1–20 of cable 1–20 can be connected to relays D1, D2, and more than two D-relays may be equipped.

For example terminal 1 of cable 1–20 could be cross-connected to relay D1 and the make contacts of relay D1 could be cross-connected to relays P4, P5, P19, and P20. Terminal 2 of cable 1–20 could be cross-connected to the terminals associated with relays P1 and P2. Terminal P20 of cable 1–20 could be cross-connected to the terminal associated with relay P3, etc.

It should be observed that when relay 1PN1 operates upon initiation of a call to a PBX group, ground through contacts 1PN1–*d*, conductor 27, cable 1–27, cable to MLI, conductor 27, contacts AB–*d*, conductor 5, cable to MTT, conductor 5, contacts BYP2–*a*, upper winding of relay BYP1 to battery, operates relay BYP1. Relay BYP1 closes circuits through its contacts *a* and *b* to make itself slow in releasing via its lower winding and operates relay BYP2 over the circuit from ground on conductor 5, contacts BYP1–*c*, winding of relay BYP2 to battery. Relay BYP2 locks over the circuit from battery through its winding, contacts BYP2–*b*, to ground on conductor 5, opening the upper winding circuit of relay BYP1 at contacts BYP2–*a*. Contacts BYP2–*b* close before contacts BYP2–*a* open. Relay BYP1 has a release time of 50 to 60 milliseconds. If relay AB in the MLI circuit has not operated by this time (indicating a busy PBX group),

the holding circuit of relay BYP2 has been maintained and relay BYP2 has remained operated. Ground through contacts BYP1–*e*, BYP2–*d* to lead "PBX Busy" actuates a PBX busy indication on the SLM Fuse Panel. Positive 48 volts potential through contacts BYP1–*d*, BYP2–*c*, conductor LBY, cable to MCR, conductor LBY, contacts RA3–*b*, CRG–*a*, tip conductor T, cable to MCC, conductor T, contacts 5RAN1A–*i*, conductor T, cable to LCT, conductor T, contacts of magnets M39 and M1, conductor T otherwise designated **5982**, contacts **5930**–*m*, **5940**–*e*, conductor **5956** otherwise designated T, through GSB crosspoints, GSA crosspoints, SRL crosspoints as conductor ST, through the register, through contacts of the register-sender connect relays, through break contacts of relay S (FIGURE 10), make contacts A4 of relay A, through the winding of relay LBY to ground operates this relay, which closes ground over its make contacts to release circuitry. The release circuitry places ground on lead RD to the register, operating relay RD. Relay RD releases connections in a manner essentially the same as described hereinbefore.

However if relay AB has operated, indicating an available PBX group, ground is removed from conductor **5**, opening the holding circuit of relay BYP2 and this relay releases before BYP1 releases. When contacts BYP2–*a* reclose, ground is not present on conductor **5** and accordingly relay BYP1 is not reenergized. Accordingly, when relay BYP1 releases no circuit obtains to the PBX Busy indicator and 48 volts positive potential through BYP1 is prevented from reaching the LBY conductor.

It should be observed that when relay 1PBX operated as a result of the sender sending the hundreds digit, relay 1PBX connected battery through a 200 ohm resistor and 8 mf. condenser, contacts 1PBX–*i*, to conductor **2**, which, passing through contacts 1ABL–*i* to conductor **1** and the cable to the MCI circuit, emerging on conductor **1** and passing through the winding of relay K3 to battery extends the release time of relay K3 by an interval in the order of 150 milliseconds. Accordingly, if by any chance a PBX line is not found and a path established thereto from the calling CRB by the time relay K3 releases, a congestion busy signal is sent to the sender which releases connections. Ordinarily on a call to a busy PBX group, the LBY signal to the marker will have been sent before this by relays BYP1 and BYP2 as described above.

It should be noted that on a call to a regular line, the operation of relay BY2 places +48 volts through contacts BY2–*c* on conductor LBY which effects the operation of sender relay LBY and in turn register relay D which in turn effects the release of the connections.

Furthermore it should be noted that when all terminating paths are busy, +48 volts, through make contacts of relay K4, break contacts of relay K3 or K5, conductor CBY, cable to MCR, conductor CBY, contacts RA3–*d*, CRG–*b*, ring conductor R over a similar path to that traced for conductor T, through make contacts A1 of relay A, rectifier in the correct direction, winding of relay CBY to ground operates this relay which connects ground through its make contacts to release circuitry. The release circuitry effects the operation of register relay D which effects the release of connections. It should be observed that if a path is not obtained within a specified time, relay K3 releases. Relay K3 opens the normal operating circuit of relay K4 (ground, K5–*b*, K3–*b*, winding of relay K4 to battery). Relay K4 is a slow release relay and during the interval between the release of relay K3 and the release of relay K4, this ground obtains on conductor CBY.

M. *Terminating call from wire chief or busy verification trunk*

Referring now to FIGURES 1–4, therein is illustrated a wire chief trunk **235** which can also be considered illustrative of a busy verification trunk accessible to local operators. In FIG. 4 is shown a group of such wire chief or busy verification trunks, designated **235**–**235***a*.

When such a trunk which we shall generically call a test trunk, initiates a call trunk **235**, for example, a signal over path **235'**, path **239***a*, and path **239***x* (assuming that test trunk **235** is associated with horizontal **1** of the first TRL switch **239***f*) actuates the guard and connect relays associated with TRL switch circuit **239***f*, which energize appropriate horizontal and vertical magnets of the TRL crossbar switch to extend the test trunk **235** over one of its TRL verticals and path **245** to an incoming register such as **300** which via path **310**, guard and connect relays **301** and path **311** engages a sender translator such as **302** which via path **312**, connect relays and paths **313** and **318** engages a number group circuit such as **308**.

Referring now to FIGS. 10 and 11, a marking conductor extends from test trunk **235** over the TRL crosspoints into the register to a test indication circuit which passes the information to the "classification of call" circuit in the sender.

The digits of the called number are dialled into the register over the TRL crosspoints via one or more of the leads RT and RR into the sender.

The sender in response to information received from the number group sends two signals to the group selector marker which extends the trunk ring and tip circuits over path **246**, **129** etc. through thee group selector GSA and GSB crosspoints into the CRB circuit.

When the CRB circuit is ready to receive, the sender sends two signals to the CRB circuit, the first of which is a test signal comprising ground on the ring and nothing on the tip occasioned by the ring conductor SR fan of contacts in the sender block labeled "classification of calls, etc.," being so adjusted in response to the test indication signal from the marker. (Refer to page 77 of the copending patent application for this signal in the chart thereat. While this signal is designated "Wire Chief Test" thereat, it should be understood that it is used for "Busy Verification" also. The sender also sends the party signal to the CRB.)

The "test" trunk signal referred to comprising ground on the Ring Conductor and nothing on the Tip results in relay WC in the CRB circuit being operated as described in the copending application.

Of course, the CRB circuit has seized a subscribers line marker such as SLM–1 shown. With relay WC operated in the CRB circuit, a circuit is completed from ground through contacts WC–*j* in the CRB circuit, conductor **5968** which becomes **5985** and lead RWC, through contacts associated with multiple relay magnet M1 in the LCT circuit, contacts associated with magnet M39, cable **6003**, conductor RWC, contacts 5RAN1A–*f* in the MCC circuit, conductor RWC, cable to the MTT circuit, conductor RWC, contacts RC–*b*, 1RC–*c*, through the winding of relay WC to battery, operating relay WC in the MTT circuit, whereby the marker is marked for a call from a test trunk such as used by a wire chief or a busy verification operator. It should be observed that this occurs upon first seizure of the marker. Relay WC immediately disconnects the S-wire circuit from the lower winding at contacts WC–*b* and completes the following circuit to simulate an idle line to the lower winding of relay 1RC, shunting relay 1RC: battery through a 350 ohm resistor, contacts WC–*a*, BT–*b*, lower winding of relay 1RC, to battery.

When the marker is ready to receive, the sender transmits the hundreds, tens, and units signal to the marker code receiver.

When the originating end of the marker is available, it is seized and the SLA horizontal magnets are operated, extending the called S-wire into the marker as described hereinbefore. This S-wire circuit extends through the marker into the MTT circuit via conductor **14**, break contacts IA–*g*, BY2–*e*, IRC–*g*, to open contacts WC–*b*.

When relay BT operates during the S-wire test, battery through the 350 ohm resistor, contacts WC–*a*, BT–*c*, through the upper winding of relay BY1 operates this relay, which locks from battery through its lower winding, contacts BY1–*b* and BT–*f* to "master ground." Relay BY1 opens its contacts BY1–*a* preventing the operation of relay BY2. Thereby the marker is set up as it is for an idle call and proceeds as though the called line is idle, closing SLB and SLC horizontal magnets, and then SLB and SLC vertical magnets to set up the call to the called line whether it is busy or not.

Thereupon ring and tip circuits extend from the Wire Chief Trunk or Busy Verification trunk through the group selector crossbar switches GSA and GSB, CRB circuit, and crossbar switches SLC, SLB, and SLA to the ring and tip conductors of the called line. More specifically, referring to FIG. 3 a four conductor path can be traced from test trunk 235 (which can be a wire chief trunk or a Busy Verification trunk) over paths 246, 129, 169, 170 to the GSA cross bar switch, which conductors as shown in FIG. 13C comprises conductors R, T, S, and C. These conductors can be traced further by reference to FIGS. 13A and 14D in that order into the CRB circuit. The ring conductor R (5957) can be traced through contacts 5940–*b*, 5930–*d*, conductor 5995, 5710–*g*, 5700–*c*, conductor 5788 which is conductor R through the SLC, SLB, and SLA crosspoints to the called line. A similar circuit can be traced for the ring conductor.

Of course the ring was pre-tripped by relay WC in the CRB circuit which provides a locking path for relay RT in the CRB, preventing its release.

Ground on the S-wire from the test trunk holds relay MB in the CRB circuit which places ground its contacts 5920–*g* on conductor 5997 which becomes conductor 5786 which is the outgoing H-wire, holding vertical magnets in the SLC, SLB, and SLA switches.

Thereupon the Busy Verification operator or Wire Chief can monitor the called line.

The C-wire (conductor 5959) entering the CRB circuit from the GSB switch can be traced further as conductor 5999, through contacts 5760–*d*, to conductor 5787 which is the called S-wire and passes through the SLC, SLB, and SLA crosspoints to the called line circuit.

A wire chief's trunk is arranged so that by manipulation of a key the wire Chief can selectively place ground on the C-wire which by its connection to the called S-wire operates the cut off and lock-out relays of the called line to clear the called line for testing and to busy it out. Thereupon the Wire Chief can make a batter, ground, and other tests of the call line ring and tip.

Furthermore, the Wire Chief can then manipulate the key to remove ground from the C-wire, releasing the called lockout and cut-off relays. By manipulation of another key the Wire Chief trunk can then place a loop across the ring and tip, causing the associated line relay to operate, seizing a marker via the LEO circuit which connects up the line to an idle register over an available path. Thereupon the Wire Chief can dial up any number over this loop. In review this connection extends from the Wire Chief trunk, over the GSA and GSB crossbar switches, through a CRB circuit, over SLC, SLB, and SLA switches to the called line, thence over a different SLA vertical, through SLB and SRL switches to a register, etc., and after the call is switched through, over a different GSA–GSB path, a different CRB, and a different path through SLC, SLB, and SLA crossbar switches to the called line. This connection involves three SLA verticals.

When the test trunk opens removes ground from the S-wire (by means of which the CRB circuit was seized and held), relay MB (5920) releases, removing ground from the H-wire which releases the SLC, SLB, and SLA switches to the called line. Removal of the loop on the called line releases the second seized CRB which releases the connections set up over the called line loop.

VII. Miscellaneous

A. *Originating call self release*

Relay K1 (see MLI) is normally operated. Relay K1 operates over the path from battery through the upper winding of relay K1, contacts K1–*e*, 1ANC–*e* to ground and locks over the circuit from battery through the upper winding of relay K1, in series through the lower winding of relay K1, contacts K1–*f* which close before contacts K1–*e* open, 1ANC–*e* to ground.

Relay K3 also is normally operated over the path from battery through the winding of relay K2, contacts K1–*d* to ground. It should be observed that relay K2 is a 100 millisecond slow release relay.

When relay 1ANC operates during the passage of an originating call through the marker, relay 1ANC removes direct ground from the holding circuit of relay K1 at its contacts 1ANC–*e*, and at its contacts 1ANC–*f* which close before contacts 1ANC–*e* open connects 2200 ohm battery to the holdling circuit of relay K1. Circulating current through the two windings in series of relay K1 will hold relay K1 in the operated position for approximately 200 milliseconds. Accordingly, if the calling line is not identified by the time K1 releases, the trouble recorder is signalled over the following paths. Ground, K1–*a*, K2–*b*. Ground, K1–*d*, K2–*g*. These two ground circuits identify the SLM marker by operating appropriate group and units relays in the trouble recorder. Any time that relay K1 releases and identifies the SLM marker to the trouble recorder, the trouble recorder observes which other leads from the marker have ground on them and thus is enabled to make a tape recording of the trouble. At its contacts *d*, relay K1 opens the circuit of relay K2, which begins its slow release period. At its contacts *b*, relay K1 operates relay K1 over the circuit from ground, contacts K1–*b*, K2–*e*, upper winding of relay REL1 to battery, relay REL1 locking over the path from battery over the upper winding of relay REL1, contacts REL1–*a*, 2AND–*e*, to ground. Relay REL1 places ground on the calling S-wire over the path from ground, contacts REL1–*b*, 1ABL–*e*, conductor SLA–S, etc., operating the line cut off relay (CO17 for example) which releases the line relay (LR17 for example), preparing the line to go on lockout when REL1 subsequently releases.

After approximately 100 milliseconds, relay K2 releases opening the SLM identifying leads to the trouble recorder at contacts K2–*f* and K2–*g*. The release of relay K2 operates relay REL2 over the path from battery through the winding of relay REL2, REL1–*d*, K2–*d*, K1–*b*, to ground. Relay REL2 locks over the path from battery through the winding of relay REL2, contacts REL2–*c*, 2AND–*g*, to ground.

With relay LR17 released, any calling loop circuit to the marker is opened. With relay K2 released, the holding circuit of any relay A1–A20 and relays 1AA, 2AA, and 3AA is opened at contacts K2–*f*. With relay REL2 operated, the holding ground circuit of relays B0–B24 (B17 for example) and 1BA is open at contacts REL2–*a*; the holding battery circuit of B17 and 1BA is open at contacts REL2–*d*; and the circuit of relay 4BA is open at contacts REL2–*b*; effecting release of the marker.

When relay 1ANC releases, relay K1 reoperates, in turn releasing relay REL2 and reoperating relay K2. When relay 2AND releases, the holding circuit of relay REL1 is opened and this relay releases.

However, if the line is identified before relay K1 releases (i.e. within approximately 200 milliseconds), as evidenced by the operation of relay BB, at its contacts K, relay BB, connects a circuit from battery through a 200 ohm resistor, condenser C1, contacts BB–*k*, K1–*f* to the holding circuit of relay K1, increasing the release time of relay K1 to approximately 1000 milliseconds. It should be observed that before the operation of relay BB, ground through contacts BB–1 charged condenser C1. If a path

is not found by the time relay K1 releases, relay K1 initiates release of the marker in the manner described.

B. *Terminating call self release*

Relay K3 is normally operated over the cidcuit from battery through the winding of rlay K3 and contacts 2RANC–*e* to ground. Relay K4 of the 100 millisecond slow release type is normally operated over the circuit from battery through the winding of relay K4, contacts K3–*b*, and K5–*b* to ground. Ground through 2 RANC–*b* charges condenser 8.

When relay 2RANC operates, the ground circuit to the winding of relay K3 through contacts 2RANC–*e* is opened but relay K3 will remain in the operated position due to circulating current over the path from battery through the winding of relay K3, condenser 8, 200 ohm resistor to battery for approximately 200 milliseconds. If the codes from the sender have not all been received by the time relay K3 releases, the release of relay K3 closes the following two circuits to the trouble recorder which operates group and units relays in the trouble recorder to identify the particular SLM marker to the trouble recorder. Ground, contacts K4–*d*, K3–*a*, ground, contacts K4–*f*, K3–*d*. Relay K3 opens the circuit of 100 milliseconds slow release relay K4 at contacts K3–*b*.

After approximately 100 milliseconds relay K3 releases, opening the SLM identifying circuits to the trouble recorder. At its contacts K3–*a*, relay K4 removes the holding battery from the operated relay of the group RB1–RB11 and relay 1RBA which initiates release of the marker.

However, if all codes have been received by the marker code receiver from the sender as evidenced by the operation of relay RA3 in the marker code receiver and in turn relay 1ABL in the originating end of the marker an additional holding circuit is connected to the winding of relay K3 over the following circuit, increasing the release time of relay K3 to approximately 1000 milliseconds; battery, 200 ohm resistor, condenser 30, conductor 2, contacts 1ABL–*i*, conductor 1, cable to MCI, conductor 1, winding of relay K3 to battery. Accordingly, if a path is not found by the time relay K3 releases, marker release is initiated by the operation of relay K3 in the manner described. Relay K3 also completes a circuit from +48 volt battery, through contacts K4–*e*, K3–*c*, lead CBY, cable to MCR, lead CBY, contacts RA3–*d*, CRG–*b*, conductor R, etc. to relay CBY in the sender. The sender transmits a congestion busy signal to the calling end and releases connections.

C. *Terminating call preference*

When an originating call is progressing through the marker and a terminating call is waiting, release of the marker is such that relay RBL in the MTT circuit releases and permits relay 1ABL in the MLI circuit to operate, preventing another originating call from seizing the marker before the waiting terminating call. (It should be appreciated that even though an originating call is passing through the marker, the terminating end of the same marker can be seized by a CRB and progress through the terminating end of the marker can take place up to the point where all codes have been received by the marker code receiver from the sender and relay RA3 has operated. However, if relay RBL or relay O1 in the terminating end is operated due to a call to the same 500 group in the same or the companion marker, relay RA3 is prevented from operating relays 1ABL, 2ABL, and 1CN1–3CN1.)

D. *Congestion busy and other miscellaneous release*

Relay K5 in the MCI circuit can be operated in several ways.

(1) If no path is found, ground on the start lead, through contacts DGC–*a* and R–*b*, through the lower winding of relay CB to battery energizes relay CB. Relay CB is made slow to energize by its short circuited upper winding. After approximately 50 milliseconds have elapsed, relay CB operates, placing ground through contacts CB–*a* on conductor 2 through a cable to the MCI circuit, conductor 2, winding of relay K5 to battery operating relay K5 which locks over contacts K5–*d*, 1RAND–*g*, and RANA–*d* to ground. Relay K5 releases relay K4 which releases the marker. As the marker releases, relay K5 is released and reoperates relay K4.

(2) If relay TO1 or TO2 in the marker code receiver releases, ground is placed on lead CRF (code receiver failure) which becomes conductor 2. This operates relay K5 which performs functions described above.

(3) Also, if a path is found, as evidenced by the operation of relay DGC and the release of relay DGD, and SLB horizontals operate as evidenced by the non-operation of relay HF4, ground through contacts *d*, *e*, and *f* of relay 3RBA (in MCI), conductors 3, 4, and 5 respectively, cable 3–5, cable to MVT, cable 3, 4, 5, conductors 3, 4, and 5, contacts *e*, *d*, and *c*, of relay DGC, contacts *d*, *c*, *b* of relay DGD, contacts *e*, *c*, and *a* of relay HF3, contacts *e*, *c*, and *a* of relay HF4 on conductor 2 operates relay K5 which performs functions described. (As stated previously, if relay HF3 non-operated this ground passes through contacts *f*, *d*, and *b* of relay HF3 through the winding of relay R to battery. Relay R locks over contacts RC and DGC–*f* to ground, disconnecting the start lead ground and the lower winding circuit of relay CB from relay DGC and the operated one of the relays DG1–DG20. Pathfinding is tried again and with the jump rotator ASG1–ASG20 shifted the chances are good of the call progressing to completion.)

These and other features of the invention which are believed to be new are set forth in the accompanying claims.

What is claimed is:

1. In an automatic telephone system including a plurality of switching stages for extending calls between a plurality of lines, means for controlling said switching stages to extend connections made by parties on a line to other parties on the same line including means for detecting such calls as attempted, means operative with detection of such type call to transmit a recorded message to the calling subscriber requesting him to restore his receiver to permit ringing of the called party, and means operative responsive to answer by the called party to send a signal to the called party requesting the party to hold the connection pending re-answer by the calling party.

2. In an automatic telephone system comprising a plurality of switching stages for extending calls between a plurality of lines including a subscriber line-switch stage, a group selector switch stage, and a cord relay circuit stage for establishing a main path connection between the calling and called subscribers, and at least a marker circuit and a sender circuit operative over by-path connections to control said switches in the establishment of the main path, means in the cord relay circuit operable with seizure thereof to seize an idle marker circuit, means in said marker circuit operative to establish a by-path connection to the called line for the purpose of determining the availability thereof, busy test means in said marker for determining the availability of said line over said by-path connection, reverting call test means, means operative with selection of a busy called line to connect said reverting call test means to a circuit including the called line by-path connection and the calling line main path connection, and means operative responsive to the determination in such test that the connections of the called line and the calling line are the same to control the switches to extend the main path to the called line independent of the busy condition indicated.

3. In an arrangement as set forth in claim 2 in which the cord relay circuit includes means for extending a recorded message to the calling subscriber responsive to the

extension of a reverting call thereover which instructs the calling party to replace his handset, and means operative as the called party answers to connect a recorded message to the connection requesting the called party to await re-answer by the calling party.

4. An arrangement as set forth in claim 2 in which each line includes an associated test conductor, and the revertive call test comprises means for testing for the establishment of a loop which extends from the revertive call test circuit over the by-path connection to the called line test conductor and over the calling line test conductor path which has been extended over the switching stages with the main path to the revertive call test circuit.

5. In an automatic telephone system comprising a plurality of switching stages for extending calls between a plurality of lines including a subscriber line switch stage, a group selector switch stage and a cord relay stage for establishing a main path connection in the direction of a called subscriber, and at least a marker circuit, and a sender circuit operative over by-path connections to control said switches in the establishment of the main path, means in said cord relay circuit operable with seizure thereof to seize an idle marker circuit, means in said marker circuit operative to establish a by-path connection to the called line for the purpose of determining the availability thereof, busy test means in said marker for determining the availability of said line over said by-path connection, reverting call test means, means operative with selection of a called line which tests busy to connect said reverting call test means to a circuit including the called line by-path connection and the calling line main path connection, and means operative responsive to the determination that the called line and the calling line are the same in such test to effect extension of the main path to the called line independent of the busy condition indicated.

6. In an automatic telephone system comprising a plurality of switching stages for extending calls between a plurality of lines including at least a subscriber line switch stage, a group selector switch stage, and a cord relay stage for establishing a main path connection in the direction of the called subscriber, and at least a marker circuit and a sender circuit operative over by-path connections to control said switches in the establishment of the main path, means in said cord relay circuit operable with seizure thereof to seize an idle marker circuit, means in said marker circuit for detecting reverting calls and signaling the cord relay circuit as to the nature of the call, means in the cord relay circuit for holding the switching stages extending the calling line connection thereto including means for signaling the calling party over the connection to restore his handset, and means operative to simultaneously signal the marker to extend the main path connection over succeeding subscriber line switches to the called party line, means in said succeeding switches for signaling said sender equipment to release, means in said cord relay circuit for initially ringing the called party as the calling party restores his receiver, means in said cord relay circuit for terminating ringing as the called party answers, and means for thereafter applying signals over the connection requesting the called party to await re-answer by the calling party.

7. An arrangement as set forth in claim 6 in which said cord relay stage includes means for restoring said calling subscriber line stage and said group selector stage responsive to restoration of the handset by the calling party.

8. An arrangement as set forth in claim 6 in which said cord relay stage includes a timing circuit for effecting application of a signal to the called party for a predetermined period to inform the called party to await re-answer by the calling party.

9. In an automatic telephone system comprising a plurality of switching stages for extending calls between a plurality of lines including coin box lines, said switching stages including at least a subscriber line switch stage, a group selector switch stage, and a cord relay circuit stage for establishing a main path connection in the direction of the called subscriber, and at least a marker circuit, a register and a sender circuit operative over by-path connections to control said switches in the establishment of the main path connection; a plurality of groups of connecting relay circuits for use in extending the connection between the subscriber line switch stage and the group selector switch stage, each circuit of at least one of said groups having a coin box trunk associated therewith, coin box test means in the exchange for detecting calls which originate over coin box lines, and means controlled by said coin box test means responsive to detection of a call of coin box line origin to effect seizure of one of said connecting relay circuits of said one group for use in extending the connection.

10. In an automatic telephone system comprising a plurality of switching stages for extending calls between a plurality of lines including coin box lines, said switching stages including at least a subscriber line switch stage, a group selector switch stage, and a cord relay circuit stage for establishing a main path connection in the direction of the called subscriber, and at least a marker circuit, a register and a sender circuit operative over by-path connections to control said switches in the establishment of the main path connection; coin box test means in said marker for detecting calls which originate over coin test lines, and coin box trunk means connected for seizure only responsive to detection of a call of coin box origin by said test means for controlling alternatively coin collection and refund as each such call is completed.

11. An automatic telephone system as set forth in claim 10 in which each coin box trunk has marking means operative to mark a call as answered and unanswered, and means for selectively transmitting tip and ring signals to effect alternatively collect and refund of the coins deposited by the calling party.

12. An arrangement as set forth in claim 10 in which each register circuit includes means operative to block the call progression following receipt of a given number of digits and prior to coin deposit by the calling party.

13. An automatic telephone system as set forth in claim 10 which includes means for providing normal answer supervision responsive to answer by a called party to indicate to a trunk that the call is answered and which includes means in the calling coin box trunk for marking the call as unanswered to thereby retain control of the connection release in the calling line on a call from a pre-pay coin box line.

14. In an automatic telephone system comprising a plurality of switching stages for extending calls between a plurality of lines including coin box lines, said switching stages including at least a subscriber line switch stage, a group selector switch stage, and a cord relay circuit stage for establishing a main path connection in the direction of the called subscriber, and at least a marker circuit, a register and a sender circuit operative over by-path connections to control said switches in the establishment of the main path connection; coin box test means in the exchange for detecting calls which originate over coin box lines, coin box trunk means for controlling coin refund and collection connected for seizure only responsive to detection of a coin box call by said test means, means operable prior to coin deposit to block extension of a coin box call beyond the switching stage in the exchange which is normally seized with receipt of the predetermined number of digits, and operator trunks connected to be seized from said coin box lines responsive to dialing of a number of digits less in number than said predetermined number.

15. An automatic telephone system as set forth in claim 14 in which said operator trunks include means for providing a "no-answer" signal to the coin box trunks re-

sponsive to answer by an operator to permit refund of the coins by the trunks as the calling party restores.

16. An automatic telephone system as set forth in claim 14 in which said operator trunks include a special group of toll operator trunks which are connected to be seized responsive to dialing of the digit groups preassigned thereto which are of a number less than said predetermined number, means in said toll trunks for effecting refund automatically with operator answer, and means for simultaneously conditioning the coin box trunk to effect automatic collection of the coin deposit requested by the operator as the calling subscriber subsequently restores.

17. An automatic telephone system as set forth in claim 14 in which said exchange includes means for detecting calls from a coin box line to predetermined numbers, and means in the sender circuit operative responsive to detection of such call to transmit a signal to the cord relay circuit to control same to withhold answer supervision, and means in the coin box trunk operative following restoration by the calling party to effect coin refund whenever answer supervision is thus withheld.

18. An arrangement as set forth in claim 14 in which said register circuit includes means for signaling the sender circuit responsive to receipt of a call from a coin box line to route the call over special toll operator trunks having collect and refund facilities, means for indicating to the operator that the call is a coin box call, and means in the toll operator trunks and toll board facilities for providing control of coin box collect and refund by the operator.

19. In an automatic telephone system including switching stages for establishing connections between the calling and called lines, testing means associated with one of said stages operative to determine the idle, busy, and lock-out condition of the called line responsive to advancement of the call to the stage associated therewith comprising a first means for testing for a busy line, means operated as said means detects a busy line to initiate a test to determine if the call is a reverting call; a second means operative to test said line for an idle condition; a third means operative to indicate a line as alternatively in a busy and lock-out condition whenever said second means indicates that the line is not idle; and means operative responsive to detection of a reverting call to effect operation of said second means and to prevent operation of said third means, to thereby permit establishment of the connection to a line indicated as busy.

20. In an automatic telephone system for establishing connections between calling and called lines, a line circuit associated with each calling line including a test conductor, and means for providing signals over the test conductor which indicate respectively the idle, busy and lock-out conditions of the associated line; test circuit means in said exchange for testing the condition of a line during establishment of a connection thereto comprising a first test member connected to operate after expiration of a given delay period responsive to seizure of the test circuit, a second test member connected to said test conductor by said first test member only for said delay period and connected to operate only if the signal on the test conductor indicates the called line is busy; a third test member, and means controlled by said first test member in its operation following said delay period to connect said third test member to said test conductor, means connecting said third member for operation only responsive to an idle signal on said test conductor, and means for maintaining said third member operated whenever an idle line signal is received, a fourth test member, and means for connecting same to operate after a delay period responsive to seizure of said test means and failure of operation of said third means as a result of the test wire indicating alternatively a busy and lock-out condition, whereby said fourth test member is operative responsive to receipt of a lock-out and alternatively a busy condition signal.

21. An automatic telephone system as set forth in claim 20 which includes means controlled by said fourth test member in its operation to signal a line busy condition, and means controlled by said second means as operated whenever a test wire line busy indication signal is received to initiate a test for a reverting call, and means operative responsive to detection of a reverting call to effect operation of said third test member, means controlled by said third test member in its operation to prevent the operation of said fourth test member and thereby permit extension of the connection to the called line independent of the called line busy indication received by the test means.

22. In an automatic telephone system comprising a plurality of switching stages for extending calls between a plurality of lines, said switching stages including at least a subscriber line switch stage, a group selector switch stage including a cord relay circuit for establishing a main path connection comprised of two talking conductors and a sleeve conductor in the direction of the called subscriber, and at least a marker circuit, a register and a sender circuit operative over a by-path connection and a portion of the main path connections thus far established to control certain of said switching stages in the further establishment of the main path connection; a trunk group means operative to seize an idle trunk in establishing calls to a given group of subscribers, a control signal conductor connected for extension from said subscriber line switch stage over the group selector switch stage to the trunk for use in conditioning same to receive signals from the sender circuit, means in said register for controlling said subscriber line switch stage to place the conditioning signal on said control signal conductor upon receipt of a signal from the sender circuit prior to the initiation of the sending operation thereby, and means in said sender for causing said register to control said subscriber line switch stage to remove said conditioning signal following termination of the sending operation by the sender.

23. An automobile telephone system as set forth in claim 22 which includes coin box lines and coin box trunks which are connected for seizure responsive to establishment of a call by a coin box line, and means in the cord relay circuit operative over the said signal control conductor with subscriber answer to condition a seized coin box trunk to effect coin collect following restoration by the calling party.

24. An automatic telephone system as set forth in claim 22 which includes wire chief trunk extension means for establishing a connection over a group selector stage and a cord relay circuit in the direction of a desired line, and means in said cord relay circuit operable responsive to calls over a wire chief trunk to connect said signal conductor from the trunk to the test conductor of the called line to permit control of the called line circuit by the wire chief.

25. An automatic telephone system as set forth in claim 22 which includes delayed ring trunks, means for seizing said trunks over said switching stages, means for extending said signal conductor from a delayed ring trunk to the cord relay circuit for the purpose of extending signals over said signal conductor to delay the ringing operation.

26. In an automatic telephone system comprising a plurality of switching stages for extending calls between lines, a plurality of groups of lines, certain of which line groups include a PBX line group, said switching stages including at least a group of subscriber line switches for terminating said plurality of groups of lines and having a set of identification devices associated therewith, a marker circuit for controlling said stages in the extension of connections, means in said identification groups for identifying the calling line group and the calling line of the group to said marker to assist same in controlling the extension of the call, means in said subsequent switching stages for detecting calls directed to said PBX group in

one of said certain line groups, and means responsive to detection of a call to a PBX line group to engage the identification set associated with the group of said subscriber line switches which includes the calling line, and means for controlling said identification set to effect selection of a subscriber line switch having at least one idle PBX line in the selected PBX group.

27. In an automatic telephone system having switching stages for extending connections between calling and called lines, certain of which are PBX lines, register means, means for effecting seizure of said register means responsive to initiation of a call, means for transmitting thereto the called party directory number for registration therein, directory number translator means including means for providing signals of a first code which are indicative of the terminal location of the line having the registered directory number, means for detecting calls as registered which are directed toward a private branch exchange group, means operative responsive to detection of a private branch exchange group to provide signals of a second code different than said first code, marker means for controlling said stages in effecting extension of a call, and means in said marker means operative responsive to receipt of a set of signals of said first code to effect selection of the line indicated thereby, and means operative responsive to receipt of a set of signals of the second code to effect selection of an idle line in the PBX group indicated thereby.

28. In an automatic telephone system having switching stages for extending connections between calling and called lines which are divided into groups, certain of which are PBX lines, means for controlling said switches in the establishment of the connections including marker means, means for transmitting three digit signals to said marker means to further extend the connection toward the desired line, the regular subscriber line groups having hundreds designations which lie within a first set of values, and the PBX line groups having hundreds designations which lie within a second set of values, a group of selection paths for effecting selection of said subscriber line groups, a group of selection paths for effecting selection of said PBX line groups, means operative in accordance with the value of the tens and units digits received to prepare selection paths for a certain regular subscriber line group, and simultaneously to prepare selection paths for corresponding PBX line groups, means for preparing one of the selection paths thus selected in accordance with the value of the hundreds digit received.

29. An automatic telephone system as set forth in claim 28 in which said marker includes means operative in accordance with the value of said tens and units digits to select the desired subscriber line in the selected group of subscribers' lines.

30. An automatic telephone system as set forth in claim 28 in which at least one of said switching stages includes a plurality of subscriber line switches, each of said switches having line groups associated therewith; identification means associated with predetermined groups of said subscriber line switches operative with initiation of a call to identify the calling line group and the calling line in the group and means controlled by the paths which extend a connection to the PBX line groups for connecting said identification means to operate in selecting a subscriber line switch having at least one idle one of the desired PBX lines associated therewith and in selecting an idle PBX line therein.

31. In an automatic telephone system as set forth in claim 28 in which said means which prepare the selection paths comprises relay members each of which prepares paths for selection of regular line groups and paths for selection of corresponding PBX line groups, which corresponding paths are selectively prepared according to whether the hundreds digit is the proper lower hundreds digit or the proper higher hundreds digit, and means operative responsive to receipt of a hundreds digit within a first set of values to prepare the selection path for a regular line group and to select a specific line group in accordance with the particular value of the hundreds digit and in which said means prepare a selection path for a PBX line group if the hundreds digit is within a second set of values and in which the particular value of the hundreds digit determines which PBX group will be selected.

32. In an automatic telephone system comprising crossbar switching stage means for extending calls between lines, said lines including subscriber multiparty lines, subscriber coin box lines and groups of subscriber PBX lines; means for establishing by-path connections to control said switching stage means in the establishment of main path connections including at least marker circuit means; detection means in said marker circuit means operative to test calling lines to detect the ones of the calling lines which are coin lines, including means operative responsive to detection of a coin line to selectively engage coin box trunk means for use with the call; identification means operative responsive to receipt of the called party number for providing signals of a first code over the main path connection to said marker circuit means which identify calls directed to lines other than PBX lines, and signals of a second code different than said first code which identify calls directed to PBX lines; means in said marker circuit means operative responsive to receipt of said second signal code to control the establishment of a connection to an idle one of the PBX lines, and operative responsive to the receipt of said first signal code to control establishment of a connection to a line other than a PBX line; and means in said marker circuit means including said detection means for detecting a reverting call, including means operative in response to detection of a reverting call to control the switching stages to establish a reverting call connection between the called and calling parties.

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