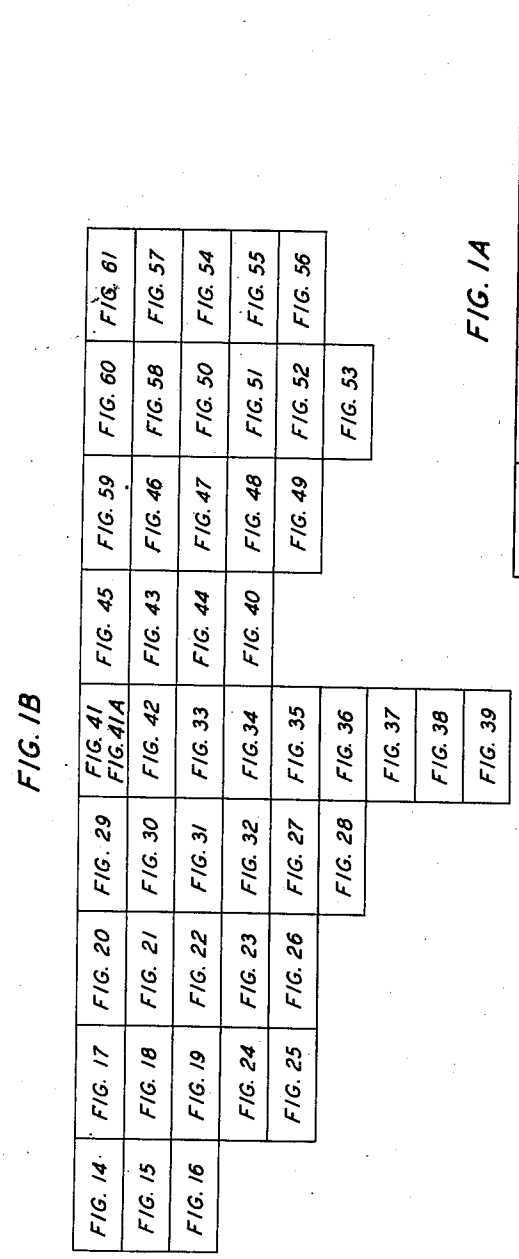
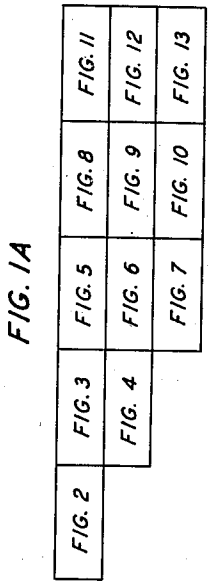
Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 1





INVENTOR
W. W. CARPENTER
BY W. W. Carpenter
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 2

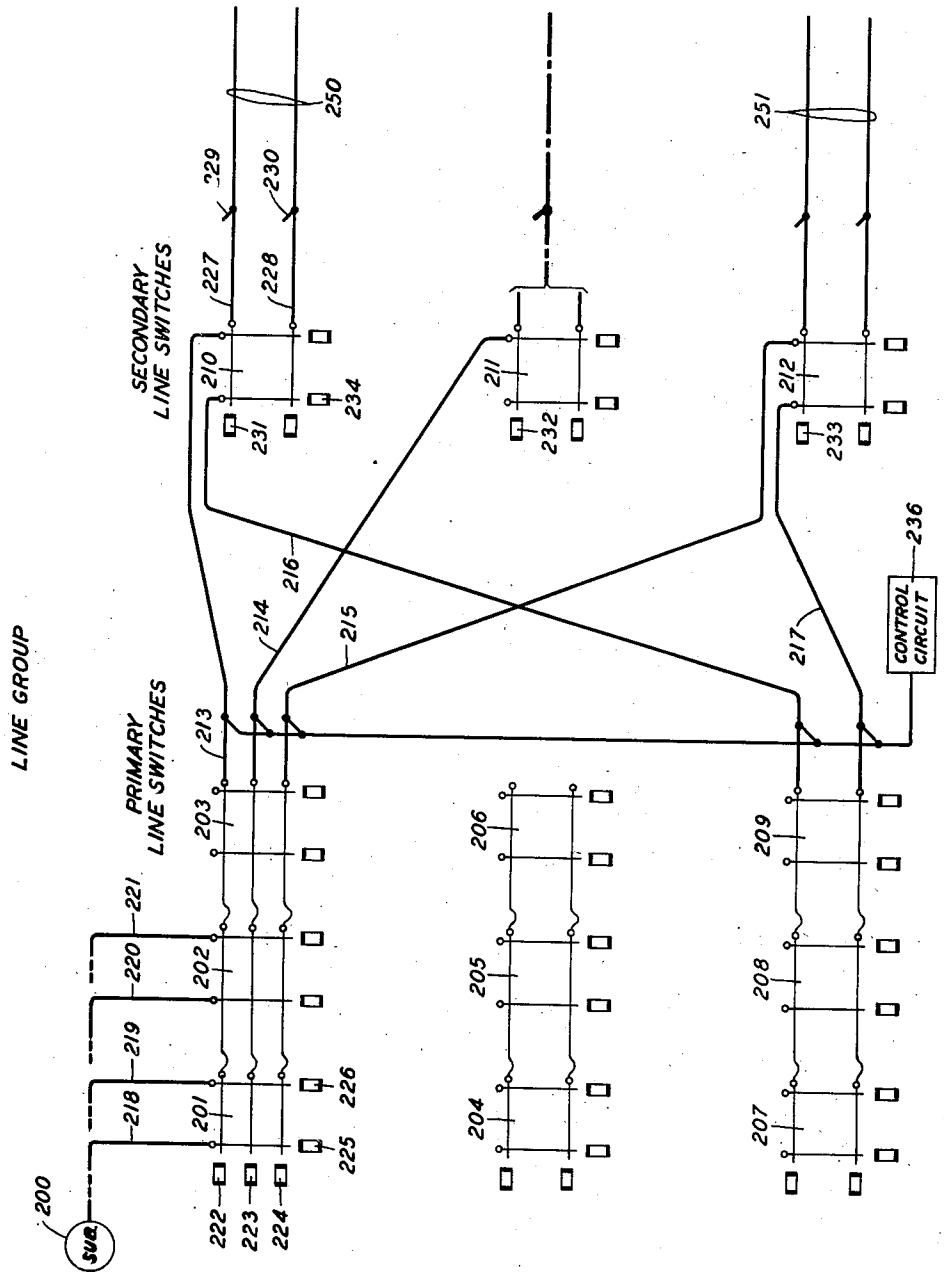


FIG. 2

INVENTOR
W. W. CARPENTER
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ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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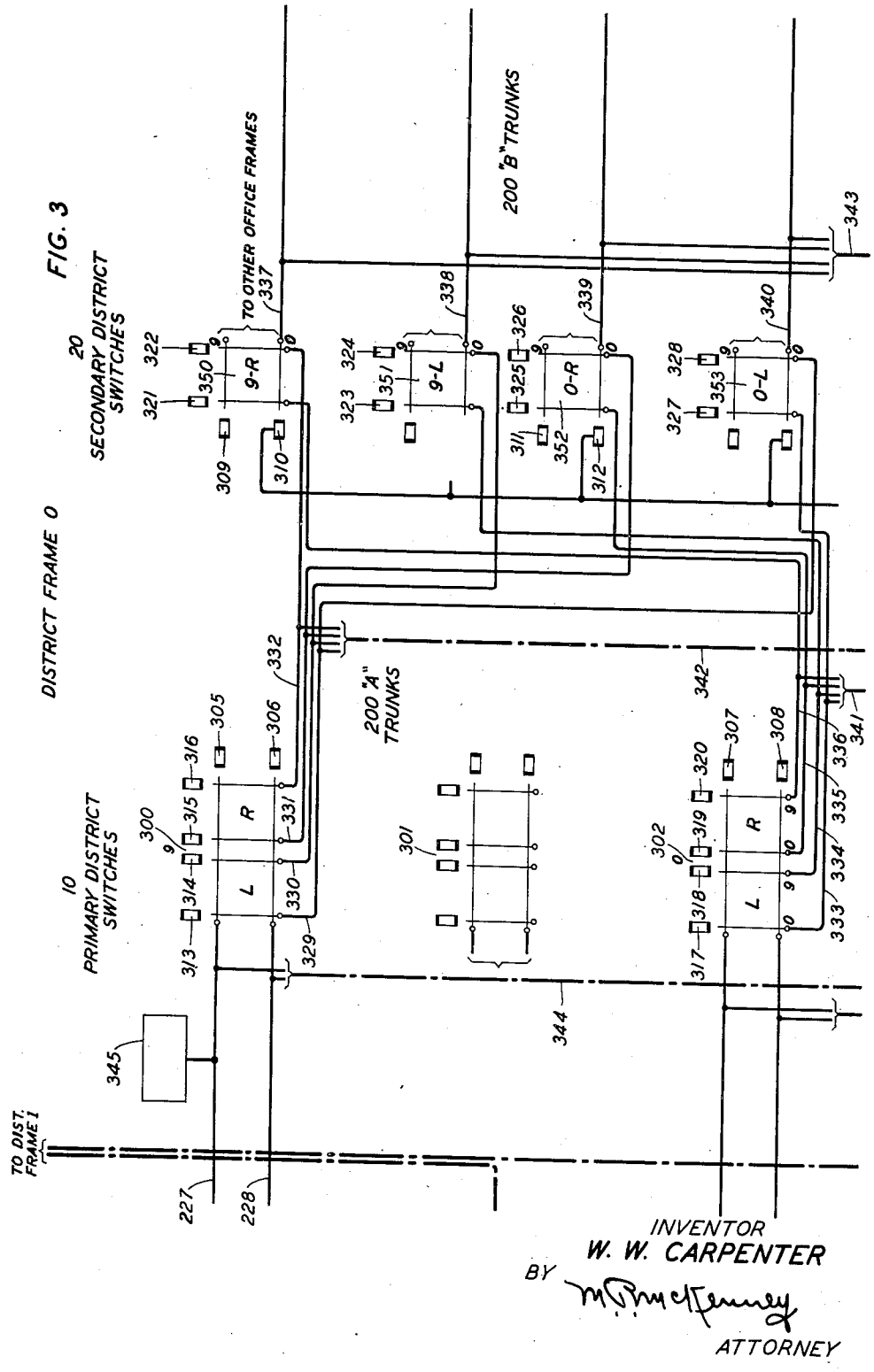

INVENTOR
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Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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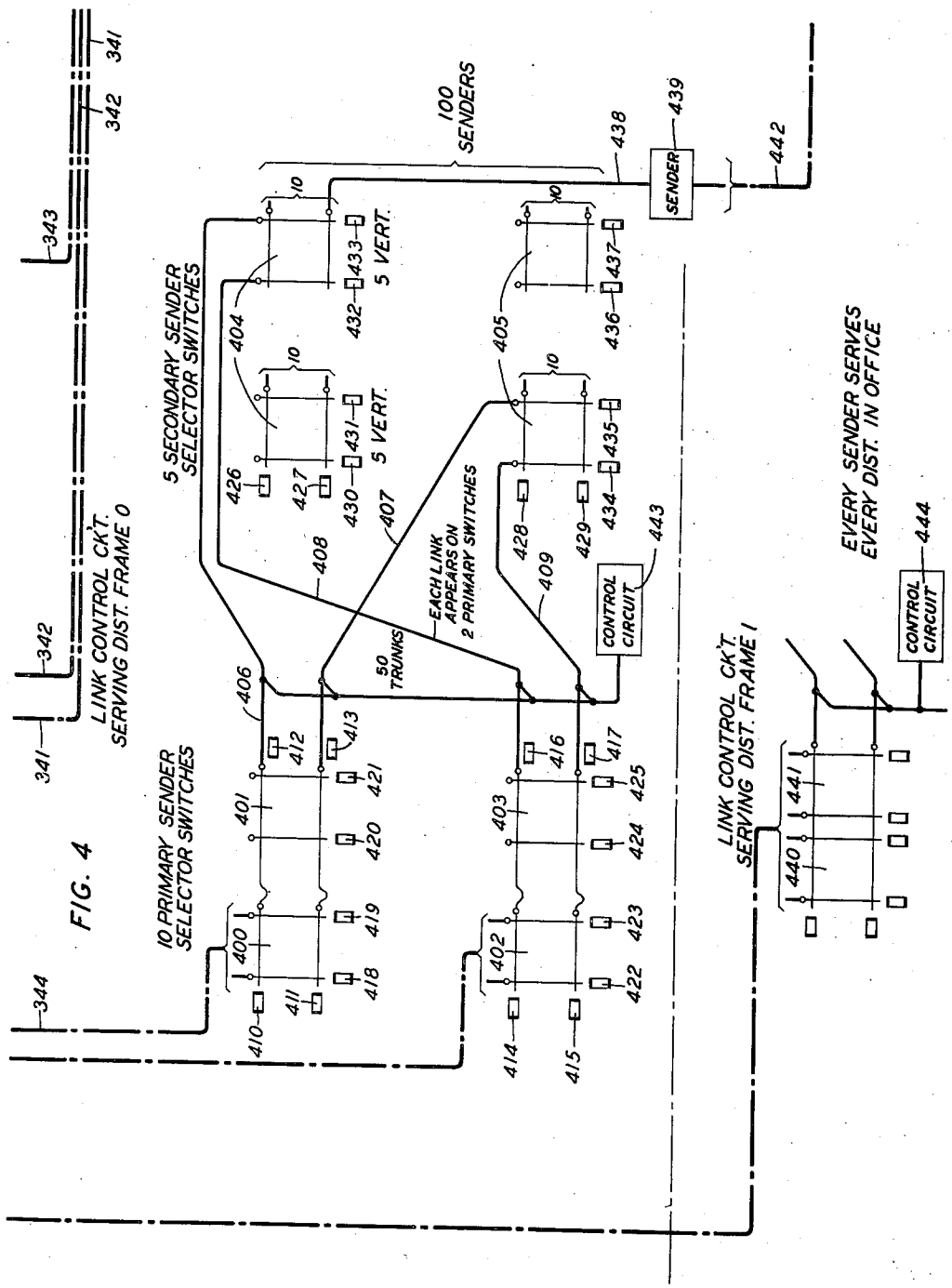

FIG. 4

INVENTOR
W. W. CARPENTER
BY M. P. McKenney
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 5

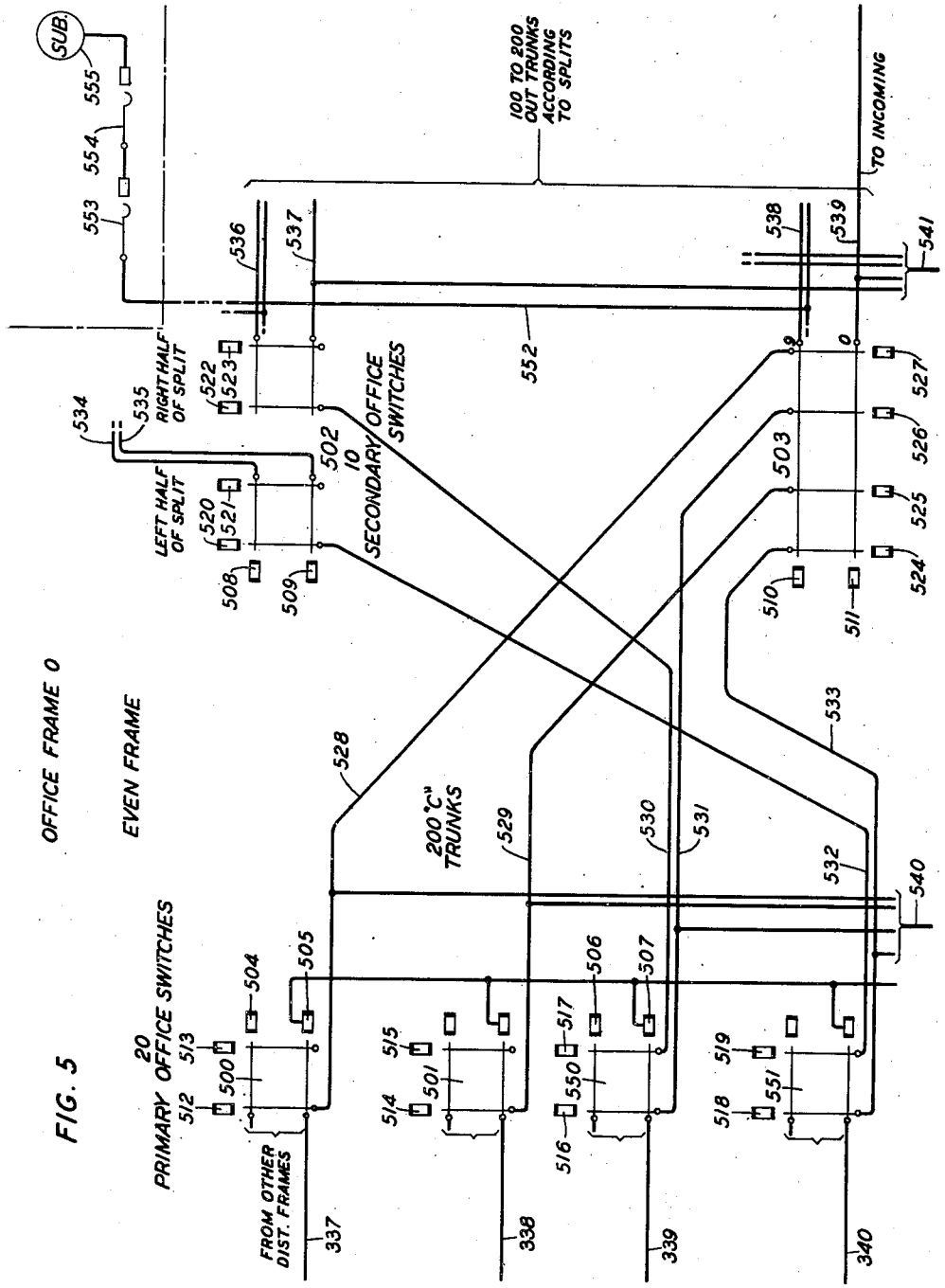

FIG. 5

INVENTOR
W. W. CARPENTER
BY M. P. McKenney
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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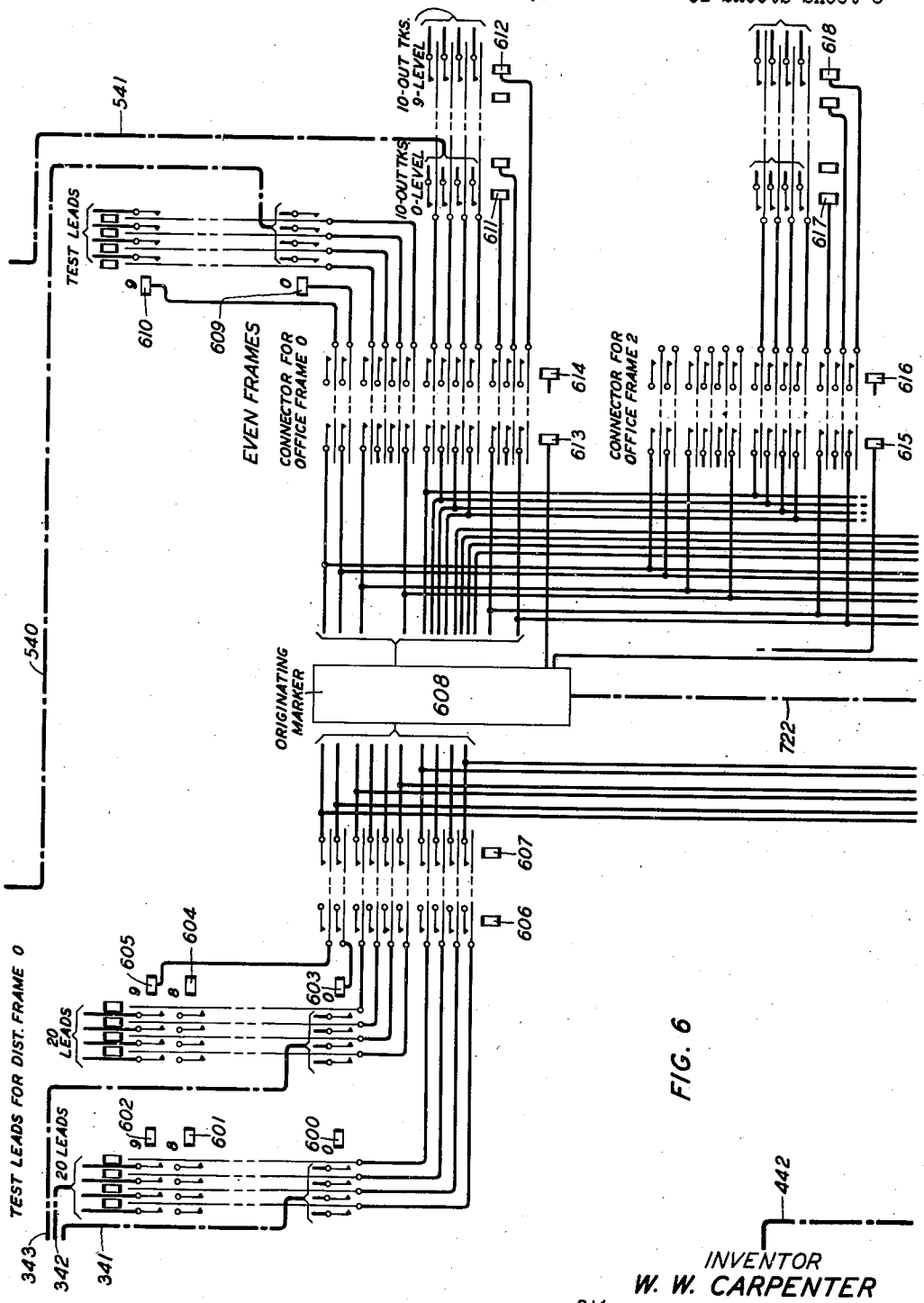

FIG. 6

INVENTOR
W. W. CARPENTER
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Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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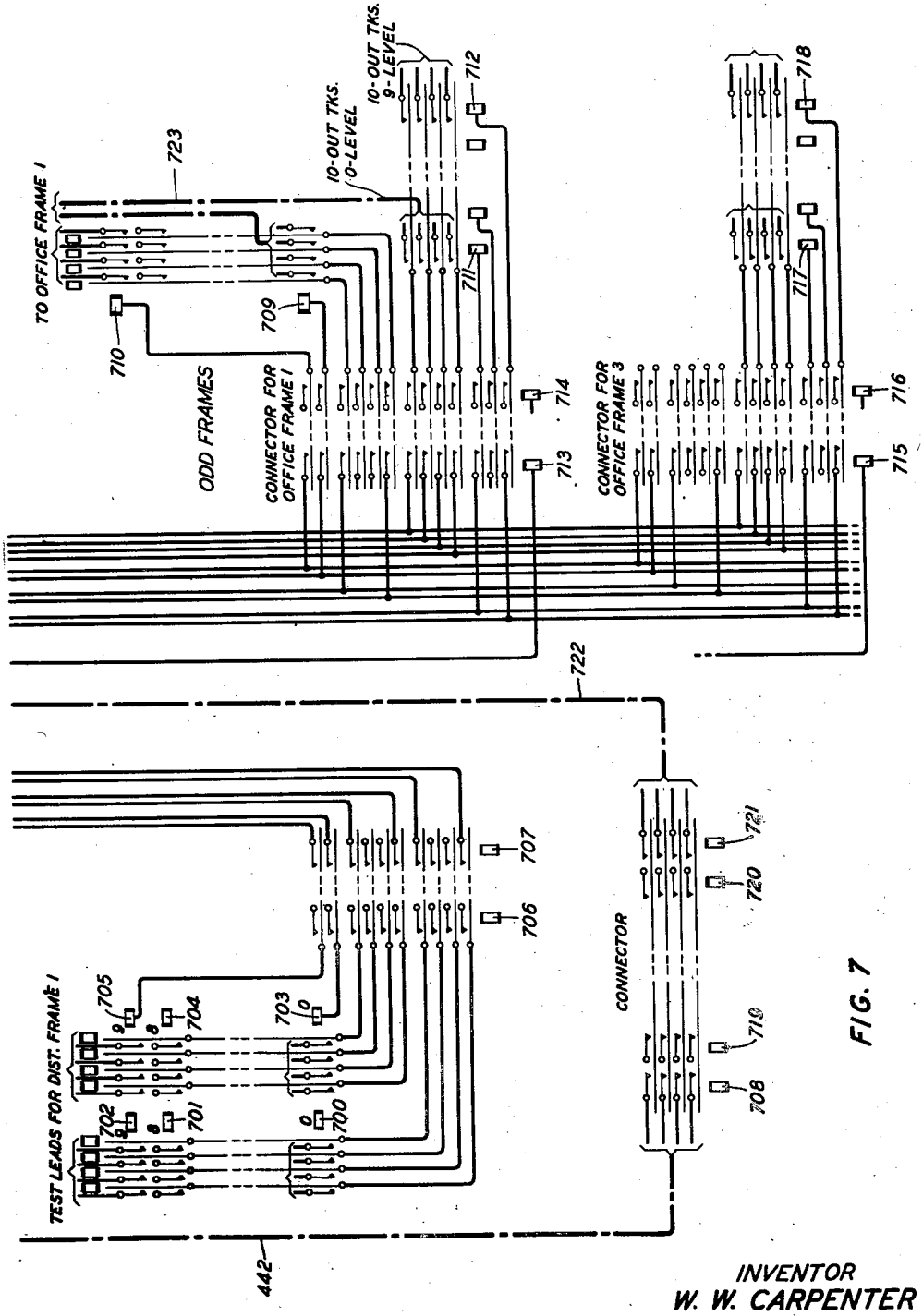

FIG. 7

INVENTOR
W. W. CARPENTER
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Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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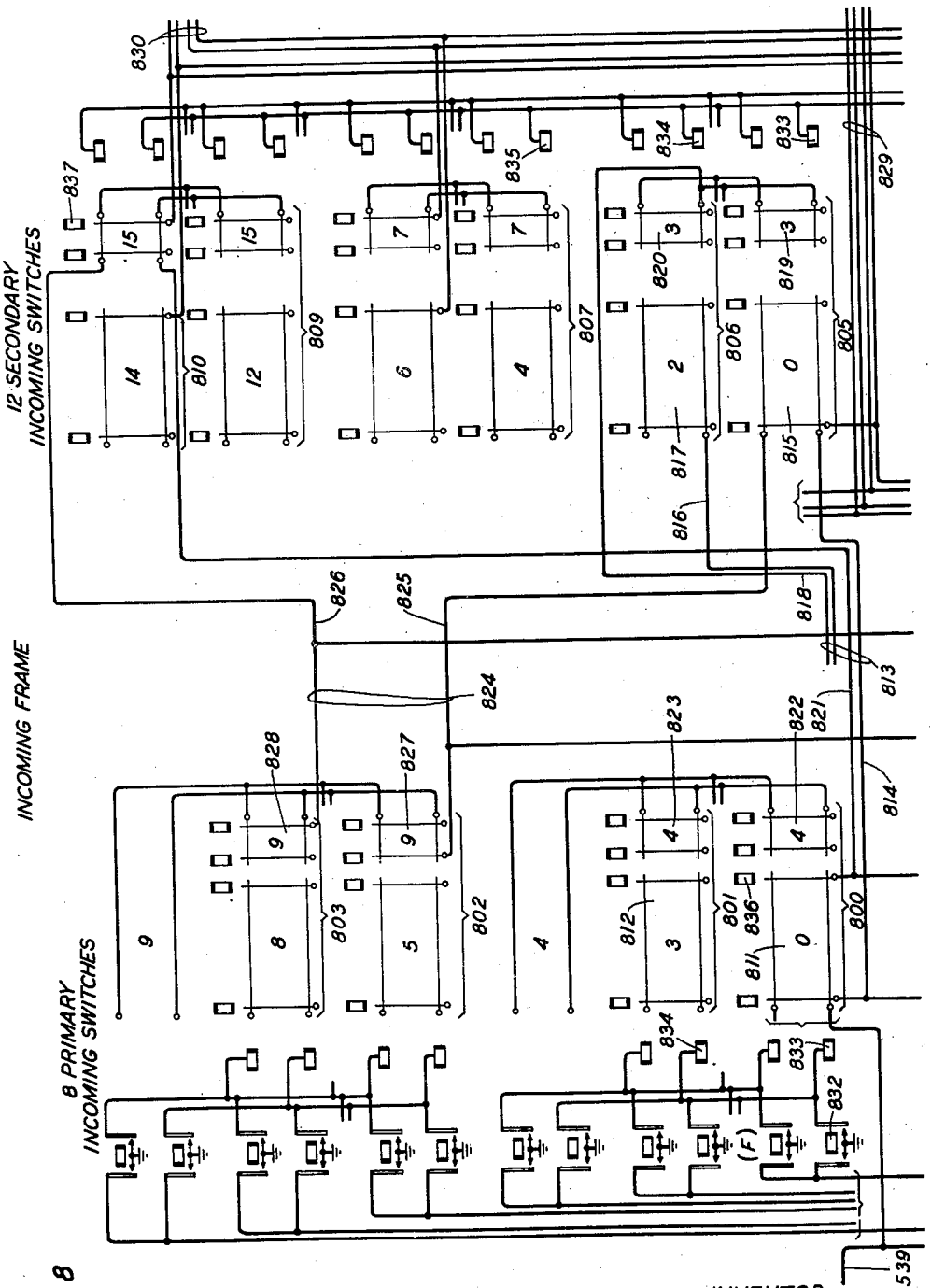

FIG. 8

INVENTOR
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BY
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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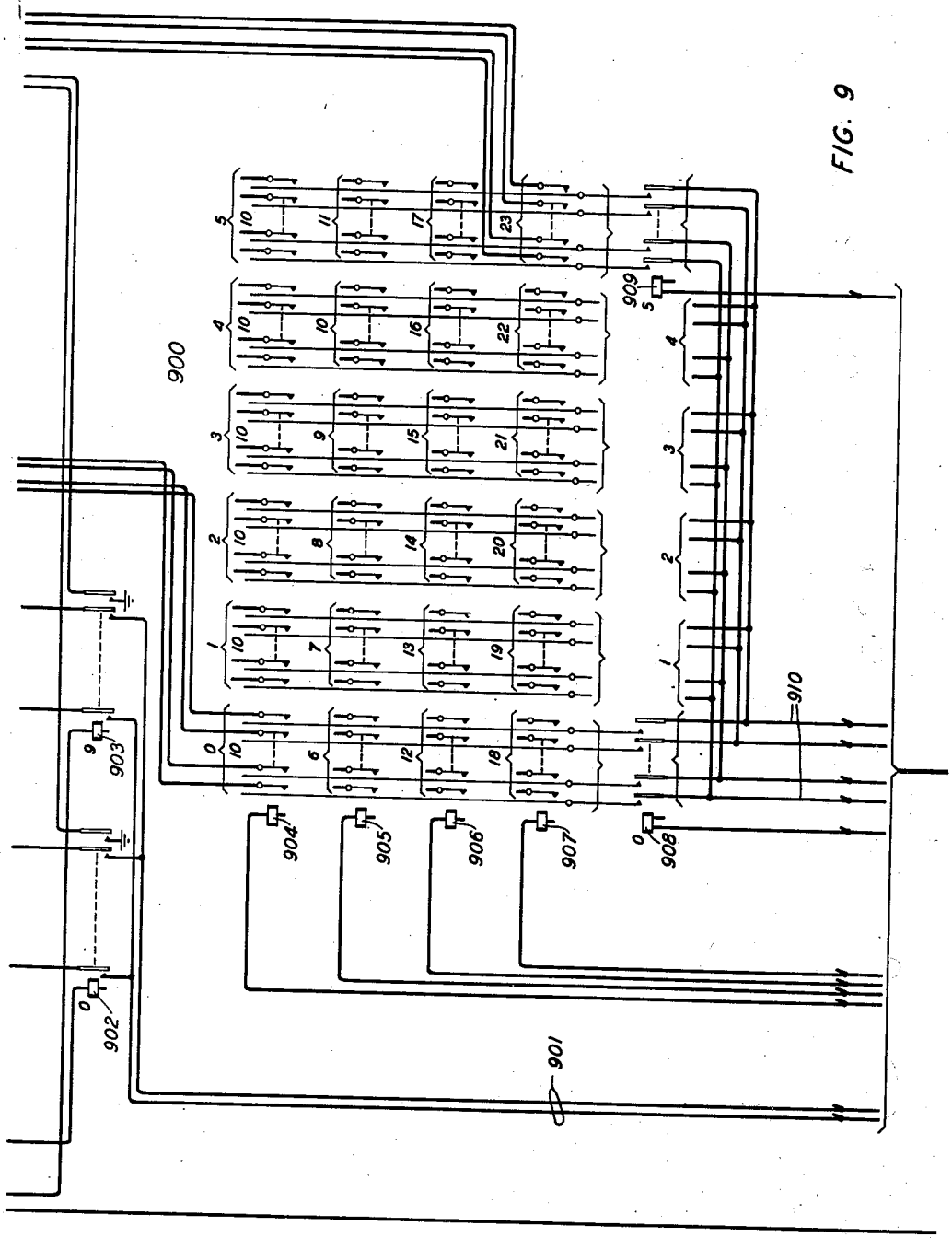

FIG. 9

INVENTOR
W. W. CARPENTER
BY M. P. McKenney
ATTORNEY

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TELEPHONE SYSTEM

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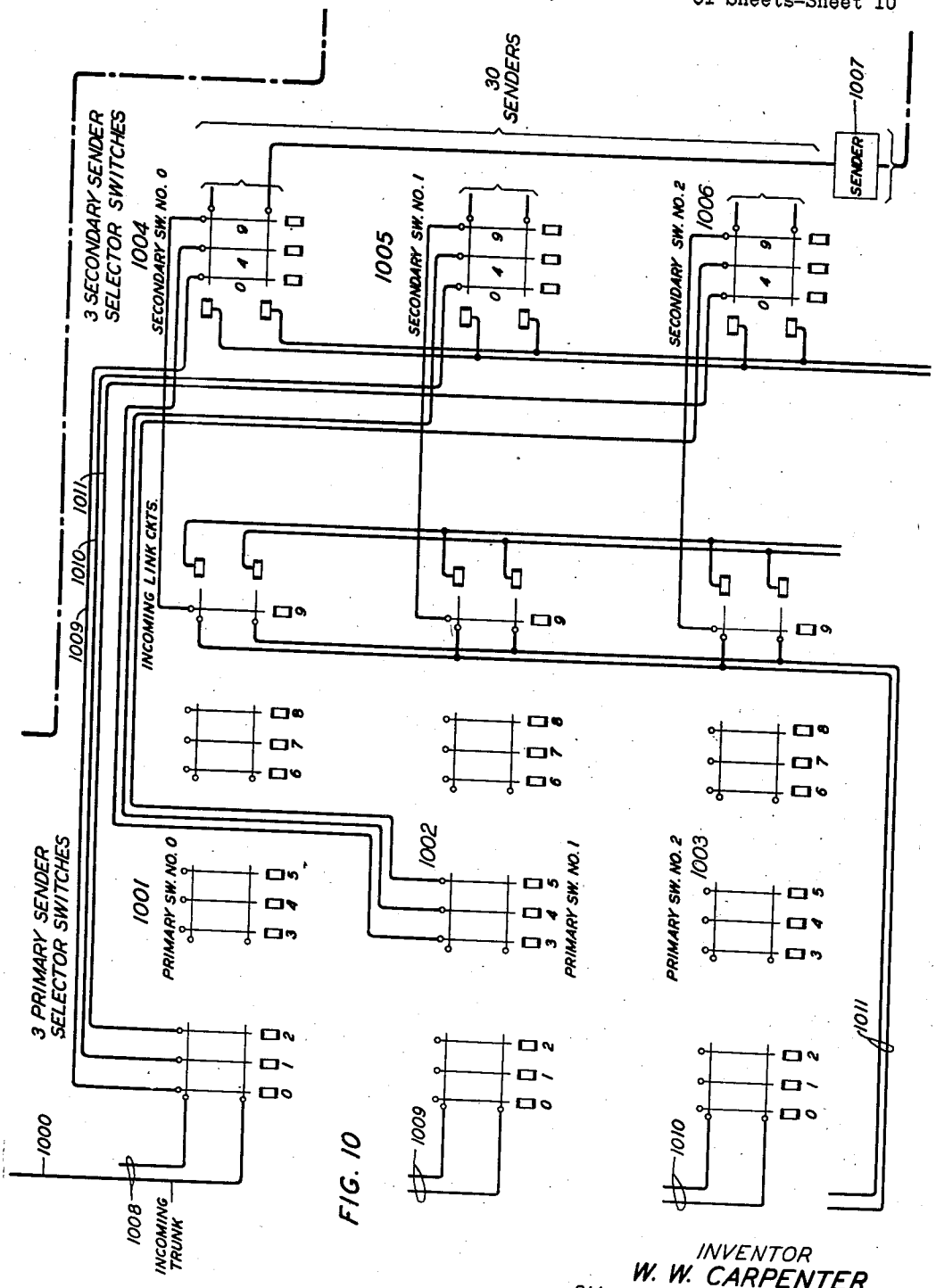

FIG. 10

INVENTOR
W. W. CARPENTER
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TELEPHONE SYSTEM

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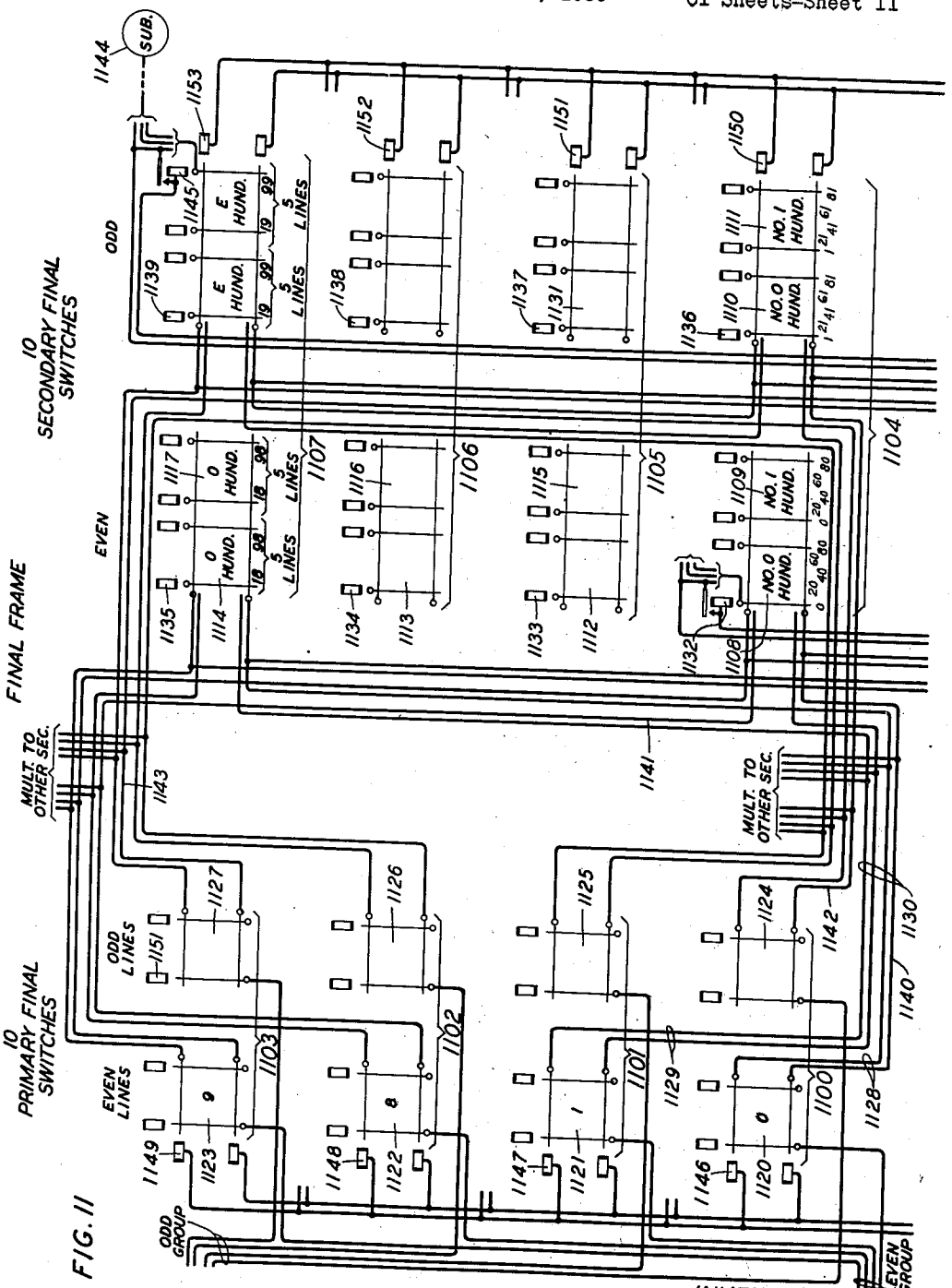

FIG. 11

INVENTOR
W. W. CARPENTER
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ATTORNEY

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TELEPHONE SYSTEM

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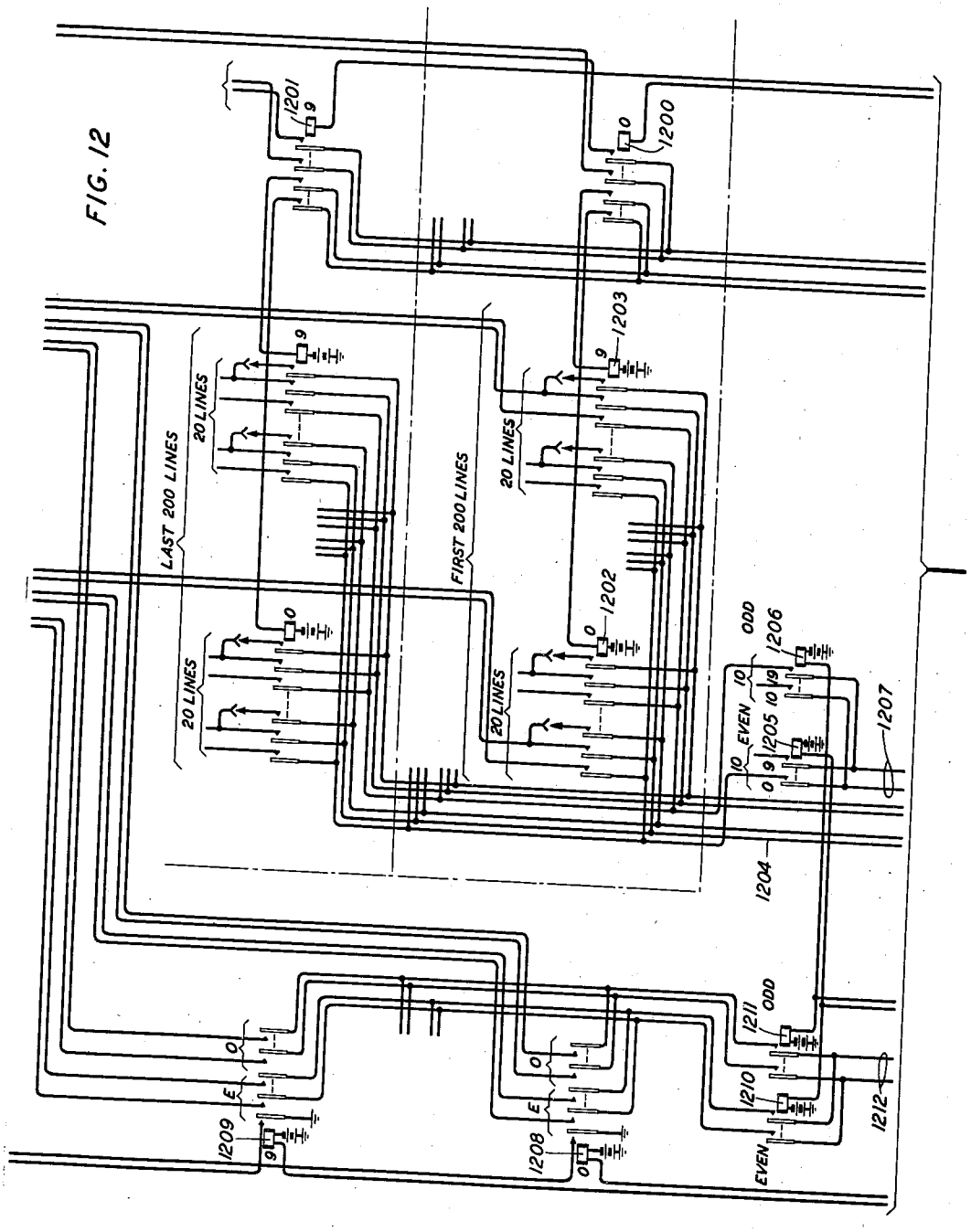
FIG. 12



INVENTOR
W. W. CARPENTER
BY W. W. Carpenter
ATTORNEY

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 13

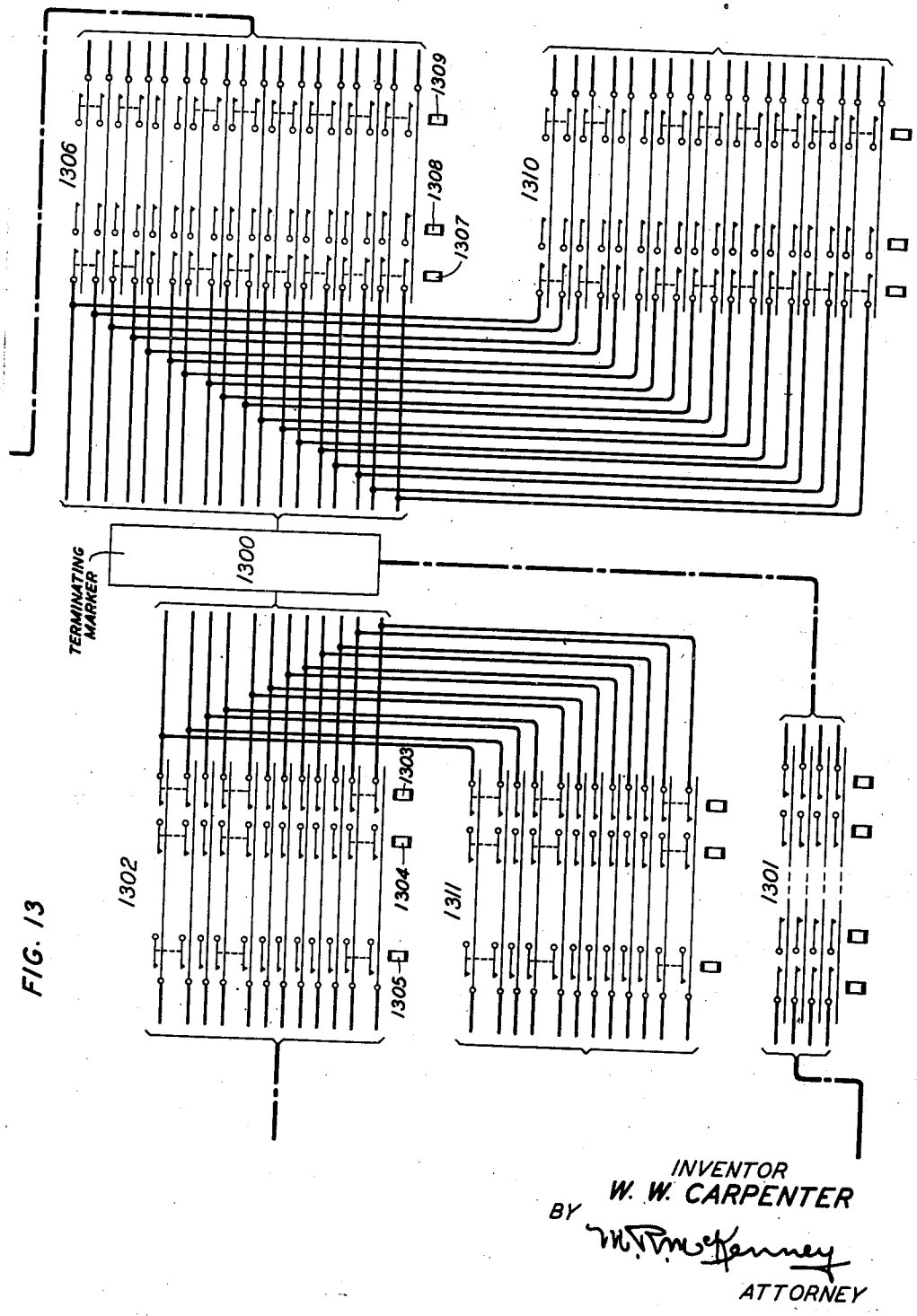

FIG. 13

INVENTOR
W. W. CARPENTER
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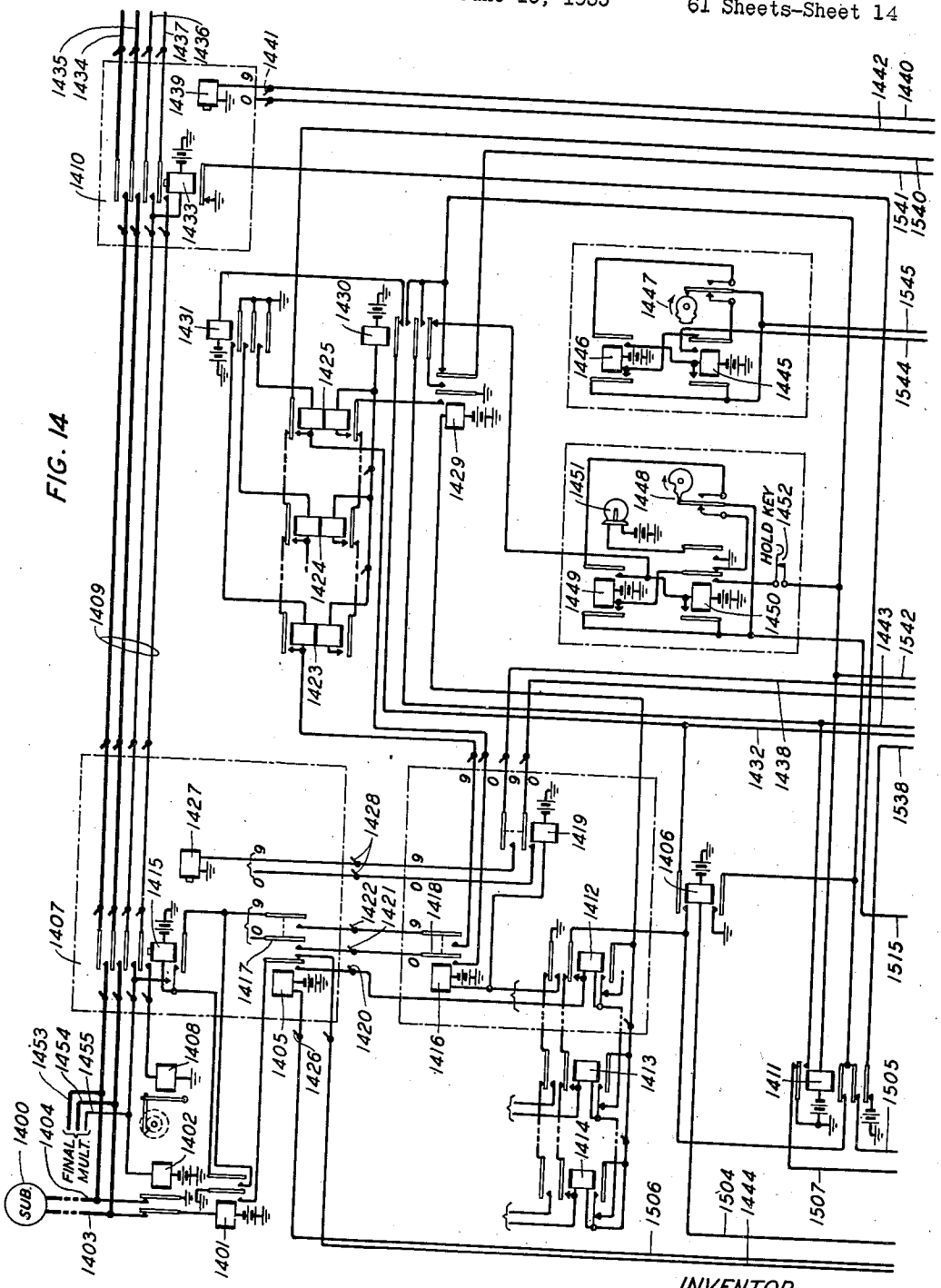

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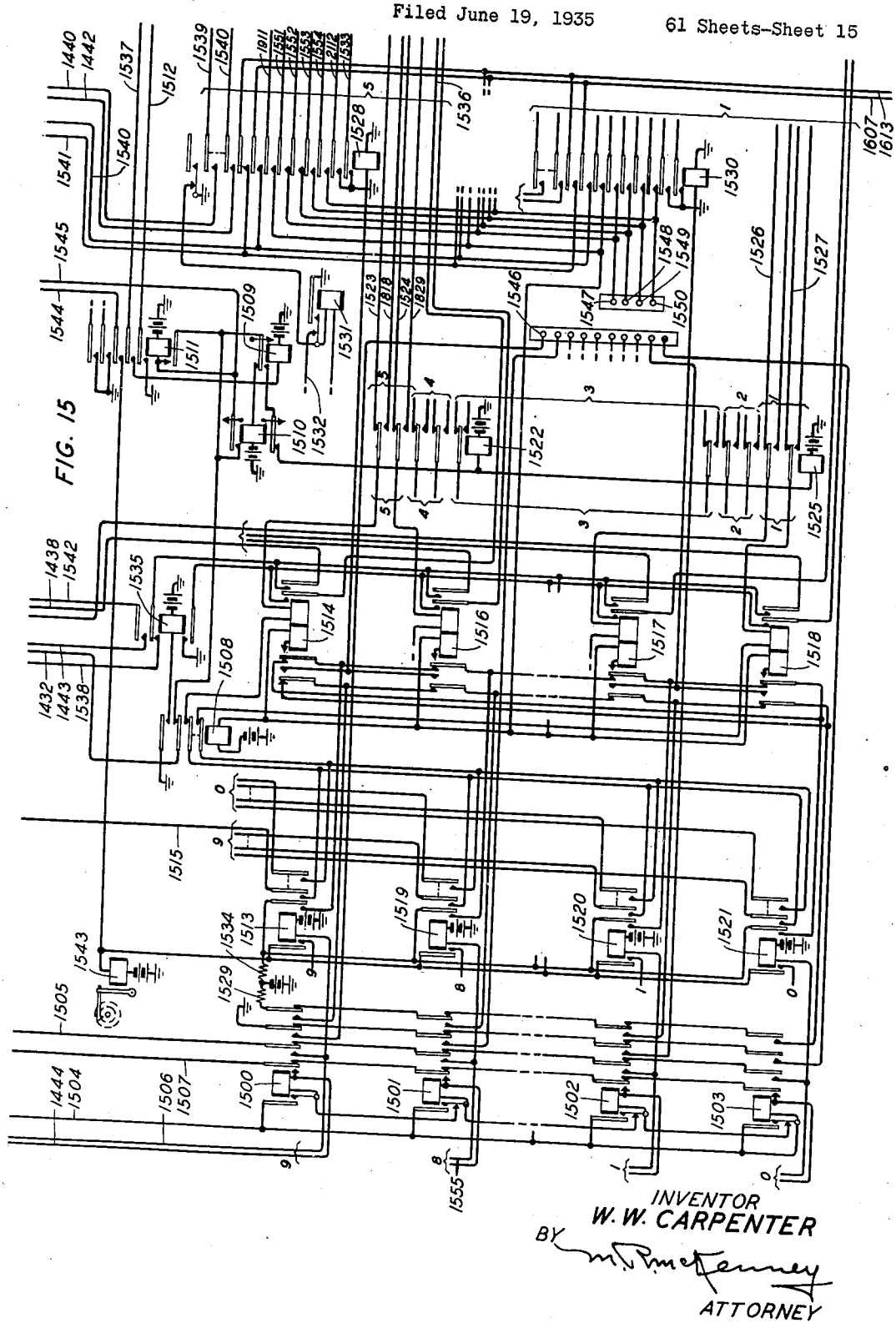

FIG. 15

INVENTOR
W. W. CARPENTER
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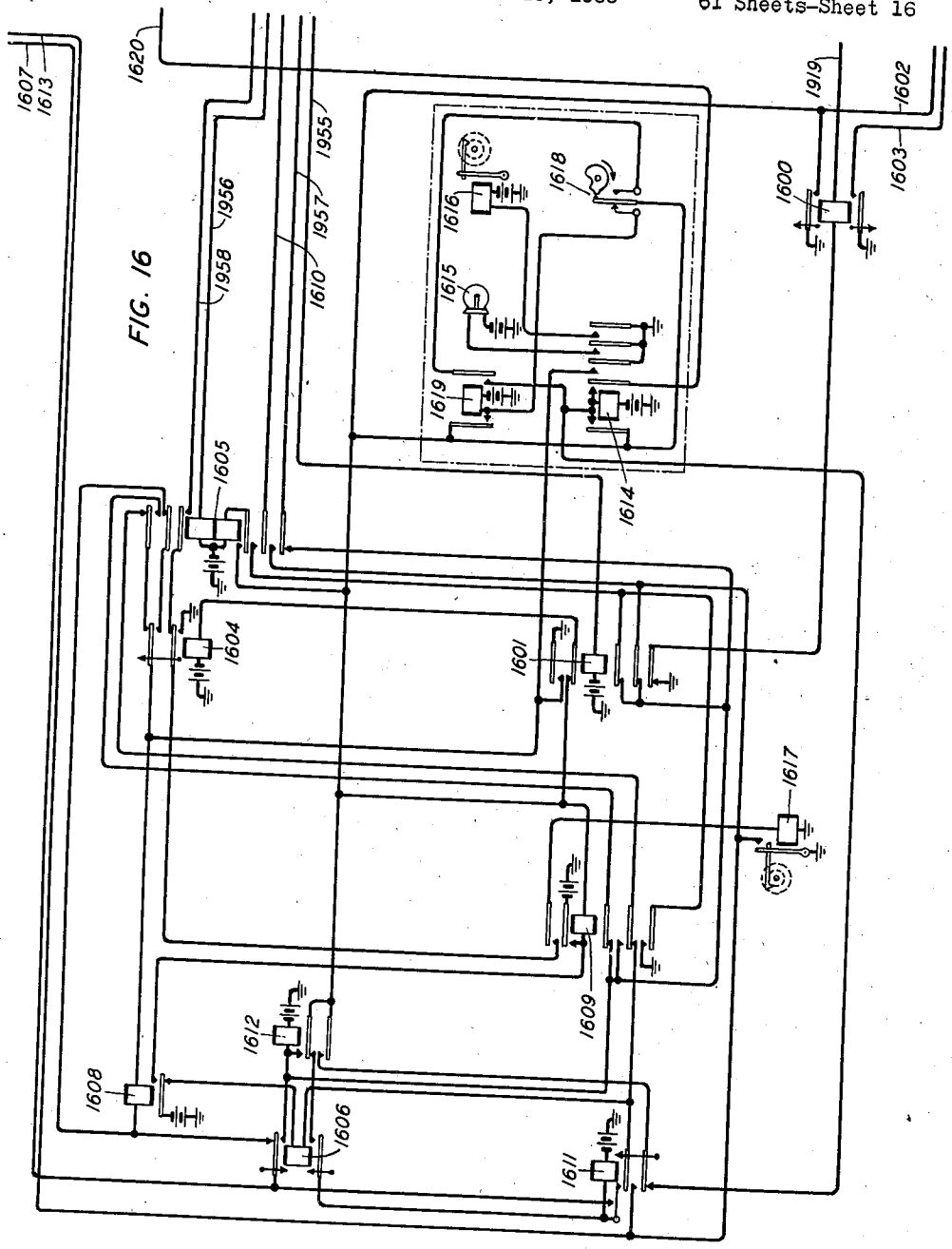

FIG. 16

INVENTOR
W. W. CARPENTER

BY

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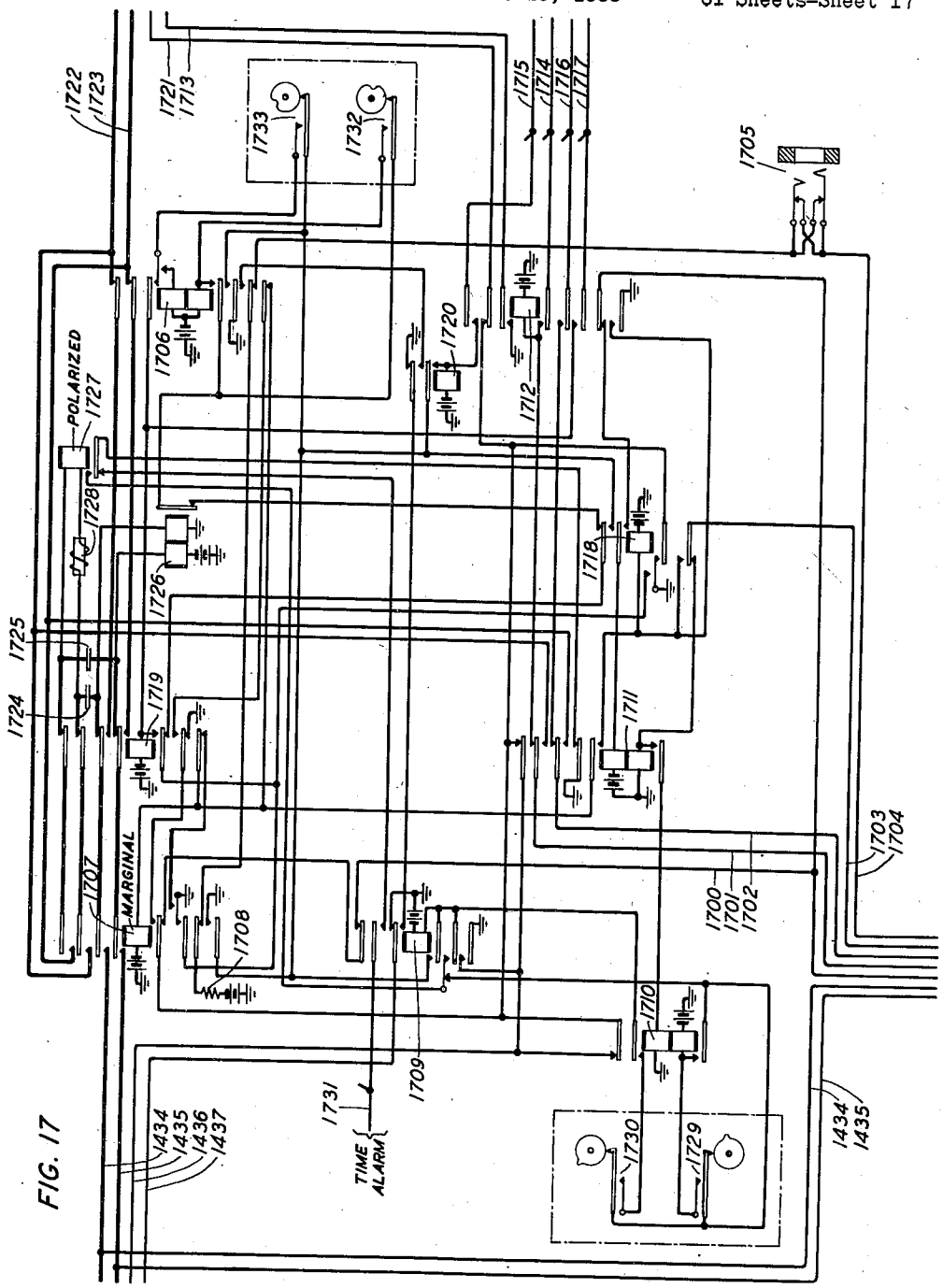

FIG. 17

INVENTOR
W. W. CARPENTER
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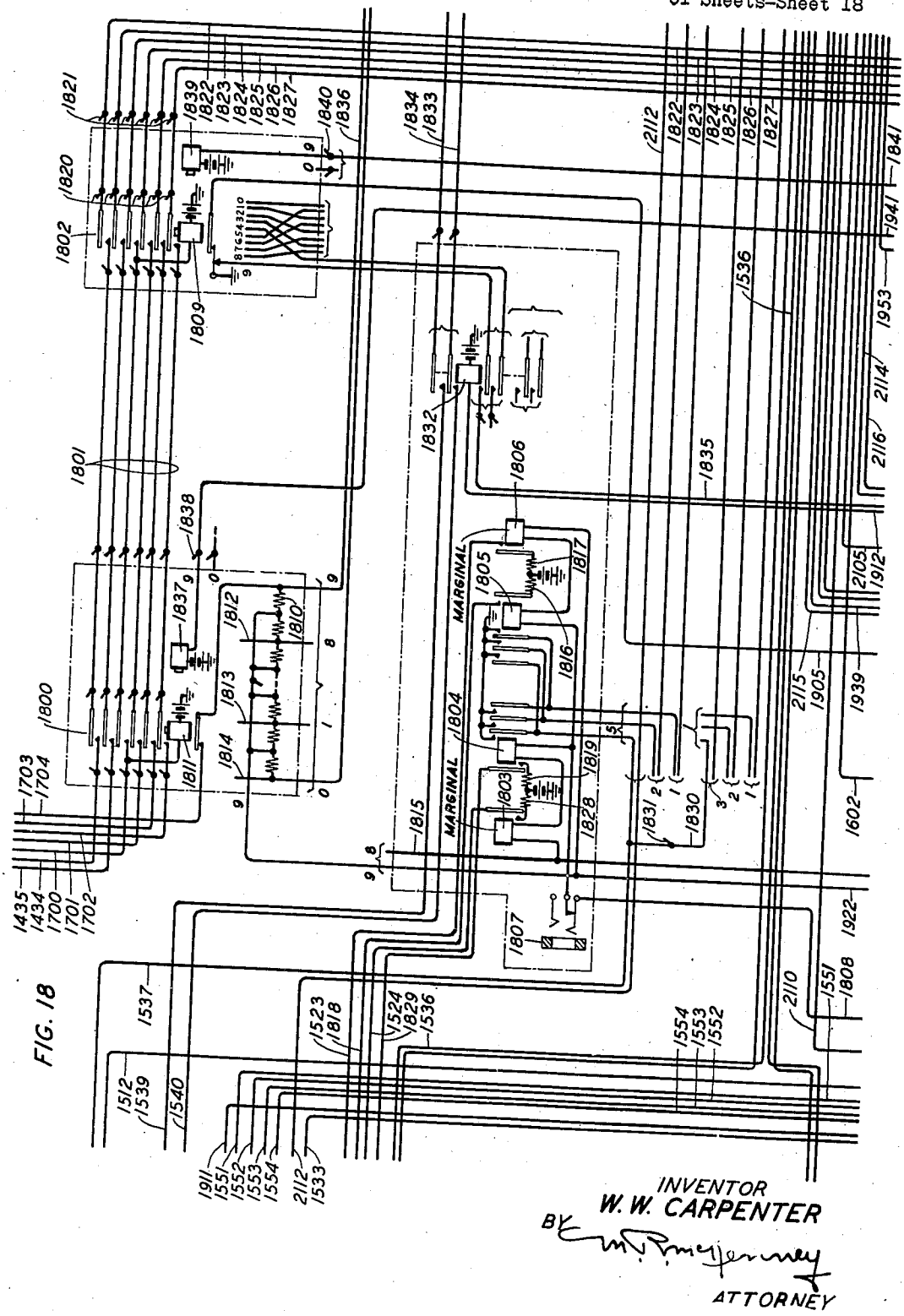

FIG. 18

INVENTOR
W. W. CARPENTER
BY
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TELEPHONE SYSTEM

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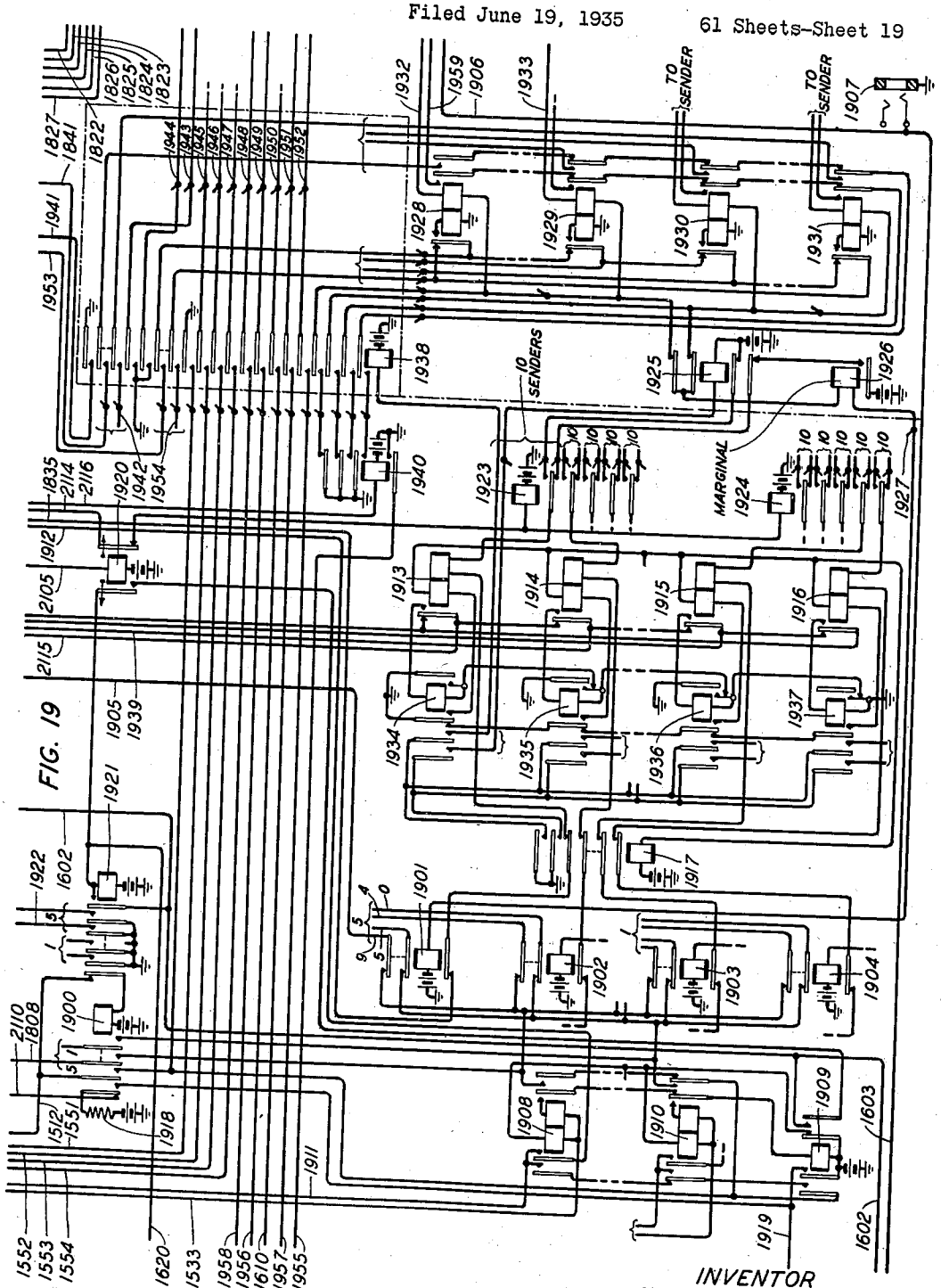

FIG. 19

INVENTOR
W. W. CARPENTER
BY
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TELEPHONE SYSTEM

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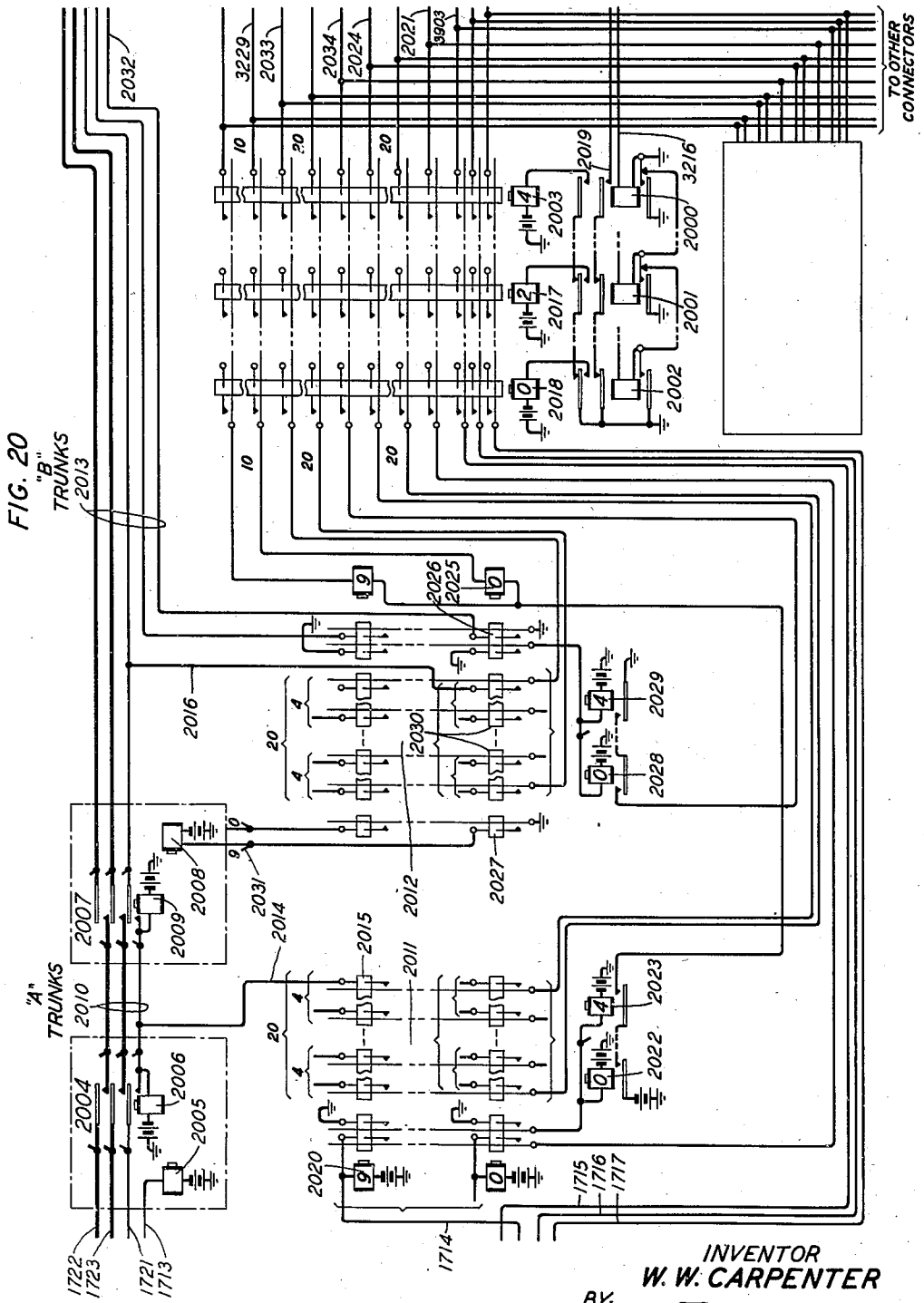

FIG. 20

INVENTOR
W. W. CARPENTER
BY
ATTORNEY

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TELEPHONE SYSTEM

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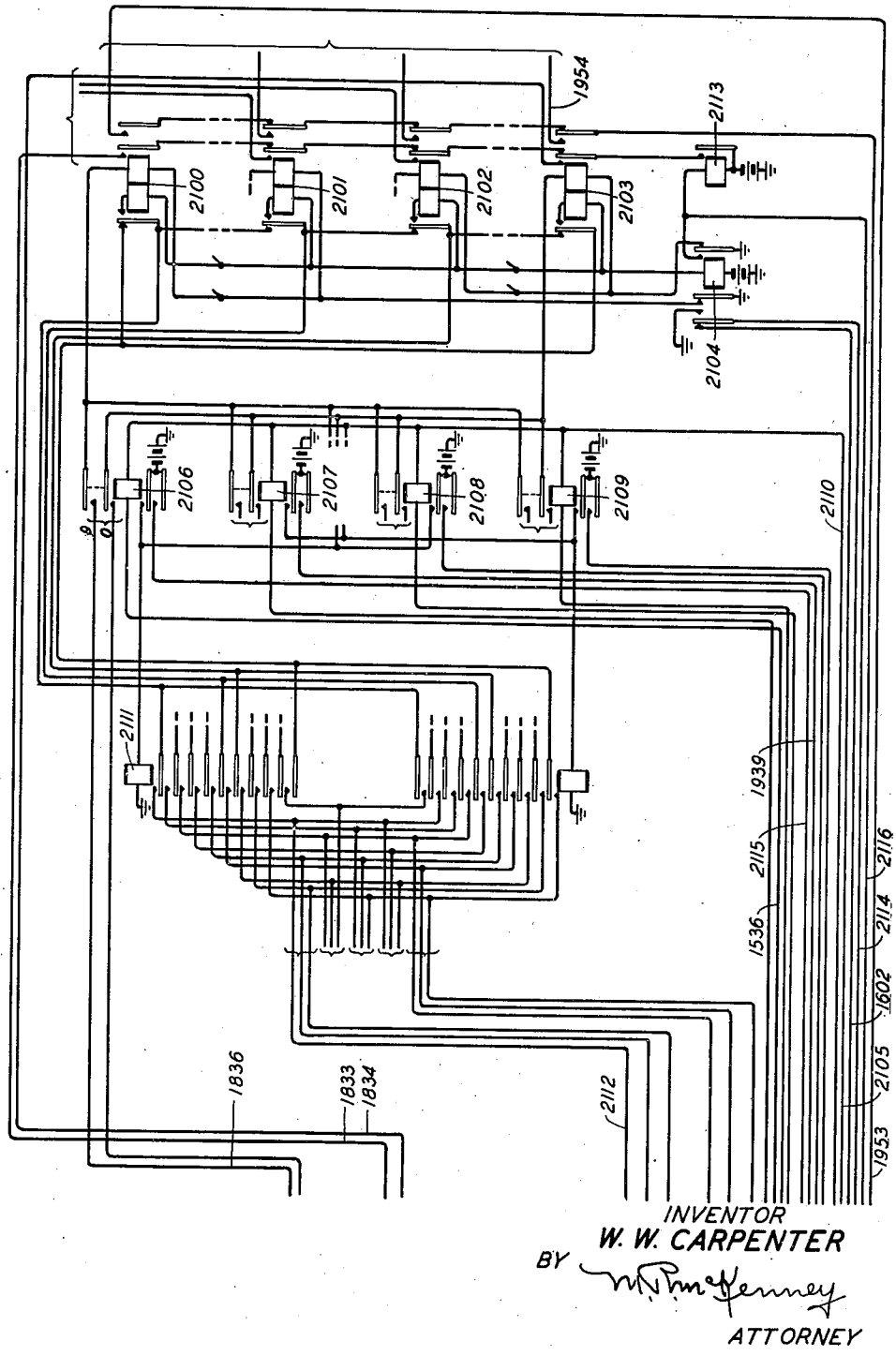

FIG. 21

INVENTOR
W. W. CARPENTER
BY W. P. McKenney
ATTORNEY

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TELEPHONE SYSTEM

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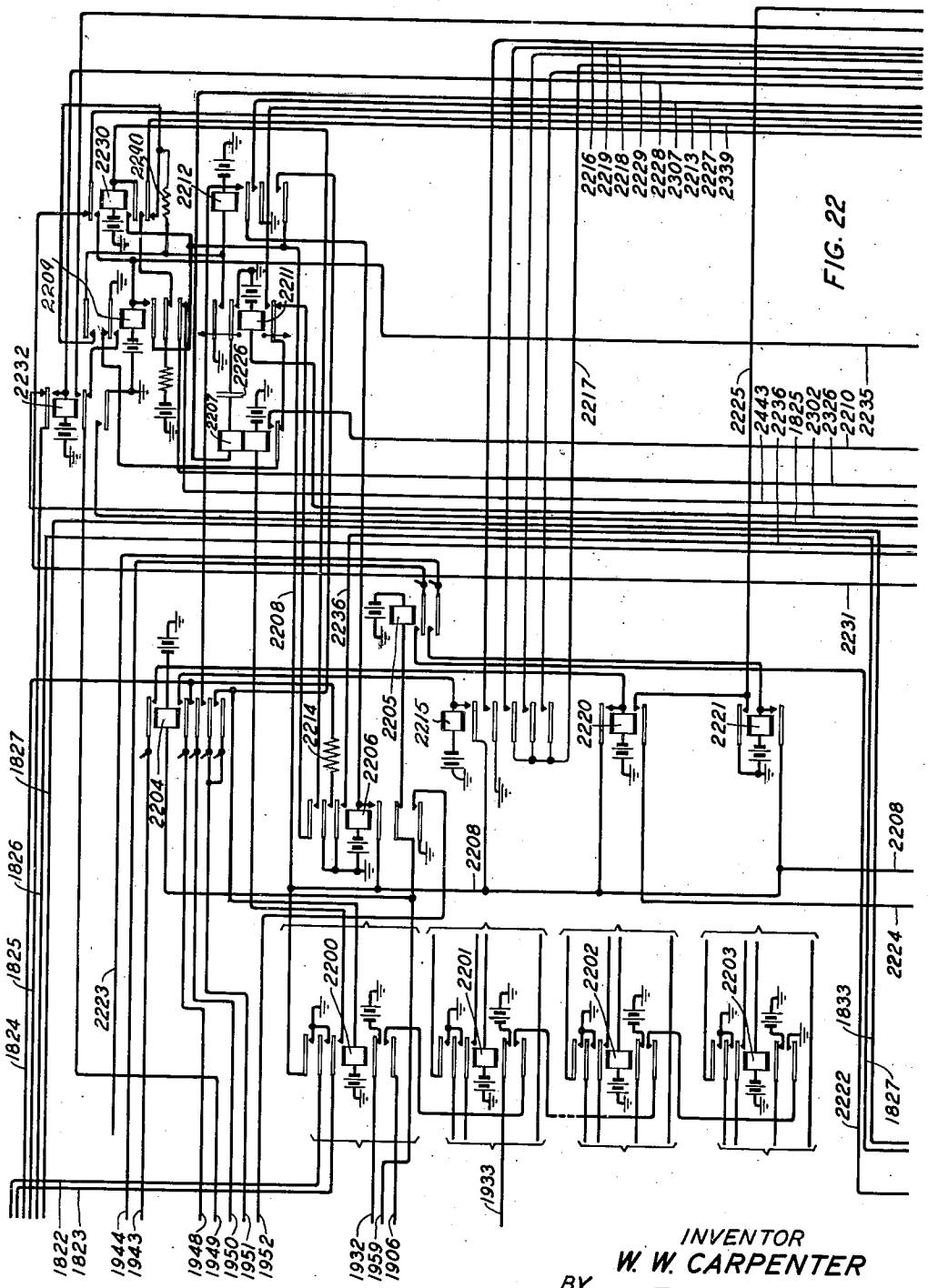

FIG. 22

INVENTOR
W. W. CARPENTER
BY
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TELEPHONE SYSTEM

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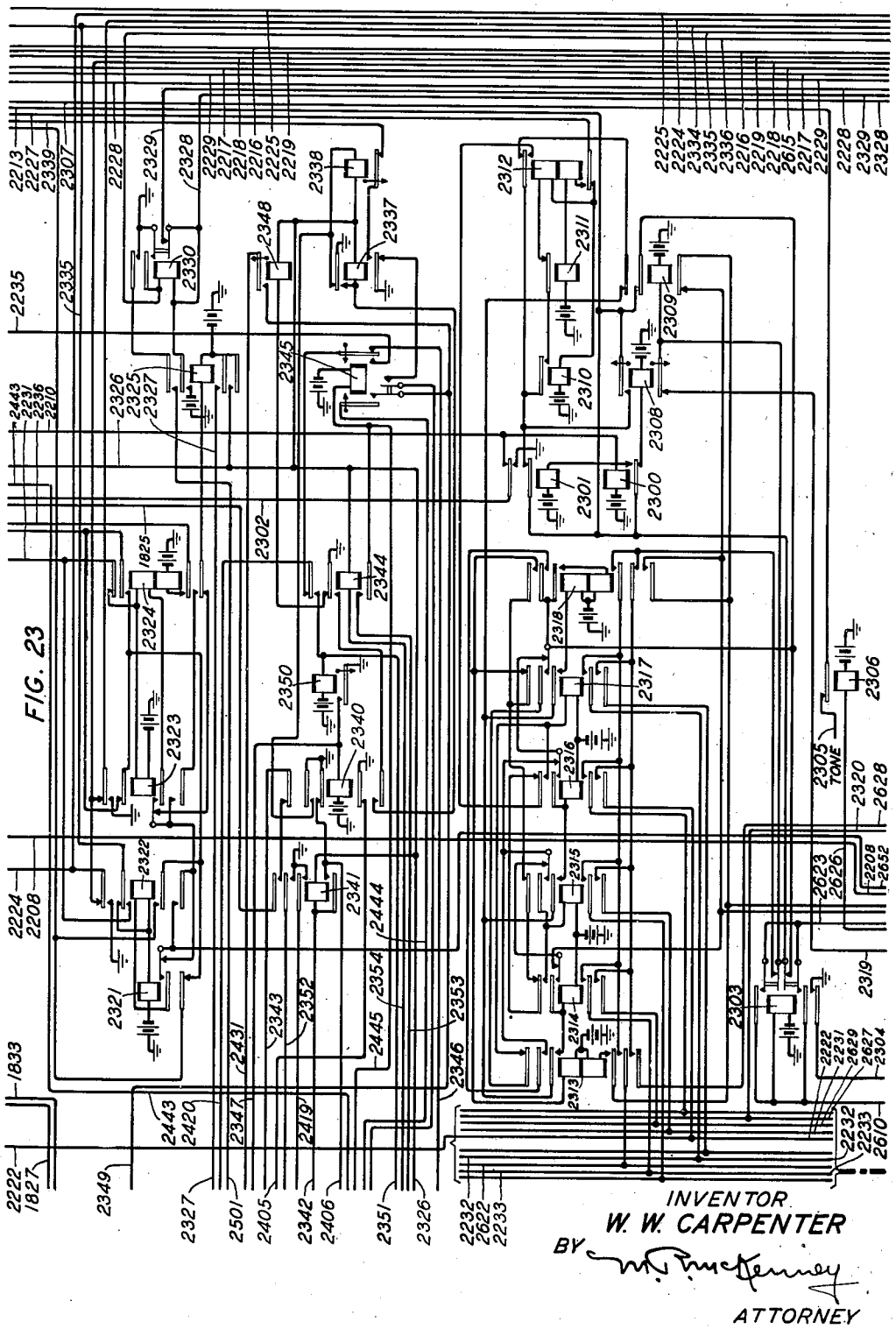

FIG. 23

INVENTOR
W. W. CARPENTER
BY
ATTORNEY

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TELEPHONE SYSTEM

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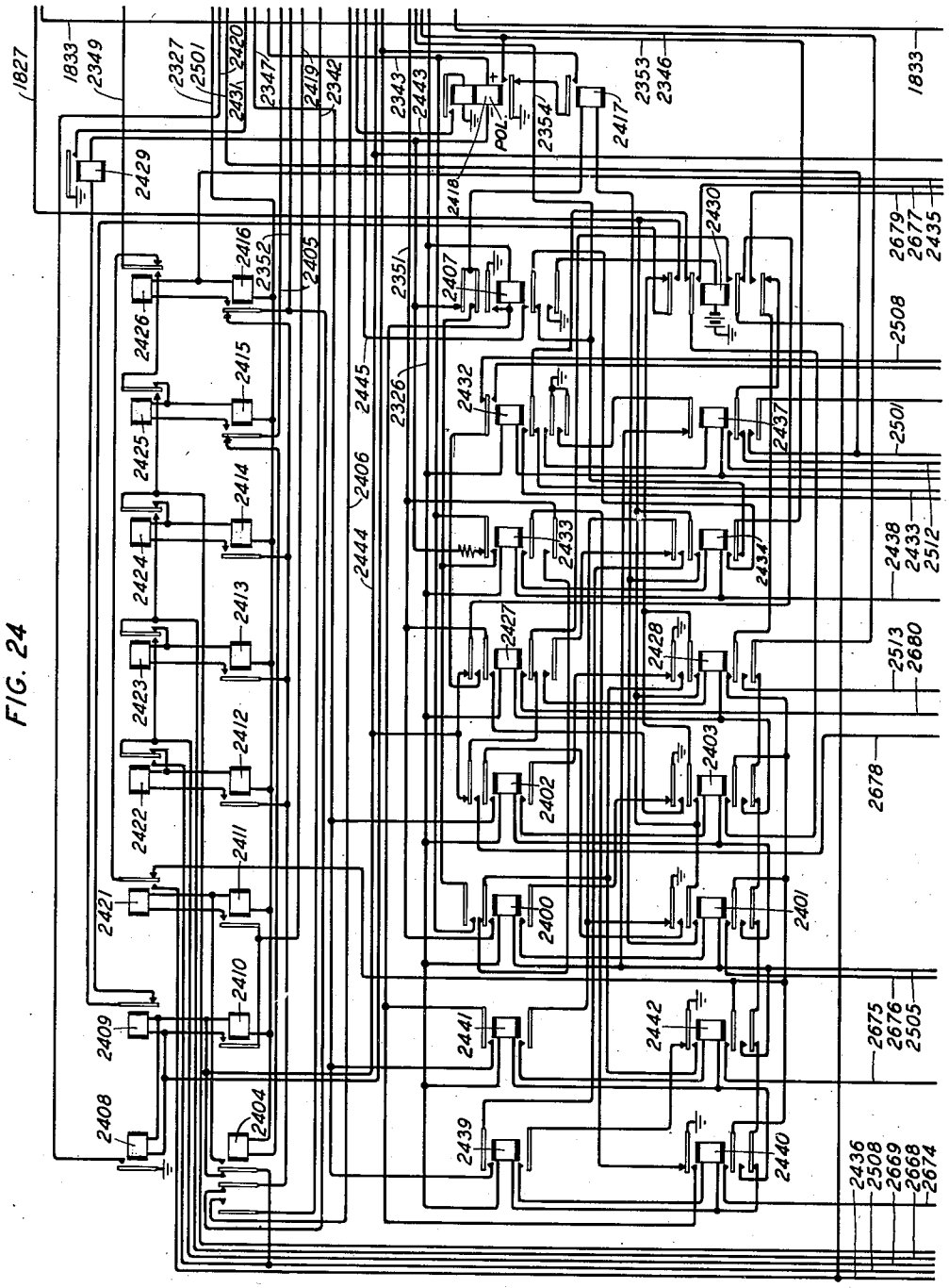

FIG. 24

INVENTOR
W. W. CARPENTER
BY
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TELEPHONE SYSTEM

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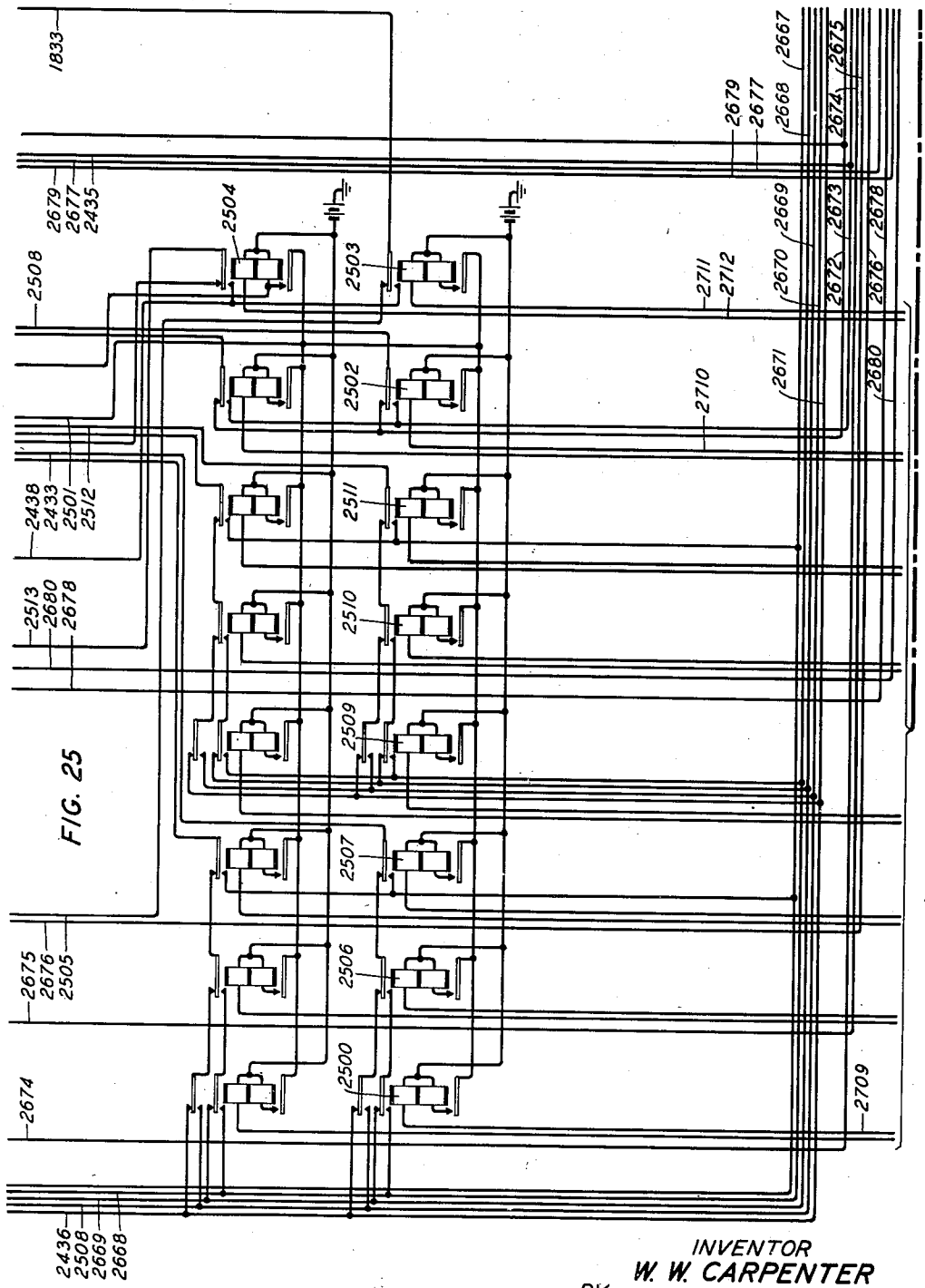

FIG. 25

INVENTOR
W. W. CARPENTER
BY
ATTORNEY

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TELEPHONE SYSTEM

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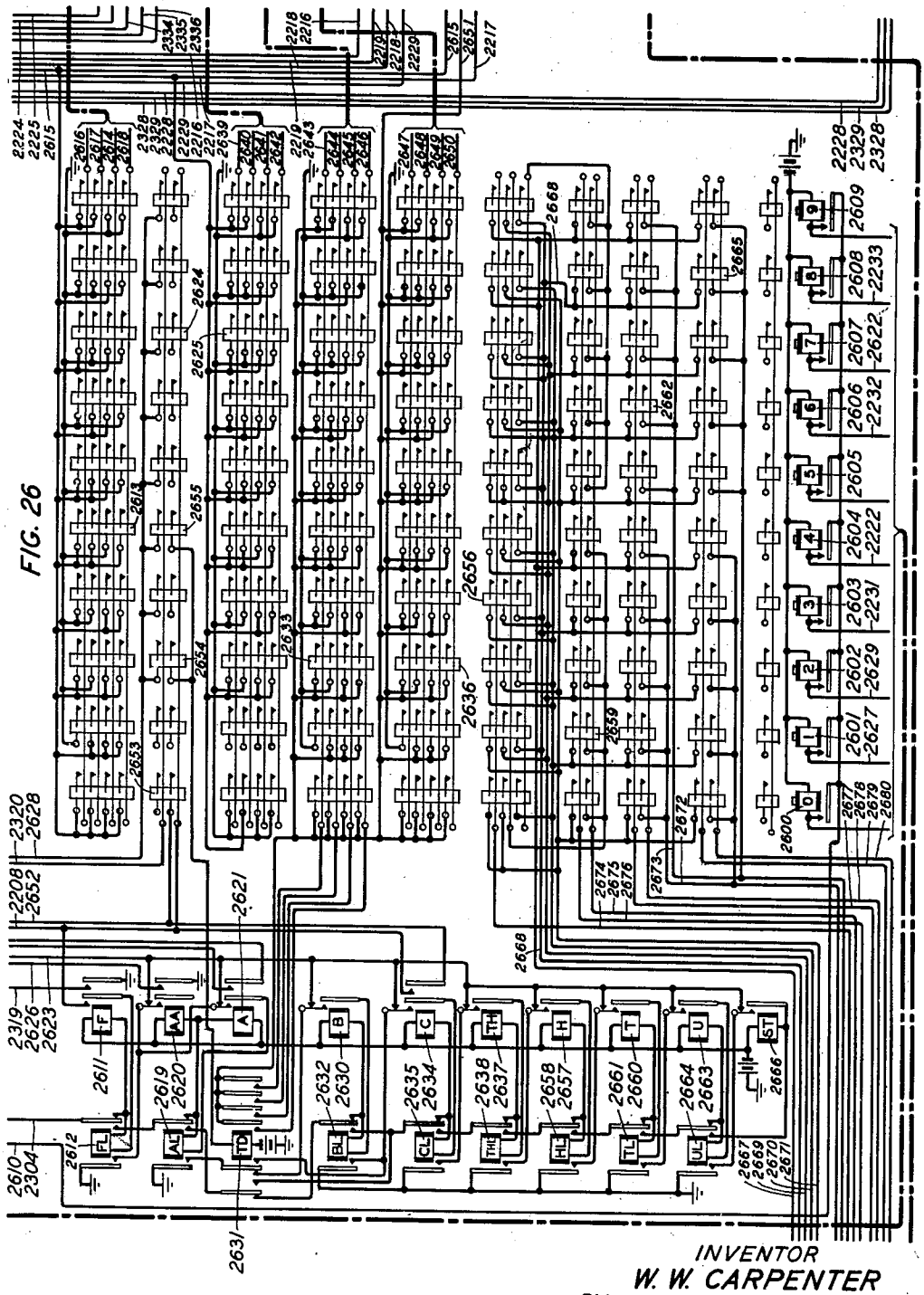

FIG. 26

INVENTOR
W. W. CARPENTER
BY M. Rinckenney
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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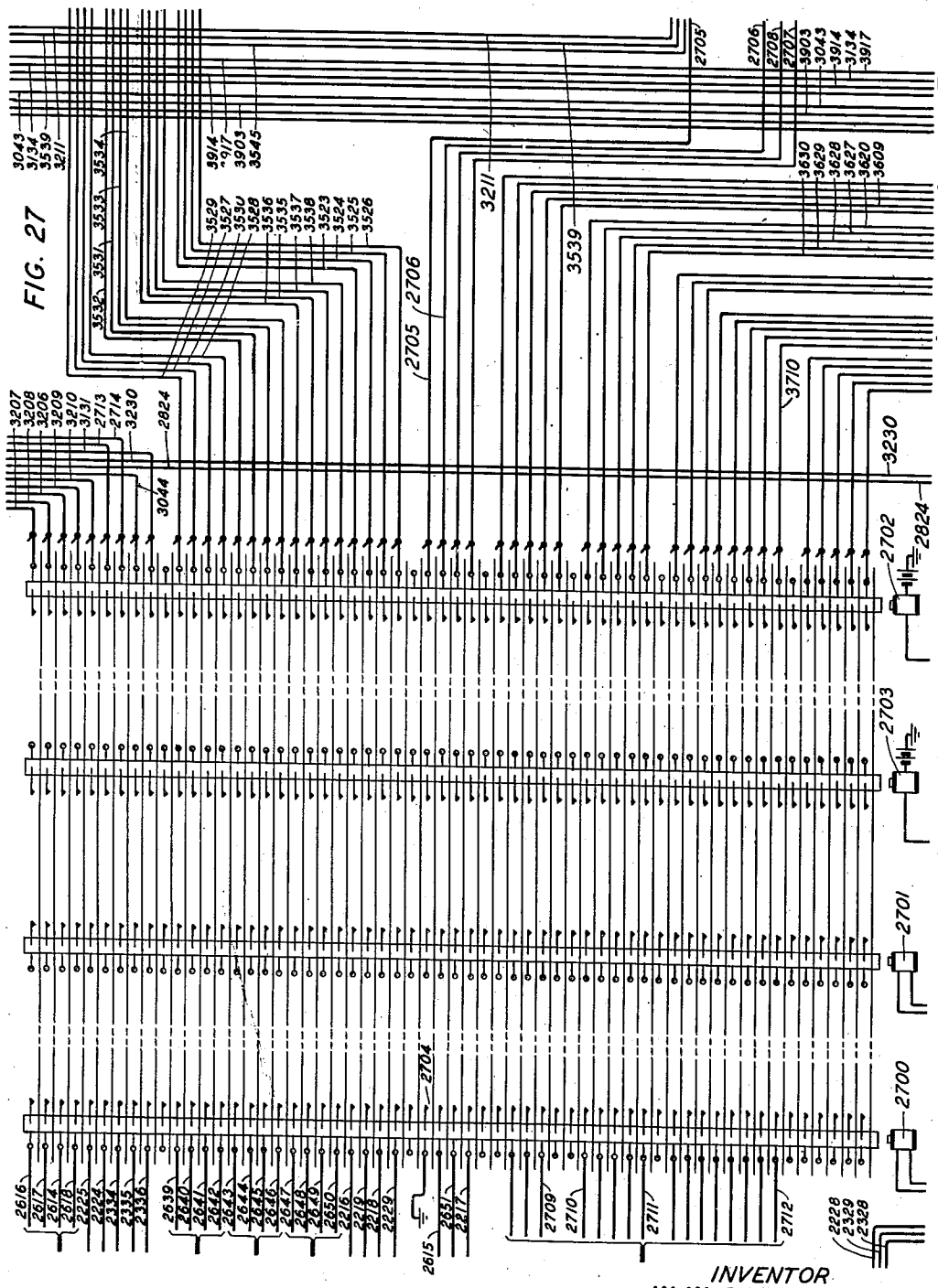
FIG. 27



INVENTOR
W. W. CARPENTER
BY
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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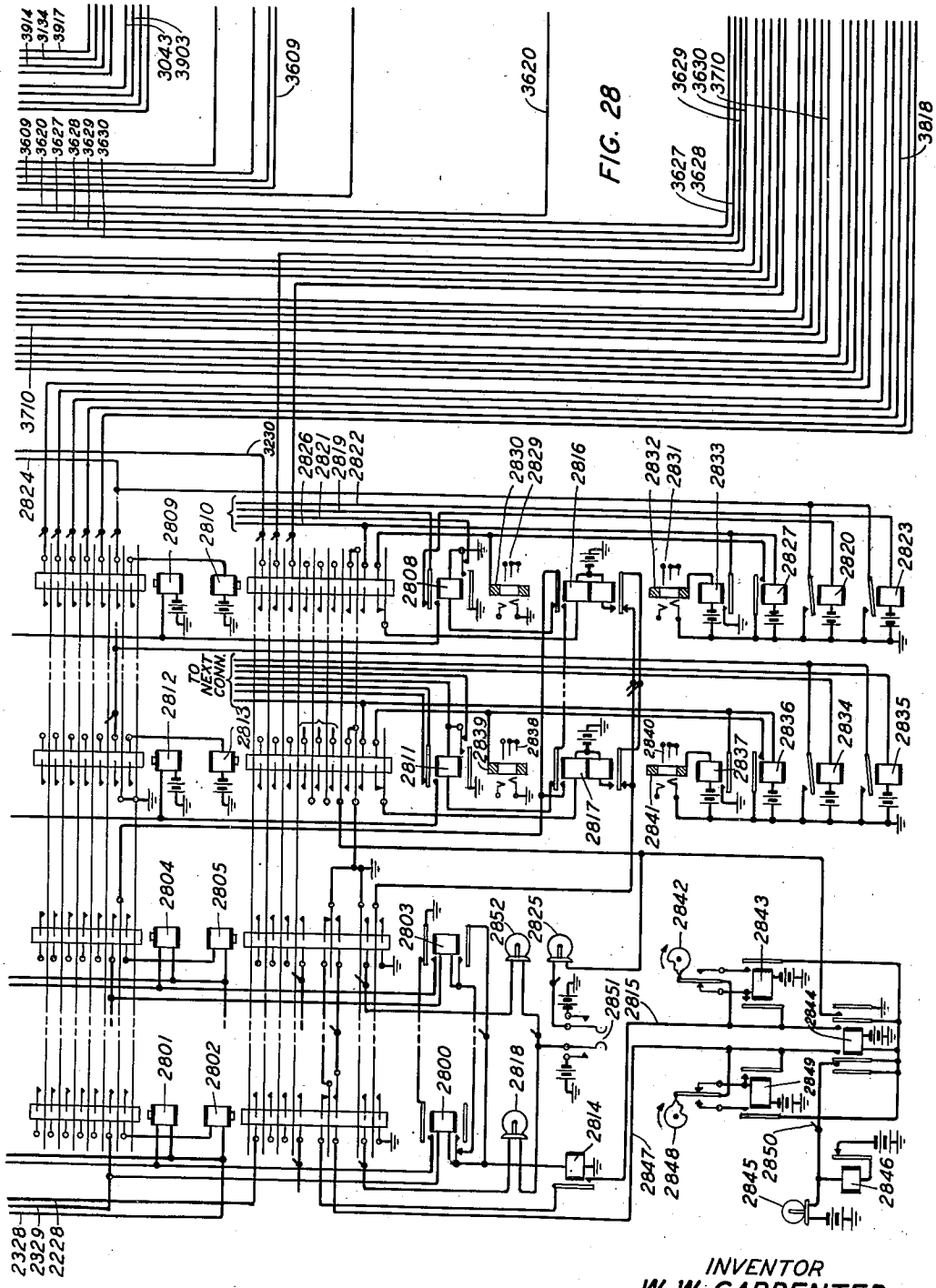

FIG. 28

INVENTOR
W. W. CARPENTER
BY
ATTORNEY

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TELEPHONE SYSTEM

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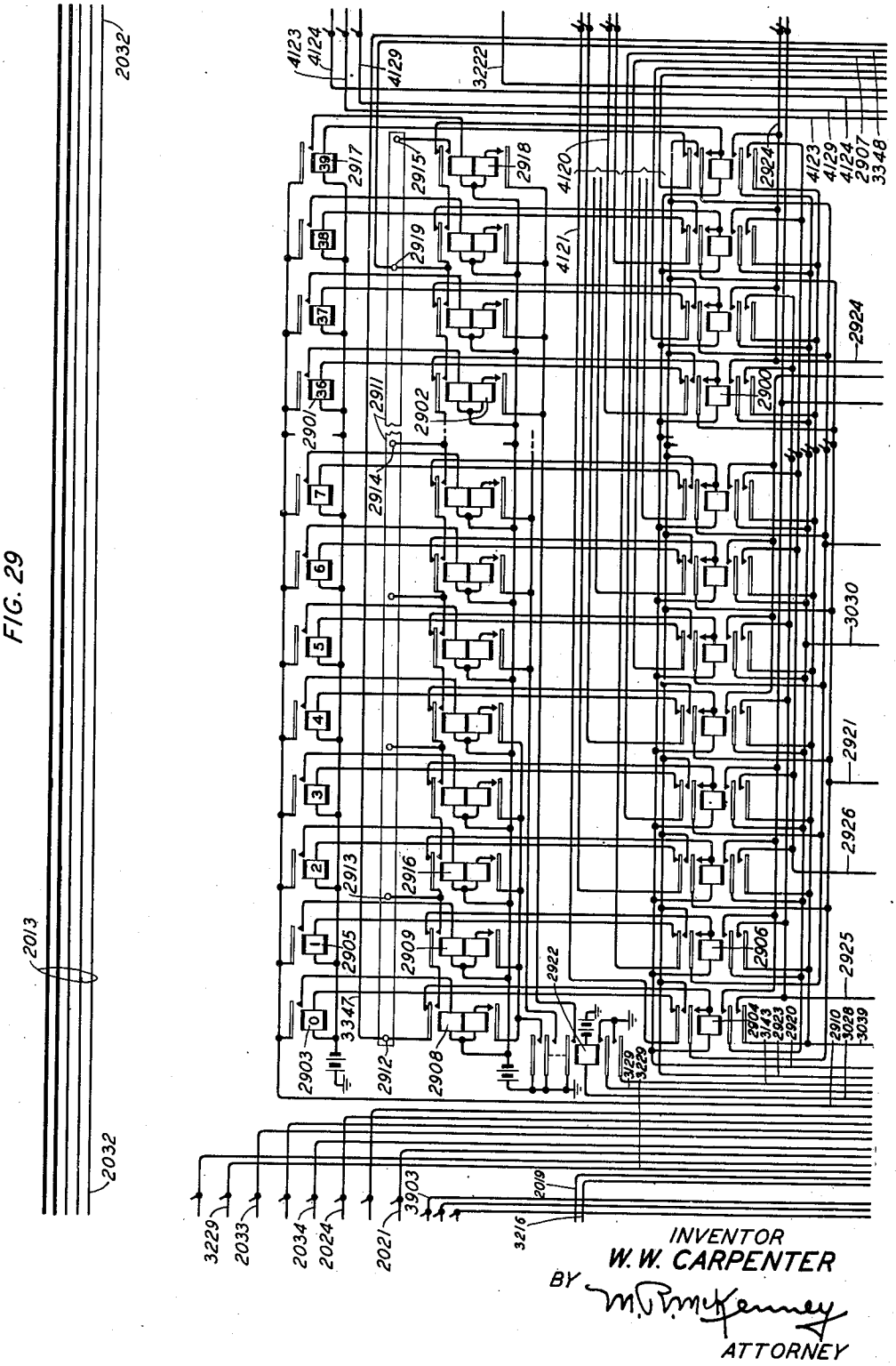

FIG. 29

INVENTOR
W. W. CARPENTER
BY M. J. McKenney
ATTORNEY

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TELEPHONE SYSTEM

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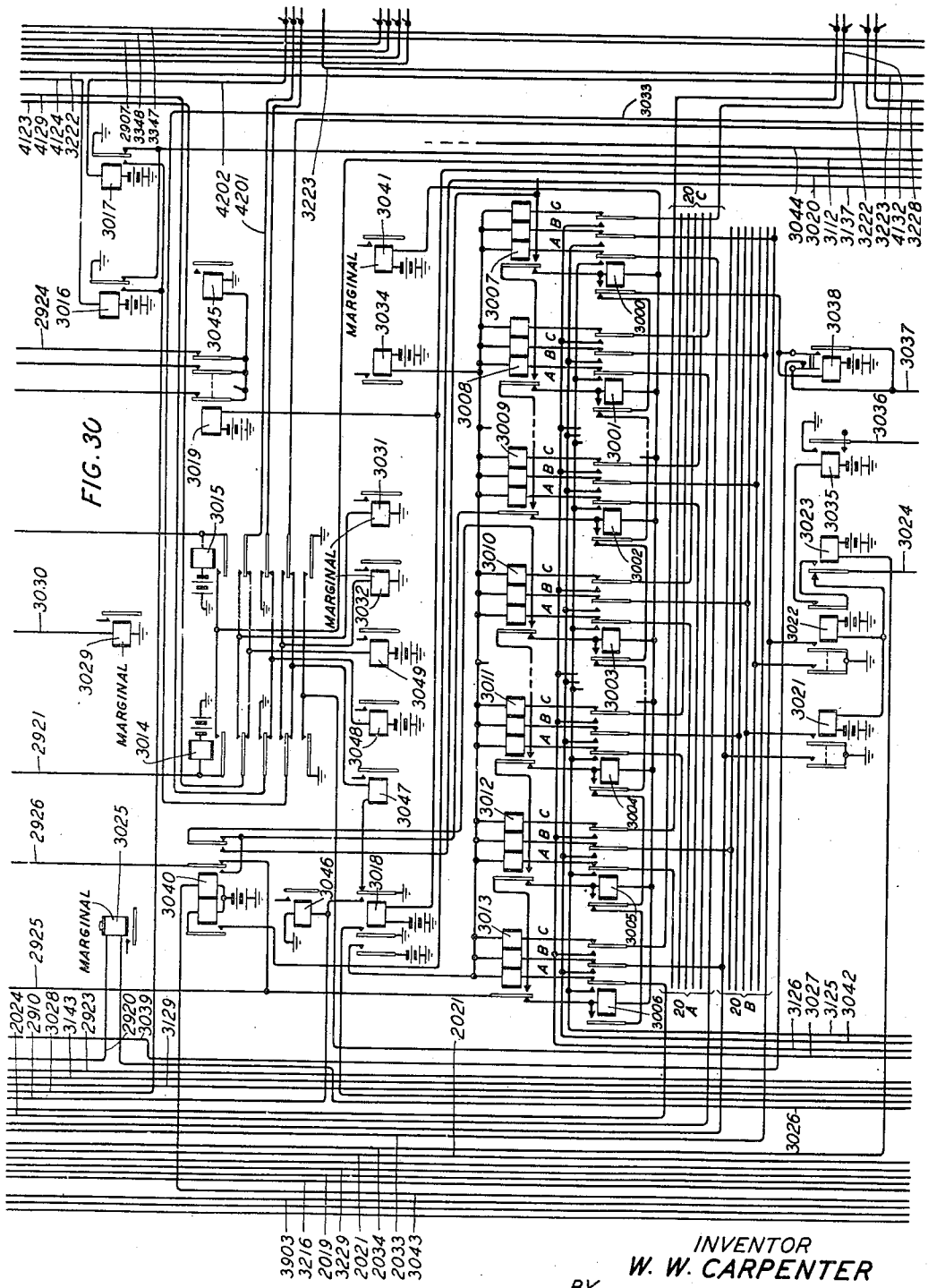

INVENTOR
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TELEPHONE SYSTEM

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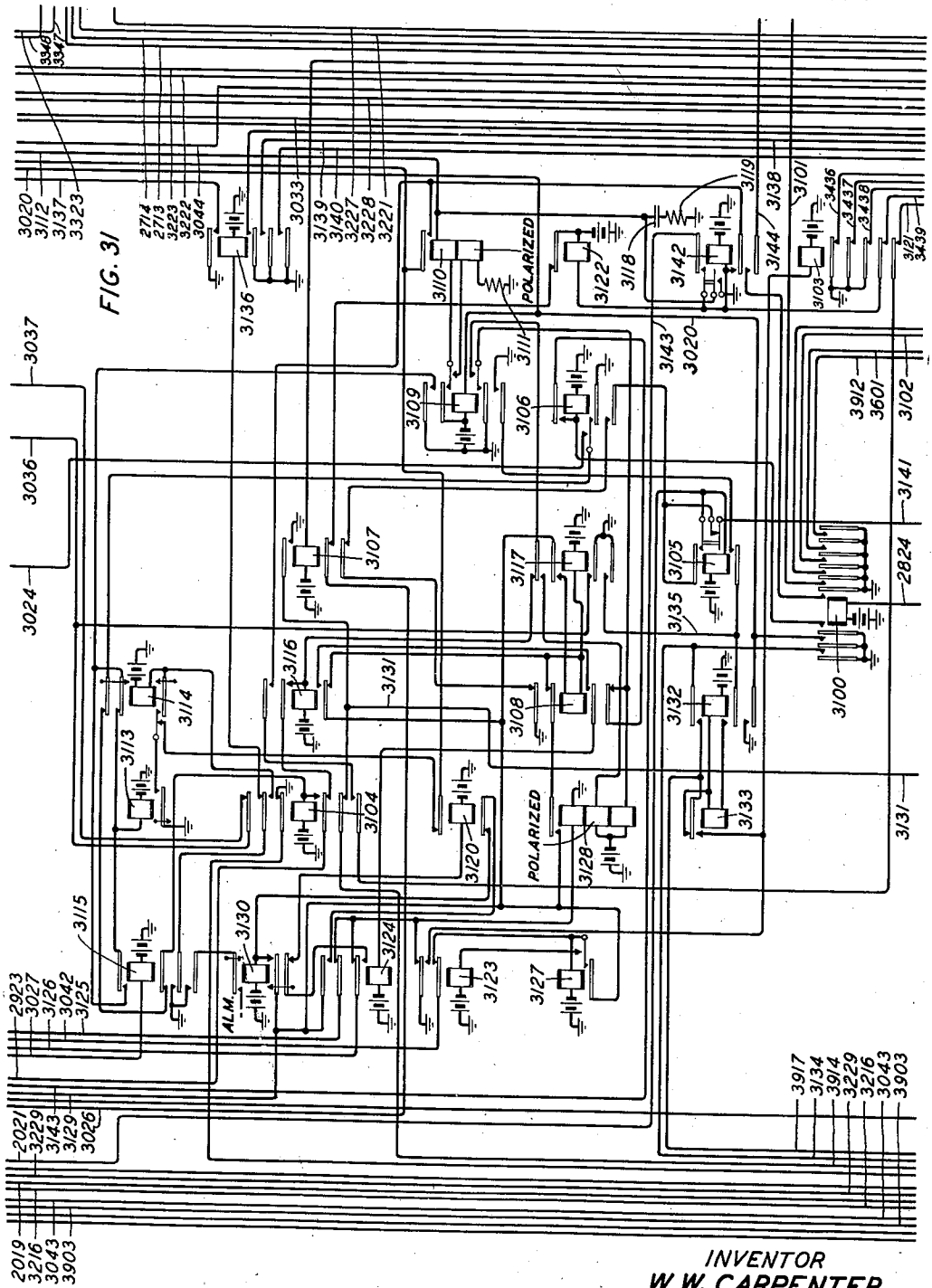

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TELEPHONE SYSTEM

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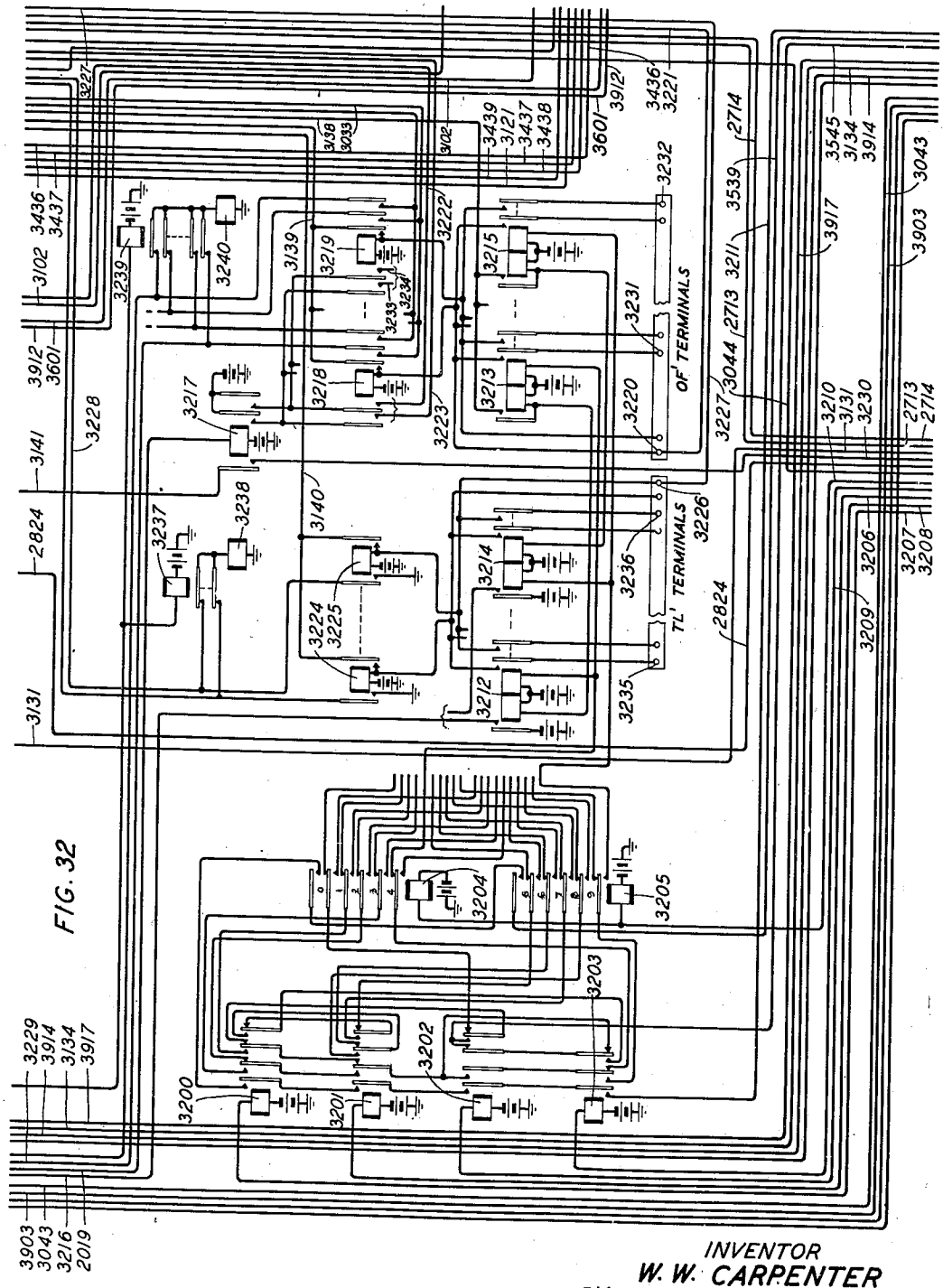

FIG. 32

INVENTOR
W. W. CARPENTER
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TELEPHONE SYSTEM

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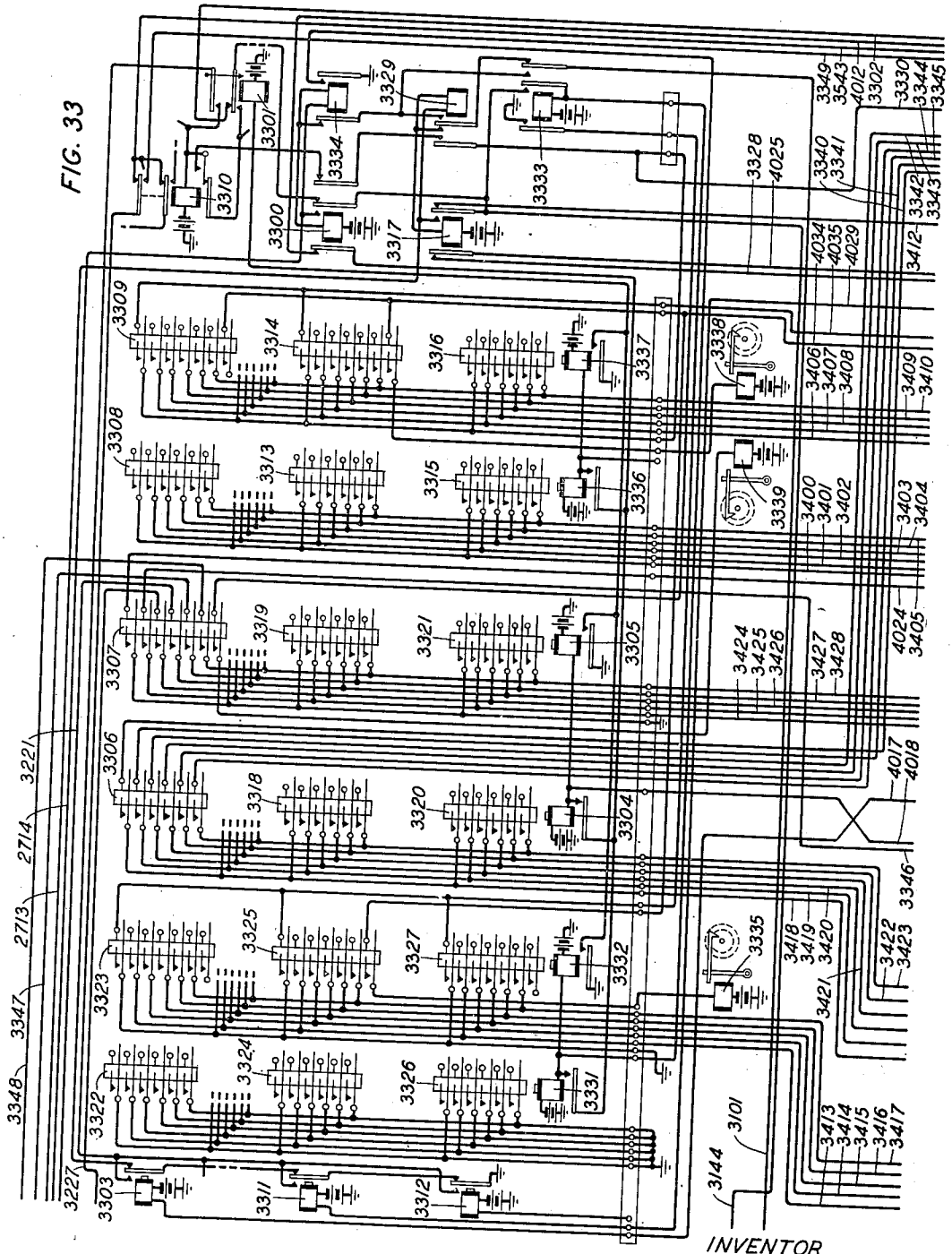
FIG. 33



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TELEPHONE SYSTEM

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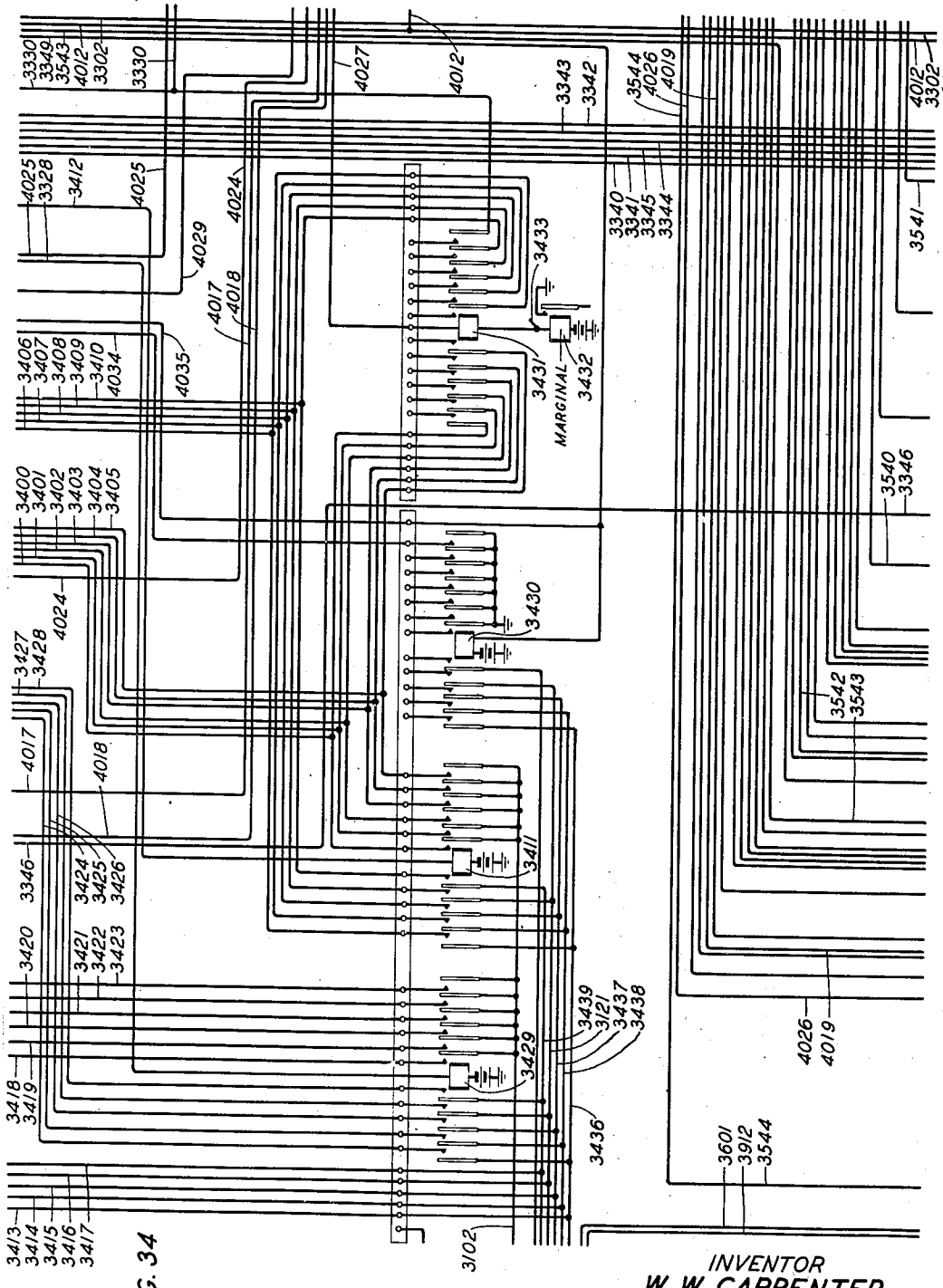

FIG. 34

INVENTOR
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TELEPHONE SYSTEM

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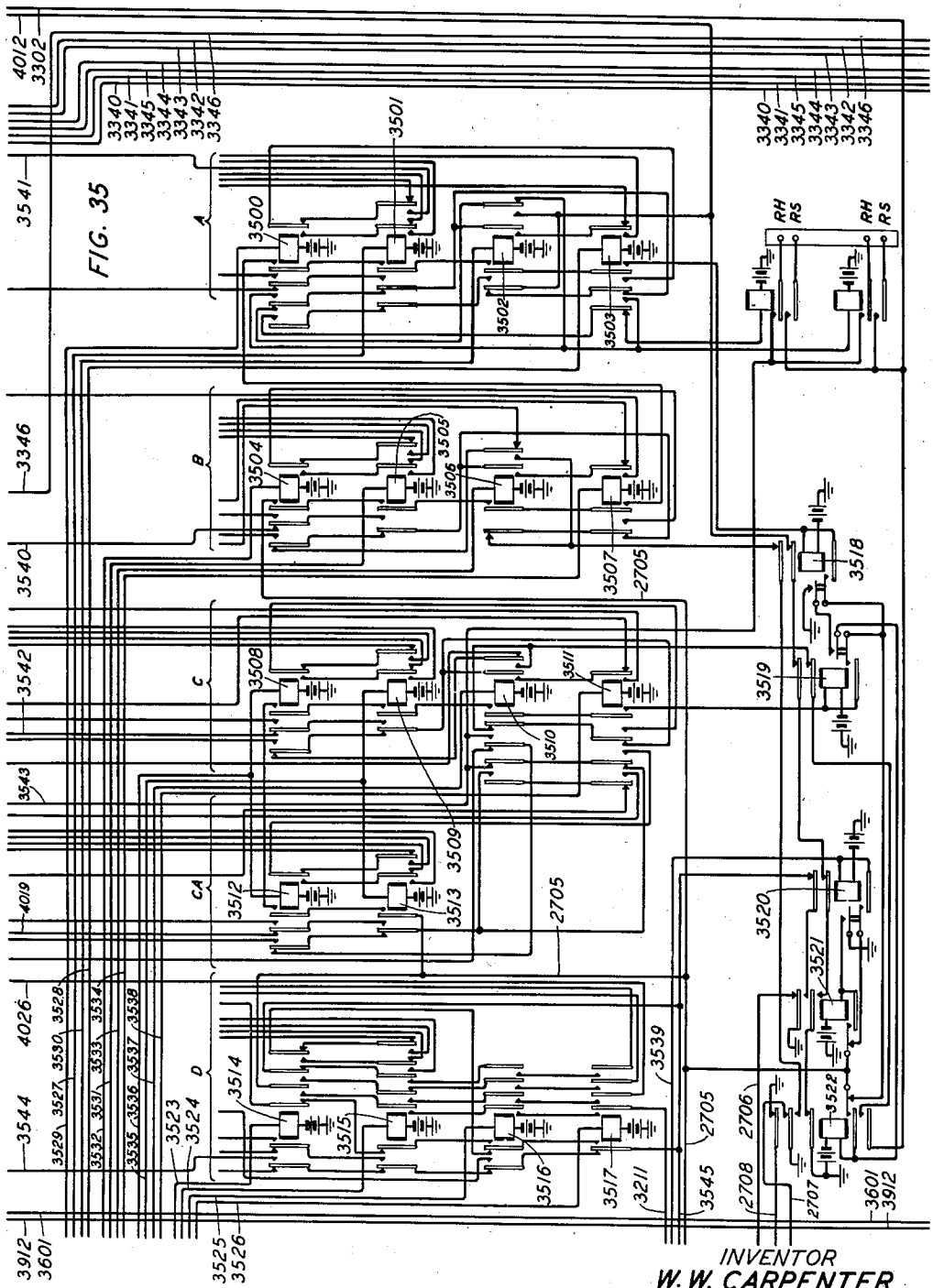

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BY
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TELEPHONE SYSTEM

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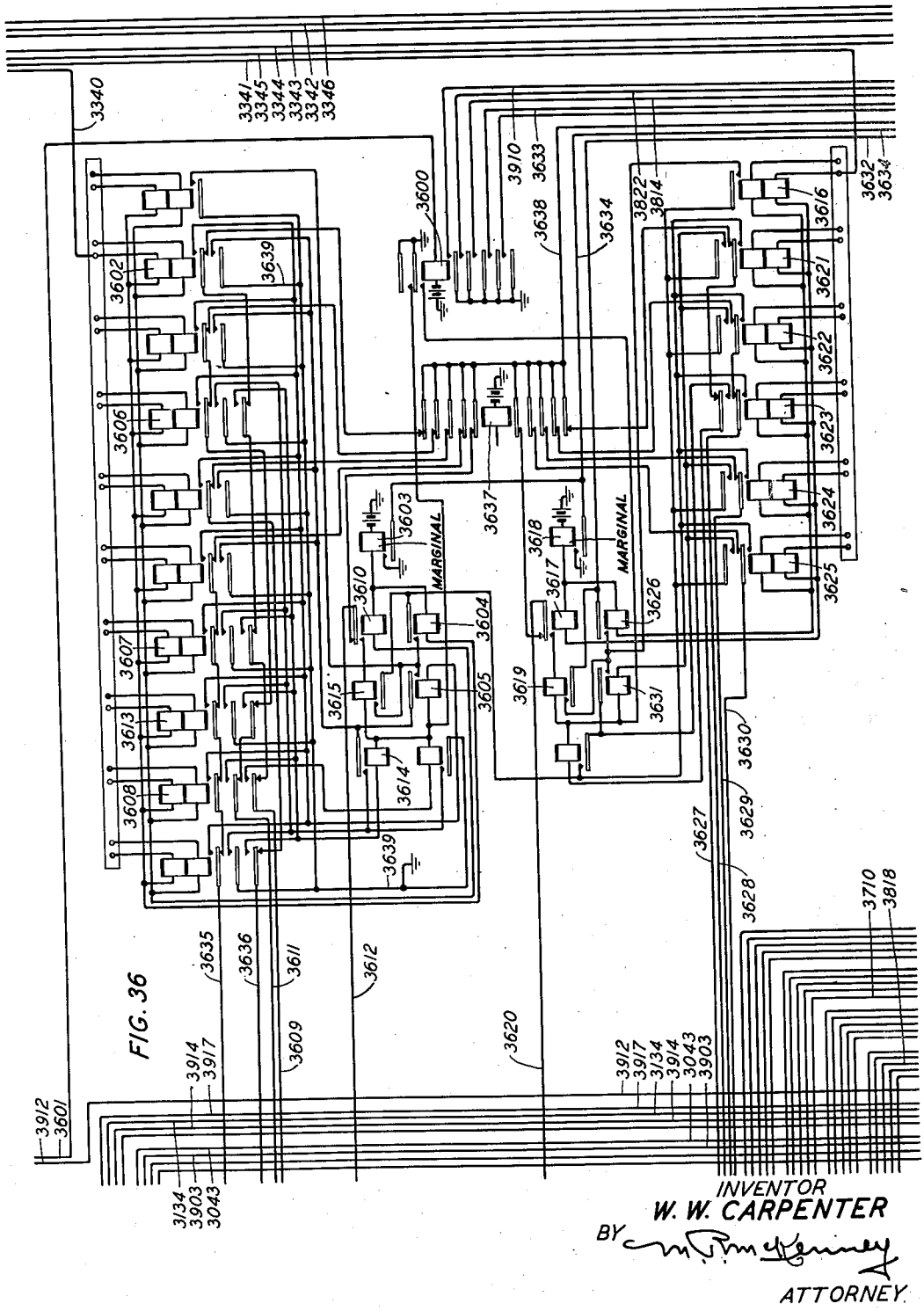

FIG. 36

INVENTOR
W. W. CARPENTER
BY
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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 37

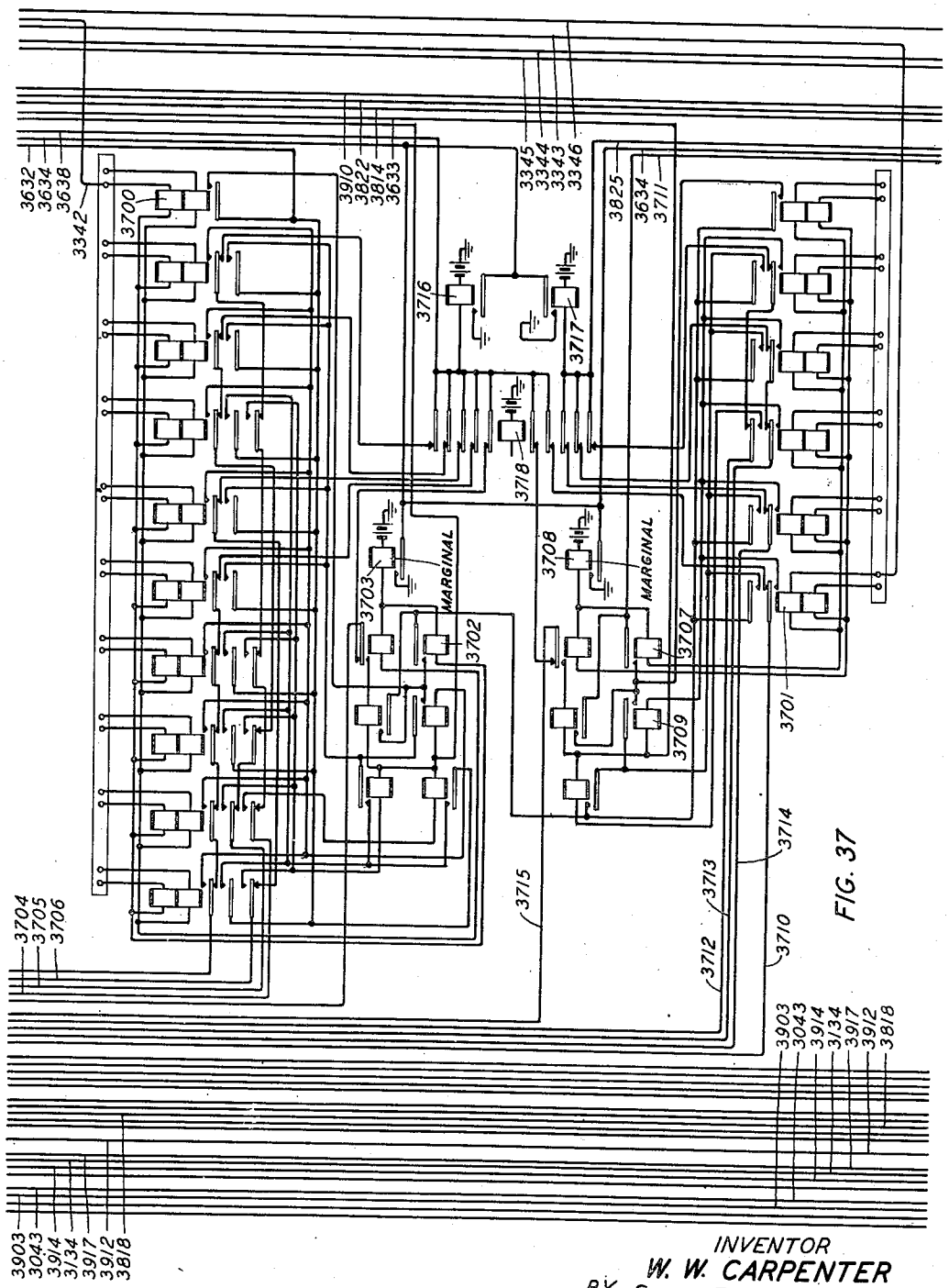

FIG. 37

INVENTOR
W. W. CARPENTER
BY
ATTORNEY

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 38

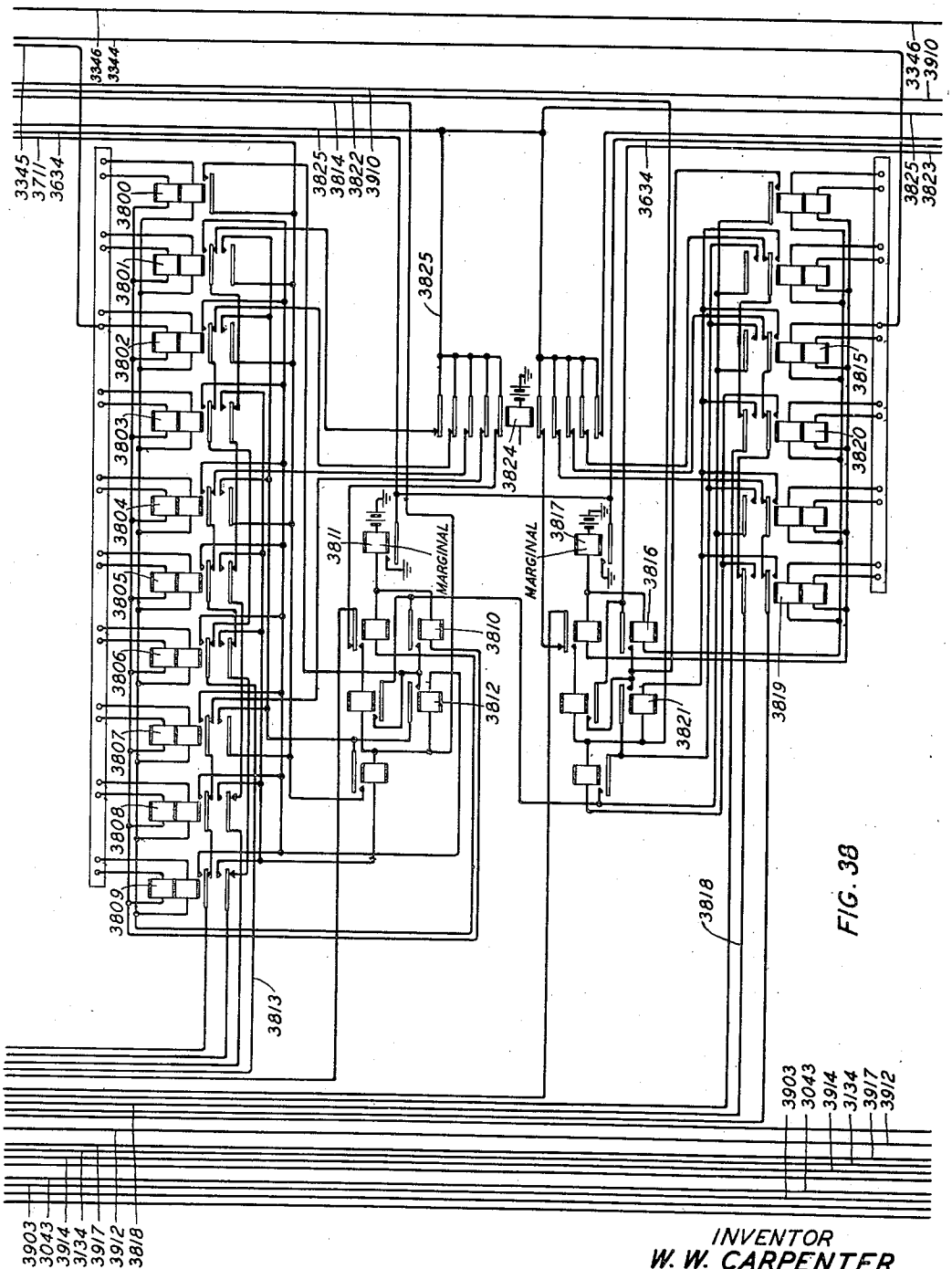

FIG. 38

INVENTOR
W. W. CARPENTER
BY
ATTORNEY

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 39

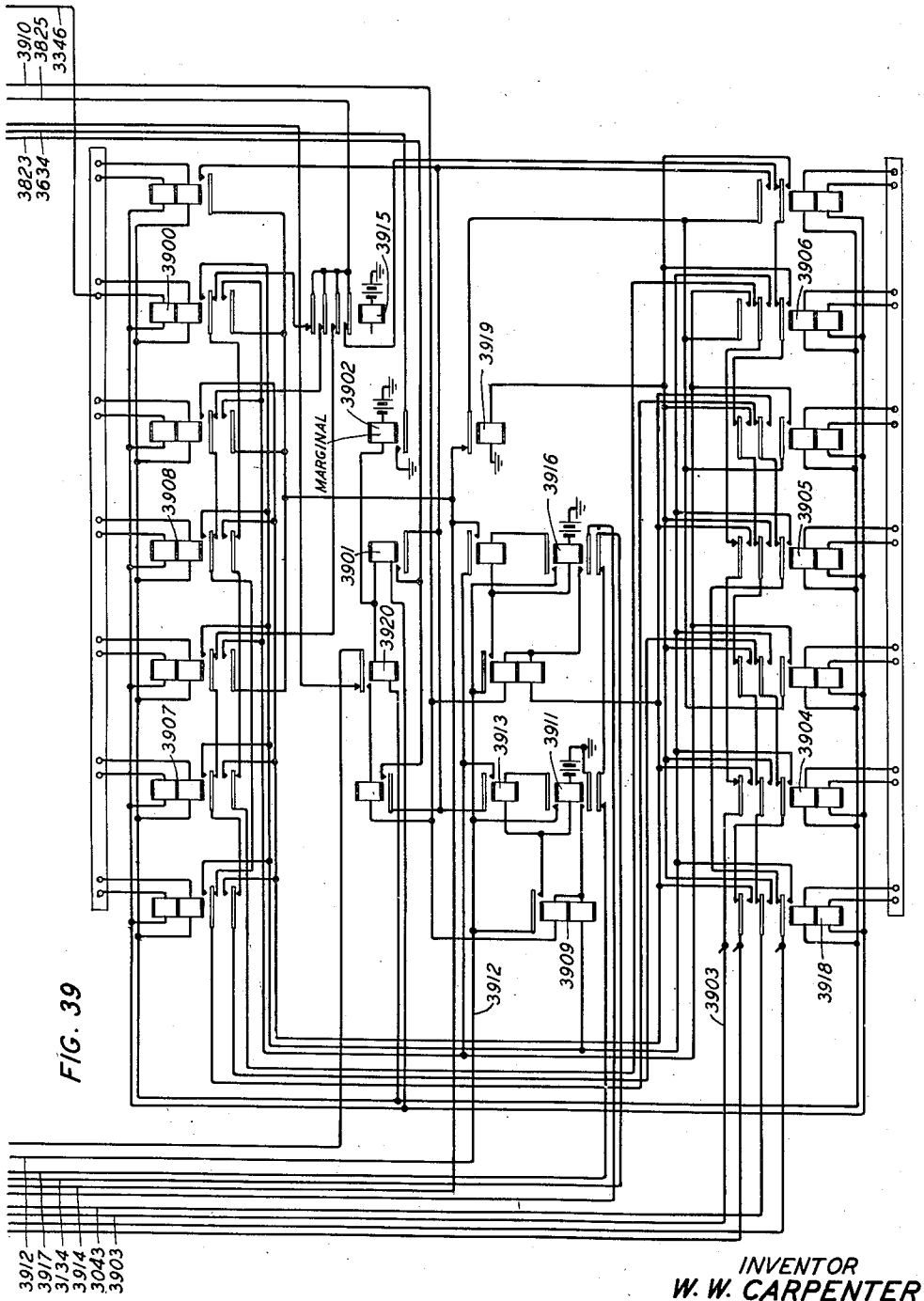

FIG. 39

INVENTOR
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BY
ATTORNEY

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TELEPHONE SYSTEM

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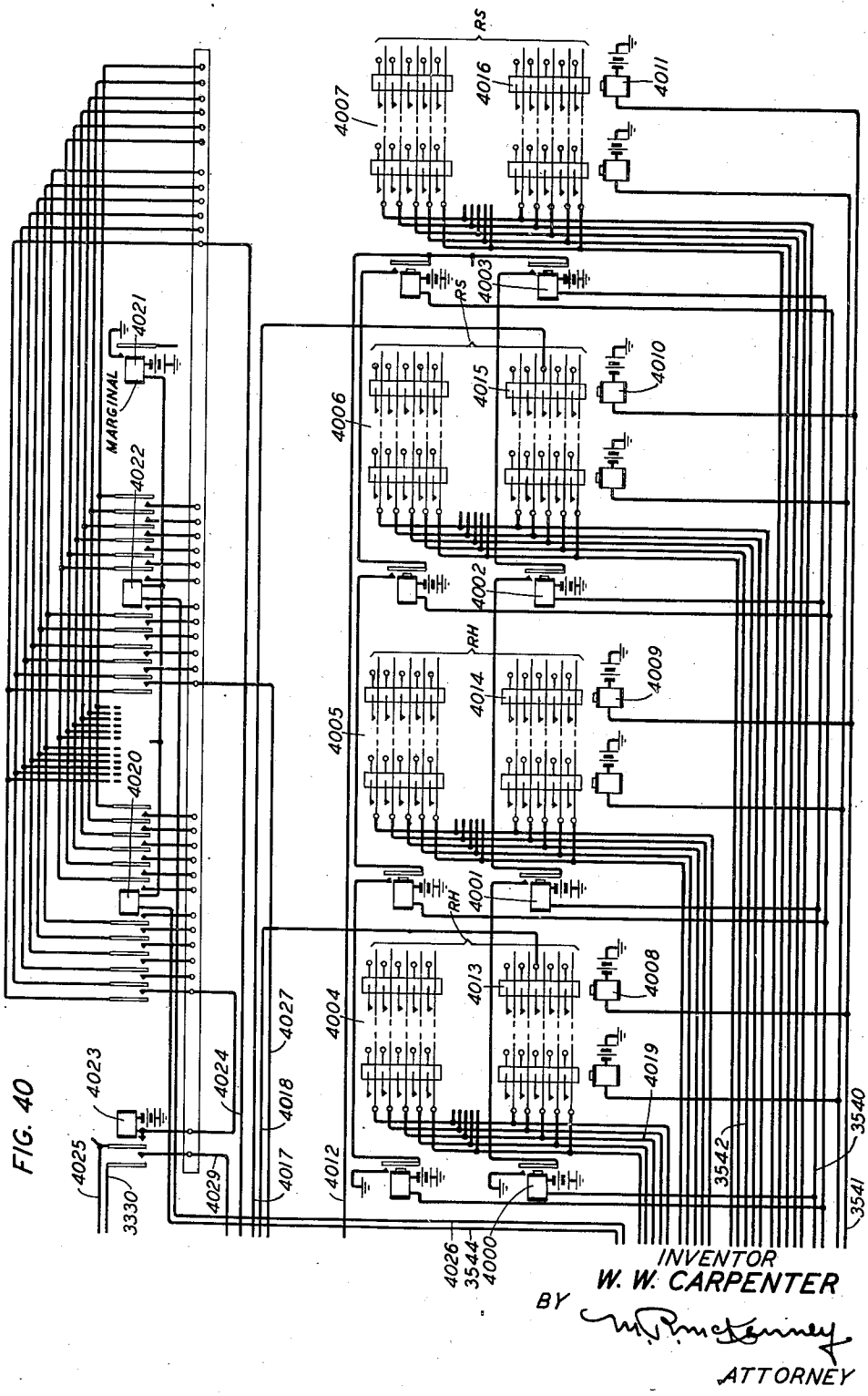

FIG. 40

INVENTOR
W. W. CARPENTER
BY
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

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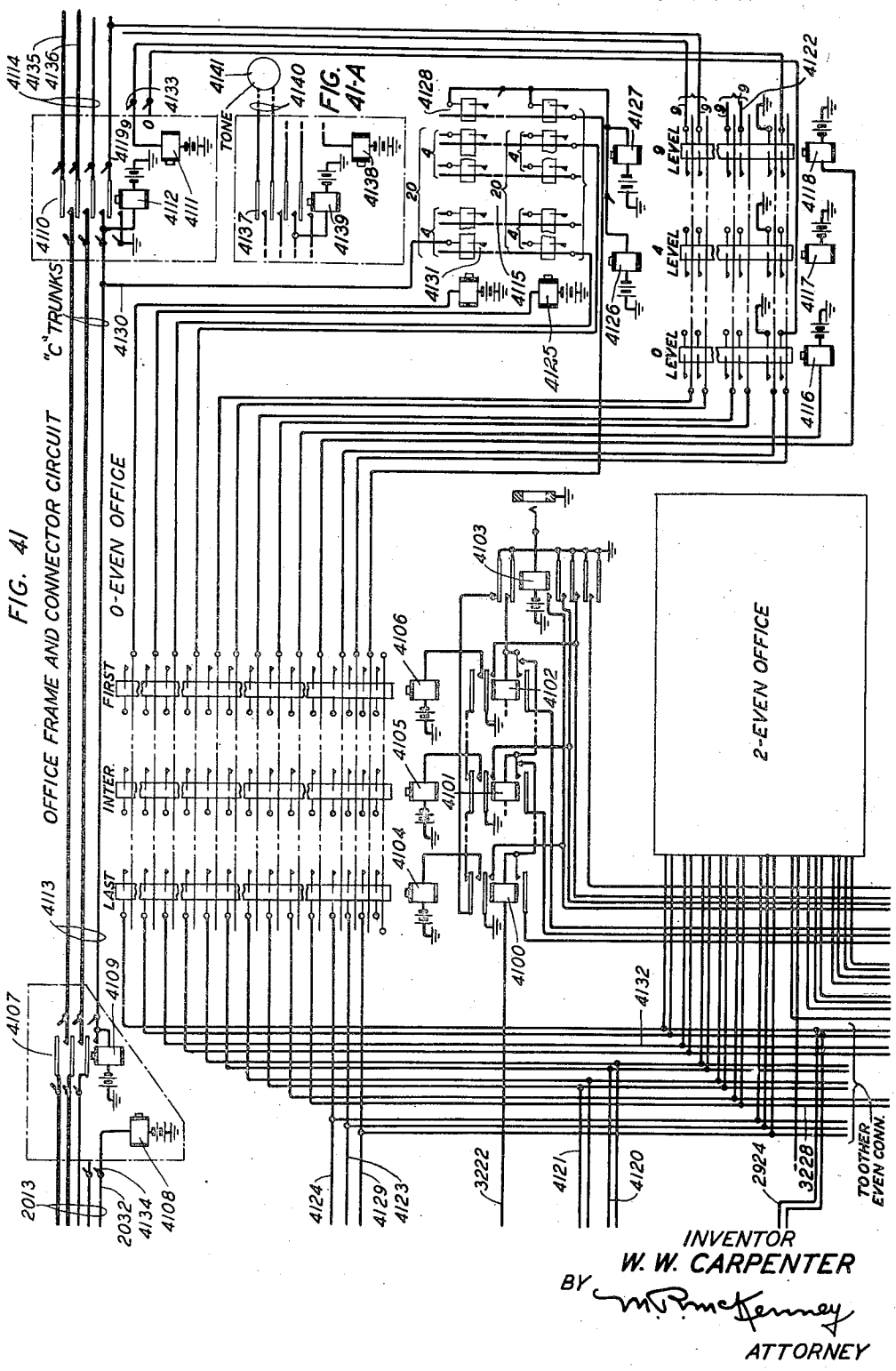

INVENTOR
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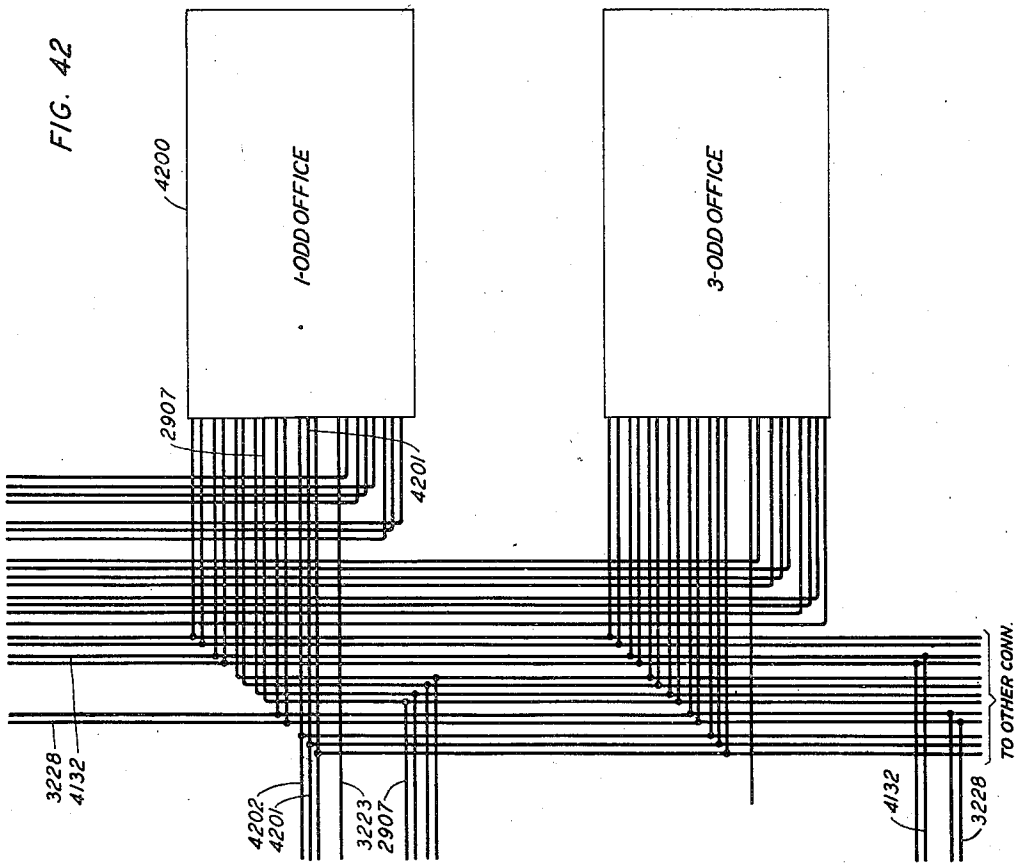
BY
ATTORNEY

Sept. 14, 1937. W. W. CARPENTER 2,093,117

TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 42

FIG. 42



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TELEPHONE SYSTEM

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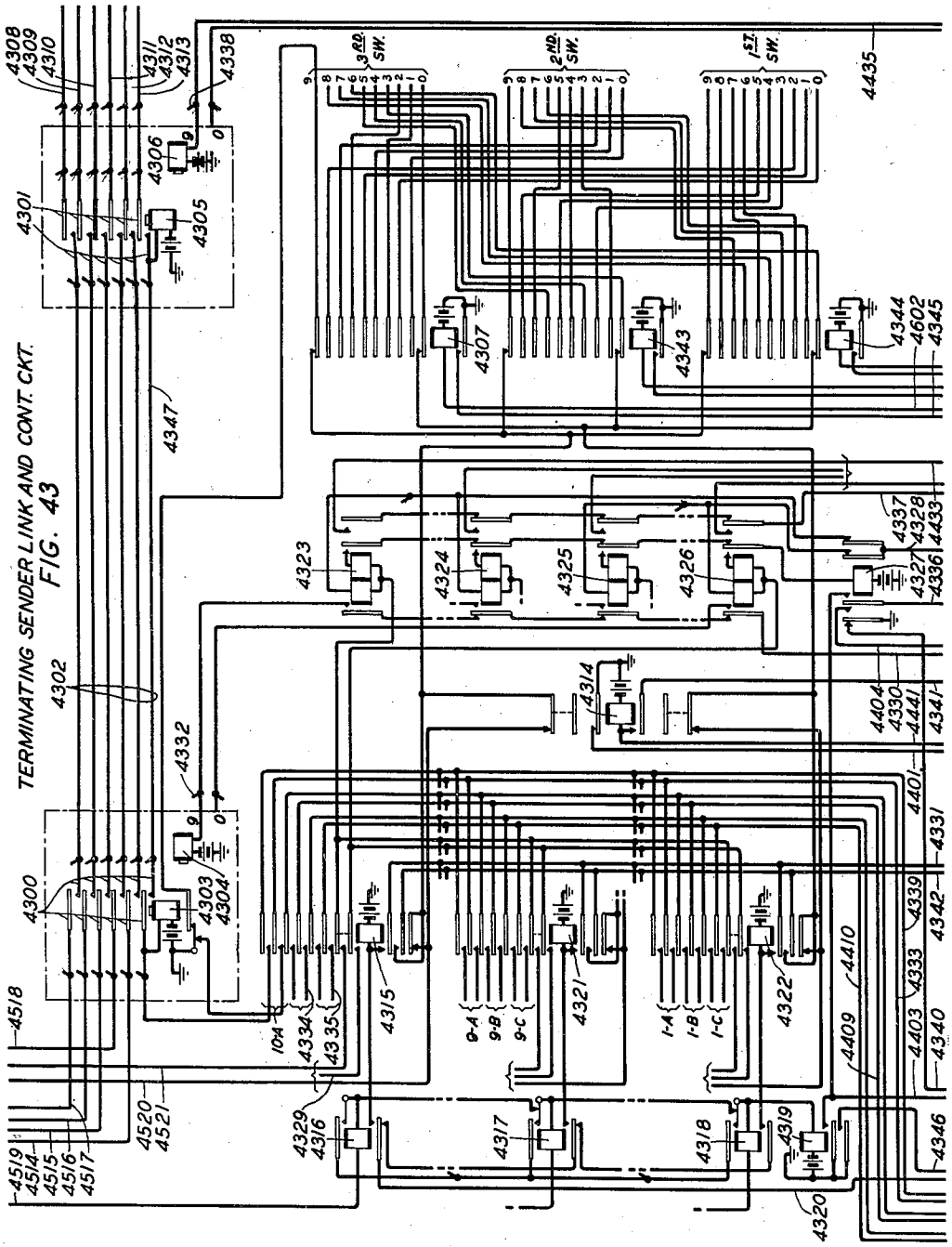

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TELEPHONE SYSTEM

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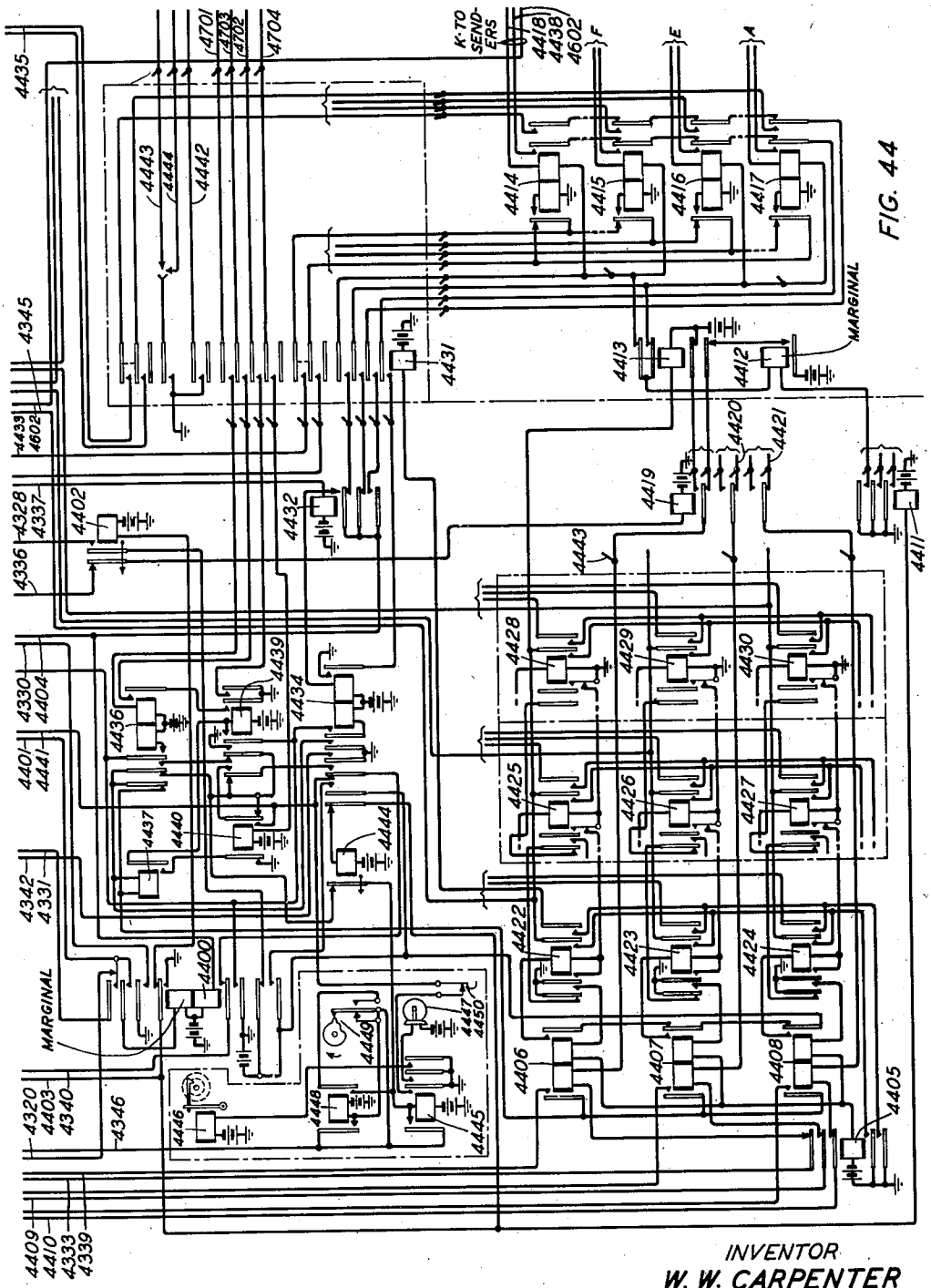

FIG. 44

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TELEPHONE SYSTEM

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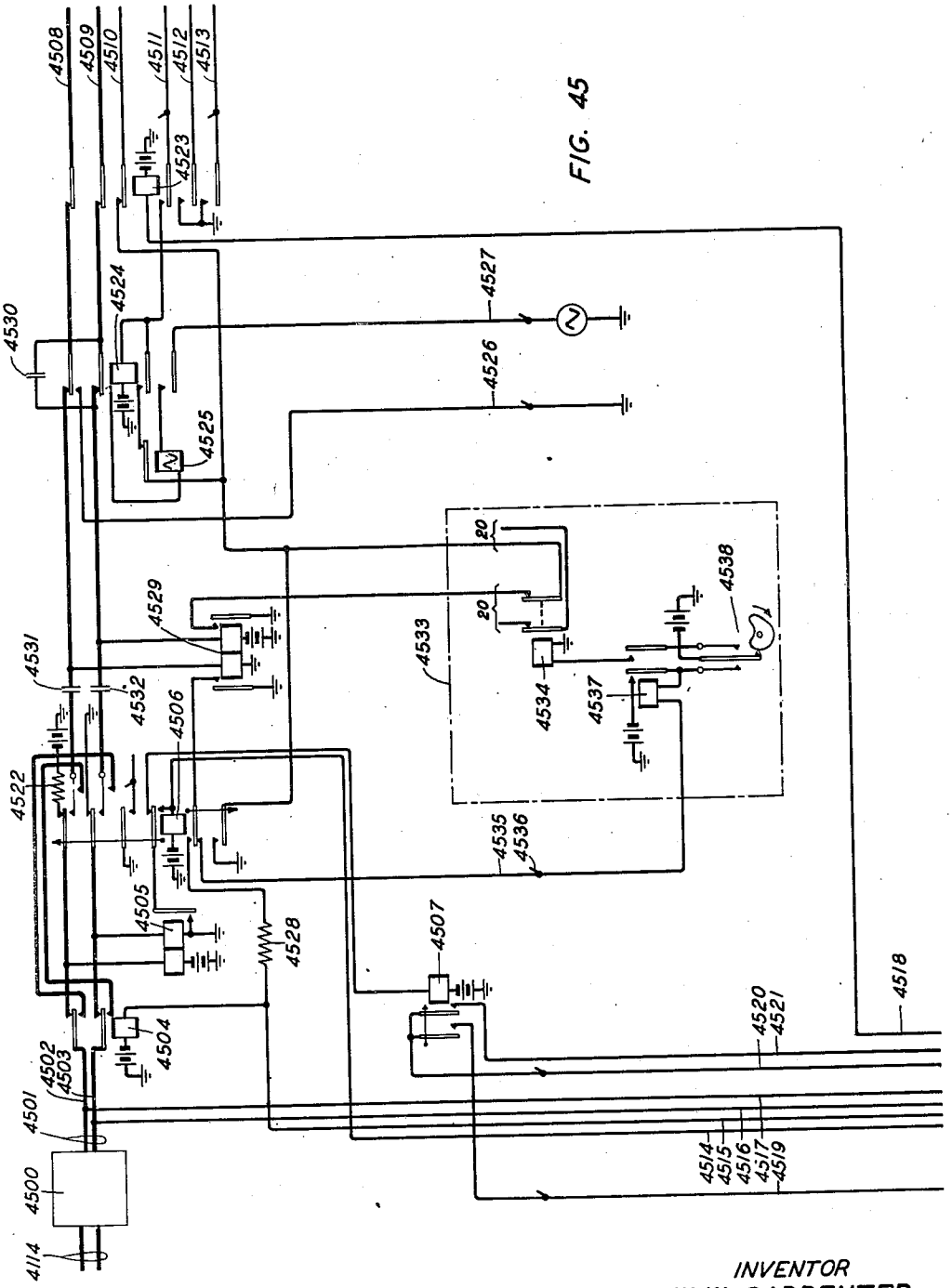
FIG. 45



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TELEPHONE SYSTEM

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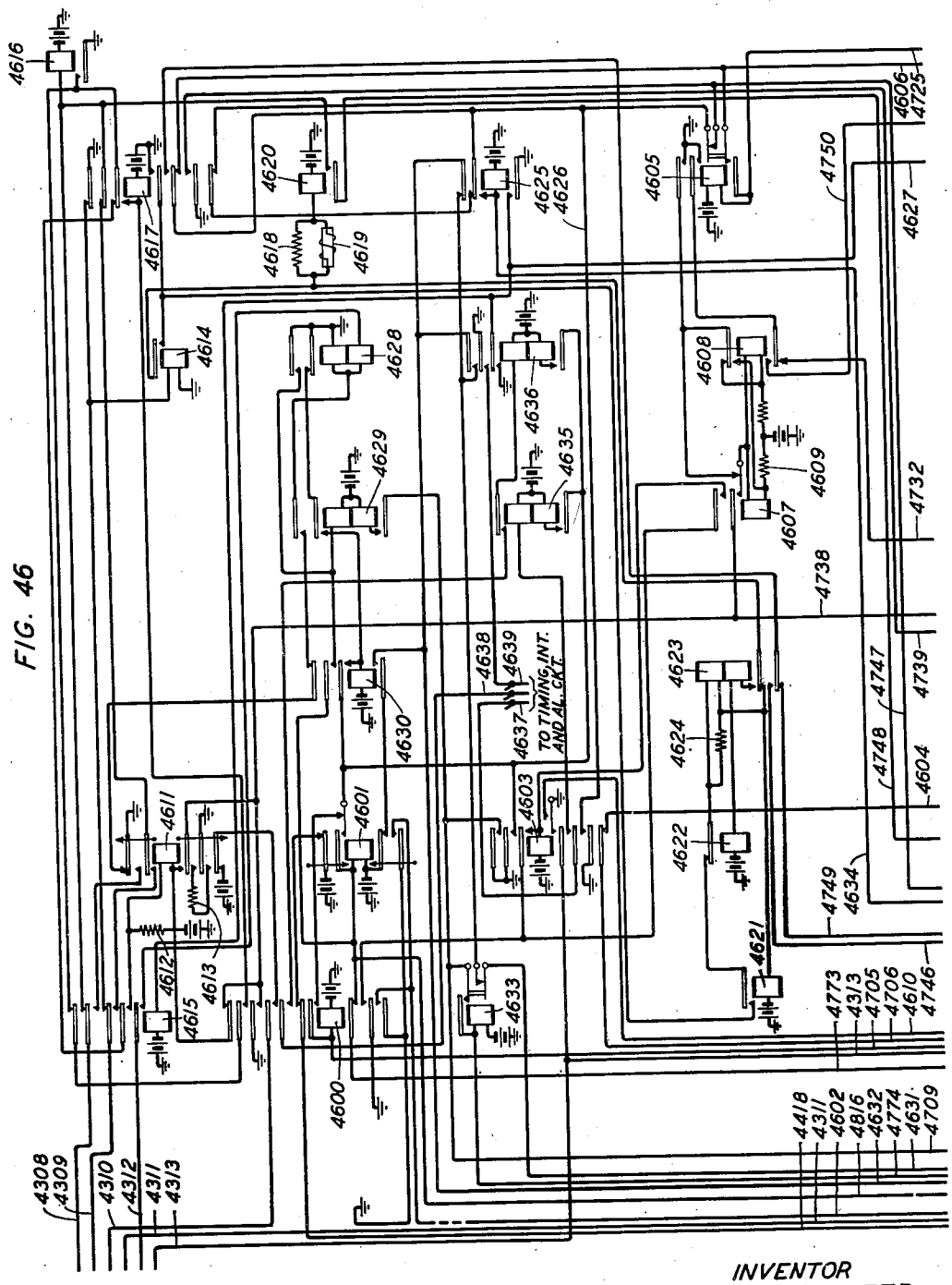

FIG. 46

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 47

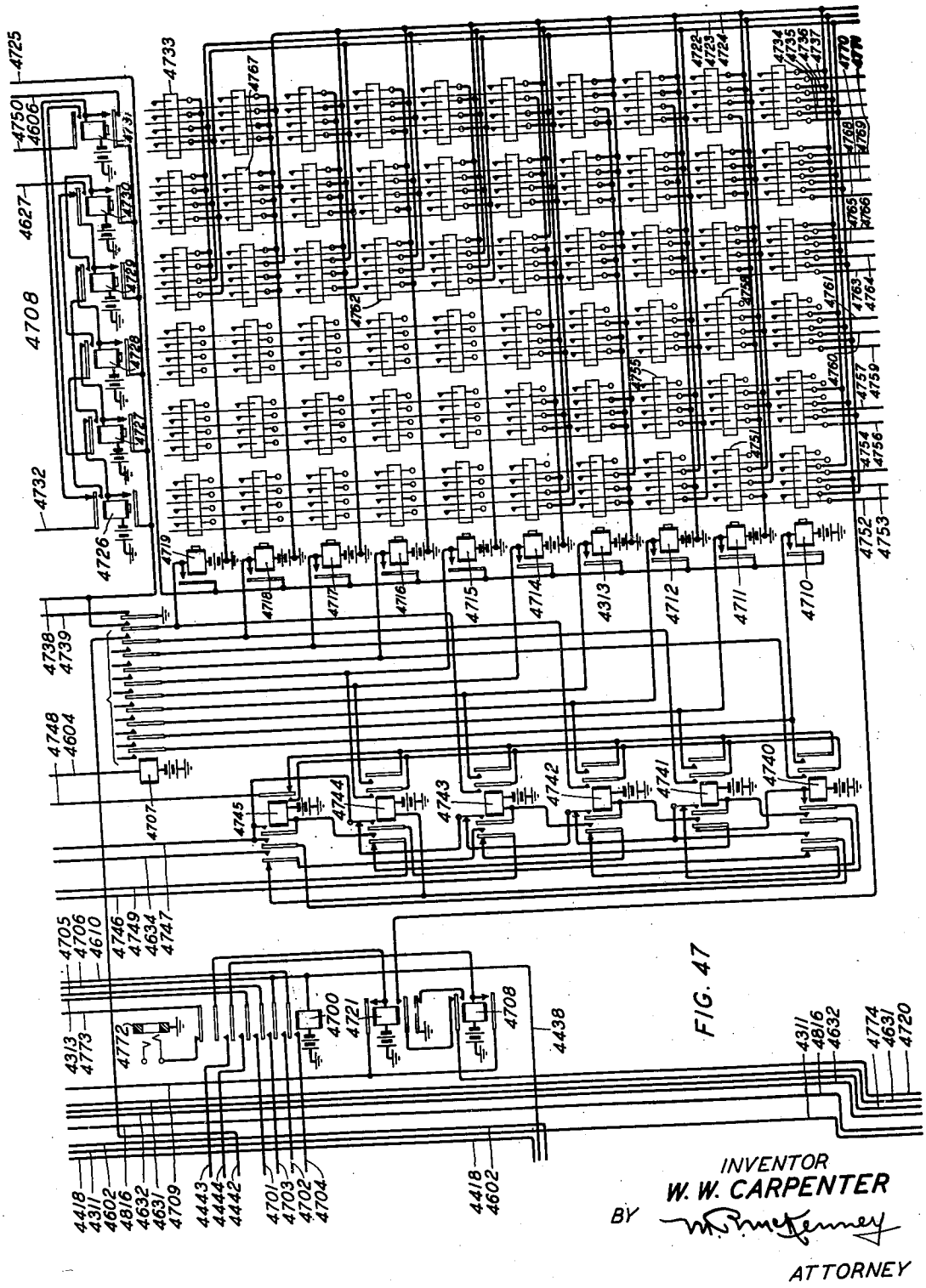

FIG. 47

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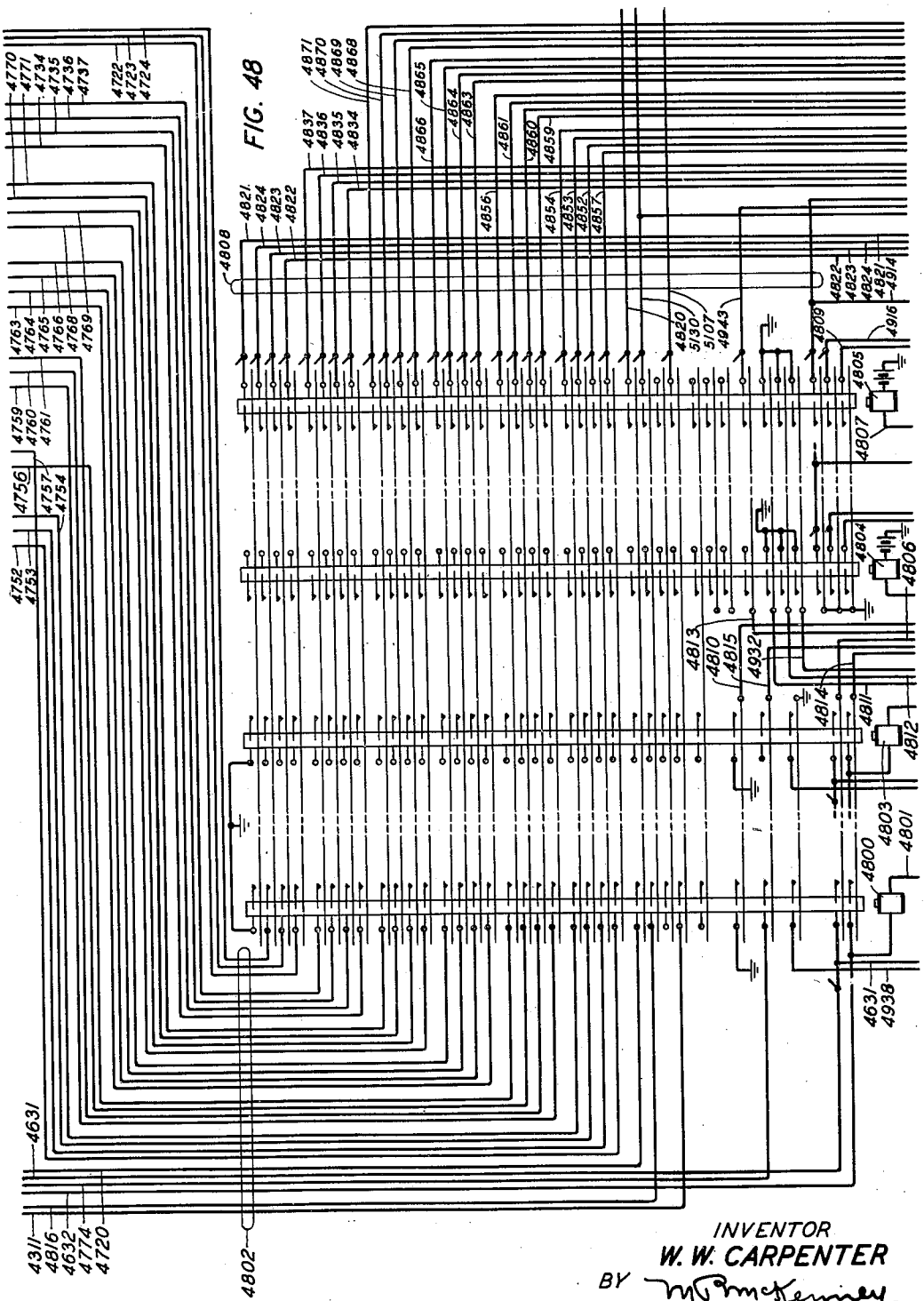
TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 48



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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 49

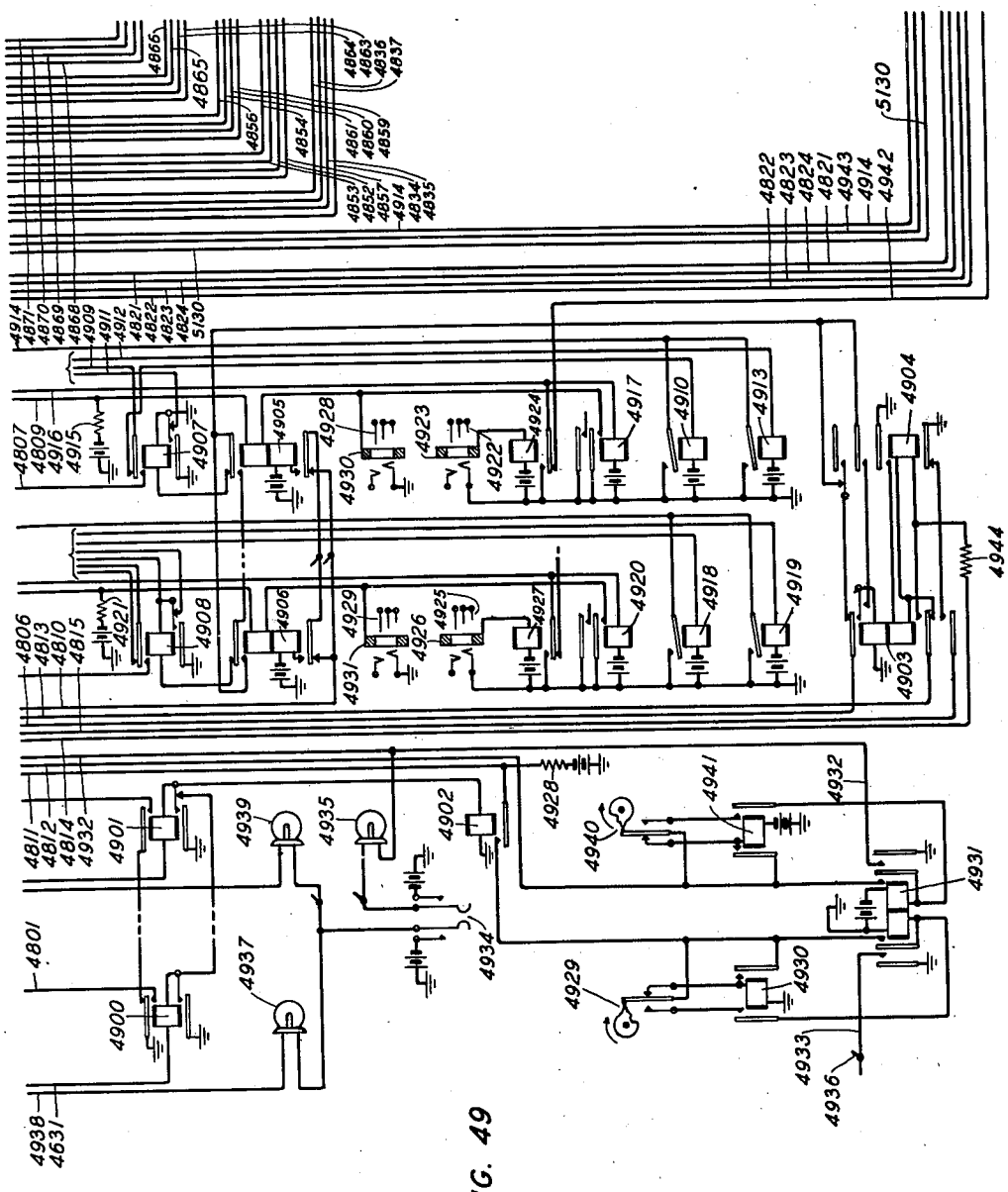

FIG. 49

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 50

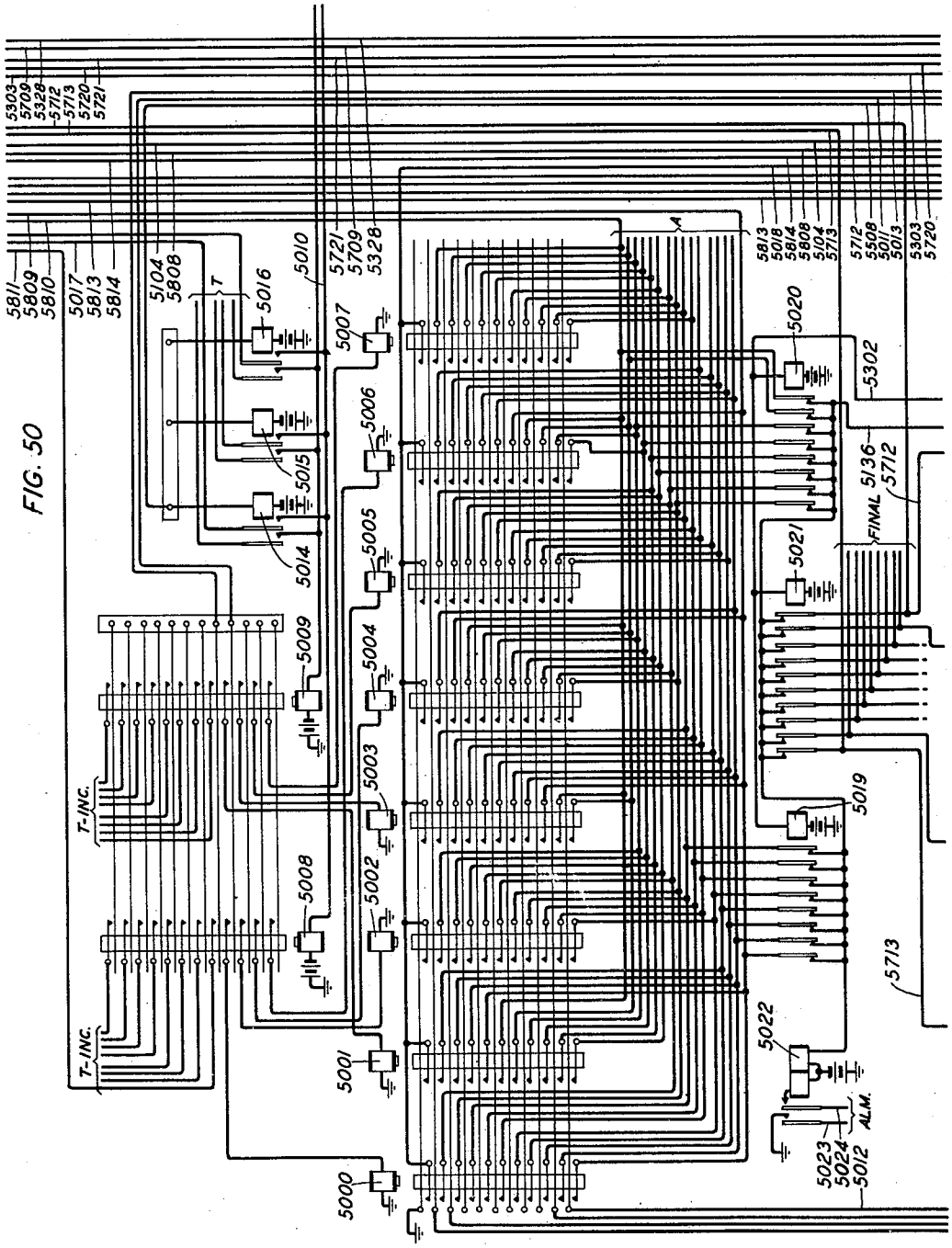

FIG. 50

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 51

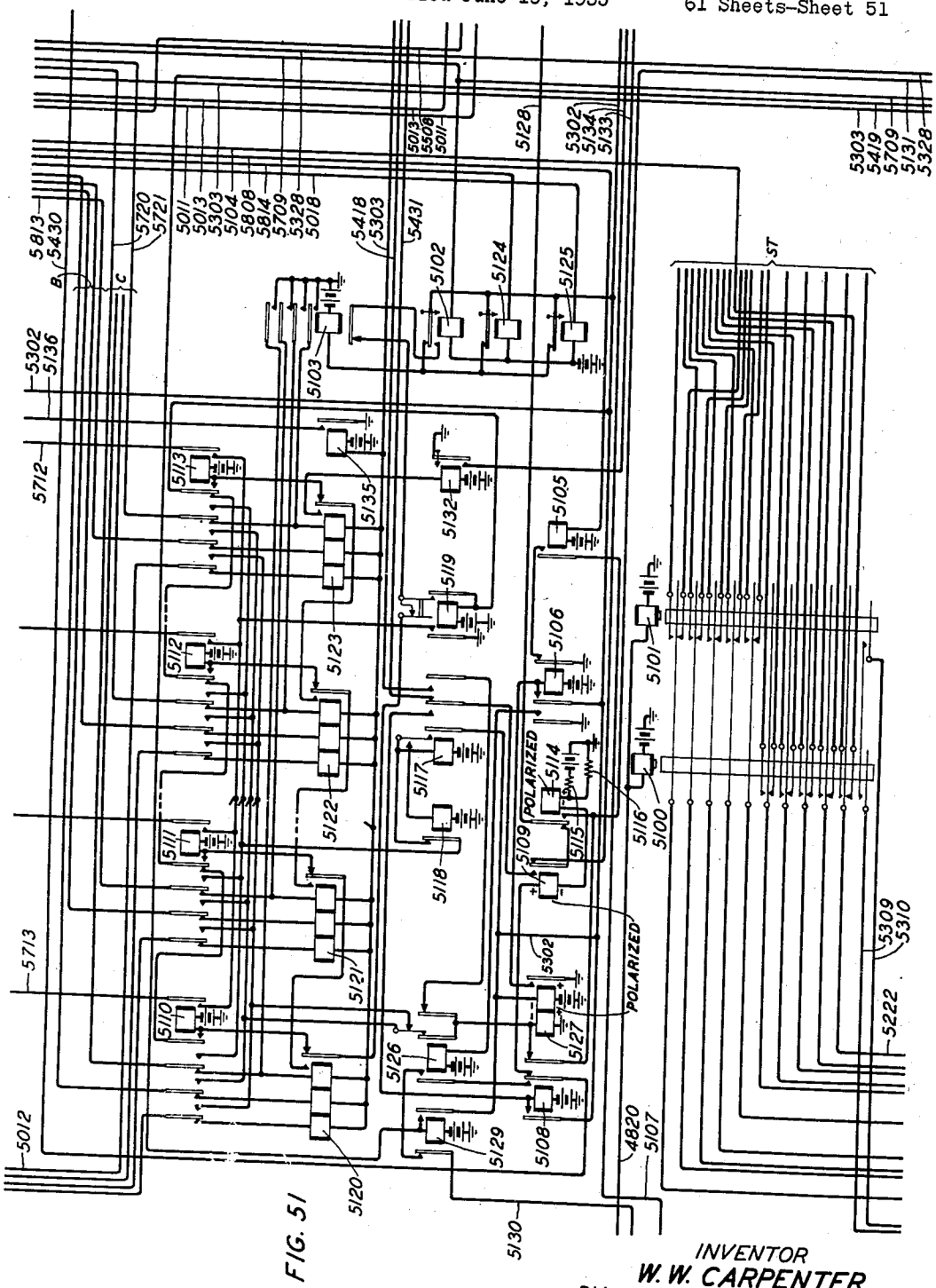

FIG. 51

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 52

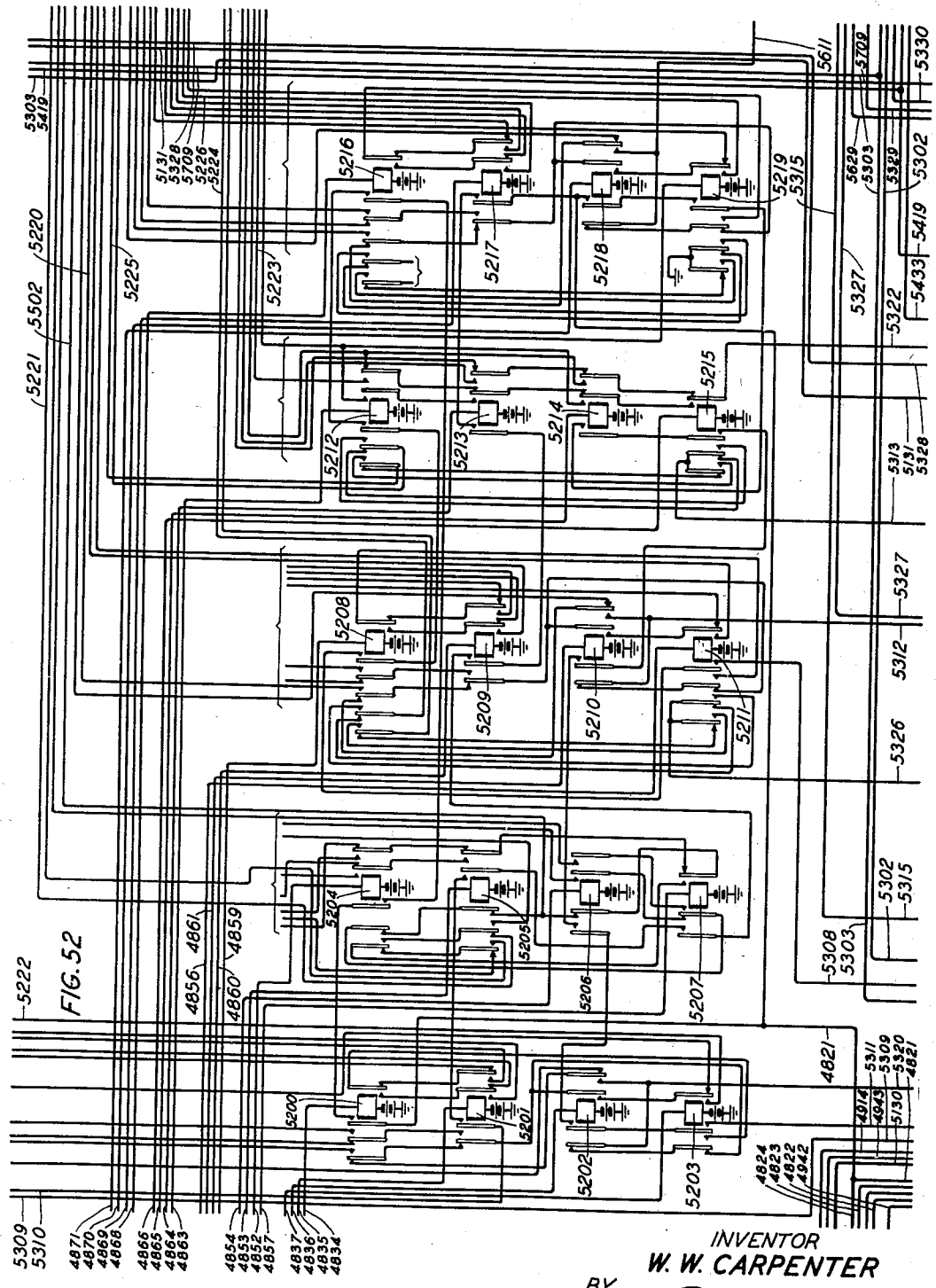

FIG. 52

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 53

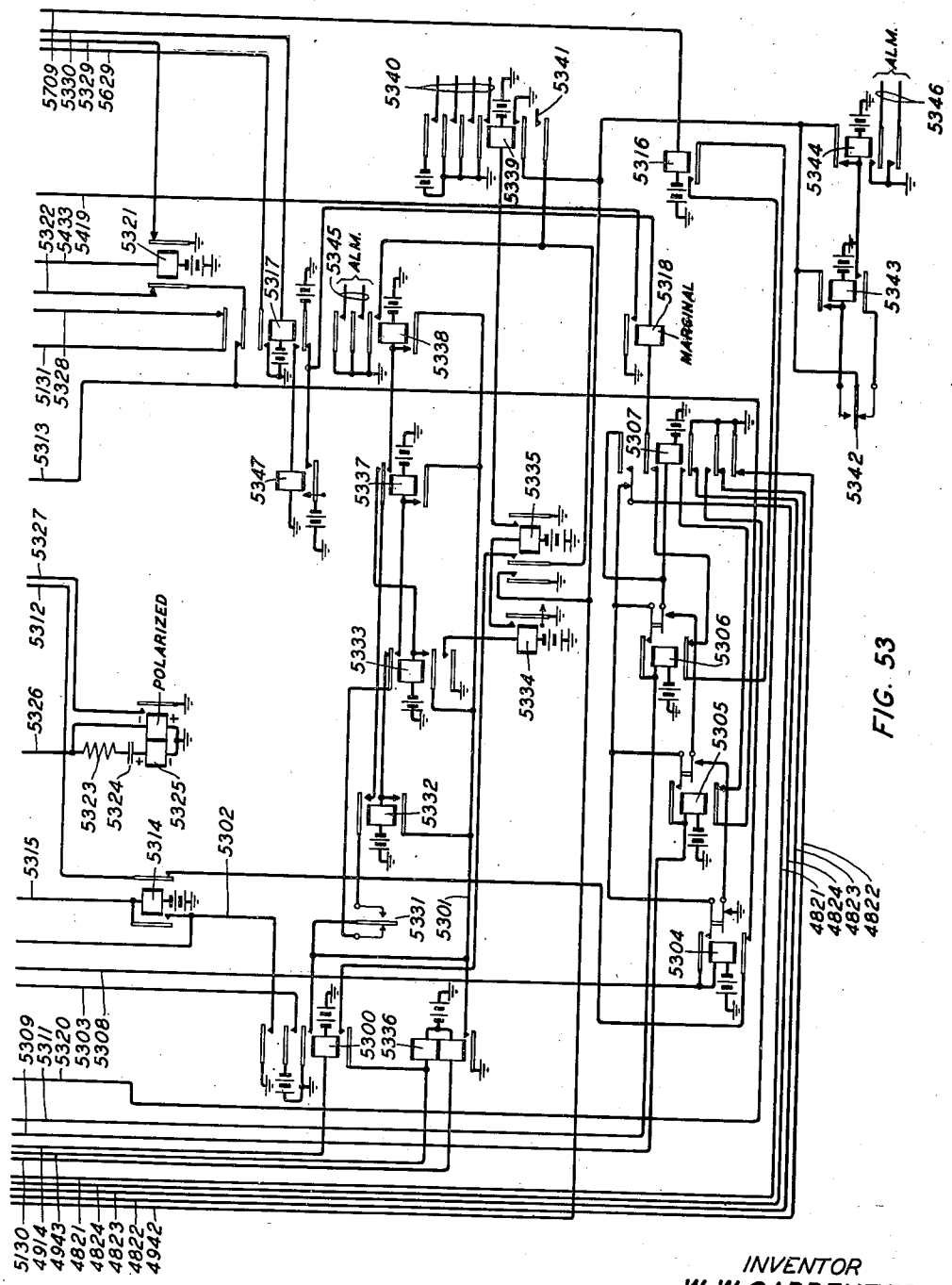

FIG. 53

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 54

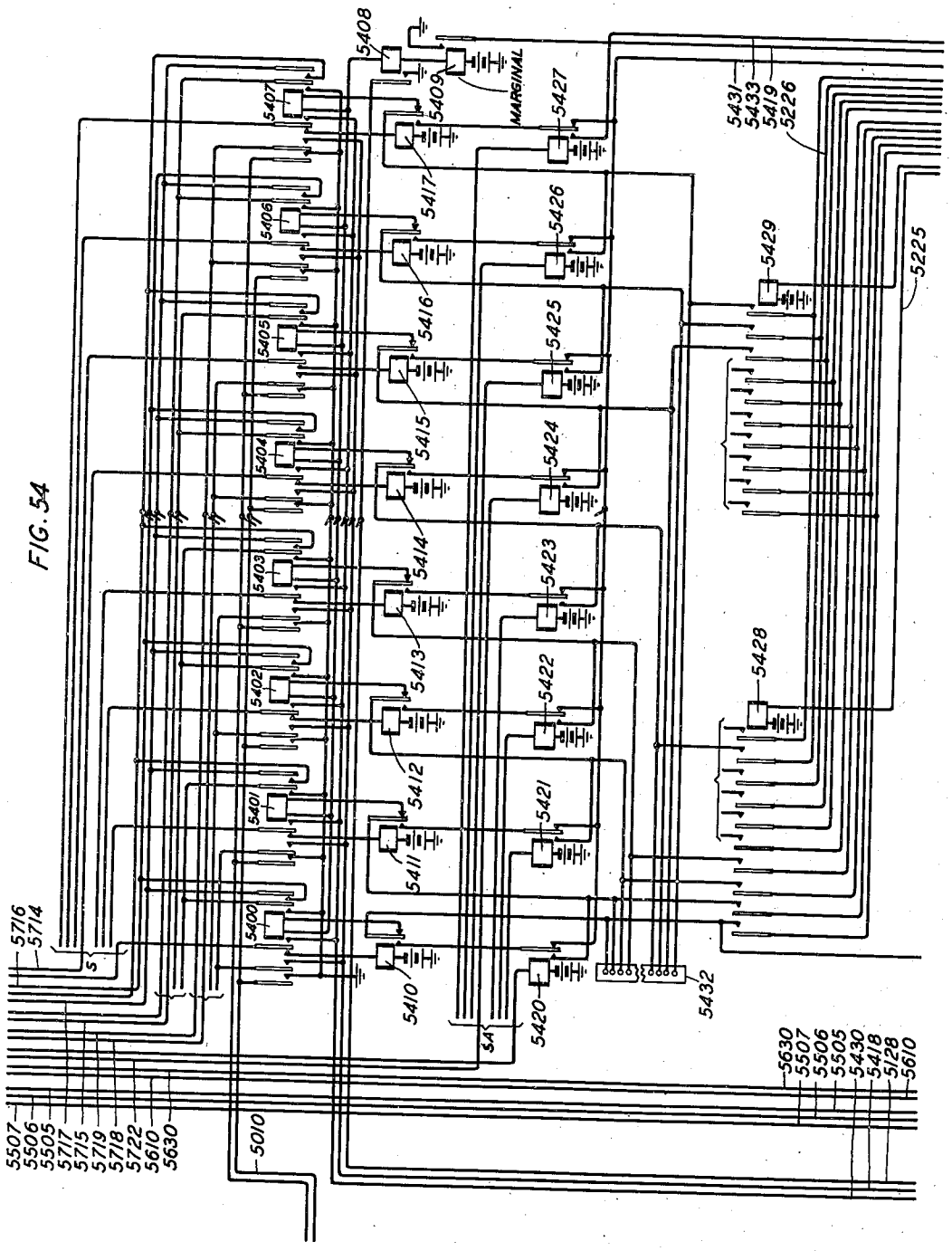

FIG. 54

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TELEPHONE SYSTEM

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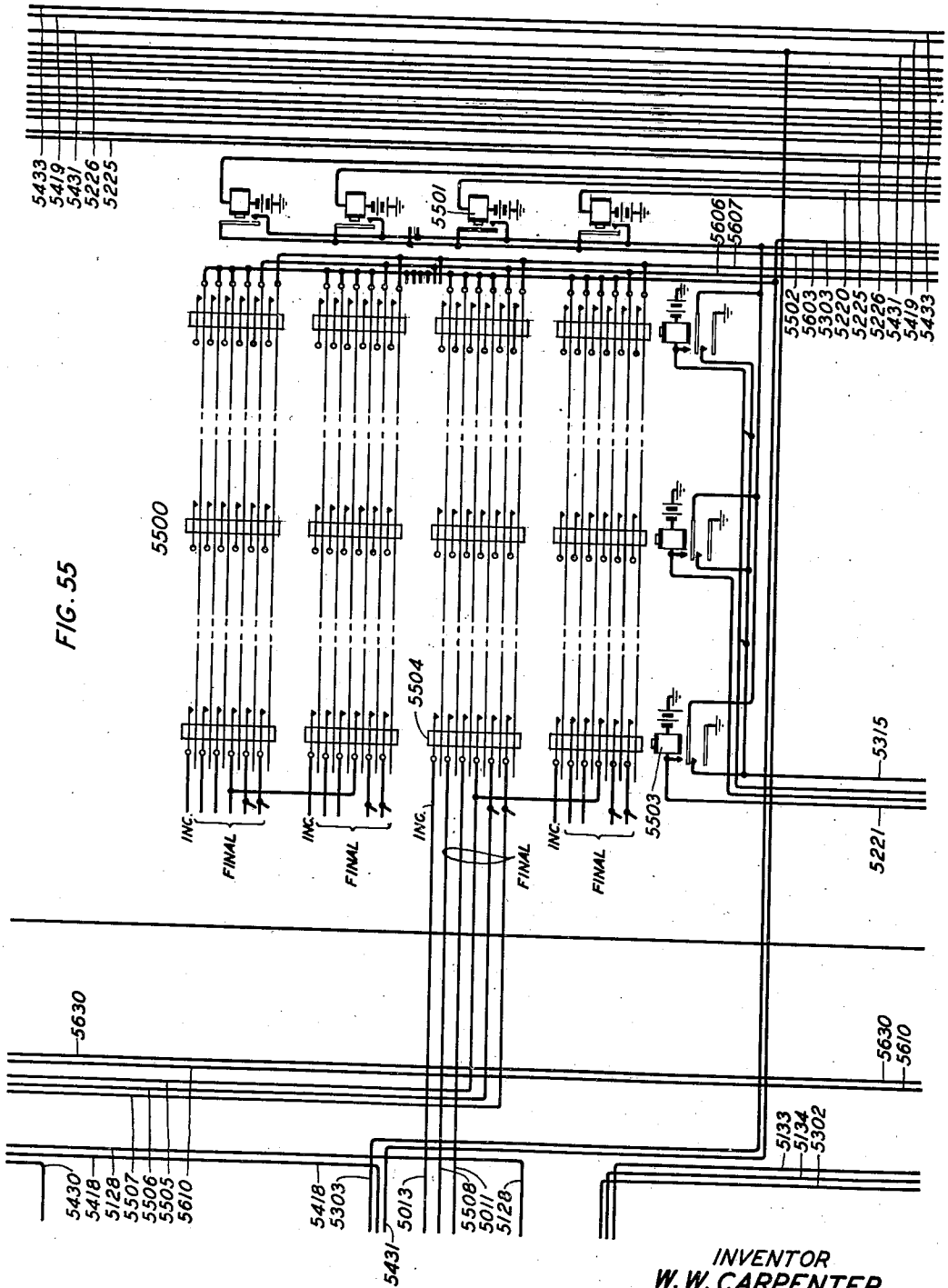

FIG. 55

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TELEPHONE SYSTEM

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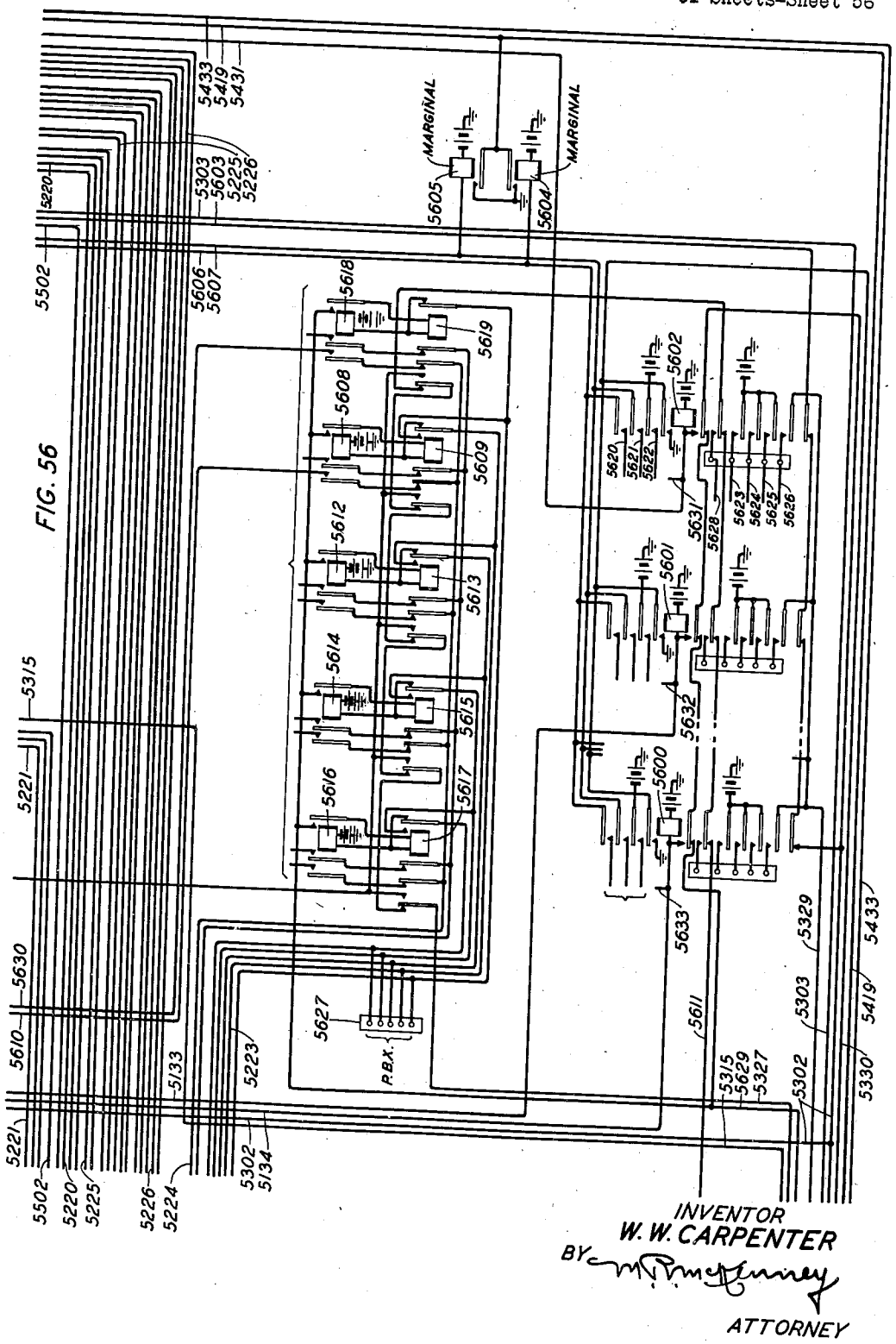

FIG. 56

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TELEPHONE SYSTEM

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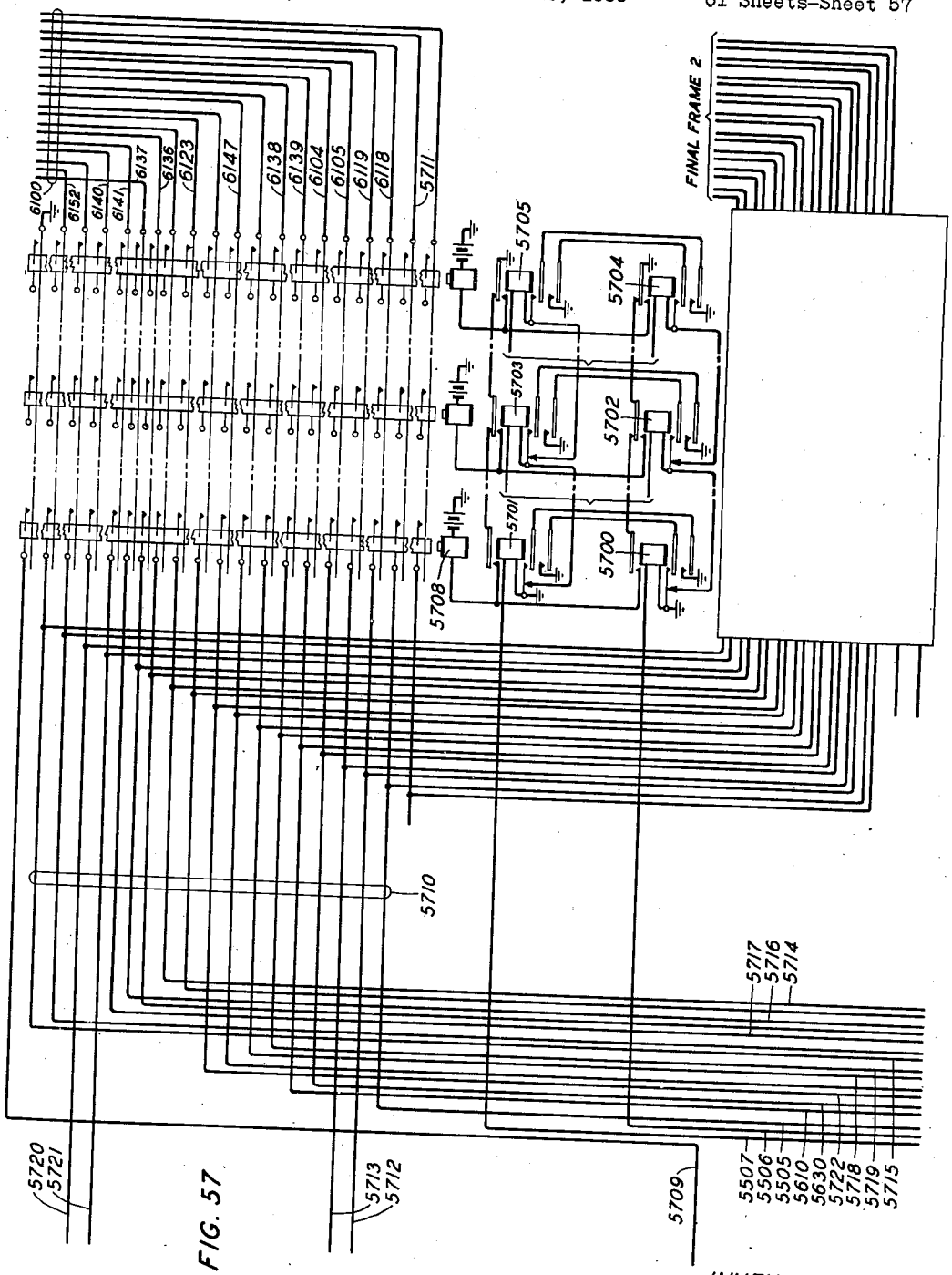

FIG. 57

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Filed June 19, 1935 61 Sheets-Sheet 58

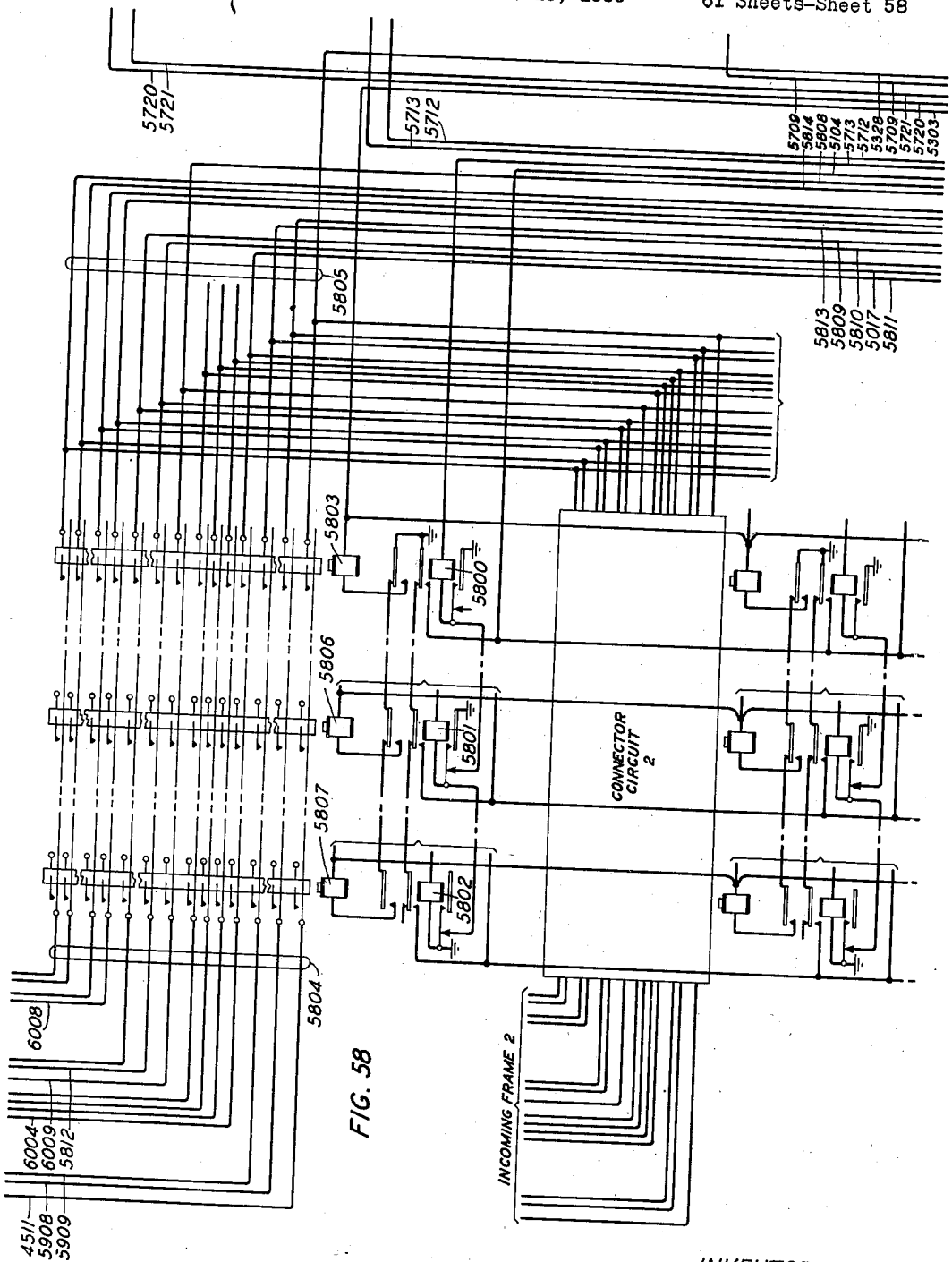

FIG. 58

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TELEPHONE SYSTEM

Filed June 19, 1935 61 Sheets-Sheet 59

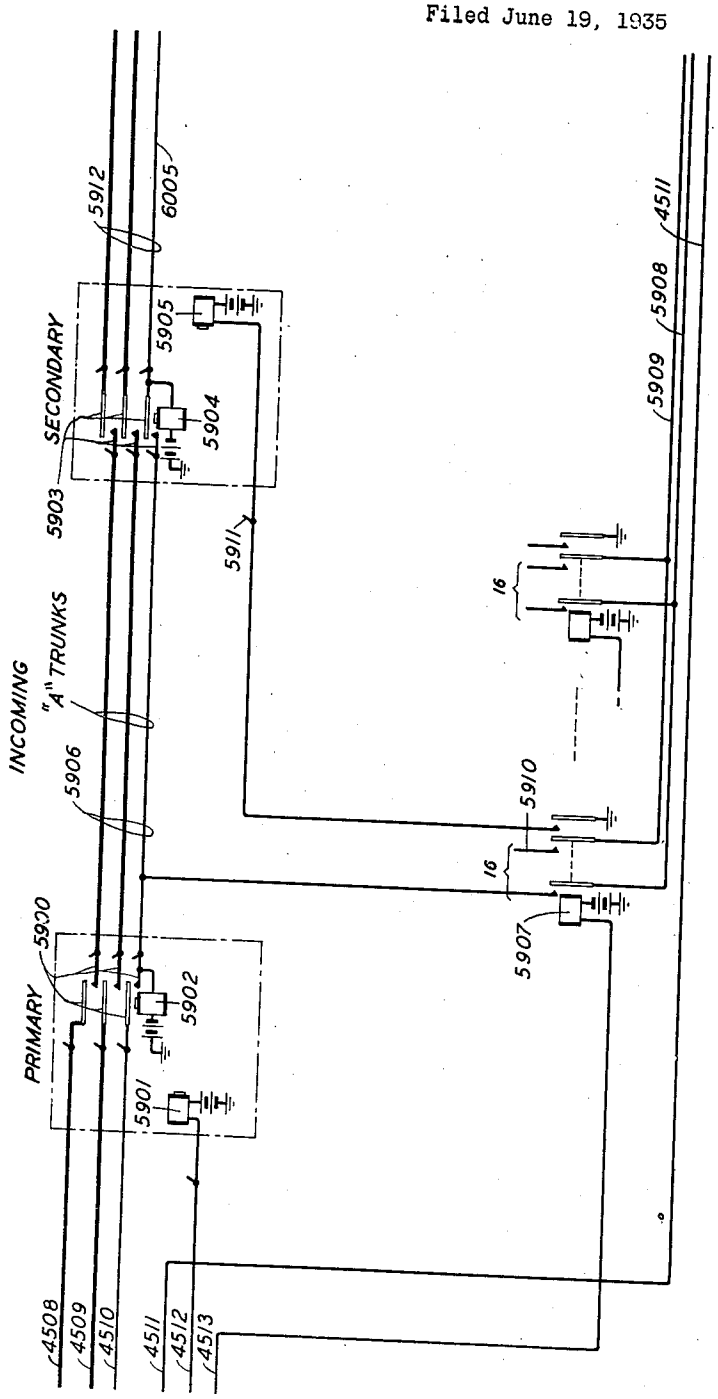

FIG. 59

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TELEPHONE SYSTEM

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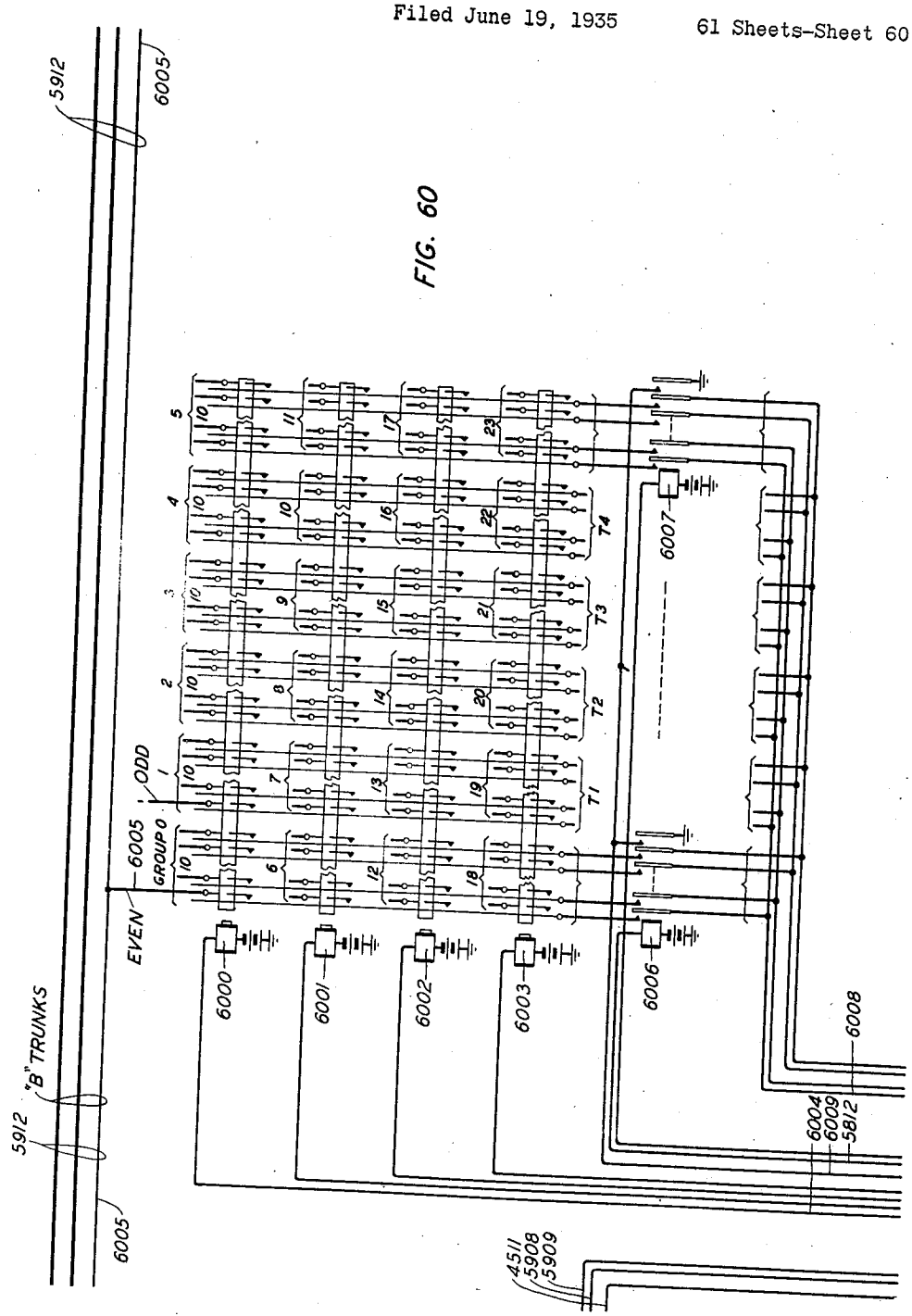
FIG. 60



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TELEPHONE SYSTEM

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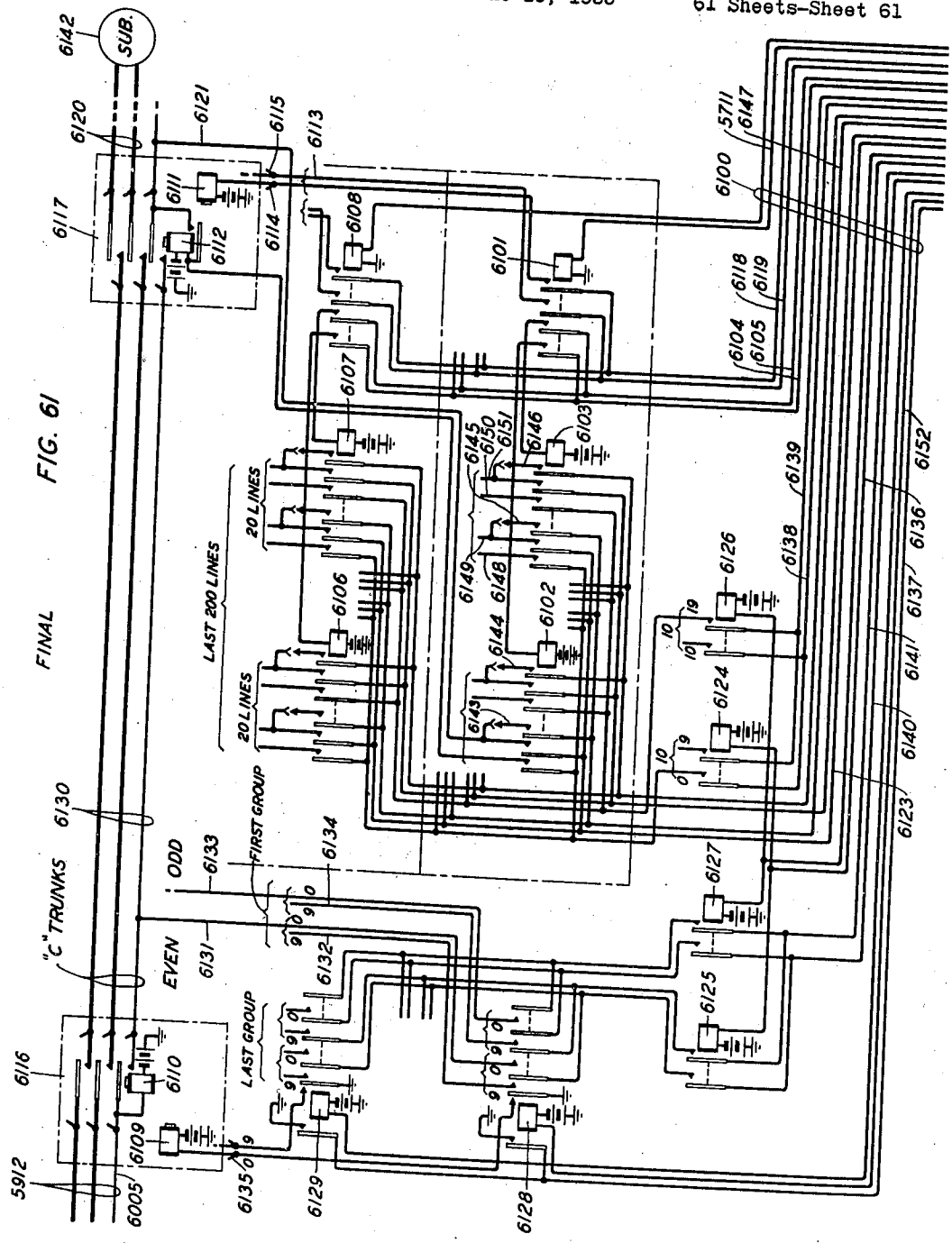

FIG. 61

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Patented Sept. 14, 1937

2,093,117

UNITED STATES PATENT OFFICE

2,093,117

TELEPHONE SYSTEM

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Application June 19, 1935, Serial No. 27,305

60 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to systems in which connections are established by automatic switches under the control of central office number recording equipment.

The objects of this invention are to enable the use of a simple and economic type of switching device for establishing the conversational connections between subscribers' lines and also for making connection to the common recording and controlling equipment; to secure a highly efficient trunking arrangement for extending connections from one switching stage to another by giving a greater degree of availability to the trunks that may serve any given connection; to increase the speed and reliability with which calls are completed; to simplify the controlling and testing equipment employed in the establishment of connections; and to otherwise improve systems of the foregoing character.

This invention is in part an improvement over the system disclosed in my copending application Serial No. 681,102, filed July 19, 1933, issued as Patent 2,004,599, June 11, 1935. In the system of the said patent subscribers' lines are extended to a first or district selector stage by means of primary and secondary cross-bar switches, each primary switch having access through secondary switches to a plurality of groups of trunks to district selectors. These trunks also have access through primary and secondary cross-bar sender selector switches to a plurality of groups of register senders.

According to a feature of the present invention, primary and secondary cross-bar line switches are provided for extending the subscriber's line to the district trunks, and primary and secondary sender selector switches are provided for selecting an idle sender. Each primary line switch, serving a group of lines, has a plurality of links, which extend respectively to separate secondary switches, each of which has access to a separate group of district trunks. Likewise the several groups of district trunks appear respectively in the primary sender selector switches, each of which has a plurality of links leading respectively to secondary switches, each of which has access to a separate group of senders. When a subscriber calls in any group, a test is made of all groups of district trunks accessible through idle links extending from the primary line switch containing the calling line, and at the same time a test is made to determine which groups of district trunks with idle trunks therein have access through idle sender selector links to an idle sender. If two or more district groups satisfy the test, the one chosen will depend on which group of subscribers' lines made the call, different groups of lines preferring different groups of districts. Thereupon an idle district trunk in the chosen group is selected for the call, and the several groups of senders, accessible through the primary sender selector in which appears the selected district trunk, are tested to determine which groups have idle senders. If several groups have idle senders, the group chosen will be the one preferred by the chosen group of district selectors, different district groups preferring different sender groups. Thereupon an idle sender is selected. Following these tests the primary and secondary line switches and sender selector switches are operated, and the calling line is extended through to the district trunk and to the idle sender. By this arrangement an increased efficiency is realized in the use of the circuits for connecting a calling line to a district trunk and sender.

Another feature is a system in which a line group is provided with a line control mechanism for outgoing calls and has access to a plurality of groups of district trunks, each controlled by a different sender selector link control circuit. When a call is made in the line group, all of the sender selector control circuits that are idle and that serve such line group make a preliminary test of the corresponding district group in conjunction with its links and the sender groups reached by such links. If several sender selector control circuits find idle paths that can serve the call, one such control circuit is preferred and is connected to the line group control mechanism to the exclusion of all other control circuits. Following this it is necessary to test the individual district trunks in the preferred group and to test the links and individual senders for a single idle path to a sender. If, following the connection of the preferred control circuit to the line group mechanism, all of the paths become busy before one is finally chosen, the control circuit will automatically disconnect itself from the line control mechanism, permitting the latter to associate itself with all of said control circuits serving it, and the preliminary tests are made over again in another attempt to extend the calling line to an idle sender. This may be repeated a number of times until finally some one of the control circuits succeeds in making both the preliminary and final tests for an idle path and the switches are operated to connect the calling line to the sender for dialing.

This invention is also an improvement in cross-bar systems of the kind shown in the patents to Williams 1,672,970 of June 12, 1928 and 1,525,787 of February 10, 1925. In these prior arrangements it is necessary to use switch units of large capacity in order that the trunk groups to which the switch has access shall be sufficiently large. Since the switch is of large capacity, each incoming line and each outgoing line appears in a relatively large number of contact points, with the result that each connection through the switch disables several contact sets although only one such contact set is used for the connection. This requires the provision of much equipment that is used a comparatively small part of the time.

According to the present invention advantages are secured over these prior systems by a switching arrangement employing cross-bar switches of small capacity in which each switching stage comprises a plurality of primary switches and a plurality of secondary switches, and in which a common controlling device or marker is selectively connected to the switches of two successive stages, such as the district and office stages, to test and select an idle outgoing trunk and to extend the calling line to this idle trunk over a series of interconnecting links or trunks, one of which extends the calling line from the primary district switch to a secondary district switch, another of which extends the call from the secondary district to the primary office switch, and a third of which extends the call through a secondary office switch to the idle outgoing trunk. The marker first prepares these links, and then the switches are operated to complete the connection. Thereupon the marker is released and may be connected to other district and office switches to set up another connection.

Another feature of the invention is a system in which a district frame, comprising primary and secondary switches, has access to a plurality of office frames, each comprising primary and secondary switches, and in which a group of outgoing trunks, representing a numerical direction, are allotted to two different office frames. With this plan half of each group of trunks appear in one office frame and the other half in a second frame, and the marker is automatically connected to both frames to test and select an idle trunk irrespective of the frame.

Another feature is an arrangement by which large trunk groups, namely those exceeding the total number of test relays in the marker, are divided into three subgroups. If the call seeking connection to the trunk group comes in to a particular district frame, the marker is caused to connect its trunk test relays to the pair of office frames on which appear the trunks of the first subgroup of the desired group and to test this subgroup for an idle one. On the other hand, if the incoming call appears on some other district frame, the marker would associate its test relays with the particular pair of office frames in which appear the trunks of the second subgroup and would test these for an idle one. In the event all trunks of either of the first two subgroups are found busy on the first test, the marker disconnects its test relays from that subgroup and connects them to the trunks of the third subgroup, which also may be located on any pair of office frames.

Another feature is a system in which the marker is equipped with a series of triple-wound relays for testing the three sets of interconnecting links in the district and office frames. The three windings of a test relay are included in the respective test circuits of the corresponding three serially related links which constitute one of the possible paths through these frames. Either link being busy causes the energization of the winding of its test relay, and the entire path is thereby rejected as busy, although the other two links may be idle.

A further feature is a testing arrangement in the marker, including a chain of test relays for testing the successive trunks of a group outgoing from the office frames. Since the trunk groups are of different sizes and since it is undesirable to restrict the appearance of the first trunk in any group to any particular trunk terminal in the office frame, it has been necessary heretofore to provide means for so connecting the test relay series to the switch frame that the first relay of the series tests the first trunk of the group, the second relay the second trunk, and so on. According to the present invention, however, the only requirement of the connecting means is that the series of test relays be connected to the switch frame in such a way that they embrace all of the trunks to be tested without particular regard to which relays correspond to the first and last trunks of the group. And the marker is so arranged that it is able, from the digital information it receives about the trunk group, to start the test with the particular relay and to end the test with the particular relay which correspond, respectively, with the first and last trunks of the group or subgroup being tested. By this plan the connecting equipment is greatly simplified, and less alterations are needed to change the size or location of trunk groups.

Another feature relates to a novel way of operating the overflow registers for the trunk group. The system is so arranged that if all direct trunks of a group are busy, the marker disconnects itself from this group, sets up a new translation, and reconnects itself to a group of trunks leading to a tandem office which in turn has access to the desired office. This enables a call to be completed over the direct route if any direct trunk is available or over an alternate route if all direct trunks are busy. According to this feature if all direct trunks are busy, a register for recording this fact is operated from the route relay in the marker. Also if all tandem trunks are busy, a second register is operated, to record this condition, from the corresponding route relay in the marker. These records show what proportion of calls fail because of all direct trunks being busy and also because of all tandem trunks being busy.

Another feature is a registering system in which the designation of the call and the identity of the switch frame to which the calling line is extended are both set up on a register mechanism comprising a cross-bar switch. This register switch is located in the common subscriber sender and passes the information thus registered to the marker. The marker uses the frame identification in order to connect itself to the proper frame.

Another feature of the invention is an arrangement whereby the marker is capable of functioning in connection with two independent calls at the same time. Following the seizure of the marker by a sender the designation identifying the call is transferred from the sender to the marker and registered on code registers. This information is then decoded by the marker and is utilized by it to determine the desired group of trunks and to test these trunks for an idle one, fol-

lowing which the marker proceeds to control the selective operation of the switches to extend the calling connection through to the idle trunk. Following the testing of the trunks the marker releases itself from the sender and continues its function of controlling the selective switches as mentioned to extend the connection. As soon as the marker has released itself from the sender, another sender containing the information for a second call may reseize the marker and transfer the code information thereto, and the marker will proceed to translate this code and to progress with the second call while it is still controlling the selective switches for the purpose of extending the first connection. This overlapping operation of the markers enables two separate calls to be handled at the same time by any one marker, thus economizing in time and equipment.

Another feature is an arrangement in which the sender automatically releases a marker that fails to progress in its regular functions and again seizes an idle one of the markers, which may be the one just released or any other one, and in which the second marker attempts to extend the call to the desired destination over the group of alternate route trunks if such a group is provided. If no alternate route group is provided, the second marker proceeds to extend the calling line to an idle overflow trunk. If the second marker also fails to progress in its operation, the sender releases it and a third time seizes any one of the idle markers. In this event the third marker receives a signal from the sender telling it to proceed at once and set up the connection to the overflow trunk.

Another feature is a system in which the marker, on making a test of the direct trunk group and finding them all busy, then proceeds to test the alternate route group and to extend the call over one of these trunks if such a group is provided and one of the trunks is idle at the time. In case the marker is unsuccessful either in finding an idle trunk in the direct group where no alternate group is provided or in finding an idle trunk either in the direct group or in the alternate group where such alternate group is provided, it then sets the switches to extend the calling line to the overflow trunk.

A further feature, related to the one last mentioned, is that in the event the connection is successfully extended over a trunk from the originating end to the equipment at the incoming end, which may be in a distant office, and then fails to progress to completion because of trouble or all circuits being busy, a signal is sent back to the sender at the originating office, and the sender seizes one of the markers and signals the marker to set up the connection to one of said overflow trunks.

Another feature relates to an arrangement whereby an efficient use is made of the trunks and switches at a selective stage where the size of the trunk group to which the switch has access does not correspond to the physical capacity of the switch. For example, if the capacity of the switch is greater than the group of outgoing trunks to which it is to have access, there will be a group of outgoing trunks of the required size for each of the respective switches, each one of such groups appearing only in one switch and occupying the greater portion of its total number of terminal outlets, and each one of the remaining groups of outgoing trunks will be derived by adding together the balance of trunks on as many switches as is necessary to give a full group. The incoming trunks are also arranged in groups, several such groups appearing each exclusively in that portion of the switch serving a full outgoing group, and each of the remaining incoming groups is multipled to appear in the remaining portions of the several switches whose outlets collectively comprise an outgoing group. This enables the switches to be made of standard size without interfering with the efficiency that is possible by using trunk groups that do not correspond with the switch capacity.

Another feature of the invention is a testing arrangement in the terminating marker whereby the marker on each call connects its test relays to a block of lines whether the call is for a direct line or for a private branch exchange group. The test relays determine the condition of all lines in the block, following which a circuit is extended through contacts of the particular test relay that has tested the line called to determine if such line is idle or busy. If the called line is the first line in a private branch group and is busy, the test circuit is continued to succeeding lines in the group until an idle one is reached.

Referring now to the drawings, Figs. 2 to 13, inclusive, when taken in the order illustrated in Fig. 1A, disclose schematically the manner in which a connection is completed over a telephone exchange system embodying the features of this invention;

Fig. 2 shows a subscriber's station together with certain primary and secondary line switches and their interconnecting line links;

Fig. 3 shows certain of the primary and secondary switches of a district frame together with the links or "A" trunks which interconnect these switches;

Fig. 4 shows portions of two sender selector circuits and a subscriber sender;

Fig. 5 shows various primary and secondary switches of an office frame together with the "B" trunks extending from the district frame to the office frame, the "C" trunks or office links interconnecting the primary and secondary office switches, and outgoing trunks extending to a distant exchange;

Fig. 6 shows certain relays and switches of the district and office frame connector circuits whose function it is to connect these said frames to an originating decoder marker circuit which is also shown in Fig. 6;

Fig. 7 shows certain relays of a decoder marker connector circuit as well as certain relays and switches of district and office frame connector circuits;

Fig. 8 shows certain of the primary and secondary switches of an incoming frame together with their interconnecting links or "A" trunks;

Fig. 9 shows an incoming frame connector circuit the function of which is to establish connections between a terminating decoder marker and the particular incoming frame being used for the call;

Fig. 10 shows certain of the primary and secondary switches and interconnecting links of terminating sender selector circuit the purpose of which is to connect an incoming trunk being used on a connection to an idle terminating sender which is also shown in Fig. 10;

Fig. 11 shows the primary and secondary switches of a final frame together with the "B" trunks extending from the secondary switches of an incoming frame to the primary switches of

a final frame, and also the "C" trunks which interconnect the primary and secondary switches of a final frame. Fig. 11 also shows the called subscriber's station;

Fig. 12 shows certain relays of a final frame connector circuit whose function it is to connect certain blocks or subgroups of lines of a final frame with a terminating decoder marker circuit;

Fig. 13 shows a terminating decoder marker circuit together with certain relays of an incoming frame connector circuit, a final frame connector circuit and a decoder marker connector circuit, all of which serve to associate a particular selected terminating decoder marker with the terminating sender, incoming frame and final frame involved in the connection being established.

Figs. 14 to 61, inclusive, when taken in the order illustrated in Fig. 1B show in detail such of those portions of the various circuits referred to above as are necessary for a complete description of the various functions performed, in the establishment of a connection between two subscribers located in different exchanges, by an exchange system embodying the features of this invention;

Figs. 14 and 15 show a calling subscriber's station together with the line switches and associated control circuit;

Fig. 17 shows a district trunk circuit;

Figs. 16, 18, 19, and 21 show an originating sender selector circuit;

Fig. 20 shows a portion of a district frame and associated frame connector circuit;

Figs. 22 to 26, inclusive, show the major portions of a subscriber register sender;

Figs. 27 and 28 show the decoder marker connector circuit which establishes connections between the selected sender and an idle originating decoder marker circuit;

Figs. 29 to 40, inclusive, show an originating decoder marker circuit;

Figs. 41 and 42 show portions of office frames together with certain connector relays used to establish connections between the office frames and the decoder marker;

Fig. 41A shows a crosspoint of a secondary office switch having access to an overflow trunk;

Figs. 43 and 44 show portions of a sender selector circuit whose function it is to associate an incoming trunk on which a call appears with an idle terminating sender;

Fig. 45 shows an incoming trunk circuit;

Figs. 46 and 47 show a terminating sender;

Figs. 48 to 49 show portions of a terminating decoder marker connector circuit;

Figs. 50 to 56, inclusive, show a terminating decoder marker;

Fig. 57 shows a portion of a final frame connector circuit;

Figs. 58 and 60 show portions of an incoming frame connector circuit;

Fig. 59 shows portions of an incoming frame circuit; and

Fig. 61 shows a final frame circuit and the called subscriber's station.

General description of system and apparatus

For the purpose of simplicity Figs. 2 to 13, inclusive, disclose diagrammatically only such portions of the various circuits as are required to illustrate, in general, the manner in which a connection is extended from a calling subscriber's station served by a cross-bar exchange to a called subscriber's station served by the same or another cross-bar exchange. They also illustrate a called subscriber's line in a terminating office equipped with switches of the moving type, such as power driven switches.

The switches shown in Figs. 2, 3, 4, 5, 8, 10, and 11 are of the cross-bar type and consist briefly of a plurality of sets of contacts arranged in horizontal and vertical rows. Associated with each horizontal row of contact sets is a horizontal operating magnet, hereinafter referred to as a select magnet, under control of which the contact sets of that horizontal row are prepared for operation. Associated with each vertical row of contact sets is a vertical operating magnet, hereinafter referred to as a hold magnet, under control of which any set of contacts in that vertical row, after being prepared for operation by the operation of its respective select magnet, is caused to close and remain in the closed position under control of the operated hold magnet. For a more detailed explanation of the construction and operation of these cross-bar switches reference may be had to the copending application of J. N. Reynolds, Serial No. 702,453, filed December 15, 1933, granted as Patent 2,021,329, Nov. 19, 1935.

The subscriber's lines are arranged in groups which may vary in size, say, from two hundred to seven hundred lines each, the size of the group depending upon the calling rate of the lines in the group. Each group of lines is served by line switches and by a line switch control circuit, such as shown in Fig. 2, which provides for connecting any line of the group, upon the initiation of a call over that line, to a district frame circuit such as shown in Fig. 3 and to a sender selector and control circuit, such as shown in Fig. 4.

The line switches consist of primary cross-bar switches, such as switches **201** to **209** inclusive; secondary switches, such as switches **210, 211**, and **212**, and line links, such as links **213** to **217** inclusive, which interconnect the primary and secondary line switches. And controlling equipment **236** is provided for causing the operation of proper select and hold magnets of the primary and secondary line switches for the purpose of closing the contact sets thereof in extending a connection.

The primary line switches are arranged in ten horizontal groups, each group consisting of any desired number, as from two to seven switches, the number of parallel switches in each horizontal primary group depending upon the size of the line group being served. For simplicity of illustration, only three of the ten horizontal primary switch groups are shown, each group having three parallel switches. Each primary and each secondary switch is equipped with ten vertical and ten horizontal rows of contact sets. On switches **201, 202**, and **203** only three of the ten horizontal rows and two of the ten vertical rows are shown, while on switches **204** to **212** inclusive only two vertical and two horizontal rows are shown. The subscribers' lines connect to the vertical rows of contacts of the primary switches, ten lines to each switch. Line **218**, which is associated with subscriber's station **200**, is shown connected to the left vertical row of contacts of primary switch **201**. Other subscribers' lines, such as lines **219, 220**, and **221**, connect to other vertical rows of contacts on the same and other primary switches.

The corresponding rows of horizontal sets of contacts of each horizontal group of primary switches are multiplied together, and each of the ten rows is extended over a separate line link to the corresponding vertical row of contacts of

one of ten secondary switches, only three of which are shown. For example, the three horizontal rows of contacts of the primary switch group composed of switches **201**, **202**, and **203** extend over line links **213**, **214**, and **215** to the right vertical row of contacts of secondary switches **210**, **211**, and **212**. The remaining seven horizontal rows (not shown) of this primary switch group extend over seven other line links to the right vertical rows of seven other secondary switches (not shown). The horizontal rows of other primary line switch groups extend over other line links to the corresponding vertical rows on the secondary switches. Since there are ten primary switch groups each having ten horizontal rows of contacts, there are one hundred line links extending to the ten vertical rows of each of the ten secondary switches. As each of the ten line links from any primary line switch group extends to a different one of the ten secondary switches, each subscriber's line may be connected to any secondary switch by the operation of the proper primary switch select and hold magnets. Should select magnet **222** and hold magnet **225** be operated by the control circuit, the left upper set of contacts or crosspoints of primary switch **201** close and extend subscriber's line **218** over line link **213** to the right vertical row of contacts of secondary switch **210**. Should select magnet **223** and hold magnet **225** be operated, the resultant closure of the left middle crosspoints of primary line switch **201** extends subscriber's line **218** over line link **214** to secondary line switch **211**. Similarly, select magnet **224** and hold magnet **225**, if operated, extend subscriber's line **218** over the left lower crosspoints of primary switch **201** and line link **215** to secondary line switch **212**.

The trunks outgoing from the secondary line switches extend to the primary district selector switches of a number of different district frames. One of these district frames is illustrated in Fig. 3. The number of trunks extending from a line switch group to any particular district frame will depend upon traffic conditions. Since there are ten secondary line switches in the line switch group, there are correspondingly ten groups of outgoing district trunks, each group consisting of ten trunks. And one suitable arrangement is to distribute these ten groups of district trunks among five different district frames, two groups of district trunks forming a line switch group extending to one district frame, two groups to a second district frame and so on for the five district frames. For example, the groups of trunks **250** and **251** lead to the primary switches of the district frame shown in Fig. 3. The other four pairs of groups of district trunks outgoing from the line switch group shown in Fig. 2 lead respectively to four other district frames.

Under light traffic conditions it may be desirable to combine two or more groups of line switches, giving them access in common to the same groups of district trunks. This arrangement is illustrated by the multiple taps on the district trunks, such as taps **229** and **230** shown on the trunks **227** and **228**, respectively.

A district frame, such as the one shown in Fig. 3, consists of ten primary cross-bar switches of which three, switches **300**, **301**, and **302**, are shown and twenty secondary switches of which four, switches **350** to **353**, are shown. These primary and secondary switches are also provided with ten horizontal rows of contacts. The primary switches, however, are provided with twenty vertical rows of contacts, whereas each of the secondary switches is provided with ten vertical rows of contacts. They are also equipped with select magnets **305** to **312** inclusive, and with hold magnets **313** to **328** inclusive.

The groups of district trunks **250** and **251** come from the line switch group shown in Fig. 2 and terminate in the corresponding horizontal rows of contacts of primary district switches **300** and **302**, respectively. In a similar manner the remaining four pairs of primary district switches in this district frame receive the district trunks coming from four other line switch groups serving four other groups of subscribers' lines.

The vertical rows of contacts of each primary district switch extend to vertical rows of contacts of each secondary district switch over district links called "A" trunks, such as trunks **329** to **336** inclusive. Since there are ten primary district switches, each switch having twenty vertical rows of contacts, there are two hundred "A" trunks. The twenty "A" trunks extending from each primary district link switch are divided into two groups of ten trunks each. The trunks in the left hand group of ten trunks connect respectively to vertical rows of contacts in half of the twenty secondary district switches, and the trunks in the right hand group of ten trunks connect respectively to corresponding vertical rows in the other half of the twenty secondary switches. For example, the left hand group of ten trunks from primary switch **300**, represented by trunks **329** and **330**, extend to the secondary switches **353** and **351**, and the right hand group of ten trunks, represented by trunks **331** and **332**, extend to corresponding vertical rows in the secondary switches **352** and **350**. The ten horizontal rows of contacts of each of the twenty secondary district switches connect, over "B" trunks such as **337** and **340** inclusive, to the horizontal rows of contacts of the primary switches of ten office selector frames, one of which frames is shown in Fig. 5. There are two hundred of these "B" trunks from the ten secondary switches of each district frame, and they are divided into ten groups of twenty trunks each, extending respectively, to ten different office frames.

An office frame, such as shown in Fig. 5, consists of twenty primary switches of which four switches, **500**, **501**, **550**, and **551**, are shown, and ten secondary switches of which two, switches **502** and **503**, are shown. Each primary and secondary office switch is provided with ten horizontal rows of contacts. The primary switches have ten and the secondary switches have twenty vertical rows of contacts. A select magnet, such as magnets **504** to **511** inclusive, is associated with each horizontal row of contacts, and a hold magnet, such as magnets **512** to **527** inclusive, is associated with each vertical row of contacts. Each of the ten vertical rows of contacts of the twenty primary office switches extends over one of two hundred office links or "C" trunks, such as trunks **528** to **533** inclusive, to a vertical row of contacts of a secondary office switch. Each of the ten "C" trunks from each of the primary office switches extends to a separate secondary office switch. For example, each the ten "C" trunks from the primary switch **551**, of which two trunks, **532** and **533**, are shown, extends to the left vertical row of contacts of the left half of a different secondary switch. The ten "C" trunks from the primary switch **550**, such as trunks **530** and **531**, extend to the ten left vertical rows of the right half of each secondary switch. In this manner, any primary office switch has access, over a sep-

arate "C" trunk, to any secondary office switch.

The ten secondary office switches, each having twenty vertical rows of contacts, may have the multiple extending across the horizontal rows of contacts of any switch split between each half of the switch, as shown for secondary switch **502**, or the horizontal multiple may extend across the entire switch, as shown for switch **503**. The horizontal rows of contacts of the secondary office switches connect to outgoing trunks such as trunks **534** to **539** inclusive. Where the secondary office switch is split, as is shown in the case of switch **502**, there are twenty outgoing trunks per switch, ten trunks extending from the ten horizontal rows of contacts of each half of the switch. Where the secondary office switch is not split, as is shown in the case of switch **503**, there are but ten outgoing trunks per switch.

Before proceeding with a description of the incoming and final selector switches shown in Figs. 8 and 11, which constitute the terminating selector equipment and may be located either in the same office with the district and office switches shown or in a distant office, an explanation will be given of how an idle sender **439** is seized by the calling line, how an idle marker **608** is associated with the sender and also with the district and office switches, all for the purpose of recording the number dialed by the subscriber and for selectively operating the district and office switches to extend the call to the terminating switches in the desired office.

Each district frame, such as shown in Fig. 3, is served by a sender selector and control circuit, such as shown in Fig. 4, the purpose of which is to provide means for extending a calling line through to an idle sender circuit. The sender selector circuit consists of ten primary cross-bar switches of which four, switches **400** to **403** inclusive, are shown, five secondary cross-bar switches of which two, switches **404** and **405**, are shown, and sender links such as links **406** and **409** inclusive, which interconnect the horizontal rows of contacts of the primary sender link switches with the vertical rows of contacts of the secondary sender link switches. The control circuit **443** is common to the switches and links and serves to test and control their operation. Each primary sender link switch is provided with ten vertical and ten horizontal rows of contacts, only two rows of each of which are shown. A select magnet, such as magnets **410** to **417** inclusive, is associated with each horizontal row of contacts, and a hold magnet, such as magnets **418** to **425** inclusive, is associated with each vertical row of contacts. The ten primary switches are arranged in five groups of two switches each, such as switches **400** and **401** and switches **402** and **403**, and the ten corresponding horizontal rows of contacts of the two switches of each pair are multipled to each other. There are ten horizontal rows of contact sets, therefore, for each of the five pairs of primary switches, and each of these fifty horizontal rows extends, over a sender link, such as links **406** to **409** inclusive, to a vertical row of contacts of the secondary switches, such as switches **404** and **405**. There are five secondary switches of which only two, switches **404** and **405**, are shown. Each secondary switch is provided with ten vertical and ten horizontal rows of contacts, each horizontal row having an associated select magnet such as magnets **426** to **429** inclusive, and each vertical row having an associated hold magnet such as magnets **430** to **437** inclusive. The multiple extending across each of the ten horizontal rows of contacts of each secondary sender link switch is split between the fifth and sixth vertical rows of contacts. Each secondary switch, such as switches **404** and **405**, therefore, has, in effect, twenty horizontal rows of contacts, ten in each half of the switch. Five sender selector links, such as links **406** and **408**, one for the upper horizontal row of contacts of each pair of primary sender link switches, extend to the five vertical rows of contacts of the right half of secondary switch **404**. Five other sender links, such as links **407** and **409**, one from the lower horizontal row of contacts of each pair of primary sender link switches, extend to the five vertical rows of contacts of the left half of secondary switch **405**. Similarly, five other sender links, one from the corresponding horizontal row of contacts of each pair of primary sender link switches extend to another group of five vertical rows of contacts of a secondary sender link switch. The ten horizontal rows of contacts of each half of the five secondary sender link switches connect to a group of ten subscribers' senders, one of which, sender **439**, is shown connected to the lower horizontal row of contacts of the right half of secondary switch **404** over conductor **438**. Switches **440** and **411** represent two primary sender link switches, corresponding to switches **400** and **401**, of a sender link and control circuit serving some other district frame.

Each subscriber sender, such as sender **439**, when selected for use, is connected to a common decoder marker circuit, such as decoder marker **608** of Fig. 6, by means of a decoder connector circuit represented in part by relays **708**, **719**, **720**, and **721** of Fig. 7. Each sender is provided with a group of control conductors, one group of which is represented by conductor **442**, which connects to the contacts of an associated sender connector relay, such as relay **708** or relay **719**. The corresponding armatures of these sender connector relays are multipled together and connect, in turn, to the multipled armatures of decoder connector relays **720** and **721**. The contacts of each decoder connector relay **721** connect to an individual decoder marker, such as decoder marker **608**, over a group of conductors represented by line **722**. When sender **439** is selected for use, it causes its associated sender connector relay **708** to operate and connect the sender control conductors **442** to the multipled corresponding armatures of all decoder connector relays **720**, **721**, etc. The decoder connector control circuit (not shown), under control of the selected sender, causes the decoder connector relay whose associated decoder marker is idle, to operate and thereby connect the control conductors **442** of the selected sender **439** over the contacts and armatures of the operated relays **708** and **721** to the idle decoder marker **608**.

Each district frame is provided with ten primary switch connector relays, such as relays **600**, **601**, and **602** of Fig. 6, ten secondary switch connector relays, such as relays **603**, **604**, and **605**, and as many marker connector relays, such as relays **606** and **607**, as there are markers serving that district frame. The function of these relays is to provide for connecting test and control conductors from the primary and secondary district switches to any selected marker circuit to enable the marker to extend a connection through the district frame to an office frame. Twenty test conductors, such as indicated by conductors **341** and **342**, extend from the twenty

"A" trunks of each primary district switch to the contacts of the associated primary switch connector relay, such as relays 600 and 602 respectively. Twenty test conductors, such as indicated by conductor 343, extend from each group of twenty "B" trunks, which connect from the secondary district switches to an office frame, to the contacts of the associated secondary switch relay, such as relay 603. The armatures of all primary switch conector relays are multipled and connect, in turn, to multipled armatures of the marker connector relays 606 and 607. The armatures of all secondary switch connector relays are multipled and also connect, in turn, to multipled armatures of the marker connector relays 606 and 607. The contacts of relay 607 are shown connecting to marker 608. The contacts of other marker connector relays, such as relay 606, connect to other markers. Relays 700 to 707, inclusive, of Fig. 7, correspond to relays 600 to 607, inclusive, of Fig. 6, and represent primary switch and secondary switch connector relays and district frame marker connector relays associated with some other district frame.

Each office frame is provided with primary switch connector relays, such as relays 609 and 610 of Fig. 6, secondary switch connector relays, such as relays 611 and 612, and marker connector relays, such as relays 613 and 614. The function of these relays is to provide for connecting test and control conductors from the primary and secondary switches of any office frame to any marker circuit to enable the marker to extend a connection through the office frame to an outgoing trunk. Twenty conductors, such as indicated by conductor 540, extend from the twenty "C" trunks to the contacts of an associated primary switch connector relay 609. Ten test conductors, such as indicated by conductor 541, extend from each group of ten outgoing trunks of any particular level of the secondary office switches, to the contacts of an associated secondary switch connector relay, such as relay 611. The armatures of all primary switch connector relays are multipled and connect, in turn, to the multipled armatures of marker connector relays 613, 614, etc. The armatures of all secondary switch connector relays are multipled and also connect, in turn, to multipled armatures of marker connector relays 613 and 614. There is one marker connector relay for each marker serving the office frame and the contacts of this relay connect to that particular marker. The contacts of other marker connector relays connect to other markers.

Each group of outgoing trunks representing a particular numerical direction are allotted to two different office frames, one-half of the trunks being allotted to an odd numbered office frame while the other half of the trunk group is allotted to the companion even numbered frame. When a marker circuit functions to test and select an idle trunk of a particular group of outgoing trunks, it automatically connects to both office frames in which this trunk group appears. Assuming that the office frame shown in Fig. 5 is the No. 0 office frame, then primary switch connector relays 709 and 710, secondary switch connector relays 711 and 712, and marker connector relays 713 and 714 of Fig. 7 are for the companion odd numbered office frame No. 1, and perform the same functions for office frame No. 1 as relays 609, 610, 611, 612, 613, and 614, respectively, perform for office frame No. 0. Should a marker, such as marker 608, operate its associated office frame connector relay 613 to test a group of trunks, half of which appear in office frame No. 0 of Fig. 5, the marker will simultaneously operate its office frame connector relay 713 to gain access to the other half of the outgoing trunk group which appears in office frame No. 1. Similarly, should a marker (not shown) operate marker connector relay 615 or 616 which will be assumed to be associated with office frame No. 2, the marker will also operate marker connector relay 715 or 716, respectively, which will be assumed to be associated with office frame No. 3, thereby gaining access to groups of trunks of which one-half of the trunks appear in the even numbered office frame No. 2 and the other half appear in the companion odd numbered office frame No. 3. Relays 617 and 618 are secondary switch connector relays the contacts of which connect to test conductors extending to the outgoing trunks from the secondary office switches of office frame No. 2. Relays 717 and 718 are secondary switch connector relays associated with office frame No. 3.

In addition to the direct trunks between any two offices, one or more indirect or alternate trunk routes may be provided. These alternate trunks extend to the terminating office through one or more intermediate or tandem offices. Should the decoder marker in testing for a path over which to extend the connection to the desired terminating office find all direct trunks thereto unavailable or busy it will select one of the alternate route trunks, if provided. During its connection with the decoder marker 608, the sender 439 receives from the decoder marker, over control conductors 442, such information regarding the class of the particular call and the route which the decoder marker has selected for its completion, as the sender requires to properly control the selective mechanism at the terminating office and at the intermediate office or offices if the selected trunk route extends through such intermediate offices.

The trunks 536, 537, 538, and 539 shown in Fig. 5 lead to the terminating units of cross-bar offices such as the one shown in Figs. 8 to 13. Besides these trunks, there may also be trunks, such as trunk 552, leading to the terminating unit of an exchange equipped with selective control equipment of the revertive control type. One such type of equipment may be power driven switches of the panel type such as the incoming and final selectors 553 and 554 of Fig. 5 are assumed to be, but it is to be understood that the connections of the cross-bar system disclosed herein are not limited to that but may be connected to any system, manual or dial operated, in which the selective control is arranged to operate on a revertive pulse basis.

Before taking up the equipment in the terminating unit of the cross-bar office shown in Figs. 8 to 13, a brief description will be given of the operations involved in the originating office when a subscriber initiates a call.

Assuming that the subscriber at station 200 initiates a call, the associated line switch control circuit 236 operates to determine the horizontal row of line switches and the vertical row of line switches in which the line switch 201 containing the calling line appears. Since the calling line 200 is in the upper horizontal row of primary line switches, the call must be extended over one of the ten links including links 213, 214, and 215. However, since these ten links extend to the ten secondary line switches 210, 211, etc. it is

possible that the call may be routed over any one of the ten groups of district trunks 250, 251, etc., which reach into five different district frames. Before it can be determined which line switch link and which group of district trunks will be used, it is necessary to make a test of all of the ten groups of district trunks in conjunction with tests of the five sender selector switches serving the five district frames involved, in conjunction with the senders available to these five sender selector switches. To this end, the line switch control circuit 236 when the call is first initiated, sends a signal to all five of the sender selector control circuits 443, 444, etc., provided they are idle. Each of these sender selector control circuits thereupon makes a preliminary test to determine which of the ten groups of district trunks, such as groups 250 and 251 which extend from the calling line group and eight other similar groups extending from four other line groups to the associated district frame, have one or more idle trunks therein, in conjunction with a test of the sender selector links 406, 407, etc., to which these groups of district trunks have access, and also in conjunction with a test of the groups of senders to which the said links 406, 407, etc., have access. Each of the sender selector control circuits that finds one or more idle paths over one or both of the groups of district trunks from the calling line group through the sender selector link to an idle sender, prepares test circuits in the control circuit 236 so that the corresponding line switch links, such as links 213 and 215, may be tested to determine whether they are busy or idle, these being the links that are capable of extending the calling line to the groups of district selector trunks which it has been determined have at least one idle trunk therein. Although the other eight groups of district trunks served by a particular circuit, such as control circuit 443, have been tested for their idle or busy condition, the line switch link circuits having access to these other district trunk groups occur in other line switch groups and will not be tested unless there happens to be a subscriber's line making a call at this time in such other line switch group. In that event the line switch links are tested and, at the proper time, one of the calling line groups will be preferred with respect to having access to the sender selector control circuit under discussion, such as the control circuit 443, and the other line group will be required to wait or make use of some other control circuit.

When it has finally been determined by the foregoing test which ones of the ten links, 213 to 215, inclusive, are idle and have access over idle district groups 250 to 251, which district groups in turn have access over idle sender selector links 406, 407, etc., in the five respective sender selector switch circuits, which sender selector links in turn have access to idle senders, such as the sender 439, the line switch control circuit 236 by a preference arrangement determines that a particular one of these groups of district trunks, such as the group 250, is preferred to all others. Accordingly, the sender selector control circuit 443, serving this particular group of district trunks, is retained for use and the other four sender selector control circuits are dismissed. The particular group of district trunks preferred by the control circuit 236 depends upon the particular horizontal group of primary line switches in which the calling line occurs, different horizontal groups of primary line switches preferring different groups of district trunks. At the same time the sender selector control circuit 443 associated with the preferred district frame makes tests of the ten district trunks in the chosen group 250 to determine which one is idle and also makes a test of the ten sender selector links 406 to 407, inclusive, in conjunction with the respective groups of senders accessible to these links. In this way a path is chosen from the calling line over the line switch link 213 over an idle district selector trunk in the group 250 through the primary sender selector switch 400 over some idle link in the group 406 to 407, inclusive, to an idle sender in the group to which these links have access through the secondary sender selector switches 404, 405, etc. If a number of the sender selector links 406, 407, are idle and have access respectively to idle groups of senders, a particular sender group will be preferred to all others in accordance with which of the district trunk groups is making the call, different district trunk groups having preference for different sender groups.

Following the determination of an idle path, as above described, between the calling subscriber's line 200 and an idle sender 439, the proper select and hold magnets of the primary line switch 201, secondary line switch 210, primary sender selector switch 400 and secondary sender selector switch 404 are operated to complete a dialing connection from the subscriber's line to the register sender.

As the subscriber at station 200 proceeds to dial the number of the desired station, the sender 439 registers this number and transmits to the decoder marker 608 such information as the decoder marker requires to select, test, and close a path through the district and office frames to an outgoing trunk extending to the terminating office in which the called station is located.

After a district trunk, such as trunk 227 having associated control equipment 345, subscriber's sender 439, and decoder marker 608 are selected, as hereinbefore set forth, the decoder marker operates its associated district frame connector relay 607 and, under control of the selected district trunk, operates the primary district switch relay 602. With relays 602 and 607 operated, the test and control conductors associated with the twenty "A" trunks or district links extending from primary district switch 300, represented by conductor 342, are connected to decoder marker 608.

Upon receiving information from sender 439 regarding the office code dialed by the calling subscriber, decoder marker 608 decodes this information and operates to select an idle outgoing trunk to the desired terminating office and an idle path over which to extend the connection from the district trunk 227 through the district and office switches to this outgoing trunk. As hereinbefore stated, each group of outgoing trunks of a particular numerical direction are allotted to two office frames. Assume for illustration that the group of trunks extending to the terminating office desired in this instance appears on office frames No. 0 and No. 1. Decoder marker 608 upon determining that the desired trunk group appears on office frames No. 0 and No. 1, operates its office frame connector relays 613 and 713 which are associated with office frames No. 0 and No. 1, respectively. Assuming that the trunks of the desired group are those which are connected to the lowest horizontal row of con-

tacts of the secondary office switches of frames No. 0 and No. 1, including trunks 537 and 539, decoder marker 608 now operates the secondary office switch connector relays 611 and 711 which connect the test conductors of the outgoing trunks represented by conductors 541 and 723 to the decoder marker. Assuming further for illustration that trunk 539 is the first idle outgoing trunk of the desired group, decoder marker 608 selects this trunk and, having now determined on which of the two office frames the trunk appears, causes primary office switch connector relay 609 to operate. Relay 609, in operating, connects the test and control conductors, represented by conductor 540, associated with the twenty office links or "C" trunks over which trunk 539 may be reached to the decoder marker. Having determined the particular office frame, decoder marker 608 also operates secondary district switch connector relay 603 over the contacts of the previously operated district frame connector relay 607. Relay 603, in operating, connects the test conductors, represented by conductor 343, of the twenty "B" trunks which extend from the secondary district switches to the primary switches of the particular office frame on which the selected outgoing trunk is located, to the decoder marker 608 over the contacts of the operated relay 607.

The marker, having received the designation information from the sender, and having completed the selection of an idle trunk in the desired group, is now disconnected from the sender by the release of the marker connector and the opening of leads 722.

Having selected idle outgoing trunk 539 and having associated itself with the test and control conductors of the "A", "B" and "C" trunks which offer possible paths over which the selected district trunk 345 may be extended to trunk 539, decoder marker 608 now matches an idle "A", "B" and "C" trunk and thereupon energizes the various district and office frame switch magnets for the purpose of closing the proper crosspoint contacts of these switches. Assume, for illustration, that decoder marker 608 matches and selects idle "A" trunk or district link 332, idle "B" trunk 337, and idle "C" trunk or office link 528. Select magnet 305 of primary district switch 300 previously operated at the time that district trunk 345, with which select magnet 305 is associated, was selected. District secondary connecting relay 603, in operating, caused the operation of the lowest select magnet, such as magnets 310 and 312, of each secondary district switch and also caused the operation of the lowest select magnet, such as magnets 505, 507, of the office primary switches 500, 550 to which "B" trunks 337 to 340 extend. When decoder marker 608 selected idle outgoing trunk 539 it caused the operation of the secondary office switch select magnet 511 which is associated with the level on which the trunk appears.

Decoder marker 608, having matched idle "A" trunk 332, idle "B" trunk 337, and idle "C" trunk 528, now causes the operation of hold magnets 316, 322, 512, and 527 of switches 300, 303, 500, and 503, respectively. The operation of hold magnet 316, with select magnet 305 operated, causes the closure of the upper right crosspoints of primary district switch 300. The operation of hold magnet 322, with select magnet 310 operated, causes the closure of the right lower crosspoints of the secondary district switch 350. Hold magnet 512, in operating, with select magnet 505 operated, closes the left lower crosspoints of the primary office switch 500. The operation of hold magnet 527, with select magnet 511 operated, closes the right lower crosspoints of secondary office switch 503. With the closure of the aforementioned crosspoints, the connection from district trunk 345 and subscriber's sender 439 is thereby extended over "A" trunk 332, "B" trunk 337, and "C" trunk 528, to outgoing trunk 539 which extends to the terminating office in which the desired called station is located.

Decoder marker 608, having completed its functions, now releases from the district and office frames.

Thus the connection from the calling subscriber's line 200, and from the sender 439 in which the designation of the called line is recorded, is extended over the selected idle trunk 539 to the desired terminating office. Before proceeding further with the operations involved in the completion of the connection to the called subscriber's line in the terminating office, a description will first be given of the switches, senders, markers and other pieces of equipment located in the latter office.

There are two selective switching stages in the terminating part of an office. These are the incoming and final stages, and it is through them that connections are completed to the called subscribers' lines or to private branch exchange trunks. Both the incoming and final stages comprise a number of separate frames of switches, called the incoming frames and the final frames. One of the incoming frames is illustrated in Fig. 8 and one of the final frames is illustrated in Fig. 11.

An incoming frame comprises a plurality of primary cross-bar switches 800, 801, 802, 803, etc., and a plurality of secondary cross-bar switches 805, 806, 807, etc., the primary and secondary switches being interconnected by links or trunks which may conveniently be designated as "A" trunks. While different arrangements of the primary and secondary switches may be used for an incoming frame, one suitable arrangement is shown in Fig. 8. According to this plan, an incoming frame serves one hundred incoming trunk circuits, such as the trunk 539, and these trunks are distributed among eight primary incoming switches. Each of the eight primary switches comprises ten horizontal rows of contacts and twenty vertical rows of contacts. In each of these switches the horizontal multiple is divided so as to separate the switch into two parts, the larger part including sixteen vertical rows of contacts and the smaller part four vertical rows. The one hundred incoming trunks are divided into ten groups of ten each. Eight of these groups appear respectively in the horizontal contact rows of the larger parts of the eight primary switches. For example, the No. 0 group of trunks, which includes the trunk 539, appears in the ten horizontal rows of the part 811 of the No. 0 primary switch 800. The No. 3 group of trunks likewise appears in the part 812 of the fourth primary switch 801. Similarly, trunk groups Nos. 1 and 2 appear respectively in the corresponding portions of the two primary switches (not shown) intermediate the switches 800 and 801. It will be noted that these first four groups of trunks appear in a single switch each, that is, they are not multipled from one switch to another. However, the next or No. 4 group of trunks, instead of appearing in the larger portion of one of the switches, is multipled to the smaller portions of

all of the first four primary switches 800 and 801. In like manner, the remaining five groups of incoming trunks are divided among the last four primary switches, of which two switches 802 and 803 are shown.

The incoming frame also includes twelve secondary cross-bar switches, each of which is divided into a larger part and a smaller part of contact rows, the larger part having sixteen vertical rows and the smaller part four vertical rows, both the larger and smaller portions having ten horizontal rows. The primary and secondary switches are interconnected by one hundred and sixty "A" trunks, these trunks being divided into ten groups of sixteen each. The first group 813 of sixteen "A" trunks appears respectively in the sixteen vertical rows of contacts in the part 811 of the first primary switch 800, and they are wired in such a manner that some one of the sixteen trunks appears in each part of all of the secondary switches. For example, the first trunk 814 of the first group 813 appears in the first horizontal row of the left-hand part 815 of No. 0 secondary switch 805. The second trunk appears in the first horizontal row of the No. 1 secondary switch (not shown). The third trunk 816 of group 813 appears in the lowermost horizontal row of part 817 of the No. 2 secondary switch 806. The fourth trunk 818 of the group 813 is multipled and appears in the lowermost horizontal rows of the smaller parts 819, 820 of all of the first three secondary switches 805, 806. It will be noted that these smaller right-hand portions are wired in a manner similar to the wiring of the primary incoming switches. This method of wiring the several trunks of the group 813 continues throughout the secondary switches until finally the last or sixteenth trunk 821 appears in the first horizontal row in the smaller portions of the last three secondary switches 809, 810.

In like manner, the next three groups of "A" trunks outgoing from the left-hand parts of the next three primary switches, the last of which is switch 801, extend and appear in the corresponding horizontal rows of contacts of the secondary switches. The No. 4 or fifth group of sixteen trunks is made up of the four vertical rows of the smaller parts 822, 823 of each of the first four primary switches 800, 801, and this group of sixteen "A" trunks is wired to the horizontal rows of contacts in the secondary switches in the manner already described. Similarly, the last five groups of "A" trunks outgoing from the primary switches 802, 803 are wired to the secondary switches. The last or tenth group 824 is represented by the first and last trunks 825 and 826 of this group. The first trunk 825 of the group appears in the first vertical row of the smaller portion 827 of switch 802, and the last trunk 826 in the last vertical row of the right-hand portion 828 of the switch 803. Thus, any group of ten incoming trunks has access through a primary switch to all of the secondary switches.

The trunks outgoing from the secondary incoming switches extend to the final switch frames. These are called "B" trunks, and it is possible for an incoming frame to reach any final frame over these "B" trunks. Since there are twelve secondary incoming switches, each switch having twenty vertical rows, there are a total of two hundred and forty "B" trunks, each of which occupies a full vertical row in a secondary switch. This total group of two hundred and forty is divided into twenty-four groups of ten "B" trunks each. Each of these groups is made up by taking a trunk from each of ten successive portions of the secondary switches. In other words, if the left-hand parts 815, 817 of the first three switches 805, 806 are designated as levels 0, 1 and 2, and if the right-hand parts 819, 820 of these three switches are collectively designated as level No. 3, and if the corresponding parts of the remaining secondary switches are likewise designated as levels 4 to 15, inclusive, each of the twenty-four groups of "B" trunks is derived by starting with the first level of trunks and taking a single trunk from each of the first ten consecutive levels for the first group, a single trunk from the second ten consecutive levels for the second group, a single trunk from each of the third consecutive levels for the third group, and so on, repeating the cycle until all of the two hunded and forty trunks have been used. The first and last groups 829 and 830 are illustrated.

Any suitable number of final frames may be employed but it will be assumed in the present case that the office comprises twelve final frames, one of which is shown in Fig. 11. It will further be assumed that each incoming frame has two groups of "B" trunks extending to each of the twelve final frames, thereby utilizing the total twenty-four groups.

Each final frame, such as the one shown in Fig. 11, comprises ten primary cross-bar switches 1100, 1101, 1102, 1103, etc., each having ten horizontal rows and twenty vertical rows of contacts, and ten secondary cross-bar switches 1104, 1105, 1106, 1107, etc., each having ten horizontal and twenty vertical rows of contacts. The primary switches are divided into two sections each. The sections 1120, 1121, 1122, 1123 of switches 1100 to 1103 each have ten vertical rows and serve to extend calls to all even numbered lines in the final frame. Similarly, sections 1124, 1125, 1126, 1127 of these switches have ten vertical rows each and serve the odd numbered lines. And each final secondary switch has its horizontal multiple divided into two equal sections. For instance, switch 1104 has a left-hand or even section comprising parts 1108 (5 verticals) and 1109 (5 verticals) and a right-hand or odd section comprising parts 1110 (5 verticals) and 1111 (5 verticals).

The subscribers' lines and the private branch exchange lines appear in the vertical rows of contacts of the secondary final switches, each line occupying a single vertical row of contacts in a single switch, that is, the lines do not multiple from one switch to another. The size of the group of lines served by a final frame may vary according to the arrangement and number of switches but it will be assumed in the present disclosure that a convenient number of lines for a final frame is two hundred lines or some multiple thereof. The two hundred lines in a final frame are preferably divided so that the even and the odd lines are segregated. For example, if the frame shown in Fig. 11 serves the number 0 and No. 1 hundreds lines of a particular thousand in the exchange, all of the even lines of these two hundreds appear in the left-hand halves or even sections of the ten secondary switches, and all of the odd lines of these two hundreds appear in the right-hand halves or odd sections of the secondary switches. All even lines of the No. 0 hundred occur in the parts 1108, 1112, 1113, 1114 of the respective secondary switches and similarly all of the even lines of the No. 1 hundred occur in the parts 1109, 1115, 1116,

1117. Similarly, the odd lines of the No. 0 and No. 1 hundreds are disposed in the left and right-hand parts of the right-hand sections of the ten secondary switches. More specifically, the first ten even numbered lines, namely, lines 0 to 18, inclusive, of the No. 0 hundred appear respectively in the extreme left-hand vertical rows of the parts 1108, 1112, etc., of the ten switches 1104 to 1107. The second ten even numbered lines of this hundred, namely, lines 20 to 38, inclusive, appear respectively in the No. 2 vertical rows of contacts of these parts of the ten switches 1104 to 1107, and similarly the remaining three groups of even numbered lines of the No. 0 hundred occur in the next three vertical rows of contacts in the respective switches. The same is true of the even numbered lines of the No. 1 hundred appearing in the vertical rows of parts 1109, 1115, 1116 and 1117 of the successive secondary switches. And the same plan is followed for the odd numbered lines of the No. 0 and No. 1 hundreds in the right-hand halves of the secondary switches.

The primary and secondary switches of the final frame are interconnected by links or trunks which may be designated as "C" trunks. All ten of these primary switches 1100 to 1103 have access not only to all of the secondary switches but also to the even and odd sections of these secondary switches. For example, the even section 1120 of primary switch 1100 has ten "C" trunks 1128 outgoing therefrom which appear each in a horizontal row of contacts in the even section of each of the ten secondary switches. Likewise, the even section 1121 of primary switch 1101 has ten "C" trunks 1129 which appear in the even sections of the respective ten secondary switches, and the same is true of the left-hand or even sections of the remaining eight primary switches. In other words, the left-hand sections of the primary switches have access to the left-hand halves of the secondary switches and, therefore, access to all even numbered lines in the two hundreds served by this particular final frame. Similarly, the right-hand or odd sections 1124, 1125, etc., of the primary final switches have access to the right-hand halves of the respective secondary switches 1104 to 1105, etc., and, therefore, access to all odd numbered lines in the frame.

Returning now to the "B" trunks which interconnect the incoming frame with the final frames, there are, as above explained, two groups of ten "B" trunks leading from a particular incoming frame to each of the final frames. One of these groups of ten "B" trunks has access ultimately to the even numbered lines in the final frame, and the other group of ten "B" trunks has ultimate access to the odd numbered lines in the final frame. For example, the group of ten trunks 829 extend from the incoming secondary switches and appear respectively in vertical rows of contacts in each of the ten even sections of the final primary switches 1100 to 1103. The second group of ten "B" trunks 830 extend from the incoming secondary switches and appear respectively in vertical rows of contacts in the odd sections of the ten final primary switches 1100 to 1103. Thus, the incoming frame shown in Fig. 8 has access to even numbered lines in the final frame of Fig. 11 by way of the group 829 of "B" trunks, and has access to the odd numbered lines of this frame by way of the group 830 of "B" trunks. In a similar way this particular incoming frame has a corresponding pair of "B" trunk groups extending to each of the remaining final frames in the office. Also, each of the other incoming frames in the office has a pair of "B" trunk groups extending to the primary switches of the final frame shown in Fig. 11 and to the primary switches in all other final frames in the office.

The explanation thus far given has been based on the assumption that a final frame serves a group of two hundred lines. The capacity of the final frame may be enlarged to include two or more groups of two hundred lines by adding corresponding sets of ten secondary final switches and by multipling the "C" trunks outgoing from the ten primary switches 1100 to 1103 of the frame to all sets of final secondary switches. For example, the "C" trunks 1130 extending from the primary final switches 1100, 1101 would appear in the even sections of secondary final switches 1104 to 1107, serving a particular two hundred line, would appear in similar secondary switches for another two hundred lines and so on for as many groups of two hundred lines as are assigned to this final frame, and the same would be true of all other "C" trunks.

The incoming and final selector switches which have been described above are controlled by terminating register senders and terminating markers which are generally similar to the senders and markers previously described in connection with the originating part of the exchange. As disclosed in the drawings, there are thirty terminating senders, such as the sender 1007, and these are automatically connected to the calling incoming trunks by a sender selector switch and control circuit illustrated in Fig. 10. The sender selector comprises three cross-bar primary switches 1001, 1002, and 1003, and three cross-bar secondary switches 1004, 1005, and 1006. All these switches have ten horizontal and ten vertical rows of contacts. The three primary switches have their horizontal multiple divided in four parts, as shown, three of these parts having three vertical rows each and the fourth part having a single vertical row. The sender selector is associated with a particular incoming frame, such as the frame shown in Fig. 8 and the one hundred trunks incoming to said frame also appear in the primary switches of the sender selector. These one hundred trunks are divided into ten groups, nine of which, 1008, 1009, 1010, etc., appear in the horizontal rows of contacts of the respective parts of the three switches having the three vertical rows of contacts. The trunks of the tenth group are multipled to appear in the horizontal rows in all three of the primary switches 1001, 1002 and 1003.

The link circuits interconnecting the primary and secondary switches of the sender selector appear in the vertical rows of contacts of both primary and secondary switches. And these links are so connected, as shown in the drawings, that every group of ten incoming trunks has access through a primary switch to any one of the three secondary switches 1004, 1005, and 1006. For example, the three links 1009, 1010, and 1011 accessible to the incoming trunk group 1008 extend from the primary switch 1001 to the secondary switches 1004, 1005, and 1006, respectively. Each of the three secondary switches has access to a group of ten terminating senders comprising thirty senders in all, any one of which is suitable for completing the call to a desired line.

The purpose of the terminating sender is to receive that portion of the total designation, re-

corded in the originating sender by the calling subscriber, which identifies the called subscriber's line in the terminating office. This numerical designation is transferred from the originating sender **439** to the terminating sender **1007** by means of revertive impulses. These impulses are created by the sender **1007** and react on the sender **439**. This general method of controlling switches and other devices is well known in the art.

In addition to the terminating senders the office is equipped with a plurality of terminating markers, one of which, marker **1300**, is illustrated in Fig. 13. These markers receive the recorded designation from the senders and decode this information for the purpose of controlling the incoming and final switches to establish the incoming connection through to the desired line. Since the markers are common to all of the senders, a sender connector device **1301** is provided for connecting any one of the senders with any one of the markers. This device is similar in construction and operation to the connector shown in Fig. 7 at the originating office.

The several incoming frames are provided respectively with incoming frame connectors, the purpose of which is to associate a marker with the incoming frame through which it is desired to extend an incoming call. The connector for the incoming frame shown in Fig. 8 comprises the multi-contact relay device **900**, shown in Fig. 9, and the multi-contact relay device **1302**, shown in Fig. 13. The device **1302** comprises a plurality of multi-contact relays **1303**, **1304**, and **1305**, each of which is individual to one of the common markers. When one of these relays is operated, the several test and control leads from the particular marker are extended to the multi-contact relay device **900** relating to the particular incoming frame shown in Fig. 8. One of the functions of the device **1302** is to extend a group of sixteen test leads **901** from the marker to the contacts in multiple of ten multi-contact relays, of which two relays **902** and **903** are shown. These ten relays are respectively individual to the ten groups of incoming trunks, and when a particular one of the relays operates, it indicates that the incoming call is in the group of ten trunks to which it is individual. Therefore, an operated one of the relays **902**, **903**, etc., extends the sixteen test leads **901** through its contacts to the sixteen "A" trunks outgoing from the primary incoming switch to which the incoming call has been extended. For instance, if the incoming call appears on trunk **539**, the relay **902** individual to the group containing trunk **539** is operated, and the test leads **901** are connected to the respective "A" trunks of the group **813** since this group of "A" trunks and no other can be of service in extending the call through the incoming frame.

Another function of the device **1302** is to extend from the marker the operating leads for the four multi-contact relays **904**, **905**, **906**, and **907**. These latter relays have six sets of contacts each, making a total of twenty-four sets of contacts, one for each of the groups of "B" trunks **829**, **830**, etc., extending from the incoming frame shown in Fig. 8 to the twelve final frames assumed for the office. Accordingly, when one of the relays, such as the relay **904**, is operated by the digit information stored in the marker, it prepares the test leads for the "B" trunk groups extending to each of three different final frames. Since the called line appears in a particular one of these three final frames, the marker also causes the operation of one of six relays **908**, **909**. The particular one of these latter relays, such as the relay **908**, that is operated, determines not only that the "B" trunk group to be tested extends to the desired final frame, but also that it extends to the even or odd section of the final primary switches according to whether the called line is an even line or an odd line in the group of two hundred lines.

Each of the remaining incoming frames has a frame connector similar to that shown in Figs. 9 and 13. A portion of one of these connectors **1311**, corresponding to the device **1302**, is shown for a second incoming frame.

In like manner each of the final frames is provided with a frame connector. The one for the frame shown in Fig. 11 comprises the relay device shown in Fig. 12 and the multi-contact relay connecting device **1306** shown in Fig. 13. These final frame connectors serve to connect the marker to the particular final frame in which appears the called line. For this purpose, the device **1306** consists of a number of multi-contact relays **1307**, **1308**, **1309**, each individual to a different one of the common markers.

Inasmuch as a final frame may serve two or more groups of two hundred lines each, the frame connector is provided with a plurality of multi-contact relays **1200**, **1201**, each individual to a particular group of two hundred lines, and these relays are selectively operated by the marker depending on which group of two hundred is desired. A two hundred line group is divided for the purpose of testing into ten subgroups or blocks of twenty lines each, and to this end there are provided ten multi-contact relays **1202**, **1203**, one for each of the blocks of twenty lines in the two hundred line group. A block of twenty lines comprises twenty consecutively numbered lines, such as the lines 0 to 19, inclusive. As was above explained, these lines are segregated according to whether they are odd or even in different parts of the secondary final switches. The ten even lines of block No. 1 for example, namely, lines 0, 2, 4, 6,—18, occur in the respective sections **1108**, **1112**, **1113** and **1114** of the ten secondary switches, and the ten odd lines of the same block of twenty, namely, lines 1, 3, 5, 7,—19, occur similarly in the sections **1110**, **1131**, etc., of said secondary switches. Accordingly, the multi-contact relay **1202** individual to this particular block of twenty lines extends to the marker test leads, such as the test lead **1204**, for all twenty lines in the block whether odd or even, and the same, of course, is true of each of the remaining relays, such as relay **1203**, individual to the other blocks of twenty lines.

The purpose of these test leads for the different blocks of twenty lines is to permit testing either of an individual line or of a group of private branch exchange lines which may contain twenty or more lines. If the desired number identifies a private branch exchange line, the testing operation is performed in a group of twenty lines until an idle one is found, and, if no line therein is idle, connection is made to a second (and a third, etc.) group of twenty lines, and the testing is resumed until an idle line is located or until all are found to be busy. If the called number represents a direct subscriber's line, then twenty test leads are connected to the block of twenty lines containing the called line, the same

as though a private branch exchange group were to be tested. However, the marker by its testing operation detects the fact that the line desired is a direct line and confines its testing operation thereto.

If the private branch exchange line has been located in the group of twenty or if the direct line has been tested and found to be idle, it is necessary to prepare an operating circuit for the hold magnet of the secondary final switch, some of which magnets are indicated by the characters 1132 to 1139, inclusive. Inasmuch as the chosen line is either in the even or odd sections of the final switch and since the marker has this information, one or the other of the two relays 1205 and 1206 is operated from the marker. The even relay 1205 closes the operating leads 1207 which also extend through the contacts of the block relay 1202 to the windings of the hold magnets 1132, 1133, 1134, 1135, individual respectively to the ten even numbered lines in the block of twenty. Similarly, the odd relay 1206 connects the same operating leads 1207 through the contacts of the block relay 1202 to the windings of the hold magnets 1136, 1137, 1138, 1139, individual respectively to the ten odd lines in the block of twenty.

Another function of the connecting device 1306 is to extend the operating leads to ten multi-contact relays 1208, 1209, one for each of the pair of "C" trunk groups which extend respectively to the two sections of one of the final secondary switches. For example, the relay 1208 relates to and serves to operate select magnets in the final primary switches 1100, 1101, etc., for all "C" trunks extending to the final secondary switch 1104. Similarly, the relay 1209 relates to and serves to operate the select magnets in the primary switches for all "C" trunks which extend to the secondary final switch 1107. Since half of these trunks extend to the even half of a secondary switch and the other half to the odd section of the secondary switch, and since the called line is in one or the other of the two halves of the secondary switch, it is necessary to test that half of the total group of "C" trunks reaching the secondary switch which terminates in the section containing the called line. Since this division is one between even and odd lines, the test is confined to the proper half of the "C" trunks by the operation of either the even relay 1210 or the odd relay 1211. It will be noted that these relays are operated in parallel with either the even and odd relays 1205 and 1206. If the even relay 1210 is operated, the test conductors 1212, which serve to test the "C" trunks, are connected through the contacts of the operated relay, such as relay 1208, to the ten "C" trunks including trunks 1140 and 1141 which terminate in the even half of the final secondary switch 1104. Likewise, if the odd relay 1211 is operated, these test conductors 1212 are connected through the contacts of relay 1208 to the ten "C" trunks including the trunks 1142 and 1143 extending to the odd half of the final secondary switch 1104.

Similarly, other final frames are equipped with final frame connectors including relay mechanisms similar to that shown in Fig. 12 and other relay mechanisms similar to the one, 1306, shown in Fig. 13. A second one of these latter devices, 1310, is illustrated.

In this way it is possible for the marker 1300 to which the numerical designation of the wanted line has been transferred to connect itself to the incoming frame to which the incoming trunk has been extended, and to the final frame containing the called line, and to associate its test conductors with the proper group of "A" trunks interconnecting the incoming primary and secondary switches and with the proper group of ten "B" trunks extending from these secondary incoming switches to the primary final switches and with the proper group of ten "C" trunks extending from these primary final switches to the particular half of the particular final secondary switch in which the called line or the idle private branch exchange line has been located.

A brief description will now be given of the sequence of operations in the completion of the call to the subscriber's line. At the time the connection was extended from the originating office over the selected idle trunk 539, relay mechanism individual to the trunk was caused to operate and initiate the operation of a control circuit (not shown) associated with the sender selector switch of Fig. 10. The control circuit proceeds to test the senders and links, such as links 1009, 1010, 1011, etc., and when an idle sender and an idle link have been found, the select and hold magnets of the primary and secondary sender selector switches are operated, thereby extending the incoming trunk 539 through to an idle sender, such as the sender 1007.

Also at this time the incoming trunk 539 causes the operation of a relay 832 which in turn effects the operation of the lowermost select magnets 833, 834, etc., of the first four primary incoming selector switches 800, 801. Also, the relay 832 operates the multi-contact relay 902 which, as has been explained, is individual to the group of ten trunks including the trunk 539 incoming to the primary switch 800. Inasmuch as the incoming trunk 539 is served only by the group of sixteen "A" trunks 813, each one of which appears in a corresponding horizontal row in one of the respective secondary switches 805, 806, etc., it is possible to operate the select magnets for these "A" trunks at this time. These select magnets 833, 834, 835, etc., are all operated by relay 902 although only one of the magnets will be used.

As soon as the circuits are prepared between the originating sender 439 and the terminating sender 1007, the numerical portion of the called designation is transferred by revertive impulses to sender 1007. Thereupon, the connector 1301 is operated to connect sender 1007 to an idle marker 1300, and the number of the called line is then transferred to register relays in the marker, and this information is set up on a translator. The marker proceeds to operate the frame connector 1306 and 1200 relating to the final frame containing the called subscriber's line 1144. From the thousands and hundreds digits stored in the marker, it is possible for the marker to determine the operation of the particular relay, such as relay 1200, which identifies the group of two hundred lines in the group of a thousand lines which contain the called line. Following the operation of relay 1200, the marker causes the operation of the particular block relay 1203 relating to the group of twenty lines in the determined group of two hundred. Test leads are then extended to these lines, and the particular line desired, 1144, is tested to determine whether it is busy or idle. Since the line 1144 appears in the odd half of the final switch 1107,

the odd relay 1206 is operated, and the operating lead for the hold magnet 1145 is prepared.

At about the same time, the marker institutes the operation of the proper incoming frame connector 1302, 900 and connects itself to the incoming frame shown in Fig. 8. Since the calling trunk 539 appears in the incoming primary switch 800, and since only ten of the sixteen trunks of the group 813 have ultimate access through the secondary incoming switches to a particular group of ten "B" trunks, such as group 829 or group 830 to the called line in the final frame, the marker, knowing the identity of the called line, is able to prepare the test circuits for the proper ten of these sixteen "A" trunks that can possibly be used for extending the connection. The marker also operates one of the multi-contact relays of the device 900, such as relay 907, and also one of the relays 908, 909, such as the relay 909, to extend the ten test leads 910 to the particular group of ten "B" trunks 830 over which it is possible to extend connection from this incoming frame to the called line 1144. Also, the marker 1300, by operating the proper one of the relays 1208, 1209 and one of the relays 1210, 1211 (in this case relays 1209 and 1211), extends the ten test leads 1212 to the particular ten "C" trunks over which it is possible to extend the connection through the final primary switches to the particular secondary final switch 1107 containing the called line 1144. Relay 1209 serves to operate the select magnets 1146, 1147, 1148, 1149 for the respective horizontal rows in the final primary switches in which appear the respective "C" trunks of the group of ten that lead to the odd section of the switch 1107 containing the called line 1144. By analyzing these circuits through the incoming and final frames, it will be found that there are ten separate paths over which a connection can possibly be extended from the incoming trunk 539 to the called line 1144, and for one of these paths to be useable, it is necessary that all three of its component links, trunks "A", "B" and "C" be simultaneously idle. Having determined an idle path in this way, the marker first operates a select magnet on each of the final secondary switches, such as magnets 1150, 1151, 1152, 1153, the particular magnet of switch 1107 operated being the one individual to the particular one of the ten "C" trunks that is chosen for use. The marker also proceeds to operate the necessary hold magnets, such as magnet 836 of switch 800, magnet 837 of switch 810, and magnet 1151 of switch 1103, to complete the connection through to the called subscriber's line.

At the proper time, the terminating marker 1300 is released from the sender 1107, the incoming and final frame connectors are released, and a signal is sent back to the originating sender 439 in the calling office to effect its release. The talking connection is established through from the calling to the called lines as explained, and when the called party answers, conversation may ensue. At the end of the conversation, the parties, by replacing their receivers, effect the release of the entire connection by opening the circuits of the hold magnets of the several switches involved, the select magnets having been released shortly after the original operation of the respective hold magnets.

Should the calling subscriber at line 200 desire to extend a connection to a terminating office equipped with switches of the revertive control power-driven type, such as the well-known panel switches, the operations involved in seizing the originating sender 439, seizing an originating marker 608, and operating the district and office selector switches, are the same as already described. In this case, however, a trunk 552 is chosen at the office selector frame extending to an incoming selector switch 553 in the office containing the called subscriber's line 555. The switches 553 and 554 operate on the revertive impulse principle under the control of a register sender. Hence, these switches can be controlled directly by the originating sender 439 which, as has been already seen, is designed to receive revertive impulses. Switches 533 and 534 are set and the calling subscriber's line 555 is rung in the usual manner and the sender 439 is dismissed. Release takes place when the subscribers replace their receivers.

Thus, it is possible for a telephone area to be comprised of some exchanges equipped with switches of the cross-bar type and other exchanges equipped with switches of the revertive control type, such as panel power-driven switches, and calls may be extended from the cross-bar office either to a terminating cross-bar office or to a panel power-driven office.

Similarly, since the terminating cross-bar senders function on a revertive control basis, calls may be completed to a subscriber in a cross-bar office from any other type of office, manual or dial, providing that the equipment at this latter office is arranged to function in response to pulses transmitted from the terminating cross-bar office.

Detailed description of operation

Referring now to Figs. 14 and 15, there is shown therein a subscriber's station 1400 together with its associated line circuit, one set of horizontal and vertical crosspoint contacts 1407 of the particular primary line switch to which the line conductors 1403 and 1404 of station 1400 are connected, one line link 1409, one set of horizontal and vertical crosspoint contacts 1410 of one of the secondary line switches serving the primary line switches of the group, and the line link control equipment associated with this particular group of line switches.

As hereinbefore set forth in the general description, each line switch group consists of ten horizontal rows or groups of primary line switches, each group having any desired number of switches in parallel. The control circuit is provided with ten horizontal group relays of which four, relays 1500 to 1503 inclusive, are shown. Each of these group relays is associated with a particular horizontal level or group of primary line switches and its function is to associate the common control equipment with the particular horizontal level or group of primary switches containing the primary switch in which the calling line appears. A further function of the horizontal group relays is to prevent the common control circuit from serving more than one horizontal group of primary switches at one time.

Subscriber initiates a call—Operation of line switch and sender selector control circuits

Assuming now that a call is initiated at station 1400, line relay 1401, which is associated with the line of that station, operates over a circuit from battery through its winding, over the outer back contact of the associated cut-off relay 1402, line conductor 1403, the closed switchhook contacts (not shown) at station 1400, line conductor 1404, inner back contact of relay 1402, to ground. Re-

lay 1401, in operating, operates horizontal group relay 1500 which is associated with the horizontal row or group of line switches containing that switch in which the calling line appears. The circuit for relay 1500 may be traced from ground over the inner front contact of relay 1401, back contact of relay 1405, conductor 1444, winding of relay 1500, normally closed left contacts of the other horizontal group relays such as relays 1501, 1502 and 1503, conductor 1504, to battery through the winding of relay 1406 which also operates. Relay 1500, operating, locks over its inner left and inner right front contacts to ground over conductor 1507 and the upper back contact of relay 1411. Relay 1406, in operating, operates relay 1405 over a circuit from ground over its lower front contact, lower middle back contact of relay 1411, conductor 1505, next-to-inner right front contact of relay 1500, conductor 1506, to battery through the winding of relay 1405. The relays, corresponding to relay 1405, associated with each of the other primary switches in the same horizontal group operate simultaneously since their windings are also connected to conductor 1506 as indicated by multiple strap 1426. Relay 1405, in operating, opens the operating circuit for relay 1500, and connects ground from the inner front contact of relay 1401, over its inner front contact, to the winding of relay 1412. The operation of relay 1405 also connects the outer front contact of line relay 1401 and the bottom armature of primary line switch hold magnet 1415 to the outer armature of relay 1416. As hereinbefore set forth in the general description, there are ten subscribers' lines connected to each primary switch, one line being connected to each of the ten vertical rows of contacts of the switch. Relay 1405, by its operation, also connects the outer front contact of the line relays (not shown) of the other nine lines of the primary switch, together with the bottom armature of the other nine primary switch hold magnets (not shown) over nine additional armatures such as armature 1417, to nine additional armatures, such as armature 1418, of relay 1416. The operation of the relays (not shown), corresponding to relay 1405, of the other primary switches of the horizontal group similarly connect the inner front contacts of the ten line relays and the bottom armatures of the ten primary switch hold magnets, of the primary switch with which they are associated, to the ten armatures of other relays, corresponding to relay 1416, one of which is associated with each vertical row of primary switches. The ten line circuits connected to the primary switch containing the calling line, together with the ten hold magnets associated with the ten vertical rows of contacts to which these lines connect, have therefore, by the operation of horizontal group relay 1500 and the subsequent operation of relay 1405, been connected to the vertical group selection circuit associated with the vertical group in which the primary switch appears. Similarly, the operation of each relay (not shown), corresponding to relay 1405, of the other primary switches in the same horizontal group, has connected the ten line relays and ten hold magnet armatures of its primary switch to the vertical group selection circuit associated with the vertical group containing that primary switch.

Each vertical group selection circuit consists of three relays, relays 1412, 1416, and 1419, which are common to the switches in a particular vertical row. The armatures of relay 1416 connect, as indicated by multiple straps 1420 to 1422 inclusive, to the front contacts of each of the relays such as relay 1405 of all primary switches in the same vertical group. The ten armatures of relay 1419, of which only two are shown, connect to the windings of the ten primary switch select magnets, such as magnet 1427, of all primary switches in the same vertical row as indicated by multiple straps 1428. The function of the vertical group selection relays is to connect the lines of the primary switches in any vertical group of switches to ten line test relays, three of which, relays 1423 to 1425, inclusive, are shown, and also to connect the windings of the select magnets of these primary switches to the control circuit for future operation.

Since the operation of vertical selection relay 1416 connects the front contacts of ten relays such as relay 1405, one for each of the ten primary switches in the vertical group, to the line test relays, it is necessary that only one relay such as relay 1405, in any particular vertical row of primary switches, be operated at one time, to insure the proper functioning of the line test relays in their selection of the calling line.

Assume now that at this time a second line, associated with a primary switch in the same vertical group of switches, but connected to a primary switch located in a different horizontal group, for example, the group with which horizontal group relay 1501 is associated, initiates a call. The operation of the line relay (not shown) of this second calling line operates relay 1501 over a circuit similar to that described for the operation of relay 1500 except that in this case the operating circuit extends over the back contact of the primary switch relay, corresponding to relay 1405, which is associated with the primary switch in which this second calling line is located. The relay, corresponding to relay 1405, of this second primary switch does not operate at this time however, since its operating circuit over the partially indicated conductor 1555 was opened by the previous operation of relay 1500 over the next-to-inner right back contact of that relay. Relay 1501 remains operated from the front contact of the line relay of the second calling line but no further operations for associating the lines of that horizontal group of switches with the vertical selection relays takes place until the control circuit releases after having disposed of the first calling line.

When relay 1405, together with the corresponding relays of the other primary switches of the same horizontal group, operates during horizontal group selection as previously set forth, a circuit is closed from ground over the inner armature and front contact of relay 1401, inner armature and front contact of relay 1405, winding of vertical group relay 1412, normally closed lower contacts of the vertical group relays, such as relays 1413 and 1414, associated with the other vertical groups of switches, to battery through the winding of relay 1429. Relays 1412 and 1429 operate in series, relay 1412 locking in a circuit over its lower front and upper inner front contacts, lower inner back contact and armature of relay 1411, to ground over the lower armature and front contact of relay 1406. Relay 1412, in operating, removes the ground over its upper outer back contact from the chain circuit extending over the upper outer armature of the other vertical group relays, such as relays 1413 and 1414, and closes a circuit from ground over its upper outer front contact to battery through the windings of relays 1416 and 1419 in parallel, these

relays operating. Relay 1416, in operating, closes the circuit from the outer front contacts of the ten line relays and the bottom armatures of the ten hold magnets, of the primary switch containing the calling line, over ten front contacts of relays 1405 and 1416, to the upper windings of ten line test relays such as relays 1423 to 1425, inclusive. Only one vertical selection relay, such as relay 1416, can be operated at any time. As previously stated, relay 1412, by its operation, opened the ground from the upper outer armatures of relays 1413 and 1414 so that, should these latter relays operate at this time due to the presence of a call in some other vertical switch of the same horizontal group, their operation is ineffective in operating their associated vertical selection relay corresponding to relay 1416. Had relay 1414 been operated instead of relay 1412, it would, by the opening of its lower normally closed contacts, have opened the operating circuit for relays 1412 and 1413 thereby making these relays ineffective until the release of relay 1414 by the release of the control circuit upon the disposal of the first call in the vertical group.

Upon the previous operation of relay 1406 a circuit was closed from ground over its lower front contact, lower inner back contact of relay 1411, upper front contact of relay 1406, lower inner back contact of relay 1430, to battery through the winding of relay 1431 which operated and connected ground over its front contacts to the upper winding of each of the ten line test relays such as the relays 1423 to 1425, inclusive. Upon the operation of vertical selection relay 1416, a circuit is completed from battery through the winding of primary switch hold magnet 1415 which is associated with the vertical row of contacts to which the calling line connects, over the outer front contact of line relay 1401, outer front contact of relay 1405, outer front contact of relay 1416, upper winding of line test relay 1423, to ground over the front contact of relay 1431. Relay 1423 operates but primary hold magnet 1415 does not since it does not receive sufficient current at this time. Relay 1423, in operating, locks in a circuit from ground over the inner front contact of relay 1429, lower armature and back contact of relays 1425 and 1424, lower armature, front contact and lower winding of relay 1423, to battery through the winding of relay 1430 which operates. Relay 1430, in operating, opens the operating circuit for relay 1431 which releases. Relay 1431, in releasing, opens the ground from the upper windings of the ten line test relays.

Should there be several simultaneous calls over the lines connected to any primary switch at the time that the ten lines of this switch are associated with the line test relays as just described, the separate line test relays corresponding to these several calling lines will operate at the same time. The line test relays, in this case, will prefer and select only one of the several calling lines. Assume, for example, that both relays 1423 and 1425 operate due to calls being initiated over the lines with which these two relays are associated. Upon the operation of relay 1430 and the subsequent release of relay 1431, relay 1425 remains locked through its lower winding in series with relay 1430 which it operated over that path. Relay 1423, however, since the holding circuit through its lower winding is opened at the lower back contact of relay 1425, releases when the operating circuit through its upper winding is opened by the release of relay 1431. The call initiated over the line with which relay 1423 is associated will not be served at this time but must await the release of the control circuit upon the disposal of the calling line which it preferred. For the purpose of this description, however, it is assumed that the line with which relay 1423 is associated is the only line, of the ten lines appearing in that particular primary switch, over which a call is being initiated.

When relay 1406 operated during horizontal group selection as hereinbefore described, a circuit was closed from ground over the lower front contact of relay 1406, back contact of relay 1411, upper front contact of relay 1406, conductor 1432, back contact of relay 1508, back contact of relay 1509, to battery through the winding of relay 1510 which operated. Relay 1510, in operating, closes a circuit from this same ground on conductor 1432, over its upper front contact, to battery through the winding of relay 1511. Relay 1511 operates and locks over its lower front contact to the ground on conductor 1432. Relay 1511, in operating, closes a circuit from ground over its upper inner front contact, over conductor 1512, back contact of relay 1921, to battery through the winding of start relay 1900 of the subscriber's sender selector control circuit shown in part in Fig. 19, the remainder being shown in Figs. 16 and 18. The operation of the sender selector circuit following the closure of the operating circuit for its control circuit start relay 1900 will subsequently be set forth in detail.

When relay 1500 operated during horizontal group selection it closed a circuit from ground over conductor 1505, over its next-to-inner right front contact, to battery through the winding of relay 1513 which operated. Relay 1513 upon its operation closed a circuit from the right winding of relay 1514, over the next-to-inner back contact of relay 1508, next-to-inner right front contact of relay 1513, conductor 1515, to the armature of the secondary line which hold magnet 1433 which is associated with that row of secondary switch contacts to which line link 1409 is connected. There are nine additional relays, similar to relay 1514, three of which, relays 1516 to 1518, inclusive, are shown. The operation of relay 1513 also closes circuits from the right windings of each of the aforementioned nine relays, over nine additional back contacts (one of which is shown) of relay 1508, over nine additional front contacts (one of which is shown) of relay 1513, to the armatures of nine other secondary line switch hold magnets (not shown), one per secondary line switch, which are associated with vertical rows of contacts to which the other nine line links (not shown) from the primary line switch horizontal group containing the calling line are connected. Relay 1513 is individual to the primary line switch horizontal group with which horizontal group relay 1500 is associated.

There are nine other relays corresponding to relay 1513, three of which, relays 1519 to 1521, inclusive, are shown. One each of these relays is associated with each of the nine other horizontal group relays, such as relays 1501 to 1503, inclusive, and perform functions similar to those of relay 1513. Any relay, such as relay 1519, 1520 or 1521, when operated under control of its associated horizontal group relay over a circuit similar to that described for the operation of relay 1513, closes the circuits from the armatures of the ten secondary line switch hold magnets, one on each of the ten secondary line switches, which are associated with the vertical

rows of contacts to which the ten line links, similar to line link 1409, extending from that particular horizontal primary switch group, are connected.

The armatures of crosspoints 1410, which represent one horizontal row of contacts on one secondary line switch, connect to a district trunk such as shown in Fig. 17 over conductors 1434 to 1437, inclusive. The two upper armatures of crosspoints 1410 also connect, over conductors 1434 and 1435, together with conductors 1700 to 1704, inclusive, of the associated district trunk, to one vertical row of contacts, represented by the contacts of crosspoints 1800 of one of ten primary sender selector switches. The other nine horizontal rows of contacts (not shown) of the same secondary line switch connect to nine other district trunks (not shown) and, together with these district trunks, connect to nine other vertical contact rows of the same primary sender selector switch in which crosspoints 1800 appear. The ten horizontal rows of contacts of another of the ten secondary line switches connect to ten other district trunks located on the same district frame and, together with these district trunks, connect to the vertical rows of contacts of another primary sender selector switch. The corresponding horizontal rows of contacts of the two primary sender selector switches associated with the two groups of ten district trunks located on the same district frame are multipled together and extend, over ten sender links such as sender link 1801, to one vertical row of contacts in each half of the five secondary sender selector switches. In a similar manner the eight remaining secondary line switches (not shown) of the line switch group are arranged in pairs, the ten horizontal contact rows of each pair connecting to two groups of ten district trunks each, the district trunks to which each pair of secondary line switches extend being located on one of four other district frames. The horizontal contact rows of these eight remaining secondary line switches also connect, together with their associated district trunks, to the vertical contact rows of primary sender selector switches of four other sender selector circuits.

Since each of the five pairs of secondary line switches connects to groups of district trunks on separate frames, there are five district frames, two groups of ten district trunks of each frame serving the same line switch group. The remaining eight groups of ten district trunks of each district frame serve some other four line switch groups. The line switch group having access to district trunks located on five different district frames, the five sender selector circuits associated with these district frames are all caused to function simultaneously in connection with the selection of the particular district trunk to which the calling line is to be connected. For this purpose the line switch control circuit start relay 1511 is provided with four additional front contacts and armatures, the front contacts being connected to ground and the armatures extending over conductors, corresponding to conductor 1512, to the windings of the start relays, corresponding to relay 1900, of each of the other four sender selector circuits (not shown). All five sender selector circuits function simultaneously in an identical manner to the point where the line switch control circuit prefers a particular group of district trunks in which to place its call as will hereinafter be set forth.

Each sender selector control circuit is provided with five group circuits, one for each of the groups of twenty district trunks serving a particular line switch group. One of these group circuits, consisting of relays 1803 to 1806, inclusive, is shown and is associated with that group of twenty district trunks in which the trunk shown in Fig. 17 is located. The four other similar group circuits (not shown) are associated with the four other groups of twenty district trunks which are located on the same district frame served by this sender selector circuit but which connect to the secondary line switches of four other line groups.

As hereinbefore set forth in the general description, each sender selector circuit is provided with five secondary sender selector switches, one half of each of which has ten horizontal rows of contacts which in turn connect to ten senders. There are ten group busy relays, four of which, relays 1901 to 1904, inclusive, are shown. Should all ten senders of a particular group be busy simultaneously or should the entire group of senders be removed from service for maintenance purposes, the group busy relay associated with that particular sender group operates as will hereinafter be described.

The operation of relay 1513 having connected the armatures of the ten secondary line switch hold magnets associated with the ten line links to which the primary line switch horizontal group containing the calling line has access, to the right windings of ten relays, such as relays 1514 to 1518, inclusive, and the operation of the line switch control circuit start relay 1511 having operated the five sender selector control circuit start relays, such as relay 1900 and four similar relays, the sender selector circuits are now ready to test the ten groups of district trunks to which the horizontal rows of contacts of the ten secondary line switches, accessible over the ten aforementioned line links, are connected, to determine and thereupon inform the line switch control circuit which of these groups of district trunks contain one or more idle trunks and have simultaneously at least one path over an idle sender link, such as link 1801, to an idle sender circuit. Should more than one group of district trunks satisfy these aforementioned tests, the line switch control circuit, upon receiving this information, prefers one of the groups, causes the other line groups associated with the district frame containing the preferred group of trunks to be locked out of the sender selector circuit, and removes the test from the groups of district trunks located on the other four district frames. The manner in which these tests and selections are made in one of the sender selector circuits is set forth in detail in the succeeding paragraphs.

The right end of the right winding of relay 1514 connects over the outer armature and back contact of relay 1522 and over conductor 1523 to the front contact of relay 1806. The right end of the right winding of relay 1516 connects over the next-to-outer back contact of relay 1522 and over conductor 1524 to the armature of relay 1803. The right end of the right windings of relays 1517 and 1518 connect over the next-to-inner and the inner back contacts respectively of relay 1525 and over conductors 1526 and 1527, respectively, to the front contact and to the armature respectively of relays (not shown) which correspond to relays 1806 and 1803 and which are associated with a sender selector con-

trol circuit serving some other district frame. In a similar manner, as indicated by the partially shown conductors at the lower three armatures and back contacts of relay 1522 and the upper three armatures and back contacts of relay 1525, the right windings of the other six relays (not shown) which are similar to relays 1514 to 1518, inclusive, connect to relays which correspond to relays 1803 and 1806 of the sender selector control circuits associated with three other district frames.

One side of the windings of relays 1804 and 1805 are connected together and extend, through the normally closed contacts of jack 1807, over conductor 1808 and over the next-to-inner front contact of relay 1900 to the upper outer back contact of each of the ten sender group busy relays such as relays 1901 to 1904, inclusive. As hereinbefore set forth, each sender selector control circuit has five group circuits composed of relays, such as relays 1803 to 1806, inclusive, one for each of the five groups of twenty trunks on the district frame which it serves. The windings of each of the other four pairs of relays (not shown) corresponding to relays 1804 and 1805, are similarly connected together and extend over one of four additional armatures and front contacts of relay 1900, as indicated by the inner armature and front contact, to one of four additional upper back contacts of the sender group busy relays 1901 to 1904, inclusive, as indicated by the upper inner back contact and armature of these relays. The upper outer armature of relay 1901 connects over conductor 1905 to the armature of sender selector secondary switch hold magnet 1809 which is associated with that row of secondary switch contacts to which sender link 1801 is connected. The other four upper armatures of relay 1901, one of which is shown, together with the five upper armatures of relay 1902, connect over the partially indicated conductors extending from them, to the armatures of nine other sender selector secondary switch hold magnets, similar to magnet 1809, which are associated with the rows of secondary switch contacts to which nine other sender links are connected. The ten upper armatures of each of the other four pairs of sender group relays, similar to relays 1901 and 1902, such as the pair consisting of relays 1903 and 1904, connect to the armatures of ten other sender selector secondary switch hold magnets, similar to hold magnet 1809, one on each half of each of the secondary sender selector switches.

Assuming now that sender link 1801 is not in use and that its associated sender selector secondary switch hold magnet 1809 is therefore not operated, ground over the inner back contact and armature of hold magnet 1809 is connected to the windings of relays 1804 and 1805 over a previously traced circuit. Any other unoperated sender selector secondary switch hold magnet associated with an idle sender link extending from the same sender selector primary switch also connects ground, over identical circuits, to the windings of relays 1804 and 1805. Similarly, unoperated sender selector secondary switch hold magnets associated with sender links extending from other sender selector primary switches connect ground to the windings of relays corresponding to relays 1804 and 1805 which are associated with other groups of district trunks connecting to other primary sender selector switches and therefore having access to these other sender links.

District group has more than one idle trunk

The windings of relays 1805 and 1806 are connected in series and connect to ten resistances, such as resistance 1810, six of which are shown. The other side of each of these resistances is associated with one of the ten district trunks which connect to the same sender selector primary switch. For example, resistance 1810 connects over the back contact of sender selector primary switch hold magnet 1811 and over conductor 1704, over the normally closed contacts of jack 1705, lower inner back contact of relay 1706, lower outer back contact of relay 1707, to battery through resistance 1708. The other nine resistances connect over conductors, such as 1812 to 1814, inclusive, over the back contacts of the other nine hold magnets of the same primary sender selector switch, to battery in each of nine other district trunks over circuits similar to that just traced for resistance 1810. The windings of relays 1803 and 1804 are also connected in series and connect, over conductor 1815, to ten resistances (not shown) each of which extends through the lower contact of a primary sender selector switch hold magnet, similar to magnet 1811, to one of ten other district trunks. Each idle district trunk of the group, since its relays 1706 and 1707 are unoperated, supplies battery over the previously traced circuit to one of the ten resistances, such as resistance 1810, associated with that group of districts. Relays 1803 and 1806 have marginal operating characteristics and will receive sufficient operating current only if two or more district trunks of a group are idle and supply battery to their respective resistances. Relays 1804 and 1805, however, receive sufficient operating current if only one district trunk of a group is idle. Assuming now that the district trunk shown in Fig. 17, as well as some other trunk in the same group, is idle, both relays 1805 and 1806 operate. Relay 1806, in operating, closes a circuit from battery through resistance 1817, over its front contact and over conductor 1523 to the right winding of relay 1514. Relay 1805 in operating, closes a circuit from battery through resistance 1816 and over its right front contact and conductor 1818, to the outer front contact of relay 1522. Should only one district trunk be idle, relay 1805 operates but relay 1806 does not since it receives an insufficient flow of current through its winding. In the event that none of the district trunks of the group are idle, neither relay 1805 nor relay 1806 will operate since there is no battery connected to any of the resistances such as resistance 1810. Relays 1803 and 1804 operate over a circuit similar to that described for relays 1806 and 1805, respectively, both relays operating if two or more of their associated district trunks are idle, but only relay 1804 operating if but one district trunk is idle. Relay 1804, if operating, connects battery through resistance 1819, over its left front contact, and over conductor 1829 to the next-to-outer front contact of relay 1522. Relay 1803, if operating, connects battery through resistance 1828, over its front contact, over conductor 1524, over the next-to-outer back contact of relay 1522, to the right winding of relay 1516.

Since the operating ground for relays 1803 to 1806, inclusive, is obtained over the armatures and back contacts of the sender selector secondary switch hold magnets, such as magnet 1809, which are associated with the ten sender links, such as link 1801, to which the two groups of

district trunks with which relays 1803 to 1806, inclusive, are associated connect, relays 1803 to 1806, inclusive, cannot operate unless there is at least one sender selector secondary switch hold magnet unoperated and thereby signifies that its associated sender link is idle. In addition, each of the circuits for supplying an operating ground to relays 1803 to 1806, inclusive, from the armature of a hold magnet on each of the sender selector secondary switches extends over a corresponding upper armature and back contact of one of the ten sender group busy relays such as relays 1901 to 1904, inclusive. Taking sender group busy relay 1901, for example, should all ten senders of the group associated therewith be busy simultaneously, the last sender of the group, in a manner which will be set forth in detail under the description of the operation of the sender, causes a ground to be connected to conductor 1906. This ground operates relay 1901 in a direct circuit to battery through the winding of that relay. Relay 1901 will also operate upon the connection of ground to conductor 1906 by the insertion of a plug (not shown) into jack 1907 which is done if it is desired to remove the particular sender group from service for maintenance reasons. With relay 1901 operated under either of the above conditions the operating path for relays 1803 to 1806, inclusive, to the armatures of the sender selector secondary switch hold magnets associated with the sender links having access to the group of senders associated with relay 1901, is opened and is ineffective even though the particular sender link is idle at that time.

From the foregoing description it may therefore be seen that a sender selector group relay, such as relay 1806, can only operate and connect battery to the right winding of its associated line switch group relay, such as relay 1514, when all of three separate test conditions are satisfied, namely, that at least one district trunk of the group with which that sender selector group relay is associated, is idle, and that there is at least one available idle sender link, such as link 1801, which extends from the primary sender selector switch to which the group of district trunks connect to a sender selector secondary switch which in turn has access to an idle sender at that time.

Operations similar to those set forth in the preceding paragraphs take place simultaneously in the other four sender selector circuits associated with the other four district frames to which the horizontal rows of contacts of each of the other four pairs of secondary line switches of the line switch group are connected.

As hereinbefore set forth, the operation of relay 1513, closed circuits previously traced from the left end of the right windings of ten relays such as relays 1514 to 1518, inclusive, to the armatures of the ten secondary line switch hold magnets such as magnet 1433, associated with the ten line links extending from the primary line switch group containing the calling line. Assuming that line link 1409 is idle, relay 1514 operates through its right winding from ground over the back contact of secondary line switch hold magnet 1433 to battery over the right front contact of relay 1806 over previously traced circuits. Similarly, any of the other nine relays, of which relays 1516 to 1518, inclusive, are shown, will also operate if the secondary line switch hold magnet to which one side of their right windings connect is idle and if battery is connected to the other side of their right windings from an operated sender selector group relay such as relay 1803, or relays corresponding to relays 1803 or 1806, of the sender selector control circuits associated with other district frames.

Relays 1528 and 1530 are two of five relays one of which is associated with each pair of line switch group relays such as relays 1514 and 1516 and relays 1517 and 1518, respectively. The line switch control circuits of other groups of line switches having access to the same district frames also have five relays corresponding to relays 1528 to 1530. Partially shown relay 1531 represents a relay corresponding to relay 1528 of some other line switch control circuit. Conductor 1532 represents the continuation of the chain circuit extending over the normally closed contacts of the make-before-break springs of relays 1528 and 1531 to the identical contacts and windings, of relays similar to relay 1531, in the other line switch control circuits whose secondary line switches have access to the same group of district trunks. In a like manner the other four relays of each line switch control circuit which are similar to relay 1528, such as relay 1530, are also connected in a chain circuit (not shown) with the corresponding relay of the other line switch control circuits the secondary switches of which have access to the same district trunk group.

Upon the operation of relay 1514, previously assumed, a circuit is closed from battery through resistance 1529, right outer front contact of relay 1500, left outer front contact of relay 1514, to ground through the winding of relay 1528 which operates. The operating circuits for relays 1528 and 1530 and the three other similar relays (not shown) of each line switch control circuit extend in a chain circuit over the left outer front and back contacts and armatures of the relays such as relays 1514 to 1518 inclusive, in such a manner that one relay such as relay 1528 or 1530 can operate at any one time regardless of the number of relays such as relays 1514 to 1518, inclusive, which may operate simultaneously. In addition, this chain circuit provides a preference as to which relay, such as relays 1528 and 1530, operates, the particular relay preferred depending upon the horizontal group in which the calling line appears. For illustration, since the calling line is assumed to be located in the horizontal line group with which relay 1500 is associated, relay 1500 operated and upon the subsequent operation of relay 1514 the preferred relay 1528 operates over the circuit just previously traced regardless of whether or not other relays, such as relays 1517 and 1518 are also operated at this time. Assuming that both relays 1514 and 1517 are operated, relay 1530 cannot operate since its operating circuit is open at the left back contact of relay 1514. Had relay 1517 alone operated and not delay 1514, relay 1528 which is normally preferred by relay 1500 cannot operate since both relays 1514 and 1516 are unoperated. In this instance relay 1530 would operate in a circuit from ground through its winding, left outer front contact of relay 1517, left outer back contacts of relays 1518 and 1514, right outer front contact of relay 1500, to battery through resistance 1529. In this manner a particular horizontal group relay such as relay 1500 prefers a particular relay such as relay 1528 but, should the operating path thereto be incomplete due to the failure of relay 1514 to operate, will cause the operation of some other relay,

such as relay 1530, provided some other relay, such as relay 1517, is operated indicating available idle district trunks in the group with which it is associated.

Relay 1528, in operating, removes the ground over its back contact from the aforementioned chain circuit extending through corresponding relays of other line groups thereby preventing the possible operation of a relay, such as relay 1531, of some other line switch control circuit whose associated secondary line switches extend to the same twenty district trunks as the secondary line switches with which relays 1514 and 1516 are associated. The operation of relay 1528 also closes a circuit from ground over its inner front contact, over conductor 1533, through the left winding of relay 1908, to battery over the right back contact of relay 1909, thereby operating relay 1908. There are four other relays similar to relay 1908, one of which, relay 1910, is shown. The left windings of each of these other four relays, such as relay 1910, connect to the inner front contact of one of the other four relays, such as relays 1528 or 1530 of some other line switch control circuit. Any or all of these five relays, such as relays 1908 and 1910, may operate at the same time depending upon whether or not the relays such as relays 1528 and 1530 of other line switch control circuits are operated at this same time. The locking and holding circuit through the right windings of relays 1908 and 1910 and the three similar relays (not shown) extends over a chain circuit through the back contacts of the first four relays, such as relay 1910, to battery through the winding of relay 1909. In the event that more than one of the relays 1908 and 1910 operate, only one will lock since it opens the holding circuit for the others. For example, should both relays 1908 and 1910 operate, only relay 1910 will lock since the locking circuit for relay 1908 is open at the right inner back contact of relay 1910. It will be assumed for this description, however, that only relay 1908 operates over the circuit hereinbefore set forth. Relay 1908, in operating, locks from ground on conductor 1533, through its right winding and over its right inner front contact, over the right inner back contact of the other four similar relays, such as represented by relay 1910, to battery through the winding of relay 1909 which operates. Assuming that relay 1901 is the only unoperated sender group busy relay at this time, relay 1909, in operating, closes a circuit from ground over the inner back contact and armature of sender selector secondary switch hold magnet 1809 which is associated with idle sender link 1801, over conductor 1905, upper outer back contact of relay 1901, right outer front contact of relay 1908, right outer back contact of the other four relays such as relay 1910, left outer front contact of relay 1909, left outer back contacts of relays such as relay 1910, left outer front contact of relay 1908, conductor 1911, an outer front contact of relay 1528, to the left winding of all of the line switch control circuit group relays 1514 to 1518, inclusive, and to battery through the winding of relay 1508 which operates. Relay 1514 locks from this ground just traced, through its left winding and left inner front contact, over the right inner front contact of relay 1513, to battery through resistance 1534. Relay 1508, in operating, opens the operating circuit through the right windings of relays 1514 to 1518, inclusive, and closes an obvious circuit for operating relay 1535. Upon the opening of their operating circuits, any of the relays 1516 to 1518, inclusive, which may have been operated, release since the locking circuit through their left windings is opened due to relays 1519 to 1521 being unoperated. The operation of relay 1508 also opens the locking circuit of relay 1511 which releases. Relay 1511, in releasing, releases relay 1510 and removes the ground from sender selector start conductor 1512 and from the four similar start conductors (not shown) which extend to the other four sender selector circuits. Start relay 1900 remains locked operated in a circuit from battery through its winding, over the back contact of relay 1921, its own next-to-outer front contact, right outer back contact of relay 1910, right outer front contact of relay 1908, upper outer back contact of relay 1901, conductor 1905, to ground over the back contact of the sender selector secondary switch hold magnet 1809. The start relays, corresponding to relay 1900, of the other four sender selector circuits release, however, since their group relays, corresponding to relay 1908, remain unoperated due to the fact that only relay 1528 and no other similar relay of the same line switch control circuit, such as relay 1530, is operated. The release of these other four sender selector start relays removes the test from the district groups with which they are associated and these sender selector circuits are therefore restored to normal. With relays 1535 and 1514 operated, a circuit is completed from ground over the lower front contact of relay 1535, the right inner front contact of relay 1514, and over conductor 1536 to the sender selector control circuit to inform that circuit which group of ten district trunks has been chosen by the line link control circuit. The operation of the sender selector control circuit upon the placing of ground on conductor 1536 will later be set forth in detail.

District group has only one idle trunk

In the foregoing description it was assumed that in the group of ten district trunks with which relays 1805 and 1806 are associated there was more than one idle district trunk having an available path to an idle sender. Both relays 1805 and 1806 therefore operated, and relay 1806 connected battery to conductor 1523 to operate relay 1514 in the manner hereinbefore set forth. Let it now be assumed instead that at the time that the district trunk groups accessible over the secondary line switches of the line group containing the calling line are tested for idle trunks none of these district groups has more than one idle trunk. In this instance, since at least two idle district trunks per group are necessary to provide a sufficient flow of current for operating their associated marginal sender selector group circuit relays, neither relay 1803 nor relay 1806, nor the corresponding relays of the group circuits of the other sender selector control circuits associated with the other district frames, operate. None of the relays 1514 to 1518, inclusive, therefore operate at this time since there is no battery on conductors 1523, 1524, 1526, and 1527. Although no district group has two idle trunks, let it be assumed further, for illustration, that one trunk is available in each of the groups with which relays 1803 to 1806, inclusive, are associated. Relays 1804 and 1805 therefore operate, but relays 1803 and 1806 do not. Relays 1804 and 1805, in operating, place a battery potential on

the outer and the next-to-outer front contacts of relay 1522 over previously traced circuits. In addition, relay 1509 operates in a circuit from battery through its winding, over the upper middle front contact of relay 1511, over conductor 1537, to a ground supplied jointly, in this instance, over the right inner front contact of relay 1804 and the left outer front contact of relay 1805. Should group relays corresponding to relays 1804 and 1805, of sender selector circuits associated with other district frames also operate at this time due to finding one idle trunk in their associated district group, they also connect ground to conductor 1537, as indicated by the extended conductor 1830 and multiple strap 1831. Relay 1509, in operating, opens the circuit through the winding of relay 1510 which releases. Upon the release of relay 1510, relays 1522 and 1525 operate from battery through their windings in multiple, over the lower back contact of relay 1510, front contact of relay 1509, outer back contact of relay 1508, conductor 1432, upper front contact of relay 1406, upper inner front contact of relay 1412, inner front contact of relay 1405, to ground over the inner front contact of line relay 1401. Relays 1522 and 1525, in operating, transfer the right end of the right windings of each of the ten relays such as relays 1514 to 1518, inclusive, from the conductors extending to the armatures and front contacts, respectively, of marginal relays 1803 to 1806 and of the corresponding marginal relays of the sender selector circuits associated with the other district frames to which the same line group secondary line switches have access, to the left armatures and right front contacts, respectively, of relays 1804 and 1805 and of the corresponding relays of the other sender selector control circuits. Assuming that line link 1409 is idle, secondary line switch hold magnet 1433 therefore being unoperated, relay 1514 operates in a circuit from ground over the back contact of magnet 1433, over conductor 1515, right middle front contact of relay 1513, middle back contact of relay 1508, right winding of relay 1514, outer front contact of relay 1522, conductor 1818, right front contact of relay 1805, to battery through resistance 1816. Similarly, any of the other relays, such as relays 1516 to 1518, inclusive, whose associated secondary line switch hold magnet is unoperated indicating an idle line link, and to whose right winding a battery potential is connected by an operated sender selector group relay such as relay 1804 or 1805, or a relay corresponding thereto, also operates. Relay 1514, in operating, functions in the manner previously described, operating relay 1528 which in turn operates relays 1908 and 1909. Relay 1508 which operates under control of relay 1908 opens the circuit through the right windings of relays 1516 to 1518, any or all of which, if operated, release. Relay 1508, in operating, also operates relay 1535 which in turn causes the release of relays 1511 and 1509 in that order, and connects ground to conductor 1536, the function of which will shortly be described. Relay 1509, in releasing, releases relays 1522 and 1525. Relay 1509 is of the slow-to-operate type and relay 1510 is of the slow-to-release type and provide a sufficient delay interval before closing the operating circuit for relays 1522 and 1525, to allow the line group relays, such as relays 1514 to 1518, inclusive, to operate over their regular circuits which extend over the back contacts of relays 1522 and 1525 to the armatures and contacts of the marginal sender selector group relays such as relays 1803 and 1806 which, if operated, indicate more than one idle district trunk, before transferring the right windings of relays 1514 to 1518, inclusive, to their reserve circuits extending over the front contacts of relays 1522 and 1525 to the armatures and contacts of relays such as relays 1804 and 1805, which, if operated alone, indicate only one idle district trunk. For example, the operating circuit for relay 1509 is closed over conductor 1537 from the left outer front contact of relay 1805 whether relay 1805 operates alone upon finding only one idle district trunk, or whether relays 1805 and 1806 both operate due to several district trunks being idle. Where both relays 1805 and 1806 operate, the call is to be placed in that group of district trunks and it is therefore not desired to operate relays 1522 and 1525. Relay 1514, upon operating over its regular circuit over the outer back contact of relay 1522 and conductor 1523 to battery over the front contact of relay 1806, as hereinbefore set forth in the first illustration covering the instance where group relays 1805 and 1806 both operated upon finding several of their associated district trunks idle, operated relay 1528. Relay 1528 operated relays 1908 and 1909 which in turn returned a ground over conductor 1911 thereby locking relay 1514 and operating relay 1508, as previously described. Relay 1508, upon operating, removes the ground supplied over conductor 1432 and its outer back contact, from the armatures of relays 1509 and 1511 before the slow-to-operate relay 1509 and the slow-to-release relay 1510 can function to complete the operating circuits for relays 1522 and 1525.

The operation of relays 1514 and 1535, under either of the conditions set forth in the preceding paragraphs, causes the operation of primary line switch select magnet 1427 in a circuit which may be traced from ground through the winding of that magnet, over the outer front contact of relay 1419, conductor 1438, right outer front contact of relay 1514, upper inner front contact of relay 1535, conductor 1538, to battery over the lower outer back contact of relay 1411.

Repeated trials by line-switch control circuit

As previously set forth, relays 1508 and 1514 are held operated over conductor 1911 by a ground supplied over a circuit extending over the upper outer back contact of relay 1901, which is assumed to be the only unoperated sender group busy relay at this time. Since all sender selector circuits have access to all sender groups some other sender selector circuit or circuits, functioning slightly earlier in connection with some other call or calls, may select the only remaining idle senders of the group associated with relay 1901 before the sender selector circuit whose operation is being described can function to select an idle sender for itself in a manner which will be set forth later. Under this condition the sender group busy relay 1901 operates and opens the ground from conductor 1911 thereby releasing relays 1508 and 1514 of the line switch control circuit and also opening the holding circuit for the sender selector start relay 1900 which also releases. The release of relay 1514 releases relay 1528 which, in turn, removes the ground from conductor 1533 thereby releasing relays 1908 and 1909 and restoring the sender selector circuit to its normal condition. The release of relay 1508 again closes the circuits to the right windings of relays 1514 to 1518 inclusive, and also releases

relay 1535. Relay 1508, in releasing, also again operates relay 1510 over a previously traced circuit. The operation of relay 1510 again operates relay 1511 which connects ground to the sender selector start conductor 1512 as well as to four similar start conductors (not shown) which extend to four other sender selector circuits. The line switch and sender selector circuits function from this point in a manner identical with that described for their original operation, the same or one of the other four sender selector circuits being selected, depending upon the conditions encountered during the testing of the various district trunk groups.

The winding of secondary line switch select magnet 1439, in multiple with the winding of the corresponding select magnet (not shown) of the other secondary line switch connecting to the same two groups of district trunks as indicated by multiple strap 1441, connects over conductor 1440, the outer front contact of relay 1528, and over conductor 1539 to the upper outer front contact of relay 1832. Similarly, the windings of the other nine select magnets (not shown) of the same secondary line switch on which select magnet 1439 is located also connect, in multiple with the corresponding select magnets of the other secondary line switch, over nine other conductors such as conductor 1442, over nine other front contacts of relay 1528, such as the next-to-outer front contact, and over nine other conductors such as conductor 1540, to nine other upper front contacts, such as the inner front contact, of relay 1832. Each of the ten upper armatures of relay 1832, two of which are shown, connect over conductors such as 1833 and 1834 to the right inner front contact of one of ten district selecting relays, four of which, relays 2100 to 2103, are shown. The back contacts of each of the ten sender selector secondary switch hold magnets, such as magnet 1809, which are associated with the ten sender links, such as link 1801, to which the chosen group of district trunks has access, connect to one of ten lower armatures, four of which are shown, of relay 1832. The lower inner front contact of relay 1832 connects to the left end of the right winding of a sender group relay 1913, which is associated with that group of senders which connect to the sender selector secondary switch on which hold magnet 1809 is located, over a circuit extending over conductor 1835, over the lower back contact of sender group busy relay 1901 which is also associated with the same group of senders, over the outer back contact of relay 1917, to the right winding of relay 1913. The other nine lower front contacts of relay 1832, three of which are shown, connect to the right windings of nine other sender group relays, such as relays 1914 to 1916, inclusive, over similar circuits but in each case extending over the lower back contact of the particular sender group busy relay, such as relays 1902 to 1904, inclusive, which is associated with the group of senders connecting to the other sender selector secondary switches.

When relays 1908 and 1909 operated, as hereinbefore set forth, the same ground previously traced to conductor 1911 also caused relay 1832 to operate in a circuit over the left inner front contact of relay 1908, over conductor 1912, to battery through the winding of relay 1832. Relay 1832, in operating, connected the windings of the secondary line switch select magnets, such as magnet 1439, to the right inner front contacts of relays 2100 to 2103, inclusive, and connected the back contacts of the sender selector secondary switch hold magnets, such as magnet 1809, to the right windings of sender group relays 1913 to 1916, inclusive, over circuits which have just previously been traced.

When relay 1900 operated initially it closed a circuit from battery through resistance 1918, over its left outer front contact, conductor 1919, winding of relay 1600, to ground over the lower back contact of relay 1601. Relay 1600 operated over this circuit and closed the circuit from ground over its upper front contact, over conductor 1602, left back contact of relay 2104, conductor 2105, to battery through the winding of relay 1920 which operated. When relay 1909 operated in series with the right winding of relay 1908, as previously described, it caused relay 1921 to operate in a circuit from battery through the winding of that relay, over the left front contact of relay 1920, right front contact of relay 1909, to the previously traced ground on conductor 1602. In addition, the operation of relay 1909 also connected direct battery over its left inner front contact to conductor 1919 thereby holding relay 1600 operated independently of the control of relay 1900. Relay 1921, in operating, locks over its inner front contact to ground on conductor 1602, opens the circuit to the winding of relay 1900 which releases, and connects ground over its middle front contact and over conductor 1922 to the common point of the resistances, such as resistance 1810, which are associated with the ten district trunks of the chosen group. Relay 1900, in releasing, opens one side of the operating circuit for relays 1803 to 1806 inclusive, as well as for the other four corresponding sets of group relays associated with this sender selector circuit, and, since none of these relays can now operate, causes this sender selector circuit to test busy at this time to all line link circuits which have access to it.

Trunks of district group tested

The sender selector control circuit is provided with ten district group relays, four of which, relays 2106 to 2109 inclusive, are shown. The function of these district group relays is to connect a test conductor from each of the ten district trunks with which they are associated to the right windings of each of the ten district selecting relays 2100 to 2103 inclusive. At the time that relays 1514 and 1535 operated, upon the selection of the particular group of district trunks in which the call is to be placed, a ground was connected to conductor 1536 as hereinbefore set forth. This ground connects over conductor 1536 to the winding of district group relay 2106 which is associated with the selected group of district trunks. When relay 1900 releases, as aforementioned, a circuit is completed from battery through resistance 1918, over the back contact of relay 1900, over conductor 2110, and through the winding of relay 2106 to ground on conductor 1536, thereby causing relay 2106 to operate. Relay 2106, in operating, closes ten test conductors, one from each of the ten district trunks of the group with which it is associated, over its ten upper front contacts and armatures, two of which are shown, to the upper end of the right windings of the district selecting relays 2100 to 2103, inclusive. Any or all of relays 2100 to 2103, inclusive, operate if the district trunk with which they are associated at this time is idle. For illustration, assuming that the district trunk shown in Fig. 17 is idle, district selecting relay 2100 operates over a circuit from battery through resistance 1708,

lower outer back contact of relay 1707, lower inner back contact of relay 1706, normally closed contacts of jack 1705, conductor 1704, back contact of sender selector primary switch hold magnet 1811, conductor 1836, upper outer front contact of relay 2106, right winding of relay 2100, to ground over the left inner back contact of relay 2104. Relay 2106, upon its previous operation, operated relay 2111 in a local circuit. Relay 2100, in operating locks over a circuit from battery through the winding of relay 2104, left winding and left front contact of relay 2100, inner front contact of relay 2111, conductor 2112, to ground over the next to inner front contact of relay 1528. Relay 2104 operates in series with the left winding of relay 2100 and removes the operating ground from the right windings of relays 2100 to 2103, inclusive, thereby releasing any operated relays 2101 to 2103, inclusive, relay 2100 remaining locked over the circuit just traced. Relay 2104, in operating, also operates relay 2113 in a local circuit. Relay 2113, in operating, completes a circuit from battery over its front contact, over the right inner back contacts of relays 2103, 2102 and 2101, right inner front contact of relay 2100, conductor 1833, upper outer front contact of relay 1832, conductor 1539, outer front contact of relay 1528, conductor 1440, to ground through the winding of secondary line switch select magnet 1439 which operates.

As previously set forth, the operation of relay 1832, connects the back contacts of ten sender selector secondary switch hold magnets, such as magnet 1809, to one end of the right windings of ten sender group relays, such as relays 1913 to 1916, inclusive. The other side of the right winding of relay 1913 is connected over the inner armature and back contact of relay 1923 and over the lower outer back contact of relay 1925 to the front contact of relay 1926. The other side of the right windings of the other nine sender group relays, such as relays 1914 to 1916, inclusive, connect over other armatures and back contacts of relays 1923 and 1924, over the lower outer back contacts of nine other relays corresponding to relay 1925, to the front contact of nine other relays corresponding to relay 1926, there being two relays, such as 1925 and 1926 associated with each group of ten senders.

Senders tested

When relay 1600 previously operated, it connected ground over its lower front contact and over conductor 1603 to the winding of relay 1926 and to the windings of the corresponding relays of other sender groups as indicated by multiple strap 1927. The other side of the winding of each relay, such as relay 1926, connects, over the upper armatures and back contacts of a relay, such as relay 1925, to one end of the right windings of ten sender selecting relays, four of which, relays 1928 to 1931, are shown, one of which is associated with each sender of the group. Any sender which is idle connects battery to the other end of the right winding of its associated selecting relay, over conductors, such as 1932 and 1933. The manner in which the sender returns this battery to the sender selector circuit will be described in detail under the operation of the sender. With ground connected to its winding over conductor 1603, relay 1926 will operate if two or more relays, such as relays 1928 to 1931 inclusive, have battery connected to their right windings by associated idle senders. Should only one sender of the group be idle and therefore battery connected to the right winding of only one of the sender selecting relays of the group, relay 1926 will not receive sufficient current to operate. Similarly, relays corresponding to relay 1926, of other sender groups, will also operate if two or more senders of the sender group with which they are associated are idle. Assuming that two senders of the group with which relay 1926 is associated are idle, relay 1926 operates and connects battery over its front contact and over a previously traced circuit to the right winding of sender group relay 1913. Any other relay corresponding to relay 1926 which may operate, similarly connects battery to the right winding of one of the other sender group relays, such as relays 1914 to 1916 inclusive. Should none of the ten groups of senders have at least two idle senders, none of the group test relays, such as relay 1926, will operate and there will therefore be no battery connected to the right winding of any of the sender group relays 1913 to 1916, inclusive. Relay 2104, previously operating at the completion of the selection of a particular district trunk opened the circuit over its left back contact to the winding of relay 1920. Relay 1920, which is of the slow-to-release type, releases after an interval, and closes a circuit from ground over the right front contact of relay 2104, over conductor 2114, right back contact of relay 1920, to battery through the windings of relay 1923 and 1924 in parallel, thereby operating both relays 1923 and 1924. Relays 1923 and 1924, in operating, transfer the right end of the right windings of the sender group relays 1913 to 1916 inclusive, from the contacts of the relays, such as relay 1926, to the lower inner back contacts of the relays, such as relay 1925. Unless held busy by some other sender selector circuit, as will be brought out in subsequent paragraphs, the relays, such as relay 1925, will be unoperated and therefore connect battery over their lower inner back contacts, and a front contact of relay 1923 or 1924 as the case may be, to the right windings of relays 1913 to 1916, inclusive. The battery supplied over the back contact of relay 1925 in this latter instance merely indicates that the associated group of senders is not being held busy by some other sender selector circuit but does not indicate that there are any idle senders in that group. Should all senders in that particular group be busy at that time, the group busy relay 1901 will be operated, as previously explained, and by the opening of its lower back contact, renders the operating circuit through the right winding of the sender group relay, such as relay 1913, ineffective even though battery is connected to the other side of that winding. The interval introduced by the slow release characteristic of relay 1920 is provided to allow sufficient time for any of the sender group relays 1913 to 1916 inclusive, to operate over their regular paths extending to the front contacts of relays, such as relay 1926, before transferring their right windings to the reserve path extending to the lower inner back contacts of relays, such as relay 1925, by the operation of relays 1923 and 1924.

Assuming now that relay 1926 operates, signifying at least two idle senders in its associated sender group, relay 1913 operates in a circuit from ground over the back contact of sender selector secondary switch hold magnet 1809 which is unoperated since it was previously assumed that its associated sender link 1801 is idle, over the lower inner front contact of relay 1832, conductor 1835, lower back contact of sender group

busy relay 1901 which is unoperated since it is assumed that there are at least two idle senders in its associated group, over the outer back contact of relay 1917, right winding of relay 1913, inner back contact of relay 1923, which, together with relay 1924, is still unoperated since relay 1920 has not yet had time to release, and over the lower outer back contact of relay 1925, to battery over the front contact of relay 1926. Other sender group relays, such as relays 1914 to 1916 inclusive, may also operate simultaneously if conditions similar to those just described for relay 1913 obtain. Relay 1913, in operating, operates relay 1934 in a circuit which may be traced from battery over the lower outer front contact of relay 2106, conductor 2115, front contact of relay 1913, winding of relay 1934, normally closed right contacts of relays 1935 to 1937, inclusive, to ground. Relay 1934, in operating, locks to ground over its right front contact, and closes a locking circuit for relay 1913 from ground over its left inner front contact, left winding of relay 1913, to battery through the winding of relay 1917 which also operates. Relay 1917, in operating, opens the circuit to the right windings of relays 1913 to 1916, inclusive, any of which, if operated, release with the exception of relay 1913 which is locked through its left winding. Relay 1925 operates in a circuit from battery through its winding, over the left outer front contact of relay 1934, to ground over the inner front contact of relay 1917 and, since its operation opens the circuit to the winding of relay 1926 and also removes the battery from the inner front contact of relay 1923, causes the group of senders with which it is associated to test busy to all sender selector circuits.

There are nine additional relays corresponding to relay 1934, three of which, relays 1935 to 1937, inclusive, are shown, one each of which is associated with each of the ten sender group relays such as relays 1913 to 1916, inclusive. As hereinbefore set forth, at the time that relay 1913 operates, other sender group relays, such as relays 1914 to 1916, inclusive, may also operate. Regardless of the number of sender group relays which may operate, only one relay such as relay 1934 can operate at a time since the operation of the particular sender group relay, in closing the circuit for its associated relay, such as relay 1934, simultaneously opens the operating circuit for the other relays such as relays 1935 to 1937, inclusive. For example, assume that at the time that sender group relay 1913 operates, relay 1914 also operates. Relay 1914, in operating, closes a circuit from ground through the normally closed right contacts of relays 1937 and 1936, winding of relay 1935, front contact of relay 1914, conductor 1939, to the lower outer front contact of district group relay 2107 which, however, is unoperated since relay 2106 is operated. With relays 2106 and 1913 operated, relay 1934 operates to battery over conductor 2115 as hereinbefore set forth. Had relay 1913 not operated, relay 1935 instead of relay 1934 would then operate to the previously traced battery on conductor 2115, over a circuit extending over the armature and back contact of relay 1913, the back contacts of relays 1916 and 1915, respectively, and over the front contact of the operated relay 1914. In this manner a particular group of district trunks always prefers a particular group of senders although if, as has just been brought out, the preferred sender group is busy or has no idle sender as indicated by the failure of its sender group relay, such as relay 1913, to operate, any other available sender group will be used.

When relay 1925 operated upon the operation of relays 1917 and 1934, as previously described, it opened the circuit extending from ground on conductor 1603, through the winding of relay 1926, and over its upper back contact to the right windings of sender selecting relays 1928 to 1931, inclusive. With relays 1917 and 1934 operated, a circuit is closed from ground over the upper front contact of relay 1917, left middle front contact of relay 1934, to battery through the winding of relay 1938 which operates. Relay 1938, in operating, connects ground supplied over the two upper back contacts of relay 1940, over two of its front contacts, to one end of the right windings of the sender selecting relays 1928 to 1931, inclusive. Relay 1938 also operates sender selector primary switch select magnet 1837, together with the corresponding select magnet of the other sender selector primary switches, as indicated by multiple strap 1838, in a circuit from ground over its outer front contact, over conductor 1941, to battery through the windings of these magnets. The winding of sender selector secondary switch select magnet 1839, together with the windings of the corresponding select magnets of the other sender selector secondary switches, as indicated by multiple strap 1840, connect over conductor 1841 and over the next-to-outer front contact of relay 1938, to the right outer front contact of sender selecting relay 1928. Similarly, the right outer front contacts of the other sender selecting relays, such as relays 1929 to 1931, inclusive, connect over other front contacts of relay 1938, such as indicated by conductor 1942, to the windings of other corresponding select magnets of the sender selector secondary switches. Relay 1938 also closes the circuits over conductors 1943 to 1952, inclusive, the function of which will later be described under the operation of the sender.

When ground is connected to the right windings of relays 1928 to 1931, inclusive, as previously described, those relays whose associated sender is idle, operate, since battery is connected to the other end of their right windings over conductors 1932 and 1933 as hereinbefore set forth. Assuming that the sender associated with relay 1928 is idle, relay 1928 operates through its right winding and locks in a circuit from ground through its left winding and over its left front contact, a front contact of relay 1938, conductor 1953, right outer front contact of the operated district selecting relay 2100, right outer back contacts of relays 2101 to 2103, inclusive, conductor 2116, to battery through the winding of relay 1940 which operates. Relay 1940 opens the operating ground from the windings of relays 1928 to 1931, inclusive, thereby releasing any of these relays which may have operated with the exception of relay 1928 which remains locked over the circuit just traced. The locking circuit for the sender selecting relays 1928 to 1931, inclusive, is extended over a chain circuit through the left contacts and armatures of these relays in such a manner as to give preference to a particular sender in accordance with the particular chosen district trunk. For illustration, assume that relay 1931 operated at the same time as relay 1928. Relay 1931, upon its operation, closes a circuit from ground over its left winding and left front contact, over a front contact of relay 1938, over the partially shown conductor 1954, to the right outer front contact of district selecting relay 2103 as indicated by the extension of conductor 1954 which is shown con-

nected to that contact. Since relay 2100 is operated, as previously set forth, and since only one district selecting relay can operate at a time, relay 2103 is therefore unoperated and the locking circuit for relay 1931 is incomplete. Relay 1931 will release as soon as the operation of relay 1940 opens the operating circuit through its right winding. Should the sender preferred by a particular district trunk be unavailable, as indicated by the failure of its associated sender selecting relay to operate, some other available sender will be selected. For example, with district selecting relay 2100 operated, assume that sender selecting relay 1931 operates and that sender selecting relay 1928, which is associated with the sender preferred by the district trunk with which relay 2100 is associated, does not operate. Relay 1931, upon operating, locks in a circuit from ground through its left winding and over its left front contact, over the left back contact of the unoperated relay 1928, a front contact of relay 1938, to battery through the winding of relay 1940 over a previously traced circuit extending over the right outer front contact of relay 2100. Under this condition, relay 1940 would operate in series with the left winding of relay 1931 and would function in the same manner as hereinbefore set forth for its operation in series with the left winding of relay 1928.

The sender with which relay 1928 is associated having now been selected by the operation of relay 1928, as set forth in the preceding paragraph, a circuit is completed to operate the sender selector secondary switch select magnets associated with the horizontal row of contacts to which this sender is connected. This circuit may be traced from ground over the upper inner front contact of relay 1940, over the inner front contact of relay 1938, right outer back contacts of relays 1931, 1930, and 1929, right outer front contact of relay 1928, next-to-outer front contact of relay 1938, conductor 1841, to battery through the winding of select magnet 1839. As indicated by multiple strap 1840, the select magnets corresponding to magnet 1839, of the other sender selector secondary switches, also operate at this time.

Primary and secondary line switch and primary sender selector switch operated

At the time that relay 1600 operated it closed a circuit from ground over its upper front contact and over the upper back contact of relay 1601, to battery through the winding of relay 1604 which operated. When relay 1940 operated in series with sender selecting relay 1928 as an indication that sender selection was completed, it closed a circuit from ground over its lower front contact, and over conductor 1955, to battery through the winding of relay 1601 which operated. Relay 1601, in operating, closes a circuit from ground over its upper front contact, upper outer front contact of relay 1604, upper inner back contact of relay 1605, back contact of relay 1606, conductor 1607, a front contact of relay 1528, conductor 1540, upper back contacts of relays 1425 and 1424, upper front contact of relay 1423, outer front contact of relay 1416, outer front contact of relay 1405, outer front contact of line relay 1401, to battery through the winding of primary line switch hold magnet 1415 which operates. Primary line switch select magnet 1427 having previously operated upon the operation of relay 1535 at the completion of district group selection, the operation of hold magnet 1415 causes the cross-point contacts 1407 of the primary line switch to operate. Primary line switch hold magnet 1415, in operating, immediately locks over its lower front contact and armature to its previously traced operating ground. This locking circuit extends directly over the outer armature of relay 1405 and is therefore no longer under control of the outer front contact of relay 1401. Cut-off relay 1402 operates from battery through its winding to the same ground which operated magnet 1415, over the inner front contact of that magnet. Relay 1402, in operating, removes the ground, and the battery through the winding of line relay 1401, from line conductors 1404 and 1403, respectively, thereby causing line relay 1401 to release. Cross-point contacts 1407 having operated, the secondary line switch hold magnet 1433 which is associated with that vertical row of secondary line switch contacts to which line link 1409 is multipled now operates in a circuit from battery through its winding, over the next-to-bottom conductor of line link 1409, next-to-bottom operated contact of cross-points 1407, lower inner front contact of magnet 1415, to the ground which was previously traced to the winding of magnet 1415. Secondary line switch select magnet 1439 having been previously operated at the completion of district trunk selection by the operation of relays 2100 and 2113, the operation of secondary line switch hold magnet 1433 causes cross-point contacts 1410 of the secondary line switch to operate. Cross-point contacts 1410 having operated, the sender selector primary switch hold magnet 1811, which is associated with the vertical row of contacts to which the chosen district trunk connects, operates in a circuit from battery through its winding, over conductor 1700, upper outer back contact of relay 1709, lower inner back contact of relay 1707, back contact of relay 1710 in parallel with the upper outer back contact of relay 1711, over conductor 1436, next-to-bottom operated contact of cross-points 1410, to the same ground which was extended from the winding of primary line switch hold magnet 1415 to operate the secondary line switch hold magnet 1433.

Sender selector secondary switch operated

Sender selector primary switch select magnet 1837 having been previously operated by the operation of relay 1938 at the completion of sender group selection, the operation of sender selector primary switch hold magnet 1811 causes cross-point contacts 1800 to operate. Cross-point contacts 1800 having operated, the sender selector secondary switch hold magnet 1809, which is associated with the row of sender selector secondary switch contacts to which sender link 1801 is multipled, now operates in a circuit from battery through its winding, over one of the conductors of sender link 1801, and over an operated contact of cross-points 1800, to the same ground which was traced to the winding of magnet 1811. Sender selector secondary switch select magnet 1839 having been previously operated upon the operation of relays 1928 and 1940 at the completion of the selection of the particular sender, the operation of hold magnet 1809 causes cross-point contacts 1802 of the sender selector secondary switch to operate.

With cross-points 1407 and 1410 of the primary and secondary line switches, respectively, and cross-points 1800 and 1802 of the sender selector primary and secondary switches, respectively, operated, the calling subscriber's line is now ex-

tended to the district trunk and to the subscriber's sender which have been selected to handle this particular call. The line conductors 1403 and 1404 of the calling station 1400 extend over the two uppermost contacts of primary line switch cross-points 1407, over the two uppermost conductors of line link 1409, the two uppermost contacts of secondary line switch cross-points 1410, conductors 1434 and 1435, to the upper inner and upper next-to-inner front contacts of relay 1707 of the selected district trunk shown in Fig. 17, and also, over the two uppermost contacts of sender selector primary switch cross-points 1800, over the two uppermost conductors of sender link 1801, the two uppermost contacts of sender selector secondary switch cross-points 1802, and to the selected subscriber's sender over conductors 1822 and 1823. Conductors 1700 to 1704, inclusive, of the selected district trunk are extended over the four lowermost contacts of the operated sender selector primary switch cross-points 1800, over the four lowermost conductors of sender link 1801, over the four lowermost contacts of the operated sender selector secondary switch cross-points 1802 to the selected subscriber's sender over conductors 1824 to 1827, inclusive, respectively. The previous operation of relay 1938 closed conductors 1943 to 1952, inclusive, which are common to the group of senders containing the selected sender, as indicated by the multiple strap associated with each of these conductors, to various points in the line switch and sender selector control circuits. The points to which these aforementioned conductors connect, as well as the functions which they control, will later be described in detail under the operation of the sender.

Trouble conditions

Upon the operation of sender selector secondary switch cross-points 1802, the operating ground which was traced to the winding of the associated hold magnet 1809 is extended over one of the operated contacts of cross-points 1802, and over conductor 1824, to the sender circuit which functions in a manner later to be set forth and returns a ground over conductor 1950. This ground on conductor 1950 extends over a front contact of relay 1938, over conductor 1956, to battery through the upper winding of relay 1605, which operates. Relay 1605, in operating, removes the short circuit from the winding of relay 1608. Relay 1608 operates in a circuit from ground over the front contact of relay 1601, winding of relay 1608, back contact of relay 1606, conductor 1607, and over a previously traced circuit to battery through the winding of the primary line switch hold magnet 1415, which holds in series with relay 1608. Relay 1608, in operating, operates relay 1609 in a circuit from battery over the front contact of relay 1608, winding of relay 1609, to ground over the upper front contact of relay 1600. Relay 1609, in operating, closes a ground over its lower outer front contact, over the lower middle front contact of relay 1605, conductor 1610, a front contact of relay 1938, to the sender circuit over conductor 1951. This ground on conductor 1951 is an indication to the sender that the circuit over which the ground is supplied to the primary line switch hold magnet is continuous. When relay 1601 operated to close the ground to the winding of primary switch hold magnet 1415, it also opened the circuit through the winding of relay 1604 which is of the slow-to-release type. Assuming now that the circuit from ground over the upper front contact of relay 1601 to primary line switch hold magnet 1415 is open at some point, magnet 1415 fails to operate and consequently the hold magnet 1433 of the secondary line switch and hold magnets 1811 and 1809 of the sender selector primary and secondary switches, respectively, also fail to operate since the operating circuit for each of these hold magnets is extended only upon the operation of the cross-points of the preceding switch. Under this condition, since the cross-points of the switches are not closed, no ground is connected over conductor 1824 to the sender circuit and the sender, therefore, does not return a ground over conductor 1950 to operate relay 1605. Slow-to-release relay 1604 releases after an interval and operates relay 1606 in a circuit from battery over the back contact of relay 1608, winding of relay 1606, lower outer back contact of relay 1609, upper outer back contact of relay 1605, outer back contact of relay 1604, to ground over the upper front contact of relay 1601. Relay 1606, in operating, operates relay 1611 in a circuit from battery through the winding of that relay, lower front contact of relay 1606, back contact of relay 1612, to ground over the upper front contact of relay 1600. Relay 1611, in operating, locks over its inner front contact to ground over the lower outer back contact of relay 1609, upper outer back contact of relay 1605, upper outer back contact of relay 1604 and upper front contact of relay 1601. Relay 1611 also operates relay 1612 in a circuit from this locking ground on its inner armature, over its inner front contact, over the upper front contact of relay 1606, to battery through the winding of relay 1612. Relay 1612, in operating, closes a circuit from the ground just traced to its winding, over its inner and outer front contacts, outer front contact of relay 1611, conductor 1613, a front contact of relay 1528, conductor 1541, outer front contact of relay 1429, outer front contact of relay 1430, to battery through the winding of the line switch control circuit release relay 1411 which operates. Relay 1411, in operating, causes the line switch control circuit to release, in a manner which will later be described in detail, since the connection of the calling line to the district trunk and the sender cannot be established due to the failure of the primary line switch hold magnet 1415 to operate. The slow-to-release characteristic of relay 1604 introduces a sufficient delay before its closure of the operating circuit for relay 1606 to allow relays 1605, 1608 and 1609 to operate, in the manner hereinbefore set forth, should the operation of the hold magnets of the several aforementioned switches take place in the usual manner.

Should a false ground be present on the circuit extending from the upper front contact of relay 1601 to the winding of the primary line switch hold magnet 1415, the operation of the line switch and sender selector circuit proceeds to the completion of the sender selection in the regular manner as hereinbefore set forth. Upon the completion of sender selection, relay 1940 operates and closes a previously traced circuit for operating relay 1601 of the line switch control circuit. Relay 1601, in operating, connects ground to one side of the winding of relay 1608 and also connects ground over a previously traced circuit to conductor 1607. Relay 1601, in operating, also opens the circuit through the winding of the slow-to-release relay 1604. The false ground to the winding of primary line switch hold mag-

net 1415 having caused that magnet to operate before the operating circuit for select magnet 1427 was closed, the primary line switch cross-points 1407 cannot operate since it is necessary for a select magnet to operate before a hold magnet. Cross-points 1407 failing to operate, the cross-points of the secondary line switch and the sender selector primary and secondary switches cannot operate since the operating circuit for the hold magnet of these switches is under control of cross-points of the preceding switch. Due to the failure of sender selector secondary switch cross-points 1802 to operate, no ground is extended over conductor 1824 to the sender, and the sender, therefore, does not return a ground over conductor 1950 to operate relay 1605. When relay 1604 releases after an interval, the circuit through its winding having previously been opened by the operation of relay 1601, it closes an operating circuit for relay 1606. This circuit may be traced from ground over the upper front contact of relay 1601, outer back contact of relay 1604, upper outer back contact of relay 1605, lower outer back contact of relay 1609, winding of relay 1606, to battery over the back contact of relay 1608. Relay 1612 now operates from battery through its winding, over the upper front contact of relay 1606, over conductor 1607 to the false ground on the circuit extending to the winding of primary line switch hold magnet 1415. Relay 1612, in operating, closes a circuit from the false ground just traced to its winding, over its inner and outer front contacts, over the back contact of relay 1611, to battery through the winding of alarm relay 1614, which operates. Relay 1614, in operating, lights alarm lamp 1615 and operates trouble register 1616 in local circuits. In addition, relay 1614, closes a circuit from ground over its next-to-inner front contact, upper outer back contacts of relays 1604 and 1605, and lower outer back contact of relay 1609, to the winding of relay 1606 thereby locking relay 1606. Relay 1612, therefore, remains operated and maintains the alarm indication until the false ground is cleared.

After cross-points 1407, 1410, 1800 and 1802 have operated, should the conductor which extends the operating ground from the primary line switch hold magnet 1415 to the hold magnet and over an operated contact of the cross-points of each succeeding switch become crossed, due to a trouble condition, with the corresponding grounded conductor extending over some other cross-point contact over which another calling connection has been established, the circuit functions as hereinbefore described for a normal call up to and including the operating of relay 1605 by the ground which the sender returns over conductor 1950. Relay 1605, in operating, removes the short-circuit over its upper outer back contact from the winding of relay 1608. Relay 1608 does not operate in series with hold magnet 1415 as on a normal connection, however, as it remains short-circuited by the aforementioned crossed trouble ground which extends from the sleeve conductor, over the front contact and armature of primary line switch hold magnet 1415, over a previously traced circuit to conductor 1607, back contact of relay 1606, to one side of the winding of relay 1608, the other side of that winding having ground connected to it over the upper front contact of relay 1601. Relay 1604, the circuit through its winding having been opened when relay 1601 previously operated, releases after an interval and operates relay 1612 in a circuit from battery through the winding of that relay, over the lower inner back contact of relay 1609, upper outer front contact of relay 1605, outer back contact of relay 1604, to ground over the upper front contact of relay 1601. Relay 1612, in operating, closes the circuit from the ground just traced to its winding, over its inner and outer front contacts, back contact of relay 1611, to battery through the winding of alarm relay 1614 which operates, lighting alarm lamp 1615 and closing the circuit through the winding of trouble register 1616.

Upon the closure of cross-points 1407, 1410, 1800 and 1802 and the resultant extension of the tip and ring conductors of the calling line to the sender circuit over conductors 1822 and 1823, as hereinbefore set forth, the sender circuit, in a manner which will later be described in detail, recognizes its connection to the calling line and, provided that ground has also been connected to the sender over conductor 1951, thereby indicating that the operating circuit to the proper primary line switch hold magnet was established, the sender returns a ground on conductor 1952. This ground extends over a front contact of relay 1938, over conductor 1957, lower outer front contact of relay 1605, conductor 1613, a front contact of relay 1528, conductor 1541, outer front contact of relay 1429, outer front contact of relay 1430, to battery through the winding of the line switch control circuit release relay 1411 which operates. Relay 1411, in operating, causes the line switch control circuit and, in turn, the sender selector control circuit, to release in a manner which will later be described in detail. Should the sender find the loop to the subscriber's station open due to the failure of any of the cross-point contacts in the connection to close, or due to the subscriber having replaced his receiver on the switch-hook prior to this time, the sender does not return ground to conductor 1952 to cause the normal release of the line switch and sender selector control circuit. The sender now functions, in a manner later to be described, and returns a battery over conductor 1949. This battery extends over a front contact of relay 1938, conductor 1958, upper inner front contact of relay 1605, inner back contact of relay 1604 which released after an interval following the opening of its operating circuit by the previous operation of relay 1601, and over the upper outer front contact of relay 1609 to ground through the winding of trouble release register 1617. Register 1617 operates to record this trouble release condition and closes a circuit from ground over its front contact to conductor 1613 and over the previously traced circuit to battery through the winding of the line switch control circuit release relay 1411 which operates and causes the line switch and sender selector circuit to release.

When relay 1600 operates at the time that the sender selector circuit is initially engaged, it closes a circuit from ground over its upper front contact to the armature of interrupter 1618. The cam of interrupter 1618 rotates continuously and causes the armature to contact the left and right contacts of the interrupter at spaced intervals determined by the speed of rotation of that cam. Upon the first closure of its left front contact, the ground just traced to the armature of interrupter 1618 is closed over that left contact to battery through the winding of relay 1619. Relay 1619, in operating, locks over its left front contact directly to ground over the

upper front contact of relay 1600, and closes a circuit from battery through the winding of relay 1614, over its right front contact, to the right contact of interrupter 1618. When, after an interval, the cam of interrupter 1618 disengages from the armature and the armature contacts the right contact, relay 1614 operates to the ground over the upper front contact of relay 1600. Relay 1614, in operating, closes circuits to light alarm lamp 1615 and operate trouble register 1616. The speed of rotation of the cam of interrupter 1618 is such that the measured interval between the operation of relay 1600 and the operation of relay 1614 is of sufficient duration to allow the sender selector circuit to perform its functions in establishing a normal connection before the alarm is brought in. It is only when a call is blocked and the sender selector circuit fails to operate relay 1601, that the slow-to-release relay 1600 remains operated for a sufficient length of time for relay 1614 to operate, under the control of interrupter 1618, and bring in the alarm. Relay 1614, when operated, also closes a circuit from the operating ground traced to its winding, over its right inner front contact, over conductor 1620, to battery through the winding of relay 1921 thereby holding relay 1921 operated as long as the call is blocked. Relay 1921, remaining operated, holds the sender selector busy since it holds open the operating circuit for the sender selector start relay 1900.

The line switch control circuit is provided with an overflow register 1543 which registers the number of half second intervals which elapse between the time that the line switch control circuit starts to function and the time that the selection of the district trunk group is completed. When line switch control circuit start relay 1511 operates upon the initiation of a call, as hereinbefore set forth, it closes a circuit from battery through the winding of overflow register 1543, over its upper outer front contact and conductor 1544 to the right front contact of relay 1445. At that time a circuit is also closed from ground over the inner front contact of line relay 1401, inner front contact of relay 1405, upper inner front contact of relay 1412, upper front contact of relay 1406, conductor 1432, outer back contact of relay 1508, lower armature and front contact of relay 1511, conductor 1545 to the left armatures of relays 1445 and 1446 and to the armature of interrupter 1447. The cam of interrupter 1447 rotates at a speed of approximately once per half second, closing and opening both its left and right contacts during that interval. With ground on the armature of interrupter 1447, as just described, the first closure of the left contact of the interrupter causes relay 1446 to operate. Relay 1446, in operating, locks over its left front contact to ground on conductor 1545, and closes the circuit from battery through the winding of relay 1445, and over its right front contact, to the right contact of the interrupter. When the interrupter 1447 functions and transfers its armature from its left to its right contact, relay 1445 operates and locks over its left front contact to ground on conductor 1545. With relay 1445 operated, the next closure of the left contact of the interrupter completes the operating circuit through the winding of overflow register 1543 which operates. Subsequent openings and closures of the left contact of interrupter 1447 release and reoperate register 1543 as long as relays 1445 and 1446 remain locked to the ground on conductor 1545. As previously set forth, the ground on conductor 1545 is supplied under control of a back contact of relay 1508 which operates upon the completion of district group selection. Register 1543, therefore, does not operate if district group selection is completed before interrupter 1447 has caused relays 1445 and 1446 to operate and close the circuit from the left contact of the interrupter to the winding of register 1543. Register 1543 records only the fact that some calls in the entire line switch group with which the line switch control circuit is associated require more than the measured time before being connected to a group of district trunks. If specific information is desired as to which horizontal group of line switches of the line switch group are originating traffic sufficient to cause register 1543 to operate, this information may be obtained by connecting a register similar to register 1543, to the conductor connecting to the left front contact of the relays such as relays 1513, 1519, 1520 and 1521. Each of these aforementioned relays is associated with each particular horizontal group relay and operates under control of that relay. For example, relay 1513 is associated with and operates under control of horizontal group relay 1500, and a register connected to the left front contact of relay 1513 would therefore operate in multiple with register 1543 and would record only those operations which are caused by a call originating in the horizontal line switch group with which relay 1500 is associated.

When relay 1406 of the line switch control circuit operates upon the initiation of a call as hereinbefore set forth, it closes a circuit from ground over its lower front contact to the armature of interrupter 1448 and to the left armatures of relays 1449 and 1450. Upon the first closure of the left contact of interrupter 1448, relay 1449 operates in a circuit over the right back contact of relay 1450. Relay 1449, in operating, locks over its left front contact and closes a circuit from battery through the winding of relay 1450, over its right front contact, to the right contact of interrupter 1448. When interrupter 1448 now functions and closes its right contact, relay 1450 operates and locks over its left front contact. Relay 1450, in operating, lights alarm lamp 1451 in a local circuit and closes a circuit from the previously traced ground to the left armature of relay 1449, over the left front contact of that relay, right inner front contact of relay 1450, closed contact of key 1452, to battery through the winding of the line switch control circuit release relay 1411 which operates and causes the line switch control circuit and, in turn, the sender selector to release in a manner which will later be described in detail. During the release of the line switch control circuit, relay 1406 releases thereby releasing relays 1449 and 1450 and extinguishing the alarm lamp 1451. The speed of rotation of the cam of interrupter 1447 is such that approximately six seconds are required from the time that relay 1406 operates and grounds the armature of the interrupter until relay 1450 operates and lights the alarm lamp and closes the operating circuit for release relay 1411. On a normal connection the line switch control circuit releases in the regular manner in less than this six-second interval and it is therefore only a connection on which a call is blocked that the alarm lamp 1451 is lighted and that the line switch control circuit is released by the operation of relay 1450. If, due to recurrent alarm indications, it is desired to check the condition which is

causing the alarm, key 1452 is operated. Upon the following blocked call condition, interrupter 1447 and relays 1449 and 1450 function as before and cause alarm lamp 1451 to light. Since key 1452 is operated, however, the operation of relay 1450 does not operate release relay 1411 and the line switch control circuit does not release. The trouble condition is therefore held until such time as key 1452 is restored to normal thereby permitting relay 1411 to operate.

Class of service indications

The subscribers' lines are so located in the various horizontal groups of line switches that all the lines appearing in any horizontal group require the same class of service. The right next-to-outer front contact of the horizontal group relays, such as relay 1500, connect to one of ten terminals, such as terminal 1546. Each of these ten terminals is in turn connected to one of four class of service terminals, such as terminal 1547, depending upon the class of service required by the line located in the horizontal group with which that particular horizontal group relay is associated. Class of service terminal 1547 extends over a front contact of relay 1528, conductor 1551, and a front contact of relay 1938, to the sender over conductor 1945. Similarly, the other three class of service terminals 1548, 1549, and 1550 extend over other front contacts of relay 1528, over three conductors 1552, 1553, and 1554, respectively, and over three other front contacts of relay 1938, to the sender over conductors 1946, 1947 and 1948, respectively. The operation of any horizontal group relay, such as relay 1500, connects ground over its right next-to-outer front contact, over one of the ten terminals such as terminal 1546, over one of the four class of service terminals, to the sender, over one of the circuits just traced, to notify the sender which class of service the calling line requires. The ground on the right next-to-outer armature of relay 1500 connects to the corresponding armatures of the other horizontal group relays, such as relays 1501 to 1503, inclusive, over a chain circuit which extends over the corresponding right armatures and back contacts of each of the intermediate horizontal group relays. In this manner, only one class of service terminal can be grounded at any one time. For example, relay 1500 in operating connects ground to terminal 1546 which, in turn, is connected to one of the class of service terminals 1547 to 1550, inclusive. Relay 1500, in operating, also removes the ground from the chain circuit extending over the right next-to-outer back contacts and armatures of relays 1501 to 1503, inclusive. The operation of any relay such as relays 1501 to 1503, inclusive, at this time, due to some other call being originated in another horizontal line switch group, cannot therefore ground some other class of service terminal. On the other hand, should horizontal group relay 1502 operate first in response to an originating call, the class of service terminals associated with relays 1500 and 1501 cannot be grounded at this time although the right next-to-outer armatures of these latter relays are grounded, since the operating circuit for relays 1500 and 1501 is opened by the operation of relay 1502.

Each subscriber sender, such as the sender shown in Figs. 22 to 26, inclusive, is provided with a sender busy relay which, when unoperated and thereby indicating that the sender is idle, connects battery to its associated sender selecting relay of the sender selector circuit. In the foregoing description, it was assumed that the sender shown in Figs. 22 to 26, inclusive, was idle at the time that the sender selector circuit was selecting an idle sender. Battery was therefore connected over the lower back contact of sender busy relay 2200 and over conductor 1932 to the right winding of the sender selecting relay 1928 which is associated with this particular sender circuit and caused that relay to operate in the manner hereinbefore set forth. Relays 2201 to 2203, inclusive, represent the sender busy relays of the other senders of the same group of ten which include the sender of which relay 2200 is a part. Whenever all senders of the group are busy, all of the sender busy relays 2200 to 2203, inclusive, are operated and a circuit is closed from ground over the lower front contacts of relays 2203, 2202, 2201 and 2200, conductor 1906, to battery through the winding of the associated sender group busy relay, such as relay 1901, of the sender selector circuit which, under this condition, functions in the manner previously described.

At the time that the sender is selected, as set forth in the preceding description, the operation of relays 1928, 1938 and 1940 of the sender selector circuit close a circuit from ground over the upper outer front contact of relay 1940, next-to-inner front contact of relay 1938, right inner back contact of relays 1931, 1930, and 1929, right inner front contact of relay 1928, conductor 1959, to battery through the winding of relay 2204 and also, over the back contact of relay 2206, to battery through the winding of relay 2205, thereby operating both relays 2204 and 2205. Relays 2204 and 2205, in operating, extend conductors 1943, 1944, and 1948 to 1952, inclusive, from the sender selector circuit to various points in the sender. Relay 2204 also operates the sender busy relay 2200 in a circuit from battery through the winding of that relay over the lower outer front contact of relay 2204, to ground over conductor 1951 from the sender selector circuit. Relay 2200, in operating, connects ground over its upper middle front contact to conductor 1822 which extends to the tip of the calling subscriber's line over a previously traced circuit; connects the ring of the calling line, which was previously extended to conductor 1823, over its upper inner front contact to battery through the lower winding of the sender line relay 2207 which operates over the closed line loop; closes an off-normal ground over its upper outer front contact to conductor 2208; removes the battery from conductor 1932 thereby causing this sender to test busy to all sender selector circuits; and, in addition, closes in part, over its lower front contact, the sender group busy chain circuit which connects to conductor 1906.

Relay 2207, in operating, closes a circuit from ground over the upper back contact of relay 2209, front contact of relay 2207, conductor 2210, to battery through the winding of relay 2300 which operates. This ground on conductor 2210 also extends over the outer back contact of relay 2301 and over conductor 2302 to battery through the winding of relay 2211 which operates. Relay 2211 operates relay 2212 in local circuit. Relay 2212, in operating, closes a circuit from ground over its middle front contact, conductor 2213, front contact of relay 2300, to battery through the winding of relay 2301 which operates. Relay 2212 also closes a locking circuit for relay 2200 over its outer front contact to the off-normal ground on conductor 2208. Relay 2301, in operating, transfers the holding circuit for relay 2211 from ground

on conductor 2210, to ground over its own front contact.

Upon the operation of relay 2212 a circuit is closed from battery through the winding of relay 2206, inner front contact of relay 2212, lower next-to-outer front contact of relay 2204, and over conductor 1951 to the associated sender selector circuit. When the cross-point contacts of the line and sender selector switches operated, as previously described, the operating ground for the hold magnet of these switches was extended to the sender over conductor 1824 indicating that all of the cross-point contacts had operated. Upon the operation of relay 2204, this ground on conductor 1824 is connected over the lower next-to-inner front contact of that relay to conductor 1950. As hereinbefore set forth in the description of the operation of the sender selector circuit, this ground over conductor 1950 from the sender causes relay 1605 of the sender selector control circuit to operate which, in turn, removes the short circuit from the winding of relay 1608 and allows that relay to operate provided that the circuit for supplying the operating ground through the primary line switch hold magnet is properly closed. Relay 1608 operates relay 1609 which in turn, grounds conductor 1951 over a previously traced circuit. Relay 2206 operates to this ground on conductor 1951 and closes a circuit from ground over its upper middle front contact, through resistance 2214, to conductor 1824 to hold the hold magnets of the line and sender selector switches operated upon the subsequent release of the line and sender selector control circuits. Since relay 2206 cannot operate unless the cross-points of the line and sender selector switches are closed and ground is supplied over the proper circuits to the primary line switch hold magnet in the manner just described, and since the operating circuit for relay 2206 also extends over a front contact of relay 2212 which is only operated if relays 2207 and 2211 are operated indicating a closed subscriber's line loop, relay 2206, by its operation, simultaneously checks all three of these aforementioned conditions. The functions performed by the operation of relay 2206 will be described later.

As hereinbefore set forth, the sender selector circuit connects four class of service conductors, conductors 1945 to 1948, inclusive, to the sender. Only one of these conductors, conductor 1948, is shown extended in the sender. One of these conductors is grounded under control of a horizontal group relay of the line switch control circuit in the manner previously described. Assuming that conductor 1948 is grounded, the operation of relay 2204 of the sender extends this ground over its inner front contact, to battery through the winding of class of service relay 2215 which operates. Since there are four class of service conductors extending from the sender selector circuit there are also four class of service relays, such as relay 2215. For simplicity, however only one of these class of service relays has been shown. Relay 2215, in operating, locks over its inner front contact to the off-normal ground on conductor 2208, connects ground to conductor 2216 and connects conductor 2217 to conductors 2218, 2219, and 2229 over its outermost front contacts. Conductors 2216 to 2219, inclusive, and 2229 extend to the decoder marker circuit and their functions will be detailed in the description of the operation of the decoder marker.

District frame indication

At the same time that the required class of service is recorded in the sender as just described, the number of the district frame on which the district trunk selected for this particular call is located is also recorded in the sender by means of relay 2220 or relay 2221 and a set of cross-point contacts of the cross-bar register switch shown in Fig. 26. This district frame information is transmitted from the sender selector circuit by means of one of its ten sender connector relays, such as relay 1938. Relay 1938 is associated with a particular sender link, such as link 1801, and since a particular sender link is accessible to only two primary sender selector switches whose vertical rows of contacts are connected to district trunks located on the same district frame, the sender connector relay, such as relay 1938, is therefore always identified with the same district frame. Assuming now that the district trunks connected to the primary sender selector switches having access to sender link 1801 are located on the fourth district frame of a maximum of twenty district frames, the previous operation of relay 1938, which is associated with the selected sender link 1801, closes a circuit from ground over a front contact to conductor 1944. This ground extends over the inner front contact of relay 2205 and over conductor 2222, continuation of conductor 2222 on Fig. 26, to battery through the winding of one of the ten select magnets 2600 to 2609, inclusive, of the cross-bar register switch shown in Fig. 26. The ten select magnets represent the ten digits 0 to 9, inclusive, and, since the selected district trunk is assumed to be located on the fourth district frame, select magnet 2604, representing the digit 4, is operated by the ground on conductor 2222. Select magnet 2604, in operating, closes a circuit from its operating ground, over its front contact and over conductor 2610, to battery through the winding of relay 2303 which operates. Relay 2303, in operating, closes a circuit from ground over its lower front contact, conductor 2304, back contact of relay 2612, to battery through the winding of hold magnet 2611 which operates and, since select magnet 2604 was previously operated, causes cross-point contacts 2613 to close. The operation of cross-point contacts 2613 connects ground to conductor 2614 and connects conductor 2615 to conductors 2616 to 2618 inclusive. Conductors 2614 to 2618, inclusive, extend to the decoder marker and transmit, in part the district frame number in a manner which will be described later. Since there may be as many as twenty district frames, and since the cross-bar register of Fig. 26 is arranged to register only one of ten digits, it is necessary to transmit additional information to the decoder marker. For this purpose, the sender is provided with two frame relays, relays 2220 and 2221. The winding of relay 2220 connects over the upper front contact of relay 2204 and over conductor 1943 to a front contact of all sender connector relays, such as relay 1938, which are associated with sender links accessible to district trunks on the first ten district frames, that is, district frames No. 0 to No. 9. The winding of relay 2221 connects over the outer front contact of relay 2205, to conductor 2223. Conductor 2223 is connected over conductor similar to conductor 1943 of Fig. 19 to a front contact of all sender connector relays, such as relay 1938, which are associated with sender links accessible to district trunks on the second ten district frames,

that is, district frames No. 10 to No. 19. Relay 1938, upon its previous operation therefore grounded conductor 1943 of Fig. 22, since the selected district trunk is located on the fourth district frame, and relay 2220 operates over the previously traced circuit to battery through its winding. Relay 2220 in operating, locks over its upper front contact to the off-normal ground on conductor 2208, and closes the circuit over its lower front contacts from conductor 2224 to conductor 2225. Conductors 2224 and 2225 extend to the decoder marker and transmit information to that circuit that the district frame is one of the first ten frames. This information, together with the information transmitted over the operated cross-points 2613 of the cross-bar register, informs the decoder marker that the fourth district frame contains the selected district trunk. In the event that the district trunk had been located on the fourteenth district frame for example, cross-point contacts 2613 of the cross-bar register operate in the same manner as hereinbefore set forth, but the sender connector relay corresponding to relay 1938 would, in this case, connect ground to conductor 2223 of Fig. 22 and operate relay 2221 instead of relay 2220. Relay 2221, in operating, would lock over its lower front contact to the ground on conductor 2208, and would connect ground over its upper front contact to conductor 2225 to notify the decoder marker that the district frame used was one of the second ten frames. The foregoing operations involving the recording of the class of service required by the calling line and the recording of the number of the district frame on which the chosen district trunk is located take place prior to the aforementioned operation of relay 2206.

Line switch and sender selector control circuits released

Relay 2206, in operating over the circuit hereinbefore described, locks over its lower inner front contact to the off-normal ground on conductor 2208, opens the circuit through the winding of relay 2205 which releases, and connects ground over its upper middle front contact and through resistance 2214 to conductor 1824 to hold the line and sender selector switches upon the subsequent release of the line and sender selector control circuit which now takes place in the following manner under control of the ground connected to conductor 1952 over the lower outer front contact of relay 2206. This ground on conductor 1952 extends over a front contact of relay 1938, conductor 1957, lower outer front contact of relay 1605, conductor 1613 a front contact of relay 1528, conductor 1541, outer front contacts of relays 1429 and 1430, to battery through the winding of the line switch control circuit release relay 1411 which operates. Relay 1411, in operating, locks in a circuit from ground over its front contact, conductor 1443, upper outer front contact of relay 1535, conductor 1542, to battery through its winding, and opens the holding circuit for relays 1405, 1406, and 1500 in series, 1513, and 1412 and 1429 in series, causing all of these relays to release. Operation of relay 1411 also releases the primary line switch select magnet 1427. Relay 1412, in releasing, releases relays 1416 and 1419. The release of relay 1429 releases relays 1423 and 1430. Relay 1513 in releasing, releases relay 1514 which removes ground from conductor 1536. The release of relay 1500 releases relay 1528 which in turn releases relay 1508, secondary line switch select magnet 1429, and removes the ground from conductors 1533 and 2112. The release of relay 1508 releases relay 1535 which opens the locking circuit for relay 1411. Relay 1411 thereupon releases and restores the line switch control circuit to normal. The removal of ground from conductor 1533 by the release of the line switch control circuit releases relays 1832, 1908 and 1909 of the sender selector control circuit. The removal of ground from conductor 1536 releases relay 2106 which in turn releases relays 1934 and 2111. The release of relay 1934 releases relays 1913, 1917 and 1938. Relays 2100 and 2104 release upon the removal of ground from conductor 2112 by the line switch control circuit. Relay 2100, in releasing, releases relays 1928 and 1940. The release of relay 2104 releases relay 2113. Relay 1938, in releasing, releases sender selector primary switch select magnet 1837 and opens conductors 1944 to 1952, inclusive. The release of relay 1928 opens the operating circuit for sender selector secondary switch select magnet 1839 which releases. The release of relay 1940 releases relay 1601 which in turn releases relay 1608. The opening of conductor 1950 by the release of relay 1938 releases relay 1605. Relay 1921 releases upon the release of relay 2104 and again closes the operating circuit for the sender selector control circuit start relay 1900 thereby restoring the sender selector control circuit to its normal condition. With the line switch and sender selector control circuits normal the hold magnets of the primary and secondary line and sender selector switches are held operated over the sleeve conductor which extends over the operated cross-point contacts of those switches and over conductor 1824 to ground supplied through resistance 2214 by relay 2206 of the sender.

When relay 2205 releases following the operation of relay 2206, as previously described, it opens the circuit through the winding of select magnet 2604 of the cross-bar register switch and that magnet releases, in turn releasing relay 2303. Relay 2303, in releasing, removes the ground over conductor 2304 from the winding of hold magnet 2611 and that hold magnet now holds operated in series with relay 2612, which operates, to the off-normal ground on conductor 2208. Relay 2612, in operating, connects conductor 2304 over its right front contact over the back contact of relay 2619, to the winding of relay 2619 and to the windings of hold magnets 2620 and 2621 preparatory to the registration of the number to be dialed by the calling subscriber. Relay 2211, upon its previous operation, closed a circuit from ground over its upper inner front contact to condenser 2226. The other side of condenser 2226 connects through the upper winding of the sender line relay 2207, over conductor 2307, and over the back contact of relay 2306 to a source of tone over conductor 2305. This tone is induced in the lower winding of relay 2207 and is thereby transmitted to the calling station as an indication that the dialing of the desired station number may proceed. The dialed number is recorded on the cross-bar register switch of Fig. 26 in the manner to be described in subsequent paragraphs. Only so much of the subscriber's sender is shown as is necessary to an understanding of the present invention. In general senders of this type are well known in the art, and for a more detailed disclosure of them reference is

made to the application of R. Raymond, Serial No. 27,340, filed July 19, 1935.

The subscriber dials wanted number

The sender line relay **2207**, which is held operated over the calling subscriber's station loop, follows the pulses produced by the station dial during the dialing of the called station number, and momentarily releases once for each open period of each train of dial pulses. Relays **2300** and **2301** operate and release under control of relay **2207** and provide additional contacts. Relay **2300** is fast in operating to quickly open the operating circuit for relay **2308** when relay **2207** remains operated at the end of a train of dial pulses. Relay **2301** is fast in releasing to provide a nearly continuous operating circuit for relay **2211** and also to provide a locking circuit for relays **2310** and **2312** as soon as possible after the momentary release of relay **2207** upon the first open dial pulse. Relay **2211** is slow in releasing and, therefore, together with relay **2212**, holds operated during the momentary releases of relays **2207**, **2300**, and **2301** during dialing. Relay **2308** is slow in releasing and remains operated during the momentary opening of its operating circuit by relay **2300** during a train of dial pulses. Between successive trains of dial pulses, relays **2207** and **2300** remain operated for a sufficient interval to allow relay **2308** to release. Relays **2310**, **2311**, and **2312** transmit the dial pulses represented by back contact closures of relay **2207**, to a chain of pulse-counting relays **2313** to **2318**, inclusive. Upon the first release of relay **2207** during the first open pulse of any train of dial pulses, a circuit is closed from ground over the upper back contact of relay **2209**, back contact of relay **2207**, lower front contact of relay **2211**, conductor **2227**, lower back contact of relay **2312**, to battery through the winding of relay **2310** which operates. Relay **2308** previously operated in a circuit from battery through its winding, back contact of relay **2300**, conductor **2213**, to ground over the middle front contact of relay **2212** and, being slow in releasing, remains operated during each train of dial pulses. When relay **2207** now reoperates upon the closure of the line loop following the first open dial pulse, relay **2312** operates in a circuit from battery through the winding of relay **2310**, upper winding of relay **2312**, back contact of relay **2311**, front contacts of relays **2310** and **2308**, respectively, to ground on conductor **2213**. When relay **2207** releases on the open period of the second dial pulse, relay **2311** operates in a circuit from battery through its winding, lower winding and lower front contact of relay **2312**, conductor **2227**, lower front contact of relay **2211**, back contact of relay **2207**, to ground over the upper back contact of relay **2209**. The operation of relay **2311** opens the circuit through the winding of relay **2310** and the upper winding of relay **2312**. Relay **2310** releases, but relay **2312** remains operated through its lower winding. When relay **2207** reoperates upon the line loop closure following the second dial pulse open period, it removes the ground from conductor **2227** and relays **2311** and **2312** both release. The foregoing cycle of operations of relays **2310**, **2311** and **2312** is repeated for each two pulses of the pulse train of any digit dialed. If the number of pulses is even, the last pulse leaves relays **2310**, **2311**, and **2312** released. If the number of pulses is odd, relay **2311** is released, but relays **2310** and **2312** remain operated until the subsequent operation of relay **2301** and the release of relay **2308** opens their holding circuits. The important point for subsequent reference is that each odd pulse of any dialed digit operates relay **2312** and each even pulse causes that relay to release.

The pulses of each dialed digit are counted by relays **2313** to **2318**, inclusive, which are operated in rotation by alternate closures of the upper front and back contacts of relay **2312**, and each of which locks until released by the operation of another, or by the operation of relay **2303** at the end of the train of pulses of any particular digit, as will be described later. When relay **2312** is operated during the first pulse of any digit, as hereinbefore described, relay **2313** operates from battery through its upper winding, upper outer back contacts of relays **2317**, **2315**, **2314**, and **2316** in that order respectively, upper front contact of relay **2312**, front contact of relay **2308**, to the previously traced ground on conductor **2213**. Relay **2313**, in operating, locks in a circuit from battery through its lower winding, over its lower inner front contact, lower back contact of relay **2309**, upper inner back contacts of relays **2314** to **2317**, inclusive, upper inner back contact of relay **2309**, to ground on conductor **2213**. When relay **2312** releases following the second dial pulse, the previously traced ground on its upper armature is extended over its upper back contact, upper outer back contact of relay **2309**, upper inner front contact of relay **2313** to battery through the winding of relay **2314** which operates. Relay **2314**, in operating, locks over its upper inner front contact over the same path previously traced for locking relay **2313**, and opens the locking circuit for relay **2313** which releases. The operation of relay **2312** in response to the third dial pulse, extends ground previously traced to its armature, over its upper front contact, upper outer back contact of relay **2316**, upper outer front contact of relay **2314**, to battery through the winding of relay **2315** which operates. Relay **2315** locks in the same manner as relay **2314** did, and opens the locking circuit for relay **2314** which releases. The release of relay **2312** upon the fourth dial pulse connects ground over its upper back contact, upper outer back contact of relay **2309**, upper inner front contact of relay **2315**, to battery through the winding of relay **2316**. Relay **2316** operates, locks over the previously traced locking circuit, and opens the locking circuit for relay **2315** which releases. The operation of relay **2312** on the fifth dial pulse connects ground over its upper front contact and over the upper outer front contact of relay **2316** to battery through the winding of relay **2317** which operates. Relay **2317** locks in a circuit over the upper outer back contact of relay **2313** and over its upper outer front contact to the same ground to which the preceding relay is locked. Relay **2317**, in operating, also opens the locking circuit for relay **2316** which releases. The release of relay **2312** in response to the sixth dial pulse connects ground over its upper back contact, upper outer contact of relay **2309**, upper inner front contact of relay **2317**, to battery through the upper winding of relay **2318**. Relay **2318** operates and locks through its lower winding and its upper inner front contact to the previously traced locking ground. Relay **2318** does not unlock relay **2317** and remains operated for the remaining pulses of the digit. On the seventh dial impulse, the operation of relay **2312** again operates relay **2313** as it did on the first pulse, but this time over a circuit traced from its upper front con-

tact, over the upper outer back contact of relays 2316, 2314, and 2315, and over the upper outer front contact of relay 2318, to battery through the upper winding of relay 2313. Relay 2313 again locks through its lower winding as it did before and opens the locking circuit for relay 2317 which releases. The release of relay 2312 in response to the eighth dial pulse again operates relay 2314 which, as in the case of the second dial pulse, locks and opens the locking circuit for relay 2313 which releases. The ninth dial pulse operates relay 2312 which in turn operates relay 2315. Relay 2315 locks, as previously, and opens the locking circuit for relay 2314 which releases. The release of relay 2312, in response to the tenth dial pulse, again causes relay 2316 to operate, lock, and release relay 2315, as it did for the fourth dial pulse. Each train of dial pulses transmitted from the subscriber's station may consist of from one to ten pulses depending upon the numerical value of the particular digit dialed. At the conclusion of the dial impulse train of any digit, the operated pulse count relay or relays is dependent upon the number of pulses contained in that train of impulses as has been set forth above. For one pulse, relay 2313 is operated; two pulses, relay 2314; three pulses, relay 2315; four pulses, relay 2316; five pulses, relay 2317; six pulses, relays 2317 and 2318; seven pulses, relays 2313 and 2318; eight pulses, relays 2314 and 2318; nine pulses, relays 2315 and 2318; ten pulses, relays 2316 and 2318. The function of the pulse counting relays 2313 to 2318, inclusive, is to prepare operating circuits for the select magnets 2600 to 2609, inclusive, of the cross-bar register switch to provide for the registration of the dialed number in the manner described below.

Recording office designation

It will be assumed for illustration that the number of the desired station dialed by the calling subscriber is RA—2—3168. The office designation RA has a numerical equivalent of the digits 7 and 2 respectively. The seven trains of impulses transmitted by the contacts of the dial at the calling station therefore contain the following number of impulses in the order listed: Seven, two, two, three, one, six and eight. The first train of pulses dialed, containing seven impulses, causes pulse counting relays 2313 and 2318 to operate as described above. When relay 2300 operates, under control of relay 2207 upon the closure of the station loop at the conclusion of the first train of dial pulses, it releases relay 2308 which causes select magnet 2607 of the cross-bar register switch to operate in a circuit from battery through its winding, conductor 2622, continuation of conductor 2622 on Fig. 23, lower middle front contact of relay 2313, lower inner front contact of relay 2318, upper back contact of relay 2303, back contact of relay 2308, conductor 2319, to ground over the outer front contact of hold magnet 2611 which previously operated and locked during the registration of the number of the district frame. Relay 2308, in releasing, also operates relay 2309 from the ground on conductor 2319. Relay 2309, in operating, opens one locking circuit for relays 2313 and 2318, these relays now being held operated through the parallel locking circuit extending from conductor 2213, over the lower back contact of relay 2303, to the upper outer front contact of relay 2317 and the upper inner armature of relay 2318. Select magnet 2607, in operating, closes a circuit from its operating ground, over its front contact and conductor 2610 to battery through the winding of relay 2303 which operates. Ground over the left front contact of the previously operated relay 2612, over the back contact of hold magnet 2620, conductor 2623, and the upper front contact and lower inner front contact of relay 2303, locks relay 2303 and, since it also connects to conductor 2610, locks select magnet 2607. Relay 2303, in operating, opens the operating circuit for select magnet 2607, opens the remaining locking circuit for relays 2313 and 2318 which release, and, in addition, connects ground over its lower outer front contact, conductor 2304, right front contact of relay 2612, right back contact of relay 2619, to battery through the windings of hold magnets 2620 and 2621 in parallel. Hold magnets 2620 and 2621 operate and, since select magnet 2607 is operated, cause cross-point contacts 2624 and 2625 to close. The operation of hold magnets 2620 and 2621 also opens the locking circuit for relay 2303 and select magnet 2607 and they release. Relay 2303, in releasing, opens the operating circuit for hold magnets 2620 and 2621 and these magnets now hold in a circuit which may be traced from ground over the left front contact of relay 2612, inner front contact of hold magnet 2621, winding of relay 2619, and the windings of hold magnets 2620 and 2621 in parallel to battery. Relay 2619 operates in series with hold magnets 2620 and 2621. Hold magnet 2620 also closes a circuit from ground over its outer front contact and over conductor 2626 to battery through the winding of relay 2306 which operates and opens the tone circuit extending through the upper winding of sender line relay 2207 thereby removing the dialing signal from the calling station. Before the release of relay 2308 can be effective in operating a select magnet, hold magnet 2611 must have been properly operated during the registration of the district frame number since the ground to the lower contact of relay 2308 is supplied over conductor 2319 from a front contact of hold magnet 2611. This arrangement insures that the first dialed digit cannot be registered in that row of cross-point contacts of the register switch which are used for the district frame registration in the event of a failure of that registration to take place.

Should an accidental pulse be transmitted from the calling station due to an unintentional movement of the switch-hook before the dialing of the first digit takes place, or should the digit 1 be dialed in error for the first digit, relays 2207, 2300, 2301, 2310, and 2312 operate as for a legitimate digit and cause pulse counting relay 2313 to operate and lock in the manner previously described. Since the digit 1 is never used for the first digit of an office or an operator designation, it is necessary to prevent the registration of this digit should it be transmitted under either of the aforementioned conditions. For this purpose the operating circuit for select magnet 2601 is placed under control of those cross-point contacts which represent the digits 2 to 9, inclusive, of that row of switch contacts associated with hold magnet 2620 and shown to the right thereof. The operating circuit for select magnet 2601 may be traced from battery through its winding, over conductor 2627, conductor 2320, to the multipled upper armatures of the row of cross-point contacts to the right of and associated with hold magnet 2620. The upper front contacts, of this same row of cross-point contacts, which may be

prepared for operation by the operation of select magnets 2602 to 2609, inclusive, and which, therefore, represent the digits 2 to 9, inclusive, are multipled together and extend over conductor 2628 to the lower outer armature of pulse counting relay 2313. Since the registration of the first dialed digit causes the operation of corresponding sets of cross-points contacts in the two contact rows to the right of hold magnets 2620 to 2621, as previously set forth, select magnet 2601 cannot operate until such time as some digit from 2 to 9 inclusive, has been registered for the first dialed digit. As previously stated, pulse counting relay 2313 operated in response to the single first digit dial pulse. Upon operating, relay 2313 locks in a circuit from battery through its lower winding and over its lower inner front contact, lower back contact of relay 2309, upper inner back contact of relays 2314 to 2317, inclusive, upper inner back contact of relay 2309, to a previously traced ground over conductor 2213. When relays 2207, 2300, and 2301 reoperate upon the closure of the line loop following the single first digit dial pulse, the operation of relay 2300 releases relay 2308 which, in turn, operates relay 2309 in a circuit from battery through the winding of that relay, over the back contact of relay 2308, conductor 2319, to ground over the outer front contact of hold magnet 2611. Relay 2309, in operating, opens the holding circuit through the lower winding of relay 2313 which releases and thereby restores the dial pulse counting circuit to normal. Since select magnet 2601 does not operate in response to the single first digit dial pulse, due to the fact that none of the cross-point contacts in the contact row to the right of hold magnet 2620 are closed, relay 2303, hold magnets 2620 and 2621, and relays 2619 and 2306 also do not operate. The first digit 1 is therefore not recorded, the registering process is not advanced to the succeeding row of cross-point contacts, and, since relay 2306 does not operate, the dial tone indication is not cut off from the calling station. In the above manner, any number of single first digit dial pulses may be absorbed provided they are spaced far enough apart to allow relay 2308 to release between them.

The first digit 7, corresponding to the first letter R of the office designation, having been registered by the operation of cross-point contact 2625 in the manner hereinbefore set forth, the registration of the succeeding digit now proceeds. The second letter of the office designation being the letter A which corresponds to the digit 2, the second train of dial pulses contains two open periods and causes pulse counting relay 2314 to operate and lock in the manner previously described. Upon the release of relay 2308 following the operation of relay 2300 at the end of the second train of pulses, select magnet 2602 of the cross-bar register switch operates from battery through its winding, over conductor 2629, lower outer front contact of relay 2314, lower back contact of relay 2318, upper back contact of relay 2303, back contact of relay 2308, to ground over conductor 2319. Select magnet 2602, in operating, operates relay 2303 over conductor 2610. Relay 2303 locks itself and select magnet 2602 to ground over conductor 2623, opens the locking circuit over its lower back contact for relay 2314 which releases, and, in addition, connects ground over its lower outer front contact, over conductor 2304, right front contact of relays 2612 and 2619, left outer back contact of relay 2631, right back contact of relay 2632, to battery through the winding of hold magnet 2630 which operates. Select magnet 2602 being operated, the operation of hold magnet 2630 causes cross-point contacts 2633 to close. Hold magnet 2630, in operating, also opens the holding ground from conductor 2623 thereby releasing relay 2303 and select magnet 2602. The release of relay 2303 opens the operating circuit for hold magnet 2630 and that magnet now holds operated in series with relay 2632 in a circuit from battery through its winding, winding of relay 2632, front contact of magnet 2630, left inner back contact of relay 2631, to ground over the left front contact of relay 2619. Relay 2632 operates and connects ground over its left front contact and over the back contact of hold magnet 2634 to conductor 2623 for locking relay 2303 upon its next operation, and also connects the winding of hold magnet 2634 to the lower outer armature of relay 2303 in a circuit which may be traced from the winding of magnet 2634, over the back contact of relay 2635, right front contact of relay 2632, left outer back contact of relay 2631, right front contacts of relays 2619 and 2612, and over conductor 2304. The third digit 2 of the office designation causes pulse counting relay 2314 to operate which, upon the release of relay 2308 at the end of the third train of pulses, is followed by the operation of select magnet 2602, relay 2303, and hold magnet 2634 in that order. The operation of hold magnet 2634, with select magnet 2602 operated, causes cross-point contact 2636 to close. In addition, hold magnet 2634 opens the holding ground from conductor 2623 thereby releasing relay 2303 and select magnet 2602. The release of relay 2303 releases relay 2314 and opens the operating circuit for magnet 2634 which now holds in series with relay 2635 which also operates. Relay 2635 extends conductor 2304 to the winding of hold magnet 2637 and connects ground over its left front contact and the back contact of magnet 2637 to conductor 2623.

The closing of cross-point contacts 2625 connects ground to conductors 2640 and 2642 and connects conductors 2639 and 2641 to conductor 2217. The closing of cross-point contacts 2633 connects ground to conductor 2644 and connects conductors 2643, 2645, and 2646 to conductor 2651. The closing of cross-point contacts 2636 connects ground to conductor 2648 and connects conductors 2647, 2649, and 2650 to conductor 2651. Conductors 2639 to 2651 inclusive extend to the decoder marker circuit and transmit to that circuit the information regarding the dialed office designation which enables the decoder marker to establish a path to the proper outgoing trunk as will later be set forth in the description of the operation of the decoder marker circuit. When hold magnet 2634 operates, signifying that the three digits comprising the office designation have been recorded, it closes a circuit from the off-normal ground on conductor 2208, over its outer front contact, conductor 2652, inner back contact of relay 2321, lower back contact of relays 2323 and 2324, to battery through the winding of relay 2325 which operates. Relay 2325, in operating, connects off-normal battery to conductors 2326 and 2327 which connect to various points in the sender, and also connects battery over its upper inner front contact to conductor 2328 and, over the back contact of relay 2330, to conductor 2329.

Conductors 2328 and 2329 extend to a decoder marker connector circuit and, upon having battery connected to them, cause this connector circuit to function and connect the sender to an idle decoder marker in a manner which will later be set forth in detail. The outer front contact and armature of hold magnet 2634 are paralleled by the lower front contact and armature of cross-points 2653 which are located in that row of the cross-bar register switch which operate when the first dialed digit is registered. Should a subscriber dial the zero operator which is represented by the digit 0, the subsequent operation of select magnet 2600 and hold magnet 2620 will cause cross-point contacts 2653 to close and perform the same function as the outer front contact and armature of hold magnet 2634 and thereby cause the sender to become associated with an idle decoder marker circuit.

When the sender is required to register both two and three digit office designations, relay 2631 is provided and operates whenever the first digit dialed is one representing a block of two-digit office designations. Assume for illustration that all office designations whose first digit is either 2 or 4 are two-digit office designations, battery through the winding of relay 2631 extends, in this case as shown, to the lower front contact of cross-point contacts 2654 and 2655 of that row of contacts associated with hold magnet 2620. Cross-point contacts 2654 will operate if the first dialed digit is 2, and cross-point contacts 2655 operate if the digit is 4. In either case, relay 2631 operates over the lower front contact of one of these sets of contacts to the off-normal ground on conductor 2208. Relay 2631, in operating, connects conductors 2643 to 2646 inclusive, to conductor 2651 for the purpose of notifying the decoder marker that only a two-digit office designation is to be dialed and, over its left armatures, transfers the ground supplied to conductor 2623 from the back contact of hold magnet 2630 to the back contact of hold magnet 2634, and transfers the hold magnet operating circuit extending over conductor 2304 from the winding of hold magnet 2630 to the winding of hold magnet 2634. In this case the second digit dialed will be registered in that row of cross-point contacts to the right of, and associated with, hold magnet 2634. The cross-point contacts in the row associated with hold magnet 2630 are ineffective under this condition since that hold magnet has been skipped due to the operation of relay 2631. Where only three-digit office designations are employed, relay 2631 is omitted and the conductors shown connecting to its left armatures are strapped directly to the conductors shown connecting to the respective back contacts associated with these left armatures. The conductors shown connecting to its right armatures and front contacts are omitted entirely in this case. Where only two-digit office designations are employed relay 2631 is also omitted and the conductors shown connecting to its left armatures are strapped directly to the conductors shown connecting to the respective left front contacts. The conductors shown connecting to the right front contact of the relay are, in this instance, strapped directly to the conductors shown connecting to the right armatures. In this latter instance, the second dialed digit will always be registered in that row of contacts of the cross-bar register switch which are at the right of, and associated with, hold magnet 2634.

Recording numerical designation

The three digits of the office designation having been recorded, as hereinbefore set forth, the digits 3, 1, 6, and 8 of the desired line are now registered in a similar manner. The three dial pulses transmitted for the thousands digit 3 cause pulse counting relay 2315 to operate. Upon the subsequent release of relay 2308 at the end of the pulse train, select magnet 2603 operates over conductor 2231. The operation of select magnet 2603 is followed by the operation of relay 2303 which, in turn, operates hold magnet 2637. Select magnet 2603 having previously operated, the operation of hold magnet 2637 causes cross-point contacts 2656 to operate. Relay 2303 releases upon the operation of hold magnet 2637 and in turn releases relay 2315. Relay 2638 operates in series with hold magnet 2637 upon the release of relay 2303, and extends conductor 2304 to the winding of hold magnet 2657 over the back contact of relay 2658. The single dial pulse of the hundreds digit 1 causes relay 2313 to operate which is followed, upon the release of relay 2308, by the operation of select magnet 2601, relay 2303, and hold magnet 2657. Hold magnet 2657, together with the operated select magnet 2601, causes cross-point contacts 2659 to operate. The operation of hold magnet 2657 releases relay 2303 which, in turn releases relay 2313. Relay 2658 operates in series with hold magnet 2657 and extends conductor 2304 to the winding of hold magnet 2660 over the back contact of relay 2661. The six dial pulses of the tens digit 6 cause pulse counting relays 2317 and 2318 to operate. The subsequent release of relay 2308 at the end of the tens digit pulse train operates select magnet 2606 over conductor 2232, over a circuit which may be traced from ground over the outer front contact of hold magnet 2611, conductor 2319, back contact of relay 2308, upper back contact of relay 2303, lower inner front contacts of relays 2318 and 2317, conductor 2232, continuation of conductor 2232 of Fig. 26, to battery, through the winding of select magnet 2606. The operation of select magnet 2606 is followed by the operation of relay 2303 and hold magnet 2660 which, in turn, causes cross-point contacts 2662 to close. The operation of hold magnet 2660 releases relay 2303 which, in turn, releases relays 2317 and 2318. Upon the release of relay 2303, relay 2661 operates in series with hold magnet 2660 and extends conductor 2304 to the winding of hold magnet 2663. The eight dial pulses of the units digit 8 cause the operation of pulse counting relays 2314 and 2318. The subsequent release of relay 2308 completes a circuit from ground over conductor 2319, over its back contact, upper back contact of relay 2303, lower inner front contact of relays 2318 and 2314, conductor 2233, continuation of conductor 2233 of Fig. 26, to battery through the winding of select magnet 2608. Magnet 2608 operates, operating relay 2303 which, in turn, operates hold magnet 2663. The cross-point contacts 2665 close as a result of the operation of select magnet 2608 and hold magnet 2663. Hold magnet 2663 opens the locking ground from conductor 2623 thereby releasing relay 2303 and select magnet 2608. The release of relay 2303 releases relays 2314 and 2318, and, since it opens the operating circuit for magnet 2663, relay 2664 now operates in series with hold magnet 2663. The operation of relay 2664 extends conductor 2304 to the winding of hold magnet 2666. The lowest row of contacts of the cross-bar register

switch of Fig. 26, which are shown not wired, are used to record the digital equivalent of a station letter, if dialed. In this description it is assumed that the number dialed by the calling subscriber has no station letter and therefore this portion of the register switch is ineffective. In the case where a station letter such as J, M, R or W is dialed, the equivalent digit 5, 6, 7 or 9 respectively, is recorded by the operation of a corresponding set of contacts in this lowest contact row of the switch. The operation of these cross-point contacts is identical to the operation outlined for any of the preceding digits. A particular pulse counting relay or pair of relays operate in response to the number of dial pulses transmitted for the station letter and prepare the operating circuit for the corresponding select magnet of the register switch. When relay **2308** subsequently releases, the particular select magnet, relay **2303**, hold magnet **2666**, and the particular set of cross-point contacts involved, operate. Magnet **2666** locks directly to ground over the left front contact of relay **2664** and removes ground from conductor **2623** thereby releasing relay **2303** and the operated select magnet. The release of relay **2303** releases whichever pulse counting relay or relays operated and locked in response to the station letter dial pulses.

The operation of cross-point contacts **2656**, **2659**, **2662** and **2665**, representing the dialed thousands, hundreds, tens and units digits, complete certain connections between conductors **2667** to **2680**, inclusive. These conductors extend to Figs. 24 and 25 which show that portion of the sender circuit used in the revertive control of the selective operations which will later take place at the terminating office. The detailed functions controlled by these aforementioned conductors will subsequently be set forth under the description of the operation of the sender circuit located at the terminating office.

Sender connected to a marker

Referring now to Figs. 27 and 28, there are shown thereon such portions of a decoder marker connector circuit as are required to illustrate the manner in which the subscriber sender of Figs. 22 to 26, inclusive, is connected to a decoder marker circuit such as shown on Figs. 29 to 40, inclusive. The subscriber senders are divided into a number of groups, each group connecting to a particular decoder marker connector circuit. All of the decoder marker connector circuits, one for each group of subscriber senders, has access to a common group of decoder marker circuits. As many simultaneous connections between senders and decoder markers can be established as there are decoder markers, but only one sender of the group connected to any particular decoder marker connector circuit can be connected to a decoder marker at any one time even though other senders of that group require decoder markers and their are available decoder markers at that time. The decoder marker connector control circuit shown in Fig. 28 is provided with one start relay and three multi-contact connecting relays for each sender which connects to it. Start relay **2800** and multi-contact connecting relays **2700**, **2801**, and **2802** are associated with the subscriber's sender of Figs. 22 to 26, inclusive. Start relay **2803** and connecting relays **2701**, **2804** and **2805** are associated with some other subscriber sender (not shown). For each decoder marker circuit used, each decoder marker connector control circuit is provided with one decoder marker start relay and three multi-contact decoder marker connecting relays. Start relay **2808** and connecting relays **2702**, **2809**, and **2810** are associated with the decoder marker shown in Figs. 29 to 40, inclusive. The contacts of relays **2702**, **2809** and **2810** which extend to the decoder marker, are multipled, as indicated by the multiple straps directly at the right thereof, to the corresponding contacts of a similar set of relays associated with the same decoder marker in each of the other decoder marker connector circuits (not shown). Relays **2703**, **2812**, and **2813** are similar in function to relays **2702**, **2809**, and **2810**, respectively, and are associated with some other decoder marker circuit (not shown). The corresponding armatures of the similar sender and decoder marker connecting relays **2700**, **2701**, **2702**, and **2703** are mulipled together. Similiarly, with the exception of a few armatures which are individually wired for control purposes, the corresponding armatures of relays **2801**, **2804**, **2809**, and **2812**, and the corresponding armatures of relays **2802**, **2805**, **2810**, and **2813** are also multipled together.

After the office code dialed by the calling subscriber is registered in the sender, that circuit functions in the manner previously described and connects battery over conductors **2328** and **2329** to the decoder marker connector control circuit of Fig. 28. Sender start relay **2800** operates from battery on conductor **2329**, through its winding, to ground through the winding of relay **2814** which also operates. Relay **2814**, in operating, closes a circuit from ground over the back contacts of relays **2805** and **2802**, over its front contact, and over conductor **2815** to a timing circuit the function of which will be described later. Assuming that no other sender of the group is connected to the decoder marker connector circuit at this time, the operation of relay **2800** operates sender connecting relays **2700** and **2801** in a circuit from battery over conductor **2328**, windings of these relays in parallel, upper front contact of relay **2800**, to ground over the back contact of relay **2803**. This operating ground for relays **2700** and **2801** extends over a chain circuit through the back contact of all start relays similar to relay **2803**, as indicated by the broken conductor extending from the back contact of relay **2803** to the upper armature of relay **2800**. In the event that some other sender of the group had already been connected to the decoder marker connector circuit at this time, its associated sender start relay, such as relay **2803**, would be operated. The operation of relay **2800** would therefore, in this case, be ineffective in operating relays **2700** and **2801** due to the opening of the chain circuit over which the operating ground for those relays extends.

The operation of relay **2800** also opens the chain circuit extending from ground through the winding of relay **2814**, over the back contacts of the sender start relays, such as relays **2800** and **2803**, to the windings of the intermediate and last start relays, such as relay **2803**. With relay **2800** operated, no other sender of the same group can be connected to a decoder marker since the operating circuit for its start relay, such as relay **2803**, is open.

Upon the aforementioned operation of relay **2801**, relay **2802** operates in a circuit from battery over conductor **2328**, winding of relay **2802**, and over the inner front contact of relay **2801** to ground. Relays **2700**, **2801**, and **2802**, in operating, close the various control conductors extending from the sender to the multipled armatures of the

decoder marker connecting relays **2702** and **2703**, **2809** and **2812**, and **2810** and **2813**. Relay **2802**, in operating, connects ground over its outer front contact to the lower armature of relay **2816** over the lower back contact of relay **2817**, and to the lower armature of relay **2817** over the lower back contact of relay **2816**. In addition, relay **2802** also connects ground to lamp **2818**, the function of which will later be described. Assuming that the decoder marker shown in Figs. 29 to 40, inclusive, and associated with relays **2702**, **2808**, **2809**, **2810**, and **2816**, is idle at this time, relay **2808** operates in a circuit from ground through its winding, over the upper back contact of relay **2816**, a front contact of relay **2801**, to battery on conductor **2329**. The upper armature of relay **2808** connects over conductor **2819**, over a chain circuit extending over the upper armatures and back contacts of the start relays corresponding to relay **2808**, associated with the same decoder marker, but located in the other decoder marker connector circuits (not shown), to a ground on the last relay, corresponding to relay **2808**, in the chain circuit. Relay **2820** is normally operated from battery through its winding, over the upper back contact of relay **2808**, to ground over conductor **2819**, over the aforementioned chain circuit as long as no decoder marker connector circuit has connected to the decoder marker associated with relay **2808** or with a corresponding relay of some other decoder marker connector circuit. The ground over the lower back contact of relay **2808** connects over conductor **2821**, over a chain circuit extending over the lower back contacts of the relays corresponding to relay **2808**, associated with the same decoder marker and located in the other decoder marker connector circuits (not shown), and back over conductor **2822**, to battery through the winding of relay **2823**. Relay **2823** is therefore normally operated as long as no decoder marker connector circuit has connected to the decoder marker associated with relay **2808** and the corresponding relays in the other decoder marker connector circuits.

Upon its operation, relay **2808** opens the aforementioned chain circuits thereby releasing relays **2820** and **2823** and preventing the operation of any start relay corresponding to relay **2808**, associated with the same decoder marker in the other decoder marker connector circuits. In addition, relay **2808** operates relays **2702** and **2809** from battery through their windings in parallel, over its upper front contact, to the chain circuit ground supplied over conductor **2819**. Relay **2809**, in operating, connects ground over a front contact to conductor **2824** which extends to the decoder marker circuit and the function of which will later be set forth, and operates relay **2810** from battery through the winding of that relay to ground over its inner front contact. Relays **2702**, **2809**, and **2810**, in operating, extend the control conductors from the sender through to the decoder marker circuit shown in Figs. 29 to 40, inclusive. Relay **2810** also connects ground over a front contact to lamp **2825**, the function of which will be described later.

Each subscriber sender of the group connected to any decoder marker connector circuit prefers a particular decoder marker circuit. If the preferred decoder marker is unavailable, however, the sender is connected to the nearest idle decoder marker in the sequence preference. For illustration, the sender shown in Figs. 22 to 26, inclusive, prefers the decoder marker shown in Figs. 29 to 40, inclusive, since the operation of relay **2801** operates relay **2808** provided that the connector busy relay **2816** is unoperated indicating that the decoder marker with which it is associated is idle. Should relay **2816** be operated, in a manner which will subsequently be described, indicating that the associated decoder marker is unavailable, relay **2801** will cause some other decoder start relay, for example, relay **2811**, to operate provided its associated connector busy relay **2817** is unoperated indicating that its associated decoder marker is idle. When relay **2810** operated, during the establishment of the connection to the decoder marker of Figs. 29 to 40, inclusive, as hereinbefore set forth, it opened the operating circuit for relay **2816** and connected ground over its outer front contact to conductor **2826**. This ground on conductor **2826** operates relay **2827** and also operates corresponding relays in all other decoder marker connector circuits. The operation of relay **2827** is ineffective since the circuit extending from its armature is opened at the back contact of the operated relay **2810**. In all other decoder marker connector circuits, however, the operation of the relay corresponding to relay **2827** connects battery over its front contact and over the back contact of the relay corresponding to relay **2810**, to ground through the upper winding of the relay corresponding to relay **2816** which operates and transfers the operating circuit for the decoder marker start relay corresponding to relay **2808** to the start relay of the next available decoder marker in the other decoder marker connector circuits. Whenever relay **2816**, or a similar relay such as relay **2817**, operates and indicates that its associated decoder marker is unavailable to that particular decoder marker connector circuit, it locks through its lower winding and front contact provided that the decoder marker connector circuit is in use at that time in which case some sender connecting relay, such as relay **2802** or **2805**, is operated. In this manner relay **2816** cannot release and prematurely release a decoder start relay, such as relay **2811**, even though the circuit through its upper winding is opened by the release of relay **2827** after the decoder marker associated therewith again becomes available. This prevents a decoder marker connector which has started to connect to some decoder marker other than its first choice from abandoning that decoder marker and going to an earlier choice decoder marker should one become idle at that particular time.

Any decoder marker may be rendered busy to any decoder marker connector circuit or to all decoder marker connector circuits by the insertion of a make-busy plug into the proper connector busy or decoder marker busy jack associated with that particular decoder marker. For example, if it is desired to make the decoder marker shown in Figs. 29 to 40, inclusive, busy to the decoder marker connector circuit shown in Figs. 27 and 28, plug **2829** is inserted into connector busy jack **2830** thereby operating relay **2816** which functions as previously described. If it is desired to make the decoder marker busy to all decoder marker connector circuits, plug **2831** is inserted into jack **2832** thereby operating relay **2833**. Relay **2833**, in operating, connects ground to conductor **2826**, operating relay **2827**, and operating relays corresponding to relay **2827** of the other decoder marker connector circuits. Relay **2827** operates relay **2816** through its upper winding over the back contact of relay **2810**. Relay **2816** transfers the decoder start relay operating

circuit as previously described. The relays corresponding to relay **2827** of the other decoder marker connector circuit operate their respective associated relays, corresponding to relay **2816**, which function in a similar manner. Relays **2834**, **2835**, **2836**, and **2837**, plugs **2838** and **2840**, and jacks **2839** and **2841** correspond to relays **2820**, **2823**, **2827**, and **2833**, plugs **2829** and **2831**, and jacks **2830** and **2832**, respectively, and function in a similar manner in connection with another decoder marker circuit (not shown).

When relay **2814** operated in series with sender start relay **2800** upon the connection of the sender to the decoder marker connector circuit, conductor **2815** of the timing circuit was grounded as hereinbefore set forth. Upon the subsequent operation of relay **2802** this ground was removed from conductor **2815** and the timing circuit restored to normal before sufficient time had elapsed for it to function. Should relay **2802** fail to operate for any reason, the ground is maintained on conductor **2815** and causes the timing circuit to function and give an audible indication of this condition in the following manner. With conductor **2815** grounded, the first closure of the left contact of interrupter **2842** operates relay **2843**. Relay **2843** locks over its left front contact to ground on conductor **2815** and closes a circuit from the right contact of interrupter **2842**, over its right front contact to battery through the winding of relay **2844**. When interrupter **2842** then closes its right front contact after an interval, relay **2844** operates to the ground on conductor **2815**. Relay **2844** locks over its right inner front contact to ground over conductor **2815** and connects this ground, over its left outer front contact, to alarm lamp **2845** and to the audible signal **2846**, lighting the lamp and causing the signal to sound. Lamp **2845** and signal **2846** are common to all decoder marker connector circuits, as indicated by multiple strap **2850**. The location of the circuit causing the alarm indication may now be determined by the operation of key **2851** which, in this instance, lights signal lamp **2825**. Lamp **2825** identifies the particular decoder marker connector circuit causing the alarm condition. The speed of rotation of the cam of interrupter **2842** is such that relay **2844** will not operate and give the alarm unless conductor **2815** remains grounded for an interval greater than that required for the normal operation of relay **2802** after the sender connects to the decoder marker connector circuit.

When relay **2802** operates upon the connection of the sender to the decoder marker connector circuit, it closes a circuit from ground over a front contact to conductor **2847** which connects to the timing circuit. Under normal operation, the sender, when it has finished with the decoder marker circuit, releases the decoder marker connector circuit, in a manner which will be set forth later, thereby releasing the various operated sender and decoder marker start and connecting relays, such as relays **2700**, **2702**, **2800**, **2801**, **2802**, **2808**, **2809**, and **2810** in the case of the connection hereinbefore established. The release of relay **2802** removes the ground from conductor **2847** before the timing circuit can function. Should the sender fail to release the decoder marker connector circuit after a given interval, relay **2802** remains operated and the timing circuit causes an alarm indication to be given in the following manner: With ground on conductor **2847** the first closure of the right contact of interrupter **2848** operates relay **2849** which locks over its right front contact to ground on conductor **2847**. Upon the subsequent closure of the left contact of interrupter **2848**, relay **2844** operates over the left front contact of relay **2849**. Relay **2844** causes alarm lamp **2845** to light an audible signal **2846** to sound. The operation of key **2851** at this time lights lamps **2818** and **2825** to identify the particular sender and the particular decoder marker connector circuit which is causing the alarm indication. The speed of rotation of the cam of interrupter **2848** is such that relay **2844** will not operate and bring in the alarm if the sender releases the decoder marker connector circuit in the normal time required for this release to take place. Signal lamp **2852** is associated with sender connecting relay **2805** and performs the same function in connection with that relay as signal lamp **2818** performs in connection with relay **2802**.

Record transferred from sender to marker

Referring now to the decoder marker circuit shown in Figs. 29 to 40, inclusive, the first function of this circuit upon its connection with a sender is to receive and record the office code, class of service, and district frame information from the sender and to check the integrity of the conductors over which this information is received. The first digit of the dialed office code is recorded on register relays **3500** to **3503**, inclusive; register relays **3504** to **3507**, inclusive, record the second office code digit and relays **3508** to **3513**, inclusive, record the third digit of the office code. Relays **3514** to **3517**, inclusive, record the class of service required by the calling subscriber. Register relays **3200** to **3205**, inclusive, of Fig. 32, record the number of the district frame. Five check relays, relays **3518** to **3522**, inclusive, of Fig. 35 are provided for the purpose of checking the conductors over which the decoder marker receives the foregoing information from the sender for continuity and for false grounds.

Upon the previous operation of relays **2700** and **2702**, which close the various conductors from the sender to the decoder marker, a circuit was also closed from ground over front contact **2704** of relay **2700**, and over a front contact of relay **2702** to conductor **2705**. The purpose of this ground on conductor **2705** is to provide for operating and locking the checking relays as will subsequently be described. District frame register relay **3202** now operates in a circuit from battery through its winding, over conductor **3206**, a front contact of relays **2702** and **2700**, conductor **2614**, to ground over a front contact of cross-points **2613** of the sender cross-bar register switch. District frame register relays **3200**, **3201**, and **3203** operate over conductors **3207**, **3208**, and **3209**, respectively, over front contacts of relays **2702** and **2700**, over conductors **2616**, **2617**, and **2618**, respectively, operated contacts of cross-points **2613**, conductor **2615**, front contacts of relays **2700** and **2702**, conductor **2706**, to ground over the upper back contact of check relay **3521**. District frame relays **3204** and **3205** operate from battery through their windings in parallel, over conductor **3210**, front contacts of relays **2702** and **2700**, conductor **2225**, lower front contact of relay **2220**, conductor **2224**, upper outer back contact of relay **2322**, to the previously traced ground over conductor **2615**. Class of service register relay **3514** operates from battery through its winding, over conductor **3523**, front contact of relays **2702** and **2700**, conductor **2216**, to ground over a front contact of the sender class of service

relay 2215. Class of service relays 3515 to 3517, inclusive, operate in circuits over conductors 3524, 3525, and 3526, respectively, front contacts of relays 2702 and 2700, conductors 2219, 2218, and 2229, respectively, front contacts of relay 2215, conductor 2217, front contact of relay 2700 and 2702, conductor 2707, to ground over the upper middle back contact of check relay 3522.

The first office code digit register relays 3501 and 3503 are operated from battery through their windings, over conductors 3527 and 3528, respectively, front contacts of relays 2702 and 2700, conductors 2640 and 2642, respectively, to ground over the front contact of cross-points 2625 of the sender register switch. Register relays 3500 and 3502 are operated over conductors 3529 and 3530, respectively, front contacts of relays 2702 and 2700, conductors 2639 and 2641, respectively, front contact of cross-points 2625 of the sender register switch, to the previously traced ground on conductor 2217. The second office code digit register relay 3505 operates over conductor 3531, front contacts of relays 2702 and 2700, conductor 2644, to ground over the operated cross-points 2633 of the sender register switch. Register relays 3504, 3506, and 3507 operate over conductors 3532 to 3534, respectively, front contacts of relays 2702 and 2700, conductors 2643, 2645, and 2646, respectively, operated contact of cross-points 2633, conductor 2651, front contacts of relays 2700 and 2702, conductor 2708, to ground over the upper outer back contact of check relay 3522. The third office code digit register relays 3509 and 3513 operate from battery through their windings in parallel, over conductor 3535, front contacts of relays 2702 and 2700, conductor 2648, front contact of cross-points 2636 of the sender register switch, to ground. Register relays 3508 and 3512, in parallel, and relays 3510 and 3511 operate over conductors 3536 to 3538, respectively, front contacts of relays 2702 and 2700, conductors 2647, 2649, and 2650, respectively, front contacts of sender register switch cross-points 2636, to the previously traced ground on conductor 2651.

All of the decoder marker register relays are now operated and by their operation indicate the continuity of the conductors extending from their windings to the sender circuit. Check relay 3518 now operates over a chain circuit extending over the left inner front contacts of relays 3503, 3502, 3501, 3500, 3507, 3506, 3505, and 3504 to ground on conductor 2705. Check relay 3519 operates over a chain circuit extending over the left inner front contacts of relays 3511, 3510, 3509, 3508, 3512, and 3513 to ground on conductor 2705. Check relay 3520 operates over a circuit extending over conductor 3539, over a chain circuit extending over the upper front contacts of relays 3205 and 3204, inner front contacts of relays 3200 to 3203, inclusive, conductor 3211, right inner front contacts of relays 3517, 3516, 3515, and 3514 to ground on conductor 2705. Relays 3518 and 3519, in operating, lock over their lower outer front contacts and over the lower back contact of relay 3522 to ground on conductor 2705. Relay 3520 locks over its lower outer front contact and over the lower back contact of relay 3521 to the same ground. Check relay 3522 now operates from battery through its winding, over the lower inner front contacts of relays 3519 and 3518 to ground. Relay 3522, in operating, locks over its lower inner front contact to ground on conductor 2705, and removes the ground from conductors 2707 and 2708. Relay 3520, in operating, operates check relay 3521 which locks over its lower front contact to ground on conductor 2705 and removes the ground from conductor 2706. The removal of ground from conductors 2706 to 2708, inclusive, by the operation of relays 3521 and 3522 releases all decoder marker register relays which are not operated directly from the sender circuit, only register relays 3202, 3501, 3503, 3505, 3509, 3513, and 3514 remaining operated. The release of the other register relays opens the chain circuit over which relays 3518 to 3520, inclusive, are operated and these latter relays therefore release since their locking circuits were opened by the operation of relays 3521 and 3522.

Translator and route switch operated

Upon the operation of relay 3522 and the release of relay 3518 a circuit is completed from ground over the upper front contact of relay 3522, upper outer back contact of relay 3518, left back contacts of relays 3506 and 3507, left outer front contact of relay 3505, left inner back contact of relay 3504, conductor 3540, to battery through the windings of select magnets 4000, 4001, 4002, and 4003 of the four translating cross-bar switches 4004 to 4007, inclusive, of Fig. 40, operating these select magnets. Hold magnets 4008 to 4011, inclusive, of these switches now operate in a circuit from battery through their windings in parallel, over conductor 3541, right outer front contact of relay 3501, right back contact of relay 3500, left middle front contact of relay 3503, left back contact of relay 3502, conductor 4012, and front contacts of select magnets 4003, 4002, 4001, and 4000, to ground. The operation of hold magnets 4008 to 4011, inclusive, cause cross-point contacts 4013 to 4016, inclusive, to close since these said contacts were prepared for closure by the operation of select magnets 4000 to 4003, inclusive.

Each cross-point contact of switches 4006 and 4007 connects to the winding of a select magnet of a route switch such as is shown in Fig. 33. Each cross-point contact of switches 4004 and 4005 connects to the windings of a pair of hold magnets of the same route switch. For simplicity, only one each of these connections is shown, that extending from the middle front contact of cross-point 4015, over conductor 4017, to the winding of select magnet 3303, and that extending from the middle front contact of cross-point 4013, over conductor 4018, to the windings of route switch hold magnets 3304 and 3305.

Select magnet 3303 operates in a circuit from battery through its winding, over conductor 4017, contact of cross-point 4015, conductor 3542, left inner back contact of relay 3508, left outer front contact of the previously operated register relay 3509, left inner back contact of relays 3511 and 3510, inner back contact of relay 3519, lower outer front contact of the operated check relay 3522, conductor 3302, back contact of relay 3301, right inner back contact of relay 3300, conductor 3101, to ground over a front contact of relay 3100 which previously operated when ground was placed on conductor 2824 by the decoder marker connector circuit as hereinbefore set forth. The operation of select magnet 3303 prepares cross-points 3306 to 3309, inclusive, and cross-points 3322 and 3323 for operation and also causes hold magnets 3304 and 3305 to operate. The circuit for hold magnets 3304 and 3305 is traceable from battery through their windings, over conductor 4018, contact of cross-point 4013, conductor 4019, left inner back contact of relay 3512, left outer front

contact of the operated register relay **3513**, left middle back contact of relay **3511**, left outer back contact of relay **3510**, conductor **3543**, upper outer back contact of relay **3310**, front contact of select magnet **3303**, back contacts of select magnets **3311** and **3312**, to ground. The operation of hold magnets **3304** and **3305**, with select magnet **3303** previously operated, cause route cross-points **3306** and **3307** of the route switch to close.

The route cross-bar switch, such as is shown in Fig. 33, is provided with ten vertical and ten horizontal rows of contact sets. Each route requires one pair of horizontal cross-points, such as cross-points **3306** and **3307**, and the switch therefore has provision for fifty routes. For simplicity of illustration only three of the ten horizontal rows of contact sets and six of the vertical rows of contact sets are shown. Six of the contacts of each pair of cross-points which represent a particular routing provide for setting up and transmitting such information to the subscriber sender as that circuit requires to properly control the selections to be made later at the intermediate office or offices (if any) and at the terminating office in the completion of the connection. Other contacts of the route cross-points provide for determining the pair of office frames on which the particular group of trunks is located, the trunk level on the office switches in which this trunk appears, and the particular location of the trunk group with respect to the group of forty trunks on the indicated office switch level. Another route cross-point contact transmits talking selection and zone information to the district trunk. A twelfth contact provides for setting up of an alternate route (if provided) or of an overflow route, in the event that the regular route is unavailable.

All sets of route cross-points which are used for regular routes and for which it is not necessary to differentiate between the different classes of service to which the calling subscribers are entitled are grouped together in the same vertical rows of the route switch. Three of these regular route cross-point sets are shown in the two right vertical rows of the switch shown in Fig. 33, namely, cross-points **3308** and **3309**, **3313** and **3314**, and **3315** and **3316**. The corresponding armatures of these cross-points are multipled in each vertical row and extend over conductors **3400** to **3410**, inclusive, to front contacts on relay **3411** which is the ground supply relay for these route cross-points. Relay **3411** operates as soon as the decoder marker is seized. The operating circuit for relay **3411** is traceable from battery through its winding, over conductor **3412**, back contact of relay **3317**, conductor **3101**, to ground over a front contact of start relay **3100**.

All sets of route cross-points which are used for regular routes on which it is necessary to differentiate between the class of service to which the calling subscriber is entitled are grouped together in other vertical rows of the route switch. Three of these route cross-point sets are shown in the two middle rows of the switch, namely, cross-points **3306** and **3307**, **3318** and **3319**, and **3320** and **3321**. The corresponding armatures of these cross-points are multipled in each vertical row and extend over conductors **3418** to **3428**, inclusive, to the front contact of ground supply and block relay **3429** which operates over a circuit which will later be described.

All sets of route cross-point contacts which are used for alternate routes are grouped together in other vertical contact rows of the route switch. Three of these route cross-point sets are shown in the two left vertical rows of the route switch, namely, cross-points **3322** and **3323**, **3324** and **3325**, and **3326** and **3327**. The corresponding armatures in one vertical row of these alternate route cross-points are multiplied and connect directly to ground. The corresponding armatures of the other vertical row of these cross-points are also multipled and extend over conductors **3413** to **3417**, inclusive, to various points in the decoder marker where they connect to ground over circuits which will later be described in detail.

In addition to the routes provided by the cross-points of the route cross-bar switch, several other routings are obtained by the use of multi-contact relays. Relay **3430**, whose contacts perform functions similar to the cross-points of the route switch, provides for routing the call to a group of overflow trunks in the event that all trunks, both regular and alternate routes (if provided), are found busy. Service group relay **3431**, which functions in connection with the service relays shown in the upper portion of Fig. 40, provides for routing a call to a group of operator trunks in those cases where a subscriber dials a code representing a destination to which he is not entitled. The manner in which the service group and service relays function is set forth in the succeeding paragraph.

In the foregoing description, it was assumed that the class of service to which the calling subscriber originating the particular call under consideration is entitled was such that class of service register relay **3514** of the decoder marker was operated from the sender circuit. Upon the previous release of check relay **3520** a circuit was closed from ground over the upper outer front contact of relay **3521**, upper back contact of relay **3520**, left outer back contacts of relays **3517**, **3516** and **3515**, left outer front contact of relay **3514**, conductor **3544**, to battery through the winding of service relay **4020** and service check relay **4021** in series. Relay **4020** operates but check relay **4021**, which has marginal characteristics, does not operate. Relay **4020**, in operating, operates relay **4023** in a circuit from battery through the winding of relay **4023**, over the left outer front contact of relay **4020**, conductor **4024**, upper contact of the previously operated cross-point **3307**, to ground. Relay **4023**, in operating, closes a circuit from the operating ground just traced to its winding, over its inner front contact, conductor **4025**, left back contact of relay **3317**, conductor **3328**, to battery through the winding of the ground supply block relay **3429** which operates. Relay **3429**, in operating, closes through the conductors which extend to the armatures of the operated route cross-points **3306** and **3307**. In this foregoing illustration, the code dialed by the calling subscriber, as represented by the operated cross-points **3306** and **3307**, was unrestricted to this subscriber and the subsequent operation of relay **3429** completed the circuits for making route cross-points **3306** and **3307** effective. To illustrate the manner in which the circuit functions where a subscriber dials a restricted destination, let it be assumed that the class of service which causes the decoder marker class of service register relays **3514** to **3517**, inclusive, all to operate is one to which access to the destination represented by route cross-points **3306** and **3307** is restricted. In this instance, the call progresses up to and including the operation

of cross-points 3306 and 3307 in the same manner as previously described with the exception that service relay 4022 instead of service relay 4020 is operated. The operating circuit for relay 4022 is traceable from battery through its winding, over conductor 4026, next-to-inner right front contacts of the operated class of service register relays 3517, 3516, 3515, and 3514, upper outer back contact of relay 3520, to ground over the upper outer front contact of relay 3521. Upon the closure of route cross-points 3306 and 3307, a circuit is completed from ground over the upper armature and front contact of cross-point 3307, over conductor 4024, left outer front contact of service relay 4022, conductor 4027, to battery through the winding of service group route relay 3431 and service group check relay 3432 in series. Relay 3431 operates but relay 3432, having marginal characteristics, does not operate. The armatures of relay 3431 extend to front contacts of the previously operated ground supply relay 3411. The front contacts of relay 3431 close circuits which perform functions similar to the route cross-points of the cross-bar route switch except that in this instance the call will be routed to an operator instead of being completed to the destination dialed. Since relay 3429 does not operate under these conditions, the regular route cross-points 3306 and 3307 are ineffective. As indicated by strap 3433, the winding of the marginal service group route check relay 3432 is multipled to the winding of all service group route relays, such as relay 3431. Similarly, the winding of the service check relay 4021 is multipled to the windings of all service relays such as relays 4020 and 4022. As hereinbefore set forth, these check relays 3432 and 4021 have marginal characteristics and do not operate in series with any one of their associated service group route relays and service relays, respectively. Should more than one service group route relay or more than one service relay operate simultaneously due to a trouble condition, the associated marginal check relay receives sufficient current to operate and causes the decoder marker to transmit a release signal to the sender which thereupon releases from this decoder marker and chooses and connects to a second decoder marker in a manner which will later be set forth in detail. The contacts of check relays 3432 and 4021 are grounded and the armatures of these relays extend to a timing circuit (not shown) which, after a predetermined interval, transmits the trouble release signal to the sender in a manner which is described and illustrated in the patent of S. B. Williams, 1,601,053, September 28, 1926, to which reference is hereby made for an understanding of the various operations involved, but not specifically described herein.

The armatures and contacts of overflow route relay 3430 perform functions similar to the contacts of cross-points on the cross-bar route switch and provide for routing a call to a group of overflow trunks in those cases where all trunks of a group of a desired route are busy and no alternate routing is provided, and also in those cases where all trunks of a group of a regular route and also all trunks of the associated alternate route group are busy. Whenever all trunks of a group are found busy, certain operations take place in the decoder marker and cause the operation of relay 3317 and the subsequent operation of relay 3329. The detailed operating circuits for relays 3317 and 3329 will be described in detail in subsequent paragraphs. As hereinbefore set forth, in connection with the particular call under consideration, select magnet 3303 and hold magnets 3304 and 3305 are operated. Upon the operation of hold magnet 3305, relay 3301 operated in a local circuit to ground over the front contact of magnet 3305. Relay 3301, in operating, opens the operating circuit for select magnet 3303 which releases, cross-points 3306 and 3307 now being held in their closed position by the operated hold magnets 3304 and 3305. Relay 3310 now operates in a circuit from battery through its winding over the outer front contact of relay 3301, and the back contact of select magnets 3303, 3311, and 3312, to ground. The release of select magnet 3303 and the operation of relay 3310 opens the operating circuit for hold magnets 3304 and 3305, these magnets remaining locked, operated in a circuit traceable from battery through their windings in parallel, over the front contact of magnet 3304, left back contact of relay 3300, conductor 4012, and front contact of select magnets 4003, 4002, 4001, and 4000, to ground. Should all trunks of the regular group extending to the destination represented by route cross-points 3306 and 3307 subsequently test busy, certain operations, which will later be set forth in detail under the description of the trunk testing, take place in the decoder marker and cause the operation of relay 3317 followed by the operation of relay 3329. Relay 3317, in operating, opens the operating circuit for relays 3411 and 3429, both of which release. The release of relay 3429 opens all conductors which extend from its contacts to the armatures of cross-points 3306 and 3307 thereby making these cross-points ineffective with the exception of the upper contact of cross-point 3307 which is grounded directly. Relay 3329 now operates in a manner which will later be described and completes a circuit from ground over a right front contact of relay 3100, conductor 3101, right inner back contact of relay 3300, inner front contact of relay 3301, lower inner front contact of relay 3310, right outer back contact of relay 3300, outer front contact of relay 3329, conductor 3330, outer front contact of relay 4023, conductor 4029, to battery through the winding of the cross-bar route switch select magnet 3311, causing that select magnet to operate. Magnet 3311, in operating, completes a circuit from ground over the back contact of select magnet 3312, front contact of select magnet 3311, upper outer front contact of relay 3310, to battery through the winding of hold magnets 3331 and 3332 in parallel. Hold magnets 3331 and 3332 in operating with select magnet 3311 previously operated, cause the alternate route cross-points 3324 and 3325 to close. Relay 3333 operates in a circuit from battery through its winding, to ground over the upper contact of cross-point 3325 and, over its outer front contact, prepares the operating circuit for relay 3300. In this case, the contacts of the alternate route cross-points 3324 and 3325 perform functions similar to those which will later be set forth for the contacts of the regular route cross-points 3306 and 3307 except that an idle trunk in the alternate instead of the regular trunk group will be selected and that the information transmitted to the sender will be such as to enable the sender to properly complete the connection over this alternate route.

In the event that all trunks of the alternate route trunk group are busy, the decoder marker

functions during the trunk test period and causes first relay 3300 and then relay 3334 to operate in a manner which will subsequently be described. Relay 3300, in operating, opens the holding circuit for hold magnets 3304 and 3305 and these magnets release thereby allowing the regular route cross-points 3306 and 3307 to restore to their normal unoperated positions. The operation of relay 3300 also opens the operating circuit for select magnet 3311 and the holding circuit for relay 3310 and both said select magnet and relay release. The release of select magnet 3311 opens the operating circuit for hold magnets 3331 and 3332 which release and allow the alternate route cross-points 3324 and 3325 to restore to their normal positions. The release of hold magnet 3332 also opens the circuit through the winding of relay 3301 which thereupon releases. Relay 3310 may momentarily reoperate over its original operating circuit traceable from battery through its winding, over the outer front contact of relay 3301, to ground over the back contact of select magnets 3303, 3311, and 3312, before relay 3301 releases but hold magnets 3331 and 3332 cannot reoperate since their operating circuit is opened at the front contact of the released select magnets 3303, 3311, and 3312. Relay 3334, upon its subsequent operation, operates overflow route relay 3430 in a local circuit over conductor 3349. The contacts of relay 3430 perform functions similar to those performed by the route switch cross-points except that in this case the call is routed to one of a group of overflow trunks as will be set forth later.

Where no alternate route is provided, the operating circuit for the overflow route relay 3430 is directly under control of the regular route cross-points and relay 3329. This condition is illustrated in connection with route cross-points 3313 and 3314 which represent a destination for which no alternate route is provided. Assuming that cross-points 3313 and 3314 are operated and that all trunks of the group associated therewith are busy, the decoder marker functions and causes relays 3317 and 3329 to operate in a manner which will later be described. Relay 3317, in operating, releases the previously operated ground supply relay 3411 which, in turn, opens the circuits which extend to the various contacts of cross-points 3313 and 3314 thereby making that pair of route cross-points ineffective. Since it is assumed that cross-points 3313 and 3314 are operated, both select magnet 3311 and hold magnets 3336 and 3337 previously operated to cause the operation of these aforementioned cross-points. The operation of hold magnet 3337 operated relay 3301 which, in turn, caused the operation of relay 3310 in a circuit from battery through the winding of relay 3310, over the outer front contact of relay 3301, back contact of select magnet 3303, front contact of select magnet 3311, and back contact of select magnet 3312, to ground. With relay 3310 operated, the operation of relay 3329 completes a circuit from the previously traced operating ground at the winding of relay 3310, lower inner front contact of relay 3310, right outer back contact of relay 3300, outer front contact of relay 3329, upper contact of cross-points 3314, conductor 4035, to battery through the winding of the overflow route relay 3430 which operates and causes the call to be routed to one of the group of overflow trunks. Relay 3430, in operating, also closes a circuit from ground over its right outer front contact, over conductor 4034, lower contact of cross-points 3314 to battery through register 3338. Register 3338 operates and records the fact that there was no available trunk to the desired destination and that the call was routed to an overflow trunk.

Routes for which alternate routes are provided may also be provided with registers which record the number of times that all of the regular route trunks are busy and the call is rerouted over the alternate route. This arrangement is illustrated in connection with the route represented by route cross-points 3306 and 3307. When all regular route trunks associated with these aforementioned cross-points are busy, this fact is recorded on register 3339 which operates in a circuit from battery through its winding, over the lower contact of cross-point 3307, to ground over the left front contact of relay 3333, this latter relay operating from the alternate route cross-points 3323 as previously set forth. Alternate routes may also be provided with registers which record the number of times that the decoder marker routes the call to an overflow trunk due to all trunks of a particular alternate route being unavailable. This arrangement is illustrated in connection with alternate route cross-points 3324 and 3325. As previously set forth the decoder marker, upon finding no available alternate route trunks, functions and causes relays 3300 and 3334 to operate. Relay 3334, in operating, operates overflow route relay 3430 for the purpose of routing the call to an overflow trunk. Upon the operation of relay 3430, a circuit is completed from ground over its right outer front contact, conductor 4034, lower contact of cross-point 3325, to battery through the winding of register 3335. Register 3335 operates and records the fact that no trunk of the particular alternate route with which it is associated was available at that time.

Route cross-points 3306 and 3307 having operated, as hereinbefore set forth, the information necessary for the sender to properly control the subsequent selective operations at the desired distant office in the completion of the connection is now transmitted by the decoder marker to the sender. Upon the operation of start relay 3100 at the time of the seizure of the decoder marker, relay 3600 operated in a circuit from battery through its winding, over conductor 3601, to ground over a right front contact of relay 3100. Relay 3600, in operating, supplies ground over its various front contacts to the decoder marker transmitting relays of which the office brush and office group relays are shown in Fig. 36, the extra or second office brush and extra or second office group relays in Fig. 37, the compensating resistance and class relays in Fig. 38 and the zone relays in Fig. 39. With both relays 3100 and 3429 operated, as previously set forth, a circuit is closed from ground over a right front contact of relay 3100 over conductor 3102, the right front contacts of relay 3429, and over conductors 3418 to 3423, inclusive, to each pair of contacts of route cross-point 3306. Each of the six contacts of cross-point 3306 connects to the winding of a decoder marker transmitting relay, the particular relay to which each contact connects depending upon the selective operation which the sender is required to control in the completion of the call over the particular route represented by cross-points 3306 and 3307.

Transfer of decoded information to sender

Assuming that the call is to be routed through

an intermediate office equipped with moving type switches, such as panel switches, and that the route represented by cross-points **3306** and **3307** requires the selection of office brush **1** and office group **5** of the first distant office selector and that no second distant office selector is involved in the connection, the necessary information for controlling these selections is transmitted to the sender in the following manner: As previously set forth, all of the contacts of cross-point **3306** are grounded under control of the operated relays **3100** and **3429**. The first office brush transmitting relay **3602** operates in a circuit traceable from battery through the winding of relay **3603**, winding of relay **3604** and upper winding of relay **3602**, conductor **3340**, and over a closed set of contacts of cross-point **3306** to the previously traced ground. Relay **3604** also operates in this aforementioned circuit, but relay **3603**, which has marginal characteristics, does not operate. Upon the operation of relay **3602**, a circuit is closed from ground over the upper outer front contact of relay **3600**, winding of relay **3605**, inner front contact of relay **3602**, outer back contacts of relays **3606**, **3607**, and **3608**, conductor **3609**, a front contact of the operated multi-contact decoder marker connecting relay **2702** and sender connecting relay **2700**, conductor **2709**, continuation of conductor **2709** in Fig. 25, and through the upper winding of the sender first office brush relay **2500** to battery. Relay **2500**, in operating, partially closes its locking circuit which may be traced from battery through its lower winding and over its lower front contact, over conductor **2501**, upper outer front contact of relay **2325**, to the upper armature of the as yet unoperated relay **2330**. Relay **3605**, the winding of which is in series with the upper winding of the sender first office brush relay **2500**, operates simultaneously with relay **2500**. Relays **3603**, **3604**, and **3605** are provided for the purpose of checking the first office brush information transmitted from the decoder marker to the sender and function in a manner which will subsequently be described. Should the route represented by cross-points **3306** and **3307** require the selection of some other brush of the first office selector, instead of office brush **1**, as illustrated, conductor **3340** would be connected to some other winding of one of the first office brush transmitting relays. Assuming, for example, that the selection of brush **3** of the first office selector is required, conductor **3340** in this case connects to the lower winding of the office brush transmitting relay **3606** and relay **3606** operates in a circuit from ground on conductor **3340** from the operated route cross-point, through the lower winding of relay **3606**, windings of relays **3610** and **3603** in series, to battery. Relay **3610** operates in the aforementioned circuit but marginal relay **3603** does not operate. With relays **3606** and **3610** operated, conductors **3609**, **3611**, and **3612** which extend to the sender are grounded and cause the operation of sender relay **2500** and two additional sender relays, thereby preparing the sender for selecting brush **3** of the first office selector. The ground for operating the three sender relays in this case is supplied in circuits which are traceable from ground over the upper outer front contact of relay **3600** through the winding of relay **3605**, inner front contact of relay **3606**, outer back contact of relay **3613**, middle back contact of relay **3608**, to conductor **3611**; from the ground over the upper outer front contact of relay **3600**, through the winding of relay **3614**, outer front contact of relay **3606**, outer back contact of relays **3607** and **3608**, to conductor **3609**; and from the ground over the upper outer front contact of relay **3600** through the winding of relay **3615**, front contact of relay **3610** to conductor **3612**. Relays **3605**, **3614**, and **3615** each operate to the battery supplied through the lower winding of the respective sender relay, such as relay **2500**, to which they are connected over conductors **3609**, **3611**, and **3612**. Relays **3605**, **3614**, and **3615** prepare a checking circuit which will subsequently be described.

The information necessary to prepare the sender for controlling the selection of group **5** of the first office selector is transmitted in the following manner. The previously traced ground at the contacts of cross-points **3306** extends over an operated set of contacts of those cross-points and over conductor **3341** which is cross-connected to the lower winding of the first office group transmitting relay **3616**. Relay **3616** operates through its lower winding to battery through the winding of relays **3617** and **3618** in series. Relay **3617** also operates in this aforementioned circuit but relay **3618**, having marginal characteristics, does not operate. Relay **3616**, in operating, closes in part a checking circuit which will be described later. Relay **3617**, in operating, closes a circuit traceable from ground over the upper inner front contact of relay **3600**, through the winding of relay **3619**, over the front contact of relay **3617**, conductor **3620**, a front contact of connecting relays **2702** and **2700**, conductor **2710**, continuation of conductor **2710** in Fig. 25, and through the upper winding of the sender first office group relay **2502** to battery. Relays **2502** and **3619** both operate, relay **2502** partially closing a future locking circuit over its lower front contact to conductor **2501**. Relay **3619**, in operating, closes a portion of the checking path already partially closed by the previous operation of relays **3602**, **3604**, **3605**, and **3616**. For any first office group, other than group **5**, conductor **3341** would be cross-connected to some other upper or lower winding of the first office group transmitting relays **3616** and **3621** to **3625**, inclusive, the particular relay and winding thereof depending upon the first office group selection desired. The operation of a particular office group transmitting relays **3616** or **3621** to **3625**, inclusive, together with the operation of either series relay **3617** or **3626**, depending upon which winding of the office group transmitting relay is energized, grounds one or two of the conductors **3620** and **3627** to **3629**, inclusive, which extend through the winding of the sender first office group relays and cause the operation of those relays in a manner similar to that described for the operation of the sender first office group relay **2502** by the ground supplied over conductor **3620**. Had there been no distant office selector involved in the route represented by route cross-points **3306** and **3307**, conductor **3341** would cross-connect to the upper winding of relay **3625** instead of to the lower winding of relay **3616**. Under this condition, relays **3625** and **3626** operate in series and conductor **3630** would be grounded in a circuit traceable over the inner front contact of relay **3625**, winding of relay **3631**, to ground over the inner front contact of relay **3600**. Conductor **3630** extends over a front contact of connecting relays **2702** and **2700**, over conductor **2711**, continuation of conductor **2711** in Fig. 25, to battery through the upper winding of the sender skip office relay **2503**. Relays **2503** and **3631** operate in series, the

operation of relay 2503 indicating to the sender that no first office selection is required.

Since it has been assumed that there is no second office selector involved in the selected route as represented by route cross-points 3306 and 3307, the decoder marker transmits only such information to the sender to inform that circuit to skip the second office selections. In this instance, conductor 3342 is cross-connected to the upper winding of the second office brush transmitting relay 3708 and conductor 3343 is cross-connected to the upper winding of the second office group transmitting relay 3701. Relay 3708 operates from the previously traced ground on conductor 3342, through its upper winding and through the windings of relays 3702 and 3703, to battery. Relay 3702 also operates in this series circuit but relay 3703, having marginal characteristics, does not operate. Relays 3700 and 3702, in operating, extend the chain checking circuit which will be described later. It will be noted that none of the second office brush selection transmitting conductors 3704, 3705, and 3706 are grounded in this instance since it is not required to operate any of the second office brush selection relays of the sender. The ground over conductor 3343 from route cross-point 3306 operates the second office group transmitting relays 3701 in a circuit through its upper winding, and through the windings of relays 3707 and 3708 in series, to battery. Relay 3707 operates in series with relay 3701 but relay 3708, being marginal, does not operate. Relay 3701, in operating, closes a circuit from ground over a lower front contact of relay 3600, over conductor 3633, through the winding of relay 3709, over the inner front contact of relay 3701, conductor 3710, a front contact of connecting relays 2702 and 2700, conductor 2712, continuation of conductor 2712 in Fig. 25, to battery through the upper winding of the second skip office relay 2504 of the sender, thereby operating both relays 2504 and 3709. Relay 2504, in operating, closes in part its future locking circuit from battery through its lower winding and over its lower front contact to conductor 2501 and indicates to the sender that no second office selections are required. Relay 3709, in operating, extends the decoder marker transmitting relay checking circuit from the second office brush transmitting relays to the compensating resistance transmitting relays shown in the upper half of Fig. 38. This portion of the checking circuit may be traced from the armature of relay 3702 of the second office brush transmitting relays, over the upper front contact of relay 3701 and the front contacts of relays 3709 and 3707 of the second office group transmitting relays, to the compensating resistance transmitting relays, over conductor 3711. It will be noted that since no second office selections are required for the selected route, none of the second office group selection transmitting conductors 3712 to 3715, inclusive, is grounded.

The information which enables the sender to insert the proper compensating resistance in the loop during its subsequent control of the distant office selections and during trunk test is transmitted from the decoder marker under control of the compensating resistance transmitting relays shown in the upper portion of Fig. 38. Conductor 3345, which extends from a grounded contact of cross-point 3306, is cross-connected to one of the windings of one of the ten compensating resistance transmitting relays 3800 to 3809, inclusive, the particular relay and winding thereof depending upon the value of the compensating resistance required to be set up in the sender by the particular route selected. For the route represented by cross-points 3306 and 3307 it will be assumed that conductor 3345 is cross-connected to the upper winding of the compensating resistance transmitting relay 3802. Relay 3802 operates from the ground on conductor 3345 in a circuit through its upper winding, and through the windings of relays 3810 and 3811 in series, to battery. Relay 3810 also operates in this series circuit, but relay 3811, having marginal characteristics, does not operate. Relay 3802, in operating, connects ground to the compensating resistance transmitting conductor 3813 in a circuit traceable from that conductor, over the inner back contacts of relays 3806 and 3803, inner front contact of relay 3802, winding of relay 3812, conductor 3814, to ground over a front contact of relay 3600. This ground on conductor 3813 extends to the sender where it causes the operation of one of several compensating resistance relays. These sender compensating resistance relays are not shown, but are similar to the sender office brush and office group relays, having an operating winding and a locking winding which are connected in a manner identical with the similar respective windings of the sender office group relays, such as relay 2502, for example. Relay 3812 operates in series with the sender compensating resistance relay and extends the transmitting relay checking circuit. This checking circuit may be traced from conductor 3711, over the outer front contact of relay 3802, and over the front contact of relays 3812 and 3810 to the class of call transmitting relays shown in the lower portion of Fig. 38.

The information regarding the type or class of call is transmitted to the sender by means of the relays shown in the lower half of Fig. 38. One contact of each set of route cross-points is cross-connected to one of the windings of a class transmitting relay, the particular relay and winding thereof depending upon the class of the call represented by the route cross-point. In the case of route cross-points 3306 and 3307 the next to the lowest set of contacts of cross-point 3306 is shown cross-connected over conductor 3344 to the upper winding of class transmitting relay 3815. Relay 3815 operates from the ground over conductor 3344, through its upper winding, and through the windings of relays 3816 and 3817 in series, to battery. Relay 3816 operates in this series circuit, but relay 3817, being marginal, does not operate. Upon the operation of relay 3815 the class of call transmitting conductor 3818 is grounded in a circuit from that conductor, over the outer back contact of relay 3819, inner back contact of relay 3820, inner front contact of relay 3815, winding of relay 3821, and over conductor 3822 to ground over a lower front contact of relay 3600. Conductor 3818 extends over a front contact of connecting relays 2809 and 2801 to battery through the winding of one of several class of call relays (not shown) in the sender circuit. The particular sender class of call relay operates in series with relay 3821 which also operates and further extends the transmitting relay checking circuit. The extension of this checking circuit may be traced from the armature of relay 3818, over the outer front contact of relay 3815, front contacts of relays 3821 and 3816, and over conductor 3823, to the zone transmitting relays shown in Fig. 39.

One of the contacts of cross-point 3307 is

cross-connected over conductor **3346** to one of the windings of one of thirteen zone relays shown in the upper and lower portions of Fig. 39. In the case illustrated, conductor **3346** is connected to the upper winding of zone relay **3900**, and relay **3900** operates in a circuit traceable from battery through the windings of relays **3902** and **3901** in series, through the upper winding of relay **3900**, over conductor **3346**, a front contact of cross-point **3307**, conductor **3424**, a front contact of relay **3429**, conductor **3436**, to ground over a back contact of relay **3103**. Relay **3901** also operates in this aforementioned circuit, but relay **3902** being marginal does not operate. Relay **3900**, in operating, grounds conductor **3903** in a circuit traceable from that conductor, over the outer back contacts of relays **3904**, **3905**, **3906**, **3907**, and **3908**, inner front contact of relay **3900**, both windings of relay **3909**, and over conductor **3910** to ground over the lower inner front contact of relay **3600**. Conductor **3903** extends to the district frame connector circuit shown in Fig. 20 and its function will be set forth in the description of the operation of the district trunk circuit. Relay **3909**, in operating, completes a circuit for operating relay **3911**. This circuit may be traced from battery through the winding of relay **3911**, over the front contact of relay **3909**, conductor **3912**, to ground over the right outer front contact of relay **3100**. Relay **3911**, in operating, connects ground to both windings of relay **3909**, thereby shunting the upper operating winding of relay **3909** which thereupon releases. Upon the release of relay **3909**, relay **3913** operates in series with relay **3911** to the ground on conductor **3912**. The transmitting relay checking circuit previously traced to conductor **3823** is now extended over the front contacts of relays **3901** and **3913**, the outer front contact of relay **3900**, and over conductor **3914** to the lower middle armature of relay **3104** of Fig. 31 where it will function in a manner which will subsequently be described.

Each of the aforementioned decoder transmitting relays which operated was energized in series with a marginal relay such as relays **3603**, **3618**, **3703**, **3708**, **3811**, **3817**, and **3902**, as previously set forth. These marginal relays are provided to determine whether more than one transmitting relay in any group is operated at a time, thereby insuring the integrity of the information transmitted to the sender. Should more than one transmitting relay of any group operate, due to a trouble condition, the marginal relay associated with that group of transmitting relays receives sufficient current through its winding to operate. The contacts of each of these marginal checking relays is connected to ground and the armatures of these relays connect to a common conductor **3634** which in turn connects to a timing circuit (not shown). The grounding of conductor **3634** by the operation of any of the marginal checking relays causes the associated timing circuit to function and, after an interval, to connect a trouble indicating circuit (not shown) to the decoder marker to take a record of the trouble condition encountered and to send a release indication to the sender. The sender thereupon releases itself from the decoder marker in trouble and attaches itself to some other decoder marker for a second trial. The manner in which the timing circuit and the trouble indicating circuit function is well-known to the art and no further reference to their operation will be made herein.

All transmitting conductors between the decoder marker and the sender which are not grounded by the decoder marker on a particular call connect over the back contacts of the various transmitting relays with which they are associated and over the back contacts of a cut-off relay to battery through the windings of two trouble detecting relays **3716** and **3717**. For illustration, of the transmitting conductors associated with the first office brush transmitting relays shown in the upper half of Fig. 36, only conductor **3609** is grounded for the call being described, as previously set forth. The remaining conductors **3611**, **3612**, **3635**, and **3636** connect over the back contacts of the various unoperated first office brush transmitting relays, over upper back contacts of cut-off relay **3637**, and over conductor **3638** to battery through the winding of trouble detecting relay **3716**. The ungrounded conductors **3627** to **3630**, inclusive, which are associated with the first office group transmitting relays shown in the lower half of Fig. 36 connect over back contacts of the various unoperated first office group transmitting relays, over lower back contacts of cut-off relay **3637**, and over conductor **3638** to battery through the winding of relay **3716**. Similarly, all ungrounded conductors associated with the second office brush transmitting relays shown in the upper half of Fig. 37 connect over the back contacts of the unoperated transmitting relays and over the upper back contacts of cut-off relay **3718** to battery through the winding of relay **3716**. The ungrounded conductors associated with the second office group transmitting relays shown in the lower half of Fig. 37 connect over back contacts of the unoperated transmitting relays and lower back contacts of relay **3718**, to battery through the winding of the second trouble detecting relay **3717**. The ungrounded conductors associated with the compensating resistance and class transmitting relays of Fig. 38 connect over the back contacts of their associated unoperated transmitting relays, over the upper and lower back contacts of cut-off relay **3824**, and over conductor **3825** to battery through the winding of relay **3717**. The ungrounded conductors associated with the zone transmitting relays of Fig. 39 connect over the back contacts of their associated unoperated transmitting relays, over the back contacts of cut-off relay **3915**, and over conductor **3825** to battery through the winding of relay **3717**. Should any transmitting conductor which is not being used in conjunction with a particular call become falsely grounded or crossed with some conductor which is being used and is therefore grounded by the decoder marker, the trouble detecting relay **3716** or **3717**, with which it is associated, will operate. The operation of either relay **3716** or **3717** connects ground to conductor **3634** which in turn connects to the timing circuit. The timing circuit (not shown) functions, connects a trouble indicating circuit to the decoder marker and causes a release signal to be sent to the sender which thereupon releases and connects to another decoder marker. The cut-off relays **3637**, **3718**, **3824**, and **3915** are operated by the trouble indicating circuit over circuits which are not shown and, by their operation, isolate each transmitting conductor, thus enabling the indicating circuit to record the trouble encountered on any particular conductor.

Marker connects to district and office frames

Simultaneous with the transmission of the selection information to the sender, connections

between the decoder marker and the district frame on which the district trunk serving the call is located, and between the decoder marker and the pair of office frames containing the group of trunks extending to the desired destination, are being established. With the district frame register relay 3202 and check relay 3521 operated and check relay 3520 released, as previously set forth, a circuit is completed from ground over the upper outer front contact of relay 3521, upper outer back contact of relay 3520, over conductor 3545, outer front contact of relay 3202, middle back contact of relay 3200, inner back contact of relay 3201, middle front contact of relay 3202, inner back contacts of relays 3203 and 3204, to battery through the right windings of district frame relays 3212 and 3213, both of which operate. Relays 3214 and 3215 represent another pair of district frame relays, there being one pair of these relays for each district frame to which the decoder marker may connect. Relay 3212, in operating, closes a circuit from battery over its left front contact and over conductor 3216, to ground through the winding of relay 2000 of the district link and frame connector circuit shown in Fig. 20.

As hereinbefore set forth in the general description, the district link and connector circuit is provided with ten primary and twenty secondary district link cross-bar switches. Crosspoint 2004 of Fig. 20, together with select magnet 2005 and hold magnet 2006 represents a particular crosspoint of one of the ten primary district link switches. Similarly, crosspoint 2007, together with select magnet 2008 and hold magnet 2009, represents a particular crosspoint of one of the twenty secondary district link switches. The contacts of crosspoints 2004 and 2007 are interconnected by a district link or "A" trunk 2010. Associated with the ten primary district link switches is a 200 point cross-bar switch 2011, the function of which is to connect the test conductors, from the twenty "A" trunks extending between any one of the primary district link switches and the twenty secondary district link switches, to the decoder marker. One of these "A" trunk test conductors is shown, conductor 2014, which extends from the lowest or sleeve conductor of "A" trunk 2010 to a contact of crosspoint 2015 of switch 2011. Associated with the ten secondary district link switches is a similar cross-bar switch, 2012, which provides means for operating the secondary district link switch select magnets, such as select magnet 2008, and also extends the test conductors of the "B" trunks, such as conductor 2016 of "B" trunk 2013, to the decoder marker.

Upon the connection of battery to conductor 3216 by the decoder marker, as previously set forth, relay 2000 of the district link and frame connector circuit operates. Provided that relay 2001 or 2002, the windings of which extend to other decoder markers (not shown) are not operated at this time, the operation of relay 2000 closes a circuit from ground over the outer back contacts of relays 2002 and 2001 and over the outer front contact of relay 2000, to battery through the winding of the multi-contact district frame decoder marker connector relay 2003 which operates and closes through the various conductors from the district frame to the decoder marker. Relays 2017 and 2018 are similar in function to relay 2003 and serve to establish connections to the decoder markers to which the windings of relays 2001 and 2002 connect. Relay 2000, in operating, also closes a circuit from ground over the inner back contacts of relays 2002 and 2001, inner front contact of relay 2000, conductor 2019, to battery through the winding of relay 3217. Relay 3217 operates and closes a circuit from ground through the upper contact of relay 3108, lower contact of relay 3107, lower front contact of relay 3106, the latter relay having operated in a circuit over the front contact of relay 3100, normal contacts of relay 3105, conductor 3141, closed contacts of relay 3217, conductor 3230 through the marker connector to conductor 2228, winding of relay 2232 to battery. Relay 2232 operates and extends the grounded conductor 2228 over its front contact thence over conductor 1825 through the sender selector switch to conductor 1701 through the back contact of relay 1711 to battery through the winding of relay 1712. Relay 1712 operates and closes a local circuit over conductor 1713 to operate select magnet 2005 of the primary district link switch. Relay 1712 also extends its operating ground over its lower inner front contact and over conductor 1714 to battery through the winding of select magnet 2020 of switch 2011, operating magnet 2020. In addition, the operation of relay 1712 extends conductor 1702 and the windings of relays 1719 and 1720 of the district trunk, over conductors 1716, 1717, and 1715, respectively, and over front contacts of the operated district frame connector relay 2003, to the decoder marker. Relay 1718, the function of which will later be set forth, is also operated in a local circuit from a front contact of relay 1712. Select magnet 2020, in operating, extends its operating ground over its inner front contact, a front contact of relay 2003, conductor 2021, to battery through the winding of relay 3105 which operates. Relay 3106 previously operated in a local circuit upon the operation of the decoder marker start relay 3100. Relay 3105, in operating, locks in a circuit over its upper front contact, lower outer front contact of relay 3106, lower outer back contact of relay 3107, to ground over the upper outer back contact of relay 3108. Relay 3105 extends its holding ground over its upper front contact back on conductor 2021 to hold select magnet 2020 and relay 1712 since the original operating circuit for relay 1712 and select magnet 2020 is opened at the upper back contact of relay 3105. Also this holding ground is extended over conductor 1714 through the inner lower front contact of relay 1712, back contact of relay 1711 and thence into the sender to hold the relay 2232 operated, the original operating circuit of this latter relay having been opened by the operation of relay 3105. Hold magnets 2022 and 2023 operate in multiple from ground over the outer front contact of select magnet 2020 and cause the closure of crosspoint 2015 as well as the other crosspoints in that level of switch 2011 with which select magnet 2020 is associated. The test conductors of the twenty district links or "A" trunks to which the district trunk shown in Fig. 17 has access are extended over the operated crosspoints of switch 2011 and over front contacts of connector relay 2003 to the decoder marker. The circuit for the test conductor of "A" trunk 2010 may be traced from the lower contact of the primary district link switch crosspoint 2004, over conductor 2014, crosspoint 2015 of switch 2011, a front contact of relay 2003, conductor 2024, right inner back contact of channel relay 3000, to the left winding of channel testing relay 3007. There are twenty channel relays and twenty channel

testing relays, one of each for each of the twenty "A" trunks to which a particular district trunk has access. Seven channel relays, **3000** to **3006**, inclusive, and seven channel testing relays, **3007** to **3013**, inclusive, are shown.

The pair of office frames to which the decoder marker connects on a particular call is determined by the cross-connection of one of the route crosspoint contacts to one of the ten decoder marker office frame relays of which two, relays **3218** and **3219**, are shown. In the case illustrated it is assumed that the group of trunks extending to the destination represented by route crosspoints **3306** and **3307** contains less than forty trunks and is therefore not split into trunk subgroups. It is further assumed that one-half of this desired group of trunks appear on the even office frame shown in part in Fig. 41 while the other half of the group appear on the odd office frame indicated by block **4200** in the upper half of Fig. 42. Upon the previous closure of route crosspoints **3306** and **3307** the decoder marker office frame relay **3218** operated in a circuit from battery through its winding, over cross-connecting terminal **3220**, conductor **3221**, a contact of crosspoint **3307**, conductor **3426**, a contact of relay **3429**, conductor **3437**, to ground over a back contact of relay **3103**. Upon the subsequent operation of relay **3217**, during the connection of the decoder marker to the district frame as hereinbefore described, circuits are closed from battery over the right front contacts of relay **3217**, left front contacts of relay **3218**, to the start conductors **3222** and **3223** which extend to the office frame connector circuit of the two office frames on which the desired trunk group appears. The battery on conductor **3222** operates the office frame start relay **4100** in a circuit through the winding of that relay, over the lower back contacts of relays **4101** and **4102**, to ground over the upper inner back contact of office frame make-busy relay **4103**. Relay **4100**, in operating, operates the office frame decoder connecting relay **4104** in a circuit from battery through the winding of relay **4104**, over the upper outer front contact of relay **4100**, to ground over the upper outer back contact of relay **4103**. The operating circuits for the office frame connector start and decoder connecting relays are arranged in chain circuits so that only one decoder connecting relay can operate at any one time. For example, with start relay **4100** and connecting relay **4104** operated, the operation of start relay **4101** or **4102** from some other decoder marker is ineffective in operating connecting relay **4105** or **4106** since the operation of relay **4100** opens the operating circuits for relays **4105** and **4106**. Had start relay **4102** and its associated decoder connecting relay **4106** been operated from some other decoder marker at the time that battery was connected to conductor **3222** by this decoder marker, connecting relay **4104** would not operate since its associated start relay **4100** could not operate due to its operating circuit being open at the lower back contact of relay **4102**.

Each office frame is provided with ten primary and ten secondary cross-bar switches as previously described in the general description. Crosspoint **4107** of Fig. 41, together with select magnet **4108** and hold magnet **4109**, represents a particular crosspoint of one of the ten primary office switches located on the No. 0 office frame. Crosspoint **4110** together with select magnet **4111** and hold magnet **4112**, represents a particular crosspoint of one of the ten secondary office switches located on the same office frame. Extending from the district frame to the office frame are "B" trunks, such as trunk **2013** which extends from the district frame shown in Fig. 20 to crosspoint **4107** of the primary office switch of Fig. 41. The primary and secondary office switches are interconnected by office links or "C" trunks such as trunk **4113**. The horizontal multiple on the secondary office switches, such as represented by the armatures of crosspoint **4110**, connects to outgoing trunks such as trunk **4114**. Associated with the ten primary office switches is a 200 point cross-bar switch **4115**, the function of which is to connect the test conductors of twenty office links or "C" trunks extending from any primary office switch, to the decoder marker. Associated with the secondary office switches are ten multi-contact relays, one for each level of the secondary office switches, the function of which is to connect the test conductors of the outgoing trunks, as well as the secondary office switch select magnets associated with the levels in which these trunks appear, to the decoder marker. Three of these ten relays, relays **4116**, **4117**, and **4118**, are shown, relay **4118** being associated with that level of the secondary office switches in which outgoing trunk **4114** is located. The operation of the office frame decoder connector relay **4104**, upon the operation of start relay **4100** as previously set forth, extends the circuit from the windings of the select and hold magnets of switch **4115** and from the windings and contacts of relays **4116** to **4118**, inclusive, to the decoder marker.

As previously set forth, it is assumed that one-half of the desired group of outgoing trunks appear on the even office frame No. 0 shown in Fig. 41, while the other half of the trunk group appear on the odd office frame No. 1 which is indicated by block **4200** in Fig. 42. Upon the connection of battery to conductor **3223** by the operation of relay **3217**, a start relay and a decoder connecting relay of the No. 1 office frame operate, in a manner similar to that described for relays **4100** and **4104** of Fig. 41, and by their operation extend the various select and hold magnets, as well as the windings and contacts of the outgoing trunk test conductor multi-contact connecting relays corresponding to relays **4116** to **4118**, inclusive, of Fig. 41, to the decoder marker.

Test of desired trunk group

The decoder marker is provided with ten trunk location relays of which two, relays **3224** and **3225**, are shown. The function of these relays is to inform the office frame circuit on which levels of the secondary office switches the desired group of outgoing trunks is located and to cause the proper office frame connecting relays to operate and extend the test conductors of the trunks in those levels, as well as the windings of the secondary office switch select magnets associated therewith, to the decoder marker. Where the desired group of outgoing trunks does not exceed 40, or where the trunk group exceeds 40 and is therefore divided into subgroups each of which is located in the same level of different pairs of secondary office switches, the trunk location relays operate directly under control of the decoder marker route crosspoint. Since it is assumed that the group of trunks to the desired destination does not exceed 40 and, assuming further that these trunks are located in the ninth level of the secondary office switches of office

frames No. 0 and No. 1, trunk location relay 3225 operates in a circuit from battery through its winding, over cross-connecting terminal 3226, conductor 3227, a contact of route crosspoint 3307, conductor 3425, a front contact of relay 3429, conductor 3438, to ground over a back contact of relay 3103. Relay 3225, in operating, closes a circuit from ground over its left front contact, over conductor 3228, a front contact of relay 4104, to battery through the winding of relay 4118 which operates. The ground on conductor 3228 also causes the relay, corresponding to relay 4118 of Fig. 41, associated with office frame No. 1 to operate. Relay 4118, in operating, closes the test conductors of the twenty outgoing trunks extending from the ninth levels of the secondary office switches of office frame No. 0 to the testing relays of the decoder marker. The circuit for the test conductor 4119 of outgoing trunk 4114 may be traced from that conductor, over a front contact of relays 4118 and 4104, conductor 4120, upper outer back contact of trunk relay 2900, to battery through the winding of testing relay 2901. There are forty trunk relays such as relay 2900, twelve of which, those appearing in the same horizontal row containing relay 2900, are shown. There are also forty test relays such as relay 2901, twelve of which, those appearing in the same horizontal row containing relay 2901, are shown. Each of the test conductors of the twenty outgoing trunks of the ninth levels of the secondary office switches of office frame No. 0 connect, over a circuit similar to that traced for test conductor 4119 of trunk 4114, to battery through the winding of one of twenty of the forty test relays. For illustration, a circuit may be traced from battery through the winding of test relay 2903, over the upper outer back contact of relay 2904, conductor 4121, a front contact of relays 4104 and 4118, and over conductor 4122 which extends to the test conductor (not shown) of an outgoing trunk appearing in the ninth level of some other secondary office switch (not shown) of office frame No. 0. Relay 4118, by its operation, also prepares the operating circuit for the select magnet, such as magnet 4111, associated with the ninth level of each secondary switch. The circuit for select magnet 4111 may be traced from battery through the winding of that magnet, over one of the front contacts of relay 4118, a front contact of relay 4104, conductor 4123, to an armature of the even office frame decoder marker relay 3014. The ground connected to conductor 3228 by the operation of relay 3225 also operated a multi-contact connecting relay (not shown), corresponding to relay 4118 of Fig. 41, in the odd office frame No. 1. The operation of this aforementioned relay connects the test conductors of the twenty outgoing trunks of the ninth levels of the secondary office switches of office frame No. 1, as well as the windings of the select magnets associated with these trunks, to the decoder marker in the same manner as set forth for office frame No. 0. The twenty test conductors from office frame No. 1 connect to the windings of the other twenty of the forty test relays. For illustration, one of the twenty circuits may be traced from battery through the winding of test relay 2905, over the upper outer back contact of relay 2906, and over conductor 2907 to a No. 1 office frame outgoing trunk test conductor (not shown). The windings of the No. 1 office frame secondary switch select magnets (not shown) associated with the ninth levels of those switches are connected over conductor 4201 to an armature of the odd office frame decoder relay 3015. Relay 4118, in operating, also closes a circuit from ground over one of its front contacts, a front contact of relay 4104, over conductor 4124, to battery through the winding of relay 3016 which operates. Similarly, the No. 1 office frame connecting relay corresponding to relay 4118 of the No. 0 office frame connects ground over conductor 4202 to battery through the winding of relay 3017 which also operates. The functions performed by the operation of relays 3016 and 3017 will be set forth in the subsequent paragraph.

Whenever an outgoing trunk is in use and therefore busy, its associated test conductor is grounded under control of the particular secondary office switch hold magnet involved in extending the connection over that trunk. For illustration, should outgoing trunk 4114 be in use, both the secondary office switch select magnet 4111 and hold magnet 4112 would be operated to effect the closure of crosspoint 4110. Ground over the lower front contact of the operated hold magnet 4112 would be connected, under this condition, to test conductor 4119 of trunk 4114 as an indication that this trunk was busy. Upon the closure of the forty outgoing trunk test conductors to the windings of the forty test relays, such as relays 2901, 2903 and 2905, each of those test relays whose associated test conductor is grounded, thereby signifying that its associated trunk is busy, operates. Associated with each of the forty test relays is an auxiliary relay, such as relays 2902, 2908, and 2909 which are associated with test relays 2901, 2903, and 2905, respectively. Each test relay which operates due to the trunk to which it is connected being busy in turn operates its auxiliary relay. For example, assuming that test relay 2903 operates, a circuit is closed from battery through the upper winding of relay 2908, front contact of relay 2903, conductor 2910, to ground over the right front contact of relay 3018, relay 3018 having previously operated, together with relays 3019 and 3109, over conductor 3020, from ground over a left front contact of the decoder start relay 3100. Relay 3109, previously operated under control of decoder start relay 3100, closed a circuit from battery over its upper switchhook contacts to one end of both the upper and lower windings of polarized timing relay 3110. The lower winding of relay 3110 is energized from this battery to ground through resistance 3111, while the upper winding of the relay is energized, initially, in a circuit from this battery, over conductor 3112, to ground over the back contacts of relays 3016 and 3017. The windings of relay 3110 are connected in opposition, however, and the relay therefore does not operate until the circuit through its upper winding is opened at the back contacts of relays 3016 and 3017 as will later be set forth. Upon the previous operation of relay 3109, relay 3113 operated in a circuit from battery through its winding, over the upper inner back contact of relay 3114, to ground over the upper outer front contact of relay 3109. Relay 3116 also operated from battery through its winding, over the back contact of relay 3117, to ground over the lower inner front contact of relay 3109. Upon the initial operation of the decoder start relay 3100, relay 3106 operated in a local circuit and closed a circuit from ground over its lower middle front contact, upper outer back contact of relay 3114, back contact of relay 3115, to battery through the winding of relay 3104 which operated. Relays 3021 and 3022 also operated at

this time in a circuit from battery through their windings in multiple, over the back contact of relay 3023, conductor 3024, to ground over the lower inner front contact of relay 3106. The function of relays 3021, 3022, 3104, 3113 and 3116 will be set forth in detail in subsequent paragraphs.

As previously described, the operation of the office frame relays, such as relay 4118, in addition to closing the outgoing trunk test conductors to the decoder marker trunk testing relays, also operated relays 3016 and 3017 which, in turn, remove ground over conductor 3112 from the upper winding of relay 3110 and also from condenser 3118 which, up to this time, has been short-circuited. As previously stated, the windings of relay 3110 are so connected that the force exerted by the upper winding opposes that of the lower winding and the relay therefore cannot operate as long as both windings remain energized. When the ground is removed from the upper winding of relay 3110 by the operation of relays 3016 and 3017, relay 3110 does not operate immediately since condenser 3118, having its short circuit removed, now charges through the upper winding of relay 3110 and momentarily maintains the energizing current through that winding. As condenser 3118 approaches its charged state the current through the upper winding of relay 3110 diminishes to a point where it no longer sufficiently opposes the current through the lower winding of the relay and relay 3110 thereupon operates. The capacity of condenser 3118 and the value of resistance 3119 are so chosen that the charging time of the condenser delays the operation of relay 3110 for an interval sufficient to insure the operation of all test relays which may be associated with busy outgoing trunks at that time.

As set forth above, forty outgoing trunk test conductors representing the forty outgoing trunks extending from the secondary office switches of office frames Nos. 1 and 0 are now connected to the decoder marker trunk testing relays. Since a group of trunks to a particular destination, as represented by a particular set of route cross-points, may contain less than forty trunks, it is necessary for the decoder marker to know the exact location of the trunk group. For this purpose, two contacts of each set of route cross-points are employed, one representing the first trunk and the other representing the last trunk of the desired trunk group. These group start and group end route cross-point contacts are cross-connected to terminals located on terminal strips 2911 of Fig. 29, the particular cross-connection depending upon the size of the trunk group extending to the destination represented by that route cross-point. There are twenty cross-connecting terminals, such as terminals 2912 to 2915, inclusive, and 2919 on terminal strip 2911, seven of these terminals being shown. These terminals connect to the upper armature of every other auxiliary trunk test relay, such as relays 2902, 2908, and 2916, with the exception of the last of the twenty terminals, terminal 2915, which connects to the upper front contact of the last of the forty auxiliary trunk test relays, relay 2918. Only twenty trunk group terminals are provided since it is assumed that the number of trunks in a group will always be in multiples of two. It is to be understood however, that the trunk groups may be in multiples of one, in which case forty terminals would be provided, one connecting to each of the auxiliary trunk test relays. It will be assumed that the group of trunks extending to the destination represented by route cross-points 3306 and 3307 contains thirty-eight trunks, and that these are the first thirty-eight trunks of the group of forty trunks being tested. The group start contact of route cross-point 3307 is therefore cross-connected over conductor 3347 to terminal 2912 of terminal strip 2911, and the group end contact of the cross-point is cross-connected over conductor 3348 to terminal 2919 of terminal strip 2911. Upon the operation of relay 3110, after an interval sufficient to permit the operation of all trunk test relays associated with busy trunks as set forth in the preceding paragraph, a circuit is closed from ground over the front contact of relay 3113, lower back contact of relay 3114, upper back contact of relay 3120, front contact of relay 3110, upper outer front contact of relay 3116, lower outer front contact of relay 3104, outer back contact of relay 3103, conductor 3121, a front contact of relay 3429, conductor 3427, a contact of route cross-point 3307, conductor 3347, to the upper armature of the first auxiliary trunk test relay 2908. The upper back contacts of each auxiliary trunk test relay, such as relay 2908, extend to the winding of an associated trunk relay, such as relay 2904, and the upper front contact of each auxiliary trunk test relay connects to the upper armature of the succeeding similar relay. Since the trunk test relay and auxiliary trunk test relay associated with any busy outgoing trunk are both operated at this time, the ground supplied over conductor 3347 to the chain circuit starting at the upper armature of relay 2908 will be connected over the front contacts of the operated auxiliary trunk test relays associated with busy trunks and over the back contact of the unoperated auxiliary trunk test relay associated with the first idle trunk, to the winding of the trunk relay of that idle trunk. It will be assumed that, of the particular thirty-eight trunks being tested in connection with the call being described, all of the trunks whose test conductors connect to the windings of the trunk test relays shown to the left of relay 2901 are busy, and that trunk 4114 of office frame No. 0, whose test conductor connects to the winding of relay 2901, is the first idle trunk of the group extending to the desired destination. Since the trunks whose test conductors connect to the windings of the test relays shown at the left of relay 2901 are assumed to be busy, these test relays are all operated and have, in turn, operated their associated auxiliary test relays shown at the left of relay 2902. The ground connected to conductor 3347 by the operation of relay 3110 therefore extends over the upper armature and front contact of each of the operated auxiliary test relays, such as relays 2908, 2909, 2916, etc., over the upper armature and back contact of the unoperated auxiliary trunk test relay 2902 which is associated with idle outgoing trunk 4114, through the winding of relay 2900, over conductor 2920, winding of relay 3025, conductor 3026, lower inner back contact of relay 3107, to battery over the back contact of relay 3122. Relay 2900 operates over this aforementioned circuit and extends its operating ground over its upper inner front contact and over conductor 2921 to battery through the winding of the even office frame relay 3014 since trunk 4114 is located on the even office frame No. 0. Relay 3014 operates and closes a circuit from ground over its outer front contact and over conductor 3027 to battery through the winding of relay 3115 which operates. The func-

tion of relay 3115 will be described in subsequent paragraphs.

Upon the previous operation of relays 3016 and 3017 these relays connect ground, over conductor 3028, to battery through the winding of trunk lock relay 2922 which operates and connects ground over its upper front contact to the lower armature of each of the auxiliary trunk test relays. Any of the auxiliary trunk test relays such as relay 2908 for example, upon being operated through its upper winding under control of its associated trunk test relay, such as relay 2903, locks through its lower winding to this ground supplied over a front contact of relay 2922. The purpose of locking these auxiliary trunk test relays, when operated, is to prevent an initially busy trunk, becoming idle during trunk selection, from interfering with the seizure of the first initially idle trunk. It was assumed in the foregoing paragraph that the trunk associated with test relay 2901 was the first initially idle trunk, and trunk relay 2900 therefore subsequently operated. Assuming now, for illustration, that the trunk associated with test relay 2903 became idle while trunk selection was in progress, relay 2903 would release due to the removal of ground from the test conductor connected to its winding. Relay 2908, however, would remain operated, being locked through its lower winding, and thereby not interfere with the operating circuit for trunk relay 2900.

During the selection and seizure of an outgoing trunk by the decoder marker an unguarded interval exists during which a selector of the panel type located at some other office and hunting over the same group of trunks might seize the trunk already selected by the decoder marker. For example, the trunk 4114, and other trunks of the same group, may be multipled to the banks of panel type selector switches as well as being multipled to the contacts of the cross-bar office secondary switch illustrated in Fig. 41. To guard against this possibility of a double selection the decoder marker is arranged to check for this double connection and, if encountering it, to release the initially selected trunk and select another idle trunk of the same group. Upon the operation of relay 2900 the test conductor 4119 of trunk 4114 is transferred from the winding of test relay 2901, to the winding of relay 3104 in a circuit traceable from conductor 4120, upper outer front contact of relay 2900, conductor 2923, and lower inner front contact of relay 3104, this latter relay having previously operated as hereinbefore set forth. The operation of relay 3115, which occurred upon the operation of the even office frame decoder marker relay 3014, opens the operating circuit for relay 3104 which, if the trunk is still idle, releases. If the trunk has been seized by a panel type selector in the meantime, relay 3104 will remain locked over its lower inner front contact and over the previously traced circuit to the sleeve or test conductor of the trunk which will have been grounded by the panel selector. With both relays 3104 and 3115 operated, a circuit is completed from battery through the winding of relay 3114, upper front contact of relay 3104, to ground over the lower inner front contact of relay 3115. Relay 3114, which is slow in operating in order to permit relay 3104 to release if the trunk is idle, thereupon operates and opens the previously traced operating circuit for trunk relay 2900 and the even office frame decoder marker relay 3014, both of which release. Relay 3014, in releasing, releases relay 3115. With relay 3114 operated, the release of relay 3115 opens the circuit through the winding of relay 3113 which releases. The release of relay 3113 releases relay 3114 which, in turn, closes the previously traced operating circuit through the winding of relay 3104. Relay 3104 reoperates and again closes ground, over a previously traced circuit, over the group start contact of route cross-point 3307 to the upper armature of auxiliary trunk test relay 2908. This ground extends over the upper front contact of the operated auxiliary trunk test relays associated with busy trunks and causes the selection of the first idle trunk of the desired group in the same manner as hereinbefore set forth. Upon the operation of the trunk relay, such as relay 2900, the even or odd office frame decoder marker relay 3014 or 3015 will again operate, depending upon which frame the selected trunk is located, and reoperate relay 3115. This trunk is thereupon tested for double connection in the same manner as described above.

Testing the "A", "B" and "C" trunks and operation of district and office switches

Upon the operation of relay 2900 during the selection of outgoing trunk 4114, as set forth in the preceding paragraph, a circuit is closed from ground through the winding of relay 3029, over conductor 3030, the lower inner front contact of relay 2900, conductor 2924, a front contact of relay 4104, to battery through the winding of select magnet 4125 of switch 4115. Select magnet 4125 operates, but relay 3029, being marginal, does not operate. The function of relay 3029 which is a trouble detecting relay, will be described later. Upon the operation of select magnet 4125 a circuit is closed from battery through the winding of hold magnets 4126 and 4127 in parallel, over a front contact 4128 of select magnet 4125, a front contact of relay 4104, conductor 4129, to ground over a front contact of the even office frame decoder marker relay 3014. Hold magnets 4126 and 4127 operate and, since select magnet 4125 is already operated; cause the closure of the cross-point of switch 4115 in that level with which select magnet 4125 is associated. The closure of these cross-points extend the test conductors of the twenty office links or "C" trunks over which the selected outgoing trunk may be reached to the right windings of the twenty channel testing relays of the decoder marker. The circuit for test conductor 4130 of "C" trunk 4113 may be traced from that conductor, over cross-point 4131 of switch 4115, a front contact of relay 4104, conductor 4132, right outer back contact of relay 3000, to the right winding of channel testing relay 3007. The test conductors of the nineteen other "C" trunks over which the connection may be extended to outgoing trunk 4114 are similarly connected to the right windings of the other nineteen channel testing relays over other cross-points in the same level with cross-point 4131 and other front contacts of relay 4104.

Upon the previous operation of relay 3014 a circuit was closed from ground through the winding of relay 3031, a front contact of relay 3014, conductor 4123, a front contact of relays 4104 and 4118, to battery through the winding of select magnet 4111 of the secondary office switch, thereby operating that select magnet. As indicated by strap 4133, the winding of select magnet 4111 is multipled to the winding of the select magnet (not shown) of the corresponding

level of the other secondary office switches and these select magnets also operate. Relay **3014** also closes a circuit from ground through the winding of relay **3032**, a front contact of relay **3014**, conductor **3033**, a right front contact of relay **3218**, conductor **3229**, a front contact of the district frame connecting relay **2003**, winding of select magnet **2025** of the "B" trunk cross-bar connecting switch, to battery over the lower front contact of hold magnets **2023** and **2022** of the "A" trunk cross-bar connecting switch of the district frame. Select magnet **2025** operates and closes its contacts **2026** and **2027**. Ground over contact **2027** energizes the winding of select magnet **2008** which is associated with that level of the secondary district link switch from which "B" trunk **2013** extends. The windings of the select magnets of the corresponding level of each secondary district link switch are multipled, as indicated by strap **2031**, and these magnets also energize from the ground over contact **2027**. Ground over contact **2026** extends over conductor **2032**, to battery through the winding of select magnet **4108** of the primary office switch on which cross-point **4017** appears. The windings of the select magnets of the corresponding level of each primary office switch are multipled, as indicated by strap **4134**, and these magnets therefore all energize from the ground over conductor **2032**. Ground over the left contact of contacts **2026** operates hold magnets **2028** and **2029** and, since select magnet **2025** is already operated, cause cross-point **2030** of the "B" trunk switch **2012** to close and extend the test conductors of the 20 "B" trunks to the decoder marker. The circuit for test conductor **2016** of "B" trunk **2013** may be traced from conductor **2016**, over a contact of cross-point **2030**, a front contact of relay **2003**, conductor **2033**, a right back contact of relay **3000**, to the middle winding of channel testing relay **3007**. The middle windings of the other channel testing relays, such as relays **3007** to **3013**, inclusive, connect to the test conductors of other "B" trunks in a manner similar to that described for relay **3007**.

As previously stated, relays **3021** and **3022** operated upon the seizure of the decoder marker. These relays connected ground over their front contacts to the middle winding of each of the twenty channel testing relays **3007** to **3013**, inclusive, all of which operated. The circuit for relay **3007** may be traced from ground over the left inner front contact of relay **3022**, right middle back contact of relay **3000**, middle winding of relay **3007**, to battery over the left outer front contact of relay **3018** which previously operated upon the operation of start relay **3100**. This battery also connects to the left and to the right windings of each of the channel testing relays. The other end of the left, middle, and right windings of each channel testing relay has been connected to the test conductor of an "A", "B", and "C" trunk, respectively, which represents a possible path over which the connection may be extended from the primary district link switch to the selected outgoing trunk. Taking relay **3007** for example, the upper ends of its three windings connect to battery over the left outer front contact of relay **3018**. The lower end of its left winding connects to test conductor **2014** of "A" trunk **2010** over a previously traced circuit. The lower end of its middle winding connects to test conductor **2016** of "B" trunk **2013** over a previously traced circuit. The lower end of its right winding connects to test conductor **4130** of "C" trunk **4113** over a previously traced circuit.

In addition, the lower end of the middle winding of relay **3007** also connects to ground over the left inner front contact of relay **3022**, the relay being operated over this local circuit through its middle winding at this time. The three windings of each of the other nineteen channel testing relays are connected to "A", "B", and "C" trunk test conductors in a manner similar to that described for the windings of relay **3007**. When hold magnets **2028** and **2029** of the "B" trunk switch **2012** operated, a circuit was closed from ground over their front contacts, a front contact of relay **2003**, conductor **2034**, to battery through the winding of relay **3023**. Relay **3023** operates and opens the circuit through the windings of relays **3021** and **3022**. Relays **3021** and **3022** both release and open the circuit through the middle winding of each of the channel testing relays. Each channel testing relay which has no ground connected to any of its three windings over the three test conductors connected thereto, i. e., if the "A", "B", and "C" trunks with which this relay is associated are all idle, will release and thereby indicate that this path or channel is available for the extension of the call from the district trunk to the outgoing trunk. Those channel testing relays which have ground connected to any or all of their windings due to any or all of the trunk test conductors associated therewith being grounded from a busy trunk, will remain operated. It will be assumed that relays **3008** to **3013**, inclusive, all remain operated due to one or more of the trunks associated therewith being busy, and that only channel testing relay **3007** releases upon the release of relays **3021** and **3022**. With relay **3023** operated and relay **3022** released, relay **3035** operates in a circuit from battery through its winding over the back contact of relay **3022**, front contact of relay **3023**, conductor **3024**, to ground over a front contact of relay **3106**. Relay **3035** is slow-to-operate to permit sufficient time to elapse for the channel testing relays associated with idle channels to release. Relay **3035**, in operating, closes a circuit from ground over its front contact, conductor **3036**, upper outer back contact of relay **3104**, conductor **3037**, back contact of relay **3038**, conductor **3039**, lower outer front contact of the operated trunk relay **2900**, conductor **2925**, front contacts of the operated channel testing relays **3013** to **3008**, inclusive, in that order, back contact of channel testing relay **3007**, winding of channel relay **3000**, to battery through the winding of relay **3041**. Relay **3000** operates but relay **3041**, which has marginal characteristics, does not operate. The function of relay **3041** will be described in a subsequent paragraph. Relay **3000**, in operating, extends its operating ground, over its left front contact, to battery through the winding of relay **3038**. Relay **3038** operates and locks over its right front contact to the ground previously traced to conductor **3047**. In addition, the operation of relay **3038** removes the ground from conductor **3039** thereby opening the operating circuit for relay **3000** which remains locked in a circuit over its left front contact and over the right front contact of relay **3038** to the ground on conductor **3047**.

Relay **3000**, upon its operation also transfers the test conductors of the "A", "B" and "C" trunks from the windings of relay **3007** to armatures of relays **3123** and **3124**. A circuit is thereby completed from ground over the outer back contact of relay **3123**, outer back contact of relay **3124**, conductor **3125**, the right inner front con-

tact of relay 3000, conductor 2024, a front contact of relay 2003, crosspoint 2015 of the "A" trunk switch 2011, and over conductor 2014 to battery through hold magnet 2006 of the primary district link switch and hold magnet 2009 of the secondary district link switch. Since the primary district link switch select magnet 2005 and the secondary district link switch select magnet 2008 have previously operated, the operation of hold magnets 2006 and 2009 cause crosspoints 2004 and 2007 of the primary and secondary district link switches, respectively, to close and thereby extend the connection from the district trunk of Fig. 17, over the district link or "A" trunk 2010 to the "B" trunk 2013. A circuit is also completed, upon the operation of relay 3000, from ground over the outer back contact of relay 3123, inner back contact of relay 3124, conductor 3126, right outer front contact of relay 3000, conductor 4132, a front contact of relay 4104, crosspoint 4131 of the "C" trunk switch 4115, and over conductor 4130 to battery through the winding of hold magnet 4109 of the primary office switch and hold magnet 4112 of the secondary office switch, both of these hold magnets operating. Select magnets 4108 and 4111 of the primary and secondary office switches, respectively, having previously operated, the operation of hold magnets 4109 and 4112 cause crosspoints 4107 and 4110 of the primary and secondary office switches to close. The connection is thereby further extended from "B" trunk 2013, over "C" trunk 4113 to the selected outgoing trunk 4114. As soon as hold magnet 2009 of the secondary district link switch operates, it extends its operating ground over its front contact to test conductor 2016 of the "B" trunk. Test conductor 2016 extends to the right middle armature of relay 3000, over a previously traced circuit, and this ground extends from that point over the middle front contact of relay 3000, conductor 3042, inner back contact of relay 3123, to battery through the winding of relay 3127 which operates. Relay 3127, extends its operating ground over its inner front contact to battery through the winding of relay 3123 which operates. Relay 3123, in operating, removes the direct ground from the "A" and "C" trunk test conductors, these conductors now being connected to ground through the upper winding of relay 3128. The operated hold magnets 2006, 2009, 4109, and 4112 of the district link and office switches remain operated in this circuit to ground through the upper winding of relay 3128. The operation of relay 3123 also opens the operating circuit for relay 3127, but relay 3127, together with relay 3123, remains locked in a circuit over conductor 3129, to ground over the lower inner front contact of relay 2922. If there are no false grounds on the "A" and "C" trunk test conductors, relay 3128 operates through its upper winding to the battery supplied through the four aforementioned district link and office switch hold magnets in parallel. Relay 3128, in operating, closes a circuit from ground previously traced over conductor 3129, over its front contact, upper inner back contact of relay 3108, to battery through the winding of relay 3117. Relay 3117 operates and energizes the middle winding of relay 3128 in a circuit from battery through that winding, over the upper outer front contact of relay 3117, to ground over the lower inner front contact of relay 3109. Relay 3128 is of the polarized type and its lower winding, which is energized in a circuit to ground over a lower front contact of relay 3109 at the time that the decoder marker is seized, is so connected that the flux which it produces maintains the armature of the relay in its unoperated position. The upper winding of the relay is so connected that its flux opposes and overcomes that of the lower winding and the relay therefore operates to the battery through the four parallel hold magnets as has just been set forth. The middle winding of relay 3128, which is energized by the operation of relay 3117, is so connected that its flux opposes that of the upper winding and relay 3128 therefore releases when its middle winding is energized, provided that the current through its upper winding is not greater than that produced by four parallel hold magnets. Should a fifth hold magnet or pair of magnets be falsely connected to the "A" or "B" trunk test conductors due to a trouble condition, the current through the upper winding of relay 3128 is obviously increased, in turn increasing the flux exerted by that winding to a point where the flux produced by the middle winding of the relay is incapable of causing the release of the relay. The release of relay 3128 therefore checks that only four district links and office switch hold magnets are operated. Relay 3128, in releasing, removes the short-circuit from the winding of relay 3108, and relay 3108 and now operates in series with relay 3117, over the upper inner front contact of relay 3117, to ground over conductor 3129. Relay 3117 holds operated in this circuit in series with relay 3108.

Relay 3108, in operating, opens the holding circuit for relay 3105 which releases, and also removes the ground from conductor 2021 which extends to the district link and connector circuit. The removal of ground from conductor 2021 releases select magnet 2020 of the "A" trunk connecting switch 2011 and also releases relay 1712 of the district trunk. Relay 1712 in releasing opens the energizing circuit of relay 1718 but the latter relay holds in a circuit from battery through its winding and lower front contact, conductor 1703 through the sender selector switches 1800 and 1802, conductor 1826, back contact of relay 2323, back contact of relay 2321, back contact of relay 2230, resistance 2290 to ground at the front contact of relay 2211. Relay 1712 in releasing also closes an operating circuit for relay 1711. This circuit may be traced from battery through the upper winding of relay 1711, front contact of relay 1718, back contact of relay 1712, thence over the sleeve conductor 1700 through the sender selector switches 1800 and 1802, conductor 1824, resistance 2214 to ground at the front contact of relay 2206. The release of relay 1712 connects a holding ground to the armature of hold magnet 2003 of the primary district link switch from which point it extends to the hold magnet of the secondary district link switch and the primary and secondary office switches over the armatures and front contacts of these aforementioned hold magnets and the sleeve conductors of the "A", "B" and "C" trunks. The circuit for this holding ground may be traced from the armature of primary district link switch hold magnet 2006, over conductor 1721, upper back contact of relay 1712, lower inner back contact of relay 1707, upper outer back contact of relay 1709, conductor 1700, a contact of crosspoint 1800 of the primary sender link switch, a conductor of link 1801, a contact of crosspoint 1802 of the secondary sender link switch, conductor 1824, resistance 2214, to ground over the upper middle front contact of relay 2206 of the sender, this being the same ground which is also holding the

line link and sender link primary and secondary switch hold magnets operated. Relay **3108**, in operating, also operates relay **3124** in a circuit from battery through the winding of that relay, over the lower front contacts of relays **3108** and **3116**, to the previously traced ground on conductor **3129**. The operation of relay **3124** connects the "C" trunk test conductor, the circuit for which was previously traced to the upper inner armature of relay **3124**, to the winding of relay **3120** over the lower back contact of relay **3130**. If relay **1712** of the district trunk has properly released and connected the holding ground to the district link and office switch hold magnet, and if the sleeve conductor of the "A", "B" and "C" trunks over which this ground extends is continuous, relay **3120** now operates in a circuit from battery through its winding, over a previously traced circuit to test conductor **4130** of the "C" trunk **4113**, to the ground extended from the district to the sleeve of this "C" trunk. Upon the previous release of relay **3104**, the sleeve or test conductor **4119** of outgoing trunk **4114**, which extends to the lower inner armature of relay **3104** over a previously traced circuit, is connected over the upper inner contact of the operated relay **3116** to the winding of that relay. When relay **3117** operates as set forth in the preceding paragraph, after crosspoints **4107** and **4110** of the primary and secondary office switches have operated, it opens the operating circuit for relay **3116**, relay **3116** now holding operated to the ground supplied over the front contact of the secondary office switch hold magnet **4112** to conductor **4119**. Relay **3116**, by holding, checks that the test conductor of the outgoing trunk has been made busy by the office switch. Should relay **3116** fail to hold, the operating circuit for relay **3124** is not closed and the test conductor of the "C" trunk is not closed through the winding of relay **3120** during the check of the continuity of the sleeve conductor from the district to the office frame switches as set forth in the preceding paragraph. Relay **3120**, which controls the release of the decoder marker as will subsequently be described, therefore cannot operate and the decoder marker will not release, but will, after an interval, cause a trouble indication to be given.

Crosspoint **4137** of Fig. 41—A together with select magnet **4138** and hold magnet **4139**, represents a secondary office switch crosspoint similar to crosspoint **4110** and select and hold magnets **4111** and **4112**. The horizontal multiple of crosspoint **4137**, however, instead of extending to an outgoing trunk as in the case of crosspoint **4110**, connects to an overflow trunk **4140** which is provided with a source of tone **4141**. Whenever the overflow route relay **3430** of the decoder marker operates, under any of the several overflow conditions outlined herein, its contacts close circuits similar to those closed by any of the sets of crosspoints of the route switch, such as crosspoints **3306** and **3307** for example. The decoder marker thereupon functions in a manner similar to that hereinbefore set forth for the establishment of connections between the district trunk shown in Fig. 17 and the outgoing trunk **4114**, and causes a connection to be completed, over an idle "A", "B" and "C" trunk channel, from the district trunk to the overflow trunk **4140**. An audible signal from the tone source **4141** is thereupon transmitted back to the calling subscriber as an indication that the call cannot be completed and that it will be necessary for the subscriber to replace his receiver and subsequently initiate a second call.

Marker releases from sender

When relay **3104** released after the check for the double connection of a panel type selector with the outgoing trunk, as hereinbefore set forth, it closed a circuit through the transmitting relay checking path to operate the decoder marker release relay **2330** of the sender circuit. This circuit may be traced from ground on conductor **3639**, outer front contact of office brush transmitting relay **3602**, front contact of relays **3605** and **3604**, front contact of relays **3616** and **3619**, conductor **3632**, front contact of relays **3700** and **3702**, outer front contact of relay **3701**, front contacts of relays **3709** and **3707**, conductor **3711**, front contacts of relays **3802**, **3812**, **3810**, outer front contact of relay **3815**, front contact of relays **3821** and **3816**, conductor **3823**, front contact of relays **3901**, **3913**, outer front contact of relay **3900**, conductor **3914**, lower outer back contact of relay **3104**, conductor **3131**, a front contact of relays **2702** and **2700**, conductor **2336**, winding of relay **2330**, to battery over the upper inner front contact of the sender decoder start relay **2325**. Relay **2330** operates, locks and closes a circuit from ground over its upper outer front contact, over the upper outer front contact of relay **2325**, to conductor **2501** for the purpose of locking the sender selection relays, such as relays **2500**, **2502**, **2503**, and **2504**, which were operated by the decoder marker transmitting relays. The operation of relay **2330** also removes the battery from conductor **2329** thereby releasing relays **2800** and **2814**. Relay **2800**, in releasing, releases the sender connecting relays **2700** and **2801**. The release of relay **2801** releases relay **2802**. The release of sender connecting relays **2700**, **2801**, and **2802** opens all direct connections between the sender and the decoder marker. The removal of battery from conductor **2329** also releases relay **2808** which, in turn, releases relays **2702** and **2809**. Relay **2809**, in releasing, releases relay **2810**, thereby restoring the decoder marker connector circuit to normal. At the time that the decoder marker was seized, the operation of relay **3100** closed a circuit from ground over its left outer front contact, conductor **3134**, outer back contact of relay **3916**, back contact of relay **3911**, conductor **3917**, back contact of relay **3133**, to battery through the winding of relay **3132**. Relay **3132** operated and locked over its upper front contact to ground over a front contact of relay **3100**. In operating, relay **3132** closed a circuit from the winding of relay **3133**, over conductor **3135**, to the lower outer front contact of relay **3117**. The subsequent operation of relay **3117** grounded conductor **3135** but relay **3133** did not operate at that time since a short-circuit is maintained around its winding by the ground supplied over the front contact of relays **3100** and **3132**. Upon the release of relay **2809** of the decoder marker connector circuit ground is removed from conductor **2824** thereby releasing the decoder marker start relay **3100**. Relay **3100**, in releasing, removes the short-circuit from the winding of relay **3133**, that relay now operating in series with relay **3132**, and both relays **3132** and **3133** holding to the ground over conductor **3135**. Relay **3133**, in operating, opens the circuit over which relay **3132** originally operated under control of relay **3100**. Upon the previous release of relay **3104** a

circuit was closed from ground over the lower inner front contact of relay 3115, upper middle back contact of relay 3104, to battery through the winding of relay 3136. Relay 3136 operated and connected ground to conductors 3137 to 3140, inclusive, for the purpose of locking the operated district and office frame and trunk level relays. District frame relays 3212 and 3213 lock through their left windings to ground on conductor 3138, office frame relay 3218 locks over conductor 3139, and trunk level relay 3225 locks over conductor 3140. The ground on conductor 3137 locks split trunk group relay 3040 through its left winding if this relay was operated. When relay 3123 operated following the operation of the "A", "B", and "C" trunk hold magnets, it operated relay 3103 in an obvious circuit. Relay 3103, in operating, opens the circuit to the zone, trunk level, office frame, group start and group end contacts of the route cross-point 3307. Relays 3900 and 3901 thereupon release. When relay 3120 is operated, as hereinbefore described, following the check for continuity of the sleeve conductor of the "A", "B", and "C" trunk, it opens the circuit through the windings of relays 2900 and 3014 and both of these relays release. Relay 3014, in releasing, opens the circuit for select magnet 2025 of the "B" trunk switch. Magnet 2025 releases, in turn releasing hold magnets 2028 and 2029 and thereby restoring switch 2012 to normal. Relay 2900, in releasing, opens the circuit through the winding of select magnet 4125 of the "C" trunk switch, releasing that magnet. The release of relay 3014 also opens the circuit to the windings of hold magnets 4126 and 4127 of the "C" trunk switch, releasing these magnets and thereby restoring switch 4115 to normal. In addition, the release of relay 3014 opens the circuit through the winding of relay 3115 which releases and, in turn, releases relay 3136. Relay 3136, in releasing, opens the locking circuit for relays 3212, 3213, 3218, and 3225, all of which release. The release of relay 3212 removes the battery from conductor 3216 thereby releasing relay 2000 which, in turn, releases relay 2003. The release of relay 2003 opens the connections between the district frame and the decoder marker and restores the district frame connector circuit to normal. Relay 3217 releases upon the breaking of the connection between the district frame and the decoder marker. The release of relay 3225 opens the circuit through the winding of relay 4118 which releases and opens the connections to the test conductors of the outgoing trunks in the selected level. The release of relays 3217 and 3218 opens the circuit through the winding of the office frame relay 4100 which releases, in turn releasing the connector relay 4104. The release of relay 4104 opens all connections between the office frame and the decoder marker and restores the office frame connector circuit to normal. Select magnet 4108, together with the select magnets associated with the same level of the other primary office switches, released upon the previous release of the "B" trunk switch 2012. Select magnet 4111, together with the select magnets associated with the same level of the other secondary office switches, released upon the previous release of relay 3014. The release of the office frame connector circuit releases relays 3016 and 3017 which, in turn, release relay 2922. Relay 2922, in releasing, releases any of the locked auxiliary trunk test relays, such as relays 2908, 2909, and 2916, and also releases relays 3108, 3117, 3123, 3124, and 3127. The release of relay 3117 releases relays 3132 and 3133. If the decoder marker start relay 3100 has not yet been operated in response to seizure by another sender circuit, the release of relay 3132 releases relays 3106 and 3109. The release of relays 3106 and 3109, together with the previous release of relay 3100, release all the remaining operated relays thereby restoring the decoder marker to normal.

Should the decoder marker be seized by a second sender after its disconnection from the first sender and before the release of relay 3109, start relay 3100 reoperates and holds relay 3109 operated upon the subsequent release of relays 3132 and 3133. Relay 3109, in turn, holds relay 3106 operated over the lower back contact of relay 3108. Certain of the decoder marker register relays shown in Fig. 35 will operate in response to the setting of the dial register of the second sender and cause the operation of the hundreds and tens translating switches of Fig. 40 which, in turn, cause the closure of a pair of crosspoints of the route cross-bar switch in a manner similar to that hereinbefore set forth. With relay 3100 operated, ground is supplied over conductor 3102 to those contacts of the route cross-points which connect to the first and second office brush and group, class, and compensating resistance transmitting relays, certain of which operate, depending upon the particular route, and, in turn, cause the proper selection register relays in the sender to operate in the regular manner as hereinbefore set forth. The closure of the route cross-points for this second call, however, does not operate a second office frame relay, such as relays 3218 or 3219, a second trunk level relay, such as relay 3224 or 3225, or any of the zone transmitting relays of Fig. 39, since relay 3103, which is held operated over the contacts of relays 3100, 3132, and 3133, holds open the ground from the conductors over which the office frame, trunk level and zone transmitting relays operate. The purpose of delaying the operation of the zone transmitting relays at this time is to prevent the closure of the transmitting relay checking circuit which, if completed, would cause the decoder marker release relay 2330 of the second sender to operate and release the decoder marker. The district frame relays 3212 and 3213, the office frame relay 3218 and the trunk level relay 3225, which were operated for the first call, are at this time still locked to the ground over the contacts of relay 3136 which is being held operated by relay 3115, relay 3115 in turn being held by the even office frame relay 3014. In response to information from the second sender, certain of the district frame identification relays 3200 to 3205, inclusive, operate and, in turn, operate a corresponding pair of district frame relays, such as relays 3214 and 3215, for example. The operation of these district frame relays connects battery to the start conductor, such as conductor 3216, of the district frame on which the district trunk associated with the second call is located. In this manner the second district frame may be seized before the release of the frame containing the first call takes place. Upon the seizure of the second district frame the operation of a start relay returns ground over conductor 2019 thereby operating relay 3217. On the first call the operation of relay 3217 closed a circuit from ground over the upper outer back contact of relay 3108, lower outer back contact of relay 3107, lower outer front contact of relay 3106,

back contact of relay 3105, conductor 3141, front contact of relay 3217, conductor 3230, and through the decoder marker connector and sender circuit over previously traced circuits to battery through the winding of relay 2232, causing in turn the operation of relay 1712 of the district trunk. Relay 1712 caused the operation of the "A" trunk switch select magnet and closed certain conductors through to the decoder marker. In the case of the second call, however, the relay of the second district trunk, corresponding to relay 1712, cannot operate at this time since its operating circuit is open at the upper outer back contact of relay 3108. During the aforementioned operation of the decoder marker in connection with the second call, the release of the decoder marker in connection with the first call, as set forth in the preceding paragraph, is simultaneously taking place. The operation of relay 3120, following the check for the continuity of the sleeve conductor from the district through the "A", "B" and "C" trunks, opens the circuit to the windings of relays 2900 and 3014, both of which release. Relay 3014, in releasing, releases relay 3115 which, in turn, releases relay 3136. Relay 3136, in releasing, releases relays 3212, 3213, 3218, and 3225, all of which were operated for the first call. The release of relay 3014 also causes the office frame connector circuit to restore, as described in the preceding paragraph, thereby releasing relays 3016 and 3017. The release of relays 3016 and 3017 releases relay 2922 which, in turn, releases relays 3108, 3117, 3123, 3124, and 3127. Relay 3108, in releasing, closes ground over the previously traced circuit to cause the operation of the relay of the second district trunk, corresponding to relay 1712, which now operates and connects this second district to the decoder marker. The release of relay 3117 releases relays 3132 and 3133 which, in turn, release relay 3103. The release of relay 3103 connects ground to the conductors extending to the route cross-point contacts which control the operation of the office frame, trunk level and also the zone transmitting relay and these relays now operate in a manner identical with that described for the first call. As soon as relay 3133 releases, relay 3132 reoperates from battery through its winding, over the back contact of relay 3133, conductor 3917, back contacts of relays 3911 and 3916, conductor 3134, to ground over the left outer front contact of relay 3100, and thereupon locks over its upper front contact to this same ground. From this point on the decoder marker functions in the same manner, in connection with the second call, as has been set forth for the first call. The purpose of this overlap operation just described is to permit the decoder marker, after its decoding functions are complete, that is, after its receiving and transmitting relays have functioned and set up the proper selection relays in the sender, to perform these same functions in connection with a second sender while it is completing its marker functions on the first call.

Subdivision of large trunk groups

In the foregoing description it was assumed that the group of outgoing trunks extending to the destination represented by route cross-points 3306 and 3307 contained no more than forty trunks (38 trunks) and that these trunks were located on the No. 0 and No. 1 office frames. The office frame contact of route cross-point 3307 was therefore cross-connected, over conductor 3221, directly to the winding of the decoder marker office frame relay 3218 which, upon its operation, closed the start circuit for the No. 0 and No. 1 office frame connector circuit. In those cases where the outgoing trunks to a particular destination are in excess of forty, the trunk group is split into at least three subgroups so that each subgroup contains no more than forty trunks. Two of these subgroups, the trunks of which will be located on different pairs of office frames, will serve one half of the district frames. The third subgroup, the trunks of which are connected to a third pair of office frames, will serve as an overflow group for each of the other subgroups. For those district frames which have regular access to the first subgroup, the office frame contact of the route cross-points is cross-connected to terminals, such as terminal 3231, which connect over a front contact of the district frame relays, such as relay 3213, to the winding of the office frame relay associated with the office frames on which the first subgroup of trunks are located. For those district frames which have regular access to the second subgroup, the route office frame contact is cross-connected over the front contacts of the district frame relays to the winding of the office frame relay associated with that pair of office frames on which the second subgroup is located. By way of illustration, assume for example that the group of outgoing trunks extending to the destination represented by route cross-points 3306 and 3307 contains more than forty trunks and that these trunks are therefore divided into two regular subgroups, one serving the first ten district frames while the other subgroup serves the second ten district frames. Assume further that the first subgroup of trunks is located on the No. 0 and No. 1 office frames while the second subgroup of trunks is located on the No. 18 and No. 19 office frames. Under this condition, the office frame contact of route cross-point 3307 cross-connects to ten terminals, such as terminal 3231, which in turn connect to the armatures of the ten district frame relays, such as relay 3213, associated with the first ten district frames. The office frame contact of cross-point 3307 is also cross-connected to ten terminals, such as terminal 3232, which connect to the armatures of the district frame relays, such as relay 3215, which are associated with the second ten district frames. Upon the closure of route cross-points 3306 and 3307 ground is connected, over conductor 3221, to the armatures of the district frame relays. The decoder marker frame register relays have previously operated under control of the sender and, in turn, caused the operation of that pair of district frame relays associated with the district frame in which the call appears. If one of the first ten pairs of district frame relays, such as relays 3212 and 3213, are operated, office frame relay 3218 operates and closes battery to the start conductors 3222 and 3223 of the No. 0 and No. 1 office frames on which the first trunk subgroup is located. If one of the second ten pairs of district frame relays, such as relays 3214 and 3215, are operated, office frame relay 3219 operates, and closes battery to the start conductors 3233 and 3234 which extend to the No. 18 and No. 19 office frames (not shown) on which the second trunk subgroup is located. From this point on the various circuits function in the manner previously described.

Where the trunks of a particular outgoing group exceed forty and are therefore split into subgroups located on different pairs of office

frames as set forth above, the subgroups may or may not be located in the same level of the secondary office switches of the two pairs of office frames. If the same trunk level is employed in both pairs of frames, the trunk level contacts of the route cross-point representing these trunks is cross-connected directly to the winding of the trunk level relay, such as relay **3225**, associated with the secondary office switch level employed. If the trunk subgroups are located in different secondary switch levels on the two pairs of office frames, the trunk level contact of the route cross-point is cross-connected to the windings of the proper trunk level relays over front contacts of the twenty district frame relays, conductor **3227** connecting, in this case, to terminals such as **3235** or **3236**. The operation of the district frame relay under control of the district frame register relays closes the circuit for operating the proper trunk level relay and from this point on the circuits function as hereinbefore set forth.

As has been set forth in the general description, the horizontal multiple extending across the contacts of any secondary office switch may be split at the mid-point of the switch in which event the switch accommodates twenty outgoing trunks each of which may be reached over any of ten "C" trunks. In the foregoing description it was assumed that the secondary office switch over which outgoing trunk **4114** is reached is not split, and therefore twenty "C" trunks were available for extending the connection to this outgoing trunk. Since one winding of each of the twenty channel testing relays, such as relays **3007** to **3013**, inclusive, is connected to the test conductor of each of the twenty "C" trunks extending to the secondary office switches regardless of whether or not these switches are split, the decoder marker must know which condition it will encounter in order to properly select the first idle "A", "B" and "C" channel extending to the selected outgoing trunk. Relay **3040** is provided for this purpose and functions in the following manner:—The operating circuit for relay **3040** may be traced from battery through its right winding, over conductor **3043**, to the middle armature of zone transmitting relay **3918** from which point it extends over an armature and back contact of the other zone transmitting relays shown in the same horizontal row with relay **3918**. For those routes on which the corresponding outgoing trunk group may be reached over but ten "C" trunks, the zone contact of the route cross-point is cross-connected to one of the windings of one of these aforementioned zone transmitting relays. Upon the closure of the route cross-point the zone transmitting relay, for example relay **3918**, operates through one or the other of its windings in series with either relays **3920** and **3902** or relays **3901** and **3902** as the case may be. Relay **3918**, in operating, completes the circuit from battery through the right winding of relay **3040** previously traced to the middle armature of relay **3918**, to ground through the winding of relay **3919** thereby operating both relays **3040** and **3919**. Relay **3919**, in operating, opens in part the transmitting relay checking circuit so that this circuit now extends over a front contact of relay **3918**. Relay **3040**, in operating, prepares its future locking circuit through its left winding, over its left inner front contact and over conductor **3137** to the upper front contact of relay **3136**. The operation of relay **3040** also transfers conductor **2926** from the armature of the first channel testing relay **3013** of the first group of ten channel testing relays to the armature of the first relay **3009** of the second group of channel testing relays. In addition, the operation of relay **3040** transfers the front contact of the last relay **3010** of the first group of ten channel testing relays to conductor **3044**. With relay **3040** operated, the operation of relay **3035**, during the test for an idle "A", "B" and "C" trunk channel as hereinbefore set forth, connects ground over conductor **3036**, upper outer back contact of relay **3104**, conductor **3037**, back contact of relay **3038**, conductor **3039**, and over the lower outer front contact of the operated trunk relay corresponding to the first idle trunk of the desired group, to the armature of channel testing relay **3013** or **3009** depending upon whether the first ten "C" trunks or the second ten "C" trunks extend to the desired outgoing trunk group. In this instance the "A", "B" and "C" trunk channels are tested and the first idle channel in either the first or the second group is selected in the manner identical with that hereinbefore set forth where the twenty "C" trunks were available to the outgoing trunk group.

Second trial—alternate route—overflow

Whenever the marker fails for any reason to progress with its functions, a time interval may be measured by any suitable timing means, and at the end of the interval a signal is transmitted to the sender, causing the sender to release the marker. To accomplish this the marker closes a circuit over conductor **3044** which extends over a front contact of relays **2702** and **2700**, over conductor **2335**, upper inner back contact of relay **2322** of the sender, to battery through the winding of relay **2321**. Relay **2321** operates and opens the operating circuit for the sender decoder connector start relay **2325** which releases. The release of relay **2325** removes the battery from the decoder marker connector start conductor **2329** which releases connector relays **2800** and **2814**. The release of relay **2800** releases sender connector relays **2700** and **2801**. The release of relay **2801** releases relay **2802**. The release of relays **2700**, **2801**, and **2802** opens all direct connections between the sender and the decoder marker. Conductor **2335** being opened with the rest opens the operating circuit for relay **2321**, relay **2321** holding in a circuit from battery through its winding, through the winding of relay **2322**, front contact of relay **2321**, conductor **2652**, outer front contact of sender register switch magnet **2634**, conductor **2208**, to ground over the upper outer front contact of relay **2200**. Relay **2322** operates in this aforementioned circuit in series with relay **2321** and closes a circuit from the ground previously traced to conductor **2652**, over its lower outer front contact, lower normal contact of relay **2323**, lower back contact of relay **2324**, to battery through the winding of the decoder connector start relay **2325** which again operates and causes the decoder connector circuit to function in the manner previously set forth and establish connections between the sender and the same or another decoder marker. The manner in which a marker is released by the sender after a measured interval of time and a second marker is seized is shown and described in the patent to Williams 1,601,053 of September 28, 1926. Relay **2322** in operating, also connects a ground over its upper outer front contact to conductor

2224. This ground extends over a front contact of the operated connecting relays 2700 and 2702, over conductor 2713, and through the windings of relays 3329 and 3317 to battery. Immediately upon the establishment of connections between the sender and the decoder marker for the second trial, therefore, both relays 3317 and 3329 of the decoder marker operate. The operation of relay 3317 opens the operating circuit for relays 3411 and 3429. The decoder marker functions up to and including the operation of the regular route cross-points 3306 and 3307 in the manner identical with that hereinbefore described. The operation of cross-points 3306 and 3307 is ineffective, however, due to relay 3429 being unoperated. Relays 3317 and 3329 being operated, a circuit is closed from ground over a right front contact of relay 3100, conductor 3101, right inner back contact of relay 3300, inner front contact of relay 3301, lower front contact of relay 3310, right outer back contact of relay 3300, outer front contact of relay 3329, to conductor 3330. This ground on conductor 3330 causes the alternate route cross-points to operate in the manner previously described. In this foregoing manner, therefore, the sender, upon receiving a release indication from the decoder marker during the initial trial, releases and summons a second decoder marker which may be the same or some other decoder marker, and informs this second decoder marker to immediately attempt to complete the connection over the alternate route, if provided, disregarding the regular route. Should the marker encounter trouble after it has released from the sender, the marker timing mechanism counts time and effects the release of the marker. This may be done by a timing mechanism of the general type disclosed in the patent to Williams, No. 1,601,053, granted September 28, 1926. The release of the marker causes the sender to attempt, as described herein, to continue the extension of the connection. Since this is impossible, however, an interval is counted by any suitable timing mechanism, after which the sender may be released.

Should the decoder marker, in making the second trial, fail to progress, ground is applied over conductor 3044, a front contact of relays 2702 and 2700, conductor 2335, upper inner front contact of relay 2322 of the sender, upper back contact of relay 2324, to the windings of relays 2323 and 2324, operating relay 2323 to battery through the winding of that relay. Relay 2323, in operating, opens the operating circuit for the sender decoder connector start relay 2325 which thereupon releases and removes the battery from the decoder connector start conductor 2329. Relays 2800, 2814, 2700, 2801, and 2802 release in that order as previously set forth and open the connections between the sender and the decoder marker. The opening of conductor 2335 opens the operating circuit for relay 2323, relay 2323 now holding in a circuit from battery through its winding, through the winding of relay 2324, lower inner front contact of relay 2323, lower outer front contact of relay 2322, to ground previously traced to conductor 2652. Relay 2324 operates in this aforementioned circuit in series with relay 2323 and connects the ground previously traced to conductor 2652, over the lower outer front contact of relay 2322, lower outer front contact of relay 2323, lower outer front contact of relay 2324, to battery through the winding of the sender decoder connector start relay 2325 which reoperates and again connects battery to conductors 2328 and 2329 and causes the decoder connector circuit to function and establish connections between the sender and the same or another decoder marker for the third time. Relay 2323, in operating, also connects ground over its upper front contact to conductor 2334. This ground extends over front contacts of the operated connecting relays 2700 and 2702, over conductor 2714, to battery through the windings of relays 3334 and 3300, both of which operate immediately upon the establishment of the connections between the sender and the decoder marker for the third trial. The call is thereupon routed to an overflow trunk in a manner which will be described later.

As hereinbefore set forth, direct connection between the sender and the decoder marker is broken following the selection of an outgoing trunk and the checking of this trunk for a double connection with a panel selector, the sender having at this time received from the decoder marker all information which it requires for the completion of the call. The sender is still in indirect communication with the decoder marker through the district trunk and the district connector circuit. Following the extension of the connection from the district trunk to the selected outgoing trunk over an idle "A", "B" and "C" channel or link, the decoder marker completely releases and the sender has no further connection therewith under normal conditions.

Selective operations now take place first at the intermediate office or offices if the call is so routed, and then at the terminating office, under the revertive control of the subscriber sender at the originating office. Where the terminating office is of the cross-bar type the sender circuit in that office records the entire selection information which it requires for the completion of the connection, functioning in the manner which will later be set forth in detail. Where the terminating office is of the panel type, the incoming and final selector circuits of that office complete the connection under control of the sender at the originating office in a manner well known to the art. Should the panel type office selector circuit at the intermediate office fail to find an idle trunk to the desired terminating cross-bar office; should the sender circuit at the terminating cross-bar office encounter a trouble condition during its registration of the selection information; or, on a call to a terminating office of the panel type, should the incoming selector circuit in the terminating panel type office find all trunks to the proper final selective stage busy, the intermediate office selector circuit, the terminating cross-bar sender, or the panel type incoming selector circuit, as the case may be, will cause a pulse of reversed battery to be transmitted to the subscriber sender in the originating cross-bar office. This latter sender recognizes this reversed battery pulse as an overflow signal, and thereupon functions and causes its selection register and selection sequence relays to restore to normal and summons a decoder marker, informing the decoder marker to route the connection to an overflow trunk. When any of the above conditions are encountered relay 2337 of the sender operates in a manner which will later be described and opens the operating circuit for relay 2338 which releases. A circuit is thereupon completed from ground over the lower front contact of relay 2337, back contact of relay 2338, conductor 2339, upper back contact of relay 2230,

conductor 2231, upper back contact of relay 2324, to battery through the winding of relay 2323. Relay 2323 operates and opens the operating circuit for relay 2325 which releases, in turn releasing relay 2330 which, upon its previous operation during the release of the sender from the original decoder marker used, locked to battery over the upper inner front contact of relay 2325. The release of relay 2325 also opens the operating circuit for relay 2337 which releases. In addition, the release of relay 2325 removes battery from conductor 2326 thereby releasing any operated selection sequence relays shown in the lower portion of Fig. 24. The release of relay 2330 removes the ground from conductor 2501 thereby releasing any operated selection register relays, such as relays 2500, 2502, 2503, and 2504. Relay 2337, in releasing, removes the ground from conductor 2231 and from the winding of relay 2323. Relay 2323 remains operated in a circuit from battery through its winding, through the winding of relay 2324, lower inner front contact of relay 2323, to a previously traced ground on conductor 2652. Relay 2324 operates in series with relay 2323 and again closes the operating circuit for relay 2325. The reoperation of relay 2325 again connects battery to the decoder marker connector circuit start conductor 2329 and that circuit functions, in the manner hereinbefore set forth, and connects the sender to an idle decoder marker. Sender relay 2323 being operated at this time, ground is connected over its upper front contact to conductor 2334. Upon the closure of the connections between the sender and the decoder marker this ground is extended, over conductor 2714, through the windings of relays 3300 and 3334 of the decoder marker, causing both of these relays to operate and function, in the manner previously described, to route the call to an overflow trunk.

All trunks test busy

As hereinbefore set forth, should all trunks of a particular group test busy, the decoder marker either routes the call over an alternate route, if provided, or to an overflow trunk in those cases where no alternate route is provided or where all the alternate route trunks also test busy. When all trunks of a group are busy the trunk test relays, such as relay 2900, and the auxiliary trunk test relays, such as relay 2901, associated with each trunk of the group are operated in the manner previously described. Under this condition a circuit is completed from ground over the front contact of relay 3113, lower back contact of relay 3114, upper back contact of relay 3120, front contact of relay 3110, upper outer front contact of relay 3116, lower outer front contact of relay 3104, outer back contact of relay 3103, conductor 3121, a front contact of relay 3429, conductor 3427, the group start contact of cross-point 3307, conductor 3347, the armatures and front contacts of the operated auxiliary trunk test relays associated with that group of trunks under test, conductor 3348, the group end contact of cross-point 3307, conductor 3428, a front contact of relay 3429, conductor 3439, a back contact of relay 3103, to battery through the windings of relays 3122 and 3142 in parallel, both of which operate. Relay 3122, which has fast operating characteristics, immediately removes the battery from the windings of all of the trunk relays, such as relay 2900, thus preventing the operation of the trunk relay next after the relay associated with the last trunk of the group being tested. Relay 3142, in operating, locks over its lower inner front contact to the ground previously traced to the armature of relay 3110 and also locks over its upper outer front contact and over conductor 3143 to ground over the lower outer front contact of relay 2922. The operation of relay 3142 connects ground to one side of condenser 3118 and to the upper winding of relay 3110. Condenser 3118 discharges and relay 3110 releases since its windings are so connected that they oppose each other. The operation of relay 3142 also closes a circuit from ground over the right inner front contact of relay 3100, lower outer front contact of relay 3142, conductor 3144, back contact of relay 3333, back contact of relay 3329, to battery through the winding of relay 3317. Relay 3317 operates and opens the operating circuit for relays 3411 and 3429, both of which release. The release of relays 3411 and 3429 open all conductors extending through the operated route cross-points thereby causing the release of the various relays which are operated over those contacts including the office frame relay, such as relay 3218, the release of which in turn removes the ground from the start conductors of the associated pair of office frame connector circuits. The office frame connector circuits release, in turn releasing relays 3016 and 3017. The release of relays 3016 and 3017 release relay 2922 which, in turn, opens the locking circuit for relays 3122 and 3142. The release of relay 3122 again connects battery, over conductors 3026 and 2920, to the windings of the trunk relays, such as relay 2900. The release of relay 3142 opens the operating circuit for relay 3317 and that relay now holds in series with relay 3329 which operates over a circuit from battery through the windings of relays 3317 and 3329, front contact of relay 3317, conductor 3101, to ground over a right front contact of relay 3100. The operation of relay 3329 causes the route switch select magnet associated with the alternate route cross-point to operate and the circuit to function in the manner previously set forth under the description of the operation of the route cross-points.

Should all trunks of the alternate route group test busy the subsequent operation of relay 3142, which operates together with relay 3122 in the manner hereinbefore set forth, closes a circuit from ground over the right inner front contact of relay 3100, lower outer front contact of relay 3142, conductor 3144, back contact of relay 3333, inner front contact of the previously operated relay 3329, back contact of relay 3334, to battery through the winding of relay 3300 which operates. The operation of relay 3300 causes the regular and the alternate route cross-points to restore in the manner previously described. The restoring of the alternate route cross-points release the various relays which are operated over the contacts of those cross-points including the office frame relay which, by its release, causes the office frame connector circuits of the two office frames involved to restore, in turn releasing relays 3016 and 3017. Relay 2922 thereupon releases and opens the locking circuit for relays 3122 and 3142 both of which release. The release of relay 3122 again connects battery to the windings of the trunk relays, while the release of relay 3142 opens the operating circuit for relay 3300 which holds in a circuit from battery through its winding, through the winding of relay 3334, front contact of relay 3300, and over conductor 3101 to ground over a right front contact of relay 3100. Relay 3334 operates over this

aforementioned circuit and operates overflow route relay 3430 over conductor 3349. The contacts of relay 3430 perform functions similar to the contacts of the route switch cross-points and cause the call to be routed to one of a group of overflow trunks as hereinbefore set forth. Where no alternate routes are provided, the operation of relays 3317 and 3329, upon the operation and release of relays 3122 and 3142 as described above, cause the original route cross-point to be made ineffective and also operates the overflow route relay 3430 in the manner hereinbefore set forth under the description of the route cross-points.

When the decoder marker is normal the ten trunk level conductors, such as conductor 3228, are connected over back contacts of relay 3237 to the winding of check relay 3238, the other end of which winding is connected to ground. Should any of the contacts of the office frame multi-contact connecting relays over which these trunk level conductors extend, such as relay 4104, become crossed, the battery connected to the common conductor extending to the corresponding armatures of these connecting relays by some other decoder marker will cause relay 3238 to operate and give an alarm signal over a circuit which has not been shown. The conductors which extend to the select magnets of the "B" trunk switch of the district frame connector circuit, such as conductor 3229, connect over back contacts of check relay 3239 to ground through the winding of check relay 3240 which will operate, with the decoder marker normal, if any of these conductors is crossed with some other similar conductor which has battery connected to it by some other decoder marker. The ten conductors, such as conductor 2924, which extend to the select magnets of the office frame connector switch, connect over back contacts of relay 3019, to ground through the winding of check relay 3045 which will operate if any of these conductors is crossed with battery from any of these select magnets. Battery through the winding of check relay 3034 is connected to each of the windings of the forty channel testing relays, such as relays 3007 to 3013, inclusive, and, through these windings connects to the conductors which extend to the "A", "B", and "C" trunk test conductors when the decoder marker is in use. Should any of these conductors be crossed or falsely grounded, with the decoder marker normal, relay 3034 operates and causes an alarm to be given over a circuit which has not been shown. When the decoder marker is in use direct battery over the left outer front contact of relay 3018 shunts out the winding of relay 3034. Should any of the contacts of the office frame connector multi-contact relays which close the circuits from the forty test conductors of the outgoing trunks to the trunk test relays become short-circuited, the corresponding trunk test relay of this decoder marker, such as relay 2903, for example, will operate whenever the office frame connector circuit is in use by some other decoder marker and the trunk associated with that particular test relay is busy. The trunk test relay, such as relay 2903, in operating operates its associated auxiliary relay, such as relay 2908, in series with check relay 3046. Relay 3046, in operating, closes the alarm circuit (not shown). When the decoder marker is in use, check relay 3046 is short-circuited by ground over a front contact of relay 3018 which operates under control of the decoder marker start relay 3100. Check relays 3047, 3048 and 3049 are connected, over back contacts of the even and odd office frame relays 3014 and 3015, to the conductors which extend from the armatures of these relays to the ten decoder marker office frame relays, such as relays 3218 and 3219, and to the office frame connector circuit, and check these conductors for short-circuited contacts of the relays to which they connect. Each of these check relays, if operated when the decoder marker is normal, closes the alarm circuit (not shown). The battery for operating the select magnets of the "C" trunk switch 4115 is supplied through the winding of relay 3028. Relay 3028 has marginal characteristics and does not receive sufficient current through one select magnet to operate. Should one or more additional select magnets operate falsely due to short-circuited conductors, relay 3029 operates and closes an alarm circuit (not shown). Marginal relay 3032 is in series with the winding of the select magnet of the "B" trunk switch 2012 and operates if one or more additional select magnets of this switch falsely operate, thereby closing an alarm circuit (not shown). The ground for operating the select magnets of the secondary office switches, such as select magnet 4111, is supplied through the winding of relay 3031 which has marginal characteristics and receives sufficient current to operate only if additional select magnets are falsely operated due to a trouble condition. The contacts of relay 3031 close an alarm circuit. The battery for each of the forty trunk relays, such as relay 2904, is supplied through the winding of check relay 3025 while the battery for each of the twenty channel relays, such as relay 3000, is supplied through the winding of check relay 3041. Both relays 3025 and 3041 have marginal characteristics and do not receive sufficient operating current through the winding of one of their associated trunk or channel relays. Should more than one trunk or channel relay falsely operate, relay 3025 or 3041 operates as the case may be, and closes the alarm circuit.

Operation of intermediate office switch

It has been assumed in the foregoing description that route cross-points 3306 and 3307 represent a destination which extends to the desired distant office through one intermediate or tandem office and the decoder marker therefore caused the operation of certain selection relays of the sender to enable that circuit to control the selective operations at this intermediate office. It was further assumed that the particular destination desired requires the selection of brush 1 and group 5 of the intermediate office selector and sender selection relays 2500 and 2502 were therefore operated as hereinbefore set forth. At the time that relay 2232 of the sender was operated by the decoder marker it closed a circuit from ground over its lower outer front contact, over conductor 1833, back contact of relay 2503, conductor 2505, winding of relay 2400, conductor 2326, to battery over the lower outer front contact of relay 2325. Relay 2400 operates and closes a circuit from the winding of relay 2401 to ground over the upper back contact of relay 2403, but relay 2401 does not operate since it is short circuited by the ground on conductor 2505. At the time that relay 2325 operated and connected off-normal battery to conductors 2326 and 2327 relay 2404 operates from the battery over conductor 2327, through its winding, back contact of relay 2415, conductor 2405, to ground over the lower back contact of relay 2340. Relay 2341 thereupon operates from battery on conductor

2326, through its winding, conductor 2342, outer front contact of relay 2404, conductor 2406, to ground over the upper inner back contact of relay 2340. The release of relay 2232, which takes place when its holding circuit is opened upon the disconnection of the decoder marker, opens the previously traced operating circuit for relay 2400 and that relay now holds in a circuit from battery over conductor 2326, through its winding, winding of relay 2401, lower front contact of relay 2400, to ground over the upper back contact of relay 2403. Relay 2401 also operates in this series circuit. Upon the operation of relays 2401 and 2341, the fundamental circuit of the sender is connected to the outgoing trunk for the purpose of testing the intermediate office selector circuit to ascertain if it is normal and, if normal, to cause the selective mechanism of that circuit to start. This fundamental circuit may be traced from the tip conductor 4135 of outgoing trunk 4114, a contact of cross-point 4110, tip conductor of "C" trunk 4113, a contact of cross-point 4107, tip conductor of "B" trunk 2013, a contact of cross-point 2007, tip conductor of "A" trunk 2010, a contact of cross-point 2004, conductor 1722, upper outer front contact of relay 1711 of the district trunk, conductor 1701, a contact of cross-point 1800, a conductor of sender link 1801, a contact of cross-point 1802, conductor 1825, upper back contact of relay 2232, upper outer front contact of relay 2341, upper outer back contact of relay 2340, conductor 2343, upper outer front contact of relay 2400, upper inner back contact of relay 2407, winding of trunk test relay 2417, upper inner front contact of relay 2401, conductor 1827, a contact of cross-point 1802, a conductor of sender link 1801, a contact of cross-point 1800, conductor 1702, upper middle front contact of relay 1711, conductor 1723, a contact of cross-point 2004, a conductor of "A" trunk 2010, a contact of cross-point 2007, a conductor of "B" trunk 2013, a contact of cross-point 4107, a conductor of "C" trunk 4113, a contact of cross-point 4110, to the ring conductor 4136 of outgoing trunk 4114. Assuming that the intermediate office selector, which is indicated by block 4500, is normal, trunk test relay 2417 operates over the fundamental circuit to battery and ground supplied by the office selector circuit. Relay 2417, in operating, closes a circuit from ground over the back contact of relay 2418, front contact of relay 2417, windings of relays 2408, 2409, and 2410 in series to battery over conductor 2327. Relays 2408, 2409, and 2410 operate and lock, through their windings in series over the front contact of relay 2410, conductor 2419, to ground over the upper inner front contact of relay 2341. Relay 2408, in operating, closes a circuit from ground over its front contact, conductor 2420, upper outer back contact of relay 2344, back contact of relay 2345, conductor 2346, lower back contacts of relays 2428 and 2403, lower outer front contact of relay 2401, winding of relay 2402, to battery over conductor 2326, thereby operating relay 2402. Relay 2340 thereupon operates in a circuit from battery through its winding, over conductor 2347, upper inner front contact of relay 2402, to ground over the upper outer front contact of relay 2401. Relay 2340, in operating, opens the operating circuit for relay 2341 which releases, opening the fundamental circuit and opening the locking circuit for relays 2408, 2409, and 2410, all of which release. The release of relay 2408 opens the operating circuit for relay 2402 which remains locked in a circuit from battery over conductor 2326, windings of relays 2402 and 2403, lower front contact of relay 2402, to ground over the upper back contact of relay 2428. Relay 2403 operates in series with relay 2402 and opens the locking circuit for relays 2400 and 2401, both of which release. The release of relay 2401 opens the operating circuit for relay 2340 which releases and again permits relay 2341 to operate. The operation of relay 2431 closes the fundamental stepping circuit of the sender for the revertive control of the brush selection which now takes place at the intermediate office. The fundamental stepping circuit may be traced from the tip conductor 4135 of the outgoing trunk, previously traced to conductor 1825, over the upper outer front contact of relay 2341, upper outer back contact of relay 2340, conductor 2343, winding of relay 2418, winding of stepping relay 2429, back contact of relay 2409, upper outer back contact of relay 2430, upper inner front contact of relay 2403, and over conductor 1827 which extends, over a previously traced circuit, to the ring conductor 4136 of the outgoing trunk 4114. Relay 2429 operates from battery and ground supplied from the distant office selector circuit but relay 2418, which is polarized, does not operate at this time since the flow of current through its winding is in its non-operate direction. Upon the previous operation of relay 2325 relay 2348 operated from battery over conductor 2326 to ground over the upper inner back contact of relay 2344. The operation of relay 2429 therefore completes a circuit from ground over its front contact, over conductor 2431, front contact of relay 2348, conductor 2349, back contacts of relays 2426 and 2421, lower inner front contact of relay 2403, upper inner back contact of relay 2430, lower inner back contact of relay 2432, conductor 2433, back contacts of relays 2507 and 2506, upper outer front contact of relay 2500, conductor 2508, inner front contact of relay 2404, winding of the No. 1 counting relay 2411, to battery over conductor 2327. Counting relay 2411 operates and connects the ground on conductor 2419 to one end of the winding of the No. 1' counting relay 2421 but this latter relay does not operate since its winding is short-circuited by the ground supplied over the front contact of the stepping relay 2429. As the office selector circuit proceeds with its operation for the selection of the office brush and office group it opens the fundamental stepping circuit once for each successive step of either of these selections in a manner well-known to the art. For an illustration and a description of the operation of a typical office selector circuit of the panel type reference may be had to the patent to Johnson 1,567,271 of December 29, 1925. Upon the first open pulse, relay 2429 releases and opens the operating circuit for relay 2411. The No. 1' counting relay 2421 now operates in series with the No. 1 counting relay 2411 to the ground over conductor 2419, and both relays 2411 and 2421 hold over the front contact of relay 2411. Upon the reoperation of relay 2429, following the first open pulse, the No. 0 counting relay 2410 operates in a circuit from battery over conductor 2327, winding of relay 2410, upper back contact of relay 2427, lower inner back contact of relay 2430, front contact of relay 2421, and over a previously traced circuit to the ground over the front contact of stepping relay 2429. Upon the release of relay 2429 during the second open pulse, relays 2408 and 2409, their windings in

parallel, operate in series with relay 2410 to the ground over conductor 2419, relay 2410 remaining locked in this circuit. The operation of relay 2408 opens the fundamental stepping circuit thereby causing the distant office selector circuit to stop the advance of its brush selection, the two open pulses representing the selection of office brush No. 1 which was previously assumed to be the desired brush. Relay 2408, in operating, operates relay 2427 in a circuit which may be traced from battery on conductor 2326, through the winding of relay 2427, lower outer front contact of relay 2403, lower outer back contact of relay 2428, conductor 2346, right back contact of relay 2345, upper outer back contact of relay 2344, conductor 2420, to ground over the front contact of relay 2408. Relay 2350 now operates from battery through its winding, over conductor 2351, upper inner front contact of relay 2427, to ground over the upper outer front contact of relay 2403. Relay 2350, in operating, operates relay 2340 which, in turn, releases relay 2341. The release of relay 2341 removes the ground from conductor 2419 thereby releasing the operated counting relays 2408, 2409, 2410, 2411 and 2421. The release of relay 2408 opens the operating circuit for relay 2427. Relay 2427 locks in a circuit from battery on conductor 2326, windings of relays 2427 and 2428 in series, lower outer front contact of relay 2427, upper back contact of relay 2434, to ground over the upper back contact of relay 2401. Relay 2428 operates in series with relay 2427 and opens the locking circuit for relays 2402 and 2403, both of which release. The release of relay 2403 releases relay 2350 which, in turn, releases relay 2340. The release of relay 2340 operates relay 2341 which again closes the fundamental circuit to cause the distant office selector to start its group selection. During group selection the office selector returns open pulses over the fundamental stepping circuit which, in the manner identical with that set forth above for office brush selection, cause the stepping relay to count down the pairs of counting relays until relay 2409 operates and opens the fundamental circuit to cause the office selector to halt in its group selection advance. Since it has been assumed that the desired office group is No. 5, the sender must open the fundamental circuit after receiving six pulses during the office group selection (one pulse accounting for the No. 0 group). On the initial operation of relay 2429, upon the closure of the fundamental circuit at the start of the office group selection, the No. 6 counting relay 2416 operates in a circuit from battery on conductor 2327, winding of relay 2416, conductor 2435, upper front contact of relay 2502, conductor 2508, upper back contact of relay 2432, upper outer front contact of relay 2427, lower inner back contact of relay 2430, conductor 2436, upper outer back contact of relay 2509, upper back contacts of relays 2510 and 2511, conductor 2512, lower inner back contact of relay 2437, lower outer back contact of relay 2430, lower inner front contact of relay 2428, back contacts of relays 2421 and 2426, conductor 2349, front contact of relay 2348, conductor 2431, to ground over the front contact of relay 2429. Upon the release of relay 2429 during the first pulse relay 2426 operates in series with relay 2416 and both relays lock over the front contact of relay 2416. The reoperation of relay 2429 operates the No. 5 counting relay 2415 which opens the circuit for relay 2404, releasing relay 2404. The release of relay 2429 on the second open pulse causes relay 2425 to operate in series with relay 2415, both relays locking. For the third pulse relay 2414 operates followed by the operation of relay 2424. The fourth pulse causes relays 2413 and 2423 to operate. The fifth pulse operates relays 2412 and 2422. The operation of relay 2422 extends the pulsing contact of stepping relay 2429, over its front contact and over the inner back contact of relay 2404, to the winding of the No. 0 counting relay 2410 and the windings of relays 2408 and 2409. The reoperation of relay 2429 after the fifth open pulse operates the No. 0 counting relay 2410. On the sixth open pulse, which signifies that the office selector has advanced in its group selection to the desired group No. 5, the release of relay 2429 causes relays 2408 and 2409 to operate in series with relay 2410, all three relays locking. Relay 2409, in operating, opens the fundamental circuit thereby stopping any further advance of the office selector which thereupon completes its function and selects an idle trunk to the desired terminating office. Relay 2408, in operating, operates relay 2433 in a circuit traceable from battery on conductor 2326, winding of relay 2433, conductor 2438, upper front contact of the skip second office register relay 2504, conductor 2513, lower outer front contact of relay 2428, conductor 2346, to ground at the front contact of relay 2408 over a previously traced circuit. Relay 2433, in operating, operates relay 2350 in a circuit from battery through the winding of relay 2350, over conductor 2351, lower outer front contact of relay 2433, upper back contact of relay 2400, to ground over the upper back contact of relay 2428. Relay 2350, in operating, operates relay 2340, which, in turn, opens the fundamental circuit to keep that circuit open upon the subsequent release of relay 2409, removes the ground from conductor 2405, and releases relay 2341. The release of relay 2341 removes the ground from conductors 2352 and 2419 thereby releasing relays 2408 to 2414, inclusive, 2416, 2421 to 2424, inclusive, and 2426. The removal of ground from conductor 2405 releases relays 2415 and 2425. The release of relay 2408 opens the operating circuit for relay 2433, that relay now holding in series with relay 2434 in a circuit over the lower front contact of relay 2433 to ground over the upper back contact of relay 2440. Relay 2434 operates in series with relay 2433 and opens the locking circuit for relays 2427 and 2428, both of which release. Relay 2428, in releasing, opens the operating circuit for relay 2350 which releases, in turn releasing relay 2340. The release of relay 2340 permits relay 2341 to reoperate and close the fundamental circuit for the purpose of testing the distant incoming trunk to which the connection has now been extended by the selective operations of the office selector circuit at the intermediate office. The fundamental circuit over which the sender tests the incoming trunk may be traced from the tip conductor 4135 of the outgoing trunk 4114, to conductor 1825 over a previously traced circuit extending over the office frame and district frame switches, district trunk and sender link circuits, from conductor 1825 over the upper outer front contact of relay 2341, upper outer back contact of relay 2430, conductor 2343, upper front contact of relay 2433, upper inner back contact of relay 2407, winding of trunk test relay 2417, upper inner front contact of relay 2434, conductor 1827, and thence to ring conductor 4136 of the outgoing trunk over a previously traced circuit.

Trunk **4114**, outgoing from the originating office, is extended by office selector **4500** at the intermediate or tandem office, over trunk **4501** to the incoming trunk circuit, shown in Fig. 45, at the desired terminating office. This incoming trunk circuit connects, over conductors **4508** to **4513**, inclusive, to the incoming frame, the tip, ring and sleeve conductors **4508**, **4509** and **4510** connecting to horizontal rows of contacts of the primary incoming cross-bar switches, a portion of one of which is indicated by cross-point **5900** of Fig. 59. The incoming trunk circuit also connects, over conductors **4514** to **4521**, inclusive, to the terminating sender link and control circuit shown in Figs. 43 and 44. Conductors **4514** to **4518**, inclusive, connect to a horizontal row of contacts of one of three primary sender link switches, a portion of the horizontal multiple of one of these switches being indicated by the armatures of cross-point **4300**. The vertical multiple of this primary sender link switch, indicated by the front contacts of cross-point **4300**, connects over a sender link **4302** to a vertical row of contacts of a secondary link switch which is indicated by the front contacts of cross-point **4301**. One horizontal row of contacts of this secondary sender link switch which contains cross-point **4301** extends over conductors **4308** to **4313**, inclusive, to the terminating sender shown in Figs. 46 and 47. As has been set forth in the general description, the vertical rows of contacts of the primary sender link switches extend over links, such as link **4302** to vertical rows of contacts located in each of three secondary sender link switches. Each of these three secondary switches is provided with ten horizontal rows of contacts, each row extending to one of thirty terminating senders. Any incoming trunk, therefore, has access over its associated primary sender link switch and the three secondary sender link switches to any of the thirty senders. For the purpose of simplicity, Fig. 43 shows only such portions of one primary and one secondary sender link switch as is necessary to illustrate the manner in which these switches, together with their associated control circuit, function in establishing connections between the incoming trunk and an idle terminating sender.

Operation of terminating sender selector

When office selector **4500** extends outgoing trunk **4114** to the incoming trunk **4501**, relay **4505** of the incoming trunk circuit operates in a circuit from battery through its left winding in parallel with battery through resistance **4522**, over the outer back contact of relay **4504**, tip conductor **4502** of trunk **4501**, through office selector **4500** and over the previously traced fundamental circuit which extends through the winding of relay **2417** of the originating sender which functions in the manner which will be set forth later, back over ring conductor **4503** of trunk **4501**, inner back contact of relay **4504**, to ground over the upper middle of contact of relay **4506**. Relay **4505**, in operating, operates relay **4507** in a circuit through the upper inner back contact of relay **4506**. Assuming that sender link **4302** is idle at this time, hold magnet **4303** of the primary sender link switch on which crosspoint **4300** is located is unoperated and a circuit is thereby completed from ground over the back contact of magnet **4303**, outer back contact of sender group busy relay **4307** (it being further assumed that not all senders of the group are busy), over the upper outer back contact of relay **4314** in parallel with the lower back contact of relay **4315** conductor **4520**, outer front contact of relay **4507**, conductor **4519**, winding of trunk group relay **4316**, upper back contacts of the nine other trunk group relays of which two, relays **4317** and **4318** are shown, to battery through the winding of relay **4319**. Relay **4316**, in operating, operates relay **4315** in a circuit from battery through the winding of that relay, lower front contact of relay **4316**, conductor **4320**, upper outer back contact of relay **4400**, conductor **4401**, to ground over the upper inner back contact of relay **4314**. Relay **4316** is associated with that group of ten incoming trunks, of which there are ten such groups, which connect to the ten horizontal rows of contacts of a primary sender selector switch and have access over three vertical rows of contacts of this same primary switch to three sender links, such as link **4302**. Relays **4317** and **4318** each are associated with some other group of ten incoming trunks which connect to ten horizontal rows of contacts of a primary switch each of which has access to three other sender links (not shown). The operation of relay **4316** therefore identifies the particular group of ten trunks containing that trunk seeking connection with an idle sender. Relay **4315** is associated with the same group of trunks as relay **4316** and, by its operation, selects that group as the one to be served by the sender link circuit at this time. Relays **4321** and **4322** are associated with relays **4317** and **4318**, respectively. The operation of relay **4316**, in addition to operating relay **4315**, opens the chain circuit which extends over its lower back contact and the lower back contacts of the similar relays **4317** and **4318** thereby preventing the possible operation of relays **4321** and **4322** in the event that relays **4317** and **4318** should operate due to simultaneous calls being placed in incoming trunks of the groups with which they are associated. In this manner only one group of ten incoming trunks is served by the sender link circuit, the other groups remaining locked out by the operation of the relay such as relay **4316**.

There are ten trunk selecting relays, four of which, relays **4323** to **4326**, inclusive, are shown, which correspond to the ten trunks of any incoming trunk group and which select the particular trunk of that group to be served in the event that simultaneous calls are placed in more than one trunk of the group. Upon the operation of relay **4315** a circuit is closed from the ground previously traced to conductor **4520**, over the inner front contact of relay **4507**, conductor **4521**, an upper front contact of relay **4315**, to the windings of relay **4323**. Relay **4323** operates through its left winding, over the right outer back contact of relay **4327**, conductor **4328**, inner front contact of relay **4402**, to battery over the lower back contact of relay **4400**, relay **4402** having previously operated over conductor **4403** to ground over the inner front contact of relay **4319**. Relay **4315**, in operating, also closes circuits from the inner front contacts of relays corresponding to relay **4507** of the other nine trunks of the group, over nine additional front contacts, one of which is indicated by conductor **4329** and the upper inner front contact of relay **4315**, to the windings of the nine other trunk selecting relays, such as relays **4324**, **4325**, and **4326**. Those trunk selecting relays associated with trunks on which simultaneous calls have been placed operate through their left windings in a manner similar to that described for relay

4323. It will be assumed that the trunk with which relay 4323 is associated is the only trunk of the group on which a call has been placed at this time and the operation of relay 4323 therefore closes a circuit from batery through the winding of relay 4327, right inner back contacts of relays 4326, 4325, and 4324, right inner front contact and right winding of relay 4323, to ground previously traced to that point. Relay 4323 locks through its right winding in series with relay 4327 which operates and opens the operating circuit through the left windings of the ten trunk selecting relays thereby releasing all but one of these relays in the event that several had operated. For example, had both relays 4323 and 4324 operated, relay 4324 would lock in series with relay 4327 and open the locking circuit for relay 4323 which would release upon the subsequent opening of its operating circuit by the operation of relay 4327.

Relay 4327, in operating, operates relay 4400 in a circuit from battery through the lower winding of that relay, over conductor 4404, to ground over the outer front contact of relay 4327. Relay 4400, in operating, operates primary switch select magnet 4304 in a circuit from battery through that magnet, over the left front contact of relay 4323, left back contacts of relays 4324 to 4326, inclusive, conductor 4330, to ground over a front contact of relay 4400. Relay 4400 also opens the operating circuit for relay 4315 which now holds in a circuit over its lower inner front contact, conductor 4331, upper outer front contact of relay 4400, conductor 4401, to ground over the upper inner back contact of relay 4314. In addition, relay 4400 locks through its upper winding and an upper front contact to the ground on conductor 4401. As indicated by strap 4332, the conductor connected to the winding of select magnet 4304 is multipled to the other corresponding select magnets (not shown) of the primary switches and these magnets all operate in parallel and prepare their associated cross-points for closure upon the subsequent operation of some primary switch hold magnet. The operation of relay 4315 completes a circuit from the back contact of primary switch hold magnet 4303, over one of the upper front contacts of relay 4315, conductor 4333, outer back contact of relay 4405, to the left winding of sender group relay 4406. There are three sender group relays, relays 4406, 4407, and 4408, one for each of the three groups of ten senders. The left windings of relays 4407 and 4408 connect over back contacts of relay 4405, over conductors 4409 and 4410, front contacts of relay 4315, and over conductors 4334 and 4335 to the back contacts of two other primary switch hold magnets (not shown) which are associated with the row of contacts corresponding to that row with which magnet 4303 is associated and which contacts can be connected, by the operation of the switch magnets, to sender links similar to link 4302.

It will be assumed that sender link 4302 is idle. Its associated hold magnet 4303 therefore being unoperated connects ground over the previously traced circuit to the left winding of relay 4406. The two other available sender links (not shown) may also be idle at this time in which case their associated primary switch hold magnets connect ground to the left windings of relays 4407 and 4408. Having indicated by the connection of ground to the left windings of these sender group relays which of the three links are idle, it is necessary to determine if there are any idle senders in the three respective groups to which these links have access. Relay 4411 operates over conductor 4402 to ground over the inner front contact of relay 4319 at the time that relay 4319 operated in series with relay 4316. Relay 4411 completes a circuit from ground over a front contact, through the winding of relay 4412, upper back contacts of relay 4413, to the right windings of the sender test relays 4414 to 4417, inclusive. There are ten sender test relays, one for each of the senders, for each of the three groups of senders. For simplicity of illustration, only four test relays, relays 4414 to 4417, inclusive, of one of the three sender groups have been shown. The winding of relay 4412, therefore, also extends over three additional back contacts (not shown) of relay 4413 to the right windings of six additional sender test relays (not shown) in the manner identical with its connection to the right windings of relays 4414 to 4417, inclusive. The other end of the right winding of relay 4414 connects over conductor 4418, over the upper inner back contact of start relay 4600 of the terminating sender shown in Figs. 46 and 47, to battery over the upper outer back contact of relay 4601 of that sender, providing the sender is not in use and its start relay 4600 is therefore not operated. Similarly, the right windings of the nine other sender test relays extend over conductors corresponding to conductor 4418, to battery to their associated senders if those senders are idle. Relay 4411 is provided with two other front contacts which connect ground, through the windings of two other relays (not shown) corresponding to relay 4412, which are associated with the two other groups of ten senders. The other end of the windings of these relays, corresponding to relay 4412, connect in a manner similar to that described for relay 4412, through the windings of ten sender test relays to the ten senders of each of the two additional sender groups. Relay 4412 has marginal characteristics and operates if it receives battery through the right windings of two or more sender relays, such as relays 4414 to 4417, inclusive, from two or more idle senders of the group of ten with which it is associated. Similarly, the two relays corresponding to relay 4412, have marginal characteristics and also operate if supplied by battery by two or more idle senders of their respective sender groups. Relay 4412, if operating, connects battery over its front contact, lower outer back contact of relay 4413 if that relay is normal, thereby indicating that its associated group of ten senders is not being used by some other sender link circuit as will be set forth later, and over the inner back contact of relay 4419 to one end of the left winding of sender group relay 4406. Relay 4406 operates through its left winding, over the outer back contact of relay 4405, conductor 4333, a front contact of relay 4315, to ground over the back contact of the unoperated hold magnet 4303 associated with the idle sender link 4302. The two relays (not shown) corresponding to relay 4412, of the other two groups of senders, if operating, connect battery over the back contacts of relays corresponding to relay 4413, over conductors 4420 and 4421, back contacts of relay 4419, to the left windings of relays 4407 and 4408. Relays 4407 and 4408 will operate over circuits similar to that traced for relay 4406, if the primary sender selector switch hold magnets to which they connect are unoperated indicating that the sender links associated therewith are idle.

At the time that the particular incoming

trunk to be served was selected, as indicated by the operation of relay 4327 in series with trunk selecting relay 4323, relay 4400 operated over a previously traced circuit and opened the operating circuit for relay 4402. Relay 4402, which has slow-releasing characteristics, upon its ultimate release closes a circuit traceable from ground over the inner front contact of relay 4319, inner front contact of relay 4327, conductor 4336, back contact of relay 4402, to battery through the winding of relay 4419. Relay 4419 operates and transfers the left windings of the sender group selecting relays 4406 to 4408, inclusive, from the front contacts of relay 4412 and the two corresponding relays (not shown) of the other sender groups to the lower inner armatures of relay 4413 and the two corresponding relays of the other sender groups. If any of the three sender groups has one idle sender, relay 4413 or the relay corresponding thereto of the other groups, will be unoperated since the associated group busy relay, as relay 4307, is unoperated, and will supply battery over its lower inner back contact to the right winding of its sender group selecting relay, such as relay 4406. The delay introduced by the slow-release characteristics of relay 4402 provides a sufficient interval for any of the sender group relays 4406 to 4408, inclusive, whose associated sender groups have more than one idle sender, as indicated by the operation of relay 4412, to operate and lock before the windings of these sender group relays are transferred to the armature of relay 4413 which provides the operating battery for its sender group relay if only one sender in that group is idle. In this foregoing manner the sender link circuit first prefers to place its call in a sender group having several idle senders, but, if no such group is available or accessible over an idle sender link, it will place its call in a group having only one idle sender.

It will be assumed for the purpose of this description that the terminating sender shown in Figs. 46 and 47 is the only idle sender of that group of senders of which it is a part. Under this condition relay 4412 does not receive sufficient current to operate. Upon the operation of relay 4400, as set forth above, relay 4402 releases and closes the circuit for operating relay 4419. Relay 4406 operates in a circuit traceable from ground over the back contact of the unoperated primary sender selector switch hold magnet 4303, a front contact relay 4315, conductor 4333, outer back contact of relay 4405, left winding of relay 4406, inner front contact of relay 4419, to battery over the lower inner back contact of relay 4413. Relay 4406, in operating, operates link lock relay 4422 in a circuit traceable from ground over the back contacts of relays 4428 and 4425, through the winding of relay 4422, over the right front contact of relay 4406, back contacts of relays 4407 and 4408 which will be assumed to be unoperated signifying that there are no available idle senders in the two groups of senders with which they are associated, to battery at the lower armatures of relay 4400. Relay 4414 does not operate at this time due to the resistance of the winding of relay 4412 limiting the current through the right winding of relay 4414. Relay 4422, in operating, closes a circuit from battery through the winding of relay 4405, right winding of relay 4406, left front contact of relay 4422 to ground, thereby locking relay 4406 and operating relay 4405. Relay 4405, in operating, opens the operating circuits through the left windings of the sender group relays 4406 to 4408, inclusive, and operates relays 4413 and 4431. The circuit for relay 4413 is traceable from battery through its winding, right inner front contact of relay 4422, to ground over the inner front contact of relay 4405. The circuit for relay 4431 is traceable from battery through its winding, over the right outer front contact of relay 4422, to ground over the outer front contact of relay 4405. Relay 4413, in operating, causes the group of ten senders with which it is associated to become unavailable to other sender link control circuits since it opens the circuits to the right windings of the ten sender selecting relays, such as relays 4414 to 4417, inclusive, and also removes the battery from the inner front contact of relay 4419. Relay 4431, in operating, closes a circuit from ground over the outer front contact of relay 4327, over conductor 4404, back contacts of relay 4432, front contacts of relay 4431, to one end of the right windings of the sender selecting relays 4414 to 4417, inclusive, thereby causing those sender selecting relays, the associated senders of which are idle, to operate. Since it has been assumed that the sender shown in Figs. 46 and 47 is the only idle sender of the group, sender selecting relay 4414 alone now operates. The locking circuit for the ten sender selecting relays is arranged in a circuit extending over the left armatures and back contacts of these relays in a manner which gives a preference as to which sender selecting relay will lock in the event that several operate, the preference depending upon which incoming trunk has placed the call and determined by which trunk relay, such as relay 4323, remains locked after the operation of relay 4327. Since relay 4323 previously operated, relay 4414 now locks in a circuit from ground through its left winding and over its left front contact, a front contact of relay 4431, conductor 4433, right outer front contact of relay 4323, right outer back contacts of relays 4324 to 4326, inclusive, conductor 4337, to battery through the winding of relay 4432. Relay 4432 operates, opens the operating circuit for the sender selecting relays 4414 to 4417, inclusive, operates relay 4434 through the right winding of that relay, and, in addition, completes a circuit from ground over the front contact of relay 4327, conductor 4404, outer front contact of relay 4432, a front contact of relay 4431, right outer back contacts of relays 4417, 4416, and 4415, right outer front contact of relay 4414, a front contact of relay 4431, conductor 4435, to battery through the winding of the secondary switch select magnet 4306. As indicated by strap 4338, the winding of select magnet 4306 is multipled to the windings of the other corresponding secondary switch select magnets (not shown) and these select magnets all operate in parallel and prepare their associated crosspoints for closure upon the subsequent operation of some secondary switch hold magnet. Relay 4434, in operating, locks through its left winding and left inner front contact to ground over the lower middle front contact of relay 4400, and also operates hold magnet 4303 of the primary sender link switch over a circuit from battery through the winding of that magnet, a front contact of relay 4315, conductor 4339, left front contact of relay 4406, outer back contact of relay 4436, to ground over a left front contact of relay 4434. Select magnet 4304 having previously operated upon the operation of relay 4400 after the incoming trunk to be served has been selected,

the operation of hold magnet 4303 now causes crosspoint 4300 of the primary sender link switch to close and extend conductors 4514 to 4518, inclusive, from the incoming trunk, over sender link 4302, to the contacts of crosspoints 4301 of the secondary sender link switch. The operating ground for hold magnet 4304 is extended over the lower contact of crosspoint 4300 and over the lower conductor of sender link 4302 to battery through the winding of the secondary switch hold magnet 4305 which operates and, since select magnet 4306 previously operated as set forth above, causes crosspoints 4301 of the secondary switch to close and further extend the aforementioned conductors from the incoming trunk, over conductors 4308 to 4313, inclusive, to the terminating sender of Figs. 46 and 47.

At the time that relay 4434 operated it closed a circuit from ground over its right front contact, a front contact of relay 4431, right inner back contacts of relays 4417, 4416, and 4415, right inner front contact of relay 4414, conductor 4438, to battery through the winding of relay 4700 of the terminating sender, operating that relay. The operation of secondary sender link switch hold magnet 4305 extends its operating ground, over the lower contact of crosspoint 4301, conductor 4313, a front contact of relay 4700 of the sender, conductor 4701, a front contact of relay 4431, to battery through the right winding of relay 4436. Relay 4436 operates and locks through its left winding and over its left inner front contact to ground over the lower middle front contact of relay 4400. Relay 4436, in operating, opens the short circuit around the winding of relay 4437 which now operates in series with the primary switch hold magnet 4303 over a previously traced circuit. Relay 4437, in operating, operates relay 4439 in a circuit from battery through the winding of that relay, over the front contact of relay 4437, to ground over the left back contact of relay 4440. Relay 4439, in operating, locks over its left inner front contact to ground over the lower middle front contact of relay 4400, and connects ground over its right outer front contact and over a front contact of relay 4431 to conductor 4702 of the sender, and also connects ground over its right inner front contact, right front contact of relay 4436, and over a front contact of relay 4431 to conductor 4703 of the sender. The function of the ground on conductors 4702 and 4703 will be set forth later under the description of the operation of the terminating sender circuit. The terminating sender performs certain functions which will later be set forth in detail and returns a ground over conductor 4313 to hold the secondary sender selector switch hold magnet 4305, this ground in turn extending over the lowest conductor of sender link 4302 thereby also holding the primary sender selector switch hold magnet 4303. The terminating sender also returns a ground over conductor 4704, in a manner which will subsequently be described, and this ground extends over a front contact of relay 4431 to battery through the winding of relay 4440, operating relay 4440. The terminating sender also grounds conductor 4312, this ground extending over a front contact of cross-point 4301, a conductor of sender link 4302, a contact of cross-point 4300, conductor 4514, to battery through the winding of relay 4506 of the incoming trunk circuit. Relay 4506 operates and opens the operating circuit for relay 4507. Relay 4507 releases and opens the circuit between conductors 4520 and 4521 thereby releasing relays 4323 and 4327 which were holding in series over conductor 4521. The release of relay 4323 opens the holding circuit extending from battery through the winding of relay 4432 to ground through the left winding of relay 4414 and relays 4432 and 4414 both release. The release of relay 4327 operates relay 4314 in a circuit traceable from ground over the left back contact of relay 4327, conductor 4340, lower inner front contact of relay 4400, a front contact of relay 4434, left outer front contact of relay 4439, front contact of relay 4440, conductor 4441, to battery through the winding of relay 4314. Relay 4314, in operating, opens the circuit over conductors 4520 and 4519 thereby releasing relays 4316 and 4319. In addition, the operation of relay 4314 removes the ground from conductor 4401 thereby opening the locking circuits for relays 4315 and 4400, both of which release. The release of relay 4400 opens the locking circuits of relays 4434, 4436 and 4439, all of which release. Relay 4314, which upon its previous operation locked over its front contact and over conductor 4341 to ground over a front contact of relay 4400, also releases since its original operating circuit was opened by the release of relay 4440. Upon the release of relays 4314 and 4400, ground is again connected to the chain circuit extending over the lower armatures and back contacts of the group selecting relays 4316 to 4318, inclusive, so that these relays may now function should another incoming trunk desire connection to a sender. The release of relay 4400 opens the holding circuit for relay 4422 which releases and in turn opens the circuit through the winding of relay 4405 and the right or locking winding of relay 4406, both of these latter relays releasing. Relay 4431 also releases, its operating circuit being opened by the release of relay 4422. Relay 4431, prior to its release, connected ground over conductor 4442 and over conductor 4443 or 4444 for the purpose of transmitting to the terminating sender information regarding the number of the incoming frame containing the incoming trunk which is placing this particular call. The sender circuit functions, in a manner which will be described later, and retains this information upon the subsequent release of relay 4431.

It will be noted that the battery supplied through the winding of relay 4319 to the windings of the ten trunk group selecting relays, such as relays 4316 to 4318, inclusive, extends in a chain circuit over the upper back contacts of these trunk group selecting relays. In addition, the lower or functional contacts of these relays also extend over a chain circuit to the ground normally supplied over conductor 4320 from the upper inner back contact of relay 4314. This arrangement provides for the connection of the sender link control circuit to but one group of incoming trunks at a time regardless of the number of trunk groups which may wish simultaneous connection to the control circuit. For example, when relay 4316 operated in response to the call incoming to the incoming trunk shown in Fig. 45, it opened the circuit from the ground over conductor 4320 to the lower armatures of the other trunk group relays 4317 and 4318. Had there been a call incoming on a trunk of the group associated with relay 4317 before the release of the sender link control circuit in connection with the call incoming on the trunk shown in Fig. 45, relay 4317 would operate, but would be ineffective in operating its associated horizontal group relay 4321 due to the lower

contacts of relay **4316** being open. With relays **4316** and **4317** both operated, relay **4316** would hold in a circuit from battery through the winding of relay **4319**, upper back contact of relay **4318**, upper front contacts of relays **4317** and **4316**, winding of relay **4316**, conductor **4519**, a front contact of relay **4507**, conductor **4520**, upper outer back contact of relay **4314**, lower outer front contact of relay **4315**, conductor **4342**, to ground over a left front contact of relay **4434**. Upon the establishment of the connection between the incoming trunk shown in Fig. 45 and the terminating sender shown in Figs. 46 and 47, the sender link control circuit release relay **4314** operates in the manner hereinbefore set forth and opens the holding circuit for relay **4316**. Relay **4316** thereupon releases and closes the circuit to the lower armature of the operated trunk group relay **4317** from which point the control circuit functions in a manner similar to that previously described. Should another incoming trunk in the same group containing the trunk shown in Fig. 45 be selected at this time its associated trunk group selecting relay **4316** of the sender link control circuit cannot operate since the circuit through its winding is opened at the upper back contact of the operated relay **4317**. Upon the subsequent release of relay **4317**, when the trunk in its associated group has been connected to an idle terminating sender, relay **4316** would operate provided that relay **4318** was not operated at that time due to an incoming call on a trunk of the group associated with relay **4318**. In the event that relay **4318** is operated, the sender link control circuit will function and establish connections between the trunk of the group associated therewith before returning to the second trunk of the group associated with relay **4316**. After the lowest numbered trunk group, namely the group associated with relay **4318**, has been served the subsequent operation of relay **4314** during the restoring of the control circuit to normal, causes both relays **4318** and **4319** to release. The release of relay **4318** again closes the chain circuit extending from battery through the winding of relay **4319** over the upper back contacts and to the windings of the trunk group selecting relays **4316** to **4318**, inclusive. The subsequent release of relay **4314** closes the circuit to start conductor **4520** and any of the trunk group selecting relays operate if a call is awaiting in their respective associated trunk groups. The trunk group associated with the highest numbered operated trunk group relay, for example relay **4316**, will be served first, the other operated trunk group relays being ineffective due to the opening of the circuits through their functional contacts by the lower armature of relay **4316**.

All sender link and control circuits function with all terminating senders; therefore upon the selection of a particular group of ten senders by a sender link and control circuit it is necessary to lock out the other sender link and control circuits from that group of ten senders until the particular sender to be used in connection with the call has been selected and seized. This is accomplished by the link lock relays of the control circuit, each control circuit being provided with as many link lock relays as there are groups of ten senders. Since it has been assumed that the sender link and control circuit shown in Figs. 43 and 44 has access to thirty terminating senders arranged in three groups of ten senders each, this control circuit is therefore provided with three link lock relays, relays **4422**, **4423**, and **4424**. Relays **4425** to **4427**, inclusive, and **4428** to **4430**, inclusive, represent the three link lock relays of two other sender link control circuits (not shown). The operating circuit and the circuit over the left outer functional contacts of each link lock relay of a sender link and control circuit extends in a chain circuit over contacts of the corresponding link lock relays of the other sender link and control circuits in such a manner that only one control circuit link lock relay can be effective at a time during the selection of a particular group of ten senders. For example, in connection with the operation of the sender link and control circuit in establishing the connection to the sender shown in Figs. 46 and 47, link lock relay **4422** operated and locked and, over its left outer front contact closed the holding circuit for sender group relay **4406** through the right winding of that relay. Should the control circuits of which relays **4425** and **4428** are associated function at this time due to incoming calls on trunks with which these control circuits are associated, relays **4425** and **4428** may operate, in the manner identical to the previously described operation of relay **4422**, but are ineffective in causing the selection of the sender group already selected by the operation of relay **4422** since the opening of the back contact of relay **4422** has removed the ground from the left outer armatures of relays **4425** and **4428** and they, therefore, cannot complete the holding circuits for their associated sender group relays corresponding to relay **4406**. In the event that the group of senders with which relay **4406** is associated had already been selected by some other control circuit at the time that relay **4406** operated during the progress of the connection hereinbefore set forth in detail, relay **4422** would not operate since its operating ground would have been removed by the previous operation of either relay **4425** or relay **4428**, depending upon which of the other sender link and control circuits had already selected the group of ten senders associated with sender group relay **4406** of this control circuit.

The sender link and control circuit is provided with a sender group busy relay for each group of senders to which it has access. Relay **4307** is the group busy relay associated with that group of ten senders of which the sender shown in Figs. 46 and 47 is a part. Relays **4343** and **4344** are group busy relays associated with two other groups of senders (not shown). A circuit may be traced from ground over the lower outer armature and front contact of start relay **4600** of the terminating sender, over the identical contacts of the start relays (not shown) of the nine other senders of the group, over conductor **4602**, to battery through the winding of relay **4307**. Whenever all senders of that group are busy this chain circuit extending over the front contacts of the ten start relays is closed, thereby operating group busy relay **4307**. Relay **4307**, in operating, opens the circuits from the back contacts of the ten primary sender link switch hold magnets, such as magnet **4303**, associated with the ten sender links which extend to the secondary sender link switch connecting to the busy group of senders. The operation of relay **4307** also closes a circuit from ground over its front contact, conductor **4345**, to battery through the winding of relay **4413** which operates and opens the operating circuit for the sender group relay as-

sociated with that group of senders which is busy, such as relay 4406, in this case, and also opens the operating circuits for the corresponding sender group relays of the other sender link control circuits, these latter circuits being indicated by multiple strap 4443.

In the event of a failure of the primary or secondary link switch cross-points to close properly, or should the sleeve conductor of a sender link become crossed with the sleeve conductor of another sender link, the progress of the connection is blocked and an alarm indication of this condition is given. At the time that relay 4319 operates in series with any of the trunk group relays 4316 to 4318, inclusive, it closes a circuit from ground over its inner front contact, conductor 4403, outer back contact of relay 4434, to battery through the winding of relay 4444. As soon as the terminating sender has been selected, relay 4432 operates followed by the operation of relay 4434 as previously described. The operation of relay 4434 opens the operating circuit for relay 4444 and also closes a circuit from ground over its next-to-inner left front contact, middle back contact of relay 4436, to the back contact of relay 4444. Following the seizure of the sender, that circuit completes an operating path through the right winding of relay 4436, the ground being supplied over contacts of the operated primary and secondary sender link switch cross-points and through the sender as hereinbefore set forth. The operation of relay 4436 opens the circuit to the back contact of relay 4444 which is slow to release, thereby making that contact ineffective upon the ultimate release of the relay. Should either the primary or secondary switch cross-points fail to close, relay 4436 will not operate and, upon the release of relay 4444, alarm relay 4445 operates to the previously traced ground over a left front contact of relay 4434. Relay 4445, in operating, lights the alarm lamp 4447 and operates the trouble register 4446, both over local circuits.

If, upon the closure of the primary and secondary sender link switch cross-points, the sleeve conductor of the sender link, such as conductor 4347, becomes crossed with the sleeve conductor of some other sender link which is also in use at that time, relay 4437 will fail to operate since it is short-circuited by the ground over a front contact of relay 4434 on one end of its winding and the false ground from the crossed sleeve conductors on the other end of its winding. The failure of relay 4437 to operate results in relay 4439 also remaining unoperated. Upon the subsequent release of relay 4444, following the operation of relay 4436 after the closure of the sender link, a circuit is completed from ground over the next-to-inner front contact of relay 4434, outer front contact of relay 4436, inner back contact of relay 4439, back contact of relay 4444, to battery through the winding of alarm relay 4445 which operates and functions as set forth above.

As soon as relay 4319 operates in series with a trunk group relay, at the outset of the functioning of the sender link and control circuit during the establishment of a connection between an incoming trunk and a terminating sender, it closes a circuit from ground over its outer front contact, over conductor 4346, to the left armatures of relays 4445 and 4448 and to the armature of interrupter 4449. Upon the first closure of the left contact of interrupter 4449 relay 4448 operates and locks to the ground over conductor 4346. The operation of relay 4448 closes a circuit from battery through the winding of alarm relay 4445 to the right contact of interrupter 4449. When interrupter 4449 subsequently closes its right contact, relay 4445 operates, locking to the ground over conductor 4346, lighting alarm lamp 4447, and causing trouble register 4446 to operate. If key 4450 is in its unoperated position with its contacts closed, the operation of relay 4445 also operates release relay 4314 over conductor 4441. The operation of relay 4314 causes the control circuit to release from the group of trunks with which it was connected, in the manner previously set forth under the description of the return of the control circuit to normal upon the completion of a normal connection, thereby permitting other groups of trunks to be served. The cam of interrupter 4449 is arranged to rotate at a speed such that the time elapsing between the grounding of its armature by the operation of relay 4319 and the ultimate operation of relay 4445 is greater than the time required for a sender link and control circuit to perform its functions and restore on a normal connection. On a recurring trouble condition, key 4450 may be operated to prevent the operation of release relay 4314, thereby blocking the connection for subsequent investigation.

Recording incoming frame indication

Referring now to the terminating sender shown in Figs. 46 and 47, at the time this circuit was selected its relays 4700 and 4707 operated to a ground supplied over conductor 4438 by the sender link control circuit as previously set forth. The operation of relay 4700 closes the sender start conductor 4705 from the winding of start relay 4600 to the sender link control circuit over conductor 4703. The operation of relay 4431 of the sender link control circuit connects ground to the frame identification conductors 4442 and 4443 or 4444. There are ten conductors, such as conductor 4442, extending to ten front contacts of frame relay 4707 of the sender. Since there may be as many as twenty incoming trunk frames, two additional frame identification conductors, 4443 and 4444, are provided, one or the other of which is connected to relay 4431 depending upon whether that relay is associated with one of the first ten incoming trunk frames or the second ten incoming trunk frames. It will be assumed, for illustration, that the incoming trunk shown in Fig. 45 is located on the nineteenth incoming trunk frame. The No. 9 frame identification conductor 4442 is therefore connected to a front contact of relay 4431 and grounded by the operation of that relay. In addition, since the nineteenth frame is used, conductor 4444, which identifies the second ten frames, is also connected to and grounded by relay 4431. The ground on conductor 4442 operates select magnet 4719 of the cross-bar register switch 4708 of the sender. The ground on conductor 4444 operates relay 4708 which closes, in part, its locking circuit over its lower front contact and over conductor 4709 to the upper front contact of relay 4603. The operation of relay 4708 connects ground over the back contact of relay 4721 to conductor 4720 which extends to the decoder marker and causes that circuit to function as will be set forth hereinafter. Had relay 4721 operated instead of relay 4708, indicating that one of the first ten incoming trunk frames was being used, conductor 4720 would be connected to conductor 4723 instead of being

grounded. Select magnet 4719, in operating, extends its operating ground over its front contact and conductor 4725 to battery through the winding of relay 4605. Relay 4605 operates and locks itself and select magnet 4719 in a circuit over its lower front contact, conductor 4606, back contact of hold magnet 4731 of the register switch, to ground over a front contact of relay 4707. Relay 4605, in operating, also operates hold magnet 4731 in a circuit from battery through the winding of that magnet, upper back contact of hold magnet 4726, conductor 4732, lower back contact of relay 4608, to ground over the upper inner front contact of relay 4605. Relay 4607 also operates from battery through resistance 4609, winding and break-after-make contact of relay 4607, to ground over the upper outer front contact of relay 4605. Hold magnet 4731, in operating, closes cross-points 4733, since the previous operation of select magnet 4719 prepared these cross-points, as well as the other cross-points in the same horizontal row, for operation. Hold magnet 4731 locks over its lower front contact and over a front contact of relay 4707 to ground. Four frame identification conductors extend from the register switch of the sender, over a decoder marker connector circuit, to the terminating decoder marker. These conductors are either grounded or connected to conductors 4722 and 4723 in various combinations depending upon the numerical value of the frame registration. In the case illustrated, the closure of cross-points 4733 connects ground to conductors 4736 and 4737 and connects conductors 4734 and 4735 to conductors 4722 and 4723, respectively. The function of the decoder marker in connection with the grounding and closure of these conductors will be set forth later. The operation of relay 4607 closes in part, the operating circuit for relay 4603.

As hereinbefore set forth, the sender link control circuit, after checking the continuity of the sleeve or holding conductor 4347 of sender link 4302, functions and connects a ground to the sender start conductor 4703. This ground extends over a front contact of relay 4700, over conductor 4705, to battery through the winding of the sender start relay 4600. Relay 4600 operates and opens the battery, over the upper outer back contact of relay 4601, from conductor 4418 thereby making this sender test busy to the sender link control circuits. Ground over the lower outer front contact of relay 4600 closes, in part, the sender group busy chain circuit which extends over front contacts of the start relays of the other senders of the group to conductor 4602 as previously described. Ground over the lower inner front contact of relay 4600 completes the operating circuit for relay 4603 which operates and connects ground over its lower next-to-inner front contact to sleeve conductor 4313 for the purpose of locking the hold magnets 4303 and 4305 of the primary and secondary sender link switches. The operation of relay 4603 also connects ground over its lower inner front contact over conductor 4610, a front contact of relay 4700, to release conductor 4704 to signal the sender link control circuit to release in the manner hereinbefore set forth. Upon its release, the sender link control circuit removes the ground from conductors 4438, 4442, and 4444. Relays 4700 and 4707 thereupon release, their functions having been completed. The removal of ground from conductor 4444 does not release relay 4708, however, since that relay now holds over its lower front contact, over conductor 4709 to ground over the upper outer front contact of relay 4603. Relay 4603 locks over its upper inner front contact to the ground over the lower inner front contact of relay 4600. Relay 4600, in turn, locks over its upper inner front contact, over the upper inner back contact of release relay 4601, to ground over the upper middle front contact of relay 4603. It will be noted that the operating circuit for relay 4603 extends over a front contact of relay 4607, this latter relay operating only if relay 4605 operates. This is done to insure that the sender link control circuit will be given the release indication, by the operation of relay 4603, only if the sender link control circuit has grounded one of the frame identification conductors and thereby caused the operation of a select magnet of the register switch for the purpose of recording the number of the incoming trunk frame used.

At the time that relay 4707 operated it closed a circuit from ground over its outer front contact, over conductor 4738, upper outer back contact of relay 4600, winding of relay 4611, to battery through resistance 4612. Relay 4611 operated and, upon the subsequent operation of relay 4600, locked over its lower inner front contact to the ground over an upper front contact of relay 4600, relay 4707 maintaining the operating circuit for relay 4611 until after the operation of relay 4600 had taken place. The operation of relay 4611 closes a circuit from ground over its lower middle front contact, through resistance 4613, its lower outer front contact, and upper front contact of relay 4600, conductor 4310, a closed contact of cross-point 4301, a conductor of sender link 4302, a closed contact of cross-point 4300, conductor 4515, to battery through the winding of relay 4504 of the incoming trunk circuit. Relay 4504 operates and opens the windings of the supervisory relay 4505 from the tip and ring conductors 4502 and 4503 of the incoming trunk. Relay 4616 of the terminating sender operates as soon as the connections between the incoming trunk circuit and the sender are established in a circuit traceable from battery through its winding, over an upper back contact of relay 4615, conductor 4308, a conductor of sender link 4302, conductor 4517, tip conductor 4502 of incoming trunk 4501, over the incoming trunk to the originating sender shown in Figs. 22 to 26, inclusive, over the previously traced fundamental circuit extending through the windings of stepping relay 2429 and overflow relay 2418 of the originating sender, back over the ring conductor 4503 of the incoming trunk, conductor 4516, a conductor of sender link 4302, conductor 4309, an upper back contact of relay 4615, to ground over the upper outer back contact of relay 4617. Relay 4616, in operating, operates relay 4617 from battery through the winding of relay 4617, upper outer front contact of relay 4600, upper outer back contact of relay 4615, to ground over the front contact of relay 4616. Relay 4617, in operating, locks over its upper front contact to its operating ground and removes, over its upper outer back contact, one of the grounds which is short-circuiting the winding of stepping relay 4614. The operation of relay 4504 of the incoming trunk circuit opens the ground over the upper middle back contact of relay 4506 from conductor 4516, this being the second ground which is short-circuiting the winding of relay 4614. Upon the operation of both relays 4617 and 4504, the stepping relay 4614 therefore operates, over the fun-

damental circuit extending back through the originating sender, in series with relay 4616, this latter relay holding. Relay 4614, in operating, closes a circuit from ground over the lower inner front contact of relay 4617, front contact of relay 4614, resistance 4618 and retard coil 4619 in parallel, to battery through the winding of relay 4620. The function of resistance 4618 and retard coil 4619 is to slow up the operation of relay 4620 sufficiently to insure the operation of stepping relay 2429 of the originating sender. Relay 4621 also operates to the same ground which operates relay 4620. Relay 4620, in operating, closes a circuit from ground over the back contact of relay 4707, conductor 4739, front contact of relay 4620, to the winding of relay 4616 thereby holding relay 4616 operated but short-circuiting the winding of stepping relay 4614 as well as the winding of stepping relay 2429 of the originating sender thus causing both of these stepping relays to release. The release of relay 4614 opens the operating circuit for relay 4620 which releases and removes the short-circuiting ground from the windings of stepping relays 4614 of the terminating sender and 2429 of the originating sender, both of which again operate. This stepping operation continues until the originating sender opens the fundamental circuit indicating that its revertive control mechanism has been satisfied for the particular selective information being transmitted to the terminating sender. The detailed functioning of the originating sender in connection with this phase of the call will subsequently be set forth. The manner in which the terminating sender functions to record the selective information transmitted from the originating sender occurs as detailed in the succeeding paragraphs.

The terminating sender is provided with six counting relays, relays 4740 to 4745 inclusive, which operate in conjunction with relays 4621 to 4623, inclusive, under control of the pulses generated by the operation and release of stepping relay 4614, and in turn prepare the operating circuits for the various select magnets of register switch 4708 upon which the selective information is recorded. As set forth above, relay 4621 operates upon the initial operation of relay 4614. Upon the first open pulse transmitted, the opening of the contacts of relay 4614 removes the ground from one end of the upper winding of relay 4623 and that relay now operates in a circuit from battery through the winding of relay 4621, upper winding of relay 4623 in parallel with resistance 4624, back contact of relay 4622, front contact of relay 4621, to ground over the lower inner front contact of relay 4617. The zero counting relay 4740 thereupon operates in a circuit from battery through its winding, left outer back contacts of relays 4741 and 4743, conductor 4746, outer front contact of relay 4623, lower middle front contact of relay 4617, to ground over the lower outer front contact of relay 4603. Relay 4740, in operating, locks from battery through its winding, over its left inner front contact, left inner back contacts of relays 4741 to 4744, inclusive, conductor 4747, back contact of relay 4605, to ground over the lower outer front contact of relay 4603. The operation of relay 4740 also prepares the operating circuit for select magnet 4710 of the register switch 4708 should the originating sender be satisfied by the single pulse and open the fundamental circuit thereby releasing relays 4616 and 4617. The operating circuit for select magnet 4710 may be traced from battery through its winding, right outer front contact of relay 4740, right back contact of relay 4745, conductor 4748, to the lower back contact of relay 4617 from which point it extends over the inner back contact of relay 4625 to ground over the lower outer front contact of relay 4603.

Assuming that the originating sender is not satisfied, the reoperation of relay 4614 following its transmission of the first open pulse, operates relay 4622 in a circuit from battery through the winding of that relay, lower winding and inner front contact of relay 4623, front contact of relay 4614, to ground over the lower inner front contact of relay 4617. The operation of relay 4622 opens the operating circuit for relay 4621 which releases. The release of relay 4614 for the second open pulse opens the locking circuit for relays 4622 and 4623 both of which release. The No. 1 counting relay 4741 thereupon operates in a circuit from battery through its winding, left middle front contact of the operated No. 0 counting relay 4740, left outer back contacts of relays 4742 and 4744, conductor 4749, outer back contact of relay 4623, lower middle front contact of relay 4617, to ground over the lower middle front contact of relay 4603. Relay 4741, in operating, locks over its left inner front contact, left inner front contacts of relays 4742 to 4744, inclusive, to the ground previously traced over conductor 4747. Relay 4741 also opens the locking circuit for relay 4740 which releases, and in addition, prepares the operating circuit for select magnet 4711 over its right outer front contact and the right back contact of relay 4745 to the previously traced circuit over conductor 4748. Should the originating sender open the fundamental circuit after the second open pulse, select magnet 4711 operates upon the release of relay 4617.

The reoperation of relay 4614 following the second open pulse causes relay 4621 to reoperate. The release of relay 4614 for the third open pulse operates relay 4623 in series with relay 4621 in the manner previously set forth for the first open pulse. The operation of relay 4623 operates the No. 2 counting relay 4742 over the left outer front contact of relay 4741, left outer back contact of relay 4743, to the previously traced ground over conductor 4746. Relay 4742 locks over the previously traced chain circuit to ground over conductor 4747, opens the locking circuit for relay 4741 which releases, and prepares the operating circuit for select magnet 4712 should relay 4617 release after the third open pulse. Relay 4622 operates in series with the lower winding of relay 4623 upon the reoperation of relay 4614 following the third open pulse and causes relay 4621 to release, relay 4623 remaining locked through its lower winding. The release of relay 4614 for the fourth open pulse releases relays 4622 and 4623, the No. 3 counting relay 4743 thereupon operating over the left outer front contact of relay 4742, left outer back contact of relay 4744, conductor 4749, and over the lower outer back contact of relay 4623 to a previously traced ground. Relay 4743, in operating, locks over the left inner front contact of relay 4744 to ground previously traced over conductor 4747, releases relay 4742 and prepares the operating circuit for select magnet 4713. When relay 4614 reoperates after the fourth open pulse, relay 4621 again operates and, during the fifth open pulse, locks in series with relay 4623 which operates, in turn operating the No. 4 counting relay 4744 in a circuit from bat-

tery through the winding of relay 4744, left back contact of relay 4745, left outer front contact of relay 4743, to the previously traced ground over conductor 4746. Relay 4744, in operating, locks over the left back contact of relay 4740 and its own left inner front contact to the previously traced ground over conductor 4747, opens the locking circuit for relay 4743 which releases, and prepares the operating circuit for select magnet 4714. The reoperation of relay 4614 following the fifth open pulse operates relay 4622 in series with the locking winding of relay 4623. The operation of relay 4622 releases relay 4621. The release of relay 4614 for the sixth open pulse releases relays 4622 and 4623, the No. 5 counting relay 4745 thereupon operating from battery through its winding, over the left outer front contact of relay 4744, conductor 4749, outer back contact of relay 4623, to a previously traced ground. Relay 4745 locks over its left inner front contact directly to the ground over conductor 4747, this locking circuit being independent of the contacts of the other counting relays. The operation of relay 4745 prepares the operating circuit for select magnet 4715, this circuit being traceable from battery through the winding of magnet 4715, over the right inner front contact of the locked No. 4 counting relay 4744, right front contact of relay 4745, conductor 4748, to the lower outer back contact of relay 4617 which, in the event that the originating sender is satisfied with six pulses and opens the fundamental circuit, releases and causes select magnet 4715 to operate to the previously traced ground supplied over the lower outer front contact of relay 4603. Should the originating sender require more than six pulses to satisfy a particular selection the No. 5 counting relay 4745 remains operated and the No. 0 to No. 3 counting relays 4740 to 4743, inclusive, are reused, providing means for the registration of a maximum of ten pulses in the manner set forth below.

Relay 4621 operates upon the reoperation of relay 4614 following the sixth open pulse. On the seventh open pulse relay 4623 operates in series with relay 4621 and the No. 0 counting relay 4740 operates over a previously traced circuit. Relay 4740, in operating, releases the locked No. 4 counting relay 4744 and prepares the operating circuit for select magnet 4716 traceable from battery through the winding of that magnet, right inner front contact of relay 4740, and over the right front contact of relay 4745 to the lower outer back contact of relay 4617 over conductor 4748. Relay 4740 also locks over its left inner front contact, left inner front contact of relay 4741, left outer front contact of relay 4740, left middle front contact of relay 4745, to the previously traced ground over conductor 4747. The reoperation of relay 4614 following the seventh open pulse operates relay 4622 in series with the lower winding of relay 4623. Relay 4622, in operating, releases relay 4621. The release of relay 4614 for the eighth open pulse releases relays 4622 and 4623 and counting relay 4741 thereupon operates over a previously traced circuit. Relay 4741, in operating, locks over a previously traced circuit, opens the locking circuit for relay 4740, which releases, and prepares the operating circuit for select magnet 4717 over its right inner front contact and right front contact of relay 4745. The reoperation of relay 4614 following the eighth open pulse reoperates relay 4621. The release of relay 4614 for the ninth open pulse causes relay 4623 to operate in series with relay 4621 and the No. 2 counting relay 4742 thereupon operates over a previously traced circuit. Relay 4742, in operating, locks as hereinbefore set forth, opens the locking circuit for relay 4741 which releases, and prepares the operating circuit for select magnet 4718. Upon the reoperation of relay 4614 following the ninth open pulse, relay 4622 operates in series with relay 4623 and releases relay 4621. The release of relay 4614 for the tenth open pulse releases relays 4622 and 4623 and the No. 3 counting relay 4743 operates over a previously traced circuit. Relay 4743, in operating, locks as previously set forth, opens the locking circuit for relay 4742 which releases, and prepares the operating circuit for select magnet 4719 upon the subsequent release of relay 4617.

In the manner set forth above, the terminating sender transmits open pulses to, and under control of, the originating sender, and by means of its counting relays prepares for operating a select magnet of register switch 4708 corresponding numerically to the number of pulses transmitted for each selection. This cycle of operations is repeated five times, once for each of the selections controlled revertively by the originating sender, namely, incoming brush, incoming group, final hundreds, final tens, and final units selections, these selections being registered, in that order, on register switch 4708 in the manner which will subsequently be set forth.

Transfer of record from originating to terminating sender

Referring back to the originating sender shown in Figs. 22 to 26, inclusive, at the conclusion of the control of the selection of intermediate office selector 4500, relay 2434 operated in series with relay 2433 and opened the locking circuits for relays 2427 and 2428. The release of relay 2428 released relay 2350 which, in turn, released relay 2340. The release of relay 2340 caused relay 2341 to reoperate and close the previously traced fundamental circuit from the originating sender to the selected incoming trunk circuit for the purpose of making trunk test. At this point trunk guard relay 2417 operates from battery and ground supplied from the distant incoming trunk circuit as hereinbefore set forth. Relay 2417, in operating, closes a circuit from ground over the back contact of relay 2418, front contact of relay 2417, windings of relays 2408 and 2409 in parallel, winding of relay 2410, conductor 2327, to battery over the lower inner front contact of relay 2325, relays 2408, 2409 and 2410 operating and locking to ground over conductor 2419. Relay 2439 thereupon operates in a circuit from battery over the lower outer front contact of relay 2325, conductor 2326, winding of relay 2439, lower back contacts of relays 2440, 2442, 2401, 2403 and 2428, conductor 2346, back contact of relay 2345, outer back contact of relay 2344, conductor 2420, to ground over the front contact of relay 2408. Relay 2439, in operating, operates relay 2340 in a circuit from ground over the upper back contact of relay 2401, upper outer front contact of relay 2434, upper front contact of relay 2439, conductor 2347, to battery through the winding of relay 2340. The operation of relay 2340 releases relay 2341 which opens the fundamental circuit and the locking circuit for relays 2408, 2409 and 2410, all of which release. Upon the release of relay 2408, relay 2440 operates in series with relay 2439 and these relays lock in a circuit traceable from battery on conductor 2326,

windings of relays 2439 and 2440, lower front contact of relay 2439, to ground over the upper back contact of relay 2442. Relay 2440, in operating, opens the locking circuits for relays 2433 and 2434 over its upper back contact, and these relays release. The release of relay 2434 opens the operating circuit for relay 2340 which releases and causes relay 2404 to operate from ground over the lower back contact of relay 2340, conductor 2405, back contact of relay 2415, winding of relay 2404, to battery over conductor 2327. Relay 2404, in operating, reoperates relay 2341 in a circuit from ground over the upper inner back contact of relay 2340, conductor 2406, outer front contact of relay 2404, conductor 2342, winding of relay 2341, to battery over conductor 2326. Relay 2440, in operating, also closes a circuit from ground over its upper outer front contact, winding of relay 2407, to battery over conductor 2326. Relay 2407 locks over its upper inner front contact and operates relay 2430 in a local circuit. The function of relays 2407 and 2430 is to establish connections between the register switch shown in Fig. 26 and the selection sequence relays shown in the lower portion of Fig. 24 to enable the originating sender to revertively control the incoming and final selections in the terminating sender. Relay 2341, in operating, again closes the fundamental circuit between the terminating and originating senders, this circuit being traceable, in the originating sender, from the fundamental ring conductor 1827, upper outer front contact of relay 2430, back contact of relay 2409, winding of stepping relay 2429, lower winding of overflow relay 2418, conductor 2343, upper outer back contact of relay 2340, upper outer front contact of relay 2341, to the fundamental tip conductor 1825. This circuit extends to battery and ground in the terminating sender, the stepping relay 4614 of this latter circuit being in series with relays 2418 and 2429 as previously set forth. Relay 2429 operates in series with relay 4614, but relay 2418, being polarized, does not operate at this time, the current through its winding being in the non-operate direction.

It has been assumed hereinbefore that the desired number dialed by the calling subscriber is 3168 and corresponding thousands, hundreds tens and units cross-points of the register switch of the originating sender have been operated accordingly in the manner previously described. The required selections for this number are:—incoming brush 1 which represents numbers from 2000 to 3999 and which requires the transmission of two pulses; incoming group 2 which represents numbers from 3000 to 3499 and which requires the transmission of three pulses; final hundreds 1 which represents numbers from 3100 to 3199 and requires two pulses; final tens 6 which represents numbers from 3160 to 3169 and requires seven pulses; and final units 8 representing the called number 3168 and which requires the transmission of nine pulses.

When relay 2429 operates, following the closure of the fundamental circuit by the operation of relay 2341 after relays 2439 and 2440 have operated, it closes a circuit from ground over its front contact, conductor 2431, front contact of relay 2346, conductor 2349, back contacts of relays 2426 and 2421, lower inner front contact of relay 2440, conductor 2674, upper contact of the operated thousands register cross-point 2656, conductor 2670, conductor 2503, inner front contact of relay 2404, winding of the No. 1 counting relay 2411, to battery over conductor 2327. Relay 2411 operates and, upon the release of relay 2429 on the first open pulse, relay 2421 operates in series with relay 2411 and both relays lock to ground over conductor 2419. The reoperation of relay 2429 following the first open pulse operates the No. 0 counting relay 2410 in a circuit from battery over conductor 2327, winding of relay 2410, back contact of relay 2402, lower back contact of relay 2427, lower inner front contact of relay 2430, front contact of relay 2421, to ground over the front contact of relay 2429 over a previously traced circuit. Upon the release of relay 2429 during the second open pulse, relays 2408 and 2409, in parallel, operate in series with relay 2410 and all three relays lock over the front contact of relay 2410 to the ground over conductor 2419. The operation of relay 2409 opens the fundamental circuit and indicates to the terminating sender that the originating sender is satisfied with the transmission of two pulses corresponding to incoming brush 1. The terminating sender thereupon functions, in the manner later to be described, and registers this information. The operation of relay 2408 operates relay 2441 in a circuit traceable from battery over conductor 2326, winding of relay 2441, lower outer front contact of relay 2440, lower back contacts of relays 2442, 2401, 2403 and 2428, conductor 2346, back contact of relay 2345, outer back contact of relay 2344, conductor 2420, to ground over the front contact of relay 2408. The operation of relay 2441 operates relay 2340 in a circuit from ground over the upper front contact of relay 2440, upper front contact of relay 2441, conductor 2347, to battery through the winding of relay 2340. The operation of relay 2340 releases relay 2341 which makes an additional break in the fundamental circuit in anticipation of the release of relay 2409, and also opens the locking circuit for relays 2408 to 2410, inclusive, all of which release. Relay 2404 also releases upon the operation of relay 2340. Upon the release of relay 2408 relay 2442 operates in series with relay 2441, both relays holding over the lower front contact of relay 2441 to ground over the upper back contact of relay 2401. The operation of relay 2442 opens the locking circuits for relays 2439 and 2440, both of which release. The release of relay 2440 opens the operating circuit for relay 2340 which releases and permits relay 2404 to reoperate. Relay 2341 thereupon reoperates and locks under control of the released relay 2340.

The operation of relay 2341, with relays 2340 and 2409 released, again closes the fundamental circuit and relay 2429 thereupon operates to start the revertive control of the incoming group selection at the terminating sender. The No. 2 counting relay 2412 operates in a circuit from battery over conductor 2327, winding of relay 2412, back contact of relay 2422, conductor 2669, middle contact of thousands register cross-point 2656, lower contact of hundreds register cross-point 2659, conductor 2675, lower inner front contact of relay 2442, back contacts of relays 2421 and 2426, conductor 2349, and over a previously traced circuit to ground over the front contact of relay 2429. Upon the release of relay 2429 during the first open pulse, relay 2422 operates in series with relay 2412 and both relays lock over the front contact of relay 2412 and the back contact of relay 2416 to ground over conductor 2352 from a front contact of relay 2341. The operation of relay 2422 transfers the circuit from the pulsing contact of relay 2429, previously traced to the armature of relay 2422, over its front contact and the inner

front contact of relay 2404 to the windings of relays 2411 and 2421. When relay 2429 reoperates following the first open pulse, the No. 1 counting relay 2411 operates. The subsequent release of relay 2429 during the second pulse causes relay 2421 to operate in series with relay 2411, both relays locking to ground over conductor 2419. The next reoperation of relay 2429 operates the No. 0 counting relay 2410. On the third open pulse relays 2408 and 2409 operate and lock in series with relay 2410, relay 2409 opening the fundamental circuit and causing the terminating sender to function and record incoming group 2. The operation of relay 2408 operates relay 2400 in a circuit from battery over conductor 2326, winding of relay 2400, lower outer front contact of relay 2442, lower back contacts of relays 2401, 2403 and 2428, and over a previously traced circuit to ground over the front contact of relay 2408. Relay 2400, in operating, operates relay 2350 in a circuit traceable from ground over the upper front contact of relay 2442, upper inner front contact of relay 2400, conductor 2351, to battery through the winding of relay 2350. Relay 2350 operates relay 2340 in local circuit. Relay 2340, in operating, releases relay 2341 which further opens the fundamental circuit and removes the ground from conductors 2352 and 2419 thereby releasing relays 2408 to 2412, inclusive, and relays 2421 and 2422. Relay 2404 also releases upon the operation of relay 2340. Upon the release of relay 2408, relay 2401 operates in series with relay 2400, both relays locking over the lower front contact of relay 2400 to ground over the upper back contact of relay 2403. The operation of relay 2401 opens the locking circuit for relays 2441 and 2442 both of which release. The release of relay 2442 opens the operating circuit for relay 2350 which releases, in turn releasing relay 2340. Relay 2340, in releasing, reoperates relay 2404 which is followed by the operation of relay 2341. Relay 2341 locks under control of the upper inner back contact of relay 2340 and again closes the fundamental circuit to cause the terminating sender to start sending pulses for final brush or hundreds selection. Relay 2429, upon its initial operation following this closure of the fundamental circuit, operates the No. 1 counting relay 2411 in a circuit from battery over conductor 2327, winding of relay 2411, inner front contact of relay 2404, conductor 2508, conductor 2670, upper contact of the hundreds register cross-point 2659, conductor 2676, lower inner front contact of relay 2401, back contacts of relays 2421 and 2426, to ground over the front contact of relay 2429 over a previously traced circuit. During the release of relay 2429 on the first open pulse, relay 2421 operates in series with relay 2411 and both relays lock as previously described. The operation of relay 2421 transfers the pulsing contact of relay 2429 to the winding of relay 2410 over a previously traced circuit. The reoperation of relay 2429 following the first open pulse therefore operates the No. 0 counting relay 2410. Upon the release of relay 2429 during the second open pulse, relays 2408 and 2409 operate in series with relay 2410 and all three relays lock as hereinbefore set forth. The operation of relay 2409 opens the fundamental circuit and causes the terminating sender to function and record brush 1 for final hundreds selection. Relay 2408, in operating, operates relay 2402 in a circuit from battery over conductor 2326, winding of relay 2402, lower outer front contact of relay 2401, to ground at the front contact of relay 2408 over a previously traced circuit. The operation of relay 2402 closes a circuit from ground over the upper outer front contact of relay 2401, upper inner front contact of relay 2402, conductor 2347, to battery through the winding of relay 2340. Relay 2340 operates, releasing relays 2341 and 2404. The release of relay 2341 further opens the fundamental circuit and opens the locking circuits for relays 2408 to 2411, inclusive, and relay 2421, all of which release. The release of relay 2409 again partially closes the fundamental circuit. The release of relay 2408 allows relay 2403 to operate in series with relay 2402, both of these latter relays locking over the lower front contact of relay 2402 to ground over the upper back contact of relay 2428. The operation of relay 2403 opens the locking circuit for relays 2400 and 2401 both of which release. The release of relay 2401 opens the circuit through the winding of relay 2340 which releases thereby reoperating relay 2404 which is followed by the reoperation of relay 2341. Relay 2341 again closes the fundamental circuit for the start of the final tens selection.

The operation of relay 2429 upon this closure of the fundamental circuit operates the No. 1 counting relay 2411 in a circuit from battery over conductor 2327, winding of relay 2411, inner front contact of relay 2404, conductor 2508, conductor 2670, upper contact of the tens register cross-point 2662, conductor 2677, upper inner front contact of relay 2430, lower inner front contact of relay 2403, back contacts of relays 2421 and 2426, to ground at the front contact of relay 2429 over a previously traced circuit. The release of relay 2429 during the first open pulse permits relay 2421 to operate in series with relay 2411, both relays locking. The operation of relay 2421 transfers the pulsing contact of relay 2429 to the winding of the No. 6 counting relay 2416 in a circuit traceable from the front contact of relay 2421, lower inner front contact of relay 2430, lower back contact of relay 2427, upper outer front contact of relay 2402, conductor 2678, lower contact of tens register cross-point 2662, conductor 2673, conductor 2435, winding of relay 2416, to battery over conductor 2327. Relay 2416 operates upon the operation of relay 2429 following the first open pulse. Relay 2426 operates in series with relay 2416 upon the release of relay 2429 in response to the second open pulse. Relays 2426 and 2416 lock in series to ground over conductor 2352. The operation of relay 2426 transfers the pulsing contact of relay 2429 to the winding of relay 2415 which operates upon the reoperation of relay 2429 after the second pulse. The operation of relay 2415 opens the circuit through the winding of relay 2404 which thereupon releases. The release of relay 2429 during the third pulse permits relay 2425 to operate in series with relay 2415 both relays locking to ground over conductor 2405. The operation of relay 2425 closes the pulsing circuit to the winding of relay 2414 which operates upon the operation of relay 2429 at the conclusion of the third pulse. The fourth pulse causes relay 2424 to operate in series with relay 2414, both relays locking. The operation and release of relay 2429 for the fifth pulse operates first relay 2413 and then relay 2423 which lock in series. The sixth pulse causes relays 2412 and 2422 to operate and lock. The operation of relay 2422 extends the pulsing contact of relay 2429, over its front contact and the inner back contact of relay 2404 to the winding of the No. 0 counting relay 2410. Relay 2410 operates upon the reoperation of relay 2429 fol-

lowing the sixth pulse. The seventh open pulse causes relays 2408 and 2409 to operate in series with relay 2410, all three relays locking. Relay 2409 opens the fundamental circuit and causes the terminating sender to function and record final hundreds or brush selection 6. Relay 2408, in operating, operates relay 2427 in a circuit from battery over conductor 2326, winding of relay 2427, lower outer front contact of relay 2403, lower back contact of relay 2428, and over a previously traced circuit to ground over the front contact of relay 2408. The operation of relay 2427 operates relay 2350 from battery through the winding of relay 2350, conductor 2351, upper inner front contact of relay 2427, to ground over the upper outer front contact of relay 2403. Relay 2350, in operating, operates relay 2340 which, in turn, releases relay 2341 and removes the ground from conductor 2405 thereby releasing relays 2415 and 2425. Relay 2341, in releasing, removes the ground from conductors 2419 and 2352 thereby releasing relays 2408 to 2414, inclusive, 2416, 2421 to 2424, inclusive, and 2426. The release of relay 2409 closes, in part, the fundamental circuit. Upon the release of relay 2408, relay 2428 operates in series with relay 2427, both relays locking over the lower outer front contact of relay 2427, upper back contact of relay 2434, to ground over the upper back contact of relay 2401. The operation of relay 2428 opens the locking circuit for relays 2402 and 2403, both of which release. The release of relay 2403 releases relay 2350 which, in turn, releases relay 2340. Relay 2340, in releasing, reoperates relay 2404. Relay 2341 thereupon reoperates and locks, closing the fundamental circuit for the start of final units selection by the terminating sender.

Upon the operation of relay 2429 after the aforementioned closure of the fundamental circuit, the No. 3 counting relay 2413 operates in a circuit from battery over conductor 2327, winding relay 2413, back contact of relay 2423, conductor 2668, upper contact of the operated units register cross-point 2665, conductor 2679, lower outer front contact of relay 2430, lower inner front contact of relay 2428, back contacts of relays 2421 and 2426, to ground at the front contact of relay 2429 over a previously traced circuit. Relay 2423 operates in series with relay 2413 on the release of relay 2429 for the first open pulse and both lock over the back contact of relay 2416 to ground over conductor 2352. The operation and release of relay 2429 during the second pulse operates relays 2412 and 2422 which lock in series over the back contact of relay 2416. Relays 2411 and 2421 operate and lock over conductor 2419 in response to the third open pulse, the operating circuit for relay 2411 extending over the inner front contact of relay 2404. Relays 2416 and 2426 operate and lock in response to the fourth pulse, the operating circuit for relay 2416 extending from the front contact of relay 2421 over the lower inner front contact of relay 2430, lower inner front contact of relay 2427, conductor 2680, the lower contact of units register cross-point 2665, conductor 2673, conductor 2435, winding of relay 2416, to battery over conductor 2327. The operation of relay 2416 opens the locking circuit for relays 2412, 2413, 2422, and 2423, all of which release. Relays 2415 and 2425 operate and lock in response to the fifth pulse, relay 2415 opening the locking circuit for relay 2404 which releases. The sixth, seventh and eighth pulses cause relays 2414 and 2424, 2413 and 2423, and 2412 and 2422 to operate in that order, each pair locking in series. Upon the reoperation of relay 2429 following the eighth pulse, relay 2410 operates in a circuit over the front contact of relay 2422 and the inner back contact of relay 2404. When relay 2429 releases in response to the ninth pulse, relays 2408 and 2409 operate in series with relay 2410, all three relays locking. Relay 2409 opens the fundamental circuit and causes the terminating sender to record final units selection 8. Relay 2408, in operating, operates relay 2433 in a circuit from battery over conductor 2326, winding of relay 2433, conductor 2438, upper front contact of relay 2504, conductor 2513, lower outer front contact of relay 2428, to ground at the front contact of relay 2408 over a previously traced circuit. Relay 2433 operates relay 2350 in a circuit from battery through the winding of that relay, over conductor 2351, lower outer front contact of relay 2433, upper back contact of relay 2400, to ground over the upper outer front contact of relay 2428. Relay 2350, in operating, operates relay 2340 which releases relays 2341, 2415, and 2425. Relay 2431, in releasing, provides an additional open in the fundamental circuit in anticipation of the release of relay 2409, and removes ground from conductors 2352 and 2419 thereby releasing relays 2408 to 2414, inclusive, 2416, 2421 to 2424, inclusive, and 2426. Upon the release of relay 2408, relay 2434 operates in series with relay 2433, both relays locking in a circuit over the lower inner front contact of relay 2433 to ground over the upper back contact of relay 2440. The operation of relay 2434 opens the locking circuits of relays 2427 and 2428, both of which release. The release of relay 2428 releases relay 2350 which in turn releases relay 2340. Relay 2340, in releasing, reoperates relay 2404 which, in turn, closes the circuit for reoperating relay 2341.

Relay 2431 operates and closes the fundamental circuit to await a release signal from the terminating sender. The terminating sender, after recording the entire selection information which was revertively controlled by the originating sender, causes a long pulse of battery to be applied to the fundamental circuit, in a manner which will later be set forth in detail, the polarity of this battery being the reverse of that which was connected to the fundamental circuit during the transmission of the selection information. Relay 2418, which is polarized, did not operate during selection transmission since the current through its winding was in the non-operate direction. However, in response to the long pulse of reverse battery, both relays 2418 and 2429 of the originating sender operate. Relay 2418, in operating, locks in a circuit from ground through its upper winding and upper front contact, over conductor 2443, lower outer back contact of relay 2209, to battery over conductor 2326. Relay 2345 operates in a circuit from battery through its winding, over conductor 2445, lower inner front contact of relay 2407, lower front contact of relay 2434, to ground over the lower front contact of relay 2418. Relay 2429, in operating, closes a circuit from ground over its front contact, conductor 2431, front contact of relay 2348, left outer front contact of relay 2345, conductor 2444, to battery through the winding of the No. 0 counting relay 2410 which thereupon operates. When the reverse battery is removed from the fundamental circuit by the terminating sender, relay 2429 releases, relay 2418 remaining locked as set forth above. On the release of relay 2429, relays 2408 and 2409 operate in series with relay 2410 and all three relays lock to ground over conductor

2419. The operation of relay 2409 opens the fundamental circuit in the originating sender in anticipation of the subsequent action of the district trunk which connects a trunk closure bridge across the fundamental circuit in a manner and for a purpose which will later be set forth. The operation of relay 2408 operates relay 2209 in a circuit from battery through the winding of relay 2209, conductor 2235, right front contact of relay 2345, upper outer back contact of relay 2344, conductor 2420, to ground over the front contact of relay 2408. Relay 2209 locks over its lower front contact to ground over the upper outer front contact of relay 2200 and, by its operation, starts a series of operations to cause the release of the originating sender which has now completed its functions with respect to the connection being established. The manner in which the sender releases will be described later.

As set forth under the description of the operation of the originating decoder marker circuit, should a trouble condition be encountered during the selective operations of an office or incoming selector circuit of the panel type or during the transmission of the required selection information between the originating and terminating cross-bar senders, the originating sender functions, releases its selection register and selection sequence relays and recalls a second decoder marker circuit which it signals to route the connection to an overflow trunk. The manner in which the originating sender functions under either of these conditions is set forth in the succeeding paragraphs.

At the time that the office selector 4500 is hunting for an idle incoming trunk, the originating sender is in the trunk test position, office brush and office group selections having been completed. As hereinbefore set forth, selection sequence relays 2433 and 2434 are operated at this time and the fundamental circuit extends through the winding of relay 2417, the winding of relay 2418 being short-circuited over the upper front contact of relay 2433. Should the office selector circuit fail to find an idle trunk to the terminating office it goes to overflow and causes a pulse of reversed battery to be connected to the fundamental circuit in a manner well-known to the art. Relay 2417 operates on this reversed battery and operates relays 2408, 2409, and 2410. Relay 2408 operates relay 2439 which in turn operates relay 2340. Relay 2340 releases relay 2341 which opens the fundamental circuit and releases relays 2408, 2409, and 2410. The release of relay 2408 allows relay 2440 to operate in series with relay 2439, both relays locking. The operation of relay 2440 releases relays 2433 and 2434. The release of relay 2434 releases relay 2340 which permits relay 2341 to reoperate and again close the fundamental circuit, this time through the windings of relays 2418 and 2429 in series. The detailed manner in which these foregoing operations take place has previously been set forth. Relays 2418 and 2429 both operate on the reversed battery. Relay 2418 locks over its upper winding and closes a circuit from ground over its lower front contact, lower back contact of relay 2434, conductor 2354, winding of relay 2344, to battery over conductor 2326. Relay 2344 operates, and operates relay 2345 in a circuit from battery through the winding of relay 2345, lower front contact of relay 2344, conductor 2353, to ground over the lower front contact of relay 2418. Relay 2410 operates in a circuit from battery over conductor 2327, winding of relay 2410, conductor 2444, left outer front contact of relay 2345, front contact of relay 2348, conductor 2431, to ground over the front contact of relay 2429. The operation of relay 2344 also opens the operating circuit for the slow-to-release relay 2348 which, after an interval, releases and opens the operating circuit for relay 2410. Relays 2408 and 2409 thereupon operate and lock in series with relay 2410 and cause the sender to function in a manner which will subsequently be set forth.

On a call to a terminating office of the panel type, the failure of the incoming selector circuit of that office to find an idle trunk to the proper final selecting stage also results in the transmission of a pulse of reversed battery to the originating sender in the manner well-known to the art. Relays 2418 and 2429 of the originating sender both operate on this reversed battery causing the ultimate operation of relays 2408, 2409, and 2410 in a manner similar to that set forth in the preceding paragraph. The originating sender thereupon functions in the manner which will shortly be described.

If the terminating sender, during its pulsing operations in connection with its recording of the selection information under the revertive control of the originating sender, encounters a trouble condition which causes more than the maximum of ten pulses to be generated, it connects a reversed battery to the fundamental circuit in a manner which will later be described in detail. The originating sender at this time is in incoming brush, incoming group, final hundreds, final tens, or final units selection position with the windings of relays 2418 and 2429 in series across the fundamental circuit as has hereinbefore been set forth. Relays 2418 and 2429 both operate on the reversed battery, relay 2418 locking over its upper winding and operating relay 2344 in a circuit from battery over conductor 2326, winding of relay 2344, conductor 2354, lower back contact of relay 2434, to ground over the lower front contact of relay 2418. Relay 2344 operates relay 2345 over a previously traced circuit. The No. 0 counting relay 2410 operates over a previously traced circuit extending over the left outer front contact of relay 2345. Relay 2344, in operating, also opens the circuit through the winding of the slow-to-release relay 2348 which, after an interval, releases and allows relays 2408 and 2409 to operate and lock in series with relay 2410. The delay introduced by the slow-release characteristic of relay 2348 provides an interval of closure of the operating circuit for relay 2410 of sufficient duration to insure the operation of that relay.

When relay 2408 operates under any of the aforementioned conditions, it closes a circuit from ground over its front contact, conductor 2420, upper outer front contact of relay 2344, to battery through the winding of relay 2350. Relay 2350 operates, operating relay 2340 which, in turn, releases relay 2341 and also opens the fundamental circuit. The release of relay 2341 releases relays 2408, 2409, and 2410. Relay 2340, in operating, closes a circuit from ground over the upper inner front contact of relay 2344, lower front contact of relay 2340, winding of relay 2337, to battery over conductor 2326. Relay 2337 operates and locks to ground over its upper front contact. The release of relay 2408 releases relay 2350 which, in turn, releases relay 2340 thereby permitting relay 2341 to reoperate. The oper-

ation of relay 2341 and the release of relay 2340 again close the fundamental circuit as it was before, either through the windings of relays 2418 and 2429 or the windings of relays 2417 and 2418 depending upon which of the conditions set forth in the preceding paragraphs obtains. This closure of the fundamental circuit is recognized by the panel type office or incoming selector or by the incoming trunk at the terminating cross-bar office, as the case may be, and causes those circuits to function and restore to normal. The manner in which the incoming trunk and terminating sender function under this condition will subsequently be set forth.

Relay 2338 operates at the time that relay 2325 operates during the initial functioning of the originating sender to ground over the upper back contact of relay 2337. Upon the operation of relay 2337, relay 2338 holds to ground over the upper front contact of relay 2340. When relay 2340 releases to close the fundamental circuit, as set forth above, it opens the circuit through the winding of relay 2338. Relay 2338 has slow-to-release characteristics and, after an interval sufficient to allow the office selector or incoming trunk circuit to recognize the trunk closure signal, releases and closes a circuit from ground over the lower front contact of relay 2337, its own back contact, conductor 2339, upper back contact of relay 2230, conductor 2231, upper back contact of relay 2324, to battery through the winding of relay 2323. Relay 2323 operates and opens the operating circuit for relay 2325. Relay 2325 releases and removes the off-normal battery from conductors 2326 and 2327 thereby releasing any operated selection sequence relays and all other relays which were operated or locked over circuits supplied by this off-normal battery. The release of relay 2325 also releases relay 2330. Relay 2337, releasing with the other operated relays upon the opening of the off-normal battery, removes the operating ground from the winding of relay 2323. Relay 2324 thereupon operates in series with relay 2323, both relays locking over the lower inner front contact of relay 2323, inner back contact of relay 2321, conductor 2652, contact of crosspoint 2653, to the off-normal ground over conductor 2208. The operation of relay 2324 closes a circuit from the ground just traced to the lower inner front contact of relay 2323, over the lower outer front contacts of relays 2323 and 2324, to battery through the winding of relay 2325 which operates and causes the decoder marker connector circuit to function, in the manner hereinbefore set forth, and again establish connections between the sender and a decoder marker. During the operations of the originating sender just described the holding circuit of relay 1718 in the district trunk, which was previously traced over conductor 1703 through the sender selector, thence through the contacts of relays 2323 and 2321, thence to ground at the front contact of relay 2211, is opened temporarily to permit the release of said relay 1718. Relay 1718 also causes the release of relay 1711. When the marker, which the sender has just seized for the purpose of setting up an overflow connection, operates relay 2232, relay 1712 of the district trunk again operates as hereinbefore explained and in so doing opens the connection to conductor 1721 to permit the deenergization of the holding magnets of the district and office selectors over which the connection was extended to the distant office. These switches release the connection to the distant office. The line switches 1407 and 1410 and the sender selector switches 1800 and 1802 are held, however, under the control of the sender. The sleeve conductor 1701 which is grounded in the sender extends over the back contacts of relays 1709 and 1707 and also the back contact of relay 1710 to conductor 1436 for holding the line switch hold magnets. Relay 2323 being operated, ground over the upper front contact of that relay is connected over conductor 2334 and, upon the establishment of the connection between the sender and the second decoder marker, causes relays 3300 and 3334 of the decoder marker to operate. The operation of relays 3300 and 3334 causes overflow route relay 3430 to operate and route the call to an overflow trunk in the manner hereinbefore set forth.

Release of originating sender

The subscriber or originating sender having completed its functions with the opening of the fundamental circuit after incoming advance, relay 2209 operates and locks as hereinbefore set forth. The operation of relay 2209 opens the circuit through the winding of relay 2300 which releases, in turn releasing relay 2301. The release of relay 2301 releases relay 2211 which, in turn, releases relay 2212. Relay 2212, in releasing, releases relay 2200 which, in turn, releases relay 2206. The release of relay 2200 also opens the tip and ring conductors 1822 and 1823 between the sender link and the sender, opens in part the group busy chain circuit over its lower front contact, reconnects battery over its back contact to conductor 1932 so that the sender again provides an idle indication to sender link and control circuits, and also removes the off-normal ground from conductor 2208 thereby releasing any relays which were operated or locked thereto. The release of relay 2206 removes the ground from conductor 1824 thereby releasing the primary and secondary sender link switch hold magnets 1811 and 1809 which open the sender link switch crosspoints 1800 and 1802 thereby opening sender link 1801 and restoring that portion of the primary and secondary sender link switches which were used for this connection, to normal. The release of relay 2206 also removes the ground from conductor 2236 and thereby releases relay 2324 in the event that this relay had operated, under any of the several aforementioned conditions, during the progress of the call. The originating sender is thereby restored to its normal condition.

The terminating sender, during the transmission of pulses under the revertive control of the originating sender as hereinbefore described, records the proper selection information on the crosspoints of its register switch 4708 in the manner which will now be set forth. The two pulses transmitted for the desired incoming brush 1 operate counting relays 4740 and 4741 in the manner previously described, relay 4740 releasing upon the operation of relay 4711. The opening of the fundamental circuit by the originating sender after the second pulse causes relay 4616 to release which in turn releases relay 4617. Select magnet 4711 thereupon operates in a circuit from battery through its winding, over the right outer front contact of relay 4711, right back contact of relay 4745, conductor 4748, lower outer back contact of relay 4617, upper inner back contact of relay 4625, to the ground supplied to conductor 4626 over the lower outer front contact of relay 4603. Relay 4605 operates in a circuit from battery through its winding, over conductor 4725,

and over the front contact of magnet 4711 to the operating ground just traced to that point. Relay 4605 locks over its lower front contact and over the lower inner back contact of relay 4617 to ground over conductor 4626. Counting relay 4741, which remains locked over the back contact of relay 4605 to ground over conductor 4626 upon the release of relay 4617, therefore releases upon the operation of relay 4605. Ground over the upper outer front contact of relay 4605 short-circuits the winding of relay 4607, which together with relay 4608, was previously operated and locked during frame registration as hereinbefore set forth, thereby causing relay 4607 to release. Hold magnet 4726 operates in a circuit from battery through its winding, back contact of hold magnet 4727, upper front contact of hold magnet 4731, conductor 4750, lower front contact of relay 4608, to ground over the upper inner front contact of relay 4605. Hold magnet 4726 locks over its lower front contact to the off-normal ground on conductor 4738 which is supplied over an upper front contact of relay 4600. Select magnet 4711 having previously operated, the operation of hold magnet 4726 causes crosspoint 4751 to close which connects ground to conductor 4752 and connects conductors 4753 and 4754 to conductors 4723 and 4724, respectively, for a purpose which will later be set forth.

When the originating sender recloses the fundamental circuit for incoming group selection, relays 4616 and 4617 reoperate. Relay 4617 opens the locking circuit for select magnet 4711 and relay 4605, both of which release. The release of relay 4605 opens the holding circuit for relay 4608 which releases and prepares the operating circuit for hold magnet 4727. The three pulses transmitted for the desired incoming group 2 operate counting relays 4740, 4741, and 4742, relay 4742 locking while relays 4740 and 4741 release as previously set forth. Relay 4616 releases upon the opening of the fundamental circuit following the third pulse and releases relay 4617. Select magnet 4712 thereupon operates in a circuit from battery through its winding, right outer front contact of relay 4742, right back contact of relay 4745, conductor 4748, lower outer back contact of relay 4617, upper inner back contact of relay 4625, to ground on conductor 4626. Relay 4605 operates over conductor 4725 and front contact of select magnet 4712 to the ground just traced to that magnet. Relay 4605 locks over a previously traced circuit and opens the locking circuit for relay 4742 which releases. Relay 4607 operates to the ground over the upper outer front contact of relay 4605 and locks to ground on conductor 4738. Hold magnet 4727 operates in a circuit from battery through its winding, upper back contact of magnet 4728, upper front contact of magnet 4726, conductor 4732, lower back contact of relay 4608, to ground over the upper inner front contact of relay 4605. Hold magnet 4727 locks over its lower front contact to the off-normal ground on conductor 4738. Select magnet 4712 being operated, the operation of hold magnet 4727 causes crosspoint 4755 to close thereby connecting ground to conductor 4757 and connecting conductor 4756 to conductor 4722, the function of these conductors being set forth under the subsequent description of the terminating decoder marker.

When the originating sender recloses the fundamental circuit for final hundreds selection, relays 4616 and 4617 reoperate. Relay 4617 opens the locking circuit for select magnet 4712 and relay 4605 both of which release. Relay 4605, in releasing, removes the short-circuit from the winding of relay 4608 which thereupon operates and prepares the operating circuit for hold magnet 4728. The two pulses transmitted for the desired final brush or hundreds 1 operate counting relays 4740 and 4741, relay 4741 locking and opening the locking circuit for relay 4740 which releases. When the originating sender opens the fundamental circuit, relay 4616 releases, in turn releasing relay 4617. Select magnet 4711 thereupon operates over the identical circuit previously traced for its operation during the recording of the incoming brush selection. The operation of select magnet 4711 operates relay 4605 over a previously traced circuit. Relay 4605 locks, as hereinbefore set forth, and releases relay 4741. With relay 4608 operated, the operation of relay 4605 short-circuits the winding of relay 4607 which releases. Hold magnet 4728 operates in a circuit from battery through its winding, back contact of magnet 4729, upper front contacts of magnets 4727 and 4731, conductor 4750, lower front contact of relay 4608, to ground over the upper inner front contact of relay 4605. Hold magnet 4728 locks to the ground on conductor 4738 and, since select magnet 4711 is operated, causes crosspoint 4758 to close. The closure of crosspoint 4758 connects ground to conductor 4759 and connects conductors 4760 and 4761 to conductors 4723 and 4724, respectively, the functions of which will be set forth later.

When the originating sender recloses the fundamental circuit for final tens selection, relays 4616 and 4617 reoperate. The operation of relay 4617 releases select magnet 4711 and relay 4605. The release of relay 4605 releases relay 4608 which prepares the operating circuit for hold magnet 4729. The seven pulses transmitted for final tens selection 6 operate counting relays 4740 to 4745, relay 4745 locking while relays 4740 to 4744, inclusive, release, and relay 4740 reoperates and locks a second time in the manner hereinbefore set forth. Upon the release of relays 4616 and 4617 after the seventh pulse, select magnet 4716 operates in a circuit from battery through its winding, over the right inner front contact of relay 4740, right front contact of relay 4745, to a previously traced ground over conductor 4748. The operation of select magnet 4716 operates relay 4605 over a previously traced circuit. Relay 4605 locks under control of the released relay 4617 and operates relay 4607. Relays 4740 and 4745 release upon the operation of relay 4605. Hold magnet 4729 operates in a circuit from battery through its winding, back contact of magnet 4730, upper front contacts of magnets 4728 and 4726, conductor 4732, lower back contact of relay 4608, to ground over the upper inner front contact of relay 4605. Hold magnet 4729 locks to the off-normal ground over conductor 4738 and, select magnet 4716 being operated causes crosspoint 4762 to close thereby grounding conductors 4763 and 4766 and connecting conductors 4764 and 4765 to conductors 4723 and 4724, respectively.

The reoperation of relays 4616 and 4617 upon the closure of the fundamental circuit for final units selection causes the release of select magnet 4716 and relay 4605. The release of relay 4605 removes the short circuit from the winding of relay 4608. Relay 4608 thereupon operates and prepares the operating circuit for hold magnet 4731. The nine pulses transmitted for final units selection 8 operate all of the counting

relays, relays 4740, 4741, and 4742 operating twice, and relays 4742 and 4745 remaining locked in the manner previously set forth. When relays 4616 and 4617 release at the conclusion of the ninth pulse, select magnet 4718 operates in a circuit from battery through its winding, over the right inner front contact of relay 4742, right front contact of relay 4745, to a previously traced ground over conductor 4748. Select magnet 4718 extends its operating ground to the winding of relay 4605 which operates, locking over a previously traced circuit and releasing relays 4742 and 4745. The operation of relay 4605 also releases relay 4607 and, in addition, operates hold magnet 4730 in a circuit from battery through the winding of that magnet, upper front contacts of hold magnets 4729, 4727, and 4730 in that order, conductor 4750, lower front contact of relay 4608, to ground over the upper inner front contact of relay 4605. Hold magnet 4730 locks over its lower front contact to the off-normal ground on conductor 4738 and, since select magnet 4718 is operated, causes cross-point 4767 to close. The closure of cross-point 4767 connects ground to conductors 4768, 4769, and 4771 and connects conductor 4770 to conductor 4724. The function of the grounding and interconnection of these conductors will be set forth under the description of the operation of the terminating decoder marker circuit.

The operation of hold magnet 4730 for the registration of the final units selection information operates relay 4615 in a circuit from battery through the winding of relay 4615, conductor 4627, upper front contact of magnet 4730, lower front contact of magnet 4729, to the off-normal ground over conductor 4738. Relay 4615, in operating, transfers the fundamental tip conductor 4308 from battery through the winding of relay 4616 to ground over the upper front contact of relay 4611, and transfers the fundamental ring conductor 4309 from ground over the upper outer back contact of relay 4617 to battery through the winding of relay 4616 over the upper inner front contact of relay 4611, thereby reversing the polarity of the current over the fundamental circuit. Relay 4616 operates over the fundamental circuit in series with relays 2418 and 2429 of the originating sender. Relay 4616, in operating, closes a circuit from ground over its front contact, upper inner back contact of relay 4617, an upper front contact of relay 4615, to resistance 4612 thereby shunting the winding of relay 4611. Relay 4611, which has slow-to-release characteristics, releases after an interval and removes the battery and ground from the fundamental circuit. The long pulse of reversed battery, the duration of which is controlled by the releasing time of relay 4611, causes relays 2418 and 2429 of the originating sender to operate and bring about the release of the originating sender in the manner hereinbefore described.

Upon the operation of relay 4615 a circuit is closed from ground through both windings of relay 4628 in series, over the upper inner front contact of relay 4615, conductor 4312, a conductor of sender link 4302, conductor 4514, to battery through the winding of relay 4506 of the incoming trunk circuit. Relay 4628 operates, but relay 4506 of the incoming trunk circuit does not, the resistance of the two windings of relay 4628 limiting the current to a value below that necessary for the operation of relay 4506. The operation of relay 4628 operates relay 4629 in a local circuit through the upper winding of the latter relay. Relay 4629 locks through its lower winding and lower front contact to ground over the upper outer front contact of relay 4603. When relay 4611 releases after the connection of the reversed battery pulse to the fundamental circuit as set forth above, it closes a circuit from ground over its upper back contact, upper back contact of relay 4630, upper outer front contact of relay 4629, to the midpoint of the windings of relay 4628, thereby short-circuiting the upper winding of relay 4628. The previous release of relay 4611 opened the operating circuit for relay 4504 of the incoming trunk circuit. Relay 4504 releases and connects the tip and ring conductors 4502 and 4503 of the incoming trunk 4501 to the windings of supervisory relay 4505. Upon the short-circuiting of the upper winding of relay 4628 the current through the winding of relay 4506 of the incoming trunk circuit increases to a value sufficient to operate relay 4506. Relay 4505 thereupon operates in a circuit from battery and ground through its windings, over trunk 4501 and back over the loop extending to the calling subscriber's station over previously traced circuits. The operation of relay 4505 provides a locking ground for relay 4506 and this ground extends over the upper inner front contact of relay 4506 and conductor 4514, over a previously traced circuit, to the lower winding of relay 4628 thereby short-circuiting relay 4628 which releases. Relay 4630 thereupon operates in a circuit from battery through its winding, over the upper inner front contact of relay 4629, to ground over the back contact of relay 4628. Relay 4630, in operating, locks over its upper inner front contact to ground over the upper middle front contact of relay 4603, and connects battery to conductors 4631 and 4632 which extend to a decoder marker connector circuit and thereupon causes this connector circuit to function and connect the terminating sender to an idle decoder marker in a manner which will be set forth later. The battery on conductor 4631 is supplied over the lower back contact of relay 4601, lower front contact of relay 4630, upper outer back contact of relay 4625, and over the back contact of relay 4633. The battery on conductor 4632 is supplied over the lower back contact of relay 4601 and over the lower front contact of relay 4630, directly to conductor 4632.

As hereinbefore set forth, the maximum number of pulses generated by the terminating sender for a particular selection is ten, the originating sender becoming satisfied and opening the fundamental circuit to stop the pulsing at some point between the first pulse and the end of the tenth pulse depending upon the numerical value of the selection information being recorded. Should the terminating sender generate more than ten pulses due to any trouble condition which prevents the originating sender from being satisfied or which causes the terminating sender to continue pulsing after the fundamental circuit has been opened, an indication is transmitted to the originating sender to cause it to recall a decoder marker circuit for the purpose of routing the connection to an overflow trunk in the originating office. The terminating sender, under the above condition, functions in the following manner: During the tenth open pulse, if transmitted, the release of relay 4614 releases relays 4622 and 4623 which is followed by the operation of counting relay 4743, relay 4745 having previously operated and locked in response to the sixth open pulse. These

aforementioned operations have been detailed under the description of the operation of the terminating sender during the counting of the pulses. The reoperation of relay **4614** following the tenth pulse again operates relay **4621** over a previously traced circuit. The release of relay **4614** on the eleventh or first false pulse permits relay **4623** to operate in series with relay **4621**. Upon the reoperation of relay **4614** following the first additional pulse, relay **4625** operates in a circuit from battery through its winding, conductor **4634**, left outer front contacts of relays **4745** and **4743**, conductor **4746**, outer front contact of relay **4623**, lower middle front contact of relay **4617**, to ground on conductor **4626**. Relay **4625**, in operating, locks over its upper inner front contact to the ground on conductor **4626**, opens the decoder marker connector start conductor **4631**, opens the circuit over conductor **4748** which supplies the ground for normally operating the select magnets of register switch **4708**, and, in addition, operates relay **4615** from battery through the winding of that relay to ground over the lower front contact of relay **4625**. Relay **4615**, in operating, reverses the polarity of the potential connected to the fundamental circuit. The originating sender at this point is in some selection position with its relays **2418** and **2429** in the fundamental circuit. Relays **2418** and **2429** both operate on the reversed battery and cause the originating sender to function and recall a decoder marker which it signals to route the call to an overflow trunk in the manner hereinbefore described in detail. The aforementioned operation of relay **4615** also closes a previously traced circuit to shunt the winding of relay **4611** which releases, and in addition, closes a circuit from battery through the winding of incoming trunk circuit relay **4506**, over a previously traced circuit, to ground through the windings of relay **4628** in series. Relay **4628** operates in turn operating relay **4629**. Relay **4629** locks through its lower winding. The release of relay **4611** short-circuits the upper winding of relay **4628** thereby causing relay **4506** of the incoming trunk circuit to operate as previously set forth. The subsequent operation of supervisory relay **4505** short-circuits the lower winding of relay **4628** which releases and causes relay **4630** to operate and lock. The operation of relay **4630** under this condition does not connect battery to the decoder marker connector circuit start conductor **4631** since the circuit to this conductor is open at the upper outer back contact of relay **4625**. The originating sender, as it functions to recall another decoder marker for the purpose of routing the connection to an overflow trunk, opens the connections to outgoing trunk **4114** thereby causing supervisory relay **4505** of the incoming trunk circuit to release. Relay **4628** of the terminating sender thereupon reoperates through its lower winding in series with relay **4506** of the incoming trunk circuit. The operation of relay **4628** closes a circuit from ground over its front contact, upper outer front contact of the operated relay **4630**, to battery through the winding of release relay **4601**. Relay **4601** operates and causes the release of the terminating sender and the subsequent restoring of the primary and secondary sender link switches in a manner identical with the normal release of these circuits which will be set forth in detail later.

At the time that relay **4603** operates shortly after the seizure of the terminating sender it closes a circuit from battery through the upper winding of relay **4635**, over the lower middle front contact of relay **4603**, to a timing and alarm circuit (not shown) over conductor **4637**. This timing circuit grounds conductor **4637** and thereby operates relay **4635** which locks through its lower winding to ground over the upper middle front contact of relay **4603**. After an interval greater than that required for the sender to perform its normal functions and release, the timing circuit connects a ground to conductor **4638**. If the sender has not yet restored to normal, as indicated by the operated relay **4600**, this ground on conductor **4638** extends over an upper front contact of relay **4600**, upper front contact of relay **4635**, to battery through the upper winding of relay **4636**. Relay **4636** operates, locks through its lower winding to ground over an upper front contact of relay **4603**, connects ground to conductor **4639** to cause the alarm circuit to function and give an alarm indication, and connects ground over its upper inner front contact to the winding of relay **4615**. The operation of relay **4615** reverses the polarity of the potential connected to the fundamental circuit thereby causing the originating sender to disconnect from the incoming trunk circuit and route the connection to an overflow trunk in the originating office in the manner hereinbefore set forth. Upon the operation of relay **4615**, relays **4628**, **4629**, and **4630** function as previously described, relays **4629** and **4630** locking, and relay **4628** releasing upon the operation of supervisory relay **4505** of the incoming trunk circuit. When the originating sender opens the connection to the incoming trunk the release of supervisory relay **4505** allows relay **4628** to reoperate, in turn operating release relay **4601**. The terminating sender thereupon releases in the manner which will be set forth later.

Jack **4772** is provided for the purpose of making the terminating sender busy if it is desired to remove the sender from service for maintenance or any other reason. The insertion of a plug (not shown), the ring and sleeve elements of which are strapped together, into make-busy jack **4772** closes a circuit from ground over the sleeve and ring of the jack and plug, over the back contact of relay **4700**, over conductor **4773**, lower back contact of relay **4600**, to battery through the winding of relay **4601**. Relay **4601** operates and removes the battery from conductor **4418** thereby making this sender present a busy condition to the sender link and control circuits. The lower front contacts of relay **4601**, which parallel the lower outer front contacts of start relay **4600**, close in part the sender group busy chain circuit previously described.

Terminating sender connects to a marker

The terminating sender having recorded the entire selection information, signals the originating sender to release, and causes the closure of the incoming trunk to the windings of supervisory relay **4505** of the incoming trunk circuit, operates its relay **4630** in the manner hereinbefore set forth and connects battery, over previously traced circuits, to conductors **4631** and **4632** to start the associated decoder marker connector circuit shown in Figs. 48 and 49 to function for the purpose of associating the terminating sender with an idle terminating decoder marker circuit. Assuming that the decoder marker connector circuit is not engaged in establishing connections between some other terminating sender and a decoder marker, the battery on conductor **4631** extends through the winding of relay **4900** which is associated with

the sender shown in Figs. 46 and 47, over the back contacts of relays similar to relay 4900, such as relay 4901, which are associated with other terminating senders, and through the winding of relay 4902 to ground, thereby operating both relays 4900 and 4902. The multi-contact sender connecting relay 4800, associated with the sender shown in Figs. 46 and 47 thereupon operates in a circuit from ground over the upper front contact of relay 4900, conductor 4801, winding of relay 4800, to the previously traced battery over conductor 4632. The operation of relay 4800 closes the various conductors extending from the sender, as indicated by the cable 4802, to the multipled armatures of the decoder marker connecting relays 4804 and 4805. The operating circuits for the sender selecting relays, such as relays 4900 and 4901, as well as the circuits from their functional contacts, extend in chain circuits over the back contacts of these relays in such a manner that only one of these relays is effective at a time. For example, relay 4900, in operating, locks over its lower front contact and removes the ground over its upper back contact from the chain circuit extending over the upper armatures of the other similar relays, such as relay 4901. Should the sender associated with relays 4803 and 4901 desire connection to a decoder marker at this time, relay 4901 would operate in series with relay 4902 and lock over its lower front contact, but would be ineffective in causing the operation of relay 4803 until the release of relay 4900 restores the functional ground to the upper armature of relay 4901. Similarly, had relays 4803 and 4901 been operated at the time that the sender of Figs. 46 and 47 connected battery to conductors 4631 and 4632, relay 4900 could not operate and in turn operate relay 4800 until the release of relay 4901 again closed its lower back contact and completed the circuit for operating relay 4900.

Upon the aforementioned operation of relay 4803 a circuit is closed from the battery over conductor 4631, over a front contact of relay 4800, conductor 4806, upper back contacts of relays 4903 and 4904, upper back contact of relay 4905, to ground through the winding of decoder selecting relay 4907 which operates and locks over its lower front contact. The upper armature of relay 4907 connects over conductor 4909, over a chain circuit extending over the upper armatures and back contacts of the decoder selecting relays corresponding to relay 4907, associated with the same decoder marker, but located in other decoder marker connector circuits (not shown), to a ground on the last relay, corresponding to relay 4907, in the chain circuit. Relay 4910 is normally operated from battery through its winding, over the upper back contact of relay 4907, conductor 4909, to ground over this aforementioned chain circuit as long as no decoder marker connector circuit has connected to the decoder marker associated with relay 4907 or with a corresponding relay of another decoder marker connector circuit. The ground over the lower back contact of relay 4907 is normally connected over conductor 4911, over a chain circuit extending over the lower back contacts of relays corresponding to relay 4907 in the other decoder marker connector circuits (not shown) and back over conductor 4912 to battery through the winding of relay 4913. Relay 4913 is therefore normally operated as long as no decoder marker connector circuit connects to the decoder marker with which relay 4907, and similar relays in the other connector circuits, is associated.

Upon the operation of relay 4907 the aforementioned chain circuits are opened, releasing relays 4910 and 4913 which, in turn, connect ground over their back contacts to the decoder marker start conductor 4914. Relay 4805 operates in a circuit from battery through its winding, over conductor 4807, upper front contact of relay 4907, and over conductor 4909 to ground supplied over the chain circuit over which this conductor extends. The operation of relay 4805 extends the conductors from the terminating sender to the decoder marker shown in Figs. 50 to 56, inclusive, over conductors indicated by cable 4808. Ground is connected over a front contact of relay 4805, over conductor 4809, to one side of resistance 4915 and to one end of the upper winding of relay 4905 to shunt that winding of relay 4905. Ground is connected over another front contact of relay 4805 to the decoder marker start conductor 4914 and supplements the ground supplied over the back contacts of relays 4910 and 4913. In addition, ground is connected over still another front contact of relay 4805, over conductor 4916, to battery through the winding of relay 4917. Relay 4917, which is individual to a particular decoder marker circuit, thereupon operates and connects ground to the upper winding of relay 4905 and, over other front contacts, to the upper windings of relays corresponding to relay 4905 of other decoder marker connector circuits (not shown), relay 4917 having as many front contacts as there are decoder marker connector circuits having access to its associated decoder marker. Relay 4905 does not operate since its upper winding is shunted out by the ground supplied over conductor 4809. The relays corresponding to relay 4905 in the other connector circuits operate, however, opening the circuits to the windings of the decoder selecting relays, corresponding to relay 4907, in the other connector circuits to prevent those circuits from selecting the decoder marker associated with relay 4907. The operation of the relays corresponding to relay 4905 also transfer, over their upper contacts, the decoder selecting start circuits to the decoder selecting relays associated with the next idle decoder marker, such as relays corresponding to relay 4908 of this circuit. Whenever a sender connecting relay, such as relay 4800 or 4803 operates, a ground is connected over conductor 4810 to lock any operated connector busy relay, such as relay 4905 or 4906, through its lower winding. This is done to prevent a connector which has started to select a particular idle decoder marker, other than that of its first choice, to abandon that decoder marker and return to an earlier choice if this latter decoder marker becomes idle during the selecting operation. It will be noted that the locking circuit for relays 4905 and 4906 extends in a chain circuit over the lower back contacts of these relays. This is done to prevent them from permanently locking in the event that they should all be operated at any time. Relays 4804, 4906, 4908, 4918, 4919, 4920, and resistance 4921 are associated with some other decoder marker circuit and perform functions identical with those performed in connection with the decoder marker shown in Figs. 50 to 56, inclusive, by relays 4805, 4905, 4907, 4910, 4913, 4917 and resistance 4915, respectively.

The decoder marker shown in Figs. 50 to 56, inclusive, may be rendered busy to all decoder marker connector circuits by insertion of plug 4922 into jack 4923 which causes relay 4924 to

operate. The operation of relay 4924 operates relay 4917 which, in turn, operates relay 4905 through its upper winding and also operates relays corresponding to relay 4905 of the other decoder marker connector circuits. The operation of relay 4905 transfers the decoder marker selecting start conductor from the winding of relay 4907 to the winding of the next idle decoder marker selecting relay, such as relay 4908. A similar operation takes place in the other connector circuits. Plug 4925, jack 4926 and relay 4927 are used for making some other decoder marker busy and perform functions identical with those set forth for plug 4922, jack 4923 and relay 4924. If it is desired to make a decoder marker busy to only a particular connector circuit, plug 4928 or 4929 is inserted into jack 4930 or 4931 as the case may be. The corresponding connector busy relay 4905 or 4906 thereupon operates through its upper winding and transfers the circuit from the winding of its associated decoder marker selecting relay to the winding of the next selecting relay whose associated connector busy relay, such as relay 4905 or 4906, is unoperated.

The terminating decoder marker connector circuit is provided with a timing circuit which functions and causes an audible and visual alarm indication to be given in the event that the decoder marker connector circuit encounters any trouble condition and fails to complete its functions in the normal time required for these functions to take place. At the time that the terminating sender connected battery to start conductor 4631 both relays 4900 and 4902 operated in series. The operation of relay 4902 closes a circuit from battery, through resistance 4928, to the armature of interrupter 4929. When the constantly rotating cam of interrupter 4929 closes the right contact of that interrupter, relay 4930 operates and locks to the battery through resistance 4928. The operation of relay 4930 connects the left contact of interrupter 4929 to battery through the left winding of relay 4931. Relay 4931 operates through its left winding upon the subsequent closure of the left contact of interrupter 4930 and locks over its left inner front contact and the front contact of relay 4902 to battery through resistance 4928. In operating, relay 4931 connects ground over its left and right outer front contacts to conductors 4932 and 4933. Conductor 4933 extends to an audible alarm circuit (not shown) which, as indicated by multiple strap 4936, is common to all decoder marker connector circuits, and causes that alarm to function. The operation of key 4934 causes alarm lamp 4935 to light in a circuit to the ground on conductor 4932 and thereby giving an indication of which decoder marker connector circuit has encountered the trouble condition. Battery over the left contact of key 4934 extends through lamp 4937 and over conductor 4938 to ground over a front contact of sender connecting relay 4800, thereby indicating which terminating sender is involved in the connection whose failure has caused the alarm indication to be given. The aforementioned alarm is given upon the failure of a decoder marker connecting relay, such as relay 4804 or 4805, to operate in a predetermined normal time. During the normal functioning of the decoder marker connector circuit as set forth in the preceding paragraph, the operation of decoder marker connecting relay 4805 closed a circuit from ground over one of its front contacts, and over conductor 4811, thereby shunting the winding of relay 4930 and causing the alarm timing circuit to be ineffective. Lamp 4939 is the individual alarm lamp associated with sender connecting relay 4803.

In the event that a decoder marker connecting relay, such as relay 4804 or 4805, operates, but, due to a trouble condition, does not release within a predetermined normal interval, an alarm indication of this condition is also given. At the time that relay 4805 operated, during the normal connection previously described, it closed a circuit from ground over one of its front contacts, over conductor 4812, to the armature of interrupter 4940. Upon the closure of the left contact of interrupter 4940, if not initially closed, relay 4941 operates from battery through its winding to the ground over conductor 4812. Relay 4941, in operating, locks over its left front contact to ground over conductor 4812 and closes the right contact of interrupter 4940 to battery through the right winding of relay 4931. When interrupter 4940 subsequently closes its right contact relay 4931 operates and locks through its right winding and right inner front contact to ground over conductor 4812. Relay 4931, in operating, grounds conductors 4932 and 4933 thereby causing an audible alarm (not shown) to sound and also providing the ground for lighting lamp 4935 should key 4934 be operated. The time interval introduced by the action of interrupter 4940 and relays 4941 and 4931 is greater than the total normal time that a decoder marker connecting relay is operated and the alarm therefore is only brought in when a trouble condition is encountered.

Should a false ground be connected to the decoder marker start conductor 4914 at any time, with the decoder marker connecting relay 4805 and corresponding relays in other connector circuits normal, this ground operates the decoder marker start relay, such as relay 5300, and causes a time measure and alarm circuit of the decoder marker to function, in a manner which will be set forth later, and give an alarm indication.

When a terminating decoder marker circuit encounters some trouble condition which prevents it from completing its functions and returning a release indication in the regular manner, its timing circuit functions, as will subsequently be set forth under the description of the operation of the terminating decoder marker, and connects a ground to conductor 4943 as a trouble release signal to the decoder marker connector circuit. This ground extends over a front contact of an operated decoder connecting relay, such as relay 4805, over conductor 4813, lower back contact of relay 4903, winding of relay 4904, resistance 4944, conductor 4814, a front contact of an operated sender connecting relay, such as relay 4800, to the battery over conductor 4632. Relay 4904 thereupon operates, opens the start conductor which extends over an upper back contact of relay 4905 or 4906 through the winding of relay 4907 or 4908, respectively, thereby releasing relay 4907 or 4908 and causing the associated decoder marker to release due to the removal of ground from its start conductor, such as conductor 4914. Relay 4904, by its operation, also connects ground over its upper inner front contact to one end of the lower winding of relay 4903. Relay 4903 does not operate at this time, however, since its lower winding is short-circuited by the presence of ground over conductor 4813 on the other end of its lower winding. The subsequent release of relay 4805 or 4804, following the release of relay 4907 or 4908, respectively, opens conductor 4813.

Relay 4903 thereupon operates through its lower winding in series with the winding of relay 4904, both relays locking to the ground over the upper inner front contact of relay 4904. Relay 4904, in operating, again closes the decoder marker connector start conductor to the winding of some decoder selecting relay. This circuit may be traced from battery on conductor 4631, a front contact of relay 4800, conductor 4806, upper front contact of relay 4903, upper middle front contact of relay 4904, to the upper armature of relay 4905 and the upper front contact of relay 4906 from which point it extends to the winding of relay 4907 or 4908, depending upon whether relay 4905 is operated or normal. Relay 4903 also locks through its upper winding and upper front contact to the battery over conductor 4806. The aforementioned closure of the start conductor to the winding of relay 4907 or 4908 causes one or the other of these relays to operate and engage another decoder marker in the manner previously described. Relays 4903 and 4904 both remain operated while this second decoder marker is attached. Should this second decoder marker also fail to complete its functions, it returns a trouble release ground over conductor 4943 in the same manner as the first decoder marker did. This ground shunts out the winding of relay 4904 and the lower winding of relay 4903, relay 4904 releasing but relay 4903 remaining locked through its upper winding. The release of relay 4904 closes a circuit from ground over its lower back contact, lower outer front contact of relay 4903, conductor 4815, a front contact of relay 4800, conductor 4774, to battery through the winding of relay 4633 of the terminating sender. Relay 4633 operates and locks over its front contact to ground over the upper outer front contact of relay 4603. The operation of relay 4633 opens conductor 4631 to prevent the decoder marker connector circuit from attempting to engage a third decoder marker, two of these latter circuits already having been unsuccessful in completing the connection. Since the terminating sender can proceed no further in its normal operation it awaits the action of its time measure and alarm circuit, consisting of relays 4635 and 4636, which functions to bring about the release of the connection in the manner hereinbefore set forth. Upon the release of the terminating sender, the removal of battery from conductor 4632 permits the decoder marker connector circuit to restore to normal.

Transfer of record to terminating marker

Referring now to the terminating decoder marker circuit shown in Figs. 50 to 56, inclusive, the start relay 5300 of this circuit operates as soon as the decoder marker connector circuit connects ground to conductor 4914 in the manner hereinbefore set forth. Relay 5300, in operating, connects off-normal ground to conductors 5301 and 5302 and off-normal battery to conductor 5303 for purposes which will subsequently be set forth. The closure of conductors 4834 to 4837, inclusive; 4852 to 4854, inclusive; and 4857; 4856 and 4859 to 4861, inclusive; 4863 to 4866, inclusive; and 4868 to 4871, inclusive; cause the register relays shown in Fig. 52 to function and record the selection information, previously registered on the register switch of the terminating sender, in the manner set forth in the subsequent paragraphs.

The number of the particular frame containing the incoming trunk used for this connection, assumed to be frame No. 19, was previously registered in the terminating sender by the operation of relay 4708 and register switch crosspoint 4733 of the sender, this latter relay and crosspoint grounding conductors 4720, 4736 and 4737, and connecting conductors 4734 and 4735 to conductors 4722 and 4723, respectively, in the manner hereinbefore set forth. Conductors 4720, 4722, 4723, 4734, 4735, 4736 and 4737 extend over front contacts of connecting relays 4800 and 4805 and over conductors 4820, 4822, 4823, 4834, 4835, 4836 and 4837, respectively, to the terminating decoder marker. Conductor 4821 of the terminating decoder marker is also grounded over a front contact of relays 4805 and 4800. The ground on conductor 4820 operates relays 5100 and 5101 through their windings in parallel to battery. Ground on conductors 4836 and 4837 operates frame register relays 5202 and 5203, respectively. Relay 5200 operates from battery through its winding, over conductor 4834, conductor 4734, contact of sender register crosspoint 4733, conductors 4722 and 4822, and over the lower outer back contact of relay 5307 to ground. Similarly, relay 5201 operates over conductors 4835 and 4735, contact of crosspoint 4733, conductors 4723 and 4823, to ground over the lower middle back contact of relay 5307.

The operated incoming brush crosspoint 4751, incoming group crosspoint 4755, final hundreds crosspoint 4758, final tens crosspoint 4762 and final units crosspoint 4767 of the terminating sender register switch have also grounded and connected together certain recording conductors extending from the terminating sender to the decoder marker, the particular conductors involved as well as the condition imposed thereon having previously been set forth. The thousands register relays are operated under control of both the incoming brush and incoming group crosspoints of the sender register, while the hundreds, tens and units register relays are operated under control of the final hundreds, final tens and final units cross-points respectively. Thousands register relay 5204 operates from ground over conductor 4852. Relay 5207 operates from ground over conductor 4857. Relays 5205 and 5206 operate, respectively, in circuits over conductors 4853 and 4854, contacts of relays 4805 and 4800, conductors 4753 and 4754, contacts of crosspoint 4751, conductors 4723 and 4724, contacts of relays 4800 and 4805, conductors 4823 and 4824, to ground over lower back contacts of relay 5307. Hundreds register relay 5208 operates from ground on conductor 4859. Relays 5209 and 5210 operate respectively over conductors 4860 and 4861, conductors 4760 and 4761, contacts of crosspoint 4758, conductors 4723 and 4724, conductors 4823 and 4824, to ground over lower back contacts of relay 5307. Relay 5211 operates over conductors 5856 and 4756, over a contact of crosspoint 4755, conductors 4722 and 4822, to ground over the lower outer back contact of relay 5307. Tens register relays 5212 and 5215 operate to ground over conductors 4863 and 4866, respectively. Relays 5213 and 5214 operate respectively over conductors 4864 and 4865, conductors 4764 and 4765, contacts of cross-point 4762, conductors 4723 and 4724, to ground over previously traced circuits over conductors 4823 and 4824. Units register relays 5216, 5217, and 5219 operate to ground over conductors 4868, 4869, and 4871, respectively. Relay 5218 operates over conductors 4870 and 4770, a contact of cross-point 4767, con-

ductors 4724 and 4824, to ground over a lower back contact of relay 5307.

Providing that none of the recording conductors extending between the terminating sender and the decoder marker are open, all of the decoder marker register relays are now in their operated position and complete chain circuits for operating three check relays 5304, 5305, and 5306. Relay 5304 operates in a circuit traceable from battery through its winding, over conductor 5308, right inner front contacts of relays 5211, 5208, 5212, 5216, 5204, and 5200, in that order, over conductor 4821, a front contact of sender connector relays 4805 and 4808, to ground. Relay 5304, in operating, locks over its inner front contact to the ground on conductor 4821 and closes, in part, the operating circuit for relay 5307. Relay 5305 operates from battery through its winding, over conductor 5309, outer front contacts of relays 5100 and 5101, conductor 5310, left inner front contact of relay 5201, right inner front contact of relay 5205, left outer front contact of relay 5207, left inner front contacts of relays 5209, 5213, and 5217, to ground on conductor 4821. Relay 5305 locks over the upper outer back contact of relay 5307 to the ground on conductor 4821 and advances the as yet incomplete operating circuit for relay 5307 to the inner front contact of relay 5306. Relay 5306 operates from battery through its winding, over conductor 5311, left inner front contacts of relays 5203, 5202, 5206, 5210, 5215, 5214, 5219, and 5218, in that order, to ground on conductor 4821. Relay 5306 locks over the upper outer back contact of relay 5307 and also completes the operating circuit for relay 5307. Relay 5307, in operating, locks over its upper outer front contact to ground over conductor 4821, opens the locking circuits for relays 5304 to 5306, inclusive, and removes the ground from conductors 4822 to 4824, inclusive. Relays 5304 to 5306, inclusive, momentarily remain operated over their original operating circuits which extend over front contacts of the various register relays. The removal of ground conductors 4822 to 4824, inclusive, causes all register relays which are not operated by direct ground over the contacts of the terminating sender register switch cross-points to release. In the case of the connection being described, only register relays 5202, 5203, 5204, 5207, 5208, 5212, 5215, 5216, 5217, and 5219 remain operated. Since at least one register relay in each chain, over the contacts of which the check relays 5304 to 5306, inclusive, were operated, releases, relays 5304, 5305, and 5306 release. The release of relays 5304 and 5305 close circuits from ground over the lower front contacts of relay 5307, over conductors 5312, 5313, and 5322, to chain circuits extending over the functional contacts of the register relays, and the terminating decoder marker thereupon proceeds with its functions in the manner set forth below.

Marker connects to incoming frame

Ground over conductor 5312 extends in a circuit over the left back contact of relay 5210, left inner back contact of relay 5211, left back contact of relay 5209, left middle front contact of relay 5208, over conductor 5220, to battery through the winding of select magnet 5501 of the translating cross-bar switch 5500, shown in Fig. 55. Select magnet 5501 operates, prepares the sets of cross-point contacts in the associated horizontal row for subsequent operation and, in addition, operates translating switch hold magnet 5503 in a circuit traceable from ground over the upper outer front contact of relay 5300, conductor 5302, outer back contacts of relays 5600 to 5602, inclusive, conductor 5603, contacts of select magnet 5501, conductor 5502, left back contact of relay 5206, right front contact of relay 5207, left outer front contact of relay 5204, left middle back contact of relay 5205, conductor 5221, to battery through the winding of hold magnet 5503. The translating switch 5500 is provided with one hundred sets of cross-point contacts arranged in ten horizontal and ten vertical rows, these being partially indicated by the four horizontal and three vertical rows of contact sets. The switch is also provided with ten select and ten hold magnets, only four of the former and three of the latter being indicated however, to conform with the partial indication of the rows of contacts illustrated. Ten conductors, partially indicated, extend from the functional contacts of the hundreds register relays 5208 to 5211, inclusive, to the windings of the ten select magnets of the translating switch. Similarly, ten partially indicated conductors extend from the functional contacts of the thousands register relays 5204 to 5207, inclusive, to the windings of the ten hold magnets of the translating switch.

Hold magnet 5503, in operating, locks over its inner front contact to the off-normal ground supplied over a previously traced circuit to conductor 5603 and, since select magnet 5501 previously operated, causes cross-point 5504 of the translating switch to close its contacts. Select magnet release relay 5314 also operates at this time in a circuit from battery through its winding, over conductor 5315, to ground over the outer front contact of hold magnet 5503. Relay 5314, in operating, locks to the off-normal ground on conductor 5302, and opens the operating circuit for select magnet 5501 which thereupon releases. Upon the closure of cross-point 5504 circuits are completed from battery through the windings of relays 5604 and 5605, over conductors 5606 and 5607, contacts of cross-point 5504, conductors 5506 and 5507, to ground through the windings of relays 5700 and 5701, respectively, of the final frame connector circuit shown in Fig. 57. Relays 5700 and 5701 both operate, but relays 5604 and 5605, being marginal, do not operate under this condition. The function of relays 5604 and 5605, which are trouble detecting relays, will be set forth later. Relay 5700, in operating, opens the chain circuit extending from ground over its back contact to the windings of the corresponding relays, such as relays 5702 and 5704, which are associated with other final frames. Provided that the final frame connector circuit is not already in use, connecting relay 5708 operates in a circuit from battery through its winding, over the upper front contact of relay 5700, and over the upper back contacts of relays 5702 and 5704 to ground. Relay 5701, in operating, removes the ground from the chain circuit extending over its back contact over the back contacts and to the windings of the corresponding relays 5703 and 5705 which are associated with other final frames. A supplementary ground is also connected over the upper back contacts of relays 5705 and 5703 and over the upper front contact of relay 5701 to the winding of relay 5708. The operation of multi-contact relay 5708 closes the circuits between the conductors indicated by cable 5710 and the conductors indicated by cable 6100 thereby establishing connections between the particular terminating decoder

marker being used and the final frame shown in Fig. 61 which serves two hundred lines including the particular line to which it is desired to complete the connection being described. Ground over the upper outer front contact of relay 5708 extends over conductor 5709 to battery through the windings of check relays 5102 and 5316 both of which operate. The operation of relay 5102 opens one circuit from the off-normal ground on conductor 5302 from the winding of relay 5103 for a purpose which will be set forth later. The operation of relay 5316 completes a circuit to cause the incoming frame connector circuit shown in Fig. 58 to establish connections between the incoming frame containing that trunk on which the incoming connection appears and the terminating decoder marker being used. This circuit is traceable from battery over the lower back contact of relay 5317, winding of relay 5318, upper inner front contact of relay 5307, back contact of relay 5306, front contact of relay 5316, back contact of relay 5319, conductor 5320, right outer front contact of relay 5202, left outer back contacts of relays 5200 and 5201, right inner front contacts of relays 5202 and 5203, conductor 5222, a front contact of relay 5100, conductor 5104, to the winding of start relay 5800 of the incoming frame connector circuit. There are ten conductors, similar to conductor 5222, which extend from the functional contacts of the frame register relays 5200 to 5203, inclusive, to the armatures of relays 5100 and 5101. There are twenty conductors, similar to conductor 5104 and partially indicated, which extend from the front and back contacts of relays 5100 and 5101 to the winding of a start relay, such as relay 5800, in each of twenty incoming frame connector circuits which are associated with twenty incoming trunk frames. The particular incoming frame start relay to be energized depends upon which combination of frame register relays are operated and also upon relays 5100 and 5101 which are operated only where the incoming trunk appears on one of the second ten of the twenty trunk frames. It has been assumed that the incoming trunk used for the connection under discussion is located on incoming trunk frame No. 19 and it will further be assumed that the incoming frame connector circuit shown in Fig. 58 is associated with this particular incoming trunk frame. Relays 5801 and 5802 represent start relays associated with other terminating decoder markers, there being as many start relays as there are decoder markers serving a particular group of incoming trunk frames. Assuming that the incoming frame connector is not engaged in establishing connections for some other decoder marker, relay 5800 operates from the previously traced battery over conductor 5104, through its winding, over the chain circuit extending over the lower back contacts of the other start relays associated with other decoder markers, such as relays 5801 and 5802, to ground. Relay 5800, in operating, operates multi-contact connector relay 5803 in a circuit through the winding of that relay to the off-normal battery over conductor 5303. The operation of relay 5803 closes the conductors indicated by cable 5804 to the conductors indicated by cable 5805, thereby completing the connections between the incoming trunk frame shown in Fig. 59 and the terminating decoder marker circuit. The operation of relay 5800 also opens the chain circuit extending from ground over its outer back contact and over the upper outer armatures of relays 5801 and 5802 thereby preventing the operation of these latter relays under control of other decoder markers from causing the operation of their associated connecting relays 5806 and 5807 which would interfere with the connections already established.

Upon the operation of relay 5800 of the incoming frame connector a circuit is completed from ground over the upper inner front contact of that relay, over conductor 5808, to battery through the winding of a check relay 5105 which operates, indicating that connections have been established between the incoming frame and the decoder marker. A circuit is thereupon completed from ground over the back contact of relay 5106, front contact of relay 5105, conductor 5107, front contacts of relays 4805 and 4800, conductor 4311, contacts of secondary and primary sender selector switch cross-points 4301 and 4300, conductor 4518, to battery through the winding of relay 4523 of the incoming trunk circuit. Relay 4523 operates and connects ground over its lower front contacts to conductors 4512 and 4513. The ground on conductor 4512 operates select magnet 5901 of the primary incoming switch containing cross-point 5900. The ground on conductor 4513 operates multi-contact connecting relay 5907. Relay 5907 closes a circuit, over conductor 5908, from the lowest or test conductor of "A" trunk 5906 to the multipled armatures of the incoming frame connecting relays 5803, 5806, and 5807. Since there are sixteen "A" trunks or links interconnecting the primary incoming switch containing cross-point 5900 with the secondary incoming switches, as has previously been set forth in the general description, relay 5907 closes circuits from the test conductors of fifteen other "A" trunks (not shown) to the armatures of connecting relays 5803, 5806, and 5807. One of these additional circuits is indicated by the partially shown test conductor 5910 which extends over a front contact of relay 5907 and over conductor 5909 to the frame connector circuit relays. The operation of relay 5907 also closes a circuit from ground over its outer front contact to battery through the winding of secondary incoming switch select magnet 5905, and, as indicated by multiple strap 5911, to the windings of the corresponding select magnets of the other secondary incoming switches, these latter select magnets being associated with those rows of cross-points of their respective switches to which the other fifteen "A" trunks to which the particular primary switch containing cross-point 5900 has access. The operation of relay 4523 of the incoming trunk circuit also closes a circuit from the winding of ringing control relay 4524, over conductor 4511, to the frame connector relays. The sixteen "A" trunk test conductors represented by conductors 5908 and 5909, extend over front contacts of the operated frame connector relay 5803, over conductors 5809 and 5810, respectively, to the front contacts of eight "A" trunk pattern relays 5000 to 5007, inclusive, only ten trunk test conductors connecting to any of the relays 5000 to 5007, inclusive, in various arrangements. As set forth above, a particular primary incoming switch has access to the secondary incoming switches over sixteen "A" trunks or links, but, since there are only ten "C" trunks between the primary and secondary final frame switches, only ten of the "A" trunks may be used for a particular connection. It is the function of relays 5000 to 5007, inclusive, to select, under control of the translator switch, a particular ten

"A" trunks in a manner which will subsequently be set forth.

Marker connects to final frame

As hereinbefore set forth in the general description, the two hundred lines served by a final frame are divided into ten groups of twenty lines each for testing purposes. It is therefore necessary for the decoder marker, in addition to associating itself with the proper final frame, to further limit its testing operations to the particular group of twenty lines in which the called line is located. This is accomplished in the following manner:— When check relay **5307** operated and check relay **5305** released, following the recording of the desired number by the register relays of Fig. 52, a circuit was completed from ground over the lower inner front contact of relay **5307**, back contact of relay **5305**, upper inner back contact of relay **5317**, back contact of relay **5321**, conductor **5322**, right front contact of tens register relay **5215**, right inner back contacts of tens register relays **5214** and **5213**, right inner front contact of tens register relay **5212**, conductor **5223**, right back contact of relay **5609**, to battery through the winding of relay **5608**. Relays **5608**, **5612**, **5614**, **5616**, and **5618** are private branch exchange progress relays, the function of which is to associate that group of twenty lines containing the called line with the terminating decoder marker line testing relays and, should the called line be one of a group of private branch exchange lines, to shift the decoder marker line testing relays to the next consecutively numbered group of lines in the event that all of the lines of the private branch exchange group appearing in a particular twenty-line group are busy and the private branch exchange group extends into another twenty-line group. The detailed manner in which the private branch exchange progress circuit functions will be set forth later, since, for the present, it is assumed that the called line is an individual line.

Upon the operation of cross-point **5504** of the translator switch a circuit is closed from the off-normal battery on conductor **5303**, over a contact of cross-point **5504**, conductor **5505**, a front contact of relay **5708**, conductor **5711**, to ground through the winding of relay **6101**. Relay **6101** operates and closes a circuit from battery through the winding of relay **6102**, outer front contact of relay **6101**, conductor **6104**, contact of relay **5708**, conductor **5610**, left outer front contact of relay **5608**, left outer back contact of relay **5609**, conductor **5224**, a left front contact of relay **5208**, left middle back contact of relay **5211**, conductor **5326**, to resistance **5323** and to ground through the right winding of relay **5325**. There are ten relays, such as relay **6102**, for each group of two hundred lines, one relay being associated with a particular twenty lines. Only two of these relays, **6102** and **6103**, are shown for that group of two hundred lines containing the desired called line. Relays **6106** and **6107** are two of ten relays, corresponding to relays **6102** and **6103**, respectively, which are associated with some other final frame serving a different group of two hundred lines. There are also ten relays, such as relay **6101**, one for each group of two hundred lines. Only two of these latter relays, **6101** and **6108** are shown. The operation of relay **6101**, under control of the translator switch cross-point **5504**, therefore identifies the particular group of two hundred lines containing the called line and connects the windings of the ten, twenty-line group selecting relays associated therewith, such as relays **6102** and **6103**, to the decoder marker. The operation of relay **6101** also closes circuits from the select magnets of the secondary final switches to the decoder marker for future operation. The circuit for select magnet **6111**, associated with the secondary final switch containing cross-point **6117**, may be traced from battery through the winding of that select magnet, over the inner front contact of relay **6101**, conductor **6118**, a contact of relay **5708**, conductor **5712**, to the right front contact of relay **5113**. As indicated by multiple straps **6114** and **6115**, the windings of the corresponding select magnets of all secondary final switches are connected together. The windings of the nine other select magnets of the secondary final switch containing cross-point **6117** together with the windings of the corresponding select magnets of the other secondary final switches, are also connected to front contacts of nine other relays similar to relay **5113**, of which only four, relays **5110** to **5113**, inclusive, are shown. Only one of these nine additional circuits has been indicated and may be traced from conductor **6113**, over a front contact of relay **6101**, conductor **6119**, a contact of relay **5708**, conductor **5713**, to the right front contact of relay **5110**. The operation of relay **6102** identifies the particular group of twenty lines containing the called line **6120** and closes circuits for testing these twenty lines and for the future operation of the proper secondary final switch hold magnet. The test circuit for the called line **6120** may be traced from test conductor **6121**, over a front contact of relay **6102**, conductor **6123**, contact of relay **5708**, a conductor **5714**, to the left inner armature of line relay **5404** and thence through the winding of line test relay **5414**, to battery. There are twenty line relays, eight of which, relays **5400** to **5407**, inclusive, are shown. Relay **6102** is provided with additional contacts (not shown) and connects the test conductors of the nineteen other lines of the group to the left inner armatures of the nineteen other line relays over circuits similar to that traced from test conductor **6121**. The circuit for secondary final switch hold magnet **6112** may be traced from battery through the winding of that magnet, over a front contact of relay **6102**, to a front contact of relay **6124**. As set forth in the general description, each final switch has ten horizontal and twenty vertical rows of contacts and is therefore provided with ten select and twenty hold magnets. The windings of the remaining hold magnets of the secondary switch on which hold magnet **6112** is located are also connected over additional front contacts of relay **6102** to front contacts of relays **6124** and **6126**, the first ten hold magnets being connected to contacts of relay **6124** while the second ten connect to contacts of relay **6124**. The function of relays **6124** and **6126** will be set forth in a subsequent paragraph.

Test of called line

Relay **5325** operates in series with relay **6102** after an interval sufficient to insure the complete operation of this latter relay. This delay in the operating time of relay **5325** is produced by the action of condenser **5324** on the left winding of relay **5325**. The two windings of relay **5325** are electrically opposed and, upon the closure of the previously traced circuit to battery through the winding of relay **6102**, are initially equally energized. As condenser **5324** becomes charged, however, the current through the left winding of

relay 5325 gradually diminishes to a point where it no longer overcomes the energy produced in the right winding of the relay and relay 5325 thereupon operates. Resistance 5323, together with condenser 5324, determines the length of this delay interval. At the time that check relay 5307 operated, following the recording of the wanted number by the register relays, it closed a ground to conductor 5313 as previously stated. This ground extends in a circuit over the left outer front contacts of relays 5215 and 5212, over conductor 5225, to battery through the winding of relay 5428 which operates. Relay 5428 is operated under control of the tens register relays whenever an even tens digit is registered. In the example given, relay 5428 is operated when the tens digit 6 is registered and it closes circuits from the contacts of the units register relays 5216 to 5219 inclusive to the armatures of the first ten of the twenty line test relays, that is, the ten line test relays which are represented by relays 5410 to 5414 inclusive. Relay 5429, similar in function to relay 5428, is operated under control of the tens register relays whenever an odd tens digit is registered and closes circuits from the contacts of the units register relays to the armatures of the second ten of the twenty line test relays, that is, the ten test relays represented by relays 5415 to 5417 inclusive. With relay 5428 operated, the operation of relay 5325 closes a circuit from ground over its front contact, conductor 5327, left outer back contacts of relays 5617, 5615, 5613, 5609, and 5619, inner back contacts of relays 5602, 5601, and 5600, conductor 5611, left back contact of relay 5218, a left front contact of the operated units register relay 5219, right front contact of the operated units register relay 5216, right inner front contact of the operated units register relay 5217, conductor 5226, a front contact of relay 5428, to the armature of relay 5414. The test conductor 6121 of the desired line 6120 was previously traced to battery through the winding of relay 5414. Assuming that line 6120 is idle, that is, there is no ground on test conductor 6121, relay 5414 remains unoperated. The previously traced ground to the armature of relay 5414 therefore extends through the winding of line relay 5404 and through the windings of relays 5408 and 5409 to battery. Relays 5404 and 5408 both operate, but relay 5409, which is a trouble detecting relay having marginal characteristics, does not operate. The operation of relay 5404 transfers the test conductor of line 6120, previously traced to conductor 5714, from the winding of relay 5414 to a testing circuit which may be traced over the left inner front contact of relay 5404, conductor 5430, inner back contact of relay 5108, windings of polarized test relays 5109 and 5114 in series, to a potential supplied through resistance 5115 to battery in parallel with resistance 5116 to ground. This testing circuit performs two functions; it checks that the line called has a potential on its test conductor signifying that it is a regular and not an intercepted line whose test conductor is open, and also checks for a ground on the test conductor prior to the connection of ground to that conductor by the decoder marker in its regular function of making the called line busy, the former ground, if present, indicating that the called line has originated a call during the interval occurring after its original test for busy by relay 5414. Should this latter condition exist, polarized relay 5109 operates and causes the decoder marker to function in the same manner as if the line had originally tested busy as will be set forth later. Assuming that the called line 6120 is a regular line, a potential on its test conductor 6121 (the battery through the winding of the cut-off relay associated with that line) causes polarized test relay 5114 to operate and function in the manner described in the subsequent paragraphs.

Test of "A", "B" and "C" trunks

The aforementioned operation of line relay 5404 closes a circuit from ground over its left outer front contact, conductor 5010, to battery through the winding of relay 5008 which operates. Relay 5008 is associated with the even numbered lines of any group of twenty lines being tested as will be noted by the fact that conductor 5010, over which the relay operates, extends to the left outer armatures of line relays 5400, 5402, 5404, etc. Relay 5009 is associated with the odd numbered lines, its operating circuit extending to left armatures of relays 5401, 5403, 5405, etc. As hereinbefore set forth, relays 5000 to 5007 are pattern relays which, by their operation, determine the particular ten "A" trunks of a group of sixteen trunks which are to be used in the extension of the connection. Upon the operation of relay 5008 a circuit is completed from ground through the winding of relay 5000, a front contact of relay 5008, conductor 5011, a contact of the operated translator switch cross-point 5504, to the off-normal battery previously traced to conductor 5303, thereby operating relay 5000. The operation of relay 5000 closes the circuits from ten "A" trunk test conductors over the outer back contacts of relays 5110 to 5113, inclusive, to the left windings of ten three-winding channel testing relays of which four, relays 5120 to 5123, inclusive, are shown. The circuit for the test conductor of "A" trunk 5906 may be traced from its lowest conductor, over the inner front contact of relay 5907, conductor 5908, a contact of relay 5803, conductor 5809, a front contact of relay 5000, conductor 5012, outer back contact of relay 5113, left winding of relay 5123, and thence to the off-normal battery over conductor 5303. The test conductors of nine other "A" trunks extend over similar circuits to the left windings of the nine other channel testing relays such as 5120 to 5122, inclusive.

As set forth in the general description, there are a total of 240 "B" trunks extending from the secondary switches of a particular incoming frame to the primary switches of the various final frames. The test conductors of the particular ten "B" trunks which may be used to extend the connection to the final primary switches having ultimate access, through final secondary switches, to the desired called line 6120 are separated from the total of 240 test conductors and connected to the windings of the ten channel testing relays in the following manner. The 240 "B" trunks are divided into twenty-four groups of ten trunks each, each group consisting of one trunk taken from each of the ten successive portions of the secondary incoming switches of the frame as has previously been set forth. The incoming frame connector circuit, a portion of which is shown in Fig. 60, is provided with four multi-contact relays 6000 to 6003, inclusive, each of which is provided with six sets of contacts making a total of twenty-four sets of contacts for the four relays. Each of these aforementioned sets of contacts contains ten contacts, only four of which, however, are indicated. The test conductors of each group of

ten "B" trunks of the twenty-four groups are connected to one set of contacts of the relays **6000** to **6003**, inclusive. For the connection being described, relay **6000** operates in a circuit from battery through its winding, over conductor **6004**, a front contact of relay **5803**, conductor **5811**, a front contact of relay **5008**, conductor **5013**, upper contact of translator switch crosspoint **5504**, to the off-normal battery on conductor **5303**. By its operation relay **6000** closes test conductor **6005** of "B" trunk **5912** to the inner front contact of relay **6006**. In addition, the operation of relay **6000** also closes the test conductors of fifty-nine other "B" trunks to front contacts of relay **6006** and four other similar relays, one of which, relay **6007**, is shown. Under control of the translator switch crosspoint **5504** sixty of the 240 "B" trunks have been separated by the operation of one of the four relays **6000** to **6003**, inclusive. These sixty "B" trunks (six groups of ten trunks each) extend from the secondary incoming switch to primary switches on three different final frames, one group of trunks connecting to the odd and even sections of each of the three final primary switches. It is therefore necessary for the decoder marker to identify and separate the sixty "B" trunks not only as to which one of the three final frames they extend to, but also as to which portion, either odd or even, of the particular final primary switch having access to the secondary switch over which the called line may be reached. This is accomplished by the operated translator switch crosspoint in conjunction with the even or odd relay **5008** or **5009** which in turn was operated under control of the line relay associated with the line called. For the connection illustrated, the operated translator switch crosspoint **5504** closes a circuit from off-normal battery on conductor **5303**, next-to-upper contact of crosspoint **5504**, conductor **5508**, to battery through the winding of relay **5014**, which operates. The three relays **5014**, **5015**, and **5016** are identified with the three different final frames to which sixty "B" trunks connect and, operating under control of the translator switch crosspoints, identify which of the three final frames is the one having access to the called line. The even relay **5008** was previously operated by a ground over conductor **5010** supplied under control of the operated line relay **5404**. Upon the operation of relay **5014** the ground on conductor **5010** is extended over the inner front contact of relay **5014**, over conductor **5017**, a front contact of relay **5803**, conductor **5812**, to battery through the winding of relay **6006**. Relay **6006** operates and extends the ten "B" trunk test conductors previously traced to its armatures to the middle windings of the ten channel testing relays. The circuit for test conductor **6005** of "B" trunk **5912** may be traced over a front contact of relays **6000** and **6006**, conductor **6008**, a front contact of relay **5803**, conductor **5813**, a back contact of relay **5113**, middle winding of channel testing relay **5123**, to battery over conductor **5303**. The remaining nine "B" trunk test conductors extend over similar circuits to the middle windings of the other channel testing relays **5120** to **5122**, inclusive. The upper contact of each of the other sets of crosspoints of translator switch **5500** is cross-connected (connection not shown) to the winding of one of three relays **5014**, **5015**, or **5016** and the operation of one of these latter relays, in conjunction with the operation of either the even relay **5008** or the odd relay **5009**, as the case may be, determines the particular group of ten "B" trunks to be tested by controlling the closure of the "B" trunk test conductor circuits through the operation of one of the relays **6000** to **6003**, inclusive, and one of the relays **6006**, **6007**, etc. of the incoming frame connector circuit in the manner set forth above. Each "B" trunk test conductor also provides operating circuits for the hold magnets of the respective secondary incoming switch and final primary switch which it interconnects, as will be noted by the fact that test conductor **6005** of "B" trunk **5912** extends to the winding of hold magnet **5904** of that portion of the secondary incoming switch shown in Fig. 59 and also to the winding of hold magnet **6110** of that portion of the final primary switch shown in Fig. 61.

The test and control conductors of the proper ten "C" trunks which interconnect the final switches reached by the aforementioned "B" trunks to the secondary final switch containing the called line are separated and connected to the windings of the channel testing relays in the following manner: Upon the previous operation of line relay **5404** which is associated with the called line of the group of twenty lines being tested, a circuit is completed from ground over the right inner front contact of that relay, over conductor **5715**, a front contact of relay **5708**, conductor **6152**, to battery through the winding of relay **6128**. There are ten relays such as relay **6128**, two of which, relays **6128** and **6129**, are shown. Each of these relays is associated with the test conductors of the two groups of ten "C" trunks which extend from the primary final switches to the two sections, even and odd, of a particular secondary final switch. In addition, this aforementioned relay also controls the operating circuits of the final primary switch select magnets associated with those sets of crosspoint contacts from which these two groups of "C" trunks extend. Relay **6128**, in operating, closes test conductor **6131** of "C" trunk **6130**, over its next-to-inner front contact, to a front contact of relay **6125**. Nine other test conductors, one of which is partially indicated by conductor **6132**, which are associated with the other nine "C" trunks extending to the even section of the secondary final switch containing crosspoint **6117**, are also closed over additional front contacts of relay **6128** to front contacts of relay **6125**. In addition, the ten test conductors, two of which are partially indicated by conductors **6133** and **6134**, of the ten "C" trunks extending to the odd section of the same secondary final switch are also closed over front contacts of relay **6128** to front contacts of relay **6127**. The operation of relay **6128** also operates select magnet **6109** of the final primary switch on which crosspoint **6116** is located and, in addition, as indicated by multiple strap **6135**, operates the select magnets of the corresponding levels of the other primary final switches.

Since there are but ten channel testing relays and since only one group of "C" trunks extending to either the even or odd section of the secondary final switch is available for use in extending the connection, it is further necessary for the decoder marker to identify and separate the particular "C" trunk group which it will test. The final frame connector circuit is provided with two pairs of even and odd relays, relays **6124** and **6125** and relays **6126** and **6127** which are operated, in pairs, by the decoder marker. As set forth above, the test conductors of the ten "C" trunks extending to the even section of the secondary final switch containing crosspoint **6117**

have been connected, by the operation of relay 6128, to the front contacts of even relay 6125, while the test conductors of the "C" trunks extending to the odd section of the secondary final switch have been connected to front contacts of odd relay 6127. The previous operation of relay 6102, under control of translator switch crosspoint 5504, has connected the windings of the ten hold magnets located in the even section of the secondary final switch containing crosspoint 6117 to front contacts of the even hold magnet selecting relay 6124 and has connected the windings of the hold magnets located in the odd section of the switch to the front contacts of the odd hold magnet select relay 6126. The operation of relay 6128 closes a circuit from ground over its left front contact, conductor 6137, a front contact of relay 5708, conductor 5717, right outer front contact of relay 5404, conductor 5716, a front contact of relay 5708, conductor 6136, to battery through the windings of the even relays 6124 and 6125 in parallel, operating both relays. Relay 6124, in operating, extends the operating circuits for the ten hold magnets of the even section of the secondary final switch containing crosspoint 6117, over ten conductors such as 6138 and 6139, front contacts of relay 5708, conductors 5718 and 5719, to the left middle armatures of the twenty line relays, such as relays 5400, 5402, 5404, etc., each select magnet conductor extending to the armatures of two line relays. For example, conductor 5718, which extends the operating circuit from the winding of secondary final switch select magnet 6112, connects to the left middle armatures of both relays 5404 and 5405. Since line relay 5404 is operated, the circuit for select magnet 6112 further extends over the left middle front contact of relay 5404, over conductor 5418, to the outer front contact of relay 5117, the function of which latter relay will be set forth later. Relay 6125, in operating, extends the ten "C" trunk test conductors which include test conductor 6131 of trunk 6130, over ten conductors such as 6140 and 6141, front contacts of relay 5708, conductors 5720 and 5721, over left back contacts of relays 5110 to 5113 inclusive, to the right windings of the ten channel testing relays 5120 to 5123, inclusive, test conductor 6131 of trunk 6130 extending over conductor 5721 to the right winding of relay 5123, the other end of that winding connecting to off-normal battery over conductor 5303.

The test conductors of the ten "A", "B" and "C" trunks over which the connection may be extended from the incoming trunk shown in Fig. 45 to the called line 6120 have now been connected to the three windings of the ten channel testing relays. Upon the initial seizure of the decoder marker, the off-normal ground connected to conductor 5302 by the operation of start relay 5300 operates relay 5103 over back contacts of check relays 5102, 5124, and 5125. The operation of relay 5103 in turn connects ground to the right windings of the channel testing relays 5120 to 5123, inclusive, all of which operate to the off-normal battery on conductor 5303. After connections have been established between the final frame and the decoder marker, check relay 5102 operates as previously set forth, and opens one of the multiple operating circuits for relay 5103. When relay 5000 operates and connects the ten "A" trunk test conductors to the armatures of the ten trunk auxiliary relays 5110 to 5113, inclusive, it also returns a check ground over its upper front contact, conductor 5018, to battery through the winding of relay 5125. Relay 5125 operates and opens a second multiple operating circuit for relay 5103. When relay 6000 of the incoming frame connector circuit operates to close through the ten "B" trunk test conductors it also returns a check ground over its outer front contact, conductor 6009, contact of relay 5803, conductor 5814, to battery through the winding of check relay 5124. Relay 5124 operates and opens the last multiple operating circuit for relay 5103. Relay 5103 thereupon releases and opens the circuit through the right winding of each of the ten channel testing relays. Those channel testing relays whose associated "A", "B" and "C" trunks are idle thereupon release. A busy "A", "B" or "C" trunk will have its associated test conductor grounded over the contact of the operated hold magnet of the crosspoint from which this busy trunk extends and this ground in turn holds the channel testing relay to which it connects operated through one of the three windings of that relay. Any channel testing relay may remain operated over one, two or three windings depending upon the condition encountered on the trunks associated with it. An auxiliary trunk relay is associated with each channel testing relay. Four of these auxiliary relays, relays 5110 to 5113, inclusive, are shown, associated respectively with channel relays 5120 to 5123, inclusive. The winding of each of these auxiliary relays connects to the back contact of the associated channel testing relay. The armatures and front contacts of the channel testing relays are connected in a chain circuit in such a manner that only one auxiliary relay can operate at a time. For example, should all channel relays release upon the release of relay 5103, only auxiliary relay 5110 can operate since the circuits to the windings of the other auxiliary relays 5111 to 5113, inclusive, are open at the front contacts of relays 5120, 5121 and 5122, respectively.

Incoming and final switches operate

It will be assumed for the particular connection being described that all channels except that with which relay 5123 is associated are unavailable due to some "A", "B" or "C" trunk being in use on each of the other channels. Relays 5120, 5121, and 5122 therefore all remain operated, only relay 5123 releasing. Auxiliary trunk relay 5113 operates in a circuit from battery through its winding, back contact of relay 5123, front contacts of relays 5122, 5121, and 5120, back contacts of relays 5119 and 5103, front contact of relay 5102, to the off-normal ground on conductor 5302. Relay 5113, in operating, extends its operating ground, over its left inner front contact, to battery through the winding of end relay 5119. Relay 5119, operates and locks over its right front contact, back contact of relay 5103, front contact of relay 5102, to off-normal ground on conductor 5302 and thereby also locks relay 5113 operated. The back contact of relay 5119, which functions after the right front contacts of the relay have closed, opens the original operating circuit for relay 5113 and, since this circuit extends over the contacts of all of the channel testing relays, stabilizes the circuit and prevents the subsequent release of some operated channel relay from operating its associated auxiliary relay. Ground over the left front contact of relay 5119 operates the secondary final switch hold magnet 6111 in a circuit traceable over the right front contact of auxiliary

relay 5113, conductor 5712, a front contact of relay 5708, conductor 6118, inner front contact of relay 6101, to battery through the winding of magnet 6111. As indicated by multiple strap 6114, the corresponding select magnets of the other secondary final switches also operate over this same circuit. The operation of relay 5113 also closes circuits for operating the proper hold magnets to close the selected "A", "B" and "C" trunk channel. The circuit for hold magnet 5902 of the primary incoming switch has previously been traced to the left outer armature of auxiliary relay 5113 from which point it extends over the left outer front contact of that relay, inner back contacts of relay 5126, right outer back contact of relay 5108, front contact of relay 5114, conductor 5128, to ground over the front contact of relay 5408 which previously operated in series with line relay 5404. Select magnet 5901 of the primary incoming switch having previously operated, the operation of hold magnet 5902 causes crosspoint 5900 to close and extend the tip, ring and sleeve conductors 4508, 4509, and 4510 from the incoming trunk shown in Fig. 45 to the "A" trunk 5906. The operating circuit for hold magnet 5904 of the secondary incoming switch and hold magnet 6110 of the primary final switch is traceable from battery through the windings of these magnets in parallel, over conductor 6005, a front contact of relays 6000 and 6006, conductor 6008, a front contact of relay 5803, conductor 5813, next-to-outer left front contact of auxiliary trunk relay 5113, right inner back contacts of relay 5126, right outer back contact of relay 5108, front contact of relay 5114, conductor 5128, to ground over the front contact of relay 5408. Select magnet 5905 of the secondary incoming switch having previously operated, together with the corresponding select magnets of the other secondary incoming switches, the operation of hold magnet 5904 causes crosspoint 5903 to close and extend the connection over "A" trunk 5906 to "B" trunk 5912. Select magnet 6109 of the primary final switch having previously operated, together with the corresponding select magnets of the other primary final switches, the operation of hold magnet 6110 causes crosspoint 6116 to close and extend the connection from "B" trunk 5912 to "C" trunk 6130. The operating ground traced through the winding of hold magnet 6110 of the primary final switch extends over the lower contact of cross-point 6116, over conductor 6131, a front contact of relays 6128 and 6125, conductor 6141, a front contact of relay 5708, conductor 5721, next-to-inner left front contact of relay 5113, back contact of relay 5118, to battery through the winding of relay 5117. Relay 5117 operates, locking to the off-normal ground on conductor 5302 and operating relay 5118 which, in turn, opens the circuit to test conductor 6131 and thereby clears the "C" trunk 6130. The operation of relay 5117 closes a circuit from the winding of relay 5108 to the front contact of relay 5109 for a purpose which will subsequently be set forth. The operation of relay 5117 also completes the operating circuit for the secondary final switch hold magnet associated with that set of cross-point contacts to which the desired called line is connected. This circuit may be traced from ground over the front contact of relay 5408, conductor 5128, front contact of relay 5114, right outer back contact of relay 5108, right outer back contact of relay 5126, right outer front contact of relay 5117, conductor 5418, left middle front contact of line relay 5404, conductor 5718, a front contact of relay 5708, conductor 6138, outer front contacts of relays 6124 and 6102, to battery through the winding of secondary final switch hold magnet 6112. Select magnet 6111 having previously operated, together with the corresponding select magnets of the other secondary final switches, the operation of hold magnet 6112 causes cross-point 6117 to close its contacts and extend the connection from "C" trunk 6130 to the called line 6120. The operating ground for hold magnet 6112 extends over the lower front contact of that magnet over conductor 6121, a front contact of relay 6102, conductor 6123, a front contact of relay 5708, conductor 5714, left inner front contact of relay 5404, conductor 5430, right inner back contact of relay 5108, through the windings of polarized relays 5109 and 5114 in series to a potential supplied through resistances 5115 and 5116 in parallel to battery and ground. As previously stated, a regular line circuit has a potential connected to its sleeve conductor, such as conductor 6121. This battery is supplied through the winding of the cut-off relay associated with that line. This condition is illustrated in Fig. 14 in which battery is supplied through the winding of cut-off relay 1402 to a sleeve conductor 1455 which, together with the tip and ring conductors 1453 and 1454, extends to the cross-point contacts of some secondary final switch. Conductor 1455 corresponds to conductor 6121 of the called line 6120. This potential on the test or sleeve conductor 6121 originally operated relay 5114 as previously set forth. The connection of ground to conductor 6121 by the operation of hold magnet 6112 shunts out the potential on conductor 6121 and thereby reverses the flow of current through the windings of the polarized relays 5109 and 5114, causing relay 5109 to operate and relay 5114 to release. Relay 5108 thereupon operates from battery through its winding, over the right middle front contact of relay 5117, front contact of relay 5109, back contact of relay 5114, to a previously traced ground over conductor 5128.

Relay 5108, in operating, locks over its left front contact to the off-normal ground over conductor 5302 and, together with the release of relay 5114, removes the direct operating ground for hold magnets 5902, 5905, 6110, and 6112 (supplied over conductor 5128) and substitutes in its place a ground supplied through the left winding of polarized relay 5127. The right winding of relay 5127 is normally energized as soon as the decoder marker is seized and the operation of start relay 5300 connects off-normal ground to conductor 5302. The flux produced by this right winding is insufficient, however, to cause the contacts of the relay to operate. The left winding of relay 5127 is connected in such a manner that the flux which it produces, when energized by a current which flows through the windings of four hold magnets in parallel, aids that produced by the right winding of the relay sufficiently to cause the relay contacts to close. Should one of the "A", "B" or "C" trunks selected for this call become crossed with some other busy "A", "B" or "C" trunk the direct ground on the test conductor of any of these latter trunks would be connected to the test conductor of one of the former trunks (those now connected to ground through the left winding of relay 5127) and would shunt the left winding of relay 5127 and prevent the operation of that

relay. Under this condition no further progress is made by the decoder marker in completing the connection as set up and the decoder marker time alarm circuit eventually functions, as will be set forth later, and causes a second trial to be made. Assuming that "A" trunk **5906**, "B" trunk **5912** and "C" trunk **6130** are not crossed with some other "A", "B" or "C" trunk, relay **5127** operates and operates relay **5106** in a local circuit for the purpose of preparing a circuit for testing the continuity from the incoming trunk circuit to the called line through the incoming and final switches.

Relay **5106**, in operating, removes the ground over its right back contact and the front contact of relay **5105** from conductor **5107** which extends to battery through the winding of relay **4523** of the incoming trunk circuit over a previously traced circuit. Relay **4523** of the incoming trunk circuit thereupon releases and closes the tip and ring conductors **4508** and **4509** from the incoming trunk circuit to "A" trunk **5906** through cross-point **5900** of the primary incoming switch from which point these conductors extend to the tip and ring of the called line **6120** over "B" trunk **5912** and "C" trunk **6130**. In addition, the release of relay **4523** also removes the ground from conductors **4512** and **4513** and closes a circuit from ground over the lower outer front contact of relay **4506**, upper inner back contact of relay **4523**, conductor **4510**, lowest contact of cross-point **5900**, to lock the primary incoming switch hold magnet **5902** operated. This ground extends over the lowest conductors of trunks **5906**, **5912**, and **6130** to hold magnets **5904**, **6110**, and **6112** all of which it locks operated. This ground is further extended over the lowest contact of cross-point **6117**, test conductor **6121**, over a previously traced circuit to the right inner armature of relay **5108**. Relay **5126** operates in local circuit upon the operation of relay **5106** and opens the circuit from ground through the left winding of relay **5127** to the test conductors of the "A", "B" and "C" trunks thereby opening the original operating circuits for hold magnets **5902**, **5904**, **6110**, and **6112**, these magnets remaining locked as has just been set forth. Upon the operation of relay **5126** the ground just previously traced to the right inner armature of relay **5108** is extended over the left front contact of relay **5126**, back contact of relay **5129**, conductor **5130**, a front contact of relays **4805** and **4800** of the decoder marker connector circuit, conductor **4816**, to battery through the winding of release relay **4601** of the terminating sender, operating relay **4601**.

Release of terminating marker and sender

The operation of release relay **4601** of the terminating sender releases start relay **4600** and removes the battery from conductors **4631** and **4632** thereby releasing relays **4900** and **4800** of the decoder marker connector circuit. The release of relay **4600** removes the ground from conductor **4738** thereby releasing hold magnets **4726** to **4731**, inclusive, of the register switch **4708**, the release of these magnets in turn causing the various operated cross-points of that switch to restore to normal. The release of relay **4800** of the decoder marker connector opens all connections between the terminating sender and the decoder marker including conductor **4816** which provided the operating circuit for release relay **4601**. Relay **4601** temporarily locks over its upper front contact to ground over the upper middle front contact of relay **4603**. The release of relay **4600** also opens the locking circuit for relay **4603**. The release of relay **4603** opens the locking circuit for relays **4601**, **4629**, **4630**, and **4708**, and also for relays **4625**, **4635**, and **4636** if previously operated, all of which release. The release of relay **4603** also removes the ground from conductor **4313** towards the sender selector circuit thereby releasing hold magnets **4303** and **4305** of the primary and secondary sender link switches, respectively. Cross-points **4300** and **4301** of these latter switches thereupon release, opening sender link **4302** and restoring the sender selector circuit to normal. The release of relay **4601** again closes the circuit from battery over its upper outer back contact, upper inner back contact of relay **4600**, to conductor **4418** as an indication to the sender selector circuits that this sender is again idle, and also opens its portion of the sender group busy chain circuit extending over conductor **4602**. With the completion of these operations the terminating sender is restored to normal. The release of relay **4600** during the restoring of the terminating sender removes the battery, supplied over the lower back contact of relay **4611**, from conductor **4310**, thereby removing the short circuit on the winding of relay **4504** of the incoming trunk circuit to allow this latter relay to subsequently operate, in the manner which will be set forth later, when the called subscriber answers.

The aforementioned removal of battery from start conductor **4631** of the decoder marker connector circuit, in addition to releasing relay **4900**, also releases relays **4902** and **4907** of that circuit. Relay **4902**, in releasing, releases relays **4930** and **4931**, if operated. The release of relay **4907** releases relay **4805**. The release of relay **4805** opens the connections to the decoder marker shown in Figs. 50 to 56, inclusive, and releases relays **4941** and **4931**, if operated, thereby restoring the decoder marker connector circuit to normal. The release of relay **4805** removes the ground from the decoder marker start conductor **4914** to cause that circuit to release in the manner which will be described in later paragraphs.

At the time that relay **5114** operated to indicate that the calling line is a regular and not an intercepted line and is idle, it closed a circuit to operate a ringing control relay in the incoming trunk circuit shown in Fig. 45. This circuit may be traced from ground over the front contact of relay **5408**, which operated in series with line relay **5404**, over conductor **5128**, front contact of relay **5114**, conductor **5131**, upper outer back contact of relay **5317**, conductor **5328**, a front contact of relay **5803**, conductor **4511**, lower inner front contact of relay **4523** which has not yet released, to battery through the winding of ringing control relay **4524** of the incoming trunk circuit. Relay **4524** operates and locks over its lower inner front contact, back contact of ringing trip relay **4525**, to ground over the lower outer front contact of relay **4506**. The operation of relay **4524** closes circuits from a common source of ringing current, over conductors **4526** and **4527**, and over its upper front contacts to the two outer back contacts of the operated relay **4523**. After the decoder marker has checked the continuity of the connection from the incoming trunk to the called line it causes the terminating sender and sender selector circuits to release as set forth in the preceding paragraph. This opens all conductors between the incoming trunk and the de-

coder marker over the sender link including conductors 4515 and 4518. The opening of conductor 4515 removes the direct battery from the winding of relay 4504 and resistance 4528 to allow relay 4504 to operate upon the subsequent operation of relay 4529. The opening of conductor 4518 releases relay 4523. Relay 4523, in releasing, opens the operating circuit for relay 4524 which remains locked under control of relay 4525; removes ground from conductors 4512 and 4513; closes the holding ground for the incoming and final switch hold magnets over conductor 4510, its upper inner back contact and the lower outer front contact of relay 4506; and in addition, connects the ringing current previously traced to its upper outer back contacts to the tip and ring conductors 4508 and 4509 which extend over the incoming and final switches to the called line 6120. Condenser 4530 provides for feeding back a portion of the ringing current to the calling subscriber as an indication that the desired called subscriber's station is being rung. The removal of ground from conductor 4512 releases the select magnets of the primary incoming switches. The removal of ground from conductor 4513 releases the incoming frame relay 5907 which, in turn, releases the select magnets of the secondary incoming switches and also opens the test conductors of the sixteen "A" trunks which were connected to the decoder marker through the incoming frame connector circuit.

Called subscriber answers

When the called subscriber at station 6142 answers, the removal of the receiver from the switch-hook closes the loop extending from the incoming trunk over the called line. The ringing trip relay 4525 of the incoming trunk thereupon operates and opens the locking circuit for relay 4524. Relay 4524 releases, removing the ringing potential from the called station line and closing the called station loop, over conductors 4508 and 4509, to condensers 4531 and 4532 and to battery and ground through the windings of supervisory relay 4529 which supplies transmission battery for the called station. Relay 4529 operates over the called station loop and completes a circuit from ground over its right front contact, a back contact of relay 4534 which is a part of the timing circuit 4533 common to twenty incoming trunks, and over the upper inner back contact of relay 4523 to the sleeve or control conductor 4510. This ground supplements the ground supplied over the lower outer front contact of relay 4506 which is holding the hold magnets of the incoming and final switches operated. The function of this timing circuit and the ground supplied under its control will be set forth under the description of the disconnection of the subscribers. Relay 4504 operates in a circuit from battery through its winding, resistance 4528, lower inner front contact of relay 4506 to ground over the left front contact of relay 4529. The operation of relay 4504 reverses the polarity of the potential supplied, through the windings of relay 4505, to the tip and ring conductors of the incoming trunk 4501, the tip conductor 4502 now connecting to one side of transmission condenser 4532 and over an upper front contact of relay 4506 to ground through the right winding of relay 4505 while the ring conductor 4503 now connects to one side of transmission condenser 4531 and over an upper front contact of relay 4506 to battery through the left winding of relay 4505. This reversal of battery over the incoming trunk in response to the answer of the called station causes the district trunk circuit in the originating office to function as set forth below.

Returning now to the district trunk circuit shown in Fig. 17, the originating sender, after setting up the outgoing connection, connected a direct ground to conductor 1703 of the district trunk circuit in the manner previously set forth. This circuit may be traced from ground at the upper contact of relay 2211, closed contact of relay 2209, lower back contact of relay 2230, thence over contact of relays 2321 and 2323, conductor 1826, thence to conductor 1703. Marginal relay 1707, the circuit for which extends from battery through its winding, over the upper inner front contact of relay 1711, and lower outer front contact of relay 1718, operated to this direct ground on conductor 1703, which excludes the resistance 2290, and locked in a circuit over the lower outer back contact of relay 1719 to ground over its own lower middle front contact. The operation of relay 1707 closed the tip and ring conductors 1434 and 1435 from the secondary line switch, over its upper inner front contacts and the upper inner back contacts of relay 1719, to condensers 1724 and 1725 and to ground and battery through the right and left windings of the called supervisory relay 1726, respectively; closed the tip and ring conductors 1722 and 1723 of the "A" trunk over its upper outer front contacts and over the upper outer back contacts of relay 1719 to the winding of the calling supervisory relay 1727 in series with retardation coil 1728; grounded the sleeve conductor 1721 of the "A" trunk in a circuit traceable from that conductor, upper back contact of relay 1712, lower inner front contact of relay 1707, to ground over the lower middle back contact of relay 1719; connected ground over its lower middle front contact to the lower inner armature of relay 1719 to provide for locking this latter relay upon its subsequent operation; and also connected ground over its lower outer front contact to the inner armature of relay 1720 to hold that relay operated.

When the originating sender completed its functions and released, as previously described, it removed the ground from conductor 1703 thereby releasing relays 1711 and 1718. The release of relay 1718 closed a circuit from ground to the contact of relay 1726, but since relay 1726 is operated over the calling station loop, this circuit is ineffective. Its function will be described later under the details of the disconnection of the subscribers. The release of relay 1711 closed a circuit from ground over its inner back contact to the armature of the calling supervisory relay 1727. Relay 1727 is a polarized relay and its winding is so connected that the relay does not operate on the polarity of the potential which it originally encountered in the incoming trunk circuit at the terminating office. When the called subscriber answers however, the incoming trunk circuit causes a reversal of polarity of the battery over the incoming trunk, as hereinbefore set forth, and the supervisory relay 1727 of the district trunk thereupon operates. The operation of relay 1727 connects the ground previously traced to its armature, over its front contact and the lower back contact of relay 1709, to the armatures of interrupters 1729 and 1730 which control the charging operations of the district trunk circuit. Upon the closure of the contacts of interrupter 1729, relay 1710 operates through its lower winding and locks over its lower front contact under control of the operated relay 1727.

Interrupter 1730 closes its contacts after interrupter 1729 has functioned and completes a circuit from ground previously traced to its armature, over the upper front contact of relay 1710, to battery through the winding of charge relay 1709. Relay 1709 operates and locks jointly over its lower inner front contact to ground over the lower outer front contact of relay 1707 and over its lower middle front contact to ground previously traced to the armature of relay 1727. Relay 1709, in operating, releases relay 1710; closes a circuit from the back contact of relay 1727, over its upper middle front contact to conductor 1731 which extends to a common time alarm circuit (not shown) which functions as will later be set forth under the description of the disconnection of the subscribers; connects a ground over its lower outer front contact to sleeve conductors 1436 and 1721 to hold the holding magnets of the line, district and office switches; and closes, in part, the message register circuit which may be traced from ground through the winding of message register 1408 associated with the line circuit of the calling station 1400, a contact of cross-points 1407 and 1410 of the primary and secondary line switches, conductor 1437, upper inner front contact of relay 1709, upper outer front contact of relay 1720, to the lower outer front contact of the as yet unoperated message register relay 1706.

The calling and called subscribers are now in communication over the completed connection which may be traced as follows: From the calling station 1400, tip and ring line conductors 1403 and 1404, two upper contacts of cross-point 1407 of the primary line switch, two upper conductors of line link 1409, two upper contacts of crosspoint 1410 of the secondary line switch, conductors 1434 and 1435, two upper inner front contacts of relay 1707, two upper inner back contacts of relay 1719, to transmission condensers 1724 and 1725 and to ground and battery supplied through the windings of relay 1726. From the other side of condensers 1724 and 1725 the transmission circuit extends over two upper back contacts of relay 1719, two upper front contacts of relay 1707, conductors 1722 and 1723, two upper contacts of primary district switch crosspoint 2004, two upper conductors of "A" trunk 2010, two upper contacts of crosspoint 2007 of the secondary district switch, two upper conductors of "B" trunk 2013, two upper contacts of crosspoint 4107 of the primary office switch, two upper conductors of "C" trunk 4113, two upper contacts of crosspoint 4110 of the secondary office switch, tip and ring conductors 4135 and 4136 of outgoing trunk 4114, through the intermediate office selector 4500, over the incoming trunk conductors 4502 and 4503, front contacts of relays 4504 and 4506, to transmission condensers 4532 and 4531 and to battery and ground through the windings of relay 4505. From the other side of condensers 4531 and 4532, which also connect to ground and battery through the windings of relay 4529, over upper back contacts of relays 4524 and 4523, conductors 4508 and 4509, two contacts of crosspoint 5900 of the primary incoming switch, upper conductors of "A" trunk 5906, upper contacts of crosspoint 5903 of the secondary incoming switch, upper conductors of "B" trunk 5912, upper contacts of crosspoint 6116 of the primary final switch, upper conductors of "C" trunk 6130, upper contacts of crosspoint 6117 of the secondary final switch, and over the called line 6120 to the called station 6142.

Subscriber release

At the termination of the conversation the replacing of the receiver on the switch-hook at the calling station 1400 opens the calling station loop extending to the windings of relay 1726 of the district trunk shown in Fig. 17. Relay 1726 releases and extends the ground previously traced to its back contact to the armature of interrupter 1732. When interrupter 1732 closes its contacts, the message register relay 1706 operates through its lower winding and locks over its lower inner front contact to the ground over the back contact of relay 1726. Relay 1706, in operating, grounds the armature of interrupter 1733; supplies a supplementary locking ground for relays 1709 and 1720 to hold these relays operated upon the subsequent release of relay 1707; and extends the message register conductor 1437, previously traced to its lower outer front contact, to the lower outer back contact of operated relay 1707. When interrupter 1733 closes its contacts it locks relay 1706 through the upper winding of that relay and this locking ground further extends, over the upper front contact of relay 1706, to battery through the winding of relay 1719. Relay 1719 operates and opens the bridge consisting of relay 1727 and retardation coil 1728 from across the tip and ring conductors 1722 and 1723 extending toward the terminating office thereby releasing relay 1727 and causing the incoming trunk circuit in the terminating office to function as will be set forth in subsequent paragraphs. The operation of relay 1719 also opens the locking circuit through the lower winding of relay 1706 which holds through its upper winding, as set forth above, and, in addition, opens the locking circuit for relay 1707. Relay 1707 releases and completes the message register operating circuit. This circuit may be traced from battery, through resistance 1708, lower outer back contact of relay 1707, lower outer front contact of relay 1706, upper outer front contact of relay 1720, upper inner front contact of charge relay 1709, conductor 1437, and over a previously traced circuit to ground through the winding of message register 1408 which is associated with the calling station 1400. Message register 1408 operates and records a completed call. When interrupter 1733 again opens its contacts, relay 1706 releases. The release of relay 1706 releases relays 1709 and 1720. The release of relay 1709 removes the ground from control conductors 1436 and 1721. The removal of ground from conductor 1436 releases hold magnets 1415 and 1433 of the primary and secondary line switches which causes crosspoints 1407 and 1410 of those switches to restore to normal. The removal of ground from conductor 1721 releases hold magnets 2006 and 2009 of the primary and secondary district switches, and hold magnets 4109 and 4112 of the primary and secondary office switches. The release of magnets 2006 and 2009 restores crosspoints 2004 and 2007, respectively, of the district switches, while the release of magnets 4109 and 4112 restores crosspoints 4107 and 4110, respectively, of the office switches thereby restoring that portion of these circuits, which was used for the connection described, to normal. The release of relay 1706 also completes the circuit from battery through resistance 1708, lower outer back contact of relay 1707, its lower inner back contact, contacts of jack 1705, to conductor 1704

which extends to the associated sender selector circuit. This battery again indicates to the sender selector circuit that the district trunk shown in Fig. 17 is normal and available for use on another connection.

In the event that the called subscriber disconnects, but the calling subscriber fails to do so, an alarm indication is given in the following manner: When the called subscriber disconnects, the incoming trunk circuit at the terminating office functions as will be set forth later and reverses the polarity of the potential over the trunk to the originating office. Polarized relay 1727 of the district trunk releases on this reversal of polarity and completes a circuit from ground over the inner back contact of relay 1711, back contact of relay 1727, over the upper outer front contact of the operated relay 1709, and over conductor 1731 to a time alarm circuit (not shown) which functions, after an interval, and gives an alarm indication of the failure of the calling subscriber to disconnect at the termination of the conversation.

On calls to an operator, the line, sender selector, originating sender, originating decoder marker connector, originating decoder marker, and district and office frame circuits function in a manner similar to that hereinbefore set forth except that the decoder marker, from the information it receives from the sender regarding the number dialed by the calling subscriber, routes the connection to an operator's trunk instead of to an outgoing trunk. In addition, the decoder marker connects ground to conductor 1717 instead of 1715 of the district trunk. Under this condition, relay 1719 operates to the ground over conductor 1717 and locks to ground over the lower inner front contact of relay 1718, this latter relay, together with relay 1712, having operated in the same manner as on a regular through connection. The operation of relay 1719 opens the bridge of relay 1727 and retardation coil 1728 from across the operator's trunk and relay 1727 therefore does not operate. With relay 1727 unoperated, the circuit to the armature of charge interrupters 1729 and 1730 is open and the charging feature is therefore inoperative. The operation of relay 1719 also opens the circuit to the armature of the disconnect interrupter 1732 thereby making the disconnect feature ineffective.

Returning now to the incoming trunk circuit shown in Fig. 45, the replacing of the receiver on the switchook at the called station 6142 opens the circuit through the windings of the called supervisory relay 4529 which releases. The release of relay 4529 removes one of the grounds from conductor 4510 over which the incoming and final switches are being held, and also releases relay 4504. The release of relay 4504 reverses the polarity of the potential supplied over the incoming trunk and causes the release of supervisory relay 1727 of the district trunk circuit in the originating office, as hereinbefore set forth, if this latter relay has not already released in response to the disconnection of the calling subscriber. Assuming that the calling subscriber has disconnected, the district trunk has opened the bridge across the outgoing trunk, as previously stated, and relay 4505 of the incoming trunk circuit thereupon releases. The release of relay 4505 opens the locking circuit for relay 4506 which releases. The release of relay 4506 again connects ground and battery, in parallel with ground and battery through the windings of relay 4505, to the tip and ring conductors 4502 and 4503 of incoming trunk 4501, and removes the ground from the sleeve or control conductor 4510. The removal of ground from conductor 4510 releases hold magnets 5902 and 5904 of the primary and secondary incoming switches, respectively, and also hold magnets 6110 and 6112 of the primary and secondary final switches, respectively. The release of hold magnets 5902 and 5904 cause the associated crosspoints 5900 and 5903 to release, thereby opening the "A" trunk 5906 and the "B" trunk 5912 and restoring that portion of the incoming switches used for this connection to normal. The release of hold magnets 6110 and 6112 causes the associated crosspoints 6116 and 6117 to release, thereby opening the "C" trunk 6130 and the connection to the called line 6120, thus restoring that portion of the final switches used for this connection to normal.

Should the called subscriber fail to disconnect at the termination of the call, relay 4529 remains operated over the called station loop. The disconnection of the calling subscriber causes the district trunk circuit to function, as hereinbefore set forth, and opens the bridge across the incoming trunk 4501. Relay 4505 thereupon releases and opens the locking circuit for relay 4506 which also releases. A circuit is thereupon completed from ground over the left front contact of the operated relay 4529, lower back contact of relay 4506, conductor 4535, through the winding of relay 4537 of the timing circuit 4533, to the left contact of interrupter 4538. The release of relay 4506 also opens one of the grounds from conductor 4510, the incoming and final switch hold magnets remaining operated to the ground over the right front contact of relay 4529 under control of the outer back contact of relay 4534 of the timing circuit. The first closure of the left contact of interrupter 4538 operates relay 4537 which locks to battery over its inner front contact and connects the right contact of interrupter 4538 to the winding of relay 4534. After a predetermined interval, interrupter 4538 opens its left contact and closes its right contact thereby operating relay 4534. The operation of relay 4534 opens the ground from conductor 4510 and the operated hold magnets of the primary and secondary incoming and final switches thereupon release and restore the associated crosspoints to normal. Relay 4529 releases upon the opening of conductors 4508 and 4509 thereby releasing relay 4537 of the timing circuit and restoring the incoming trunk circuit to normal. As indicated by multiple strap 4536, the timing circuit 4533 is common to a number of incoming trunk circuits, relay 4534 being provided with as many sets of back contacts as there are incoming trunks which are served by the timing circuit. Should the incoming trunk be reseized before relay 4534 has had time to function and open the ground from the control conductor 4510, the incoming trunk, sender selector and terminating sender circuit function in the manner previously described, registering the desired number and signaling the originating sender to close through the connection to the incoming trunk circuit. The incoming trunk circuit thereupon signals the terminating sender, in the regular manner, that trunk closure has taken place and the terminating sender closes a ground to conductor 4518 of the incoming trunk circuit as hereinbefore set forth. This ground on conductor 4518 operates relay 4523 of the incoming trunk circuit which opens

the ground from conductor 4510 and causes the release of the incoming and final switch hold magnets in the same manner as the operation of the timing circuit relay 4534 did. From this point on the second incoming call proceeds as previously set forth for the connection described.

Called line found busy

In the foregoing description of the completion of the connection to the called subscriber at station 6142 it was assumed that the called line 6120 was idle and the connection was completed accordingly. Had the line been busy or had the called subscriber initiated a call following the initial test of his line by the terminating decoder marker this latter circuit would perform certain functions which will subsequently be set forth. It was further assumed that the desired line 6120 was an individual line and not one of a group of P. B. X. lines. The operation of the terminating decoder marker in connection with the establishment of a connection to a line of a P. B. X. group may entail several additional operations depending upon the size of the P. B. X. group and also upon the conditions encountered on the lines contained therein. These additional operations will be described hereinafter. In addition to the foregoing assumptions it was further assumed that the terminating decoder marker encountered an idle "A", "B" and "C" trunk channel between the incoming trunk circuit and secondary final frame having access to the called line. It is possible, however, for the terminating decoder marker to find all suitable channels unavailable, in which case the connection is routed to an overflow trunk in the manner set forth in subsequent paragraphs.

Let it now be assumed that the called line 6120 is busy at the time that the terminating decoder marker makes its initial test of this line by completing the circuit from battery through the winding of line test relay 5414 to the sleeve or test conductor 6121 of the line over a circuit which has previously been traced. Conductor 6121 has ground connected to it over the lower contact of some operated secondary final switch crosspoint which has closed to complete the connection which makes line 6120 busy. The line test relay 5414 therefore operates and completes a circuit from the previously traced ground on its armature (the ground which operated relay 5404 in the case where line 6120 was idle as previously described) and over its front contact, back contact of relay 5424, conductor 5431, to battery through the winding of busy relay 5602. Relay 5602 operates and locks over its lower inner front contact to the off-normal ground on conductor 5302. The operation of relay 5602 causes the call to be routed to one of a group of trunks for busy lines by performing functions hereinafter described. The operation of relay 5602 opens the locking circuit for hold magnet 5503 of the translator switch 5500 thereby causing that hold magnet to release and in turn restore crosspoint 5504 of the translator switch. The restoring of crosspoint 5504 opens all conductors extending from the contacts of that crosspoint including conductors 5506 and 5507. The opening of conductors 5506 and 5507 releases final frame relays 5700 and 5701 which, in turn, release final frame connector relay 5708. The release of relay 5708 opens all connections between the decoder marker and the final frame and also removes the ground from conductor 5709 thereby releasing check relay 5316 of the decoder marker. The release of relay 5316 opens the operating circuit for relay 5800 of the incoming frame connector circuit. Relay 5800 releases in turn releasing connector relay 5803 which opens the connections between the incoming trunk frame and the decoder marker. The incoming frame connector circuit is released at this point to prevent the occurrence of a tie-up which would prevent another decoder marker, already connected to the same final frame previously connected to by the first marker, from establishing connections to this same desired incoming frame. For this reason the definite sequence of first seizing a final frame and subsequently seizing or reseizing an incoming frame is always followed.

The aforementioned operation of busy relay 5602 also closes the start conductors to the final frame over which the busy line trunks may be reached and closes circuits similar to those closed by cross-point 5504 of the translator switch, for the purpose of establishing a connection between the incoming trunk circuit and the busy line trunk. The start circuit for the final frame connector circuit may be traced from battery through the windings of the marginal trouble detecting relays 5604 and 5605 over two upper front contacts of relay 5602, to conductors 5620 and 5621, corresponding to start conductors 5507 and 5506 of the final frame connector circuit shown in Fig. 57, and which cause the final frame containing the busy line trunks to be connected to the decoder marker in the same manner as that described when conductors 5506 and 5507 were closed by the operation of the translator switch cross-point 5504. The contacts of relay 5602 which close the partially indicated conductors 5620 to 5625, inclusive, perform functions identical with those performed by the six contacts of the translator switch cross-points such as cross-point 5504. Conductors 5620, 5621, and 5622, which correspond to conductors 5506, 5507, and 5505 extending from cross-point 5504, close similar circuits (not shown) for establishing connections between the final frame and the decoder marker and for connecting the proper group of twenty lines to the twenty line relays 5400 to 5407, inclusive. Conductors 5623, 5624, and 5625, which correspond to conductors 5013, 5011, and 5008 of cross-point 5504, close similar circuits (not shown) for establishing connections between the incoming frame and the decoder marker and for selecting the proper groups of "A" and "B" trunks. The test conductors of the "A", "B" and "C" trunks are connected to the windings of the channel testing relays 5120 to 5123, inclusive, in the manner hereinbefore set forth and the decoder marker proceeds with its functions as previously described in connection with the call to line 6120. By the opening of its lower next-to-inner back contact, relay 5602 opens the previously traced circuit over which ground was connected to the armature of relay 5414 which is associated with the operated line relay 5404. The operation of relay 5602 also operates relay 5317 in a circuit from battery through the winding of relay 5317, over conductor 5330, to ground over the upper inner front contact of relay 5602. The operation of relay 5317 opens conductor 5328 thereby opening the circuit over which the ringing control relay of the incoming trunk circuit would normally operate, and opens conductor 5322 over which relay 5608 of the P. B. X. progress circuit originally operated. A circuit is also completed, by the operation of relay 5602, from ground over the right back contact of relay 5321, over conduc-

tor **5329**, lower outer front contact of relay **5602**, conductor **5626** which extends to one of the terminals of the connecting block **5627**, over the right back contact of one of the relays **5609**, **5613**, **5615**, **5617** or **5619**, to battery through the winding of one of the P. B. X. progress relays **5608**, **5612**, **5614**, **5616**, or **5618** which operates and performs functions, in connection with the operation of the proper twenty-line final connector circuit relay, such as relay **6102**, for connecting the group of lines containing the busy line trunks to the decoder marker, similar to the functions previously performed by relay **5608**. The operation of relay **5602** also completes a circuit to supply ground to the armature of one of the line testing relays **5410** to **5417**, inclusive, which is associated with the line relay, one of the relays **5400** to **5407**, inclusive, which corresponds to the number assigned to the first line busy trunk of the group. This circuit may be traced from ground over the front contact of relay **5325** (which reoperated in series with a relay such as relay **6102** or **6103** upon the reestablishment of connections between the decoder marker and the final frame), over conductor **5327**, left outer back contacts of relays **5617**, **5615**, **5613**, **5609** and **5619**, lower next-to-inner front contact of relay **5602**, partially indicated conductor **5628** which is cross-connected (connection not shown) to one of the terminals of connecting block **5432**, to the armature of the proper relay **5410** to **5417**, inclusive. From this point on the connection is completed to an idle busy line trunk in the same manner as previously described for the completion of the connection to the called line **6120**. The busy line trunk (not shown) is arranged to connect a distinctive audible signal back over the entire connection. This audible indication is transmitted to the calling subscriber as a signal that the called line is busy. Busy line trunks are provided in groups which may vary in size depending upon traffic conditions. The decoder marker, in attempting to establish a connection to a busy line trunk, may find any number of these trunks busy, in which case it will consecutively test the lines until an idle one is found in the same manner as it does when testing for an idle line of a P. B. X. group, which latter operation is set forth in the subsequent paragraphs.

P. B. X. testing

Referring now to Fig. 61 it will be noted that each of the twenty-line group selecting relays, such as relays **6102**, **6103**, **6106** and **6107**, in addition to having one pair of contacts for closing the circuits from the test conductor and the associated secondary final switch hold magnet winding for each of the twenty lines which it is associated with, is also provided with an additional front contact for each of the twenty lines. These additional front contacts are connected, by means of multiple straps such as **6143** to **6146**, inclusive, to the test conductors of their associated lines if these lines represent first or intermediate lines of a P. B. X. group. Where the line is the last line of a P. B. X. group this multiple strap is omitted as is also the case of an individual line such as line **6120** was assumed to be in the foregoing description. These additional front contacts, if strapped, extend the test conductors of the associated lines over the final frame connector relay contacts to the windings of the auxiliary line test relays **5420** to **5427**, inclusive, of the decoder marker. For example, assuming now that line **6120** is the first line of a P. B. X. group, test conductor **6121**, in addition to extending to the winding of line test relay **5414** over a previously traced circuit, also extends over multiple strap **6143**, a front contact of relay **6102**, conductor **6147**, a front contact of relay **5708**, conductor **5722**, to the winding of the auxiliary line test relay **5424**. Should line **6120** be busy when tested by the decoder marker, the ground on its test conductor **6121** therefore operates not only line test relay **5414**, but also the auxiliary relay **5424**. The operation of relay **5414** opens the circuit to the winding of line relay **5404** while the operation of relay **5424** transfers the front contact of line test relay **5414** to the armature of the line test relay **5415** which is associated with the next line of the P. B. X. group. Should this next line of the P. B. X. group also be busy at this time its associated line test and auxiliary relays **5415** and **5425** are also operated and further transfer the circuit from the armature of relay **5414** to the armature of the next line test relay **5416**. The first unoperated line test relay encountered, signifying that its associated line is idle, completes the circuit for operating its associated line relay, such as relay **5406**, for example. From this point on the connection is completed in the manner identical with that hereinbefore set forth from the point of the operation of line relay **5404** in connection with the individual line **6120** except that the proper final switch magnet operates to close through the connection to the first idle P. B. X. line encountered in the group which the called number represents. As stated above, the last line of a P. B. X. group is not connected to the winding of its auxiliary line test relay and, in the event that this last line is also busy, the decoder marker functions to route the call to a busy line trunk in the same manner as it does when it encounters a busy individual line as has previously been described. The groups of busy line trunks are treated in the same manner as a group of P. B. X. lines, the decoder marker functioning to select the first idle busy line trunk in the manner identical with its operation in selecting the first idle line of a P. B. X. group.

As has hereinbefore been set forth, the decoder marker is provided with twenty line, line test and auxiliary line test, relays and is therefore capable of testing but twenty lines at a time. Due to the size of a P. B. X. group or due to the location of its lines it may be necessary to test several twenty-line groups before the first idle line is encountered. For this purpose the decoder marker is provided with a P. B. X. progress circuit consisting of relays **5608**, **5609**, and **5612** to **5619**, inclusive, of Fig. 56. In the manner previously described, the operations in the selection of the particular called line are as follows: The operation of one of ten relays **6101** and **6108** under control of a translator switch cross-point identifies that group of two hundred lines containing the called line and closes circuits from the windings of the ten twenty-line selecting relays associated with that group of lines to the left front contacts of the P. B. X. progress relays **5608**, **5612**, **5614**, **5616**, and **5618**. One of these latter relays operates under control of the tens register relays **5212** to **5215**, inclusive, and closes circuits from the windings of two twenty-line selecting relays of the selected two hundred-line group to the contacts of the hundreds register relays **5208** to **5211**, inclusive. The proper twenty-line selecting relay (relay **6102** in the case of the connection previously described) thereupon operates depending upon which of the hundreds register relays are

operated. The operation of this twenty-line selecting relay identifies the proper group of lines of the particular two hundred-line group and connects the test conductors of this group of lines to the windings of the twenty line testing relays of the decoder marker. On the previously described call to line 6120, which represents the number 3168, it will be remembered that P. B. X. counting relay 5608 operated identifying the 160 to 179 group of a two hundred-line group. Relay 6102 subsequently operated and connected the test conductors of the lines representing the numbers 3160 to 3179 to the windings of the line test relays. Assume now that the called line number 3168 represents the first line of a P. B. X. group containing, say, for example, twenty lines. These twenty lines then are actually the final numerical lines 3168 to 3187, inclusive, although they are all designated by the P. B. X. number 3168. It is obvious, therefore, that the operation of the twenty-line relay 6102 only connects a portion of this P. B. X. group, the lines representing the actual numbers 3168 to 3179, to the line testing relays. Should the lines 3168 to 3179, inclusive, all test busy on a call to the P. B. X. number 3168, it is therefore necessary for the decoder marker to transfer its testing operations to the next consecutively numbered group of lines, that group containing lines 3180 to 3199, inclusive, to determine if any of the remaining lines 3180 to 3187, inclusive, of the desired P. B. X. group are idle. This is accomplished in the manner set forth below.

Since it is assumed that the lines representing the final numbers 3168 to 3179, inclusive, are all busy, their associated line test and auxiliary line test relays 5414 to 5417, inclusive, and 5424 to 5427, inclusive, all operate from the ground over the test conductors of the busy lines. A circuit is thereupon completed from ground over the front contact of relay 5325, conductor 5327, left outer back contacts of relays 5617, 5615, 5613, 5609, and 5619, a lower back contact of relays 5602, 5601, and 5600, conductor 5611, left back contact of relay 5218, a left front contact of relay 5219, right front contact of relay 5216, right inner front contact of relay 5217, conductor 5226, a front contact of relay 5428 which previously operated under control of the operated tens register relays 5212 and 5215, over front contacts of relays 5414, and 5424, 5415 and 5425, 5416 and 5426, and 5417 and 5427, over conductor 5433, to battery through the winding of relay 5321. Relay 5321 operates and opens conductor 5322 thereby opening the previously traced operating circuit for relay 5608 of the P. B. X. progress circuit. Relay 5609 thereupon operates in series with relay 5608, both relays locking. This operating and locking circuit may be traced from battery, through the winding of relay 5608, winding of relay 5609, right front contact of relay 5608, lower inner back contacts of relays 5600, 5601 and 5602, to the off-normal ground on conductor 5302. The operation of relay 5609 opens the circuit over conductor 5610 thereby releasing the twenty-line final connecting relay 6102 the contacts of which had connected the line representing the numbers 3160 to 3179, inclusive, to the decoder marker. The operated line test and auxiliary line test relays 5414 and 5417, inclusive and 5424 to 5427, inclusive, thereupon release and open the operating circuit for relay 5321. The release of relay 5321 again closes the original operating circuit for relay 5608, but, since both relays 5608 and 5609 are operated, the operating ground extends over the right front contact of relay 5609, and over the right back contact of relay 5619, to battery through the winding of the next P. B. X. progress relay 5618. Relay 5618 operates and closes a circuit for operating the twenty-line final connecting relay associated with the next consecutively numbered group of lines, the lines representing the numbers 3180 to 3199 which include the remaining lines 3180 to 3187, inclusive, of the assumed P. B. X. group. This operating circuit may be traced from ground through the right winding of relay 5325, conductor 5326, left middle back contact of relay 5211, left next-to-outer front contact of the operated hundreds register relay 5208, conductor 5224, left middle back contact of relay 5619, left outer front contact of relay 5618, conductor 5630, a front contact of relay 5708, conductor 6105, a left front contact of relay 6101, to battery through the winding of relay 6103. Relay 6103 operates and closes circuits from the test conductors of these aforementioned lines and from the windings of the secondary final switch hold magnets associated therewith to the decoder marker in the same manner as relay 6102 did for the lines representing the final numbers 3160 to 3179, inclusive. These test conductor and hold magnet operating circuits are not fully shown, being indicated by the partially shown conductors 6148 to 6151, inclusive. The test conductors of these latter twenty lines are thereby connected to the windings of the twenty line test relays and the functioning of the circuit in the selection of an idle line proceeds in the manner hereinbefore set forth. Should all lines of the P. B. X. group test busy, the busy relay 5602 operates as set forth in the instance where the individual line 6120 was busy, since the multiple strap at the twenty-line final connecting relay is omitted on the last line of a P. B. X. group just as though this last line were an individual line. The operation of relay 5602 causes the terminating decoder marker to route the call to one of a group of busy line trunks as previously set forth. A group of busy line trunks is treated in the same manner as a group of P. B. X. lines, the P. B. X. progress circuit of the decoder marker transferring its testing operations from one group to the succeeding group, if the busy line trunk group exceeds twenty lines, or if its trunks are so located that they extend into several twenty-line groups, in the manner identical to that set forth above.

All "A", "B", "C" channels in terminating office busy

In the foregoing description of the completed connection to the called station 6142 it was assumed that the terminating decoder marker encountered an idle "A", "B" and "C" trunk channel between the incoming trunk circuit and the secondary final switch having access to line 6120. Channel testing relay 5123 remained unoperated and provided an operating circuit for auxiliary trunk relay 5113 and end relay 5119 both of which operated, stabilizing the channel selecting circuit and preparing operating circuits for the hold magnets associated with the "A", "B" and "C" trunks of the selected channel. Assume now, however, that none of the channels are available, all of the channel testing relays 5120 to 5123, inclusive, remaining operated through one or more of their windings under control of ground supplied over the test conductors of the "A", "B" or "C" trunks with which these relays are associated at the time. Under this condi-

tion a circuit is completed from battery through the winding of relay **5132**, front contacts of relays **5123**, **5122**, **5121**, and **5120**, back contacts of relays **5119** and **5103**, front contact of relay **5102**, to the off-normal ground on conductor **5302**. Relay **5132** operates and closes a circuit from ground over its front contact, conductor **5133**, to battery through the winding of the overflow relay **5601** which operates. The contacts of relay **5601** are connected to points similar to those connected to by the corresponding contacts of busy relay **5602** and close circuits which perform similar functions except that, in this instance, the call is routed to one of a group of overflow trunks instead of to one of a group of busy line trunks as was the case where relay **5602** operated. The circuits extending from the contacts of relay **5601** are not shown since the manner of their connection will be obvious from the preceding description of the operation performed by relay **5602** in connection with the disposition of a call encountering a busy line. The overflow trunk (not shown) to which the call is routed when no available trunk channel is found is arranged to supply a distinctive audible signal which extends back over the entire connection and is an indication to the calling subscriber that the call is not completed and that it is necessary to institute a second call in attempting to reach the desired called station.

At the time that the terminating decoder marker makes its second test of the called line to determine if a call has been initiated over this line since its initial test by the decoder marker, it also tests the called line to determine whether it is a regular or an intercepted line. As hereinbefore set forth, these testing operations are performed by the polarized relays **5109** and **5114**, relay **5109** operating and relay **5114** releasing, in the event that a call has been initiated over the called line since its initial test, and operating busy relay **5602** over conductor **5431** from the previously traced ground on conductor **5128** thereby causing the connection to be routed to a busy line trunk in the manner previously set forth. In the event that the line is idle but is also an intercepted line, there is neither ground nor battery on its test conductor and therefore both relays **5109** and **5114** remain unoperated. Under this condition a circuit is completed from ground over the front contact of relay **5408** (which operated in series with one of the line relays **5400** to **5407**, inclusive), over conductor **5128**, back contacts of relays **5114** and **5109**, conductor **5134**, to battery through the winding of the intercepting relay **5600** which operates. The contacts of relay **5600** extend to points similar to those to which the corresponding contacts of busy relay **5602** extend and perform similar functions except that in this instance the call is routed to one of a group of intercepting operator trunks (not shown) and the call is answered by an intercepting operator who advises the calling subscriber that the called station is not available. Conductors **5631**, **5632**, and **5633** extend from the conductors over which relays **5600**, **5601**, and **5602**, respectively, are operated and connect to register devices (not shown) which record the number of times that each of these relays operates under the conditions set forth above.

The terminating decoder marker is provided with relays for detecting trouble conditions on the various control conductors extending to the decoder marker and is also provided with time measure and alarm circuits which function to give an alarm indication under various abnormal conditions which the decoder marker may encounter. The manner in which the trouble detecting relays and the time measure and alarm circuits function is set forth in the succeeding paragraphs.

The sixteen conductors, such as conductors **5809** and **5810**, which extend from the front contacts of the trunk pattern relays **5000** to **5007**, inclusive, and which, during the functioning of the decoder marker, are used for associating the test conductors of the "A" trunks to the left windings of the channel testing relays **5120** to **5123**, inclusive, also connect to the armatures of cut-off relays **5019** and **5020** and over the back contacts of these latter relays to battery through the right winding of trouble detecting relay **5022**. With the decoder marker normal, a false ground on any of the conductors **5809**, **5810** operates relay **5022**. Relay **5022** locks through its left winding over conductor **5024** to a ground in an alarm circuit (not shown) and connects a ground to conductor **5023** which extends to the alarm circuit and causes that circuit to function and give an alarm indication of this aforementioned trouble condition. As soon as the decoder marker is selected for use in the establishment of a connection, the operation of its start relay **5300** grounds the off-normal ground conductor **5302** and thereby operates the cut-off relays **5019** and **5020** which open the circuits to the left winding of relay **5022** and in this manner prevent an alarm indication from being brought in during the normal functioning of the decoder marker.

The ten conductors, such as conductors **5712** and **5713**, which extend from the right armatures of the ten auxiliary trunk relays **5110** to **5113**, inclusive, to the armatures of a final frame connector relay, such as relay **5708**, and ultimately to the windings of the ten final secondary switch select magnets, are also connected to armatures of cut-off relay **5021** and thence over back contacts of this latter relay to battery through the right winding of trouble detecting relay **5022**. A false ground on any of the conductors **5712**, **5713** when the decoder marker is normal operates relay **5022** which functions to bring in an alarm indication in the manner set forth in the preceding paragraph. As soon as the decoder marker is selected for use, cut-off relay **5021** operates from off-normal ground on conductor **5302** and opens the circuit to the left winding of relay **5022** to permit the normal operations of the decoder marker to proceed without bringing in an alarm at the time that the final secondary switch select magnet operating circuit is completed.

Battery, through the winding of trouble detecting relay **5135**, is connected to each of the three windings of the ten channel testing relays, such as relays **5120** to **5213**, inclusive, at all times when the terminating decoder marker is normal. The other ends of the three windings of each channel testing relay connect to conductors over which connections are extended to the "A", "B" and "C" trunk test conductors when the decoder marker is in use. Should any of these conductors extending from the windings of the channel testing relays become falsely grounded when the decoder marker is idle, relay **5135** operates and connects a ground over conductor **5136** to battery through the right winding of trouble detecting relay **5022**. Relay **5022** operates, locks, and causes an alarm indication to be given in the

manner hereinbefore set forth. When the terminating decoder marker is selected, the operation of its start relay **5300** connects off-normal battery to conductor **5303**. This off-normal battery connects directly to the windings of the channel testing relays thereby short-circuiting the winding of trouble detecting relay **5135** and making this checking feature inoperative during the normal functioning of the decoder marker.

The operating battery for the line relays, such as relays **5400** to **5407**, inclusive, is supplied through the windings of trouble detecting relay **5409** and line end relay **5408** in series. Relay **5409** has marginal characteristics and does not receive sufficient current to operate in the normal circuit through its winding in series with the winding of relay **5408** and the winding of any one line relay. However, should the windings of several line relays become grounded simultaneously due to a trouble condition such as the crossing of adjacent contacts of a final frame connecting relay, such as relay **5708**, relay **5409** receives sufficient current to operate. The operation of relay **5409** grounds conductor **5419** which extends to battery through the winding of the master trouble detecting relay **5129**. Relay **5129** locks over its right front contact to the off-normal ground on conductor **5302** and opens conductor **5130** over which the regular release indication is normally transmitted to the terminating sender in the manner hereinbefore set forth. The terminating sender is therefore held and in turn holds the decoder marker connector and terminating decoder marker circuits. Under this condition the timing circuits of the decoder marker function, as will subsequently be set forth, to give an alarm indication and effect a trouble release of the decoder marker.

The operating battery for the final frame connector start relays, such as relays **5700** and **5701**, is supplied through the windings of marginal trouble detecting relays **5604** and **5605** respectively. These latter relays operate only if, due to a trouble condition, they are energized through the windings of more than one final frame connector start relay. In operating, relay **5604** or **5605**, or both, ground conductor **5419** and thereby operate the master trouble detecting relay **5129** which functions as set forth above.

The operating battery for the incoming frame connector start relay, such as relay **5800**, is supplied through the winding of marginal trouble detecting relay **5318** which receives sufficient current to operate only if, due to a trouble condition, the battery through its winding extends to ground through the winding of more than one incoming frame connector start relay. Relay **5318**, if operating, grounds conductor **5419** thereby operating the master trouble detecting relay **5129** which functions as set forth above.

At the time of the seizure of the terminating decoder marker the operation of its start relay **5300** closes a circuit from ground over its upper inner front contact to the armature of interrupter **5331**. Upon the first closure of the left contact of interrupter **5331** this ground is extended over the back contact of relay **5333** to battery through the winding of relay **5332**. Relay **5332** operates, locks over its lower front contact to the ground on conductor **5301**, and closes, in part, the operating circuit for relay **5333**. When interrupter **5331** subsequently functions and closes its right contact, relay **5333** operates from battery through its winding, back contact of relay **5337**, upper front contact of relay **5332**, to the ground over the right contact of interrupter **5331**. Relay **5333**, in operating, locks over its lower inner front contact to the ground on conductor **5301**; closes, in part, the operating circuit for relay **5337**; and operates relay **5334** in a local circuit. The speed of interrupter **5331** is such that the terminating decoder marker can complete its normal functions and release, thereby releasing start relay **5300** and removing the ground from conductor **5301** and the armature of interrupter **5331**, before relay **5333** can operate and in turn operate relay **5334**. Should the terminating decoder marker encounter any trouble which prevents its normal release, relay **5333** operates and, in turn, operates relay **5334**. Relay **5334**, in operating, operates relay **5335** locally. Relay **5335**, in operating, grounds conductor **4942** which operates relay **4917** of the decoder marker connector circuit. Relay **4917**, in operating, makes this decoder marker circuit test busy to all decoder marker connector circuits by causing the operation of relays similar to relay **4905**, of the other decoder marker connector circuit in the manner previously set forth. The operation of relay **5335** also extends the trouble release conductor **4943** from the decoder marker connector circuit, over the lower front contact of start relay **5300**, over its own left inner front contact, to the inner front contact of relay **5338** and the lower outer armature of relay **5339**, and also operates relay **5339** locally. The operation of relay **5339** closes the circuit over conductors **5340** and **5341** which extend to a trouble indicator circuit (not shown). This trouble indicator circuit functions to attach itself to the terminating decoder marker and records the conditions which have caused the failure of that circuit. Having obtained this record, the trouble indicator circuit returns a ground over conductor **5341**. This ground extends over the trouble release conductor **4943** to the decoder marker connector circuit which functions, in the manner hereinbefore set forth, releases the terminating decoder marker, and establishes connections between the terminating sender and another terminating decoder marker for a second trial.

The timing circuit of the decoder marker continues to function during the interval in which the trouble indicator circuit is attached to the marker. In the event that the trouble indicator circuit fails to return a ground over conductor **5341** for the purpose of releasing the decoder marker, this latter circuit will attempt to release itself and also give an alarm indication that the trouble indicator circuit has failed to effect the release. This is accomplished in the following manner: With relays **5332** and **5333** both operated, as previously set forth, the next closure of the left contact of interrupter **5331** operates relay **5337** which locks over its lower front contact. The subsequent closure of the right contact of interrupter **5331** operates relay **5338**. Relay **5338**, in operating, locks to ground on conductor **5301** and connects ground over conductors **5345** to an alarm circuit (not shown) which functions to give an alarm indication of the failure of the trouble indicator circuit to release the decoder marker. The operation of relay **5338** also connects ground over its upper inner front contact to the trouble release conductor **4943** to cause the decoder marker connector circuit to release the terminating decoder marker and function to make a second trial in the manner previously set forth. The normal time required for the trouble indicator circuit to obtain its record

of the trouble condition and bring about the release of the decoder marker is less than the time necessary for both relays **5337** and **5338** to operate under control of interrupter **5331**. No alarm indication is therefore given if the decoder marker releases under control of the ground supplied over conductor **5341** by the trouble indicator circuit.

A ground is supplied jointly under control of relays **5335** and **5339** to the upper armatures of relays **5343** and **5344** and to the armature of interrupter **5342**. Should the decoder marker connector circuit fail to effect the release of the decoder marker upon the connection of ground to the trouble release conductor **4943** by the operation of relay **5338**, these aforementioned relays and interrupter function to bring in a major alarm since the decoder marker is now tied up. The first closure of the upper contact of interrupter **5342** operates relay **5343** which locks over its upper front contact. The subsequent closure of the bottom contact of interrupter **5342** operates relay **5344** which also locks and connects ground over conductors **5345** to a major alarm circuit (not shown) which functions and gives an audible and visual signal of the tie-up of the terminating decoder marker. The time required for relays **5343** and **5344** to function under control of interrupter **5342** is greater than that required for the normal trouble release of the decoder marker by the decoder marker connector circuit and the major alarm is therefore brought in only in the event of the trouble release failure.

The release conductor **5130** and the trouble release conductor **4943** which extend to the decoder marker connector circuit are connected to battery through the lower and upper windings, respectively, of relay **5336**. Should either of these conductors become falsely grounded at any time, with the decoder marker normal relay **5336** operates through one or the other of its windings. The operation of relay **5336** grounds conductor **5301** and the decoder marker timing circuit relays thereupon function, in the same manner as when conductor **5301** was grounded by the operation of start relay **5300**, and cause alarm indications to be given as set forth in the preceding paragraph. When the terminating decoder marker connector circuit releases, either under the normal or the trouble release condition as hereinbefore described, the release of relay **4805** of the connector circuit removes the ground from the terminating decoder marker start conductor **4914** thereby releasing the start relay **5300** of this latter circuit. The release of relay **5300** removes the off-normal ground from conductors **5301** and **5302** and the off-normal battery from conductor **5303**. The various operated relays and magnets of the terminating decoder marker, incoming frame connector, incoming frame, final frame connector, and final frame circuits thereupon release thus restoring these circuits to normal.

What is claimed is:

1. In a telephone system, a plurality of primary line switches, groups of lines, each group appearing in one of said switches, a plurality of secondary line switches, groups of trunks, said secondary switches having access respectively to said groups of trunks, links interconnecting said primary and secondary switches, each primary switch having access through separate links to each secondary switch, means responsive to a call in one of said line groups for testing a plurality of said groups of trunks and for selecting one of such groups for use, and means dependent on the group of lines initiating the call for determining which group of trunks is selected.

2. In a telephone system, a plurality of primary and secondary cross-bar switches, groups of lines, each group appearing in one of said primary switches, groups of trunks, said secondary switches having access respectively to said groups of trunks, links interconnecting said primary and secondary switches, each primary switch having access through separate links to each secondary switch, means responsive to a call in one of said line groups for testing all groups of trunks that may be reached through idle links and for selecting one such group for use, and means dependent on the group of lines initiating the call for determining which group of trunks is to be selected.

3. In a telephone system, primary line switches, groups of lines appearing respectively in said switches, secondary line switches, groups of trunks, said secondary switches having access respectively to said groups of trunks, links interconnecting said primary and secondary switches, each primary switch having a separate link extending to each secondary switch, each link having access to all trunks in the group appearing in the corresponding secondary switch, means for testing a plurality of groups of trunks and for selecting one such group for use, and means dependent on the calling group of lines for determining the trunk group to be selected.

4. In a telephone system, a plurality of primary line switches, groups of lines, each group appearing in one of said switches, a plurality of secondary line switches, groups of trunks, said secondary switches having access respectively to said groups of trunks, links interconnecting said primary and secondary switches, each primary switch having access through separate links to each secondary switch, means responsive to a call in one of said line groups for testing a plurality of said groups of trunks and for selecting one of such groups for use, and means effective when more than one trunk group has an idle trunk therein for selecting for use the group preferred by the group of lines making the call, each group of lines preferring a different group of trunks.

5. In a telephone system, a plurality of primary line switches, groups of lines, each group appearing in one of said switches, a plurality of secondary line switches, groups of trunks, said secondary switches having access respectively to said groups of trunks, links interconnecting said primary and secondary switches, each primary switch having access through separate links to each secondary switch, means responsive to a call in one of said line groups for testing a plurality of said groups of trunks and for selecting one of such groups for use, means dependent on the group of lines initiating the call for determining which group of trunks is selected, means for selecting an idle trunk in the selected group, and means for then operating the primary and secondary switches to extend the line to the selected trunk.

6. In a telephone system, groups of lines, groups of recording devices, primary switches, means for extending said lines to any one of said primary switches, secondary switches having access respectively to said groups of recording devices, links interconnecting said primary and secondary switches, means for testing a plurality of said groups of devices responsive to a call in one of said line groups, and preference means

effective in accordance with the particular primary switch to be used for extending the calling line for determining which one of said groups of devices is to be selected for use.

7. In a telephone system, groups of lines, groups of recording devices, primary switches, means for extending said lines to any one of said primary switches, secondary switches having access respectively to said groups of recording devices, links interconnecting said primary and secondary switches, means for testing a plurality of said groups of devices responsive to a call in one of said line groups, and means effective when more than one group has an idle device therein for selecting for use the group preferred by the primary switch selected for use in extending the calling line, each primary switch preferring a different group of said devices.

8. In a telephone system, groups of lines, groups of senders, primary switches, means for extending said lines to any one of said primary switches, secondary switches having access respectively to said groups of senders, links interconnecting the primary and secondary switches, means for testing a plurality of said groups of senders, means effective in accordance with the particular primary switch used for extending the calling line for determining which one of the tested groups of senders is selected for use, means for selecting an idle sender in the selected group, and means for operating the primary and secondary switches to extend the calling line to the selected sender.

9. In a telephone system, groups of lines, groups of trunks, a plurality of primary selector switches, said trunk groups appearing respectively in said primary switches, a plurality of secondary switches, groups of senders, said groups of senders accessible respectively through said secondary switches, links interconnecting each primary with each secondary switch, means effective in response to a call in one of said line groups for choosing any one of said groups of trunks having an idle one therein for extending the call, means for testing a plurality of sender groups, preference means for selecting one of said sender groups dependent on the trunk group selected for the call, means for extending the calling line to an idle trunk in the selected group, and means for operating the primary and secondary switches to extend said trunk to an idle sender in the selected group.

10. In a telephone system, a group of lines, a plurality of trunk groups accessible to said lines, a line group control mechanism for controlling the connection of said lines to said trunks, a plurality of senders, sender selector control circuits, one for each trunk group for controlling the connection of said trunks to said senders, means responsive to a call on one of said lines for causing each of the said control circuits to make a preliminary test to determine if there is an idle trunk in the corresponding group having at least one idle path to an idle sender, means effective if more than one control circuit finds an idle path for preferring one such control circuit and its group of trunks and for connecting such control circuit to said line control mechanism to the exclusion of the other control circuits, means in the preferred control circuit for making a final test to select an idle trunk in the group and an idle sender accessible thereto, and means effective if all paths including a trunk and a sender become busy before one is selected for disconnecting said preferred control circuit from said line group mechanism.

11. In a telephone system, a group of lines, a plurality of trunk groups for extending calls from said lines, a plurality of recording senders, sender selector and control circuits, one for each of said trunk groups for effecting connections between said trunks and said senders, means responsive to a call on one of said lines for causing said control circuits to make preliminary tests of the corresponding trunk group to determine if there is at least one idle path from one of said trunks through the sender selector to a sender, means for preferring one of said control circuits to the exclusion of all others in case several of these circuits succeed in finding an idle path on the preliminary test, means associated with the preferred control circuit for making a final test to select an idle trunk in the group and an idle sender accessible thereto, and means effective if all paths including a trunk and a sender become busy after said preliminary test and before one of said paths is selected for use for dismissing the preferred control circuit and for rendering all of said control circuits effective to repeat said preliminary tests.

12. In a telephone system, a first group selecting stage comprising a plurality of primary switches and a plurality of secondary switches, a second stage comprising a plurality of primary and a plurality of secondary switches, a set of links interconnecting the primary and secondary switches of said first stage, each primary switch having a link leading to each of the secondary switches, a second set of links interconnecting the secondary switches of the first stage with the primary switches of the second stage, a third set of links interconnecting the primary and secondary switches of said second stage, each primary switch having separate links leading respectively to different secondary switches, a controlling device common to all of said switches, means for selectively connecting said device to the switches in both stages, means in said device for testing and selecting links in all of said sets, and means for operating the primary and secondary switches in both stages to extend a connection over a link in each set through said stages.

13. In a telephone system, a first group selecting stage comprising a plurality of primary and a plurality of secondary cross-bar switches, a second stage comprising a plurality of primary and a plurality of secondary cross-bar switches, a set of links interconnecting the primary and secondary switches of the first stage, each primary switch having a link leading to each of the secondary switches, a second set of links, each of said second links interconnecting a different secondary switch of the first stage and a different primary switch of the second stage, a third set of links interconnecting the primary and secondary switches of the second stage, each primary switch having separate links leading respectively to different secondary switches, a controlling marker common to all of said switches, means for selectively connecting said marker to the switches of both stages, means in said marker for testing and selecting links in all of said sets, and means for operating the primary and secondary switches of both stages to extend a connection.

14. In a telephone system, a district stage comprising a number of frames, each frame including a plurality of primary and a plurality of secondary switches, an office stage comprising a number of frames, each frame comprising a plurality of primary and secondary switches, a set of links interconnecting the primary and sec-

ondary switches of a district frame, each primary switch having a link leading to each of the secondary switches, a second set of links leading from the secondary switches of a district frame to the primary switches on all of said office frames, a third set of links interconnecting the primary and secondary switches of an office frame, each primary switch of the office frame having separate links extending respectively to the different secondary switches of such frame, a number of markers, each common to all of the switches on said frames, means for selectively connecting any one of said markers to any of said frames, means in each of said markers for testing and selecting links in all of said sets, and means for operating the primary and secondary switches of the district frame and the primary and secondary switches of an office frame to extend a connection therethrough.

15. In a telephone system, a number of selective switches, a group of trunks appearing in a plurality of said switches, each trunk appearing in only one switch, a switch controlling marker common to said switches, means for connecting said marker simultaneously to all of the switches in which appear the trunks of a desired group, means in said marker for testing all of said trunks to locate an idle one, and means controlled by said marker for operating the proper switch to seize the idle trunk located by said test.

16. In a telephone system, a plurality of frames, each comprising a number of cross-bar selector switches, groups of trunks, each group having half of its trunks appearing in the switches on one frame and the other half of its trunks appearing in switches on another frame, a plurality of switch controlling markers common to the switches of all frames, frame connectors, means for operating two frame connectors to connect any one of said markers to the pair of frames including the trunks of a desired group, means in the marker for testing all of said trunks to locate an idle one on either of said frames, and means controlled by said marker for operating the proper switch to seize the idle trunk.

17. The combination in a telephone system of a plurality of switches, means for extending a call to any one of said switches, a group of trunks for further extending the call, said group divided into a plurality of first choice subgroups and a second choice subgroup, means for performing a simultaneous test of all of the trunks of a subgroup, means dependent on the switch to which a call is extended for connecting said testing means to a particular one of said first choice subgroups, and means effective if all trunks of a first choice subgroup are busy for connecting said test means to said second choice subgroup.

18. The combination in a telephone system of a plurality of switches, means for extending the call to one of said switches, a group of trunks for further extending the call, said group divided into a plurality of first choice subgroups and a second choice subgroup, a marker common to said switches and having a series of test relays, means dependent on the switch to which a call is extended for connecting said relays to a particular one of said first choice subgroups, means effective if all trunks of a first choice subgroup are busy for disconnecting said relays therefrom and for connecting them to the trunks of said second choice subgroup.

19. In a telephone system, a plurality of selective switches, three sets of links interconnecting said switches, said sets being arranged in serial relation, a controlling mechanism common to all of said switches, a series of testing relays in said mechanism, each relay having three windings, one winding for a link in each of the three sets, and means controlled by the test for selectively operating said switches.

20. In a telephone system, four sets of selective switches, a first group of links interconnecting the first and second sets of switches, a second group of links interconnecting the second and third sets of switches, a third group of links interconnecting the third and fourth sets of switches, a marker common to all of said switches, a series of testing relays in said marker, each relay having three windings, one winding for testing a link of each of the three groups, and means controlled by the test relays for selectively operating said switches to extend a connection involving a link in each of the three groups.

21. In a telephone system, a switching stage having a plurality of trunk terminals, groups of trunks appearing in said terminals, said groups being of variable sizes and promiscuously located, a series of testing relays, one for each trunk terminal appearance, and means for rendering effective any portion of said series of relays for testing a group of trunks.

22. In a telephone system, a switching stage having a plurality of trunk terminals, groups of trunks appearing in said terminals, said groups being of variable size and promiscuously located, a series of test relays, each relay serving to test a different trunk, and means to render any portion of said relays effective depending on the size and location of the trunk group.

23. In a telephone system, a plurality of trunk terminals, groups of trunks appearing in said terminals, said trunk groups varying in size, a marker having a series of test relays therein, each relay serving to test a different trunk, means for registering a desired designation in said marker, and means depending on the designation received for rendering effective a variable portion of said relays depending on the number and location of the trunks in the group undergoing test.

24. In a telephone system, a group of direct route trunks, a group of alternate route trunks, switches for extending calls over said trunks, a common marker for controlling the selective operation of said switches, testing means in said marker for testing said direct group of trunks, a set of route contacts in said marker, means controlled by said contact set for applying said test means to said alternate group of trunks if all of said direct trunks test busy, a counting register for said direct group, and means controlled by said route contacts for operating said register.

25. In a telephone system, a group of direct trunks, a group of alternate route trunks, switches for extending calls over said trunks, a common marker for controlling the selective operation of said switches, testing means in said marker for testing said direct group of trunks, a route contact set in said marker, means controlled by said contact set for applying the test means to said alternate group of trunks if all of the direct trunks are busy, a second route contact set operable if all trunks in the alternate group are busy, and registering means controlled by each of said route contact sets.

26. In a telephone system, a plurality of automatic switches, a switch-controlling mechanism

common to said switches, connecting means for connecting said mechanism to any one of said switches, means for extending a call to one of said switches, a registering device comprising a single switch structure for registering the wanted designation and the identity of the switch to which said call is extended, and means controlled by said registering device for selectively operating said connecting means.

27. In a telephone system, a plurality of automatic switches, a switch controlling mechanism common to said switches, means for connecting said mechanism to any one of said switches, means for extending a call to one of said switches, a cross-bar switch register for registering the designation of a called line and for registering the identity of the switch to which the call is extended, and means controlled by said cross-bar register for selectively operating the means for connecting said switch controlling mechanism to the automatic switch to which the call has been extended.

28. In a telephone system, a subscriber's line, a switching stage comprising a plurality of selective switches, means for extending said line to said switching stage, a second switching stage having selective switches thereat for further extending said line, a register sender for recording wanted designations, a number of markers, means for connecting said sender to one of said markers, means in the connected marker for selectively operating a switch in the first mentioned stage to extend the line to said second stage, means for operating the switch at said second stage under the control of said sender to further extend the subscriber's line, an auxiliary circuit appearing in one of the switches at said first stage, means in said marker operative if an all-trunks-busy condition is encountered at said first stage for operating one of the switches at said first stage to extend the subscriber's line to said auxiliary circuit, means for sending a signal to said sender if one of the switches at said second stage encounters an all-trunks-busy condition, means in said sender responsive to such signal for causing the connection of one of said markers to said sender, means in the connected marker operative as a result of the signal sent to said sender for causing the operation of the switches at the first stage to extend the subscriber's line to said auxiliary circuit, and signaling means in said auxiliary circuit.

29. In a telephone system, a calling line, a first stage having a plurality of selective switches thereat, means for extending the calling line to said stage, a second stage having a plurality of selective switches thereat, a sender for registering the designations of wanted lines, a plurality of markers, means for connecting said sender to any one of said markers, means controlled by the connected marker in accordance with the designation registered in said sender for operating the switches at said first stage to extend the calling line to said second stage, means for causing the release of said marker following the extension of the line to said second stage, means controlled by said sender for operating a switch at said second stage to further extend said line, overflow circuits appearing in the switches at said first stage, means in said marker effective in case it is unable to operate said switches at the first stage to extend the line to said second stage to cause the operation of the switches in the first stage to extend said line to one of said overflow circuits, means controlled by the switch at said second stage in case it is unable to further extend said line for sending a signal back to said sender, means in the sender responsive to such signal for causing the sender to be connected to any one of said markers, means in the marker thus connected to the sender and operative in response to the signal received by said sender for operating the switches at said first selective stage to extend said line to one of said overflow circuits, and in said overflow circuits for sending a signal to said line.

30. The combination of a plurality of switches, each having a plurality of connecting terminals, the terminals of each switch being divided into first and second portions, groups of outgoing lines, said groups appearing respectively each in the first terminal portion of a separate one of said switches, a plurality of additional groups of outgoing lines, each divided in subgroups, the subgroups of each additional group appearing respectively each in the second terminal portion of a separate one of said switches, a plurality of incoming lines appearing in the terminal portions of each switch, and operating means for each switch for effecting connections in both terminal portions thereof.

31. In a telephone system, a plurality of switches, each having a plurality of connecting terminals, the terminals of each switch being divided into first and second portions, groups of outgoing lines, said groups appearing each in the first portion of only one of said switches, a plurality of additional groups of outgoing lines, each divided in subgroups, the subgroups of each additional group appearing in the second portion of only one of said switches, a plurality of incoming lines appearing in the terminal portions of each switch, and operating means for each switch for effecting connections in both terminal portions thereof.

32. In a telephone system, a plurality of cross-bar switches, each having a plurality of connecting terminals, the terminals of each switch being divided into first and second portions, groups of incoming lines, said groups appearing respectively, each in the first portion of a separate one of said switches, additional groups of incoming lines, each additional group appearing in the second portion of a plurality of said switches, and operating means for each switch for effecting connections in both terminal portions thereof.

33. In a telephone system, a plurality of cross-bar switches, each having a plurality of connecting terminals, the terminals of each switch being divided into first and second parts, groups of incoming lines, said groups appearing each in the first part of only one of said switches, other groups of incoming lines, each of said other groups multipled to appear in the second part of a number of said switches, outgoing lines appearing in the terminals of each of said switches, and operating means for each switch for effecting connections in both terminal parts thereof.

34. In a telephone system, a plurality of lines arranged in blocks, a marker common to said lines and arranged to receive the called designation of any one thereof, test means in said marker and means for connecting the same to all of the lines in a block when one of such lines is called, a test circuit, and means for extending said circuit to said test means to determine the condition of the particular line called.

35. In a telephone system, a plurality of lines arranged in blocks, a marker common to said

lines for receiving the called designation of any one of said lines, a plurality of test relays in said marker, there being as many of these relays as there are lines in a block, means for connecting the test relays to the lines of any block when one of these lines is called, a test circuit, and means for extending said circuit to the test relay connected to the called line for determining the condition of such line.

36. In a telephone system, subscribers' lines, private branch exchange lines, said lines being arranged in blocks having a uniform number of lines therein, some of said blocks containing both subscribers' lines and private branch exchange lines, a marker common to said lines and arranged to receive the called designation of any one thereof, means in the marker for testing all of the lines in any one of said blocks, means for connecting the testing means to a block of lines when any one of the lines therein is called and a test circuit cooperating with said test means for determining the condition of the called line.

37. In a telephone system, subscribers' lines, private branch exchange lines, said lines arranged in blocks having a uniform number of lines, some of said blocks having both subscribers' lines and private branch exchange lines, a marker common to said lines for receiving the designation of a called one thereof, a series of test relays in the marker, one for each line in any of said blocks, means for connecting said test relays to the lines of a particular block for performing a simultaneous test of said lines when any one of the lines therein is called, a test circuit, and means for extending the same to the particular one of said test relays connected to the called line in the block, and means effective if said particular relay represents a busy private branch exchange line for further extending said test circuit to succeeding test relays connected to other lines in the same private branch exchange group.

38. In a telephone system, selective switches for establishing connections, a switch controlling device having mechanism for registering the designation of the call and mechanism for selectively controlling said switches in accordance with the designation registered, means for seizing said device for use when a call is made, and means for permitting the seizure of said device for use on a second call while it is still operating to control the extension of the first connection.

39. In a telephone system, selective switches for establishing connections, a switch controlling device having registers therein, means for seizing said device when a call is made and for operating said registers to register the designation of said call, means in said device effective in accordance with the designation registered therein for controlling the selective operation of said switches to extend the desired connection, and means effective in response to a second call for causing the reseizure of said device and the operation of said registers to register therein the designation of said second call while said device is proceeding with the control of said switches in connection with the first one.

40. In a telephone system, selective switches for establishing connections, a switch controlling marker having designation registers therein, senders for recording call designations, means for causing a sender to seize said marker and to transfer a call designation to the registers of said marker, means in the marker effective in accordance with the designation registered therein for operating said switches to extend the connection, means for releasing said marker from the sender before the marker has completed its control over said switches, means for causing a second one of said senders to seize said marker as soon as it has been released from the first-mentioned sender and to transfer to said marker the designation of a second call, and means in the marker effective in accordance with the designation of the second call registered therein for preparing to control the selective switches while the marker is still operating to control the switches in the establishment of the first connection.

41. In a telephone system, groups of trunks, automatic switches, a marker, senders for storing wanted designations, means for causing a sender to seize said marker and to transfer thereto the designation of a call, means for causing said marker to test a group of trunks corresponding to the designation transferred to the marker and to then operate said switches to extend a connection to an idle trunk in the tested group, and means for permitting a second sender to seize said marker and to transfer thereto the designation of a second call as soon as the marker has tested the trunks of said group.

42. In a telephone system, calling lines, groups of trunks, automatic switches, a marker, connectors for selectively connecting said marker to said switches, digit registering senders, means responsive to a calling line for causing a sender to seize said marker and to transfer thereto the designation of the call, means in said marker responsive to the receipt of said designation for operating one of said connectors to connect the marker to one of said switches, other means in said marker operable in accordance with the designation received for testing the desired one of said groups of trunks and for operating said switches to extend the calling line to an idle trunk in such group, means for releasing said marker from the sender after said designation has been transferred to said marker and before the marker has completed its functions, means responsive to a second calling line for causing a second sender to seize said marker as soon as it is released from said first sender and to transfer thereto the designation of the second call, and means for causing the marker to operate another of said connectors to connect the marker to another of said switches preparatory to the extension of the second calling line while it is still in the process of controlling said first-mentioned switch to extend the first calling line.

43. In a telephone system, automatic switches, a group of trunks appearing in said switches, an auxiliary trunk appearing in said switches, a plurality of markers for testing said trunks and for controlling the operation of said switches to extend connections to said trunks, means effective in response to a call for taking any one of said markers into use to extend the call over said group of trunks, means effective if said marker fails to progress in the performance of its functions for releasing it and again taking any one of the markers into use, and means for causing the second marker to control said switches for extending the call to said auxiliary trunk.

44. In a telephone system, a calling circuit, automatic switches, a group of trunks appearing in said switches, overflow trunks appearing in said switches, a sender, a plurality of markers for testing said trunks and for controlling the operation of said switches to extend connections to said trunks, means effective in response to a

call on said calling circuit for causing said sender to seize any one of said markers for extending the calling circuit over an idle trunk in said group, means effective if the seized marker fails to perform its functions for releasing it from said sender and for causing the sender to seize again any one of said markers, and means for causing the second marker to control said switches for extending the calling circuit to one of said overflow trunks.

45. In a telephone system, a calling circuit, automatic switches, a direct route group of trunks appearing in said switches, an alternate route group of trunks appearing in said switches, a plurality of markers for testing said trunks and for controlling the operation of said switches, means effective in response to a call on said calling circuit for taking any one of said markers into use to extend the calling circuit over an idle one of the trunks in said direct group, means effective if said marker fails to progress in the performance of its functions for releasing it and again for taking one of said markers into use, and means for causing said second marker to test the trunks of said alternate group and to extend the calling circuit over said switches to an idle one of the trunks in said alternate group.

46. In a telephone system, a calling line, a group of direct trunks, a group of alternate route trunks, overflow trunks, automatic switches having access to all of said trunks, a plurality of markers for testing said trunks and for controlling the operation of said switches to extend connections to said trunks, means effective in response to a call on said line for taking any idle one of said markers into use to test the trunks of said direct group and to extend the calling line over said group if any one of the trunks is found idle, means effective if said marker fails to perform its functions for releasing it and again taking any idle one of said markers into use, means for causing the second marker to test the trunks of said alternate group and to extend the calling line over said switches to an idle one of the trunks in said alternate group, means effective if said second marker fails to perform its functions for releasing it and again seizing any idle one of said markers, and means for causing said third marker to test said overflow trunks and for controlling the operation of said switches to extend the calling line to an idle one of said overflow trunks.

47. In a telephone system, automatic switches, telephone lines, a direct group of trunks, an alternate route group of trunks, overflow trunks, automatic switches having access to all of said trunks, a sender for recording the designations of called lines, a plurality of switches, controlling markers for testing said trunks and for controlling the operation of said switches, means responsive to a call on one of said lines for causing said sender to seize an idle one of said markers for the purpose of extending the calling line over said switches to a trunk in said direct group, means effective if said marker fails to progress in its operation for transmitting a signal to said sender and for causing the sender to release the marker and seize again any idle one of said markers, means responsive to the signal transmitted to said sender by the first marker for causing said second marker to test the trunks of said alternate group and to control the operation of said switches to extend the calling line over said alternate group if an idle trunk is found therein, means effective if said second marker fails to progress in its operation for transmitting a second signal to said sender and for causing the sender to release said second marker and again seize any idle one of said markers, and means effective in response to the second signal transmitted to said sender for causing the third marker to test said overflow trunks and to control the operation of said switches to extend the calling line to an idle one of said overflow trunks.

48. In a telephone system, a group of direct route trunks, a group of alternate route trunks, a group of overflow trunks, a selective switch having access to all of said trunks, a marker for testing said trunks and for selectively operating said switch, means in said marker effective if all of said direct trunks are busy for causing the extension of a connection over one of said alternate route trunks, and means in said marker effective if all alternate route trunks are busy for extending a connection to one of said overflow trunks.

49. In a telephone system, a calling line, a group of direct route trunks, a group of alternate route trunks, a group of overflow trunks, selective switches having access to all of said trunks, a sender for recording the designations of called lines, a marker for testing said trunks and for selectively operating said switches, means responsive to a call for causing said sender to seize the marker for the purpose of testing the trunks of said direct group and for operating said switches to extend the call over an idle trunk in said group, means in said marker effective if all said direct trunks are busy for causing it to test the trunks in said alternate group and for controlling the operation of said switches to extend the call over an idle trunk in said alternate group, and means in said marker effective if all trunks of the alternate group are busy for causing it to test said overflow trunks and for operating said switches to extend the call to an idle one of said overflow trunks.

50. In a telephone system, a calling circuit, a group of outgoing trunks, an auxiliary trunk, switches having access to said trunks, a marker, switching equipment at the distant ends of said outgoing trunks, means responsive to a call on said calling circuit for taking said marker into use for controlling the selective operation of said switches to extend the calling circuit over one of said outgoing trunks, means for releasing said marker, means for controlling said switching equipment to further extend the call at the distant end, means effective if the call fails to progress at said distant end to send a signal back over the trunk to the outgoing end thereof, and means responsive to said signal for taking said marker into use to extend the calling circuit through said switches to said auxiliary trunk.

51. In a telephone system, a calling office, a telephone line therein, a called office, a group of trunks outgoing from said calling office to said called office, an overflow trunk in said calling office, automatic switches in said calling office having access to said trunk, a plurality of markers in said calling office, means responsive to a call on said line for taking an idle one of said markers into use for controlling the selective operation of said switches to extend said line over one of said outgoing trunks to the called office, means for releasing said marker, switching means in the called office for further extending the connection, means effective if the connection fails to progress in said called office for sending a signal back over the trunk to the calling office, and means responsive to said signal for taking any idle one

of said markers into use for controlling said automatic switches to extend said line to said overflow trunk.

52. In a telephone system, a group selecting stage comprising a plurality of primary switches and a plurality of secondary switches, link circuits interconnecting said primary and secondary switches, each primary switch having link circuits leading to a plurality of different secondary switches, circuits incoming to said stage, circuits outgoing from said stage, a number of markers, each common to all of the switches of said stage, means for selectively connecting one of said markers to said switches, means in the marker for testing and selecting said links, and means for operating said switches to extend a connection from an incoming circuit to an outgoing circuit over a selected link.

53. In a telephone system, a group selecting stage comprising a plurality of primary switches and a plurality of secondary switches, links interconnecting said switches, each primary switch having links extending respectively to a plurality of secondary switches, a plurality of recording senders, a plurality of switch controlling markers, trunks incoming to said switch, trunks outgoing from said switch, means responsive to a call on one of said incoming trunks for seizing an idle one of said senders, means for connecting the seized sender to an idle one of said markers, means for connecting the seized marker to the switches of said stage to test said links and outgoing trunks, and means controlled by the seized marker for operating said switches to complete a connection from the incoming circuit over said primary and secondary switches and interconnecting link circuit.

54. In a telephone system, a calling line, a group of direct route trunks, a group of alternate route trunks, a group of overflow trunks, selective switches having access to all of said trunks, a sender for recording the designations of called lines, a plurality of markers each arranged to test said trunks and to selectively operate said switches, means responsive to a call for causing said sender to seize one of said markers for the purpose of testing the trunks of said direct group and for operating said switches to extend the call over an idle trunk in said group, means in the marker effective if all said trunks are busy for causing it to test the trunks in said alternate group and for controlling the operation of said switches to extend the call over an idle trunk in said alternate group, means in the seized marker effective if all trunks of the alternate group are busy for causing it to test said overflow trunks and for operating said switches to extend the call to an idle one of said overflow trunks, and means effective if said marker fails to progress for releasing it and causing the sender to seize another marker for a new trial.

55. In a telephone system, a group of lines, groups of trunks accessible to said lines, a line group control mechanism for controlling the connection of said lines to said trunks, a plurality of senders, sender selector control circuits, one for each group of trunks, for controlling the connection of said trunks to said senders, means responsive to a call on one of said lines for causing said group control mechanism and said control circuits to make a test to determine which groups of trunks have an idle trunk and have access to an idle sender, means for establishing a connection between said line group control mechanism and the one of said control circuits corresponding to a trunk group found to have an idle trunk and to have access to an idle sender, automatic switches operable to extend the calling line to a selected idle trunk and for extending the selected idle trunk to a selected idle sender, and means effective if all senders become unavailable before said switches are operated to disconnect said control circuit from said line group control mechanism to allow said group control mechanism to connect again to one of said control circuits in a repeated attempt to complete the connection.

56. In a telephone system, a group of lines, a plurality of trunk groups accessible to said lines, a line group control mechanism for controlling the connection of said lines to said trunks, a plurality of senders, sender selector control circuits, one for each group of trunks, for controlling the connection of said trunks to said senders, line links for extending said lines to said trunks, sender selector links for extending said trunks to said senders, means responsive to a call on one of said lines for causing said control mechanism and said control circuits to make a preliminary test to determine how many available paths exist from the calling line by way of said line links, said trunks, and said sender selector links, to idle senders, means effective if there are available paths by way of a plurality of said trunk groups for choosing a particular one of said trunk groups for use, means for connecting the line group mechanism to the control mechanism individual to the chosen trunk group, means for performing a further test to select an idle trunk in the chosen group and to select an idle sender accessible to said trunk by way of an idle sender selector link, automatic switches for connecting the calling line to the chosen idle trunk and for connecting said trunk to an idle sender, and means effective if all available senders become busy before said automatic switches are operated for causing the release of said group control mechanism from said control circuit to permit said group control mechanism to perform again said preliminary test in conjunction with said control circuits in a repeated attempt to complete the connection.

57. In a telephone system, a plurality of groups of lines, a plurality of trunk groups accessible to said lines, line control mechanisms, one for each of said line groups, for controlling the connection of said lines to said trunks, a plurality of senders, sender selector control circuits, one for each trunk group for controlling the connection of said trunks to said senders, means responsive to a call on any one of said lines in any one of said line groups for causing the corresponding control mechanism and said control circuits to make a test to determine if there are idle trunks in said groups having access to idle senders, means effective if more than one control circuit finds an idle trunk for preferring a particular one of the control circuits and its associated group of trunks, means effective if a plurality of line control mechanisms are attempting to gain access to a sender by way of the same group of trunks for preferring a particular one of said control mechanisms, means for interconnecting the preferred line control mechanism and the preferred sender selector control circuit, automatic switches operated under the control of the interconnected control mechanism and control circuit for extending the calling line to an idle sender, and means effective if all available paths to idle senders be-

come busy before said switches are operated to disconnect the interconnected control mechanism and control circuit to allow said control mechanism to make repeated attempts to establish the connection.

58. In a telephone system, a group selecting stage comprising a plurality of primary switches and a plurality of secondary switches, link circuits interconnecting said primary and secondary switches, each primary switch having link circuits leading to a plurality of different secondary switches, circuits incoming to said stage, trunks outgoing from said stage, a number of markers, each common to all of the switches of said stage, means for selectively connecting one of said markers to said switches, means in the marker for testing and selecting an idle trunk outgoing from said stage, means in the marker for testing and selecting said links, and means for operating said switches to extend a connection from an incoming circuit to a selective outgoing trunk over a selected one of said link circuits.

59. In a telephone system, a group selecting stage comprising a plurality of primary switches and a plurality of secondary switches, circuits incoming to said primary switches, link circuits interconnecting said primary and secondary switches, a second group selecting stage comprising primary and secondary switches, trunks outgoing from the secondary switches of said second stage, links interconnecting said primary and secondary switches of said second stage, links interconnecting the secondary switches of said first stage and the primary switches of said second stage, a plurality of markers, each of which is common to all of said switches, means for selectively connecting one of said markers to said switches, means in the marker for testing and selecting an idle one of said outgoing trunks, means in the marker for testing all paths comprising the link circuits in said stages available for extending a connection from any one of said incoming circuits to the selected outgoing trunk and for choosing a particular one of said paths if idle, and means for operating said switches to complete the connection over the chosen idle path.

60. In a telephone system, a plurality of frames, each comprising a number of selector switches, groups of trunks, each group having part of its trunks appearing in the switches on one frame and part of its trunks appearing in the switches on another frame, a plurality of switch controlling markers common to the switches of all frames, connectors, means for operating said connectors to connect any one of said markers to the pair of frames including the trunks of a desired group, a series of testing relays in the marker for making a simultaneous test of all the trunks of said group to locate an idle one on either of said frames, some of said relays testing the trunks on one frame and other of said relays testing the trunks on the other frame, and means for operating one of said switches to establish a connection to an idle trunk.

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