Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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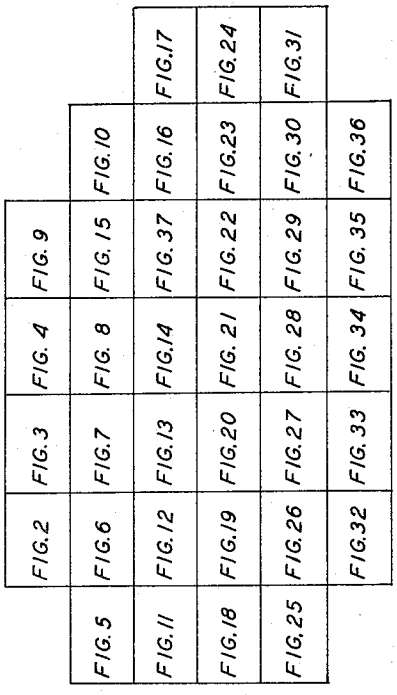
FIG. 1



INVENTORS: J.W.DEHN
O.MYERS
BY
P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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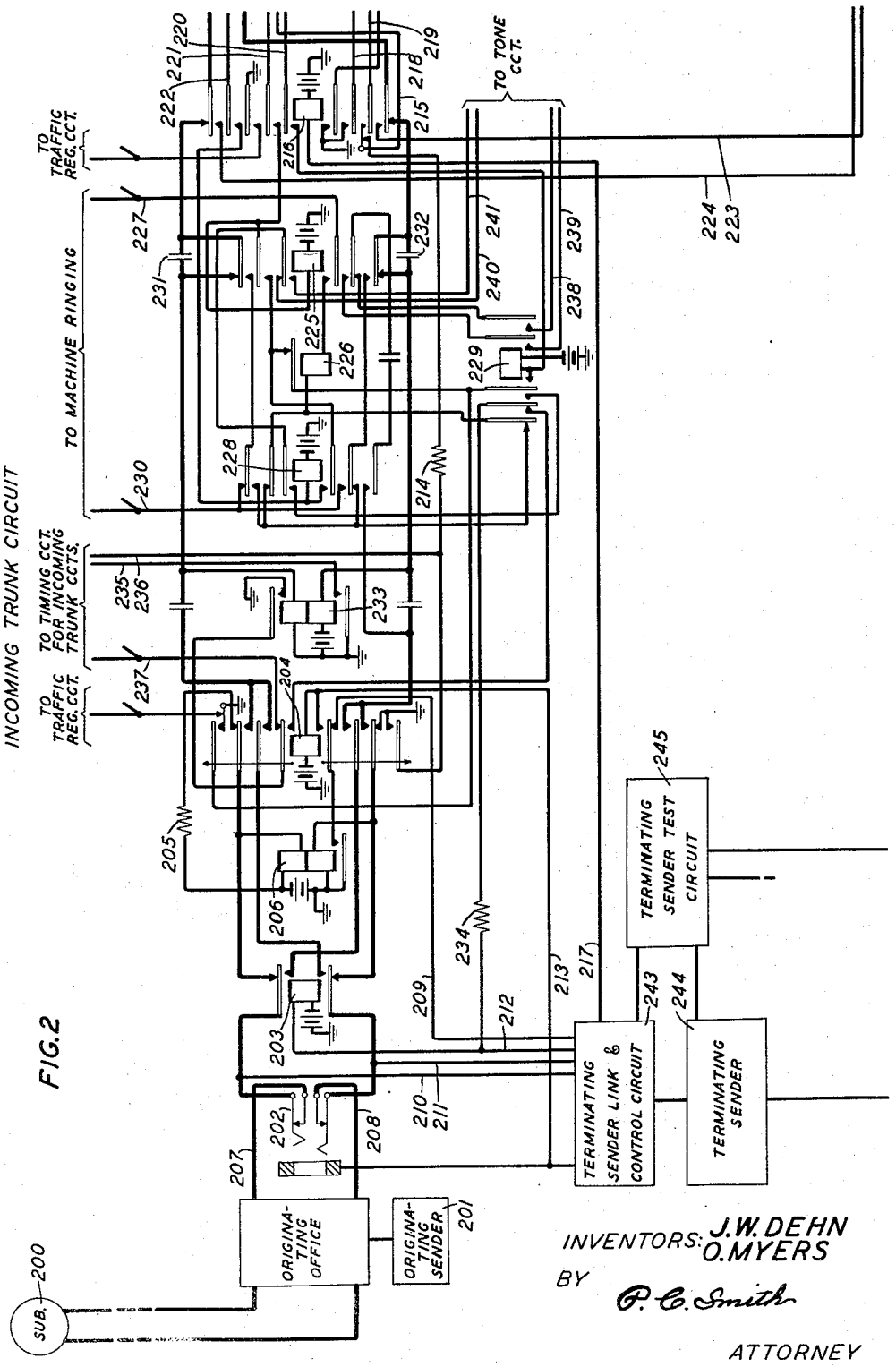

FIG. 2

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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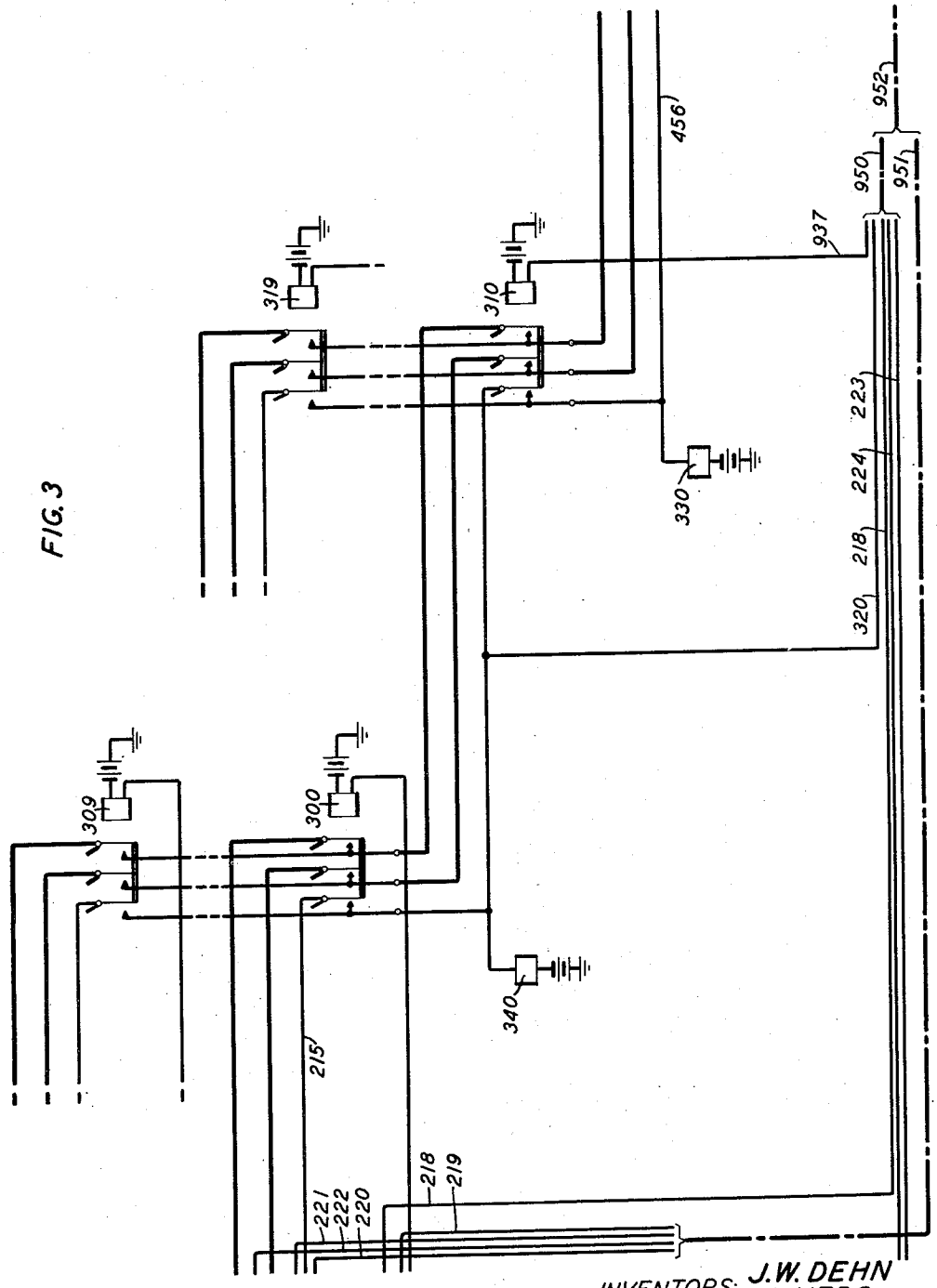

FIG. 3

INVENTORS: J.W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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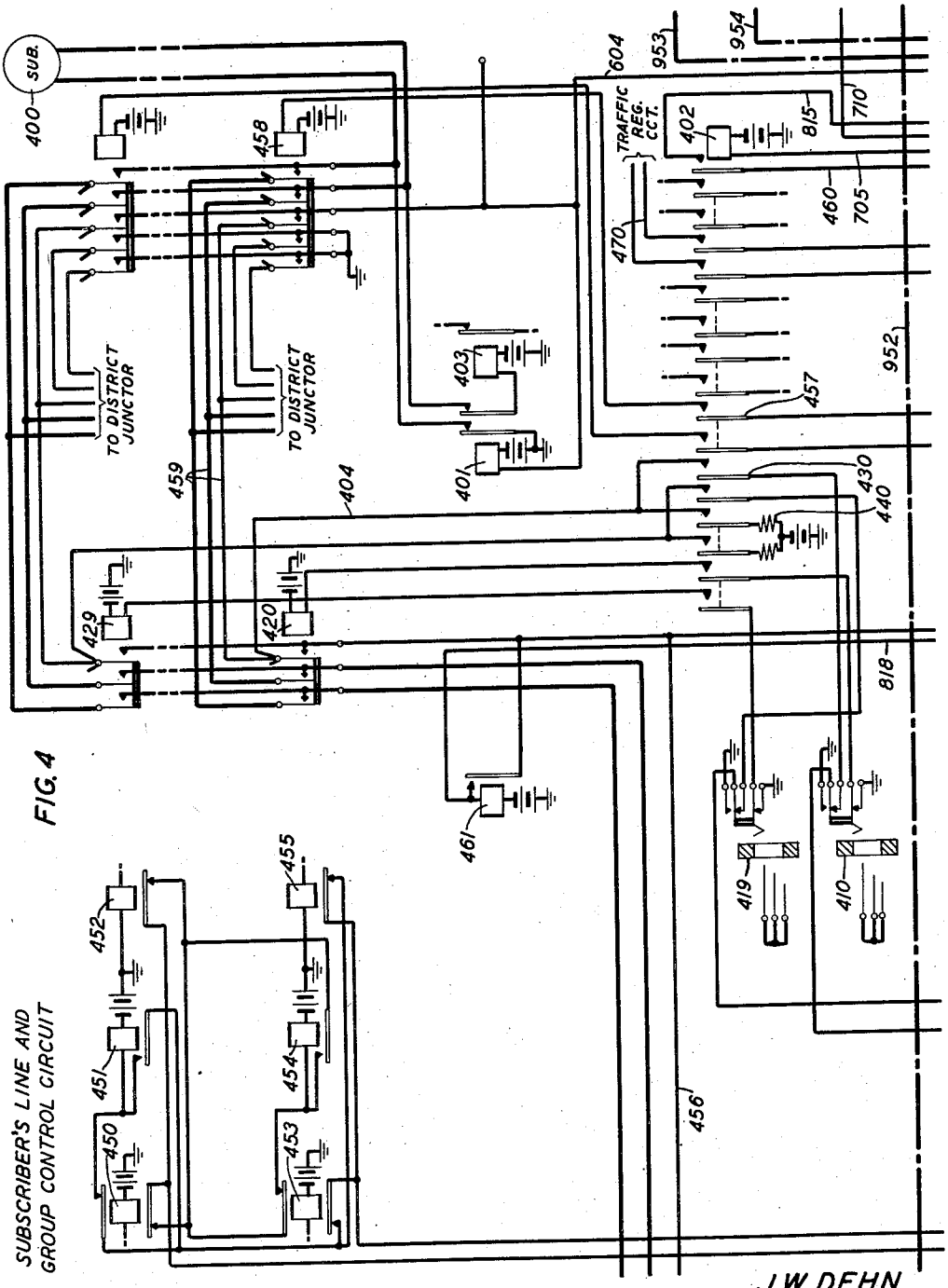

FIG. 4

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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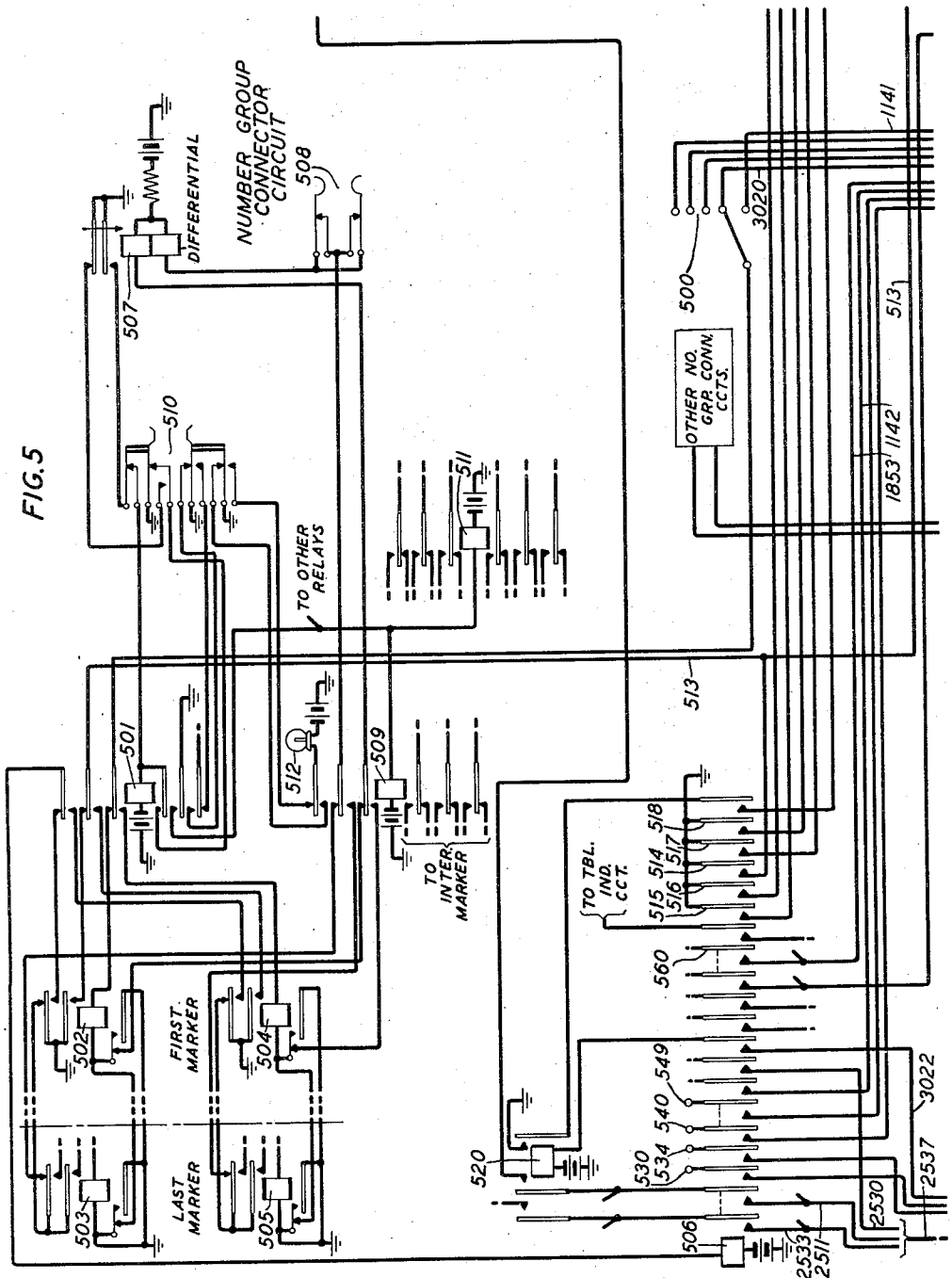
FIG. 5



INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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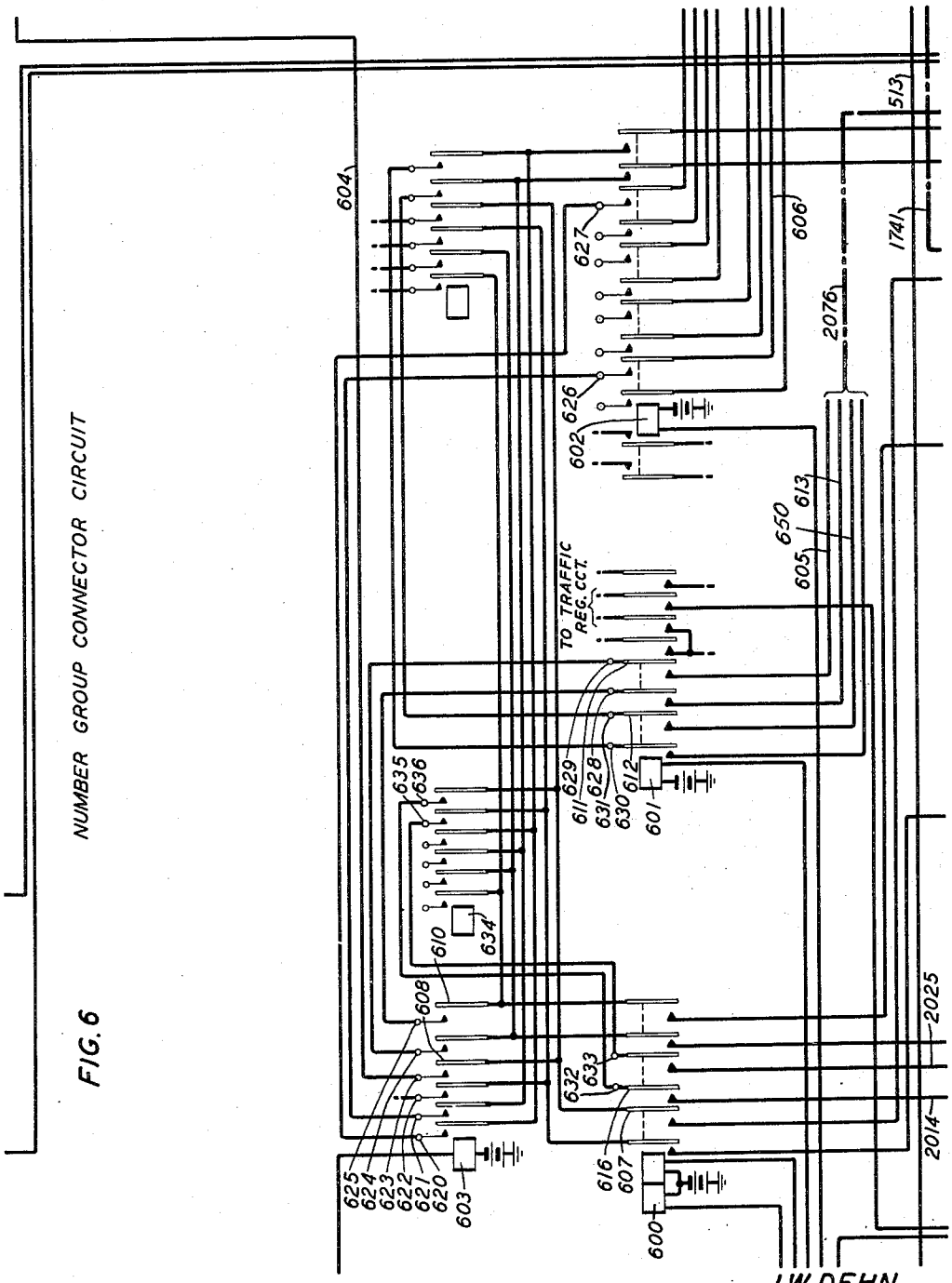

FIG. 6

INVENTORS: J.W. DEHN
O. MYERS

BY P. C. Smith

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TELEPHONE SYSTEM

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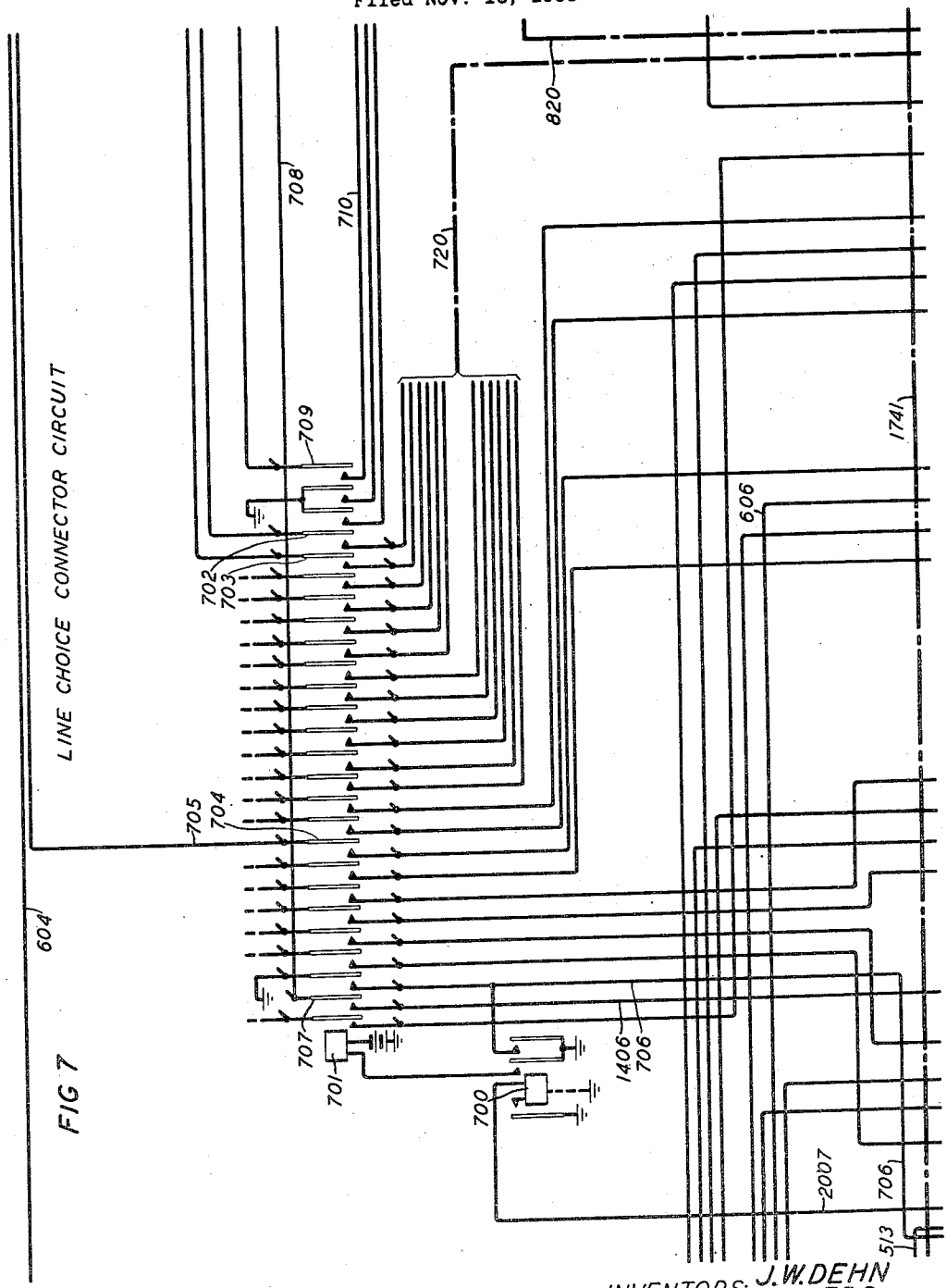

FIG 7

INVENTORS: J. W. DEHN
O. MYERS
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ATTORNEY

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TELEPHONE SYSTEM

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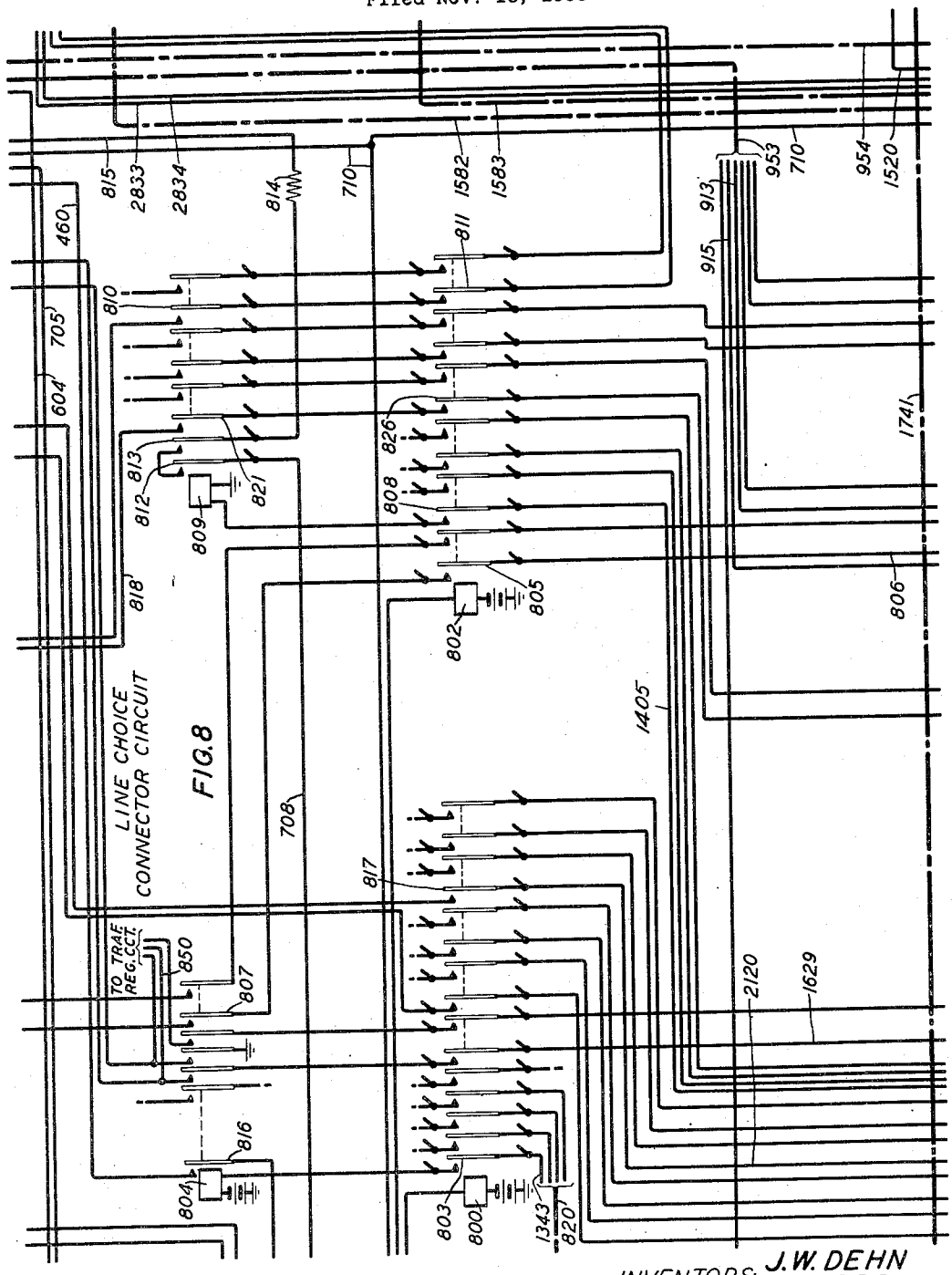

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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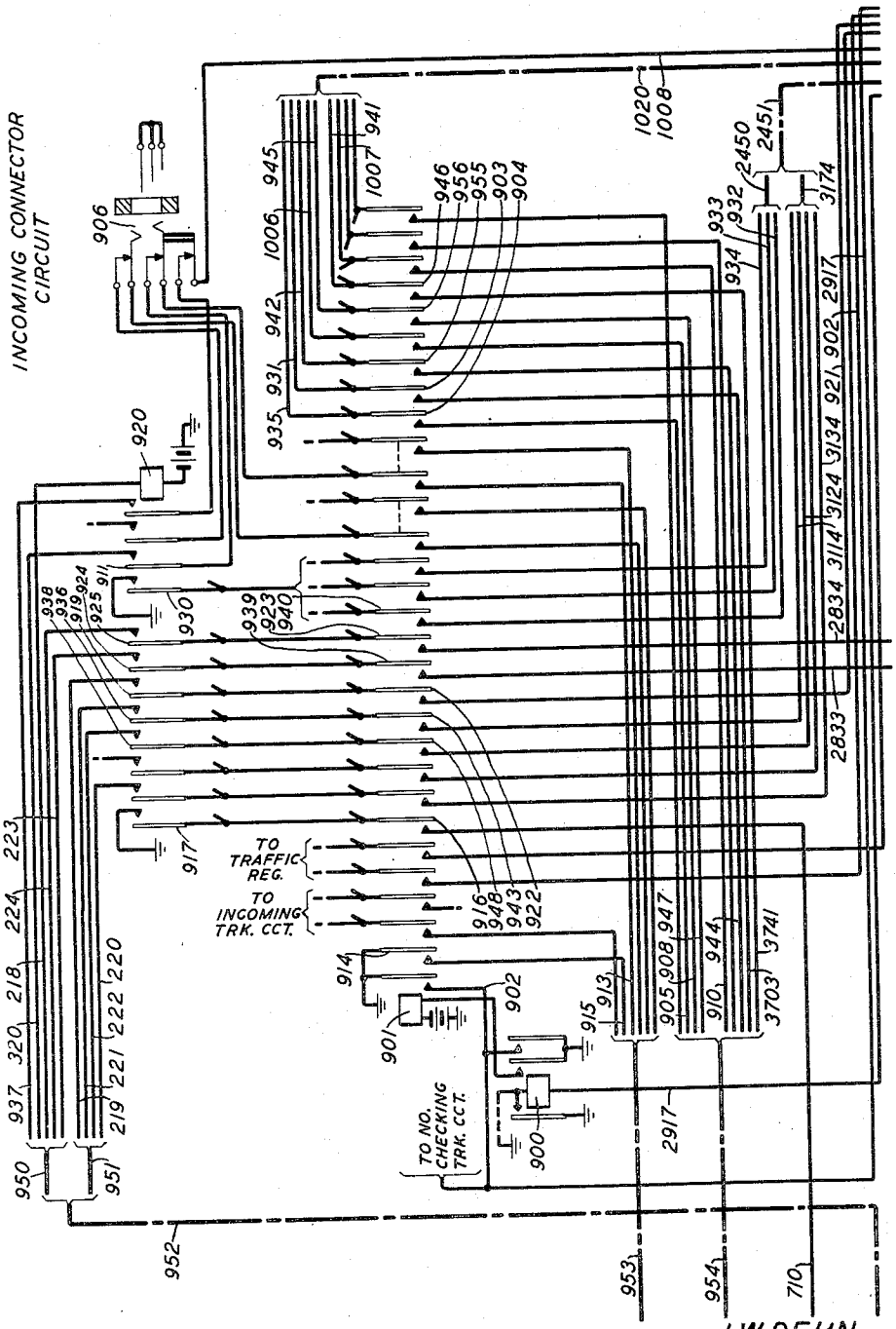

FIG. 9

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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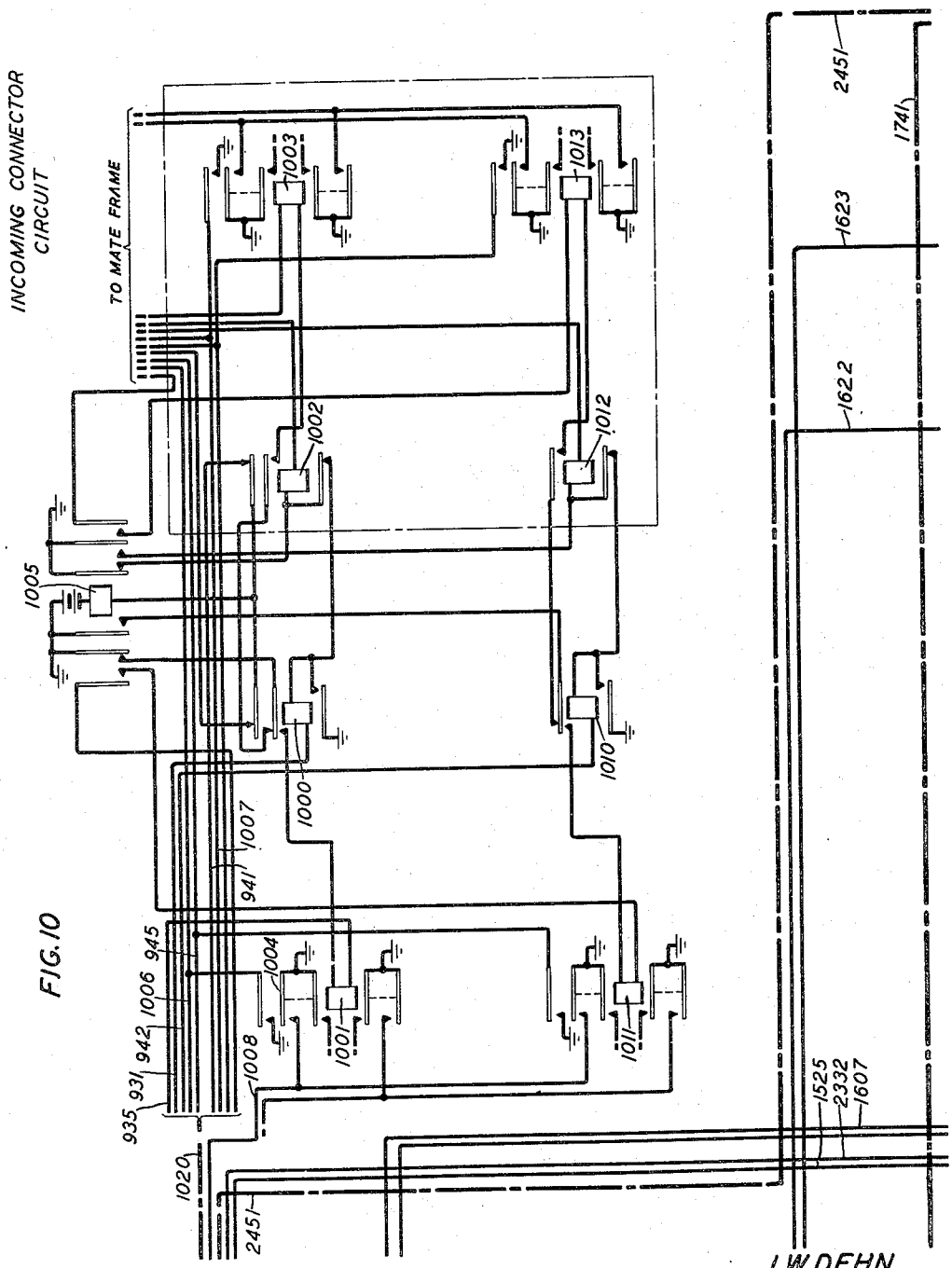

FIG. 10

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
ATTORNEY

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TELEPHONE SYSTEM

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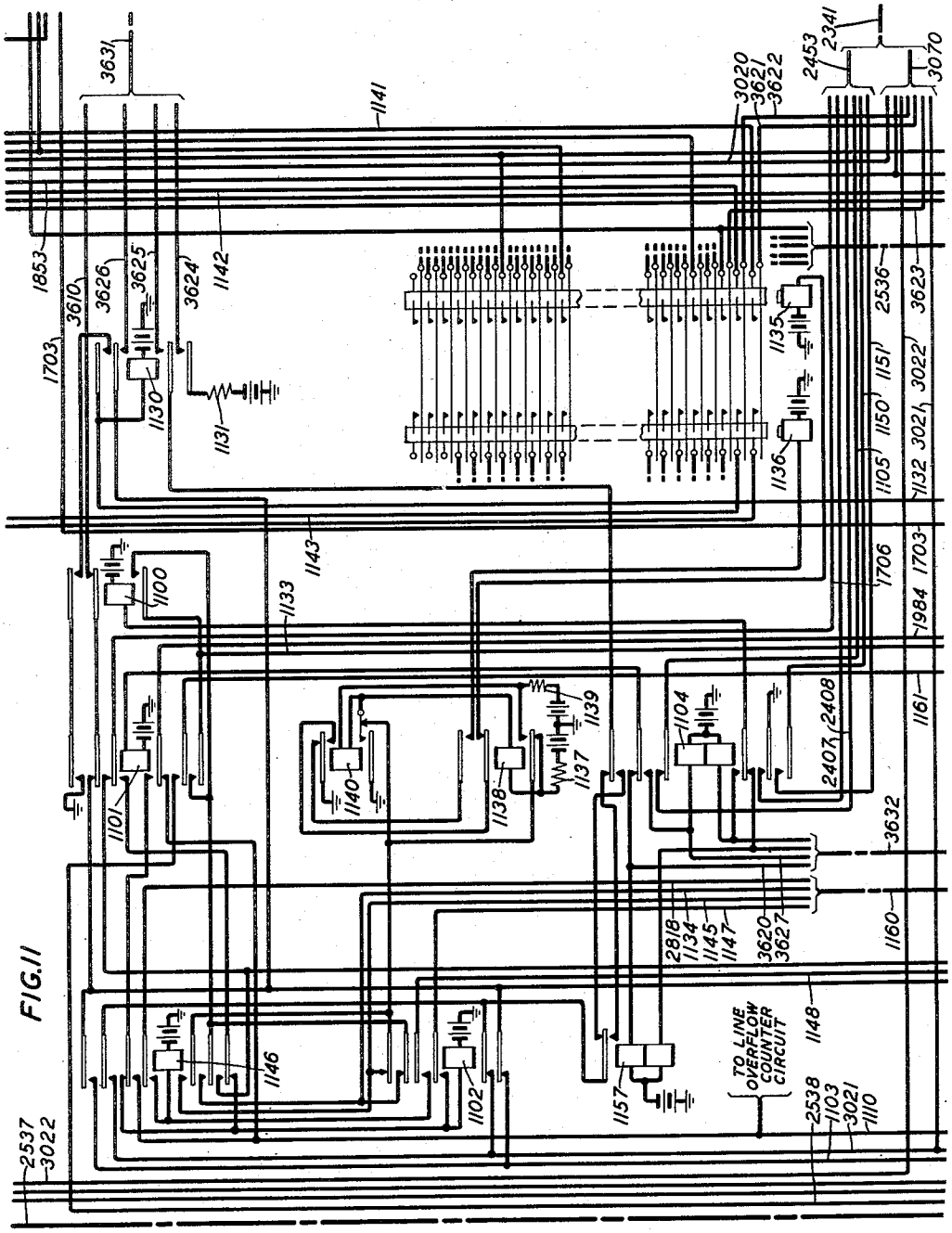

FIG. 11

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith

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Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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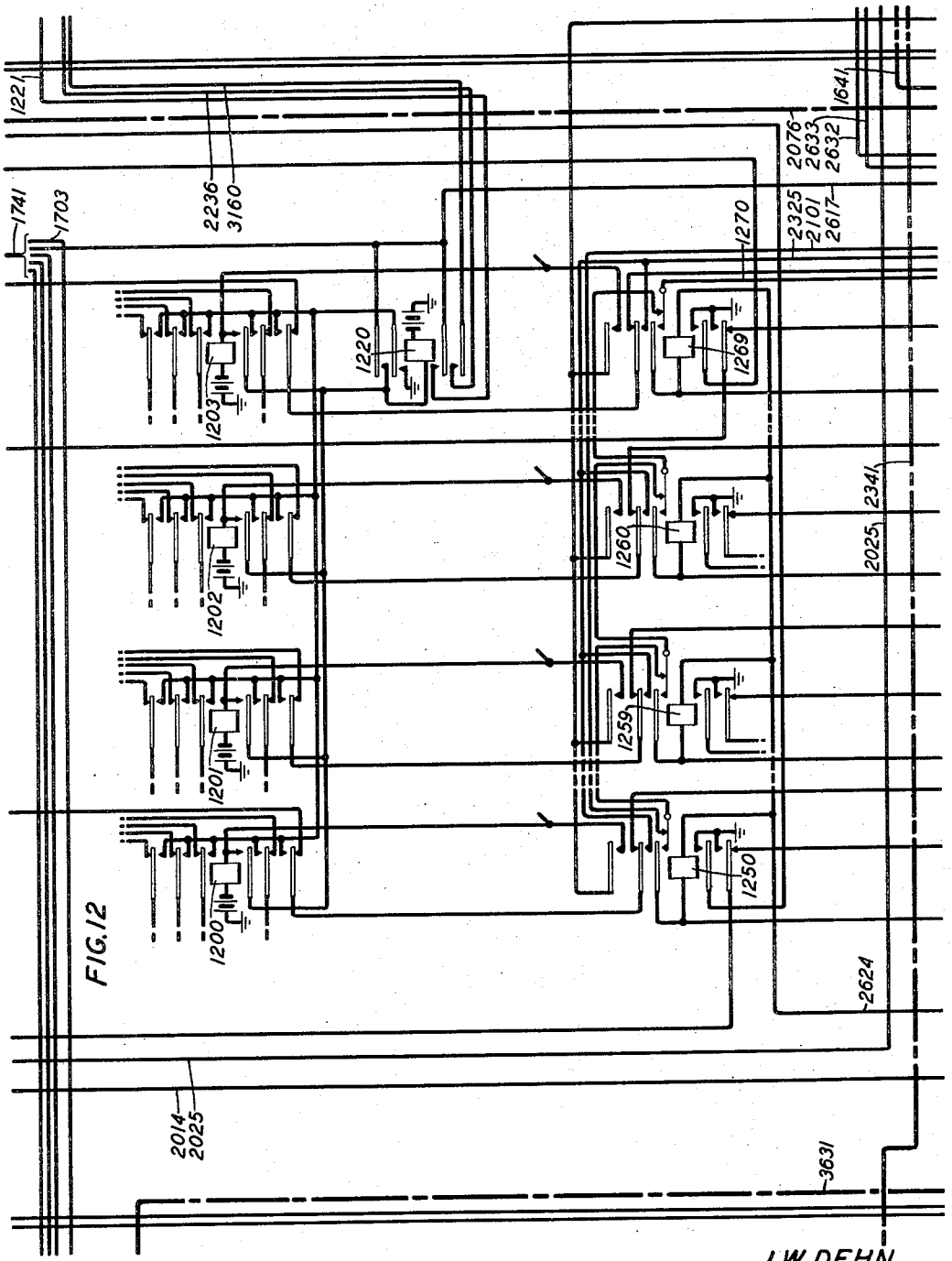

FIG. 12

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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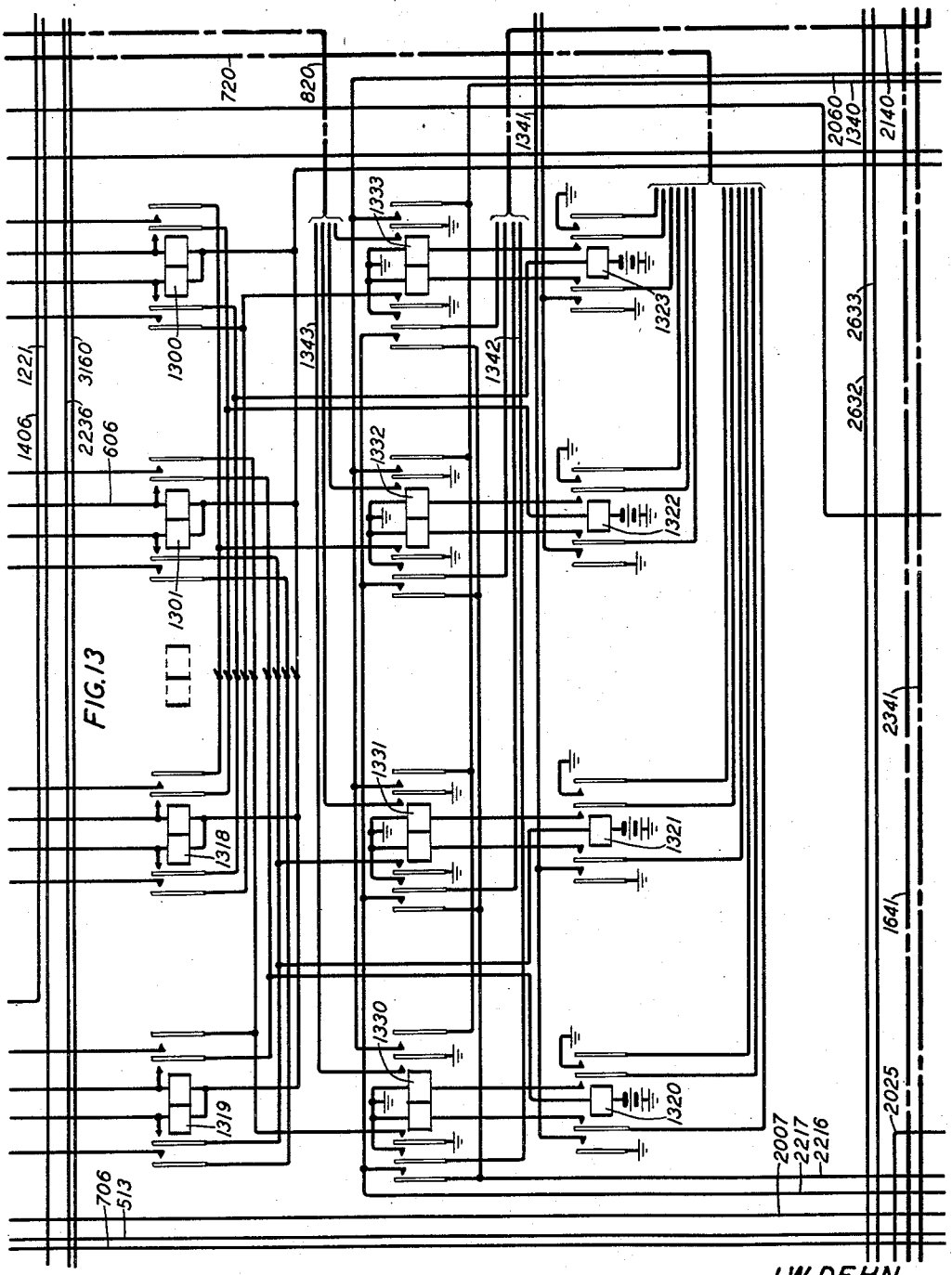

FIG. 13

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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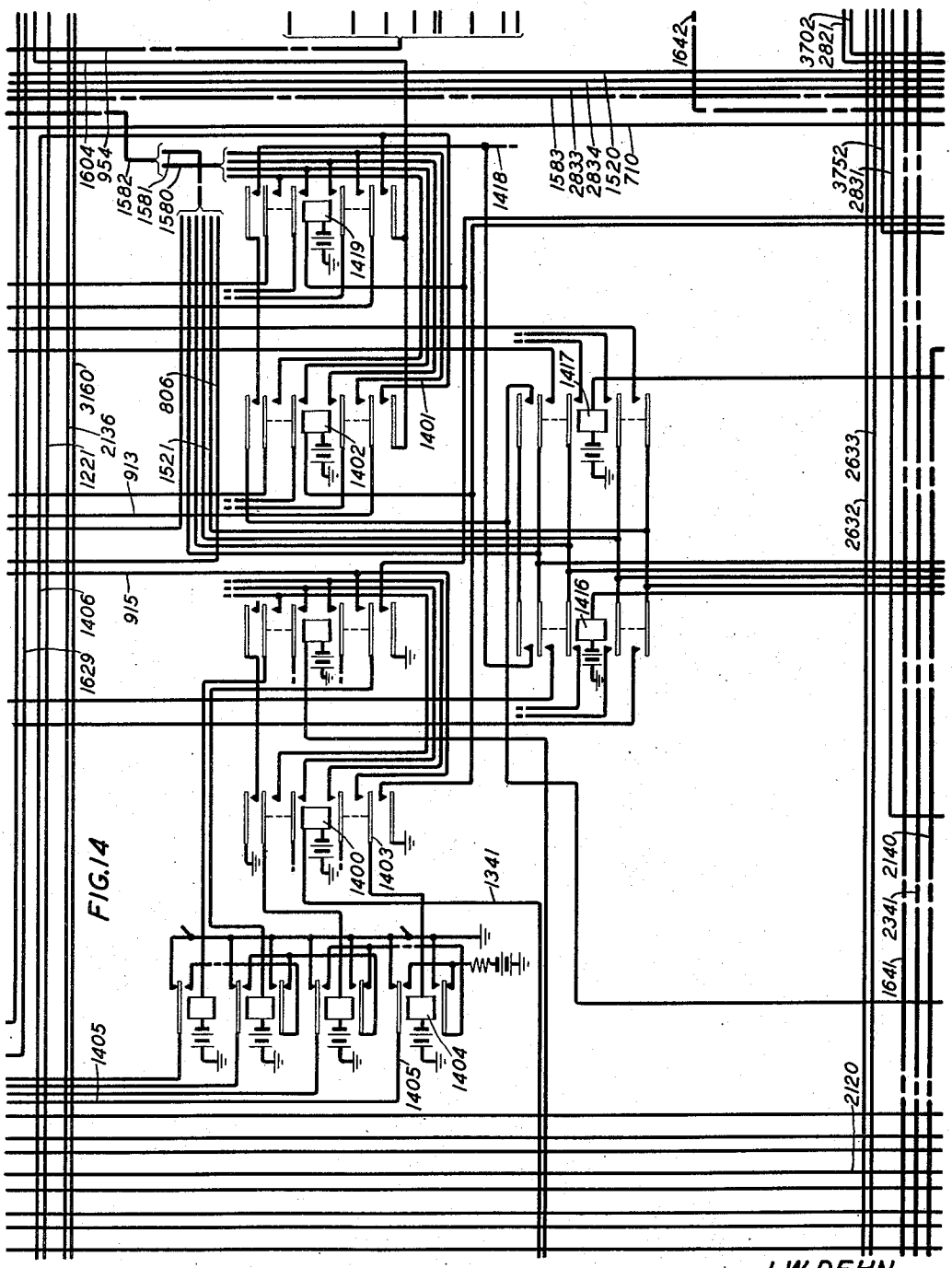

FIG. 14

INVENTORS: J. W. DEHN
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BY P. C. Smith
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TELEPHONE SYSTEM

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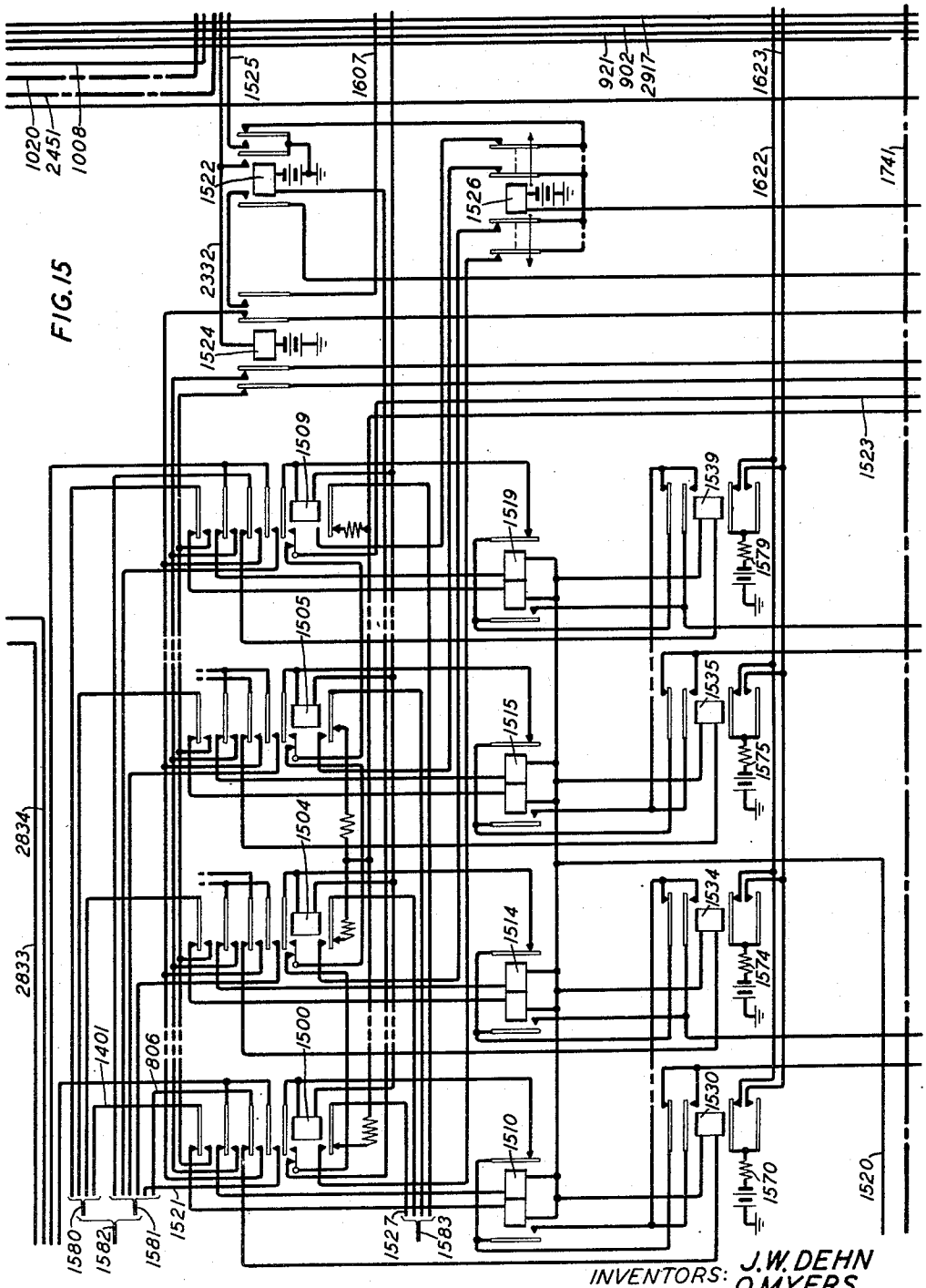

FIG. 15

INVENTORS: J. W. DEHN
O. MYERS
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TELEPHONE SYSTEM

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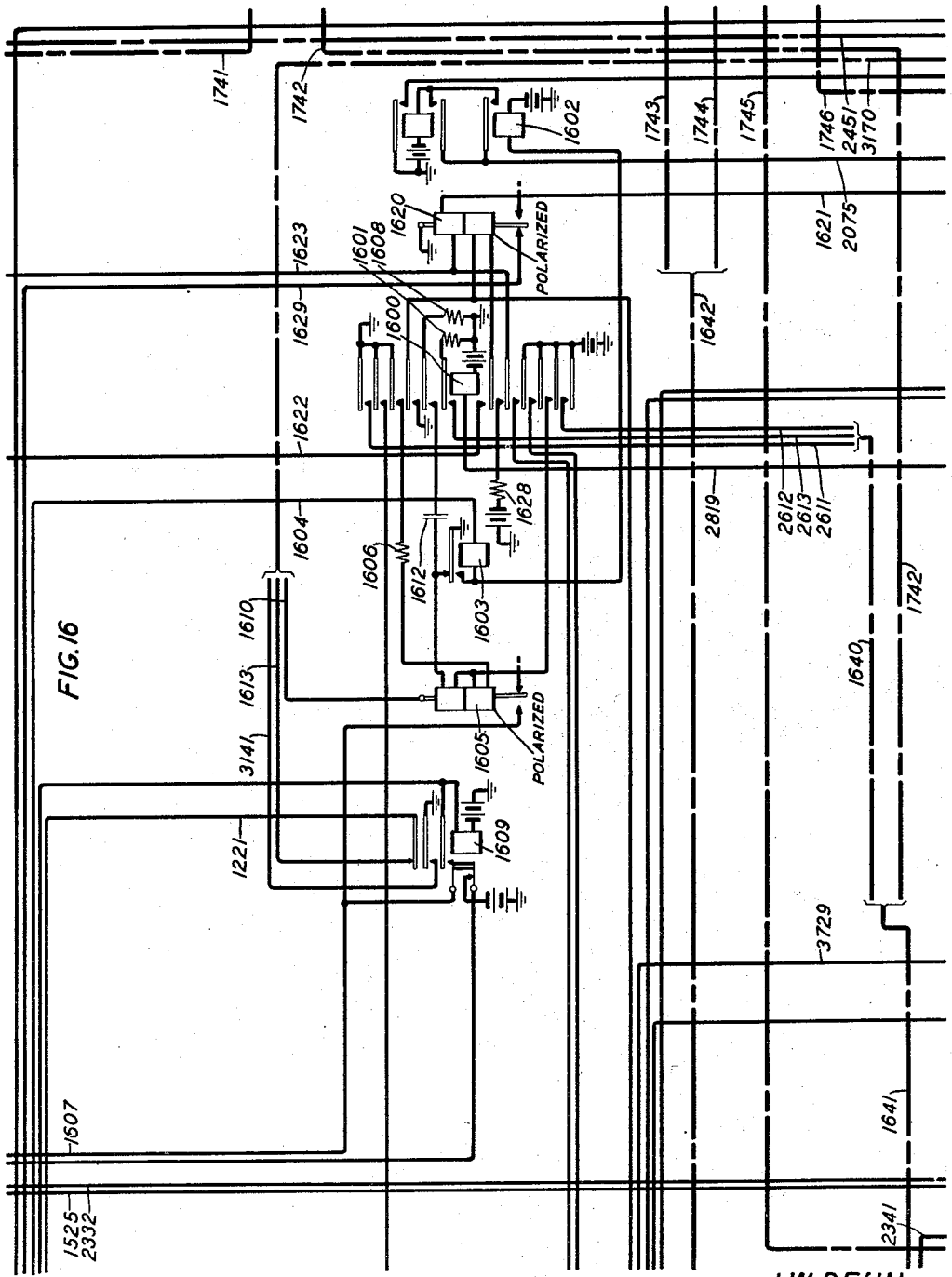

FIG. 16

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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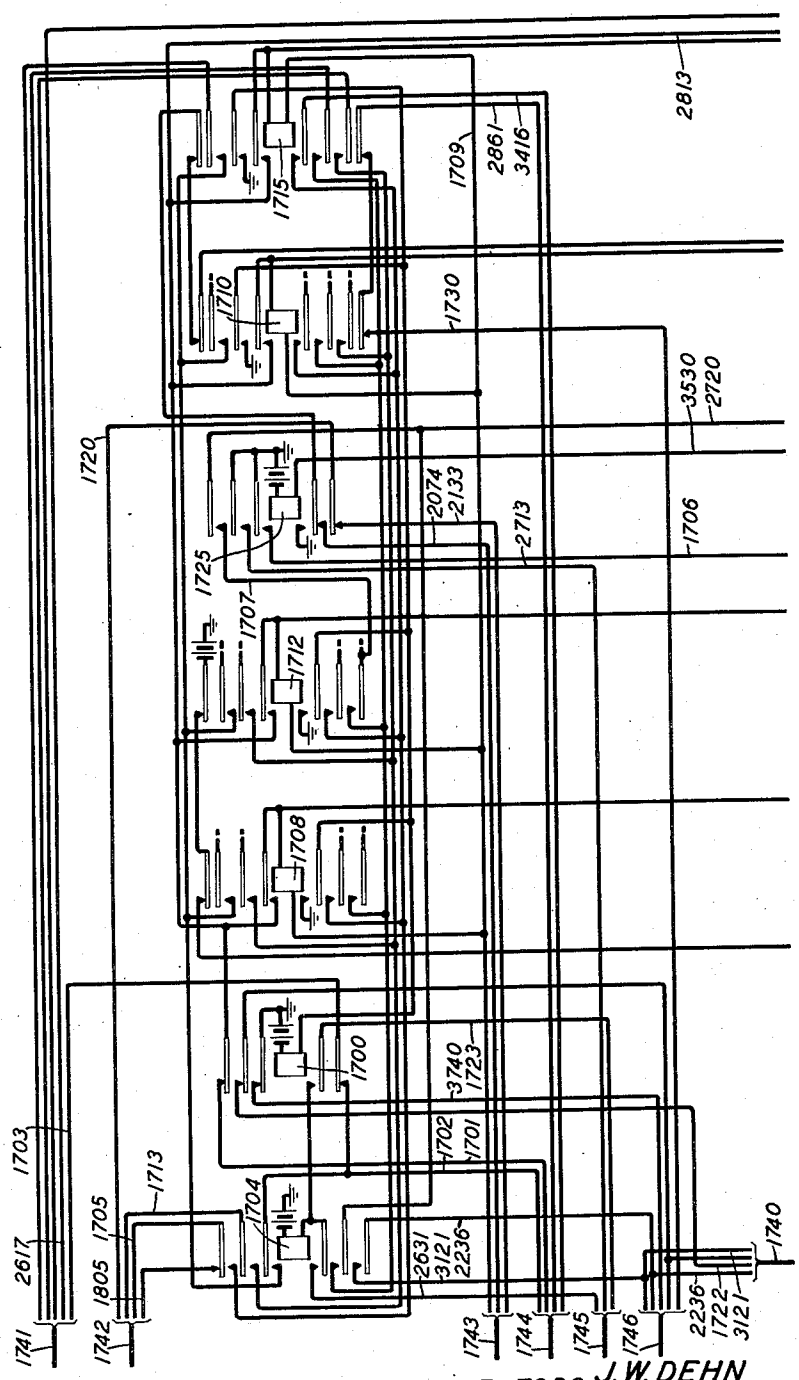
FIG. 17



INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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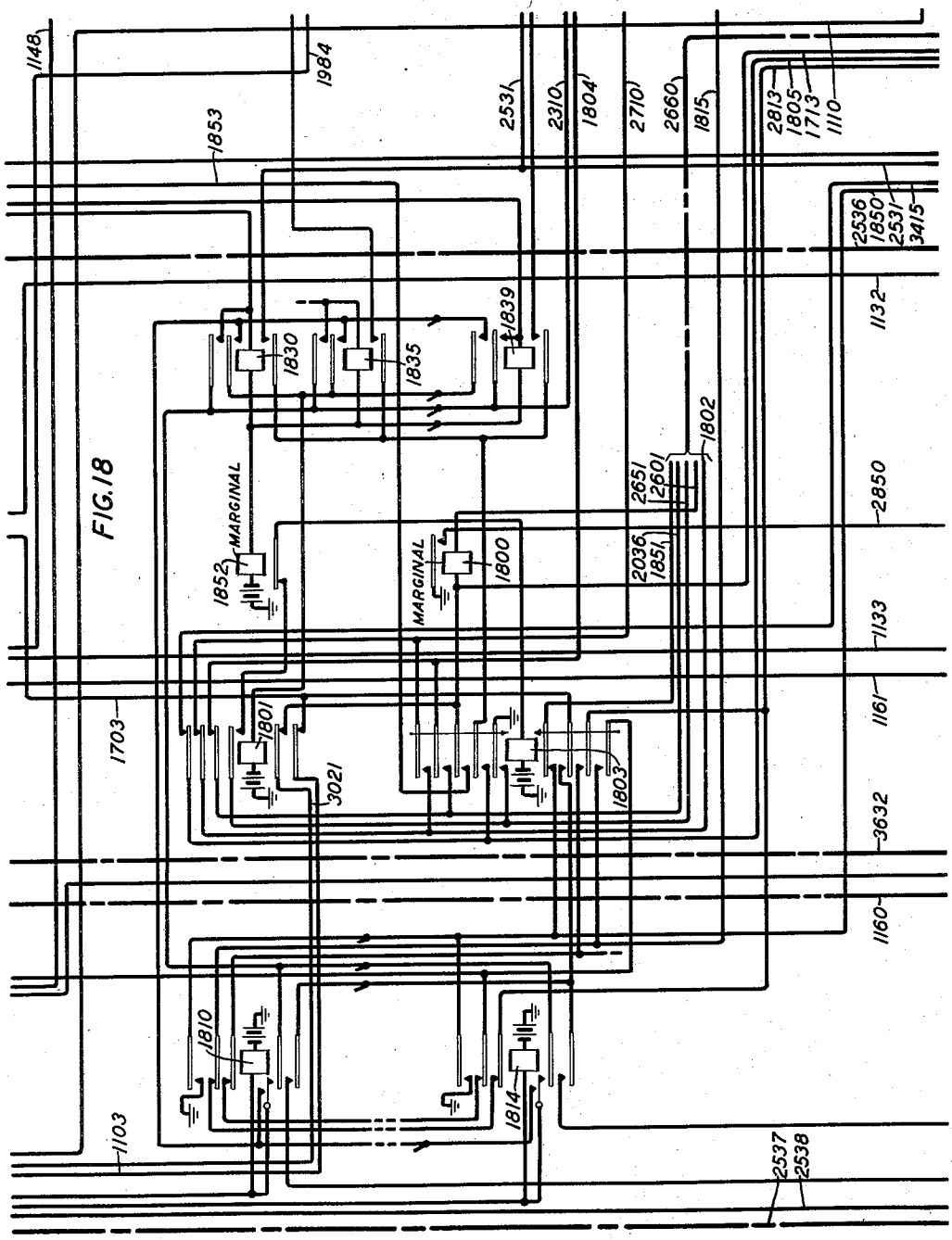

FIG. 18

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

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TELEPHONE SYSTEM

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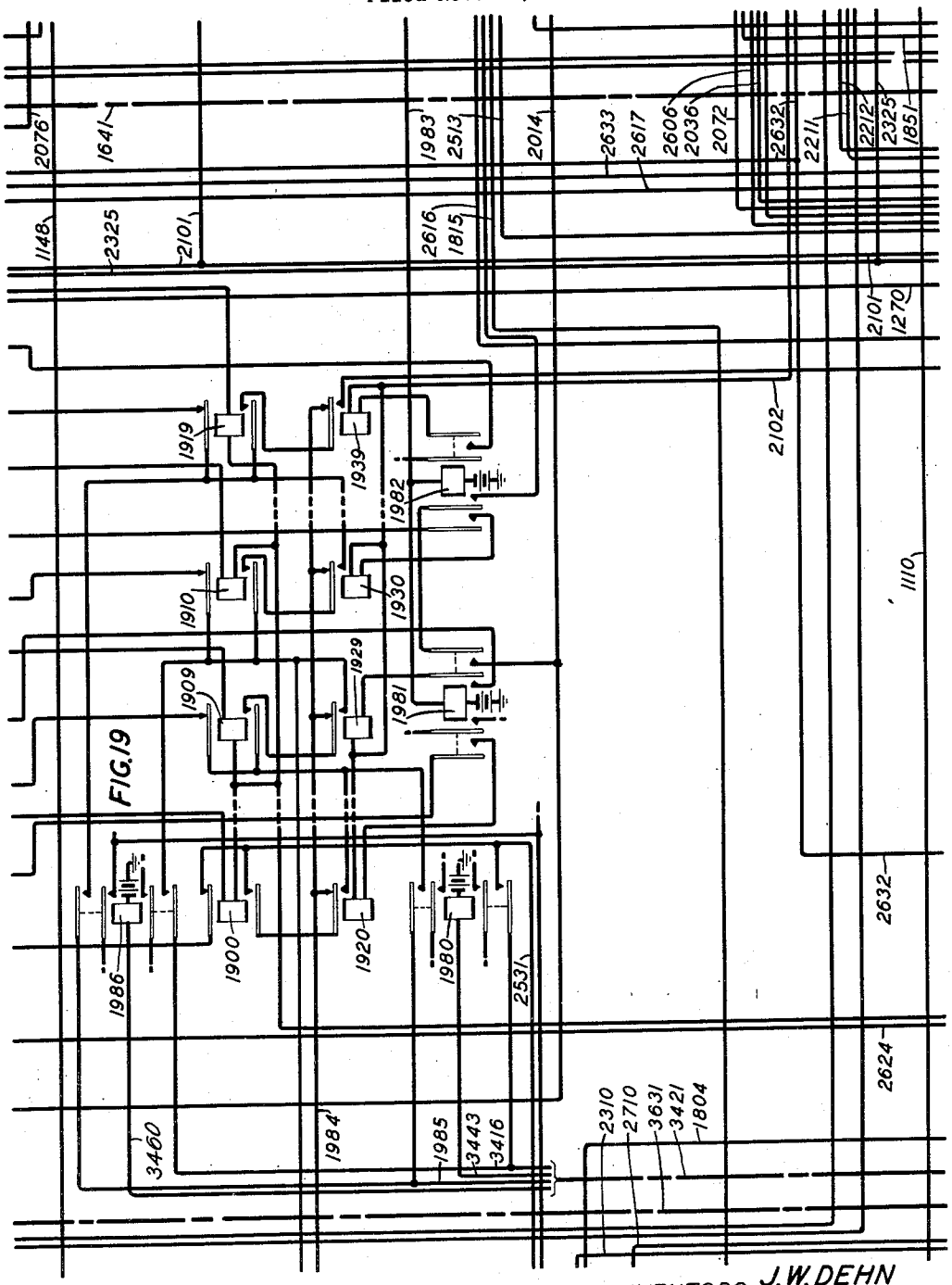

FIG. 19

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

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TELEPHONE SYSTEM

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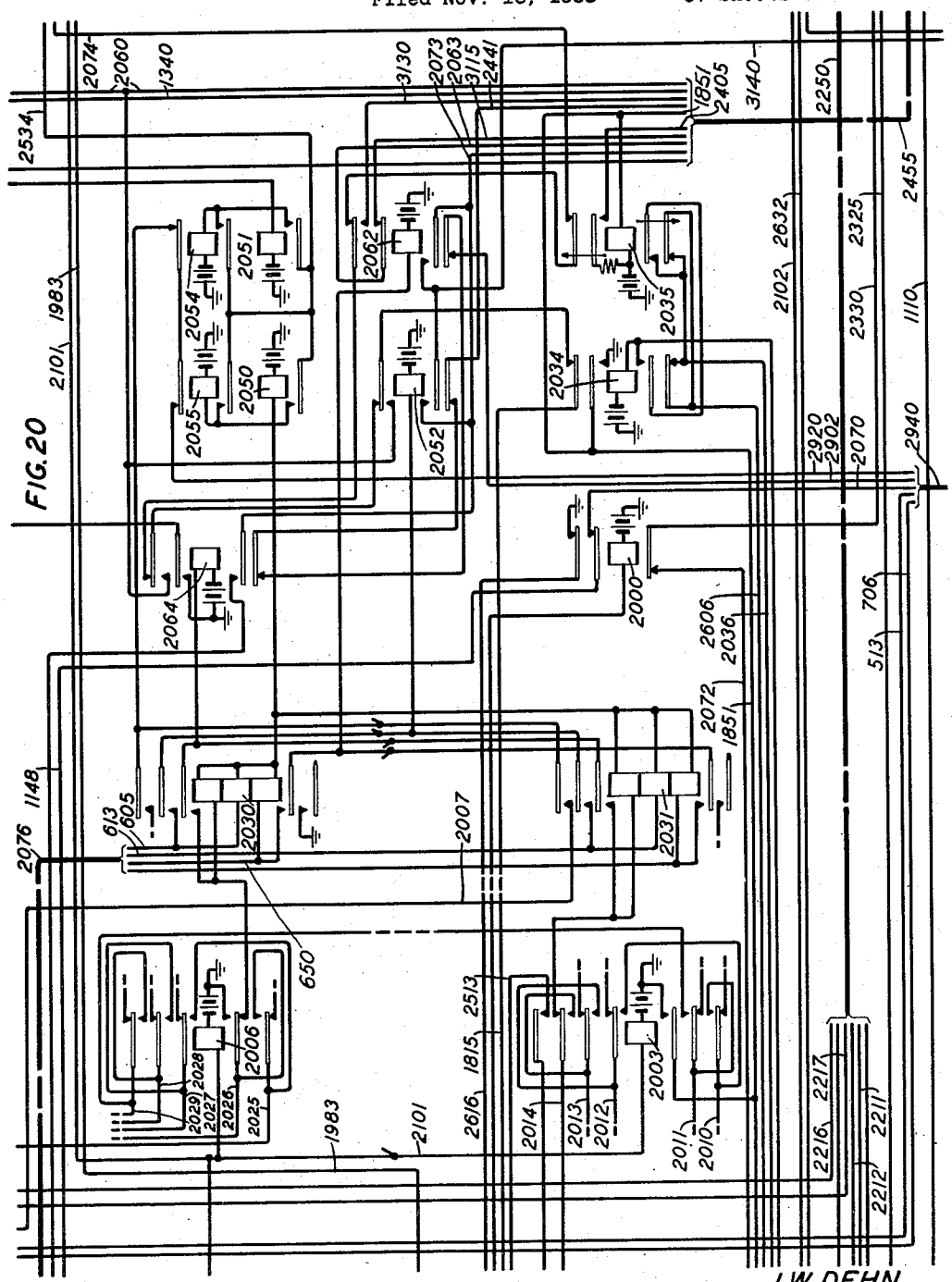

FIG. 20

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
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TELEPHONE SYSTEM

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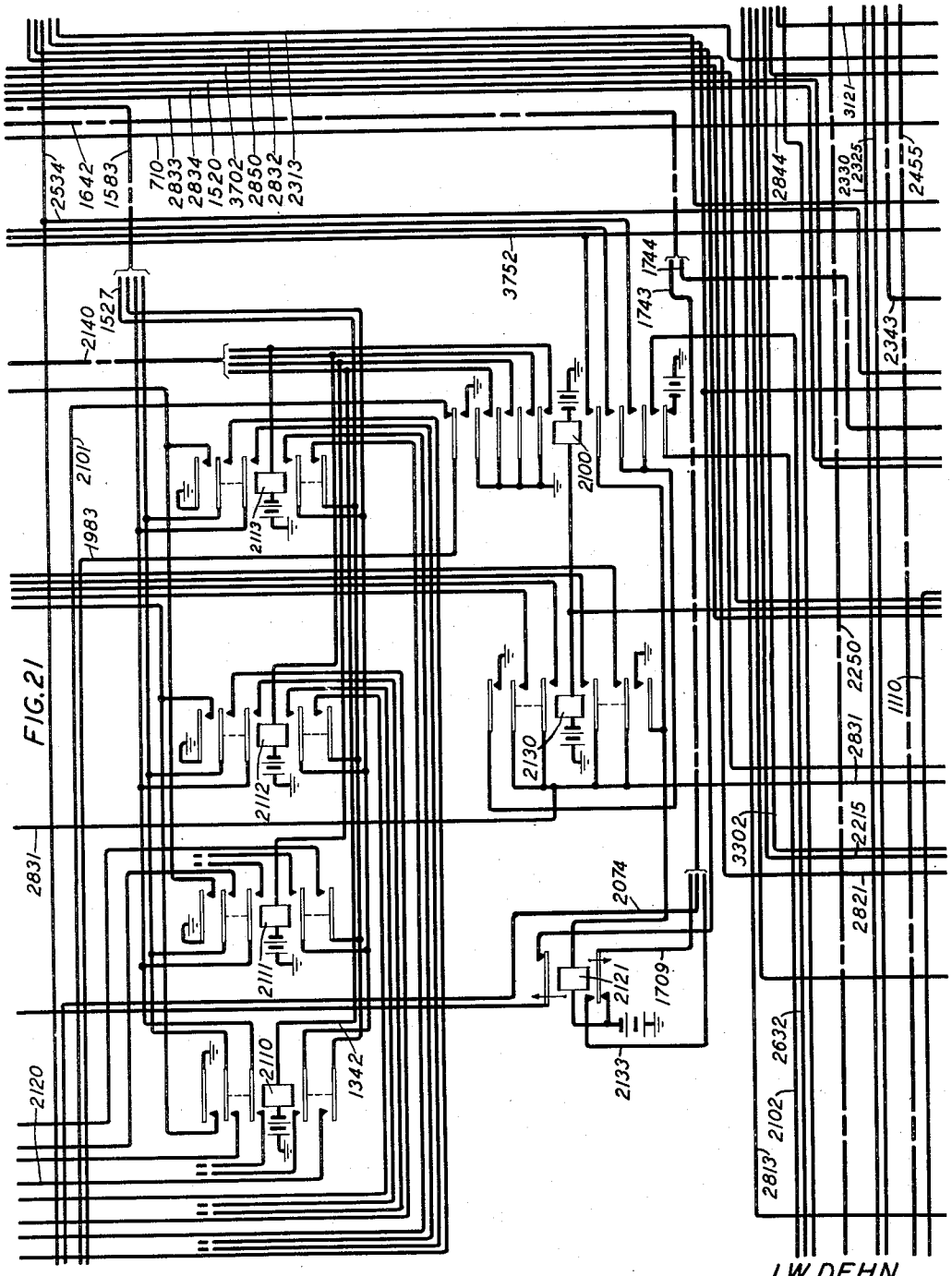

FIG. 21

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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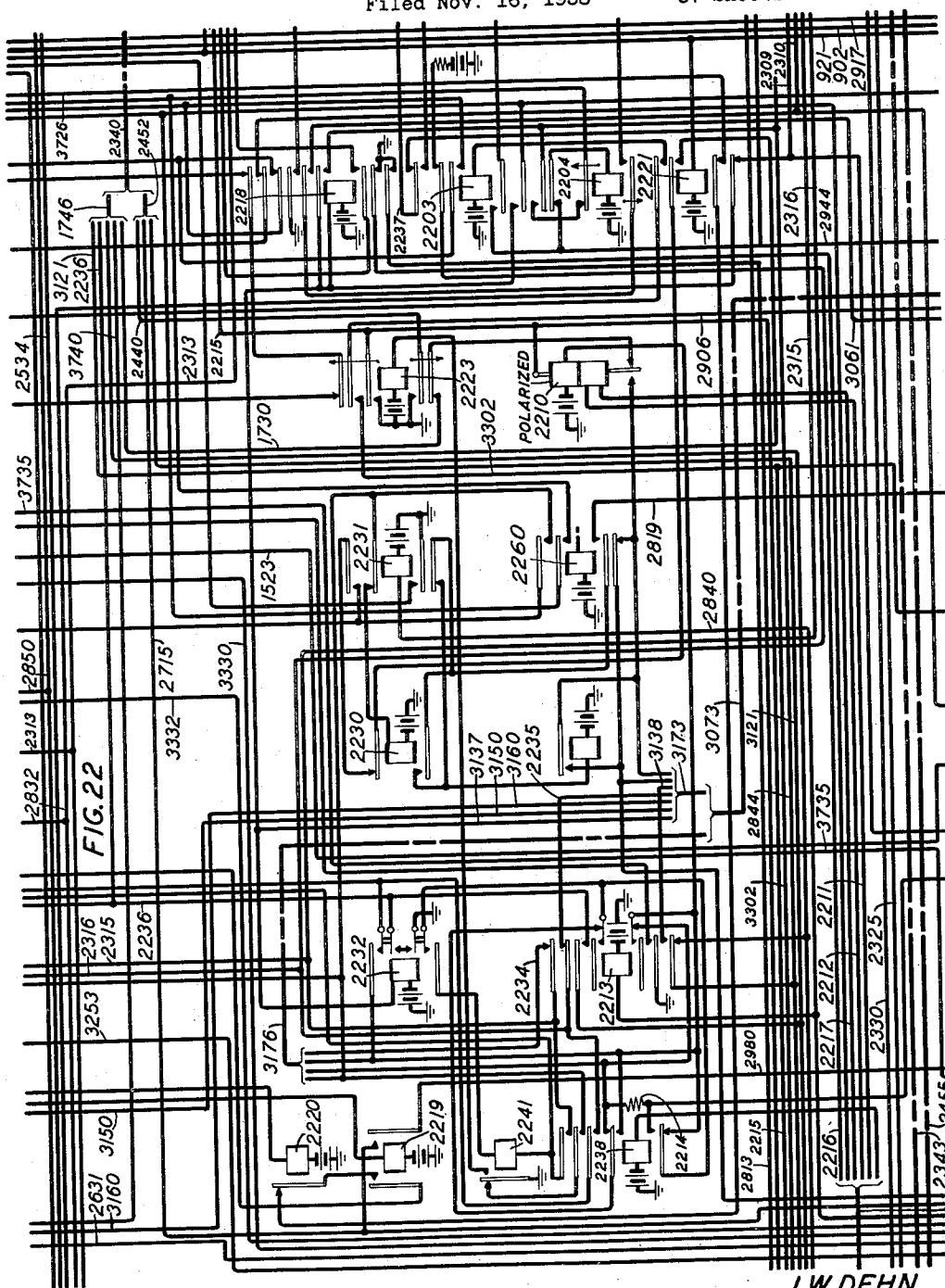

FIG. 22

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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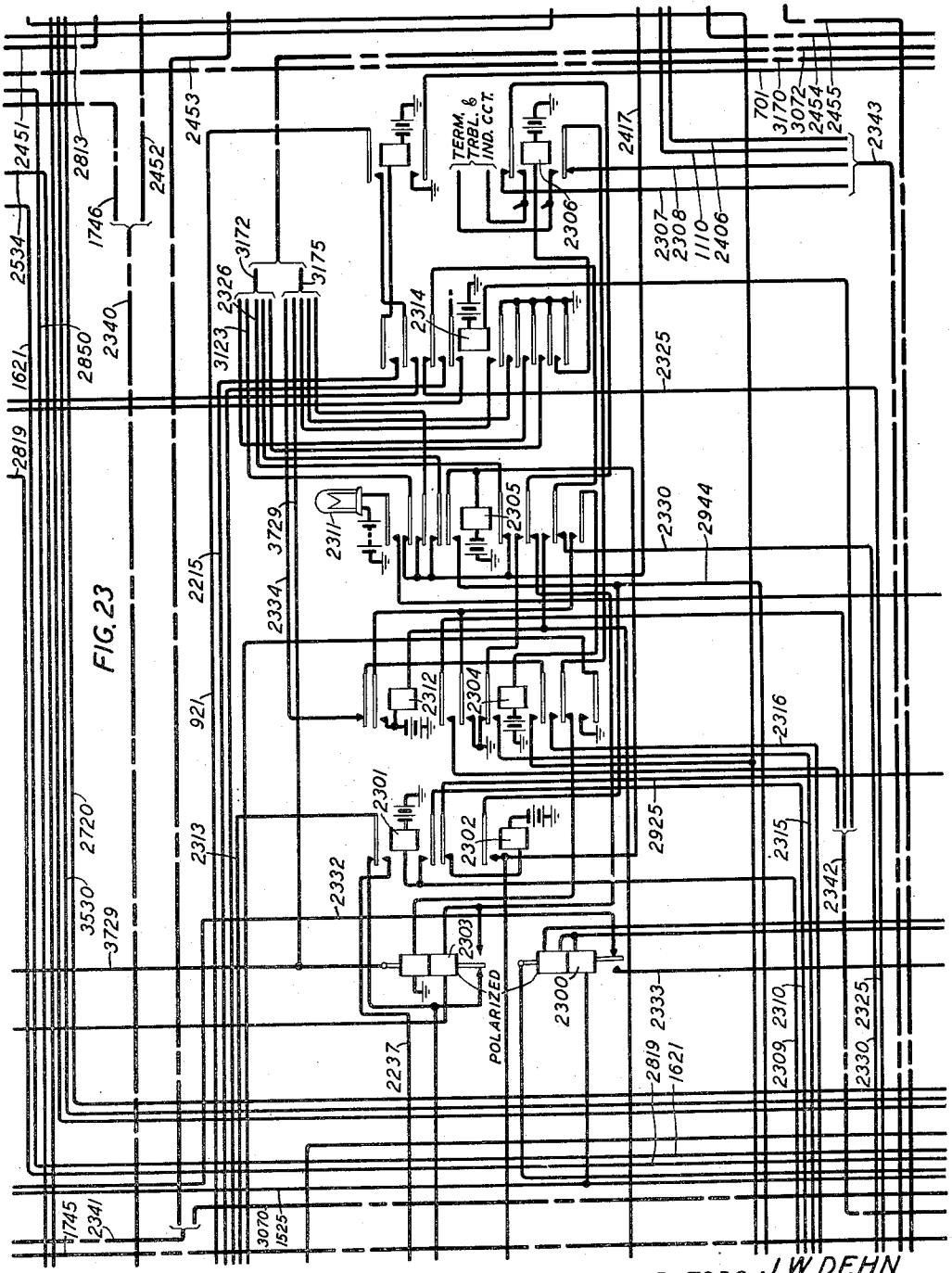

FIG. 23

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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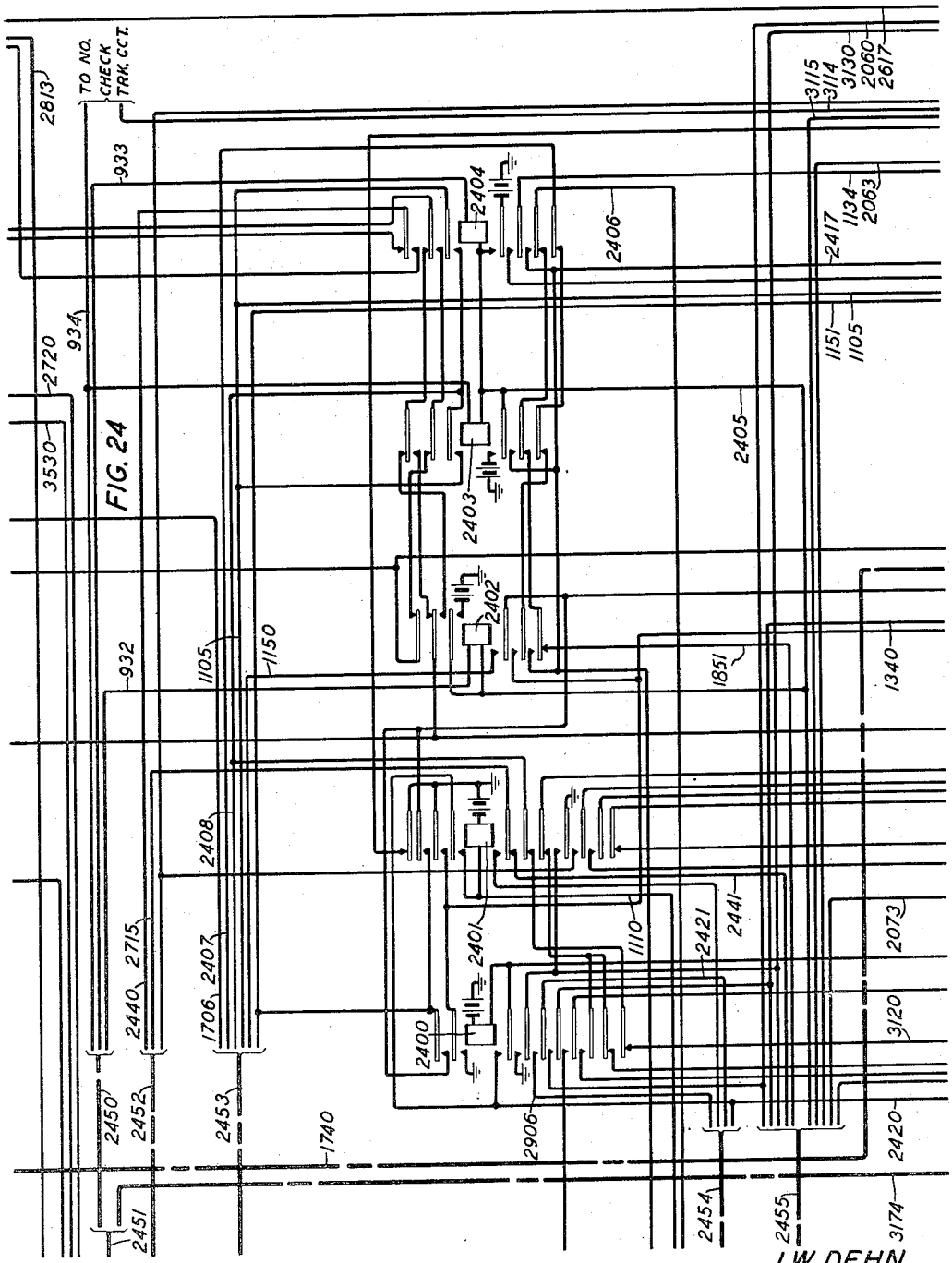

FIG. 24

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith

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Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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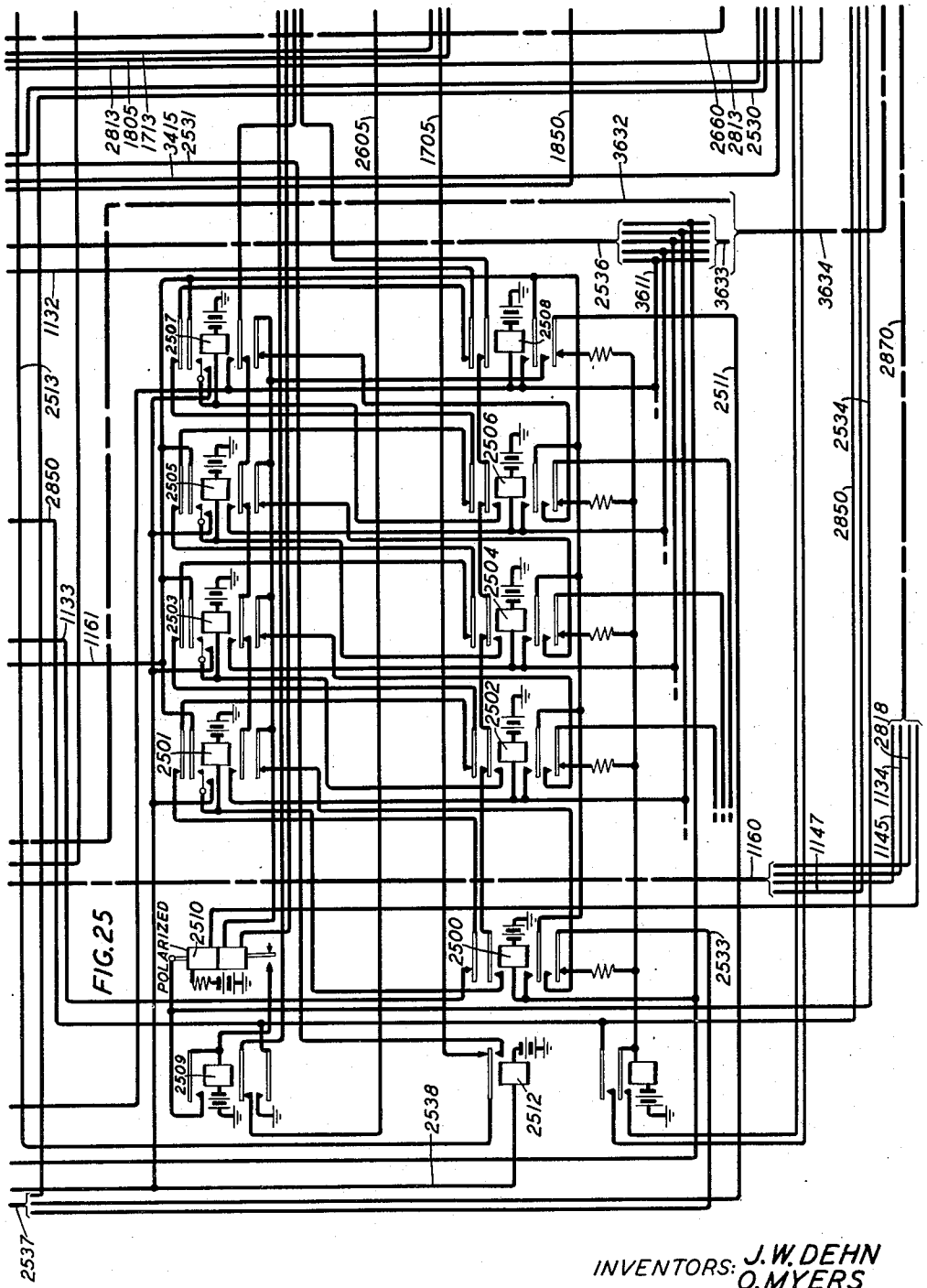

FIG. 25

INVENTORS: J. W. DEHN
O. MYERS

BY

P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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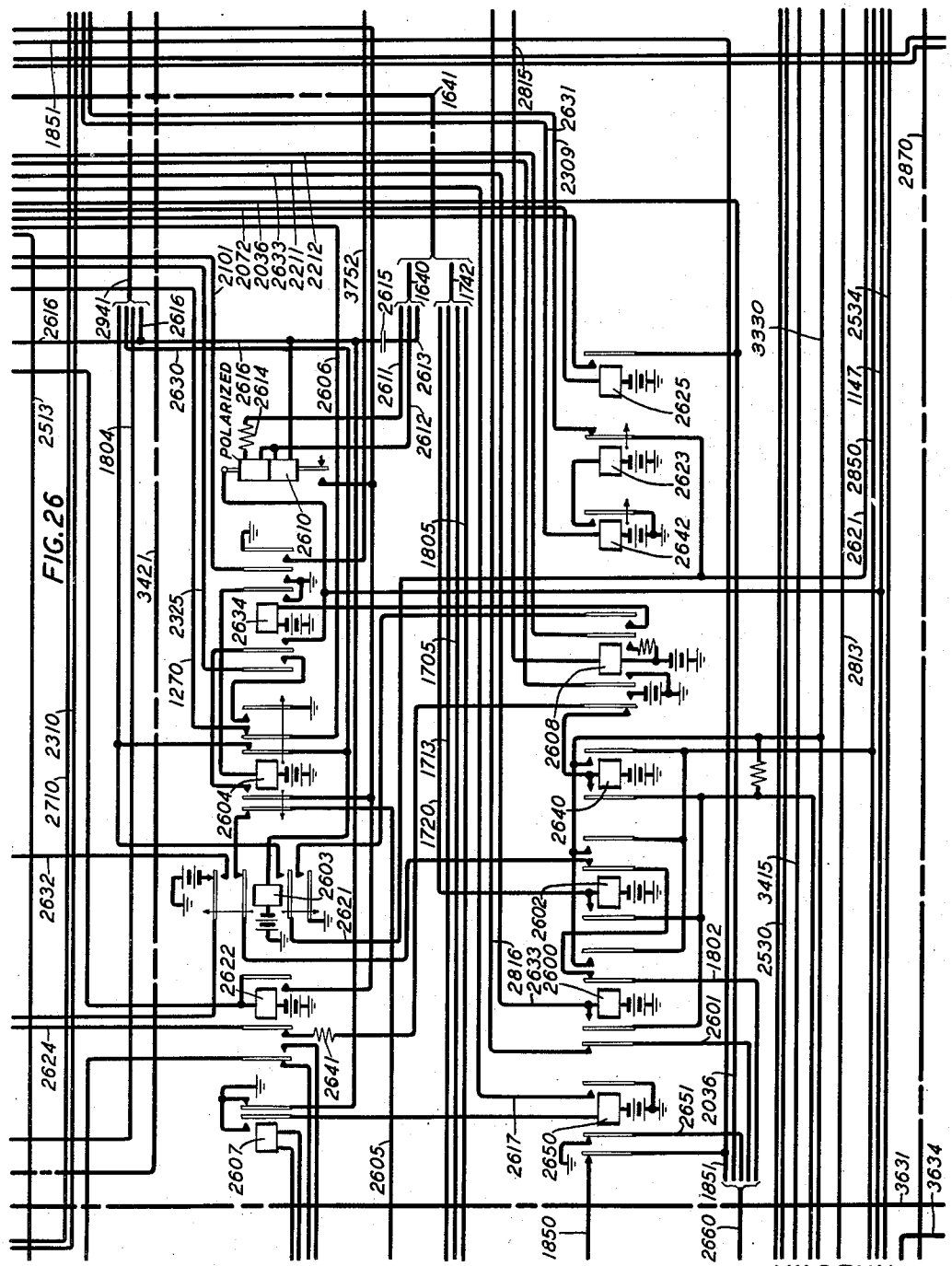

FIG. 26

INVENTORS: J. W. DEHN
O. MYERS

BY R. C. Smith

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Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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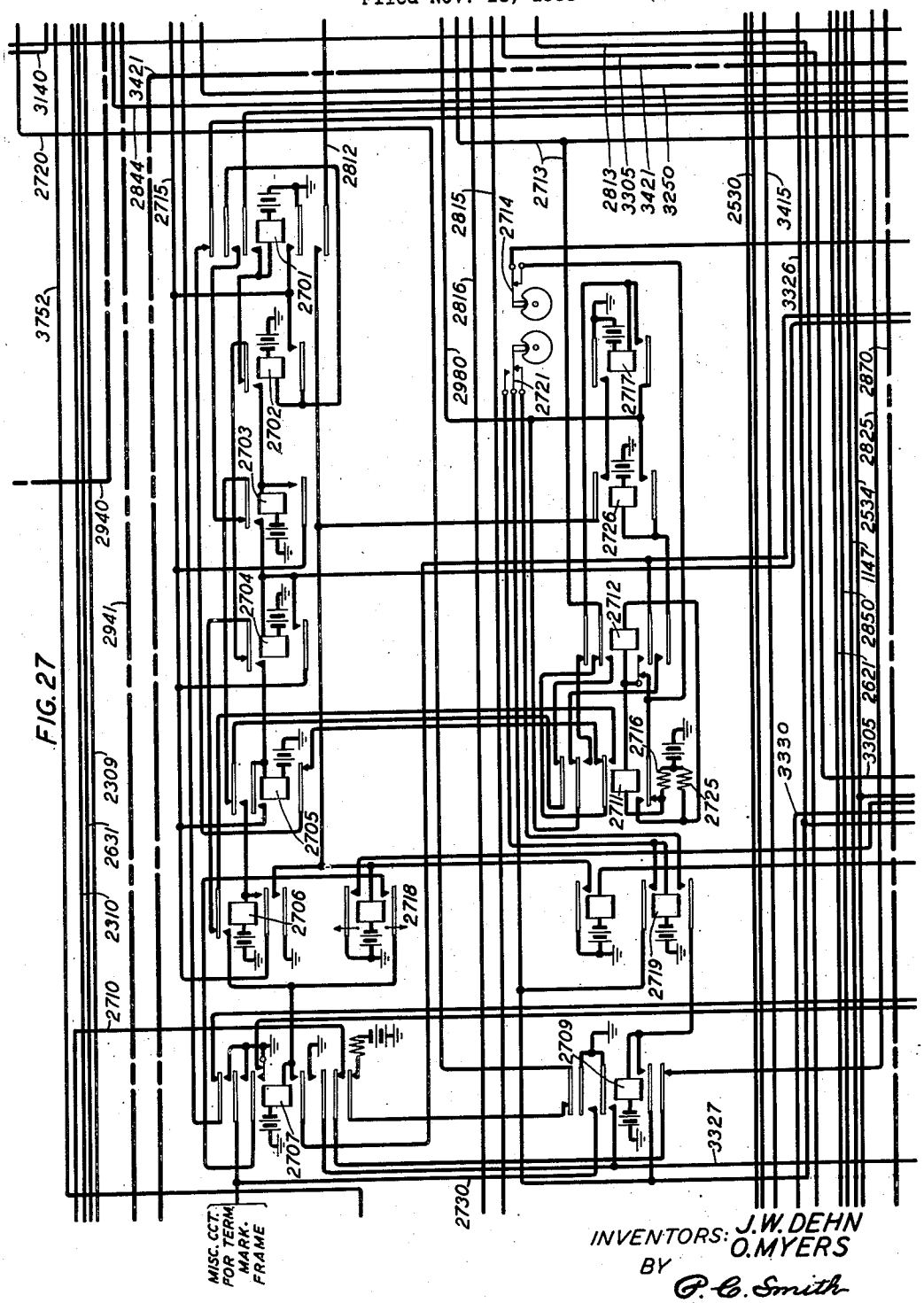

FIG. 27

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
ATTORNEY

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TELEPHONE SYSTEM

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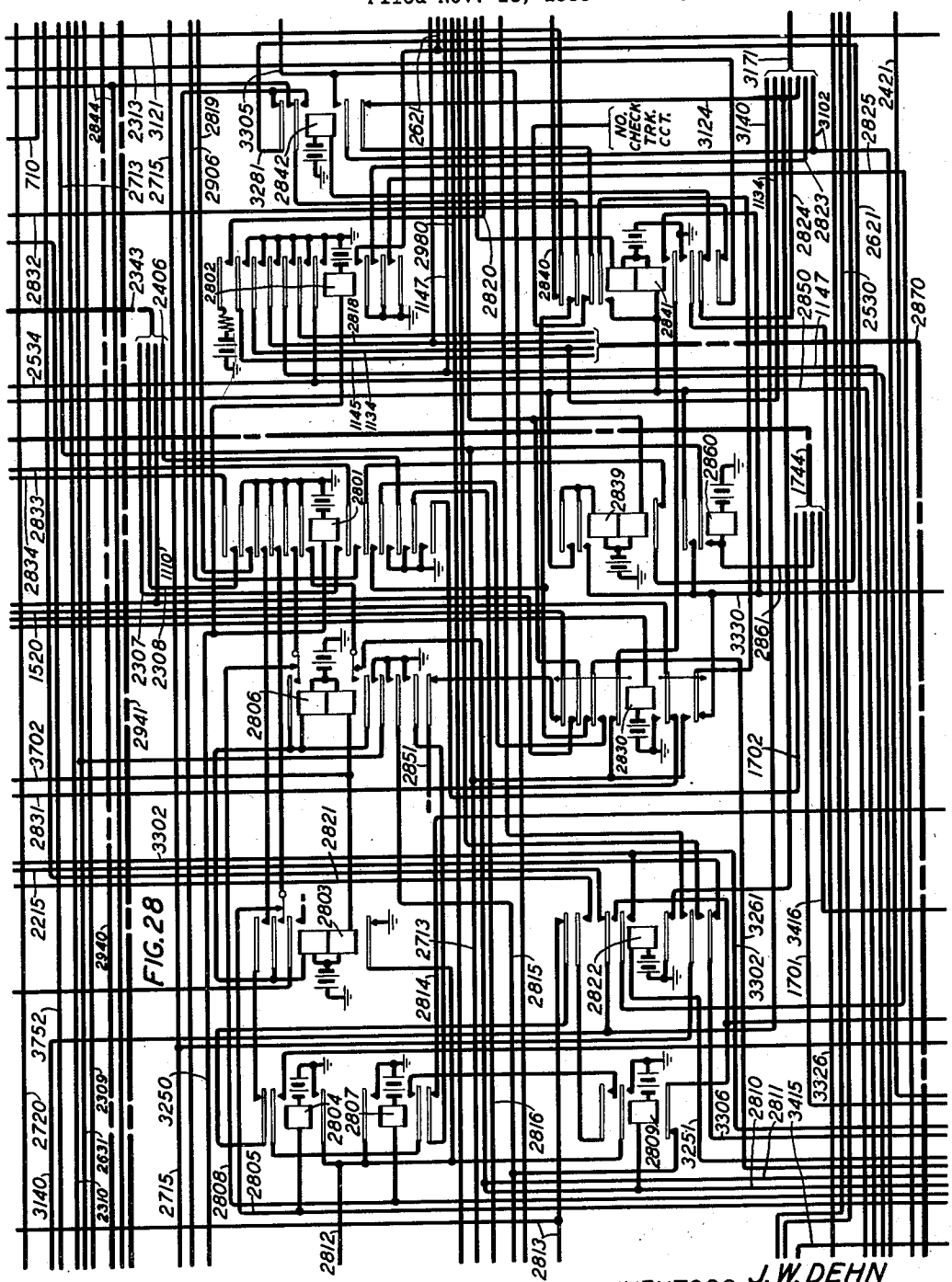

FIG. 28

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith
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Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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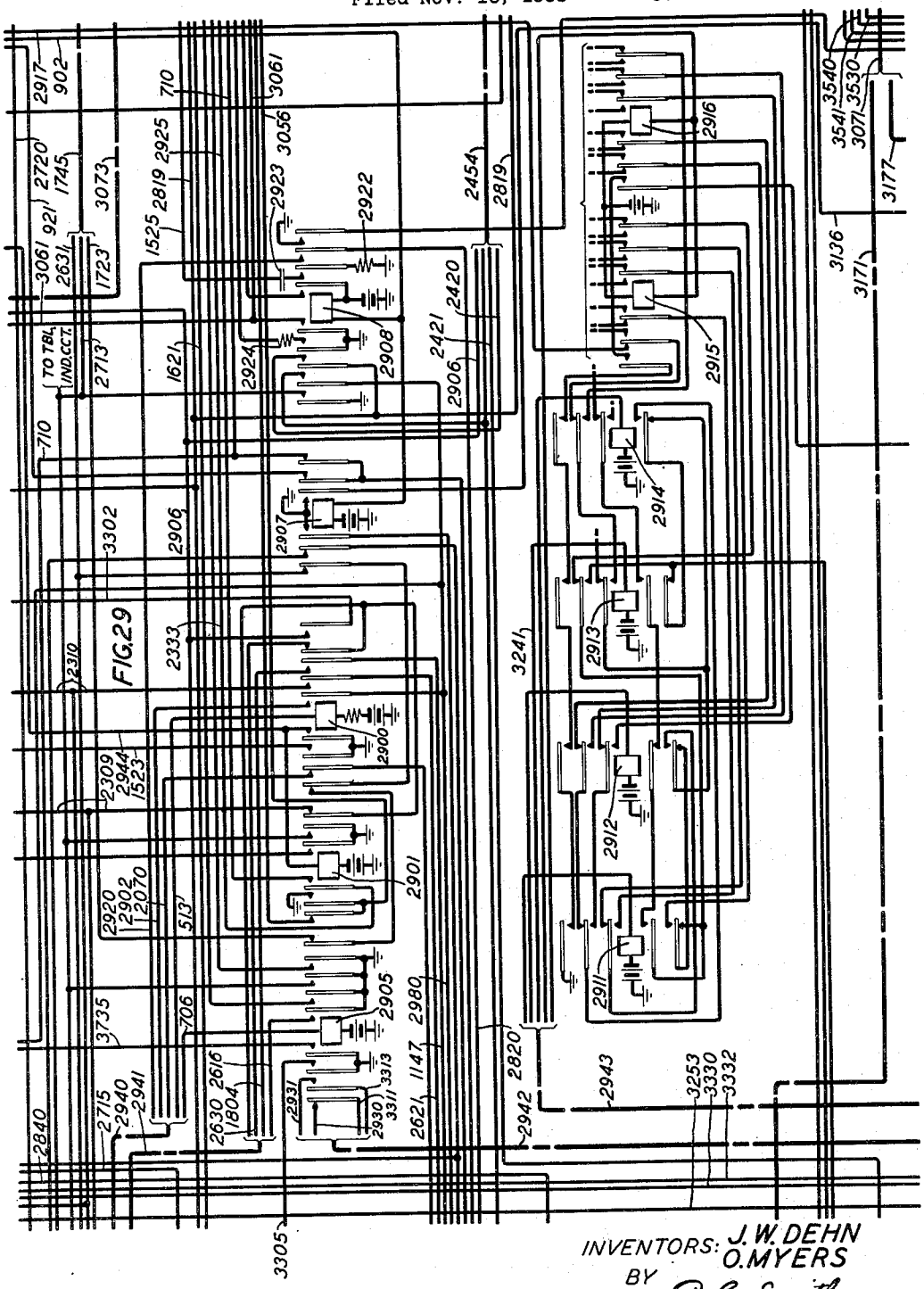

INVENTORS: J. W. DEHN
O. MYERS
BY P. C. Smith

ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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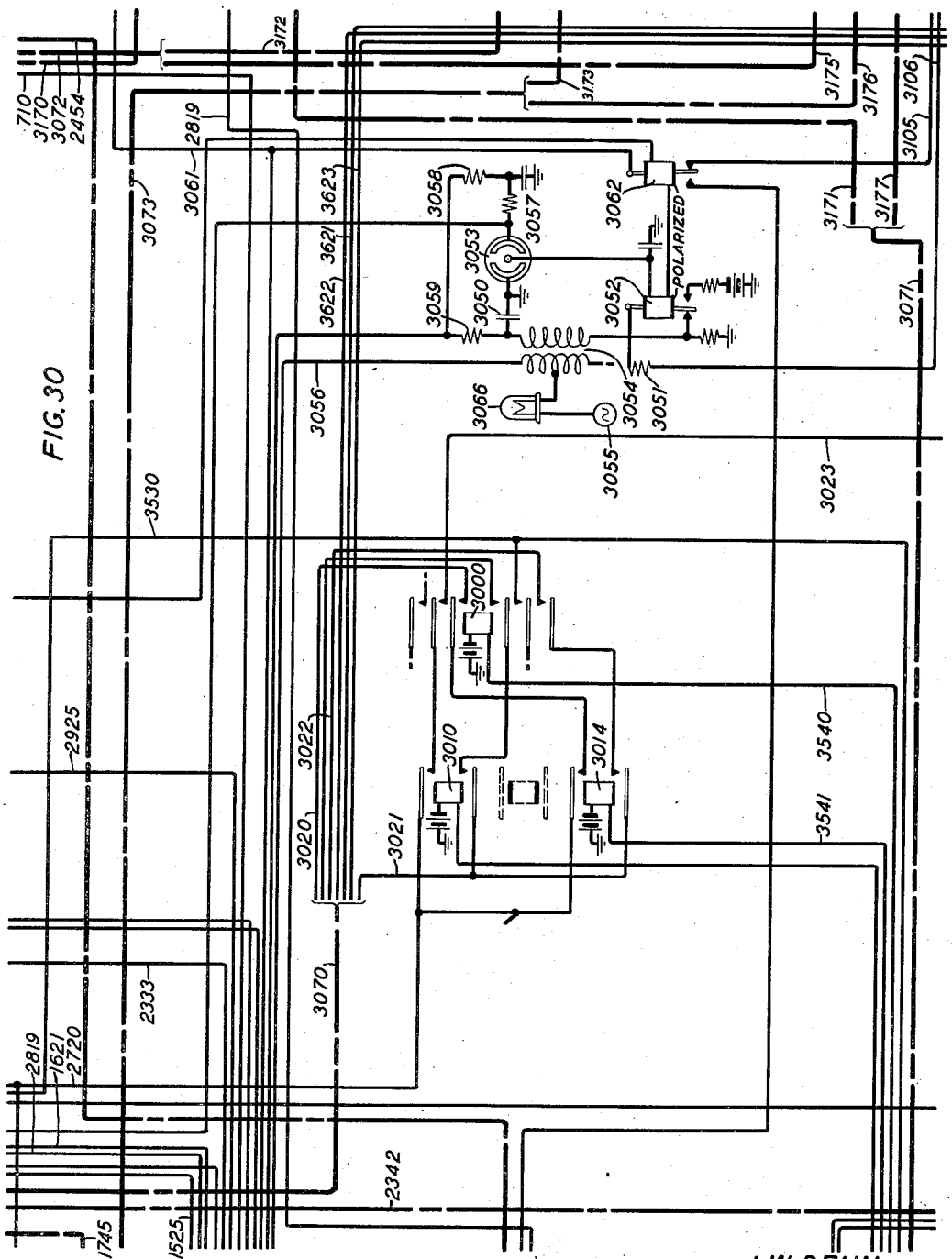

FIG. 30

INVENTORS: J. W. DEHN
O. MYERS
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R. C. Smith
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TELEPHONE SYSTEM

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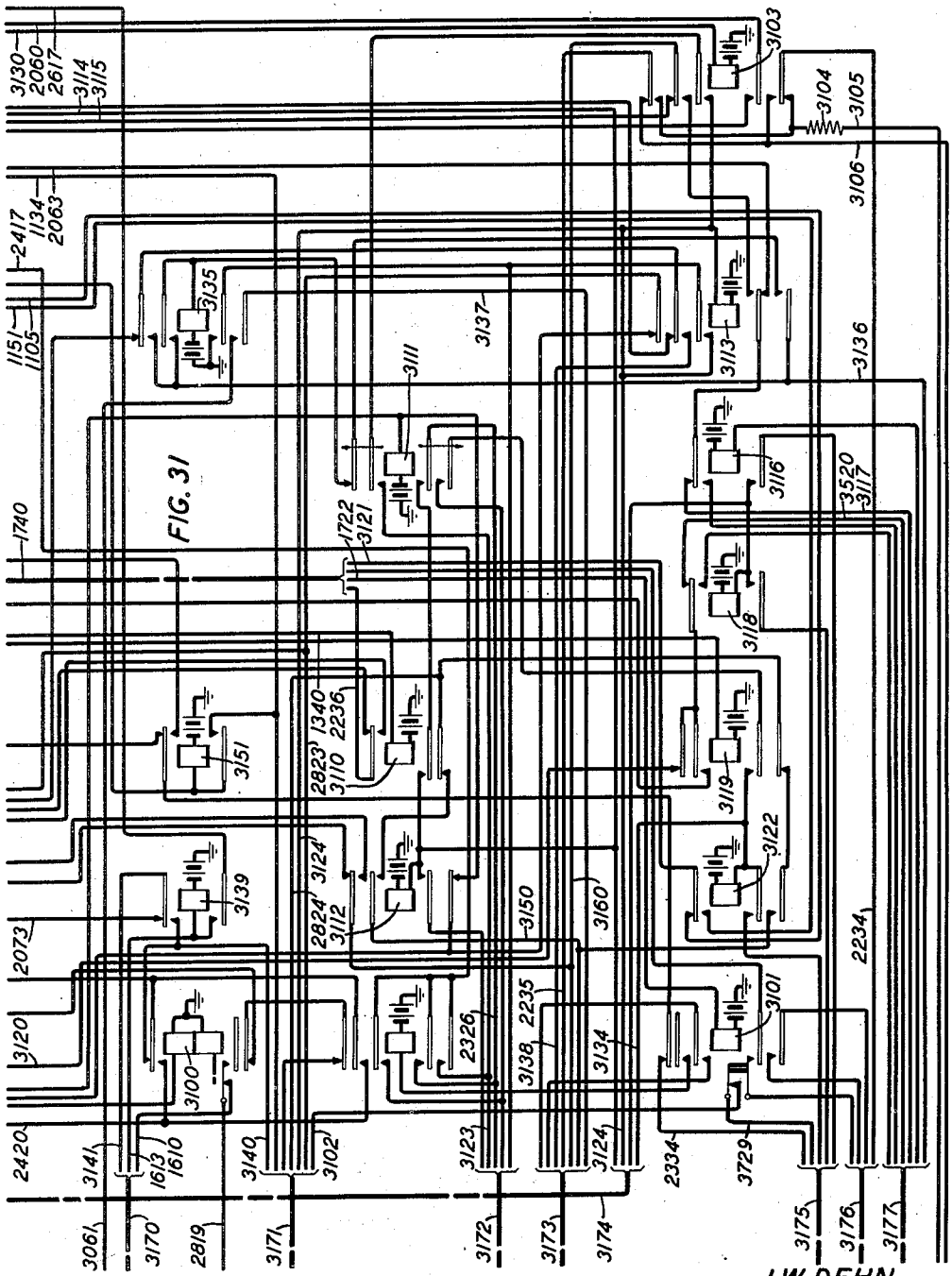

INVENTORS: J. W. DEHN
O. MYERS
BY
P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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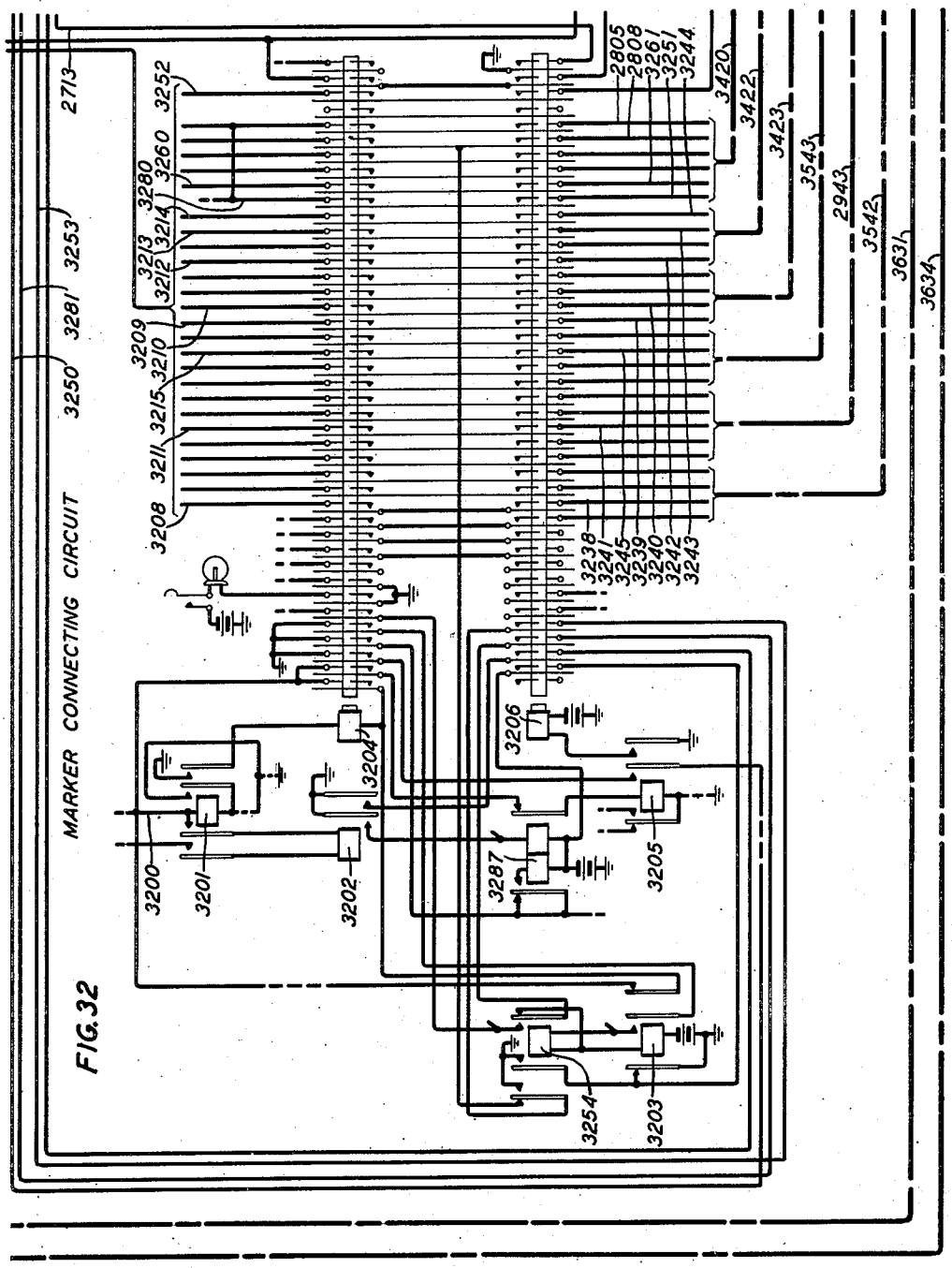

FIG. 32

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

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TELEPHONE SYSTEM

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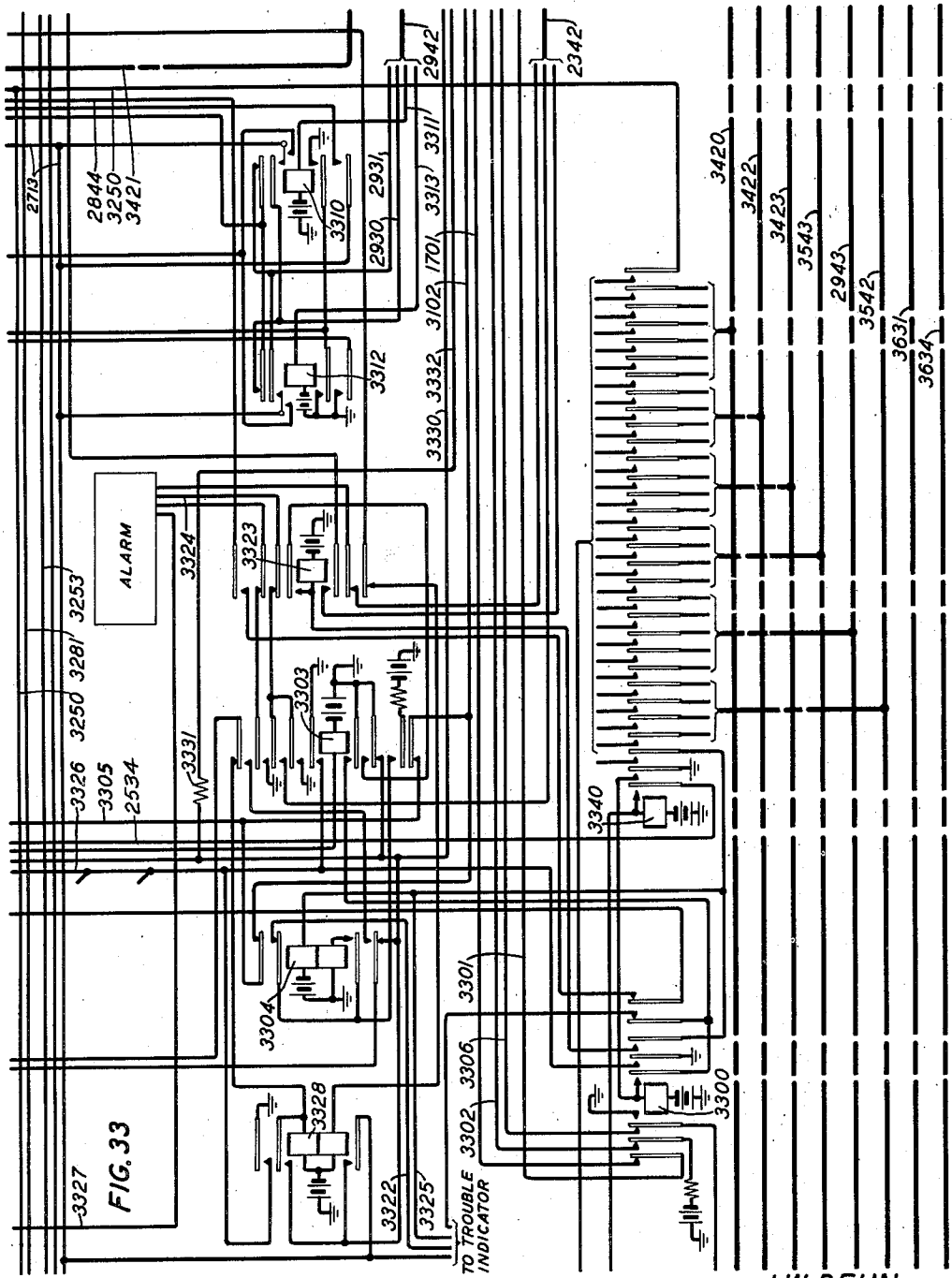

FIG. 33

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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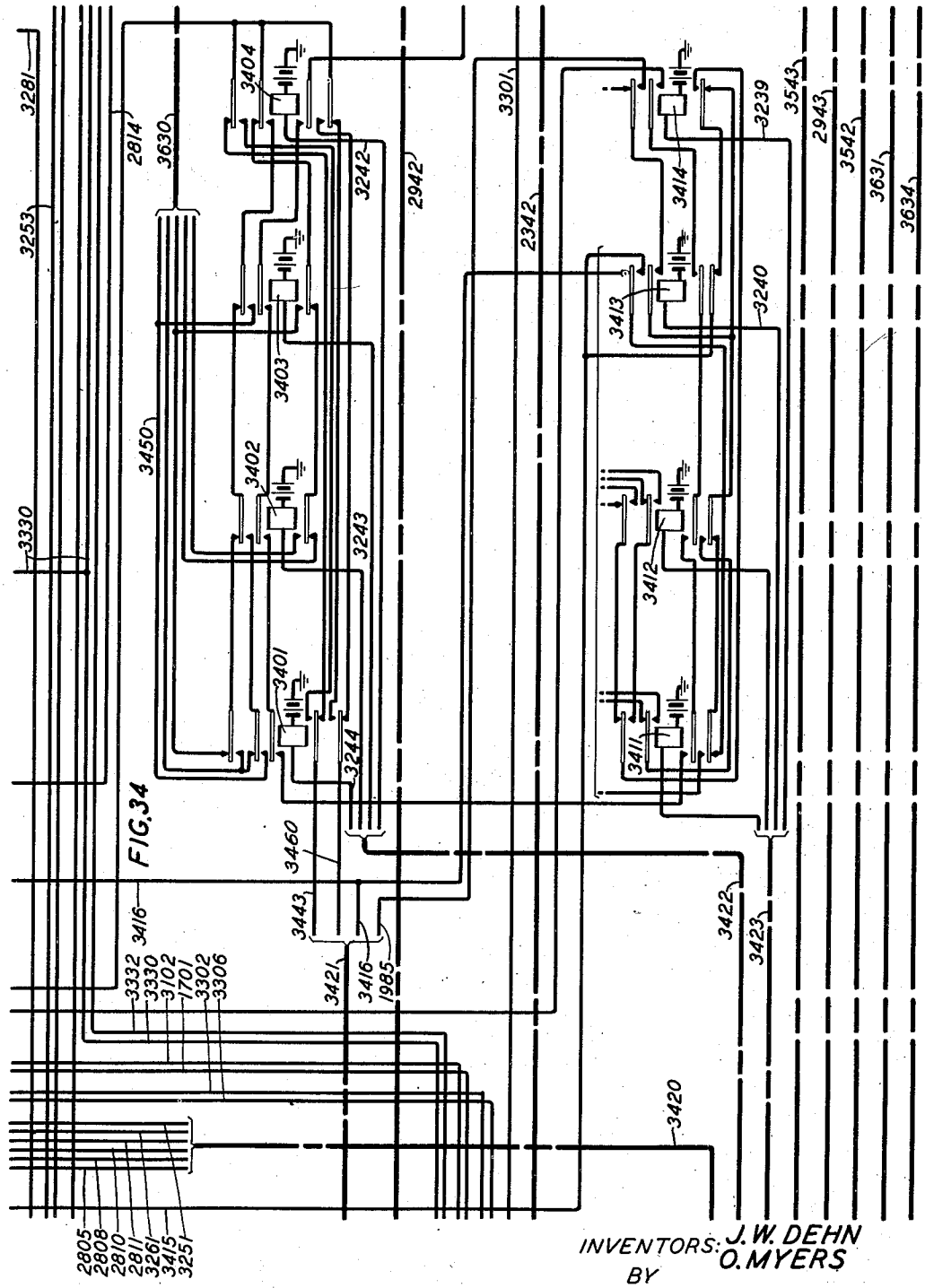

FIG. 34

INVENTORS: J. W. DEHN
O. MYERS

BY

P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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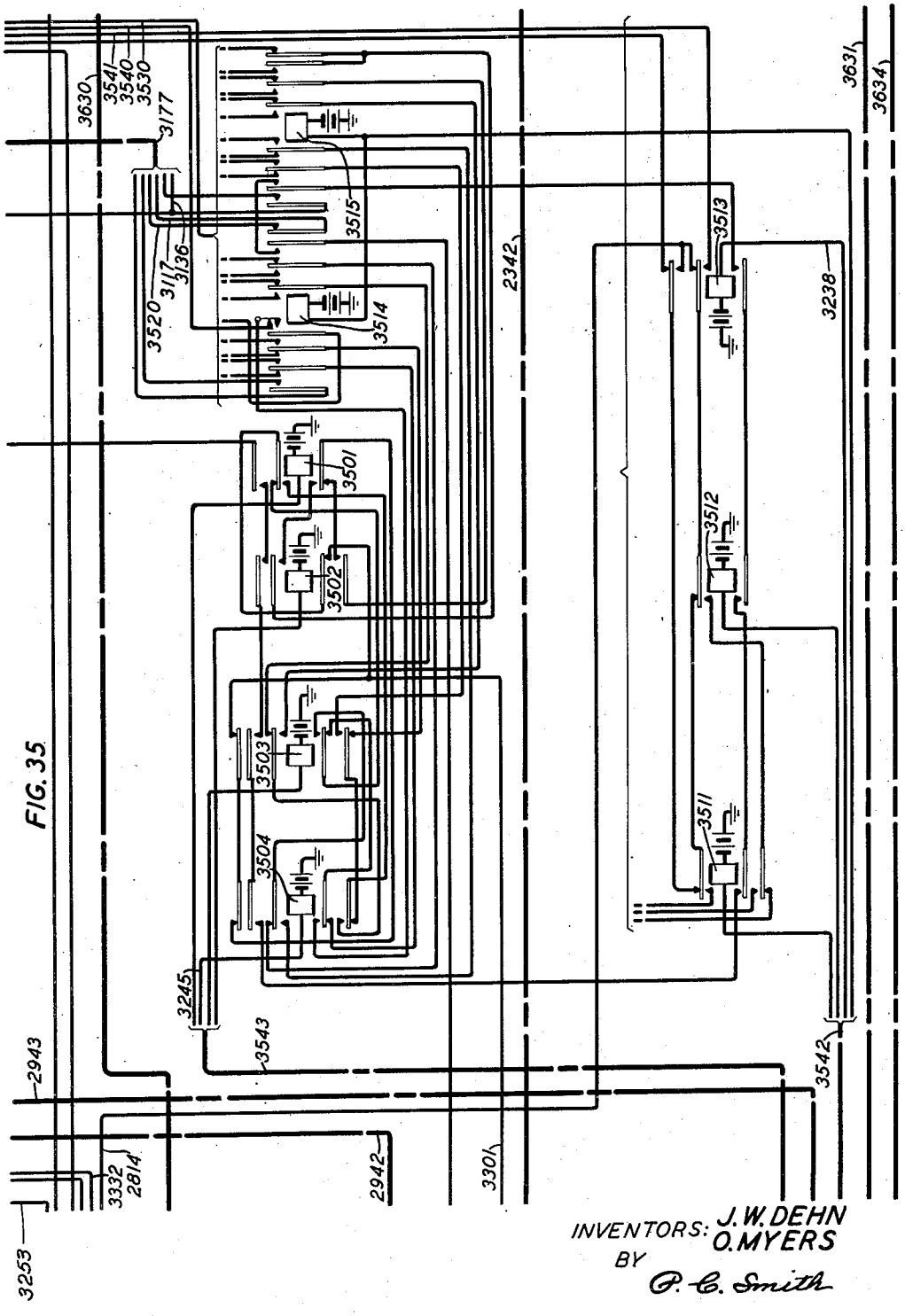

FIG. 35

INVENTORS: J. W. DEHN
O. MYERS
BY
P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

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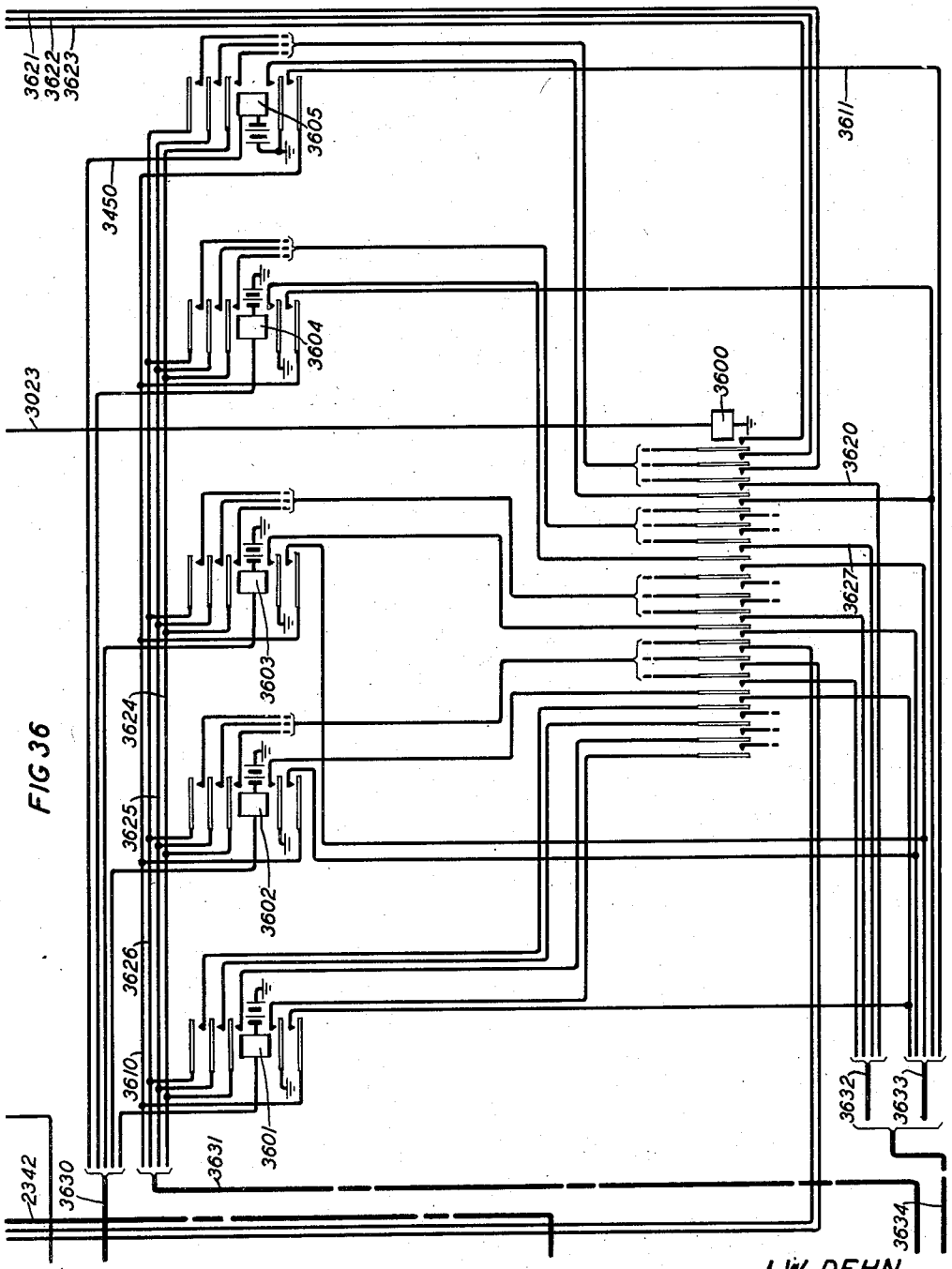

FIG 36

INVENTORS: J. W. DEHN
O. MYERS
BY
P. C. Smith
ATTORNEY

Feb. 18, 1941. J. W. DEHN ET AL 2,232,371

TELEPHONE SYSTEM

Filed Nov. 16, 1938 37 Sheets-Sheet 37

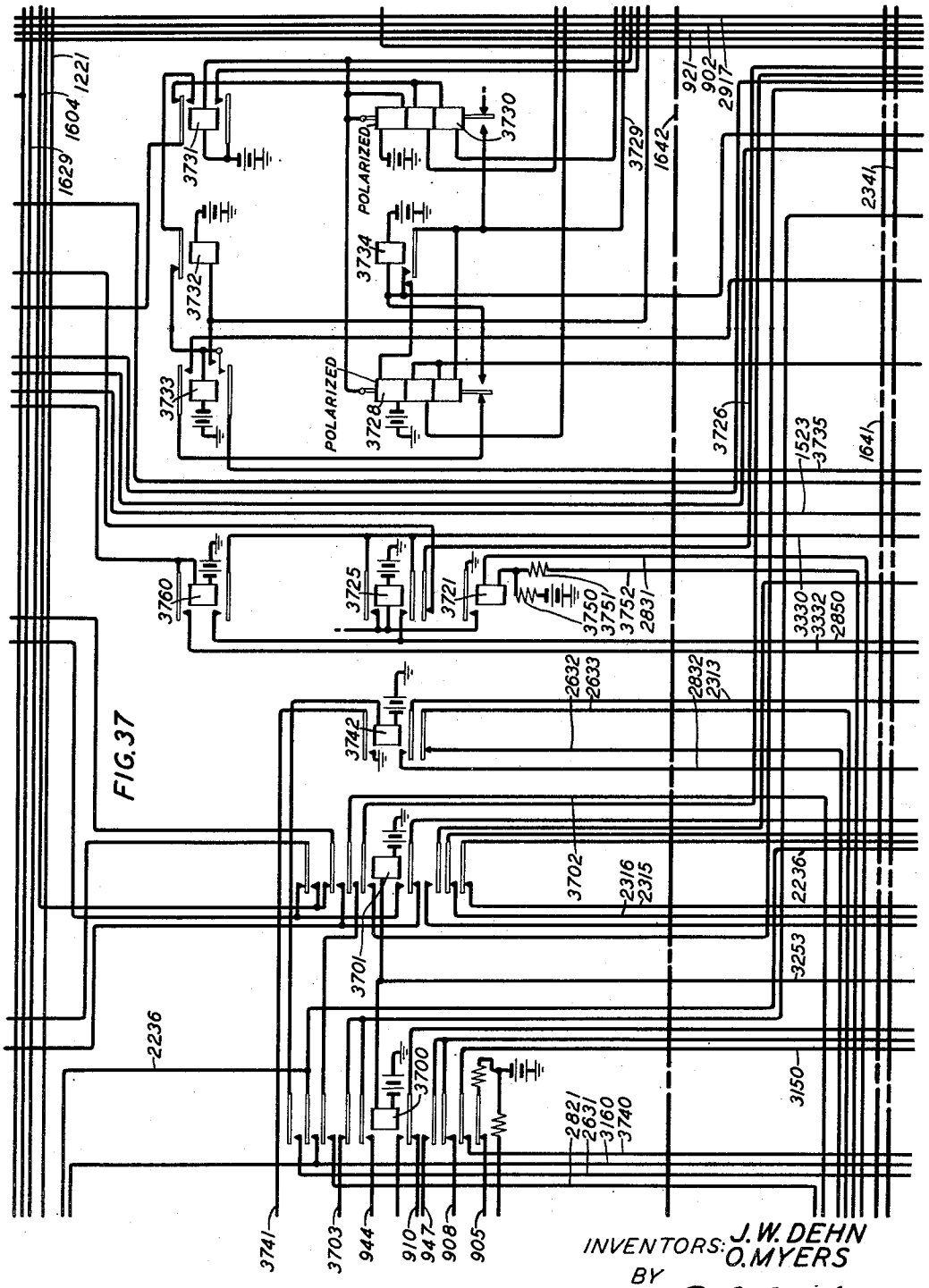

FIG. 37

INVENTORS: J. W. DEHN
O. MYERS

BY P. C. Smith

ATTORNEY

Patented Feb. 18, 1941 2,232,371

UNITED STATES PATENT OFFICE

2,232,371

TELEPHONE SYSTEM

Joseph W. Dehn, Great Neck, and Oscar Myers, Mount Vernon, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application November 16, 1938, Serial No. 240,718

17 Claims. (Cl. 179—18)

This invention relates to telephone systems and has for its object to facilitate the handling of large groups of lines serving a single subscriber.

In the cross-bar system as disclosed in Patent No. 2,201,573, granted May 21, 1940 to W. W. Carpenter et al., the line numbers are independent of the location of the line in the switches. Each line number has a set of terminals individual thereto in a number group, and normally the registration of that line number in common control equipment causes the selection of the number group and the set of terminals. Cross-connections in the number group complete a test circuit for the corresponding line and transmit the necessary information back to the control equipment to enable the establishment of the connection with that line. Since only one control equipment may seize a number group at a time, a large and busy branch exchange might overload the number group in which the line number is located.

In accordance with the present invention, means is provided whereby a large group of branch exchange trunks identified by a single designation may be divided between a plurality of number groups with means, independent of the designation, for determining which number group shall be seized in response to the registration of the designation. If all of the trunks appearing in the first seized number group are found busy when tested, means is provided to seize another number group and test the trunks appearing therein.

In addition, the trunks appearing in each number group are divided for testing into subgroups and the testing of the trunks in a number group is always started with a predetermined trunk of a predetermined subgroup, irrespective of the designation of the branch exchange.

If, having selected an idle trunk, a connection therewith is attempted and no connecting circuit is available, the control equipment again closes the test circuits of the subgroup of trunks containing the selected idle trunk, makes this selected trunk and a part of the remaining trunks artificially busy and retests the group. Since the trunks are scattered throughout the switching equipment, the trunk selected on the retest is likely to have idle means of access.

Lines requiring special treatment are assigned numbers within specified groups and the registration of one of these numbers sets up a supplementary record indicative of the treatment necessary.

The invention will be more clearly understood from a consideration of the following description together with the attached drawings in which:

Fig. 1 shows the manner in which the remaining drawings are to be arranged;

Fig. 2 shows a calling line, the circuits of an incoming junctor and originating and terminating control equipment in schematic form;

Fig. 3 shows the primary and secondary incoming switches;

Fig. 4 shows the primary and secondary line switches, the called line and a part of the line group control circuit;

Figs. 5 and 6 show the number group connector;

Figs. 7 and 8 show the line choice connector;

Figs. 9 and 10 show the incoming connector;

Figs. 11 to 31 and 33 to 37 show the circuits of the marker;

Fig. 11 showing the allotter;

Figs. 12 and 19 showing the line test relays;

Fig. 13 showing the line group recording relays;

Figs. 14 and 21 showing the junctor selecting relays;

Fig. 15 showing the channel testing relays;

Figs. 16, 22, 23, 26, 28, and 37 showing the various testing and control relays;

Fig. 17 showing the intercept relays;

Fig. 18 showing the jump hunting control relays;

Fig. 20 showing the line choice recording relays;

Fig. 24 showing the incoming class recording relays;

Fig. 25 showing the twenty-block selecting relays;

Fig. 27 showing the time measure circuit;

Figs. 29, 34 and 35 showing the frame and designation recording relays;

Figs. 30 and 36 showing the translating relays;

Fig. 31 showing the ringing control relays;

Fig. 33 showing the sender test connecting relay; and

Fig. 32 shows the marker connector.

Briefly, the operation of the circuits is as follows: After the trunk to the terminating office has been selected, a terminating sender is attached to the junctor in which the trunk terminates and receives the numerical designation of the wanted line from the originating office. The sender then connects, through the marker connector, with a terminating marker and transfers the line designation and the location of the incoming junctor to the marker. The marker translates the designation and seizes the number group including the line number. From the num-

ber group the marker receives an indication of the location of the line, the nature of the line and the busy or idle condition of the line. The marker then connects with the incoming junctor. If the line is idle the marker then connects with the switching equipment having access to the wanted line, and selects an idle channel with which to connect the line and trunk. The channel is tested for false ground and then connected with the line. The line and channel are then tested for continuity and for grounds or double connections. In the meantime the ringing control equipment of the incoming junctor is prepared, and if the above tests prove successful the junctor is connected with the channel and the marker and sender are released.

Detailed Description

Connection with marker

When the subscriber at substation **200** originates a call for a subscriber located at the crossbar office, a connection is established through the equipment at the originating office to the originating sender **201** where the wanted number is recorded, and a trunk leading to the wanted office is selected. Thereupon, a selection controlling bridge is closed between the talking conductors of the trunk, completing a circuit from battery through the upper winding of relay **206**, upper back contact of relay **203**, tip contact of jack **202**, conductor **207**, through the bridge at the originating sender **201**, conductor **208**, ring contact of jack **202**, lower back contact of relay **203**, lower winding of relay **206** to ground. With relay **204** unoperated, battery through resistance **205** is connected over the middle upper back contact of relay **204** in parallel with the upper winding of relay **206** and ground over the outer lower back contact of relay **204** is connected in parallel with the lower winding of relay **206** to improve the operating conditions for the relays at the originating sender.

Relay **206** in operating connects ground over its front contact and the inner lower back contact of relay **204** to conductor **209** leading to the terminating sender link and control circuit **243** to cause the connection of an idle terminating sender **244** with the incoming trunk. When this has been done and battery and ground are supplied from the sender **244** to the originating sender **201** over conductors **210** and **211**, ground is connected to conductor **212**, operating relay **203**, which disconnects relay **206** from the incoming end of the trunk.

Registration

The designation recorded on the originating sender **201** is now transferred to the terminating sender **244** after which a release signal is transmitted from the terminating sender **244** to the originating sender **201** causing the establishment of the talking connection at the originating office. The terminating sender also removes the ground from conductor **212**, restoring the control of the connection to relay **206**. At the same time ground is connected to conductor **213**, operating relay **204**, which locks under the control of relay **206**. Relay **204** connects ground over its lowermost front contact through resistance **214** and the inner lower normal contacts of relay **216** to conductor **215** leading to the primary incoming selector, and also removes the battery and ground from in parallel with the windings of relay **206** to improve its holding condition. The locking ground for relay **204** acts as a signal to the terminating sender that the trunk has been closed through, and that it may proceed with selections.

After the wanted line number has been registered in the terminating sender, the sender connects battery to conductor **3200** leading to the marker connector of Fig. 32 for connecting an idle marker with the sender. Conductor **3200** extends through the winding of relay **3201** through a preference circuit (not shown) to ground. Relay **3201** closes a circuit from battery on conductor **3200**, back contact of relay **3203**, winding of multicontact relay **3204** to ground at the outer right contact of relay **3201**. Relay **3204** which is individual to sender **244** locks to conductor **3200** over its own innermost contact and also extends battery from conductor **3200** over its second contact and the right back contact of relay **3287**, through the winding of relay **3205** to ground through a combined busy and preference circuit which is merely indicated by the dotted connection. Relay **3205** closes an obvious circuit for multicontact relay **3206**. Relay **3206** is individual to the marker shown, in this particular section of the marker connector.

With multicontact relays **3204** and **3206** operated, a plurality of connections are established between the sender and the marker for the purpose of transferring the registered designation from the sender to the marker as well as the identity of the frame on which the incoming trunk is located. Certain other circuits, used for testing the condition of the registering connection, are also closed.

Assuming by way of example that the called number is **2489**, the sender will connect direct ground to thousands conductor **3215**, hundreds conductor **3208**, tens conductors **3212**, **3213** and **3214** and units conductors **3209** and **3210**. It may also be assumed that frame conductor **3211** is also connected to direct ground. These grounds are extended over the contacts of multicontact relays **3204** and **3206** to conductors **3245**, **3238**, **3242**, **3243**, **3244**, **3239**, **3240** and **3241**, respectively, resulting in the operation of register relay **3504** in the thousands register, relay **3513** in the hundreds register, relays **3401**, **3402** and **3404** in the tens register, relays **3413** and **3414** in the units register and relay **2913** in the frame register.

The operation of relay **3205** in the establishment of a connection between the sender and marker closes a circuit from ground over a contact of relay **3204**, contact of relay **3205**, through a chain circuit over contacts on other decoder relays like relay **3205** to conductor **3250** through the windings of relays **2801** and **2802** in parallel to battery. Relays **2801** and **2802** supply offnormal ground to the circuits of the marker, preparing for operations which will be described hereinafter.

Relay **2801** closes ground to three register checking circuits which may be traced as follows: From ground over the third upper contact of relay **2801**, upper normal contact of relay **2803**, to the winding of relay **2804** and battery and in parallel with relay **2804** to conductor **2805** which is included in cable **3420**, and thence through the marker connector to a part of the ungrounded contacts closed by the sender registers and thence back through the marker connector to the corresponding register relays. A second circuit is closed from ground over the second upper contact of relay **2801**, upper normal contact of relay **2806**, through the winding of relay **2807** to battery and in parallel therewith to conductor

2808 which extends through cable 3420, the marker connector and over other ungrounded contacts of the sender register back to other register relays. A third circuit extends from ground over the first upper contact of relay 2801, lower normal contact of relay 2806, winding of relay 2809 to battery and in parallel therewith over conductors 2810 and 2811 in a similar path to the remaining register relays. In consequence, checking relays 2804, 2807 and 2809, frame register relays 2911 to 2916, thousands register relays 3501 to 3504, hundreds register relays 3511 to 3515, tens register relays 3401 to 3404 and units register relays 3411 to 3414 are operated. In addition, a branch of the circuit over conductor 2805 returns through the marker connector to conductor 3251 and the winding of reorder relay 2822, while ground connected to conductor 2808 is extended over the contact of relay 3206 and thence over the left back contact of relay 3254, contact of relay 3206 to conductor 3253 and the windings of second trial relays 3700 and 3701 in parallel to battery. The purpose of these circuits is to insure the continuity of all recording circuits at each establishment of a connection with the marker. Such an arrangement is disclosed and claimed in Patent No. 2,112,366 to R. E. Hersey, granted March 29, 1938.

If all of the registering conductors are in standard condition so that all of the register relays operate, as well as the reorder relay and the second trial relays, a chain circuit will be completed from ground over the uppermost front contacts of relays 2911, 2912, 2913 and 2914, outermost left front contacts of relays 2915 and 2916, outer upper front contacts of relays 3501, 3502, 3503 and 3504, inner lower front contacts of relays 3511, 3512 and 3513, third left front contact of relay 3515, third right front contact of relay 3514, inner lower front contact of relay 3404, inner upper front contacts of relays 3403, 3402 and 3401, inner lower front contacts of relays 3411, 3412 and 3413, inner upper front contact of relay 3414, upper front contact of relay 2804, lower front contact of relay 2807, outer upper front contacts of relays 2809 and 2822, conductor 2821, second upper front contacts of relays 3700 and 3701, conductor 3702, windings of relays 2806 and 2803 in parallel to battery. If this chain circuit is completed, relays 2803 and 2806 operate, relay 2803 locking over its middle upper front contact to ground at the third upper contact of relay 2801, and relay 2806 locking over its upper front contact to the second upper contact of relay 2801 and likewise over its inner lower front contact and the inner upper contact of relay 2801. Relays 2803 and 2806 disconnect ground from the windings of relays 2804, 2807 and 2809 and from conductors 2805, 2808, 2810 and 2811 thereby releasing all of the register relays not connected to direct ground by the sender, likewise releasing the reorder relay 2822 and the second trial relays 3700 and 3701. Relays 2804, 2807 and 2809 remain connected to conductors 2805, 2808, 2810 and 2811 as a test for false grounds on these conductors, one or more of them remaining operated should a false ground exist on the corresponding conductor. If one of these relays remains operated or relay 2803 fails to operate, ground is connected over the front contact of relays 2804, 2807 or 2809 or over the back contact of relay 2803 to conductor 2812 to control the time measure circuit of Fig. 27 and to bring about the release of the marker and a second attempt to establish the connection.

Number group selection

With relays 2803 and 2806 operated and relays 2804, 2807 and 2809 released, the marker proceeds to determine the location, class and condition of the wanted line. In order to do so it first identifies the number group in which the wanted line is located. To this end, one of a group of twenty relays is operated, each relay being individual to a group of five hundred numbers and also one of a group of five relays each identifying, in combination with the five hundreds relays, a group of one hundred numbers within which the wanted line is located. Under the assumption above made, that thousands relay 3504 is operated, the release of relay 2804 completes a circuit from ground at the fourth upper contact of relay 2801, outer upper front contact of relay 2803, back contact of relay 2804, outer upper back contact of relay 2822, conductor 2813, outer upper back contact of relay 1700, conductor 1701, through cables 1744 and 1642, outer left back contact of relay 3300, conductor 3301, lower back contact of relay 3502, upper back contact of relay 3501, inner lower back contact of relay 3503, inner lower front contact of relay 3504, inner left normal contact of relay 3514, conductor 3540, to the winding of relay 3000 and battery. This circuit is extended over the back contacts of relays 2822, 1700 and 3300 as a test that the reorder relay released with the other temporarily operated relays, that the call is not one to the intercepting operator and that it is not a call originating at the sender test circuit.

Relay 2807, in releasing, closes a circuit from ground over the fourth lower front contact of relay 2806, back contact of relay 2807, conductor 2814, outer upper front contact of relay 3513, back contact of relay 3511, back contact of relay 3512, inner upper front contact of relay 3513, conductor 3541, winding of relay 3014 and battery.

With relays 3014 and 3000 operated, a circuit is closed for seizing the number group connector having access to the wanted number. This circuit may be traced from battery over the outer lower back contact of relay 2707, upper back contact of relay 2709, conductor 2720, upper front contact of relay 3014, inner upper front contact of relay 3000, conductor 3020, through cables 3070 and 2341, cross-connected at rack 500 to the inner upper back contact of relay 501 and the winding of relay 502, normal contact of relay 503 and ground. If the number group connector is idle, relay 502 operates in this circuit and locks over its own lower front contact to ground. Relay 502 in operating connects ground over its outer upper front contact and the outer upper back contact of relay 501 to the winding of multicontact relay 506, completing the connection between the marker and the number group to perform certain functions which will be described hereinafter.

At the number group connector circuit there is one regular preference relay, one emergency preference relay and one set of multicontact relays for each marker, relay 502 being a regular relay for the marker shown and relay 504 being the emergency relay for this same marker. Relays 503 and 505 are individual to some other marker and a similar pair is provided for each marker in the office.

Because of the chain operating circuit, relay 503 being nearest the operating ground has first preference in operating, but again due to the chain arrangement, the relay 502 has the preference in operating the corresponding multi-contact relays. When all of the regular marker relays 502 and 503 are normal, a circuit is closed from battery through the lower winding of relay 507, normal contacts of key 508, middle upper back contact of relay 509, back contacts of relays 503 and 502 to ground. Similarly, the upper winding is closed over the innermost upper back contact of relay 509 and the normal contacts of relays 502 and 503 to ground. Relay 507, being differentially wound, does not operate as long as the chain circuits are either both open or both closed. This relay is also slow to operate to prevent undesirable operation thereof due to differences in contact transfer time of relays 502 and 503. If, however, one chain remains open while the other chain circuit remains closed, relay 507 operates, closing a circuit from ground over its front contact, uppermost normal contact of key 510, winding of relay 501 to battery. Relay 501 locks to ground over the inner upper normal contact of key 510 and closes an obvious circuit for relays 509 and 511, transferring the start, chain and other control circuits to the emergency relays 505 and 504. With relay 509 operated, lamp 512 is lighted to indicate the trouble condition. Keys 510 and 508 are both operated to restore the circuit to normal. Relays 504 and 505 function in precisely the same way as do relays 503 and 502. If it is desired to use the emergency relays, the transfer can be brought about by first operating and releasing key 508 to unbalance relay 507, and lock the transfer relays under the control of key 510. If key 510 is then operated, the locking circuit for the transfer relays is transferred to the back contact of relay 507 which restores it with the restoration of key 508.

When relay 502 operates as above described, it closes a checking circuit to the marker to indicate that it had been operated. This circuit may be traced from ground over the inner upper front contact of relay 502, middle upper back contact of relay 501, conductor 513, through cable 2940, winding of relay 2900 to battery. When relay 506 operates it connects ground over armature 514 to supplement the ground furnished by relay 502. At armatures 515, 516, 517 and 518 relay 506 completes circuits for multicontact relays 600, 601 and 602, thereby providing sufficient contacts for establishing the necessary circuits.

The operation of relay 2900 is an indication to the marker that the number group has been seized. Relay 2900 closes an obvious circuit for relay 2901 and in parallel therewith a circuit over conductor 2944, lowermost back contact of relay 2203 to the winding of relay 2204 and battery. Relays 2900 and 2901 chiefly supply off-normal grounds for circuits to be described hereinafter. Relay 2204 opens one circuit and prepares another also to be discussed later.

When the number group connector has operated, in turn operating relay 2900, a circuit is closed for connecting the marker with the incoming link and connector circuit by which the incoming junctor of Fig. 2 is extended to the line link. The circuit for this purpose may be traced from battery over the middle left back contact of relay 3300, conductor 3302, outermost right front contact of relay 2900, conductor 2906, second lower front contact of relay 2801, lower back contact of relay 2838, middle upper front contact of frame register relay 2913, outer lower back contacts of relays 2911 and 2912, inner upper front contact of relay 2913, upper back contact of relay 2914, outer left back contact of relay 2915, conductor 2917, winding of marker preference relay 900 and ground. Relay 900 is included in a preference circuit, similar to that of the number group connector, which has been omitted for simplicity. Relay 900 locks to ground, closes an obvious circuit for multi-contact relay 901 and connects ground in multiple with relay 901 to conductor 902 thereby completing a circuit for relays 2907 and 2908 in parallel.

Selection of twenty-block

With the number group seized, the group of twenty numbers, within which the wanted number is located, is selected. The group of one hundred numbers is first determined under the control of the five hundreds relay 3000 and hundreds relay 3014 by operating a hundred-block relay in the number group over a circuit which may be traced from ground at the fifth lower front contact of relay 2801, conductor 2816, left back contact of relay 2600, conductor 2601, through cable 2660, winding of relay 1800, inner lower back contact of relay 1801, conductor 3021, through cables 3070 and 2341, lower front contact of hundreds relay 3014, lower contact of five hundreds relay 3000, conductor 3022, through cables 3070 and 2341, contact of relay 506, winding of hundred-block relay 520 in the number group circuit to battery.

In the selection of the group of twenty numbers containing the wanted number, a circuit is first closed from ground over the third lower front contact of relay 2806, conductor 2815, lower back contact of relay 2809, inner upper front contact of relay 3404, upper back contact of relay 3403, outer upper front contact of relay 3402, middle upper front contact of relay 3401, conductor 3450 through cable 3630, winding of relay 3605 to battery. A parallel circuit is closed from ground as just traced to the armatures of relay 3404, over the outer lower front contact of relay 3404, outer lower back contact of relay 3401, conductor 3460 through cable 3421, to the winding of relay 1986 and battery. With relay 3605 operated, a circuit is closed from ground at the lowermost front contact of relay 2801, conductor 1702 through cables 1744 and 1642, lower back contact of relay 1700, conductor 1703 through cable 1741, lower back contact of relay 1801, conductor 1103, outer lower back contact of relay 1102, upper back contacts of relays 1101 and 1100, conductor 3610 through cable 3631, outer lower front contact of relay 3605, conductor 3611, through cables 3633 and 3634, winding of relay 2508 and battery. This circuit extends over the back contacts of relays 1100, 1101 and 1102 to insure that none of these relays are falsely operated on a call to a line which is not included in a group requiring special assignment such as a private branch exchange line of an allotted group, etc. It is also carried over the back contact of relay 1700 to guard against false operation of that relay where the call is not directed to an intercepting operator.

With relay 2508 operated, a circuit is closed from ground over the lowermost front contact of relay 2802, conductor 2825, lower back contact of relay 2709, inner lower back contact of relay 2707, conductor 2710, middle upper back contact of relay 1801, conductor 1802, through cable 2660,

right back contacts of relays **2600** and **2602**, inner upper back contact of relay **2603**, left back contact of relay **2604**, conductor **2605**, back contact of relay **2509**, winding of relay **2607**, lower winding of relay **2510**, outer lower front contact of relay **2508**, conductor **2511** through cable **2537**, contact of relay **506**, contact of hundreds relay **520** to the winding of twenty-block relay **603** and battery.

Recording location of line

As set forth in the patent to W. W. Carpenter et al., mentioned above, each directory number has a set of three terminals individual thereto in one of the number group frames. When a number is assigned to a line, the set of terminals is cross-connected to the line sleeve and to two terminal strips on the frame. There is one strip for each of the ten levels of the four frames in a choice, forty in all. There is also one set of three strips for each of the choices in the office, a maximum of thirty in all. Each of the latter sets of strips contains one strip for each of the three classes of line, namely, individual line, tip party and private branch exchange trunk. The ring party and the last line of a private branch exchange group are classed with individual lines. The number terminals are cross-connected to these strips in accordance with the location and class of the line to which they are individualized by the connection of the sleeve terminal.

Specifically, twenty-block relay **603** connects the marker to terminals **620** to **625**, representing twenty sets of three terminals individual to the twenty numbers in the corresponding twenty-block. According to present assumptions, terminals **621**, **623** and **625** are individual to the recorded designation, **2489**.

The terminal strips indicated at **626**, **627**, etc. are connected by multicontact relay **602** to the windings of relays **1300** to **1319**. Relays **1300** and **1301** identify the No. 0 level on a frame, while relays **1318** and **1319** identify the No. 9 level and intermediate relays identify intermediate levels. Each relay has two windings and the four energizing circuits for the relays of each pair identify the four frames of a choice. When a level relay is operated, it extends its operating circuit to one of the relays **1320** to **1323** to record the number of the frame.

The strips indicated at **628**, **629**, etc. are connected by multicontact relay **601** to the center windings of relays **2030**, **2031**, etc. Strips **630**, **631**, etc. are connected to the lower windings of relays **2030**, **2031**, etc. while strips **632**, **633**, etc. are connected over back contacts of relays **2003** to **2006** to the upper windings of relays **2030**, **2031**, etc. Relays **2030**, **2031**, etc. identify the line choice, while the winding identifies the class of the line. When one of these relays is operated it extends its operating circuit to one of the relays **2052**, **2062** or **2064** to record the class of the line.

Referring to the drawings, it will be seen that the terminals **621**, **623** and **625**, individual to the recorded number are cross-connected to strip **626**, the sleeve of line **400** and strip **628**, respectively. The marker is therefore informed that the wanted line is located on No. 0 level of the No. 0 frame, of the No. C choice and that it is an individual line.

With relay **603** operated, three circuits are prepared as pointed out above, individual to each of the twenty numbers included in the group. A busy test circuit is closed for each of the twenty lines, one of which may be traced as follows: from battery over the outer upper back contact of relay **2603**, through the winding of relay **1919**, outer upper back contact of relay **1269**, lower back contact of relay **1219**, over the contact **607** of number group relay **600**, armature **608** of twenty-block relay **603**, terminal **623**, conductor **604** to the sleeve contact of the primary line switch and the winding of the hold magnet **401**. If the line is busy, ground will be connected to the sleeve of the line and relay **1919** will be operated. Similar circuits are closed for each of the lines identified by the group of twenty numbers and the corresponding relay in the group **1900** to **1919** is operated or not according to the busy condition of the line.

The wanted number is identified by a circuit controlled by the units register. In preparation for the closing of this circuit, however, several other circuits are closed.

When relay **2900** operates in response to the association of the marker with a number group connector, a circuit is closed from battery through the windings of relays **1981** and **1982**, conductor **1983**, upper back contact of relay **2100**, conductor **2101** and in parallel therewith through the windings of relays **2003** to **2006**, only two of which have been shown for convenience, over the inner upper normal contacts of relays **1250** to **1269**, inclusive, conductor **1270**, outer right back contact of relay **2604**, over the lower back contacts of relays **2034** and **2035** in parallel, conductor **2036** through cable **2660**, inner upper back contact of relay **1801**, conductor **1804**, through cable **2941**, third right front contact of relay **2900** to ground over conductor **1147**. With relays **1981**, **1982** and **2003** to **2006** operated, a chain circuit is closed from ground over the inner lower front contact of relay **2006** and thence over the outer lower, inner, middle and outer upper contacts of relay **2006**, over a similar chain circuit including the front contacts of intermediate relays, and over the similar contacts of relay **2003**, conductor **2014**, outer right front contact of relay **1981**, inner left front contact of relay **1982** to battery through the winding of relay **2000**. Relay **2000** holds certain circuits open until the busy test has been completed.

With relays **1981** and **1982** operated, relays **1920** to **1939**, which are connected to battery over conductor **2102** and the lower back contact of relay **2100**, are connected over the lower back contacts of the corresponding relays **1250** to **1269** and armatures of relay **600** to the outer group of armatures of twenty-block relay **603**, and terminals **624**, **625**, etc. which are cross-connected to strips **628**, **629**, etc. and over armatures of relay **601** to the windings of relays **2030**, **2031**, etc. The circuit of relay **1939**, for example, extends over the lower back contact of relay **1269**, armature of relay **600**, armature **610** of relay **603**, terminal **625**, which is cross-connected to strip **628**, over an armature of relay **601**, conductor **613**, middle winding of relay **2031** to battery through the winding of relay **2050**. Since battery is connected to each end of this circuit neither relay **1939** nor relay **2031** can operate at this time.

When relay **2801** operated, it closed a circuit from ground at the fifth upper front contact over conductor **2819**, winding of relay **1600** and battery. Relay **1600** prepares three circuits leading to relay **2610**. One circuit extends from battery over the outer lower front contact of relay **1600** to conductor **2612**, a second extends from ground over the uppermost contact of relay **1600** to conductor **2611**, while the third extends from ground through resistance **1601** over the inner upper front contact of relay **1600** to conductor **2613**.

Conductors 2611, 2612 and 2613, grouped in cables 1640 and 1641 extend respectively to resistance 2614 and the upper winding of relay 2610, to the two windings of relay 2610 in parallel and to condenser 2615 and the lower winding of relay 2610. At the time the above circuits are closed, condenser 2615 is short-circuited by ground over the back contact of relay 2607, and ground over conductor 2616 and the outer upper back contact of relay 2000. The operation of relay 2000, as previously described, opens one of these shunts, while the operation of relay 2607 in series with the twenty-block relay 603, at which time the busy test circuits are closed, opens the other shunt around condenser 2615. Relay 2610 is a condenser timed polarized relay whose timing interval starts when relay 2607 operates. Its purpose is to measure a sufficient time for the operation of the twenty-block relay and the sleeve test relays before closing the individual circuit. The energizing circuits closed by relay 1600 with condenser 2615 short-circuited holds the armature in its normal position. When the short circuits around condenser 2615 are removed and the condenser charges in series with the lower winding of relay 2610, the tendency for the relay to operate through its upper winding is retarded until the charging current in the lower winding has decreased sufficiently.

Selection of wanted number

When relay 2610 closes its contact, it completes an individual selecting circuit for the wanted line which may be traced from battery, through the winding of relay 2640, left back contact of relay 2608, resistance 2641, left back contact of relay 2622, conductor 2624, winding of relay 1269, upper back contact of relay 1919 (assuming that the wanted line is idle) outer upper front contact of relay 1986, conductor 1985 through cable 3421, outer upper front contact of relay 3414, inner upper front contact of relay 3413, outer lower back contacts of relays 3412 and 3411, upper front contact of relay 3413, conductor 3415, outer back contact of relay 1801, conductor 1805 through cables 1742 and 1641, upper back contact of relay 1704, conductor 1705, through cables 1742 and 1641, back contact of relay 2512, conductor 2513, outer upper front contact of relay 2003, front contact of relay 2610, conductor 1147, third upper front contact of relay 2802 to ground.

Recording location of line

Relay 1269 operates in this circuit and locks over its inner upper front contact to ground over conductor 1270 as previously traced. The operation of relay 1269 opens the circuit of relays 1981, 1982 and 2003 to 2006 and these relays release, in turn releasing relay 2000. With relay 1269 operated, ground is substituted for the winding of relay 1939 thereby operating relay 2031 and identifying the line choice within which the wanted line is located as well as the nature of the line. In addition, relay 1269 closes a circuit from ground over its inner lower front contact, armature of relay 602, armature of relay 603, terminal 621, cross-connected to strip 626, armature of relay 602, conductor 606, through the right winding of relay 1301, winding of relay 2051 to battery. Relay 1301 locates the frame and horizontal group within which the wanted line is located.

Connecting with line choice

Relay 2031 in operating, extends its operating ground over its middle upper front contact to the winding of relay 2052 and battery to prepare the ringing control circuits. In addition, it closes a circuit from battery over the uppermost contact of relay 2802, conductor 2820, third right contact of relay 2908, conductor 2920 through cable 2940, back contacts of relays 2055 and 2054, outer upper front contact of relay 2031, conductor 2007, through the winding of the marker preference relay 700 of the line choice connector of Fig. 7 to ground. Relay 700 locks and operates the multicontact relay 701, connecting the marker to the group of switching equipment embodied in the selected line choice. Relay 701 in turn operates multicontact relays 800 and 802.

Relay 1301 in operating extends its operating ground over its inner right contact to the winding of relay 1320. Relay 1320 connects the windings of relay 1330 over its inner contacts and cable 720 to the contacts of armatures 702 and 703 of relay 701 and thence to the windings of relays 451 and 454 in the line group control circuit of Fig. 4. These relays function to prevent the extension of originating calls in the line group while it is in use with the terminating marker. When the group circuit is free for use and battery through relays 451 and 454 is connected to the windings of relay 1330, that relay operates, in turn closing a circuit from ground over its inner left front contact, outer right front contact of relay 1301, armature 704 of relay 701, conductor 705, winding of horizontal group relay 402 to battery. Relay 402 prepares the operating circuits for the selected horizontal group. It closes, over the tip contacts of jacks 410 to 419, the circuits for the secondary select magnets 420 to 429, preparing the secondary line switches, which serve the selected line group, for operation. It also prepares the circuit for the primary select magnets by which the line link, which is to serve the wanted line, is selected.

When relay 700 operates it connects ground over its outer right contact, conductor 706, through cable 2940, to the winding of relay 2905 and battery, indicating to the marker that the line choice has been connected. When relay 701 operates it connects a second ground to this circuit.

Selecting a channel

Assuming that there are ten incoming frames and ten line choices, which is the simplest condition, there will be a total of four thousand outlets from the line switch frame and two thousand outlets from the incoming frame, that is, each line junctor will be connected in multiple to two line frames. Each line is served by ten line links, while each incoming junctor is served by twenty incoming links which in turn have access to twenty line junctors. However, for any one line and incoming junctor there will be ten line links, ten junctors and ten incoming links which may be used in connecting the line and junctor together. The identity of the line will determine the group of line links, the identity of the incoming junctor will determine the group of incoming links and the line frame and the incoming frame will jointly determine the group of line junctors.

Selecting line links

The operation of the select magnets 420 to 429 as above described prepares the group of line links and the operation of relay 402 connects this group of links through to the marker for test.

Selecting incoming links

When relay 2806 operated, connecting ground to conductor 2815, it operated relay 2608 which closed over its inner front contacts, battery and ground to the lower winding of relay 2210, over conductors 2211 and 2212 and cable 2250, while relay 2901 in operating closed a biasing circuit from battery through the upper winding of relay 2210, inner lower normal contact of relay 2213, resistance 2214 to ground at the innermost right contact of relay 2901. Relay 2210 operates in this circuit and closes a circuit which becomes effective when the incoming connector has operated as evidenced by the operation of relay 2907. This may be traced from ground over the innermost left front contact of relay 2907, back contact of relay 2260, operated contact of relay 2210, conductor 2215, lower back contact of relay 2822, conductor 3306, innermost left back contact of relay 3300, contacts of relays 3206 and 3204 of the marker connector, to conductor 3252. This conductor extends through the terminating sender link to conductor 217, winding of relay 216 and battery. Relay 216 disconnects the circuits of the incoming junctor from the incoming switches and extends them to the incoming connector. Relay 216 also closes a circuit from ground over its second lower front contact, conductor 218 through cables 950 and 952 to the winding of relay 920 and battery. Relay 920 extends the junctor control circuits and the test circuits of the proper incoming links to contacts of relay 901, which, being operated as previously described, extends these circuits to the marker. Relay 216 also operates the primary select magnet 300 and the nine other select magnets corresponding to the incoming links to which the incoming junctor has access.

Selecting line junctors

Relay 1320 in operating closes a circuit for relay 1400 over conductor 1341, to indicate that the wanted line lies in the corresponding half choice and relay 1400 operates relay 1402 to select the corresponding half of the incoming circuits. Relay 1402 extends the proper half of the incoming link sleeve conductors to the channel test relays. Relay 1330 operates relay 2110, over conductor 1342 through cable 2140 and also connects ground over its inner right front contact, conductor 1343 through cable 820, over armature 803 of line choice connector relay 800 to the winding of relay 804, which connects the marker to the proper frame. With relays 402, 804 and 802 operated the test circuits for the line links are connected to the channel testing relays.

The group of line junctors to be used in establishing a particular connection is a joint function of the line choice and the incoming frame. As before described, relay 1400 was operated to indicate the half choice. The multicontact relay 901 in the incoming link and connector circuit is individual to the incoming frame. Therefore, by the joint operation of these two relays a group of line junctors is selected. The circuit for this purpose may be traced from ground at armature 914 of relay 901, conductor 915 through cable 953, armature 1403 of relay 1400 to the winding of relay 1404 and battery. Relay 1404 substitutes battery for the ground which, up to this time, it has held connected to conductor 1405 in order to positively prevent the false operation of a line junctor relay. Battery on conductor 1405 extends over armature 808 of relay 802 of the line choice connector to the winding of line junctor relay 809 and ground. Relay 809 operates and with relay 802 connects the test conductors from the corresponding ten junctors to the marker.

Channel testing circuits

The sleeve test conductor of the incoming link shown in Fig. 3 may be traced over conductor 320 through cables 950 and 952, armature 911 of relay 920, normal ring contact of jack 906, armature of relay 901, conductor 913 through cable 953, next to lower armature of relay 1402, conductor 1401 through cables 1580 and 1582, uppermost back contact of relay 1500, left winding of relay 1510, conductor 1520, inner lower back contact of relay 2830, conductor 2831, through the winding of relay 3721, resistance 3750 and battery.

The circuit for testing the corresponding line link may be traced from the sleeve conductor 404 of the line link corresponding to select magnet 420, armature 430 of horizontal group relay 402, auxiliary contact of jack 410, armature 807 of relay 804, armature 805 of relay 802, conductor 806 through cables 1581 and 1582, second upper back contact of relay 1500, winding of relay 1530, conductor 1520 to battery as traced for relay 1510.

The test circuit for the line junctor shown in Figs. 3 and 4 may be traced from the sleeve conductor 456 of the line junctor, armature 810 of relay 809, armature 811 of relay 802, third upper back contact of relay 1500, right winding of relay 1510 to battery over conductor 1520. Therefore relays 1510 and 1530 together test the three elements of one channel which may be used for connecting the incoming trunk to the wanted line. Similar circuits are prepared for all of the relays of the groups 1510 to 1519 and 1530 to 1539. For any channel in which any one of the elements is busy, one of the corresponding relays will be operated.

In offices where it is expected that there will be more than ten incoming frames, the secondary holding magnets of two incoming frames are multipled and the pair of incoming frames are described as mate frames. Since a marker may be connected to each incoming frame of such a pair through the associated incoming connector, it is necessary to prevent the operation of secondary select magnets on one of a pair of incoming frames when the select magnets of the other frame are in use. The incoming frame is therefore provided with a regular and an emergency set of preference relays and auxiliary relays for closing the secondary select magnet leads. These preference relays are shown in Fig. 10. Relays 1000, 1001, 1010 and 1011 belong to the frame on which the incoming switches of Fig. 3 are located while relays 1002, 1003, 1012 and 1013 belong to the frame which is acting as the mate frame.

Relay 1330, as well as any other relay of that group, closes a circuit from battery over the inner upper back contact of relay 2203, conductor 2216 through cable 2250, outer left front contact of relay 1330, conductor 2217, through cable 2250, middle upper back contact of relay 2218, upper back contact of relay 3700, conductor 3703 through cable 954, armature 903 of relay 901 of the incoming link and connector circuit, conductor 931 through cable 1020, winding of relay 1000, back contact of relay 1002 to ground at the inner right back contact of relay 1005. Relay 1000 locks to ground at its front contact and connects ground over the left back contact of relay 1005, over the inner upper front contact of relay 1000 through the winding of relay 1001, conductor

935 through cable 1020, armature 904 of relay 901, conductor 905 through cable 954 to battery over the lower back contact of relay 3700. Relay 1001 closes circuits for operating the secondary select magnets for the line junctors serving the corresponding frame. One circuit extends from ground over armature 1004, conductor 1008, auxiliary contact of jack 906, innermost armature of relay 920, conductor 937 through cables 950 and 952 to the winding of secondary incoming select magnet 310 and battery. Relay 1001 also closes a circuit from ground over its outermost upper contact, conductor 1006 through cable 1020, armature of relay 901, conductor 908, through cable 954, second lower back contact of relay 3700 to the winding of relay 2219 and battery, as a signal that the preference circuit has been seized.

At the same time a branch of conductor 1006 extends to the mate frame. If a marker has also seized the mate frame, ground on conductor 1006 closes a circuit in that marker similar to that which would be closed if relay 1003 were operated, which would extend from the uppermost contact of relay 1003, conductor 1007, through cable 1020, armature of relay 901, conductor 910, inner lower back contact of relay 3700 to the winding of relay 2220. Relay 2220 opens the circuit controlled by relay 2219 to prevent the two markers connected to mate frames from testing for an idle channel at the same time. With relay 2219 operated and relay 2220 released, the circuit for selecting the desired channel is prepared.

Selection of idle channel

In preparation for selecting the first idle channel, a circuit is closed from battery through the winding of relay 1522, inner upper normal contacts of relays 1500 to 1509, conductor 1523, to ground at the second left armature of relay 2900. Relay 1522 closes an obvious circuit for relay 1524, which holds open the operating circuit for the hold magnets. Furthermore, a check that all of the relays which connect the channel elements to the marker have been operated is made by means of a circuit extending from battery through the windings of relays 1602 and 1603, conductor 1604, lowermost front contact of relay 1402, conductor 1406, armature 707 of relay 701 in the line choice connector, conductor 708, armatures 812 and 813 of line junctor relay 809, resistance 814, conductor 815, innermost armature of horizontal group relay 402 in the line group control circuit, conductor 460, armature 816 of relay 804, armature 709 of relay 701, conductor 710, armature 916 of relay 901 in the incoming like connector circuit, armature 917 of relay 920 to ground. Relay 1603 operates in this circuit but relay 1602 operates only under trouble conditions.

When relay 1600 operated as previously described, it connected ground over its fourth upper armature, through resistance 1606 to the lower winding of relay 1605, ground through resistance 1608 over its second upper front contact through condenser 1612 to the upper winding of relay 1605 and battery over its fifth lower contact to both windings of relay 1605. When these circuits are closed, condenser 1607 is short-circuited by ground over the back contact of relay 1603 and under this condition the flux through the windings of relay 1605 holds its contact in the position shown. When relay 1603 operates as above described, it opens the circuit of the upper winding of relay 1605, but this winding remains effective for a time due to the charging of condenser 1607. When the charge current dies down, the current through the lower winding of relay 1605 becomes effective to cause it to close its alternate contact.

When this contact is closed, a circuit is completed for selecting the first idle channel. This circuit may be traced from grounded conductor 2819, inner lower normal contact of relay 3100, conductor 1610 through cable 3170, left contact of relay 1605, conductor 1607, front contact of relay 1524, left front contact of relay 1522, lower back contact of relay 3725, conductor 3726, inner lower back contact of relay 2221, back contact of relay 2220, front contact of relay 2219, inner lower back contact of relay 3701, to the upper armatures of relay 1530. If relay 1530 were operated, the circuit would extend over its upper front contact to the upper contacts of the next relay in the chain. If relay 1530 is not operated, the circuit extends over tis upper back contact to the armature of relay 1510. If relay 1510 is operated the circuit is also extended over the front contact of that relay to the upper contacts of the next relay in the 1530—1539 chain. Similarly, the circuit is extended to succeeding relays of the chain if either of the channel test relays is operated. If all of the channels are busy the circuit extends over the upper front contacts of relays 1530 to 1534, outer upper back contact of relay 3701, upper front contacts of relays 1535 to 1539 and over the inner upper back contact of relay 3701 to the winding of relay 1609 and battery. Relay 1609 locks to ground over the contact of relay 1605, opening the operating circuit of the channel selecting relays. The function of this relay will be described hereinafter.

Assuming, however, that neither relay 1510 nor relay 1530 is operated because the corresponding channel elements are idle, the circuit will extend over the back contacts of relays 1530 and 1510 to the winding of relay 1500 and battery over the upper normal contact of relay 1609. Relay 1500 locks to ground over the operating circuit for relay 1522, thereby opening the circuit of that relay, permitting it to release and in turn release relay 1524. The release of relay 1522 prevents a preferred channel from being seized should it become idle subsequent to the selection of a less preferred channel. With relay 1500 operated and 1522 released the operating circuit for the primary line select magnet is closed from ground over the back contact of relay 1522, outer left back contact of relay 1526, inner lower front contact of relay 1500, conductor 1527 through cable 1583, outer lower front contact of relay 2110, conductor 2120, armature 817 of relay 800, armature 457 of relay 402, winding of select magnet 458, controlling line link 459, and battery.

Test of selected channel

Relay 1500 transfers the link and junctor test leads to testing circuits preparatory to operating the hold magnets. However, the testing circuit is not immediately applied, but waits for an interval, determined by relay 2300, to insure that the hold magnets have a minimum release interval before reoperation.

When relay 2908 operated, it connected battery over its inner right contact to the windings of relay 2300, connected ground through resistance 2922 and condenser 2923, over conductor 1525 to the lower winding of relay 2300 and connected ground through resistance 2924 to the

upper winding of relay 2300. At the same time, relay 1522, having been operated when relay 2900 operated as above described, connects ground over its outer right front contact and conductor 1525 in shunt of condenser 2923. With relay 2300 thus energized, the circuit is closed from ground at the fourth right contact of relay 2905, armature of relay 2300 in engagement with its right contact, conductor 2332, to the winding of relay 1524 and battery, in parallel with the ground furnished by relay 1522, to hold relay 1524 operated for a measured time interval following the release of relay 1522. When relay 1522 was released by the operation of channel relay 1500, the circuit of the lower winding of relay 2300 is opened, but the effect of this winding is continued due to the charging current through condenser 2923 for a predetermined length of time. When the charging current dies down, relay 2300 closes its left contact completing a circuit from ground as previously traced over its left contact, conductor 2333, innermost left contact of relay 2901, conductor 2925, back contact of relay 2301 to the winding of relay 2302 and battery. The function of relays 2301 and 2302 will be described hereinafter.

When the armature of relay 2300 leaves its right contact, the circuit of relay 1524 is opened and that relay releases to close the channel leads to the testing circuits.

The testing circuit for the incoming link extends to polarized relay 3728. The lower and middle windings of relay 3728 are connected in a differential circuit which holds the relay non-operated. This circuit may be traced from battery at the fourth lower contact of relay 1600 through the middle winding of relay 3728, through the lower winding of relay 3728, conductor 3729 through cables 3175 and 3072, lower normal contact of relay 3101, conductor 3102 through cables 3171 and 3071, back contact of either relay 3303 or 3304, conductor 3305 to ground at the second left front contact of relay 2905. The mid-point of these two windings is connected over the upper back contacts of relays 2223 and 2218, outer left back contact of relay 1524 to the uppermost front contact of relay 1500 and thence as traced to the sleeve of the incoming link. A circuit is also closed from battery through the upper winding of relay 3728, normal contact of relay 3734, inner upper back contact of relay 2218, inner left back contact of relay 1524, fourth upper contact of relay 1500, armature 811 of relay 802 and thence as previously traced to the sleeve conductor 456 of the line junctor. If the incoming link and line junctor are not grounded and have battery connected to them from hold magnets 340 and 330, respectively, showing that they are continuous, relay 3728 will operate.

At the same time that the incoming link and line junctor are being tested by relay 3728, the line link, to which battery was connected by the operation of relay 402, is being tested by the polarized relay 3730. The lower and middle windings of this relay are wound in differential relation and are included in a circuit extending from ground at the third upper contact of relay 1600 through the windings of relay 3730 in series to battery, at the third lower contact of relay 1600. The sleeve of the line link is connected to the middle upper armature of relay 1500 as above described and over the front contact of that armature, right back contact of relay 1524, upper back contact of relay 3731, to the point between the lower and middle windings of relay 3730. If battery is present on the line link, relay 3730 operates, locking in a circuit from battery through its upper winding and closed contact to ground over conductor 3729 as previously traced. Relay 3730 also extends its locking ground to the winding of relay 3731. With relay 3731 operated, the circuit of the line link sleeve is transferred from relay 3730 over the front contact of relay 3731, back contact of relay 3732 to the winding of relay 3733 and battery. With relays 3728 and 3730 both operated, a circuit is closed from ground over conductor 3729, left contact of relay 3730, right contact of relay 3728 to the winding of relay 3734 and battery. Relay 3734 locks over its alternate contact to ground over conductor 3729, disconnects the upper winding of relay 3728 from the line junctor and connects ground over conductor 3729 to the sleeve of the line junctor over the path above traced.

Operation of hold magnets

The ground connected to the sleeve of the line junctor starts the operation of secondary hold magnet 330 direct and of secondary hold magnet 461 over a parallel circuit extending over the second upper front contact of relay 1500, conductor 1521 through cables 1581 and 1582, lowermost front contact of relay 1416, armature 826 of relay 802, armature 821 of relay 809, conductor 818 to the winding of magnet 461. When magnet 330 operates, it extends its operating ground over the sleeve contact of the secondary incoming selector to conductor 320 causing the operation of the primary incoming hold magnet 340. This ground also extends to the lower and middle windings of relay 3728, in shunt of the lower winding of that relay. However, this relay is held operated until relay 3734 completes operates, over the make-before-break contact of relay 3734 and conductor 3729. When relay 3734 is operated and locked, and hold magnet 330 is operated, relay 3728 opens its right contact and closes its left contact.

When hold magnet 461 of the secondary line switch operates, it extends its operating ground over its local front contact to the sleeve contact of the secondary line switch and the sleeve conductor 404 of the line link, which was extended as above described to the winding of relay 3733 and battery. Relay 3733 now operates, locking to conductor 3735 which is grounded at the innermost left contact of relay 2905. Relay 3733 also extends ground from conductor 3735 to the winding of relay 3732 which also operates, disconnecting relay 3733 from the sleeve conductor of the line link.

When hold magnet 340 of the primary incoming selector operates, as previously described, it extends its operating ground over conductor 215, third lower front contact of relay 216 to conductor 219 and thence through cables 951 and 952, over armature 919 of relay 920, armature 922 of relay 901, conductor 921 to the winding of relay 2221 and battery, operating that relay.

As a signal that all of the hold magnets necessary to set up the call, with the exception of the line hold magnet, have been operated, a circuit is now closed from battery through the winding of relay 2203, uppermost front contact of relay 2221, upper front contact of relay 3733, left normal contact of relay 3728, left contact of relay 3730 to ground over conductor 3729 as previously described. With relay 2203 operated, the marker awaits certain tests to be described hereinafter before operating the line hold magnet 401.

False charge test

A false battery on the tip conductor, a false ground on the ring conductor or a short circuit between the tip and ring conductors of the incoming or line switches would operate the supervisory relay of the incoming junctor regardless of the status of the called line. The function of relay **2303** is to detect these conditions as well as certain forms of double connections. This test is made only when the release of relays **2642** and **2623** between calls indicates light traffic conditions. The function of these relays will be described hereinafter. The operation of relay **2801** connects the windings of relays **2303** toward the incoming link and connector circuit which in operating extends them to contacts of relay **216** in the incoming junctor, and this relay in turn extends them to the tip and ring of the primary incoming switch linkage, while subsequent operations of the hold magnets continues the test up to the cross-point of the line. The test circuits are made effective by the operation of relay **3731** and may be traced from battery at the lower front contact of relay **3731** through the lower winding of relay **2303**, second lower back contact of relay **2305**, upper back contact of relay **2306**, conductor **2307** through cable **2343**, innermost lower front contact of relay **2801**, conductor **2833**, armature **939** of relay **901**, armature **924** of relay **910**, conductor **223** through cables **950** and **952**, lowermost front contact of relay **216**, over the ring conductor of the trunk outgoing to the primary incoming selector and thence when hold magnets **340**, **330** and **461** have operated, over the ring conductors of the switch linkage. A second circuit is closed from ground through the upper winding of relay **2303**, lower back contacts of relays **2304** and **2306**, conductor **2308** through cable **2343**, uppermost front contact of relay **2801**, conductor **2834**, armature **923** of relay **901**, armature **925** of relay **910** to conductor **224** through cables **950** and **952**, uppermost front contact of relay **216** to the tip conductor of the switch linkage. If both conductors are free from grounds or crosses, relay **2303** does not operate. It it operates, it locks through its lower winding to ground over conductor **3729**. In operating, it opens the operating circuit for the line hold magnet, preventing the further operation of the marker and permitting the timing circuit of the marker to function.

Assuming light traffic, relay **2301** is operated, as soon as relay **2802** is operated, in a circuit over conductor **2309**, back contact of relay **2623**, conductor **2621** to ground at the innermost lower contact of relay **2802**. When relay **2900** operates it closes a locking circuit for relay **2301** extending over the front contact of relay **2301**, conductor **2310**, second right front contact of relay **2900**, to conductor **2621**. Relay **2301**, operated, prevents the operation of heavy traffic relay **2302**, and prepares a link in the operating circuit of the line hold magnet.

When relay **2203** operates as above described, it in turn operates relay **2305** over its inner lower front contact to ground on conductor **2944**. Relay **2305** locks over its inner upper front contact to ground on conductor **2944**, independent of relay **2203**. Relay **2305** in operating, opens the circuit of relay **2303**, disconnects ground from the ringing control relays of the incoming junctor and completes the circuit of the line hold magnet **401**. The circuit for operating magnet **401** may be traced from battery through the magnet winding, conductor **604**, contact **623**, armatures of relays **603** and **600**, back contact of relay **1203**, middle upper front contact of relay **1269**, conductor **2325**, upper back contact of relay **2314**, middle lower front contact of relay **2305**, front contact of relay **2204**, conductor **2832**, lowermost back contact of relay **2841**, conductor **2313**, front contact of relay **2301**, conductor **2237**, outer upper front contact of relay **2203**, normal contact of relay **2303** to ground on conductor **3729**.

The operation of magnet **401** completes the physical connection between the incoming junctor and the wanted line and also disconnects the line from the line relay **403** but the line is not signaled until after the ringing control relays in the incoming junctor have been operated and a continuity test of the cross-points included in this part of the connection has been made.

Continuity test

The cross-point continuity test is performed by the condenser **3050**, relays **3062**, **2218**, **2232** and **3052** and the ionic tube **3053**. The purpose of this test is to indicate that the cross-points of the tip and ring conductors are properly closed and that the hold magnets have operated. For this test, ground is connected to one side of the subscriber's line and ringing voltage stepped up by the transformer **3054** to the other. The primary circuit of the transformer **3054** may be traced from source **3055**, through ballast lamp **3066**, primary winding of transformer **3054**, conductor **3056**, outer left front contact of relay **2901** to ground. The control elements of the tube **3053** are connected one on each side of condenser **3050**. One element is connected directly to ground and the other element is connected through resistances **3057**, **3058** and **3059**, which amount to 200,000 ohms, to the condenser **3050**. The anode or plate circuit is connected in series with relays **3052** and **3062** over the uppermost front contact of relay **2305** through ballast lamp **2311** to 110-volt positive battery.

When relay **2900** operated, a circuit was closed from ground at the inner left front contact of relay **2900**, over the outer lower back contact of relay **2203**, to the winding of relay **2204** and battery. Relay **2204** is slow to release and holds its lower contact closed for a measured interval following the operation of relay **2203**.

When relay **2305** operates and closes the circuit for operating the line hold magnet, it also closes a circuit for relay **2312** in parallel therewith. With relay **2312** operated, a circuit is closed from ground over the upper front contact of relay **2312**, lowermost front contact of relay **2305**, winding of relay **2304** and battery. Relay **2304** locks under the control of relay **2305** to ground over its own middle upper front contact, independent of relay **2312**. Relay **2305** disconnects the conductor **2307** which extends to the ring conductor of the switch linkage from battery through the lower winding of relay **2303** and extends it to ground over the upper back contact of relay **2304** until that relay operates. The purpose of this short ground connection is to discharge the capacity between the conductors **2307** and **2308** before connecting them to the ionic tube. When relay **2304** operates, it further extends the circuit over conductor **2307** over its inner upper front contact, conductor **2315**, upper back contact of relay **2213**, conductor **2234**, through cables **3176** and **3073**, lower back contact of relay **3103**, assuming that relay not to be operated, resistance **3104**, conductor **3105**, normal contact of relay **3062**, conductor **3061** to ground at the inner left

front contact of relay 2308. During the interval between the operation of relays 2305 and 2304 conductor 2308 continues to be connected to ground through the upper winding of relay 2303. When relay 2304 operates, conductor 2308 is extended over the middle lower front contact of relay 2304, conductor 2316, middle upper back contact of relay 2213, conductor 2235 through cables 3173 and 3073, outer upper back contact of relay 3103, conductor 3106, resistance 3051, normal contact of relay 3052, through the winding of repeating coil 3054 to the ungrounded terminal of condenser 3050.

The connection of conductor 3106 to the condenser 3050 causes a voltage drop across this condenser. If the voltage drop is caused only by the capacity and leak of the switches and associated cabling it is less than the break-down voltage of the tube. When the line hold magnet operates, adding the capacity and leak of the line the voltage drop across the condenser 3050 as measured by the control elements of the tube 3053 is sufficient to cause the control gap of the tube to break down and the anode circuit becomes effective. Current flow in the anode circuit operates relays 3052 and 3062. Relay 3062 closes a circuit from battery through the windings of relays 2232 and 2218, in parallel, middle lower front contact of relay 2203, left contact of relay 3062, conductor 3061 to ground at the inner left front contact of relay 2908. Relays 2218 and 2232 operate, relay 2218 closing a locking circuit for the two relays over its innermost upper front contact direct to conductor 3061. Relay 3052 opens the test circuit and connects battery to the line, to charge the line capacity for the purpose of reducing the surge which occurs when relay 2210 is later connected to the line.

Ringing control

In the meantime the ringing control relays of the incoming junctor have been operated to control the ringing. Under the assumption that this was an individual line, relay 2052 was operated as above described. Relay 2052 in operating closes a circuit which may be traced from ground at the fourth upper front contact of relay 2801, outer upper front contact of relay 2803, upper back contact of relay 2804, upper back contact of relay 2822, conductor 2813, upper back contacts of relays 1814 and 1810, conductor 1815, back contact of relay 2034, upper front contact of relay 2052, conductor 2060, outer right front contact of relay 1330, conductor 1340 through cable 2455 to the winding of relay 3110 and battery.

When relay 2802 operated, it closed a circuit from ground over its middle lower front contact, conductor 2823 through cables 3171 and 3071, over the back contacts of relays 3113 and 3112 to the winding of relay 3111 and battery, as a check that the ringing control relays have been released from the previous call. Relay 2035 is operated as a check that all three of the relays 2402, 2403 and 2404 are released at the beginning of a call, the circuit extending from battery through the winding of relay 2035, conductor 1851, through cable 2455 over the lower back contacts of relays 2402, 2403 and 2404, conductor 2406 through cable 2343 to ground at the fourth lower contact of relay 2801. When the marker is connected to the incoming junctor, ground is connected to one of the conductors 932, 933 or 934 to operate one of the relays 2402, 2403 and 2404 as an indication of the type of incoming junctor, or the type of the originating office. In this case, ground is connected over armature 930 of relay 920, armature 940 of relay 901, conductor 932 through cables 2450 and 2451, to the winding of relay 2402, conductor 2405 through cable 2455 to battery over the inner upper front contact of relay 2035. Relay 2402 opens the circuit of relay 2035 but this relay is slow to release and holds its contact closed long enough for relay 2402 to lock directly to battery over its inner upper front contact.

When relay 3110 operates, it connects ground on conductor 2406, over the back contacts of relays 2404 and 2403, outer lower front contact of relay 2402, conductor 2417, inner lower back contact of relay 2305, conductor 2326 through cables 3172 and 3072, inner lower front contact of relay 3111, lower front contact of relay 3110 to the winding of relay 3112 and battery and, in parallel therewith, to conductor 3114 which extends through cables 3174 and 2451 over armature 943 of relay 901 and armature 936 of relay 920 to conductor 221 of the incoming junctor through cables 951 and 952 and over the second upper front contact of relay 216 to the winding of relay 225 and battery. Relay 225 closes a locking circuit for itself over its middle upper front contact, back contact of ringing relay 226 to ground at the uppermost front contact of relay 204. This ground extends back over conductor 221 to conductor 3114 of the marker. Relay 3112 in operating opens the circuit of relay 3111 which releases slowly. When relay 2305 is operated as previously described, the operating ground of relay 3112 is opened, but if the ringing control relay 225 of the incoming junctor has operated and locked, the locking ground, extended back, holds relay 3112 operated.

A circuit is now closed to determine whether the ringing relay has been properly operated and that no false grounds exist which would lead to erroneous ringing or charging. In the present case, this circuit may be traced from ground over the inner contacts of relay 2232, conductor 2236 through cables 1746, 2340 and 1740, upper front contact of relay 3110, lowermost back contact of busy-back relay 2401 as an indication that that relay has not operated, outer upper front contact of relay 3112, indicating that the ringing relay has locked, conductor 3160, inner upper back contact of relay 3103, conductor 3115, through cable 2455, back contact of relay 2062 as a check that there was no tip party indication, conductor 2063 through cable 2455, lower back contact of relay 3113 to indicate the corresponding non-operation of the reversing relay of the incoming junctor, upper back contact of relay 3116, which is employed in four-party ringing and therefore has no function with the present junctor, conductor 3117 through cables 3177 and 3071, back contact of relay 3514 which controls the four-party ringing, conductor 3520, upper back contact of relay 3118 which is controlled by relay 3116, upper back contact of free call relay 3119, conductor 3120, back contacts of relay 2400 and busy-back relay 2401, conductor 2408 through cables 2453 and 2341, back contact of free line relay 1104, conductor 1105 through cables 2453 and 2341, back contact of relay 3122, conductor 3121 through cables 1740, 1746 and 2340, uppermost back contact of relay 2841, conductor 2840, windings of relays 2213 and 2231 in parallel to battery. The operation of these relays indicates that no false grounds exist on any of the leads not supposed to be grounded for this

particular call as well as the fact that the ringing control relay of the incoming junctor has been properly operated and locked. If these relays operate, relay 2213 closes a locking circuit for itself and relay 2231 which extends over conductor 2840, back contact of relay 2841, conductor 3121, second upper front contact of relay 2213 to ground over the inner contacts of relay 2232.

The operation of relay 2232 as above described extended the tip and ring test conductors to the upper winding of relay 2210. The tip conductor extends from conductor 2316, over the middle lower back contact of relay 3701, outer upper front contact of relay 2232, to battery through the upper winding of relay 2210 and the ring conductor extends from conductor 2315 over the outer lower back contact of relay 3701, through the winding of relay 2241, outer lower front contact of relay 2232, lower back contact of relay 2238 to the upper winding of relay 2210 and battery. Relay 2213 in operating opens the energizing circuit for relay 2210 as well as the previously traced extensions of these conductors which were employed during the continuity test by the tube 1553, leaving relay 2110 dependent on the condition of the talking circuit. The purpose of this arrangement is to test the two sides of the line for false grounds such as might be caused by double connections, crosses with the message register lines, etc.

Marker release

If no such ground is present, relay 2210 releases, opening the circuit of relay 216 in the incoming junctor, thereby closing the incoming talking conductors through to the line. Relay 216 also releases relay 920 in the incoming link and connector circuit and the incoming class relay 2402 in the marker. It connects ground over the lowermost front contact of relay 204 through resistance 214 and the inner lower normal contact of relay 216 to conductor 215 and over the sleeve switch points to the windings of hold magnets 340, 330, 461 and 401 and the sleeve of the line to maintain the connection under the control of the incoming junctor. It also disconnects ground from conductor 219 thereby releasing relays 2221 and 2203 in the marker. The release of relay 2203 disconnects the ground from conductor 604 by which the line and the connection have been held previously. The release time of relays 2221 and 2203 therefore covers the releasing time of the relay 216 and insures that the holding ground has been reliably closed. The release of relay 2203 also extends ground supplied to the sleeve of the line by the incoming junctor from the uppermost back contact of relay 2203, conductor 2844, inner upper back contact of relay 2842, middle upper back contact of relay 2841, third lower front contact of relay 2801, upper front contact of relay 2830, conductor 3261 through cable 3420, and through the marker connector to the release conductor 3260 of the terminating sender. The release relay of the terminating sender removes battery from the start lead 3200 of the marker connector, thereby releasing the connector relays. The release of the marker connector opens the register leads and disconnects ground from conductor 3250, thereby releasing relays 2801 and 2802 which in turn release relays 2803, 2806 and 2608. Relay 2801 opens the circuit of the sender release relay to prevent a false release should the marker be reseized immediately. Relay 2802 opens the circuit of the marker preference relay 700 in the line choice connector as well as the operating circuit for the twenty-block relay 603 in the number group circuit. Both of these relays remove off-normal ground from a large number of circuits. The release of the register relays opens the circuit of the marker preference relay 502 in the number group connector as well as that of the marker preference relay 900 in the incoming link connector.

The operation of the release relay in the terminating sender completes the release of the sender.

Functions of incoming junctor

When relay 216 releases as above described, relay 225, being operated and locked, connects ringing current to the ring conductor from the ringing supply on conductor 227, inner lower front contact of relay 225, winding of relay 226, inner upper back contact of relay 228 or the outer left back contact of relay 229, lower back contact of relay 228, outer lower front contact of relay 225, outer lower back contact of relay 216 and the ring conductor leading to the wanted line. It also connects generator ground, supplied over conductor 230, over the upper back contact of relay 228, outer upper front contact of relay 225, upper back contact of relay 216 to the tip conductor. When the called subscriber answers, relay 226 operates, opening the locking circuit of relay 225 which restores the shunts to condensers 231 and 232, extending the called subscriber's line to battery and ground through the windings of relay 233. This relay connects ground to conductor 235 which is connected through the timing circuit to conductor 236 and conductor 215 to supply supplemental holding ground for the switches. The release of the terminating sender removes battery from conductor 212. Therefore, the operation of relay 233 is effective to close a circuit from ground over its upper front contact, the innermost upper front contact of relay 204, inner left back contact of relay 229, resistance 234 to the winding of relay 203 and battery, operating relay 203 to transmit a reverse battery signal to the originating office for supervisory purposes.

The release of the connection is under the joint control of the calling and called subscribers, that is, the release of both relays 204 and 233 is necessary for the immediate disconnection of ground from conductor 215. However, if relay 204 releases while the called subscriber is still holding relay 233 operated, ground over the upper front contact of relay 233 is connected over the innermost upper back contact of relay 204 to conductor 237 leading to the timing circuit and, after a predetermined time has elapsed, conductors 235 and 236 are disconnected, removing ground from conductor 215, releasing the switches and thereby releasing relay 233.

Tip party calls

The operation of the circuit in establishing a connection with a tip party on a two-party line differs slightly from that described. Assuming that the number previously registered belonged to such a tip party located in the same line choice, terminal 625 will be cross-connected to strip 631 and the circuit closed by relay 1269 will extend over conductor 613 through cable 2076 through the lower winding of relay 2030. Thus, relay 2030 is energized over its lower winding and extends its operating ground over its inner lower front contact to the winding of relay 2062 instead of to relay 2052. Relay 2062

closes a circuit from ground extending to conductor 1815 as previously traced, over the back contacts of relays 2034, 2052 and 2064, upper front contact of relay 2062, conductor 3130 through cable 2455 to the winding of relay 3103 and battery. Relay 3103 connects ground on conductor 2417 over the upper back contact of relay 2305, conductor 3123 through cables 3172 and 3072, upper front contact of relay 3111, inner upper front contact of relay 3103, to the winding of relay 3113 and to conductor 3124 through cables 3174 and 2451, armature 948 of relay 901, armature 938 of relay 926, conductor 222 through cables 951 and 952, fourth upper front contact of relay 216 to the winding of relay 228 to battery. Relay 228 reverses the connection of ringing current and generator ground to the wanted line thereby ringing the tip party instead of the ring party as before.

In addition, relay 3103 closes a circuit from ground at the upper back contact of relay 2401, inner lower front contact of relay 3103 to conductor 2060 which extends as previously traced over the outer right front contact of relay 1330 to conductor 1340 and the winding of relay 3110. Relay 3110 performs the same functions as heretofore described. Relay 3103 also reverses the connection between the tip and ring conductors of the switch linkage and the testing equipment of the marker. Otherwise the handling of the call is precisely like the above.

Terminal hunting group—small

In the case of a small group of lines serving a single subscriber which constitutes a terminal hunting group, ordinarily a group of consecutive numbers are assigned and the directory number is that of the first line of the group. This directory number is recorded in the usual manner and the registration causes the selection of a number group, a hundred-block and a twenty-block in the number group as previously described. However, in this case the terminals 624, 625, etc. of the twenty-block relay such as relay 603, which correspond to the first and intermediate lines of the terminal hunting group are cross-connected to strips 632, 633, etc. and thence over conductors 2014, 2025, etc. to the armatures of relays 2003 to 2006. It will be remembered that relays 2003 to 2006 are operated prior to the testing of the wanted line and that when all are operated the ground is extended over a chain circuit covering all of the relay armatures and therefore to each of the conductors 2014, 2025, etc. corresponding to the terminal hunting group. This ground is transmitted back over the armatures of relays 600, 603 and 600 to the lower back contacts of relays 1250 to 1269 and to the windings of such relays of the group 1920 and 1939 as are included in the terminal hunting group. Assuming momentarily that the group includes twenty lines, so that relay 1920 corresponds to the first line of the group and relay 1939 to the last line of the group, each of relays 1920, 1929, 1930, etc. will be operated, but relay 1939 will not operate since terminals belonging to the last line of a terminal hunting group are cross-connected in the same manner as for individual lines. With relays 1920, 1929, etc. operated, the line selecting circuit extends as previously traced to the units register. Under the assumption that the first line of the group is the first line of the twenty-block, the circuit will extend over the lower back contacts of relays 3413, 3414, 3412 and 3411, upper back contact of relay 3413, conductor 3416 through cable 3421, outer lower front contact of relay 1980 to the contacts of relay 1900. Assuming that the first ten trunks are busy, relays 1900 to 1909 will be operated from ground on the corresponding trunks and the test circuit will extend over the front contact of relay 1900 and the front contact of relay 1920 to the armatures of the next sleeve relays and thence over the front contacts of relays 1909 and 1929 to the back contact of relay 1910 and the winding of relay 1260 and battery. Relay 1260 performs the same functions as relay 1269 did previously. If all of the trunks had been busy, the selecting circuit would have extended over the front contacts of the sleeve and trunk relays to the lower front contact of relay 1919. Relay 1939, being the last line of the group, is not operated and hence the circuit extends over the back contact of relay 1939, conductor 1984, lower back contact of relay 1101, conductor 1110 through cable 2343, winding of busy-back relay 2401 to battery. The function of relay 2401 will be described hereinafter.

Terminal hunting progress

For the case of a terminal hunting group which includes more than twenty lines, assume that the recorded number is 2440, thereby connecting with the same number group but operating relays 3603 and 2504 to, in turn, operate a different twenty-block relay, for example, relay 634. The line selecting circuit will extend as traced for the previous case to the contacts of relay 1900. In this case, all of the choice identifying terminals 635, 636, etc. on twenty-block relay 634 will be cross-connected over strips 632, 633, etc. to the windings of relays 1920 to 1939 so that, if the first twenty trunks are all busy, the selecting circuit will extend over the front contact of relay 1939 to the winding of relay 2622 and battery. Relay 2622 locks under the control of relay 2610 which is energized at this time and disconnects battery from relays 1250 to 1269 to prevent their premature operation. It also opens the operating circuit of the even-numbered hundred-block control relay 2504 which remains operated over its locking circuit and closes a circuit over its left front contact, upper back contacts of relays 2508 and 2506 and the upper front contact of relay 2504 to the winding of relay 2505 and battery. Relay 2505, in operating, disconnects ground from the twenty-block relay in the number group connector and it, in turn, releases relay 2607 followed by relay 2610. When relay 2610 releases, relay 2622 also releases, connecting ground over its outer left back contact to the lower back contact of relay 2507, lower front contact of relay 2505, winding of relay 2506 and battery. With relay 2506 operated a new twenty-block relay is operated and the test for an idle trunk is continued. When the first twenty-block relay releases, relays 1900 to 1919 and 1920 to 1939 also release so that they are ready for reoperation in accordance with the number of trunks and their busy or idle condition. Relay 2505, in operating, closes a circuit from battery through the winding of relay 2512, conductor 2538, upper front contacts of relay 2505, conductor 1101, inner lower front contact of relay 2506 to ground over the operating circuit of that relay. With relay 2512 operated, the selecting circuit is independent of the units digit, and extends directly over the front contact of relay 2512, conductor 2531 to the contacts of relay 1900, thereby starting the test with the first line of the twenty-block. By means of the relays 2500

to 2508, groups of terminal hunting lines as large as one hundred all located in one number group may be hunted over.

Jump hunting

If a group of trunks becomes too small and no additional numbers are available directly following those already in the group, a method known as "jump hunting" is provided for including other lines in the same terminal hunting group. When it is desired to enlarge a group of private branch exchange trunks, the cross-connecting terminals corresponding to the last trunk of the original group are disconnected. The sleeve terminal corresponding to terminal 623 is left open, the choice identifying terminal corresponding to terminal 625 is cross-connected to one of the five terminals 530 to 534 which correspond to the twenty-block in a hundred-block containing the new trunks, while the level identifying terminal corresponding to terminal 621 is cross-connected to one of the ten terminals 540 to 549 which correspond to ten even-numbered start points within the twenty-block.

When relays 1900 to 1919 are connected to the lines including the last line thus cross-connected, because the sleeve circuit is open the corresponding relay of that group cannot operate and the trunk appears idle. If now, all of the remaining trunks are busy, the relay of the group 1250 to 1269 corresponding to the last trunk operates, connecting ground to the choice and level terminals. Cross-connecting terminals 530 to 534 are connected through armatures of relay 506 to the windings of relays 1810 to 1814 and battery, and cross-connecting points 540 to 549 are connected over other armatures of relay 506 to the windings of relays 1830 to 1839 and to battery through the winding of relay 1852. Assuming that terminals 530 and 540 have been connected with, the ground supplied by the relay 1260, for example, operates relays 1810 and 1830. Relays 1810 and 1830 both lock to grounded conductor 2310. With these relays operated, ground over conductor 2310 is extended over the inner lower front contact of relay 1810, inner upper front contact of relay 1830 to the winding of relay 1801 and battery.

Relay 1801 disconnects ground from the circuit of the hundred-block relay and disconnects ground from the units register thus opening the selecting circuit by which one of the relays 1250 to 1269 is normally operated. It also opens the circuit for operating the twenty-block relay and the circuit for operating the relays 2500, 2502, 2504, etc. The opening of the circuit of the twenty-block relay causes relay 2607 to release in turn releasing relay 2650. When relay 2650 closes its own back contact, it completes a circuit from ground over this contact, conductor 2651 through cable 2660, inner upper front contact of relay 1801, back contact of relay 1852, winding of relay 1803 and battery. Relay 1803 locks under the control of relays 1852 and 1801 to ground at its own innermost upper front contact.

Relay 1803 connects the operating ground for the relays of group 1250, etc., from conductor 1805, over its second upper front contact to the lower front contact of relay 1830 and over conductor 2531 to the contacts of relay 1900. If some other relay of the group 1830 to 1839 were operated, the circuit would be extended to the corresponding even-numbered relay of the group 1900 to 1919. When relay 1810 operated, it connected ground over its uppermost front contact to conductor 1850, over the back contact of relay 1803 to conductor 1851 and over the back contact of relay 2650 to conductor 1851 and the winding of relay 2035 and battery. When relay 1803 operates, it opens one of these circuits of relay 2035. It also connects ground from conductor 2601 through the winding of relay 1800, third upper front contact of relay 1803, conductor 1853 to the armature 560 of relay 506 in the number group connector and thence to the hundred-block relay (not shown) through which all of such jump hunted trunks are reached. It also connects ground on conductor 1703 over its inner lower front contact, outer lower front contact of relay 1810 to the winding of relay 2500 and battery. Relay 2500 grounds conductor 2533 leading over an armature of relay 506 to the armature of the operated hundred-block relay to select the particular group of twenty lines within which the next trunk to be tested is located. Relay 1803 also recloses ground to the operating circuit for the twenty-block relay. From the point of operation of the twenty-block relay to the grounding of the armature of the sleeve test relay, the line test proceeds in the usual manner.

This jump hunting arrangement permits the addition of lines to terminal hunting groups without changing numbers. It therefore reduces the necessity of leaving spare numbers following lines of groups which may grow. On the other hand, the use of jump hunting adds to marker holding time. The lines added by means of jump hunting need not be numbered. If they are not in the regular numbering system and it is desired to furnish terminal numbers for testing, bridged cross-connections to numbered terminals may be employed. The number terminals bridged to need not be in numerical order nor in hunting sequence, and may be wired as individual lines. These numbers may be used for future numbers or other similar purposes. If the hundred-block jumped to is in a regular numbering system, it may be used for numbers called directly as well as for numbers jumped to. If a number group is not provided with jump hunting and it is desired to add this feature by jump hunting into a hundred-block already assigned to a hundred-block lead, this lead may be strapped to the special jump hunting lead in the number group and cross-connection changes thus avoided.

Allotted terminal hunting groups

Where branch exchanges employ large groups of trunks or the traffic is extremely heavy, so that the calls for the wanted subscriber may make an excessive load for one number group connector, the trunks may be distributed over two number group connectors by an allotting arrangement such as shown in Fig. 11.

The marker normally handles a block of one hundred consecutive numbers as a unit and furnishes a start and hundred-block circuit whereby the hundred-block located in one number group connector may be seized. However, if the hundred-block contains the directory number of an allotted private branch exchange, when non-consecutive end of block hunting is required or when free lines are required, a split hundreds relay, such as relay 3600, is provided. The start circuit of the particular hundred, which would normally be extended to the number group connector, is in this case extended to the winding of relay 3600. The corresponding hundred-block circuit at the five hundred group relay is left open.

Assuming that the five hundreds relay 3000 indicating the group of five hundred numbers lying between 2000 and 2499 is operated, and that relay 3010 representing the zero hundred group is also operated, in combination representing the group of one hundred numbers lying between 2000 and 2099, the battery supplied to the upper armatures of the hundreds relays 3010 to 3014 over conductor 2720 is connected over the upper front contact of relay 3010, second upper front contact of relay 3000, over conductor 3023 to the winding of relay 3600 and ground. Relay 3600 has five sets of armatures each set corresponding to one group of twenty numbers making up the one hundred numbers represented by relay 3600. Assuming that, as in the previous case, the twenty's relay 3605 is operated, the four innermost contacts of relay 3600 will belong to the group of twenty numbers lying between 2080 and 2099. Further, assuming that 2090 represents the directory number of an allotted private branch exchange, the fourth armature of relay 3608, to which ground is connected over the inner lower front contact of relay 3605, will be connected over conductor 3620 through cables 3632 and 3634 to the upper winding of relay 1157 and battery and over the middle upper back contact of relay 1104 to the winding of relay 1101 and battery. Relay 1101, in operating, closes a circuit from battery through the winding of relay 1130, conductor 1132, over the outer upper back contacts of relays 2508, 2507, 2506, 2505, 2504, 2503, 2502, 2501, and 2500, conductor 1133, outer lower front contact of relay 1101, inner upper back contact of relay 1102, conductor 1134 through cables 1160 and 2870 to ground at the fifth upper front contact of relay 2802. Relay 1130 closes links in the start, hundred-block and twenty-block circuits. With relay 1130 operated, the start circuit for the number group connector is closed. This circuit may be traced from battery through resistance 1131, outer lower front contact of relay 1130, conductor 3624 through cable 3631, inner upper front contact of relay 3605, third contact of relay 3600, conductor 3621 through cables 3070 and 2341 to the lowermost contacts of relays 1135 and 1136. Under the control of relays 1138 and 1140 one of these relays is operated whenever a call is in progress as will appear hereinafter. With relay 1135 operated, the start circuit is extended over conductor 1141 to the cross-connecting rack 500 where it may be connected to the winding of the marker relay 502, seizing the same number group as in the call previously traced. With relay 1136 operated, the start circuit is extended to the preference relay of a different number group connector. With relays 1130 and 1157 operated, ground over the fifth lower contact of relay 2801, conductor 2816, left back contact of relay 2600, conductor 2601, through cable 2660, winding of relay 1800, inner lower back contact of relay 1801, to conductor 3021, is connected over the inner lower back contact of relay 1102, upper front contact of relay 1157, upper back contact of relay 1104, inner lower front contact of relay 1130 to conductor 3625 and thence through cable 3631, over the middle upper front contact of relay 3605, second contact of relay 3600, conductor 3622 through cables 3070 and 2341 to the second armatures of relays 1135 and 1136. With relay 1135 operated, the hundred-block circuit is extended over conductor 1142 to a hundred-block relay in the number group connector shown, while, with relay 1136 operated, it is extended over conductor 1143 to a hundred-block relay in the number group connector selected over the lowermost contact of relay 1136. The operation of relay 1101 opens the circuit which normally supplies ground for operating one of the relays 2500 to 2508. However, with relay 1130 operated, ground connected to conductor 1103 as previously traced, is now extended over the outer lower back contact of relay 1102, inner upper front contact of relay 1130, conductor 3626 through cable 3631, outer upper front contact of relay 3605, innermost contact of relay 3600, conductor 3623 through cables 3070 and 2341, to the third armatures of relays 1135 and 1136 which function to operate one of the even-numbered relays 2500 to 2508 which in turn operates the proper twenty-block relay in the selected number group connector.

To control the operation of relays 1135 and 1136 a pair of relays 1138 and 1140 are provided. These relays function on every call regardless of its kind. Each time that the marker is summoned and operates relay 2802, ground is connected to conductor 1145 over the sixth upper front contact of relay 2802. Assuming relays 1138 and 1140 unoperated, connection of ground to conductor 1145 will complete a circuit which may be traced over the upper back contact of relay 1102, normal contact and winding of relay 1140 to battery through resistance 1139. Relay 1140 operates, locking to ground over its lower front contact and closing an operating circuit for relay 1138 which is prevented from operating as long as ground remains connected to conductor 1145. With relay 1140 operated and relay 1138 normal, a circuit is closed from ground over the upper front contact of relay 1140, upper back contact of relay 1138 to the winding of relay 1135 and battery, thereby preparing the circuits controlled by relay 1135 in case the call is one to an allotted branch exchange. At the termination of the call, relay 2802 releases, opening the shunt around the winding of relay 1138, and both relays 1138 and 1140 are operated, opening the circuit of relay 1135 and causing that relay to release. When relay 2802 reoperates on the next call, the ground on conductor 1145 extends over the lower front contact of relay 1138 to resistance 1139 in shunt of the winding of relay 1140 which now releases. Relay 1138 holds operated over the normal contact of relay 1140 to grounded conductor 1145. Under this condition, ground over the upper back contact of relay 1140 is extended over the upper front contact of relay 1138 to the winding of relay 1136, preparing the circuits controlled by that relay.

The testing of the twenty lines in the first twenty-block takes place as above described, except that the operation of relay 1101 closes a circuit from battery through the winding of relay 2512, conductor 2538, middle lower front contact of relay 1101 to ground over conductor 1161 and the front contact and operating circuit of the operated relay of the group 2500, etc., thereby transferring the line selecting circuit from the control of the units register directly to the armatures of the first sleeve test relay. If the last line of the group is busy, the busy-back circuit normally closed over the back contact of relay 1939 and conductor 1984 and the back contact of relay 1101 to the busy-back relay 2401, is transferred by the operation of relay 1101 over the front contact of that relay and the upper back contact of relay 1146, to the winding of relay 1102 and battery. Relay 1102 locks over

conductor 1147 through cable 1160 to ground at the third upper front contact of relay 2802. With relay 1102 operated, grounded conductor 1145 is disconnected from relays 1138 and 1140, causing these relays to function. With both of these relays operated or released, relays 1135 and 1136 release, in turn releasing the number group connector, the hundred-block relay and the relay of Fig. 25. When the number group circuit has been released, a circuit is closed from battery through the winding of relay 1146, outer upper front contact of relay 1102, conductor 1148, upper back contact of relay 2000, conductor 2070 through cable 2940, inner left back contact of relay 2900 to ground over the fourth upper front contact of relay 2802. With relay 1146 operated, ground on conductor 1145 is again connected to relays 1138 and 1140 and, under their control, relay 1136 or 1135, whichever was not previously operated, is now operated, controlling the selection of the other number group connector, another hundred-group relay and another relay of Fig. 25. If a busy last line is encountered in this second number group, relay 1146, being operated, completes the circuit for the busy-back relay.

The allotter is normally used with private branch exchange groups whose calling rate is such that more than a thousand busy-hour calls would be directed into one number group connector. It may also be used to distribute calls to two number group connectors to reduce the hazard in case trouble should tie up a number group connector. When used, no individual line nor other branch exchange may be assigned a number in the twenty-block which contains the directory number of the allotted branch exchange. Regardless of the directory number, the testing of the trunks of an allotted branch exchange always starts with the first line of the twenty-block. Since a maximum of one hundred lines may be tested in one number group connector, the largest branch exchange trunk group must be not more than two hundred lines.

Since lines in terminal hunting groups are expected to carry heavy traffic it is desirable to distribute such lines as evenly as possible over the line choices and over the subgroups in the line choices for the following reasons:

To keep the line choices the same size if possible.

To prevent excessive overflow signals because of unbalance of load on junctors and links.

To cause as little disturbance as possible in the branch exchange trunk group if a line choice must be put out of service for any reason.

The arrangement used for distributing lines is such that any number may be connected to any line choice. This is of advantage in connection with the transfer of working lines from one line choice to another without number changes for balancing traffic, for filling party lines and for class-of-service change reasons.

The number frame punching of the terminal hunting lines, except the last line of each group, is cross-connected to a terminal of a number group connector corresponding to the line choice in which the associated holding magnet is located. The last line of a group is treated like an individual line.

Free lines

Lines which may be called free of charge are grouped in special twenty-blocks in the number group connectors and are therefore selected by means of a split hundreds relay, such as relay 3600. Assuming that, with relay 3600 operated, relay 3604 represents a free line group which is allotted over two number groups, the ground supplied by the inner lower front contact of relay 3604 will be extended over the eighth contact of relay 3600, conductor 3627 through cable 3632 and 3634, upper winding of relay 1104 to battery. Relay 1104 extends its operating ground over its inner upper front contact to the winding of relay 1101 and battery. Assuming that relay 3602 is operated in combination with relay 3600 for a free line group that is not allotted, the sixteenth armature of relay 3600 will be grounded by relay 3602, operating relay 1104 over its lower winding. Relay 1104, in operating, extends this operating ground to the winding of relay 1100 and battery. It will, of course, be understood that the particular arrangement of relays 3601 to 3605, the groups of armatures of relay 3600 and relays 1100, 1101, 1157 and 1104 is merely by way of example and may be varied according to the requirements of actual service conditions. The third set of terminals of relay 3600 represents a group of twenty lines which are neither allotted nor free lines, in which case the twelfth armature will be connected to the lower winding of relay 1157 and over the lower back contact of relay 1104 to the winding of relay 1100 and battery.

If relay 2402 is operated to indicate that a call has been received from a full mechanical incoming selector, the operation of relay 1104 will cause the operation of relay 3119 to indicate that no charge is to be made. This circuit may be traced from battery through the winding of relay 3119, middle lower front contact of relay 2402, lower back contacts of relays 2403 and 2404, conductor 2407 through cables 2453 and 2341, middle lower front contact of relay 1104, to ground. Relay 3119 operated, connects ground from the fourth lower contact of relay 2801, conductor 2406 through cable 2343, inner lower back contacts of relays 2404 and 2403, outer lower front contact of relay 2402, inner upper back contact of relay 2305, lower front contact of relay 3111, lower front contact of relay 3119 to the winding of relay 3122 and to conductor 3134. Conductor 3134 is extended through cables 3174 and 2451, over contacts of relays 901 and 920 to conductor 220 through cables 951 and 952, inner upper front contact of relay 216, winding of relay 229 and battery. Relay 229 locks under the control of relay 204. With relay 229 operated, the ringing circuit is opened as well as the circuit for operating relay 203 under the control of relay 233. With relays 3119 and 3122 operated, the checking circuit extends over the upper front contact of relay 3119, inner lower front contact of relay 2402, conductor 1150 through cables 2453 and 2341, lower front contact of relay 1104, conductor 1151 through cables 2453 and 2341, to the front contact of relay 3122 as a check that both the free line relay and the full selective relay are operated.

Sleeve guard

An originating call does not ground the sleeve of a calling line until after the subscriber's sender has been seized. A terminating call does not lock out originating calls in the line link group until the line test has been completed. It is evident, therefore, that there is an unguarded interval during which the terminating marker may select a line, which appears to be idle because the sender has not yet been seized, but

which is actually busy and will ultimately appear so by the time the marker is able to lock out the line link group. To take care of this condition, relay 2625 is furnished. It is a function of this relay to detect a ground on the sleeve of the called line subsequent to its selection and to cause a retest of all lines in the selected twenty-block in order to cause the seizure of a new line if the tested line was a terminal hunting line other than the last or to return a busy-back signal if no other line is available. When relay 1269 operated as above described, it transferred the sleeve of the called line from the winding of relay 1919 to conductor 2325, upper back contact of relay 2314, outer lower back contact of relay 2305, conductor 2330, lower back contact of relay 2000, conductor 2072 to the winding of relay 2625 and battery. If the line remains idle, relay 2625 has no function. However, if the line becomes busy, relay 2625 closes a circuit from battery through the winding of relay 2034, front contact of relay 2625, conductor 2036 through cable 2660, inner upper back contact of relay 1801, conductor 1804 through cable 2941, third right front contact of relay 2900, to ground on conductor 1147. Relay 2034 locks temporarily to this same ground under the control of relay 2035. However, relay 2034 operates relay 2035 and in so doing opens the locking circuit of relay 1269 to reclose the testing circuits. When relay 2000 released, it reclosed ground in shunt of condenser 2615 preparing relay 2610 for timing the interval of operation for the sleeve test relays.

Busy line

Whenever busy-back relay 2401 is operated, because the marker finds an individual line or the last line of a terminal hunting group busy, it closes local circuits for relays 3119 and 3103 at its middle upper and second lower front contacts. With relay 2401 operated, the circuit by which relay 3103 operates relay 3110 is opened at the uppermost back contact of relay 2401. Relays 3119 and 3103 operate their associated test relays 3122 and 3113, respectively, as well as grounding conductors 3134 and 3124 to operate relays 229 and 228, respectively. With both relays 228 and 229 operated, a line-busy tone on conductor 238 is connected over the outer right front contact of relay 229, inner lower back contact of relay 225, outer lower front contact of relay 228 to the ring conductor leading towards the calling line. At the same time a circuit is closed from battery through the winding of relay 203, resistance 234, outer left front contact of relay 229, inner upper front contact of relay 228, inner upper back contact of relay 225 to interrupted ground on conductor 240. Relay 203 is operated intermittently in this circuit to periodically reverse the connection of battery and ground to the incoming end of the trunk as a busy-back signal to an operator if the call passes through an operator's position.

When relay 3113 operates, it opens the circuit of relay 3111 which is slow to release, in order to permit the slowest ringing control relay of the trunk to operate. When relay 3111 releases, a circuit is closed from battery through the winding of relay 3135, upper back contact of relay 3111, outer lower front contact of relay 3113 to ground over conductor 3136, through cables 3177 and 3071 and the inner right front contact of relay 2907. Relay 3135 locks over its inner upper front contact to this ground, independent of relays 3111 and 3113. Relay 3135, in operating, closes a circuit from battery through the windings of relays 2218 and 2232, conductor 3137 through cables 3173 and 3073, lower front contact of relay 3135, conductor 3061 to ground at the inner left front contact of relay 2908. Relay 2218 locks itself and relay 2232 over its inner upper front contact to conductor 3061 independent of relay 3135. With relay 2232 operated, a circuit is closed from battery through the windings of relays 2213 and 2231 in parallel, conductor 2840, outer upper back contact of relay 2841, conductor 3121 through cables 1746, 2340 and 1740, inner upper front contact of relay 3122, conductor 1151, outer upper front contact of relay 2401, inner upper front contact of relay 3119, back contacts of relays 3118, 3514 and 3116, inner lower front contact of relay 3113, middle upper front contact of relay 3103, upper back contact of relay 3112, outer lower front contact of relay 2401, upper back contact of relay 3110, conductor 2236 through cables 1740, 1746 and 2340, inner contacts of relay 2232 to ground. Relay 3135 also extends its locking ground over its outer upper front contact, outer upper front contact of relay 3113, conductor 3138 through cables 3173 and 3073, outer lower front contact of relay 2213, conductor 2844, inner upper back contact of relay 2842, middle upper back contact of relay 2841, third lower front contact of relay 2801, upper front contact of relay 2830 to conductor 3261 which extends through the marker connector to the release relay of the terminating sender, thereby causing the release of the marker. Relay 3135 closes a locking circuit for relay 3113 at its inner lower front contact in order to prevent a short closure of the release circuit.

All channels busy

If when testing for an idle channel, all of the channels available prove busy, the channel selecting circuit, controlled by relay 1605, extends over the front contacts of one or both of the sets of relays 1510 to 1519 and relays 1530 to 1539 assigned to each of the channels being tested, and thence to the winding of relay 1609 and battery. Relay 1609 removes the operating battery for the channel hold relays 1500 to 1509, locks under the control of relay 1605, opens the circuit of relay 3139 and closes a circuit from battery through the winding of relay 2400, upper back contact of relay 3100, conductor 3140 through cables 3171 and 3071, over the front contact of either relay 2052 or 2062, conductor 2073 through cable 2455, back contact of relay 3139, conductor 3141 through cable 3170, outer upper front contact of relay 1609 to ground. Relay 2400 locks over its inner lower front contact, conductor 2420 through cable 2454, third left contact of relay 2908 to grounded conductor 2819. With relay 2400 operated, local circuits are closed at the inner upper and second lower front contacts of relay 2400 for operating relays 3119 and 3103, respectively. Since relay 2401 is not operated, a circuit is closed from ground at the upper back contact of relay 2401, inner lower front contact of relay 3103, fourth lower front contact of relay 2400, conductor 1340 to the winding of relay 3110 and battery so that this relay is also operated.

The operation of relays 3110, 3103 and 3119 causes the operation of relays 225, 228 and 229 in the junctor circuit. Under these conditions, overflow tone from conductor 239 is extended over the inner right front contact of relay 229,

middle lower front contact of relay 225, outer lower front contact of relay 228 to the ring conductor to signal the calling subscriber, and interrupted ground over conductor 241 is connected over the inner upper front contact of relay 225, inner upper front contact of relay 228, outer left front contact of relay 229 and resistance 234 to the winding of relay 203 to cause that relay to operate at a rate characteristic of an overflow condition as a signal to an operator, if present. Relays 3122, 3113 and 3112 are operated, as usual, from the ringing control relays and open the circuit of relay 3111, which releases after an interval sufficient for the operation of the junctor relays, to operate relays 3135, 2218 and 2232 as described in connection with a busy line condition. Relays 2213 and 2231 are operated in a circuit which extends as traced for a busy condition to conductor 3121 and thence over the front contact of relay 3122, conductor 1151, upper front contact of relay 2400, front contact of relay 3119, back contacts of relays 3118, 3514 and 3116, front contacts of relays 3113 and 3103, front contact of relay 3112, outer lower back contact of relay 2401, front contact of relay 3110, to conductor 2236 and ground at the front contact of relay 2232. Relays 2213 and 3135 cooperate to ground the release circuit of the terminating sender, thereby causing the release of the marker.

Reorder

When the marker is used in connection with a call through a B operator's position, if that operator depresses her disconnect key, the sender connects ground to conductor 3280 which is connected through the marker connector to conductor 3251 through cable 3420 and the winding of reorder relay 2822. Normally, until relay 2907 operates, relay 2839 is connected in parallel with the winding of relay 2400 in a circuit from battery through its lower winding, inner left back contact of relay 2907, inner upper back contact of relay 2822 and conductor 3140. When relay 2822 operates, it disconnects relay 2839 from the circuit of relay 2400 and extends the circuit of relay 2400 from conductor 3140, over the middle upper front contact of relay 2822 and the lower back contact of relay 2809 to grounded conductor 2815, thereby operating relay 2400. When relay 2907 operates, with relay 2822 operated, it connects ground over the inner left front contact of relay 2907, outer lower front contact of relay 2822, conductor 3306, inner left back contact of relay 3300, through the marker connector to conductor 3252 to operate relay 216 in the incoming junctor. Relay 2822 disconnects ground from the thousands register, thereby preventing the operation of a five-hundreds relay, such as relay 3000. Without the operation of the five-hundreds relay, the number group connector, line choice connector and incoming connector cannot be operated. However, relay 2822 connects battery from the left back contact of relay 3300, conductor 3302, inner upper front contact of relay 2822, conductor 2421 through cable 2454, third lower front contact of relay 2400, conductor 2906, second lower front contact of relay 2801, lower back contact of relay 2839, through the frame register, to the marker preference relay of the incoming connector circuit which will associate the marker with the incoming junctor. Upon the seizure of the incoming junctor the operation of relay 2400 performs the same functions as for the all-trunks-busy condition above described.

Ringing circuit troubles

The marker is arranged to test for trouble conditions in connection with the ringing and tone control relays. If the ringing control lead is falsely grounded or open, the overflow and busy-back signals may be interchanged, while if the tone control or free call lead is falsely grounded, there may be no charge on a charge call or a false overflow signal. None of these troubles are considered serious. On the other hand, if the tone control lead is open, the reverse lead open or falsely grounded or the lead controlled by relay 3116 open or falsely grounded, a false charge may be made. In any of these cases the checking circuit which causes the connection of ground to the sender release relay is opened because the corresponding pairs of control relays are not both operated or both released. Therefore, the timing circuit will function to summon the trouble indicator and will normally force a second trial using a different marker. However, if relay 3112 is operated while relay 3110 is normal indicating a false ground on the ringing control lead, or relay 3122 is operated while relay 3119 is normal indicating a false ground on the tone control lead, a circuit is closed from battery through the winding of relay 2842, inner lower back contact of relay 2841, conductor 2824, through cables 3171 and 3071, over the back contact of relay 3119 and the front contact of relay 3122 or over the back contact of relay 3110 and the inner upper front contact of relay 3112, conductor 3150, through cables 3173 and 3073, third lower back contact of relay 3700, conductor 3740 through cables 1746 and 2340, inner upper back contact of relay 1700 to ground. Relay 2842 opens ground closed by the timing relays to the trouble release circuit and conductor 3281 and connects this ground to the regular release circuit over conductor 3261.

Unequipped numbers

Numbers may be left blank in blocks of five hundred, blocks of one hundred, or individually, in which case corresponding equipment or cross-connections or both may be omitted and the call is ultimately routed to an intercepting operator.

When a five hundred-block is omitted, the corresponding relays for that block in the number group connector and marker need not be furnished. When such a block is not equipped, the corresponding terminal, among the terminals of relays 3514 and 3515, is connected to conductor 3530 and the winding of relay 1725. When, on the other hand, the five hundred-block is equipped but one or more of its hundred blocks are blank, the corresponding terminal of the five hundred-block relay such as relay 3000 is connected to conductor 3530 and relay 1725. An individual number may be left blank by omitting the line cross-connections in the number group connector.

The sequence of operations when a five hundred-block or one hundred-block of numbers is omitted is as follows: The ground which would operate relay 3000 or the one hundred-block relay in the number group connector now operates relay 1725. Relay 1725 closes a circuit from battery over the back contacts of relays 2707 and 2709, conductor 2720, outer upper front contact of relay 1725 to conductor 1707 which is

connected to the marker preference relay in the number group connector which includes the numbers identifying lines leading to the intercept operator. The operation of the number group connector causes the operation of the incoming connector which in turn causes the operation of one of the relays 2402, 2403 or 2404, according to the class of the incoming junctor. Since no twenty-block relay has been operated, relay 2610 is not operated nor is any relay of the group 1250 to 1269. With either relay 2402 or relay 2403 operated, local intercepting relay 1708 operates in a circuit which may be traced from battery over the back contact of relay 2121, conductor 1709 through cables 1743 and 1642, winding of relay 1708 to the middle upper armature of relay 2402 and thence over the front contact of relay 2402 and the back contact of relay 2403, or over the back contact of relay 2402 and the front contact of relay 2403 to the inner upper back contact of relay 2404, back contacts of relays 1710 and 1715 to ground at the inner lower front contact of relay 1725. The circuit for toll intercepting relay 1712 extends from battery on conductor 1709 through the winding of relay 1712 over the back contacts of relays 2402 and 2403, middle upper front contact of relay 2404 and thence to ground as traced for relay 1708. Either relay 1708 or relay 1712 locks to conductor 2813 and closes an obvious circuit for relay 1700 which opens the operating circuit for relay 1725. The release of relay 1725 opens the circuit of the number group connector which releases, in turn causing the release of the incoming connector. With these connectors released, a circuit is closed from battery through the winding of relay 1704, lower front contact of relay 1700, conductor 1723 through cable 1745, outer right back contact of relay 2905, outer left back contact of relay 2900, outer left back contact of relay 2907, to ground over conductor 2631 and the second lower front contact of relay 2806. Relay 1704 locks to conductor 2631 and supplies ground over conductor 1702 and its inner upper front contact to the uppermost front contact of relay 1708 or relay 1712 for the purpose of operating one of the relays of group 2500 to 2508 which, in turn, causes the operation of a twenty-block relay in the number group connector. Battery over the back contact of relays 2707 and 2709 and conductor 2720 is extended over the middle lower front contact of relay 1704 to the lowermost front contacts of relays 1708 and 1712 for operating the marker preference relay in the number group connector including the lines leading to the intercepting operators. Ground over conductor 2601, through the winding of relay 1800 is connected over conductor 1713, through cables 1742 and 1641, and the middle upper front contact of relay 1704 to the middle upper front contacts of relays 1708 and 1712 to operate the desired one hundred-block relay in the number group connector. Ground under the control of relay 2610 is extended as previously traced to conductor 1705 and over the outer upper front contact of relay 1704 to the middle lower front contacts of relays 1708 and 1712 to the armature of the relay of the group 1900 to 1919 which corresponds to the first line of the group leading to the intercepting operator's position.

As previously indicated, there are two groups of trunks to the intercepting operators for calls intercepted because they are for blank numbers, etc., namely, those used in connection with local calls for which relay 1708 is operated and those used in connection with toll calls for which relay 1712 is operated. The line terminals for such intercepting lines are cross-connected to ring the proper intercepting operator.

In the case of the individual line which has been permanently disconnected, the cross-connections in the number group connector belonging to the corresponding number will be opened. Therefore, when handling a call for this number the marker will receive and translate the number and, the sleeve lead being opened, will operate the corresponding relay of group 1900 followed by the corresponding relay of group 1250. Since the line choice cross-connection is open neither relay 2052 nor relay 2062 can operate. The operation of the relay of group 1250 releases relays 2003 to 2006, in turn releasing relay 2035. Relay 2035 closes a circuit which may be traced from grounded conductor 2813, inner upper back contact of relay 1814, outer upper back contact of relay 1810, conductor 1815, back contacts of relays 2034, 2052, 2064, 2062 and 2035, conductor 2074 through cables 1743 and 1642, back contacts of relays 1725, 1715 and 1710 to the middle upper armature of relay 2404. As described in connection with unequipped blocks of numbers, the operation of relays 2402, 2403 and 2404 determines whether relay 1708 or relay 1712 is operated. Either intercept relay locks, operating relay 1700 which releases the five hundred-block relay of the previously used number group connector and in turn the incoming group connector. With both of these circuits released, relay 1704 is operated to make effective the cross-connections closed at the contacts of relays 1708 or 1712. The release of the number group connector also releases relays 2607 and 2650, preparing relay 2610 for the testing of the intercept trunks. The test takes place as for a regular call, except that none of the special terminal hunting features are applied.

This arrangement also permits detecting lines on which the sleeve circuit has become open accidentally. Such a fault would result in the line appearing idle to the line test and the call would proceed as previously described to the operation of relay 2203. Relay 2203 operates relays 2312 and 2305 and opens the circuit of slow-to-release relay 2204. Relay 2305 operates relay 2304 under the control of relay 2312 and connects relay 2312 to the sleeve of the line. Relay 2204 releases after an interval, opening the operating circuit of relay 2312. If the sleeve conductor is open, relay 2312 will release, closing a circuit from grounded conductor 2813, over the inner lower front contact of relay 2304, upper back contact of relay 2312, conductor 2334 through cables 3175 and 3072, upper back contact of relay 3101, upper back contact of relay 3151, to the winding of relay 1708 and battery. If the call in progress is a toll call, relay 2404 would be operated, in turn operating relay 3151 in a circuit over the middle lower front contact of relay 2404, to ground over conductor 1134 and the fifth upper front contact of relay 2802. Relay 3151 locks to this same ground and transfers the circuit controlled by relay 2312 to the winding of relay 1712.

Trouble intercept

Where lines are in trouble, a shoe is inserted at the distributing frame which connects the line itself directly to a trunk to an "A" operator's position and connects ground and battery to the

tip and ring conductors respectively which lead to the terminating equipment. The selection and test of such a line proceeds as described until relay 2210 is connected thereto in making the ground test. The grounded tip conductor holds relay 2210 operated and prevents the release of relay 216 in the incoming junctor. It will be remembered that relay 2241 was included in the ring conductor during the ground test. Therefore the battery now present on this conductor causes the operation of relay 2241, which in turn operates relay 2223. Relay 2223 at its outer upper front contact connects conductor 2906 to conductor 3302 to maintain battery on the start circuit of the incoming link and connector circuit and prevent its release. It connects ground over its inner upper front contact to the armature of relay 2210 and to conductor 2215, holding relay 216 operated in the incoming junctor. It also opens the connection between the back contact of relay 2210 and the winding of relay 2860 to prevent the operation of the latter relay on the release of relay 2210. According as relay 2404 is operated or not, a circuit is closed from battery through the winding of relay 1715 or 1710, respectively, over the uppermost armature of relay 2404 and conductor 2440 through cables 2452 and 2340 to ground at the lower front contact of relay 2223. These relays control the extension of the connection to groups of trunks identified as local trouble intercepting trunks or toll trouble intercepting trunks in the same manner as the ordinary intercepting relays 1708 and 1712 function. The release of the number group connector also causes the release of the channel selecting relay which opens the ground supplied by the marker for operating the hold magnets and the train of hold magnets starts to release. As soon as the first tip or ring cross-point opens, relay 2241 releases, in turn opening the circuit of relay 2223. Relay 2223 being slow to release delays the release of relay 216 in the incoming junctor to give ample time for the hold magnets to release. This is necessary because the release of relay 216 normally provides a ground for maintaining the hold magnets operated. Relay 2223 also holds the incoming connector to prevent trouble because of an overlapping seizure of this circuit by a different marker. With relay 2223 released, followed by the release of the incoming connector the circuit above traced for relay 1704 is completed and that relay operates to render the cross-connections at relay 1710 or relay 1715 effective.

Private branch exchange retest

When all channels having access to an intermediate private branch exchange line are found busy, there probably is a subsequent line in another choice, served by different channels and line links, which will have an idle channel available. The marker is therefore arranged to make the first selected intermediate private branch exchange line busy and to retest once when it encounters an overflow condition in connection with a private branch exchange group. It will be remembered that relay 1609 operates if all of the channels prove busy. With relay 2064 operated to indicate that the line selected is one of a terminal hunting group, a circuit is closed from ground over the outer upper front contact of relay 1609, conductor 3141 through cable 3170, back contact of relay 3139, conductor 2073 through cable 2455, lower front contact of relay 2064 over the front contact of the operated relay of group 1250 to 1269, to the corresponding relay of the group 1200 to 1203. Assuming that relay 1250 is operated, the circuit will extend over the outer upper front contact of that relay to the winding of relay 1200 and battery. Relay 1200 extends its operating circuit to the winding of relay 1220 and battery. Relay 1220 locks over its uppermost front contact and conductor 2617 to ground at the front contact of relay 2650. Relay 1200 has five armatures which are connected to the middle upper armatures of five relays of the group 1250 to 1269, namely, the first, fifth, ninth, thirteenth and seventeenth relays of the group. The armatures of relay 1201 are connected to the second, sixth, tenth, fourteenth and eighteenth relays of the group while the armatures of relays 1202 and 1203 are similarly connected. The middle upper armature of relay 1250 has a back contact extending to the winding of relay 1900 and a front contact leading over the circuit previously traced to the winding of relay 2625. With relay 1220 operated, a circuit is closed from ground over the inner upper front contact of relay 1220, outer lower front contact of relay 1200, middle upper front contact of relay 1250 to the winding of relay 2625 as previously traced. At the same time ground over the front contact of relay 1220 is connected over the other four armatures of relay 1200 to the armatures of intermediate relays of group 1250, thereby operating the corresponding relays of the group 1900. Relay 2625 functions as previously described to cause a second test of the group of twenty lines, relay 1250 being released before the second test takes place. At this time the previously selected line and four other lines are marked busy artificially by the operation of the corresponding sleeve test relays 1900 etc. Therefore the marker is forced to select a different line.

With relay 1220 operated, the release of relay 1609, in response to the release of the channel test relays, closes a circuit from grounded conductor 2617, inner lower front contact of relay 1220, conductor 1221, outer back contact of relay 1609, conductor 1613 through cable 3170, winding of relay 3139 and battery. Relay 3139 locks over its lower front contact to grounded conductor 2617, and at its upper armature disconnects conductor 3141 from conductor 2073. If after selecting a second branch trunk, no idle channel is found, the operation of relay 1609 closes a circuit from ground over its upper front contact, conductor 3141 through cable 3170, upper front contact of relay 3139, upper back contact of relay 3100 to the winding of overflow relay 2400. Therefore only one retest can be made of the same group of twenty trunks where no idle channel is found.

If there is an additional group of lines leading to the branch exchange and the line test advances into this group when retesting, the release of the first twenty-block relay releases relay 2650 in turn opening the locking circuit of relay 1220. In this case an additional retest is possible.

Private branch exchange lines are normally arranged so that successive lines are served by different junctors and links. The private branch exchange retest on an intermediate line will therefore greatly decrease the occurrence of overflow conditions on private branch exchange lines caused by busy channels.

Time measure

An open circuit or a ground on one or more

of the receiving leads, any trouble that blocks the progress of the marker, or any operation of a cross-detecting relay will prevent the connection of ground to the release circuit leading to the sender. Likewise, if the release circuit itself is open or the sender or marker connector fails to release properly, the marker will remain connected to the connector until the timing circuit functions.

The marker timing circuit has six stages, namely, (1) from the seizure of the marker to the completion of the recording relay check as indicated by the release of relays **2804**, **2807** and **2809** and the operation of relay **2803**; (2) from the seizure of the number group, as indicated by the operation of relay **2900**, to the completion of the line test, as indicated by the operation of one of the line class relays **2052**, **2062** and **2063** or the busy-back relay **2401**; (3) from the seizure of the marker to the seizure of the line choice which causes the operation of relay **2905**; (4) from the seizure of the line choice to the release of the marker which removes the operating ground for the timing relays; (5) from the seizure of the incoming select magnet lock-out circuit as indicated by the operation of relay **2219** to the operation of the channel hold magnets as indicated by the operation of relay **2203** which causes the release of relay **2219**; and (6) to cover the seizure and release of the trouble indicator following one of the earlier periods.

The first and third stages are started simultaneously by the operation of relay **3310** in a circuit which may be traced from battery through the winding of relay **3310**, conductor **3311** through cable **2942**, left back contact of relay **2905**, conductor **2930** through cable **2942**, back contact of relay **3312**, back contact of relay **2701**, lower back contact of relay **2705**, inner upper back contacts of relays **2711** and **2712**, conductor **2713** to ground at the contact of marker connector relay **3206**. Relay **3310** locks under the control of relay **2905** to conductor **2713** and closes a circuit from ground on conductor **2713** over its inner upper front contact to interrupter **2714** and thence over the normal contact and winding of relay **2712** to battery through resistance **2725**. Relay **2712** operates when the interrupter closes its contact, locking to ground at the inner lower front contact of relay **3310** and closing an operating circuit for relay **2711** from battery through resistance **2716**, winding of relay **2711**, alternate contact of relay **2712** to ground at the front contact of relay **3310**. However, relay **2711** does not operate as long as the interrupter **2714** remains closed, since it is shunted by ground over its lower back contact. At the next closure of interrupter **2714** relay **2712** is shunted, releasing and closing a holding circuit for relay **2711** under the control of the interrupter over the normal contact of relay **2712**. When the interrupter opens a second time relay **2711** also releases and the relays are ready for a new cycle.

When relay **2712** releases with relay **2711** operated, a circuit is closed from battery through the winding of relay **2701**, back contacts of relays **2702**, **2704** and **2706**, inner upper front contact of relay **2711**, inner upper back contact of relay **2712** to ground over conductor **2713**. Relay **2701** operates and locks over its inner upper front contact and the outer lower front contact of relay **3310** to ground over conductor **2713**. With relay **2701** operated, locking ground is supplied to relays **2702** to **2706** over the inner lower front contact of relay **2701**.

The operation of relay **2701** terminates the first timing stage which is between 1.15 seconds and 2.45 seconds. If the registration and checking has not been completed at this time, ground will be connected to the outer lower front contact of relay **2701** over the front contacts of relays **2804**, **2807** and **2809** and over the back contact of relay **2803**. Relays **2804**, **2807** and **2809**, it will be remembered, are operated in parallel with the register relays until the closure of the chain circuit, operating relays **2803** and **2806**, opens their operating circuits. If the timing stage is completed, the ground connected to the lower contact of relay **2701** is extended to the winding of relay **2718** to summon the trouble indicator.

The second and third timing stages overlap each other. The completion of the registration check summons the number group connector, which operates relay **2900** as an indication that the connection has been completed. Relay **2900** starts the second timing stage by closing a circuit from ground at the front contact of relay **2701**, conductor **2715** through cables **2452** and **2340**, inner lower back contact of relay **2401**, conductor **2441** through cable **2455**, over the back contacts of relays **2052**, **2064** and **2062**, conductor **2902** through cable **2940**, inner right front contact of relay **2900**, conductor **2980**, to the middle upper armature of relay **2711**. If relay **2711** is operated and relay **2712** released, relay **2717** is operated, while if relay **2711** is released and relay **2712** operated relay **2726** is operated. Which ever operates first, the subsequent function of relays **2711** and **2712** causes the other relay to operate after an additional interval of 1.15 to 2.45 seconds. Both relays lock to ground over conductor **2980** and when both relays are operated, a circuit is closed from ground over the upper front contacts of relays **2717** and **2726** to the winding of relay **2718** for the purpose of summoning the trouble indicator.

The third stage coincides with the first stage until relay **2701** is operated. If the call is progressing properly so that the completion of the registration check renders relay **2701** ineffective to operate relay **2718**, the opening of the interrupter contact permits relay **2711** to release. The next closure operates relay **2712**, thereby completing a circuit from battery through the winding of relay **2702**, outer upper front contact of relay **2701**, back contacts of relays **2703** and **2705**, outer upper back contact of relay **2711**, upper front contact of relay **2712** to grounded conductor **2713**. Relay **2702** transfers the circuit used for operating relay **2701** to the winding of relay **2703** so that relay **2703** operates when next relay **2711** is operated and relay **2712** released. With relay **2703** operated, when relay **2711** is released and relay **2712** reoperated, relay **2704** is operated, followed by relays **2705** and **2706** in a similar manner. If relay **2706** is operated, which takes place after a maximum period of 8.95 seconds, it closes an obvious circuit for relay **2718**.

In a normal call, the timing circuit does not progress as far as operating relay **2706** before it is reset for the next timing stage. The operation of relay **2905**, following the seizure of the line choice connector, releases relay **3310**, in turn releasing relay **2701** and any other relays locked under the control of relay **2701**. When all of these relays have released, a circuit is closed from battery through the winding of relay **3312**, conductor **3313** through cable **2942**, outer right front contact of relay **2905**, conductor **2931** through cable **2942**, upper back contact of re-

lay 3310, back contacts of relays 2701, 2705, 2711 and 2712 to grounded conductor 2713. Relay 3312 locks under the control of relay 2905 to conductor 2713 and connects ground from conductor 2713 to interrupter 2714 causing relays 2711 and 2712 to function again.

The operation of relay 2905, in turn operating relay 3312, initiates the fourth timing stage. With relay 3312 operated, a circuit is closed from ground at the lower front contact of relay 3312 to the winding of relay 2704 and battery. Therefore the first release of relay 2712 closes a circuit from battery through the winding of relay 2705, upper front contact of relay 2704, back contact of relay 2706, inner upper front contact of relay 2711, inner upper back contact of relay 2712 to grounded conductor 2713. Relay 2705 prepares a circuit for relay 2706 which will be operated when relay 2711 is released and relay 2712 reoperated. Relay 2706 if operated, closes an obvious circuit for relay 2718. The minimum interval between the operation of relay 2905 and the operation of relay 2706 is 2.45 seconds. However, the channel should be selected, the connection established and the marker released within this time, resulting in the removal of ground from conductor 2713.

The fifth stage which overlaps the fourth stage in part, is initiated by the operation of relay 2219 from the incoming link connector. Relay 2219 closes a circuit from ground at the outer lower front contact of relay 3312, lower front contact of relay 2704, conductor 2715, right front contact of relay 2219, conductor 2980 to the middle upper armature of relay 2711. Relays 2726 and 2717 are operated as previously described and if both relays are operated, close an obvious circuit for relay 2718. The time interval measured is from 1.15 to 2.45 seconds and is sufficient to test the maximum number of junctors for one call. After the hold magnets, with the exception of the line hold magnet, have been operated, relay 2203 operates, disconnecting battery from the winding of relay 1000, thereby releasing relays 1000 and 1001 and opening the circuit of relay 2219 which opens the operating ground for relays 2726 and 2717.

The sixth timing stage is a continuation of either the third or fourth stage, being initiated by the operation of relay 2706 and terminated by the release of the marker under the control of the trouble indicator. If the marker is not released prior thereto, relay 2707 operates at the end of 1.3 seconds following the operation of relay 2706, connects ground to the trouble release lead to release the sender, disconnects battery from the number group connector preference relay and opens the circuit of the twenty-block relay.

When operated, relay 2718 closes a circuit for operating relay 3303, which, with relay 3304 normal, connects battery over its outer lower front contact and the inner upper back contact of relay 3304 to conductor 3322 leading to the trouble indicator, causing the trouble indicator to connect with the marker and take a record of the difficulty which caused the marker to time out. It also connects ground to conductor 3324, over the inner upper back contact of relay 3323, to cause an audible alarm to be sounded. When the trouble indicator has completed its record, it connects ground to conductor 3325, operating relay 3304. With both relays 3303 and 3304 operated, ground over the normal contact of relay 2707 is connected over the outer lower front contact of relay 3304, outer upper front contact of relay 3303, upper back contact of relay 2707, outer upper back contact of relay 2842 to the trouble release conductor 3281.

With conductor 3281 grounded, a circuit is completed over the right back contact of relay 3254 in the marker connector, winding of relay 3203 and battery. Relay 3203 locks through the winding of relay 3254 to ground over a contact of sender relay 3204. The operation of relay 3203 disconnects ground from in shunt of the winding of relay 3287 causing that relay to operate and lock under the control of the sender relay and other idle channel-busy relays. Relay 3287 releases relay 3205, in turn releasing relay 3206 and dismissing the marker. When relay 3206 releases, relay 3254 operates in the locking circuit of relay 3203 and reconnects ground in shunt of the winding of relay 3287 and other similar relays. However, since relay 3287 is locked, the operation of relay 3287 advances the start lead to the next marker relay thereby causing the second trial to be handled by a different marker unless all of the other markers are also busy. If the second attempt to complete the call also meets with failure, ground connected to conductor 3281 is extended over the right front contact of relay 3254 and the sender multicontact relay to the trouble release relay of the sender.

In addition to the time intervals above mentioned, means is provided for sounding an alarm and releasing the associated circuits if some trouble should occur that would prevent the short time-out relays from functioning or in case the marker-busy lead should be permanently grounded, which would keep the marker out of service. Relays 2709 and 2719 are provided for this purpose in connection with interrupter 2721. This interrupter closes its upper contact for one second and then after an interval of twenty-eight seconds closes its lower contact. When the marker-busy conductor 3326 becomes grounded, this ground is extended to interrupter 2721 and, when the interrupter closes its upper contact, relay 2719 operates, locking to conductor 3326. Twenty-eight seconds later this ground is extended over the lower contact of interrupter 2721, lower front contact of relay 2719 to the winding of relay 2709 and battery. Relay 2709 also locks to grounded conductor 3326. Relay 2709, in addition, releases the number group connector and grounds conductors 2730 and 3327 to sound alarms. The ground must be removed from conductor 3326 in order to restore the marker to service.

Grounded release lead

Since a false ground on either the regular release lead or the trouble release lead would cause senders connecting to the marker to release falsely before they have had time to function, relay 3328 is connected through its upper winding, over the back contacts of relays 3303, 2707 and 2842 to the trouble release lead 3281 and through its lower winding over the back contacts of relays 3323, 2213, 2842, 2841 and 2830 to the regular release conductor 3261. A false ground on either of these leads will, therefore, operate relay 3328 which locks through its upper winding and over its inner upper front contact to ground at the inner lower back contact of relay 3303 and in parallel therewith over the lower back contact of relay 3304 to ground at the normal contact of relay 2207. Relay 3328,

if operated, connects ground to the marker-busy conductor 3328 to prevent the selection of this marker until the trouble has been eliminated. It also extends its locking ground over its lower front contact to conductor 2713 to cause the timing circuit to function and summon the trouble indicator, whereby a record will be made of the nature of the trouble.

Grounded or crossed sleeve leads

A false ground on the connection to the line sleeve lead between the marker cut-in relay and the twenty-block relay in the number group connector circuit would cause a percentage of all calls to that number group to fail falsely. The marker is arranged to test for such false ground. However, this test is made only during intervals of light traffic, in order to avoid slowing up heavy traffic. Periods of light traffic are determined by the use of relays 2642 and 2623 which measure an interval of approximately one-half second. Relay 2642 is operated over conductor 2631 and the second lower front contact of relay 2806, and in turn operates relay 2623, as soon as the registration test has been made. These relays remain operated until the end of a call and then consume one-half second in releasing, due to their slow-to-release character. If they have completely released before the marker is seized again, relay 2603 is operated in a circuit which may be traced over conductor 2630 through cable 2941, right back contact of relay 2900, right back contact of relay 2901, conductor 2309, back contact of relay 2623, conductor 2621, to ground at the inner lower front contact of relay 2802, which operates directly from the marker connector. With relay 2603 operated, battery is disconnected from the windings of the sleeve test relays 1900 to 1919 and these relays are connected over the upper front contact of relay 2603, conductor 2632, back contact of relay 3742, conductor 2633, winding of relay 2600 to battery. Relay 2603 also closes a circuit from battery through the winding of relay 2634, outer right front contact of relay 2608, which operates as soon as the registration has been checked, to ground at the outer lower front contact of relay 2603. Relay 2634 closes an obvious circuit for relay 2604, which further opens the circuit of the twenty-block relay in the number group. As soon as the number group has been seized and relay 2900 operates, the circuit of relay 2603 is opened and that relay starts to release, but due to its slow-to-release character maintains the circuit of relay 2600 closed for a sufficient time to permit that relay to operate in case a ground is present on any of the sleeve test wiring. If relay 2600 should operate, it extends ground from the inner lower back contact of relay 3303 and conductor 3330 to conductor 2850 and the lower winding of relay 2841 to prevent the release of the marker. If no such false ground is detected, when relay 2604 releases the circuit of the twenty-block relay is reclosed and the call proceeds.

Relays 2634 and 2604 are also used to detect cross-connections between the sleeve test wiring. For this purpose relay 2634, when operated as above described, connects ground over its middle right contact to conductor 2104, thereby holding relays 2003 to 2006 operated which, in turn, hold relay 2000 operated, while relay 2003 provides a holding circuit for relay 2035. With relays 2634 and 2604 operated, the operating path prepared by the units register is closed over the inner left front contacts of relays 2634 and 2604 in shunt of the contact of relay 2610, and, since none of the sleeve test relays 1900 to 1919 should be operated, the relay of the group 1250 to 1269 corresponding to the units indication is operated. However, relay 2604 holds the locking circuit of this relay open so that it will release following the test. Relays 2604 and 2634 also connect ground over the outer right front contact of relay 2604, outer left front contact of relay 2634, and conductor 2325, to the middle upper front contact of the operated relay of the group 1250 to 1269. If a cross exists between this wire and some other in the test wiring, this ground will be returned by way of the crossed wire to the associated relay of the group 1900, etc. and relay 2600 will operate and block the call.

If no such cross exists, relay 2604, which is slow to release, opens the circuit of the relay of the group 1250, etc., permitting it to release and then closes the circuit of the twenty-block relay to permit the call to proceed.

Test for grounded terminal hunting leads

Relay 2600 may also be used for testing for false ground on the terminal hunting leads when it is desired to make such test. For this purpose a plug is inserted in a jack (not shown) connecting ground to conductor 2851, thereby closing a circuit over the lower back contact of relay 2806 and the outer upper back contact of relay 2830 to the windings of relays 2100 and 2130 and battery. This circuit is only effective when the marker is normal as indicated by the released condition of relays 2806 and 2830. Relay 2100 disconnects battery at its lower back contact from conductor 2102 which supplies battery to the terminal hunting relays 1920 to 1939, and connects the windings of these relays to conductor 2632 which extends as above traced to the winding of relay 2600. If one of the terminal hunting leads is grounded, relay 2600 would be operated in turn operating relay 2841. As soon as the marker is seized, the circuit of relays 2130 and 2100 is opened and the call proceeds in a normal manner.

Tests for grounded or crossed hold magnet circuits

With relays 2103 and 2100 operated the operating circuits for the hold magnets are also tested. Relays 2110 to 2113 are operated by ground over the upper contacts of relay 2100 and these relays in turn operate relays 1416 and 1417. Relays 1416 and 1417 connect the hold magnet operating circuits to the armatures of relay 2130 which are connected in multiple to conductor 2831 and the winding of relay 3721. Relay 2130 at its lowermost front contact connects ground over the inner lower front contact of relay 2100 to conductor 3752 which extends through resistances 3751 and 3750 to battery. The winding of relay 3721 is connected to a point between resistances 3750 and 3751, thereby receiving a potential of approximately 24 volts. Relay 2130 also closes an obvious circuit for relay 2121 which disconnects battery from the windings of relays 1708, 1710, 1712 and 1715 and connects them over conductor 2133 through cables 1743 and 1642, lower back contact of relay 1725, conductor 1720 through cables 1742 and 1641 to the winding of relay 2602 and battery. Relay 2121 also disconnects conductor 1418 from the winding of relay 2841. Relay 2121 is made slow-to-release to cover the release time of relays 1416 and 1417. If a false ground or cross

is present on a hold magnet operating circuit relay 3721 operates, in turn operating relay 3725. Relay 3725 locks over conductor 3330 to ground at the inner lower back contact of relay 3303 and extends its locking ground to conductor 2850 to operate relay 2841.

Test for grounded link and junctor leads

In addition to the functions above described, relays 2100 and 2130 operate relays 1402 and 1419 which, in combination with relays 2110 to 2113, connect the link and junctor test leads to the windings of relays 1510 to 1519 and 1530 to 1539. The windings of these relays are connected in multiple over the inner lower back contact of relay 2830 to conductor 2831 and the winding of relay 3721. Therefore, a false ground or battery connected to one of these circuits would also operate relays 3721, 3725 and 2841.

Other cross-detecting relays

Throughout the marker an effort is made to detect all crosses which might be expected to occur. Two methods are used for detecting such crosses. One is the use of a marginal relay which does not normally operate but does operate in the presence of a cross-connection which will produce about twice the normal current. The second is the connection of a non-marginal relay to leads to be tested. Examples of the first method are the following: Relay 2510 is included in the operating circuit for the twenty-block relay and operates if more than one is operated. If relay 2510 is operated, it connects ground from conductor 2534 to the winding of relay 2509 which locks directly to this conductor, opens the operating circuit for the twenty-block relay and connects ground to conductor 2850 to operate relay 2841. Similarly relay 2051 is connected in multiple to the windings of relays 1300 to 1319 which indicate the horizontal group in which the wanted line is located. This relay in operating operates relay 2054 from grounded conductor 2534 and relay 2054 locks directly to that conductor. Likewise, relay 2050 is connected in multiple to the windings of the line choice relays 2030, 2031, etc., and, if operated, connects conductor 2534 to the winding of relay 2055 which operates and locks to this conductor. Either relay 2054 or 2055, if operated, opens the operating circuit for the marker preference relay in the line choice, thereby blocking the operation of the marker. In a similar manner, relay 1852 is connected in parallel to the windings of relays 1830 to 1839 and operates if two of these relays are energized. Relay 1832 prevents the operation of relay 1803 and blocks the connection.

As an example of the non-marginal type of cross-detecting relay, relay 3760 may be mentioned. This relay is connected over a resistance and the back contacts of the channel selecting relays to the line select magnet operating circuits to detect a false ground or cross thereon during the time that the circuit is not in use. Relay 3760, if operated, locks to conductor 3332 which extends through resistance 3331 to ground at the inner lower back contact of relay 3303. It also connects grounded conductor 3330 to conductor 2850, operating relay 2841. Similarly, the lower winding of relay 2839 is connected over the inner left back contact of relay 2907 and the inner upper back contact of relay 2822, to conductor 3140 over which the overflow relay 2400 is operated and over the third upper back contact of relay 2830 to conductor 1110 over which the busy-back relay 2401 is operated. The selection of the number group opens the first of these circuits while the seizure of the marker opens the second of these circuits. Relay 2839, if operated, locks to conductor 3330 and connects ground from conductor 3330 to the lower winding of relay 2841.

As previously described, relays 2602 and 2640 are non-marginal relays of this class.

Relay 2860 is connected over conductor 2861 through cables 1744 and 1642, over back contacts of relays 1715 and 1710, conductor 1730 through cables 1746 and 2340, lower back contact of relay 2223 to the back contact of relay 2210 and conductor 2215 which forms a part of the operating circuit for relay 216 in the incoming junctor. If relay 2860 is operated it locks to conductor 2713 and connects the lower winding of relay 2841 to grounded conductor 3330.

The use of relays 2842, 3112, 3122, 3118 and 3113 to detect false grounds on the ringing control conductors has been described hereinbefore.

Second trial

As previously described, if the marker times out or some other type of trouble appears, a record is made in the trouble indicator, which operates relay 3304. Relay 3304 grounds the trouble release conductor 3281, resulting in the operation of relay 3203, the dismissal of the marker, the operation of relay 3254 and the selection of another marker. When the marker is selected in connection with the second trial, relay 3254 connects ground over its outer left front contact through the contacts of relay 3206 to conductor 3253, operating relays 3700 and 3701 in parallel. Relay 3742 is also operated over the outer upper front contact of relay 3700 and conductor 2631 which is grounded as soon as the registration check has been made. The function of these relays is to modify the marker operation to permit the completion of the connection in spite of trouble which would probably not interfere with the conversation.

They start the channel test at a new point in order to permit the selection of a different channel in case the selected channel was in trouble. On inspection of the drawings it will be seen that the channel selecting circuit normally extends over the inner lower back contact of relay 3701 to the contacts of relay 1530; from the front contacts of relays 1514 and 1534, over the outer upper back contact of relay 3701 to the contacts of relay 1535 and from the front contacts of relays 1519 and 1539 over the inner upper back contact of relay 3701 to the winding of relay 1609. With relay 3701 operated, the incoming end of the channel selecting circuit extends over the inner lower front contact of relay 3701 to the contacts of relay 1535, from the front contacts of relays 1519 and 1539 over the third upper front contact of relay 3701 to the contacts of relay 1530 and from the front contacts of relays 1514 and 1534 over the uppermost front contact of relay 3701 to the winding of relay 1609, thereby causing selection to progress from the sixth channel to the tenth and then from the first channel to the fifth instead of from the first to the tenth as for a first attempt. Relay 3700 connects conductors 2236 and 3160 together, thereby by-passing the contacts of relays 3110 and 3112 to permit the connection to be established irrespective of trouble on the ringing control conductor 3114.

The ground test and the continuity test are canceled for the two-fold purpose of permitting

test incoming junctors to complete calls to lines in trouble and of attempting to complete service calls on which conversation can be held in spite of trouble. The continuity test is canceled by operating relays 2218 and 2232 over a circuit from ground at the innermost left front contact of relay 2908, closed as soon as the incoming connector has been operated, over conductor 3061, and the outer lower front contact of relay 2203 following the sleeve test, back contact of relay 2204, which releases at a measured interval after the operation of relay 2203, inner upper front contact of relay 3701, middle lower front contact of relay 2203 to the windings of relays 2218 and 2232 in parallel, thereby simulating a successful continuity test. Relay 3701 opens the circuit used for the ground test, thereby also canceling that test.

On second trial, the emergency preference equipment of the incoming connector is used as a means of exercising this equipment and detecting any difficulties which may exist therein. Relay 3742 connects ground over conductor 3741 through cable 954, armature 946 of relay 901, conductor 941 through cable 1020, back contact of relay 1002 to the winding of relay 1005 and battery. This relay disconnects ground from the windings of relays 1000 and 1002 and connects it to relays 1010 and 1012. A circuit is therefore closed from ground at the inner right front contact of relay 1005, back contact of relay 1012, winding of relay 1010, conductor 942 through cable 1020, armature 955 of relay 901, conductor 944 through cable 954, inner upper front contact of relay 3700, middle upper back contact of relay 2218, conductor 2217 through cable 2250, over the armature of the operated relay of group 1330 to 1333, conductor 2216 through cable 2250 to battery over the inner upper back contact of relay 2203. Relay 1010 operates, in turn operating relay 1011. Relay 1011 operates the secondary line switch select magnet in the same manner as did relay 1001. It connects ground over its outer upper front contact, conductor 945 through cable 1020, armature 956 of relay 901, conductor 947 through cable 954, outer lower front contact of relay 3700 to the winding of relay 2219 and battery.

Furthermore, on second trial the sleeve linkage test is canceled since the circuit of relay 2600 is opened at the lower back contact of relay 3742. Similarly, the circuit of relay 2842 is opened at the third lower back contact of relay 3700.

Line link per cent load register

It sometimes occurs that line links receive their maximum load at only one period of the year. In view of the small size of the line link subgroups they may be easily overloaded at this period and it is undesirable to rearrange lines at the time of heaviest traffic. A circuit has therefore been provided which will operate to register every time a line link subgroup has a certain predetermined load calculated to correspond to a heavy load at the busy period. For this purpose, relay 1620 is provided together with resistances 1570 to 1579. When relay 1600 operates, it connects battery over its second lower front contact to the upper winding of relay 1620 which is connected over conductor 1621 to ground at the second right front contact of relay 2905. Relay 1600 also connects ground to the lower winding of relay 1620 and connects the other side of the lower winding over its inner lower front contact to conductor 1622 which extends to the back contacts of the inner lower armatures of relays 1530 to 1539. In parallel with the battery connected to the upper winding of relay 1620 is connected conductor 1623 which extends to the front contacts of the outer lower armatures of relays 1530 to 1539. The two lower armatures of each of these relays are connected together and to battery through the corresponding resistances 1570 to 1579. The windings of relay 1620 are so arranged that by the adjustment of resistance 1628, relay 1620 will operate for any desired number of busy line links. When relay 1620 operates it connects ground over conductor 1629, through the line choice connector to conductor 850 leading to a traffic recorder individual to the line choice, and over the contact of relay 402 to conductor 470 leading to a traffic recorder individual to the group of line links.

Other traffic recorders which have not been described are provided for making peg count and overflow registration.

Special calls

Since the present invention is not particularly concerned with those features, the equipment for making number checking, no test and no hunt calls have been omitted, as well as the junctor pattern arrangement used when the number of incoming frames differs from the number of line choice frames. These features have been described in detail in connection with the Patent No. 2,089,921 to W. W. Carpenter granted August 10, 1937.

Sender test call

When the marker is seized in connection with a sender test call, relay 3340 is operated from the sender test circuit through the marker connector circuit and in turn operates relay 3300. Relay 3340 locks to ground over conductor 2534 holding relay 3300 operated. Relay 3340 connects the receiving leads to the sender test circuit so that the test circuit may record the number, frame indication, etc., passed by the sender to the marker. Relay 3300 opens the operating circuit of relays 3000, etc., blocking the translation, disconnects the start battery used for seizing the incoming frames so that the frames will not be seized, grounds conductor 3252 and provides operating circuits for relays 3304 and 3323 from ground in the test circuit to prevent the seizure of the trouble indicator and the sounding of alarms.

What is claimed is:

1. In a telephone system, control equipments, means for recording directory numbers in said control equipments, number groups including sets of terminals individual to directory numbers, means responsive to the registration of a directory number in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, groups of lines located in a plurality of number groups and serving a single directory number, and means responsive to the registration of such a directory number for connecting said control equipment with any one of said plurality of number groups.

2. In a telephone system, control equipments, means for recording directory numbers in said control equipments, number groups including sets of terminals individual to directory numbers, means responsive to the registration of a direc-

tory number in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, groups of lines located in a plurality of number groups and serving a single directory number, means responsive to the registration of such a directory number for connecting said control equipment with any one of said plurality of number groups, and means independent of said directory number for determining with which of said number groups said control equipment is to be connected.

3. In a telephone system, control equipments, means for recording directory numbers in said control equipments, number groups including sets of terminals individual to directory numbers, means responsive to the registration of a directory number in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, groups of lines serving a single directory number, said lines appearing in a plurality of number groups, means responsive to the registration of the directory number of such a group of lines for connecting with any one of said number groups, and means responsive to the busy condition of all the lines in said one number group for disconnecting said control equipment from said one number group and causing the connection of said control equipment with another of said number groups.

4. In a telephone system, control equipments, means for recording directory numbers in said control equipments, number groups including sets of terminals individual to directory numbers, means responsive to the registration of a directory number in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, groups of lines serving a single directory number, said lines appearing in a plurality of number groups, means responsive to the registration of the directory number of such a group of lines for connecting with one of said number groups, means in said control equipment to test said lines in groups, means responsive to the busy condition of all the lines in said one number group to cause the connection of said control equipment with another of said number groups, and means independent of said directory number registration for determining with which of said number groups said control equipment shall be first connected.

5. In a telephone system, control equipments, means for recording directory numbers in said control equipments, number groups including sets of terminals individual to directory numbers, means responsive to the registration of a directory number in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, groups of lines serving a single directory number, said lines appearing in a plurality of number groups, means responsive to the registration of the directory number of such a group of lines for connecting with one of said number groups, means in said control equipment to test said lines in groups, said test means being normally effective to start testing with the line bearing the directory number, means independent of said directory number registration for determining with which of said number groups said control equipment shall be first connected, said independent means being also effective to cause said testing means to start the test with the first line of the group irrespective of the directory number.

6. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, control means common to said switches and to said lines, means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, and means effective, if no idle channel is found, to mark said idle line busy and to retest said group of lines.

7. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, control means common to said switches and to said lines, means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, and means effective if no idle channel is found to mark said idle line and a plurality of other lines in said group busy and to retest said group of lines.

8. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, control means common to said switches and to said lines, means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, means effective, if no idle channel is found, to mark said idle line busy and to retest said group of lines, and means to prevent a second retest if no idlie channel is found following said first retest.

9. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, control means common to said switches and to said lines, means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, means effective, if no idle channel is found, to mark said idle line busy and to retest said group of lines, and means under the control of said busy marking means to prevent a second retest if no idle channel is found following said first retest.

10. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, control means common to said switches and to said lines, means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, means effective if no idle channel is found to mark said idle line and a plurality of other lines in said group busy and to retest said group of lines, and means to prevent a second retest if no idle channel is found following said first retest.

11. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, control means common to said switches and to said lines, means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, means effective if no idle channel is

found to mark said idle line and a plurality of other lines in said group busy and to retest said group of lines, and means under the control of said busy marking means to prevent a second retest if no idle channel is found following said first retest.

12. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, means effective if no idle channel is found to mark said idle line and a plurality of other lines in said group busy and to retest said group of lines, means under the control of said busy marking means to prevent a second retest of the same group of lines if no idle channel is found following said first retest, means responsive to the busy condition of said group of lines on retest to select another group of lines for test and means responsive to the selection of said other group of lines to permit a retest of said other group of lines.

13. In a telephone system, a plurality of lines serving a single subscriber, channels comprising link circuits and switches for establishing connections with said lines, control means common to said switches and to said lines. means in said control means for testing said lines in groups, means responsive to the selection of an idle line for testing for an idle channel having access to said line, means effective if no idle channel is found to mark said idle line and a plurality of other lines in said group busy and to retest said group of lines, means under the control of said busy marking means to prevent a second retest of the same group of lines if no idle channel is found following said first retest, means responsive to the busy condition of said group of lines on retest to select another group of lines for test and means responsive to the selection of said other group of lines to release said busy marking means to permit a retest of said other group of lines.

14. In a telephone system, control equipment, means for recording directory numbers in said control equipment, number groups including sets of terminals individual to directory numbers, means responsive to the registration of certain directory numbers in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, and means responsive to the registration of other directory numbers for connecting said control equipment with any one of a plurality of number groups.

15. In a telephone system, control equipment, means for recording directory numbers in said control equipment, number groups including sets of terminals individual to directory numbers, means responsive to the registration of certain directory numbers in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, and means responsive to the registration of other directory numbers for establishing a supplementary record in said control equipment and means under the control of said supplementary record for connecting said control equipment with any one of a plurality of number groups.

16. In a telephone system, control equipment, means for recording directory numbers in said control equipment, number groups including sets of terminals individual to directory numbers, means responsive to the registration of certain directory numbers in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, means responsive to the registration of directory numbers representing lines requiring special treatment for establishing a record in said control equipment characteristic of said special treatment, and means under the control of said supplementary record for connecting said control equipment with one of said number groups.

17. In a telephone system, control equipment, means for recording directory numbers in said control equipment, number groups including sets of terminals individual to directory numbers, means responsive to the registration of certain directory numbers in one of said control equipments to connect said equipment with the number group including the corresponding set of terminals, means responsive to the registration of directory numbers representing lines requiring special treatment for establishing a record in said control equipment characteristic of said special treatment, and means under the control of said supplementary record for connecting said control equipment with any one of a plurality of number groups.

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