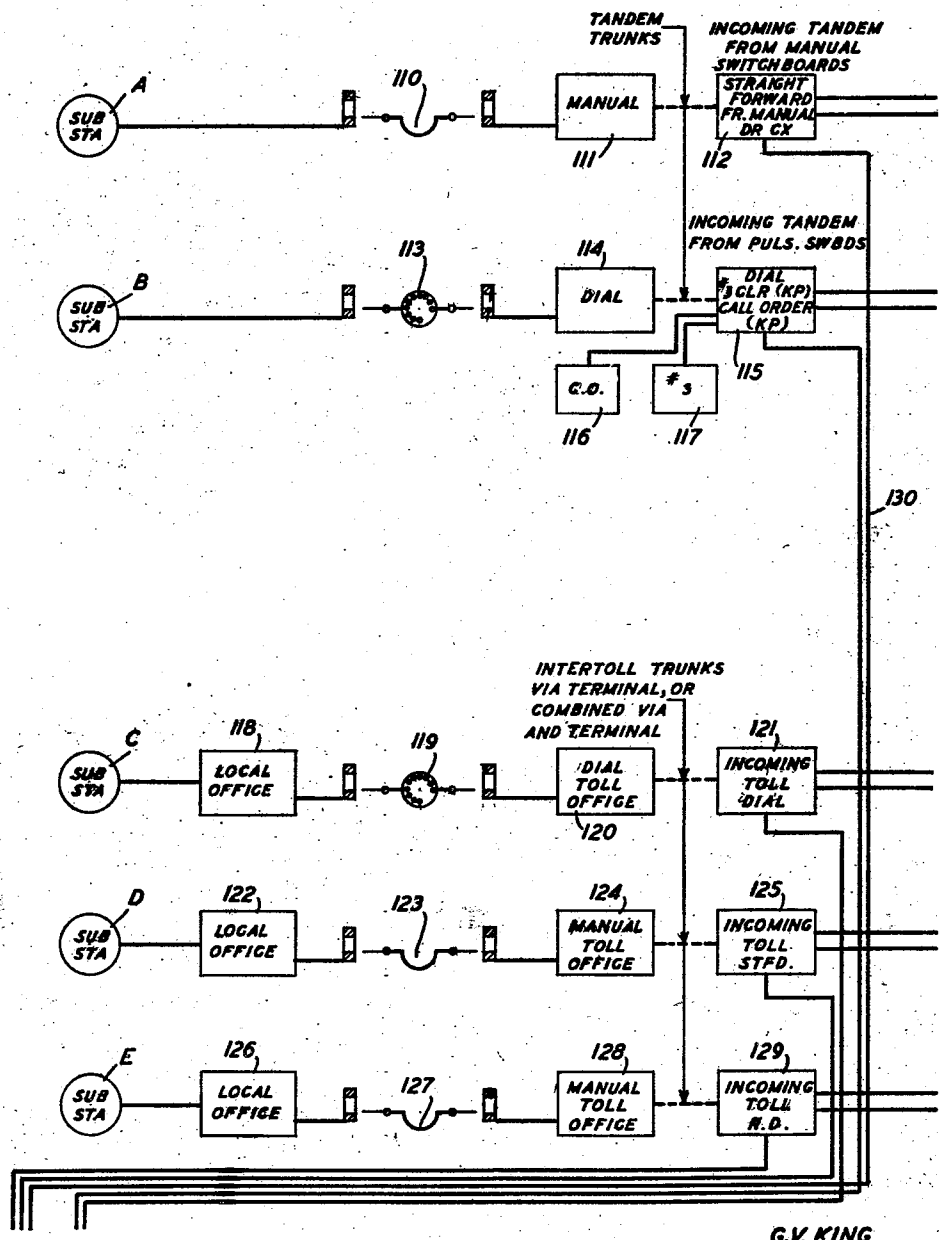
March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 1

FIG. 1



INVENTORS G. V. KING
J. B. MCKIM
O. MYERS

BY W. T. McKenney

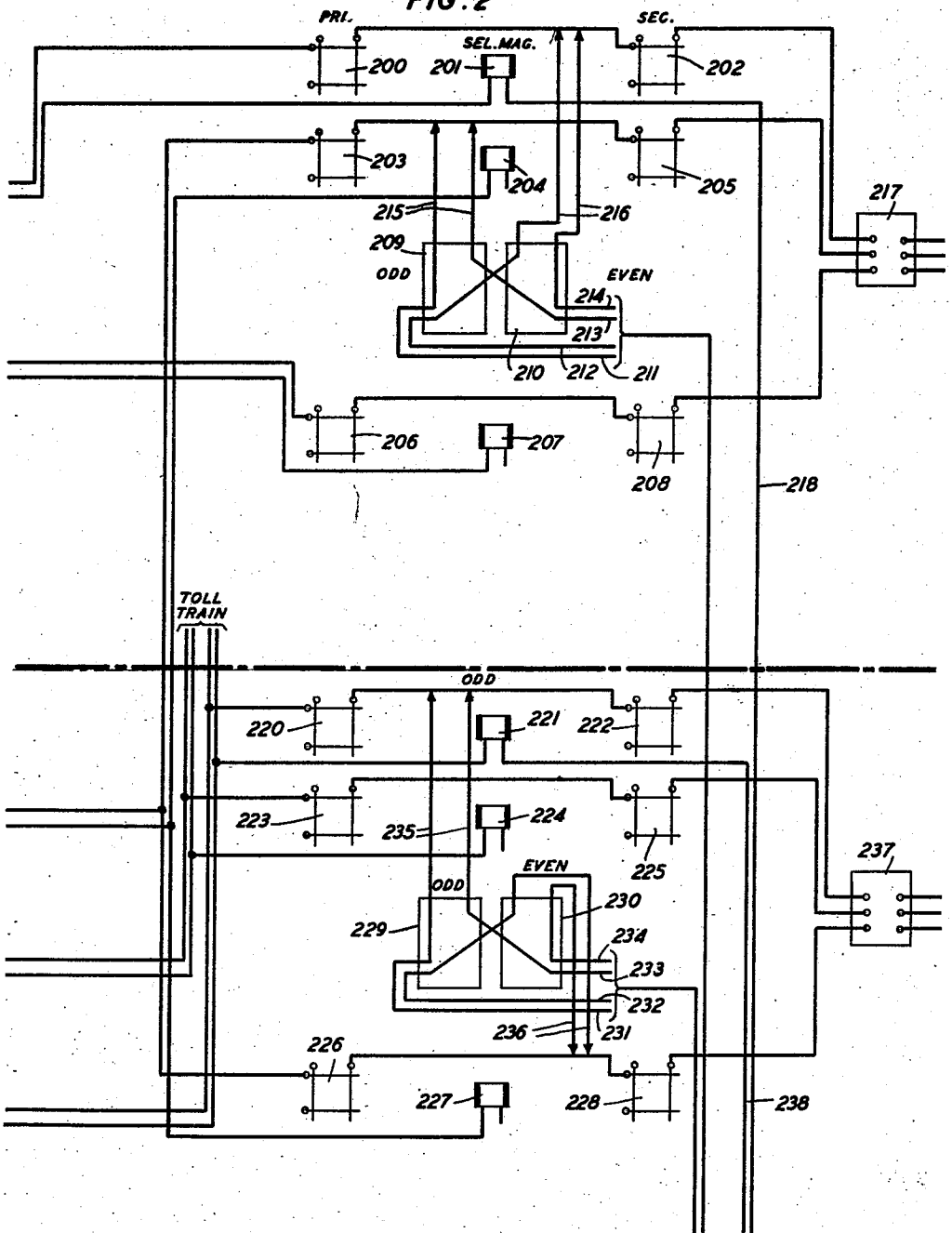
ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 2

FIG. 2



INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.T.McKenney

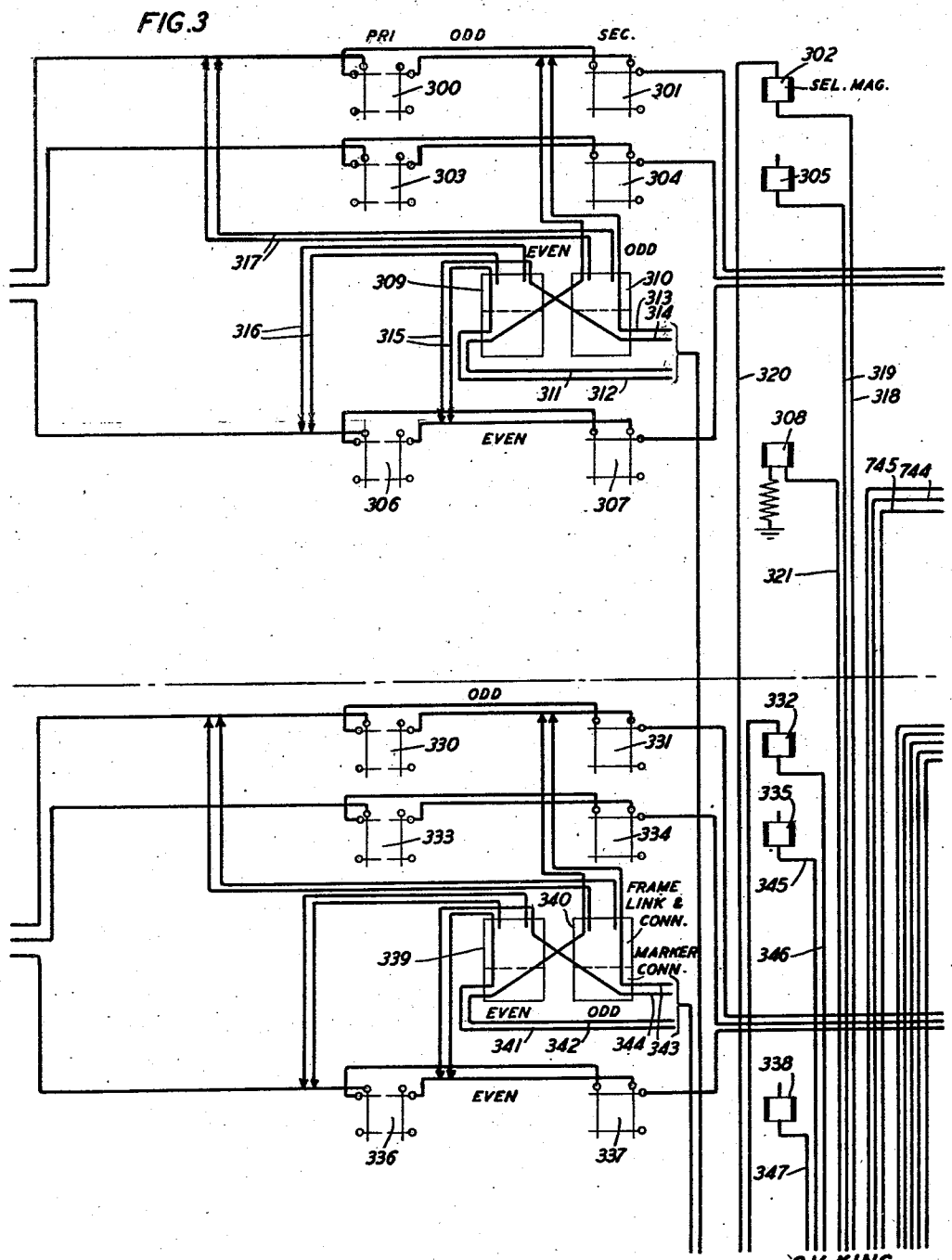
ATTORNEY

March 25, 1941. G. V. KING ET AL. 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 3

FIG. 3



INVENTORS: G. V. KING, J. B. MCKIM, O. MYERS

BY W. T. McKenney

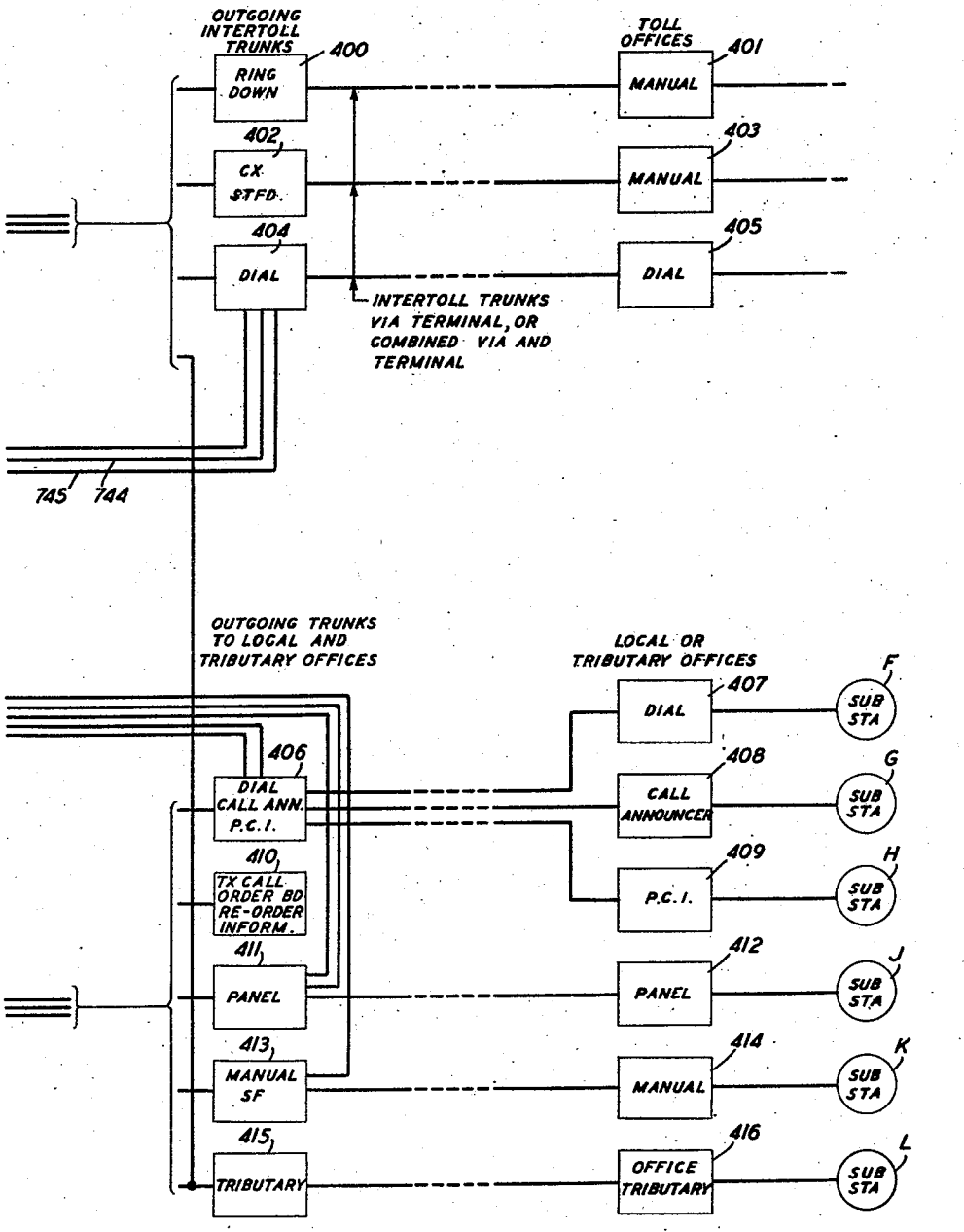
ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 4

FIG. 4



INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.T. McKenney

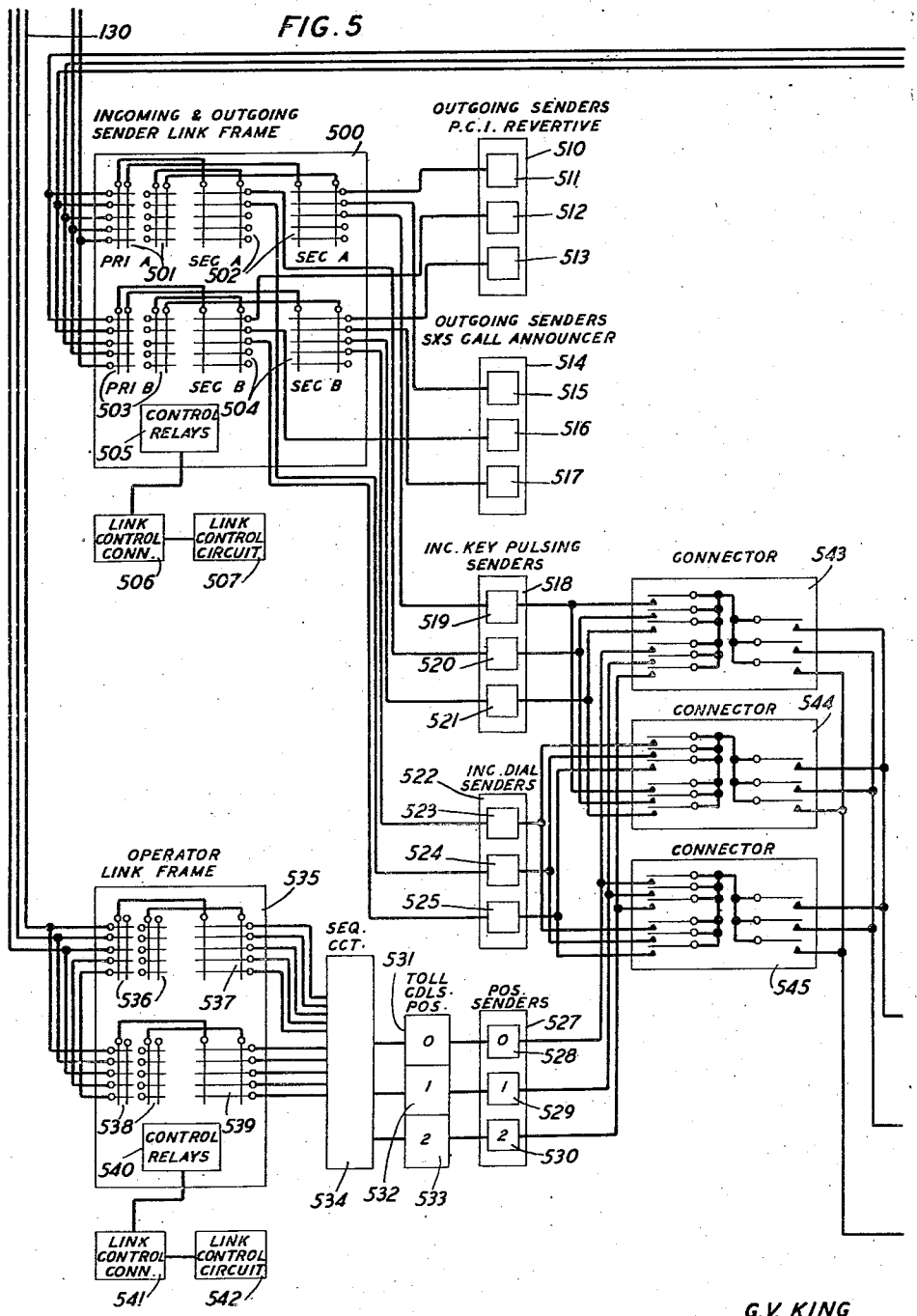
ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 5

FIG. 5



INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. V. McKenney

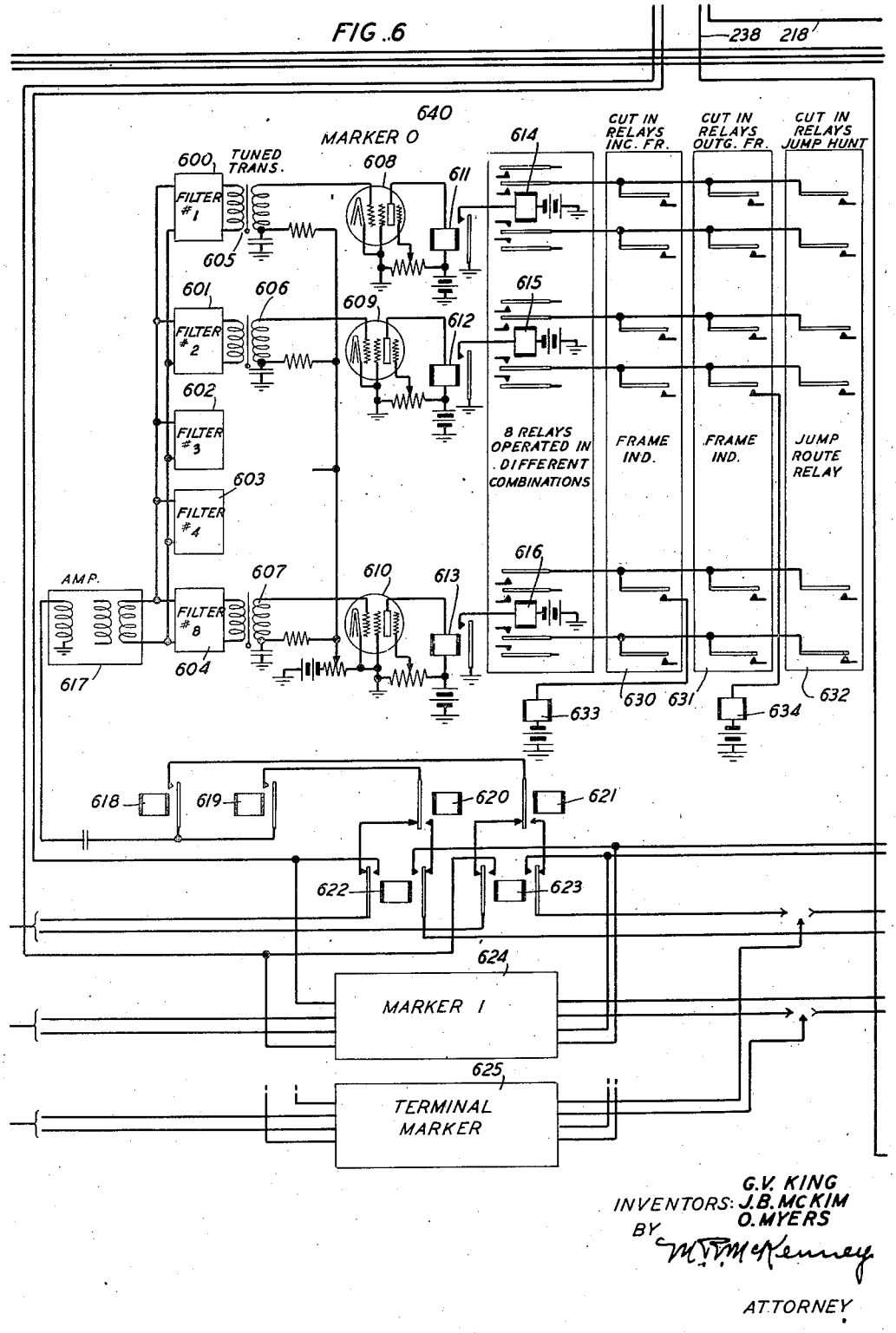
ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 6

FIG. 6



INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY W.T.M. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 7

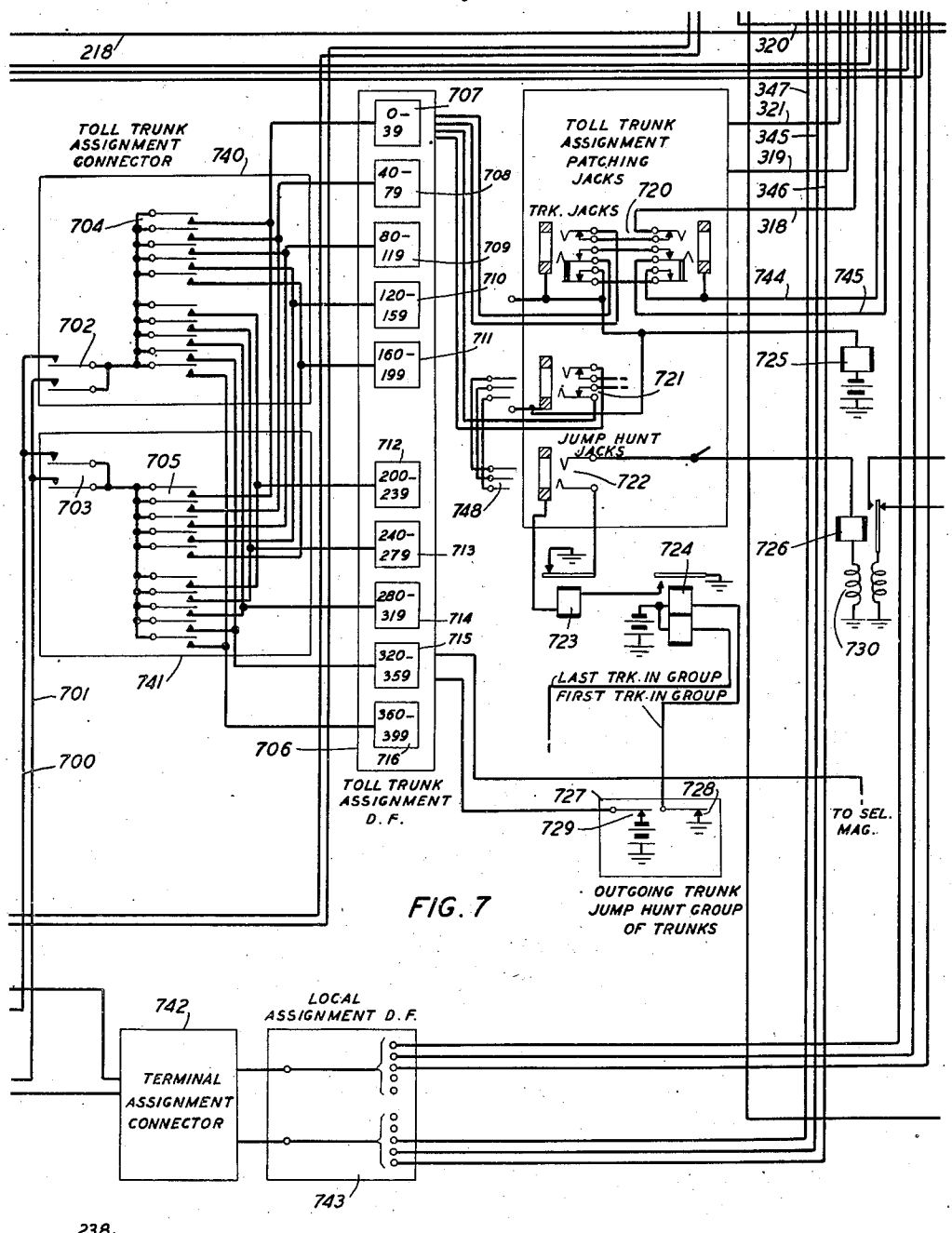


FIG. 7

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.T. McKenney

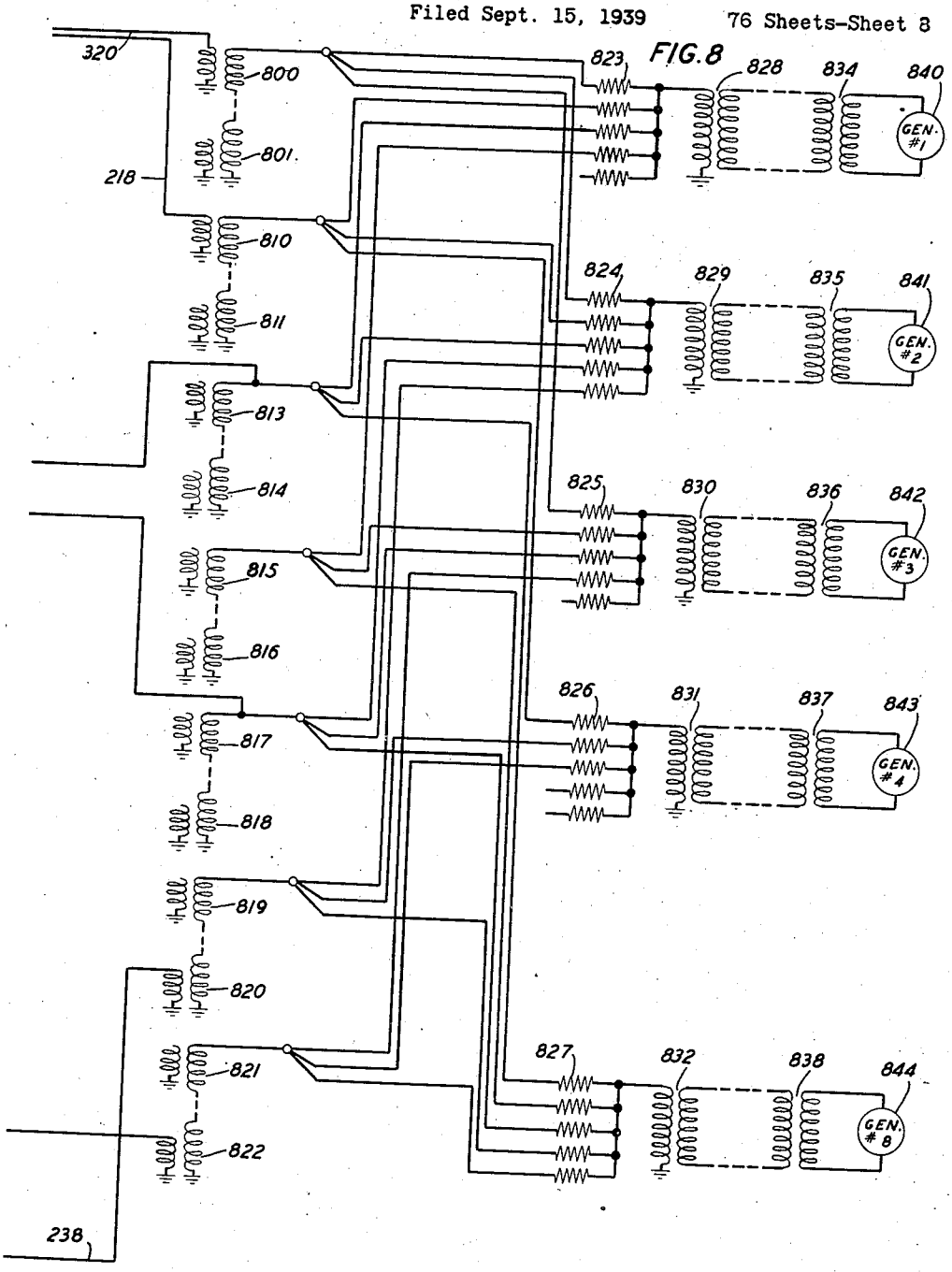
ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 8

FIG. 8



INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.T. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 9

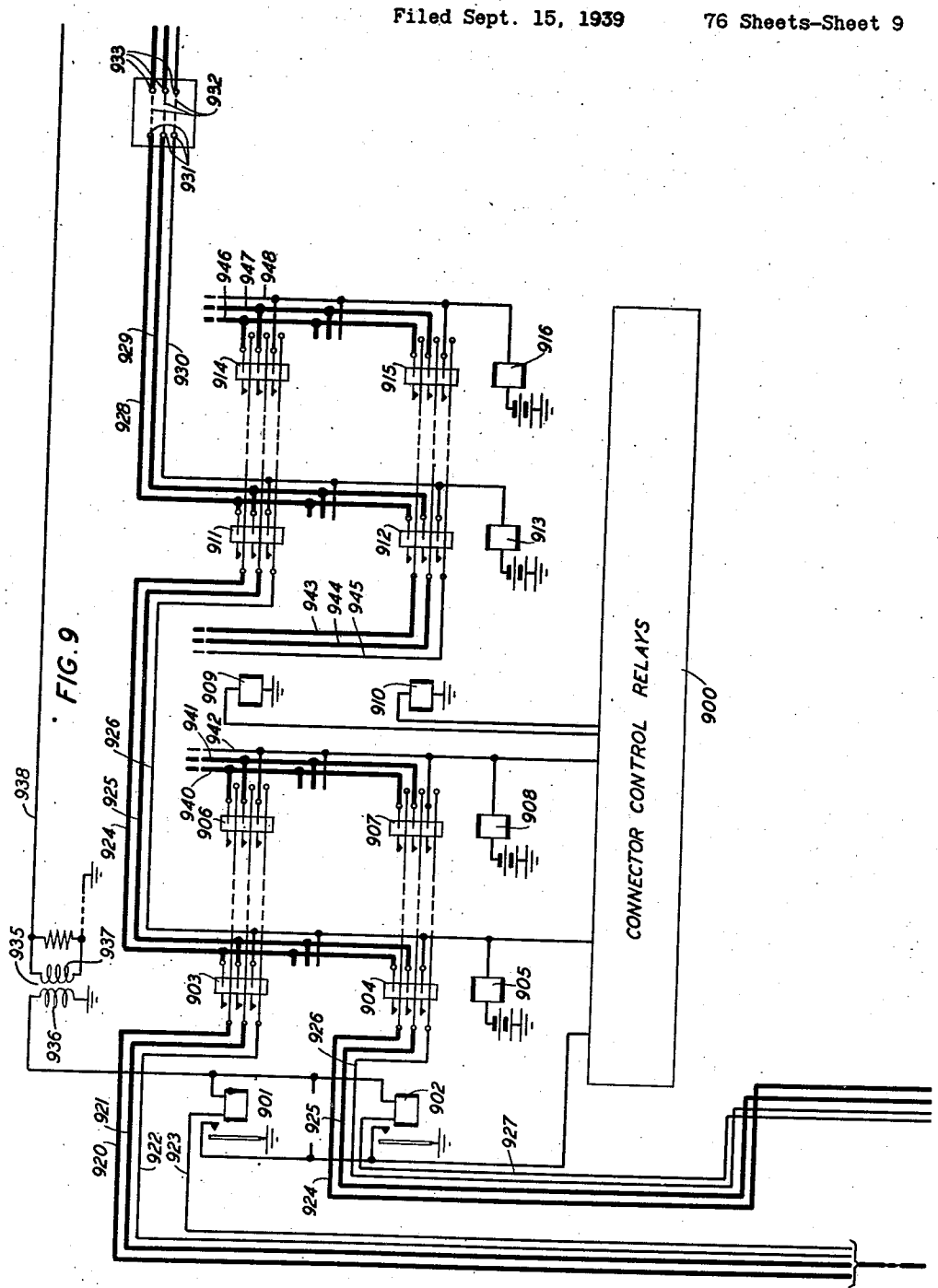


FIG. 9

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 10

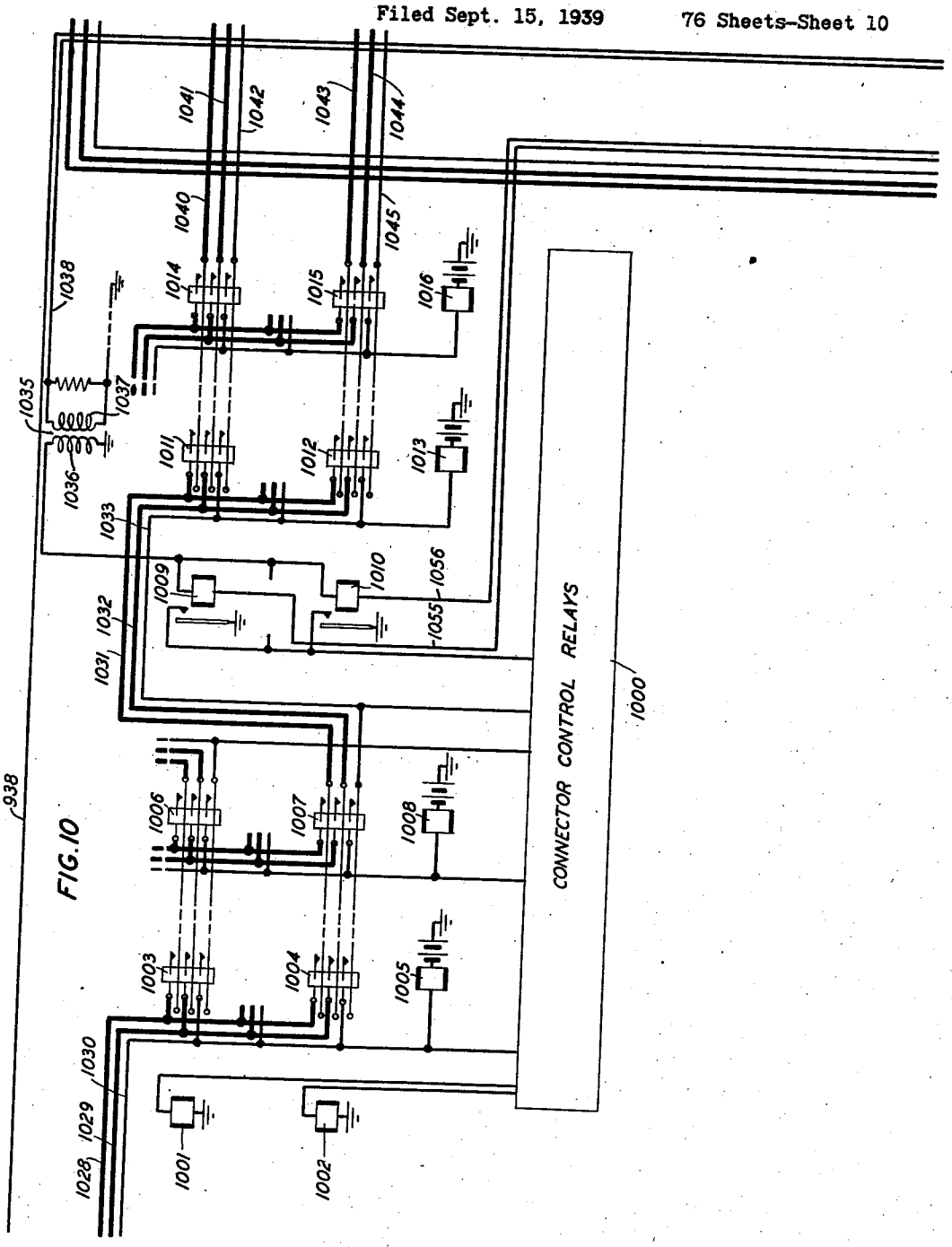


FIG. 10

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY McFarney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 11

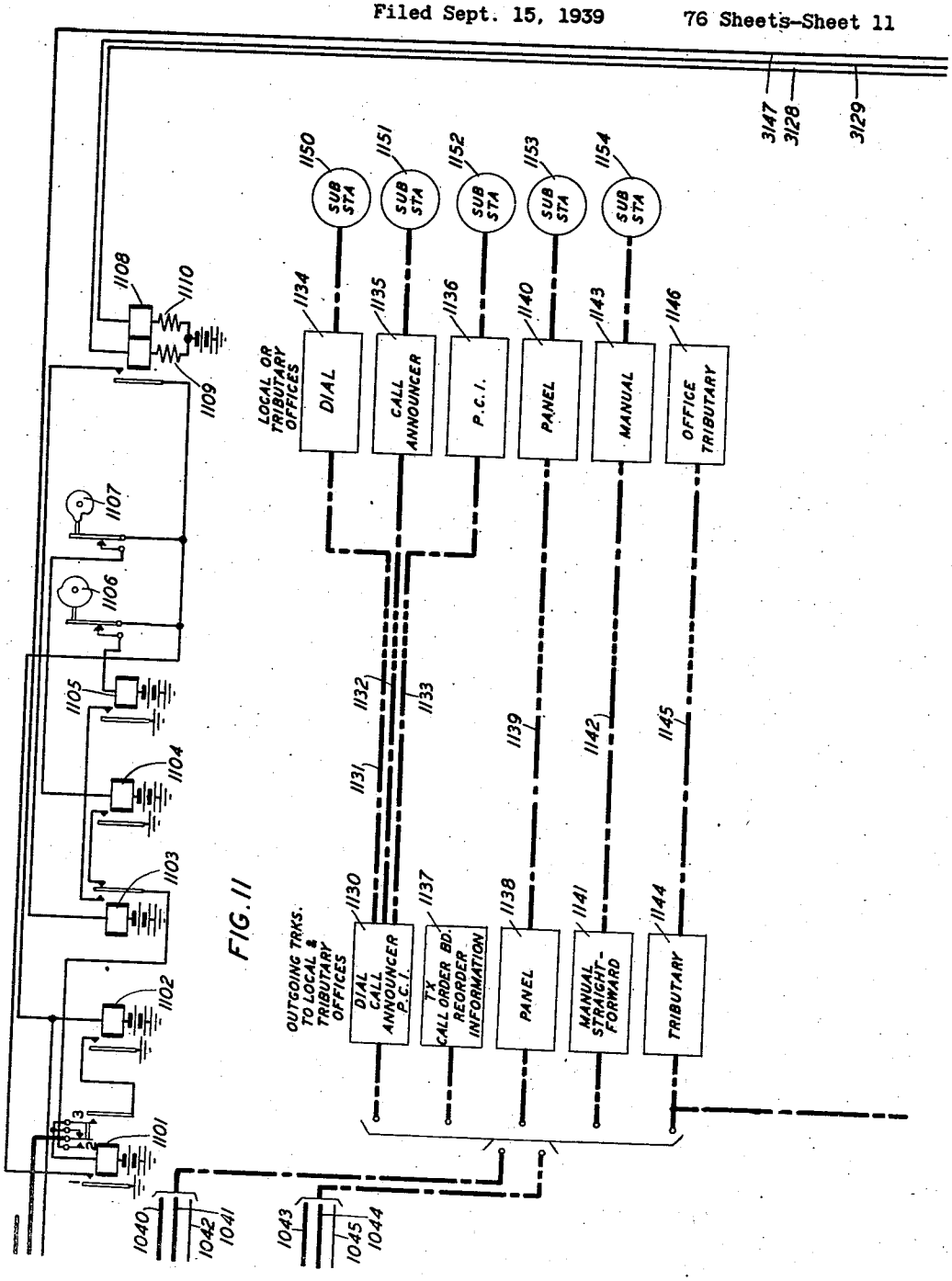


FIG. 11

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.D.M. Kenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 12

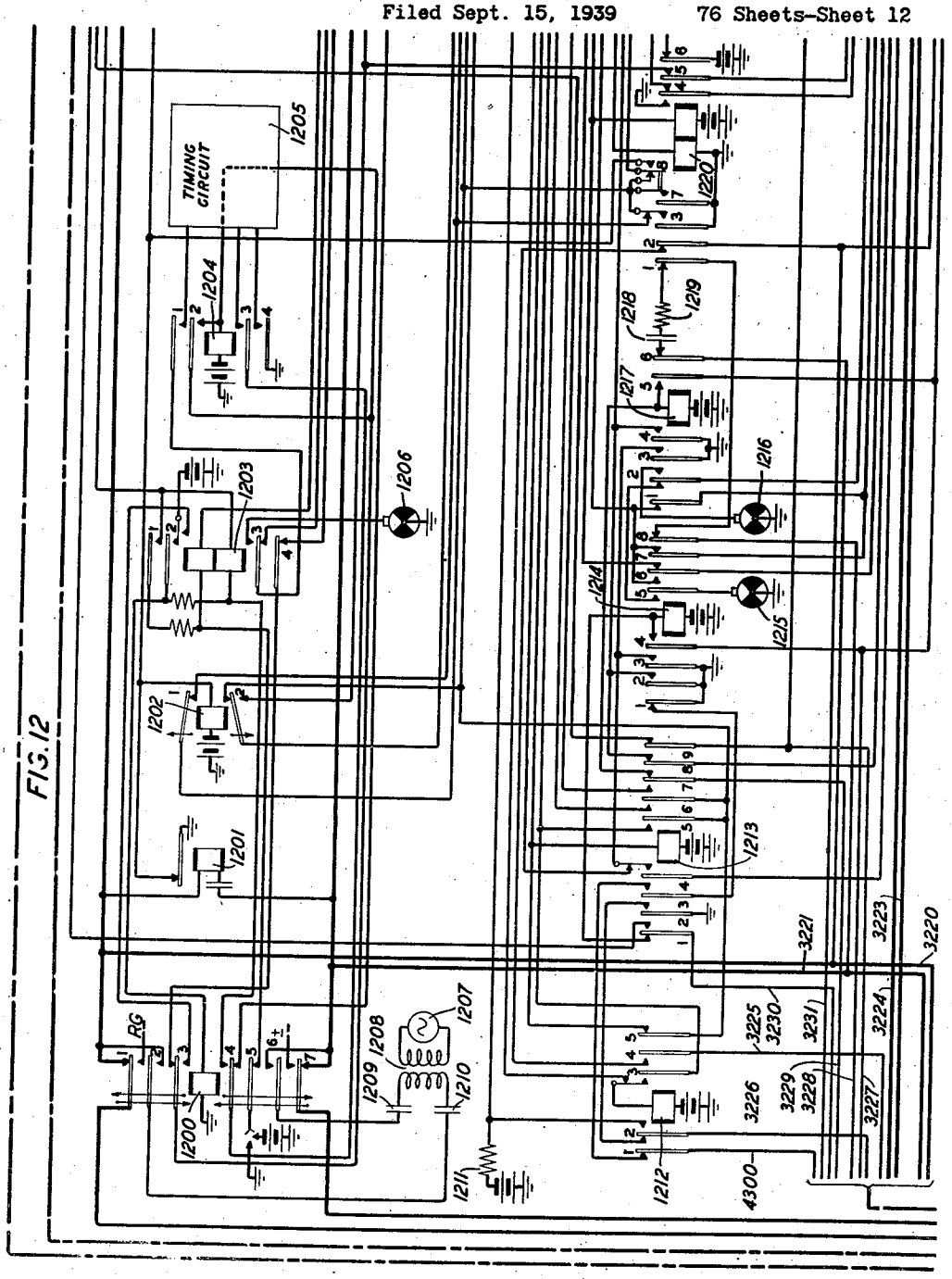


FIG. 12

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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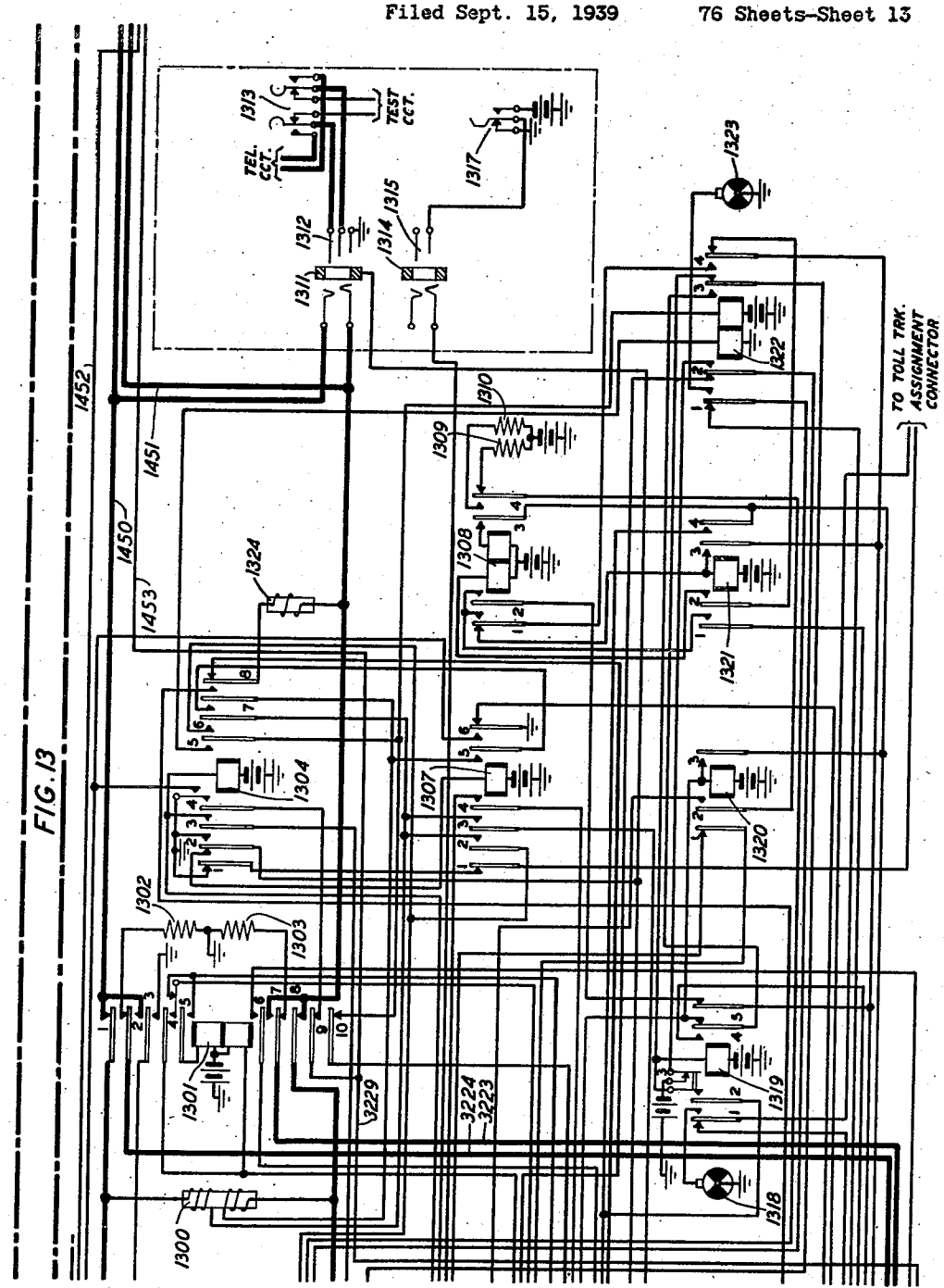

FIG. 13

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 14

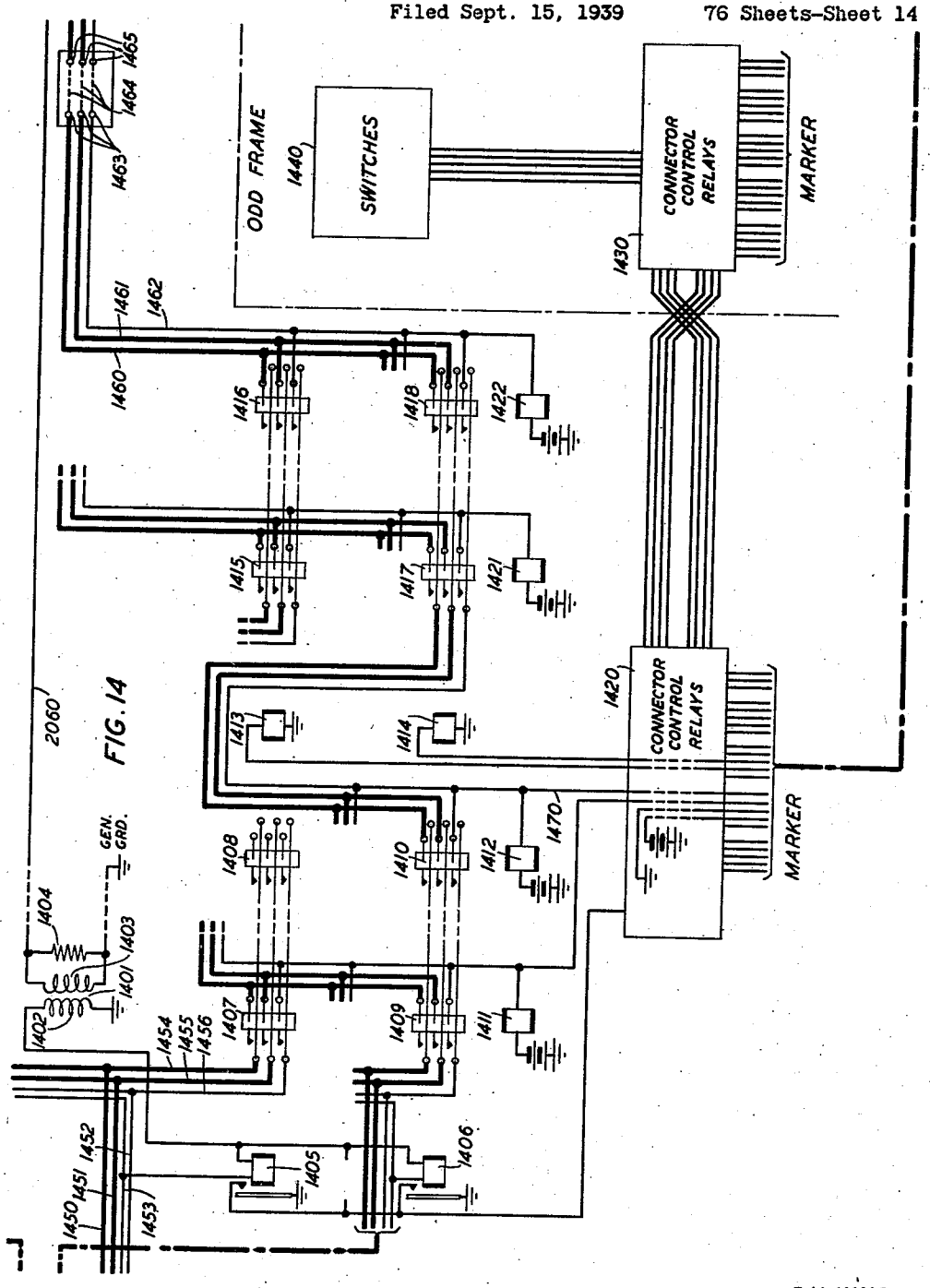

FIG. 14

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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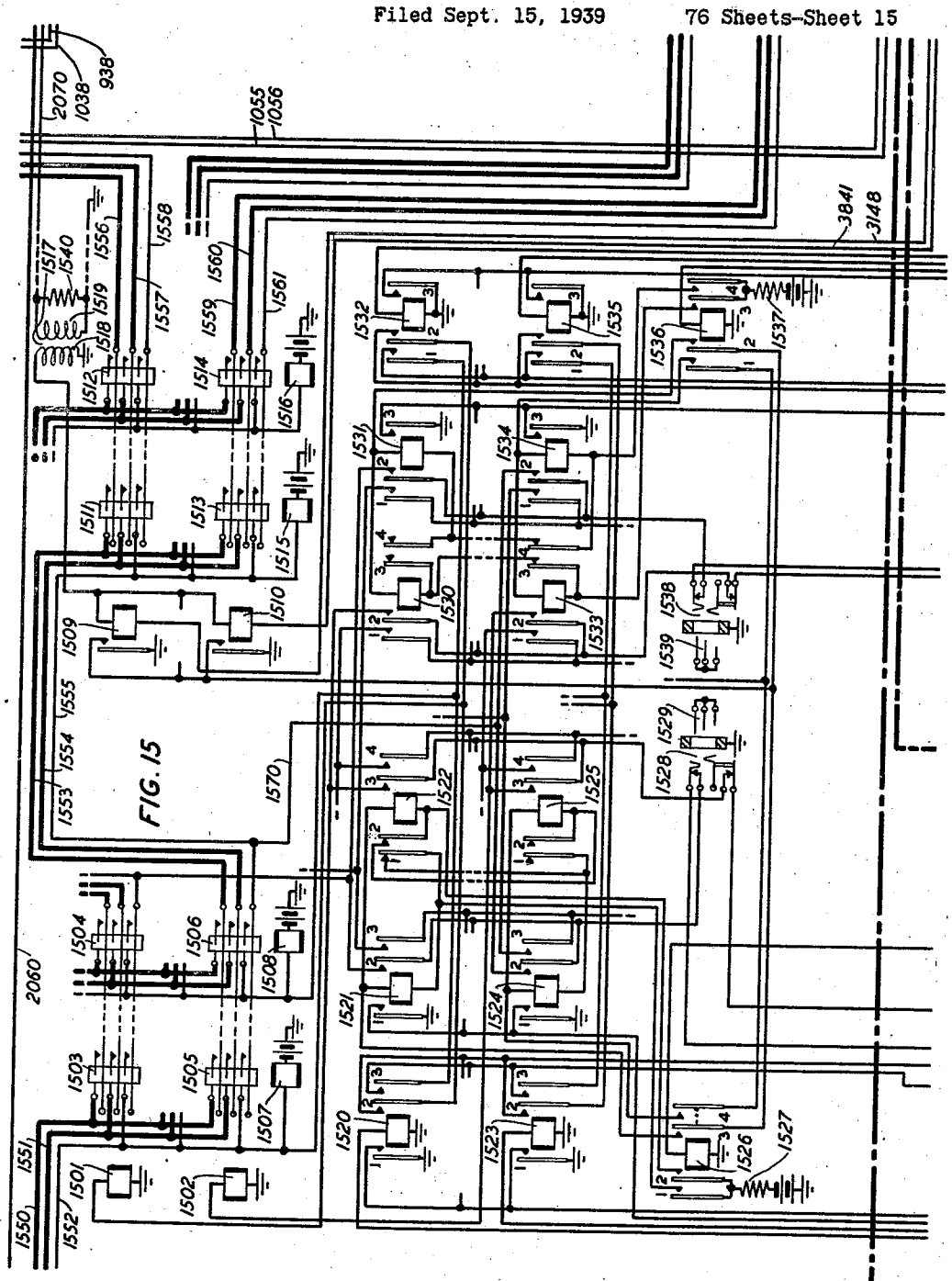

FIG. 15

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 16

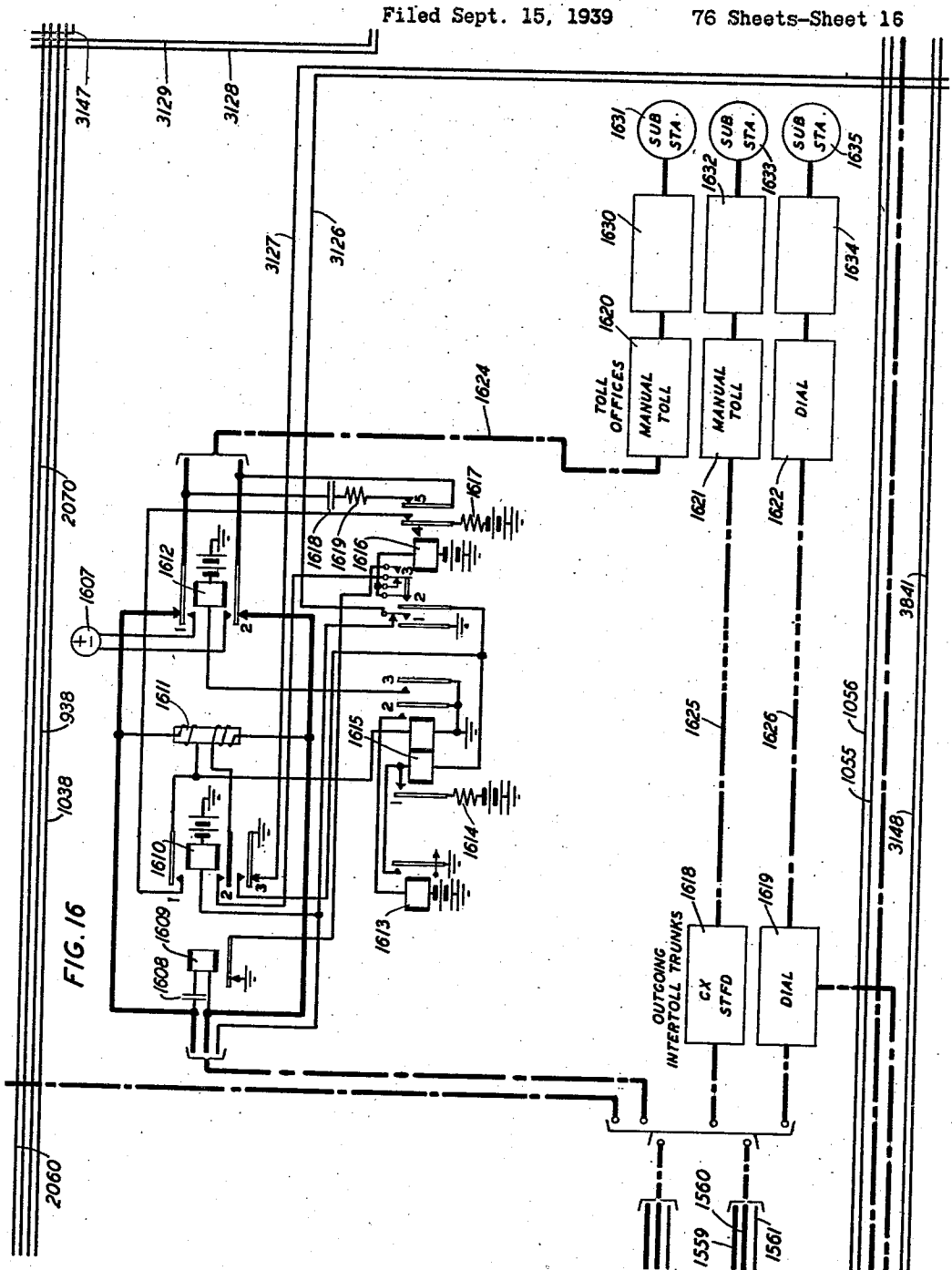

FIG. 16

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY Wm McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 17

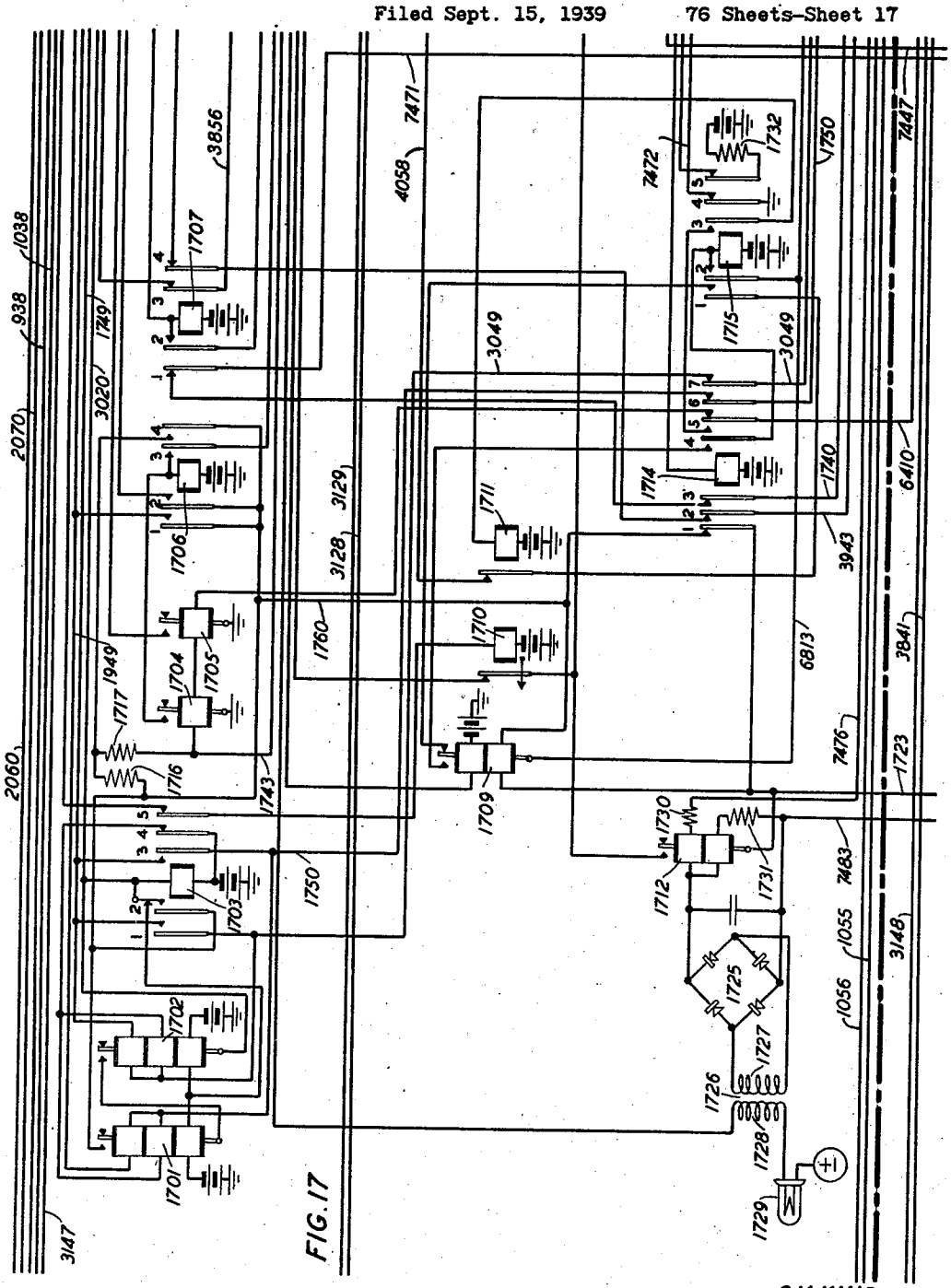

FIG. 17

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. F. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 18

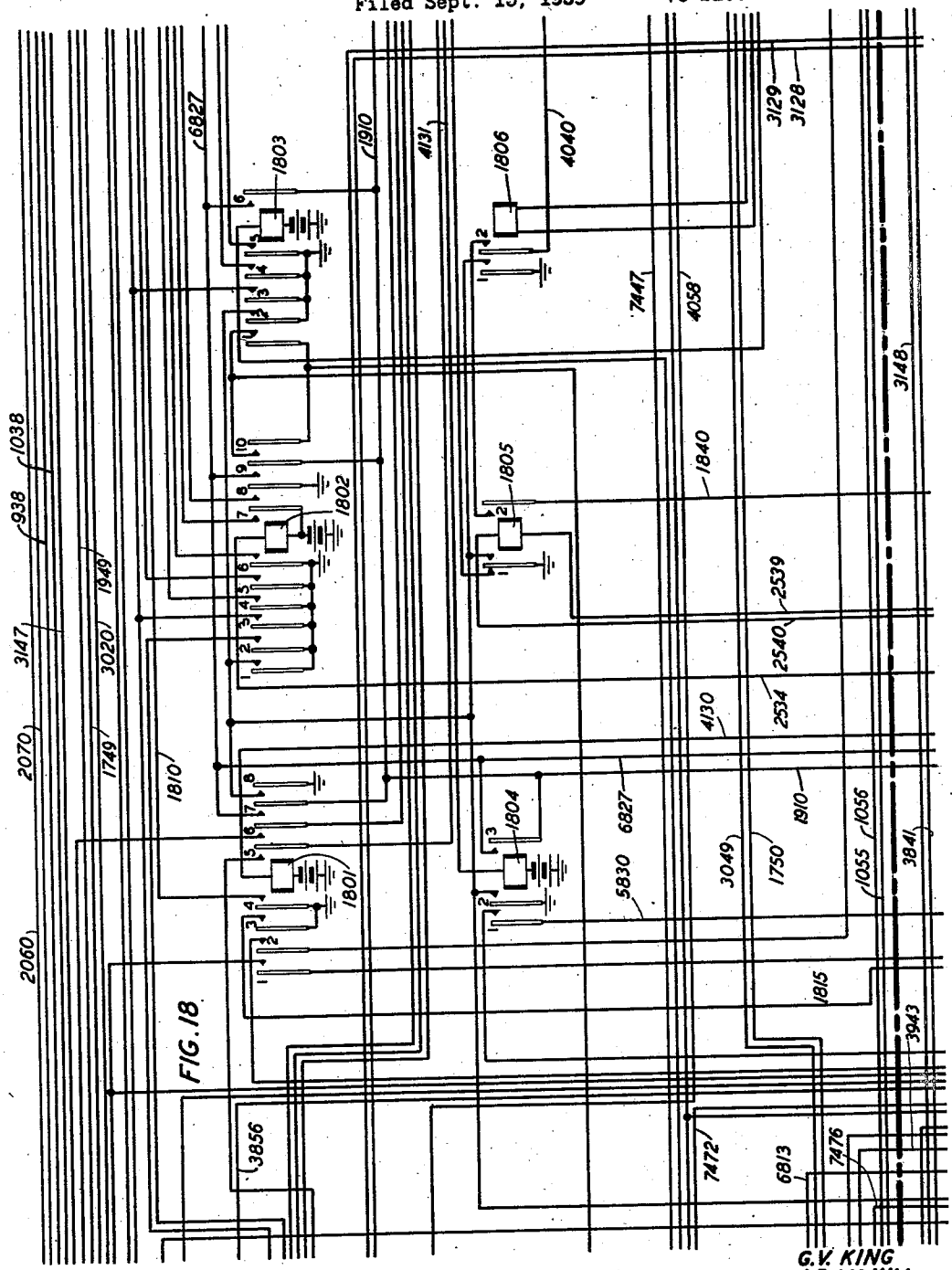

FIG. 18

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 19

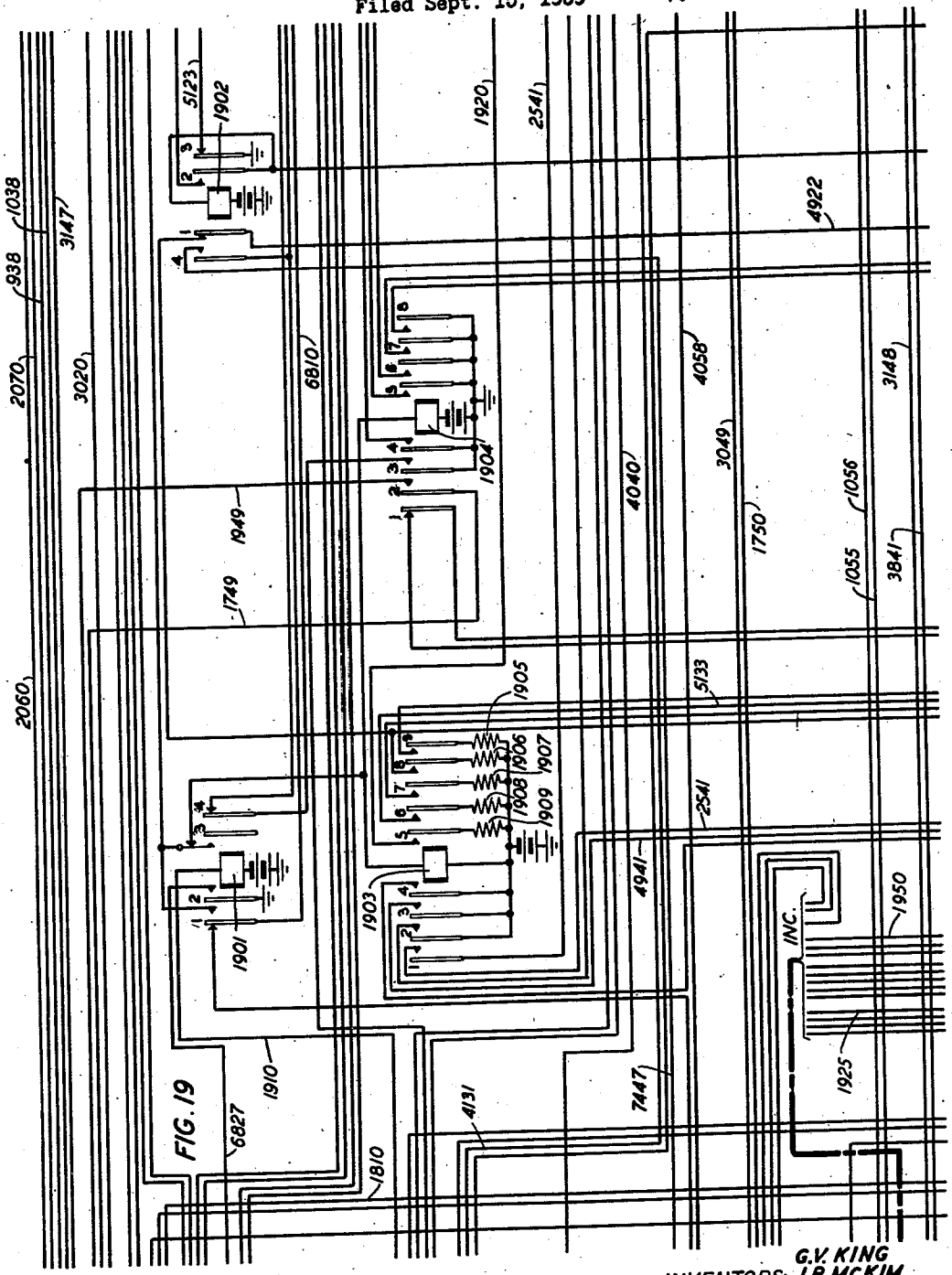

FIG. 19

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

W.T. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 20

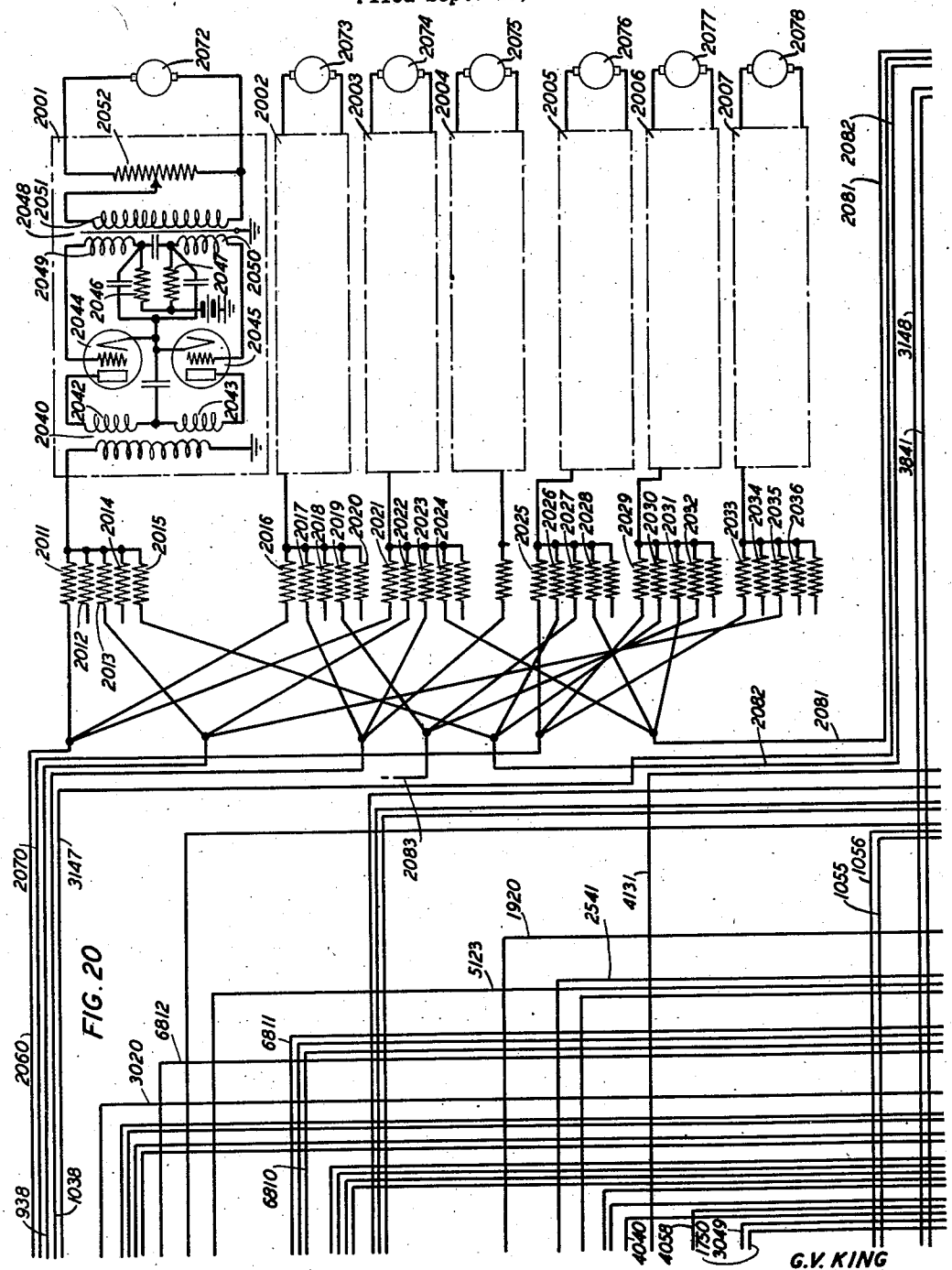

FIG. 20

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.R. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 21

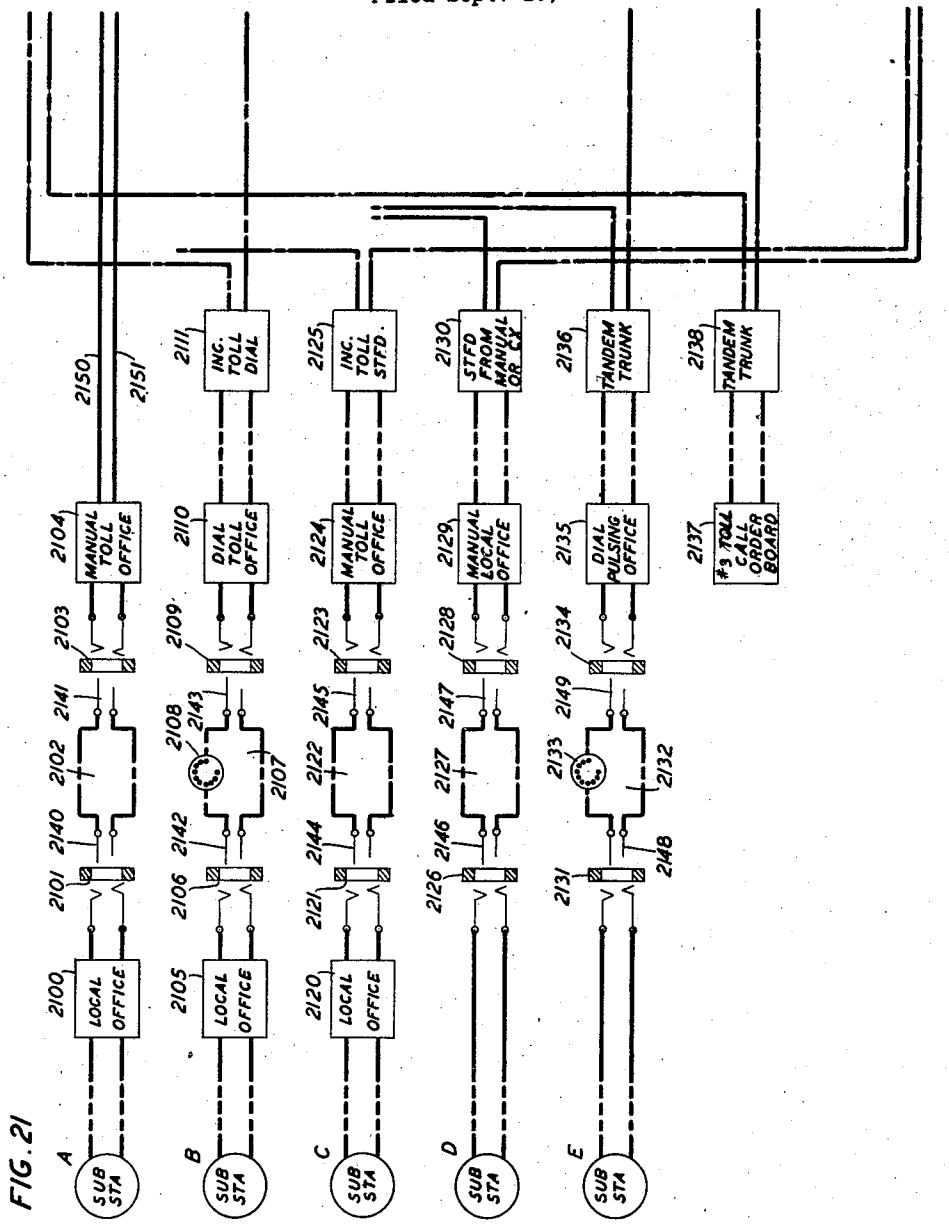

FIG. 21

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. F. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 22

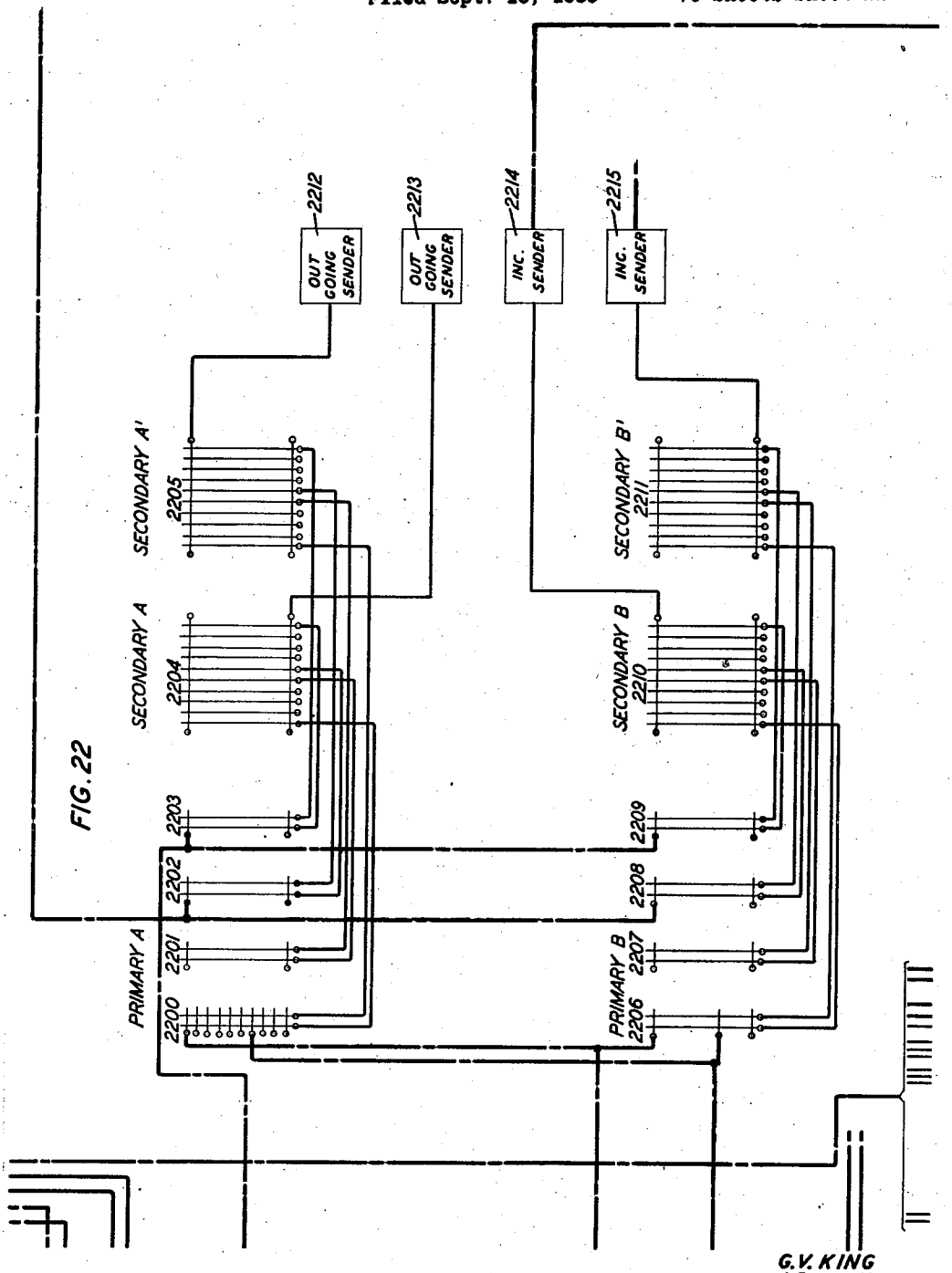

FIG. 22

INVENTORS: G. V. KING
J. B. McKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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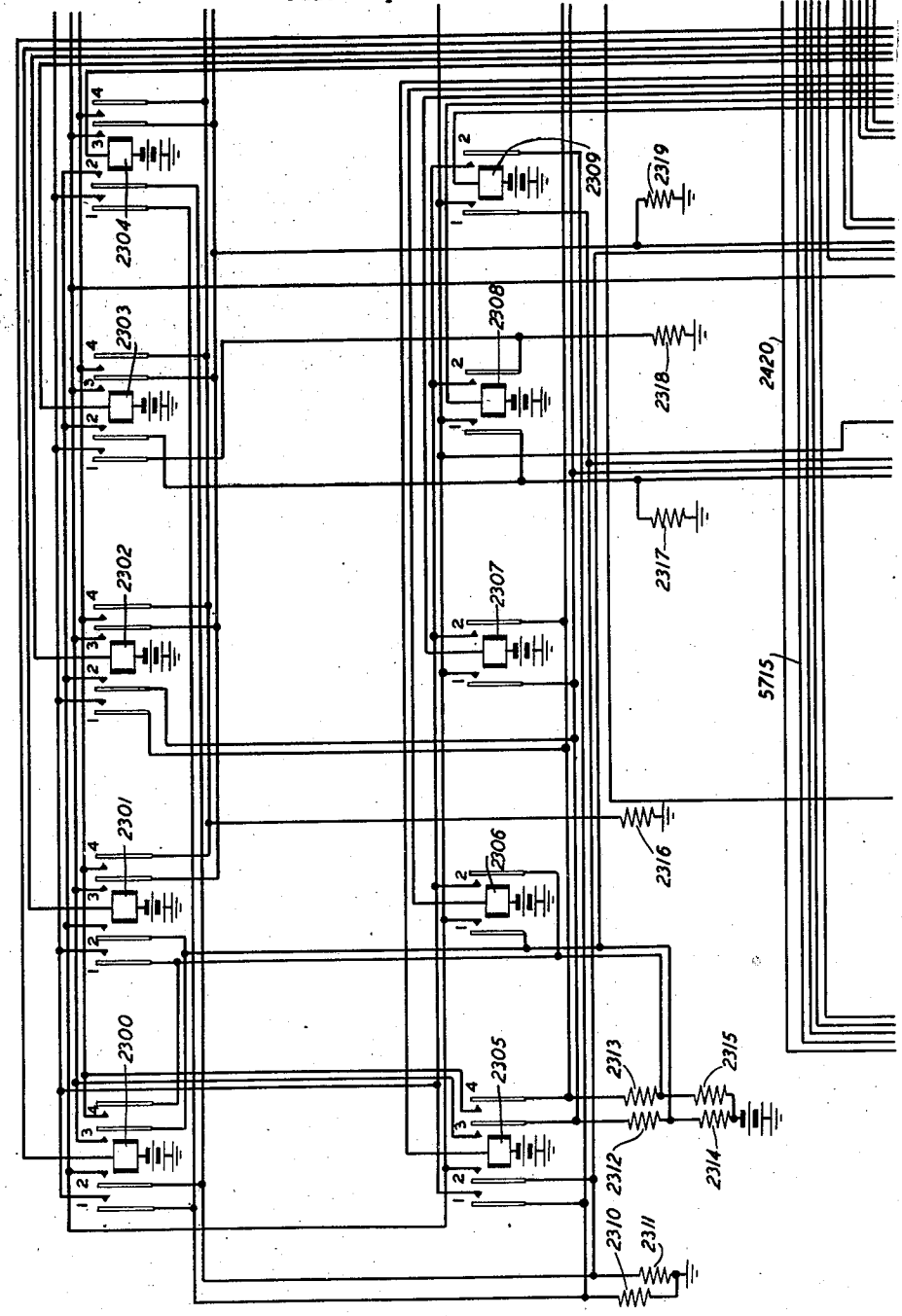

FIG. 23

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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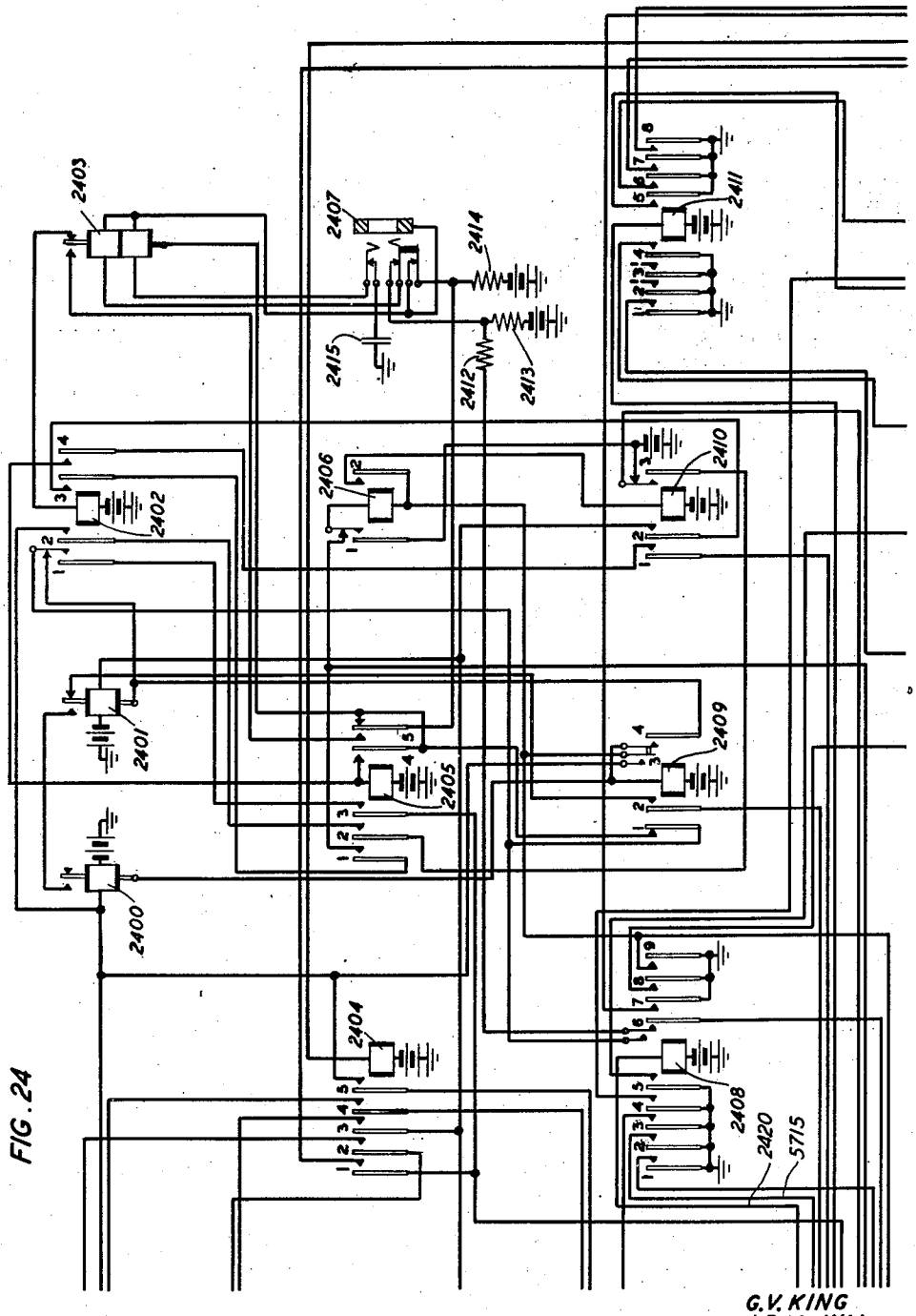

FIG. 24

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 25

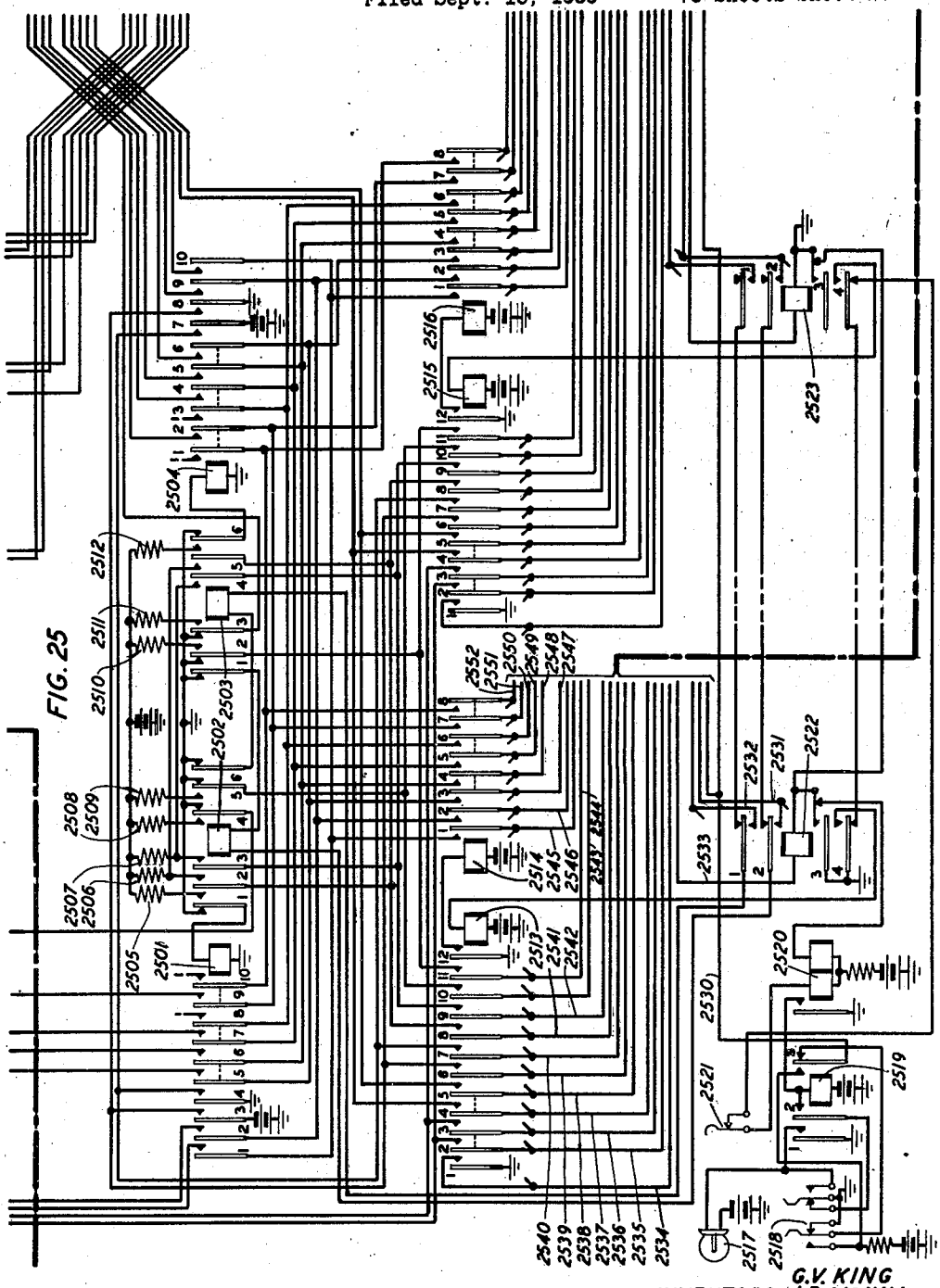

FIG. 25

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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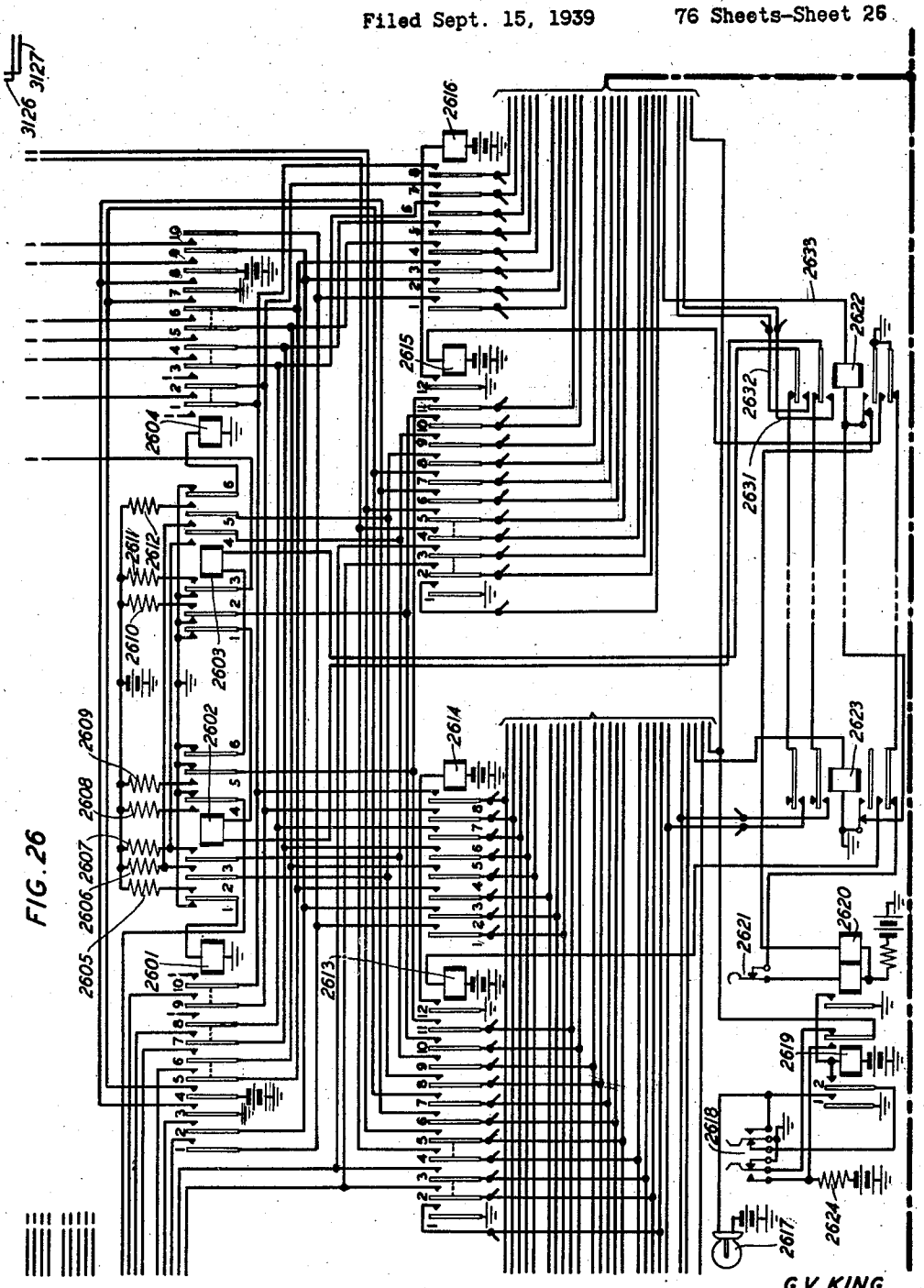

FIG. 26

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY E. R. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 27

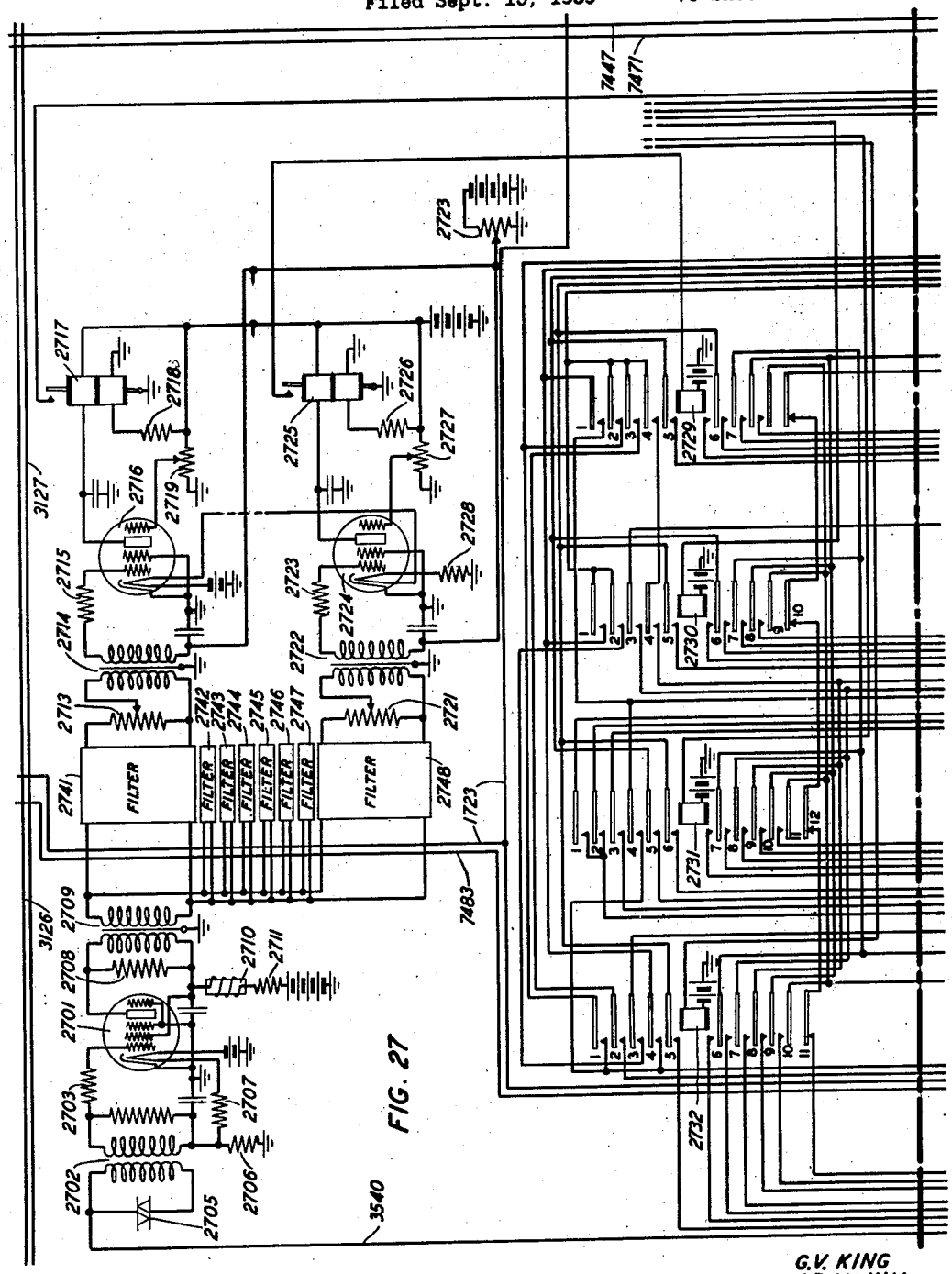

FIG. 27

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY Chas. P. McCarthy

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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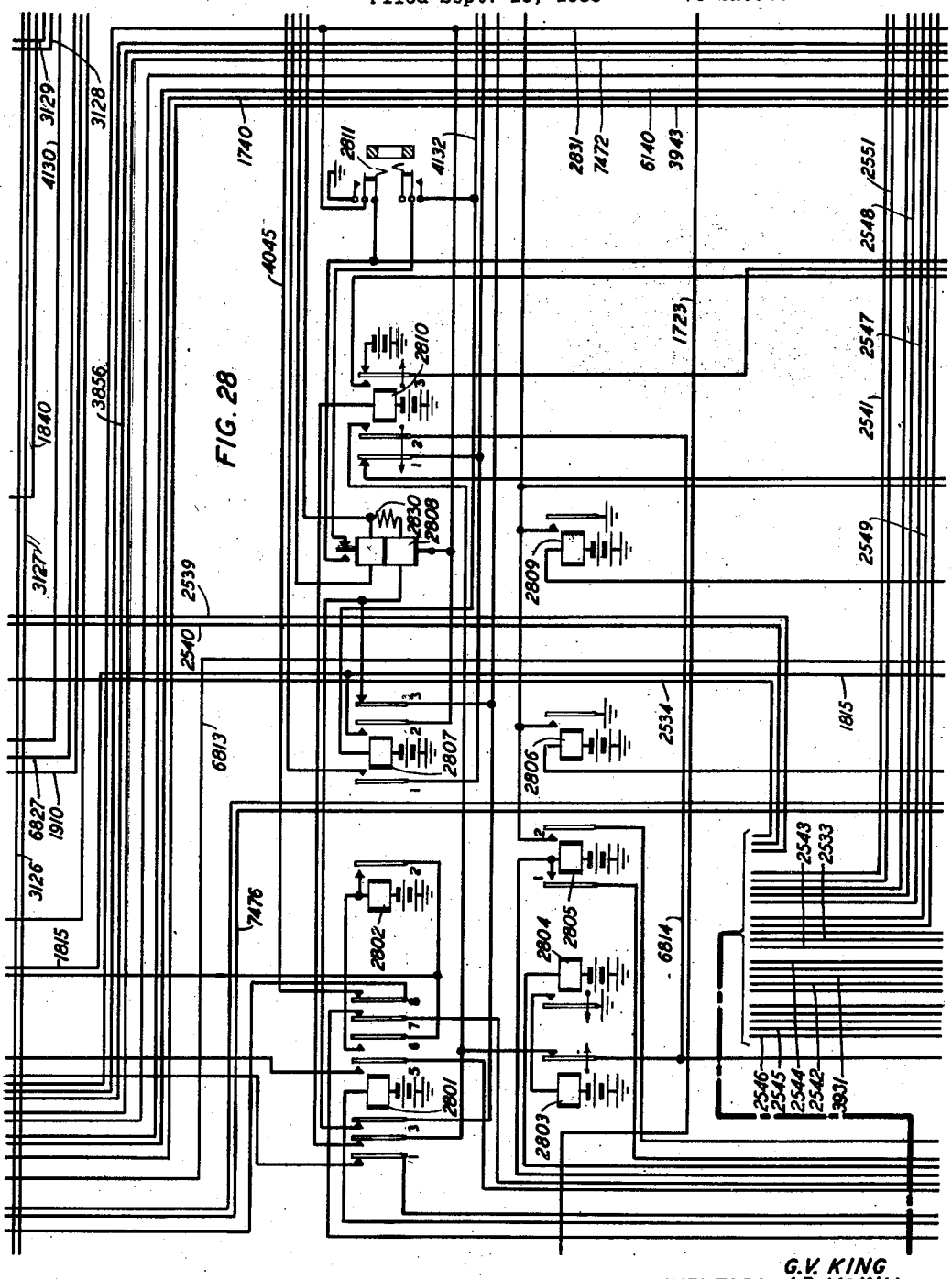


INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

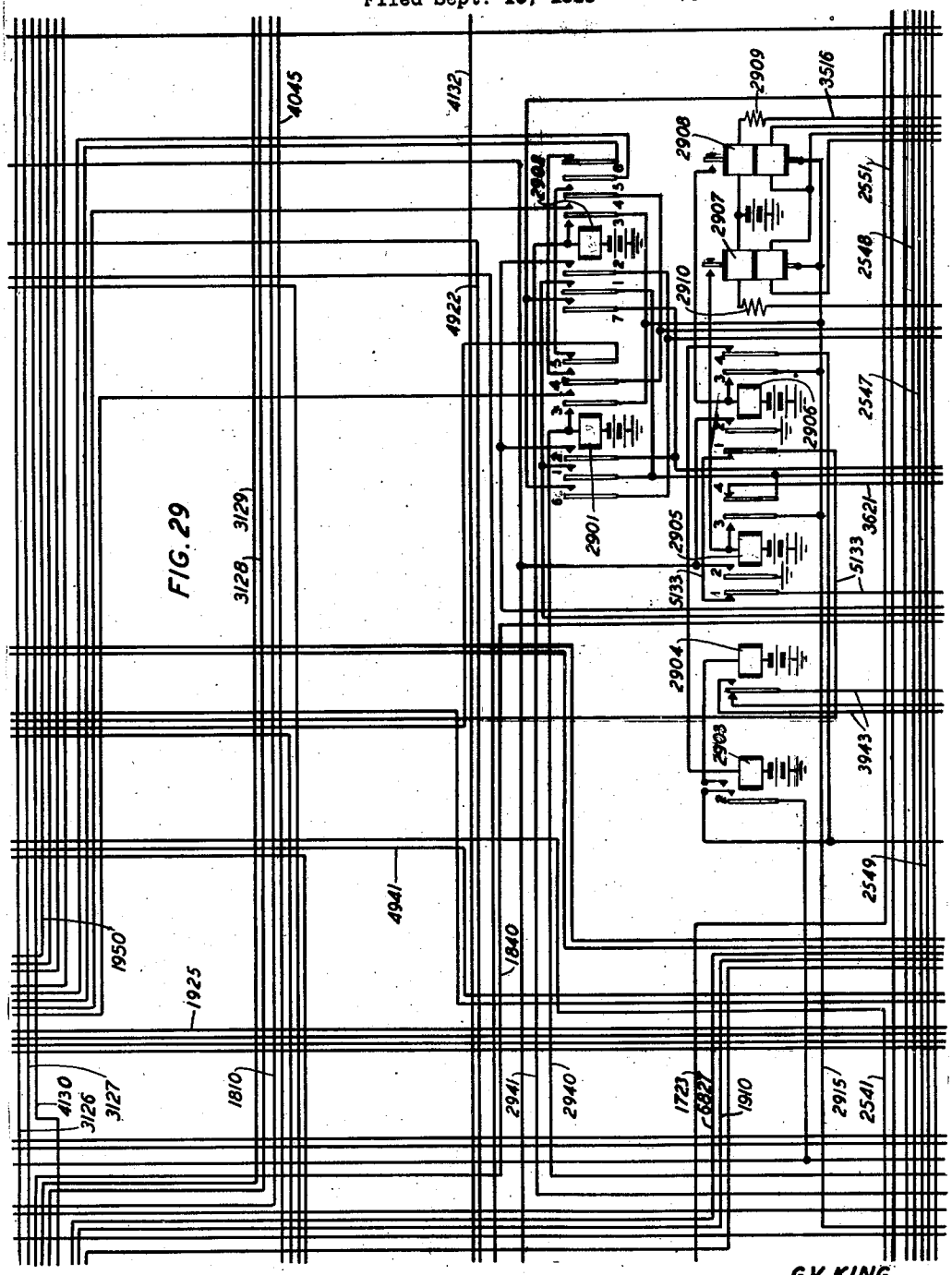
BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 29



INVENTORS G.V. KING
J.B. MCKIM
O. MYERS

BY M. J. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 30

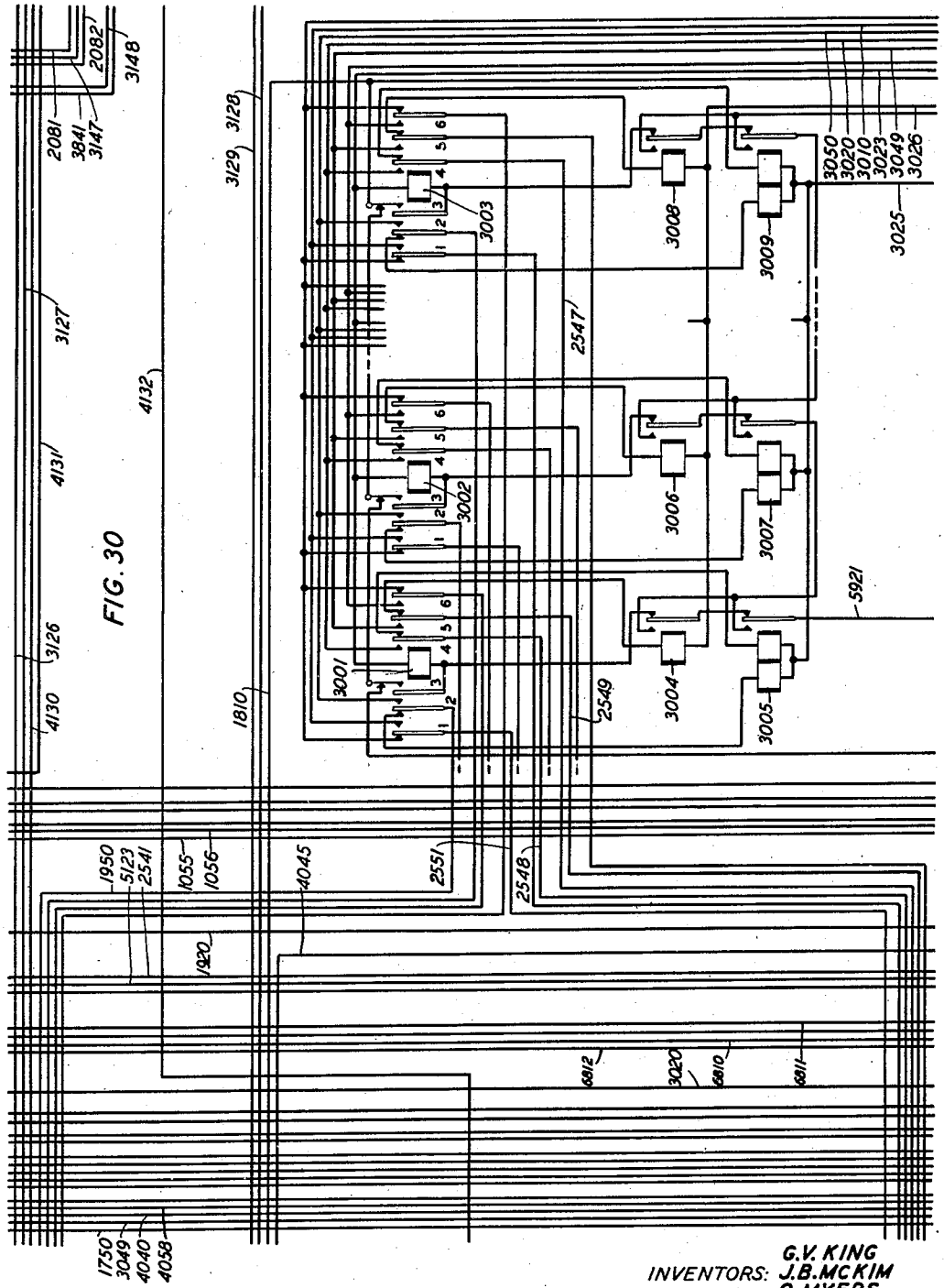


FIG. 30

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

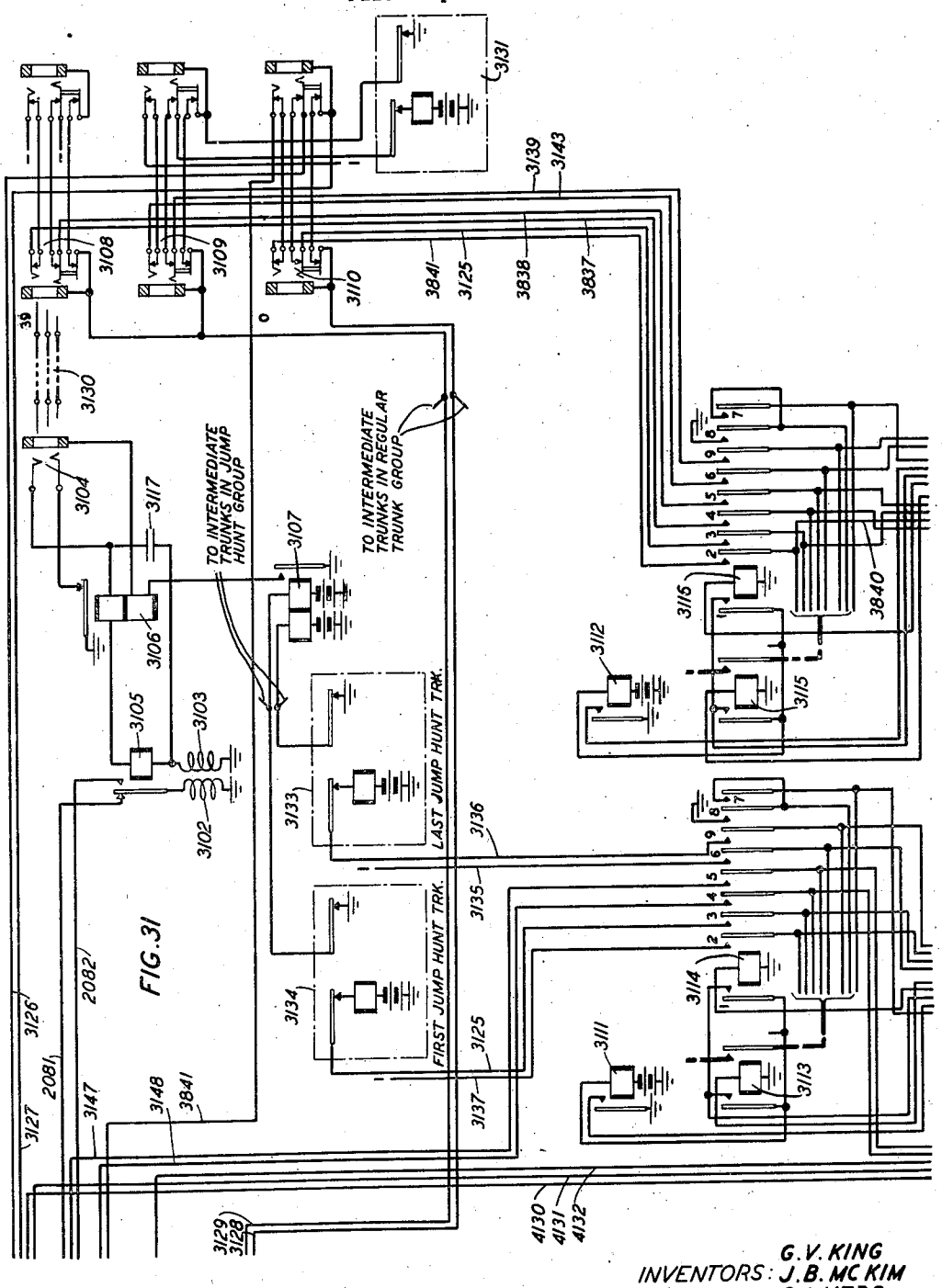
BY W. Dale McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 31



INVENTORS: G. V. KING
J. B. MC KIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 32

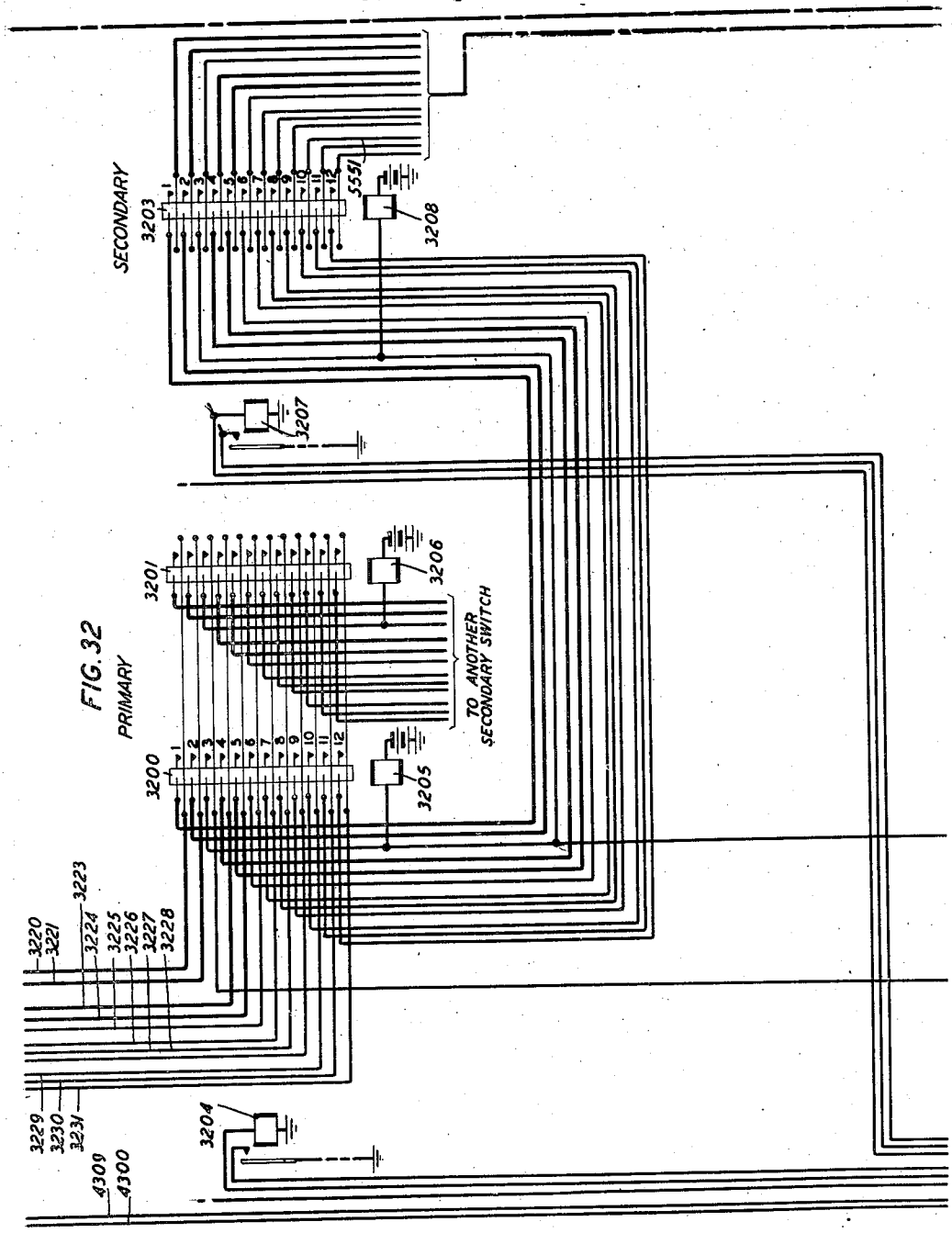


FIG. 32

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY W.T. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 33

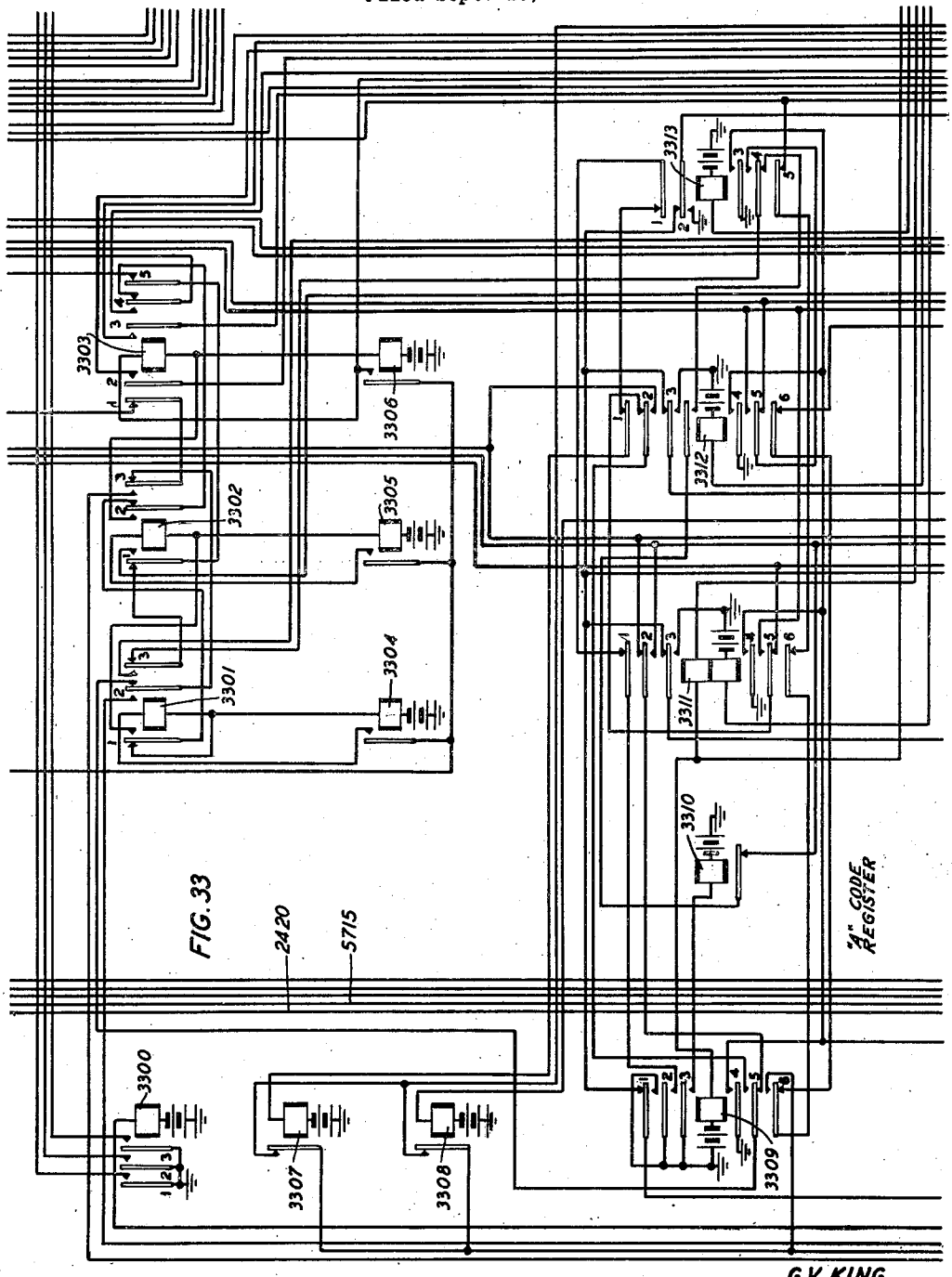


FIG. 33

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 34

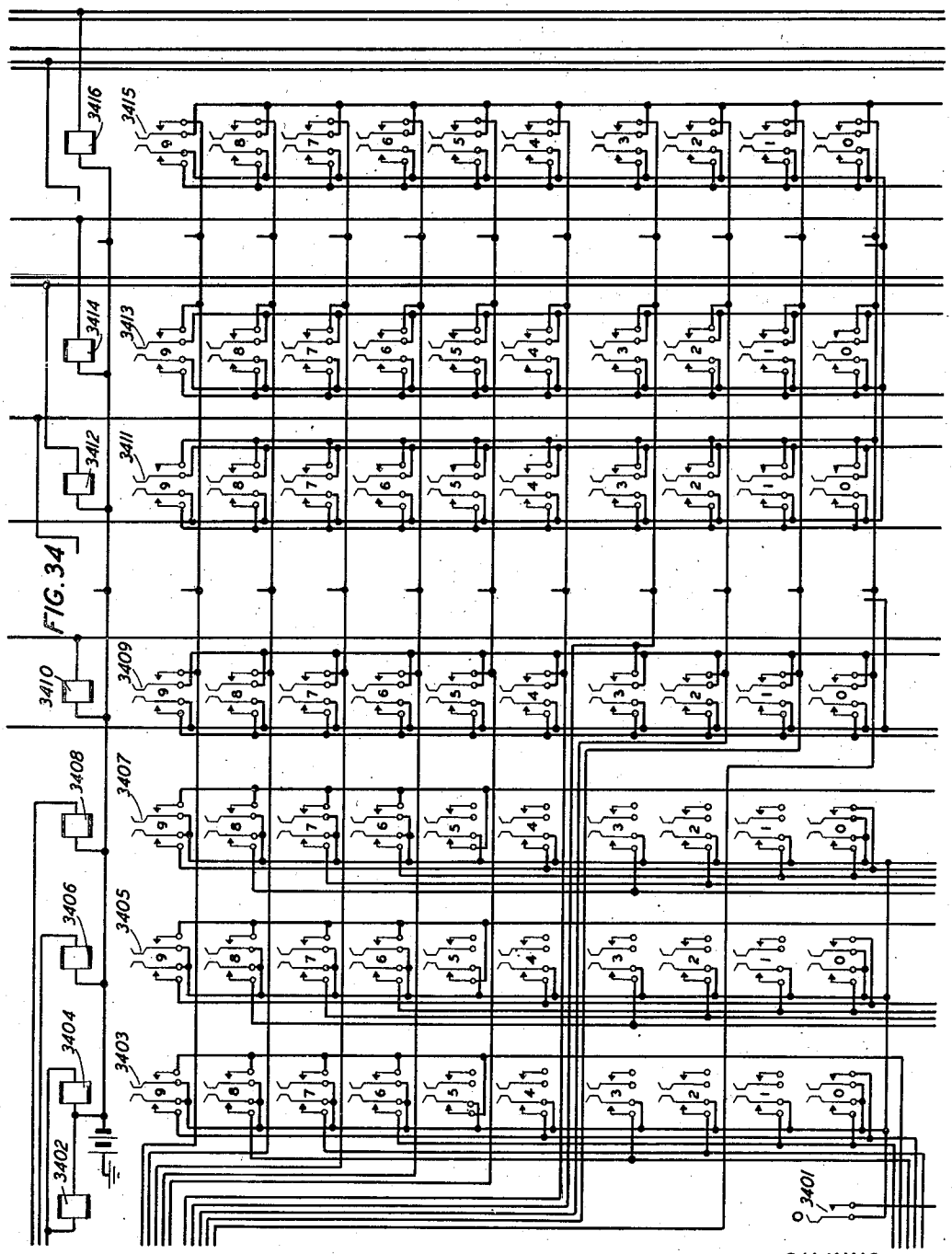


FIG. 34

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY W. F. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 35

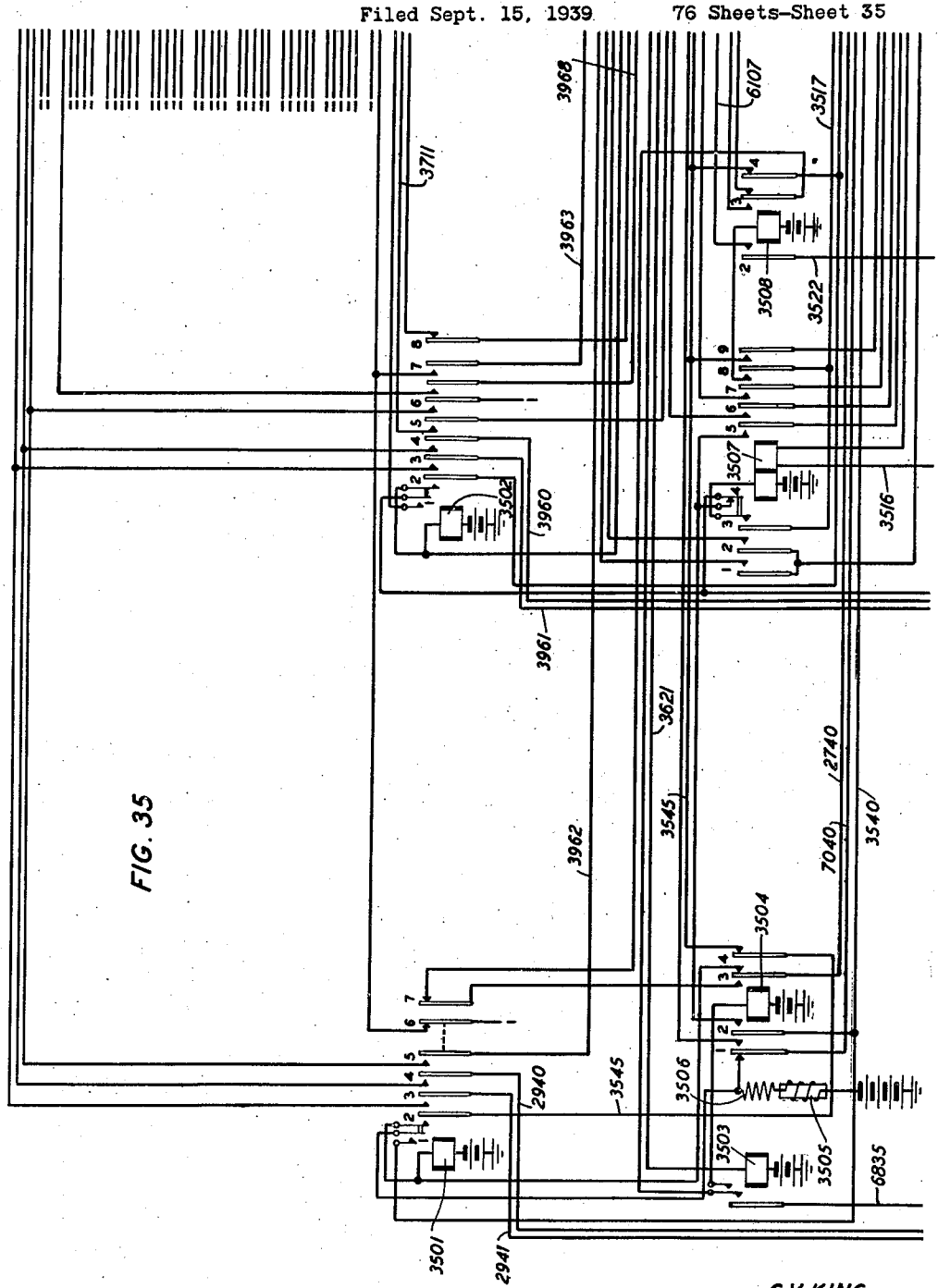


FIG. 35

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 36

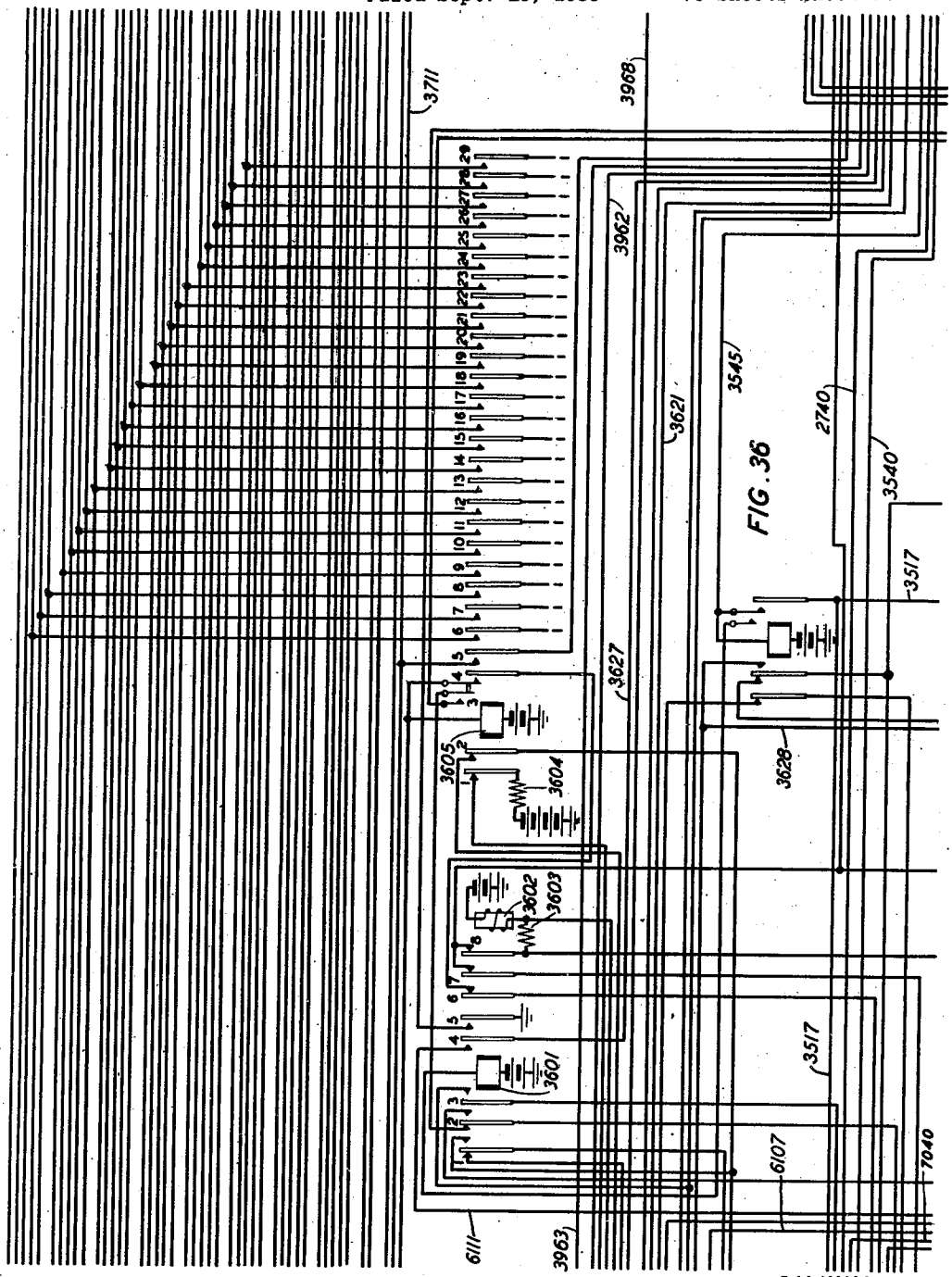


FIG. 36

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 37

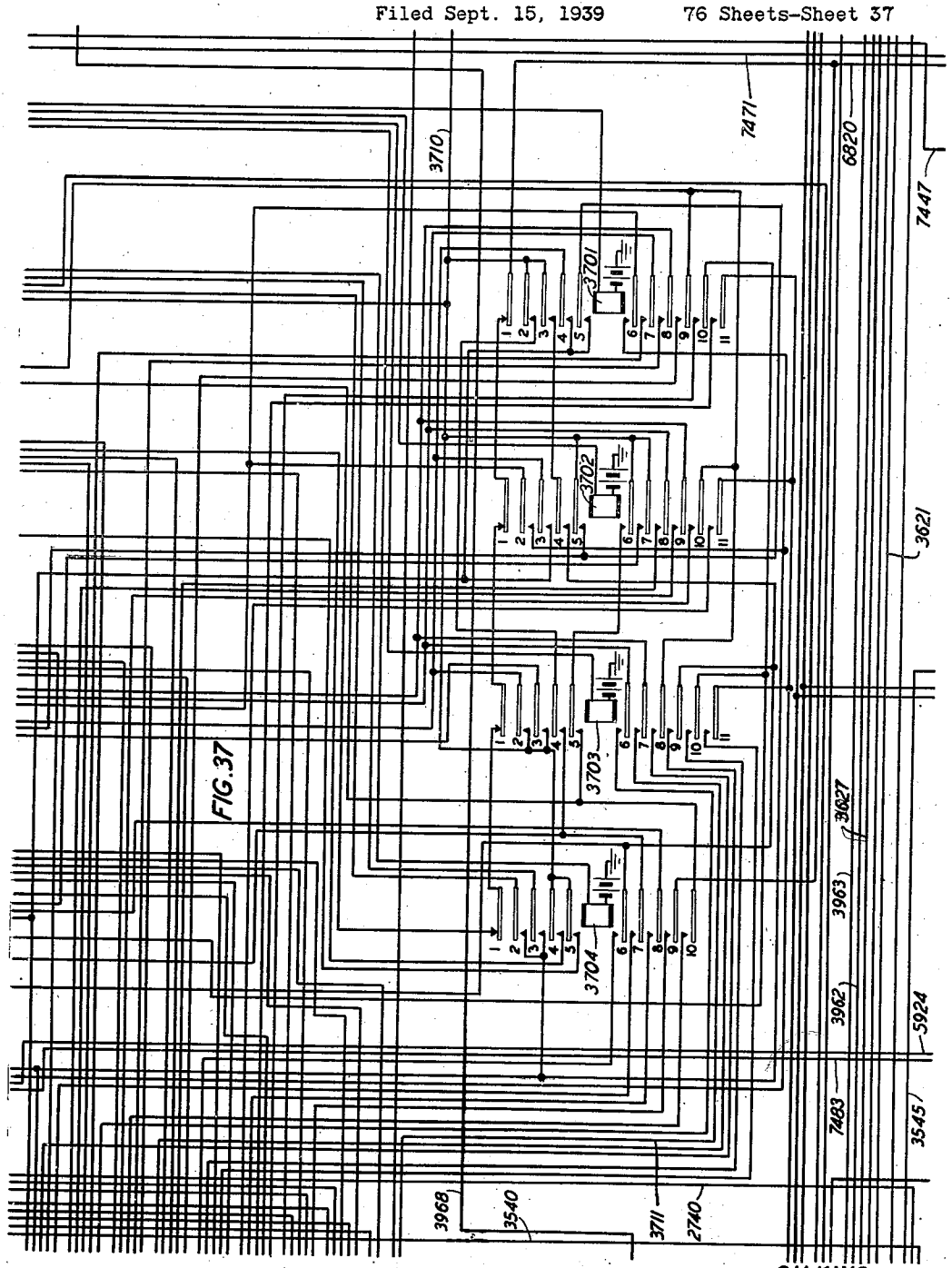


FIG. 37

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

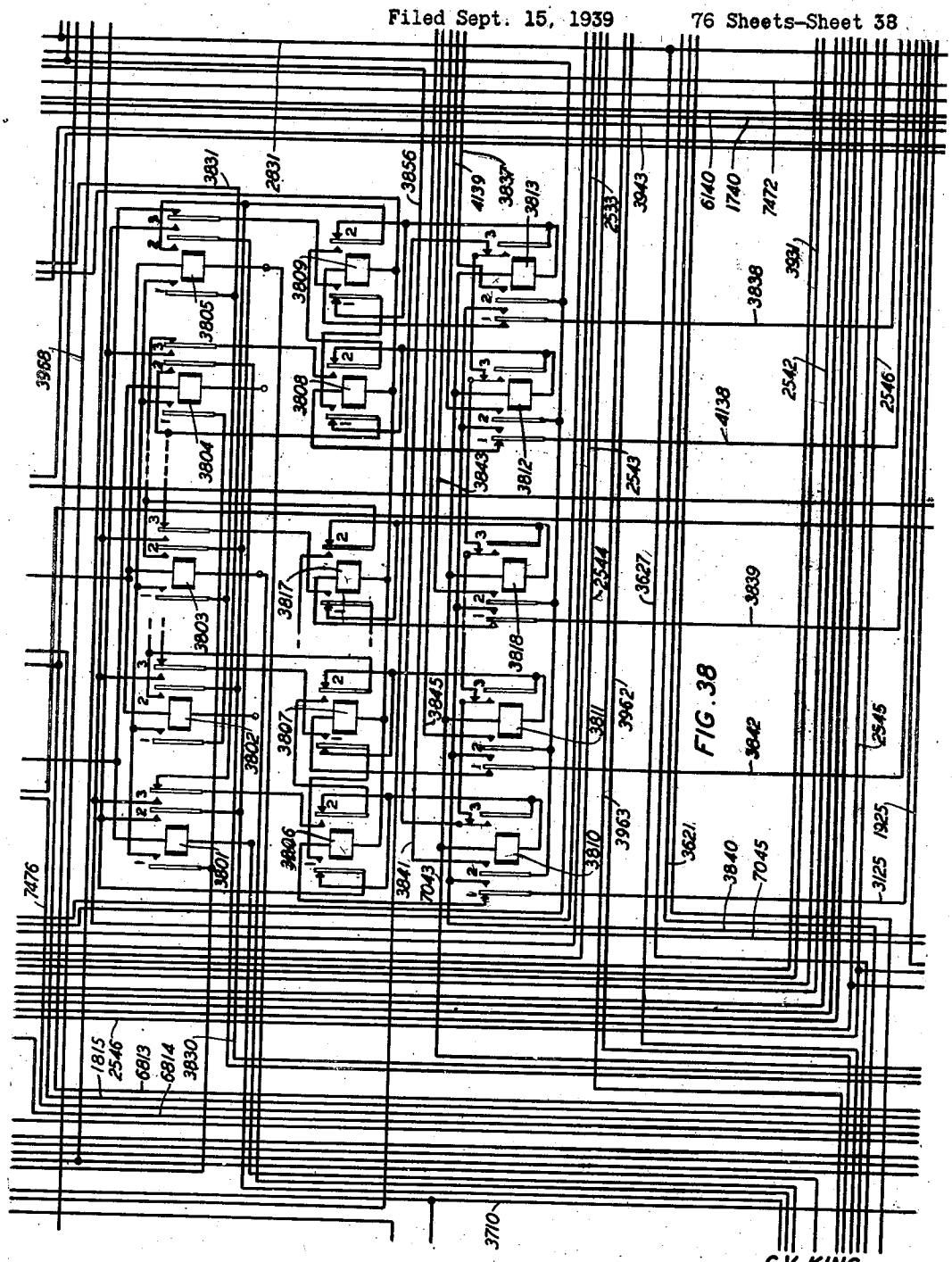
BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 38



INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

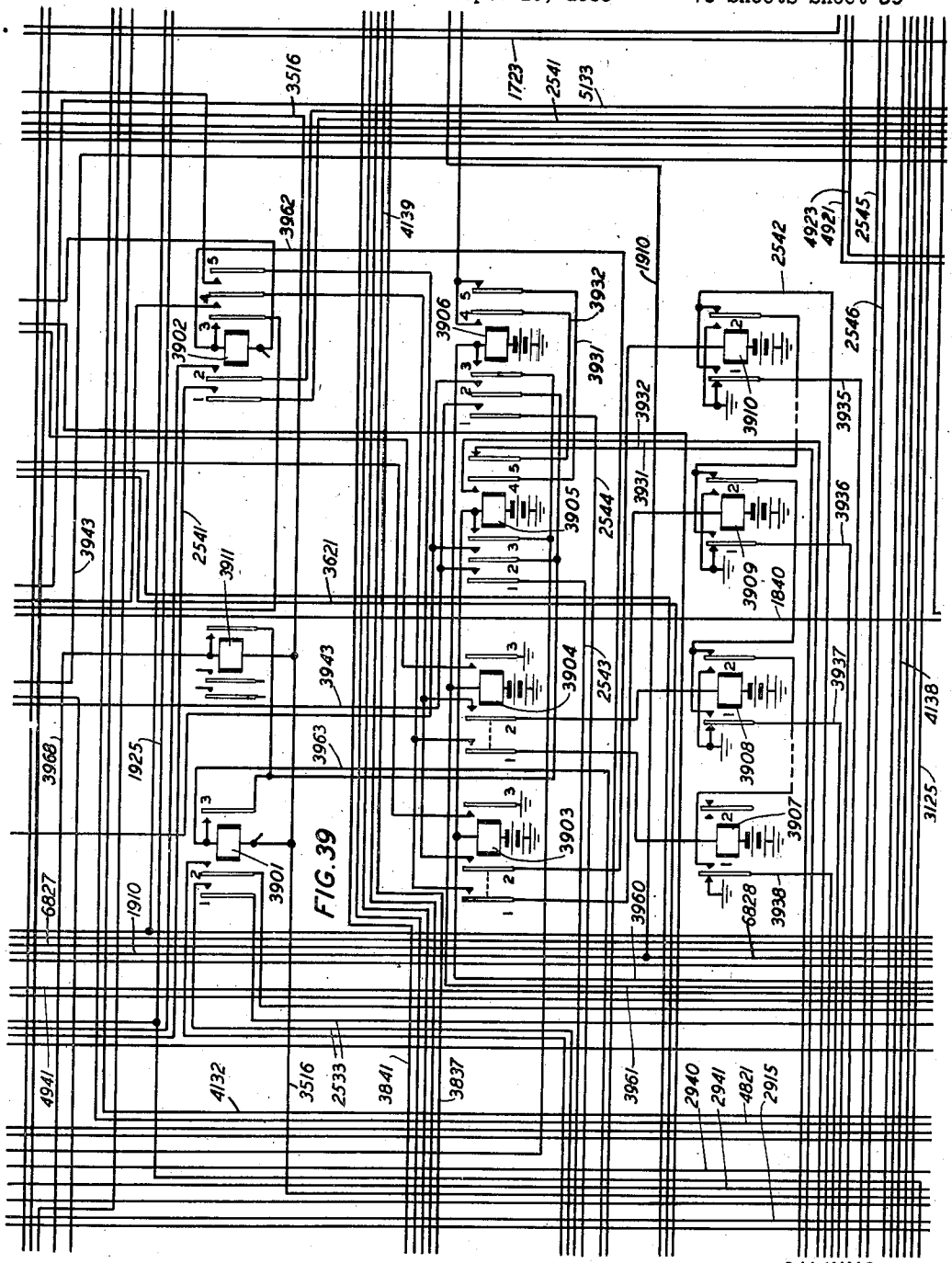
BY W.T. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 39



INVENTORS: G. V. KING, J. B. MCKIM, O. MYERS

BY W. T. McKinney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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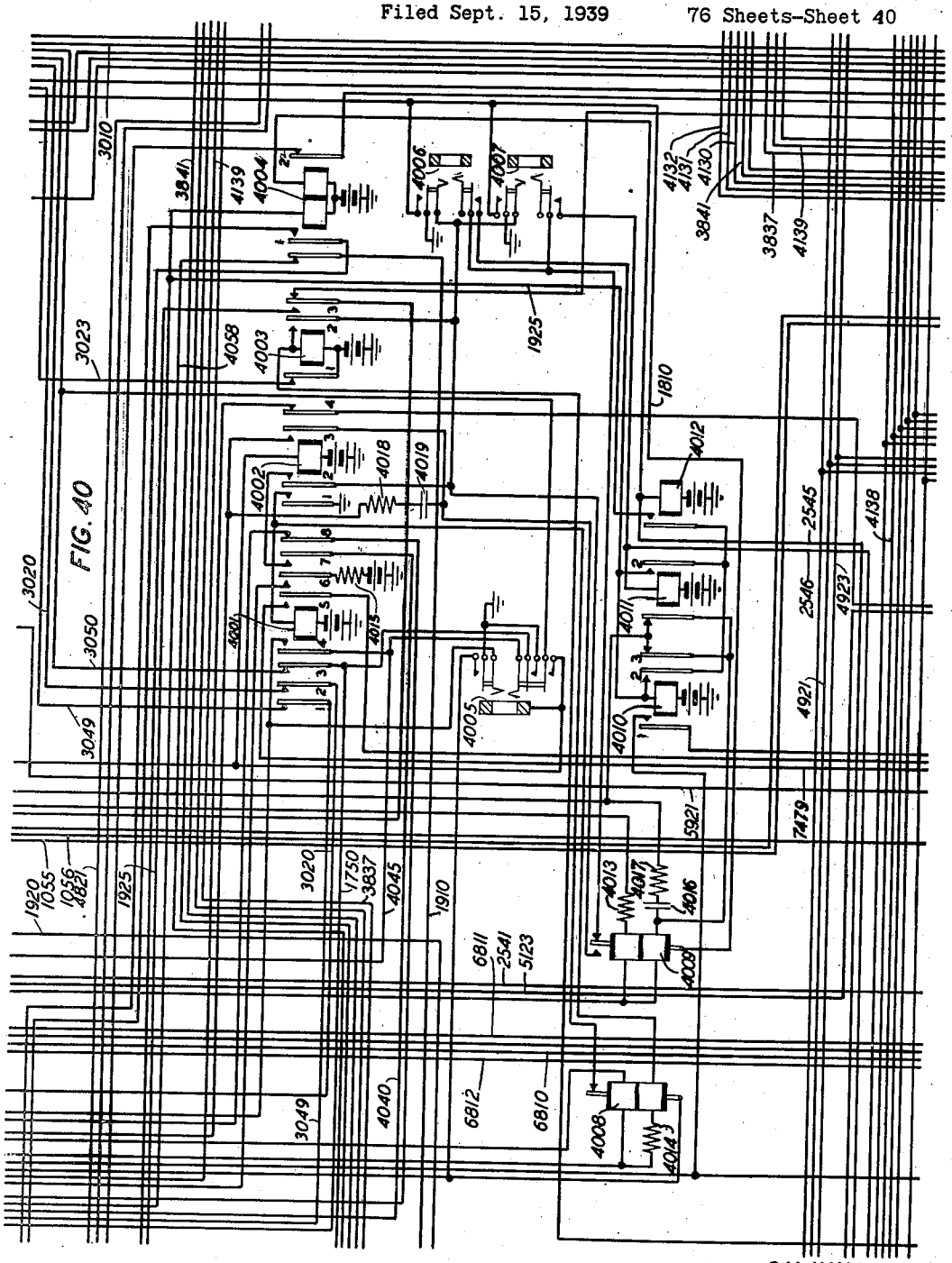

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY W. T. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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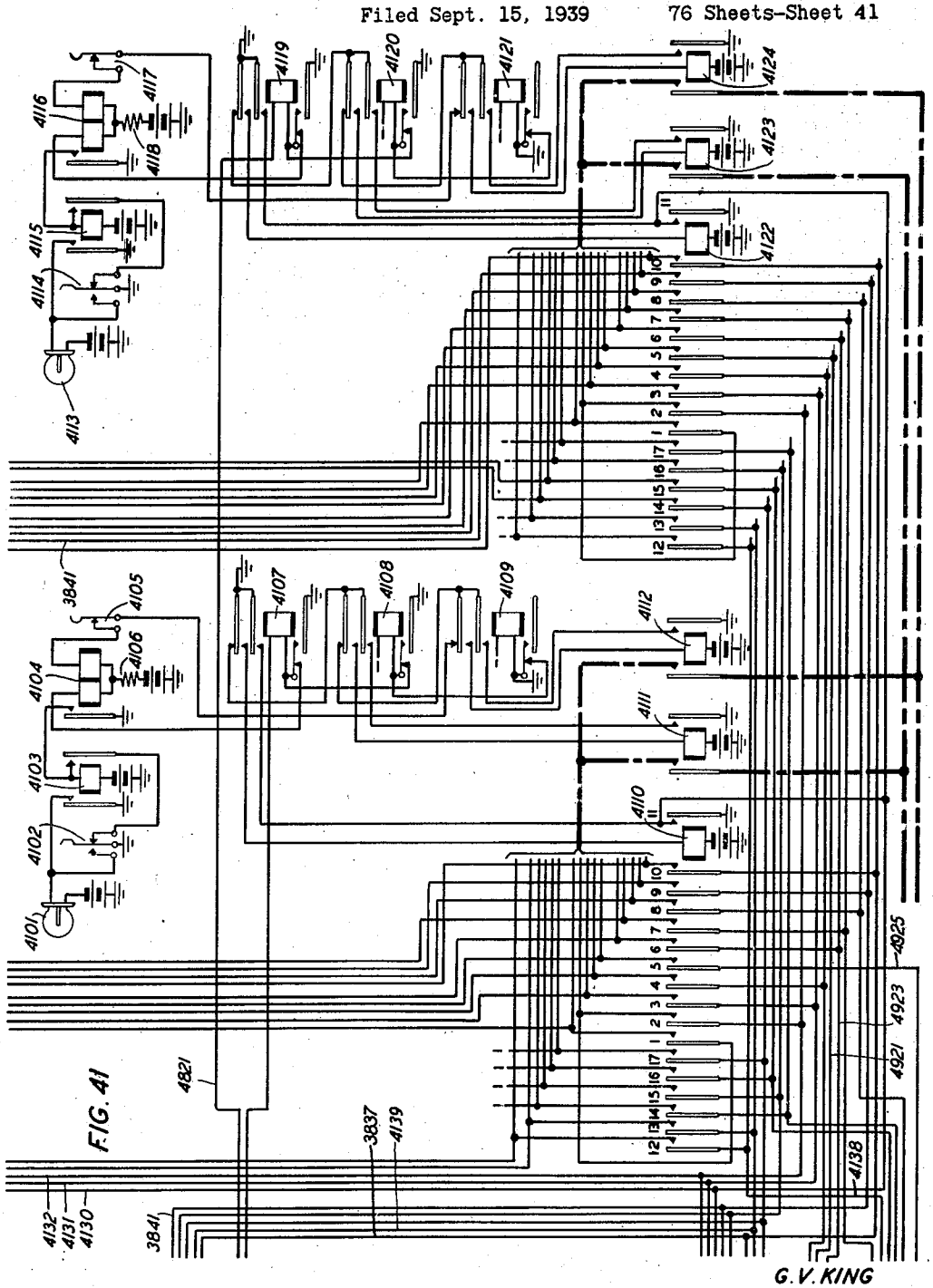

FIG. 41

INVENTORS: G. V. KING
J. B. MC KIM
O. MYERS

BY W. T. McTeague

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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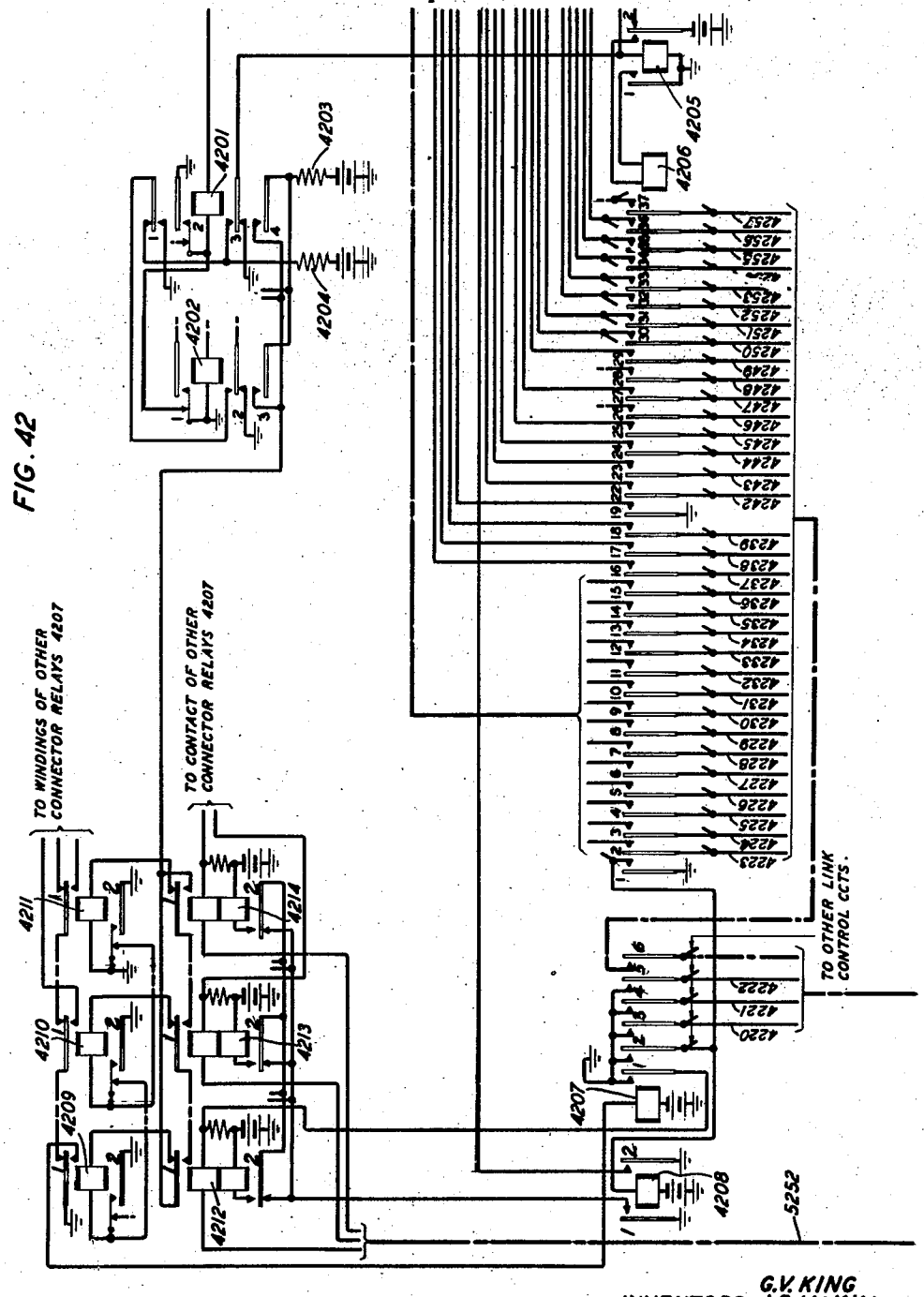

F/G. 42

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 43

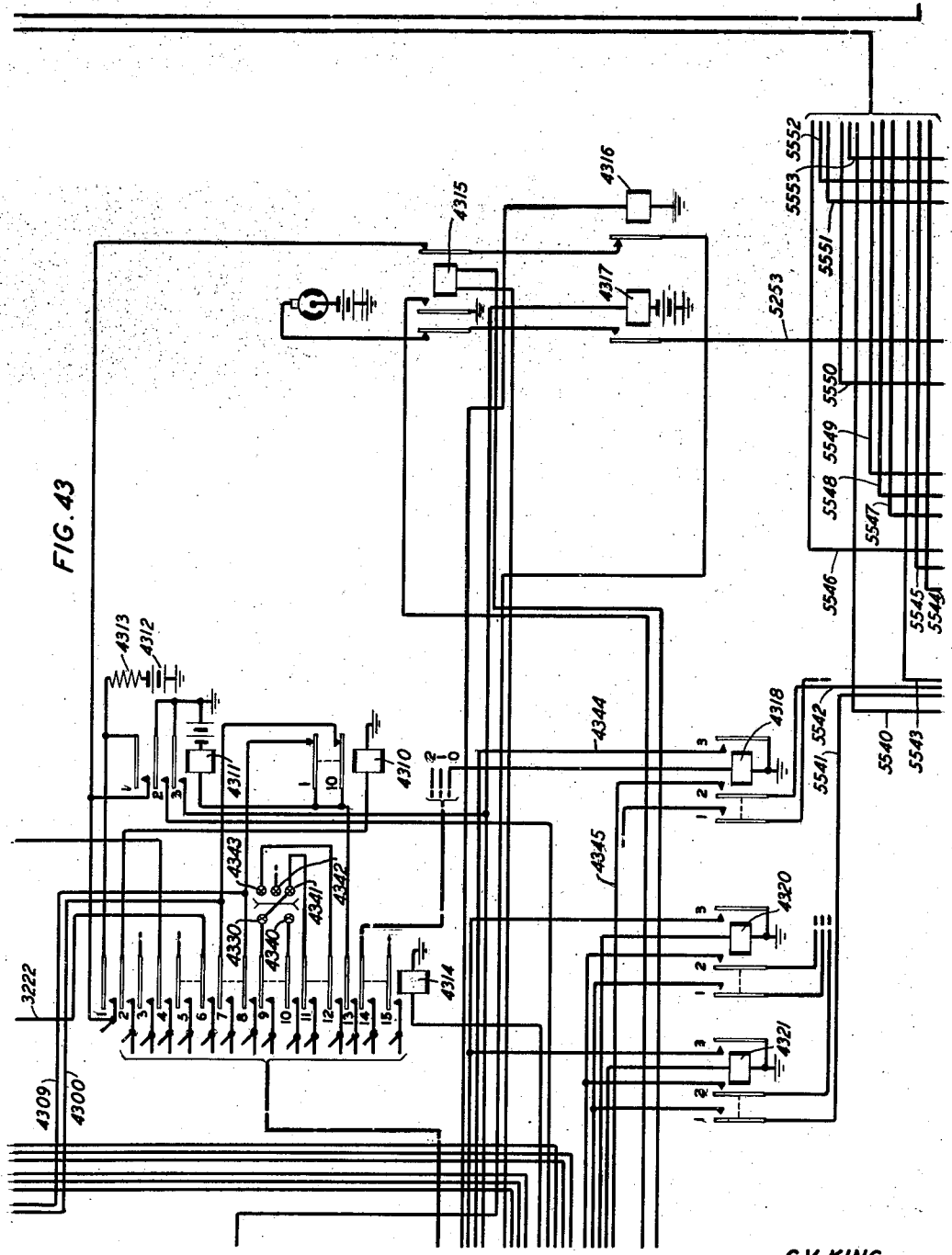

FIG. 43

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY W.T. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 44

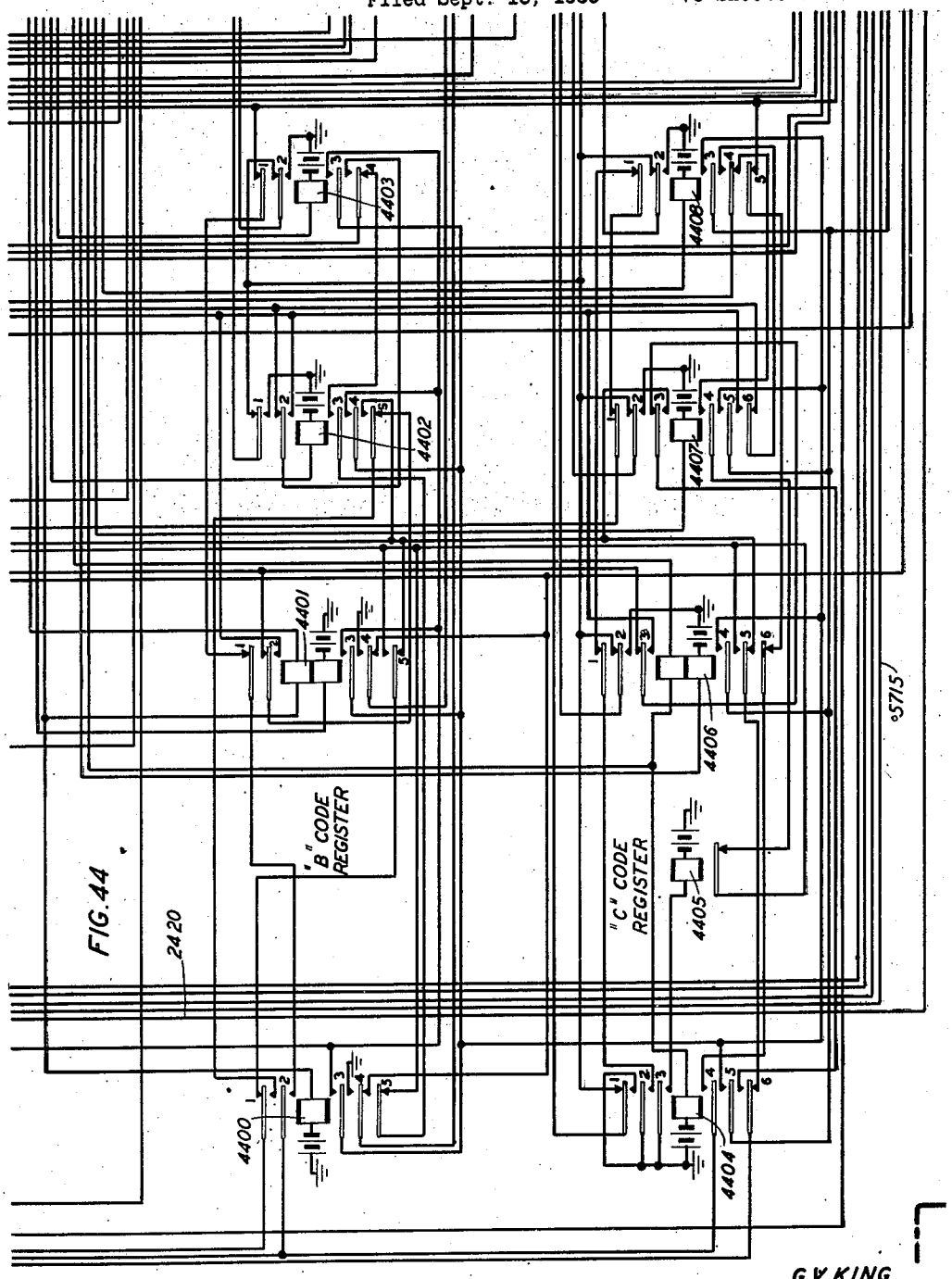

FIG. 44

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.F. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 45

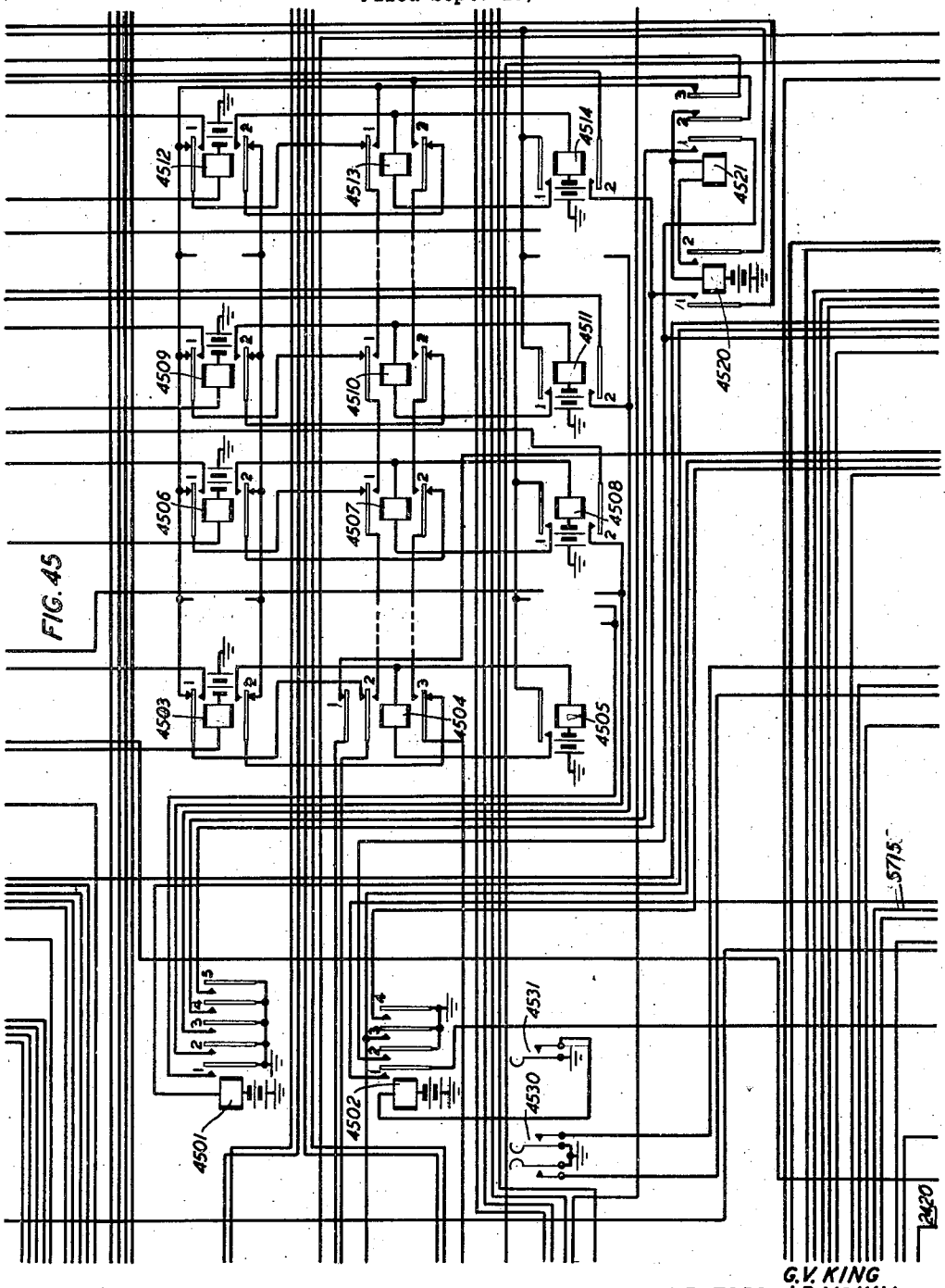

FIG. 45

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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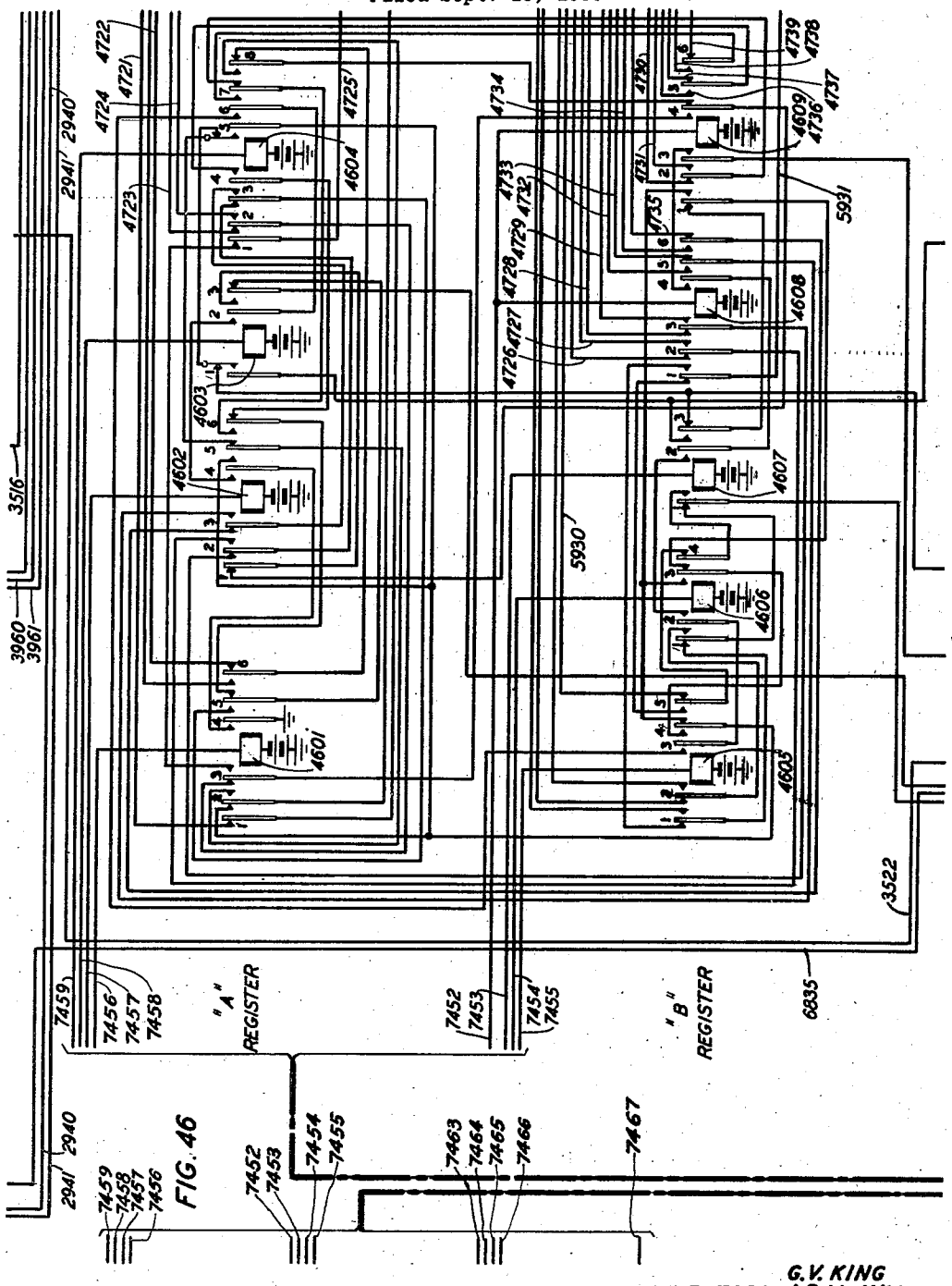

FIG. 46

INVENTORS: G. V. KING, J. B. MCKIM, O. MYERS

BY M. F. McKinney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 47

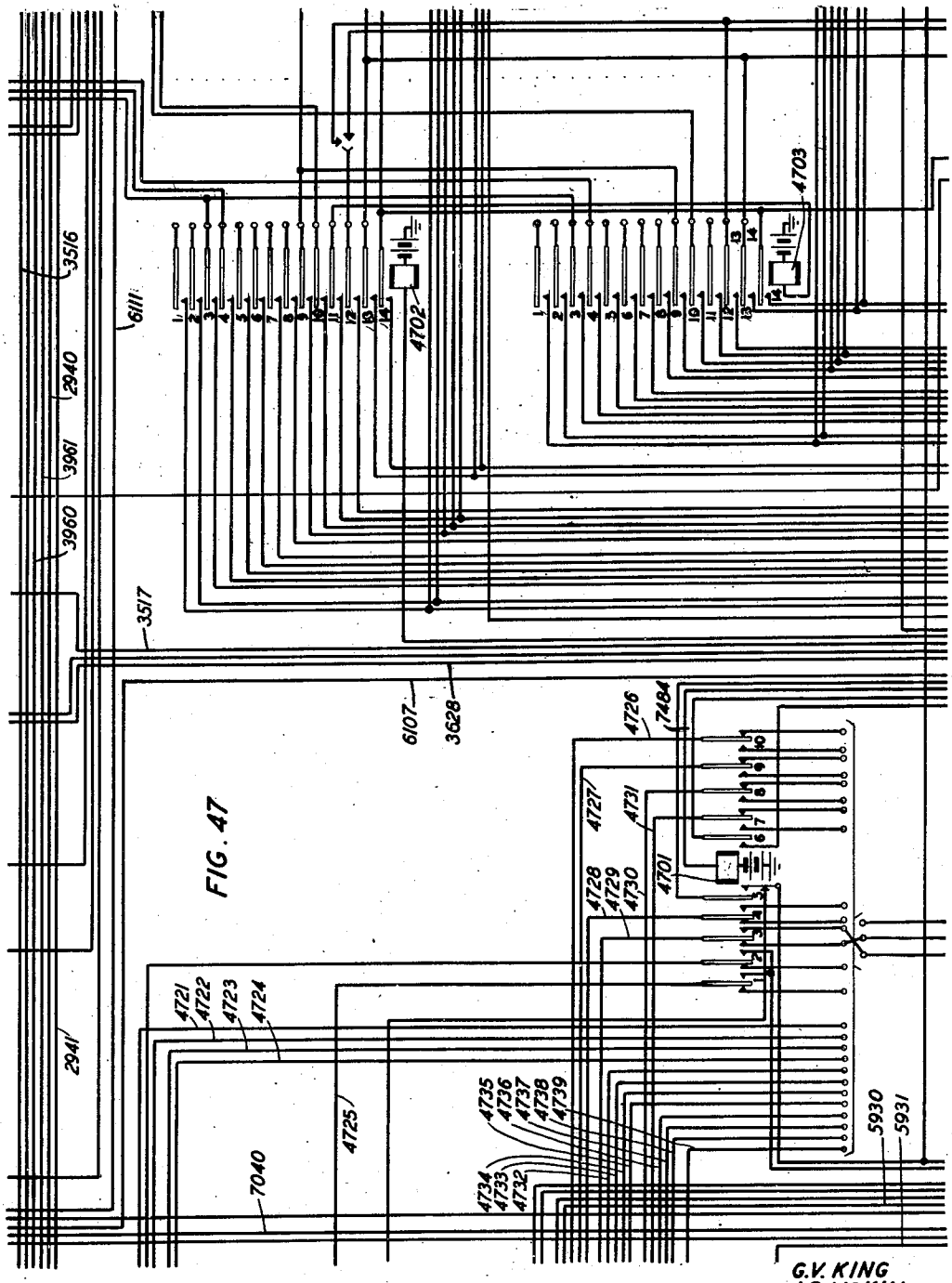

FIG. 47

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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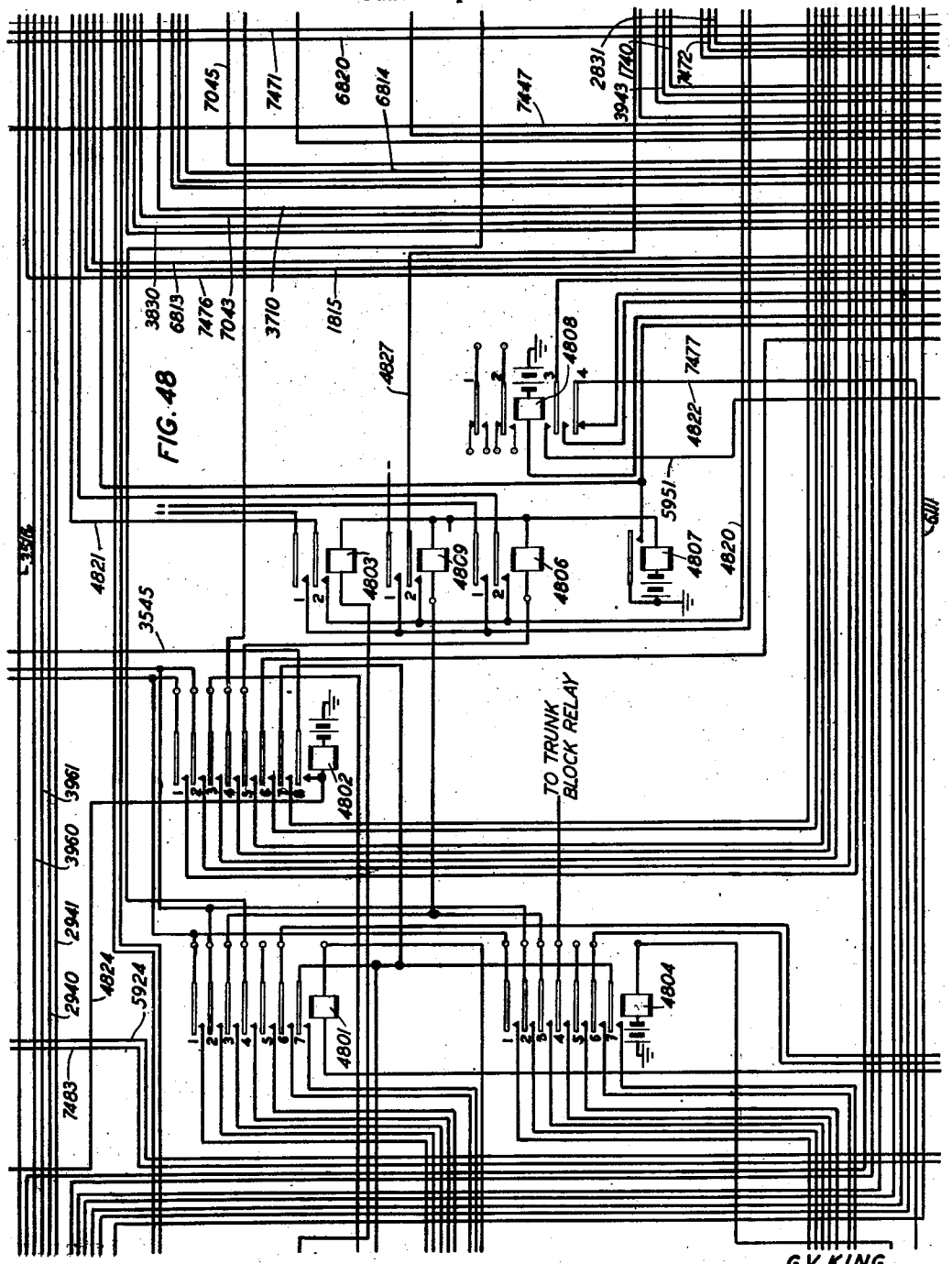

FIG. 48

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. T. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 49

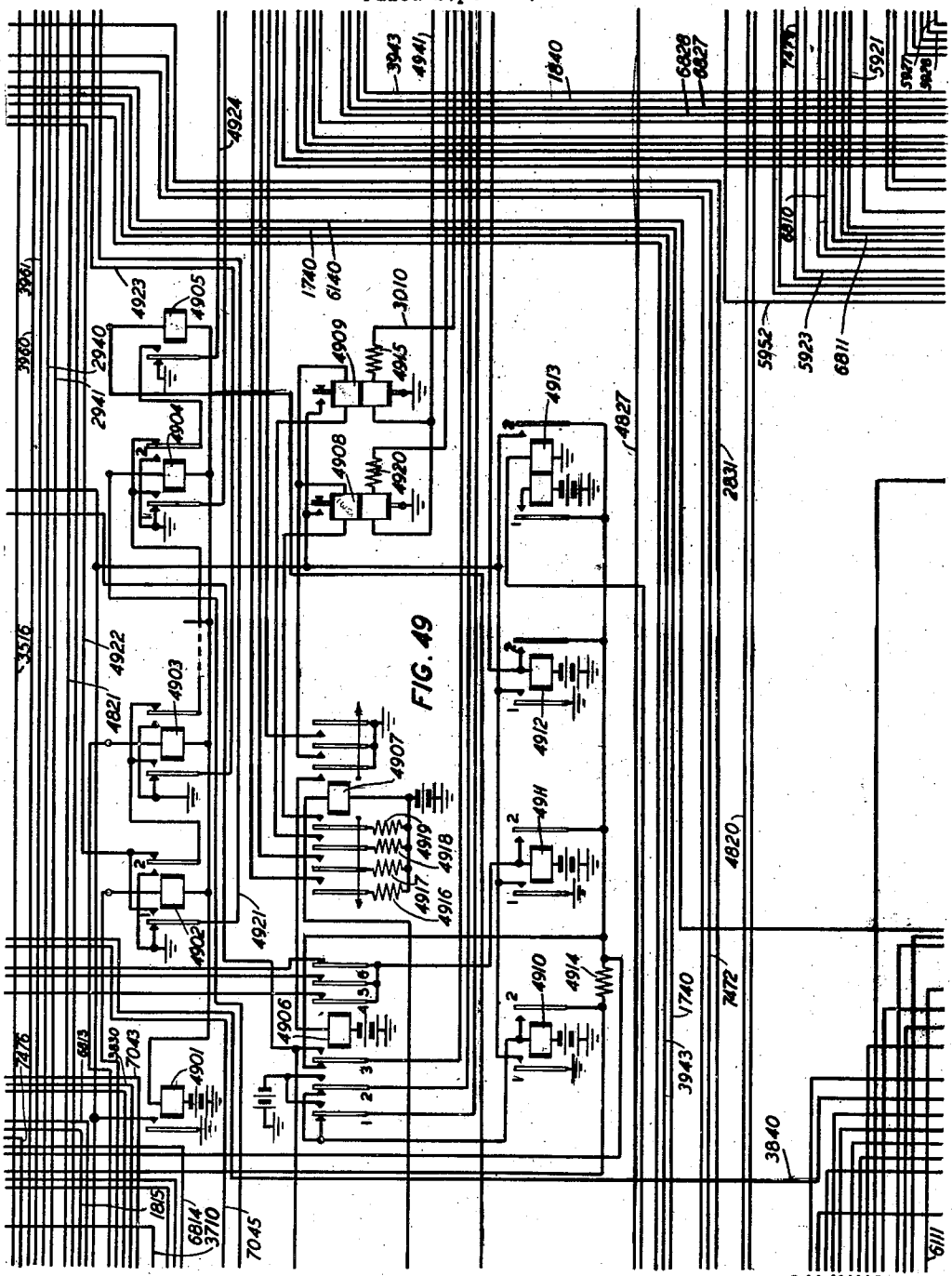

FIG. 49

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. F. McKenney

ATTORNEY

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TELEPHONE SYSTEM

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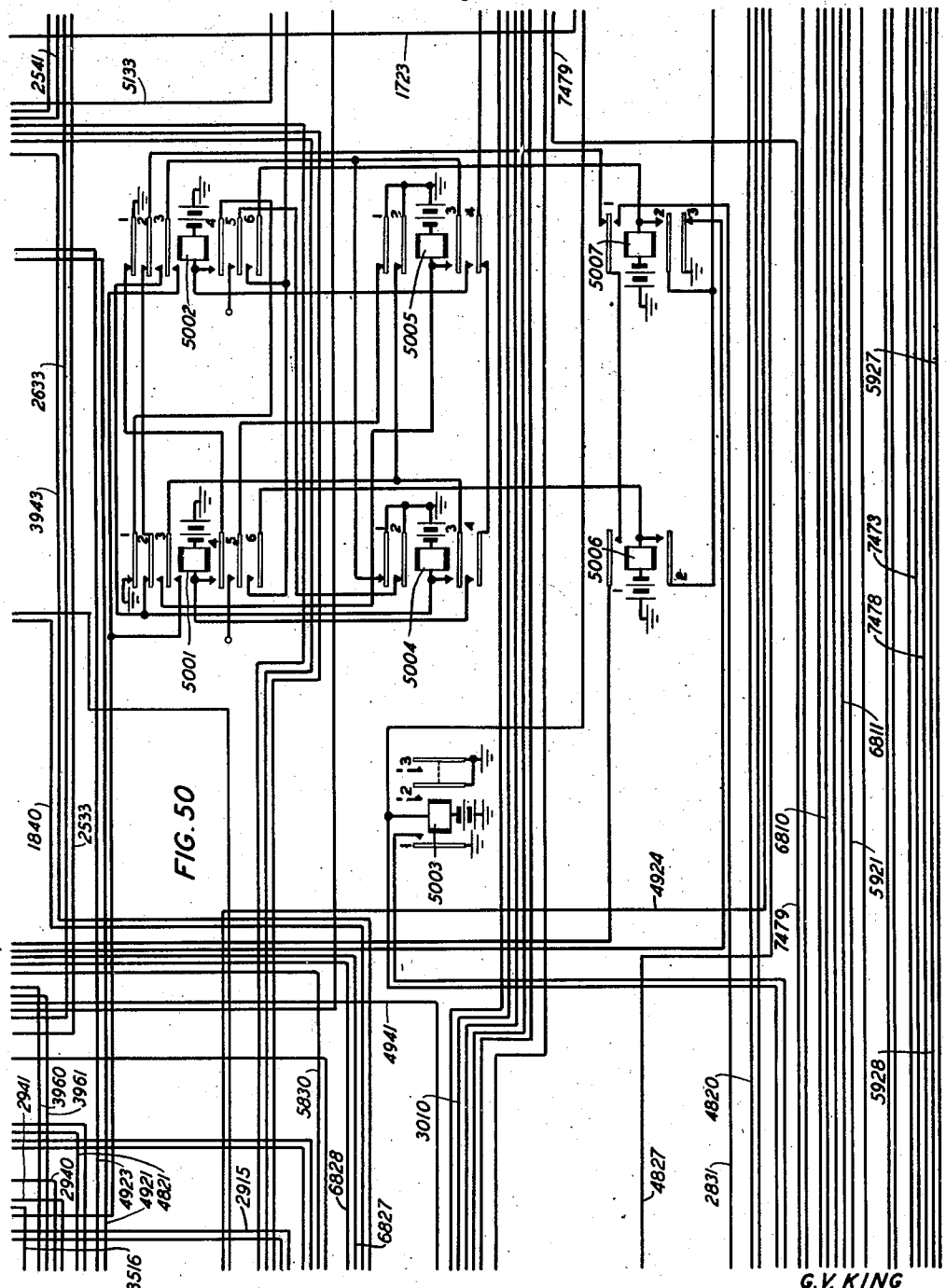


INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 51

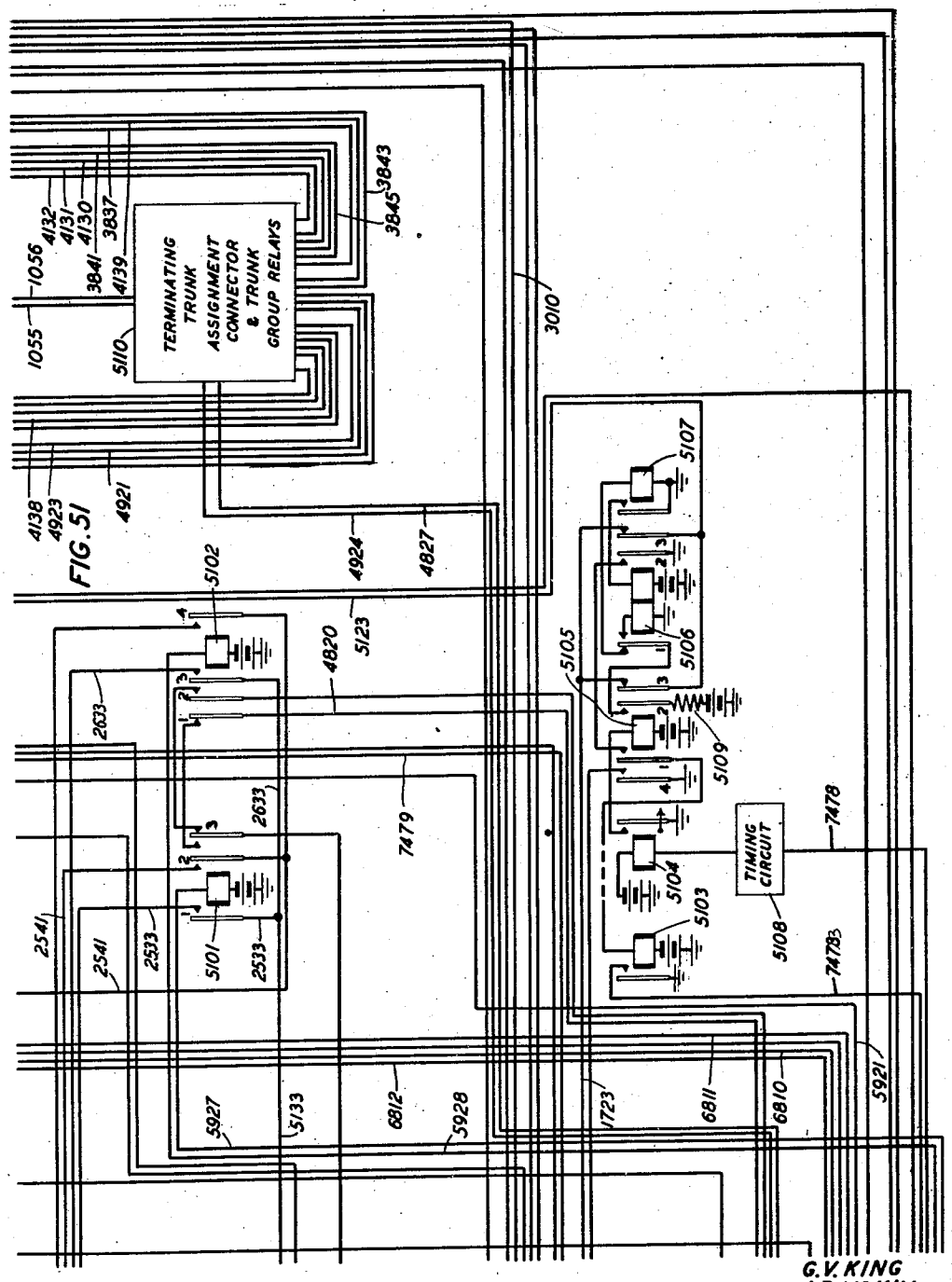


FIG. 51

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. F. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 52

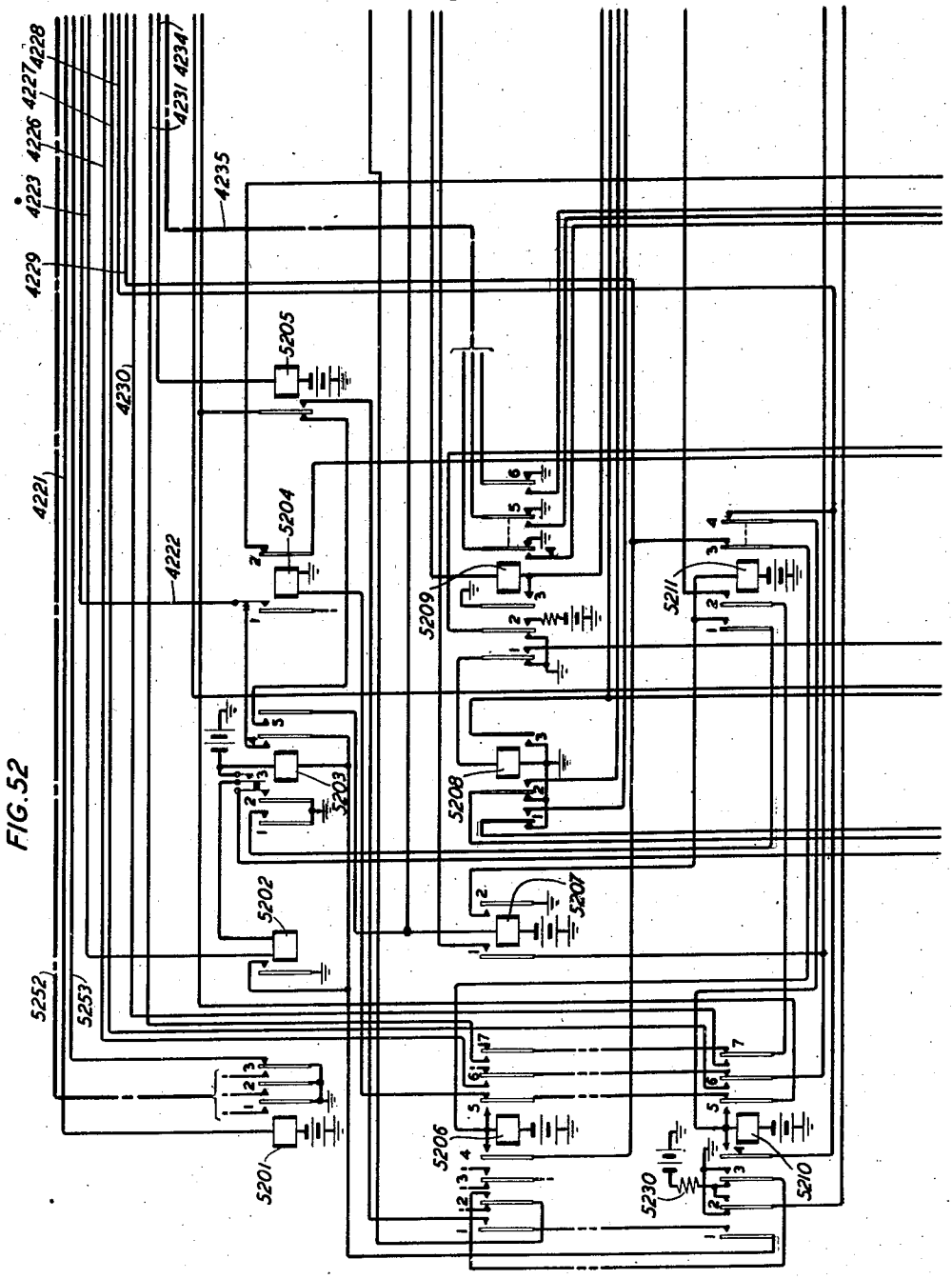


FIG. 52

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 53

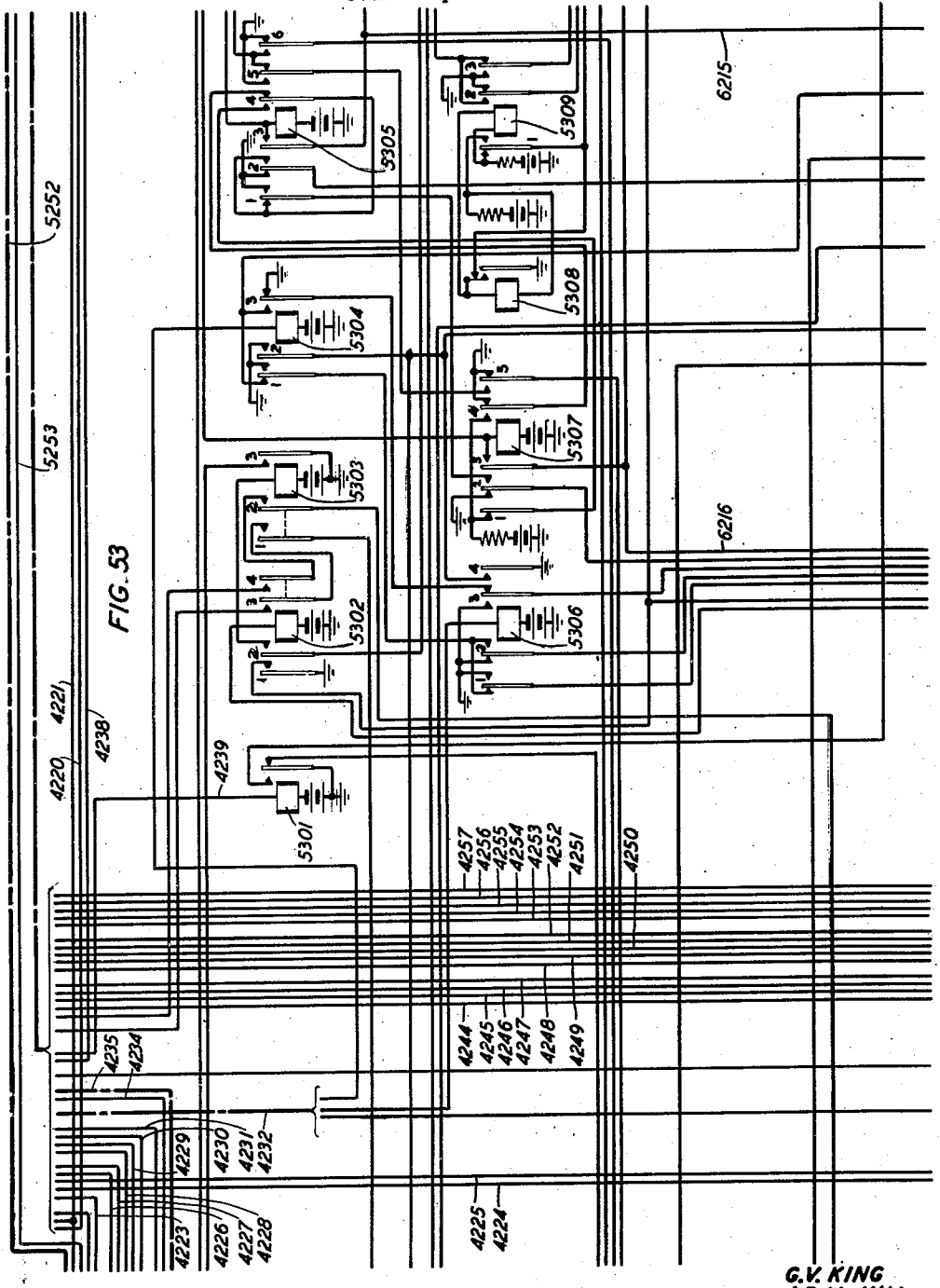


FIG. 53

INVENTORS: G.V. KING
J.B. McKIM
O. MYERS

BY W. T. McGenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 54

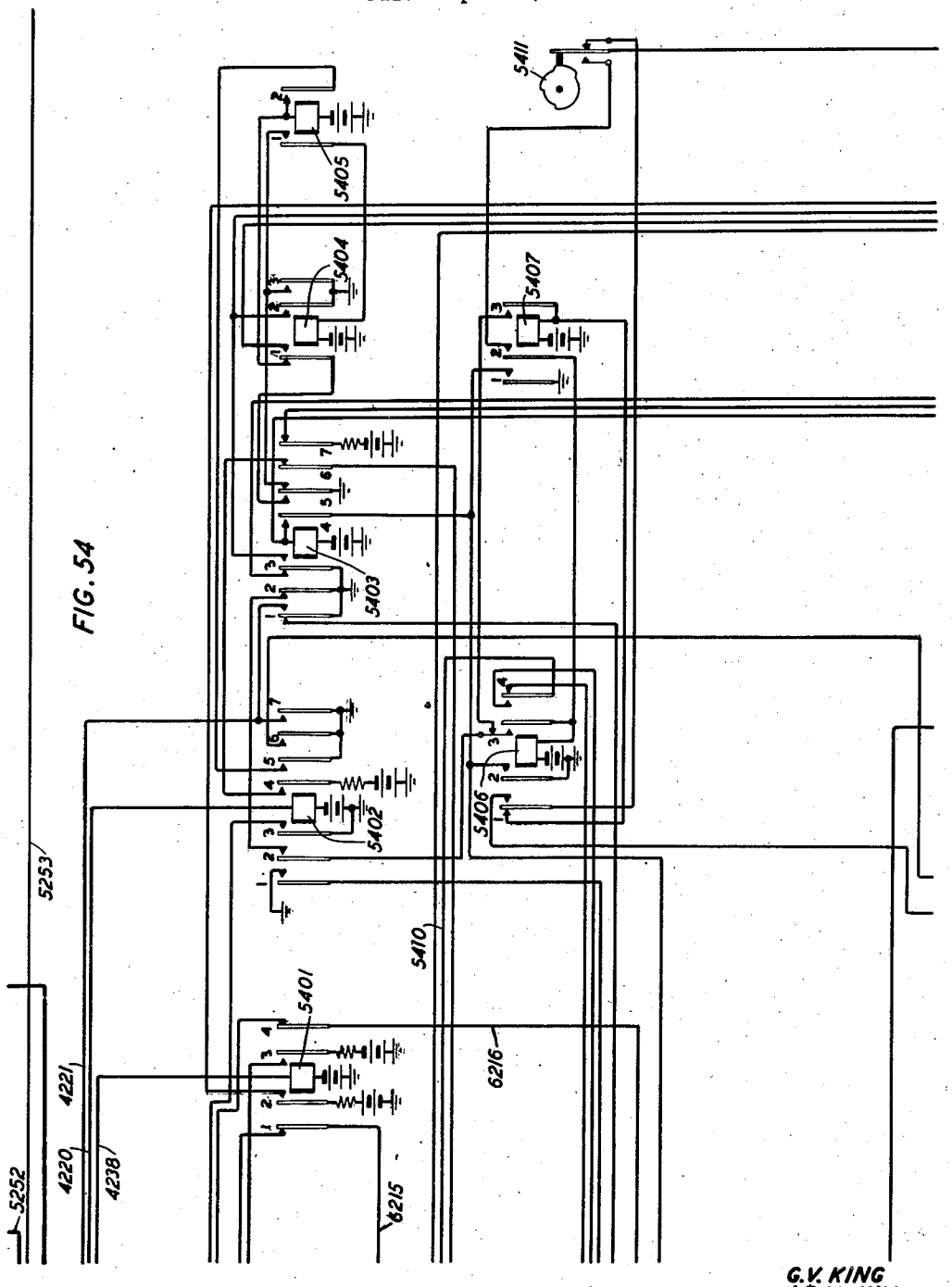


FIG. 54

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. R. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 55

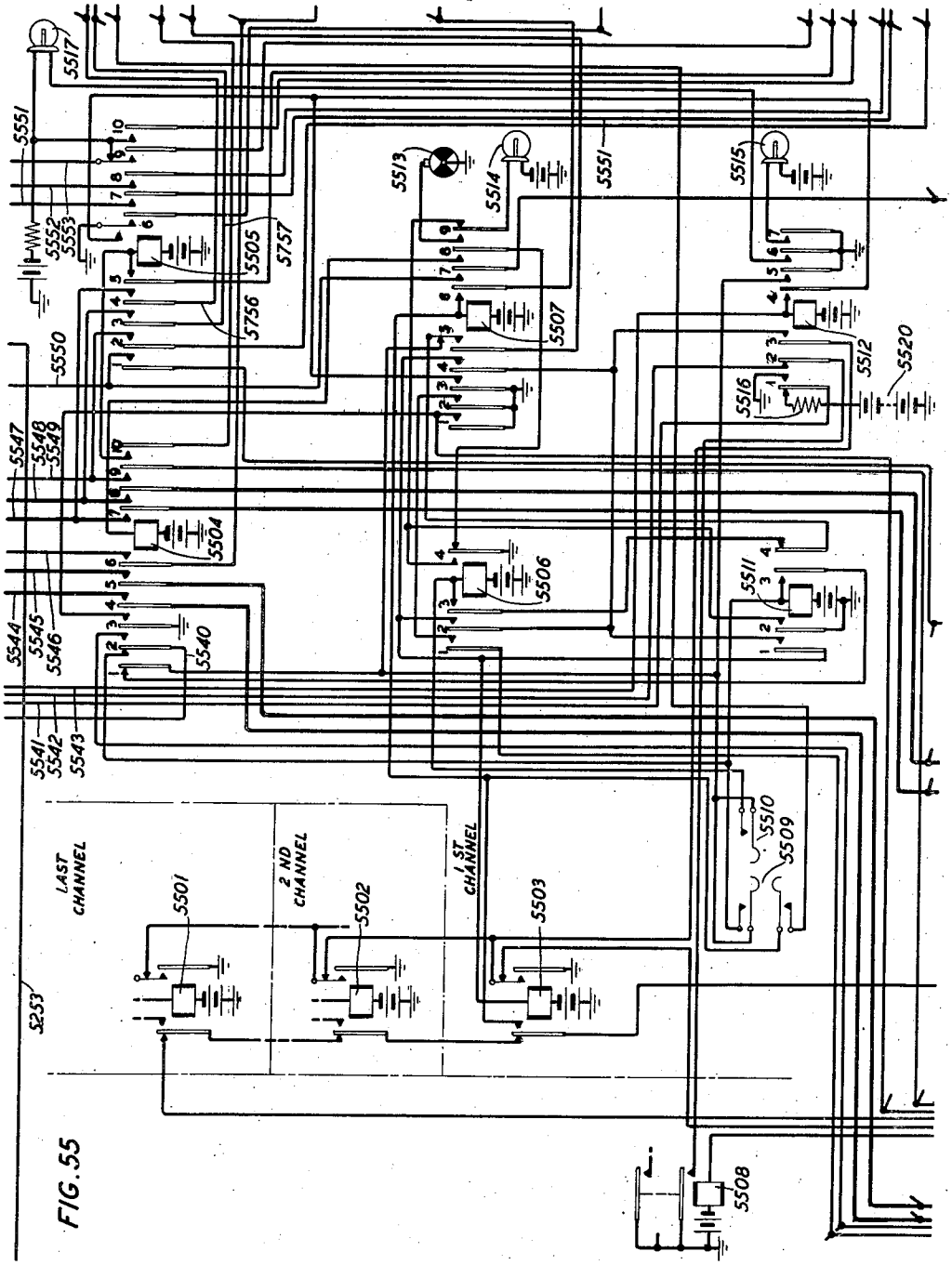


FIG. 55

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.T. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 56

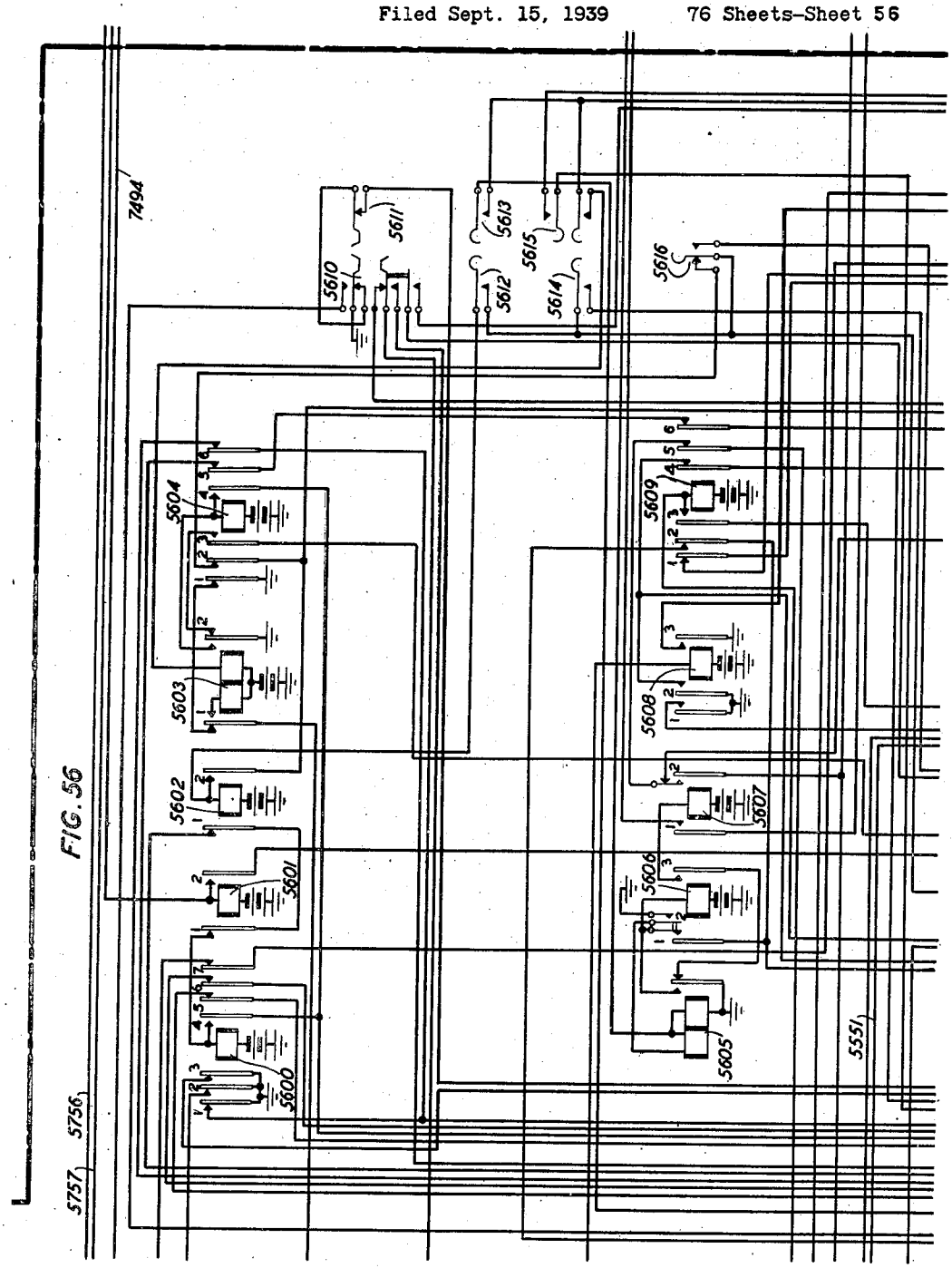


FIG. 56

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY W.A. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 57

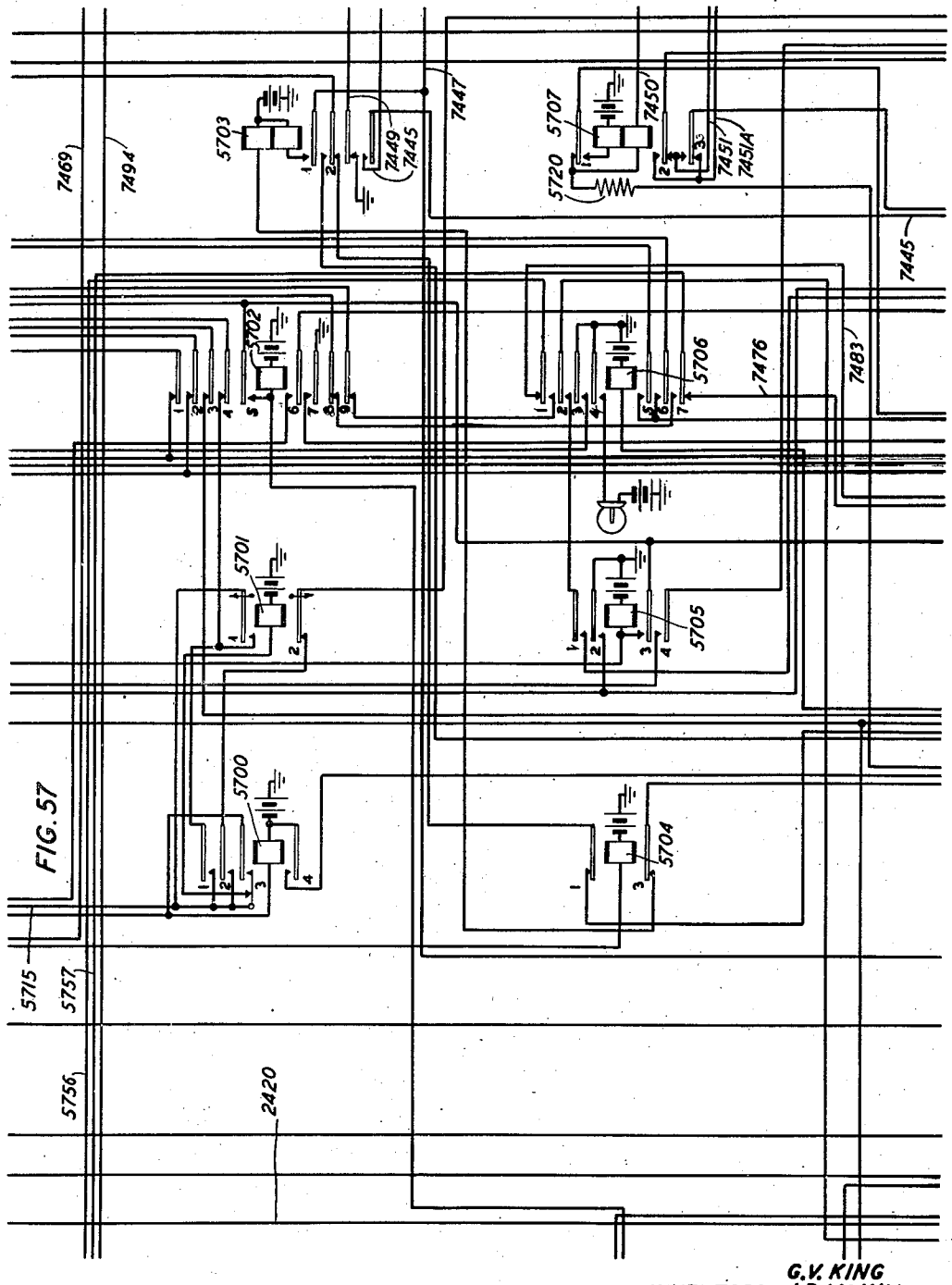


FIG. 57

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY W.T. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 58

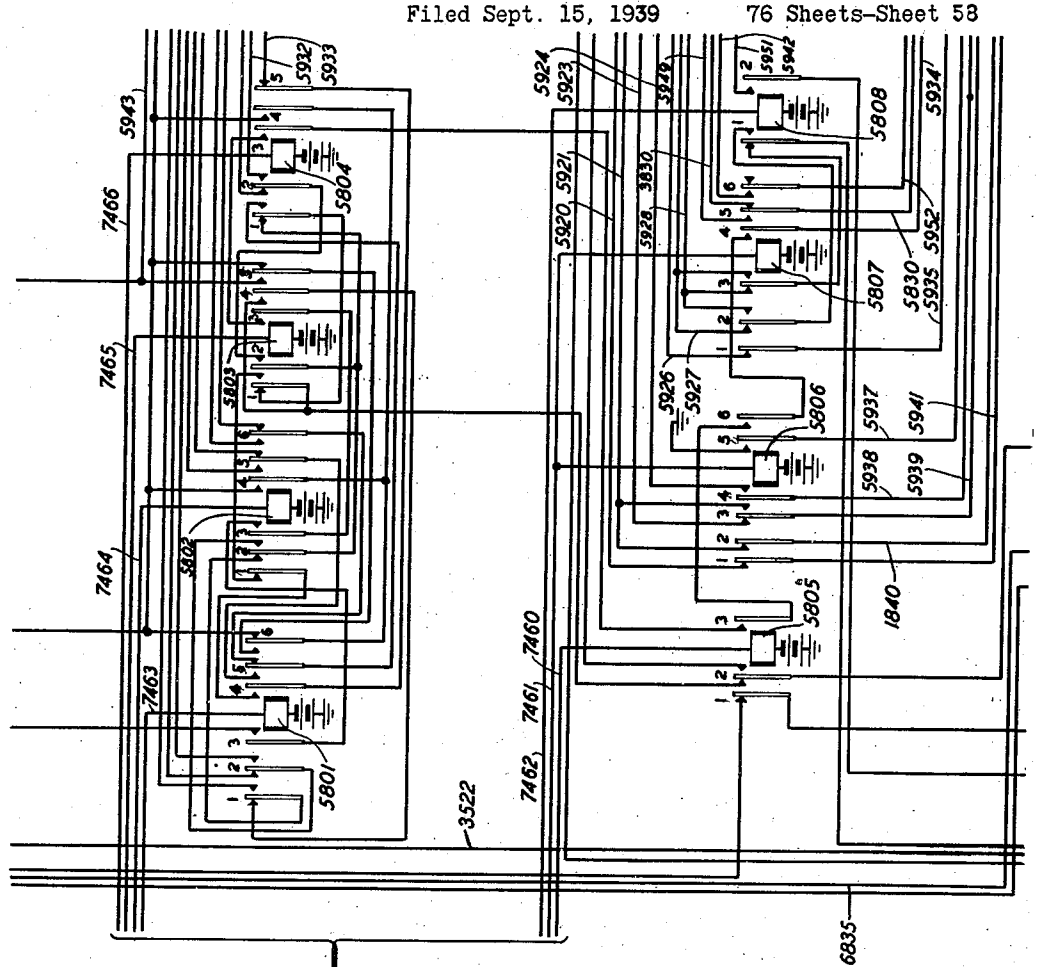
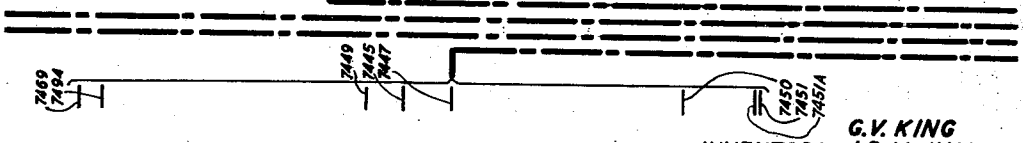


FIG. 58

"C" REGISTER



INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY M. T. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 59

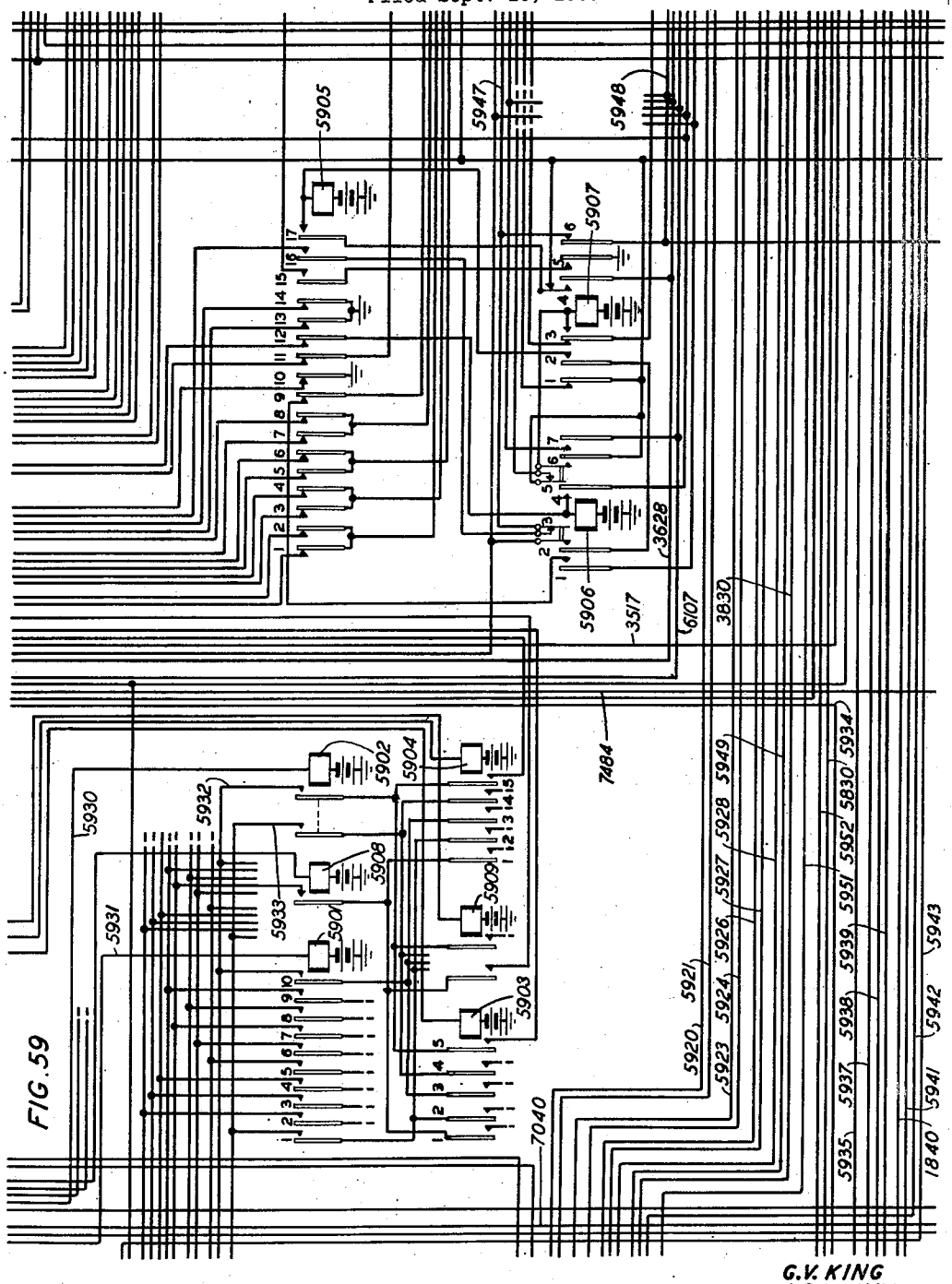

FIG. 59

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 60

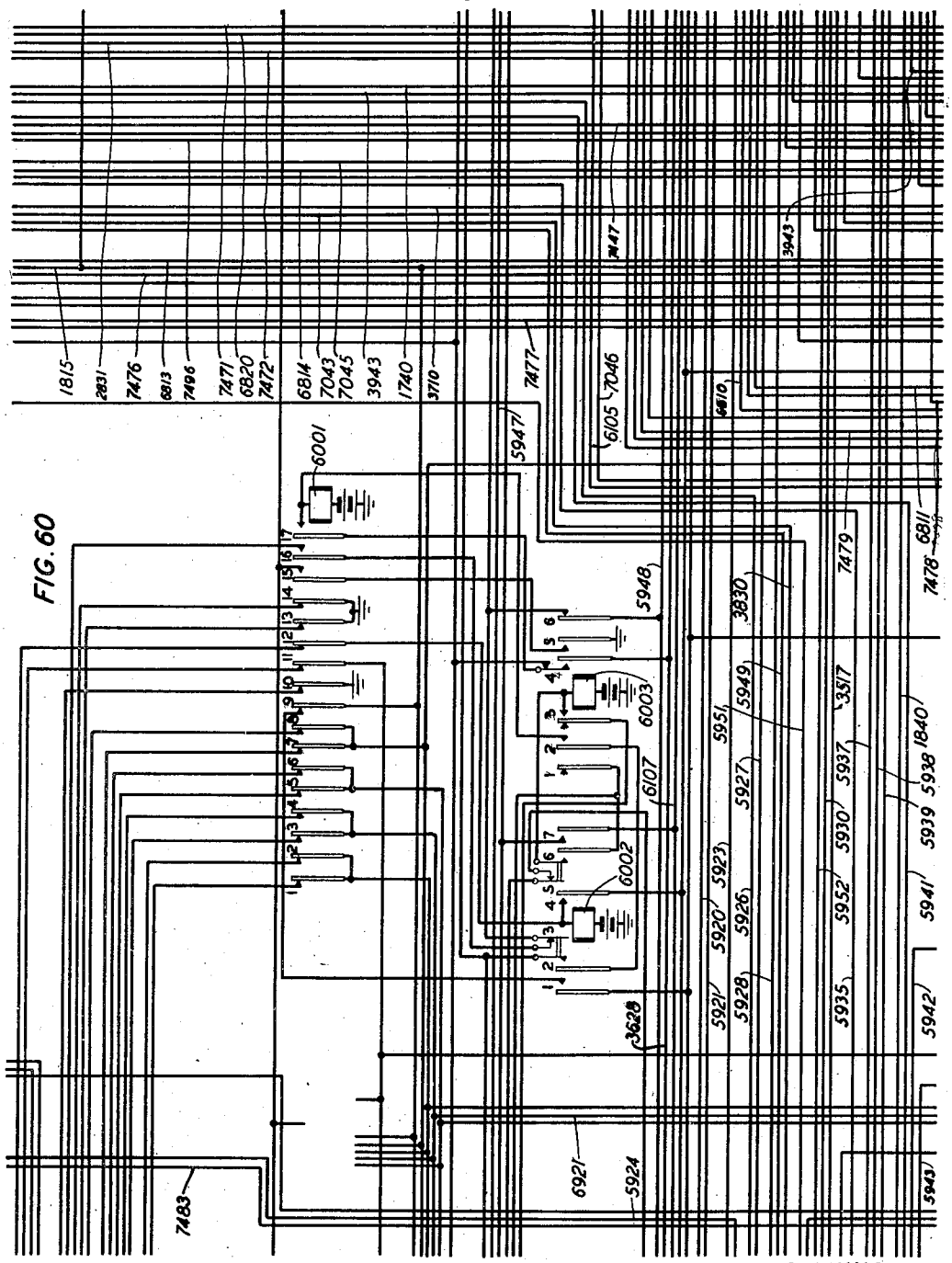

FIG. 60

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY Chas. R. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 61

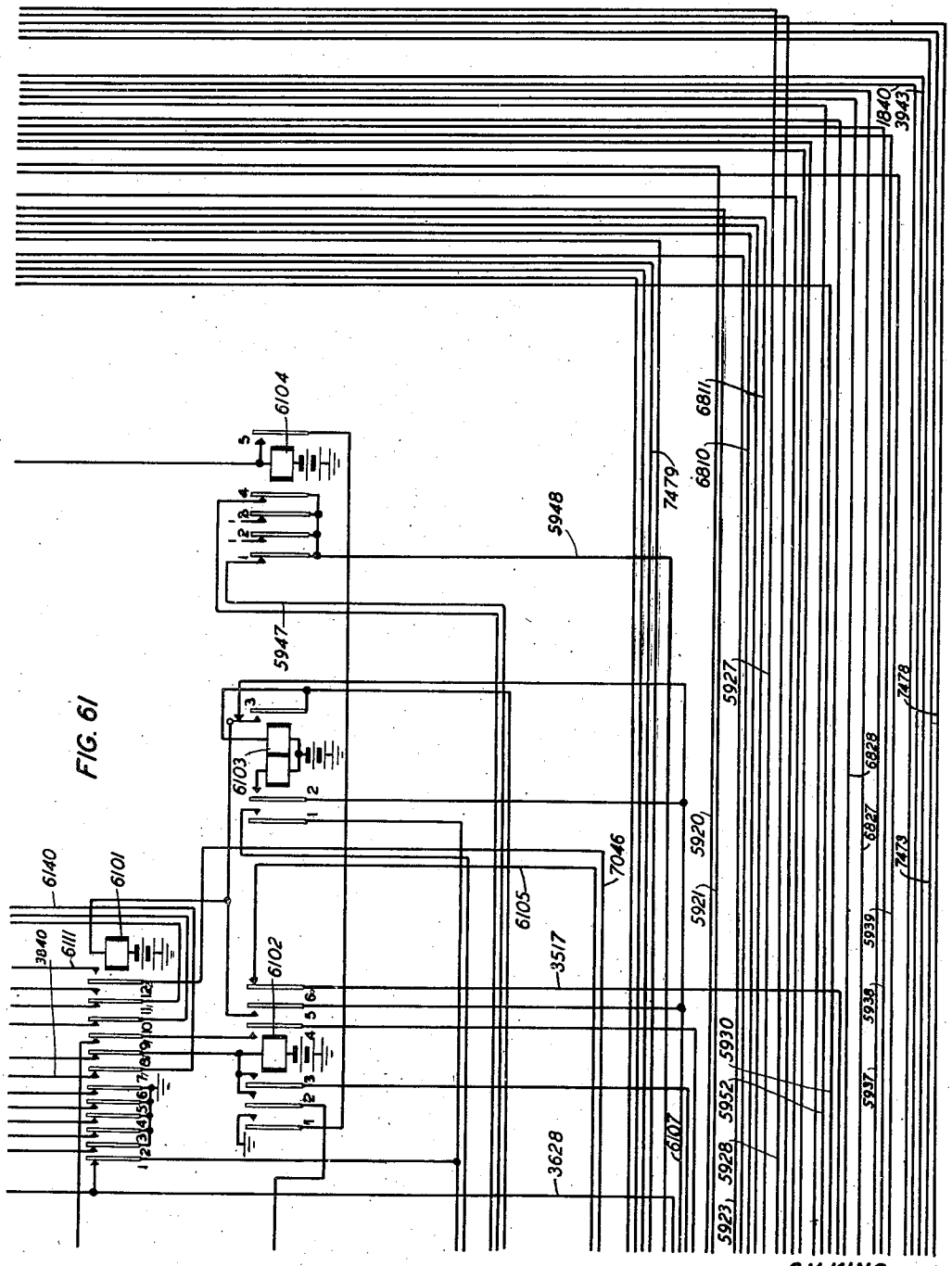

FIG. 61

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.P. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 62

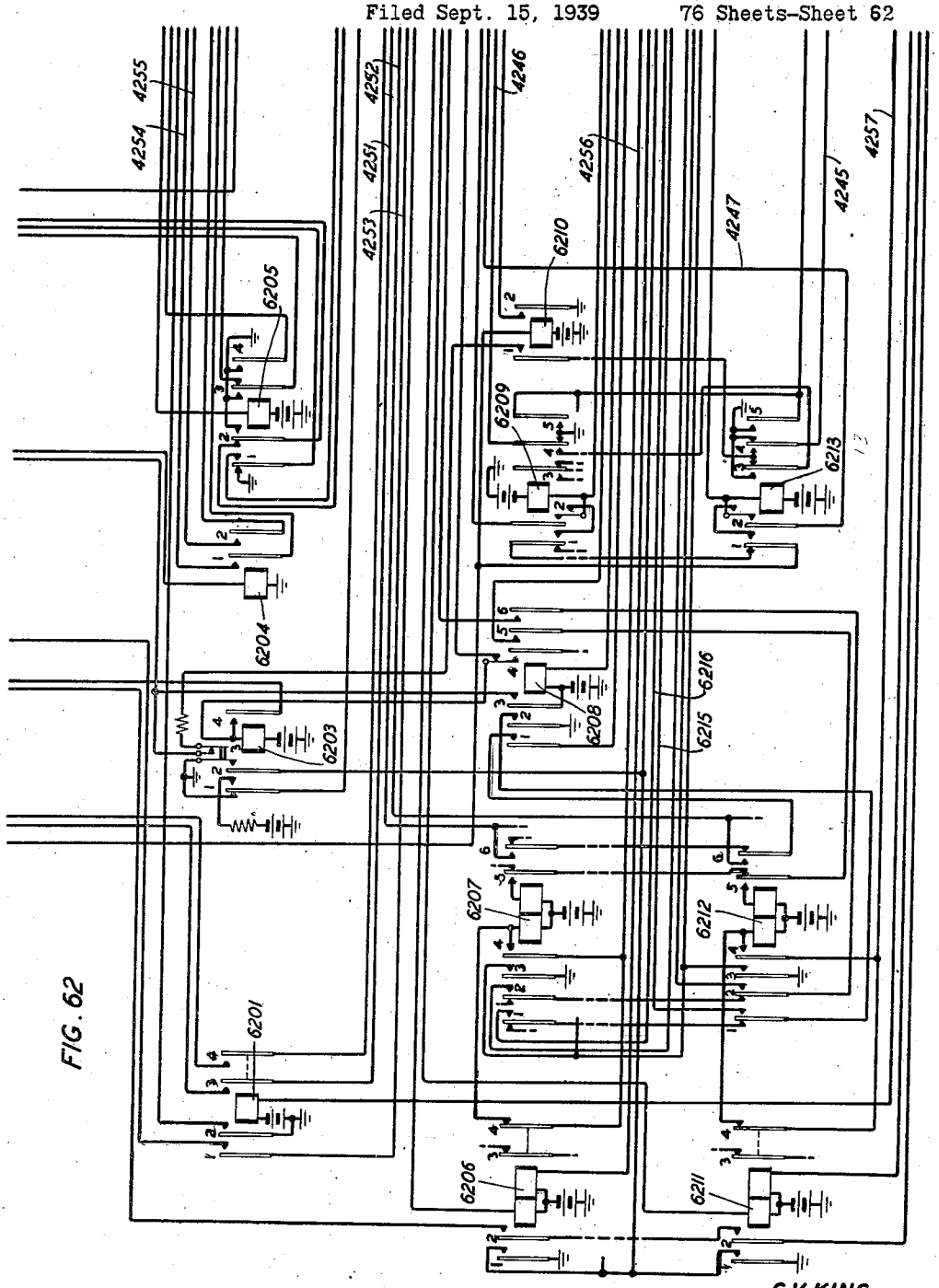

FIG. 62

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY W. F. McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 63

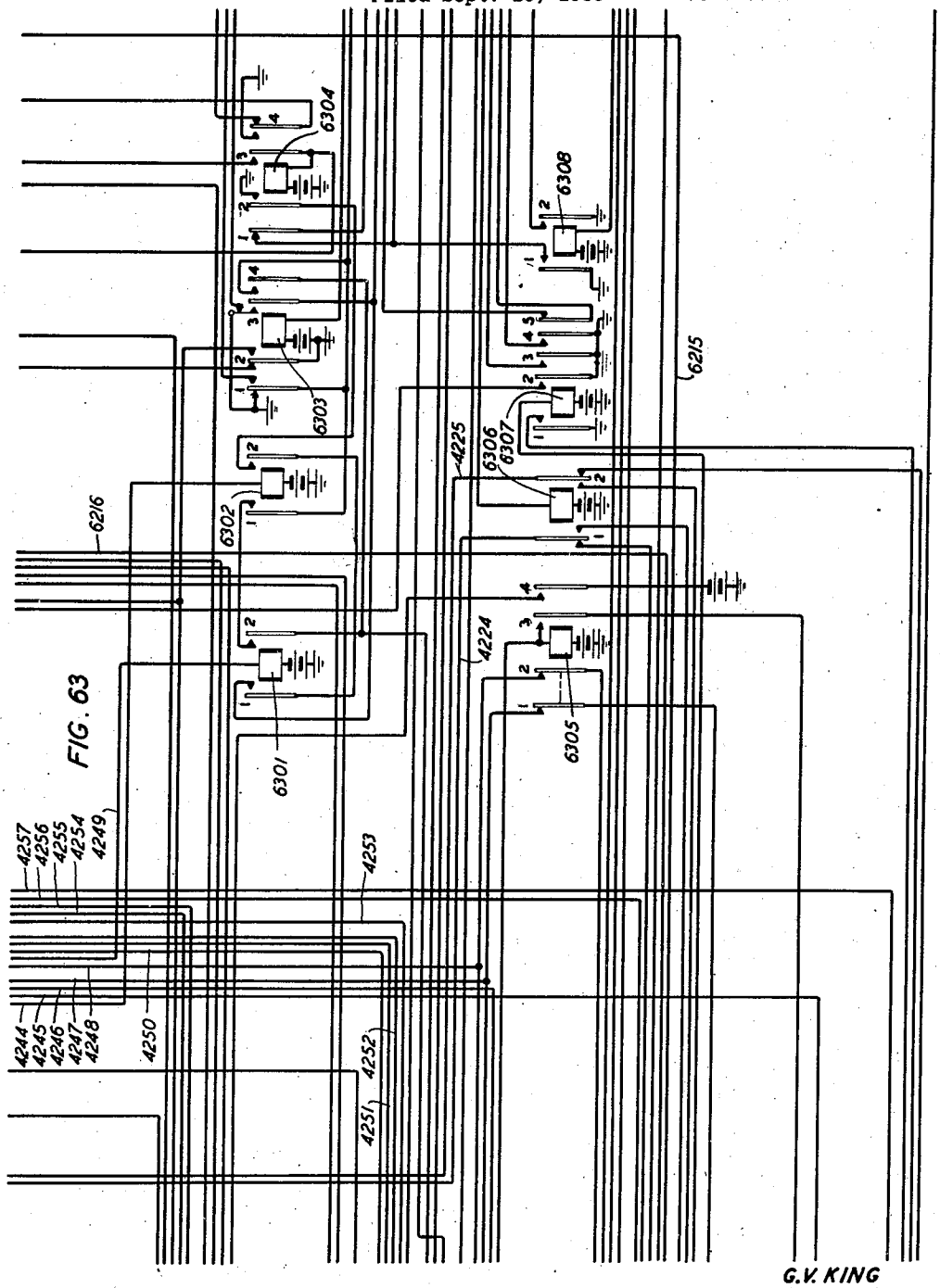

FIG. 63

INVENTORS: G.V. KING
J.B.MCKIM
O.MYERS

BY Wm. McKenney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 64

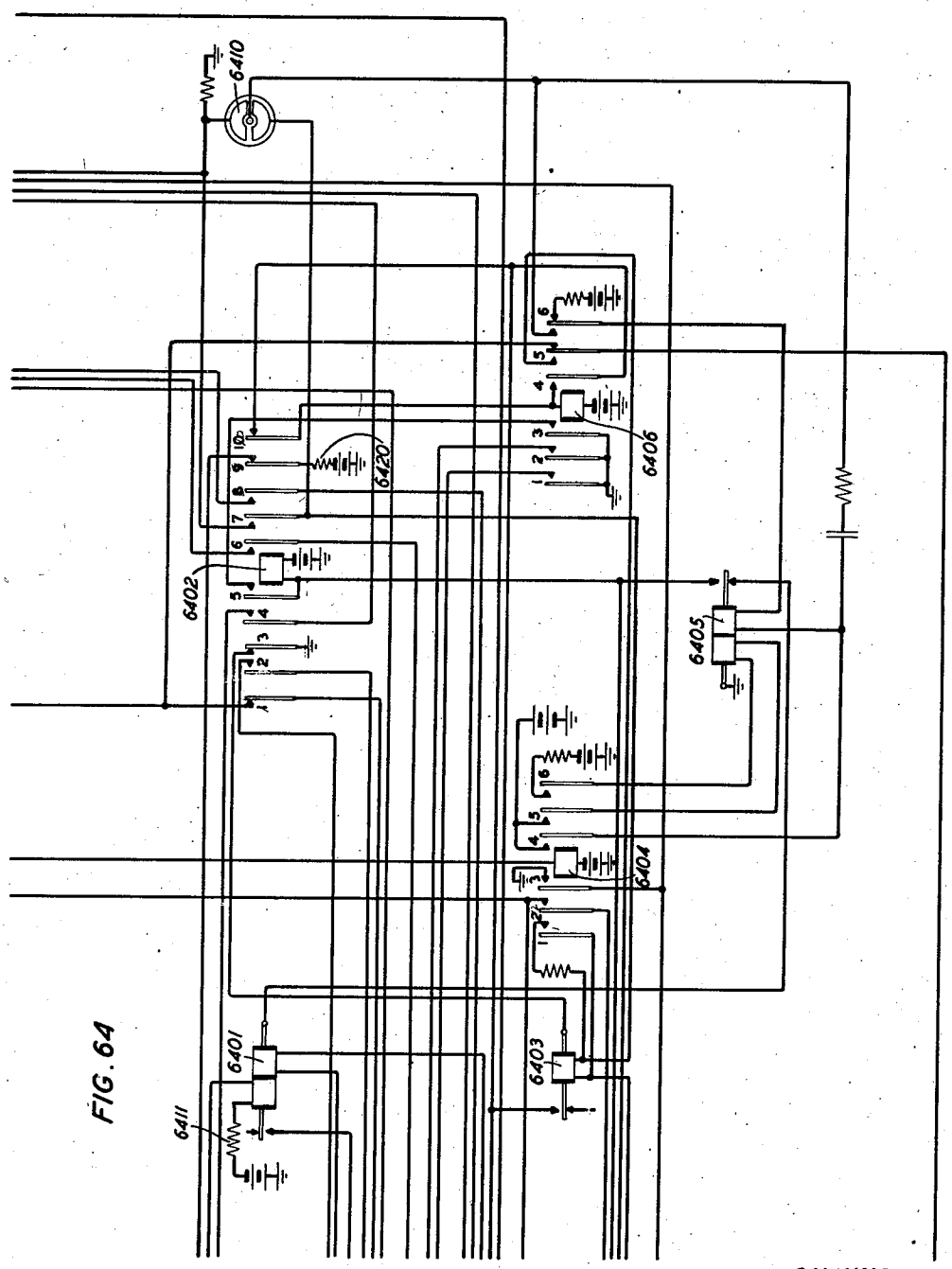

FIG. 64

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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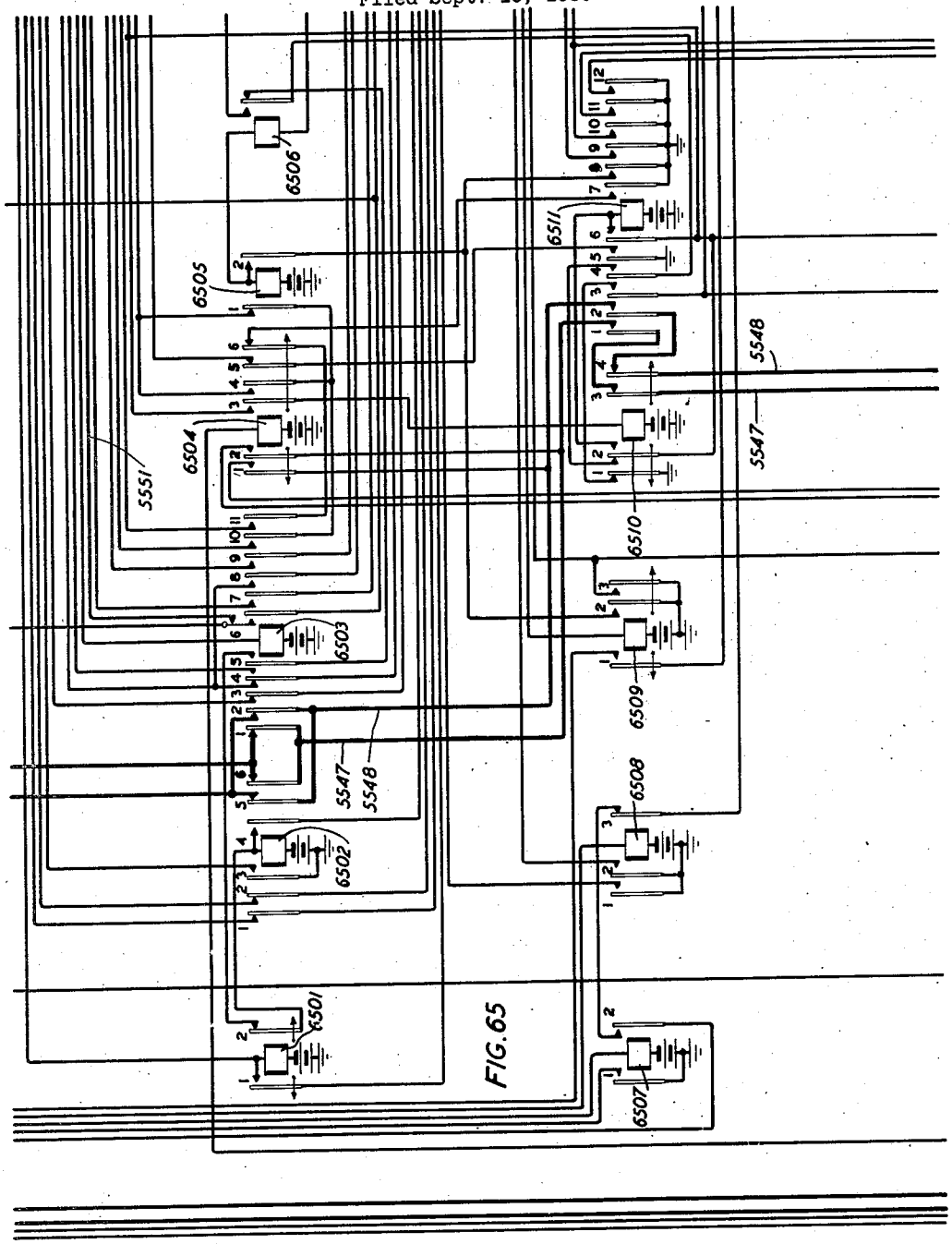

FIG. 65

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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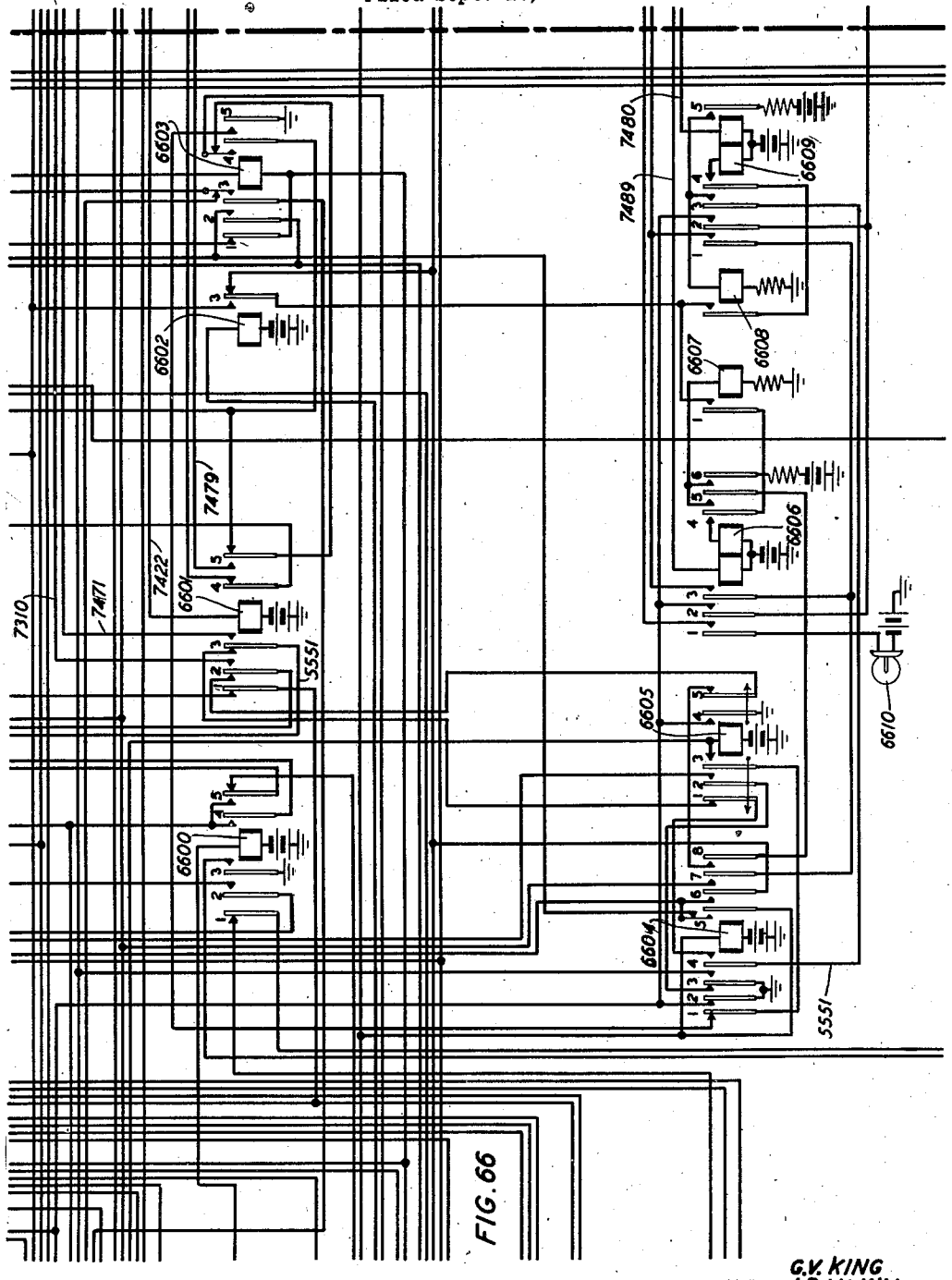

FIG. 66

INVENTORS: G.V. KING
J.B.MCKIM
O.MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 67

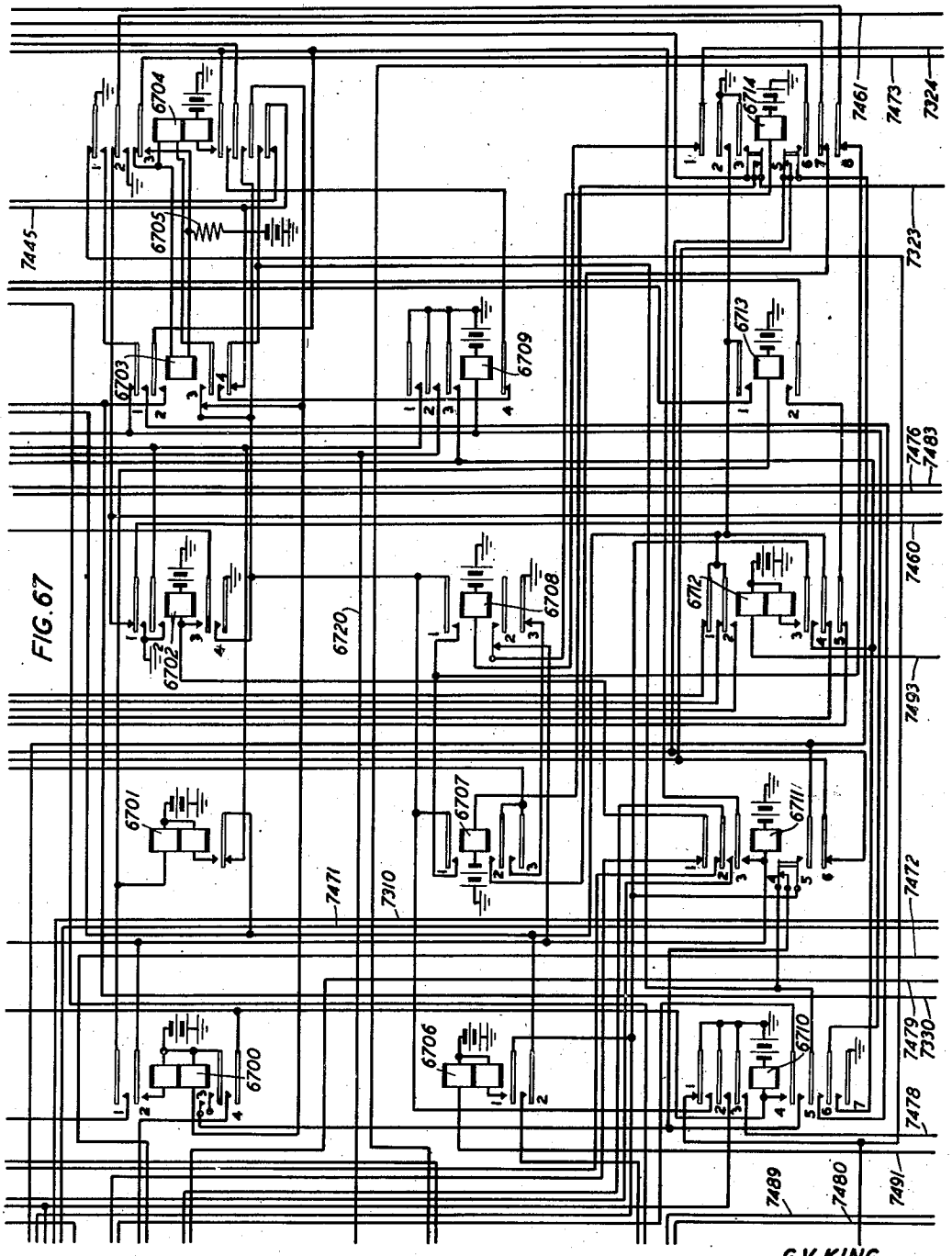

FIG. 67

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY M.F. McInerney

ATTORNEY

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TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 68

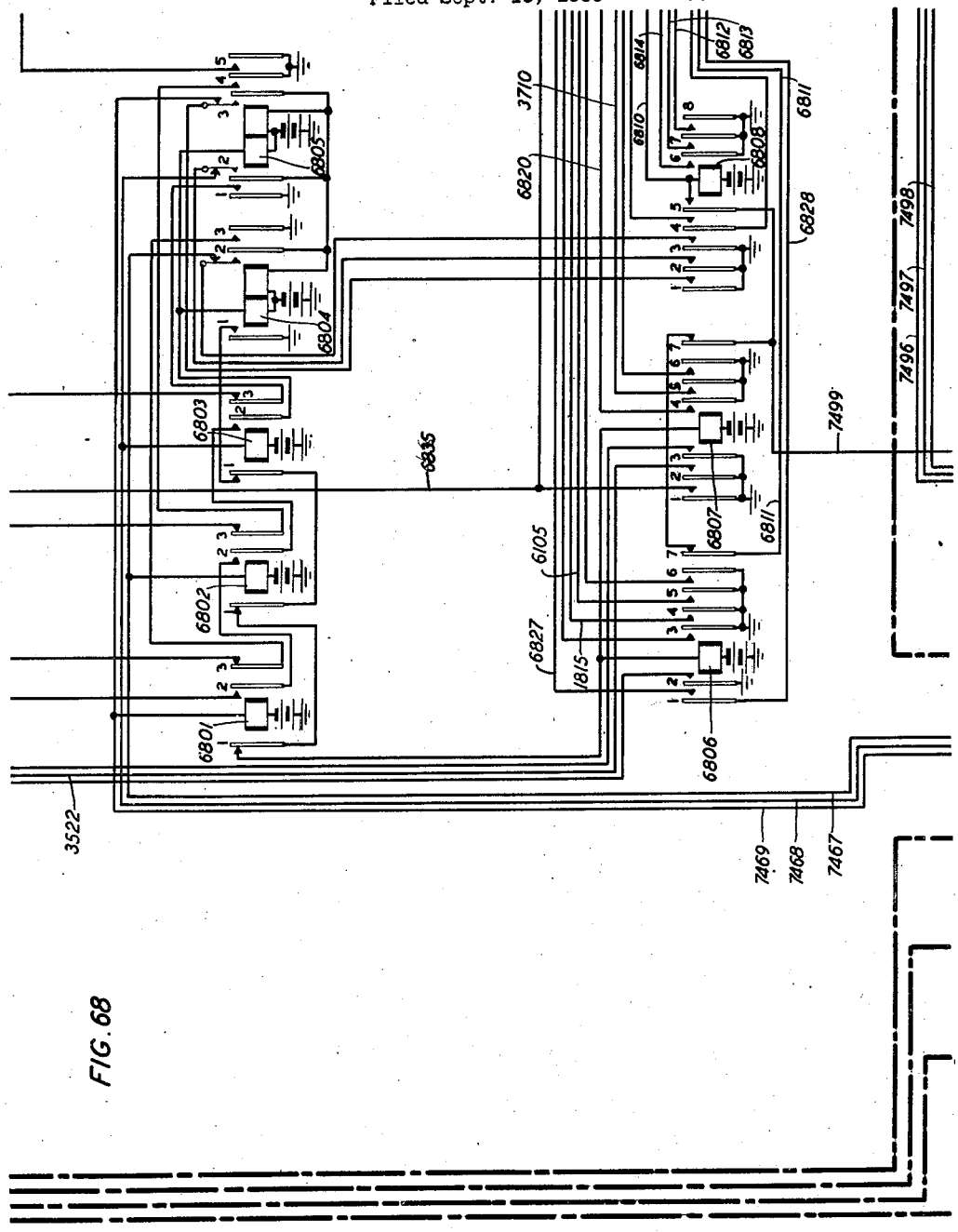

FIG. 68

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

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TELEPHONE SYSTEM

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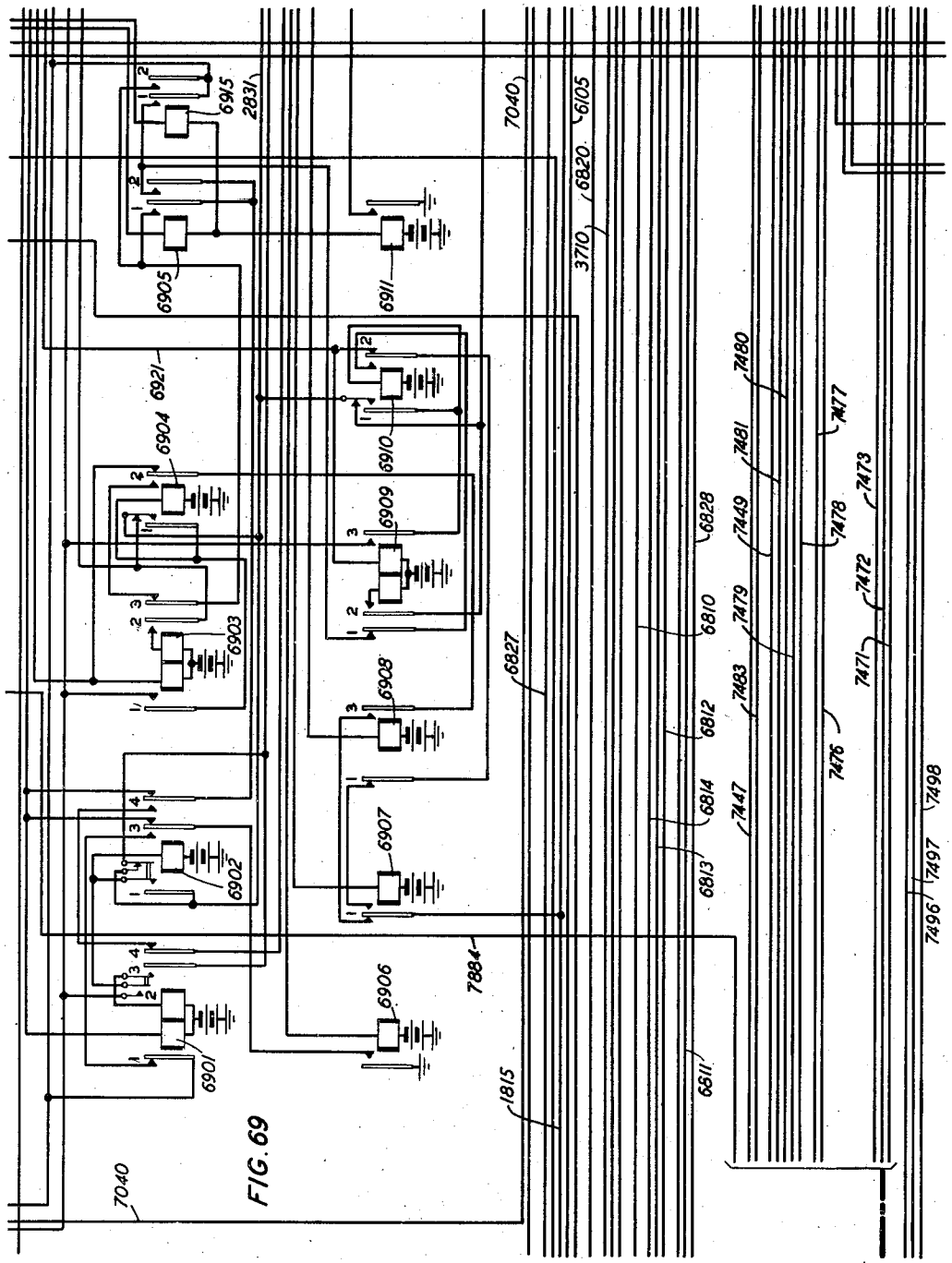

FIG. 69

INVENTORS: G.V. KING
J.B.MCKIM
O.MYERS

BY

ATTORNEY

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TELEPHONE SYSTEM

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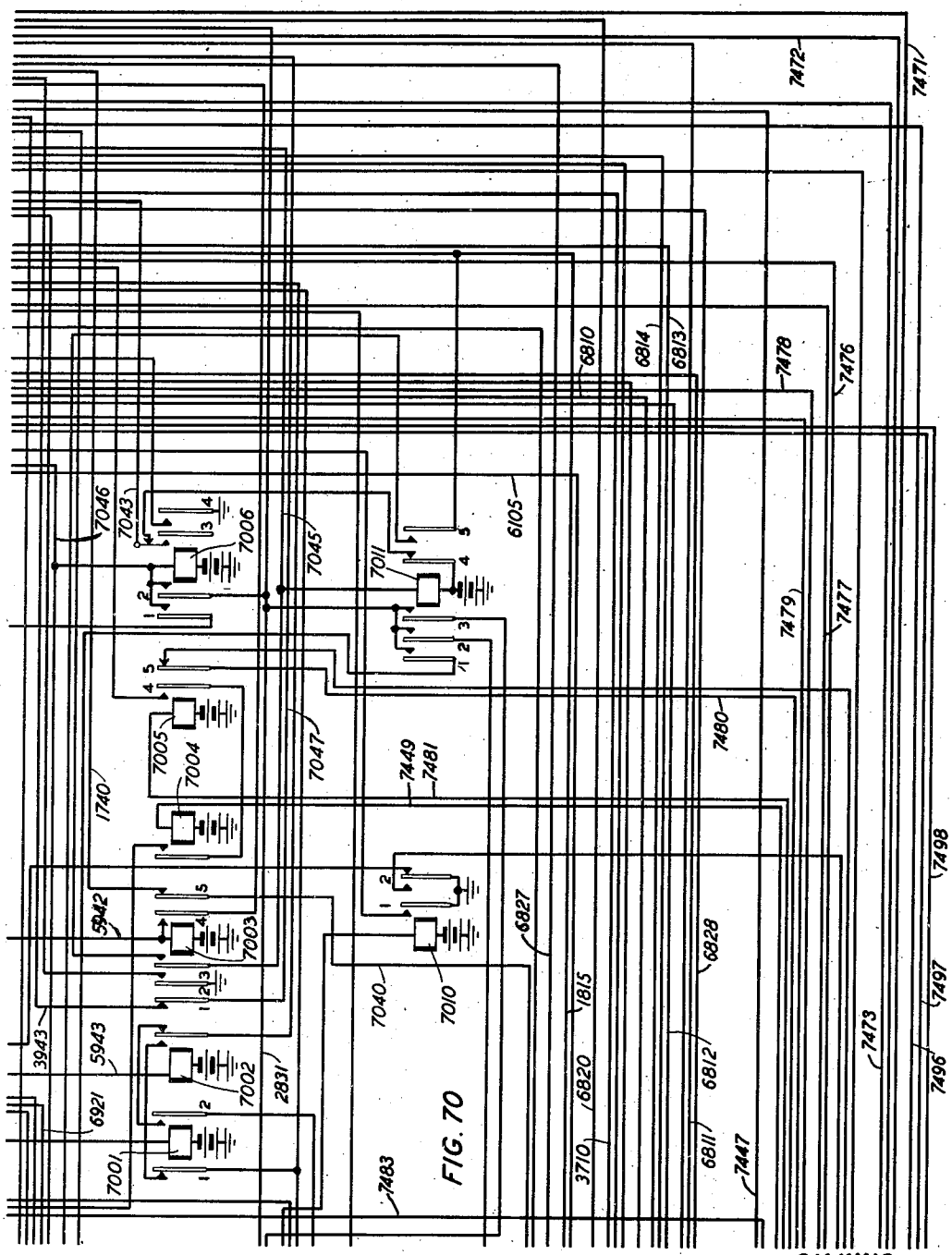

FIG. 70

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY W.T. McGarvey

ATTORNEY

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TELEPHONE SYSTEM

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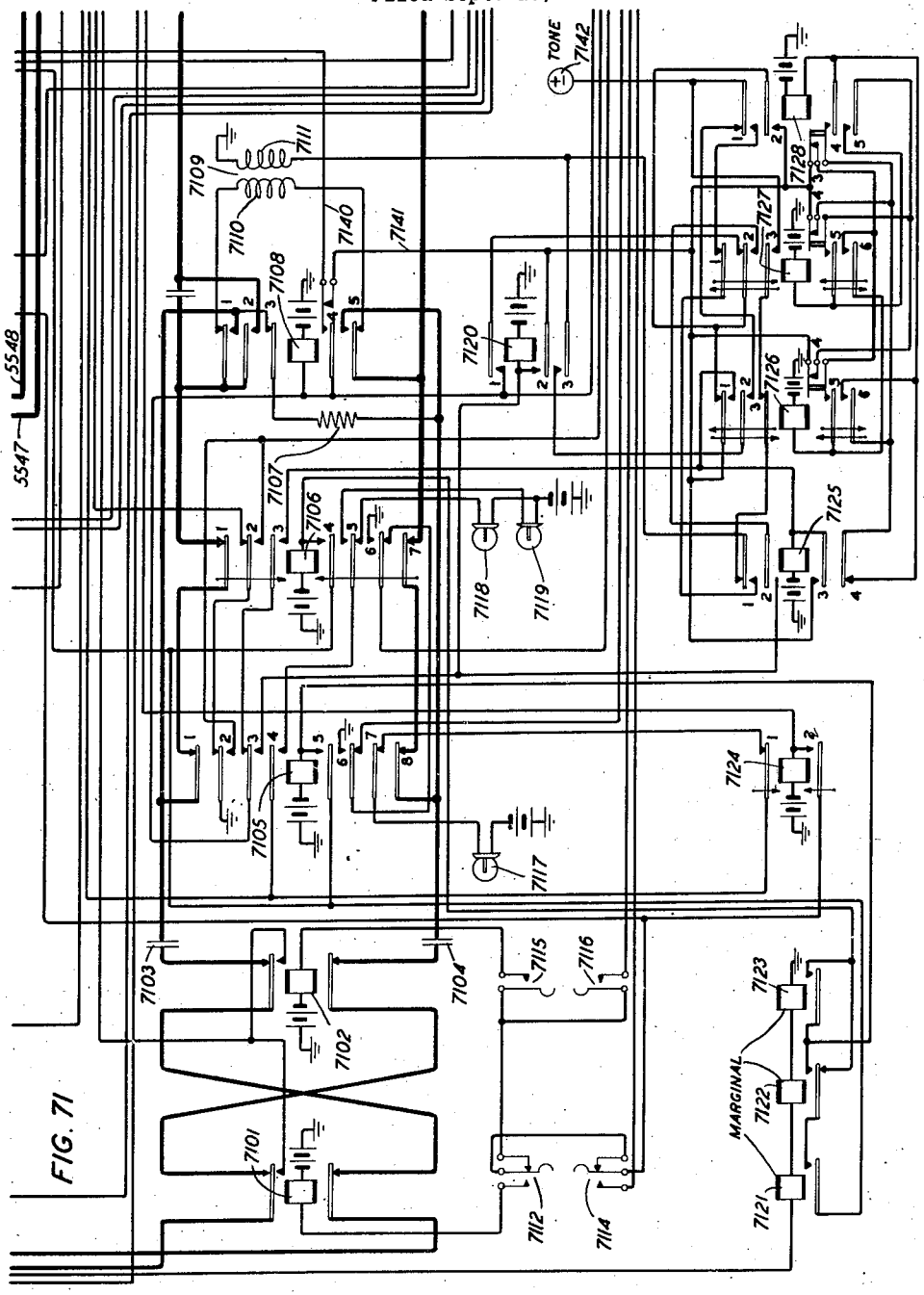

FIG. 71

INVENTORS: G.V. KING
J.B.MCKIM
O.MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 72

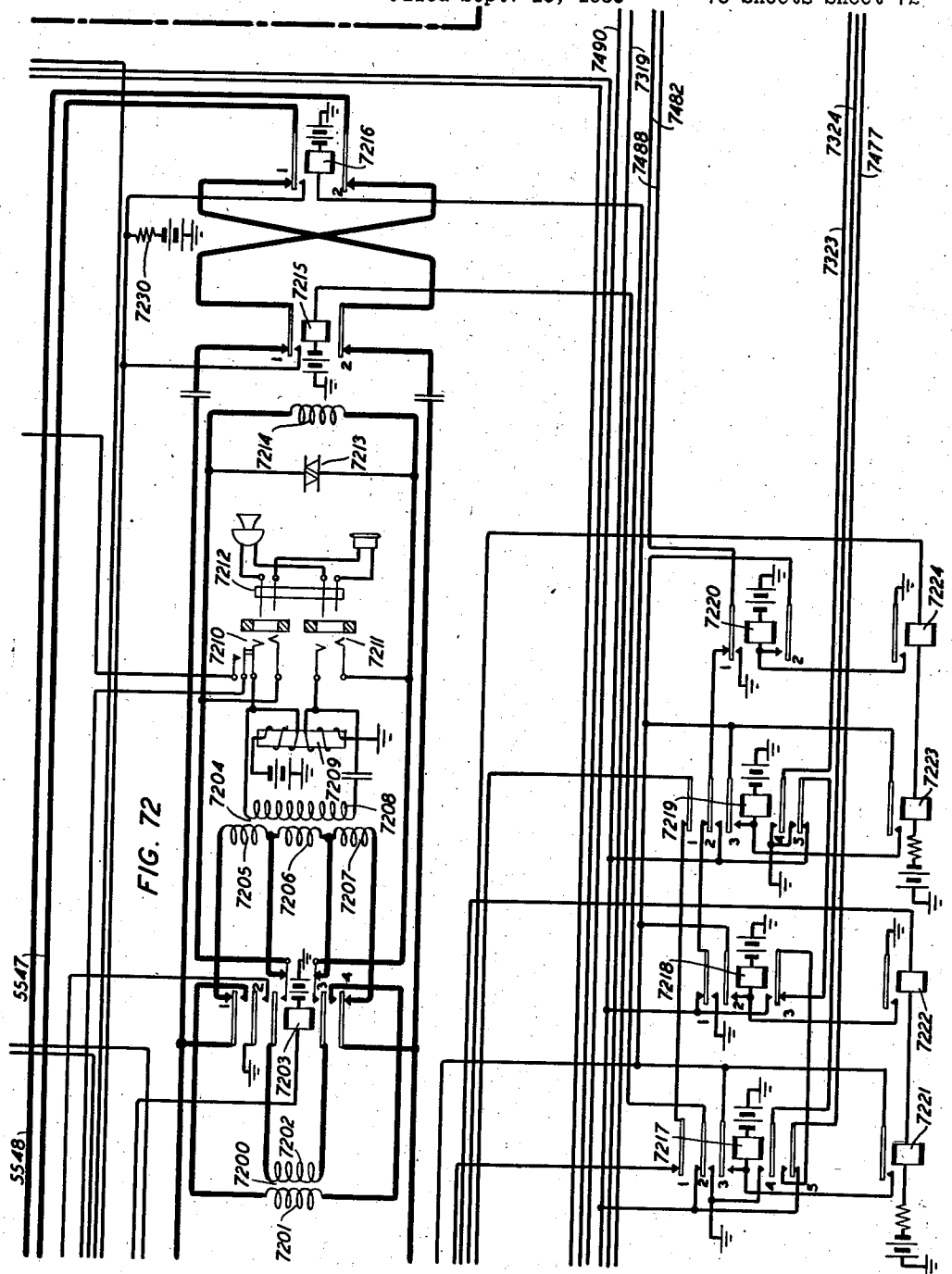

FIG. 72

INVENTORS: G.V. KING
J.B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 73

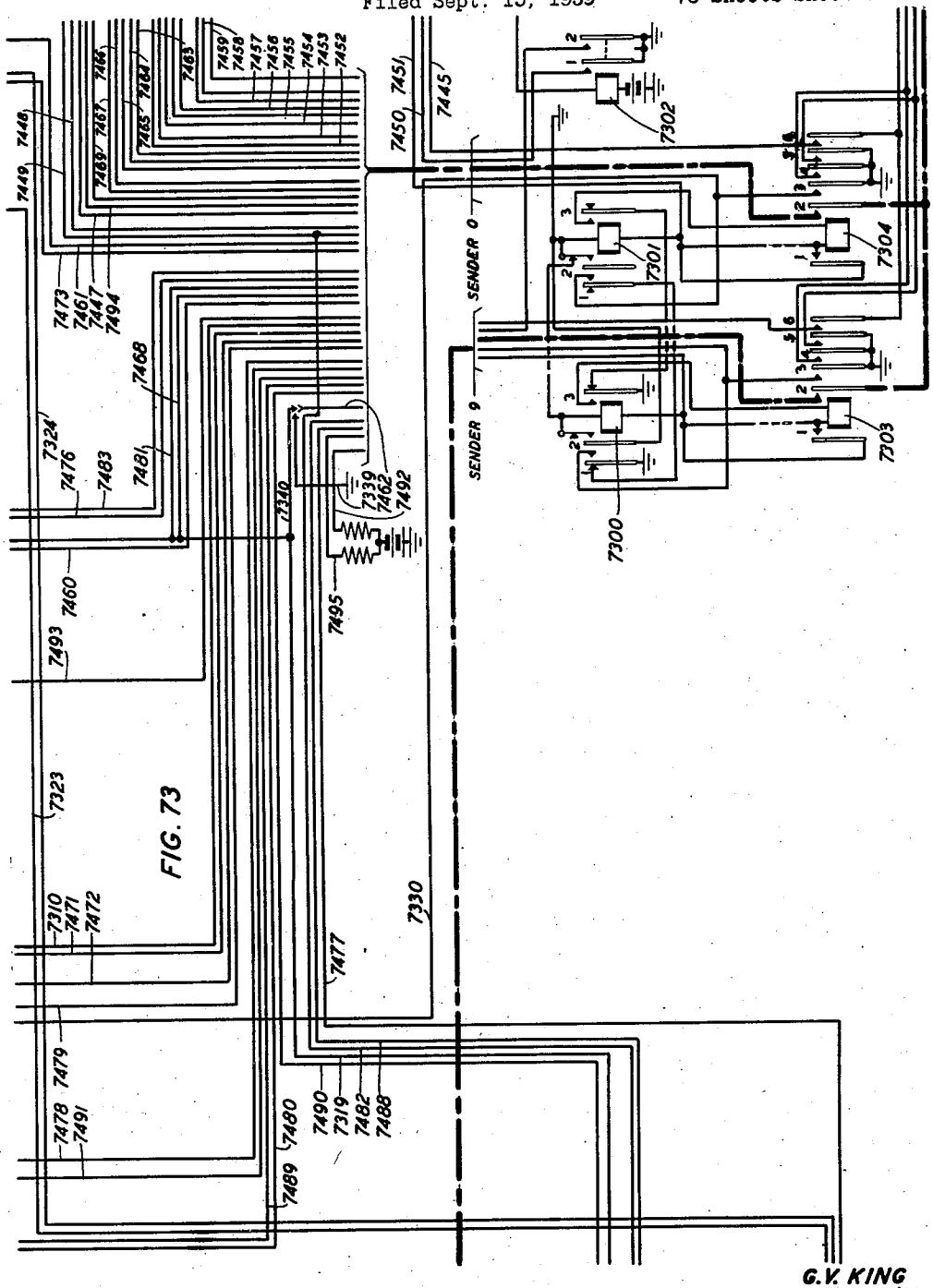

FIG. 73

INVENTORS: G.V. KING
J.B. McKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

Filed Sept. 15, 1939 76 Sheets-Sheet 74

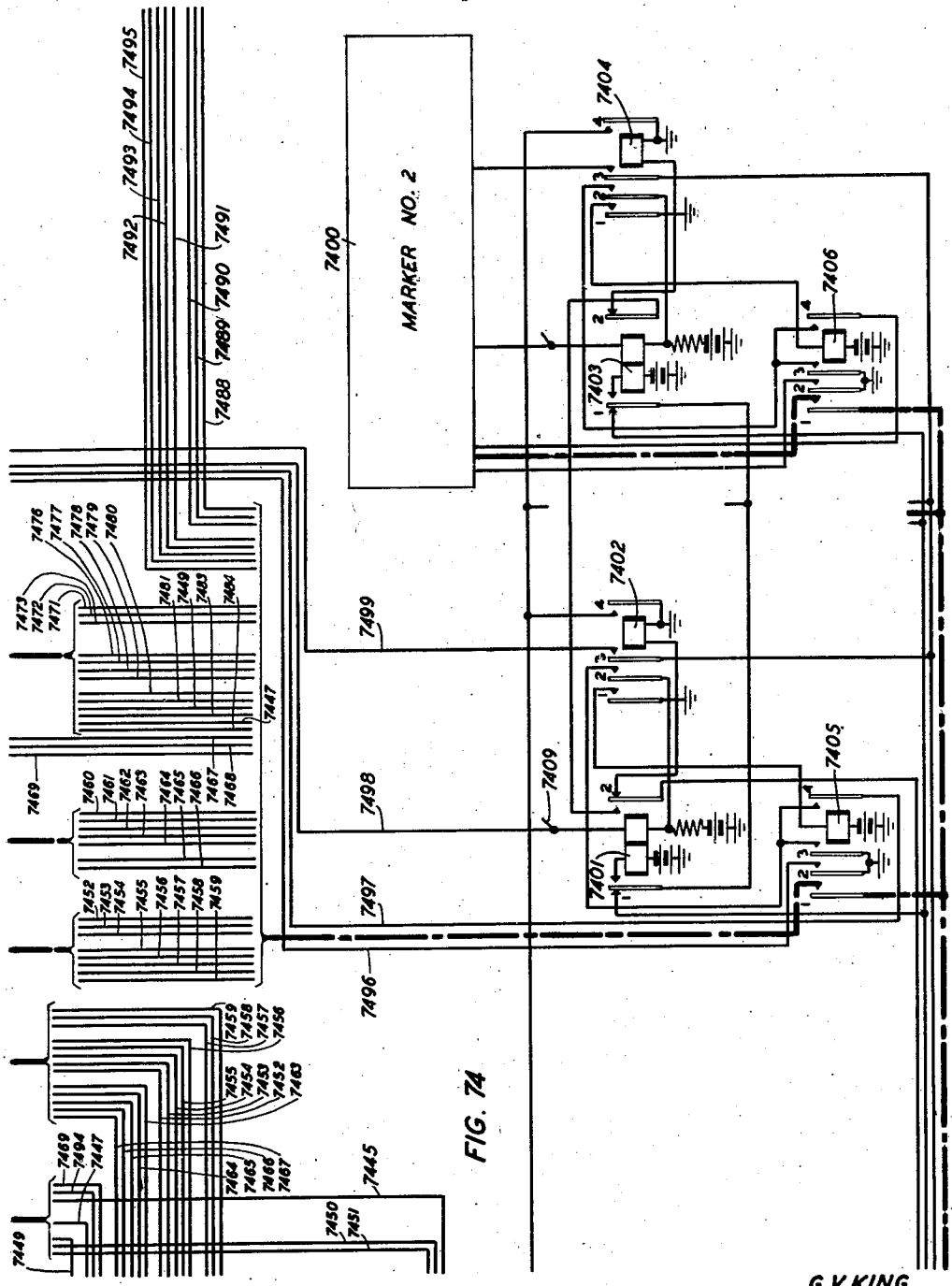

FIG. 74

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246

TELEPHONE SYSTEM

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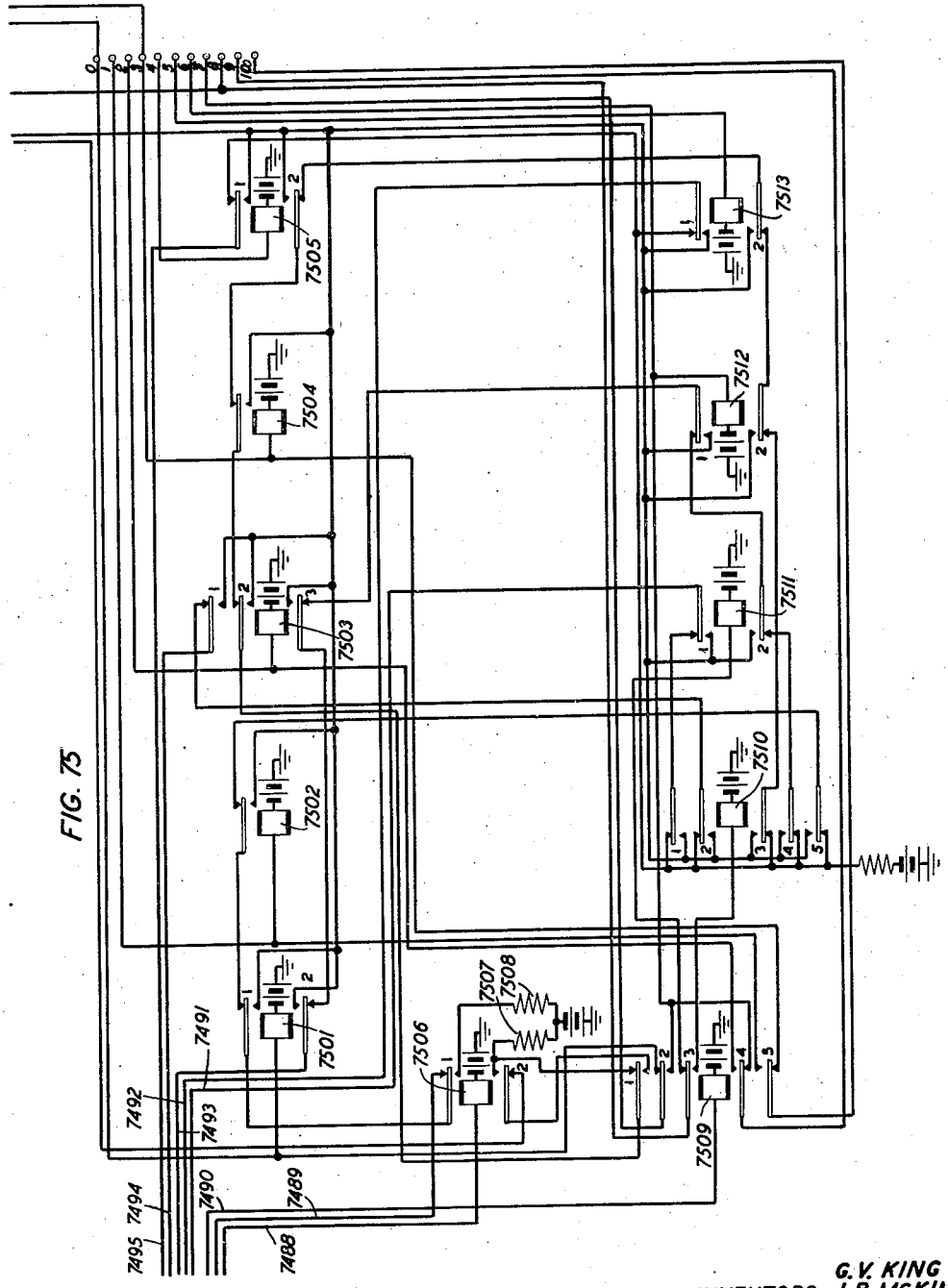

FIG. 75

INVENTORS: G. V. KING
J. B. MCKIM
O. MYERS

BY Emmett McKenney

ATTORNEY

March 25, 1941. G. V. KING ET AL 2,236,246
TELEPHONE SYSTEM
Filed Sept. 15, 1939 76 Sheets-Sheet 76

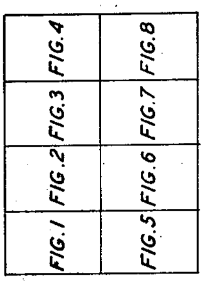

FIG. 76

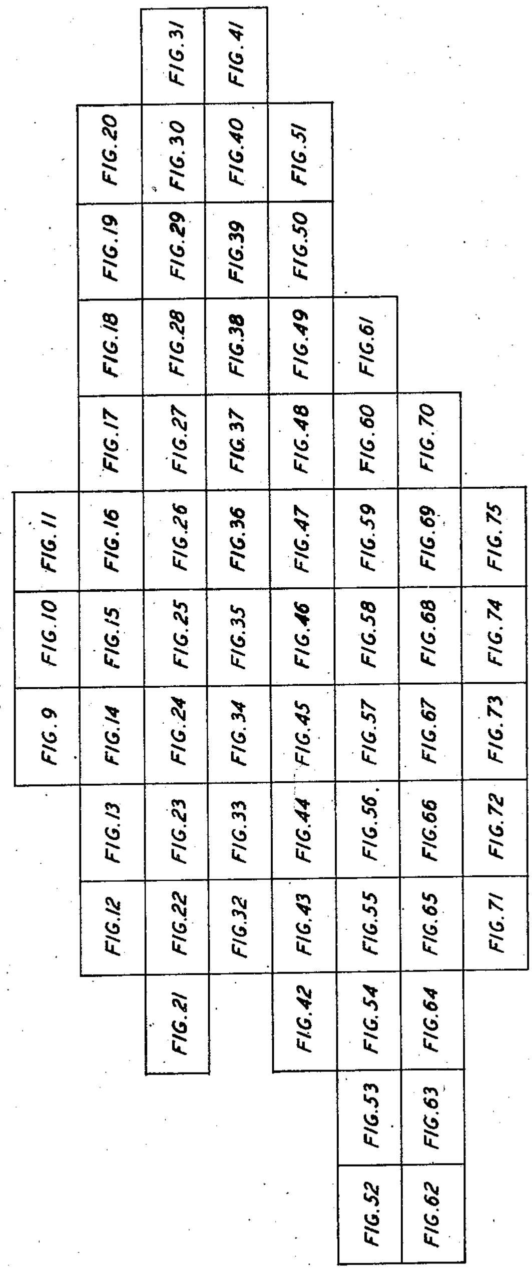

FIG. 77

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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to systems in which toll or long distance connections are established by means of automatic switching apparatus.

The objects of the invention are to establish maximum efficiency in a toll telephone system in which connections from incoming to outgoing toll lines or trunks are completed by the control and operation of automatic switches mounted on a plurality of frames in a telephone office, to simplify the completion of toll connections in a minimum time period, to obtain economy in the operation of toll systems by using units of equipment which are common to the incoming and outgoing toll lines or trunks for controlling the automatic switches to complete connections between said lines or trunks, and to provide a signaling system common to said incoming and outgoing lines or trunks for providing the location of the switches connected to individual trunks.

According to the present invention a toll telephone system is provided with trains of automatic switches having incoming trunks from tandem offices and distant toll offices connected to incoming switches of the train and outgoing trunks to distant toll offices and offices within the area of the toll center connected to outgoing switches of the train, with other switches operable in various combinations under the control of markers in a group common to the incoming and outgoing switches of the train for interconnecting switches associated with any calling incoming trunk entering the train of switches and any idle trunk outgoing from the train of switches according to a routing given over the calling incoming trunk, the switches and other trunk apparatus being mounted on a large plurality of frames. A multifrequency signaling system is provided for progressively transmitting signals to the marker giving the location of a switch connected to the calling incoming trunk, the location of a switch connected to the selected outgoing trunk and the character of the frame on which these trunks are located, also for progressively transmitting signals for directing the marker to abandon one group of trunks and select another group of trunks for test. This signaling system is so arranged as to operate and readjust the marker between successive signals for progressively selecting units of apparatus associated with the calling incoming trunks and the selected outgoing trunks, for establishing circuits between the marker and said units of apparatus to obtain a combination of switches and connecting circuit paths between the calling incoming trunk switch and the selected outgoing trunk switch.

A feature of this invention is a telephone system in which an automatic switching toll office has two trains of automatic switches, each mounted on a plurality of frames, for interconnecting lines incoming from associated toll offices to either lines outgoing to distant associated toll offices or to lines outgoing to terminating offices within the area of the automatic switching toll office and a switch controlling device common to both trains of switches, for selecting idle lines outgoing from either train of switches according to line selecting registrations received over a calling incoming line and for controlling the operation of switches in either train of switches, for interconnecting a calling incoming line with a selected outgoing line as registered.

Another and related feature of this invention is a system in which signals are transmitted to the common switch controlling device giving the location of switches connected to a calling incoming toll line or trunk and a selected outgoing toll line or trunk.

Another and related feature is a system in which the switch controlling device is automatically readjusted responsive to the transmission of successive signals.

Another and related feature is a system in which the use of a circuit for the transmission of switch locating signals is later used for the operation of the switches connected to the calling incoming trunk and the selected outgoing trunk.

Another and related feature is a system in which signals, each comprising a plurality of current frequencies, are automatically transmitted to the marker control device responsive to the seizure of an incoming or outgoing switch, each signal being transmitted over a single conductor for operating an equivalent plurality of units of apparatus in the control device for establishing signaling circuits corresponding to the location of the switches seized.

Another and related feature is the organization of this multifrequency signaling system wherein action takes place in the marker responsive to signals transmitted, independent of trunk routing apparatus, for selecting connecting links between the marker and the switches associated with the calling incoming trunk and the selected outgoing trunk.

Another and related feature is a system in which the multifrequency signalings direct the marker in the testing of groups of outgoing trunks to a particular office, when these groups

of trunks are connected to switches located on different frames in the trains of switches.

Another and related feature is a system in which the marker control device and the signaling system are both automatically readjusted responsive to successive signals when the lines or trunks of a group on one frame are busy and a group of lines or trunks on another frame is available.

Another and related feature is a signal transmitting system common to the incoming and outgoing switches of the office for directing the switch controlling device in the operation of the switches connected to a calling incoming line and a selected outgoing line.

Another and related feature is a signal transmitting system common to the incoming and outgoing lines of the office for successively transmitting a series of combinations of signals for directing successive functional operations in a control device.

These and other features will be discussed more fully in the following description.

To illustrate the features of the invention, reference may be had to the accompanying drawings in which:

Figs. 1 to 8, inclusive, when arranged as indicated in Fig. 76, show diagrammatically the circuit of a toll system, and Figs. 9 to 75, inclusive, when arranged as shown in Fig. 77, disclose the detail circuits of said system.

In the detailed disclosure, Fig. 21 illustrates diagrammatically the distant toll offices connected over intertoll trunks to the incoming trunk circuits of this office with which they establish connection by signaling in different manners. This figure also illustrates tandem trunks entering the office from manual or pulsing offices and tandem trunks from a No. 3 toll-board within the toll area and trunks from service switchboards.

An incoming ring-down trunk has been shown in detail in Figs. 12 and 13 to illustrate the operations in the incoming trunk which actuate the apparatus of this toll office.

Fig. 22 illustrates cross-bar link switches for connecting calling incoming trunks directly with any of a plurality of incoming senders and for connecting an outgoing trunk with any of a plurality of outgoing senders. These link cross-bar switches are usually wired, as shown, between the primary and secondary switches in order to obtain a large plurality of choices in selecting idle senders.

Fig. 32 illustrates the link cross-bar switches for connecting incoming trunks from manual offices to channels entering the cordless operators' positions.

Fig. 43 illustrates control relays including a start relay operated by an incoming trunk for establishing a connection between the incoming trunk and a control circuit for operating the cross-bar link switches to obtain connection between an incoming trunk and an idle channel in one of the cordless toll positions.

A connector is shown in Fig. 42 operated by the apparatus of Fig. 43 for obtaining the temporary use of a link control circuit shown in Figs. 52, 53, 54, 62, 63 and 64.

Fig. 55 illustrates one channel circuit entering the toll cordless position. A plurality of such channels is indicated diagrammatically in these figures.

The common position apparatus for the toll operator's switchboard is illustrated in Figs. 56, 65, 66, 71 and 72.

A sender directly associated with each cordless position is illustrated in Figs. 23, 24, 33, 34, 44, 45, 57 and 67.

Figs. 73 and 74 illustrate connectors for connecting a large plurality of leads from any of a large plurality of senders to an idle marker in a common group of markers. A second marker is also diagrammatically shown in Fig. 74.

A combined toll and terminal marker is illustrated in Figs. 17 to 19, 27 to 30, 35 to 40, 46 to 51, 58 to 61, 68, 69, 70 and 75.

Fig. 20 illustrates a plurality of current sources and amplifiers for the multifrequency signaling circuit.

A toll train of cross-bar switches is illustrated in Fig. 14 and the upper portion of Fig. 15 over which connections are completed between a calling incoming trunk and a distant toll office.

A terminating train of cross-bar switches is shown in Figs. 9 and 10 over which calls are completed between incoming trunks and offices within the area of this toll center. Figs. 9, 10 and 14 also diagrammatically illustrate connectors and control relays for connecting a marker with the incoming secondary cross-bar switches and the outgoing primary cross-bar switches. The apparatus and circuits for this connector and control unit for one pair of frames are illustrated in detail in the lower portion of Fig. 15 and in Figs. 25 and 26.

Fig. 11 illustrates an over-flow trunk in sufficient detail for operating the apparatus of this system.

Fig. 16 illustrates one intertoll outgoing trunk in detail and diagrammatically illustrates other outgoing trunks and distant toll offices which are reached from the toll train of switches.

Figs. 31 and 41 illustrate connectors, trunk block relays, patching jacks and apparatus for enlarging a group of outgoing trunks by associating the marker with a group of trunks on a different frame from the one on which the regular group of trunks to an office is located. The outgoing trunk assignment frame connectors for associating a marker with what are known as trunk block relays or outgoing trunk group relays is shown in the lower portion of Fig. 41. The relays governing this selection are also shown in Fig. 41. Multicontact trunk block relays are shown in the lower portion of Fig. 31. Patching jacks and trunk group enlarging apparatus are shown in the upper portion of Fig. 31.

The system chosen to illustrate the features of this invention is in general similar to the one disclosed in the application of Moody-Newby-Shipley, Serial No. 140,022, filed April 30, 1937, now Patent No. 2,161,376, issued June 6, 1939. In the present system automatic switches of the cross-bar type are disclosed for selectively establishing the desired connections, and these switches are controlled by common register senders and common markers. The cross-bar switches, the senders and markers for controlling said switches, the marker connectors for connecting the markers to said senders, including the keyboard senders, and the frame connectors which serve to associate the markers with the cross-bar switch frames, and the methods whereby these switches are controlled in their selective operations are in many respects the same as those already known in the art. For a more detailed disclosure of these marker-con-

trolled cross-bar switch systems reference is made to the patent to Williams, No. 1,553,347 of September 15, 1925, and to the patent to Carpenter, No. 2,093,117 of September 14, 1937. For a better understanding of the detailed structure and operation of the cross-bar switch itself reference is made to the patent to Reynolds, No. 2,021,329 of November 19, 1935.

General description

A toll office for this cross-bar toll system, as diagrammatically shown in Figs. 1 to 8, inclusive, comprises two trains of cross-bar switches each for completing connections from an incoming line or trunk to an outgoing line or trunk. One train of cross-bar switches, as shown in the upper half of Figs. 2 and 3, is provided for completing telephone calls to other distant toll offices. In the lower half of Figs. 2 and 3 is shown a second train of cross-bar switches for completing what are known as terminating calls. These telephone calls may be originated in a distant toll office or a service switchboard and completed to subscribers of local offices within the area of this particular toll center. An exception to the above exists wherein tributary offices may be reached over either the toll train or the terminating train of switches. A tributary office may be herein defined as an office within the area of the toll center but outside of the minimum rate zone in that area. Fig. 1 illustrates the various offices and switchboards from which calls entering this toll office may be originated, for example, tandem calls originating in the vicinity of the toll center are handled in tandem switchboards illustrated diagrammatically as **112** and **115**. Tandem calls are routed over the toll train of cross-bar switches to outgoing intertoll trunks to distant toll offices indicated diagrammatically as **401**, **403** and **405** or may be routed to a tributary office such as **416**. Calls may enter the toll office from dialing or key pulsing offices or service switchboards indicated diagrammatically as **115**, **116** and **117**. Calls may enter the toll train of switches from a call order board having a key-set similar to the key-set disclosed for the toll operator, or from a key pulsing No. 3 toll-board such as disclosed in Patent 1,780,906 to W. W. Carpenter et al. November 11, 1930, all of which are routed through the toll train of cross-bar switches. Distant toll offices are illustrated diagrammatically as **120**, **124** and **128** which receive calls from other toll offices or from subscribers such as C, D and E entering local offices **118**, **122** and **126**, respectively. Subscriber E may initiate a call by transmitting a signal to a local office indicated as **126** and request a connection to be completed over a toll line. The call may be recorded in the usual manner and the subscriber connected with an operator in the toll office **128** who, in this case, may route the call to the toll office of the present embodiment which actuates the apparatus of incoming trunk **129**. In each case the drawing indicates that the subscriber has requested a connection to the toll office illustrated herein and consequently toll lines are shown between the distant toll offices **120**, **124** and **128** and incoming intertoll trunks **121**, **125** and **129** located in this toll office.

Examples are given of three types of toll lines herein known as intertoll trunks. An incoming intertoll trunk from a distant toll office having a pulsing key-set is shown as **121**. An incoming intertoll trunk from a manual office having straightforward trunking equipment is shown as **125**. An incoming intertoll trunk having ringdown trunking equipment is shown as **129**. Each of the foregoing types of intertoll trunks may again be specifically classified according to a plurality of different transmission characteristics. An intertoll trunk which may be used for extending a call from one distant toll office through another toll office and from there extended to a third toll office is given the name of via intertoll trunk. This intertoll trunk has the highest obtainable transmission characteristics. An intertoll trunk which extends from one toll office to another toll office and is there terminated in an associated local office or a subscriber entering that office, is known as a terminating trunk and does not require the transmission characteristics of the via intertoll trunk. Certain toll offices are equipped with a third type of intertoll trunk having combined transmission characteristics which may be used either as a via intertoll trunk or a terminating intertoll trunk. Toll offices may have intertoll trunks of all three characteristics extending to another toll office. The combined intertoll trunks are used whenever there are insufficient via intertoll trunks or terminating intertoll trunks available. In view of the fact that calls from distant toll offices entering this toll office may be routed either to another toll office or terminated in this toll center, these incoming intertoll trunks enter both trains of switches, thus cross-bar switches on both the toll train and the terminating train are associated with the incoming intertoll trunks **121**, **125** and **129**. As illustrated in Fig. 2, the incoming intertoll trunk **121** is connected both to the cross-bar switch **203** of the toll train of switches and to the cross-bar switch **226** of the terminating train of switches. The incoming trunks **125** and **129** are connected to switches **220** and **223** of the terminating train of switches and are also extended upward for connection to switches in the toll train.

An incoming calling signal energizes apparatus in an incoming intertoll trunk which automatically starts the operation of a link such as **500** or **535** for associating the incoming trunk either directly with an idle incoming sender in groups such as **518** or **522** or with an idle cordless toll operator's position such as **531**, **532** or **533** which have senders **528**, **529** and **530** associated therewith. The link **500** is also used for selecting outgoing senders in sender groups **510** and **514** which are automatically actuated by an outgoing trunk for transmitting pulses to a distant office when required. Reference is made to patent application Serial No. 295,012 to A. J. Busch et al., filed September 15, 1939, for a detailed description of such incoming and outgoing senders. An incoming call from a key pulsing call order board or a key pulsing No. 3 toll-board automatically actuates a link for selecting an idle sender of groups **518** or **522** which are associated through connector **543** directly with a marker for setting the switches to complete a call. The same is true on incoming calls from distant key pulsing toll offices which automatically direct the link **500** for selecting an idle sender. The senders automatically actuate a connector **543**, **544** or **545** for associating a marker therewith for completing a connection. In each case the registration is transmitted from the originating operator through the link **500** to a sender in groups **518** or **522** for setting a plurality of registers which record the type of incoming

trunk connected therewith, and the designation of the office or office and subscriber to which the call shall be routed. This registration is transferred to the marker for setting switches to complete the connection and the registration in the sender is a constant check upon the operation of the marker. Incoming calls over incoming intertoll trunks from manual toll offices which may be equipped with straightforward trunks or ringdown trunks actuate the link **535** in order that calls from manual offices may be routed through the toll office by a cordless toll operator. This link is automatically controlled by the calling incoming trunk circuit for indicating the character or class of the incoming trunk to the equipment associated with the cordless toll operator's position. A link **535** has associated therewith a sequence circuit illustrated diagrammatically as **534** for distributing incoming calls to the various operators and for finding idle channels to operators which are available for handling the incoming calls.

Links **500** and **535** each comprise a small train of cross-bar switches having primary switches connected with the incoming intertoll trunks and secondary switches associated with a large plurality of senders or toll cordless switchboard positions. The link control circuits **507** and **542**, link control connectors **506** and **541**, and control relays **505** and **540** are each separate units which are combined as required for locating idle senders of the type required or idle cordless operator's position channels and for operating the link cross-bar switches **501**, **502**, **503**, **504** or **536**, **537**, **538**, **539**, according to the connection established. Each incoming trunk is connected to the contacts of a primary cross-bar switch such as **501** and is also connected to a start relay in the control relay unit. The start relay is actuated in response to a signal over the calling incoming trunk for actuating an idle link connector such as **506** and obtaining the use of an idle link control unit such as **507** selected from a common group of control units. The link control units **507** or **542** act in a similar capacity to a marker to control the connection and operation of primary and secondary cross-bar switches of the link for connecting an incoming trunk to an idle sender or an idle cordless toll operator's position according to class registrations from the calling incoming trunk.

After an idle sender has been selected or an idle toll cordless position has been selected and the cross-bar switches of link **500** or **535** operated to connect the calling incoming trunk with the selected sender or operator's position, the control relay unit, connector and link control unit are disconnected from the switches. The switches are held by apparatus in the sender or cordless operator's position for a period of time depending upon the functions to be performed and upon the character of the calling incoming trunk. A plurality of channels are provided in each cordless operator's position to which the link switches are connected, one link per channel. Common equipment of the cordless operator's position may be associated with any channel, either automatically in response to a signal over an incoming trunk or at the will of the operator. A plurality of link switches **535** may be connected with a plurality of position channels at the same time and the position equipment common to those channels may be automatically associated successively with different channels for completing incoming calls or for responding to recalls over either incoming or outgoing trunks and may be manually associated with any of said plurality of link connections.

In case an incoming call actuates the link **535** a plurality of conductors from the incoming intertoll trunk are connected through the link to an idle channel in a toll cordless operator's position and a signal is actuated in the toll cordless position to indicate that a new incoming call is awaiting completion. The cordless toll operator challenges the distant toll operator who transmits the code or designation of the outgoing toll office or station desired. The cordless toll operator then actuates the proper keys which energizes the registers of an associated sender such, for example, as sender **528** associated with the cordless toll operator's position **531**. In addition, class signals are transmitted directly from the incoming intertoll trunk to the sender for registering in the sender the character of the calling incoming trunk. The completion of registrations in the sender actuates apparatus for selecting an idle connector between the sender and an idle marker. The office is equipped with a plurality of markers so that an idle marker is normally available for completing any call entering the office.

A toll office may be equipped with a plurality of a single type of marker known as a combination toll and terminal marker. This type of marker is arranged to complete connections from incoming trunks to either a distant toll office, an office within the area of the toll center or service switchboards and service trunks. Other toll offices may be equipped with separate markers comprising a plurality of markers for completing calls to distant toll offices, service switchboards and service trunks and a plurality of other markers for completing terminating calls within the area of the toll center and to service switchboards and service trunks. Both types of markers have been diagrammatically illustrated. Markers **0** to **1** numbered **640** and **624** may be either combined toll and terminal markers or they may be toll markers only. A terminal marker is shown diagrammatically as **625** which would be used in a toll office when markers **0** to **1** are used for completing calls to distant toll offices only.

Let it be assumed for this description that marker **0** was idle and selected by a connector such as **543**, **544** or **545** and associated with sender **528** in cordless toll position **531**. The registers of the marker illustrated in the detail embodiment are actuated by the registrations made by the cordless operator in the sender and remain under the control of the associated sender for completing the connection. These registrations control various operations in the marker including the routing of the call to an idle one of a group of outgoing trunks extending to a particular toll office or to an idle outgoing switching trunk for connection to an office within the area of the toll center. Let it be assumed, for example, that a registration has been made for connecting an incoming intertoll trunk from a distant toll office to an outgoing intertoll trunk extending to another distant toll office. A route relay in the marker is thus actuated which will bring about the selection of an idle outgoing trunk extending to this particular office by associating the marker with a group of terminals with which these outgoing trunks are associated. These registers may cause the operation of a single route relay or the successive operation of a plurality of route relays and the actuation of a connector such as **740** or

741 for associating the marker with particular trunk block relays diagrammatically shown as 707 to 716 connected to the group or groups of outgoing trunks extending to an office for which the call is registered. When an idle outgoing trunk to a particular office is available, information is transmitted by signals to the marker which continues successive operations for completing the connection.

Any character of incoming intertoll trunk, tandem trunk or trunk from service operators entering the office may be connected to any character of outgoing trunk. In view of the many characteristics of the different trunks and in view of the number of groups and subgroups into which these trunks must necessarily be divided, considerable information must be transmitted to the marker from various sources, to guide the marker in completing a connection from an incoming trunk of a particular character, connected to a cross-bar switch mounted on a particular odd or even-numbered incoming frame to an outgoing trunk of the same or different character connected to a cross-bar switch mounted on a particular odd or even-numbered outgoing frame.

Due to the comlexities of a toll system and the flexibility required, no permanent connection is made between the marker and the cross-bar switches. Frame connector units such as 209, 210, 309 and 310 are used for connecting a large number of incoming secondary cross-bar switches, such as 202, and outgoing primary cross-bar switches, such as 300, with the marker for establishing circuit paths over junctor leads between an incoming primary cross-bar switch, such as 200, to which a calling incoming trunk is connected and an outgoing secondary cross-bar switch, such as 301, to which an idle outgoing trunk is connected. These frame connector units are, however, selected by the marker according to the location of the incoming trunk and outgoing trunk switches after the location of these switches is indicated to the marker. The incoming trunk primary cross-bar switch, such as 200, is associated with the marker through the calling incoming trunk, a link switch, such as 500 or 535, and a toll trunk assignment connector, such as 543, which with the exception of the incoming trunk bear no designated or numerical relation to the incoming primary switch or the frame on which this cross-bar switch is mounted. These units of equipment may be used for calls from many different incoming trunks connected to variously located incoming primary switches. This is also true of the outgoing trunk secondary cross-bar switch, such as 301, which is associated with the marker through the outgoing trunk equipment, patching jacks which are used for flexibility in arranging trunk groups, trunk group relays, such as 707 to 716, and connectors, such as 740 and 741. Since no connection exists between the incoming primary or outgoing secondary switches and the marker except through units of selectable equipment which are common to different frames of switches, a multi-frequency signaling system is included in this toll system to transmit signals to the marker giving the location of the switches connected to the incoming and outgoing trunks selected for a telephone connection and whether they are mounted on odd or even frames. This signaling system is associated with the marker through the incoming primary cross-bar switch, the apparatus of the calling incoming trunk and thence over circuits established through the units of equipment selected for connecting this trunk to the marker. The signaling system is also connected through the outgoing secondary cross-bar switch associated with the selected idle outgoing trunk to the marker over circuits established through units of equipment selected for connecting this outgoing trunk to the marker. In this signaling system electrical currents of different frequencies are variously combined to obtain a large plurality of different signals equivalent to the large plurality of switch frames in the toll office. The signaling system is also used for indications to the marker that the trunks of the group tested are all busy and that a group of trunks has been added to this regular group of trunks and that the added group may be found on a different frame from the one on which the regular trunks are located. In this case the signaling system causes an adjustment of the apparatus in the marker for associating the marker with the added group of trunks. If an idle trunk is selected from the latter group a multifrequency signal is automatically transmitted to the marker giving the location of the switch connected with the selected idle trunk.

A multifrequency signal sending system is associated with the select magnets of the incoming primary switches and the outgoing secondary switches. The signals are transmitted as a combination of frequency over a single conductor, which conductor is later used for operating the select magnets. As previously explained, this signaling system extends throughout the entire toll exchange system and, consequently, the ability to transmit the signals over a single lead is a matter of great economy. The organization of the signal transmitting apparatus as shown in Fig. 8 comprising a plurality of generators or other current sources each having an amplifying system and each having associated therewith a plurality of resistances for distributing the generator load and to facilitate the connection of frequency combinations with transformers associated with each cross-bar switch frame. Three frequencies are combined for each frame number signal. For example, transformers 800 to 801 comprise a plurality of transformers associated with the cross-bar switches of one frame. These transformers have their primary windings connected with frequency generator 840, frequency generator 841 and frequency generator 842 through their respective amplifying circuits, each generator transmitting a current of a different frequency. The secondary windings of transformers 800 to 801 are each connected to the windings of the select magnets on this one frame. Transformers 810 to 811 are used for transmitting a different combination of frequencies to the select magnets of another frame. The select magnet 201 associated with primary cross-bar switch 200 located on a particular frame, is connected to the multifrequency signaling system over lead 218 which may be traced to the secondary coil of transformer 810. A combination of frequencies is transmitted through transformer 810 from generator 840, generator 841 and generator 843. Since the transformers 810 to 811, which may represent ten transformers, are associated with a particular frame, the secondary coils of these transformers are connected through the windings of the select magnets of this particular frame. The combination of frequencies thus transmitted to the secondary coil of transformer 810 extends through the winding of select magnet 201, thence through the incoming trunk which is connected to the cross-bar

switch 200, continuing over lead 130 through the contacts of the cross-bar switches of link 535, sequence circuit 534, cordless toll position apparatus such as 531, and a sender associated therewith, such as sender 528, through the contacts of the multicontact relays of connector 543, thence to the marker through the contact of normal relay 622, normal relay 620, relay 619, which is operated, to the primary winding of transformer 617.

The combination of three frequencies is thus transmitted to the receiving system of the marker shown in the upper portion of Fig. 6. The receiving system comprises a plurality of filters 600 to 604 each having a band which passes a particular frequency, for example the filter 600 passes the frequency generated by generator 840 as transmitted through its associated amplifier. Each receiving unit of the receiving system has a tuned transformer 605 to 607 which is actuated by a particular frequency. The frequency transmitted energizes the tube, such as 608, 609 or 610, which creates a plate current for operating a relay, such as 611, 612 or 613. Since the frequencies transmitted through the select magnet 201 were from generators 840, 841 and 843, the currents of different frequencies pass through filters 600, 601 and 603 for actuating tuned transformers 605, 606 and a tuned transformer associated with the fourth filter 603. Relays 611, 612 and a relay associated with filter 603 are operated for establishing a location signal circuit. Each relay of the receiving units has associated therewith another relay having a large plurality of contacts, such as 614, 615 and 616. In view of the large plurality of contacts on these relays, they could not be operated directly by the plate current of the tubes in each receiving unit. The operation of three relays, such as 614, 615 and a relay operated by current through filter 603 establishes a particular series circuit for operating apparatus in the marker including a relay such as 633 which corresponds to the frame number on which select magnet 201 and the switch 200 are located. There is a frame relay, such as 633, for each incoming frame in the office. At the proper time for receiving the signals to indicate the number of the incoming switch frame on which the calling incoming trunk is located, the incoming frame cut-in relay 630 is operated by the marker for closing a circuit path for the frame relays. The circuit for operating relay 633 is, however, established by the combination of frequencies transmitted. This combination of relays 614, 615 to 616 operated by the frequency combination also establishes a circuit to indicate whether the frame on which the trunk is located is an odd or an even frame and accordingly operates apparatus in the marker to so adjust the marker that it will be correctly connected to a link such as 209 associated with the proper incoming frame. The trunk group and trunk number are also given by signals to the marker and thus the switch location is positively identified.

When an idle outgoing trunk to a designated office has been located, circuits are energized for indicating the frame number on which this idle outgoing trunk is located. The outgoing trunks of the various groups are connected to the local or terminal assignment frame or to patching jacks on what is known as the toll trunk assignment frame, shown in the left portion of Fig. 7. Intertoll trunks are very expensive and the number of trunks extending between offices is maintained within limits which will handle the normal maximum load of connections. The patching jacks are provided for flexibility in rearranging trunk grouping during emergencies and for adding trunks to a group easily when, for any unforeseen reasons, they are required. These trunks may be added directly to the regular group of office trunks or they may be routed through other toll centers to the office requiring the added trunks. Each outgoing trunk is connected by two leads, such as 744 and 745, to its associated patching jack in order that the trunk may be tested for idle and busy conditions and for controlling the operations in the marker. A third lead, 318, is extended from the patching jack to the select magnet associated with the secondary cross-bar switch connected to that trunk. Let it be assumed that the idle trunk found is connected to cross-bar switch 301 and that select magnet 302 is used for operating that switch. This select magnet is connected to the secondary winding of transformer 800 of the frequency generating circuit by lead 320. The transformers 800 to 801 are associated with the frame on which the cross-bar switch and select magnet are mounted. Three frequencies are thus transmitted from generators 840, 841 and 842 through their associated amplifiers and resistances which are connected to the primary of transformers 800 and 801. This causes the three currents to be transmitted from the secondary of transformer 800, through the winding of select magnet 302, over conductor 318, through the contacts of patching jack 720, through a multicontact trunk group relay shown schematically as 707 and the toll trunk assignment connector 704 to the marker. In preparation for receiving the signal, the marker has operated relay 620, relay 619 and the outgoing frame cut-in relay 631. The multifrequency signaling combination is thus transmitted through the right contact of relay 622, normal contact of relay 620, contact of relay 619, to the primary winding of transformer 617. In this case the frequencies are transmitted through filters 600, 601 and 602 for energizing the associated tuned transformers 605, 606 and a transformer connected to filter 602, which current is amplified for energizing the associated tubes, such as 608, 609 and a tube in circuit with filter 602. Responsive to the transmission of these three frequencies, the first three relays, such as 611, are actuated for actuating the first three relays, such as 614, 615 and a third relay. The operation of the latter three relays establishes a series circuit through their contacts and through a particular contact of the outgoing trunk frame cut-in relay 631 for energizing a particular frame relay, such as 634, to arrange the circuits of the marker for connection to the frame on which the idle outgoing trunk was found. The contact combination of relays, such as 614, is also such as to indicate to the marker whether this frame is an odd or an even frame. The marker is thus given the frame number on which the calling incoming trunk is located and the frame number on which the idle outgoing trunk extending to a particular office is located.

Considering the number of frames of cross-bar switches in an office, the number of different combinations of connections required may be visualized. For example, the calling incoming trunk may be any trunk located in any group of one of the odd or even frames and a path through

the cross-bar switches must be found to an idle outgoing trunk to any office which includes switches on all of the outgoing frames. Combinations of incoming secondary and outgoing primary cross-bar switches must be operated for connecting the talking and signaling leads between any of the incoming primary cross-bar switches and any of the outgoing secondary switches. The incoming secondary switches, such as **202**, **205** and **208**, and the outgoing primary switches, such as **300**, **303** and **306**, are used for such connections. Idle junctors must also be found between incoming secondary switches and outgoing primary switches for establishing this connection. The marker is thus guided by the multifrequency signaling combinations to associate itself with particular frame connectors, such as **209**, **210**, **309**, **310**, to reach frames having switches to be used for establishing connections responsive to registrations transmitted to the marker. Connectors of this character are associated with all frames of the office and are shown diagrammatically associated with the incoming terminal frame, outgoing terminal frame, incoming toll frame and outgoing toll frame. If the calling incoming trunk is located on an even frame, a connector such as **210** associated with that frame is energized by the marker and circuits established between the marker and cross-bar switches over what is known as the home channel, represented by lead **214**. A second path may be used under certain circumstances from the same marker to the same switches over circuit **212** through the mate channel of the connector by seizure of the mate channel in the odd frame connector. The circumstances governing this arrangement will be discussed in connection with the detailed description.

If the outgoing trunk were found on an odd frame, a connector **310** associated with this frame would normally be operated. The circuit path through this connector would be over lead **313** which would again be known as the home channel. Under certain circumstances, however, this frame may be reached through the even connector over circuit lead **311** when the mate channel is taken for use. The operation of the incoming and the outgoing connector circuits in combination with the marker, controls the selection of secondary incoming cross-bar switches and primary outgoing cross-bar switches and a set of junctors through cross-connecting frame **217** for associating the incoming trunk on the primary cross-bar switch to the outgoing trunk on the secondary outgoing cross-bar switch. This connection is completed when incoming secondary and outgoing primary cross-bar switches and a set of junctors therebetween have been tested and found idle.

In the organization of the trunk grouping for a toll office, space is allowed on both the switch frames and trunk relay frames for expected growth of the trunk groups. However, when rapid changes take place in a particular vicinity, because of unexpected circumstances, a larger group of trunks may be required than anticipated. In some cases space cannot be found for such enlargement of the trunk group on the frame having the regular group of trunks thereon. In such an event, an additional group of trunks is located upon a different frame. This flexibility is an advantage in a toll system but requires a plurality of multifrequency signal indications to the marker for the group of trunks extending to this particular toll office. Facilities are provided in the multifrequency signaling system for accommodating this flexibility. When the marker has tested the trunks of a regular group extending to a particular office and found all the trunks busy and an additional group of trunks is available, the marker is so notified when it tests the last trunk of the regular group. In this case, the last trunk of the group simulates an idle trunk and the apparatus of the marker is operated accordingly in an attempted seizure of the trunk, but instead of finding an idle trunk, a complete group of trunks is taken for test. The apparatus for such an arrangement is indicated in the right-hand portion of Fig. 7. Jack **721** represents the last trunk in a regular group and is connected by patching cord **748** with an added group of trunks known as the jump hunt group of trunks, since it may be on a different frame from the regular group of trunks. An idle trunk is ordinarily indicated to the marker by battery extending from the outgoing trunk to the test lead in the marker. This may also be indicated by an open circuit. A busy outgoing trunk has ground associated with this lead. This condition may be observed by referring to Fig. 16 of the detailed drawing. A circuit condition prevails between the regular group of outgoing trunks and the jump hunt group of outgoing trunks which alters, depending upon the busy or idle condition of these trunks. An idle outgoing trunk in the jump hunt group of trunks is shown diagrammatically as **727**. This illustrates battery associated with the test lead extending to the marker and ground connected to the group busy lead through the winding of relay **724**. As long as there are idle trunks in the added jump hunt group of trunks, this ground is extended from all the idle outgoing trunks through the winding of relay **724** to battery which operates relay **724**, connecting ground through the winding of relay **723** to the sleeve of jack **722**. A similar condition prevails in the regular group of trunks, since a ground is connected from all idle trunks to a lead, such as **744**, from the idle trunk and extends through the patching jacks to the winding of a relay in the over-flow trunk, such as **725**. When there are idle trunks in the regular group, a circuit is consequently established from ground to all of the sleeve conductors of the patching jacks in the regular group. Since the added jump hunt group of trunks is connected to the last regular trunk, this ground is extended from idle trunks in the regular group over the sleeve of the patching cord **748**, sleeve of jump hunt jack **722**, winding of relay **723** to ground on the contact of relay **724**. Therefore, a ground from idle trunks in the regular group shunts relay **723** and will not permit this relay to operate. This also places a busy ground on the jump hunt group from the back contact of relay **723** through the ring conductor and patching cord to the marker, as a check indication that there are idle trunks in the regular group of trunks and that the marker has made a mistake in attempting to seize the added jump hunt group.

When all of the outgoing trunks in the regular group are busy, the ground is removed from the test conductor of all trunks in this group and a circuit is established at this time for operating relay **723**, from ground on the contact of relay **724** through the winding of relay **723**, sleeve of jack **724**, sleeve of patching cord **748** to battery through the winding of relay **725**. The jump hunt

group of trunks is thus available for selection and a multifrequency signal is transmitted to the marker for accordingly readjusting the marker. The transformer 730 is similar in its arrangement to the foregoing arrangement described for transmitting a signal through the select magnet. In this case, a special frequency is transmitted from generators 841, 842 and 844 through the primary winding of transformer 730 and from the secondary winding through the winding of relay 726, ring conductor of jack 722, ring of the patching cord, ring of the jack 722 representing the last jump hunt trunk of the regular group, thence to transformer 617 in the marker. The transmission of this combination of frequencies operates three relays, such as 614, establishing a series circuit for operating the jump hunt cut-in relay 632, releasing the outgoing trunk cut-in relay 631 and establishing a circuit for operating the multifrequency relay 726. After this is accomplished, the combination of three relays, such as 614, is released and a second combination of frequencies is transmitted for establishing a circuit in the marker to operate a particular route relay used for reaching the added jump hunt group of trunks. This combination of frequency is transmitted from three generators, depending upon the office to which the trunks extend. An example is given where the combination is transmitted from generators 840, 841 and 844 through the inside contact of relay 726 and primary winding of transformer 730 over a path to the marker which is the same as previously described, terminating in transformer 617. Relays 614, 615 and 616 are now operated for establishing a circuit through a contact of the cut-in relay 632 for operating the particular route relay controlling the test of the added group of trunks. The test of the outgoing trunks in the added jump hunt group of trunks now proceeds in the usual manner and the jump hunt apparatus including relay 632 is released to permit this normal procedure. The outgoing frame cut-in relay 631 is again operated for establishing a path over which a multifrequency signal may be transmitted, giving the frame on which the added group of trunks is located. When an idle trunk is found in the jump hunt group of trunks this multifrequency signal is transmitted through the select magnet associated with the switch connected with the idle outgoing trunk in the same manner as previously described for the transmission of a signal for a frame number giving the location of an idle trunk of a regular group.

When an idle trunk has been located in an added jump hunt group and the frame number on which the trunk is located transmitted to the marker, operations take place as previously described for controlling the operation of one of the frame connectors 209, 210, 309, 310, 229, 230, 339, 340, depending upon whether the call is a via toll call extending to a distant toll office or a terminating toll call extending to the office within the area of the toll center. This causes the selection of a secondary incoming switch, a primary outgoing switch and a junctor path between these switches for connecting the calling incoming trunk to the selected idle outgoing trunk to a particular office.

If at this time the service of an outgoing sender is required, such sender is automatically connected to the outgoing trunk by the energization of a link, such as 500, actuated by the outgoing trunk circuit. For example, if the outgoing trunk extends to an office requiring dial pulses or key pulses, these are transmitted from an outgoing sender, such as 510 or 514. The outgoing senders are shown in Fig. 5 adjacent to the link which serves both the incoming and the outgoing senders. A circuit may be traced from these senders through the switches to the outgoing trunk circuits. Consequently, after the connection through the incoming and outgoing switches of Figs. 2 and 3 has been established, pulses may be transmitted from an incoming sender through a link, such as 500, thence over the train of switches, Figs. 2 and 3, through the same link or another link to the outgoing sender for setting the registers of the outgoing sender, the incoming sender having been previously set by either the operator originating the call or by the cordless operator. As soon as the registers of the outgoing sender are set according to the setting of the incoming sender, the pulses are transmitted directly over the outgoing trunk conductors to either a distant toll office or to a terminating office, such as 407, 409, or 412, depending upon the designation of the call.

Incoming calls from straightforward or ring-down manual toll offices are completed by the cordless toll operator in positions 528, 529 or 530. In this case, the code of the distant office is registered upon the key-set of the cordless toll position for controlling the sender associated therewith and a marker. When the cross-bar switches have been set and a connection completed to a distant operator, the cordless operator may transmit the calling designation to the distant operator or the calling designation may be given to the distant operator by the originating operator as soon as the connection has been completed through this toll office and the called operator obtained.

Detail description

Let it be assumed that a toll call is initiated by subscriber A, Fig. 21, who calls the operator in the local subscriber's office 2100 and advises her of the destination of a toll call. The subscriber's operator makes a connection with the manual toll office 2104 over trunk 2102 in the usual manner by associating plug 2140 with jack 2101 and plug 2141 with jack 2103. This equipment may be of a well-known character and need not be described in this specification. The toll designation is recorded by the toll operator in toll office 2104 who proceeds to make the desired connection by initiating a call over an intertoll trunk outgoing from this distant office represented by conductors 2150 and 2151. To facilitate this description, a ring-down intertoll trunk has been assumed between the distant toll office 2104 and the incoming ring-down trunk disclosed in Figs. 12 and 13 of the cross-bar toll office. The call may have originated from subscriber B or C and a toll connection completed through a dial toll office 2110 or a straightforward trunking toll office 2124. An incoming call from toll office 2110 over a pulsing incoming trunk would enter the cross-bar toll switching office in an incoming trunk arranged for such connection, which would automatically route the call through a link to a key pulsing sender such as 2214 shown in Fig. 22. A call from an office such as 2124 using what are known as straightforward intertoll trunks would enter the cross-bar toll office in an incoming intertoll trunk adapted to receive signals from this character of distant toll office. This signal will be transmitted to the straightforward incoming trunk by associating

battery and ground with the trunk conductors at the distant end of the trunk. Calls over tandem trunks are of the same character, either transmitting signals by pulses or originating a call by a battery signal and thereafter completing the connection by instructions from one operator to another. As indicated on the drawings, all of the calls over ring-down intertoll trunks or straightforward intertoll trunks are connected through a link to the cordless operator's position. The connection from the toll office 2104 to the incoming ring-down trunk shown in Figs. 12 and 13 is initiated by the application of ringing current to the trunk conductors 2150 and 2151 which energizes relay 1201 in the incoming intertoll trunk circuit. A circuit is normally established by relay 1201 from ground through the winding of relay 1202 which maintains the relay 1202 operated and therefore the energization of relay 1201 by the transmission of the aforesaid ringing signal releases relay 1202 to establish circuits for associating this incoming trunk with apparatus of the cross-bar toll office for completing a connection from this trunk to a desired outgoing trunk. As previously stated, ring-down intertoll trunks are of varied transmission characteristics, depending upon their use. For the example to be given of a connection from subscriber A, it may be assumed that the calling incoming intertoll trunk has the highest transmission characteristics and connection is to be made through the toll train of switches to an outgoing trunk extending to another distant toll office. This constitutes a via connection and requires the use of intertoll trunks of the highest transmission characteristics, both from the originating office to the cross-bar toll switching office and from the cross-bar toll switching office to another distant toll office to which a connection has been requested. Responsive to the operation of relay 1201 and the release of relay 1202 a circuit is established from ground on contact 6 of relay 1307 through contact 5 of relay 1220, contact 2 of relay 1202, winding of relay 1304 to battery, which operates relay 1304. Relay 1304 establishes a locking circuit for itself through its contact 3, contact 5 of relay 1220, contact 6 of relay 1307 to ground, connects ground to the armature of relay 1202 and through contact 9 of relay 1301 to lead 3228 which is used later for testing purposes from the position circuit and for establishing a holding circuit for the cross-bar switching magnets of the toll train of switches shown in Figs. 14 and 15. A circuit is also established through the windings of relay 1322 and the contacts of relay 1304 which is not effective at this time, since the windings of this relay are arranged to oppose each other.

When the period of ringing has ceased, relay 1201 restores to normal and reestablishes an operating circuit for relay 1202 and the following operations take place for associating a link control circuit with the calling incoming trunk. In the circuit previously traced for locking relay 1304 it was shown that ground is connected to the armature 2 of relay 1202. The reoperation of relay 1202 transfers ground from the outer contact to the inner contact which establishes an operating circuit for relay 1213 through contact 5 of relay 1212. Relay 1213 establishes a locking circuit for itself through contact 5 of relay 1301, which locking circuit remains under the control of relay 1301. The operation of relay 1213 connects certain leads to the link relays for controlling link selection including a circuit for the link start relay 4311. The operation of this start relay causes the selection of a connector Fig. 42 for associating the incoming trunk with a link control circuit. There are a plurality of selectable link control circuits which may be temporarily associated with an incoming trunk or an outgoing trunk for selecting circuit paths through link switches such as shown in Figs. 22 and 32, to connect an incoming trunk with either an incoming sender Fig. 22 or a cordless operator's position channel Fig. 55, or connect an outgoing trunk to an outgoing sender Fig. 22. This control circuit shown in Figs. 52 to 54 and 62 to 64 registers the class and characteristics of the calling incoming trunk and completes the connection through the cross-bar link switches accordingly. Since there are numerous classifications of incoming trunks, the link control circuit acting in the capacity of a register and marker must in all cases be operated in a manner depending upon the class of trunk connected therewith.

As previously stated, the operation of relay 1213 associated ground with the start lead 4300 which may be traced from ground through contact 1 of relay 1214, contact 3 of relay 1213, contact 1 of relay 1212, thence over conductor 4300 through contact 1 of relay 4310 and winding of the start relay 4311 to battery. The operation of relay 4311 establishes the starting circuits for selecting a link and controlling the connection of the cross-bar link switches shown in Fig. 32 between the ring-down incoming trunk circuit (Figs. 12 and 13) and one of a plurality of cordless switchboard circuits as shown in Figs. 55, 56, 65, 66, 71 and 72 as follows. A circuit is first established for operating one of relays 4201 or 4202. This circuit may be traced from battery 4312 through resistance 4313, contact 1 of relay 4311, contact 3 of relay 4315, contact of relay 4316, winding of relay 4201 to ground through contact 1 of relay 4202. A second circuit is established for the operation of timing relay 4317 from ground through contact 3 of relay 4311. A third circuit is established from ground through contact 2 of relay 4311 to contact 27 of relay 4206 for use when the latter relay is operated. The operation of relay 4201 establishes a circuit for relay 4205 which in turn establishes an obvious circuit for relay 4206. The operation of relay 4201 also establishes a circuit for one of a chain of relays 4209, 4210 or 4211 operated successively as idle link connectors are selected and become busy. In this example the circuit is shown arranged to operate relay 4209 from battery through contact 4 of relay 1201, contact 1 of relay 4212, winding of relay 4209 through the chain of relays to ground on contact 2 of relay 4211. The link connector associated with relay 4209 is thus taken for use.

The link system disclosed in this application constitutes an arrangement of apparatus for obtaining connections between a large plurality of toll or tandem lines, herein known as trunks, and a large plurality of senders or cordless position circuits with a minimum amount of apparatus. The link system is therefore divided into separate sections or units which creates a large number of choices for the connection of any intertoll or tandem trunk to idle senders or idle cordless positions. The cross-bar switches shown in Fig. 22 disclose the arrangement of interconnecting toll trunks with idle incoming senders, which senders may be of different character, depending upon the character of the incoming toll trunk used for the connection. The cross-bar switches

of Fig. 22 are associated with the remainder of the link, such as shown in Figs. 42, 43, 52, 53, 54, 62, 63 and 64, and with the senders in the same manner as the cross-bar switches of Fig. 32 are connected to cordless positions. The link cross-bar switches of Fig. 32 are used in interconnecting intertoll trunks from manual offices such, for example, as incoming ring-down trunks, straightforward trunks or tandem trunks to the cordless position operators. It is apparent that intertoll trunks from manual toll offices require the services of an operator in the cross-bar intertoll office, whereas incoming toll trunks from toll offices handled on the pulsing signal basis only require the service of an incoming sender, such as shown in Fig. 22. The multicontact relay 4314, the multicontact relay 4206 and the relays shown in the upper portion of Fig. 42 constitute an arrangement for giving an incoming trunk a plurality of choices in obtaining the services of a link control circuit. There are a plurality of relays 4314 for each group of incoming trunks. This plurality of relays 4314 are connected to a plurality of relays 4206 which are interconnected when strapped as shown so that a choice of relays is available where a particular one is found busy. Relay 4207 and the armatures of relay 4206 constitute a connector between groups of trunk circuits and the link control circuit. There are a plurality of relays 4207 in each connector equal to the number of control circuits. There are a plurality of relays such as 4206 for each connector equal to the groups of trunks entering the right-hand contacts of relay 4314.

From the foregoing it is apparent that for each toll trunk entering the office there is a choice of a plurality of circuit paths for obtaining the services of an idle link control circuit (Figs. 52, 53, 54, 62, 63, 64) and that there is a plurality of choices between the trunk circuit and senders or cordless positions, since there are a number of different paths through the cross-bar switches to idle equivalent senders or cordless positions. The foregoing arrangement makes it possible to have numerous paths to the more expensive groups of apparatus such, for example, as the link control circuit and thus limit the number of control circuits. This link control circuit may be likened to a marker for controlling the link switches in somewhat the same manner as the main marker of the cross-bar system controls the switches arranged to connect an incoming trunk to an outgoing trunk.

In the present instance it is assumed that the control circuit associated with relay 4207 is idle since relay 4209 was operated. The operation of relay 4209 establishes an obvious circuit for operating relay 4207 which connects a link control circuit through its contacts and the contacts of relay 4206 to the left-hand contacts of relay 4314 which has not as yet been operated. The operation of relay 4207 establishes an obvious circuit for operating relay 4208 and extends ground over leads 4220, 4221 and 4222 to the control circuit. The circuit established over lead 4220 energizes relay 5402. The circuit over lead 4221 operates relay 5201. The circuit over lead 4222 establishes a locking circuit for relay 5203, which is used later after this relay has been operated. The operation of relay 5201 completes a circuit for the operation of relays 4213 and 4214 traced from battery through their upper windings and over the three leads represented by lead 5252 to ground on contacts 1, 2 and 3 of relay 5201. Ground is also connected to the upper winding of relay 4212 but the operating circuit for this relay is shunted by ground from contact 1 of relay 4207 which prevents relay 4212 from operating. This indicates that all paths over this connector are busy. The circuit for relay 4208 is established either by the operation of relay 4206 or relay 4207 and the busy condition of the link is therefore maintained until both relays are released. Relay 4208 establishes a locking circuit for relays 4213 and 4214 through contact 1 and a circuit for timing relay 4315 which may be completed when relay 4205 is released if relays 4207 and 4208 are not released. The operation of relay 5402 establishes an obvious operating circuit for relay 6404 and an operating circuit for relay 5209 from battery through resistance 5412, contact 4 of relay 5402, contact 5 of relay 5403, contact 3 of relay 5309, contact 4 of relay 5410, winding of relay 5209, to ground on the contact of relay 5301. Relay 5209 locks to ground on its contact 3.

A particular control circuit such as represented by Figs. 52, 53, 54, 62, 63, 64 has now been seized for controlling the selection of available cross-bar switches such as shown in Fig. 32 for establishing a connection between the calling incoming toll trunk circuit (Figs. 12 and 13) and a position channel. The operation of relay 6404 prepares a testing circuit, as explained later, and applies a non-operate test to the test relay 6405. It may be here explained that a test of circuits is progressively made as the control circuit operates. If relay 6405 operates on the non-operate test the control circuit operation will be blocked by the operation of relay 6402. It will be assumed for this description that relay 6405 responded correctly to the non-operate test and thus did not operate. At this time or previously, relay 6213 operates from battery through its winding, contact 1 of relay 6305, lead 4247, contact of relay 4207, contact 27 of relay 4206 to ground on contact 2 of the start relay 4311. Contact 6 of relay 4207 represents a large number of contacts as shown on relay 4206. There are a plurality of relays such as 6213 or 6209 corresponding to the subgroups of calling incoming trunks in a large trunk group and one of these relays is now operated to identify the subgroup of trunks in which the calling trunk is included. It may be assumed that relay 6213 corresponds to the calling incoming trunk subgroup in use for the connection being described. Relay 6213, in operating, establishes a locking circuit to its operating ground over lead 4247 and also establishes an operating circuit for relay 6210 through its contact 1 to ground over lead 4247. Relay 6210, in operating, establishes a circuit for relay 6305, which circuit is obvious. Relay 6305 locks to ground on contact 5 of relay 6213 and opens the operating circuit for relay 6213 which is now maintained in an operated position by its locking circuit. Relay 6305 also completes a circuit for operating relay 4314, which circuit may be traced from battery through contact 4 of relay 6305, contact 2 of relay 5204, contact 3 of relay 6203, contact 1 of relay 6210, contact 4 of subgroup relay 6213, lead 4245, contact of relay 4207, contact 25 of relay 4206, winding of relay 4314 to ground. The operation of relay 4314 now associates conductors from the link primary switches and from the calling incoming trunks in a particular subgroup through contacts 2 to 15 of relay 4206 and an equivalent number of contacts of relay 4207 to the link control circuit.

Toll trunk selection

It may be pointed out at this time that the contacts of relay **4314** are associated with a plurality of trunks (usually ten) represented by leads **4300** and **4309**. There is, however, a common start circuit for the plurality of trunks in this subgroup through the contacts of relay **4310** and after the seizure of the control circuit the calling trunk must be individualized in order to be served. The leads extending from these trunks over contacts **7** and **8**, which may represent ten trunks, are extended through contacts **7** and **8** of relay **4206** and similar contacts on relay **4207**, thence over leads **4228** and **4229** to ten relays **5206** to **5210** of the control circuit. It was assumed in this case that the ring-down trunk (Figs. 12 and 13) is associated with lead **4300** connected to the zero trunk of the group. A ground was associated with lead **4300** by the ring-down trunk to operate the start relay **4311**. This ground is now extended through contact **7** of relay **4314** and contacts **7** of relays **4206** and **4207** over lead **4228**, contact **4** of relay **5211**, winding of relay **5210** to battery. Relay **5210** operates and locks through its contact **4** to lead **4228**. This same ground lead **4300** extends through the contacts of relay **4310**, contact **8** of relay **4314** and all similar contacts associated with the plurality of trunks, contacts of relays **4206** and **4207** over separate leads in the control circuit, such as lead **4229**, to battery through the windings of a plurality of relays such as **5206** to **5210**. At this time all of the relays **5206** to **5210** are operated. This is done to guard against or test for faults in the control circuit, since later when the circuit is made individual to the calling trunk only one of these relays should remain locked up. The operation of relay **4314** also extends ground from lead **4300** through the contacts of relay **4310**, contact **13** of relay **4314**, contact **13** of relay **4206** and a similar contact on relay **4207** to lead **4234** which is connected through the winding of the control circuit, start relay **5205** to battery. The operation of relays **5206** to **5210** and a start relay **5205** establishes a series circuit for the operation of relay **5203** traced from battery through the winding of relay **5203**, contact **1** of relay **5210** and a series of other contacts to the contact **1** of relay **5206**, contact of start relay **5205**, contact **5** of relay **5210** to ground on the operating circuit for relay **5210**. The operation of relay **5203** establishes a locking circuit for itself through the contact of relay **5204** to ground over lead **4222** to contact **5** of relay **4207**. This relay also establishes a holding circuit for relays **6210** and **6213** and connects battery through the winding of relay **5202** to lead **4223**. The battery on lead **4223** operates relay **4310** since, as noted, it is extended through a contact of relay **4207**, contact **2** of relay **4206**, contact **2** of relay **4314** to ground through the winding of relay **4310**. The operation of relay **4310** opens the ground circuit extending from the calling incoming trunk through its contacts and therefore this ground from the incoming trunk on lead **4300** is now only extended through contact **7** of relay **4314**. The start relay **4311** is released and relay **5205** of the control circuit is released. This restores all of the control relays included in the group **5206** to **5210** excepting the one associated with the calling incoming trunk which in this example is relay **5210** which remains operated. The release of relay **5205** establishes an operating circuit for relay **5207** through contact **5** of relay **5203**, back contact of relay **5205**, contact **5** of relay **5210** to ground over lead **4228**. The following circuits are established through the contacts of relay **5207**: (1) Relay **5211** is operated over an obvious circuit which locks to ground on contact **1** of relay **5203**; (2) establishes a circuit from battery through the winding of relay **6304** and contact **6** of relay **4210** to lead **4227**, thence through contacts **6** of relays **4207** and **4206**, contact **6** of relay **4314** through the cross-bar switch contacts to the hold magnet when the cross-bar switch is operated as set forth later in the description. Relay **5211** opens the operating paths for relays **5206** to **5210** but does not open the locking circuit for relay **5210**. Relay **5211** also connects ground from the normal contacts of relay **6303** to one of the ten leads **4230** to **4231** through contacts of relay **5206** to **5210**. In this case it is assumed that the ground is connected from contact **7** of relay **5210** to lead **4230** extended through the contacts **9** of relays **4207** and **4206**, to contact **9** of relay **4314**. Contacts **9** and **10** of relay **4314** representing ten trunks have cross-connecting terminals **4330** to **4340** connected to their armatures. A plurality of class punchings **4341**, **4342** and **4343** are connected to armatures **11—12** of relay **4314** and may be cross-connected to punchings **4330** to **4340** according to the class of the calling incoming trunk being served. A plurality of leads, represented by one lead **4232**, are connected between the class contacts of relay **4314** and class relays **5304**, **5306** and **6205** in the link control circuit. One of the latter relays is operated to indicate the method of operation which should take place in the control circuit for the class of trunk being served. In this example it may be assumed that punching **4330** is cross-connected to punching **4341** and that class relay operated, which identifies the calling trunk as the class of calls handled by the cordless operator. Relay **5304** indicates the class of incoming trunk by connecting battery to one of the three leads connected to normal contacts **4**, **5** or **6** of relay **5209**. This circuit may be traced from battery through resistance **6420**, normal contact **9** of relay **6402**, normal contact **4** of relay **6304**, contact **3** of relay **5304**, normal contact **3** of relay **5306**, normal contact **3** of relay **6205**, contact **4** of relay **5209** previously operated, to lead **4235** which is used to represent the three leads extending to the link relay **4314**. Lead **4235** extends to contacts of relay **4207**, and relay **4206**, contact **14** of relay **4314** to ground through the winding of relay **4318**.

There are a plurality of relays the same as relay **4318** for associating test leads from the control circuit with incoming senders, outgoing senders, position channels, etc. The circuit established through the winding of a relay, such as **4318**, depends upon which of the class relays **5304**, **5306** or **6305** has been operated. The operation of the relay **4318** shown, establishes a circuit over lead **4344** through contacts of relays **4206** and **4207** to the control circuit over lead **4239** for operating relay **5301** and connecting a large plurality of test leads, such as **4345**, from the cordless position circuits to enable the control circuit to find an idle position channel. Each lead is connected with a channel in a cordless switchboard position to which an incoming toll trunk may be connected if this channel is idle and an operator is in attendance in the position. The channels represented by these test leads may enter all or part of the different switchboard positions and also may enter a plurality of channels in each of these positions. In order that rapid service be maintained the above is required so that an idle channel to an operator's position may

be immediately found under normal traffic conditions. There is one relay in the control circuit for each test lead extending to the channels of the cordless operator's positions. Only two of these relays, 6207 and 6212, are shown. A circuit for one of these relays is established when an idle channel to an idle operator's position is found.

Position relay 5508 is operated when an operator is in attendance in a position and is not busy completing or supervising another connection. A test circuit may, therefore, be traced from ground on a contact of relay 5508 to contact 2 of relay 5512. There is one relay 5512 for each of the channels in a position. This relay is operated when the channel is busy and released when it is idle. If there is an idle channel in the position, one of these relays is released and consequently ground is extended from a contact on relay 5508 through contact 2 of an idle channel in the position, thence over lead 5542 to one of a large plurality of contacts on relay 4318. One test circuit is shown through contact 2 of relay 4318 extending over lead 4345 through the contacts of relays 4206 and 4207 to lead 4256 in the control circuit. This lead extends through contact 4 of relay 6206, and the winding of relay 6207 to battery, operating the latter relay which indicates that the channel associated with relay 6207 is idle.

It will be remembered that relay 4318 also established an operating circuit for relay 5301 which is for the purpose of connecting ground to timing interrupter 5411 to release the control circuit if all channels are found busy. The circuit for interrupter 5411 may be traced from ground on the contact of relay 5301 through contact 1 of relay 6402, contact 5 of relay 6307 to the armature of interrupter 5411. Relay 5301 also establishes a ground circuit through the contacts of relays 6206 to 6211 for a circuit to be described later. The ground associated with interrupter 5411 establishes a circuit for relay 5407. The continued movement of the interrupter associates its grounded armature with a circuit through contact 2 of relay 5407 and the winding of relay 5406 to battery which operates relay 5406. The continued rotation of the interrupter 5411 again establishes a grounded circuit with a contact 2 which now establishes a circuit through the inner contact 1 of relay 5406, contact 2 of relay 6404, winding of relay 6308 to battery which operates relay 6308 for establishing the releasing circuit for the control unit, which circuit may be traced from ground on contact 1 of relay 6308 through the winding of the release relay 5403 to battery. The operation of relay 5403 causes the release of the control circuit so that it may be used for other connections. All idle channel circuits will have ground connected to their busy test leads from the position channel circuits whereas the busy circuits will be indicated by an open lead. Consequently all of the available channel circuits are represented in the control circuit by an operated relay such, for instance, as relays 6207 and 6212. A chain circuit is carried through the relays 6207 to 6212 and 6206 to 6211 so that one of the idle channels may be taken for use. The association of the test relays in the different control circuits with the channels of different positions is altered as to choice in order to distribute the incoming calls to the different operators. The operation of relay 6207 establishes an obvious circuit for the operation of relay 6307 which establishes an operating circuit for relay 6406 through contact 10 of relay 6402. Relay 6307 also operates relay 5302 over a circuit which may be traced from ground on contact 2 of relay 6307 through the winding of relay 5302 to battery. A circuit for relay 6201 is established from ground on contact 1 of relay 6307. The operation of relay 6406 establishes operating circuits through the right winding of all busy test relays represented by relays 6206 to 6211. Some of these relays were already operated due to busy link conditions since their left windings are connected over leads 4224 and 4225 through the contacts of relays 4207 and 4206, contacts 3 and 4 of relay 4314 to the hold magnets of cross-bar switches serving this group of trunks. Busy switches have ground connected to their hold magnets which causes the operation of relays 6206 to 6211 associated therewith. All of relays 6206–6211 are now operated to establish chain circuits through their contacts. The circuits for the foregoing relays are established through contacts 1 and 2 of relay 6406 which represent a plurality of contacts which are equal to the number of busy test relays, such as 6206 to 6211. Relay 6406 also establishes a circuit for relay 6208 traced from battery through the winding of the latter relay through contact 4 of relay 6406, contacts 2 of relays 6211 to 6206 to ground on contact 1 of relay 5403 normal and contact 3 of relay 5402 which is operated. Relay 6208 establishes a circuit for one of a plurality of relays such as 5305 and 5307 associated with the preferred available circuit which may be traced from ground on contact 2 of relay 6208 over leads 6215 to 6216 depending upon which is the preferred circuit of the circuits found idle. The circuit over lead 6216 extends through contact 4 of relay 5401, winding of relay 5307 to battery. The circuit over lead 6215 extends through contact 1 of relay 5401, winding of relay 5305 to battery. The operated relay locks to its operating ground and establishes a circuit for the associated test relay, such as 4321 in Fig. 43. This circuit may be traced as follows: Assuming that relay 5305 was operated, battery is connected from normal contact 1 of relay 5307 through contacts 4 and 2 of relay 5305, contact 2 of relay 6204, lead 4255, contact of relay 4207, contact 35 of relay 4206, winding of relay 4321 to ground.

The operation of relay 6208 opens the operating circuit for relay 6203 and connects the test relay 6403 to lead 4253 for making a double test, which double test circuit may be traced from the plate circuit of tube 6410 through the winding of relay 6403, contact 1 of relay 6208, contact 6 of relay 6212, lead 4253 to contacts 33 of relays 6207 and 6206, contact 1 of relay 4321 to the double test lead in the channel of a selected position circuit, which to be idle should have battery thereon through contact 1 of relay 5512. The operation of relay 5305 as previously described locks to its operating ground and connects battery to lead 4255 through contact 1 of relay 5307, contacts 4 and 2 of relay 5305, contact 2 of relay 6204, lead 4255 through contacts 35 of relays 4207 and 4206 through the winding of relay 4321 to ground. This extends the double test circuit previously described through contact 1 of relay 4321 to battery through contact 1 of relay 5512 and resistance 5516.

Senders are selected by the link control circuit in the same manner as described for selecting a position channel.

The channel circuit shown in Fig. 55 repre-

sents one of a plurality of channels for establishing circuits between the link switches of Fig. 32 and cordless operators' positions. In order to select a channel the link control circuit obtains access to the testing facilities of these channels through the connector relays such as 4207 and 4206 as described. An idle and available channel is indicated by ground on the busy test lead 5542 from the contacts of relay 5508 and battery on the double test lead 5541 from contact 1 of relay 5512. It will be noted that as previously described these extend through the contacts of relays 4318 and 4321. When the cordless position is attended by an operator and a channel is idle and the operator is not busy handling another call, relay 5508 is operated by the position relay 6507, which latter relay is operated when the telephone operator's headset plug is inserted in the telephone jack. The circuit for relay 6507 may be traced from battery through its winding and through a chain of contacts on relays 5501, 5502 and 5503 which represent a plurality of channels, thence through the contact of telephone jack 7210, contact of key 5610 to ground on contact 1 of relay 5600. The busy test relay 5508 has a plurality of contacts for supplying ground to the contacts of a plurality of relays such as 5512, one for each channel circuit in a position. When a channel is not busy, relay 5512 is normal for indicating the idle condition and ground is thus extended through its contact 2 to the associated lead 5542. When a channel is busy the operation of relay 5512 causes ground to appear on the double test lead 5541 and the busy test lead 5542 is opened. The channel is seized by the link control circuit after the closure of the link switch cross-points by the link control circuit. The closure of such cross-points causes ground to appear on leads 5540 and 5543 which will be traced later from the link control circuit. These grounds transmitted through the link switch, operate relays 5512 and 5511. The winding of relay 5512 is directly connected with lead 5543 and the winding of relay 5511 is connected with lead 5540 through contact 2 of relay 5504 which is normal at this time. The operation of relays 5511 and 5512 initiates the operation of the channel and position circuit apparatus and will be described in detail after the seizure of the channel by the link control circuit.

The test and seizure of a position channel indicate to the link control circuit that it may proceed to associate the cross-bar link switches of Fig. 32 with the channel selected. Test relays 6403 and 6405 of the tube testing circuit were connected to the double test lead 4253. This circuit may be traced from battery 5520 through resistance 5516 and contact 1 of relay 5512, lead 5541, contact 1 of relay 4321, contact 33 of relay 4206, corresponding contact of relay 4207, lead 4253, contact 6 of relay 6212, contact 1 of relay 6208, winding of relay 6403 to plate of test tube 6410. If no other control circuit is attempting to seize the link at this time the plate resistance of tube 6410 will instantly drop, thus making the selected link busy to other control circuits. Also, it provides an operating circuit for relay 6405 to the tube plate circuit through contact 6 of relay 6406 and contact 4 of relay 6404. The operation of relay 6405 establishes an operating circuit for relay 6402 and a locking circuit for relays such as 6207 to 6212. The double test feature of relay 6405 is important when two identical tests are made of the channel circuit by two control circuits at the same instant so that the tubes, such as 6410, instantaneously operate in both control circuits. In such case neither of the relays 6405 in the two control circuits operates and a different circuit is selected so that the contested circuit may be seized for another call. The channel circuit being contested will remove ground from its busy test lead 4253 when it is seized by another circuit, causing the associated relay 4321 to release and advance the test relay 6405 to the next available circuit. The purpose of relay 6403 is to cause the link control circuit to time and transfer the facilities to avoid operating an alarm when two circuits prevent each other from seizing the desired circuit. In this case relay 6402 does not operate and therefore relay 6403 connects ground to interrupter 5411 so that the interrupter will cause relays 5407 and 5406 to function as herein described. Since the operating time of the vacuum tube is negligible the repetition of the first unsuccessful attempt to seize a particular circuit is extremely remote.

Relay 6402 operated by relay 6405 for the seizure of an idle line switch establishes a locking circuit for itself to ground through contact 3 of relay 6406 and establishes an operating circuit for relay 5303 from battery through its winding, contact 2 of relay 5302, previously operated, contact 4 of relay 6402 to ground through normal contact 3 of relay 6303. The operation of relay 6402 removes battery from class lead 4235 as previously traced from battery through resistance 6420, contact 9 of relay 6402, contact 4 of relay 6403 through the contacts of class relay 5304 to lead 6235, thus releasing all channel relays, such as 6207, except the one which is locked for the call. The operation of relay 6402 further establishes operating circuits for relays 6306 and 5208. The operating circuit for relay 6306 may be traced from ground through contact 3 of relay 5403. The operating circuit for relay 5208 may be traced from battery through contact 6 of relay 5403, contact 6 of relay 6402, contact 1 of relay 6201, contact 1 of relay 5209, winding of relay 5208 to ground. Relay 6402 also opens the ground circuit through the contact of relay 6403 which is extended to interrupter 5411. The operation of relay 5303 connects battery to lead 4243 for operating the primary select magnet 3204 on the link frame. This circuit may be traced from battery through resistance 5230, contact 2 of relay 5210, contact 2 of relay 5303, contact 4 of relay 5302, lead 4243, contacts 23 of relays 4207 and 4206, winding of primary select magnet 3204 to ground. The operation of relay 5208 connects battery to lead 4251 to operate the secondary select magnet 3207 of the selected secondary link switch as traced from battery through contact 3 of relay 5401, contact 6 of relay 5305, contact 2 of relay 5208, contact 3 of relay 6201, lead 4251, contacts 31 of relays 4207 and 4206 to ground through the winding of secondary select magnet 3207. The primary select magnet 3204 energizes its armature and associates ground with contacts 24 of relays 4206 and 4207 and lead 4244 for operating relay 6302. The secondary select magnet 3207 energizes its armature and establishes a circuit through contacts 29 of relays 4206 and 4207 to lead 4249 which is carried through the winding of relay 6301 to battery.

A path has been selected through the link switches after tests of hold magnets controlling this path and therefore the next step is to oper-

ate the hold magnets under the control of the link control circuit. This is accomplished by the aforesaid operation of relays 6402 and 6301 which establishes a circuit from ground through contact 1 of relay 6303, contact 1 of relay 6302, contact 2 of relay 6301, contact 6 of relay 6208, contact 2 of relay 6212, contact 2 of relay 6306 over lead 4225 to contacts 4 of relays 4207, 4206 and 4314, windings of hold magnets 3205 and 3208 to battery. When the primary switch cross-points are closed a circuit is established for relay 6304 which is operated over the lead corresponding to the trunk number and thus corresponding to the switch level with which the control circuit is now associated. It will be noted that all of these levels are represented on contacts 5 to 6 of cut-in relay 4314. There may be, however, ten such contacts representing ten levels of the switch. The circuit for relay 6304 may be traced from battery through its winding, contact 1 of relay 5207, contact 5 of relay 5210, lead 4227 which is representative of a plurality of leads, contacts 6 of relays 4207, 4206 and 4314, contact 3 of the cross-bar switch 3200 thence to ground over the above-described operating circuit for the holding magnets. Relay 6304 establishes a locking circuit to lead 4227 through contact 5 of relay 5210 and also operates relay 6303 from battery through its winding, contact 2 of relay 6402, contact 1 of relay 6301, contact 2 of relay 6302 to ground through contact 2 of relay 6304. Relay 6303, in operating, establishes the locking circuit to ground on its contact 1 through contacts 3 and 2 of relay 6402 and in operating causes the release of relay 5303 by opening the circuit for this relay at contact 3. Release of relay 5303 opens the operating circuit for primary select magnet 3204, causing its release. The switches, however, are maintained in position by the hold magnet. Relay 5303 also removes the shunt from the right winding of relay 6401 and connects both windings of this relay in series circuit which may be traced from battery through resistance 6411, left winding of relay 6401, contact 1 of relay 6303, right winding of relay 6401, contact 3 of relay 6307 to ground. The operating circuit for the hold magnets must be constantly maintained and therefore the control circuit must not release this circuit until a holding ground has been applied over the sleeve circuit through the switching contacts. The sensitive polarized relay 6401 is used to indicate to the link control circuit when this ground has been applied. The link control circuit thus awaits certain conditions before energizing the release relay 5403. The application of the holding ground to the sleeve lead as explained later operates relay 6401 which partly prepares the circuit for operating the release relay 5403.

Position channel

At this time the connection has been completed by the cross-bar switches (Fig. 32), from the incoming trunk leads to an idle position channel and the following operations take place in the position and position channel circuits. As previously stated, the closure of the cross-bar link switch cross-points due to the operation of the select magnets and hold magnets causes ground to appear on leads 5540 and 5543 as previously traced, which operated relays 5512 and 5511. The operation of relay 5512 establishes obvious circuits for lighting the busy lamp 5515 and guard lamp 5517. Relay 5511 establishes an obvious circuit for guard lamp 5514. The operation of relays 5511 and 5512 establishes a circuit for the associated channel relay which in this instance has been shown as relay 5503. This may be traced from battery through the winding of relay 5503, contact 1 of relay 5511, contact 3 of relay 5512, contact 2 of relay 5503 to ground on contact 1 of relay 6507. Relay 5503 locks to ground on its contact 2 and opens the operating circuit for relay 6507 extending through its contact 1. The release of relay 6507 releases relay 5508 so that all channels of the position are made busy during the period required by the operator in completing the connection. The operation of relay 5503 connects ground from contact 1 of relay 5600 through contact 1 of relay 5503, winding of relay 5507 to battery. The operation of relay 5507 causes the operation of relay 5504 from ground through contact 4 of relay 5506, contact 8 of relay 5507, winding of relay 5504 to battery, and changes the guard lamp 5514 from a steady to a flashing condition by the connection of interrupter 5513 through the lamp filament. This flashing signal indicates to the position operator that an incoming trunk has been connected to an idle channel of the position, and is a preparatory signal in advance of a tone signal given to the operator a fraction of a second later. Relay 5507 establishes a holding ground circuit through its contact 3 and contact 4 of relay 5512 for hold-magnets 3205 and 3208 and for locking relay 5512. The operation of relay 5504 closes circuit paths for the talking and signaling conductors from the link switch to the position, opens the locking path for relay 5511 which restores to normal and closes the operating path for relay 5505 through contact 10 of relay 5504, contact 7 of relay 5600, contact 1 of relay 6603, contact 3 of relay 6503, contact 2 of relay 6604 to ground. Relay 5505 is a marginal check relay and only operates if no other like relay in another channel is operated. There is a condition of overlap calls wherein another relay 5505 in a different channel may be associated with this relay 5505 so that its operation must await the completion of the overlap call. It then operates for connecting conductors through from the position circuit to the link switch.

The operation of relay 5504 establishes a circuit through the cross-bar switches for operating relay 1212 in the incoming intertoll trunk circuit, which circuit may be traced from ground through contact 1 of relay 5604, contact 1 of relay 5603, contact 6 of relay 5504, lead 5546, contact 12 of switches 3203 and 3200, lead 3231, contact 2 of relay 1220 to battery through the winding of relay 1212 which locks to ground on contact 6 of relay 1307 through contact 1 of relay 1320, contact 2 of relay 1202, contact 3 of relay 1304 and contact 5 of relay 1220. The operation of relay 1212 removes the link start ground from lead 4300 extending through contacts of relays 4314, 4206 and 4207 to lead 4228, causing the release of relay 5210 in the link control circuit. Release of this relay causes the release of relays 5303 and 5207 which causes the release of relay 6304. When the link is made busy by the application of ground to the hold magnets relay 6401 is operated which removes battery from lead 4253 which causes the release of the test relay 6405. Release of this relay and relay 6304 which was released previous to the release of relay 6401, establishes a circuit for the operation of link control circuit release relay 5403 which operates over a circuit from battery through its winding,

contact 1 of relay 6304, contact of relay 6401 to ground through the contact of relay 6405.

The operation of relay 5403 releases relay 6306 and relay 5407, operates relay 5405 and removes ground from the chain contacts of relays 6206 to 6211 initially used to operate relay 6208. The latter relay also releases. Relay 5405 locks to ground supplied by relay 5402 and prepares a circuit for relay 5404 which operates when relay 5403 releases if another call is waiting service. Relay 6201 is also released which removes battery from the secondary select magnet 3208 on the link frame. This magnet releases, opening the circuit for relay 6301. This causes the link chain to remove ground from relay 5401 which releases. The release of relay 6208 opens the circuit for relay 5305 which opens the battery circuit for relay 4321 thus releasing the relay on the link frame which controlled the double test of the selected channel circuit, and further causes the release of relay 6207 which was used to make the position channel connection. Battery is also removed from the test circuit relay 6405. The release of relay 6207 opens the circuit for relay 6307 and removes ground from associated leads. Relay 6307 opens the circuit for relays 6302 and 6406. The release of relay 6406 causes the release of relay 6402 which now opens the circuit for relay 6303 and the control circuit release relay 5403. A circuit is now established through the contacts of the release relay 5403 for operating relay 5204 which remains operated if another call is awaiting service. If no other call is awaiting service relay 6314 is released. The releasing of this relay opens the starting circuit causing release of relay 4201 and the release of relay 4209. This releases the connector relay 4207 and the multicontact relay 4206 opening the circuit for relay 4208 and other circuits between the connector and the control circuit which releases relay 5402 and relays associated therewith. This removes ground from the test conductor of the control circuit permitting its seizure by another connector.

Class of trunk signals

The operation of the previously described relay 5507 in one of the channels connects ground through its contact 1 to the winding of relay 6508. This relay operates and connects ground through its contact 1, contact 5 of relay 5600, contact 1 of the normal class relays 7217 and 7219 to battery through the winding of class relay 6504. Relay 6504 operates and connects leads 5547 and 5548 through its contacts 1 and 2 to the windings of class relays 7221, 7222, 7223 and 7224, to battery through resistances 7225 and 7226, respectively, thus starting class determination. The ground from contact 1 of relay 6508 also extends ground through contact 3 of relay 6504 for operating relay 6510. Relay 6510 opens leads 5547 and 5548 extending to the telephone circuit and operates relay 6511 through its contact 2 to ground on contact 1 of relay 6508. Relay 6508 locks to this operating ground through its contact 6. The class signals are transmitted to the position circuit in order that the position sender and marker may be guided by the type of incoming intertoll trunk connected therewith. The incoming toll trunks which are connected through the cordless position for toll or terminating connections may be of the ringdown or straightforward type from distant toll offices or from tandem offices and they may vary in transmission characteristics. For example, a via intertoll outgoing trunk must be selected by the marker for a call from a distant toll office which shall be routed outgoing to another toll office. On the other hand, if a call is for a connection which may extend from one toll office to this cross-bar switching toll office and there terminate in a local subscriber's station, it is not necessary to use a toll trunk of the equivalent transmission characteristics as used for the via connection. There are also trunks which are of these characteristics in so far as transmission qualities are concerned but which have different signaling devices such as the difference in signaling between the straightforward intertoll trunk and the ring-down intertoll trunk. The class signal in each case indicates the character of the trunk by associating a grounded circuit, which may or may not have resistance in series therewith, and open circuits in various combinations with the class relays. These are connected from the trunk circuit through the contacts of relay 1301 or a similar relay in the different intertoll circuits over leads 3223 and 3224 through the cross-bar switches of Fig. 32, over leads 5547 and 5548 to the class relays 7221, 7222, 7223 and 7224. These relays are marginal and consequently operate according to the resistance in series with the energizing circuit. The following are examples of some combinations that are made: If a grounded resistance is connected to lead 5547 and lead 5548 remains open, relay 7221 operates, which energizes relay 7217. Relay 7217 is operated through the contact of relay 7221 to ground on contact 11 of relay 6511 and locks to this same ground. When lead 5547 is connected directly to ground with no resistance in series therewith, relays 7221 and 7222 are operated which causes the operation of relays 7217 and 7218, both locking to ground on contact 11 of relay 6511. The same combination is used where lead 5548 is either connected to direct ground or ground resistance therein which operates relay 7223 in one case and both relays 7223 and 7224 in the other case. This causes the operation of either relay 7219 or both relays 7219 and 7220 which lock in the same manner as described for relays 7217 and 7218. Other varied combinations are used throughout to indicate the characteristics of different trunks. These indications are later transmitted to the sender and marker used for connecting the incoming trunk to an intertoll outgoing trunk having the same transmission characteristics.

It will be noted that when any class determination is made the operating path for relay 6504 is opened by the operation of either relay 7217 or 7219, thus causing the release of relay 6504. The release of relay 6504 operates relay 6509 and releases relay 6510. The circuit for relay 6509 may be traced from ground through contact 5 of relay 6511, contact 5 of relay 6504, contact 5 of relay 5600 to battery through the winding of relay 6509. Relay 6509, in operating, associates ground with lead 5549 to operate the splitting relay 1301 of the incoming trunk over a circuit which may be traced from ground through contact 1 of relay 6509, contact 9 of relay 5504, lead 5549, contacts 6 of the switches 3203 and 3200, contact 4 of relay 1212, winding of relay 1301 to battery. Relay 6510 is slow to release and prevents further action in the position until sufficient time has elapsed to guarantee that the splitting relay 1301 has operated. The splitting relay disassociates the inward and forward ends of the trunk and associates the forward end with

the cordless position circuit. However, prior to the operation of the splitting relay a check for sleeve holding ground is made by the application of ground to the inward sleeve lead 5550 by the operation of relay 1304 in the incoming trunk as previously described. If this ground is present and the leads between the position and the incoming trunk are closed, relay 6505 will operate over a circuit which may be traced from battery through the windings of relays 6505 and 6506 in series, thence through contact 5 of relay 5604, contact 6 of relay 5609, contact 5 of relay 5601, contact 4 of relay 6603, contact 7 of relay 5507, thence over lead 5550 to contacts 9 of the link switches (Fig. 32), thence over lead 3228 through contact 9 of relay 1301 to ground on contact 4 of relay 1304. Relay 6505 is locked to ground on contact 8 of relay 6511. This low resistance holding ground later serves to hold the switch hold magnets of the incoming and outgoing link frames, Figs. 9, 10 or 14, 15, and certain relays in the incoming and outgoing trunks if at such certain times the splitting relay 1301 of the incoming trunk is operated. In the circuit above traced for a new call, relay 6506 does not operate. This distinguishes between new calls and recalls by making a check to determine whether an established connection exists. After the operations of relay 6505 and the splitting relay 1301 in the incoming trunk circuit, the marginal test relay 6506 will operate if the hold magnets of cross-bar switches of a previously established connection associate battery circuit traced through the winding of relay 6506 to ground on contact 8 of relay 6511, thus indicating a recall on a connection already established. A circuit is established for relay 6600 through the contact of relay 6506, contact 4 of relay 6511, contact 2 of relay 6510, contact 5 of relay 5600 to ground on contact 1 of relay 6508. The operation of relay 6600 supplies ground to the position circuit for lighting one of the recall lamps 7117, 7118 or 7119, the purpose of these lamps to be explained later. If no connection has already been established, relay 6506 does not operate at this time but ultimately operates when the marker has established the connection and has released.

The forward relay such as 5505 of the position channel is operated if no other forward relay in the sequence circuit is operated. A circuit for this relay is established when the backward relays 5504 and 5507 of the channel operate. Relay 5505 establishes a circuit for relay 5608 over an obvious circuit and the latter relay establishes a circuit for relay 6503 which ties the forward and backward portions of the position circuit together for service on the same call. The circuit for relay 6503 may be traced from ground through contact 3 of relay 5608, contact 3 of relay 6603, thence through the winding of relay 6503 to battery.

For the purpose of indicating to the operator what type of call is to be answered, an arrangement of signals is provided which are operated by relay combinations in the position circuit under the control of the ring-down incoming intertoll trunk circuit (Figs. 12 and 13) or incoming intertoll trunk circuits of other characters which have apparatus responsive to different signals transmitted over the toll lines or trunks. The operation of apparatus in the incoming trunk circuit under different conditions connects battery through different values of resistance which lead 3226 which may be traced through the link switches (Fig. 32) to lead 5540 and thence through the windings of marginal relays 7121, 7122 and 7123 to ground. The number of these relays operated depends upon the value of resistance associated therewith responsive to calls of different character. For example, when the call is a new call for connection to an outgoing toll trunk, relay 1212 is operated which associates resistance 1211 in circuit with relays 7121, 7122 and 7123. The value of resistance 1211 is such that only relay 7121 is operated. This establishes a circuit for relay 7106 to ground on contact 12 of relay 6511. Since it is a new call, apparatus will be in position to establish a circuit for relay 7124 from battery through its winding, contact 1 of relay 6600, contact 3 of relay 6511 to ground on contact 1 of relay 6510. This will establish a circuit for giving the operator a distinctive tone, as described later. In the case of a recall from the calling distant operator, the same circuits will be established with the exception of the circuit for relay 7124. As previously explained, in the case of a recall relay 6600 is operated and thus there would be no circuit for relay 7124. Therefore, in the case of a recall a circuit is established to light lamp 7117 and a distinctive tone indicating a recall is transmitted to the operator.

The following is in advance of a description of the apparatus and circuits for establishing a connection to a distant office but will be covered at this time in connection with the position circuit structure. In the case of a recall from a called office over an outgoing trunk and through the switches of Figs. 9 and 10 or Figs. 14 and 15 which have been previously set by the marker for completing a connection, circuits are established for relays 1212, 1320 and 1308 of the incoming trunk (Figs. 12 and 13). The operation of the above three relays connects resistance 1310 in series circuit with relays 7121, 7122 and 7123. The value of resistance 1310 is such as to cause the operation of relays 7121 and 7122. The operation of both relays 7121 and 7122 establishes an obvious circuit for relay 7105 which establishes a circuit for lamp 7118 and associates a distinctive tone with the operator's headset. A different signal is given when the distant called party does not answer. In this case, incoming trunk relays 1212 and 1320 are operated which connects resistance 1309 in series with relays 7121, 7122 and 7123. The value of resistance 1309 is such as to cause the operation of all of the above three relays. The operation of these three relays establishes an obvious circuit for both relays 7105 and 7106 which establishes a circuit for lamp 7119 through their contacts.

The tone circuit, known as the "order tone," for indicating to operators that a connection has been established is under the control of the tone relays shown in Fig. 71. The operation of either of relays 7105 or 7106 indicates to the position operator, that the incoming call is from a ring-down intertoll trunk and also establishes a characteristic circuit to the marker. With these relays released, circuits are established for indicating that the call is from a straightforward intertoll trunk. In the case where both relays are released three pulses of order tone are transmitted to both the distant operator and the cordless operator. When only one of the above relays is operated the tone will be transmitted only to the cordless operator. One pulse of tone is transmitted when relay 7105 is operated and two pulses

of tone are transmitted when relay 7106 is operated.

The order tone circuit is established from the position control circuit through contact 10 of relay 6511 which associates ground with lead 7140, through contact 4 of relay 7108, lead 7141, contact 4 of relay 7127, contact 4 of relay 7126, winding of relay 7128 to battery. Relay 7128 is the first of a series of operations for energizing and de-energizing the tone circuit. This tone circuit may be traced from tone source 7142 through various contacts of relays 7120, 7125, 7126, 7127 and 7128, thence through the right winding 7111 of tone transformer 7109 to ground. The tone is transmitted by induction through winding 7110 of tone transformer 7109, through contacts 1 and 5 of relay 7108 to the talking conductors which in one case extend through contacts 1 and 5 of relay 7203 and windings 7205, 7206 and 7207 of transformer 7204, by induction through coil 7208 to the cordless operator's headset. As previously stated, on certain calls the tone is transmitted only to this cordless operator, but in the case of a straightforward intertoll incoming call, when relays 7105 and 7106 are both released, the tone is transmitted through contacts 1 and 7 of relay 7106, 1 and 8 of relay 7105, thence through the contacts of relays 7102 and 7101, contacts 4 and 5 of relay 5504, leads 5544 and 5545 to the trunk conductors. The sequence of operation of the tone relays is as follows: Relay 7128 operates to ground on contact 10 of relay 6511 as previously traced. The operation of this relay establishes a circuit for relay 7127 to the same ground through contact 4 of relay 7128 and contact 4 of relay 7126. The operation of relay 7127 closes the tone circuit through its contact 3 from the tone source and the tone coil 7111. Relay 7127 locks through its contact 4 and contact 4 of relay 7126 and opens the operating circuit for relay 7128 which releases. A circuit is thus established for relay 7126 through contact 5 of relay 7127 and contact 3 of relay 7128. The operation of relay 7126 opens the tone circuit for ending the first impulse of tone. The circuit for relay 7127 is opened by the operation of relay 7126, causing its release. A circuit is now established for relay 7125 through contact 1 of relay 7126 and a locking circuit is established through its contact 3. This sequence of events again establishes an operating circuit for relay 7128 through contact 6 of relay 7126 and contact 4 of relay 7127. A second impulse of tone is now started by again closing the tone circuit through contact 1 of relay 7128, normal contact 1 of relay 7127, contact 1 of relay 7125, which is operated through coil 7111, to ground. The circuit of relay 7126 was opened by the operation of relay 7128 and releases. A circuit is now established for relay 7127 which is the same as the circuit over which it was previously established, and a circuit is also established for relay 7120 through contact 2 of relay 7125 which is held locked, contact 2 of relay 7127 and contact 1 of relay 7126 to the original ground as traced from contact 10 of relay 6511. Relay 7120 locks to this same ground. Operation of relay 7127 opens the circuit for relay 7128, causing its release and opening the tone circuit which ends the second pulse of tone. A circuit is now established for relay 7126, which circuit is the same as previously established for this relay. This again closes the tone circuit for a third impulse of tone and opens the circuit for relay 7127. This tone circuit, which is the last tone circuit established, may be traced from the tone source 7142 through contact 1 of relay 7128, contact 2 of relay 7126, contact 3 of relay 7120, winding 7111 of the tone coil to ground. A circuit is now established for relay 7128 through contact 6 of relay 7126, contact 4 of relay 7127 over lead 7141 to the original ground, and the operation of relay 7128 opens the tone circuit and terminates the third impulse and also establishes a circuit for relay 7108 through contact 1 of relay 7120, contact 2 of relay 7127, contact 2 of relay 7128 to the originating ground. Relay 7108, in operating, establishes a locking circuit for itself through its contact 4 to ground over lead 7140. The operation of relay 7108 separates leads 7140 and 7141 at its contact 4, thus releasing all of the relays which were held to this ground including 7120, 7125 and 7128.

The foregoing explains the operation of the tone circuit when a series of three tones is given in the case where a call is incoming to the toll office over a straightforward trunk, which tone is heard by the cordless operator and the originating toll operator in a distant office both in the case of a new call and in the case of a recall by the originating distant operator. On a call of this character neither relay 7105 nor 7106 is operated.

As previously described, where an incoming ring-down trunk is used for an incoming call relay 7106 is operated when the call is a new call or a recall from the calling distant operator. Upon the establishment of a recall from the distant calling office where the called party does not answer, relay 7105 is operated. In the arrangement of apparatus when the called party does not answer both relays 7105 and 7106 are operated but relay 7105 is the only one effective for controlling the tone circuit.

It will be remembered that when the class indications were described the operation of relay 7121 indicated a new call from an incoming ring-down intertoll trunk or a recall from the calling end of an incoming ring-down intertoll trunk and that on this call or recall a circuit was established for relay 7106 and, as stated, only one pulse is transmitted to the cordless operator. The talking circuit to the incoming trunk is opened through contacts 1 and 7 of relay 7106 and thus this pulse does not reach the incoming trunk and is not transmitted to the originating distant toll operator. With relay 7106 operated, a circuit is established for relay 7108 after one pulse has been transmitted. This circuit may be traced from battery through the winding of relay 7108 through normal contact 3 of relay 7105, contact 3 of relay 7106, contact 1 of relay 7126 which is operated at this time, and thence to ground over leads 7141 and 7140 to contact 4 of relay 7108 and contact 10 of relay 6511. Relay 7108, in operating, separates leads 7141 and 7140 and locks through its contact 4 to lead 7140. The relays of the tone circuit are thus released and the transmission of tone is ended after one pulse. It will also be remembered that relay 7105 is operated on a recall from the called toll office or when the called party does not answer. With relay 7105 operated, two pulses are transmitted to the cordless operator but these pulses of tone do not reach the incoming or outgoing trunk. With relay 7105 operated, the operation of the tone circuit relays proceeds as previously described until relay 7127 operates the second time. A circuit is then established for relay 7108 from battery through its winding, inside contact 3 of relay 7105, contact 2 of relay 7125, contact 2 of relay 7127, contact 2 of relay 7128 to ground over lead 7141. The oper-

ation of relay 7108 opens the tone circuit as previously described and locks through its contact 4 to lead 7140.

In certain instances more than one operation has taken place at the same time. For example, the sender start relay 6502 is operated as soon as certain relays are in the following positions: Relay 6508 operated, relay 5600 released, relay 6510 released, relay 6511 operated, relay 6506 released, relay 6503 operated and relay 6501 released. The operating circuits for the foregoing relays designated as operated were established as previously described. The circuit for the sender start relay 6502 may therefore be traced from ground through contact 1 of relay 6508, contact 5 of relay 5600, contact 2 of relay 6510, contact 4 of relay 6511, contact of relay 6506, contact 5 of relay 6503, contact 2 of relay 6501, winding of relay 6502 to battery. Relay 6502 locks over lead 6516, contact of relay 5609, lead 5618, normal contact 5 of relay 6604, lead 6610 to ground through contact 2 of relay 5608 which was operated by relay 5605. The operation of the sender start relay 6502 establishes an operating circuit for sender control relay 2408 of the sender from ground through its contact 3, lead 2420, winding of relay 2408 to battery. Relay 2408 operates relay 6501 from battery through its winding, lead 6515, contact 2 of relay 5609, lead 2421, contact 8 of relay 2408 to ground. Relay 6501 locks to this same ground through its contact 1 over lead 2421. This opens the operating path of the sender start relay 6502 which now remains operated under control of its locking circuit. The above relay 6501 is slow in operation to guard against too rapid seizure of the sender.

The elements of the position sender may be roughly divided with respect to their functions into principal parts: the key-set, the register circuit, the connector control circuit for associating a connector between the sender and the marker, and control relays for establishing circuits through the connector to the marker for controlling operations of apparatus in the marker.

The key-set is of the locking type and consists of eleven rows of keys, each having ten individual keys. The eleven rows are numbered 0 to 9 from the bottom up and may carry letter designations in addition to the numerals for party designations used in some cases. Key 3401 at the left of the code keys is used for associating incoming calls with the call order board (not shown). On calls to the call order board, the cordless operator will operate key 3401 and follow this with the operator's number on the first row of keys. Key 3401 operates relay 5704 in the sender which establishes a circuit over lead 7484 for operating the marker relay 4701 which transfers the registrations to a different set of relays for extending the call to the call order board. On all other calls, the cordless operator sets the code keys 3403, 3405 and 3507 and continues across the key-set in regular order when the numerical keys are required for setting the registers. Grounded circuits are established for the code keys 3403, 3405 and 3407 by the operation of relay 5701. Grounded circuits for the numerical keys are established by the operation of a start key 4530 which is energized after the numerical keys have been set. The energization of key 4530 establishes a circuit for start relay 5705 which maintains contacts closed for later use and at this time establishes a circuit for relay 2411 over lead 5735. This circuit may be traced from ground through contact 3 of relay 6714 when operated, contact 4 of relay 5705, lead 5735 through the winding of relay 2411 to battery. The numerical keys are required on terminating calls where an extension is completed in an office in the area in which this toll office is located and for calls requiring the services of an outgoing sender. The code registering keys and register relays of this toll office are wired in a manner to distinguish between toll calls which are extended to another toll office and toll calls which are terminated locally. For example, the toll codes are arranged so that an 0 or 1 appearing as the first code indicates definitely that the call is to be extended to another toll office and that the connection should be established over the toll train of switches, Figs. 14 and 15. For this purpose, when the 0 key of the key-set 3403 is actuated, a positive signal is registered by operating the sender A1 register relay 3309 and the sender A4 register relay 3312. This registration is later transferred to a selected idle marker and, consequently, the A1 and A4 relays of the marker register are operated to designate that 0 is the first number of the code. This is also true of the 1 key which sets the A1 register relay 3310 in the sender which later sets the A1 register relay of the marker to indicate that the first digit of the code is a 1. Otherwise, the code registers are set in a manner well known in the art. For example, when the operator sets the No. 1 key of key-set 3403, 3405 or 3407 an obvious circuit is established for operating the No. 1 relay of the A, B or C register relays 3309, 4400 and 4404. Key No. 2 sets register relays 3311, 4401 and 4406. Key. No. 3 sets registers 1 and 2 which in the A register would be 3309 and 3311. Key No. 4 will set the No. 4 register, relays 3312, 4402 and 4407. Key No. 5 sets the No. 5 register which are relays 3313, 4403 and 4480. The other keys set registers which are additive to establish a circuit over the particular leads for setting the marker registers according to the code register. For example, key 6 operates registers 1 and 5; key 7 operates registers 2 and 5; key 8 operates registers 1, 2 and 5; and key 9 operates registers 5 and 4. The registers operated establish circuits to the marker as soon as the connector circuit has been seized and established. It may be stated, however, at this time that the registrations in the sender establish circuits through leads 7456, 7457, 7458 and 7459 for setting the marker A register relays in Fig. 46 according to the registrations in the sender. The B registrations are transmitted from the B sender register relay over leads 7452, 7453, 7454 and 7455 to the B register relays in Fig. 46 of the marker and the C registrations are transmitted from the sender C register relays over leads 7463, 7464, 7465 and 7466 for setting the relays of the C register in Fig. 58 of the marker.

It may be assumed for this example that the code registered is 057 which indicates an incoming via toll call, which should be extended through the toll train of switches 14 and 15 to a distant toll office. As soon as the sender is seized and relay 2408 operated, as previously described, relay 5701 is operated for associating ground supply circuits with the code keys 3401, 3403, 3405 and 3407. The circuit for operating relay 5701 may be traced from ground on contact 2 of relay 2408 over lead 5715 through contact 3 of relay 5700, winding of relay 5701 to battery. The operation of relay 5701 extends this ground from contact 2 of relay 2408 through contact 1 of relay 5701, contact 4 of relay 5702, thence over lead 5717 to keys 3401, 3403, 3405

and 3407. The operation of the 0 key in key-set 3403 connects this ground through the winding of relay 3312 and through the winding of relay 3309. The operation of the No. 5 key in key-set 3405 establishes a circuit from this ground through the winding of the No. 5 B register relay 4403. The operation of the 7 key in the key-set 3407 associates ground with the winding of No. 5 relay 4408 in the C register circuit and also through the lower winding of No. 2 relay 4406 of the C register circuit. The operation of these relays establishes circuits, as previously stated, for operating the marker register relays 1 and 4 of the A register, 5 of the B register and 2 and 5 of the C register. The operation of the sender register relays, as above given, establishes a circuit for relay 5700 from battery through its winding, thence over lead 5718 through contact 3 of relay 4408, contact 3 of relay 4403, contact 4 of relay 3309 to ground. The circuit for relay 5700 is established after at least one register in each set of registers has been set. This relay now starts the selection of a connector circuit for connecting the sender with the marker. The operation of relay 5700 releases relay 5701 which establishes a circuit for the operation of relay 6700 from battery through the lower winding of relay 6700, contact 3 of relay 6703, contact 1 of either relay 6707 or 6708 previously operated by the sender, contact 8 of relay 6714 normal, contact 2 of relay 5700 to ground on contact 2 of relay 2408. Either or both of the above relays 6707 and 6708 are operated when the sender is seized, depending upon the class registration of the calling incoming trunk or the registration made by the cordless operator on the code register keys.

When the transmission characteristic of a calling incoming trunk is that used for via calls to an outgoing intertoll trunk extending to another toll office, relay 6707 is operated from battery through its winding, contact 4 of relay 6714 to ground on class register relay 7219, which was operated as previously described, over a circuit to the incoming intertoll trunk. When the transmission characteristic of the calling incoming trunk is that which terminates in the area of the toll office, a terminating call, relay 6708 is operated from battery through its winding contact 1 of relay 6714, lead 7324 to ground on contact 4 of class relay 7217, also operated by a circuit as previously described extending to the incoming trunk. In certain cases on via calls in combined groups, relays 6707 and 6708 are both operated. In the case of a toll call with either relay 6707 operated or both relays 6707 and 6708 operated, relays 5703 responds to indicate to the marker that an intertoll connection is to be completed. When relay 6707 only is operated, a circuit for relay 5703 may be traced from battery through its winding, contact 3 of relay 5704, contact 4 of relay 6707 to ground on contact 3 of relay 6708. When relays 6707 and 6708 are both operated and the code registers are set for routing the call to an outgoing intertoll trunk, the circuit for relay 5703 is established through the register relays and may be traced from battery through its winding, contact 3 of relay 5704, contacts 3 and 2 of relay 6707, contact 7 of relay 6714, over lead 6723, contact 6 of relays 3307 and 3308, contact 6 of relay 3309, contact 6 of relay 3311 normal, contact 5 of relay 3313 normal to ground on contact 1 of relay 2408. As previously stated, the register relay 3309 is operated by key 0 and thus indicates a toll call when relays 3311 and 3313 are normal. It is apparent that, if either relay 3311 or 3313 is operated as could be the case on a terminating call, the circuit above traced for relay 5703 would not be completed.

There are optional features in the toll system for transmitting code information to the marker. For three-digit areas, it is necessary to transmit information to the marker from the A, B and C code registers. In two-digit areas and other specific areas, it is only necessary to transmit information to the marker from the A and B registers with possibly a 0 for the C register which operates relays C1 and C4 for transmitting the 0 to the marker register. For a one-digit area and other specific areas, it is necessary to transmit information to the marker only from the A register with a 0 from the B and C registers. This would mean that the 1 and 4 relays are operated in both the B and C registers. This also applies to code information for connections to special operators. The TX key 3401 operates relay 4701 in the marker in order that the call be connected to a special operator.

Marker connector

When the digits of the office code have been registered in the sender and relays 5700 and 6700 have been operated or when the sender has recognized a reorder signal, it establishes a start circuit for actuating a marker connector shown in Figs. 73 and 74. The function of the connector is to seize an idle marker in a common group of markers and associate the sender therewith. If no marker is available the connector waits a limited time for an idle marker to become available and seizes this marker for making the proper connections. A busy connector is indicated by the operation of relay 7302 which associates ground with lead 7450 and an idle connector is indicated by the absence of ground on this lead. The operation of relay 5700 establishes a circuit for testing the idle or busy condition of the preferred connector which circuit may be traced from battery through connector 4 of relay 5700, contact 6 of relay 6711, resistance 5720, winding of relay 5707, thence over conductor 7450 to contact 1 of relay 7302. If the preferred connector is busy and relay 7302 is operated the circuit is established for relay 5707 to ground on the contact of relay 7302. The operation of relay 5707 transfers the connector start lead to another connector (not shown). The start lead for the preferred connector as traced later is over lead 7451 and for an alternate connector is over lead 7451A. If the preferred connector is idle, as will be used for this example, relay 7302 remains normal and a circuit is not completed for the operation of relay 5707. The connector start circuit is therefore completed from battery through contact 3 of relay 6700, contact 4 of relay 6711, contact 4 of relay 6703, contact 6 of relay 6704, contact 3 of relay 5707, conductor 7451, winding of relay 7301 to ground, the latter relay being individual to this sender in this connector. This connector is shown associated with a plurality of senders, each having a relay such as 7300 or 7301 connected thereto. A chain circuit is extended through relays such as 7300 and 7301 to make the connector busy to other senders in a sender group when one sender of the group seizes the connector. As previously stated when a sender finds the preferred connector busy, it is transferred by the operation of relay 5707 to another connector and thus no interference is encountered between senders of a group in seizing connectors for con-

necting the senders to idle markers. Relay 7301 operates in the start circuit traced, which establishes a circuit for the multicontact relay 7304 from ground through contact 3 of relay 7308 over a chain circuit through like relays associated with a plurality of senders, thence through contact 3 of relay 7301, winding of relay 7304 to battery as traced over start lead 7451. The operation of the multicontact relay 7304 now establishes a circuit from the sender over lead 7445 for obtaining the use of an idle marker. This circuit is extended to a relay associated with the preferred marker. If this marker is busy the circuit is progressively advanced over a chain of contacts to find an idle marker. This circuit for obtaining access to an idle marker extends from battery on sender relay 6700 through its contact 3, contact 4 of relay 6711, contact 4 of relay 6703, contact 3 of relay 5703 thence over conductor 7445 through contact 6 of relay 7304, contact 2 of relay 7401, winding of relay 7402 to ground.

The circuit traced assumes that the marker preferred by this connector is idle. If, however, this marker has previously been seized by a sender using a different connector, a busy condition would have been established which would have operated relay 7401 in the connector shown herein. This would advance the start circuit through the inner contact 2 of relay 7401 for operating relay 7404, if the marker No. 2 associated with relay 7404 is idle. When this condition exists marker No. 2 is taken for use instead of marker No. 1 and the leads from the sender are extended to marker No. 2 by the operation of relay 7406. Assuming that marker No. 1 is found idle relay 7402 is operated over the circuit as previously traced which establishes an obvious circuit for the multicontact relay 7405 for connecting the operating and control leads from the sender to the marker. A busy condition is also immediately established for this marker in all other connectors where it appears for service connections to senders. The operation of relays 7402 and 7405 places a shunt on relay 7401 to prevent its operation when ground is connected to lead 7498 by the maker as will be later traced, to make this marker busy to all senders associated with other connectors. This shunt circuit may be traced from ground on contact 3 of relay 7405 through contact 3 of relay 7402 to a point between resistance 7408 and the winding of relay 7401. Ground is connected by contact 4 of relay 7405 to lead 7497 extending through the winding of marker relay 5003 to battery which operates and connects ground through its contact to lead 7498 which extends through the windings of a plurality of relays 7401 used for connecting this marker to senders through other connectors. As explained above a shunt was placed around winding of 7401 in this connector from ground on contact 3 of relay 7405 and therefore relay 7401 in this connector does not operate from ground placed on conductor 7498, but this ground is extended over multiple connections 7409 through the windings of other relays the same as 7401 in other marker connectors which do not have the shunt ground connected thereto. It is apparent therefore that in the other connectors the relay 7401 operates for extending the start lead to another marker over a chain circuit previously described. The operation of the marker preference relay 7402 also connects ground from contact 5 of relay 7304 to lead 7499 for operating relay 6808 which circuit may be traced as follows: Ground on contact 5 of relay 7304, contact 3 of relay 7402, conductor 7499, contact 7 of relay 6807, contact 7 of relay 6808, thence over lead 6811 through sheets 69, 70, 60, 61, 49, 50, 51, 40, 30, 20 and 19 to contact 4 of relay 1901 returning through the same sheets over lead 6810 through the winding of relay 6808 to battery. The latter relay operates and locks to the same ground. The operation of relay 6808 establishes operating circuits from its contacts 1, 2 and 3 for relays 6801, 6802 and 6803 over obvious circuit paths through contact 2 of relays 6804 and contacts 2 and 3 of relay 6805. Relay 6808 also connects ground with leads 7467, 7468 and 7469 extending to the sender circuit through the multicontact relays 7405 and 7304 to leads 7467, 7468 and 7469, respectively, in the sender circuit. Relay 6808 also connects ground to leads 6812, 6813 and 6814 extending to the marker and closes a circuit from battery through this contact 4, the use of which will be given in the marker circuit operation. To facilitate following the circuit paths from the sender, through the connector to the marker, the circuit leads have been given the same numbers in the sender, connector and marker.

When the marker connector establishes a connection between a sender and a marker, the marker immediately receives the record which has been set up in the sender such as the record of the code, the preference of the sender for odd or even cross-bar switch frame connectors, information regarding the type of incoming trunk over which the toll call was initiated and the transmission characteristic of this trunk, the routing required over an outgoing trunk, and the transmission characteristic of the outgoing trunk including the train of cross-bar switches to be used for completing the connection. The character of outgoing trunk to be selected is given to the marker automatically by registrations of the class and type of calling incoming trunk and the code registrations. The sender at this time tells the marker whether a previous attempt has been made to complete the connection from the calling incoming trunk. If the marker fails for any reason to function properly on the first trial, its time measuring circuit will ground lead 7473 which operates relay 6703 to notify the sender to release the marker and make a second trial according to circuit operations later described for this second trial. In making this second trial a different marker is usually obtained, although under some conditions the same marker may be selected. The timing circuit 5108 is shown diagrammatically associated with a timing interrupter which operates a series of relays 5104, 5105, 5107, 5106 and 5103. Relay 5103 connects ground to the lead 7473, through the connector for operating the relay 6703 in the sender. Relay 6703 releases relays 6700 and 5700, which opens the start leads for the connector and marker thereby releasing the leads therebetween and breaking all direct connections between the sender and marker and also releasing all relays used for registering information in the marker. Subsequently, the relays 6700 and 5700 are reoperated for making a second trial to complete the connection. All of the register relays in the marker, including those which record the above items of information, are reoperated, provided, of course, none of their leads are open. Those which are not operated by ground from the sender are operated by ground from the contacts of relay 6808 extending to contacts of sender

register relays as will be shown throughout the description.

Marker registrations

Considering this as a first trial with the marker associated with the sender as previously described, the following register relays in the marker are operated, including registers for establishing an initial series checking circuit, some of which may be released before connecting circuits are established. All of the A and B register relays of Fig. 46 and the C register relays in the upper portion of Fig. 58 are operated from ground placed on leads **7467** and **7469** by the operation of relay **6808** in the marker or by grounds placed on some of the leads **7452** to **7459**, inclusive, and leads **7463** to **7466**, inclusive, by the operation of some of the sender register relays. The ground circuits for leads **7467** and **7469** may be traced from contacts **1** and **3** of relay **6808** through contact **3** of relay **6805** and contact **2** of relay **6804**, thence through the contacts of connector relays **7405** and **7304** to the contacts of the sender register relays **3309** to **3313** and **4400** to **4408**, inclusive. Ground circuits are thus established through the contacts of all A, B and C sender register relays which are not at the time operated and extended over any of the leads **7452** to **7459**, inclusive, and **7463** to **7466**, inclusive, associated therewith, through the contacts of connector relays **7304** and **7405** to the windings of the marker A, B and C register relays. Relay **5808** is operated over lead **7319** from the sender class relays or from ground on lead **7468** over lead **7462** extending to the marker. Relay **7005** is operated from ground on lead **7468** which is connected in the sender to lead **7481**. Relay **7004** is operated through the contacts of the sender class relays over lead **7482**; relay **4701** is operated from ground through the contacts of relays **5704** over lead **7484**. Relay **5807** is operated over the lead **7461** and ground through the contacts of relay **6704**. Relay **5806** is operated from this same ground. Relay **5805** is operated over lead **7460** either from ground on the contact of relay **6702** or from ground applied by relay **6808** to lead **7468** which, as noted, is connected to lead **7460** in the sender. While these register relays are all operated, a series circuit is established through their contacts for the operation of relays **6804** and **6805** which may be traced from ground on contact **4** of the A1 register relay **4601** over a series circuit extending through the contacts of the A register relays **4602**, **4603** and **4604** to contact **3** of the B1 register relay **4605**, over a series circuit through the contacts of B register relays **4606**, **4607**, **4608** and **4609** to contact **3** of C1 register relay **5801**, over a series circuit through B register relays **5802**, **5803** and **5804**, thence through contact **3** of relay **5805**, contact **6** of relay **4701**, contact **1** of relay **7004**, contact **4** of relay **7005**, contact **3** of relay **4008**, contact **2** of relay **5808**, contact **2** of relay **6801**, contact **2** of relay **6802** and contact **2** of relay **6803** through the left windings of relays **6804** and **6805** to battery. The operation of relays **6804** and **6805** removes ground from the windings of relays **6801**, **6802** and **6803** and from leads **7467**, **7468** and **7469**. The removal of ground from leads **7467** and **7469** disconnects ground from the windings of the marker register relays which were operating through circuit paths extending through the contacts of the non-operated sender A, B and C register relays. The removal of ground from lead **7468** also disestablishes circuits as traced which are not established by registrations in the sender. Therefore, at this time the only register relays in the marker which remain operated are those which are operated directly from ground through contacts of operated sender register relays for recording information to the marker to guide the marker in completing the connection as designated over the incoming intertoll trunk.

The operation of relay **6804** and release of relays **6801**, **6802** and **6803** establishes a circuit from ground on contact **1** of relay **6804** through contacts **1** of relays **6803**, **6802** and **6801**, windings of relays **6806** and **6807** to battery which operate both of the latter relays. The operation of relay **6808** also connects ground to leads **6812**, **6813** and **6814**. A circuit is established for marker battery and ground supply relays **1903** and **1904** from ground on contacts of relay **6808**, over lead **6812** extending through sheets **69**, **70**, **60**, **61**, **49**, **50**, **51**, **40**, **30**, **20**, contact **3** of relay **1901**, windings of relays **1903** and **1904** to battery, both of which operate. The circuits over leads **6813** and **6814** are not established at this time and are used during the operation of the marker apparatus.

Route relay selection

The route relays are operated over circuit paths created by the operation of the register relays, Figs. 46 and 58, certain fifties relays and certain tens relays. As is well known, the number of fifties and tens relays depends upon the maximum number of routings to be established in an office. Only two fifties relays, **5903** and **5904**, and two tens relays, **5901** and **5902**, have been shown for completed typical circuit paths for this toll office. The circuits for the operation of fifties relays are established through the contacts of the A register relays **4601**, **4602**, **4603** and **4604** and B register relays **4608** and **4609**. The circuits for the operation of tens relays are established through the contacts of B register relays **4605**, **4606**, **4607** and **4608**. The circuit paths for the operation of the route relays are over a combination of relay contacts established by the operation of certain of the C register relays **5801**, **5802**, **5803** and **5804**, certain tens relays, such as **5901** and **5902**, and certain fifties relays, such as **5903** and **5904**. It is clear that a large plurality of contact combinations can be made in the above manner for establishing circuit paths for the operation of different route relays. The circuit for route relays is extended from the windings of the route relays through the contact combinations established through the above relays to ground on the contacts of relays **6804** and **6805**, as will later be traced. An example of route relays for this toll office is shown in the right portion of Fig. 47 and the left portion of Fig. 48 for associating incoming trunks with outgoing trunks having particular destinations. There may be approximately as many route relays assigned for intertoll routes as there are trunk group relays, which are also known as trunk block relays, associated with the various groups or subgroups of outgoing trunks to toll offices. Other route relays are assigned for connecting incoming trunks from toll offices with outgoing toll switching trunks to offices within the area of the toll center and to trunks extending to tributary offices which may appear on either the toll trunk assignment frame Fig. 31 or the terminating trunk Fig. 51 assignment frame. Other route relays are assigned for toll trunk groups, known herein as jump hunt groups of trunks, which may be

reached by a route relay, such as relay 4802, which may be assigned to a group of trunks which has been added for the purpose of enlarging a regular group of trunks. The jump hunt routing will be explained in connection with trunk groups which do not have sufficient capacity to handle an unforeseen demand with relation to calls for a particular toll office. This addition of trunks on a jump hunt basis is, however, made necessary only when there is insufficient space for the added group of trunks on the same frame with the original group of trunks. The means of associating this added jump hunt group of trunks with the trunk group originally assigned to an office will hereinafter be explained in connection with the frame number indicating system. The trunk block associated with a group of outgoing trunks ordinarily has a capacity for forty trunks each having a route relay assigned thereto for associating the apparatus of the marker with the test terminals and apparatus of the outgoing trunks of the group through the contacts of multicontact trunk block relays such as shown in Fig. 31. There is a large plurality of such trunk block relays which is at least the equivalent of the number of route relays to facilitate the association of the apparatus of the marker with all groups and subgroups of trunks to assign a connection from an incoming trunk to an available idle outgoing trunk having the desired destination.

A large plurality of three-digit codes may be provided for intertoll switching and service codes, terminal codes which the sender receives as one, two or three-digit codes are usually received by the marker as three-digit codes with zero substituted by the sender for omitted digits. Examples of arrangements are given below with arbitrary letters for different characters of areas.

A, B, C area—Absence of zero or one in all three places.

A, B, X area—Absence of zero or one in first two places.

A, B area—Absence of zero or one in first two places.

A area—Absence of zero or one in first place.

A, B or A, B, X area—Absence of zero or one in first two places.

A or A, B area—Absence of zero or one in first place.

Three-digit codes not used for local or service codes or not started with zero are used for intertoll codes. Examples of three-digit toll codes may be distinguished as follows:

Area 1—Any code containing zero or one in any digit except codes starting with one which also have one in the second or third place.

Area 2—Any code containing zero or one in the first two digits except codes starting with one which have one in the second position.

Area 3—Codes containing zero or one in first digit except codes starting with one which have one in the third position.

Area 4—Where three digits do not provide enough intertoll codes, four-digit codes may be employed. It is, however, not necessary that they be disclosed for the invention being described.

As hereinbefore stated the tributary trunks outgoing from the cross-bar switching office appear in both the toll train of switches and the local train of switches and consequently tributary codes may be either terminal or intertoll codes.

Delayed outward operator codes may be one, two or three-digit codes but no combination of these is used for reaching the delayed outward operator who may be centralized or decentralized. The incoming sender on calls from pulsing trunks receives distinctive preliminary digits such as 11 and on calls to the cordless position the position sender recognizes the depression of the delayed outward operator's key as a signal that a delayed outward code is required. In either case lead 7484 to the marker is grounded to operate the cut-in relay 4701 which transfers the registers to a different group of fifties relays for the operation of the correct route relay, extending the connection to the delayed outward operator.

Incoming intertoll calls may be for groups containing terminal, via or combined trunks or any combination of the three. The type of trunk required is usually indicated by the first digit in the intertoll code such for instance, as the zero alone or a zero preceding a one registers a via code. A one alone or preceding a one or zero registers a terminal code. A circuit in the marker from ground on contact 2 of relay 6806 through normal contact 5 of relay 4701 and contacts of the A, B and C register relays (Figs. 46 and 58) when operated for registering a via toll code is used to operate the via code relay 7002. Another circuit from the same ground and contact 5 of relay 4701 when it is operated is directed through the contacts of the A, B and C register relays operated for registering a terminal code is used to operate a non-via code relay 7001 which operates on all terminating calls. The via relay 6907 or terminal relay 6908 used for controlling the test of trunks in subgroups is thus operated depending upon the routing of the call.

The provision of two trains of switches, one for telephone connections which terminate within the area of the toll office and the other train of switches for telephone connections which are extended to distant toll offices, makes possible the selection of many more paths for completing telephone calls than would be possible with a single train of switches. The character of the intertoll trunks connected to either train of switches is the same. Trunks which are known as via intertoll trunks are connected through the toll train of switches when extended to a distant toll office but are connected through the terminating train of switches when extended to an office within the area of the toll center. The character of the trunk used depends entirely upon the distance over which the call must travel and the train of switches used depends entirely upon where the call terminates. A call using a via inter-toll trunk may originate in a distant toll office, for example, office A, and be extended through the toll train of switches of this toll office to a third toll office. A call originated in this same distant toll office, for example, office A, which is to be terminated in the cross-bar switching toll office, would use a terminal intertoll trunk and connection would be made over the terminating train of switches. A call originating in a second distant toll office through office A which is to be terminated in this cross-bar toll office would use a via intertoll trunk which would be extended through the terminating train of switches in the cross-bar toll office to a toll switching outgoing trunk extending to an office within the area of the toll center. The foregoing explanation is given to point out the advantage of two trains of switches in the cross-bar toll office and to make clear the character

of trunks which are used for different connections over the different trains of switches.

Routing over toll train of switches

A typical arrangement of route relays has been disclosed in the right portion of Fig. 47 and the left portion of Fig. 48 for controlling routings to different characters of outgoing trunks which is believed to cover examples of sufficient scope to demonstrate the completion of connections from incoming calls from intertoll or tandem trunks to distant toll offices or to terminating offices within the area in which the cross-bar switching office is located or which may be tributary offices a short distance from the toll center. Route relays **4702** and **4703** are arranged in combination for successively associating the marker apparatus with two groups of the same kind of trunks and selecting idle trunks from either group. Route relay **4702** is also wired for an example of selectively or successively associating the apparatus of the marker with small subgroups of outgoing trunks of different character under the control of a single route relay. By the use of this method an incoming call may be routed to any one of three different types of outgoing trunks, via trunks for toll connections involving more than two toll offices, terminal trunks for connections from one toll office to another toll office and combined toll trunks which may be used as either a via or terminal toll trunk. Route relay **4804** is arranged to select idle trunks extending to the delayed outward operator. Route relay **4801** is arranged for selecting terminating trunks only. Route relay **4802** known as jump hunt route relay is arranged to select trunks which have been temporarily added to a group of trunks which has outgrown the service required in this trunk group. Let it be assumed for the first example that an incoming call has been received in this office from a distant toll operator who has requested a connection which must be routed through another distant toll office and that therefore the call is known as a via call which requires intertoll trunks of the highest transmission quality obtainable. Also let it be assumed that this group of trunks is large enough to require the service of two route relays **4702** and **4703**. In this case the transfer relay **4701** is normal and the fifties relay **5904** and tens relay **5902** are operated and the relays of the registers A, B and C (Figs. 46 and 58) must be set for this character of connection. Assuming that register relays **4608** and **4601** have been operated the circuit for operating the fifties relay **5904** may be traced as follows: Battery through winding of fifties relay **5904**, contact **3** of relay **4701**, lead **4729**, contact **3** of relay **4608** operated, contact **2** of relay **4602** normal, contact **3** of relay **4604** normal, contact **5** of relay **4601** operated, contact **3** of relay **4603** normal, contact **1** of relay **5805** normal, contact **3** of relay **6801** normal to ground through contact **3** of relay **6804** operated. Let it be assumed that register relay **4607** has been operated to complete a circuit for the tens relay **5902** which circuit may be traced as follows: Battery through the winding of tens relay **5902**, lead **5950**, contact **5** of relay **4605** normal, contact **4** of relay **4606** normal, contact **1** of relay **4607** operated, contact **3** of relay **6802** normal to ground to contact **4** of relay **6805** operated. With the above relays operated, a particular fifties relay of a large group of fifties relays and a particular tens relay, a circuit is established for route relay **4702** by the operation of particular register relays **5803** and **5804** which circuit may be traced from battery through the winding of route relay **4702**, contact **4** of the fifties relay **5904**, contact **2** of the tens relay **5902**, lead **5932**, contact **2** of register relay **5804** operated, contact **2** of register relay **5803** operated, contact **2** of register relay **5802** normal, contact **1** of register relay **5801** normal, contact **4** of relay **5803** operated, contact **2** of relay **5805** normal, contact **3** of relay **6803** normal to ground through contact **1** of relay **6805**.

Route relay **4702** operates and in so doing establishes circuits for testing and selecting an idle trunk in a group of trunks extending to a particular distant toll office. Connector circuits are used between the marker and the trunk blocks of a trunk assignment frame similar in character to the connector between the sender and the marker. These connectors are selected for temporary use by the marker as required. For this example the contact **9** of route relay **4702** is connected to a connector start lead for operating the start relay **4803** corresponding to the assignment connector associated with the trunk block containing the wanted outgoing intertoll trunk which extends to the distant toll office requested over the incoming intertoll trunk.

After the operation of the route relay **4702** leads are connected from certain register relays to the trunk block having the group of trunks associated with and controlled by this particular route relay. As previously stated, the switch frames and senders are divided into odd and even groups. If an odd sender seizes a marker on first trial, register relay **5808** of the marker is operated. If on first trial the marker is seized by an even sender, this relay remains normal. An odd sender associates ground directly with lead **7462** which maintains relay **5808** operated. When an even sender seizes a marker, relay **5808** is momentarily operated by ground over conductor **7468**, but upon the release of certain relays, hereinbefore described, relay **5808** releases. Assuming that the marker is seized by an odd sender, a circuit is established to operate relay **5101** if it is on a first trial and **5102** on second trial. The circuit for operating relay **5101** may be traced from ground through contact **3** of relay **6807**, contact **1** of relay **5808**, contact **2** of relay **5807**, thence over conductor **5927** to battery through the winding of relay **5101**. On second trial relay **5807** is operated, which establishes a circuit in the same manner over lead **5928** for relay **5102**. Relays **1903** and **1904** having previously been operated over a circuit from ground on contact **8** of relay **6808**, lead **6812**, contact **3** of relay **1901** to battery through the windings of relays **1903** and **1904**, a circuit will now be established for operating the marker preference relay **4119** for associating what is known as the "assignment frame connector" between the marker and the groups of outgoing trunk test leads. This circuit may be traced from battery through contact **8** of relay **1903**, contact **3** of relay **5101**, which may be assumed to be operated, contact **1** of relay **5102**, which may be assumed to be normal, lead **4820**, contact **2** of relay **4803** to battery through the winding of relay **4119**, thence over a chain circuit through the marker preference relays to ground on contact **3** of relay **4121**. The operation of relay **4119** establishes a circuit for multicontact relay **4122** from battery through its winding to ground on contact **1** of relay **4119**. The operation of the latter

relay 4122 connects a plurality of leads from the marker to the trunk assignment frame which ultimately provides testing means to ascertain whether there is an idle trunk in the group of trunks controlled by the route relay 4702.

The multicontact relay 4122 first establishes a circuit for the operation of trunk checking relay 1801 over lead 4130. Each assignment connector of the plurality of connectors, may be equipped with a plurality of trunk block relays such as 3113, 3114, 3115 and 3116 each arranged to connect to a group of outgoing trunks which may constitute a small number of trunks 5 or 10 or a larger number of trunks such as forty outgoing trunks. Corresponding trunk block relays in the marker represented by relays 4902 to 4905 are common to the trunk block relays of all of said plurality of connectors representing many different groups of trunks; however, each connector has the same number of trunk block relays as the marker which are correspondingly designated. For completing a typical circuit, the trunk block relay 4902 is cross-connected to contact 10 of route relay 4702 and is associated through this relay contact with ground on contact 17 of the multicontact relay 5905. Relay 4902 is therefore operated when the route relay is operated, since its winding is associated with battery through the winding of timing relay 4901. Relay 4902, in operating, connects lead 4921 to lead 4922. Lead 4922 is connected to battery through contact 8 of relay 1903. Lead 4921 is connected to the winding of trunk block relay 3116 through contact 5 of the multicontact connector relay 4122. Thus the trunk block relay in the connector is operated for associating the trunk test leads of the desired trunk group with the marker test relays shown in Fig. 38. Lead 3125 is shown as an example of one trunk test lead.

The following operations take place preparatory to the test of the trunks of a group for finding an idle trunk to a particular office. Relay 2807 is operated from battery through its winding, over lead 4732, contacts 2 and 3 of relay 4710 to ground on contacts 7 and 8 of the trunk block relay 3116. Relay 2801 is operated from battery through its winding over a series circuit through the contacts of the trunk test relays 3813, 3812, 3811 and 3810, contact 3 of relay 1707, contact 1 of relay 1801, lead 1815 to ground on contact 4 of relay 6806. The series circuit through the contacts of relays 3813, etc., as traced, establishes the fact that these relays are all in condition for making a trunk test and is preliminary to the operation of these relays for the trunk test. In Fig. 38 there are shown three rows of relays, each row extending horizontally across the figure. There are as many relays in each horizontal row as there are trunks in the largest group or subgroup of trunks in an office to be simultaneously tested, usually forty in number. Only sufficient relays are shown to give an example of the testing facilities. The remainder of the equipment and the operation thereof is believed to be clearly understandable from this small number of relays. Proceeding with the preparation of circuits approaching the test of trunks in the group controlled by the route relay, a differential relay 2808 is operated. It will be noted that the circuit for this relay was established by relays previously operated but was maintained in a non-operated position by a shunt from ground through contact 7 of relay 1904, contacts of relays 2807 and 2808. The operation of relays 2807 and 2801 makes effective the operating circuit through the upper winding of relay 2808 from battery on contact 4 of relay 1903 to ground on contact 8 of relay 1904. The operation of relay 2808 connects ground to the first one of relays 3810 to 3813 which is not operated. Relays in this row which are normal (not operated), represent the idle trunks in the group. The first trunk of a group of trunks is tested and taken for use if idle by the functioning of relays 3801, 3806 and 3810 the vertical rows of relays shown in this figure representing the testing apparatus for successively numbered trunks of a group.

It has been assumed that the call being completed is incoming from a distant toll office and is to be extended to another distant toll office, which is known as a "via toll connection." In view of this, the via relay is operated over a circuit established by a register relay combination set up by the sender. Relay 7002 is first operated from battery, through its winding, lead 5943, contact 1 of relay 4603, contact 5 of relay 4604, contact 5 of relay 4602, contact 2 of relay 4601, contact 5 of relay 4701 to ground through contact 2 of relay 6806. This circuit established through the register relays for relay 7002 establishes a circuit for the via relay 6907 from battery, through its winding, contact 1 of relay 7001, contact of relay 7002, contact 4 of relay 4808, lead 4822, to ground on contact 2 of relay 6806. Assuming in this case that all of the trunks in the group to be tested extend to the same distant toll office and therefore are all via trunks of a high character of transmission, a via trunk relay 6915 is cross-connected to contact 12 of the route relay 4702 and is operated when the route relay was operated. This relay is used for progressive operation in case the trunks of this group are all busy. The operation of relay 6907 establishes a circuit for relay 6909 which may be traced from battery, through the right winding of relay 6909, contact 2 of relay 6910, contact 1 of relay 6908, contact 1 of relay 6907 to ground on contact 4 of relay 6806. This ground is also extended through the contact of relay 6907 to contacts of the route relay for marking the number of trunks in a group to be tested. This marking is accomplished by the operation of two of the relays in the upper horizontal row (Fig. 38). If, as presupposed, all of the trunks in the group are via trunks, the trunks of the complete group may be tested to find an idle trunk. In this case the first relay, 3801, is operated and the last relay, 3805, is operated, indicating that all trunks therebetween may be tested to find an idle trunk. For this purpose ground is extended from contact 4 of relay 6806, as traced, through contact 1 of relay 6907, contact 1 of relay 6908, contact 2 of relay 6910 and thence over lead 6921 to contacts 3 and 4 of the ground supply multicontact relay 5905 and contacts 3 and 4 of route relay 4702. In this case also the right-hand contacts 3 and 4 of relay 4702 are cross-connected to relays 3801 and 3805. The circuit through contact 3 of relay 4702 operates relay 3801 for the starting point of test and the circuit through contact 4 of relay 4702 extends to the relay indicating the end of test, or relay 3805. The operation of these two relays, therefore, indicates the limit of the test. An example will be given later of the same arrangement when only part of the group is tested and therefore an intermediate relay is operated to terminate the point of test.

If the first trunk is busy relays 3806 and 3810 are operated. The circuit established for finding

the first idle trunk of a group is therefore extended over a chain circuit on the relays 3806, 3807, etc., until one such relay is found which has not been operated. This represents the first idle trunk. A ground is placed on a lead through the contacts of relay 3806 which, if the first trunk of the group is idle and therefore relay 3806 is normal, will operate relay 3810. If, however, the trunk represented by these relays is busy, relay 3806 will be operated and extend the circuit to relay 3807. If this trunk is idle relay 3811 is then operated. Assuming that the first trunk is idle, a circuit may be traced for operating relay 3810 from battery, through contact 4 of relay 7011, contact 3 of relay 7006, lead 7043, winding of relay 3810, contact 1 of relay 3806, which is normal, contact 2 of relay 3801, which is operated, lead 3830, contact 5 of relay 5807, lead 5830, contact 1 of relay 1804, contact 5 of relay 2801, contact 1 of relay 3801, contact 1 of relay 3805, lead 3831, contact and armature of relay 2808, contact 2 of relay 2807 to ground on contact 4 of relay 6806.

The operation of any of the forty relays such as 3810 to 3813 opens the circuit for relay 2801 to prevent another like relay from operating if a trunk ahead of the one seized should become idle after the idle trunk is selected. This, of course, presupposes that a trunk further along in the series, for instance trunk 10 or trunk 15, is the idle trunk selected, instead of the first trunk as chosen for this connection. Relay 2801 in releasing causes the movement of the armature of relay 2808 to the right.

The operation of relay 3810 connects leads from the idle outgoing trunk selected to the marker and also connects a lead from the select magnet of the cross-bar switch associated with this outgoing trunk to the marker such for example as cross-bar switch 1511. The completion of circuits established by this connection and the operation of the outgoing trunk and switches associated therewith will be resumed after a description of the operation in the marker which takes place when no idle trunk is found in this group of trunks tested.

Heavy traffic between certain toll offices may require the use of several groups of trunks, each group comprising forty trunks. Under this condition where no idle trunk is found in a group of trunks, another group of trunks extending to the same distant toll office is available and is therefore tested to obtain an idle trunk in this second group of trunks. The second group of trunks is associated with and under the control of a second route relay which must be operated for associating the trunk conductors with the testing apparatus of the marker. The following operations takes place when the cross-bar switches for this second group of trunks are located on the same frame as the first group of trunks tested. When all of the trunks in a group have been found busy and there are other trunks available to the same office, a chain circuit is established through the contacts of the test relays of Fig. 38 over lead 7045, winding of relay 7011 to battery, which operates this relay. The operation of relay 7011 establishes an operating circuit for relay 6910 from battery through its winding, contact 3 of relay 6909, contact 5 of relay 7011 to ground through contact 4 of relay 6806. Relay 6910 in operating establishes a locking circuit for itself over lead 2831 to ground through contact 2 of relay 7006 and through the contacts of relay 7011. The operation of relay 6910 opens the locking circuit for relay 6909, which releases. The operation of relay 6910 further establishes an operating circuit for trunk-busy relay 7006 through the contacts of the trunk pattern relay 6915 to battery through the winding of relay 7006, contact 1 of relay 6915, contact 1 of relay 6909, contact 2 of relay 6910, contact 1 of relay 6908, contact 1 of relay 6907 to ground through contact 4 of relay 6806. The operation of the trunk-busy relay 7006 establishes a circuit for shifting operating circuits and trunk testing circuits from route relay 4702 to route relay 4703 by the operation of a progression circuit apparatus or circuit transferring apparatus which transfers circuit establishing conductors from one route relay to another. To accomplish this transfer the trunk busy transfer relay 5906 is first operated over a circuit which may be traced from ground on contact 4 of relay 7006, contact 14 of relay 4702, contact 11 of relay 5905 to battery through the winding of relay 5906. The latter relay, in operating, locks to ground on contact 4 of relay 7006 and establishes an obvious circuit for the operation of relay 5907 through its contact 6 to ground on contact 3 of relay 6806. A locking circuit for relay 5907 through contact 5 of relay 5906 and contact 5 of relay 6002 is established when relay 5906 releases, as later described. Relays 5906 and 5907 establish a circuit for the operation of the multicontact relay 5905 which operates and thus opens all circuits previously established through the contacts of route relay 4702, releases relays which were operated for the previous test and completes new circuits for transferring the trunk test control to another route relay 4703. The operating circuit for relay 5905 may be traced from battery through its winding, contact 2 of relay 5907, contact 2 of relay 5906, contact 2 of relay 3606, contact 3 of relay 6806 to ground. The multicontact relay 5905 locks through its contact 17, contact 4 of relay 5907, contact 1 of relay 6101 to ground on relay 6806. Since the operating circuit for relay 5906 was established through contact 11 of relay 5905, this relay 5906 now releases and in doing so opens the operating circuit for relay 5907 but establishes a locking circuit for relay 5907 through its contact 4 to ground on relay 6806 as given above. Thus, relays 5905 and 5907 remain operated and relay 5906 is released. Upon the operation of relay 5905 the circuit for relays 3801 to 3805 is opened, which release, and in so doing opens the operating circuit for relay 7011 which, it will be remembered, operated when all trunks in the group were found busy. The circuits for the trunk pattern relay 6915 and for the trunk-busy relay 7006 are also opened by the release of relay 5905. The operation of relay 5905 and the release of the trunk-busy relays, now establish a circuit for operating the next successive route relay which selects another group of trunks to be tested. The winding of route relay 4703 is connected to contact 11 of route relay 4702 and therefore a circuit is established for relay 4703 from battery through its winding, contact 11 of route relay 4702, which remains operated, contact 15 of relay 5905, contact 3 of relay 5906, which released, lead 5947, contact 1 of relay 6104, lead 5948 to ground on contact 6 of relay 6806.

The progression from one route relay to another for the purpose of finding an idle trunk to a particular toll office has now been made, the transfer being effected through relays operated when all trunks of the previous group were found busy and also through the operation of relays 5906, 5907 and 5905 and the subse-

quent release of relay 5906. Certain control leads from the sender and the grounded circuits previously described are thus transferred from the contacts of relay 5905 to the contacts of relay 6001 which are now connected to the contacts of route relay 4703. Where the trunks to a particular toll office are large in number, a plurality of route relays may be used which is greater than shown, and the successive transfer from one route relay to another and, consequently, from one group of trunks to another, each group being controlled by a route relay, is effected in the same manner as described for the transfer from route relay 4702 to route relay 4703. If no idle trunk is found in the second group and a third route relay is used, relays 6002, 6003 and 6001 are operated in the same manner as described for relays 5906, 5907 and 5905 for making the transfer of control leads from the second route relay to a third route relay. A transfer to a new route relay for testing a different group of trunks which is part of a large group of trunks going to the same office would normally establish circuits for operating the common apparatus of the marker as previously described. The same start circuit for a connector between the marker and the assignment frame may be used, or in certain cases, a different start circuit may be used. For this example, the same start circuit is connected to route relay 4703 and relay 4803 is again operated. This causes the selection of the same connector between the marker and the assignment frame if this connector is not engaged by another marker. If, however, it is engaged by another marker, a sequence circuit is established in the same manner as described for the connector between the sender and the marker and, consequently, another connector is used which functions in the same manner as the connector previously described. The particular object in transferring from one route relay to another is to establish circuits for testing a different block of trunks outgoing to a particular toll office and for designating the extent of this group of trunks by marking the starting point and ending point of the trunk subgroup in the apparatus of Fig. 38. For this example, the trunk group or block relay 4903 in the marker is cross-connected to contact 10 of route relay 4703 in the same manner that trunk group relay 4902 was cross-connected to contact 10 of route relay 4702. A circuit is thus established from battery through the winding of relay 4901, winding of relay 4903, contact 10 of route relay 4703, contact 17 of relay 6001 to ground. The operation of the trunk group relay 4903 connects conductor 4922 with conductor 4923. Conductor 4922 is connected to battery through contact 8 of relay 4903 as previously traced. Conductor 4923, however, extends to a different trunk group relay than before since it is connected through contact 6 of relay 4122 to ground through the winding of trunk block relay 3115 and associates the test conductors with a second group of trunks extending to the same toll office. The route relay 4703 is connected with the same class relays as route relay 4702 since, in this instance, the class would not change. Let it be assumed that the second group of trunks comprises only seventeen trunks and that, therefore, the test for an idle trunk is begun with the zero trunk and finished with trunk 16. In order to mark this limitation of test, relay 3801 is connected to contact 3 of route relay 4703 and the seventeenth relay, or relay 3803, is connected to contact 4 of the route relay 4703. This, of course, assumes that relay 3803 is the seventeenth relay in the series of forty relays. As was previously the case, the via relay 6907 is operated and the terminal trunk relay 6908 is normal, showing that a via outgoing trunk to a distant toll office must be selected. Thus, a ground is connected from contact 4 of relay 6806 through contact 1 of relay 6907, contact 1 of relay 6908, contact 2 of relay 6910 through the winding of relay 6909 to battery, which operates the latter relay. This ground is also extended from contact 2 of relay 6910 over conductor 6921, contacts 3 and 4 of relay 6001, contacts 3 and 4 of route relay 4703, windings of relays 3801 and 3803 to battery through relays 2806 and 2809. Relay 2806 is an alarm relay for the even-numbered test relays, such as number zero relay 3801. Relay 2801 is an alarm relay for the odd-numbered relays, such as number seventeen relay 3803. As will be explained, these relays associate ground with a timing circuit which operates only after an interval, allowing the maximum time for completing the test of a group of trunks. If the test of the trunks in a group is not made in this maximum time, the alarm and a trouble circuit indicates that a trouble exists in the marker of such nature that the test of the trunks cannot be completed. In this event, the marker is released and the sender seizes another marker for a second trial. The test leads from the outgoing trunks of this group are connected to the test relays of Fig. 38 in the same manner as previously described. For making this test, the same relays are operated by the trunk block relay as previously described, including relay 1801. The trunk testing circuit is connected through the series circuit extending through the contacts of relays 3801 to 3803, including the intermediate relays, and through the contacts of relays 3806 to 3817, including the intermediate relays. When one of the relays 3806 to 3817 is found normal, this indicates that the trunk of that number in the group is idle and, consequently, the circuit through the series of contacts is terminated at this relay and extended through the winding of the corresponding relays 3810 to 3818. The operation of a particular relay in horizontal row 3810 to 3818 associates the trunk leads through the contacts for seizure of the outgoing trunk and for making a secondary test of the trunk to ascertain whether the trunk is in condition for the completion of the connection.

The circuit extended from contact 1 of relay 3806 through an associated series of contacts when this relay and the associated relays in this horizontal row are found operated, indicating that the associated trunks are busy, is the same circuit which operates relays 6810 to 6813 when an idle trunk is found. For the sake of simplicity, it will be assumed that the zero trunk is found idle and a circuit established for relay 3810. This circuit may be traced from battery through contact 4 of relay 7011, contact 3 of relay 7006 over lead 7043 through the winding of relay 3810, contact 1 of relay 3806, which is normal, contact 2 of relay 3801, which is operated, thence over lead 3830 to contact 5 of relay 5807, lead 5830 to contact 1 of relay 1804, contact 5 of relay 2801, contact 1 of relay 3801, contact 1 of relay 3803, lead 3831, contact and armature of relay 2806, contact 2 of relay 2807 to ground on contact 4 of relay 6806. Relay 3810 in oper-

ating establishes a locking circuit for itself from its operating battery through contact 4 of relay 711, contact 3 of relay 7006, lead 7043, winding of relay 3810, thence through its contact 3 over lead 3856, contact 3 of relay 1707, lead 1765 which connects to lead 1850 extending to ground on contact 4 of relay 6806. As previously described, relay 2808 operates in the opposite direction as soon as relay 3810 is operated and, consequently, relay 3810 remains operated over the above locking circuit to ground on contact 4 of relay 6806. The operation of relay 3810 connects a lead to its contact 1 from the idle outgoing trunk for the operation of apparatus in the marker and for a secondary test of the trunk to make sure that, during the time between the operation of relay 3810 and the seizure of the trunk, some other marker has not seized this trunk. This circuit from the idle outgoing trunk may be traced from battery through winding of relay 1610 of the typical toll outgoing trunk shown in Fig. 16, through contact 1 of relay 1616, thence over lead 3126 to a patching jack 3110 on the assignment frame, through the ring springs of this patching jack to lead 3125, contact 5 of the trunk group relay 3116, contact 8 of multicontact connector relay 4122, thence over lead 3125 to contact 1 of relay 3810, lead 3840 to contact 7 of relay 6101, lead 6140 through the windings of relays 1705 and 1704 to a potentiometer, one branch being established over lead 1743, contact 6 of relay 4001, resistance 4015 to battery; the other branch of the potentiometer extending through resistances 1717 and 1716 over lead 1760, contact 1 of relay 1740, lead 1723, contact 3 of relay 5105 or 5106 to ground on contact 3 of relay 1902. The ground circuit of the potentiometer is of low resistance and establishes a circuit for relay 1704 and relay 1610 in the outgoing trunk circuit. Relay 1704 in operating establishes a circuit for operating relay 1706 which establishes a lower resistance ground circuit for the potentiometer and also establishes other circuits to be traced later. A locking circuit for relay 1706 is established later through a contact of relay 1802. The latter relay is, however, not operated until a link and connector circuit, as shown in Figs. 15, 25 and 26, has been actuated.

Recycle of marker

Relay 1705 is poled in the opposite direction from relay 1704 and only operates if the outgoing trunk was seized by another marker between the time when relay 3810 is operated and the time when this marker attempts to seize the trunk. In this case, a double connection exists, and a ground is connected to lead 3126 of the outgoing trunk, Fig. 16, by the first marker to seize the trunk. A circuit is thus established for relay 1705 to battery on the battery leg of the potentiometer as traced. The operation of relay 1705 establishes a circuit for the operation of relay 1717 from ground on the contact of relay 1705, thence over lead 1760 through contact 4 of relay 4001, lead 4043, contact 8 of relay 2801 through the winding of relay 1707 to battery. A locking circuit is shown for relay 1707 which is only established if the relay is operated on a double connection after the link and connecter circuit, Figs. 15, 25 and 26, have been actuated. This locking circuit also extends to ground on a contact of relay 1802. The operation of relay 1707 opens the locking circuit for relay 3810 since this locking circuit, as traced, extends through contact 3 of relay 1707. Relay 3810 is released and in releasing opens the circuit established through its contact 1 for relays 1704 and 1705, causing their release and the release of relays 1706 and 1707 since at this time no locking circuit was established for the latter two relays. This is what is known as causing the marker to recycle since upon the release of relay 3810 the marker immediately reestablishes its testing circuit for finding another idle trunk, the circuit being the same as previously described. Since the trunk previously found idle was seized by another marker, relay 3806 is operated and at the time when relay 3810 is released by the double connection the testing circuit for finding an idle trunk is extended through contact 1 of relay 3806 to the armature of relay 3807 and thence over the chain circuit from one relay to another until a normal or non-operated relay is found, indicating that the corresponding trunk is idle. When this idle trunk is found, the same operation takes place as previously described for operating the relay in the lower horizontal row corresponding to relay 3810 associated with the relay in the next horizontal row which was found normal. The corresponding idle trunk is seized in the same manner as previously described and a test made for a double connection on this trunk, the same as previously described.

In toll offices there are many small groups of trunks extending to small toll centers and, therefore, on certain trunk blocks or trunk groups there may be toll trunks of different transmission characteristics, such, for example, as terminal trunks which are extended from one toll office to another and terminate in the second toll office, via toll trunks used for connections which are extended beyond the next distant toll office and combined toll trunks which may be used for either via or terminal service. A group of trunks of this character may be given as an example comprising a subgroup of twelve terminal trunks, a subgroup of eight via trunks and a subgroup of fourteen combined trunks. The arrangement is such that if no terminal trunks are found idle in the terminal trunk subgroup, a transfer is automatically made to the combined subgroup of trunks. Also, if no via trunks are found idle in a via subgroup of trunks, a transfer is automatically made to a combined subgroup of trunks so that in either case an attempt is made to find an idle trunk of the transmission characteristic desired. As an example of the testing of trunks in a group of this character, let it be assumed that an incoming call requires a via trunk, as in the previous example of incoming calls, and, consequently, the via relay 6907 is operated. Also, let it be assumed that route relay 4702 is arranged for this type of split group and, therefore, has its contacts 1, 2, 3, 4, 5 and 6 connected to the windings of certain of the forty relays 0 to 39, such as relays 3801 to 3805, in the following manner to mark the starting and ending trunks of each subgroup. Thus, contact 1 of relay 4702 may be cross-connected to the zero relay 3801 in the horizontal row to control the starting circuit for testing trunks in the terminal trunk subgroup. The second contact of relay 4702 may be connected to relay 11 in this horizontal row to control the end of test of the terminal trunks. Contact 3 may be connected to relay 12, contact 4 to relay 19 to control the start and end of the via trunk subgroup. Contact 5 may be connected to relay 20 and contact

6 to relay 33 to control the start and end of the combined trunk subgroup. The connection from the contacts of route relay 4702 to the windings of these relays is done in the manner shown from contacts 5 and 6 of relay 4702 to the windings of relays 3801 and 3805, respectively. Since, as herein stated, relay 6907 is operated, ground from contact 4 of relay 6806 is associated as before through contact 1 of relay 6907 and contact 1 of relay 6908 to operate relay 6909 and connect ground to the starting and ending points of the subgroup of via trunks. The test for an idle trunk is made as herein described. If no idle trunks are available in the via group, a transfer is automatically made to the combined trunks without transferring to another route relay. This is accomplished through the operation of relay 6905, which, in this instance, may be assumed to be cross-connected to contact 12 of route relay 4702 in place of relay 6915. As previously described, when no trunks in a group are found to be idle, relays 7011 and 7006 are operated. This also applies to small subgroups when the contacts of the route relay are connected as described. In the previous arrangement these relays accomplish the transfer of leads from one route relay to another but in the present small group arrangement within a group of forty trunks a transfer is merely made from the test of one small group to the test of another which, in this instance, will be from the via subgroup to the combined subgroup. When relay 7011 operates, ground is placed on contact 5 which extends through contact 3 of relay 6909, winding of relay 6910 to operate the latter relay. The operation of this relay establishes a circuit for operating the combined trunk relay for placing ground through the windings of the associated relays in Fig. 38 for marking the starting and ending points of the combined trunks as follows. The operation of relay 6910 opens the circuit for relay 6909, causing its release. A circuit is thus established for relay 6901 from ground on contact 4 of relay 6806, contact 1 of relay 6907, contact 1 of relay 6908, contact 2 of relay 6910, which is operated, contact 1 of relay 6909, which has been released, contact 2 of relay 6905, contact 4 of relay 6902 to battery through relay 6901, operating the latter relay. The ground which operated relay 6901 is also extended to contacts 5 and 6 of relay 5905 and contacts 5 and 6 of the route relay 4702. The test of the combined trunks now proceeds in the manner previously described for via trunks, and it may be assumed that an idle trunk is found in this subgroup of trunks which is seized by the marker. When the call is for a terminal type of trunk, relay 7001 in the marker is operated by a registration from the sender and relay 7002 previously operated for a via call remains normal. This establishes an operating circuit for relay 6908 for completing a connection to a terminal outgoing trunk. The ground for operating the terminal relay 6908 is extended through the registers in the same manner as before over contact 5 of relay 4701, contact 4 of relay 4808, contact of relay 7002, contact 2 of relay 7001, winding of relay 6908 to battery. Thus, a ground is placed through contact 1 of relay 6907, contact 3 of relay 6908, contact 2 of relay 6904, winding of relay 6909 to battery. This ground is also extended through contacts 1 and 2 of relays 5902 and 4702 for the operation of the relays marking the start and end of the terminal subgroup. If no idle trunks are found in the terminal subgroup, relays 7011 and 7006 are operated as before and a ground is connected from contact 5 of relay 7011 through contact 1 of relay 6903, winding of relay 6904 to battery, operating the latter relay. The operation of relay 6904 causes the release of relay 6903 and thus connects ground to relay 6901 for operating the relays for marking the combined trunk test. This ground may be traced from contact 3 of relay 6908, contact 2 of relay 6904, contact 3 of relay 6903, contact 1 of relay 6905, contact 4 of relay 6902, winding of relay 6901 to battery. This same ground also extends to contacts 5 and 6 of relays 5905 and 4702 for operating the relays marking the start and end of the combined trunk subgroup and a test is then made of the trunks in this subgroup.

Routing incoming calls over terminating train of switches

Route relay 4801 is given as an example of an arrangement for routing an incoming call over the terminating train of switches shown in Figs. 9 and 10. As previously stated, the trunk over which a call is to be extended over this train of switches may be incoming from a via intertoll trunk or may be incoming over a terminal intertoll trunk. The illustration using route relay 4801 is connected for routing a call from a terminal trunk to an office within the area of the cross-bar switch toll office. Route relay 4801 is operated in the same manner as other route relays, that is, from a circuit established through the setting of register relays (Fig. 46 and the upper portion of Fig. 58). These relays operate a particular tens relay, such as relay 5908, and a particular fifties relay, such as 5909, which establishes a circuit for the route relay 4801 traced from battery through its winding, through the contact of relay 5909, contact of relay 5908, contact 6 of register relay 5802, contact 5 of register relay 5801, contact 1 of register relay 5804, contact 1 of register relay 5803, contact 2 of relay 5805, contact 3 of relay 6803 to ground on contact 1 of relay 6805. The operation of relay 4801 associates control leads through the contacts of relay 5905 with the trunk testing apparatus of Fig. 38 and with the trunk group relay control apparatus extending through the terminating trunk assignment connector 5110. This terminating trunk assignment connector is the same as shown in Fig. 41 and the trunk block or trunk group relays for the terminating train of switches are the same as shown in Fig. 31. They are, however, associated with outgoing trunks to offices in the area of this cross-bar switch toll office. Such trunks are shown in Fig. 11 of the drawing extending to various types of local offices and also to tributary offices which may be out of a flat rate zone but are reached by a toll switching trunk. This assignment frame and the trunk block relays have been shown diagrammatically as 5110 in order not to duplicate the circuit and apparatus arrangement shown in detail in Figs. 41 and 31. The circuits established through this assignment frame to the trunk block relays to the outgoing trunks are made in the same manner as described for circuits established through the apparatus of Figs. 41 and 31. Contacts 1 and 2 of the route relay 4801 establish the number of trunks to be tested by establishing circuits for operating relays, such as 3801 and 3805, in the marker. The circuit for relay 3801, marking the starting point of test, extending through contact 1 of the route relay is the

same as previously traced for establishing a connection through the toll train of switches. The circuit for the relay **3805**, establishing the end point of test, is also the same as the circuit traced for this relay when establishing a connection through the toll train of switches.

As previously stated, for this example, a terminal intertoll trunk has been used and, consequently, relay **7001** is operated to the register relay contacts (Fig. 46 and the upper portion of Fig. 58). Relay **7002** is normal. A circuit is therefore established for the terminal trunk relay **4908** and the via trunk relay **4907** remains normal. The circuit for relay **4908** may be traced from battery through its winding, contact **2** of relay **7001**, contact **1** of relay **7002**, contact **4** of relay **4808** to ground on contact **2** of relay **6806**. With relay **6908** operated, a circuit may be traced for relays **3801** and **3805** from ground on contact **4** of relay **6806**, contact **1** of relay **6907**, contact **3** of relay **6908**, contact 2 of relay **6904**, normal, contacts **1** and **2** of relay **5905**, contacts **1** and **2** of the route relay **4801** to the windings of relays **3801** and **3805**. The circuit from the winding of relay **3801** is extended to battery through the winding of relay **2806** and the circuit for relay **3805** is extended to battery through the winding of relay **2809**. Contact **4** of the route relay **4801** is connected to the winding of marker trunk block relay **4905**, a circuit for which is completed from battery through the winding of relay **4901**, winding of relay **4905** to ground on contact **14** of relay **5905**. The operation of relay **4905** establishes a circuit for a particular trunk block relay connected through the contacts of the assignment frame connector relays **5110** which are established after the start circuit is established.

This start circuit is established through contact **3** of route relay **4801** which energizes relay **4809** over a circuit traced from ground on contact **13** of relay **5905**, through contact **3** of route relay **4801**, winding of relay **4809**, winding of relay **4807** to battery. The operation of relay **4809** establishes a circuit for selecting a preferred connector between the marker and the trunk assignment frame **5110**. This circuit may be traced from battery through resistance **1905**, contact **7** of relay **1903**, over lead **5121**, through contact **3** of relay **5101** which is operated, contact **1** of relay **5102** which is normal, lead **4820**, contact **2** of relay **4809**, lead **4827**, through the winding of a marker preference relay, the same as **4119** to ground, which marker preference relay is in the terminating trunk assignment connector **5110**. The operation of the marker preference relay establishes a circuit for the multicontact relay of the connector similar to relay **4122**. The operation of this multicontact relay associates a plurality of leads between the marker and the trunk block relays of the terminating trunk assignment frame. A circuit is now established for the selection of a particular trunk block relay through the contact of relay **4905**. Lead **4922** extends from battery through resistance **1906** and contact **8** of relay **1903**, as previously traced to the contact of relay **4905**, thence over lead **4924**, through the multicontact relay of the connector to ground through the winding of a trunk group relay, the same as **3114** or **3116**, but in the terminating trunk assignment connector **5110**. A group of trunks extending over the terminating train of switches is thus associated with the marker for test. The remaining contacts on route relay **4801** are similar to those previously described, contact **6** extending to class terminal **3** (Fig. 75) for operating relay **7504** and contact **7** extending to the group busy relay combination including relays **7006** and **7011** previously described which operate when all of the trunks in a group are busy. Each trunk in the trunk group connected to the terminating train of switches has leads extending to the assignment trunk frame the same as described for toll outgoing trunks, such, for example, as leads **3126** and **3127**. Since a multicontact relay has been operated in an assignment frame connector extending to the outgoing trunks of the terminating train of switches, all relays of Fig. 38 are connected through this multicontact relay to the trunk group apparatus and the outgoing trunks of a group of trunks terminating in this terminating train of switches and are not connected to trunks associated with the toll train of switches. A test is, therefore, made through the contacts of relays **3806** to **3809** for finding an idle trunk in this group of outgoing trunks. This is accomplished in the same manner as previously described for obtaining an idle trunk in a group of trunks connected to the toll train of switches. When an idle trunk is found, one of relays **3810** to **3813** is operated, corresponding to the number of the idle trunk, and a circuit is established through contact **1** of the relay operated for connecting battery from an outgoing trunk relay to the testing apparatus (Fig. 17) as previously described, a double test of the trunk being made in the same manner as previously described by the operation of relay **1705**. After the idle trunk is found, multifrequency signals are transmitted in the manner described under multifrequency signals.

Trunks to call order board

Route relay **4804** is given as an example of an arrangement for routing an incoming call over a terminal train of switches to the call orderboard. Calls are routed to a call order operator during a very busy period of calls and all trunks to a particular office are found busy, and the cordless operator is of the opinion that no idle trunk will be available in the time allowed for holding the apparatus including the marker to wait for an idle trunk. The incoming call may have been initiated over any character of trunk incoming to the office. The route relay **4804** is operated in the same manner as other route relays, that is, from a circuit established through setting of register relays (Fig. 46 and the upper portion of Fig. 58) with the exception that, in addition to setting the code register keys, the cordless operator also sets the TX key **3401**. The operation of key **3401** establishes a circuit for the TX relay **4701** which transfers the leads from the registers to a different set of fifties relays than are used for connections to toll offices and offices within the area of the toll center. The circuit for the TX relay **4701** is established as follows. Relay **5704** in the sender is first operated over a circuit from ground on lead **5717**, through the contact of the TX key **3401**, winding of relay **5704** to battery. The operation of relay **5704** associates ground through its contact **2** to lead **7434** which extends through the contacts of connector relays **7304** and **7405** to lead **7484** in the marker, winding of relay **4701** to battery. A circuit is thus established through the contacts of the register relays, contact **4** of relay **4701**, winding of fifties relay **5903** to battery. The tens relay **5901** is also operated through a combination of contacts in the register relays as previously described. A circuit is thus

established for the route relay 4804 from battery, through its winding, contact 1 of relay 5903, contact 1 of relay 5901, contact 5 of register relay 5804, contact 4 of register relay 5801, contact 1 of register relay 5802, contact 1 of register relay 5803, contact 2 of relay 5805, contact 3 of relay 6803 to ground on contact 1 of relay 6805. The operation of route relay 4804 associates control leads through the contacts of relay 6001 with the trunk testing apparatus of Fig. 38 and with the trunk route relay control apparatus extending through the terminating trunk assignment connector 5110. This terminating trunk assignment connector is the same as shown in Fig. 41 and the trunk block or trunk group relays for the terminating train of switches are the same as shown in Fig. 31. The trunk groups reached through this assignment frame and through the trunk block relays associated therewith include the trunks to the call order board and the information desk. Such trunks are shown diagrammatically in Fig. 11 of the drawings. The circuits established through this assignment frame to the trunk block relays are made in the same manner as described in circuits established through the apparatus of Figs. 41 and 31.

Contacts 1 and 2 of the route relay 4804 established the number of trunks to be tested by establishing circuits for operating relays such as 3801 to 3805. The circuit for relay 3801 marks the starting point of test and the circuit for relay 3805 or a similar relay establishes the end point of test. Since a terminal intertoll trunk is in use, a circuit is established through the register relays for relay 7001 which in this case is operated and, consequently, relay 7002 is normal, one or the other of these relays being operated for a call determining the character of trunk in use. A circuit is, therefore, established for the terminal trunk relay 4908 and the via trunk relay 4907 remains normal. The circuit for relay 4908 may be traced from battery, through its winding, contact 2 of relay 7001, contact 1 of relay 7002, contact 4 of relay 4808 to ground on contact 2 of relay 6806. With relay 6908 operated, a circuit may be traced for the operation of relays 3801 and 3805 from ground on contact 4 of relay 6806, contact 1 of relay 6907, contact 3 of relay 6908, contact 2 of relay 6904, normal contacts 1 and 2 of relay 6001, contacts 1 and 2 of the route relay 4804 to the windings of relays 3801 and 3805. The circuit from the winding of relay 3801 is extended to battery through the winding of relay 2806 and the circuit for relay 3805 is extended from battery through the winding of relay 2809. Contact 3 of route relay 4804 is connected for establishing a start circuit extending through the winding of start relay 4809 and contact 4 of the route relay extends to a trunk block relay the same as trunk block relays 4902, 4903, 4904 and 4905 and completed in the same manner as circuits previously traced for these relays.

The start circuit established through contact 3 of the route relay 4804 energizes relay 4809 over a circuit traced from ground on contact 13 of relay 6001, through contact 3 of the route relay, winding of relay 4809, winding of relay 4807 to battery. The operation of relay 4809 establishes a circuit for selecting a preferred connector between the marker and the trunk assignment frame 5110. This circuit may be traced from battery, through resistance 1905, contact 7 of relay 1903, over lead 5121, through contact 3 of relay 5101 operated and contact 1 of relay 5102 normal, thence over lead 4820, contact 2 of relay 4809, lead 4827, through the winding of a marker preference relay the same as relay 4119 to ground, which marker preference relay is in the terminating trunk assignment connector 5110. The operation of the marker preference relay establishes a circuit for the multicontact relay of the connector similar to relay 4122. The operation of this multicontact relay associates a plurality of leads between the marker and the trunk block relays of the terminating trunk assignment frame. A circuit is now established for the selection of a particular trunk block relay through the contact of the trunk block relay operated to contact 4 of route relay 4804. This circuit is established the same as other circuits through the trunk block relays in which battery is extended over lead 4922 to the contact of the trunk block relay the same as 4902, thence over a lead (not shown), through the multicontact relay of the connector and through the winding of a trunk block or trunk group relay the same as 3114 in the terminating trunk assignment connector 5110. A group of outgoing trunks to the call order board is thus associated with the marker for test and the test of these trunks is made through the contacts of relays such as 3806 to 3809 for finding an idle trunk to the call order board. As previously stated, a relay such as 3806 to 3809 which is normal indicates that the trunk of that number in the trunk group is idle and, consequently, a circuit through the contacts of this normal relay is extended to the relay below such as relays 3810 to 3813, inclusive. This circuit is extended through the winding of the relay in the lower horizontal row which operates the relay in the manner previously described. The operation of this relay associates leads from the trunk extending to the call order board to the marker in the same manner as previously described for other outgoing trunks and thus the outgoing trunk to the call order board may be seized after a double test for determining its idle or busy condition, which is made by the apparatus of Fig. 17, as previously described.

After the idle trunk is found, multifrequency signals are transmitted to the marker apparatus to indicate to the marker the location of the frame on which the cross-bar switch is located connected to the calling incoming trunk and the number of the frame on which the cross-bar switch is located which is connected to the outgoing trunk to the call order board. The operation of this apparatus in the marker designates the connectors to be used between the marker and the link switches for establishing the operation of secondary incoming cross-bar switches and primary outgoing cross-bar switches to establish a channel between the primary incoming cross-bar switches connected to the calling incoming trunk and the secondary outgoing cross-bar switches connected to the call order board trunk. A description of such a connection is given later for completing calls over both the toll train of switches and the terminating train of switches.

Multifrequency signaling system toll train

In order that the marker functions for operating the cross-bar switches between a calling incoming trunk and a chosen idle outgoing trunk to a particular office, including the selection of a junctor channel therebetween, the number of the frames on which these trunks are located must be transmitted by signals to the marker and a signal must be given indicating whether the frame

is an odd or an even frame. A toll system must be particularly flexible and, therefore, the present cross-bar toll system is arranged for transferring trunk groups to desired locations without interfering in any way with the operation of the toll system and the ability of the marker to locate the position of trunks incoming from particular offices or outgoing to particular offices. It may be seen that with the proper frame number signaling system a route relay operated for selecting an outgoing trunk to a particular office need not be associated with any particular frame in order that the system function efficiently. The incoming frame number on which the calling incoming trunk is located is given to the marker shortly after the marker is seized by the sender and the registers of the marker set for operating circuits to establish this frame number signaling circuit. It has been assumed for this description that the incoming trunk is located on frame number **0** which is an even numbered frame. The following will describe the method of transmitting cross-bar switch frame numbers to the marker.

Fig. 20 discloses a multifrequency transmitter comprising a plurality of current sources shown as generators **2072** to **2078**, inclusive, each arranged to transmit current of a different frequency than the others. Each generator has an adjustable amplifier associated therewith and a transformer such as **2048** tuned to oscillate at a particular frequency and an output transformer such as **2040** for transmitting current of this frequency to the frame number signaling circuit. The circuit structure of one amplifier **2001** is shown and the other amplifiers **2002** to **2007**, inclusive, which are of the same circuit structure, are diagrammatically shown. Resistances, such as **2011** to **2036**, inclusive, are individual to each signaling lead for the purpose of distributing the load. A large number of different signals is required equivalent to the maximum number of frames in the toll office plus other signals for special purposes. These are obtained by combining a plurality of current frequencies from different generator circuits for each signal transmitted. The combinations disclosed are three in number for actuating corresponding receivers and combinations of apparatus in a marker receiving circuit. Conductor **2060** is shown as an example of a signal sending circuit extending to a switch on an incoming frame connected by three leads to resistances **2011**, **2016** and **2021**, each resistance having current of a different frequency flowing therethrough. A large plurality of combinations of three frequencies, all having different combinations of frequencies, is available from a given plurality of generators and amplifying circuits. Ordinarily, eight such generators and amplifying circuits provide sufficient combinations for a large telephone office. The example here given is an office having forty incoming trunk frames and forty outgoing trunk frames. Special frequency combinations are used for trunking facilities where trunks are added to a regular group of trunks for temporary service when the added trunks and the regular trunks are located on different frames. This is known as "jump hunting" for special trunks which will be described in detail later. The three frequencies are transmitted over a single lead such as lead **2060**, to a transformer associated with the cross-bar switch select magnets of a frame. In this case, lead **2060** has been connected through the transformer coil **1401** which is associated with the select magnets of the zero incoming frame. Each incoming frame has a similar lead connected to a coil, such as **1401**, and each frame has a different combination of frequencies transmitted through the primary winding of its coil. Each frame may have a plurality of such coils having all of the primary windings in series with each other and connected by a lead such as **2060** to the output of three generator amplifying circuits, the secondary windings of these coils being individual to the select magnets of the different cross-bar switches on a frame. Such an arrangement may be used in order that the load may be spread over a plurality of such devices. A combination of three frequencies is also connected over a single lead to transformers associated with the select magnets of the secondary outgoing trunk cross-bar switches, each frame being connected substantially as illustrated in Fig. 15. Coil **1517** is disclosed having the primary winding connected to the frequency generating circuit and the secondary through the windings of select magnets **1509** and **1510**.

The multifrequency frame number signals are transmitted from the select magnets in the individual frames to a receiving circuit shown in Fig. 27 of the marker. These signaling circuits from the individual frames are associated with the receiving circuit of Fig. 27 by apparatus in the marker actuated during the progressive sequence of operations in the marker for giving the number of the incoming frame on which the calling incoming trunk is located and subsequently the frame number on which an idle outgoing trunk to a particular office is found. After each signal is transmitted, the marker is readjusted for a subsequent signal. Each combination of signals is transmitted over lead **3540** to the input transformer **2702** of the receiving circuit. The output winding of this transformer is associated with an amplifying circuit which includes the tube **2701** having the primary winding of transformer **2709** in the plate circuit. The secondary winding of transformer **2709** is connected to a plurality of individual receivers having filter circuits **2741** to **2748**, inclusive. Each of the above filters is designed for passing a particular band of frequencies. Tuned transformers such as **2714** or **2722** are connected through an adjustable resistance such as **2713** or **2721** to the filters, each transformer being tuned to actuate its reed only at a particular frequency. The three frequencies transmitted over a frame signal, therefore, actuate three tuned transformers associated with the individual filter circuits, each transformer creating a current in the grid circuit of an associated amplifier for actuating individual relays, such as **2717** and **2725** in the plate circuit of the amplifier. These frame signals thus actuate a combination of three relays such as **2717** and **2725** which establish circuits for actuating three of the relays shown in Fig. 37 and the lower portion of Fig. 27. It is well known that it is difficult to create sufficient current in an amplifying circuit such as shown in Fig. 27 to operate relays of the character shown in Fig. 37 and the lower portion of Fig. 27. Consequently, relays such as **2717** and **2725** are used for creating individual circuits for the relays which are heavily loaded with contacts. These relays **3701** to **3704**, inclusive, and **2729** to **2732**, inclusive, each have a large number of contacts through which various circuit combinations may be established for signals created by the multifrequency transmitting circuit. It is clear that these relays may be oper-

ated in combinations as numerous as the combinations of frequencies transmitted. The circuits established through these contacts operate apparatus in the marker in various manners for controlling the operation of the marker for association of the marker with frames of a given number. These circuits are so established that the result created checks the correctness of the signals transmitted.

Incoming frame indication—Toll train

The incoming frame indication is transmitted to the marker as follows:

The incoming frame number indicating cut-in relay **3501** is first operated over a circuit which may be traced from ground through contact **4** of relay **6807**, over lead **6820**, through a chain of contacts which are the uppermost contacts of relays **3701**, **2702**, **3703** and **3704**, and the lowermost contacts of relays **2729**, **2730**, **2731** and **2732**, thence over lead **2740** to contact **3** of relay **3504**, winding of cut-in relay **3501** to battery. This circuit is extended through the contacts of relays **3701** to **3704** and **2729** to **2732**, inclusive, to prevent the transmission of a multifrequency signal if any of these relays are operated and, therefore not in condition for response to the signal currents. Relay **3501** operates and locks through its contact **2** and contact **4** of relay **3504** over lead **3545** which joins lead **6820** extending to ground on contact **4** of relay **6807**. The cut-in relay **3501** may constitute a single relay or a plurality of relays having sufficient contacts for simultaneously cutting through the frame number signaling leads from all frames. However, the signaling lead over which the frame number signal is transmitted is made individual to the particular frame on which the calling incoming trunk is located by connecting this signaling lead to the marker through the calling incoming trunk circuit. Relay **3501**, in operating, therefore, connects the multifrequency signaling circuit extending through the winding of the incoming primary select magnet **1405** of the cross-bar switch, connected to the calling incoming intertoll trunk (Figs. 12 and 13) to the primary winding of the input transformer **2702**. This circuit may be traced from its origin as follows:

Generator current transmitted from generators **1**, **2** and **3**, amplified by the associated amplifying circuits, through the output transformer **2040** and similar transformers in the second and third frequency transmitting circuit to resistances **2011**, **2016** and **2021** which are connected to lead **2060**. The three frequencies are thus transmitted through the primary winding **1403** of transformer **1401** and to the secondary winding **1402** by induction. From the secondary winding **1402** the frequencies are transmitted through the winding of the associated select magnet **1405** of the cross-bar switch connected to the calling incoming trunk disclosed in Figs. 12 and 13. The circuit may be traced from the select magnet, over lead **1453**, thence through contact **7** of relay **1213** operated in the incoming trunk circuit to lead **3229** extending through the link switches (Fig. 32) which were operated for associating the incoming trunk with the cordless operator's position and sender associated therewith. The lead **3229** extends through contact **10** of the cross-bar link switches **3200** and **3203** to lead **5501**, thence through contact **7** of relay **5505**, continuing on lead **5501** to contact **3** of sender relay **5601**, lead **7311**, contact **2** of the marker connector multicontact relay **7304**, contact **1** of multicontact relay **7405**, lead **7471**, contact **1** of relay **1707**, contact **3** of relay **1714**, lead **1740**, contact **5** of relay **7003**, lead **7040**, contact **1** of relay **3504** normal, contact **1** of relay **3501**, thence over lead **3540** to the input transformer **2702** of the multifrequency signaling circuit. It will be noted that the circuit to the transformer **2702** is in multiple with a circuit through resistance **3506** and retard coil **3505** to grounded battery which is merely for the purpose of reducing contact resistance. As previously stated, the three frequencies transmitted over the circuit traced to the transformer **2702** are amplified and transmitted to the filters **2741** to **2748** having bands arranged to pass particular frequencies. In the circuit described, the first three frequencies were used to indicate that the incoming trunk is located on the zero incoming frame. Consequently, the first three filter circuits are used for operating the marker number indicating apparatus. The first and last amplifying circuits associated with the filters are shown. The intermediate circuits are the same as the ones shown, each having a relay, such as **2717**, for establishing operating circuits. In this case the first three relays, such as **2717**, are actuated by frequencies transmitted through filters **2741**, **2742** and **2743**. Each relay associates a ground over a lead extending to the relays in Fig. 37 and the lower portion of Fig. 27. In this case, ground is associated with conductors **2758**, **2757** and **2756** for operating relays **3701**, **3702** and **3703**. Circuits are thus established for operating the frame relay **3902** to signal the marker that the chosen trunk is on frame number zero and relay **2902** to signal the marker that the frame on which the trunk is located is an even frame. The circuit for relay **2902** may be traced from battery through its winding, thence over lead **2941**, contact **3** of relay **3501**, contact **3** of relay **3702**, contact **2** of relay **3703**, over lead **3710** to ground on contact **5** of relay **6807**.

The marker has one relay, such as **3902**, corresponding to each incoming frame and another relay to be described later, corresponding to each outgoing frame. The circuit for operating relay **3902** corresponding to frame zero may be traced from battery through contact **1** of relay **2907**, resistance **2910**, winding of relay **3902**, lead **3962**, contact **5** of relay **3501**, contact **9** of relay **3703**, contact **4** of relay **3702**, contact **3** of relay **3701** to ground through contact **5** of relay **6807**. After an idle outgoing trunk has been chosen, circuits are established for indicating the frame number on which the outgoing trunk is located, but previous to this a locking circuit must be established for the incoming frame relay **3902**, since circuits are established through the contacts of both the incoming and the outgoing frame relays to determine the operations in the link and connector circuits for the incoming and outgoing frames. The outgoing frame link and connector circuit is shown on Figs. 15, 25 and 26 which is substantially the same as the incoming link and connector circuit shown diagrammatically in Fig. 14 as **1420**. The locking circuit for the incoming frame relay **3902** acts as a switching circuit for the multifrequency system so that previous to the transmission of the multifrequency frame number signal giving the outgoing trunk frame number, the multifrequency relays shown in Figs. 27 and 37 may be released. This locking and releasing circuit arrangement is as follows: Relay **3503** is first operated from

battery through its winding over lead 3621 to contact 4 of relay 2905, contact 1 of relay 2902, contact 3 of relay 3902 over lead 3962 which was the operating circuit for relay 3902, extending through contact 5 of relay 3501, contact 9 of relay 3703, contact 4 of relay 3702, contact 3 of relay 3701 to ground on contact 5 of relay 6807. The operation of relay 3503 connects ground from contact 1 of relay 6807 over lead 6835, armature and middle contacts of relay 3503, thence over lead 3547 to contact 1 of relay 2902, contact 3 and winding of relay 3902, resistance 2910, winding of relay 2907 to battery. The circuit traced locks relay 3902 and the ground from the inner contact of 3503 establishes an obvious circuit for relay 3504. The operation of relay 3503 also establishes a locking circuit for itself from battery through its winding, thence over lead 3621 to contact 4 of relay 2905, lead 3547, contact of relay 3503, lead 6835, contact 1 of relay 6807 to ground.

A registration has now been made in the marker recording the number of the incoming frame on which the cross-bar switch connected to the calling incoming trunk is located and that the frame number is even. Apparatus has also functioned for locking the registering apparatus to await the frame location of the cross-bar switch connected to the selected idle outgoing trunk. At this time an adjustment is made in the marker to prepare it for receiving other signals from the multifrequency signaling system. It will be remembered that the locking circuit for the incoming frame cut-in relay 3501 was established through its contact 2 and contact 4 of relay 3504. Therefore, the operation of relay 3504 now causes the release of relay 3501 which disconnects the multifrequency signaling circuit from lead 3540 extending to transformer 2702. All of the apparatus in Figs. 27 and 37, operated for establishing the incoming frame number, is released.

Multifrequency circuit for indicating frame number for outgoing trunk

A circuit path for the operation of the outgoing frame number indicating apparatus is prepared by the release of relays 3701, 3702 and 3703, the operation of relay 3504 and the release of relay 3501. A circuit is now established for a cut-in relay which has sufficient contacts for receiving signals from any of the outgoing trunk cross-bar switch frames. A circuit for this cut-in relay 3502 is established from battery through its winding, thence over lead 3548, contact 2 of relay 3605, contact 3 of relay 3508, contact 7 of relay 3501, contact 3 of relay 3504, lead 2740, lowermost contacts of relays 2732, 2731, 2730 and 2729 and uppermost contacts of relays 3704, 3703, 3702 and 3701, thence over lead 6820 to ground on contact 4 of relay 6807. It will be noted that the circuit traced extended through contacts of relays in Fig. 27 and Fig. 37 which checked the readjustment of the marker for receiving the multifrequency signal indicating the frame number on which the cross-bar switch is located which is connected with the idle outgoing trunk selected. Relay 3502 locks through its contact 2 and contact 4 of relay 3508, lead 3545 which branches into lead 6820 extending to ground on contact 4 of relay 6807. For this example, it is assumed that the idle outgoing trunk selected for this connection is the zero trunk of a trunk group located on the odd outgoing frame number 39 and, therefore, the corresponding frame relay in the marker should be operated by a combination of frequencies transmitted from the frequency signaling transmitter to the marker. Relay 3901 in the marker has been shown to represent the frame relay for frame 39 of the outgoing trunk frames. In addition to the frame indication, other relays, 3903 and 3905, are operated by the multifrequency system to establish circuits in the marker which are required for its operation when the idle outgoing trunk is on an odd frame. Therefore, a combination of three frequencies is transmitted through the select magnet of the outgoing trunk cross-bar switch for operating particular relays of Fig. 37 and the lower portion of Fig. 27 which will establish series circuits through their contacts to actuate these relays. In this case, electric currents of frequencies generated by generators 2076, 2077 and 2078 are used in combination, amplified by their associated amplifiers 2004, 2005 and 2006 which are the same as shown associated with generator 2072. These three frequencies are transmitted through resistances 2025, 2029 and 2033 which are connected to lead 2070 for transmission over this single lead to transformer 1517 which, in this example, is associated with frame number thirty-nine. The three frequencies are transmitted from the primary winding 1519 to the secondary winding 1518 of this transformer and thus transmitted to the select magnets of the secondary cross-bar switch associated with the idle outgoing trunk which has been chosen for connection to the calling incoming trunk. In this example this is the zero outgoing trunk in a via intertoll group of trunks. Winding 1518 is individual to the switch with which it is associated. These currents of different frequency are thus transmitted through the winding of select magnet 1510, thence over lead 3841 to the patching jack 3110, over the tip springs of this patching jack to contact 2 of trunk block relay 3116, contact 9 of assignment frame connector relay 4122, thence over lead 3841 to contact 2 of relay 3810 which, it will be remembered, was operated when the idle trunk was selected. The circuit continues over lead 3842 to contact 4 of relay 1707, contact 2 of relay 1714, lead 1752, contact 1 of relay 7003, lead 7047, back contact of relay 2904, lead 2911 and upward on lead 2812 through contact 7 of relay 2801, over lead 2813, contact 1 of relay 3502, lead 3513, contact 4 of relay 3507, lead 3514, contact 2 of relay 3504, lead 3540 to transformer 2702. The three frequencies transmitted over the circuit traced for controlling the frame signaling apparatus pass through filters 2745, 2746 and 2747, respectively, which have bands for passing the amplified currents from generators 2076, 2077 and 2078 and energize the associated tuned transformers individual to these filter circuits for operating the three associated relays the same as 2717. The three relays operated connect ground with conductors 2752, 2753 and 2754 for operating relays 2729, 2730 and 2731, which relays establish series circuits through their combined contacts for operating the apparatus of the marker to ultimately establish telephone connections between an incoming trunk on the even incoming trunk switch frame with an outgoing trunk on an odd outgoing trunk switch frame. The outgoing trunk frame relay 3901 is operated from battery through the winding of relay 2908, resistance 2909, winding of relay 3901, lead 3963, contact 7 of relay 3502, lead 3515, contact 9 of

relay 2731, contact 4 of relay 2730, contact 4 of relay 2729, lead 3710 to ground on contact 5 of relay 6807. A circuit is also established for indicating that the frame is an odd frame by operating relays 3903 and 3905. The circuit for these relays may be traced from battery through the windings of both relays 3903 and 3905 over lead 3960 to contact 4 of relay 3502, contact 4 of relay 2731, contact 1 of relay 2729, contact 1 of relay 2730, over lead 3710 to ground on contact 5 of relay 6807. A locking circuit is simultaneously established for relays 3901, 3903 and 3905 as follows: The operation of relay 3901 associates its operating ground from its inside contact 3 to its armature for operating relay 2903 which may be traced from ground on the above armature through contact 2 of relay 3905, contact 4 of relay 2906, winding of relay 2903 to battery. Relay 2903 establishes a locking circuit for relay 3901 from ground on contact 5 of relay 6807, over lead 3710 through contact 1 of relay 2801, contact 2 of relay 1801, contact 2 of relay 2903, contact 2 of relay 3905, armature 3 and winding of relay 3901 to battery through the winding of relay 2906. The circuit traced also connects ground through contact 2 of relay 2903 for operating relay 2904. It will also be noted that the operation of relay 2903 associates ground with the armature 3 of relay 3905 as a locking path for both relays, 3905 and 3903. The operation of relay 2904 opens the multifrequency circuit traced from the generators to the transformer 2702, thus opening the operating circuit for the frame number receiving circuit relays of Figs. 27 and 37 which now release. Relay 2904 in operating also establishes through its inner contact an operated circuit for the select magnet 1510 which is effective when the apparatus of Figs. 15, 25 and 26 has been operated, which will be explained with the description of the link and connector circuit disclosed in the above figures of the drawings.

Multifrequency check circuit

It is apparent that if a fault should occur in the multifrequency transmitting system which would cause fewer than three frequencies to be transmitted or more than three frequencies to be transmitted, incorrect switching connections would result if there were not included in the marker a checking arrangement to guard against such errors. This checking arrangement involves a particular wiring of the series circuits through the relay contacts shown on Fig. 37 and the lower portion of Fig. 27 so that when less than three frequencies are transmitted no circuit is established for continuing the progressive operation of the marker and, consequently, the marker cannot continue to function for operating the cross-bar switches to complete the connection. The marker is then released after a period of time which is measured by the timing circuit 5108 previously described. When more than three frequencies are transmitted, the series circuit arrangement through the contacts of the relays in Fig. 37 and the lower portion of Fig. 27 is such that a plurality of frame relays are operated. For example, if this occurs when the incoming frame number indication is transmitted, relay 3902 and another similar relay for a different frame would be operated. If it should occur when the outgoing frame number is transmitted, relay 3901 and another similar relay would be operated. The frame relays, such as 3902 and 3901, derive battery for operation through the windings of marginal polarized relays 2907 and 2908, as previously traced for the operation of the frame relays. When one frame relay, such as 3901 or 3902, is operated from battery through the winding of either check relay 2907 or 2908, the resistance of the frame relay winding is sufficiently great to prevent the operation of these check relays since the current is below the operating value. When a plurality of frame relay windings are associated in multiple through the winding of either relay 2907 or 2908, the resistance is reduced and sufficient current flows through the winding of the check relay in use to cause its operation. The operation of check relay 2907 establishes an obvious circuit for relay 2905 which locks to its operating ground. The operation of relay 2908 establishes a circuit for operating relay 2906 which locks to its operating ground. The operation of either relay 2905 or 2906 establishes a circuit for operating the master control relay 1902 from ground on contact 2 of either relay through the winding of relay 1902 to battery. The operation of relay 1902 opens at its contact 1, the controlling circuit for the trunk block relays of the assignment frame, such as 3116, which are operated over leads 4922, 4921 and 4923 extending through the contacts of marker trunk block relays 4902, 4903, 4904 and 4905 which are associated with particular route relays. Relay 1902, also in opening its contact 3, removes ground from the controlling circuit for the operation of the link and connector circuits shown on Figs. 15, 25 and 26 of the drawings and the operating circuits for the incoming connector and link circuits shown on Fig. 14. The operation of the marker is thus blocked and no error in telephone connections is made. A signal is transmitted to the sender to make a second trial as described. This marker is, therefore, released and the sender and calling incoming trunk are subsequently associated with a different marker which completes the connection.

Multifrequency system for jump-hunt trunk groups

The groups of toll trunks to the various toll centers are assigned regular positions or locations on the various switch frames and on the assignment frame where the patching jacks are located with an allotted additional space on these frames for normal expected growth. These patching jacks are particularly for the purpose of enlarging groups of toll trunks as the occasion arises either through a temporary emergency or through an unforeseen added requirement. In the case of an emergency, larger groups of trunks may be added to the regular groups of trunks extending to a particular office, by rerouting trunks through another toll office to the toll office in which the emergency arises. In other cases, trunks are added for permanent use between two toll offices. In the event of unforeseen growth or an emergency, it is sometimes impossible to immediately position the added trunks upon the same frame as the originally installed trunks between the two offices and, therefore, a temporary arrangement is provided whereby the originally installed trunks between offices may be tested for obtaining an idle trunk and, if no idle trunk exists in this group of toll trunks, another group of trunks located on a different frame, known herein as the jump-hunt group of trunks, may be tested in an effort to find an idle trunk extending to this toll office.

In the foregoing description an idle outgoing

toll trunk was found in the regular group of outgoing toll trunks reached through route relays 4702 and 4703. The term regular group will be herein applied to groups of toll trunks which may be reached from the original routing given the marker and are located on the same outgoing trunk switch frame. As previously described, the trunks associated with route relay 4702 were first tested and since no idle trunk was found in this group a second route relay 4703 was operated through the contacts of route relay 4702 in order that a second successive group of trunks on the same frame and extending to the same toll office could be tested to find an idle trunk. Let it now be assumed that the regular groups of trunks reached through the route relays 4702 and 4703 were all busy and that an added group of trunks is available through the jump-hunt process. Let it also be assumed that the added trunks are on a different switch frame from the trunks which could be reached through the route relays 4702 and 4703 and that a third route relay not directly under the control of route relay 4703 must be used to reach the added trunks. It will be apparent from the earlier description that in order to indicate a frame number to the marker a multifrequency circuit combination is required which forms a particular combination of circuits in the marker. Circuit arrangements are also required to guard against false operations in making a connection between the calling incoming trunk and the outgoing trunk of the added group located on a different frame. In the disclosure route relay 4802 is provided for adding toll trunks to what may be assumed as either a terminal, via or combined regular group or subgroup of trunks. Since in the earlier description a via call was assumed, it will also be assumed in this case that route relay 4802 is used for adding a group of trunks to a via group of trunks or a combined group of trunks which may be used on via trunks.

An arrangement for adding a jump-hunt group of trunks to a regular group of trunks is disclosed in Fig. 31. The patching cord 3130 with its associated plugs is connected between the jump-hunt jack 3104 and the last patching jack of a regular group of trunks. For this description it may be assumed that this trunk is trunk number thirty-nine associated with route relay 4703 and that the regular group constituted forty trunks zero to thirty-nine associated with route relay 4702 and thirty-nine trunks zero to thirty-eight associated with relay 4703. The fortieth regular trunk position is used for jump-hunting to the added group and is herein shown as the trunk associated with patching jack 3108. Two other trunks of the regular group associated with route relay 4703 are shown connected to patching jacks 3110 and 3109, 3110 being the first regular trunk of this group and 3109 being an intermediate trunk of the group. Since the plug of the patching cord 3130 is inserted in jack 3108, the last trunk of the regular group is not available for use since the contacts extending to the last outgoing trunk are opened by the insertion of the plug. The insertion of this patching cord in jacks 3108 and 3104 associates the test and operating leads of the marker with the jump-hunt apparatus shown in the left portion of Fig. 31. The outgoing trunk line may be disconnected from the jack and connected elsewhere. The first and last outgoing toll trunks of the jump-hunt trunk group are diagrammatically shown as 3134 and 3133, associated with relay 3107 and associated with leads 3125 and 3136 extending to the marker test relays, Fig. 38. The intermediate toll trunks of this jump-hunt group are also connected to the windings of relay 3107 as shown by the multiple strapping. In order that the circuit arrangement may be adequately described, two regular outgoing trunks are shown. The toll outgoing trunk of Fig. 16 is associated with the patching jack 3110 and an outgoing trunk 3131 is diagrammatically shown associated with patching jack 3109. In each case the outgoing trunks 3131, 3133 and 3134 may be assumed as the same type of outgoing trunks as shown in Fig. 16 and as having the same circuit arrangement and apparatus. In each case these trunks are shown as idle trunks. A busy trunk will not have the ground associated with the sleeve of the patching jack and also will not have battery through the relay associated with the ring conductor of the jack, which, as noted, extends to the marker for the purpose of testing busy and idle trunks. Consequently, as long as there are idle trunks in the regular group of trunks, ground is associated through the sleeve conductor of one of the patching jacks and the winding of relay 1108 in the overflow circuit. This relay in the overflow circuit is used in order to prevent a calling incoming trunk from being routed to the overflow if there are idle trunks available. The ground from any idle trunk in the regular group also extends over the sleeve of the patching cord 3130, sleeve of the jump-hunt jack 3104 and the lower winding of jump-hunt relay 3106. In the jump-hunt group of trunks ground is also extended from any idle trunk through a winding of special jump-hunt relay 3107 which operates relay 3107. This associates ground in the circuit just traced with the lower winding of relay 3106. As long as there are idle trunks available in the regular group, relay 3106 does not operate since the ground previously traced from idle trunks in the regular group shunts the lower winding of relay 3106. However, when all trunks of the regular group are busy, no ground is associated with relay 3106 and it, therefore, operates from battery through the winding of overflow relay 1108, sleeve of jack 3108, patching cord 3130 and jump-hunt jack 3104, lower winding of relay 3106 to ground on the contact of relay 3107. Thus, the jump-hunt group of trunks is made available for use when the ground is removed from the ring conductor extending to the marker. This ground is used as a false busy to indicate to the marker that jump-hunt control trunk 39 is busy whenever there are idle trunks available in the regular trunk group. The marker finds trunk 39 in the condition of an idle trunk when all trunks in the regular group are busy and, therefore, seizes this trunk in the same manner as it would any idle trunk, by operating relay 3813 which associates the marker circuit with the jump-hunt circuit of the upper left portion of Fig. 31. The operating circuit for relay 3813 is the same as the one traced for relay 3810 which may be followed from battery over lead 7043, through the winding of relay 3813, contact 1 of relay 3809, normal, through a series of contacts on relays 3808, 3817, 3807 and 3806, each of which are associated with busy trunks and are thus operated, thence to contact 2 of relay 3801 to ground over lead 3830.

The operation of relay 3813 establishes the following circuit which prepares the marker for releasing apparatus associated with the regular group of trunks so that the circuits may be rearranged for association with the jump-hunt

group of trunks. This circuit extends from battery through a retard coil 3602, resistance 3603, contact 8 of relay 3601, lead 3622 which branches into lead 2911, back contact of relay 2904, lead 7047, contact 1 of relay 7003, lead 1752, contact 2 of relay 1714, contact 4 of relay 1707, lead 3842, contact 2 of relay 3813 which was operated, thence over lead 3837, contact 10 of assignment connector relay 4110, contact 4 of trunk block relay 3114, tip of jack 3108, tip conductor of patching cord 3130, tip of jack 3104, upper winding of relay 3106, winding of relay 3105 through the multifrequency coil 3103 to ground. The circuit established also extends from the multifrequency coil over the circuit traced to the back contact of relay 2904, thence over lead 2911 branching to lead 2812 to contact 7 of relay 2801, lead 2813, contact 1 of relay 3502 which is operated, thence over lead 3513, contact 4 of relay 3507, lead 3514, contact 2 of relay 3504 and over lead 3540 to the multifrequency transformer 2702. Relay 3105 does not operate in the circuit traced because of high resistance 3603. Three frequencies are thus transmitted from the frequency generating circuit through the back contact of relay 3105 and coil 3102 transmitted by induction to coil 3103 over the circuit traced through the transformer 2702. A special combination of frequencies is transmitted for this purpose from generators 2074, 2076 and 2077 through their associated amplifier circuits 2003, 2005 and 2006, resistances 2024, 2028 and 2031, over lead 2081, back contact of relay 3105, through transformer coil 3102 transmitted to coil 3103 and thence over the circuit traced to transformer 2702. The three frequencies transmitted extend through filter circuits 2743, 2745 and 2746 for operating the associated tuned transformers which are the same as 2714. An electric current is thus set up in the associated plate circuits of the associated tubes, such as 2716, for operating relays the same as 2717. The contacts of these relays associate ground with conductors 2756, 2754 and 2753 for operating relays 3703, 2729 and 2730. The operation of the latter three relays establishes a circuit through their contacts to operate jump-hunt relay 3507 from ground to contact 5 of relay 6807 over lead 3710, contact 4 of relay 2729, contact 4 of relay 2730, contact 7 of relay 3703, lead 3711, contact 5 of relay 3502, contact 1 of relay 3606, right winding of relay 3507, lead 3516, resistance 2909, winding of relay 2908 to battery. Relay 3507 locks through its contact 3 over lead 3517 through contact 6 of relay 6102, lead 6105 to ground on contact 5 of relay 6806. This same ground extends through contact 8 of relay 3507 to operate relay 3508. Relay 3502 now releases since this relay was locked to contact 4 of relay 3508. The operation of relay 3502 opens the special frequency indicating circuit established through its contact for indicating to the marker that a jump-hunt group of trunks is to be tested. In the circuit previously traced through the winding of jump-hunt relay 3105, it will be remembered resistance 3603 was included in the circuit. This is a high enough resistance to prevent the operation of relay 3105 so that the special frequency may be transmitted through its back contact. The operation of relay 3507, however, eliminates resistance 3603 from the circuit traced through the winding of relay 3105, short-circuiting resistance 3603 through its contact 2. Relay 3105 now operates for the purpose of transmitting another frequency for selecting a route relay to be used for testing this particular group of added trunks. The group of three frequencies transmitted is one of a plurality of frequency combinations which are transmitted, depending upon the route relay to be used for reaching a group of trunks added to any particular regular group of trunks. As will be seen by the circuits which are traced, the route relay operated in accordance with the frequency transmitted is controlled by the original routing for the selection of an outgoing trunk to a particular office.

In preparation for the selection of a jump-hunt route relay, the jump-hunt ground supply relay 6101 is operated from battery through its winding, contacts 3 of relay 6103, lead 6107, contact 2 of relay 3508, lead 3517 to ground on contact 2 of relay 6807. A relay is now operated for cutting through a combination of frequencies for indicating the route relay to be used. This relay 3605 is operated from battery through its winding, contact 8 of relay 3502, contact 1 of relay 3601, contact 3 of relay 3508, contact 7 of relay 3501, contact 3 of relay 3504, lead 2740, lowermost contact of relays 2732, 2731, 2730 and 2729, uppermost contacts of relays 3704, 3703, 3702 and 3701 to ground on contact 4 of relay 6807. Relay 3605 locks through its contact 4, contact 6 of relay 3601, contact 9 of relay 3507, lead 3545 to ground on contact 4 of relay 6807.

A frequency combination is now transmitted through the contact of relay 3605 as follows: Generators 2072, 2076 and 2077 supply the frequencies which are transmitted through their respectively associated amplifiers, through resistances 2015, 2026 and 2030 over lead 2082, inside contact of relay 3105, transformer winding 3102 to ground. This combination of frequencies is transmitted through transformer winding 3103, winding of relay 3105 and upper winding of relay 3106 in multiple with condenser 3117, tip of jack 3104, tip of patching cord 3130, tip of jack 3108, contact 4 of relay 3114, contact 10 of relay 4110, lead 3837, contact 2 of relay 3813, lead 3842, contact 4 of relay 1707, contact 2 of relay 1714, lead 1752, contact 1 of relay 7003, lead 7047, armature of relay 2904, lead 2911 which branches into lead 3622 which again branches into lead 3623 to contact 11 of relay 6101 thence over lead 6169 to contact 3 of relay 3605, contact 2 of relay 3601, contact 5 of relay 3507, contact 2 of relay 3504, lead 3540 to transformer 2702. The frequencies in this case are transmitted through filters 2741, tips 2745 and 2746 to their respective tuned transformers which operate the associated relays such as 2717 by energizing the plate circuit of the associated tubes. Ground is thus connected to leads 2758, 2754 and 2753 for energizing relays 3701, 2729 and 2730, respectively. A circuit is established through the contacts of the energized relays for operating the jump hunt route relay 4802 from battery through the winding of relay 4802 over lead 4824, contact 17 of relay 3605, contact 8 of relay 3701, contact 4 of relay 2730, contact 4 of relay 2729, thence over lead 3710 to ground through contact 5 of relay 6807. The operation of route relay 4802 extends the operating ground for this relay through its contact 8 over lead 4825 through the winding of relay 3606 to battery. Relay 3606 in operating connects this ground through the inner spring of contact 3 to lead 3625 for operating relay 3601. A locking ground is now established for relay 3606 and for route relay 4802 to prevent the release of these relays when the operating ground is removed by the release of relays 3701, 2930 and 2729. This locking circuit may be traced from battery through the

winding and contact 8 of route relay 4802 over lead 4825 to contact 3 of relay 3606 and from battery through the winding and contact 3 of relay 3606, thence over lead 3517 extending through contact 6 of relay 6102 over lead 6105 to ground on contact 5 of relay 6806. Relay 3605 now releases since its locking ground was extended through contact 6 of relay 3601. The operation of relays 3606 and 3601 and the release of relay 3605 opens the frequency transmitting circuit to transformer 2702 and thus releases the relays of Figs. 27 and 37 and establishes an operating circuit for relays 6104 and an operating circuit for the outgoing trunk frame number signal cut-in relay 3502. The operating circuit for relay 6104 extends from battery through its winding to ground through contact 5 of relay 3601. The operating circuit for the signal cut-in relay 3502 may be traced from battery through its winding over lead 3548, contact 2 of relay 3605, contact 1 of relay 3601, contact 3 of relay 3508, contact 7 of relay 3501, contact 3 of relay 3504, lead 2740, lower contacts of relays 3732, 2731, 2730 and 2729, upper contacts of relays 3704, 3703, 3702 and 3701 to ground on contact 4 of relay 6807. The operation of relay 3502 permits a combination of frequency signals to be transmitted for giving the frame number upon which the jump hunt trunk group is located after the following series of operations which causes the transfer of control leads from route relay 4703 for the regular trunk group to route 4802 for the jump hunt group.

The trunk busy relay 7006 is first operated from battery through its winding thence over lead 7046, contact 12 of relay 6101, leads 6111, contact 4 of relay 3601, lead 3627 branching into lead 2831 to contact 1 of relay 1801 which was held operated by the assignment frame relay and thence over lead 1815 to ground through contact 4 of relay 6806. Relay 7006 is locked to ground through the contact of relay 1801 over lead 2831. The circuit for relay 3813 which was operated for the purpose of obtaining access to the jump hunt group of outgoing toll trunks extends through contact 3 of relay 7006 to battery on contact 4 of relay 7011 and thus the operation of relay 7006 releases relay 3813. The operation of relay 7006 established an operating circuit for relay 6002 from battery through the winding of relay 6002, contact 15 of relay 6001, contact 14 of route relay 4703 to ground on contact 4 of relay 7006. Relay 6002 locks to contact 4 of relay 7006 and opens the locking circuit earlier established for relay 5907. The operation of relay 6002 also establishes an operating circuit for relay 6003 from battery through the winding of the latter relay, contact 6 of relay 6002, contact 1 of relay 5907 to ground through contact 3 of relay 6806. A circuit for relay 6103 is established from battery through its winding, contact 7 of relay 6002, contact 2 of relay 3508, lead 3522 to ground on contact 2 of relay 6807. A locking circuit is established through the left winding of relay 6103 also through its contact 2 to the operating ground over the above circuit traced. A circuit is established for the operation of relay 6001 from battery through its winding, contact 2 of relay 6003, contact 2 of relay 6002, contact 1 of relay 6103 to ground through contact 3 of relay 6806. The operation of relay 6001 connects the ground control circuits through its contacts to the contacts of the jump hunt route relay 4802. The operation of the ground supply relay 6001 makes ineffective the contacts of the original route relays. The assignment frame relay, class relay, trunk hunt relay, pattern trunk relays, group start and group end relays of Fig. 38 are all released. The release of the assignment frame relay is followed by the release of the marker preference and multicontact relays 4119 and 4122 and also relay 1801. The release of relays 4803 and 4903 releases the assignment connector relay 4122 and the marker preference relay 4119 and trunk group relay 3116. Since the locking circuit for trunk busy relay 7006 was through the contact of relay 1801, relay 7006 releases upon the release of relay 1801. Relay 7006 in releasing opens the locking circuit for relay 6002 which latter relay opens the locking circuit for relay 6101. The release of relay 6101 makes the jump hunt route relay 4802 effective for establishing circuits in the marker.

The group start and group end relays are operated through contact 1 and contact 2 of route relay 4802 from ground on the contacts of relay 6101 to battery through the windings of relays 3801 and 3805 assuming that this trunk hunt group is a group of 40 trunks. The jump hunt group of trunks may be of any size and the group start and group end leads from contacts 1 and 2 of the group relay 4802 connected accordingly. For example, if the group comprises eighteen trunks the group start lead may be connected to the zero relay and the group end lead connected to relay No. 17. The class relay through contact 3 of route relay 4802 is connected as before since the class will be the same. The start lead through contact 5 of route relay 4802 establishes a circuit for the assignment connector start relay 4806. The circuit through contact 4 of route relay 4802 establishes a circuit for operating the trunk block marker relay 4904. The circuit for relay 4806 may be traced from battery through the winding of relay 4807, winding of relay 4806, contact 5 of relay 4802, to ground on contact 2 of relay 6101. This establishes a circuit for the marker preference relay 4107 from ground through contact 3 of relay 4109, contact 3 of relay 4108, winding of relay 4107, lead 4132, contact 2 of relay 4806, lead 4820, contact 1 of relay 5102 which is normal, contact 3 of relay 5101 which is operated since the sender associated with the marker is an odd sender, thence over lead 5121 through contact 9 of relay 1903, resistance 1905 to battery. The operation of relay 4107 operates the multicontact relay 4110 and relay 1801. The circuit for operating relay 4110 is obvious and need not be traced. The circuit for operating relay 1801 may be traced from ground through contact 2 of relay 4107 over lead 4130 to battery through the winding of relay 1801. A ground is also associated with this lead upon the operation of relay 4110 which is of value during the release of the circuit. The trunk block relay of the connector is now operated through the contact of the multicontact relay 4110. This circuit may be traced from ground through the winding of relay 3114, contact 5 of relay 4110, thence over lead 4925 through contact 1 of relay 4904, contact 2 of relay 4903, contact 2 of relay 4902, lead 4922, contact 1 of relay 2810, contact 1 of relay 1902, contact 8 of relay 1903, to battery through resistance 1906.

In order that the example, herein given, for selecting an idle trunk may be made as simple as possible, trunk No. 0 will again be used. The testing apparatus for this idle trunk is represented by relays 3806 and 3810. Relay 3806 is normal under this condition and, therefore, a

circuit is established through its contacts for operating relay 3810 as previously traced. A circuit is also established through the apparatus of Fig. 17 as previously described for testing the selected idle trunk to ascertain whether it has been seized by another marker while the circuit was being established between this marker and the apparatus of the outgoing trunk. For this example, the 0 idle trunk of the jump hunt group of trunks is found on outgoing trunk frame No. 3 and a multifrequency combination accordingly transmitted to the marker for operating the frame relay No. 3. The frequencies for indicating frame No. 3 are transmitted from generators 2073, 2076 and 2077 through their respective associated amplifying circuits and through resistances 2019, 2027 and 2032 over conductor 2083 and through a transformer like 1517 connected to the select magnet of the 0 trunk cross-bar switch of the group located on frame No. 3 in the same manner as described for select magnet 1510 which was located on frame 39. From the select magnet associated with this trunk the circuit extends to lead 3137 shown on Fig. 31 associated with the first trunk of the jump hunt group, thence through contact 2 of trunk group relay 3114, contact 9 of the multicontact assignment frame connector relay 4110 over lead 3841 to contact 2 of relay 3810, lead 3842 to contact 4 of relay 1707, contact 2 of relay 1714, lead 1752, contact 1 of relay 7003, lead 7047, back contact of relay 2904, lead 2911 which branches into lead 2812 to contact 7 of relay 2801, over lead 2813, contact 1 of relay 3502, lead 3513, contact 4 of relay 3507, lead 3514, contact 2 of relay 3504, lead 3540 to transformer 2702. In this case the three frequencies are transmitted through filters 2742, 2745 and 2746 for energizing their associated tuned transformers and energizing the three relays associated therewith similar to the relay 2717. This associates ground with conductors 2757, 2754 and 2753 for operating relays 3702, 2729 and 2730. A circuit is established through the contacts of these relays for operating the frame relay which may be traced from battery through the upper winding of test relay 2908, resistance 2909, over conductor 3516, winding of No. 3 frame relay 3911 over lead 3968 through contact 6' of relay 3502, contact 9 of relay 3702, contact 4 of relay 2730, contact 4 of relay 2729 over lead 2710 to ground on contact 5 of relay 6807. The frame number on which the idle outgoing trunk of the jump hunt group which has been selected is, therefore, given to the marker and in addition the marker is signaled through the same combination of relays in Fig. 37 and lower section of Fig. 27, that the frame on which the trunk is found is an odd frame. The circuit established for this purpose is the same as previously described and need not be again described in connection with frame No. 3 since it is again an odd frame. The circuit combination for an even outgoing frame is similar and the circuit for establishing contacts and circuits for indicating an even frame was given in connection with the description of the selection of an idle trunk in the regular trunk route. The circuits for establishing a connection between the calling incoming trunk on frame 0 of the incoming trunk frame to an outgoing trunk of the special trunk hunt group on frame 3 may now proceed in the usual manner. It is possible to have a second jump hunt group of trunks to the same office so that if no idle trunk is found in the first jump hunt group of trunks the marker may proceed in establishing a connection by selecting the second jump hunt group of trunks as described for selecting the first group. In this case, the trunk busy relay 7006 is again operated as previously described for abandoning the first jump hunt group trunks and proceeding to the next jump hunt group trunks. If a second group of trunks is not available the marker may connect with an overflow trunk or establish connection to the master busy circuit as described later.

Multifrequency signal terminating train of switches

The terminating train of switches is numbered in the same manner as the toll train of switches and constitutes a plurality of odd and even frames. Route relay 4801 was operated for selecting an idle outgoing trunk connected to a secondary outgoing switch located on an outgoing terminating frame. This route relay was actuated in response to an incoming call over one of the various incoming trunks disclosed on sheet 21. In response to this incoming call a link is actuated for associating the incoming trunk either directly with an incoming sender such as 2214 or 2215 or with a cordless operator's position as previously described and with a sender associated with this cordless operator's position. In this manner the incoming trunk is associated through a link with a sender which is actuated either by the distant operator such as would be the case when sender 2214 is directly associated with the trunk, or the sender may be actuated by the cordless operator as previously described. This sender actuates a connecting circuit such as shown in Figs. 73 and 74 for associating an idle marker therewith and for actuating route relay 4801 by the settings of the register relays. As soon as the apparatus of the marker has been actuated a signal is transmitted for indicating the frame number on which the cross-bar switch connecting to the calling incoming trunk is located. It may be assumed for this example that this calling incoming trunk is connected to cross-bar switch 904 and that the multifrequency signal is, therefore, transmitted through the winding of primary select magnet 902.

In the marker the incoming frame number cut-in relay 3501 is operated for establishing a circuit over which the multifrequency signal may be transmitted. A circuit may be traced for this relay from ground, through contact 4 of relay 6807, over lead 6820, through a chain of contacts which are the uppermost contacts of relays 3701, 3702, 3703 and 3704 and the lowermost contacts of relays 2729, 2730, 2731 and 2732, thence over lead 2740 to contact 3 of relay 3504, winding of relay 3501 to battery. Relay 3501 locks through its contact 2 and contact 4 of relay 3504 over lead 3545 which joins lead 6820 extending to ground on contact 4 of relay 6807. Relay 3501 in operating connects the mutifrequency signaling circuit from the winding of the incoming primary select magnet 902 to the marker circuit. This circuit may be traced from generators 2072, 2074 and 2078 through their respective amplifying circuits to resistances 2013, 2022 and 2035 which are joined together and extend over lead 938 to the individual frame transformer winding 937. The multifrequency combination of signals is thus transmitted to the secondary 936 of the frame transformer and through the winding of select magnet 902 over lead 927, thence through the

calling incoming trunk circuit to the sender or cordless position, whichever may have been associated with the calling incoming trunk. This signaling circuit extends to the contacts of the cross-bar switches of the link either in Fig. 22 or Fig. 32. Assuming that the circuit is carried through the cordless position, the signaling lead extends to lead 5501, thence through contact 7 of relay 5505, contact 3 of sender relay 5601, lead 7311, contact 2 of the connector multicontact relay 7304, contact 1 of the multicontact relay 7504, lead 7471, contact 1 of relay 1707, contact 3 of relay 1714, lead 1740, contact 3 of relay 7003, lead 7040, contact 1 of relay 3504, normal contact 1 of relay 3501, thence over lead 3540 to the input transformer 2702 of the multifrequency signaling circuit. The above circuit traced through the sender associated with the cordless position is substantially the same as the circuit traced through an incoming sender, such as 2214, not associated with the cordless position and, therefore, the description of the circuit extending through sender 2214 may be omitted in this description. The three frequencies transmitted pass through the transformer 2702 and associated amplifier through filters 2741, 2743 and 2745 to their respective amplifying circuits for actuating relays 2717, 2725 and the relay associated with filter 2743. The three relays operated associate ground with leads 2758, 2756 and 2751 for energizing relays 3701, 3703 and 2732. The operation of the latter three relays establishes a circuit through their contacts for energizing the frame relay corresponding to the signals transmitted which also corresponds to the number of the frame to which the calling incoming trunk is connected. This frame relay is operated and locked in position in the same manner as described for the operation of frame relay 3902 which was operated for indicating the number of the incoming frame in the toll train with which the calling incoming trunk was connected. A circuit is also established through the contacts of these relays for indicating whether the frame on which the calling incoming trunk is located is an odd or even frame in the same manner as previously described. The locking circuit for the incoming frame relay is established in the same manner as described for the incoming frame relay 3902 and establishes a switching circuit for the multifrequency system to restore the relays of Figs. 27 and 37 to normal before the transmission of a subsequent signal. A summary of this operation is as follows. Relay 3503 is first operated from battery through its winding over a circuit extending through the frame relay to ground on contact 5 of relay 6807. Relay 3503 connects ground from contact 1 of relay 6807 through the winding of the frame relay, winding of a coil such as 2907 to battery. The circuit traced locks the frame relay and also establishes an obvious circuit for relay 3504. The operation of relay 3503 also establishes a locking circuit for itself from battery through its winding to ground on contact 1 of relay 6807. The operation of relay 3504 causes the release of the incoming cut-in relay 3501 which disconnects the multifrequency signaling circuit from lead 3540 extending to transformer 3702. Thus, all of the apparatus in Figs. 27 and 37 operated for establishing the terminating incoming frame number is released.

Outgoing frame number signal

As previously described, an idle outgoing trunk associated with a switch in the terminating train of switches was selected by the operation of route relay 4801. A circuit path for the operation of the multifrequency signaling apparatus to indicate the frame number on which the outgoing trunk is located is prepared by the release of relays 3701, 3703 and 2732, the operation of relay 3504 and the release of relay 3501. A circuit is now established for the outgoing trunk frame cut-in relay 3502 as previously traced from battery, through its winding, contact of relay 3605, contact of relay 3508, contact of relay 3501, normal, contact of relay 3504, lowermost contacts of signaling relays (Fig. 27), uppermost contacts of the signaling relays (Fig. 37), thence over lead 6820 to ground on contact 4 of relay 6807. Relay 3502 locks through its contact 2 and contact 4 of relay 3508, lead 3545, lead 6820 to ground on contact 4 of relay 6807. The signals for operating the outgoing trunk frame relay in the marker are transmitted in this case from generators 2073, 2074 and 2075 through their respective amplifying circuits and resistances 2017, 2023 and 2057 over lead 1038 to the frame number signaling transformer 1035. This transformer is associated with the frame having the selected outgoing trunk thereon and is the same as transformers associated with each of the outgoing frames in the terminating train of switches. The multifrequency signals extend through the primary coil 1037 of this transformer and are transmitted to the secondary winding 1036 of this transformer and thence through the select magnet of the switch to which the outgoing trunk is connected. Let it be assumed for this example that the multifrequency signals are transmitted through the winding of select magnet 1010 and over lead 1056 to the apparatus of the associated trunk group relay in the terminating trunk group relays associated with the assignment connector 5110. This lead extends through the contacts of the trunk block relay and the multifrequency connector relay to contact 1 of the relays 3810 to 3183 which was operated for indicating the idle trunk. From contact 1 of the operated relay the circuit extends over a chain circuit through the contacts of these relays to lead 3842 extending to contact 4 of relay 1707, thence through contact 2 of relay 1714, lead 1752, contact 1 of relay 7003, lead 7047, contact of relay 2904, lead 2911, lead 2812 to contact 7 of relay 2801 over lead 2813, contact 1 of relay 3502, lead 3513, contact 4 of relay 3507, lead 3514, contact 2 of relay 3504, lead 3540 to transformer 2702. The three frequencies transmitted over this circuit for controlling the frame signaling apparatus pass through filters 2742, 2743 and 2744 and their respective amplifying circuits for operating relays associated therewith, such as relay 2717. This associates ground with leads 2757, 2756 and 2755 for operating relays 3702, 3703 and 3704. This establishes a circuit through the contacts of the latter relays for operating a frame relay (not shown) which corresponds to the number of the frame on which the idle outgoing trunk selected is located. This frame relay may be assumed to be operated in the same manner as relay 3901 previously described. The operation of the aforementioned relays 3702, 3703 and 3704 also establishes a circuit through their contacts for indicating whether the frame is an odd or an even frame. This circuit may be assumed as one of the combinations previously described. The frame relay is locked as previously described for the frame relay 3901 and in so doing opens the multifrequency signaling circuit extending to the trans-

former 2702 for releasing the multifrequency signaling apparatus (Figs. 27 and 37) which now release. In response to the operation of apparatus in the marker, indicating the numbers of the frame in the terminating train of switches of which the calling incoming trunk and the idle outgoing trunk are located, and also in response to the operation of apparatus indicating whether these frames are odd or even, circuits are established in the marker for associating the marker with connector control relays such as diagrammatically indicated in Fig. 9 and connector control relays such as diagrammatically indicated in Fig. 10. Such connector control relays are associated with each pair of frames in the same manner as shown for the connector control relays (Figs. 15, 25 and 26). The secondary incoming switches and primary outgoing switches (Figs. 9 and 10) are thus selected for establishing a junctor path over conductors such as 928, 929, 930, 1028, 1029 and 1030 for connecting the primary cross-bar switch on the incoming frame to the secondary cross-bar switch on the outgoing frame associated with the calling incoming trunk and the selected idle outgoing trunk as hereinafter described.

Operation of cross-bar switches—Toll train

As previously stated, an idle outgoing trunk to a particular destination has been selected and multifrequency signals have been transmitted to the marker for operating apparatus giving the frame numbers on which the calling incoming and the idle outgoing trunks are located and also whether these frames are odd or even frames. For example, the incoming trunk may be located upon an odd frame of a particular number and the outgoing trunk may be located upon an even frame of a particular number. The frame numbers showing the location of the calling incoming trunk switch and the idle outgoing trunk switch, may be both odd or both even or any combination thereof. The operation of the following apparatus will be reviewed as operated by the multifrequency frame number signaling apparatus to facilitate the establishment of circuits through contacts of this apparatus in order to make clear the operation of the link and connector circuits for connecting the marker to the incoming and outgoing switches which are to be operated for completing the connection. The example which will be assumed for the connection being described is a condition where the incoming trunk is located on an even frame 0 and the outgoing trunk is located on an odd frame 39. Relay 3902 was operated to signal the marker that the frame on which the calling incoming trunk is located is frame No. 0. This relay is operated over a circuit traced from battery through the winding of relay 2907, resistance 2910, winding of relay 3902, thence over lead 3962 to contact 5 of relay 3501 and through the relays of Figs. 27 and 37 to ground. When the incoming trunk is located on an odd frame the frame number signaling apparatus operates relay 2901 from battery through the winding of this relay over lead 2940 to contact 4 of relay 3501 and thence to ground through a combination of relays in Figs. 27 and 37. When the incoming trunk is located on an even frame relay 2902 is operated from battery through its winding and over lead 2941 to contact 3 of relay 3501 and thence to ground through a combination of the relays in Figs. 27 and 37. Outgoing frame relay 3901 is operated from battery through the windings of relay 2908, resistance 2909, winding of relay 3901 and thence over lead 3963 to contact 6 of relay 3502, contacts of a relay combination in Figs. 27 and 37 to ground. When the outgoing trunk is located on an odd frame, relays 3903 and 3905 are operated from battery through the windings of both relays, lead 3960, contact 4 of relay 3502 through the relays and through a combination of the relays in Figs. 27 and 37 which are set by the number indicating apparatus and thence to ground on contact 5 of relay 6807. When the idle outgoing trunk selected is located on an even frame relays 3904 and 3906 are operated from battery through their windings, lead 3961 through contact 3 of relay 3502 through a combination of the relays in Figs. 27 and 37 to ground on contact 5 of relay 6807.

The cross-bar switch frames with which the outgoing link and connector circuits and equipment shown in Figs. 15, 25 and 26 are associated are furnished in pairs with one connector, such as is shown in Figs. 15, 25 and 26, per pair of frames. Each connector is arranged to close junctor sleeve leads, link sleeve leads and also the windings of the primary select magnets together with various miscellaneous leads from any one of the primary or secondary switches located on either of the paired frames, such circuits being established through the marker by apparatus which indicates the location of the incoming and outgoing trunks on the switch frames. This arrangement permits the marker to test the large plurality of junctor sleeve leads between the incoming secondary cross-bar switches shown in the right portion of Fig. 9 and the outgoing primary cross-bar switches shown in the left portion of Fig. 10 or between the incoming secondary cross-bar switches shown in the right portion of Fig. 14 and the outgoing primary switches shown in the left portion of Fig. 15. The connector and link circuit for a pair of frames as shown in Figs. 15, 25 and 26 has four separate channels, two extending from Fig. 25 to the odd and even frames of the pair and two extending from Fig. 26 to the odd and even frames of the pair. Fig. 25 is shown as the connector and link for the odd frame. The two channels through this connector and link circuit will be herein identified as the home and mate channels. The home channel in Fig. 25 connects the marker to the switches on the odd frame, the mate channel connects the marker to the switches on the even frame. In the link and connector circuit shown in Fig. 26 the home channel connects the marker to the switches on the even frame and the mate channel connects the marker to the switches on the odd frame. For example, if an idle outgoing trunk which has been selected for a telephone connection is located on an odd frame and the odd link and connector, Fig. 25, has been seized by the marker the home channel is used between the marker and the cross-bar switches in the upper portion of Fig. 15. If this idle outgoing trunk is located on an odd frame and the marker has selected an even link and connector circuit such as shown in Fig. 26 the mate channel is used in order to connect the marker to the cross-bar switches on the odd frame where the cross-bar switch connected to the idle outgoing trunk is located.

The operation of the marker in associating itself with a particular link and connector such as shown in Fig. 25 or Fig. 26 is initially directed by the sender which is operated for completing the connection. If the sender is an odd numbered

sender the marker is directed to an odd link and connector circuit as shown in Fig. 25. This is considered as a first trial which if satisfactorily completed establishes the connection properly. If on the first trial to complete a connection the marker is seized by an even numbered sender the marker then prefers an even numbered link connector such as shown in Fig. 26. In each case the home or mate channel is used depending upon the location of the cross-bar switch connected to the idle outgoing trunk selected. When a second trial is required because of a failure in the marker, the associated sender is adjusted by this marker before its release so that a different circuit is established in another marker which is seized by this sender for completing the connection. This readjustment is such that when an odd link and connector, Fig. 25, is seized on the first trial the even link and connector, Fig. 26, is seized on the second trial. When the home channel of a link and connector is seized on the first trial the mate channel is seized on the second trial. In consequence of this when an odd link and connector is seized on the first trial and the home channel is seized, the connection is made from the marker to a cross-bar switch over this home channel and on second trial the alternate or even frame and connector is seized and the connection is made from the marker over the mate channel thus reaching the cross-bar switches on the same frame as reached over the home channel on the first trial. This applies to the incoming cross-bar switch frames of both the terminal and toll train of switches and also the outgoing cross-bar switch frames of both the terminal and toll train of switches and the link and connector circuits associated therewith. The seizure of link and connector circuits associated with particular cross-bar switch frames is regulated as herein stated by the sender and also by the multifrequency signaling circuits which establish the connections to be made between the marker and particular frames.

Let it be assumed that the marker circuit has been seized by an odd numbered sender on the first attempt to set up the connection as outlined. In this case the marker will prefer odd numbered link and connector circuits for associating the marker with switches associated with the calling incoming trunk and those associated with the idle outgoing trunk. The link and connector associated with the outgoing trunk switches is first actuated by the marker which connects battery over the start lead **2533** for operating the associated marker preference relay **2522**. It is assumed that relay **5101** was operated by an odd numbered sender making a first attempt and that relay **3905** was operated by the frame number signaling apparatus since the outgoing trunk is on an odd frame. The circuit for the start lead therefore, may be traced from battery through resistance **1908**, contact **6** of relay **1903**, contact **1** of relay **2906**, contact **1** of relay **2905**, lead **5133**, contact **1** of relay **5101**, contact **1** of relay **3901** thence over lead **2533** to ground through the winding of the marker preference relay **2522**. This ground is associated with one of a chain of relays which are used to prevent more than one marker being connected to the same connector circuit. These relays as noted are wired on a preferred and a lock-out basis and as indicated by the wiring the marker associated with the marker preference relay **2522** has first preference for operating its marker preference relay **2522** but last preference for operating its associated connector relay **2513**; therefore, when one of the other marker preference relays in the chain is operated the marker must wait for its release before operating its associated multicontact relay **2513** in the connector. The operation of relay **2522** associates ground through its contact **4** with the winding of relay **2513** which operates. Assuming that the home channel is the one to be used, a circuit is established through contact **2** of relay **2522** for operating the home channel relay **2502**. If on the contrary the mate channel is the one to be used a circuit is established through contact **1** of relay **2522** which operates the mate channel **2503**.

The above circuits are established by the operation of apparatus in the marker responsive to the multifrequency signals transmitted giving the character of the frame, odd or even, on which the trunk is located as previously described. The home channel relay **2502** is operated over lead **2531** extending from the marker through contact **2** of relay **2522** or the mate channel relay is operated over lead **2532** extending from the marker through contact **1** of relay **2522** depending upon the multifrequency signal transmitted to the marker. The circuit for the operation of relay **2502** may be traced as follows: ground through contact **1** of relay **2503**, winding of relay **2502**, contact **2** of relay **2522**, lead **2531** which connects with lead **3931**, thence through contact **4** of relay **3905** which is operated, contact **5** of relay **3906** which is normal, thence over lead **1920** through contact **5** of relay **1903**, resistance **1909** to battery. If the mate channel is used and a circuit is established over conductor **2532**, for extending connection to a mate frame, which in this case would be an even frame, relay **2503** is operated from ground through contact **6** of relay **2502**, winding of relay **2503**, contact **1** of relay **2522**, conductor **2532** which connects with conductor **3932** through contact **5** of relay **3905** normal, contact **4** of relay **3906** operated, thence over lead **1920** through contact **5** of relay **1903**, resistance **1909** to battery. Under a condition where the marker has been connected to an even connector, Fig. 26, and the marker preference relay **2622** was operated, the aforementioned conductors **3931** and **3932** from the circuit traced to battery through the marker apparatus, are reversed with relation to the home and mate channels, that is, lead **3931** is connected to lead **2631** for operating the mate channel apparatus for extending the marker leads to the odd frame or lead **3932** is connected to lead **2632** for operating the home channel apparatus on the even frame. This arrangement is indicated on the drawing. In the circuits traced for operating either relay **2502** or **2503**, it will be noted that ground for the operating circuit of the home channel relay **2502** is taken through the contact of the mate channel relay **2503** and the ground for the mate channel relay is taken through a contact of the home channel relay. Therefore, when either of these relays operates, the circuit for the alternate relay is opened so that the alternate channel cannot be used in error by another marker.

The following are combinations of apparatus which are operated in the marker responsive to different conditions, an understanding of which is desirable for an understanding of the apparatus operations responsive to the association of the marker with the link and connector circuit.

When an outgoing trunk on an even incoming frame is to be connected to an outgoing trunk on an even outgoing frame, relays 3904, 3902 and 2902 are operated by the multifrequency frame number signaling apparatus. This establishes a circuit for relay 3907 from battery through its winding, contact 1 of relay 3904, contact 4 of relay 3902, contact 2 of relay 2902 to ground through contact 3 of relay 3904. If an incoming trunk on an odd incoming frame is to be connected to an outgoing trunk on an even outgoing frame, relays 3904, 3902 and 2901 are operated by the frame number signaling apparatus and a circuit is established for relay 3908 from battery through its winding, contact 2 of relay 3904, contact 5 of relay 3902, contact 6 of relay 2901 to ground to contact 3 of relay 3904. In an incoming trunk on an odd incoming frame is to be connected to an outgoing trunk on an odd outgoing frame, relays 3903, 3902 and 2901 are operated by the frame number signaling apparatus which establishes a circuit for relay 3909 from battery through its winding, contact 1 of relay 3903, contact 4 of relay 3902, contact 2 of relay 2901 from ground through contact 3 of relay 3903. If an incoming trunk on an even incoming frame is to be connected to an outgoing trunk on an odd outgoing frame, relays 3903, 3902 and 2902 are operated by the frame number signaling apparatus which establishes a circuit for relay 3910 from battery through its winding, contact 2 of relay 3903, contact 5 of relay 3902, contact 7 of relay 2902 to ground through contact 3 of relay 3903.

Assuming that relay 2502 is operated over a start circuit from the marker, circuits are established through its contacts for operating the apparatus associated with the home channel. Relay 2501 is operated from ground through its winding, contact 1 of relay 2502, resistance 2505 to battery. Other circuits are established through the contacts of relays 2513, 2502 and 2501 for operating test relays and completing circuits to the marker and for finding an idle junctor channel between the secondary incoming switches and the primary outgoing switches over which the connection may be completed from the incoming trunk on the primary incoming switches to the outgoing trunk on the outgoing secondary switches. The operation of relay 2513 associates ground with lead 2534 which extends through the winding of relay 1802 to battery. This relay operates after relay 2513 for the purpose of checking the operation of relay 2513 and for completing circuits in the marker at the proper time. A check circuit is also established to the marker from battery through contact 3 of relay 2501, contact 5 of relay 2513, over conductor 2539 through the winding of relay 1805, returning over lead 2540, contact 6 of relay 2513 to ground through contact 4 of relay 2504, operating relay 1805.

Incoming trunk frame link and connector

A circuit is now established for starting the operation of the link and connector circuit 1420 associated with the incoming frame. This link and connector circuit is diagrammatically shown as 1420 and is substantially the same as that shown in Figs. 15, 25 and 26 and its operation may be assumed to be substantially the same. The following start circuit is established through marker relay contacts which were operated by the multifrequency frame number signaling apparatus as previously described for indicating the frame on which the incoming trunk is located. This start circuit may be traced from battery through resistance 2506, contact 2 of relay 2502, contact 8 of relay 2513, thence over lead 2541 to contact 1 of relay 1903 which is operated, contact 2 of relay 5101 which is operated to indicate that the call is from an odd sender, contact 1 of incoming frame relay 3902, also operated, to ground through a marker preference relay in the incoming link and connector circuit 1420 which is the same as marker preference relay 2522 shown in Fig. 25 for the outgoing frame. This incoming link and connector circuit now functions for making tests and establishing operating circuits at the same time as the outgoing link and connector circuit, as will be described for the outgoing circuit and ascribed to the incoming frame operations as they take place. In response to the operation of the preference relay in the connector 1420, relays are operated which are the same as those operated in the outgoing connector such as 2513, 2502 and 2501.

The operation of the foregoing relays 3907, 3908, 3909 or 3910 establishes circuits for one of a plurality of relays, such as 1520 to 1523, in the home channel or similar relays, such as 1532 to 1535, in the mate channel. For this example, let it be assumed that relay 3909 has been operated for establishing a circuit for junctor cut-in relay 1523 which may be traced from ground through its winding, contact 3 of relay 2513, conductor 2536, contact 1 of relay 3909 operated, contact 2 of relay 3910 normal, thence over lead 2542 to contact 9 of relay 2513, contact 3 of relay 2502 to battery through resistance 2507. Relay 1520 is operated over a similar circuit with the exception that the circuit is established through contact 1 of relay 3910 when operated and returns over lead 2942 in the same manner as traced for relay 1523. A circuit is further established for operating the outgoing trunk switch select magnet 1510 from battery through resistance 2509, contact 5 of relay 2502, contact 10 of relay 2513, lead 2543, contact 1 of relay 3905, lead 3943, contact of relay 2904 which is operated, contact 1 of relay 7003, contact 2 of relay 1714, contact 4 of relay 1707, lead 3842, contact 2 of relay 3810 which was operated when the idle trunk was found, thence over lead 3841, individual to the idle trunk selected through contact 9 of relay 4122, contact 2 of relay 3116, winding of secondary select magnet 1510, coil 1518 on frame number signaling circuit transformer 1517 to ground. The foregoing circuit is traced for operating a secondary select magnet when the select magnet is associated with a trunk on an odd frame. A similar path may be traced from battery through contact 2 of the mate relay 2503 over conductor 2544 through contact 1 of relay 3906 for operating a secondary select magnet on an even frame, as indicated by the frame number signaling apparatus.

An obvious circuit for relay 1526 was established from battery through resistance 2508 and contact 4 of relay 2502 to ground through the winding of relay 1526. The operation of relay 1526 and the foregoing operation of the outgoing trunk secondary select magnet establishes a circuit for operating the link cut-in relay 1521 from battery through resistance 1527, contact 1 of relay 1526, winding of relay 1521, contact 3 of relay 1526 to ground on the contact of a select magnet, such as 1510, associated with the idle out-

going trunk selected. A circuit is established for operating three relays in the marker from ground on contact 1 of relay 1521 or contact 1 of relay 1524, contact 1 of relay 2501, contact 1 of relay 2514, conductor 2545 through the winding of relay 4012 to battery in multiple with the right winding of relay 4044 to battery. Conductor 2545 also extends through contact 4 of relay 4906 to battery through the winding of relay 4911. Another circuit is established from ground through contact 1 of one of the relays 1520 to relay 1523, inclusive, which may include ten relays, thence through contact 2 of relay 2501, contact 2 of relay 2514, lead 2546, to battery through the winding of relay 4011.

Channel selection

There are a plurality of channels between each primary outgoing cross-bar switch and each secondary incoming cross-bar switch for linking the primary incoming cross-bar switch to the secondary outgoing cross-bar switch. The outgoing connector circuits (Figs. 15 and 25) has been operated as previously described for associating leads from all of said plurality of channels with a like plurality of channels shown in Fig. 30 of the marker. The channel circuits of Fig. 30 are thus connected to all available channels between the outgoing primary switches and the incoming secondary switches that may be used for completing this connection regardless of whether these channels are idle or busy. The busy channels operate the apparatus of Fig. 30 as will be described and consequently by the process of elimination and a sequence circuit an idle channel is chosen. Three channels have been shown in Fig. 30 as an example of the plurality of channels used. In order to determine which channels are busy when the marker is associated with these channels, the windings of relays 3004, 3006 and 3008 are connected through the outgoing connector circuit to the link switches. The circuit for relay 3004 may be traced from battery extending through the winding of relay 4910 to contact 1 of relay 4906, lead 3026, winding of relay 3004, contact 5 of relay 3001, thence over lead 2549 to the connector circuit. This lead extends through contact 5 of relay 2514, contact 7 of relay 2501, contact of jack 1528, contact 2 of relay 1524 to sleeve lead 1570. A similar circuit extends through contact 2 of relay 1521 to another sleeve circuit. In this manner all of the sleeve circuits of the switch are tested. The right windings of relay 3005 and other similar channels relays 3007 and 3009 test the hold magnet. This circuit may be traced from battery through the winding of relay 4910, contact 2 of relay 4906, lead 3025, right winding of relay 3005, contact 4 of relay 3001, thence over lead 2548 to the outgoing connector circuit. This lead extends through contact 4 of relay 2514, contact 6 of relay 2501, contact 2 of relay 1520 to the hold magnet winding 1507. A circuit is also extended to the incoming connector through the left winding of relay 3005 which may be traced from the same source of battery, through the left winding of relay 3005, contact 2 of relay 3001, lead 1950, through a series of contacts in the connector circuit 1420 to the incoming primary hold magnet 1412. When a junctor link between a primary outgoing switch and a secondary incoming switch has been seized by another marker for completing a telephone connection, or one over which a telephone connection is taking place, ground is associated with the hold magnet for maintaining these cross-bar switches in operation. Therefore, if ground is associated with sleeve conductor or the hold magnets of a channel, either from the outgoing or the incoming end, the channel relays in Fig. 30, 3004, 3006, 3008 or 3005, 3007, 3009 associated with those channels are operated to indicate that the channel is busy. If a channel is found idle the marker then prepares to seize this channel as follows.

The previously described operation of relays 4012 and 4011, which responded to the operations of the link cut-in relay 1521 and the junctor cut-in relay 1523 on the outgoing frame, established a circuit for the operation of relays 4010 and 4004 if relays in the incoming connector circuit the same as 1521 on the outgoing frame have also operated. The circuit for relay 4010 may be traced from battery through its winding, contact 2 of relay 4011, contact of relay 4012, thence over lead 1925. The circuit for relay 4004 is also traced through its left winding to lead 1925, which lead extends to the incoming connector circuit 1420. This circuit continues in the incoming connector over a lead similar to lead 2545 in the outgoing connector which extends through a contact of a relay the same as 2514, contact of a relay similar to 2501, to ground on the relay similar to 1524. Relay 4010 when operated locks to lead 1925 through the contact of relay 4012. This locking circuit extends around the contact of relay 4011 so that it will not release if relay 4011 is released on a junctor retest. It will be noted that a contact of relay 4010 which parallels the back contact of relay 4011 removes a ground which has been holding relay 4009 non-operated and permits current to flow in the non-operated winding of relay 4009 to charge condenser 4016. After an interval of time as measured by the charging condenser 4016 the current in the non-operated winding of relay 4009 decreases and the primary operating winding takes control and operates relay 4009. By this means an interval of time is permitted for the operation of the slowest channel relay 3004, 3005, 3006, 3007, 3008 or 3009 if the junctor connection has been seized by another marker between the time that the channel was found busy and the time when it is seized. If an idle channel is available the test and operation of relay 4009 causes the operation of a channel relay in the marker circuit such as relays 3001, 3002 and 3003. Assuming that the first channel is idle, a circuit is established for the channel relay 3001 which may be traced from ground, through contact 4 of relay 1801, over lead 1810, contact of relay 4009, contact 2 of relay 4002, contact 7 of relay 4001, lead 4040, front contact 2 of relay 1806, front contact 2 of relay 1805, lead 1840, contact 2 of relay 5806, lead 5921, contacts of the first normal pair of relays 3005 and 3004, winding of the associated channel relay 3001, to battery through contact 1 of relay 4003. The channel relay 3001 locks through its contact 3 in a chain circuit through contacts 3 of relays 3002 and 3003 over lead 1810 to ground on contact 4 of relay 1801. It is apparent that the operation of any of the relays 3004 to 3009, inclusive, when connected with busy circuits as described will open the circuit extending through their contacts to the windings of the channel relays 3001 to 3003, inclusive.

In certain instances a hold magnet may test idle but may have just been released by another connection and had not had time to release. In order to make sure that the hold magnet on a

switch is seized by a connection before it has released, a timing arrangement is used to insure the restoration of the select finger on the crossbar switch before it is again seized. If a crossbar switch should be seized before the trip finger has had time to release, the successive operations might be incorrectly established with consequent failure in properly completing the telephone connection. To prevent failure of this type the hold magnet timing feature has been provided by operating relay 4001 to ground on relay 1803 through the back contact of relay 4008 and to ground on relay 4002. Relay 4002 operates to ground on relay 1801; therefore, this circuit may be the first closed. Relay 4002 also associates ground with the non-operate upper winding of relay 4008 and shunts condenser 4019. If relay 4008 is not on its back contact at the start of the connection then relay 4002 releases it. The selection of a channel by the operation of a channel relay such as 3001, causes relay 4002 to release, removing ground from a non-operated winding of relay 4008 and permitting condenser 4019 to charge in series with this winding. After an interval measured by the charging time of condenser 4019 the contact, the lower winding of relay 4008 takes control and operates the relay releasing relay 4001 and connecting the incoming link and outgoing link to the primary windings of relays 1701 and 1702, respectively. The interval measured by the operating time of relay 4008 and the releasing time of relay 4001 is sufficient to permit a previously operated holding magnet to release and to have its select finger unlatch.

For the establishment of circuits for the aforementioned relays 1701 and 1702 for ultimately operating the incoming primary and outgoing secondary hold magnets a circuit must first be established through the individual outgoing trunk sleeve lead which extends to contact 1 of relay 3810. This circuit when established, in addition to operating relays which are necessary for keeping the hold magnet operated, also tests the continuity of the individual trunk sleeve lead. This continuity test is made by relays 1706 when relay 3810 operates. A potential is applied to the outgoing trunk sleeve to make the trunk appear busy as soon as it is seized. This potential operates a relay in the outgoing trunk associated with the sleeve conductor and may be traced from battery through relay 1610 in the outgoing trunk circuit selected, thence through the assignment connector apparatus of Fig. 41 thence over lead 3125 through contact 1 of relay 3810 which is operated, thence over lead 3840 to contact 7 of relay 6101, lead 6140, contact 5 of relay 1714, winding of relay 1705 and winding of relay 1704 to a potentiometer comprising battery on lead 1743 from contact 6 of relay 4001 and resistance 4015 and ground through resistances 1717 and 1716, lead 1760, contact 1 of relay 1740, lead 1723, contact 3 of relay 5105 or 5106 to ground on contact 3 of relay 1902. Relay 1704 operates in the above circuit traced and establishes a circuit for operating relay 1706 which locks to contact 3 of relay 1802 and establishes a ground circuit to the operating windings of polarized relays 1701, 1702 and 1709 which now makes them effective for the link and junctor test. This, however, is not an operating circuit for the foregoing relays 1701, 1702 and 1709. This operating circuit will be described later. Relay 1706 reduces the potential applied to the sleeve to a value somewhat closer to ground to insure the operation of the outgoing trunk sleeve relay 1610 in case it did not previously operate on the higher potential which was required to operate relay 1704.

After the operation of relay 1706 and the selection of an idle channel through the junctors from the secondary incoming switches to the primary outgoing switches the operation of the hold magnets and the test for double connections take place. The release of relay 4001 starts the test and operation of the hold magnets by connecting the primary windings which are the top windings of relays 1701 and 1702 to the hold magnets of the incoming primary and outgoing secondary links respectively. These windings which have ground on them as previously traced from contact 3 of relay 1901 to contact 1 of relay 1706 is of comparatively high resistance and may not operate the hold magnets. Their purpose is to test the continuity of the leads to the hold magnets by operating if they find battery on these leads, which is the normal condition. This circuit may be traced as follows: Battery through the hold magnet windings over lead 1570 through contact 2 of relay 1524, contacts of jack 1528, contact 7 of relay 2501, contact 5 of relay 2514, lead 2549 to contact 5 of the channel relay 3001 which has been operated, thence continuing over lead 3409 to contact 1 of relay 4001, contact 7 of relay 1714, top primary winding of relay 1702, lead 1749, contact 2 of relay 1904, lead 1949, top primary winding of relay 1701, leads 1750, contact 6 of relay 1714, contact 3 of relay 4001, lead 3050, contact 2 of channel relay 3001, lead 1950 thence through the incoming link and connector 1420 to hold magnet 1412 over leads 1470. Relays 1701 and 1702 operate and lock on their lowermost tertiary windings through the continuity contact 2 of relay 1703. At the same time that the winding of relay 1703 is grounded through the contacts of relays 1701 and 1702 in series, this same ground is connected to the incoming secondary and outgoing primary switch hold magnets 1422 and 1507 which also operate. This circuit may be traced as follows: Battery through both windings of hold magnets 1422 and 1507, contact 2 of relay 1520, contact 6 of relay 2501, contact 4 of relay 2514, lead 2548, contact 4 of channel relay 3001 thence over lead 3020, contact 2 of relay 4001, contacts of relays 1702 and 1701 which are operated as stated, contact 1 of relay 1714, lead 1723, contacts 3 of relay 5106, contact 3 of relay 5105, lead 5123 to ground and contact 3 of relay 1902.

Relay 1703 in operating shunts the high resistance upper primary winding of relay 1701 and 1702 and now establishes a low resistance circuit for operating the incoming primary and outgoing secondary hold magnets. Relay 1703 also removes ground from the tertiary circuits of relays 1701 and 1703 to reduce the negative potential on the sleeve circuit and aid the operation and holding of hold magnets and the incoming trunk and outgoing trunk sleeve relays. The ground which has been applied to these various sleeve conductors from contact 1 of relay 1714 shunts the operating winding of the double connection test relay 1709. When all of the hold magnets have operated and both sets of tip and ring conductors have been closed, relay 1712 operates which now operates relay 1714. The operation of relay 1714 removes the shunt from relay 1709 and removes the solid ground from the junctor sleeve. Relay 1709 is now connected to the junctor sleeve in series with the hold magnets. If no double connection exists, as indi-

cated by the absence of ground on the junctor sleeve, then relay 1709 operates in series with the hold magnets and at the same time maintains the hold magnets operated. If there is a double connection ground will be present on the sleeve lead and will not permit the operation of relay 1709 which blocks the next step in the progress of the marker operations and causes the marker ultimately to disconnect after a time period. The operation of relays 1709 and 1714 causes the operation of relay 1715 which locks and removes ground from lead 7312 to the marker connector. This lead extends through the marker connector to the sender relay 6601 which operated over this circuit. The removal of ground releases relay 6601 which applies holding ground to the hold magnets through its contacts and through the incoming trunk circuit. The circuit for applying this ground may be traced as follows: Starting with the hold magnet 1411 the circuit extends over the sleeve conductor through switch 1407 to lead 1456 thence over lead 1452 to the incoming trunk circuit and through contact 7 of incoming trunk relay 1213 thence over lead 3229 to contact 10 of the primary cross-bar link switch 3200 and secondary link switch 3203 extending over lead 5551 through contact 7 of relay 5585 continuing over lead 5551 through contact 3 of relay 6601, contact 1 of relay 6605, contact 4 of relay 6604, contact 3 of relay 6609, winding of relay 6608 to ground and through contact 5 of high resistance to battery. This ground is connected to the marker over the sleeve lead and shunts down the previously operated relay 1709. At the same time relay 1711 should have operated in the circuit traced through contact 3 of relay 1715, contact 5 of relay 1714, lead 6140, contact 7 of relay 6101, contact 1 of relay 3810, contact of relay 3814 and thence over lead 3125 as previously traced through the assignment frame and over lead 3126 to the sleeve of the outgoing trunk extending through the outgoing frame cross-bar switch cross-points to ground in the marker over lead 1570 as previously traced. This checks the sleeve cross-points of the outgoing primary and outgoing secondary cross-bar switches. With relay 1709 normal and relays 1715 and 1711 operated the operated path of the marker release relay 1901 is partly established. This test in conjunction with the tip and ring continuity tests to be described, checks every cross-point for continuity and checks the link and junctor sleeves for continuity, checks for the absence of double connections as indicated by the absence of ground on the sleeve lead and checks for the application of holding ground by the sender or position circuit. The tip and ring leads through the switches are checked for continuity by the marker. Coil 1726 and varistor 1725 connect non-grounded battery to leads 1753 and 1752 in series with the winding of relay 1712. This circuit may be traced as follows: The test as applied extends from winding of relay 1712 through the contacts of marker connector relay 7304 continuing over leads 7356 and 7357 to contacts 1 and 7 of sender relay 5706 which is normal, thence over leads 5756 and 5757 to contacts 3 and 4, respectively, of relay 5505, thence through the link switches 3203 and 3200 to the incoming ring-down trunk and cross-points of the connecting switches. This circuit becomes effective when generator ground is applied to the coil 1726 and when all of the tip and ring cross-points are closed.

Trunk connection

The outgoing trunk apparatus, Fig. 16, is partly operated when the trunk is found idle after the test of this trunk is complete and the remainder of the apparatus is operated when the cross-points of the switches in the complete train of switches have been closed. Relay 1610 is operated when the trunk is found idle. The operating ground for this relay is replaced by a holding ground as soon as the switch points have closed. This holding ground is the same ground that is placed on the sleeve conductor by the incoming trunk for maintaining the hold magnets operated and may be traced from contact 4 of relay 1304 in the incoming trunk, contact 9 of relay 1301, sleeve conductor 1452, thence through the contacts of the switches, sleeve conductor 1561 to battery through the winding of relay 1610. As previously stated, whenever the splitting relay 1301 is operated the ground just traced from contact 4 of relay 1304 is replaced by ground from the apparatus of the cordless toll position circuit. For tracing this circuit it should be remembered that relay 6505 was operated and locked to ground on contact 7 of relay 6511 when the position apparatus was operated, therefore, this sleeve ground circuit may be traced from ground on contact 8 of relay 6511 through contact 2 of relay 6505, winding of marginal relay 6506, contact 5 of relay 5604, contact 6 of relay 5609, contact 5 of relay 5601, contact 4 of relay 6603, contact 7 of relay 5507, thence over lead 5550 through the contacts of link switches 3203 and 3200 to lead 3228 to a junction point with sleeve lead 1452. The relay 1610 and the hold magnets are thus maintained operated under all conditions after the outgoing trunk has been seized. The operation of relay 1610 disconnects ground from test lead 3127 and associates this ground with a holding circuit for relay 1615 through its left winding and its contact 1, which is effective as soon as this relay is operated. Relay 1615 is operated from ground through its right winding, contact 1 of relay 1610, contact 4 of relay 1616 and resistance 1617 to battery. The operation of relay 1615 establishes an obvious circuit for the ringing relay 1612 through its contact 3 and establishes a circuit for the timing relay 1613 to ground through its contact 2. The operation of relay 1612 applies ringing current over the trunk 1624 to the distant toll office 162. Relay 1613 requires 2 seconds for operation which permits ringing the distant office for 2 seconds as explained later. During this period relay 1615 is locked from battery through resistance 1614, contact 1 through its left winding to ground on contact 3 of relay 1610. The operation of the switches in the toll train establishes a circuit over the ring conductor for the operation of relay 1616 as follows: Battery through the winding of relay 1616 is extended through its contact 3, contact 2 of relay 1610, lower winding of retard coil 1611, thence over the ring conductor through the contacts of the operated switches to the incoming trunk conductor 1451, through retard coil 1324, contact 7 of relay 1304 which is operated, thence over conductor 3227 to the contacts of link switch 3200 and link switch 3203 which are operated, thence over conductor 5553 through contact 9 of relay 5505 which is operated, contact 5 of relay 5609 normal, contact 2 of relay 5606 normal, contact 4 of relay 6601 normal, contact 2 of relay 6611 which is operated and through the

high resistance right winding of relay 5605. Relay 5605 operates over the circuit traced but relay 1616 in the outgoing trunk circuit does not operate due to the high resistance of the right winding of relay 5605. The operation of relay 5605 establishes an obvious circuit for relay 5606 which in operating locks to ground on contact 8 of relay 2408. The operation of relay 5606 associates ground through the low resistance left winding of relay 5605 and over the circuit traced to battery through the winding of relay 1616. Relay 1616 now operates. The operation of relay 1616 opens the circuit traced from the ring conductor through its winding and connects the ring conductor through its contact 3 to ground on the contact of relay 1609, thus causing the release of relay 5605. With relay 5605 released and relay 5606 operated a circuit is established for relay 5607 from ground through the contact of relay 5605, contact 2 of relay 5606, winding of relay 5607 to battery. The operation of relay 5607 associates the position supervisory lamp 5517 with the ring conductor as follows: As previously traced the circuit on the ring conductor passes through the inner spring of contact 2 on relay 5607. The operation of relay 5607 associates this lead with the associated armature and thence through contact 10 of relay 5505 to a mid-point between battery and the supervisory lamp 5517 which has its other filament terminal connected to ground on contact 6 of relay 5512. The ground extended from the contact of outgoing trunk relay 1609 through the lower winding of the retard coil 1611 and over the ring conductor establishes a shunt for supervisory lamp 1517 which extinguishes the lamp indicating to the operator that the outgoing trunk apparatus has satisfactorily operated. Returning to the relay 1616 in the outgoing trunk, the operation of this relay disconnects battery connected to the test lead 3126 through the winding of relay 1610 and connects ground through its contact 1 to this test lead. The operation of relay 1616 also opens the circuit from battery through resistance 1617, contact 1 of relay 1610, right winding of relay 1615 to ground. Relay 1615 is now maintained in operation through its left winding holding circuit. Relay 1616 establishes a locking circuit for itself from battery through its winding and its contact 2 to ground on contact 3 of relay 1610. The ringing tone circuit through its contact 5 is also opened. After a period of 2 seconds relay 1613 operates over the circuit established to ground on contact 3 of relay 1610 and in operating connects ground through its contact to the mid-point of the locking circuit for relay 1615 thus shunting battery from the left winding of the latter relay and causing its release. The release of relay 1615 opens the circuit for ringing relay 1612 which terminates the ringing over trunk 1624 to the toll office 1620. Should the operator in office 1620 wish to signal the cordless toll operator, ringing current is applied to the trunk 1624 which operates relay 1609 for disassociating ground from the ring conductor. This opens the shunt path previously traced to the mid-point of the circuit for lamp 5517 thus causing the lamp to light from battery through its filament to ground on contact 6 of relay 5512. The cordless operator responds to the signal by associating her telephone apparatus with the tip and ring conductors extending through cross-points of the cross-bar switches.

Operation of cross-bar switches in terminating train

The connector control circuits 900 and 1000 associated with the cross-bar switches of the incoming terminating train of switches and the outgoing switches of the terminating train are the same as shown and described for associating the marker with the switches of the toll train. The operation in the marker and in the connector apparatus is the same as described for Figs. 15, 25 and 26 and it is believed need not be redescribed for illustrating the operation of the cross-bar switches in the terminating train of switches.

Second trial to complete connection

When trouble is encountered in the marker and consequently the marker is unable to complete a connection between the calling incoming trunk and the desired outgoing trunk, the timing circuit is operated as previously described which operates the relays in the lower portion of Fig. 51, causing the operation of relay 5103. This relay connects ground to lead 7473 which extends through the connector circuit shown in Figs. 73 and 74 to the sender. Lead 7473 is extended through contact 3 of relay 6704, winding of relay 6703, resistance 6705 to battery. The operation of relay 6703 causes the release of relay 6700 and also opens the connector start lead and holding leads to the connector, thereby entirely releasing the connector in use. The release of the connector opens lead 7473, which operated relay 6703. This causes the operation of relay 6704 in series with relay 6703 over a circuit which may be traced from battery through the winding of relay 6703, winding of relay 6704, contact 3 of relay 6703 to ground on contact 1 of relay 6710. The operation of relay 6704 establishes a circuit for reoperating relay 6700 from battery through its winding, contact 5 of relay 6704 to ground on contact 1 of relay 6710. A start circuit is now established for a connector, the same as previously described, for again seizing an idle marker. This is usually a different marker from the one originally seized, since a delay circuit is used in the marker which prevents the second seizure within a short period of time. This delay circuit is established by the slow release of the timing relays which holds relay 5104 for a definite time. Relay 5104 holds relay 5105 over an obvious circuit and relay 5105 holds relay 5003 for placing a busy ground on the marker which has just been released. This busy ground is established from the ground on relay 5003 over lead 7498 which maintains the connector relays, such as 7401, operated for the period of time and maintains the marker in a busy condition. After the seizure of a connector, relays are operated in the marker to indicate that a sender has seized the marker for a second trial. With relay 6704 operated in the sender a different condition prevails than on the first trial since ground is connected to lead 7461 through contact 2 of relay 6704, contacts of connector relays 7304 and 7405 for operating relays 5806 and 5807 in the marker to indicate a second trial to the marker. The main difference in the marker between first and second trial constitutes an arrangement for using a different link and connector circuit for associating the marker with the cross-bar switches. It will be remembered that a connection from an odd sender on the first trial was given as an example and relay 5101 was operated to

guide the marker, as previously described, for its operation when associated with an odd sender. The operation of relay 5907 on second trial changes the order of selection by operating relay 5102 over lead 5928 since an odd sender is still associated with the marker. With relay 5102 operated and a connection desired to outgoing trunks on the same frame, according to the original routing, the marker now selects the frame connector circuit shown in Fig. 26 instead of the frame connector shown in Fig. 25. The operation of the connector shown in Fig. 26 is substantially the same as previously described with the exception that the link relays 2601 and 2602 are operated to extend the conductors from the marker over the mate channel to the apparatus of Fig. 15 in order that the trunks on the same switch frame may be reached. The differences between the operation of the home channel and the mate channel have been previously described and, therefore, it is believed that this description is adequate for an understanding of the operation in Fig. 26. These differences are slight and reside particularly in the reversal of leads in the marker and connector for energizing the relays of the mate channel instead of the relays of the home channel when a connection on second trial is made.

If the marker again fails to complete the connection it will time out in the same manner as previously described, which eventually connects ground to lead 7473 which now will cause the release of relay 6703. It will be remembered that this relay was operated after the first failure of the marker to properly complete the connection to the desired outgoing trunk. After the second failure, ground connected to relay 7473 extends through the inner contact 3 of relay 6704 for placing a shunt on the winding of relay 6703. This relay no longer receives battery through resistance 6705 and thus releases. The release of the latter relay establishes an operating circuit for relay 6709 from battery through the winding of relay 6709, contact 1 of relay 6703 to ground on contact 1 of relay 6704. The operation of relay 6709 connects ground to lead 6720 for operating relay 6604 to release the sender. The operation of relay 6604 connects ground to the winding of relay 5600. It will be remembered that relay 5608 was operated from ground on contact 6 of relay 5505 and that relay 6503 was operated from ground on relay 5608 through contact 3 of relay 6603. Consequently a circuit is now established from battery through the winding of relay 5600 through contact 1 of relay 5601, contact 1 of relay 5602, contact 4 of relay 6503 to ground on contact 3 of relay 6604. The operation of relay 5600 causes the release of the position relays and the release of the position relays causes the release of the sender apparatus.

Overflow

In certain cases, if all of the trunks extending to a particular office are found busy and if no additional trunks are provided on a different frame, a group of overflow trunks is provided in order that the originating operator and the cordless operator of this office may be advised that all of the trunks in the group tested are temporarily busy. When this overflow group or subgroup is provided, test leads are extended from the trunk block relay to certain of the relays in Fig. 38. These overflow trunks appear on the relays in Fig. 38 the same as a regular outgoing trunk and are selected in the same manner. For example, if the regular trunk group constitutes trunks 0 to 35 and the overflow subgroup constitutes trunks 36 to 39, assuming that the trunks 0 to 35 are found busy, a test of the overflow trunks is made. If an overflow trunk is found idle, it may be assumed that relay 3808 is not operated and a circuit for relay 3812 is established in the same manner as described for relay 3810 when a regular outgoing trunk was found idle. Thus, a circuit is completed through the trunk block relay for seizing the idle overflow trunk and the switches of Figs. 14 and 15 are directed for associating the incoming trunk with the overflow trunk in the same manner as they would be associated with the outgoing trunk extending to a distant toll office or a terminating trunk in a local office. The test is made for the idle or busy condition of an overflow trunk over lead 4138 in the same manner as for the outgoing trunk. Lead 4138 extends through contact 12 of the assignment frame connector relay 4110, contact 5 of trunk block relay 3114, thence over lead 3147 through the winding of overflow relay 1102. When this overflow trunk is found idle after the apparatus of Fig. 17 is associated with the overflow trunk over leads 4138 and 3147 in the manner previously described for testing an outgoing trunk, a low resistance ground is connected from the marker Fig. 17 to the winding of relay 1102 which operates this relay. The low resistance ground makes the overflow trunk busy to other markers. As soon as the idle overflow trunk is found, the multifrequency signaling system indicates the frame number on which this trunk is located in the same manner as herein described for a multifrequency indication of the frame number on which a regular outgoing trunk is found. The multifrequency signaling system would have already transmitted signals to the marker giving the frame location of the primary cross-bar switch connected to the calling incoming trunk.

It may be assumed that for this example the outgoing frame multifrequency signal is transmitted through the winding of select magnet 1509 over conductor 2070. This multifrequency indication is given through the select magnet of the switch associated with the overflow trunk in the same manner as herein described. Responsive to the frame number indication, a frame relay is operated in the marker in the same manner as previously described. Also, relays are operated to indicate whether the overflow trunk is associated with an odd or even frame. This establishes circuits for energizing a frame link and connector circuit, such as shown in Figs. 15, 25 and 26 and a similar connector such as 1420 associated with the incoming frame for testing the junctor leads which may be used for connecting the switch associated with the overflow trunk with the switch associated with the calling incoming trunk. Junctors are thus selected for this use and the secondary incoming switches, also the primary outgoing switches, are operated in the manner previously described for such a connection. When the switch hold magnets are operated in the manner previously described, ground is connected to sleeve conductor 1558 of the overflow trunk from contact 4 of incoming trunk relay 1304 before the marker low resistance ground is removed. Thus, the switch hold magnets are maintained operated and the sleeve conductor of the overflow trunk is maintained busy to other markers. When

the switch contacts are closed a circuit is established for operating relay 1101 as follows: Battery is extended through its winding and contact 2, over the ring conductor 1557 through the contacts of the cross-bar switches to ring conductor 1451 of the incoming trunk, thence through retard coil 1524, contact 7 of relay 1304 which is operated, over lead 3227, contact 8 of link cross-bar switches 3208 and 3203 thence over lead 5553, contact 9 of relay 5505 which is operated, contact 5 of relay 5609, normal, contact 2 of relay 5607 normal, contact 4 of relay 6601 normal, contact 2 of relay 6611 operated through the high resistance right winding of relay 5605. Relay 5605 operates in a circuit traced but relay 1101 does not operate due to the high resistance of the right winding of relay 5605. An obvious circuit is established for relay 5606 which locks to ground through contact 8 of relay 2408. The operation of relay 5606 connects ground through the low resistance left winding of relay 5605 to the circuit traced through the winding of overflow relay 1101. Relay 1101 now operates and locks to ground on the contact of relay 1102 and in so doing removes battery from the ring conductor extending through the cross-points of the cross-bar switches through both windings of relay 5605. This causes the release of relay 5605. With relay 5605 released and relay 5606 operated an obvious circuit is established for relay 5607 which operates and establishes a circuit through its contact 2 for the supervisory lamp 5517. The supervisory lamp is, therefore, now connected over the ring conductor through contact 2 of relay 1101 to the armature of relay 1103. Since all of the trunks in the regular group were found busy, no ground is connected through the windings of relay 1108 to battery. It will be remembered that all idle outgoing trunks of the regular group associate ground with the sleeve lead, such as lead 3127 shown in the regular outgoing trunk of Fig. 16. When this trunk is busy, relay 1610 is operated and the ground removed from lead 3127 extending to the sleeve of the patching jack. Consequently, when all trunks of a group are busy, this ground is not associated with any of the patching jacks and, since the sleeve terminals of the patching jacks are connected through the windings of overflow relay 1108, this relay, under this all trunks busy condition, is released. With relay 1108 released, a circuit is established for transmitting interrupted ground over the ring conductor 1557 according to the timing of interrupter 1107. Relay 1103 remains normal and relay 1104 is intermittently operated by interrupter 1107 and, thus, the interrupted ground is connected from the contact of relay 1104 through the back contact of relay 1103, contact of relay 1101 to the ring conductor 1557. This interrupted ground is extended through the calling incoming intertoll trunk over the circuit above traced for flashing lamp 5517 in the cordless toll operator's position in this office. This operator recognizes the period of flash as indicating that all the trunks of the desired outgoing group are busy. The connection will not immediately be abandoned since, under ordinary traffic conditions, a trunk will become idle within a short period of time. When a trunk in the group becomes idle, ground is immediately connected from relay 1610 of the idle trunk through the winding of relay 1108 which operates. The operation of relay 1108 establishes a circuit for relay 1103 from battery through its winding contact of relay 1108 to ground of contact 1 of relay 1101. This transfers the interrupted ground circuit from interrupter 1107 to interrupter 1106 which transmits interruptions of a different interval than interrupter 1107. Relay 1105 is operated according to the interrupting period of interrupter 1106 and transmits ground intermittently through the inner contact of relay 1103 to the ring conductor 1557. The change in the period of flash as indicated on lamp 5517 is noted by the cordless operator. A second attempt is made immediately by this operator to complete the call to an idle trunk in the desired group of outgoing trunks. In this case, the code of the outgoing trunk group is again registered on the key-set by the cordless operator and the same or a different marker is seized and the trunks of the group are again tested in an attempt to find an idle trunk which is usually successful under ordinary traffic conditions. When no idle trunk is available over an extended period the originating operator is so advised and a ticket is written for a delayed call. In this case the call may be routed by the cordless toll operator to an operator's position in the call order board in the usual manner.

Release of marker

The operating path for the marker release relay 1901 is closed through a contact of relay 4004 when the latter relay is released. The circuit for relay 4004 is opened by the release of the primary incoming select magnet and the secondary outgoing select magnet when connecting circuits have been completely established by the incoming and outgoing connector circuits associated with the cross-bar switches of the different frames. Therefore, the marker cannot release and start to release the associated connectors including the frame connectors until the operations in the frame connectors have established certain operating circuits extending to the marker which are as follows. It will be remembered that relay 1802 was operated from ground on contact 1 of relay 2513 in the outgoing link connector circuit and that relay 1803 was operated from ground on an incoming connector relay the same as relay 2513. During the test of sleeve leads and hold magnets for double connections ground is applied to the various lead conductors from contact 1 of relay 1714 which shunts the operating winding of the double connection test relay 1709. When all of the hold magnets have operated and both sets of tip and ring conductors have been closed, relay 1712 operates which establishes the operating circuit for relay 1714 which may be traced as follows: Battery through the winding of relay 1714, contact 10 of relay 1802, contact of relay 1712, lead 1723, contact of relays 5105 and 5107, thence over lead 5123 to ground on contact 3 of relay 1902. The operation of relay 1714 removes the shunt from relay 1709 and removes the solid ground from the junctor sleeve. Relay 1709 is now connected to the junctor sleeve in series with the hold magnets. If no double connection exists, as indicated by the absence of ground on the junctor sleeve, then relay 1709 operates in series with the hold magnets and at the same time maintains the hold magnets operated. The operation of relays 1709 and 1714 causes the operation of relay 1715 which locks and removes ground from lead 7472 extending through the marker connector to the winding of relay 6601 which releases relay 6601 in the sender. This

applies holding ground to the sleeve magnets through its contacts and through the incoming trunk circuit as previously described. This application of ground to the sleeve lead shunts down the previously operated relay 1709 and causes the operation of relay 1711 over a circuit traced through contact 3 of relay 1715, contact 5 of relay 1714, lead 6140, contact 7 of relay 6101, contact 1 of relay 3810, contact of relay 3814 and thence over lead 3125 as previously traced through the assignment frame and over lead 3126 to the sleeve of the outgoing trunk extending through the outgoing frame cross-bar switch cross-points to ground in the marker over lead 1570. The operation of relay 1714 opens the circuit for relays 1521 and 1524 in the outgoing connector and similarly in the incoming connector. The operation of relay 1714 also in opening its contact 2 disestablishes a circuit for the outgoing select magnet 1510 and in opening its contact 3 disestablishes its circuit for the incoming primary select magnet 1405. The release of relays 1521 to 1524 opens the circuit extending over lead 2545 to the marker relays and the release of similar relays in the incoming connector opens the circuit extending over lead 1925. The circuit originally established over lead 2545 operated relays 4012 and 4004. A similar circuit from the incoming connector was established over lead 1925 to the left winding of relay 4004 and the winding of relay 4010. The opening of leads 2545 and 1925 causes the release of these relays. Since relay 1709 is now normal and relays 1715 and 1711 are operated a circuit for the operation of the marker release relay 1901 is established. The circuit for the release relay 1901 may be traced from battery through its winding over lead 1910 through contact 1 of relay 6806, contact 4 of relay 4004, lead 4050, contact of relay 1711, contact 1 of relay 1715, contact of double connection test relay 1709, thence over lead 6813 to ground on contact 7 of relay 6808. By means of these various paths the operation of the release relay 1901 indicates that the connection has been properly set up. Relay 1901 locks over lead 1910 which branches into lead 6827, contact 1 of relay 6806, lead 6828 and in multiple through the contacts of relays 1804, 1801, 1802 and 1803 to ground on its own contact 2. This locking ground is furnished to insure that the release relay remains operated until the various off-normal ground supply relays and frame relays have released. The operation of the release relay 1901 opens the operating circuit for the ground supply relay 6808. This relay is, however, held operated over its locking circuit to ground on relay 7304 and does not release until the marker connector circuit has been released. A circuit is now established for the operation of the sender release relay 6711 which extends from battery through its winding over lead 7447 through the marker connector relays 1704 and 7405 to contact 4 of relay 1902, contact 1 of the marker release relay 1901, thence over lead 6812 to ground on contact 8 of relay 6808. The operation of the sender release relay 6711 opens the locking circuit extending over lead 7451 through the windings of the marker connector relays 7304 and 7301 to ground. This causes release of these connector relays and the release of relay 7304 opens the circuit for relay 7402 which in releasing opens the circuit for relay 7405. Relay 6808 which was locked through contact 3 of relay 7402 to ground on contact 5 of relay 7304 now releases. The release of relay 6808 opens the circuit for marker relays including relays 1903 and 1904 which supplies battery and ground to marker apparatus and to the frame connector operating apparatus. The release of relay 1903 removes the start battery from frame connector preference relays such as 2522 and a similar preference relay in the incoming connector, which causes the release of the circuits. The assignment frame connector also receives battery from relay 1903 and is thus released. The connector circuits which have been restored to normal are now available for seizure by other markers and in releasing the marker removes its busy ground and is thus available for association with other sender circuits for completing other connections. The operation of the sender release relay 6711 and the disconnection of the marker from the sender cause the release of the sender apparatus after the sender has completed all functions. The release relay is located to the numerical apparatus of the sender so as to hold the sender operated until pulses have been transmitted from the sender to an outgoing sender when an outgoing trunk has been selected to an office requiring pulses for the operation of its apparatus. When the pulses have been transmitted from the incoming sender to the outgoing sender the release of the incoming sender takes place.

What is claimed is:

1. In a telephone exchange, an automatic switching toll office, a plurality of connecting offices including other toll offices and other offices within the local area of said switching toll office, two trains of automatic switches in said automatic switching toll office, one train for calls to distant toll offices and the other train for calls to offices within said local area, incoming lines from said connecting toll offices to said automatic switching toll office, lines outgoing to connecting toll offices and to said offices within said local area, a marker common to said two trains of switches for controlling the operation of said switches, means in said marker responsive to line selection routing registrations for automatically completing connections over either of said trains of switches in accordance with said registrations, a signaling system for signaling to the marker the location of the switches involved in a connection, and means in said marker for operating said switches.

2. In a telephone exchange, an automatic switching toll office, a plurality of connecting offices including other toll offices and other offices within the local area of said switching toll office, two trains of automatic switches in said automatic switching toll office, one train for calls to distant toll offices and the other train for calls to offices within said local area, incoming lines from said connecting toll offices to said automatic switching toll office, lines outgoing to connecting toll offices and to said offices within said local area, a marker common to said two trains of switches for controlling the operation of said switches, means in said marker responsive to line selection routing registrations for automatically completing connections over either of said trains of switches in accordance with said registrations, a multifrequency signaling system for signaling to the marker the location of switches involved in a connection comprising means for utilizing electrical currents of different frequencies for different switch locations, means for transmitting said identifying frequencies to said marker and

means in said marker for operating switches according to the frequencies transmitted.

3. In a telephone exchange, an automatic switching toll office, a plurality of connecting offices including other toll offices and other offices within the local area of said switching toll office, two trains of automatic switches in said automatic switching toll office, one train for calls to distant toll offices and the other train for calls to offices within said local area, incoming lines from said connecting toll offices to said automatic switching toll office, lines outgoing to connecting toll offices and to said offices within said local area, a marker common to said two trains of switches for controlling the operation of said switches and means in said marker responsive to line selection routing registrations for automatically completing connections over either of said trains of switches in accordance with said registrations.

4. In a telephone exchange, an automatic switching toll office, a plurality of connecting offices including other toll offices and other offices within the local area of said switching toll office, two trains of automatic switches in said automatic switching toll office, one train for calls to distant toll offices and the other train for calls to offices within said local area, incoming lines from said connecting toll offices to said automatic switching toll office, lines outgoing to connecting toll offices and to said offices within said local area, a marker common to said two trains of switches for controlling the operation of said switches, means in said marker responsive to line selection routing registrations for automatically completing connections over either of said trains of switches in accordance with said registrations, means in said marker responsive to line selection registrations for automatically routing a call over either train of switches and means in said marker for selecting an idle outgoing line according to said routing and for operating switches in the train of switches over which the call is routed for connecting a calling incoming line with said idle outgoing line.

5. In a telephone exchange, an automatic switching toll office, a plurality of connecting offices including other toll offices and other offices within the local area of said automatic switching toll office, two trains of automatic switches in said automatic switching toll office, one train for calls to distant toll offices and the other train for calls to offices within said local area, incoming lines from said connecting toll offices to said automatic switching toll offices, lines outgoing to connecting toll offices and to said offices within said local area, a group of senders, means responsive to a signal over a calling incoming line for associating an idle sender with said calling line, registers in said sender for recording the routing of a wanted outgoing line responsive to signals over said calling incoming line, a group of markers common to said two trains of switches for controlling the operation of said switches, means in said sender for selecting an idle one of said markers and for registering in said marker the routing of said wanted outgoing line, means in said marker for selecting an idle outgoing line according to said routing and means in said marker for controlling the operation of the switches in the train over which the call is routed for connecting the calling incoming line with the selected outgoing line.

6. In a telephone exchange, an automatic switching toll office, a plurality of connecting offices including other toll offices and other offices within the local area of said automatic switching toll office, two trains of automatic switches in said auotmatic switching toll office, a train for calls to distant toll offices and the other train for calls to offices within said local area, incoming lines from said connecting toll offices to said automatic switching toll offices, lines outgoing to connecting toll offices and to said offices within said local area, a group of toll operators' positions common to said two trains of switches, means responsive to a signal over a calling incoming line for associating an idle position with said calling line, a group of markers common to said two trains of switches for controlling the operation of said switches, means in said toll operator's position for controlling the selection of an idle one of said markers and for registering in said marker the routing of a wanted outgoing line receiver over said calling incoming line and means in said marker controlled by said registrations for routing said call over the one of said trans of switches selected by said registrations and for operating switches in this train to connect the calling incoming line to the wanted outgoing line.

7. In a telephone exchange, an automatic switching toll office, a plurality of connecting offices including other toll offices and other offices within the local area of said automatic switching toll office, two trains of automatic switches in said automatic switching toll office each comprising incoming switches mounted on a plurality of frames and outgoing switches mounted on another plurality of frames, one train for calls to distant toll offices and the other train for calls to offices within said local area, incoming lines from said connecting toll offices to the incoming switches of said automatic switching toll offices, lines outgoing to connecting toll offices and to said offices within said local area from said outgoing switches, a marker common to said two trains of switches for controlling the operation of said switches, means in said marker responsive to line selection routing registrations for automatically completing connections over either of said trains of switches in accordance with said registrations, a multifrequency signaling system common to all of the switches in both trains comprising means for utilizing electrical currents of different frequencies for establishing the location of switches, means for successively transmitting identifying frequencies to said marker for establishing the location of the incoming switch and the location of the outgoing switch for a telephone connection and means in said marker for operating said switches according to said identifying frequencies.

8. In a telephone exchange, a telephone office, a train of automatic switches located on a large plurality of frames, incoming lines connected to the incoming switches of said train, outgoing lines connected to the outgoing switches of said train, intermediate switches in said train operable in various combinations for interconnecting any of said incoming switches to any of said outgoing switches, a control system for operating said switches, and a signal transmitting system common to said plurality of frames of switches successively responsive to the seizure of an incoming line and an outgoing line for directing said control system in the selection of intermediate switches for the interconnection of an

incoming and an outgoing switch corresponding to the lines seized.

9. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of automatic switches for interconnecting any of said lines, a control device, means in said control device operable over one line for registering a desired connection to another of said lines, means in said office for transmitting signals to said control device representing the location of the switches connected to lines according to said registration and means in said control device responsive to said signals for operating switches for connecting said particular lines together.

10. In an automatic switching telephone office, incoming and outgoing lines, a train of automatic switches connected to said incoming and outgoing lines operable for interconnecting any of said incoming and outgoing lines, said train of switches being mounted on a large plurality of odd and even numbered frames, a switch controlling device having a routing system under the direction of signals transmitted over an incoming line for routing telephone calls to particular groups of lines, a signaling transmitting system common to all of said switches successively responsive to the seizure of a calling incoming line and an outgoing line to which the call was routed for directing the control system to make a connection to the switches on odd or even frames according to the location of the incoming and outgoing lines, and means in said control device responsive to said signals for operating switches on said odd or even frames for connecting said calling incoming line to a desired outgoing line.

11. In a telephone office, automatic switches, incoming and outgoing lines terminating in the switches of said office, a control device for operating said switches, a signaling system independent of the contacts of said switches for successively transmitting signals to said control device for signaling the location of a switch connected to a calling incoming line and the location of a switch connected to a selected outgoing line and for readjusting said control device between said successive signals, and means in said control device for operating particular switches according to the signals transmitted.

12. In a telephone exchange, a telephone office, a train of automatic switches located on a large plurality of frames, incoming lines connected to the incoming switches of said train, outgoing lines connected to the outgoing switches of said train, intermediate switches in said train operable in various combinations for interconnecting any of said incoming switches to any of said outgoing switches, a control system for operating said switches, a signal transmitting system common to said plurality of frames of switches successively responsive to the seizure of an incoming line and an outgoing line for directing said control system in the selection of intermediate switches for the interconnection of an incoming and an outgoing switch corresponding to the lines seized, and means for readjusting said control system between successive responses of said signal transmitting system.

13. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of automatic switches in different locations for interconnecting any of said lines, a control device, means for registering in said control device two lines to be interconnected, a multifrequency signaling system for indicating the location of switches required for operation to connect said two lines comprising electrical circuits and apparatus for transmitting currents of different frequencies to said control device, and means in said control device operated by the particular frequencies transmitted for controlling the energization of switches as indicated for interconnecting the lines registered.

14. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of automatic switches for interconnecting any of said lines, magnets for operating said switches, a control device for operating the magnets, a multifrequency signaling system for indicating the location of magnets required for operation to connect together two particular lines comprising means for utilizing electrical currents of different frequencies for different locations, and means for transmitting said identifying frequencies to said control device.

15. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of automatic switches for interconnecting any of said lines, magnets for operating said switches, a control device for operating said magnets, a signaling system having its circuit paths through the windings of said switch magnets for signaling the location of switches to said control device, means responsive to the selection of two of said lines for establishing particular ones of said signaling circuits, and means in said control device responsive to said signals for establishing operating circuits through said magnet windings for operating said switches.

16. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of switches for interconnecting calling incoming lines with outgoing lines, magnets for operating said switches, a marker for controlling the operating of said magnets, a signal receiving circuit in said marker and a signal transmitting system having circuits extending through all said magnets to the receiving circuit in said marker for establishing the location of switches for operation to interconnect the calling incoming line with an outgoing line.

17. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of automatic switches for interconnecting any of said lines, select magnets individual to said lines for operating said switches, a marker common to said lines for controlling the operation of switches for the interconnection of selected lines and a signaling system operably responsive to the selection of lines having a circuit extending through said magnets to said marker for directing the operation of said marker.

18. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of automatic switches for interconnecting any of said lines, means individual to said lines for operating said switches, a marker common to said lines for controlling the operation of switches for the interconnection of selected lines and a signaling system operably responsive to the selection of lines having a circuit extending through said means to said marker for directing the operation of said marker.

19. In a telephone exchange, a telephone office, lines terminating in said office, a plurality of automatic switches for interconnecting any of said lines, magnets for operating said switches, a control device for operating the magnets, a multi-frequency signaling system for indicating the location of magnets required for operation

to connect together two particular lines utilizing electrical currents of different frequencies for different locations, means for transmitting said current frequencies to said control device, and means in said control device including tuned apparatus responsive only to the frequencies transmitted for identifying the location of switches operable by said magnets.

20. In a telephone system, a telephone office, incoming and outgoing lines, a plurality of banks of automatic switches for said incoming lines, another plurality of banks of automatic switches for said outgoing lines, magnets for operating the individual switches of said banks to obtain connection from calling incoming lines to idle outgoing lines of wanted destination, a common control device, means to direct said control device to the location of banks having switches for completing said connection utilizing electric currents of different frequencies for indicating different location, means for transmitting said identifying frequencies to said control device, and means operable in said control device for translating said identifying frequencies for controlling the operation of said switch magnets.

21. In a telephone system, a telephone office, incoming and outgoing lines, a plurality of frames of automatic switches for said incoming lines, another plurality of frames of automatic switches for said outgoing lines, magnets for operating switches on the incoming and the outgoing frames to connect calling incoming lines with idle outgoing lines of wanted destination, a common switch controlling marker for operating said magnets, and means to indicate to said marker the location of magnets required for operation to complete said connections comprising sources of electric currents of different frequencies associated with the magnets of different frames, and means for transmitting said frequencies to said marker.

22. In a telephone exchange system, a telephone office, associated telephone offices, incoming lines from said associated offices, a plurality of frames of automatic switches for said incoming lines, outgoing lines assembled in groups according to the associated offices to which they are connected, a plurality of frames of automatic switches variably cross-connected to said groups of lines, a control device for testing lines and operating switches for connecting a calling incoming line to an idle line of a designated group of lines, and a multifrequency signaling system for indicating to said control device the location of the frame having the calling incoming line and associated switch thereon, and the location of a frame with a group of lines and associated switches having an idle line thereon extending to the designated office, comprising circuits and apparatus associated with said frames for transmitting electrical currents of particular frequencies to said control device according to the location of the switches, and means in said control device for identifying said frequencies as indications of said locations.

23. In a telephone switching office, a plurality of separately terminated lines arranged for interconnection for completing telephone calls, electrically operated switches having a network of conductors therebetween operable in various combinations for variably interconnecting said telephone lines, a remotely operable control device for automatically setting said switches, means remote from said control device for registering in said control device the lines to be interconnected, a multifrequency signaling system for indicating to said control device the lines to be interconnected, a multifrequency signaling system for indicating to said control device the location of switches required for operation to connect together a network for interconnecting the registered lines, comprising electrical circuits and apparatus associated with the lines for transmitting currents of different frequencies to said control device, and means in said control device operated by particular ones of said frequencies for controlling the energization of switches for said interconnection.

24. In a switching office, a plurality of separately terminated sets of electrical conductors arranged for interconnection for transmitting electric currents, electrically operated switches having a network of lines therebetween operable in various combinations for variably interconnecting said conductors, a controlling marker for automatically setting said switches, means remote from said marker for registering in said marker the sets of conductors to be interconnected, a multifrequency signaling system for indicating to said marker the location of switches required for operation to connect together a network for interconnecting the conductors registered, comprising electrical circuits and apparatus associated with the conductors for transmitting currents of different frequencies to said marker, and means in said marker operated by particular ones of said frequencies for controlling the energization of switches for said interconnection.

25. In a telephone exchange, a telephone office, lines entering said office, incoming switches mounted on a plurality of frames used for incoming calls over said lines, outgoing switches mounted on a plurality of frames used for outgoing calls over said lines, a marker for controlling the operation of said switches for connecting the calling incoming line with an outgoing line and a signaling system arranged to successively transmit electrical signals from a signaling source common to said frames for establishing the frame locations of switches on the incoming and the outgoing frames for directing the operation of said marker in completing a connection.

26. In a telephone exchange, a telephone office, lines entering said office, incoming switches mounted on a plurality of frames used for incoming calls over said lines, outgoing switches mounted on a plurality of frames used for outgoing calls over said lines, a marker for controlling the operation of said switches for connecting the calling incoming line with an outgoing line, a signaling system arranged to successively transmit electrical signals from a signaling source common to said frames for establishing the frame locations of switches on the incoming and the outgoing frames for directing the operation of said marker in completing a connection, and means for readjusting the marker between successive signals.

27. In a telephone exchange, a telephone office, lines entering said office, incoming switches mounted on a plurality of frames used for incoming calls over said lines, outgoing switches mounted on a plurality of frames used for outgoing calls over said lines, a marker for controlling the operation of said switches for connecting a calling incoming line with an outgoing line and a signaling system arranged to successively transmit combinations of a plurality of

electrical signals from a signaling source common to said frames for establishing the frame location of switches on the incoming and the outgoing frames for directing the operation of said marker in completing connections.

28. In a telephone exchange, a telephone office, lines entering said office, incoming switches mounted on a plurality of frames used for incoming calls over said lines, outgoing switches mounted on a plurality of frames used for outgoing calls over said lines, a marker for controlling the operation of said switches for connecting a calling incoming line with an outgoing line and a signaling system in said office arranged to transmit different combinations of a plurality of signals for different frame locations of switches on the incoming and the outgoing frames for directing the operation of said marker in completing a connection.

29. In a telephone exchange, a telephone office, lines entering said office, incoming switches mounted on a plurality of frames used for incoming calls over said lines, outgoing switches mounted on a plurality of frames used for outgoing calls over said lines, a marker for controlling the operation of said switches for connecting a calling incoming line with an outgoing line and a signaling system arranged to successively transmit different combinations of a plurality of signals for different frame locations of switches on the incoming and the outgoing frames for directing the operation of said marker in completing a connection and means for readjusting said marker between successive signals.

30. In a telephone exchange, a telephone office, lines entering said office, incoming switches mounted on a plurality of frames used for incoming calls over said lines, outgoing switches mounted on a plurality of frames used for outgoing calls over said lines, a marker for controlling the operation of said switches for connecting a calling incoming line with an outgoing line and a multifrequency signaling system for indicating the frame location of switches on the incoming and outgoing frames utilizing different combinations of electrical currents of different frequencies for different frame locations, means for transmitting said current frequency combinations to said marker and means in said marker responsive to the frequency combinations transmitted for identifying the frame location of switches for operation to complete a connection between a calling line and an outgoing line.

31. In a telephone exchange, a telephone office, a plurality of apparatus frames in said office, trunks, automatic switches connected to said trunks for completing telephone connections, said trunks and associated switches being mounted on a plurality of said frames, a control device for operating said switches and a multifrequency system arranged to transmit different combinations of a plurality of current frequencies for each different frame location of trunks for directing the operation of said control device.

32. In a telephone exchange, a telephone office, a plurality of apparatus frames, trunks, automatic switches connected to said trunks for completing telephone connections, said trunks and associated switches being mounted on a plurality of said frames, a control device, a multifrequency signaling system arranged to transmit different combinations of a plurality of current frequencies for each different frame location of trunks for directing the operation of said control device, and means in said control device for establishing connections with switches in locations as directed by said signaling system for operating said switches to complete a telephone connection.

33. In a telephone exchange system, a telephone office, automatic switches for completing telephone connections, trunks and trunk switches in preferred groups and secondary groups, said trunks extending to a particular distant office, the apparatus for said different groups being mounted on different frames, a control device, means in said control device for testing the preferred group of trunks for an idle trunk, a signaling system, means in said signaling system for transmitting a signal to said control device indicating the frame location of the preferred group when a trunk in said group is found idle, means in said signaling system to direct the control device for testing the trunks of a secondary group when all trunks of the preferred group are found busy, and means in said signaling system to indicate the frame location of said secondary group when a trunk in the latter group is found idle.

34. In a telephone exchange system, a telephone office, a plurality of apparatus frames, automatic switches connected to trunks for completing telephone connections, said trunks and associated switches being mounted on a plurality of different frames in preferred groups and secondary groups, a control device, means in said control device for testing the preferred group for an idle trunk, a signaling system arranged to transmit different signals for directing the operation of said control device, means in said signaling system for directing the control device to an idle preferred trunk when found, and means in said signaling system for directing said control device to abandon the preferred group of trunks on one frame and test a secondary group of trunks on a different frame as directed when the trunks of the preferred group are all busy.

35. In a telephone exchange system, a telephone office, a plurality of apparatus frames, automatic switches connected to trunks for completing telephone connections, said trunks and associated switches being mounted on a plurality of different frames in preferred groups and secondary groups, a marker, means in said marker for testing the preferred group for an idle trunk, a signaling system arranged to transmit different signals for directing the operation of said marker, means in said signaling system for directing the marker to an idle preferred trunk when found, means in said signaling system for signaling said marker that all trunks of the preferred group are busy and that there is a secondary group of trunks available on a different frame, means responsive to the latter signal for readjusting the marker and the signaling system and means in said signaling system for transmitting another signal for readjusting the routing of the marker for testing the trunks in said secondary group.

36. In a telephone exchange system, a telephone office, a plurality of apparatus frames, automatic switches connected to trunks for completing telephone connections, said trunks and associated switches being mounted on a plurality of different frames in preferred groups and secondary groups, a marker, means in said marker for testing the preferred group for an idle trunk, a signaling system arranged to transmit different signals for directing the operation of said marker, means in said signaling system for directing the marker to an idle preferred trunk when found, means in said signaling system for

transmitting different signals successively (1) for establishing that all trunks in the preferred group are busy and that there is a secondary group of trunks available on a different frame, (2) to alter the routing of the marker for testing the trunks in the secondary group, (3) for establishing the location of a switch connected to an idle trunk found in the secondary group, and means for readjusting the marker between successive signals according to the signal transmitted.

37. In a telephone exchange, a telephone office, a plurality of apparatus frames, automatic switches connected to trunks for completing telephone connections, said trunks and associated switches being mounted on a plurality of said frames in preferred groups and secondary groups, a control device, means in said control device for testing the preferred group for an idle trunk, a multifrequency signaling system arranged to transmit different combinations of a plurality of current frequencies for directing the operation of said control device, means in said signaling system for transmitting one combination of a plurality of current frequencies for directing the control device to the location of an idle preferred trunk when found and means in said signaling system for transmitting other combinations of current frequencies for directing said control device to abandon the preferred group of trunks and for directing the test of a secondary group of trunks when the trunks of the preferred group are all busy.

38. In a telephone exchange system, a telephone office, a plurality of apparatus frames, automatic switches connected to trunks for completing telephone connections, said trunks and associated switches being mounted on a plurality of said frames in preferred groups and secondary groups, a control device and means in said control device for testing the preferred group for an idle trunk, a multifrequency signaling system arranged to transmit different combinations of a plurality of current frequencies for directing the operation of said control device, means in said signaling system for transmitting a combination of current frequencies for directing said control device to abandon the preferred group of trunks and for transmitting a different combination of current frequencies for directing the test of a secondary group of trunks and for transmitting a third different combination of frequencies for directing the control device to the location of an idle secondary trunk when found.

39. In a telephone exchange system, a telephone office, associated telephone offices, incoming lines from said associated offices, a plurality of frames of automatic switches for said incoming lines, outgoing lines assembled in groups according to the associated offices to which they are connected, a plurality of frames of automatic switches variably cross-connected to said groups of lines, a control device for testing lines and operating switches for connecting an incoming line to an idle line of a designated group of lines, a multifrequency signaling system for indicating to said control device the location of the frame having the incoming line and associated switch thereon, and the condition of a group of lines and associated switches extending to the designated office, comprising circuits and apparatus for transmitting a frequency to said control device for indicating the location of switches connected with said incoming line, and circuits and apparatus associated with said groups of outgoing lines for transmitting a particular frequency to the control device indicating that no line in the group tested is idle and that another group of lines extending to the same office is available.

40. In a telephone exchange system, a telephone office, associated telephone offices, incoming lines from said associated offices, a plurality of frames of automatic switches for said incoming lines, outgoing lines assembled in groups according to the associated offices to which they are connected, a plurality of frames of automatic switches variably cross-connected to said groups of lines, a control device for testing lines and operating switches for connecting an incoming line to an idle line of a designated group of lines, a multifrequency signaling system for indicating to said control device the location of the frame having the incoming line and associated switch thereon, and the condition of a group of lines and associated switches extending to the wanted office, comprising circuits and apparatus for transmitting electric currents of different frequencies to said control device for indicating the frame location of switches connected with said incoming line, and circuits and apparatus associated with said groups of outgoing lines for transmitting particular frequencies to the control device indicating that no line in the group tested is idle, for transmitting different frequencies to indicate another group of lines extending to the same office, and for transmitting a third difference in frequencies to indicate the frame location of the switches for connecting the incoming line to an idle line in the latter group of lines.

41. In a telephone exchange system, a telephone office, associated telephone offices, incoming lines for said associated offices, a plurality of frames of automatic switches for said incoming lines, outgoing lines assembled in groups according to the associated offices to which they are connected, a plurality of frames of automatic switches variably cross-connected to said groups of lines, a control device for testing lines and operating switches for connecting an incoming line to an idle line of a designated group of lines, and a multifrequency signaling system for indicating to said control device the location of the frame having the incoming line and associated switch thereon, and the condition of a group of lines and associated switches extending to the wanted office, comprising circuits and apparatus for transmitting electric circuits of particular frequencies to said control device for indicating the location of switches connected with said incoming line, and circuits and apparatus associated with said groups of outgoing lines for transmitting electric currents of particular frequencies to the control device, indicating that no line in the group tested is idle, for transmitting electric currents of different frequencies to indicate another group of lines extending to the same office, and for transmitting electric currents of different frequencies to indicate the location of the switches for connecting the incoming line to an idle line in the latter group of lines, and means in said control device for successively responding to said different frequencies for altering the connecting circuit paths to said line groups.

42. In a telephone exchange, a telephone office, trunks terminating in said office, a plurality of automatic switches in different locations in said office for connecting trunks, a control device, means for registering in said control device a trunk for connection to a switch, selectively

operable receiving circuits in said control device, a plurality of sources of electrical currents, said sources differing in frequency, means in said control device for establishing a sending circuit for connecting selected sources to said receiving circuits, means in each receiving circuit for establishing a signaling circuit responsive to its energization and means responsive to the establishment of said signaling circuit for directing said control device in the operation of one of said switches in a particular location for connection to a trunk as registered.

43. In a telephone exchange, a telephone office, incoming and outgoing trunks in said office, a plurality of automatic switches in different locations in said office for interconnecting calling incoming trunks with outgoing trunks, a control device, means for registering trunk connections in said control device, selectively operable receiving circuits in said control device, a plurality of sources of electrical currents, said sources differing in frequency, sending circuits, means in said control device for successively establishing sending circuits for connecting selected sources to said receiving circuits to successively actuate said receiving circuits, and means responsive to successive actuations of said receiving circuits to cause the operation of switches in particular locations for interconnecting a calling incoming trunk with an outgoing trunk according to registrations in said control device.

44. In a telephone exchange, a telephone office, incoming and outgoing trunks in said office, a plurality of automatic switches in different locations in said office for interconnecting the calling incoming trunks with outgoing trunks, a control device, means for registering trunk connections in said control device, selectively operable receiving circuits in said control device, a plurality of sources of electrical currents, said sources differing in frequency, sending circuits, means in said control device for successively establishing sending circuits for successively connecting selected sources to said receiving circuits for actuating a plurality of receiving circuits, means responsive to the first actuation of said receiving circuits for directing said control device in the operation of a switch in a particular location associated with a calling incoming trunk and for disestablishing said sending circuit, means for establishing a second sending circuit for actuating a plurality of receiving circuits and means responsive to the latter actuation of the receiving circuits for directing said control circuit in the operation of a switch in a particular location associated with an outgoing trunk according to said registrations.

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