Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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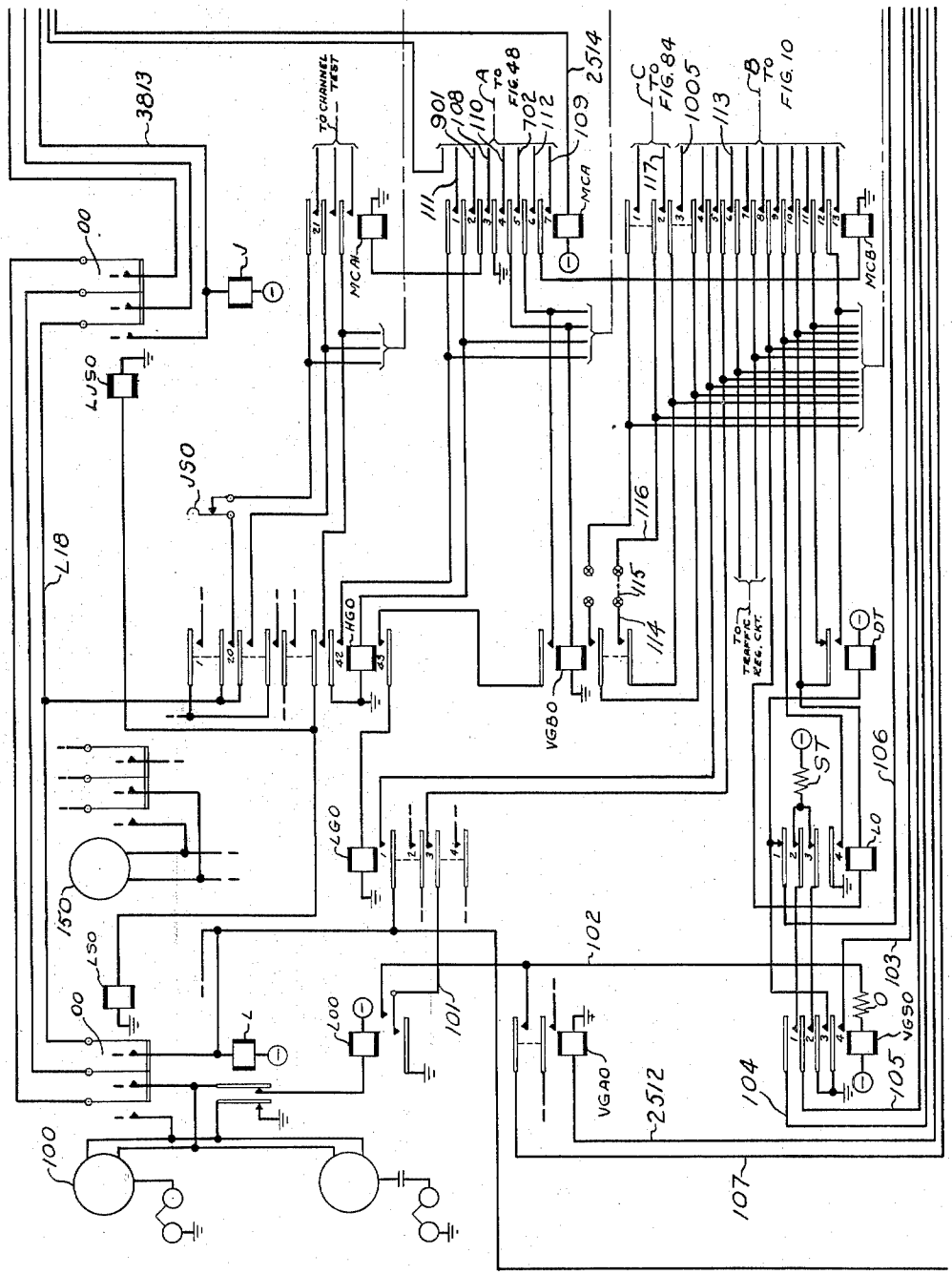

FIG. 1

INVENTORS. A.O. ADAM, JR.
R.C. AVERY

BY. P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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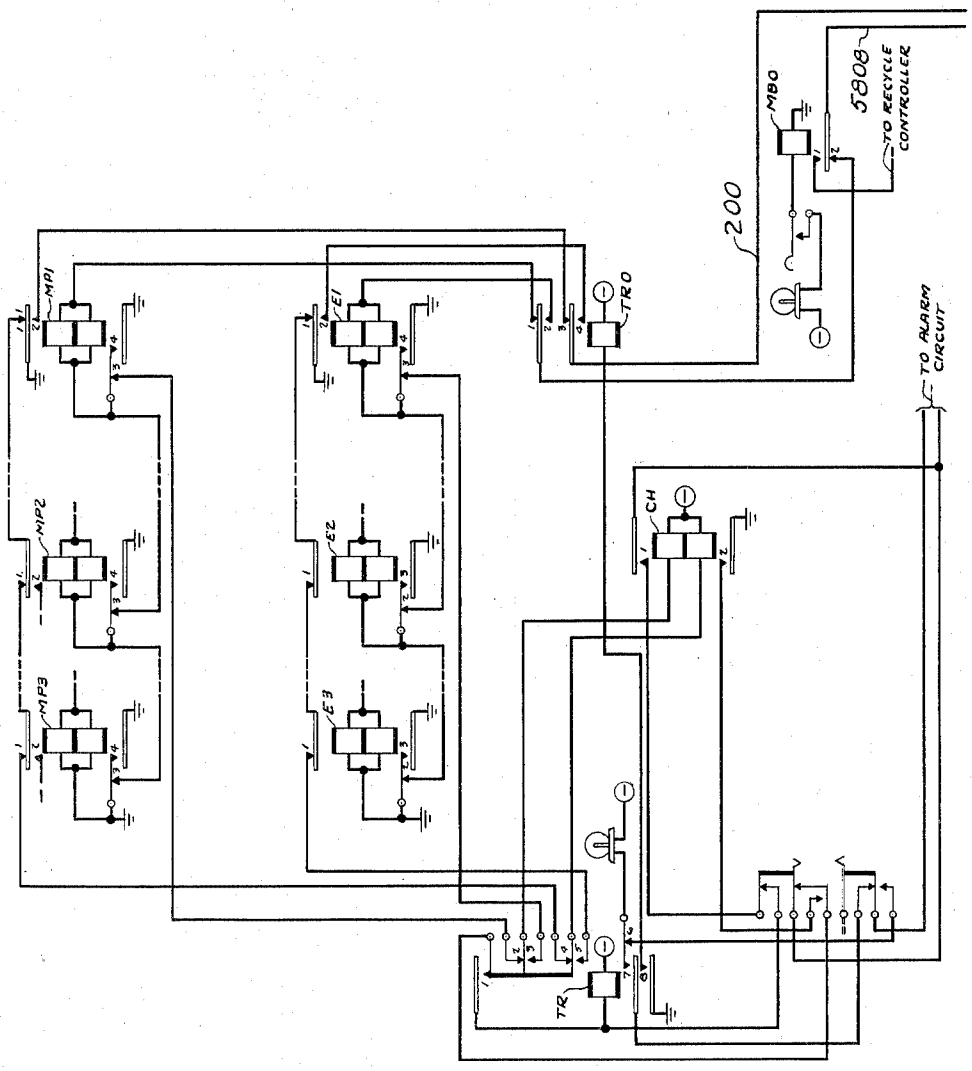

FIG. 2

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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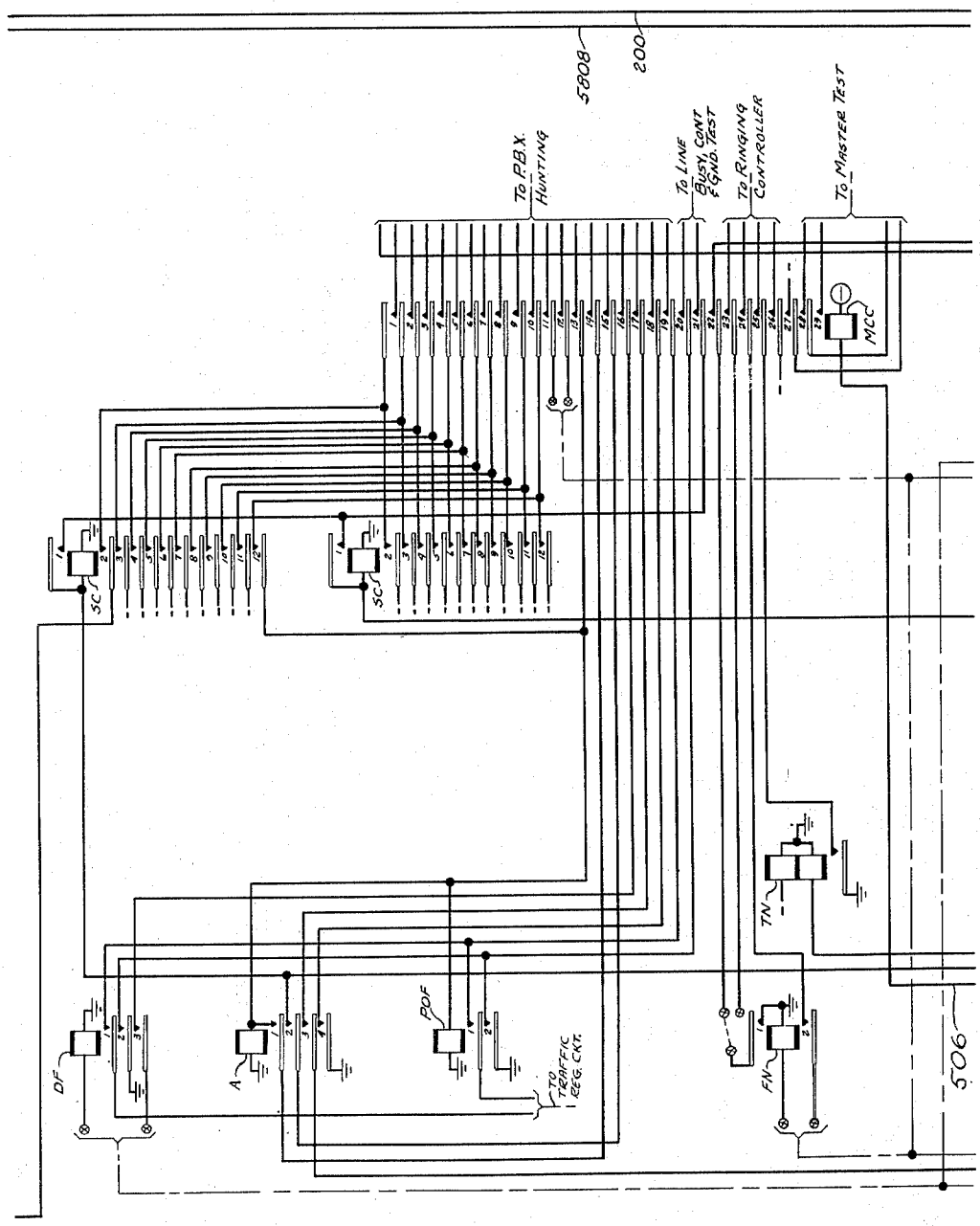

FIG. 3

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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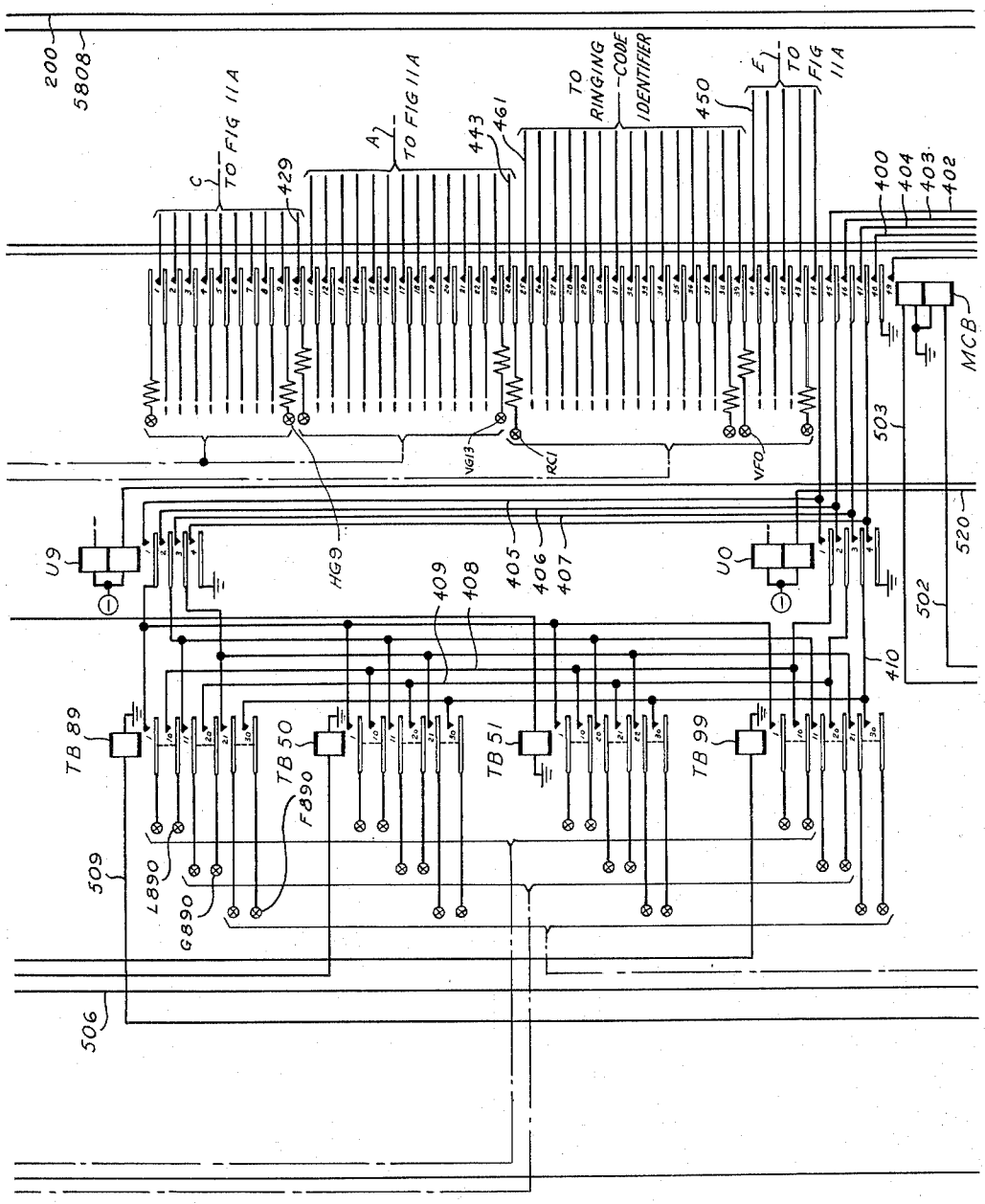

FIG. 4

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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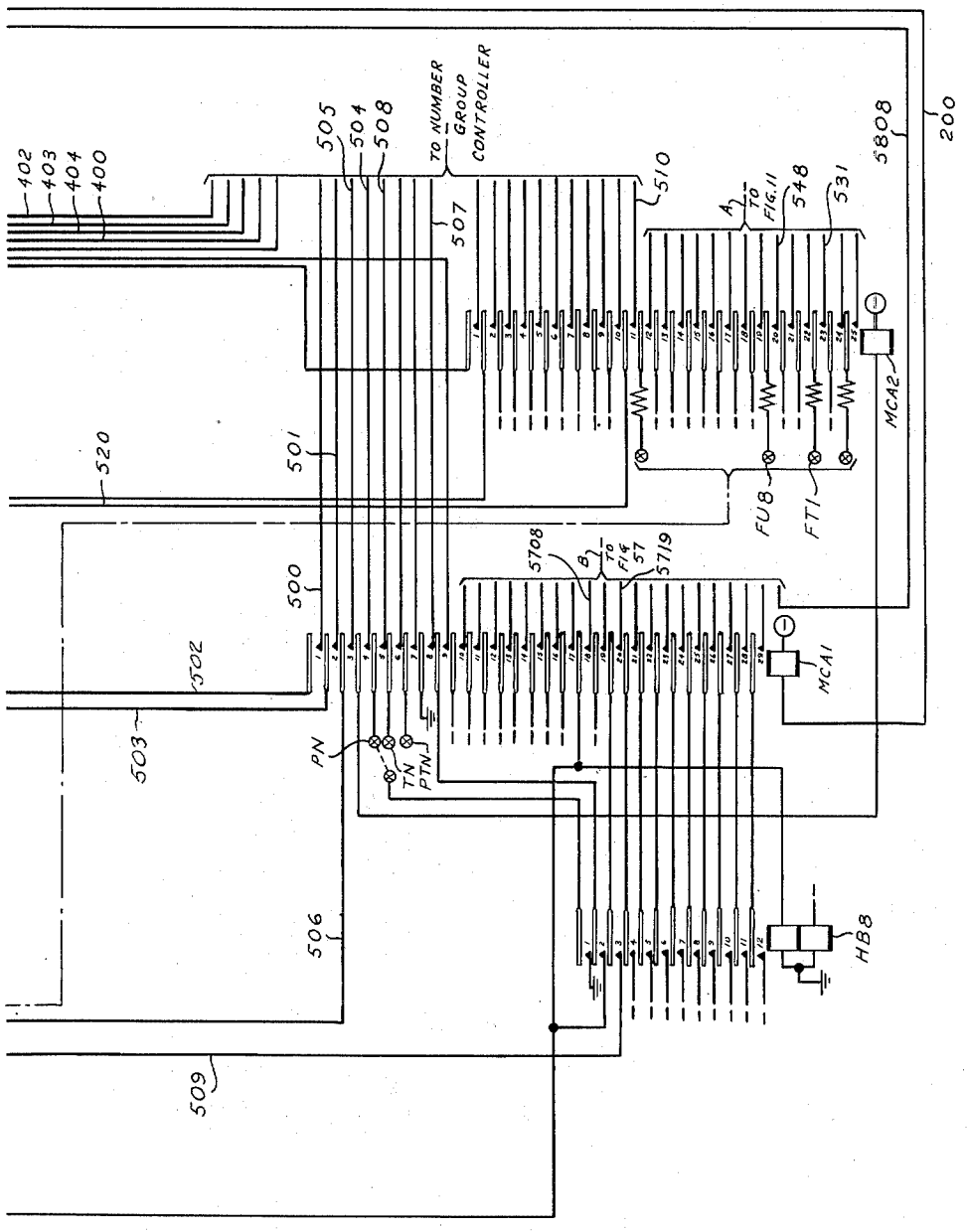

FIG. 5

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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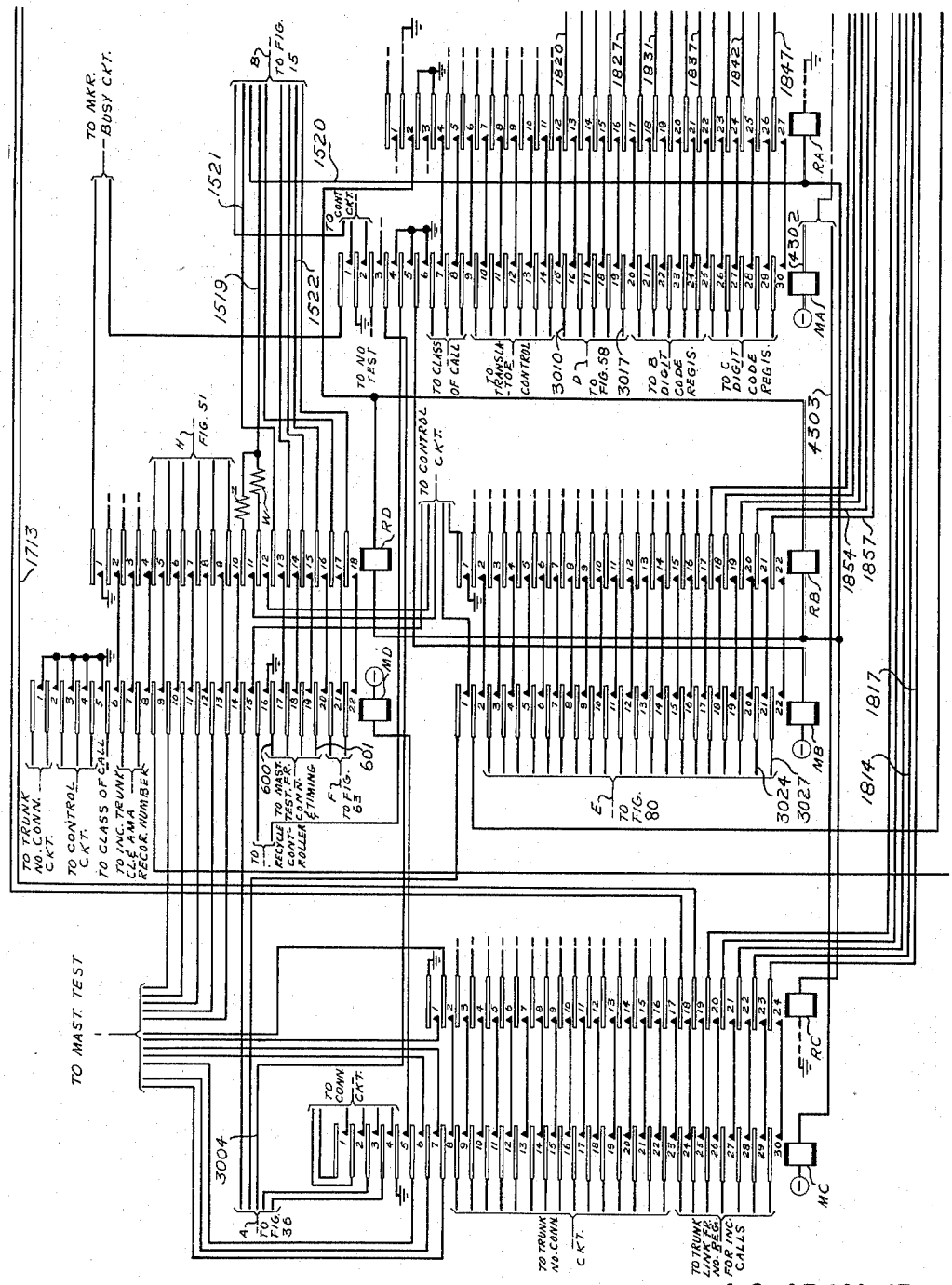

FIG. 6

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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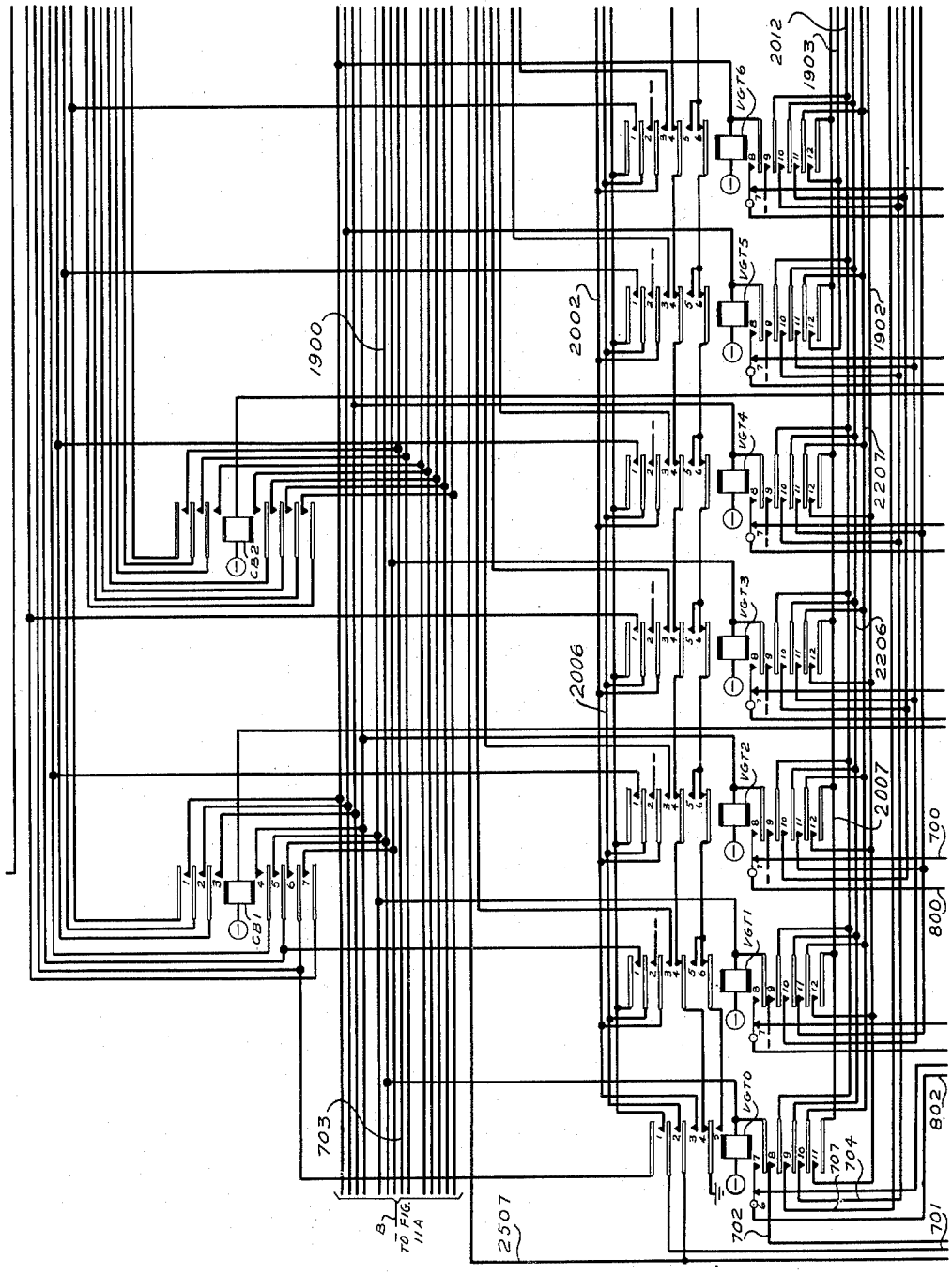

FIG. 7

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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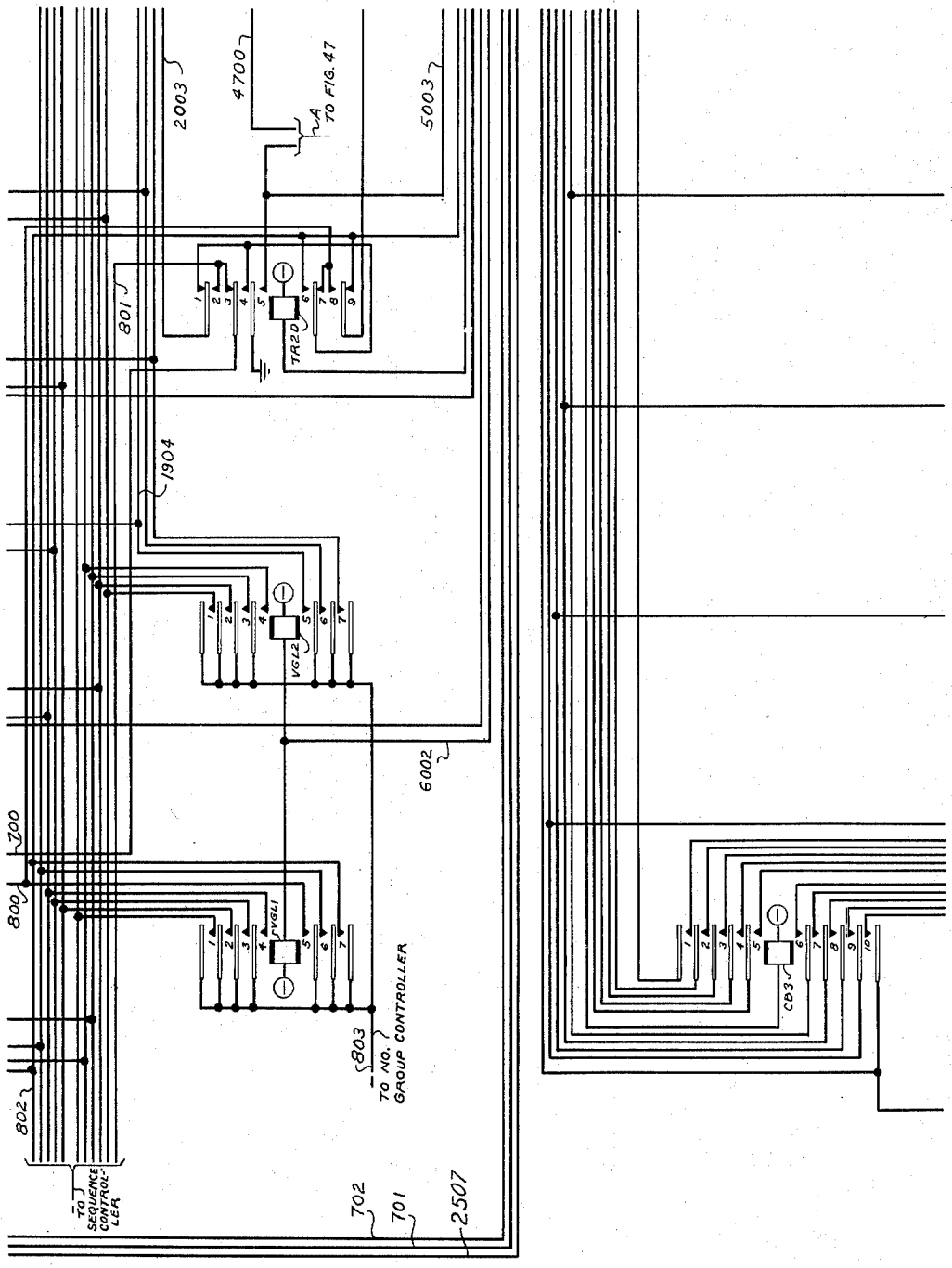

FIG. 8

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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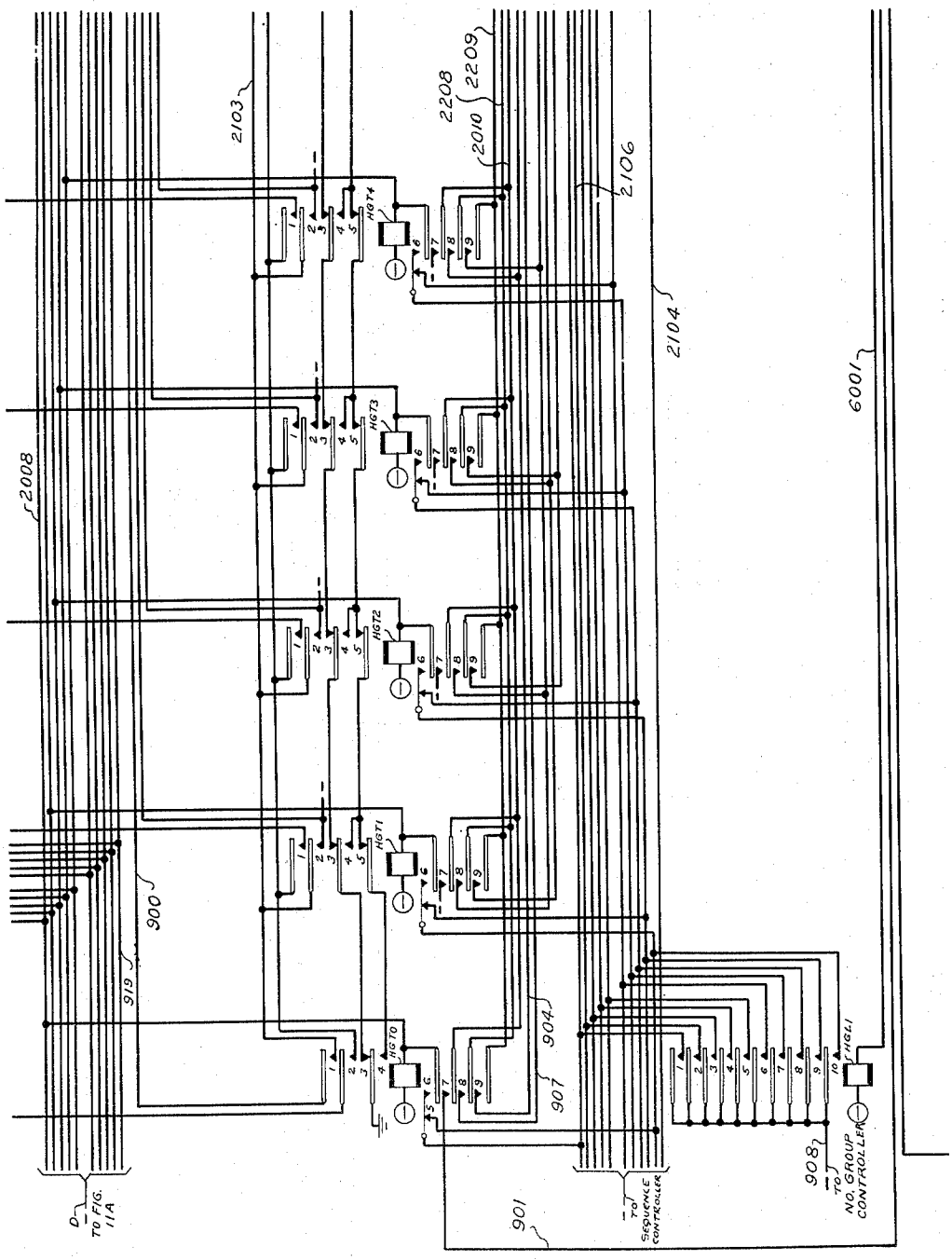

FIG. 9

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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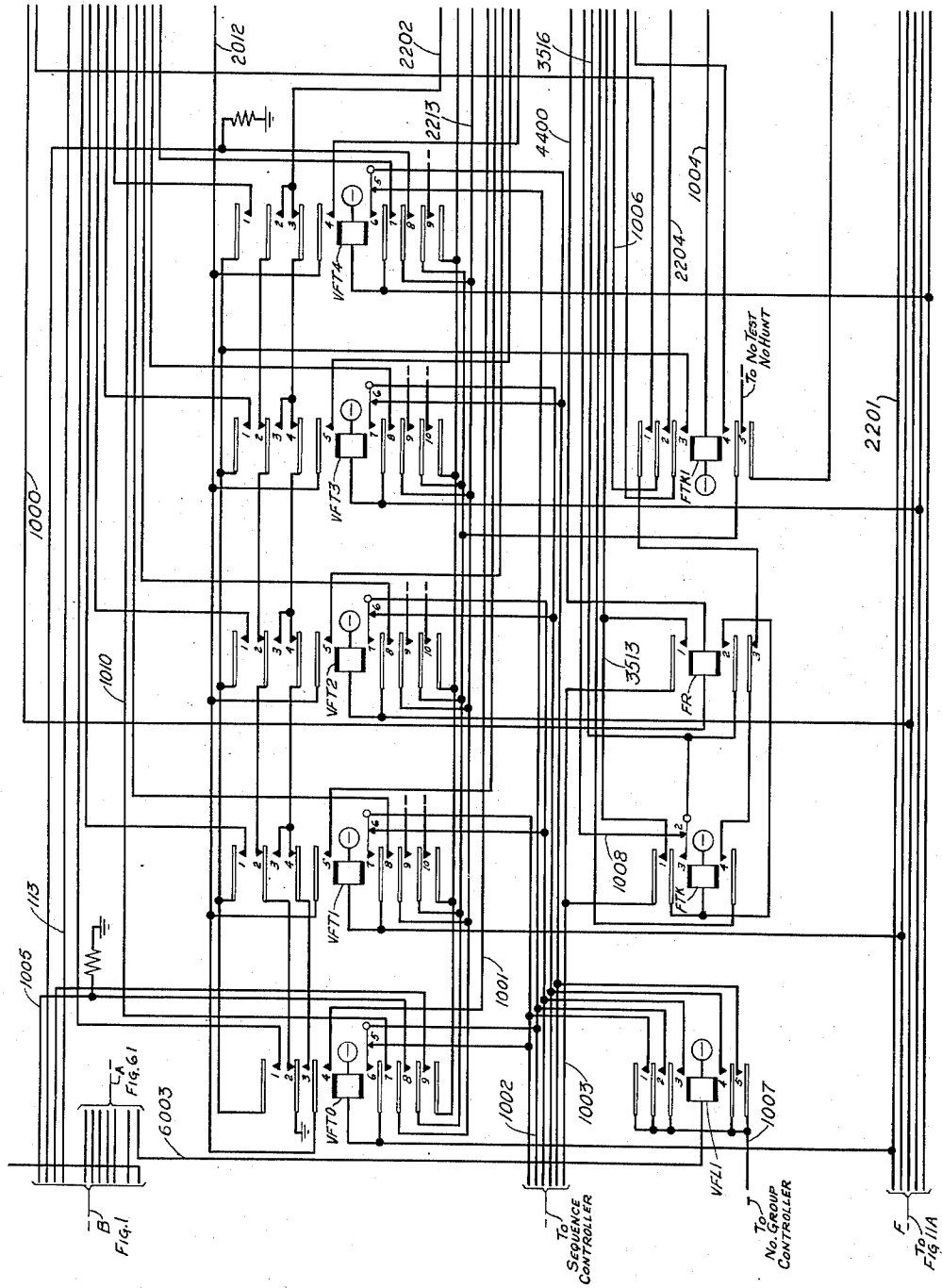

FIG. 10

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL. 2,535,661

CONTROL CIRCUITS

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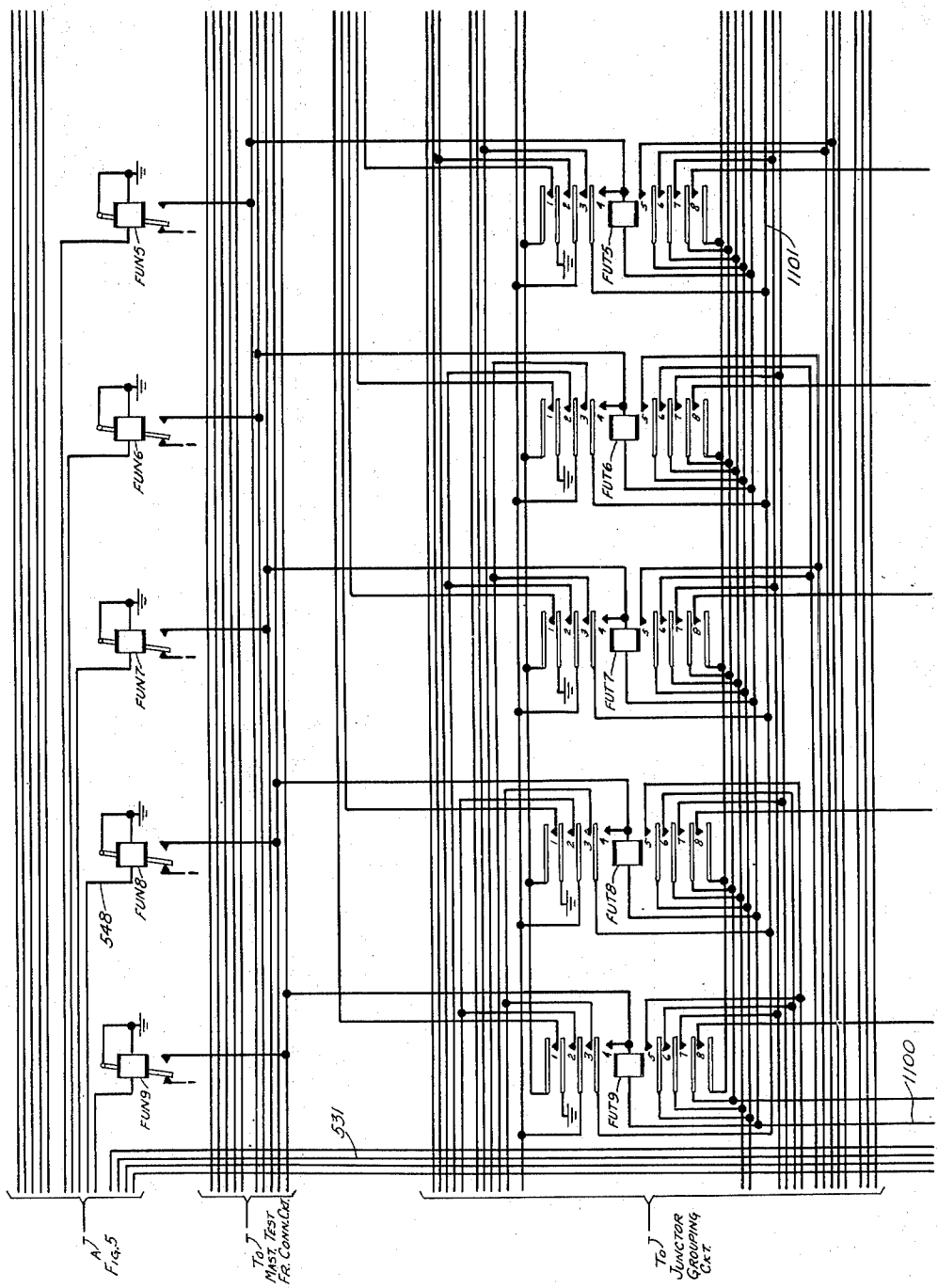

FIG. 11

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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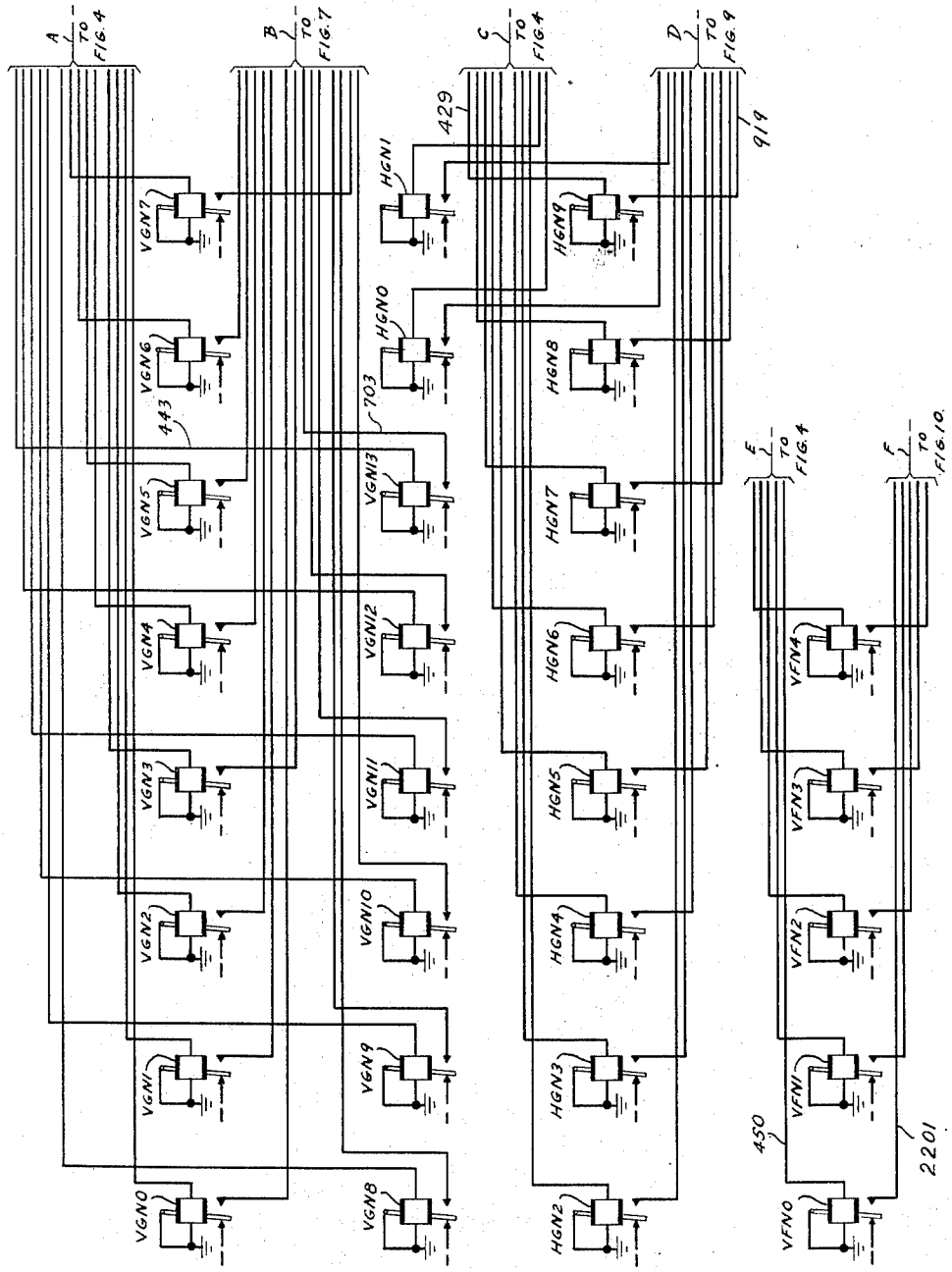

FIG. 11A

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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Filed Oct. 29, 1948 88 Sheets-Sheet 13

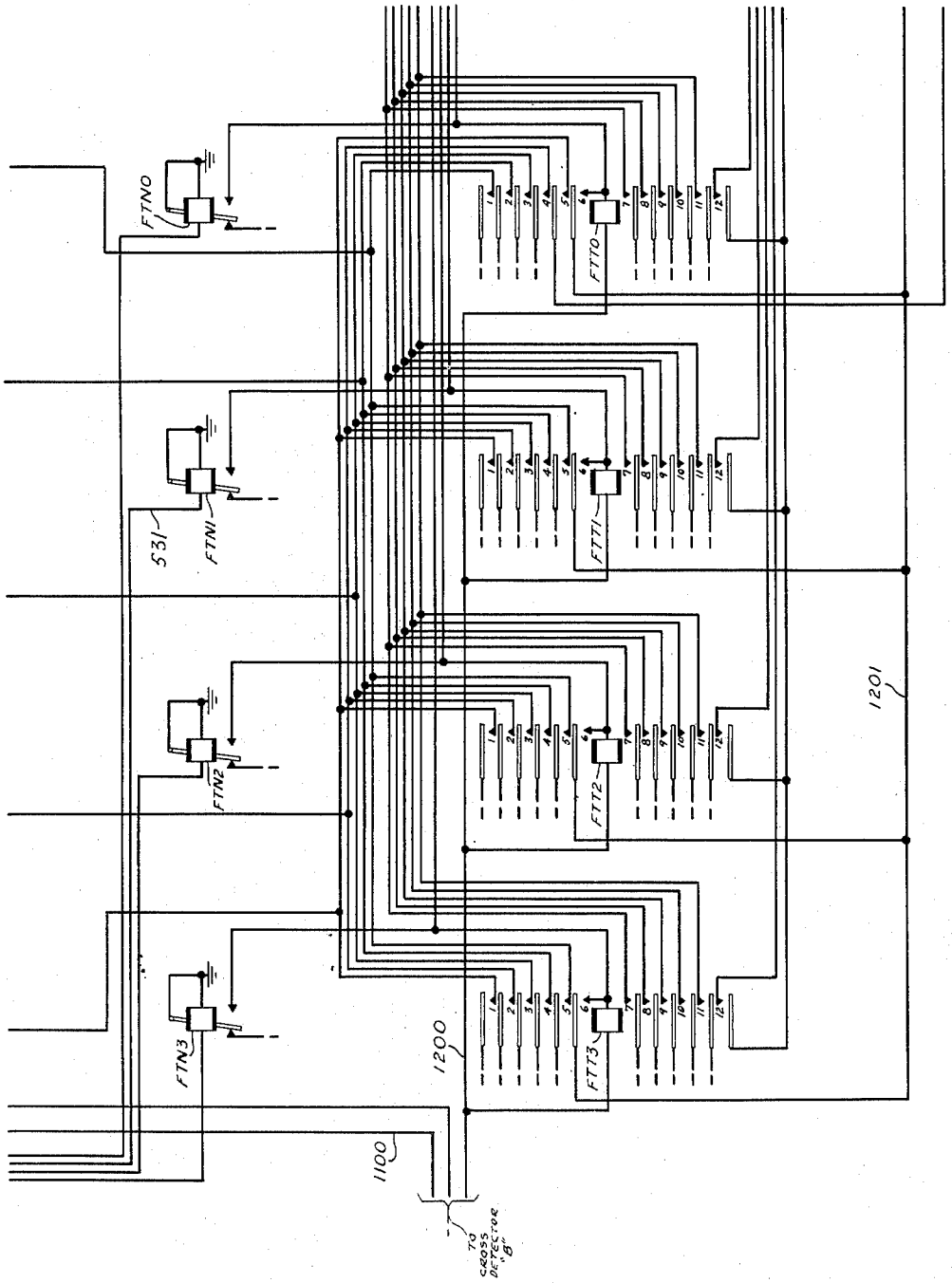

FIG. 12

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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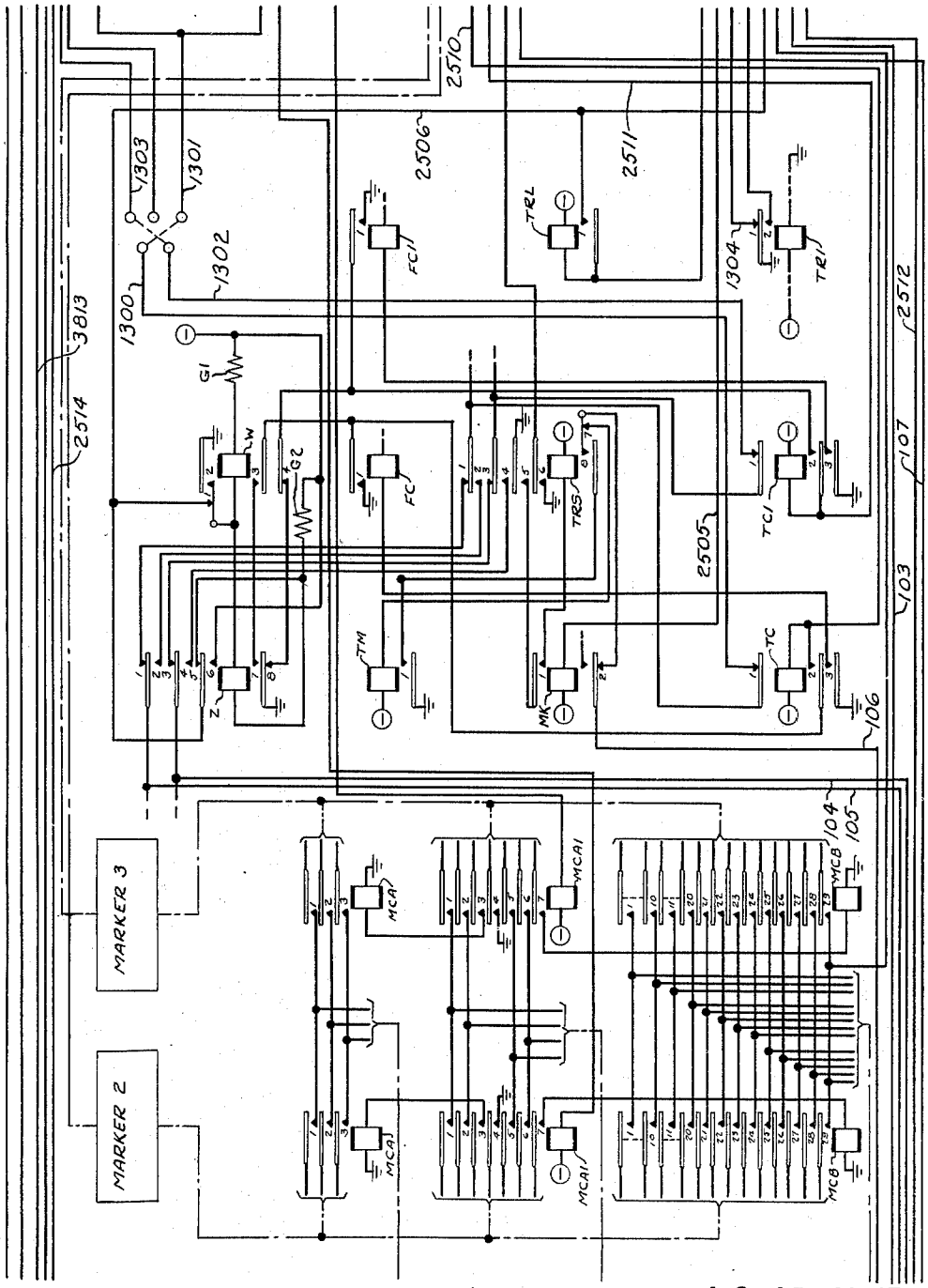

FIG. 13

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL. 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 15

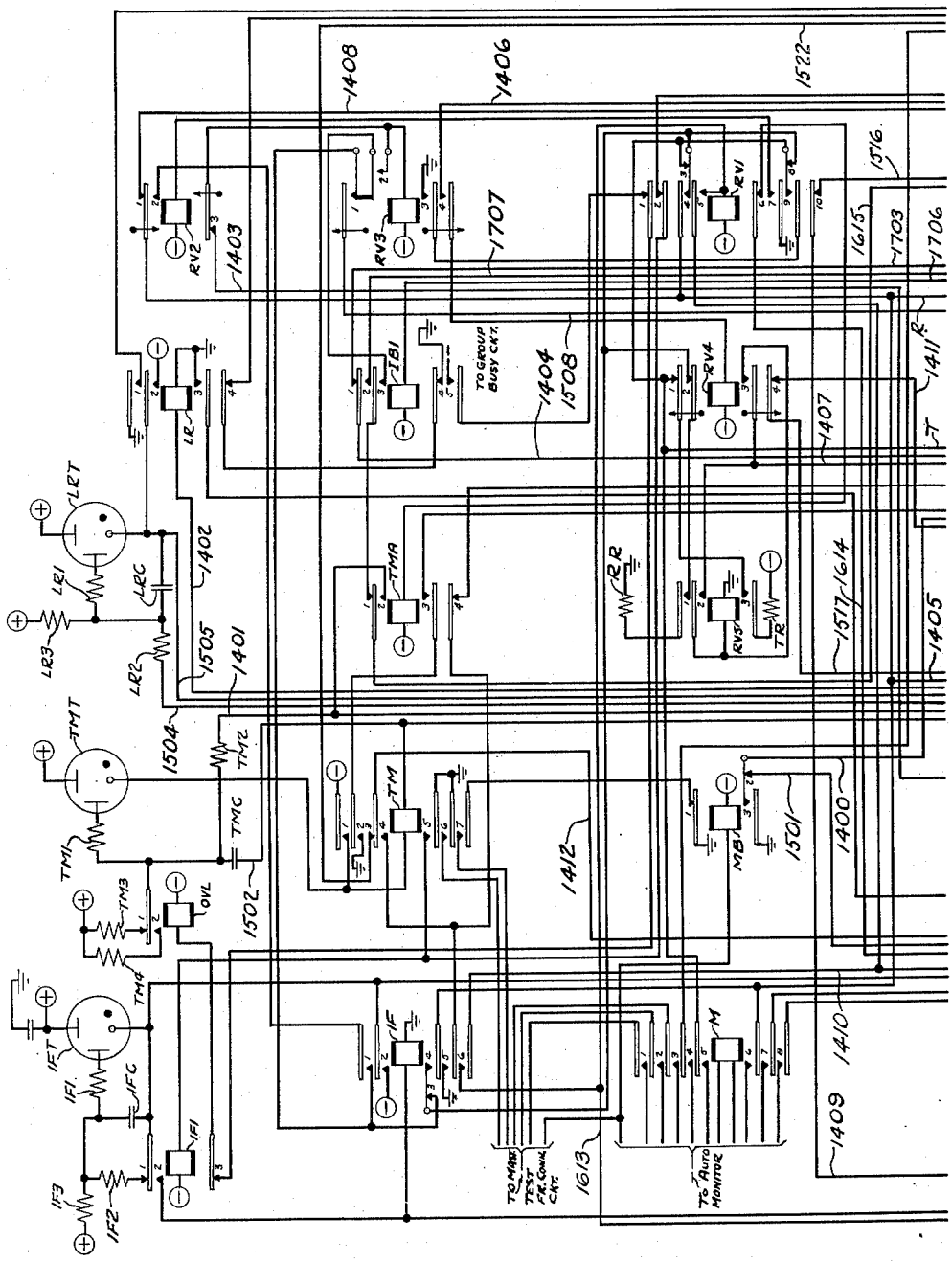

FIG. 14

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY G. C. Smith

ATTORNEY

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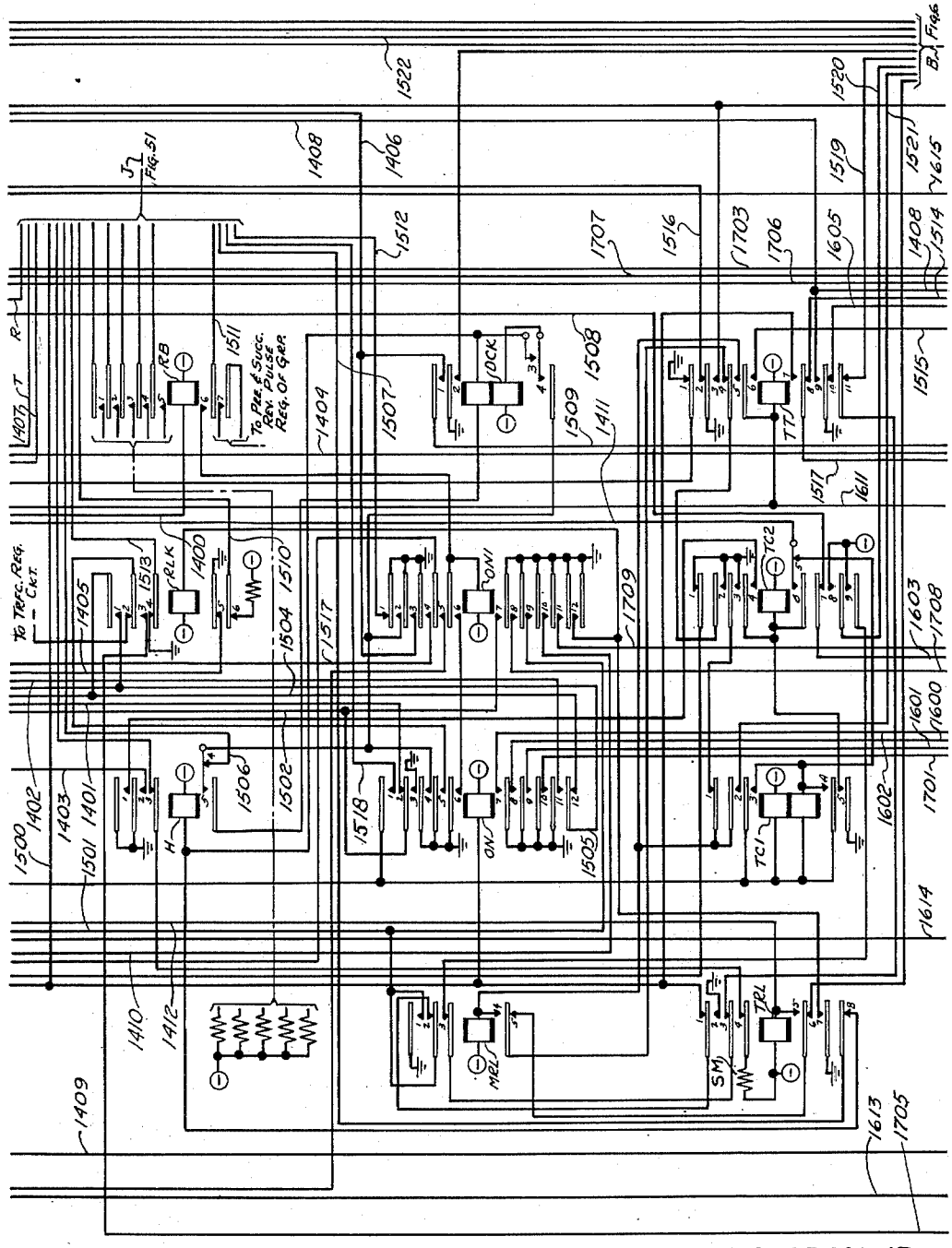

FIG. 15

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

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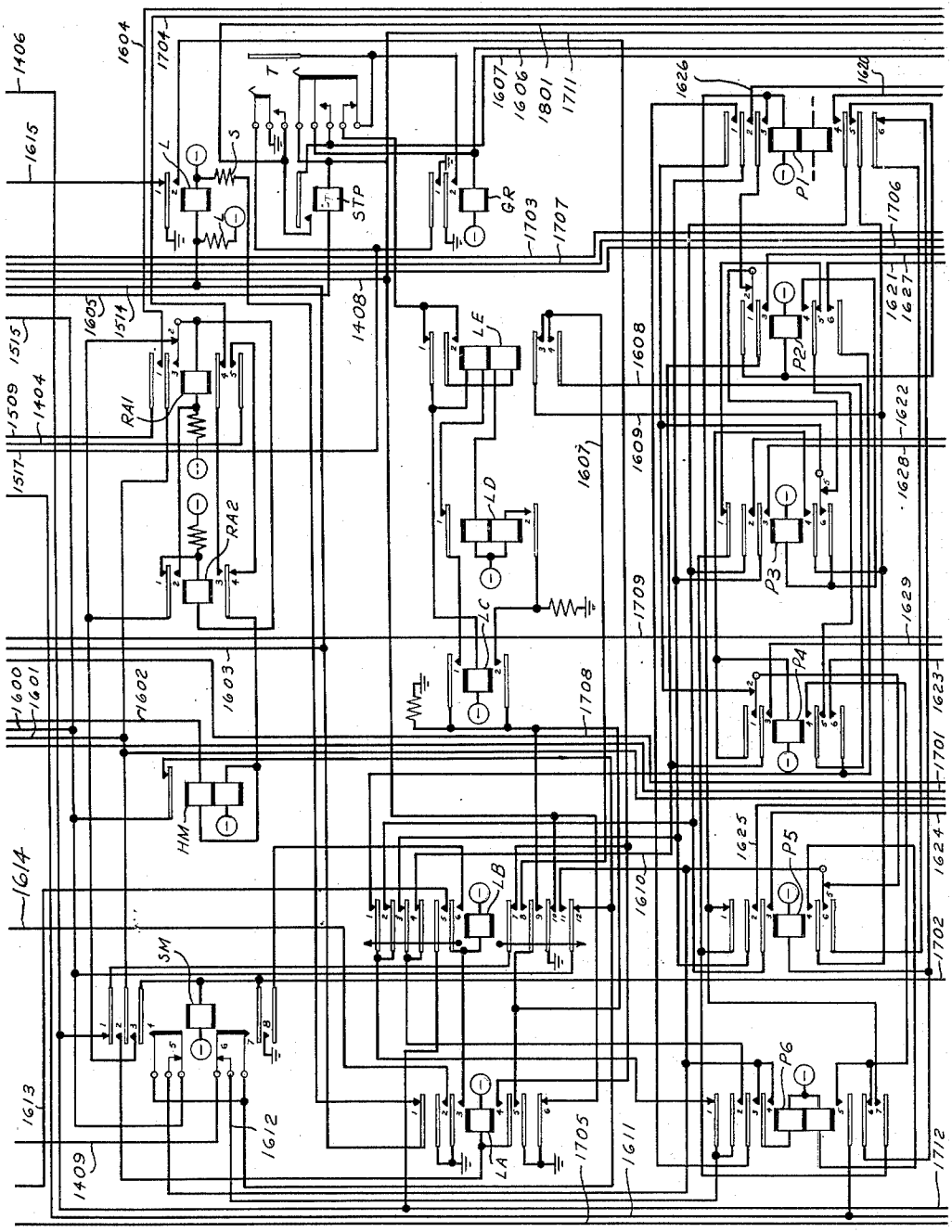

FIG. 16

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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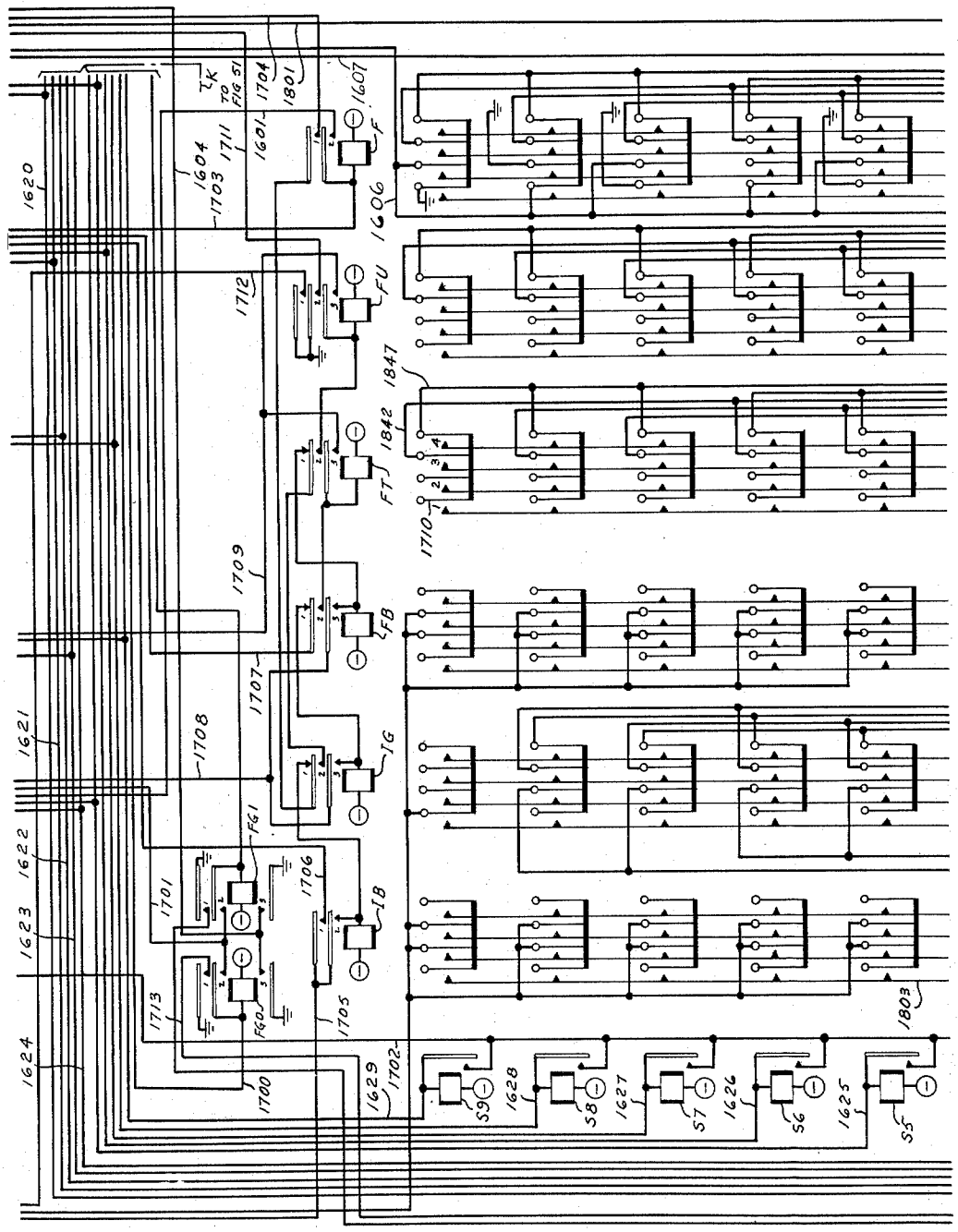

FIG. 17

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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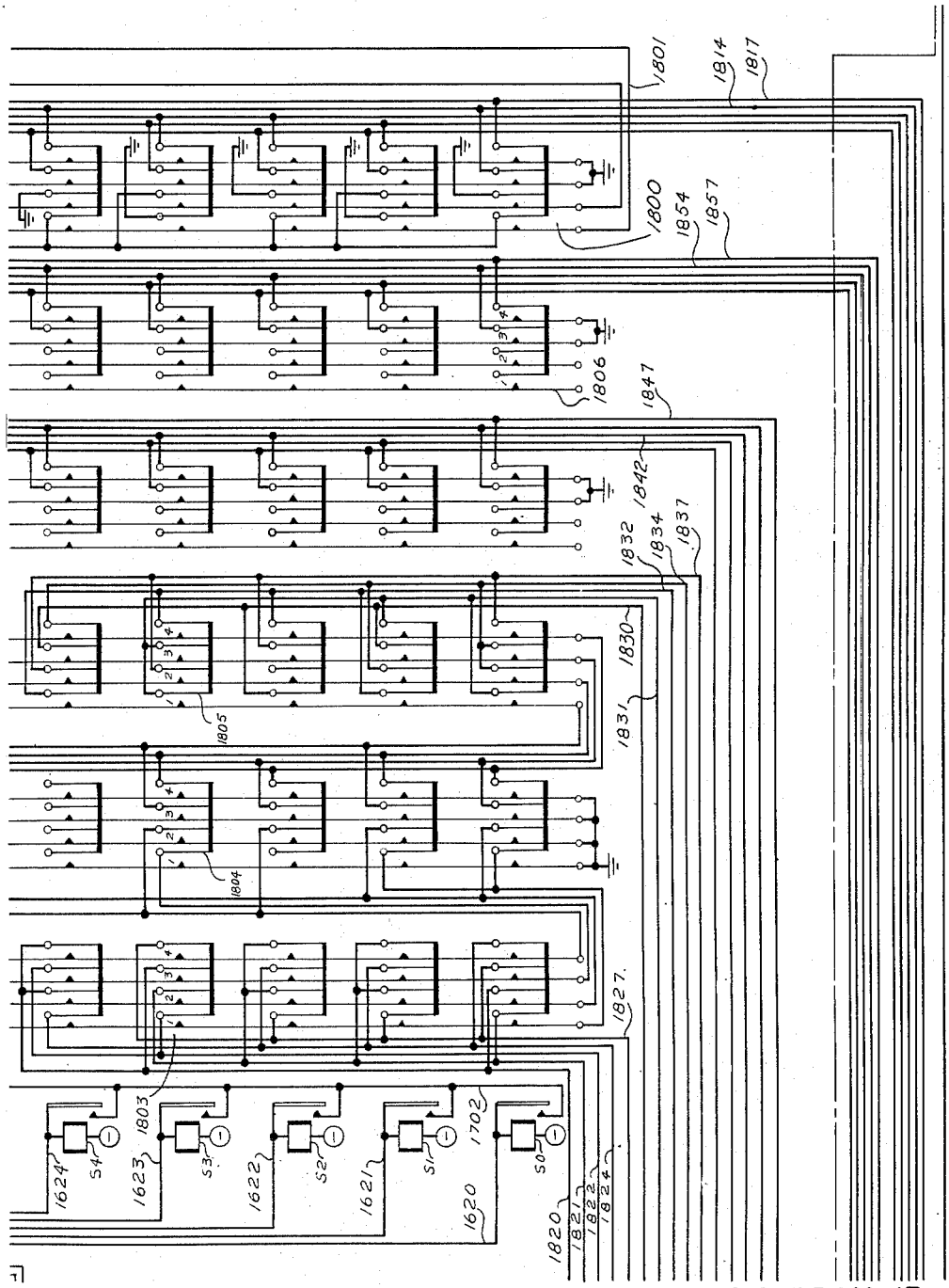

FIG. 18

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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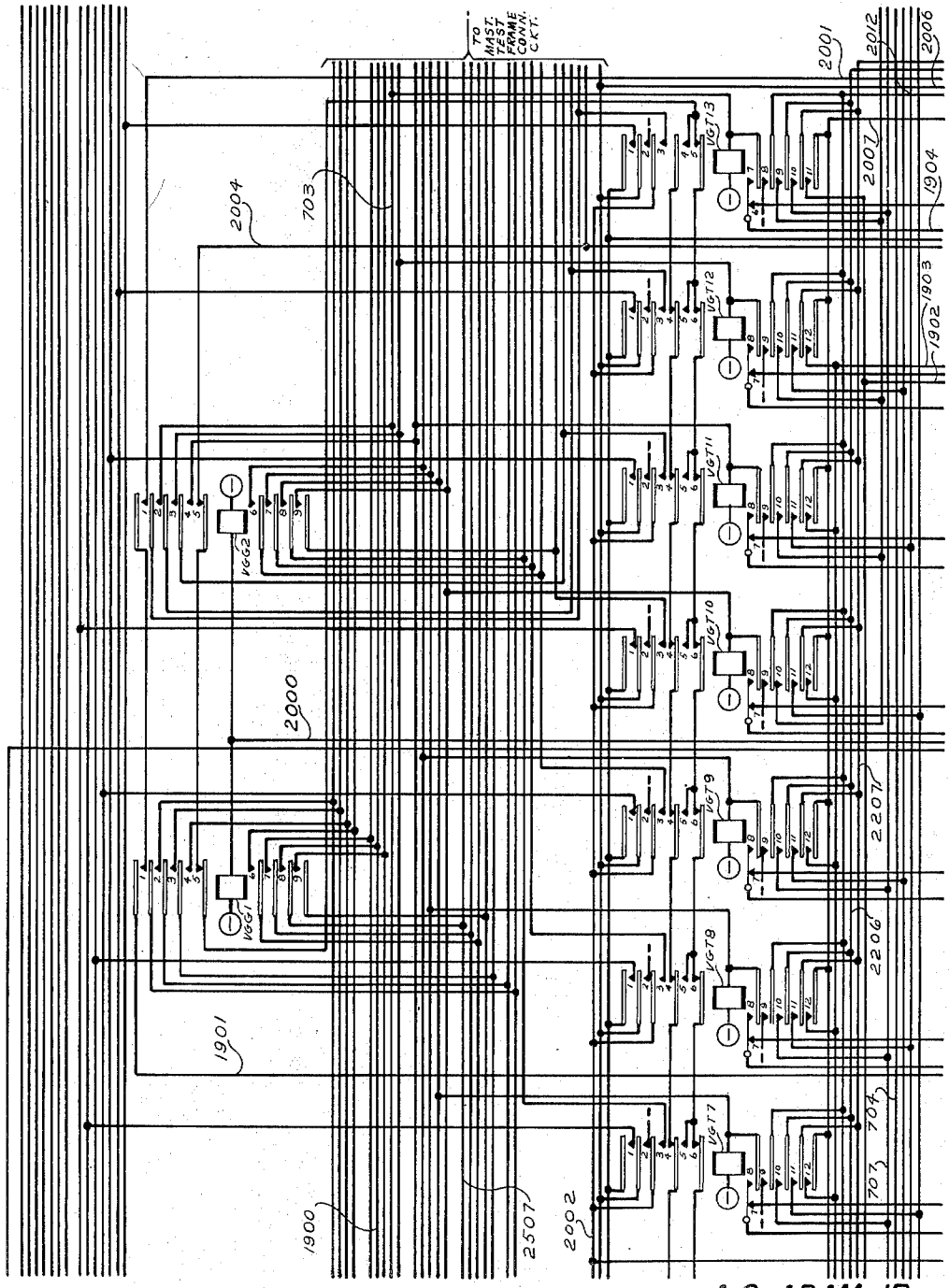

FIG. 19

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

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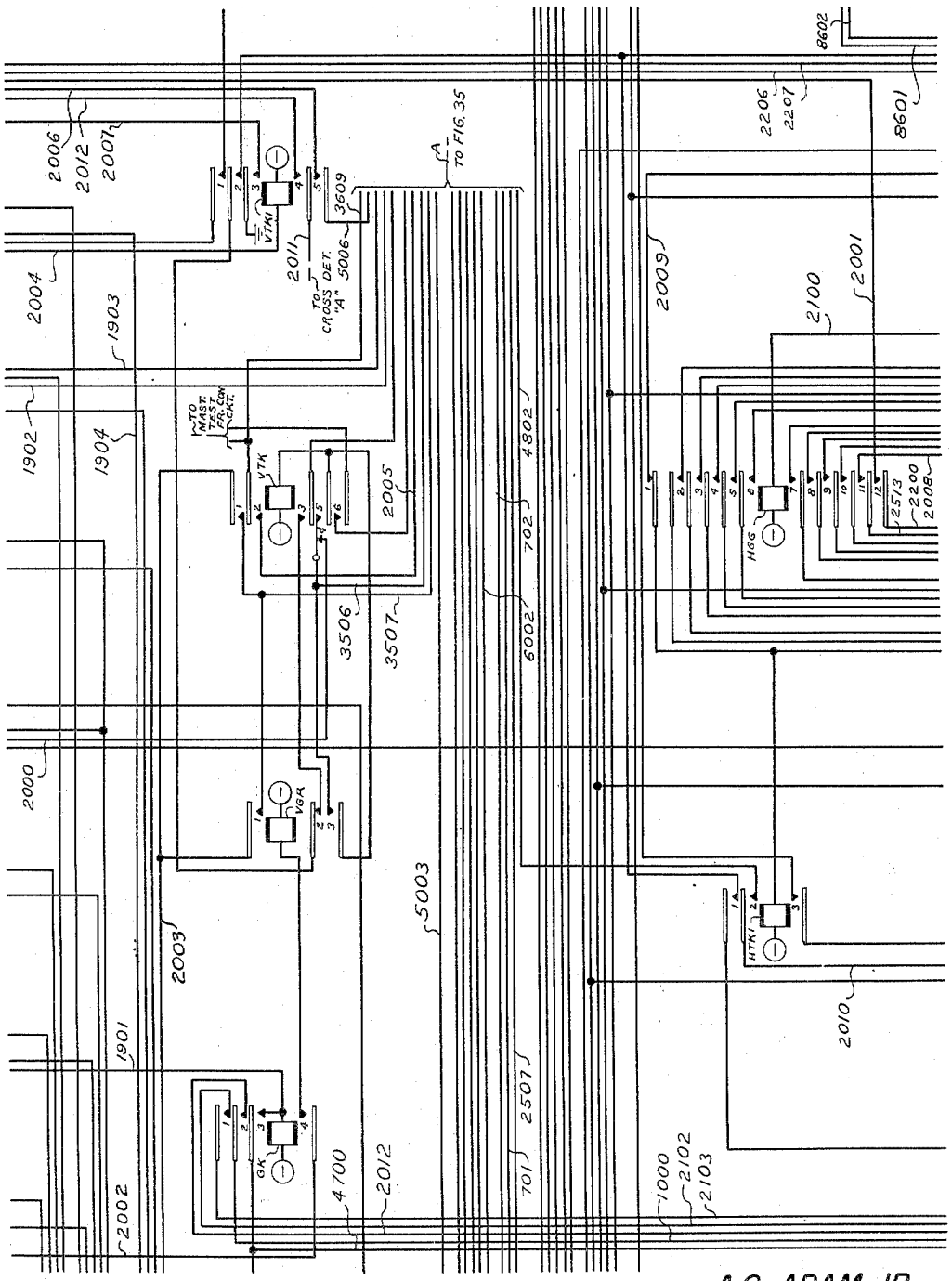

FIG. 20

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

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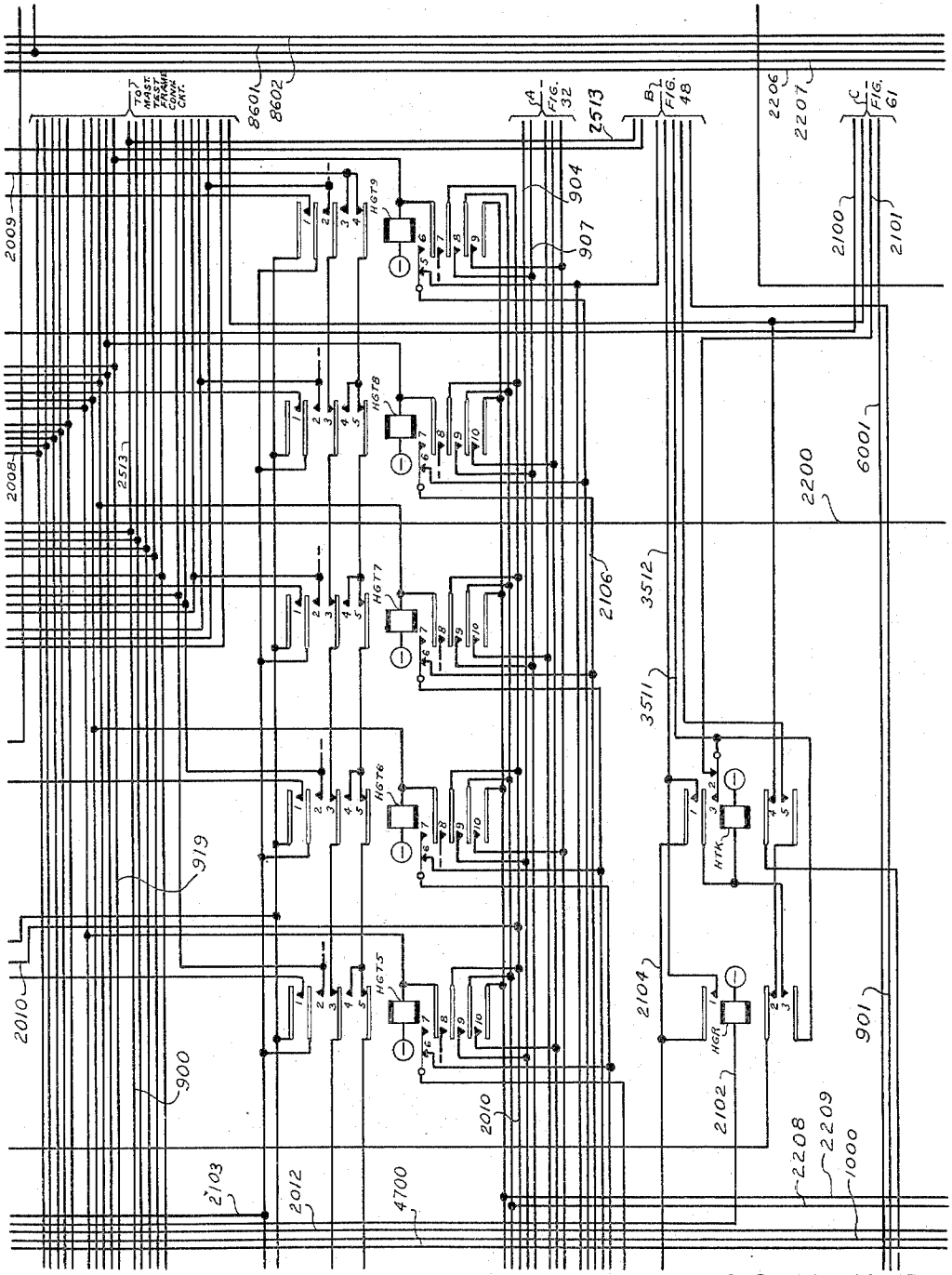

FIG. 21

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

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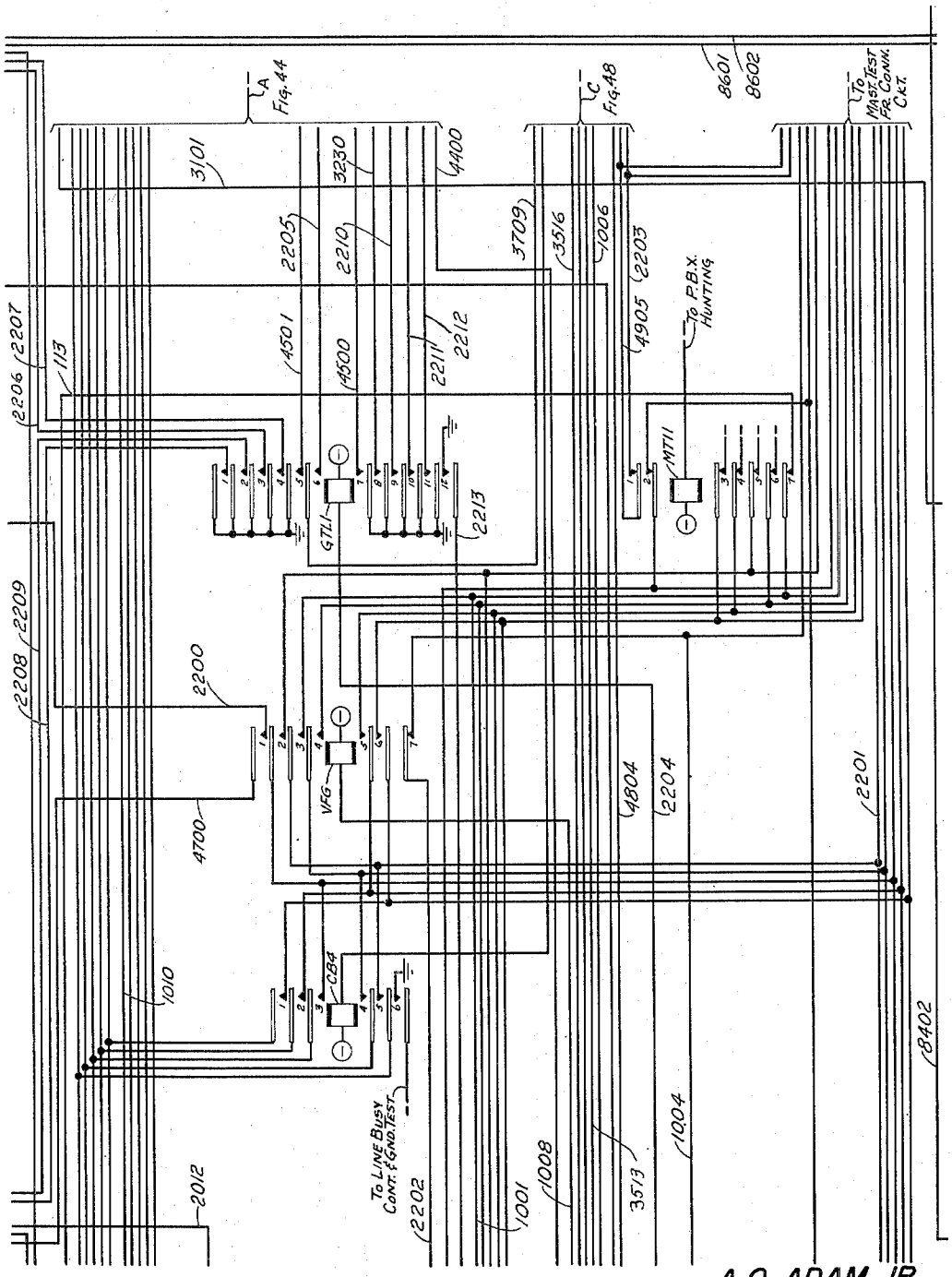

FIG. 22

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

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Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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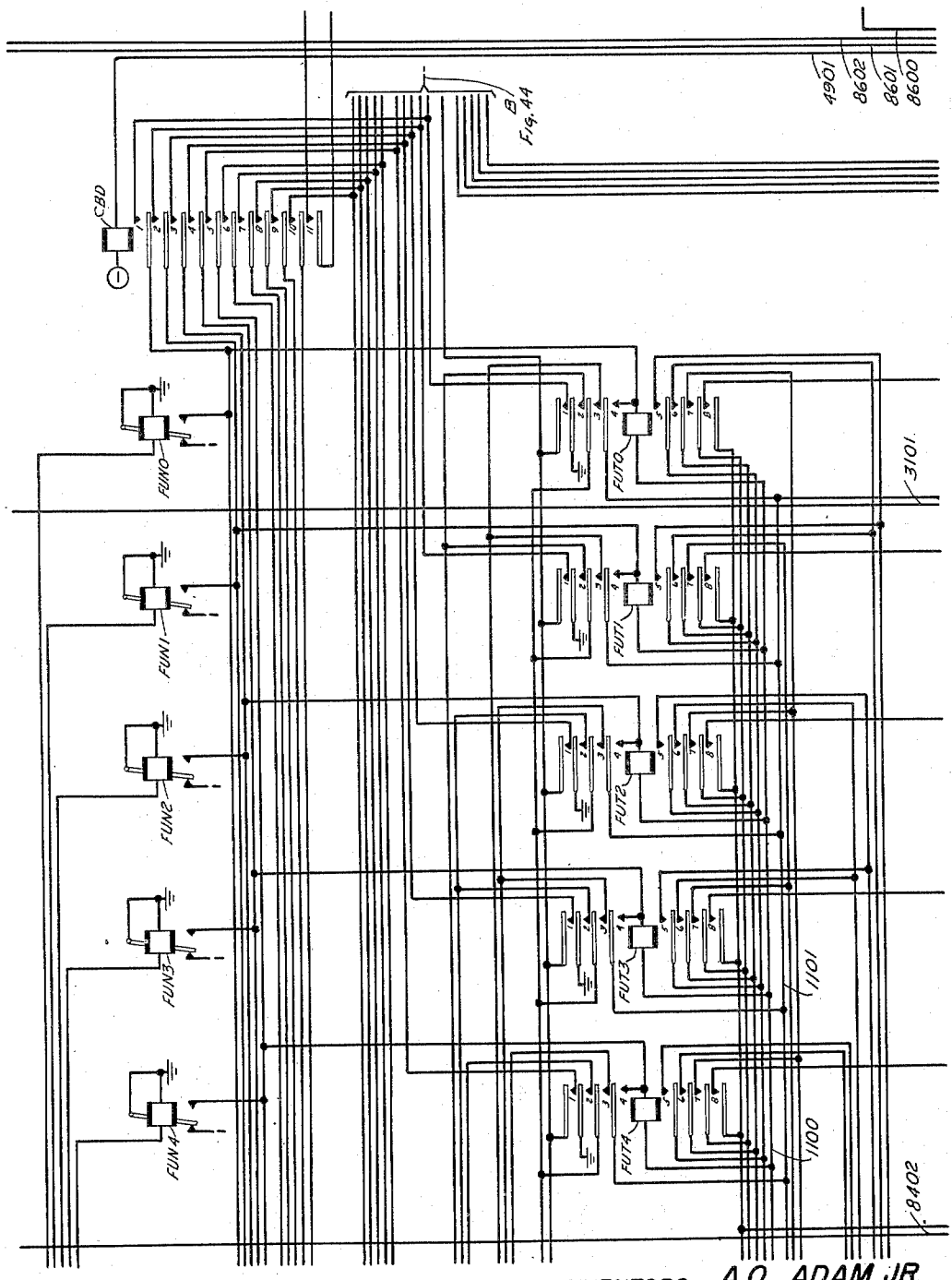

FIG. 23

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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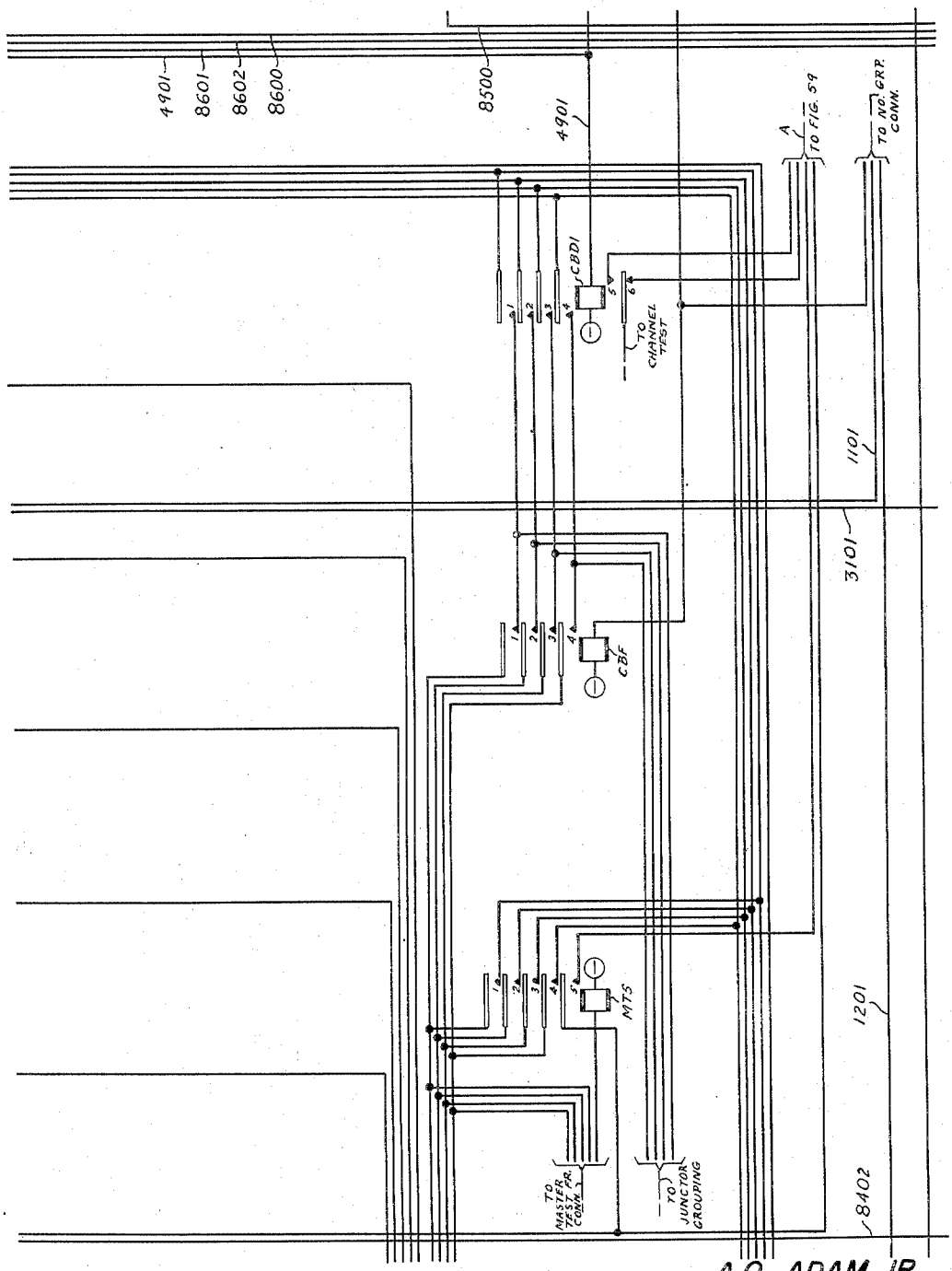

FIG. 24

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

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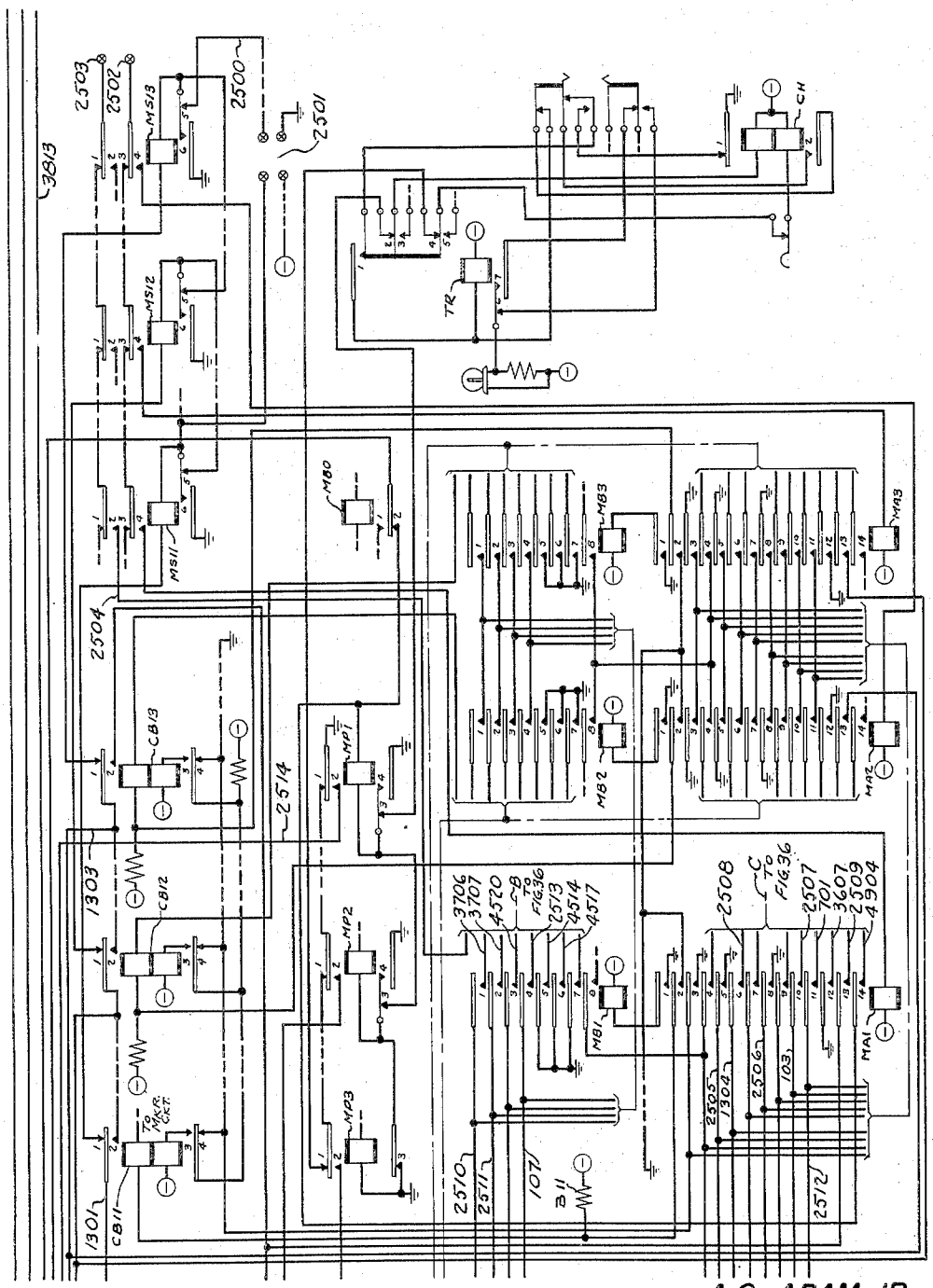

FIG. 25

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

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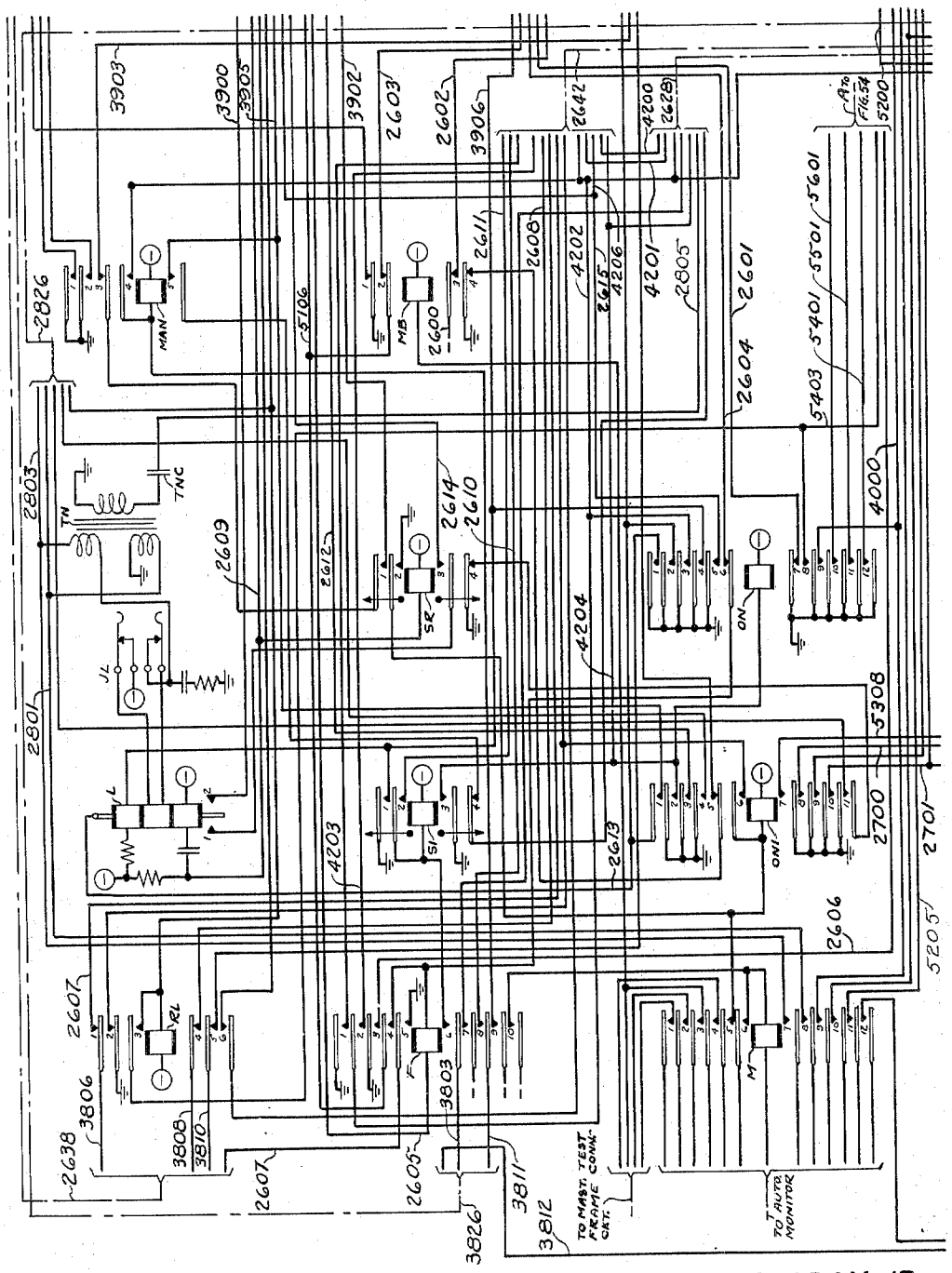

FIG. 26

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

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Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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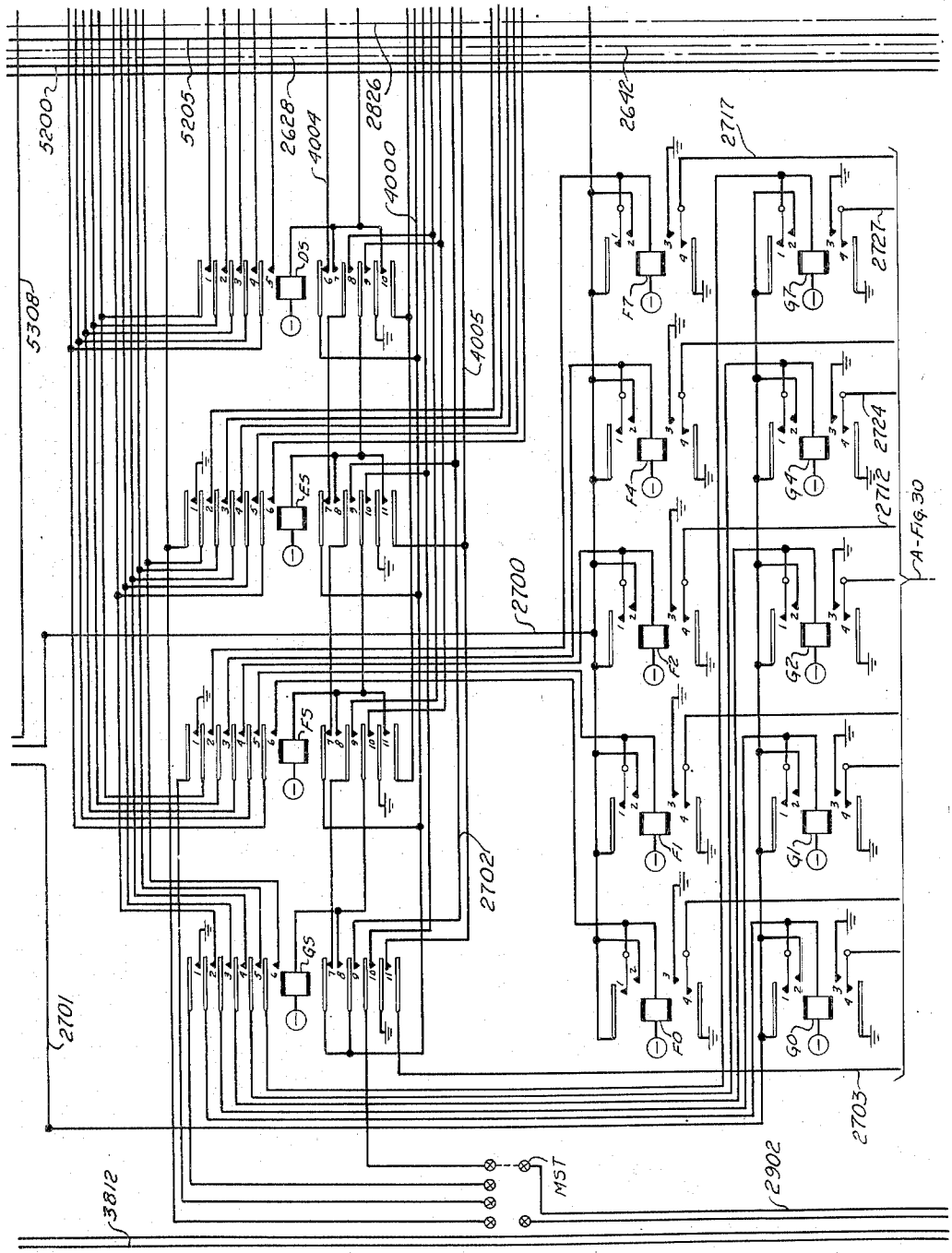

FIG. 27

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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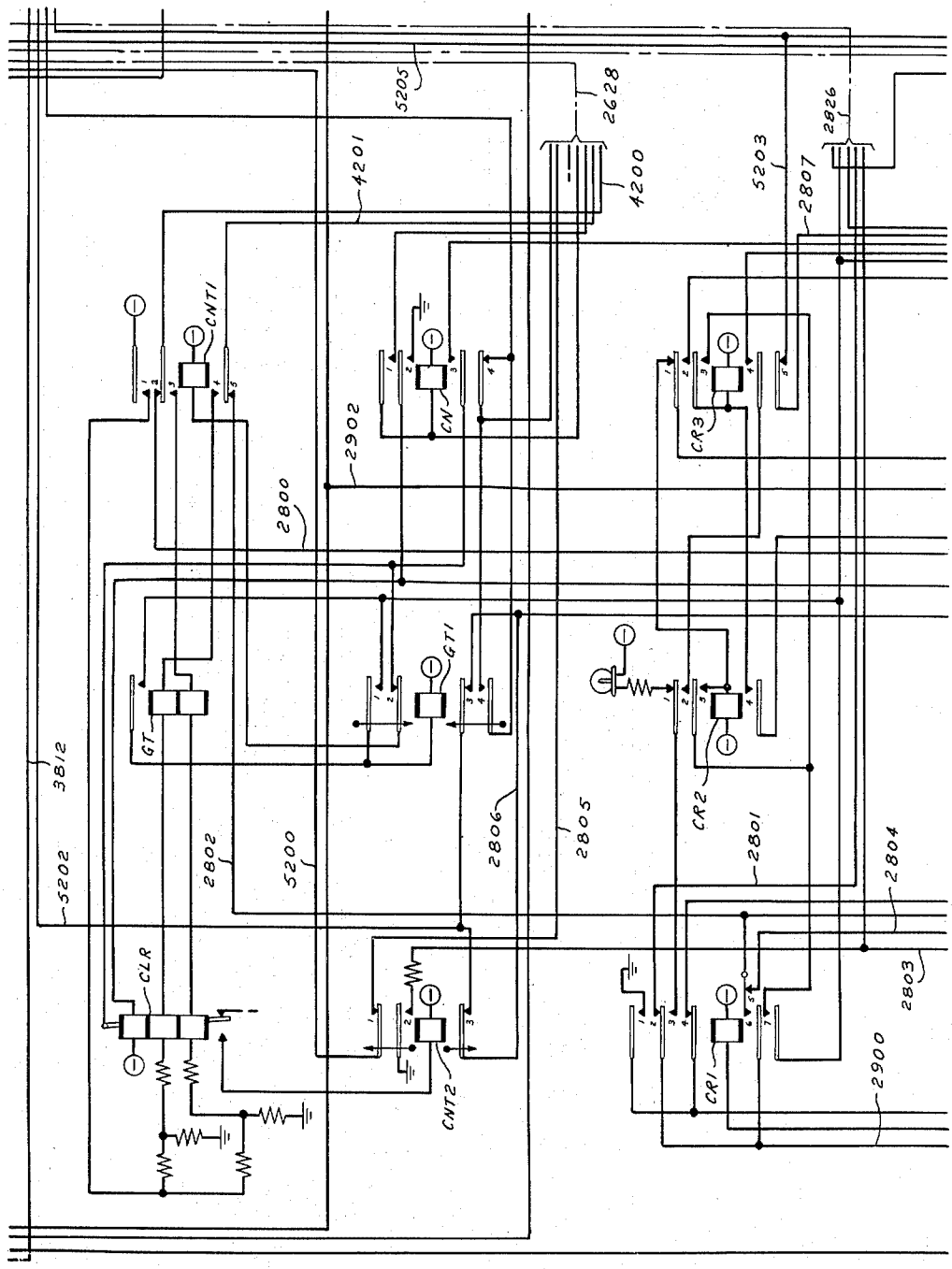

FIG. 28

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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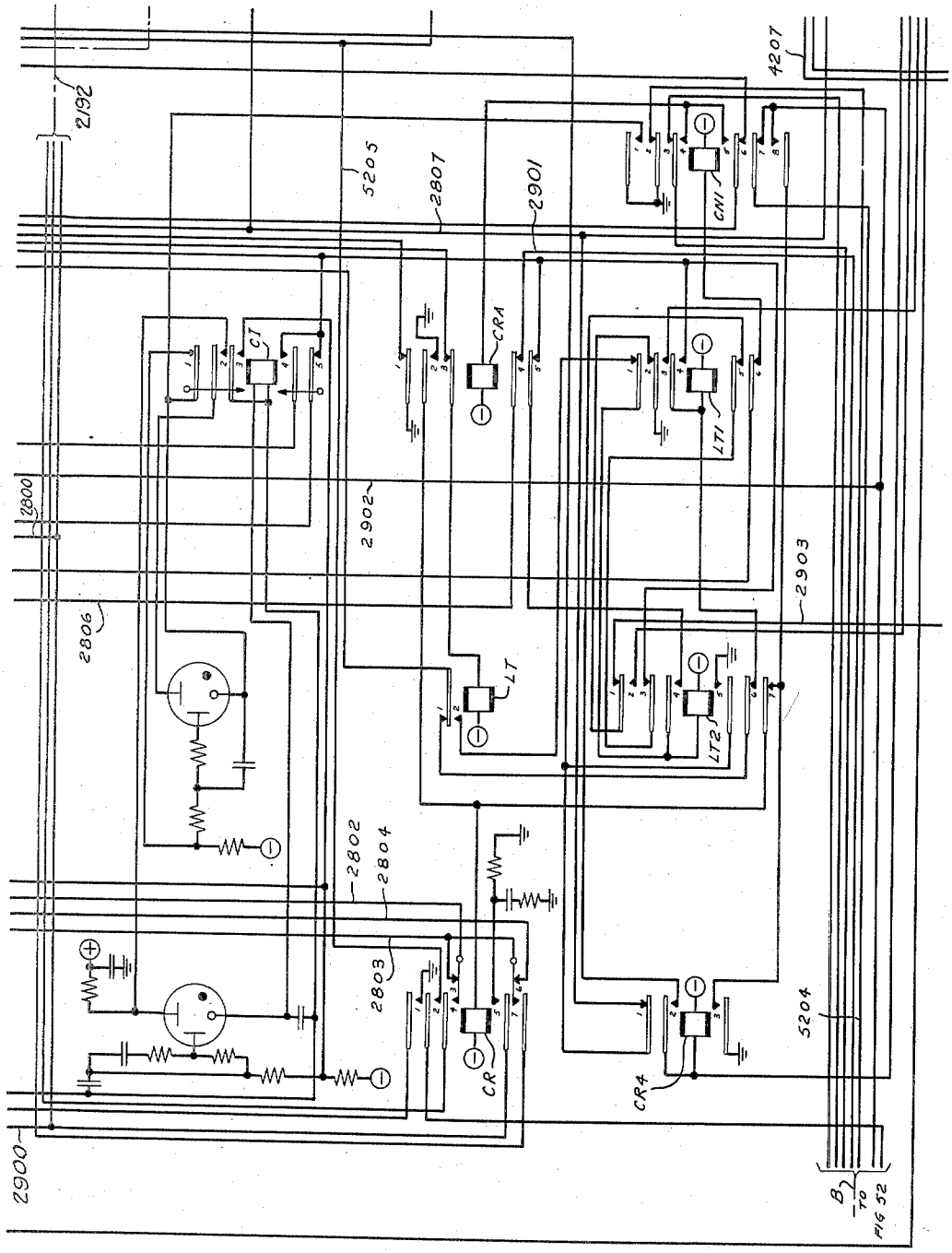

FIG. 29

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

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Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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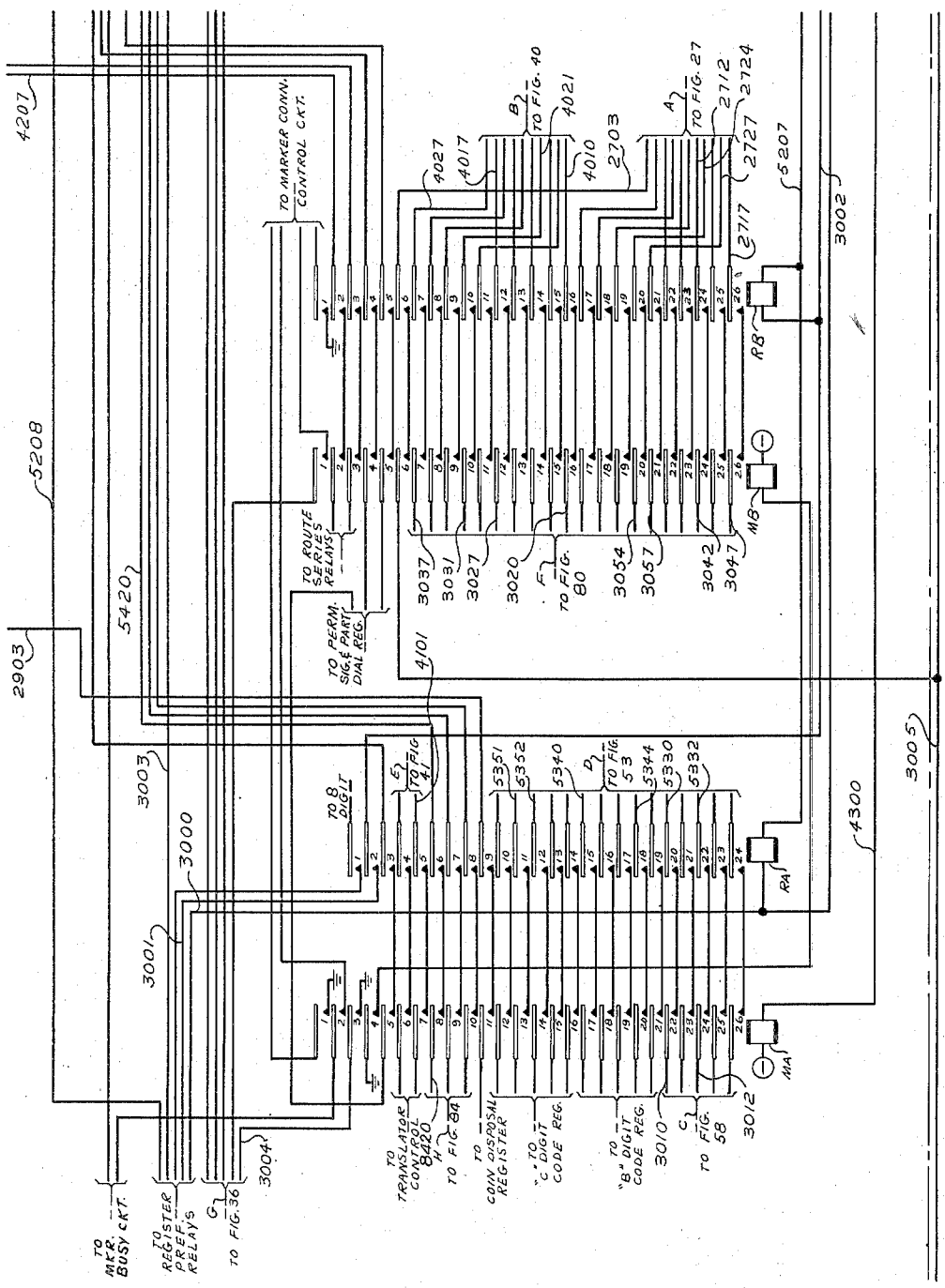

FIG. 30

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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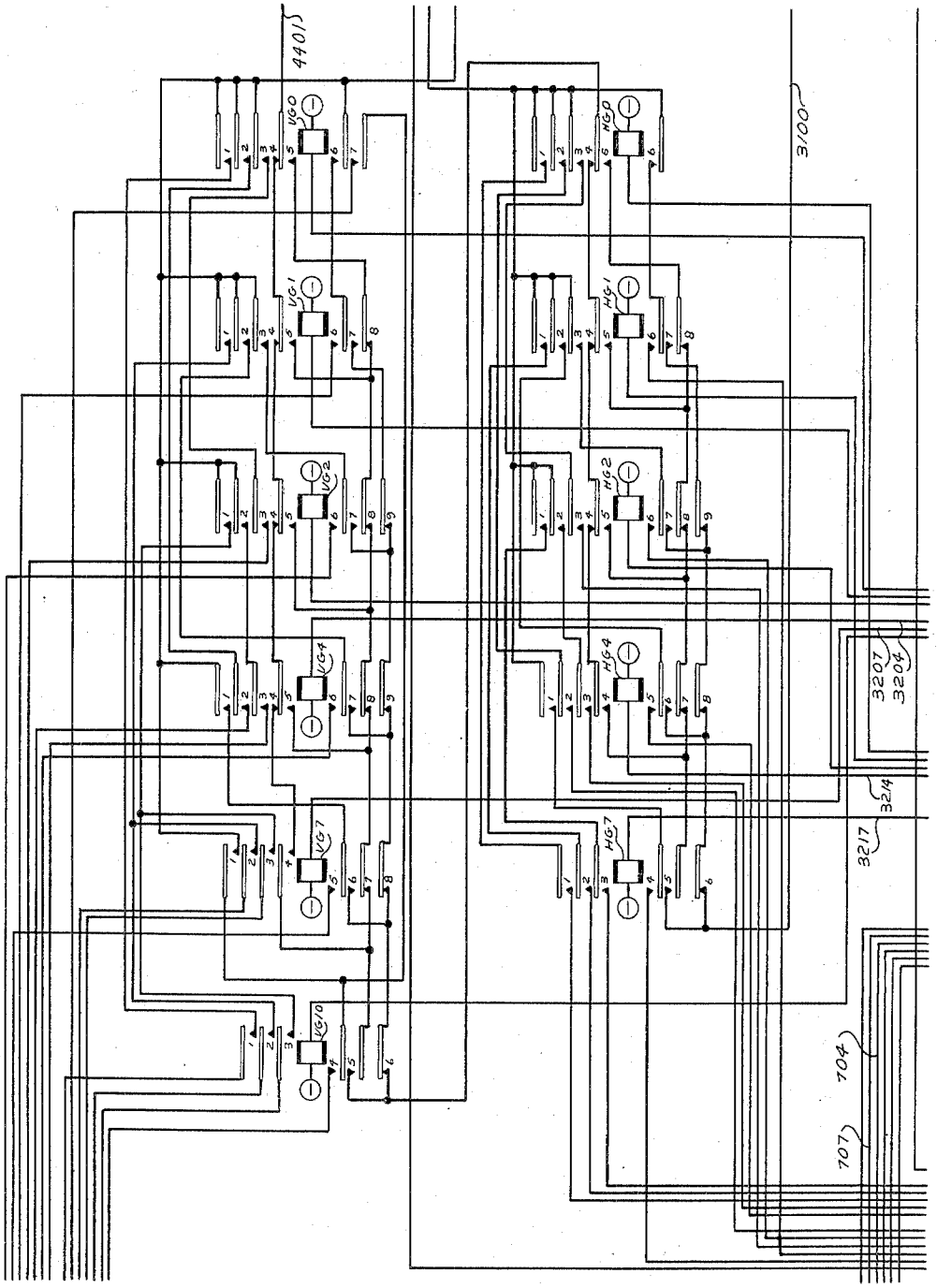

FIG. 31

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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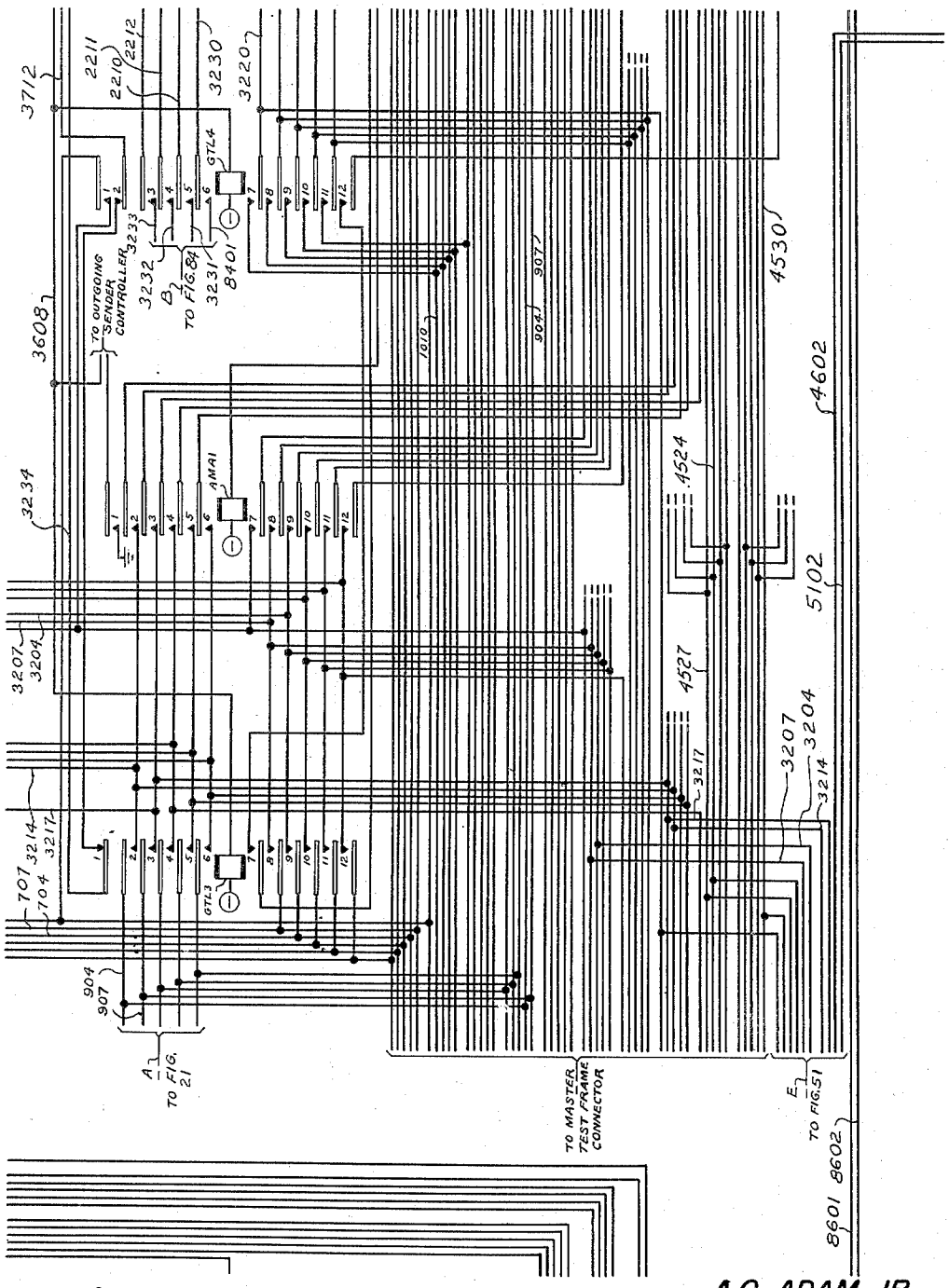

FIG. 32

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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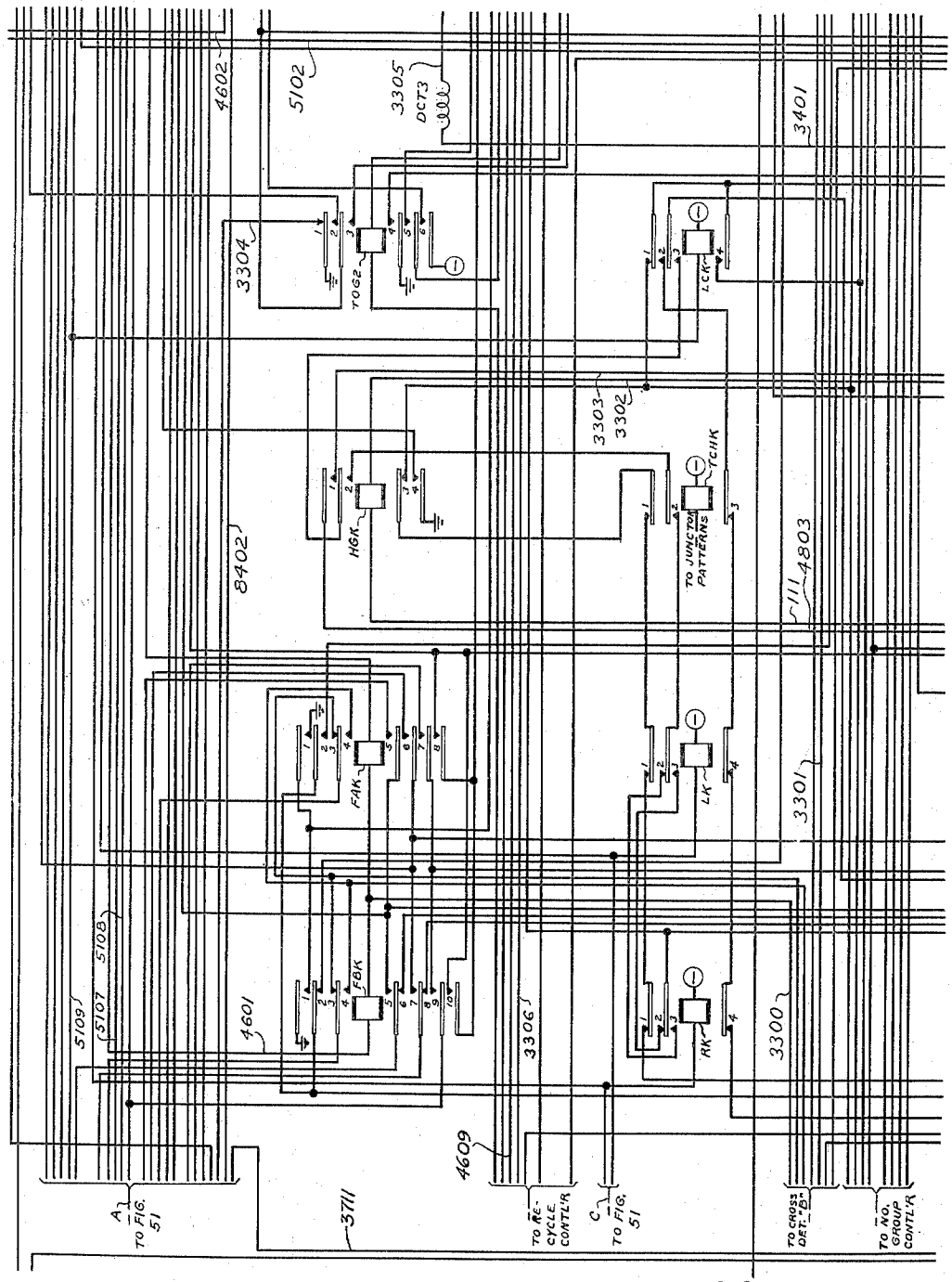

FIG. 33

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 35

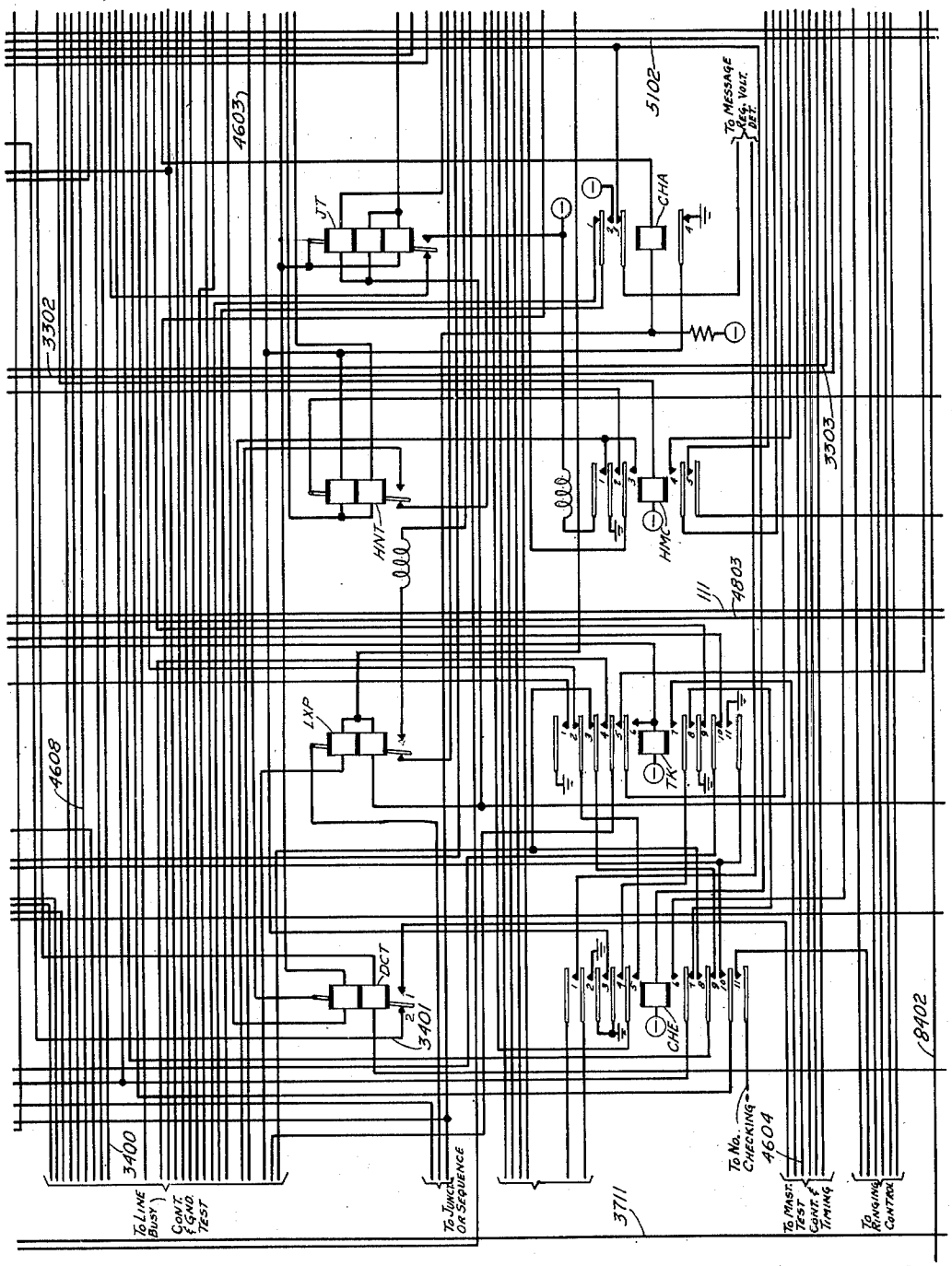

FIG. 34

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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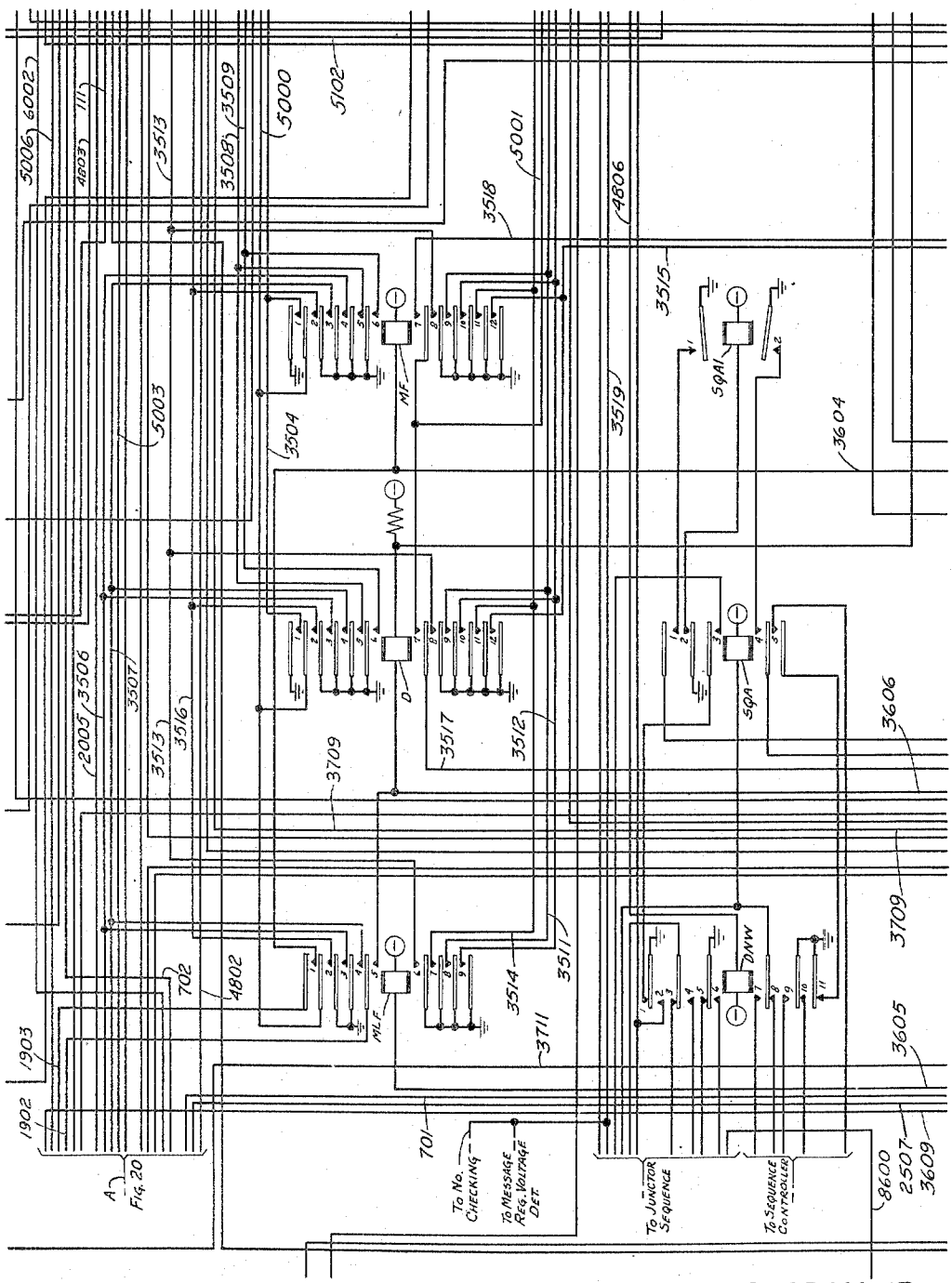

FIG. 35

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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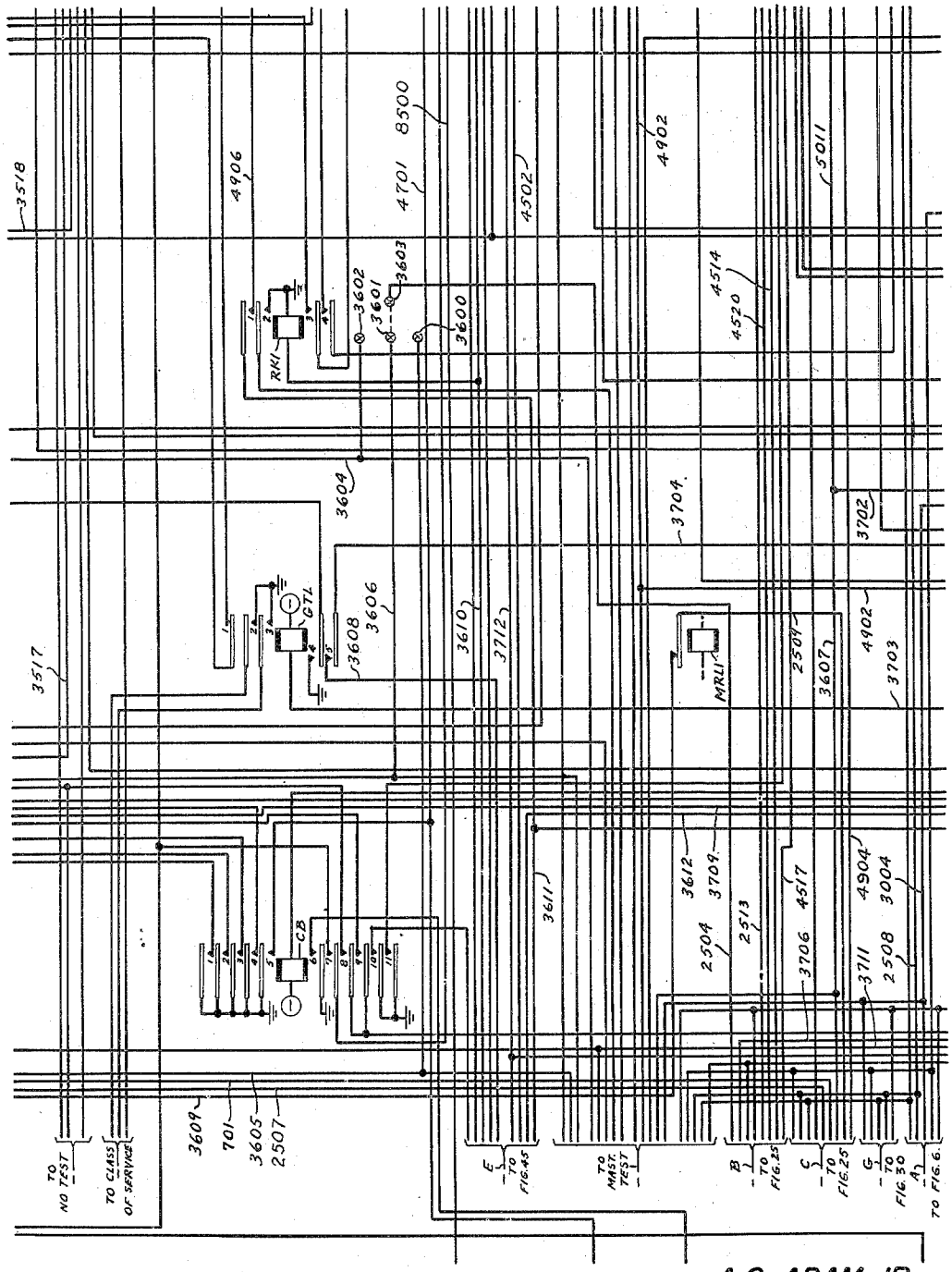

FIG. 36

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

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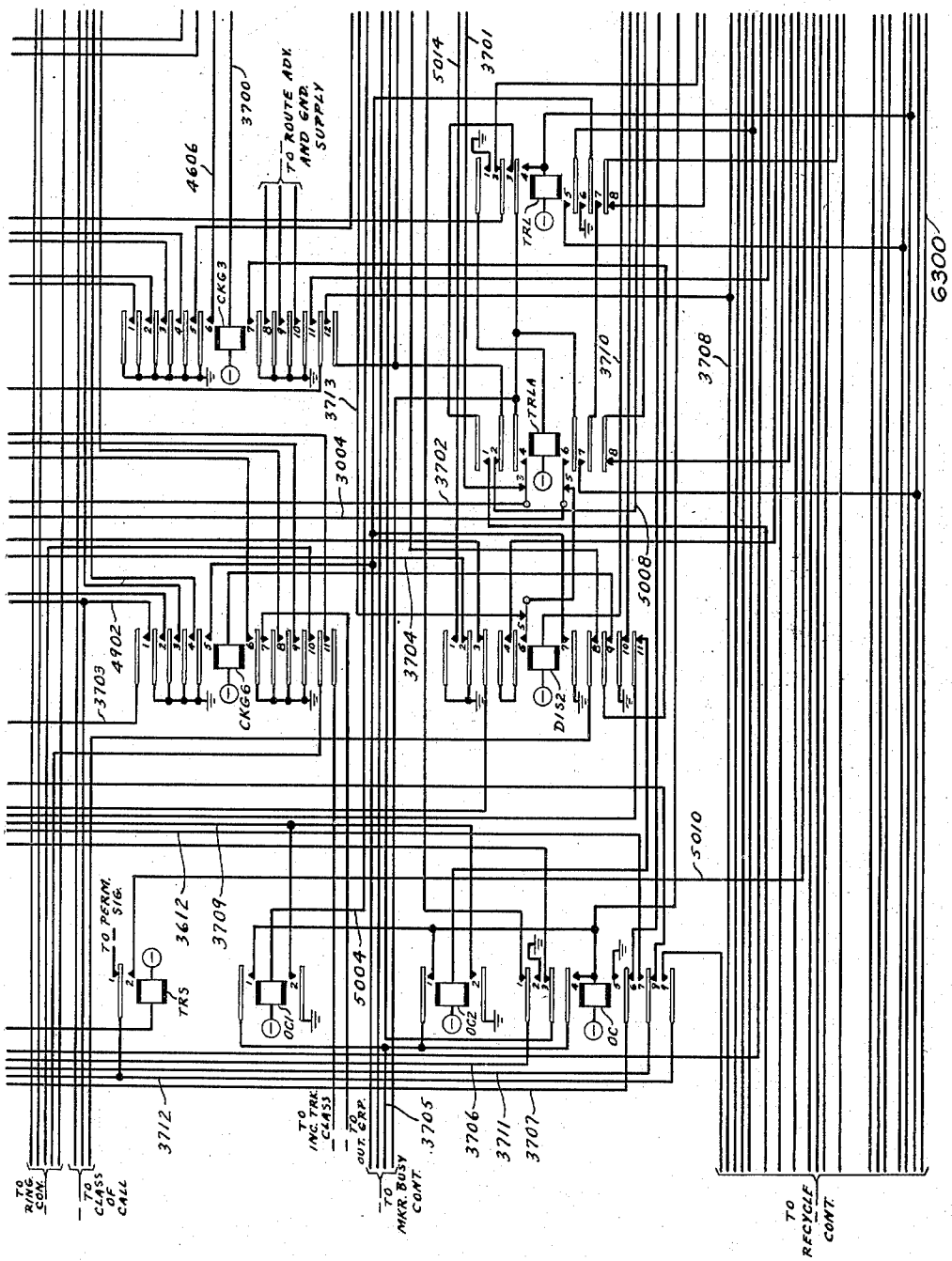

FIG. 37

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

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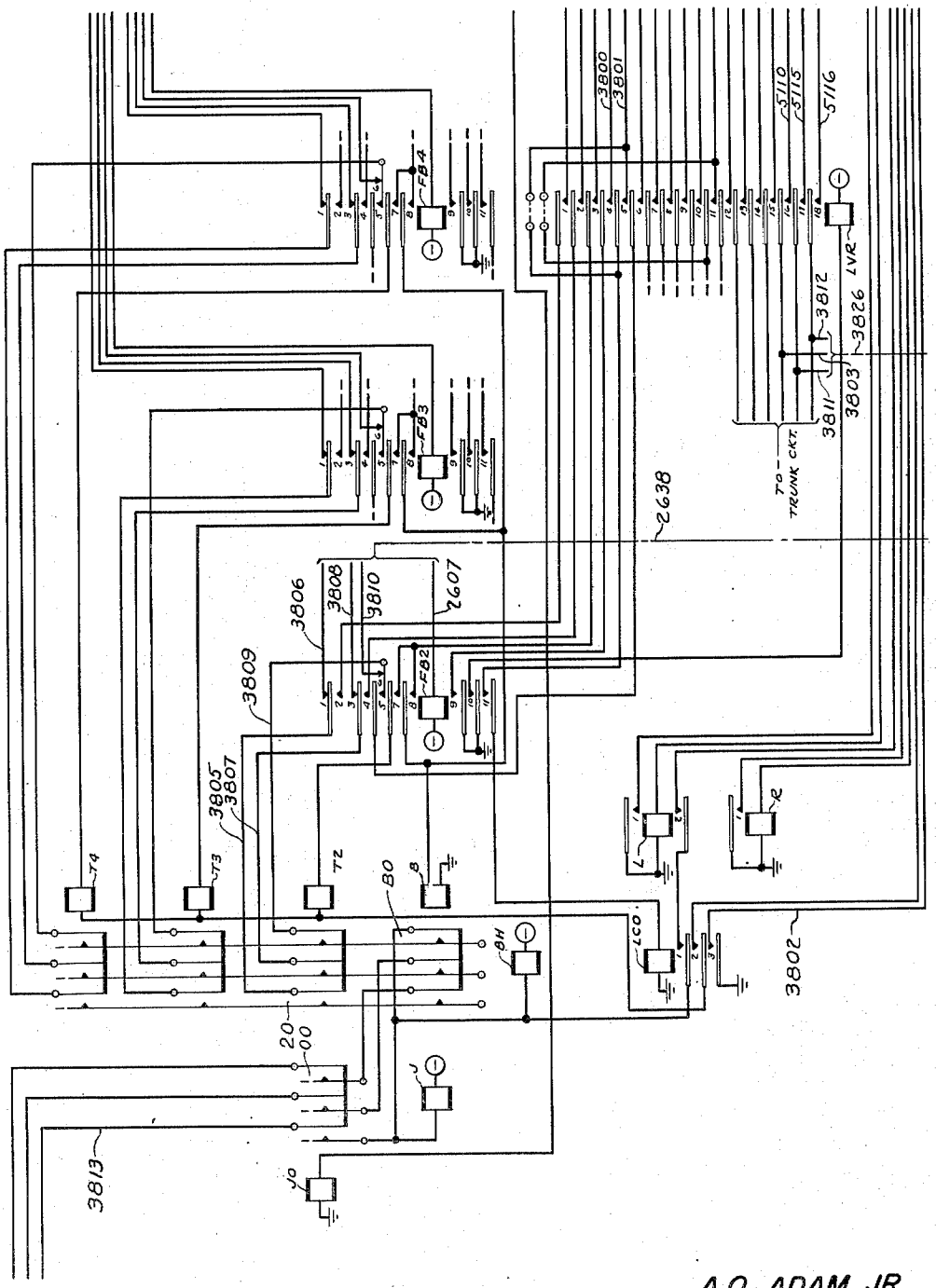

FIG. 38

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 40

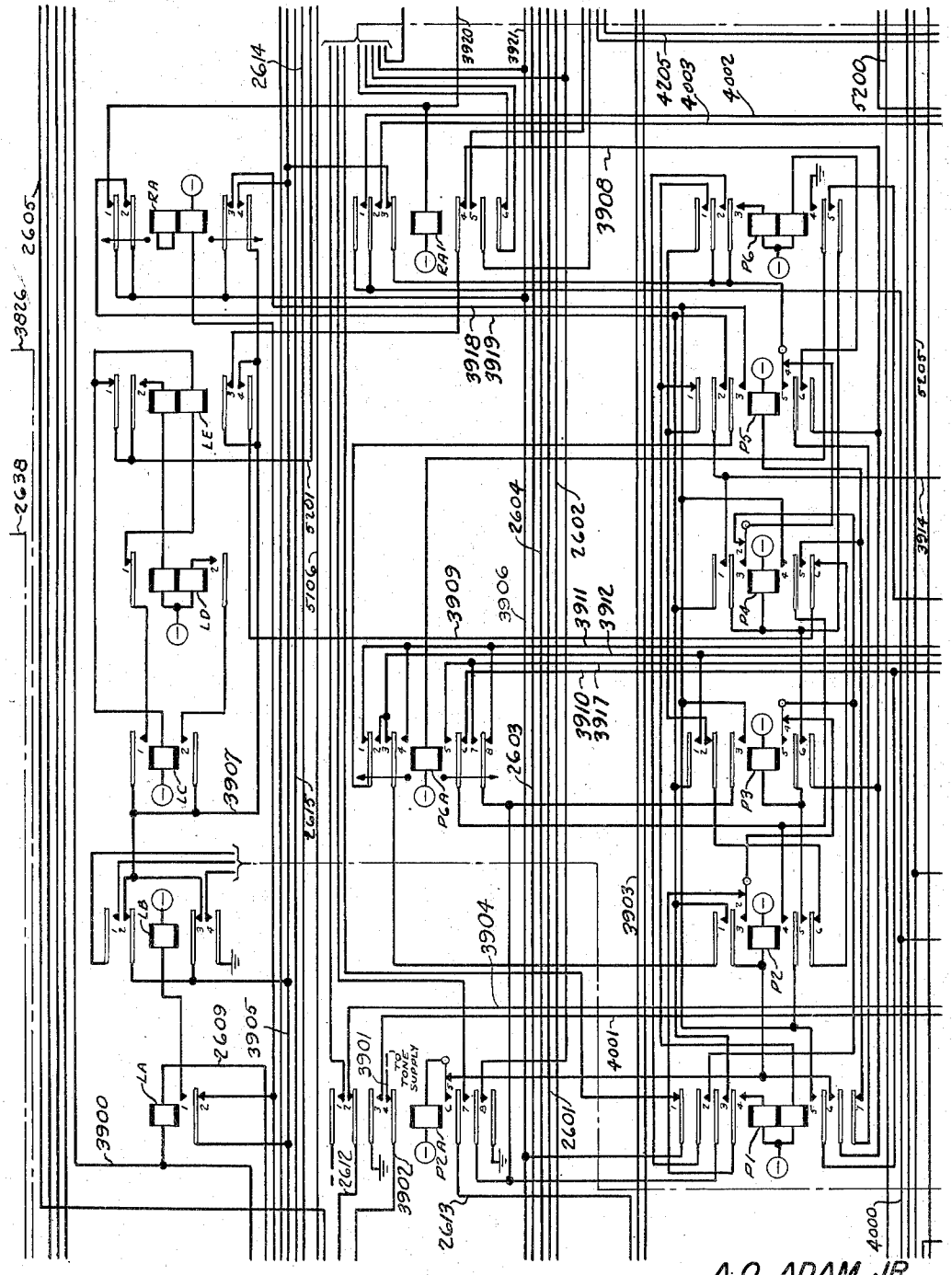

FIG. 39

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 41

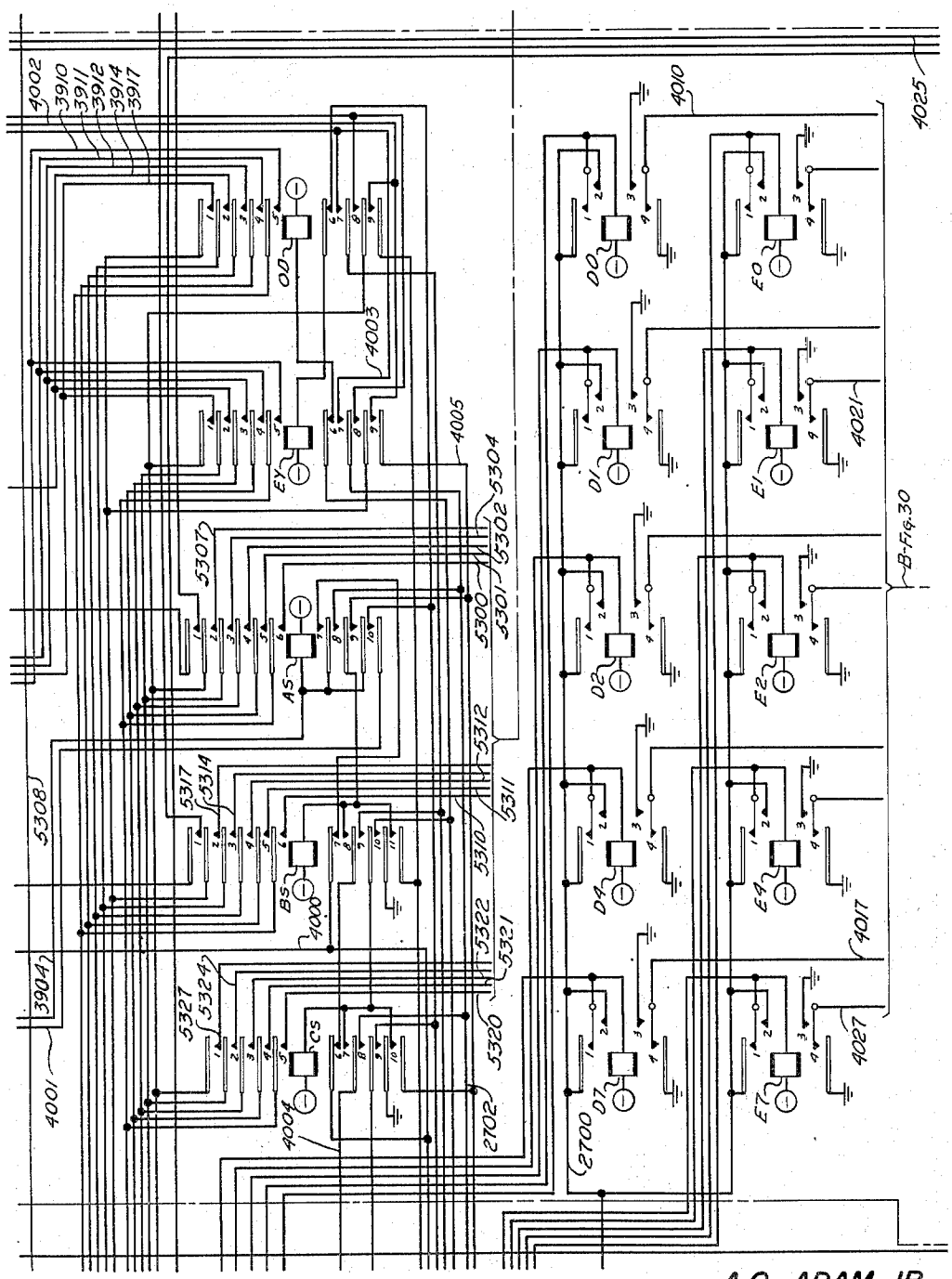

FIG. 40

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 42

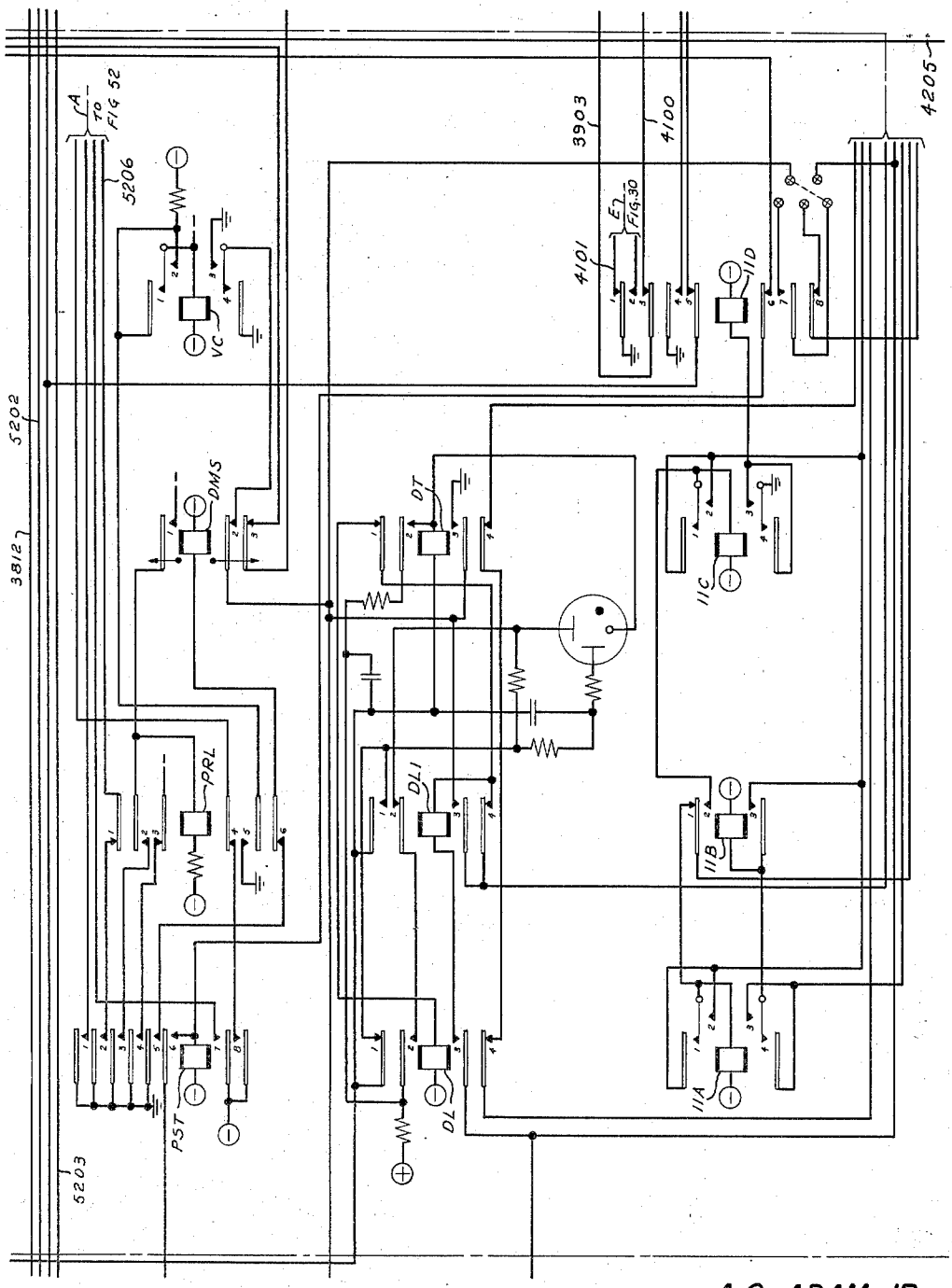

FIG. 41

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 43

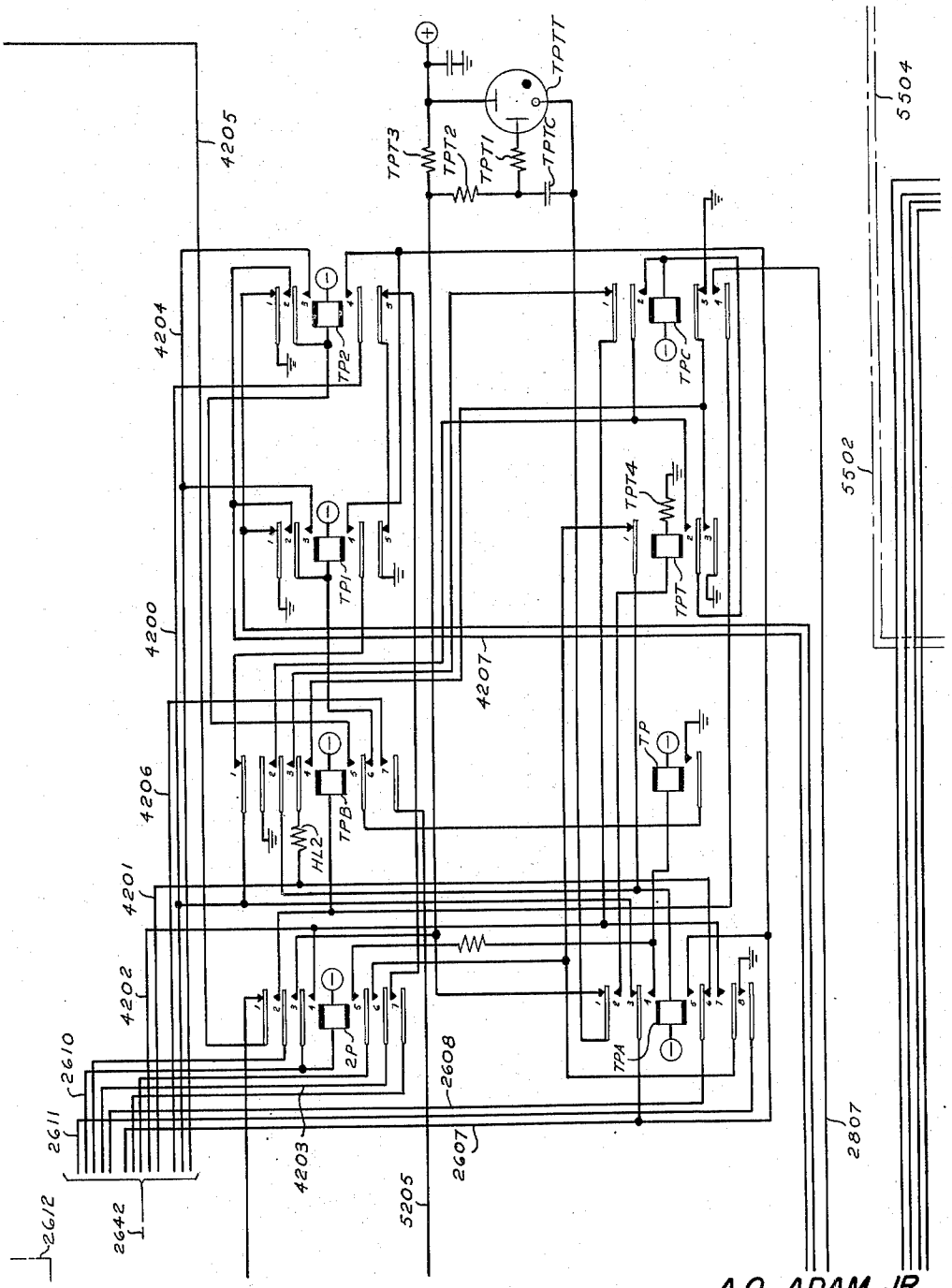

FIG. 42

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 44

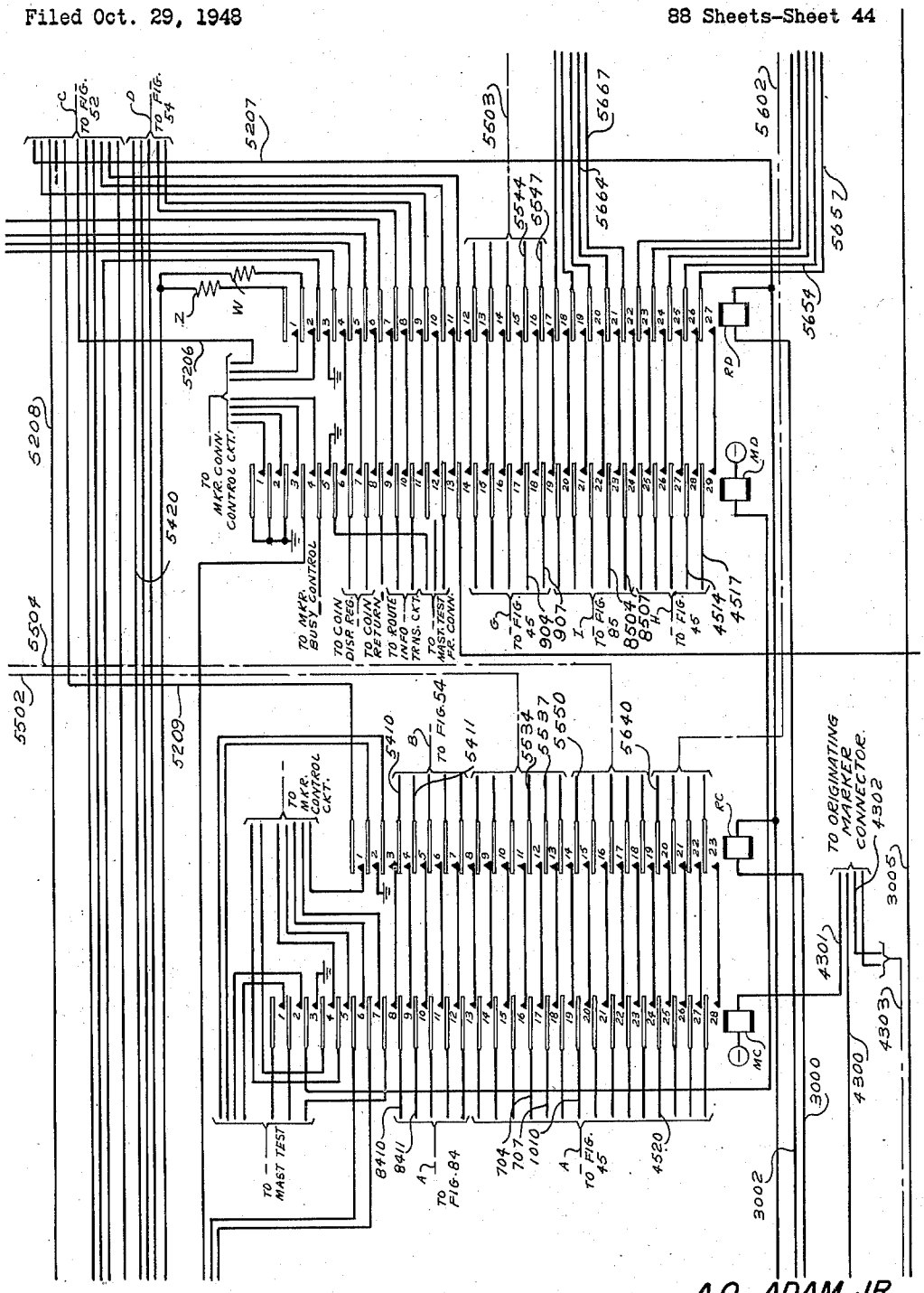

FIG. 43

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY R. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 45

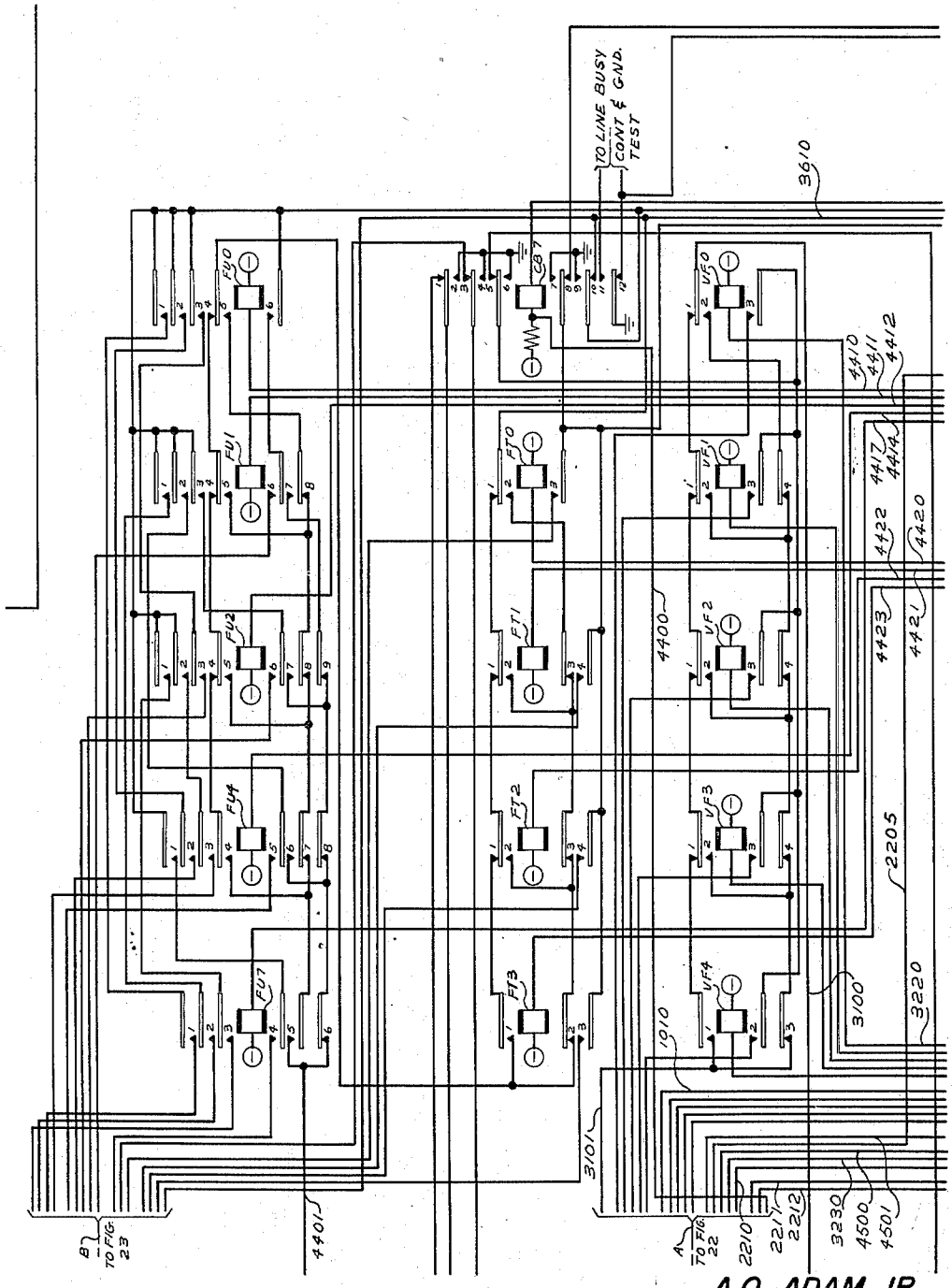

FIG. 44

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 46

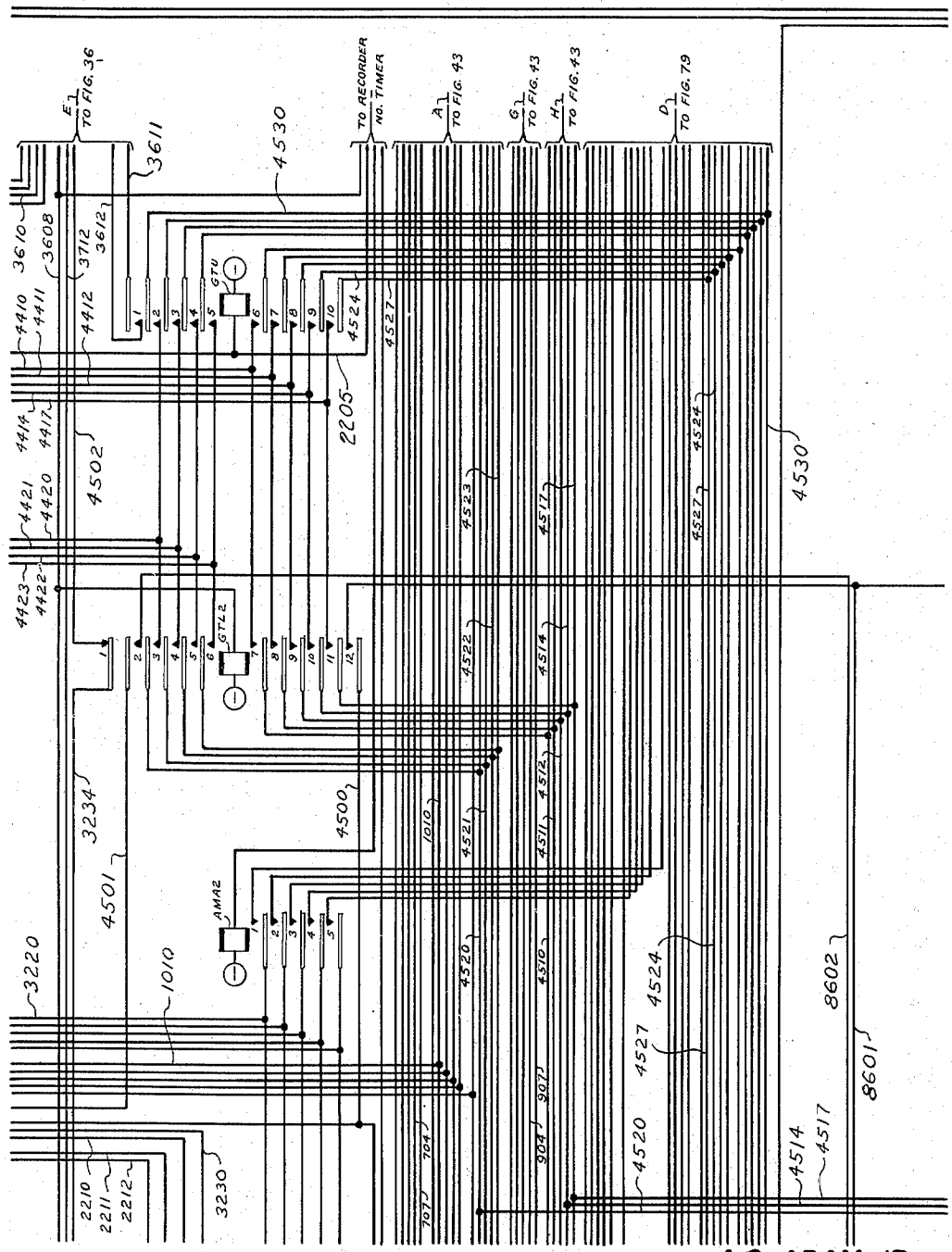

FIG. 45

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 47

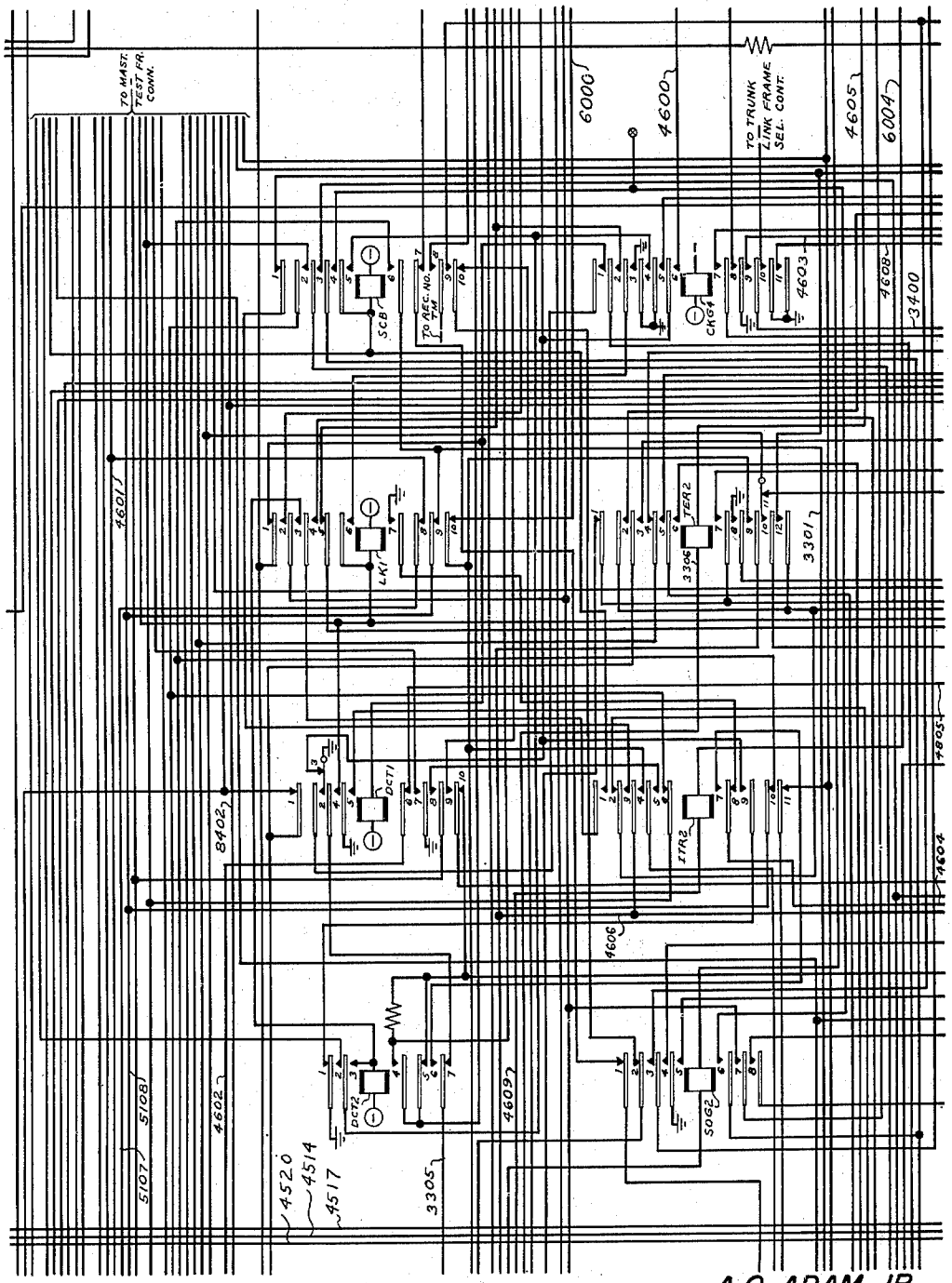

FIG. 46

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY C. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 48

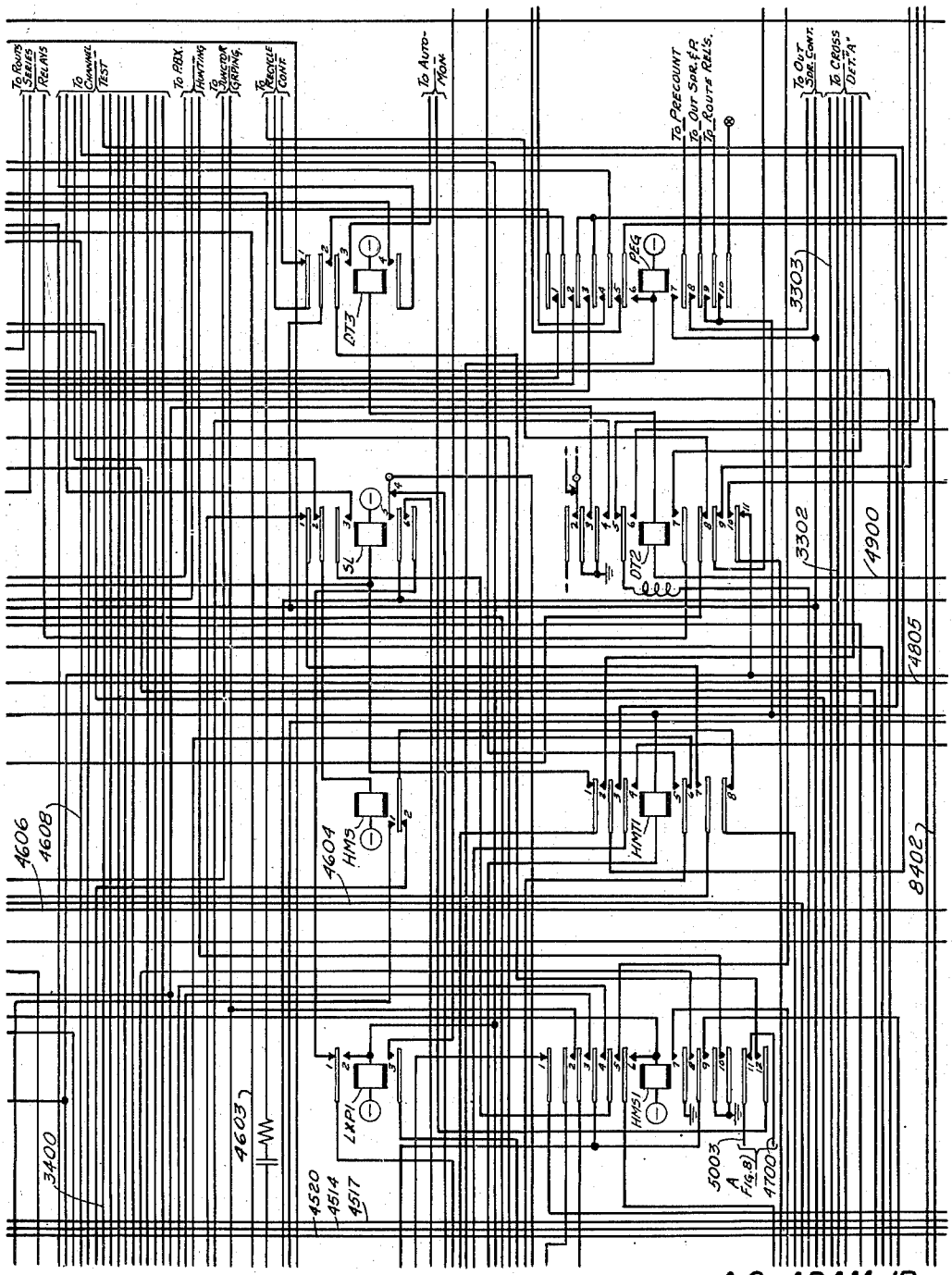

FIG. 47

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 49

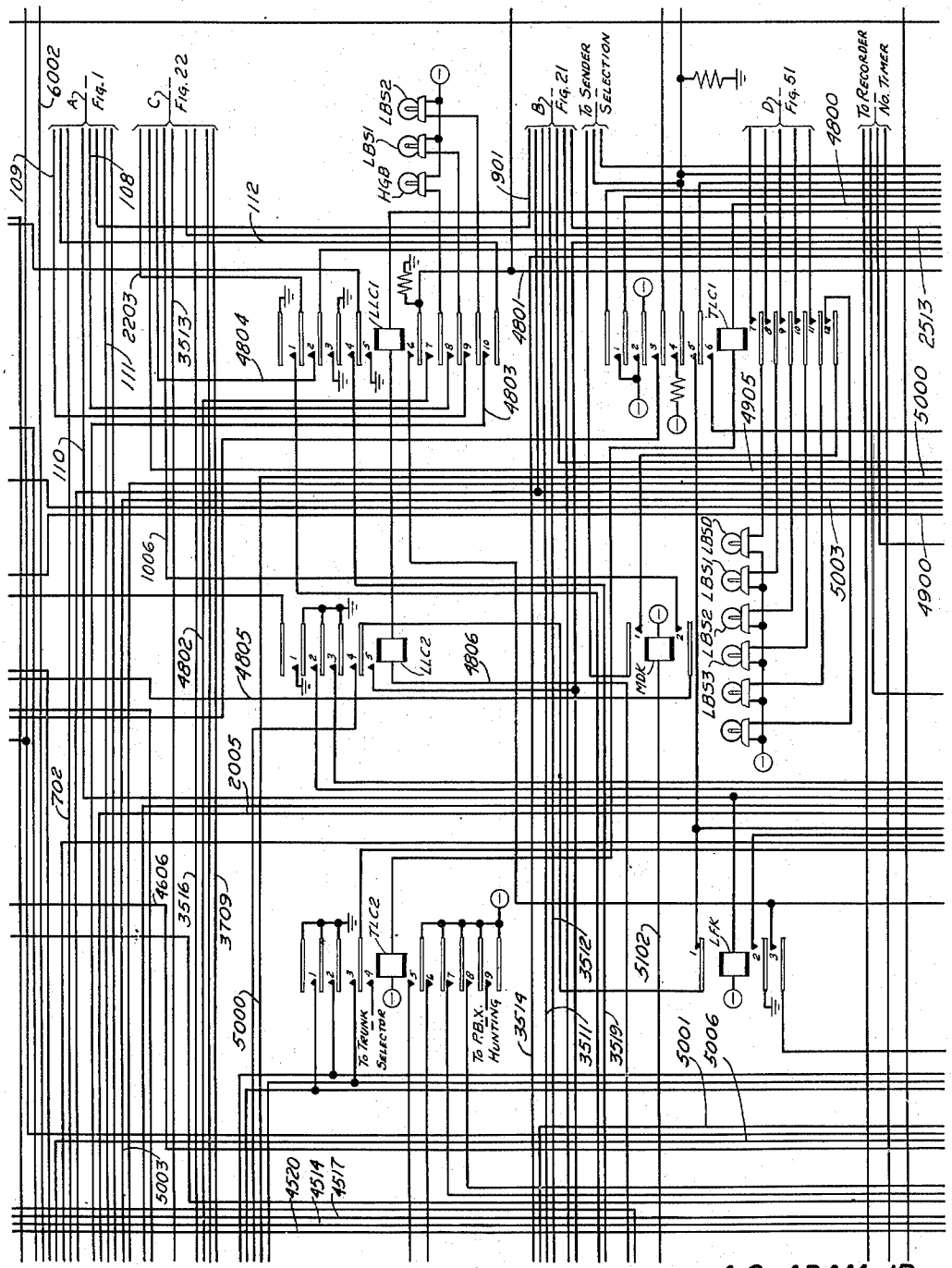

FIG. 48

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 50

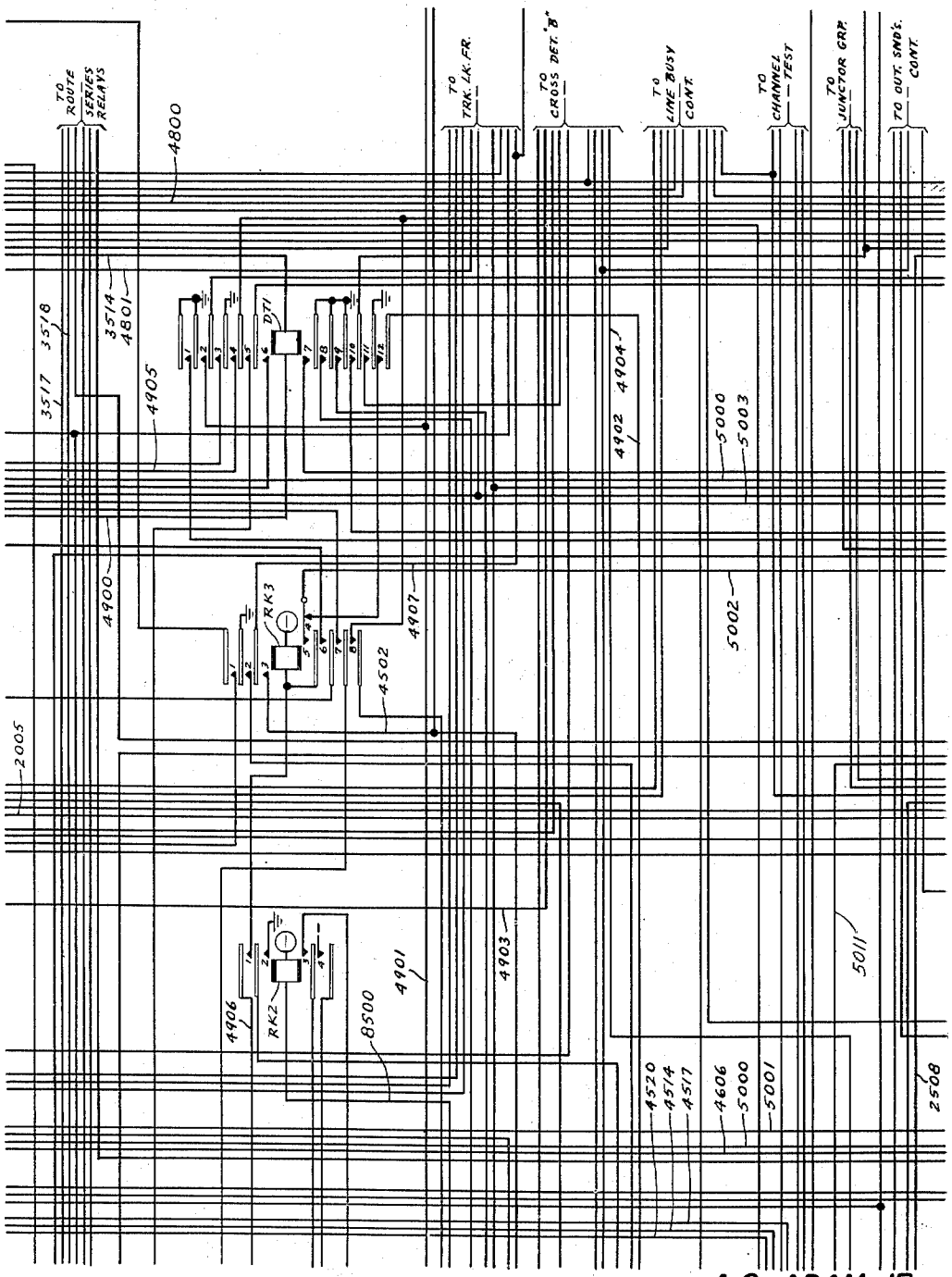

FIG. 49

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 51

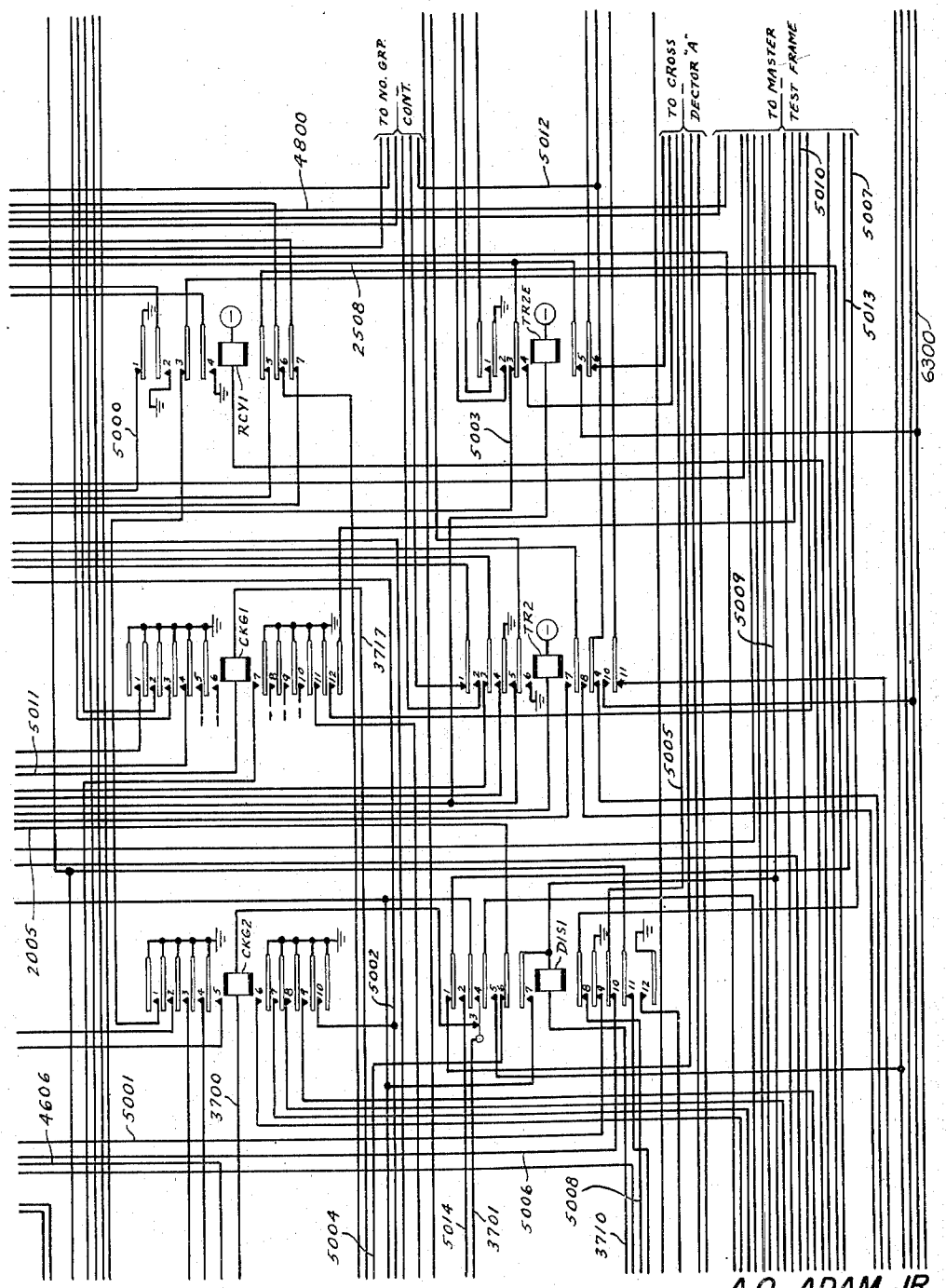

FIG. 50

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 52

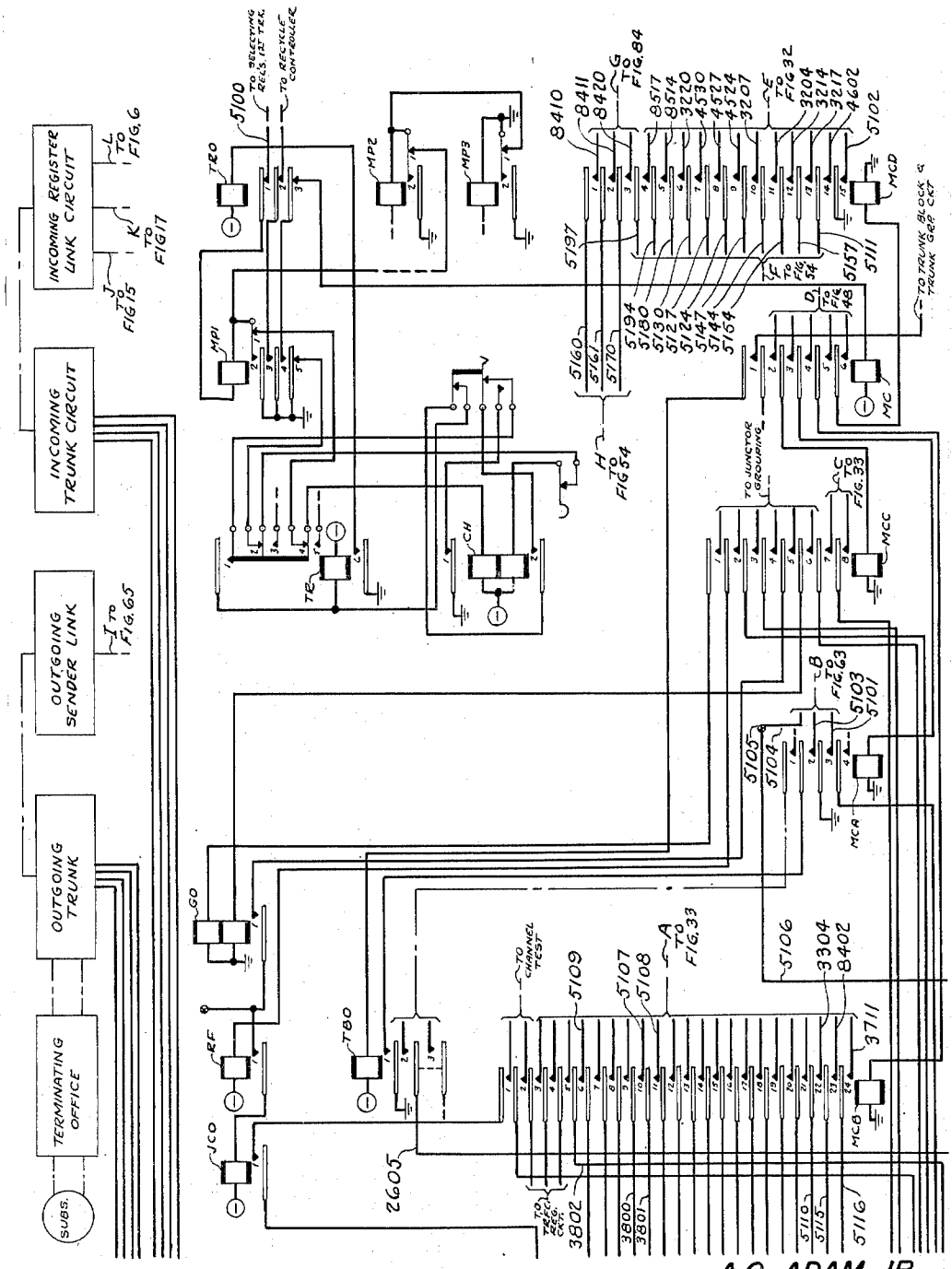

FIG. 51

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 53

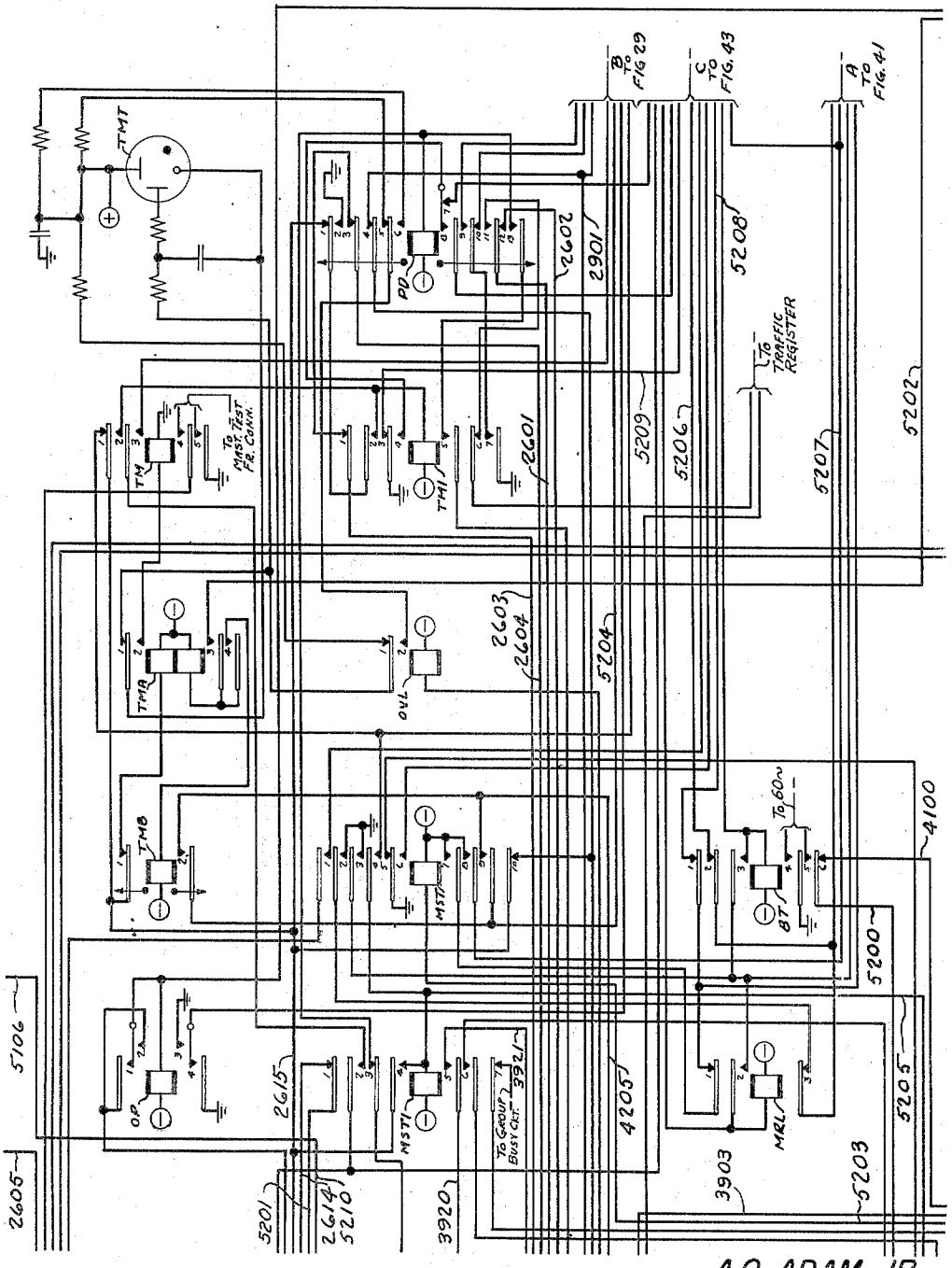

FIG. 52

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 54

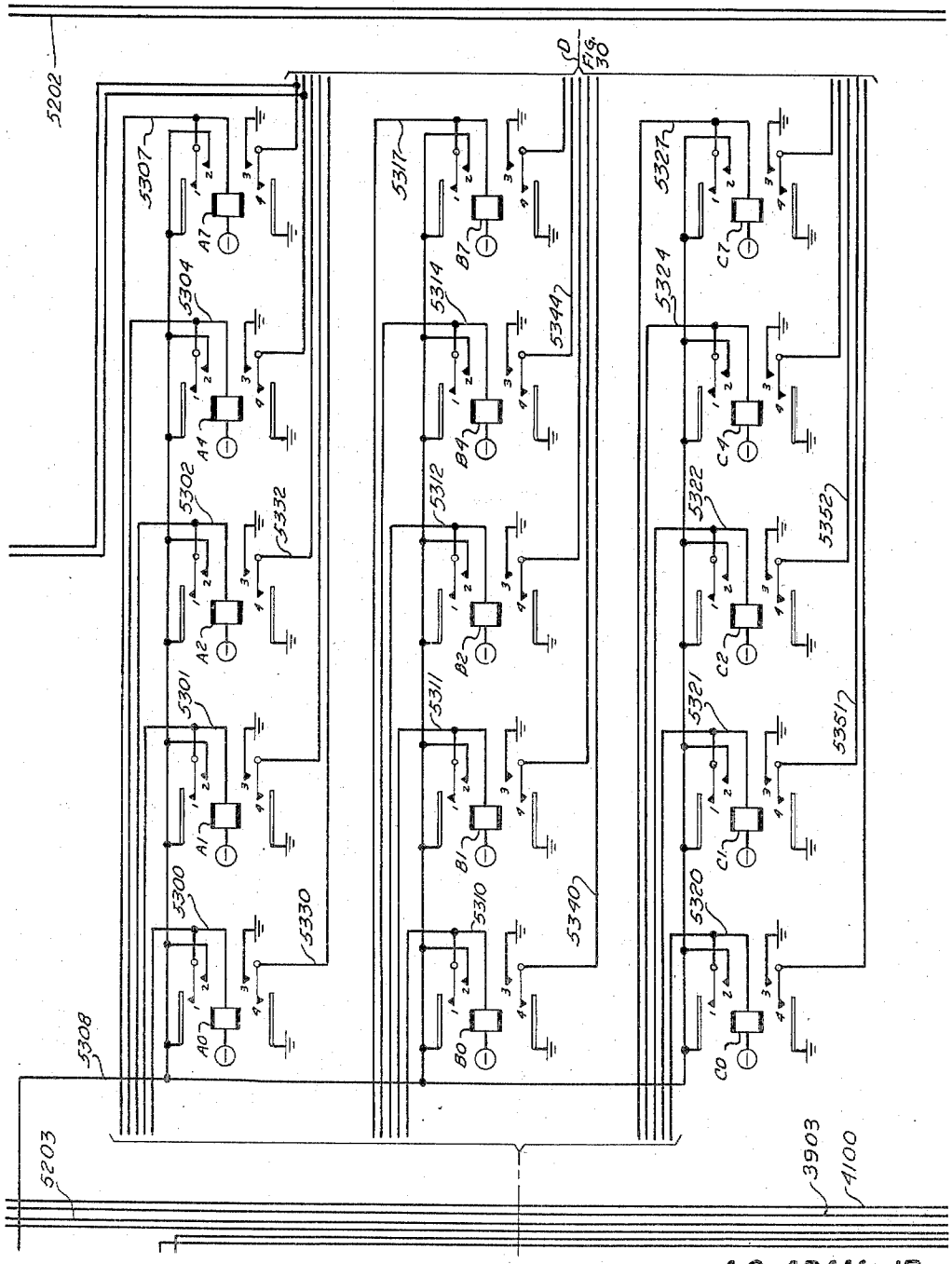

FIG. 53

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 55

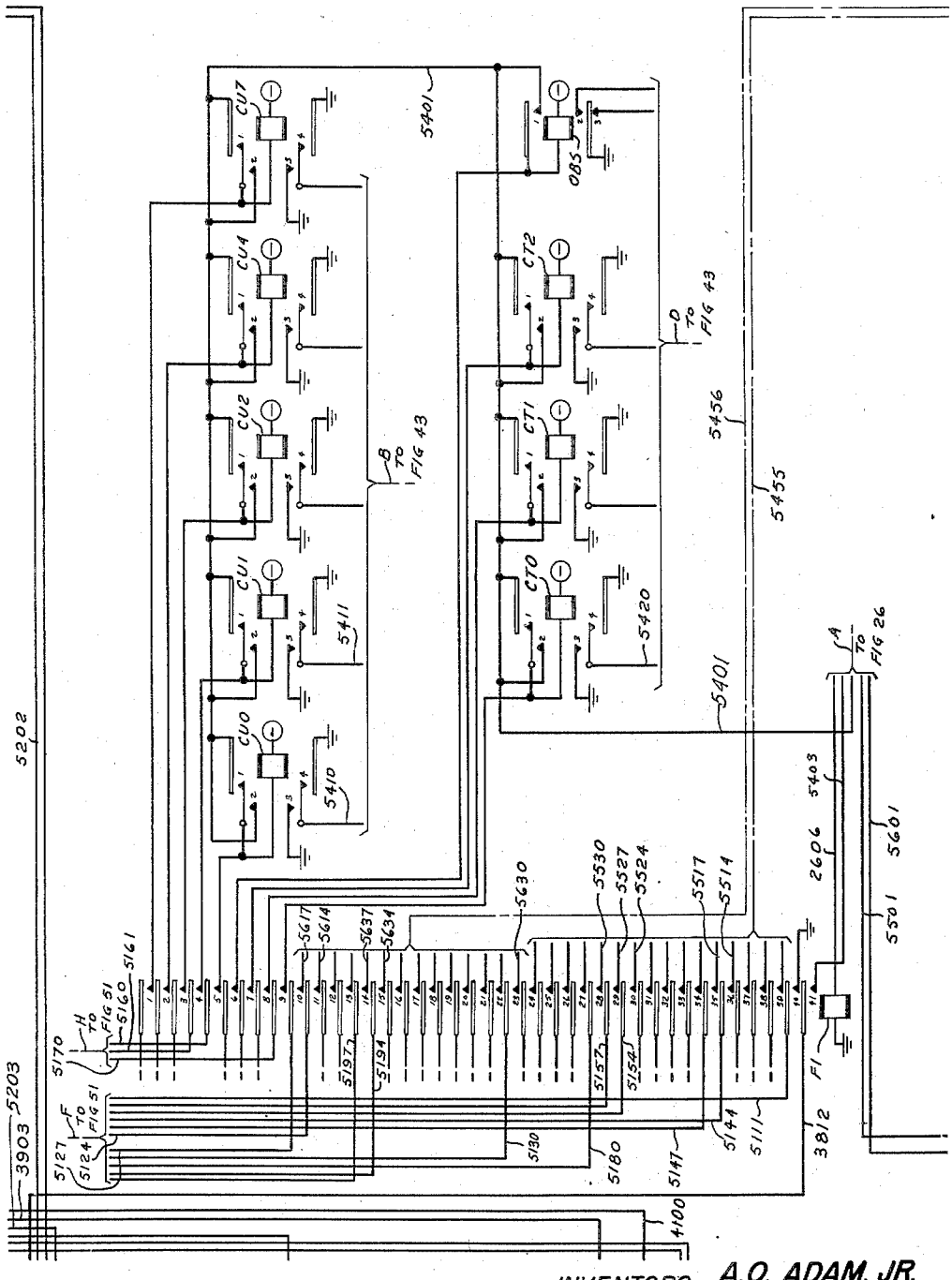

FIG. 54

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 56

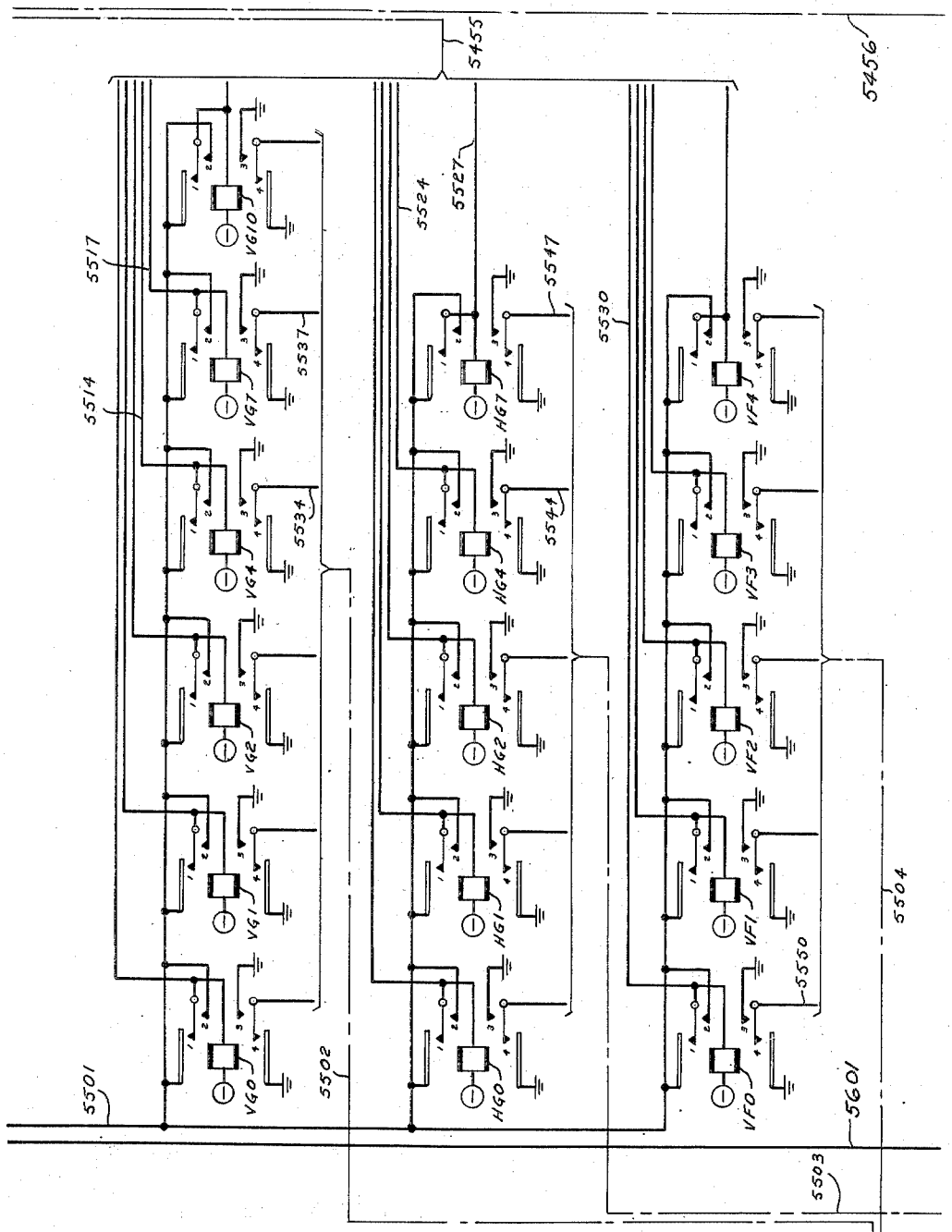

FIG. 55

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 57

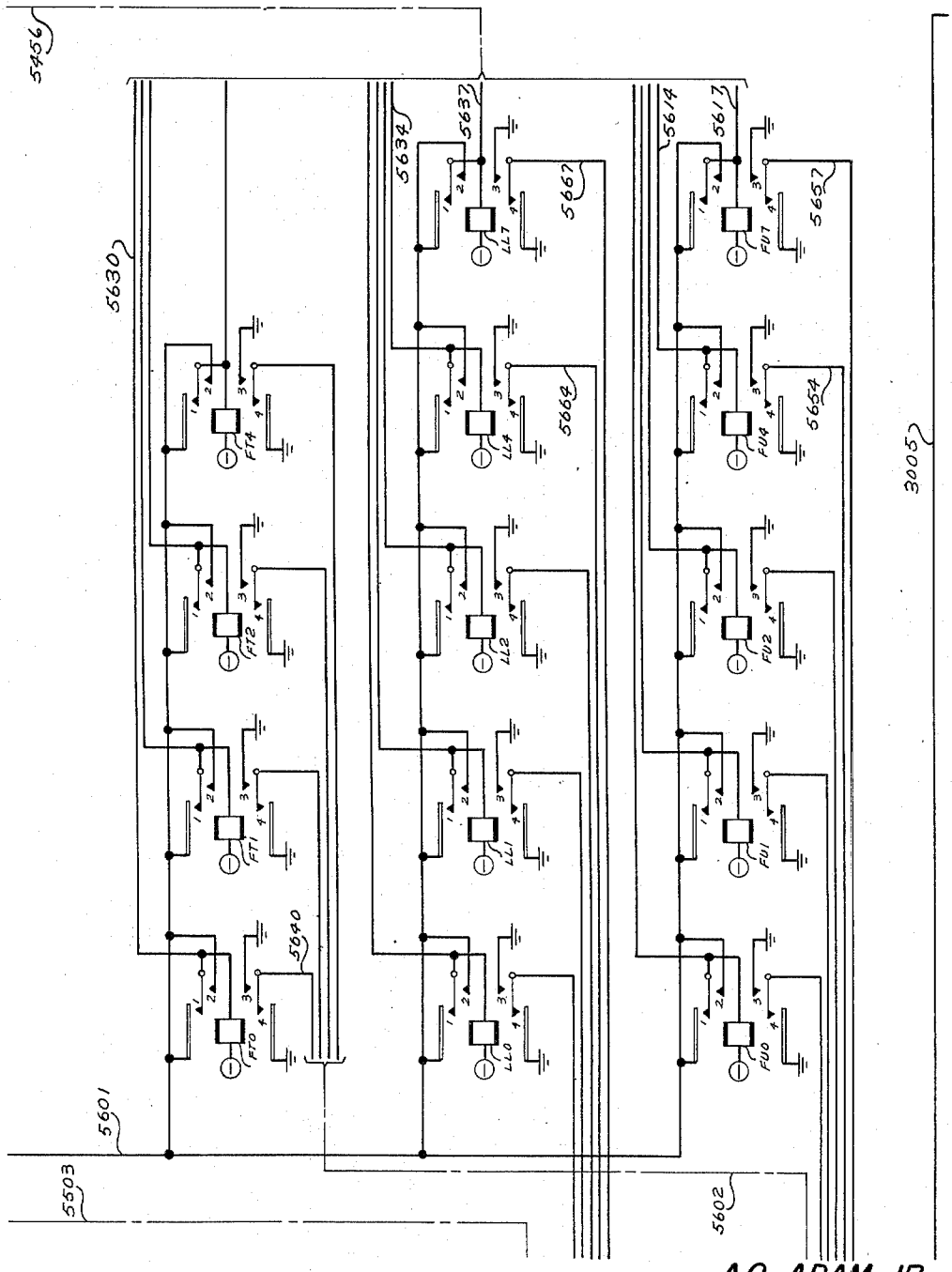

FIG. 56

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 58

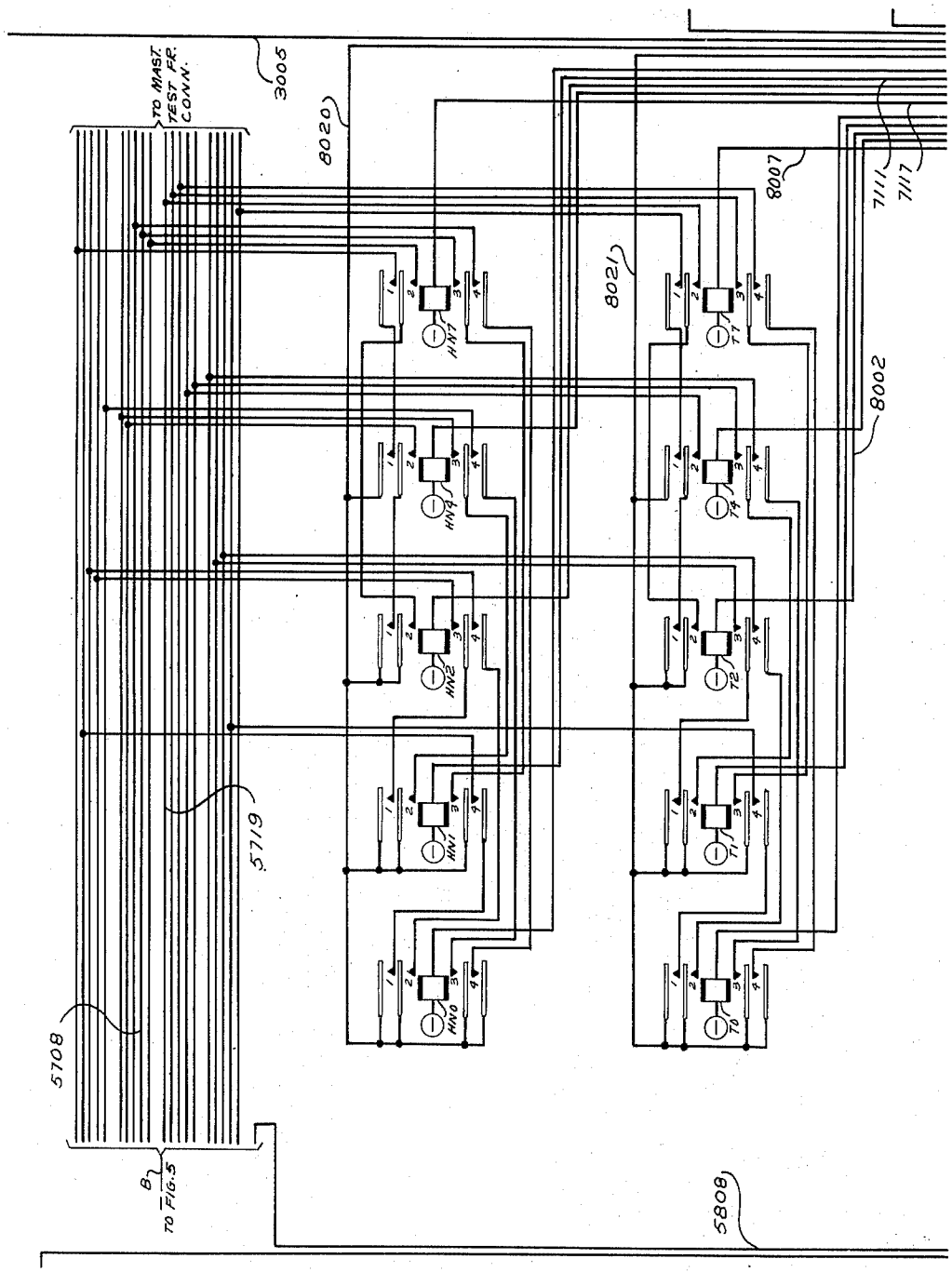

FIG. 57

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 59

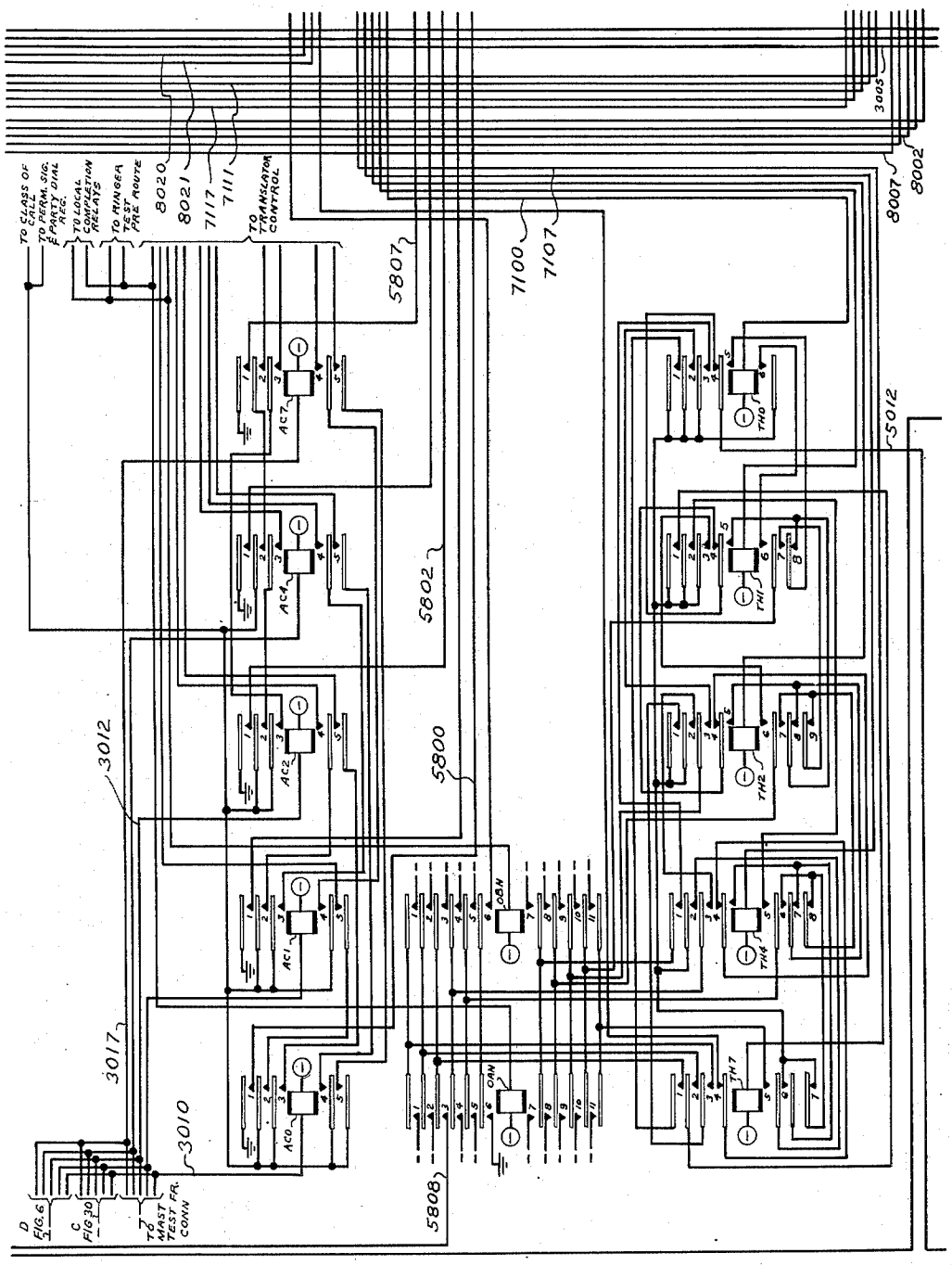

FIG. 58

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 60

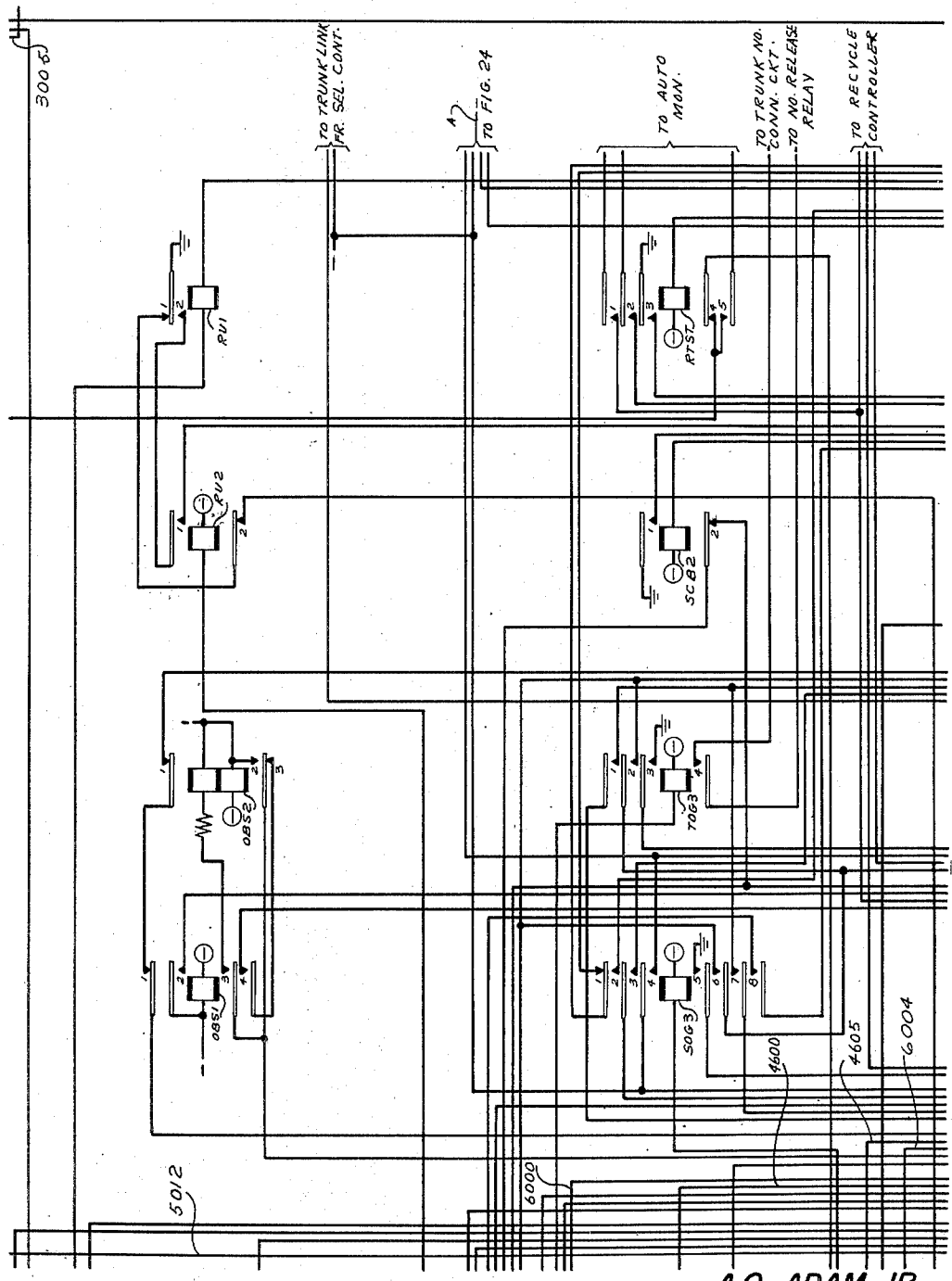

FIG. 59

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 61

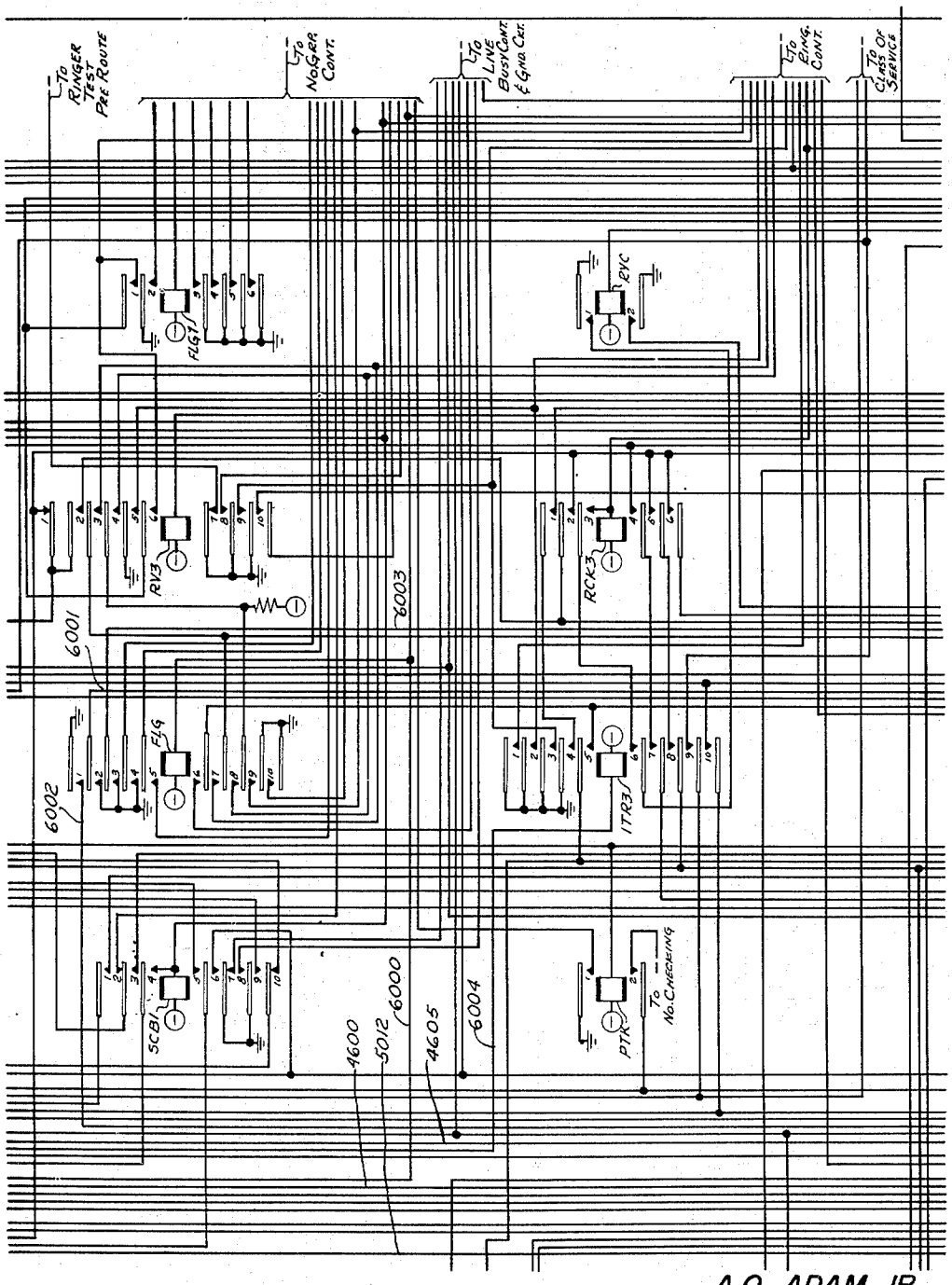

FIG. 60

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 62

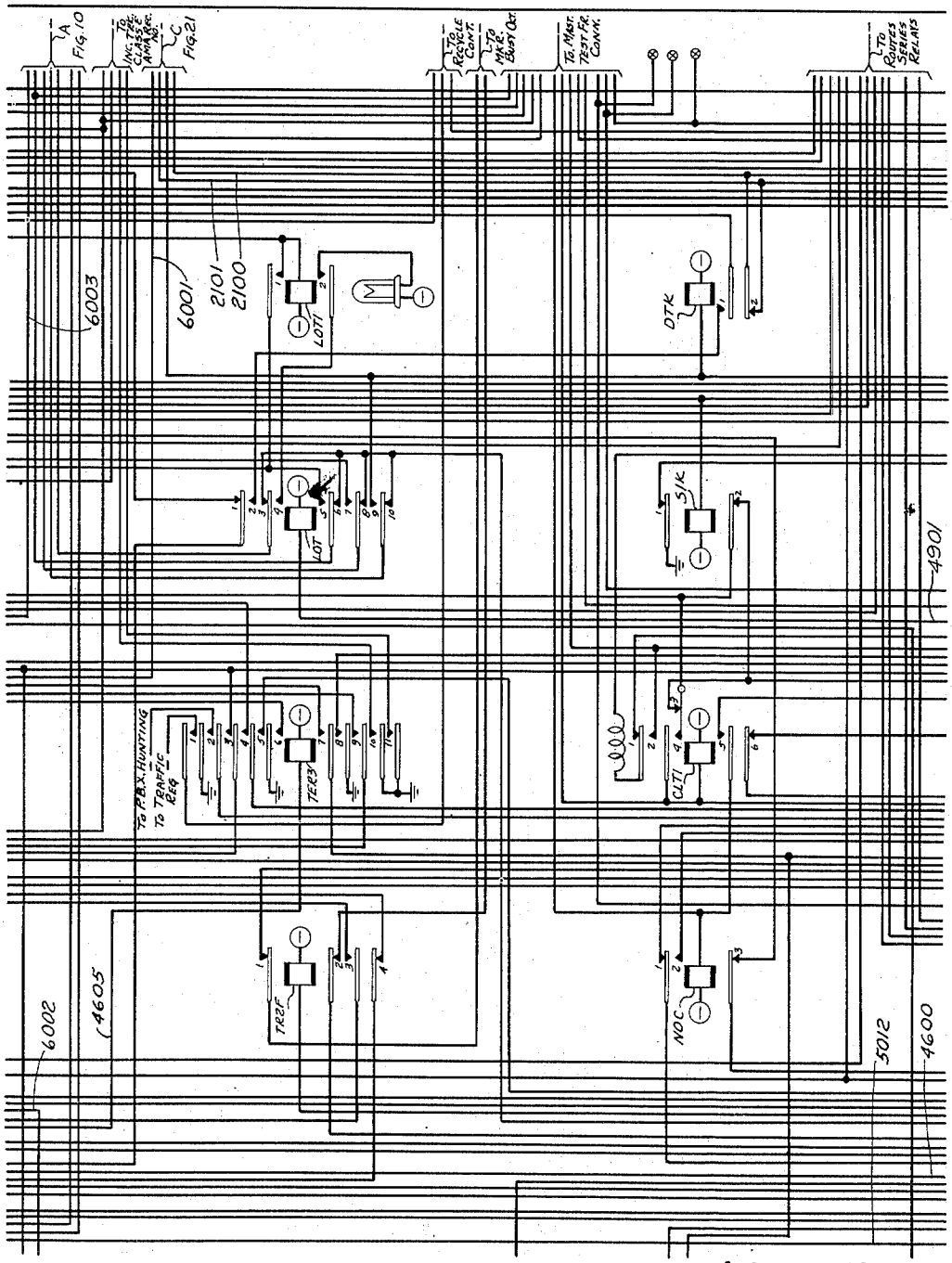

FIG. 61

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 63

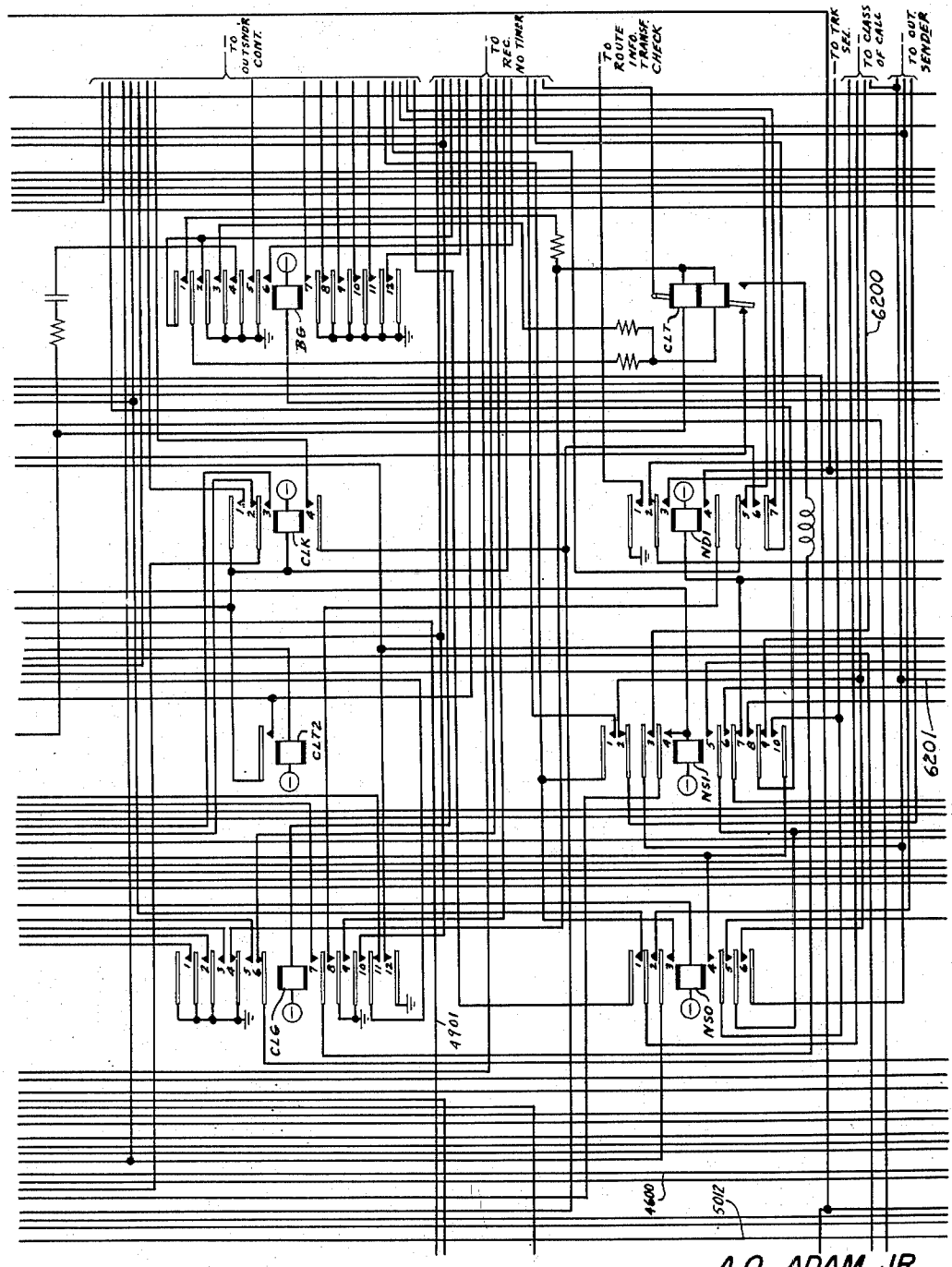

FIG. 62

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 64

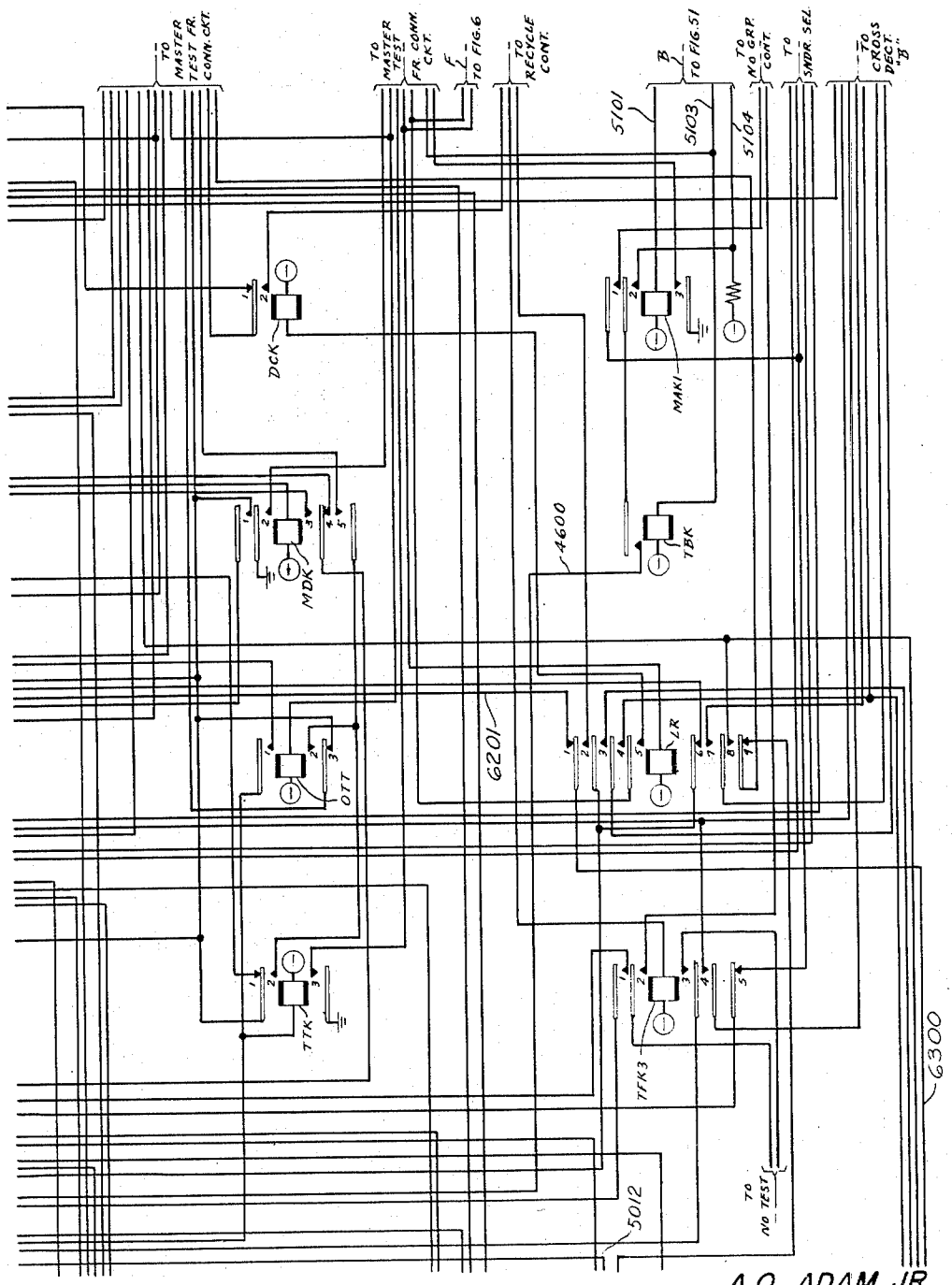

FIG. 63

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 65

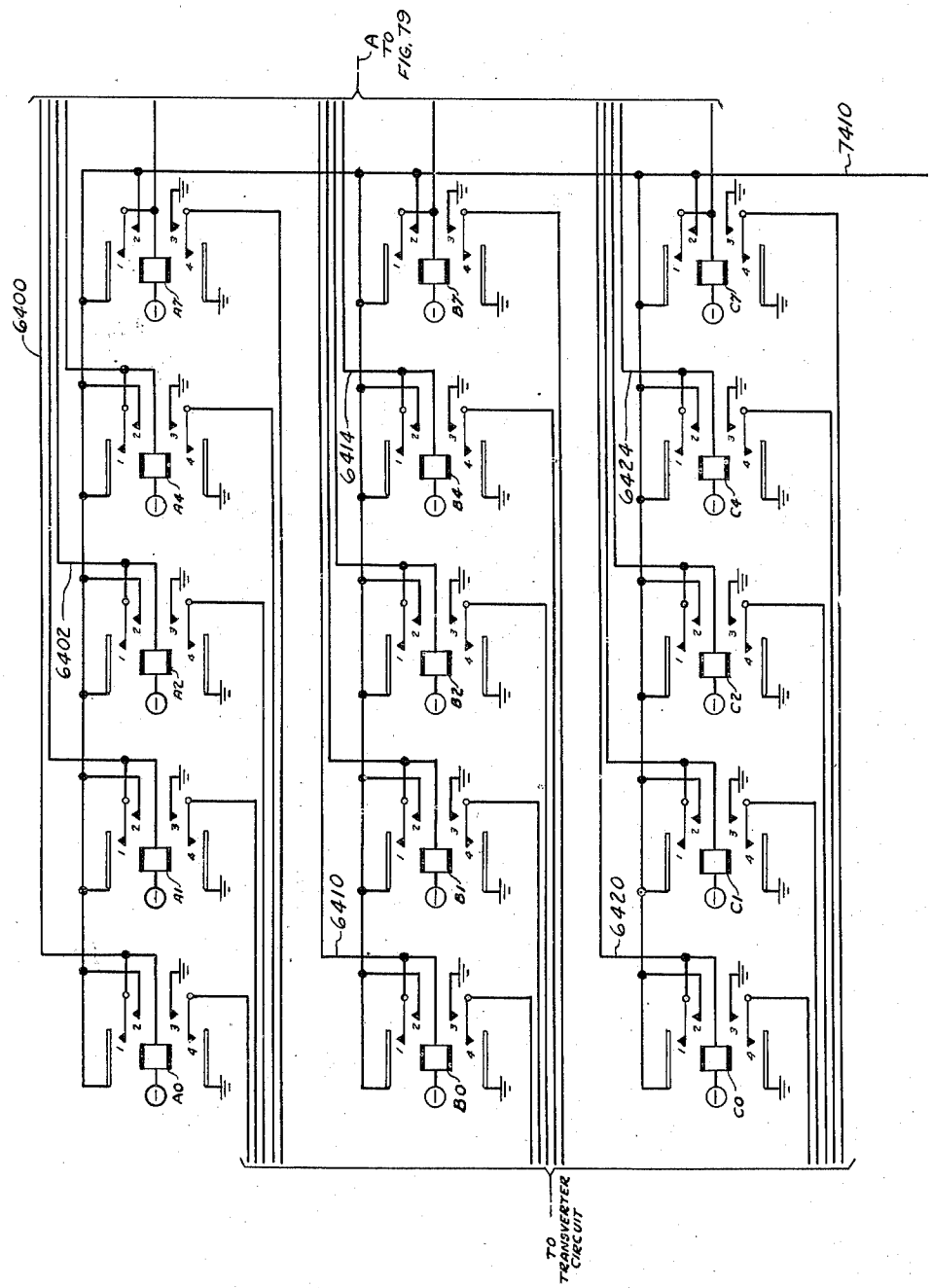

FIG. 64

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 66

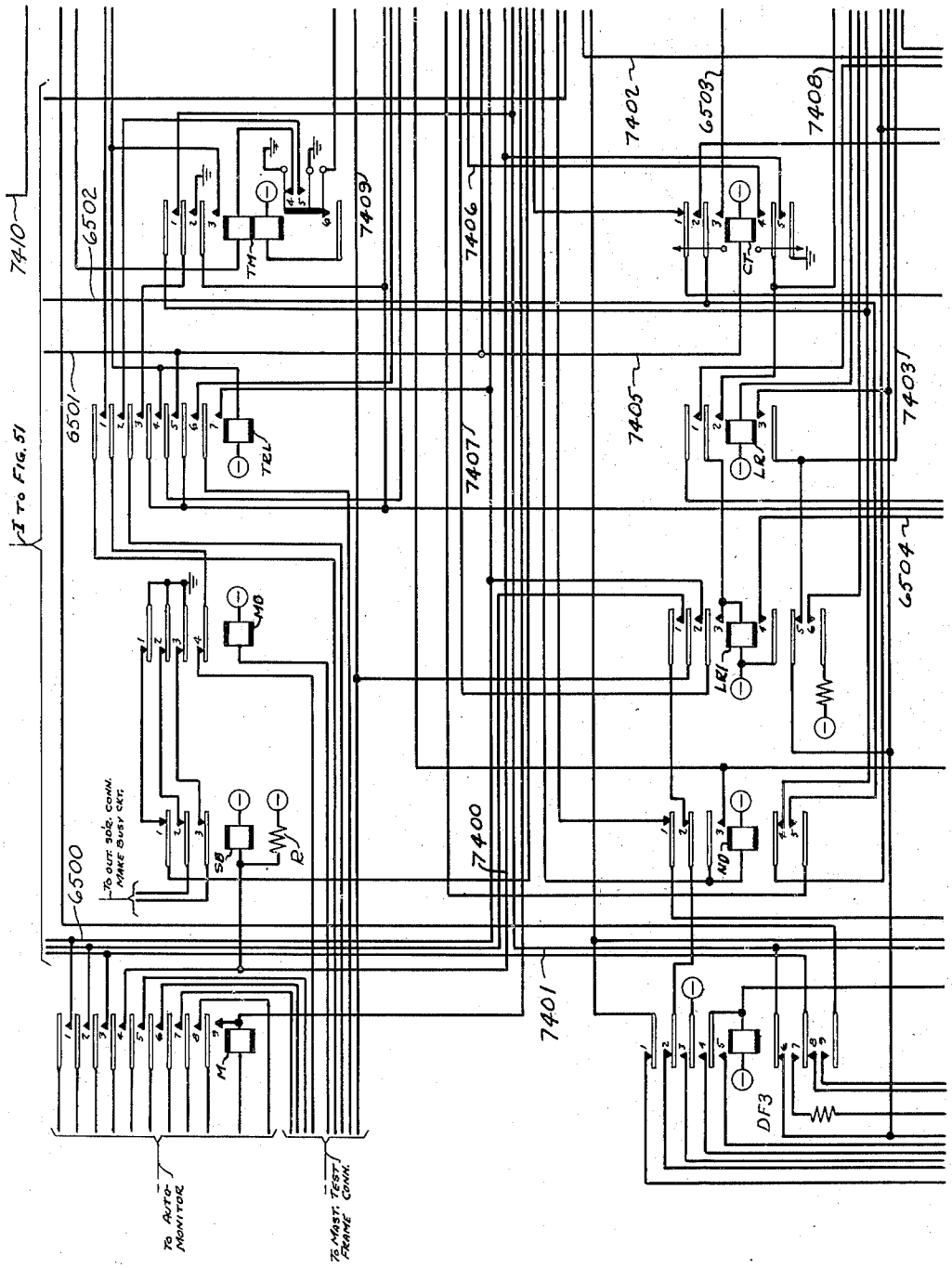

FIG. 65

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 67

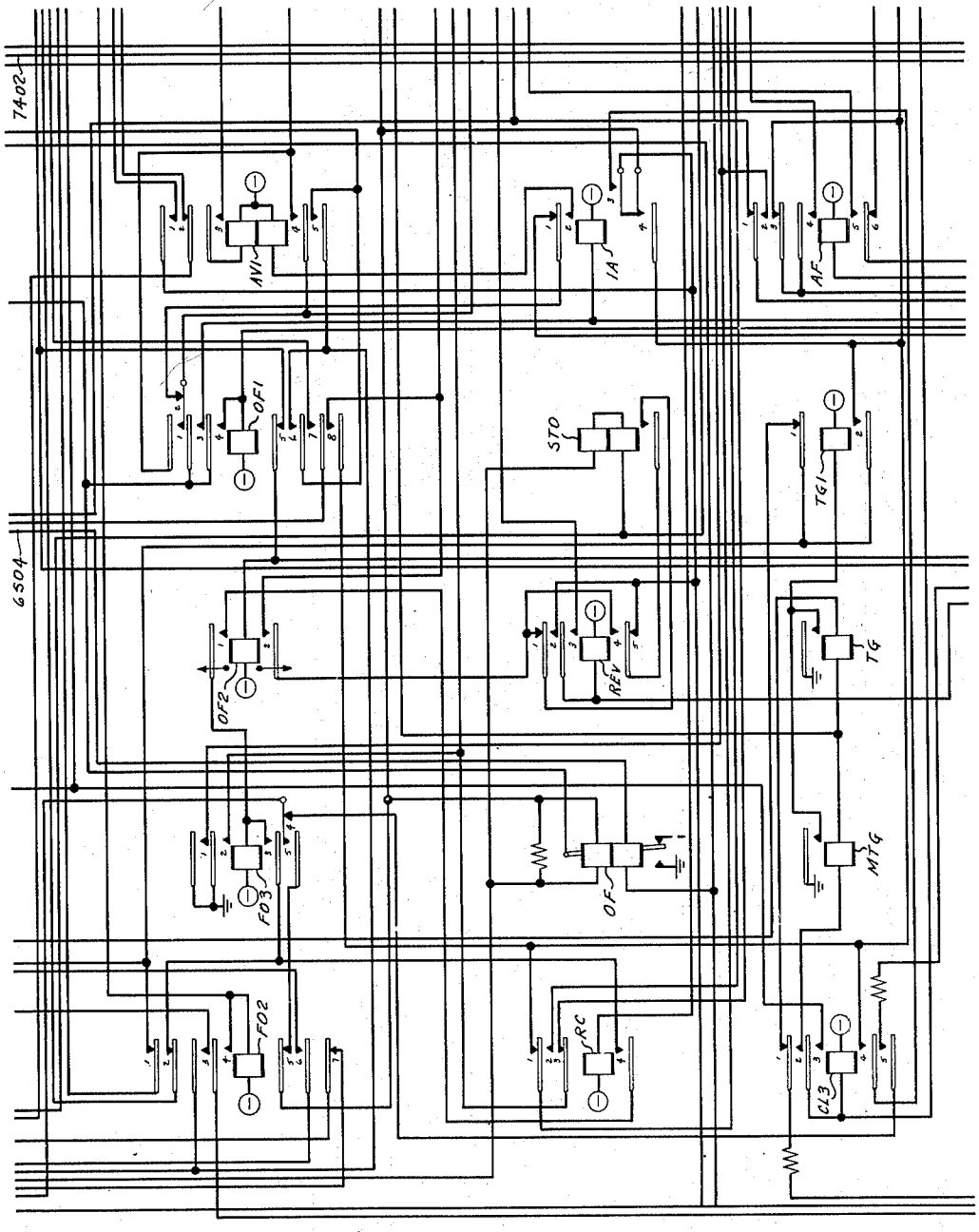

FIG. 66

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 68

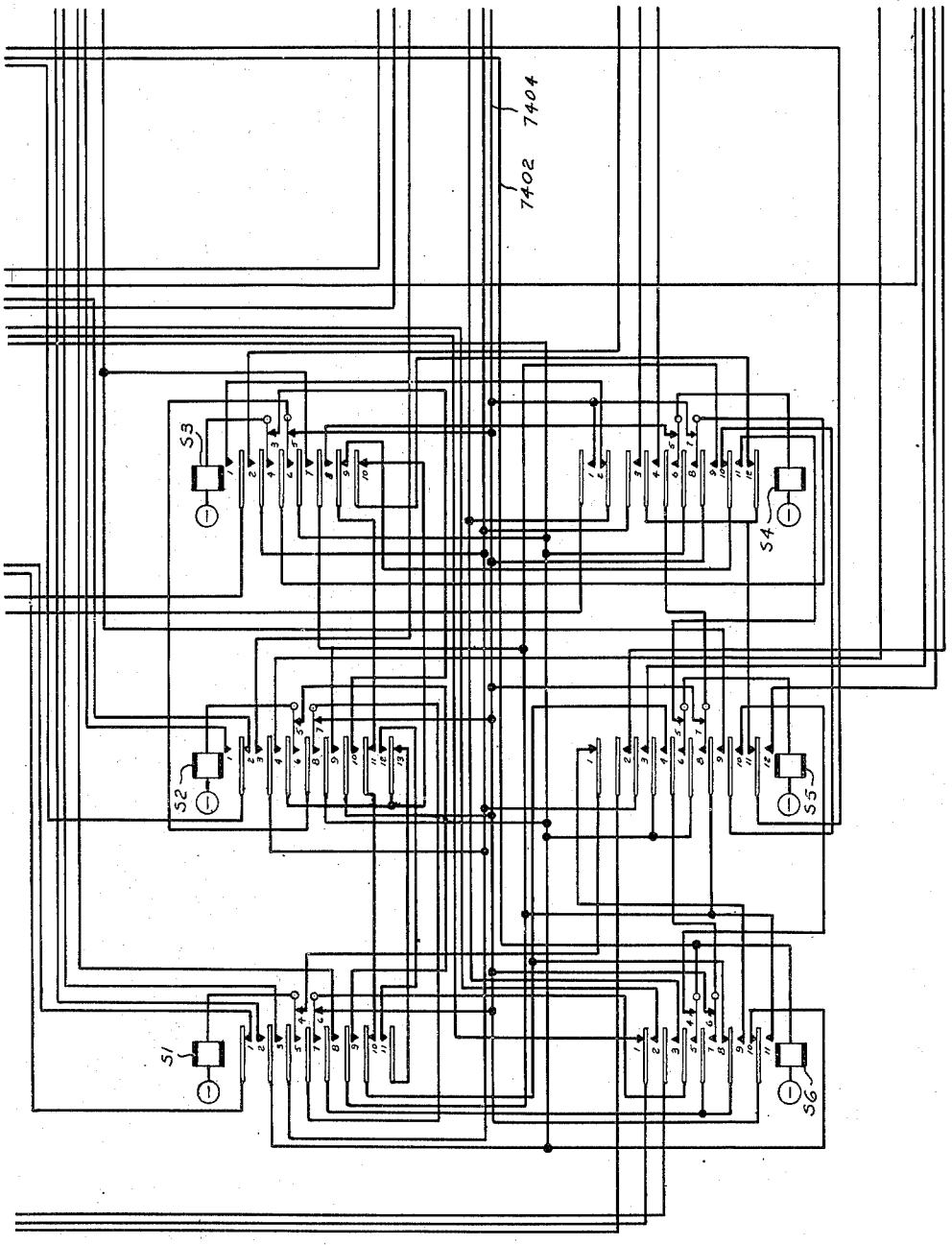

FIG. 67

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

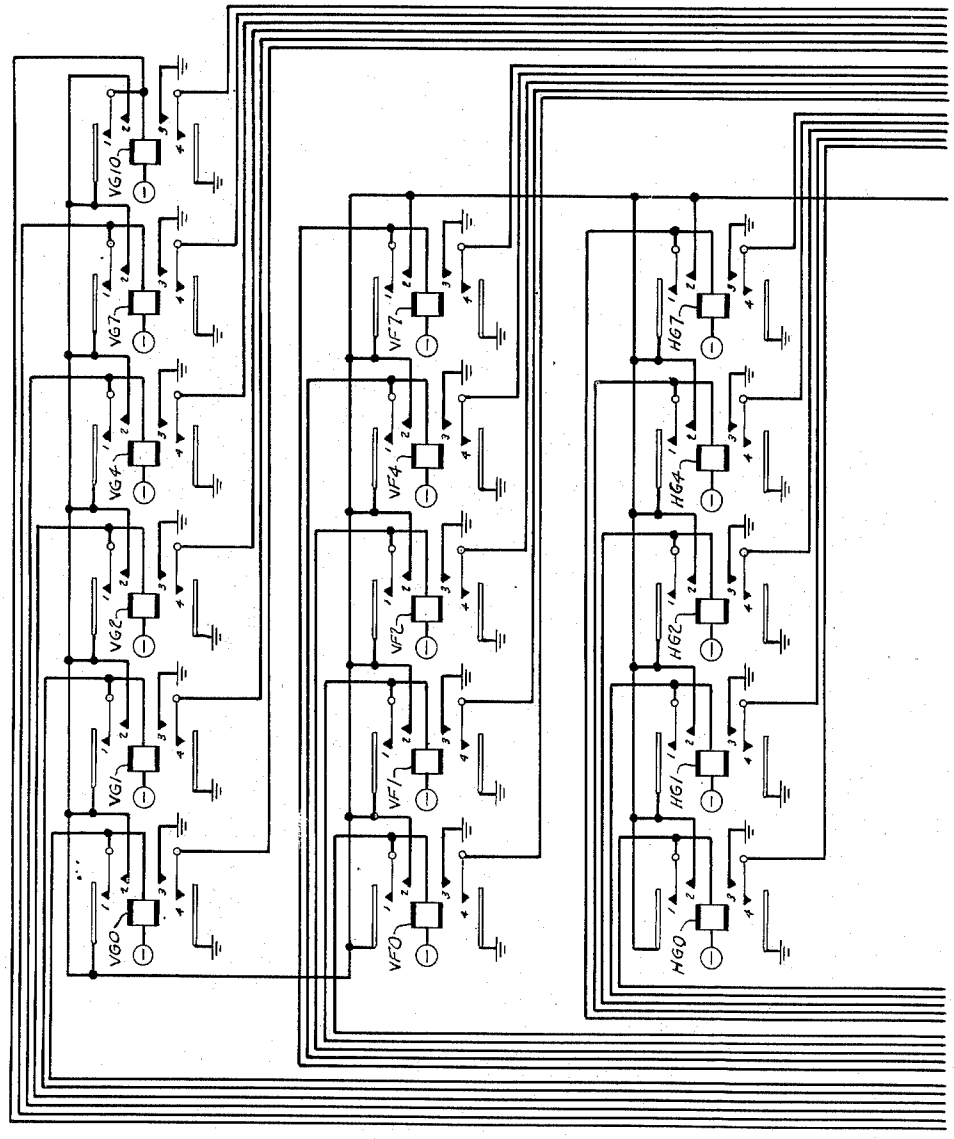

FIG. 68

INVENTORS. A.O. ADAM, JR.
R.C. AVERY
BY P. C. Smith
ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 70

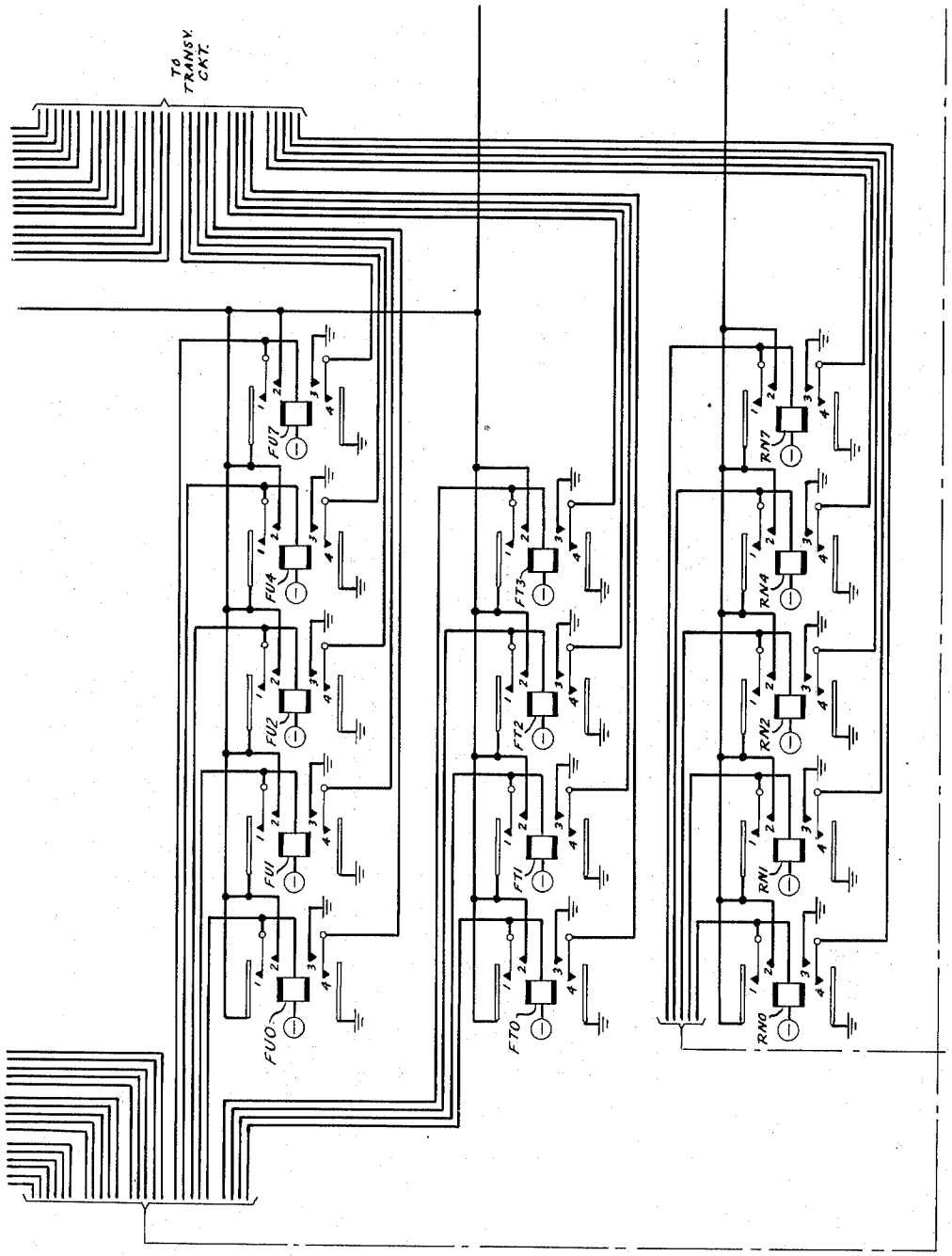

FIG. 69

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 71

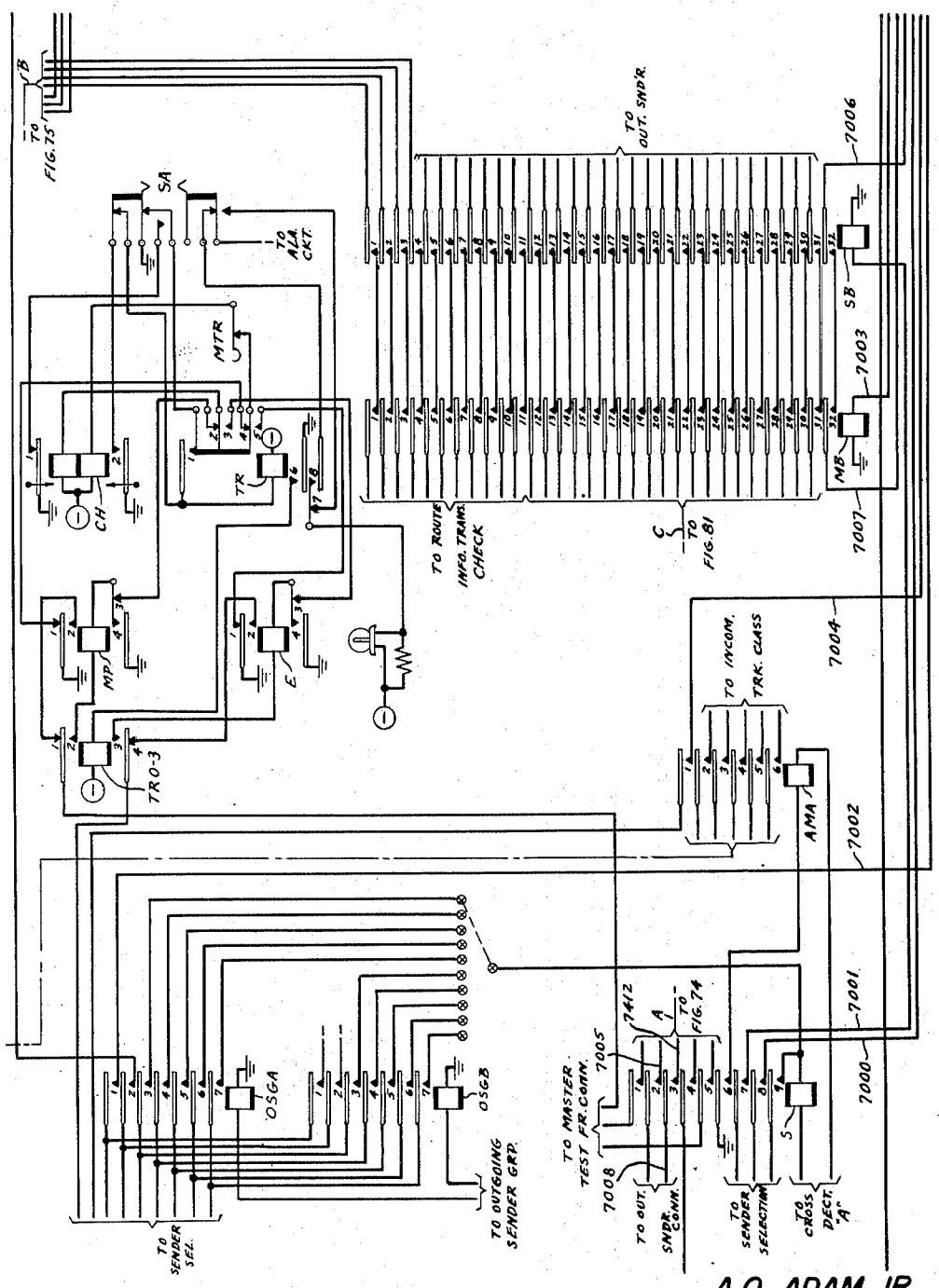

FIG. 70

INVENTORS A. O. ADAM, JR.
R. C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 72

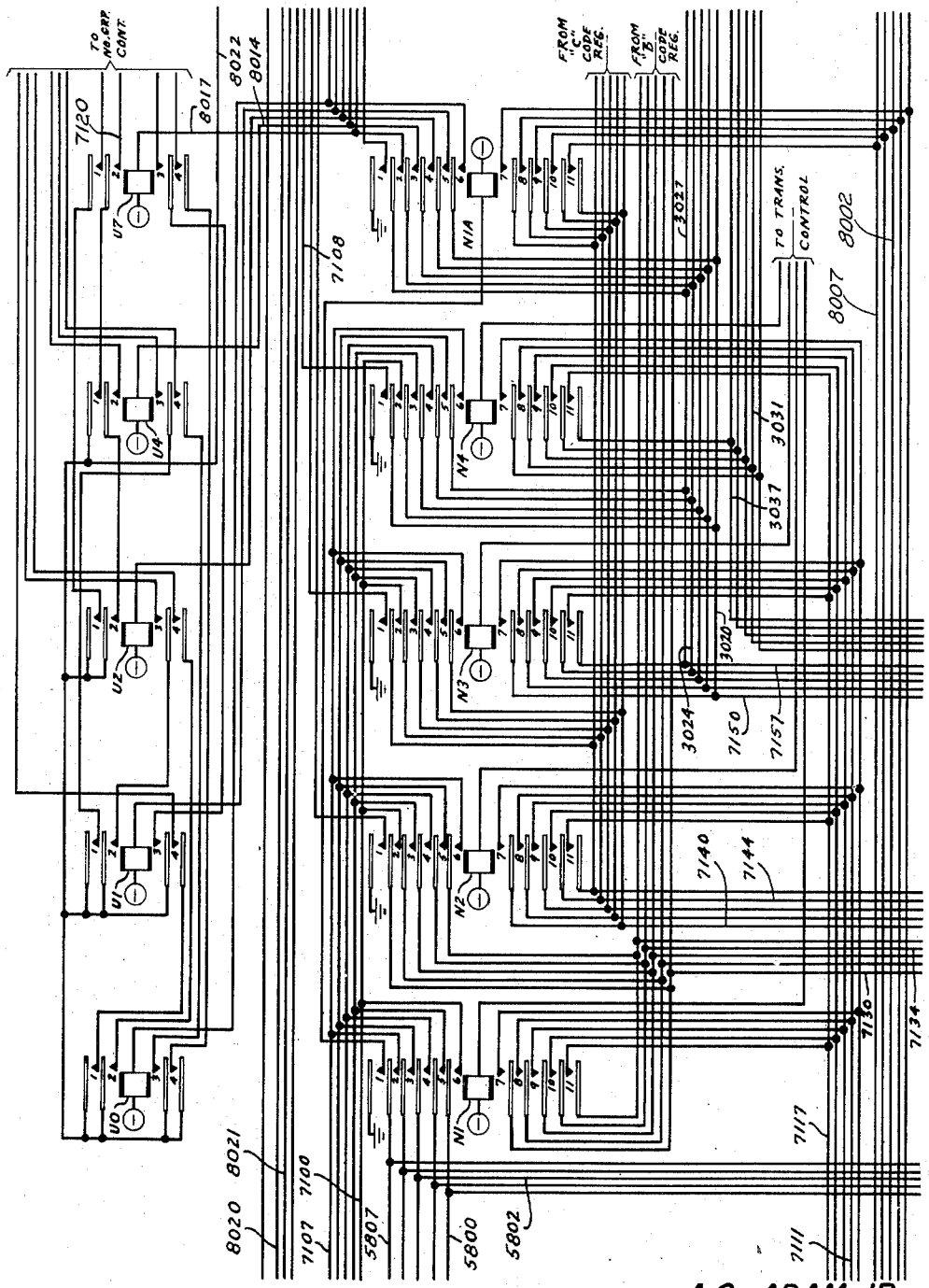

FIG. 71

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 73

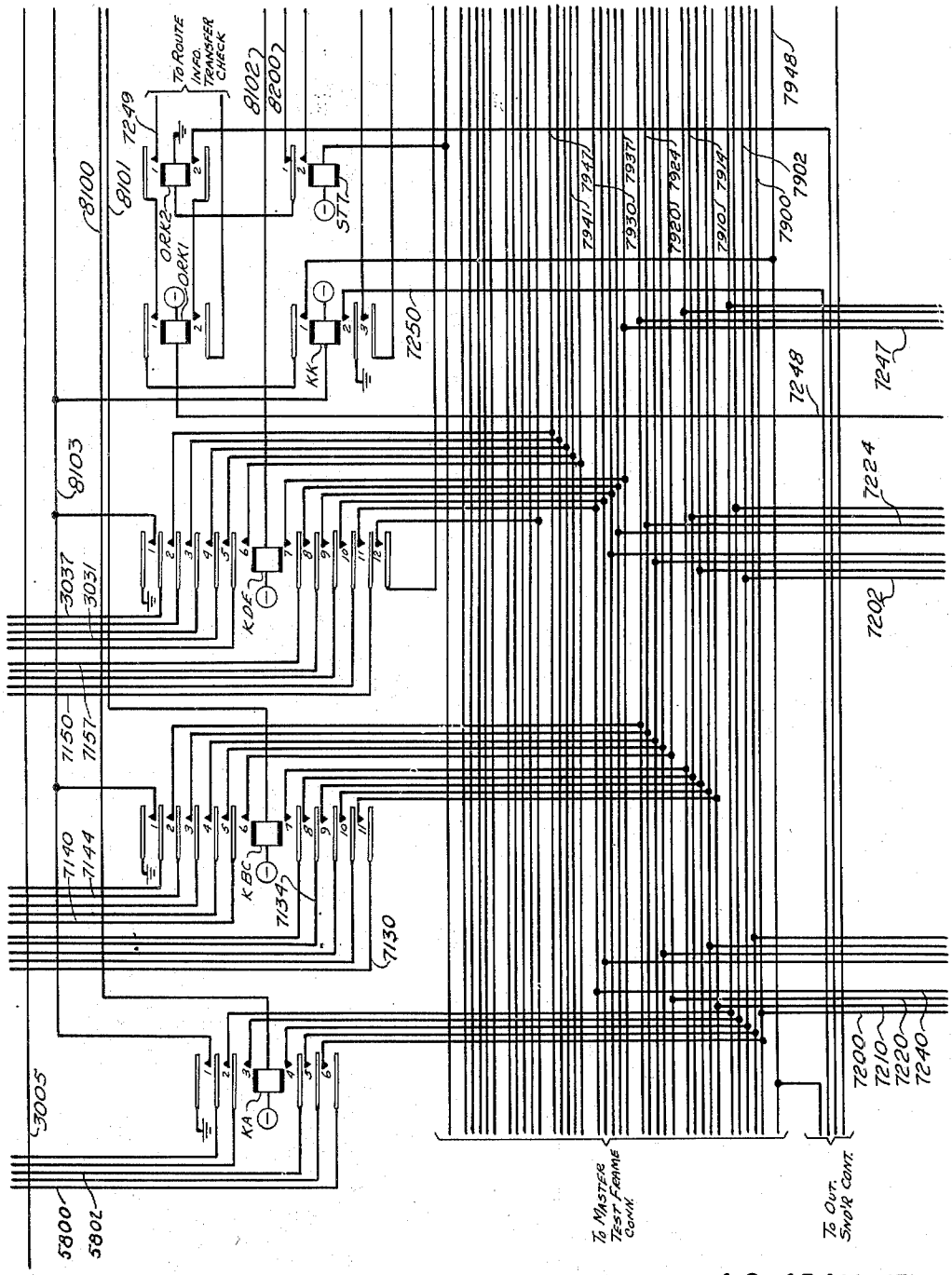

FIG. 72

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

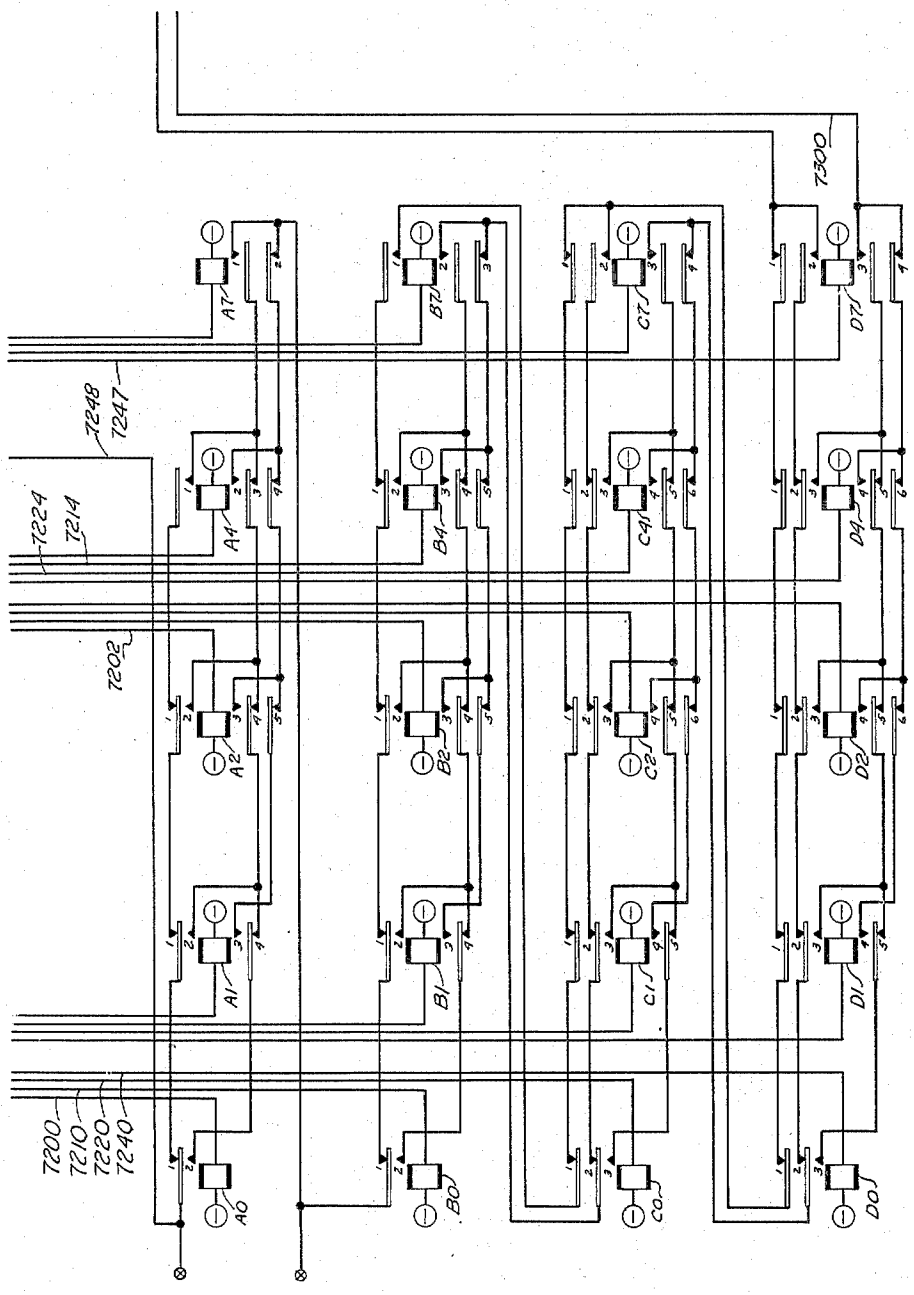

FIG. 73

INVENTORS A.O. ADAM, JR.
R.C. AVERY
BY R. C. Smith
ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 75

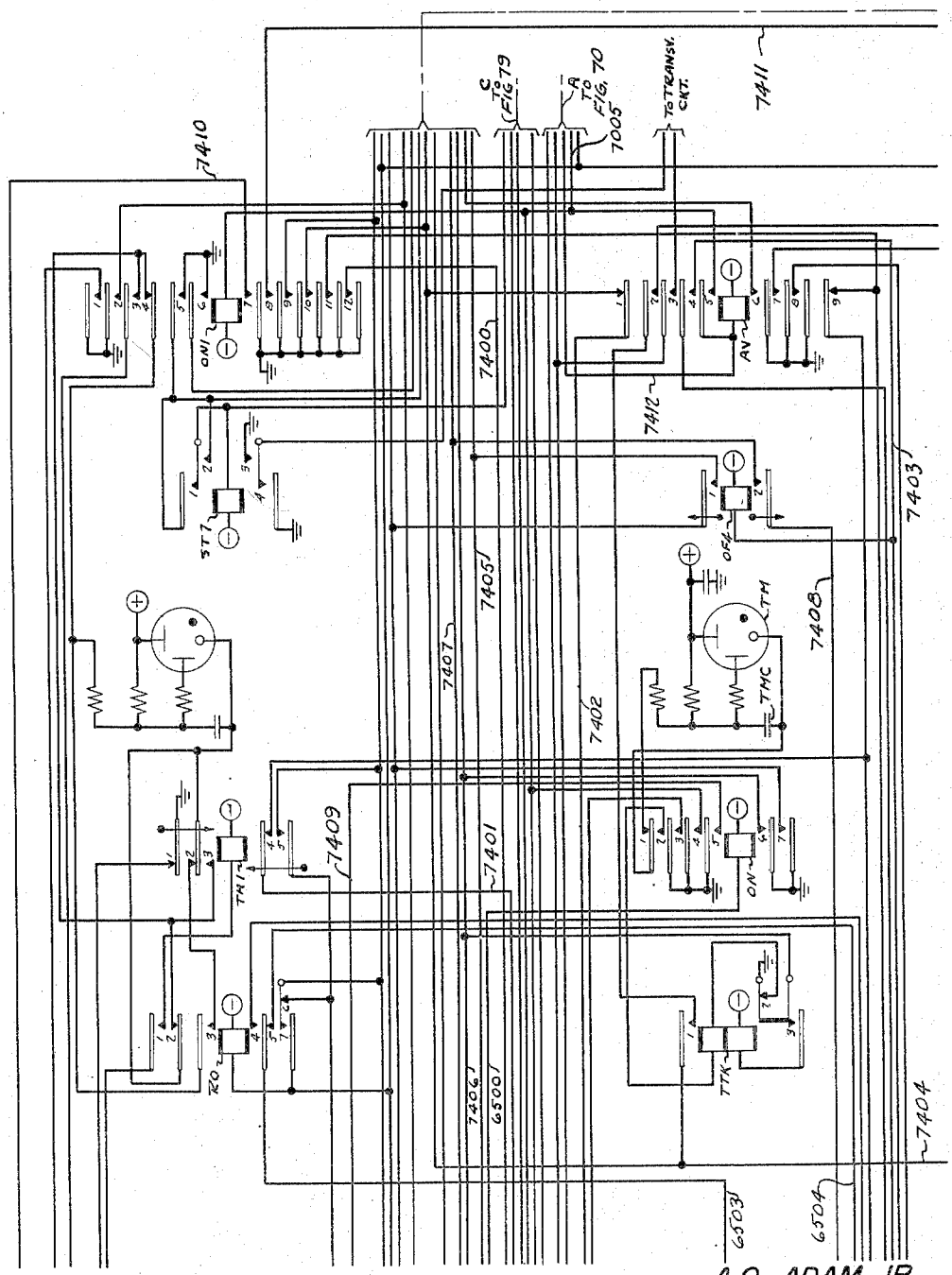

FIG. 74

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 76

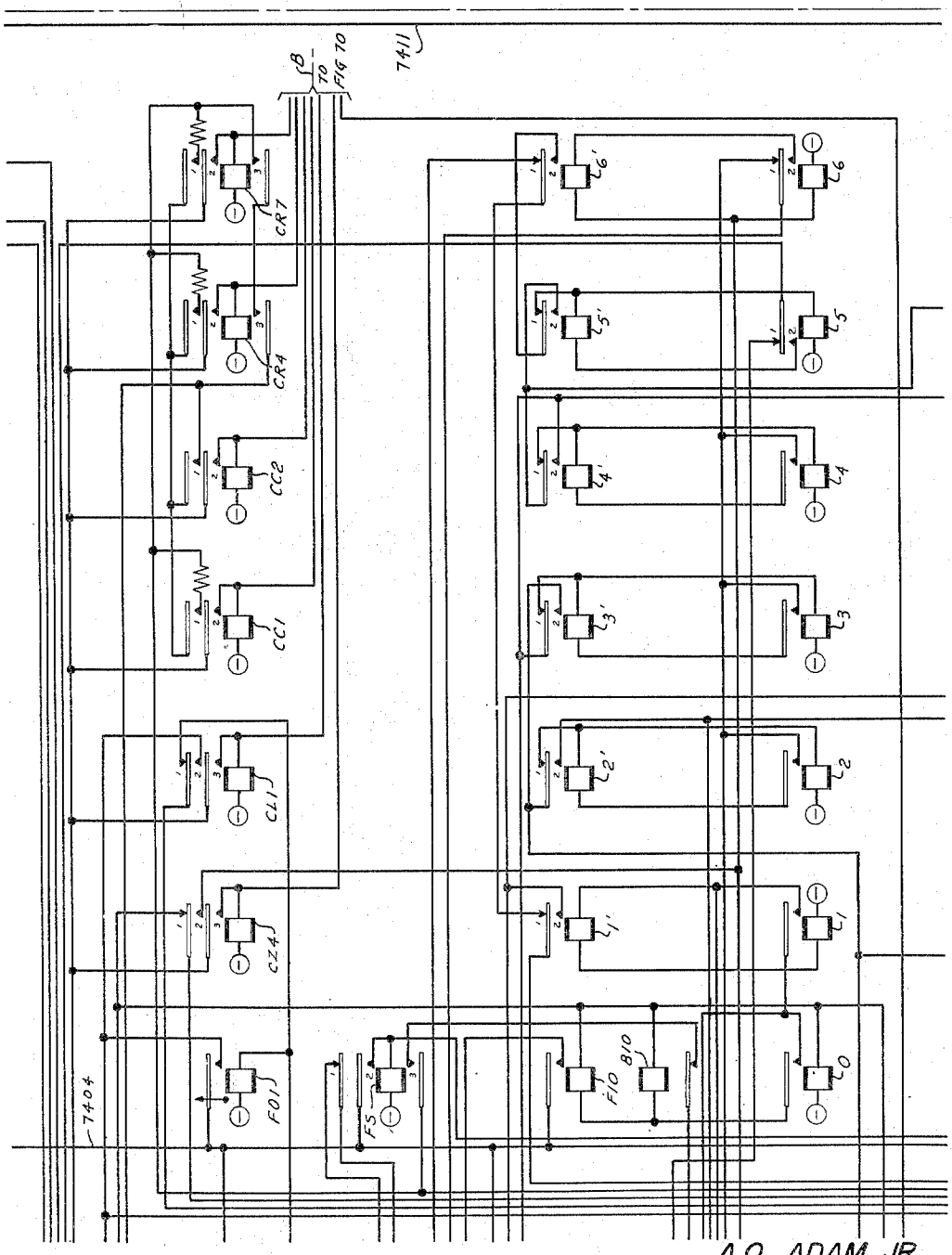

FIG. 75

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY G. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 77

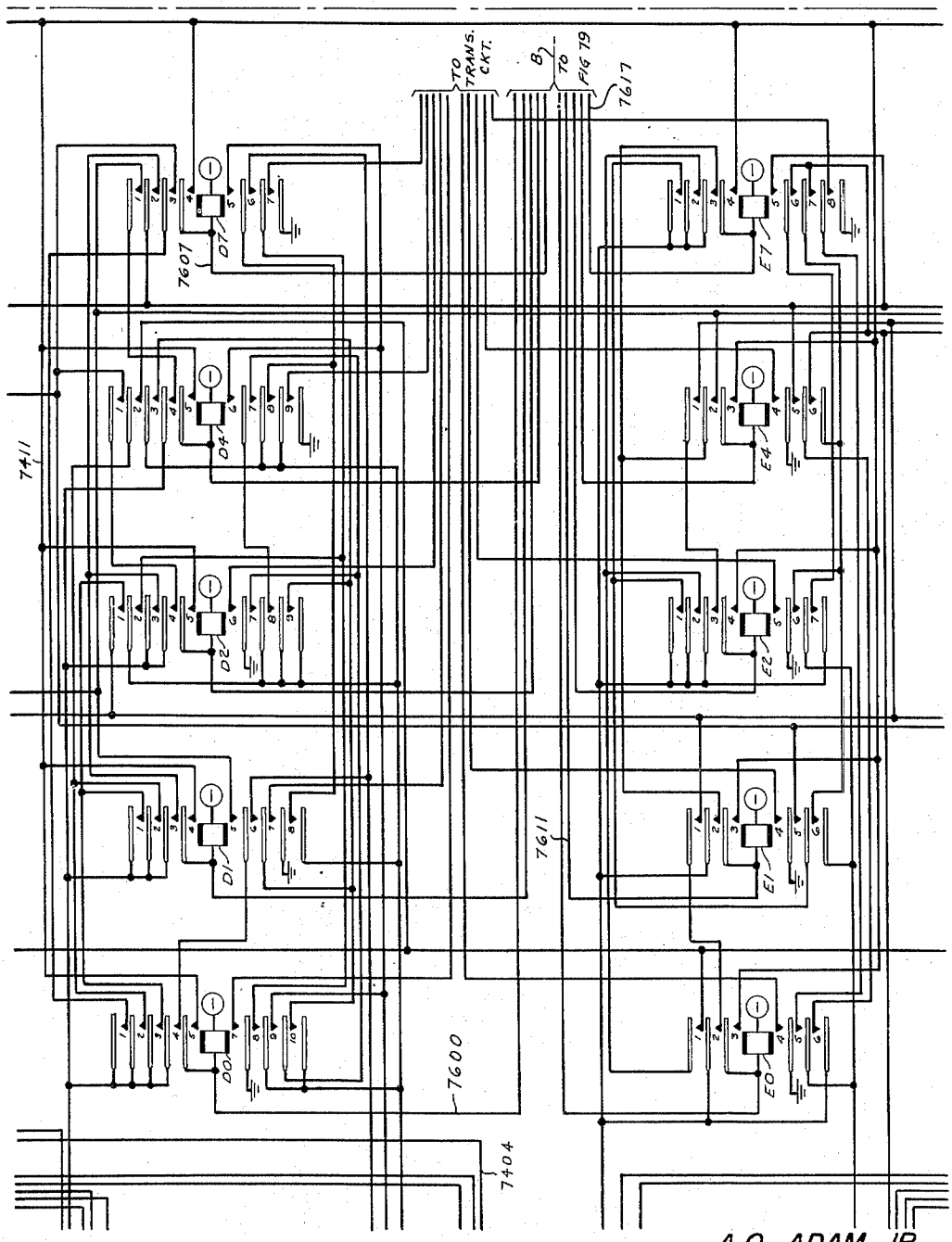

FIG. 76

INVENTORS A.O. ADAM, JR.
R.C. AVERY

BY P. C. Smith

ATTORNEY

Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 78

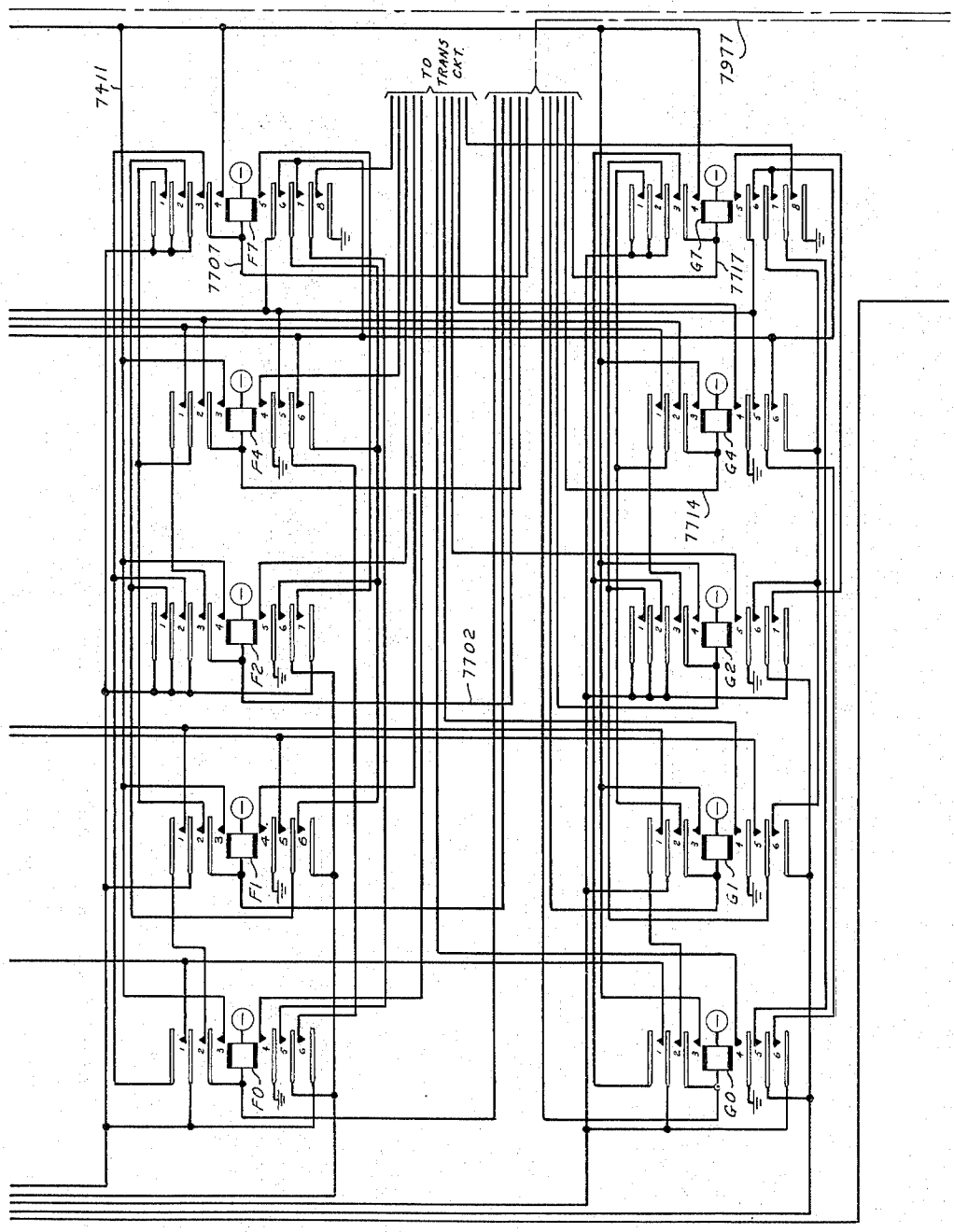

FIG. 77

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BY P. C. Smith

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Dec. 26, 1950 A. O. ADAM, JR., ET AL 2,535,661

CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 79

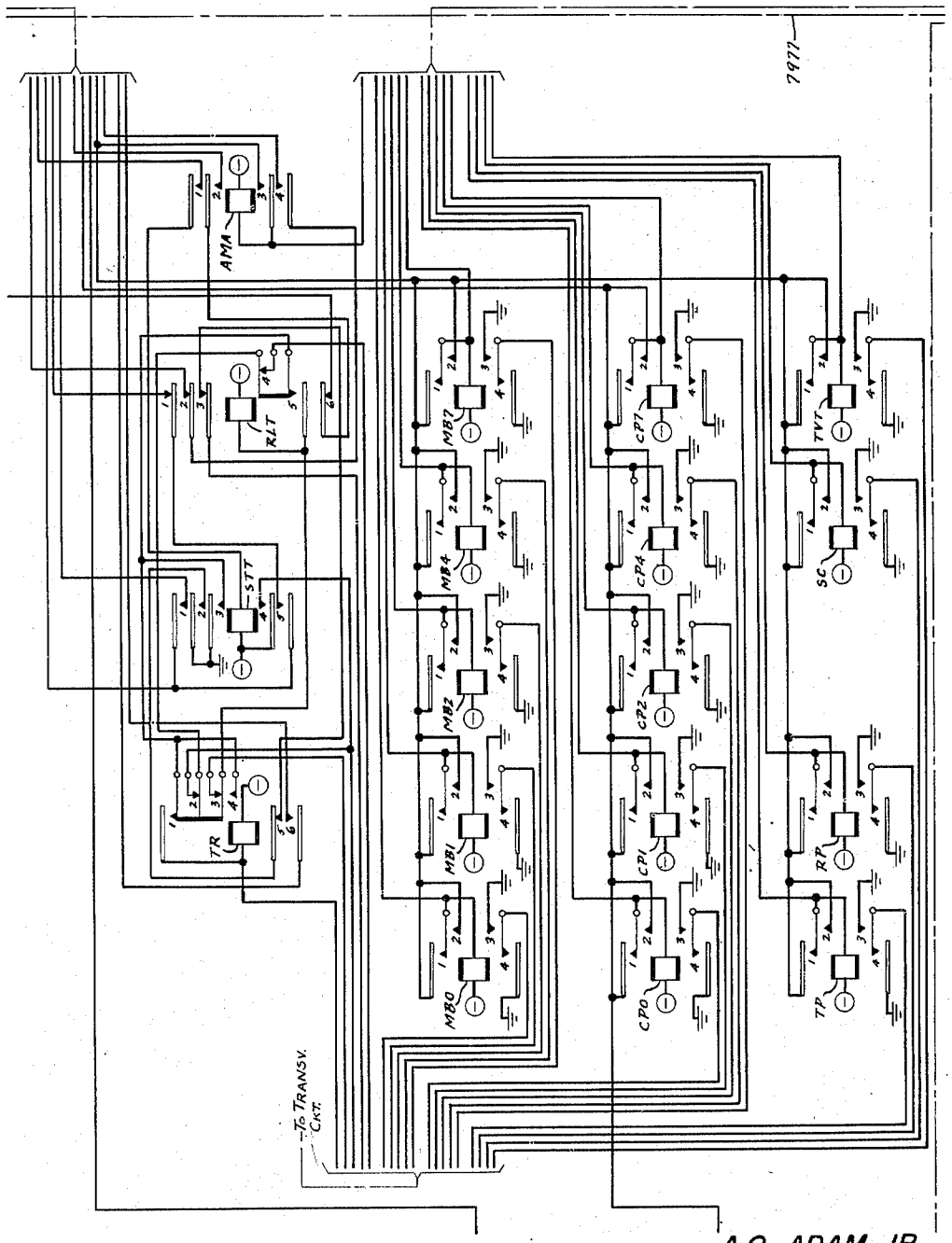

FIG. 78

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CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 80

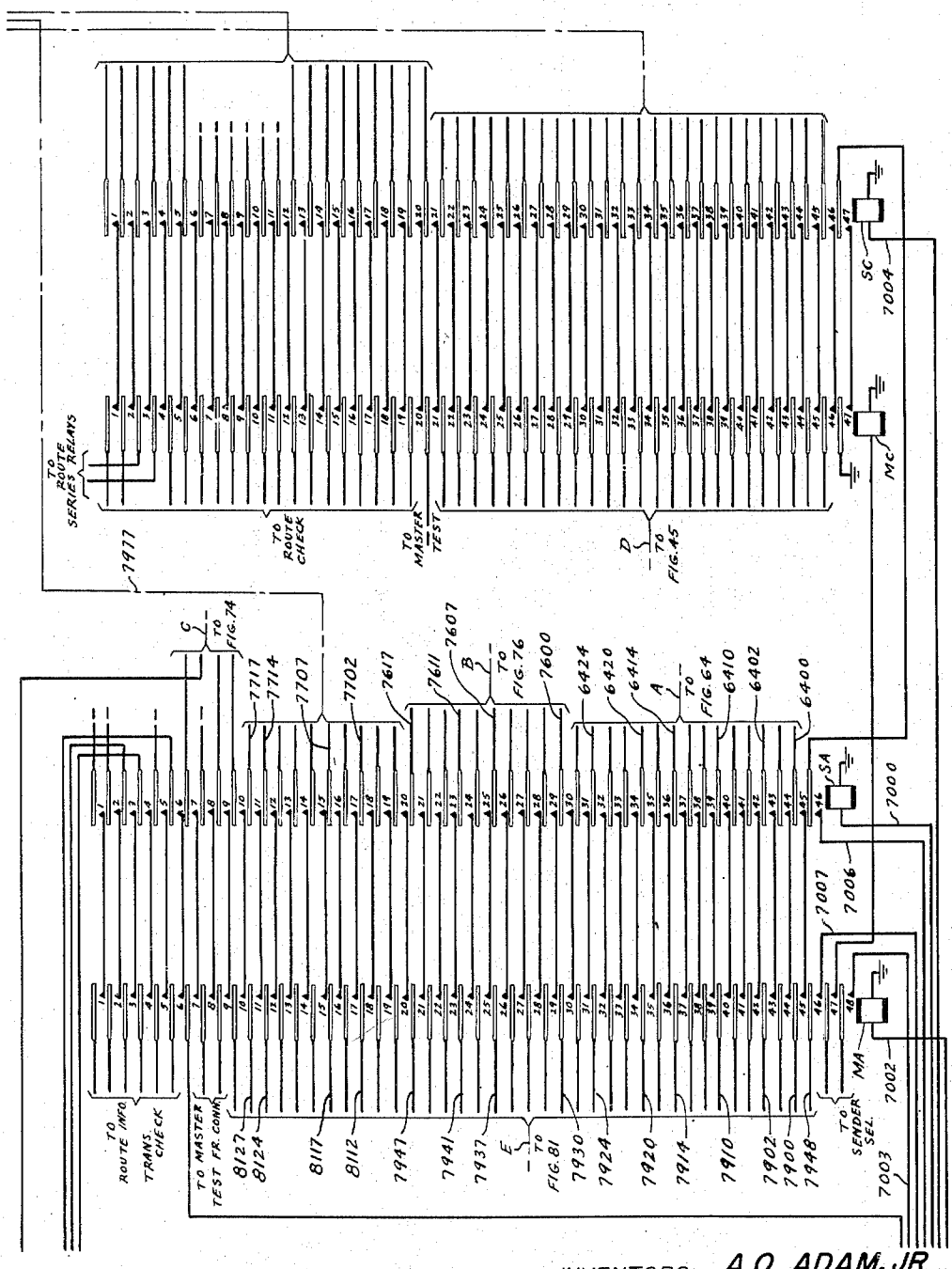

FIG. 79

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CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 81

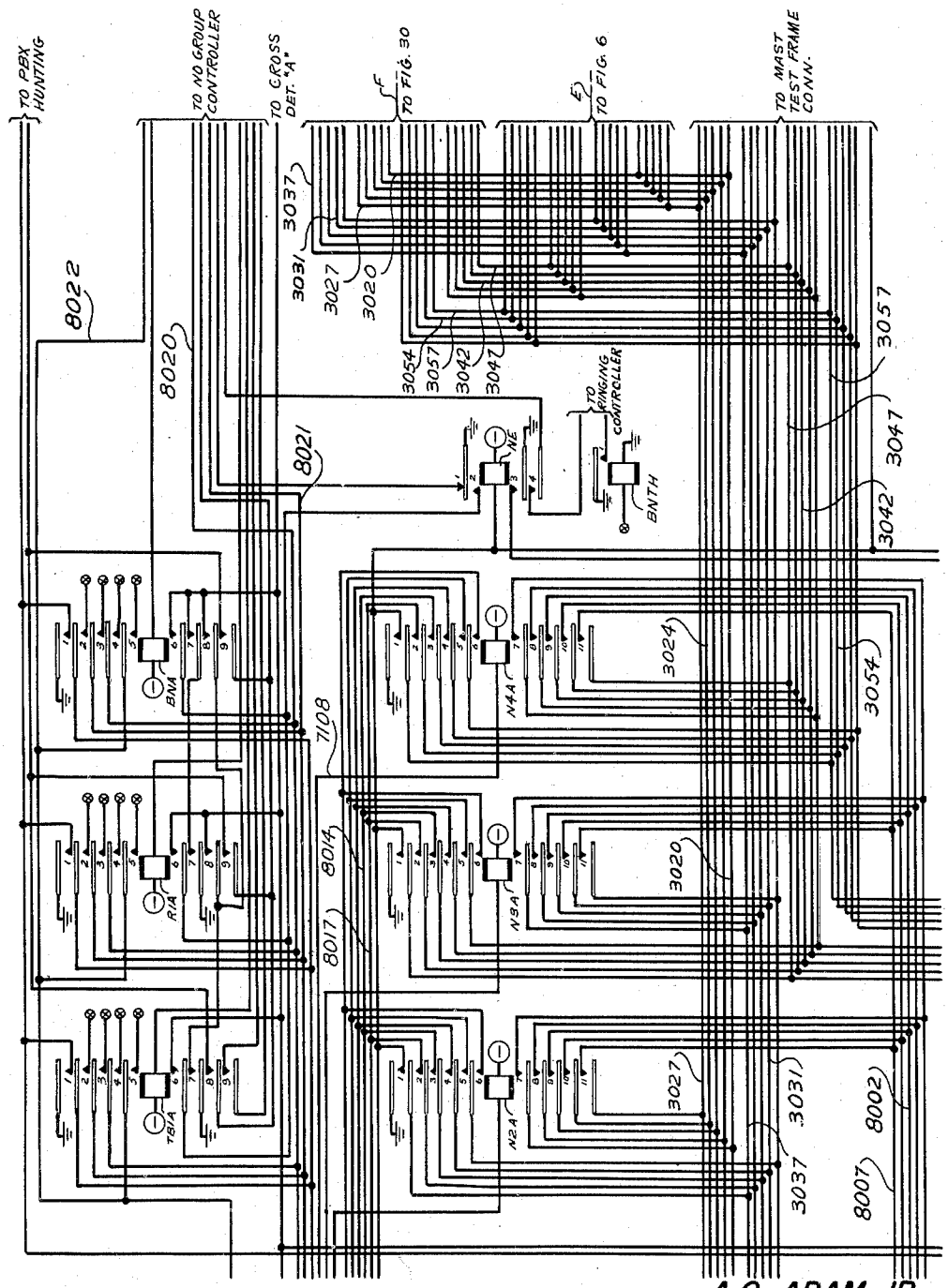

FIG. 80

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CONTROL CIRCUITS

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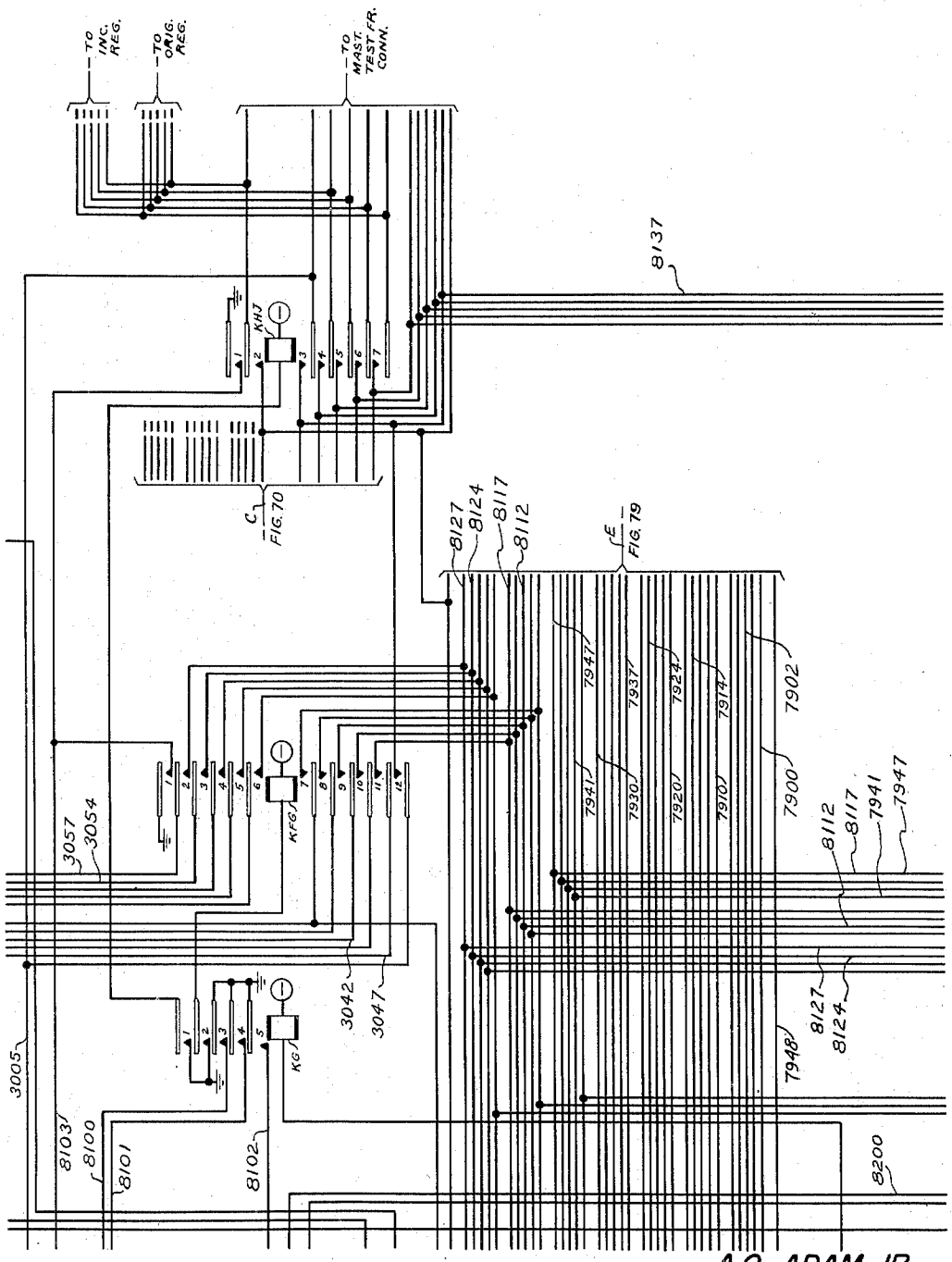

FIG. 81

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CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 83

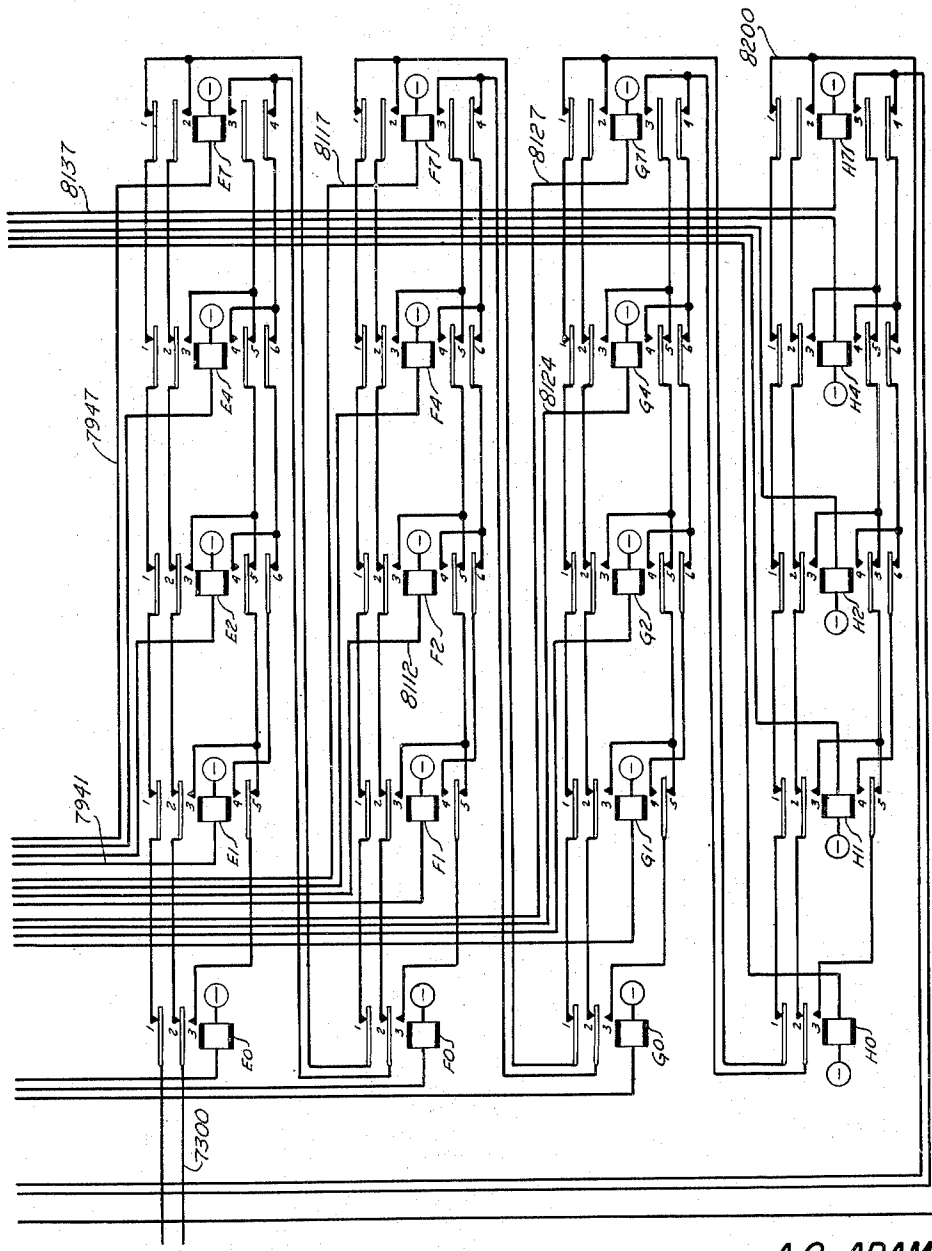

FIG. 82

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CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 84

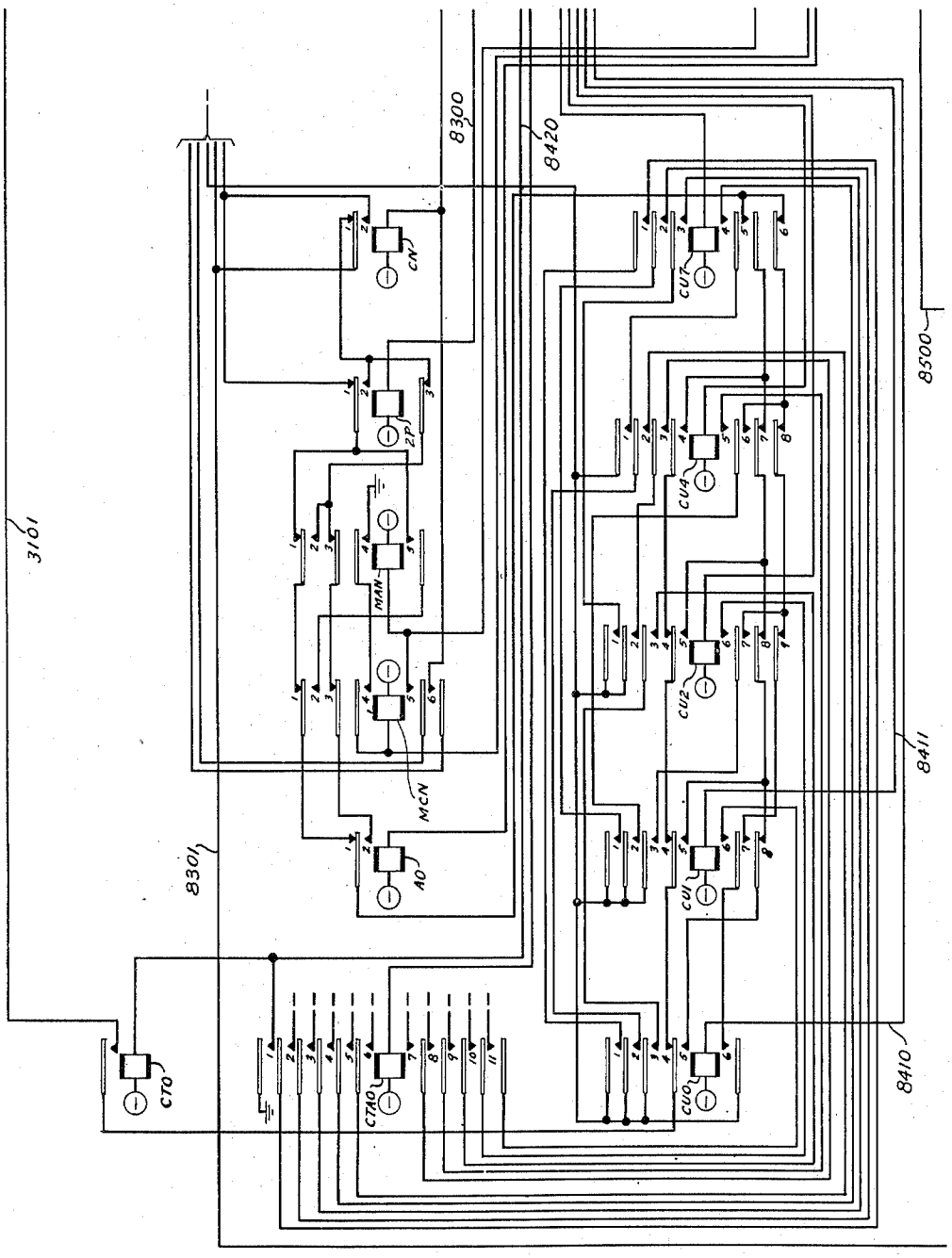

FIG. 83

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CONTROL CIRCUITS

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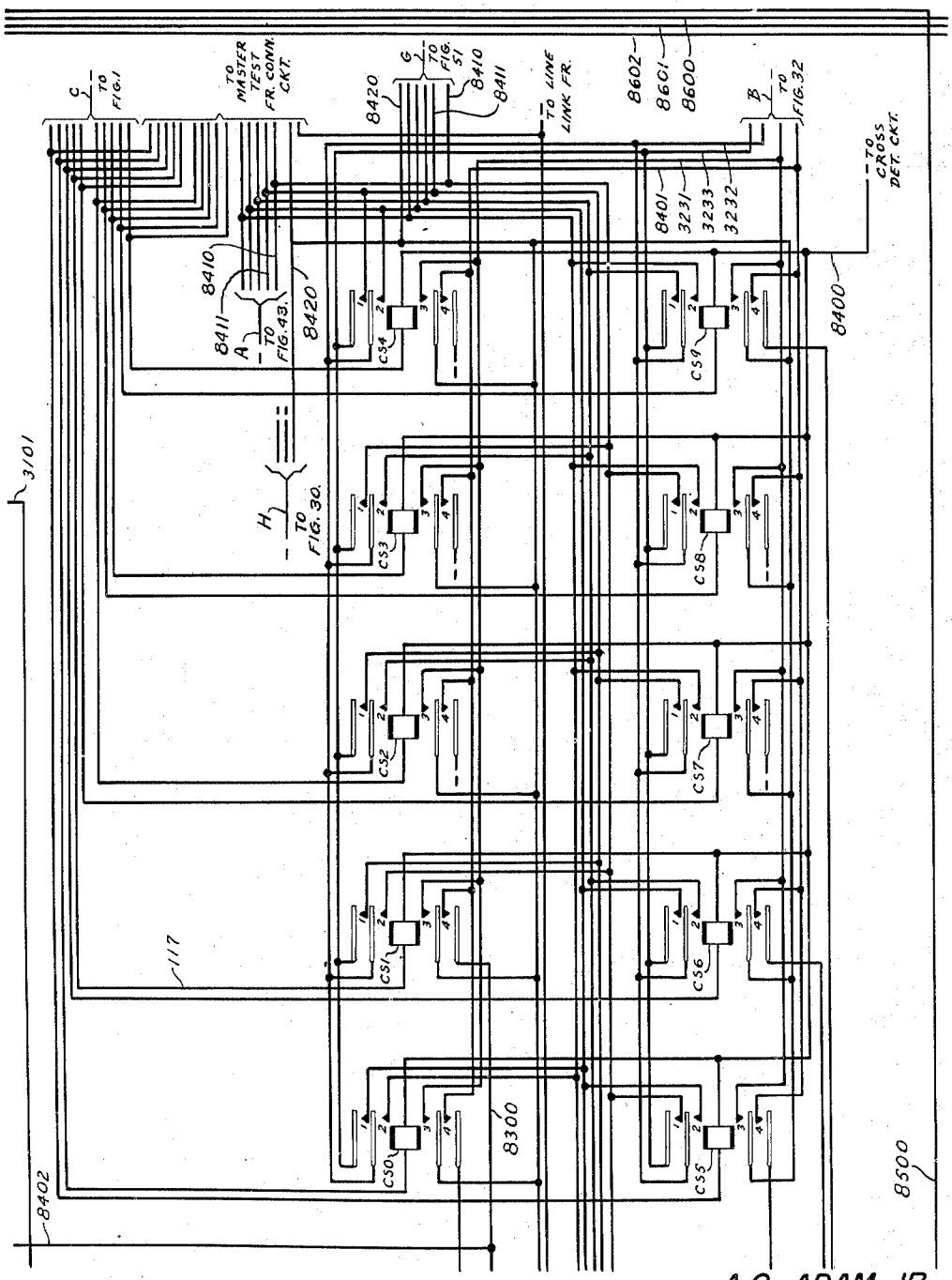

FIG. 84

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CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 86

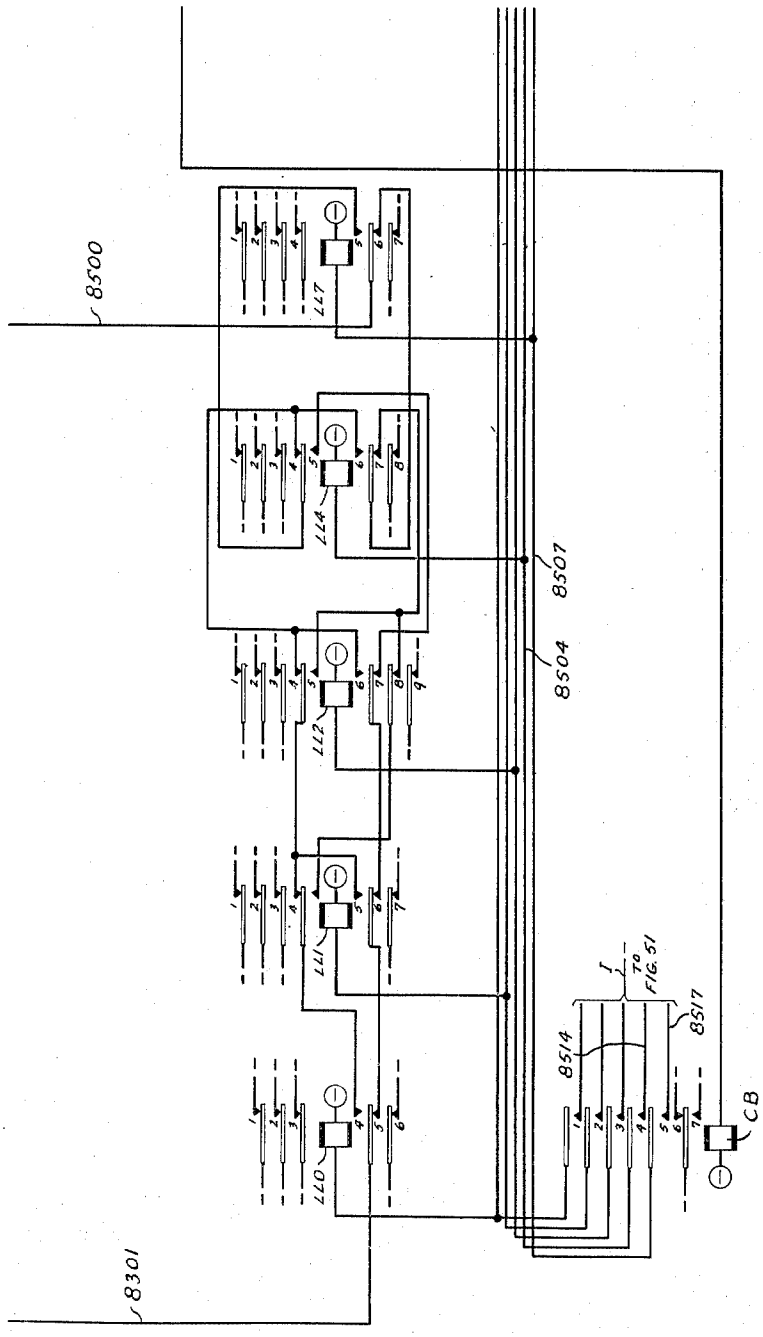

FIG. 85

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CONTROL CIRCUITS

Filed Oct. 29, 1948 88 Sheets-Sheet 87

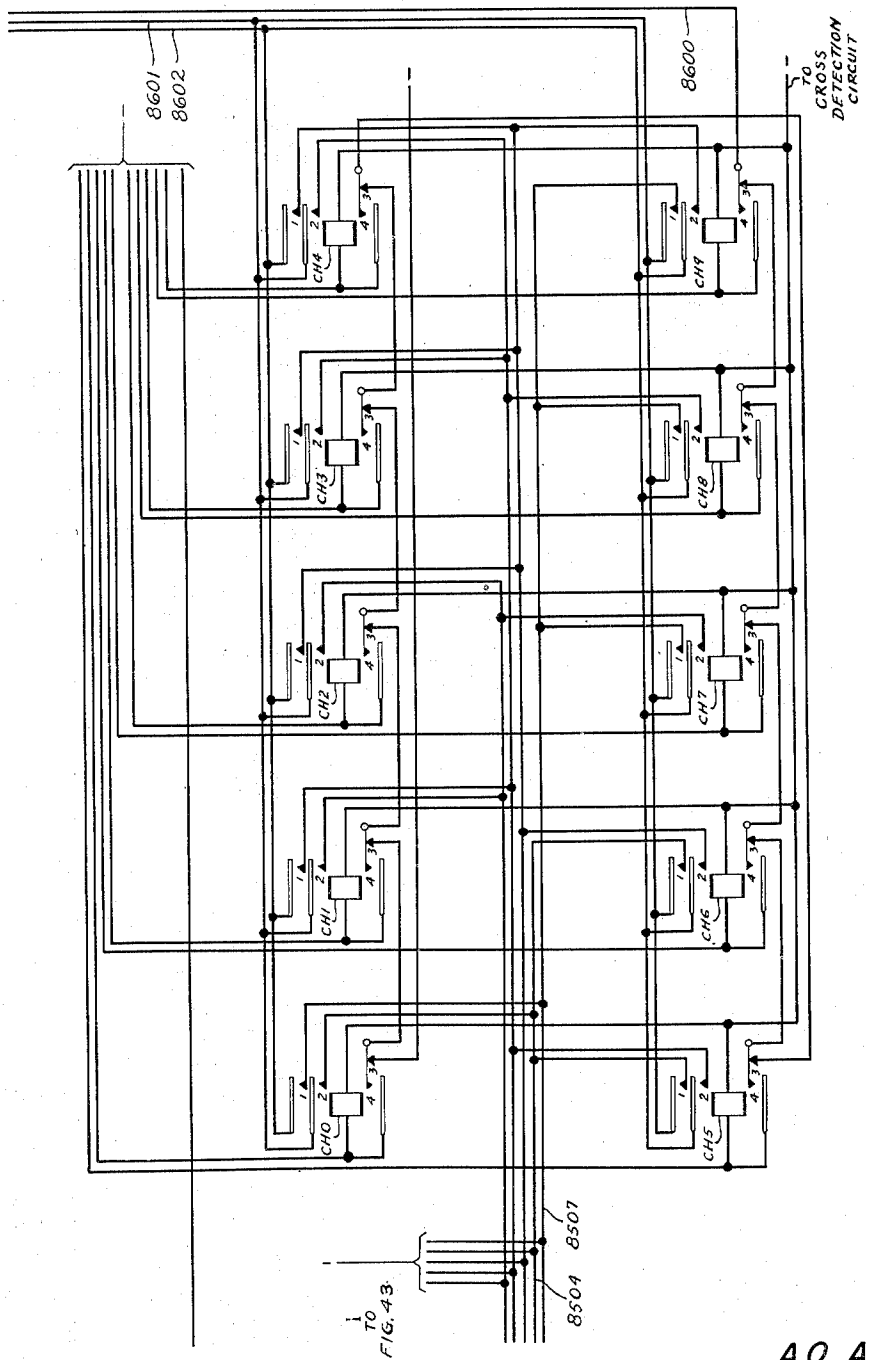

FIG. 86

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CONTROL CIRCUITS

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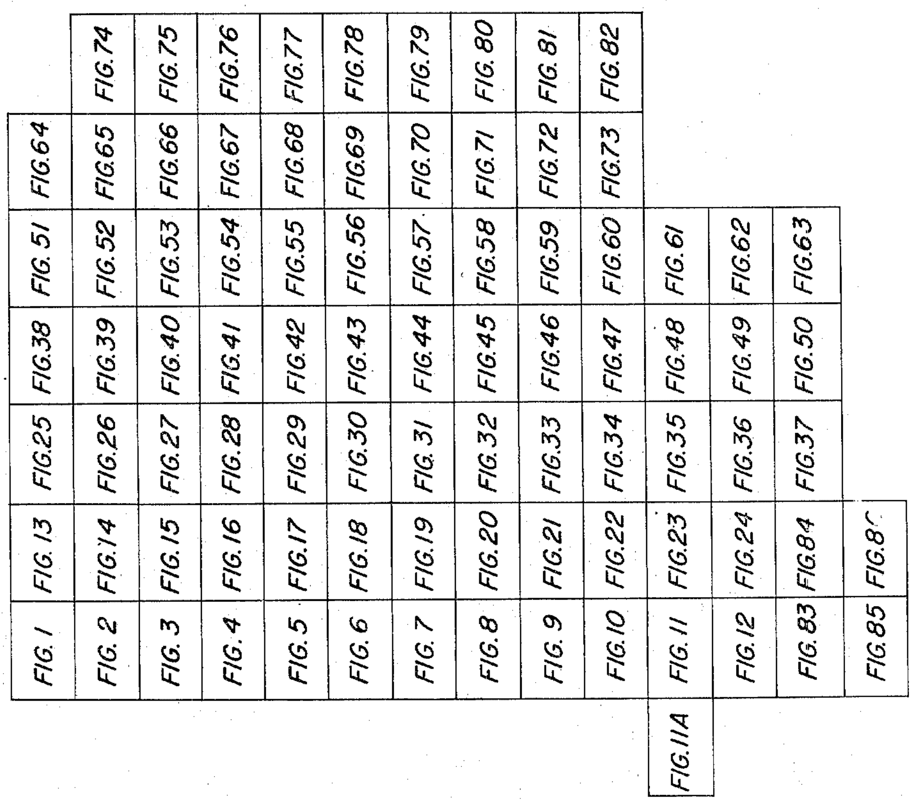
FIG. 87



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Patented Dec. 26, 1950 2,535,661

UNITED STATES PATENT OFFICE

2,535,661

CONTROL CIRCUITS

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Application October 29, 1948, Serial No. 57,383

19 Claims. (Cl. 179—18)

1

This invention relates to dial switching telephone systems and more particularly to circuits and apparatus for transferring information for assisting in the establishment of connections between parts of the system.

The invention is particularly adapted for use in a cross bar system of the type disclosed in the application of A. J. Busch, Serial No. 57,394 filed October 29, 1948. In a system of this type, subscriber lines terminate at the cross-points of cross bar switches on line-link frames and trunks for interconnecting subscriber lines, for extending incoming connections to such lines or for extending outgoing connectios from such lines terminate at the cross-points of cross bar switches on trunk-link frames. Also, originating registers for securing information from calling lines to be used in establishing connections terminate at cross-points of cross bar switches on trunk-link frames.

A subscriber may originate a call by removing the receiver from the switchhook thereby operating an associated line relay on the line-link frame. The operation of the line relay causes the line-link frame to engage a marker or common control circuit through a line-link marker connector which connects only such leads as are used for a dial tone connection to an originating register. The line-link frame identifies itself through the line-link marker connector to the marker by the frame number and the line-link marker connector informs the marker that a dialing connection is to be established. The line-link marker connector also tells the marker whether the call is on a line-link frame equipped with all dial, or all multifrequency or mixed types of lines so that the marker may seize an originating register of the proper type. The marker then proceeds to select an originating register to receive dial pulses and to receive the location of the position of the calling line on the line-link frame. Originating registers are distributed over the trunk-link frames and are connected to the calling line by the marker.

The location of the calling line is begun as soon as the marker is seized and continues while the marker is selecting an originating register. Line location is made in terms of the line-link frame, vertical group, horizontal group and vertical file. A line-link vertical group of subscriber lines is five verticals wide and ten switches high and the largest line-link frame contains fourteen vertical groups. Following the marker seizure the marker determines which vertical group contains the line awaiting service and since each vertical group

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contains a maximum of fifty lines the location of the calling line is established within fifty lines.

A line-link horizontal group of subscriber lines is one switch high and the width of the supplied line of switches and the marker determines in which of the horizontal groups the subscriber line is located. The line to be served is thus located within five lines as determined by the vertical and horizontal groups.

The line location does not proceed past the horizontal group selection until the marker has seized the trunk-link frame and, before the line location can be fully completed, the marker must also seize the line-link frame through the line-link connector. Following trunk-link frame seizure the marker seizes the line-link frame which has identified itself through the marker connector. The marker upon seizing the line-link frame receives information concerning the vertical file in which the calling line is located. A line-link vertical file of subscriber lines is one vertical wide and ten switches high. One vertical group contains five vertical files. The marker tests the five lines found in the vertical and horizontal groups selected and records the file in which the calling line is found.

If there is more than one call awaiting service the marker decides on a preference basis which one it shall serve.

The class of service of the calling line is identified by the marker after the calling line has been located. Each vertical file is assigned a class of service. Therefore, the marker can determine the class of service after the vertical file is located. The marker next transmits the line frame number, the selected line location and the class of service to the selected originating register and at the same time registers this information in the marker as a check that it has properly transmitted the information.

After the horizontal group has been determined and the originating register has been seized, the marker selects one of ten channels which may be used to connect the calling line to the originating register, registers the number of the line link used, transmits the number of the line link to the originating register and checks to determine that the register has properly recorded the line-link information. Each channel comprises a junctor, a line link and a trunk link. After the channel has been established and checked the marker releases leaving in the originating register the line-link frame number, calling line location and class of service, and the line-link number which is the same as the num-

ber of the channel selected to establish the connection.

After connection of the originating register to the calling line the subscriber receives a dial tone from such register and he then proceeds to dial the digits of the wanted line number which are registered in the originating register. After the entire number has been dialed and registered the originating register engages a marker and transfers to the marker all of the information concerning the location and class of the calling line and number of the called line, and other information which the marker may need in establishing a connection to the wanted line. The marker then proceeds to establish a new connection from the calling line to the wanted line in accordance with the information which it has received whereupon the marker is released.

If the connection is to be terminated in the same office as the calling line, the marker seizes an intraoffice trunk, both ends of which terminate on the trunk-link frame, or if the connection is to be terminated in another office the marker selects an idle trunk terminating on the trunk-link frame and extending to the office in which the desired line terminates, selects an idle outgoing sender of the proper type and connects it to the marker over an outgoing sender connector and causes the connection of the selected outgoing sender to the selected outgoing trunk through an outgoing sender link. The marker then transmits to that sender such information concerning the called line as has been registered in the originating register and marker to enable the sender to control the establishment of the desired connection. The sender also registers the calling line identification for automatic accounting purposes. As soon as the trunk-link frame on which the outgoing trunk terminates has been seized, the marker, from the information concerning the location of the calling line which has been registered therein, seizes the line-link frame on which the calling line is located and proceeds to select and establish an idle channel to interconnect the calling line and the outgoing trunk. The originating register releases when the distant office connection has been established and the marker releases when the calling line is connected to the trunk.

A call incoming from another office enters the cross bar office on an incoming trunk terminating on a trunk-link frame. On such an incoming call the incoming trunk becomes connected over an incoming register link with an idle incoming register of the type adapted to receive information from the particular calling distant office. The selected register upon its seizure records the number of the trunk-link frame on which the incoming trunk terminates so that the marker can later select the incoming trunk, registers the called numerical digits of the wanted line secured from the distant office and then connects itself through an incoming register marker connector with a marker. The marker then receives the numerical digits and the trunk-link frame number from the register and seizes the trunk-link frame to gain access to the incoming trunk.

As the marker seizes the trunk-link frame it also seizes the proper number group circuit and connects to it through the number group connector and transfers to the number group circuit the number of the desired line. Thereupon the number group circuit translates the numerical digits into the location of the called line and causes such line location to be registered in the marker. After the called line location has been obtained from the number group circuit and the trunk-line frame has been seized, the marker seizes the line-link frame on which the desired line terminates in accordance with the line location information secured from the number group circuit and proceeds to select and establish a channel from the incoming trunk to the desired line. When the channel is established and tested and the line found to be idle, the marker, incoming register and register link release.

From the foregoing brief description of the manner in which connections are established, it will be noted that it is necessary to transfer information from one portion of the system to another as, for example, from the line-link frame to the marker and then to an originating register; from the originating register to the marker; from an incoming register to a marker and thence to a number group circuit; from a number group circuit to a marker after the number group has translated the digital information into the location of the wanted line and from an originating register and a marker to an outgoing sender.

It is therefore the object of the present invention to provide facilities for enabling the transfer or information concerning the establishment of telephone connections between different portions of the system in an accurate, reliable and simple manner.

It is believed that the invention will be best understood by reference to the following detailed description when read in connection with the accompanying drawings in which:

Fig. 1 shows schematically a calling line, a line-link frame on which such line terminates, a portion of the line-link frame connector, control circuits appertaining to such frame, and a portion of a line-link frame marker connector;

Figs. 2 to 5, inclusive, show schematically one of a group of ten number group circuits appertaining to the marker disclosed herein;

Fig. 6 shows schematically a portion of an incoming register marker connector;

Figs. 7 to 11, 11A, 12, 19 to 24, 31 to 37, 44 to 50, 57 to 63, 71 to 73 and 80 to 86 disclose such portions of a marker as are deemed necessary to an understanding of the invention, Figs. 7 to 11, 11A, 12, 19 to 24, 31, 44, 57, 58, 71 and 83 to 86 disclosing circuits more particularly concerned with the present invention for registering information received from other equipment assemblies of the disclosure;

Fig. 13 shows schematically additional control relays of the line-link frame and connector shown in Fig. 1 and additional connector relays;

Figs. 14 to 18, 26 to 29, 39 to 42 and 52 to 56 show an originating register;

Fig. 25 shows portions of a line-link marker connector;

Figs. 30 and 43 show multicontact relays of an originating register marker connector;

Fig. 38 shows portions of a trunk-link frame and connector;

Fig. 51 shows portions of a trunk-link connector for connecting a marker with a trunk-link frame and the schematic representation of an out trunk, out trunk sender link, incoming trunk and incoming trunk link;

Figs. 64 to 69 and 74 to 78 show portions of an outgoing sender;

Figs. 70 and 79 show an outgoing sender con-

nector for connecting the outgoing sender with the marker disclosed; and

Fig. 87 is a diagram showing how the remaining figures of the drawings should be arranged to disclose the invention.

Only such portions of the circuits of the cross bar office have been disclosed herein as are deemed essential to a clear understanding of the invention. For a complete disclosure of all of the circuits, reference may be had to the application of A. J. Busch hereinbefore referred to, it being understood that the disclosure of that application is incorporated herein by reference and is to be considered as a part of the present disclosure.

Throughout the specification each apparatus element will be referred to by letters representing its functional designation followed by a numeral enclosed in parentheses indicative of the figure of the drawing on which the element is to be found. For example, the horizontal group relay for the horizontal group 0 shown in Fig. 1 will be referred to as relay HG0(1). Where cables of conductors are extended from one figure or sheet of drawings to another, such cables will be referred to by numbers indicative of the two figures between which such cables extend. For example, the cable connecting Fig. 38 with Fig. 26 will be indicated as cable 3826 and the cables extending between Figs. 26 and 28 as cables 2628 and 2826. In most instances, however, in order to reduce the number of sheets of drawing, the cables interconnecting figures have not been shown in full, but each such cable has been shown only where it leaves a group of bracketed conductors on one figure and enters a group of bracketed conductors on another figure. For example, cable A leaving Fig. 1 is indicated as extending to Fig. 48 and the same cable is indicated on Fig. 48 as cable A extending to Fig. 1. In this case, if a connection were being traced from Fig. 1 toward Fig. 48, the cable would be referred to as cable A(1) extending to Fig. 48, or if a connection were being traced from Fig. 48 towards Fig. 1, the cable would be referred to as cable A(48) extending to Fig. 1.

To illustrate the manner in which registrations are transferred from one apparatus assembly of the cross bar office to another, the establishment of an intraoffice call, an outgoing call and an incoming call will be described in as much detail as is deemed essential to an understanding of the invention. It will be first assumed that the subscriber at substation 100 removes the receiver from the switchhook to initiate an intraoffice call.

DETAILED DESCRIPTION

Dial tone connection originating call

When the subscriber at tip substation 100 initiates a call the removal of the receiver at the substation completes a circuit from battery through the winding of line relay L00(1), inner back contact of hold magnet L(1), over the switchhook contacts of the line at substation 100, and over the outer back contact of hold magnet L(1) to ground. Line relay L00(1) operates in this circuit and connects ground to conductors 101 and 102. The connection of ground to conductor 101 is ineffective at this time.

The connection of ground to conductor 102 completes a circuit through resistance 0(1) and the winding of vertical group relay VGS0(1) to battery. Relay VGS0(1) is individual to the zero vertical group of fifty lines on frame zero on which the calling line is assumed to terminate and is operated in response to the initiation of a call by any one of the fifty lines. Each vertical group includes ten horizontal subgroups of five lines and each horizontal subgroup has an individual conductor such as conductor 102 and an individual resistance such as 0 through which any one of the five lines in that horizontal subgroup may operate the corresponding group relay. These subgroup conductors are used subsequently to identify the horizontal group to the marker. Relay VGS0(1) at its No. 3 contacts establishes an obvious circuit for relay DT(1) which operates for a purpose to be later described.

At its No. 4 contacts relay VGS0(1) connects ground to conductor 103 and at its Nos. 1 and 2 contacts connects battery through resistance ST, over contacts 2 and 3 of relay L0(1), contacts 1 and 2 of relay VGS0(1), to start conductors 104 and 105 of the line-link marker connector individual to line-link frame 0.

Each line-link frame has a line-link marker connector individual thereto comprising a control circuit and a plurality of multicontact relays. The control circuit for the line-link frame 0 is shown in Fig. 13 and the multicontact relays for that connector are shown in Fig. 25. There is a set of multicontact relays for each marker to which the line-link frame may be connected. The multicontact relays MA1(25) and MB1(25) are individual to the first marker shown in some detail in Figs. 7 to 12, 9 to 24, 31 to 37, 44 to 50, 57 to 63, 71, 72, 73, 80, 81 and 82.

Multicontact relays MA2(25) and MB2(25) are individual to an intermediate marker, called marker 2, and indicated by the first box in the upper left corner of Fig. 13, while multicontact relays MA3(25) and MB3(25) are individual to a last marker, called marker 3, and indicated by a second box in the upper left corner of Fig. 13.

The start circuits for the line-link frame connector of frame No. 0 closed by the connection of battery to conductors 104 and 105, as above described, may be further traced to contacts 1 and 3 of relay Z(13). At the same time, the operation of relay VGS0(1) closes a circuit from ground over its contact 3, contact 1 of relay L0(1), conductor 106, contact 2 of relay MK(13), contact 7 of relay TRS(13) to the winding of relay TM(13) and battery. Relay TM(13) operates to initiate the operation of a timing device for timing the interval during which a marker should be connected with the line-link frame. This timing device has not been disclosed herein.

In order to distribute the use of the markers by any one line-link frame, relays W(13) and Z(13) are provided which operate on alternate calls and are released on alternate calls so that a different marker preference relay is used on successive calls. Assuming that relay Z(13) is unoperated at the present time, conductor 105 will be extended over contact 1 of relay Z(13), contact 1 of relay TRS(13), contact 1 of relay TC(13) to conductor 1300 which is shown cross-connected to conductor 1301 extending to the upper armature of relay CB11(25). When relay Z(13) is operated, conductor 104 is extended over contact 4 of relay Z(13), contact 3 of relay TRS(13), contact 1 of relay TC1(13), to conductor 1302 which is cross-connected to conductor 1303 extending to the upper armature of relay CB13(25). Each connector has a chain-busy relay CB and a marker start relay MS for each marker. While three markers have been indicated in the drawing and several more markers may be used in an actual installation, only three

chain-busy relays have been shown for the line-link marker connector of frame 0 with their associated marker start relays. Each connector control circuit has its two start leads cross-connected to the armatures of two CB relays, preferably at separated points in the CB chain of relays.

Assuming that relay CB11(25) is not operated, the start circuit previously traced to conductor 1301 extends over contact 1 of relay CB11(25), winding of relay MS11(25), contact 5 of relay MS11(25), contact 5 of relay MS12(25), conductor 2500 and to ground at the marker connector preference circuit. Relay MS11(25) operates and locks over its contact 6 to ground.

Since the marker must also be associated with originating registers and incoming registers a connector is provided for associating the marker with the originating registers, known as the originating register marker connector, the multicontact relays of which are shown in Figs. 30 and 43, and a connector is provided for associating the marker with the incoming registers, known as the incoming register marker connector, the multicontact relays of which are shown in Fig. 6. Each of the control circuits for these connectors is provided with a chain of CB relays similar to the CB relays shown in Fig. 25 and with a chain of MS relays such as the MS relays shown in Fig. 25. The CB relays of the three connector control circuits are connected into a single chain and also the MS relays are connected into a single chain. The CB and MS relays of the originating and incoming register connectors have not been disclosed herein in order to simplify the disclosure. The CB relays for each connector are arranged in a continuous chain so that irrespective of the CB relay to which the start circuit of a particular connector is connected, all of the markers will be available. For example, with conductor 1301 connected to the armature of relay CB11(25), if the first marker is busy resulting in the operation of relay CB11(25) as described hereinafter, the circuit will be extended over contact 2 of relay CB11(25) to the armature of the next CB relay of the chain, over the back contact of that relay if the corresponding marker is idle and to the winding of the MS relay of such idle marker. If, for example, the start circuit is extended to the armature of the relay CB12(25), assumed to be idle, then it is further extended over the back contact of such armature and through the winding of relay MS12(25) to battery. On the other hand, if the second start circuit is closed which extends as traced over conductor 1303 to the armature of relay CB13(25) and the associated marker is busy so that relay CB13 is operated, the start circuit extends over contact 1 of relay CB13 to the armature of relay CB11(25) and thence over the back contact of such relay to the winding of relay MS11(25). It will be understood, of course, that there will be a plurality of CB relays, one for each marker with contact 2 of each relay connected to the armature of the subsequent relay in the chain.

Similarly, the marker start relays MS are arranged in a chain individual to each marker and are so arranged that the line-link marker connectors have preference over the originating marker connectors and the originating marker connectors have preference over the incoming register marker connectors. The cross-connections 2501 at the marker may be used to rearrange the order of preference for any individual marker.

With relay MS11(25) operated, a circuit is closed from ground cross-connected to terminal 2502, over contacts 3 of relays of the chain of MS relays, such as MS13 and MS12, contact 4 of relay MS11(25) and through the winding of marker connector relay MA1(25) to battery. In addition, relay MS11(25) closes a circuit to tell the marker that it is to serve a dial tone connection, which circuit may be traced from ground at the cross-connection terminal 2503, over contacts 1 of relays of the chain of MS relays, such as MS13 and MS12, contact 2 of relay MS11(25), conductor 2504 of cable B(25) extending to Fig. 36 to a cross-connection terminal such as 3603 for each line-link frame and thence cross-connected to one of the terminals 3600, 3601 or 3602 in accordance with the type of line connected to that frame. If all of the lines on the frame use dials, terminal 3603 will be connected to terminal 3601, thence over conductor 3606 and through the winding of relay D(35) to battery. If, on the other hand, all of the subscribers whose lines appear on a particular line-link frame have multi-frequency dialing arrangements, the terminal corresponding to terminal 3603 will be connected to terminal 3602, thence over conductor 3604 and through the winding of relay MF(35) to battery. If both types of lines appear on a frame, the terminal corresponding to terminal 3603 will be cross-connected to terminal 3600, thence over conductor 3605 and through the winding of relay MLF(35) to battery. In the case of line-link frames which serve both dial and multifrequency line, the determination of the type of line is made by means of cross-connections on the vertical group relays of Figs. 7 and 19, that is, with the line-link frame relay MLF(35) operated circuits are prepared over contacts 1 and 5 of relay MLF(35) by which relay MF(35) and relay D(35) may be operated as will be described hereinafter. In general, relays D and MF perform similar functions but operate different route relays which serve to distinguish the type and location of the originating register to be selected in accordance with the type of pulses which they are designed to receive.

Relay MA1(25) when operated as above described, closes a plurality of contacts for associating the marker 1 with the line-link frame 0. In addition, relay MA1(25) closes a circuit from ground over its contact 1 to the winding of relay MB1(25) and battery to cause the operation of relay MB1(25) to further connect the marker 1 with the line-link frame 0.

Relay MA1(25) closes a circuit from ground at contact 5, over conductor 2505 to the winding of relay MK(13) and battery. Relay MK(13) operates as an indication that the marker has been connected to the line-link frame and at its contact 2 opens the circuit of relay TM(13) which releases. During the time that relay TM(13) has been operated, a timing circuit (not shown) has been in operation to measure a marker selection timing period. At its contact 8, relay MA1(25) closes a circuit extending over conductor 2506, contact 1 of relay W(13), winding of relay W(13) and through resistance G1 to battery. Relay W(13) operates in this circuit and locks over its contact 2 to ground. It also closes a circuit from battery through resistance G2, winding of relay Z(13), contact 2 of relay W(13) to ground. However, relay Z(13) cannot operate in this circuit since it is shunted by ground over its contact 5 from conductor 2506 over which relay W(13) was operated. In addi-

tion, relay MA1(25) closes a circuit (not shown) for a relay in the marker which establishes an operating circuit for the CB relays such as CB11(25) allocated to the No. 1 marker assumed to be taken for use, in the line-link originating register and in the incoming register connector circuits to cause such CB relays to operate to mark such marker as busy and to extend the start circuits incoming to such connector circuits to the MS relays corresponding to the next available marker. However, in the connector associated with line-link frame 0, the operation of relay MA1(25) has already closed a circuit from ground in the marker, over contact 2 of relay MA1(25), to a point between resistance B11 and the upper winding of relay CB11(25) thereby shunting the winding of relay CB11(25) to prevent its operation and the opening of the circuit of relay MS11(25).

In addition, relay MA1(25) when operated as previously described, closes a circuit from battery through the winding of relay CKG3(37), conductor 3700, the winding of relay CKG2(50), contact 3 of relay DIS1(50), conductor 3701, contact 3 of relay TRLA(37), conductor 3702, conductor 3607 of cable C(37) extending to Fig. 25 and to ground over contact 12 of relay MA1(25). Relays CKG3(37) and CKG2(50) establish a number of circuits for supplying operating and locking grounds to the circuits in the marker, one of which circuits may be traced from ground over contact 7 of relay CKG3(37), contact 9 of relay DIS2(37) and through the winding of relay CKG6(37) to battery. Relay CKG3(37) upon operating causes the operation of relay CKG4(46) which in turn closes a circuit which may be traced in part from ground applied over its contact 2, contact 5 of relay LK1(46), and thence through the windings of relays LLC1(48) and LLC2(48), conductor 4806 and through the winding of relay ONW(35) to battery. These relays now operate.

Response to dial tone connection indication

Relay D upon operating at contacts 1, 3, 4, 5, 6, 8, 9, 10, 11 and 12, connects ground to conductors 3504, 3506, 3507, 3508, 3509, 3513, 3511, 3512, 3514 and 3515 respectively. Conductors 3508 and 3509 extend to the trunk-link selection circuits of the marker and connection of ground thereto by relay D(35) causes the operation of relays to prepare for the connection of a trunk-link frame as described in the application of R. E. Hersey Serial No. 57,396 filed concurrently herewith. Ground on conductor 3506 completes a circuit through cable A(35) extending to Fig. 20, over contact 4 of relay VGK(20), conductor 2000 and in parallel through the windings of relays VGG1(19) and VGG2(19) to battery. Relays VGG1(19) and VGG2(19) prepare the marker for receiving the vertical group identification of the calling line. Ground on conductor 3511 completes a circuit through cable B(48) extending to Fig. 21, contact 2 of relay HTK(21), conductor 2101 of cable C(21) extending to Fig. 61, contact 2 of relay DTK(61), conductor 2100 of cable C extending to Fig. 21 and through the winding of relay HGG(20) to battery. Relay HGG(20) upon operating, prepares the marker to receive the horizontal group of the calling line identification. Ground on conductor 3514 completes a circuit through the winding of relay DT1(49), conductor 4900, winding of relay DT2(47) and winding of relay DT3(47) to battery. Ground on the remaining conductors of relay D(35) serve circuits which will be traced hereinafter.

In addition, relay D(35) completes a circuit from ground over contact 1 of relay RCY1(50), conductor 5000, contact 2 of relay D(35), conductor 3516 extending through cable C(43) extending to Fig. 22, contact 2 of relay FTK(10), conductor 1008 and through the winding of relay VFG(22) to battery. Relay VFG(22) prepares the marker to identify the vertical file in which the calling line is located. At contact 7, relay D(35) completes a circuit from ground over contact 9 of relay DIS1(50), conductor 5001, contact 7 of relay D(35), conductor 3517 to operate a route relay (not shown) to inform the marker that it should establish a route to an idle originating register. The functioning of the marker to select an idle originating register is described in full in the application of A. J. Busch Serial No. 57,394 previously referred to and in the application of R. E. Hersey Serial No. 57,396 also hereinbefore referred to.

It may be noted that relays D(35) and MF(35) at contacts 1 to 6 and 8 to 12 close identical circuits, while relay D(35) at contact 7 operates a route relay over conductor 3517 and relay MF(35) at contact 7 closes a similar circuit over conductor 3518 for a similar route relay. The route relay operated by relay MF(35) would cause the selection of an originating register which would receive multifrequency impulses.

When relay DT1(49) was operated as previously described, it closed a circuit from ground over its contact 2 to conductor 4901 which extends in parallel branches through the winding of relay CBD(23), through the winding of relay CBD1(24) and through the winding of relay LOT(61) to battery. Relay DT1(49) also closes a circuit from ground over contact 10 of relay CKG2(50), conductor 5002, contact 4 of relay RK3(49), contact 12 of relay DT1(49), conductor 4902, contact 1 of relay CKG6(37), conductor 3703 and through the winding of relay GTL(36) to battery. Relay GTL(36) operates in this circuit and closes a circuit from ground over contact 2 of relay DIS2(37), conductor 3704, contact 5 of relay GTL(36), conductor 3608 of cable E(36) extending to Fig. 45 and thence in parallel through the windings of relays GTL2(45), GTL3(32) and GTL4(32) to battery. The functions of these relays will appear hereinafter.

When relay CKG3(37) operated as previously described, it establishes a circuit which may be traced in part from battery in series through the windings of relays TLC2(48) and TLC1(48), conductor 4800 extending to the controller and busy circuit (not shown), thence returning over conductor 5007, contact 8 of relay DIS1(50), conductor 5008, contact 2 of relay TRLA(37), contact 12 of relay CKG3(37) to ground on conductor 3708 at the recycle controller (not shown). These relays supply battery and ground for the trunk-link control.

The foregoing operations, which are performed as the result of the operation of the marker start relay MS11(25) in the line-link marker connector, serve to place the marker in condition to handle a dial tone connection. While these operations have been in progress the marker has also been receiving an indication of the location of the calling line so that it may seize the proper line-link frame when it is ready to connect the line with a selected idle originating register.

To completely identify the calling line, infor-

mation is required which will identify the line-link frame on which the calling line terminates and the location of the calling line termination on the line-link frame.

Each subscriber line terminates on one cross bar switch vertical of a line-link frame line switch. Therefore, each vertical unit of this line cross bar switch may be associated with a particular subscriber line and the identification of the calling line cross bar switch vertical unit will identify the calling line on that line-link frame. For the purpose of line identification, the line cross bar switch vertical units are grouped as follows:

A. Vertical groups

The line-link frame has cross bar switches mounted on ten horizontal switch levels on the line-link frame. Each switch is divided into subscriber line groups of five adjacent vertical units. The ten subscriber line groups located in the same position on each of the ten horizontal levels are designated the vertical groups. One vertical group will contain a total of fifty vertical units and fifty subscriber line terminations. The maximum number of vertical groups on any one line-link frame will be fourteen.

B. Horizontal group

The vertical units within the same horizontal switch level are designated a horizontal group. One horizontal group will consist of a minimum of thirty vertical units to a maximum of seventy vertical units. On any line-link frame there will be ten horizontal groups—see vertical files. The ten vertical units located in the same position on each of the ten horizontal switch levels are designated a vertical file. One vertical file will consist of one cross bar switch vertical unit in each of the ten horizontal switch levels. There will be five vertical files within one vertical line group.

Line-link frame identification

When the line-link marker connector which is individual to the line-link frame operates, it identifies that frame to the marker. Since the marker is arranged to serve a maximum of forty line-link frames, the frame number may conveniently be indicated by separately indicating the frame tens digit and the frame units digit. The frame tens digit is indicated by grounding one of four frame tens conductors and the units digit is identified by grounding in code two of five frame units conductors. Specifically, the conductors which may be grounded by the line-link frame connector to indicate the frame tens digit may be identified as conductors 4520, 4521, 4522 and 4523 while the units conductors which may be grounded by the line-link marker connector may be identified as conductors 4510, 4511, 4512, 4514 and 4517. The code according to which the units conductors are grounded is such that for a digit one to nine the sum of the units digits of the conductor numbers is equal to the units digit of the frame number. For example, to indicate frame units digit five, conductors 4511 and 4514 would be grounded. For units digit zero, conductors 4514 and 4517 would be grounded.

Since it has been assumed that the marker is connected to line-link frame zero, the operation of relay MB1(25) grounds units conductors 4514 and 4517 and tens conductor 4520. These conductors extend through cable B(25) extending to Fig. 36 to the contacts of relay GTL2(45). When relay GTL2(45) operated as previously described, conductors 4510 to 4517 and 4520 to 4523 were connected over conductors 4410 to 4417 and 4420 to 4423 through the windings of relays FU0(44) to FU7(44) and FT0(44) to FT3(44) respectively. Since conductors 4514, 4517 and 4520 are grounded, relays FT0(44), FU4(44) and FU7(44) operate.

Vertical group identification

When the vertical group relay VGS0(1) on the line-link frame operated as the result of the operation of the line relay L00(1), it grounded conductor 103 which extends to contact 10 of relay MA1(25). Since the marker is equipped to serve frames having a maximum of fourteen vertical groups, relay MA1(25) in operating extends fourteen vertical group identifying conductors, such as conductor 103, to the marker whence they are connected to contacts of relays VGG1(19) and VGG2(19). The operation of these relays as above described, further extends these vertical group identifying conductors to windings of the vertical group test relays VGT0(7) to VGT6(7) and VGT7(19) to VGT13(19). Conductor 103 is extended over contact 10 of relay MA1(25), conductor 2507 extending through cable C(25) to Fig. 36 thence through cable A(35) to Fig. 20, contact 8 of relay VGG1(19), conductor 1900 and through the winding of relay VGT0(7) to battery. Relay VGT0(7) operates in this circuit to identify the calling line as located in the zero vertical group. If at the same time some other line on line-trunk frame zero is also calling the corresponding vertical group test relay would also be operated.

When the marker is ready to receive the line identification, that is with the vertical group gating relays VGG1(19) and VGG2(19), horizontal group gating relay HGG(20) and vertical file gating relay VFG(22) operated, a circuit for checking their proper operation is closed which may be traced from ground at contact 1 of relay TR1(13), conductor 1304, contact 6 of relay MA1(25), conductor 2508 extending over cable C(25) to Fig. 36, contact 3 of relay TR2E(50), conductor 5003 extending through cable A(50) to Fig. 20, through the cable A extending to Fig. 47, contact 11 of relay HMS1(47), conductor 4709 of the cable extending to Fig. 8, contact 1 of relay VFG(22), conductor 2209, contact 12 of relay HGG(20), conductor 2001, contact 1 of relay VGG2(19), contact 1 of relay VGG1(19), conductor 1901 and through the winding of relay GK(20) to battery. Relay GK operates in this circuit if the gating relays are operated and locks over its contact 3 and conductor 4709 to its operating ground independent of the gating relays.

With relay GK(20) operated, the operation of relay VGT0(7) closes a circuit from battery through the winding of relay VGR(20), contact 4 of relay GK(20), conductor 2002, contact 3 of relay VGT0(7), conductor 2507 and to ground over the previously traced operating circuit for relay VGT0(7). A parallel circuit for relay VGR(20) extends over the contacts of any other vertical group test relay which may be operated. Since the circuit of relay VGR(20) is under the control of the line relay L00(1), this relay serves to monitor for disconnection by the subscriber.

Relay VGR(20) closes a circuit for locking the operated vertical group test relay or the preferred relay if more than one such relay is operated. On

the line-link frame all lines requiring special attention are included in vertical group 2 and that group is given preference over all other groups. The preference among the other groups is controlled by the sequence relays of the sequence controller (not shown) where it may be assumed that relay SQ8 has been operated. It will be also assumed that no other vertical group test relay has been operated. Therefore the locking circuit of relay VGT0(7) may be traced from ground at contact 4 of relay D(35), over conductor 3507 extending through cable A(35) to Fig. 20, contact 1 of relay VGR(20), conductor 2003, contacts 1 and 7 of relay TR2D(8), conductor 800, normally closed contact 7 of relay VGT2(7), conductor 700, contact 3 of relay TR2D(8), conductor 801 extending to the sequence controller and returning over conductor 802 through contact 7 and the winding of relay VGT0(7) to battery. If some other VGT relay had been operated, a locking circuit for that relay would have extended over the normally closed contact 6 of relay VGT0(7). Therefore with VGT0(7) operated no other VGT relay can be locked.

With relay VGR(20) operated, a circuit is closed from battery through the winding of the vertical group test check relay VTK(20), contact 3 of relay VGK(20), conductor 3506 extending through cable A(20) to Fig. 35 to ground over contact 3 of relay D(35). Relay VTK(20) operates in this circuit locking over its contact 5 to grounded conductor 3506. At contact 1, relay VTK(20) closes a supplementary locking circuit for relay VGT0(7) in parallel with contact 1 of relay VGR(20) and at contact 4 opens the operating circuit for relays VGG1(19) and VGG2(19). Relays VGG1(19) and VGG2(19) release opening the vertical group test circuits and releasing any non-locked VGT-relays and preventing the subsequent operation of any other vertical group test relays.

A check is now made that one and only one VGT relay is operated and that relays VGG1(19) and VGG2(19) have released. For this purpose a circuit is closed from battery through the winding of relay VTK1(20), conductor 2004, contact 5 of relays VGG1(19) and VGG2(19), contact 5 of relay VGT13(19), contacts 6 of relays VGT12(19) . . . VGT1(7), contact 5 of relay VGT0(7) and to ground.

When relay VTK1(20) operates, it closes the locking circuit for relay MS11(25) which may be traced from ground over contact 6 and through the winding of that relay, contact 1 of relay CB11(25), contact 13 of relay MA1(25), conductor 2509, through cable C(25) to Fig. 36, back contact of relay MRL1(36), conductor 3609 through cable A(35) to Fig. 20, contact 2 of relay VTK(20), conductor 2005 of cable A(20) to Fig. 35, contact 6 of relay DIS1(50), conductor 5004 and through the winding of relay OC1(37) to battery. Relay OC1(37) operates in this circuit in series with relay MS11(25) and establishes a circuit from battery through the winding of relay OC(37), contact 1 of relay OC1(37), conductor 3705 to ground at the marker make-busy circuit (not shown). Relay OC(37) operates, locks over its contact 4 to ground on conductor 3705 and at its contacts 2 and 5 applies ground to conductors 3706 and 3707 which extend through cable B(37) to Fig. 25 over contacts 2 and 3 of relay MB1(25), conductors 2510 and 2511 and through the windings of relays TC(13) and TC1(13) to battery. Relays TC(13) and TC1(13) operate in these circuits, relay TC(13) locking over its contact 2, contact 3 of relay W(13), which was operated as previously described, to ground at contact 7 of relay Z(13). Relay TC(13) opens the operating circuit for the marker start relay MS11(25) but that relay is held operated in the circuit above traced through the winding of relay OC1(37). Relay TC1(13) opens the alternate marker start circuit.

With relay VTK1(20) operated, a circuit is closed from battery through a relay in the cross-detection circuit (not shown), conductor 5005, contact 10 of relay DIS1(50), conductor 5006, extending through cable A(35) to Fig. 20, contact 5 of relay VTK1(20), conductor 2006, contact 2 of relay VGT0(7), conductor 701 extending through cable A(20) to Fig. 35 through cable C(36) extending to Fig. 25, contact 11 of relay MA1(25), conductor 2512 and through the winding of relay VGA0(1) to ground. Relay VGA0(1) prepares the circuits for identifying the horizontal group in which the calling line is located. The circuit closed by relay VTK1(20) extends in multiple to contact 2 of each of the vertical group test relays so that the vertical group auxiliary relays on the line-link frame corresponding to the operated vertical group test relays in the marker will be operated in response to the operation of relay VTK1(20).

It may be noted that relay VTK1(20) also closes a circuit from ground over its contact 3, conductor 2007 to the lowermost armatures of the vertical group test relays, the front contacts of which are cross-connected to conductors 1902 and 1903 extending through cable A(20) to Fig. 35 for the purpose of operating either relay D(35) or relay MF(35) over contacts of relay MLF(35) in the case of a mixed frame as mentioned previously.

Horizontal group identification

With relay VGA0(1) operated, conductor 102 grounded by line relay L00(1) is extended together with nine other similar conductors individual to the vertical group zero in the nine other horizontal levels, to contacts of relay MB1(25) and then over contacts of horizontal group gating relay HGG(20) to the windings of the ten horizontal group test relays HGT0(9) to HGT9(21). Ground connected to conductor 102 completes the circuit over a contact of relay VGA0(1), conductor 107, contact 4 of relay MB1(25), conductor 2513 through cable B(25) extending to Fig. 36, through cable B(48) extending to Fig. 21, contact 11 of relay HGG(20), conductor 2008 and through the winding of relay HGT0(9) to battery. Relay HGT0(9) operates in this circuit. If some other line in the vertical group zero but in a different horizontal group is also waiting for a dial tone connection, the corresponding horizontal group test relay will also be operated.

With relay GK(20) operated as previously described, the operation of relay HGT0(9) closes a circuit indicating that at least one horizontal group test relay has been operated, which circuit may be traced from battery through the winding of relay HGR(21), conductor 2102, contact 1 of relay GK(20), conductor 2103, contact 1 of relay HGT0(9), conductor 900, conductor 2513 and thence to ground at the contact of the line relay L00(1) as previously traced. Relay HGR(21) operates and monitors for a subscriber disconnection within the selected horizontal group of the selected vertical group.

If two or more horizontal group test relays

have been operated, one of these relays and the associated horizontal group will be preferred by means of a preference circuit controlled by the sequence circuit (not shown). With relay SQ3 of the sequence circuit assumed to be operated, the operation of the relay HGR(21) closes a circuit from ground at contact 10 of relay D(35), conductor 3512 extending through cable B(43) to Fig. 21 over contact 1 of relay HGR(21), conductor 2104 extending to the sequence circuit and returning from the sequence circuit over contact 6 and through the winding of relay HGT3(9) to battery. Relay HGT3(9) is locked in this circuit opening the locking circuits for any other horizontal test relays which may have been operated.

With relay HGR(21) operated, horizontal test check relay HTK(21) operates in a circuit from battery through its winding, contact 3 of relay HGK(21) to ground over conductor 3511. Relay HTK operates in this circuit and locks over its contact 3 to ground on conductor 3511. At contact 2 relay HTK(21) opens the operating circuit for relay HGG(20) causing the latter relay to release and disconnect horizontal group test relays from the line-link frame to release any unlocked horizontal group test relays which may have been operated and to prevent the subsequent operation of any other horizontal group test relays which might interfere with the horizontal group to be served by this marker. At contact 1, relay HTK(21) closes a supplementary locking circuit for relay HGT3(9) in parallel with contact 1 of relay HGR(21). With relay HGG(20) released, relay HGT3(9) locked and the remaining horizontal group test relays released, a circuit is closed to check the completion of these operations which may be traced from battery through the winding of relay HTK1(20), contact 1 of relay HGG(20), conductor 2009, contact 4 of relay HGT3(21), contacts 5 of relays HGT2(21) to HGT1(9), contact 4 of relay HGT3(9) and to ground. Relay HTK1 operates in this circuit.

Further identification takes place after the marker has seized the line-link frame through the line-link frame connector which is delayed until the marker has selected and seized a trunk-link frame having one or more idle originating registers. The purpose of this delay is to prevent two markers from competing simultaneously for the same line-link frame and trunk-link frame and thereby blocking operation of either marker. In the selection of an idle originating register for connection with the calling line, the marker performs five chief functions, namely identifying the type of originating register required, tests for and selects an idle trunk-link frame connecting with one or more idle originating registers of the required type, connects with the selected trunk-link frame, tests for and selects an idle originating register of the required type and connects the calling line with the selected register.

The type of originating register required is indicated by the operation of relay D(35) or relay MF(35). As above described, one of these relays is operated directly from the marker start relay in the line-link marker connector if all of the lines on the frame use the same type of pulse generator, either dial or multifrequency generating key-set. If some of the lines on the line-link frame have one type of pulse generator and the other lines have the other type, the operation of relay D(35) or relay MF(35) is delayed until after the vertical group identification has taken place. In the present disclosure it has been assumed that the line-link frame zero serves only lines having dials and relay D(35) was operated in response to the operation of relay MS11(25).

After the marker has determined the type of originating register required it will connect with two leads extending to each trunk-link frame. One lead from each frame is designated the trunk-link frame busy test lead and will be grounded at the trunk-link frame whenever this frame is not accessible to a marker. The other lead designated the trunk frame test lead is grounded by the presence of one or more idle originating registers of the desired type associated with that frame. The marker tests all of these leads simultaneously and by its preference arrangement selects a frame from among those available to the marker and having idle registers of the required type.

When relay D(35) was operated, it conditioned the originating register selection equipment of the marker for operation. Since the present invention is not concerned directly with the manner in which a marker causes the selection of an idle originating register, such equipment has in large part been omitted from the disclosure of the present invention in order that such disclosure may not be unnecessarily encumbered. For a full disclosure of such equipment, reference may be had to the applications of A. J. Busch and R. E. Hersey hereinbefore referred to. The marker first looks for a frame not in use by another marker on which there is an idle register. It will be assumed that there is an idle register on the trunk-link frame disclosed in Fig. 38 and that such register is disclosed in part in Figs. 26 to 29, 39 to 42 and 52 to 66. The fact that an idle register is located on such frame will be indicated to the marker by ground connected to conductor 2003 extending to the marker. Such ground is applied over contact 7 of relay ON(23), conductor 2601, contact 12 of relay PD(32), conductor 2602 and contact 4 of relay MB(26). If there is an idle register on another frame available to the marker, ground will also be applied to a conductor at such frame corresponding to conductor 2003. The marker will thereupon bid in competition with other markers for one of the frames on which there is an idle originating register.

Each marker in the office has access to each trunk-link frame but only one marker at a time is allowed to connect to a frame. The circuits involved in this operation comprise the marker preference (MP) relays for each frame. The marker preference relays for the frame shown in Fig. 38 are the relay MP1(51) for the first marker, shown in some detail herein, relay MP2(51) for an intermediate marker and relay MP3(51) for a last marker. It will be assumed that the first marker is successful in bidding for the frame on which the idle register disclosed is located and establishes a circuit from battery at the marker, over conductor 5100, over the back contact of relay TR3(51), through the winding of relay MP1(51), contacts 1 of relays MP2(51) and MP3(51) and other marker preference relays of the same chain to ground. Relay MP1(51) thereupon operates and locks to ground over its contact 2 and establishes a circuit from ground at its contact 4, contact 3 of relay TR3(51) and through the winding of relay MC(51) to battery. At its contact 3 relay MP1(51) establishes a check circuit to the marker to inform the marker that it has seized a particular trunk-link frame. Relay MC(51) upon operating establishes cir-

cuits extending from battery through the windings of relays MCA(51), MCB(51), MCC(51), and MCD(51) over its contacts 3, 4, 5 and 6 conductors of cable D(51) extending to Fig. 48 and contacts of relay TLC1(48) through ballast lamps LBS0 to LBS3 to battery. Relays MCA(51), MCB(51), MCC(51) and MCD(51) prepare a plurality of circuits for connecting the marker with the trunk-link frame. Relay MCA(51) connects ground to a conductor (not shown) multiplied to all of the markers to indicate to the markers that the seized trunk-link frame assumed to be frame zero is busy.

As a check that the multicontact relays of the trunk-link connector have operated, relay MCA(51) closes a circuit from ground over its contact 3, conductor 5101 of cable B(51) extending to Fig. 63 and thence through the winding of relay MAK1(63) to battery. In addition, relay MCD(51) closes a circuit from ground over its contact 15, conductor 5102 of cable E(51) extending to Fig. 32 and to battery through the winding of relay MDK(48).

Selection of originating register

When the marker is connected to the selected trunk-link frame by the trunk-link connector, a group of twenty busy test leads is extended from the marker to the trunk-link frame. The trunk-link connector is further controlled by the marker to further extend one of these busy test leads to each originating register of the required type associated with the selected frame. The marker then tests for an idle originating register of the desired type and selects the register to serve the calling line. Before the marker can test for an idle register, it must determine the location of all the originating registers of the required type.

In each trunk-link frame there are one hundred and sixty terminations to which originating registers or trunks may be connected. The trunks and registers associated with a trunk-link frame are divided into twenty block groups containing a maximum of twenty registers or trunk circuits. There will be a maximum of only six such twenty block groups on a frame since certain trunks such as incoming trunks are not selectable from the marker. Within any one trunk-link frame all dial pulsing originating registers will be placed within one twenty-block group, although the same twenty-block group may also contain multifrequency originating registers or trunks. The twenty-block group and the location of the register of the desired type within the group are determined by the route relay.

On the trunk-link frame the sixty routes are numbered 00 to 59 and there are six trunk block relays numbered 0 to 5 corresponding to the six possible tens digits of the route numbers. In addition, there are ten units terminals on each trunk-link frame corresponding to the units digits of each route. Each trunk and each register is connected with the trunk-link frame by two conductors, a frame conductor and a busy test conductor. In the register or trunk, ground is connected to the busy test conductor when the trunk or register is idle, this connection including the winding of the frame relay. The frame conductors of all trunks belonging to routes having the same units digit are cross-connected to the corresponding units terminal. The busy test conductors of all trunks or registers corresponding to routes having the same tens digit are connected individually to contacts on the corresponding numbered trunk block relay. The twenty-block relay extends twenty such busy test conductors toward the marker. Any number of these conductors may be assigned to one route. However, there can be no more than ten routes assigned to one twenty-block relay because each such route must have a separate units digit.

The route relay in the marker operates a trunk block and test group relay (not shown), the trunk block relay being effective to establish a circuit for the proper one of the tens block relays of the trunk-link frame. It will be assumed that a circuit is established for the tens block relay TB0(51) over contact 1 of relay MC(51) to the marker wherein it is completed to ground by the tens block relay of the marker. Relay TB0(51) operates in this circuit extending the busy test conductors from the registers and trunks belonging to the group having the tens digit zero associated with the trunk-link frame zero through the contacts of multicontact relay MCA(51). At its contact 1 relay TB0(51) connects ground over contact 2 of relay MCA(51) and conductor 5103 of cable B(51) extending to Fig. 63 and through the winding of relay TBK(63) to battery whereupon such relay operates to indicate to the marker that the TB0(51) relay has operated.

With the TBK(63) and MAK1(63) relays operated to indicate the operation of the twenty-block and multicontact relays of the trunk-link connector and a trunk group relay of the marker operated by the group relay, ground is connected from contact 3 of relay DCT1(46), contact 6 of relay CKG4(46), conductor 4600, contact of relay TBK(63), contact 2 of relay MAK1(63), over conductor 5104 of cable B(63) extending to Fig. 51 to a cross-connecting terminal 5105 which is connected to the frame test conductors of the registers and trunks associated with routes identified by markers as having the units digit zero. Since relay TB0(51) is operated, only those circuits associated with group 00, that is, dial type registers are connected with the marker over their frame and busy test conductors by the operation of the marker. In idle registers the frame and busy test conductors are connected together. In the originating register shown, the circuit traced to terminal 5105 is extended over conductor 5106 to contact 2 of relay MB(26) of the idle register, conductor 2603, contact 1 of relay TM1(52), contact 3 of relay PD(52), conductor 2604, contact 6 of relay ON(26), winding of relay F(26), conductor 2605, contact 2 of relay TB0(51), contact 1 of relay MCA(51) and thence to the marker where it extends through the winding of a trunk test relay to battery. When the trunk test relay of the marker operates, it reduces the resistance of the circuit traced through the winding of relay F(26) and such relay operates closing a locking circuit for itself over its contact 4 to conductor 5106 to which ground is connected at the marker as previously traced. Relay F(26) when operated, extends a number of circuits from the originating register to the trunk-link connector and closes a circuit from ground over its contact 3, conductor 2606 of cable A(26) extending to Fig. 54 and through the winding of relay F1(54) to battery. Relay F1(54) operates in this circuit preparing for the reception of the called line designation. Relay F(26) also closes a circuit from ground over its contact 5, conductor 2607 of cable 2638 and through the winding of relay FB2(38) to battery. Relay FB(38) operates in this circuit in turn closing a circuit from ground over its contact 10 and

through the winding of relay LV2 (38) to battery whereupon the latter relay operates.

Each cross-point of a trunk switch closes contacts leading to two trunks or registers, one of which is said to have an A appearance and the other of which is said to have a B appearance. Each trunk and register has an individual relay such as FB2(38) or an FA relay (not shown) which serves to associate the individual trunk and its contacts in the trunk switch with the marker. There are eight levels of cross-points in each switch connected to trunks or registers, the remaining two cross-points being employed to extend the trunk junctor to either the A or B appearance trunk or register. There is a level relay such as relay LV2(38) individual to each of the eight levels on which trunks and registers appear and each relay, such as relay FB2(38), operates the level relay corresponding to the level in which the associated trunks or registers appear. With relays FB2(38) and LV2(38) operated, a plurality of circuits are extended through the trunk-link connector to the marker. With relays FB2(38) and LV2(38) operated, a circuit is closed to indicate to the marker that those relays have operated. This circuit may be traced from ground at contact 9 of relay FB2(38), contact 4 of relay LV2(38), conductor 3900, contact 10 of relay MCB(51), conductor 5107 of cable A(51) extending to Fig. 33, contact 8 of relay LK1(46), conductor 4601, winding of relay FBK(33) to battery on conductor 3300. Relay FBK(33) operates in this circuit. Relay FB2(38) also establishes a circuit from ground through the winding of relay LC0(38), contact 10 of relay FB2(38), contact 5 of relay LV2(38), conductor 3801, contact 11 of relay MCB(51), conductor 5108 of cable A(51) extending to Fig. 33 and contact 10 of relay LK1(46) to battery on conductor 3301.

Relay LC0(38) operates in this circuit preparing circuits for the operating magnets of the trunk switch having access to the selected register. In addition it closes the circuit to inform the marker that it has operated, which circuit may be traced from ground over contact 3 of relay LC0(38), conductor 3902, contact 6 of relay MCB(51), conductor 5109 of cable A(51) extending to Fig. 33 and through the winding of relay LCK(33) to battery. The marker has now established the necessary connections with the selected trunk-line frame by which it may determine the channel to be used in connecting that frame with the line-link frame on which the calling line is located.

Connection with line-link frame

In the meantime, the marker has been setting up similar connections with the line-link frame on which the calling line is located through the line-link frame connector. As soon as the marker has been signaled and a trunk-line frame has been seized, a circuit is established which may be traced in part from battery applied at the cross-detector circuit of the marker to conductor 4903, over contact 6 of relay LLC1(48), conductor 4801 extending to the cross-detector circuit, over the contact of the relay therein which has operated in response to the seizing of the trunk-link frame, thence over conductor 4904 extending through cable C(36) extending to Fig. 25, contact 14 of relay MA1(25) to the winding of marker preference relay MP1(25). Assuming that no other marker is attempting to seize line-link frame 0 at this time, the circuit of relay MP1(25) will extend over contacts 3 of the other marker preference relays such as relays MP2(25) and MP3(25) to ground.

Relay MP1(25) operates in this circuit locking to ground over its contact 4 and at contact 2 connects ground to conductor 2514 completing the circuit for relay MCA(1). Relay MCA(1) closes circuits from ground through the windings of relays MCA1(1) and MCB(1), over its contacts 3 and 7, conductors 108 and 109 extending through cable A(1) to Fig. 48, contacts 8 and 9 of relay LLC1(48) and through resistance lamps LBS1 and LBS2 to battery. The operation of relays MCA1(1) and MCB(1) extends a large number of circuits from the line-link frame connector to the marker which are required for vertical file identification, class of service identification and other necessary functions. As soon as relay MCA operates, it closes a circuit from ground over its contact 4 and conductor 110 of cable A(1) to Fig. 48 and thence through the winding of relay LFK(48) to battery. Relay LFK(48) operates as an indication to the marker that the marker has become connected to the line-link frame but has no other special function in connection with a dial tone call.

When relay HTK1(20) operated as previously described following the operation and locking of relay HGT0(9) to select horizontal group 0 for service, it connected battery through resistance lamp HGB(48), contact 7 of relay LLC1(48), conductor 4802 extending through cable A(35) to Fig. 20, contact 2 of relay HTK1(20), conductor 2010, contact 7 of relay HGT0(9), conductor 901 extending through cable B(21) to Fig. 48, through cable A(48) extending to Fig. 1, contact 2 of relay MCA(1) and through the winding of the corresponding one of the ten horizontal group relays of the line-link frame 0, namely relay HG0(1) and thence to ground. Relay HG0(1) operates in this circuit to prepare circuits for testing the line link, for operating the select magnets and for operating the line group relay. As an indication to the marker that the horizontal group relay has been operated, relay HG0(1) closes a circuit from ground over its contact 42, contact 1 of relay MCA(1), conductor 111 of cable A(1) extending to Fig. 48, through the winding of relay HGK(33) and conductor 3302 to battery at the cross-detection circuit of the marker. Relay HGK(33) operates in this circuit.

When relay VTK1(20) operated as above described, following the operation and locking of relay VGT0(7) to select vertical group 0 for service, it connected battery through the winding of a cross-detecting relay (not shown), over conductor 2011, contact 4 of relay VTK1(20), conductor 2012, contact 8 of relay VGT0(7), conductor 702 extending through cable A(20) to Fig. 35, through cable A(48) extending to Fig. 1, contact 5 of relay MCA(1) and through the winding of the corresponding one of fourteen vertical group relays, namely relay VGB0(1) to ground. Relay VGB0(1) operates in this circuit and prepares circuits for transmitting to the marker an indication of the class of service to which the calling line belongs, which will be described hereinafter.

The operation of one vertical group relay and one horizontal group relay in the line-link frame connector will identify the line group in which the calling line is located. With relay VGB0(1) and relay HG0(1) operated, a circuit is closed for the line group relay individual to the line

group of the calling line. This circuit may be traced from ground through the winding of line group relay LG0(1), contact 43 of relay HG0(1), upper contact of relay VGB0(1), contact 6 of relay MCA(1), conductor 112 of cable A(1) extending to Fig. 48, contact 10 of relay LLC1(48), conductor 4803, contact 1 of relay HGK(33), conductor 3303 and to battery through the winding of a relay in the cross-detecting circuit (not shown). Relay LG0(1) operates in this circuit extending the five vertical file identification leads of the five lines belonging to the associated line group to the marker.

Vertical file identification

Relay L00(1) when operated grounded the individual conductor 101 which is extended by the operation of relay LG0(1), over contact 3 of relay LG0(1), contact 6 of relay MCB(1), conductor 113 of cable B(1) extending to Fig. 10, contact 7 of relay MT11(22), contact 3 of relay VFG(22), conductor 2201 and through the winding of vertical file test relay VFT0(10) to battery. Relay VFT0(10) operates in this circuit. If any other line in this group of five lines were also awaiting a dial tone connection at this time, the corresponding vertical file test relay would be operated.

As soon as relay VFT0(10) operates, a circuit is closed from battery over conductor 4400 of cable A(44) extending to Fig. 22, winding of relay FR(10), conductor 1000, contact 2 of relay GK(20), conductor 2012, contact 4 of relay VFT0(10), conductor 1001, contact 7 of relay MT11(22), conductor 113 and ground at the contact of the line relay L00(1) as previously traced. Relay FR(10) operates in this circuit and monitors on a subscriber disconnect within the selected vertical file, vertical group and horizontal group.

With relay FR(10) operated one of the vertical files is preferred for seizure under the control of the sequence circuit. If it is assumed that relay SQ0 of the sequence circuit (not shown) has been operated, relay VFT0(10) locks over its contact 6, conductor 1002 extending to the sequence circuit, thence returning over conductor 1003, contact 1 of relay FR(10), conductor 3513 of cable C(22) extending to Fig. 48 and to ground over contact 8 of relay D(35). Relay VFT0(10) at its contact 5 opens the locking circuits for the other vertical file test relays so that even though another one of these relays may have been operated it cannot be locked.

Relay FR(10) also closes a circuit from battery through the winding of relay FTK(10), contact 2 of relay FR(10) and conductor 3516 extending through cable C(22) to Fig. 48 and thence to ground over contact 2 of relay D(35), conductor 5000 and contact 1 of relay RCY1(50). Relay FTK(10) locks over its contact 3 to ground on conductor 3516 independent of relay FR(10) and closes at its contact 1 an alternate connection between conductors 1003 and 3513 in parallel with contact 1 of relay FR(10).

Relay FTK(10) at its contact 2 opens the operating circuit for relay VFG(22) causing that relay to release and open the vertical file test circuits releasing all of the non-locked vertical file test relays and leaving relay VFT0(10) operated alone. As soon as relay VFG(22) and the vertical file test relays have released, a circuit is closed for relay FTK1(10) extending from battery through the winding of that relay, conductor 1004, contact 7 of relay VFG(22), conductor 2202, contact 3 of relay VFG4(10), contact 4 of relays VFG3(10), VFG2(10) and VFG1(10) to ground over contact 3 of relay VFG0(10). Relay FTK1(10) upon operating also establishes a circuit for relay GTL1(22) extending from battery through the winding of the latter relay, over conductor 2204, contact 2 of relay FTK1(10), conductor 1006 of cable C(22) extending to Fig. 48, contact 2 of relay MDK(48), conductor 4805, contact 6 of relay DCT1(46), conductor 4602 of cable E(32) extending to Fig. 51, contact 14 of relay MCD(51), conductor 5111 of cable F(51) extending to Fig. 54 and to ground over contact 40 of relay F1(54).

Class of line registration

In order to properly charge the calling subscriber for the call, it is necessary to determine the class of service to which the calling line belongs. It is possible to have as many as thirty different classes of service in any office and on any one line-link frame. Calling subscriber lines for different classes of service many be grouped on the line-link frame in any manner subject to one limitation, namely that all subscriber lines terminating in the same vertical file on the same line-link frame must be of the same class of service. The marker is normally equipped with thirty class of service identification relays but for convenience only ten such relays have been shown. These relays are used to determine the class of service by being connected to class of service cross-connections on the line-link frame and in turn operate relays in the marker to indicate the type of line.

When relay VGB0(1) was operated as above described, it prepared the five class of service identification circuits for the five vertical files included in the corresponding vertical group. When relay FTK1(10) operated as above described, the circuit associated with the vertical file which has been selected to be served is closed from ground, contact 4 of relay DT1(49), conductor 4905 of cable C(48) extending to Fig 22, contact 2 of relay MT11(22), conductor 2203 of cable C(22) extending to Fig. 48, contact 2 of relay LLC1(48), conductor 4804 of cable C(48) extending to Fig. 22, contact 4 of relay FTK1(10), contact 8 of relay VFT0(10), conductor 1005 of cable B(10) extending to Fig. 1, contact 3 of relay MCB(1), lower contact of relay VGB0(1), conductor 114 cross-connected at rack 115 to conductor 116, thence over contact 2 of relay MCB(1), conductor 117 of cable C(1) extending to Fig. 84 and through the winding of class relay CS1(84), conductor 8400 and to battery through the winding of a cross-detecting relay of the cross-detecting circuit (not shown). Relay CS1(84) in operating closes a circuit for relay 2P(83) extending from battery through the winding of such relay, conductor 8300, contact 4 of relay CS1(84), conductor 8401 extending through cable B(84) to Fig. 32, contact 6 of relay GTL4(32), conductor 3230 of cable A(44) extending to Fig. 22 and to ground at contact 6 of relay GTL1(22). Relay 2P(83) operates in this circuit to indicate that the line is of the two-party type.

A circuit is also established in parallel with the winding of relay 2P(83) over conductor 8402 extending through cable A(33) to Fig. 51, contact 23 of relay MCB(51), conductor 5115, contact 17 of relay LV2(38), conductor 3811 of cable 3826, contact 8 of relay F(26), conductor 2610 of cable 2642 and through the winding of relay 2P(42) to battery. Relay 2P(42) operates in this circuit and locks over its contact 4 and conductor 4202

extending through cable 2642 to ground at contact 3 of relay ON(26).

Transfer of calling line identification to originating register

The marker is now ready to transfer the calling line identification including the class to the originating register for storage.

When the frame relay F(26) of the originating register operates, it closes a circuit from ground at contact 1 of relay TOG2(33), conductor 3304 of cable A(33) extending to Fig. 51, contact 22 of relay MCB(51), conductor 5110, contact 16 of relay LV2(38), conductor 3803 of cable 3826, contact 6 of relay F(26), and through the winding of relay S1(26) to battery. Relay S1(26) operates, closing at its contact 3 a circuit through the winding of relay ON(26) which operates, providing off-normal grounds for the originating register circuit.

In order to transmit the line identification to the originating register, the marker grounds 11 out of 33 conductors leading to the originating register and at the same time will operate 11 out of 33 relays in the marker so that the marker may check the operation of the recording relays in the originating register.

As set forth above, relay FTK1(10) was operated following the identification of the vertical file of the calling line which completed the identification of the calling line to be served. Relay MDK(48) was operated following the operation of relay MCD(51) in the trunk-link connector to indicate that the marker had been connected with the originating register and relay F1(54) in the originating register was operated. With these three relays operated a circuit is closed as previously traced for relay GTL1(22), and relay GTL1(22) upon operating, established a circuit from ground at contact 2 of relay OC1(37), conductor 3709 of cable C(43) extending to Fig. 22, contact 6 of relay GTL1(22), conductor 2205 of cable A(22) extending to Fig. 44 and thence through the winding of relay GTU(45) to battery. Relay GTL1(22) provides the grounds for transmitting the line identification to the originating register and relay GTU(45) closes circuits for transmitting the frame identification to the originating register.

It will be remembered that the calling line is located in the line-link frame 0, in horizontal group 0, vertical group 0, and vertical file 0, and belongs to class 1. In consequence, relays FT0(44), FU4(44) and FU7(44), horizontal group test relay HGT0(9), vertical group test relay VGT0(7), vertical file test relay VFT0(10), and class relay CS1(84) were operated.

When relay GTU(45) operates, it connects the conductors grounded by the line-link marker connector for identifying the line-link frame, through the marker to the trunk-line connector. It will be remembered that conductors 4514, 4517 and 4520 were grounded by the operation of relay MB1(25). With relays GTL2(45) and GTU(45) operated, these conductors are extended over contacts 10, 11 and 3 of relay GTL2(45), contacts 9, 10 and 2 of relay GTU(45), conductors 4524, 4527 and 4530 of cable E(32) extending to Fig. 51, contacts 9, 8 and 7 of relay MCD(51), conductors 5124, 5127 and 5130 extending through cable F(51) to Fig. 54 and over contacts 23, 10 and 11 of relay F1(54) to conductors 5614, 5617 and 5630 of cable 5455 which extends through the windings of relays FU4(56), FU7(56) and FT0(56) to battery. Relays FT0(56), FU4(56) and FU7(56) operate, locking over their contacts 1 and 2, conductor 5501 of cable A(54) extending to Fig. 26 and to ground over contact 10 of relay ON(26). The locking ground for these relays hold operated relays FT0(44), FU4(44) and FU7(44) in the marker.

When relay GTL1(22) operates, it closes two out of a possible six circuits under the control of the vertical group test relay VGT0(7), one of which extends from ground at contact 3 of relay GTL1(22), conductor 2206 and contact 9 of relay VGT0(9) to conductor 707, and the other of which extends from ground over contact 4 of relay GTL1(22), conductor 2207, contact 10 of relay VGT0(9) and to conductor 704. Conductors 707 and 704 are further extended over contacts 8 and 9 of relay GTL3(32) and conductors 3207 and 3204 through the windings of relays VG7(31) and VG4(31) to battery and in parallel therewith over cable E(32) extending to Fig. 51, contacts 10 and 11 of relay MCD(51), conductors 5147 and 5144 of cable F(51) extending to Fig. 54, contacts 35 and 36 of relay F1(54) and conductors 5517 and 5514 of cable 5455 through the windings of relays VG7(55) and VG4(55) to battery. Relays VG7(31) and VG4(31) in the marker operate as well as relays VG7(55) and VG4(55) in the originating register. The latter relays close locking circuits for themselves over their contacts 1 and 2, conductor 5501 of cable A(54) extending to Fig. 26 and to ground over contact 11 of relay ON(26). The locking ground for these relays holds operated relays VG7(31) and VG4(31) in the marker.

Relay GTL1(22) at contacts 1 and 2 closes two out of a possible five circuits under the control of the horizontal group test relays and with relay HGT0(9) operated, one of these circuits extends from ground at contact 1 of relay GTL1(22), conductor 2208, contact 8 of relay HGT0(9) to conductor 907, and the other of which extends from ground at contact 2 of relay GTL1(22), conductor 2209, contact 9 of relay HGT0(9) to conductor 904. Conductors 904 and 907 are further extended through cable A(21) extending to Fig. 32, over contacts 2 and 3 of relay GTL3(32) and conductors 3214 and 3217 through the windings of relays HG4(31) and HG7(31) to battery and in parallel therewith through cable E(32) extending to Fig. 51, contacts 12 and 13 of relay MCD(51), conductors 5154 and 5157, contacts 30 and 29 of relay F1(54) and conductors 5524 and 5527 of cable 5455 through the windings of relays HG4(55) and HG7(55) in the originating register to battery. Relays HG4(31) and HG7(31) in the marker operate as well as relays HG4(55) and HG7(55) in the originating register, the latter relays locking over their contacts 1 and 2 to ground on conductor 5501 as previously traced and holding relays HG4(31) and HG7(31) in the marker operated.

At its contacts 9, 10 and 11, relay GTL1(22) closes three circuits in conjunction with the class relay CS1(84). The first of these circuits extends from ground over contact 9 of relay GTL1(22), conductor 2210 of cable A(22) extending to Fig. 44, thence over contact 5 of relay GTL4(32), conductor 3221 of cable B(32) extending to Fig. 84 and contact 3 of relay CS1(84) to conductor 8420. The second of these circuits extends from ground over contact 10 of relay GTL1(22), conductor 2211 of cable A(22) extending to Fig. 44, thence over contact 4 of relay GTL4(32), conductor 3232 of cable B(32) extending through Fig. 84 and contact 2 of relay CS1(84) to conductor 8411. The

third of these circuits extends from ground over contact 11 of relay GTL1(22), conductor 2212 of cable A(22) extending to Fig. 44, thence over contact 3 of relay GTL4(32), conductor 3233 of cable B(32) extending to Fig. 84, contact 1 of relay CS1(84) and to conductor 8410. Conductors 8420, 8410 and 8411 extend to the windings of relays CT0(83), CU0(83) and CU1(83) and battery and in parallel therewith through cable G(84) extending to Fig. 51, contacts 3, 1 and 2 of relay MCD(51), conductors 5170, 5160 and 5161 of cable H(51) extending to Fig. 54, contacts 9, 5 and 4 of relay F1(54) and through the windings of relays CT0(54), CU0(54) and CU1(54) to battery. Relays CT0(83), CU0(83) and CU1(83) in the marker operate over the above-traced circuits. Relays CT0(54), CU0(54) and CU1(54) in the originating register also operate over these circuits and lock over their contacts 1 and 2 and conductor 5401 extending through cable A(54) to Fig. 26 and to ground at contact 12 of relay ON(26), this locking ground also serving to hold the corresponding relays in the marker operated.

It will be observed that the class identification is translated into a combination of a class tens indication and a class units indication. While in the present disclosure only ten class relays have been shown, so that the class tens relay has little significance, yet in the case where a complete set of thirty class indications is used, the class tens indication is necessary.

At contact 12 relay GTL1(22) closes one out of a possible five circuits in cooperation with the vertical file test relay FVT0(10), which may be traced from battery over contact 12 of relay GTL1(22), conductor 2213, contact 7 of relay VFT0(10), conductor 1010 extending through cable A22 to Fig. 44, contact 7 of relay GTL4(32), conductor 3220 and through the winding of relay VF0(44) to battery and in parallel therewith through cable E(32) extending to Fig. 51, contact 6 of relay MCD(51), conductor 5180 of cable F(51) extending to Fig. 54, contact 28 of relay F1(54), conductor 5530 of cable 5455 and through the winding of relay VF0(55) to battery. Relays VF0(44) and VF0(55) operate, relay VF0(55) locking over its contacts 1 and 2 to ground on conductor 5501, the locking ground for relay VF0(55) serving to hold relay VF0(44) operated.

Having obtained access to the selected originating register through the trunk-link frame connector and to the calling line through the line-link frame connector, the marker now proceeds to select an idle connecting path or channel by which the calling line may be connected to the selected register. In the selection of such path the marker must perform the following functions, namely: select the ten line links by which the calling line may be extended; select the ten trunk links which have access to the selected register; select the subgroup of junctors by which the selected line link and the selected trunk link may be connected; test for and select an idle channel comprising an idle line link, an idle junctor and an idle trunk link and transmit to the originating register the identity of the channel selected.

The number of line links to which the calling line has access and the number of trunk links having access to the selected register or trunk are fixed by the nature of the cross bar switches. Similarly, the total number of junctors outgoing from any one line-link frame and the number of junctors incoming to any one trunk-link frame are fixed by the arrangement of the switches on the frame. However, the number of junctors connecting a particular line-link frame with a particular trunk-link frame will vary in accordance with the size of the office as determined by the number of such frames furnished. There are always twice as many line-link frames as there are trunk-line frames and the size of the office with which control equipment will function may vary from four line-link frames and two trunk-link frames to forty line-link frames and twenty trunk-link frames. Since there are one hundred junctors outgoing from each line-link frame and two hundred junctors incoming to each trunk-link frame, the number of junctors in the group connecting a particular line-link frame with a particular trunk-link frame will vary from fifty in the smallest size office to ten in the office having ten trunk-link frames. Where the number of trunk-link frames exceeds ten extension switches are connected in parallel with the junctor switches of the line-link frames and the trunk-link frames so that in no case will there be less than ten junctors connecting a particular line-link frame with a particular trunk-link frame. If there are more than ten junctors in a junctor group they are subdivided into subgroups of ten junctors or less.

Within a junctor subgroup containing ten junctors there will be one junctor connecting a horizontal termination on each line-link frame junctor switch to a horizontal termination of the like numbered junctor of the trunk-line switch. The junctors constituting a subgroup will be connected either to the right section or the left section of the trunk-line junctor switch. The junctors of a subgroup are all connected to the same horizontal levels in the ten trunk-link frame junctor switches.

To determine if a particular connecting path or channel through which it is possible to connect a calling subscriber's line to an originating register is idle and available for use it is necessary to test the particular line link, junctor and trunk link associated with this channel for an idle condition. If any of these elements is busy the entire channel is unavailable.

The marker is equipped to simultaneously test ten separate channels between a particular subscriber line and an originating register. To do this the marker will test the line link, the junctor and the trunk link associated with each of the ten channels. However, before it is possible to test for an idle channel the marker must determine which ten channels in the office should be selected for testing and must then determine the elements associated with these ten channels. After the line link, the junctor and the trunk link associated with each channel have been determined, the marker may proceed to test for an idle channel.

The elements of the channel are so assigned that the numerical designation of the channel is the same as the designation of the line link, which is the same as the designation of the level in the line switch in which the line link is connected and also the same as is the numerical designation of the line-link junctor switch to which the line link extends.

The group of line links associated with the ten channels to be tested is determined by the location of the calling subscriber's line, being the line link which terminates in the same horizontal group of the same frame as the calling line. When relay HG0(1) was operated, following the operation of the line-link connector relay MCA1(1), a pair of test circuits for the line links

were established to the marker. Since the testing and selection of an idle channel is only incidental to the present invention, such testing circuits and the description of their operation has been omitted from the present disclosure. For a complete disclosure and description thereof, reference may be had to the application of A. J. Busch hereinbefore referred to. It will be assumed that as a result of the tests which are made the channel represented by relay CH0(86) of Fig. 86 becomes operated, locking itself over its contact 4, contacts 3 of the remaining channel relays CH1(86) to CH9(86) and thence over conductor 8600, over the contact of a relay in the junctor sequence circuit (not disclosed) and thence over conductor 3519 to ground over conductor 4 of relay LLC1(48).

Transfer of line-link identification to originating register

The channel having been selected the identity of the selected line link is registered on the line-link relays of Fig. 85 and transmitted to the originating register. Since relay CH0(86) has been operated, a circuit is established from battery through the winding of relay LL4(85), conductor 8504, contact 2 of relay CH0(86), conductor 8601, contact 12 of relay GTL2(45), conductor 4500 of cable A(44) extending to Fig. 22 and contact 7 of relay GTL1(22) to ground. A second circuit is established from battery through the winding of relay LL7(85), conductor 8507, contact 1 of relay CH0(86), conductor 8602, contact 2 of relay GTL2(45), conductor 4501 of cable A(44) extending to Fig. 22 and contact 5 of relay GTL1(22) to ground.

At the same time, with relay CB(85) operated from the channel testing circuit, branches from conductors 8504 and 8507 are extended over contacts 4 and 5 of relay CB5(85), conductors 8514 and 8517 of cable I(85) extending to Fig. 51, contacts 5 and 4 of relay MCD(51), conductors 5194 and 5197 of cable F(51) extending to Fig. 54, contacts 15 and 14 of relay F1(54) and conductors 5634 and 5637 of cable 5456 through the windings of relays LL4(56) and LL7(56) and battery. Relays LL4(56) and LL7(56) lock over their contacts 1 and 2 to ground on conductor 5601 holding relays LL4(85) and LL7(85) operated.

Check of line identification transfer

The marker now checks to see that all of the necessary information has been properly transmitted to the originating register. A circuit for this purpose is established from ground through the winding of relay RK1(36), conductor 3619 of cable E(36) extending to Fig. 45, contact 2 of relay FT0(44), contacts 3 of relays FT1(44) and FT2(44), contact 2 of relay FT3(44), contacts 4 of relays FU0(44), FU1(44), FU2(44) and FU4(44), contact 5 of relay FU7(44), conductor 4401, contacts 4 of relays VG0(31), VG1(31) and VG2(31), contact 5 of relay VG4(31), contact 6 of relay VG7(31), contact 6 of relay VG10(31), contacts 4 of relays HG0(31), HG1(31), HG2(31) and HG4(31), contact 5 of relay HG7(31), conductor 3100, contact 2 of relay VF0(44), contacts 4 of relays VF1(44), VF2(44) and VF3(44), contact 3 of relay VF4(44), conductor 3101 of cable A(44) extending to Fig. 22, contact of relay CT0(83), contact 5 of relay CU0(83), contact 7 of relay CU1(83), contact 9 of relay CU2(83), contact 8 of relay CU4(83), contact 6 of relay CU7(83), contacts 1 of relays A0(83), MCN(83) and MAN(83), contact 2 of relay 2P(83), contact 1 of relay CN(83), conductor 8301, contact 5 of relay LL0(85), contacts 6 of relay LL1(85), contact 7 of relay LL2(85), contact 5 of relay LL4(85), contact 5 of relay LL7(85) and conductor 8500 through the winding of relay RK2(49) and battery. If the proper number of relays in each of the checking registers has been operated, relays RK1(36) and RK2(49) operate in the above-traced circuit.

A circuit is now closed to check that the circuits for operating and locking the register relays in the originating register have been closed. For this purpose, a circuit is closed responsive to the operation of relays RK1(36) and RK2(49) which may be traced from battery through the winding of relay RK3(49), contact 1 of relay RK2(49), conductor 4906, contact 1 of relay RK1(36), conductor 3611 of cable E(36) extending to Fig. 45, contact 1 of relay GTU(45), conductor 3612 of cable E(45) extending to Fig. 36, contact 7 of relay OC(37), conductor 3711 of cable A(33) extending to Fig. 51, contact 24 of relay MCB(51), conductor 5116, contact 18 of relay LV2(38), conductor 3812 of cable 3826, contact 41 of relay F1(54), conductor 5403 of cable A(54) extending to Fig. 26 and to ground at contact 1 of relay ON(26). If all of the relays connecting the marker with the originating register are operated and the register checking relays have been operated, relay RK3(49) operates locking over its contact 5 and conductor 5002 to ground at contact 10 of relay CKG2(50). Relay RK3(49) at contact 4 opens the operating circuit for relay GTL(36) which in turn at contact 5 opens the operating circuits for relays GTL2(45), GTL3(32) and GTL4(32).

The release of relays GTL2(45), GTL3(32) and GTL4(32) removes all of the operating grounds for the register relays both in the marker and in the originating register. However, if the register relays in the originating register have operated and locked, the associated register relays in the marker will be held operated from the originating register and relays RK1(36) and RK2(49) will remain operated.

After the selection of an idle connecting path or channel has been completed, the marker will proceed to set up the selected connecting path by operating the select magnets on both the line-link frame and the trunk-link frame which are associated with the selected path and operating the hold magnets associated with the selected channel after the select magnets are operated. It will then test the selected channel for false crosses or grounds, for continuity and for double connections to determine that the channel is in a proper condition for service and if the connection is satisfactory will extend the selected channel from the trunk-link frame to the selected register. These functions are carried forward by the marker in the manner fully set forth in the application of A. J. Busch hereinbefore referred to and since they do not specifically concern the present invention they will not be described in detail herein. Suffice it to say that in the line-link frame the line links appear on the horizontal levels of both the line switches and the junctor switches and that with the HG0(1) relay operated as previously described and the CH0(86) relay operated to select the channel 0, a circuit is established to the winding of select magnet LS0(1) and ground and to the winding of the select magnet LJ0(1) and ground thereby operating the select magnets associated with the two

ends of the selected line link 0. Select magnets LJS0(1) and LJ0(1) prepare the cross-points of the zero levels of the line switch and the line-junctor switch for operation. On the trunk-link frame, the junctors appear in the horizontal levels of the trunk-link junctor switches so that the selection of a junctor as a part of a channel will determine the select magnet to be operated. Therefore, if it be assumed that in the selection of the channel 0, the junctor switch relay JC0(51) has been operated and therefore the select magnet J0(38) of the junctor of the selected channel is operated to prepare cross-points of the zero level in the trunk-junctor switch for operation. When the originating register was selected, relay FB2(38) was operated and therefore select magnets B(38) and T2(38) are now operated from the marker. Select magnet B(38) prepares the zero level cross-point of the trunk circuit for operation to prepare for connecting the trunk link with the B appearance in the other levels. Select magnet T2(38) prepares the cross-points of the second level on a trunk switch for operation.

In order to complete the operations of the cross bar switches, the marker must then operate the hold magnets of these switches. The identification of the line group within which the calling line is located and the operation of relay LG0(1) extends the operating circuits for the hold magnets associated with the five lines included in the line group to the marker. The identification of the junctor group to be used and the operation of relay JC0(51) extends the operating circuits for the associated hold magnets belonging to the line-junctor switches toward the marker. The identification of the group of trunk links to be used and the operation of the link connector relay LC0(38) extends the operating circuits for hold magnets associated with the trunk link toward the marker. After the selection of the connection path, the marker will delay the operation of the hold magnets for a period of time sufficient to allow the select magnets to fully operate and will then close the circuits for the hold magnets to complete the connection. Line junctor hold magnet L(1) and hold magnets J(38) and BH(38) of the trunk-link frame are now operated from the marker. Hold magnet BH(38) now closes cross-points B0 and 20 in the trunk-link switch of Fig. 38 while magnet J(38) closes the cross-point 00 of the trunk frame junctor switch of Fig. 38. With cross-point 00 of the trunk frame junctor switch operated, the operating circuit of hold magnet J(38) is extended over the sleeve conductor 3813 to the winding of the hold magnet J(1) of the line-junctor switch causing that magnet to operate to close cross-point 00 on the line-junctor switch of Fig. 1. The operation of hold magnet L(1) has closed the cross-point contacts 00 of the line switch of Fig. 1.

The marker now checks to determine that the above-mentioned cross-points have been closed and that there are no false grounds, crosses at the cross-points and no double connections, and if the connection has been properly set up relay DCT1(46) will operate and open at its contact 3 the locking circuit of relay F(26) in the originating register causing that relay to release in turn releasing relay FB2(38). With relay FB2(38) released, the tip, ring and sleeve conductors of the established connection are disconnected from the marker and extended to the originating register.

First party line station test

It will be recalled that relay 2P(42) of the originating register has been operated to signify that the originating call is from a two-party line. When this relay operated it established a circuit from battery through the winding of relay TPA(42), contact 1 of relay TPT(42), contact 6 of relay 2P(42), conductor 4203 of cable 2642, contact 2 of relay F(26) and to ground on conductor 4202 at contact 3 of relay ON(26). Relay TPA(42) operates in this circuit and locks over contact 1 of relay TPT(42), contact 7 of relay TPA(42) to ground over conductor 4202 independent of relay 2P(42). When relay FB2(38) releases, the tip conductor 3805 is extended over contact 1 of relay FB2(38), conductor 3806 of cable 2638 extending to the originating register where it further extends over contact 1 of relay RL(26), conductor 2607 of cable 2642, contact 4 of relay TPA (42) and thence through the winding of relay TP(42) to battery, and ring conductor 3807 is extended over contact 3 of relay FB2(38), conductor 3808 of cable 2638, contact 4 of relay RL(26), conductor 2608 of cable 2642, contacts 5 and 4 of relay TPA(42) and through the winding of relay TP(42) to battery. Relay TPA(42) also establishes a holding circuit for relay S1(26) which extends through the winding and contact 2 of relay S1(26), conductor 2611 of cable 2642 and to ground over contact 8 of relay TPA(42). The sleeve conductor 3809 extends over contact 6 of relay FB2(38), conductor 3810 of cable 2628 to the originating register where it further extends over contact 5 of relay RL(26) and contact 1 of relay ON(26) to ground.

If the calling line is grounded indicating that the tip party is calling, as assumed, relay TP(42) operates establishing a circuit over its contact, contact 6 of relay TPB(42) and through the winding of relay TP1(42) to battery. Relay TP1(42) operates in this circuit and locks over its contact 3, conductor 4204 of cable 2642 to ground at contact 3 of relay S1(26) and connects the tip and ring conductors of the connection appearing in conductors 2607 and 2608 at Fig. 42, over contact 4 of relay TP1(42), contact 1 of relay TPB(42), conductor 4200 extending through cables 2642 and 2628, contact 2 of relay CNT1(28), conductors 2800 and 2900, contact 2 of relay CR1(28), conductor 2801 of cable 2826 and thence through the lower left winding of dial tone coil TN(26) to ground to reduce the current in the tip party's ringer so that the self-induced voltage will not be high enough to cause ring party bell tapping when the circuit through the relay TP(42) and the ringer is broken.

When relay TPA(42) operates as previously described, a charging circuit is established for condenser TPT(42) which extends from positive battery through resistance TPT3(42), resistance TPT2(42), condenser TPT(42), contact 2 of relay TPA(42), the winding of relay TPTC(42) and resistance TPT4(42) to ground. In approximately 0.3 second, the voltage across the condenser will rise sufficiently to cause the breakdown of the control gap of tube TPTT(42). Relay TPT(42) will then operate over the main gap of the tube and at its contact 1 open the locking circuit of relay TPA(42) which then releases. With relay TPA(42) released, the circuit through the tube and relay TPT(42) is opened and relay TPT(42) releases and the tube becomes extinguished. A discharge path for condenser TPTC(42) is now established through resistance

TPT2(42) and over contact 1 of relay TPA(42). Relay TPA(42) also at contact 8 opens the locking circuit of relay S1(26) and at its contacts 4 and 5 disconnects the winding of relay TP(42) from the tip and ring conductors of the established connection. Thereupon relay TP(42) releases. The time required to cause the tube to fire, relay TPT(42) to operate and relay TPA(42) to release is sufficient to allow the relay FB2(38) to release as previously described and connect the tip and ring conductors to the originating register and for relay TP(42) and relay TP1(42) to operate as above described.

The release of relay TPA(42) also connects tip conductor 2607 over contact 3 of such relay, conductor 4208 of cables 2642 and 2628, contact 2 of relay CNT1(28), conductors 2609 and 2806, contact 2 of relay CR1(28), conductor 2801 of cable 2826 and through the lower left winding of tone coil TN(26) and ground. The ring conductor 2608 extends over contact 6 of relay TPA(42), conductor 4201 extending through cables 2642 and 2628, contact 5 of relay CNT1(28), conductor 2802, over either contact 3 of relay CR(29) or contact 5 of relay CR1(28), conductor 2804 and contact 6 of relay CR(29) to conductor 2803, thence over cable 2826 through the upper left winding of dial tone coil TN(26), lower contact of jack JL(26), middle winding of relay L(26) and upper contact of jack JL(26) to battery.

With the calling subscriber's receiver off the switchhook, relay L(26) operates over the tip and ring conductors in series with the calling line in a direction to close its contact 2 thereby reclosing a circuit from battery, through the winding of relay SR(26), conductor 2609, winding of relay LA(39), conductor 3900, contact 2 of relay L(26) and to ground at contact 2 of relay ON(26). Relay SR(26) and relay LA(39) operate in this circuit, relay SR(26) closing a circuit from ground over its contact 2 through the winding of relay ON1(26) to battery. Relay ON1(26) operates in this circuit connecting ground at its contact 2 to the winding of relay ON(26) to hold that relay operated and thereby hold the dial tone connection under the control of the calling subscriber. The circuit controlled by relay S1(26) which operated relay ON(26) is opened by the release of relay F(26) but relay S1(26) is sufficiently slow in releasing to prevent the release of relay ON(26) until relay ON1(26) is operated. Relay F(26) in releasing also opens the previously traced circuit for relay F1(54) causing that relay to release and disconnect the calling line registers from the marker.

As a check that relay FB(38) has released, it will open the circuit of relay FAK(33) at the marker, releasing that relay to in turn release relay SL(47). When relay FB2(38) in releasing extends the sleeve conductor of the selected connecting path to ground in the originating register as above described, this ground is extended to the winding of relay DCT(34) in shunt of battery to the winding of the hold magnet causing relay DCT(34) to open its contact 1 and reclose its contact 2. With contact 2 of relay DCT(34) closed a circuit is established from ground at the line busy and continuity ground test circuit (not shown) over conductor 3400, contact 9 of relay CKG(46), conductor 4603, contact 2 of relay DCT(34) conductor 3401, coil DCT3(33), conductor 3305, contact 7 of relay DCT2(46), contact 4 of relay DCT1(46) and through the winding of relay LK1(46) to battery. Relay LK1(46) operates in this circuit and locks over its contact 6 to ground at contact 3 of relay CKG4(46). The operation of relay LK1(46) is an indication that the connecting path between the calling line and the selected originating register has been set up, has been tested and has been found in condition for service.

Marker release

When relay LK1(46) operates, it opens the operating circuit for relays ONW(35), LLC2(48) and LLC1(48) causing them to release. Relay LK1(46) closes a circuit which may be traced in part from battery through the windings of relays DIS1(50) and DIS2(37), conductor 5909 extending to the master test frame connector controller and timing circuit (not shown), over contacts of relays therein, returning over conductor 5010, contact 2 of relay TRS(37), conductor 3712 of cable E(36) extending to Fig. 45, contact 2 of relay GTL4(32), contact 1 of relay GTL3(32), conductor 3234, contact 1 of relay GTL2(45), conductor 4502 of cable E(45) extending to Fig. 36, contact 3 of relay RK3(49), conductor 4907 extending to the trunk-link frame selector circuit (not shown), thence through the master test frame connector controlling and timing circuits and returning over conductor 4604, contact 8 of relay ITRE(46) and to ground at contact 7 of relay LK1(46). Relays DIS1(50) and DIS2(37) operate in this circuit, relay DIS1(50) closing the locking circuit for itself and relay DIS2(37) which may be traced through the windings of these relays, contacts 7 and 4 of relay DIS1(50), conductor 3701, contact 3 of relay TRLA(37), conductor 3702, conductor 3607 and to ground at contact 12 of relay MAI(25).

Relay DIS1(50) at its contact 8 opens the operating circuit for relays TLC1(48) and TLC2(48) causing these relays to release. At contact 3, relay DIS1(50) opens the operating circuit for relays CKG2(50) and CKG3(37) causing these relays to release. Relay DIS1(50) upon operating opens the operating circuit of the operated route relay which has determined that the call was for a dial pulsing originating register, and at its contact 6 opens the circuit over which relay MS1I(25) was locked in series with relay OC1(37) thereby releasing both relay OC1(37) and relay MS1I(25).

Relay MS1I(25) opens the operating circuit for the multicontact relay MA1(25) of the line-link marker connector which in turn releases the multicontact relay MB1(25) thereby completing the opening of the connections established between the line-link frame and the marker through the line-link marker connector. Relay MA1(25) opens at its contact 2 the circuit of a relay (not shown) which releases, disconnecting ground from conductors to release the CB relays in all of the marker connectors and the markers associated with such connectors.

The release of relay CKG2(50) causes the opening of the operating circuit for relays DIS1(50) and DIS2(37), while the release of relay MA1(25) opens the locking circuit for these relays permitting them to release in turn.

In addition, the release of relay MS1I(25) opens the circuit of relay D(35) which will release in turn releasing relays DT1(49), DT2(47) and DT3(47). When relay DCT1(46) operated as previously described, it opened the circuit of relay GTL1(22) which released in turn releasing relay GTU(45). Relay GTU(45) opens the circuits by which relays FT0(44), FU4(44) and

FU7(44) have been held operated from the originating register, causing these relays to release.

The release of relay MA1(25) in the line-link marker connector will release relay GK(20) which in turn releases relays VGR(20), HGR(21) and FR(10). The release of relay D(35) opens the locking circuit for relays VGT0(7), HGT0(9), VFT0(10), VTK(20), HTK(21) and FTK(10). Relays VGT0(7), HGT0(9) and VFT0(10) releasing in turn release relays VTK1(20), HTK1(20) and FTK1(10) respectively.

When relay LLC1(48) releases in response to the operation of relay LK1(46), it opens the circuit of the marker preference relay MP1(25) of the line-link frame connector causing that relay to release, in turn releasing the multicontact relay MCA(1) of the line-link frame connector. Relay MCA(1) opens the circuit for the other multicontact relays MCA1(1) and MCB(1) of the line-link frame connector completing the disconnection of the marker from the line-link frame. At the line-link frame the release of relay MCA(1) opens the circuit for the horizontal group relay HK0(1) which releases in turn releasing the line group connector relay LC0(1). Relay MCA(1) also opens the circuit of relay VGB0(1) causing that relay to release. When relay DIS1(50) operates it opens the circuit for relay VGA0(1) which was further opened by the release of relay MA1(25).

Relay LLC1(48) also opens the circuit of the operated class relay CS1(84) causing that relay to release. The release of relay F1(54) in the originating register opens the circuits by which relays VG4(31), VG7(31), HG4(31), HG7(31), VF0(44), CT0(83), CU0(83) and CU1(83) were being held from the originating register causing all of these relays to release. As soon as any one of these relays releases, the circuit of relays RK1(49) and RK2(49) is opened and such relays release.

Relay TLC1(48) in releasing opens the circuit of relay MP1(51) in the trunk-link frame, releasing that relay in turn releasing relays MC(51), MCA(51), MCB(51), MCC(51) and MCD(51) to disconnect the marker from the trunk-line frame. The release of relay FB2(38), previously described, releases level relay LV2(38) and link connector relay LC0(38). Relay LC0(38) in releasing, opens the circuit for relay LCK(33) in the marker. When relay MP1(51) releases, it also releases the trunk frame check relay (not shown) in the marker while the release of relay MCA(51) releases relay MAK1(63) and relay MCD(51) releases relay MDK(48).

The remaining operated relays of the marker now release as fully set forth in the application of A. J. Busch hereinbefore referred to. The marker is now ready to serve another call.

On the line-link frame the operation of hold magnet L(1) releases the line relay L00(1) which disconnects ground from conductors 101 and 102 thereby releasing relay VGS0(1) if no other line on this frame is seeking a dial tone connection. The release of relay VGS0(1) opens the circuit of relay DT(1) which releases to stop timing and opens the start conductors leading to the line-link marker connector. When relay MA1(25) in the line-link marker connector releases, it disconnects ground from conductor 2506, opening the operating circuit for relay W(13) and permitting relay Z(13) to operate in the locking circuit for relay W(13). Therefore on the next seizure of the line-link marker connector, the start circuit 105 becomes effective to prepare a different marker to serve that call.

Intraoffice call—registration of called line number

When relay SR(26) operated as previously described, it was effective to close the dial tone supply circuit which may be traced from the tone supply connected to conductor 3901, contact 4 of relay P2A(39), conductor 3902, contact 1 of relay SR(26), contact 3 of relay MAN(26), conductor 3903, contact 8 of relay 11D(41), conductor 4100, contact 6 of relay BT(52), conductor 5200, contact 1 of relay CNT2(28), conductor 2805 of cable 2628, condenser TNC(26) and through the primary or right winding of dial tone coil TN(26) to ground. The completion of this circuit transmits a dialing tone signal to the calling line. The subscriber hearing the tone, commences to dial the number of the desired connection.

When relay ON1(26) operated as above described, it closed the circuit from ground over its contact 3, conductor 2612, contact 2 of relay P2A(39), conductor 3904 and through the winding of steering relay AS(40) to battery. Relay AS(40), which is the first of a group of seven steering relays which serve to control the successive operation of the groups of register relays shown in Figs. 27, 40 and 53, operates in this circuit and locks in a circuit over its contact 7, contact 7 of relay BS(40), conductor 4000 and to ground at contact 9 of relay ON(26).

It will be assumed that the calling subscriber wishes to establish an intraoffice connection, for example, to a line whose number is Chester 3–7890, which is equivalent to 243–7890. Such a line is schematically illustrated as line 150 in Fig. 1. When the subscriber dials the first digit 2, the line loop will be opened twice. On the first opening of the line loop, relay L(26) releases, thereby opening the circuit previously traced through the windings of relay LA(39) and relay SR(26). Relay SR(26) is slow to release and holds operated during the momentary openings of the right contact relay L(26), but relay LA(39) follows relay L(26), releasing when relay L(26) releases and reoperating when L(26) reoperates. Relay LB(39) in turn follows relay LA(39), its operating circuit extending from battery through its winding, contact 1 of relay LA(39), conductor 3905, contact 1 of relay ON1(26) and to ground at contact 2 of relay ON(26). When the first dial opening occurs and relay LA(39) releases, a circuit is established from battery through the lower winding of relay RA(39), contact 2 of relay LA(39) to ground on conductor 3905. Relay RA(39) operates and being slow to release remains operated during the train of pulses. When relay RA(39) operates, it supplies holding ground from conductor 3905 over its contact 4 for relays LC(39), LD(39) and LE(39).

Due to the fact that relay RA(39) is somewhat slow in operating as well as in releasing, relay LB(39) is arranged to close this holding circuit over its normally closed contacts 2 and 3 until relay RA(39) has had time to operate.

Relay RA1(39) was operated as soon as the originating register was seized over a circuit extending from battery through its winding, contact 1 of relay RA(39), conductor 3906 and to ground at contact 4 of relay ON(26). When relay RA(39) operates, relay RA1(39) releases, thereby closing the operating circuit for the even pulse counting relays P2(39), P4(39) and P6(39) and preparing locking circuits for all of the pulse

counting relays P1(39) to P6(39). With relay RA(39) operated, and relay RA1(39) released, the register is ready to count dial pulses. At each closure of contact 1 of relay L(26) there is the connection of ground over contact 2 of relay ON(26), conductor 2613, over contact 1 of relay L(26), contact 3 of relay SR(26), conductor 2614, contact 1 of relay MST1(52) and conductor 5201 to contacts of relay LE(39). The first release of relay L(26) in response to the first dial pulse therefore completes the circuit over contact 1 of relay LE(39) and through the winding of relay LC(39) to battery. Relay LC(39) thereupon operates and locks in a circuit through the lower winding of relay LE(39), contact 1 of relay LD(39), contact 1 of relay LC(39), contact 4 of relay RA(39) and to ground over conductor 3905 as previously traced. Relay LE(39) does not however operate in this locking circuit because, until relay L(26) reoperates, its lower winding is shunted. When, however, relay L(26) reoperates, relay LE(39) operates. At the next release of relay L(26) in response to a second dial pulse, ground is again applied to conductor 5201 and a circuit is completed over contact 2 of relay LE(39) and through the upper winding of that relay and through the upper winding of relay LD(39) to battery whereupon relay LD(39) operates and relay LE(39) is held operated. Relay LD(39) in operating, opens the holding circuit for relay LC(39) and relay LC(39) thereupon releases. When relay L(26) reoperates, the circuit traced through the upper winding of relay LE(39) and through the upper winding of relay LD(39) is opened and LE(39) releases, but relay LD(39) is maintained operated over a locking circuit which extends from battery through the lower winding and contact 2 of relay LD(39), contact 2 of relay LC(39), conductor 3907, contact 4 of relay RA(39) to ground on conductor 3905, so that relay LD(39) holds the circuit for relay LC(39) open until the latter relay has completely released. Assuming that there is a third pulse, the release of relay L(26) to apply ground to conductor 5201 is effective to again operate relay LC(39) and the cycle will be repeated. Pulses 1, 3, 5, 7 and 9 will thus cause the operation of relay LE(39) and pulses 2, 4, 6, 8 and 10 will cause relay LE(39) to release.

The first time that relay LE(39) operates it establishes a circuit from ground on conductor 3905, over contact 4 of relay RA(39), contact 4 of relay LE(39), conductor 3909, contact 6 of relay P4(39), contact 6 of relay P2(39), contact 2 of relay P3(39), contact 1 of relay P5(39) and through the lower winding of relay P1(39) to battery. Relay P1(39) thereupon operates and locks in a circuit from battery through its upper winding and contact 4, contact 2 of relay P2(39), contact 4 of relay P3(39), contact 2 of relay P4(39), contact 4 of relay P5(39), contact 3 of relay RA1(39) and to ground on conductor 3905.

When relay LE(39) releases in response to the second pulse, ground is connected from conductor 3907 over contact 3 of relay LE(39) and contact 4 of relay RA1(39) to conductor 3908, and with relay P1(39) operated, the circuit is completed over contact 6 of relay P1(39) in parallel to the winding of relay P2(39) and over contact 5 and through the winding of P2A(39) to battery. Relay P2(39) operates and locks over contact 3 and as previously traced over the locking circuit of relay P1(39) to ground on conductor 3905. It opens the locking circuit of relay P1(39) which relay thereupon releases. Relay P2A(39) also operates and locks over its contact 6 to ground on conductor 2613.

Under the assumption that the first digit dialed is the digit 2, the pulses for the first digit now terminate and certain interdigital operations would take place which will be described hereinafter. However, for convenience, the operation of the pulse counting relays for a maximum number of pulses will be described at this time. When relay LE(39) again operates in response to a third impulse, and connects ground to conductor 3909, a circuit is completed over contact 6 of relay P4(39), a contact 5 of relay P2(39) to battery through the winding of relay P3(39). Relay P3(39) thereupon operates and locks over its contact 5 to the locking circuit previously traced to ground on conductor 3905, and at its contact 4 opens the locking circuit for relay P2(39) which now releases. On the fourth pulse, when relay LE(39) releases and applies ground to conductor 3908, a circuit is established over contact 6 of relay P3(39) and through the winding of relay P4(39) to battery. Relay P4(39) operates and locks over its contact 3 to ground on conductor 3905, and at its contact 2 opens the locking circuit for relay P3(39) which now releases. On the fifth pulse when relay LE(39) again operates and connects ground to conductor 3909, a circuit is established over contact 5 of relay P4(39) through the winding of relay P5(39) to battery, and the latter relay thereupon operates, locks over contact 7 of relay P1(39), contact 5 of relay P5(39) to ground on conductor 3905, and at its contact 4 opens the locking circuit for relay P4(39) which now releases.

On the sixth pulse when relay LE(39) again releases and connects ground to conductor 3908, a circuit is completed over contact 6 of relay P5(39) through the lower winding of relay P6(39) to battery, and the latter relay operates and locks through its upper winding and contact 3 to ground on conductor 3905, and over its contact 4 establishes an obvious circuit through the winding of relay P6A(39) to battery and the latter relay then operates. It is to be noted that the operation of relay P6(39) does not cause the release of relay P5(39).

In response to the seventh pulse, relay LE(39) again operates and connects ground to conductor 3909, completing a circuit over contact 6 of relay P4(39), contact 6 of relay P2(39), contact 2 of relay P3(39), contact 1 of relay P6(39) and through the lower winding of relay P1(39) to battery. Relay P1(39) operates and locks over a circuit which extends as previously traced to contact 4 of relay P3(39) and thence over contact 2 of relay P1(39), contact 2 of relay P6(39), contact 3 of relay RA1(39) and to ground on conductor 3905. Relay P1(39) at its contact 7 opens the locking circuit of relay P5(39) which now releases.

On an eighth pulse, relay LE(39) again releases, connects ground to conductor 3908, and with relay P1(39) operated, completes the previously traced circuit for operating relay P2(39). Relay P2(39) operates and locks over its contact 3 and the locking circuit just traced to ground on conductor 3905 and opens the locking circuit for relay P1(39) which now releases.

In a ninth pulse, relay LE(39) operates grounding conductor 3909 and closes the previously traced circuit for relay P3(39) which operates, locks over its contact 5 to the second locking circuit previously traced and at its contact 4, opens

the locking circuit for relay P2(39) which releases.

The tenth pulse causes relay LE(39) to release, thereby grounding conductor 3908 and closing the previously traced circuit for relay P4(39). Relay P4(39) operates, locking over its contact 3 and contact 4 of relay P5(39), which has been released, to ground on conductor 3905, as previously traced. Relay P4(39) opens the locking circuit for relay P3(39) which releases.

The following table shows the relays operated after any pulse:

Pulse No.	Relays Operated	Conductor Grounded
1	LC, LE, P1	3910 3911
2	P2	3910 3912
3	LC, LE, P3	3911 3912
4	P4	3910 3914
5	LC, LE, P5	3911 3914
6	P5, P6, P6A	3912 3914
7	LC, LE, P1, P6, P6A	3910 3917
8	P2, P6, P6A	3911 3917
9	LC, LE, P3, P6, P6A	3912 3917
10	P4, P6, P6A	3914 3917

The pulse counting will of course stop when the dial reaches its normal position, leaving the pulse counting relays operated as shown in the preceding table.

When a train of pulses for a digit ends, relays L(26) and LA(39) remain operated and relay RA(39) releases, thereby causing the reoperation of the relay RA1(39). Relay RA(39) at its contacts 2 and 3 now closes paths over the contacts of relays P1(39) to P5(39) and P6A(39) to two of the conductors 3910, 3911, 3912, 3914 and 3917, according to the pattern in the preceding table. The operation of relay RA1(39) at its contact 3 disconnects ground on conductor 3905 from the locking circuits for the "P" relays, thereby releasing any operated P relay and removing ground from the two selected conductors. During the operating time of relay RA1(39) and the release time of the P relays, a pair of the register relays of Figs. 29, 40 and 53 will be operated corresponding to the two conductors grounded and corresponding to the digits being registered. The conductors 3910 to 3917 will be extended to the group of five relays constituting the registers in sequence, as will be hereinafter described.

When relay P2A(39) operated as previously described, in response to the second dial pulse, it opened at its contact 4 the previously traced circuit through the right winding of the dial tone coil TN(26) to stop the transmission of dial tone, and at its contact 2 it established a circuit for relay EV(40) which may be traced from battery through the winding of said relay, over the normally closed contact 6 of relay OD(40), contact 10 of relay AS(40), conductor 4001 and to ground at contact 3 of relay P2A(39). Relay EV(40) connects conductors 3910 to 3917 over its contacts 1 to 5 and contacts 2 to 6 of relay AS(40), over conductors 5300 to 5307 to the windings of relays A0(53) to A7(53). Since conductors 3910 to 3917 cannot be connected to the relays of the A digit register until relay P2A(39) operates following the transmission of two pulses, a single pulse digit or series of single pulse digits will not affect the A digit register and a wrong number will not be registered if a calling subscriber accidentally generates a single pulse by opening the switchhook contacts before dialing.

It has been assumed that the calling subscriber has operated his dial to transmit two pulses as a first digit of the wanted number. Consequently at the end of the series of two pulses, relay P2(39) will be operated, and upon the release of relay RA(39) at the end of the pulse series, ground is applied from conductor 3906, contact 3 of relay RA(39), conductor 3918, contact 4 of relay P2(39), contact 6 of relay P6A(39), conductor 3910, contact 5 of relay EV(40), contact 6 of relay AS(40), conductor 5300 and through the winding of relay A0(53) to battery, and ground is applied from conductor 3906, contact 2 of relay RA(39), conductor 3919, contact 1 of relay P2(39), contact 3 of relay P6A(39), conductor 3912, contact 3 of relay EV(40), contact 4 of relay AS(40), conductor 5302 and through the winding of relay A2(53) to battery. Relays A0(53) and A2(53) both operate and lock over their contacts 1 and 2, conductor 5308 and to ground at contact 7 of relay ON1(26). Thus the relays of the A digit register have been operated to register digit 2.

As above mentioned, when relay RA1(39) operates at the end of the pulse series, the pulse counting relay P2 is released. At its contact 1, relay RA1(39) closes a circuit from battery through the winding of relay AS(40) and its contact 9, contact 9 of relay EV(40), conductor 4002 and to ground over conductor 4000 as previously traced, thereby holding relay AS(40) operated after the previously traced locking circuit over a normal contact of relay BS(40) has been opened until the beginning of the reception of the next digit series. At its contact 2, relay RA1(39) closes a circuit from grounded conductor 4000, contact 2 of relay RA1(39), conductor 4003, contact 7 of relay EV(40), contact 8 of relay AS(40), and through the winding of relay BS(40) to battery. Relay BS(40) operates in this circuit and locks in a circuit over its contact 8, contact 6 of relay CS(40) and to ground over conductor 4000, preparatory to registering a second digit.

At the beginning of the second digit series relay RA1(39) is released in the manner described for the first digit, opening the holding circuit for relay AS(40) and the initial energizing circuit for relay BS(40). When relay AS(40) releases, the circuit of relay EV(40) is opened and that relay also releases. With relay BS(40) operated and relay EV(40) released, a circuit is closed from battery through the winding of relay OD(40), contact 6 of relay EV(40) and contact 10 of relay BS(40) to ground. Relay OD(40) operates in this circuit to prepare the circuits for registering the second digit.

At the end of the second digit series, which is the digit 4, relay P4(39) will be operated, and when relay RA(40) releases, ground on conductor 3906 is connected over contact 3 of relay RA(39), conductor 3918, contact 4 of relay P4(39), contact 6 of relay P6A(39), conductor 3910, contact 5 of relay OD(40), contact 6 of relay BS(40), conductor 5310 and through the winding of relay B0(53) to battery. A second circuit extends from ground on conductor 3906, over contact 2 of relay RA(39), conductor 3919, contact 1 of relay P4(39), conductor 3914, contact 2 of relay OD(40), contact 3 of relay BS(40), conductor 5314 and through the winding of relay B4(53) to battery. Relays B0(53) and B4(53) operate and lock over their contacts 1 and 2 to grounded conductor 5308 to record that the second digit is the digit 4.

When relay RA1(39) reoperates at the end of the second digit series, it closes the circuit from battery through the winding of relay BS(40), contact 11 of relay BS(40), contact 9 of relay OD(40), conductor 4002, contact 1 of relay RA1(39) to grounded conductor 4000 to hold relay BS operated until the first pulse of the third digit is received. At its contact 2, relay RA1(39) connects ground over conductor 4003, contact 7 of relay OD(40), contact 9 of relay BS(40) through the winding of relay CS(40) to battery. Relay CS(40) operates in this circuit, locking over its contact 7, conductor 4004 and contact 6 of relay DS(27) to ground on conductor 4000.

At the beginning of the third digit series, relay RA(39) reoperates, in turn releasing relay RA1(39) and opening the operating circuits for the B register relays of Fig. 53. Relay RA1(39) upon releasing, opens the holding circuit for relay BS(40), which now releases opening the operating circuit for relay OD(40) which also releases. With relay CS(40) operated and relay OD(40) released, a circuit is closed from battery through the winding of relay EV(40), contact 6 of relay OD(40) and to ground at contact 9 of relay CS(40). With relays CS(40) and EV(40) operated, conductors 3910 to 3917 are extended over conductors 5320 to 5327 to the C register relays of Fig. 53.

This progression continues, relay EV(40) being operated in combination with relays ES(27) and GS(27) to transmit the fifth and seventh digits to registers E and G of Figs. 40 and 27, respectively, while relay OD(40) is operated in combination with relays DS(27) and FS(27) to transmit the fourth and sixth digits to the registers D and F of Figs. 40 and 27, respectively.

Therefore, from a consideration of the foregoing table, it will be apparent that conductors 3911 and 3912 will be grounded following the third digit to operate relays C1(53) and C2(53); conductors 3910 and 3917 will be grounded following the fourth digit to operate relays D0(40) and D7(40); conductors 3911 and 3917 will be grounded following the fifth digit to operate relays E1(40) and E7(40); conductors 3912 and 3917 will be grounded following the sixth digit to operate relays F2(27) and F7(27), and conductors 3914 and 3917 will be grounded following the seventh and last digit to operate relays G4(27) and G7(27). Relays C1(53) and C2(53) lock over their contacts 1 and 2 to conductor 5308, relays D0(40), D7(40), E1(40), E7(40), F2(27) and F7(27) lock over their contacts 1 and 2 and conductor 2700 to ground at contact 8 of relay ON1(26) and relays G4(27) and G7(27) lock over their contacts 1 and 2, conductor 2701 and contact 10 of relay ON1(26) to ground.

When relay ON(26) operates when the register is seized and connects ground over its contact 5 to conductor 2615, it completes the circuit over contact 1 of relay TMB(52) and to battery through the upper winding of relay TMA(52). Relay TMA(52) operates in this circuit and closes a locking circuit for itself from battery through its lower winding and contact 3, conductor 5202, contact 3 of relay CT1(28), conductor 2806, contact 4 of relay CRA(29), conductor 2901 of cable B(29) extending to Fig. 52, contact 4 of relay PD(52), contact 10 of relay MST(52) and to ground on conductor 2615. At its contacts 3 and 4, relay TMA(52) connects the winding of relay TMB(52) to the locking circuit above traced, causing relay TMB(52) to operate and open the operating circuit of TMA(52). When relay RA(39) releases at the end of the seventh digit series, permitting relay RA1(39) to reoperate, with relay 2P(42) operated a circuit is established for making a second party line test.

Second party line test

This circuit extends from battery through the winding of relay TPB(42), contact 2 of relay 2P(42), conductor 4205, contact 2 of relay TMB(32), conductor 5204 of cable B(52) extending to Fig. 29, contact 7 of relay CN1(29), conductor 2902, terminal MST cross-connected to contact 9 of relay GS(27), conductor 2702, contact 7 of relay EV(40), conductor 4003, contact 2 of relay RA1(39) and to ground on conductor 4000.

Relay TPB(42) operates over this circuit and establishes a circuit from battery through the winding of relay MST1(52), conductor 5205, contact 7 of relay TPB(42), conductor 4206 of cable 2642 to ground over contact 5 of relay ON(26). Relay MST1(52) operates in this circuit to prevent further dial registration. Relay TPB(42) also establishes a circuit for relay TPA(42) from battery through its winding, contact 3 of relay TPB(42), contact 1 of relay TPC(42), and to ground over conductor 4202, whereupon relay TPA(42) operates. Relay TPB(42) also establishes a holding circuit for relay L(26) over the circuit previously traced through the middle winding of relay L(26) to conductor 4201, thence through resistance HL2(42), contact 4 of relay TPB(42) and to ground at normal contact 3 of relay TPC(42). Relay TPA(42) upon operating disconnects relay L(26) and the lower left winding of tone coil TN(26) from the tip and ring conductors 2607 and 2608 of Fig. 42, connected to the tip and ring of the connection established to the calling line, and connects such conductors to the winding of relay TP(42) to make a second two-party identification test. If relay TP(42) now operates as it should under the assumption that the tip party of a two-party line has originated the call, a circuit is established from ground over its contact and contact 5 of relay TPB(42) and through the winding of relay TP2(42) to battery. Relay TP2(42) now operates and locks over its contact 3 to ground on conductor 4204.

The operation of relay TPA(42) starts the timer in the manner previously described so that after an interval of 0.3 second, condenser TPTC(42) will charge to the breakdown potential of tube TPTT(42) and such tube will conduct across its main gap, thereby causing the operation of relay TPT(42). Relay TPT(42) upon operating establishes a circuit from ground at contact 2 of relay TPB(42), contact 2 of relay TPT(42) and through the winding of relay TPC(42) to battery. Relay TPC(42) operates in this circuit, locks over its contact 2 to ground over contact 2 of relay TPB(42), and opens the circuit of relay TPA(42) which now releases and connects the winding of relay L(26) and the lower left winding of tone coil TN(26) to the tip and ring of the calling line. The release of relay TPA(42) causes the release of relay TPT(42) and the extinction of the tube. With relay TPT(42) released and relay TPC(42) operated, the local holding circuit for relay L(26) is opened, so that relay L(26) is now solely under the control of the subscriber's switchhook.

Relay TPC(42) upon operating establishes the circuit of relay MST(52) which may be traced

from battery through the winding of such relay, conductor **5203** either over contact **5** of relay CR3(28) or contact **1** of relay CRA(29), conductor **2807**, contact **4** of relay TPC(42), contact **2** of relay 2P(42), conductor **4205**, contact **2** of relay TMB(52), conductor **5204**, contact **7** of relay CN1(29), conductor **2902**, terminal MST cross-connected to contact **9** of relay GS(27), conductor **2702**, contact **7** of relay EV(40), conductor **4003**, contact **2** of relay RA1(39) and to ground over conductor **4000**. Relay MST(52) operates in this circuit, closing the holding circuit for relay MST1(52) from battery through the winding of relay MST1(52), contact **4** of relay MST(52), contact **1** of relay TM(52), to ground on conductor **2615**, and relay MST1(52) locks in a circuit from battery through its winding, over its contact **4** and to ground on conductor **2615** independent of relays MST(52) and TM(52).

Relay MST(52) in operating also establishes a circuit from ground over its contact **2**, contact **3** of relay MRL(52), contact **2** of relay BT(52), conductor **5206** of cable C(52) extending to Fig. 43 and thence through the winding of the timer start relay (not shown) in the marker connector circuit. At its contact **8**, relay MST(52) connects battery over conductor **5207** of cable A(52) extending to Fig. 43, to supply battery to the windings of the multicontact register connector relays RA(30), RB(30), RC(43) and RD(43) in the originating register marker connector.

Connection of originating register to marker

At its contact **7**, relay MST(52) establishes a start circuit for the originating register marker connector which may be traced in part from battery over such contact, contact **1** of relay MRL(52), contact **1** of relay BT(52), and conductor **5208** of cable C(52) extending to Fig. 43, and through the winding of the register preference relay RS1 (not shown) of the marker connector. This relay will operate if no other register is using the connector at this time and will connect ground to conductor **3000** to complete the circuit of connector relays RA(30) and RC(43), which will now operate. Relay RA(30) at its contact **2**, connects conductor **3001** to conductor **3002** and to the winding of re'ay RB(30) and to the winding of relay RD(43) to complete their operating circuits.

With relay RD(43) operated, battery supplied at the originating register over conductor **3003** through resistances Z(43) and W(43) and contacts **1** and **2** of relay RD(43), is applied to the armatures of a relay Z of the originating register marker connector control circuit, corresponding to relay Z(13), and assuming such relay and the associated relay TRS are not operated, a start circuit is completed over the upper contact of a CB relay corresponding to relay CB11(25) which is individual to marker No. **1** in the originating register marker connector connected with the originating register shown. Assuming that the marker No. **1** is idle and therefore that the CB relay of such marker is not operated, the start circuit will be extended to the winding of the marker start (MS) relay corresponding to relay MS11(25) allocated to such marker, if no incoming register is attempting to seize the marker, over contacts of the intermediate and last MS relays of the chain to ground. This start relay upon operating applies ground over conductors **4300** and **4301** of a cable extending from the originating register marker connector to the windings of the originating register marker connector relays MA(50) and MC(43) of the idle No. **1** marker whereupon such relays operate. The circuits over which the MS, MA and MC relays are operated are fully disclosed in the application of A. J. Busch hereinbefore referred to and function in the manner described therein and in a manner similar to that described herein in connection with the operation of the similar relays of the line-link marker connector. Relay MA(50) upon operating establishes over its contact **4** an obvious circuit for relay MB(50) and relay MC(43) establishes over its contact **3** an obvious circuit for relay MD(43). With relays RA(30), RB(30), MA(30), MB(30), RC(43), RD(43), MC(43) and MD(43) operated the originating register is connected with the selected marker over a large plurality of conductors.

In the originating register, relay MST(52) at its contact **9**, interconnects conductors **4205** and **5204** to close a holding circuit for itself independent of relay TMB(52). At its contact **10**, relay MST(52) opens the locking circuit for relay TMA(52) and the operating circuit for relay TMB(52) causing these relays to release to arrest the timing operation. With relay MST1(52) operated as above described, a holding circuit is closed for relay RA1(39) which may be traced from battery through the winding of relay RA1(39), conductor **3920**, contact **5** of relay MST1(52), conductor **3921** and conductor **3906** to ground at contact **4** of relay ON(26). At its contact **1** relay MST1(52) also opens the operating circuit for relays LC(39), LD(39) and LE(39) so that further pulsing will be ineffective.

Relay MA(30) closes a circuit to operate a relay OR (not shown) for informing the marker that it has been called in by an originating register and over its contact **3** connects ground over conductor **3004** of cable G(30) extending to Fig. 36, contact **5** of relay TRLA(37), contact **5** of relay DIS2(37), conductor **3713**, winding of relay CKG1(50), conductor **5011**, conductor **3702**, contact **3** of relay TRLA(37), conductor **3701**, contact **3** of relay DIS1(50), winding of relay CKG2(50), conductor **3700** and through the winding of relay CKG3(37) to battery. Relays CKG2(50) and CKG3(37) prepare the marker for operation as described in connection with the dial tone connection.

The marker having been informed that the connection which it is to serve is from an originating register, establishes the circuit of relay GTL(36) which in turn causes the operation of relays GTL2(45), GTL3(32) and GTL4(32).

Transfer of information from originating register to marker

When the multicontact relays of the originating register marker connector have operated as above described, a plurality of circuits are closed for transferring the calling line designation and the called line designation from the originating register to the marker. It will be recalled that as a result of the transfer of the calling line designation, the following relays were operated to identify the location and class of the calling line: frame tens relay FT0(56), frame units relays FU4(56) and FU7(56), horizontal group relays HG4(55) and HG7(55), vertical group relays VG4(55) and VG7(55), vertical file relay VF0(55), class tens relay CT0(54), class units relays CU0(54) and CU1(54). It will also be recalled that in addition, relays LL4(56) and LL7(56) were operated to record the identity of

the line link which was used for the dial tone connection.

As a result of dialing a called line designation, relays A0(53) and A2(53), B0(53) and B4(53), C1(53) and C2(53) were operated to register three digits of the office code designation of the desired line while relays D0(40) and D7(40), E1(40) and E7(40), F2(27) and F7(27), G4(27) and G7(27) were operated to register the four digits of the numerical designation of the wanted line. Each of these relays grounds a conductor individual thereto which is extended through the originating register marker connector to the marker to operate the corresponding register relays in the marker. In addition, the originating register grounds one of three conductors to inform the marker whether the call was a permanent signal, a partial dial or a regular call and one of three conductors to inform the marker whether a coin has been returned, a stuck coin has been encountered or that no coin return attempt has been made and one of two conductors to inform the marker if the call was from a tip or ring station of a two-party line.

More specifically, in the registers of Fig. 54, relays CU0(54), CU1(54) and CT0(54) connect ground at their contacts 3 and 4 to conductors 5410, 5411 and 5420 respectively. Conductors 5410 and 5411 extend through cable B(54) extending to Fig. 43, contacts 4 and 5 of relay RC(43), contacts 9 and 10 of relay MC(43), conductors 8410 and 8411 of cable A(43) extending to Fig. 84 and through the windings of relays CU0(83) and CU1(83) and battery. Conductor 5420 extends through cable D(54) extending to Fig. 43, contact 6 of relay RA(30), contact 8 of relay MA(30), conductor 8420 of cable H(30) extending to Fig. 84 and through the winding of relay CT0(83) and battery.

In the registers of Fig. 55, relays VG4(55), VG7(55), HG4(55), HG7(55) and VF0(55) connect ground over their contacts 3 and 4 to conductors 5534, 5537, 5544, 5547 and 5550 respectively. Conductors 5534 and 5537 extend through cable 5502, contacts 12 and 13 of relay RC(43), contacts 17 and 18 of relay MC(43), conductors 704 and 707 of cable A(43) extending to Fig. 45 and thence over contacts 9 and 8 of relay GTL(32), conductors 3204 and 3207 and through the windings of relays VG4(31) and VG7(31) to battery. Conductors 5544 and 5547 extend through cable 5503, contacts 16 and 17 of relay RD(43), contacts 18 and 19 of relay MD(43), conductors 904 and 907 of cable G(43) extending to Fig. 45, contacts 2 and 3 of relay GTL3(32), conductors 3214 and 3217 and through the windings of relays HG4(31) and HG7(31) and battery. Conductor 5520 extends through cable 5504, contact 15 of relay RC(43), contact 20 of relay MC(43), conductor 1010 of cable A(43) extending to Fig. 45, contact 7 of relay GTL4(32), conductor 3220 and through the winding of relay VF0(44) to battery.

In the registers of Fig. 56, relays FT0(56), FU4(56), FU7(56), LL4(56) and LL7(56) connect ground over their contacts 3 and 4 to conductors 5640, 5654, 5657, 5664 and 5667 respectively. Conductor 5640 extends through cable 5602, contact 20 of relay RC(43), contact 25 of relay MC(43), conductor 4520 of cable A(43) extending to Fig. 45, contact 3 of relay GTL2(45), conductor 4420 and through the winding of relay FT0(44) to battery. Conductors 5654 and 5657 extend over contacts 26 and 27 of relay RD(43), contacts 28 and 29 of relay MD(43), conductors 4514 and 4517 of cable H(43) extending to Fig. 45, contacts 10 and 11 of relay GTL2(45), conductors 4414 and 4417 and through the windings of relays FU4(44) and FU7(44) to battery. Conductors 5664 and 5667 extend over contacts 21 and 22 of relay RD(43), contacts 23 and 24 of relay MD(43), conductors 8504 and 8507 of cable I(43) extending to Fig. 86 and through the windings of relays LL4(85) and LL7(85) to battery.

Since the calling line is not a coin line and therefore none of the coin functions are employed, ground is connected over the back contact 2 of relay LT1(29), back contact 1 of relay LT2(29), conductor 2903, contact 10 of relay RA(30), contact 11 of relay MA(30) and thence to the winding of a relay in the coin disposal register of the marker (not shown) which informs the marker of this fact.

Since a complete designation has been dialed and therefore the timing circuit of Fig. 52 has not operated to indicate a permanent signal or partial dial condition, a circuit will be closed from ground over the back contact 3 of relay TM1(52), conductor 5209 of cable C(52) extending to Fig. 43, contact 1 of relay RC(43) and to the winding of a relay in the marker control circuit which informs the marker of this fact.

Since the calling station is a tip party station and relay TP2(42) has been operated, a circuit is established from ground at contact 2 of relay TP2(42), conductor 4207, contact 2 of relay RB(30), contact 2 of relay MB(30) and to the route relay control circuit of the marker to signify that the call originated at a tip party station.

Translation of office code

With register relays A0(53), A2(53), B0(53), B4(53), C1(53) and C2(53) operated to register the digits representing the office at which the called line is located, ground is connected over their contacts 3 and 4 to conductors 5330, 5332, 5340, 5344, 5351 and 5352 respectively. Conductors 5330 and 5332 extend through cable D(53) extending to Fig. 30, contacts 20 and 22 of relay RA(30), contacts 22 and 24 of relay MA(30), conductors 3010 and 3012 of cable C(30) extending to Fig. 58 and through the windings of relays AC0(58) and AC2(58) to battery. Conductors 5340 and 5344 extend through cable D(53) extending to Fig. 30, contacts 15 and 18 of relay RA(30), contacts 17 and 20 of relay MA(30) and conductors of a cable extending to the windings of relays of the second or B code digit register (not shown). Conductors 5351 and 5352 extend through cable D(53) extending to Fig. 30, contacts 11 and 12 of relay RA(30), contacts 13 and 14 of relay MA(30) and conductors of a cable extending to the winding of relays of the third or C code digit register (not shown). The second and third code digits are registered in exactly the same manner as the first code digit.

Since the complete designation was dialed and relay 11D(41) in the originating register has not been operated, a circuit is closed from ground over contact 1 of relay 11D(41), conductor 4101 of cable E(41) extending to Fig. 30, contact 5 of relay RA(30), contact 7 of relay MA(30) and thence through the winding of a relay in the translator control circuit which operates to signify that there are seven digits in the dialed number.

Transfer of numerical designation of called line to marker

With relays in the translator control circuit now operated to signify that a seven digit number has been dialed and the calling line is not a coin line but a two-party line, and that there is no permanent signal or partial dial condition, the registration of the first code digit in the A code digit register of Fig. 58 and the second and third code digits registered in the B and C code digit registers, the translator control circuit of the marker is effective to cause the operation of a route relay signifying that an intraoffice trunk should be selected. These functions are all carried out in the manner fully set forth in the application of A. J. Busch hereinbefore referred to and it is deemed unessential to describe them in detail herein.

In a seven digit area such as has been assumed for the present discussion, the office code digits are registered as above described on the A, B and C registers in the originating register and the four numerical digits are registered on registers D, E, F and G. However, certain areas may include offices employing one or two code digits or may employ no code digits whatsoever for local calls. Where only two office code digits are employed, the numerical digits will be registered on registers C, D, E and F, where only one office code digit is registered the numerical digits will be registered on registers B, C, D and E and where no code digit is registered, the numerical digits will be registered on registers A, B, C and D. Since the marker is designed to function with any one of such areas or with an area connected with a plurality of such areas, means is required for connecting the proper registers in the originating register with the numerical digit registers of the marker. For this purpose, relays N1(71), N2(71), N3(71), N4(71) and their associated relays N1A(71), N2A(80), N3A(80) and N4A(80) are provided. Relays N1(71) to N4(71) inclusive have their windings cross-connected to terminals in the translator control circuit so that they may be placed under the control of relays operated from the originating register which indicate the total of digits dialed for any call. It has been assumed that a relay has been operated indicative of the fact that a seven digit number has been dialed and will establish the circuit through the winding of relay N4(71) and such relay will operate closing at its contact 1 a circuit extending over conductor 7108 through the winding of relay N4A(80) and to battery whereupon relay N4A(80) operates.

With relays N4(71) and N4A(80) operated, the numerical designation of the wanted line is registered in the marker. It will be remembered that in the registers of Figs. 40 and 27, relays D0(40), D7(40), E1(40), E7(40), F2(27), F7(27), G4(27) and G7(27) were operated to register the numerical designations 7, 8, 9, 0. These relays at their contacts 3 and 4 connect ground to conductors 4010, 4017, 4021, 4027, 2712, 2717, 2724 and 2727 respectively. Conductors 4010, 4017, 4021 and 4027 extend through cable B(40) extending to Fig. 30, thence over contacts 16, 10, 11 and 7 of relay RB(30) and contacts 16, 12, 10 and 7 of relay MB(30) to conductors 3020, 3027, 3031 and 3037 of cable F(30) extending to Fig. 80 thence to the armatures of the N1 to N4 relays of Fig. 71. With relay N4(71) operated, conductors 3020 and 3027 become extended over contacts 2 and 6 of relay N4(71) and conductors 7100 and 7107 to the windings of relays TH0(38) and TH7(58) of the thousands digit register and thence to battery and conductors 3031 and 3037 become extended over contacts 8 and 11 of relay N4(71) and conductors 7111 and 7117 to the windings of relays HN1(57) and HN7(57) of the hundreds digit register and to battery. Conductors 2712, 2717, 2724 and 2727 extend through cable A(27) extending to Fig. 30, over contacts 24, 26, 20 and 21 of relays RB(30) and MB(30) to conductors 3042, 3047, 3054 and 3057 of cable F(30) extending to Fig. 80 thence to the armatures of the N1A to N4A relays of Figs. 71 and 80. With relay N4A(80) operated, conductors 3042 and 3047 become extended over contacts 9 and 11 of relay N4A(80), conductors 8002 and 8007 to the windings of relays T2(57) and T7(57) of the tens digit register and to battery and conductors 3054 and 3057 become extended over contacts 3 and 2 of relay N4A(80), conductors 8014 and 8017 to the windings of relays U4(71) and U7(71) of the units digit register and to battery. These numerical register relays operate in the circuits above traced.

Since from the operation of the route relay, it has been determined that the call is a local call, the numerical registration will be transmitted to the number group circuit which will inform the marker as to the location and type of the calling line and the nature of the ringing current required. However, since the connection cannot be completed unless an idle trunk is available, the seizure of the number group circuit is delayed until a trunk link frame has been seized upon which there is an idle intraoffice trunk. Since the present invention is not directly concerned with the functions of the marker in seizing an idle intraoffice trunk, such functions have not been disclosed and discussed herein, but reference is made to the application of A. J. Busch hereinbefore referred to for a complete disclosure and discussion thereof.

In response to the registration of the code digits of the called line number in the marker a route relay (not shown) is operated indicative of the route that must be set up to complete the desired connection, thereby causing the operation of the NS1(62) relay indicative of the fact that no sender will be required for the connection. Relay NS1(62) upon operating, causes the operation of relays ITR1 (not shown), ITR2(46) and ITR3(60) in a circuit which may be traced in part from battery through the winding of relay ITR3(60), conductor 6004, winding of relay ITR2(46), conductor 4609 extending to the recycle controller (not shown), thence through the class of call circuit (not shown), conductor 6200, contact 3 of relay NS1(62), conductor 6201, contact 1 of relay LR(63), conductor 6300, contact 5 of relay TR2E(50), conductor 2508 of cable C(36) extending to Fig. 25, contact 6 of relay MA1(25), conductor 1304 and to ground at contact 1 of relay TR1(13). These relays being operated, the marker is conditioned to complete the required intraoffice connection.

Selection of trunk link frame

The marker now proceeds to seize a trunk link frame having at least one idle intraoffice trunk appearing thereon, and to thereafter seize an idle intraoffice trunk in the same general manner as has been described in connection with the seizure of an idle originating register and as fully described in the application of A. J. Busch hereinbefore referred to.

Operation of number group circuit

The marker is now ready to determine the location of the called line. When relay ITR2(46) operated as previously described, it closed the circuit from battery through the winding of relay FLG(60), conductor 6000, contact 10 of relay LK1(46), contact 4 of relay ITR2(46), conductor 4606 and to ground at contact 6 of relay CKG3(37). To determine the location of the called line, the marker must select and seize a number group frame for the purpose of translating the digits of the called number registered in the marker into the location digits of the called line. Each number group circuit is equipped to assist in the location of one thousand directory numbers. Therefore, there will be one number group circuit, such as is disclosed in Figs. 2, 3 and 4, assigned to each series of one thousand directory numbers and the marker by examining the thousands digit of the directory number will determine the particular number group circuit which is required.

It will be recalled that relay FLG(60) was operated to inform the marker that it has been seized to terminate a call. Among other circuits established by the operation of relay FLG(60) a circuit is established from ground at its contact 2, over conductor 6001 of cable C(61) extending to Fig. 21 and through the winding of relay HGL1(9) to battery. Another circuit is established from ground at contact 1 of relay FLG(60), conductor 6002 of cable A(35) extending to Fig. 20 and thence in parallel through the windings of relays VGL1(8) and VGL2(8) to battery. A further circuit is established from ground at contact 3 of relay FLG(60), conductor 6003 of cable A(61) extending to Fig. 10 and thence through the winding of relay VFL1(10) to battery. At its contact 4 relay FLG(60) establishes a circuit for relays SNG1 and SNG2 in the number group control circuit (not shown) which upon operating supply controls for the number group circuit. Relay OAN(58) is also operated at this time. A circuit is now established which may be traced in part from battery supplied from the number group controller under the control of relay SNG2 to conductor 5012, contact 5 of relay TH0(58), contact 8 of relay TH1(58), contact 8 of relay TH2(58), contact 7 of TH4(58), contact 6 of relay TH7(58), contact 1 of relay TH0(58), contact 1 of TH7(58), contact 3 of relay OAN(58), conductor 5808 of cable B(57) extending to Fig. 5, contact 2 of MB3(2), contact 1 of relay TR0(2), windings of marker preference relay MP1(2) and over normally closed contacts 3 of other marker preference relays such as MP2(2) and MP3(2) to ground, provided no other marker is attempting to seize this number group circuit at this time. Assuming that the number group circuit disclosed is available relay MP1(2) operates and locks to ground at its contact 4. At its contact 1 relay MP1(2) disconnects ground from the upper armatures of the other marker preference relays and at contact 2 closes the circuit over contact 3 of TR0(2) and conductor 200 through the winding of relay MCA1(5) to battery. While only the contacts concerned with the No. 1 marker have been shown on relay TR0(2) this relay also controls the circuits for the other markers and serves when operated to transfer the start circuits of the multicontact relay operating circuits from the regular chain of marker preference relays MP1(2), MP2(2) and MP3(2) to the emergency preference relays E1(2), E2(2) and E3(2).

Relay MCA1(5) in operating closes a plurality of circuits connecting the marker with the number group circuit and closes a plurality of circuits for operating other multicontact relays of the number group circuit. These circuits may be traced in part from battery supplied over contacts of relays SNG2 at the number group controller (not shown) to conductors 500 and 501, thence over contacts 1 and 2 of relay MCA1(5), conductors 502 and 503 and through the windings of multicontact relay MCB(4) to ground; from battery supplied over a contact of relay SNG2 at the number group controller to conductor 504, thence over contact 4 of relay MCA1(5) through the winding of relay MCA2(5) to ground and from battery supplied over a contact of relay SNG2 at the number group controller to conductor 505, thence over contact 3 of relay MCA1(5) and conductor 506 through the winding of relay MCC(3) to ground. With these multicontact relays operated all of the circuits are completed which are necessary for transmitting the called line designation from the marker to the number group circuit and for receiving the translation of that designation from the number group circuit. At its contact 8 relay MCA1(5) connects ground to conductor 507 extending to the number group controller which causes the operation of a relay therein to indicate that the multicontact relays have all been operated.

The hundreds register of Fig. 57 connects battery to one of ten conductors leading to the number group circuit, which conductors are extended to the windings of ten hundreds block relays. Since relays HN1(57) and HN7(57) have been operated the first circuit is closed from battery over a contact of relay SNG2 at the number group controller to conductor 8020, thence over contact 3 of relay HN1(57), contact 3 of relay HN7(57), conductor 5708 of cable B(57) extending to Fig. 5, contact 18 of relay MCA1(5) and through the winding of hundreds-block relay HB3(5) to ground, operating such relay.

Since the marker is equipped to serve offices having both physical and theoretical numbers the hundreds-block relays in the number group circuit are arranged to inform the marker whether the blocks of one hundred numbers corresponding thereto contains only physical numbers or theoretical numbers or both physical and theoretical numbers. For this purpose terminals PN(5), TN(5) and PTN(5) are provided on the number group frame and relays corresponding thereto are provided in the marker and contacts 1 of the hundreds-block relays are cross-connected to the proper one of these three terminals. Under the assumption that the office of the present disclosure has only physical numbers contact 1 of all hundreds-block relays will be cross-connected to the terminal PN(5) and relay HB3(5) in operating closes a circuit from ground at its contact 1 cross-connected to terminal PN(5), contact 5 of relay MCA1(5) and thence to conductor 508 extending to the number group controller of the marker whereupon a PN relay in such controller operates to inform the marker that the wanted number is a physical number.

The tens register of Fig. 57 connects battery to one of ten conductors extending to the number group circuit where they are further extended in multiple to the ten hundreds-block relays

so that one of one hundred tens-block relays in the number group circuit will be operated corresponding to the combination of the hundreds and tens digits. Since relay T2(57) and relay T1(57) have been operated a circuit is closed from battery supplied over a contact of relay SNG2 at the number group controller to conductor 8021, contact 2 of relay T2(57), contact 2 of relay T1(57), conductor 5719 of cable B(57) extending to Fig. 5, contact 20 of relay MCA1(5), contact 3 of relay HP8(5), conductor 509 and thence through the winding of tens-block relay TB89(3) to ground. Relay TB89(3) together with a relay TBW (not shown) in the marker operate in this circuit.

The units register of Fig. 71 connects battery to one of ten conductors leading to the number group circuit to operate one of the units relays in that circuit. Since relay U4(71) and U1(71) have been operated a circuit is closed from battery supplied at the number group controller to conductor 8022, contact 1 of relay U4(71), contact 1 of relay U1(71) and conductor 7120 to the number group controller, thence over a contact of the operated relay therein to conductor 510 extending to Fig. 5, contact 11 of relay MCA2(5) and conductor 520 through the winding of units relay U0(4) to ground. Relay U0(4) operates in this circuit and closes the circuit from ground over its contact 4, contact 48 of relay MCB(4) and conductor 400 extending to the number group controller to operate a relay NGK1 therein to indicate to the marker that the units relay has been operated in the number group circuit.

Each number group circuit has one thousand sets of terminals as indicated at the left side of Fig. 4, each set corresponding to one of the one thousand designations having the one thousand digit to which the number group is allocated. When one units relay and one tens-block relay operate, one set of terminals is marked by having extended to them battery supplied by the marker to conductors 402, 403 and 404. Corresponding to the three terminals of each line designation set there are three sets of translator terminals which are used for transmitting to the marker the location of the called line and the kind of ringing current required. One field of terminals provides the identity of the line-link frame on which the called line is located in terms of the tens and units digits of the frame number. A second field identifies the line group in terms of the horizontal group and the vertical group on the line-link frame within which the called line is located and the third field identifies the vertical file in which the line is located and the type of ringing current required by the line. Each translator field has as many terminals as there are combinations of the items in that field. Each translator terminal is connected in parallel through two resistances to one conductor in each of two sets, each set having one conductor for each item. These conductors are extended over contacts of the multicontact relays back to the marker. The following table signifies the facts in the translator fields:

Translator Field	Number of Terminals	Each Translator Terminals Connects To	
		First Item	Second Item
LL	40	One of four line-link frame number tens digit conductors.	One of ten line-link frame number units digit conductors.
VHG	140	One of fourteen vertical group conductors.	One of ten horizontal group conductors.
RF	75	One of fifteen ringing control conductors.	One of five vertical file conductors.

Assuming that the designation 7890 applies to line 150 of Fig. 1, the set of terminals F890(4), G890(4) and L890(4) selected by the operation of relays HB8(5), TB89(4) and U0(4) will be cross-connected to frame tens terminal FT1(5), frame units terminal FU8(4), horizontal group terminal HG9(4), vertical group terminal VG13(4), vertical file terminal VF0(4) and the ringing selection terminal RC1(4). Since relays MCB(4) and MCA2(5) are operated the terminals in the translator fields and their associated resistances are connected to the windings of relays in the marker.

When relay NGK1 in the number group controller operates as a check that the multicontact relays for connecting the marker to the number group circuit have operated, it causes the connection of battery to conductors 402, 403 and 405 extending from the number group controller and thence over contacts 45, 46 and 47 of relay MCB(4) to conductors 405, 406 and 407. When relay U0(4) operates as above described it extends these conductors to conductors 408, 409 and 410 and over contacts 10, 20 and 30 of relay TB89(4) to terminals L890(4), G890(4) and F890(4). As previously assumed terminal F890(4) is cross-connected in parallel to terminals FT1(5) and FU8(5) and over contacts 23 and 20 of relay MCA2(5), conductors 531 and 548 of cable A(5) extending to Fig. 11 and thence to ground through the windings of relays FTN1(11) and FUN8(12). Terminal G890(4) is cross-connected in parallel to terminals HG9(4) and VG13(4) and over contacts 10 and 24 of relay MCB(4), conductor 429 of cable C(4) extending to Fig. 11A and thence through the winding of relay HGN9(11A) to ground and conductor 443 of cable A(4) extending to Fig. 11A and through the winding of relay VGN13(11A) to ground. Terminal L890(4) is cross-connected in parallel to terminals VF0(4) and RC1(4). Terminal VF0(4) is connected over contact 40 of relay MCB(4) and conductor 450 of cable E extending to Fig. 11A thence through the winding of relay VFN0(11A) to ground. Terminal RC1(4) is connected over contact 25 of relay MCB(4) to conductor 461 extending to the ringing control identifier (not disclosed) to cause the operation of the register relay therein to register the required ringing selection.

Registration of called line location

When the identification relays have operated as above described, they, in turn, operate relays in the marker which register the identification and which lock independent of the number group circuit. Relay FTN1(12) closes a circuit from ground over its contact and through the winding of relay FTT1(12) to battery on conductor 1200 supplied from the cross-detection circuit (not shown). Relay FTT1(12) operates in this circuit and extends its operating ground over its contact 6 to conductor 1201 extending to the

number group controller (not shown), to operate a relay therein which locks and returns ground on conductor 1201 to lock relay FTT1(12) operated. Relay FUN8(11) closes a circuit from ground over its contact and through the winding of relay FUT8(11) and over conductor 1100 to battery supplied from the cross-detection circuit (not shown). Relay FUT8(11) operates in this circuit and extends its operating ground over its contact 4 to the number group controller (not shown) to operate a relay therein which locks and returns ground on conductor 1101 to lock relay FUT8(11) operated.

Relay HGN9(11A) closes a circuit from ground over its contact, conductor 919 of cable D(11A) extending to Fig. 9 and through the winding of relay HGT9(21) to battery. Relay HGT9(21) operates in this circuit and extends its operating ground over its contact 6, contact 2 of relay HGL1(9) and over conductor 908 to the number group controller (not shown) to operate a relay therein which locks and returns ground on conductor 908 to lock relay HGT9(21) operated.

Relay VGN13(11A) closes a circuit from ground over its contact, conductor 703 of cable B(11A) extending to Fig. 7 and through the winding of relay VGT13(19) to battery. Relay VGT13(19) operates in this circuit and extends its operating ground over its contact 7, conductor 1904, contact 5 of relay VGL2(8) and conductor 803 to the number group controller (not shown) to operate a relay therein which locks and returns ground on conductor 803 to lock relay VGT13(19) operated.

Relay VFN9(11A) closes a circuit from ground over its contact, conductor 2201 of cable F(11A) extending to Fig. 10 and through the winding of relay VFT9(10) to battery. Relay VFT9(10) operates in this circuit and locks over its contact 6 and contact 2 of relay VFL1(10) and conductor 1007 to the number group controller (not shown) to operate a relay therein which locks and returns to ground on conductor 1007 to lock relay VFT9(10) operated.

In a similar manner a ringing selection relay is operated and is locked operated together with a relay in the ringing selection circuit.

The registration of the called line location and the type of ringing required has now been set up in the marker and locked therein independent of the number group circuit. The operation of the locking relays in the number group controller, indicating that the called line designation as translated by the number group circuit, has been registered in the marker, closes a circuit for bringing about the release of the number group circuit by opening the circuit of relay MP1(2) as fully described in the application of A. J. Busch hereinbefore referred to. The release of relay MP1(2), in turn, releases the multicontact relays MCA1(5), MCA2(5), MCB(4) and MCC(3) to disconnect the number group circuit from the marker and releases relays HB8(5), TB89(4) and U0(4) of the number group circuit.

Seizure of line link frame of called line

After the location of the called line is identified, the marker will proceed to test the called line for a busy condition, to select an idle channel by which the called line may be connected to the selected intraoffice trunk and to connect the called line to the intraoffice trunk over the selected channel.

After the marker establishes the terminating connection, it seizes the line-link frame of the calling subscriber in accordance with the calling line location registered in the marker and selects an idle channel between the intraoffice trunk and the calling line. If an idle channel is found, the previously established dialing connection from the calling line to the originating register is released and the marker proceeds to set up the connection from the intraoffice trunk to the calling line and to cause the called subscriber to be rung in accordance with the ringing information which it has received from the number group circuit and transmitted to the ringing selection switch associated with the selected intraoffice trunk.

After the marker has completed the intraoffice call functions it releases from the terminating connection and is recycled to the idle condition so as to be available for assistance to other calls or connections.

Outgoing call

To further illustrate the invention it will be assumed that the calling subscriber dials the number of a subscriber line which is located in a distant office and that the designation of such line is Binghamton 4–7890 which is the equivalent of 244–7890. In the manner previously described in connection with the establishment of a local connection, an originating register will be seized in response to the establishment of the dial tone connection and the digits of the called number will be registered on the A, B, C, D, E, F and G registers thereof. At the end of dialing the following register relays will be operated to register the dialed digits. A0(53), A2(53), B0(53), B4(53), C0(53), C4(53), D0(40), D7(40), E1(40), E7(40), F2(27), F7(27), G4(27) and G7(27).

Thereafter, in the manner previously described the A, B and C digits together with the digits registered in the originating register to identify the location and class of the calling line are transferred to a marker available to control the establishment of the desired connection, and relays AC0(58) and AC2(58) and relays BC0, BC4, CC0 and CC4 of the B and C code digits registers (not shown) in the marker are operated to register the A, B and C code digits. From this registration the code translator in the marker functions to operate the route relay to control the setting of the route to the office in which the desired line terminates. Since it has been assumed that a route to a distant office is required, the selected route relay causes the operation of an outgoing sender group relay OSG (not shown).

Selection of outgoing sender

With this relay operated, the marker proceeds to select an idle outgoing sender of the type required to transmit to the distant office the correct type of pulses to control the equipment at the distant office to terminate the connection and to select an outgoing trunk extending to the desired office. An outgoing trunk has been schematically disclosed in Fig. 51 by the box labeled "Outgoing trunk." An outgoing sender of the revertive pulse type which may be later connected to the outgoing trunk over the out trunk sender link schematically indicated by the box so labeled in Fig. 51, is disclosed in Figs. 64 to 69 and 74 to 78, inclusive.

As soon as the marker has identified the call

as an outgoing call it causes the operation of relay KG(81) and this relay operates establishing obvious circuits over its contacts 1 and 2 for relays KFG(81) and KHJ(81) and over its contacts 3, 4 and 5 and conductors 8100, 8101 and 8102, through the windings of relays KA(72), KBC(72) and KDE(72) to battery. These cut-in relays being operated, the marker is prepared to transmit the office code and numerical digits of the wanted line number to the outgoing sender. Relays KA(72), KBC(72), KDE(72), KFG(81) and KHJ(81) upon operating connect ground over their contacts 1 to conductor 8103 thereby completing the circuit of relay KK(72) which then operates. Relay KK(72) will thus remain operated as long as the previously mentioned cut-in relays remain operated. The marker now proceeds to operate relay S(70) to establish a channel between the marker and the outgoing sender.

The operation of the outgoing sender connector relay S(70) will establish circuits from the sender selection circuits of the marker over its contacts 7 and 8 and conductors 7000 and 7001 through the windings of the common channel relays SA(79) and SB(70) associated with the selected sender circuit and thence to ground. The operation of the outgoing sender connector relay OSGA(70) will operate in the outgoing sender circuit the common channel relay MA(79) over conductor 7002 and contact 1 of relay OSGA(70) to battery supplied at the sender selection circuit of the marker. Relay MA(79) upon operating establishes a circuit from battery at the sender selection circuit over its contact 48 and conductor 7003 through the winding of relay MB(70) to ground and establishes a circuit from battery at the sender selection circuit over its contact 47 and through the winding of relay MC(79) to ground. Relay S(70) establishes a circuit from ground at its contact 6 through the winding of relay AMA(70) to battery at the cross-detection circuit and relay AMA(70) establishes a circuit from battery at the sender selection circuit over contact 1 of relay AMA(70) and conductor 7004 through the winding of relay SC(79) to ground. With relays MA(79), MB(70), MC(79), SA(79), SB(70), and SC(79) operated the marker is connected with the selected outgoing sender over a plurality of circuits.

A circuit is now established from ground at the outgoing sender controller of the marker, contact 2 of relay S(70), conductor 7005 of cable A(70) extending to Fig. 74 and through the winding of relay ON1(74) to battery. Relay ON1(74) operates in this circuit supplying locking ground for all of the class and register relays of the sender and establishes a circuit from ground at its contact 12, over conductor 7400 and through the winding of relay SB(65) to battery. Relay SB(65) operates in this circuit and at its contacts removes ground from leads to make the sender appear busy. A shunt of the winding of relay SB(65) through resistance R(65) renders the relay slow to release at the end of a call so that all sender relays will have sufficient time to release before the sender can be reseized. The operation of relay ON1(74) also establishes a circuit from ground over its contact 11, contact 9 of relay AV(74), contact 4 of relay TM1(74), conductor 7401, contact 6 of relay OF3(65), contact 5 of relay LR1(65) and conductor 7403 through the winding of relay OF4(74) to battery, causing the latter relay to operate. Relay ON1(74) also establishes a circuit for the steering relay S6(67) which may be traced from ground over contact 10 of relay ON1(74), contact 1 of relay AV(74), conductor 7402 and through the winding of relay S6(67) to battery. Relay S6(67) upon operating locks over its contact 5, contact 6 of relay S1(67) and conductor 7404 to ground at contact 10 of relay ON1(74).

When the individual outgoing trunk has been selected by the marker the select magnet of the outgoing sender link corresponding to the sender selected will be operated as fully described in the application of A. J. Busch hereinbefore referred to and will cause the operation of the hold magnet corresponding to the selected trunk. The hold magnet operating ground will be extended through the cross-point to lead 6500 of cable I(51) extending to Fig. 65, thence through the winding of relay ON(74) to battery. Relay ON(74) upon operating connects holding ground over contact 4 for relays ON1(74) and AV(74), removing at its contact 1 the shunt of condenser TMC(74) of the trunk test timing circuit and establishing at its contact 2 the charging current for such condenser. Relay ON(74) also establishes a circuit from ground at its contact 7, contact 1 of relay OF4(74) and conductor 7405 through the winding of sender cut-through relay CT(65).

At the trunk the splitting relay operates over conductor 6501 of cable I(65) extending to Fig. 51, from the operating ground of relay CT(65) and removes the trunk supervisory relay from the tip and ring conductors and closes the operating circuit of a slow releasing trunk auxiliary supervisory relay in a circuit extending to ground at the marker. This relay in operating establishes a circuit through one winding of the marginal overflow relay of the trunk over conductor 6502 of cable I(51) extending from Fig. 65, contact 3 of relay CT(65), conductor 6503, contact 5 of relay R0(74), conductor 6504 and through the winding of relay LR(65) to battery. Relay LR(65) operates in this circuit but the trunk overflow relay does not operate. Relay LR(65) upon operating establishes a circuit from ground at contact 6 of relay ON(74), conductor 7406, contact 4 of relay CT(65), contact 2 of relay LR(65) and through the winding of relay LR1(65) to battery. Relay LR1(65) operates in this circuit and locks over it contact 3, conductor 7407, contact 2 of relay OF4(74), conductor 7408, contact 4 of relay CT(65) to off-normal ground on conductor 7406 so that the sender will not release on an abandoned call until the trunk has been conditioned to return to normal. Relay LR1(65) also extends a locking ground for the ON(74) relay extending from ground at contact 5 of relay ON(74), conductor 7409, contact 2 of relay LR1(65) and conductor 6500, through the winding of relay ON(74) to battery, this locking ground being extended back over lead 6500 to the sender-link hold magnet.

Transfer of called line number to sender

With the ON1(74) relay in the sender and the KA(72), KBC(72), KDE(72), KFG(81) and KHJ(81) relays of the marker operated the marker may now proceed to transfer the called line number digits to the sender where they will be registered and locked in. It will be recalled that relays AC0(58) and AC2(58) have been operated to register the A code digit 2 and therefore two circuits are established from ground at contacts 1 of such register relays, conductors 5800 and 5802, contacts 4 and 6 of relay KA(72), conductors 7200 and 7202 and through the windings of relays

A0(73) and A2(73) to battery, and in parallel over conductors 7900 and 7902 of cable E(81) extending to Fig. 79, contacts 45 and 43 of relays MA(79) and SA(79), conductors 6400 and 6402 of cable A(79) extending to Fig. 64 and through the windings of register relays A0(64) and A2(64) to battery. Relays A0(73), A2(73), A0(64) and A2(64) operate in these circuits, relays A0(64) and A2(64) locking over their contacts 1 and 2 to ground applied to conductor 7410 at contact 7 of relay ON1(74), this locking ground serving to hold relays A0(73) and A2(73) in the marker operated.

With relays BC0 and BC4 of the B code digit register (not shown) operated and relay KBC(72) operated, two circuits are established from ground applied over contacts of such register relays to conductors 7130 and 7134, thence over contacts 8 and 11 of relay KBC(72), conductors 7210 and 7214 and through the windings of register relays B0(73) and B4(73) to battery, and in parallel over conductors 7910 and 7914 of cable E(81) extending to Fig. 79, contacts 40 and 37 of relays MA(79) and SA(79), conductors 6410 and 6414 of cable A(79) extending to Fig. 64 and through the windings of register relays B0(64) and B4(64) to battery. Relays B0(73), B4(73), B0(64) and B4(64) operate in these circuits, relays B0(64) and B4(64) locking over their contacts 1 and 2 to ground on conductor 7410, this locking ground serving to hold relays B0(73) and B4(73) in the marker operated.

With relays CC0 and CC4 of the C code digit register (not shown) and relay KBC(72) operated, two circuits are established from ground applied over contacts of such register relays to conductors 7140 and 7144, thence over contacts 6 and 3 of relay KBC(72), conductors 7220 and 7224 and through the windings of register relays C0(73) and C4(73) to battery, and in parallel over conductors 7920 and 7924 of cable E(81) extending to Fig. 79, contacts 35 and 32 of relays MA(79), conductors 6420 and 6424 of cable A(79) and SA(79) and through the windings of register relays C0(64) and C4(64) to battery. Relays C0(73), C4(73), C0(64) and C4(64) operate in these circuits, relays C0(64) and C4(64) locking over their contacts 1 and 2 to ground on conductor 7410, this locking ground serving to hold relays C0(73) and C4(73) in the marker operated.

With relays D0(40) and D7(40) of the originating register operated to register the thousands digit 7 of the dialed number and relay KDE(72) operated, two circuits are established from ground over contacts 3 and 4 of relays D0(40) and D7(40), conductors 4010 and 4017 of cable B(40) extending to Fig. 30, contacts 16 and 12 of relays RB(30) and MB(30), conductors 3020 and 3027 of cable F(30) extending to Fig. 80, conductors 7150 and 7157, contacts 11 and 7 of relay KBE(72), conductors 7240 and 7247, and through the windings of register relays D0(73) and D7(73) to battery, and in parallel over conductors 7930 and 7937 of cable E(81) extending to Fig. 79, contacts 30 and 26 of relays MA(79) and SA(79), conductors 7600 and 7607 of cable B(79) extending to Fig. 76 and through the windings of register relays D0(76) and D7(76) to battery. Relays D0(73), D7(73), D0(76) and D7(76) operate in these circuits, relays D0(76) and D7(76) locking over their contacts 3 and 4, conductor 7411 and to ground at contact 8 of relay ON1(74), this ground serving to hold relays D0(73) and D7(73) in the marker operated.

Since relays E1(40) and E7(40) of the originating register have operated to register the hundreds digit 8 and relay KDE(72) has operated, two circuits are established from ground over contacts 3 and 4 of the register relays, conductors 4021 and 4027 of cable B(40) extending to Fig. 30, contacts 10 and 7 of relays RB(30) and MB(30), conductors 3031 and 3037 of cable F(30) extending to Fig. 80, contacts 5 and 2 of relay KDE(72), conductors 7941 and 7947 and through the windings of register relays E1(82) and E7(82) to battery, and in parallel over conductors 7941 and 7947 of cable E(81) extending to Fig. 79, contacts 24 and 21 of relays MA(79) and SA(79) and conductors 7611 and 7617 of cable B(79) extending to Fig. 76, through the windings of register relays E1(76) and E7(76) to battery. Relays E1(82), E7(82), E1(76) and E7(76) operate in these circuits, relays E1(76) and E7(76) locking over their contacts 3 and 4 to ground on conductor 7411, this locking ground serving to hold relays E1(81) and E7(81) in the marker operated.

With relays F2(27) and F7(27) of the originating register operated to register the tens digit 9 and relay KFG(81) operated, two circuits are established from ground over contacts 3 and 4 of relays F2(27) and F7(27), conductors 2712 and 2717 of cable A(27) extending to Fig. 30, contacts 26 and 24 of relays RB(30) and MB(30), conductors 3042 and 3047 of cable F(30) extending to Fig. 80, contacts 9 and 11 of relay KFG(81), conductors 8112 and 8117 and through the windings of register relays F2(82) and F7(82) to battery, and in parallel over conductors 8112 and 8117 of cable E(81) extending to Fig. 79, contacts 18 and 16 of relays MA(79) and SA(79), conductors 7702 and 7707 of cable 7977 and through the windings of register relays F2(77) and F7(77) to battery. Relays F2(82), F7(82), F2(77) and F7(77) operate in these circuits, relays F2(77) and F7(77) locking over their contacts 4 to ground on conductor 7411, this locking ground serving to hold relays F2(82) and F7(82) in the marker operated.

With relays G4(27) and G7(27) of the originating register operated to register the units digit 0 and relay KFG(81) operated, two circuits are established from ground over contacts 3 and 4 of relays G4(27) and G7(27), conductors 2724 and 2727 of cable A(27) extending to Fig. 30, contacts 20 and 21 of relays RB(30) and MB(30), conductors 3054 and 3057 of cable F(30) extending to Fig. 80, contacts 3 and 2 of relay KFG(81), conductors 8124 and 8127 and through the windings of register relays G4(82) and G7(82) to battery, and in parallel over conductors 8124 and 8127 of cable E(81) extending to Fig. 79, contacts 12 and 11 of relays MA(79) and SA(79), conductors 7714 and 7717 of cable 7977 and through the windings of register relays G4(77) and G7(77) to battery. Relays G4(82), G7(82), G4(77) and G7(77) operate in these circuits, relays G4(77) and G7(77) locking over their contacts 3 and 4 to ground on conductor 7411, this locking ground serving to hold relays G4(82) and G7(82) in the marker operated.

A circuit is also established from the originating register to operate relay H7(82), which circuit may be traced from ground on conductor 4002, contact 9 of relay EV(40), conductor 4005, contact 11 of relay GS(27), conductor 2703 extending through cable A(27) to Fig. 30, contacts 6 of relays RB(30) and MB(30), conductor 3005, contact 12 of relay KFG(81), conductor 8127 and

through the winding of relay H7(82) to battery. Relay H7(82) operates in this circuit.

Check of transfer of information to sender

A check circuit is now established to determine if the proper number of digit register check relays in the marker have been operated. This circuit may be traced from battery through the winding of relay ORK1(72), conductor **7248**, contact **2** of operated register relay A0(73), contact **4** of relay A1(73), contact **3** of operated relay A2(73), contact **4** of relay A4(73), contact **2** of relay A7(73), contact **2** of operated relay B0(73), contact **4** of relay B1(73), contact **4** of relay B2(73), contact **3** of relay B4(73), contact **3** of relay B7(73), contact **3** of operated relay C0(73), contact **5** of relay C1(73), contact **5** of relay C2(73), contact **4** of operated relay C4(72), contact **4** of relay C7(73), contact **3** of operated relay D0(73), contact **5** of relay D1(73), contact **5** of relay D2(73), contact **5** of relay D4(73), contact **3** of operated relay D7(73), conductor **7300**, contact **2** of relay E0(82), contact **3** of operated relay E1(82), contact **5** of relay E2(82), contact **5** of relay E4(82), contact **3** of operated relay E7(82), contact **2** of relay F0(82), contact **2** of relay F1(82), contact **3** of operated relay F2(82), contact **5** of relay F4(82), contact **3** of operated relay F7(82), contacts **2** of relays G0(82), G1(82) and G2(82), contact **3** of operated relay G4(82), contact **3** of operated relay G7(82), contacts **2** of relays H0(82), H1(82), H2(82) and H4(82), contact **2** of operated relay H7(82), conductor **8200**, contact **1** of relay ST7(72) and through the winding of relay ORK2(72) to ground. Relays ORK1(72) and ORK2(72) operate in this circuit if the correct number of register relays have been operated and, upon operating, establish a circuit which may be traced in part from ground over contacts of multicontact relays MC(79) and SC(79), contact **46** of relay SA(79), conductor **7006**, contact **32** of relays SB(70) and MB(70), conductor **7007**, contact **46** of relay MA(79), conductor **7948** of cable E(79) extending to Fig. 81, contact **1** of relay KK(72), contacts **1** of relays ORK1(72) and ORK2(72) to conductor **7249** and thence through the winding of a relay (not shown) which operates to start the measurement of a timing interval to insure that the register relays of the outgoing sender have been operated, have locked and have returned their locking ground to hold the corresponding register relays of the marker operated. At the end of the measured time interval, another relay associated with the timing circuit operates to open the circuit of relay KG(81) which now releases and in turn causes the release of relays KA(72), KBC(72), KDE(72), KFG(81) and KHJ(81). When the latter relays have all released no operating circuit for relay KK(72) is effective and such relay also releases opening at its contact **1** the circuit previously traced over the contacts of the check relays ORK1(72) and ORK2(72) to conductor **7249** over which the timing circuit was started.

With relays KA(72), KBC(72), KDE(72), KFD(81) and KHJ(81) all released, the initial operating circuits for the register relays shown in Figs. 73 and 82 of the marker are opened leaving such register relays held from the locking grounds supplied from the registers of the outgoing sender. Relay KK(72) upon releasing removes ground at its contact **2** from conductor **7250** thereby opening the locking circuit for the timing start relay which with its initial operating circuit opened at contact **1** of relay KK(72) now releases to restore the timing circuit. After a further time interval the timing circuit becomes restored and if the register relays of the marker are still operated by the locking grounds supplied from the outgoing sender, the check circuit previously traced through the windings of relays ORK1(72) and ORK2(72) will still be effective and the latter relays will remain operated to establish a circuit over their contacts **2** for a sender connector release relay (not shown) which is effective to signal the outgoing sender that the required information has been successfully transmitted from the marker to the outgoing sender and that the outgoing sender may now advance to out-pulse the information to the distant office. This circuit may be traced in part from battery applied by the marker sender connector release relay to conductor **7008**, contact **3** of relay S(70), conductor **7412** of cable A(70) extending to Fig. 74 and through the winding of relay AV(74) to battery. Relay AV(74) operates in this circuit and locks over its contact **5** to ground at contact **4** of relay ON(74). The operation of the outgoing sender connector release relay of the marker also initiates the release of the outgoing sender connector, schematically illustrated in Figs. 70 and 79, to disconnect the marker from the outgoing sender. The marker then proceeds in the manner fully described in the application of A. J. Busch hereinbefore referred to, to set up the connection from the calling line to the selected outgoing trunk and to release the originating register. After the marker has established the connection and checked it the marker releases.

Following the operation of relay AV(74) in the outgoing sender, the sender proceeds to control revertively the setting up of a connection in the distant office which may, for example, be another cross bar office of the same type as disclosed herein, in accordance with the digits registered in the registers of the outgoing sender.

Incoming call

To illustrate the manner in which digit information is transferred to the marker on a call incoming from an outside office to be terminated in the office in which the disclosed marker is located, it will be assumed that a subscriber, for example in an outside office, dials the number of a subscriber whose line terminates in the cross bar office disclosed herein and that in response to dialing the office code digits a trunk incoming to the called subscriber's office is seized. This trunk circuit is schematically illustrated by the box in Fig. 51 labeled "Incoming Trunk Circuit," which trunk circuit may be of the type fully disclosed in the application of M. C. Goddard, Serial No. 57,386 filed concurrently herewith. Upon its seizure this trunk circuit is connected by the incoming register link circuit, illustrated by the box of Fig. 51 so labeled which, in the manner fully disclosed in the application of A. J. Busch hereinbefore referred to, causes the seizure and connection of an incoming register with the incoming trunk circuit over cables J(51) and K(51) extending to Figs. 15 and 17, respectively.

The incoming register, disclosed in Figs. 14 to 18, inclusive, registers the numerical digits of the called number when it is selected by an incoming trunk receiving calls on a revertive pulse basis. It also records other information received from the trunk as to the trunk location. The registered information is transmitted to an available marker

which completes a connection from the trunk to the wanted line. It will be assumed that the numerical digits of the wanted line number dialed by the calling subscriber are 7890.

Seizure of incoming register

To seize a register, the register link circuit connects ground to conductor 1500 of cable J(51) extending to Fig. 15 thereby completing a circuit through the winding of relay ON(15) to battery and in parallel over contact 1 of relay TRL(15), contact 2 of relay MRL(15), conductor 1501, contact 2 of relay MB(14), conductor 1400 and through the winding of relay RB(15) to battery. Relay RB(15) operates in this circuit and connects battery through a resistance, over each of its contacts 1 to 5, inclusive, and conductors of cable J(15) extending to Fig. 51 to operate relays in the register link circuit to make the incoming register busy to all of the five trunk groups except the one connected to the register. Ground connected from contact 4 of relay RLK(15) over a conductor of cable J(15) extending to Fig. 51, prevents the operation of the link relay associated with the link group connected to the register disclosed. Battery applied over contact 6 of relay RLK(15) and conductor 1510 of cable J(15) extending to Fig. 51 locks the trunk to the register.

Relay ON(15) upon operating starts one cycle of register timing by opening the discharge path for timing condenser TMC(14) extending through resistor TM2(14), conductor 1401, contact 2 of relay ON(15) and conductor 1502 to condenser TMC(14), and establishing a charging path for such condenser extending from ground at contact 3 of relay ON(15), conductor 1502, condenser TMC(14), contact 1 of relay OVL(14) and through resistance TM3(14) to positive battery. Relay OM(15) also starts a link release timing circuit by removing a shunt extending over contact 12 of relay ON(15), conductors 1504 and 1505 and through resistance LR2(14) from condenser LRC(14), and connecting ground through the winding of relay LR(14), conductor 1402, contact 11 of relay ON(15), conductor 1505, condenser LRC(14) and through resistance LR3(14) to positive battery. Relay ON(15) also connects off-normal ground to various parts of the register.

When the register is seized, its associated select magnet in the link group connected to the register is operated by the battery applied through resistance SM(15), over contact 4 of relay TRL(15), contact 3 of relay H(15) and a conductor of cable J(15) extending to Fig. 51. When such select magnet operates, ground applied over contact 4 of relay ON(15), contact 4 of relay H(15) and a conductor 1506 of cable J(15) extending to Fig. 51 and through off-normal contacts of the operated select magnet, operates the hold magnet of the incoming trunk being connected to the register. When the switch cross-points close the ground applied to the link over conductor 1506 is returned on conductor 1507 of cable J(51) extending from Fig. 51 to Fig. 15, thence over contact 8 of relay TRL(15) and through the winding of relay H(15) to battery. Relay H(15) upon operating at its continuity contacts 4 and 5 removes the operating ground from conductor 1506 for the hold magnet and closes a holding circuit for itself extending from battery through its winding, the upper winding of relay DCK(15), contact 5 of relay H(15) and to ground at contact 4 of relay ON(15). Relay H(15) also at its contact 3 opens the circuit of the select magnet at the link circuit which magnet thereupon releases and closes an operating circuit for relay RV3(14) which may be traced from battery through the winding of such relay, contact 3 of relay RV2(14), conductor 1403 and to ground at contact 2 of relay H(15). At its contact 1 relay H(15) prepares a locking circuit for relay TC2(15). Relay RV3(14) upon operating locks over its contact 2, contact 3 of relay IB1(14) when such latter relay later operates, contact 1 of relay TMA(14), conductor 1615 and to ground at contact 1 of relay L(16).

Relay DCK(15) operates in series in the locking circuit of relay H(15) and locks over its contacts 3 and 4 to ground at contact 4 of relay ON(15). If ground is present on conductor 1507 as the result of the existence of a cross or double connection in the link circuit, relay DCK(15) cannot operate, thus preventing the operation of relay RV4(14) and the subsequent termination of link release timing.

Registration of trunk link frame number

It will be assumed that the incoming trunk terminates in an appearance B on the fourth level of the trunk link frame, schematically illustrated in Fig. 38, and that the number of such frame is 00. If there are more than ten frames then either frame tens relay FG0(17) or FG1(17) will be operated dependent upon whether the frame number has a tens digit 0 or 1. It having been assumed that the frame number is 00, relay FG0(17) is therefore operated over conductor 1700 of cable K(17) extending to Fig. 51 and to ground applied thereto when the link connects the register to the trunk. Relay FG0(17) upon operating locks over its contact 2 and conductor 1701 to ground at contact 10 of relay ON(15).

When the link connects the trunk to the register one of ten leads extending from the link circuit through cable K(51) to Fig. 17 will be grounded. Since it has been assumed that the units digit of the trunk frame number is 0, conductor 1620 will be grounded and the circuit of select magnet S0(18) of the cross bar register shown in Figs. 17 and 18 will be completed. Magnet S0(18) upon operating, prepares a cross-point in the 0 level of the switch for operation and at its contact 1 establishes a circuit extending over conductor 1702 through the winding of relay SM(16) to battery. Relay SM(16) operates in this circuit locking over its contacts 4 and 7, contact 12 of relay LB(16) and conductor 1600 to ground at contact 8 of relay ON(15), and establishing a circuit for relay RA1(16) which may be traced from battery through the winding and contact 2 of relay RA1(16), contact 3 of relay SM(16) and over conductor 1601 to ground at contact 9 of relay ON(15).

Relay RA1(16) operates in this circuit, locking over its contact 3 directly to ground on conductor 1601 independent of relay SM(16), and establishes a circuit from battery through the winding of the frame hold magnet F(17) of the cross bar register, over conductor 1703, normal contact 1 of relay IB1(14), conductor 1404, contact 5 of relay RA1(16), contact 4 of relay RA2(16) to both windings of relay HM(16) the upper one of which is connected in series with the lower winding and over conductor 1602 to ground at contact 4 of relay ON(15). The windings of relay HM(16) are differentially connected and so proportioned that the relay will not operate or hold either with or without the hold magnet F(17) in parallel with its lower winding. The magnet F(17), however, operates and locks over its contact 2 to ground on conductor 1601, closing

the contacts of cross-point 1800 at the level of operated select magnet S0(18). The locking ground for hold magnet F(17) shunts the upper winding of relay HM(16) and that relay now operates over its lower winding. The operation of relay FG0(17) and the closure of cross-point 1800 have now registered the frame number 00.

It will be recalled that relay RV3(14) was operated following closure of the link switch cross-point. Upon operating it establishes a circuit from battery through the winding of relay L(16), conductor 1603, contact 7 of relay TC2(15), conductor 1508, contact 1 of relay RV3(14), contact 3 of relay IF(14), contacts 3 and 8 of relay RV1(14) to the tip conductor T of cable J(15) extending to Fig. 51 and thence to the tip of the incoming trunk. Relay L(16) may or may not operate at this time since it is in parallel with the winding of the line relay of the trunk. The ring lead of the trunk and ring lead R of the register are connected together over cable J(15) extending to Fig. 51, both being connected to direct ground over conductor 1405 and contact 5 of relay RLK(15).

If the trunk frame tens and units digits have been registered, as will be indicated by the operation of relay FG0(17) or FG1(17) and relay RA1(16), and relay DCK(15) has operated upon the completion of the double connection check, relay RV4(14) will now operate in a circuit from battery through its winding, contact 4 of relay RV3(14), conductor 1406, contact 1 of relay DCK(15), conductor 1509, contact 1 of relay RA1(16), conductor 1604 and to ground at contact 3 of relay FG0(17). Relay RV4(14) upon operating connects the winding of relay RV5(14) over its contact 3 to conductor 1407 of cable J(15) extending to Fig. 51 where it extends through the winding of a relay in the trunk circuit to battery. Relay RV5(14) thereupon operates and locks over its contact 2 to its initial operating circuit over conductor 1407. The relay in the incoming trunk operates and removes all shunts from the pulsing path which extends from the distant office to the trunk and over the trunk connector to the relays L(16) and STP(16) of the register. Relay L(16) will now operate in turn closing a circuit from ground over its contact 2, contact 7 of relay LB(16), contact 2 of relay SM(16) and through the winding of relay LA(16) to battery. Relay LA(16) operates in this circuit locking itself over its contact 4 to ground at contact 2 of relay L(16) independent of relay LB(16) and at its contact 3 establishing an obvious circuit for relay LB(16) which operates and locks over its contact 6 to ground at contact 8 of relay SM(16). The relay in the trunk circuit which operated in series with relay RV5(14) also opens the start lead to the link control relays which now hold to battery on lead 1510 at the register under the control of relay RLK(15) and this relay also connects ground to conductor 1511 of trunk J(51) extending to Fig. 15, over contact 6 of relay RB(15) and through the winding of relay ON1(15) to battery.

Relay ON1(15) now operates, locks over its contact 6 and contact 6 of relay ON(15) to ground, establishes a holding circuit for relay ON(15) which extends from ground at contact 9 of relay ON1(15), contact 2 of relay MRL(15) and contact 1 of relay TRL(15) to the winding of relay ON(15); supplies a locking ground over its contact 3 to the previously traced locking circuit for relay RV4(14); connects ground to a plurality of off-normal conductors of the register and establishes at its contact 12 an obvious circuit for relay RLK(15). Relay ON1(15) also removes ground from conductor 1512 of cable J(15) extending to Fig. 51 to release relays of the link through which the trunk link frame number has been received. This insures release of these relays before a back-up can occur between two registers through two sets of these link relays which might otherwise both be operated when relay RLK(15) operates, to permit a waiting link to connect to another register.

Relay RLK(15) upon operating, removes battery from conductor 1510 and ground from conductor 1513. This causes the release of the link preference relays which have been locked to the register and operates a relay in the link to make the register busy to the link group in which the call originated. At its contact 5 relay RLK(15) also removes ground from conductor 1405 and the R lead which has shunted the winding of relay STP(16) so that the R lead is now connected over contact 1 of relay RV2(14), conductor 1408, through the winding of relay STP(16) and conductor 1605 to ground at contact 10 of relay TT(15). Relay RLK(15) at its contact 1 interconnects conductors 1504 and 1505 to close the discharge path through condenser LRC(14) to terminate link release timing.

Registration of called line number

The five selections relating to the called line number are registered in the originating sender as incoming brush and group, and final brush, final tens and final units selections and are transferred to the incoming register by battery pulses generated in the incoming register and transmitted over the trunk. The register counts the pulses it generates and transfers this count to its cross bar switch register shown in Figs. 17 and 13 when the originating sender opens the fundamental loop as a signal to terminate pulsing on that selection. The actions of the originating sender and the incoming register are synchronized and the pulsing kept in step with the registration.

It will be recalled that relays L(16), LA(16) and LB(16) have operated, relay L(16) having operated with its non-inductive winding S(16) shunting its inductive winding. This is unimportant on the first selection but on later selections the non-inductive winding smooths out the descending side of a cable capacity surge which has a tendency to cause the distant stepping relay to momentarily release and then reoperate to generate a false pulse. When relay LA(16) operates, as previously described, it cuts off the non-inductive winding S(16) at its contact 1 in order to speed the subsequent operations of the distant stepping relay. Relay L(16) is permanently shunted by resistance L(16) to insure that the relay L(16) will hold on all lengths of cable at the end of each ground pulse. Relay LB(16) upon operating opens at its contact 12 one locking path for relay SM(16) and the select magnet S0(18) and they release when an additional locking path over the back contact of relay HM(16) is opened by the operation of relay HM(16) following the operation of the hold magnet F(17) as previously described, and when the operating circuit is removed by the release of relays in the trunk when relay ON1(15) operates as previously described.

When relay SM(16) releases shunting ground connected from conductor 1601 over contact 3 of relay SM(16) to contact 1 of relay RA2(16), is

removed and relay RA2(16) now operates over the previously traced locking circuit for relay RA1(16) and opens the operating circuit of relay HM(16) which then releases. The circuits are now ready for the registration of incoming brush selection although pulsing may start before completion of all of the foregoing operations without any circuit reaction. The purpose of the remaining contacts of relays L(16), LA(16) and LB(16) and SM(16) is to control registration and to prevent a selection from starting before the preceding one has progressed far enough in its registration to avoid possible interference and yet to allow two selections to overlap one another as much as possible so as to save time.

When relays LA(16), LB(16) and RLK(15) and a relay in the trunk have all removed shorting grounds from the ring conductor R, relay STP(16) can operate over the fundamental loop. The reason for having parallel ground connections through back contacts of relays LA(16) and LB(16) is that in their operation ground must finally be removed by relay LB(16) because if it were removed by relay LA(16) at the time relay LA(16) opens the non-inductive winding of relay L(16), the stepping relay of the originating sender might falsely release from having unshunted inductance inserted into its circuit. On the other hand, the release of relay LB(16) may be delayed and it is necessary to shunt out relay STP(16) by the release of relay LA(16) to prevent starting the next selection prematurely.

When relay STP(16) operates over the fundamental loop it establishes a circuit for relay GR(16) which may be traced from battery through the winding of relay GR(16), conductor 1606, a contact of cross-point 1800, conductor 1801, contact of relay STP(16), conductor 1607 and a second contact of cross-point 1800 to ground. Relay GR(16) in operating connects ground over its contact 1, conductor 1517, contact 8 of relay TT and conductor 1514 to a point between the winding of relay L(16) and the stepping relay of the distant sender thereby shunting down such stepping relay and relay STP(16) and holding relay L(16) and consequently relays LA(16) and LB(16) operated. This operation and release of the stepping relays constitutes the first pulse. When relay STP(16) releases, relay GR(16) also releases removing the ground from the T lead and allowing relay STP(16) and the stepping relay of the originating sender to reoperate. Relay GR(16) then reoperates and again grounds the T lead releasing relay STP(16) and the stepping relay of the originating sender. This pulsing, the alternate operation and release of the two stepping relays, continues as long as the circuit is kept closed in the originating sender or until eleven pulses have been counted to indicate a telltale condition.

The periodic operation and release of relay GR(16) causes relays LC(16), LD(16) and LE(16) to operate and release in a recurrent cycle of half the frequency. These relays in turn actuate the counting relays P1(16) to P6(16). The operation of relay GR(16) on the first or any odd-numbered pulse establishes a circuit from ground over its contact 2, the lower normal contacts of jack T(16), contact 1 of relay LE(16) and through the winding of relay LC(16) to battery and relay LC(16) operates, locking in a circuit through the upper winding of relay LE(16), contact 1 of relay LD(16), contact 1 of relay LC(16) and to ground over contact 5 of relay LA(16) or contact 9 of relay LB(16). Until relay GR(16) releases the upper winding of relay LE(16) is shunted and relay LE(16) will not operate in the locking circuit of relay LC(16). When, however, relay GR(16) releases, relay LE(16) operates. The operation of relay GR(16) on the second or any even-numbered pulse establishes a circuit from ground at contact 2 of relay GR(16), contact of jack T(16), contact 2 and the lower winding of relay LE(16) and through the upper winding of relay LD(16) to battery thereby causing the operation of relay LD(16) which now locks over its lower winding and contact 2, contact 2 of relay LC(16) and to ground as traced at contacts of relay LA(16) or relay LB(16). Relay LD(16) upon operating opens the locking circuit for relay LC(16) extending through the upper winding of relay LE(16) and relay LC(16) releases but relay LE(16) is maintained operated in the operating circuit of relay LD(16) until relay GR(16) releases whereupon relays LD(16) and LE(16) release. Thus relay LE(16) operates at the end of each odd pulse, and releases at the end of each even pulse. The ground connection for holding relay LC(16) and LE(16) in series with relay LD(16) is forwarded over front contacts of relays LA(16) and LB(16) in parallel for the following reason. In their operation relay LA(16) operates first and by having it supply a locking ground over its contact 5 there is better assurance that it will be ready in time than if reliance were placed on a possibly vibrating contact of relay LB(16) alone. On the other hand, on the release of the relays, relay LB(16) may be delayed some time and it is necessary to hold the locking ground until it releases or else an additional P relay might be operated from the back contact of relay LE(16) when it releases.

The operation of relay LE(16) on the first pulse establishes a circuit from ground at contact 5 of relay LA(16), contact 8 of relay LB(16), contact 4 of relay LE(16), conductor 1608, contact 5 of relay P4(16), contact 5 of relay P2(16), contact 1 of relay P3(16), contact 1 of relay P5(16) and through the upper winding of relay P1(16) to battery. Relay P1(16) operates in this circuit and locks over its contact 3, contact 2 of relay P2(16), contact 5 of relay P3(16), contact 2 of relay P4(16), contact 5 of relay P5(16), conductor 1610, contact 11 of relay LB(16) and to ground on conductor 1600. On its next release, relay LE(16) connects ground over its contact 3, conductor 1609, contact 5 of relay P1(16) and through the winding of relay P2(16) to battery. Relay P2(16) operates in this circuit, locking over its contact 1 and the previously traced locking circuit to ground on conductor 1610 and opens at its contact 2 the locking circuit of relay P1(16) which now releases.

Similarly, and in the manner previously described in connection with the operation of the pulse counting relays of the originating register shown in Fig. 39, the operation and release of relay LE(16) on subsequent pulses operates other of the counting relays P3(16), P4(16), P5(16) and P6(16). Should relay GR operate for an eleventh pulse, at which time relays P4(16) and P6(16) would be operated, the connection of ground to conductor 1608 at contact 4 of relay LE(16) would complete a circuit over contact 4 of relay P4(16), contact 5 of relay P6(16), conductor 1611 and through the winding of relay TT(15) to battery. Relay TT(15) operates in this circuit and locks over its contact

6, conductor 1515 and to ground on conductor 1600. The pulse counting relays left up after each pulse, any of which may be the last pulse of a selection, are as follows:

Pulse	Relays	Conductors Grounded
1	P1	1620
2	P2	1621
3	P3	1622
4	P4	1623
5	P5	1624
6	P5, P6	1625
7	P1, P6	1626
8	P2, P6	1627
9	P3, P6	1628
10	P4, P6	1629
11	P4, P6, TT	1611

The operating ground for the pulse counting relays is controlled through a front contact 8 of relay LB(16) to allow sufficient time to operate the last P relay on the last pulse of a selection. For this reason, relay LB(16) is made slow to release. Relay LA(16) must be fast to release, however, because it must get down before relay L(16) operates on the next selection. The locking ground for the pulse counting relays is supplied to conductor 1610, over a front contact 11 of relay LB(16) and in parallel over back contact 5 of relay SM(16) and grounded conductor 1600. The contact 5 of relay SM(16) holds the locking circuit until a select magnet of the register switch is operated in response to the operation of the counting relays and the contact of relay LB(16) holds the locking circuit through the interval during which relay SM(16) has not yet released from the previous selection and relay LB(16) is held operated until relay SM(16) releases.

Five selections are registered on each call, incoming brush, incoming group, final brush, final tens and final units, registered in that order. Each selection is registered by operating one of the ten select magnets and then operating the hold magnet appropriate to that selection after which the select magnet is released and the hold magnet is held. This closes the cross-points which are at the levels of the operated select magnets.

When the originating sender has counted the proper number of pulses for a selection, it breaks the fundamental circuit extending over conductors T and R to the incoming register and relays L(16), LA(16) and LB(16) release. Relay LB(16) upon releasing then establishes the circuit for one of the select magnets in accordance with the operated condition of the pulse counting relays. It has been assumed that the directory number of the wanted line registered in the distant originating sender was 7890, and that consequently such sender has translated that number and will send a series of four pulses for the incoming brush selection, four pulses for the incoming group selection, four pulses for the final brush selection, ten pulses for the final tens selection and one pulse for the final units selection. Therefore, at the end of the first or incoming brush selection counting relay P4(16) will be operated and a circuit will be established from ground at back contact 2 of relay TT(15), conductor 1516, contact 9 of relay RV1(14), conductor 1409, contact 6 of relay SM(16), conductor 1612, contact 1 of relay P6(16), contact 1 of relay LB(16), contact 6 of relay P4(16), conductor 1623 and through the winding of select magnet S3(18) to battery. The select magnet thus operated has a number one less than the number of pulses counted for the particular selection.

Select magnet S3(18) upon operating connects its operating ground over its contact 1 and conductor 1702 to the winding of relay SM(16) which operates and locks as previously described under the control of relay HM(16) and holds the select magnet operated. The operating circuit from a front or back contact of relay P6(16) for the select magnets is taken through two different back contacts 1 and 3 of relay LB(16) instead of a single back contact so that if relay LB(16) operates to start the next selection while a select magnet and relay SM(16) are still locked up and two adjacent pulse counting relays are for a moment both operated, the locking ground for the operated select magnet cannot find a path to operate another select magnet. The operating circuit for the select magnet is taken over a back contact 6 of relay SM(16) so that if relay P6(16) releases faster than the other operated pulse counting relay, momentarily closing an operating path to another select magnet, there will be no ground on that path. The operating circuit for the select magnet is taken through a back contact 2 of relay TT(15) so that when eleven pulses are counted for a telltale condition no select magnet will operate. The operating circuit for the select magnet is taken through a back contact 9 of relay RV1(14) to prevent a false operation of the select magnet S0(18) if at the end of the final units selection the LA(16) and LB(16) relays operate before the FU(17) hold magnet operates and the STP(16) and GR(16) relays operate to count a pulse falsely.

When relay SM(16) operated the first time to register the incoming frame number, it operated relay RA1(16) and when it released relay RA2(16) operated. When relay SM(16) operates for the second time at the end of the incoming brush registration it establishes a circuit over contact 2 of relay RA2(16) and contact 3 of relay SM(16) to ground over conductor 1601 in shunt of the winding of relay RA1(16) and the latter relay releases followed by the release of relay RA2(16) when relay SM(16) releases. This completes the operating cycle for relays RA1(16) and RA2(16) and on the four subsequent selections they go through the same cycle twice. Each time that relay SM(16) operates it either operates relay RA1(16) and leaves RA2(16) normal or it releases relay RA1(16) and leaves relay RA2(16) operated. In either case, the effect is to connect the windings of relay HM(16) to the winding of the first non-operated hold magnet causing the same to operate. The hold magnet closes the contacts of the cross-points at the level of the operated select magnet, locks to an off-normal ground and by connecting locking ground to the windings of relay HM (16) causes that relay to operate. When relay HM(16) has operated on one selection and relay LB(16) on the next selection, relay SM(16) and the operated select magnet release. The operated hold magnet also steers the advance lead 1704 from the RA1(16) relay to the next hold magnet to be operated from that lead.

For example, when relay RA1(16) releases following the registration of the incoming brush selection, the circuit for hold magnet IB(17) is established from battery through the winding of such magnet, contact 1 of hold magnet IG(17), contact 1 of hold magnet F(17) previously operated, conductor 1704, contact 4 of relay RA1(16), contact 3 of relay RA2(16), through the windings

of relay HM(16) and to ground on conductor 1602. Magnet IB(17) operates in this circuit and locks over its contact 2, conductor 1705, contact 3 of relay RLK(15) and to ground at contact 5 of relay ON(15), the locking ground serving to cause the operation of relay HM(16) in the manner previously described. Magnet IB(17) also establishes a circuit from ground on conductor 1705 over its contact 2, conductor 1706 and through the winding of relay IB1(14) to battery and relay IB1(14) then operates to establish the previously traced locking circuit for relay RV3(14). With select magnet S3(13) and hold magnet IB(17) operated, the contacts of cross-point 1803 are closed.

When relays L(16), LA(16) and LB(16) again operate at the beginning of the next selection, relay LB(16) opens at its contact 1 the operating circuit for select magnet S3(13) and at its contact 12 opens one locking path for relay SM(16) and select magnet S3(13) and, with relay HM(16) operated, the other locking path is opened and relay SM(16) and magnet S3(13) then release. Thereupon relay HM(16) and relay RA2(16) release. Relay LB(16) also at its contact 12 removes one locking ground from conductor 1610 and relay SM(16) until it releases holds locking ground from conductor 1610 at its contact 5 and therefore the operated counting relay P4(16) releases. At the end of the second selection relays L(16), LA(16) and LB(16) release and under the assumption that the second or incoming group selection comprises four pulses, counting relay P4(16) remains operated and the previously traced circuit for select magnet S3(13) is again established resulting in the reoperation of relay SM(16) and the reoperation of relay RA1(16). The circuit for hold magnet IG(17) is now established from battery through the winding of such magnet, contact 1 of magnet FB(17), conductor 1707, contact 2 of relay IB1(14), conductor 1404, contact 5 of relay RA1(16), contact 4 of relay RA2(16), windings of relay HM(16) and to ground on conductor 1602. Magnet IG(17) operates in this circuit and locks over its contact 3, conductor 1708 and to ground at contact 8 of relay ON1(15), the locking ground serving to cause the operation of relay HM(16) in the manner previously described. With select magnet S3(13) and hold magnet IG(17) operated the contacts of cross-point 1804 are closed.

When relays L(16), LA(16) and LB(16) again operate at the beginning of the next selection, relay LB(16) opens at its contact 1 the operating circuit for select magnet S3(13) and at its contact 12 opens one locking path for relay SM(16) and select magnet S3(13) and, with relay HM(16) operated, the other locking path is opened and relay SM(16) and magnet S3(13) release, whereupon relay HM(16) releases. Relay LB(16) also at its contact 12 removes locking ground from conductor 1610 and relay SM(16) when operated removes another ground from conductor 1610 at its contact 5 and therefore the operated counting relay P4(16) releases. At the end of the third selection, relays L(16), LA(16) and LB(16) release and under the assumption that the third or final brush selection comprises four pulses, counting relay P4(16) remains operated and the previously traced circuit for select magnet S3(13) is again established resulting in the reoperation of relay SM(16) and the release of relay RA1(16). The circuit for hold magnet FB(17) is now established from battery through the winding of such magnet, contact 1 of magnet FT(17), contact 2 of magnet IG(17), contact 1 of magnet F(17), conductor 1704, contact 4 of relay RA1(16), contact 3 of relay RA2(16) and through the windings of relay HM(16) to ground on conductor 1602. Magnet FB(17) operates in this circuit and locks over its contact 3, conductor 1703 and to ground at contact 8 of relay ON1(15), the locking ground serving to cause the operation of relay HM(16) in the manner previously described. With select magnet S3(17) and hold magnet FB(17) operated the contacts of cross-point 1805 are closed.

When relays L(16), LA(16) and LB(16) again operate at the beginning of the next selection, relay LB(16) opens at its contact 1 the operating circuit for select magnet S3(13) and at its contact 12 opens one holding path for relay SM(16) and select magnet S3(13) and, with relay HM(16) operated, the other locking path is opened and relay SM(16) and magnet S3(13) release, whereupon relay HM(16) and relay RA2(16) release. Relay LB(16) also at its contact 12 removes one locking ground from conductor 1610 and relay SM(16) so long as it is operated removes another locking ground from conductor 1610 and therefore the operated counting relay P4(16) releases. At the end of the fourth selection relays L(16), LA(16) and LB(16) release and under the assumption that the fourth or final tens selection comprises ten pulses counting relays P4(16) and P6(16) remain operated and a circuit is established from ground on conductor 1409, contact 6 of relay SM(16), conductor 1612, contact 2 of relay P6(16), contact 4 of relay LB(16), contact 3 of relay P4(16), conductor 1629 and through the winding of select magnet S9(17) to battery. Magnet S9(17) upon operating causes the reoperation of relay SM(16) and the reoperation of relay RA1(16). The circuit for hold magnet FT(17) is now established from battery through the winding of such magnet, contact 2 of magnet FB(17), conductor 1707, contact 2 of relay IB1(14), conductor 1404, contact 5 of relay RA1(16), contact 4 of relay RA2(16), windings of relay HM(16) and to ground on conductor 1602. Magnet FT(17) operates in this circuit and locks over its contact 3, conductor 1709 and to ground at contact 11 of relay ON1(15), the locking ground serving to cause the operation of relay HM(16) in the manner previously described. With select magnet S9(17) and hold magnet FT(17) operated, the contacts of cross-point 1710 are closed.

When relays L(16), LA(16) and LB(16) again operate at the beginning of the next and last selection, relay LB(16) opens at its contact 4 the operating circuit for select magnet S9(17) and at its contact 12 opens one locking path for relay SM(16) and select magnet S9(17) and, with relay HM(16) operated, the other locking path is opened and relay SM(16) and magnet S9(17) release, whereupon relay HM(16) releases. Relay LB(16) also at its contact 12 removes one locking ground from conductor 1610 and until relay SM(16) releases the other locking ground is removed from conductor 1610 and the operated pulse counting relays P4(16) and P6(16) release. At the end of the fifth selection relays L(16), LA(16) and LB(16) release and, under the assumption that the fifth or final units selection comprises one pulse, counting relay P1(16) remains operated and a circuit is established from ground over conductor 1409, contact 6 of relay SM(16), contact 1 of relay P8(16), contact 2 of relay LB(16), contact 4 of relay P1(16), con-

ductor 1620 and through the winding of select magnet S0(18) to battery. Magnet S0(18) upon operating causes the reoperation of relay SM(16) and the release of relay RA1(16). The circuit for hold magnet FU(17) is now established from battery through the winding of such magnet, contact 2 of magnet FT(17), contact 2 of magnet IG(17), contact 1 of magnet F(17), conductor 1704, contact 4 of relay RA1(16), contact 3 of relay RA2(16), windings of relay HM(16) and to ground on conductor 1602. Magnet FU(17) operates in this circuit and locks over its contact 3 to ground on conductor 1709, the locking ground serving to cause the operation of relay HM(16) in the manner previously described. With select magnet S0(18) and hold magnet FU(17) operated, the contacts of cross-point 1806 are closed.

Hold magnet FU(17) upon operating at its contact 2 establishes a circuit over conductor 1711 in shunt of the winding of relay STP(16) to prevent any further pulsing and establishes a circuit from ground over its contact 1, conductor 1712, contact 5 of relay LB(16), conductor 1613 and through the winding of relay RV1(15) to battery. Relays L(16), LA(16) and LB(16) are reoperated when the originating sender closes the fundamental circuit to receive a reverse battery pulse. Relay RV1(15) operates and locks over its contact 5 and conductor 1410 to ground at contact 10 of relay ON1(15). Relay LB(16) upon operating also causes the release of relays SM(16), HM(16) and RA2(16) and select magnet S0(18) in the manner previously described.

Incoming advance

Relay RV1(15) upon operating transfers the winding of relay L(16) at its transfer contacts from the T lead of the fundamental circuit to the R lead which is at this time grounded over contact 1 of magnet FU(17), conductors 1711 and 1408 and contact 1 of relay RV2(14). The T lead of the fundamental circuit is also grounded at this time from ground at contact 3 of relay RV3(14) and over contact 9 of relay RV1(14). Relay RV1(14) also establishes the circuit for slow-to-operate relay RV2(14) over its contact 7 whereupon relay RV2(14) operates. Relay RV1(14) also opens the circuit of relay TMA(14), which operates whenever relay LA(16) operates over a circuit from ground at contact 2 of relay LA(16), conductor 1614, contact 6 of relay RV1(14) and through the winding of relay TMA(14) to battery. When relay TMA(14) releases upon the operation of relay RV1(14) it transfers the connection over conductor 1615 from the back contact of relay L(16) to the locking circuit of relay RV3(14). Relay RV1(14) opens the locking ground of the select magnet to prevent a false operation of the magnet S0(18) during incoming advance which occurs if the hold magnet FU(17) fails to short-circuit relay STP(16) before the originating sender closes the fundamental circuit to start incoming advance. Relay RV1(14) also at its contact 2 releases relay IF1(14) which may have operated before the relay LB(16) operated to operate relay RV1(14). The operation and release of relay IF1(14) performs no function at this time.

During the operate time of relay RV2(14), the T and R leads being grounded, discharge the cable and the stepping relay of the originating sender releases. The T lead is grounded to prevent premature advance of a panel subscriber-sender due to the false operation of its overflow relay which might occur if the direct battery was terminated by opening the T lead. When relay RV2(14) operates it removes the ground from the R lead which was holding relay L(16) over a local circuit. Thus reverse current which starts with a surge is applied toward the originating sender to operate the distant stepping relay and overflow relay. This surge compensates for a tendency of the overflow relay to operate faster than its associated stepping relay. Relay RV2(14) also opens the operating path of slow-to-release relay RV3(14) and that relay releases if its locking path to the back contact of relay L(16) is also open. Relay RV3(14) is locked to the back contact of relay L(16) to insure that reverse battery will continue until the originating sender, by operating relay L(16), has indicated that it has received it. This locking path provides for cases where the incoming register registers a telltale condition operating the relays TT(15) and RV1(14) and at the same time the originating sender is satisfied either by the final pulse or the ground pulse supplied by relay RV1(14). Under this condition the originating sender would be between selections and thus unable to receive the reverse battery pulse. Relay RV3(14) has a locking path which is extended over contact 3 of relay IB1(14) so that it is effective only after the incoming brush selection has been registered. If the originating sender receives reverse battery during incoming brush selection, it will open the loop during the reverse battery period without waiting for termination of the reverse battery. A locking path for relay RV3(14) during this selection would thus stick the incoming register.

Trunk closure

When relay RV3(14) releases after a reverse battery interval sufficient to satisfy the originating sender, it opens the T and R leads and releases the slow-to-release relay RV4(14). The release time of relay RV4(14) provides an interval long enough to be recognized by the originating sender as a signal to advance to trunk closure. When relay RV4(14) has released, it connects the T lead to battery over contact 1 of relay RV4(14) and contact 3 of relay RV5(14) through resistance TR(14) and the lead R over contact 4 of relay RV1(14), contact 2 of relay RV4(14) and contact 1 of relay RV5(14) through resistance RR(14) to ground. This discharges the cable from the preceding reverse battery pulse and recharges the tip side of the trunk to a negative polarity thus preventing false operation of the line relay of the trunk when it is subsequently connected to the line and the originating sender may not yet have advanced to trunk closure to close the fundamental loop.

Relay RV4(14) also connects ground in a circuit from contact 4 of relay ON1(15), conductor 1517, contact 4 of relay RV4(14), conductor 1411, contact 5 of relay TC2(15), through the lower winding of relay TC1(15), contact 1 of relay ON(15) and conductor 1518 extending over cable J(15) to Fig. 51 and thence to the trunk to operate the D relay of the trunk, which upon operating establishes the trunk transmission condition and reconnects the trunk line relay to the line. The trunk line relay may or may not operate at this time depending on the loop since it is shunted by the TR(14) and RR(14) resistances at the incoming register. When the D relay operates, it connects ground to conductor 1407 extending through cable J(51) to Fig. 15 and thence over contact 2 and through the winding

of relay RV5(14) to ground thereby shunting relay RV5(14) which then releases.

Relay RV5(14) upon releasing removes battery and ground through resistances TR(14) and RR(14) from the fundamental loop thus permitting the operation of the trunk line relay if it has not already operated. During this period the originating sender has been advancing to trunk closure position and the operation of the trunk line relay may have to wait the closure. The ground initially connected to conductor 1518 by the originating register does not operate relay TC1(15) since the current flow established at this time in its lower winding will oppose the current flow in its upper winding. However, when the trunk returns ground on conductor 1518 indicating that the trunk D relay has operated and locked to the line relay, this ground shunts the lower winding of relay TC1(15) and this relay now operates in a circuit from battery through its upper winding to ground on conductor 1518 closing an obvious circuit over its contact 5 to cause the operation of relay TC2(15). Relay TC2(15) upon operating, locks over its contact 4 to ground at contact 1 of relay H(14) and over its contact 5, conductor 1511, contact 6 of relay RV4(14) and conductor 1517 to ground at contact 4 of relay ON1(15). Relay TC1(15) upon operating short-circuits its lower winding at contact 4 so that on abandoned calls, when the duration of trunk closure is limited, it will only be necessary to operate relay TC1(15) to insure that relay TC2(15) will operate and lock. When relays TC1(15) and TC2(15) have operated, any subsequent release of the TC1(15) relay will cause the operation of relay MRL(14) to release the incoming register. The short circuit of the lower winding of relay TC1(15) also makes that relay slow to release so that it will not release the register on momentary openings of the contacts of the trunk line relay.

Connection of incoming register to marker

Relay TC2(15) connects battery in a circuit over its contact 9, contact 3 of relay MRL(15), contact 3 of relay TRL(14), contact 11 of relay TT, conductor 1519 of cable B(15) extending to Fig. 6 to start the marker connector and at its contact 8 supplies battery over conductor 1520 of cable B(15) extending to Fig. 6 and thence in parallel through the windings of connector relays RA(6) and RC(6) to ground. Relay RA(6) at its contact 2 establishes an obvious circuit through the windings of connector relays RB(6) and RD(6) to ground. With relay RD(6) operated, battery connected to start conductor 1519 is extended through resistances Z(6) and W(6) and over contacts 11 and 12 of relay RD(6) and is applied to the armature of a relay Z of the incoming register marker connector circuit (not shown), corresponding to relay Z(13), and assuming such relay and the associated relay TRS are not operated, a start circuit is completed to a relay CB, corresponding to relay CB11(25), which is individual to marker No. 1 in the incoming register marker connector connected with the incoming register shown. Assuming that the marker No. 1 is idle and therefore that the CB relay of such marker is not operated, the start circuit will be further extended to the winding of the marker start (MS), relay corresponding to relay MS11(25), allocated to such marker and over contacts of the other MS relays of the chain to ground. This start relay upon operating applies ground over conductors 4302 and 4304 of a cable extending from the incoming register marker connector circuit to the windings of the incoming register connector relays MA(6) and MC(6) of the idle No. 1 marker, whereupon such relays operate. The circuits over which the MA and MC relays are operated are fully disclosed in the application of A. J. Busch hereinbefore referred to and function in the manner described therein and in a manner similar to that described herein in connection with the operation of the similar relays of the line-link marker connector. Relay MA(6) upon operating establishes over its contact 6 an obvious circuit for relay MB(6). Relay MC(6) establishes over its contact 5 an obvious circuit for relay MD(6). With relays RA(6), RB(6), RC(6), RD(6), MA(6), MB(6), MC(6), and MD(6) operated, the incoming register is connected with the selected marker over a large plurality of conductors.

Relay RA(6) at its contact 4 closes a circuit extending over contact 7 of relay MA(6) to the class of call circuit (not shown) of the marker which establishes the circuit of a relay INC to inform the marker that it has been called in by an incoming register. This relay upon operating establishes a circuit which may be traced in part from the recycle controller circuit (not shown), over conductor 3305 through the winding of relay TER2(46), conductor 4605 and through the winding of relay TER3(61) to battery. The operation of these relays directs the marker to perform the functions required in extending a terminating call. Relay MA(6) also establishes a circuit from ground over its contact 4, conductor 3004 of cable A(6) extending to Fig. 36, contact 5 of relay TRLA(37), contact 5 of relay DIS2(37), conductor 3713, winding of relay CKG1(50), conductor 5011, conductor 3702, contact 3 of relay TRLA(37), conductor 3701, contact 3 of relay DIS1(50), winding of relay CKG2(50), conductor 3700 and through the winding of relay CKG3(37) to battery. Relays CKG1 (50), CKG2(50) and CKG3(37) prepare the marker for operation as described in connection with the dial tone connection. With relays CKG3(37) and TER2(46) both operated, the circuit for relay FLG(60) is now closed from battery through its winding, conductor 6000, contact 10 of relay LK1(46), contact 9 of relay TER2(46), conductor 4606 and to ground at contact 6 of relay CKG3(37).

The marker having been informed that the connection which it is to serve is from an incoming register, establishes the circuit of relay GTL(36) which in turn causes the operation of relays GTL2(45), GTL3(32) and GTL4(32).

Transfer of called line number from incoming register to marker

When the multicontact relays of the incoming register marker connector have been operated as above described, a plurality of circuits are closed for transferring the called line designation and the number of the trunk-link frame on which the incoming trunk terminates from the incoming register to the marker. It will be recalled that cross-points 1800, 1803, 1804, 1805, 1710 and 1806 have been closed to register the frame units and incoming brush, incoming group, final brush, final units and final tens of the called line designation and that relay FG8(17) has been operated to register the frame tens number.

The operation of the MC(6) and RC(6) relays has extended from the incoming register to the marker a group of five trunk-link frame units

leads and two trunk-link frame tens leads to identify the trunk-link frame associated with the incoming trunk circuit. It has been assumed that frame tens relay FG0(17) has been operated and consequently a circuit is now closed from ground over contact 1 of relay FG0(17), conductor 1713, contact 19 of relay RC(6), contact 25 of relay MC(6), and thence to the trunk-link frame register of the marker (not shown) and two circuits are established from ground over contacts of cross-point 1800, conductors 1815 and 1817, contacts 23 and 24 of relay RC(6) and contacts 29 and 30 of relay MC(6) and thence to the trunk frame register of the marker. Relays in the register are now operated to register the number of the trunk-link frame assumed to be 00.

It will be assumed that the marker requires no additional digit for office identification and that with the cross-points 1803 and 1804 closed to register the incoming brush as 3 and the incoming group as 3, two circuits are closed as follows: From ground, contact 1 of cross-point 1804, contact 3 of cross-point 1803 to conductor 1826 and, from ground, contact 2 of cross-point 1804, contact 4 of cross-point 1803 to conductor 1827, thence over contacts 13 and 17 of relay RA(6), contacts 16 and 20 of relay MA(6), conductors 3016 and 3017 of cable D(6) extending to Fig. 58, and through the windings of relays AC0(58) and AC7(58) to battery to register the thousands digit 7 of the called line number.

It will be recalled that the cross-point 1805 has been closed to register the final brush as 3 and with the cross-point 1804 closed to register the incoming group as 3, two circuits are closed as follows: From ground, contact 3 of cross-point 1804 and contact 1 of cross-point 1805 to conductor 1831, and from ground over contact 4 of cross-point 1804 and contact 2 of cross-point 1805 to conductor 1837, thence over contacts 19 and 22 of relay RA(6) and contacts 22 and 25 of relay MA(6) to conductors extending through the windings of relays BC1 and BC7 of the B register (not shown). Conductors of the thousands group 1820 to 1827, inclusive, and of the hundreds group 1830 to 1837, inclusive, are grounded on a two-out-of-five basis in accordance with incoming brush and group and final brush registrations as shown in the following table:

Thousands	Incoming Brush	Incoming Group	Leads Grounded
0	0	0 or 1	1824 1827
1	0	2 or 3	1820 1821
2	1	0 or 1	1820 1822
3	1	2 or 3	1821 1822
4	2	0 or 1	1820 1824
5	2	2 or 3	1821 1824
6	3	0 or 1	1822 1824
7	3	2 or 3	1820 1827
8	4	0 or 1	1821 1827
9	4	2 or 3	1822 1827

Hundreds	Final Brush	Incoming Group	Leads Grounded
0	0	0 or 2	1834 1837
1	1	0 or 2	1830 1831
2	2	0 or 2	1830 1832
3	3	0 or 2	1831 1832
4	4	0 or 2	1830 1834
5	0	1 or 3	1831 1834
6	1	1 or 3	1832 1834
7	2	1 or 3	1830 1837
8	3	1 or 3	1831 1837
9	4	1 or 3	1832 1837

It will be recalled that cross-points 1710 and 1806 have been closed to register the final tens and final units selections as 9 and 0, respectively. Accordingly, ground is connected over contacts 3 and 4 of cross-point 1710 to conductors 1842 and 1847 and thence over contacts 25 and 27 of relay RA(6) and contacts 28 and 30 of relay MA(6) to conductors extending through the windings of relays CC2 and CC7 of the C register (not shown). With cross-point 1806 closed, ground is connected over contacts 3 and 4 thereof, conductors 1854 and 1857, contacts 21 and 22 of relay RB(6), contacts 21 and 22 of relay MB(6) to conductors 3024 and 3027 of cable E(6) extending to Fig. 80.

With no additional digit registered for office identification, relays N1(71) and N1A(71) are operated from the translator control circuit to transfer the thousands, hundreds and tens digits registered on the A, B and C code digit registers to the thousands, hundreds and tens registers of Figs. 57 and 58 and to control the registration of the units digit on the units register of Fig. 71. With relay N1(71) and relays AC0(58) and AC7(58) of the A code register operated, a circuit is established from ground at contact 1 of relay AC0(58), conductor 5800, contact 6 of relay N1(71), conductor 7100 and through the winding of relay TH0(58) to battery and a second circuit is established from ground at contact 1 of relay AC7(58), conductor 5807, contact 2 of relay N1(71), conductor 7107 and through the winding of relay TH7(58) to battery. The thousands digit 7 is now registered in the thousands digit register. With relays BC1 and BC7 (not shown) operated as assumed, circuits are established over their contacts, contacts 8 and 11 of relay N1(71), conductors 7111 and 7117 and through the windings of relays HN1(57) and HN7(57) of the hundreds digit register to battery whereby the hundreds digit 8 is now registered on the hundreds digit register. With relays CC2 and CC7 (not shown) operated, and relay N1A(71) operated, circuits are established over contacts of the register relays, contacts 9 and 11 of relay N1A(7) and conductors 8002 and 8007 through the windings of relays T2(57) and T7(57) to battery whereby the tens digit 9 is now registered on the tens digit register. It will be recalled that the closure of the contacts of cross-point 1806 of the register of incoming register has connected ground to conductors 3024 and 3027 of cable E(6) extending to Fig. 80 and, with relay N1A(71) operated, circuits are completed from such conductors over contacts 3 and 2 of relay N1A(71), conductors 8014 and 8017 and through the windings of relays U4(71) and U7(71) to battery whereby the units digit 0 is now registered on the units digit register.

If an additional digit had been registered in the incoming register for office identification, then relays N2(71) and N2A(80) would have been operated instead of relays N1(71) and N1A(71) to transfer the thousands and hundreds digits registered in the B and C code digit registers to the thousands and hundreds registers of Figs. 57 and 58 and to control the registration of the tens digit in the tens register of Fig. 57 and the registration of the units digit in the units register of Fig. 71.

Completion of connection to called line

The marker having received from the incoming register the identification of the trunk-link frame, schematically indicated in Fig. 51, in the

manner fully set forth in the application of A. J. Busch hereinbefore referred to and in the manner previously outlined in connection with the seizure of the originating register on a dial type call, a relay in the marker is then operated to indicate that the trunk-link frame has been successfully seized whereupon the marker causes the operation of the F relay in the incoming trunk circuit of Fig. 51 which operates, in turn, establishinng the circuit of the FB4 relay of Fig. 38 corresponding to the incoming trunk appearance on a cross bar switch of the trunk-link frame. The operation of the FB4 relay, in turn, causes the operation of the associated LV relay.

After the marker has seized the trunk-line frame associated with the incoming trunk and has checked the seizure of the frame it proceeds to select and seize a number group frame for the purpose of translating the digits of the called number registered in the marker into the location digits of the called line. The seizure of the proper number group circuit, the transfer of the called line hundreds, tens and units digits thereto and the transmission of the called line location information from the number group circuit to the marker are carried out in exactly the same manner as hereinbefore described in connection with an intraoffice call and need not be described further.

After the registration of the called line location and the type of ringing required have been set up in the marker, the number group circuit can be dismissed from the marker. The operation of the locking relays in the number group controller of the marker indicating that the called line designation as translated by the number group circuit has been registered in the marker, closes a circuit for bringing about the release of the number group circuit by opening the circuit of the marker preference relay MP1(2) as fully described in the application of A. J. Busch hereinbefore referred to. The release of relay MP1(2) causes the release of multicontact relays MCA1(5), MCA2(5), MCB(4) and MCC(3) to disconnect the number group circuit from the marker and releases relays HBS(5), TBS9(4) and U0(4) of the number group circuit.

After the location of the called line is identified, the marker will proceed to test the called line for a busy condition, to select an idle channel over which the incoming trunk may be connected to the line and to operate the select and hold magnets in the trunk-link and line-link frames to establish the connection over the selected idle channel. These functions are fully disclosed and described in the application of A. J. Busch hereinbefore referred to and since these functions are not directly concerned with the present invention the circuits over which these functions are accomplished have not been disclosed herein.

After the marker has completely performed the terminating call functions the marker circuit will be released from the terminating connection and will be recycled to the idle condition so as to be available for assistance to other calls or connections.

When the relay FB4(38) associated with the incoming trunk is released in the manner previously described in connection with a dial tone call the relay DCT(34) in the marker is released, in turn, causing the operation of relay LK1(46) which indicates the successful completion of the marker terminating call functions. The operation of relay LK1(46) releases relays LLC1(48), LLC2(48), ONW(35) and FLG(60) and operates the DIS1(50) and DIS2(37) relays as previously described whereupon all operated relays of the marker release, and in turn, release the trunk-link and line-link frame connectors.

The operation of DIS1(50) establishes a circuit which may be traced from battery through the winding of relay MRL(15) of the incoming register, contact 2 of relay TC1(15), conductor 1521 of cable B(15) extending to Fig. 6, contact 13 of relay RD(6), contact 17 of relay MD(6), conductor 609 extending through the continuity and timing circuits of the marker and returning therefrom over conductor 5013, contact 2 of relay DIS1(50), conductor 5014 and to ground over contact 1 of relay DIS2(37). Relay MRL(15) operates in this circuit, locks over its contact 4, contact 4 of relay TT(15) and to ground at contact 2 of relay TC2(15) and at its contact 3 opens the start lead 1519 extending to the marker connector to release the marker connector.

Relay MRL(15) also releases relay ON(15) and connects holding ground over its contact 1 and the previously traced circuit to the winding of relay RB(15) to hold it operated until the release of the register is completed. Relay ON(15) upon releasing opens at its contact 1 the circuit to lead 1518 extending to the trunk-link circuit to prevent breaking that circuit at the link switch contacts, opens the circuit of relay ON1(15) at its contact 6 and opens other off-normal grounds of the register. Relay ON1(15) upon releasing releases the link switch hold magnet and also opens the remaining off-normal grounds in the incoming register circuit to release all operated relays and hold magnets of the cross bar register. Relay ON1(15) also at its contact 4 opens the locking circuit of relay TC2(15) which releases in turn releasing relays MRL(15) and RB(15). Relay RB(15) upon releasing releases relays in the link circuit which have held the incoming register busy and the register may now be selected for another call.

If the marker cannot disconnect itself from the register by the regular release circuit controlled by relay MRL(15) or if the register has seized the marker to obtain a trouble record of failure of the link control relays to release, the marker grounds conductor 601 whereupon a circuit is established over contact 26 of relay MA(6), contact 16 of relay RA(6), conductor 1522 of cable B(6) extending to Fig. 15, contact 3 of relay TM(14), conductor 1412 and through the winding of relay TRL(15) to battery. Relay TRL(15) operates in this circuit and locks over its contact 5, contact 5 of relay MRL(15), contact 4 of relay TT(15) and to ground at contact 2 of relay TC2(15) and performs the functions previously described for relay MRL(15) and in addition operates relay RLK(15) and at its contact 4 opens the circuit of the link switch select magnet. The latter two functions aid release of the register in case the control relays of the link have not released.

The incoming register is provided with three tube timing circuits, the first including the tube LRT(14) condenser LRC(14), relay LR(14) and associated resistances to time the holding period of the link control relays, the second including the tube TMT(14), condenser TM(14), relay TMC(14) and associated resistances for timing the register holding period and the third including the tube IFT(14), condenser IF(14), relay IFC(14) and associated resistance to time the auxiliary start of incoming advance and auxiliary

register release. For the purpose of the present invention it will be assumed that the incoming register performs all of these functions within the specified time intervals and that therefore relays LR(14), TM(14) and IF(14) are without function and that the description of the operation and effect of these timing circuits is not necessary herein.

In the foregoing discussion the complete circuits by which the marker actually controls the setting up of connections over the line-link and trunk-link frames have not been described nor have the release of the various established connections been described since these functions are only incidental to the present invention. However, such circuits and their operation which are deemed essential to the present invention have been fully disclosed and described herein.

What is claimed is:

1. In a telephone system, a calling line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of the indentity of said line, means in said marker responsive to said association to select an idle originating register and to transfer said registration to said selected register, means in said marker responsive to said registration to control said switches to connect said line with said register, and means thereupon effective to release said marker.

2. In a telephone system, a calling line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of the identity of said line and a registration of the class of said line, means in said marker responsive to said association to select an idle originating register and to transfer said registrations to said register, means in said marker responsive to said first registration to control said switches to connect said line with said selected register, and means thereupon effective to release said marker.

3. In a telephone system, a calling line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of the identity of said line, a registration of the class of said line and a registration of the specific type of said line, means in said marker responsive to said association to select an idle originating register and to transfer said registrations to said selected register, means in said marker responsive to said line identity registration to control said switches to connect said line with said register, means in said register responsive to the line type registration transferred thereto to vary the response of said register to the control of the calling line, and means effective upon the connection of said register with said line to release said marker.

4. In a telephone system, a calling line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of information concerning said line, means in said marker responsive to said association to select an idle originating register, registers in said selected originating register, checking registers in said marker, means controlled by said marker for simultaneously transferring said registered information from the registration means of said marker to the registers of said originating register and to said checking registers, means responsive to the operation of the registers of said originating register to lock said checking registers operated, means in said marker for thereafter disconnecting said first information registering means from the registers of said originating register and from said checking registers whereby said checking registers are held operated from said registers of the originating register, means in said marker to determine if the checking registers are then held operated and that therefore the corresponding registers of said originating register are operated, means in said marker responsive to said first information registering means if said registered information has been correctly transferred to said originating register to control said switches to connect said line with said originating register, and means thereafter effective to release said marker.

5. In a telephone system, a calling line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of the identity of said line, means in said marker responsive to said association to select an idle originating register, line identity registers in said selected originating register, line identity checking registers in said marker, means controlled by said marker for simultaneously transferring said first line identity registration to said line identity registers of said originating register and to said checking registers, means responsive to the operation of the registers of said originating register to lock said checking registers operated, means in said marker for thereafter disconnecting said first line identity registration means from the line identity checking registers of said marker and originating register whereby the line identity registers of said marker are held operated from the registers of said originating register, means in said marker to thereafter determine if the required number of the line identity registers of said marker are held operated and that therefore the corresponding number of registers of the originating register are operated, means in said marker responsive to said first line identity registration means if said registration has been correctly transferred to said originating register to control said switches to connect said line with said originating register, and means thereafter effective to release the marker.

6. In a telephone system, a calling line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of information concerning said line, means in said marker responsive to said association to select an idle originating register, registers therein each comprising a plurality of relays, checking registers in said marker each comprising a plurality of relays, means controlled by said marker for simultaneously and selectively operating corresponding relays of corresponding

originating registers and checking registers in accordance with the registration set up in said first line information registration means, means responsive to the operation of relays of the registers of said originating register to lock the corresponding relays of said checking registers operated, means in said marker for thereafter disconnecting said operated register relays from the control of said first line information registration means whereby the operated relays of said checking registers are held operated under the control of the operated relays of the registers of said originating register, means in said marker to determine if the correct number of relays of the checking registers are held operated and that therefore the registrations have been correctly transferred to the registers of the originating register, means in said marker responsive to said first registration line information means if said registered information has been correctly transferred to control said switches to connect said line with said originating register, and means thereafter effective to release said marker.

7. In a telephone system, a calling line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of the identity of said line, calling line identity and called line digit registers in said marker, means in said marker responsive to said association to select an idle originating register and to transfer said registration to said originating register, means in said marker responsive to said line identity registration to control said switches to connect said line with said originating register, means thereupon effective to release said marker, means under the control of said calling line to register a wanted line number in said originating register, means controlled by said originating register to reconnect itself to a marker and to transfer the registrations of the calling line identity and of said called line number set up therein to the calling line identity and called line number registers of said marker, means in said marker operative in accordance with said transferred registrations to control said switches to interconnect said calling and called lines, and means to then release said marker and said originating register.

8. In a telephone system, a calling line, a called line, a series of switches, a plurality of originating digit registers, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to set up in said marker a registration of information concerning said line, calling line information and called line digit registers in said marker, means in said marker responsive to said association to select an idle originating register, registers in said originating register for registering information concerning said calling line, means in said marker for controlling said registers of said originating register in accordance with the setting of the calling line information registration means, means in said marker responsive to said calling line information registration means to control said switches to connect said line with said originating register, means thereupon effective to release said marker, means under the control of said calling line to register a wanted line number in said originating register, means controlled by said originating register to reconnect itself to a marker and to transfer the registrations of the calling line information and of said called line number to the calling line identity and called line number registers of said marker, means in said marker operative in accordance with said transferred registrations to control said switches to interconnect said calling line and said called line and to release said marker and said originating register.

9. In a telephone system, a calling line, a called line, a series of switches, a plurality of originating digit registers having calling line information registers and called number registers, a switch-controlling marker having a first group of line information registers, a second group of line information checking registers and a third group of called line digit registers, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to operate said first group of registers to register information concerning the calling line, means in said marker responsive to said association to select an idle originating register and to simultaneously transfer said calling line information from the first group of registers to the second group of registers of said marker and to said calling line information registers of said originating register, means in said marker responsive to its first group of registers to control said switches to connect said calling line to said originating register, means thereupon effective to release said marker, means under the control of said calling line to register a wanted line number in the called line number registers of said originating register, means controlled by said originating register to reconnect itself to a marker to transfer the registrations of said calling line information to the second group of registers of said marker and to transfer said called number registrations to the third group of registers of said marker, means in said marker operative in accordance with said transferred registrations to control said switches to interconnect said calling line and said called line and to release said marker and said originating register.

10. In a telephone system, a calling line, a called line, a series of switches, a plurality of originating digit registers having calling line identity registers and called number registers, a switch-controlling marker having a first group of line identity registers, a second group of line identity checking registers and a third group of called line digit registers, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to operate said first group of registers to register the identity of the calling line, means in said marker responsive to said association to select an idle originating register and to simultaneously transfer said calling line identity from the first group of registers to the second group of registers of said marker, and to said calling line identity registers of said originating register, means in said marker responsive to its first group of registers to control said switches to connect said calling line to said originating register, means thereupon effective to release said marker, means under the control of said calling line to register a wanted line number in the called number registers of said originating register, means controlled by said originating register to reconnect itself to a marker and to transfer the registrations of said calling line identity to the second group of registers of said marker and to transfer said called number regis-

trations to the third group of registers of said marker, means in said marker operative in accordance with said transferred registrations to control said switches to interconnect said calling and said called lines and to release said marker and said originating register.

11. In a telephone system, a calling line, a called line, a series of switches, a plurality of originating registers having calling line identity registers and called number registers, a switch-controlling marker having a first group of line identity registers, a second group of line identity checking registers and a third group of called line digit registers, means responsive to the initiation of a call by said calling line to associate said marker with said line, means responsive to said association to operate said first group of registers to register the identity of the calling line, means in said marker responsive to said association to select an idle originating register to simultaneously transfer said calling line identity from the first group of registers to the second group of registers of said marker and to said calling line identity registers of said originating register, means in said marker responsive to its first group of registers to control said switches to connect said calling line to said originating register, means thereupon effective to release said marker, means under the control of said calling line to register a wanted line number in the called number registers of said originating register, means controlled by said originating register to reconnect itself to a marker and to transfer the registrations of the calling line identity to the second group of registers of said marker and to transfer said called number registrations to the third group of registers of said marker, a number group circuit operative in response to the registration of the numerical digits of the called number in the third group of registers of said marker to translate said digits into the identification of said called line and to register said translated identification in the first group of registers of said marker, means in said marker operative in accordance with the identity registrations of said calling and called lines as registered in said second and said first groups of registers to control said switches to interconnect said calling and called lines and to release said marker and said originating register.

12. In a telephone system, a calling line in one office, a called line in a second office, a series of switches, a plurality of originating digit registers having calling line identity register, an outgoing trunk extending to said second office, a sender associable with said trunk having called line digit registers therein, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line and to set up a registration in said marker of the identity of said line, calling line identity and called line digit registers in said marker, means in said marker responsive to said association to select an idle originating register and to control said switches to connect said line with said originating register, means to transfer the calling line identity registration to the calling line identity registers of said originating register and to then release said marker, means under the control of said calling line to register a wanted line number in said register, means in said originating register to reconnect said originating register with a marker and to transmit said calling line identity registration and said called line number registration to the calling line identity and called line digit registers of said marker, means in said marker responsive to said transferred registrations for operating said switches to connect said calling line to said outgoing trunk, means to associate said sender with said trunk and with said marker, and means to transfer said wanted line number registration to the called line digit registers of said sender independent of said trunk.

13. In a telephone system, a calling line in one office, a called line in a second office, a series of switches, a plurality of originating registers, an outgoing trunk extending to said second office, a sender associable with said trunk having called line digit registers therein, a switch-controlling marker, means responsive to the initiation of a call by said calling line to associate said marker with said line and to set up a registration in said marker of the identity of said line, means in said marker responsive to said association to select an idle originating register and to control said switches to connect said line with said originating register, means to transfer the calling line identity registration to the calling line identity register of said originating register and to then release said marker, means under the control of said calling line to register the office code and numerical digits of a wanted line number in said originating register, means in said originating register to reconnect itself with a marker and to transmit said calling line identity registration and the office code digit registrations of said called line number to said marker, means in said marker operative in response to said transferred registrations for controlling said switches to connect said calling line to said outgoing trunk, means to associate said sender with said trunk and with said marker, and means to transfer the office code digit registrations of said called line number from said marker to said sender and to transfer the numerical digit registrations of said called line number from said originating register through said marker to said sender independent of said trunk.

14. In a telephone system, a calling line in one office, a called line in a second office, a series of switches, a plurality of originating registers having calling line identity registers, an outgoing trunk extending to said second office, a sender associable with said trunk having called number digit registers therein, a switch-controlling marker having a first group of called number digit registers a second group of called number digit checking registers and a third group of calling line identity registers, means responsive to the initiation of a call by said calling line to associate said marker with said line and to set up a registration in said marker of the identity of said calling line, means in said marker responsive to said association to select an idle originating register and to control said switches to connect said calling line with said originating register, means to transfer the calling line identity registration to the calling line identity registers of said originating register, means to then release said marker, means under the control of said calling line to register the office code and numerical digits of a wanted line number in said originating register, means in said originating register to reconnect itself with a marker and to transmit said calling line identity registration and the office code digit registrations of said called line number to said first and third groups of registers of said marker, means in said marker operative in response to said transferred registra-

tions for controlling said switches to connect said calling line to said outgoing trunk, means to associate said sender with said trunk and with said marker, and means controlled by the numerical digit registers of said originating register and the office code digit registers of the first group of registers of said marker to simultaneously control the setting of the digit registers of said sender and the second group of checking registers of said marker to transfer said registrations to said sender and to check that they have been correctly transferred.

15. In a telephone system, a calling line in one office, a called line in a second office, a series of switches, a plurality of originating registers having calling line identity registers, an outgoing trunk extending to said second office, a sender associable with said trunk having called number digit registers therein, a switch-controlling marker having a first group of called number digit registers a second group of called number digit checking registers and a third group of calling line identity registers, means responsive to the initiation of a call by said calling line to associate said marker with said line and to set up a registration in said marker of the identity of said calling line, means in said marker responsive to said association to select an idle originating register and to control said switches to connect said calling line with said originating register, means to transfer the calling line identity registration to the calling line identity registers of said originating register and to then release said marker, means under the control of said calling line to register the office code and numerical digits of a wanted line number in said originating register, means in said originating register to reconnect itself with a marker and to transmit said calling line identity registration and the office code digit registrations of said called line number to said first and third groups of registers of said marker, means in said marker operative in response to said transferred registrations for controlling said switches to connect said calling line to said outgoing trunk, means to associate said sender with said trunk and with said marker, means controlled by the numerical digit registers of said originating register and the office code digit registers of the first group of registers of said marker to simultaneously control the setting of the digit registers of said sender and the second group of checking registers of said marker to transfer said registrations to said sender, locking circuits for the second group of registers of said marker controlled by the operated registers of said sender, means thereafter operable to disconnect said first group of marker registers from the second group of marker registers whereby the registers of the second group of marker registers are held operated from the sender registers, and means operable to determine if the checking registers are held operated and that therefore the sender registers have been properly operated.

16. In a telephone system, a first device having therein a first group of registers, each comprising a plurality of relays and a second group of checking registers each comprising a plurality of relays, means for selectively operating said first group of registers, a second device having a group of registers each comprising a plurality of relays, means for connecting said first device to said second device, means in said first device controlled by said first group of registers for simultaneously and selectively establishing operating circuits for operating corresponding relays of corresponding registers of the second group of said first device and of the registers of the second device in accordance with the operated condition of the relays of the first group of registers of said first device, means responsive to the operation of the relays of the registers of said second device to lock themselves operated and to thereby lock the corresponding relays of the second group of registers of said first device, and means for thereafter opening said operating circuits whereby if the operated relays of said second group in said first device then remain operated it is an indication that the corresponding relays of said second device have been properly operated.

17. In a telephone system, a first device having therein a plurality of registers for registering the digits of wanted line numbers which vary with respect to the number of digits, a second device having therein a plurality of registers for registering the office code and numerical digits of a wanted line number, means for interconnecting said devices by groups of conductors, means for transferring the settings of the registers of said first device over said conductors to the registers of said second device, and selectively operable relays in said second device for connecting said groups of conductors to the registers of said second device in such a manner that those digits registered in said first device which appertain to the office code of the desired number will be registered in the appropriate office code digit registers of said second device and that those digits registered in said first device which appertain to the numerical designation of the desired number will be registered in the appropriate numerical digit registers of said second device.

18. In a telephone system, a called line, an incoming trunk, a series of switches, an incoming register, registering means in said register for registering digits representative of the designation of said called line, means for connecting said register to said incoming trunk, a switch-controlling marker having called line designation registers, means responsive to the registrations set up in said incoming register for associating said incoming register with said marker and for transferring said registrations to the called line designation registers of said marker, a group of subscriber line identity registers in said marker, a number group circuit, means controlled by said marker to select a number group circuit and to transfer said called line designation registration from said marker to said number group circuit, means in said number group circuit for translating said called line designation registration into the called line identity registration and for transmitting it to the subscriber line identity registers of said marker, means in said marker operable in accordance with the setting of said subscriber line identity registers to control said switches to connect said incoming trunk to said identified called line, and means for releasing said incoming register and marker.

19. In a telephone system, a called line, an incoming trunk, a series of switches, an incoming register, registering means in said register for registering digits on a non-decimal basis representative of the designation of said called line, means for connecting said register to said incoming trunk, a switch-controlling marker having a group of called number registers and a group of subscriber line identity registers, means responsive to the registrations set up in said incoming register for associating said register with said

marker and for transferring said registrations to the called number registers of said marker, a plurality of number group circuits, means in said marker responsive to the transfer of said registrations to its called number registers to select a number group circuit and to transfer the registrations from its called number registers to said selected number group circuit, means in said selected number group circuit to translate said called number registrations into the called line identity registrations and to transmit them to said group of subscriber line identity registers in said marker, and means in said marker operable in accordance with the setting of said subscriber line identity registers to control said switches

to connect said incoming trunk to the identified called line.

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