April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954

140 Sheets-Sheet 1

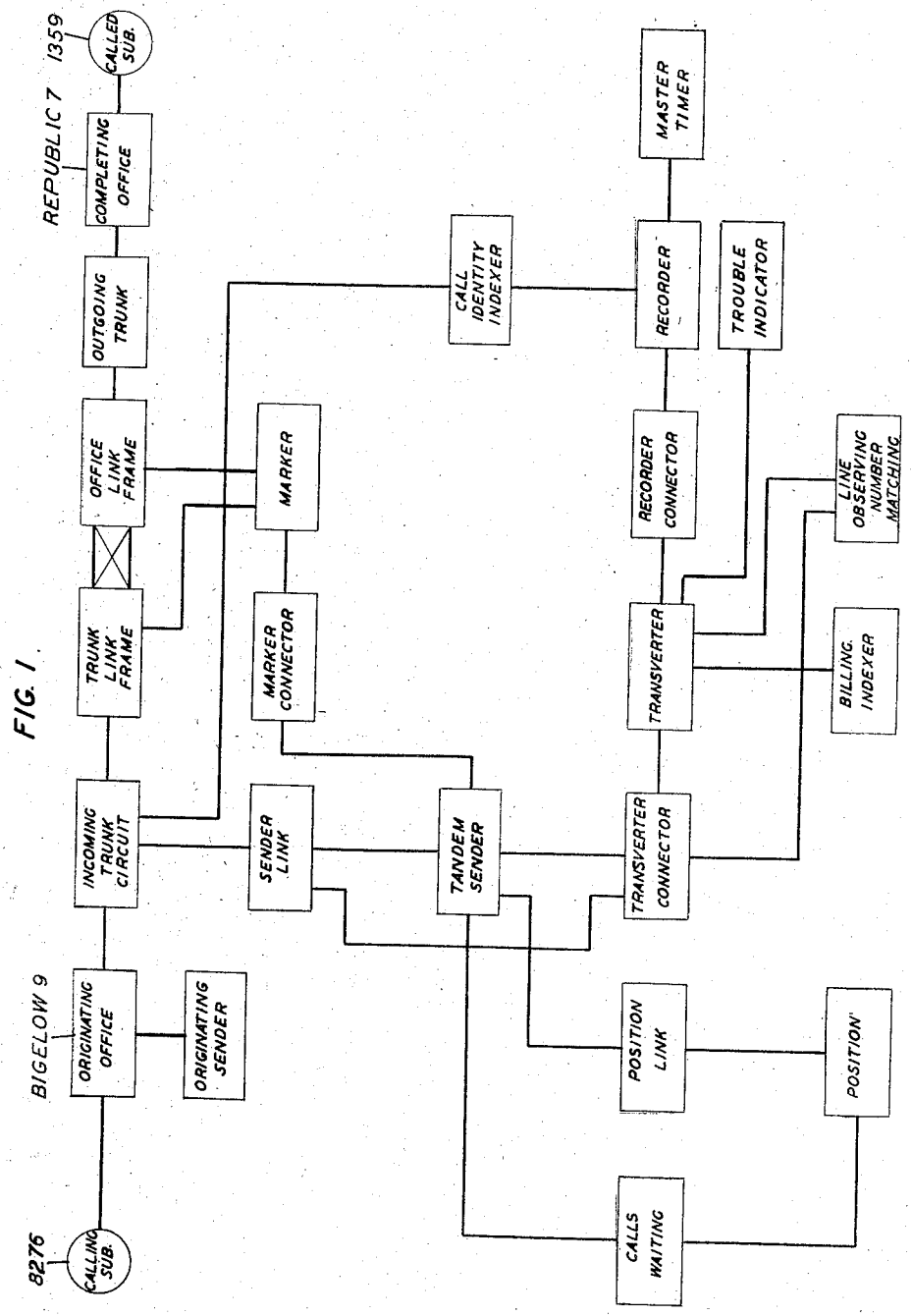


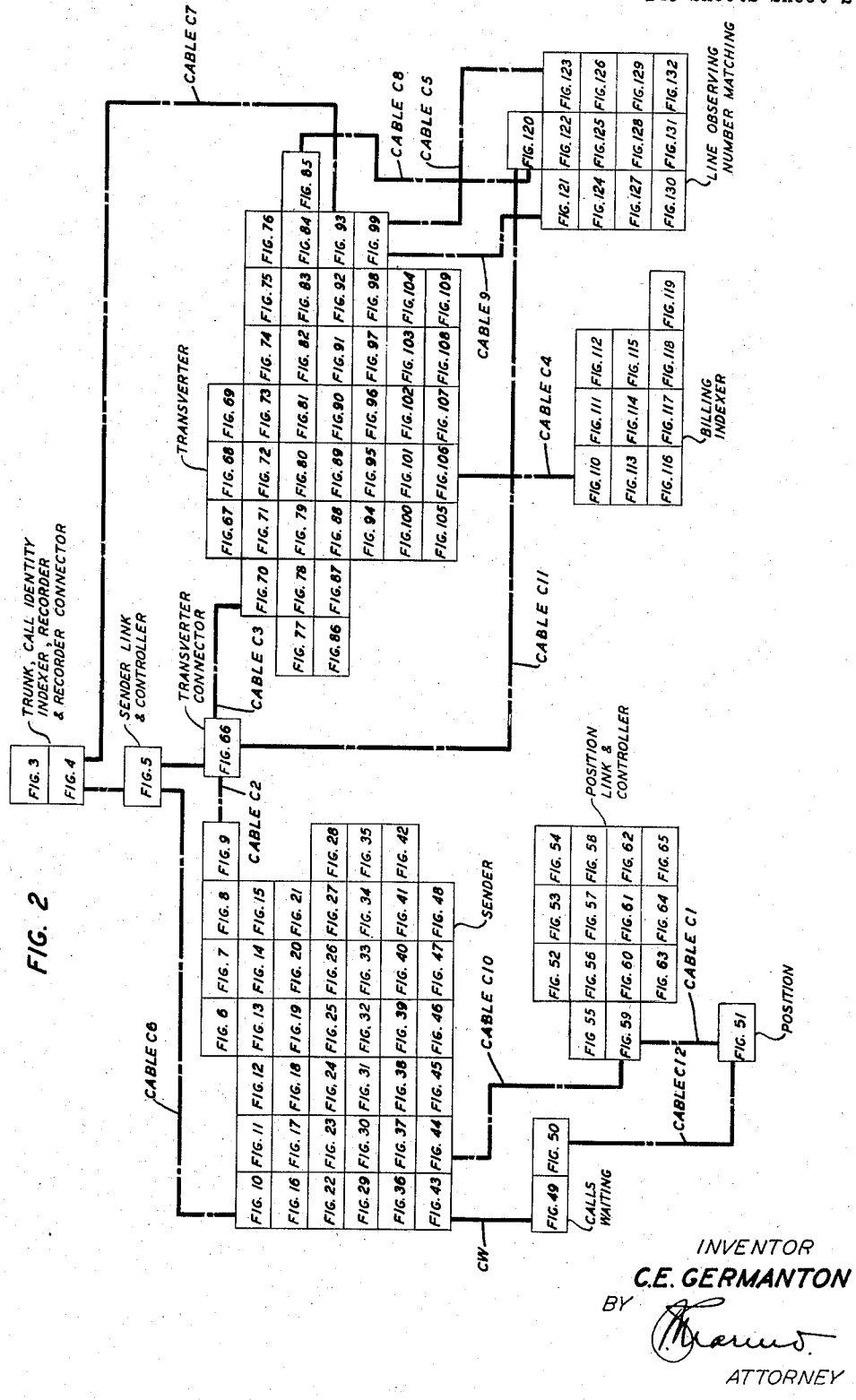
FIG. 1.

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 2



INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 3

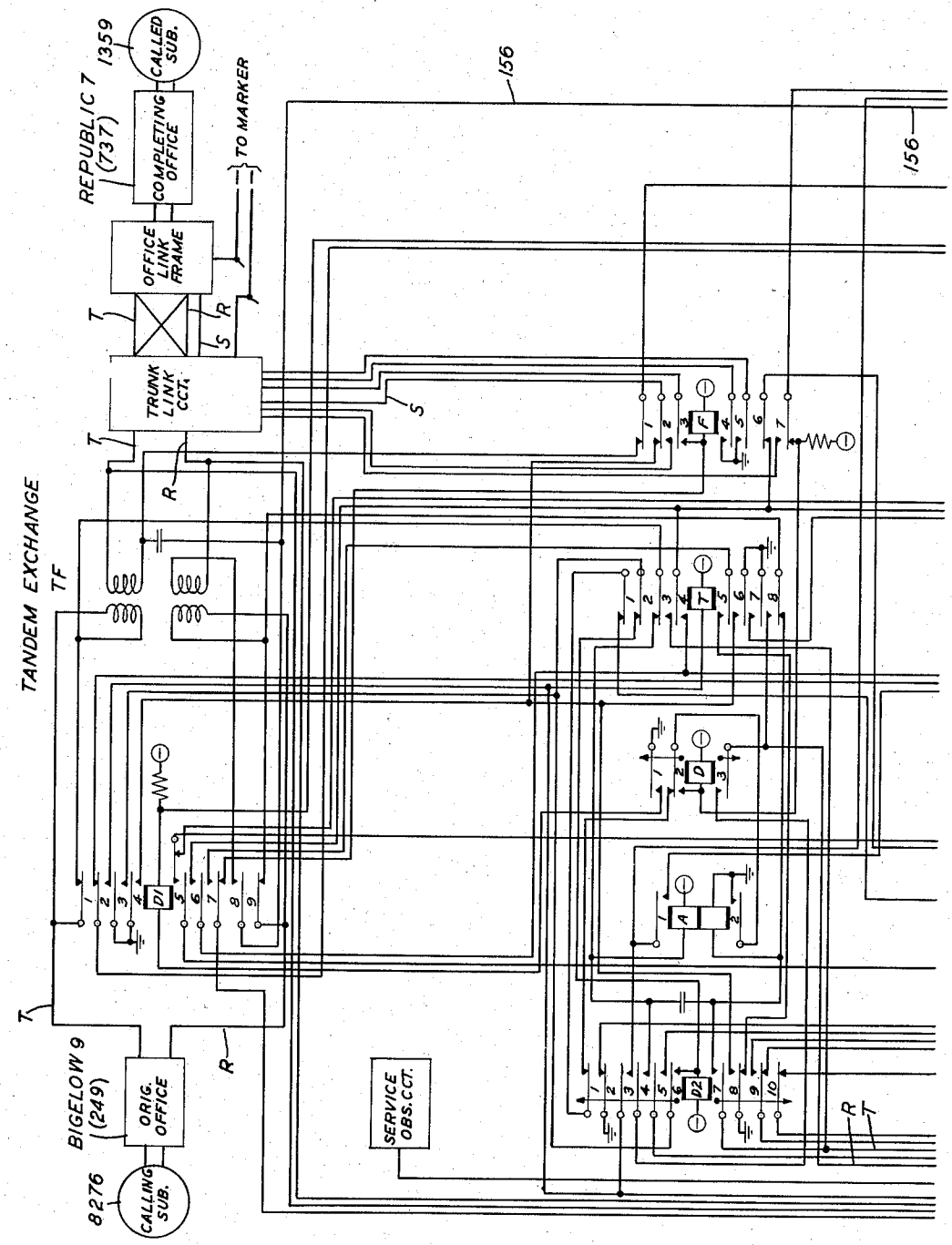


FIG. 3

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 4

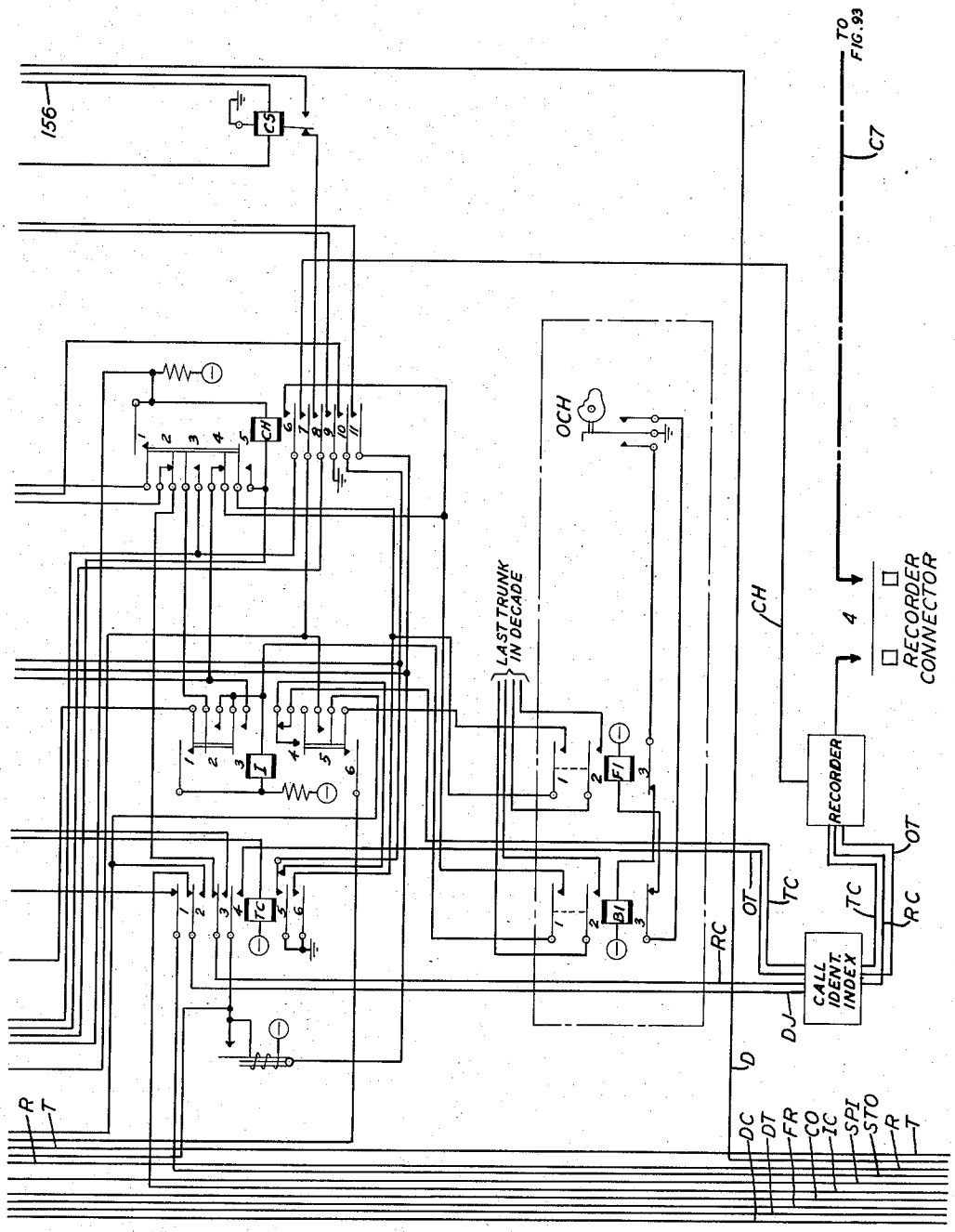


FIG. 4

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954

140 Sheets-Sheet 5

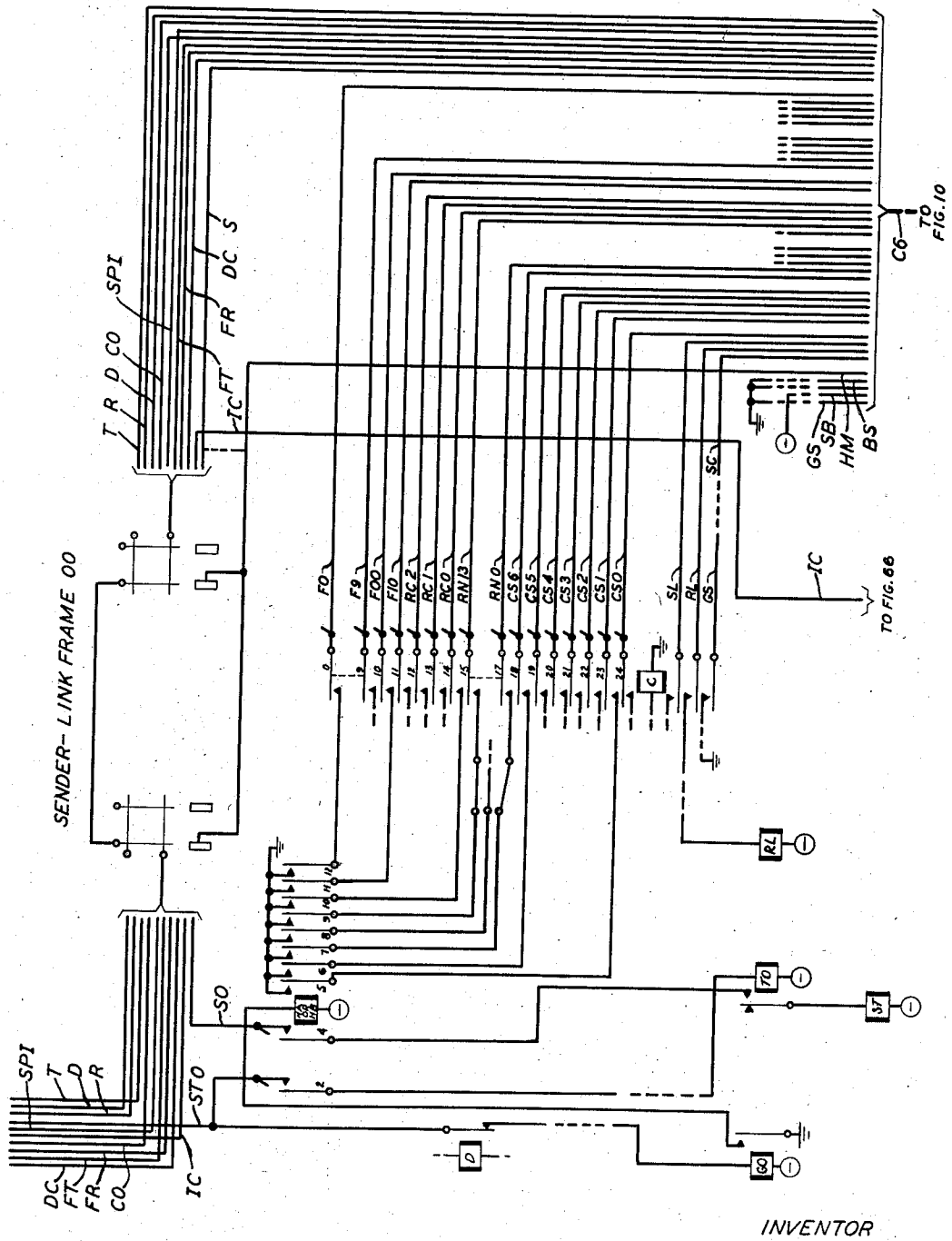


FIG. 5

INVENTOR

C.E. GERMANTON

BY

ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954

140 Sheets-Sheet 6

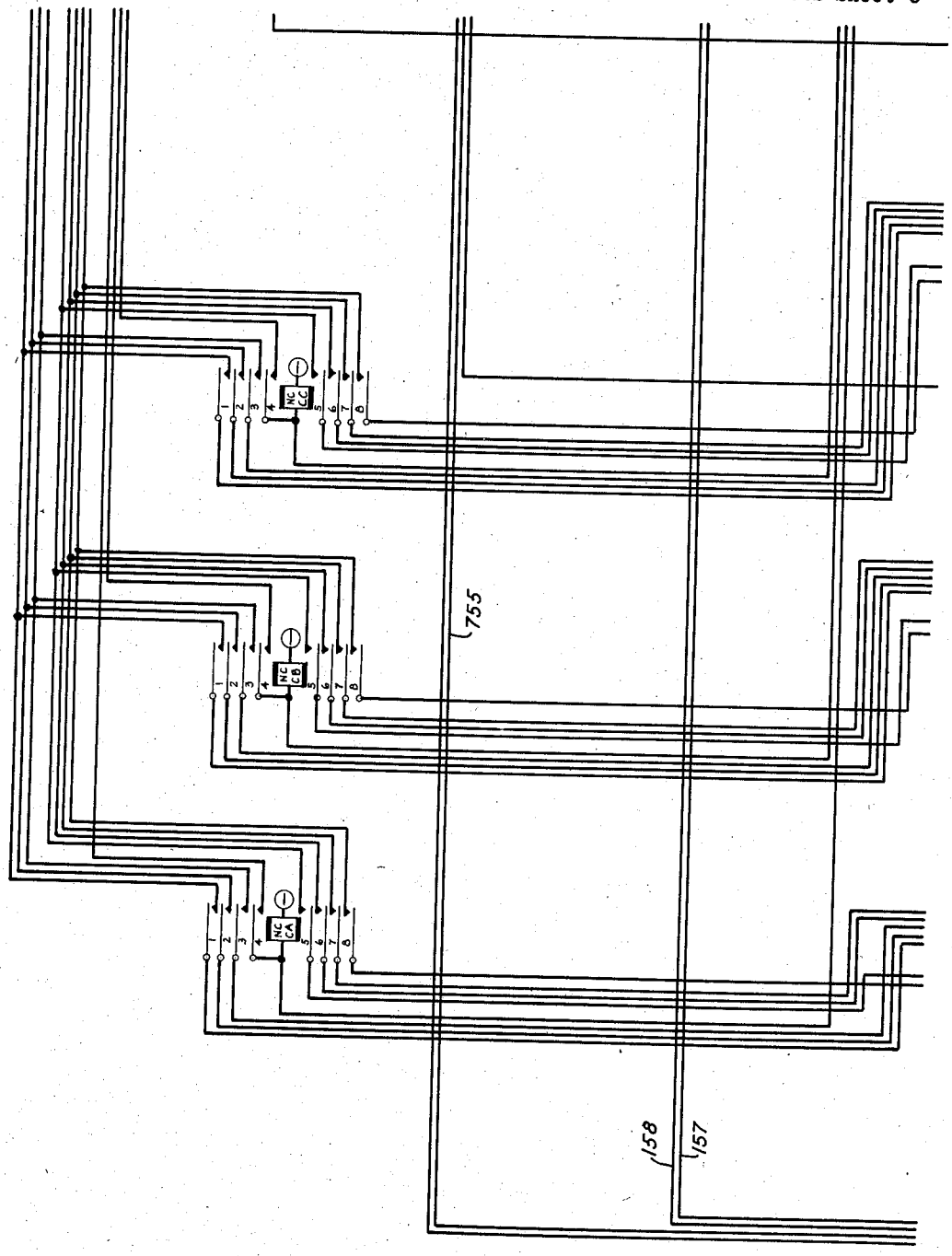


FIG. 6

INVENTOR

C.E. GERMANTON

BY

ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 7

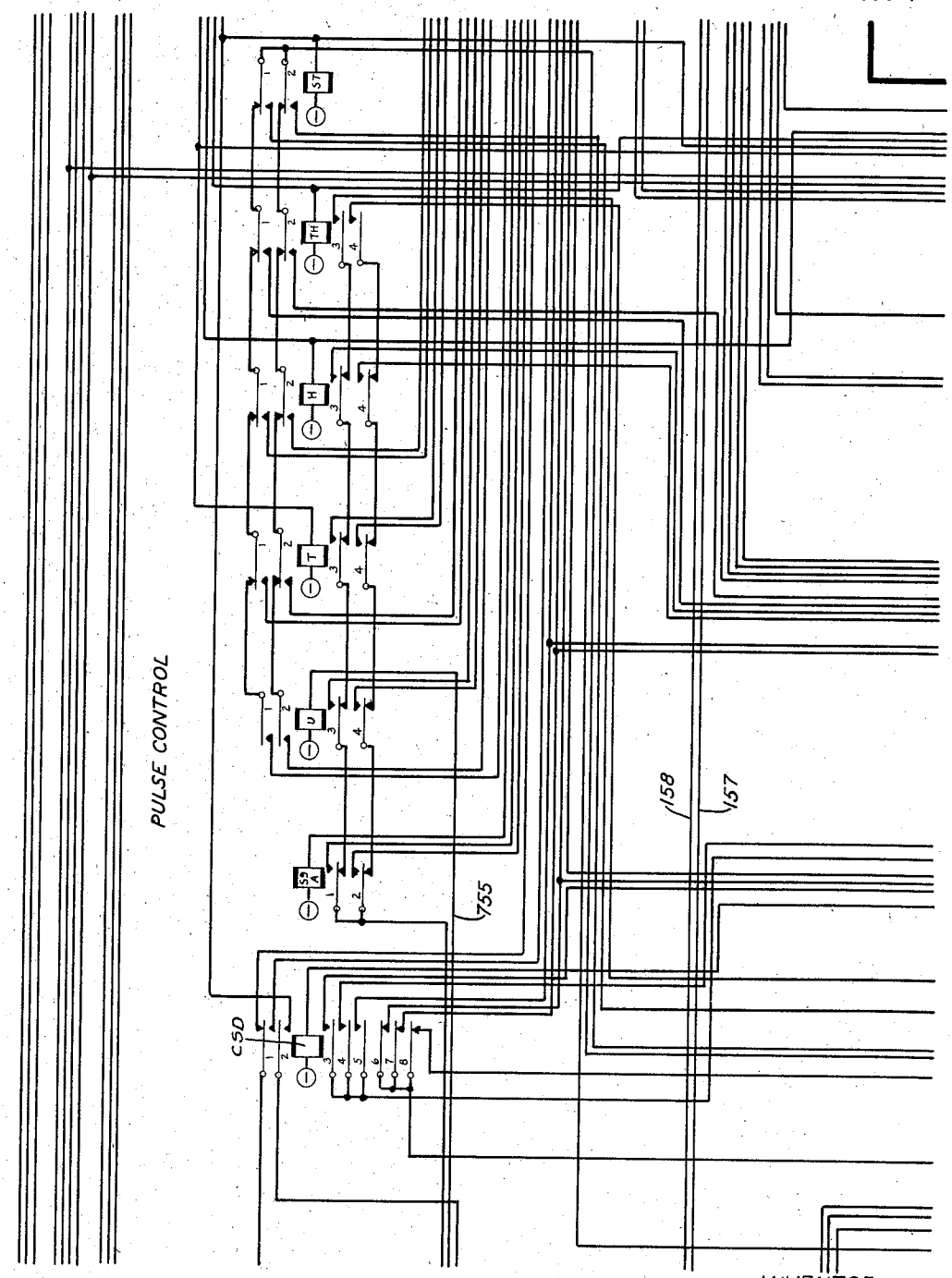


FIG. 7

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 8

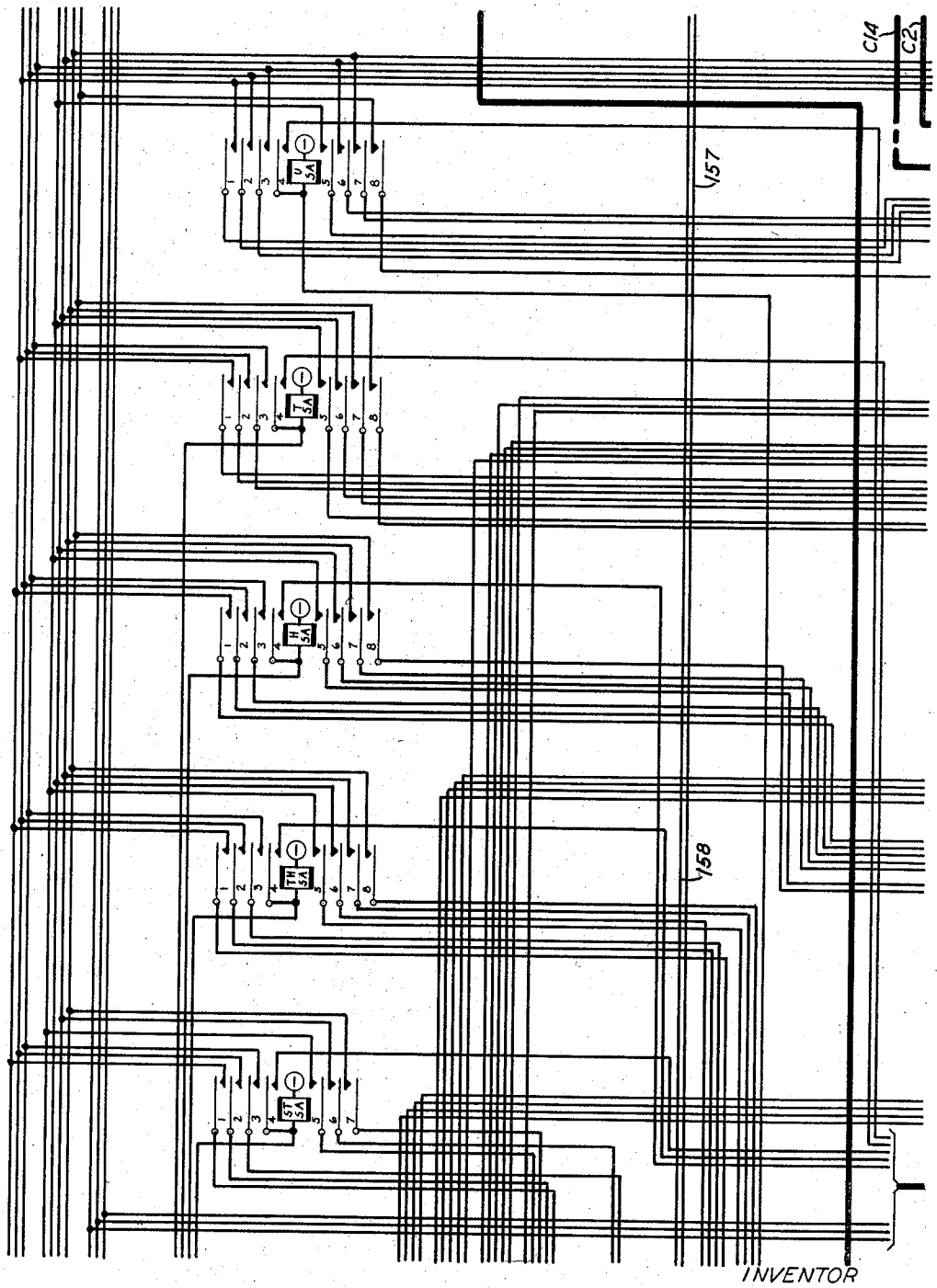


FIG. 8

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 9

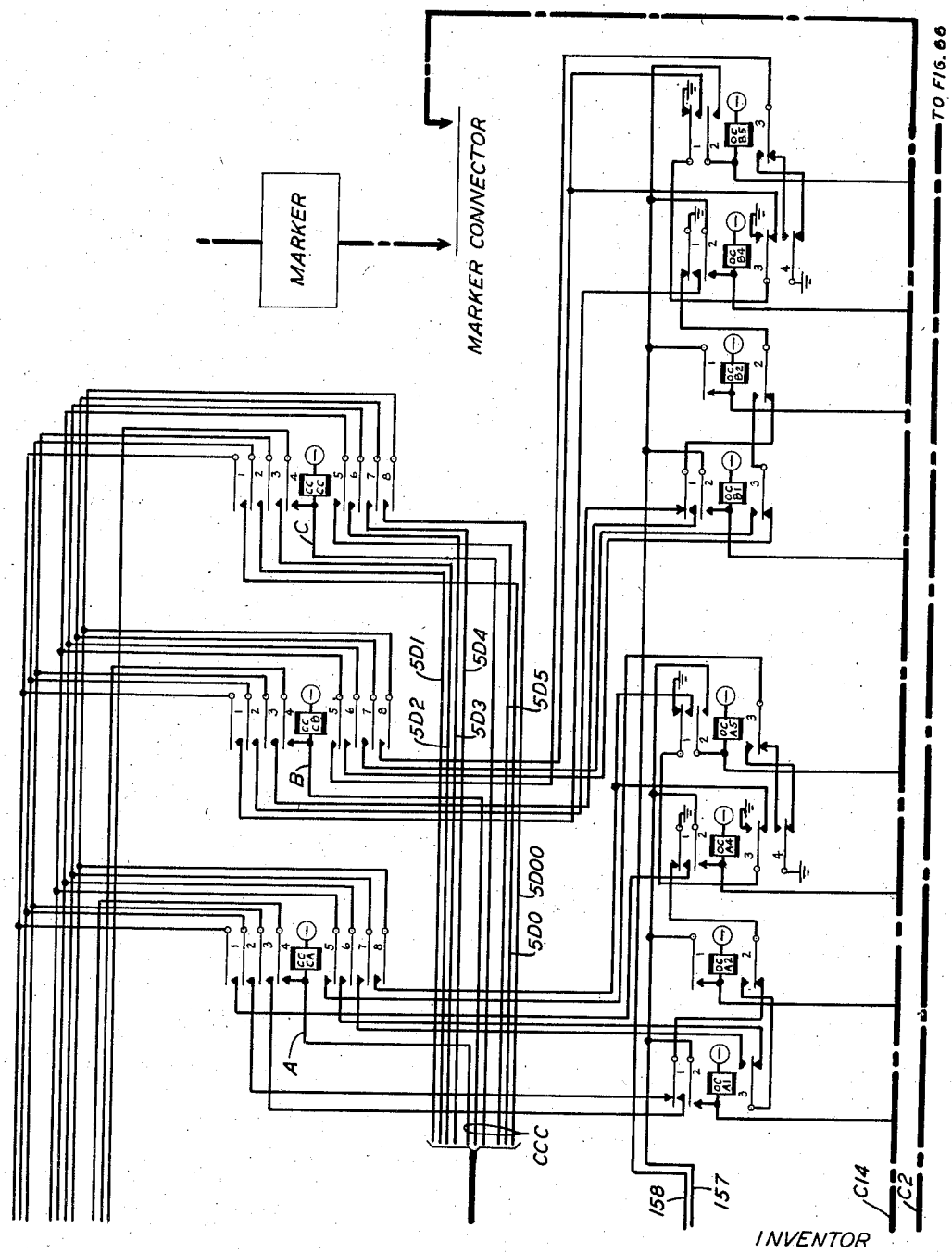


FIG. 9

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 10

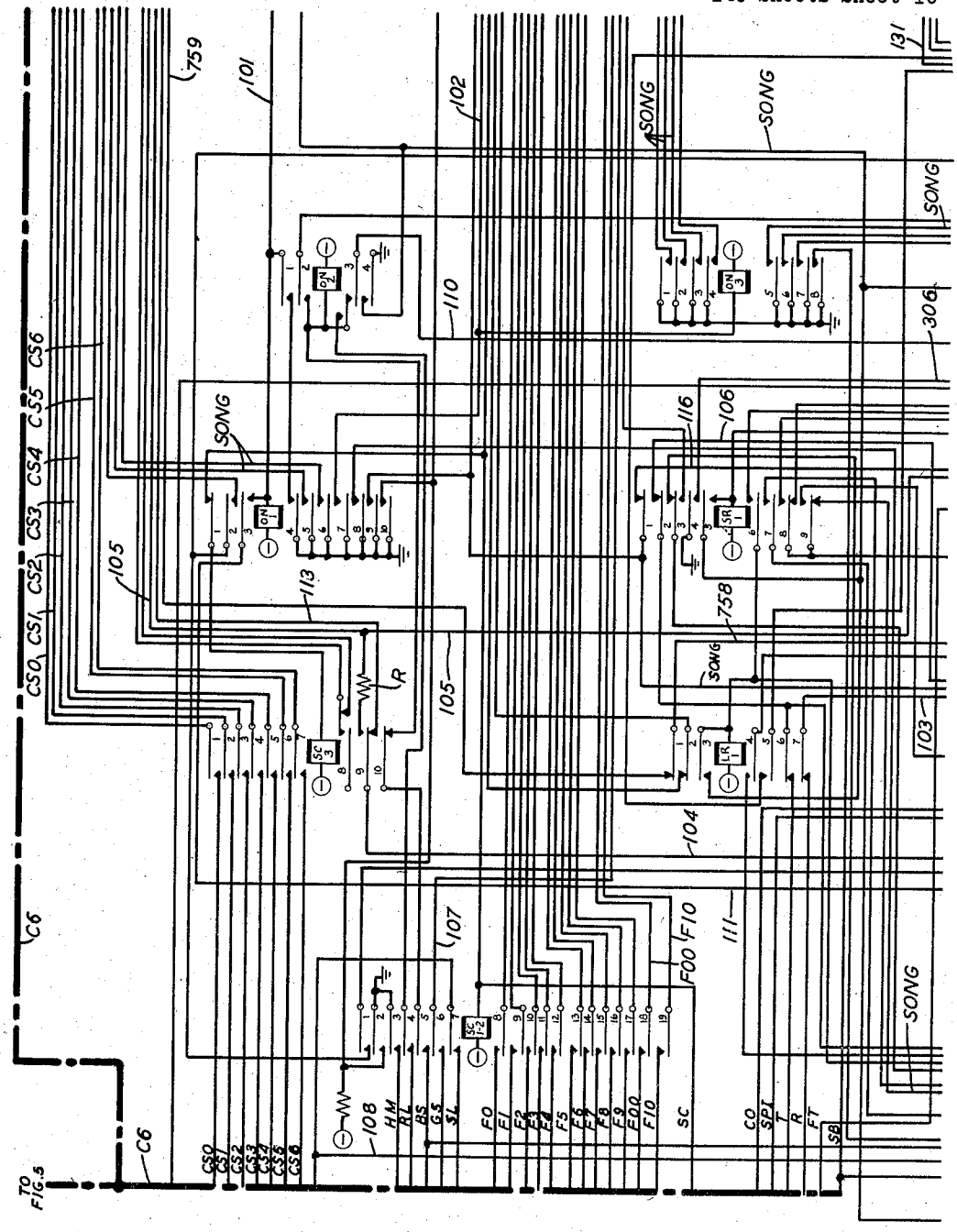


FIG. 10

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 11

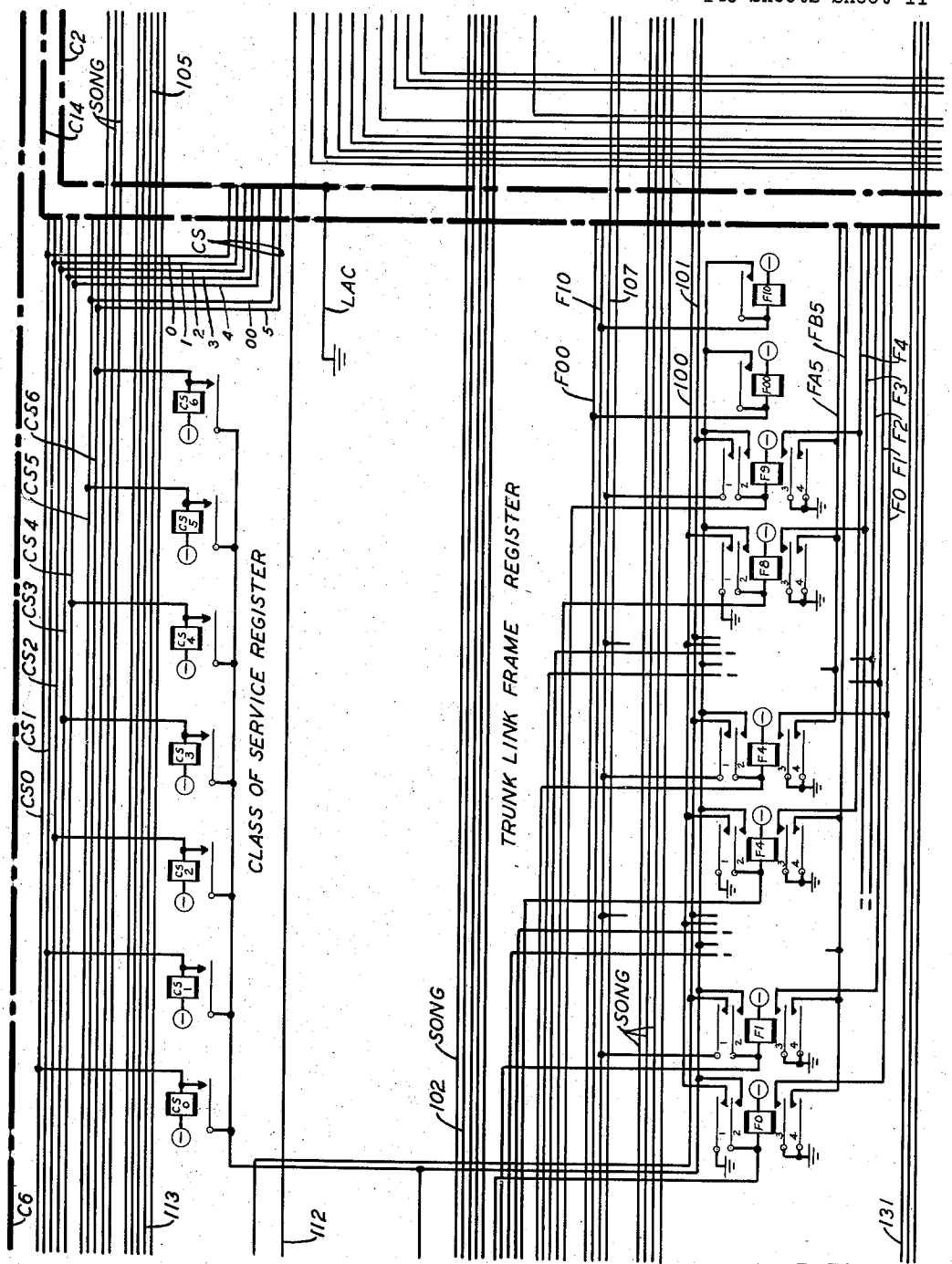


FIG. 11

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 12

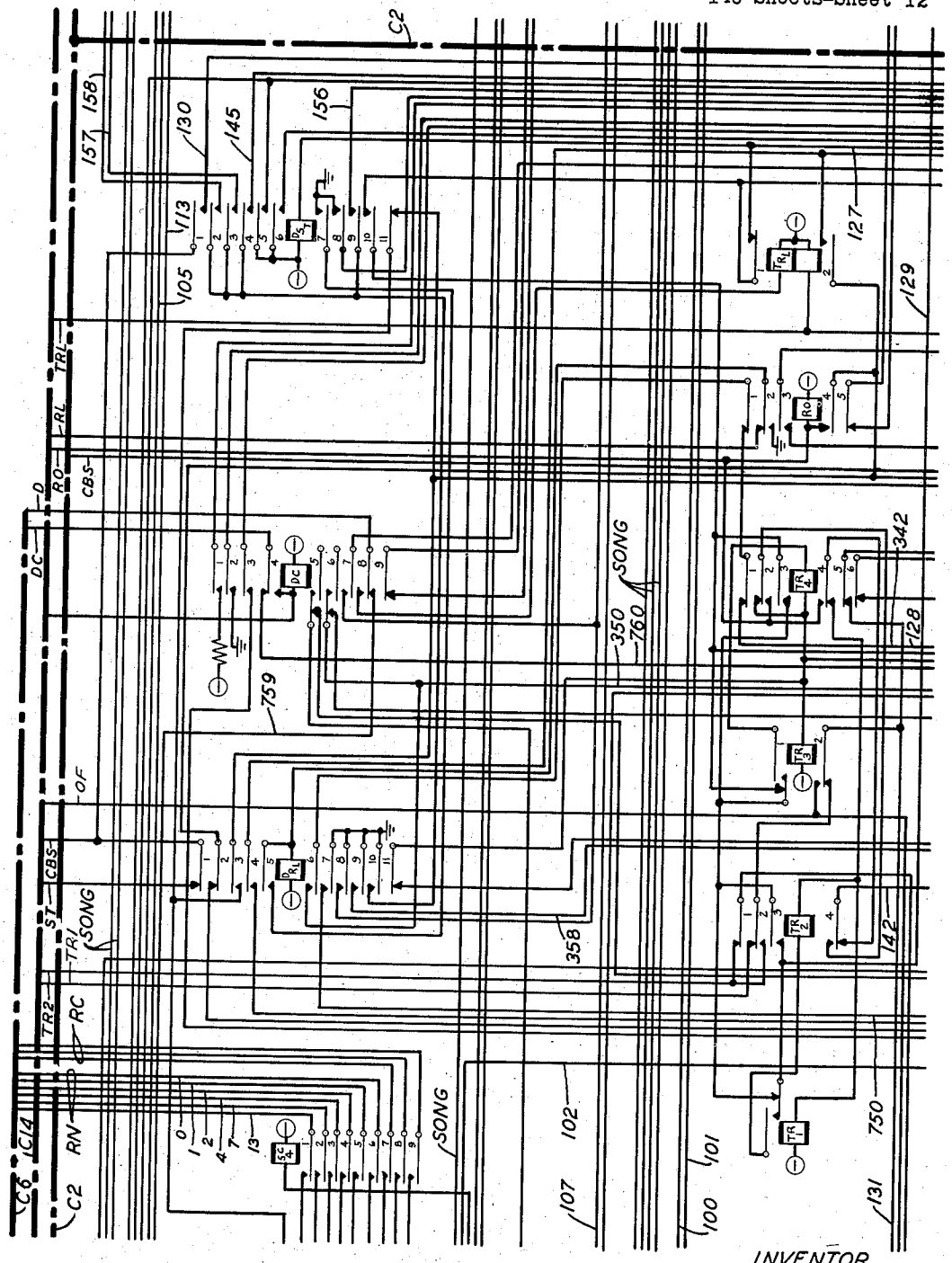


FIG. 12

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 13

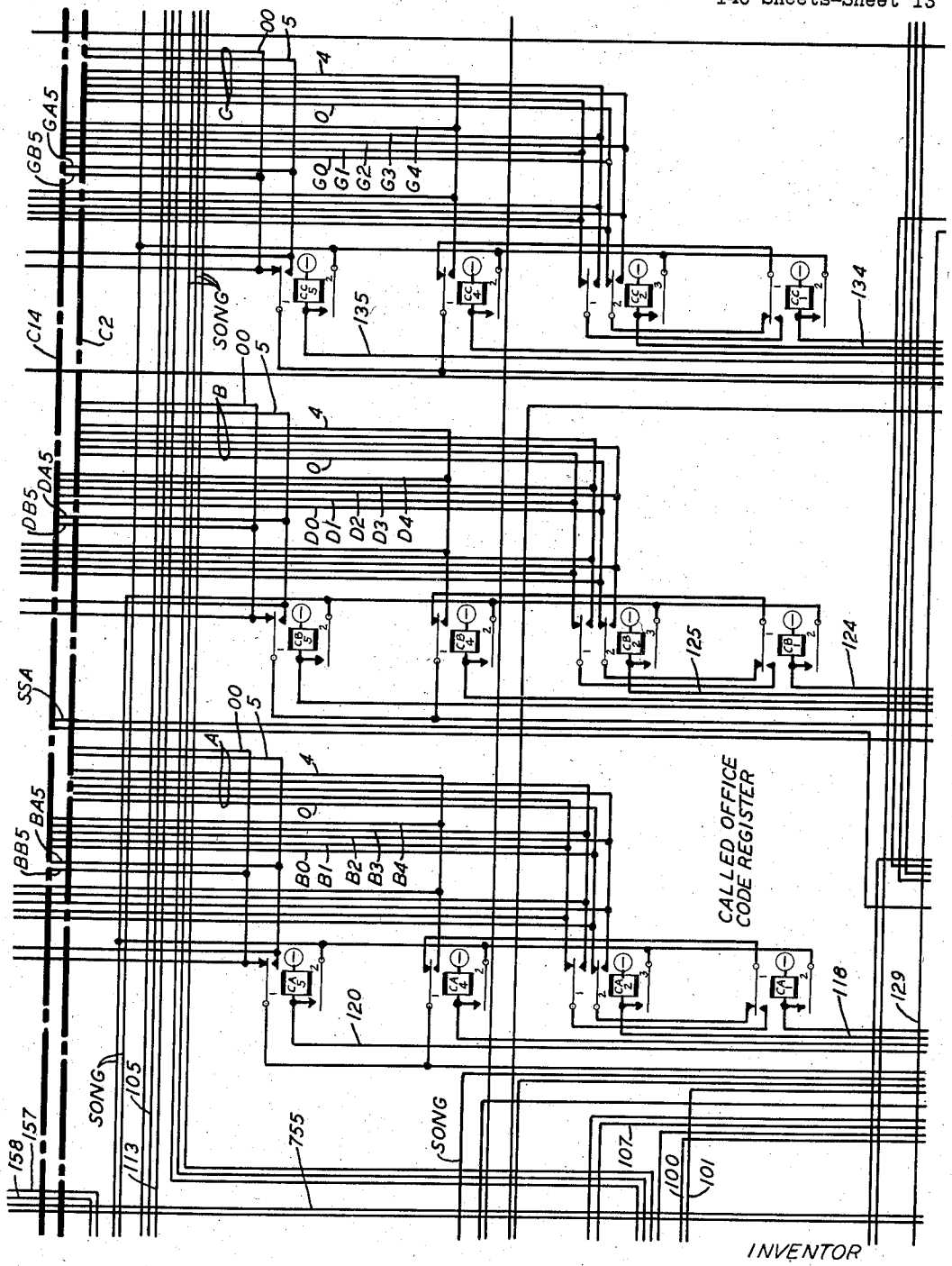


FIG. 13

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 14

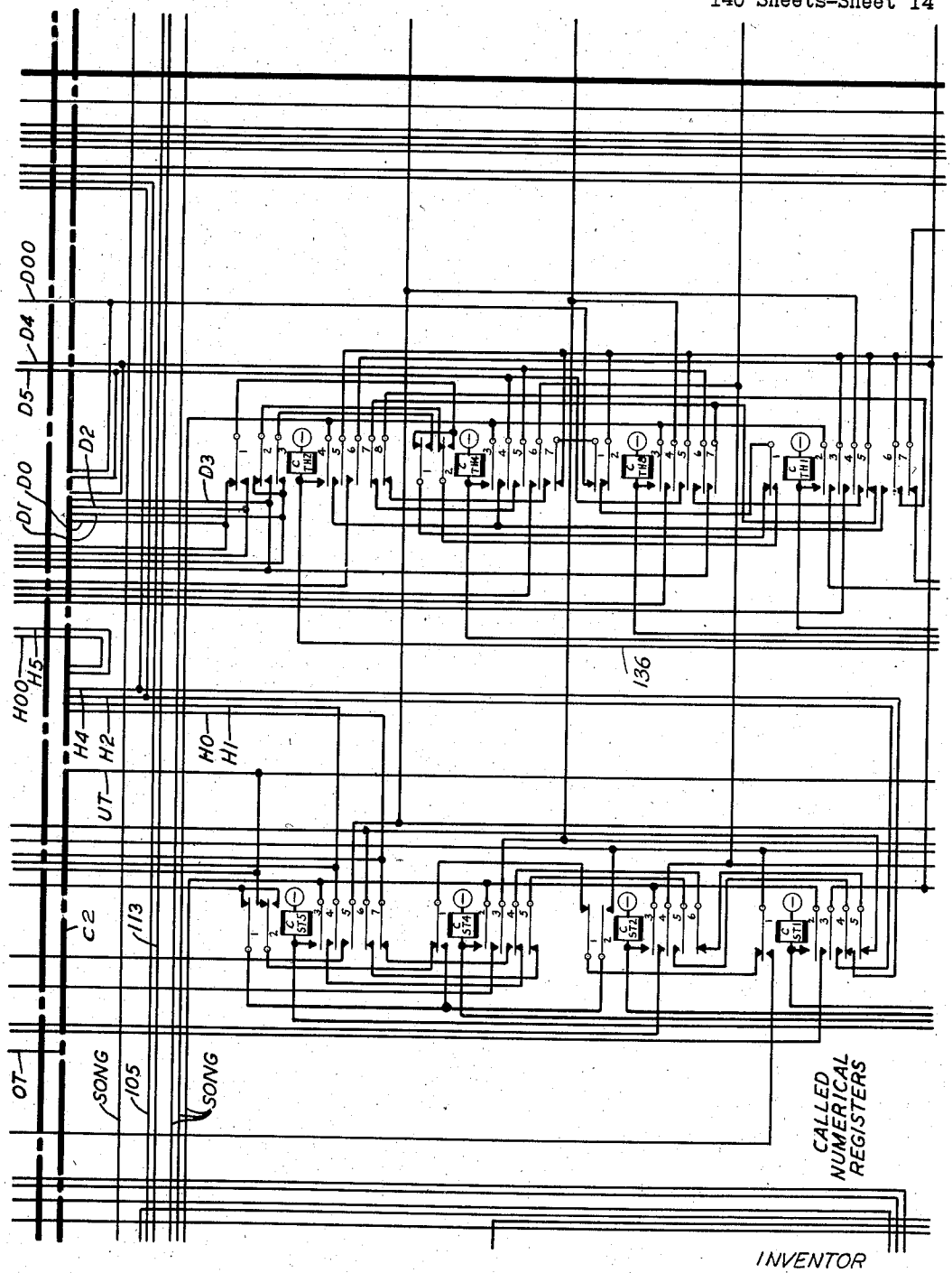


FIG. 14

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 15

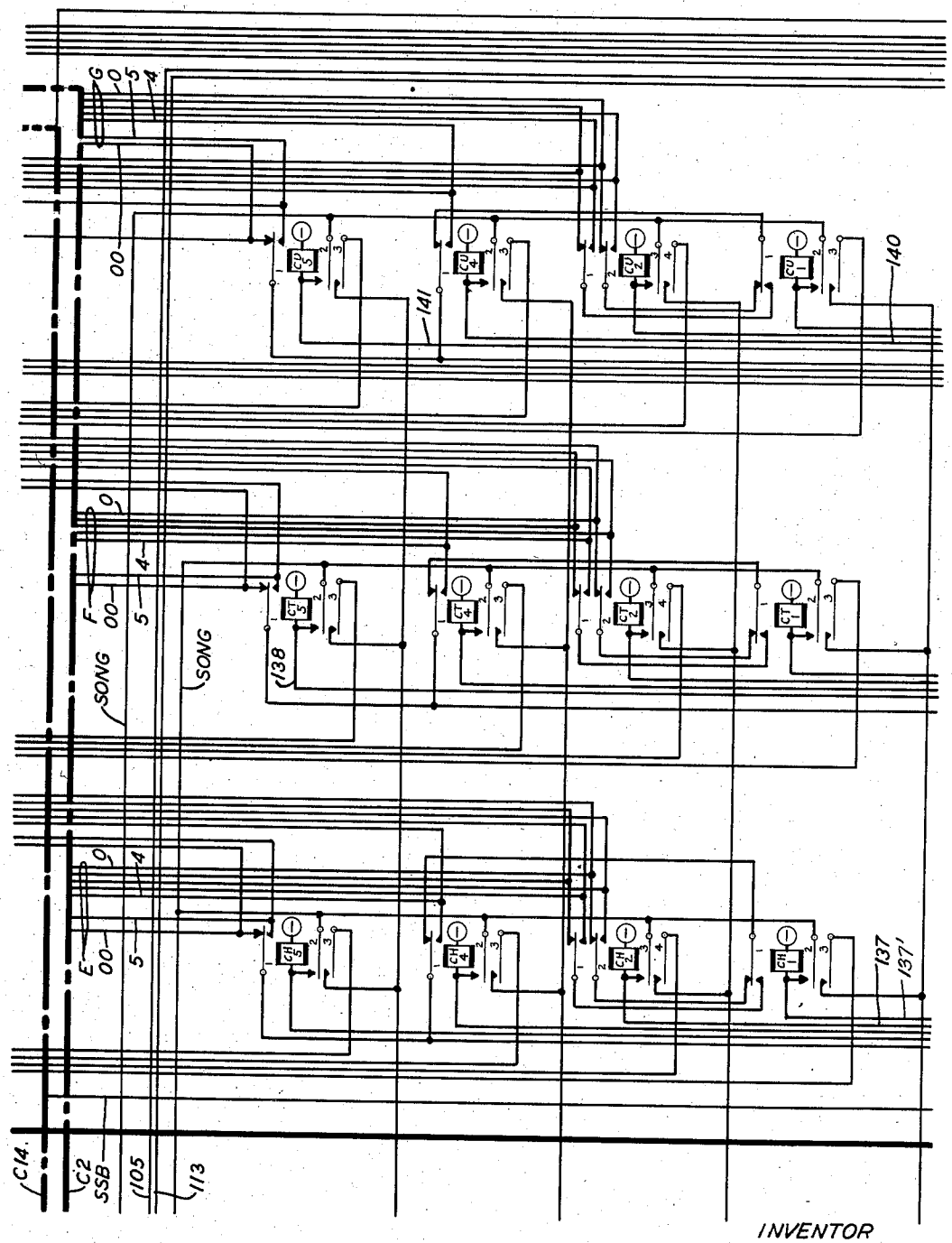


FIG. 15

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 16

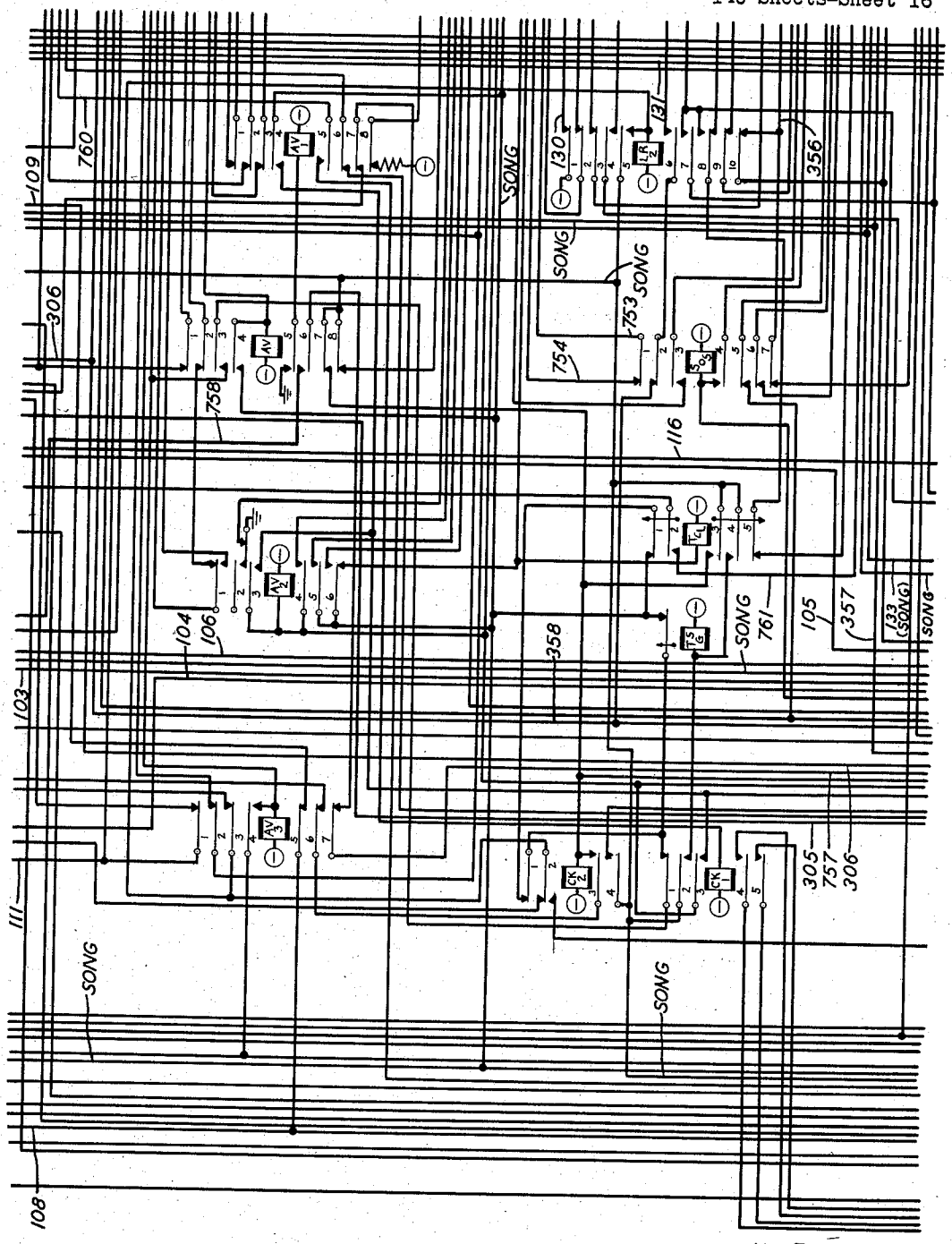


FIG. 16

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 17

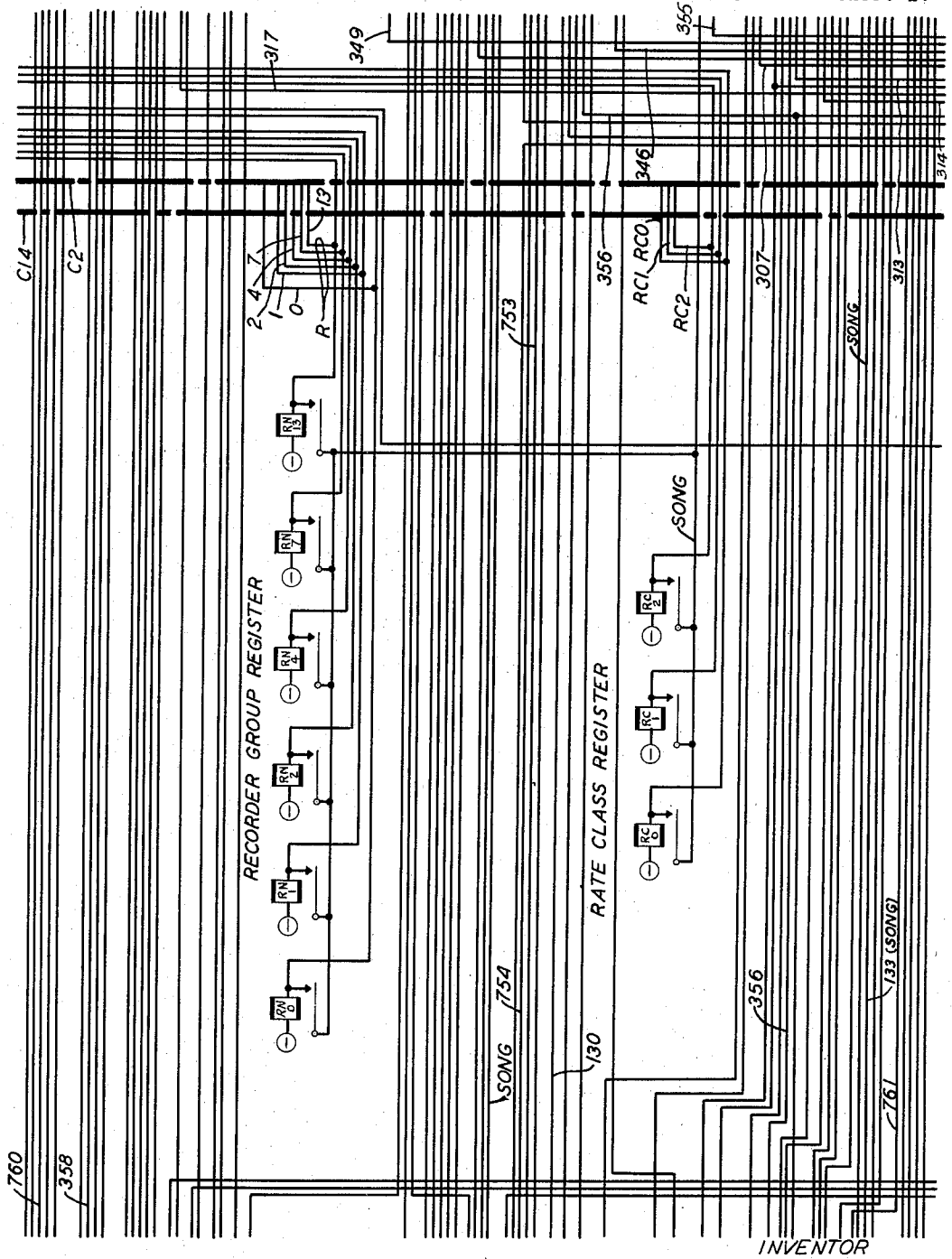


FIG. 17

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 18

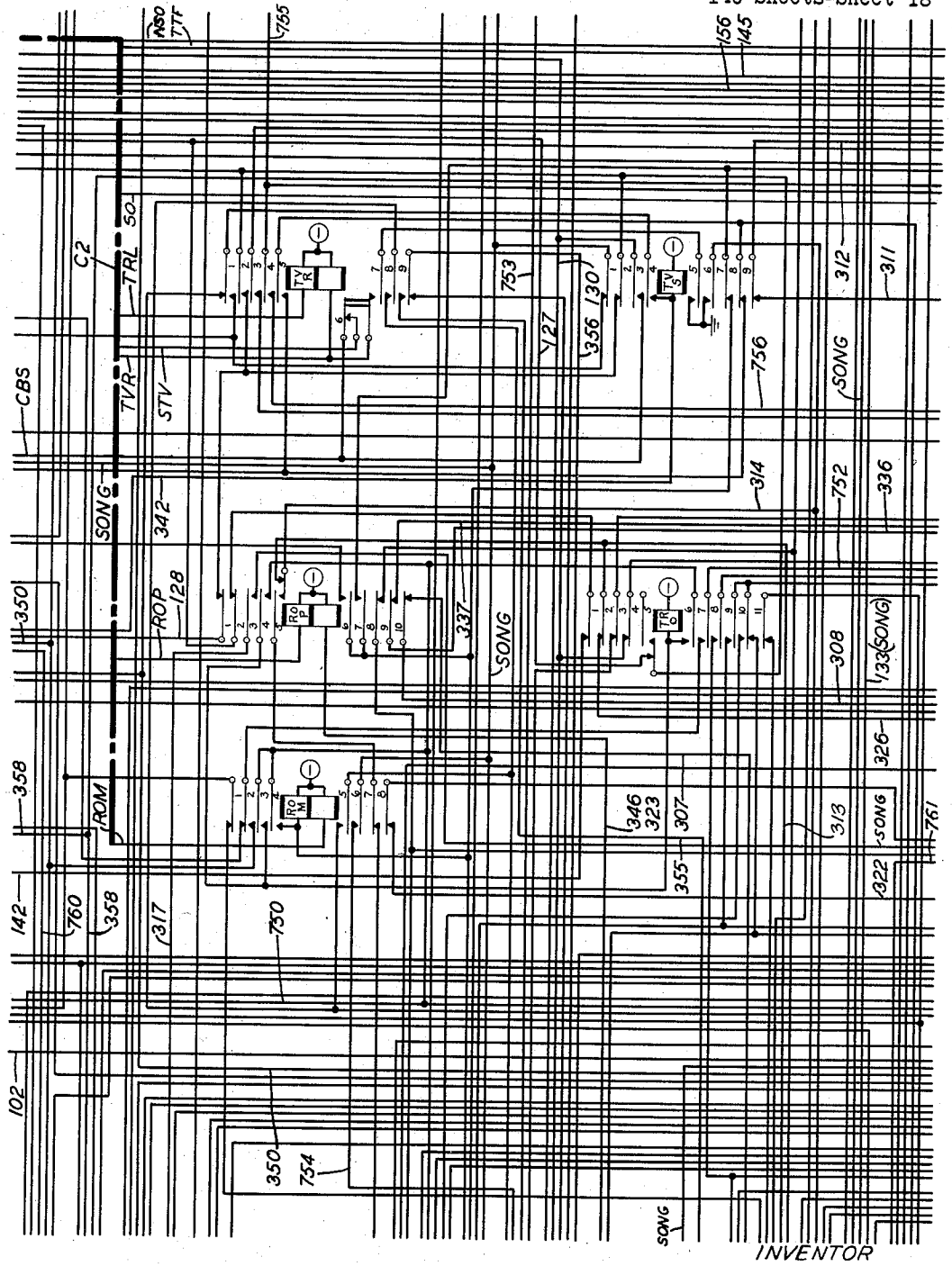


FIG. 18

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 19

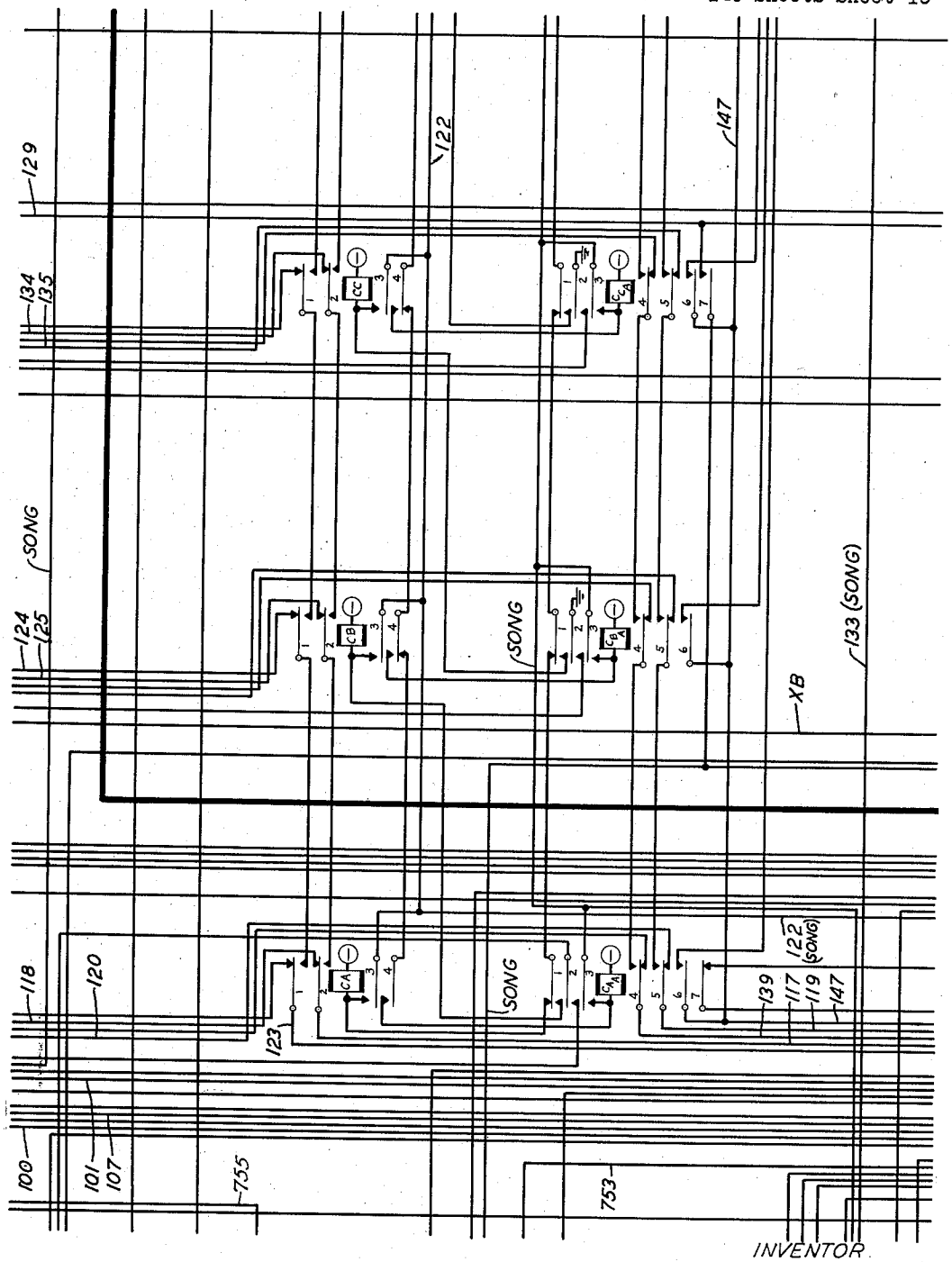


FIG. 19

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 20

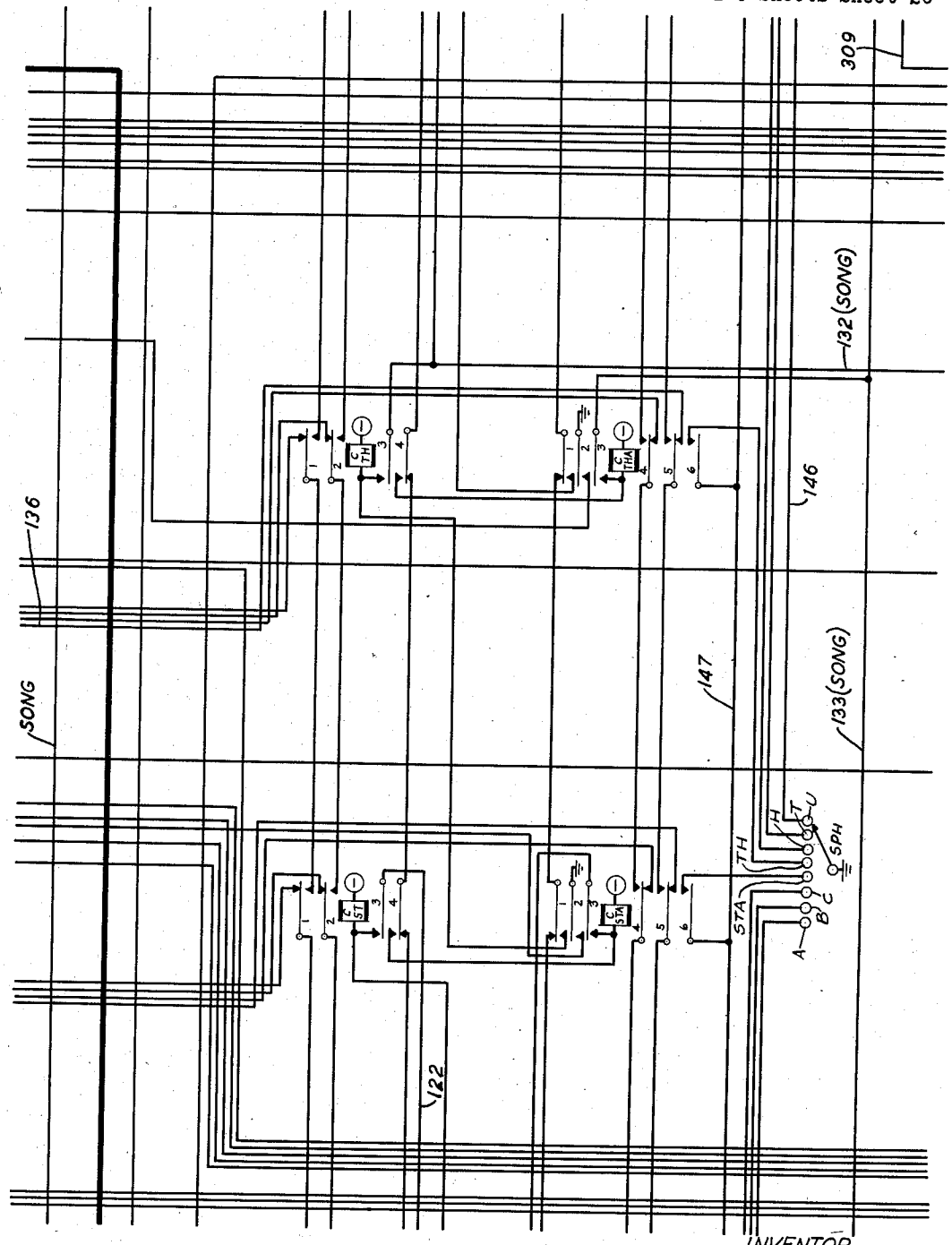


FIG. 20

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 21

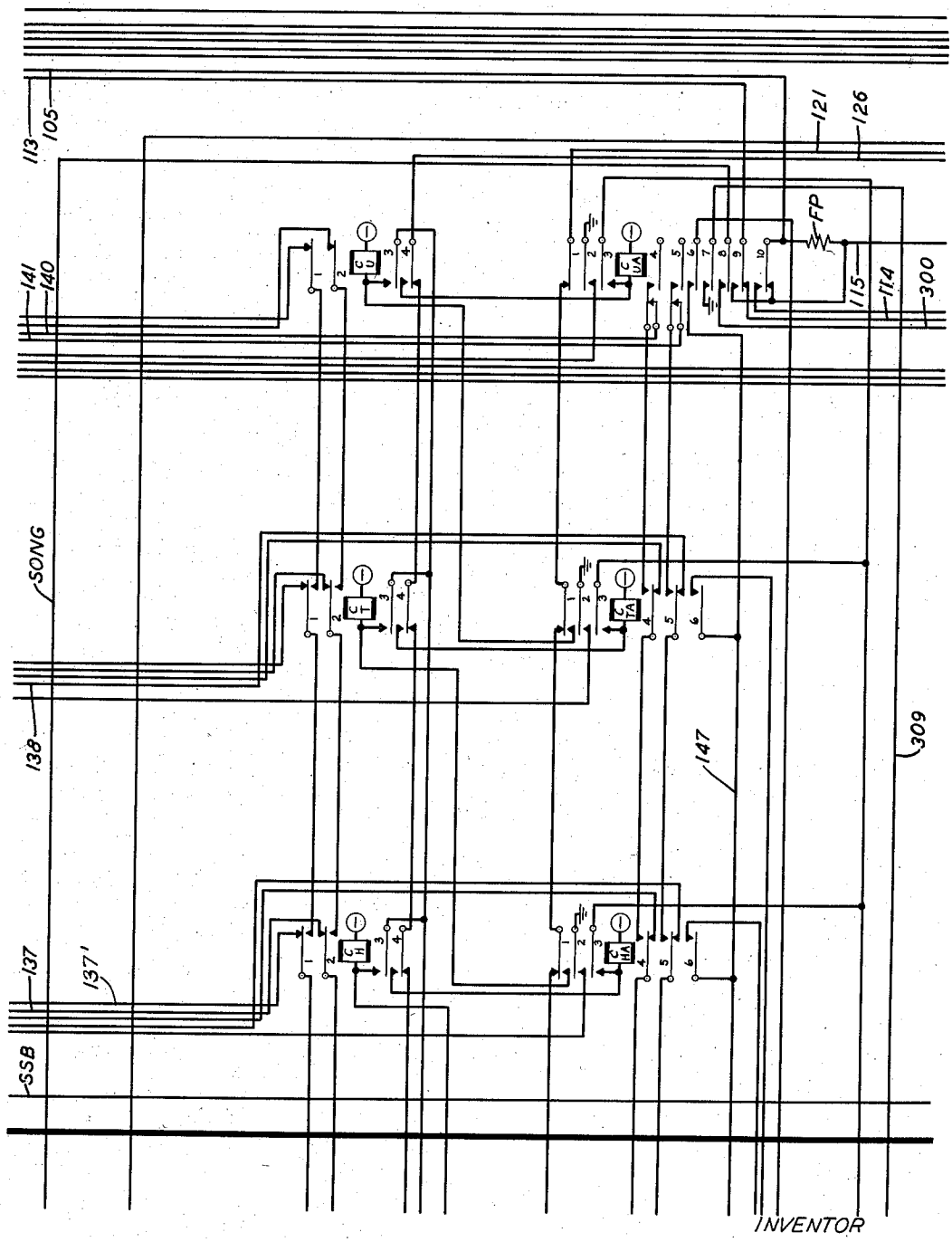


FIG. 21

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 22

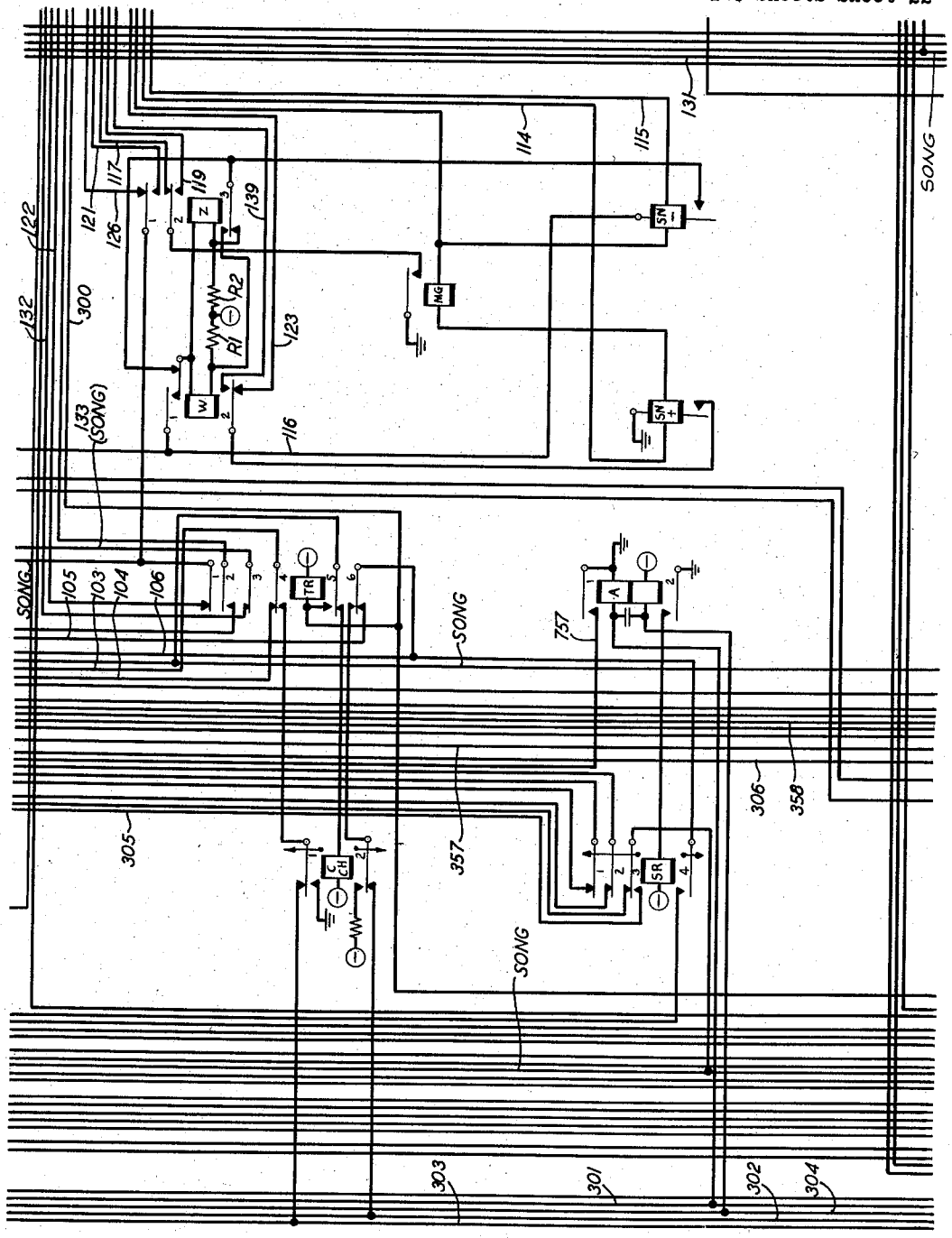


FIG. 22

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 23

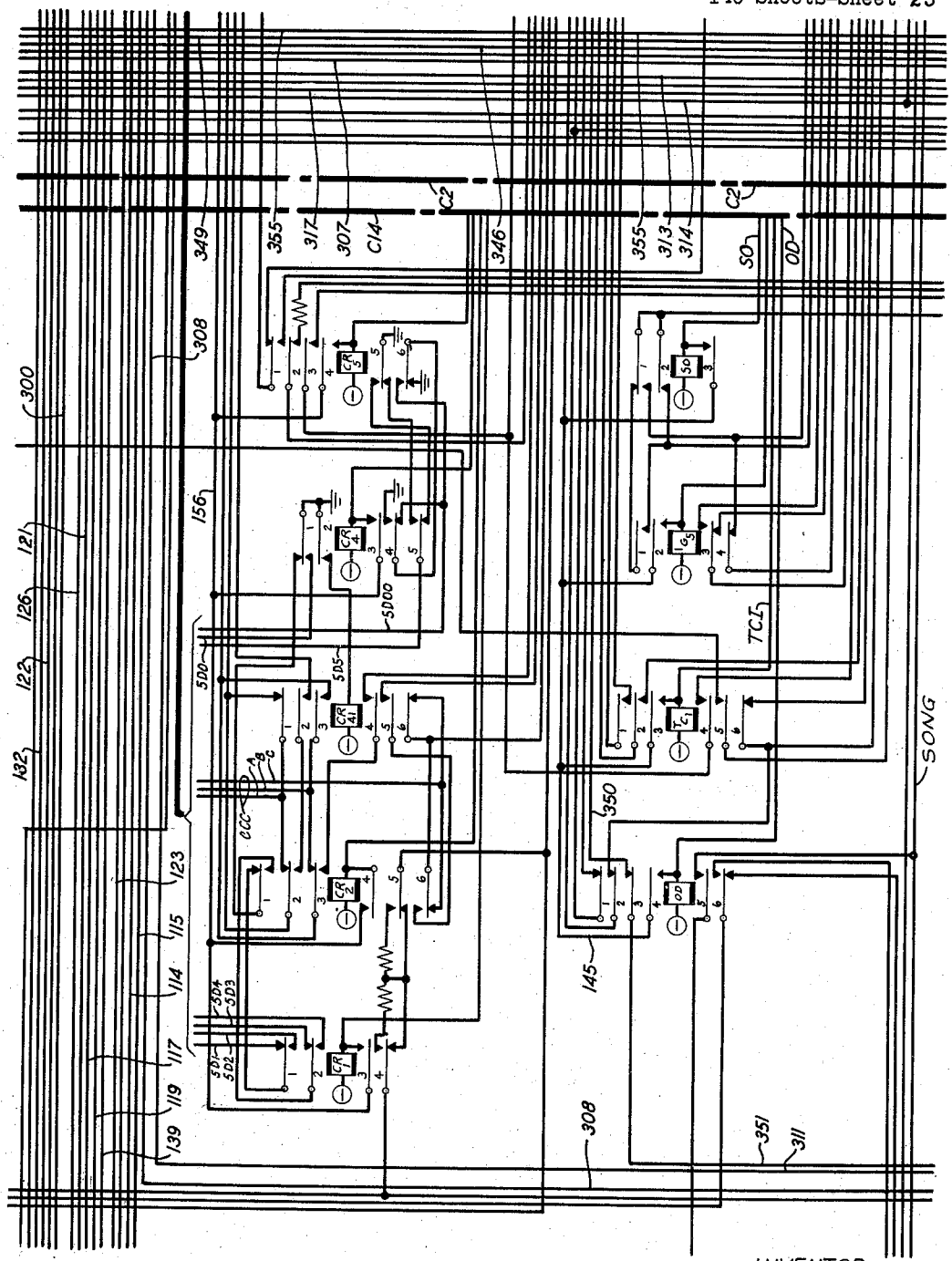


FIG. 23

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 24

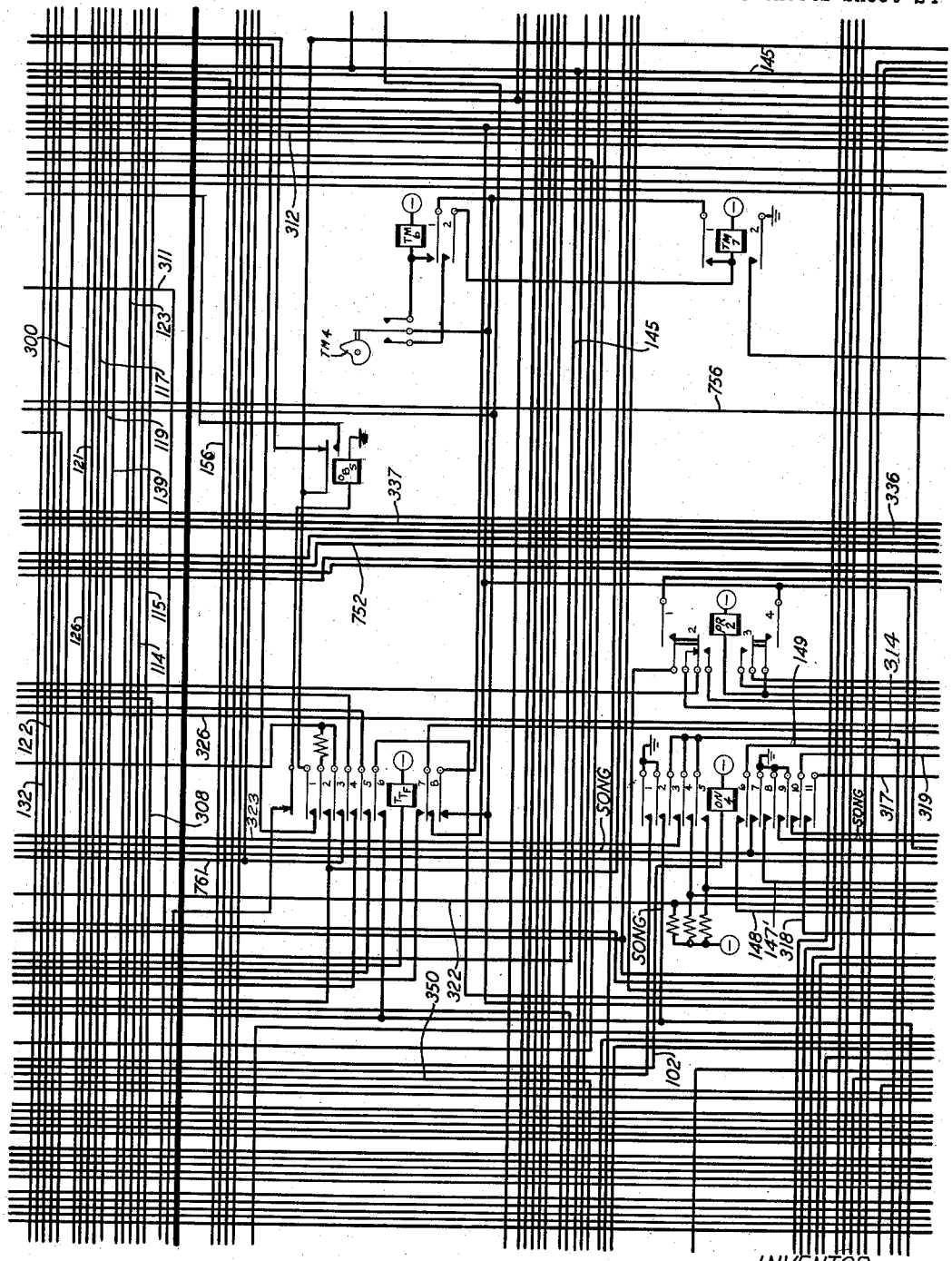


FIG. 24

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 25

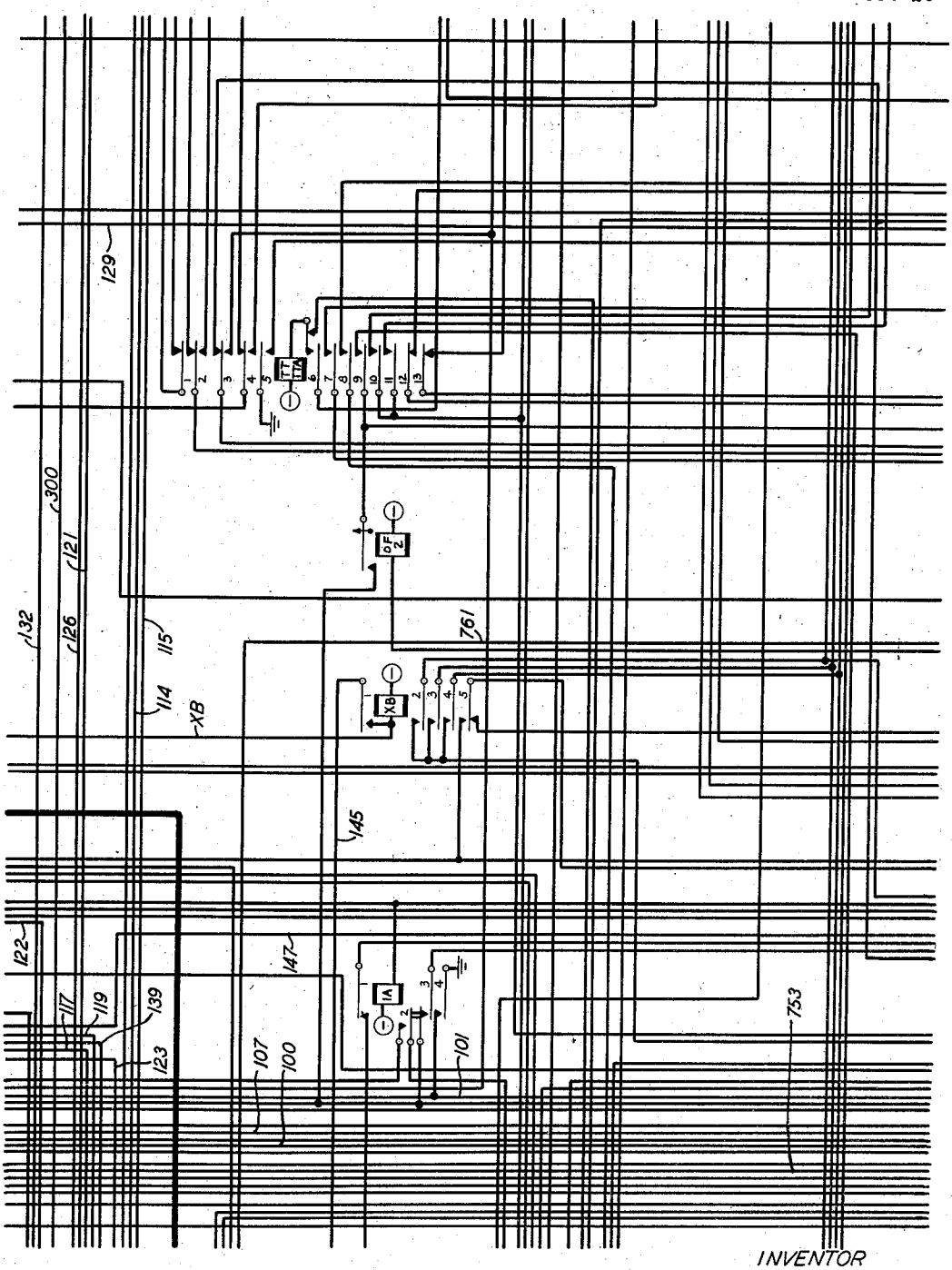


FIG. 25

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 26

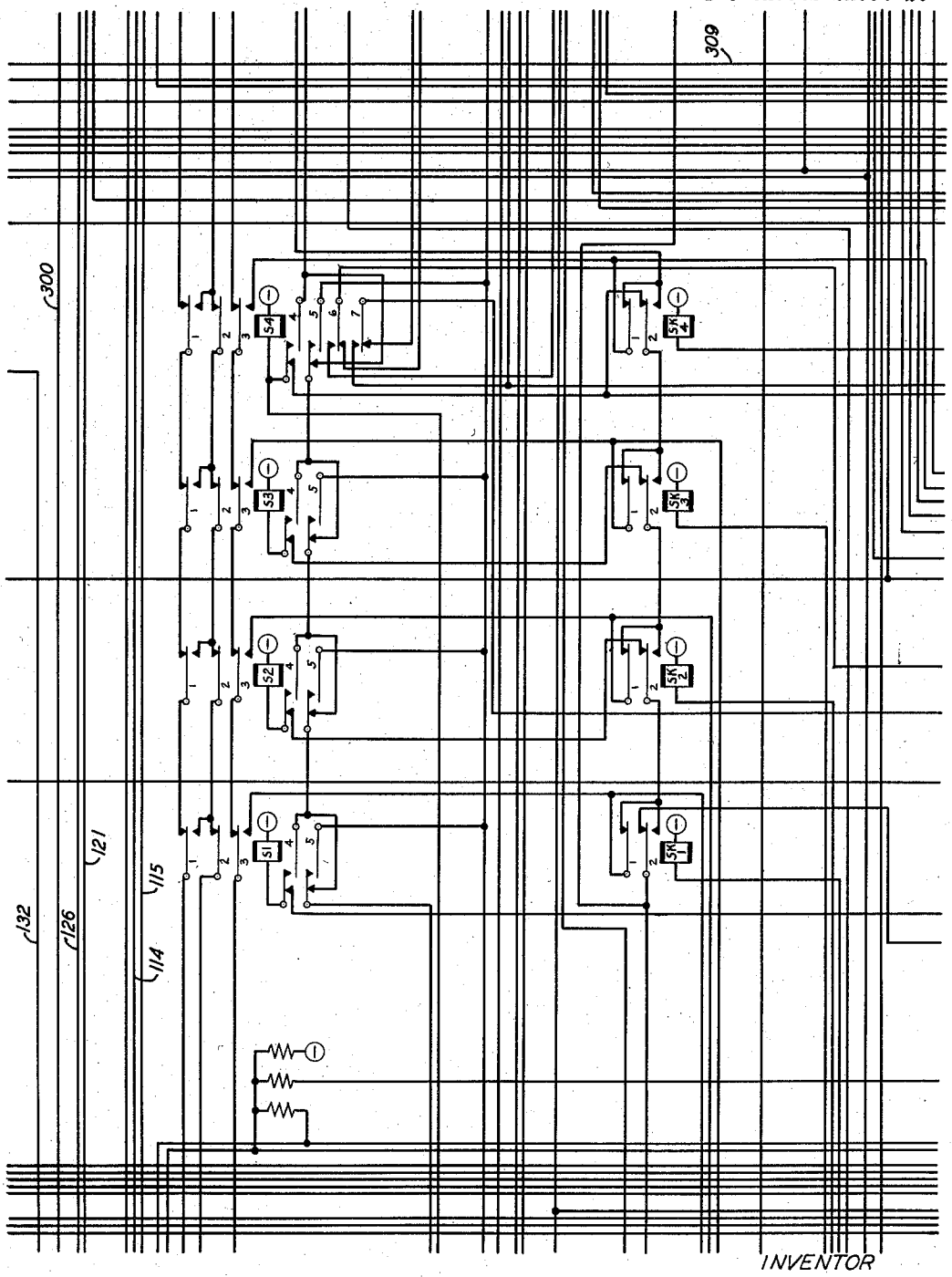


FIG. 26

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 27

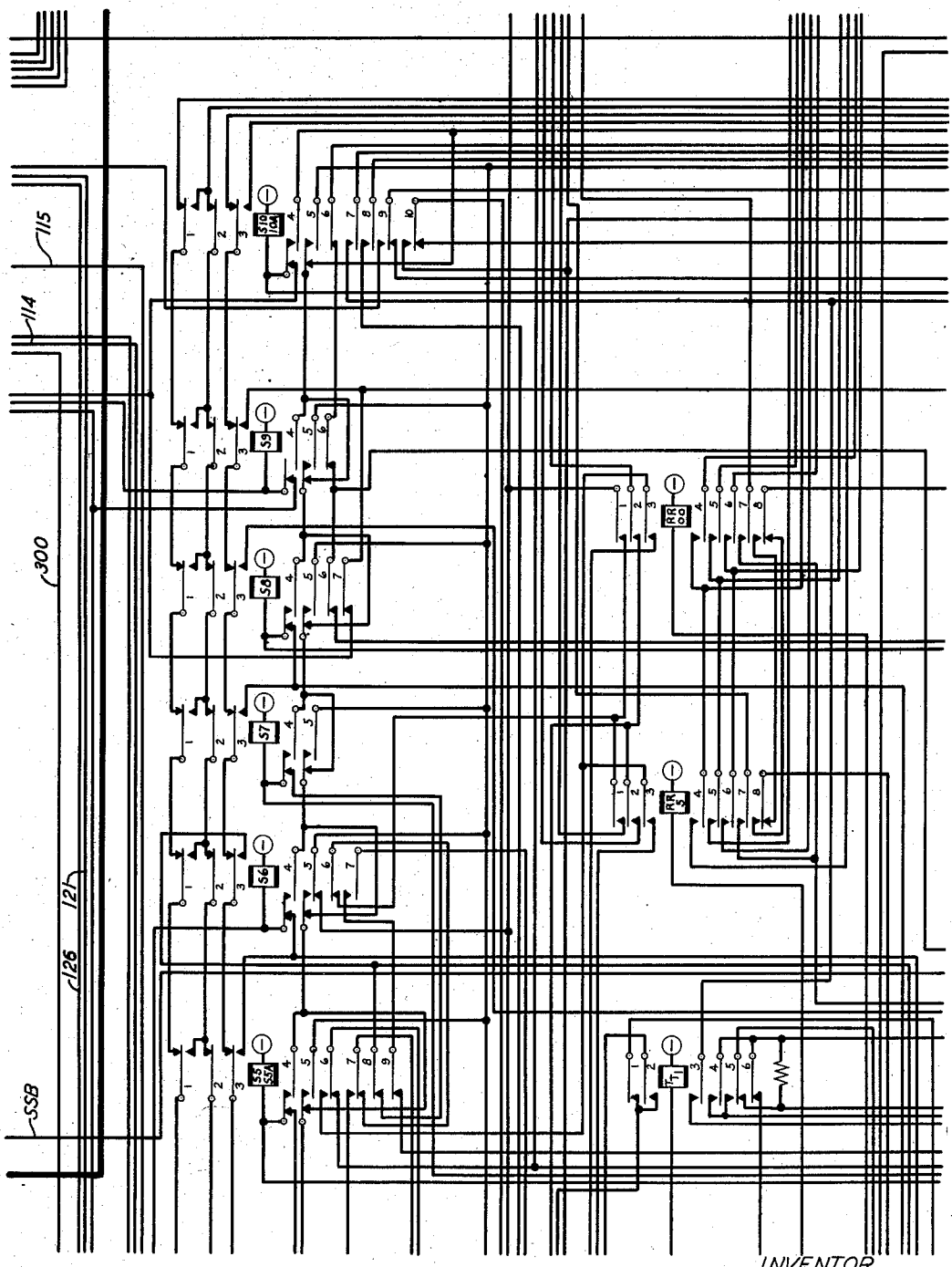


FIG. 27

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 28

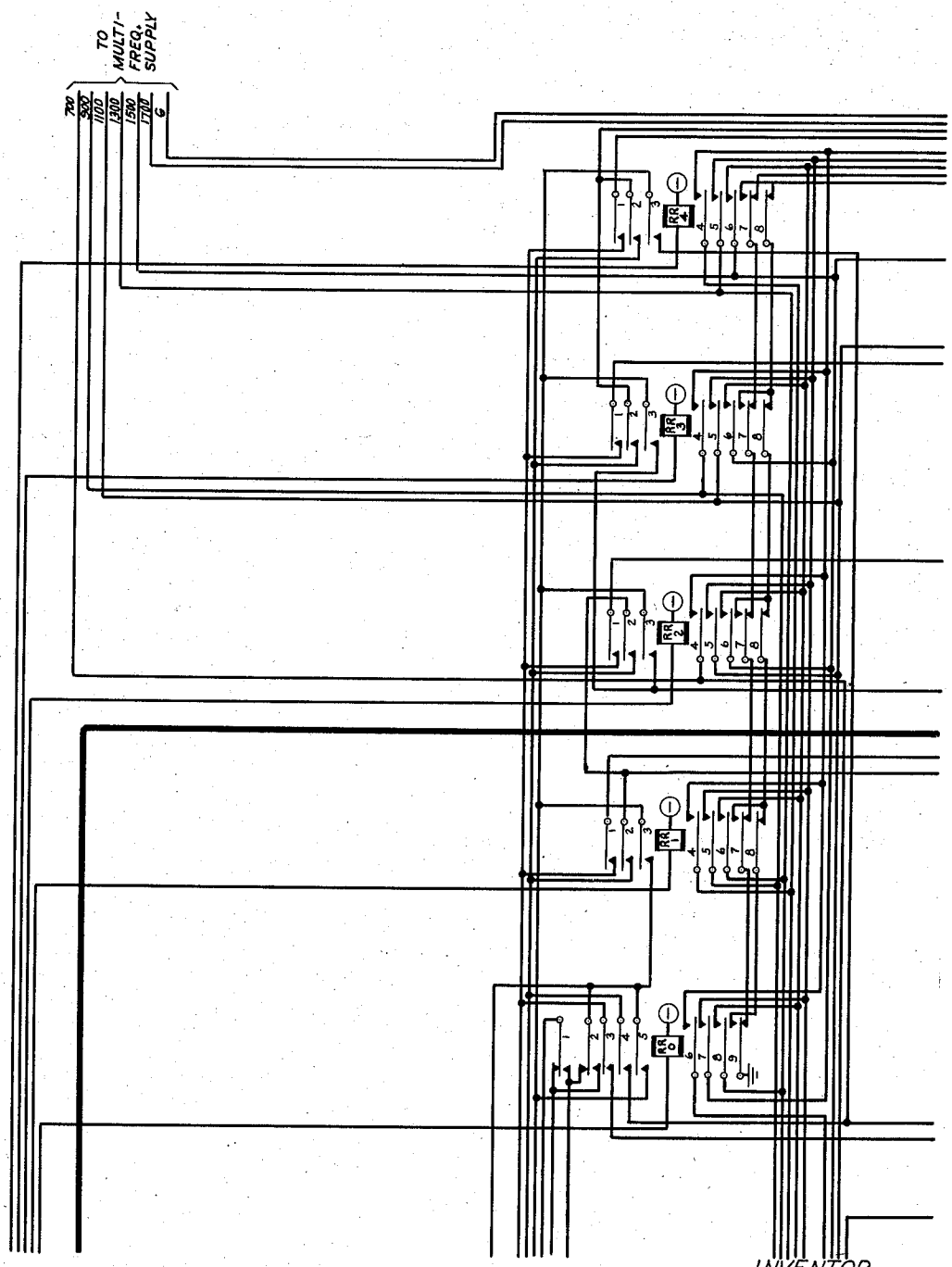


FIG. 28

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 29

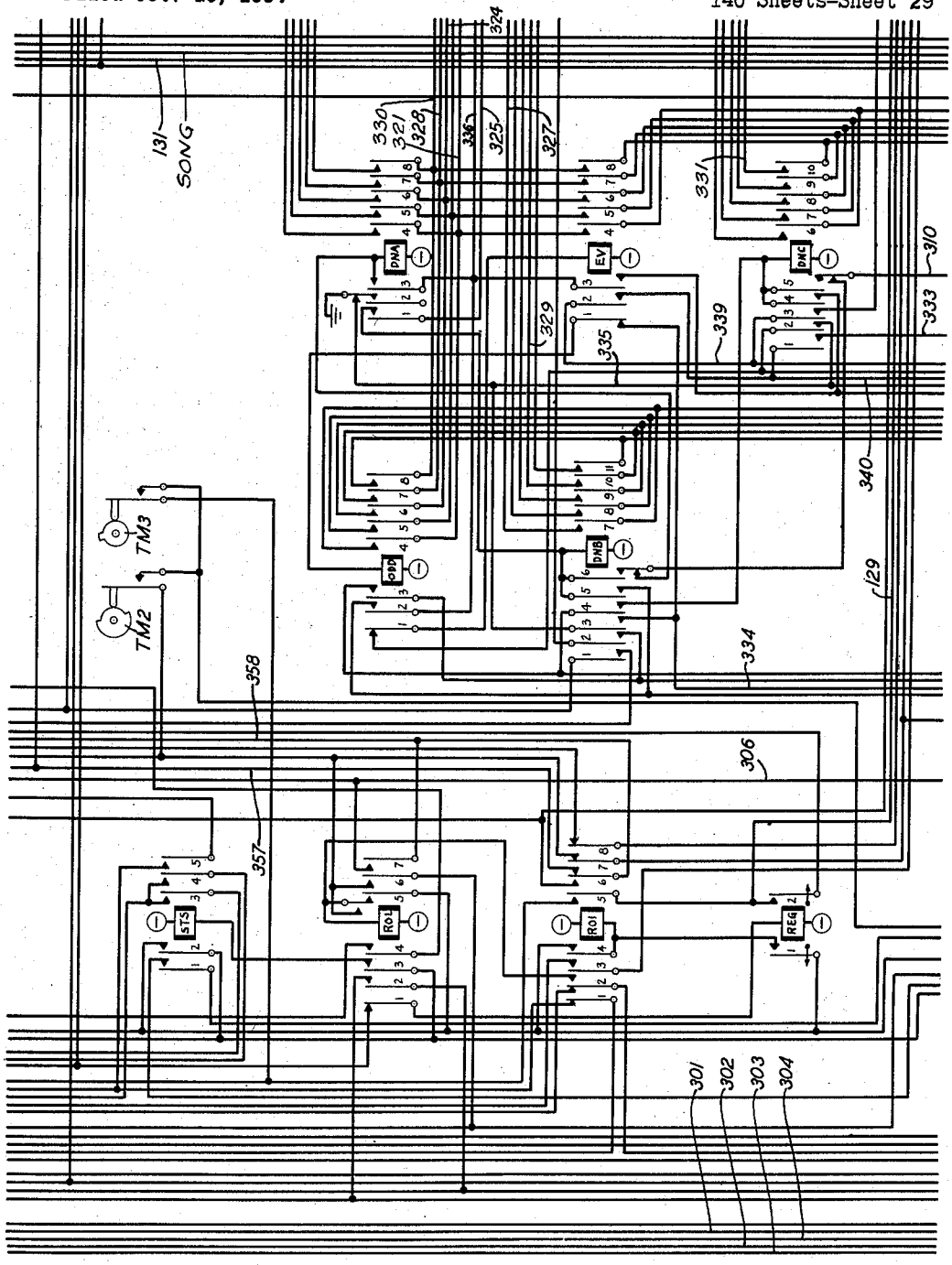


FIG. 29

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 30

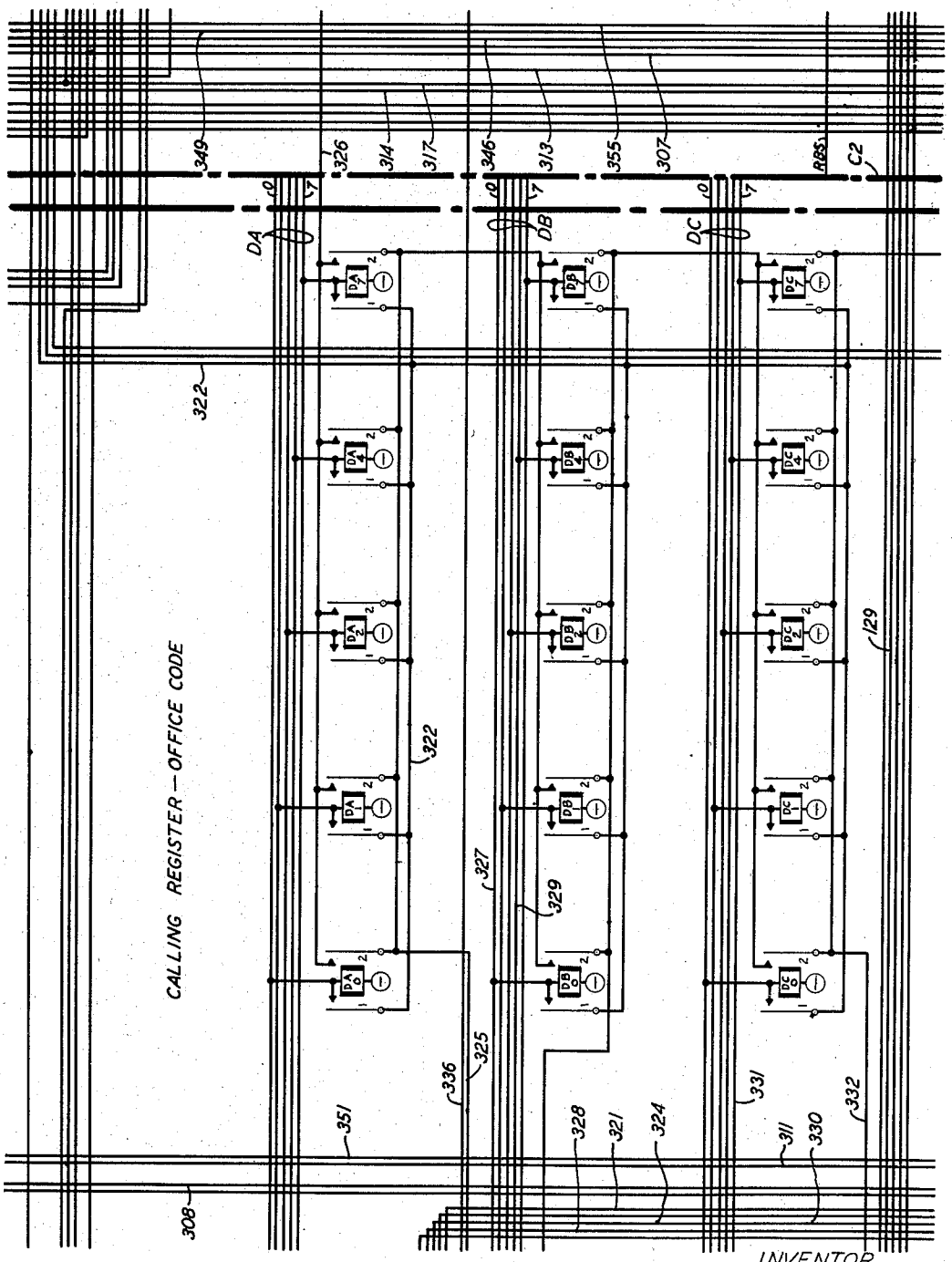


FIG. 30

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 31

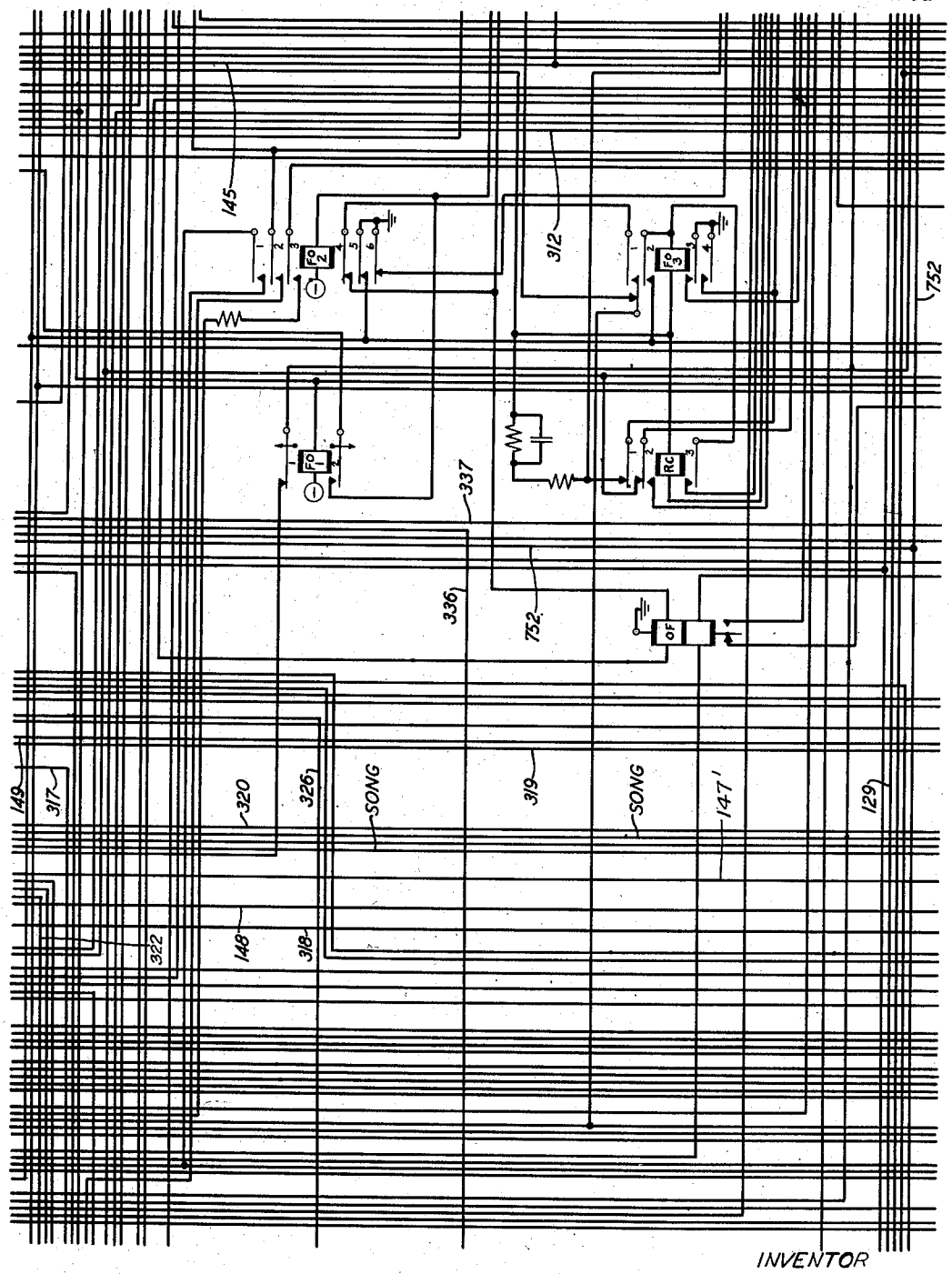


FIG. 31

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 32

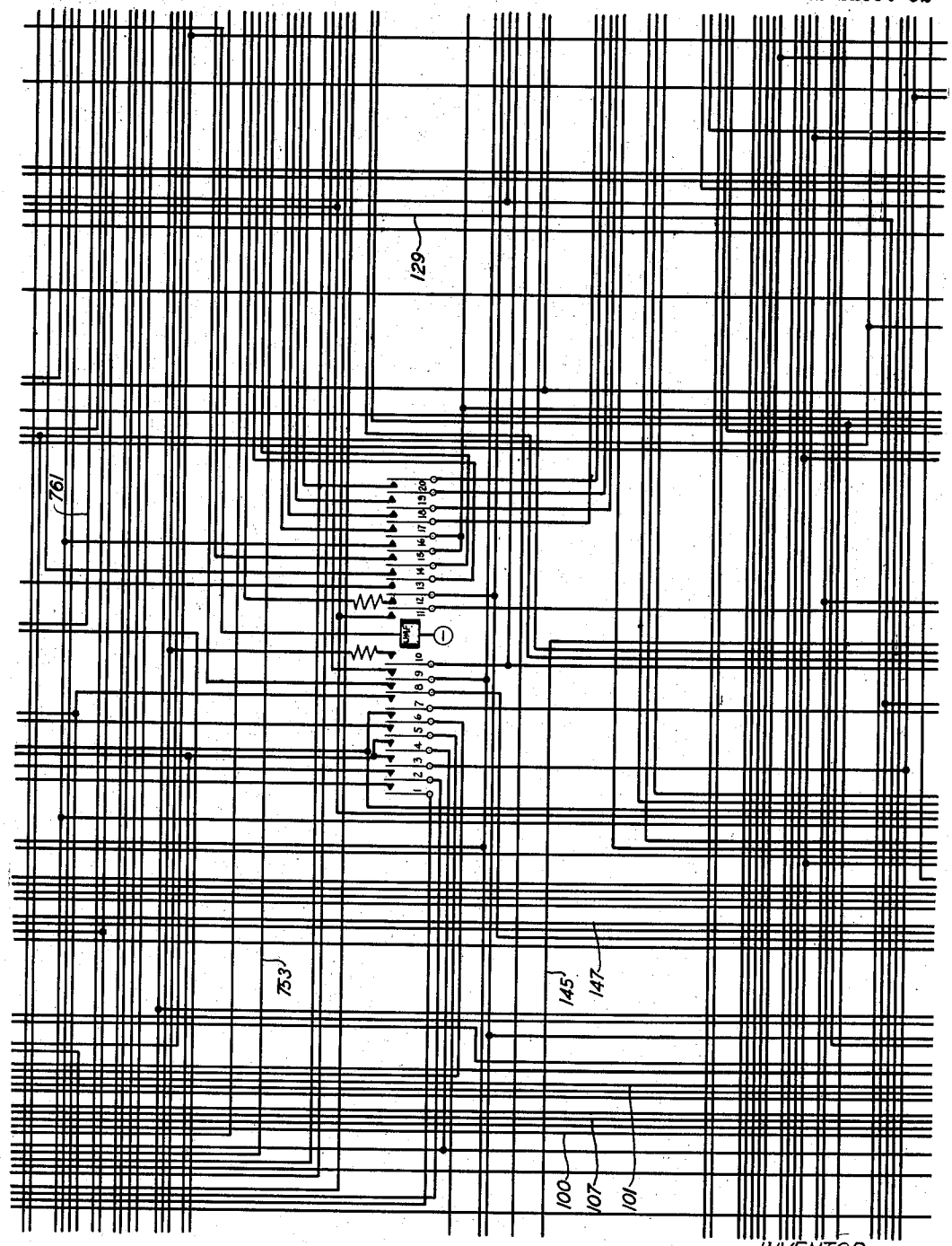


FIG. 32

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 33

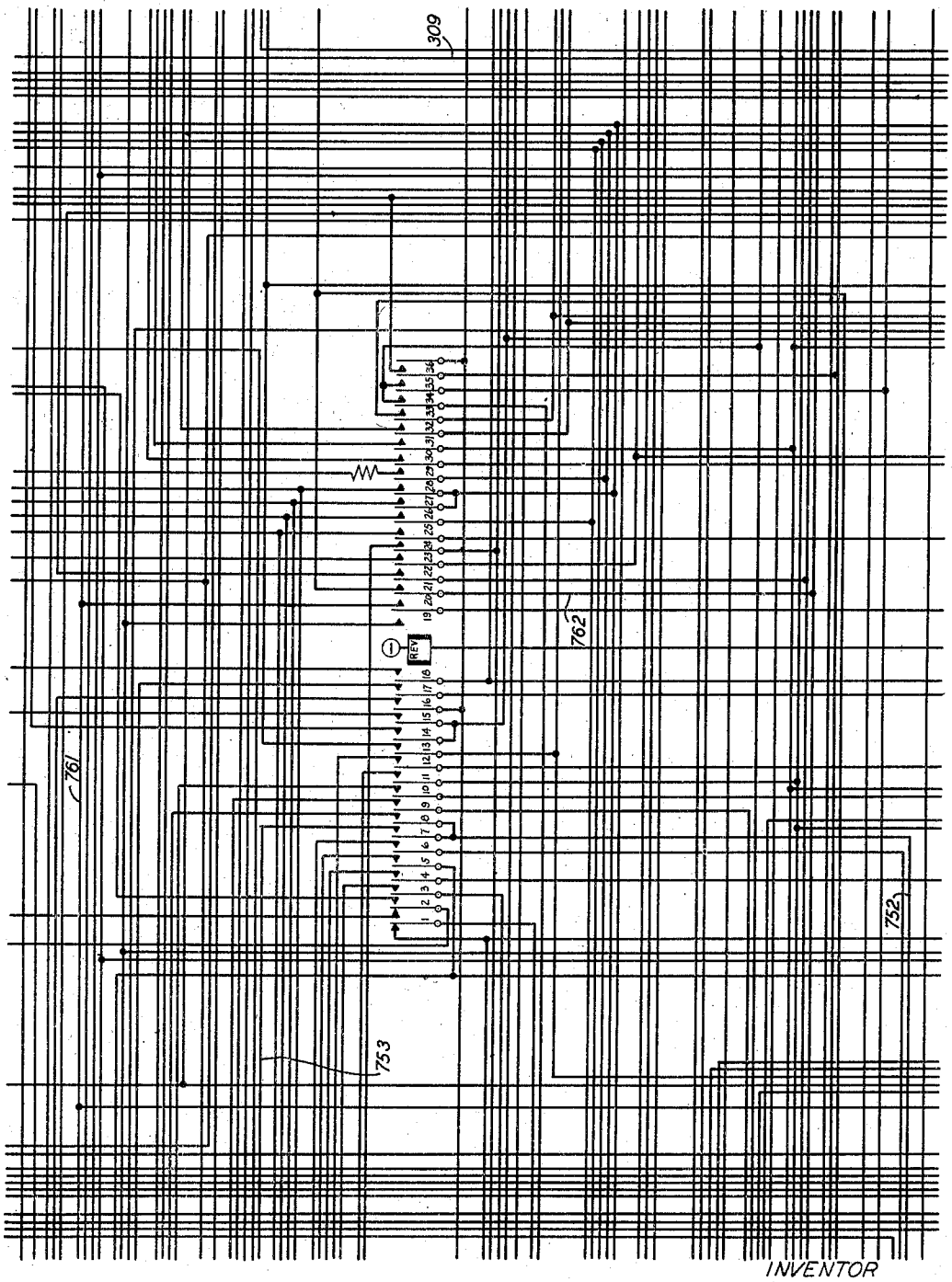


FIG. 33

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 34

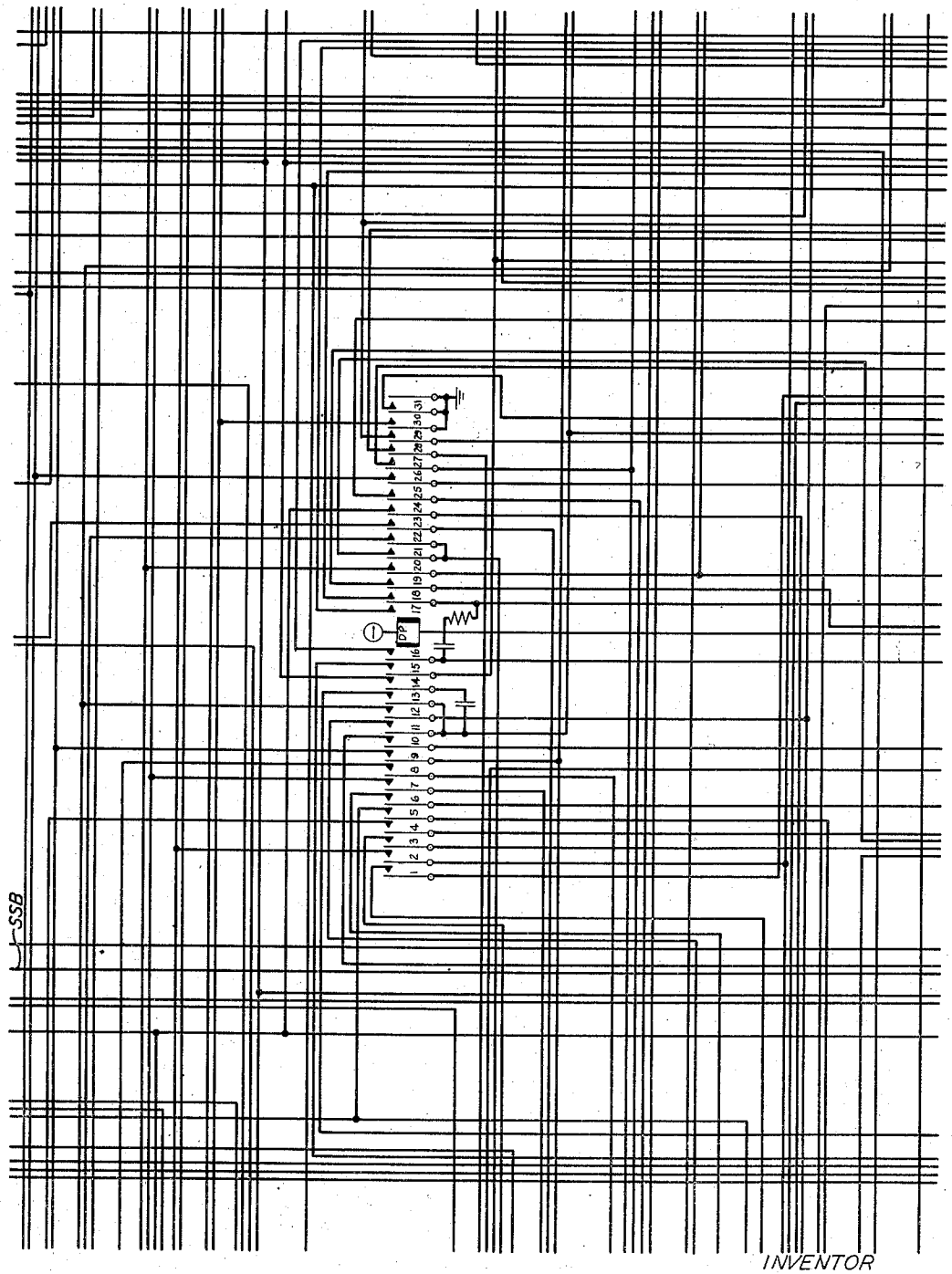


FIG. 34

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 35

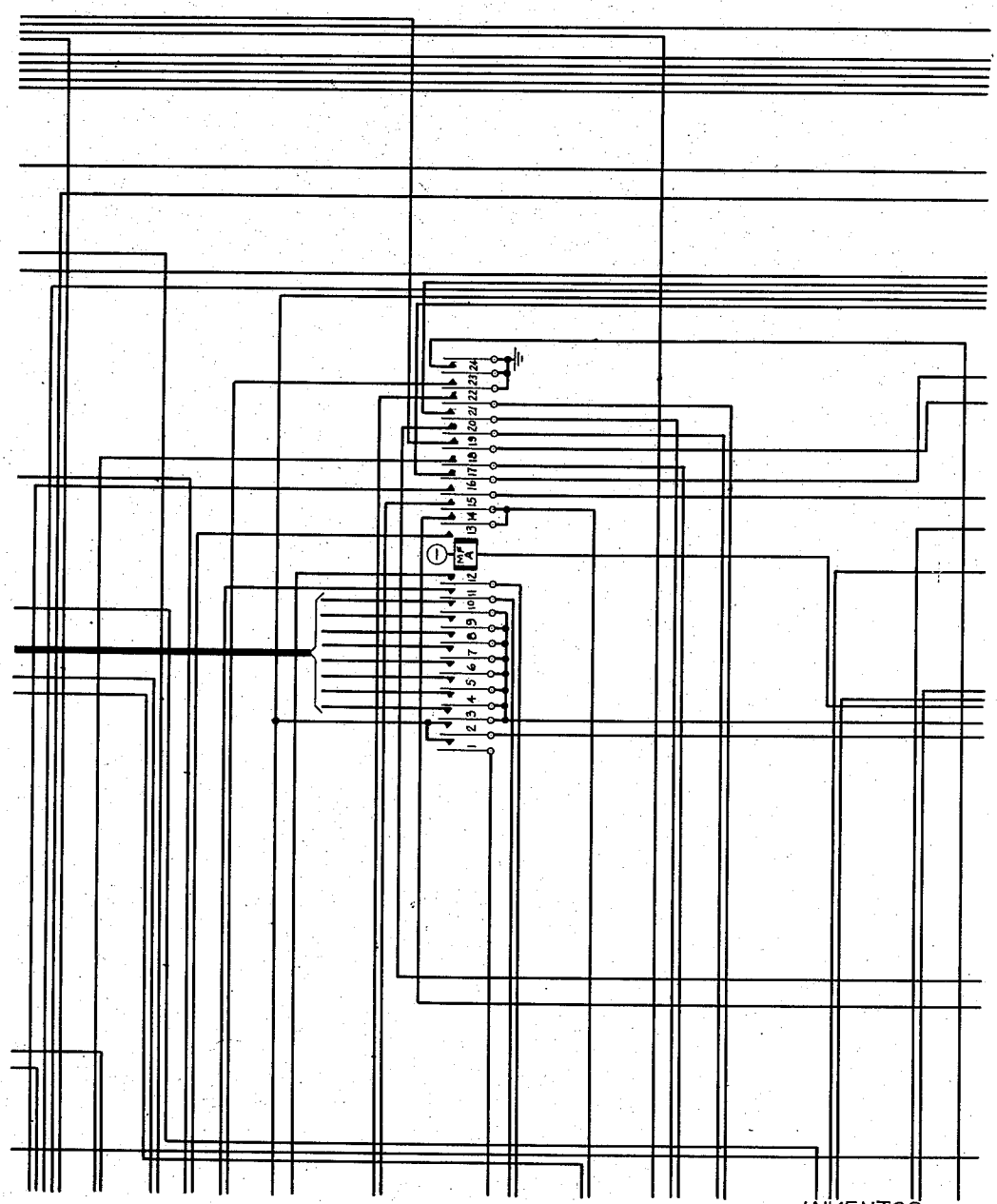


FIG. 35

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 36

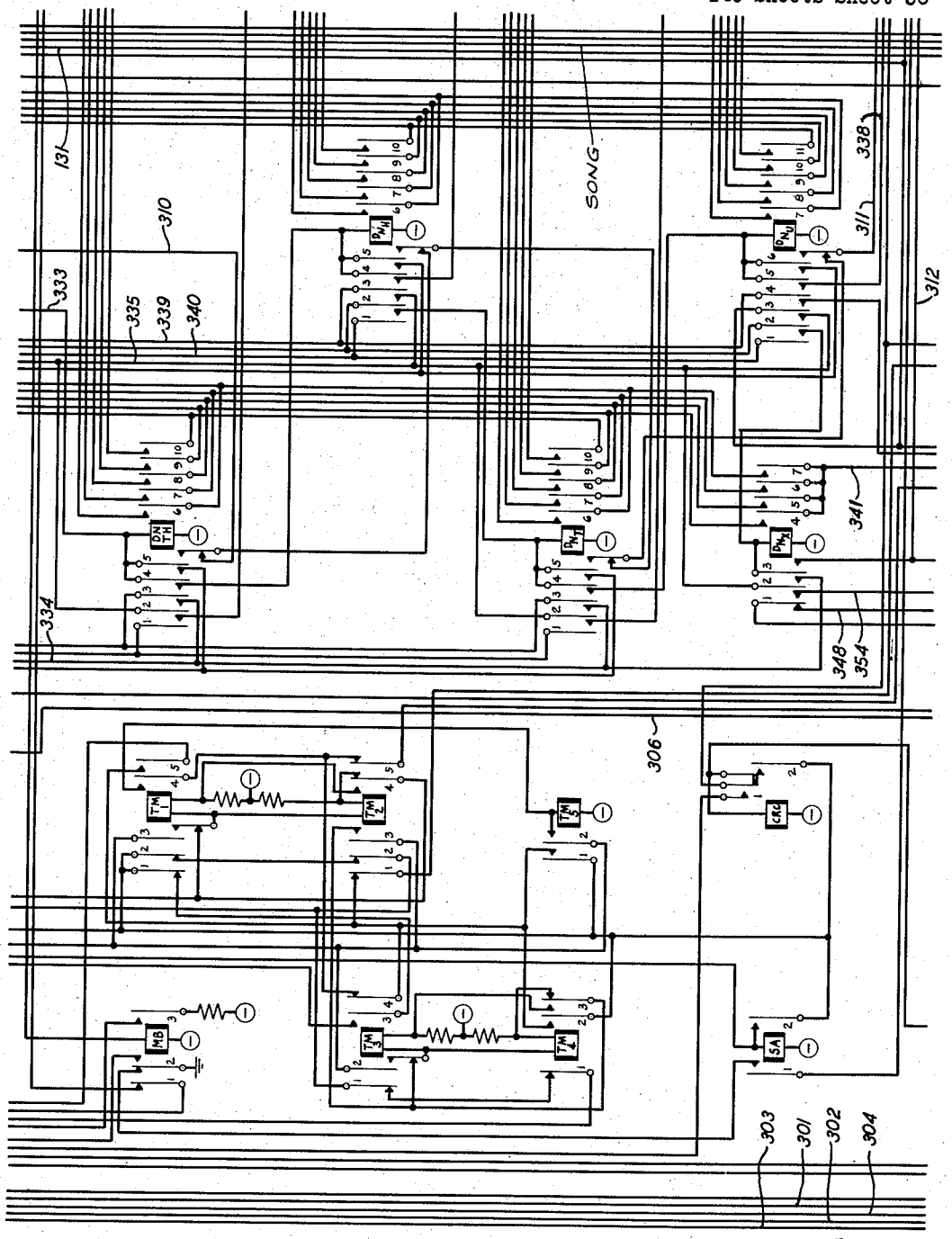


FIG. 36

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 37

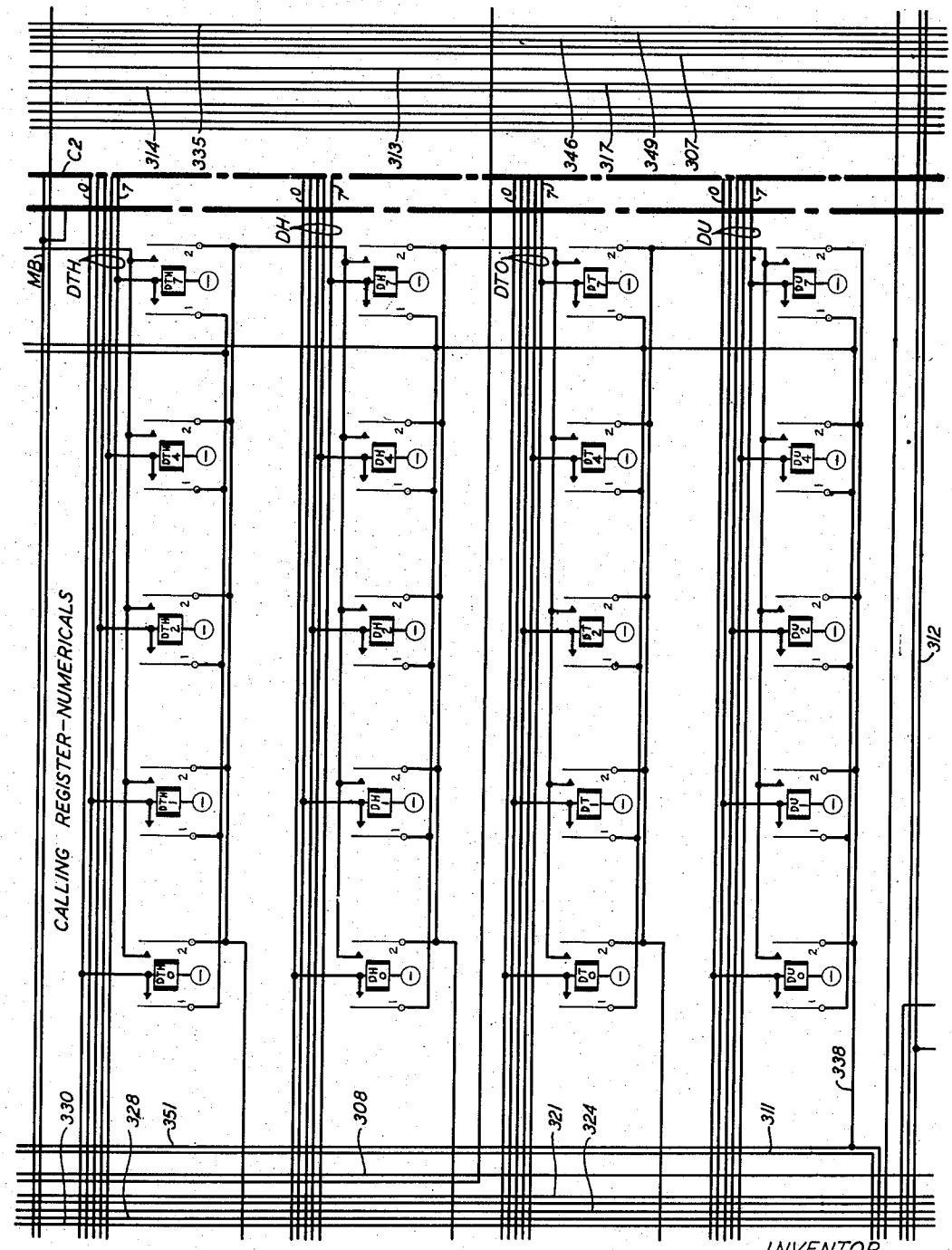


FIG. 37

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 38

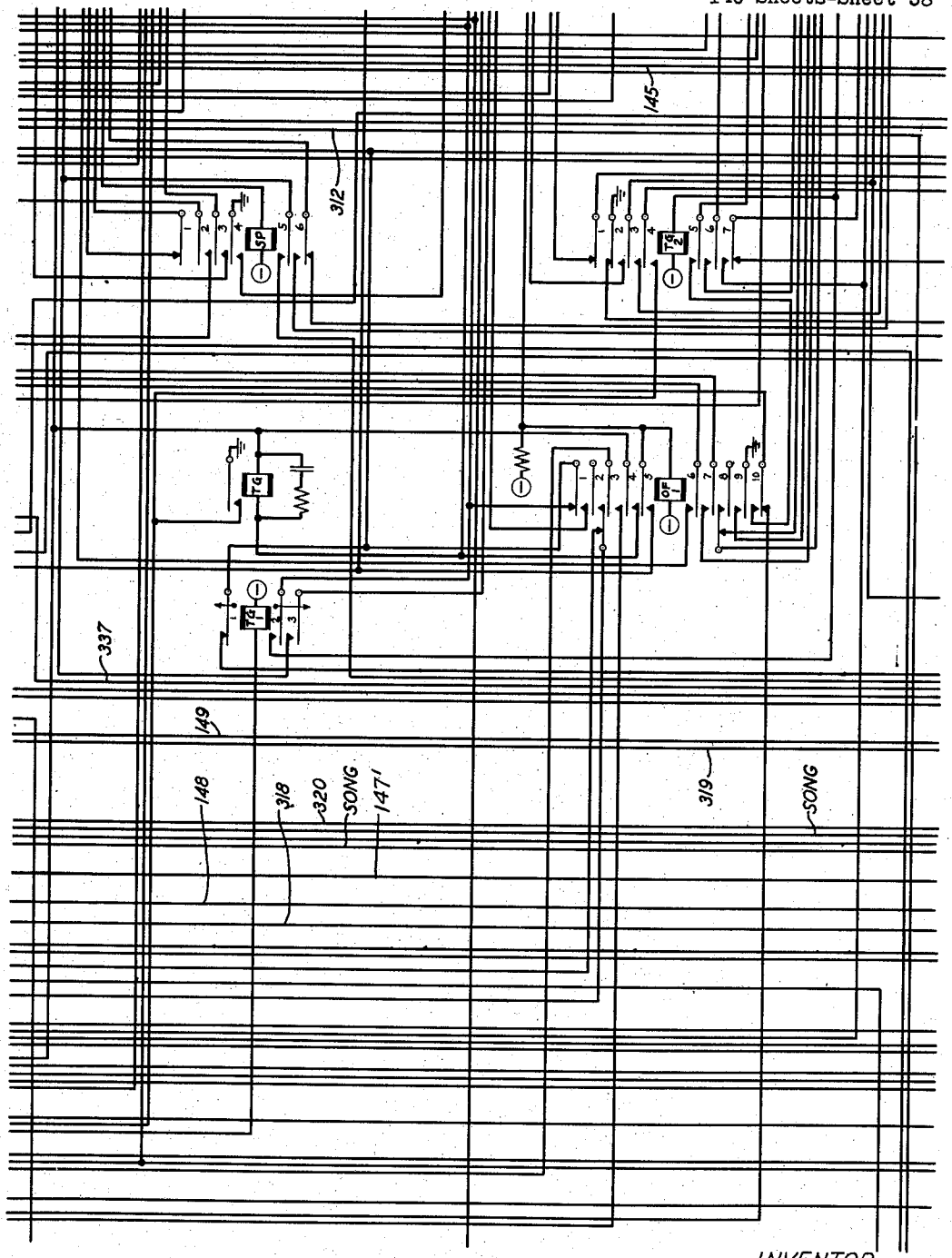


FIG. 38

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 39

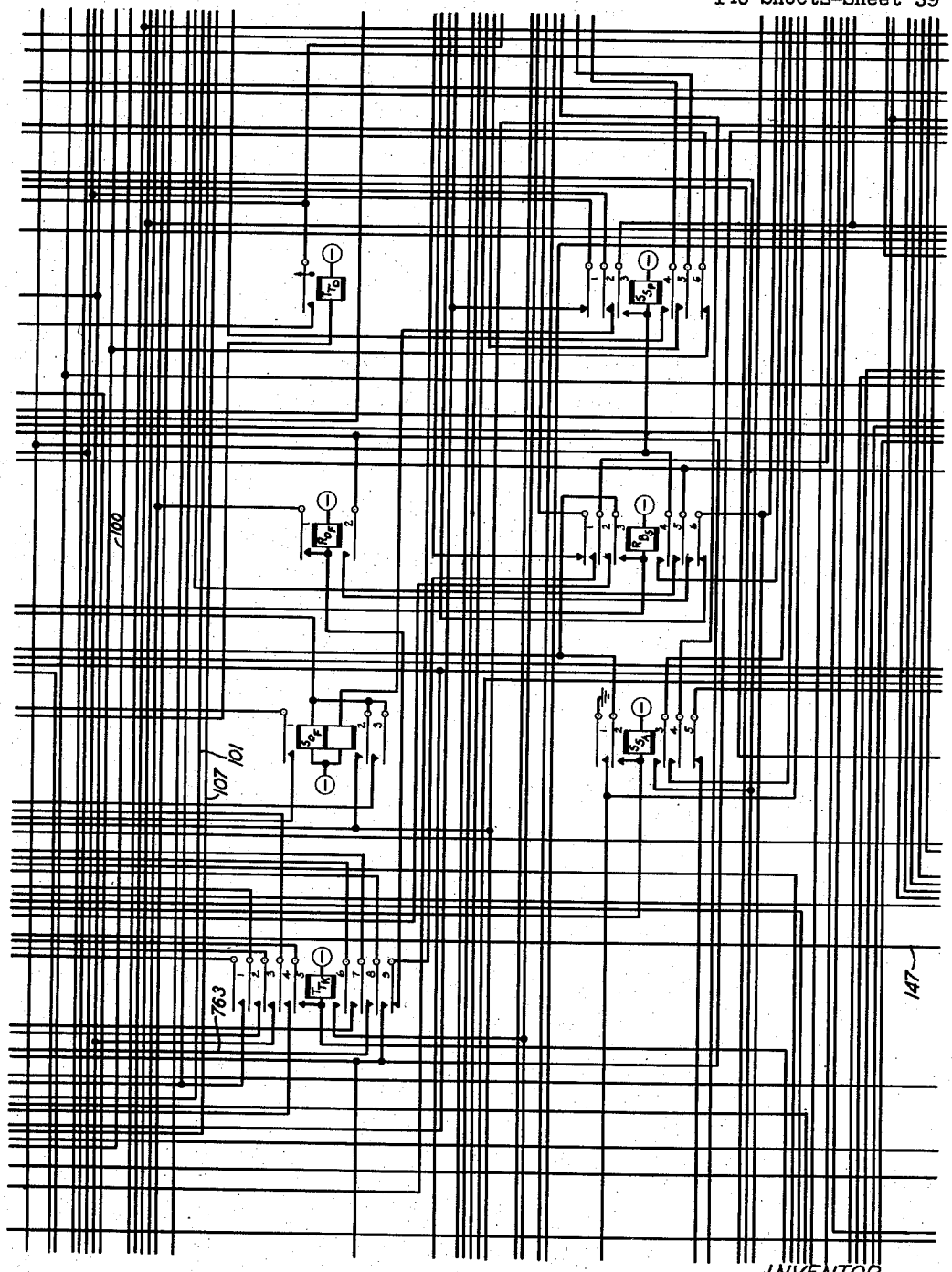


FIG. 39

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 40

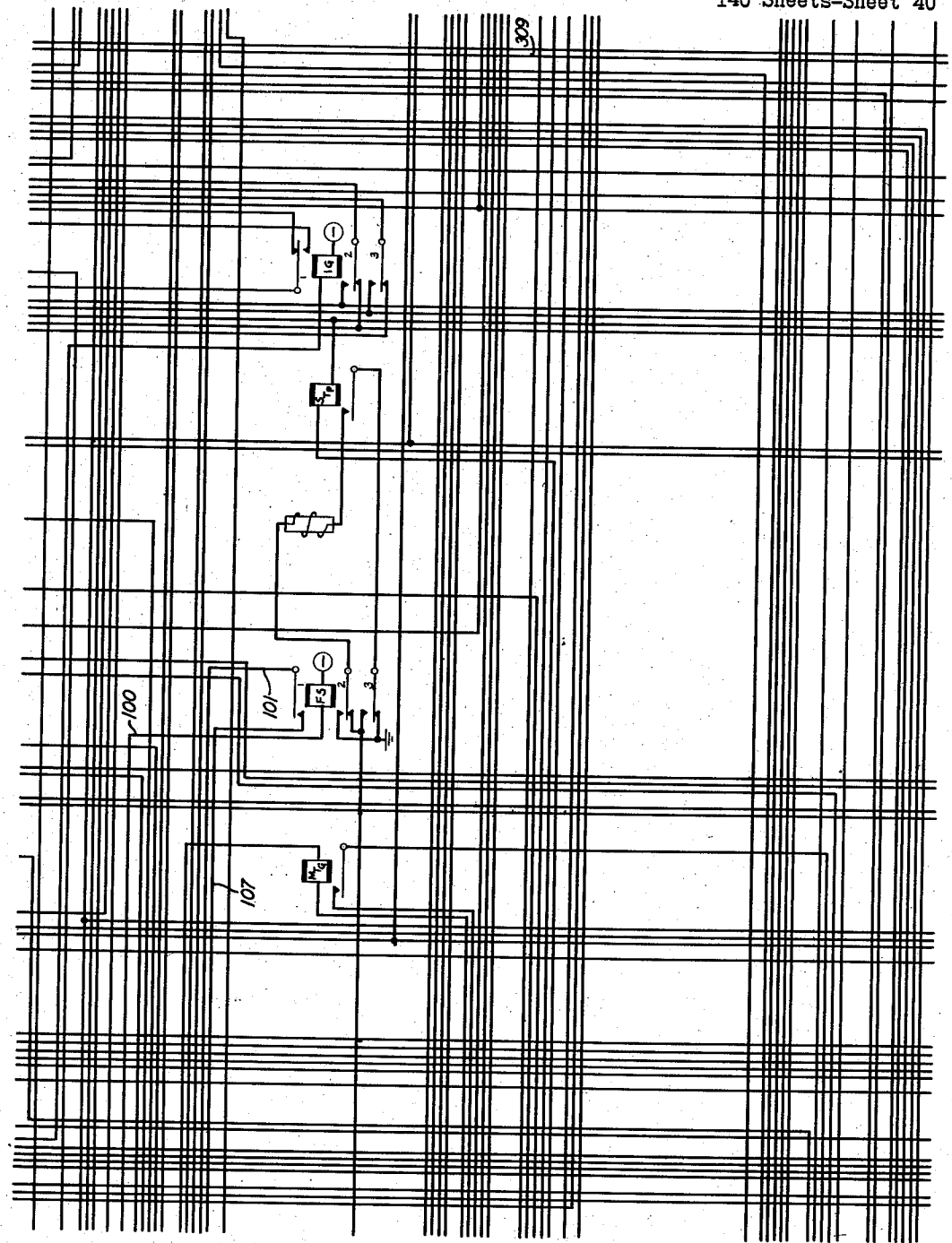


FIG. 40

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 41

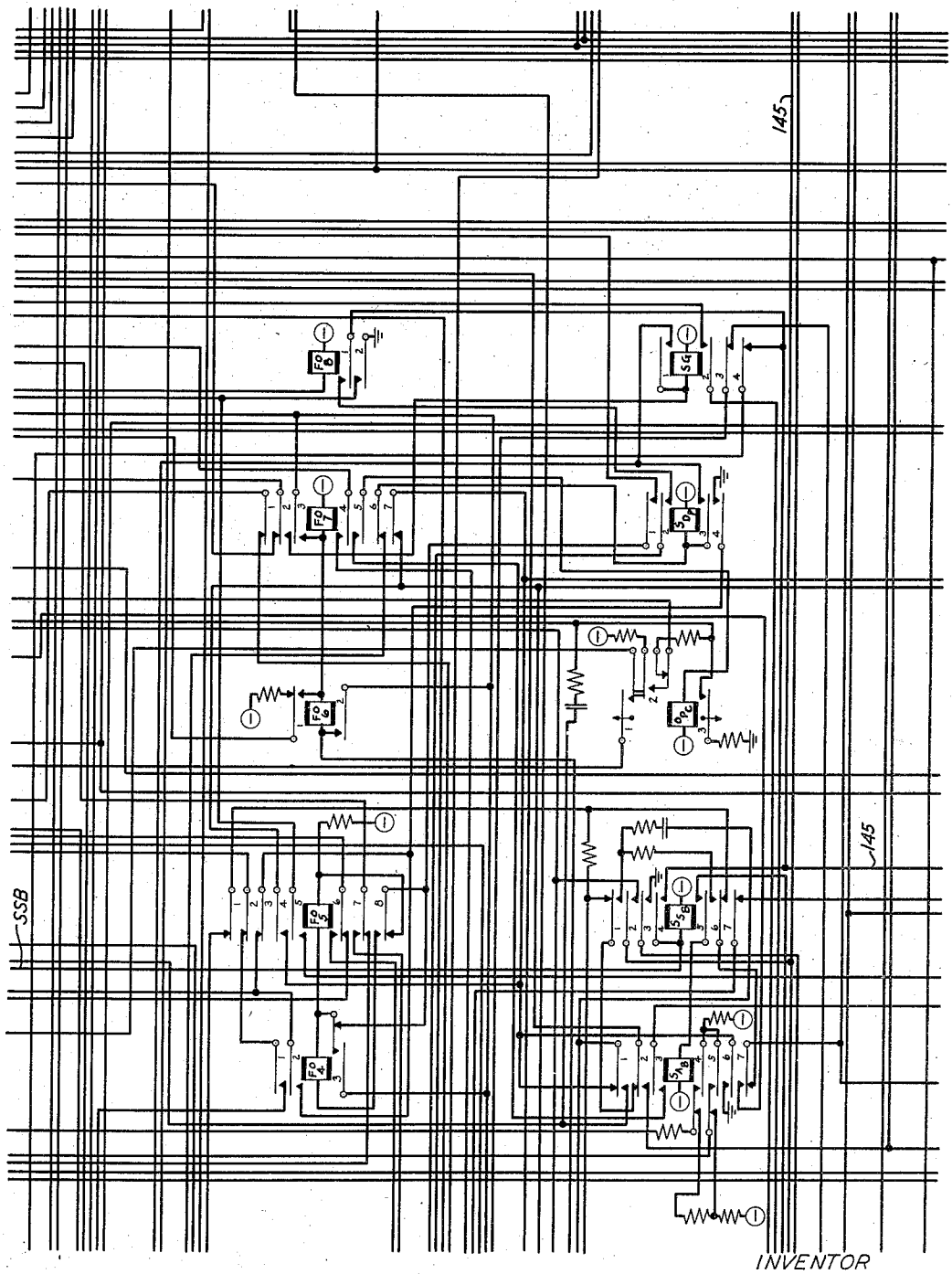


FIG. 41

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 42

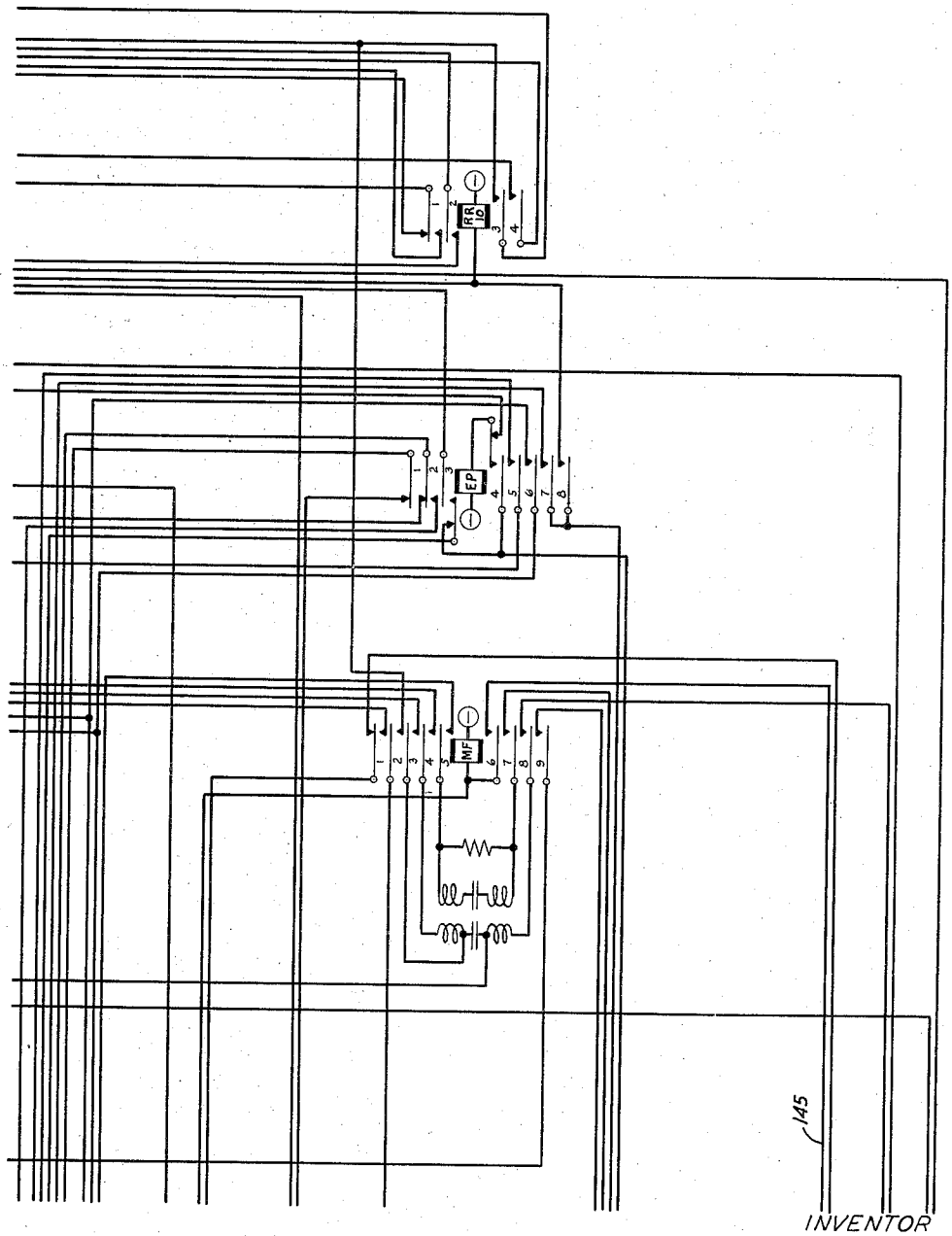


FIG. 42

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 43

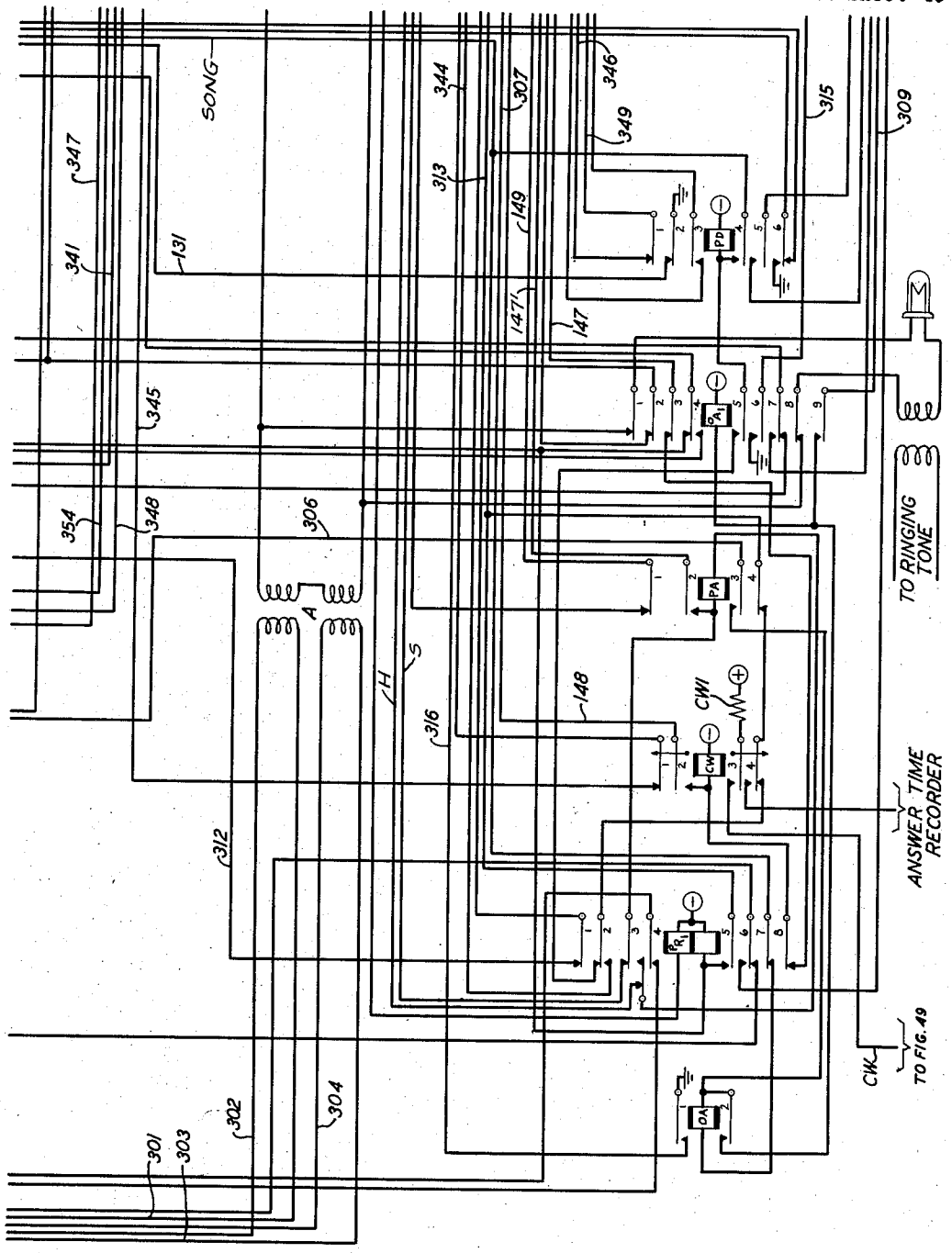


FIG. 43

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 44

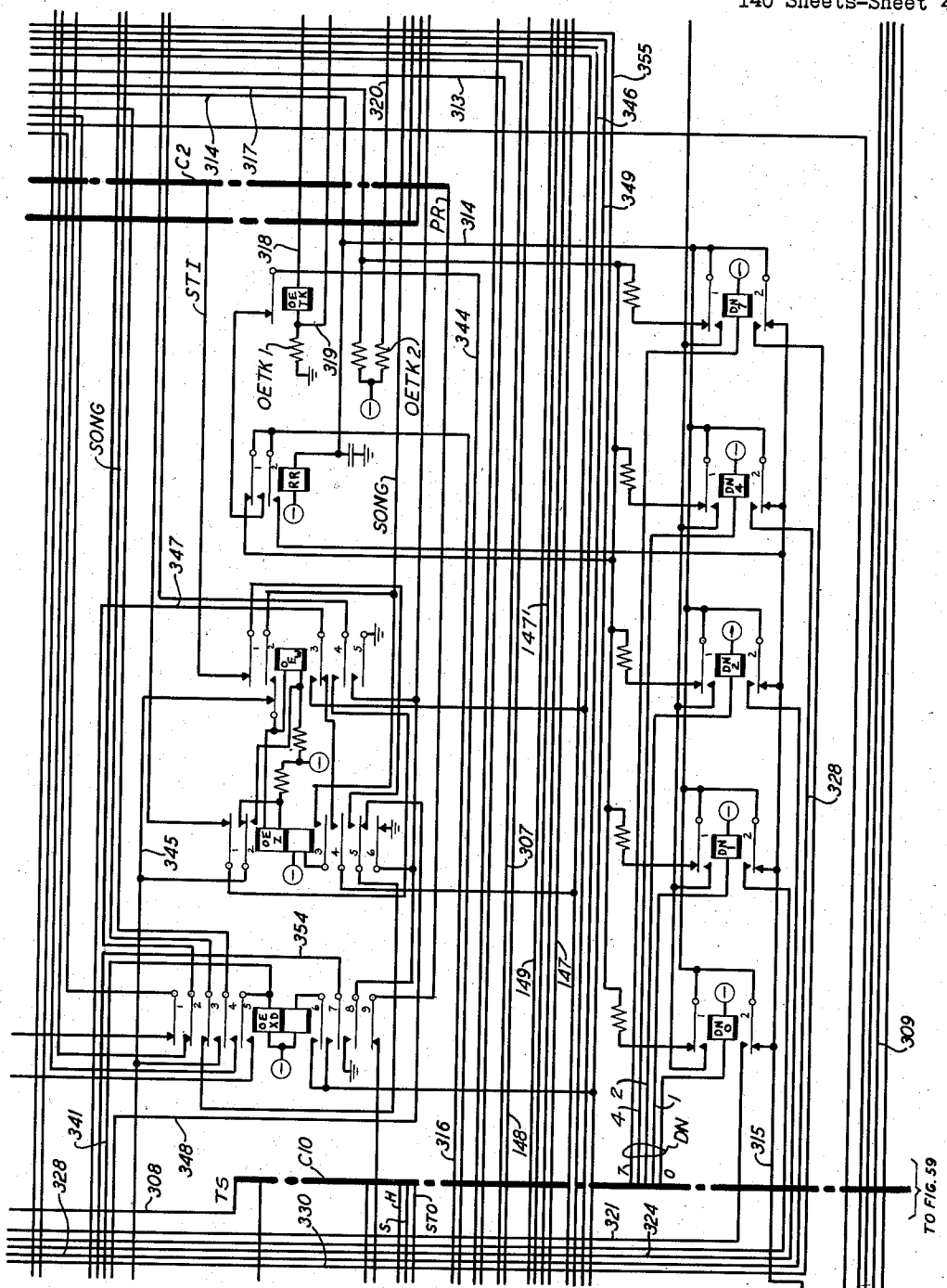


FIG. 44

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 45

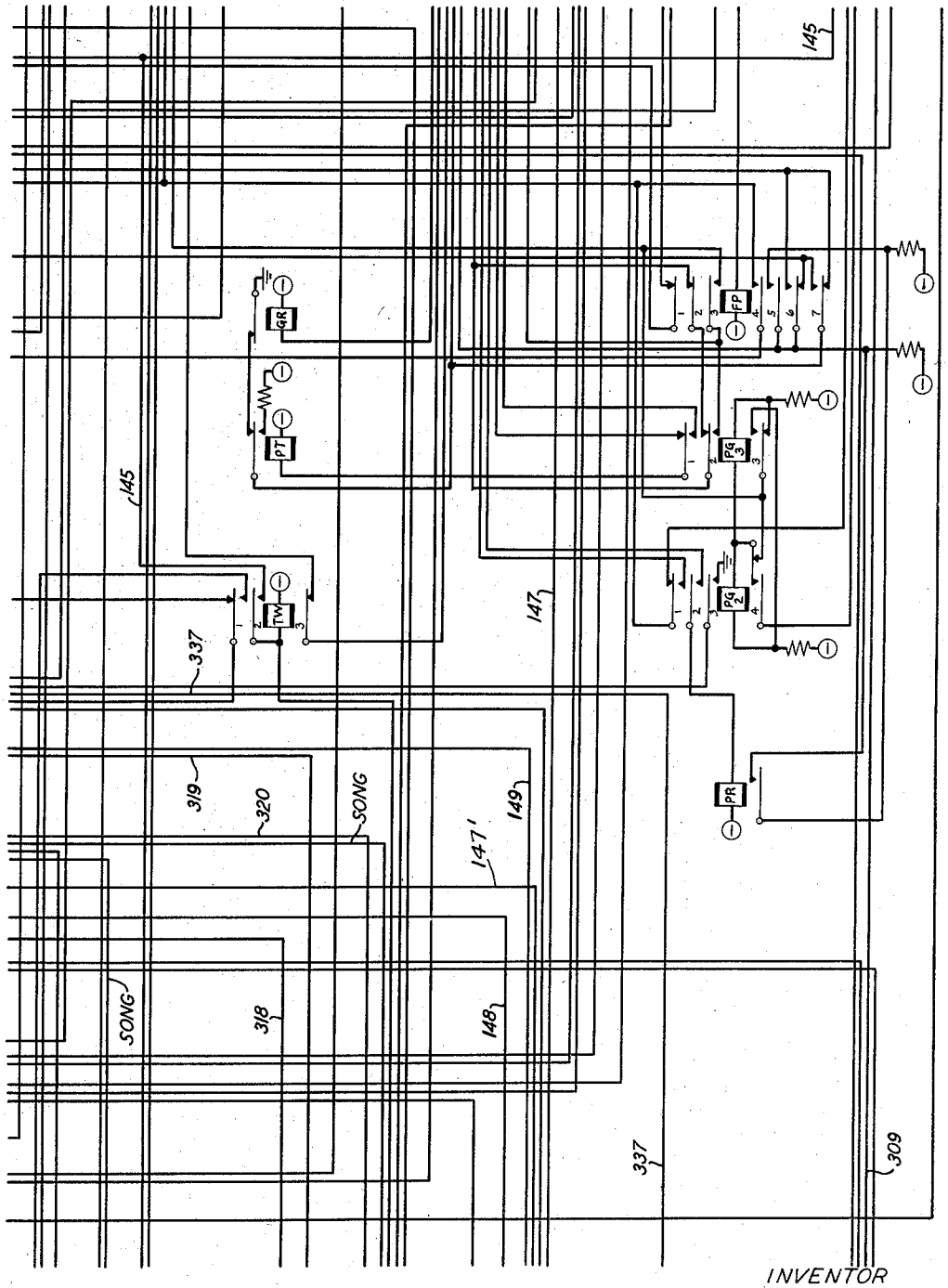


FIG. 45

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 46

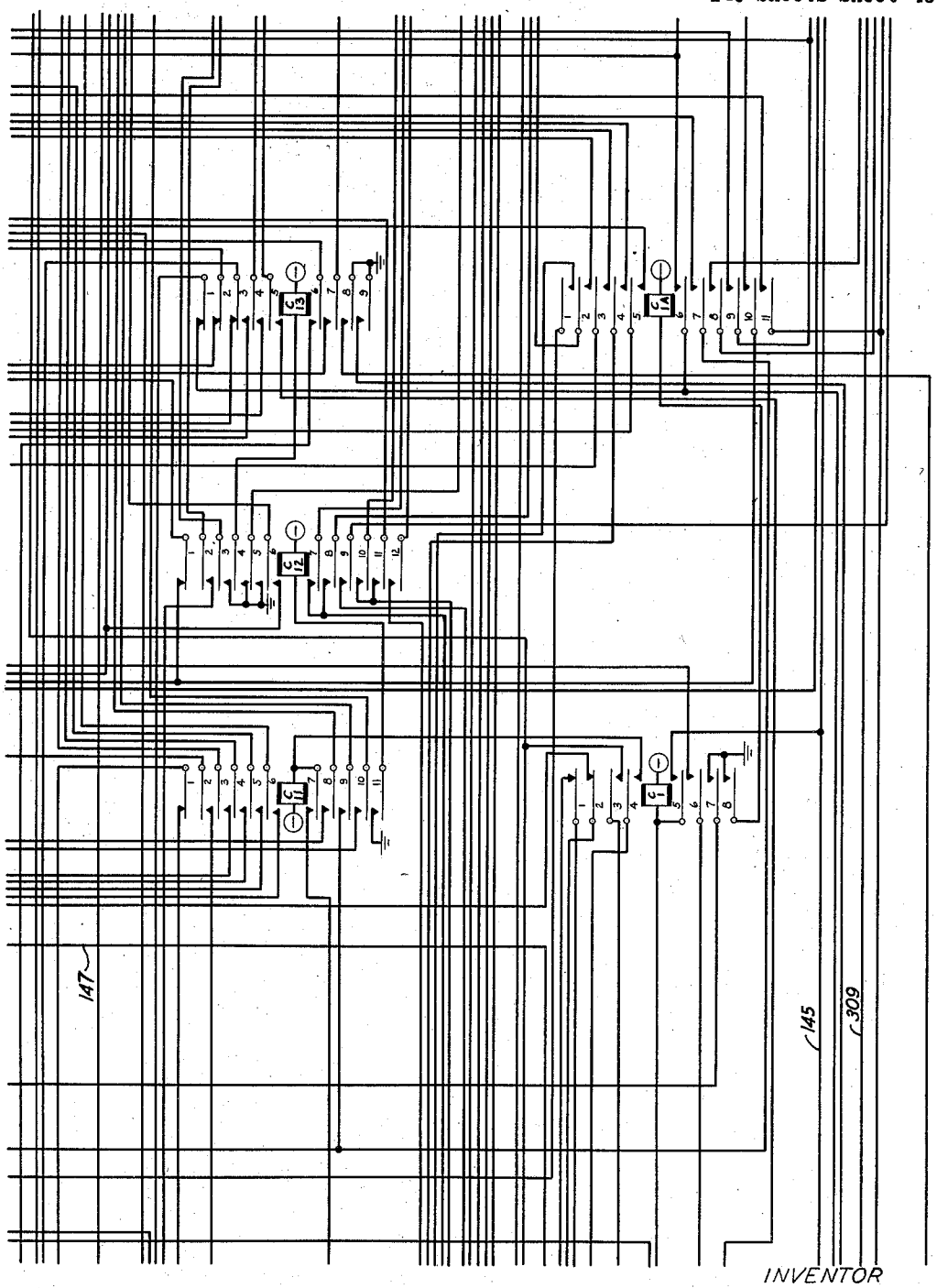


FIG. 46

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 47

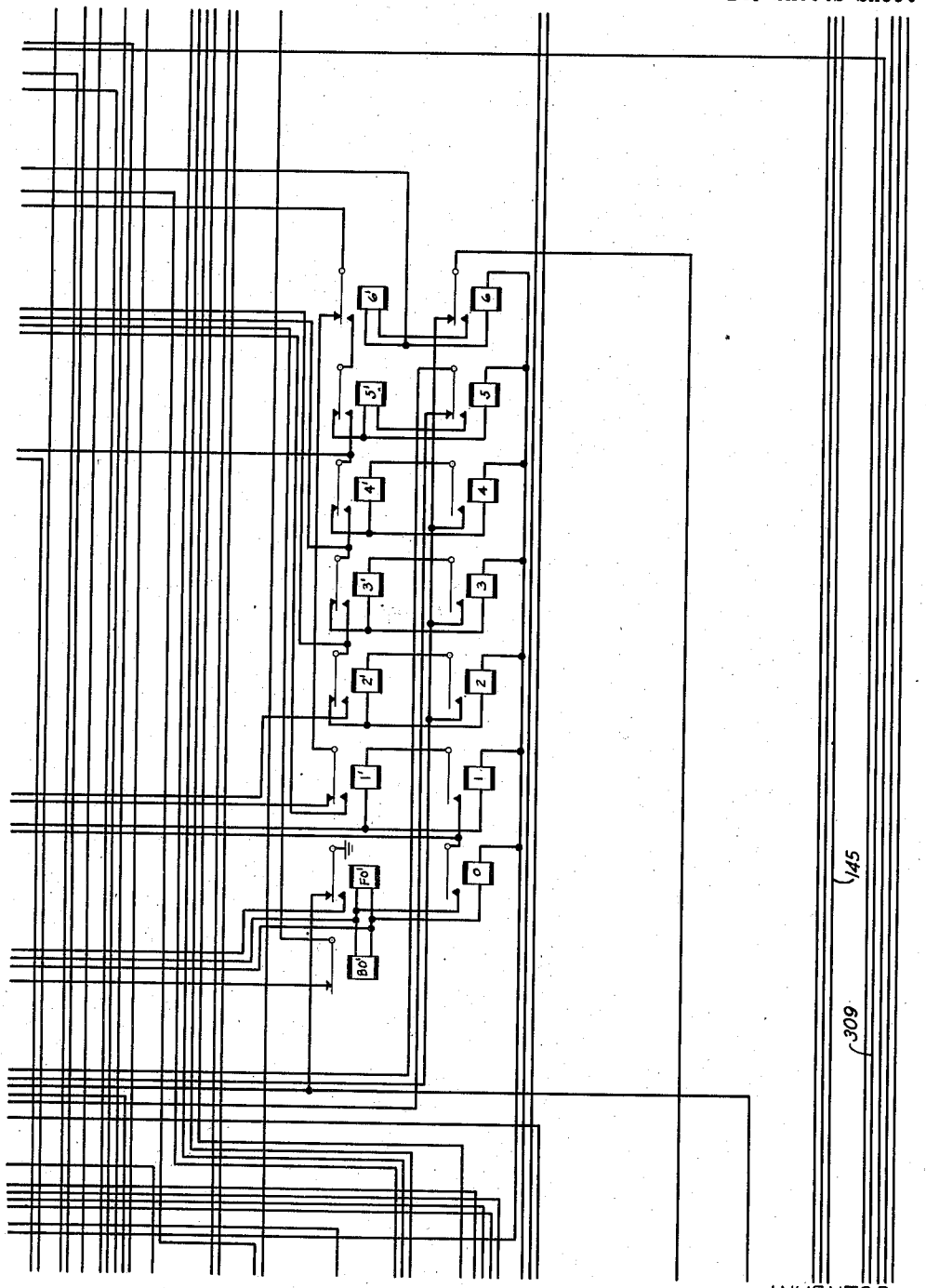


FIG. 47

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 48

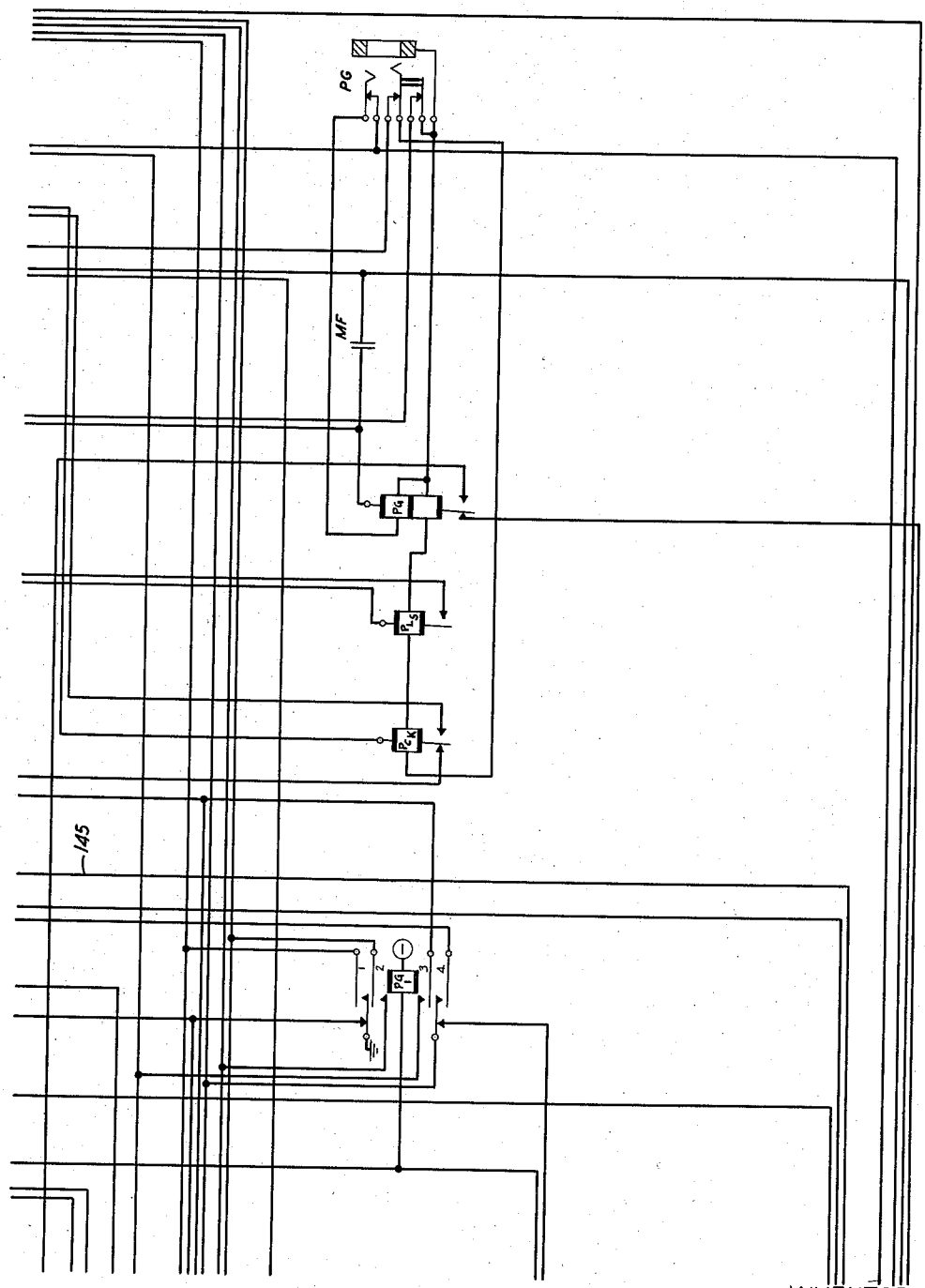


FIG. 48

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 49

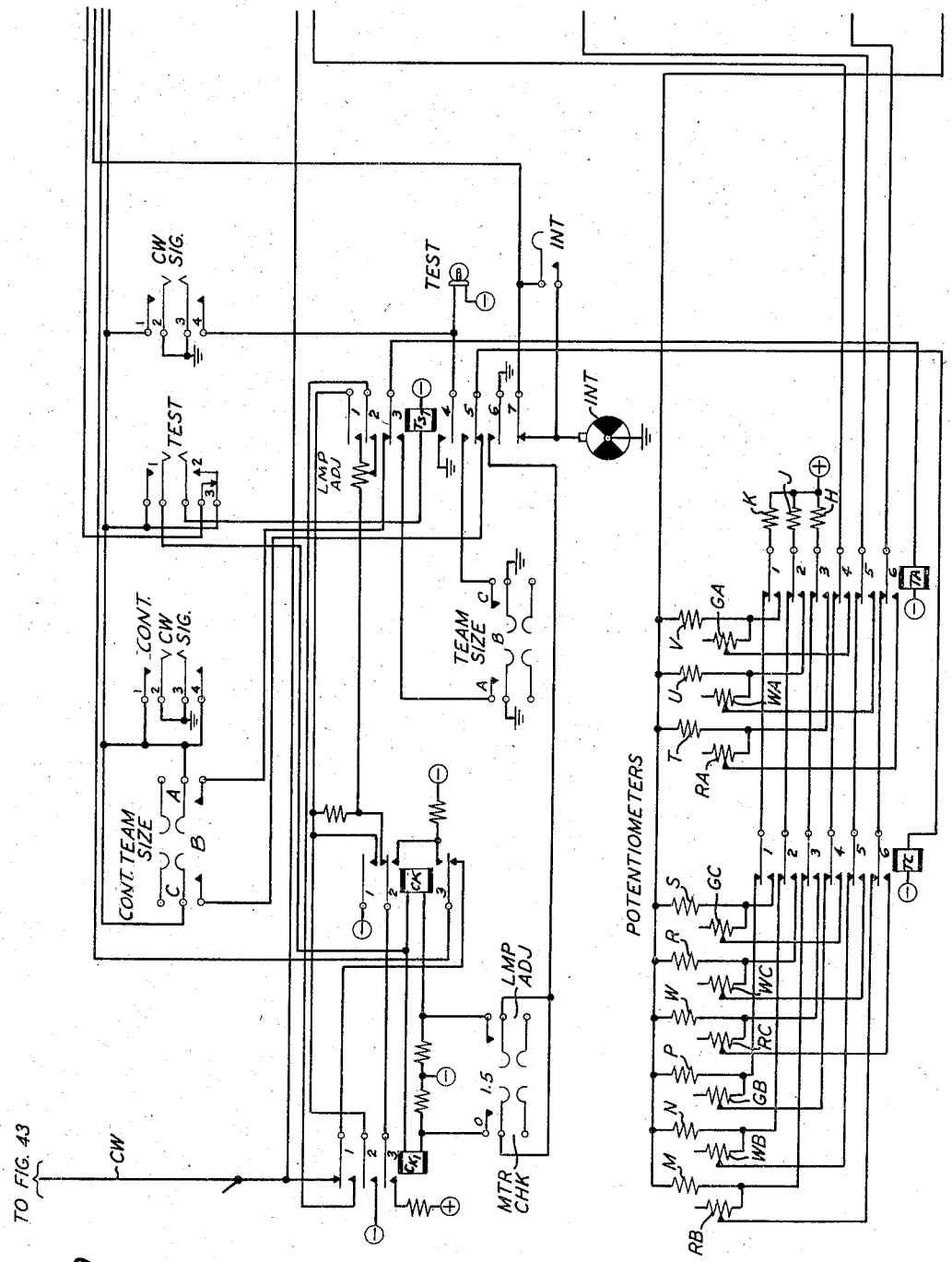


FIG. 49

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 50

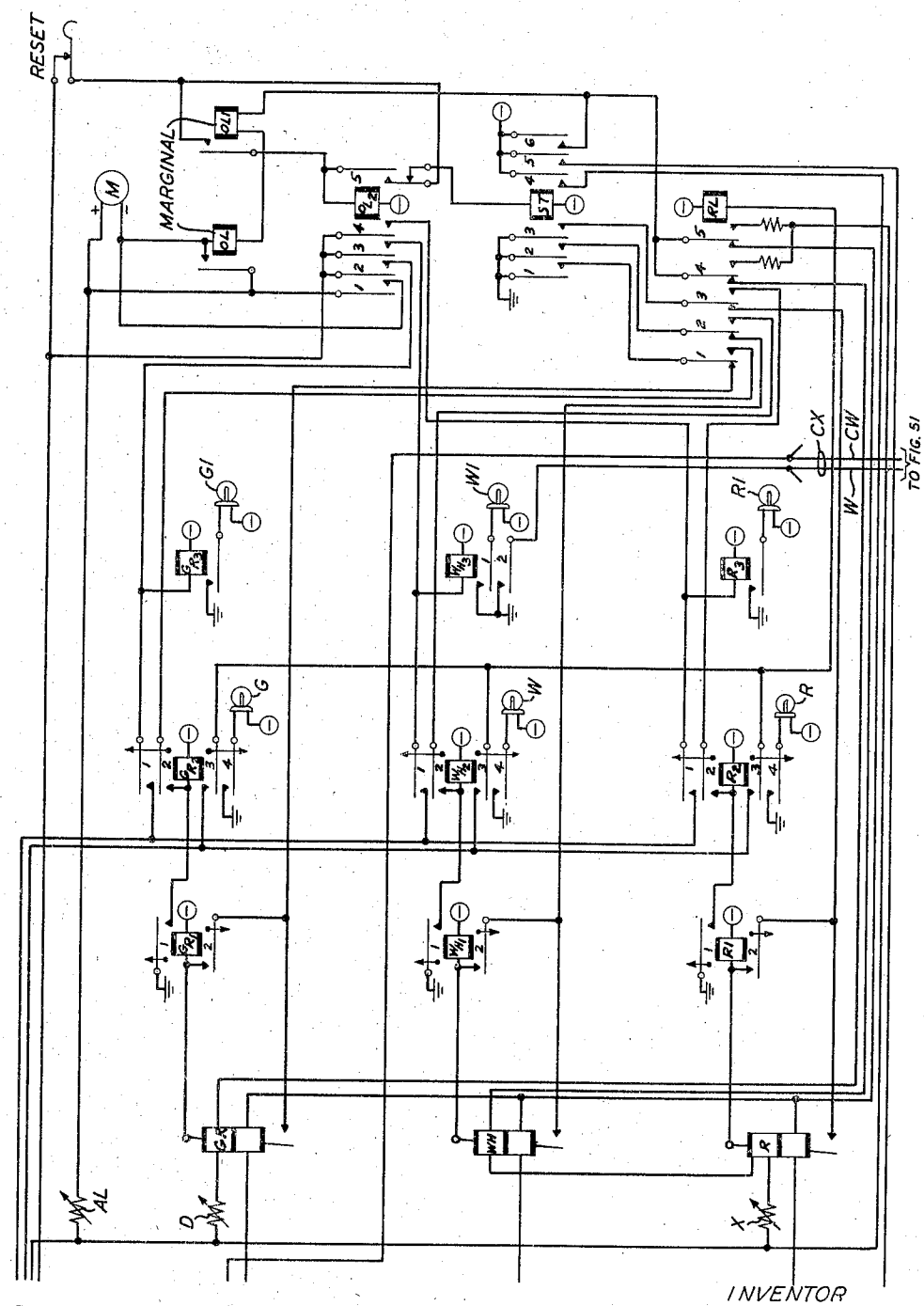


FIG. 50

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 51

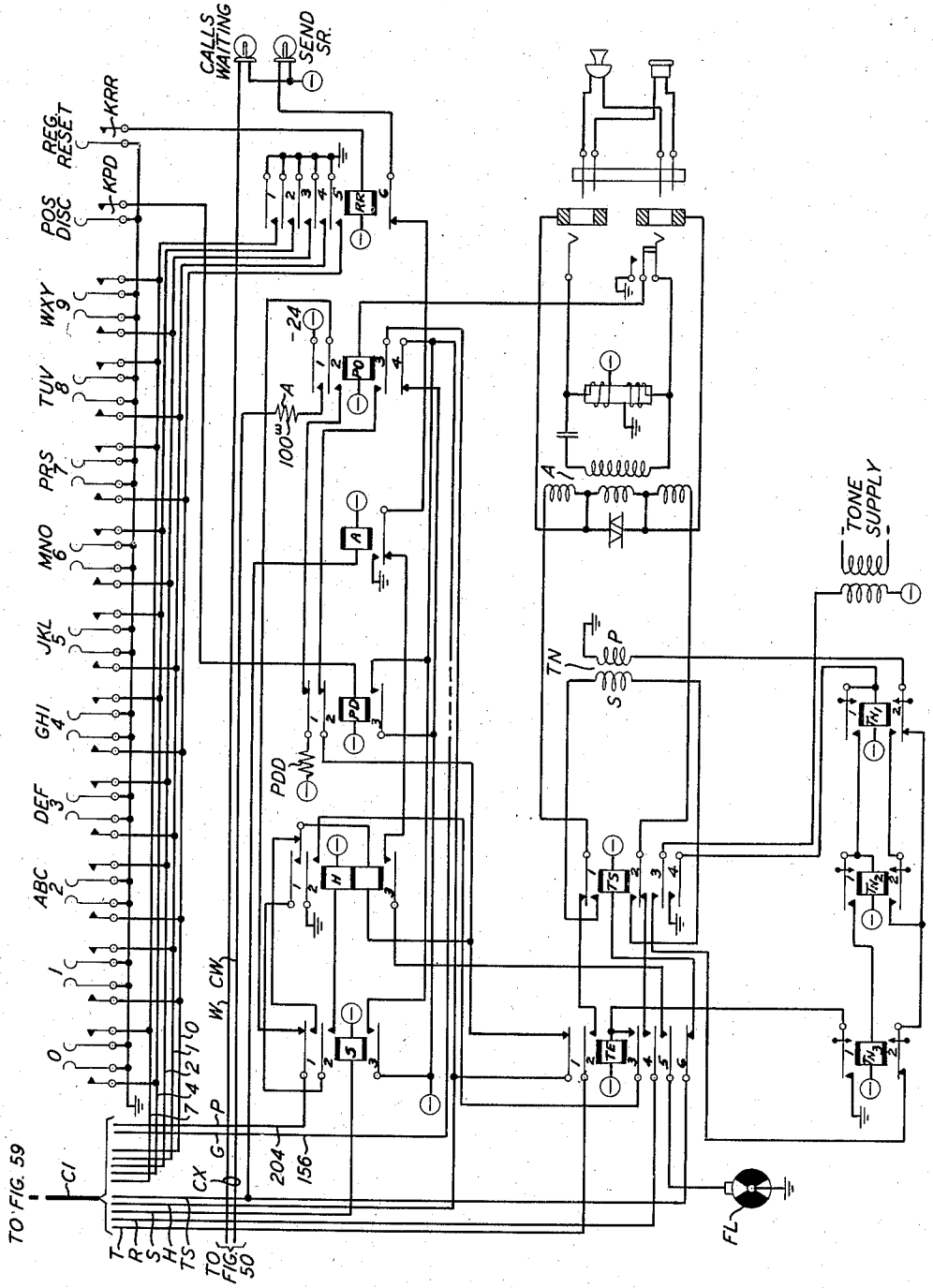


FIG. 51

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 52

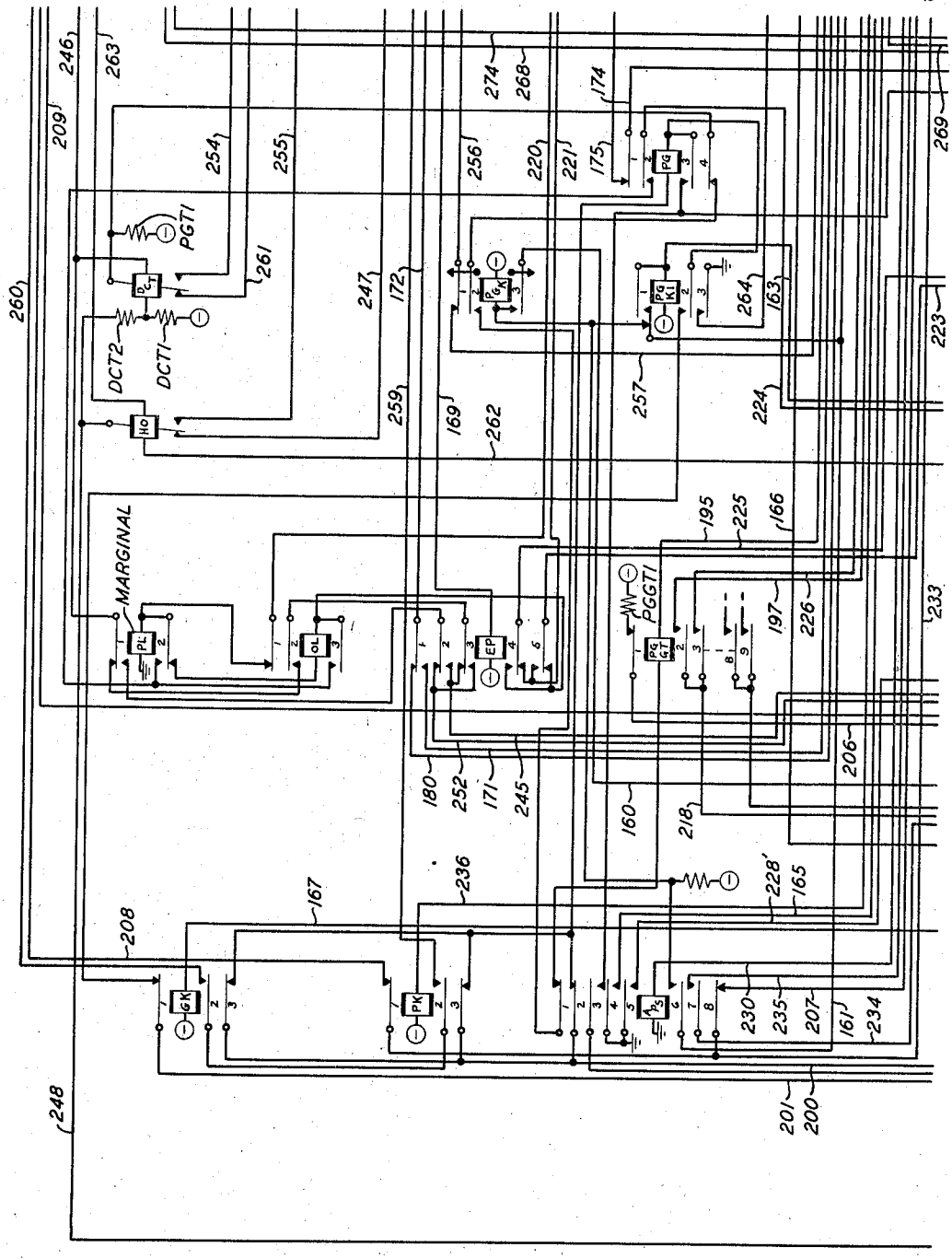


FIG. 52

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 53

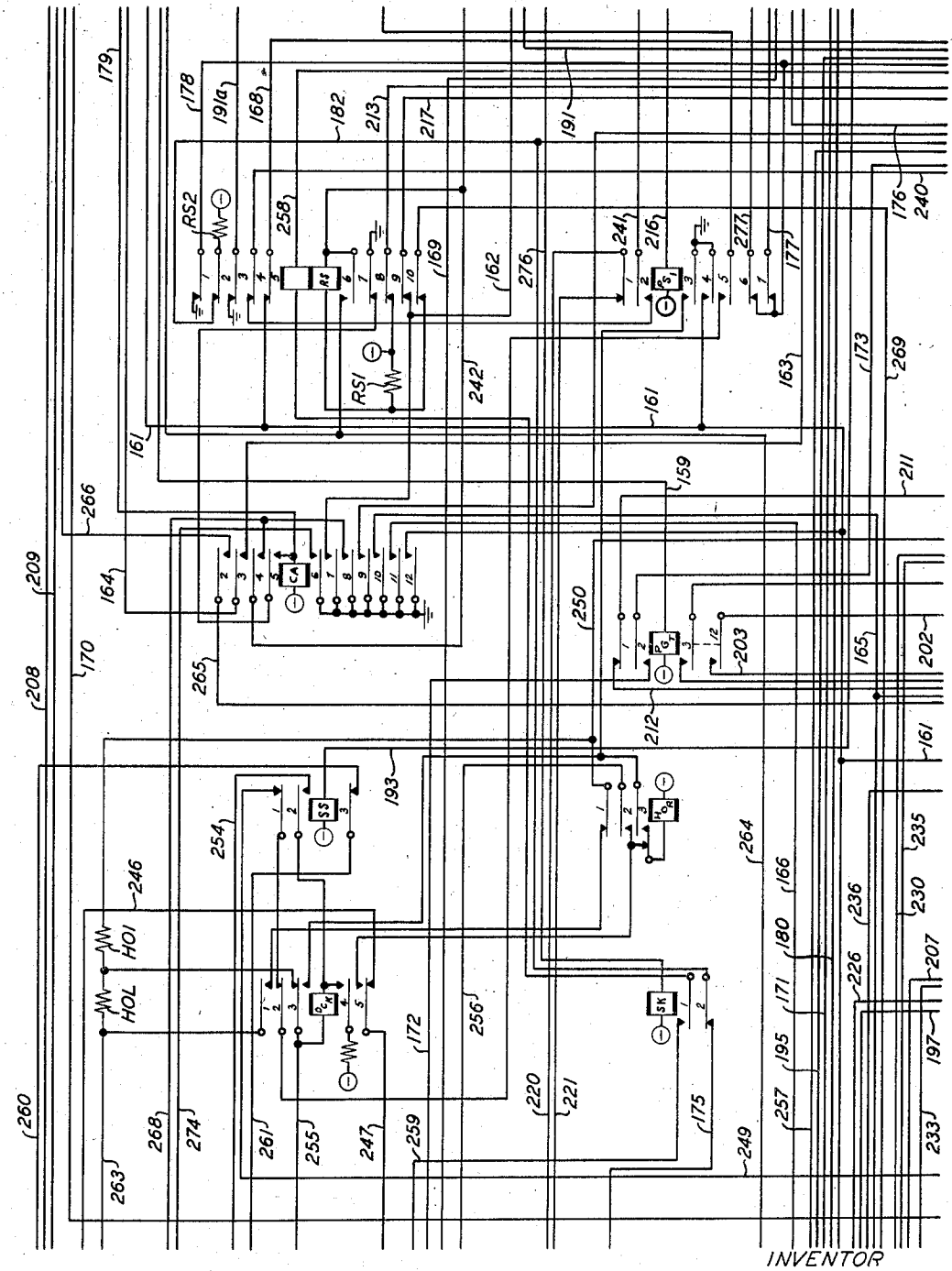


FIG. 53

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 54

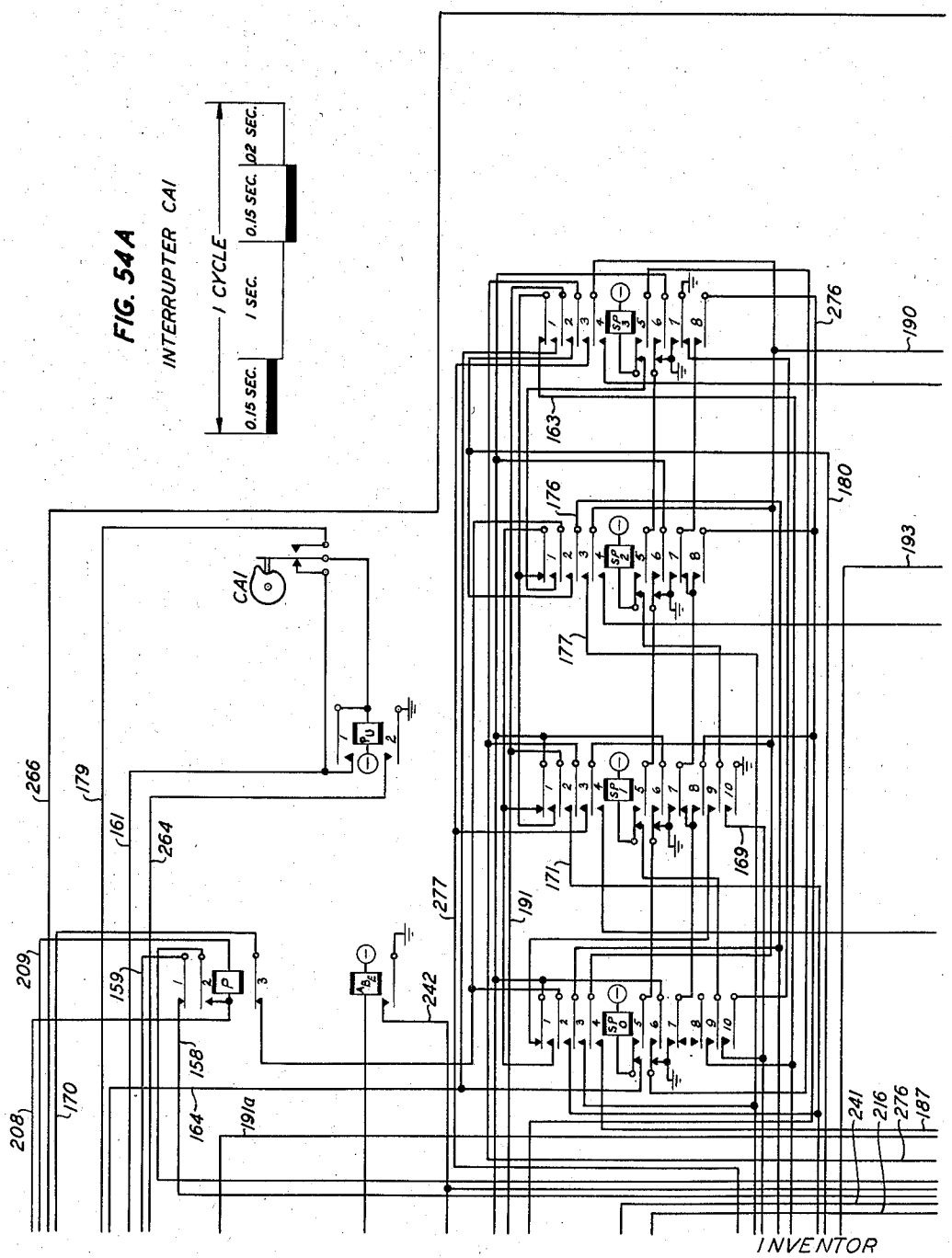


FIG. 54

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 55

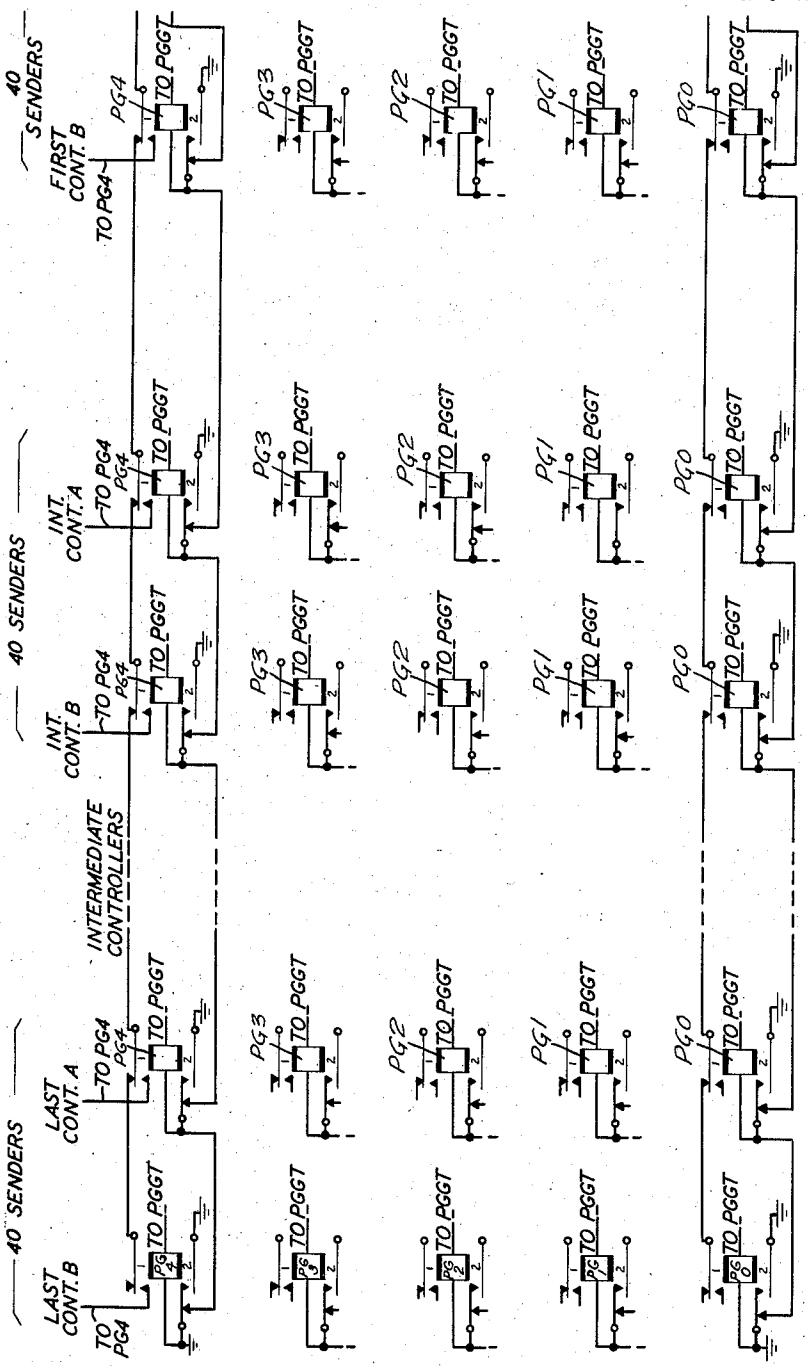


FIG. 55

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 56

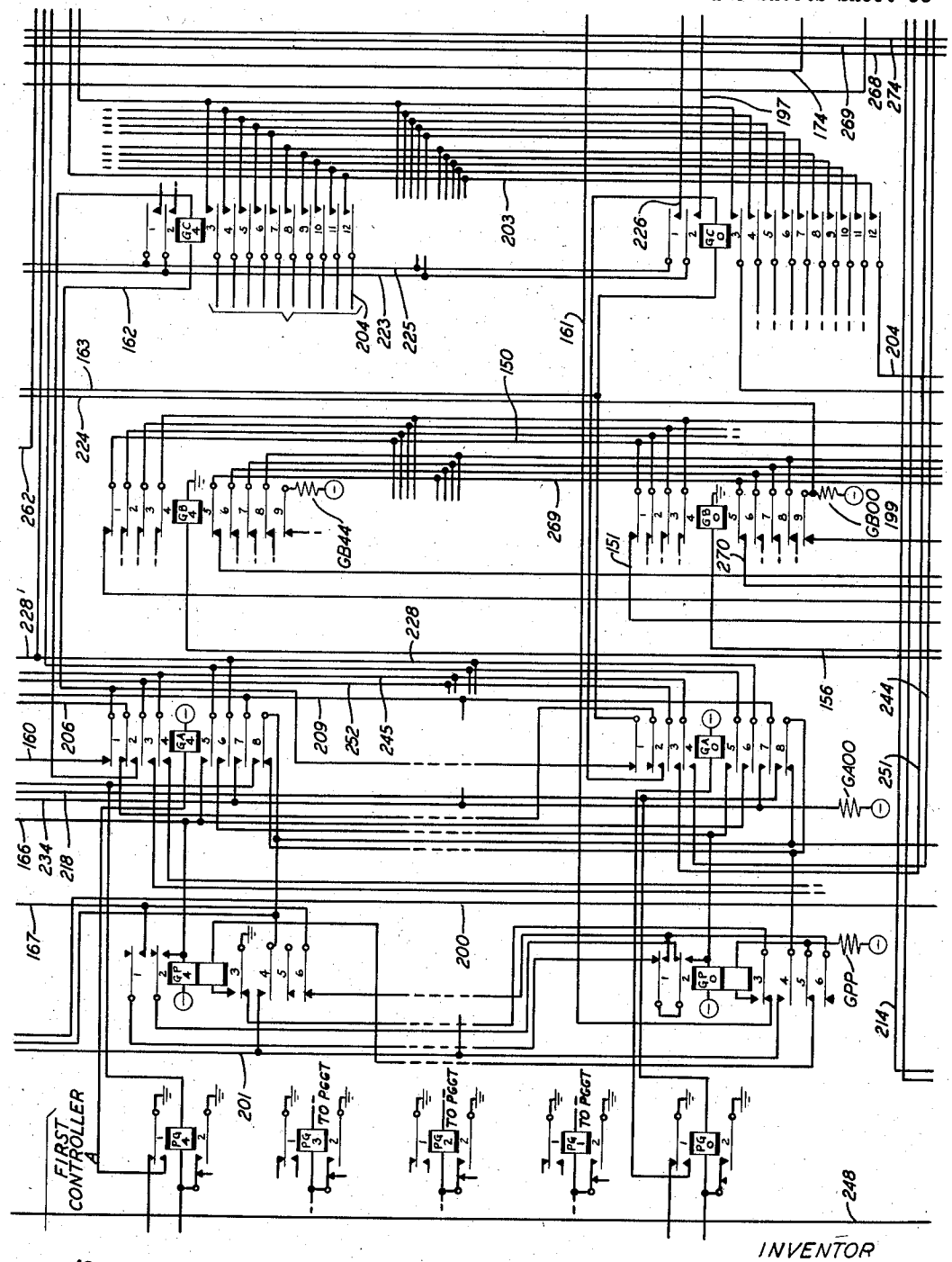


FIG. 56

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 57

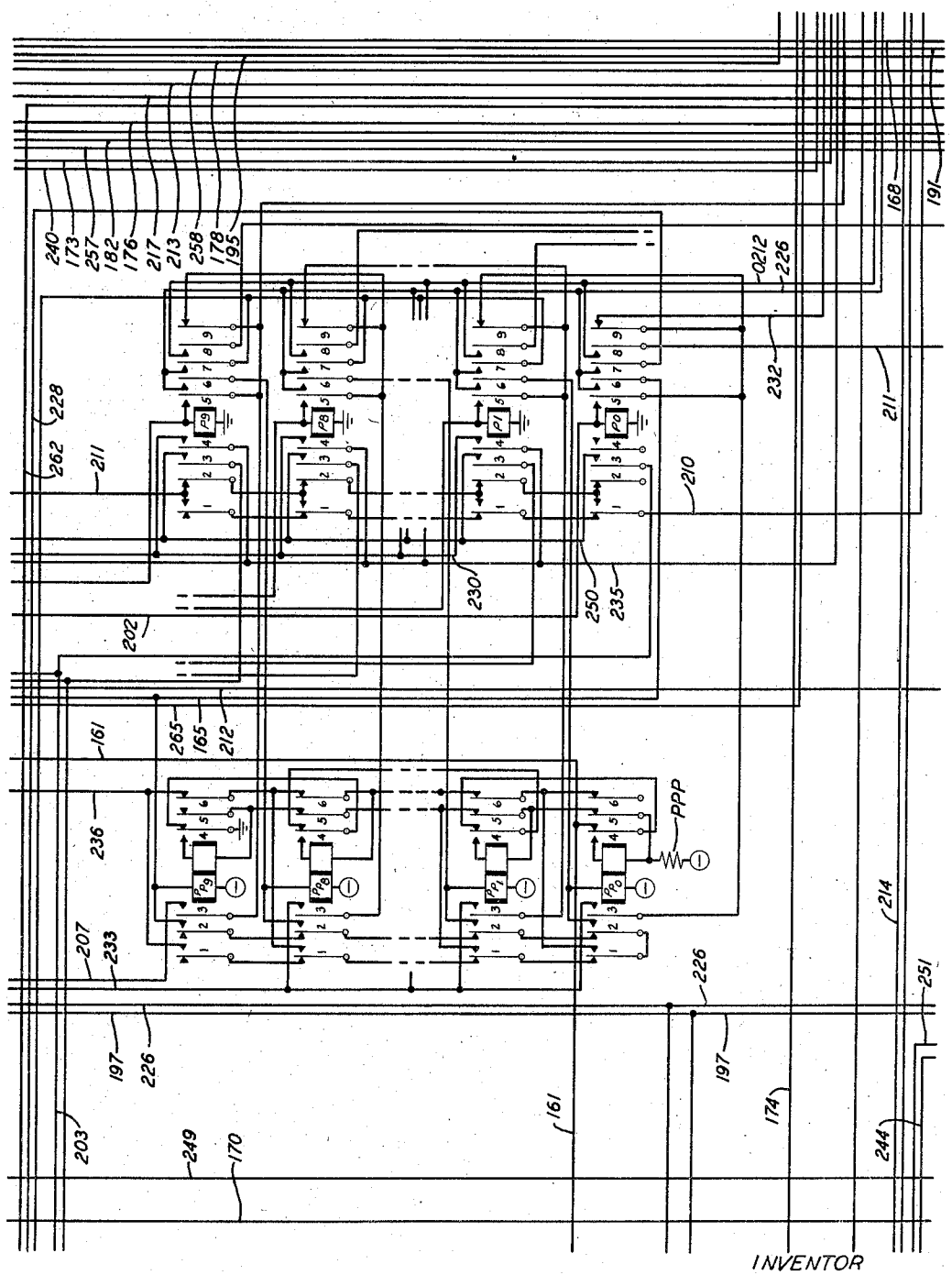


FIG. 57

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 58

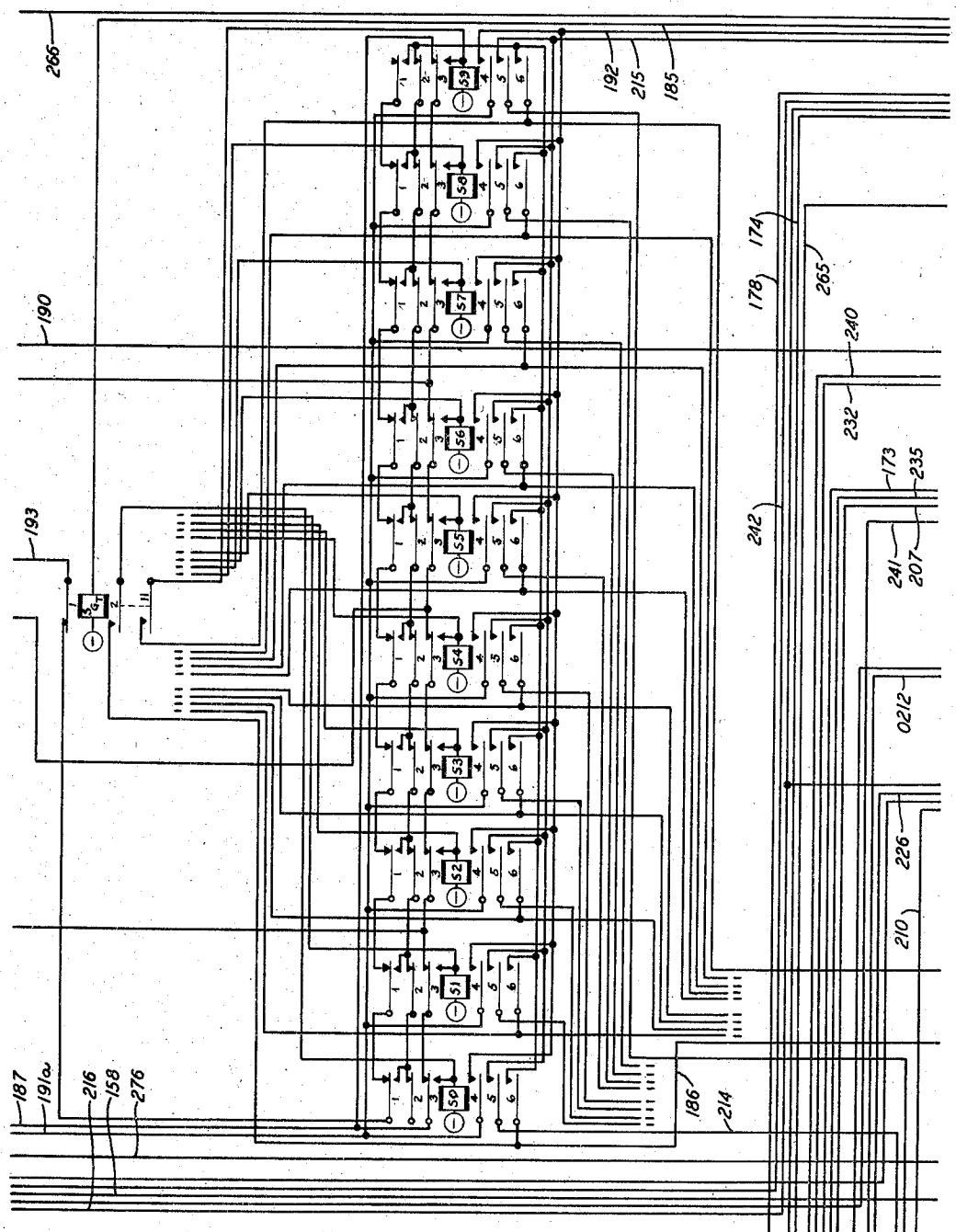


FIG. 58

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 59

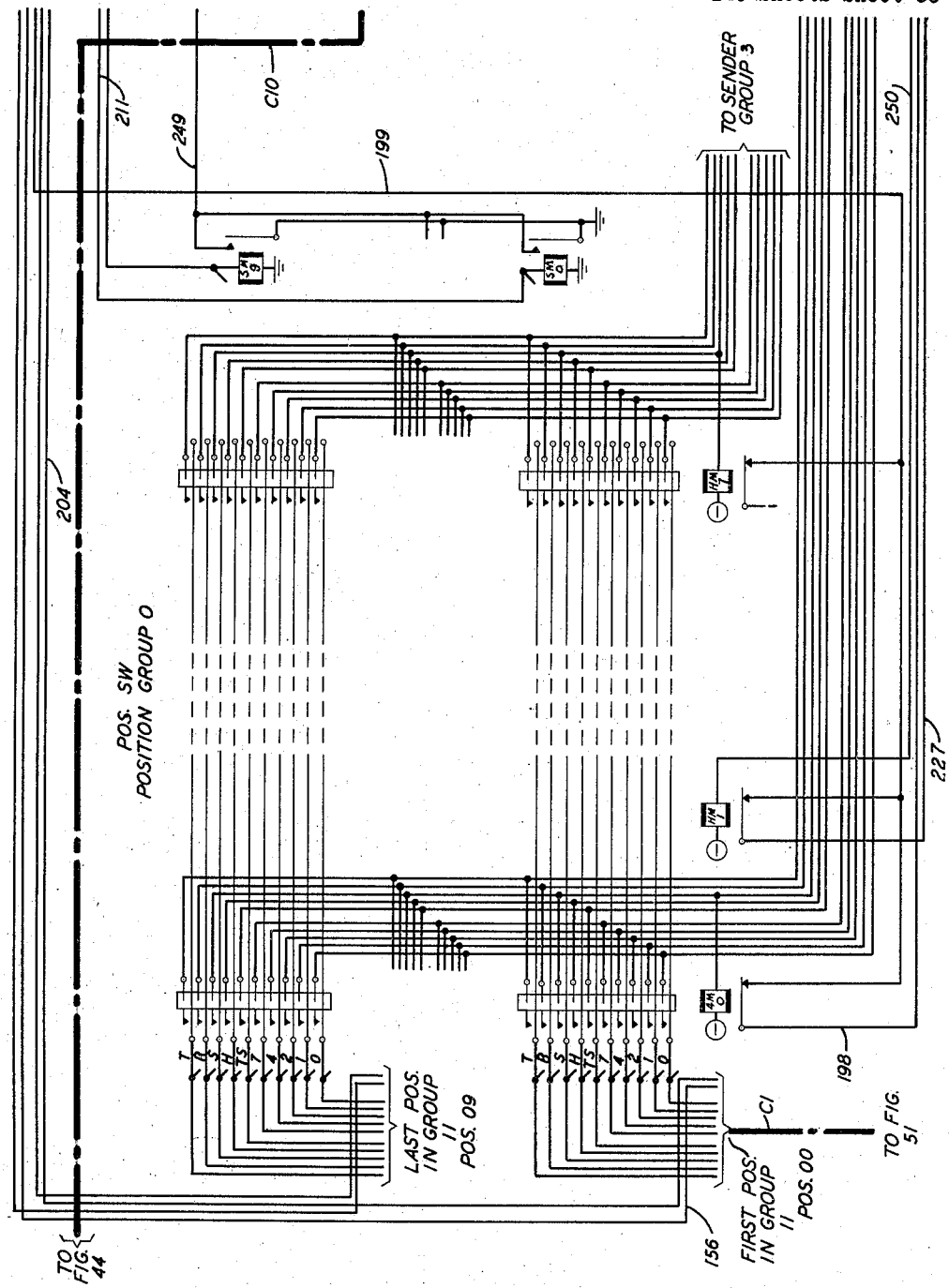


FIG. 59

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 60

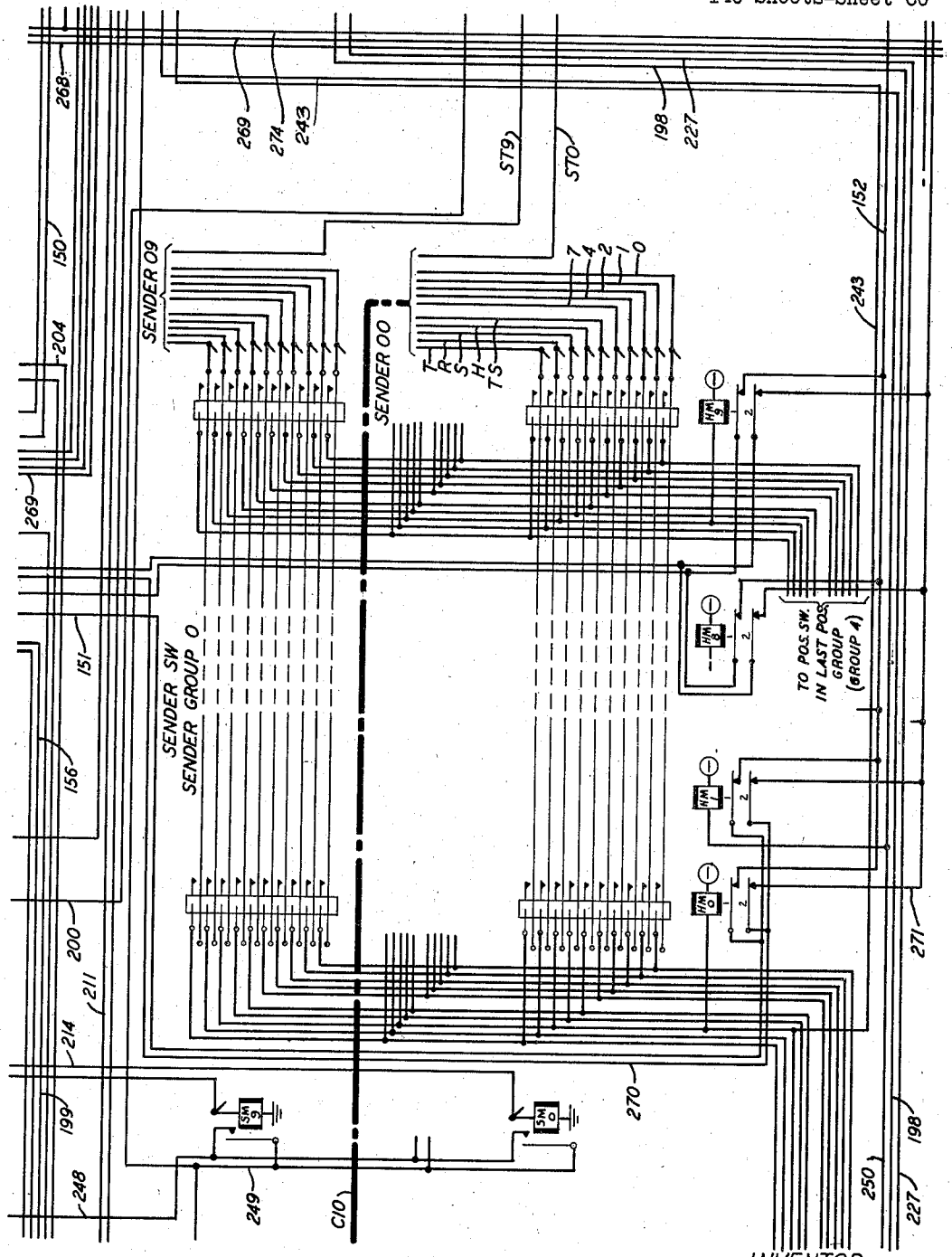


FIG. 60

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 61

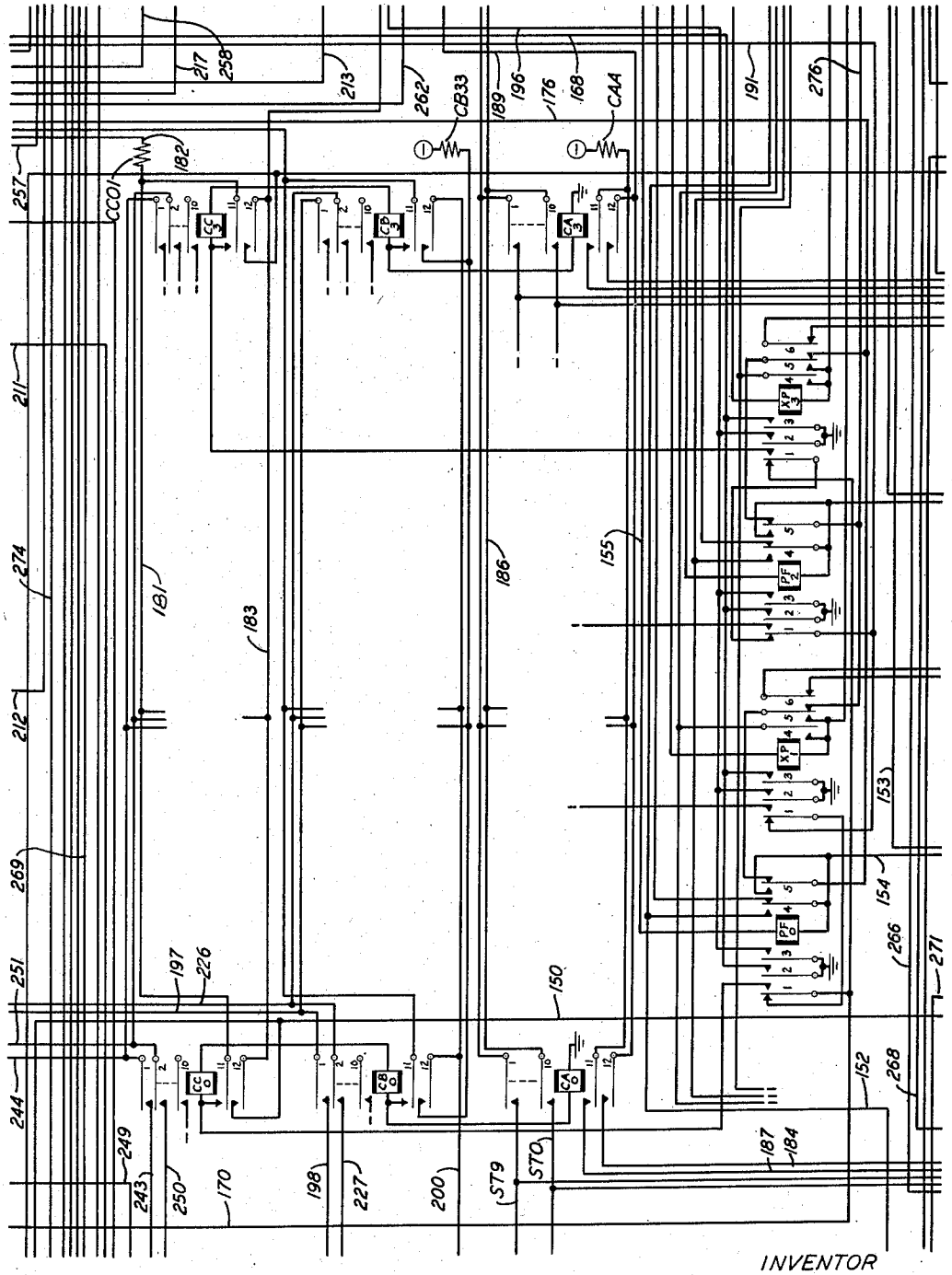


FIG. 61

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 62

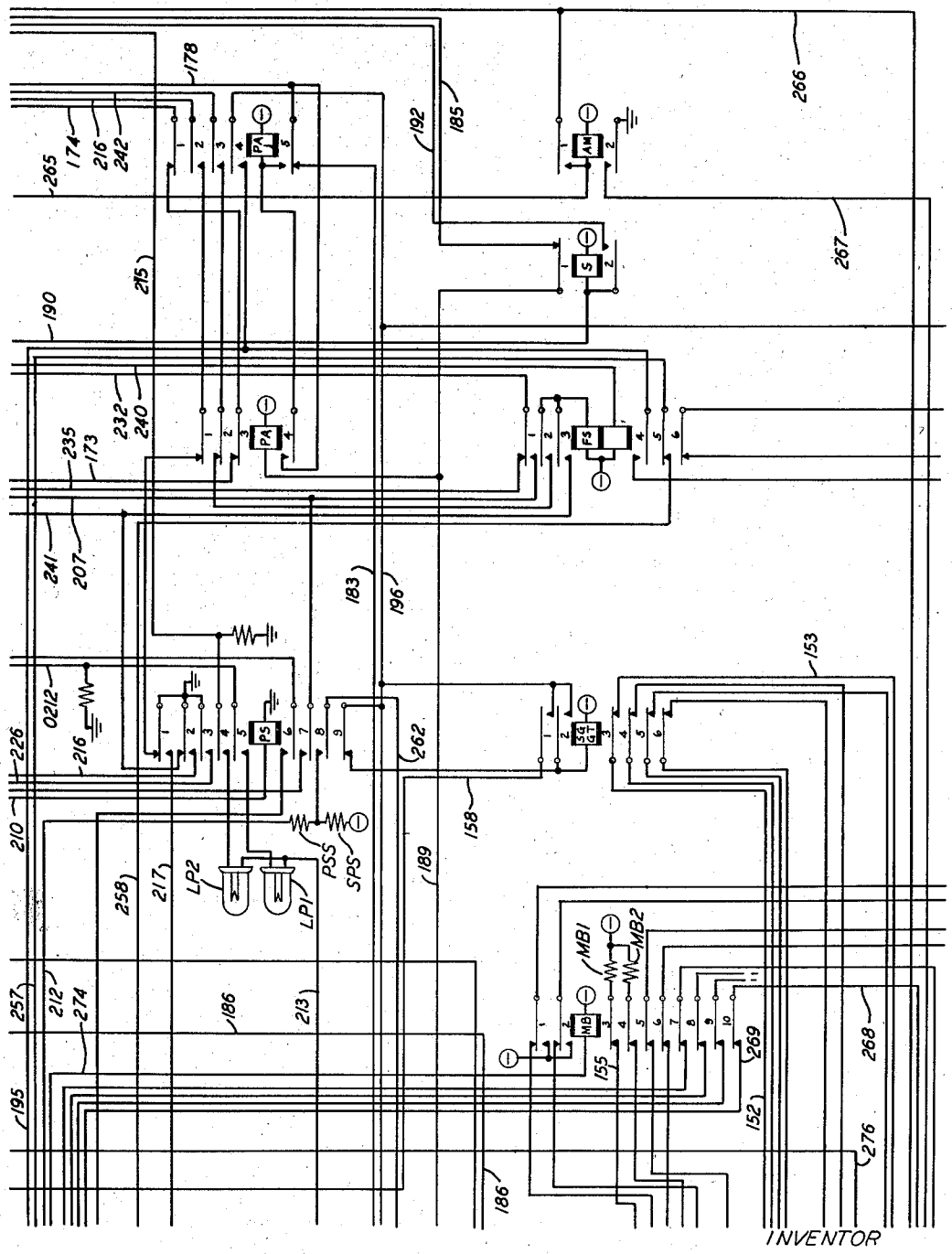


FIG. 62

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 63

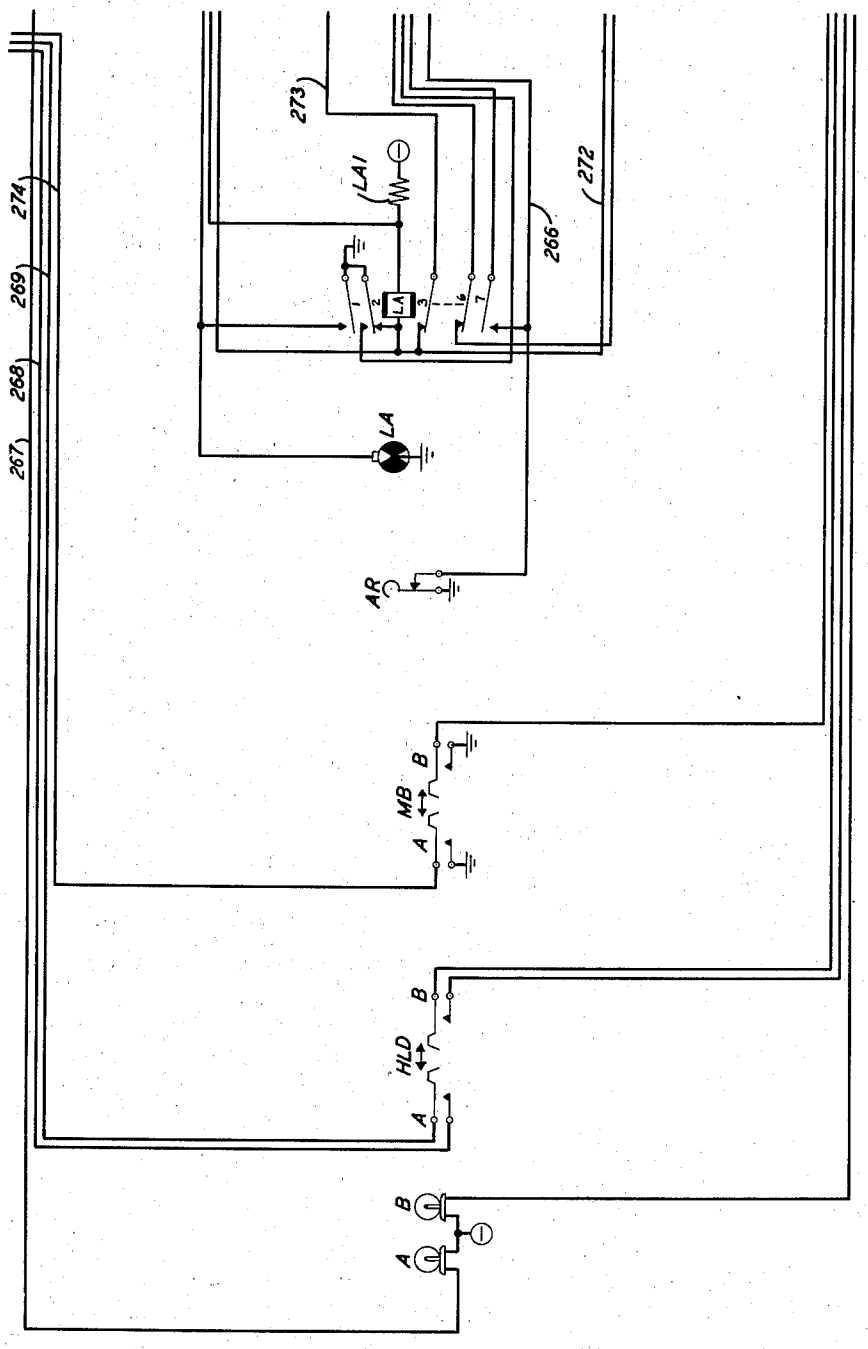


FIG. 63

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954

140 Sheets-Sheet 64

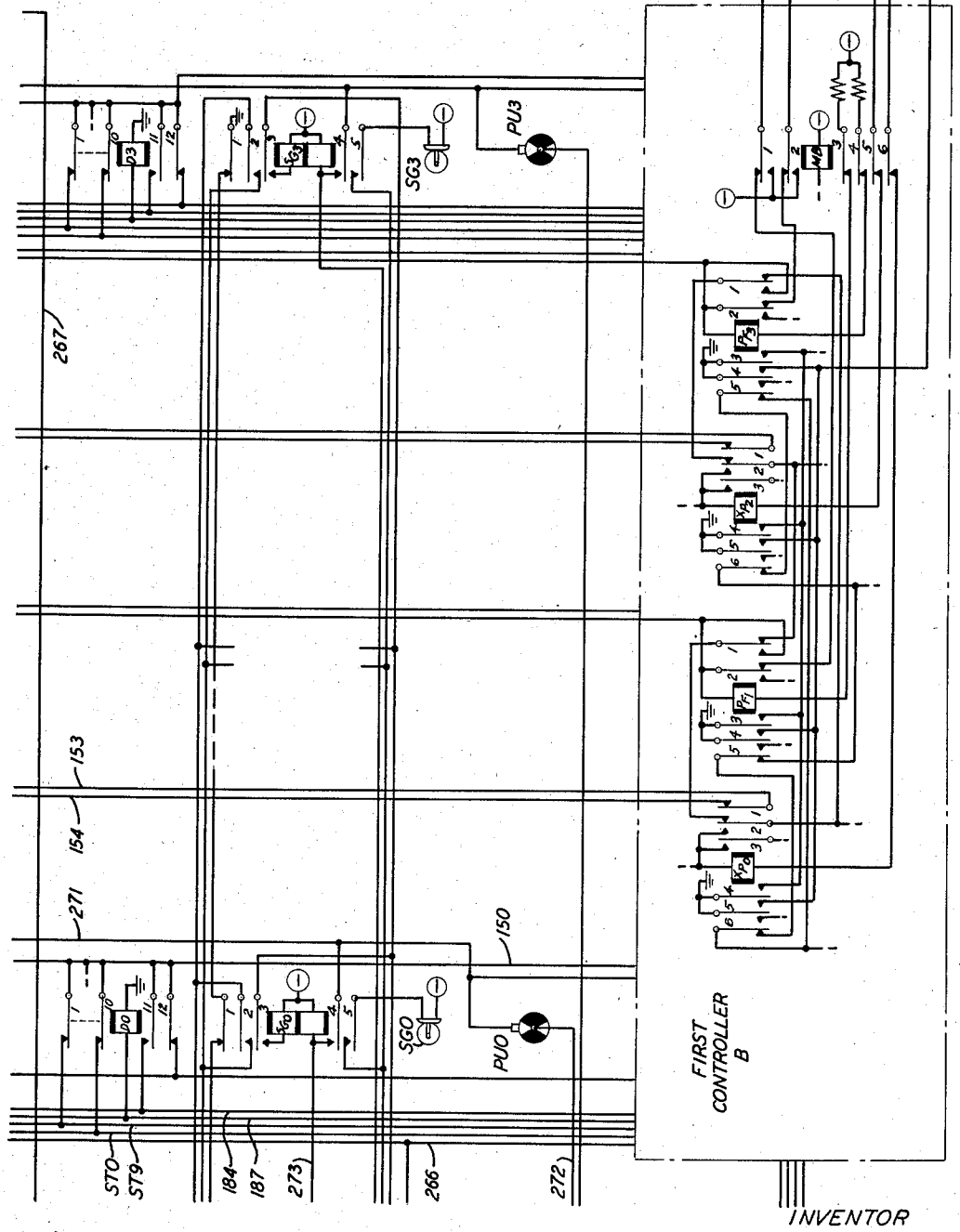


FIG. 64

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 65

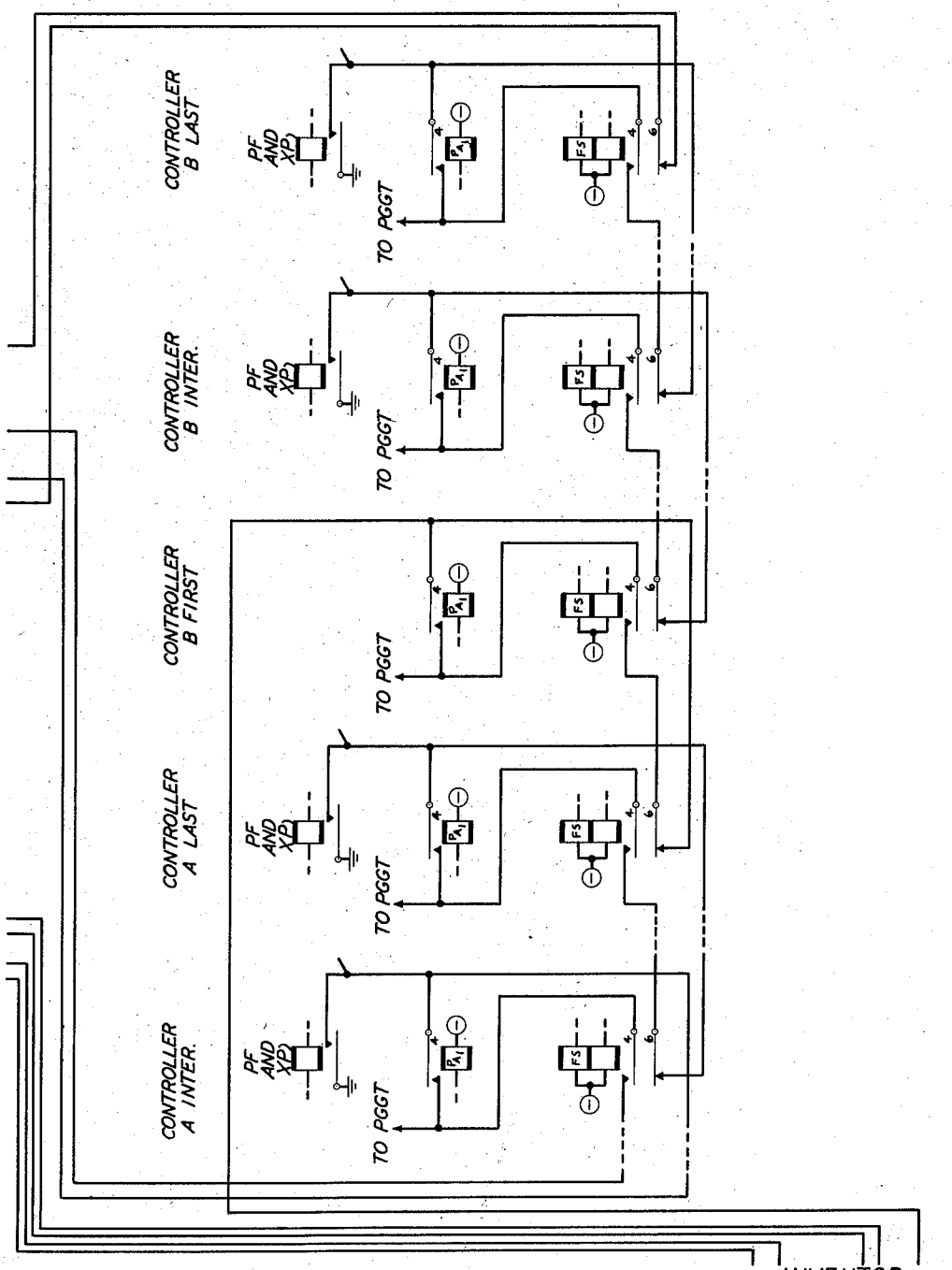


FIG. 65

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 66

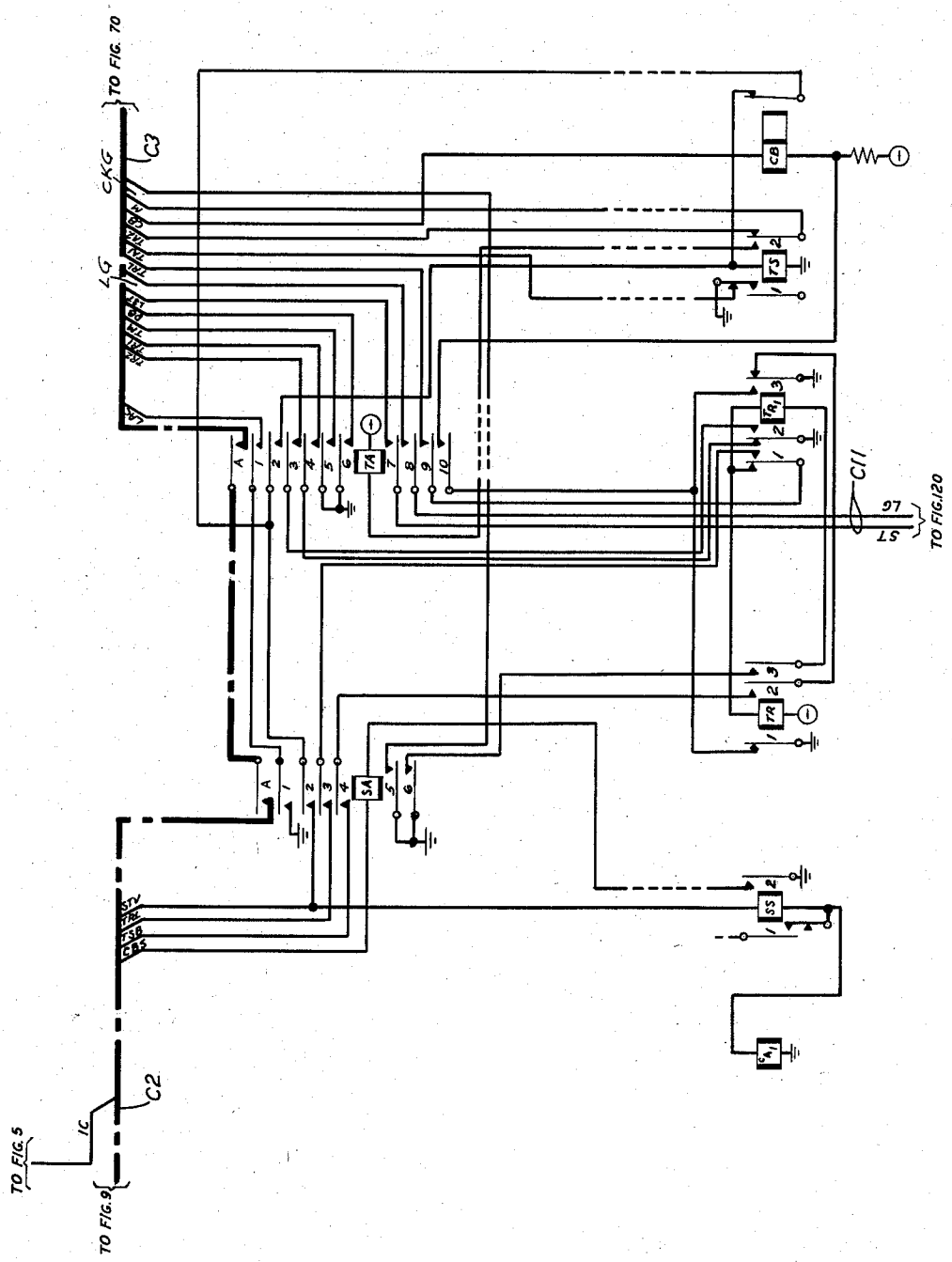


FIG. 66

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 67

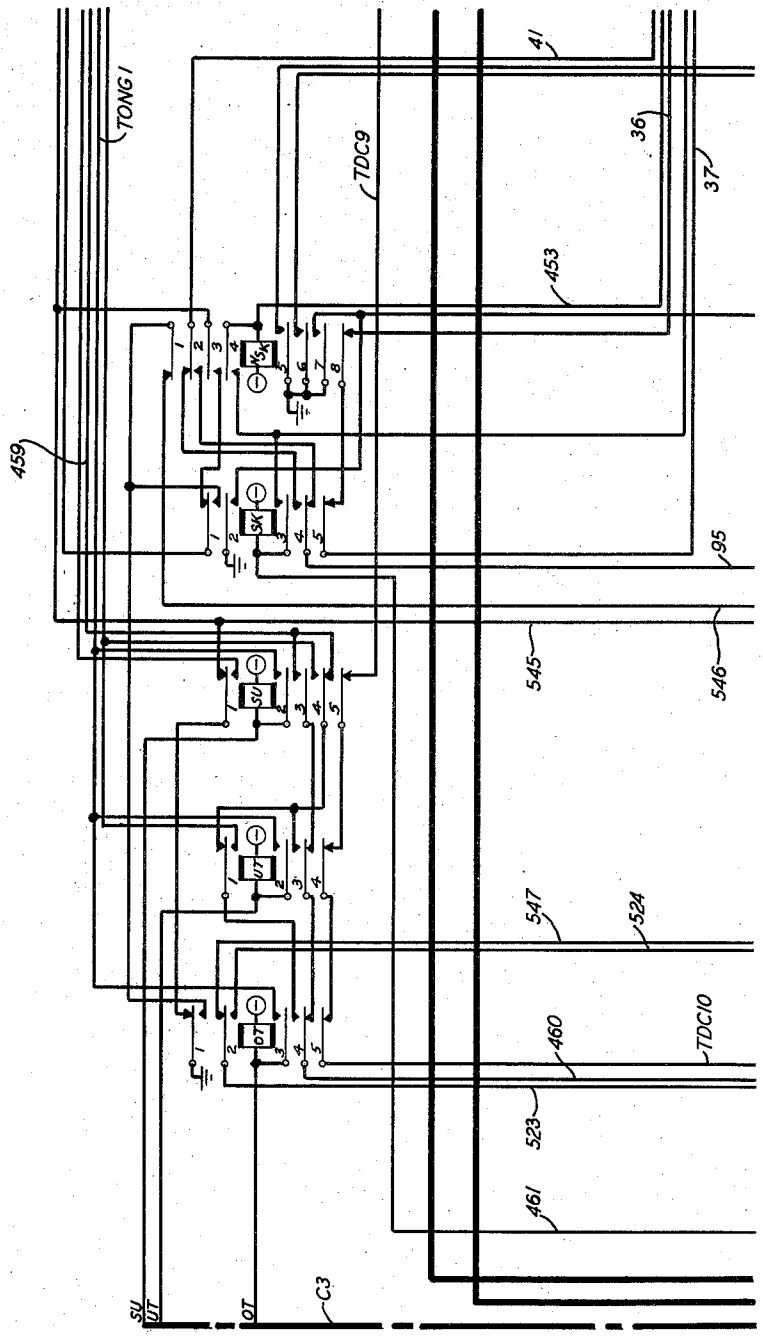


FIG. 67

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 68

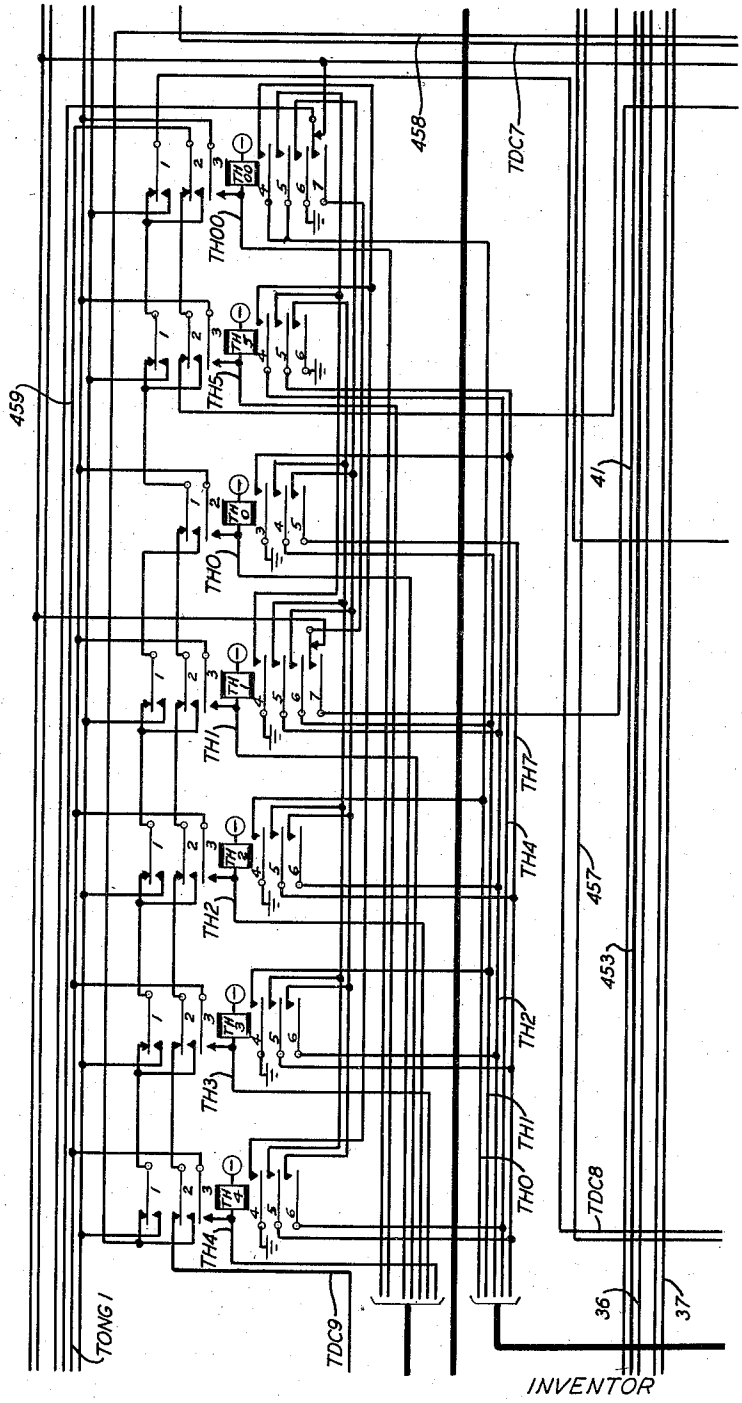


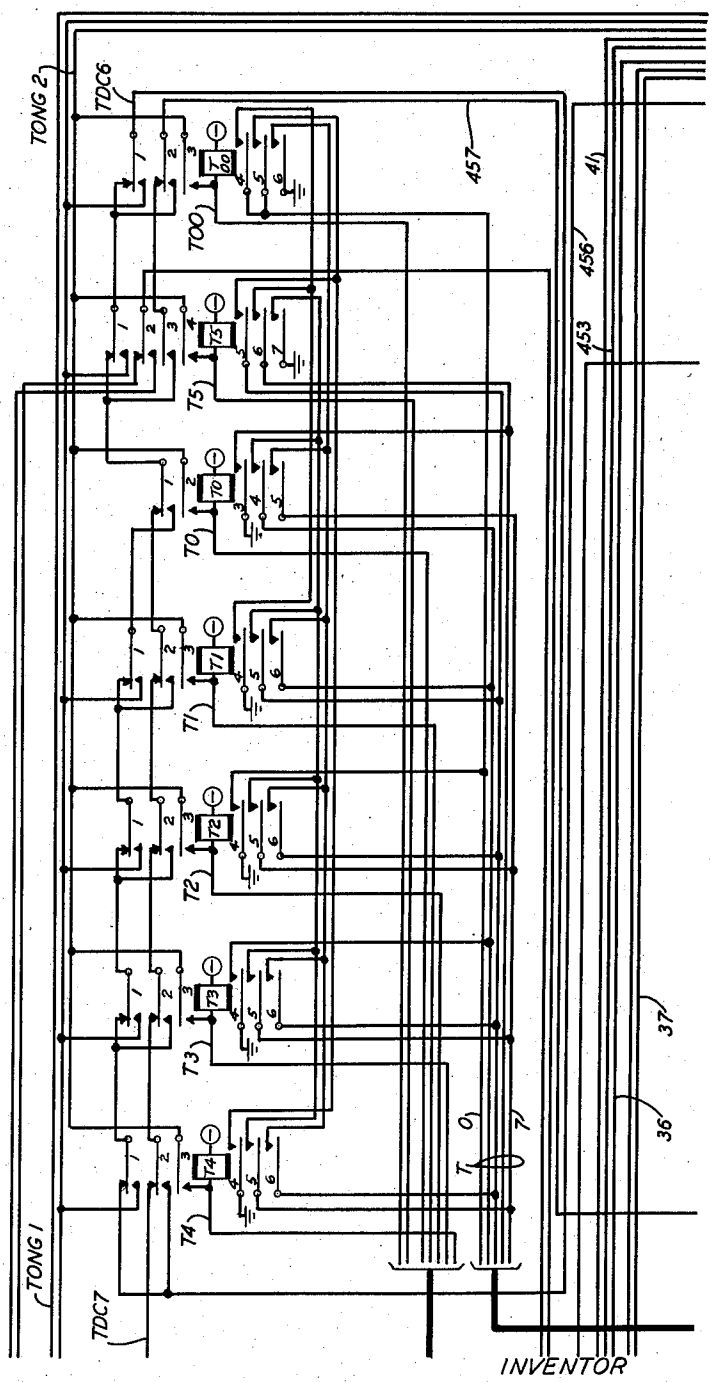
FIG. 68

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 69



CALLED NUMBER REGISTER - TENS (F) DIGIT

FIG. 69

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 70

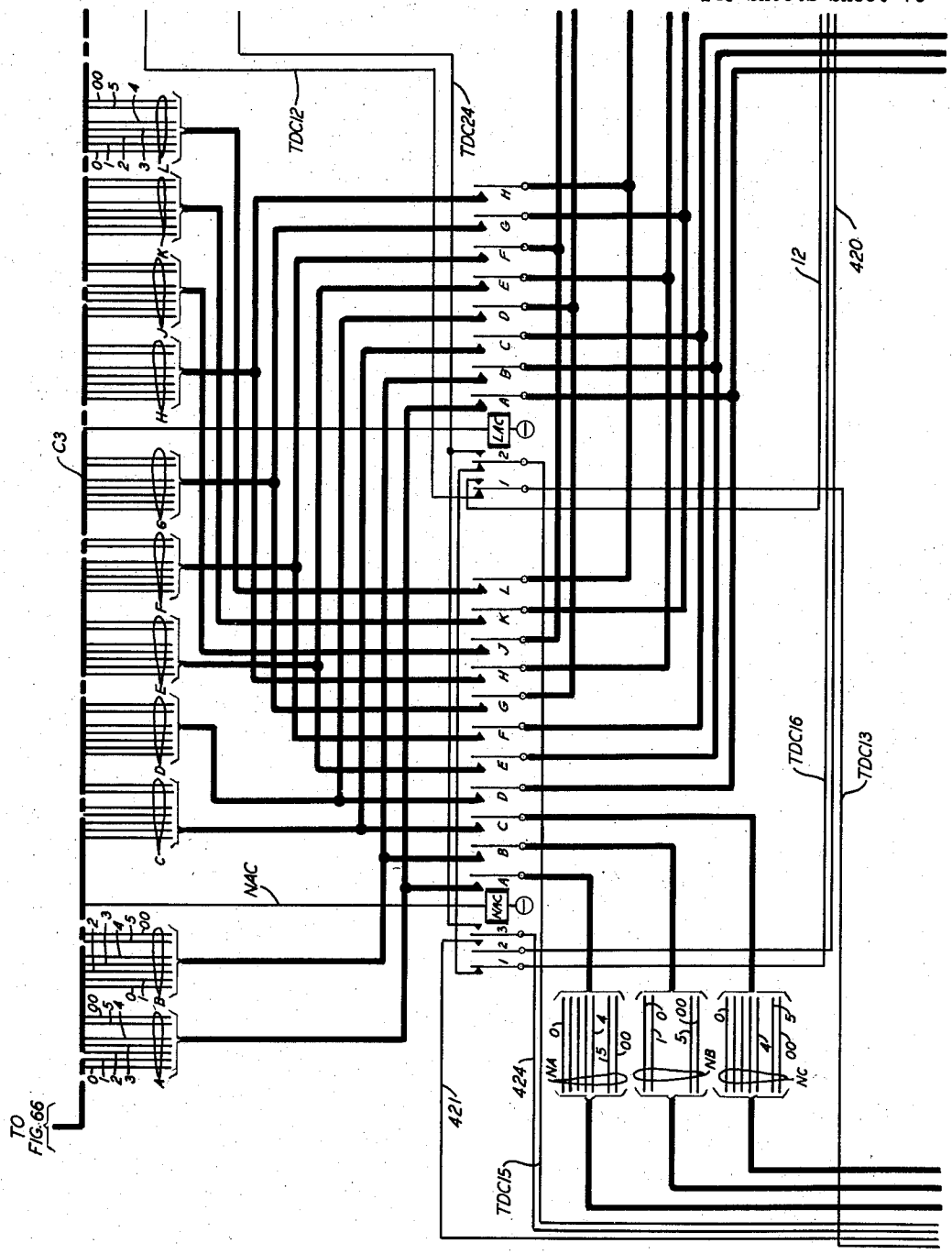


FIG. 70

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 71

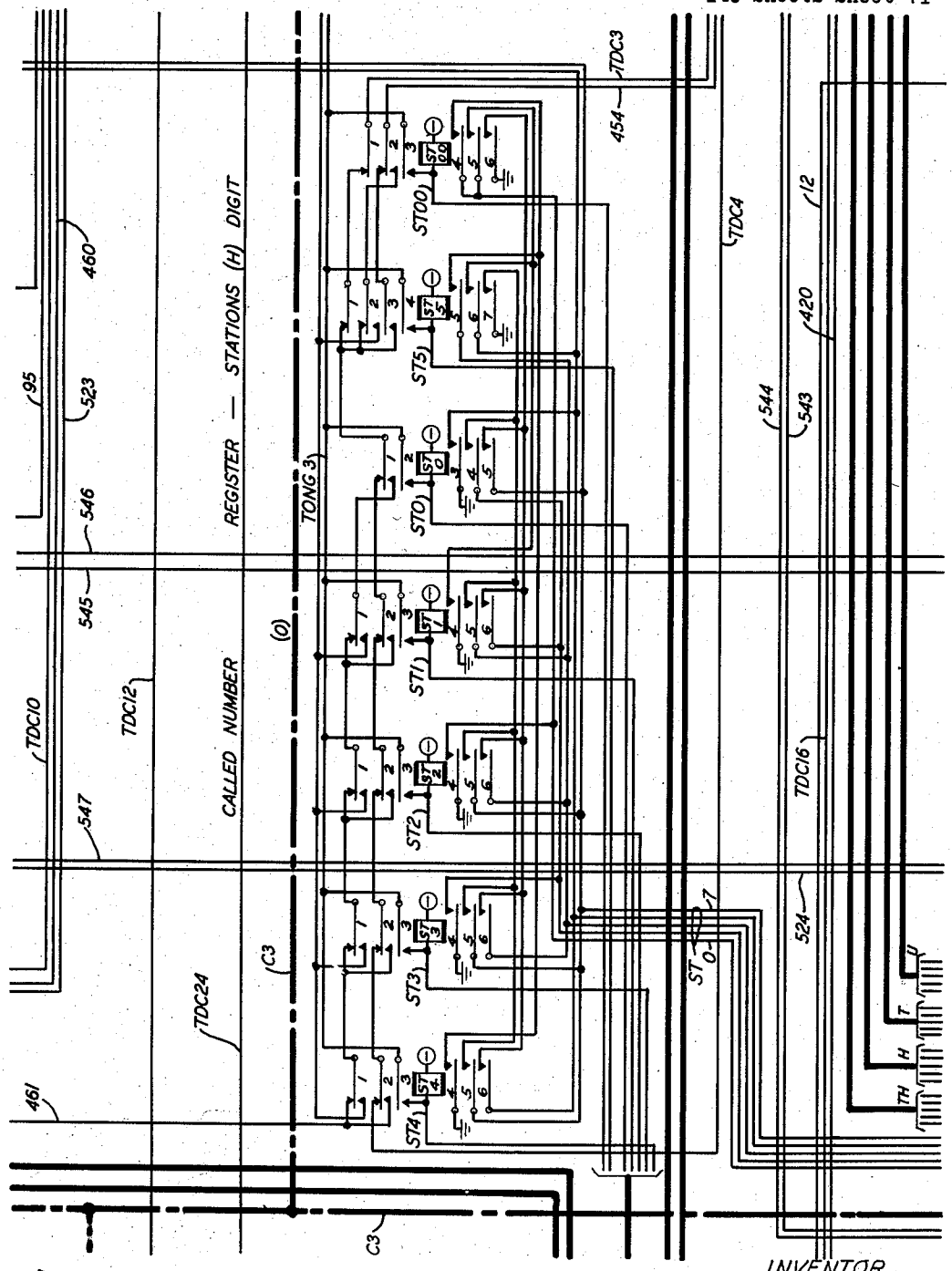


FIG. 71

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 72

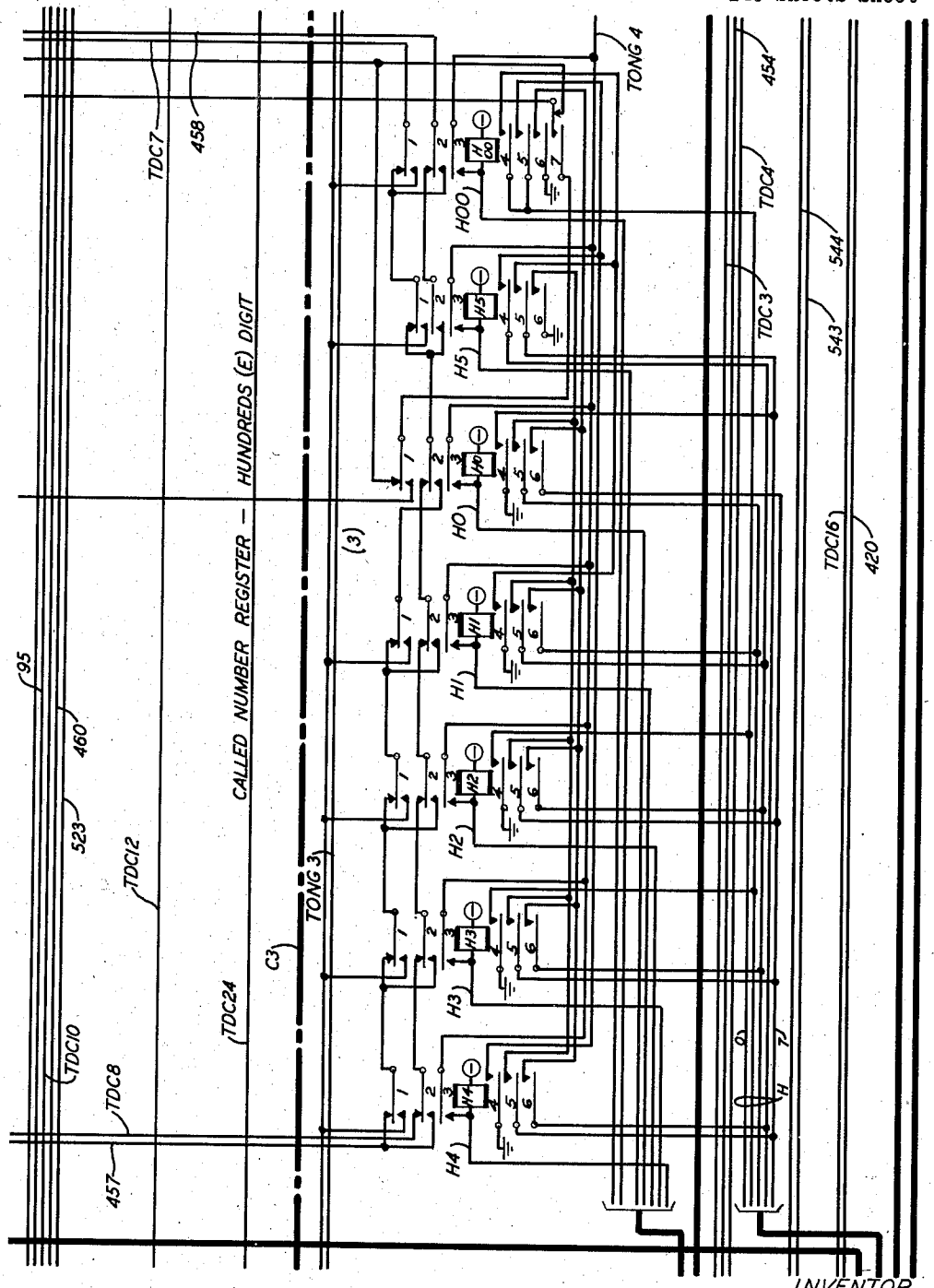


FIG. 72

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 73

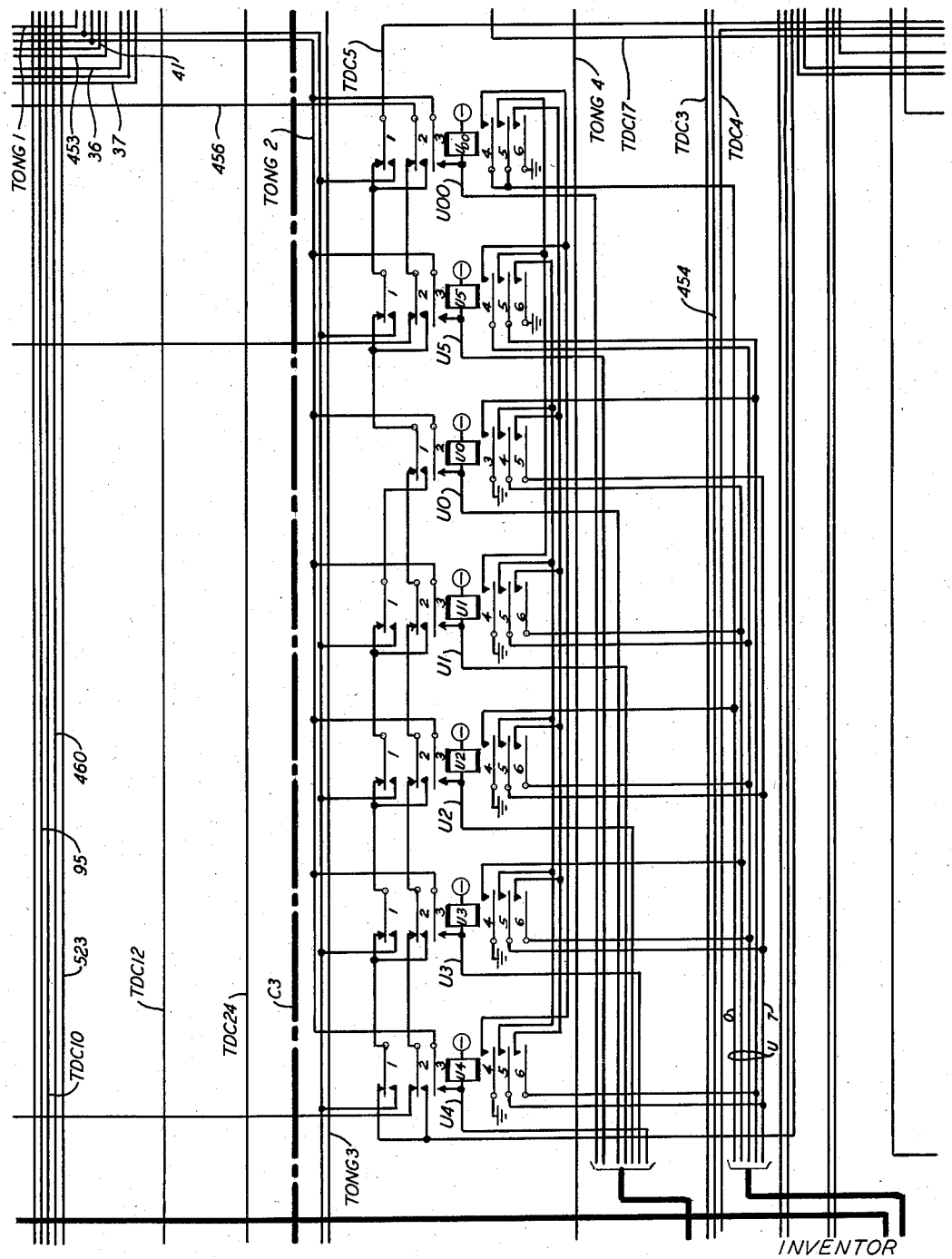


FIG. 73

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 74

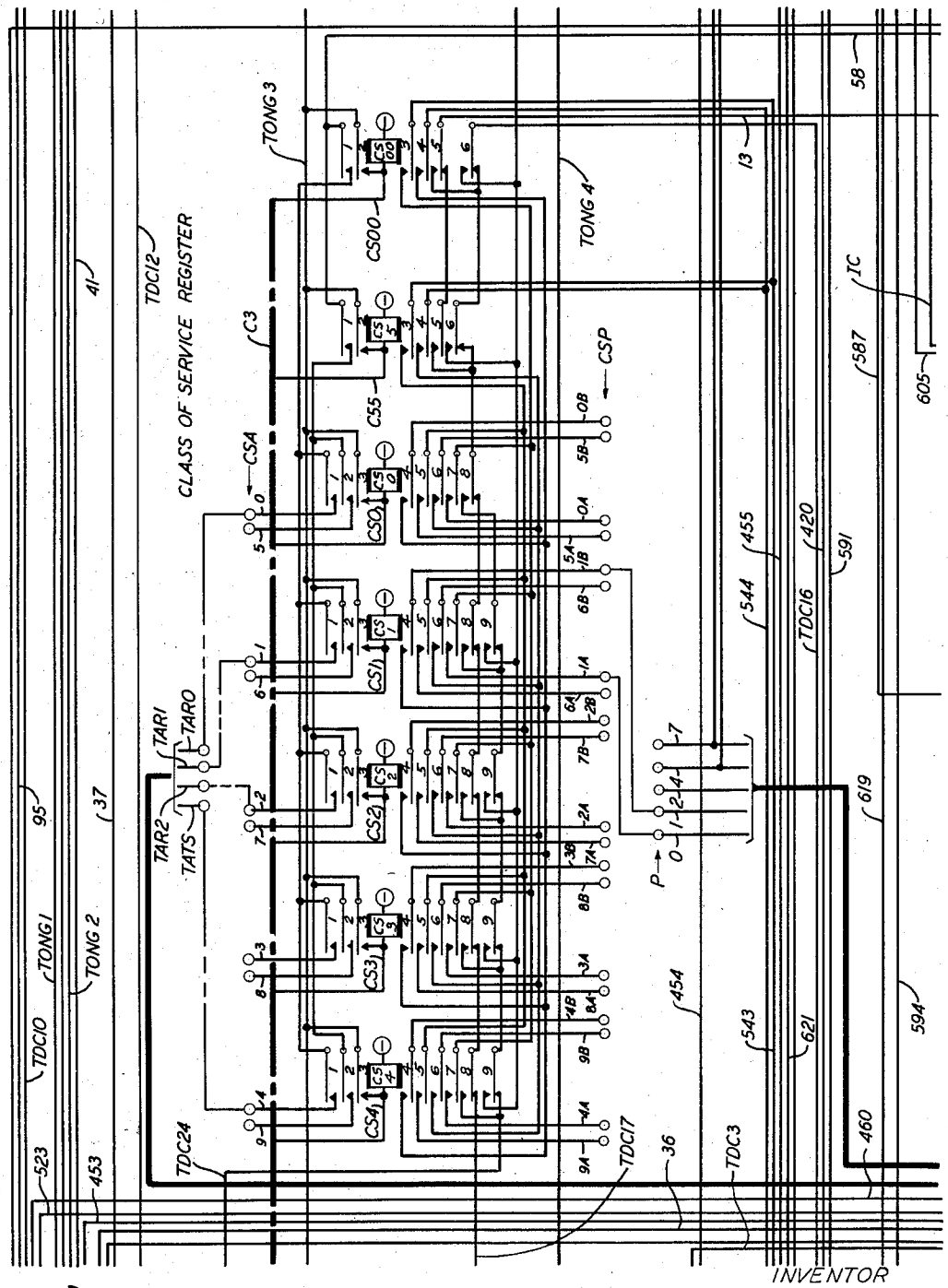


FIG. 74

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 75

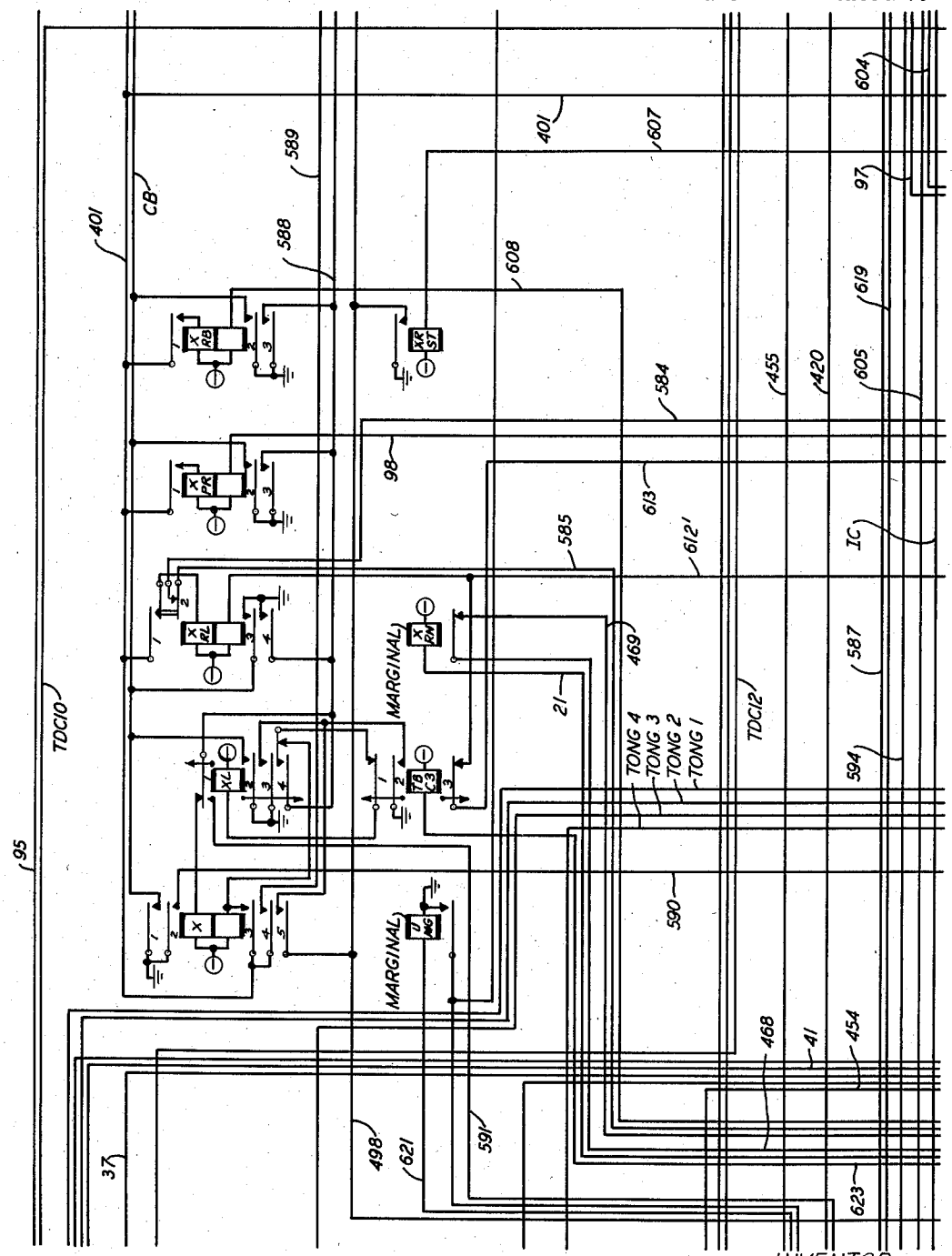


FIG. 75

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 76

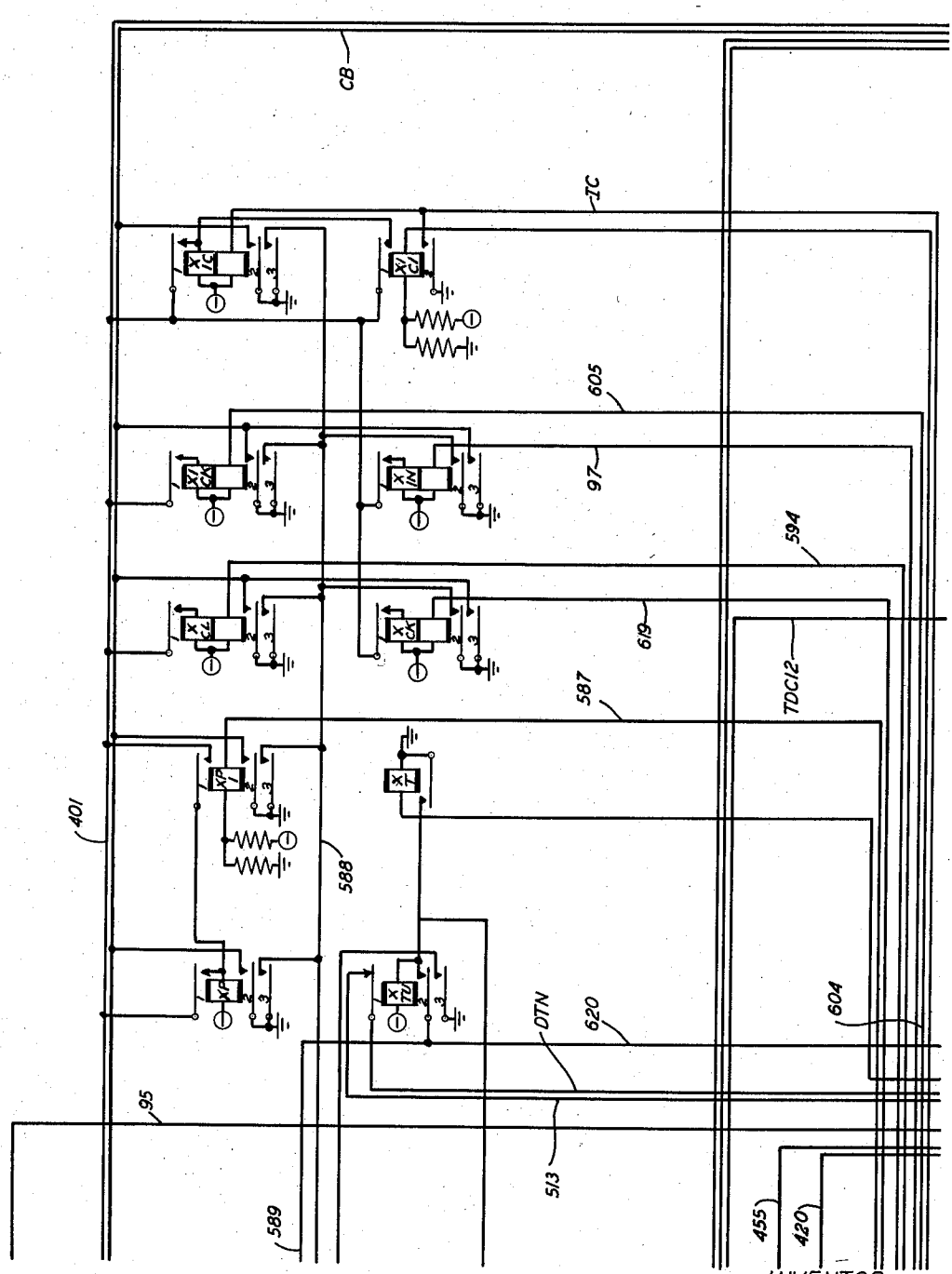


FIG. 76

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 77

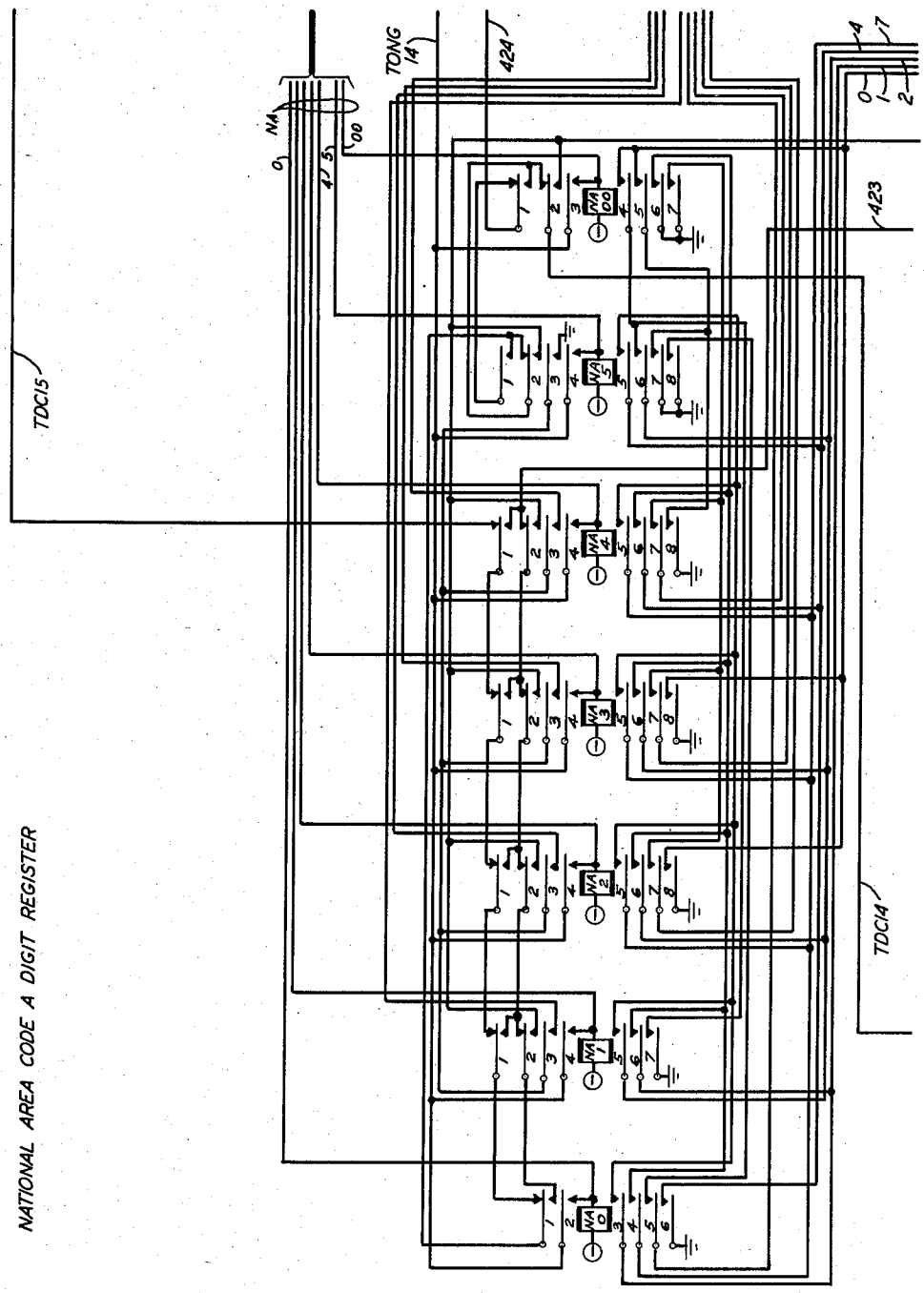


FIG. 77

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 78

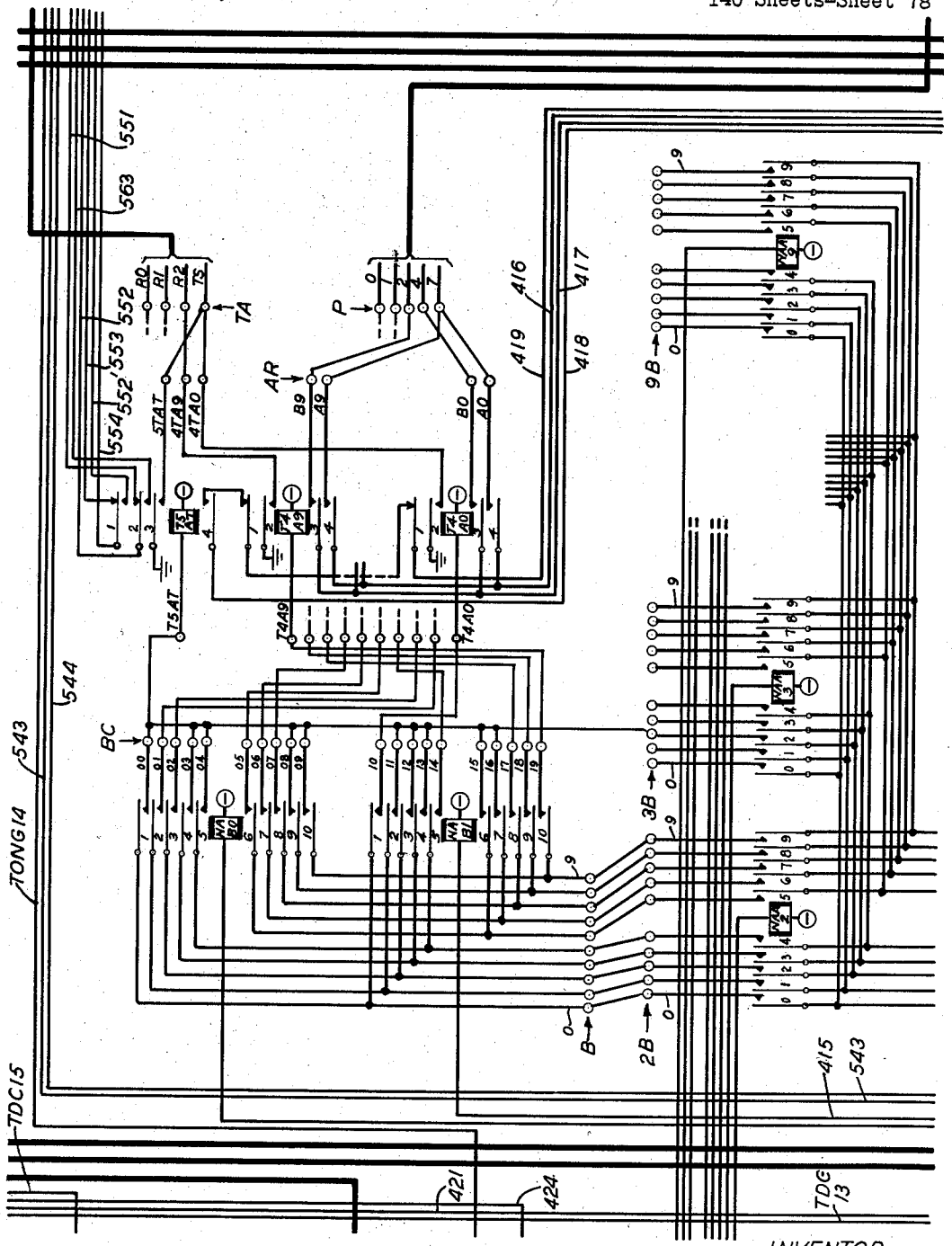


FIG. 78

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 79

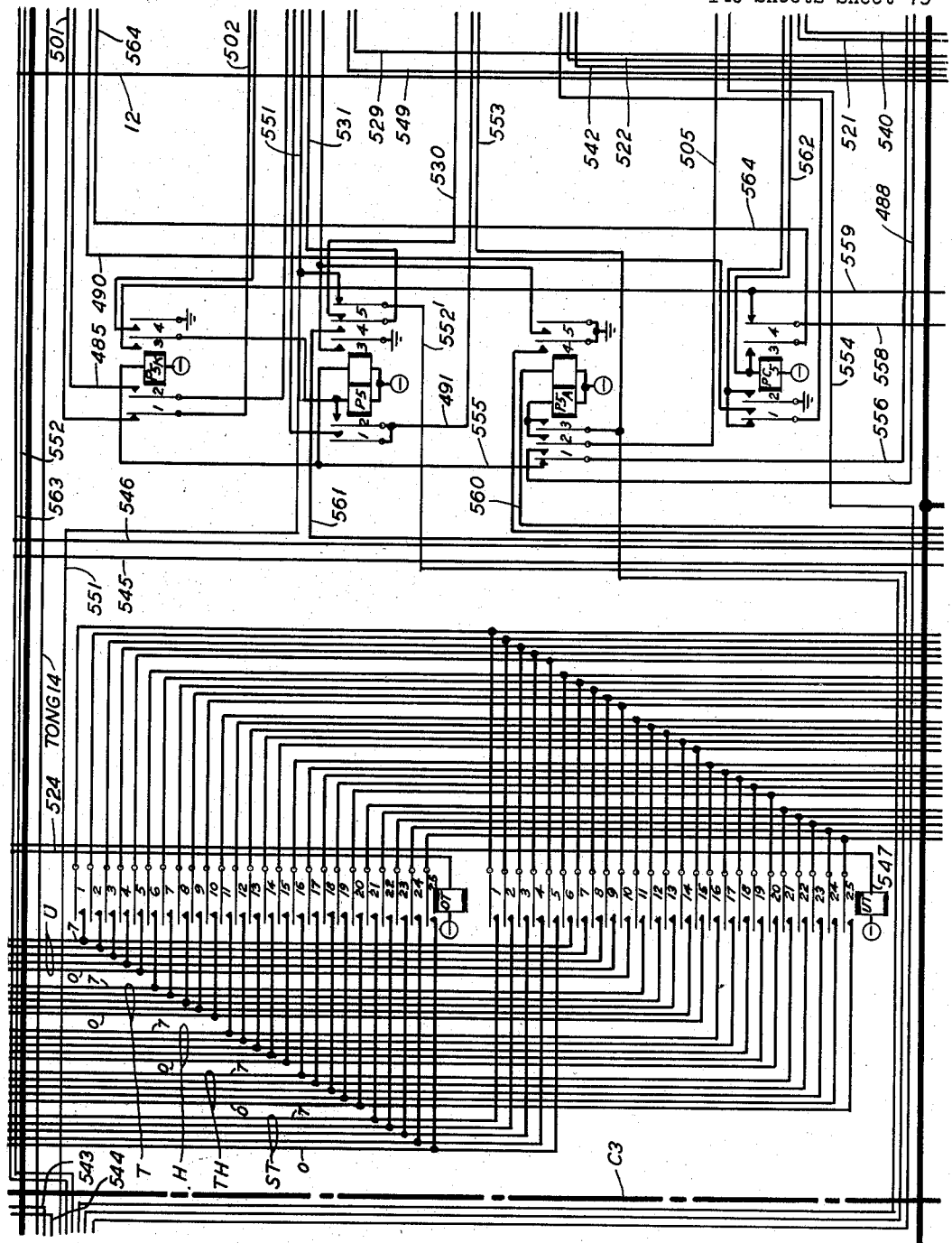


FIG. 79

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 80

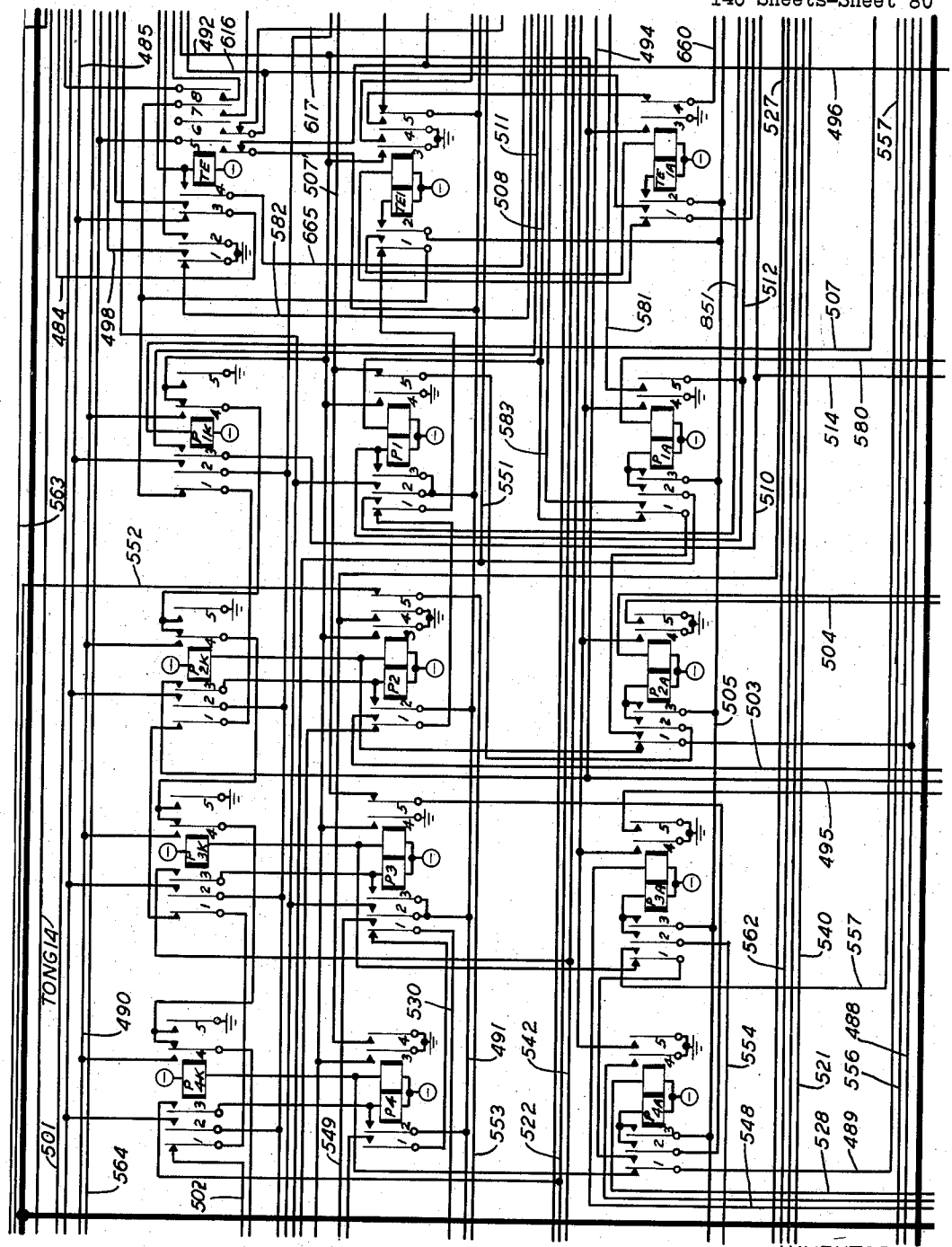


FIG. 80

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 81

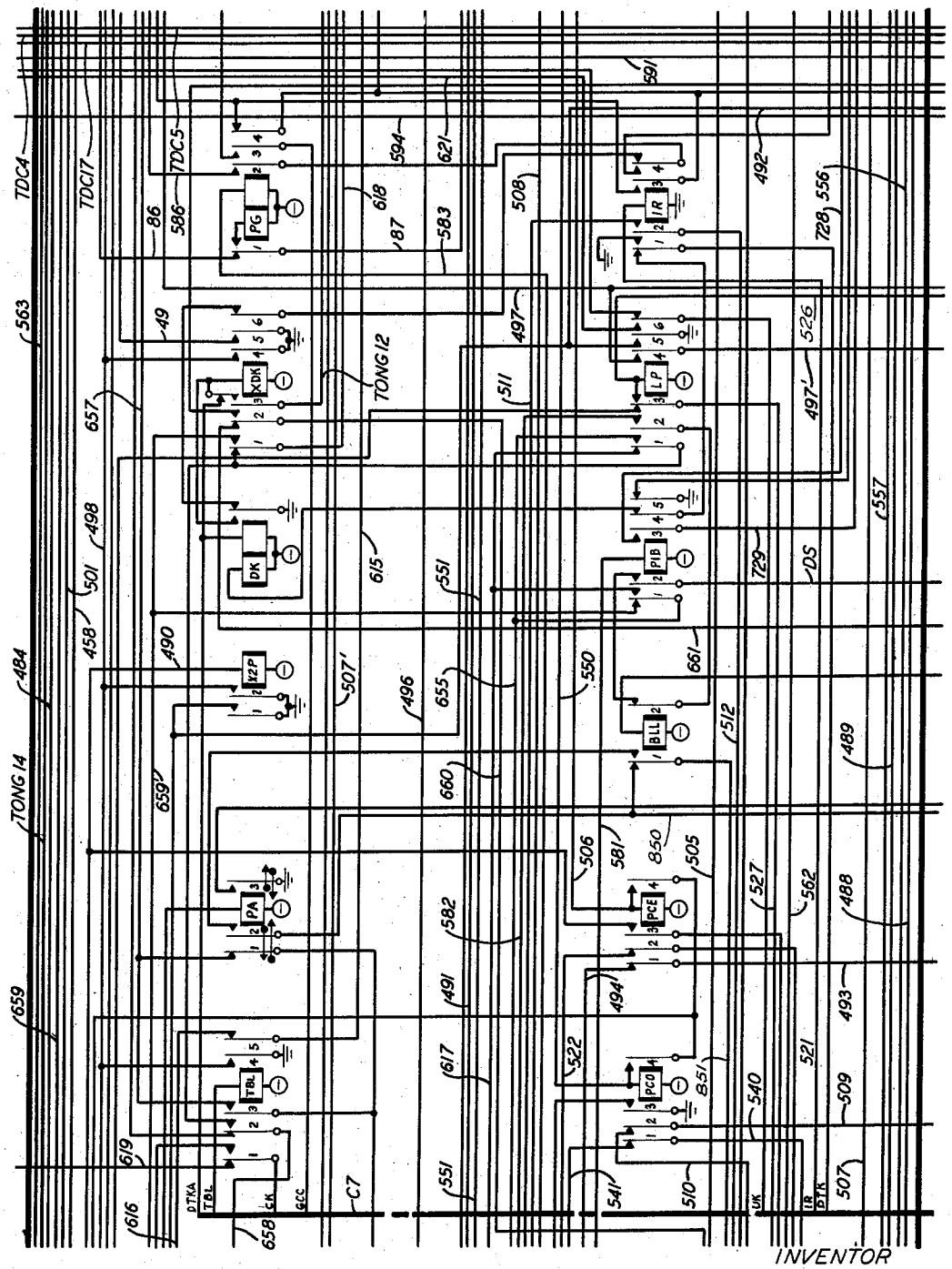


FIG. 81

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 82

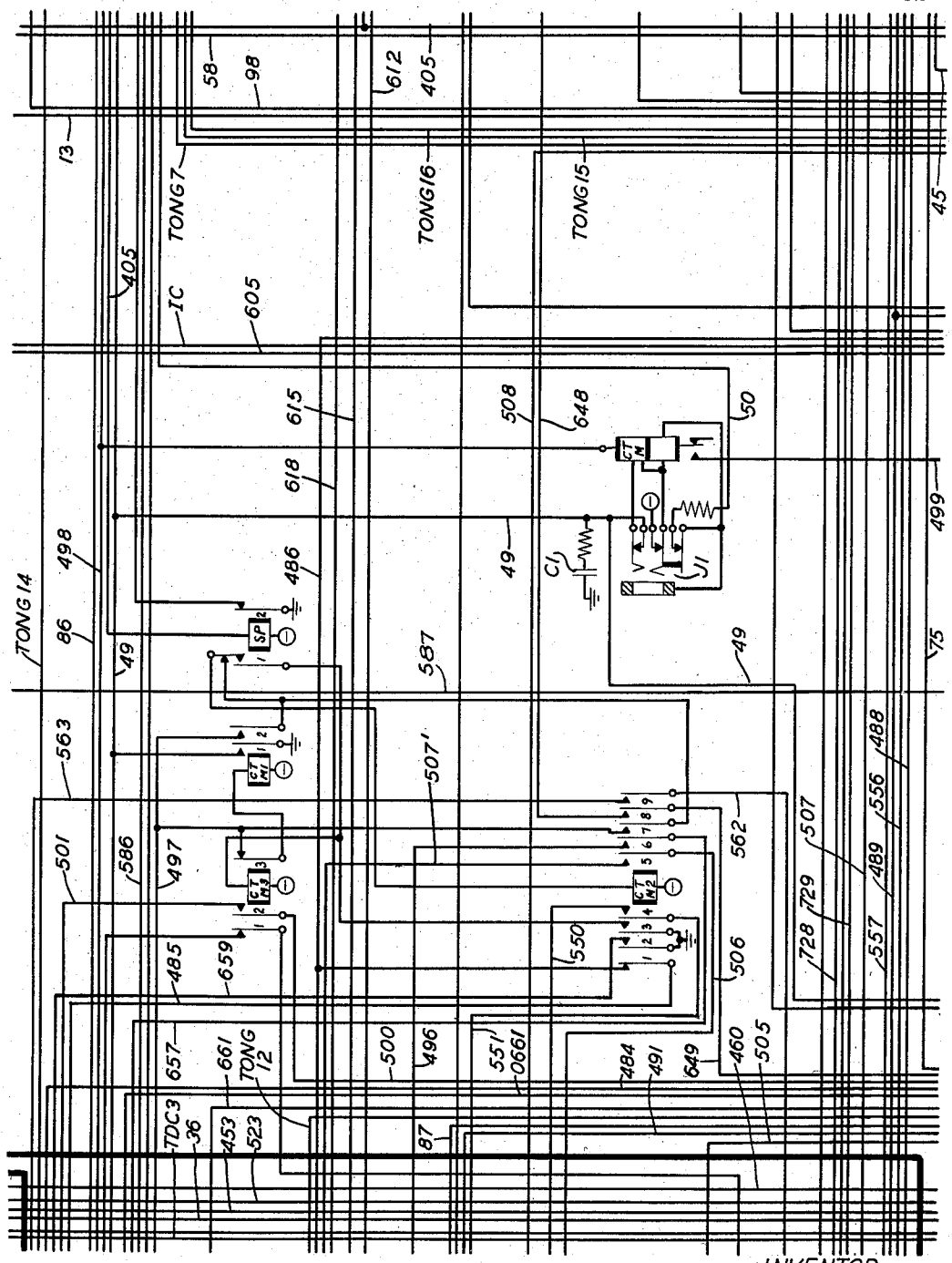


FIG. 82

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 83

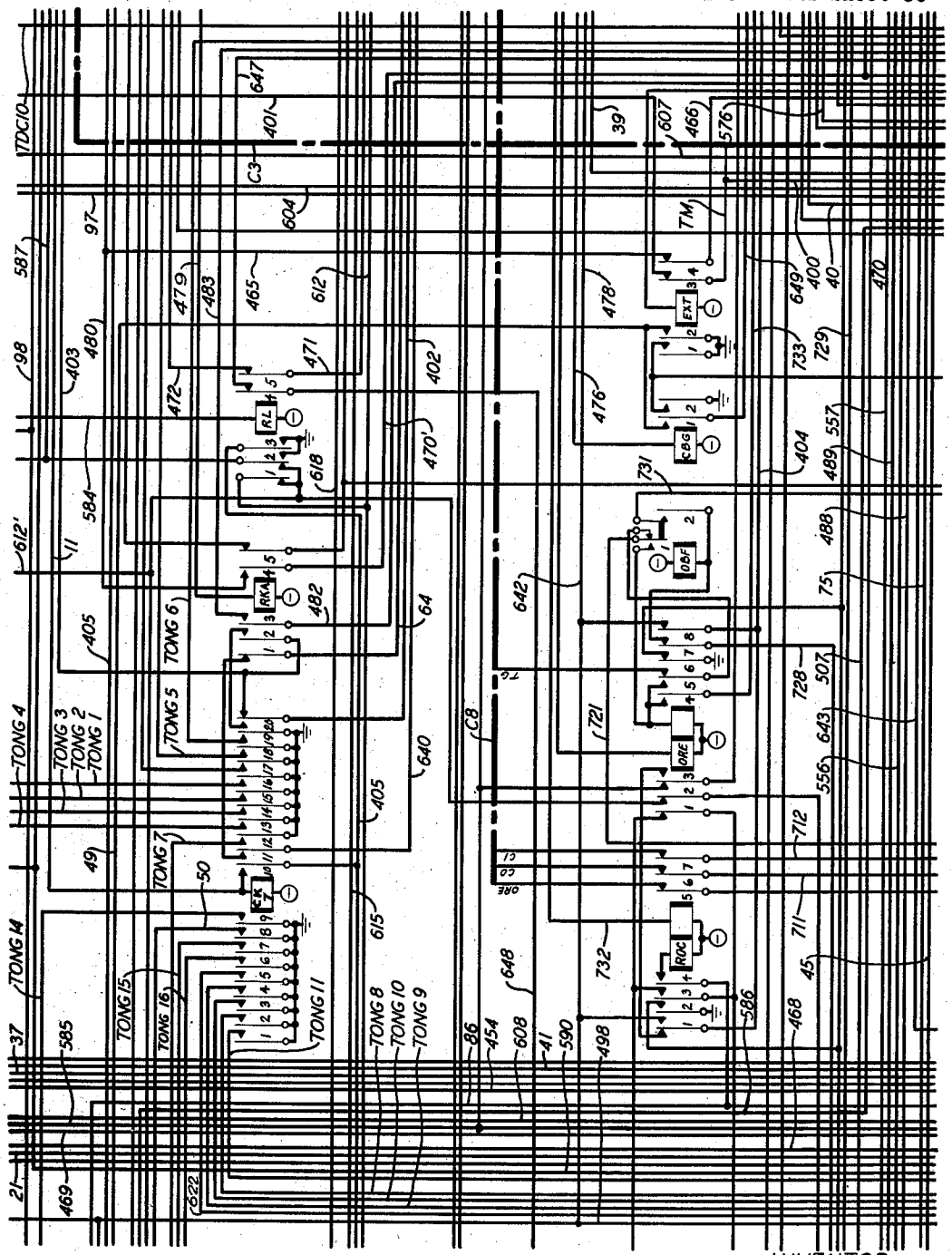


FIG. 83

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 84

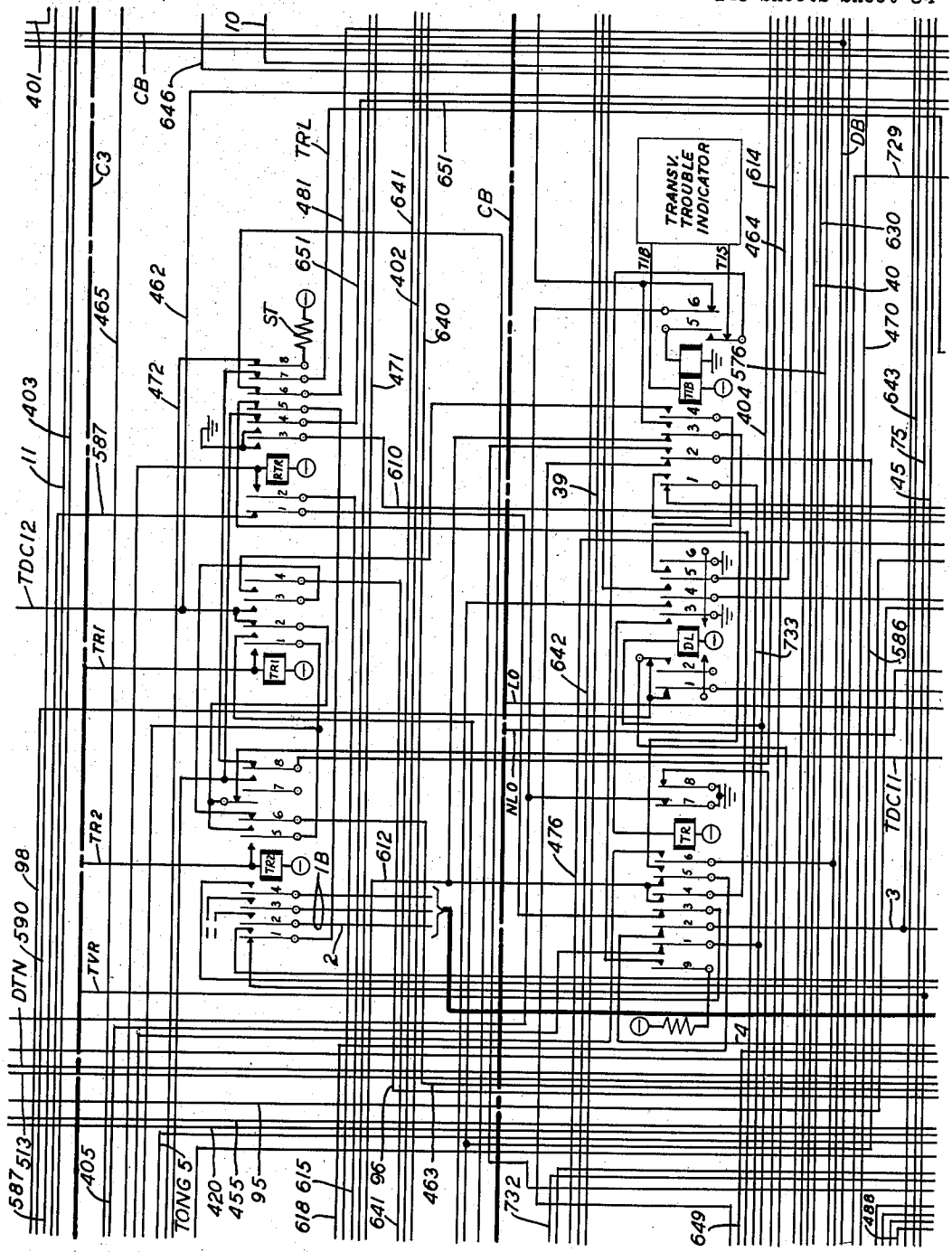


FIG. 84

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 85

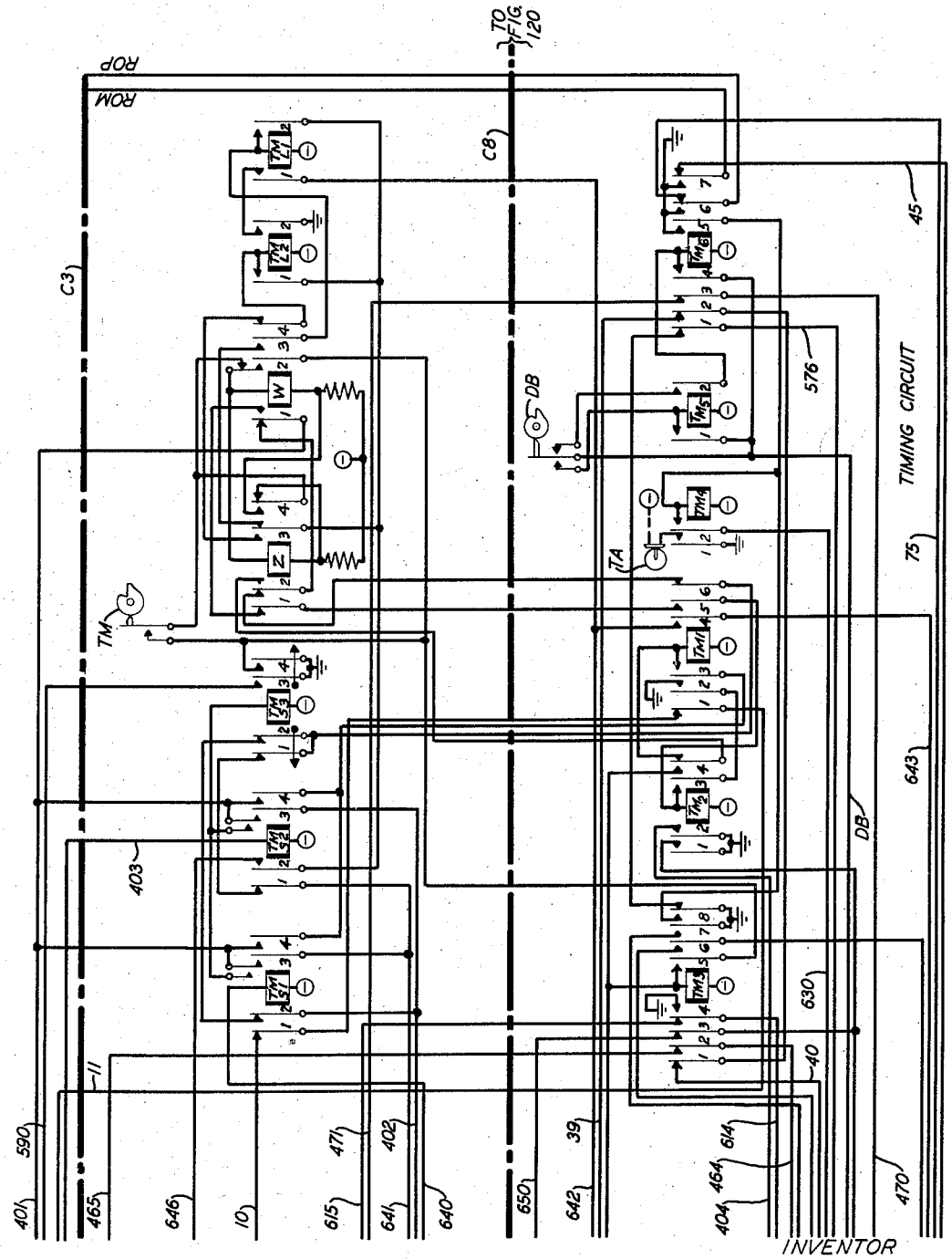


FIG. 85

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 86

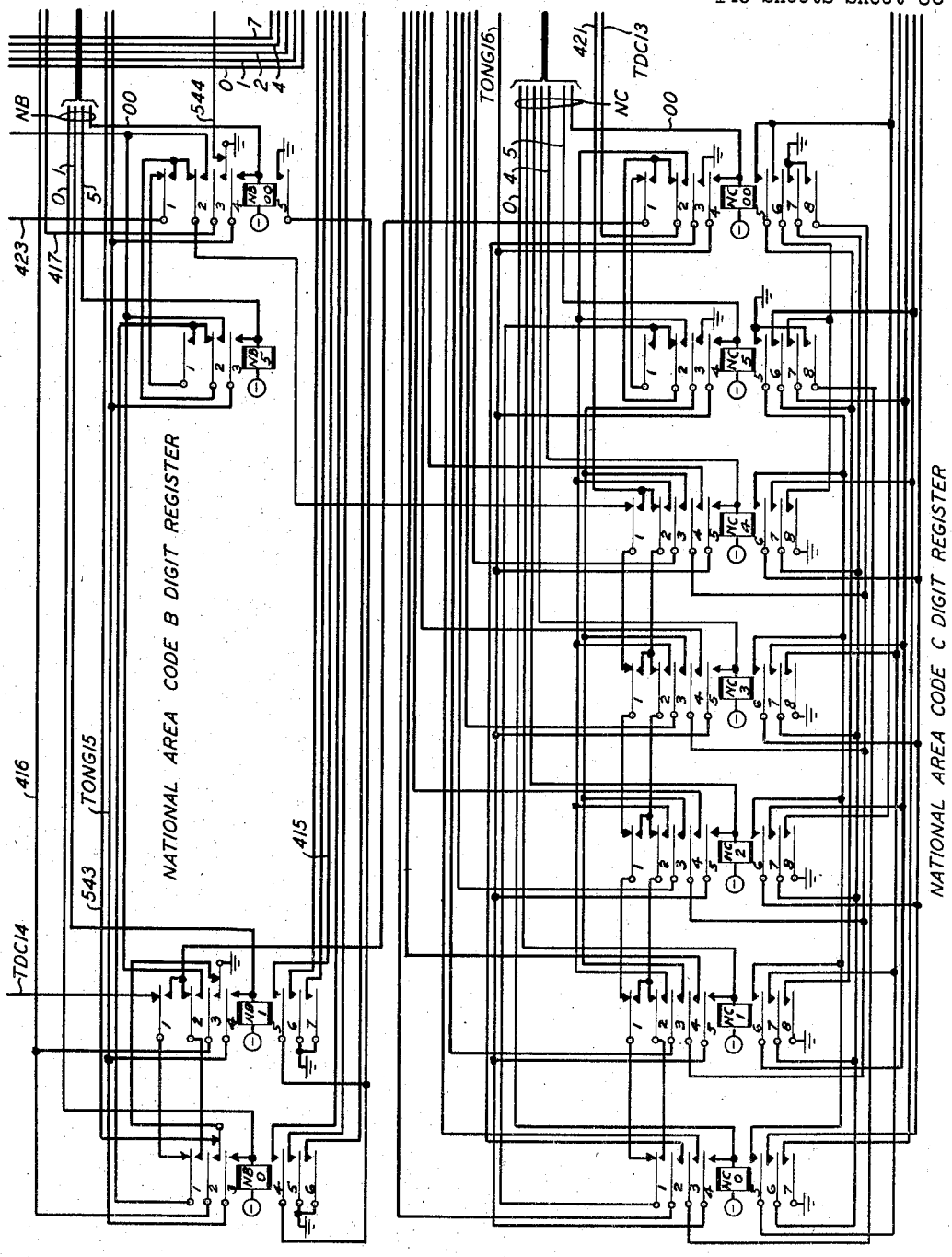


FIG. 86

INVENTOR
C.E.GERMANTON
BY

ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 87

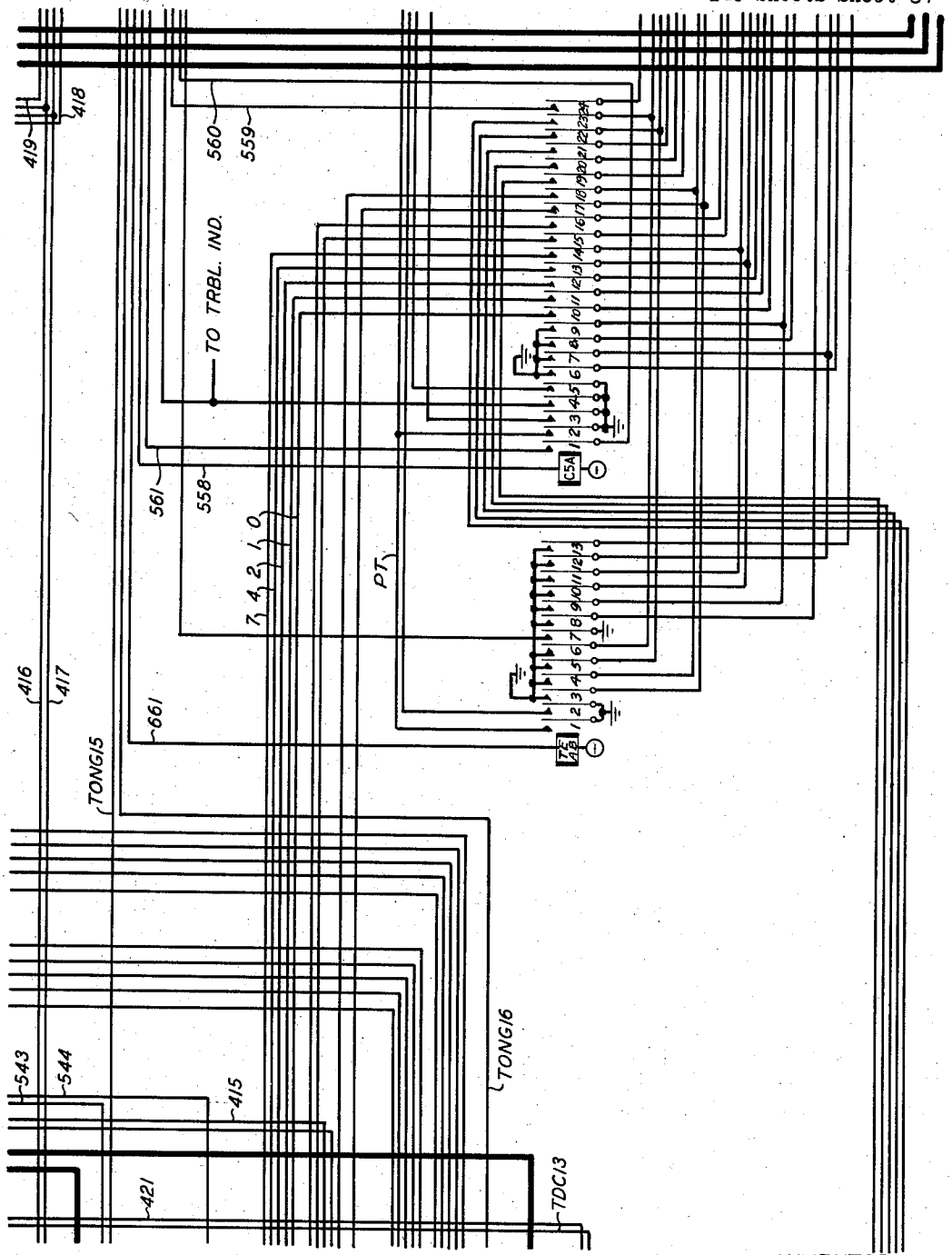


FIG. 87

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 88

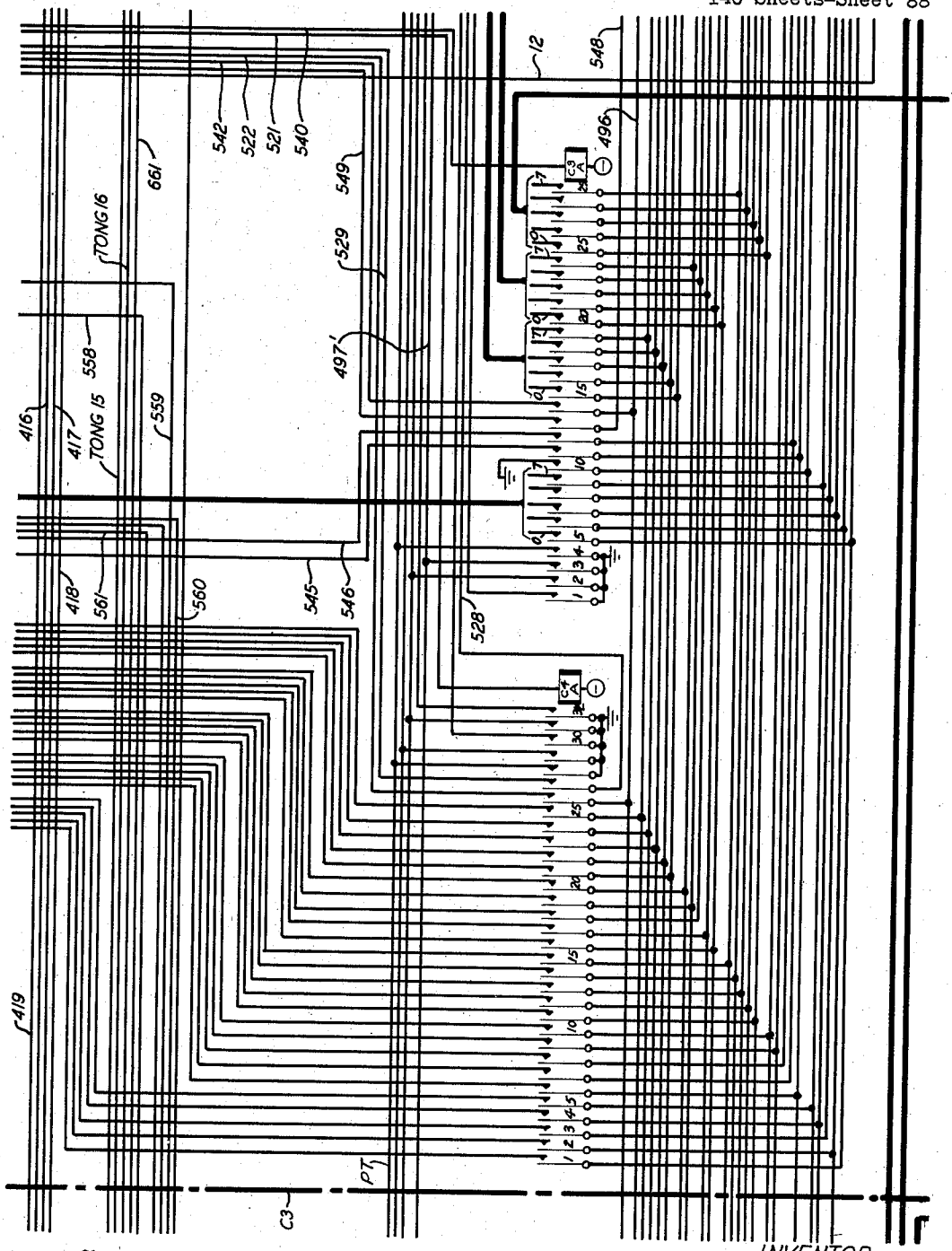


FIG. 88

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 89

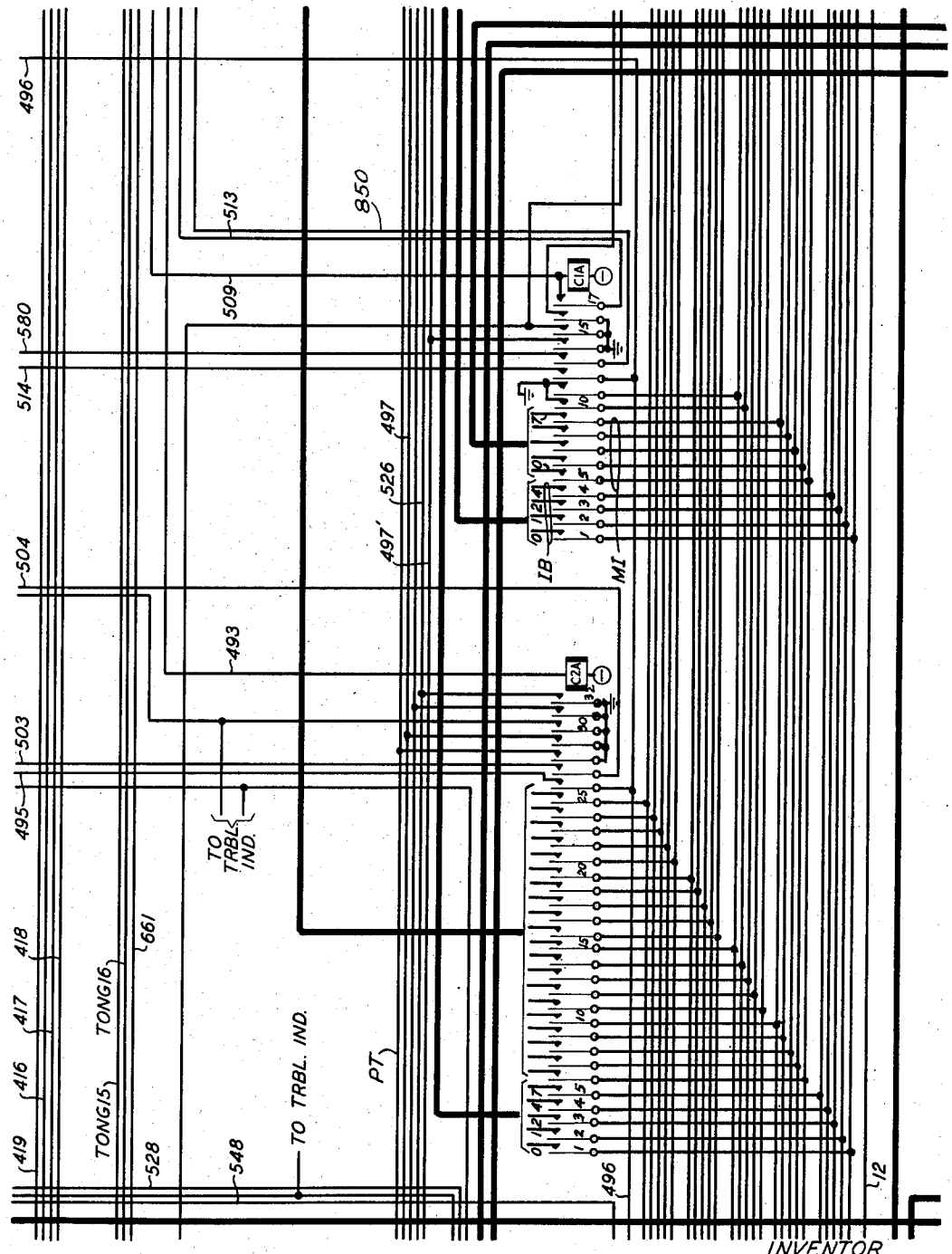


FIG. 89

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 90

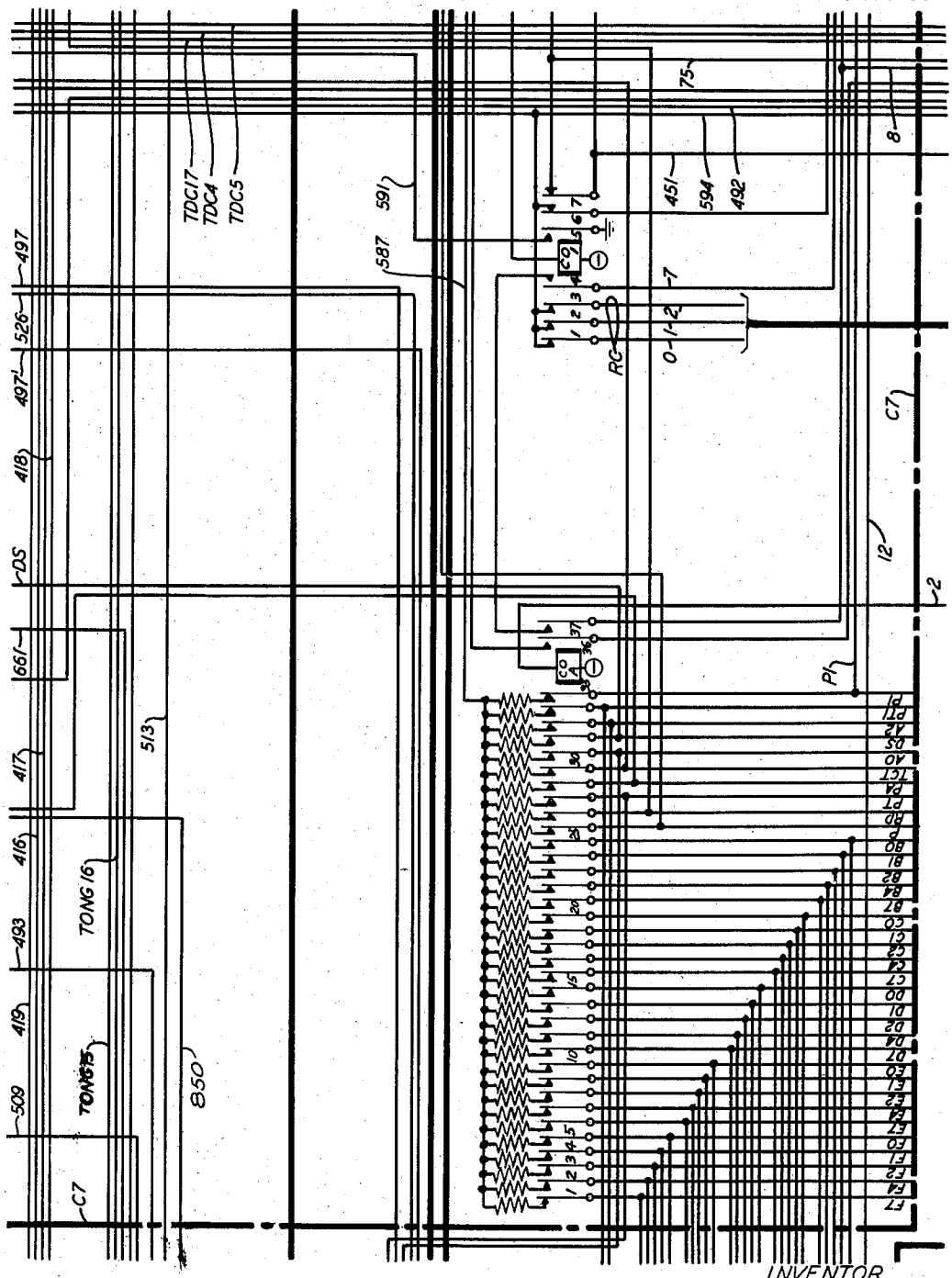


FIG. 90

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 91

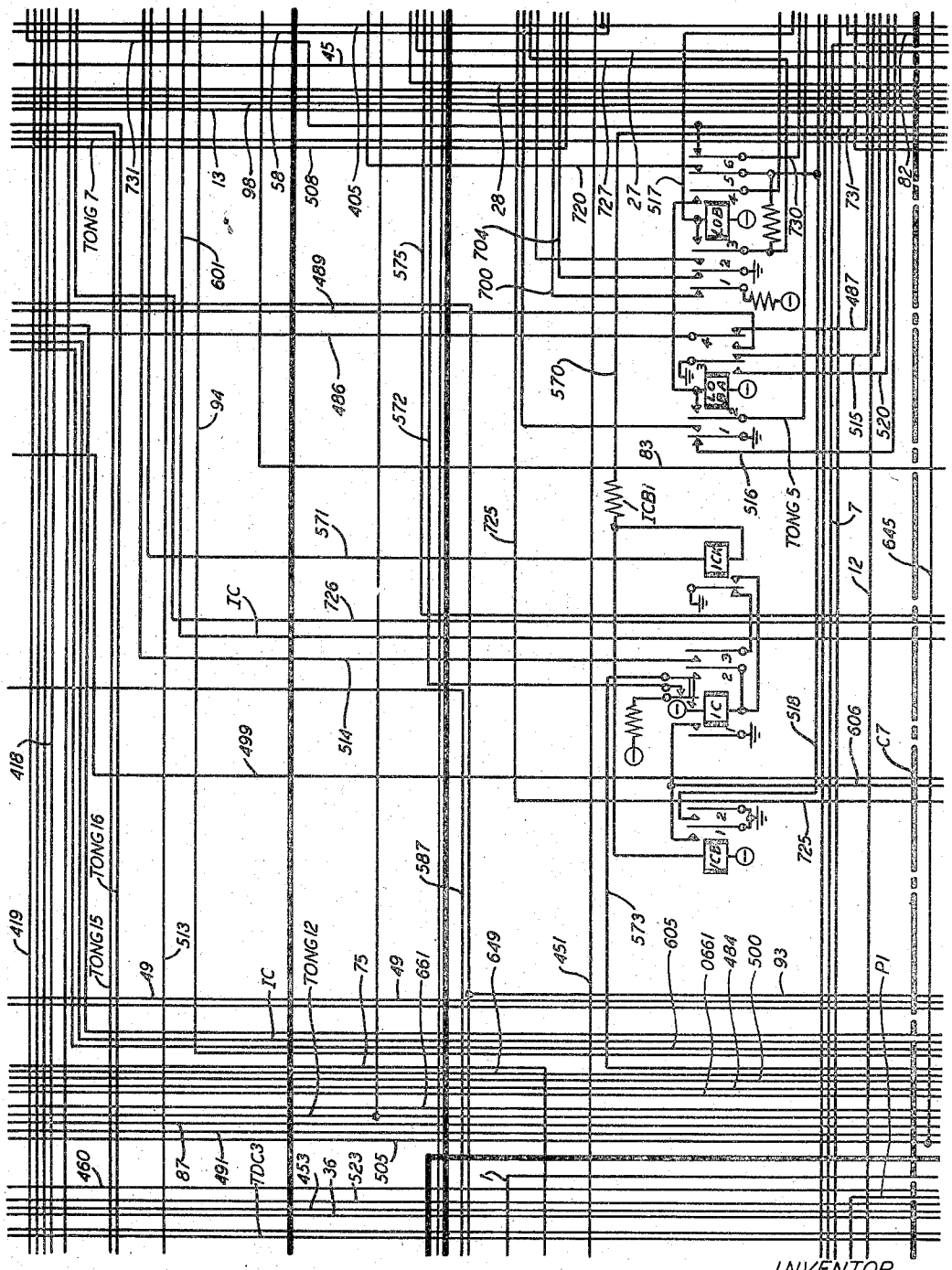


FIG. 91

INVENTOR.
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 92

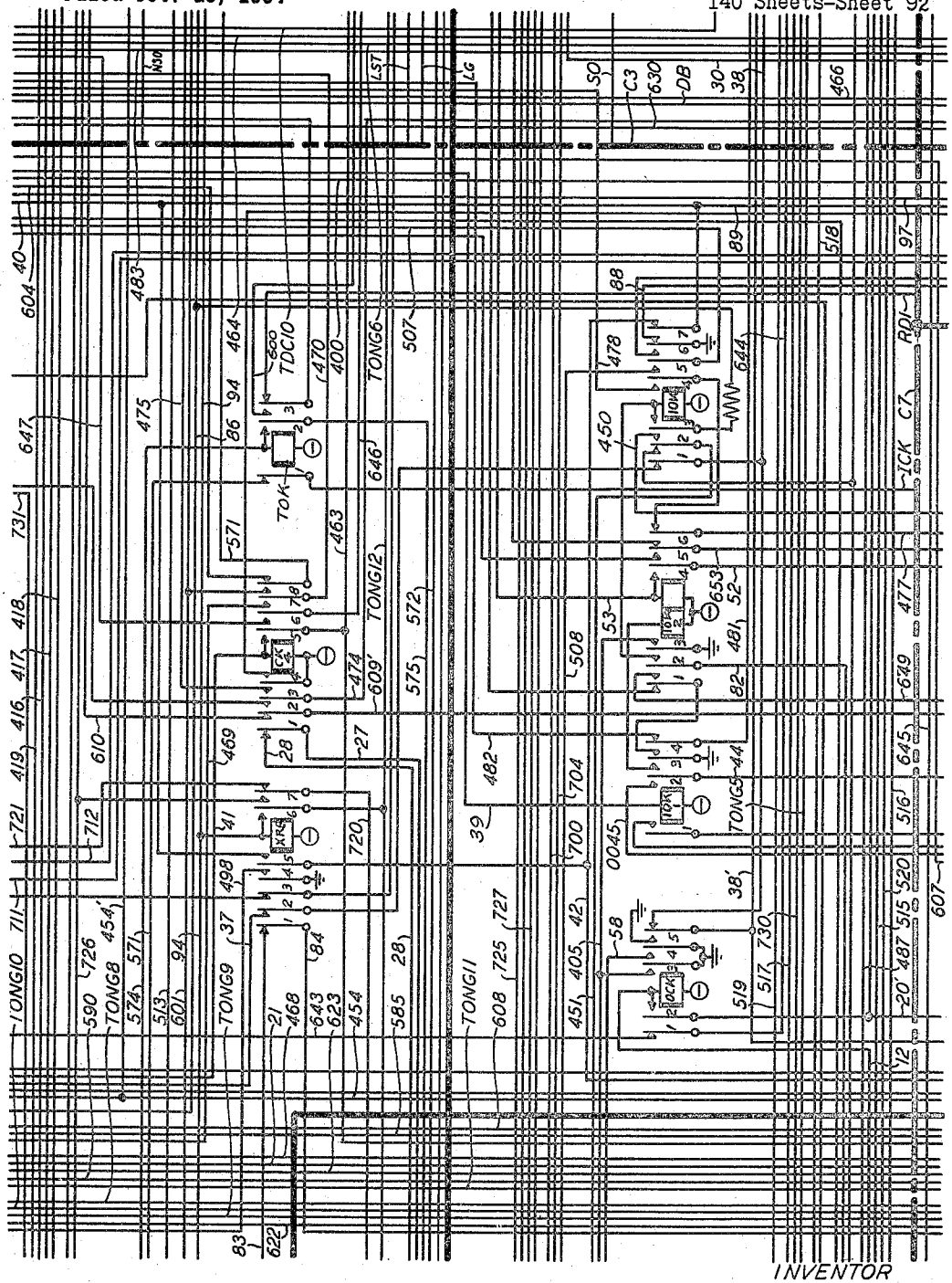


FIG. 92

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 93

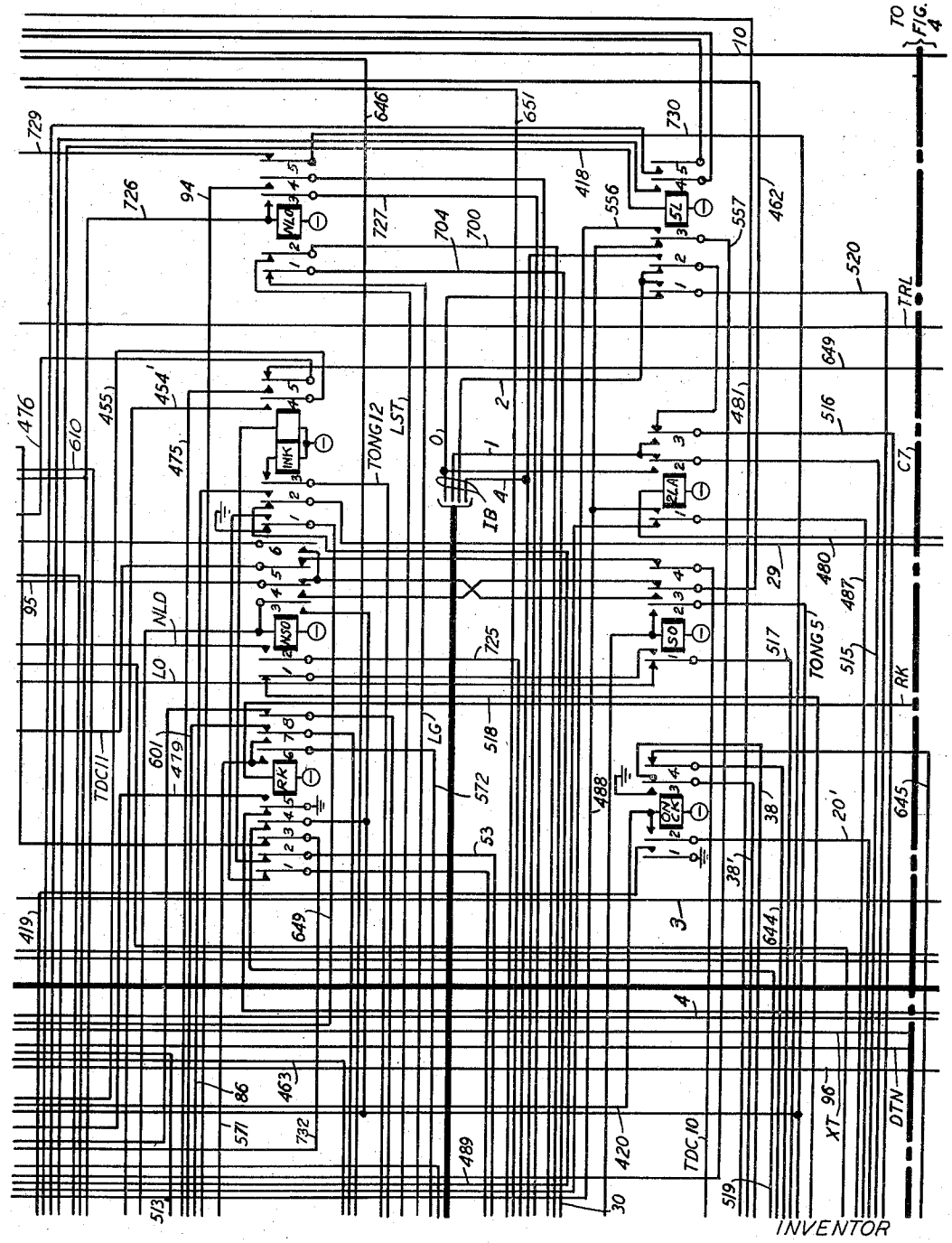


FIG. 93

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 94

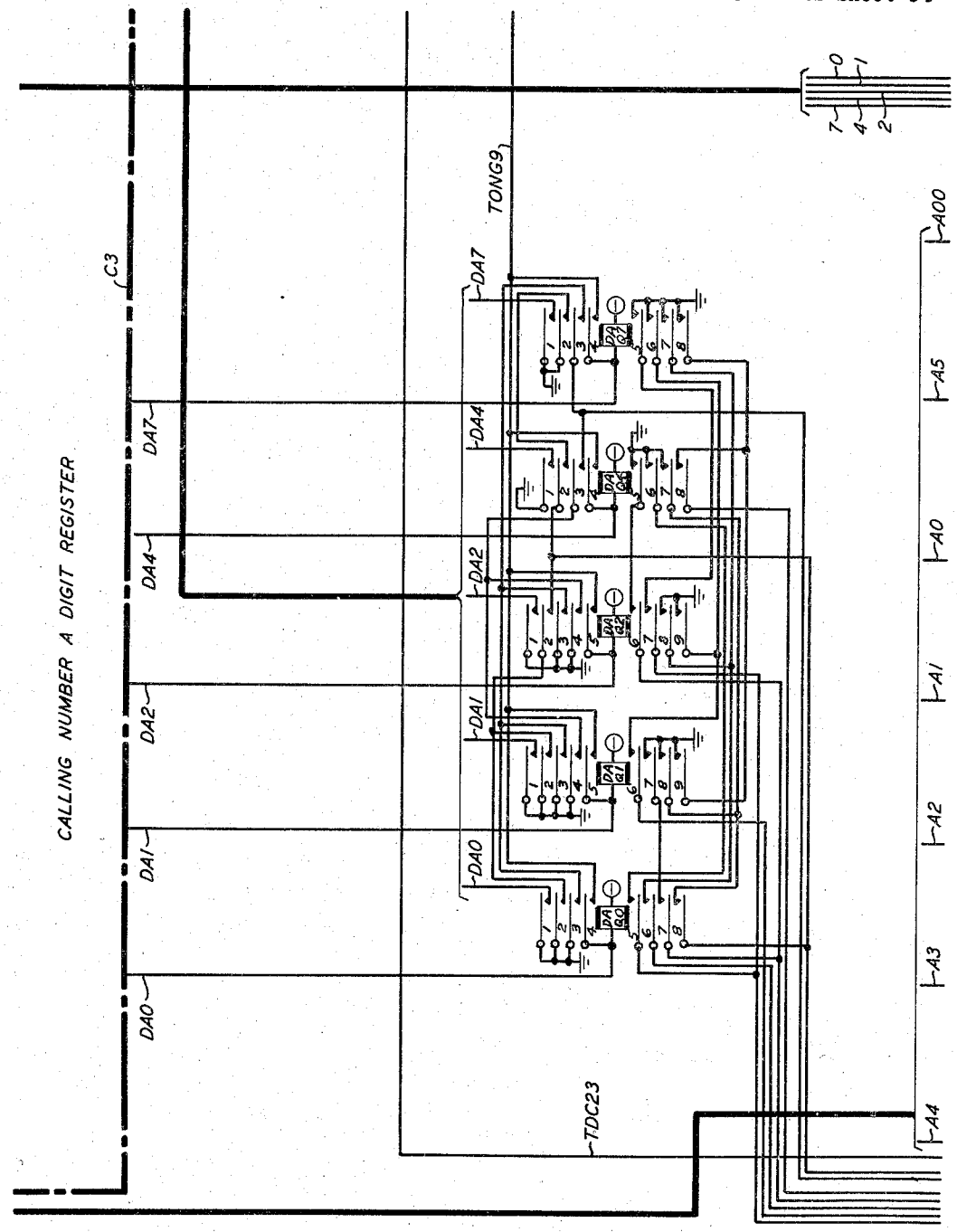


FIG. 94

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 95

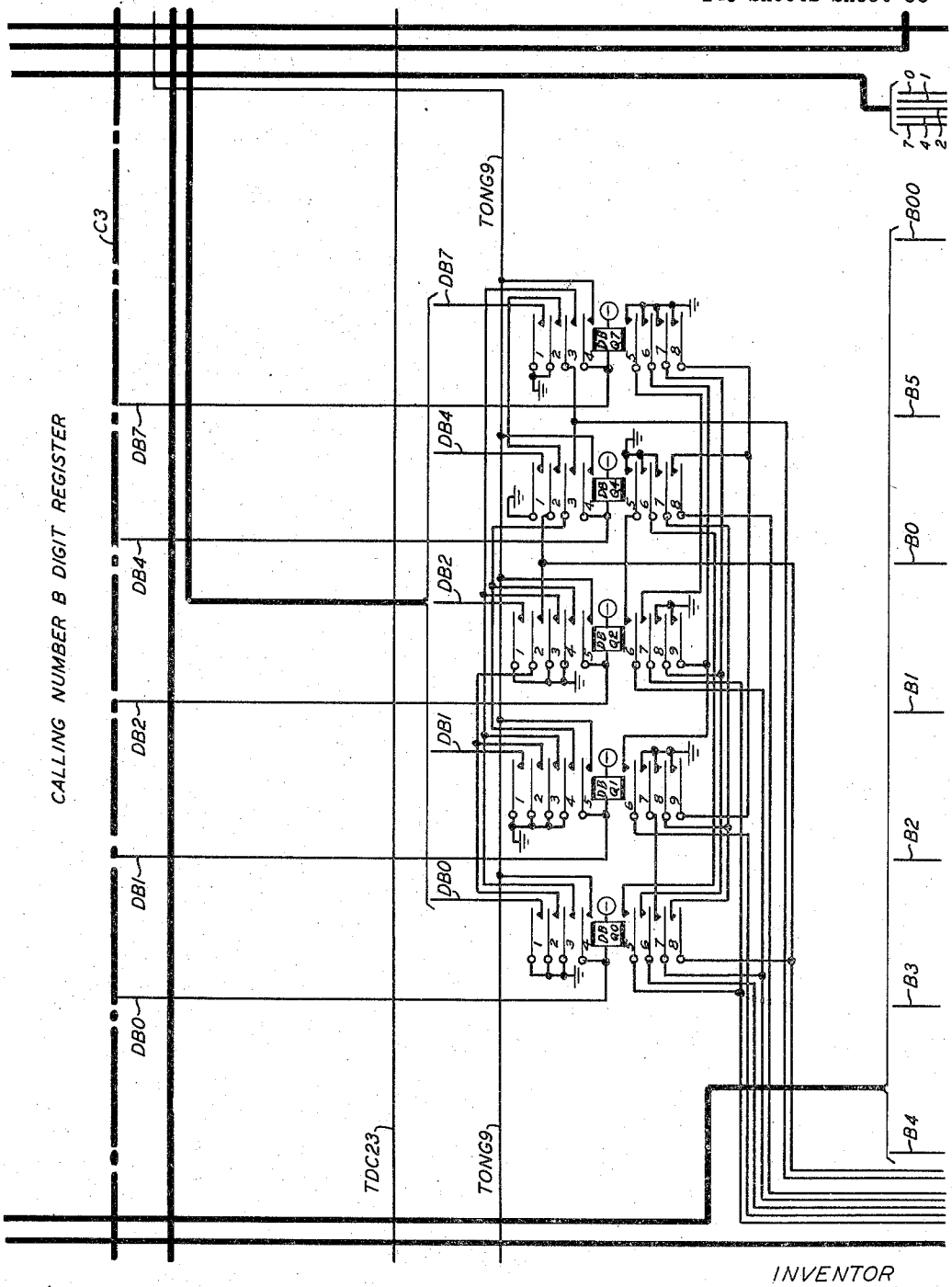


FIG. 95

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 96

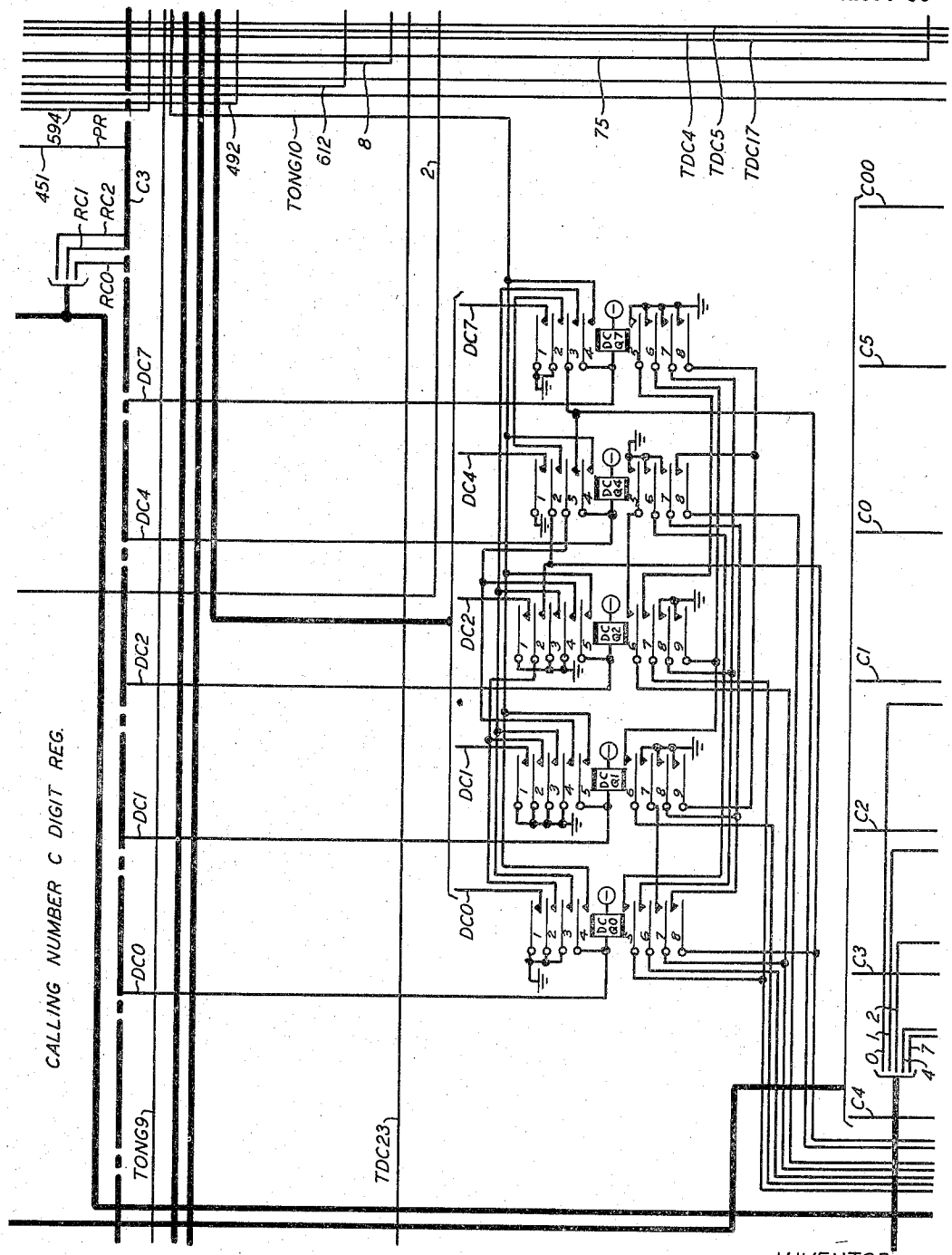


FIG. 96

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 97

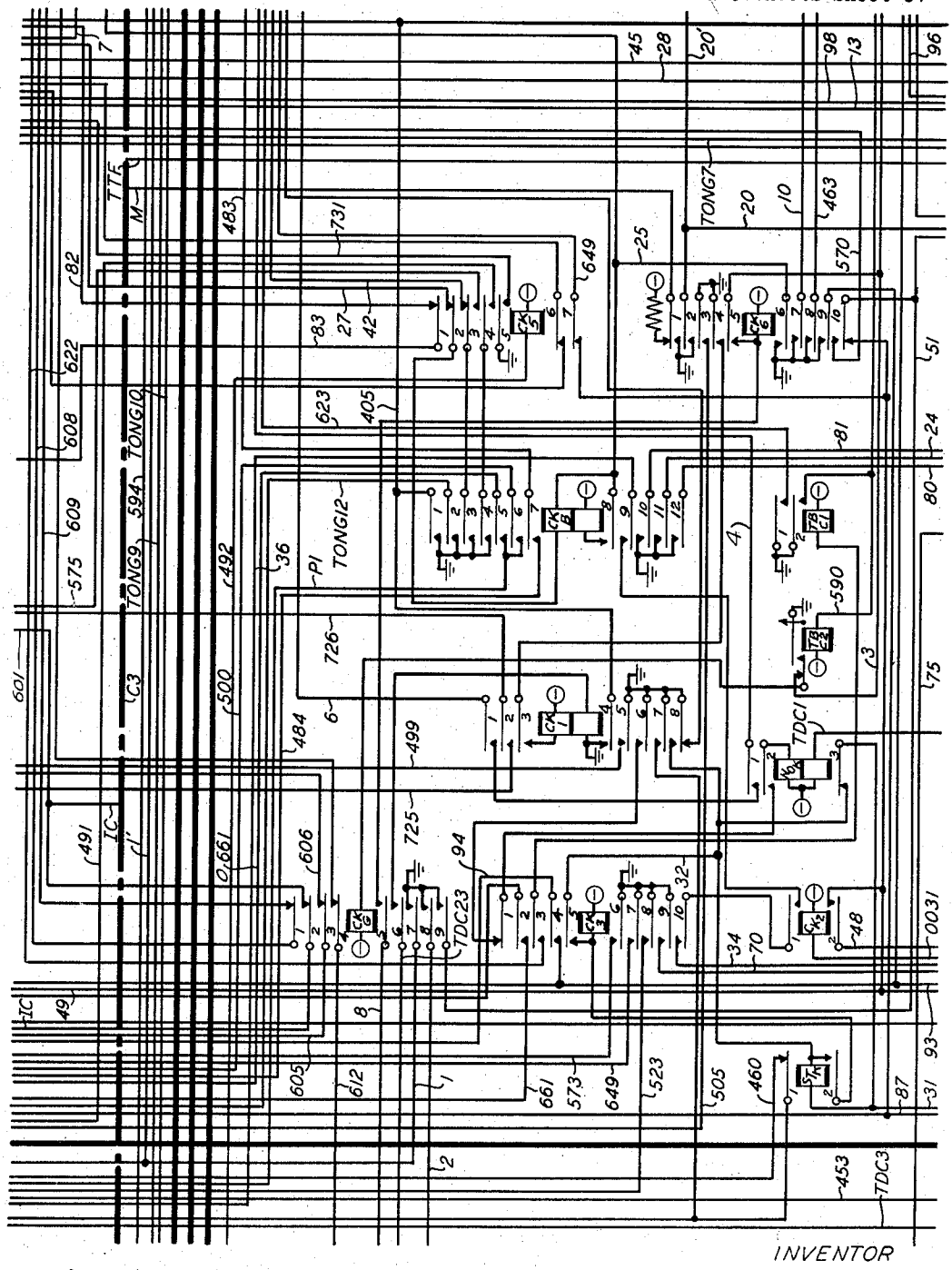


FIG. 97

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 98

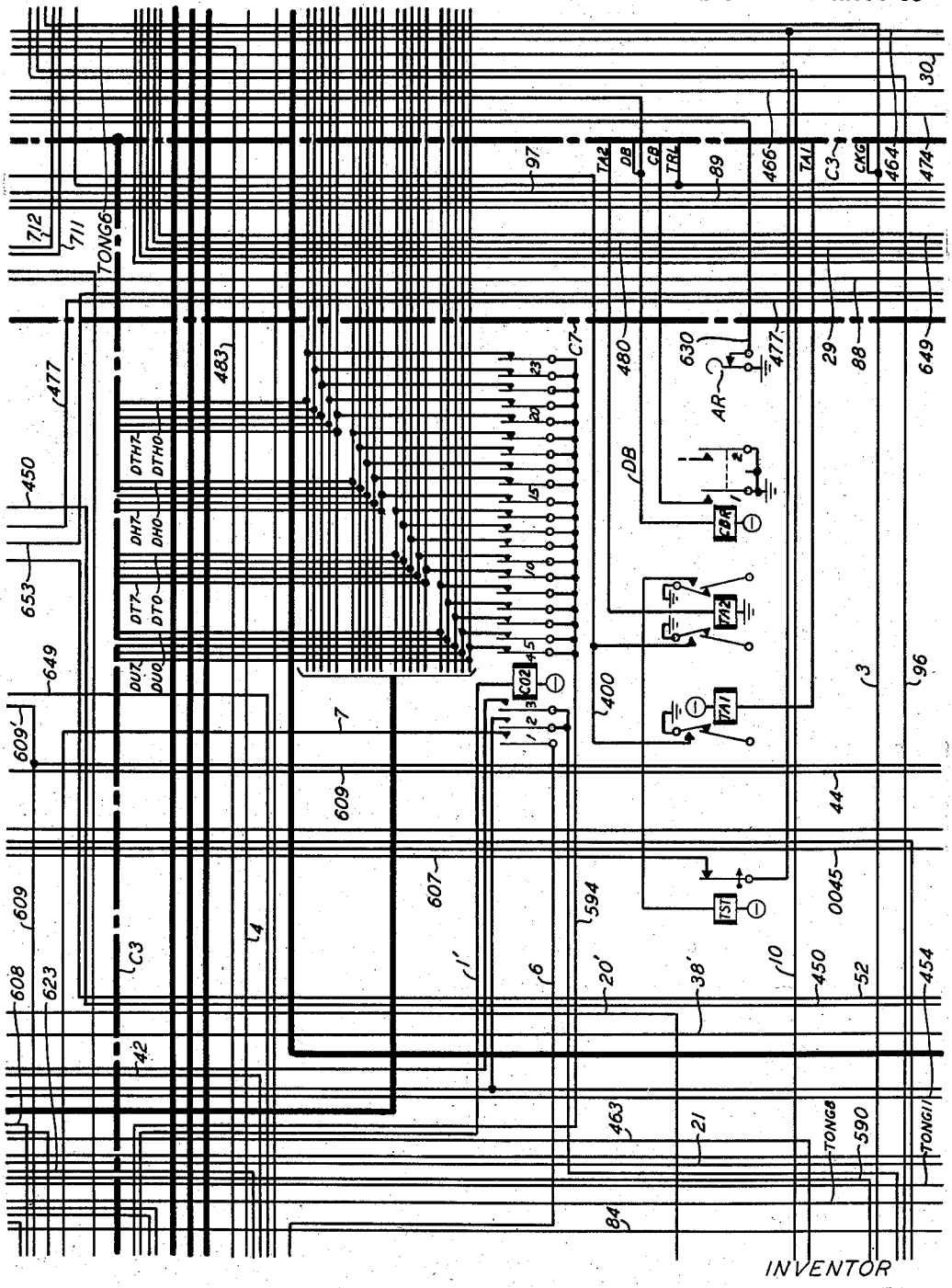


FIG. 98

INVENTOR
C.E.GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 99

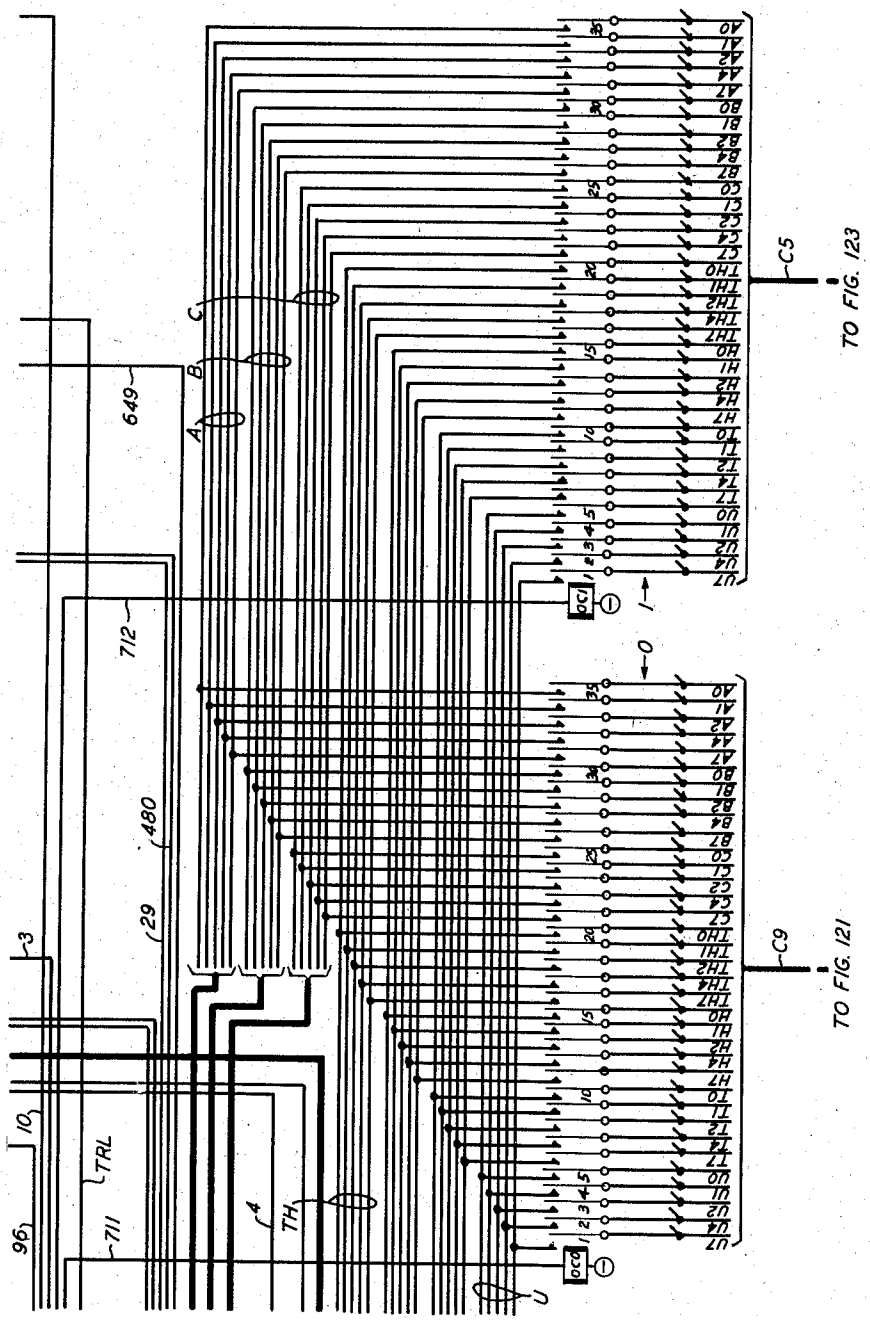


FIG. 99

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 100

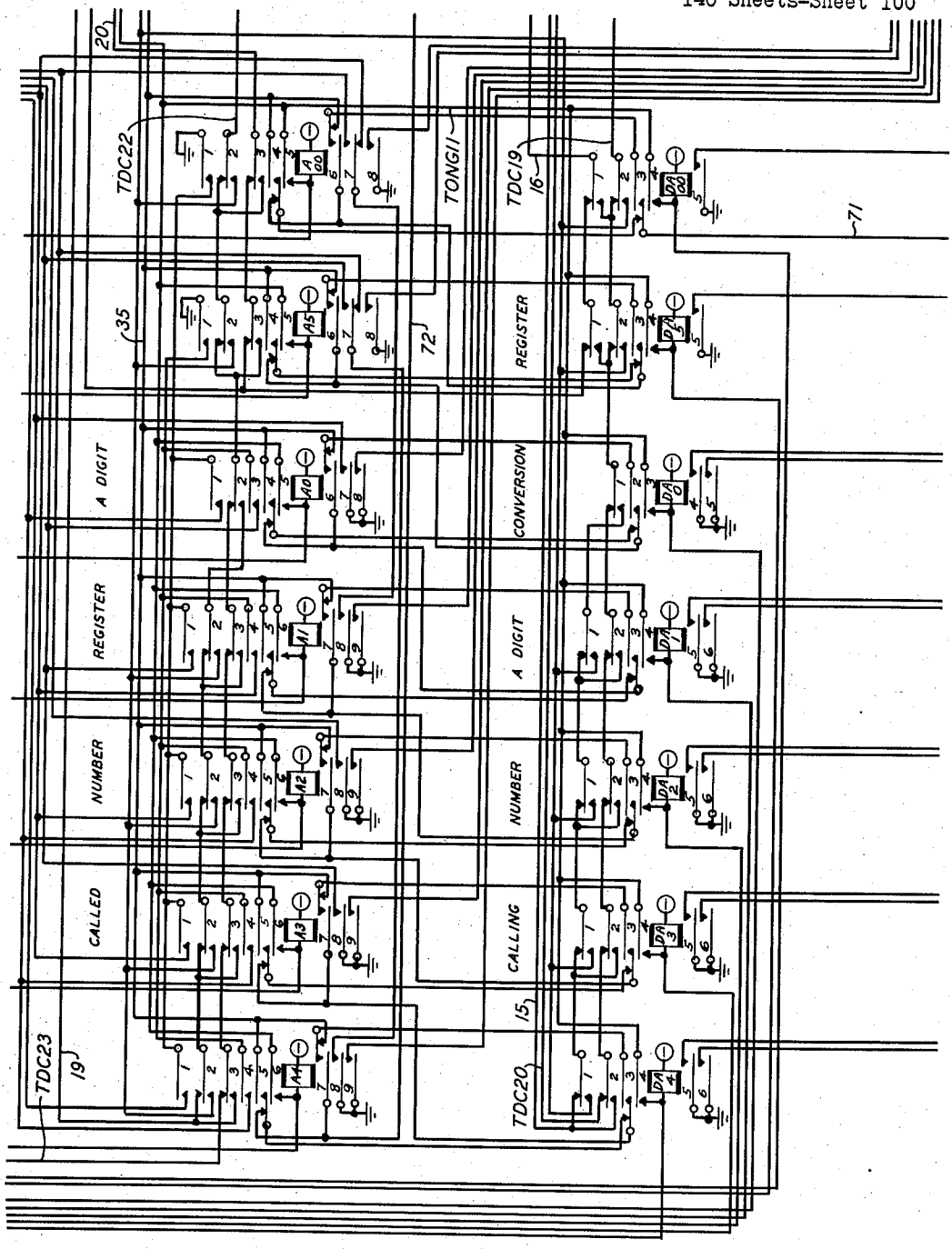


FIG. 100

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 101

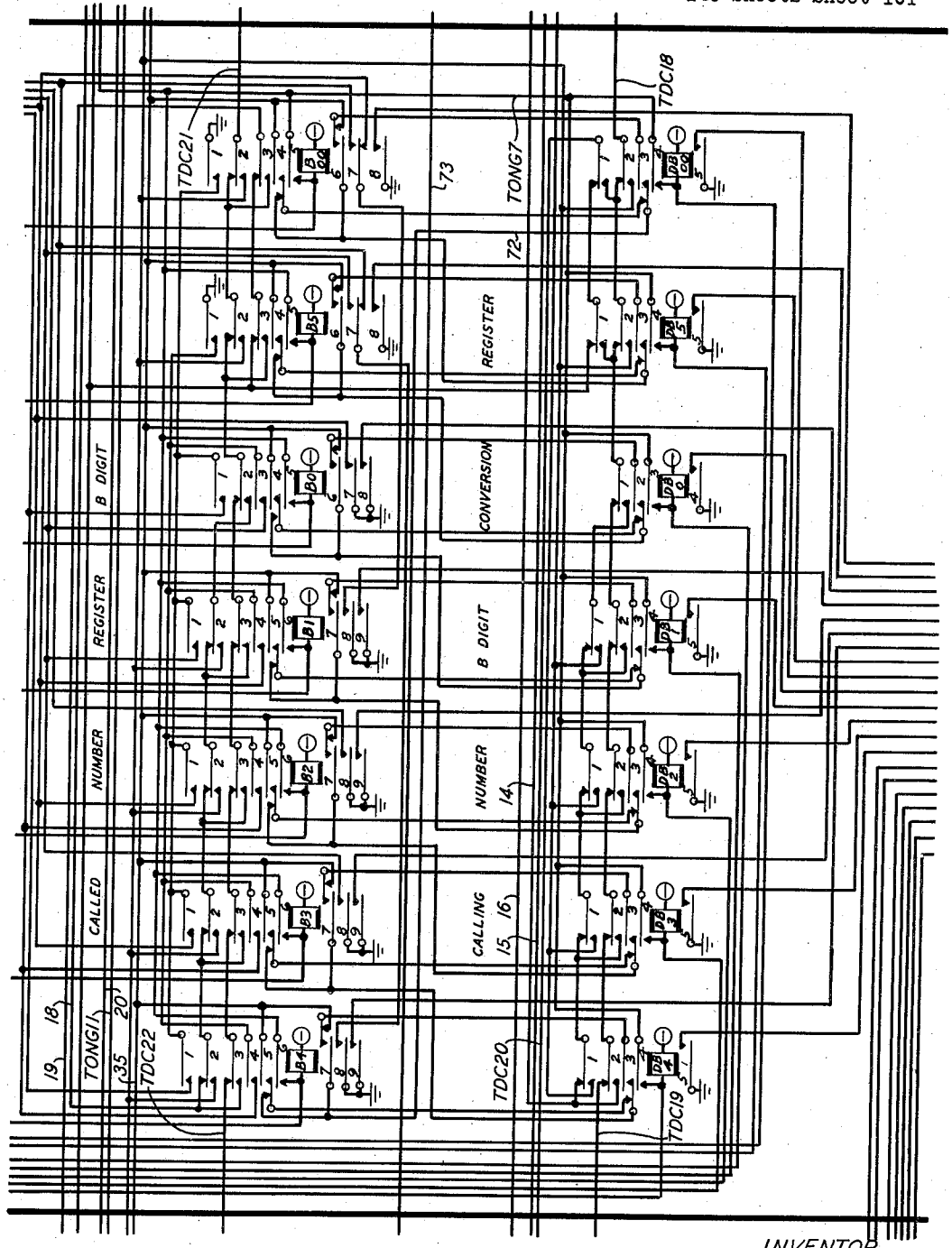


FIG. 101

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 102

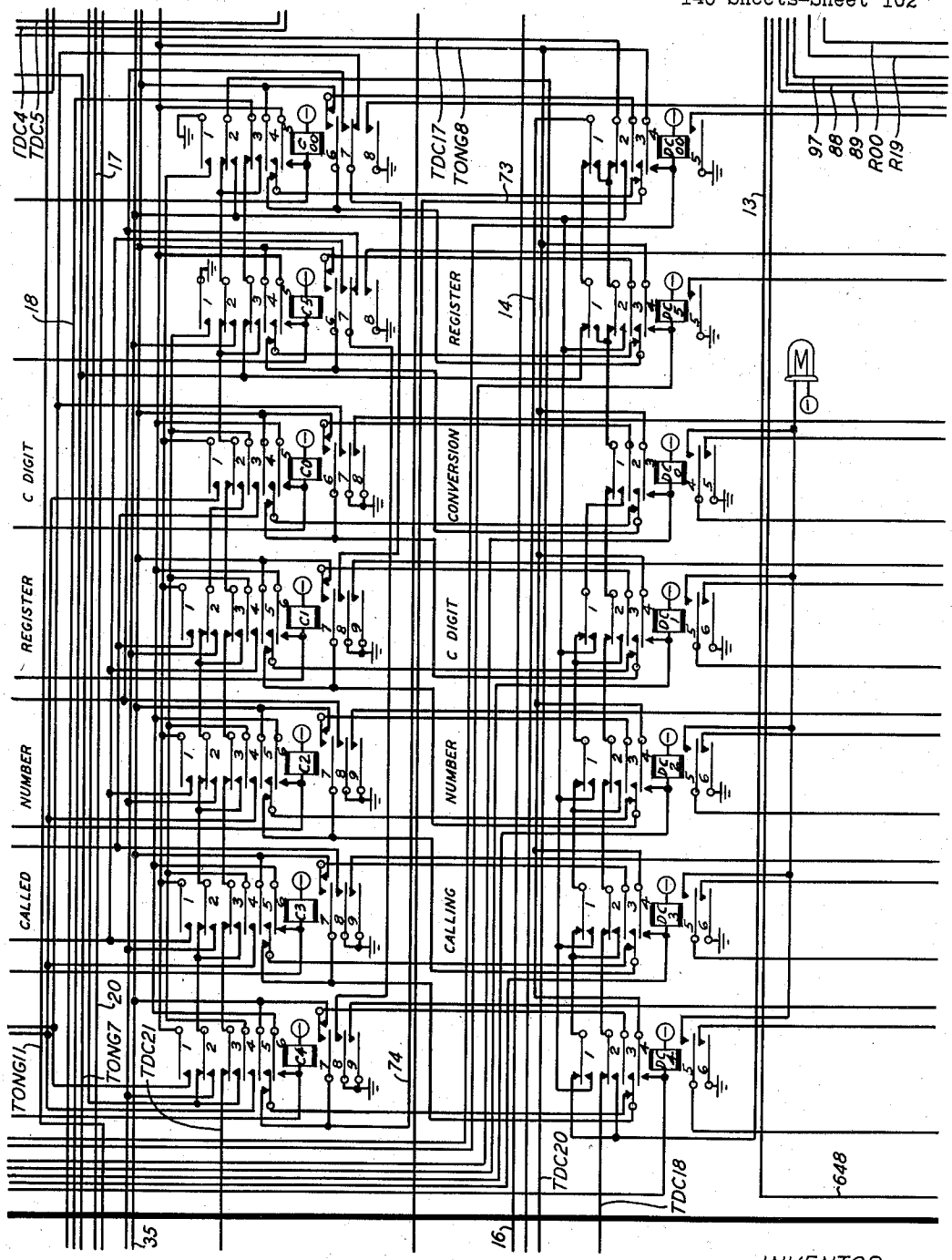


FIG. 102

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 103

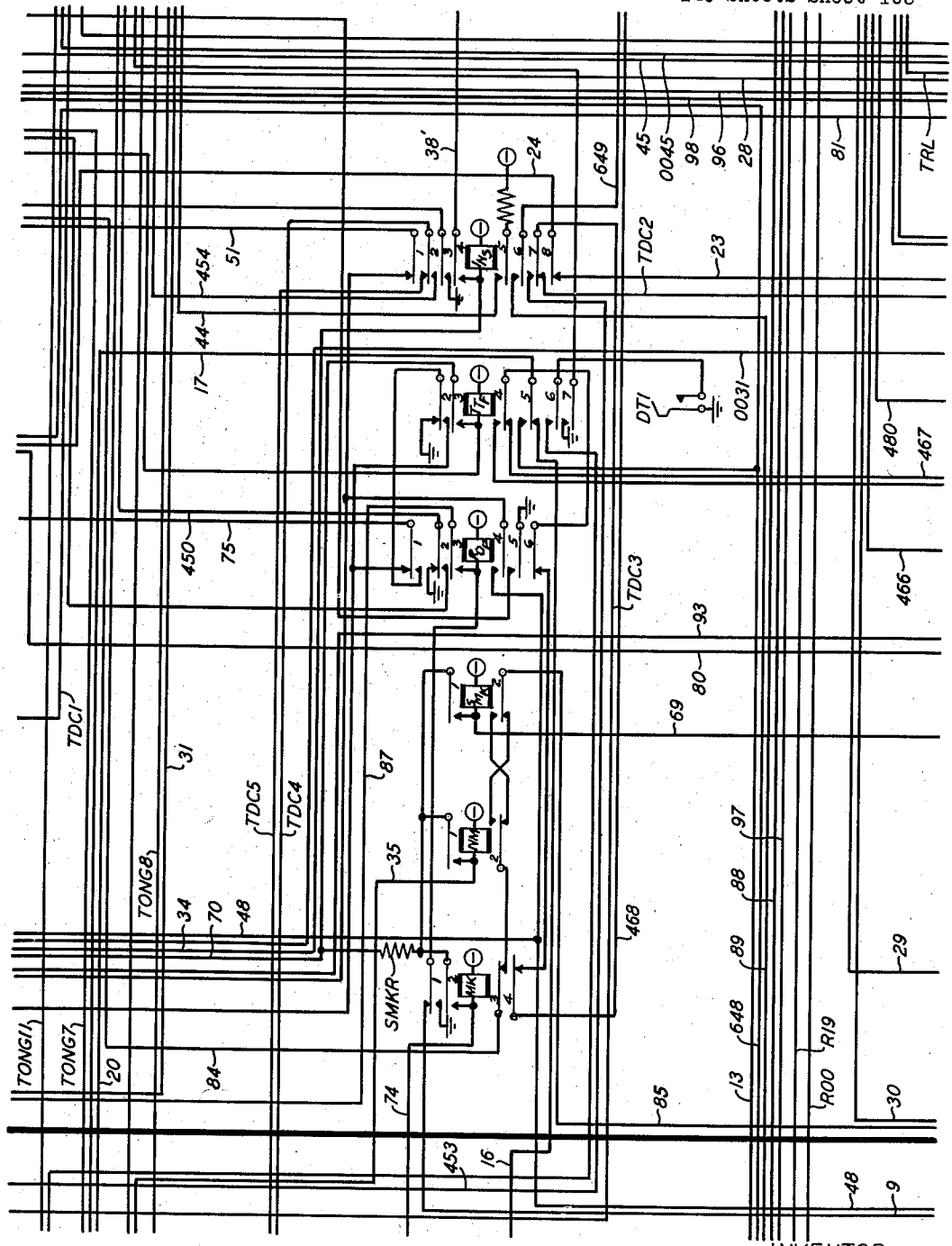


FIG. 103

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 104

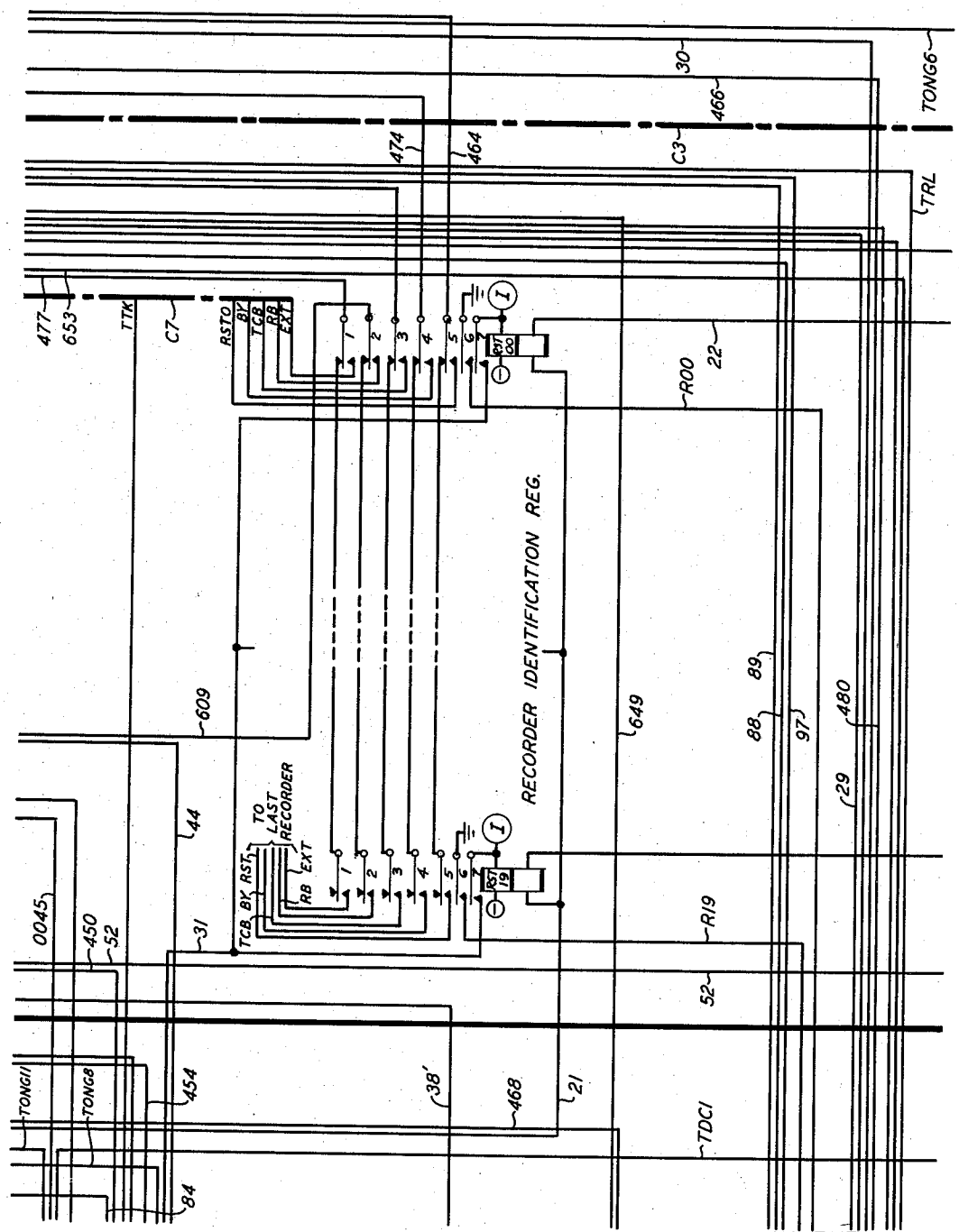


FIG. 104

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 105

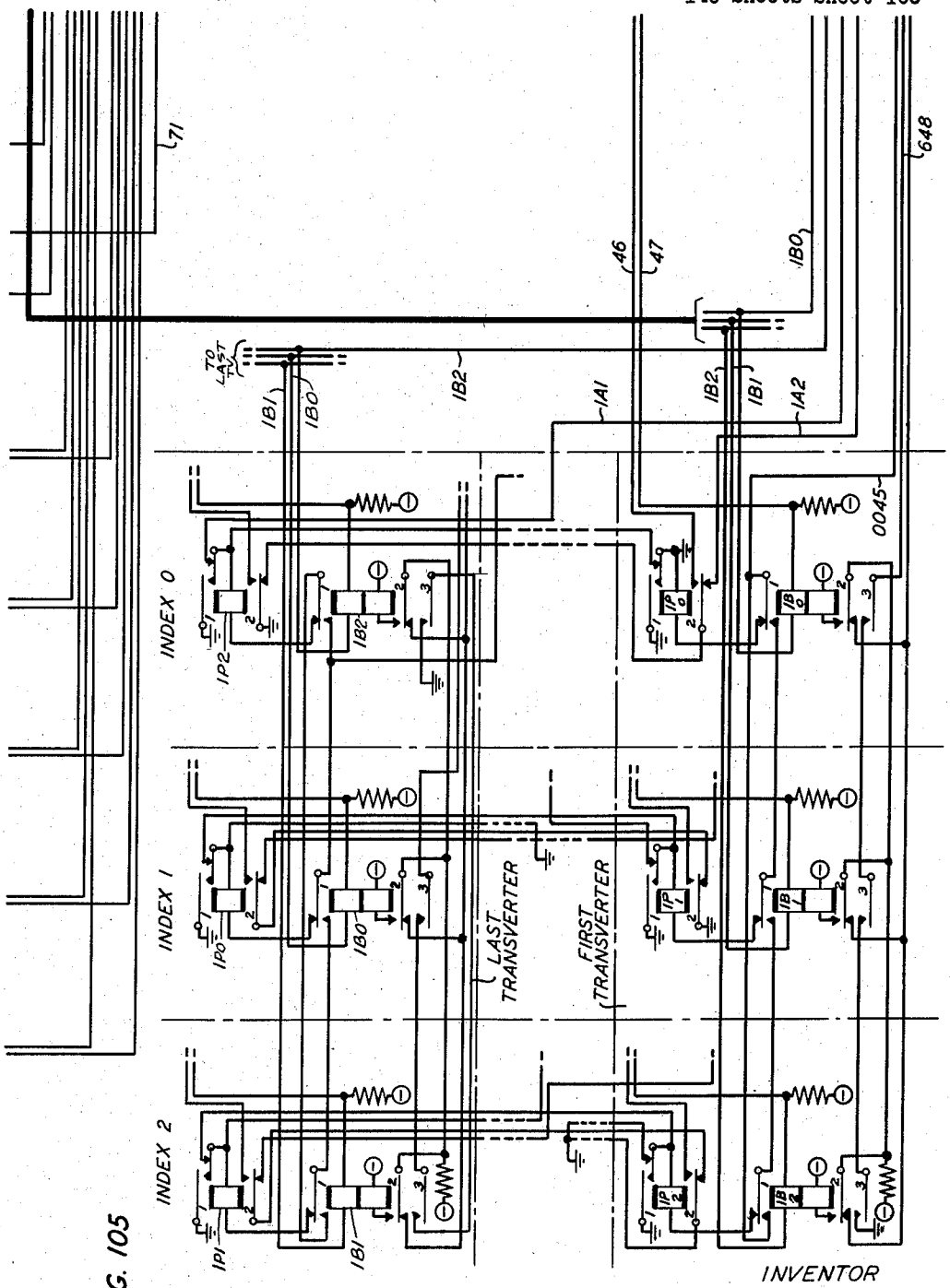


FIG. 105

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 106

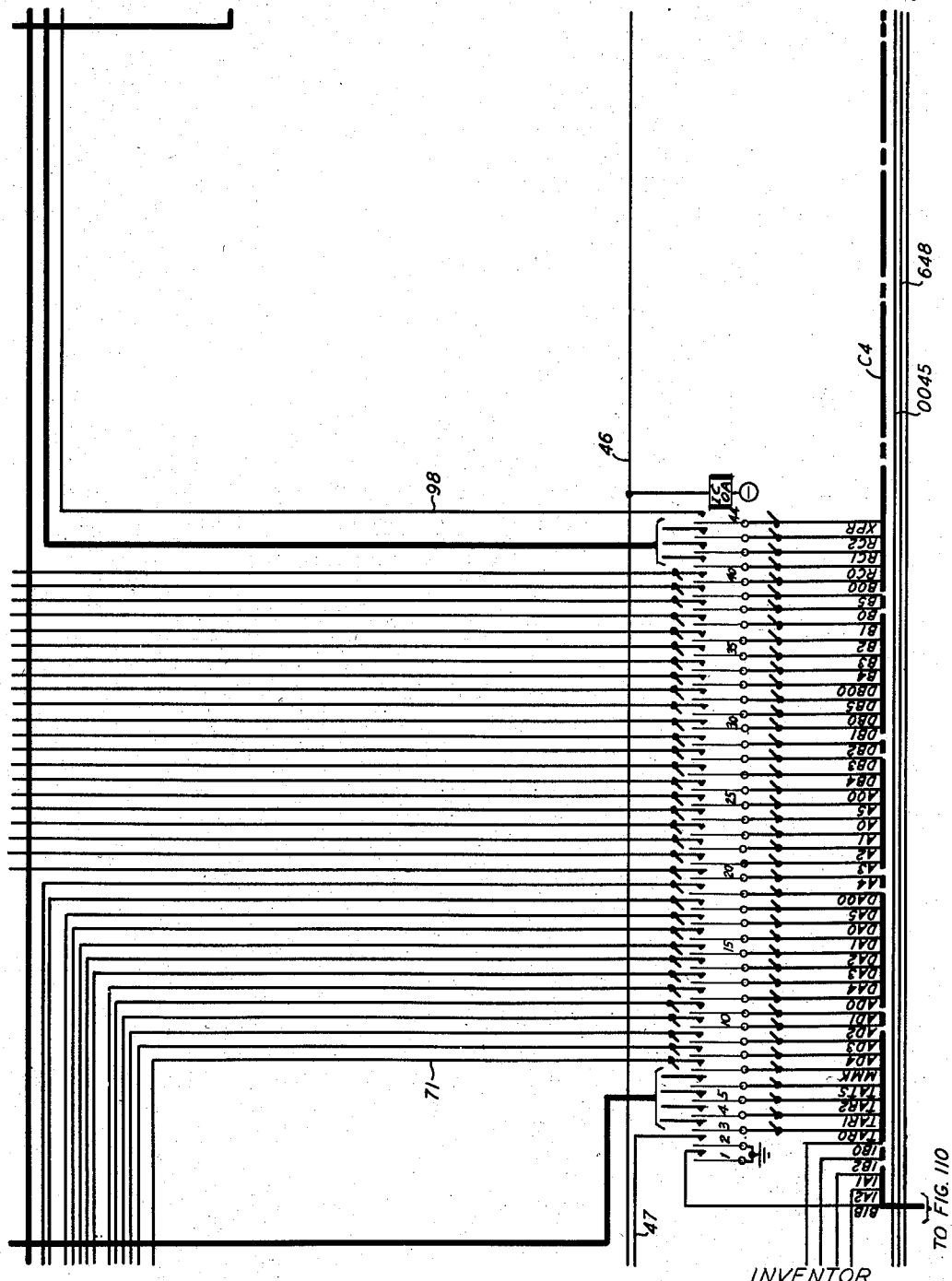


FIG. 106

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 107

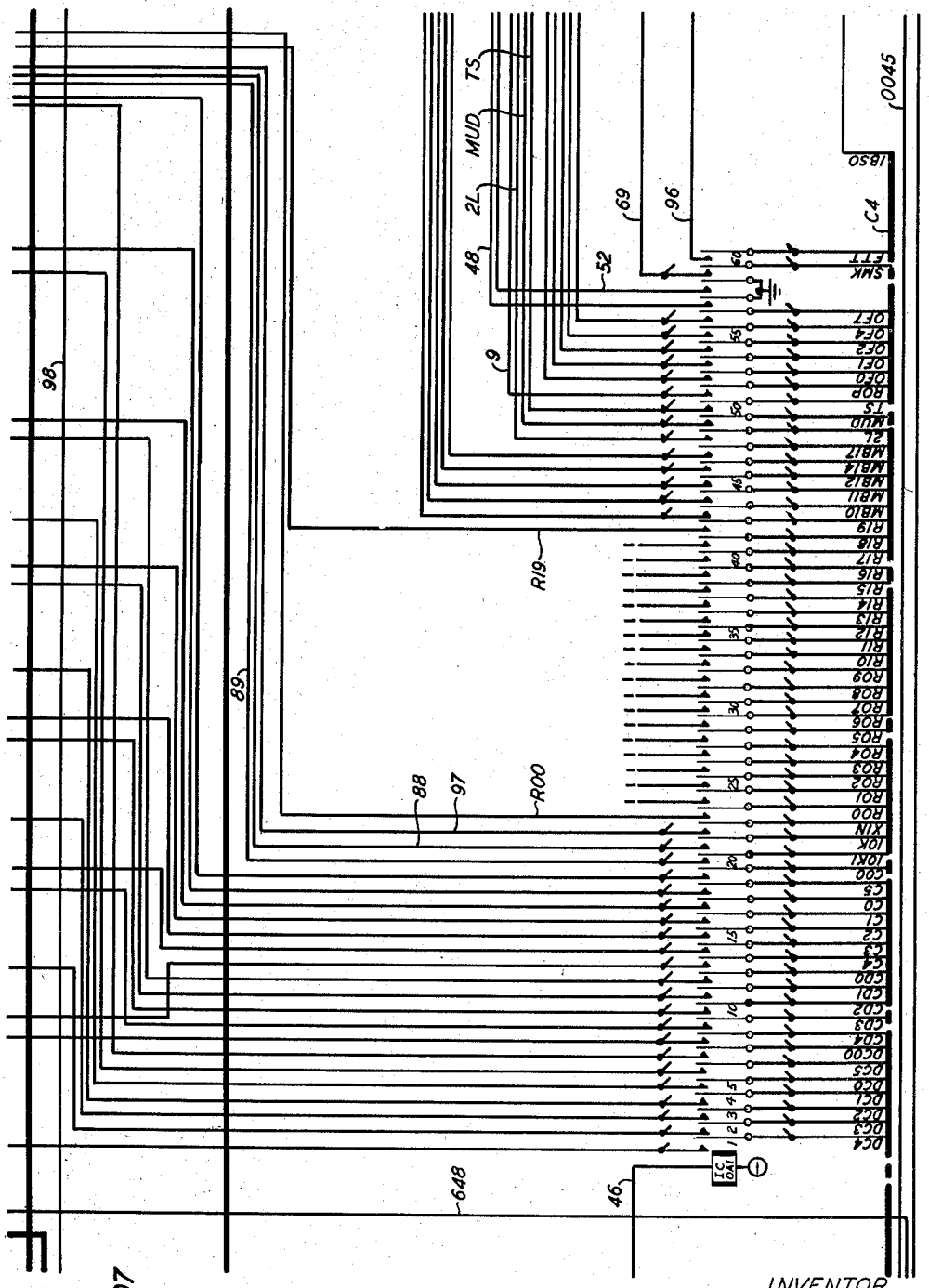


FIG. 107

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 108

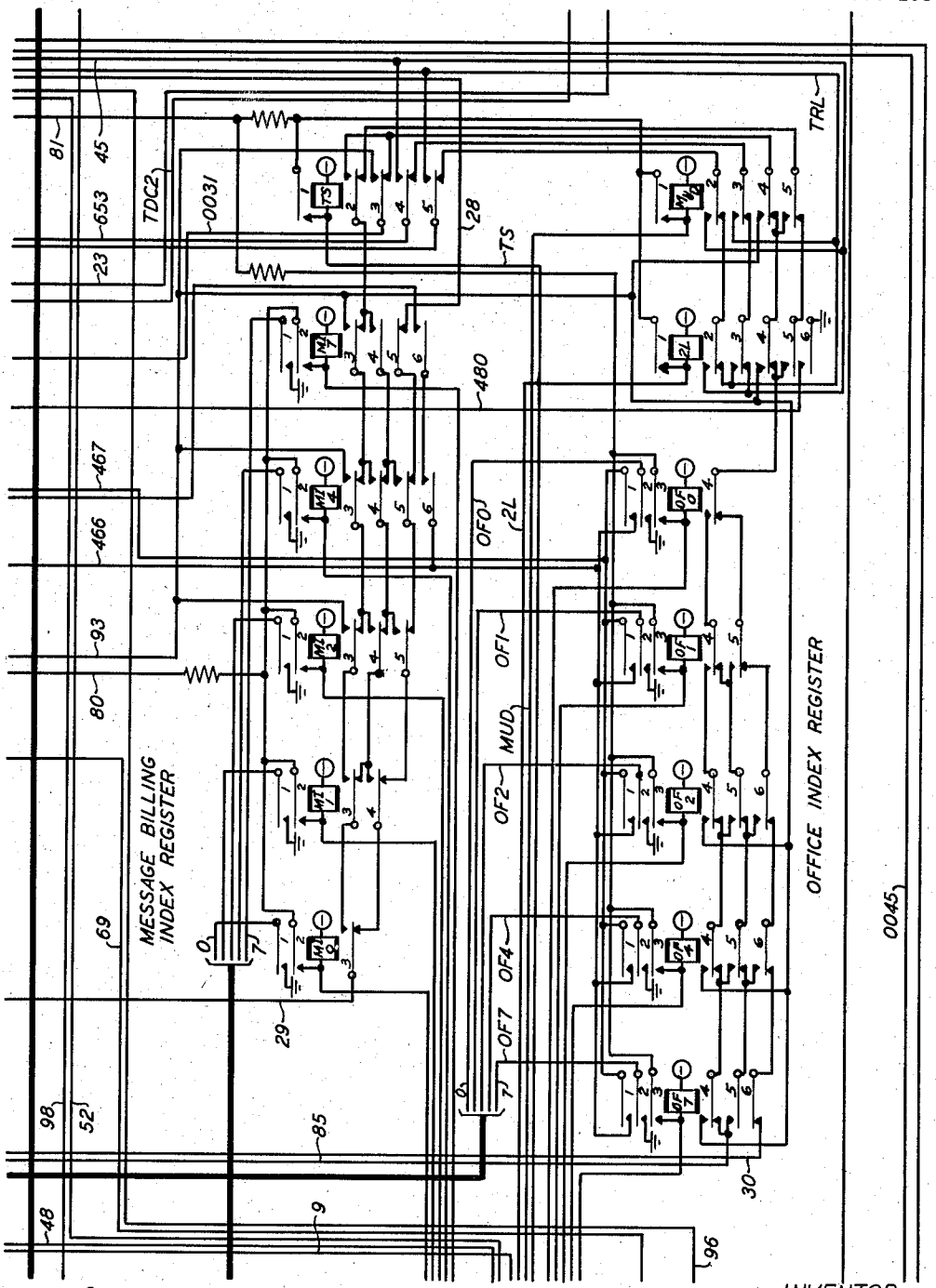


FIG. 108

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 109

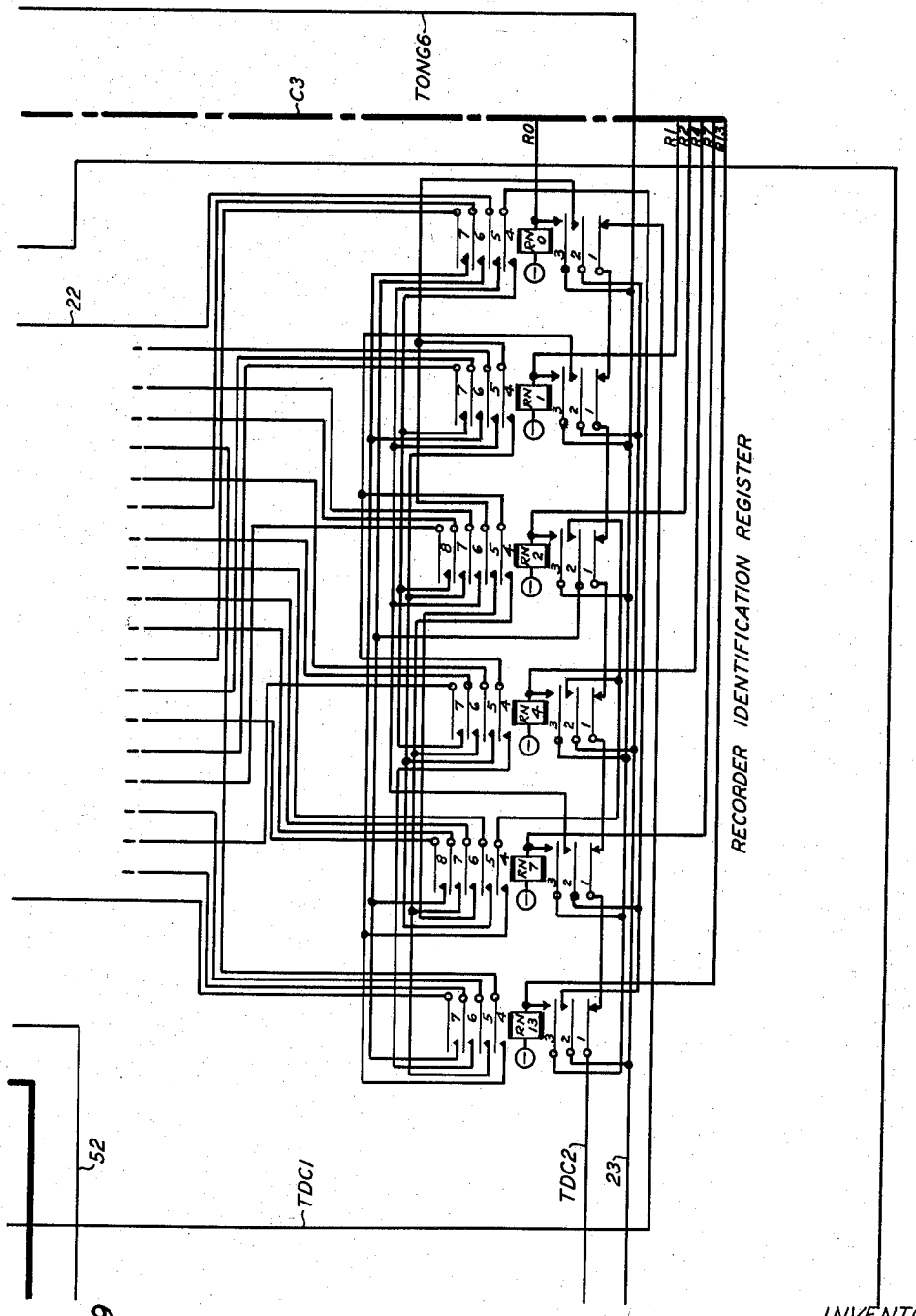


FIG. 109

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 110

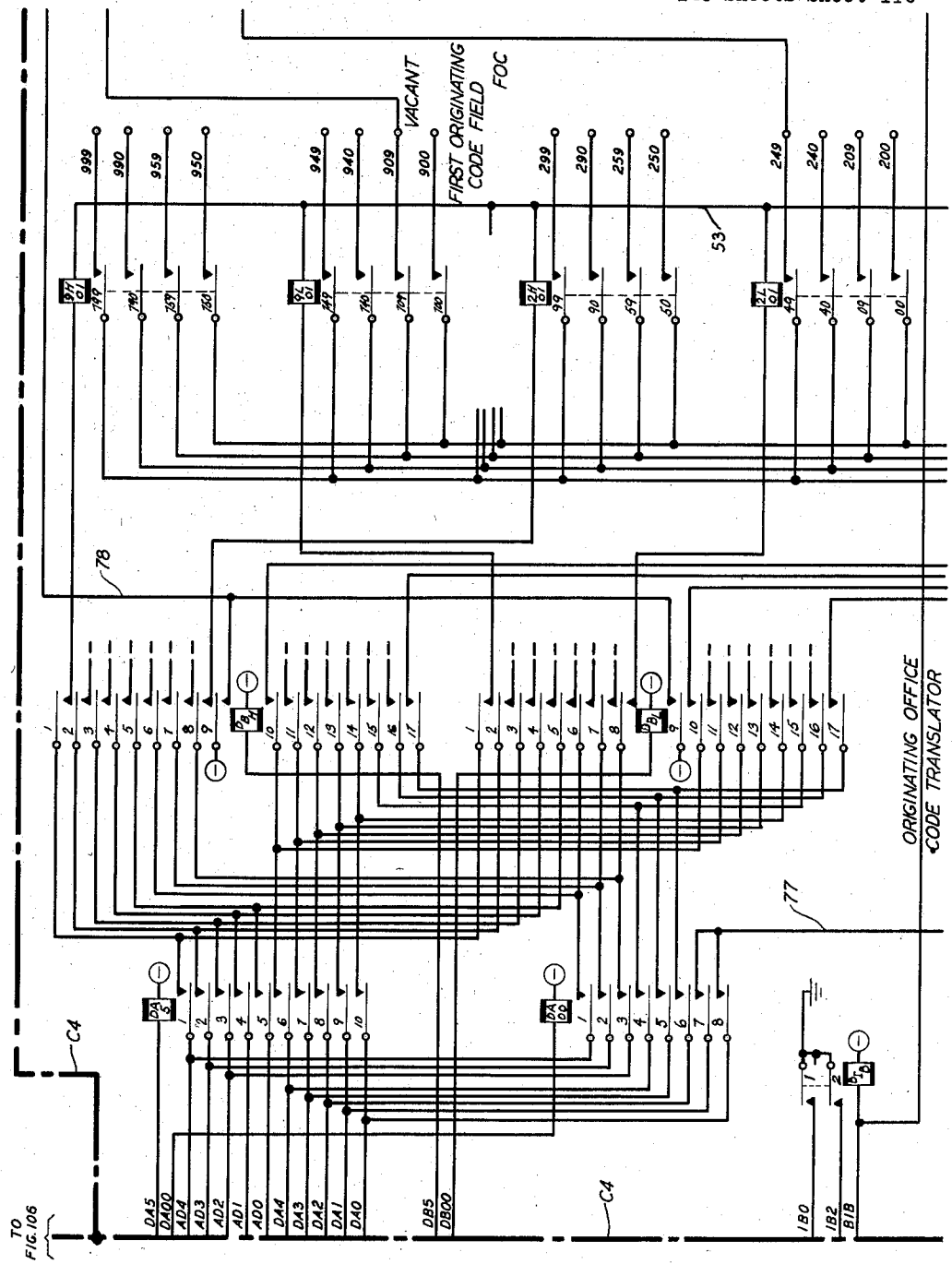


FIG. 110

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 111

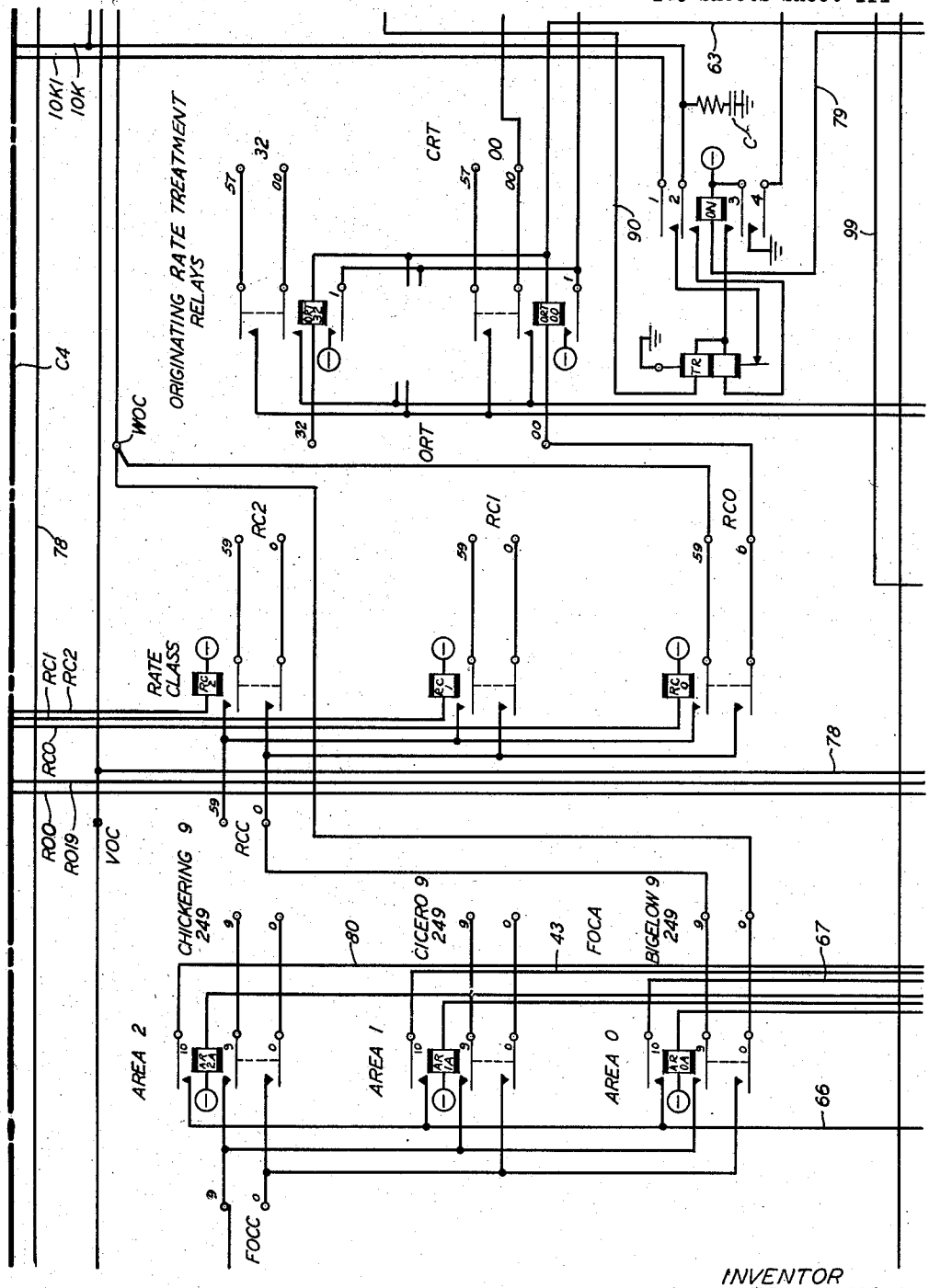


FIG. 111

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 112

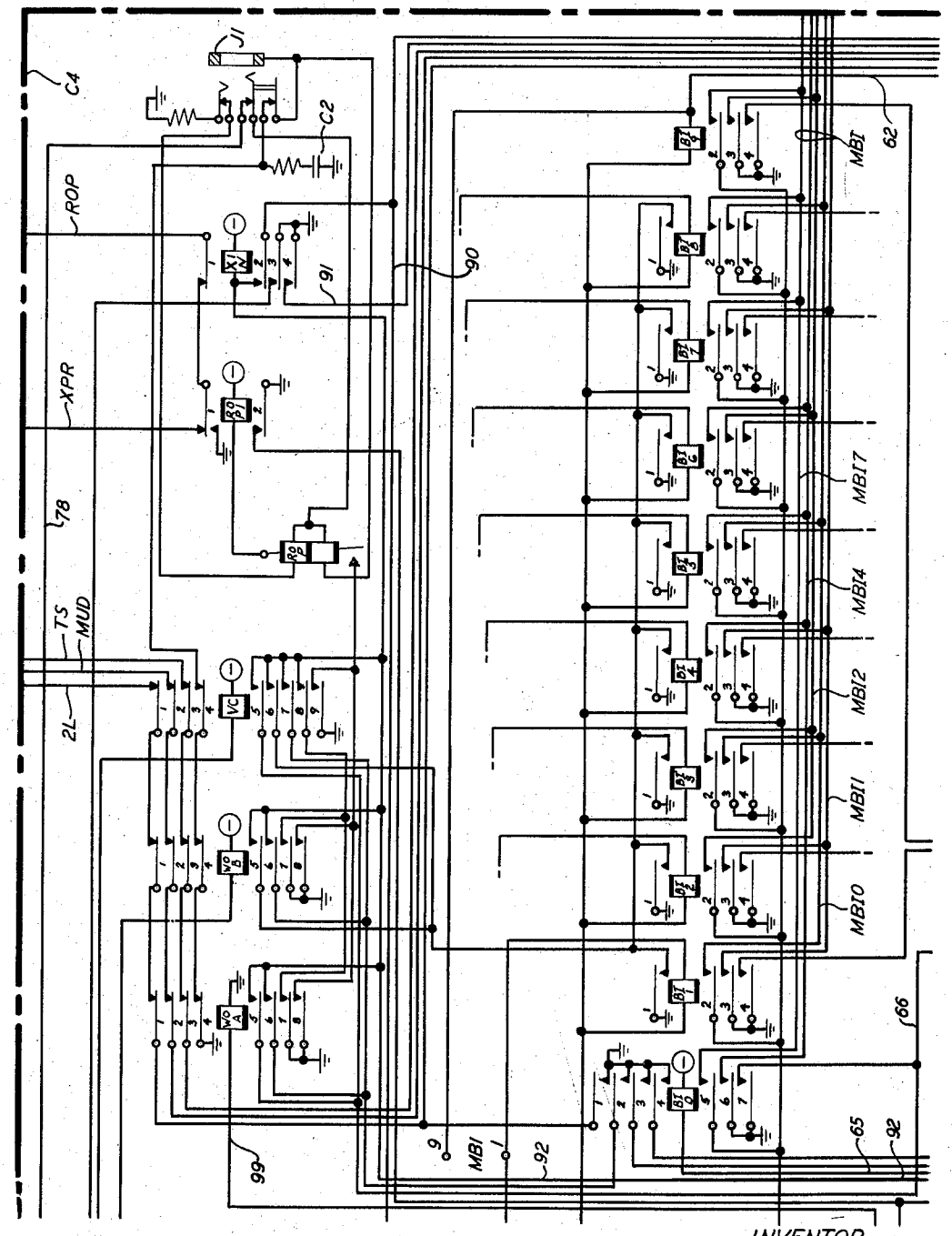


FIG. 112

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 113

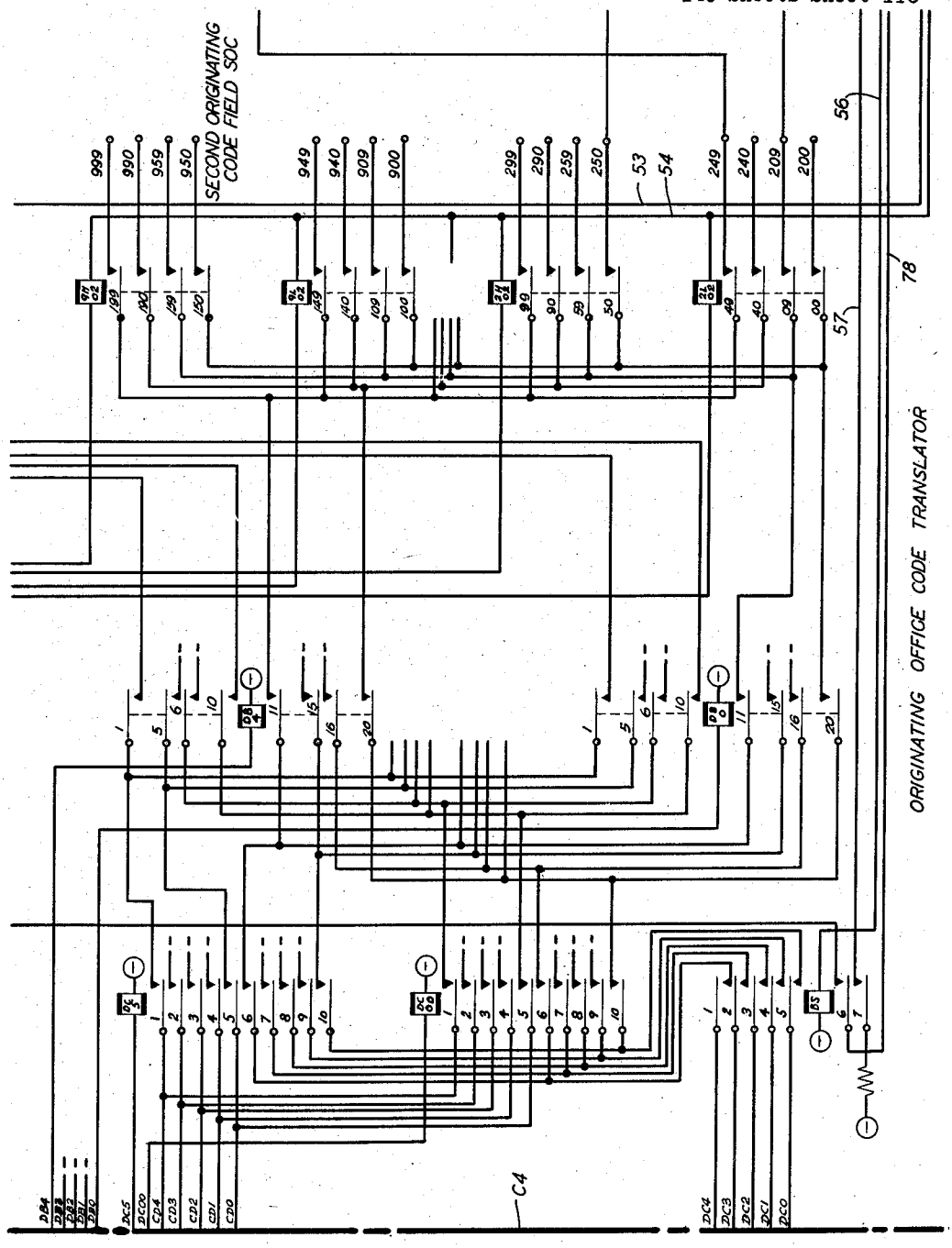


FIG. 113

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 114

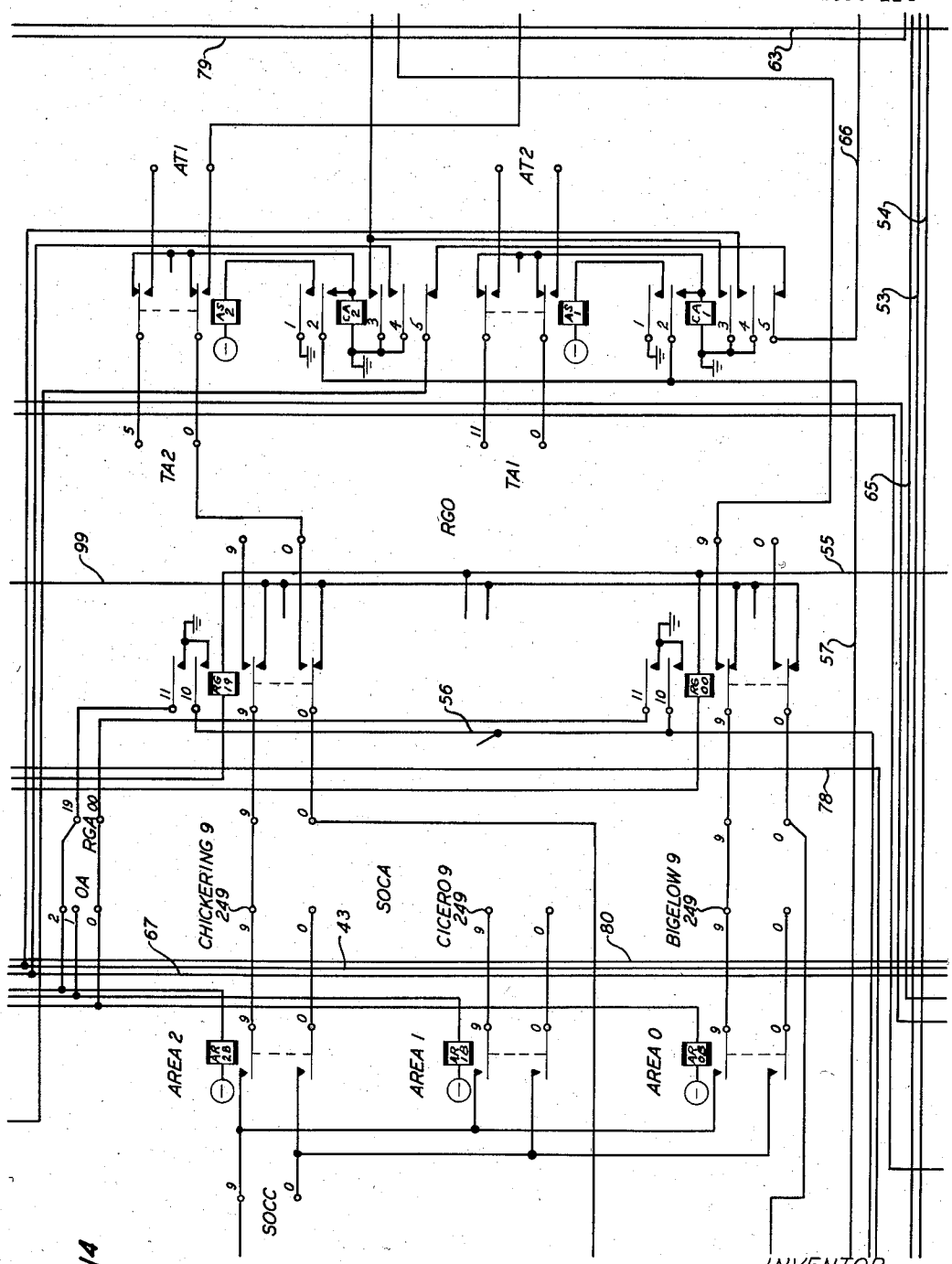


FIG. 114

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 115

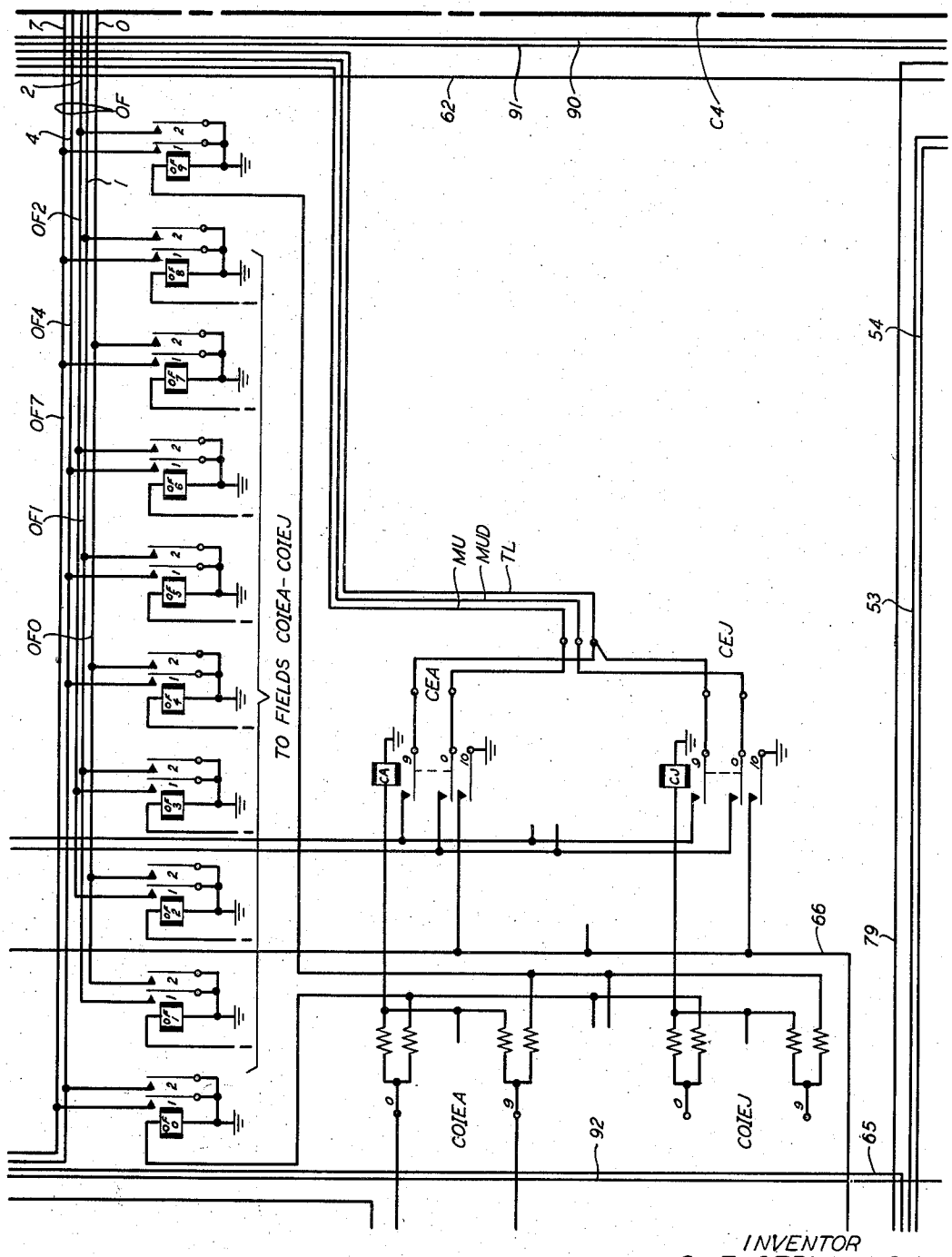


FIG. 115

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 116

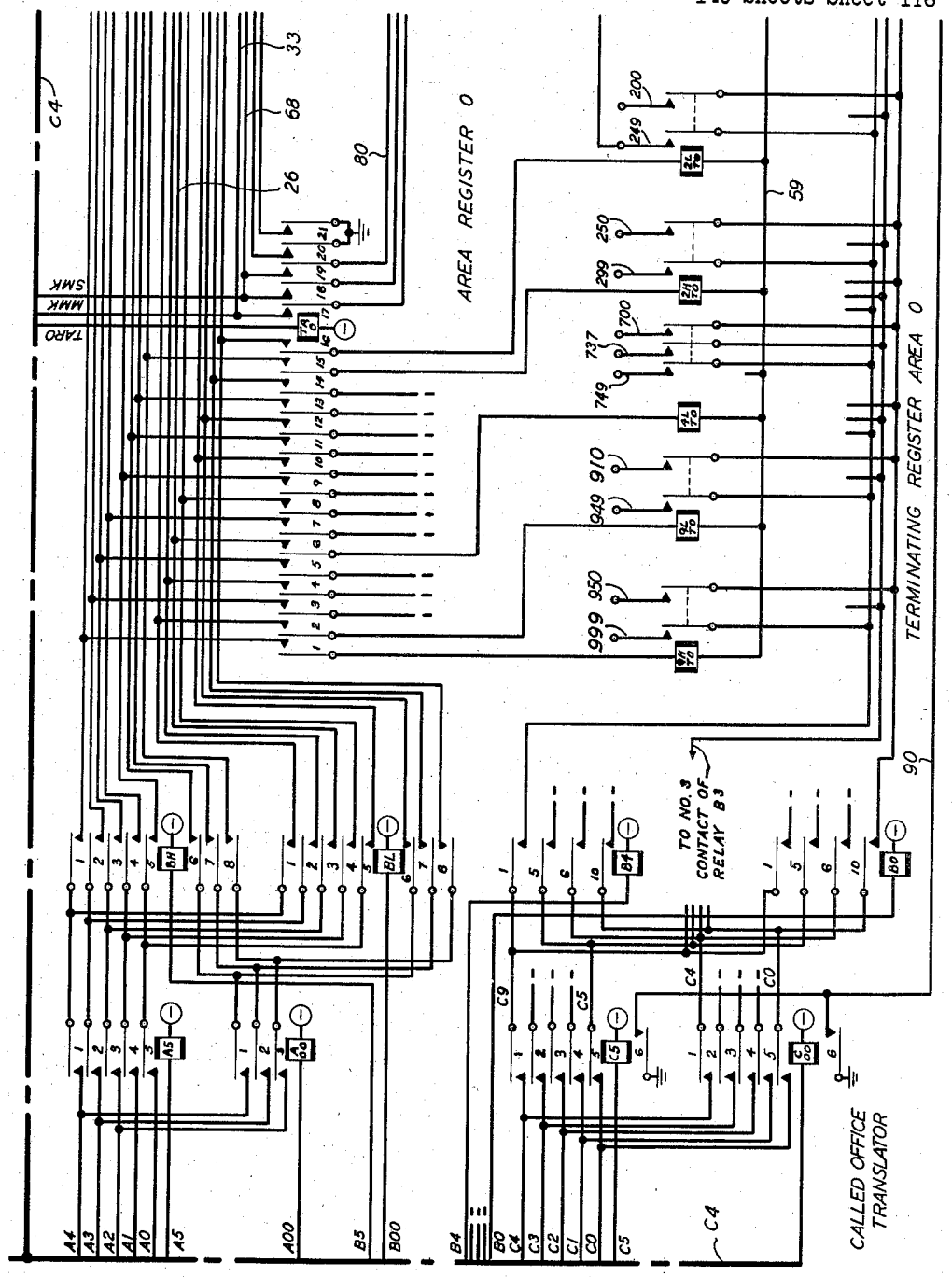


FIG. 116

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 117

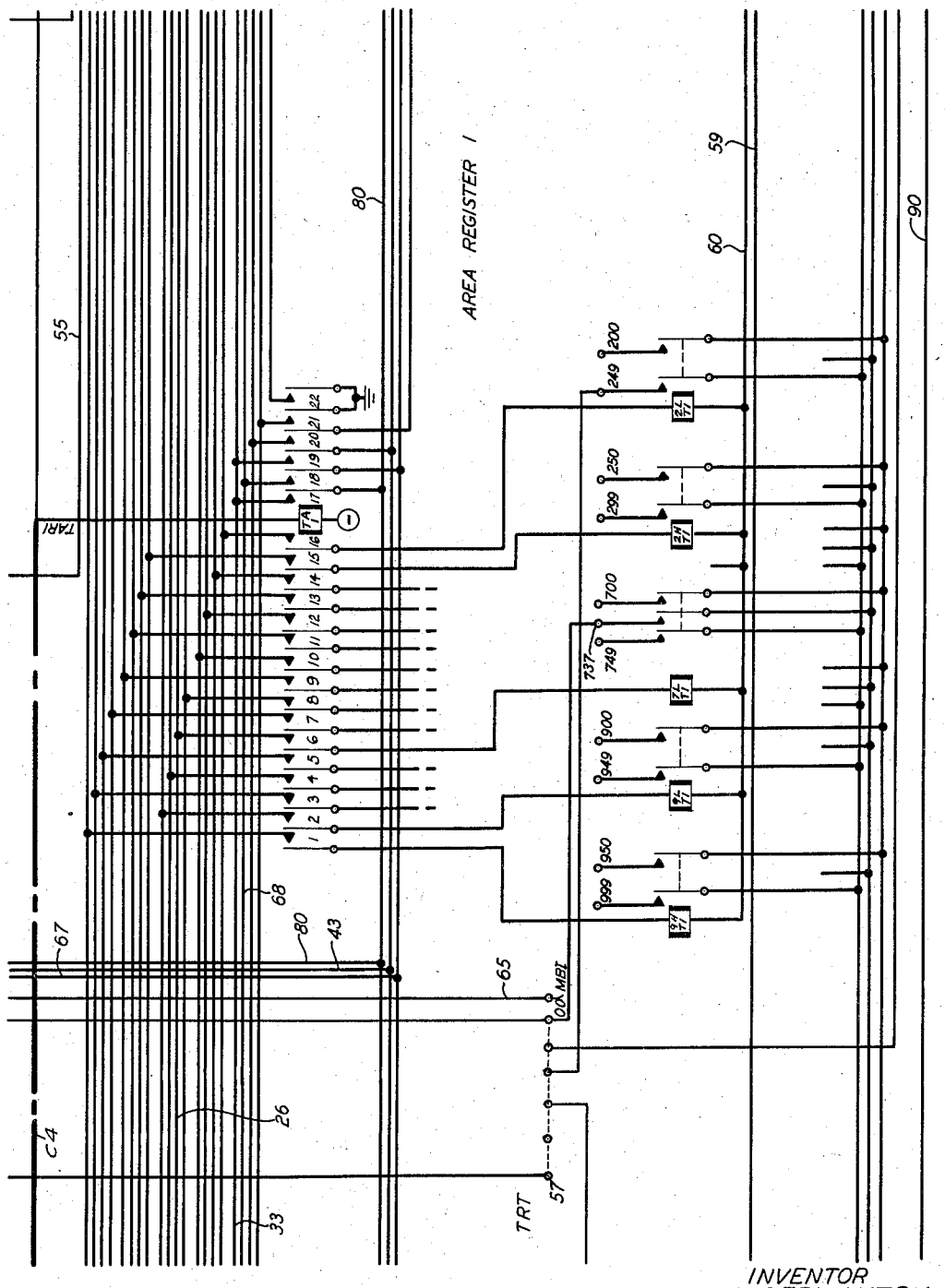


FIG. 117

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 118

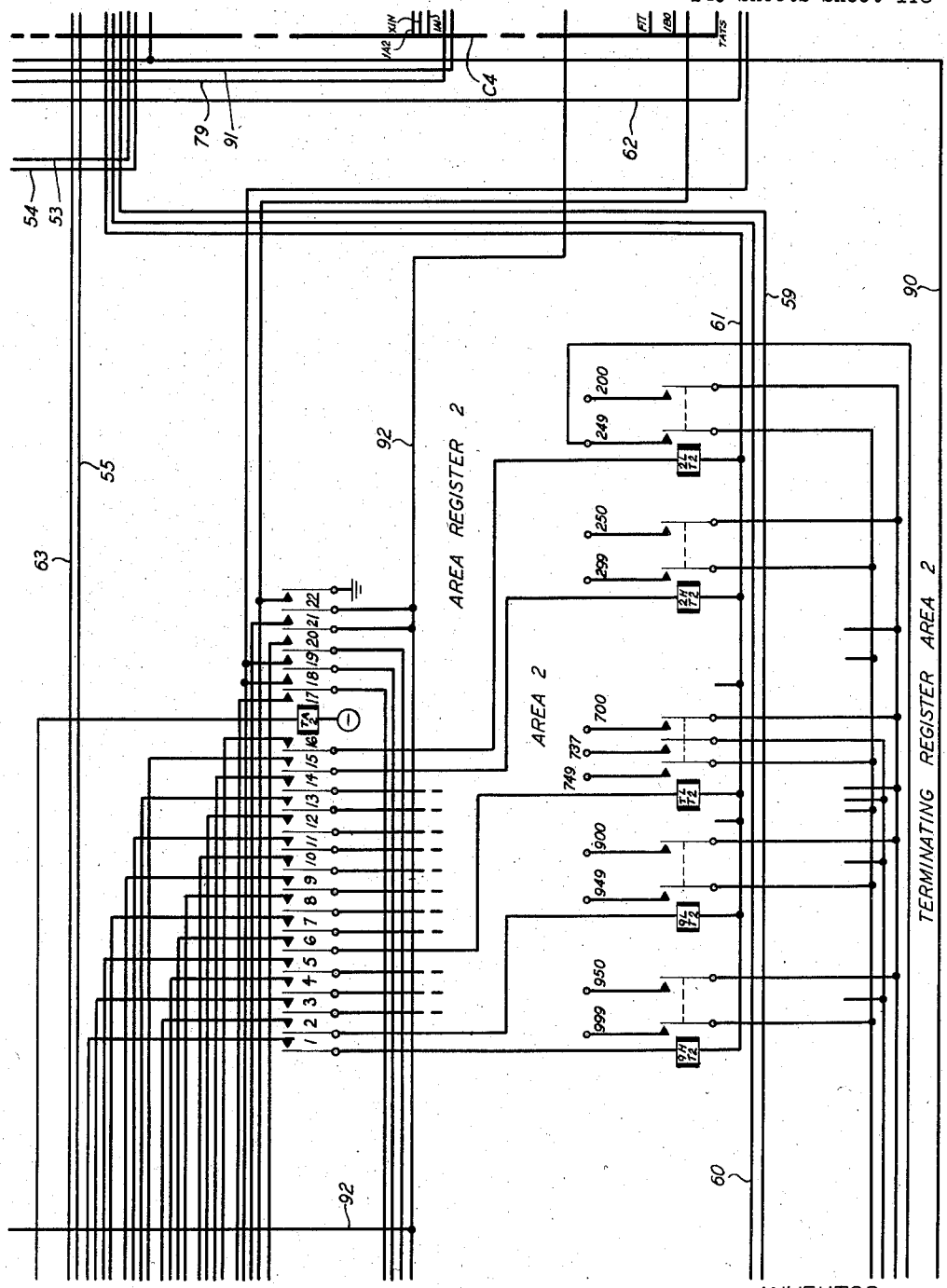


FIG. 118

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 119

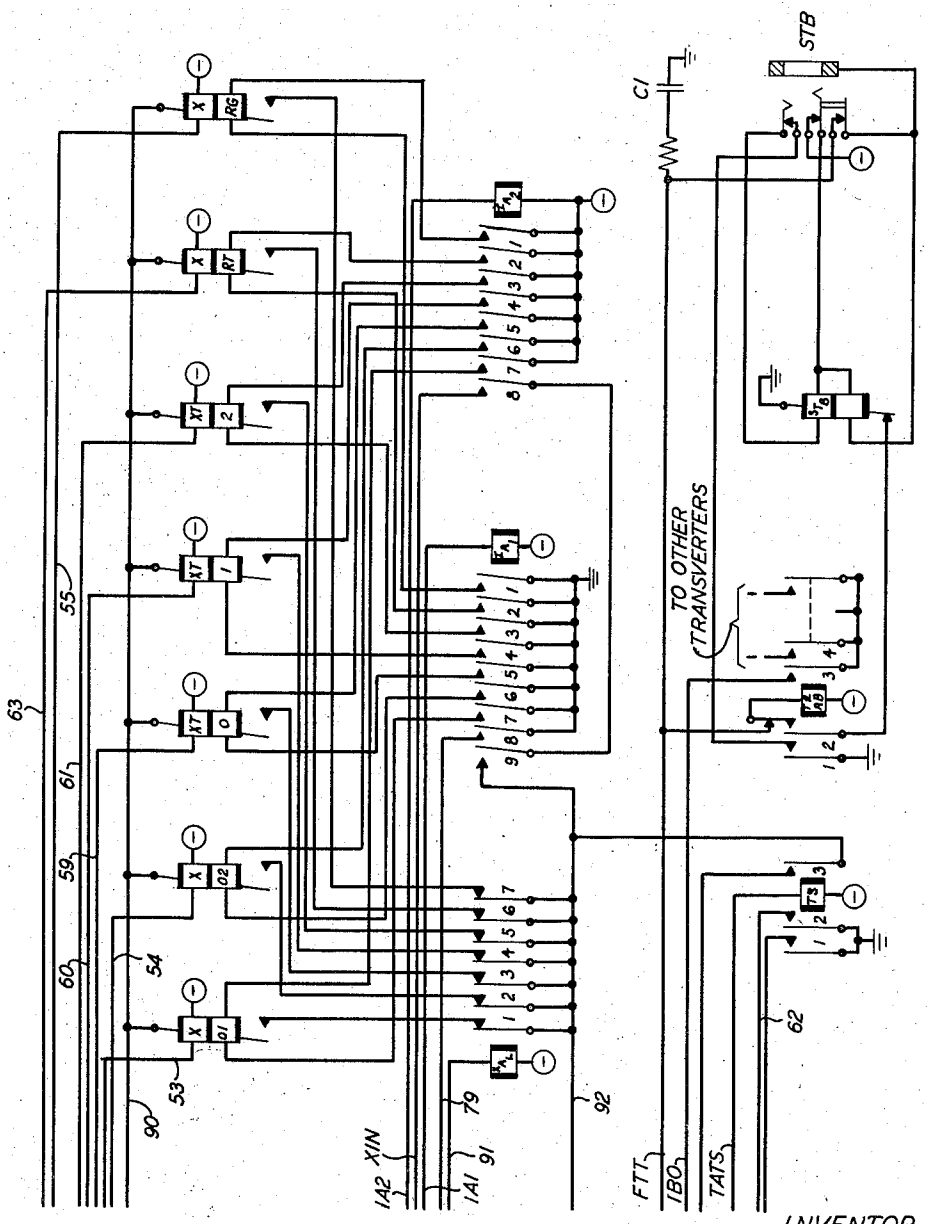


FIG. 119

INVENTOR
C. E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 120

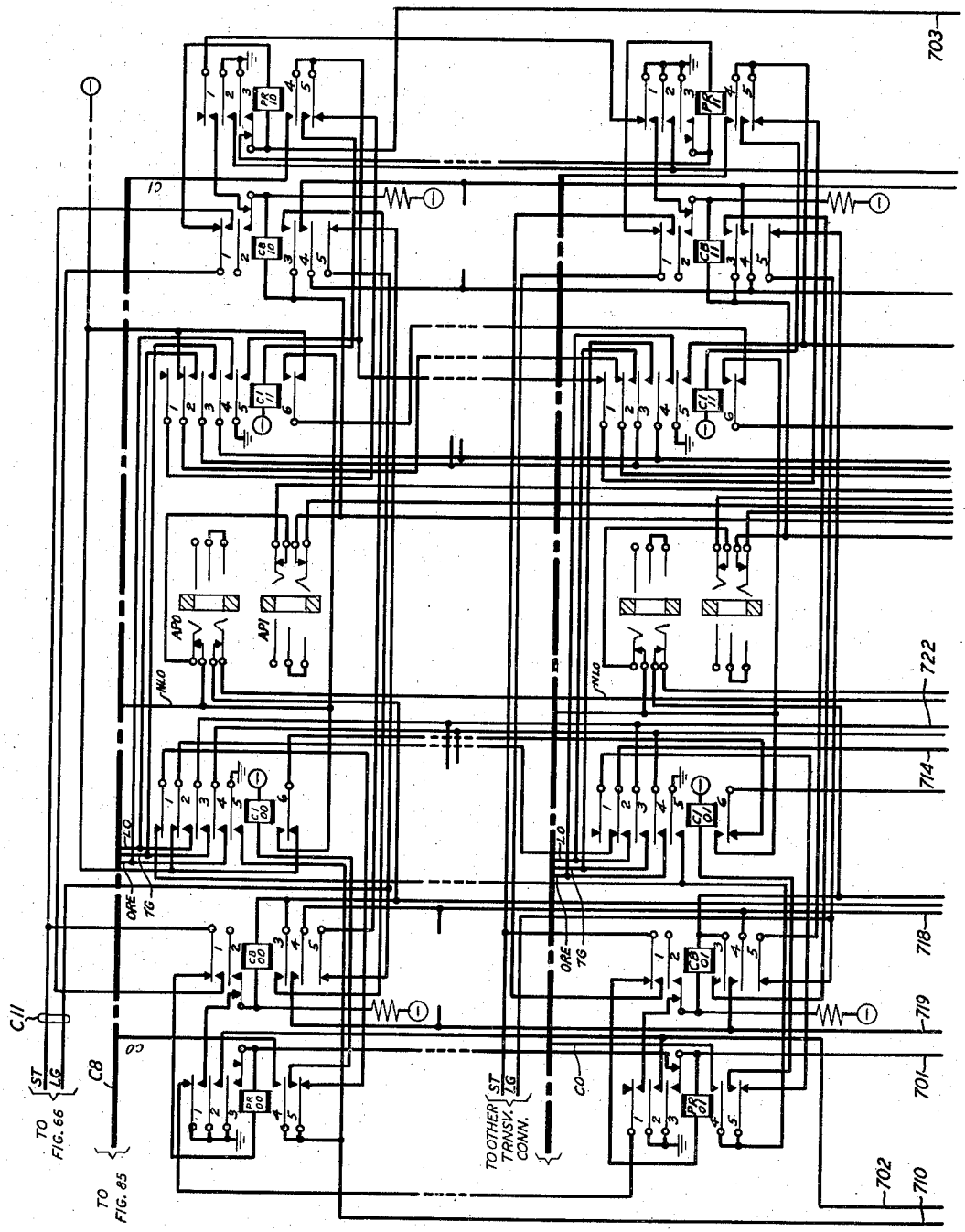


FIG. 120

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 121

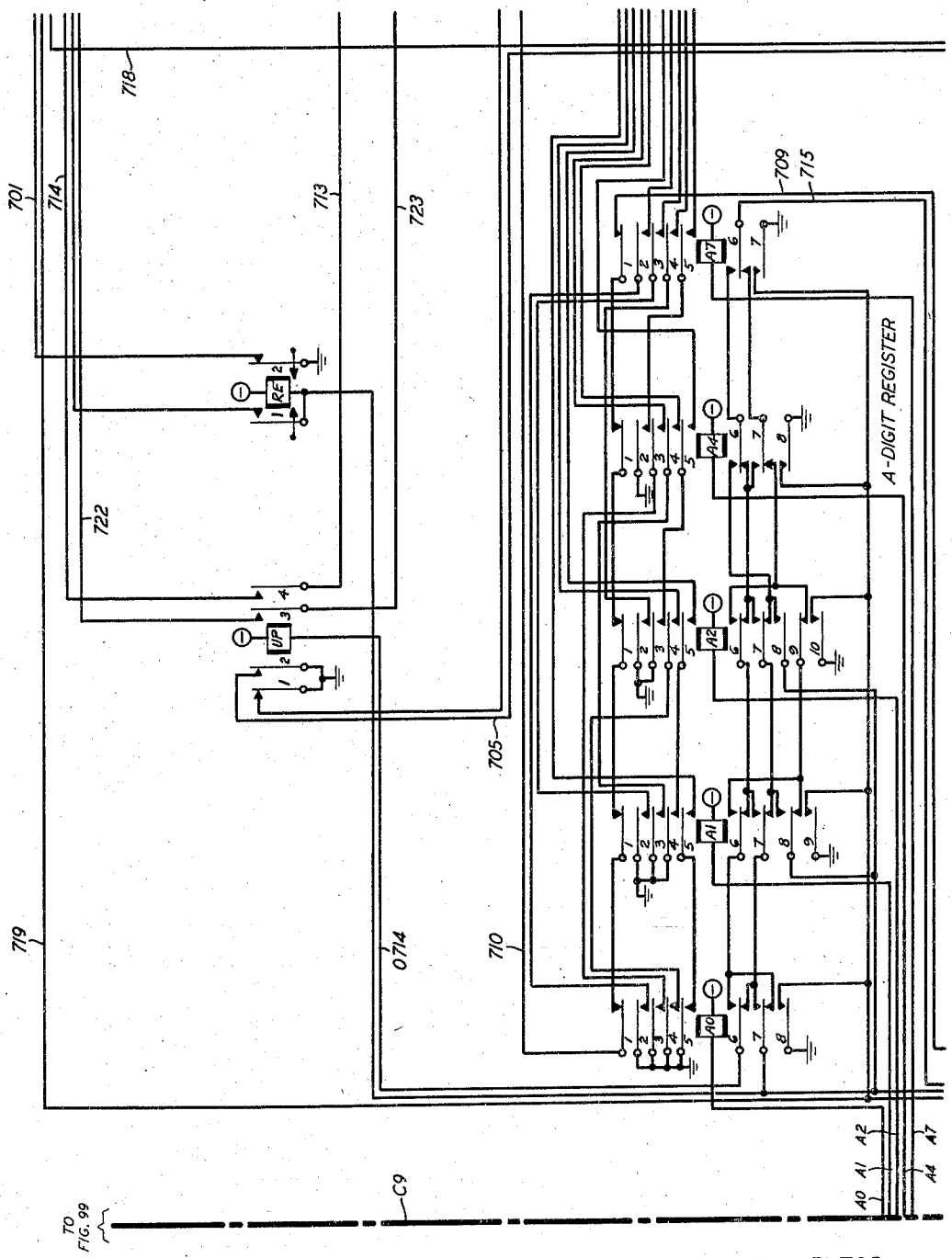


FIG. 121

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 122

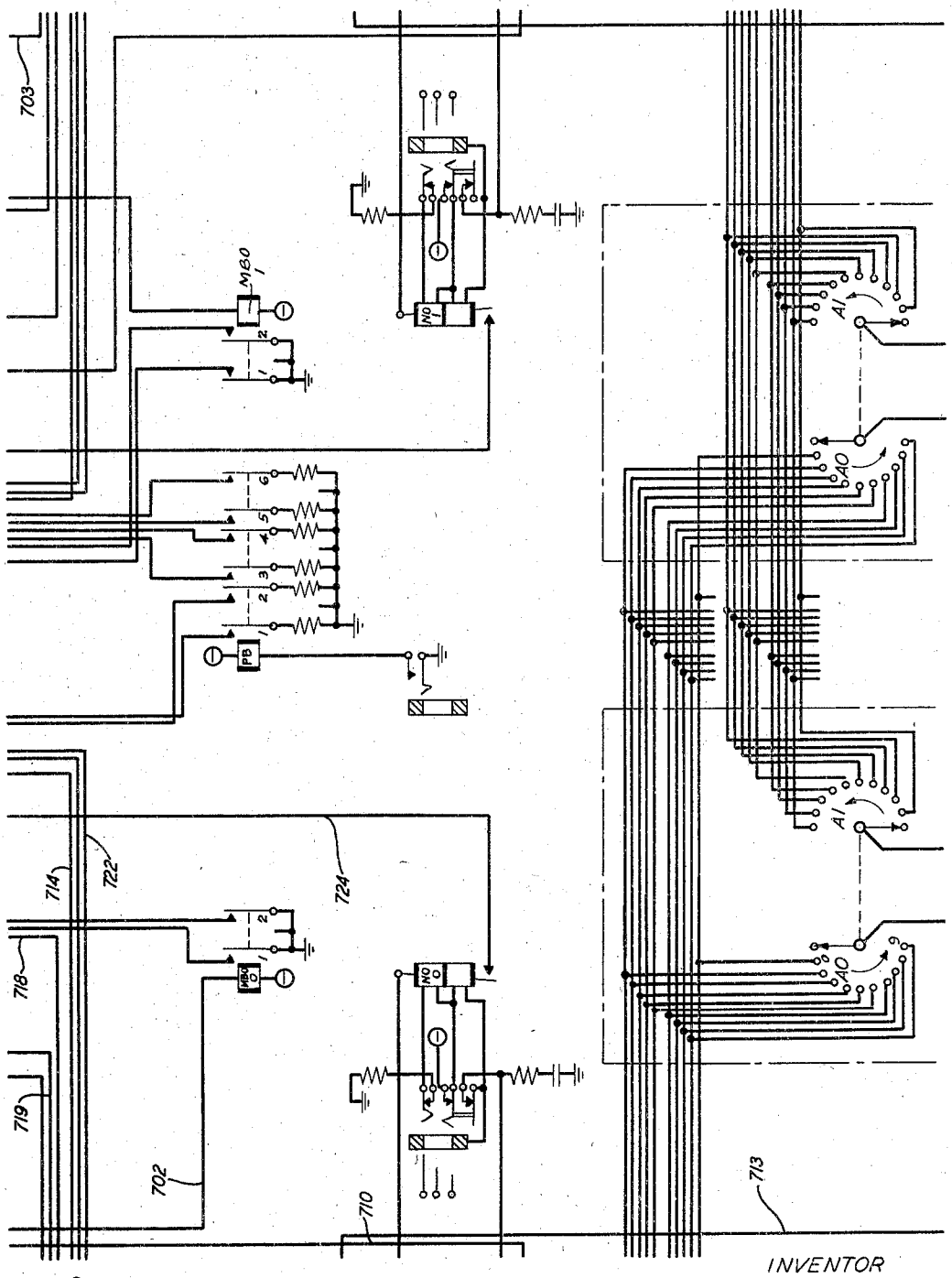


FIG. 122

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 123

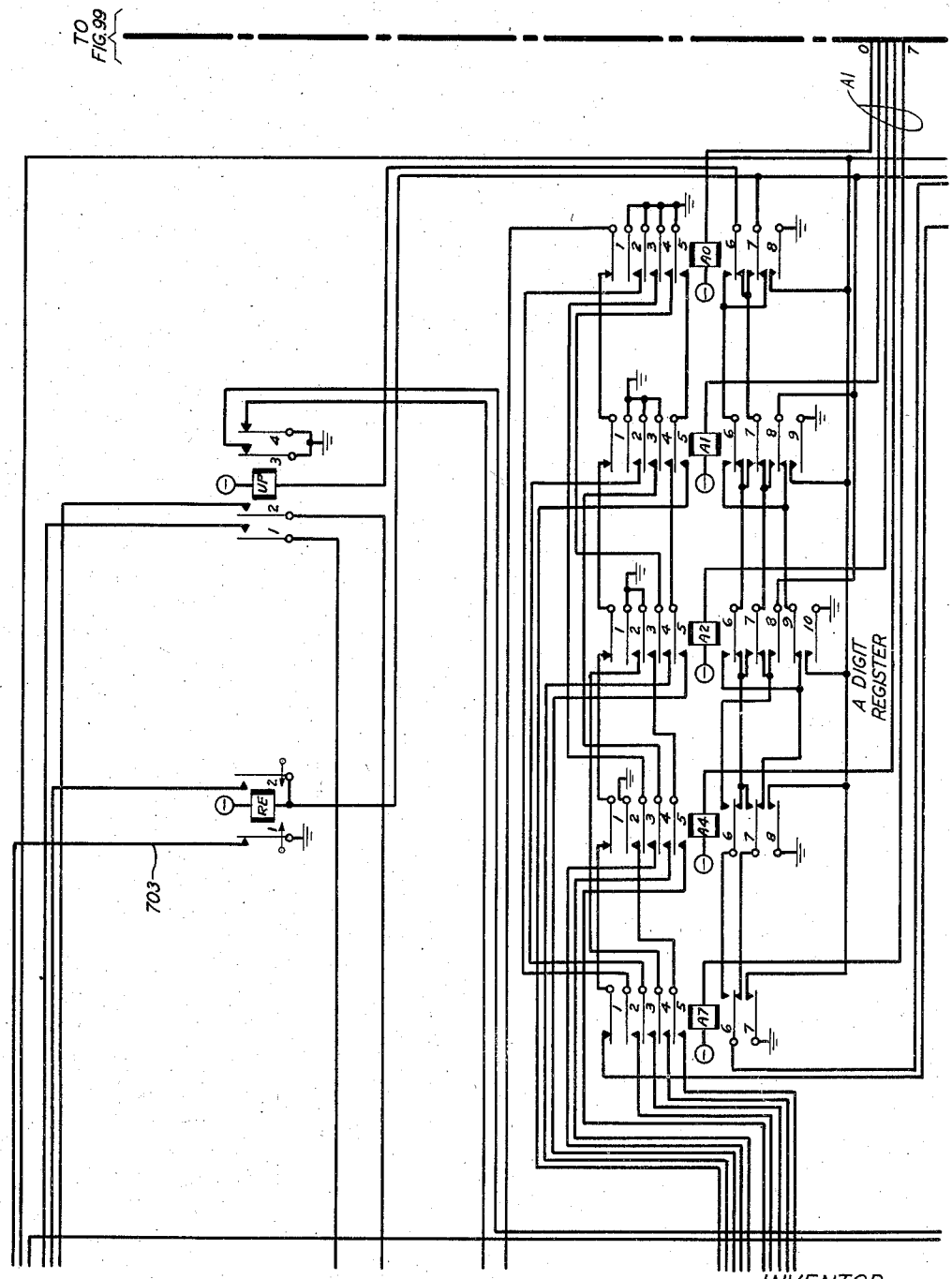


FIG. 123

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 124

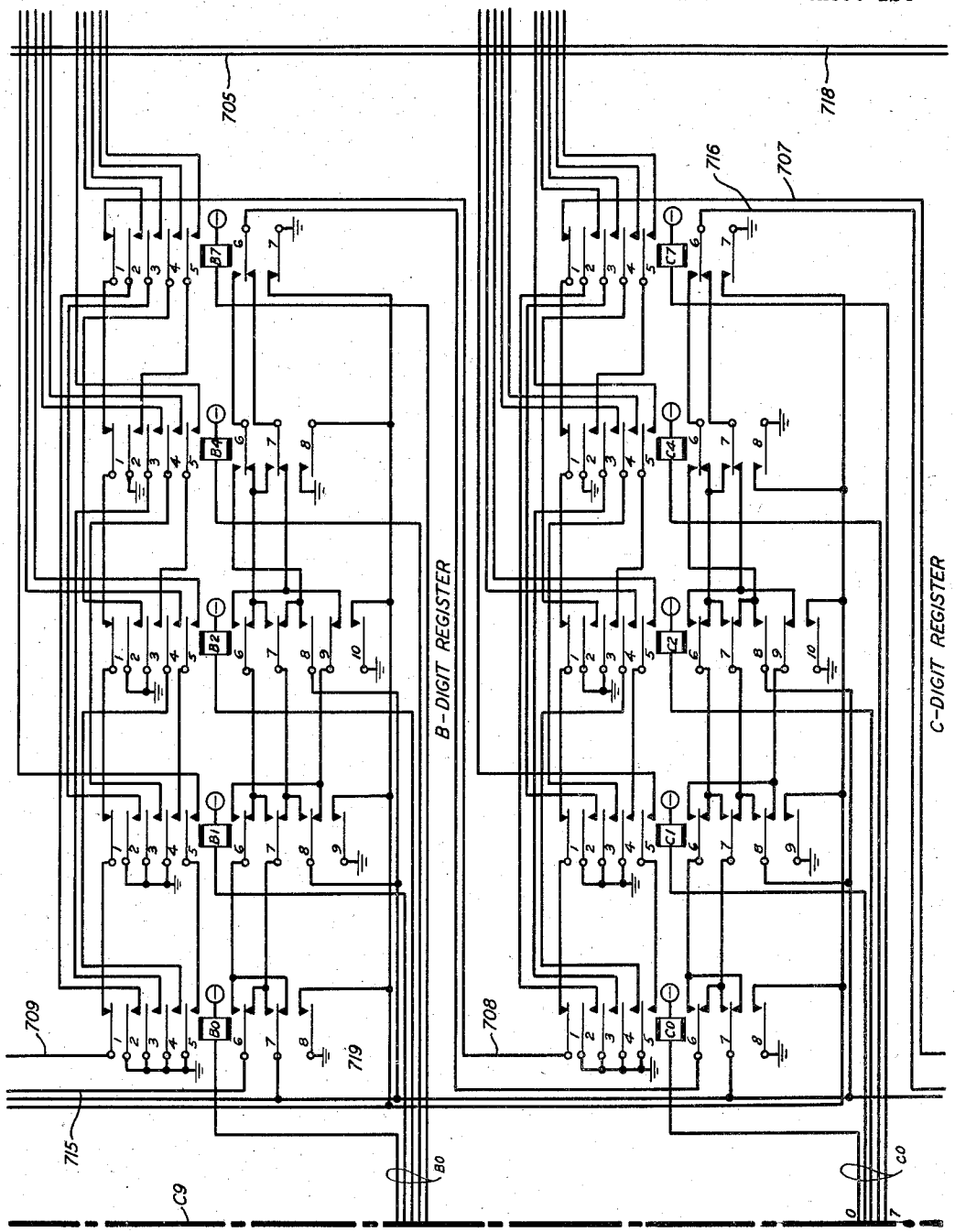


FIG. 124

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 125

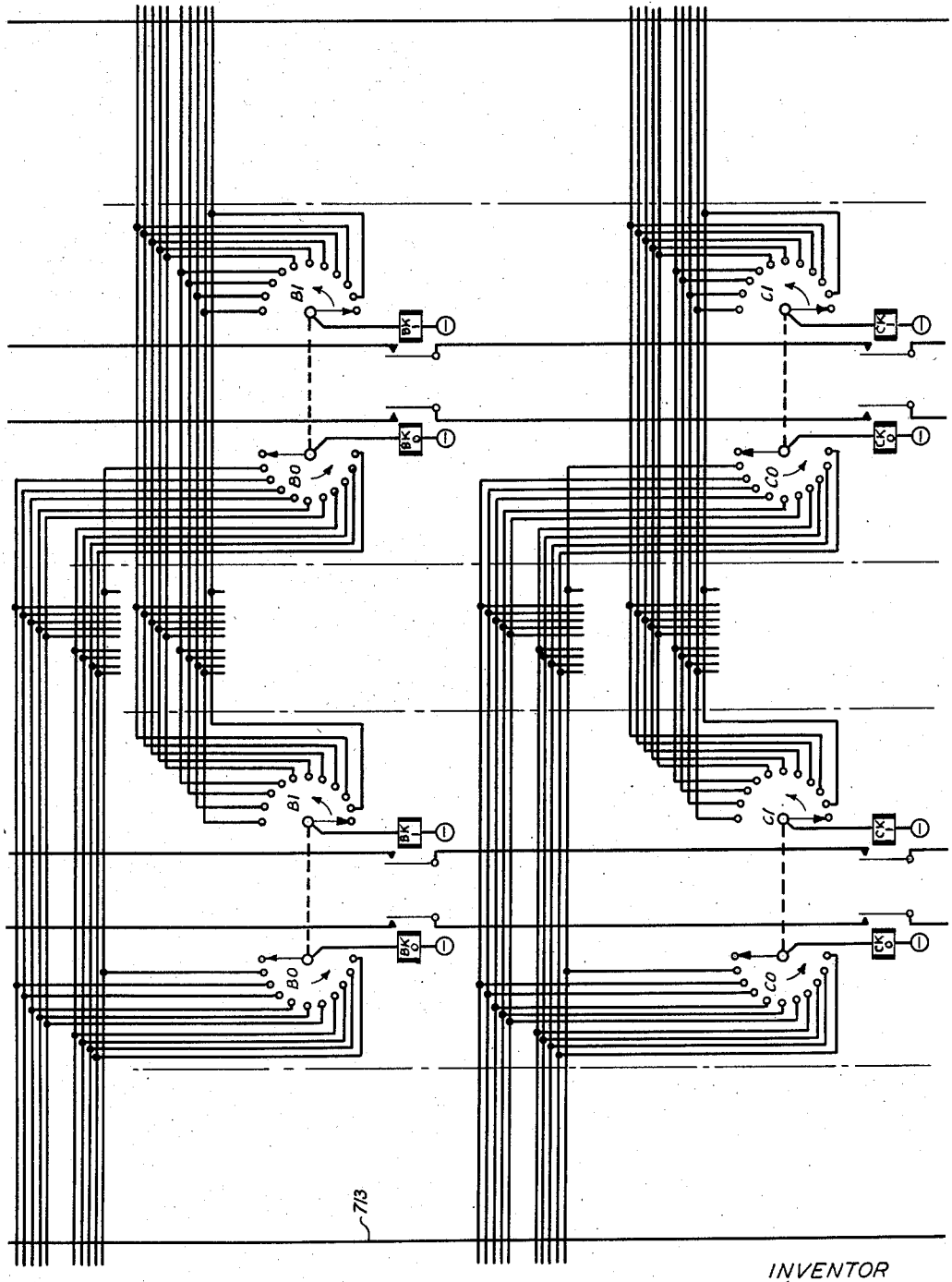


FIG. 125

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 126

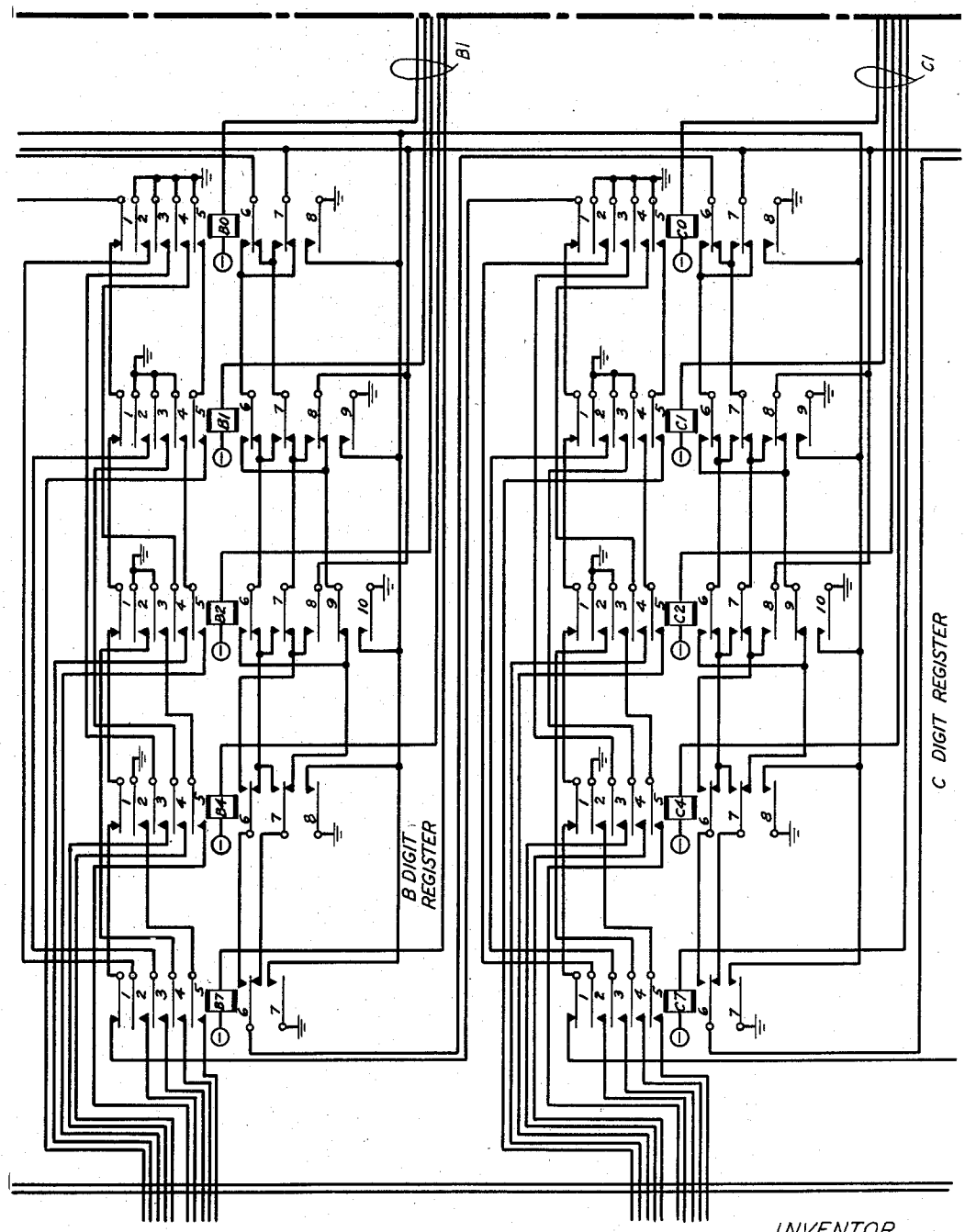


FIG. 126

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 127

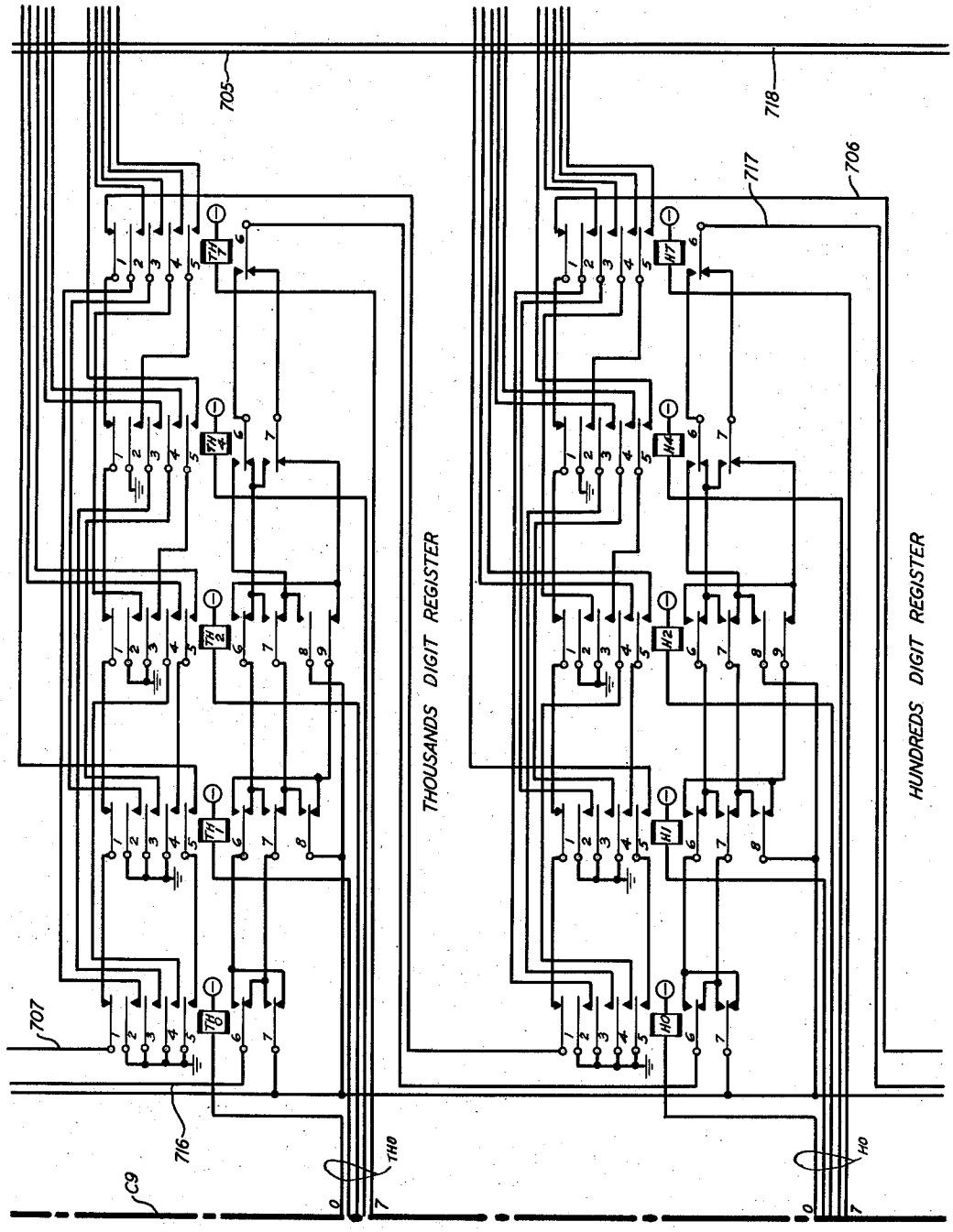


FIG. 127

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 128

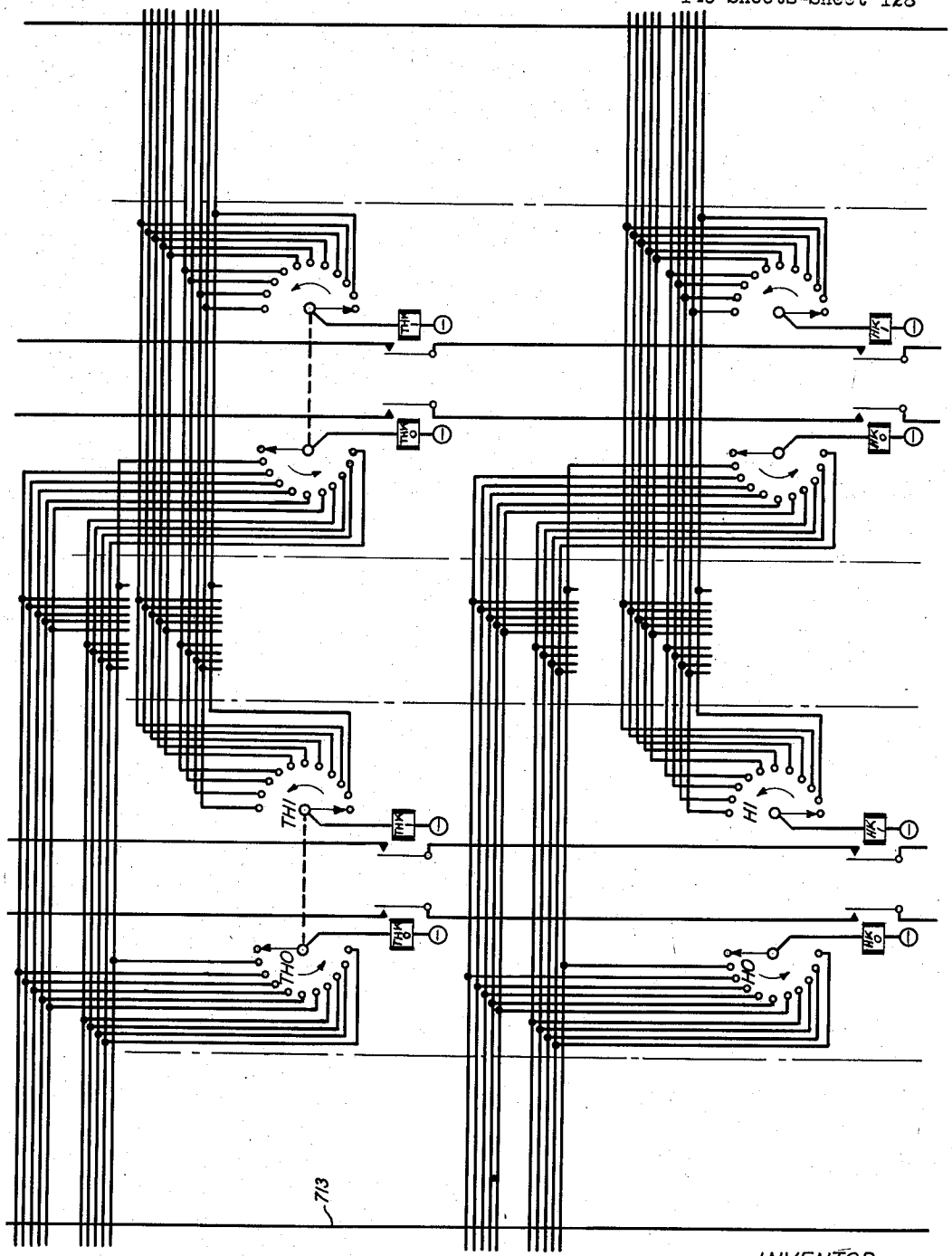


FIG. 128

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 129

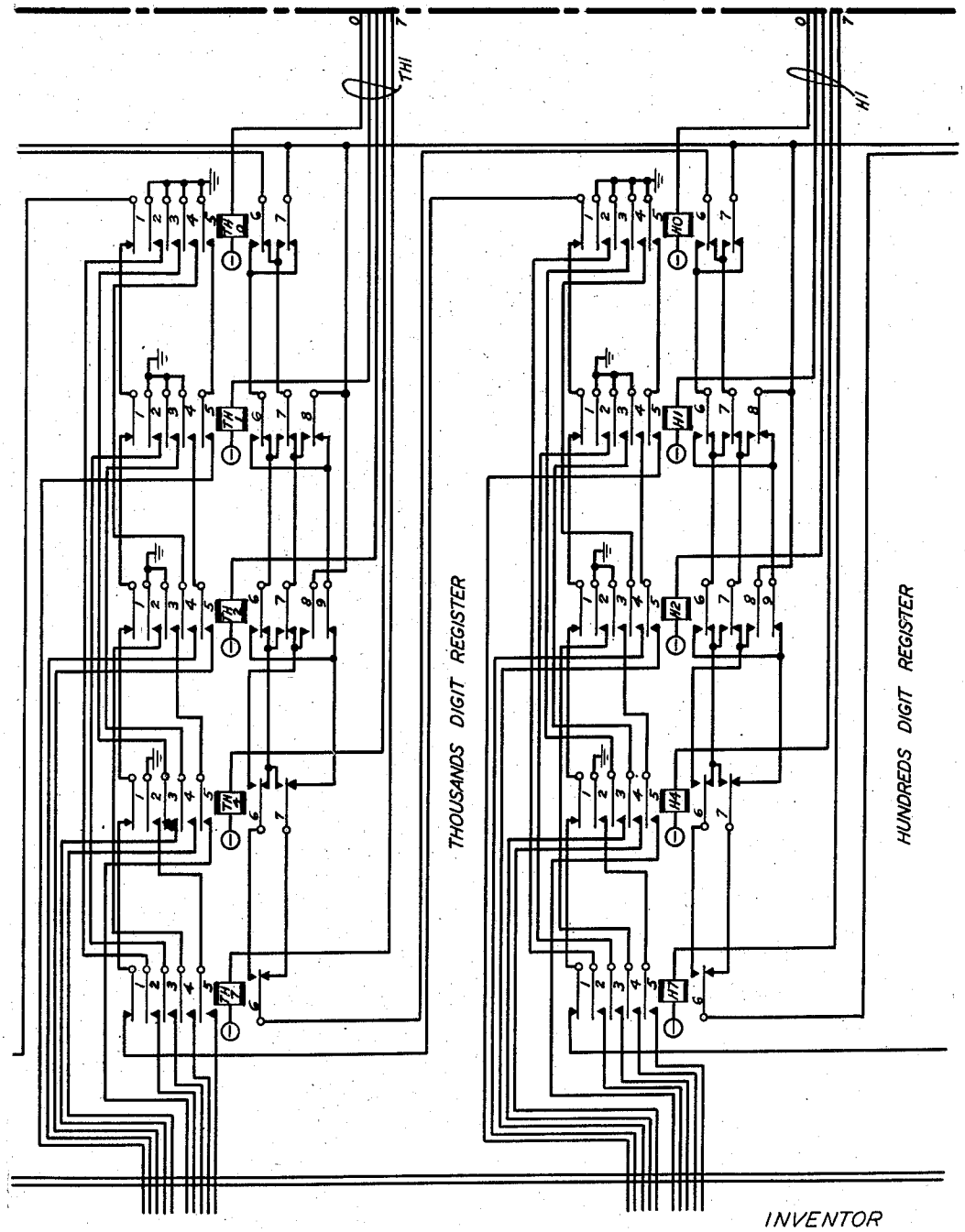


FIG. 129

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 130

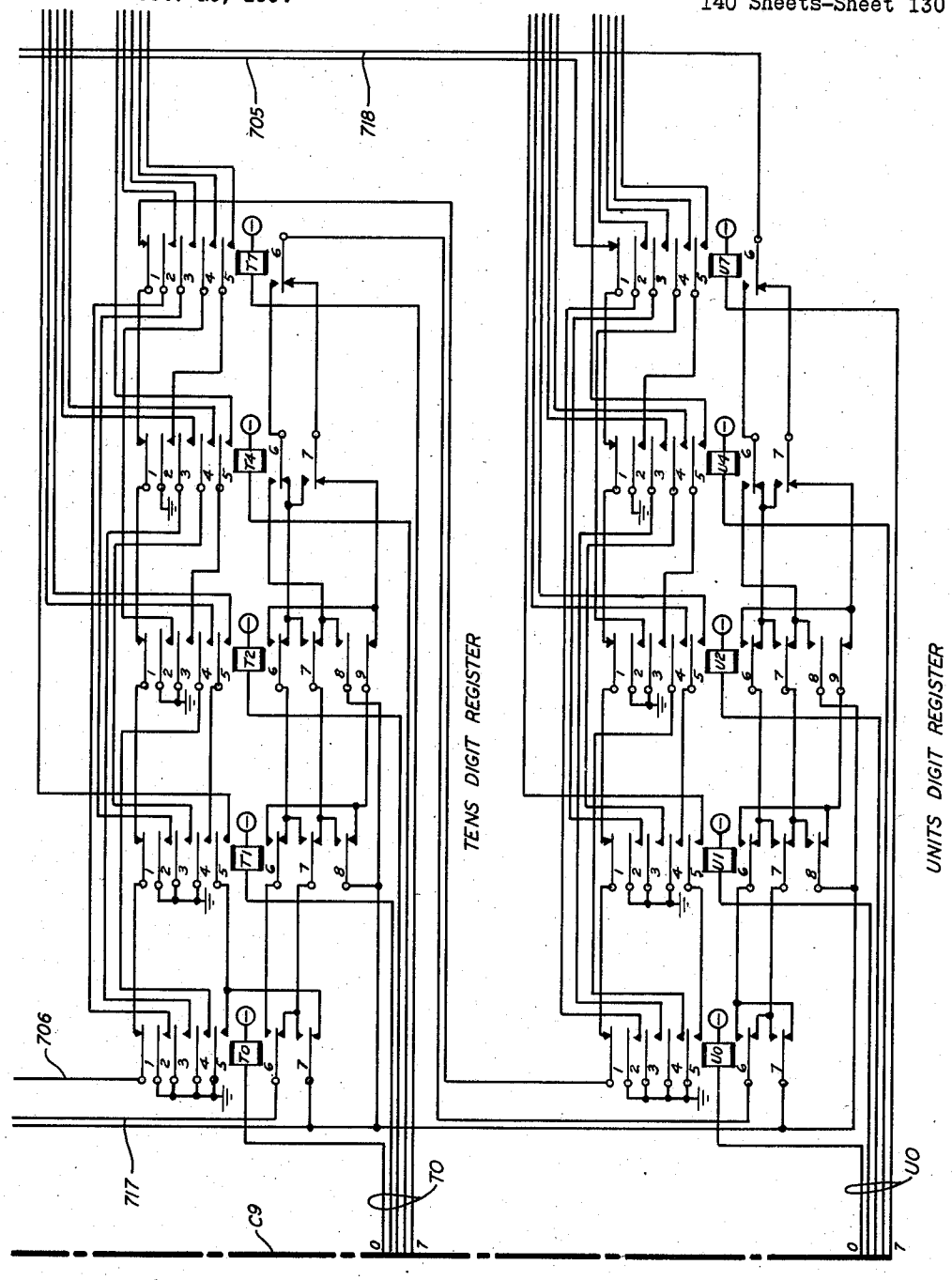


FIG. 130

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 131

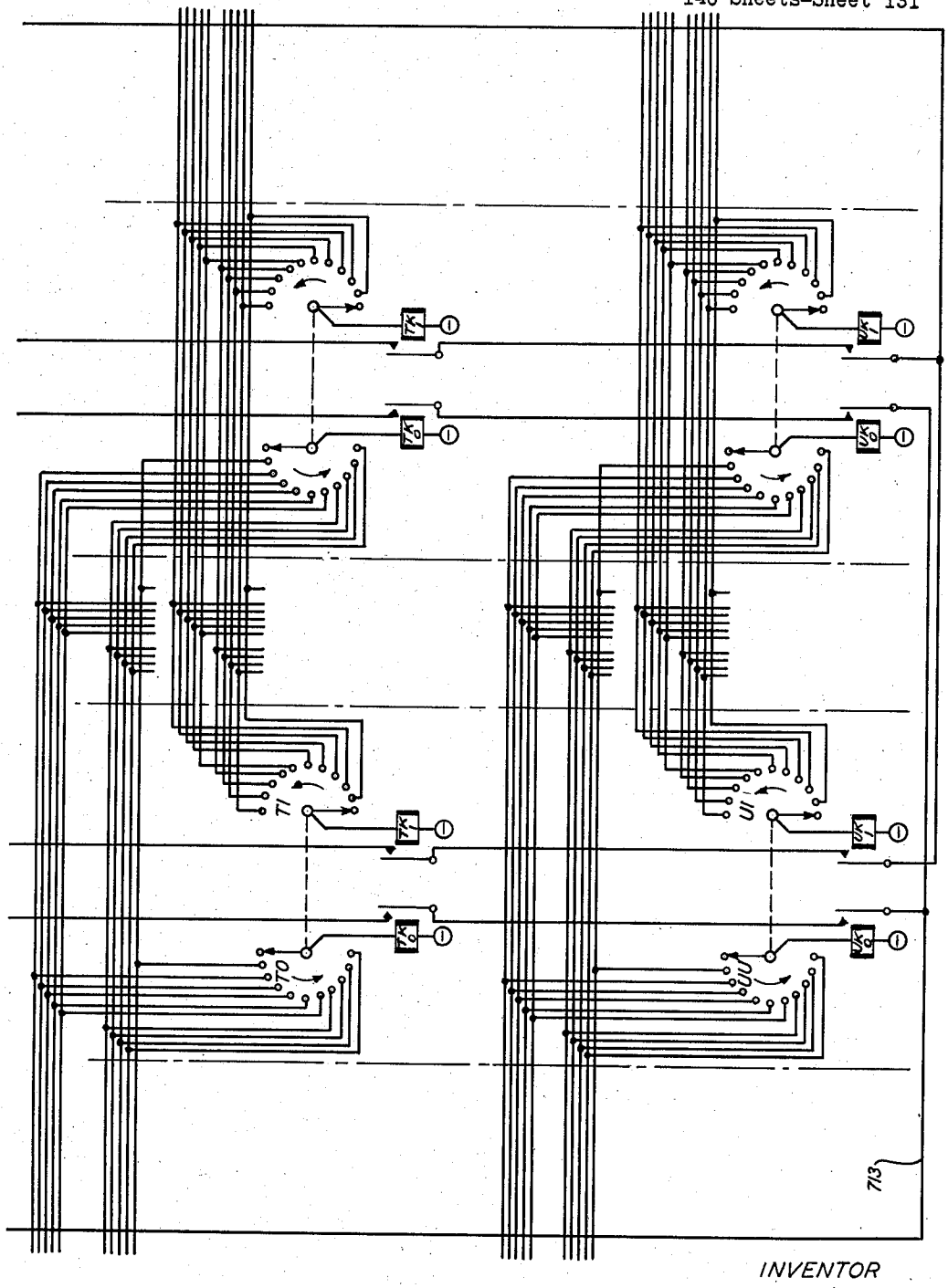


FIG. 131

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 132

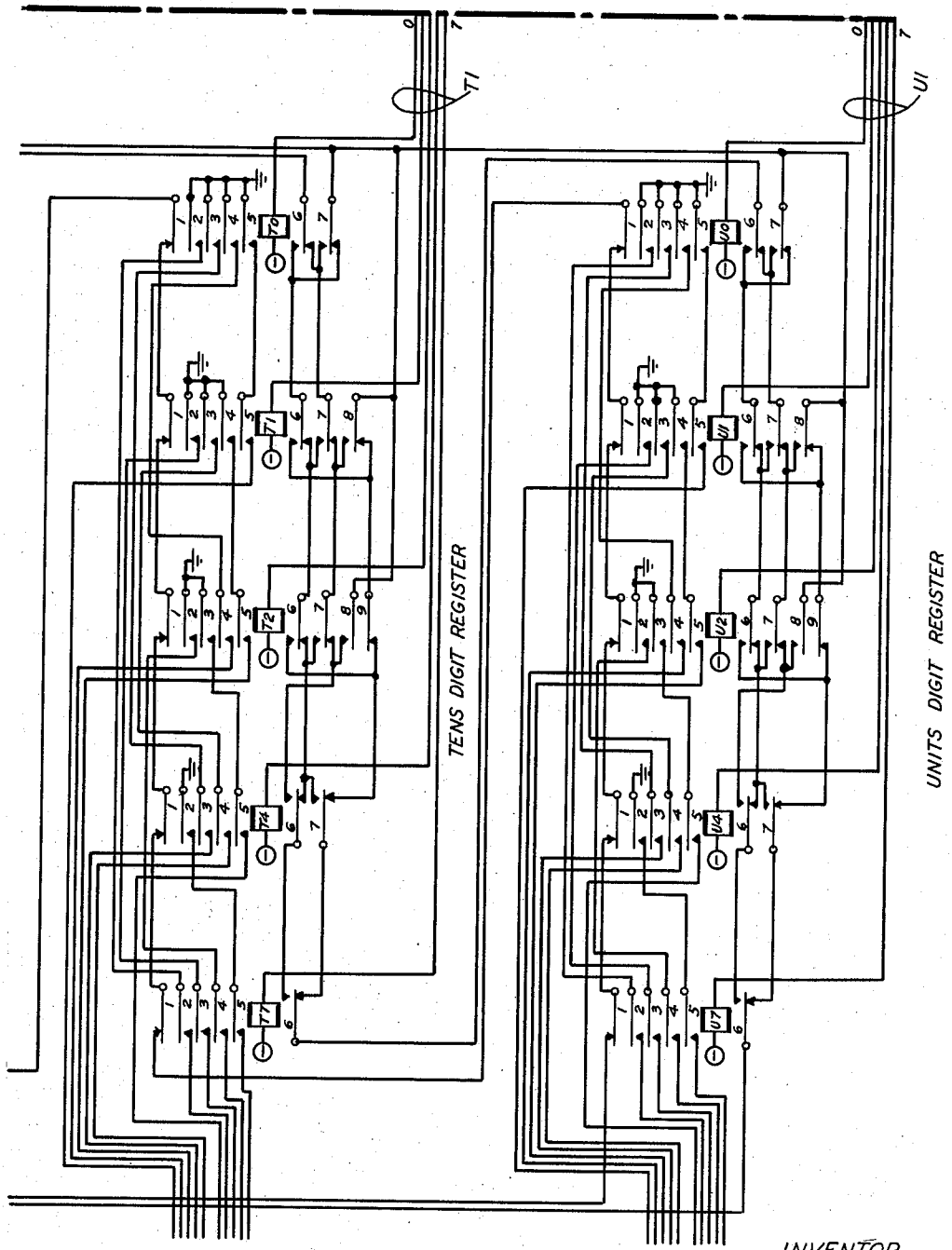


FIG. 132

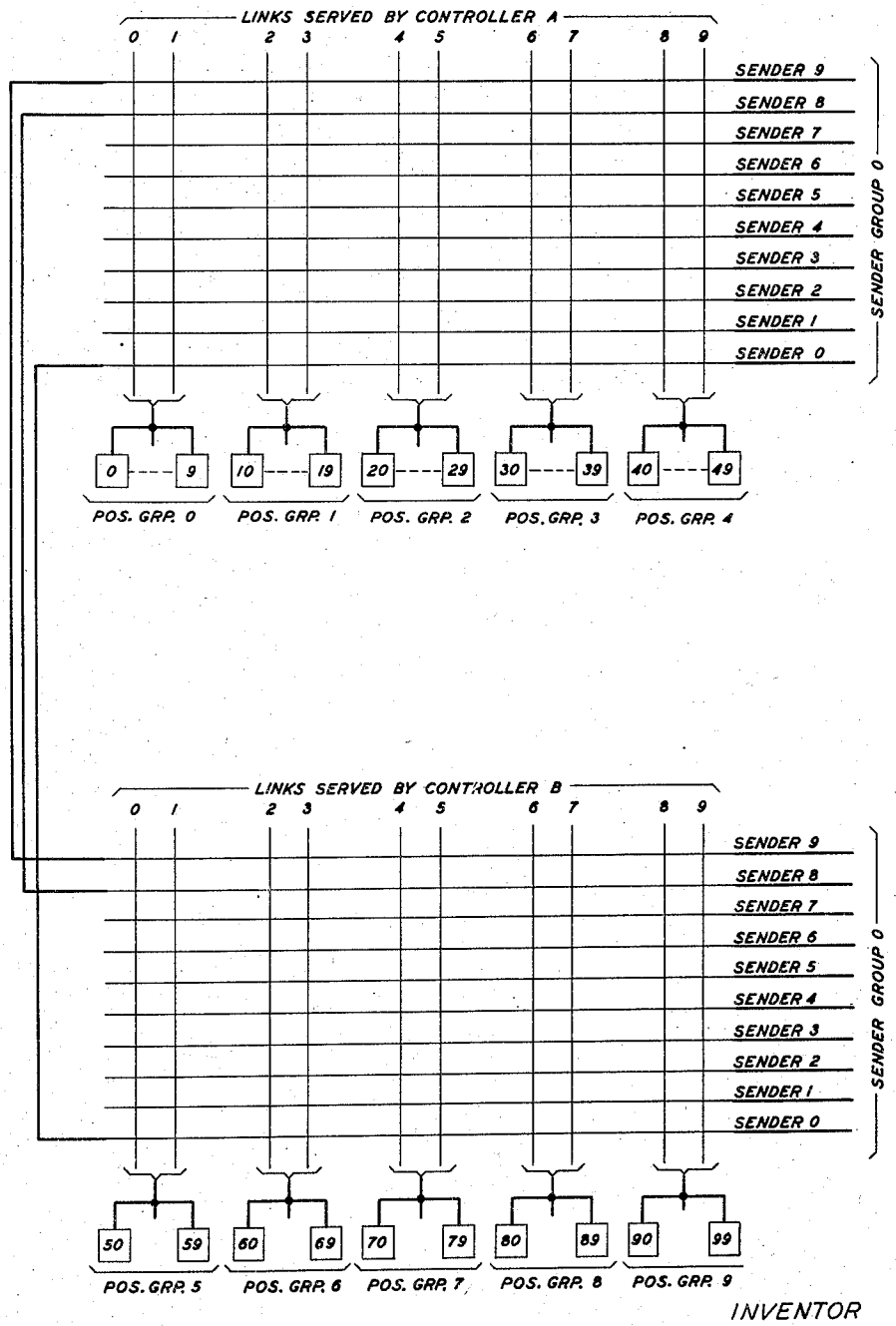
INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 133

FIG. 133



INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 134

FIG. 134

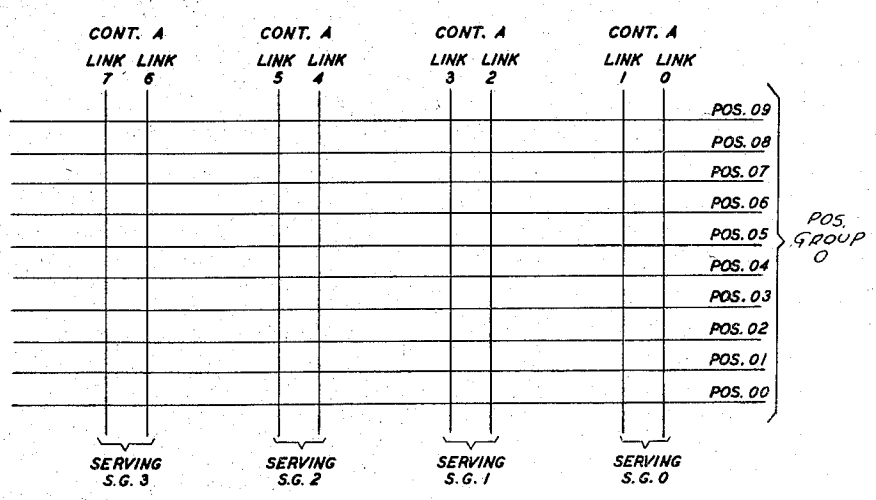
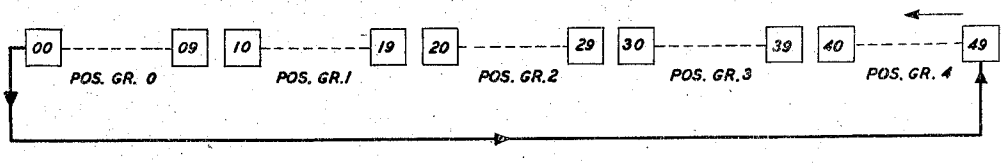


FIG. 134A

POSITION ORDER OF PREFERENCE - ADVANCE IN A CONTROLLER



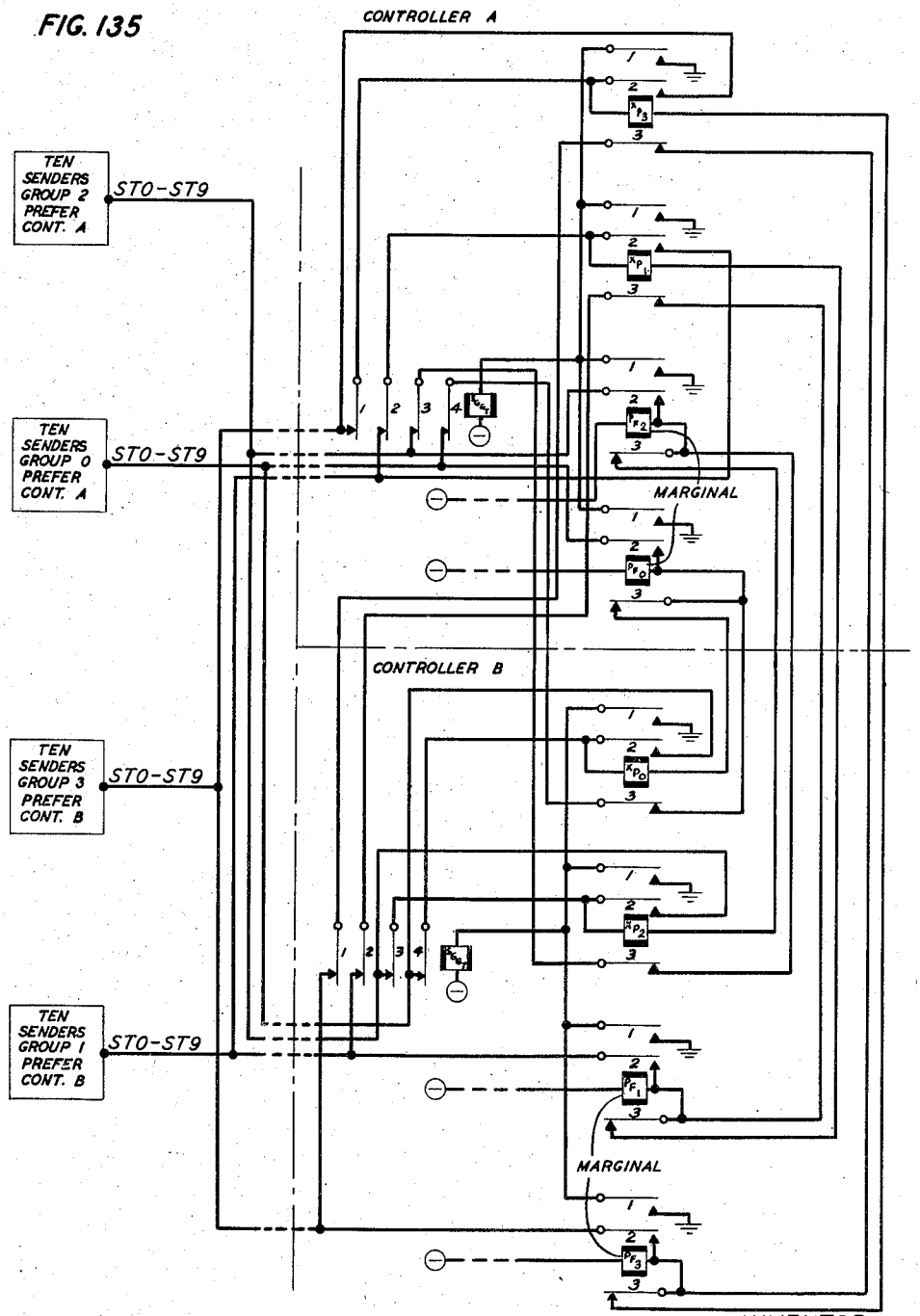
INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 135

FIG. 135

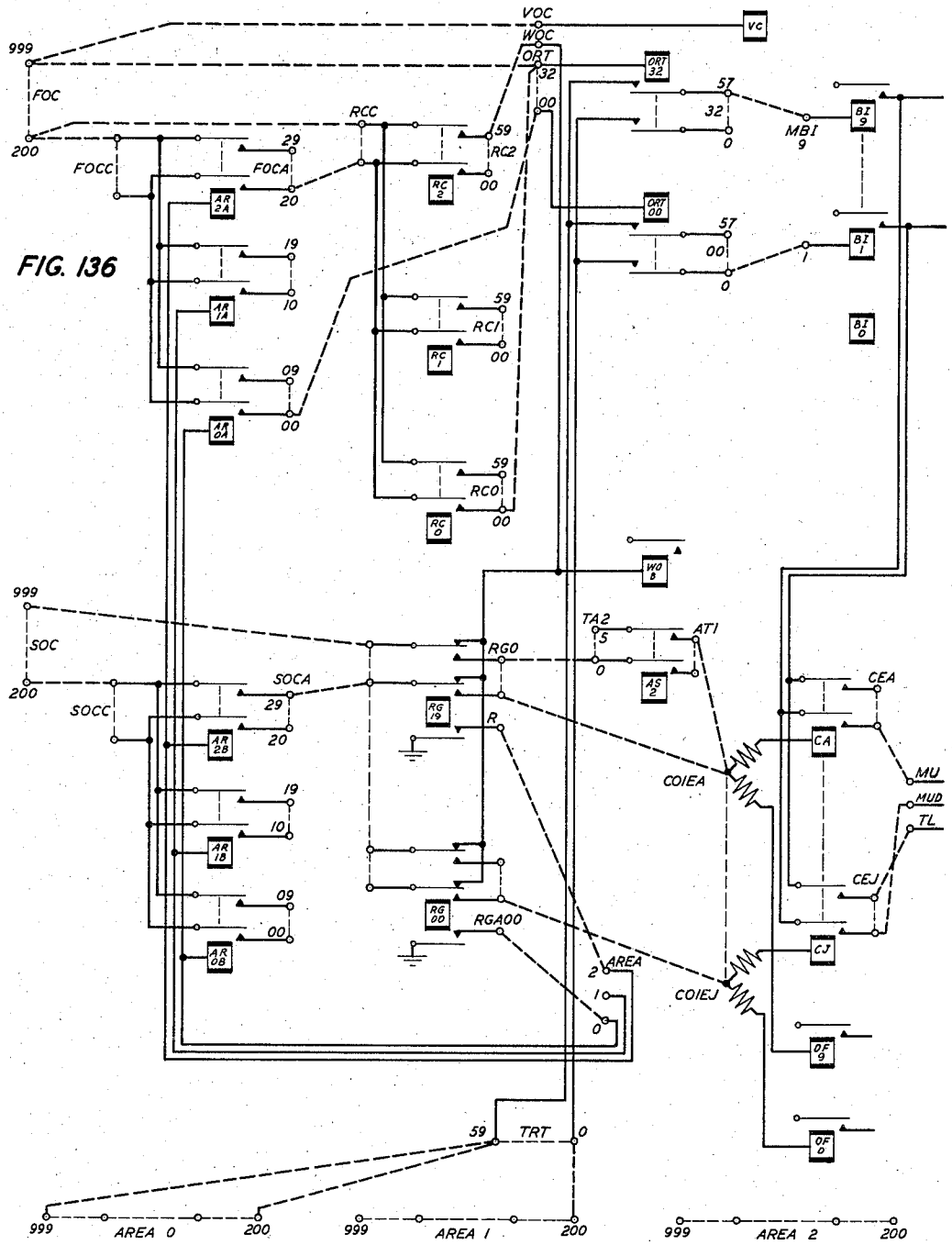


INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 136



INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 137

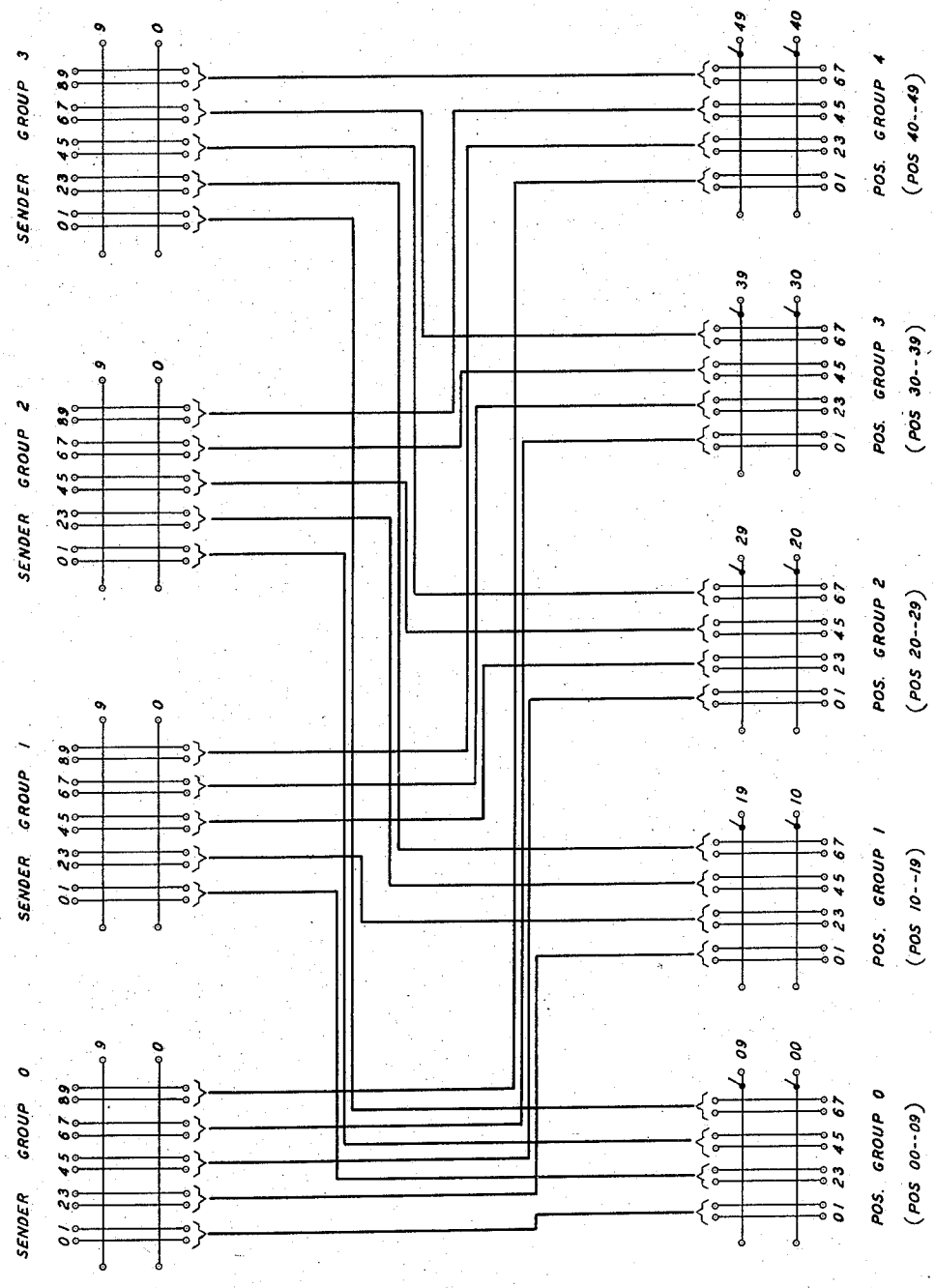


FIG. 137

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 138

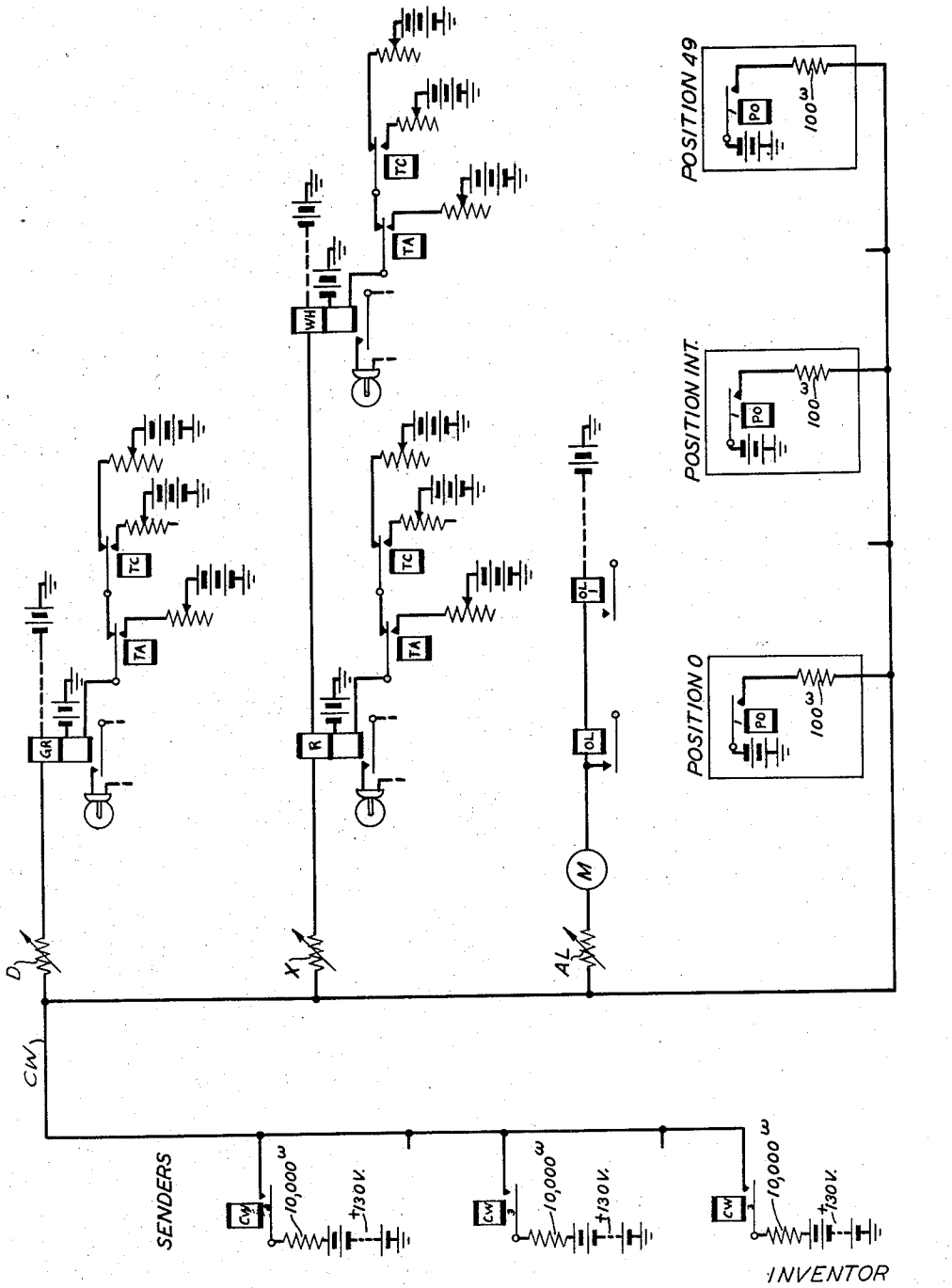


FIG. 138

INVENTOR
C.E. GERMANTON
BY
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 139

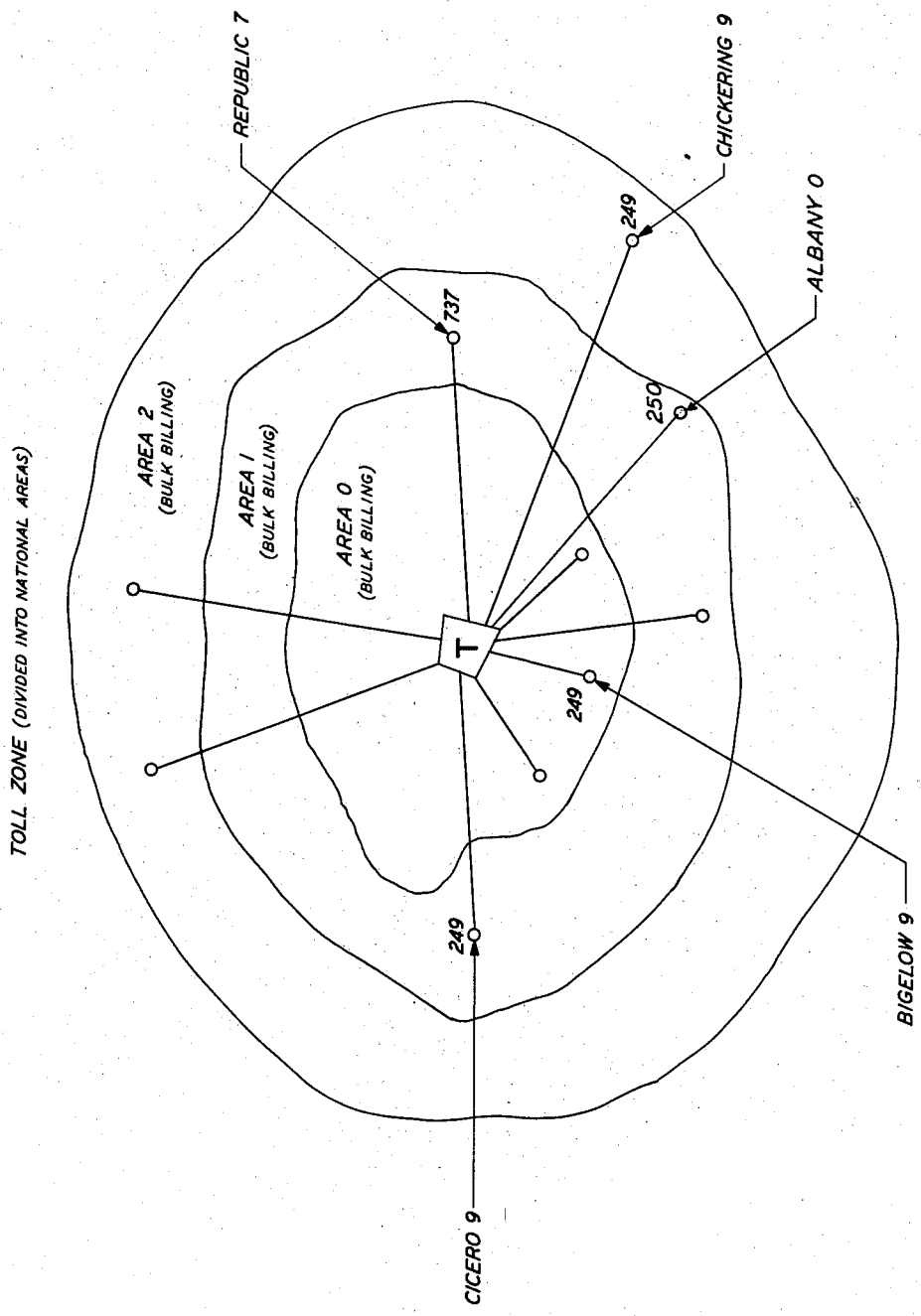


FIG. 139

BY INVENTOR
C. E. GERMANTON
ATTORNEY

April 21, 1959 C. E. GERMANTON 2,883,471

CALL ALLOTTER

Filed Oct. 19, 1954 140 Sheets-Sheet 140

FIG. 140-A

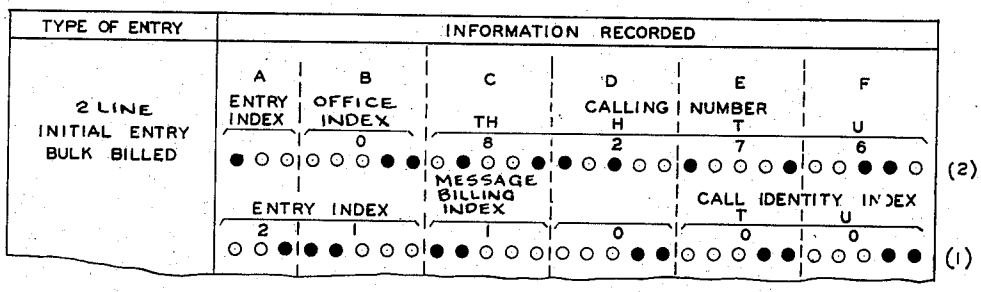


FIG. 140-B

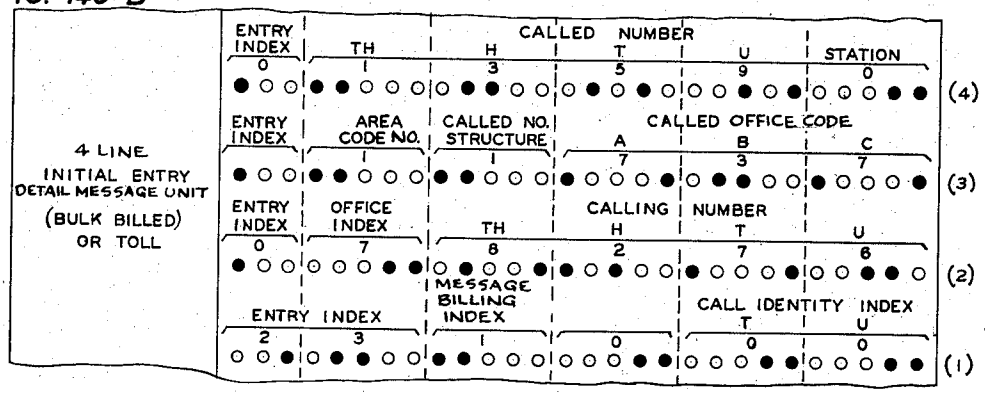
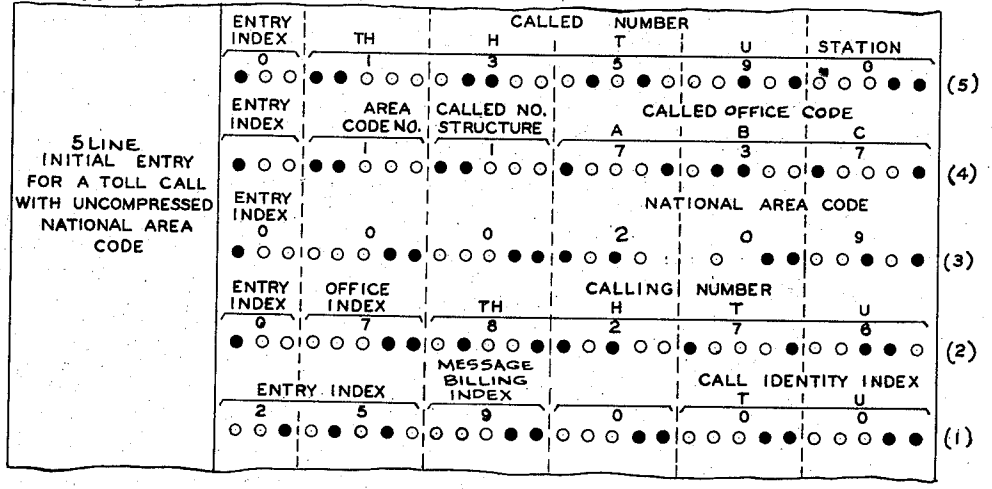


FIG. 140-C



INVENTOR
C. E. GERMANTON
BY
ATTORNEY

United States Patent Office 2,883,471 Patented Apr. 21, 1959

2,883,471

CALL ALLOTTER

Charles E. Germanton, Summit, N.J., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Application October 19, 1954, Serial No. 463,101

30 Claims. (Cl. 179—27)

This invention pertains to telephone systems, and more particularly to systems in which records are automatically produced that contain the details of telephone calls for which the subscribers are to be charged.

This invention also relates to a switching system that receives calls from a plurality of incoming sender circuits and distributes them on an equitable basis among a plurality of operators' positions.

In recent years the telephony art has progressed to a point where customers' bills may be prepared by means of automatic message accounting equipment. When such equipment is provided it is necessary that data be supplied which represents the calling party number, the called party number, the duration of the call, etc., for each call whose charge is to be computed by said automatic message accounting equipment. At the present time this data is perforated in paper tapes by recording equipment in the central offices at which the calls are placed, and said tapes are later processed by message accounting machines in the automatic message accounting center.

The present invention is primarily concerned with a telephone system in which calling register senders are temporarily connected to operators' positions for the performance of certain functions by the operators at said positions, and finds one specific use by way of example in a telephone system of the kind disclosed in the patent application of Breed-Cesareo-Germanton-Roberts-Weber-Wingardner Serial No. 463,102, now U. S. Patent 2,848,-543 filed concurrently herewith, in which tape records containing data for calls from a plurality of telephone offices are produced by equipment located at a tandem exchange through which said calls are established.

In said telephone system the equipment employed to produce the records includes, besides a recorder and a recorder controller, a register sender in which is registered the designation of the calling subscriber's number and the designation of the called subscriber's number. The latter number is obtained by pulses transmitted from a sender in the originating office, into which the calling subscriber first dialed the wanted number. The calling subscriber's number, however, is obtained orally from the subscriber himself by an operator at the tandem exchange after the connection has been extended thereto, after the tandem sender has been attached to the line, and after the called line number is registered in said sender. For this purpose the sender is temporarily connected to the operator's position, from which the calling number is keyed into the sender by the operator after obtaining it from the calling subscriber. Thereafter the sender is disconnected from the position to perform its functions of completing the connection and of initiating the operation of the recorder controller and the recorder to produce the perforated tape record for the connection.

According to the present invention, wherein operators must ascertain the calling party number, a group of fifty or more operators is located in the tandem office. The group handles the incoming calls from a plurality of lines, and each operator answers a call as a signal light is illuminated at her switchboard position. Experience has shown that serious personnel problems arise if some operators are required to handle more calls than others and

it is therefore important that the incoming calls be equitably divided among the available operator positions.

In the invention described herein, the incoming calls are equitably distributed among the available operators. Also, during periods of heavy traffic conditions, the lines containing incoming calls will be served according to an equitable plan and will be connected through to operator positions in accordance with this plan. This insures that no line will have a continuing priority over any other line in serving its calls. Provision is also made whereby the usage of the available switching equipment will be equally divided in order to equalize the wear.

The switching equipment constituting the invention described herein receives the incoming calls from forty sender circuits which are divided into four groups of ten senders each. The incoming calls are served by fifty operators who are divided into five groups of ten operators each. The interconnecting switching apparatus is functionally divided into two parts which are designated as a controller A and a controller B, and the necessary equipment is provided so that the two controllers divide the incoming calls among themselves on an equitable basis. Each controller provides two communication paths between each group of senders and each group of operator positions. Provision is made so that the traffic is distributed equitably over each path.

In its present embodiment, the invention is employed in connection with a telephone system using equipment of the crossbar type at the tandem exchange. The invention, however, is applicable to any telephone system having suitable characteristics.

In the operation of the telephone system which includes the present invention, the calling subscriber dials the called office and number which is stored in suitable storage registers of the sender connected to his line and subsequently is transmitted over a trunk extending to tandem and there stored in the called registers of a tandem sender connected to the trunk. Inasmuch as the calling subscriber's directory number is also required as part of the record to be made, the connection is momentarily bridged by an operator at the tandem exchange, who obtains said number by direct inquiry from the subscriber and keys it into storage registers of the sender. In the interests of efficiency it is desirable, of course, to use a minimum number of operators, for which purpose it is essential to distribute the load of tandem senders awaiting service among all the available operators' positions.

Accordingly, an object of the invention is a position-link controller which, in the performance of its general function of assigning waiting senders to available positions, remembers in which group of positions is made its last allotment of a sender and to which position in the group it made the allotment, choosing on its next operation another group of positions and selecting a preferred position therein if available, and if not, then another position in a definite order of preference.

Where a plurality of such controllers are used, it is another object of the present invention to prevent one such controller on successive operations from "hogging" one available position, the circuit of the controllers being so interconnected that the order of first preference for a single available position is progressively rotated among the different controllers.

Another object of this invention is to provide switching equipment that will equitably distribute incoming calls to a plurality of operator positions.

It is a further object of the invention to provide switching equipment that will serve waiting calls on a plurality of lines according to an equitable plan.

It is a further object of the invention to provide switching equipment that will distribute traffic equitably among the available switching equipment.

A feature of the invention is the provision of equipment that will serve a first call to a first preferred operator position and will then serve succeeding calls to the remaining available idle operator positions before the first operator position will again be served with a second call.

Another feature of the invention is the provision of switching equipment that, upon finding the operator's position to which a call was offered vacant or busy, will then offer the call to the next preferred operator's position.

Another feature of the invention is the provision of equipment that will offer the next call to the operator's position that is next preferred after said currently connected operator's position.

Another feature of the invention is the provision of switching equipment that will serve incoming calls from a plurality of sender groups according to an equitable plan whereby the calls from each sender group alternatively have preference over those of other groups during successive periods of time.

Another feature of the invention is the provision of switching equipment that will serve incoming calls within a sender group according to an equitable plan of distribution.

Another feature of the invention is the provision of equipment by which one controller will offer a call to a preferred group of operators if the group is not being offered another call simultaneously by the other controller.

Another feature of the invention is the provision of equipment that will insure that the traffic is distributed evenly among the two controllers.

These and other features of the invention will be more readily apparent from the following description, the appended claims, and the drawings in which:

Fig. 1 is a block diagram showing the relations to one another of the various circuit units, of which those particularly involved in the present invention are shown in detail in Figs. 3–132, inclusive, as further explained below;

Fig. 2 shows the interconnection by numbered dot-and-dash cables of the circuit unit particularly involved in the present invention, said cables being identically labeled in each of the involved separate figures of the drawing;

Figs. 3 and 4 show the tandem trunk in detail, and block indications of the call identity indexer, the recorder and the recorder connector;

Fig. 5 illustrates an abbreviated showing of the sender link-controller;

Figs. 6–48, inclusive, show the tandem sender;

Figs. 49 and 50 show the calls awaiting circuit;

Fig. 51 shows the position circuit;

Figs. 52–65, inclusive, show the position link and controller circuit;

Fig. 66 gives an abbreviated illustration of the transverter connector;

Figs. 67–109, inclusive, show the transverter;

Figs. 110–119, inclusive, show the billing indexer;

Figs. 120–132, inclusive, show the line observing and number matching circuit;

Fig. 133 illustrates the relationship between a group of senders and the operator positions divided into groups;

Fig. 134 illustrates the relationship between the operators' positions and the links serving to connect said positions with senders in different sender groups;

Fig. 134A illustrates the rotation of selection preference among all positions;

Fig. 135 is "one-line" diagram of the circuit for two controllers by which the assignment of a calling sender to an available position is effected;

Fig. 136 is a "one-line" diagram of the principle of the billing indexer;

Fig. 137 shows the distribution of connecting links between all sender groups and all position groups;

Fig. 138 shows the fundamentals of the calls-awaiting circuit;

Fig. 139 illustrates the different areas in which local telephone offices might be located, by way of example, in respect to the tandem exchange T;

While Fig. 140 illustrates the three types of initial entries which are produced by the disclosed system; Fig. 140A showing a two-line initial entry for a call charged for on a message unit or bulk-billing basis; Fig. 140B showing a four-line detailed initial entry made for a toll call in which the national area code has been "compressed" into a single digit, and for local call for which a detailed entry is required; while Fig. 140C illustrates a five-line initial entry made for a toll call for which the national area code is fully recorded.

For a complete and clear understanding of the invention the general organization of the circuits and their particular functions will first be described. The three kinds of initial entries which are made for the calls will then be described. Finally, the detailed operations of the circuits in producing each type of entry will be described.

General description of the system

The principal circuits associated with the present invention, their relations to one another and to other circuits not directly involved with the invention but with the establishment of connections to terminating offices by way of the tandem exchange, are indicated in the block diagram, Fig. 1. The originating office may be, for the present embodiment of the invention, either a panel or cross-bar office, and each will contain known apparatus for extending a connection to a trunk to the tandem exchange, referred to in Fig. 1, as the incoming trunk circuit. Of the apparatus of the originating office the unit of principal interest is the originating sender, which receives the dial pulses of the called number from the calling subscriber and utilizes the office code portion of this number to effect selective operations by which the calling line is extended to an available trunk terminating at tandem. When such a trunk is taken into use, a sender link at the tandem exchange is activated to associate an idle tandem sender with the trunk, in consequence of which the called directory number stored in the registers of the originating sender is pulsed over the trunk into appropriate storage registers of the tandem sender. When the tandem sender has received the called office code, it proceeds to obtain and become connected to a marker by way of a marker connector. The marker, in response to the called office code obtained from the sender, to the indication from the sender-link of the frame on which the incoming trunk is located, and to certain other information obtained from said sender-link, selects an outgoing trunk to the terminating office, selects an idle path between the incoming and outgoing trunks, and passes back to the sender information derived by the marker from its translation of the called office code which the sender will need to control the selective operations at the terminating office by which the connection is extended to the called line.

When the tandem sender has received the called number from the originating sender, it signals the position link control circuit to select a free but occupied operator's position. When selected, the position circuit is bridged across the talking leads, and the operator is given a "zip" tone as an indication to obtain the calling line directory number from the subscriber. After obtaining this number, she keys it in the storage registers of the sender. Should she make an error, the sender detects it, signaling her to rekey the number, and if she makes a second error, the call is completed free of charge if a bulk-billed call and dismissed if a toll call.

When the operator has keyed the last digit of the calling line number, the connection between the op-

erator's position and the sender is released. If the marker has meanwhile effected a selection of an outgoing trunk and signaled the fact to the sender, the latter calls for a transverter by way of the transverter connector. When the transverter is seized and connected to the sender, the information contained in the various registers of the sender, such as the called and calling number, the recorder group numbers serving the incoming trunk, the rate class and the class of service (in reality the terminating area of the called office) is passed to the transverter. The sender meanwhile transmits appropriate pulses to the distant office to establish the connection to the called line, but refrains from transmitting the pulses of the last or units digit until it receives a signal from the transverter that the initial entry for the call has been successfully recorded.

When the transverter is seized and the above information is received from the sender, it effects certain translations and conversions of data and then obtains a billing indexer into which it passes the calling and called office codes, the rate class and class of service. The indexer then operates to convert the information into the three indices of (calling) office index, the billing index and character of the initial entry, transmitting the same to the transverter. Should the indexer determine that the calling office code is a vacant code, a nonexistent code or (in certain instances) that it is identical with the called office code, it signals the transverter to recall the operator and recheck the calling line number. In such an event, the operator releases the original calling number registration in the sender and rekeys it after checking with the subscriber, an operation which has the effect of breaking the connection between the incoming and the selected outgoing trunk, recalling the marker to select another outgoing trunk, releasing the transverter and billing indexer and seizing another (or perhaps the same) transverter and billing indexer after the marker has completed its operation of selecting a new outgoing trunk. The transverter and indexer then function as before.

The transverter, on receiving the office index, the message billing index and the character of the initial entry from the billing indexer, bids for a connection to and seizes the particular recorder serving the group of incoming trunks that includes the one over which the connection is being established, and in cooperation with the call identity indexer circuit, controls the recorder to perforate the lines of the initial entry, which may be a two-line initial entry if the call is bulk billed and unobserved, a four-line initial entry if the call is bulk billed and observed, a four-line entry if the call is a toll call with its called national area code "compressed" into a single digit, or a five-line entry if the call is a toll call with the three digits of the called national area code fully recorded.

When the recorder has completed its function of recording the initial entry, the sender releases the transverter on signal from the latter circuit, and thereafter proceeds to transmit the pulses of the units digit to the terminating office, in consequence of which the connection is established between the calling and called subscribers and the sender released.

Although the functions of the present invention are terminated by the recording of the initial entry, it should be noted that two single line entries are subsequently made for the connection if the called subscriber answers. Since the call identity indexer is permanently associated with the incoming trunks and has access to the recorder, the latter is seized by the call identity indexer when the called subscriber answers, to perforate a single line entry of the beginning of conversation time and the identity of the trunk number. A similar entry is also made when the connection is terminated.

Before proceeding with a description of the detailed operation of the invention, it should be stated that this invention is not concerned with the operation of the marker and marker connector in selecting an outgoing trunk. These units of apparatus, therefore, are neither shown nor described herein except as blocks in the block diagram of Fig.1, the same being fully described in Patent 2,688,658, issued September 7, 1954, to W. W. Carpenter and R. E. Collis to which reference is made. In this connection, it should be mentioned that while the equipment of the tandem sender is completely disclosed, those of its operations which have to do with the operation and control of the marker are not described herein, except insofar as they affect the operation and control of the transverter, the former operations being essentially similar to those of the tandem sender disclosed in Patent No. 2,594,014, issued on April 22, 1952, to W. T. Haines and J. B. Newsom, to which reference is made. The recorder and the call identity indexer which are a part of the present disclosure (the call identity indexer only incidentally) also are neither shown nor described herein except by blocks in the block diagram of Fig. 1, the same being fully shown and described in the above-mentioned patent to W. W. Carpenter and R. E. Collis to which reference is made, the call identity indexer being referred to in said patent as the "district identifier." The trouble indicator and master timer, which also figure in the operation of the entire telephone system, but which are only of incidental interest to the present disclosure, are neither shown nor described herein except as blocks in the block diagram of Fig. 1, said units of apparatus being identical with those shown and described in the above-mentioned patent to W. W. Carpenter et al.

For a complete understanding of the invention, it is further necessary to understand certain assumptions upon which its operation is based. Referring to Fig. 139, it is therein indicated that the tandem exchange T connects with a plurality of offices, each indicated by a circle. All the offices which connect with the tandem exchange and can be reached through the tandem exchange, are divided into three areas 0, 1 and 2, each of these digits further identifying its designated area as a "class of service." Calls originating in one area and completed in offices in the same area, or another of said areas, are charged for on a bulk-billing basis, that is, in terms of message rate units. Area 2, which is remotest from the tandem exchange T, is surrounded by a generalized toll zone which takes in the rest of the country and is divided into a number of what are called national area codes. Each of these codes consists of three digits, of which the first, or A, digit has any value from 2 to 9, inclusive, the second, or B, digit has the value 0 or 1, and the third, or C, digit has any value from 0 to 9, inclusive. To reach an office in the toll zone it is necessary for the subscriber to dial first the national area code indicating the area in which the terminating office is located, then the code of such office, and then the numericals of the wanted subscriber's number. For the purpose of the present invention, a connection established from an office in any one of the three bulk-billing areas to any office in the toll zone will be treated as a toll call that will be charged for in monetary units. For such national area or toll calls, the originating sender must, of course, be adapted with suitable additional registers to accept the three digits of the national area codes, corresponding additional registers being provided in the tandem sender. Although the three latter additional registers are not shown in the tandem sender disclosed as part of the present invention, the transverter is adapted to accept calls from senders which are and senders which are not adapted to accept national area codes.

Another assumption upon which the operation of the present system is based is that no office in one area shall have the same code as any other office in the same area. The same limitation, however, is not placed on offices in different areas, which may have the same code.

This limitation is desirable in view of the widespread use of names for telephone offices, which may result in two offices in one area having the same code but different names.

The present system involves by way of example a maximum of 200 local offices connecting with the tandem exchange T, and a maximum of 2000 trunks interconnecting said offices with said tandem exchange. For purposes of recording, these trunks are divided into groups of 100 trunks, each group serving a maximum of ten offices, the distribution of the trunks among the ten offices being made, of course, as traffice dictates. Each group of 100 trunks is, moreover, served by one recorder. Since there are 2000 trunks subdivided into groups of 100 trunks entering the tandem exchange, said exchange is thus provided with twenty recorders, each herein called a "recorder group" and each numerically identified by the designation 00–19. Thus each recorder, in serving 100 trunks, serves the ten offices from which those trunks extend. Although the matter will be further amplified in connection with the operation of the billing indexer, it is evident that if each of the offices served by a recorder group is given one of the digits 1–0, the association of this digit with the recorder group number of the recorder serving the trunk group that contains the calling trunk will suffice to fully identify the calling office.

The initial entry

In the disclosed system, as previously stated, initial entries are produced by the recorder under the control of the transverter. The recorder employs a paper tape which is punched to record items of record information with a series of holes or depressions in groups, each group of holes or depressions corresponding to a digit. The series of digits thus recorded represents, in accordance with the well-known 2-out-of-5 code, the required details of the entry, and by means of suitable sensing devices, may be transferred from the record tapes to automatic billing machines for the production of subscribers' bills.

The recorder has twenty-eight punches arranged in a row across the tape, each punch controlled by a magnet. One of the first three punches (used for the so-called A digit) is operated to punch a single hole or depression in the tape, which, by its position, represents the numeral "0," "1," or "2" according to the punch operated. This serves the purpose of an "entry" digit, indicating the type of information recorded on the remainder of the line at the head of which it appears. For the initial entries the production of which the present invention is primarily concerned, the numeral "2" is always punched as the A digit of the first line of the entry, while the numeral "0" is punched for the A digit of each of the remaining lines of the entry.

The remaining punches are operated in combinations of two out of each group of five, each combination of two holes punched corresponding to a digit in accordance with the following 2-out-of-five code. For convenience of identifying each of the five punches constituting a group of punches each is given the respective designation 0, 1, 2, 4 and 7:

Digit	Punches Operated in Group of Five Punches
0	4, 7
1	0, 1
2	0, 2
3	1, 2
4	0, 4
5	1, 4
6	2, 4
7	0, 7
8	1, 7
9	2, 7

Thus six digits may be recorded on a line. After a line is punched, the paper tape is advanced to a succeeding position for punching a new line.

Fig. 140 shows the three types of entries with which the present invention is concerned, the lines of each entry being punched in the order indicated by the numeral in parenthesis at the right of the line of the entry.

Fig. 140A shows the two-line initial entry which is made for a regular unobserved "bulk-billed" call. The punch positions of the two lines of the entry are shown as circles, those filled in black indicating "punched" positions for the specific digit shown immediately above each of the position groups.

Briefly, the first line contains the record of the incoming trunk number of the connection. This number is a two-digit number (the recorder, it will be remembered, having access to 100 trunks, each numerically identified by a number from **00–99**), is called the "call identity index" and is recorded in the E and F digit positions of the line. The D digit is 0 and has no significance, while the C digit is the message billing index, indicating the number of message units which are to be charged for the connection. The A digit is 2 to indicate that the line is the first line of the entry, while the B digit is given the arbitrary value of 1, to distinguish it from B digits in the first line of other two entries which have special significance.

The second line of the entry contains the four digits of the calling line number in the C, D, E and F digit positions, while the B digit is the (calling) office index. As previously stated, this digit, combined with the recorder group number, will fully identify the calling office code.

Fig. 140B illustrates a four-line initial entry for a bulk-billed call and for a toll call. The first two lines of this entry are the same as the corresponding lines of the two-line initial entry, except that the B digit of the first line has the value 3 to indicate that the call is unobserved. If the call is observed, the B digit is 4. The third line contains the three digits of called office code in the D, E and F digit positions; the called number structure in the C digit position (that is, the digit is 1 if the numericals of the called line constitute a four-digit number and the digit 2 if they constitute a five-digit number), while for a bulk-billed detailed call the B digit is reserved for the area in which the called office is located. If the four-line initial entry is for a toll call, the B digit expresses the "compressed" national area code. The fourth line contains the numericals of the called number, including the station digit, if any, in the B, C, D, E and F digit positions. If the number contains no stations digit, then the F digit is 0, and if the number is a five-digit number, the digit position is shifted to the right by the circuits of the transverter, with the ten thousand digit number occupying the B digit position, the thousands digit number occupying the C digit position, etc.

Fig. 140C illustrates a five-line initial entry for a non-observed toll call with the three digits of the national area code fully recorded in the D, E and F digit positions of the third line. The first and second lines of the entry are the same as the corresponding lines of the four-line entry except that the B digit of the first line has the value 5 if the call is not observed and the value 6 if the call is observed. The fourth and fifth lines are the same as the third and fourth lines, respectively, of the four-line entry.

It should be understood that there are many other entries recorded on the tape which are essential to the use that is made of the initial entries by the billing machines of the accounting office. Thus there are the "answer" and "disconnect" entries of which mention has already been made; there are the "hour" entries which are recorded on the tape every hour by the re-

corder under the control of the "master timer"; there are the "end-of-tape" entries which identify the office at which the tape is produced, which contain, among other information, the recorder group number, and which are placed at the beginning and end of every tape section; there are the "splice" and "no paper" entries, and many others. The invention makes no change in any of these entries. These are fully shown and described in the above-mentioned patent to W. W. Carpenter et al., and reference to said patent is made for a description of their form and of the circuits and apparatus by which they are made.

Detailed description of the invention

To illustrate the operation of the invention, I will first describe the production of a two-line initial entry incident to the establishment of a call from a subscriber whose line terminates in the office Bigelow 9 (code 249) and whose directory number is 8276, to a subscriber whose line terminates in the office Republic 7 (code 737) and whose directory number is 1359. By reference to Fig. 139, it will be noted that the office Bigelow 9 is located in the bulk-billing area 0 while the office Republic 7 is located in bulk-billing area 1. The proposed description will also include a description of those additional circuit operations by which four-line and five-line initial entries are produced, premising the latter description on the assumption that a bulk-billed call is an observed call to produce a four-line message unit detailed entry (abbreviated as an MUD entry), on the assumption that the call is established to an area in the toll zone to produce four-line toll initial entry for which the national area code is compressed, and on the assumption that the call is established to another area in the toll zone to produce a five-line toll initial entry for which the national area code is not compressed.

When the subscriber 8276 at the originating office Bigelow 9 (which may be a crossbar, panel, or manual office) removes his receiver from the hook, devices in the office are set in motion by which, if the office is a crossbar or panel office, a sender is connected to the line. In response to dial tone transmitted to the subscriber after the sender is connected, he dials the digits 7371359 which are stored into corresponding numerical registers of the sender. If the office is a panel office, the sender, in response to the registration of the code 737, guides the movement of panel selectors to establish a connection from the line to an outgoing trunk extending to the tandem office T (see Fig. 139), which trunk may be assumed to be the one shown in Figs. 3 and 4. If the originating office is a crossbar office, the sender, in response to the registration of the code 737, obtains a marker, which functions to select said trunk (or similar trunk) and join it to the extension of the line over an interconnecting trunk-link frame. If the originating office is a manual office, the calling subscriber gives the called number to the operator, who, in turn, manually selects said trunk (or similar trunk), joining the line with the trunk by means of a cord, in the well-known manner.

It may be stated in passing that when the originating office is equipped to handle calls to national areas, the sender is provided with additional registers for the storage of the three digits of called national area code and, in response to the national area code as well as the code of the called office, effects the selection of the trunk terminating at the tandem exchange.

When the trunk to tandem is thus selected, the sender at the originating office closes a metallic loop between the leads T and R of said trunk, thereby to complete the circuit of relay A; the circuit of said relay extending from battery through its upper winding, No. 3 back contacts of relay T, No. 1 contacts of relay D1, lead T, through the metallic loop in the sender at the originating office, lead R, No. 9 contacts of relay D1, No. 8 back contacts of relay T, lower winding of relay A, to ground. Relay A operates and over its No. 2 contacts applies ground over the No. 2 back contacts of relay D, No. 1 contacts of relay D2, No. 1 contacts of relay T, No. 1 contacts of relay TC, lead ST0, extending to the sender-link controller shown in Fig. 5, a back contact of relay D, winding of relay G0, to battery, operating relay G0. Relay G0 is common to the group of ten trunks which appear on the trunk-side of the sender link frame. The sender-link controller is essentially similar to the one shown and described in the above-mentioned patent to W. W. Carpenter et al. and inasmuch as it forms no part of the present invention, only so much of it is shown as is necessary to the operation of said invention. By the operation of relay G0, an obvious circuit is completed for relay HA or HB, which operates to extend lead ST0 and the nine leads ST1–ST9 (not shown) of the other nine trunks in the decade each to the winding of a relay T0–T9 of which relay T0 only, individual to the trunk taken for the connection is shown. In consequence of operations in the sender-link controller incident to the operation of relay T0, an idle sender is selected and relay C common to five senders is operated, whereby the two crossbar switches constituting the sender-link frame are operated to extend the trunk to the selected sender, and the leads at relay C are extended to the selected sender.

On the operation of relay C, lead SC is grounded to complete in the selected sender the circuit of relays SC1–2, SC3 over the back contacts of relays ON1, and SC4, which relays operate. Relay SC3 connects resistance R between leads T and R to discharge the capacity of the trunk conductors to the sender in order to avoid the possibility of a false pulse to the receiving relays subsequently connected to said leads as hereinafter set forth. The connection of resistance R to the leads T and R is as follows: Conductor R, No. 7 contacts of relay LR1, lead 103, No. 4 back contacts of relay TR, lead 104, No. 9 front contacts of relay SC3, resistor R, lead 105, No. 6 back contacts of relay TR, lead 106, No. 2 contacts of relay SR1, No. 6 contacts of relay LR1 to lead T. Upon the operation of relay SC1–2, ground is applied over its No. 3 contacts to conductor HM, which completes the circuit of the two hold magnets of the sender-link switches, thereby to hold the selected cross-points therein after the select magnets have been released, in the usual manner of crossbar switches.

Also upon the operation of relay C the sender is advised of the particular trunk-link frame upon which the incoming trunk appears. The present embodiment of the invention is devised for use with 2000 trunks extending from 200 originating offices, the trunks being divided in groups of ten, of which ten groups, or 100 trunks, appear on each sender-link frame and are served by one sender-link control circuit. These trunks as well as the others also extend, of course, to suitable trunk-link frames, from which the connections are further extended over outgoing trunks to the different called offices, and the sender must know on which trunk-link frame the calling trunk is located, the sender later transmitting the information to the marker which functions to join, at the trunk-link frame, the incoming trunk with a selected outgoing trunk. For this purpose, each group of ten trunks appearing on the sender-link frame is provided with a relay (HA) that operates to connect ground from its contacts to one of the ten leads F0–F9, and one of the two leads F00 and F10 to indicate the designation of the trunk-link frame on which appears the particular group of ten trunks including the calling trunk, said trunk-link frames being designated 00–19. If we assume that the trunk-link frame on which appears the decade of trunk that contains the calling trunk to be the trunk-line frame 00, leads F0 and F00 are grounded at the Nos. 0 and 10 contacts of relay C by ground extended thereto from the contacts of relay HA. Consequently upon the operation of relay C and after the operation of relay SC1–2, a circuit is completed for relay F0 from ground

on lead F0, No. 8 contacts of relay SC1–2, winding of said relay F0, to battery. With the operation of relay F0, a circuit is completed for relay FS, said circuit extending from ground on the No. 1 contacts of relay F0, conductor 100, winding of relay FS, to battery, causing the operation of said relay. It should be pointed out at this time that relay FS is only operated on even frame indications. Ground on conductor F00 completes the circuit of relay F00 over the No. 18 contacts of relay SC1–2, winding of relay F00, to battery, operating said relay.

As indicated in the general description, and for the purpose of recording call data information, each group of 100 trunks, regardless of whether the group of trunks comes from one office or a plurality of offices, is served by a recorder, or group of recorders, depending on the traffic, which group is designated a "recorder group." For a purpose to be discussed hereinafter it is essential for the sender to know the particular recorder group involved for the connection to be established. Since a group of 100 trunks appears in subgroups of ten on particular trunk-link frames, of which the sender-link has knowledge by the operation of a relay H– individual to the trunk group, the latter relay may be used to indicate to the sender which recorder group serves the trunks that includes the calling trunk. Moreover the present embodiment of the invention is devised for operation with a maximum of 200 offices, with each recorder group serving a maximum of ten offices, thus making twenty recorder groups in all, each group numerically designated from 00–19, and so indicated to the sender by the selective grounding by the involved relay H– at the Nos. 15–17 contacts of relay C in the sender-link controller of three out of the six leads RN0, RN1, RN2, RN4, RN7, RN13 according to the following code:

Recorder Group Number	RN–Leads Grounded
00	0, 7, 13
01	1, 7, 13
02	2, 7, 13
03	0, 1, 2
04	4, 7, 13
05	0, 1, 4
06	0, 2, 4
07	1, 2, 4
08	0, 1, 7
09	0, 2, 7
10	1, 2, 7
11	0, 4, 7
12	1, 4, 7
13	2, 4, 7
14	0, 1, 13
15	0, 2, 13
16	1, 2, 13
17	0, 4, 13
18	1, 4, 13
19	2, 4, 13

Assuming, therefore, that the trunk group 00, containing the calling trunk is served by recorder group 00, then the Nos. 15, 16 (not shown) and 17 contacts of relay C are connected to the Nos. 7, 8 and 9 contacts of relay HA, whereupon when these relays are operated and relay SC4 is operated in the sender, circuits are completed for relays RN0, RN7 and RN13 of the recorder group register over the Nos. 6, 2 and 1 contacts, respectively, of relay SC4. These relays operate to register the recorder group number in the sender.

The sender must also receive from the sender-link frame the rate class of the calling trunk. By rate class is here meant different charges for calls to identical destinations from an originating office, or offices, that provide for such different rate service, and for which the trunks having the same rate class may be provided with the same rate-class indication. Three such rate classes are provided by way of example, and the signal to the sender for each rate class is furnished by grounding through the C relay from the involved relay H– either lead RC0, RC1 or RC2. Assuming the rate class for the given trunk group including the trunk taken into use to be the rate class 0, then the No. 14 contacts of relay C are connected to the No. 10 contacts of relay HA. Consequently upon the operation of relays HA and C and the operation of relay SC4 in the sender, ground on lead RC0 over the No. 9 contacts of relay SC4 completes the circuit of relay RC0, which operates to register in the sender that the rate class is 0 for the call.

The sender must also be informed of the class of service. For recorded calls this signal indicates, among other things, the electrical characteristics that the trunk outgoing from tandem must have, and the numerical indication of the area in which the call is to be completed. This signal is given on a two-out-of-seven biquinary code by the selective grounding by the involved relay H– of two of the seven leads CS0–CS6 at relay C in the sender-link controller. Assuming the class-of-service designation to be the digit 1, then the No. 23 and No. 18 contacts on relay C are connected to the Nos. 5 and 6 contacts of relay HA. Hence upon the operation of relays C and HA, and the operation of relay SC3 in the sender, ground on leads CS1 and CS5 completes the circuit of relays CS1 and CS5 in the class-of-service register. The latter two relays operate and register the digit 1 as the class-of-service designation.

When the sender-link circuit has performed certain other operations not necessary to the present invention but which are for the purpose of testing for double connections, said sender-link circuit applies ground over conductor GS which has the effect of completing the circuit for relay ON1 in the sender. The circuit for said relay may be traced from ground on said lead GS, No. 6 contacts of relay SC1–2, lead 107, No. 1 contacts of relays FS, conductor 101, winding of relay ON1, to battery. In the event that the trunk-link frame registration is for an odd numbered frame and relay FS is not operated in consequence, then the circuit of relay ON1 is completed as traced to lead 107, No. 1 contacts of the involved odd relay (for example, relay F1) in the trunk-link frame register, conductor 101, winding of relay ON1, to battery. Relay ON1, upon operating completes over its No. 7 contacts a parallel circuit to relays ON3 and ON4, the latter over conductor 102. With the operation of relay ON1, relay SC3 releases to remove resistor R from across the trunk leads T and R.

Relays ON1, ON3 and ON4, among other functions, ground certain off-normal leads, all designated SONG, to supply locking paths to various relays of the sender. Upon the operation of the relay ON3, ground is applied to lead SB from the No. 8 contacts of said relay, and ground on said lead completes circuits in the sender-link controller that perform certain functions, subsequent to which said controller returns ground on lead BS which completes the circuit of relay ON2 over the No. 5 contacts of relay SC1–2, No. 10 contacts of relay SC3, winding of relay ON2 to battery. Relay ON2, on operating, applies ground to lead S, the path thereof being traced from lead S, conductor 108, No. 5 contacts of relay AV3, conductor 109, Nos. 2 and 3 contacts of relay ON2, conductor 110, No. 1 contacts of relay AV3, conductor 111, No. 3 locking contacts of relay ON1, No. 1 contacts of relay ON2, to ground on the No. 4 contacts of relay ON1. The path of said ground completes over lead S a holding circuit for the hold magnets at the sender-link frame, thereby to make the holding of said magnets independent of the ground on conductor HM. Relay ON2 further grounds lead RL, said ground extending from the No. 3 contacts of relay ON2, No. 4 contacts of relay SC1–2, and therefrom to complete the circuit through a contact of relay C in the sender-link controller, of relay RL therein, which operates and initiates circuit operations by means of which the sender link controller releases. Relay ON2 further completes the circuit of relay CK2, the path of said circuit extending from battery through the winding

of said relay, No. 7 contacts of relay AV, conductor SONG, to ground on the contacts of relay ON2. Relay CK2 operates and, over its No. 3 contacts, applies operating ground over the No. 6 contacts of relay AV3, lead C0, through a contact on the two crosspoints of the sender-link frame connecting the selected sender with the trunk, the continuation of said lead into the trunk, winding of relay T of the trunk to battery. Relay T operates and, among other functions, extends the tip and ring leads T and R over its No. 3 and No. 8 front contacts, respectively, into the sender, in which said two leads complete a loop including the two polarized pulsing relays SN— and SN+ in series with the marginal pulsing relay MG. The path is as follows: Beginning with the lead T it extends over the No. 6 contacts of relay LR1, No. 2 contacts of relay SR1, lead **106**, No. 6 contacts of relay TR, lead **105**, No. 10 back contacts of relay CUA, lead **115**, winding of relay SN—, winding of relay MG, winding of relay SN+, lead **114**, No. 9 back contacts of relay CUA, lead **113**, No. 9 back contacts of relay SC3, lead **104**, No. 4 back contacts of relay TR, lead **103**, No. 7 contacts of relay LR1, to lead R. This loop completes a dry loop in the sender at the originating office, which provides a signal to said sender that the sender at the tandem office is ready to receive the pulses that make up the digits of the called subscriber's number, in consequence of which said pulses are transmitted over the trunk loop.

Before proceeding with the description of the operation of the tandem sender in response to these pulses, it should be stated that each digit is indicated by a series of pulses, of which the first and third pulses are either blank or light positive (high resistance battery on the tip lead T, ground on the ring lead R) and resulting, in the case of a positive pulse, in the operation of relay SN+; and the second and fourth pulses are either light or heavy negative (high and low resistance battery, respectively, on the ring lead R, ground on the tip lead T), and resulting, in the case of the light negative pulse, in the operation of relay SN—, and in the case of the heavy negative pulse, in the operation of both relays SN— and MG.

Because of the construction of the originating sender, the pulses for the A, B and C digits of the called office code, and the pulses for hundreds, tens and units digits of the numerical portion of the called subscriber's directory number are transmitted therefrom in accordance with the following code, in which "*n*" represents a light negative pulse, "N" a heavy negative pulse; "*p*" a light positive pulse, and "—" a blank pulse. As previously indicated, polarity is expressed in terms of ring lead R with respect to tip lead T.

A, B, C, H, T, U DIGITS

Digit	Quadrant Code Value			
	1	2	4	5
0	—	*n*	—	*n*
1	*p*	*n*	—	*n*
2	—	N	—	*n*
3	*p*	N	—	*n*
4	—	*n*	—	*n*
5	—	*n*	*p*	N
6	*p*	*n*	—	N
7	—	N	—	N
8	*p*	N	—	N
9	—	*n*	*p*	N

In the above table (and also in the next two tables) the numeral appearing at the top of each column of pulse symbols is a numeral which, alone or additively with the value of the numeral in another column expresses (except for the digit 0) the value of the digit. For convenience of easy circuit reading, each numeral is also affixed as part of the relay designation in each numerical register which registers the corresponding pulse of the pulse quadrant.

The pulses for the registration of the thousands digit are transmitted in accordance with the following code:

Digit	Thousands Digit Quadrant Code Value			
	2	4	8	1
0	—	*n*	—	*n*
1	—	*n*	—	N
2	*p*	*n*	—	*n*
3	*p*	*n*	—	N
4	—	N	—	*n*
5	—	N	—	N
6	*p*	N	—	*n*
7	*p*	N	—	N
8	—	*n*	*p*	*n*
9	—	*n*	*p*	N

If the called subscriber's number contains a ten thousand digit or a station digit (as it might have if the call is completed to a manual office containing provision for such numbers) then the pulses of said digit are transmitted in accordance with the following code:

Digit	Ten Thousand or Stations Digit Quadrant Code Value			
	1	2	4	5
0	—	*n*	—	*n*
1	*p*	*n*	—	*n*
W	—	N	—	*n*
R	*p*	N	—	*n*
J	—	*n*	*p*	*n*
M	—	*n*	—	N

Eight digits are always sent by the sender at the originating office, and they are sent in the following order: A, B, C, station, thousands, hundreds, tens and units. The stations digit will always be 0 if the called number is under 10,000 and has no party letter. If the called number is over 10,000, the value of the stations digit will be 1. A value of 2, 3, 4 or 5 represents party letters W, R, J, and M, respectively. Numerals 6 to 9 do not appear for the stations digit.

In order that the pulses of the different digits become properly registered in the digital registers of the sender, a pulsing circuit, comprising relays W and Z, and responsive to the operation of the light negative pulse relay SN, serves to operate the steering circuit comprising relays CA, CAA; CB, CBA; CC, CCA; CST, CSTA; CTH, CTHA; CH, CHA; CT, CTA, and CU, CUA for the transmission and registration of the positive and/or heavy negative pulse constituting the value of each digit. In order to avoid repeating the operation of the pulse cycle for each digit, a description will first be given of the operation of relays W and Z for one quadrant, it being understood that the operation of said relays will be identical for each quadrant.

When relay SN— operates in response to a negative pulse in the second quadrant, a circuit is completed from ground on the No. 9 contacts of relay ON1, No. 1 contacts of relay SR1, lead **116**, the contacts of relay SN—, the normally made No. 1 contacts of relay W, winding of said relay W, resistor R1, to battery. Another circuit is also closed over the contacts of relay SN—, the No. 3 back contacts of relay Z, resistor R2, to battery. Relay W operates in this circuit, closes its No. 1 contacts to ground on conductor **116**, thereby holding relay W independently of its operating circuit, and short-circuits relay Z, which is supplied with ground on the other terminal of its winding through its own No. 3 back contacts and the contacts of relay SN. The circuit remains in this condition so long as relay SN— remains operated; that is, so long as the negative pulse persists.

At the termination of the pulse, relay SN— releases, thereby removing the short circuit around relay Z and

causing it to operate over a circuit from battery, resistor R2, winding of relay Z, No. 1 front contacts of relay W, to ground on lead 116. Thus at the beginning of the first negative pulse (second pulse in the quadrant) relay W operates. At the end of the pulse relay Z operates. With the operation of relay Z, ground on conductor SONG completes the circuit of relay CA over a circuit that extends from said ground through the No. 1 front contacts of relay Z, conductor 121, serially through the No. 1 contacts of relays CUA, CTA, CHA, CTHA, CSTA, CCA, CBA, CAA, winding of relay CA, to battery, operating said latter relay, which then locks over its No. 3 contacts, lead 122, No. 1 contacts of relay TR, to ground on lead SONG.

At the beginning of the negative pulse in the fourth quadrant of the pulse cycle relay SN— again operates, and due to the fact that both relays W and Z are operated at this time, ground on the contacts of said relay SN— establishes a shunt path for relay W, said path tracing over the No. 3 front contacts of said relay Z to the lower terminal of the winding of relay W, causing said relay W to release. Relay Z, however, now remains operated under the local control of relay SN—, the contacts of which supply ground for the winding of said relay through the No. 1 normally made contacts of relay W. On the termination of the pulse, relay SN— releases, thereby to release relay Z and thus complete a full quadrant of operations for any digit. Upon the release of relay Z, a circuit is completed to operate relay CAA, the path of which may be traced from ground through No. 6 contacts of relay ON3, lead SONG, No. 1 back contacts of relay Z, lead 126, serially through the No. 4 back contacts of relays CU, CT, CH, CTH, CST, CC, CB, No. 4 front contacts of relay CA, winding of relay CAA, to battery. Said relay operates and locks over its No. 3 contacts to ground on lead SONG.

Thus as a result of the two negative pulses in a quadrant of pulses (1) relay W operates; (2) relay Z operates (both relays operated); (3) relay W releases, and (4) relay Z releases. And as a result of the operation of relay Z in the first quadrant of pulses (the first digit) relay CA of the steering circuit is operated, and on its release, relay CAA is operated. With the repetition of the cycle, and essentially over similar circuit paths completed over lead 121 on the operation of relay Z and over lead 126 on the release, relays CB, CBA; CC, CCA; CST, CSTA; CTH, CTHA; CH, CHA; CT, CTA, and CU, CUA are operated sequentially and in succession; all of which lock to ground on lead 122, or 132, or 133, all of which connect with off-normal ground conductor SONG.

We will now describe the registration of the digits Republic 7 (AB code 737) 1359 which make up the digits of the called number herein used as to illustrate the operation of the invention.

The A digit 7 calls for a blank pulse, a heavy negative pulse, a blank pulse, and a heavy negative pulse. Consequently when the heavy negative pulse is received, relay SN— operates to start the operating cycle of relays W and Z (operating relay W), and relay MG operates to complete the circuit of relay CA2 of the A digit register. The path for this circuit may be traced from ground on the contacts of relay MG, No. 2 back contacts of relay Z, lead 117, No. 2 back contacts of relay CA, lead 118, winding of relay CA2, to battery. Relay CA2 operates and then locks over its No. 2 contacts to ground on conductor SONG. The next heavy negative pulse is, of course, the same as the first. However, since relay Z is operated at this time, a circuit is completed for relay CA5 of the A digit register; the path therefor being from ground on the contacts of relay MG, No. 2 front contacts of relay Z, lead 119, No. 5 back contacts of relay CAA, lead 120, winding of relay CA5, to battery. This relay also operates, locks over its No. 2 contacts to ground on lead SONG and, in combination with operated relay CA2, registers the A digit of the called subscriber's office code.

The B digit is 3 and calls for a positive pulse in the first quadrant of four pulses, a heavy negative pulse in the second, a blank pulse in the third, and a light negative pulse in the fourth. Consequently on the arrival of the first pulse, only relay SN+ operates, and since relays W and Z are both normal at this time, a circuit is completed from ground on the contacts of relay SN+, No. 2 back contacts of relay W, lead 123, No. 1 front contacts of relay CA (said relay having operated on the operation of relay Z), No. 1 back contacts of relay CB, lead 124, winding of relay CB1, to battery. This relay operates and then locks over its No. 2 contacts to ground on lead SONG. The second pulse is heavy negative, calling for the operation of both relays SN— and MG. Therefore, since relay Z is normal at this time, the operation of relay MG completes a circuit over the No. 2 back contacts of relay Z, lead 117, No. 2 front contacts of relay CA, No. 2 back contacts of relay CB, lead 125, winding of relay CB2, to battery. Relay CB2 operates, locks over its No. 3 contacts to ground on conductor SONG and, in combination with operated relay CB1, registers the B digit 3 of the called subscriber's office. The two remaining pulses, being respectively blank and light negative, will complete the cycle for relays W and Z, but will cause the operation of other register relays.

The C digit is 7 and calls for two heavy negative pulses. On the first pulse, relay CC2 is operated over a path extending from ground on the contacts of relay MG, No. 2 back contacts of relay Z, lead 117, No. 2 front contacts of relay CA and CB (the latter relay, along with relay CBA, having operated on the previous W and Z cycle), No. 2 back contacts of relay CC, lead 134, winding of relay CC2, to battery, operating said relay, which locks over its No. 3 contacts to ground on conductor SONG. On the second heavy pulse, relay CC5 is operated over a circuit extending from ground on the contacts of relay MG, No. 2 front contacts of relay Z, lead 119, No. 5 front contacts of relays CAA and CBA, No. 5 back contacts of relay CCA, lead 135, winding of relay CC5, to battery. This relay operates, locks over its No. 2 contacts to ground on lead SONG and, in combination with operated relay CC2, registers the C digit 7 of the called office code.

The next quadrant of pulses transmitted from the originating sender is that which pertains to the station digit. Since the assumed number of the called subscriber has no station digit, no positive or heavy negative pulses are transmitted, but only the cycling light negative pulses for the relays W and Z which operate relays CC and CCA. In this connection, however, it should be noted that the call may be for a subscriber in a manual office, and that such an office may have directory numbers over 10,000. On the other hand if the call is for an automatic office (as here assumed), directory numbers are limited to ten thousand. Hence the originating sender must transmit a signal to indicate whether the call is for a subscriber with a number over 10,000 or a subscriber under 10,000, which it does in the stations quadrant. If the number is under 10,000, the station register relays CST1–CST5 will be normal, and upon the operation of relay CSTA ground will be applied to conductor UT in cable 2, said ground extending from the No. 2 contacts of relay CSTA, serially through the No. 1 back contacts of relays CST1–CST4, No. 2 back contacts of relays CST5 to lead UT. If the call is for over 10,000, the originating sender will transmit 1 for the stations digit, resulting in the operation of relay CST, whereupon when relay CSTA operates ground is applied to lead OT from the No. 2 contacts of relay CSTA, No. 1 front contacts of relay CST1, No. 8 contacts of relay CSD to lead OT. For the particular call here being described, however, it will be assumed that lead OT is grounded.

The next quadrant of pulses pertains to the thousands digit 1, which calls for a light negative pulse followed by a heavy negative. Consequently on receiving the latter pulse relays SN— and MG are operated, the latter completing a circuit from ground previously traced to lead **119**, No. 5 front contacts of relays CAA, CBA, CCA, CSTA, No. 5 back contacts of relay CTHA, lead **136**, winding of relay CTH**2**, to battery. This relay operates, locks over its No. 2 contacts to ground on lead SONG and registers the numeral digit **1** as the thousands digit.

The next quadrant of pulses pertains to the hundreds digit 3, which calls for a light positive pulse, a heavy negative pulse and a light negative pulse. On the light positive pulse, a circuit is completed from ground on the contacts of relay SN+ as previously traced to lead **123**, No. 1 front contacts of relay CA, CB, CC, CST, CTH, No. 1 back contacts of relay CH, lead **137'**, winding of relay CH**1**, to battery. This relay operates and then locks over its No. 2 contacts to ground on lead SONG. On the heavy negative pulse, relay MG operates to complete a circuit from ground over its contacts traced to lead **117**, No. 2 front contacts of relays CA, CB, CC, CST, CTH, No. 2 back contacts of relay CH, lead **137**, winding of relay CH**2**, to battery. This relay operates, locks over its No. 3 contacts to ground on lead SONG and, in combination with operated relay CH**1**, registers the numeral 3 as the hundreds digit of the called subscriber's number.

The next quadrant of pulses pertains to the tens digit 5, which calls for a light negative pulse followed by a heavy negative one. On the latter pulse, relay MG completes a circuit from ground through its contacts as previously traced to conductor **119**, No. 5 front contacts of relays CAA, CBA, CCA, CSTA, CTHA, CHA, No. 5 back contacts of relay CTA, lead **138**, winding of relay CT**5**, to battery. This relay operates, locks over its No. 2 contacts to ground on lead SONG, and registers the numeral 5 as the tens digit of the called subscriber's number.

The next and last quadrant of pulses pertains to the units digit 9, which calls for a light negative pulse, followed by a light positive pulse, followed by a heavy negative pulse. On the positive pulse following the light negative one, relay SN+ completes a circuit from ground on its contacts, No. 2 front contacts of relay W, lead **139**, No. 4 front contacts of relays CAA, CBA, CCA, CSTA, CTHA, CHA, CTA, No. 4 normally made contacts of relay CUA, lead **140**, winding of relay CU**4**, to battery. This relay operates and then locks over its No. 2 contacts to ground on lead SONG. On the following heavy negative pulse, relay MG applies ground to conductor **119**, No. 5 front contacts of relays CAA, CBA, CCA, CSTA, CTHA, CHA, CTA, No. 5 normally made contacts on relay CUA, lead **141**, winding of relay CU**5**, to battery. This relay operates, locks over its No. 2 contacts to ground on lead SONG and, in combination with operated relay CU**4**, registers the numeral 9 as the units digit of the called subscriber's number.

When the called office code digits A, B, C have been registered in the sender, as indicated by the operation of relay CCA, a circuit is completed for relay DST for the purpose of seizing an idle marker and causing it to be connected to the sender by way of the marker-connector circuit. The operating path of relay DST traces from battery through the winding of said relay, lead **127**, normally made No. 5 contacts of relay TR**0**, No. 2 contacts of relay TVS, No. 1 contacts of relay ROP, lead **128**, No. 1 normally made contacts of relay TR**3**, normally made contacts of relay TR**1**, lead **129**, No. 7 contacts of relay CCA, to ground on conductor SONG. Relay DST operates and, among other functions, applies battery over the No. 1 contacts of relay LR**2**, lead **130**, No. 1 contacts of relay DST, to lead CBS in cable C**14** and thence to the marker-connector, and also through the No. 1 contacts of relay DRL to lead ST in said cable for operating said marker-connector in a manner fully described in the above-identified patent to W. W. Carpenter et al.

Although the present invention is not concerned with the operations of the marker, which is shown and described in the above-identified Gooderham et al. copending application, said marker, in response to the called office code digits and certain other information received from the sender, operates to extend the connection from the incoming trunk in the designated trunk-link frame to a selected outgoing trunk, either extending directly to the called office (in this case Republic 7) or through some other switching point, from which the connection is then further extended with apparatus at said switching point under control of the sender. If the marker succeeds in extending the incoming trunk to the outgoing trunk, it transmits back to the sender information required for its use in transmitting the required number of pulses for completing the connection to the called subscriber, the type and intensity of pulses transmitted depending upon the distance of the terminating office from the tandem center, the number of additional switching points, if any, between tandem and the terminating office, and the character of the switching equipment contained in such offices, including the terminating office, which may be manual, step-by-step, panel, or cross-bar. In this specification, and in respect to marker functions, therefore, only those sender operations are briefly described as are needed to supply the marker with the information required by it to extend the incoming trunk to the outgoing trunk, and to indicate briefly what relays are operated by the marker in the sender for the latter to transmit the required pulsing to the terminating office, and such other operations in the sender which result from signals transmitted by the marker consequent to, or in advance of, its performance of certain of its functions. For a detailed description of the operation of the marker and marker-connector, both conventionally indicated in Fig. 9, reference is made to the above-identified Carpenter et al. patent.

The signaling between the marker and sender is carried out over a multiplicity of leads indicated as contained in the cable designated C**14** which extends to said marker-connector.

Before indicating the equipment and leads in the sender, together with their significance, which are involved in signalling between the marker and sender, it is desirable first to state that the equipment is arranged to enable different markers to attempt to extend the connection in the event that each fails to do so, and to describe those operations in the sender which result from a predetermined number of such attempts.

When, after relay DST has operated and a marker is connected to the sender via the marker-connector, the sender applies ground to lead TR**1** in cable C**14** over the No. 2 back contacts of relay TR**2**, No. 2 back contacts of relay TR**3**, lead **131**, No. 2 contacts of relay PD, to ground. If the marker, after receiving from the sender the called office code and certain other information as will hereinafter be set forth, fails for any reason to obtain an outgoing trunk, it applies ground over lead TRL, completing thereby an obvious circuit over the lower winding of relay TRL, which operates and thereby advises the sender that the marker cannot extend the connection to an outgoing trunk. Said relay opens the circuit of relay DST and thereby releases the marker. Relay TRL also completes the circuit of relay TR**1** from battery through its winding, No. 4 back contacts of relay TR**4**, No. 4 back contacts of relay TR**2**, lead **142**, No. 1 contacts of relay TR**0**, No. 2 contacts of relay ROP, No. 2 contacts of relay TRL, to ground on lead SONG. A circuit is then completed for relay TR**2** in series with relay TR**1** over the front contacts of the latter relay, lead **129**, No. 7 contacts of relay CCA to ground on lead SONG. The marker, having been released and tempo-

rarily made busy, the sender applies ground to lead TR2 over the No. 2 front contacts of relay TR2, No. 2 back contacts of relay TR3, and thence as previously traced to ground. Relay DST is now reoperated over a circuit path previously traced to lead 128, thence over the No. 1 contacts of relay TR3, No. 3 contacts of relay TR2, to aforetraced ground on lead 129. Relay DST initiates operations by which another marker is seized and connected to the sender. Should the second marker also fail to obtain an outgoing trunk, it, too, grounds lead TRL to reoperate relay TRL. Since relays TR1 and TR2 are operated, a path is now closed for relay TR3 from battery through its winding, No. 2 back contacts of relay TR4, No. 4 front contacts of relay TR2, lead 142, No. 1 contacts of relay TR0, No. 1 contacts of relay ROP, No. 2 contacts of relay TRL, to ground on lead SONG. Upon the operation of relay TR3, relay TR4 operates in series therewith through the No. 1 front contacts of relay TR3, No. 3 contacts of relay TR2, to aforetraced ground on lead 129. On the operation of relay TRL, relay DST again releases to release the second marker. The reoperation of said relay DST over a previously traced path to lead 128, and thence over the No. 3 contacts of relay TR4, No. 3 contacts of relay TR2 to ground on lead 129, causes the seizure of a third marker, in consequence of which ground is then applied to lead OF over the No. 2 front contacts of relay TR3, lead 131 to ground on the No. 2 contacts of relay PD.

If the third marker also fails to obtain an outgoing trunk and, accordingly, grounds lead TRL to operate relay TRL, then a circuit is completed for relay R0, the path of which may be traced from battery through the winding of said relay, No. 2 front contacts of relay TR4, No. 4 front contacts of relay TR2, lead 142, and thence as previously traced to ground on lead SONG. Relay R0 operates, locks over its No. 4 contacts to ground on lead SONG, and, as will be shown later, initiates the release of the sender.

It may be remarked at this point that although a marker may have obtained an outgoing trunk, it may still fail to extend the incoming trunk thereto. The marker, however, is so arranged that it will detach itself from the sender once it has obtained an outgoing trunk, for which purpose it grounds lead DC to cause the operation of relay DC in the sender, advancing the operating ground over its No. 4 front contacts to lead DC in the cable C6, to complete the circuit of relay F in the outgoing trunk as already described. This ground is further advanced over the No. 3 contacts of relay F into the trunk link circuit, thence to operate a relay. If the marker should thereafter fail to connect the incoming trunk with the selected outgoing trunk, it grounds lead D to complete over the No. 8 front contacts of the DC relay the circuit of the upper winding of relay TRL, which then operates to cause previously described functions to be performed by which the marker is released and another marker called in.

Proceeding, now, with the information supplied by the sender to the marker upon their connection through the marker connector, the marker obtains from the sender:

(*a*) The called office digits A, B, C, from the selective operation of the following relays grounding the indicated conductors within cable C14:

Digit	Relays	Conductors
A	CA1-CA5	B0-B4, BA5, BB5
B	CB1-CB5	D0-D4, DA5, DB5
C	CC1-CC5	G0-G4, GA5, GB5

Conductors B– receive ground from conductor 131 through the No. 5 contacts of relay TR4, No. 2 contacts of relay CAA; conductors D– receive ground from the No. 2 contacts of relay CBA; conductors G– receive ground from the No. 2 contacts of relay CCA.

(*b*) The trunk-link frame number 00–19 from the selective operation of the following relays grounding the indicated conductors within cable C14, conductors F00 and F10 being grounded from the sender link frame through contacts 18 and 19 of relay SC1–2 when required:

Relays	Conductors
F0-F9, F00, F10	F0-F4, FA5, FB5, F00, F10

(*c*) The class-of-service indication (0–9) of the trunk from the originating office from the selective operation of the following relays grounding the indicated conductors within cable C14:

Relays	Conductors
CS0-CS6	CS0-CS6

(*d*) Trial numbers indicating to the marker whether first, second or third trial is being made by the grounding of the following leads as previously described:

Leads	Trials
TR1	first
TR2	second
OF	third

(*e*) The marker is also supplied with certain miscellaneous information by the grounding of certain leads with off-normal ground, but which are not shown as they are not pertinent to the present invention.

The marker transmits information to the sender regarding the type of signaling to be used on the selected outgoing trunk, number of digits to be picked or other disposition of the call by grounding combinations of leads through the marker connector. Register relays in the sender which operate in response to the marker grounds lock operated variously over leads 145, 156, 157 and 158, only after relay DRL is operated by the marker as a release signal to the sender, so that involved combinations may be changed if the marker, after determining on an outgoing trunk and finding it impossible to establish connection thereto, finds it necessary to re-route the call and change the combinations. Release of the registers is, of course, necessary if second or third marker trials are made.

(1) For the classification of the call in respect to the called office, the marker operates relays S0, XB, OD, TCI, CI, and TW in the required combinations;

(2) For type of pulsing the marker operates relays SSA, SSB, RBS, and MF (multifrequency) in required combinations;

(3) For type of termination; that is, whether the terminating office receives the pulses on step-by-step switches or on a dial pulse sender, the marker operates relay RBS for the latter and leaves said relay normal for the former;

(4) For the number of office code digits to be pulsed, the marker operates relays S0, IG5 singly or in combination depending upon whether no office code digits, one, two or three office code digits are to be pulsed;

(5) For code conversion of office digits the marker operates relays CR2 and CR4 if there is to be no code conversion and leaves both relays normal if there is to be code conversion;

(6) For loop compensation for terminating manual and panel offices the marker operates relays CR1, CR2, and CR5 alone or in combination depending on the length of the loop;

(7) For the code conversion of the A code digit to step-by-step or certain types of crossbar offices, the marker operates relays OCA1, OCA2, OCA4 and OCA5—

either alone or in appropriate combinations (none for the A digit 1); for the B code digit it operates relays OCB1, OCB2, OCB4 and OCB5 either alone or in appropriate combinations (none for the B digit 1); and for the C code digit it operates relays CR1, CR2, CR4 and CR5 either alone or in appropriate combinations (none for the C digit 1);

(8) If multioffice terminating revertive units are reached over common trunk groups, relay IG5 is operated by the marker to distinguish between them, causing the sender to add five (5) to the value of its incoming group selection.

The foregoing operations are those which, as previously stated, are initiated after the three digits of the called office code have been registered in the sender, and in consequence of which a marker is caused to be connected to the sender for the purpose of extending the connection from the incoming trunk to the outgoing trunk. When the marker has completed its functions, it grounds lead RL, thereby completing the circuit of relay DRL over the No. 2 back contacts of relay R0, winding of relay DRL to battery. Said relay operates, locks over its No. 5 contacts to ground on the No. 7 contacts of relay DST, supplies ground over its No. 10 contacts and over the Nos. 4, 9, 3 and 2 contacts, respectively, of relay DST to leads 145, 156, 157 and 158 to lock up the registers operated by the marker, and performs certain other functions in connection with the further operation of the sender that will be described in due course.

When the sender at the originating office has finished sending the pulses which constitute the called office number, a circuit is completed for relay TR. However, before tracing the circuit of said relay, it will be observed that when relay ON1 was operated a circuit was completed for relay CCH through the No. 5 back contacts of relay TR to ground on lead SONG extending to the No. 9 contacts of relay ON1. Now when relay CUA operates after the last quadrant of pulses is received, relay TR operates over a circuit extending from battery through the winding of said relay TR, lead 300, No. 8 contacts of relay CUA, to ground on lead SONG. Relay TR operates, locks over its No. 5 contacts to ground on lead SONG. The operation of relay TR opens the circuit of relay CCH, but since the latter relay is slow-release, there is an interval during which relay CCH applies resistance battery to the tip lead T via the No. 6 front contacts of relay TR, lead 106 through No. 2 contacts of relay SR1 and No. 6 contacts of relay LR1, and ground to the ring lead R via the No. 4 front contacts of relay TR, lead 103, and contacts 7 of relay LR1. This is to charge the cable as already described. Relay CCH then releases to remove said battery and ground.

With the operation of relay TR, and the release of relay CCH, relay A is connected across the tip and ring leads T and R when looped at the originating sender after the transmission of the pulses. The circuit of said relay A extends from battery through its lower winding, lead 304, lower left winding of transformer A, lead 303, No. 1 back contacts of relay CCH, No. 4 front contacts of relay TR, lead 103, No. 7 contacts of relay LR1, lead R, over the loop back to lead T, No. 6 contacts of relay LR1, No. 2 contacts of relay SR1, lead 106, No. 6 front contacts of relay TR, No. 2 backs contacts of relay CCH, lead 302, left upper winding of transformer A, lead 301, upper winding of relay A, to ground. Relay A operates and over its No. 2 contacts completes an obvious circuit for relay SR which, on operating, completes a circuit for relay SR1 from battery through its winding, lead 305, No. 3 front contacts of relay SR, to ground on lead SONG. Relay SR1 operates and locks over its No. 5 contacts to ground on lead SONG. It should be noted that slow-release relay SR and the memory relay SR1 keep the tip and ring leads T and R closed, but after relay SR1 operates, if the leads are opened at the originating office for a time long enough to release A and SR, as they would be, for instance, if the subscriber disconnected, relay A cannot reoperates as the loop would be opened at the locked-up relay SR1. The release of relay A under these circumstances will cause the sender to release, as will be described. It should also be noted that ringing tone is supplied the calling subscriber by induction from the source connected over the Nos. 1 and 8 contacts of relay OA1 to the primary windings of transformer A, the secondary of which are in series with relay A as above described. The ringing tone thus supplied is removed when the sender becomes attached to an operator's position and the operator thereat is ready to ask the calling subscriber for his number, at which time relay OA1 is operated, as will be described.

When the last of the numerical digits or, if desired, any previous digit including a code digit, has been registered in the sender, operations are initiated by which the sender is caused to be connected to an operator's position, the latter having access to the incoming trunk by way of the sender as will be shown, and causing the operator to communicate orally with the calling subscriber and obtain from him the directory number of the station at which the call is placed; that is, to obtain from him the three digits of the calling exchange and the four or five digits of the station directory number. By the connection of ground shown in Fig. 20 to the appropriate one of the terminals extending to the No. 6 contacts of one of the eight relays CAA–CUA, said operations may be initiated after any one of the eight called number digits are received from the originating office. In the present embodiment of the invention, the ground connection is made at the No. 6 contacts of relay CUA, so that the operations of connecting the sender with an operator's position are initiated after the called units digit is received, after which relay CUA is operated as already described. Upon the operation of said relay, therefore, a path is established from ground on lead 146, No. 6 contacts of relay CUA, lead 147, No. 3 contacts of relay OA1, No. 8 contacts of relay PR1, winding of relay CW, to battery. Relay CW operates. Over its No. 2 contacts it advances the operating ground over lead 148, No. 6 contacts of relay ON4, lead 149, No. 1 contacts of relay PA, lead ST0 within cable C10, and thence to complete a circuit in one of two controllers (as will be shortly described) by which the sender will be connected over a link to an available operator's position. Over its No. 3 contacts, it applies positive 130 volts through the 10,000-ohm resistor CW1 to lead CW extending to the Call Awaiting circuit shown in Figs. 49 and 50 (the operation of which will be described in due course).

In order to understand more clearly how this connection is achieved, consideration is directed to Figs. 133, 134, 135 and 137, in which Fig. 133 shows schematically the relation between a sender group and the links available to the senders in the group for connecting the senders to certain operators' positions; Fig. 134 shows schematically the relation between the links and the operator's position, Fig. 135 shows the essence of the two controller circuits A and B, by one or the other of which a sender is caused to be connected to an available operator's position, while Fig. 137 schematically shows the distribution of links between sender groups and position groups.

The present embodiment of the invention is predicated on the use of two controllers for each of forty senders divided into four groups of ten each, namely, sender group 0, sender group 1, sender group 2, and sender group 3. There are ten links for each sender group by which the senders in each group are enabled to connect with fifty operators' positions (by way of example) divided into five groups of ten positions each, namely, position group 0 for positions 00–09, position group 1 for positions 10–19, position group 2 for positions 20–29, position group 3 for positions 30–39, and position group 4 for positions 40–49. The distribution of links between the sender group switches and the position group switches is shown in Fig. 137. Due to the fact that there are four

sender group switches and five position group switches, it will be seen from Fig. 137 that while each sender switch is served by ten links, each position group is served by eight of these links, each pair coming from a different sender group switch.

Each of the ten senders in a group, for example, each of the senders in sender group 0 indicated in Fig. 133 by way of example, terminates on a corresponding horizontal member on each of two crossbar switches, each of said members having a suitable number of contacts by which to engage an equal number of contacts on the vertical members of the switch.

To the ten vertical members of the upper crossbar switch (shown underneath the legend "served by controller A") are connected the ten links, numerically designated 0–9, while to the ten vertical members of the lower crossbar switch (shown underneath the legend "served by controller B") are connected ten other links, similarly and correspondingly designated 0–9. The access of each of the senders in the group to each link on the upper crossbar switch is effected by a circuit identified as controller A, while access of the same senders to each of the links in the lower crossbar switch is effected by another circuit identified as controller B.

It will be noted from Fig. 133 that the ten links in the upper crossbar switch are indicated as having access to fifty operators' positions, with each two links serving one position group of ten operators' positions. Thus as elaborated in Fig. 137, links 0 and 1 have access to positions 00–09 (designated as "position group 0"); links 2 and 3 have access to positions 10–19 (designated as "position group 1"), said links being indicated as links 0 and 1 on the position switch for position group 1, and so on up to and including links 8 and 9 which have access to operators' positions 40–49 (designated as "position group 4") and which are designated as links 0 and 1 on the position switch for position group 4. In the same manner, the ten links appearing on the lower crossbar switch in Fig. 133 similarly have access to the same operators' positions (or to fifty others if desired) with each two links serving ten positions, namely, links 0 and 1 having access to the positions 50–59 in position group 0; links 2 and 3 having access to the position 60–69 and so on up to links 8 and 9 having access to positions 90–99.

All other sender groups are each similarly connected to two crossbar switches, each switch having ten links through which the senders in the group are made to have access, through controller A and controller B, respectively, to the positions served by the links on each switch.

It is apparent from Figs. 133 and 137 that a calling sender in any sender group, for example a calling sender in sender group 0, will have access to positions 00–49 over the links 0 to 9 in the upper switch, if accessibility thereto is had through controller A, and to the same positions over the links 0 to 9 in the lower crossbar switch (Fig. 133) if access thereto is had over controller B. Since the positions are all alike and the links are all alike, a calling sender is made to obtain a position through a link allotted by one controller or the other depending upon a certain controller sender group preference and link and position availability. If the preferred controller is busy when a sender in a group is calling, then the sender will automatically obtain a link through the other controller, provided (and subject to certain later qualifications) that a link served by the latter controller is available.

Referring to Fig. 134, a crossbar switch is shown therein with ten horizontals, each connected to a position in a group of ten positions; for example, positions 00–9 of position group 0. These positions are served by eight links available through controller A and eight links served by controller B, said latter links appearing on another switch (not shown) to which the positions are multipled. By reference to Figs. 133 and 137 it will be seen that links 0 and 1 are extensions of links 0 and 1 on the sender switch for sender group 0, links 2 and 3 are extensions of links 0 and 1 on the switch of sender group 1, and so on to links 6 and 7 which are extensions of links 0 and 1 on the switch of sender group 4. Similar distribution of links is, of course, followed with respect to the links between other sender groups and other position groups, as indicated in Figs. 133 and 137.

Before describing in detail the arrangements by which a calling sender obtains access to a link through a controller, it is desirable at this point to indicate briefly that when a sender calls by grounding its lead ST– (lead ST0 for sender 0 in each sender group) as previously described, its access to its preferred controller depends upon a number of conditions. To begin with, it depends on whether links are available in the switch served by that controller; it also depends upon whether a position is free and available in the groups of positions availabe through the links served by said controller, and finally it depends on whether the controller itself is free to serve the calling sender. If all three conditions are met, then the preferred controller operates to extend the sender to a link on the link switch served by said controller. If all three conditions are not met, then the nonpreferred controller takes over to serve the sender, provided that all the three conditions are similarly met.

Fig. 135 shows the essence of the two controller circuits A and B, the details of one of which, namely, controller A, are shown in Figs. 58–63. In Fig. 135, controller A is shown above the horizontal dividing line while controller B is shown below it. The circuit is so arranged that each group of senders has preference for a particular controller, and uses the non-preferred controller only if the preferred one is not available as above described. Thus the ten senders constituting sender group 0, and those constituting sender group 2 have controller A as a preference while the ten senders of group 1 and those of group 3 have controller B as a preference. In each of the controllers a relay PF– is individual to each of the preferred groups, the relationship between the sender group and the relay individual thereto being indicated by the numerical suffix of the designation of the relay. Thus relay PF0 in controller A is associated with sender group 0, while relay PF2 is associated with sender group 2. In the same manner, relay PF1 in controller B is associated with the sender group 1 and relay PF3 is associated with sender group 3. Also in each of the two controllers a relay is provided therein for each of the sender groups which use the controller only if the preferred controller is not available. These relays are relays XP1 and and XP3 for controller A and XP0 and XP2 for controller B, relay XP1 in controller A being associated with the senders of group 1 having controller B as a preference, relay XP3 with the senders of group 3 also having controller B as a preference. In the same manner, relay XP0 in controller B is associated with the senders of group 0 having controller A as a preference, and relay XP2 is associated with the senders of group 2 having controller A as a preference.

When a calling sender has reached that stage of its operation where lead ST– is grounded; for example lead ST0 of sender 0 in sender group 0, relay PF0 will be operated if the controller A is free, if a link is available in the sender-link switch served by controller A, and if an operator's position is available through the links on that switch. Referring to Fig. 135, and assuming ground on lead ST0 (the ten leads ST0–ST9 of the ten senders of group 0 being shown as one lead for convenience) said ground will complete a circuit through a conducting path partially indicated by the dot and dash line (which will be closed in the controller if a link is available and a position is free), the No. 4 contacts of relay SGGT, No. 3 contacts of relay XP0, winding of relay PF0, to battery. It will be noted, however, that the

ground on lead ST0 is also carried through a symmetrical dot-and-dash path in controller B, through corresponding contacts of relay SGGT in controller B, to one terminal of the winding of relay XP0. However, since ground is also present at the other terminal of relay XP0 from the No. 3 contacts of relay PF0, it follows that relay PF0 will operate and relay XP0 will not. As previously stated, one or both of these paths are closed on the condition that a link and a position through the switch served by the involved controller are both free and available. When relay PF0 operates, it locks over its No. 2 contacts to ground on lead ST0, and completes an obvious circuit for relay SGGT, which operates to cut-off access to controller A by other calling senders in the two groups preferring the controller. If by way of example when sender 0 in sender group 0 calls by grounding its lead ST0, relay SGGT is operated because the controller is busy, the ground on lead ST0 is then diverted to controller B as will be explained. Relay PF0, on operating, initiates the performance of functions by which the calling sender in sender group 0 is connected to one of the two links serving an available position in the group of positions indicated to be free and served by said links.

If we now consider that controller A is busy, as indicated by the operated condition of its relay SGGT, or by the fact that no link or position is available through said controller A as indicated by an opening in the dot-and-dash line path between the sender leads ST– of the sender group and the contacts of relay SGGT, then the ground on lead ST0 is applied through the No. 4 contact so relay SGGT in controller B, winding of relay XP0, No. 3 contacts of relay PF0, winding of relay PF0, to battery. In this circuit, relay XP0 which is of relatively low resistance, will operate, but relay PF0 which is of much higher resistance will not operate. Relay XP0, on operating, locks over its No. 2 contacts to ground on lead ST0, completes an obvious circuit for relay SGGT of controller B, and initiates operations by which the calling sender in sender group 0 is caused to be connected to a free link and position served by controller B.

A calling sender in each of the other groups similarly causes the operation of its associated relay PF– in the preferred controller. For example, a calling sender in group 3 which is wired for preference to controller B, will close the circuit of relay PF3 in controller B over a circuit path corresponding to the one above traced for relay PF0. Should relay SGGT in controller B be operated, or should the dot-and-dash path connection therein be opened, then the circuit is completed to relay XP3 in controller A over a circuit path corresponding to the one above traced for relay XP0. Relay PF3 will lock to operating ground, close an obvious circuit for relay SGGT of controller B, and initiates operations by which the calling sender in group 3 is caused to be connected to a free link and position served by controller B. On the other hand, if controller B is busy and relay XP3 in controller A is operated in consequence thereof, then said latter relay will initiate operations whereby the calling sender in group 3 is caused to be connected to a free link and position reached by controller A.

With this general understanding of the relationship between the two controllers A and B, and the links and positions as indicated by Figs. 133, 134, 134A, 135 and 137, we will now describe in detail the operations by which the calling sender 0 in sender group 0 is caused to be connected to a position, say position 00 in position group 0, and reached over links 0 and 1 on the sender group switch, reference being made specifically to Figs. 52–65, and to Fig. 51.

Considering Fig. 56, it will be seen that there are five relays GB0–GB4, of which only GB0 and GB4 are shown. Each of these relays is a position "group busy" relay, and when the ten positions constituting the group are busy, unoccupied, or otherwise not available, such a relay is operated.

The position circuit is shown in Fig. 51. When the operator occupies the position, the headset is plugged into the two jacks provided therefor, completing thereby an obvious circuit for relay P0. As soon as a position is seized by a link, a circuit is completed, as will be shown, for relay S in said position. If, now, all the ten positions constituting the group are busy, as evidenced by the operated condition of relay S or that of relay PD in each position (the latter relay operating over a local circuit as soon as the position disconnect key POSDISC is operated), or if the positions, or any of them, are unoccupied, as evidenced by the released condition of relay P0 in each such unoccupied position, battery through the No. 3 contacts of relay S and through similar paths closed in each of the other ten positions if busy or unoccupied, will be applied to lead 156. Assuming that all ten positions of position group 0 are busy or unoccupied, then said battery on lead 156 will complete the circuit of relay GB0. In the same manner, if the ten positions in position group 1 are busy or unoccupied, then the corresponding relay GB1 (not shown) will be operated. The same thing is true with respect to relays GB2, GB3 and GB4 (relays GB2 and GB3 not shown) for position groups 2, 3 and 4, respectively. If all the positions in each of the different groups to which each of said relays is individual are busy or unoccupied, then the involved relay, or relays, GB– will be operated. On the other hand, if one or more positions in each of said position groups are free and occupied, then the involved relay, or relays GB– will be normal.

Assuming, therefore, that position group 0 has at least one position free and occupied, then the previously traced ground on lead ST0 of the calling sender will complete a circuit for relay PF0 in controller A if one or the other of the two links 0 and 1 serving positions 00–09 through said controller is free, and also if said controller is free. In connection with the two link verticals which are shown to the left of Fig. 59 and of which one is shown in detail, the idle condition of each link is determined by the unoperated condition of their respective hold magnets HM0 and HM1. If the preferred controller A is busy the circuit we are currently tracing is broken since either relay PF0, PF2, XP1 or XP3 is operated therein as previously described in connection with Fig. 135. If one of these relays is operated, a circuit is closed for relay SGGT of controller A, said circuit extending from battery through the winding of said relay, No. 9 contacts of relay PS, lead 196, to ground on a pair of contacts on relays PF0, PF2, XP1 or XP3, whichever is operated. Relay SGGT operates, locks over its No. 2 contacts to operating ground, and completes over its No. 1 contacts and lead 158, contacts 1 of relay P and lead 159 the circuit of relay PGT.

Assuming, however, that both links are normal, that controller A is not busy, that a position is free and available in each position group or any of them, and that links are available leading to each position group, then ground on lead ST0 of the sender is extended over the No. 10 contacts of relay D0, lead 150, No. 1 contacts of relay GB0 (or corresponding contacts on relays GB1–GB4), lead 151, the No. 1 contacts of hold magnet HM0 or HM1, lead 152, No. 3 contacts of relay SGGT, lead 153, No. 1 contacts of relay XP0, lead 154, winding of relay PF0, lead 155, No. 3 contacts of relay MB, resistor MB1, to battery. Relay PF0 operates and locks over its No. 4 contacts to previously traced ground on lead 150. It will be evident from Fig. 56 that if relay GB0 is operated, indicating that all positions in position group 0 are busy or otherwise unavailable, that lead 150 will be carried over the No. 1 back contacts of either relays GB1, GB2, GB3, or GB4 depending upon which relay is normal, as previously indicated.

Before considering the further operation of controller

A following the operation of relay PF0, or any of the three other relays XP1, PF2 or XP3 therein, it is necessary to point out that the ability of the controller to serve any calling sender depends upon the operated condition of one of the four selection preference relays SP0–SP3, one of the five position group preference relays GP0–GP4, and one of the ten position preference relays PP0–PP9 therein. Relay EP will also be operated if either relay SP0 or SP1 is operated. On the termination of the operation of the controller in connecting a calling sender to an available position, a relay in each of the three above-mentioned groups will remain operated in the controller. However, if we assume that all relays are normal prior to the application of power to the controller, then said controller will "prime" itself to operate a relay in each one of said groups before it can serve calling senders. Specifically, it will operate relays SP1, GP4 and PP9. Therefore, upon the application of power to the controller, a circuit is completed for relay PU from ground on the No. 3 back contacts of relay GP4, serially through No. 3 back contacts of relays GP3, GP2 and GP1 (not shown), No. 3 back contacts of relay GP0, lead **161**, the left contacts of interrupter CA1 when closed, winding of relay PU, to battery. It will be observed that ground is also applied to lead **161** from the No. 4 back contacts of relay PP9, serially through the No. 4 back contacts of relays PP8, PP7–PP2 (not shown), No. 4 back contacts of relays PP1 and PP0, to lead **161**. Relay PU operates and locks itself to ground on lead **161** over its No. 1 contacts. When interrupter CA1 makes its right contacts, ground on said lead **161** is advanced through the No. 1 contacts of relay PU to complete a circuit over lead **179**, winding of relay CA, to battery. Relay CA operates, locks over its No. 5 contacts to ground on the No. 7 contacts of relay RS, and completes the circuit of the latter relay from battery, resistor RS1, lower winding of relay RS, No. 4 contacts of relay CA, to ground on the latter's No. 8 contacts. Relay RS operates and opens the locking circuit of relay CA, but the latter will continue to hold over its operating circuit through the right contacts of interrupter CA1. With relay CA operated, a circuit is completed for relay GP4 over a path which extends from battery through its upper winding, lead **166**, to ground on the No. 11 contacts of relay CA. Relay GP4 operates and locks over ground through its No. 3 front contacts and lower winding, serially through corresponding front contacts on relays GP3–GP1, No. 5 contacts of relay GP0, resistor GPP, to battery. A circuit is also completed for relay PP9 from battery through its left winding, lead **165** to ground on the No. 10 contacts of relay CA. Relay PP9 operates and then locks over ground through its No. 4 front contacts and right winding, serially through the No. 5 back contacts of relays PP8–PP1, No. 5 contacts of relay PP0, resistor PPP, to battery.

The operation of relay CA also completes a circuit for relay SP0, the path of which extends from battery through its winding, No. 5 normally made contacts of said relay, lead **164**, No. 3 contacts of relay CA, lead **163**, No. 1 contacts of relay SP3, No. 1 contacts of relay SP2, No. 1 contacts of relay SP1, lead **162**, No. 7 contacts of relay CA, to ground. Relay SP0 operates and locks over its No. 5 front contacts to ground on the No. 6 normally made contacts of relay SP1. Upon the operation of relay SP0 a circuit is completed for relay SP1, the path of which extends from battery through its winding, No. 5 normally made contacts, No. 9 contacts of relay SP0, No. 1 contacts of relay SP3, thence as traced over lead **162** to ground on the No. 7 contacts of relay CA. Relay SP1 operates, locks over its No. 5 front contacts to ground on the normally made contacts of relay SP2, and advances the locking circuit of relay SP0 over its No. 6 front contacts to lead **162** and ground thereon applied over the No. 7 contacts of relay CA. Consequently when interrupter CA1 opens its right contacts and relay CA releases in consequence thereof, relay SP0 releases, while relay SP1 remains locked. With the operation of either relay SP0 or SP1 a circuit is closed for operating relay EP (Fig. 52) said circuit extending from battery through its winding, lead **169**, No. 10 contacts of relay SP0 to ground on the No. 7 back contacts of relay SP3, or No. 10 contacts of relay SP1, to ground.

Thus at the time relay CA releases, and assuming that no sender is calling, relays GP4, PP9 and SP1 are operated and locked, while relay EP holds locally from ground on the No. 10 contacts on relay SP1. The controller will now remain in this condition until one or more senders ground their respective leads ST–. For, although interrupter CA1 will continue to function in the absence of calling senders, relay PU, and hence relay CA, cannot be operated inasmuch as with relay GP4 operated (or any other relay of this group operated) and relay PP9 operated (or any other relay of this group operated) no ground is applied to lead **161**.

The cycle of interrupter CA1 is shown in Fig. 54A. As is there indicated, the left contact engages with the moving spring for approximately 0.15 second. Thereafter there is an interval of approximately one second during which neither the left nor the front contact engages the moving spring, following which the right contact only engages said spring for approximately 0.15 second, after which said spring is again unengaged for approximately .020 second and subsequent to which it is engaged by the left contact for 0.15 second at the beginning of the next cycle. Relay CA, therefore, is operated and held for approximately .150 second when it releases, since relay RS will have released before the expiration of this time interval. It should be stated at this time that the controller is permitted a time equal to the open period of both contacts of interrupter CA1 (approximately one second) to complete the operation of assigning a calling sender to a position. Should it fail to do so in this time, the reoperation of relay CA will operate an alarm, as will be described.

With the controller in the condition above described, that is, with relays GP4, PP9, SP1, and EP operated, we will now describe those operations of the controller that follow the operation of relay PF0 incident to ground on lead ST0 of the calling sender 0 in sender group 0. Relay PF0, on operating, not only locks to start ground on lead ST0 as already described, but if relays XP3 and XP2 are normal, thereby indicating that the controller is not in the act of serving a sender from group 3 or group 2, also has an additional locking circuit over its own No. 5 front contacts, No. 5 back contacts of relay XP3, No. 5 back contacts of relay PF2, lead **276**, No. 3 contacts of relay SP1 (or of relay SP3, whichever is operated at this time), lead **277**, No. 6 contacts of relay PS1 (Fig. 53), lead **178**, to ground on the No. 1 contacts of relay RS (Fig. 53). The operation of relay PF0 results in the application of ground on its No. 2 contacts, lead **168**, No. 5 contacts of relay RS, to lead **161**. If interrupter CA1 is at this time making with its left contacts, relay PU will operate as before described. However, since the closure of the left contact is followed by an open period of approximately 1 second in which the controller is to assign a calling sender to an available position, the closure of the right contact of said interrupter, and hence the operation of relay CA, will not occur during the operations that will now be described. Should the controller fail to discharge by the time the right contacts of the interrupter close and relay CA is again operated, then an alarm will be given, as will be shown.

Relay PF0 also completes the circuit for relay SGGT (Fig. 62), as previously described, and the latter relay, through its No. 1 contacts, operates relay PGT (Fig. 53) also as described. Relay PGT, in conjunction with operated relay SP1, completes a circuit for the cut-in re-

lays CA0, CB0 and CC0 individual to sender group 0 containing the calling sender. The circuit path of said relays is as follows: ground serially through the windings of relay CA0, CB0 and CC0, No. 1 contacts of relay PF0, No. 1 back contacts of relay XP3, No. 1 back contacts of relay PF2, lead 191, No. 2 contacts of relay SP1, lead 171, No. 1 front contacts of relay EP, lead 172, No. 2 contacts of relay PGT, lead 173, No. 3 contacts of relay PA, No. 1 contacts of relay PA1, lead 174, No. 1 contacts of relay PG, lead 175, No. 2 contacts of relay SK, No. 2 contacts of relay RS, resistor RS2, to battery. Relays CA0, CB0 and CC0 operate and lock through the No. 11 contacts of relay CC0, lead 181, resistor CC01, lead 182, No. 2 contacts of relay RS, resistor RS2, to battery.

Upon the operation of relays CA0, CB0 and CC0 a circuit is completed for relay D0 from ground through its winding, lead 187, No. 11 contacts of relay CA0, resistor CAA, to battery. Relay D0 operates, breaks the connection between the start leads ST0–ST9 of the senders in group 0, and completes a path for relays PA (Fig. 62) and SGT (Fig. 58). The path of said relay PA extends from ground through the No. 1 contacts of relay RS, lead 178, No. 5 back contacts of relay PA1, lead 183, No. 12 contacts of relay CC0, lead 150, No. 11 contacts of relay D0, lead 184, No. 12 contacts of relay CA0, lead 189, winding of relay PA, to battery. Another branch of the circuit extends through the No. 1 contacts of relay S, lead 185, winding of relay SGT, to battery, operating relay SGT. Relays PA and SGT both operate. Relay PA completes the circuit of relay PA1 over its No. 4 contacts to operating ground on lead 178 and operates said relay, which locks over its No. 5 front contacts to operating ground. Upon operation of relay PA1 a circuit is completed for relay PGGT, said circuit extending from battery through resistor PGT1, No. 4 contacts of relay PG, No. 2 contacts of relay PGK, No. 1 contacts of relay APS, winding of relay PGGT, lead 195, No. 4 contacts of relay PA1, lead 196, to ground on the No. 3 contacts of relay PF0. Relay PGGT operates to perform certain functions noted hereinafter. Relay SGT, through its Nos. 2–11 contacts, connects the ten sender-preference relays S0–S9 to corresponding leads ST0–ST9 of the calling sender group (in this case sender group 0) through the contacts of relay CA0. Whatever senders are calling in the group will have ground applied to their corresponding leads ST–, and said grounds will complete the circuits of the corresponding relay S–. It has been assumed that sender 00 in sender group 0 is calling, said sender having ground applied to its lead ST0 as already described. Consequently when relay SGT operates, ground on lead ST0 is applied through the No. 10 contacts of relay CA0, lead 186, No. 2 contacts of relay SGT, winding of relay S0, to battery. In the same manner, any other sender in group 0 which has ground on its lead ST– will similarly cause a circuit to be completed for a corresponding relay S– over a circuit path similar to the one just traced for relay S0.

The relay S0, on operating, advances operating ground over its No. 3 front contacts, serially through the No. 3 back contacts of relays S9–S2, No. 4 contacts of relay SP1, lead 190, winding of relay S (Fig. 62) to battery. Relay S, by closing its No. 2 contacts on operation, obtains ground therethrough from the No. 3 front contacts of relay RS, lead 191A, No. 4 contacts of relay S0, lead 192 and the No. 2 contacts of relay S. Said ground thus holds both relay S and relay S0 operated independent of relay SGT. By its operation, relay S opens its No. 1 contacts and thereby opens the circuit of relay SGT which releases. In consequence all relays S0–S9 which have operated will release except the one that is locked in parallel with relay S, in this particular instance relay S0, which represents the calling sender, and particularly the one preferred for service since there is no other sender in the group calling. If there had been more than one sender calling the particular one of the relays S0–S9 that would remain locked would depend upon which one of the four relays SP0–SP3 is operated at the time. For example, assume that relay SP0 is operated and that senders 0, 4 and 7 are calling. Relays S0, S4 and 7 are therefore operated. In this case, the locking circuit of relay S0 is completed through the No. 4 contacts of relay SP0 to lead 190. Relays S4 and S7 will have no locking circuits, so that when relay S0 is operated, sender 0, represented by relay S0 will have first preference. When relay SP1 is operated, sender 2, represented by relay S2 will have first preference inasmuch as the locking circuit of said latter relay will be through the No. 4 contacts of relay SP1. When relay SP2 is operated, the preferred sender will be sender 5, the locking of relay S5 being through the No. 4 contacts of relay SP2, and when relay SP3 is operated the preferred sender will be sender 7, the locking circuit of relay S7 being through the No. 4 contacts of relay SP3.

With the release of relay SGT and the disconnection of relays S0–S9 from the sender start leads ST0–ST9, a circuit is completed for relay SS, the path of said circuit being from battery through the winding of said relay, lead 193, No. 1 contacts of relay SGT, lead 194, No. 1 front contacts of relay S0, serially through the No. 2 back contacts of relays S1–S9, No. 6 contacts of relay S0, lead 186, No. 10 contacts of relay CA0, to ground on lead ST0 of the calling sender. By its operation relay SS indicates that the sender has been selected, and will remain operated so long as ground is maintained on start lead ST0.

Having selected the sender to be served, the controller operates also to select an available position through an available one of the links serving sender group 0. We have noted as a result of the priming of the controller, that the position group preference is initially set at position group 4 by the operation and locking of relay GP4. It may be, however, that no position is available in this group of no link free connecting with the group, in which event the sender will be connected to an available position in some other group. This makes it necessary first to determine which position groups have positions free and available therein. For this purpose each controller in the office is provided with a relay for each position group; namely relays PG0, PG1, PG2 and PG3. As shown in Figs. 55 and 56, corresponding relays in each controller are disposed in a double transfer lock-out circuit. By the operation of a relay in any controller for a position group, the operation of corresponding relays in other controllers is rendered ineffective. Remembering that two controllers are furnished for each forty senders, Fig. 55 shows the first and last of the four chains of relays PG– for a plurality of pairs of controllers, the relays PG0–PG4 of the "first" controller in the chain being those shown in Fig. 56.

Referring to Fig. 55 in conjunction with Fig. 56, it is evident that if relay PG4 in the first controller is operated, said relay will lock over its No. 2 contacts, and complete an obvious circuit over its top operated contacts for relay GA4. Should another controller now be activated, for example, controller B for the first group of forty senders, its relay PG4 will also operate if the controller has determined that a free position and a link connecting therewith are both available in group 4, said relay also locking over its bottom contacts. However, since relay PG4 in the first controller is also operated and locked at this time, said first controller renders the No. 1 back contacts of relay PG4 in controller B ineffective to operate its associated relay GA4, since ground to the armature of said contacts is not applied at this time over the No. 1 back contacts of the first PG4. This causes controller A to obtain a position in position group

4 while all other controllers, or any of them, are locked out of accessibility to said position group.

The same relation obtains for each of the five position groups, for which a separate chain of relays PG– for all controllers is provided, as indicated in Fig. 56. Hence when a controller is serving a sender, the operated condition of its five relays PG0–PG4, or any of them, indicates the availability of at least one position in each group and a free link connecting therewith.

We may now assume that a position is available in each group and that a link is idle to each group. Under these circumstances relays PG0–PG4 in Fig. 56 will all be operated, the circuit of relay PG0, by way of example, being completed from ground through the No. 2 normally made contacts of relay PG0 of the last controller B, serially through the No. 2 normally made contacts of relays PG0 of all intermediate controllers (assuming them all to be normal), winding of relay PG0 of the controller disclosed in Figs. 52–65, lead 218, No. 2 and No. 3 contacts of relay PGGT, lead 197 connecting with the No. 2 contacts of said relay PGGT, No. 1 contacts of relay CB0, lead 198, normal contacts of hold magnet HM0 of link 0 (assumed to be idle) lead 199, No. 9 contacts of relay GB0, resistor GB00, to battery. The No. 3 contacts of relay PGGT connects with the armature of hold magnet HM1 of link 1 (on the switch frame for position group 0) by means of lead 226, No. 2 contacts of relay CB0, lead 227 to armature of hold magnet HM1, lead 199, No. 9 contacts of relay GB0. Since lead 218 is connected to both the No. 2 and No. 3 contacts of relay PGGT, it follows that relay PG0 will operate if either link 0 or link 1 is free, as indicated by the normal condition of their respective hold magnets HM0 and HM1.

In the same manner, relays PG1–PG3 will operate over similar circuits closed through involved contacts of relay PGGT, providing that all other controllers are free, that a position is available in each of the four position groups (indicated by the released condition of relays GB1–GB4) and that a link is idle for each position group. For the present it will be assumed that a position is available in each group and that, accordingly, relays PG0–PG4 are all operated.

With relays PG0–PG4 operated, a position will be selected in the particular preferred group indicated by the relay in the group of five relays GP0–GP4 which is locked up. Remembering that relay GP4 was locked when the controller was primed, a position will be selected in position group 4 if available. Further, a particular position indicated by an operated relay PP– will be selected in the group if that position is free. It will be remembered that relay PP9 was locked up when the controller was primed. Consequently position 9 in position group 4 will be selected if that particular position is available.

The circuits of our invention are so arranged that the positions are selected in the order of rotation indicated in Fig. 134A to which attention is directed. The relays PP0–PP9 each represent a corresponding position in each of the five position groups, the positions being designated by numbers 00–49, the last digit of their respective numerical designations corresponding to the digit suffixed to the designation of the relays PP– and P–. If PP9 is operated in the controller as assumed, the selection will be for the last position in the group indicated by the locked-up group relay GP– which, being relay GP4 in this case, will be the last position in group four, or position 49, even though other positions may be free in the group. Of course, if position 49 is not free, and subject to a qualification later to be described, then whatever position in the group is free will be selected.

Still referring to Fig. 134A, after the position is selected, the position preference is changed for the next service operation of the controller, as will be shown. In the particular example, the selection of position 49 will mean that the next preference will be position 48 in position group 4, and this is accomplished by releasing relay PP9 and locking up relay PP8. Relay GP4 will remain locked since position 48 is in group 4. When the controller, after an assumed series of service operations, has selected position 40, the next preference will be position 39, again involving the operation and locking of relay PP9, but this time also involving the release of relay GP4 and the operation and locking of relay GP3 (not shown), since position 39 is in group 3. When the controller, after an assumed series of service operations, has assigned position 00 (relay GP0 and relay PP0 both operated) the preference rotates back to position 49 in position group 4, involving the release of relays GP0 and PP0 and the operation and locking of relays GP4 and PP9.

As previously stated, the operation of relays PG0–PG4 results in the operation of relays GA0–GA4 over local circuits. The operation of any of said latter relays unlocks at its No. 1 contacts the circuit of relay PGK (Fig. 52), allowing said relay to release after an interval since it is slow release, and completes the circuit of relay PG over a path extending from battery through resistor CB33 (Fig. 61), No. 12 contacts of relay CB0, lead 200, No. 2 contacts of relay APS (Fig. 52) or No. 3 contacts of relay PK, or No. 3 contacts of relay GK, winding of relay PG, No. 2 contacts of relay PGK1, No. 1 contacts of relay GK, lead 201, No. 4 contacts of relay GP4, No. 8 front contacts of relay GA4, winding of relay PG4, to ground on the No. 2 front contacts of the latter relay. Relay PG4 thus locks in series with relay PG. If the preferred position group had been position group 0 instead of position group 4, indicated by the locked-up condition of relay GP0 instead of relay GP4, then relay PG would have been operated in series with relay PG0 over the above-traced path as far as lead 201, thence over the No. 4 contacts of relay GP0, No. 8 front contacts of relay GA0, winding of relay PG0, to ground on its No. 2 contacts. Similarly with the three position groups 1, 2 and 3, relay PG1 or PG2 or PG3 locking in series over paths closed through the No. 8 front contacts of relay GA1, GA2 or GA3, respectively.

We may now assume for the purpose of this description that while relay PG4 is locked for preference to position 4, no position is available in said group, but there is a position available in group 0, the two respective conditions being indicated by the normal condition of relay PG4 and the operated condition of relay PG0. In this case, and since relay GA0 is operated, relay PG will operate in series with relay PG0 over a path previously traced to lead 201 and the No. 4 front contacts of relay GP4, thence through the No. 8 back contacts of relay GA4, serially through corresponding back contacts on relays GA3–GA1, No. 8 front contacts of relay GA0, winding of relay PG0, to ground on the No. 2 front contacts of said relay. Thus no matter what the position group preference may be in the controller, a position will be selected in the preferred group if there is a position available in the group, but if there is none, a position will be selected in whichever group a position is available regardless of the preference. On the operation of relay PG the circuit of relay PGGT is opened, thereupon opening the paths of the four relays PG1–PG4, thus leaving the selection of the position in position group 0.

Having determined the position group (position group 0), a circuit is closed for the connector relay GC0 individual to said group. This relay is operated over a circuit path that may be traced from battery through resistor PGGT1, No. 1 contacts of relay PGGT, lead 206, No. 2 back contacts of relay GA4, serially through corresponding contacts on relay GA3–GA1, No. 2 front contacts of relay GA0, winding of relay GC0, lead 163, No. 1 front contacts of relay PGK1, to ground on lead 161 as previously traced thereto. Relay GC0 operates to connect the position test lead of positions 00–09 (lead 203 for

example) severally to the windings of the ten position test relays P0–P9 over contacts of relay PGT. Upon the operation of relay GC0, a test is made to determine which of the two linkse serving positions 00–09 are busy, if any. If link 0 is free and relay EP is operated, a circuit is closed for relay PL from ground through its winding, No. 1 contacts of relay OL, lead 220, No. 1 contacts of relay PS1, lead 221, No. 5 front contacts of relay EP, lead 223, No. 2 contacts of relay GC0, lead 197, No. 1 contacts of relay CB0, lead 198, thence as traced through the contacts of hold magnet HM0 of link 0, lead 199, No. 9 contacts of relay GB0, resistor GB00, to battery. Relay PL operates, opens the path of relay OL, and locks over its No. 2 front contacts, No. 2 contacts of relay PG, lead 224, resistor GB00, to battery. If link 0 is busy, then link 1 must be idle, since otherwise relay PG0 would not have operated, whereupon a path is closed for relay OL from ground through the winding of relay PL, No. 2 contacts of relay PL, winding of relay OL, No. 4 front contacts of relay EP, lead 225, No. 1 contacts of relay GC0, lead 226, No. 2 contacts of relay CB0, lead 227, contacts of hold magnet HM1, and thence as traced to battery on lead 199. In this case relay OL operates, but due to the high resistance of said relay, relay PL does not. Relay OL locks over its No. 3 contacts to the same circuit as relay PL. As will be shown, relay PL controls the operation of the hold magnet HM0 of link 0 and other even numbered links, while relay OL controls the operation of the hold magnet HM1 and other odd numbered links. If relay EP is normal, as it will be for the preference selections controlled by relays SP3 and SP4, link selections are reversed (if both are free) to distribute the wear among the links, the normal condition of relay EP completing the circuit of relay PL over the contacts of hold magnet HM1 and that of relay OL over the contacts of hold magnet HM0. If both links are free and relay EP is operated, the even link will always be the one to be selected.

The controller now determines which of the positions are free and available in the selected group. If it is assumed, for example, that position 00 is free and available a circuit is completed for relay P0 from ground through its winding, lead 202, No. 12 contacts of relay PGT, lead 203, No. 12 contacts of relay GC0, lead 204, No. 1 contacts of relay S of the position circuit, No. 2 contacts of relay P0 of said circuit, No. 1 contacts of relay PD, resistor PDD, to battery. All other positions in the group which are free and available at this time will, of course, cause the operation of the corresponding relays P1–P9.

Assume, now, that positions 00, 01 and 09 are free and available, which means that relays P0, P1 and P9 are operated. A circuit is then completed to operate relay P in series with relay P9 for the preferred position 09, the circuit tracing from ground through the winding of relay P9, No. 5 contacts of said relay, No. 3 contacts of relay PP9, lead 207, No. 8 contacts of relay APS, No. 1 contacts of relay PK, lead 208, winding of relay P, lead 209, No. 7 contacts of relay GA0, resistor GA00, to battery. Relay P operates, releases relay PGT, which releases relays P0 and P1, and completes the circuit of relay PS from ground through the winding of said relay, lead 210, serially through the No. 1 back contacts of P0–P8, No. 1 front contacts of relay P9, lead 211, No. 1 contacts of relay PGT, lead 212, resistors PSS and SPS, to battery.

Postponing a consideration of what follows incident to the operation of relay PS if position 09 though preferred is not available, then subject to a qualification that will be described shortly, the next position available in the numerically descending order of preference will be taken into use. Thus if position 01 is available relay P1 would be operated, and then locked over its No. 5 contacts, serially through the No. 9 contacts of relays P2–P9, No. 3 contacts of relay PP9, lead 207, No. 8 contacts of relay APS, No. 1 contacts of relay PK, lead 208, winding of relay P, lead 209, No. 7 contacts of relay GA–, resistor GA00, to battery. With relay PP9 operated the circuit of relay PS would be completed from ground through the winding of said relay, lead 210, No. 1 back contacts of relay P0, No. 1 front contacts of relay P1, serially through the No. 2 back contacts of relays P2–P9, lead 211, No. 1 contacts of relay PGT, lead 212, through resistors PSS and SPS to battery. In this event, as will be shown, the position preference for the next service use of the controller will not be for position 08, which it would be if position 09 had been available and taken into use, but for position 00, the position immediately below in numerical order to the one actually so taken. If the position actually in use is position 00, as assumed for the further description of the invention, then according to Fig. 132A the next position preference will be position 49 in position group 4.

Relay PS, upon operating, completes a circuit for relay PS1 from ground over its No. 2 contacts and lead 216, and completes circuits to operate the select magnet SM0 at the position switch for position 00 and to operate the select magnet SM0 at the sender switch for the calling sender 0. The path of the position select magnet SM0 extends from ground through the winding of said magnet (Fig. 59), lead 211, No. 8 contacts of relay P0, lead 0212, No. 5 contacts of relay PS, through ballast lamp LP1, lead 213, No. 8 contacts of relay RS, to battery. The path of the select magnet SM0 for the sender switch 0 extends from ground through the winding of the select magnet SM0 (Fig. 60), lead 214, No. 5 contacts of relay S0, lead 215, No. 4 contacts of relay PS, through ballast lamp LP2, lead 213, and thence as traced to battery on the No. 8 contacts of relay RS. Select magnets SM0 and SM0 operate and condition the crosspoints on their respective horizontal members to lock mechanically upon the subsequent operation of any hold magnet on either switch, as is well known from the construction of the crossbar switch.

Before proceeding with circuit operations following the operation of the select magnets SM0 and SM0, we will first describe the advance of selection preference in the controller for its next service use. It will be remembered that relay SP1 was operated at the time the controller was primed, and that said relay is held locked to ground on the No. 6 normally closed contacts of relay SP2. Upon the operation of relay PS, however, a circuit is completed for relay SP2 from battery through its winding, No. 5 normally made contacts of said relay, No. 9 contacts of relay SP1, No. 1 back contacts of relay SP0, lead 162, No. 9 contacts of relay RS, lead 217, No. 1 front contacts of relay PS, to ground. Relay SP2 operates, locks over its No. 5 front contacts to the No. 6 normally made contacts of relay SP3, and advances the holding circuit of relay SP1 over its No. 6 front contacts, lead 162, No. 9 contacts of relay RS, lead 217, No. 1 front contacts of relay PS, to ground. With both relays SP1 and SP2 operated, a circuit is completed for relay SK from battery through its winding, lead 276, No. 8 contacts of relay SP2, No. 7 front contacts of relay SP1, to ground. Relay SK, by its operation, indicates that the preference has been advanced, while relay SP2, by its operation, will cause sender No. 5 in sender group 0, if calling amongst other senders in a group on the next use of the controller, to be preferred for service, as previously described.

Position group preference is also advanced in the order indicated in Fig. 134A. It will be recalled that the controller was primed by operating relay GP4, meaning thereby that the controller, on its first service use after priming, will select a position in group 4 if such a position is available therein and a link is idle therefor. Moreover, the operation of relay PP9, on priming, limited the preference to position 49 in group 4. Since it has been assumed that on the first service use of the controller after priming position 00 was selected, then according to Fig. 134A the next position preference would be position 49 in group 4. This change means that the operated condition of neither relay GP4 nor PP9 should be disturbed. Suppose, however, that position 49 had been available

and selected on the service use of the controller now being described. This would mean that after the position is selected and relay PS has been operated the preference for the next use of the controller would be for position 48, calling for the release of relay PP9 and the operation and locking of relay PP8. Accordingly, after relay PS has been operated and remembering that relay P9 is locked in series with relay P according to the assumption, a circuit for relay PP8 is completed which extends from battery through its left winding, No. 6 contacts of relay P9, lead 226, No. 3 contacts of relay PS, to ground. On operating, relay PP8 unlocks relay PP9 and locks itself over a circuit from ground on the No. 4 back contacts of relay PP9, No. 4 contacts of relay PP8, right winding of said relay, serially through the No. 5 back contacts of relays PP7–PP0, resistor PPP, to battery. Relay PP8 will remain locked on the release of the controller to insure the preference selection of position 48 on the next use thereof.

To indicate that the position preference has been changed for the next use of the controller (and specifically from position 49 to position 48), a circuit is completed for relay PK upon the operation of relay PP8 and the release of relay PP9, the circuit of said relay PK extending from battery through the winding of said relay PK, lead 236, No. 6 contacts of relay PP9, No. 1 front contacts of relay PP8, serially through the No. 1 back contacts of relays PP7–PP0, serially through the No. 2 back contacts of relays PP0–PP7, No. 2 front contacts of relay PP8, No. 6 contacts of relay P9, lead 226, and thence to ground on the No. 3 contacts of relay PS. Relay PK operates to perform certain functions to be noted hereafter.

If, in spite of the registered preference for position 49 the only available position in group 4 had been position 41 by way of example, the selection preference would then be shifted to position 40. With relay P1 operated for position 41, a circuit is completed for relay PP0 from battery through its left winding, No. 6 contacts of relay P1 and thence as traced over lead 226 to ground on the No. 3 contacts of relay PS. By similar circuits, the next position preference will always be shifted to one below the position actually taken into use, relay PK operating as before to indicate that the position selection preference has been changed.

An inspection of Fig. 134A shows that if the controller had registered therein a preference for position 00 in position group 0, the next preference registration would be for position 49 in position group 4. The preference for position group 0 will have been registered by the operation and locking of relay GP0, and the preference for the particular position 00 therein by the operation and locking of relay PP0. The selection preference of position 49 in group 4 for the next use of the controller will call for the operation and locking of relays GP4 and PP9, the change of selection preference by the operation of the involved relay in the group of relays PP0–PP9 having already been described.

The change of position group preference is similarly effected. If it is assumed that the preference is for position group 0, indicated by the locked-in condition of relay GP0, and that position 00 is the preferred position in the group as indicated by the locked-up condition of relay PP0, then the next preference will be for position group 4, which calls for the operation and locking of relay GP4. Accordingly, when relay P0 is operated, relay GP4 will operate over a circuit that extends from battery through its upper winding, No. 6 contacts of relay GA0, lead 228, No. 7 contacts of relay P0, lead 226, and thence as traced to ground on the No. 3 contacts of relay PS. Relay GP4 operates, unlocks relay GP0 which releases, and relay GP4 locks over a circuit from ground on its No. 3 front contacts and lower winding, serially through the No. 5 contacts of relays GP3–GP0 and through resistor GPP to battery, No. 3 back contacts of relays GP3–GP1, No. 5 contacts of relay GP0, resistor GPP, to battery. Relay GP4 thus sets the next group preference to position group 4, and the operation and locking of relay PP9 particularly sets the preference to position 49 therein.

The group transfer check relay GK now operates over a circuit extending from battery through its winding, lead 167, No. 1 contacts of relay GP4, serially through the No. 1 back contacts on relays GP3–GP0, serially through No. 2 back contacts of relays GP0–GP3, No. 2 contacts of relay GP4, No. 6 contacts of relay GA0, lead 228, No. 7 contacts of relay P0, lead 226, and thence as traced to ground on the No. 3 contacts of relay PS. Relay GK operates to indicate that the group preference has been changed, and performs certain functions to be noted hereinafter.

The qualification to which reference has been made with respect to position selection pertains to the condition in which all available positions are of a higher numerical designation than the operated preference relay PP–. In this case, the preference is next set to the top position (indicated by relay PP9) in the next descending position group. Thus, for example, assume that the preference is set for position 1 in group position 0, indicated by the locked-up condition of relays GP0 and PP1, respectively, that neither position 1 nor position 0 is available, but that positions 2–9 are available, meaning thereby that relays P0 and P1 are normal and relays P2–P9 are operated. In this case none of the available positions is selected, but the preference is reset to the next lower position group (in this position group 4 according to Fig. 134A) and to the top position in that group (position 49) after which the controller recycles to select a position in said group, the preferred position therein if available. Assuming, therefore, that relay GP0 is operated for the position group preference, that PP1 is operated for the position preference in the group, that positions indicated by relays P2–P9 are available, and that positions indicated by relays P1 and P0 are not, the controller now functions to select a position from the "new" position group 4, by first setting the preferences and then selecting the position preferred if available, or one numerically lower. With relay PP1 operated and relays P1 and P0 normal, a circuit is completed for relay APS extending from ground through the winding of said relay, lead 230, No. 4 contacts of any one of the operated relays P9–P2, lead 235, No. 1 back contacts of relay FS, lead 232, No. 9 back contacts of relays P0 and P1, No. 3 contacts of relay PP1, lead 233, No. 1 contacts of relay PK (which is normal since no position preference has yet been changed), lead 208 winding of relay P, lead 209, No. 7 contacts of relay GA0, resistor GA00, to battery. Relay APS operates in this circuit but relay P does not owing to the high resistance of the former relay, locking over a circuit from battery through resistor GA00, lead 234, No. 7 contacts of relay APS, lead 235, No. 4 contacts of relay P9 (for example) and thence to the winding of relay APS.

Since the preference had been set for position group 0 as evidenced by the locked-up condition of relay GP0, the shift of preference in this case can only be to the position group 4 to which relay GP4 is individual, which relay upon the operation of relay APS, operates over a circuit from battery through its upper winding, No. 6 contacts of relay GA0, leads 228, 228', to ground on the No. 5 contacts of relay APS. In operating, relay GP4 releases relay GP0 and locks in the manner described to register the preference for position group 4, relay GK operating as before to register the change of preference. At the same time the preference is changed to position 49 in the new preferred group 4 by the operation of relay PP9, which relay operates over a circuit from battery through its left winding, lead 165, to ground on the No. 4 contacts of relay APS. Relay PP9 oper-

ates, releases relay PP1 and locks in the manner described to register preference for position 49, relay PK operating to indicate the change of position preference.

With the operation of relay APS, relay PGK, which released on the operation of relay GA0, is reoperated over a circuit from battery through its winding, No. 6 contacts of relay APS on the No. 12 contacts of relay CA via lead 161 to ground, said relay PGK locking under control of the No. 1 contacts of relay GA4 until the latter operates. The operation of relay APS and the operation of relays PK and GK cause the release of relay PG and PG– (in this case relay PG0) in series, relay PG0 releasing relay GA0 and the latter causing the release of relays GC0 and GK. Relay GA0 causes the release of the operated relays P– subsequent to which relays PK and APS release. Relay PGGT now reoperates over its previously described circuit to connect relay PG4 with the links to position group 4, subsequent to which the controller operates in the manner described to select a position in said group.

The circuits of our invention are further arranged to "handicap" each and every controller on an all-positions busy condition, which, once having assigned a calling sender to an available position reenters the race for yet another position while other controllers are still waiting for theirs. In order to understand this feature of our invention reference is made to Fig. 65 which shows the wiring arrangement between relays FS of all other controllers, relay FS of the first controller A (the controller shown in detail in Figs. 52–64) being shown in Fig. 62, while a representative intermediate controller A, the last controller A, the first controller B, a representative intermediate controller B and the last controller B being shown on Fig. 65.

To understand the circuit arrangement, assume that all positions but one are busy, and that all controllers in the office each have a sender waiting for a position. From what has been previously described, each controller will have the appropriate relay, or relays PF0–XP3 operated therein, followed by the operation of relays PA and PA1 as described. By the chain arrangement of relays PG– shown in Fig. 55, some one controller will seize the available position, in consequence of which the involved relay GB– in each controller will be operated to indicate the busy condition of the position group, followed by the release of relay PA in each controller except the one controller that obtains the position. Assuming for the present that the first controller A disclosed in Figs. 52–64 is one of the controllers that failed in getting the one available position, a path is then closed therein for relay PS1 which traces from battery through the winding of said relay, lead 216, No. 2 contacts of relay PA1, No. 1 contacts of relay PA, to ground on the No. 1 contacts of relay PS. With the operation of relay PS1, a path is thereupon closed for relay FS, extending from battery through the lower winding of said relay, lead 240, No. 4 contacts of relay RS, No. 2 contacts of relay PS1, lead 241, No. 2 back contacts of relay PS, to ground. On operating, relay FS locks over its upper winding and No. 3 contacts to ground on the No. 2 back contacts of relay PS.

As indicated, the above operation of relays PS1 and FS takes place in each controller that failed to get the one available position. Relay FS in each such controller then closes a circuit for relay RS from ground previously traced to the No. 3 contacts of relay FS, No. 2 contacts of said relay, No. 2 contacts of relay PA, No. 3 contacts of relay PA1, lead 242, lower winding of relay RS, resistor RS1, to battery. Relay RS operates and releases relays CA, CB–, CC–, S, S0–S9, PA1, and the involved PF–XP relays, thus releasing the controller, but leaving relay FS therein locked under the control of relay PS.

Attention is now directed to Fig. 65 in which relay FS of the controller A may be supposed to be normal on the assumption that said controller was the one which obtained the one available position, while relay FS in each of the other controllers may be supposed to be locked as described above to represent the failure of the controller to get the one available position. Now when another position becomes available, the involved position group relay GB– in each controller is released, including that of the last controller A which got the first available position, whose relay FS is normal if said controller has meanwhile restored to normal and been reseized to serve another calling sender. In this case, however, when relay PF– of this controller is operated, ground to operate its relay PGGT will have to wait the operation of relay PA1, which controls the closure of the circuit for said relay PGGT over its No. 4 contacts as previously described. However, in the controller to the right of the last controller A, that is, the first controller B, and due to the fact that relay FS is operated therein, ground for operating relay PGGT of said first controller B is supplied directly to the winding of relay PGGT from the contacts of relay PF– or XP–, with said supply path including the No. 6 back contacts of released relay FS in the last controller A, No. 4 contacts of relay FS of the first controller B, to the winding of relay PGGT of said first controller B. This means that relay PGGT in the first controller B is operated ahead of relay PGGT in the last controller A, and because the operation of the position group relay PG– of the group having the one available position is closed through immediately upon the operation of relay PGGT which locks out the relays corresponding to relays PG– in all other controllers as previously described in connection with Fig. 55, it follows that the first controller B succeeds in getting the position while the last controller A will not. Operations following the energization of relay PGGT are the same as those already described for the controller A shown in Figs. 52–64 by which the calling sender will be connected to the available position. When relay PS operates in the first controller B, relay FS is unlocked.

Each position, as it becomes available, is then seized by a waiting controller in the closed clockwise chain indicated in Fig. 65; that is, the first controller seized in the chain is the controller after the last one served that has its relays FS locked, the latter relay releasing upon the operation of relay PS. It should be noted that waiting controllers which have their respective relays FS normal will not get a position until all controllers having their respective FS relays operated are first served. In this manner, no controller on an overload condition can get the one available position and return for another position to the exclusion of all other controllers still waiting for positions.

Under the overload condition above described the circuits of our invention are further arranged to cause each controller to prefer its own groups of senders, specifically controllers A preferring sender groups 0 and 2, controllers B preferring sender groups 1 and 3. It will be recalled that relays SP0–SP1 are operated in succession, one on each service use of the controller, and that Figs. 52–64 is assumed to represent a controller A. If relays PF0, XP1, PF2 and XP3 are all operated in this controller for example, and relay SP0 is operated, the controller will serve the calling senders represented by relays PF0, XP1, PF2 and XP3 in the order of sender groups 0, 2, 1 and 3. Thus the sender to be served first will be the sender in group 0, the circuit of the sender group 0 cut-in relays CA0–CC0 being completed through the No. 3 contacts of relay P as already traced, and thence through the No. 2 contacts of relay SP0, lead 171 and thence as traced to battery on the No. 2 contacts of relay RS. After the controller has operated to connect the sender from group 0 to an available position, relay PF0 is released but relays XP1, PF2 and XP3 will still hold to ground in the respective calling senders in the groups represented by said relays.

Relay SP1 is operated and locked over its No. 5 contacts, relay SP0 is released on the operation of relay SP1. Thereupon the sender in sender group 2 is served, the circuit of cut-in relays CA2–CC2 (not shown) being closed over the No. 1 contacts of relay PF2, lead 191, No. 2 contacts of relay SP1, lead 171, and thence as traced to battery on the No. 2 contacts of relay RS. When the sender in group 2 is served relay PF2 releases, as does relay SP1 which, in turn operates relay SP2. In this case, the circuit cut-in relays CA1–CC0 (not shown) for sender group 1 will be closed through the No. 1 front contacts of relay XP1, No. 1 back contacts of relay PF0, thence as traced to the No. 3 back contacts of relay P, No. 2 contacts of relay SP2, lead 180, No. 1 back contacts of relay EP (which is normal when relays SP0 and SP1 are both normal), lead 172, No. 2 contacts of relay PGT, lead 173, No. 3 contacts of relay PA, No. 1 contacts of relay PA1, lead 174, No. 1 contacts of relay PG, lead 175, No. 2 contacts of relay SK, No. 2 contacts of relay RS, resistor RS2, to battery. When the sender in sender group 1 is served, relay XP1 releases, leaving only relay XP3 operated. Also, relay SP2 releases and relay SP3 operates. The sender in sender group 3 is now served, the circuit of the cut-in relays CA3–CC3 being completed through the No. 1 front contacts of relay XP3, No. 1 back contacts of relay PF2, lead 191, No. 2 contacts of relay SP3, lead 180 and thence as previously traced to battery on the No. 1 contacts of relay RS.

Thus under normal conditions controllers A and B serve the senders in the four groups in the order determined by which one of the relays SP0–SP3 in each controller is operated at the time relays PF0–XP3 operate. Under overload conditions, however, all the controllers in the office are waiting for a position to become available. This means that each controller has its relays PF– operated therein but not its relay XP–, thus restricting its service to the senders indicated by the operated relays PF–.

With the description of the above specific features of the controller disposed of, the description of its operation to extend sender 0 in sender group 0 to position 0 in position group 0 will now be resumed. It will be recalled that the select magnets SM0 at both the sender and position switches were operated to condition the crosspoints at the switches. If relays EP and PL are operated, indicating that link 0 is available, a circuit is completed for the two hold magnets HM0 of said link, said circuit extending from battery through the respective windings of said magnets, lead 243, No. 1 contacts of relay CC0, lead 244, No. 4 contacts of relay GA0, lead 245, No. 2 front contacts of relay EP, No. 1 front contacts of relay PL, lead 246, No. 5 back contacts of relay DCK, lead 247, left contacts of relay H0, lead 248, contacts of select magnet SM0 on the sender switch, lead 249, contacts of select magnet SM0 on position switch, to ground. Hold magnets HM0 and HM0 operate and close the crosspoints to extend sender 00 to position 0. If link 0 is not available, indicated by the operation of relay OL as previously described, then the circuit of hold magnets HM1 of link 1 is completed from battery to the winding of said magnets, lead 250, No. 2 contacts of relay CC0, lead 251, No. 3 contacts of relay GA0, lead 252, No. 3 contacts of relay EP, No. 2 contacts of relay OL, No. 1 back contacts of relay PL, lead 246 and thence as traced to ground on the contacts of select magnet SM0 of the position group switch.

When the crosspoints have been closed in the position switch, operating ground on the hold magnet HM0 is extended to lead S and thence to the winding of relay S of the position circuit, operating the latter relay, which, by opening its No. 1 back contacts, removes battery from lead 204 thereby to indicate that the position is busy, closes in part over its No. 3 contacts the path of the position busy group chain, and over its No. 2 contacts a circuit is completed for operating relay H as will hereinafter be described. When the crosspoints have been closed at the sender switch, the operating ground for the hold magnet HM0 is further extended over lead S of the sender in cable C10, No. 3 back contacts of relay PR1, winding of the position attached relay PA, No. 3 normally made continuity contacts of relay PR1, lead H, through the sender and position switch crosspoints No. 1, contacts of relay TE, lower winding of relay H, No. 1 normally made contacts of said relay H, No. 1 front contacts of relay S, lead 204, No. 12 contacts of relay GC0, lead 203, No. 3 contacts of relay P0, lead 250, serially through resistors HO1 and HOL, lead 263, winding of relay H0, lead 262, No. 8 contacts of relay PS, resistor SPS, to battery. Due to the resistor HO1, neither relay PA in the sender nor relay H in the position operates, but relay H0 in the controller does operate as an indication that the crosspoints at the position and sender switches have been closed. On operating, relay H0 locks from battery previously traced through lead 262, winding of relay H0, lead 263, resistor HOL, No. 3 back contacts of relay DCK, lead 255, right contacts of relay H0, lead 248 and thence as traced to ground on the contacts of select magnet SM0 of the position switch. Prior to the operation of relay H0, polarized relay DCT is held on its released, or back, contact owing to the fact that current flows in the proper direction therefor by ground through the back contacts of relay DCK, lead 246, to the right terminal of the winding of said relay DCT. However, when relay H0 operates, this ground is removed from the right terminal of the winding of relay DCT. The circuit for holding the hold magnet HM– is through the winding of relay DCT and resistor DCT2 to aforesaid ground on lead 248. This causes a reversal of current through the winding of relay DCT which causes its operation. Thus the hold magnets HM– hold in series with the winding of relay DCT. In regard to the operation of this relay it should be remarked that if a double connection occurs, as might occur for example if a bent finger on the select bar of the switch causes position 9, for instance, to be simultaneously connected to position 0, and position 9 is serving a sender, ground on lead S of position 9, appearing on the No. 1 armature of relay PL, shunts the battery to the hold magnets HM0 and causes relay DCT to fail to operate. In this event, further operations will be suspended and the controller will be caused to time out, as will be shown.

With the operation of relay DCT, a circuit is closed for relay DCK, the path of which extends from battery through resistor PGT1, armature and right contacts of relay DCT, lead 254, No. 2 contacts of relay SS, winding of relay DCK, lead 255, right contacts and armature of relay H0, to ground on lead 248 as previously traced thereto. Relay DCK operates, locks to battery over its No. 4 contacts and, over its No. 1 contacts short-circuits resistors HOL and HO1 through the No. 1 contacts of relay HOR in the path of the previously established circuit for relays H, H0 and PA. Due to the increase in current flow, both relay H in the position circuit and relay PA in the sender circuit operate, relay PA locking over its No. 2 contacts, lead 147', No. 8 contacts of relay ON4, to ground. This ground is further extended over the No. 2 contacts of relay PA, No. 3 back contacts of relay PR1, lead S in cable C10, to the windings of the hold magnets HM0, through the crossbar switch contact thereby holding said magnets independently of their operating paths when the latter are opened on the discharge of the controller. The original operating ground of relays H and PA is then supplanted by the locking ground through the winding of relay PA, normally closed continuity contacts No. 3 of relay PR1, lead H in cable C10, through the sender and position switch crosspoints, lead H in cable C1, No. 1 contacts of relay TE, lower winding of relay H, No. 1 front contacts of relay H, No. 2 contacts of relay S, upper winding of relay H, to battery. Relay PA in the sender and relay H in the position thus hold in a series with each other. Relay PA, at its No. 1 contacts, removes start ground from lead ST0 and further releases relay CW, which removes positive 130

volts from lead CW to the calls waiting circuit which indicates to said circuit that the sender has become attached to a position. The operation of relay H opens the circuit through front No. 1 contacts of relay S, and releases relay H0.

Postponing until later operations which follow the energization of relay H in the position and the further operations, which follow the energization of relay PA in the sender, the removal of ground on lead ST0 releases relays PF0 and SS, while the application of ground on lead S, traced to the armature of relay PL, reverses current through relay DCT, causing it to release since it is a polarized relay. With the release of relay H a circuit is completed for relay HOR over a path which extends from battery from winding of said relay, its No. 3 normally closed contacts, No. 5 front contacts of relay DCK, lead 247, contacts of relay H0, to ground as previously traced on lead 248. Relay HOR operates and locks over its No. 3 front contacts to ground on the No. 3 contacts of relay PS1. With relays H0, SS and DCT normal and relay HOR operated, a circuit is completed for the release relay RS over a path which extends from ground as previously traced to lead 248, left contacts of relay H0, lead 247, No. 5 front contacts of relay DCK, No. 2 contacts of relay HOR, lead 256, No. 1 contacts of relay PGK, lead 257, No. 5 contacts of relay FS, lead 258, upper winding of relay RS, No. 1 contacts of relay SK, lead 259, No. 2 contacts of relay PK, No. 2 contacts of relay GK, lead 260, No. 3 contacts of relay SS, lead 261, left contacts of relay DCT, resistor PGT1, to battery. Relay RS operates, locks over battery on resistor RS1, through the lower winding of relay RS and over its No. 6 contacts via lead 264 to ground on the No. 3 contacts of relay PGK1.

With relay RS operated, relay PA1 is released at the No. 1 contacts of said relay RS, select magnets SM0 are released at its No. 8 contacts, and relays S0, S and the sender-connector relays CA0–CC0 are released at its No. 3 contacts, the first operated relay SP (in this instance relay SP1) is released at its No. 9 contacts. The release of relays CA0–CC0 releases relays D0, PG and PG0, relay PG0 being followed by the release of relay GA0. Relay GA0 releases relays GK and GP0, the release of relay GP0 being followed by the release of relays PK, PS and PS1. Relay PS1 releases relays PU, GC0, DCK and PGK1, relay PGK1 unlocking relay RS and thus restoring the controller to normal with a position group preference relay GP–, a position preference relay PP– and a sender group and sender preference relay SP– operated and locked as described.

The above completes the description of the operation of the controller. It only remains to describe certain facilities which are provided to furnish an alarm in the event that the controller does not complete its functions within the cycling time of interrupter CA1, or fails even to get started when ground is applied to the start lead ST– of one of the senders.

In the event that the controller fails to assign the sender to a position in the time allowed by the opened interval of interrupter CA1, relay CA will operate when said interrupter makes its right contacts, as already described. Relay CA locks over its No. 5 contacts to ground on the No. 7 contacts of relay RS, and completes the circuit of the latter relay from battery through resistor RS1, lower winding of relay RS, No. 4 and No. 8 contacts of relay CA, to ground. Relay RS operates to release the controller as already described, said relay RS locking to ground on the contacts of relay PU and releasing on the release of the latter relay. Relay CA releases on the operation of relay RS.

If it is desired to prevent the controller from releasing, key HLD is operated to the left for the shown controller A (and to the right for the mate controller B) thereby short-circuiting the winding of relay RS by ground on the No. 8 contacts of relay CA, lead 268, contacts of key HLD, lead 269, No. 10 contacts of relay RS, to resistor RS1. Relay RS is thus prevented from operating to release the controller for as long as key HLD is operated.

Relay CA when operated also completes a circuit for the alarm memory relay AM, from battery through the winding of said relay, lead 265, No. 2 contacts of relay CA, lead 266, key AR, to ground. Relay AM operates, locks to said ground over its No. 1 contacts, and completes the circuit of lamp A over lead 267, which lamp lights to indicate that controller A failed, though it may have released to service in the meanwhile by the operation of relay RS. A similar alarm memory relay (not shown) is provided for controller B, which causes the lighting of lamp B individual to said controller. Lamp A can only be extinguished by operating key AR which releases relay AM.

It may also happen that when a calling sender applies ground to its start lead ST–, for example lead ST0 for sender 0 in sender group 0, relay PF0 may fail to operate due to an open wire, an opened contact on relay MB, or to some other cause. In this event and if links and positions are free and available as shown by the released condition of relays GB0–GB4 or any of them and by the released condition of the link hold magnets HM–, ground on said lead ST0 will complete a circuit for relay SG0 individual to sender group 0, the path of said circuit tracing from ground on lead ST0, Nos. 10 and 12 contacts of relay D0, lead 268, No. 10 contacts of relay MB, lead 269, No. 5 contacts of relay GB0 (if a position is free in the group as well as a link connecting with the group), lead 270, contacts of link hold magnets HM0 at the sender switch, lead 271, interrupter PU0, lead 272, No. 3 contacts of relay LA, lead 273, lower winding of relay SG0, to battery. Said relay operates, locks over its No. 4 contacts to operating ground, and over its No. 2 contacts applies ground through interrupter LA to resistor LA1, to battery, releasing relay LA. On its release of relay LA, relay SG0 is provided with another locking circuit through its upper winding and No. 3 contacts, No. 7 contacts of relay LA, key AR, to ground. Thus relay SG0 will hold even if the calling sender should dismiss in the meanwhile, and by the lighting of lamp SG0 over its No. 5 contacts and the No. 2 back contacts of relay LA, calls the attention of maintenance to the fact that the controller was unable to operate any of its relays PF0–XP3. The operation of key AR releases relay SG0 and extinguishes lamp SG0.

The controller may be made busy by operating key MB to the left for the shown controller A and to the right for the mate controller B. The operation of said key MB to the left grounds lead 274, operating relay MB (also operated by ground from the No. 6 contacts of relay CA). Relay MB opens the link alarm circuits previously described, removes battery from the windings of relays PF0–XP3 thereby to prevent their operation in response to calling senders, and supplies operating battery for relays XP0 and XP2 over its Nos. 1 and 2 front contacts and the Nos. 5 and 6 contacts of relay MB of controller B, as shown thereby to enable said controller to service calling senders which ordinarily would prefer the controller made busy.

Mention has already been made of the fact that when a sender is ready for assignment to a position ground is applied to its lead ST0 and positive 130 volts through a 10,000-ohm resistance CW1 is transmitted over the No. 3 contacts of relay CW to lead CW, which extends to the Calls Waiting circuit shown in detail in Figs. 49 and 50 and in terms of its fundamental electrical components in Fig. 138. Referring more particularly to the latter figure, the Calls Waiting circuit is an arrangement which portrays at any given instant the relation between the number of positions occupied and the number of senders waiting for positions. The principle utilized is that of applying a positive potential on one side of lead CW through the No. 3 contacts of relays CW of all the senders waiting for positions, and applying a lower nega-

tive potential to the other side of said lead through the No. 1 contacts of relays P0 of all occupied positions.

As shown in Fig. 138, the Calls Waiting circuit comprises essentially three branches connected to the right of the CW lead, to which is also connected a lead parallel to each position for the application to said lead of negative 24 volts through 100 ohms when the position becomes occupied and its relay P0 is operated as previously described. The first path comprises the variable resistance D in series with the upper winding of polarized relay GR to negative 24 volts; the resistance D being capable of adjustment to bring the total resistance of the path up to 1,550 ohms. For reasons that will later appear, the lower winding of relay GR is selectively connected in series with one of three potentiometers that will enable it to operate on three different conditions of current which may flow through its upper winding.

The second path comprises the variable resistance X in series with the upper windings of relays R and WH to negative 24 volts, the resistance X being capable of adjustment bring the total resistance of the path up to 3,100 ohms. As with the first path, relays R and WH have each a lower winding selectively connected to three potentiometers by means of which each of the relays is given adjustments that enable it to operate on three different values of current that may flow through the upper winding.

The third path comprises the variable resistance AL, the meter M and the windings in series of the marginal overload relays OL and OL1 and No. 6 contacts of relay ST to negative 24 volts battery, the variable resistance AL being capable of adjustment to make the total resistance of the path 4,430 ohms.

The combined resistance of these three paths is about 832 ohms. As will be shown, the operation of relay GR controls the lighting of lamp G, while the operation of relays R and WH controls the lighting of lamps R and W, respectively. By means of the potentiometers severally and selectively connected to the lower winding of relays G, R and WH, each of these relays is biased to operate on currents resulting from predetermined differences of potentials between the positive voltage applied to the left of lead CW by calling senders through their respective relays CW and negative potential applied to the right of lead CW by the negative potential applied through each of the three branches and the branch extending to the occupied positions. Since the positive potential applied to the left of lead CW represents the number of waiting senders and the negative potential applied to the right of lead CW represents the number of occupied positions, it is evident that the difference in potential and the current determined thereby will indicate the relation between the number of waiting senders and the number of occupied positions, or the number of waiting senders per occupied position.

The circuit is arranged to provide relay adjustments for different conditions of call waiting signals which are herein defined as team size A, team size B and team size C. For team size A, relays GR, WH and R are adjusted to operate and light their respectively controlled lamps G, W and R in the following "calls waiting range," for which the values given represent the current flowing through the meter M.

CALLS WAITING—TEAM SIZE A

	G	W	R
Min.	.5	.75	.75
Norm.	1.0	2.0	3.0
Max.	2.0	3.0	3.0

This team size is used in very light load periods, at which time the switchboard is manned by less than five operators. At this time team size key is turned to position A.

For team size B, relays G, WH and R are adjusted to operate and light their respectively controlled lamps in the following "calls waiting range."

CALLS WAITING—TEAM SIZE B

	GR	WH	R
Min.	.25	.5	.5
Norm.	.5	1.0	1.5
Max.	1.5	2.75	3.0

This team size is used in medium load periods, at which time the switchboard is manned by five to ten operators and team size key is normal or in position B.

For team size C, relays GR, WH and R are adjusted to operate and light their respectively controlled lamps G, W and R in the following "calls waiting range."

CALLS WAITING—TEAM SIZE C

	G	W	R
Min.	.20	.5	.5
Norm.	.25	.7	1.0
Max.	.75	1.5	2.5

This team size is used during periods of heavy load when the switchboard is manned to full capacity.

From Fig. 138 it is evident that the difference between the positive potential applied to the left of lead CW and the negative potential applied to the right of said lead depends on the number of waiting senders and the number of occupied positions, respectively. For example, the difference of potential is greatest and the current flow through the three branches is at maximum when all senders are waiting and no positions are occupied, at which time relays GR, WH and R will be operated and the meter R will give its maximum reading. However, as positions become occupied and relay P0 in each position operates as described, the above three paths will be shunted by negative 24 volts through 100 ohms for each position. Each newly occupied position has its negative 24 volts through 100 ohms placed in parallel with that of every other occupied position, reducing the ohmic resistance of the shunt and causing more of the current to flow through the shunt and less through each of the three branches, thereby causing the meter M to give a progressively lower indication and the relays GR, R and WH to operate or non-operate in accordance with the current. Finally, when all positions are occupied, the "position shunt" attains maximum value, and the current through each of the three branches will be determined by the number of waiting senders, being a minimum when no sender is waiting.

Referring now to Figs. 49 and 50, which show the Calls Waiting circuit in all its details, said circuit is placed in operating condition by operating key CWSIG, which completes the circuit of relay ST from battery through its winding, the No. 5 normally made contacts of relay OL2, key Reset, to ground on key CWSIG. Relay ST, on operating, connects ground through the Nos. 1, 2 and 3 back contacts of relay RL to the contacts of relays GR, WH and R, respectively, connects negative battery through the Nos. 4 and 5 back contacts of relay RL to the upper windings of said relays, connects said battery through its own No. 4 contacts to the lower windings of relays GR, WH and R, connects said battery to the resistance path comprising the windings of relays OL1, OL, and the meter M, and further connects said battery through its No. 5 contacts to the potentiometers RB—GA shown at the lower left of Fig. 49.

When positive 130 volt battery through 10,000 ohms from each of the waiting senders and negative 24-volt battery through 100 ohms from each of the occupied

positions are applied to lead CW, the difference of potential between the two batteries effective at the No. 1 back contacts of relay CK1 said potential is applied (1) through variable resistance AL, meter M, relays OL and OL1 is series to negative battery at the No. 6 contacts of relay ST; (2) through variable resistance D, upper winding of relay GR, No. 4 back contacts of relay RL, to battery on the No. 6 contacts of relay ST; and (3) through variable resistance X, upper winding of relay R, upper winding of relay WH, No. 5 back contacts of relay RL, to battery on the No. 6 contacts of relay ST.

Assume that traffic is such as to justify team size A, and assume also that potentiometers GA, WA and RA have been adjusted so that when one call per position occupied is waiting, relay GR will operate; when two calls per position occupied are waiting, relay WH will also operate, and that when three or more calls per position occupied are waiting, relays GR, WH and R will all be operated. When the Teamsize key is set at position A a circuit is completed for relay TA from ground on the No. 4 contacts of key CWSIG, Teamsize key in position A, No. 3 back contacts of relay TST, winding of relay TA, to battery. Relay TA operates and applies positive battery through resistance K, J, and H, its Nos. 1, 2 and 3 front contacts, potentiometers GA, WA and RA, its Nos. 4, 5 and 6 front contacts, to the lower windings of relays GR, WH and R, completing through each of said windings a circuit to negative battery over the No. 4 contacts of relay ST and providing each of said windings with the current necessary to cause it to operate when its upper winding receives the current it requires for team size A.

If relays GR, WH and R have been adjusted to operate on certain current values for the three different adjustments placed on each of said relays through their respective lower winding, and which current will be severally applied through said lower windings by the potentiometers shown on the lower left under the three different conditions, then said relays will operate and the meter M will give a reading in accordance with the current flowing through the respective upper windings of said relays and the coil of said meter, said current being determined by whether the Teamsize key is operated to A, B or C position. If traffic is such as to justify a teamsize A, then said key is operated to position A, whereupon a circuit is completed for relay TA from ground on the No. 3 contacts of key CWSIG, Teamsize key in the A position, No. 3 back contacts of relay TST, winding of relay TA, to battery. Relay TA operates, and over its Nos. 1, 2 and 3 front contacts and the potentiometers applies positive battery through its Nos. 4, 5 and 6 front contacts to the lower windings of relays GR, WH and R, completing for each of said windings a circuit to negative battery over the No. 4 contacts of relay ST, and providing each of said windings with the appropriate adjustment current that will enable each of the relays to operate over their respective upper windings when the current therethrough reaches team size A value.

If the Teamsize key is operated to the B position (which is the neutral position of the key), the quantity of current is changed as determined by the seating of the potentiometers in series with the back contacts of relay TC, causing relays GR, WH and R to operate over their respective upper windings when the current therethrough reaches team size B value.

If the Teamsize key is operated to the C position, relay TC is operated over a circuit from battery through its winding, No. 5 back contacts of relay TST, contacts of said key in the C position, to ground on the contacts of key CWSIG. By operating, relay TC changes the current applied to the lower windings of relays GR, WH and R the value of which is determined by the potentiometers in series with its front contacts, causing said relays to operate through their respective upper windings when the current therethrough reaches team size C value.

When relay GR operates under the conditions stated, it completes a circuit for relay GR1, extending from battery through its winding, contacts of relay GR, No. 1 back contacts of relay RL, to ground on the No. 1 contacts of relay ST. Relay GR1 operates, locks over its No. 2 contacts to operating ground, and completes an obvious circuit for relay GR2, which operates and completes a circuit for the lamp G. This lamp, as well as lamps W and R and the meter M, is preferably located in the apparatus room and there supply the maintenance force with the ratio of the number of waiting senders to the number of occupied positions, as was previously discussed. Relay GR2 completes the circuit of relay GR3 from ground on key CWSIG, No. 3 normally made contacts of key Test, No. 1 contacts of relay GR2, winding of relay GR3, to battery. Relay GR3 operates to light lamp G1. This lamp, as well as lamps W1 and R1, is located at the switchboard to give a similar indication of the sender-to-position relationship that is given by lamps G, W, and R in the apparatus room.

In the same manner, the operation of relay WH will result in the operation of relays WH1, WH2, and WH3 and the lighting of lamps W and W1, while the operation of relay R results in the operation of relays R1, R2 and R3, and the lighting of lamps R and R1.

The circuit of the meter M traces from the potential at variable resistance AL, the meter M, winding of relays OL and OL1 in series, to battery on the No. 6 contacts of relay ST. The meter will give an indication of the "current equivalent" of the sender-to-position relationship previously described. Normally, relays OL and OL1 do not operate. In case of an overload, however, they do operate, relay OL shorting the meter and relay OL1 completing a circuit for operating relay OL2, which locks over its No. 5 contacts to operating ground, and releasing relay ST, which removes ground from the contacts of relays GR, WH and R, and connects holding ground for relays GR3, WH3 and R3. Relay ST, by releasing, also causes relays GR, WH and R to release and further causes the release of relays OL and OL1. With relay OL2 locked, however, relay ST cannot reoperate until key Reset is operated to release relay OL2, after which sender-to-position indications are resumed.

Under normal conditions the operation of any one of the relays GR2, WH2 and R2 completes the circuit path of relay RL over the No. 3 contacts of any one of said relays, No. 7 contacts of relay TST, to ground through conducting segments of interrupter INT. Over its Nos. 1, 2 and 3 front contacts relay RL supplies holding ground for relays GR2, WH2 and R2 to prevent their release, while over its Nos. 4 and 5 front contacts and the No. 6 front contacts of relay ST it provides a holding battery for the upper windings of relays GR, WH and R, causing said relays to hold until the insulating segment of the interrupter INT is engaged, at which time relay RL is released to again place ground on the contacts of relays GR, WH and R and battery to their upper windings. These relays, or any of them, will repeat their operation to maintain, or change, the sender-to-position indications in accordance with any change in the senders awaiting load and positions occupied load.

With the sender connected to the operator's position, and remembering that relays SR1 and PA are operated, the former after the pulses constituting the called subscriber's number have been registered in the sender and the latter when the sender is extended to an operator's position, a circuit is completed for relay OA, extending from ground on the No. 4 contacts of relay SR1, lead **306**, No. 3 contacts of relay PA, winding of relay OA, No. 7 contacts of relay PR1, lead **307**, No. 10 contacts of relay ROP, lead **308** (which is lead TS in cable C10) through the sender and position switch crosspoints, lead TS in the position to which the sender has been connected, winding of relay A, to battery, and in parallel therewith through the No. 6 contacts of relay

TE, the winding of relay TS, to battery. Relay OA operates, advances operating ground to the winding of relay OA1 which operates and locks over its No. 9 contacts to ground on the No. 7 contacts of relay CUA over lead 309, and completes the circuit of relay OETK the path of which extends from ground on the No. 1 contacts of relay OA, lead 316, No. 1 back contacts of relay RR, lead 317, No. 11 contacts of relay ON4, lead 318, winding of relay OETK, resistor OETK1 to ground, and in parallel from resistor OETK1 over lead 319, No. 10 contacts of relay ON4, lead 320, resistor OETK2, to battery. Relay OETK operates in this circuit to open its back contacts for a purpose that will be explained shortly. Upon the operation of relay OA1, a circuit is completed for relays DNA and RR. The circuit path extends from battery through the winding of relay DNA, No. 6 normal contacts of relay DNB, No. 5 normal contacts of relay DNC, lead 310, No. 5 normal contacts of relays DNTH, DNH, DNT, No' 6 normal contacts of relay DNU, lead 311, No. 9 back contacts of relay TVS, lead 312, No. 1 back contacts of relay PRI, lead 313, No. 5 normally made contacts of relay ROP, lead 314, winding of relay RR to battery, and in parallel over lead 314 through paralleled No. 2 back contacts of relays DN7–DN0, lead 315, No. 6 contacts of relay OA1, to ground. Relay DNA operates to extend the digital registering leads from the No. 2 front contacts of relays DN0–DN7 to the relays DA0–DA7 of the A digit calling register, while relay RR operates to open the operating circuit of relay OETK. The latter relay, however, will not release, holding over lead 317 to the parallel resistance path established through the No. 1 and No. 2 back contacts of relays DN0–DN7 to ground on the No. 6 contacts of relay OA1. This path will remain effective so long as no more than two of the relays DN0–DN7 are operated at a time. If three or more of said relays are operated, the current flowing through relay OETK will be insufficient to hold it, and on releasing will close its contacts to indicate a false digital registration, as will be explained.

Relays A and TS in the position also operate in the path previously described. The operation of relay A closes the circuit of lamp SENDSR over the No. 6 contacts of relay RR in the position, lighting said lamp to signal the connection of the sender to the position. The operation of relay TS connects the winding S of transformer TN at its No. 1 and No. 2 front contacts to the line windings of transformer A, closes the tone supply circuit over its No. 3 contacts, No. 2 back contacts of relays TN3 and TN1 to the winding P of transformer TN, and completes an obvious circuit for relay TN1 which, in operating, operates relay TN2, the latter operating relay TN3. The successive operation of relay TS and of slow-operate relays TN1, TN2 and TN3 provides the operator with a double order tone as a signal for her to challenge the called subscriber and obtain the calling line number. Relay TN3 completes an obvious circuit for relay TE which locks over its No. 3 contacts to ground on the No. 2 contacts of relay H, closes an interrupter ground to lamp SENDSR from ground through interrupter FL, No. 5 contacts of relay TE, No. 3 contacts of relay H, back contacts of relay A, No. 6 contacts of relay RR to the lamp SENDSR, causing this lamp to flash in the event that the sender opens lead TS and releases relay A. Relay TS is released by the operation of relay TE, thereby to extend the tip and ring leads T and R of the connection to the operator's telephone set over its No. 2 and No. 4 contacts and No. 1 and No. 2 back contacts of relay TS. Relay TS, by its release, further releases relays TN1, TN2 and TN3.

The operator, on receiving the two spurts of tone, asks the calling subscriber for his number, which she proceeds to key on the keyset at her position, and shown in Fig. 51. The depression of the keys in setting up the number connects ground in the 2-out-of-5 code to leads 0, 1, 2, 4 and 7 as follows:

Key Operated	Leads Grounded
0 (Z)	4,7
1	0,1
2 (ABC)	0,2
3 (DEF)	1,2
4 (GHI)	0,4
5 (JKL)	1,4
6 (MNO)	2,4
7 (PRS)	0,7
8 (TUV)	1,7
9 (WXY)	2,7

The connection of ground to these leads causes certain combinations of relays in the sender to operate and lock, thereby registering the calling number. Since it has been assumed that the number is Bigelow 9–8276 the operator depresses the involved keys in the indicated order.

The depression of key 2 grounds leads 0 and 2 in cable C10, which completes the circuits of relays DN0 and DN2 in the sender over the established position and sender switch crosspoints. Relay DN0, on operating, completes a circuit for relay DA0 from ground on lead 314 as previously traced thereto, No. 2 front contacts of relay DN0, lead 321, No. 4 contacts of relay DNA, winding of relay DA0, to battery. Relay DA0 operates and locks over its No. 1 contacts, lead 322, No. 8 contacts of relay ROM, lead 323, No. 3 contacts of relay ON4 to aforetraced ground on lead 314. Relay DN2, on operating, completes the circuit of relay DA2 from ground on lead 314, No. 2 front contacts of relay DN2, lead 324 No. 6 contacts of relay DNA, winding of relay DA2, to battery. Relay DA2 operates and locks over its No. 1 contacts to aforetraced ground on lead 322. Relays DA0 and DA2 by their operation register the numeral 2 for the A digit of the calling office code.

Upon the operation of relay DA0 or DA2, or any of the relays DA0–DA7 depending upon the value of the registered A digit, a circuit path is completed for relay DNB extending from battery through the winding of said relay, No. 1 contacts of relay DNA, lead 325, No. 2 contacts of relay DA, lead 326, No. 2 contacts of relay TR0, No. 5 contacts of normally made contacts of relay ROP, lead 314, and thence to ground as previously traced thereto. Relay DNB operates, locks over its No. 6 front contacts to ground on lead 310 as previously traced thereto, and completes the circuit of relay ODD extending from battery through the winding of said relay, No. 1 contacts of relay EV, No. 3 contacts of relay DNB to ground on the No. 2 normal contacts of relay DNA. Relay ODD, in combination with relay DNB, extends the digital registering leads from the contacts of relays DN0–DN7 to relays DB0–DB7 of the B digit register.

It will be observed that relay DNA is provided with a locking path through its No. 3 contacts, lead 336, No. 9 contacts of relay ROP, lead 337 and paralleled No. 1 front contacts of relays DN0–DN7 to ground on lead 314. Consequently when the operator depresses the key for the first digit and two of the relays DN0–DN7 are selectively operated in response thereto, the above path is closed to hold relay DNA locked. However, when the appropriate combination of relays DA0–DA7 is operated to register the digit, relay DNB is operated, which opens the operating circuit of relay DNA. This relay, however, will not release so long as the operator maintains the key operated, thereby keeping the two relays of the group of relays DN0–DN7 operated and thereby maintaining the above-described holding circuit of relay DNA. So long as relay DNA remains energized, therefore, relay ODD cannot operate, in the absence of which the registering leads from relays DN0–DN7 cannot be switched to relays DB0–DB7. When the operator does release the key, the two relays in the group of relays DN0-DN7 will release, thereby to release relay DNA

and to operate relay ODD, subsequent to which the registering leads are extended to relays DB0–DB7. By means of this arrangement, repeated for all of the other relays DNB–DNU of the steering circuit, registration is prevented of the one digit into a plurality of succeeding registers in the event that the operator should keep them operated beyond the period required to register the digit in the register for that digit.

When the operator depresses key 4 for the B digit and thereby grounds leads 0 and 4, circuits are completed for relays DN0 and DN4 in the manner previously described for relays DN0 and DN2, relays DN0 and DN4 then completing circuits for relays DB0 and DB4; the circuit of relay DB0 extending from ground on lead 321 as previously traced thereto, No. 4 contacts of relay ODD, No. 7 contacts of relay DNB, lead 327, winding of relay DB0, to battery; the circuit of relay DB4 extending from ground on lead 314 through the No. 2 front contacts of relay DN4, lead 328, No. 7 contacts of relay ODD, No. 10 contacts of relay DNB, lead 329, winding of relay DB4, to battery. Relays DB0 and DB4 operate, lock over their respective No. 1 contacts to ground on lead 322, thereby to register the numeral 4 for the value of the B digit. The operation of relays DB0 and DB4 advance ground from lead 326 over the No. 2 contacts of one of the two operated relays DA0 and DA2, and then over their No. 2 contacts complete the circuit of relay DNC through the No. 2 contacts of relay DNB, No. 3 contacts of relay ODD, No. 4 contacts of relay DNB, winding of relay DNC, to battery. Relay DNC operates, locks over its No. 5 front contacts and corresponding but normal contacts on relays DNTH–DNU to aforetracted ground on lead 314, and releases relay DNB if, in the meanwhile, the operator has released the key for the B digit and thereby causes the opening of the other locking circuit for said relay through its No. 5 contacts and No. 2 contacts of relay ODD to previously traced ground on lead 336. With relay DNB released, relay ODD releases and completes the circuit of relay EV from battery through its winding, No. 1 contacts of relay ODD, No. 2 contacts of relay DNC to ground on the No. 2 normal contacts of relay DNA. Relays DNC and EV extend the digital registering leads to relays DC0–DC7 for the registration of the C digit of the calling office code. Consequently when the operator depresses the digit key 9 and thereby causes the operation of relays DN2 and DN7, circuits are completed over the contacts of relays EV and DNC for relays DC2 and DC7; the circuit of relay DC2 extending from ground on lead 314 through the No. 2 front contacts of relay DN2, lead 324, No. 6 contacts of relay EV, No. 8 contacts of relay DNC, winding of relay DC2, to battery; the circuit of relay DC7 extending from ground on lead 314, No. 2 front contacts of relay DN7, lead 330, No. 8 contacts of relay EV, No. 10 contacts of relay DNC, lead 331, through the winding of relay DC7, to battery. Relays DC2 and DC7 operate, lock over their respective No. 1 contacts to ground on lead 322, thereby to register the numeral 9 for the C digit of the calling office code, and over their No. 2 contacts complete the circuit of relay DNTH from ground on lead 326, selectively through the No. 2 contacts of relays DA0–DC7, lead 332, No. 3 contacts of relay DNC, No. 2 contacts of relay EV, No. 1 contacts of relay DNC, lead 333, winding of relay DNTH, to battery. This relay operates, locks over its No. 5 front contacts to ground previously traced on lead 311, opens the circuit of relay DNC which releases when its locking circuit through its own No. 4 contacts and No. 3 contacts of relay EV to ground on lead 336 is opened as a result of the operator releasing the digit key for the third digit. With relay DNC released, relay EV releases to complete the circuit of relay ODD from battery through the winding of relay ODD, No. 1 contacts of relay EV, lead 334, No. 2 contacts of relay DNTH, lead 335, to ground on the No. 2 normal contacts of relay DNA. Relay ODD, in combination with relay DNTH, advances the digital register leads to the thousands digit register relays DTH0–DTH7, which are then selectively operated in the manner described for the relays of the previous two digital registers, to register the thousands digit; relays DTH1 and DTH7 being operated to register the given numeral 8 for the value of the thousands digit of the calling line number.

Also in the manner previously described, each of the remaining three digits 276 are successively registered; relays DH0 and DH2 being operated to register the given hundreds digits 2, relays DT0 and DT7 being operated to register the given tens digit 7, and relays DU2 and DU4 being operated to register the given units digit 6. After the registration of each of these digits, the steering relay DN– for the next digit is operated, coupled with the release of the steering relay for the previous digit as described.

When the units digit 6 is registered by the operation of relays DU2 and DU4, ground on lead 326, advanced serially over the No. 2 contacts of the operated relays in the registers for the preceding digits, is further advanced over the No. 2 contacts of said relays DU2 and DU4, lead 338, No. 4 contacts of relay DNU, lead 339, No. 2 contacts of relay EV, lead 340, No. 1 contacts of relay DNU, winding of relay DNX, to battery. Relay DNX operates and locks over its No. 3 contacts, lead 312, and thence as traced to ground on lead 314.

Relay DNX prepares the sender to cope with one of two errors which the operator might make in keying the seven digits of the wanted number. The error for which said relay prepares the sender is the erroneous keying of an eighth digit. In this event, and with relay DNX operated, ground on any one of the four registering leads 0, 1, 2 and 4, advanced through the contacts of relay ODD to the Nos. 4, 5, 6 or 7 contacts of relay DNX, completes the circuit of relay OEXD over lead 341, which relay operates and locks over its upper winding and No. 5 contacts to previously traced ground on lead 312. Ground on lead SONG from the No. 7 contacts of relay ON4 now completes the circuit of relay OEW over the No. 3 front contacts of relay OEXD, lead 345, No. 2 normally made contacts of relay OEW, winding of relay OEW, through resistance to battery, said ground maintaining relay OEZ short-circuited.

While the above operations are taking place, however, and due to the fact that the required seven digits have been registered in the sender, steps are taken immediately thereafter to connect the sender with the transverter, thereby to transfer the registration to the transverter and for other purposes. The connection is initiated by the operation of relay TVS, the path of which is controlled by the relays of the digital registers to insure that at least one relay in each register has been operated, and by the operated condition of relay DRL as an indication that the marker has completed its functions. The circuit path of said relay TVS may be traced from battery through the winding of said relay, lead 342, No. 1 contacts of relays TR4 and R0, No. 6 contacts of relay DRL, lead 350, No. 3 contacts of relay OD, lead 351, through the No. 2 contacts of an operated relay in each of the seven digital registers DU0–DU7—DA0–DA7, lead 326, No. 2 contacts of relay TR0, No. 5 normally made contacts of relay ROP, lead 314, No. 2 back contacts of any normal relay DN0–DN7, lead 315, to ground on the No. 6 contacts of relay OA1. Relay TVS operates, locks to operating ground over its No. 4 contacts, No. 1 back contacts of relay TVR, lead 350 to ground aforetraced thereto, and applies battery on lead STV in cable C2 extending to the transverter connector over the No. 1 back contacts of relay LR2, lead 130, No. 3 contacts of relay TVS, and No. 6 contacts of relay TVR. As will be shown, battery on lead STV causes a transverter to be connected to the sender, which then transmits to the transverter the digits of the called number for its use

in causing the recorder to record the initial entry for the call.

The operation of the transverter will be described in due course. At this point (in connection with operator keying errors) it is sufficient to note when the transverter has completed its functions and is ready to release, it applies ground to lead TVR in cable C2, which completes an obvious circuit over the lower winding of relay TVR, operating this relay, which then locks over its No. 7 contacts to ground on the No. 5 contacts of relay TVS. Relay TVR operates, releases relay TVS and completes a circuit for relay ROP, which circuit extends from battery through its lower winding, lead 346, No. 3 front contacts of relay OEW, lead 347, No. 1 front contacts of relay DNX, lead 354, No. 7 contacts of relay OEXD, lead 355, No. 9 front contacts of relay TVR, lead 356, No. 10 contacts of relay LR2, lead 357, No. 6 back contacts of relay RO1, lead 358, No. 9 contacts of relay DRL, to ground. Relay ROP operates and locks over the No. 1 back contacts of relay PD, lead 349, No. 7 contacts of relay ROM, lead 314, and by way of either the No. 2 back contacts of any normal relay DN0–DN7, lead 315, to ground on the No. 6 contacts of relay GA1, or to ground on the No. 6 contacts of relay TVS. It should be noted, however, that while relay ROP, in operating, opens the locking circuit of relay OEXD through the latter's upper winding, said relay will hold over its lower winding and No. 6 contacts, to ground heretofore traced on lead 356, the object being to prevent the operation of the position-release relay PR from the transverter over lead PRI and the No. 9 contacts of relay OEXD, as it normally will when the transverter has completed its function. Since relay PRI controls the release of the sender from the position, and since the sender may not be so released at this time owing to the operator having keyed an eighth digit that will require her to key the number over again, the ground on lead PR from the transverter is opened by keeping ready OEXD operated.

Relay ROP, when operated, opens the locking circuit of relays DNX and OEXD at its No. 5 normal contacts (via lead 313). In releasing OEXD removes the short circuit from the upper winding of relay OEZ, causing it to operate and then hold over its lower winding and No. 3 contacts to ground on lead SONG. The operated condition of relays OEW and OEZ records in the sender the fact that there has been one keying error made. Relay ROP also opens lead TS thereby to release relay A in the position and relay OA in the sender, and completes the circuit of relay OETK over lead 318, No. 11 contacts of relay ON4, lead 317, No. 3 contacts of relay ROP, to ground on lead SONG. By operating, relay OETK is prepared to detect another type of keying error (or what may appear to be a keying error) after the operator has discharged the locked-in registration and rekeys the number, as will presently appear.

The release of relay A in the position circuit connects the interrupter FL to the lamp SENDSR, as previously described, causing said lamp to flash as an indication to the operator that the sender has detected an error which requires her to rekey the number. To do this the operator depresses the register reset key KRR which completes an obvious circuit for relay RR. Said relay operates, extinguishes lamp SENDSR, and connects ground to the five register leads 0–7 which results in the operation of the five relays DN0–DN7, the release of relay RR, the release of all register relays locked to lead 314 by way of lead 322 and the release of relay ROP (its other locking circuit having been opened at the contacts of relay TVS when the latter released on the operation of relay TVR), relay ROP reestablishing the circuit of relays A and OA. When the operator releases the reset key KRR, relay RR and relays DN0–DN7 of the sender release, the latter relays reestablishing the parallel resistance path for relay OETK through the No. 1 back contacts of said relays DN0–DN7, causing said relay OETK to reoperate in preparation for detecting a second error. The operator then rekeys the number, preferably after checking the same with the subscriber.

The second type of error that the operator might make is to simultaneously depress two keys in registering one of seven digits. This will result, of course, in the grounding of three or more of the five digital leads 0–7 and the operation of three or more of the relays DN0–DN7. Since relay OETK is adjusted to release if three or more of said relays DN0–DN7 operates, the simultaneous depression of two keys and the consequent operation of three or more of said relays will cause relay OETK to release.

Now assume that the operator has made no previous error, including the keying of an eighth digit. In this event, and further assuming that the error now to be made is to double-key an intermediate digit, relays DNX and OEXD will be normal. The release of relay OETK consequent to the operation of three or more relays DN0–DN7 by the double-key operation then results in the operation of relay OEW from ground on the No. 1 contacts of relay OA, lead 316, No. 1 front contacts of relay RR, contacts of relay OETK, lead 344, No. 1 contacts of relay CW, 345, and thence as traced through the winding of relay OEW, causing the operation of the latter relay and the short-circuiting of relay OEZ. When the operator releases the two keys and thereby releases the three or more of the relays DN0–DN7 which have operated, relay OETK reoperates and removes the short circuit around relay OEZ, causing it to operate. As in the case of the erroneous keying of an eighth digit the operation of relays OEW and OEZ records the fact that the sender has detected a first keying error. On the operation of relay OEW, relay ROP is operated releasing relay A in the position to give the operator a reorder signal as has previously been described.

If the error made by the operator is a second error, and remembering that as a consequence of the first error relays OEW and OEZ are operated, the release of relay OETK on the release of keys shunts relay OEW with previously traced ground on lead 345, No. 2 front contacts of relay OEZ to the winding of relay OEW. In this case, the release of the keys will have no effect on relay OEZ inasmuch as said relay is held locked on its lower winding and No. 3 contacts to ground on lead SONG.

In the case of a second error (whether it be an eighth digit or the double-keying of a regular digit) the operator is given no reorder signal, inasmuch as the circuit of relay ROP is opened at the No. 5 back contact of relay OEZ. When the sender has received the full complement of digits, relay TVS is operated as described for connecting the sender to the transverter. In this case of a second error, however, ground on lead STI within cable C2 from lead SONG, No. 3 back contacts of relay OEXD, No. 5 front contacts of relay OEZ, No. 1 contacts of relay OEW, advises the transverter that the sender has detected a trouble condition. As will be shown, the transverter, in response to ground on lead STI and other conditions that will be described, will cause the trouble indicator to make a record of the call, earmarking the record with a notation of a trouble in the sender. It should also be remarked at this point that if the error noted by the sender is the first error (relays OEW and OEZ both operated) regardless of whether the error is an eighth digit or the double-keying of a regular digit, the sender is nevertheless connected to the transverter without ground on lead STI, and the transverter proceeds to make the initial entry for the call and normally dismisses. However, due to the fact that in the case of a first error the operator is given a reorder signal and the calling number is rekeyed, then, if there is no second error, the transverter will proceed to make a second initial entry for the same call. As is well known in telephone systems adapted for the recording of three entries for a call, and since the connection was not extended to its destination as a result of the keying involving the first error, the first initial

entry will not be accompanied by an "answer" entry and a "disconnect" entry. The second initial entry, however, will be so accompanied. The result is that when the record is processed by the accounting center devices, the failure to first obtain a disconnect entry and an answer entry before obtaining the "first" initial entry will cause said initial entry to be discarded.

When relay TVS operates, thereby indicating that the seven digits of the calling line number have been registered in the sender, battery previously traced to the No. 3 contacts of said relay, is applied over the No. 6 normally made contacts of relay TVR to lead STV in cable C2, and also from the No. 3 contacts of relay TVS directly to lead CBS. As will be shown, battery on both of these leads initiates operations by which the sender is caused to be connected to the transverter over the transverter connector.

Before taking up these operations, however, it may be stated in advance that the major functions of the transverter are to register, translate and convert the information received from the sender to a form or pattern satisfactory for recording, and to transmit to the recorder in the correct order and sequence all pertinent information necessary for establishing a proper message unit charge initial entry for each call completed to a local or foreign area office through (and within operating limits of) the tandem AMA office facilities. The transverter also requires the services of, connects to, and functions with a billing indexer circuit which determines the change rates where necessary and the character of the initial entry.

The transverter connector is shown in abbreviated form in Fig. 66. Essentially it is similar to the type of connector shown in Patent No. 2,668,658 to which reference is made for a complete description thereof. Basically, however, and for the purposes of this description, the transverter connector comprises a number of channels each individual to a group of senders and all common to all transverters. When a sender is ready to be connected to a transverter, it seizes its own channel, other senders in said channel being made to await their turn in a predetermined order of preference, the preferred sender (assuming it to be the one under description) proceeding to obtain a free transverter. Since the detailed structure of the transverter connector, the manner by which the preference of the senders in a channel and the manner by which all transverters are preferentially made available to all sender channels are immaterial to the present invention, Fig. 66 shows just that portion of the transverter connector which involves the extension over one channel of the conductors in cable C2 from the sender under description to the conductors in cable C3 extending to a selected transverter.

Briefly, then, when battery is applied to conductor STV, as previously described, a circuit is completed for relay SS in series with relay CA1. Relay SS operates and closes a controlled path through the winding of the sender-connector relay SA which operates from battery on lead CBS. On operating, this relay extends battery on lead STV over its No. 2 contacts and through the back contacts of relay CB to operate relay TS. Among other functions that will be described later, relay TS extends the winding of relay TA over its No. 2 front contacts to lead M in cable C3 of the available transverter. It will be noted also at this time that relay SA, on operating, applies ground over its No. 5 contacts to the lead CKG, which completes the circuit of relay CKG in the transverter over said conductor (designated as lead 3 in the transverter), No. 1 normally made contacts of relay TBC2, winding of relay CKG, to battery. This relay upon operating, short-circuits condenser C1 by ground over its No. 9 contacts, No. 10 back contacts of relay CK6 and conductor 49, which ground also completes the circuit over the upper winding of polarized relay CTM to battery on normal contacts of jack J1. The latter relay, however, operates over this circuit in the direction that causes its armature to engage its back stop. Relay CKG further completes the circuit of relays CO1, CO2, and COA. The circuit of relays CO1 and CO2 is completed from ground on the No. 7 contacts of relay CKG, lead 1, to the winding of relay CO1 to battery, and over lead 1', to the winding of relay CO2 to battery. The circuit of relay COA may be traced from ground on the No. 8 contacts of relay CKG, lead 2, winding of relay COA, to battery. Upon operating, relays CO1, CO2, and COA remove all standing tests on leads in cable C7 extending to the perforator, and on other leads that are not automatically checked. Relay CKG further closes the path of the down-check test to insure that all register relays are normal. If said relays are normal, a series circuit is completed between relay NOK and relay CK1. On the other hand, if any relay in any register is operated, said circuit will not be completed, in which event further operations are blocked and the transverter will time out, as will be described. Assuming, however, that all register relays are normal, then upon the operation of relay CKG a circuit path is completed from battery through the lower winding of relay NOK (Fig. 97), lead TDC1, the No. 1 contacts of the six relays RN0–RN13 of the recorder identification register, lead TDC2, No. 7 back contacts of relay INS, lead TDC3, No. 1 or No. 2 back contacts of the seven relays ST00–ST5 of the called number stations digit register, lead TDC4, No. 2 back contacts of relay INS, lead TDC5, No. 1 or No. 2 back contacts of the seven relays U00–U5 of the called number units register, lead TDC6, No. 1 or No. 2 back contacts of the seven relays T00–T5 of the called number tens digit register, lead TDC7, No. 1 or No. 2 back contacts of the seven relays H00–H5 of the called number hundreds digit register, lead TDC8, No. 1 or No. 2 back contacts of the seven relays TH00–TH5 of the called number thousands digit register, lead TDC9, No. 5 back contacts of relay SU, No. 4 back contacts of relay UT, No. 5 back contacts of relay OT, lead TDC10, No. 4 contacts of relay S0, No. 5 contacts of relay NS0, lead TDC11, No. 7 contacts of relay TR2, No. 2 back contacts of relay TR1, lead TDC12, No. 1 back contacts of relay LAC, lead TDC13, No. 1 or No. 2 back contacts of the seven relays NC00–NC5 of the national area code C digit register, No. 1 or No. 2 back contacts of the four relays NB00–NB5 of the national code B digit register, lead TDC14, No. 1 or No. 2 back contacts of the seven relays NA00–NA5 of the national area code A digit register, lead TDC15, No. 2 back contacts of relay LAC, No. 1 back contacts of relay NAC, lead TDC16, No. 6 or No. 8 back contacts of the seven relays CS00–CS5 of the class-of-service register, lead TDC17, No. 1 or No. 2 back contacts of the seven relays DC00–DC5 of the calling number C digit conversion register, lead TDC18, No. 1 or No. 2 back contacts of the seven relays DB00–DB5 of the calling number B digit conversion register, lead TDC19, No. 1 or No. 2 back contacts of the seven relays DA00–DA5 of the calling number A digit conversion register, lead TDC20, No. 2 or No. 3 back contacts of the seven relays C00–C5 of the called number C digit register, lead TDC21, No. 2 or No. 3 back contacts of the seven relays B00–B5 of the called number B digit register, lead TDC22, No. 2 or No. 3 back contacts of the seven relays A00–A5 of the called number A digit register, lead TDC23, No. 6 contacts of relays CKG, lower winding of relays CK1 to ground. Relays NOK and CK1 both operate over the above path, relay NOK locking over its No. 2 contacts, No. 1 contacts of relay CK3, No. 6 contacts of relay CK1 to ground. With relays CK1 and NOK operated, a path is closed for relay CK6 extending from battery through its winding, No. 5 contacts of relay CKG, lead 8, No. 37 contacts of relay COA, No. 4 contacts of relay CO1, lead 7 No. 1 contacts of relay CO2, lead 6, No. 1 contacts of relay CK1, No. 1 contacts of relay NOK, lead 4, No. 2 contacts of

relay TR, lead 3 joined to lead CKG in cable 3, No. 5 contacts of relay SA, to ground. Relay CK6 operates in this circuit. Over its No. 1 front contacts and lead M, it applies ground to complete the circuit of relay TA in the connector, the path of said latter relay extending over the No. 2 front contacts of relay TS, windings of relay TA, to battery. The latter relay operates to complete the connection between the calling sender and the transverter through their respective cables C2 and C3. The transverter connector relays also operate certain other relays (not shown) which make all sender channels busy to the transverter thus taken into use.

When relay CK6 operates it establishes a circuit for relay ICB, said circuit extending from ground on the No. 9 contacts of relay CKG, lead 51, No. 10 front contacts of relay CK6, lead 570, resistor ICB1, winding of relay ICB, to battery. There is a tap off the lead between the resistor CIB1 and winding ICB through the winding of relay ICK, which extends to the register relays of the identity indexer over lead 571, No. 1 contacts of relay TOK, lead ICK extending over cable C7 to the recorder connector. After relay CK6 has operated, a check is also made for the normal condition of the relays in certain registers which subsequently will be selectively operated by the billing indexer circuit when the latter circuit becomes connected to the transverter. Relay CK6 will also check certain other relays. These registers are the message billing index register and the office index register (Fig. 108). Assuming that the relays of the above registers are all normal, a circuit is completed from ground on the No. 6 contacts of relay CK6, lead 25, upper winding of relay CK8, No. 2 contacts of relay CK5, lead 27, No. 1 contacts of relay CK4, lead 28, No. 5 back contacts of relays M17, M14, M12, No. 4 back contacts of relay MI1, No. 3 contacts of relay MI0, lead 29, No. 2 contacts of relay INK, lead 30, No. 6 back contacts of relays OF7, OF4, OF2, No. 5 back contacts of relay OF1, No. 4 back contacts of relay OF0, No. 4 back contacts of relay 2L, No. 4 back contacts of relay MUD, No. 3 back contacts of relay TS, lead 0031, winding of relay CK2 to battery. Both relays CK8 and CK2 operate in series, relay CK8 locking over its lower winding through its No. 8 contacts, lead 25, to ground on No. 6 contacts of relay CK6. The operation of relays CK8 and CK2 indicates the normal condition of the relays in the two registers. As a consequence of the operation of relay CK8, a circuit path is completed for relay IOK1, said path extending from battery through the winding of said relay, lead 39, No. 2 contacts of relay TM6, No. 1 contacts of relay TM3, lead 40, No. 7 contacts of relay IOK, lead 42, No. 3 back contacts of relay CK5, No. 3 contacts of relay CK8, to ground. Relay IOK1 operates and completes an obvious circuit for relay IOK2, which operates.

It should be stated at this time that relays TA1 and TA2 in the transverter are normally operated, relay TA1 over a circuit from battery through its winding, lead TA1 in cable C3 to the transverter connector, No. 1 normally made contacts of relay TS, to ground; relay TA2 over a circuit from ground through its winding, lead TA2 in cable C3 to the transverter connector, No. 2 back contacts of relay TS, lead M, back through cable C3, No. 1 back contacts of relay CK6, through resistance to battery. Consequently when relay TS operates as described, relays TA1 and TA2 release. When either of these relays release, ground is applied over their respective contacts to lead 400 (joined to lead TM extending to ground on the No. 5 contacts of relay TA) thereby to complete the circuit of relay TMS2 over the No. 3 contacts of relay EXT, lead 401, No. 1 back contacts of relay W, No. 2 back contacts of relay Z, No. 6 back contacts of relay TM1, No. 2 back contacts of relays TMS3 and TMS1, lead 402, No. 20 contacts of relay CK7, lead 403, windings of relay TMS2, to battery. As will be shown below in the section on Timing, the operation of relay TMS2 starts the transverter timing, which provides an alarm if relays and other units of equipment therein are held for a period longer than their normal usage in the operation of the transverter.

Relay CK6 also operates relay CK7 if the timing relays TM1 and TMS1 are normal, and locks directly to relay CK1. The circuit of relay CK7 may be traced from ground on the No. 7 contacts of relay CK6, lead 10, No. 1 contacts of relays TMS1 and TM1, lead 11, windings of relay CK7, to battery. On operating, the latter relay locks over its No. 10 contacts, lead 405, No. 4 contacts of relay CK1, to ground, and provides ground controls for certain transverter functions, including timing.

With the transverter connected to the sender over cables C2 and C3, certain registrations in the registers of the sender are transferred to corresponding registers of the transverter as follows:

The called number is transmitted from the sender to the transverter by grounding appropriate leads A–, B–, C–, D–, E–, F–, G–, and H– in biquinary combinations of 2-out-of-7 relays in each digital register to register the involved digits. Since the registers are alike, the operation indicated below for the relays of the called number thousands (D) digit register (Fig. 68) for each of the ten decimal values of the thousands digit will serve as an example of similar operations in each of the called number registers, of which eight are provided:

CALLED NUMBER THOUSAND (D) DIGIT REGISTER

Digit	Leads Grounded	Relays Operated
0	D0, -D00	TH0, TH00
1	D1, -D00	TH1, TH00
2	D2, -D00	TH2, TH00
3	D3, -D00	TH3, TH00
4	D4, -D00	TH4, TH00
5	D0, -D5	TH0, TH5
6	D1, -D5	TH1, TH5
7	D2, -D5	TH2, TH5
8	D3, -D5	TH3, TH5
9	D4, -D5	TH4, TH5

The relays of the called number registers, when operated, lock over their respective locking contacts to offnormal ground on the contacts of operated relay CK7; relays A00–A5 of the A digit register over lead TONG11 to ground on the No. 1 contacts of said relay: relays B00–B5 of the B digit register over lead TONG7 to ground on the No. 12 contacts; relays C00–C5 of the C digit register over lead TONG8 to ground on the No. 2 contacts; relays TH00–TH5 of the thousands (D) register over lead TONG1 to ground on the No. 16 contacts; relays H00–H5 of the hundreds (E) digit register over lead TONG4 to ground on the No. 13 contacts; relays 00–T5 of the tens (F) digit register, and relays U00–U5 of the units (G) digit register over lead TONG2 to ground on the No. 15 contacts, and relays ST00–ST5 of the stations (H) digit register over lead TONG3 to ground on the No. 14 contacts.

Where the tandem office sender is equipped with registers to receive from the originating office not only the three-digit office code and the five digits (including the stations digit) which make up the numerical portion of the called number, but also three-digit national area codes, the A, B and C digits of such latter codes are registered in the national area code A, B and C digit registers of the transverter. In such codes, the B digit is limited to the value of 0 and 1, and the A digit to any value from 2–9. It should be noted that the sender constituting part of the present invention is not arranged to receive national area codes, though as will be explained, the transverter is arranged to accept and function with either type of sender. Where the sender is not arranged to register national area codes it is provided with a permanently grounded lead LAC which, upon the connection of the sender to the transverter, causes the operation of relay LAC.

Now it will be remembered that the called number which is being used to illustrate the operation of the invention is Republic 7–1359, that this number was dialed by the calling subscriber into a sender in the office of origin, and that said number was transmitted therefrom over the tandem trunk to the sender at the tandem office, resulting in the operation of the called office code and called numerical registers of the latter sender. Consequently, when said sender is connected to the transverter as previously described, and because said sender is not arranged to receive national area codes from any office of origin, relay LAC is operated, and the leads A–, B–, C–, D–, E–, F–, and G– are extended from the code and numerical registers of the sender to the called code and numerical registers of the transverter. Remembering that the registration of the called office code 737 in the sender resulted in grounding leads A5 and A2 by the operation of its relays CA5 and CA2, of leads B00 and B3 by the operation of relays CB0 and CB3, and leads C5 and C2 by the operation of its relays CC5 and CC2, then when the sender becomes connected to the transverter and relay LAC has operated, ground on the above-designated pairs of leads in the A–, B–, and C groups of leads, extended through the A, B and C groups of contacts of relay LAC, results in the operation, respectively, of relays A5 and A2 of the called number A digit register to register the A digit 7; of relays B00 and B3 of the called number B digit register to register the B digit 3; and of relays C5 and C2 of the called number C digit register to register the C digit 7. Relays A5 and A2 lock to ground on the No. 1 contacts of relay CK7 over lead TONG11, relays B3 and B00 lock to ground on the No. 12 contacts of relay CK7 over lead TONG7, while relays C5 and C2 lock to ground on the No. 2 contacts of relay CK7 over lead TONG8.

In the same manner, the grounding in the sender of leads D00 and D1 for the thousands digit 1, leads E00 and E3 for the hundreds digit 3, leads F5 and F0 for the tens digit 5, leads G5 and G4 for the units digit 9, and leads H00 and H0 for the stations digit 0 (the called number having no station's digit) for the called number 1359 results in the operation, over contact groups D–H of relay LAC, of relays TH00 and TH1 of the called number thousands (D) digit to register the thousands digit 1, of relays H00 and H3 of the called number hundreds (E) digit register to register the hundreds digit 3; of relays T0 and T5 of the called number tens (F) digit register to register the tens digit 5, of relays U4 and U5 of the called number units (G) digit register to register the units digit 9, and of relays ST00 and ST0 of the called number stations (H) register to register the stations digit 0. On operating, relays TH00 and TH1 lock over lead TONG1 to ground on the No. 16 contacts of relay CK7; relays H00 and H3 lock over lead TONG4 to ground on the No. 13 contacts of said relay; relays TS, T0, U5 and U4 lock over lead TONG2 to ground on the No. 15 contacts of said relay, while relays ST00 and ST0 lock over lead TONG3 to ground on the No. 14 contacts of said relay.

If the transverter becomes connected to a sender (not shown) which is adapted to receive not only a local area code and the numericals of the called subscriber's number but also a national area code, said sender will ground its lead NAC which, resulting in the operation of relay NAC, enables the transverter to receive and register a total of eleven (11) digits instead of eight (8) digits. The three A, B and C digits of the national area code will be registered over contact groups A, B and C of relay NAC in the national area code A, B and C digit registers, respectively, the three A, B and C digits of the local code within the dialed national area being then registered over contact groups D, E and F in the previously described local area A, B and C digit registers, respectively, while the five numericals are registered over contact groups G, H, J, K and L in the previously described numerical D, E, F, G and H digit registers, respectively. The relays NA00–NA5 of the national area code A digit register, on their selective operation in the biquinary code, lock over lead TONG14 to ground on the No. 9 contacts of relay CK7; relays NB00–NB5 of the national area code B digit register lock over lead TONG15 to ground on the No. 7 contacts of relay CK7, while relays NC00–NC5 of the national area code C digit register, on their selective biquinary operation, lock over lead TONG16 to ground on the No. 6 contacts of relay CK7.

With reference to foreign area codes, it should be noted that the A digit is limited to the eight values 2–9; the B digit to the two values 0 and 1, while the C digit may have any value 0–9. The maximum number of foreign area codes is thus 160. Theoretically, each of these codes represents a "long distance," or "toll," call for which the subscriber placing the call is furnished with a detailed statement which includes the called exchange number and the total charge in monetary units. For all such toll calls, and for a reason that will later appear, it is necessary to ground lead TS, in consequence of which the initial entry that will be made for each such call will be either a five-line entry or a four-line entry depending on whether the automatic message accounting devices serving the exchanges constituting the area that includes the exchange of the calling subscriber, are adapted to process record tapes with five-line initial entries or record tapes with four-line initial entries. If said devices are adapted to process record tapes with five-line initial entries, the third line of the entry will contain a record of the called national area code. If said devices are adapted to process record tapes having four-line initial entries, the three digits of the national area code are "compressed" by the transverter into a single digit, which digit is recorded in the third line of such four-line entry. But whether the national area code is or is not compressed, lead TS is to be grounded if a toll statement is to be made for the call.

In the present embodiment of the invention the transverter is adapted to compress only a maximum of ten (10) national area codes of the theoretrical maximum of 160 such codes. And to meet certain conditions in a maximum of three areas represented by three compressed codes, the transverter is further adapted to cause calls completed in each of said latter areas to be billed to the calling subscriber in terms of message units rather than monetary units; that is, such calls will be "bulk-billed." For each of the three national areas in the compressed group, calls to which are to be so billed, a lead R0, R1 or R2 is provided in the transverter and grounded for a call completed to such area.

Figs. 78 and 86 show the equipment by which all foreign area codes which are not compressed ground lead TS, and by which each of the ten foreign area codes which is compressed converts the code into a single digit, grounds lead TS if a toll statement is required, and grounds lead R0, R1 or R2 if the calls thereto are to be bulk-billed.

Essentially the above equipment comprises eight relays NAA2–NAA9 each having ten (10) pairs of contacts. These relays are arranged for selective operation in response to the biquinary operation of the relays NA00–NA5 for the national area A digit; two relays NAB0 and NAB1 each having ten (10) pairs of contacts, which are arranged for selective operation in response to the biquinary operation of the relays NB00–NB5 for the national area B digit 0 or 1; ten relays T4A0–T4A9 for use in expressing the single digit of a compressed code in the two-out-of-five code, and a relay TSAT for grounding lead TS.

Each pair of contacts on each of the eight relays NAA2–NAA9 represents two foreign area codes of which the first, or A, digit may be any value 2–8, the second, or B, digit is either 0 or 1, and the third, or C, digit is 0–9. Thus the contact pair (0) on relay NAA2 represents the two codes 200 and 210; the second contact pair (1) represents the two codes 201 and 211, while with the

ninth contact pair (9) represents the two codes 209 and 219. In the same manner with the remaining seven relays; the contact pair 0–9 of relay NAA3, for example, being for the twenty codes 300–319 while the contact pairs 0–9 of relay NAA9 being for the twenty codes 900–919.

The C digit of the national area code received from the sender will operate two of relays NC00–NC5 in accordance with the previously mentioned biquinary code. Ground will be transmitted in series through contacts of the two selected relays which will be transmitted to appropriate contacts of relays NAA2–NAA9 in parallel. The operation of any relay NAA2–NAA9 in accordance with the value of the A digit will effect the extension of the ground to the stationary contact on said relay.

The stationary contacts on the relays NAA2–NAA9 are wired to groups of terminals 2B–9B. Those of said terminals which severally represent double codes neither of which is to be compressed, are cross-connected directly to terminal T5AT extending to the winding of relay T5AT, the stationary contact No. 3 of which is wired to terminal TS and grounded on the operation of relay T5AT. For example, the stationary contact of the (2) contact pair on relay NAA3 is individual to the two national area codes 302 and 312. If neither of these codes is to be compressed as here assumed, then said contact is wired to terminal T5AT as shown. Consequently, when relays NA00 and NA3 of the national area code A digit register operate in response to the code digit "3," a circuit is completed for relay NAA3 extending from battery through the winding of said relay No. 7 contacts of relay NA3, No. 7 contacts of relay NA00, to ground. Relay NAA3 operates, and ground from the No. 8 contacts of relay NC00 is transmitted through the No. 4 contacts of relay NC2, the No. 2 contacts of relay NAA3, to the winding of relay T5AT. Relay T5AT operates and transmits ground through its No. 3 contacts to conductor TS.

As previously stated, the invention is adapted to compress each of ten (10) foreign area codes into a single digit 0–9. For this purpose the ten stationary contacts on the relays NAA2–NAA9 which represent the twenty paired codes including the ten to be compressed, are cross-connected to the "B" terminals, which extend in multiple to corresponding armatures on the two relays NAB0 and NAB1. While the twenty paired codes may, of course, be dispersed among contacts on the different relays NAA2–NAA9, it will be assumed for convenience of illustration that the ten codes to be compressed all have "2" as their A digit. Consequently, the ten stationary contacts of relay NAA2 representing the twenty codes 200, 210 (contact 0); 201, 211 (contact 1); 202, 212 (contact 2); 203, 213 (contact 3); 204, 214 (contact 4); 205, 215 (contact 5); 206, 216 (contact 6); 207, 217 (contact 7); 208, 218 (contact 8); and 209, 219 (contact 9) are cross-connected as shown on Fig. 78 to the "B" terminal extending to the armature of relays NAB0 and NAB1.

Now let it be further assumed that of the above twenty codes the ten codes 210, 201, 203, 214, 205, 206, 207, 217, 218 and 219 are to be compressed into the single digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, respectively. The stationary contacts on relays NAB0 and NAB1 representing these codes (in accordance with the B digit 0 or 1 of the code for which relays NAB0 and NAB1 are respectively operated) are then severally cross-connected to the ten terminals T4A0–T4A9, and therefore to the windings of the ten relays T4A0–T4A9 in accordance with the value of the compressed digit. Each of the latter relays has its lower two stationary contacts connected to two of the five terminals P0–P7 in accordance with the 2-out-of-5 code for the digit represented by each relay. Relay T4A0, for example, representing the digit 0, has its No. 3 and No. 4 contacts connected to terminals P4 and P7 in accordance with the 2-out-of-5 code expression of this digit, and relay T4A9, representing the digit 9, has its No. 3 and No. 4 contacts connected to terminals P2 and P7 for the 2-out-of-5 expression of this digit. The ten codes of the twenty represented by the contacts on relay NAA2 wired to terminals B that are not to be compressed into single digits are cross-connected through the relay NAB0 or NAB1 to terminal T5AT.

Mention has been made of the fact that of the ten (10) national area codes which are compressed, three may be arranged to have calls completed to areas represented by the codes charged for on a bulk-billing basis. For each of these three areas, the No. 4 contact on each of the three appropriate relays in the group T4A0–T4A9 which represents the compressed digit of a bulk-billed area is cross-connected to one of the three terminals R0, R1 or R2 according to assignment. The corresponding contact on each of the remaining seven relays in the group of relays T4A0–T4A9 which represent areas for which the codes are compressed and for which toll statements are to be furnished for calls completed thereto are, of course, connected to lead TS.

Thus if we assume for illustration that calls completed to the foreign areas respectively represented by the codes 203 (compressed digit 2), 206 (compressed digit 5) and 219 (compressed digit 9) are to be charged for on a bulk-billing basis, the No. 2 contacts of relay T4A2 (not shown) would be connected to terminal R0; the No. 2 contacts of relay T4A5 (not shown) would be connected to terminal R1, and the No. 2 contacts of relay T4A9 would be connected to terminal R2.

As previously stated, the operation of a relay NAA2–NAA9 in response to the A digit of a foreign area code will cause ground from the two operated relays of the foreign area C digit register to be extended to a pair of contacts on the operated NAA relay. If the dialed national area code requires no compression, as, for example, code 312, said ground is applied over a jumper, as said before, to terminal T5AT to cause the operation of relay T5AT and the grounding by the latter relay of conductor TS. On the other hand, if the dialed code is compressed into a single digit, as, for example, code 210 which is compressed to the digit 0, relay NAB1 is operated in response to the operation of relays NB00 and NB1 for the B digit 1, the circuit path of said relay NAB1 extending from ground on the No. 5 contacts of relay NB00, No. 5 contacts of relay NB1, lead 415, winding of relay NAB1, to battery. Since the No. 1 contacts of the latter relay are connected to terminal T4A0, the ground on the No. 0 contacts of relay NAA2 will complete the circuit of relay T4A0 over the No. 1 contacts of relay NAB1. Relay T4A0, upon operating, grounds conductor TS over its No. 2 contacts, and, over its Nos. 3 and 4 contacts, applies ground to terminals P4 and P7, respectively, to express the code of the compressed digit 0; ground on said terminal P4 tracing over the No. 3 contacts of relay T4A0, lead 417, to ground on the No. 3 front contacts of relay NB00; ground on said terminal P7 tracing over the No. 4 contacts of relay T4A0, lead 416, to ground on the No. 3 front contacts of relay NB1.

If the national area represented by a compressed digit is one for which calls completed to the area are to be charged for on a bulk-billing basis, as, for example, code 219 which is compressed to the digit 9, relay T4A9, representing such a code, will have its No. 2 contacts wired to one of the terminals R0, R1 or R2 (specifically terminal R2) instead of terminal TS. On the operation of said relay T4A9, lead R2 will be grounded to indicate the bulk-billing charge for the call, and terminals P7 and P2 will be grounded to express the code indication of the compressed digit 9.

Having described the operation of the foreign area code registers and related equipment for the compression of certain of the foreign area codes into single digits, for

the registration of foreign area codes, and for the appropriate electrical indications to be supplied in each case, we will now continue with the operation of the transverter in respect to the progress of its functions.

The directory number of the calling subscriber is transmitted from the sender to the transverter over leads DA–, DB–, DC–, DTH–, DH–, DT– and DU–, which leads are grounded in the sender according to the 2-out-of-5 code to express each of the seven digits that constitute the number. Leads DA–, DB–, and DC– terminate on windings of appropriate register relays in the transverter, and cause the operation of said relays to register the code of the calling office. Taking leads DA– (calling office A digit) and relays DAQ0–DAQ7 operated thereover in the 2-out-of-5 code as an example that is representative of all other of the above-mentioned leads, said relays DAQ0–DAQ7 are operated as follows for each of the ten digits:

Digit	Leads Grounded	Relays Operated
0	DA4, DA7	DAQ4, DAQ7
1	DA0, DA1	DAQ0, DAQ1
2	DA0, DA2	DAQ0, DAQ2
3	DA1, DA2	DAQ1, DAQ2
4	DA0, DA4	DAQ0, DAQ4
5	DA1, DA4	DAQ1, DAQ4
6	DA2, DA4	DAQ2, DAQ4
7	DA0, DA7	DAQ0, DAQ7
8	DA1, DA7	DAQ1, DAQ7
9	DA2, DA7	DAQ2, DAQ7

The above relays as well as relays DBQ0–DBQ7, when operated, lock over their respective locking contacts, lead TONG9, No. 4 contacts of relay CK7, to ground. Relays DCQ0–DCQ7, when operated, lock over their respective locking contacts, lead TONG10, No. 3 contacts of relay CK7, to ground.

It should be noted at this time that each of the three calling number A, B and C digit registers of the transverter is provided with an associated conversion register by which the digit registered in the first-mentioned register in the 2-out-of-5 code is changed by the associated conversion register into a biquinary expression thereof for use by the billing indexer circuit; the latter circuit coming into use, as will be shown, when the transverter has received all the information necessary to its functions. The operation in the A digit conversion register of the relays therein corresponding to the operation of the relays in the A digit register for each of the ten digits is as follows, it being understood that operations are similar for the relays in the B and C digit conversion registers:

Digit	Relays Operated in the A Digit Register	Relays Operated in A Digit Conversion Register
0	DAQ4, DAQ7	DA00, DA0.
1	DAQ0, DAQ1	DA00, DA1.
2	DAQ0, DAQ2	DA00, DA2.
3	DAQ1, DAQ2	DA00, DA3.
4	DAQ0, DAQ4	DA00, DA4.
5	DAQ1, DAQ4	DA5, DA0.
6	DAQ2, DAQ4	DA5, DA1.
7	DAQ0, DAQ7	DA5, DA2.
8	DAQ1, DAQ7	DA5, DA3.
9	DAQ2, DAQ7	DA5, DA4.

The above relays DA00–DA0, when operated, lock over their respective locking contacts, lead TONG11, No. 1 contacts of relay CK7, to ground; relays DB00–DB5, when operated, lock over their respective locking contacts, lead TONG7, No. 12 contacts of relay CK7, to ground; while relays DC00–DC5, when operated, lock over their respective locking contacts, lead TONG8, No. 2 contacts of relay CK7, to ground.

Although no storage registers are provided in the transverter for the numerical digits of the calling subscriber's number, the same pattern of grounded leads DTH–, DA–, DT– and DU– is used therefor, which leads are extended directly to the recorder (over the recorder-connector) for its use in punching the numericals of the number on the tape, and to a line observing number matching circuit for reason that will later appear. The above groups of leads, when selectively grounded in the sender according to the 2-out-of-5 code to express the involved numericals of the calling subscriber's number, will cause the recorder to punch said number on the tape.

Besides the called and calling number registers (including the conversion registers for the latter) which are operated as above described, the sender will cause the operation of certain other registers in the transverter, which will determine other actions of the transverter. Typical of these registers is the class-of-service register (Fig. 74), the relays CS00–CS5 which are selectively operated on a biquinary basis from the sender to register the class of service. When so operated, these relays translate the class-of-service indication from the biquinary pattern to a ground on one of ten leads connected from their upper contacts to the ten terminals CSA. These terminals are then selectively cross-connected to terminals TAR0, TAR1, TAR2 and TATS for terminating areas 0, 1 and 2 respectively, to indicate to the billing indexer that calls completed to such areas are to be either bulk-billed or toll-billed, and to terminal TATS if the area for which calls completed thereto are to be toll-billed only; that is, calls which are to be billed in detail on the toll statements.

Contacts of the class-of-service relays CS00–CS5 are extended to terminal CSP and thence cross-connected to the five recorder leads P0–P7 in the 2-out-of-5 code, to cause the recorder to record in the B digit of the second line of the initial entry, the area digit assigned to the terminating area. This digit will be used by the accounting center to determine the rate which applies for the call.

Another register is the recorder identification register (Fig. 109), in which is registered the number of the recorder being used for this call. A maximum of twenty (20) recorders is provided in the tandem office, each identified by one of the numbers 00–19. The number of the recorder is transmitted from the sender to the transverter over the leads R0, R1, R2, R4, R7 and R13, which are grounded according to a 3-out-of-6 pattern to result in the operation of three of the six relays RN0–RN13. These relays, when selectively operated as indicated, lock over their respective locking contacts and lead TONG6 to ground on the No. 19 contacts of relay CK7. When so operated, these relays complete the circuit of one relay in the group of twenty relays RST00–RST19 (shown in the table below):

Recorder Number	R– Leads Grounded	Relays RN0–RN13 Operated	Relays RST00–RST19 Operated
00	R0, R7, R13	RN0, RN7, RN13	RST00.
01	R1, R7, R13	RN1, RN7, RN13	RST01.
02	R2, R7, R13	RN2, RN7, RN13	RST02.
03	R0, R1, R2	RN0, RN1, RN2	RST03.
04	R4, R7, R13	RN4, RN7, RN13	RST04.
05	R0, R1, R4	RN0, RN1, RN4	RST05.
06	R0, R2, R4	RN0, RN2, RN4	RST06.
07	R1, R2, R4	RN1, RN2, RN4	RST07.
08	R0, R1, R7	RN0, RN1, RN7	RST08.
09	R0, R2, R7	RN0, RN2, RN7	RST09.
10	R1, R2, R7	RN1, RN2, RN7	RST10.
11	R0, R4, R7	RN0, RN4, RN7	RST11.
12	R1, R4, R7	RN1, RN4, RN7	RST12.
13	R2, R4, R7	RN2, RN4, RN7	RST13.
14	R0, R1, R13	RN0, RN1, RN13	RST14.
15	R0, R2, R13	RN0, RN2, RN13	RST15.
16	R1, R2, R13	RN1, RN2, RN13	RST16.
17	R0, R4, R13	RN0, RN4, RN13	RST17.
18	R1, R4, R13	RN1, RN4, RN13	RST18.
19	R2, R4, R13	RN2, RN4, RN13	RST19.

It has been assumed that recorder 00 has been taken into use for the call being described to illustrate the operation of the invention. Relays RN0, RN7 and RN13

are therefore operated and locked. Consequently a circuit is then completed for relay RST00, which extends from ground on the No. 11 contacts of relay CK8, lead 24, No. 8 contacts of relay INS, lead 23, No. 2 contacts of relays RN13 and RN7, No. 5 contacts of relay RN0 lead 22, lower winding of relay RST00, lead 21, winding of marginal relay XRN, to battery. In this circuit, relay RST00 operates but relay XRN does not. However, if two or more relays RST00–RST19 operate for any cause, then the current flowing through relay XRN is increased and said relay will operate, thereby to stop further progress of the transverter and operate an alarm. Relay RST00 locks over battery through its upper winding and No. 7 contacts, lead 31, winding of relay STK, to ground on the No. 8 front contacts of relay CK1, operating said relay STK, which checks that the locking contacts of the operated relay RST– (in this case relay RST0) are closed. Relay STK completes the circuit of relay CK3 from ground on the locking contacts of said relay STK, winding of relay CK3, to battery. Said relay CK3 operates, locks over its No. 5 contacts to ground on the No. 8 contacts of relay CK1. Any other functions, completes the circuit of relay TBC1 from ground on No. 5 contacts of relay CK7, lead 622, No. 3 contacts of relay CK3, winding of relay TBC1, to battery. Relay TBC1 operates and operates relay TBC2 over an obvious circuit, and relay TBC3 over its No. 1 contacts and lead 623. The operation of relays TBC1, TBC2 and TBC3 cancels certain standing tests which are removed after the recorder is seized, as will be explained. It is to be noted that relay CK3 locks independently of the No. 2 contacts of relay STK, and releases relay NOK which was being held locked over the No. 1 contacts of relay CK3. Relay NOK, on releasing, short-circuits relay STK which then releases. In this connection it should be noted that the trouble indicator tap I on the locking winding on each of the relays RST00–RST19 is connected to the ground side of the winding of said relays. Therefore when relay NOK is released, direct ground is applied from the No. 8 front contacts of relay CK1, No. 3 contacts of relay NOK, lead 31, No. 7 contacts of relay RST00, to tap I, which is connected to the trouble indicator circuit to identify the recorder when trouble is encountered. This locking circuit arrangement also prevents the premature release of the recorder in the event that the operating path of relay RST– through its primary winding is opened as a result of any transient trouble condition.

Most of the other registers involve one or two relays, the latter being operated on a 1-out-of-2 basis, as will appear, and include by way of example, the service observing relay S0 and the no service observing relay NS0; the first trial relay TR1 and the second trial relay TR2; and the over 10,000 number relay (OT) or under 10,000 number relay (UT). Similarly designated leads from the sender terminate on the indicated relays. All information is transmitted from the sender except that the first and second trial signals which result in the operation of relays TR1 and TR2 originate in the transverter connector. In the case of relays UT and OT, it should be observed that if relay UT operates (indicating that the digits of the called numericals constitute a four digit number) a circuit is completed for relay UTA, the path of which may be traced from battery through the winding of said relay, lead 547, No. 2 back contacts of relay OT, lead 523, to ground on the No. 8 contacts of relay CK3. As will be explained, the UTA relay when operated serves to switch the called number registering leads to the appropriate magnets of the recorder, which magnets will then operate to record the numericals in the correct digital spaces of the AMA tape. On the other hand, if relay OT is operated (indicating that the digits of the called numericals constitute a five digit number, an arrangement prevailing in certain manual offices) then a circuit is completed for relay OTA, the path of which may be traced from battery through the winding of said relay, lead 524, No. 1 front contacts of relay OT, lead 523, and thence as traced to ground on relay CK3. As will be explained, the OTA relay when operated, serves to switch the called number registering leads to the appropriate magnets of the recorder, which magnets will then operate to record the numericals in the correct digital spaces of the AMA tape. It will be assumed that since the call being established involves a four digit called number, relay UTA is operated.

The rate class leads RC0, RC1 and RC2 are grounded on a 1-out-of-3 pattern. Since these leads are not used in the transverter but are extended to the billing indexer at the proper time, no register relays are provided. Taps, however, are made to the leads for the use of the trouble indicator to record the rate class information in the event of trouble.

As will be recalled, the office of origin for the particular call being used to illustrate the operation of the invention is assumed to have the designation Bigelow 9, the dial code of which is 249, and that the numerical portion of the calling subscriber's number is 8276. It was further assumed that the called subscriber's directory number is Republic 7–1359, and that from operations previously detailed in respect to the sender, the call to be established to the station of said latter subscriber involves the use of a trunk from tandem to Republic 9 having the designation 00, the use of a recorder number designated 00, and that the class-of-service indication for the call is 1. Therefore when the sender becomes connected to the transverter, the ABC digits 249 of the calling office code are registered in the calling number A, B and C digit registers. The first, or A, digit 2 is registered in the A digit register by the operation and locking therein in the 2-out-of-5 code of relays DAQ0 and DAQ2 over leads DA0 and DA2, respectively; the second, or B, digit 4 is registered in the B digit register by the operation and locking therein in the 2-out-of-5 code of relays DBQ0 and DBQ4 over leads DB0 and DB4, respectively; and the third, or C, digit 9 is registered in the C digit register by the operation and locking therein in the 2-out-of-5 code of relays DCQ2 and DCQ7 over conductors DC2 and DC7 from the sender. As will also be recalled, the four numerical digits of the calling number are not stored in the transverter but transmitted directly to the recorder, as will be shown. Remembering that the calling office code digits are to be changed into respective biquinary representations thereof by the corresponding conversion registers for the use of the billing indexer circuit, then upon the operation of relay DAQ0 a circuit is completed for relay DA00 of the A digit conversion register, said circuit tracing from battery through the winding of said DA00 relay, No. 2 contacts of relay DAQ2 to ground on the No. 2 contacts of relay DAQ0. Another circuit is also closed for relay DA2 in said latter register, said circuit tracing from battery through the winding of said relay, No. 6 contacts of relay DAQ0, to ground on the No. 7 contacts of relay DAQ7. In the same manner and over easily traceable circuits, relays DBQ0 and DBQ4 in the calling number B digit register pull-up relays DB00 and DB4 in the B digit conversion register, while relays DCQ2 and DCQ7 in the calling number C digit register pull-up relays DC4 and DC5 in the C digit conversion register. As previously indicated, all of the above relays in the conversion registers lock to off-normal grounds on the contacts of relay CK7.

The three A, B and C digits 737 of the called office code are similarly registered in the called number A, B and C registers. The first, or A, digit 7 is registered in the A digit register by the operation and locking therein in the biquinary code of relays A2 and A5 over leads A2 and A5, respectively; the second, or B, digit 3 is registered in the B digit register by the operation and locking therein in the biquinary code of relays B00 and B3 over leads B00 and B3, respectively; while the third, or C, digit 7

is registered in the C digit register by the operation and locking therein in biquinary code of relays C2 and C5 over leads C2 and C5, respectively. As previously indicated all of the above relays lock to off-normal grounds on the contacts of relay CK7.

In contrast with the numerical digits of the calling subscriber's number, those of the called subscriber's number are stored in the transverter in appropriate digital registers therefor; the thousands digit 1 in the thousands, or D, digit register by the operation of relays TH00 and TH1; the hundreds digit 3 in the hundreds, or E, digit register by the operation of relays H00 and H3 therein; the tens digit 5 in the tens, or F, digit register by the operation of relays T0 and T5 therein; the units digit 9 in the units, or G, digit register by the operation of relays U4 and U5 therein; and the stations digit 0 in the stations, or H, digit register by the operation of relays ST00 and ST0 therein. All of these relays, on operating, lock over their respective locking contacts, leads TONG1, TONG2, TONG3 and TONG4 to ground on the contacts of relay CK7 as previously described. These relays, over their lower contacts and by appropriate wiring connections to leads extending to the perforator, convert the biquinary code of the registered digit into its equivalent 2-out-of-5 code expression for the use of the recorder, as will be explained.

The class-of-service register is also operated from the sender in the biquinary code to register the class-of-service digit. Since this digit is assumed to have the value 1 (terminating area 1), relays CS00 and CS1 are operated by ground on leads CS00 and CS1, respectively. These relays lock over their respective No. 2 and No. 3 contacts and over lead TONG3 to ground on the No. 14 contacts of relay CK7.

When all of the above relays have been selectively operated as indicated to register and convert the calling office code, to register and convert the called office code and numericals, and to register the class of service, a check is made for the operation of said relays as well as for the non-operation of certain other relays which must be normal if the functioning of the transverter is to proceed. This check is in the form of a circuit path completed for the operation of relay OCK, Fig. 92. This path extends from battery through the winding of said relay OCK, lead 12, No. 1 front contacts of relay LAC, lead TDC13, then as previously traced through contacts on the normal relays NC00–NC5, NB00, NB5, NB1, NB0, lead TDC14, through previously traced contacts on the normal relays NA00–NA5, lead TDC15, No. 2 contacts of relay LAC, lead TDC24, lead TDC4, No. 9 back contacts of relays CS4, CS3, and CS2, No. 8 front contacts of relay CS1, No. 8 back contacts of relay CS0, No. 6 back contacts of relay CS5, No. 5 front contacts of relay CS00, lead 13, No. 2 front contacts of relay DC4, No. 2 back contacts of relays DC3, DC2, and DC1, No. 1 back contacts of relay DC0, No. 1 front contacts of relay DC5, No. 1 back contacts of relay DC00, lead 14, No. 2 front contacts of relay DB4, No. 2 contacts of relays DB3, DB2 and DB1, No. 1 back contacts of relay DB0, No. 2 back contacts of relay DB5, No. 1 front contacts of relay DB00, lead 15, No. 1 back contacts of relays DA4 and DA3, No. 2 front contacts of relay DA2, No. 2 back contacts of relay DA1, No. 1 back contacts of relay DA0, No. 2 back contacts of relay DA5, No. 1 front contacts of relay DA00, lead 16, No. 5 back contacts of relay TTF, lead 17, No. 2 back contacts of relays C4 and C3, No. 3 front contacts of relay C2, No. 3 back contacts of relay C1, No. 2 back contacts of relay C0, No. 3 front contacts of relay C5, No. 3 back contacts of relay C00, lead 18, No. 2 back contacts of relay B4, No. 3 front contacts of relay B3, No. 3 back contacts of relays B2 and B1, No. 2 back contacts of relays B0 and B5, No. 3 front contacts of relay B00, lead 19, No. 2 back contacts of relays A4 and A3, No. 3 front contacts of relay A2, No. 3 back contacts of relay A1, No. 2 back contacts of relay A0, No. 3 front contacts of relay A5, No. 3 back contacts of relay A00, lead 20, No. 2 contacts of relay CK6 to ground. Relay OCK operates and locks over its No. 3 contacts, lead 20', to ground on the No. 2 contacts of relay CK6.

If the call is a national area call, then the check is made with relay ONCK (Fig. 93) instead of relay OCK. For such a call relay NAC will be operated, and the national area code A, B and C digit registers will be set for the three digits of the area code. For example, if the national area code is 219, and the calling and called office codes remain the same as above, then a circuit will be completed for relay ONCK from battery through its winding, lead 420, No. 2 contacts of relay NAC, lead 421, No. 1 front contacts of relay NC4, No. 1 back contacts of relays NC3, NC2, NC1, NC0, No. 1 front contacts of relay NC5, No. 1 back contacts of relay NC00, No. 1 front contacts of relay NB1, No. 1 back contacts of relay NB0, No. 2 back contacts of relay NB5, No. 1 front contacts of relay NB00, lead 423, No. 2 back contacts of relays NA4, NA3, No. 1 front contacts of relay NA2, No. 1 back contacts of relays NA1, NA0, No. 2 back contacts of relay NA5, No. 1 front contacts of relay NA00, lead 424, No. 3 contacts of relay NAC, lead TDC24, and thence as previously traced to ground on the No. 2 front contacts of relay CK6. Relay ONCK, on operating, locks over its No. 2 contacts, lead 20', to ground on the No. 2 contacts of relay CK6.

With relay OCK or ONCK operated, a circuit is completed for the indexer start relay INS (Fig. 103). The path of this relay extends from battery through its winding, conductor 34, No. 10 contacts of relay CK3, No. 1 contacts of relay CK2, No. 9 contacts of relay CK8, lead 36, No. 8 contacts of relay NSK, No. 5 contacts of relay SK, lead 37, No. 2 contacts of relay XRE, No. 1 contacts of relay IOK, lead 38, No. 3 back contacts of relay ONCK, lead 38', (if the call is local, this relay will be normal) No. 5 contacts of relay OCK to ground. Relay INS operates and locks over its No. 4 contacts, lead 38', to ground on either the No. 5 front contacts of relay OCK or the No. 3 front contacts of relay ONCK. If the call is a national area call, then relay ONCK will be operated and relay OCK will be normal, in which event the circuit of relay INS will be completed as traced to the No. 2 contacts of relay IOK, No. 5 back contacts of relay OCK, lead 38', No. 3 front contacts of relay ONCK, to ground.

The operation of relay INS, among other functions to be described later, initiates operations by which a billing indexer circuit is connected to the transverter. Before describing the operations by which this connection is effected, it should be stated that the billing indexer, the fundamentals of which are schematically indicated in Fig. 136 and the details of which are shown in Figs. 110–119, is a fast-acting common control type of circuit having for its primary function the determination for the use of the transverter of (1) the office index, or digit assigned to the calling office and used on the initial entry as an identification thereof, (2) the message billing index, or digit identifying the rate to be applied for the call; and (3) the character of the initial entry for the call; that is, whether the initial entry is a two-line entry (MU) thus indicating that the call is to be bulk billed in terms of message units, or a four-line entry (MUD—message unit detail) indicating a bulk-billed call, for furnishing complete details thereof for the use of the operating company, or a toll entry (TL) indicating either a four-line or five-line entry for a call for which a toll statement is to be furnished. These three items of data are derived by the billing indexer from information supplied by the transverter and, in part, also by the sender; and when determined, are passed to the transverter, which subsequently transmits them to the recorder for its use in producing the initial entry for the call on the AMA tape.

The secondary function of the billing indexer is to resolve certain conflicts in calling office codes which may occur if the calling subscriber, in passing the calling num-

ber to the operator, should give a vacant code or, in some cases, a wrong office code.

Three billing indexers may be provided by way of example to handle all the automatic accounting calls which are routed through the tandem office but, of course, more or less may be provided as the volume of traffic requires. Each transverter has access to all three billing indexers and, although arranged to prefer a particular one in the manner conventionally employed with common control units utilized in crossbar telephone systems, it may of course be served by each of the other two, if idle, in the determined order of preference.

Fig. 105 indicates the general circuit arrangement by which the connection between a calling transverter and an idle billing indexer is effected. Essentially it is similar to the sender-transverter connector previously described. The circuit is so arranged that each billing indexer has a preference relay IP– representing it in each transverter. These relays are arranged in a chain which enables a transverter to prefer a particular billing indexer as a first choice. If the preferred indexer is busy, its associated indexer busy IB relay is operated, which advances the preference lead to relay IP– of the billing indexer second in preference, and so on for all three indexers.

It will be assumed, however, that the billing indexer shown in Figs. 110–119 is the first one preferred by the transverter whose operation is here being described, and that upon the operation of relay INS (assuming that all other billing indexers are normal) a circuit is completed for relay IP0 of the preferred billing indexer. The path of this relay extends from battery through an undesignated resistance at the No. 5 contacts of relay INS, lead 44, No. 2 contacts of relay IOK1, lead 0045, No. 1 back contacts of relay IB0 (which is normal since the indexer is assumed to be idle), winding of relay IP0, to ground. This relay operates, and (1) locks to ground over its No. 1 front contacts; (2) opens at its No. 1 back contacts operating ground for relays IP0 of the same indexer in other transverter channels; (3) completes over its No. 2 front contacts the circuit of the billing indexer connector relays ICOA and ICOA1, the path of which extends from battery through the windings of said relays, lead 46, No. 2 front contacts of relay IP0, serially through the No. 2 back contacts of all relays IP0 for the same billing indexer in the other transverter channels, No. 2 back contacts of relay IP0 in the last transverter channel, to ground; and (4) release the billing indexer relays IA1 and IA2, which are normally operated, lead IA1 being opened at the No. 1 contacts and lead IA2 being opened at the No. 2 back contacts of operated relay IP0. Relays IA1 and IA2 release to supply ground and battery, respectively, to the lower windings of relays XO1–XRG to condition them for operation in the event that crosses appear on certain leads of the indexer, as will be later described. Relay IA1, on releasing, also completes the circuit of relay ON from battery through the winding of said relay ON, lead 79, No. 8 contacts of relay IA1, to ground. Relay ON operates to perform certain functions to be discussed later in regard to timing of the indexer, and in regard to information to be transmitted to the transverter. At this point, however, it will be noted that with relay ON operated, ground on the No. 6 back contacts of relay IOK in the transverter, applied over lead 88, No. 21 contacts of relay ICOA1, lead IOK, and the No. 2 contacts of relay ON, completes the circuit through the lower winding of the polar timing relay TR to battery on the No. 3 contacts of relay ON; and short-circuits the condenser-resistance network C connected to the No. 2 contacts of relay ON. The current through the lower winding of relay TR is in the opposite direction to operation, causing its armature to make with the stationary contact. Hence the ground on the contacts of said relay TR is applied over the No. 1 contacts of relay ON, lead IOK1, No. 20 contacts of relay ICOA1, lead 89, No. 7 back contacts of relay IOK, to hold relay IOK1 for an interval after relay IOK releases, and for a purpose to be noted hereinafter.

Relay ICOA, on operating, grounds lead 47 over its No. 2 contacts, thus to apply a shunt to the upper winding of relay IB0 and prevent its operation when after the indexer becomes connected to the transverter, ground is applied by said indexer to conductors IB0–IB2 to cause the operation of relays IB0–IB2 in the several transverter channels except the channel for the indexer 0 for which relay IB0 must remain normal to maintain relay IP0 operated. Ground is applied to contacts No. 57 of, relay IOCA1 which will short-circuit condenser C1 by way of lead 48, No. 2 contacts of relay CK2 and lead 49, to prevent the operation of relay CTM, thereby to cancel alarm timing, while over its No. 1 contacts, relay ICOA grounds conductor BIB in cable C4 extending to the winding of relay BIB of the billing indexer. The latter relay then operates to apply ground to conductors IB0–IB2, severally completing circuits through the upper windings of relays IB0–IB2, operating relays IB1 and IB2 to make the seized indexer busy in two of the channels, but failing to operate relay IB0 in the first channel, the upper winding of the latter relay being shunted by ground on lead 47 as before described. Over its No. 58 contacts, relay ICOA1 applies ground to lead 52, which completes the circuit of the indexer connected check relay INK, said circuit extending from ground on lead 52, No. 4 locking contacts of relay IOK2, lead 53, No. 2 contacts of relay RK, right winding of relay INK, to battery. Relay INK operates over its right winding and then locks over its left winding and No. 3 contacts to ground on conductor TONG12 from the No. 2 contacts of relay CK8. The operation of relay INK indicates that the billing indexer is connected, checks that the locking contacts of relay IOK2 are closed, and opens the circuit of relay CK2 which releases. At this point it should be stated that all information which the recorder is to punch on the AMA tape is transmitted to it by the transverter in the 2-out-of-5 code. To this end, the numerical digits of the called number, which are received and registered in the transverter in the biquinary code are converted through contacts of the involved register relays in the 2-out-of-5 code, provided, of course, that said relays are operated in the appropriate biquinary combinations. It is therefore necessary that the registers be checked to insure that their respective relays are so operated. Accordingly, when relay INK operates, and remembering that the called numericals are 1359 (no stations), a path is completed for relay NSK from battery through its winding, lead 453, No. 7 front contacts of relay INS, lead TDC3, No. 1 back contacts of relays ST00, ST5, ST0, No. 2 back contacts of relays ST1, ST2, ST3 and ST4, lead TDC4, No. 2 front contacts of relay INS, lead 454, lead 454' (Fig. 92), No. 4 contacts of relay INK, lead 455, No. 2 front contacts of relay U4, No. 2 back contacts of relays U3, U2, U1, No. 1 back contacts of relay U0, No. 2 front contacts of relay U5, No. 2 back contacts of relay U00, lead 456, No. 1 back contacts of relays T4, T3, T2, T1, No. 1 front contacts of relay T0, No. 3 contacts of relay T5, No. 2 back contacts of relay T00, lead 457, No. 1 contacts of relay H4, No. 2 front contacts of relay H3, No. 2 back contacts of relays H2, H1, H0, No. 1 back contacts of relay H5, No. 2 front contacts of relay H00, lead 458, No. 1 back contacts of relays TH4, TH3, TH2, No. 2 front contacts of relay TH1, No. 1 back contacts of relays TH0, TH5, No. 2 front contacts of relay TH00, lead 459, No. 4 back contacts of relay SU, No. 3 front contacts of relay UT, No. 4 back contacts of relay OT, lead 460, No. 1 contacts of relay STK, No. 7 contacts of relay CK1, to ground. Relay NSK operates and registers the fact that the four numericals of the called number are properly registered in the biquinary code.

Had the called number contained a stations digit, then the sender would have transmitted therefor either the digit 0, 1, 5, 6, 7 or 9, in which event the check will be made by relay SK. Assuming for example that the digit

0 had been transmitted as the stations digit, relay ST00 and ST0 would have operated. Accordingly a circuit would then have been completed for relay SK from battery through the winding of said relay, lead 461, No. 1 back contacts of relays ST4, ST3, ST2 and ST1, No. 1 front contacts of relay ST0, No. 2 back contacts of relay ST5, No. 2 front contacts of relay ST00, lead 454, lead 454', and thence as traced to ground for relay SK. The operation of relay NSK or SK checks that the involved called numericals are registered in the biquinary code.

Relays ICOA and ICOA1, by the closure of their other contacts, close the registering leads between the transverter and the indexer for all input and output information transmitted to and from the latter circuit.

The data used by the billing indexer to determine the office index, the message billing index, and the character of the initial entry, are (1) the originating office code, (2) the terminating office code, (3) the recorder group number (4) the terminating office numbering area, and (5) the originating office rate class. Therefore with the operation of relays ICOA and ICOA1, the registrations in the transverter containing the data to be used by the billing indexer to derive the office index, the billing index, and the character of the initial entry, are passed from the transverter to corresponding registers in the billing indexer.

Before describing the structure of the indexer and its mode of operation, it is desirable to recall the following previously made assumptions:

(*a*) The tandem office is provided with 20 recorder groups, each serving trunks from a maximum of ten originating offices;

(*b*) The invention is designed to operate, by way of example, with a maximum of 200 originating offices, 10 offices to a recorder group, the ABC codes of such offices being selected from a maximum of 800 available codes, omitting those with the digit 0 or 1 as a first digit;

(*c*) All offices to or from which connections are completed through the tandem exchange are located in four areas, with no area containing offices having identical codes. As shown in Fig. 139, three of these areas, designated as area 0, area 1, area 2, are conventionally indicated as concentrically surrounding the tandem exchange T. The fourth area is here defined as the "toll zone," and is divided into a plurality of "foreign exchange" areas, one or more of which are contiguous to the outer boundary of area 2;

(*d*) Connections between offices in areas 0 and 1 may be established by dialing the code of the wanted office and the numericals of the wanted number. Such connections are charged for on a bulk-billing basis;

(*e*) Connections to offices in area 3 from offices outside of said area may be established by dialing a prefixed national area code ABX, in which the A digit has any value from 2 to 9, the B digit the value of 0 or 1, and the X digit any value from 0 to 9, in addition to the code of the wanted office in such areas and the numericals of the wanted number in such office. Such connections are also charged for on a bulk-billing basis;

(*f*) Connections to offices in any area in the toll zone from offices in any of the three above-mentioned areas may be established by dialing the prefixed national code ABX individual to the area, the code of the wanted office and the numericals of the wanted number in said toll area. Such connections are charged for in monetary units and detailed on the toll statement;

(*g*) The initial entries for bulk-billed calls completed to and between offices in areas 0 and 1 are either two-line message unit (MU) entries, or four-line message unit detail (MUD) entries, the latter being produced if the operating company desires details of local calls for traffic studies, subscriber complaints, or any other reason;

(*h*) The initial entries for calls completed to offices in area 2 from offices in all other areas will be four-line (TL) entries, with the national area code compressed into a single digit. The same may be true for not more than nine additional areas, since code compression is limited to ten areas as previously described;

(*i*) The initial entries for calls completed to offices in the areas comprising the toll zone from offices in the above-mentioned areas will be five-line toll (TL) entries.

For the determination of the office index, the message billing index, and the initial entry for a call under the above-enumerated conditions, and referring to Figs. 136 and 110–119, the billing indexer is provided with an originating office code translator for 800 codes (200–999), said translator having two terminals for each code; the group of terminals shown in Fig. 110 and identified as the first originating code field FOC containing the first corresponding terminals of each code, the second group of terminals shown in Fig. 113 and identified as the second originating code field SOC, containing the second corresponding terminals of each code.

The indexer is further provided with two groups of three "area" relays each, namely relays AR0A–AR2A and AR0B–AR2B. Corresponding relays AR0A, AR0B, AR1A, AR1B, and AR2A, AR2B are wired in multiple and extended for cross-connection to terminals 0, 1 and 2, respectively, constituting the terminal field OA. The stationary contacts of the contact pairs 0–9 provided on each of the relays AR0A–AR2A are correspondingly connected together and brought out to the terminals 0–9 making up the terminal field FOCC, while the armatures severally making with said contacts are individually brought out to terminal groups 0–9 constituting the terminal field FOCA. In the same manner, the stationary contacts of the contact pairs 0–9 provided on each of the relays AR0B–AR2B are correspondingly connected together and brought out to the terminals 0–9 making up the terminal field SOCC, while the armatures severally making with said contacts are individually brought out to terminal groups 0–9 constituting the terminal field SOCA. To the first group of relays AR0A–AR2A at terminals FOCC is connected from the terminal field FOC those terminals which represent "conflicting" codes, that is, identical codes representing different offices in the three different bulk-billing areas 0, 1 and 2. To the second group of relays AR0B–AR2B at terminals SOCC is correspondingly connected from the terminal field SOC those terminals that represent the same codes.

The billing indexer is further provided with a group of twenty recorder-group relays RG00–RG19. Each of these relays has ten lower contact pairs 0–9, the armatures of which are individually extended to terminal groups 0–9 in the field SOCA, and two upper contact pairs 10 and 11, the armature of contact set 11 on each relay being extended to the one terminal 00–19 in the terminal field RGA for selective cross-connections to the three terminals 0, 1 and 2 in the field OA according to the three areas in which are located the offices served by each of the twenty recorder groups represented by each of the relays. Upon the operation of a relay RG00–RG19 as will be described later, the involved pair of area relays AR0A–AR0B, AR1A–AR1B, and AR2A–AR2B will be operated from ground on the No. 11 contacts of said operated relay RG–. The front contacts of the lower contact sets 0–9 on each of said relays RG00–RG19 are cross-connected either directly to terminals 0–9 in the ten terminal fields CO1EA–CO1EJ, or to the armatures of relays CA2 or AS2 according to a determination that will be later described.

To the terminals 0–9 of relays RG00–RG19 in the terminal field SOCA are directly connected from the terminal field SOC the terminals that represent "non-conflicting" codes representing offices which are served by the recorder group indicated by the relay RG– to an armature, or armatures, of which said connections are effected. To the terminals of the recorder group relays RG00–RG19 in said field SOCA are also cross-connected armatures of the area relays AR0B–AR2B, to which are extended over

terminals SOCC those terminals in field SOC that represent conflicting codes of offices served by the recorder groups with which said connections are effected.

The indexer is further provided by way of example with three "rate class" relays RC0–RC2. As previously indicated, the expression "rate class" indicates different charges for calls to identical destinations from an originating office that provides for such different rate service. Connections to the tandem exchange from an originating office that provides the different rate class service are effected over separate trunk groups, each individual to one of the rate classes; the sender at tandem being signaled by the trunk taken into use as to the class of service for the trunk group of which the trunk is a part, as already described. Each of the relays RC0, RC1 and RC2 is provided with contact pairs 0–59 by way of example, the corresponding stationary contacts of which are connected together and brought out to terminals 0–59 constituting the terminal field RCC, while the armatures of said contact sets are extended to the individual terminals 0–59 in each of the three terminal fields RC0, RC1 and RC2. To the terminals 00–59 in the terminal field RCC are extended from the fields FOC and FOCA the terminals which designate the codes of offices providing the rate class service indicated by each of said relays RC0–RC2.

The indexer is further provided with a group of thirty-three "originating rate treatment" relays ORT00–ORT32. The expression "originating rate treatment" is here understood to mean a grouping (usually on a geographical basis) of subscribers who are charged alike on identical calls to the same office or group of offices. The grouping of subscribers may include all or subdivisions of the subscribers in one or more offices in which the calls originate. The windings of said relays ORT00–ORT32 are severally extended to terminals 00–32 constituting the terminal field ORT. Each relay is further provided, on its upper side, with contact pairs 00–57, the corresponding stationary contacts of which are multipled and extended to the terminals 00–57 constituting the terminal field TRT (Fig. 117), while the armatures of said contacts are individually extended to the three groups of terminals 00–57 constituting the terminal field CRT. To the terminals ORT are connected from the field FOC those code terminals which represent offices the rate consideration of calls from which is not affected by either area or the rate class; from the terminal field FOCA terminals of codes representing offices the calls from which are so affected by the area, and from the field RC– the terminals of codes representing offices whose rate treatment is affected by the rate class.

The indexer is further provided with a group of ten billing index relays BI0–BI9, the windings of nine of which, namely relays BI1–BI9, are extended to terminals 0–9 constituting the terminal field MBI. To these terminals are connected the armatures of the relays ORT– in accordance with the billing index 1–9 for a call, as said index would be determined by the operation of an involved originating rate treatment relay ORT– only.

The indexer is further provided with a called office code translator (shown in Fig. 116), which is essentially the same as the originating office code translator, except that it is selectively associable with each one of three registers severally provided for the three bulk-billing areas 0, 1 and 2 with respect to calls completed in offices located in such areas. Although each area is used for both originating and terminating calls, we will refer to one area as an "originating" area and one as a "terminating" area for the purpose of this description. The register shown in Fig. 116, then, is for the terminating area 0, and is operatively associable with the translator by means of relay TA0 when operated; the register shown in Fig. 117 is for the terminating area 1, and is operatively associable with the translator by means of relay TA1 when operated, while the register shown in Fig. 118 is for terminating area 2, and is operably associable with the translator by means of relay TA2 when operated.

Each of the above terminating area registers comprises a group of relays, 2LT–, 2HT–9LT–, 9HT–, with each relay provided with fifty contacts, one for each of the codes 200–999. The stationary springs of these contacts are then severally cross-connected to terminals 00–57 in the terminating field TRT, which terminals, as previously explained, are connected to the stationary contacts of the originating rate treatment relays ORT00–ORT32.

To provide for the satisfactory distinction between "vacant codes" and "wrong offices"; that is, between such codes as are not used and those which may be given by calling subscribers in passing their numbers to the operator, but which are not respectively associated with recorder groups serving the offices from which the calls are actually placed, or which do not provide one or more of the rate classes indicated by relays RC0–RC2, relays VC, WOA and WOB are provided. The winding of relay VC is extended to the terminal VOC, and to said terminal are cross-connected from the first originating code field FOC the terminals that represent all vacant codes. The winding of relay WOB is extended to terminal WOC, and to said terminal is cross-connected from the terminal fields RC– the codes of all offices which do not provide the rate service indicated by the relay RC– from the contact, or contacts, of which the cross-connection is made. The winding of relay WOA is extended over lead 99 to the 0–9 back contacts of all the recorder group relays RG00–RG19, thereby to detect codes not served by the recorder group indicated by a non-operated recorder group relay RG–.

As already noted, the indexer is provided with twenty recorder group relays RG00–RG19, the operation of the appropriate one of which supplies the indexer with the information as to the group of ten offices that includes the calling office. In this sense, the operation of the involved group relay RG– in the manner to be described supplies the indexer with the area in which the calling office is located. It would be desirable, of course, to have all ten offices served by one recorder group located in the same area. Occasionally, however, the number of offices in one area served by a recorder group may be less than ten, while there may be offices in the adjacent area which exceed the number that can be served by one recorder group. To provide for this situation, the indexer has been arranged for transferring the area indication of recorder groups on an individual office basis, so that originating offices from more than one area may be assigned to the same recorder group when necessary. The area transfer relays AS1, CA1 provide facilities for transferring recorder group area indications to area 1 for a maximum of twelve originating offices, while relays AS2, CA2 provide facilities for transferring recorder group area indications to area 2 for a maximum of six originating offices. As will be later explained, by suitable cross-connections between terminals in terminals field RG0 and terminal fields TA1 and TA2, the change of area indication may be effected.

The indexer is further provided with a group of ten office index relays OF0–OF9, and ten initial entry combination networks, each of said networks terminating in a group of ten terminals 0–9 in a terminal field designated COIE– followed by the last letter in the designation of the relay in group of ten relays CA–CJ which appertains to the group of terminals. Each terminal RG0 (Fig. 114) being used is cross-connected directly or indirectly with the required COIE– in accordance with the office index code assigned to that office for the initial entry. As will be explained later, the operation of the involved relays CA–CJ, in combination with the message billing index determined by the operation of the appropriate billing index relays BI0–BI9, will determine the character of the initial entry by the grounding of the appropriate one of the three leads MU, MUD and TL

to which the armatures of relays CA–CJ are suitably cross-connected.

The remaining equipment of the indexer not specifically described above will be described during the following description of its operation, in which the determination of the office index is described first, the determination of the message billing index is described next, and the determination of the initial entry is described last. Its operation with reference to wrong office, vacant codes, and other miscellaneous functions, will follow thereafter.

The office index, partially identifying the originating office, is a single digit 0–9 which is to be punched on the AMA tape by the recorder. In combination with the recorder group number **00–19** (which is also punched on the tape) this digit provides the accounting center with the full identity of said office. Each of the offices served by tandem is, of course, designated by a 3-digit ABC code. When a subscriber in such an office calls, it is the function of the indexer to receive the code of the office from the transverter and translate it into the assigned single office index digit 1–9. By a correlation established by the indexer with the recorder group number serving the group of ten offices which includes the calling office, the identity of the office is established. If the correlation exists, the "office index" is forwarded to the transverter. If not, the transverter is so advised, in response to which it transmits a "wrong office" signal to the sender, which, in turn, signals the operator to recheck the code with the subscriber.

Referring, now, to the originating office code translator shown in Figs. 110 and 113, it will be noted that two relays DA**00** and DA**5** are provided for operative response to ground on leads DA**00** and DA**5**, respectively, relay DA**00** operating if the first, or A, digit of the calling office code registered in the transverter is 0–4; relay DA**5** operating if the digit so registered is 5–9. In the same manner, relays DBL and DBH are provided to operate from ground on leads DB**00** and DB**5**, respectively; relay DBL operating if the second, or B, digit of the code is 0–4, relay DB**4** operating if the digit is 5–9. It should also be noted from Fig. 113 that five relays DB**0**–DB**4** (of which only relays DB**0** and DB**4** are shown) are respectively connected to leads DB**0**–DB**4**, so that ground on these leads will cause the operation of the corresponding relays. Two relays DC**00** and DC**5** are provided for response to ground on leads DC**00** and DC**5**, respectively; relay DC**00** operating if the third, or C, digit of the code is 0–4, relay DC**5** operating if the digit is 5–9.

It will further be noted that relay DA**5** is provided with ten pairs of make contacts 1–10, the armatures of which are respectively connected to leads AD**4**—DA**0**, and that the stationary contacts 1–5 are extended in parallel to the armatures of contacts 1–5 on relays DBH and DBL. The armatures of contacts 6, 7 and 8 on both of the latter relays are connected to the stationary contacts of contacts 1, 2 and 3, respectively, on relay DA**00**, the cooperating armatures on said latter relay being connected to corresponding armatures on relay DA**5**, and to leads AD**4**, AD**3**, and AD**2**, respectively. Leads DA**4**, DA**3**, DA**2**, DA**1** and DA**0** are connected, respectively, to the armatures of contacts 6–10 on relay DA**5** and armatures of contacts 4 to 8 on relays DA**00**, the corresponding stationary contacts on relay DA**5** being respectively multipled to the armatures of contacts 10–14 on relays DBH and DBL. The stationary contacts 1, 2 and 3 on relay DA**00** are extended in multiple to armatures **6**, **7** and **8** on relays DBH and DBL and contacts 4, 5 and 6 on relay DA**00** are extended in multiple to armatures **15**, **16** and **17** of relays DBH and DBL. For a purpose to be given hereinafter leads DA**1** and DA**0**, besides going to armatures **9** and **10** on relay DA**5**, are extended through contacts 7 and 8 of relay DA**00** where they unite as lead **77** and extend to contacts 6 on relay BS.

From the above it will be seen that relays DBH and DBL (not counting the No. 9 contacts thereon which are connected to lead 78 and thence to the upper winding of relay ROP to cause its energization on the operation of relay DBH or DBL) are each equipped with sixteen contacts 1–8 and 10–17. The stationary contacts 1–8 severally extend to the windings of sixteen relays, which are alternatively designated **2LO1, 2HO1–9LO1, 9HO1** (only relays 2LO1, 2HO1, 9LO1 and 9HO1 being shown in Fig. 110). Each relay has fifty contacts extending to a terminal in the field FOC, the whole to provide a total of 800 code terminals **200–999**.

The relays 2LO2, 2HO2–9LO2, 9HO2 shown in Fig. 113 are identical with the corresponding relays **2LO1**, 2HO1–9LO1, 9HO1 shown in Fig. 110, their windings being similarly extended to the stationary contacts 10–17 on relays DBH and DBL, and their stationary contacts being identically extended to terminals in the field SOC to provide the 800 terminals **200–999** which make up said latter field.

The above two groups of relays together with relays DA**00**, DA**5**, DBL and DBH, provide for the translation of the A and B digits of the calling code. For the translation of the C digit there is provided relays DC**00** and DC**5**, which are connected, respectively, to leads DC**00** and DC**5**, relay DC**00** operating from ground applied to conductor DC**00** if the C digit registered in the transverter is **0–4**, relay DC**5** operating from ground applied to conductor DC**5** if the digit so registered is 5–9. Each of these relays is equipped with contacts 1–10; leads CD**4**, CD**3**, CD**2**, CD**1** and CD**0** being connected, respectively, to the armatures **1–5** on relays DC**5** and DC**00**. The armatures **6–10** on both relays are multipled and connected to the stationary contacts 1–5 on relay BS, the armatures of the latter relay being, in turn, connected to leads DC**4**–DC**0**. As will be shown, relay BS is interposed to delay calling office translation operations until the recorder group number serving the office has been determined.

The five relays DB**0**–DB**4** (relays DB**0** and DB**4** only being shown in Fig. 113) are respectively connected to leads DB**0**–DB**4**. Each relay is provided with contacts 1–20. The armatures 1–5 are multipled and respectively connected to the stationary contacts 1–5 on relay DC**5**, the armatures 6–10 are multipled and connected to the stationary contacts 1–5 on relay DC**00**, the armatures **11–15** are multipled and respectively connected to the stationary contacts 6–10 on relay DC**5**; the armatures of contacts 16–20 are multipled together and connected to the stationary contacts 6–10 on relay DC**00**.

It will thus be seen that the five relays DB**0**–DB**4** provide a total of one hundred contacts. Contacts 1–10 on each of these five relays are extended to the armature of the relays supplying the first originating code field FOC. Contacts 11–20 are extended to armatures of relays supplying the second originating code field SOC. The upper ten contacts on each of the relays DB– are wired to the first originating code field relays; the lower ten contacts 11–20 are wired to the second originating code field relays, making a total of fifty leads from the relays DB– to each originating code field relays. These fifty leads are strapped to corresponding armatures on each of the sixteen relays comprising the two originating code fields. The contacts for these armatures are wired individually to terminals numbered from **200–999** as indicated on the drawing. In this manner provision is made for 800 code terminals in each terminal field FOC and SOC. This number of code terminals is thought sufficient to provide (without disturbing the structure of the translator) the desired flexibility for changing codes (of which some two hundred are actually used).

We will now describe in detail the translation of the code of the originating office Bigelow 9 (code 249) to its assigned office index number. As previously described, the A digit 2 of the code is registered in the A-digit con-

version register of the transverter by the operation therein of relays DA00 and DA2, which results in the grounding of leads DA00, DA2 and AD2. The B digit 4 of the code is registered in the B-digit conversion register by the operation therein of relays DB00 and DB4, which results in the grounding of leads DB00 and DB4. The C digit 9 of the code is registered in the C-digit conversion register by the operation therein of relays DC5 and DC4, which results in the grounding of leads DC5 and DC4 and the application of battery through a resistance lamp to lead DC4. Consequently, when relays ICOA and ICOA1 operate, thereby connecting the indexer with the transverter, ground on lead DA00 completes the circuit of relay DA00 in the billing index over the No. 19 contacts of relay ICOA; ground on lead DB00 completes the circuit of relay DBL over the No. 33 contacts of relay ICOA; ground on lead DB4 completes the circuit of relay DB4 over the No. 26 contacts of relay ICOA, while ground on lead DC5 completes the circuit of relay DC5 over the No. 6 contacts of relay ICOA1. All of said relays operate. The operation of relay DBL (as also the operation of relay DBH if the B digit were 5–9) applies battery over its No. 9 contacts to lead 78 which, over the lower springs of jack J1, completes the circuit of the upper winding of the polar timing relay ROP, to ground over an undesignated resistance connected to the upper springs of said jack. The current flow through said upper winding is in the direction to keep the armature of the relay away from its stationary contact, as shown, during which time the lower winding and condenser C2 are kept short-circuited by ground on the No. 4 contacts of relay WOA, serially through the No. 4 contacts of relays WOB and VC, undesignated resistance, capacitor C2 to ground, and also through the lower contacts of jack J1 to the lower winding of relay ROP. Relay ROP remains in the unoperated condition until relay WOA, WOB or VC operates and removes the short around its lower winding to establish a charging circuit therethrough for condenser C2. Relay ROP will then remain operated for the interval required to charge the condenser, after which it releases under the influence of its upper winding to perform a later described function.

Upon the operation of relays DA00 and DBL, ground on conductor AD2 completes the circuit of relay 2LO1 over the No. 3 contacts of relay DA00, No. 8 contacts of relay DBL, winding of relay 2LO1, lead 53, upper winding of relay XO1, to battery. Relay 2LO1 operates. Now when relays DC5 and DB4 operate, and due to the fact that ground is present on lead CD4, said ground is extended over the No. 1 contacts of relay DC5, No. 1 contacts of relay DB4, No. 49 contacts of relay 2LO1, to first originating code terminal 249 in terminal field FOC. In the same manner, relay 2LO2 is operated from ground on lead DA2, No. 6 contacts of relay DA00, No. 17 contacts of relay DBL, winding of relay 2LO2, lead 54, winding of relay XO2, to battery. Battery is then extended to terminal 249 in the terminal field SOC over lead DC4, No. 1 contacts of relay BS (when operated), No. 6 contacts of relay DC5, No. 11 contacts of relay DB4, No. 49 contacts of relay 2LO2, to terminal 249 in terminal field SOC.

As previously indicated, a terminal in the field FOC which represents a code identifying an office in each of two or three of the areas 0, 1 and 2, is cross-connected to a terminal 0–9 in the field FOCC, preferably (and only for convenience), to the terminal numerically identical with the last digit of the code. Thus the code 249 (see Fig. 139) may designate the office Bigelow 9 (as assumed) in area 0, designate Cicero 9 in area 1, and designate Chickering 9 in area 2. Although the office index assigned to each of the three offices may be different (or the same), yet for a call from each office the operation of the translator results in ground being applied to terminal 249 in the code field FOC and battery to the corresponding terminal 249 in the code field SOC. Terminal 249 in the field SOC is cross-connected to the corresponding terminal 0–9 in the field SOCC associated with the lower group of area relays AR0B–AR2B. The separation (or distinction) between the three offices is then achieved (in the manner to be described) by the operation of the appropriate pair of area relays AR–A and AR–B by the appropriate recorder group relay RG– serving the group of ten offices which include the office from which the call is placed.

From the terminal field SOCA the terminals therein are severally extended to the terminals 0–9 of whichever recorder group relay RG– designates the recorder group serving the office indicated by the code in the area designated by the area relay AR–B between whose terminals and those of relay RG– the cross-connection is made. It has been assumed, for example, that Bigelow 9 (area 0) is served by recorder group 00. Consequently, terminal 9 associated with relay AR0B in the terminal field SOCA is extended to terminal 9 of recorder group relay RG00. In the same manner, if Chickering 9 (in area 2) is served by recorder group 19 as here assumed, then terminal 9 associated with relay AR2B in field SOCA is cross-connected (as shown) to terminal 9 of recorder group relay RG19.

Where there is no conflict of codes; that is, where a particular code designates but one office, the terminal in field SOC designating the code of such office is connected directly to that terminal in the field SOCA which is associated with the recorder group relay RG– serving the trunk group including that office, as, for example, code terminal 209, which is shown connected directly to terminal 0 of recorder group relay RG00. It is apparent from this illustration that the office represented by the code 209 is served by the same recorder group 00 that serves Bigelow 9, said two offices being two in the group of ten offices served by said recorder group.

The two groups of area relays AR0A–AR2A and AR0B–AR2B are cross-connected, at terminal field OA, with the terminals 00–19 of terminal field RGA in accordance with the recorder groups which serve the offices in the three different code conflicting areas. Since it has been assumed as an example that Bigelow 9 is in area 0 and is served by recorder group 00, then terminal 00 in field RGA is cross-connected to terminal 0 in field OA. Hence when relay RG00 operates, as will be described, a circuit is completed for relays AR0A and AR0B from ground on the No. 11 contacts of relay RG00. In the same manner, since Chickering 9 is in area 2, and is in the group of ten offices served by the recorder group 19, terminal 19 in the field RGA is cross-connected to terminal 2 in field OA. The operation of relay RG19 in the manner to be described then completes over said cross-connection an obvious circuit for relays AR2A and AR2B. Thus all three terminals in field OA are cross-connected in a similar manner to terminals 00–19 in field RGA in accordance with the recorder groups serving offices having a conflict of codes in the three areas 0, 1 and 2.

It will now be recalled that the recorder group indication is contained in the transverter by the operation and locking therein of one of the twenty relays RST0–RST19. It has been assumed that the recorder group having the designation 00 is the one that serves the trunks from Bigelow 9 (among others), and that, as previously described, relay RST00 for the recorder group 00 is operated and locked in the transverter. Accordingly, when relay ICOA operates, ground on the No. 6 contacts of relay RST00 is applied to lead R00, which, over the No. 23 contacts of relay ICOA1, completes the circuit of relay RG00 through the winding of said relay, lead 55, upper winding of marginal relay XRG, to battery. Relay RG00 operates in this circuit but relay XRG does not. Among other things, relay RG00 completes the circuit of relays AR0A and AR0B, which operates. Relay

AR0B extends the battery on terminal 249 over its No. 9 contacts to the No. 9 contacts of relay RG00. Had the call originated in Chickering 9 which is served by recorder group 19, then relay RST19 would have been operated in the transverter, and a circuit would have been completed for relay RG19 over lead RO19. Relay RG19, upon operating, would then operate relays AR2A and AR2B, the latter relay then extending battery on terminal 249 over its No. 9 contacts to the No. 9 front contacts of relay RG19.

It should be noted at this time that any relay RG–, when operated, grounds lead 56 to cause the operation of relay BS. On operating, the latter relay supplies locking battery over lead 57 for relays CA1 and CA2 when operated as described below, joins lead 77 to lead 78 over its No. 6 contacts for a purpose to be noted hereinafter, and closes through leads DC4–DC0 from the transverter to the translator for the translation of the C digit of the calling code. The purpose of this arrangement is to hold up supplying battery to the involved code terminal point in field SOC until the involved recorder group relay RG– is operated. Otherwise battery might be applied over the back contacts of said relay RG– to lead 99 before operation and thereby cause the false operation of relay WOA, which should operate only under certain other circumstances, as will be explained.

The office index digit 0–9 assigned to each of the offices in the areas served by the tandem exchange is determined in relation to the ten offices served by each recorder group, one of the digits being assigned to each of the offices in the group. This assignment, and the correlation of each of the assigned digits with the recorder group serving each of the offices indicated by the digits, is made by cross-connecting each of the involved terminals in the groups of terminals 0–9 constituting the terminal fiield RG0 with appropriate terminals in the ten groups of terminals COIEA–COIEJ. To which of the latter terminals the connections are made depends upon the billing index for calls from the office involved (as will later appear), upon the assigned office index, and upon the character of the initial entry. In respect to the office index, however, the connection in the involved field COIEA–COIEJ is always made to the terminal numerically identical with the assigned office digit. For instance, if it is assumed (as it is here assumed) that the office index for Bigelow 9 is the digit 0, then the No. 9 terminal in terminal field RG0 associated with the No. 9 front contacts of recorder group relay RG00 is cross-connected to terminal 0 in the appropriate one of the fields COIEA–COIEJ. In this case it is assumed that the connection is made to terminal 0 in field COIEA, whereupon the battery previously traced to the No. 9 front contacts of relay RG00, is extended to terminal 0 in field COIEA, thereby to complete the circuit of relay OF0 and of relay CA in parallel to ground, operating both relays. Relay CA performs a function later to be discussed, while relay OF0, indicating the digit 0 as the office index, grounds two leads OF4 and OF7 in the 2-out-of-5 code for the expression of the digit 0. As will be shown, ground on these two leads will cause the office index register (Fig. 108) of the transverter to be set for the digit 0. In the same manner, all the other terminals 0–9 severally connected to the front contacts of the relays RG00–RG19 in the terminal field RG0 are severally and selectively cross-connected to terminals 0–9 in each of the terminal groups constituting the terminal field COIEA–COIEJ in accordance with the assigned office index, thereby to cause the operation of the relay OF– expressive of the assigned digit and of the associated relay C–.

It will be recalled that terminal 249 in the terminal field FOC, representing the offices Bigelow 9, Chickering 9, and Cicero 9, is grounded on a call placed at any of said offices, and specifically at Bigelow 9. Since terminal 249 identifies three different offices, said terminal in the field FOC is cross-connected to terminal 9 in field FOCC for the group of area relays AR0A–AR2A, a corresponding cross-connection being made from terminal 249 in field SOC to terminal 9 in field SOCC associated with the area relays AR0B–AR2B. If the code terminal in field FOC represents a vacant code (like 909, for example) then such terminal is cross-connected to the terminal VOC, to cause a "wrong office" indication to be given by the indexer to the transverter, as will be later described.

The extension of the "working" code terminals 200–999 in the terminal field FOC for the determination of the billing index depends upon whether, among other things, such determination is contingent upon a conflict of codes, and upon whether the originating office provides different rates for different classes of subscribers. These extensions are determined as follows:

(1) If a code terminal in field FOC represents but one office, and that office does not provide different rate classes for different classes of subscribers, then said terminal is cross-connected directly to one of the terminals 00–32 in field ORT in accordance with the rate treatment to be accorded to all the subscribers in that office. Terminals 00–32 are each connected to one of thirty-three "originating rate treatment" relays ORT00–ORT32, which are provided to care for a maximum of two hundred calling offices served by the tandem exchange. As is well known, the rate for a call is a function of, among other factors, the distance between the calling office and the called, which requires that for any call a device identifying the calling office and another device identifying the called office be electrically correlated to determine the rate. However, it is evident that if individual devices were to be provided for each case, and if a large number of offices is involved, the number of devices required to determine the rate for each call would be excessive. The amount of equipment necessary can be considerably reduced, however, if account is taken of the fact that the traffic distance between a certain number of calling offices and any particular called office is the same. For such originating offices a common device identifying all such offices will do for rate determining purposes. In the present embodiment of the invention, all originating offices completing connections through tandem are divided into thirty-three originating rate treatment areas to each of which is assigned an originating rate treatment relay ORT–, and the terminals in field FOC representing single offices which do not provide different rate classes are then connected thereto, as said before, according to the rate for the calls;

(2) If a code terminal in field FOC represents but one office, and that office does provide different rate classes for different classes of subscribers, then said terminal is cross-connected to one of the terminals 0–59 in the terminal field RCC associated with the three rate-class relays RC0–RC2;

(3) If a code terminal represents a plurality of offices, each in a different area, as for instance, terminal 249 for Bigelow 9, Chickering 9 and Cicero 9, then said terminal is connected, as previously described, to one of the terminals 0–9, in the field FOCC. The cross-connection between terminals in the field FOCA and the terminals in field RCC, or between terminals in the field FOCA and the terminals in the field ORT, or between the terminals RC– and the terminals ORT, will depend on which office, or offices, provide rate-class service. For example, if Bigelow 9 provides rate-class service as assumed, and remembering that this office is located in area 0, then terminal 9 in field FOCA associated with relay AR0A is cross-connected to one of the terminals 0–59 (specifically, terminal 0) in terminal field RCC. Terminals 0 in fields RC0–RC2, respectively associated with corresponding armatures on relays RC0–RC2 are cross-connected to the three terminals in the terminal field ORT

which provide the three different originating rate treatments to be severally accorded to the three different classes of subscribers in Bigelow 9, the particular terminal rendered effective being determined by which of the relays RC0–RC2 will be operated. Since each rate-class is associated with its own trunk group in the originating office, and the trunk in the group over which the connection is extended to tandem signals the sender as to the rate-class involved by grounding one of the leads RC0–RC2 to cause the setting of the rate-class register therein as before described, relay RC0, RC1 or RC2 in the indexer will be operated on the operation of relay ICOA; relay RC0 operating over a circuit completed from ground through the contacts of relay RC0 of the rate-class register in the sender, lead RC0 in cables C2 and C3, No. 41 contacts of relay ICOA, lead RC0, winding of relay RC0 in the indexer, to battery. Relays RC1 and RC2 operate over similar circuits completed over leads RC1 and RC2 over the contacts of relays RC1 and RC2, respectively, in the rate-class register.

On the other hand, if one of the three (conflicting code) offices provides no rate-class distinction, then the terminal in field FOCA individual to the code of said office is cross-connected directly to the involved terminal in the terminal field ORT. For example, if Chickering 9 provides no class-rate distinction, and remembering that this office is located in area 2, then terminal 9 in field FOCA associated with the No. 9 contacts of relay AR2A would be cross-connected directly to the involved terminal in terminal field ORT.

It is now evident that with ground on the code terminal of the calling office in field FOC, the involved originating rate treatment relay ORT– will be operated thereby, said ground being applied directly from said code terminal to the winding of the relay ORT– if the terminal represents a single office with no rate-class distinction, or through the involved contact pair on the operated rate-class relay RC– if the terminal represents a single office providing the rate-class distinction, or through the involved contact pair on the operated area relay AR–A if the terminal represents more than one office but with the calling office having no rate-class distinction, or through the involved contacts on the operated area relay AR–A and the involved contacts on the operated relay RC– if the calling office does provids rate-class distinction; the circuit of the relay ORT– being completed over lead 63, winding of relay XRT, to battery. Thus, if it is supposed that Bigelow 9 provides for three rate classes (three separate and distinct trunk groups between Bigelow 9 and tandem) each of which requires a different originating rate treatment, say the operation of relay ORT00 for rate-class 0 (relay RC0), relay ORT01 (not shown) for rate-class 1 (relay RC1) and the operation of relay ORT02 (not shown) for rate-class 2 (relay RC2), then terminal 0 in field RC0 would be cross-connected to terminal 00 in field ORT; terminal 0 in field RC1 would be cross-connected to terminal 01 (not shown) in field ORT, while terminal 0 in field RC2 would be cross-connected to terminal 02 (not shown) in field ORT. On a call placed at Bigelow 9 would then result in the operation of relay RC0, or relay RC1 or relay RC2 depending on the rate class of the subscriber as indicated to the indexer by the sender (via the transverter) by which one of the three relays RC0, RC1 and RC2 is operated.

To complete the determination of the billing index for the call, account must now be taken of the part played by the called office and its location in one of the three areas. The called office code, which is registered in the A, B and C registers of the called number register in the transverter is passed to the called office translator of the indexer over the A–, B–, and C– leads, while the determination of the area in which the called office is located is effected by the operation of relay TA0, TA1, or TA2 over lead TAR0, TAR1 or TAR2, respectively. Remembering that the code of the called office Republic 7 herein used to illustrate the operation of the invention is 737, ground on lead A5 from the No. 8 contacts of relay A5 in the transverter operates relay A5 of the called office translator over the No. 25 contacts of relay ICOA; ground on lead B00 from the No. 8 contacts of relay B00 operates relay BL over the No. 40 contacts of relay ICOA; while ground on lead C5 from the No. 8 contacts of relay C5 operates relay C5 of the indexer over the No. 18 contacts of relay ICOA1. At this point we note that if the called office is located in area 1 as assumed, the class-of-service register in the transverter would be set for the digit 1 by the operation therein of relays CS00 and CS1 as already described. Since lead TAR1 is cross-connected as shown to the No. 1 contacts of relay CS1, then upon the operation of relay ICOA a circuit is thereby completed for relay TA1 of the indexer, said circuit being traced from ground on the No. 4 contacts of relay OCK, lead 58, No. 1 contacts of relay CS00, No. 1 contacts of relay CS1, lead TAR1, No. 4 contacts of relay ICOA, winding of relay TA1, to battery. Had the called office been located in terminating area 0, the class-of-service register of the transverter would have been set for the digit 0, lead TAR0 would have been grounded, and relay TA0 would have been operated. Similarly with relay TA2, if the called office had been located in area 2. On the other hand, if the called office is located in an area of the toll zone (see Fig. 139) the class-of-service register would have been set for the digit 4, lead TATS would have been grounded at the No. 1 contacts of relay CS4 of said register, and relay TS would have been operated over the No. 6 contacts of relay ICOA. However, in respect to the bulk-billing areas 0, 1 and 2, the operation of each of the relays TA0, TA1 and TA2 has the effect of operatively joining the involved area register to the called office translator. Since it has been assumed that the called office 737 is located in area 1, relay TA1 operates as described to connect the area register 1 to the called office translator.

It has been stated that relays A5, B1 and C5 have been operated. With operation of relay TA1, ground on lead A2 from the No. 9 contacts of relay A2 of the A-digit called number register of the transverter completes a circuit for relay 7LT1 in the area register 1, said circuit being traced from ground on lead A2, No. 3 contacts of relay A5, No. 3 contacts of relay BL, lead 26, No. 6 contacts of relay TA1, winding of relay 7LT1, lead 60, upper winding of marginal relay XT1, to battery, operating said relay 7LT1 but not relay XT1. Moreover, ground on lead B3 from the No. 8 contacts of relay B3 in the B-digit called number register of the transverter operates relay B3 (not shown) in the translator. With the operation of said latter relay, ground on lead C2 from No. 8 contacts of relay C2 in the C-digit called number register is applied over the No. 3 contacts of relay C5 of the translator, No. 3 contacts of relay B3 (not shown), to terminal 737 associated with relay 7LT1. This terminal, individual to the called office code 737 in area 1, is cross-connected to the one of the fifty-eight terminals of terminal field TRT in accordance with the originating rate treatment to be accorded to the called office. If the code represents two or three offices, one in each of the areas, then the terminal for the code in each area register will be cross-connected to the terminal in terminal field TRT in accordance with the rate treatment to be accorded to the office in that area. For example, it has been assumed that the code 249 represents Bigelow 9 in area 0, Cicero 9 in area 1, and Chickering 9 in area 2. Accordingly, terminal 249 of relay 2LT0, representing Bigelow 9 in area 0, will be cross-connected to that terminal in terminal field TRT which provides the required originating rate treatment

for Bigelow 9; the terminal 249 connected to the contact of relay 7LT1 of area register 1, and representing the office Cicero, will be cross-connected to that terminal in the terminal field TRT which provides the required originating rate treatment for Cicero 9 in area 1, while the terminal 249 connected to the contact therefor on relay 7LT2 of area register 2 and representing office Chickering 9, will be cross-connected to that terminal in the terminal field TRT which provides the required originating rate treatment for said office in area 2. If the code is individual to but one office, as assumed for code 737, the connection to a terminal in terminal field TRT is made only from the involved relay in the area register for the area in which the office is located.

It will be assumed that the rate treatment for the called office 737 is indicated by the terminal 00 in the terminal field TRT. Accordingly, terminal 737 for relay 7LT1 is cross-connected to terminal 00 of the terminal field TRT. Since ground is present on terminal 737 as already explained, and relay ORT00 is operated, said ground is applied to terminal 00 associated with relay ORT00 in the terminal field CRT. Thence terminal 00 is cross-connected to one of the nine terminals 1–9 in the terminal field MBI in accordance with the desired billing index. Assuming that said index is 1, then terminal 00 connected to an armature of relay ORT00 is cross-connected to terminal 1 in the terminal field MBI. Ground on this terminal then completes the circuit of relay BI1 through its winding to battery on the No. 1 contacts of relay ORT00. The operation of relay BI1 registers the fact that the billing index for the call is the digit 1. With relay BI1 operated, leads MBI0 and MBI1 are grounded to express the digit 1 in the 2-out-of-5 code, ground on lead MBI0 being supplied over the No. 4 contacts of relay ON (as a check that said relay is operated), and the No. 2 contacts of relay BI1; ground on lead MBI1 being supplied over the No. 3 contacts of relay BI1. As will be shown, ground on said leads will cause relays MI0 and MI1 in the message billing index register (Fig. 108) of the transverter to be operated.

Relay BI0 (index 0) is reserved for test calls, and for such calls certain codes are reserved. The particular terminals on the relays 2LT0–9HT2 which designate such test "offices" are cross-connected to the terminal MBI in the terminal field TRT. Ground on said terminal completes the circuit of relay BI0 over conductor 65, which, on operating, grounds leads MBI4 and MBI7 to express the index 0 and cause the billing index register to be correspondingly set.

For calls completed to offices located in national areas of the toll zone, no area registers are required. Although the called office translator will operate as described, the fact that no relay TA– is operated renders it ineffective. On toll calls, however, relay TS is operated as previously described, and since all toll calls require the billing index 9, relay TS grounds lead 62, which operates billing index relay BI9 to battery on the lower contacts of whichever one of the relays ORT00–ORT32 has been operated from ground on the code terminal in terminal field FOC.

As previously noted, Fig. 115 shows, among other things, the ten terminal fields COIEA–COIEJ, each containing ten terminals 0–9, and that each field is associated with one of the ten relays CA–CJ, each having ten contacts 0–9. The armatures of these contacts on each relay are severally cross-connected to the conductors MU, MUD or TL in accordance with a predetermined pattern of combinations between particular billing indices and initial entries required for the call indicated by each of said indices. Since the selection of the billing index relay BI1–BI9 for a call is determined by the calling office code through its code terminal in terminal field FOC and the called office code through the connection of the code point in the area register to a terminal in the field TRT, said relay determines whether the initial entry is a two-line message unit MU, a four-line message unit detail MUD, or a four-line or five-line toll entry TL. However, it is possible that calls may be established from two or more offices to the same called office for which the billing index is the same, and yet the initial entries might be different for each. Thus the connections from a first office to office X, let us say, will call for the billing index 1 and MU entries, and from said office to an office in the toll zone for the billing index 9 and the toll entry TL; while connections from a second office to office X will require the same index but MUD initial entries, and for calls from said second office to an office in the toll zone for the billing index 9 and the toll entry TL. For the billing indexer this means that the lead individual to the first office at the front contacts of the recorder group relay RG– is to be cross-connected to a terminal in the group of terminals COIE– connecting with that relay C– one of whose armatures is connected to the lead MU and whose engaging contact extends to the No. 4 contacts of relay BI1, and another armature connected with the lead TL whose engaging contact extends to the No. 4 contacts of relay BI9. In the same manner, the lead individual to the second office must be cross-connected to a terminal in a group of terminals COIE– connecting with another relay C– one of whose armatures is connected to lead MUD and whose engaging contact extends to the No. 4 contacts of relay BI1, and another armature connected with the lead TL whose engaging contact extends to the No. 4 contacts of relay BI9.

The ten networks COIEA–COIEJ each having one of the relays CA–CJ as a component thereof, provide for ten possible combinations of billing indices and initial entry leads, and the office leads from the front contacts of the recorder group relays RG00–RG19 are then severally cross-connected to the networks in accordance with the combination of billing index and initial entry that meets the requirements of each particular office.

In the specific illustration of the call to be completed to Republic 7 (code 737) it has been assumed that the office index for such office is to be 0 (requiring the operation of relay OF0), that the billing index therefor is 1, and that the initial entry therefor is to be a two-line entry MU. Assuming that relay CA of the network COIEA is individual to the combination including the billing index 0 and lead MU, and also billing index 9 and lead TL (since all toll calls require both of the latter), terminal 9 in the terminal field RG0 associated with recorder group relay RG00 is cross-connected to terminal 0 of the terminal network COIEA. Hence the battery previously traced to the No. 9 front contacts of relay RG00 is utilized to complete a parallel circuit to the windings of relays OF0 and CA. Relay OF0 operates as previously described, while relay CA operates to apply ground from the No. 4 contacts of relay BI1 to conductor MU, which is utilized in the manner to be described to transmit to the transverter the fact that the call requires a two-line (MU) initial entry.

If the call from Bigelow 9 had been for some office in the toll zone, billing index relay BI9 would have been operated and ground would then have been applied to lead TL from the No. 4 contacts of relay BI9 and the No. 9 contacts of relay CA. If the operating company desired a detailed record of all bulk-billed calls established from Bigelow 9, then the lead individual to said office at the front contacts of relay RG00 would have been connected to a terminal of that network COIE– which is reserved for the combination of billing indices 1 and 9 (among others) and initial entry leads MUD and lead TL. In the latter cases ground would be applied to lead MUD over the No. 4 contacts of relay BI1 and the appropriate contacts of relay C– individual to the network, for bulk-billed calls, and to lead TL over the No. 4 contacts of relay BI9 and the appropriate contacts of said relay C– individual to the network for toll calls.

Before describing the registration in the transverter of the billing index, office index, and initial entry determined for the connection by the billing indexer, we will discuss certain safeguards in the indexer which are provided to detect a calling office code other than the one of the office at which the call is placed.

The first of these safeguards is based on one of the assumptions made, which is that no area contains offices with identical codes. If, therefore, the billing indexer registers the same area for both the calling and called office codes, it is necessary to determine if the codes are identical. In the event, therefore, that the area registration is the same, the indexer signals the transverter to make a "match check" and determine whether the calling and called office codes are identical. If they are, the transverter gives the operator a "reorder" signal, thus advising her again to ask the calling subscriber for his number. If they are not, the transverter proceeds with its operations. If the area registrations are unlike, the indexer signals the transverter to skip the "match check" and proceed with its operations.

It has been assumed that the calling office is Bigelow 9 having the code 249, that said office is located in area 0 (see Fig. 139), and that said office is served by recorder group **00**, thus resulting in the operation of relay RG**00** and the area relays AR**0**A, AR**0**B. It has been further assumed that the called office code is **737**, and that said code designates an office in area 1, as evidenced by the operation of relay TA**1**. In these circumstances, when any one of the relays C– operates, a circuit is completed from ground on the No. 10 contacts of said relay, lead **66**, No. 5 contacts of relays CA**1** and CA**2**, No. 10 contacts of relay AR**0**A, lead **67**, No. 18 contacts of relay TA**1**, lead **68** joined to lead SMK in cable C**4**, No. 59 contacts of relay ICOA**1**, lead **69**, winding of relay SMK, to battery. The latter relay operates, locks over its No. 1 contacts, resistor SMKR, lead **70**, to ground on the No. 9 contacts of relay CK**3**, and furnishes the transverter with a positive signal to skip the "match check" since the calling and called areas are not the same.

Suppose, however, that the area of the calling office were to be the same as that of the called office. In this case a code check by the transverter will be necessary. If the one area involved is area 0, relays AR**0**A and TA**0** will be operated; if the area is area 1, relays AR**1** and TA**1** will be operated, and if the area is area 2, then relays AR**2**A and TA**2** will be operated. For area 0 ground is applied to lead MMK from lead **67** as traced thereto, No. 17 contacts of relay TA**0**, to lead MMK; for area 1 the path traces from lead **66**, No. 10 contacts of relay AR**1**A, lead **43**, No. 19 contacts of relay TA**1**, and to lead **33** joined to lead MMK; for area 2 the path traces from lead **66**, No. 10 contacts of relay AR**2**A, lead **80**, No. 17 contacts of relay TA**2**, to lead **33** joined to lead MMK. Ground on lead MMK is used to check the identity of the two codes as registered in the transverter. If the two codes have identical registrations, relay MK will operate in the transverter. Thus if the two codes are 249, said ground on lead MMK will complete the circuit of relay MK over the No. 7 contacts of relay ICOA, lead **71**, No. 3 front contacts of relay DA**00**, No. 6 front contacts of relay A**00**, No. 3 and No. 4 normally made contacts of relays DA**5** and A**5**, respectively, No. 2 and No. 4 normally made contacts of relays DA**0** and A**0**, respectively, No. 3 and No. 5 normally made contacts of relays DA**1** and A**1**, respectively, No. 3 and No. 5 front contacts of relays DA**2** and A**2**, respectively, No. 3 and No. 5 normally made contacts of relays DA**3**, A**3**, DA**4** and A**4**, respectively and correspondingly, lead **72**, No. 3 and No. 6 front contacts of relays DB**00** and B**00**, respectively, No. 3 and No. 4 normally made contacts of relays DB**5** and B**5**, respectively, No. 2 and No. 4 normally made contacts of relays DB**0** and B**0**, respectively, No. 3 and No. 5 normally made contacts of relays DB**1**, B**1**, DB**2**, B**2**, DB**3** and B**3**, respectively and correspondingly, No. 3 and No. 7 front contacts of relays DB**4** and B**4**, respecitvely, lead **73**, No. 3 and No. 4 contacts of relays DC**00** and C**00**, respectively, No. 3 and No. 6 front contacts of relays DC**5** and C**5**, respectively, No. 2 and No. 4 normally made contacts of relays DC**0** and C**0**, respectively, No. 3 and No. 5 normally made contacts of relays DC**1**, C**1**, DC**2**, C**2**, DC**3**, and C**3**, respectively and correspondingly, No. 3 and No. 7 front contacts of relays DC**4** and C**4**, respectively, lead **74**, winding of relay MK, to battery. The latter relay, operating over the identical setting of the two code registers, locks over its No. 2 contacts to previously traced ground on lead **70**, and indicates by its operation that the calling subscriber has erroneously given the code of the called office for that of the calling office when passing his number to the operator.

Relay MK, on operating, completes an obvious circuit for the operation of relay ROP, which locks over its No. 3 contacts, lead **87**, to ground on the No. 9 contacts of relay CK**6**. Among its other functions, relay ROP applies ground on the No. 2 back contacts of relay TTF, through the No. 1 front contacts of relay ROP, lead **75**, No. 6 back contacts of relay TM**6**, to lead ROP in cable C**3**. Ground on said lead completes the circuit through the upper winding of relay ROP in the sender, which relay operates as before described to enable the sender to transmit a reorder signal to the operator.

If, on a code check, the codes do not match, then a path is completed to relay NM over lead MMK and the first two corresponding relays in a calling and called digital register, both of which would be operated if the codes are the same, but only one of which would be if they are not. Thus, supposing that relay DA**00** is operated and relay A**00** is not, then ground on lead MMK will be applied to lead **71**, the No. 3 front contacts of relay DA**00**, No. 6 normally made contacts of relay A**00**, lead **35**, winding of relay NM, to battery. The latter relay operates, locks over its No. 1 contacts to previously traced ground on lead **70**, and closes a contact in the operate path of relay IOK, as will be explained later.

The second safeguard is against the calling subscriber giving the code of an office which is not in the group of ten offices served by the recorder group that includes the office from which the call is placed. It has been assumed as an example that the call herein being used to illustrate the operation of the invention was actually placed from Bigelow 9, served by recorder group **00** and resulting in the operation of relay RG**00**, as described. Suppose, however, that the subscriber gives as the code of the calling office the code of some office served, let us say, by recorder group **19** for which relay RG**19** will not have operated since the call has not, in fact, been placed from any office served by said group. The given code, however, will not render electrically effective the code terminal **249** in the terminal field SOC, but the terminal of the code erroneously given and representing an office served by recorder group **19**. Since relay RG**19** is normal, battery at the terminal of the erroneously given code in field SOC will complete a circuit over the involved one of the 0–9 back contacts of relay RG**19**, lead **99**, winding of relay WOA, to ground, operating said latter relay. Now it will be recalled that the circuit through the upper winding polar timing relay ROP was closed by the operation of relay DBL, and that ground through the No. 4 back contacts of relays WOA, WOB and VC maintained both condenser C**2** and the lower winding of relay ROP short-circuited, keeping the contacts of said relay opened. However, upon the operation of relay WOA, the short is removed from both condenser C**2** and the lower winding of relay ROP, enabling the condenser to be charged through said lower winding. The capacity of condenser C**2** and the resistance of the

resistor in series therewith are so chosen that a predetermined time elapses before the condenser is charged, after which relay ROP operates over its upper winding. Ground on the No. 8 contacts of relay WOA then completes the circuit of relay ROP1 over the contacts of relay ROP. Relay ROP1 operates and applies ground over its No. 1 front contacts, No. 1 contacts of relay X1N to lead ROP in cable C4. Ground on said lead, over the No. 51 contacts of relay ICOA1, lead 9, No. 1 back contacts of relay MK (which is normal if the area of the given calling office is different from the area of the dialed called office) winding of relay ROP, to battery. The latter relay operates as before described to transmit a reorder tone signal to the sender.

The third safeguard pertains to identically-coded offices in two areas and none in the third. Referring to Fig. 139, it may be assumed that Chickering 9 (249) is in area 2 and Cicero 9 (249) in area 1, but that there is no office in area 0 having the code 249 (that is, Bigelow 9 does not exist). If in this case it is supposed that terminal 249 in field FOC is cross-connected to terminal 0 in field FOCC, that terminal 249 in field SOC is cross-connected to terminal 0 in field SOCC, then terminal 9 in the field FOCA associated with relay OROA will be cross-connected to the wrong office terminal WOC, terminals 9 in FOCA respectively associated with relays AR1A and AR2A will be cross-connected to the originating treatment relays ORT– directly or through the contacts of the rate-class relays RC– as previously described. With this arrangement, should a subscriber place a call from any office in area 0 and give the operator Chickering 9 or Cicero 9 as the code of the office of origin, the operation of relay AR0A by the appropriate recorder group relay RG– for the recorder group serving the actual calling office in area 0 will cause the ground on terminal 249 in the field FOC to be applied over the No. 0 contacts of relay AR0A, terminal WOC, winding of relay WOB, to battery, operating said latter relay, and causing the operation of relay ROP in the manner previously described with relay WOA. Ground on the No. 8 contacts of said relay WOB will then complete the circuit of relay ROP1, which operates to supply ground on lead ROP, thereby to operate relay ROP of the transverter with the effects previously described.

Similar cross-connections are also made between the terminal fields RC– and terminal WOC for offices which do not provide rates indicated by the relay RC– from which the cross-connections were made. Thus, for example, if a subscriber is calling from an office which provides the rate indicated by the rate class relay RC0, and gives the operator the code of an office which does not provide this rate class, the terminal in the field RC0 for the given office (for example, terminal 59), being cross-connected to terminal WOC, will cause the operation of relay WOB on the operation of the rate class relay RC0. Relay WOB then signals the transverter for a reorder as previously described.

The third precaution pertains to vacant codes. As previously noted, all terminals in the field FOC designating such codes are wired to the terminal VOC, over which the circuit of relay VC is completed when a vacant code terminal in field FOC becomes grounded. Over its No. 9 contacts, relay VC completes the circuit of relay ROP1 to provide the transverter with the reorder signal.

Returning, now, to the normal use of the indexer and its operation for the particular call to be established to Republic 7–1359, it has determined that the billing index therefore is 1 (relay BI1), the office index is 0 (relay OF0), and the initial entry is a two-line entry MU. This information is passed to the transverter, the billing and office indices being transmitted in the 2-out-of-5 code, while the initial entry is transmitted by the grounding of lead MU.

The five MBI leads 0—1—2—4—7 are connected to the contacts of relays BI0–BI9 according to the 2-out-of-5 code expression of the digit indicated by the relay; conductors 0 and 1 of relay MBI, for example, being connected to the No. 3 and No. 2 contacts, respectively, of relay BI1. Consequently when this relay operates, leads MBI0 and MBI1 are grounded as previously described, lead MBI0 completing the circuit of relay MI0 of the transverter's message billing index register, over the No. 43 contacts of relay ICOA1, winding of relay MI0, to battery, operating said relay, which locks over its No. 2 contacts, an undesignated resistance, lead 80, No. 12 contacts of relay CK8, to ground; ground on lead MBI1 completes the circuit of relay MI1 over the No. 44 contacts of relay ICOA1, winding of relay MI1, to battery, which relay similarly operates and then locks over its No. 2 contacts to aforetraced ground on lead 80. Relays MI0 and MI1 in the transverter register the digit 1 as the billing index for the call. The other relays MI2–MI7, in selective combination with relays MI0 and MI1, register each of the other billing index digits if transmitted from the indexer.

The five leads OF0–OF7 are similarly wired to the contacts of relays OF0–OF9 in the billing indexer according to the 2-out-of-5 code for the digit represented by each relay. As already described, leads OF7 and OF4 are grounded by operated relay OF0 for the office index 0. Accordingly, lead OF7 completes a circuit over the No. 56 contacts of relay ICOA1, winding of relay OF7, to battery. Lead OF4 completes a circuit over the No. 55 contacts of relay ICOA1, winding of relay OF4, to battery. Both relays operate, locking over their respective No. 3 contacts, an undesignated resistance, lead 81, No. 10 contacts of relay CK8, to ground. By their operation, relays OF7 and OF4 of the transverter office index register record therein that the office index is 0.

Ground on lead MU completes a circuit over the No. 1 contacts of relays WOA, WOB and VC, lead C4, No. 48 contacts of relay ICOA1, to lead 2L, to the winding of relay 2L, to battery. Relay 2L operates, locks over its No. 1 contacts to aforetraced ground on lead 81, and registers in the transverter that the initial entry for the call is a two-line entry. Had the call required a four-line entry (MUD) for a local connection, then lead MUD would have been grounded, and a circuit would have been completed over the No. 2 contacts of relays WOA, WOB and VC, lead MUD, No. 49 contacts of relay ICOA1, winding of relay MUD, to battery. On operating, relay MUD would lock over its No. 1 contacts to aforetraced ground on lead 81 and register in the transverter that the initial entry is a message unit detail (MUD) entry. Had the call been a toll call requiring a toll initial entry TL (either a four-line "compressed" entry or a five-line entry) then lead TL would have been grounded, completing a circuit over the No. 3 contacts of relays WOA, WOB and WOC, lead TS, No. 50 contacts of relay ICOA1, winding of relay TS, to battery. On operating, relay TS would lock over its No. 1 contacts to aforetraced ground on lead 81 and register a toll initial entry in the transverter.

When the transverter has received the office index, the billing index and the character of the initial entry by the operation of the involved ones of the above-indicated relays, a circuit is completed for its relay IOK, said circuit tracing from battery through the winding of said relay, No. 2 contacts of relay IOK2, lead 82, No. 1 contacts of relay CK5, lead 83, No. 1 contacts of relay XRE, lead 84, No. 3 contacts of relay MK, No. 2 back contacts of NM, No. 2 front contacts of relay SMK, lead 85, No. 5 contacts of relay OF7, No. 6 front contacts of relay OF4, No. 6 back contacts of relay OF2, No. 5 back contacts of relay OF1, No. 4 back contacts of relay OF0, No. 5 front contacts of relay 2L, No. 5 back contacts of relay MUD, No. 2 back contacts of relay TS, No. 3 back contacts of relays MI7, MI4, and MI2, No. 3 front contacts of relays MI1 and MI0, lead 29, No. 2 front contacts of relay INK, lead 86, No. 1 back contacts of relay P6, lead 87, No. 9 con-

tacts of relay CK6, to ground. At this point it should be noted that if the transverter has made a code match test and found the codes to be unlike, relay NM will operate as previously described. Since relays MK and SMK are normal, the path of relay IOK is thereby completed over the No. 3 contacts of relay MK, No. 2 front contacts of relay NM, No. 2 back contacts of relay SMK, lead 85, and thence as above traced to the winding of relay IOK. Relay IOK operates, locks over its No. 3 contacts and an undesignated resistance to aforetraced ground on conductor 87 via lead 86, and performs certain functions that will shortly be described. It should be noted at this time, however, that so long as relay IOK is normal, ground on its No. 6 back contacts is applied to lead 88, No. 21 contacts of relay ICOA1, to lead IOK, which extends to the No. 2 contacts of operated relay ON, thereby completing the circuit through the lower winding of polar timing relay TR, to battery on the No. 3 contacts of relay ON.

At this time it should also be stated that when relay C00 or C5 of the indexer operates, a circuit is completed through the upper winding of relay TR over lead 90 and the No. 3 contacts of relay ON. While the current flowing through the upper winding is in the direction to operate the relay, the current flowing through its lower winding opposes it, so that the relay remains unoperated. This condition, however, prevails only so long as ground is maintained on lead IOK as above described. When, however, relay IOK operates as an indication that the transverter has received the billing index, the office index and the initial entry, ground is removed from lead IOK, in consequence of which the condenser C begins to charge through the lower winding of relay TR. The capacity of condenser C and the value of the resistance in series therewith are computed to delay the operation of relay TR for a period sufficient to allow slowest of the relays OF0–OF7, MI0–MI7, 2L, MUD, and TS in the transverter to operate, if it is to operate, or if it will operate due to a trouble condition. During the time that relay TR is normal and relay IOK released, relay IOK1 is held by ground over the contacts of relay TR, No. 1 contacts of relay ON, lead IOK1, No. 20 contacts of relay ICOA1, lead 89 joining with lead 40, and thence as previously traced to the winding of relay IOK1. If, in this interval, an additional relay OF0–OF7, or an additional relay MI1–MI7, or either relay MUD or relay TS additionally operates, relay XRE will operate in the transverter to block further progress of the call and establish a connection to the trouble indicator. For example, it has been assumed that relays OF7 and OF4 have been operated for the billing index 0. Suppose, however, that after their operation and that of relay IOK, relay OF2 should operate. In this case, the ground on lead 86 previously traced to lead 29 and thence to the No. 5 front contacts of relay 2L (on the assumption that the billing indexer register relays MI0–MI7 have been correctly set for the digit 1, that relays TS and MUD are normal and that relay 2L is operated), thence over the No. 4 back contacts of relay OF0, No. 5 back contacts of relay OF1, No. 6 front contacts of relay OF2 (falsely operated), No. 5 front contacts of relay OF4, No. 4 front contacts of relay OF7, lead 93, No. 4 contacts of relay CK3, lead 94, winding of relay XRE, to battery. Relay XRE operates, locks over its No. 6 contacts to off-normal ground on lead TONG12, and holds relay IOK1 on a previously traced path over leads 39 and 40, No. 5 contacts of relay XRE, conductor 42 and thence as previously traced to ground on the No. 10 contacts of relay CK8. Since relay IOK1 is held, the connection of the billing indexer to the transverter is held. As has been shown, the operation of relay XRE connects the transverter to the trouble indicator, and after the latter has operated to record the condition of the transverter, releases relay XRE.

In the event, however, that after relay IOK has operated and no additional relay operates in the billing index, office index and initial entry registers of the transverter, relay TR operates and relay IOK1 is released by the removal of ground on lead IOK1 from the contacts of relay TR of the indexer. The release of relay IOK1 opens the circuit of relay IP0 which, in turn, releases relays ICOA and ICOA1 and disconnects the indexer from the transverter. The indexer, however, is held busy by its relay BIB holding to ground from various parts of the circuit as shown. When released, relays IB– in the transverter channels are released to make the indexer available for use to other transverters.

It has been previously stated that relays CA1–AS2 are included in the indexer to switch the area indications of offices so that, if necessary or desirable, offices in one area may be assigned for service with a recorder group serving a group of offices leocated in another area, and given the area indication of said other area. For this purpose a group of relays CA–AS– is provided of each such other area (Fig. 114 showing only the group of relays CA1–AS1 for area 1 and another group of relays CA2–AS2 for area 2) and the front contact representing each "foreign" office on the recorder group relay RG– serving the office group which is to include such foreign office, is wired to an armature on relay AS– designating the area to which said office is assigned. Thus, for example, suppose some office located in area 1, say Albany 0 (see Fig. 139) is to be grouped with the offices (less than ten) located in area 2 which are served by recorder group 19. In this case the code terminal 250 in field SOC is cross-connected to the No. 0 armature of relay RG19, while the front contact making with such armature is extended to the No. 0 armature of relay AS2, the front contact of which is then connected to a terminal COIEA9 in accordance with the office index and determined billing index for Albany 0. When relay RG19 operates, the battery on the code terminal 250 in field SOC is extended over the No. 0 front contacts of relay RG19, No. 0 back contacts of relay AS2, to the winding of relay CA2, which operates, locks over its No. 2 contacts, lead 57, No. 7 contacts of relay BS through resistance to battery, and locally operates relay AS2. The latter relay then transfers the code terminal battery to the terminal COIEA9 to operate the involved relays OF9 and CA, while the relay CA2 supplies ground over its No. 4 contacts to lead 67, No. 18 contacts of relay TA1, lead 68, (which operated since Albany 0 is actually located in area 1) lead SMK in cable C4, and thence as traced to relay SMK of the transverter, advising the latter circuit to skip the code-match circuit. This is necessary since it may well be that the foreign office so included in area 2 may have an identical code with that of some office in said latter area. A code match check would reveal the identity and cause the operator falsely to be given a reorder signal. Hence the code match check is not made. Relay AS2 provides for the addition of six offices to area 2, while relay AS1 provides for the addition of twelve.

Provision is also made for protection against a trouble condition arising at the cross-connection terminals FOC and FOCA, which may lead to the false operation of either relay VC or WOB while the indexer is processing a regularly assigned call. When, during this procesing, the appropriate billing indexer relay BI1–BI8 operates, and either relay VC or WOB as operated because of a trouble condition, ground on the No. 1 contacts of the operated relay BI– completes a circuit for relay XIN over the No. 5 contacts of relay WOB or No. 6 contacts of relay VC whichever is operated. Relay XIN operates, locks over its No. 2 contacts to aforetraced ground on lead 90, opens lead ROP to the transverter, completes over its No. 4 contacts and lead 91 the circuit of relay XAL, which operates to remove ground on the stationary contacts of the seven polarized relays XO1–XRG, supplied over lead 92, No. 6 contacts of relay VC, or No. 5 contacts of relay WOB, to ground on the No. 1 contacts of operated relay BI–, or over No. 5 contacts of relay BC, and the No. 10 contacts of the operated relay C–. Over

its No. 3 contacts, relay XIN applies ground to lead IOK which, as previously described, results in holding the transverter until the trouble indicator has made its record.

The reason for delaying the operation of the polar relay ROP is now evident. Should a trouble occur which causes WOA, or WOB, or VC to operate while the indexer is otherwise normally operating to determine the three items of information, it is desirable to transmit a trouble signal and not a reorder signal. Since relay XIN controls the former signal and relay ROP1 controls the latter, it is necessary to hold up the operation of relay ROP1 by delaying the operation of the polar relay ROP for an interval sufficient to permit relay XIN to operate and transmit the trouble signal before relay ROP1 can operate.

Provision is further made to guard against the subscriber dialing a prohibited code, a test code for example, that results in the operation of the billing indexer relay BI0 and giving the operator a wrong calling office code. In this case, the failure of the proper recorder group relay RG– to operate will cause the operation of relay WOA over lead **99**, and since relay BI0 will have been operated, ground on the No. 2 contacts of relay BI0, passing through the No. 6 contacts of relay WOA, completes the circuit of relay XIN, with results previously described.

It may be, also, that the subscriber dials a "bulk billing" called office code from an office which is geared to establish only toll calls through tandem, and gives the operator the code of the latter office. In this case, relay TS operates from the class-of-service register in the transverter. Since the calling code given by the subscriber may be that of an office served by a recorder group other than the one which serves the office from which the call is placed, the failure to operate the recorder group relay RG– corresponding to the actual office will cause relay WOA to operate with results already described.

It will be shown in the further description of the transverter that, should it fail because of trouble condition or for any other cause, it will be dismissed and another transverter called in for a second attempt. The cause of the failure, however, may have been in the indexer, which, therefore, should be kept from being connected to the "second trial" transverter. When the transverter was originally seized, the operation of relay TA in the connector closed a circuit from ground on the No. 2 back contacts of relay TR1 of said connector, No. 4 contacts of relay TA, lead TR1 in cable C3, winding of relay TR1, to battery. The latter relay operates, locks over its No. 1 contacts and No. 17 contacts of relay CK7, to ground. Now when a trouble condition develops in the transverter, say on a failure to down-check which will result in the operation of relay TM2, as will be shown, the latter relay completes a circuit for relay DL from ground on its No. 2 contacts and lead **404**. Relay DL, on operating, completes an obvious circuit for relay TR, which operates to apply battery through a resistance over its No. 9 contacts, the No. 5 normally made contacts of relay TIB, lead TIS to the trouble indicator circuit (conventionally indicated in Fig. 84 as a box). When the trouble indicator is seized, it applies ground to lead TIB which operates relay TIB, the latter then locking over its other winding to resistance battery on the No. 9 contacts of relay TR. By connections not shown, the trouble indicator operates to record the circuit conditions of the transverter, during which time ground on the No. 6 contacts of relay DL is applied over the No. 4 contacts of relay TIB, No. 4 contacts of relay TR1, lead **96**, No. 60 contacts of relay ICOA1, lead FTT in cable C4, normally made No. 2 contacts of relay T2AB, winding of said latter relay, to battery. Relay T2AB operates, locks over its No. 2 front contacts to ground on the polar timing relay STB, grounds leads IB0–IBX extending to all transverter channels to keep the indexer busy, and, over its No. 1 contacts, closes the circuit through the upper winding of polar relay STB, which would operate but for the neutralizing effect of the charging current for condenser C1 through its lower winding. It should be noted that this condenser is first discharged by ground on lead FTT. When, however, the transverter in trouble releases the indexer and lead FTT is opened, the charging circuit for the condenser is established through the lower winding of relay STB, keeping it in its normally unoperated position until the condenser is charged. The constants of the condenser and undesignated resistance in series with it are computed to keep relay STB normal for the period required for the second transverter called in on the connection to obtain another indexer. When condenser C1 is fully charged, relay STB operates to release relay T2AB, which releases to open the circuit through the upper winding of relay STB and to remove ground from the leads IB0–IBX, thus returning the indexer to normal.

Mention has previously been made of the seven relays XO1–XRG. These relays are cross-test relays, each in series with the plurality of relays indicated by the subscript designation. If one of said relays operates (the circuit thereof being serially completed through the upper winding of the involved X– relay) the cross-test relay does not operate. However, if two relays should operate, then the involved cross-test relay (for example, relay XO1) operates on double the current. Ground on lead **90** is advanced over the contacts of relay XO1, No. 1 contacts of relay XAL, No. 9 contacts of relay IA1 and No. 8 contacts of relay IA2, lead XIN in cable C4, No. 22 contacts of relay ICOA1, lead **97**, lower winding of relay XIN, to battery. As will be shown, the operation of relay XIN will cause the transverter and the connected indexer to be connected to the trouble indicator.

In the same manner, leads ROP and XPR are continuously connected over the No. 1 back contacts of relays ROP1 and XIN with relay ROP in the transverter. However, lead XPR extends over the No. 44 contacts of relay ICOA, lead **98**, lower winding of relay XPR to battery. Hence if a false ground should ever appear on lead XPR when the indexer is connected to the transverter, relay XPR will operate therein. It will be shown later that the operation of relay XPR will cause the transverter to be connected with the trouble indicator.

Continuing, now, with those operations of the transverter which follow the release of the indexer, relay IOK completes a path for grounding lead PR to the sender, and therein operating relay PR1. The path of this circuit traces from ground on the No. 2 back contacts of relay ROP, lead **450**, No. 2 contacts of relay IOK, lead **451** joined to lead PR in cable C3, through the transverter connector and similar lead in cable C2, contacts No. 9 in relay OEXD, upper winding of relay PR1 to battery. Relay PR1 operates, locks over its lower winding and No. 5 contacts to off-normal ground on lead SONG to the No. 2 contacts of relay ON4. Relay PR1 also opens leads H and S linking relay PA of the sender with relays H and S of the position, and thus causes all three relays to release. Relay H releases relay TE. At its No. 7 contacts, relay PR1 opens leads TS thereby to cause relay A in the position to release. When relay S releases, battery is supplied through resistance PDD, No. 1 contacts of relay PD, No. 2 contacts of relay P0, No. 1 contacts of relay S, lead **204**, to the position link and controller circuit, thereby to make the position available to service on the next call.

With all registrations in the transverter checked, including those resulting from the operation of the billing indexer, a start is made to seize a recorder in the recorder group indicated by the recorder identification register; that is, recorder group number **00**. The only part of the registration, the checking of which has not been described, are the pairs of relays SK and NSK, S0 and NS0 and TR1 and TR2. Accordingly, when one of each of said relays is operated and locked as before described,

a circuit is closed for relay CK4, which may be traced from battery through its winding, lead 41, No. 2 back contacts of relay NSK, No. 4 front contacts of relay SK, lead 95, No. 4 front contacts of relay NS0 (if the call is not observed, relay NS0 operates from the sender and locks to off-normal ground on lead TONG5; if the call is observed, relay S0 is operated instead, locking over its No. 2 contacts to said off-normal ground), No. 3 back contacts of relay S0, lead 462, No. 3 contacts of relay TR1, No. 6 back contacts of relay TR2, lead 463, No. 8 contacts of relay CK6, to ground. Relay CK4 operates and locks to said ground over its No. 5 back contacts.

When relays OF– (particularly relays OF7 and OF4) of the office index register are operated, battery is applied to the start lead RST0 in cable C7 extending to the recorder connector. This path traces from the No. 5 front contacts of relay RST00 individual to recorder group 00, lead 464, No. 2 contacts of relay TM3, lead 465, No. 4 contacts of relay EXT, lead 466, No. 1 contacts of relay OF7 or OF4, lead 467, No. 4 back contacts of relay TTF, No. 6 contacts of relay ROP, No. 4 contacts of relay MK, lead 468, contacts of relay XRN, lead 469, No. 7 contacts of relay CK4, lead 470, No. 3 contacts of relay TM6, lead 471, No. 5 contacts of relay RL, lead 472, No. 8 contacts of relay RTR, resistor ST, to battery. This path is completed to ground through a relay in the recorder connector which operates when the recorder is available. Fig. 4 conventionally indicates the recorder, which is the same as the one shown and described in copending application Serial No. 759,402, filed July 7, 1947, while the recorder connector by which the leads in cable 7 are extended to the selected recorder is also conventionally indicated, it being substantially similar to the transverter connector herein shown and described.

When the recorder and transverter have become connected together via the recorder connector, the recorder applies ground to lead RK, thereby completing an obvious circuit for relay RK, which operates to complete an obvious circuit for relay RKA over its No. 5 front contacts and lead 479, to perform certain functions that will be described in due course. If the recorder is busy, it applies ground to lead BY which completes the circuit of relay CBG over the No. 4 front contacts of relay RSTO, lead 474, No. 3 contacts of relay CK4, lead 475, No. 5 front contacts of relay INK, lead 476, winding of relay CBG to battery. As will be explained later this relay operates to cancel the transverter "condenser" timing under this condition, and releases when the recorder is free to restart timing. However, this relay is also operated when the recorder is seized, but since relay RK is also operated in this case, relay RK renders relay CBG ineffective to cancel condenser timing.

In this connection it should also be noted that the recorder is also provided with lead EXT, which it grounds to operate relay EXT whenever time for transverter operations are to be extended, the path of said relay being through the No. 1 front contacts of relay RST0, lead 477, No. 6 contacts of relay IOK2, No. 4 contacts of relay IOK, lead 478, winding of relay EXT, to battery. Since the start lead RST0 to the recorder extends through a set of normal contacts on relay EXT, it follows that if relay EXT is operated, the transverter will not obtain the recorder. It is possible, however, for lead EXT to be grounded and result in the operation of relay EXT after the recorder has been attached to the transverter, in which event lead RST0 would be opened and the recorder released in the midst of operations. To prevent this occurrence, if the recorder has already been seized, as evidenced by the operation of relays RK and RKA, the path of lead RST0 is bridged at the No. 3 contacts of relay TM6 and lead 470 by way of lead 470', No. 4 contacts of relay RKA, lead 480 joined to lead 465 extending to the No. 2 contacts of relay TM3, and thence as traced to lead RST0, thus by-passing the contacts of relay EXT as well as those on relays OF0–OF7 and CK4. Under such conditions the recorder continues with its operation and timing is not extended.

As previously stated, relay 2L is operated from the indexer and locked if the initial entry for the call is a two-line entry, as it is assumed to be for the call the establishment of which is herein being described to illustrate the operation of the invention. Over its No. 6 contacts and lead 480, relay 2L completes an obvious circuit for relay 2LA. Now when the recorder has become attached to the transverter and is ready for perforating operations, it grounds lead P, whereupon a circuit is completed for relays P2 and P2K in parallel, said circuit tracing from ground on said lead P, No. 6 contacts of relay RTR, lead 481, No. 4 contacts of relay IOK1, lead 482, No. 3 contacts of relay RKA, lead 483, No. 7 contacts of relay CK8, lead 484, No. 3 back contacts of relay TE, lead 485, No. 1 contacts of relay CTM2, lead 486, No. 4 back contacts of relay LOBA, lead 487, No. 1 front contacts of relay 2LA, lead 488, No. 1 back contacts of relay P2A, right winding of relay P2 to battery, and winding of relay P2K to battery.

If the call is a message unit detail MUD and thus requires a four-line initial entry, or if the call is a toll call and thus requires either a four-line or five-line initial entry, relay 2LA will be normal and relay MUD or TS, respectively, will be operated. In either of the two latter cases a path is completed to relays P4 and P4K instead of relays P2 and P2K, the path of said relays P4 and P4K being over the No. 1 back contacts of relay 2LA, lead 489, No. 1 back contacts of relay P4A, right winding of relay P4, to battery, and winding of relay P4K, to battery. Relay X2P is provided to check against the possible false operation of relays P2–P2K and relays P4–P4K at the same time. Should this happen, relays P2K and P4K complete the circuit of relay X2P from ground on the No. 5 contacts of relay P4K, No. 4 back contacts of relay P3K, No. 4 front contacts of relay P2K, lead 490, winding of relay X2P, to battery. As will be shown, the operation of this relay arrests further operations and calls in the trouble indicator.

If the call is a toll call, as evidenced by the fact that relay TS is operated, such a call may require either a four-line initial entry or a five-line initial entry. This determination is made by the transverter itself from the setting of the national area registers which, if the call requires a five-line initial entry, will cause the operation of relay 5L. It will be recalled that this determination is made by the operation of relay T5AT, which completes the circuit of relay 5L, previously traced. It will be shown that for a call requiring a five-line initial entry, relay 5L arranges the progress relays P– and P–A to be operated in the order P4, P3, P5, P2 and P1.

When either relay P2 or P4 operates, it completes a circuit for relay CK5 from ground on the No. 3 contacts of either relay, lead 492, winding of relay CK5, to battery. The operation of this relay (which relay is also operated over the same lead by relays LP, P4A, P3A, P2A, P1A, P5A, TE1A, TE1, X2P, P3, P1, P5, P5K, P2K, P3K and P4K) completes a locking circuit for the operated relay P2 or P4 over their respective No. 2 contacts, lead 491, No. 4 contacts of relay CK5, to ground on the No. 4 contacts of relay CK8. Relay CK5, on operating, opens the operating path of relay IOK1 to prevent reseizure of the billing indexer if an over registraiton is detected in the transverter by relay XRE after the recorder is connected. Relay CK5 holds to relays P1, P2, P3, LP and TE1 in order to prevent the start of a new call in the transverter before relays P– are released.

If the call being set up requires a 2-line initial entry (MU call), relays P2 and P2K are operated as above described. A circuit is then completed for the cut-in

relay C2A from battery through the winding of said relay, lead 493, No. 1 contacts of relay PCE, lead 494, No. 3 contacts of relay P2K, No. 2 contacts of relay P2, to aforetraced ground on lead 491. Said relay operates and locks over lead 495, No. 26 contacts of relay C2A, lead 496, No. 5 normal contacts of relay TE, to aforetraced ground on lead 491. Over its No. 32 contacts and lead 526, it completes the circuit of relay LP, which operates and then locks over its No. 3 contacts, lead 527, to ground on the No. 4 contacts of relay P2; over its No. 28 contacts it grounds lead PT to the recorder thereby to advise said recorder that cut-in relay C2A has been operated, while over its No. 29 contacts and lead 497 it completes the circuit of relay CTM1, the path of said circuit further tracing over the No. 3 contacts of relay CTM3. Relay CTM1, on operating, grounds lead 49 to discharge the capacitor C1 which remains short-circuited so long as relay CTM1 remains operated. This relay, however, on coming up, completes the circuit of relay CTM2 from ground on lead 497, No. 2 contacts of relay CTM1, No. 1 normally made contacts of relay SP, winding of relay CTM2, to battery. The latter relay operates, locks over its No. 7 contacts to operating ground, and completes an obvious circuit for relay CTM3, which releases relay CTM1 to re-establish the charging circuit of capacitor C1. If by the time the capacitor is fully charged the discharge thereof is not initiated by the reoperation of relay CTM1 to indicate that the recorder is taking longer than the predetermined time to punch a line of the initial entry, relay CTM operates as previously described and completes the circuit of relay DL from ground on the No. 5 contacts of relay CK1, lead 499, contacts of relay CTM, lead 498, No. 8 contacts of relay ORE, lead 404, winding of relay DL, to battery. Relay DL then operates. As will be shown, relay DL initiates operations to connect the transverter with the trouble indicator. If, however, the line is punched in the allotted time interval, cut-in relay C2A for the second line will release, removing ground from lead 497 to cause the release of relay CTM2. As will be shown, relays CTM1, CTM2 and CTM3 are operated for every line to measure the time interval within which the line is to be punched by the recorder.

Fig. 140 illustrates the three types of entries which are produced under the control of the apparatus of this invention for the three types of calls. Fig. 140A shows a two-line initial entry for a call to be charged for on a message unit basis; Fig. 140B shows a four-line initial entry for a detailed message unit call (bulk-billed) or a toll call; while Fig. 140C shows a five-line initial entry for a toll call involving an "uncompressed" national area code.

Because the AMA record is read backwards by the automatic accounting equipment, the apparatus of the invention is arranged to punch the lines of the entries in the reverse order. In respect to Figs. 140A, 140B and 140C, this means that in reading the lines of the entries from top to bottom the first line is the last line of the entry while the last line is the first. In describing the operation of the invention with respect to the punching of the lines of the entries, therefore, it should be understood that reference to the numerical indication of the lines will be that of the order of their punching.

Referring to the two-line initial entry for a message unit call (bulk-billed call) which is illustrated in Fig. 140A, it will be seen that the second line comprises the entry index in the A digit, the office index in the B digit, and the calling number in the C, D, E, and F digits. The entry index is always zero for any line of any entry except the first. The office index may have any value from 0–9. The thousandths, hundreds, tens and units digits of the calling number are recorded in the C, D, E, and F digits, respectively. The first line of the entry comprises the entry index in the A and B digits, the message billing index in the C digit and the call identity index in the E and F digits. The A digit is 2 for the first line of any entry, while the B digit may be 1, 3, 4, 5 or 6 in accordance with the following interpretation:

B digit	Significance
1	2-line entry.
3	4-line entry (non-observed).
4	4-line entry (observed).
5	5-line entry (non-observed).
6	5-line entry (observed).

The message billing index will be 1–8. The D digit will always be zero, and the call identity index will give the number of the tandem trunk over which the call is extended.

Referring to the four-line initial entry for detailed message unit (bulk-billed) or toll calls, the fourth line will be comprised of the entry index in the A digit and the called number in the B, C, D, E, and F digits. The third line will comprise the entry index in the A digit, the area code number in the B digit, the called number structure in the C digit, and the called office code in the D, E, and F digits. The B digit will be the code number of the terminating area. The C digit will have the value of 1, if the numericals of the called number make up a number less than 10,000, and the value of 2 if more than 10,000.

The second line is comprised of the entry index in the A digit, the office index in the B digit and the calling number in the C, D, E, and F digits.

The first line will be the same as the first line of the two-line entry, except that the B digit will now be a 3, representing a four-line entry, and the C digit will always be 9 for a toll call or any digit from 1 to 8 for a bulk-billed call.

Referring to Fig. 140C, this entry consists of five lines, and is produced for a toll call for which the national area code must be recorded in full as part of the initial entry in order that it may likewise appear in full on the subscriber's bill for the call. The fifth, fourth, second, and first lines of the entry are, respectively, the same as the fourth, third, second and first lines of the four-line entry. The third line, however, is added, and consists of the A, B and C digits of the national area code, recorded, respectively, in the D, E and F positions of the line; all other entry digits of the line being 0.

Proceeding, now, with the operation of the invention, and assuming that the two-line initial entry for the call being described is to be punched, when relay C2A operates, the punch leads A to F connecting with the twenty-eight punch magnets of the recorder are joined to the transverter for the selective energization of said magnets in the 2-out-of-5 code to punch all the digits of the second line.

It will be recalled that the numericals of the calling subscriber are 8276, and that the office index is 0. Since the entry index (A digit) is 0, relay C2A, at its No. 31 contacts, grounds lead A0 to energize the magnet A0 of the recorder, thereby to punch a hole in the first, or 0 position, of the A-digit space.

The office index is punched in the B-digit space of the line. For the example given this digit is 0, as will be recalled, and is expressed by the operated condition of relays OF4 and OF7 in the office index register. Consequently when relay C2A operates, ground on the No. 2 contacts of relay OF4 is applied to lead OF4 which, over the No. 4 contacts of relay C2A, is extended to the punch lead B4 of the recorder. Similarly, ground on the No. 2 contacts of relay OF7 is applied to lead OF7 which, over the No. 5 contacts of relay C2A, extended to punch lead B7 of the recorder. Magnets B4 and B7 of the recorder, respectively connected to said leads, operate and punch holes in spaces 4 and 7 of the B-digit space, thereby to record the digit 0 as the office index.

As will be recalled, the calling numericals are not registered in the transverter, but the groups of leads (see Fig. 98) DTH0–DTH7 (thousands); DH0–DH7 (hundreds); DT0–DT7 (tens) and DU0–DU7 (units) ex-

tended from the sender are selectively grounded therein in the 2-out-of-5 code to express the number 8276. Accordingly on the operation of relay C2A, and since leads DTH1 and DTH7 are grounded for the thousands digit 8, leads DH0 and DH2 are grounded for the hundreds digit 2, leads DT0 and DT7 are grounded for the tens digit 7, and leads DU2 and DU4 are grounded for the units digit 6, punch leads C1 and C7 are grounded over the No. 7 and No. 10 contacts, respectively; leads D0 and D2 are grounded over the No. 11 and No. 13 contacts, respectively; leads E7 and E0 are grounded over the No. 16 and No. 20 contacts, respectively; while leads F2 and F6 are grounded over the No. 23 and No. 24 contacts, respectively. Punch magnets C1, C7, D0, D2, E7, E0 and F2 and F4 are operated to punch the calling number 8276.

As already stated, when relay C2A operates, it applies ground over its No. 28 contacts to lead PT, thereby to signal the recorder that the cut-in relay C2A has operated. After certain responsive operations in the recorder, the latter removes ground from lead P, thereby to release relay P2K. When the recorder has punched the line of perforations, it applies ground to lead P1, whereupon a circuit is completed for relay P2A, which circuit extends from ground on said lead P1, No. 6 contacts of relay CK8, lead 500, No. 2 contacts of relay CTM3, lead 501, No. 1 contacts of relay P5K, lead 502, No. 1 contacts of relays P4K, P3K, P2K, P1K, No. 1 back contacts of relay TE1, No. 1 back contacts of relay P1, No. 1 front contacts of relay P2, lead 503, No. 27 contacts of relay C2A, lead 504, right winding of relay P2A, to battery. Relay P2A operates, locks over its left winding, No. 3 contacts, lead 505, to ground on the No. 3 contacts of relay CK6, and completes the circuit of relay PCE from battery through its winding, lead 506, No. 5 contacts of relay CTM2, lead 507', No. 5 contacts of relay P1, No. 2 and No. 3 contacts of relay P2A, to aforetraced ground on lead 505. Relay PCE operates and opens the locking circuit of relay C2A, which releases to disconnect the registering leads from the perforator magnets and to release relay CTM2 which, in turn, releases relays CTM3 and PCE.

When the recorder is ready to perforate the first line, it becomes necessary to connect the identity indexer to it to perforate the trunk number in the E and F digit spaces of the line. In this connection it will be recalled that when the transverter was seized, and particularly after relay CK6 was operated, the winding of relay ICK was connected in parallel with resistor ICB1 to lead ICK extending to the recorder, and resulting in the operation of relay ICB. Now when the recorder becomes connected to the transverter, a marginal potential is applied to lead ICK, as determined by the ohmic resistance of the windings of relays ICB and ICK and resistor ICB1, and over said lead ICK through the numerical registers of the call identity indexer. If said registers are normal, a circuit is completed from said marginal potential on lead ICK, through the recorder connector and recorder, the numerical registers of the call identity indexer, lead DJ from the indexer, No. 2 back contacts of relay TC of the trunk, lead IC (entering cable C2 at the transverter connector), through said connector, lead IC in cable C3 extending to the transverter, lead 601, No. 8 front contacts of relay CK4, lead 571, No. 6 contacts of relay RK, lead 572, normally made No. 4 contacts of relay IC, to resistance to battery. Relay ICK operates, in turn operating relay IC over an obvious path, said latter relay locking over its No. 2 contacts, lead 573, to ground on the No. 6 contacts of relay CK3 to ground and removing battery from lead IC, causing relay ICK to release if the lead and its connecting path is free of false battery, ground or other detectable crosses. Relay ICK released, operates relay TOK over ground on its back contacts, No. 3 contacts of relay IC, lead 574, winding of relay TOK to battery. On operating, relay TOK locks over its No. 2 contacts, lead 575, No. 3 contacts of relay CK5, to ground on the No. 3 contacts of relay CK8, and disconnects lead RD1 to the recorder, releasing a relay RD therein to provide operating battery for the windings of the call identity indexer tens register relays, relay TOK applying ground to the other side of the windings of said relays, said ground being traced from the No. 8 back contacts of relay TM3, No. 1 contacts of relay TM6, lead 576, No. 3 front contacts of relay TOK, No. 7 contacts of relay RK, lead 571, No. 8 front contacts of relay CK4, lead 601, then lead IC, and thence as traced to the call indentity indexer and to the tens relays therein. One of said relays then selectively operates in accordance with the tens digit designation of the tandem trunk, and operates an auxiliary relay which furnishes operating circuits for the selective operation of one of the units register relays in accordance with the units designation of said trunk; also, of course, under control of lead IC. Said units relay when operated, grounds lead IR via the recorder circuit to operate relay IR in the transverter. Relay C1A then operates in consequence and, over its No. 17 contacts, advances operating ground over lead 513, No. 1 contacts of relay XTU, lead DTN, to the winding of a cut-in relay DTN in the recorder, which operates to extend the tens and units registering leads from the tens and units registering relays of the call identity indexer, respectively, to magnets E and F of the recorder, said leads being selectively grounded in the 2-out-of-5 code in accordance with the designation of the trunk. Since the trunk number has been assumed to be 00 for the particular connection being described, said leads are selectively grounded to operate (at the proper time) magnets E4, E7 and F4, F7 to punch the digits 00 in the E and F positions of the line, respectively. Over its No. 16 contacts, relay C1A grounds lead PT1 to start perforation timing in the recorder. For the first line, however, ground is applied to lead PT1 instead of lead PT for the purpose of checking that relay DTN in the recorder has operated, said ground being passed through a set of make contacts on said relay to insure that it has operated and that the trunk identity will therefore be recorded. Relay DTN then applies ground to the extension of lead PT in the recorder to start timing the perforation of the line. Over its No. 15 contacts, relay C1A grounds lead A2 to complete the circuit of punch magnet A2, which operates to punch a hole in position 2 of the A-digit position; over its No. 12 contacts it applies previously traced ground on lead 496 to lead 514 and thence over lead 510, the No. 3 contacts of relay P1K, lead 511, No. 2 contacts of relay IR, lead 512, to the left winding of relay P1, and thence to ground on lead 491; over its No. 10 and No. 11 contacts it applies ground to leads D4 and D7 extending to the correspondingly designated punch magnets of the recorder to operate said magnets and punch the digit 0 in the D-digit position of the first line (this digit has no significance); over its No. 1–4 contacts it closes punch leads B– to certain leads in the transverter which are selectively grounded according to the value of the B digit that indicates the character of the initial entry, as previously described. If the initial entry is a two-line entry, as evidenced by the operation of relays 2L and 2LA, the B digit of the first line will be 1, requiring leads B0 and B1 to be grounded. Lead B0 is extended through the No. 1 contacts of relay CIA, to the IB lead 0, which goes to the No. 2 front contacts of relay 2LA, lead 515, No. 3 back contacts of relay LOBA, to ground. Punch lead B1 is closed to ground over the No. 2 contacts of relay CIA, IB lead 1, No. 3 front contacts of relay 2LA, lead 516, No. 1 back contacts of relay LOBA, to ground.

If the entry is a four-line entry for a message unit detailed (non-observed) call, as evidenced by the operated condition of relays MUD and NS0, or a four-line entry toll call (non-observed), as evidenced by the operating relays TS and NS0, the B digit will be 3. Consequently register leads B1 and B2 will be grounded.

lead B1 will extend through the No. 2 contacts of relay CIA, IB lead 1, No. 2 back contacts of relay 2LA, lead 515, No. 3 back contacts of relay LOBA, to ground; lead B2 will extend through the No. 3 contacts of relay CIA, IB, lead 2, No. 2 back contacts of relay 5L, No. 3 back contacts of relay 2LA, lead 516, No. 1 back contacts of relay LOBA, to ground. If either of such calls is "observed," the B digit is 4. For an observed call, relay S0 is operated from the sender over lead S0, and locked to off-normal ground on lead TONG5. For this condition, a circuit is then completed for relay LOB extending from battery through the winding of said relay, lead 517, No. 1 front contacts of relay S0, No. 1 contacts of relay NS0, lead 518, to ground on the No. 2 contacts of relay ICB. Relay LOB operates, locks over its No. 3 contacts through resistance, lead 518, to ground on the No. 2 contacts of relay ICB, and completes the circuit of relay LOBA from battery through the winding of said relay, No. 4 contacts of relay LOB, lead 519, No. 4 contacts of relay RK, to ground on lead TONG5. Relay LOBA operates and locks to said ground over its No. 2 contacts. Lead B0 is then grounded over the No. 1 back contacts of relay 5L, lead 520, No. 3 front contacts of relay LOBA, to ground. Lead B4 is grounded from the No. 1 front contacts of relay LOBA.

If the entry is a five-line entry for a non-observed toll call, the B digit will be 5. Since relay LOBA is normal, lead B1 is grounded over the No. 2 back contacts of relay 2LA, lead 515, to ground on the No. 3 back contacts of relay LOBA. Lead B4 is grounded over the No. 2 front contacts of relay 5L, No. 3 back contacts of relay 2LA, lead 516, to ground on the No. 1 back contacts of relay LOBA. If the five-line entry is an "observed" call, the B digit will be 6. Since relay LOBA operated as before described, lead B2 is grounded over the No. 1 front contacts of relay 5L, lead 520, to ground on the No. 3 front contacts of relay LOBA. Lead B4 will be grounded over the No. 1 front contacts of relay LOBA.

Relay CIA also closes the five punch leads C0–C7 to the billing index register. Since for the call being described this index has been assumed to be the digit 1 (relays MI0 and MI1 operated), lead C0 is grounded over the No. 1 contacts of relay MI0 and the No. 5 contacts of relay CIA; lead C1 is grounded over the No. 1 contacts of relay MI1, and the No. 6 contacts of relay CIA. The punch magnets C0 and C1 of the recorder operate to punch the digit 1 in the C-digit position of the first line of the initial entry.

Before continuing with the operation of the transverter following the punching of the first line of a two-line initial entry, we will describe the operation of the transverter in connection with the punching of a four-line entry and a five-line entry.

If the call requires a four-line message unit detail entry, relay MUD is operated as already explained. Consequently when the recorder is connected to the transverter and relays P4 and P4K are operated, a circuit is completed for relay C4A from battery through the winding of said relay, lead 521, No. 2 contacts of relay PCE, lead 522, No. 3 contacts of relay P4K, No. 2 contacts of relay P4, to aforetraced ground on lead 491. Relay C4A operates, locks over its No. 26 contacts to aforetraced ground on lead 496 and, among other functions identical to those performed by relays C2A and C1A, closes the punch leads A–, B–, C–, D–, E– and F– between the recorder and the called numerical leads connecting with the called number registers.

As will be observed from Fig. 140B, the fourth line of the entry consists of the A-digit entry index 0 and the numericals of the called number, including the stations digit, if any, or the digit 0 if none; the thousands digit being punched in the B-digit space, the hundreds digit in the C-digit space, the tens digit in the D-digit space, the units digit in the E-digit space, and the stations digit in the F-digit space. Consequently when relay C4A operates, and remembering that the called number for the connection being established is 1359, lead A0 is grounded over the No. 31 contacts of said relay for the punching of the A digit 0. For the punching of the B digit 1, lead B0 is grounded over the No. 4 contacts of relay TH1, No. 4, contacts of relay TH00, lead TH0, No. 25 contacts of relay UTA, No. 1 contacts of relay C4A, to lead B0; lead B1 is grounded over the No. 6 contacts of relays TH00 and TH1, lead TH1, No. 24 contacts of relay UTA, No. 2 contacts of relay C4A, to lead B1. For the punching of the C digit 3, lead C1 is grounded over the No. 4 contacts of relay H3, lead H1, No. 19 contacts of relay UTA, No. 7 contacts of relay C4A, to lead C1; lead C2 is grounded over the No. 6 contacts of relays H00 and H3, lead H2, No. 18 contacts of relay UTA, No. 8 contacts of relay C4A, to lead C2. For the punching of the D digit 5, lead D1 is grounded over the No. 7 contacts of relay T5, No. 4 contacts of relay T0, lead T1, No. 14 contacts of relay UTA, No. 12 contacts of relay C4A, to lead D1; lead D4 is grounded over the No. 3 contacts of relay T0, lead T4, No. 12 contacts of relay UTA, No. 14 contacts of relay C4A, to lead D4. For the punching of the E digit 9, lead E2 is grounded over the No. 4 contacts of relays U4 and U5, No. 8 contacts of relay UTA, No. 18 contacts of relay C4A, to lead E2; lead E7 is grounded over the No. 6 contacts of relay U5, No. 5 contacts of relay U4, lead U7, No. 6 contacts of relay UTA, No. 20 contacts of relay C4A, to lead E7. For the punching of the F (stations) digit 0, lead F4 is grounded over the No. 3 contacts of relay ST0, lead ST4, No. 2 contacts of relay UTA, No. 24 contacts of relay C4A, to lead F4; lead F7 is grounded over the No. 6 contacts of relay ST00, No. 5 contacts of relay ST0, lead ST7, No. 1 contacts of relay UTA, No. 25 contacts of relay C4A to lead F7.

Had the called number been over 10,000, relay OTA would have been operated instead of relay UTA, as already described. Relay OTA shifts the stations digit leads from the F-digit recording leads to the B-digit recording leads, the thousands digit registering leads from the B-digit recording leads to the C-digit recording leads, etc.; so that, as the number is read on the record, the ten thousands digit will appear in the B-digit position, the thousands digit in the C-digit position, the hundreds digit in the D-digit position, the tens digit in the E-digit position, and the units digit in the F-digit position.

When the recorder is signaled by ground on lead PT that the cut-in relay C4A has been operated and, as a result, the recorder removes ground from lead P, relay P4K releases; and when ground is applied by the recorder to lead P1 as a signal that the perforator magnets have correctly operated to punch the fourth line, a circuit is completed for relay P4A, said circuit tracing from battery through its right winding, lead 528, No. 27 contacts of relay C4A, lead 529, No. 1 contacts of relay P4, No. 1 back contacts of relay P3, lead 530, No. 4 back contacts of relay P5, lead 531, No. 1 back contacts of relays P2, P1, TE1, P1K, P2K, P3K, P4K, lead 502, and thence as previously traced to lead P1. Relay P4A operates, locks over its left winding and No. 3 contacts to previously traced ground on lead 505, and operates relay PCE over a previously traced path to lead 507', No. 5 contacts of relay P3, No. 2 and No. 3 contacts of relay P4A, to ground on lead 505. With the operation of relay PCE, the circuit of relay C4A is opened, thereby releasing said relay and disconnecting the perforating leads from the recorder.

When the recorder is ready to receive the next (or third) line of perforations, ground is again applied to lead P, in consequence of which a circuit is completed for relays P3 and P3K from battery through the windings of said relays, No. 1 back contacts of relay P3A, No. 1 front contacts of relay P4A, lead 489, and thence as previously traced to ground on lead P. Relays P3 and P3K operate, the former locking over its left wind-

ing and No. 3 contacts to previously traced ground on lead 491. A circuit is thereupon closed for the cut-in relay C3A for the third line of perforations, said circuit extending from battery through the winding of said relay, lead 540, No. 1 contacts of relay PC0, lead 541, No. 3 contacts of relay P3K, No. 3 contacts of relay P3, to aforetraced ground on lead 491. Relay C3A operates, locks over lead 542, No. 14 contacts of said relay, lead 496, and thence as traced to ground on lead 491, grounds lead PT over its No. 4 contacts to the recorder as a signal that the cut-in relay C3A has been operated, applies ground over its No. 3 contacts to lead 497', thereby to complete the previously described circuit of the timing relay CTM1, which operates to initiate the timing cycle for the perforation of the line, and connects the perforating leads A–, B–, C–, D–, E– and F– to various registers and leads of the transverter.

By reference to Fig. 140B, it will be observed that the second line from the top of a four-line initial entry is made up of the A entry digit 0; the B area code digit which identifies the area in which the called office is located and has the value 1 for the called office Republic 7 (see Fig. 139); the C called number structure digit is 1 if the called number is under 10,000, and 2 if it is over 10,000; and the called office code digits A, B and C which are recorded, respectively, in the D-, E- and F-digit positions of the line, and which, for the call being described will be 737.

Consequently when relay C3A operates, ground is applied over its No. 2 contacts to lead A0 to operate recording magnet A0. For the B digit, it will be remembered that the class-of-service relays CS00 and CS1 were operated to register the terminating area digit 1. Hence when relay C3A operates, ground on the No. 3 normal contacts of relay NB1 is applied over the No. 2 normally made contacts of relay NB0, lead 543, No. 3 contacts of relay CS00, No. 7 contacts of relay CS1 (cross-connected to lead P0), No. 5 contacts of relay C3A, to lead B0. Ground is also applied over the No. 3 normally made contacts of relay NB00, lead 544, No. 4 contacts of relays CS00 and CS1 (the latter contacts being cross-connected to lead P1), No. 6 contacts of relay C3A, to lead B1. The energization of punch magnets B0 and B1 will result in the punching of the digit 1 in the B-digit spaces of the third line.

It should be stated in passing that a four-line initial entry for a message unit detail call (MUD) and a four-line initial entry for a toll call are identical, except that the B digit of the third line of the latter entry will be the digit which identifies the national area in which the called office is located, and which digit may have any value 3–9. It will be recalled that for a toll call the national area code registers come into play, and that a relay T4A0–T4A9 expressing the digit of the code will be operated by the registers, the latter relay then selectively grounding the B leads in accordance with the value of the digit. Thus if the called area code is represented by operated relay T4A9 and the digit for said code is 9, terminals A9 and B9 will be cross-connected to terminals P7 and P2, respectively. Therefore, on the operation of relay C3A, ground previously traced to lead 417 is applied over the No. 3 contacts of relay T4A9, lead P2, No. 7 contacts of relay C3A, to lead B2; ground previously traced to lead 416 is applied over the No. 4 contacts of relay T4A9, lead P7, No. 9 contacts of relay C3A, to lead B7. Punch magnets B2 and B7 will then operate to punch the B digit 9.

For the punching of the called number structure digit 1 or 2, ground is applied over the No. 10 contacts of relay C3A to lead C0 for the energization of punch magnet C0. If the number is under 10,000 (as assumed for the call being described) ground is applied over the No. 1 back contacts of relays OT and SU, lead 545, No. 11 contacts of relay C3A, to lead C1. The operation of magnets C0 and C1 cause the digit 1 to be punched in the C-digit spaces of the third line. If the number is over 10,000 relay OT will be operated. Hence a ground is applied over the No. 1 front contacts of relay OT, No. 1 contacts of relay NSK, lead 546, No. 12 contacts of relay C3A, to lead C2. The operation of punch magnets C0 and C2 causes the digit 2 to be punched in the C-digit spaces of the third line.

For the punching of the three digits of the called office code in the D-, E-, and F-digit spaces of the line, punch leads D–, E–, and F– are connected by relay C3A to the called number A-, B- and C-digit registers. The A digit 7, registered by the operation of relays A2 and A5, results in the grounding of leads D0 and D7; lead D0 being grounded over the No. 8 contacts of relay A2, No. 25 contacts of relay C3A, to lead D0; lead D7 being grounded over the No. 1 contacts of relay A5, No. 4 contacts of relay A2, No. 29 contacts of relay C3A, to lead D7. The B digit 3, registered by the operation of relays B00 and B3, results in the grounding of punch leads E1 and E2; lead E1 being grounded over the No. 8 contacts of relay B3, No. 21 contacts of relay C3A, to lead E1; lead E2 being grounded over the No. 1 contacts of relays B00 and B3, No. 22 contacts of relay C3A, to lead E2. The C digit 7, registered by the operation of relays C2 and C5, results in the grounding of leads F0 and F7; lead F0 being grounded over the No. 8 contacts of relay C2, No. 15 contacts of relay C3A, to lead F0; lead F7 being grounded over the No. 1 contacts of relay C5, No. 4 contacts of relay C2, No. 19 contacts of relay C3A, to lead F7. The six indicated punch magnets operate and punch the digits 737 in the D-, E- and F-digit spaces, respectively, of the third line of the entry.

When ground is removed from lead P in the recorder on signal from the transverter over lead PT that the cut-in relay C3A was operated, relay P3K releases; and when ground is applied to lead P1 by the recorder as an indication that the perforation of the line has been checked, relay P3A is operated over a circuit extending from battery through its right winding, lead 548, No. 13 contacts of relay C3A, lead 549, No. 1 front contact of relay P3, lead 530, and thence as previously traced to ground on lead P1. Relay P3A operates, locks over its left winding and No. 3 contacts to previously traced ground on lead 505, and completes the circuit of relay PC0 from battery through its winding, lead 550, No. 4 contacts of relay CTM2, lead 551, No. 2 back contacts of relay T5AT, lead 552, No. 5 contacts of relay P2, lead 553, No. 1 back contacts of relay T5AT, lead 554, No. 2 contacts of relay P3A, to aforetraced ground on lead 505. Relay PC0 operates and opens the circuit of the cut-in relay C3A which, on releasing, severs the connection between the perforator magnets and the transverter, and releases relays CTM2, PC0 and CTM3. When ground is next applied to lead P by the recorder for the second line of perforation, relays P2 and P2K are operated as before described for a two-line entry, operations then proceeding as previously described for the punching of the two lines of a two-line initial entry.

Fig. 140C illustrates a five-line initial entry for a national area call. It will be noted from this figure that the first, second, fourth and fifth lines (counting from the bottom up) are the same as those of a four-line initial entry. Between the second and fourth lines, however, is inserted a third line, in the D-, E-, and F-digit positions of which are recorded the three digits of the national area code, all other digit positions being filled with zeros. Assuming, then, that a call is being established to some office in a national area of which the code is 209, the operation of the transverter in recording the fifth line under control of relays P4 and P4K and the fourth line under control of relays P3 and P3K is the same as already described for the fourth and third lines of a four-line initial entry. When however, ground is applied to lead P by the recorder for the perforation of the next (or

third) line, and due to the fact that relay 2LA is normal, a circuit is completed for relays P5 and P5K from battery respectively through the windings of said relays, lead 555, No. 1 contacts of relay P5A, lead 556, No. 3 front contacts of relay 5L, lead 557, No. 1 front contacts of relays P3A and P4A, and thence to aforetraced ground on lead 489 from lead P. Relays P5 and P5K operate, relay P5 locking over its left winding and No. 2 contacts to aforetraced ground on lead 491, and completes the circuit of cut-in relay C5A from battery through its winding, lead 558, No. 4 contacts of relay PC5, No. 3 contacts of relay P5K, No. 2 contacts of relay P5, to aforetraced ground on lead 491. Relay C5A operates, locks over lead 559 ond No. 24 contacts to aforetraced ground on lead 496, and connects the perforator leads with the transverter. Over its No. 2 contacts it grounds lead PT to signal the recorder that the cut-in relay C5A has been operated; over its No. 5 contacts it grounds lead A0 for the punching of the A digit 0; over its No. 3 contacts it grounds lead 497' to initiate timing by operating relay CTM1; over its No. 6 and No. 7 contacts it grounds leads B4 and B7, respectively, for the punching of the B digit 0; and over its No. 8 and No. 9 contacts it grounds leads C4 and C7, respectively, for the punching of the C digit 0. The D digit (that is, the A digit of the code) is obtained from the setting of the A national area code A-digit register (Fig. 77). Since this digit has been assumed to be 2 (relays NA00 and NA2 operated), lead C0 is grounded over the No. 8 contacts of relay NA2 and the No. 10 contacts of relay C5A; while lead C2 is grounded over the No. 6 contacts of relays NA2 and NA00, and the No. 12 contacts of relay C5A. The E digit (that is, the B digit of the code) is obtained from the national area code B-digit register. Since this digit is 0, leads E4 and E7 are grounded by the No. 5 and No. 6 contacts, respectively, of relay NB0 and the No. 17 and No. 18 contacts, respectively, of relay C5A. The F digit (that is, the C digit of the code) is obtained from the setting of the national area code C-digit register. Since this digit has been assumed to be 9 (relays NC4 and NC5 operated) lead F2 is grounded over the No. 8 contacts of relay NC4, No. 7 contacts of relay NC5, No. 21 contacts of relay C5A to lead F2; lead F7 is grounded over the No. 5 contacts of relay NC5, No. 6 contacts of relay NC4, No. 23 contacts of relay C5A, to lead F7. The magnets indicated by identically designated perforating leads operate to punch the "third" line of the entry with the national area code "209," recorded in the D-, E- and F-digit positions of the line.

When ground is removed on lead P on signal over lead PT that the cut-in relay C5A has been operated, relay P5K is released; and when ground is again applied to lead P1 as an indication that the perforation of the line has been checked, a circuit is completed for relay P5A from battery through its right winding, lead 560, No. 1 contacts of relay C5A, lead 561, No. 4 front contacts of relay C5, lead 531, and thence as traced to ground on lead P1. Relay P5A operates, locks over its left winding and No. 2 contacts to previously ground on lead 505, and completes the circuit of relay PC5 from battery through its winding, lead 562, No. 9 contacts of relay CTM2, lead 563, No. 2 front contacts of relay T5AT, lead 552, No. 5 contacts of relay P2, lead 553, No. 3 and No. 2 contacts of relay P5A, to aforetraced ground on lead 505. Relay PC5 operates and releases relay C5A, which disconnects the perforator leads from the transverter. The succeeding lines of the entry, perforated under the control relays P2–P2A and P1–P1A, then takes place in the manner described.

When the perforation of the first line has been complete, ground is removed from lead P and connected to lead P1, whereupon a circuit is completed for relay P1A from battery over its right winding, lead 580, No. 13 contacts of relay C1A, lead 850, No. 1 back contacts of relay BLL, lead 851, No. 1 front contacts of relay P1, No. 1 back contacts of relay TE1, No. 1 back contacts of relays P1K, P2K, P3K, P4K, and thence as previously traced to ground on lead 502. Relay P1A operates, locks over its left winding and No. 3 contacts to ground on lead 505, operates relay PC0 from battery through its winding, lead 550, No. 4 contacts of relay CTM2, lead 551, No. 2 contacts of relay P1A, to ground on lead 505, and operates relay P1B from battery through its winding, lead 581, No. 5 contacts of relay P1A, No. 3 contacts of relay P1 to aforetraced ground on lead 491. Relay PC0, in operating, releases relay C1A. Relay P1B, when operated, extends ground on lead DS via the No. 1 back contacts of relay TE, lead 582, No. 2 contacts of relay LP, No. 2 contacts of relay BLL, No. 2 contacts of relay P1B, to lead DS, thereby to operate a relay in the recorder which completes the circuit of the talking charge relay TC in the trunk over or throguh ground on the contacts of said relay, lead TC (see Fig. 4), normally made No. 4 contacts of relay I, normally made No. 5 contacts of relay TC, No. 4 contacts of relay T, No. 6 contacts of relay F (which release when the trunk is extended to the outgoing trunk), winding of relay TC, to battery. This relay operates, locks to ground on its No. 5 contacts to indicate a charge for the call if answered, and releases relay DK in the recorder thereby to cause relay RD in said recorder to operate. The latter relay releases the tens and units relays of the call identity indexer, the units relay releasing a units auxiliary relay which removes battery from lead IR to release relay IR in the transverter.

When relay C1A is released, the recorder magnets and relays are restored to normal and the tape is advanced to the next line. The recorder then removes ground from lead P1 and applies it to lead P, thereby to complete the circuit of relay P6 from battery through its right winding, lead 583, No. 1 front contacts of relays P1A and P2A, lead 488, No. 1 front contacts of relay 2LA, and thence as aforetraced to ground on lead P. If the call requires a five-line entry, then said path will trace at lead 488 over the No. 1 front contacts of relay P5A, lead 556, No. 3 front contacts of relay 5L, lead 557, No. 1 front contacts of relays P3A and P4A, lead 489, and thence as previously traced to ground on lead P. If the call requires a four-line entry, then the path extends over lead 488, No. 3 back contacts of relay 5L, lead 557, No. 1 front contacts of relay P3A, No. 1 front contacts of relay P4A, and thence as traced over lead 489 to ground on lead P. Relay P6 operates, locks over its left winding, No. 1 front contacts, lead 87 to ground on the No. 9 contacts of relay CK6, and opens the circuit of relay IOK at its No. 1 back contacts, causing the release of the latter relay. With relay IR released and relay P6 operated, a path is completed for the transverter release relay RL, said path tracing from battery through the winding of said relay, lead 584, No. 2 contacts of relay XRL, lead 585, No. 3 back contacts of relay ORE, No. 2 front contacts of relay TIB, lead 586, No. 2 contacts of relay P6, No. 4 back contacts of relay IR, No. 6 contacts of relay XDK, back contacts of relay DK to ground. At its No. 5 contacts, it opens battery to the start lead ST0 of the recorder, thereby to restore both the recorder and recorder connector to normal; over its No. 2 contacts it applies ground to lead 587, No. 1 contacts of relay RTR, No. 3 contacts of relay TR, to lead TVR extending through cables C3 and C2 to the lower winding of relay TVR in the sender, thereby to cause said relays operation, locking over its No. 7 contacts to ground on the No. 5 contacts of relay TVS, and opening lead STV to the transverter connector, which releases relay SS therein, followed by the release of relay SA and relays TS and TA and the disconnection of the transverter from the sender. The release of relay SA removes ground from lead CKG, thereby to release relay CK6, in turn releasing relays OCK, CK4, CK1, CK8 and the perforation progress relays P1–P6. Relay CK1 released, releases relays CK3,

CK7 and SK or NSK. When all register relays release, the transverter is ready to process the next call, relays CK1 and NOK being operated over the down-check paths as already described. It should be noted that relay CK7 is held operated by relays IOK, ROP, RL, etc. to prevent reseizure of the transverter until all of these relays are released.

Before continuing with the sequence of operation following the release of the transverter, we will describe briefly certain safeguards provided therein for alarms which are operated in the event of trouble conditions detected before and after the transverter is taken into use, in the event that the transverter takes longer than a predetermined time to perform its over-all functions, in the event that specific functions take longer than preallotted intervals therefor, and in the event that certain other functions take more than a predetermined, though smaller time. These will be known, respectively, as Standing Tests, Long Timing, Intermediate Timing, and Condenser Timing. We will also describe the use of the transverter with the line-observing and number-matching circuit shown in Figs. 120–132, by which a certain number of subscribers' lines, listed for service observing, are checked on calls established therefrom, and a detailed record (four-line initial entry) is produced for each such call.

Standing tests

Certain leads in the transverter are constantly guarded for false grounds or shorts, and when they become so grounded or shorted, the trouble indicator is attached to the transverter to make a trouble record. The leads in the transverter which are so guarded are given below, together with operations which follow a trouble condition thereon.

(*a*) The punch and control leads F7—P1 extending to the recorder (by way of the recorder connector) are normally bunched together, connected through individual resistors at the back contacts of relay COA and lead 587 through the winding of relay XP1, and thence to a potentiometer that provides approximately 20 volts, by way of example. Relay XP1 operates on a closure to battery or ground on any of the leads. Therefore it detects either a falsely grounded lead or a cross on a recorder cut-in relay to battery through a perforator magnet. Relay XP1 operates relay X from ground on its No. 3 contacts, lead 588, No. 1 back contacts of relay XL, upper winding of relay X, to battery. Relay X operates and completes a circuit path for relay XP, which extends from battery through its winding, No. 1 contacts of relay XP1, lead 401, No. 4 contacts of relay X, lead 589, to ground on the No. 7 contacts of relay TR. Relay X also locks to said ground through its No. 3 and No. 4 contacts, and operates relay XL from ground on its No. 3 contacts, No. 4 normally made contacts of relay XL, No. 1 contacts of relay TBC3, the winding of relay XL, to battery. Relay XL then locks over the No. 1 contacts of relay TBC3, its No. 4 front and No. 1 front contacts, lead 591, to ground on the No. 5 contacts of relay CO1, the latter relay having operated at the same time as relay COA, as before described. Relay X also operates relay TBC2 from ground on its No. 2 contacts, lead 590, winding of relay TBC2, to battery, and the latter relay, when operated, operates relay CKG which, in turn, operates relay COA as before described to individualize the perforator and control leads, and to release relay XP1.

Relay XL, on operating, completes the circuit of relay DL from battery through its winding, lead 404, No. 8 contacts of relay ORE, lead 498, No. 5 contacts of relay X, No. 3 contacts of relay XL, to ground. Relay DL operates to initiate other operations previously described (including the operation and locking relay TIB) by which the transverter is connected to the trouble indicator, which operates to take a trouble record, the main part of which in this instance will be an indication of the recorder perforator or control lead having the false ground thereon. Relay DL operates relay TR which releases relay X, in turn, releasing relay XP1 and slow-release relay TBC2, which releases relay CKG, relays COA and CO1. Relay CO1 released, opens the locking circuit of slow-release relay XL. The release of relay COA again bunches the perforator leads, and if the trouble still remains, relay XP1 will reoperate before relay XL releases, relay XP1 holding relay XL. The latter relay prevents the reoperation of relay X; relay XL or XP1 then grounding lead CB to operate relays CB, thus making the transverter test busy to all connectors.

(*b*) In general, a standing test is also applied to the register leads which are not normally "down" checked when the transverter is moved off-normal. The register leads DTH, DH–, DT–, DU–, are grouped together at the contacts of relay CO2, the leads RC0, RC1 and RC2 are grouped together on the contacts of relay CO1, and both groups are connected by way of lead 594 to the lower winding of relay XCL. If one of these leads is falsely grounded, relay XCL operates, locks over its upper winding, No. 1 contacts, lead 401 to lead TM, or over lead 400 to ground on relays TA1 or TA2, if operated. Relay XCL operates relays X and XL, thereby causing the circuit to function as above described to provide a trouble indicator record. Relay CKG operates relays CO1 and CO2 to individualize the involved leads in order that the transverter trouble indicator may indicate the particular lead in trouble.

If the trouble remains after the trouble record has been made, relay CKG releases as previously described, releasing relays CO1 and CO2 and, in turn, reoperating relay XCL. Relay CO1 also opens the locking path of relay XL, but this locking circuit is re-established by relay XCL and these relays remain operated as long as the trouble continues; relay XCL, X or XL grounding lead CB to make the transverter busy at all connectors, as previously described. As will be explained later, relays X, XL and XCL also start long timing as a further safeguard.

(*c*) If lead IC in cable C3 (Fig. 97) from the transverter connector is falsely grounded, relay XIC is operated over its lower winding, as it does if relay TOK is operated and the transverter is otherwise normal; the latter circuit path being from ground on the No. 8 back contacts of relay TM3, No. 1 contacts of relay TM6, lead 576, No. 3 front contacts of relay TOK, lead 600, No. 7 back contacts of relay RK, lead 601 joined to lead IC, and thence as traced to the lower winding of relay XIC. The latter relay operates, locks to lead 401, and functions like relay XCL etc., to summon the trouble indicator.

Relay XIC1 which has a predetermined potential connected to its winding, checks that relays RK and TOK release between calls. If relay RK fails to release, then the battery supply for lead IC at the No. 4 contacts of relay IC is extended over lead 572, No. 6 contacts of relay RK, lead 571, No. 8 back contacts of relay CK4, lead 604, winding of relay XIC1, to the potential supplied by the potentiometer connected to said winding. If relay TOK fails to release, then ground previously traced to lead 576 will extend over the No. 3 front contacts of relay TOK, No. 7 front contacts of relay RK, lead 571, No. 8 back contacts of relay CK4, thence as traced to the winding of relay XIC1. Under either condition, relay XIC1 operates and closes an obvious circuit for relay XIC which operates to summon the trouble indicator.

(*d*) If relay ICK should operate because of a false ground on lead ICK, said relay will operate, in turn operating relays IC and ICB in the manner described. Due to the fact that relay CKG is normal, a circuit is completed for relay XICK either by relay IC or relay ICB, whichever is operated, the path tracing from battery through the lower winding of relay XICK, lead 605, No. 3 contacts of relay CKG, lead 606, to ground on the

No. 1 contacts of either relay IC or ICB. Relay XICK operates, locks to ground on lead **401** and operates like other relays in the group of cross test relays to summon the trouble indicator.

(*e*) Relay XRST guards the chain circuit for operating the recorder preference relays in the associated recorder connector circuit. If relay TST is normal (as it should be when the transverter is normal) and a relay RST00–RST19 has failed to release, or the chain contacts have failed to open the path to the preference relays, relay XRST operates over lead **607**, contacts of relay TST, lead **464**, No. 5 back or front contacts of relay RST–, to the grounded conductor. Relay XRST operates and grounds lead **498**, connecting with lead **404** at the No. 8 back contacts of relay ORE, and to the winding of relay DL, which operates to summon the trouble indicator as before described. Relay TST is slow to release in order to allow the start circuit paths of this transverter to be cleared before the standing test is reapplied after a call has been completed. In periods of heavy traffic relay TST may not release between calls.

(*f*) If the recorder busy lead RB is falsely grounded or crossed to ground in the transverter up to and including the chain contacts of relays RST–, relay XRB operates over a path extending from battery through its lower winding, lead **608**, No. 1 back contacts of relay CKG, lead **609**, No. 2 back contacts of the involved relay RST–, to ground on lead RB. Relay XRB operates, locks over its upper winding and No. 1 contacts to ground on lead **401**, and functions like the previously described cross-test relays to summon the trouble indicator. It should be noted that relay XRB also checks that relay RTR (recorder trouble release) does not remain operated indefinitely. If relay RTR is operated when the transverter is otherwise normal, the circuit of relay XRB is completed as traced to lead **609** (Fig. 98), thence over lead **609'**, No. 2 back contacts of relay CK4, lead **610**, No. 3 contacts of relay RTR, to ground.

(*g*) While the transverter is normal, position release lead PR and recorder operator lead ROP are covered continuously by relay XPR until required for signaling purposes. A false ground on either lead PR or ROP operates relay XPR as already described. It should be noted that the guard of relay XPR is extended over lead **98** and the No. 44 contacts of relay ICOA to the billing indexer in order to provide a continuous guard on relay ROP of said billing indexer.

(*h*) Leads TVR, TRL and ROM are guarded by relay XRL except when these leads are in use. If lead ROM becomes falsely grounded, a circuit is completed for relay XRL from said ground on lead ROM, No. 7 back contacts of relay TM6, lead 45, No. 1 back contacts of relay TR2, No. 5 contacts of relay RTR, No. 4 contacts of relay TR, lead **612**, No. 1 contacts of relay RL, lead **612'**, lower winding of relay XRL, to battery. If lead TVR is falsely grounded, the circuit of relay XRL is completed from ground on said lead TVR (Fig. 84), No. 3 contacts of relay TR, No. 1 contacts of relay RTR, lead **587**, lead **613**, No. 3 contacts of relay TBC3, lower winding of relay XRL, to battery. If lead TRL is falsely grounded, the circuit of relay XRL is completed from ground on said lead TRL (Fig. 98), No. 7 contacts of relay RTR, No. 8 back contacts of relay TR2, lead 614, No. 4 back contacts of relay TM3, lead **615**, No. 5 contacts of relay TBL, lead **616**, No. 6 normally made contacts of relay TE, lead **617**, No. 1 back contacts of relay LP, No. 1 back contacts of relay XDK, lead **618**, No. 5 back contacts of relay TR, lead **612**, and thence as traced to the lower winding of relay XRL. This relay operates, locks over its upper winding and No. 1 contacts to ground on the timing lead **401**, and functions to connect the trouble indicator. Relay XRL, at its No. 2 contacts, opens the operating path of relay RL, thus reducing the hazard of finding a grounded release lead in case a service call enters the transverter before the circuit can be made busy. Without the need of tracing the various circuit paths, relay XRL also operates if relay RL or P5 is prematurely operated, or if the contacts of relays TM3, TM6, TIB or RTR are crossed.

(*i*) Lead CK (Fig. 81) to the recorder is continuously guarded by relay XCK until its use is anticipated by the operation of relay TBL. Hence a false ground on lead CK completes the circuit of relay XCK over the No. 1 back contacts of relay TBL, lead **619**, lower winding of relay XCK, to battery. The latter relay operates, locks over its upper winding and No. 1 contacts to ground on timing lead **401**, and functions to connect the trouble indicator to the transverter.

(*j*) It will be recalled that relay X2P operates in the event that two progress relays P– are operated for one line of recording, and that said relay X2P, when operated, completes the circuit of relay DL to summon the trouble indicator. Relay X2P also provides for holding relay CK5 to assure that relay X2P is released before the start of another call.

The operation of two relays P—A is detected only when two of the relays PC0, PCE and PC5 are operated at the same time. Relay X2P is again operated through chain contacts on these relays, relay DL being then operated to provide a transverter trouble indicator record.

(*k*) If two tens relays are simultaneously operated in the call identity indexer (not shown, but indicated) while recording is in progress, relay XT is operated over the lead XT (Fig. 93). Relay XT operates relay XTU, which locks over its No. 2 contacts, lead **589**, to ground on the No. 7 contacts of relay TR. Relay XTU grounds lead **498** to operate relay DL, thus to provide a transverter trouble indicator record.

Before recording has started, relay XTU is connected to the units lead UK of the call identity indexer to check for a false ground thereon. When the perforation of the first line has started, relay LP operates as described, and, over its No. 6 contacts and lead **621**, transfers lead UK from relay XTU to relay UMG. If two or more units relays are operated in the call identity indexer, relay UMG operates, operating relay XTU to summon the trouble indicator.

(*l*) Leads DTK and DTKA (Fig. 81) from the recorder are used to check the winding and contacts of relay TC in the trunk for premature operation or for false grounds on the associated leads. When the trunk is seized and relay T therein is operated in the manner described, relay TC operates if ground is applied to lead TC from the recorder. Consequently a false ground on lead TC will result in a false operation of relay TC and a false charge for the call if not detected in advance. In the recorder, lead TC is joined through contacts of a relay to lead DTK, in consequence of which a false ground on lead TC will complete a circuit over the No. 1 back contacts of relay IR and the No. 4 contacts of relay PIB to the left winding of relay DK. Similarly, a device in the recorder responds to a falsely operated relay TC in the trunk, in consequence of which said device applies a ground over lead DTKA to the right winding of relay DK. In either case, relay DK operates, locks over its right winding and normally made No. 3 contacts of relay XDK to ground on its own front contacts and operates XDK, which locks to off-normal ground on lead TONG12 and grounds lead **498** to operate relay DL, which summons the trouble indicator.

There are certain trouble conditions detected by the sender for which trouble records are made by the transverter trouble indicator. However, since certain of these troubles involve the period taken by the transverter to process a service call, the timing of the transverter will be described first.

Long timing

The over-all operation of the transverter must take place within a predetermined "long timing" period, while certain of its specific operations must be performed with-

in certain smaller timing intervals. Long timing will be described first.

Relays TM5 and TM6 and the associated interrupter DB are furnished to give an alarm, release any engaged recorder circuit, and provide a trouble release signal if some trouble occurs that would prevent a shorter time-out, or in case lead DB is permanently grounded.

When the transverter is seized by the operation of relay TA of the transverter connector lead DB is grounded, operating relay CBR which makes the transverter busy at all other transverter connectors. Said lead DB connects to, among other places, the swinging contact of interrupter DB. Hence when the swinger of said interrupter engages with its left stationary contact, an obvious circuit is completed for relay TM5, which operates and locks over its No. 1 contacts to operating ground. When the swinger engages the right contact after the operation and locking of relay TM5, a circuit is completed from ground on lead DB, right contacts of interrupter DB, No. 2 contacts of relay TM5, winding of relay TM6, to battery, operating the latter relay, which locks to operating ground over its No. 4 contacts, opens the recorder start lead ST– (at lead 470), grounds leads ROM and ROP to the sender (the latter lead being grounded as a second means of releasing the sender in case lead ROM is in trouble), and releases relay IOK1 to release the billing indexer. By way of example, the rotation of interrupter DB may be at a speed such that the operation of relay TM6 takes place in 14 to 29 seconds after the grounding of lead DB. Relay TM4 then operates from the No. 5 contacts of relay TM6, locks over lead 630 to ground on the alarm release key AR, and lights the lamp TA. The transverter then remains out of service until key AR is operated and relay TM4 released.

Relay ROM in the sender, like relay ROP therein, operates over its lower winding and locks over its upper winding and No. 4 contacts, to ground on the No. 7 contacts of relay DRL. With the operation of relay ROP, relay TVS releases to remove ground on lead STV, thereby to release the transverter connector and the transverter. It will be noted that with the operation of relay ROM a circuit is closed for relay TR0 from battery through its winding, No. 3 contacts of relay ROM, to ground on the No. 7 contacts of relay DRL. Relay ROM locks over its upper winding and No. 4 contacts to said ground. Since the locking circuit of relay TVS extends over the back contacts of relay TR0, it follows that even if relay ROP fails to operate, the operation of relay TR0 releases relay TVS to cause the release of the transverter from the sender.

Intermediate timing

There are a number of interrupter intervals covered within the over-all time-out of relay TM6 which will cause the release of the transverter, and the seizure of another transverter (and another billing indexer) by the sender for a "second trial" in an effort to complete the record for the call. This is controlled by the duration of ground on lead TM (Fig. 83), which is grounded by relay TA of the transverter connector when operated to attach the transverter, said lead TM being lead 401 beyond the No. 3 contacts of relay EXT.

Accordingly, when ground is applied to lead TM, relay TMS2 is operated from ground on lead 401, No. 1 back contacts of relay W, No. 2 back contacts of relay Z, No. 6 contacts of relay TM1, No. 2 contacts of relay TMS3, No. 2 contacts of relay TMS1, lead 402, No. 20 back contacts of relay CK7, lead 403, winding of relay TMS2, to battery. Relay TMS2 operates and locks over its No. 3 contacts to ground on lead 401. Ground on armature 4 of relay TMS3 is applied to the contacts of interrupter TM. Relays W and Z now operate in the usual and well-known W–Z relay sequence, relay W operating on the first closure of the interrupter, relay Z operating on the first open period of said interrupter (both relays operated), relay W releasing on the second closure, and relay Z releasing on the second opening. While relay W is released and relay Z is operated, relay TM1 is operated over battery through its winding, No. 4 back contacts of relay TM2, No. 2 front contacts of relay Z, No. 1 back contacts of relay W, to ground on lead 401, locking over its No. 3 contacts and No. 4 contacts of relay TMS2 to ground on lead 401. On the closure of the interrupter TM after relay Z releases, relay TM2 operates over battery through its winding, No. 5 contacts of relay TM1, No. 1 contacts of relay Z, No. 1 front contacts of relay W, to ground on lead 401, locking over its No. 3 contacts to ground on the No. 2 contacts of relay TM1, and operating relay DL from ground over its No. 2 contacts in an obvious circuit, thereby summoning the trouble indicator. That is to say, if after the transverter is seized, relay CK7 is not operated in an interval of 2.45–3.75 seconds (measured by the operation of relay W–Z), it is assumed that the transverter is not in a functioning order. If timing continues after relay TMS2 is operated, relay TM3 is operated by the cyclic operation of relays W and Z, grounds the trouble release lead TRL to the sender at its No. 4 contacts, opens the recorder start lead ST–, and operates relay TM4 to give an alarm. Relay TM3 also releases relays IOK1 and IOK2 if operated, thereby to provide for the immediate release of the billing indexer, should the latter still be connected to the transverter.

If timing continues after relays CK6 and CK7 are operated, relay TMS2 releases (or is prevented from operating), releasing relay TMS3. With relay CK7 operated, relay TMS1 operates over a circuit extending from battery through its winding, lead 640, No. 11 contacts of relay CK7, No. 1 contacts of relay RKA, lead 641, No. 1 contacts of relays TMS2 and TMS3, and thence as traced to ground on lead 401, locks over its No. 3 contacts to said ground, and operates relay TMS3. Relays W and Z are now operated for one cycle to result in the operation of relay TM1. If by the time the latter relay has operated check relay OCK or ONCK has not operated, a circuit is closed for relay DL from battery through its winding, lead 404, No. 8 contacts of relay ORE, lead 642, No. 4 contacts of relay TM1, lead 643, No. 1 contacts of relay OCK, lead 644, No. 4 contacts of relay ONCK, lead 645, lead 505, to ground on the No. 3 contacts of relay CK6.

If timing continues until the recorder is seized, as evidenced by the operation of relays RK and RKA, the latter relay releases relay TMS1, in turn releasing relays W, Z and TMS3. A circuit is then completed for relay TMS2 from battery through its winding, lead 403, No. 2 contacts of relay RKA, No. 20 contacts of relay CK7, lead 402, and thence as traced to ground on lead 401. Relay TMS2, on operating, then operates relay DL as before described to connect the trouble indicator.

When the recorder is engaged, one of the relays P– should operate, as already described. The operated relay P– then operates a cut-in relay CO–, which, in turn, operates relays CTM1 and CTM2, also as already described. If relay TMS2 is operated, a circuit is completed for relay TML1 or TML2 depending upon which of the combination of relays W and Z is operated at the time. If relay W is operated, the circuit is completed for relay TML1 from battery through its winding, No. 3 contacts of relay W, No. 3 back contacts of relay Z, No. 2 contacts of relay TMS2, lead 646, No. 6 contacts of relay CK4, lead 647, No. 4 contacts of relay RL, lead 648, No. 8 contacts of relay CTM2, lead 649, to ground on the No. 7 contacts of relay CK3. If relay Z is operated, the circuit is completed for relay TML2 over the No. 4 contacts of relay W, No. 3 front contacts of relay Z, No. 2 contacts of relay TMS2, lead 646, and thence as traced to ground on relay CK3. Either relay when operated locks to operating ground, and when the timing has advanced until both relays are operated, a circuit is completed for relay DL from ground serially

through the No. 2 contacts of relay TML2, No. 1 contacts of relay TML1, lead 642, and thence as traced to the winding of relay DL. The operation of the latter relay operates to summon the trouble indicator and give a second trial.

Condenser Timing

There are a number of "short" timing intervals (.200–.280 second) which are measured by the operation of polar relay CTM and the charging of capacitor C1. As will be recalled, capacitor C1 is normally charged, and is discharged when the operation of any one of a number of relays indicates the completion of a particular function within the time allowed to operate relay CTM. If the function is not completed, relay CTM operates, in turn operating relay DL for a trouble indicator record and a second trial. When relay CKG operates, it grounds lead 49 to discharge the capacitor. As will be also recalled, on the operation of relay CK7, a circuit is closed to the primary (lower) winding of relay CTM, which does not operate, but begins to operate when relay INS operates to open the discharge path of capacitor C1, which is in series with the secondary (upper) winding of relay CTM, said relay then operating when the capacitor is charged, by way of example, in the predetermined interval of .200–.280 second. Hence relay CTM starts the "condenser timing" cycle from the instant that relay INS operates. If the function to be performed in the interval is actually performed, ground is reapplied to capacitor C1 to prevent relay CTM from operating. If the function is not performed, then relay CTM operates and ground on lead 499 from the No. 5 contacts of relay CK1 closes the circuit of relay DL to produce a trouble record and give a second trial.

No attempt will be made to describe all the functions, each of which, on being performed, causes the cancellation of condenser timing. The examples described below, however, are typical of those not included in this description but shown on the drawing.

(*a*) The billing indexer, if not busy, should be connected to the transverter within the condenser timing interval. If it is, relay ICOA1 operates, grounding lead 48 which joins lead 49 at the No. 2 contacts of relay CK2 to ground the capacitor C1. The release of relay CK2 then restarts the timing cycle to time the operation of the indexer.

(*b*) If all the billing indexers are busy, relay CBG is operated from ground serially through the No. 3 contacts of all relays IB–, lead 648, No. 6 contacts of relay INS, lead 649, No. 5 back contacts of relay INK, lead 476, winding of relay CBG, to battery. The latter relay, on operating, applies ground to capacitor C1 from the No. 1 back contacts of relay INK, lead 649, No. 1 contacts of relay CBG, to lead 49, thereby to cancel timing. However, if a billing indexer meanwhile becomes idle, relay CBG releases, and when said indexer is seized, relay INK operates as already described, transferring the winding of relay CBG over leads 475 and 474 to lead BY of the recorder, to determine the idle or busy condition of a recorder in the given recorder group, said relay thus performing the dual function of determining the busy condition of all billing indexers and the busy condition of all recorders. Timing for the available indexer then takes place as before.

(*c*) When the indexer is seized, one of the signals therefor is the release of relay CK2, as already pointed out, and this begins the condenser timing cycle for the indexer functions, which are completed when its output is transferred to the transverter and relay IOK operates in consequence thereof. The latter relay releases relay IOK1, which applies ground over its No. 3 back contacts, No. 1 front contacts of relay IOK2, lead 649, No. 7 contacts of relay CK5, to lead 49. Obviously if the functions are not completed within the timing cycle, relay IOK will not operate, relay IOK1 will not release, and timing lead 49 is not grounded.

(*d*) Relay IOK1, in releasing, also releases relay IOK2, thus starting a fresh timing cycle for recorder seizure. When the recorder is seized, relay RK is operated (as will be recalled), resulting in the operation of relays RKA, P4 or P2, C4A or C2A, LP and CTM1 in sequence, each of which grounds lead 49 to cancel timing.

If all the recorders are busy, relay CBG is operated over lead BY. When a recorder becomes available, relay CBG releases to start timing, and when it is seized relay RK operates, thereby making ineffective the contact on relay CBG which grounds lead 49. Relay CK4 also controls the recorder busy lead BY in order to provide a timing cycle should relay CK4 fail to operate.

(*e*) When the recorder is read to perforate a line, relay P4 or P2 operates as already described, in turn operating relay C4A or C2A, respectively, which in turn operates relay CTM1 to cancel timing. Relay CTM1 operates relay CTM2, which locks independently of relay CTM1 and operates relay CTM3, all as previously described. Relay CTM3 closes lead P1 in part and releases relay CTM1 to start a new timing cycle. When the perforation of the line is completed, the involved cut-in relay C4A or C2A releases, but timing continues until relay C3A or C1A operates to perforate the next line, and to reoperate relay CTM1. Thus a timing cycle is provided for the perforation of each line. After the last line is perforated, however, timing is not stopped with the release of relay C1A, but continues until relay CK6 is released, which stops timing.

(*f*) When the recorder start relay RST– operates, and after relay IOK1 is released, relay EXT is connected to lead EXT of the recorder. If said recorder is engaged in operations such as "end-of-tape" entries (which are entries placed on the tape under the control of another circuit for purposes of tape identification) or "3AM" patterns, as described in the above-mentioned W. W. Carpenter et al. patent, which cause more than normal delay before the transverter can gain access to the recorder, lead EXT is grounded and relay EXT is operated thereby. Relay EXT grounds lead 49 over its No. 2 contacts to cancel timing, and opens the timing lead 401 at its No. 3 contacts, leaving only the "long timing" circuit active. Relay EXT also opens the recorder start lead RST– at its No. 4 contacts unless relay RKA is operated, an arrangement which prevents interference with a call in case lead EXT is falsely grounded after perforation has started, and prevents premature release of the recorder with an incomplete entry. If relay RKA is not operated, the transverter waits until relay EXT releases and then proceeds with the call.

Second trial

In all of the above conditions that result in the operations of relay DL and the production of a trouble record by the trouble indicator, the sender is afforded an opportunity of completing the production of the initial entry by means of another transverter and another billing indexer (second trial). If operations have advanced to recording, and the perforation of the line fails to check, thus indicating an incomplete perforating operation, the entry "287000" is placed on the tape immediately following the line of the initial entry at which the failure has occurred, the purpose of the "287000" entry being to signal the accounting center equipment, on sensing the entry, to ignore the initial entry (or part thereof) that follows it. After the trouble entry is recorded, a second trial follows.

If the recorder is out of service, a second trial is afforded only with bulk-billed calls, all other calls being disposed of with a reorder (ROM signal) to the sender. If the second transverter and billing indexer also fail in causing the recorder to perforate a successful initial entry, the transverter grounds the trouble release lead TRL to

the sender for bulk-billed calls only, all other calls being disposed of by reorder.

When the transverter is first connected to the transverter connector, the operation of relay TA in the latter circuit causes ground to be applied from the No. 2 back contacts of relay TR1, No. 4 contacts of relay TA, to lead TR1, resulting in the operation of relay TR1 in the transverter, which locks over its No. 1 contacts to ground on the No. 17 contacts of relay CK7. Now when relay DL operates in response to the closure of one of its circuit paths, it results in the seizure of the trouble indicator, as already described. When the latter device has completed making the trouble record it grounds lead TIB to operate relay TIB. If the call is being timed, relay TM2 is operated, by way of example, it applies ground to lead TRL over its No. 1 contacts, No. 3 contacts of relay TM3, lead 650, No. 3 contacts of relay TIB, No. 5 front contacts of relay TR, lead 618 and thence as previously traced to the trouble release lead TRL, resulting in the operation of relay TR in the transverter connector over the No. 9 contacts of relay TA, No. 1 back contacts of relay TR1, winding of relay TR, to battery. Relay TR operates and removes the short circuit to the battery connected to the left winding of relay CB, which then operates from ground on lead CB supplied by a set of contacts on the operated relay CBR in the transverter. Relay CB operating, releases relay TS which, in turn, releases relay TA, thereby disconnecting the transverter. When relay TA releases, relay TR1 operates in series with relay TR to ground on the No. 6 contacts of relay SA, both relays remaining in this condition until the sender releases and releases relay SA. However, the fact that relay SA is still operated will cause the sender to seek another transverter, since the previously described starting circuits from the sender through the contacts of relay SA have not been disturbed. When another transverter is connected to the sender, lead TR2 is grounded (instead of lead TR1) from the No. 2 contacts of relay TR1 causing the operation of relay TR2 in the (second trial) transverter, indicating to the latter that it is used on a second trial, relay TR2 locking over its No. 5 contacts to ground in the No. 17 contacts of relay CK7.

Should the second transverter also fail to produce a record of the initial entry for the call, the trouble release ground is switched to lead TRL if the call is a bulk-billed call, or to lead ROM if the call is a toll call. In the former case, and considering that relays TR2 and 2L are operated in the second transverter, the release ground previously traced to the No. 8 back contacts of relay TR2 from lead 614 now traces through the No. 8 front contacts of said relay, No. 4 back contacts of relay RTR, lead 651, No. 5 back contacts of relay IOK2 (if normal, otherwise directly from the contacts of relay TR2 and operated contacts of relay IOK2), lead 653, No. 4 back contacts of relay TS, No. 3 back contacts of relay MUD, No. 3 front contacts of relay 2L, to lead TRL. If the call is a MUD call (bulk-billed detailed), relay 2L will be normal and relay MUD will be operated, in which event the trouble release ground traced to the No. 4 back contacts of relay TS extends directly to lead TRL over the No. 3 front contacts of relay MUD. If the call is a toll call, relay TS will be operated, and the ground on lead 653 traced to the No. 4 front contacts of said relay extends over lead 45, No. 7 back contacts of relay TM6, to lead ROM, operating relay ROM in the sender, thereby causing the connection to go to an overflow trunk, an operation which is irrelevant to the present invention.

As previously stated, arrangements are provided to record a trouble entry 287000 on the tape after one or more lines of an initial entry have been perforated by the recorder when the latter circuit cannot complete the entry, or the entry does not check correctly after perforation. When the recorder is ready for perforation, relay P4 or P2 operates to result in the operation of relay C4A or C2A, respectively, as already described. The operation of either of said relays operates relay CTM1, which grounds capacitor C1 over lead 49 to cancel condenser timing. Relay CTM1 then operates relay CTM2, locking independently of relay CTM1 and operating relay CTM3, which releases relay CTM1 to start a new period of condenser timing. However, the fact that relay C4A or C2A has operated, thereby connecting the transverter with the perforating magnets of the recorder, will cause the line of the entry or some part thereof to be perforated. The line progress relay LP, therefore, is operated by relays C4A and C2A. At its No. 1 contacts relay LP transfers the trouble release lead TRL over its front contacts and to the winding of the trouble entry relay TE, thereby to delay trouble release until the trouble entry has been recorded on the tape.

If the recorder fails to check that the perforator magnets are operated in the proper pattern, it grounds lead TBL, thereby operating relay TBL. Over its No. 4 contacts, relay TBL grounds lead 498 to complete the circuit of relay DL thereby to summon the trouble indicator, relay TR operating locally from relay DL. It also provides a supplementary locking path for the cut-in relays C– (relay C4A, for example) over lead 496, No. 6 contacts of relay CTM2, lead 657, No. 3 front contacts of relay TBL, No. 5 back contacts of relay TE1, lead 491, No. 4 contacts of relay CK5, to ground on the No. 4 contacts of relay CK8. Relay TBL also transfers lead CK over its No. 1 front contacts to ground on the No. 2 contacts of relay TE, and at its No. 5 contacts opens the trouble release control lead TRL from the transverter connector.

After the trouble indicator record is made, relay TE is operated over lead 659', No. 1 back contacts of relay PIB, No. 1 front contacts of relay LP, No. 1 back contacts of relay XDK, and thence as traced to any one of the involved grounds applied to lead TRL. Relay TE locks over its No. 4 contacts and lead 655 to trouble release ground, opens the locking path for the cut-in relays at its No. 5 contacts, which, however, remain operated under the control relay TBL via lead 496 as previously described, transfers lead P at its No. 3 front contacts to the No. 1 contacts of relay TE1A via the No. 1 contacts of relay CTM3, grounds lead CK at its No. 2 front contacts via the No. 1 front contacts of relay TBL, operates the involved P–A (relay P2A, for example) over a path previously traced to the back No. 1 contacts of relay TE1, thence over No. 7 contacts of relay TE, lead 658, and thence as traced to trouble release ground. Relay TE also operates relay PA over its No. 8 contacts, lead 659, to ground on the No. 2 contacts of relay CTM2, but the operation of relay PA serves no purpose except to release the cut-in relays C– should relay P–A fail to operate from relay TA. The ground supplied over lead CK operates a relay CK in the recorder, and when the latter has operated releases relays TBL of both the recorder and the transverter in sequence, allowing the recorder to resume progress under the control of the transverter.

Relay P2A (as an example), on operating, locks as before to ground on lead 505, and operates relay PCE (PC0 or PC5 operating according to which other relay P–A operates), in turn releasing relay C2A, the latter releasing relays CTM2 and CTM3 in sequence. Relay CTM2 releases relay PA which releases the paper advance magnet of the recorder. The released cut-in relay C2A releases the perforator magnets, and the recorder then operates to the point of grounding lead P in readiness to perforate the trouble entry line 287000. Since relay TE has transferred lead P to the No. 1 contacts of relay TE1A, ground thereon operates relay TE1 over the No. 1 back contacts of relay TE1A, which locks to ground on lead 505 and operates relay TEAB by ground on lead 491, No. 5 front contacts on relay TE1, No. 4 contacts of relay TE1A, lead 660, No. 2 back contacts of relay XDK, lead 661, winding of relay TEA, to bat-

tery. By operating, relay TEA grounds perforator leads A2, B1, B7, C0, C7, D4, D7, E4, E7, F4 and F7, thereby causing the perforator to punch the trouble entry "287000." It also grounds lead PT.

The recorder subsequently functions as on a regular call, and after checking the proper combinations of grounded perforator leads, grounds lead P1, which operates relay TE1A over a path extending from battery through its right winding, No. 1 front contacts of relay TE1, No. 7 contacts of relay TE, lead 658, No. 2 back contacts of relay TBL, lead 0661, No. 5 contacts of relay CK8, to ground on lead P1. Relay TE1A locks over its left winding and No. 2 contacts to ground on lead 505, and releases relay TEA which removes ground from the indicated perforator leads and opens lead PT. The recorder then makes the paper advance operation and grounds lead P in the regular manner. Since this lead has been joined by relays TE and TE1A to the trouble release lead TRL, the latter signals the transverter connector to release the transverter in the manner described.

Line observing and number checking

The transverter is arranged for operation with the line-observing and number-matching circuit shown in Figs. 120–132 inclusive. The purpose of the latter circuit is to provide means for designating at any particular time a predetermined number of subscribers' directory numbers with respect to which detailed information is desired on all calls originated from the stations identified by said numbers. That is to say, one or more of the originating offices served by tandem may have no service observation therein for the office as a whole, in which event the transverter relay NS0 is operated by the sender and the regular two-line or four-line initial entry will be made for the call as required. Cases arise, however, in which subscribers complain about the service, which, while not serious enough to justify service observation on all calls from the office (or offices) in which the lines of said subscribers terminate, nevertheless does require detailed records for the calls from each of the complaining lines.

The directory number of each of the lines under observation is "written up" on a set of switches in the line-observing and number-matching circuit, there being a set of such switches in the circuit for each line to be observed. When one of said lines is extended to tandem for the completion of a call therethrough and for the production of the three entries for said call, the transverter advances the registration of the calling line number (including the calling office code) into a set of numerical registers of the line-observing and number matching circuit. If the number registered in the numerical registers matches the number set up on one of the sets of switches, the transverter is signaled to make a four-line initial entry for the call. If the call is a bulk-billed call, the effect of the signal is to cause the transverter to produce a four-line (MUD) initial entry for the call instead of the usual bulk-billed two-line initial entry, but with the B digit of the first line of the initial entry the numeral 4 instead of the numeral 3 to indicate that the call is an observed call. If the call is a toll call, the regular four (or five) line initial entry will be produced, except, however, that the B digit of the first line will be the numeral 4 if a four-line entry or the numeral 6 if a five-line entry to indicate in each case that the call is an observed call.

Two number-matching circuits should suffice for one tandem exchange, and two such circuits are shown in Figs. 120–132, the plurality of set-up switches used by the two circuits being shown between the two. The two circuits are electrically so arranged that each transverter normally prefers one of them if free, but may use the other if it is not.

Returning, now, to the operation of the transverter, and referring also to Figs. 120–132, when said transverter is connected to the sender by way of the transverter connector, resistance battery on the No. 1 contacts of relay LOB (Fig. 91) completes the circuit of the transverter preference relay PR00 of the preferred line number and matching circuit, assuming that said circuit is available, the circuit path of said relay being traced from said battery, lead 700, No. 2 contacts of relay NL0, lead LST in cable C3, No. 7 contacts of relay TA, lead ST in cable 11, No. 1 back contacts of relay CB00, winding of relay PR00, serially through normally made No. 3 contacts of other relays PR0–, each individual to a transverter, lead 701, to ground on No. 2 contacts of relay RE. Relay PR00 operates. Over its No. 2 contacts it grounds lead 702 to operate relay MB00, which completes the circuits of all relays CB00–CB01 and operating all except relay CB00 associated with the operated relay PR00, the battery of which is short-circuited by ground on the No. 1 front contacts of the operated relay PR00, said latter relay also remaining operated, since battery to its winding over lead ST is maintained over the No. 1 back contacts of relay CB00.

Another transverter having the same preference and seeking a line-observing and number matching circuit will have battery on its start lead ST transferred over the front contacts of relay CB01 (for example), No. 1 back contacts of relay CB11, winding of relay PR11, normally made No. 3 contacts of intermediate relay PR1–, lead 703, to ground on the No. 1 contacts of relay RE of the second number-matching circuit. Those transverters which normally prefer the second circuit will, of course, have their start leads ST– connected directly to the armature of the No. 1 contacts of the involved relay CB1–.

If the transverter seizes its non-preferred line-observing and number-matching circuit because its preferred one is busy at the time, provision is made to hold relay CB00 of the preferred circuit in the event that said circuit is restored while the transverter is connected with the non-preferred circuit. Thus suppose that when battery is applied to the start lead ST, the preferred line-observing and matching circuit controlled by relay CB00 is busy. Relay CB00 will then be operated, and the battery on lead ST is transferred over its No. 1 front contacts and No. 1 back contacts of relay CB10 to the winding of relay PR10, resulting in the operation of all relays CB1– except relay CB10. Since relay CB00 is operated, its release when the transverter is through with the line-observing and matching circuit would disrupt battery on lead ST to the winding of relay PR10. To prevent this occurrence, ground supplied from the No. 2 back contacts of relay LOB in the transverter that operated relay PR10 is passed to lead 704, No. 1 contacts of relay NLO, lead LG in cable C3, No. 8 contacts of relay TA of the transverter connector, lead LG in cable C11, No. 5 contacts of relay CB10, No. 3 contacts of relay CB00, winding of relay CB00, resistance to battery. This prevents relay CB00 from releasing, thereby maintaining battery on lead ST to the winding of relay PR10 until the transverter releases the non-preferred line-observing and number-matching circuit.

With the transverter thus connected to one of the line-observing and number-matching circuits (for example, the one under the control of the relays PR0– and shown in Figs. 121, 124, 127, 130 and associated switches in Figs. 122, 125, 128 and 131), a "down check" is made of the numerical registers of the circuit to insure their normal condition before receiving the calling directory number from the transverter. This check traces from ground on the No. 2 contacts of relay UP (Fig. 121), lead 705, No. 1 contacts of relays U7–U0 of the units digit register, No. 1 contacts of relays T7–T0 of the tens digit register, lead 706, No. 1 contacts of relays H7–H0 of the hundreds digit register, No. 1 contacts of relays TH7–TH0 of the thousands digit register, lead 707, No. 1 contacts of relays C7–C0 of the C-digit register,

lead 708, No. 1 contacts of relays B7–B0 of the B-digit register, lead 709, No. 1 contacts of relays A7–A0 of the A-digit register, lead 710, No. 5 front contacts of relay PR00, winding of relay C100, to battery. Relay C100 operates and sets up various control paths to the transverter. The same ground is also applied over the No. 4 contacts of relay PR00 to lead C0 in cable C8 which extends directly into the transverter at Fig. 85 thereof. From the cable C8, lead C0 further extends to the No. 6 contacts of relay ROC, lead 711, winding of relay OC0, to battery, operating said relay OC0 and connecting the calling directory number leads of the transverter over cable C9 to the windings of the relays of the number registers in the selected line-observing and number-matching circuit. It should be noted that if the transverter becomes connected to the alternate circuit shown on Figs. 123, 126, 129, 132 and the right half of Figs. 122, 125, 128 and 131, relay PR10 would have been operated, and the down check ground from said latter circuit would have been applied over the No. 4 contacts of relay PR10 to lead C1 in cable C8, extending to the No. 7 contacts of relay ROC of the transverter, resulting in the operation of relay OC1 therein via lead 712, and the connection of the calling directory number leads via cable C5 to the windings of the numerical register relays of said alternate line-observing and number-matching circuit. It will be assumed, however, that the transverter has become connected to the checking circuit shown in Figs. 121, 127, etc., and, therefore, that relay OC0 is operated. It will further be noted that failure to complete the down check test of whichever circuit becomes connected to the transverter prevents the operation of relay OC0 (or OC1) and the operation of relay C100 (or CB10). Under this condition the line-observing and number-matching circuit will take no further action on the call, enabling the transverter to make the regular non-observed two-line or four-line or five-line initial entry for the call as required.

Both matching circuits are provided in common with a maximum of thirty sets of seven manually settable switches A0–UK0 (by way of example), each of which is adjustable to have its wiper engage the terminal designating the digit of a number to be registered on the switch set. Each directory number representing a line which is under observation is then registered on one of the sets of switches. The number thus registered is then "matched" against the number that will be registered in the digital registers from the transverter, as will be shown. If the two numbers agree, the transverter is signaled to have an observed four or five-line initial entry made for the call. If they do not agree, the transverter is given no signal, in which event it proceeds to have the recorder make the initial entry normally required for the call in accordance with the S0 or NS0 signal received from the sender.

Thus, for example, if we suppose that the line represented by the calling number BIgelow 9–8276 is under observation, one of the sets of switches A0–UK is adjusted to register the number. When relay OC0 is operated, and remembering that relays DAQ0 and DAQ2 of the transverter's calling number A-digit register are operated for the registration of the A-digit 2, ground on the No. 1 contacts of relay DAQ0 is applied over the No. 35 contacts of relay OC0 to lead A0 in cable C9, terminating on the winding of relay A0 of the A-digit register in the matching circuit, causing the operation of said relay A0. Likewise ground on relay DAQ2 applies ground on its No. 1 contacts over the No. 33 contacts of relay OC0 to the winding of relay A2 of the register, causing the operation of said latter relay.

In the same manner, ground on the No. 1 contacts of relays DBQ0 and DBQ4 is respectively applied over the No. 30 and No. 27 contacts of relay OC0 to cause the operation of relays B0 and B4 for the registration of the B-digit 4 in the B-digit register; while ground on the No. 1 contacts of relays DCQ2 and DCQ7 is respectively applied over the No. 23 and No. 21 contacts of relay OC0 to cause the operation of relays C2 and C7 for the registration of the C-digit 9 in the C-digit register. As previously stated, no registers are provided in the transverter for the numerical digits of the calling line number, but the leads therefor in the transverter are grounded in the sender in the 2-out-of-5 pattern and extended to the matching circuit (as clearly shown in Fig. 99) over the contacts of relay OC0 or OC1, to result in the operation of relays TH1 and TH7 for the thousands digit 8, in the operation of relays H2 and H0 for the hundreds digit 2, in the operation of relays T7 and T0 for the tens digit 7, and in the operation of relays U4 and U2 for the units digit 6. If the switches A0–UK0 are correspondingly set for the digits of the number 2498276, relays A0 and A2 will close a ground path from the No. 4 contacts of relay A0, No. 4 contacts of relay A2, No. 2 terminal and wiper of switch A0, to the contacts of relay BK0. If the B digit registered in the B register is 4 and the wiper of switch B0 engages terminal 4, relay BK0 operates from ground on the No. 3 contacts of relay B0, No. 3 contacts of relay B4, No. 4 terminal and wiper of switch B0, winding of relay BK0, to battery, causing the operation of relay BK0 and the extension of ground on its contacts to the contacts of relay CK0. In the same manner and by easily traceable circuits, if the registered C digit is 9 and the wiper of switch C0 is resting on terminal 9, relay CK0 is operated, thereby to extend the ground on its contacts to the contacts of relay THK0, which operates if the registered thousands digit matches the setting of switch TH0. Relays HK0, TK0 and UK0 will similarly operate on circuits completed over the involved registers, thereby to extend the ground advanced to the contacts of relay UK0 to lead 713.

When the relays of the digital registers have selectively operated as above described, an "up" check is made to insure that two, and only two, relays are operated in each of the registers. Assuming that the relays operated are those which express the number 2498276, a circuit is then completed from battery through the winding of relay UP, lead 0714, No. 6 front contacts of relay A0, No. 6 back contacts of relay A1, No. 6 front contacts of relay A2, No. 7 back contacts of relay A4 and No. 6 back contacts of relay A7, lead 715, No. 6 front contacts of relay B0, No. 6 back contacts of relays B1 and B2, No. 7 front contacts of relay B4, No. 6 back contacts of relay B7, No. 6 back contacts of relay C0, No. 7 back contacts of relay C1, No. 7 front contacts of relay C2, No. 6 back contacts of relay C4 and No. 6 front contacts of relay C7, lead 716, No. 6 back contacts of relay TH0, No. 7 front contacts of relay TH1, No. 6 back contacts of relays TH2 and TH4, No. 6 front contacts of relay TH7, No. 6 front contacts of relay H0, No. 6 back contacts of relay H1, No. 6 front contacts of relay H2, No. 7 back contacts of relay H4, No. 6 back contacts of relay H7, lead 717, No. 6 front contacts of relay T0, No. 6 back contacts of relays T1, T2 and T4, No. 6 front contacts of relay T7, No. 6 back contacts of relay U0, No. 7 back contacts of relay U1, No. 7 front contacts of relay U2, No. 7 front contacts of relay U4, No. 6 back contacts of relay U7, lead 718, No. 4 front contacts of relay CB01 (or any other relay of this series which is operated), lead 719, to ground on the contacts of the operated A, B and C registers (relay A0, for example).

The operation of relay UP completes the ground path on lead 713 through its No. 4 contacts, lead 714, serially through the No. 2 back contacts of the normal relays C101, No. 2 front contacts of relay C100, lead L0 in cable C8 extending to the transverter, lead L0 therein, No. 1 back contacts of relay S0 (this relay being normal if the calling office requires no message unit detail initial entry for all lines therein), lead 517, winding of relay LOB, to battery. This relay operates, locks over its No. 3 contacts to ground on the No. 2 contacts of relay ICB,

opens the start battery on lead ST to the line-matching circuit, completes a previously described circuit for relay LOBA which operates and locks to off-normal ground, and, as previously described, causes the recorder to perforate the numeral 4 if a local call or the numeral 6 if a toll call in the B digit of the first line of the entry, as an indication that the call was observed.

Relay LOBA, among other functions, switches lead P from the recorder (previously traced to lead **486** at the armature of the No. 4 contacts of relay LOBA and thence to relay P2 for a two-line entry) over the front contacts of said relay LOBA and lead **489** to the No. 1 back contacts of relay P4A, and thence to the windings of relays P4 and P4K to cause the production of a four (or five) line initial entry as before described. It should be noted that the operation of relay LOBA is also controlled by normal contacts of relay RK to prevent the operation of said relay LOBA in the event that the recorder becomes connected to the transverter before relay LOBA has operated. This is to prevent the mutilation of any record already begun in the event of a delayed signal from the matching circuit and the consequence of a late switch in the perforator progress control circuit from relay P2 to relay P4.

In the event that the matching circuit is unable to "match" the setting of any of its sets of numerical switches with the number registered in the digital registers, no ground is furnished on lead L0, and hence the operations above described will not take place. However, after an interval of approximately 33 milliseconds, by way of example, taken by the condenser-timed polar relay N00 (or N01 depending on which matching circuit is used) to operate, ground on the No. 2 contacts of relay ICB, lead **518**, No. 5 contacts of relay LOB, lead **720**, No. 7 back contacts of relay XRE, lead **721**, normally made No. 1 contacts of relay OBF, No. 5 back contacts of relay ORE, lead TG in cable C8, No. 3 contacts of relay C100, lead **722**, No. 3 contacts of relay UP, lead **723**, contacts of relay N00, lead **724**, No. 6 back contacts of relay C101, No. 6 front contacts of relay C100, lead NL0 in cable C8, lead NL0 in the transverter, No. 2 contacts of relay NS0 (which will be operated by the sender for no message unit detailed entries), lead **725**, No. 2 contacts of relay CK1, lead **726**, to the winding of relay NL0, to battery thereby operating said relay, which locks over its No. 3 contacts, lead **727**, an undesignated resistance, lead **518**, to ground on the No. 2 contacts of relay ICB. Relay NL0, like relay LOB, opens battery on lead ST to the matching circuit. The transverter now functions normally, that is, it causes the production of the initial entry normally required for the call, just as if the matching circuit had not intervened. It should be observed, however, that if the matching circuit fails to provide a signal by the time the transverter and recorder are ready to record, relays RK and RKA operate and prevent the operation of relay LOBA. The call is then recorded as a non-observed call regardless of any later signal from the matching circuit, and completes the circuit of relay DL from ground on the back contacts of relay DK, No. 6 contacts of relay XDK, No. 4 back contacts of relay IR, No. 2 contacts of relay P6, lead **586**, No. 2 back contacts of relay TIB, No. 3 front contacts of relay ORE, No. 1 back contacts of relay ROC, lead **404**, to the winding of relay DL, to battery. In the matching circuit the removal of battery from lead ST releases relay PR00. The release of relay PR00 releases relay MB0, which, in turn, releases the associated connector busy relays CBO1. When relay OC0 (or OC1) is released by the transverter, the register relays are released, which in turn release the up check relay UP and the relays BK–. The circuit is thus restored to normal.

The release of the sender and establishment of the connection

It will be recalled that the transverter grounds lead ROP for the operation of relay ROP in the sender if the calling and called office codes are identical, if the calling code is a vacant code, or if the office index does not appear in the recorder register of the transverter. As previously explained, the operation of relay ROP causes relay A in the position circuit to release, resulting in supervisory lamp SENDSR flashing thereat as an indication to the operator to re-key the calling number. Now inasmuch as forward selections to the desired office start before the transverter is engaged, a recorder to the operator, which may involve lengthy discussions with the calling subscriber, will cause selections to be held up until the sender in the terminating office times out. To avoid this timing out, whenever relay ROP is operated by the transverter (and it is operated on bulk-billed calls) the forward connection is broken down and the marker recalled to seize another outward trunk. Consequently when relay ROP in the sender is operated a circuit is completed for relay TR0 from battery through its winding, No. 4 contacts of relay ROP, lead **750**, to ground on the No. 7 contacts of relay DRL, locking over its No. 7 contacts to the same ground. In accordance with known practice, operations are initiated by relay TR0 to reorder the marker to seize another trunk extending to the same terminating office. In this event, since the call is a bulk-billed call, said call is completed free of charge, no initial entry therefor having been made by the recorder if the ROP signal comes from a second trial transverter, as already described.

In the event that the signal transmitted by the transverter is over lead ROM to result in the operation of relay ROM in the sender, as it will be if the transverter is unable to produce the initial entry for a toll call, relay ROM operates as before described, locking to ground on lead **750** and operating relay TR0 from battery through its winding, and No. 3 contacts of relay ROM, thence as traced to ground on lead **750**, locking over its No. 4 contacts to the same ground. A circuit is now completed for relay TR3 from battery through its winding, lead **350**, No. 2 contacts of relay ROM, No. 7 contacts of relay TR0, lead **752**, No. 7 contacts of relay REV (which will be operated from the operation of first marker on a call to be completed to a crossbar office), lead **753**, No. 1 contacts of relay SOS, lead **754**, No. 6 contacts of relay ROM, to ground on lead SONG. Again as in the known practice the operation of relay ROM initiates operations by which the marker is recalled to select an overflow trunk, which sends back a distinctive tone to the calling subscriber to redial the number.

The sender, according to well-known practice, proceeds to transmit the pulses of the numerical digits of the called number to the terminating office once the marker has selected an outgoing trunk to that office and effected a connection between it and the tandem trunk shown in Figs. 3 and 4. However, it holds up the transmission of the pulses of the units digit until it receives a signal from the transverter that it has completed its functions. As previously indicated, this signal consists of a ground on lead TVR and the operation and locking of relay TVR. Once the latter relay is operated, a path is closed for relay U which controls the transmission of the units digit pulses, the path of said relay U being established in part over lead **755**, No. 4 contacts of relay TVR, lead **756**. When pulsing is terminated, and as the consequence of a series of operations started by a signal from the distant office that the sender has completed its functions, relay AV is operated, locking over its No. 4 contacts to ground on lead SONG, and locally operating relay AV1, which starts the series of operations to release the sender.

The first action is to complete a circuit to operate relay D of the trunk, said circuit tracing from ground on the No. 1 contacts of relay A in the sender, lead **757**, No. 7 contacts of relay AV3, No. 6 contacts of relay AV, lead **758**, No. 1 contacts of relay LR1, lead **759**, No. 8 back contacts of relay DC, lead D through the cable C6 and

the sender link frame, No. 7 contacts of relay F, winding of relay D to battery. Relay D operates and locally operates relay D1. The latter relay grounds lead DC to the sender over the No. 8 back contacts of relay D2, No. 5 contacts of relay T and No. 7 contacts of relay D1 as a signal that relays D and D1 have operated, and applies trunk closure by connecting the two windings of relay A through the left winding of the transformer A back to the originating end of the trunk at the calling office. In the sender, the grounding of lead DC effects the operation of relay CK1 over the No. 4 back contacts of relay DC, lead 760, No. 5 contacts of relay AV1, winding of relay CK1, to battery, operating this relay and completing the circuit of relay AV2 from battery through the winding of said relay, No. 3 contacts of relay CK1, No. 4 contacts of relay AV1, to ground on lead SONG. Relay AV2, on operating, opens the circuit of relay TCL which was operated from ground on lead SONG and the No. 6 back contacts of relay AV2 when the sender was first seized, said relay having operated relay CK2 over its No. 3 contacts to ground on lead SONG, and passing said ground over its locking contacts to lead C0 of the trunk, holding relay T operated as previously described. On the release of relay TCL, therefore, relay T releases, which transfers supervision from relay A of the sender which releases, to relay A of the trunk which operates and provides a locking circuit for relay D. The release of the trunk relay T opens the circuit of relay CK1, which results in a sequence of action that releases the sender link and restores the sender to normal.

The release of the trunk relay T operates relay D2 from battery through its winding, No. 2 contacts of relay T, to ground on the No. 3 contacts of relay D1. Progress of the call now awaits the called subscriber answer, as indicated by reverse battery on the tip and ring leads T and R for an interval of two to five seconds or more. This interval is timed by the interrupter OCH and the relay I. The polarized relay CS operates on the previously indicated reversed battery from the called office and completes the circuit of relay T from ground through the right contacts of relay CS, No. 3 contacts of relay D2, winding of relay T, to battery. This relay operates and reverses the battery and ground connection back to the calling office as a signal that the call has been answered; battery through the winding of relay A, which, before the operation of relay T is on the tip lead T, is switched to the ring lead R over the No. 4 contacts of relay D2, No. 3 contacts of relay D, No. 8 front contacts of relay T, lower left winding of repeat coil TF to the ring lead R; ground through the winding of relay A, which, before the operation of relay T is on the ring lead R, is switched to the tip lead T over the No. 7 contacts of relay D2, No. 3 front contacts of relay T, upper left winding of repeat coil TF, to the tip lead T.

It will be noted that interrupter OCH, by the closure of its left contacts, operates relay B1 over the lower contacts of relay F1. With relay B1 operated after relays A and CS have operated, a circuit is completed for relay I from battery through resistance and winding, uppermost contacts of relay B1 (said contacts being individual to the trunk), No. 4 contacts of relay CH, contacts of relay A, right contacts of relay CS, to ground. Relay I operates and locks over its No. 3 contacts, contacts of relay A, to ground on the contacts of relay CS, if said relay is operated, as it should be if the called subscriber is still on the line. Now when interrupter OCH breaks its left contacts, relay B1 releases, and when it makes its right contacts, relay F1 is operated over the lower contacts of relay B1. With relay I operated, a circuit is closed for relay CH from battery through resistance, winding of said latter relay, No. 9 front contacts of relay D2, No. 6 contacts of relay I, uppermost contacts of relay F1 (said contacts being individual to the trunk), to ground on the No. 6 contacts of relay TC, which relay, it will be remembered, was operated over lead TC from the recorder when the initial entry was perforated and locked to ground on its own No. 5 front contacts, said relay indicating that the call should be charged if answered. Relay CH operates and locks over its No. 5 contacts to ground on the No. 6 contacts of relay TC, and joins lead DJ extending to the call identity indexer with lead CH extending from the recorder, said path tracing from lead DJ, No. 2 front contacts of relay TC, No. 5 contacts of relay 1, No. 7 contacts of relay CH to lead CH. When the recorder is available, it grounds lead CH, which is extended over the above path to lead DJ to act as a start signal for the call identity indexer, and to cause leads OT, TC and RC to be connected through to the recorder, thereby to cause the latter to record an answer entry which, as shown in line 7, Fig. 122 of the above-mentioned patent to W. W. Carpenter et al., consists of the answer time and the trunk number.

When the answer entry is recorded, the recorder grounds lead RC, which shunts relay I over the No. 3 front contacts of relay TC, No. 5 front contacts of relay D1 and No. 1 contacts of relay I, causing the release of said relay I, the opening of lead RC as a signal to the recorder, and the connection between leads CH and DJ.

The trunk circuit remains as above until the calling or called party disconnects. If the calling party disconnects first, relay A releases, in turn releasing relays D, D1 and D2. Relay D1 opens the talking path to the terminating office and releases relay T, which restores normal polarity rearwardly to the originating office, and releases relay TC. Relay D2, in releasing, removes battery from lead R (when the calling subscriber restores first) to insure that the sender at the originating office does not find reverse battery when testing the trunk for the next call. Relay D2 also removes ground from lead S to release the hold magnets that maintained the path through the trunk and office link frames to the outgoing trunk. Relay D2, in releasing, also recloses at its No. 10 contacts the connection between leads DJ and CH, thus again to request the services of the recorder for the disconnect entry. This entry is handled by the call identity indexer and recorder in the same way as the answer entry, and is identical to the latter except that it records the time of disconnect instead of the time of answer. Such an entry is shown on line 8, Fig. 122 of the above-mentioned patent to W. W. Carpenter et al.

On the release of relay TC, relays CH and I release, thus restoring the trunk to normal, opening lead RC and reclosing lead ST to the link.

While I have illustrated my invention by a particular embodiment thereof, said invention is not limited in its application to the specific apparatus and particular arrangements therein disclosed. Various applications, modifications, and arrangements of the invention will readily occur to those skilled in the art.

The terms and expressions which I have employed in reference to the invention are used as terms of description and not of limitation, and I have no intention in the use of such terms and expressions of excluding equivalents of the features shown and described or parts thereof but, on the contrary, intend to include therein any and all equivalents, modifications and adaptations which may be employed without departing from the spirit of the invention.

What is claimed is:

1. In a communication switching system, a plurality of groups of operator position circuits for serving a call with each circuit having an idle and a busy condition, a calling line, a first preference circuit operative to arrange said groups in a preferred order of availability for serving a call, a second preference circuit operative to arrange the circuits in each group in a preferred order of availability for serving a call, means including both of said preference circuits operative in response to a call signal applied to said line to interconnect said line with the preferred one of said operator position circuits in the

preferred group if said circuit is currently in an idle condition, means including said second preference circuit responsive to a call signal on said line to interconnect said line with the next preferred position circuit currently in an idle condition in said preferred group when said preferred position is in a busy condition, and means responsive to said interconnection to operate said preference circuits so that the operator position circuit next preferred after said currently connected circuit will be preferred during the reception of the next call signal.

2. In a communication switching system, a plurality of groups of operator position circuits for serving a call with each circuit having an idle and a busy condition, a calling line, a first preference circuit operative to arrange said groups in a preferred order of availability for serving a call, a second preference circuit operative to arrange the circuits in each group in a preferred order of availability for serving a call, means including both of said preference circuits operative in response to a call signal applied to said line to interconnect said line with the preferred one of said operator position circuits in the preferred group if said circuit is currently in an idle condition, means including said second preference circuit responsive to a call signal on said line to interconnect said line with the next preferred position circuit currently in an idle condition in said preferred group when said preferred position is in a busy condition, means including both of said preference circuits responsive to a call signal to interconnect said line with a preferred operator position circuit in the next preferred group when all the operator position circuits in the preferred group are in a busy condition, and means responsive to said interconnection to operate said preference circuits so that the operator position circuit next preferred after said currently connected circuit will be preferred during the reception of the next call signal.

3. In a communication switching system, a plurality of sender groups, a pair of controllers each of which is operatively associated with a different half of said plurality of sender groups on a preferred basis and with the other half of said plurality of sender groups on a non-preferred basis, each of said controllers having a busy and an idle condition, a plurality of groups of operator positions, means including communication paths operable to interconnect each of said sender groups with each of said groups of operator positions, signal responsive means in each controller operable when signals are received from said sender groups, means whereby the signal responsive means in a controller operates in response to a call signal received from its associated preferred sender group to connect said sender group over one of said communication paths to one of said groups of operator positions, and means whereby the signal responsive means in a controller operates in response to a call signal from its associated non-preferred sender group when the controller associated on a preferred basis with said sender group is in a busy condition to connect said sender group over one of said communication paths to one of said groups of operator positions.

4. In a communication switching system, a plurality of sender groups, a pair of controllers each of which is operatively associated with a different half of said sender groups on a preferred basis and with the other half of said sender groups on a non-preferred basis, each of said controllers having an idle and a busy condition, a plurality of groups of operator positions each of which comprises a plurality of individual position circuits, communication paths connecting each of said sender groups with each of said groups of operator positions, signal responsive means in each controller responsive to signals received from said sender groups, means whereby the signal responsive means in a controller operates in response to a call signal received from a sender group that is associated on a preferred basis with said controller to enable said sender group to transmit a call signal over one of said communication paths to one of said operator position groups, and means whereby the signal responsive means in the controller associated on a non-preferred basis with said last-named sender group operates when said preferred controller is in a busy condition to enable said sender group to transmit a call signal over one of said communication paths to one of said operator position groups, means whereby additional call signals received by said controllers are distributed equitably among said groups of operator positions, and means whereby the calls received by each group of operator positions are equitably distributed among said individual position circuits within said group.

5. In a communication switching system, a plurality of sender groups, a pair of controllers each of which is operatively associated with a different half of said sender groups on a preferred basis and with the other half of said sender groups on a non-preferred basis, each of said controllers having an idle and a busy condition, a plurality of groups of operator positions each of which comprises a plurality of individual position circuits, communication paths connecting each of said sender groups with each of said groups of operator positions, signal responsive means in each controller responsive to signals received from said sender groups, means whereby the signal responsive means in a controller operates in response to a call signal received from a sender group that is associated on a preferred basis with said controller to enable said sender group to transmit a call signal over one of said communication paths to one of said operator position groups, means whereby the signal responsive means in the controller associated on a non-preferred basis with said last-named sender group operates when said preferred controller is in a busy condition to enable said sender group to transmit a call signal over one of said communication paths to one of said operator position groups, and means whereby additional call signals re-said groups of operator positions.

6. In a switching system, a plurality of groups of sender circuits, a pair of controllers, a plurality of relays in each of said controllers with each of said relays within a controller being associated with a different one of said groups of sender circuits, means for associating on a preferred basis half of said relays in one of said controllers with a first half of said groups of sender circuits and for associating on a non-preferred basis the other half of said relays in said one controller with a second half of said groups of sender circuits, means for associating on a preferred basis half of said relays in the other of said controllers with the second half of said groups of sender circuits and for associating on a non-preferred basis the other half of said relays in said other controller with the first half of said groups of sender circuits, and means whereby a signal from a group of sender circuits operates its associated relay in its preferred controller.

7. In a switching system, a plurality of groups of sender circuits, a pair of controllers, a plurality of relays in each of said controllers with each of said relays within a controller being associated with a different one of said groups of sender circuits, means for associating on a preferred basis half of said relays in one of said controllers with a first half of said groups of sender circuits and for associating on a non-preferred basis the other half of said relays in said one controller with a second half of said groups of sender circuits, means for associating on a preferred basis half of said relays in the other of said controllers with the second half of said groups of sender circuits and for associating on a non-preferred basis the other half of said relays in said other controller with the first half of said groups of sender circuits, means responsive to a signal from a group of sender circuits to operate its associated relay in its preferred controller if said associated relay is unoperated, and means responsive to a signal from a group of sender circuits to operate

its associated relay in its non-preferred controller if its associated relay in its preferred controller is operated.

8. In combination, a group of sender circuits, a pair of controllers, a relay in each controller, means operable to connect a relay in one of said controllers directly to said group of sender circuits, means for also connecting the relay in said one controller in series with the relay in the other controller to said group of sender circuits, means whereby a signal from said group of sender circuits operates the relay in said one controller when it is connected directly to said group of sender circuits, and means whereby said signal operates the relay in said other controller when the relay in said one controller is not directly connected to said group of sender circuits.

9. In a switching system, a plurality of groups of sender circuits, a pair of controllers each of which is associated with different alternate halves of said groups of sender circuits on a preferred basis and with different alternate halves of said groups of sender circuits on a non-preferred basis, a plurality of relays in each of said controllers with each of said relays within a controller being associated with a different one of said groups of sender circuits, and means whereby a signal from a group of sender circuits operates the associated relay in its preferred controller.

10. In a switching system, a plurality of groups of sender circuits, a pair of controllers each of which is associated with different alternate halves of said groups of sender circuits on a preferred basis and with different alternate halves of said groups of sender circuits on a non-preferred basis, a plurality of relays in each of said controllers with each relay within a controller being associated with a different one of said groups of sender circuits, means whereby a signal from a group of sender circuits operates its associated relay in its preferred controller if said associated relay is unoperated, and means whereby said signal operates its associated relay in its non-preferred controller if its associated relay in its preferred controller is currently operated.

11. In a switching system, a plurality of groups of operator positions, a plurality of controllers arranged in a series, a plurality of relays in each of said controllers with each relay within a controller being associated with a different one of said groups of operator positions, an individual external operating circuit for each of said relays, and means whereby a signal from one of said operating circuits operates its associated relay if in the succeeding controllers in said series the relays are unoperated that are associated with the same group of operator positions with which said operated relay is associated.

12. In a communication switching system, a plurality of groups of operator positions, a plurality of controllers arranged in a series, a plurality of relays in each of said controllers with each relay within a controller being associated with a different one of said groups of operator positions, an individual external operating circuit for each of said relays, means whereby simultaneous signals from a plurality of said circuits in one controller operate their associated relays if in the succeeding controllers in said series the relays are unoperated that associated with the same groups of operator positions as are said operated relays, a control relay, and means to cause only one of said operated relays to lock operated to said control relay.

13. In a switching system, a group of relays arranged in series, an individual external operating circuit for each of said relays, a control relay, means whereby a signal from one of said external operating circuits operates its associated relay if the succeeding relays in said series are unoperated, and further means for causing said operated relay to lock operated to said control relay if the preceding relays in said series are unoperated.

14. In a communication switching system, a plurality of groups of relays, a plurality of controllers arranged in a series with each controller having a relay from each group contained therein, an individual external operating circuit for each of said relays, means whereby simultaneous signals from a plurality of said external operating circuits operate their associated relays if in all the succeeding controllers in said series there are unoperated the relays contained in the same groups with said operated relays, a control relay in each controller, and means whereby only one of said operated relays in each controller locks operated to its control relay.

15. In a switching system, a plurality of controllers, a plurality of relays in each controller, an individual external operating circuit and a locking circuit for each of said relays, a control relay in each controller, a preference circuit in each controller comprising a chain of relays and contacts thereon in which only one relay in said chain is operated at any one time, means whereby contacts on the operated relay of the chain within a controller prepare a path to interconnect the control relay in its controller with the locking circuits of said first-named relays in the same controller, means whereby a signal from an external operating circuit operates its associated relay, and means whereby said last-named relay locks in series with the control relay in its controller over a path that includes the contacts on the currently operated relay in said chain.

16. In a switching system, a plurality of groups of operator positions, a plurality of controllers arranged in a series, a plurality of relays in each controller with each relay within a controller being associated with a different one of said groups, an individual external operating circuit and a locking circuit for each of said relays, a control relay in each controller, a preference circuit in each controller comprising a chain of relays and contacts thereon in which only one relay in each chain is operated at any one time, means whereby contacts on the operated relay of the chain within a controller prepare a path to interconnect on a preference basis the control relay in the same controller with the locking circuits of said first-named relays in the same controller, means whereby signals from a plurality of the external operating circuits in one controller operate their associated relays if in the succeeding controllers in said series the relays are unoperated that are associated with the same group of operator positions as are said last-named operated relays, and means including said preference circuit whereby only the preferred operated relay locks in series with said control relay over a path that includes the contacts on said currently operated one relay in said chain of relays.

17. In a switching system, a plurality of groups of operator positions, a plurality of controllers arranged in a series, a plurality of relays in each controller with each relay within a controller being associated with a different one of said groups of operator positions, an individual external operating circuit and a locking circuit for each of said relays, a control relay in each controller, a preference circuit in each controller comprising a chain of relays and contacts thereon in which only one relay in each chain is operated at any one time, means whereby contacts on the one operated relay of the chain within a controller prepare a preference circuit to interconnect the control relay in the same controller with the locking circuits of said first-named relays in the same controller, said preference circuits being operative to connect the locking circuits of said first-named relays so that they are arranged in the order in which they can be locked operated and so that the locking operated of a certain one relay in each controller is preferred over the locking operated of the remaining relays in the same controller, means whereby a signal from each of the external operating circuits within a controller operates their associated relays if in the succeeding controllers in said series the relays are unoperated that are associated with the same group of operator positions as are said last-named operated relays, means including said preference circuit whereby only the one preferred operated relay locks operated in series with said control relay over a path that includes

the contacts on said currently operated one relay in said chain of relays, and means whereby the next preferred operated relay locks operated in series with said control relay over a path that includes the contacts of said currently operated one relay in said chain of relays if the preferred relay is not operated at this time.

18. In a switching system, a plurality of groups of relays with the relays within a group being arranged in series, an external operating circuit and a locking circuit for each of said relays, a control relay, a chain of relays including contacts thereon comprising a preference circuit whereby only one of the relays in said chain is operated at any one time, the contacts of the operated relay in said chain interconnecting said control relay with the locking circuits of one relay in each of said groups, means whereby a signal from an external operating circuit operates its associated relay if the succeeding relays in the same group of relays with said operated relay are unoperated, and means including said preference circuit whereby said operated relay locks operated in series with said control relay over a path that includes the contacts on said currently operated relay in said chain of relays if the preceding relays in said same group of relays with said operated relay are unoperated.

19. In a switching system, a plurality of groups of relays with the relays within a group being arranged in a series, an external operating circuit and a locking circuit for each of said relays, a control relay, a chain of relays including contacts thereon comprising a preference circuit whereby only one relay in said chain is operated at any one time, the contacts of the operated relay in said chain interconnecting on a preference basis said control relay with the locking circuits of one relay in each of said groups, said preference circuit being arranged to allow only one preferred relay to lock operated out of a plurality of operated relays in said groups of relays, means whereby a signal from a plurality of said external operating circuits operates their associated relays if the succeeding relays in the same groups with said operated relays are unoperated, and means including said preference circuit whereby only the one preferred operated relay locks in series with said control relay over a path that includes contacts on said currently operated one relay in said chain of relay if the preceding relays in the same group with said preferred operated relay are unoperated.

20. In a switching system, a plurality of groups of relays with the relays within a group being arranged in a series, an external operating circuit and a locking circuit for each of said relays, a control relay, a preference circuit comprising a chain of relays and contacts thereon whereby only one relay is operated at any one time, means whereby the contacts of the one operated relay in said chain prepare a circuit to interconnect said control relay with the locking circuits of one relay in each of said groups in the order in which they can be locked operated, means whereby signals from a plurality of said external operating circuits operates their associated relays if the succeeding relays in the same groups as said operated relays are unoperated, means whereby only the said one preferred operated relay locks in series with said control relay over a path that includes the contacts on said currently operated one relay in said chain of relays if the preceding relays in the same group as said preferred relay are unoperated, and means whereby the next preferred operated relay locks in series with said control relay over a path that includes the contacts of said currently operated relay in said chain of relays if all of the remaining relays in the same group with said preferred relay are not unoperated.

21. In a switching system, a plurality of groups of operator positions, a plurality of controllers arranged in a series, a first and a second relay in each controller associated with an individual one of each of said groups of operator positions, an external operating circuit for each of said first relays, means whereby a signal from one of the external operating circuits in a controller operates its associated first relay when in each of the succeeding controllers in said series the first relay associated with the same group of operator positions as is said operated relay is unoperated, means whereby the operation of said first relay operates the second relay associated therewith when in the preceding controllers in said series all of the first relays associated with the same group of operator positions as is said operated relay are unoperated.

22. In a switching system, a plurality of groups of operator positions, a plurality of controllers arranged in a series, a first and a second relay in each controller individually associated with each of said groups of operator positions, an external operating circuit for each of said first relays, means whereby a signal from an external operating circuit operates its associated first relay in a controller when in each of the succeeding controllers in said series the relay associated with the same group of operator positions as is said operated first relay is unoperated, means whereby the operation of said first relay operates the second relay associated therewith when in each of the preceding controllers in said series the first relay associated with the same group of operator positions as is said operated first relay is unoperated, and means operated by said operated second relay whereby a circuit is closed for said operated first relay to lock operated.

23. In a switching system, a plurality of groups of relays with each group comprising a first and a second relay and with the plurality of said first relays being arranged in series, an individual external operating circuit for each of said first relays, means whereby a signal from one of said operating circuits operates its associated first relay when all of the succeeding first relays in said series are unoperated, means whereby the operation of said first relay operates its associated second relay when all of the preceding first relays in said series are unoperated.

24. In a switching system, a plurality of pairs of relays, a first and a second relay in each of said pairs with the plurality of said first relays being connected in a series, an external operating circuit for each of said first relays, means whereby a signal from one of said operating circuits operates its associated first relay when the succeeding first relays in said series are unoperated, means whereby the operation of said first relay operates the second relay associated therewith when the preceding first relays in said series are unoperated, and means operated by said operated second relay whereby the said operated first relay is locked operated.

25. In a switching system, a plurality of groups of operator positions, a plurality of controls arranged in a series, a plurality of first relays in each controller with each of said first relays within a controller being common to or different individual one of said groups of operation positions, a second relay exclusively associated with each of said first relays, an operating circuit and a locking circuit for each of said first relays, a control relay in each controller, a relay, preference circuit in each controller comprising a plurality of relays having contacts which prepare a path to interconnect on a preferance basis a control relay in a controller with the locking circuits of the first relays within the same controller, means whereby the external operating circuits within a controller operate their associated first relays when there are unoperated in all succeeding controllers in said series the first relays associated with the same groups of operator positions as are said operated first relays, means whereby the operation of each said first relays operates its associated second relay when there are unoperated in all preceding controllers in said series the first relays associated with the same group of operator positions as are said operated first relays, contacts operated by each of said operated second relays whereby the locking circuit

of each of said operated first relays is connected to said preference circuit within its controller, means whereby said preference circuit locks operated a preferred one of said operated first relays in series with said control relay within its controller, and means whereby a second preferred relay is locked operated if said preferred first relay is not operated at this time.

26. In a switching system, a plurality of groups of operator positions, a plurality of controllers arranged in a series, a plurality of first relays in each controller with each of said first relays within a controller being common to a different individual group of operator positions, a second relay exclusively associated with each of said first relays, an external circuit and a locking circuit for each of said first relays, a control relay in each controller, a relay preference circuit in each controller comprising a plurality of relays having contacts which prepare a path to interconnect on a preference basis the control relay in its controller with the locking circuits of said first relays in its controller, means whereby the external operating circuits for said first relays within a controller operate their associated relays when there is unoperated in each succeeding controller in said series the corresponding first relays associated with the same groups of operator positions as are the operated first relays, means whereby the operation of every first relay operates its associated second relay when there is unoperated in each preceding controller in said series the corresponding first relays associated with the same groups of operator positions as are the operated first relays, contacts operated by each of said operated second relays whereby the locking circuit of each of said operated first relays is connected to said preference circuit, and means whereby said preference circuit locks operated a preferred one of said operated first relays in series with said control relay.

27. In a switching system, a plurality of groups of relays with each group having a plurality of first relays arranged in a series, a second relay individually associated with each of said first relays, an external operating circuit and a locking circuit for each of said first relays, a control relay, a relay preference circuit comprising a plurality of relays whose contacts interconnect in a preferred order of availability said control relay with the locking circuits of a first relay in each of said groups, means whereby the external operating circuit for each of said first relays operates its associated relay when the succeeding first relays in the same groups with said operated first relays are unoperated, means responsive to the operation of each first relay to operate its associated second relay when the preceding first relays in the same groups of relays as said operated first relays are unoperated, contacts operated by each of said operated second relays whereby each of said operated first relays is connected to said preference circuit, means whereby said preference circuit locks operated a preferred one of said operated first relays in series with said control relay, and means whereby a second preferred relay locks operated if the preferred relay is not operated at this time.

28. In a communication switching system, a plurality of operator position circuits for serving incoming calls, each of said circuits having an idle and a busy condition, a communication line, a preference circuit operative to arrange said operator position circuits in a preferred order for serving the next incoming call, means including said preference circuit operative in response to a call signal applied to said line to connect said line to the most preferred one of said operator position circuits in an idle condition at the time said call signal is applied to said line, a memory circuit, and means including said memory circuit operative in response to said connection to rearrange said preference circuit so that the operator position circuit next preferred after said currently connected operator position will be preferred for serving the next incoming call.

29. In a communication switching system, a plurality of operator position circuits for serving incoming calls, each of said circuits having an idle and a busy condition, a communication line, a preference circuit operative to arrange said operator position circuits in a preferred order for serving the next incoming call, means including said preference circuit operative in response to the next call signal applied to said line to connect said line to the most preferred one of said operator position circuits in an idle condition at the time of said call, a memory circuit, means including said memory circuit operative in response to said connection to rearrange said preference circuit so that said operator position circuit next preferred after said currently connected operator position will be preferred for serving the next incoming call, and means including said preference circuit responsive to the reception of the next incoming call to interconnect said line with the then currently preferred operator position circuit.

30. In a communication switching system, a calling line, a plurality of operator position circuits for serving incoming calls on said line, each of said circuits having an idle and a busy condition, a preference circuit operative to arrange said operator position circuits in a preferred order in which the next call on said line will be served by said operator position circuits, means including said preference circuit operative in response to a call signal applied to said line to interconnect said line with the preferred one of said operator position circuits when said preferred circuit is currently in an idle condition, a memory circuit, means including said preference circuit responsive to an incoming call on said line and operative when said preferred circuit is in a busy condition upon the receipt of an incoming call to interconnect said line with the next preferred position circuit currently in an idle condition, and means including said memory circuit responsive to said interconnection to rearrange said preference circuit so that said operator position circuit next preferred after said currently connected operator position will be preferred for serving the next incoming call.

References Cited in the file of this patent

UNITED STATES PATENTS

1,816,634	Carpenter	July 28, 1931
2,467,457	Balzer	Apr. 19, 1949
2,561,073	Schouten	July 17, 1951
2,598,098	Balzer	May 27, 1952
2,686,843	Shafer	Aug. 17, 1954