July 23, 1968 R. J. JAEGER, JR., ET AL 3,394,232

TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 1

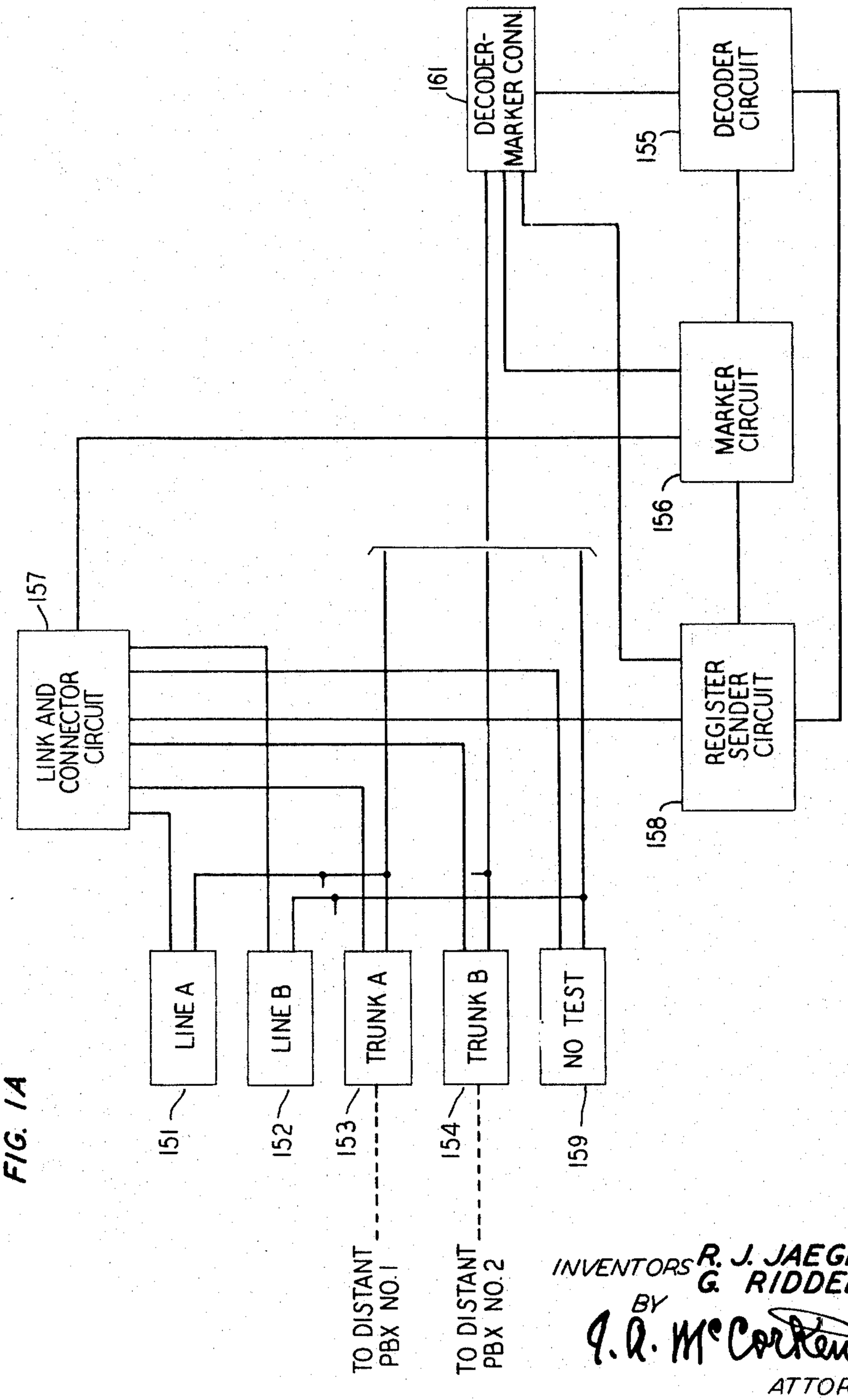

FIG. 14

INVENTORS R. J. JAEGER, JR.
G. RIDDELL

BY R. J. McCorkendale

ATTORNEY

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 2

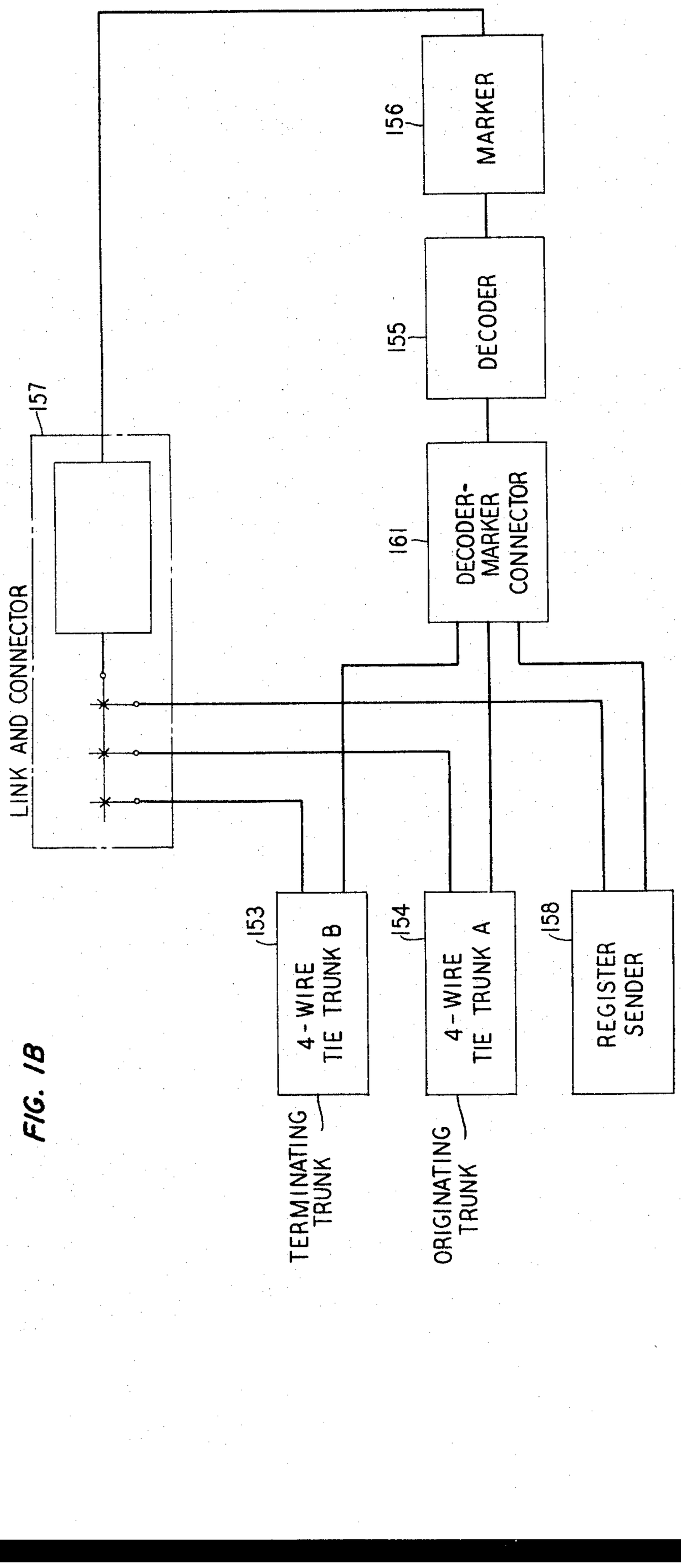

FIG. 1B

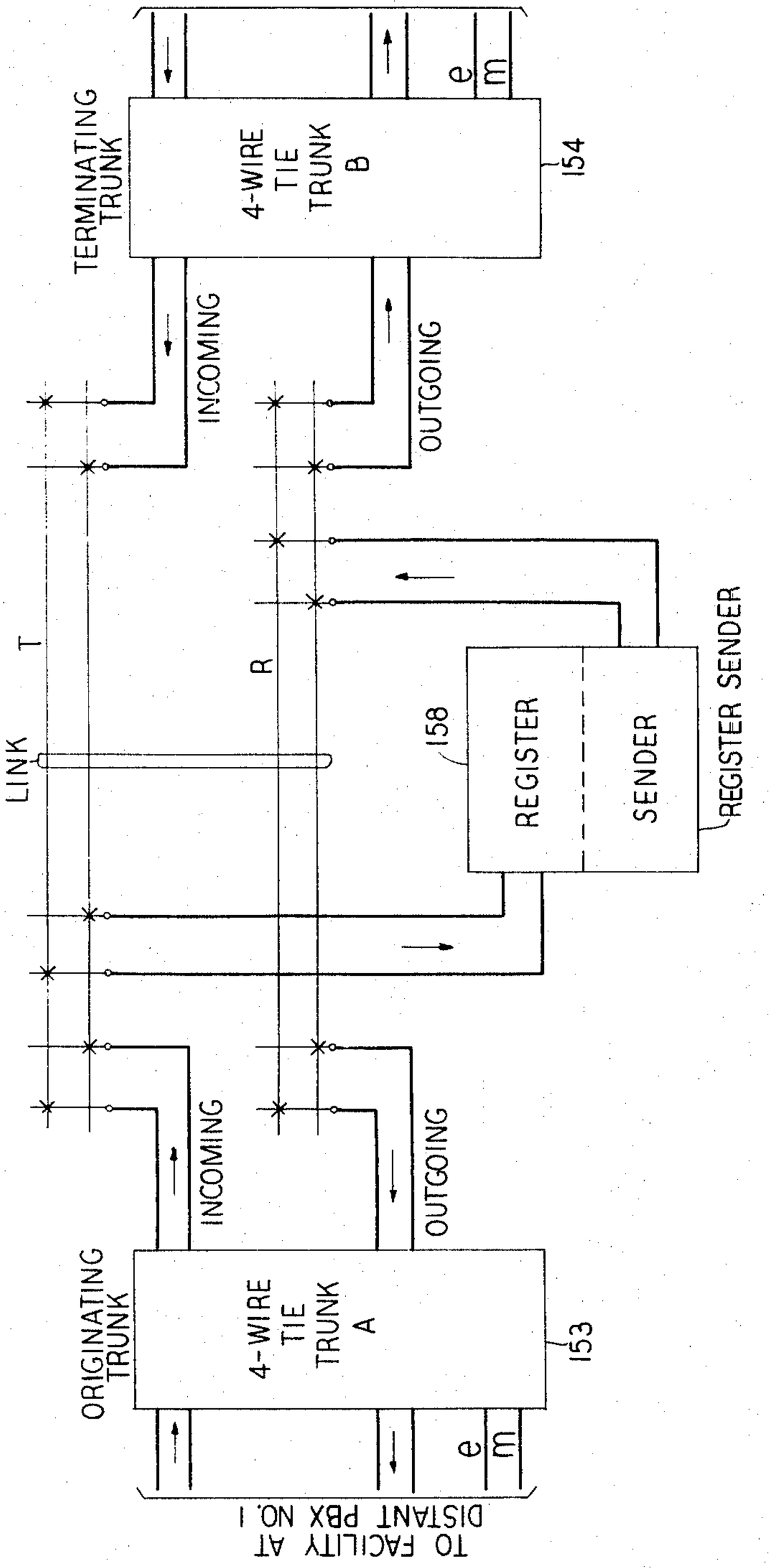
TO FACILITY AT DISTANT PBX NO. 2
e
m
TERMINATING TRUNK
4-WIRE TIE TRUNK B
154
INCOMING
OUTGOING
T
R
LINK
158
REGISTER
SENDER
REGISTER SENDER
INCOMING
OUTGOING
ORIGINATING TRUNK
4-WIRE TIE TRUNK A
153
e
m
TO FACILITY AT DISTANT PBX NO. 1

FIG. 1C

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 4

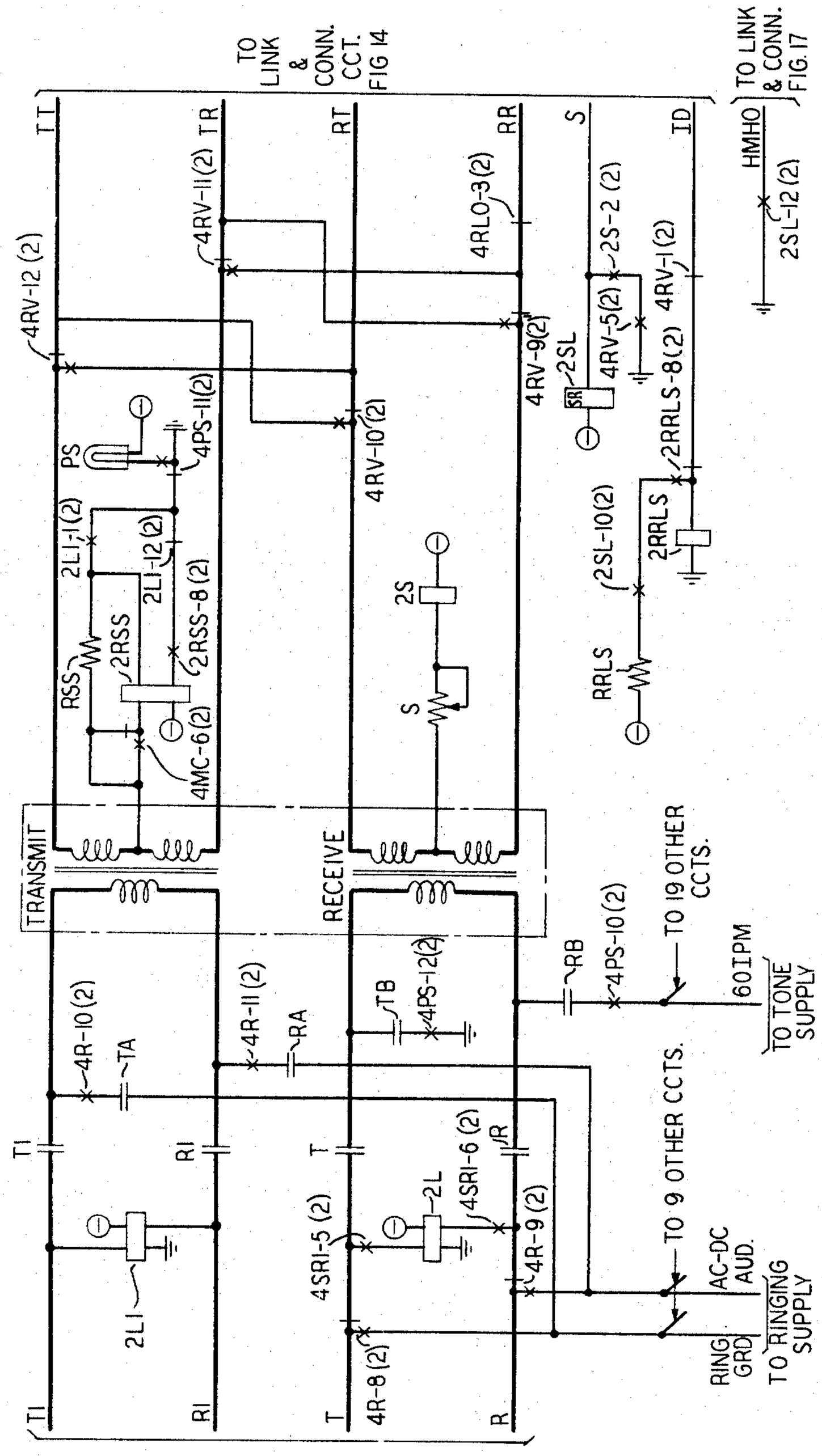

FIG2

TELEPHONE SYSTEM

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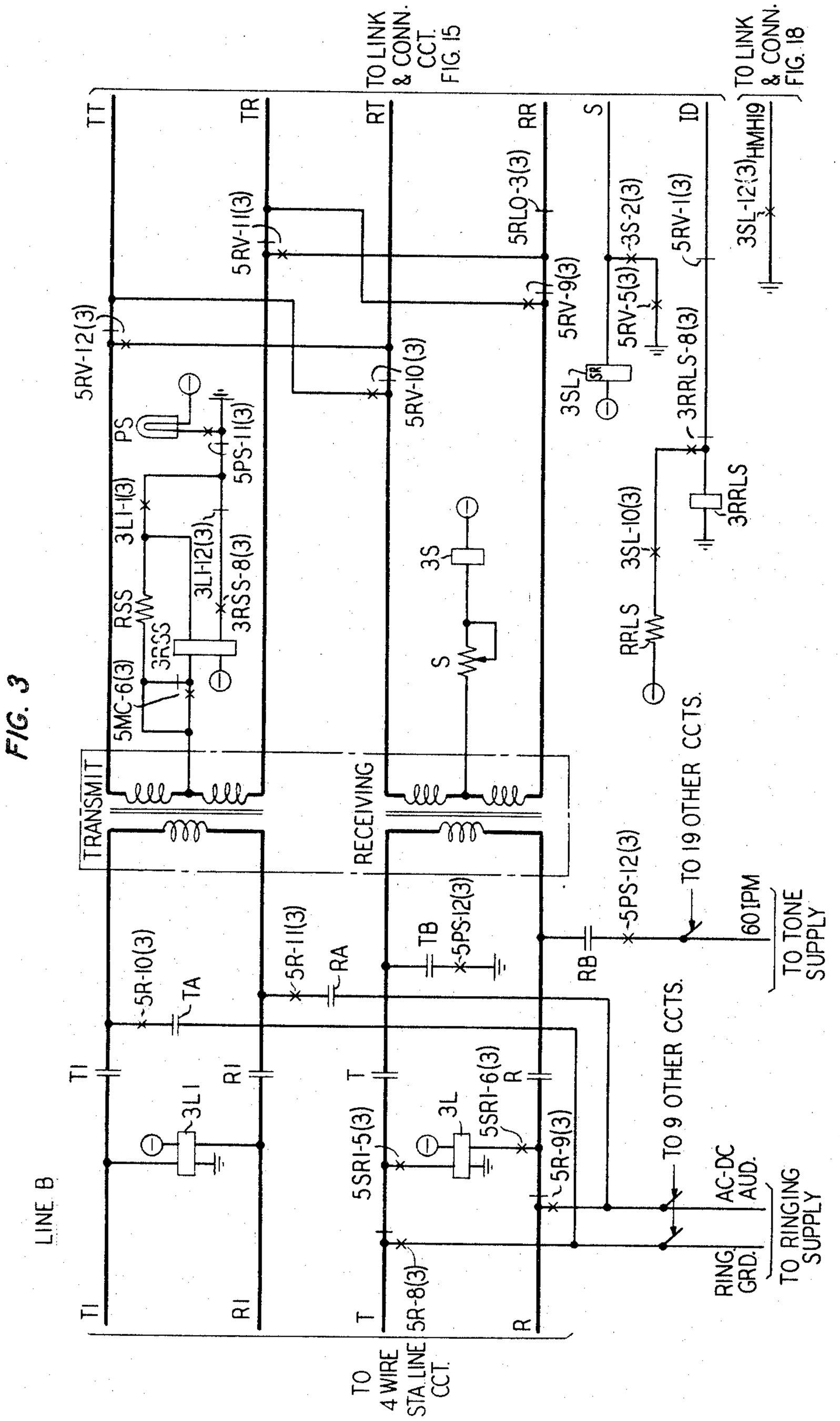

FIG. 3

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 6

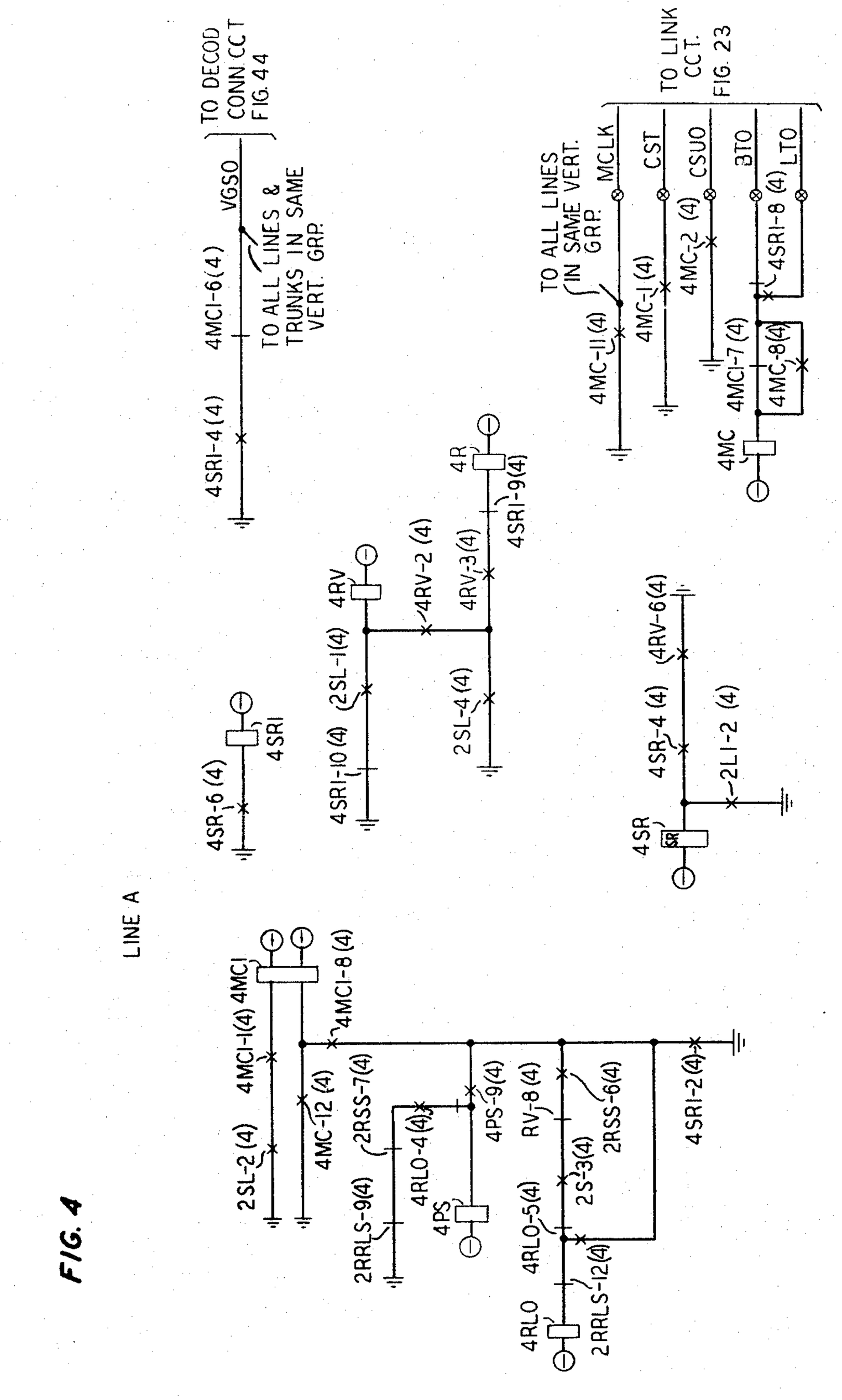

FIG. 4

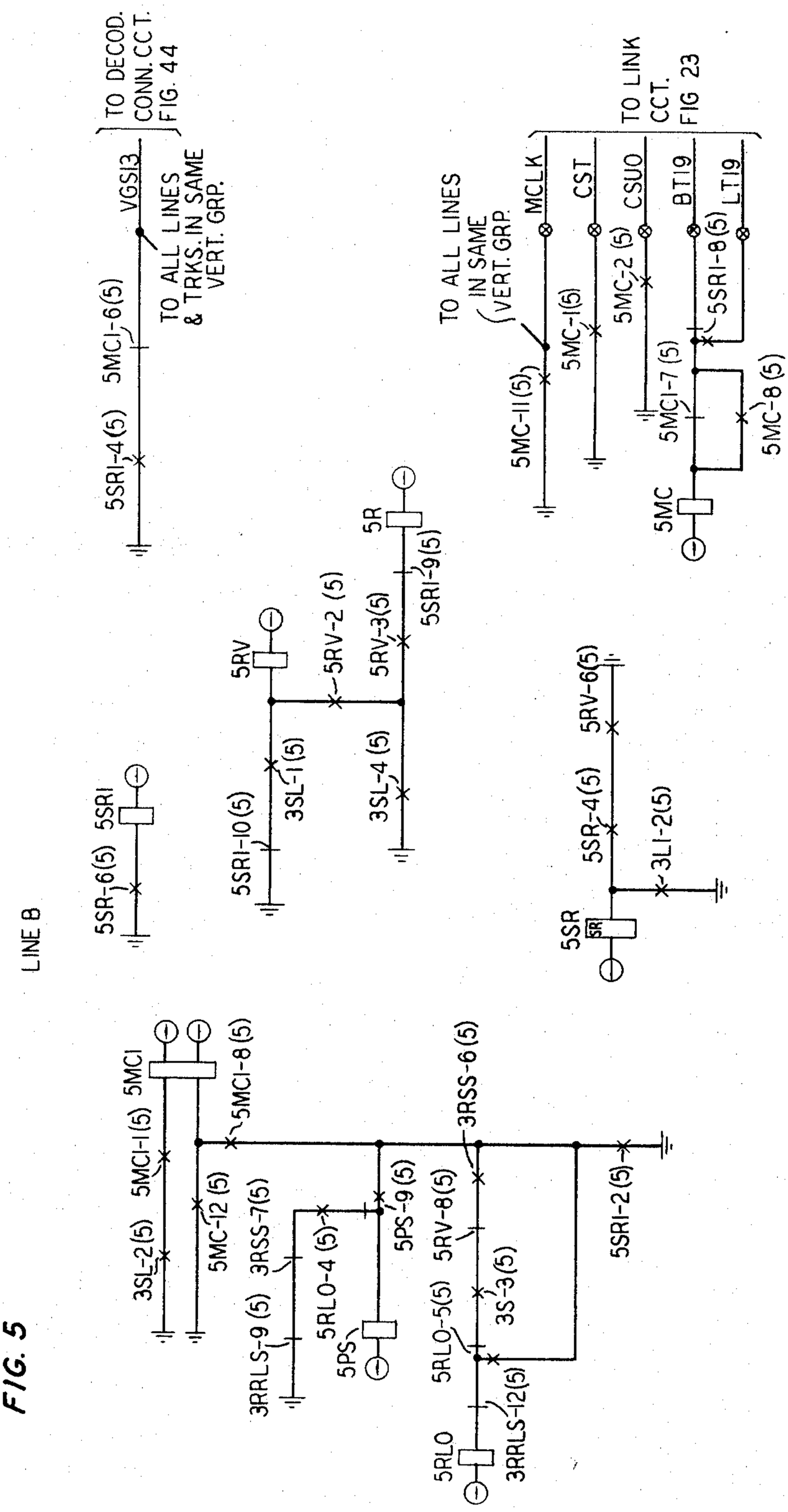
LINE B
5SR-6(5) 5SRI
5SRI-10(5)
3SL-1(5)
3SL-4(5)
5SR-4(5)
3LI-2(5)
5SR
5RV-6(5)
5RV
5RV-2(5)
5RV-3(5)
5R
5SRI-9(5)
5SRI-4(5)
5MCI-6(5)
VGSI3
TO ALL LINES & TRKS. IN SAME VERT. GRP.
TO DECOD. CONN. CCT. FIG. 44
TO ALL LINES IN SAME VERT. GRP.
5MC-11(5)
MCLK
5MC-1(5)
CST
5MC-2(5)
CSUO
5MCI-7(5)
BTI9
5SRI-8(5)
LTI9
5MC-8(5)
5MC
3SL-2(5) 5MCI-1(5) 5MCI
5MCI-8(5)
5MC-12(5)
3RSS-7(5)
5RLO-4(5)
5PS-9(5)
3RSS-6(5)
5RV-8(5)
3S-3(5)
5SRI-2(5)
3RRLS-9(5)
5RLO
5PS
5RLO-5(5)
3RRLS-12(5)

FIG. 5

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 8

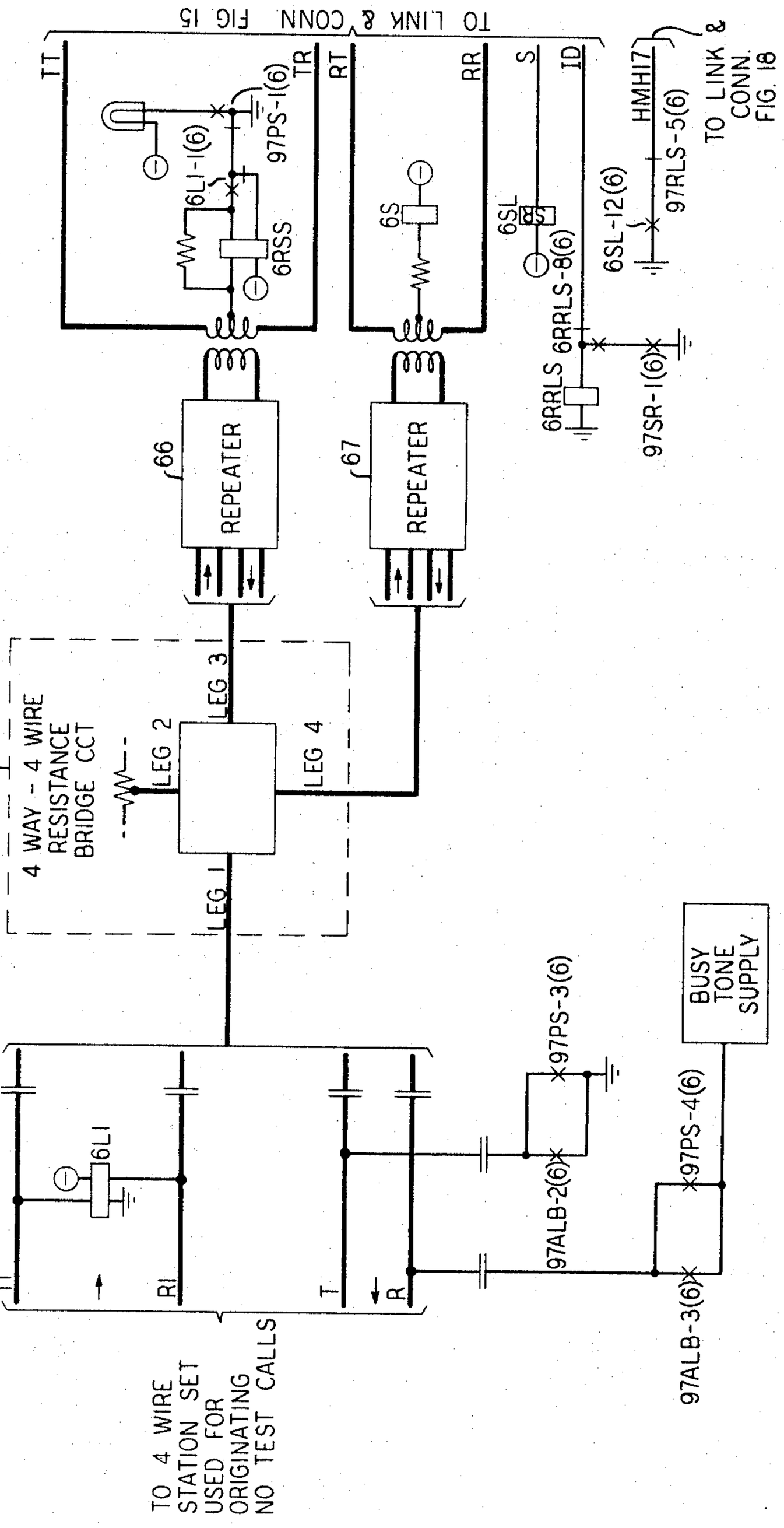


FIG. 6

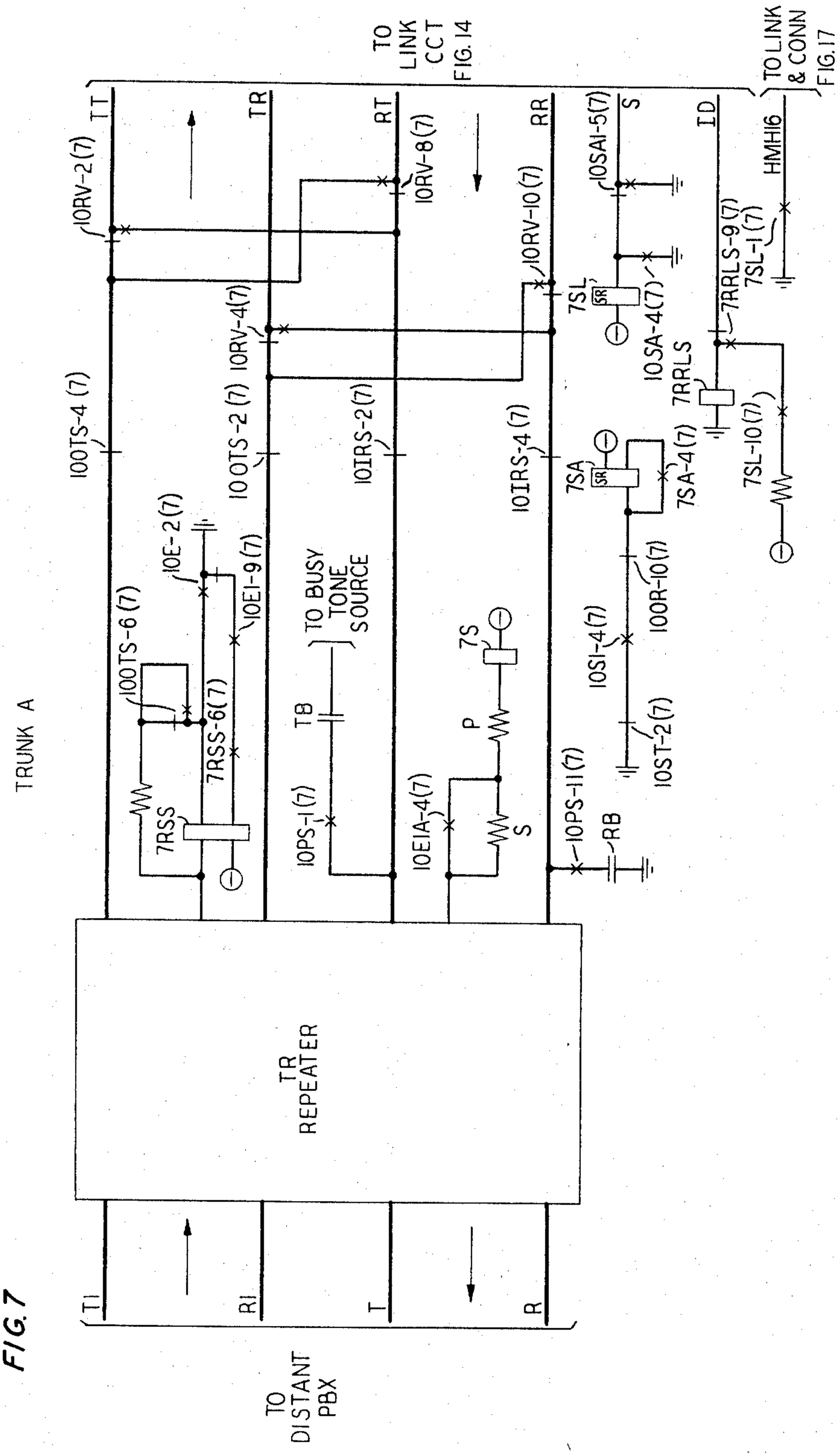

TRUNK A
TO LINK CCT FIG. 14
TO LINK & CONN FIG. 17
TT
TR
RT
RR
S
ID
10RV-2(7)
10RV-8(7)
10RV-10(7)
10SAI-5(7)
10RV-4(7)
100TS-4(7)
10OTS-2(7)
10IRS-2(7)
10IRS-4(7)
10SA-4(7)
7SL
7SA
7RRLS
7RRLS-9(7)
7SL-1(7)
HMH16
7SA-4(7)
7SL-10(7)
10E-2(7)
10E1-9(7)
TO BUSY TONE SOURCE
7S
100R-10(7)
100TS-6(7)
7RSS
7RSS-6(7)
10PS-1(7)
TB
10EIA-4(7)
P
S
10PS-11(7)
RB
10ST-2(7)
TR REPEATER
TI
RI
T
R
TO DISTANT PBX

FIG. 7

TELEPHONE SYSTEM

Filed March 9, 1965

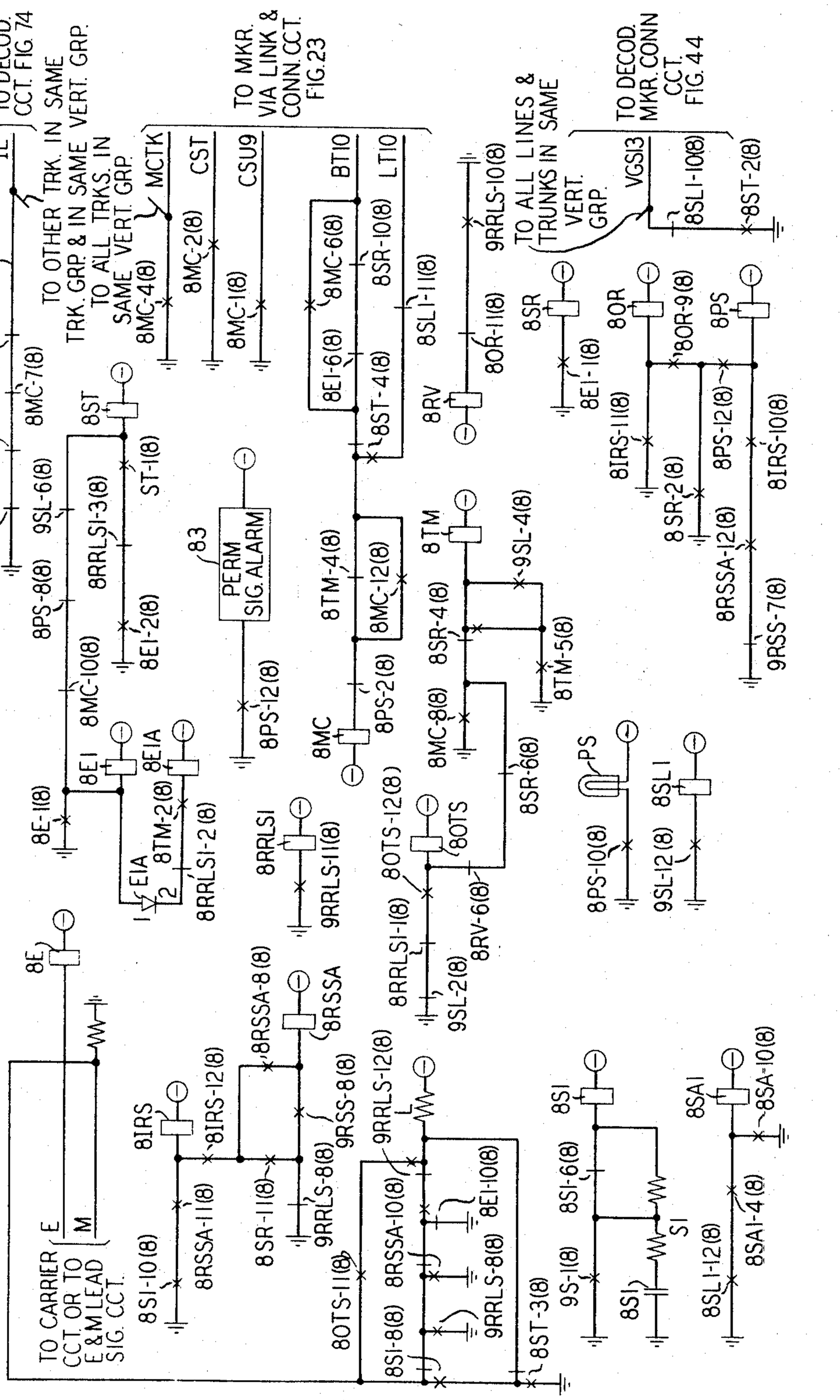
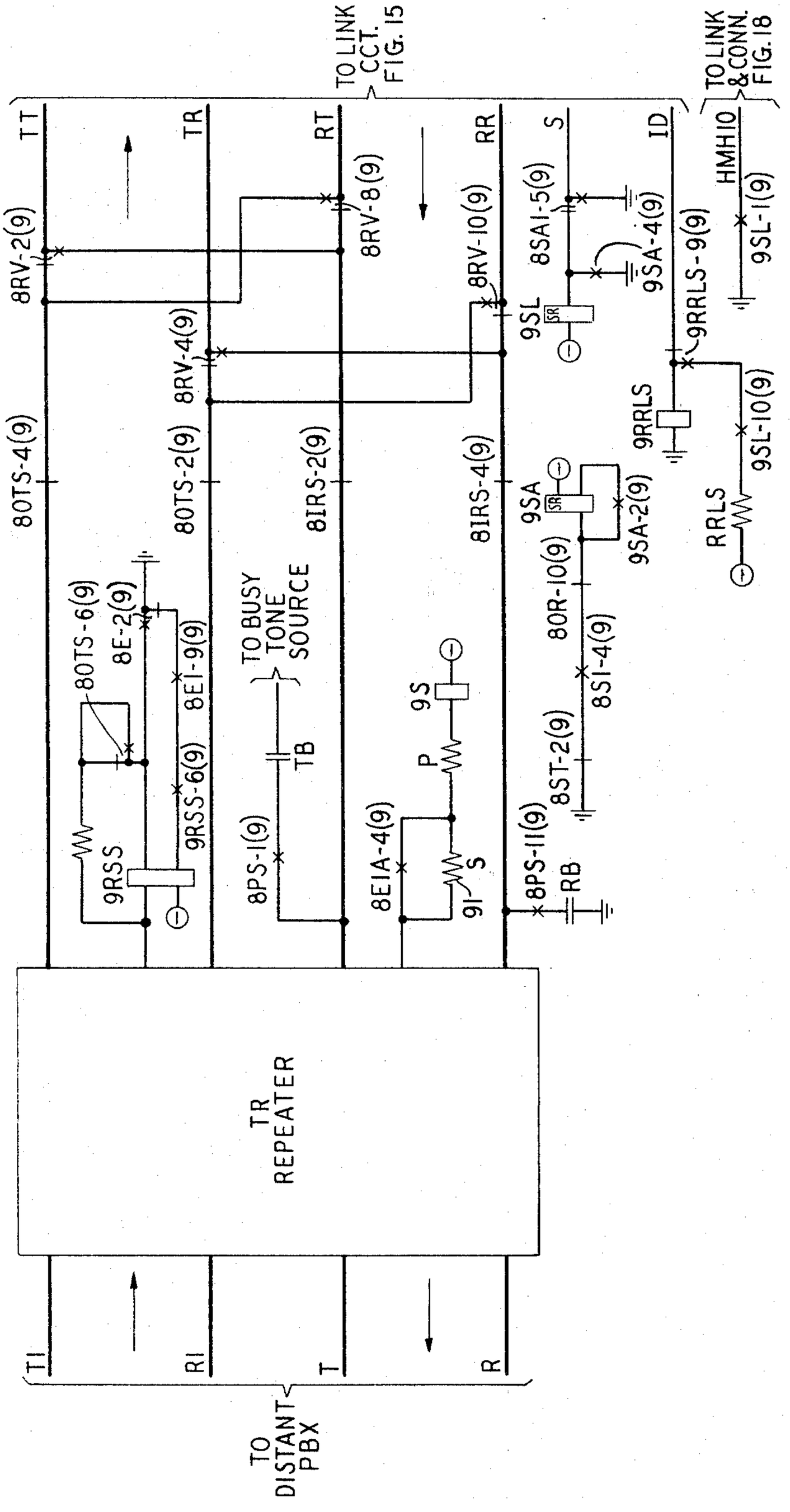


FIG. 8

FIG. 9


TO LINK CCT. FIG. 15
TO LINK & CONN. FIG. 18
TT
TR
RT
RR
S
ID
8RV-2(9)
8RV-8(9)
8RV-10(9)
8SA1-5(9)
9SA-4(9)
HMH10
9SL-1(9)
8RV-4(9)
9SL
9RRLS-9(9)
8OTS-4(9)
8OTS-2(9)
8IRS-2(9)
8IRS-4(9)
9RRLS
8OTS-6(9)
8E-2(9)
8EI-9(9)
TO BUSY TONE SOURCE
9SA
9SA-2(9)
8OR-10(9)
8SI-4(9)
9SL-10(9)
RRLS
9RSS
9RSS-6(9)
8PS-1(9)
TB
8EIA-4(9)
P
S
91
8PS-11(9)
RB
8ST-2(9)
TRUNK B
TR REPEATER
TI
RI
T
R
TO DISTANT PBX

July 23, 1968 R. J. JAEGER, JR., ET AL 3,394,232

TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 12

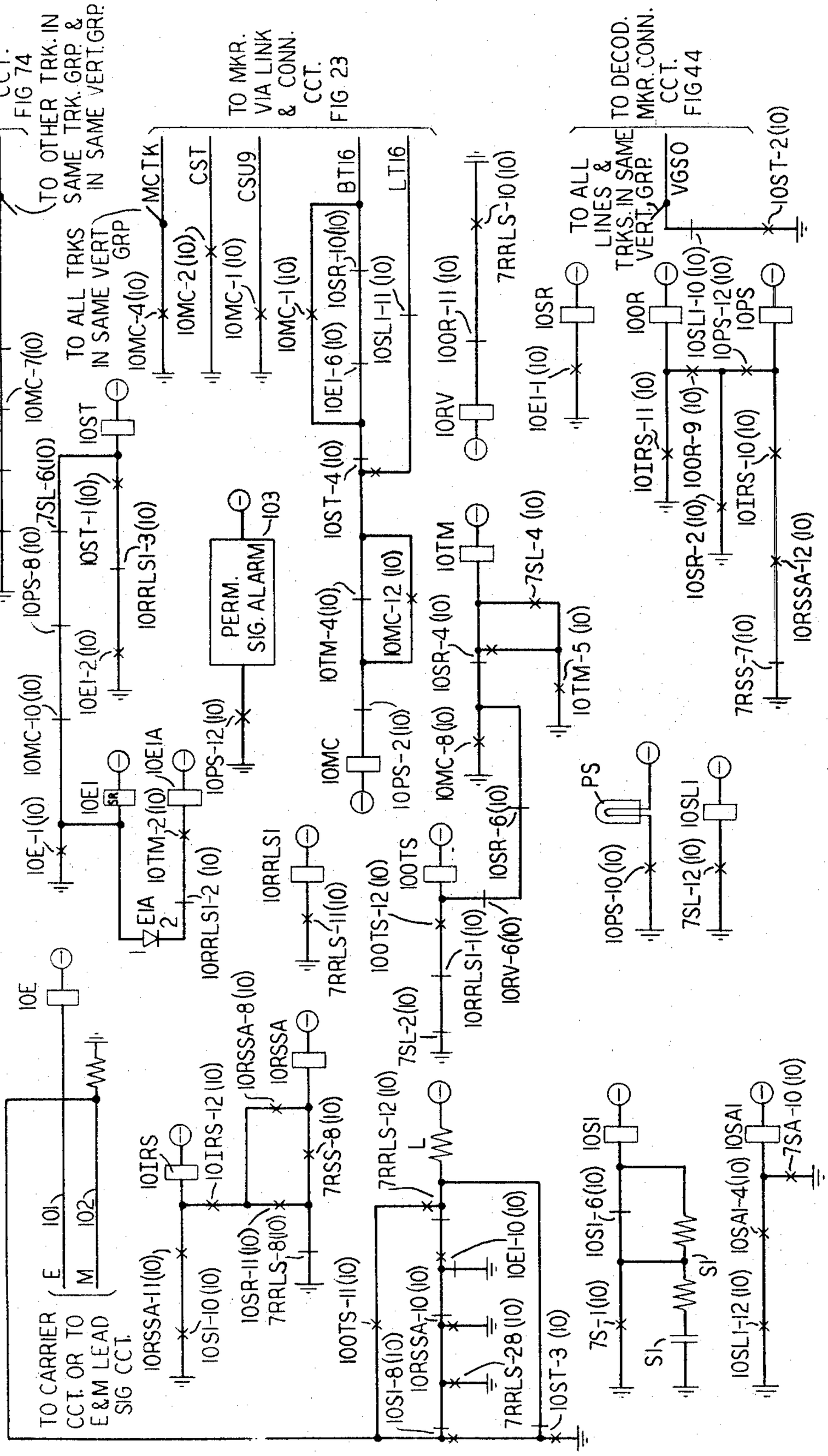


FIG. 10

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 13

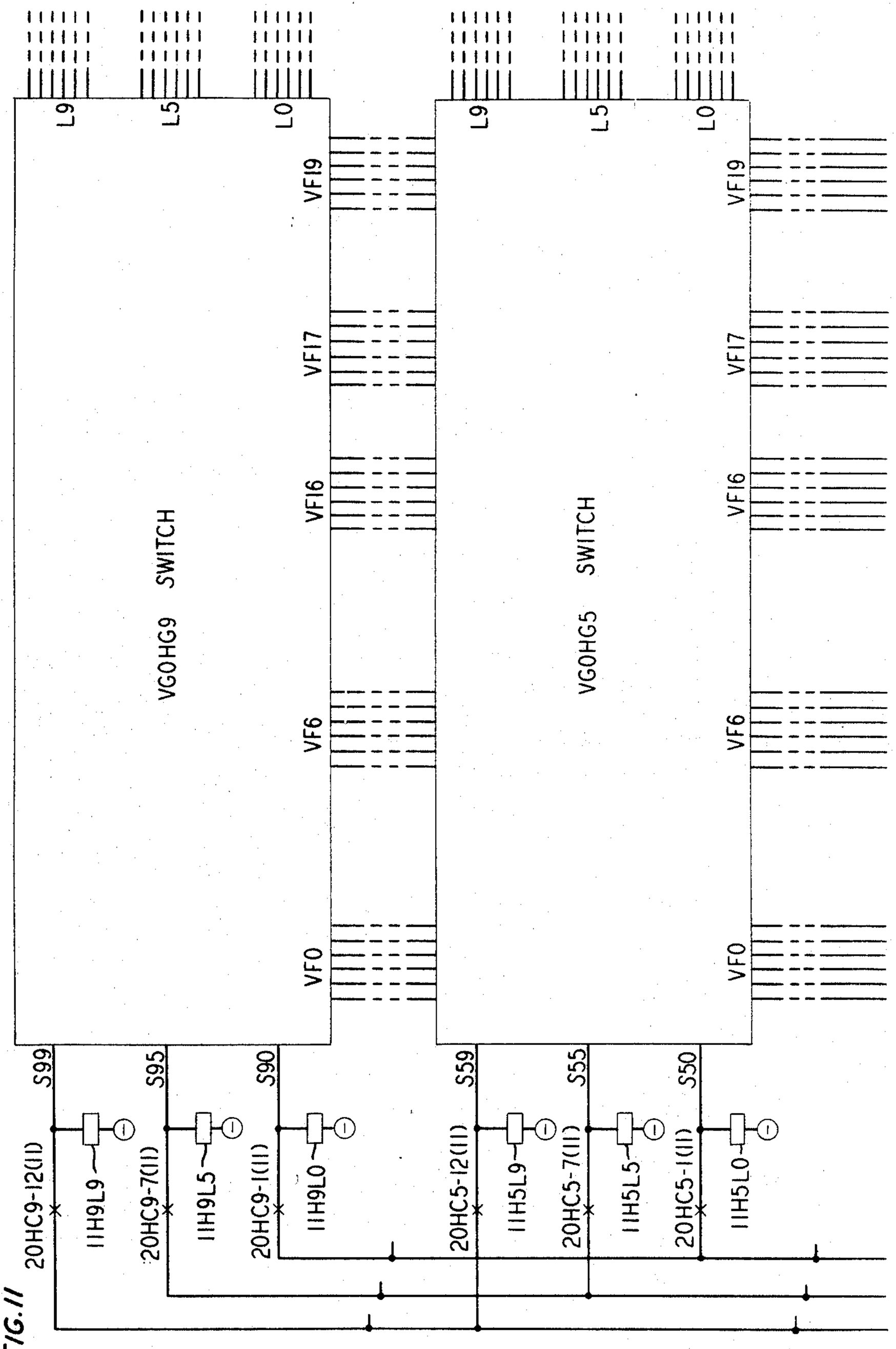

FIG. 11

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 14

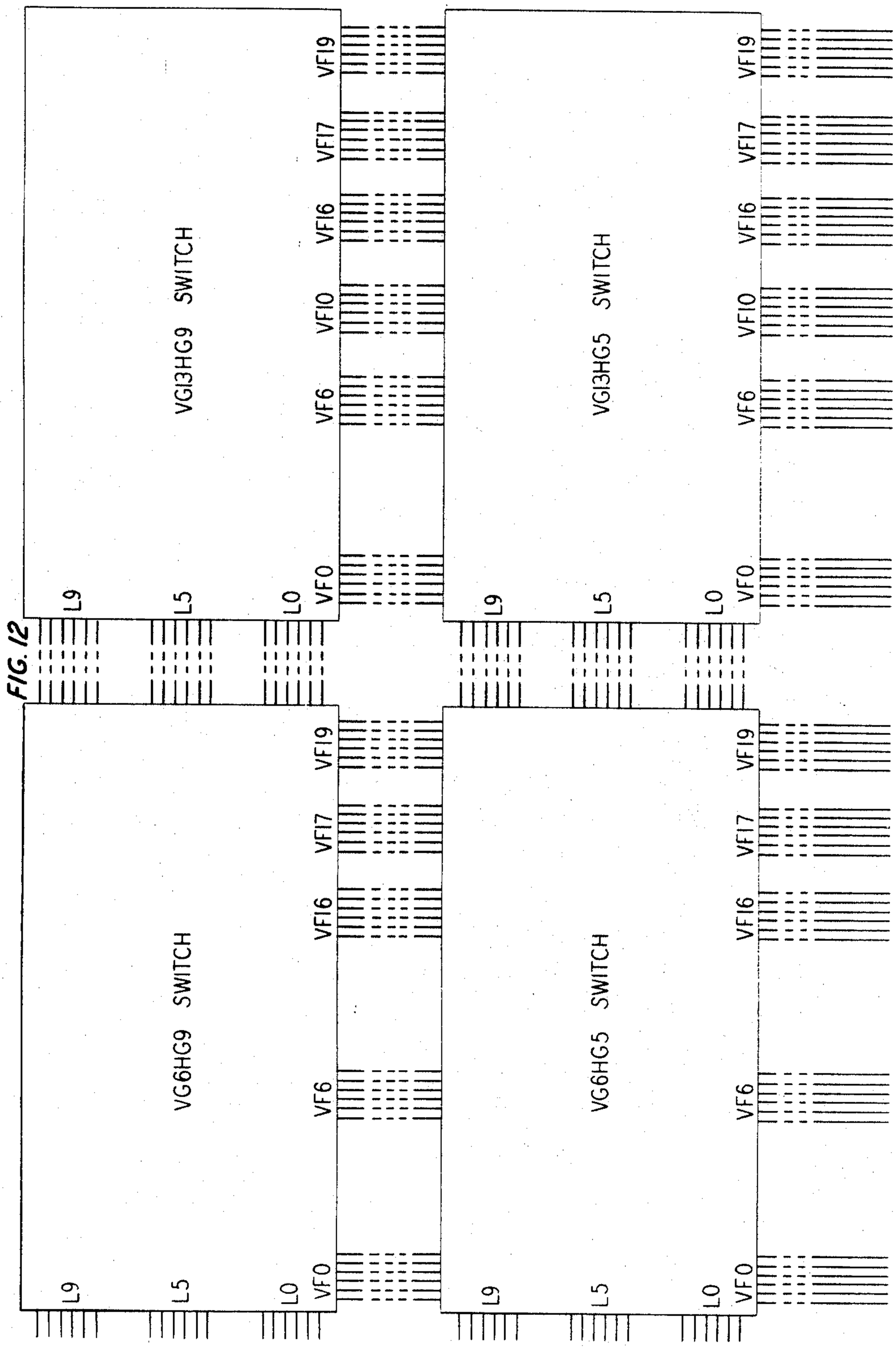

FIG. 12

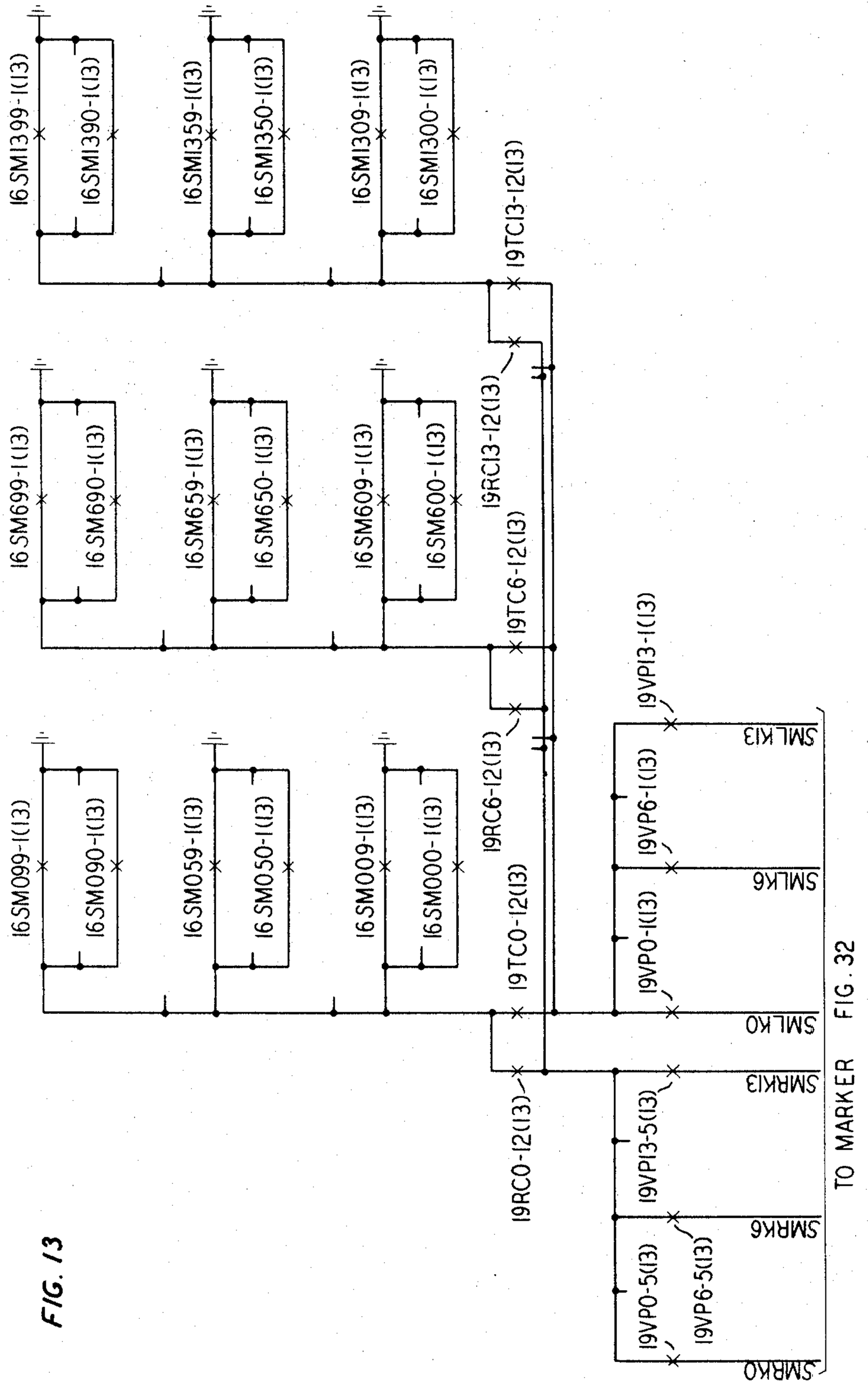
16SM1399-1(13)
16SM1390-1(13)
16SM1359-1(13)
16SM1350-1(13)
16SM1309-1(13)
16SM1300-1(13)
19TC13-12(13)
16SM699-1(13)
16SM690-1(13)
16SM659-1(13)
16SM650-1(13)
16SM609-1(13)
16SM600-1(13)
19RC13-12(13)
19TC6-12(13)
19VP13-1(13)
16SM099-1(13)
16SM090-1(13)
16SM059-1(13)
16SM050-1(13)
16SM009-1(13)
16SM000-1(13)
19RC6-12(13)
19VP6-1(13)
19TC0-12(13)
19VP0-1(13)
SMLK13
SMLK6
SMLK0
SMRK13
19RC0-12(13)
19VP13-5(13)
19VP6-5(13)
19VP0-5(13)
SMRK6
SMRK0
TO MARKER

FIG. 32

FIG. 13

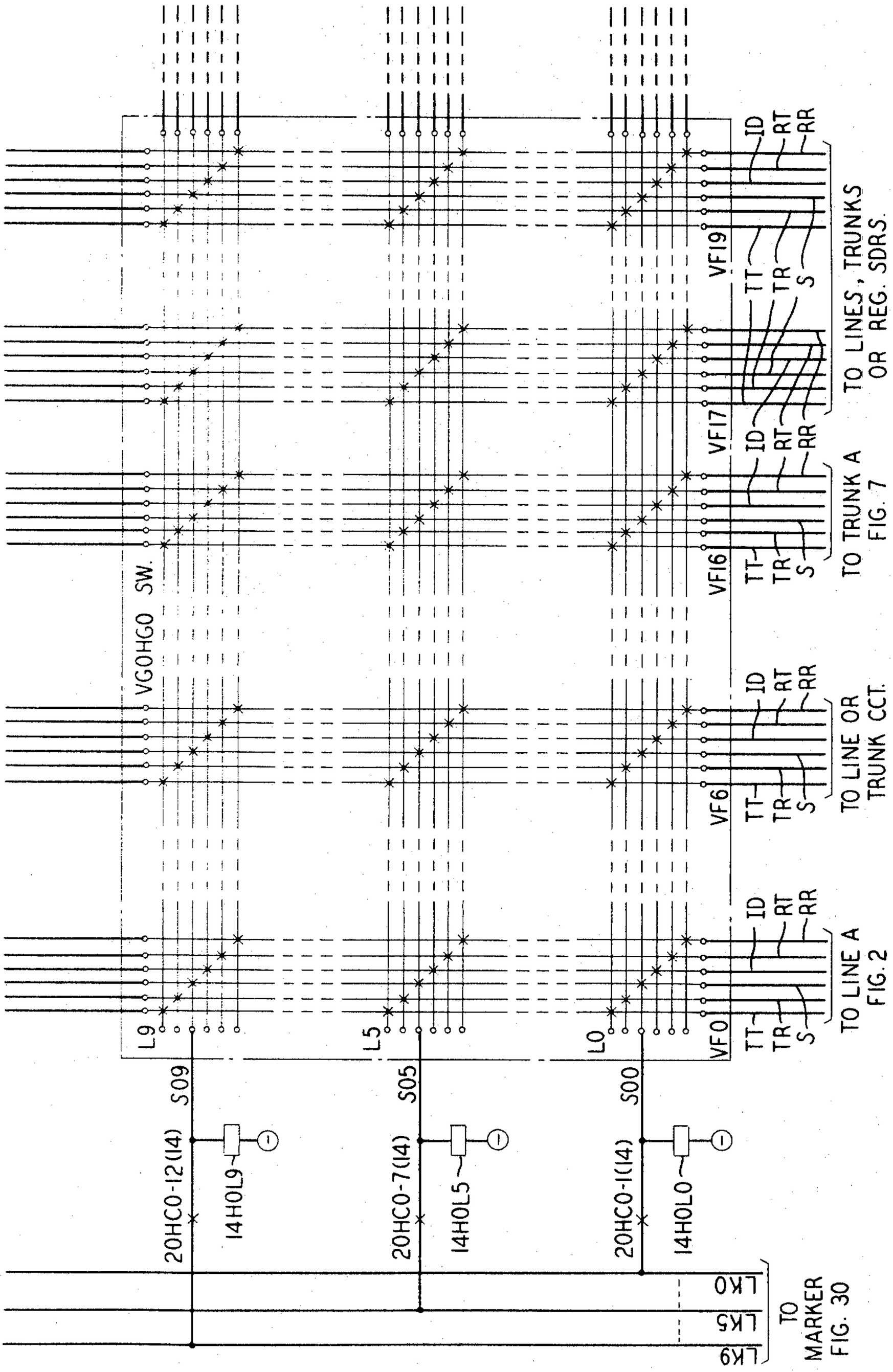
VGOHGO SW.
L9
L5
L0
S09
S05
S00
20HCO-12(14)
14HOL9
20HCO-7(14)
14HOL5
20HCO-1(14)
14HOL0
LK9
LK5
LK0
TO MARKER FIG. 30
VF19
VF17
VF16
VF6
VF0
ID
RT
RR
TT
TR
S
TO LINES, TRUNKS OR REG. SDRS.
TO TRUNK A FIG. 7
TO LINE OR TRUNK CCT.
TO LINE A FIG. 2

FIG. 14

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TELEPHONE SYSTEM

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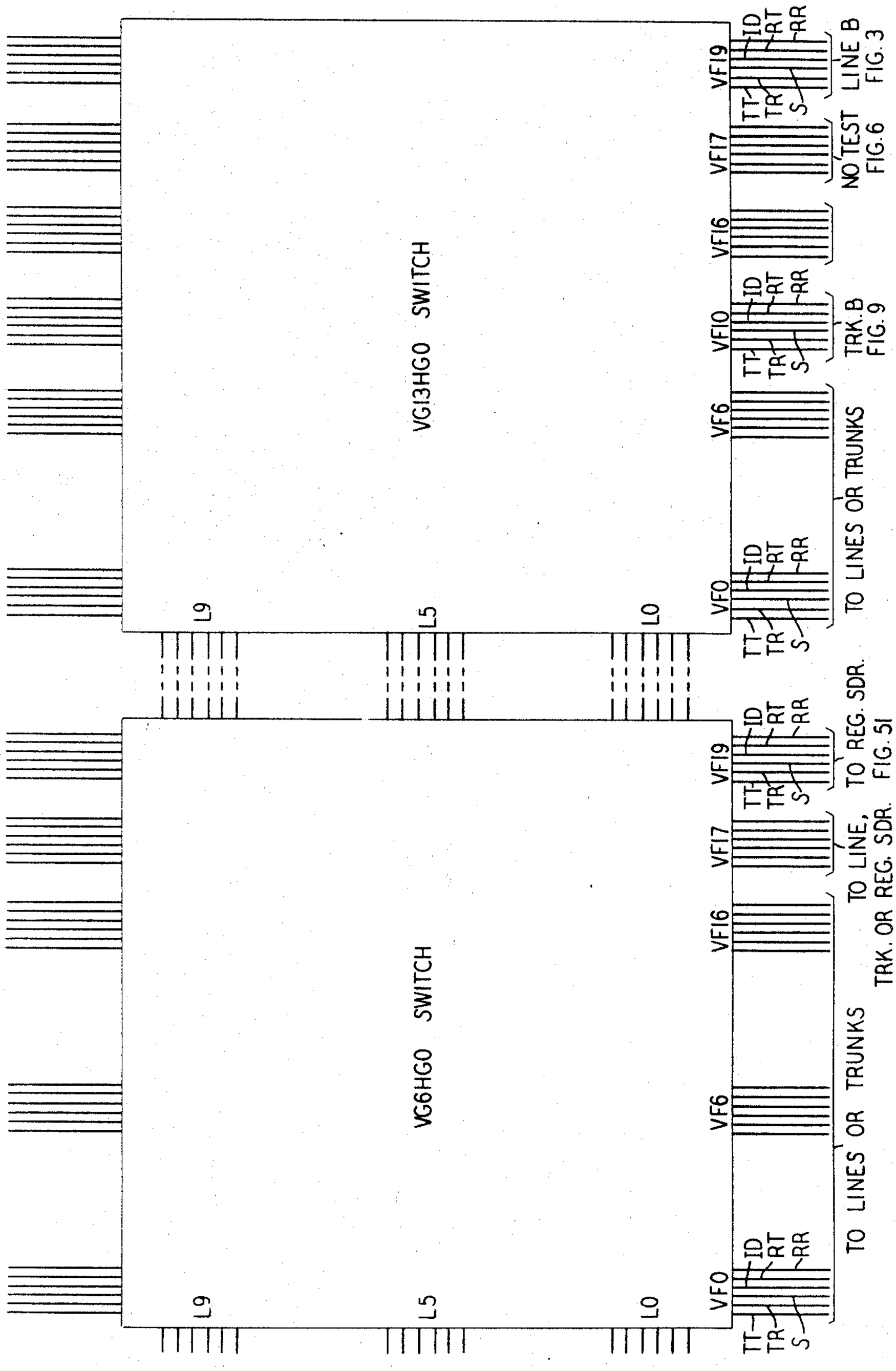

FIG. 15

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 18

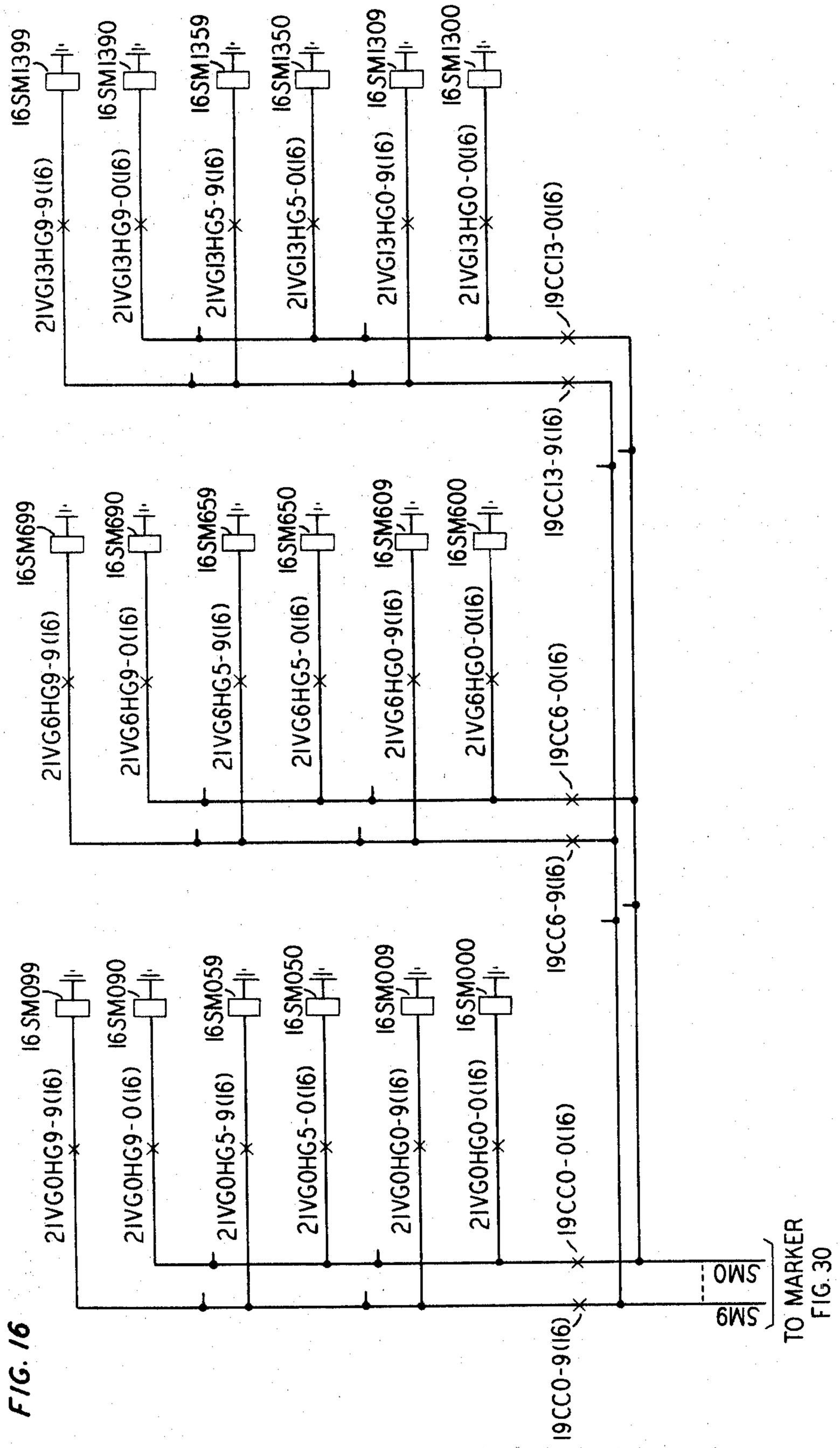

FIG. 16

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 19

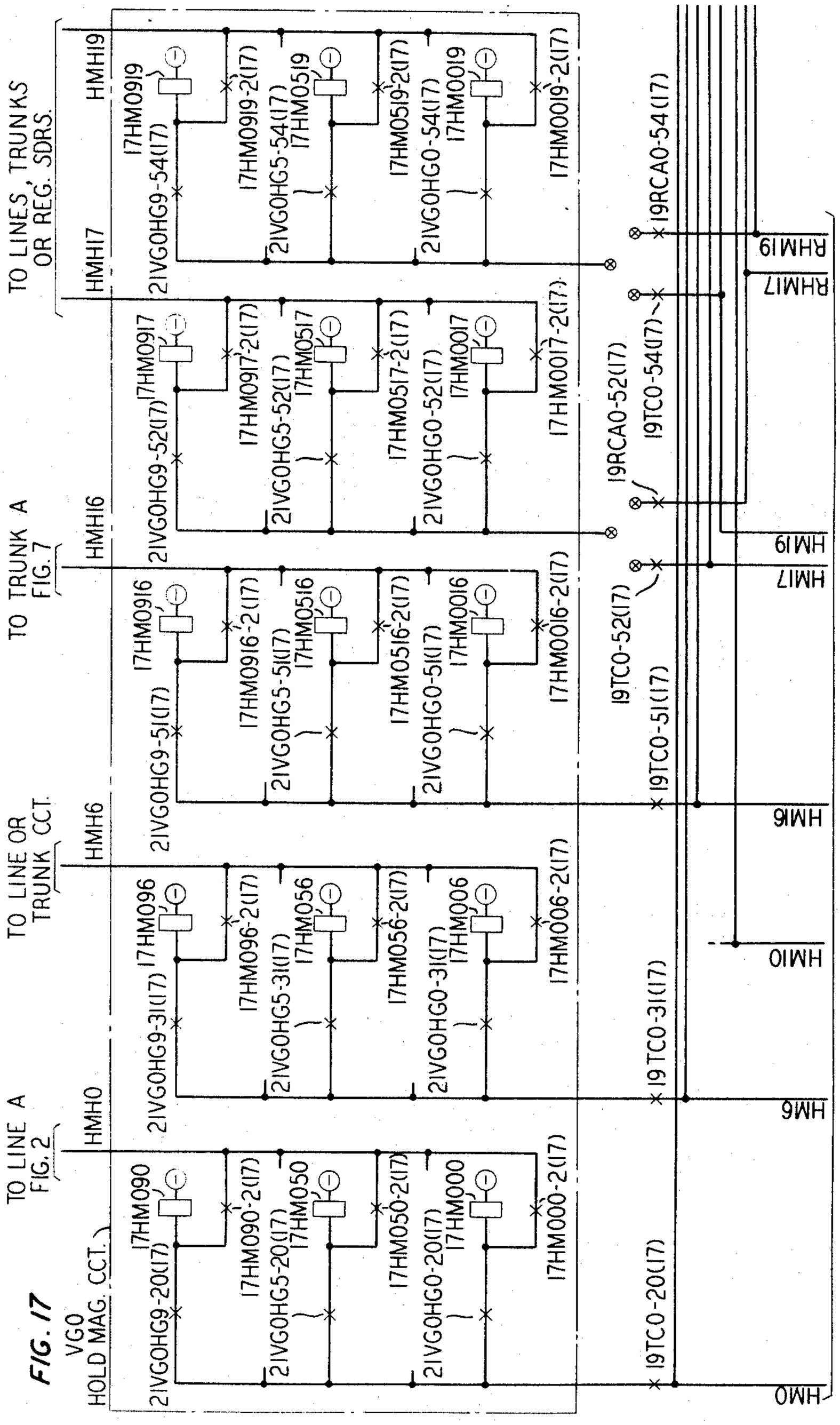

FIG. 17

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 20

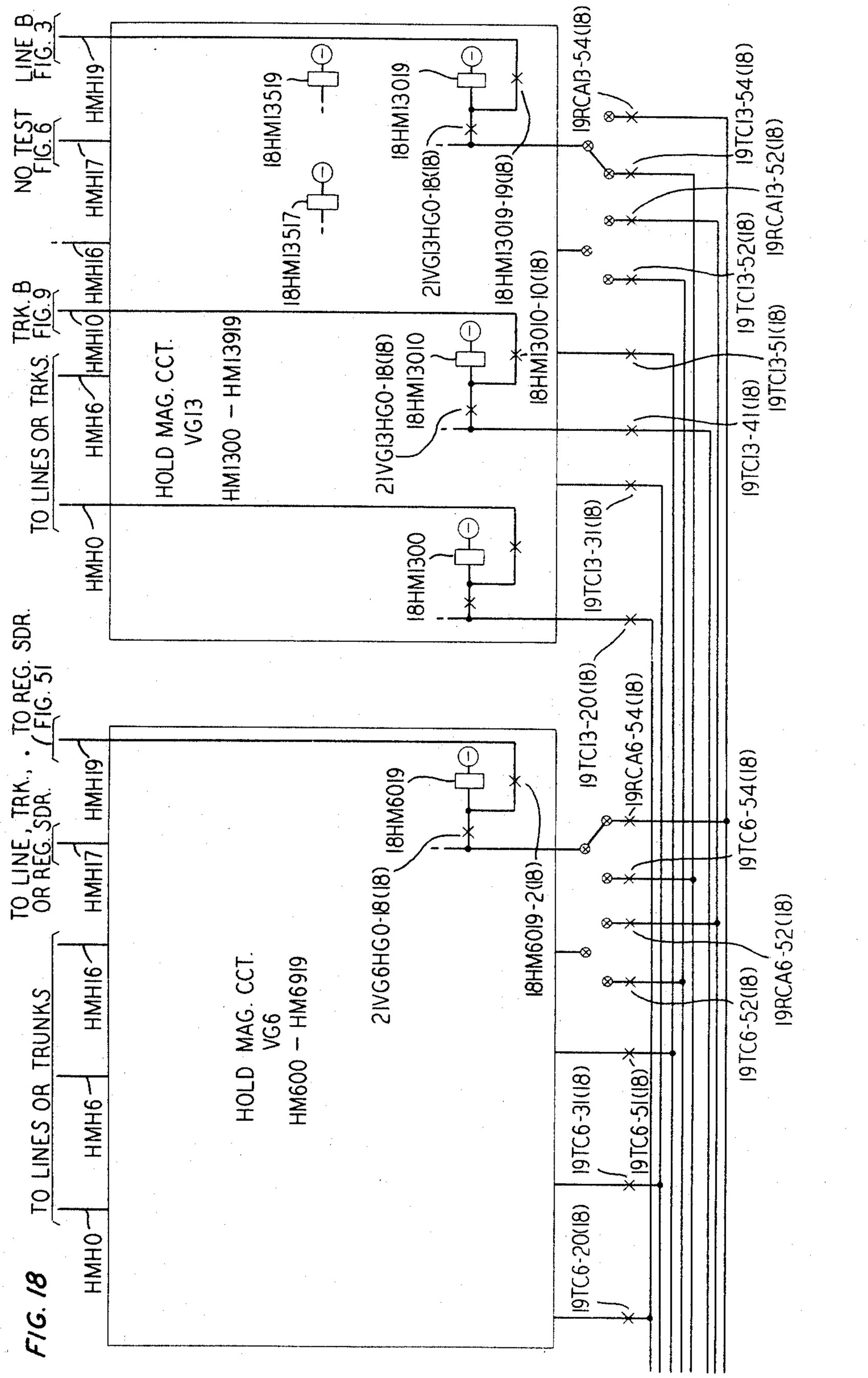

FIG. 18

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 21

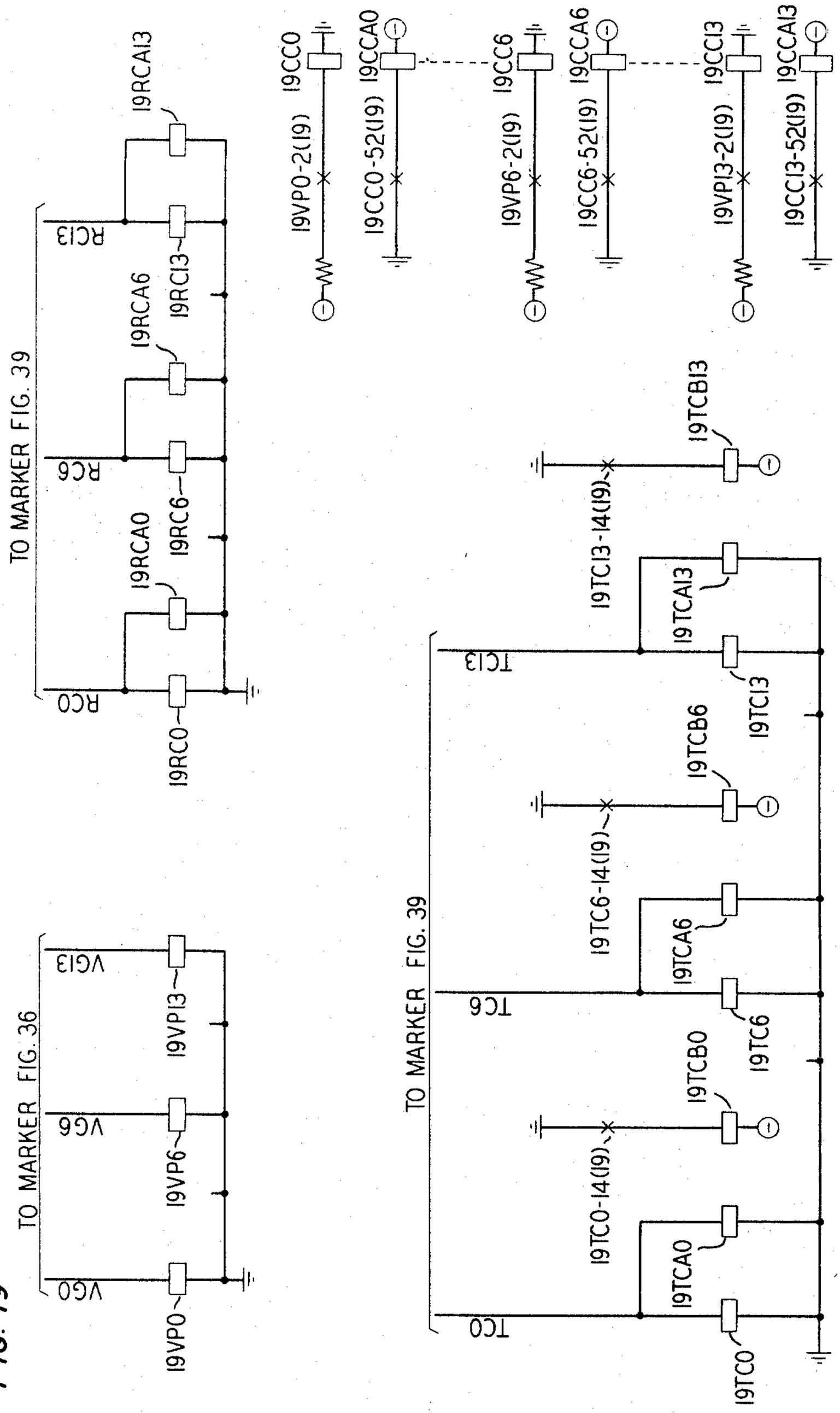

FIG. 19

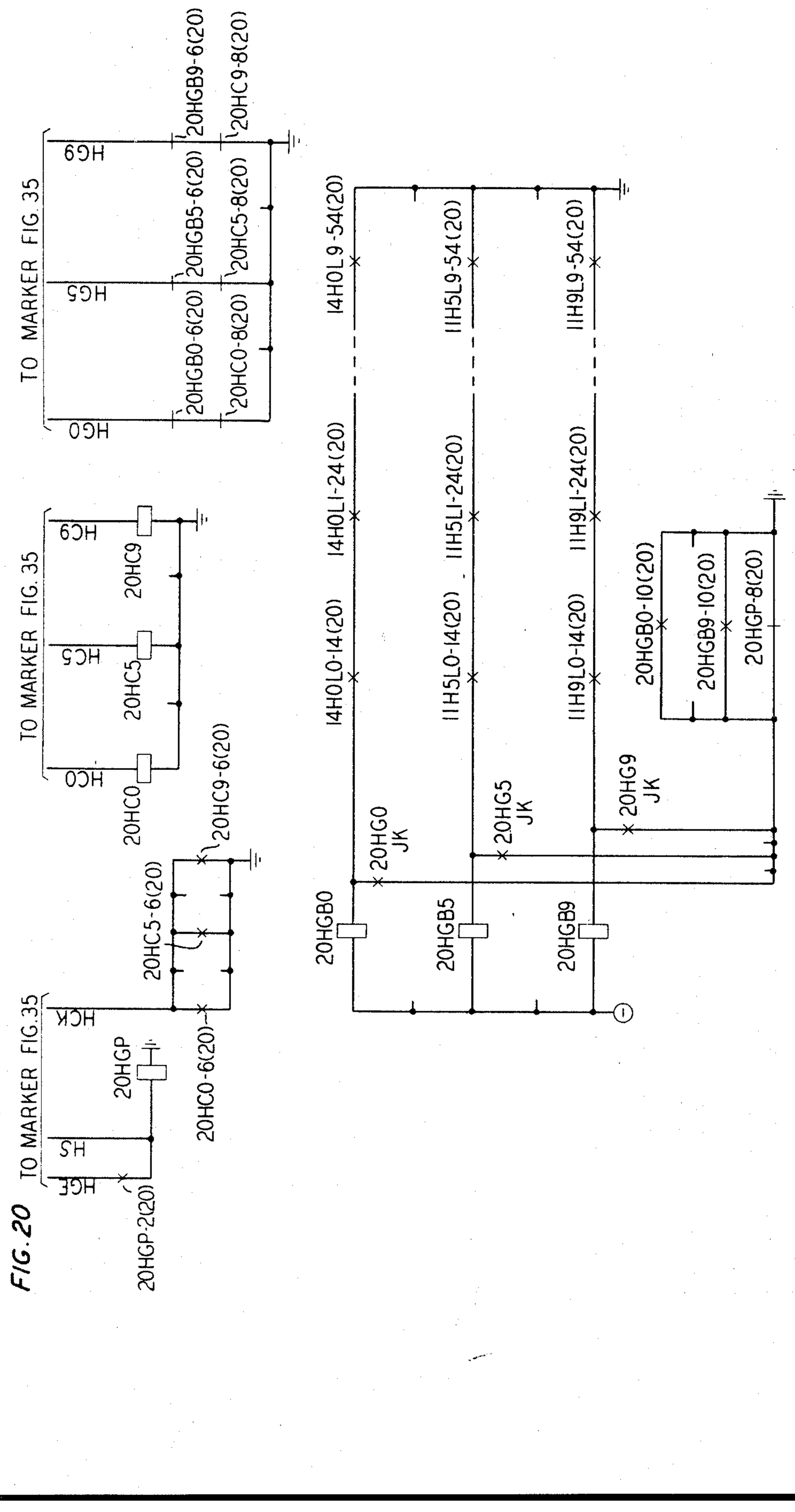
TO MARKER FIG. 35
HG9
HG5
HG0
20HGB9-6(20)
20HGB5-6(20)
20HGB0-6(20)
20HC9-8(20)
20HC5-8(20)
20HC0-8(20)
TO MARKER FIG. 35
HC9
HC5
HC0
20HC9
20HC5
20HC0
20HC9-6(20)
20HC5-6(20)
TO MARKER FIG. 35
HGK
HS
HGE
20HGP
20HGP-2(20)
20HC0-6(20)
14H0L9-54(20)
11H5L9-54(20)
11H9L9-54(20)
14H0LI-24(20)
11H5LI-24(20)
11H9LI-24(20)
14H0L0-14(20)
11H5L0-14(20)
11H9L0-14(20)
20HGB0-10(20)
20HGB9-10(20)
20HGP-8(20)
20HG0 JK
20HG5 JK
20HG9 JK
20HGB0
20HGB5
20HGB9

FIG. 20

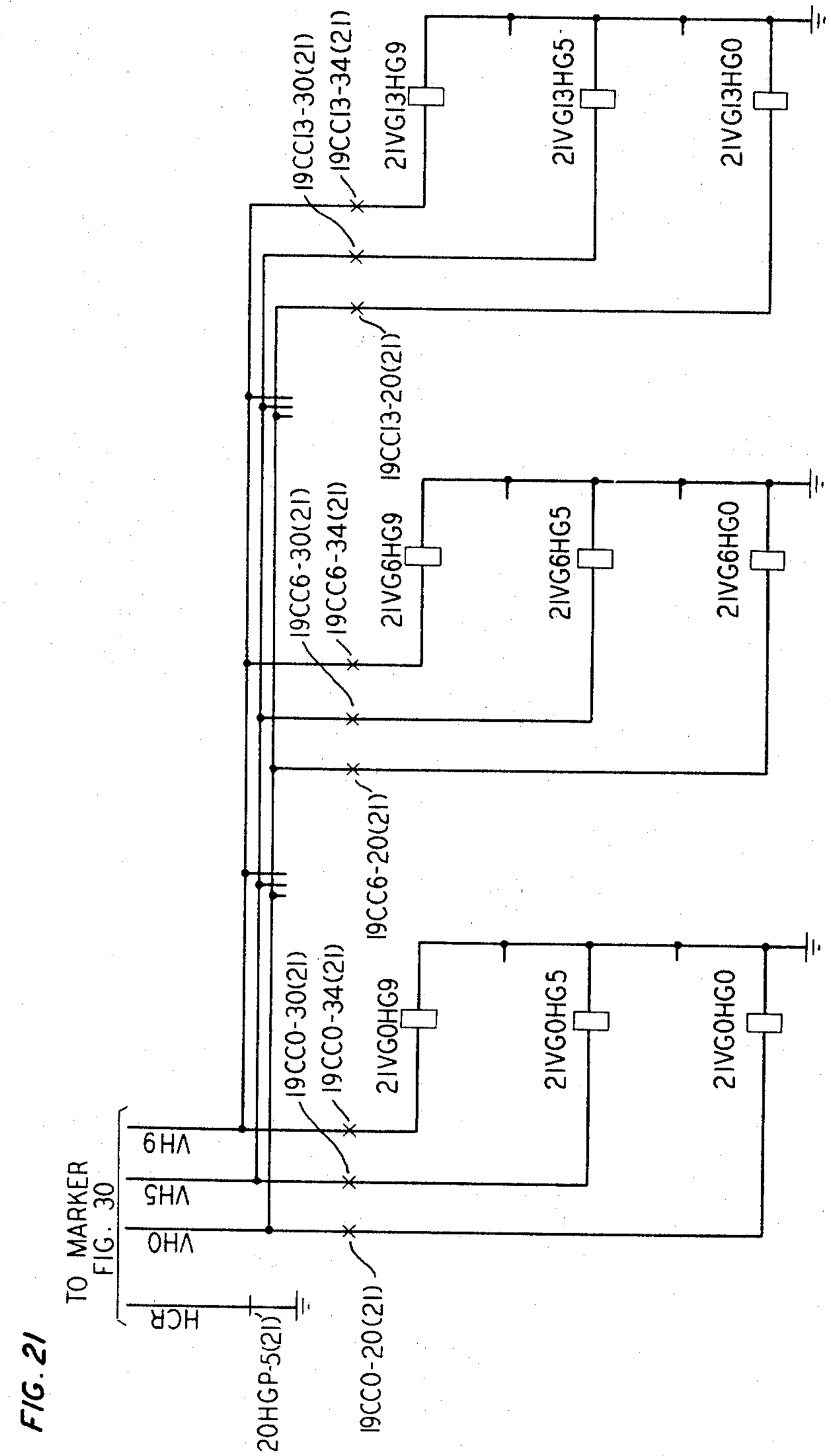
TO MARKER FIG. 30
HCR
VH0
VH5
VH9
20HGP-5(21)
19CC0-20(21)
19CC0-30(21)
19CC0-34(21)
21VG0HG9
21VG0HG5
21VG0HG0
19CC6-20(21)
19CC6-30(21)
19CC6-34(21)
21VG6HG9
21VG6HG5
21VG6HG0
19CC13-20(21)
19CC13-30(21)
19CC13-34(21)
21VG13HG9
21VG13HG5
21VG13HG0

FIG. 21

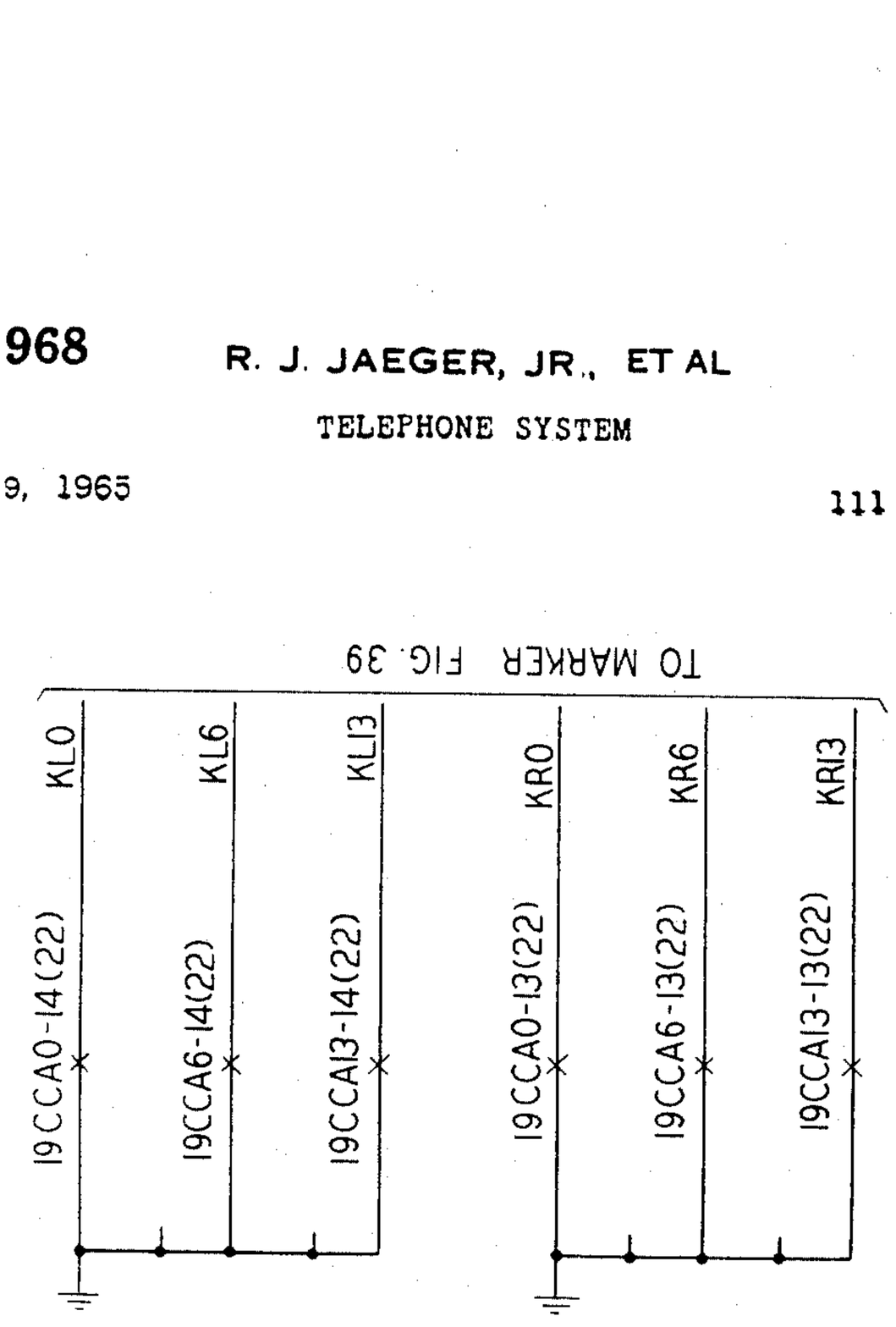
TO MARKER FIG. 39
KL0
KL6
KLI3
KR0
KR6
KRI3
19CCA0-14(22)
19CCA6-14(22)
19CCAI3-14(22)
19CCA0-13(22)
19CCA6-13(22)
19CCAI3-13(22)
TO NO TEST CCT. FIG. 97
NTR
NTK
NTLB
19RC0-50(22)
19RC6-50(22)
19RCI3-50(22)
19RC0-51(22)
19RC6-51(22)
19RCI3-51(22)
19RC0-11(22)
19RC6-11(22)
19RCI3-11(22)
TO MARKER FIG 28
TO MKR. FIG. 42

FIG. 22

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TELEPHONE SYSTEM

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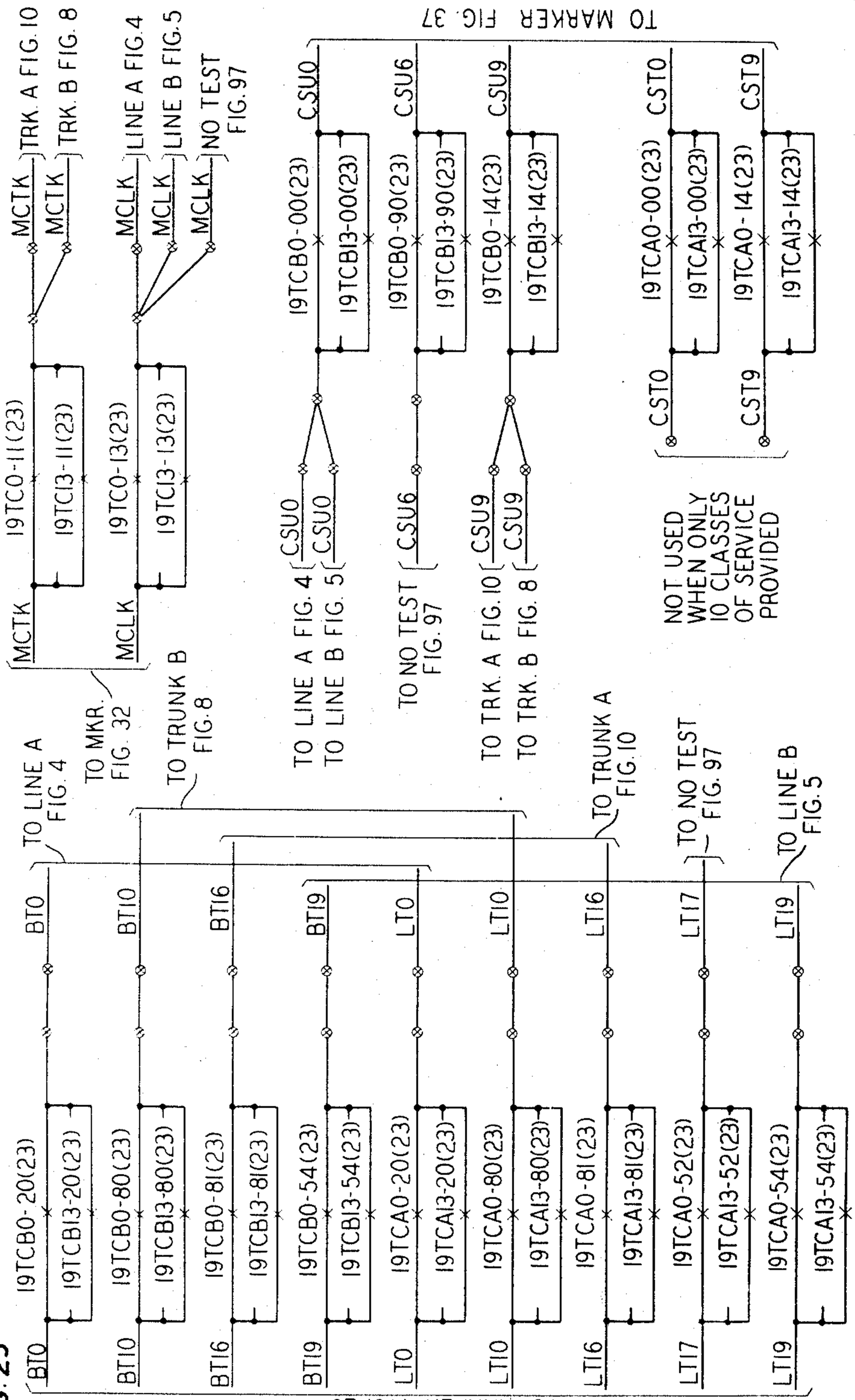

FIG. 23

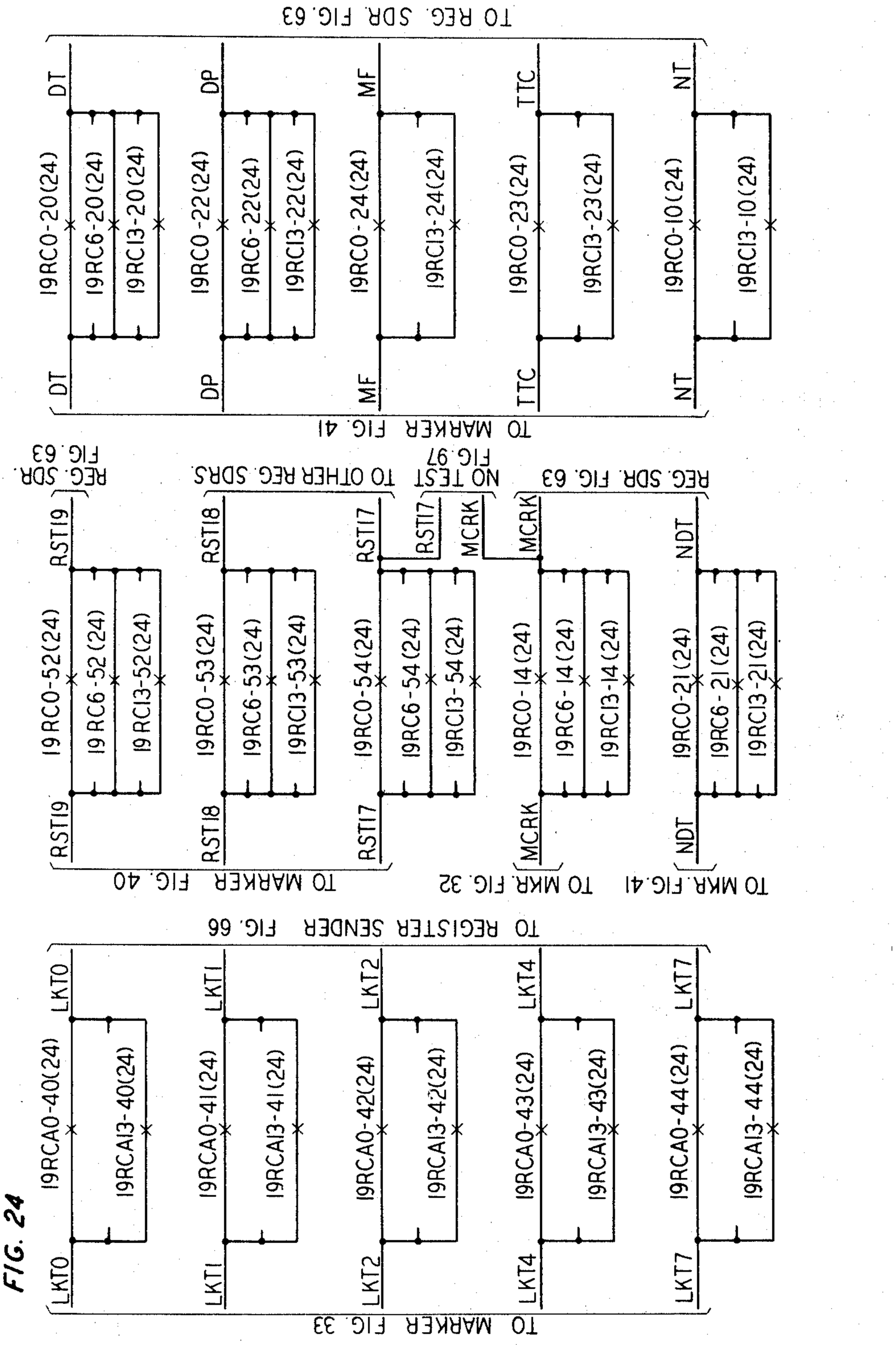
TO REG. SDR FIG. 63
DT
DP
MF
TTC
NT
19RC0-20(24)
19RC6-20(24)
19RC13-20(24)
19RC0-22(24)
19RC6-22(24)
19RC13-22(24)
19RC0-24(24)
19RC13-24(24)
19RC0-23(24)
19RC13-23(24)
19RC0-10(24)
19RC13-10(24)
TO MARKER FIG. 41
REG. SDR FIG. 63
TO OTHER REG. SDRS.
NO TEST FIG. 97
RST19
RST18
RST17
MCRK
NDT
19RC0-52(24)
19RC6-52(24)
19RC13-52(24)
19RC0-53(24)
19RC6-53(24)
19RC13-53(24)
19RC0-54(24)
19RC6-54(24)
19RC13-54(24)
19RC0-14(24)
19RC6-14(24)
19RC13-14(24)
19RC0-21(24)
19RC6-21(24)
19RC13-21(24)
TO MARKER FIG. 40
TO MKR. FIG. 32
TO MKR. FIG. 41
TO REGISTER SENDER FIG. 66
LKT0
LKT1
LKT2
LKT4
LKT7
19RCA0-40(24)
19RCA13-40(24)
19RCA0-41(24)
19RCA13-41(24)
19RCA0-42(24)
19RCA13-42(24)
19RCA0-43(24)
19RCA13-43(24)
19RCA0-44(24)
19RCA13-44(24)
TO MARKER FIG. 33

FIG. 24

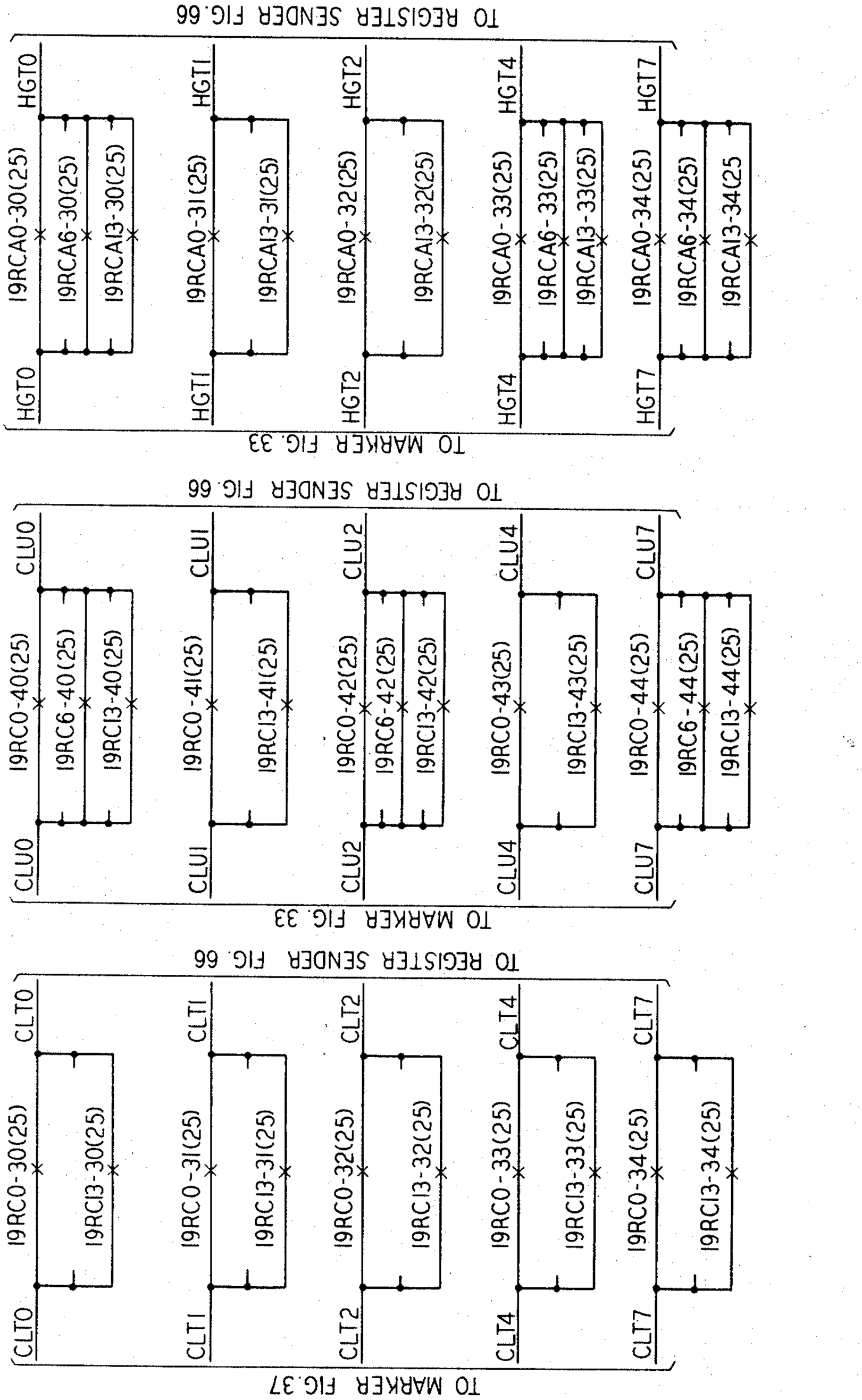
TO REGISTER SENDER FIG. 66
HGT0
HGT1
HGT2
HGT4
HGT7
19RCA0-30(25)
19RCA6-30(25)
19RCA13-30(25)
19RCA0-31(25)
19RCA13-31(25)
19RCA0-32(25)
19RCA13-32(25)
19RCA0-33(25)
19RCA6-33(25)
19RCA13-33(25)
19RCA0-34(25)
19RCA6-34(25)
19RCA13-34(25
TO MARKER FIG. 33
TO REGISTER SENDER FIG. 66
CLU0
CLU1
CLU2
CLU4
CLU7
19RC0-40(25)
19RC6-40(25)
19RC13-40(25)
19RC0-41(25)
19RC13-41(25)
19RC0-42(25)
19RC6-42(25)
19RC13-42(25)
19RC0-43(25)
19RC13-43(25)
19RC0-44(25)
19RC6-44(25)
19RC13-44(25)
TO MARKER FIG. 33
TO REGISTER SENDER FIG. 66
CLT0
CLT1
CLT2
CLT4
CLT7
19RC0-30(25)
19RC13-30(25)
19RC0-31(25)
19RC13-31(25)
19RC0-32(25)
19RC13-32(25)
19RC0-33(25)
19RC13-33(25)
19RC0-34(25)
19RC13-34(25)
TO MARKER FIG. 37

FIG. 25

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TELEPHONE SYSTEM

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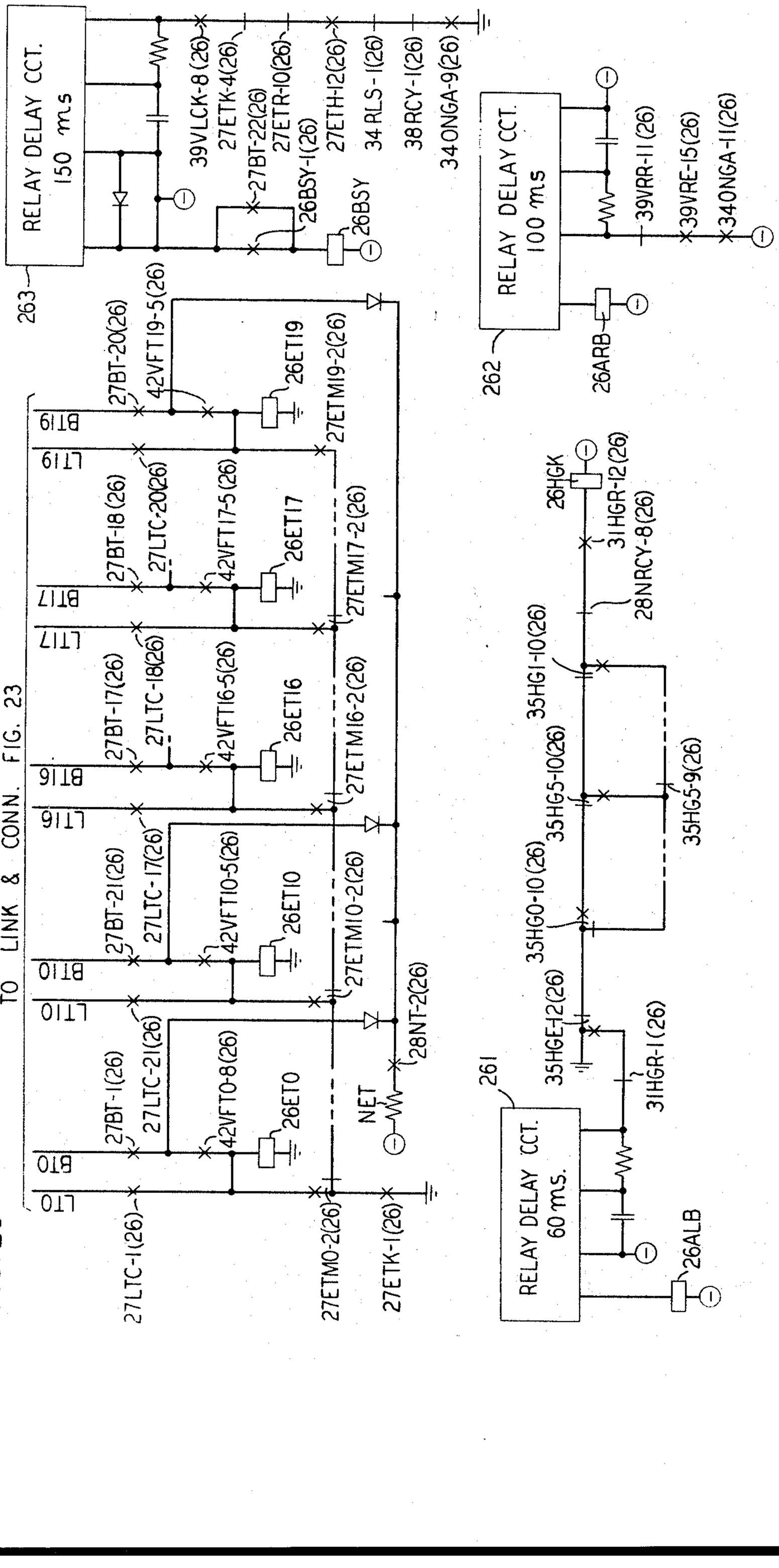

FIG. 26

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TELEPHONE SYSTEM

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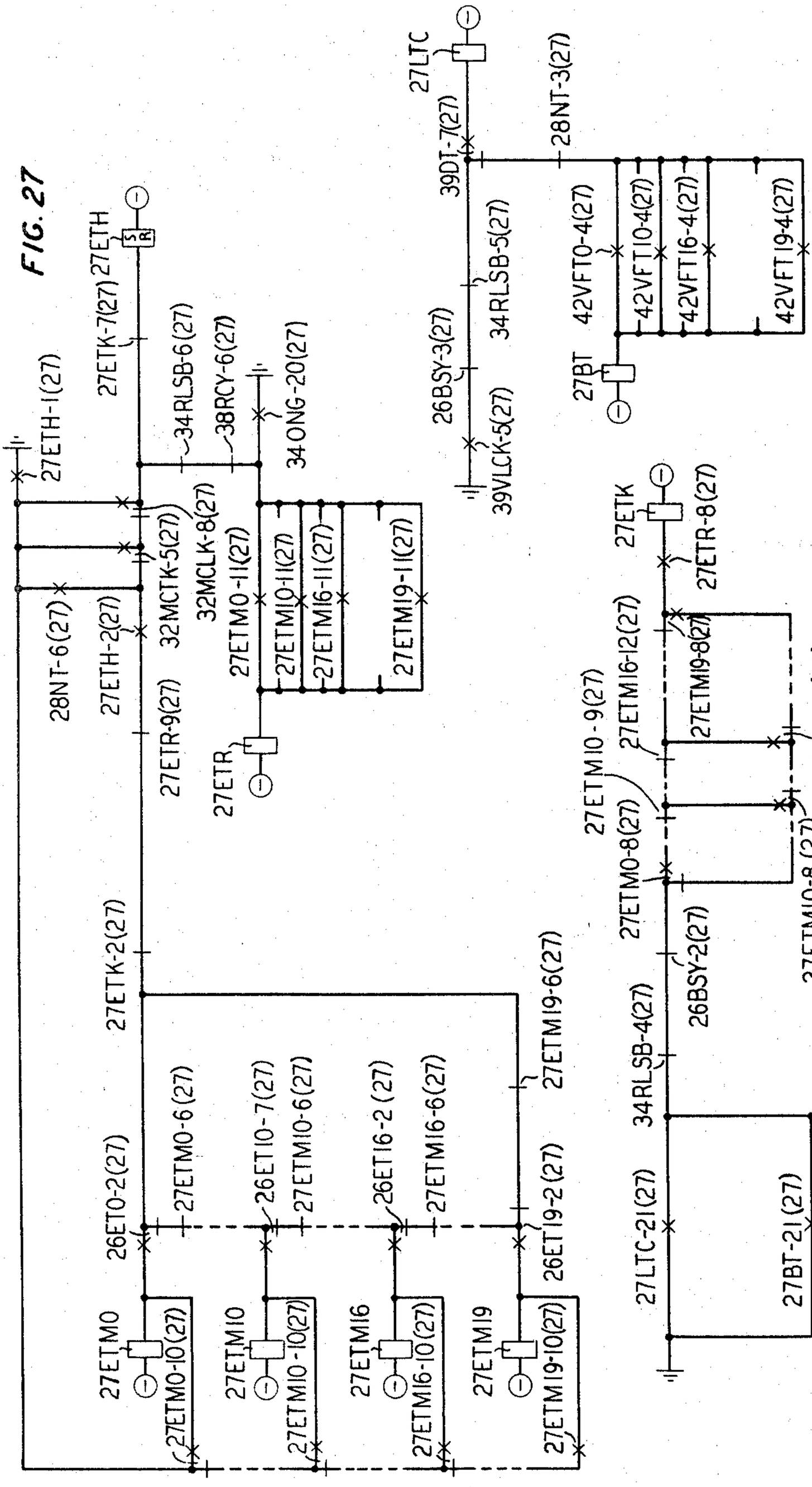
FIG. 27



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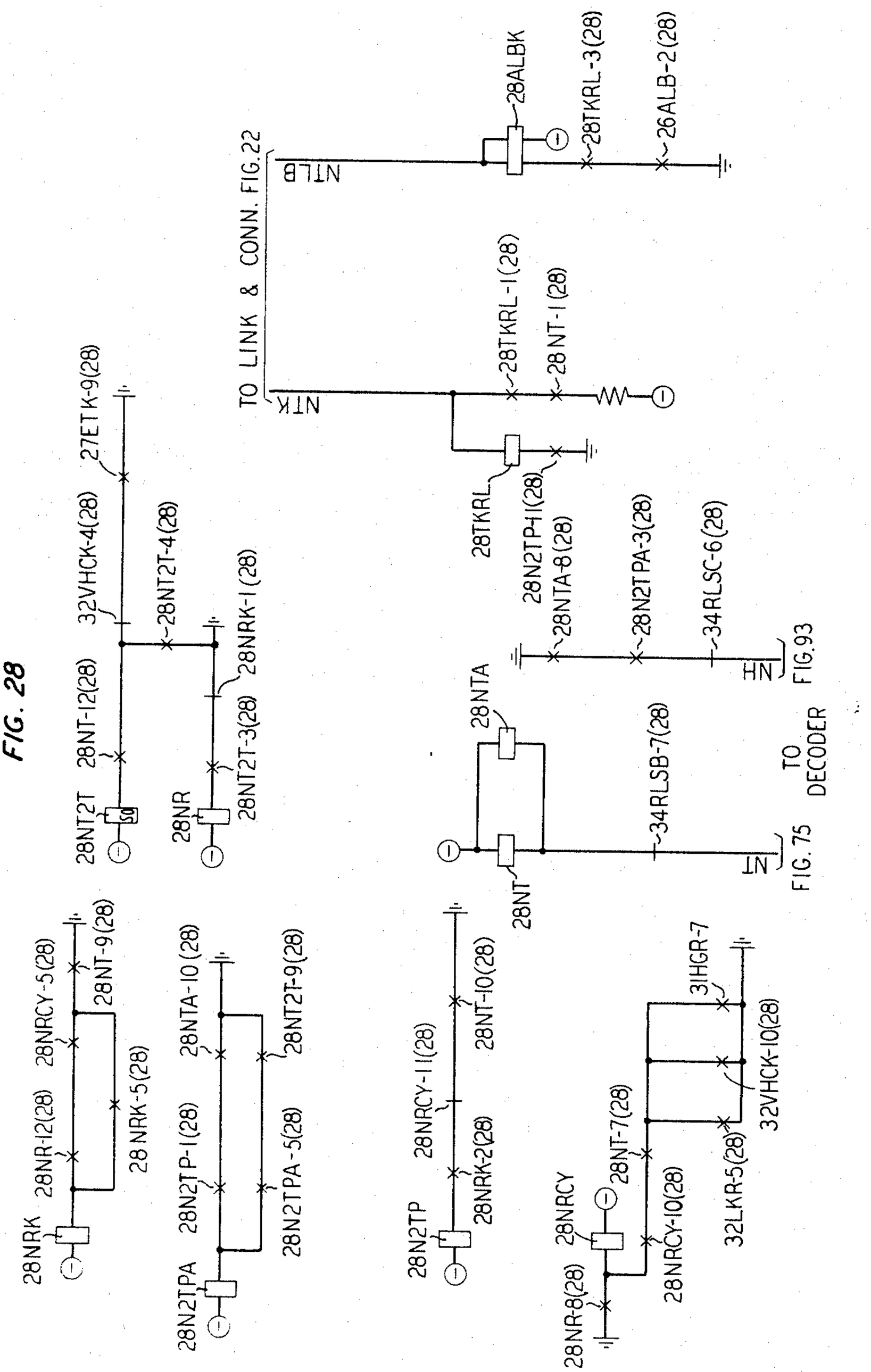
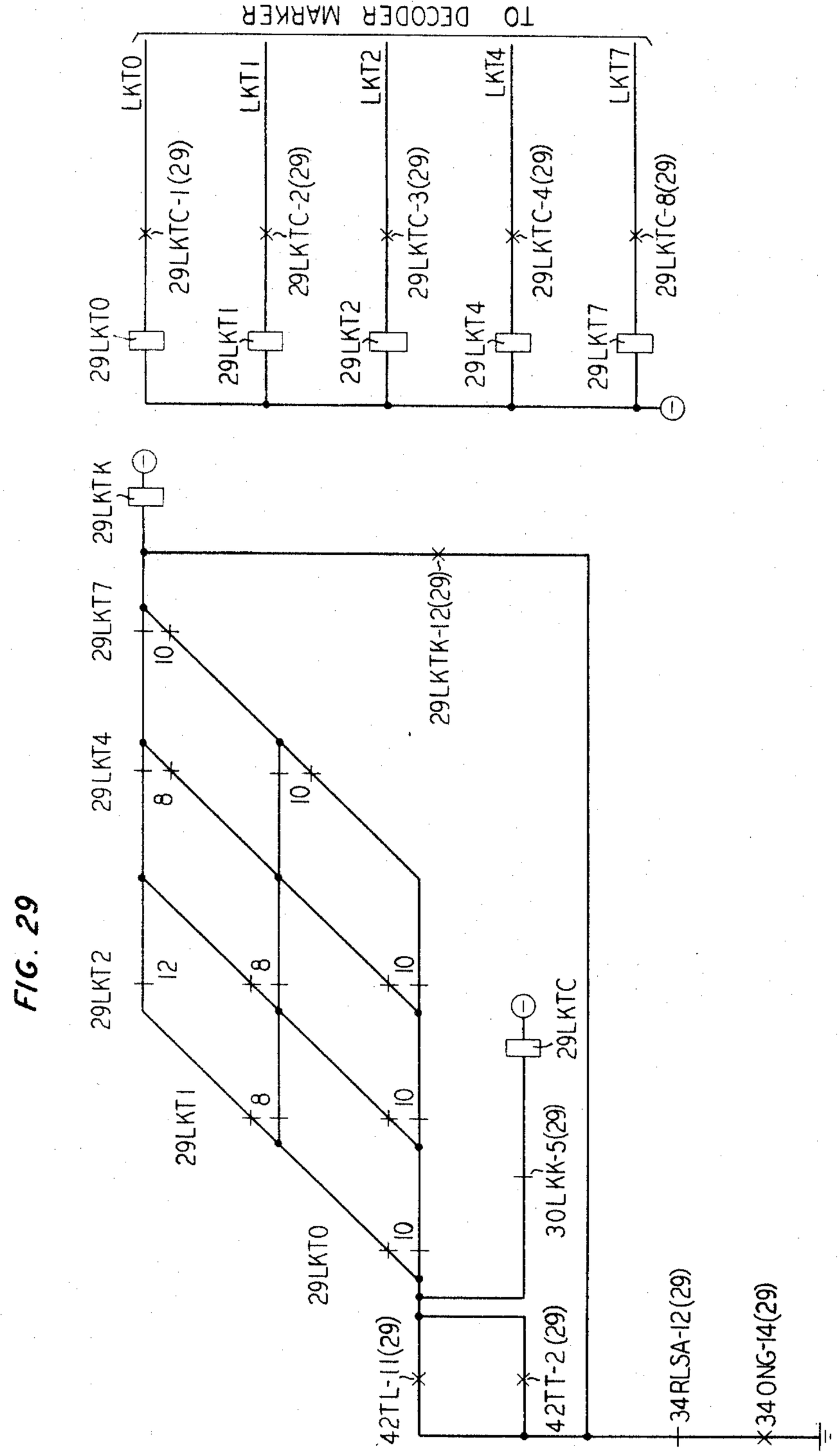


FIG. 29


TO DECODER MARKER CONNECTOR FIG. 106
29LKT0
29LKTC-1(29)
LKT0
29LKT1
29LKTC-2(29)
LKT1
29LKT2
29LKTC-3(29)
LKT2
29LKT4
29LKTC-4(29)
LKT4
29LKT7
29LKTC-8(29)
LKT7
29LKTK
29LKTK-12(29)
29LKT7
10
29LKT4
8
10
29LKT2
12
8
10
29LKT1
8
10
29LKT0
10
42TL-11(29)
29LKTC
30LKK-5(29)
42TT-2(29)
34RLSA-12(29)
34ONG-14(29)

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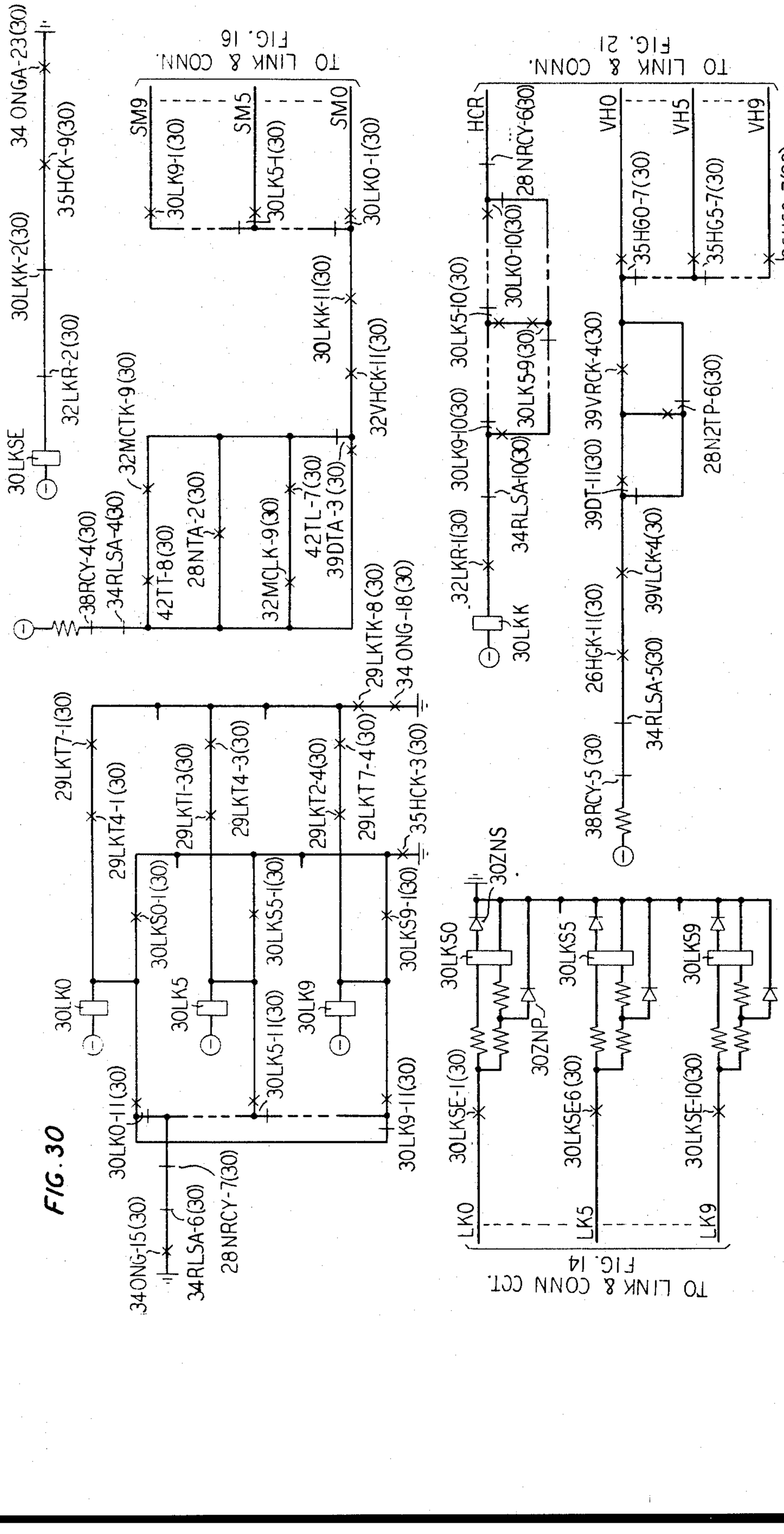

FIG. 30

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FIG. 31

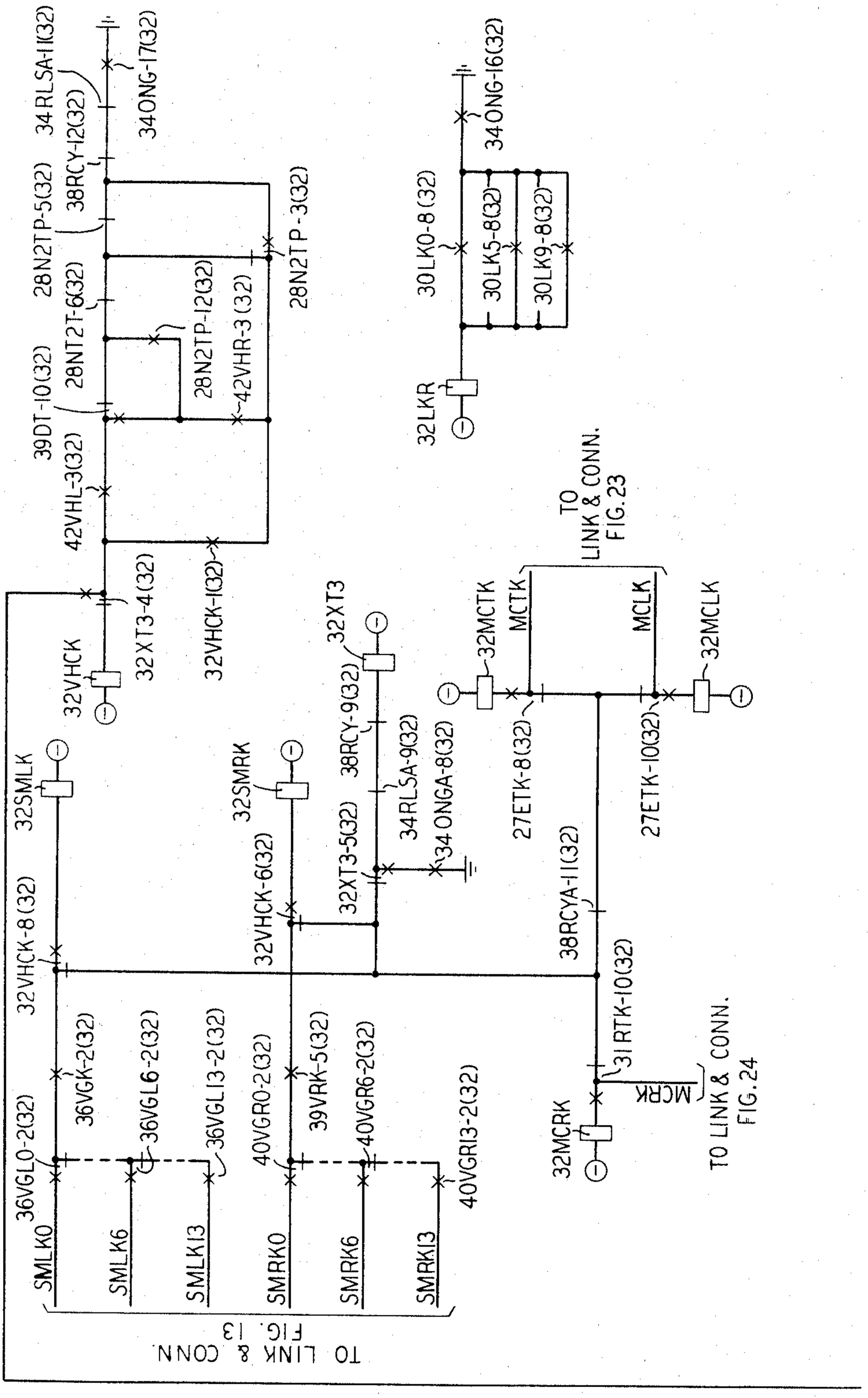
32VHCK
32XT3-4(32)
32VHCK-1(32)
39DT-10(32)
42VHL-3(32)
28NT2T-6(32)
28N2TP-12(32)
42VHR-3(32)
28N2TP-5(32)
28N2TP-3(32)
38RCY-12(32)
34RLSA-11(32)
34ONG-17(32)
32LKR
30LK0-8(32)
30LK5-8(32)
30LK9-8(32)
34ONG-16(32)
TO LINK & CONN. FIG. 23
32MCTK
MCTK
MCLK
32MCLK
32XT3
38RCY-9(32)
34RLSA-9(32)
34ONGA-8(32)
32SMLK
32VHCK-8(32)
32SMRK
32VHCK-6(32)
32XT3-5(32)
27ETK-8(32)
27ETK-10(32)
38RCYA-11(32)
31RTK-10(32)
MCRK
32MCRK
TO LINK & CONN. FIG. 24
36VGL0-2(32)
36VGK-2(32)
36VGL6-2(32)
36VGL13-2(32)
40VGR0-2(32)
39VRK-5(32)
40VGR6-2(32)
40VGR13-2(32)
SMLK0
SMLK6
SMLK13
SMRK0
SMRK6
SMRK13
TO LINK & CONN. FIG. 13

FIG. 32

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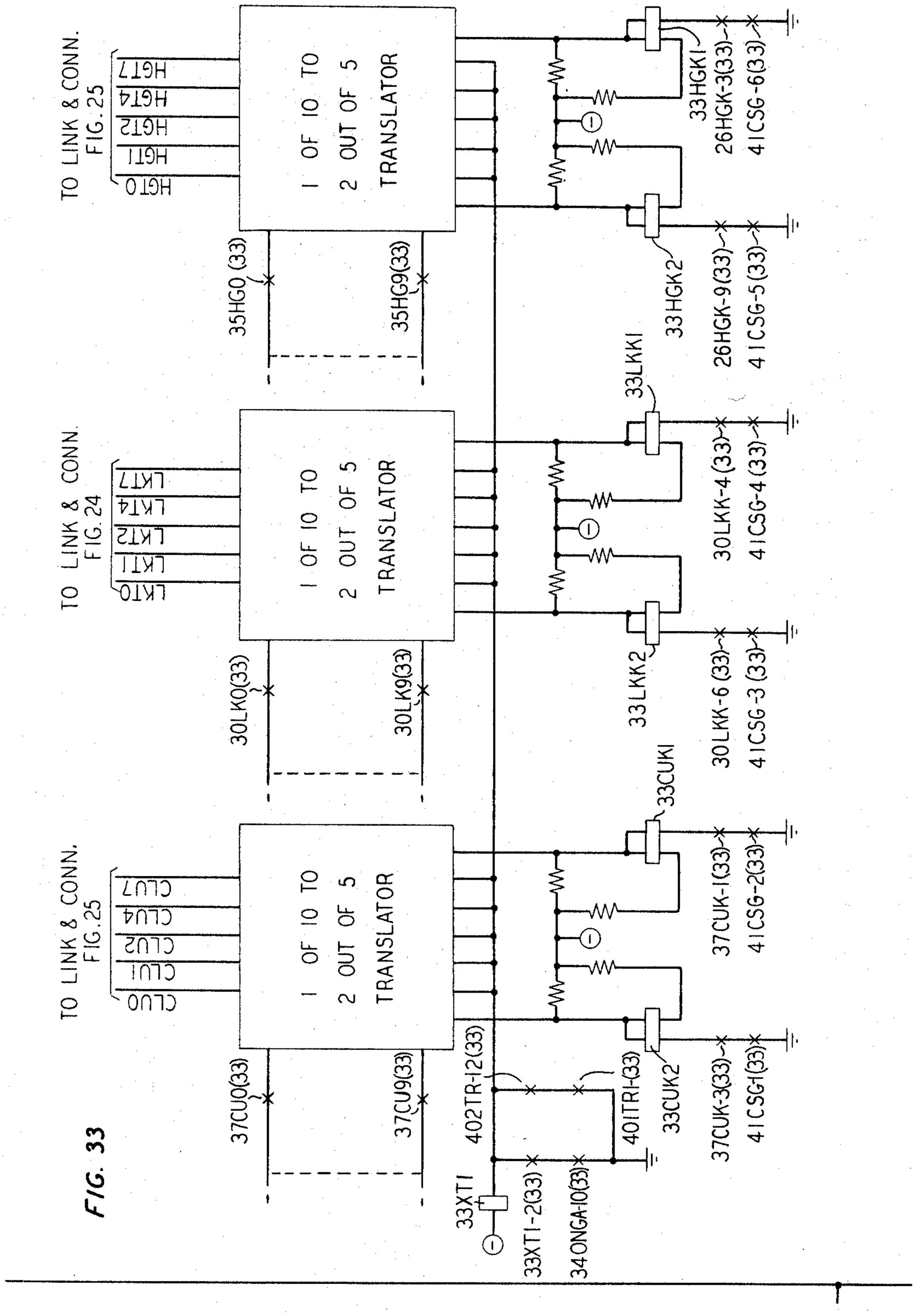

FIG. 33

FIG. 34

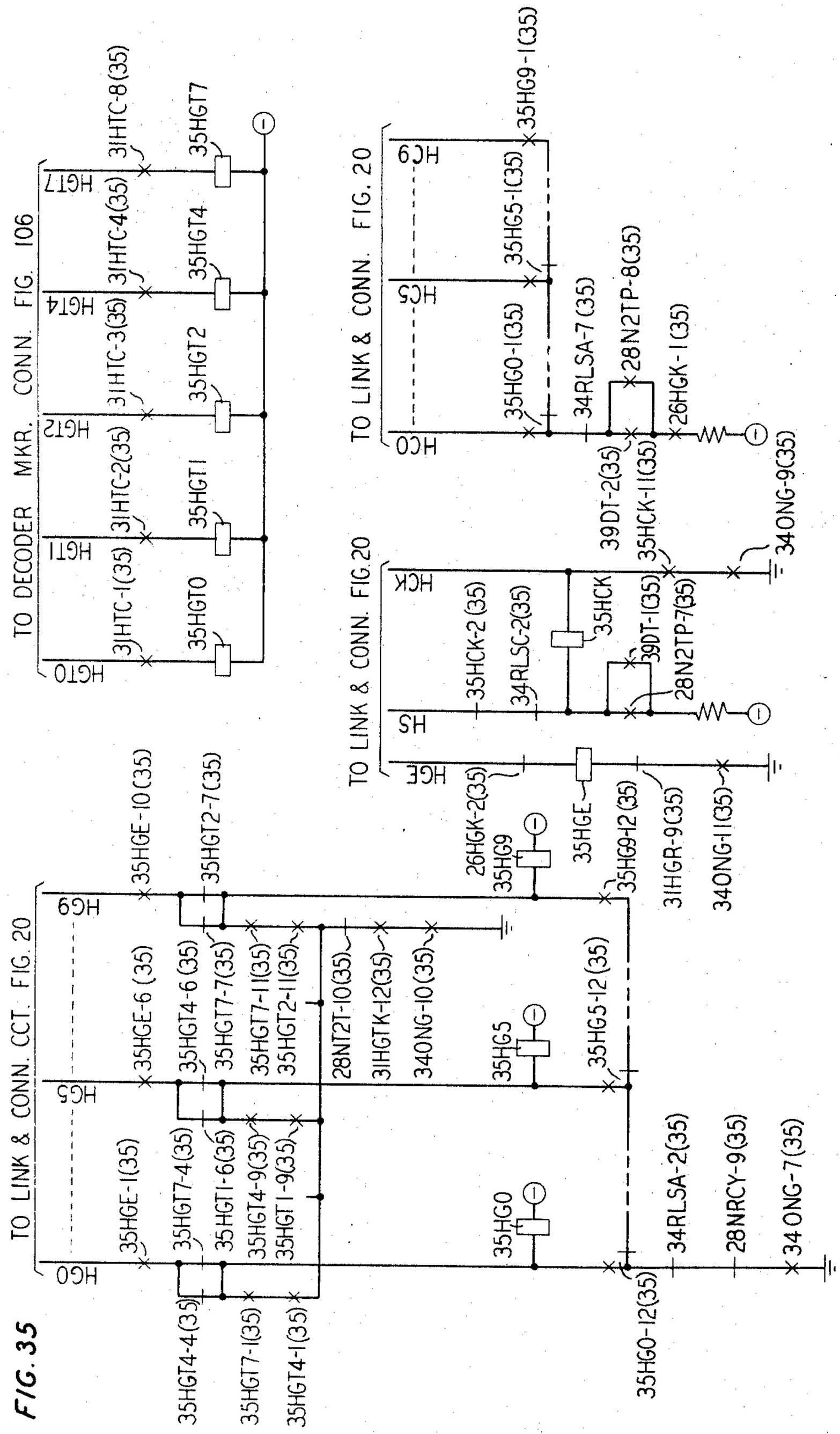
TO DECODER MKR. CONN. FIG. 106
HGT0
HGT1
HGT2
HGT4
HGT7
3JHTC-1(35)
3JHTC-2(35)
3JHTC-3(35)
3JHTC-4(35)
3JHTC-8(35)
35HGT0
35HGT1
35HGT2
35HGT4
35HGT7
TO LINK & CONN. FIG. 20
HC0
HC5
HC9
35HG0-1(35)
35HG5-1(35)
35HG9-1(35)
34RLSA-7(35)
28N2TP-8(35)
26HGK-1(35)
39DT-2(35)
35HCK-1(35)
34ONG-9(35)
TO LINK & CONN. FIG. 20
HCK
HS
HGE
35HCK-2(35)
34RLSC-2(35)
35HCK
39DT-1(35)
28N2TP-7(35)
26HGK-2(35)
35HGE
35HG9-2(35)
31HGR-9(35)
34ONG-11(35)
TO LINK & CONN. CCT. FIG. 20
HG9
HG5
HG0
35HGE-6(35)
35HGT4-6(35)
35HGT7-7(35)
35HGT7-11(35)
35HGT2-11(35)
28NT2T-10(35)
31HGTK-12(35)
340NG-10(35)
35HG5
35HG9
35HGE-10(35)
35HGT2-7(35)
35HG5-12(35)
35HGE-1(35)
35HGT4-4(35)
35HGT7-4(35)
35HGT1-6(35)
35HGT4-9(35)
35HGT1-9(35)
35HG0
35HG0-12(35)
34RLSA-2(35)
28NRCY-9(35)
34ONG-7(35)

FIG. 35

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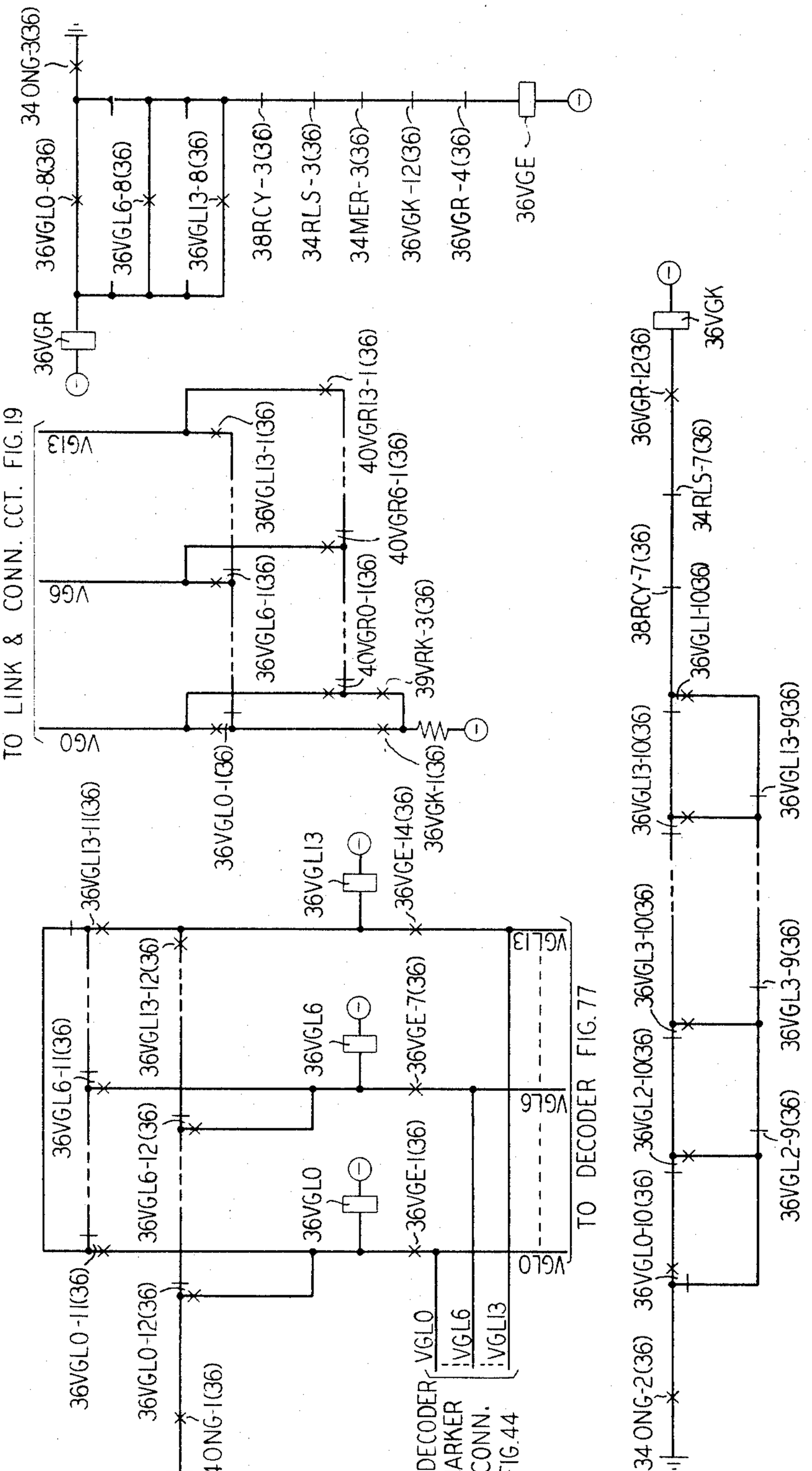
FIG. 36



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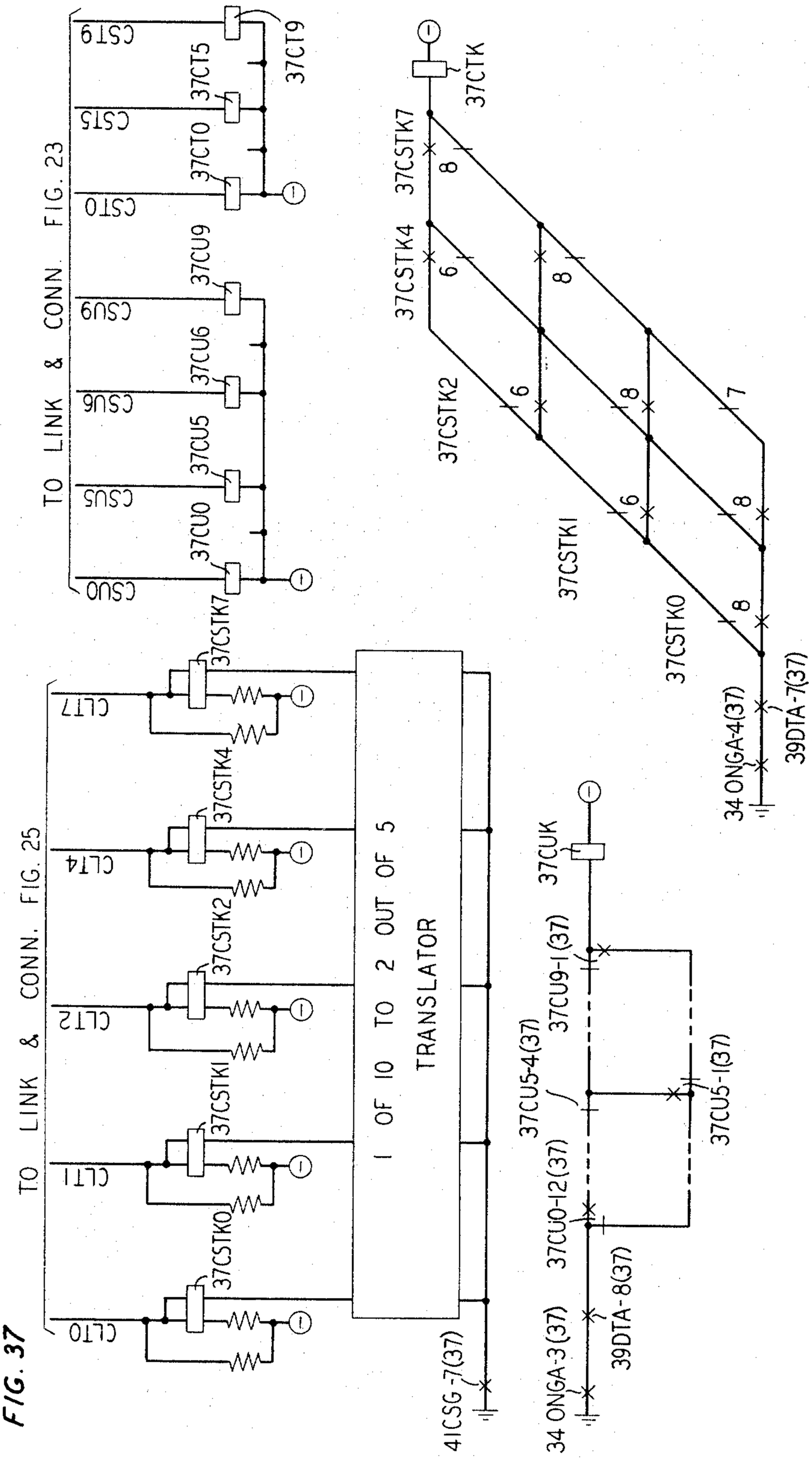

FIG. 37

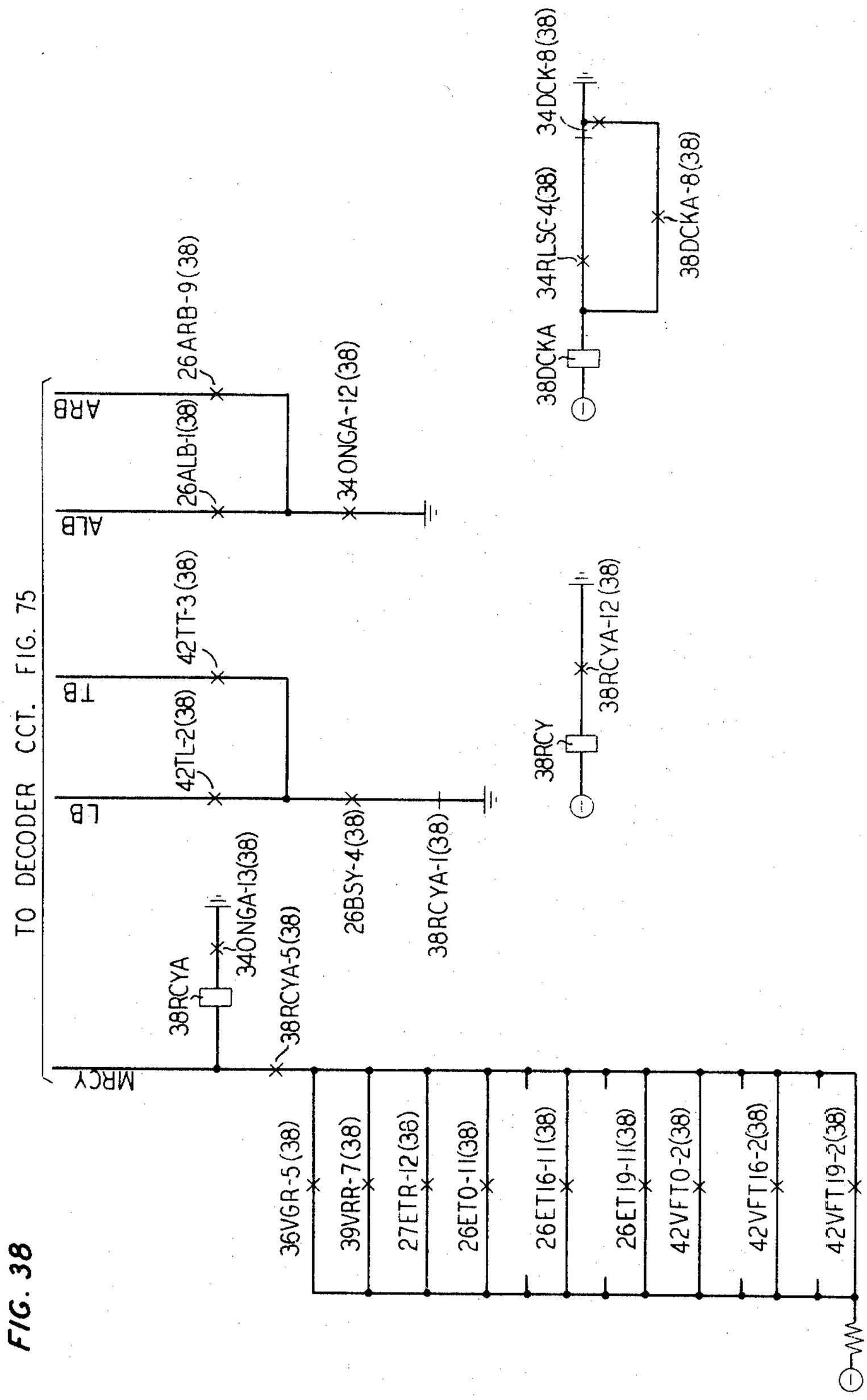
TO DECODER CCT. FIG. 75
MRCY
ALB
ARB
LB
LB
26ALB-1(38)
26ARB-9(38)
42TL-2(38)
42TT-3(38)
38RCYA
340NGA-13(38)
38RCYA-5(38)
26BSY-4(38)
38RCYA-1(38)
34ONGA-12(38)
38RCY
38RCYA-12(38)
38DCKA
34RLSC-4(38)
34DC
38DCKA-8(38)
36VGR-5(38)
39VRR-7(38)
27ETR-12(36)
26ETO-11(38)
26ETI6-11(38)
26ETI9-11(38)
42VFTO-2(38)
42VFTI6-2(38)
42VFTI9-2(38)

FIG. 38

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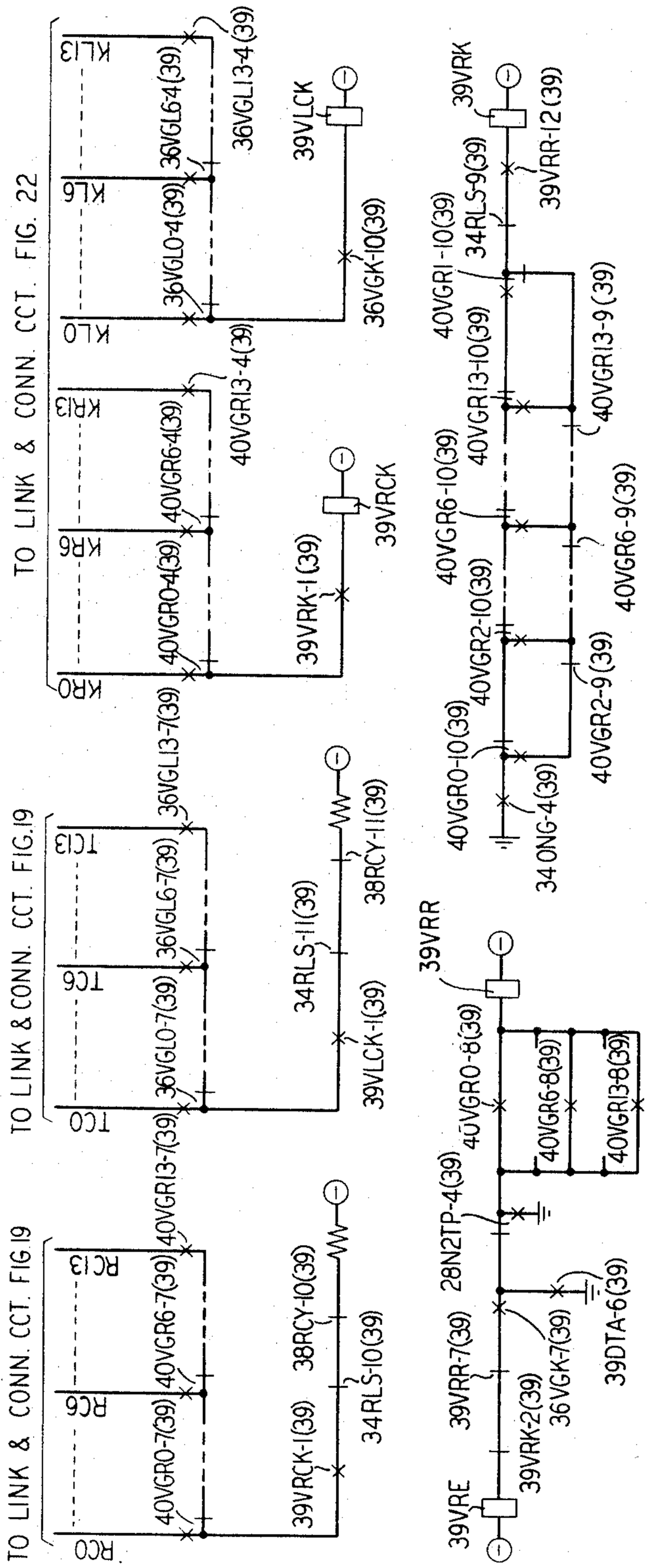
FIG. 39



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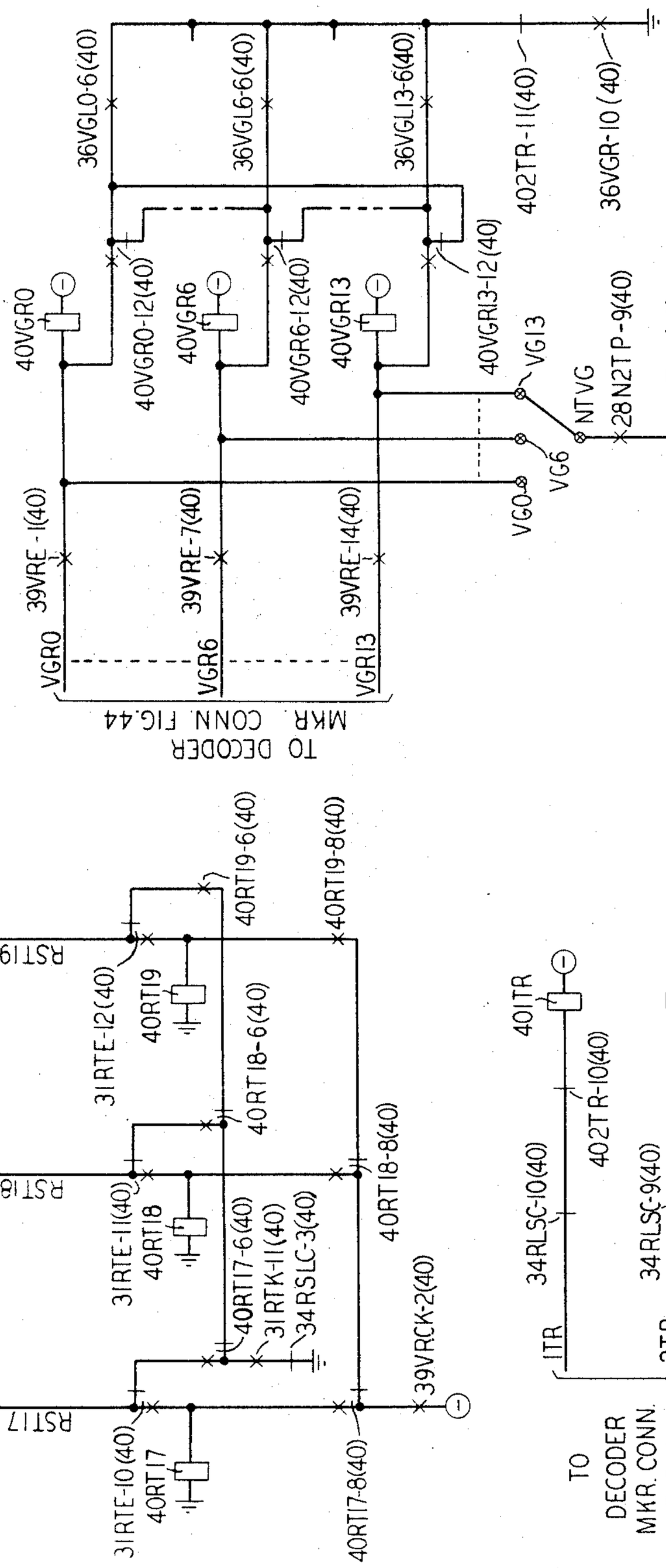

FIG. 40

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TELEPHONE SYSTEM

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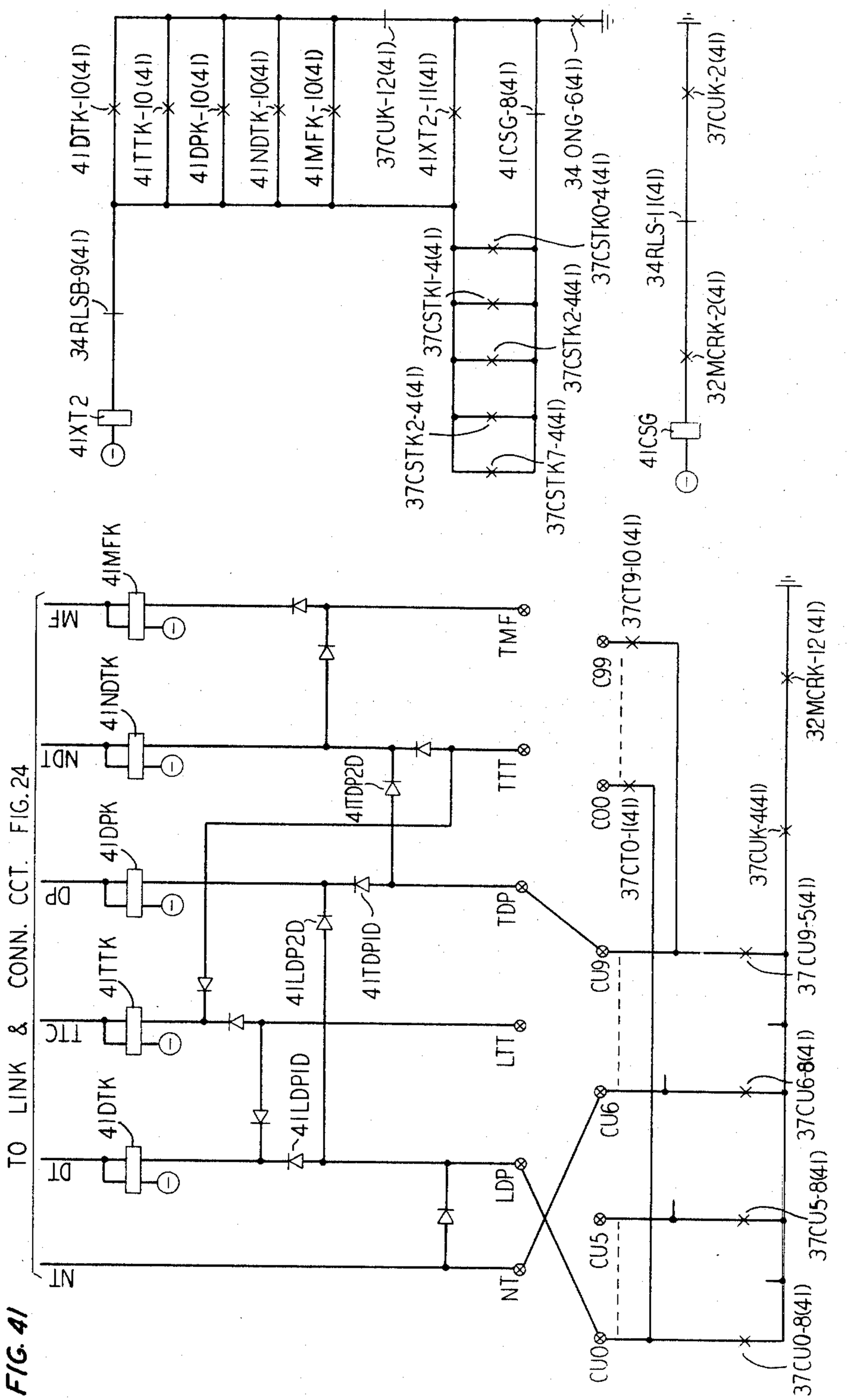

FIG. 41

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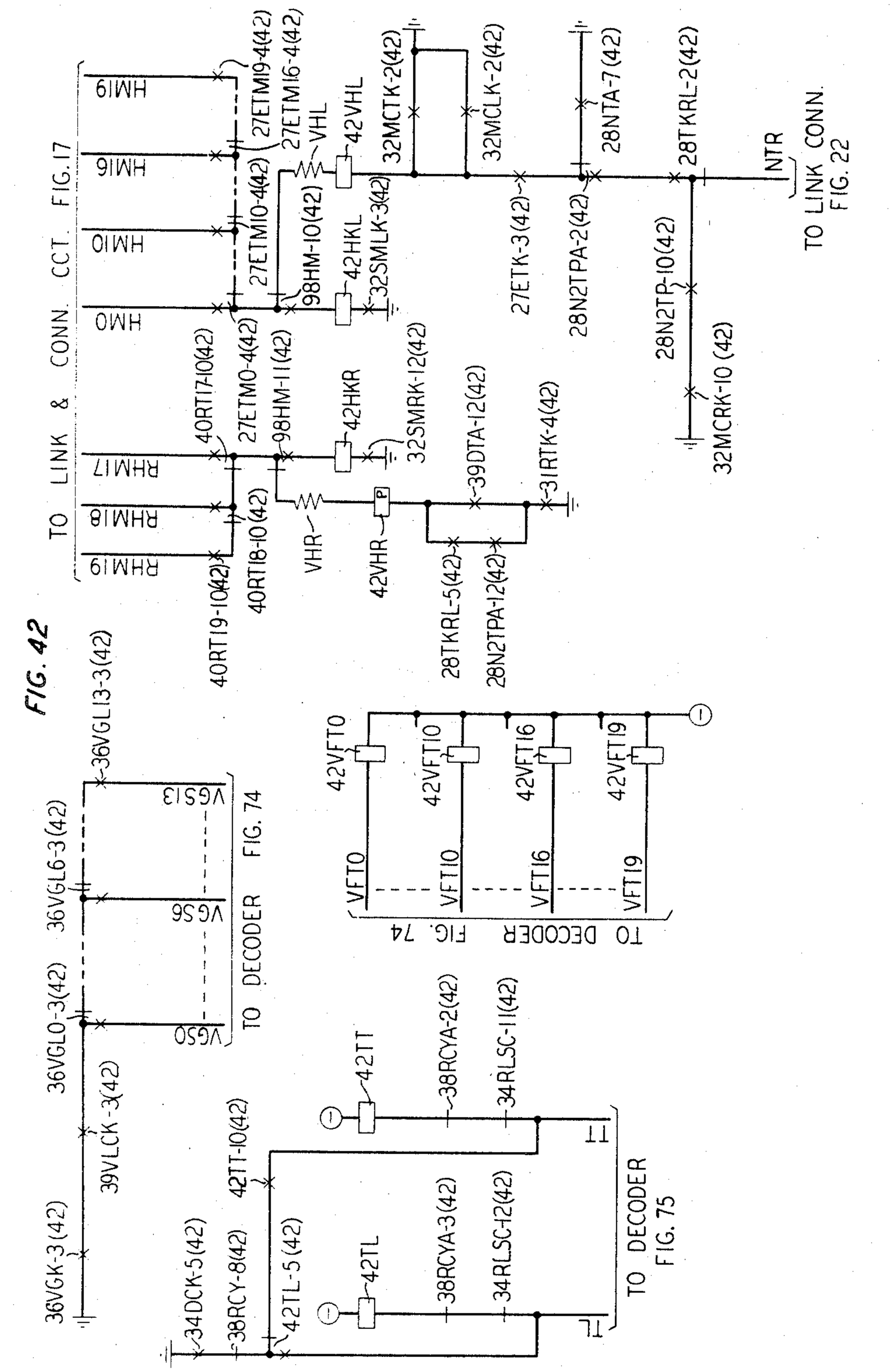

FIG. 42

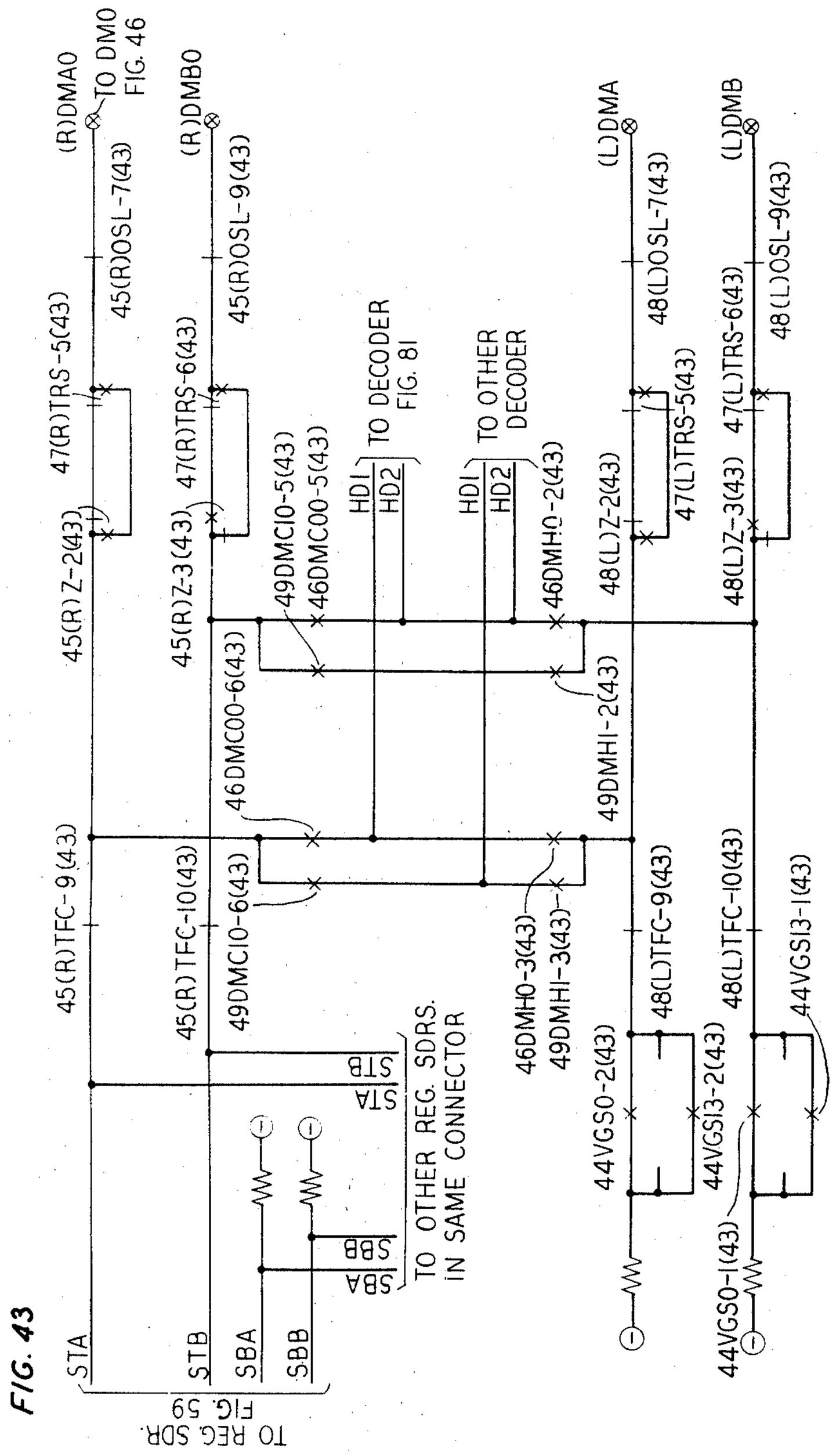
(R)DMA0
TO DM0 FIG. 46
(R)DMB0
(L)DMA
(L)DMB
45(R)Z-2(43)
47(R)TRS-5(43)
45(R)OSL-7(43)
45(R)OSL-9(43)
45(R)Z-3(43)
47(R)TRS-6(43)
45(R)OSL-6(43)
49DMC10-5(43)
46DMC00-5(43)
HD1
HD2
TO DECODER FIG. 81
TO OTHER DECODER
46DMH0-2(43)
48(L)Z-2(43)
48(L)OSL-7(43)
47(L)TRS-5(43)
48(L)Z-3(43)
47(L)TRS-6(43)
48(L)OSL-9(43)
45(R)TFC-9(43)
45(R)TFC-10(43)
49DMC10-6(43)
46DMC00-6(43)
46DMH0-3(43)
49DMH1-3(43)
49DMH1-2(43)
STA
STB
SBA
SBB
TO OTHER REG. SDRS. IN SAME CONNECTOR
44VGS0-2(43)
48(L)TFC-9(43)
44VGS13-2(43)
48(L)TFC-10(43)
44VGS13-1(43)
44VGS0-1(43)
STA
STB
SBA
SBB
FIG. 59
TO REG. SDR.

FIG. 43

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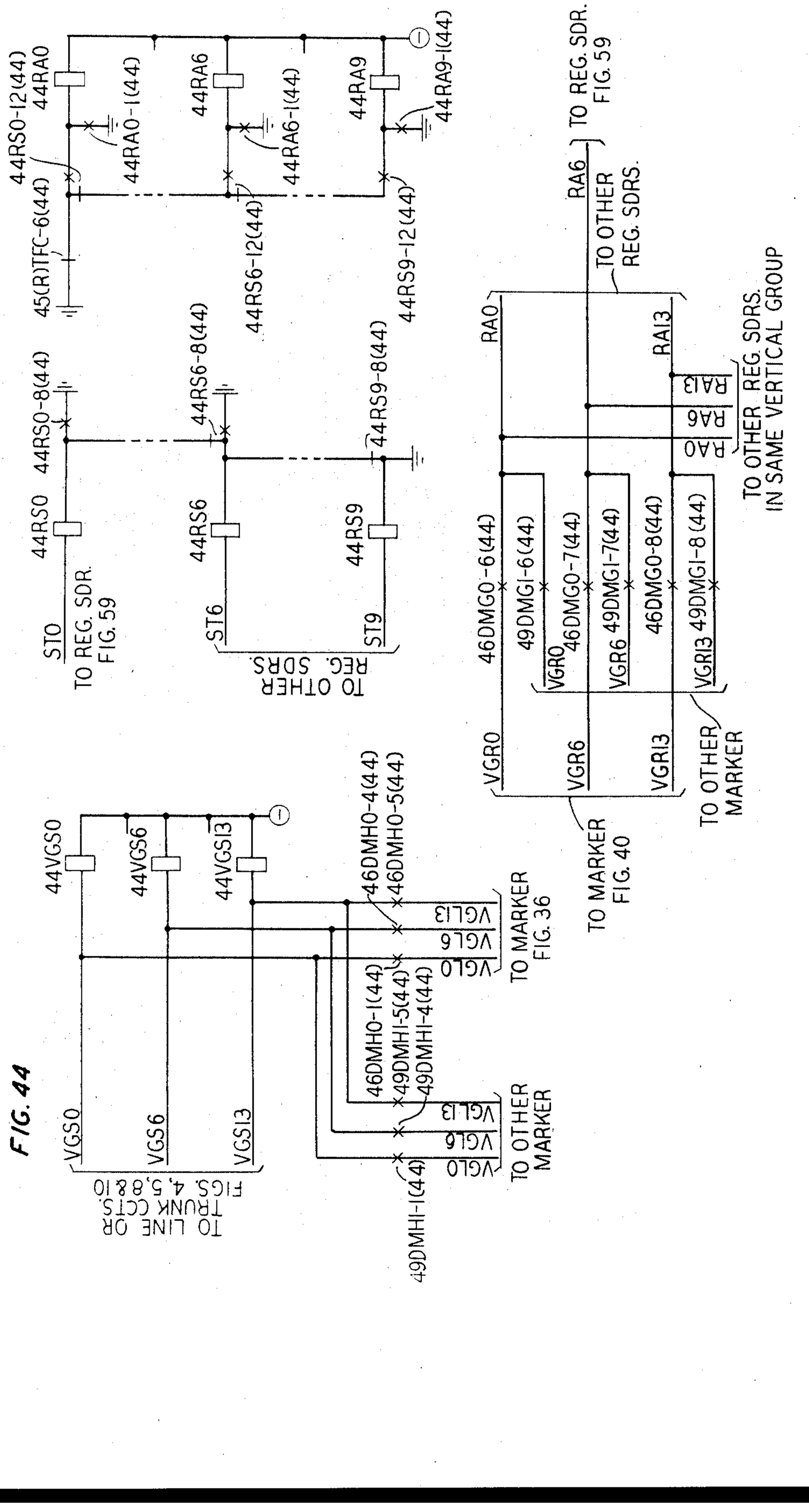

FIG. 44

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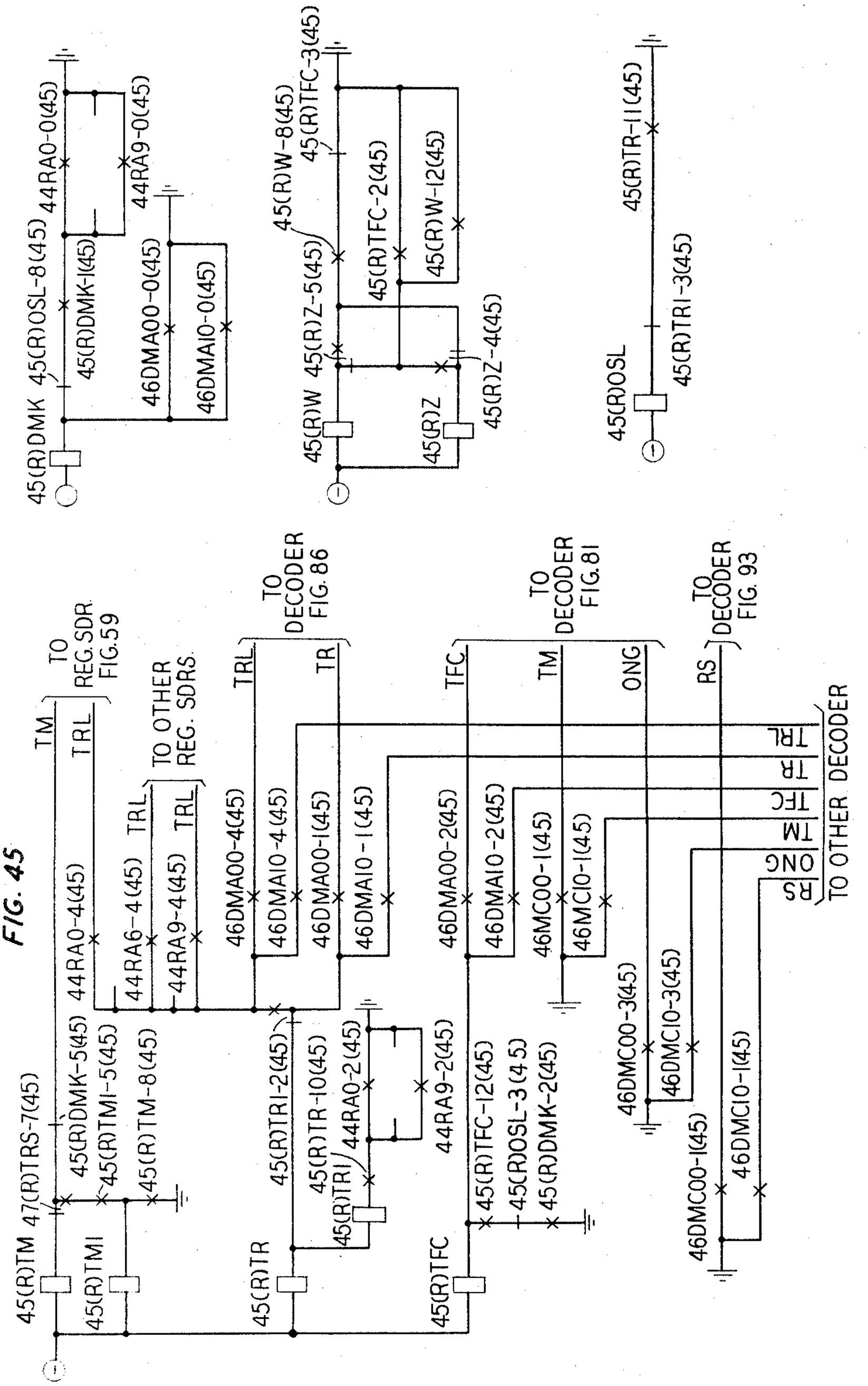
FIG. 45



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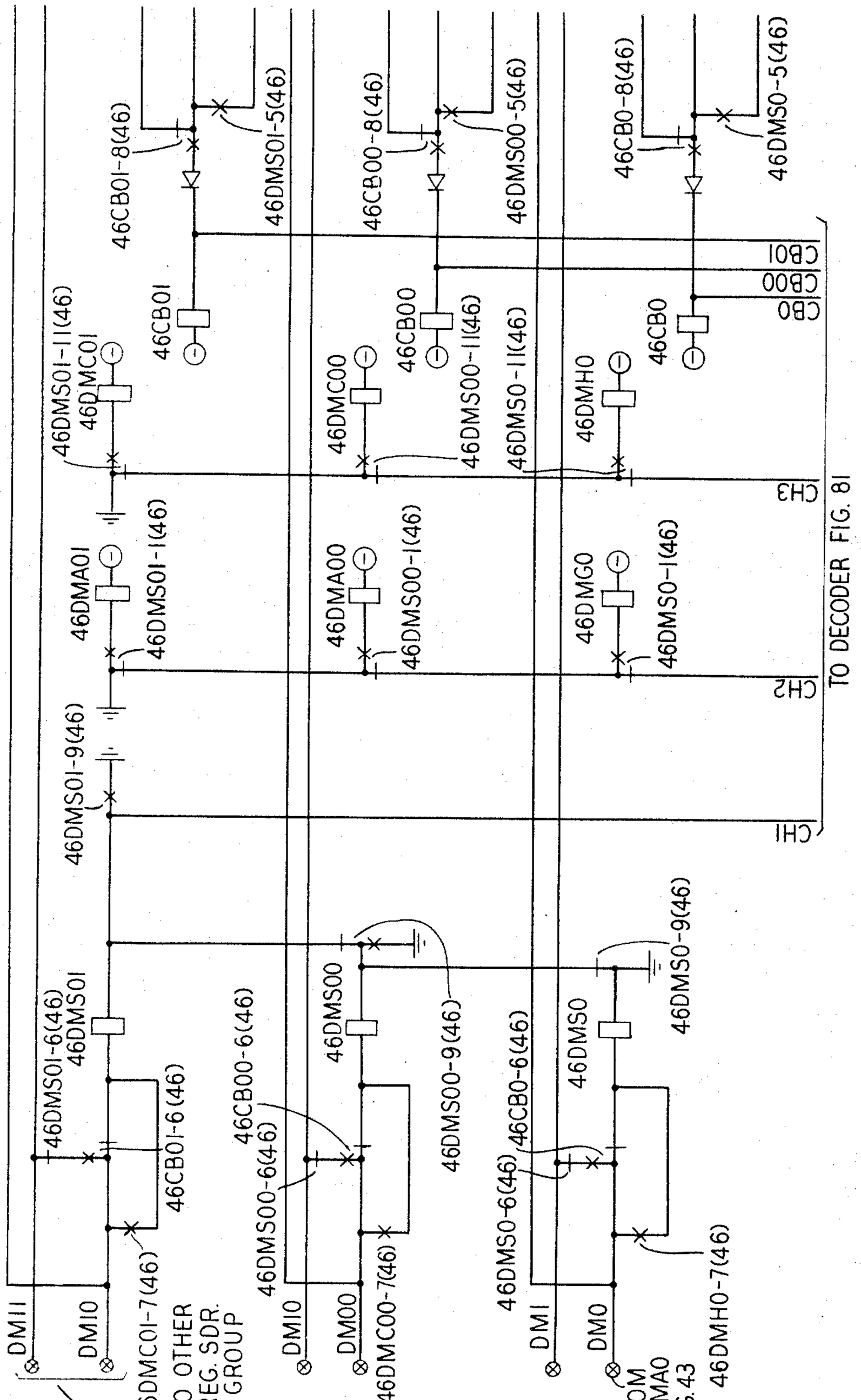

FIG. 46

FIG. 47

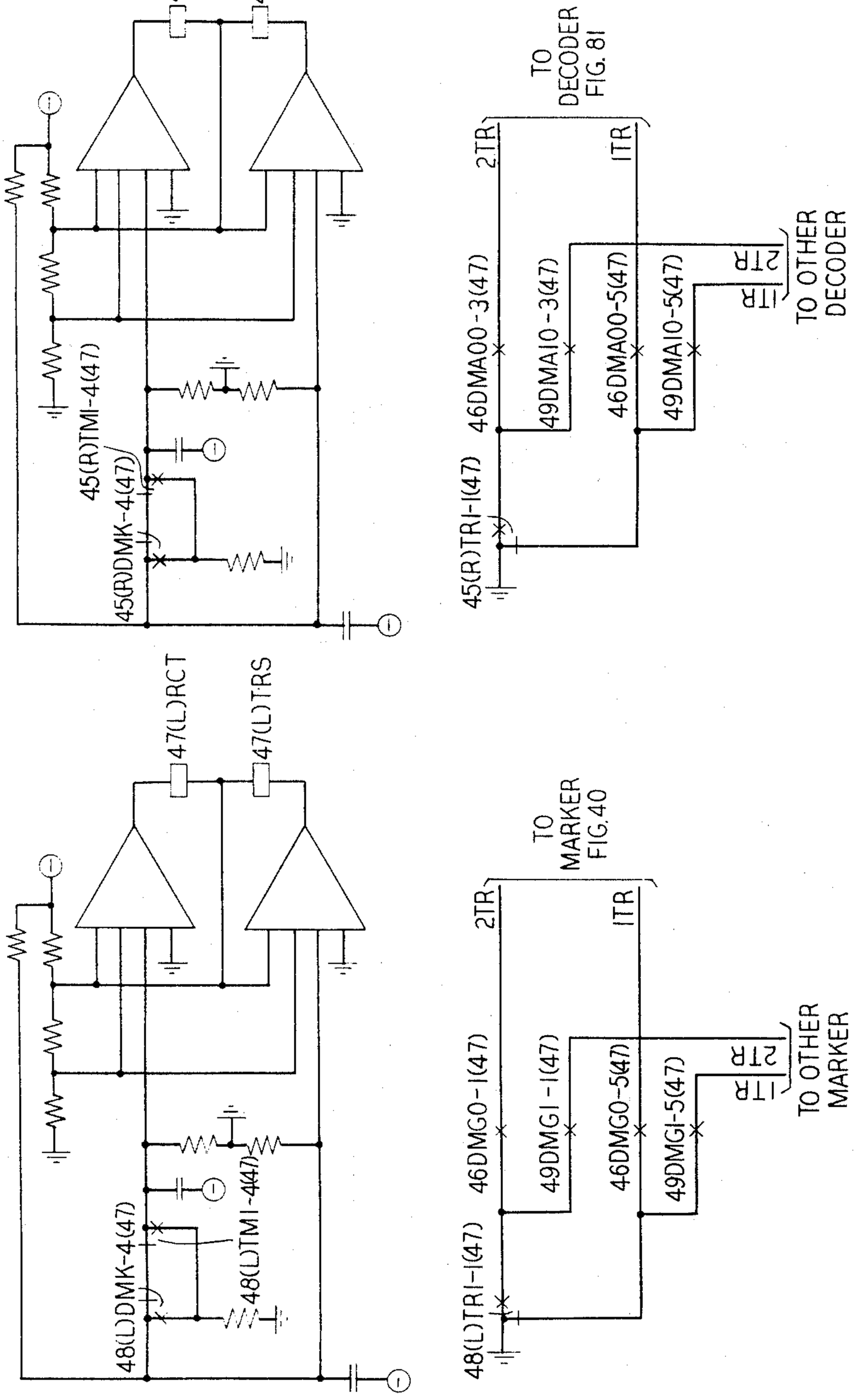
47(L)RCT
47(L)TRS
45(R)TMI-4(47)
45(R)DMK-4(47)
48(L)DMK-4(47)
48(L)TMI-4(47)
45(R)TRI-1(47)
46DMA00-3(47)
49DMA10-3(47)
46DMA00-5(47)
49DMA10-5(47)
2TR
1TR
TO DECODER FIG. 81
TO OTHER DECODER
48(L)TRI-1(47)
46DMG0-1(47)
49DMG1-1(47)
46DMG0-5(47)
49DMG1-5(47)
TO MARKER FIG. 40
TO OTHER MARKER

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FIG. 48

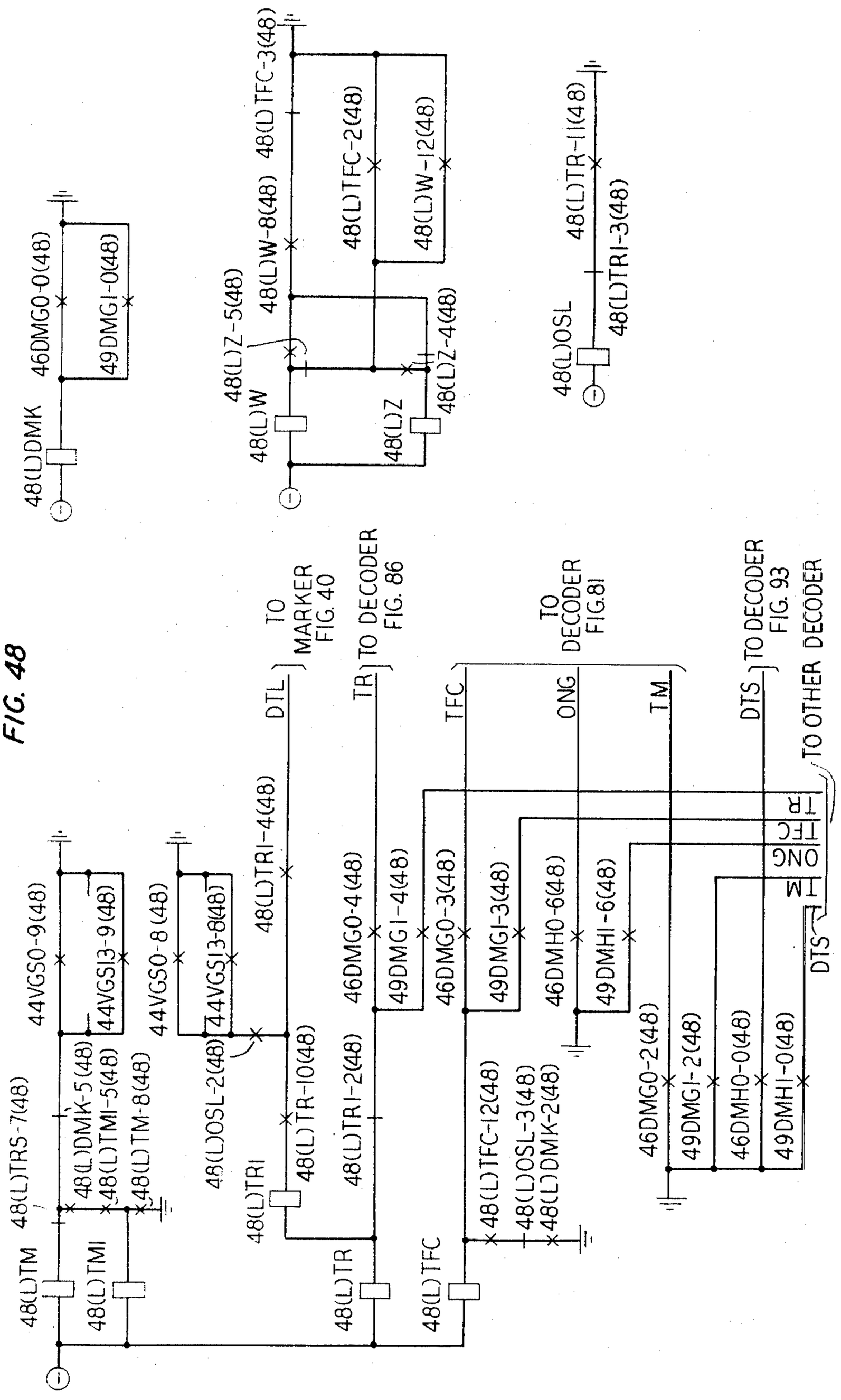
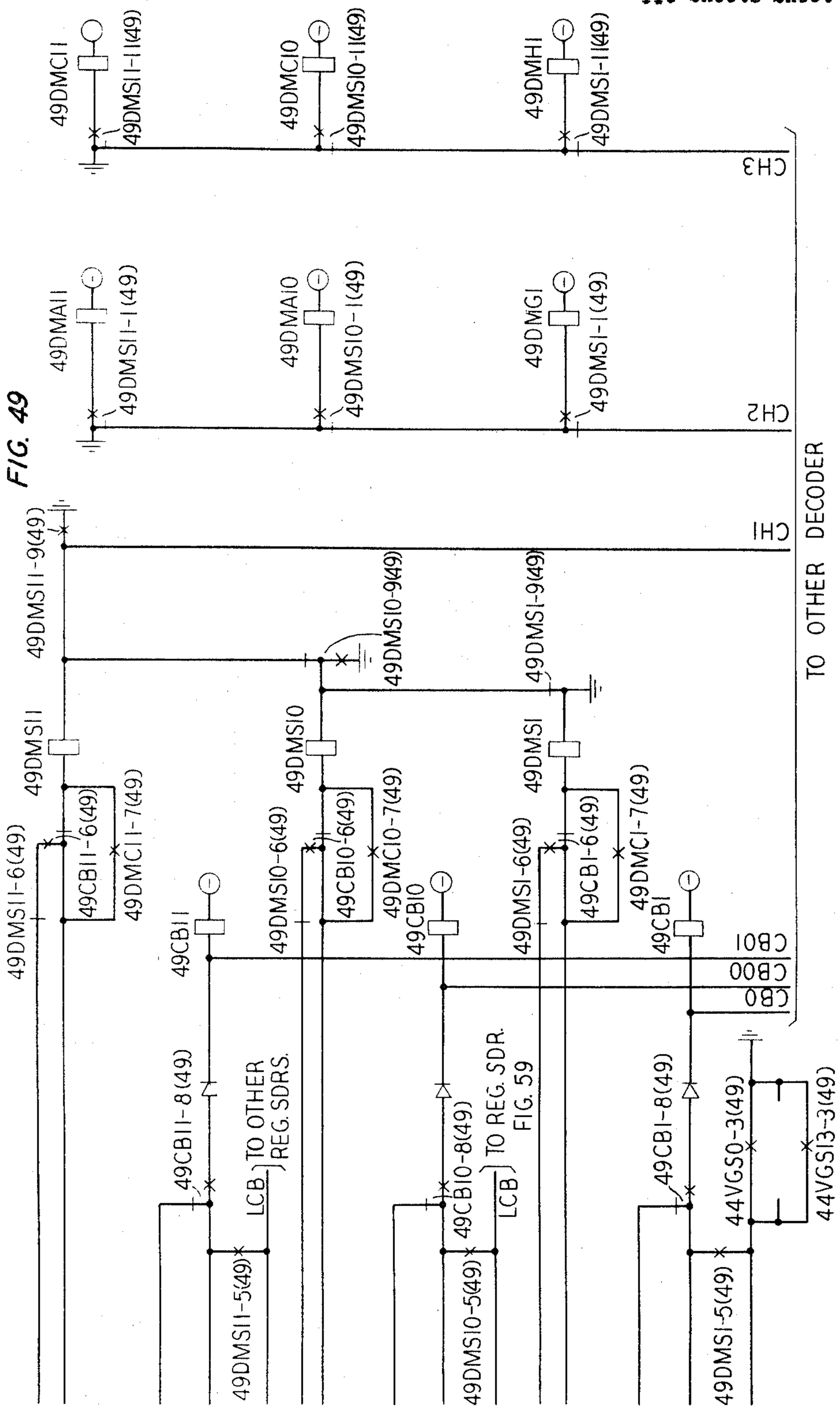


FIG. 49


49DMCI1
49DMSI1-1(49)
49DMCI0
49DMSI0-1(49)
49DMHI
49DMSI-1(49)
CH3
49DMAI1
49DMSI1-1(49)
49DMAI0
49DMSI0-1(49)
49DMGI
49DMSI-1(49)
CH2
CH1
49DMSI1-9(49)
49DMSI0-9(49)
49DMSI-9(49)
49DMSI1-6(49)
49CBI1-6(49)
49DMCI1-7(49)
49DMSI0-6(49)
49CBI0-6(49)
49DMCI0-7(49)
49DMSI-6(49)
49CBI-6(49)
49DMCI-7(49)
49CBI1
49CBI0
49CBI
CB01
CB00
CB0
49CBI1-8(49)
LCB
TO OTHER REG. SDRS.
49CBI0-8(49)
LCB
TO REG. SDR. FIG. 59
49CBI-8(49)
44VGS0-3(49)
44VGS13-3(49)
49DMSI1-5(49)
49DMSI0-5(49)
49DMSI-5(49)
TO OTHER DECODER

TELEPHONE SYSTEM

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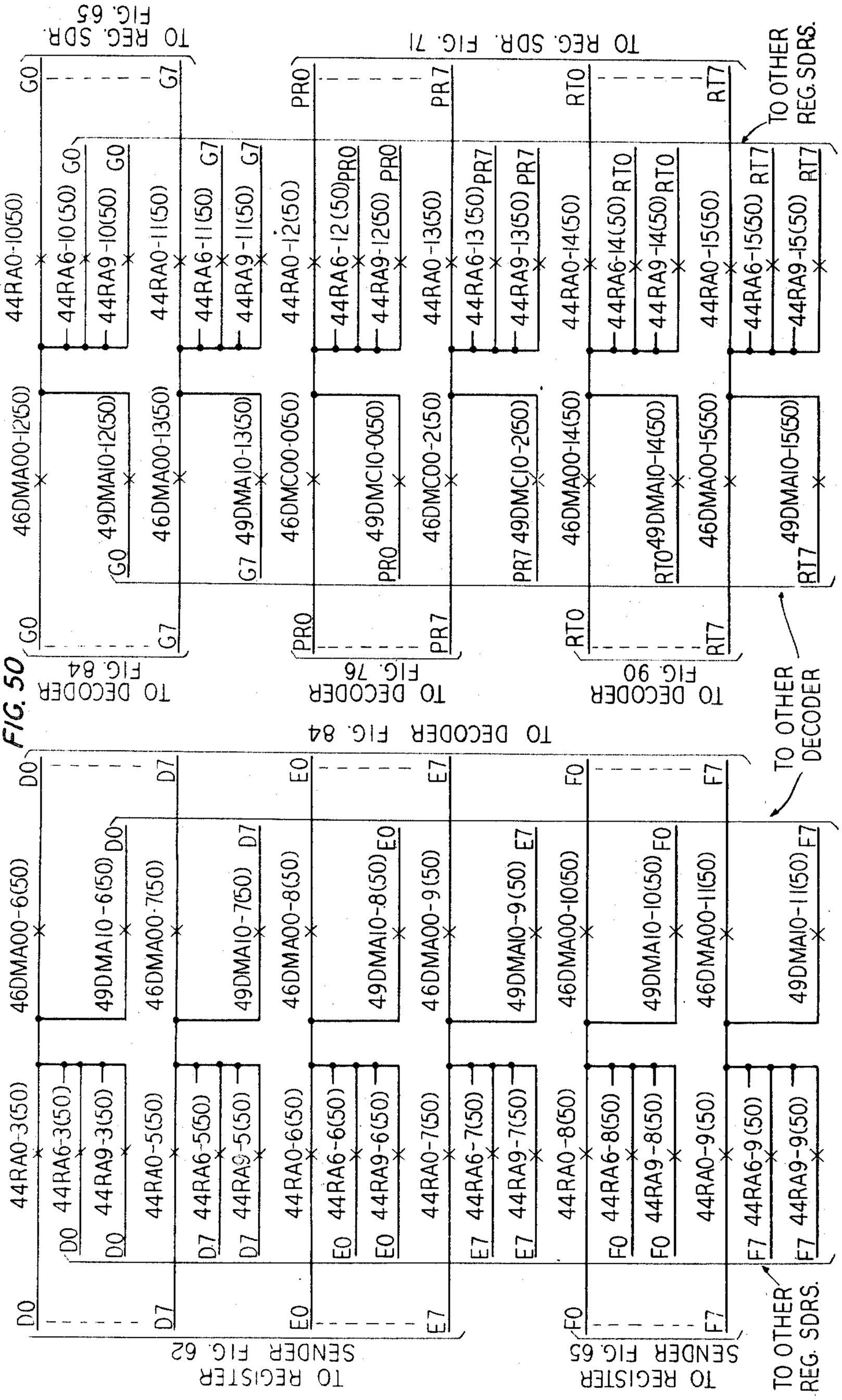

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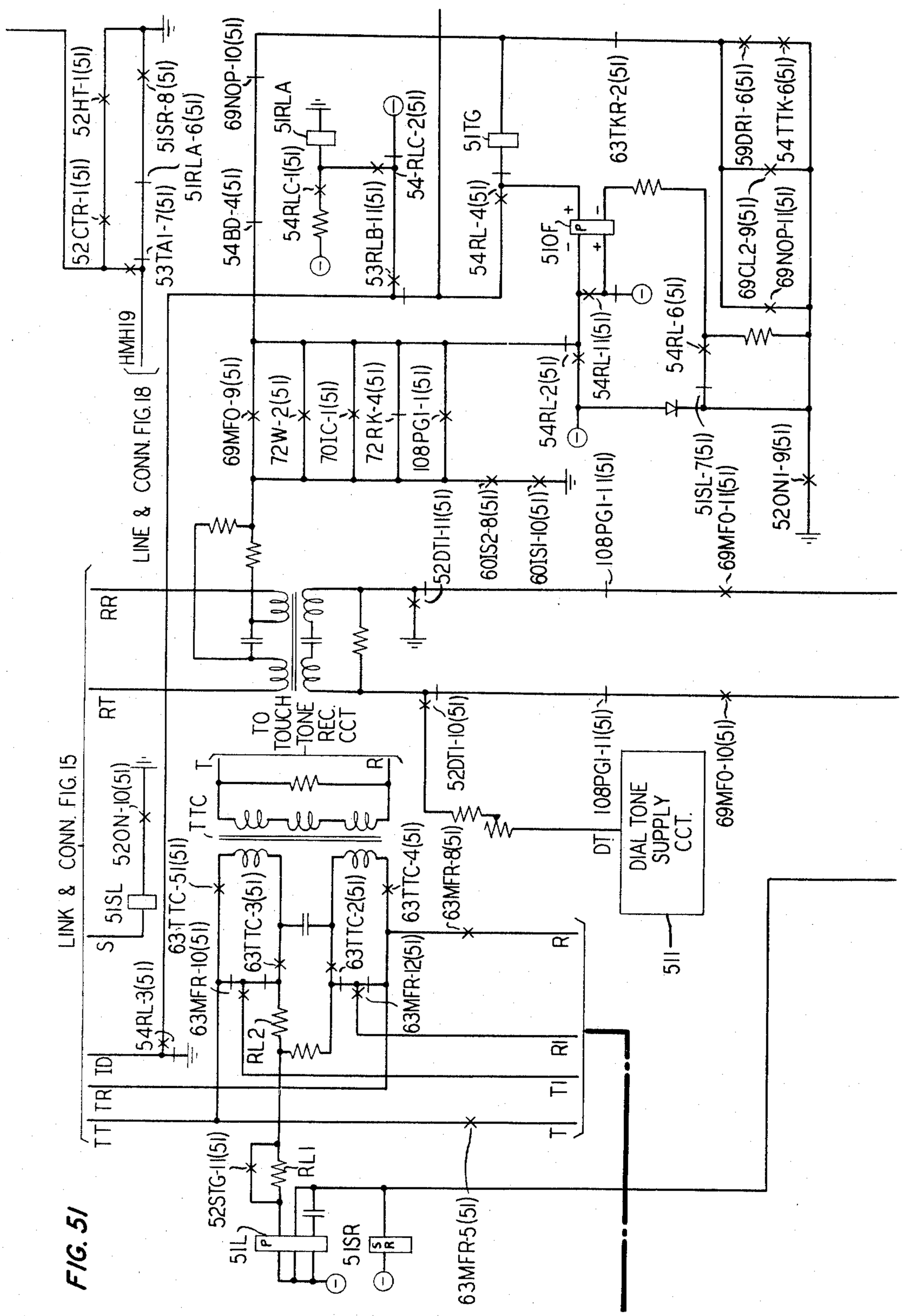

FIG. 51

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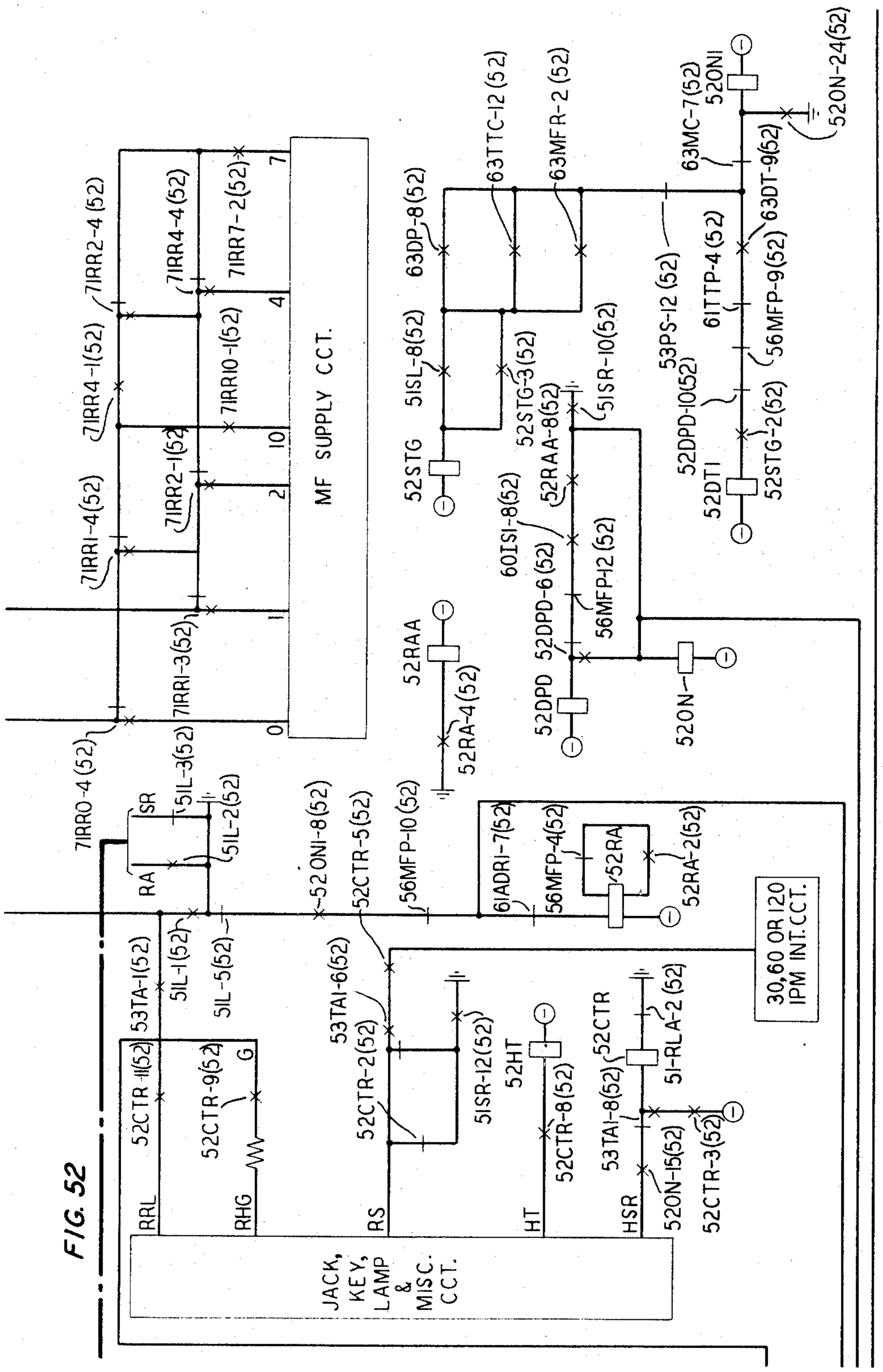

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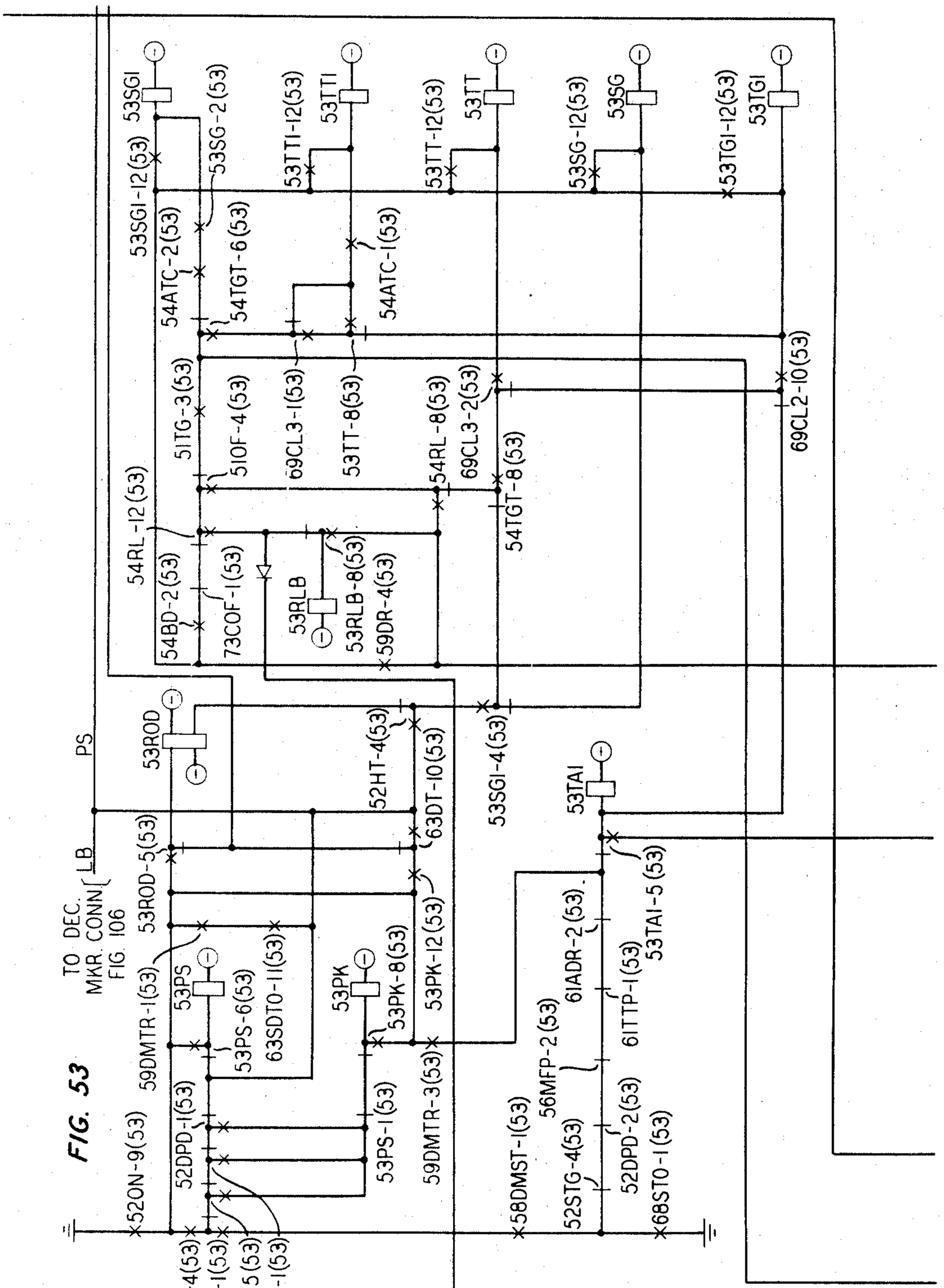

FIG. 53

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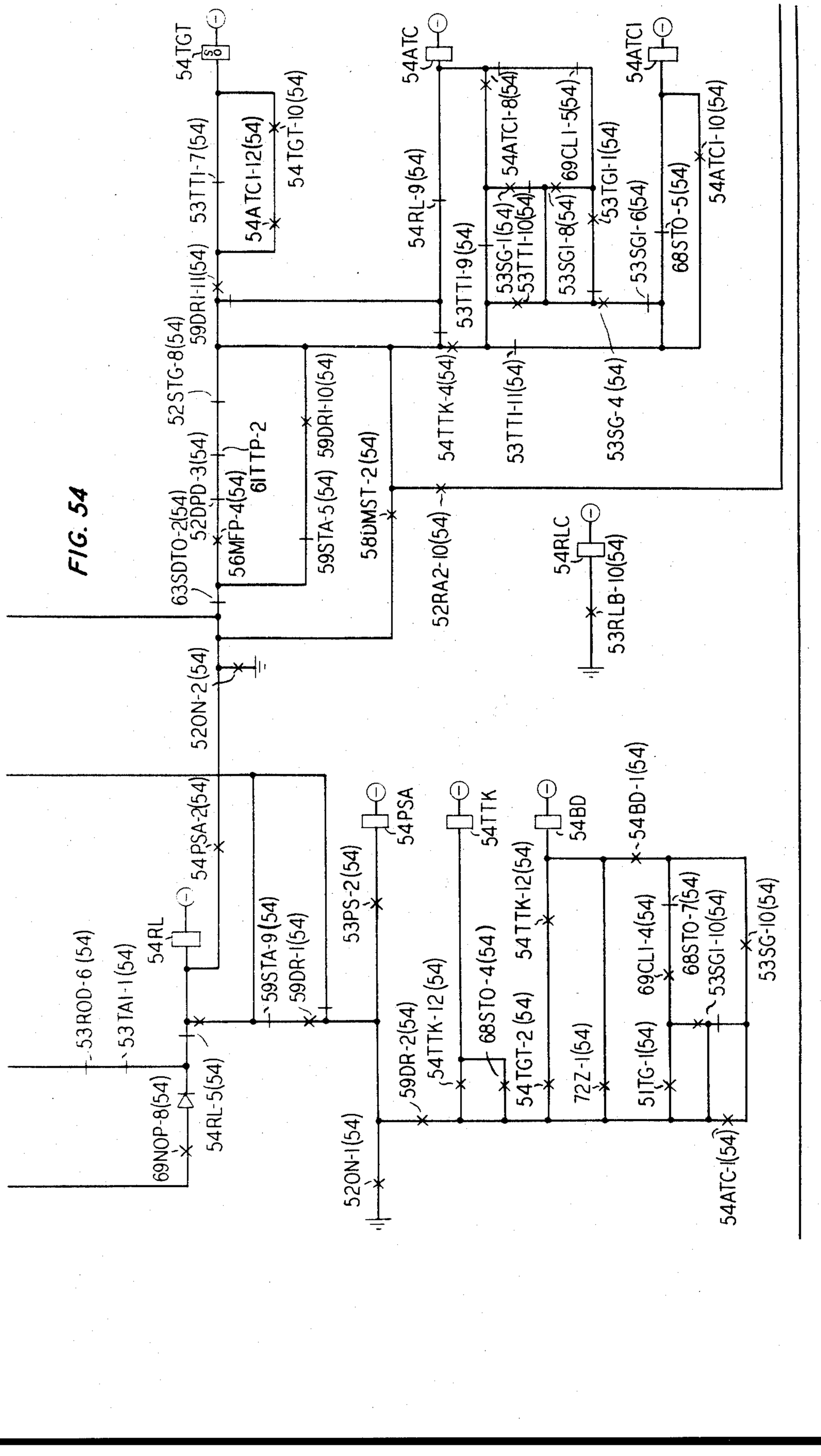
FIG. 54



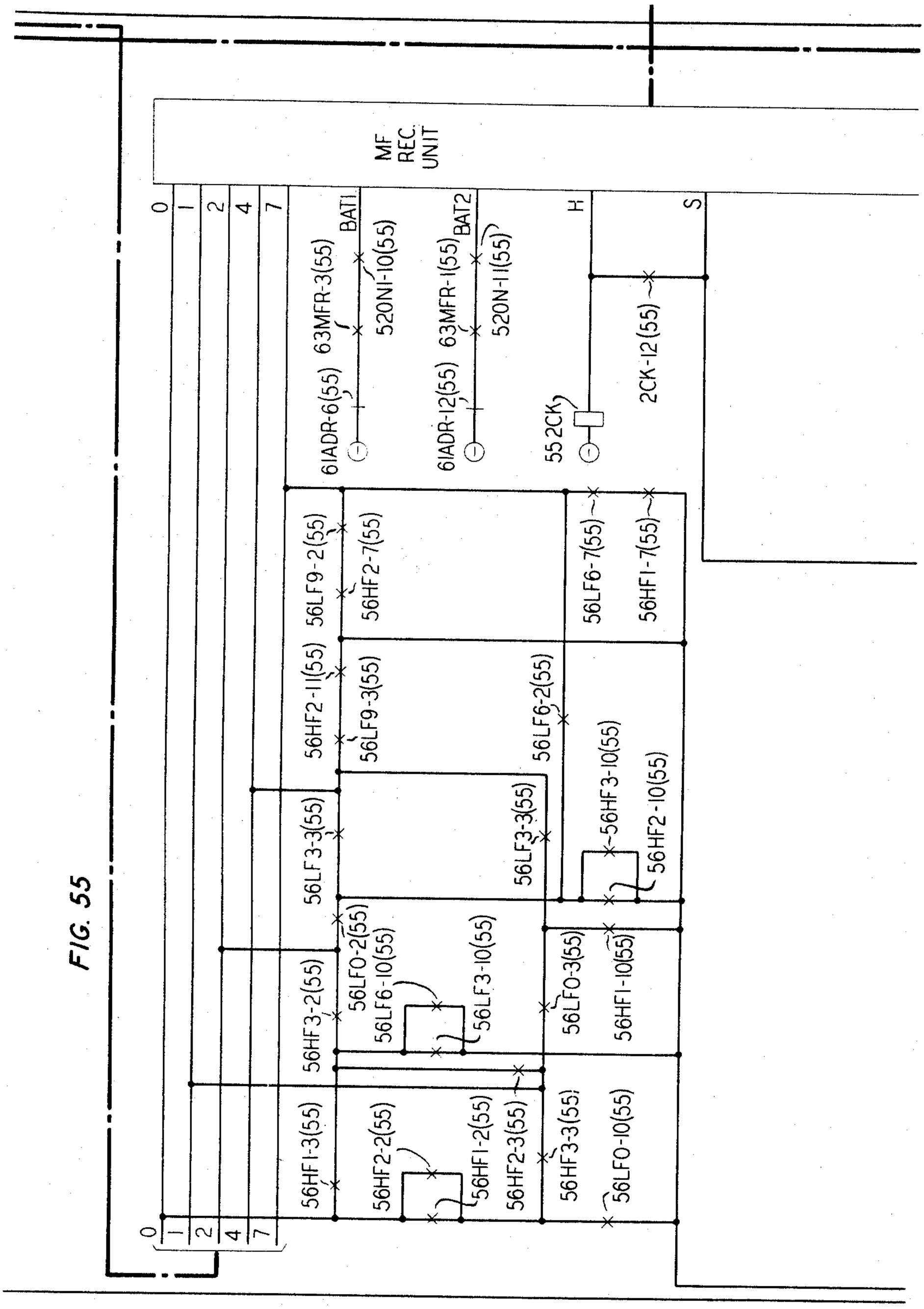

MF REC UNIT
0
1
2
4
7
61ADR-6(55)
63MFR-3(55)
BAT1
520N1-10(55)
61ADR-12(55)
63MFR-1(55)
BAT2
520N-11(55)
55 2CK
H
S
2CK-12(55)
56LF9-2(55)
56HF2-7(55)
56LF6-7(55)
56HF1-7(55)
56HF2-11(55)
56LF9-3(55)
56LF6-2(55)
56HF3-10(55)
56HF2-10(55)
56LF3-3(55)
56HF3-2(55)
56LFO-2(55)
56LF6-10(55)
56LF3-10(55)
56LFO-3(55)
56HF1-10(55)
56HF1-3(55)
56HF2-2(55)
56HF1-2(55)
56HF2-3(55)
56HF3-3(55)
56LFO-10(55)

FIG. 55

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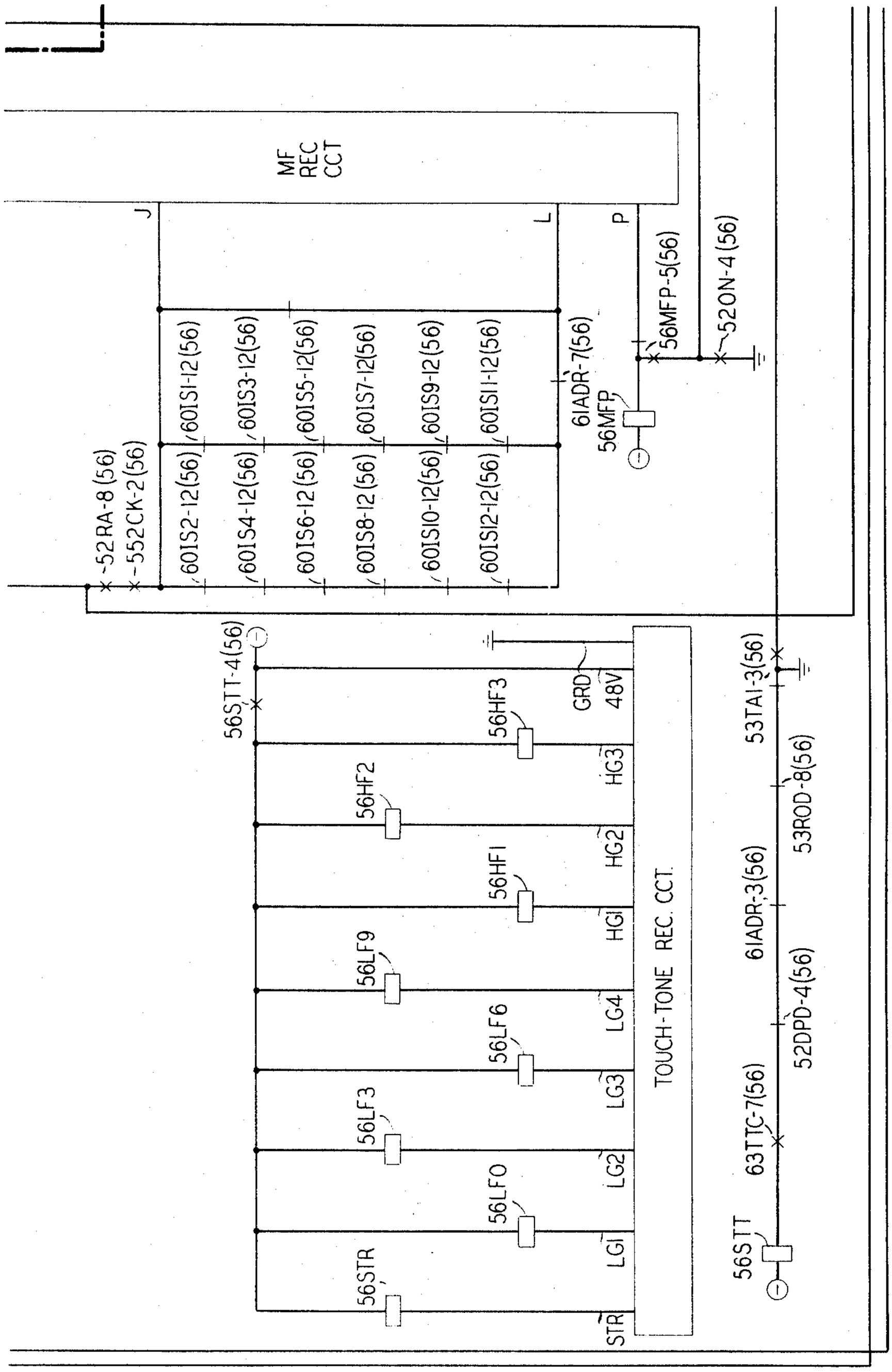

FIG. 56

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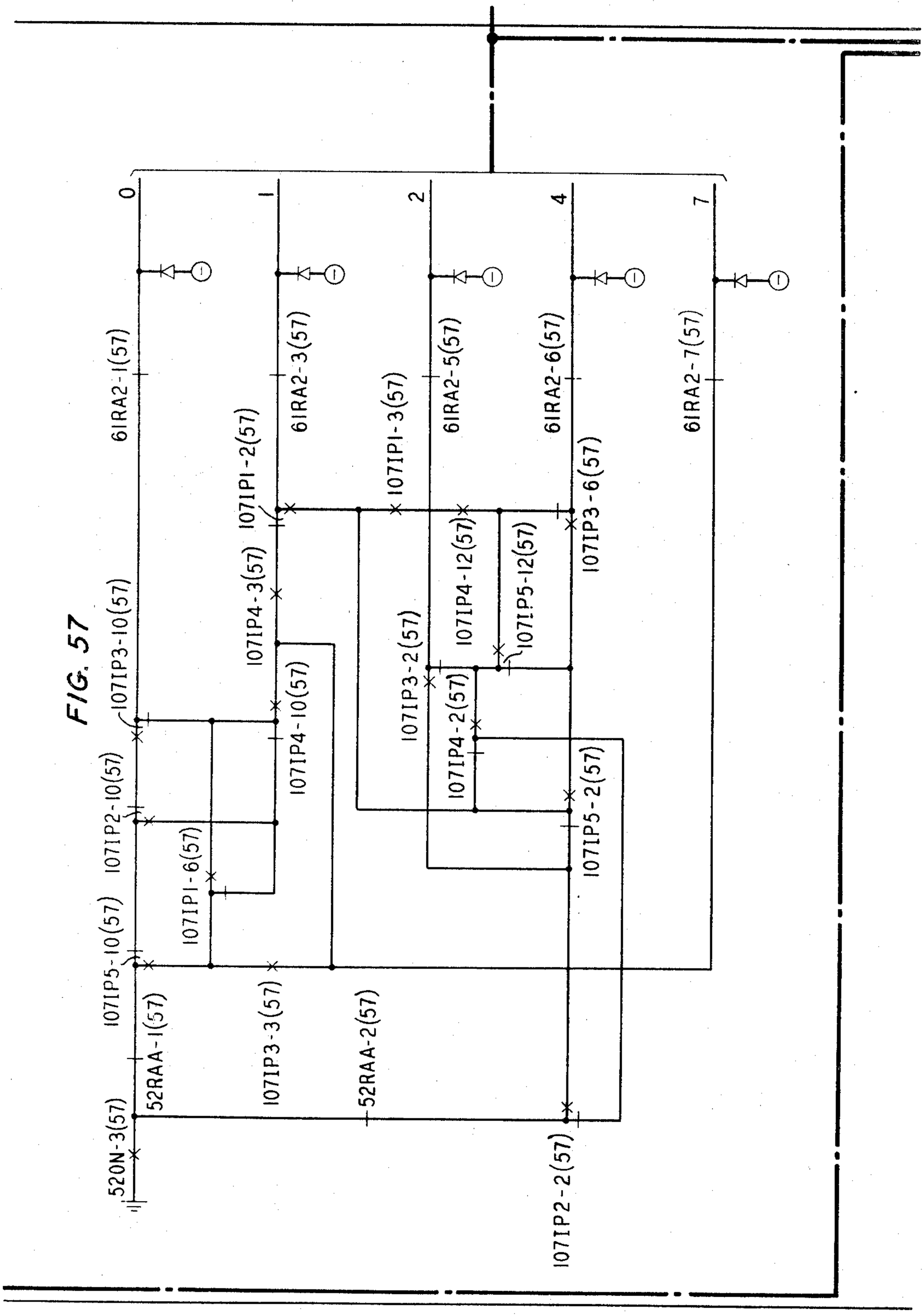
FIG. 57



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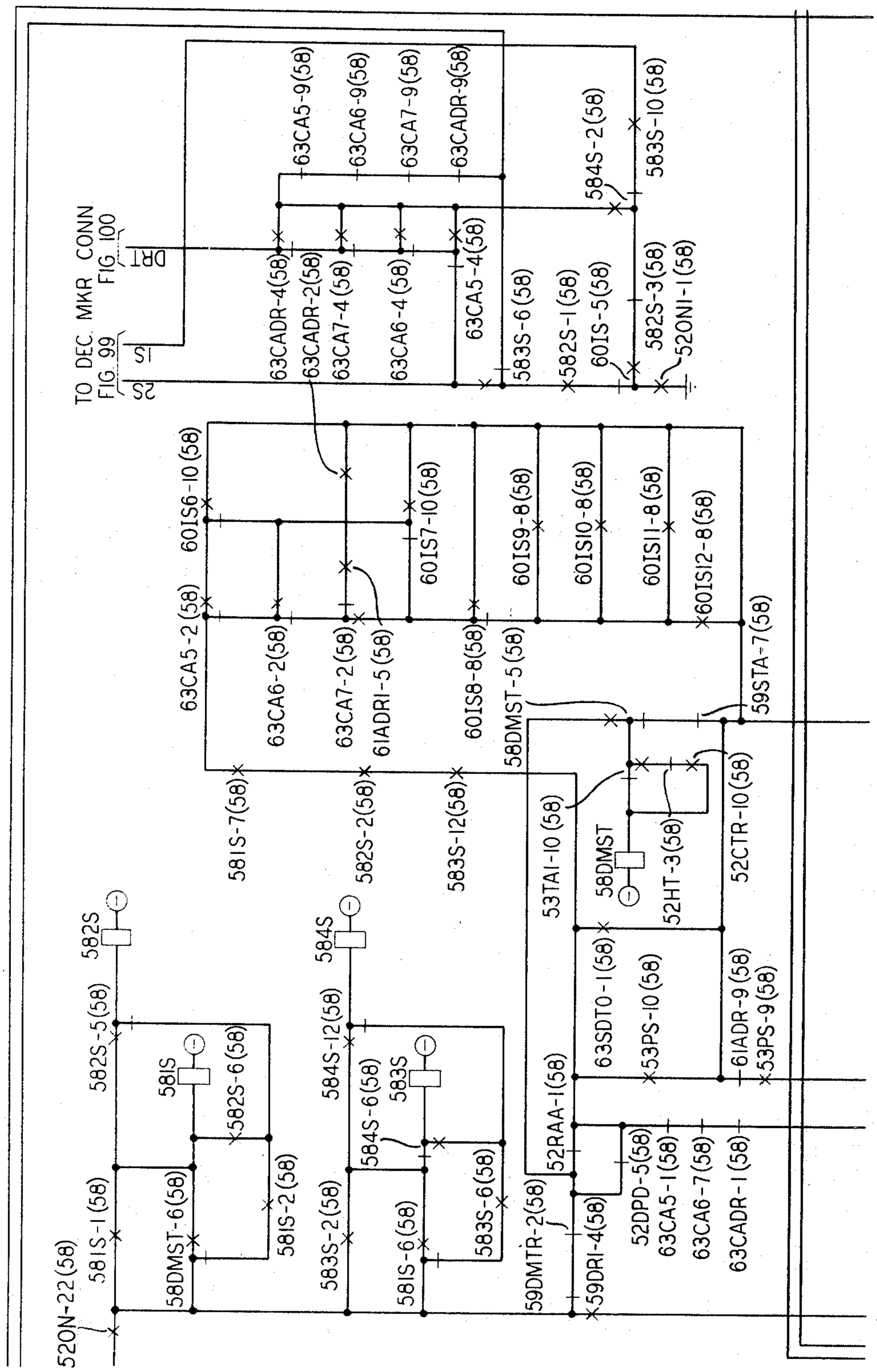

FIG. 58

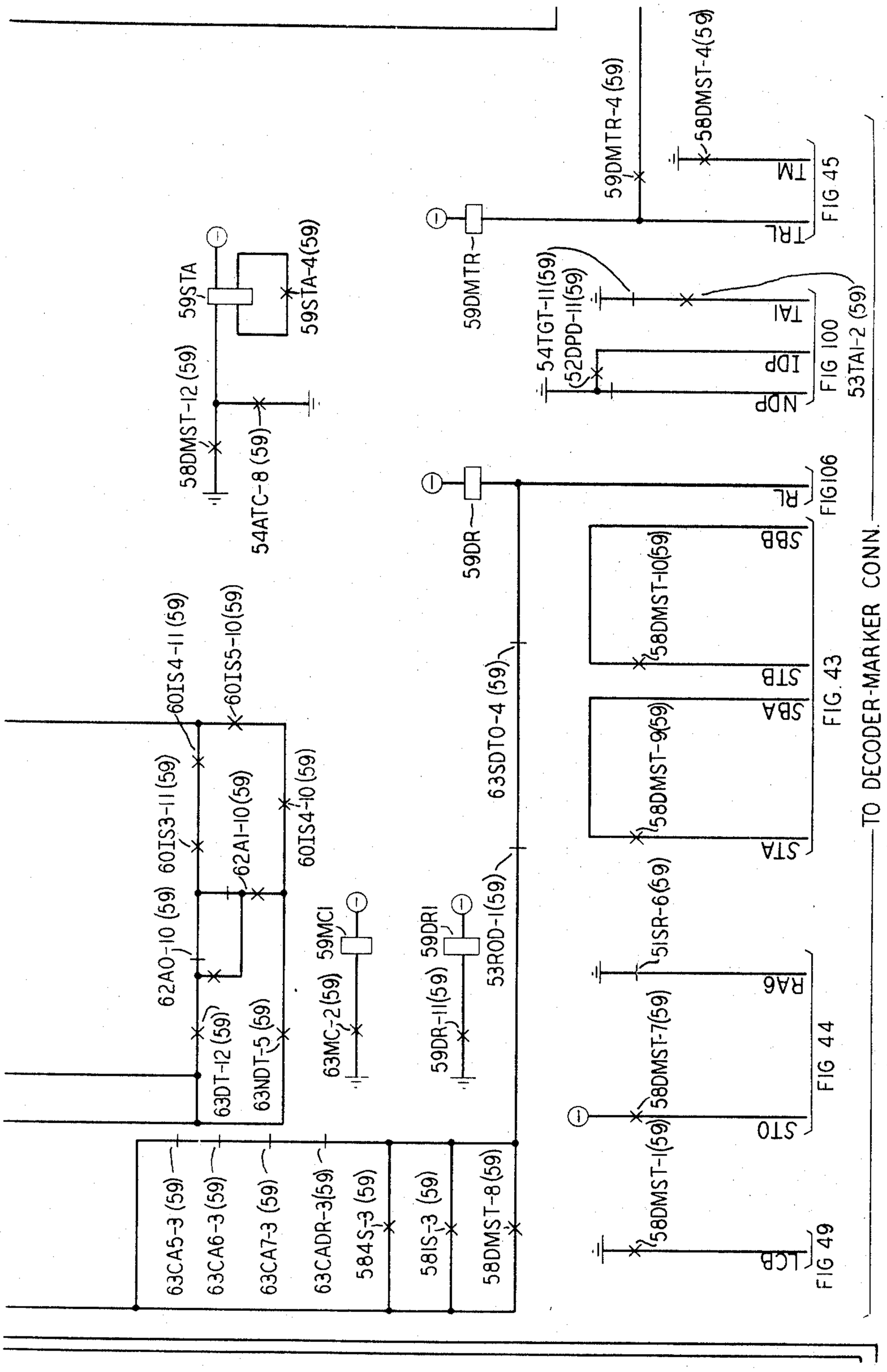
59DMTR-4(59)
58DMST-4(59)
59DMTR
TM
TRL
FIG 45
54TGT-111(59)
52DPD-111(59)
TAI
IDP
NDP
FIG 100
53TAI-2 (59)
59DR
RL
FIG106
SBB
58DMST-10(59)
58DMST-
STB
SBA
58DMST-9(59)
STA
FIG. 43
63SDTO-4 (59)
53ROD-1(59)
59DRI
59DR-11(59)
51SR-6(59)
58DMST-7(59)
RA6
FIG 44
TO DECODER-MARKER CONN.
58DMST-1(59)
ST0
FIG 49
58DMST-12 (59)
59STA
59STA-4(59)
54ATC-8 (59)
60IS4-11 (59)
60IS5-10(59)
60IS3-11(59)
62AI-10(59)
62AO-10 (59)
60IS4-10(59)
63DT-12 (59)
63NDT-5 (59)
63MC-2(59)
59MCI
63CA5-3 (59)
63CA6-3 (59)
63CA7-3 (59)
63CADR-3(59)
584S-3 (59)
581S-3 (59)
58DMST-8(59)

FIG. 59

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TELEPHONE SYSTEM

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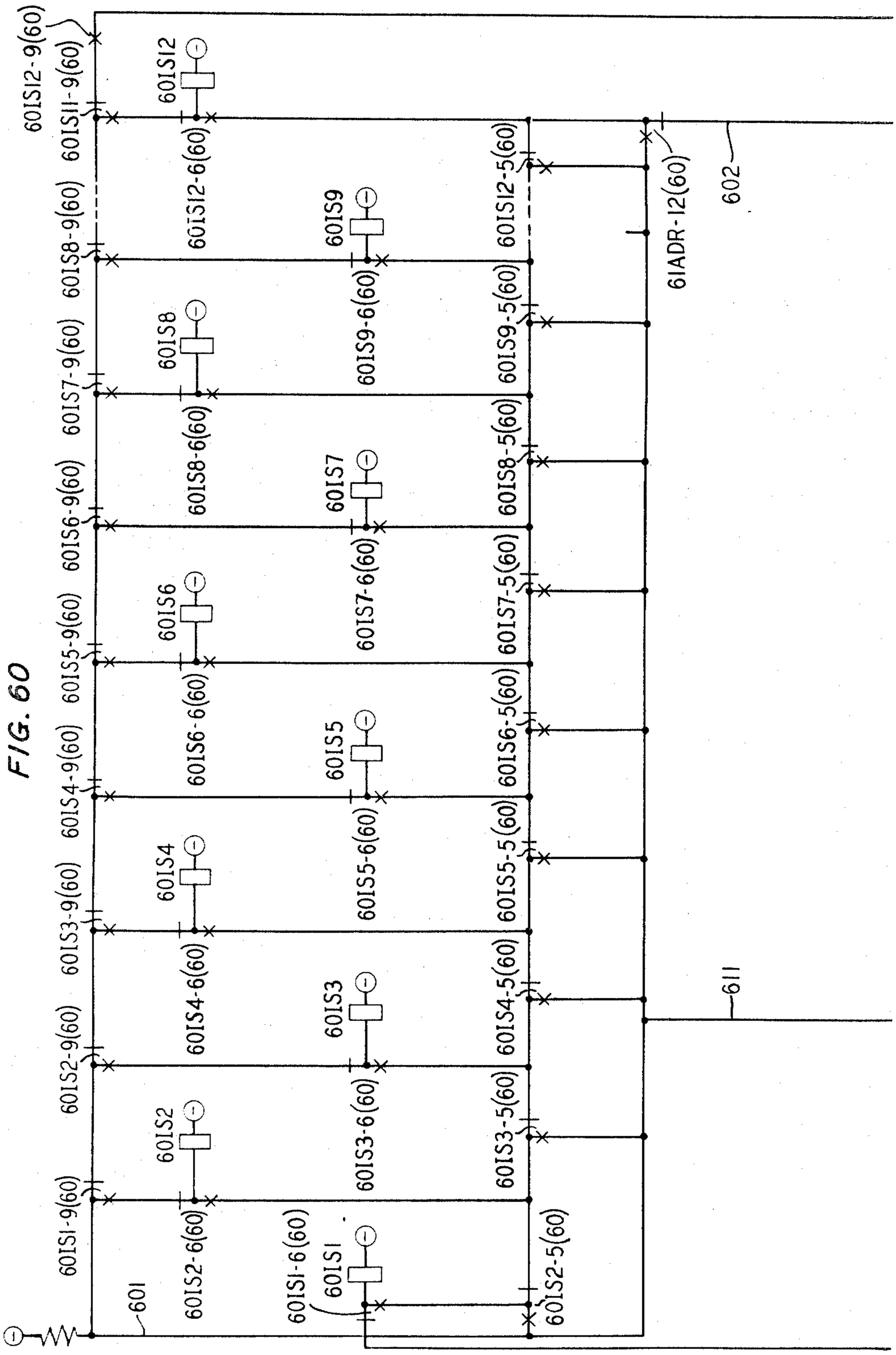

FIG. 60

July 23, 1968 R. J. JAEGER, JR., ET AL 3,394,232

TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 63

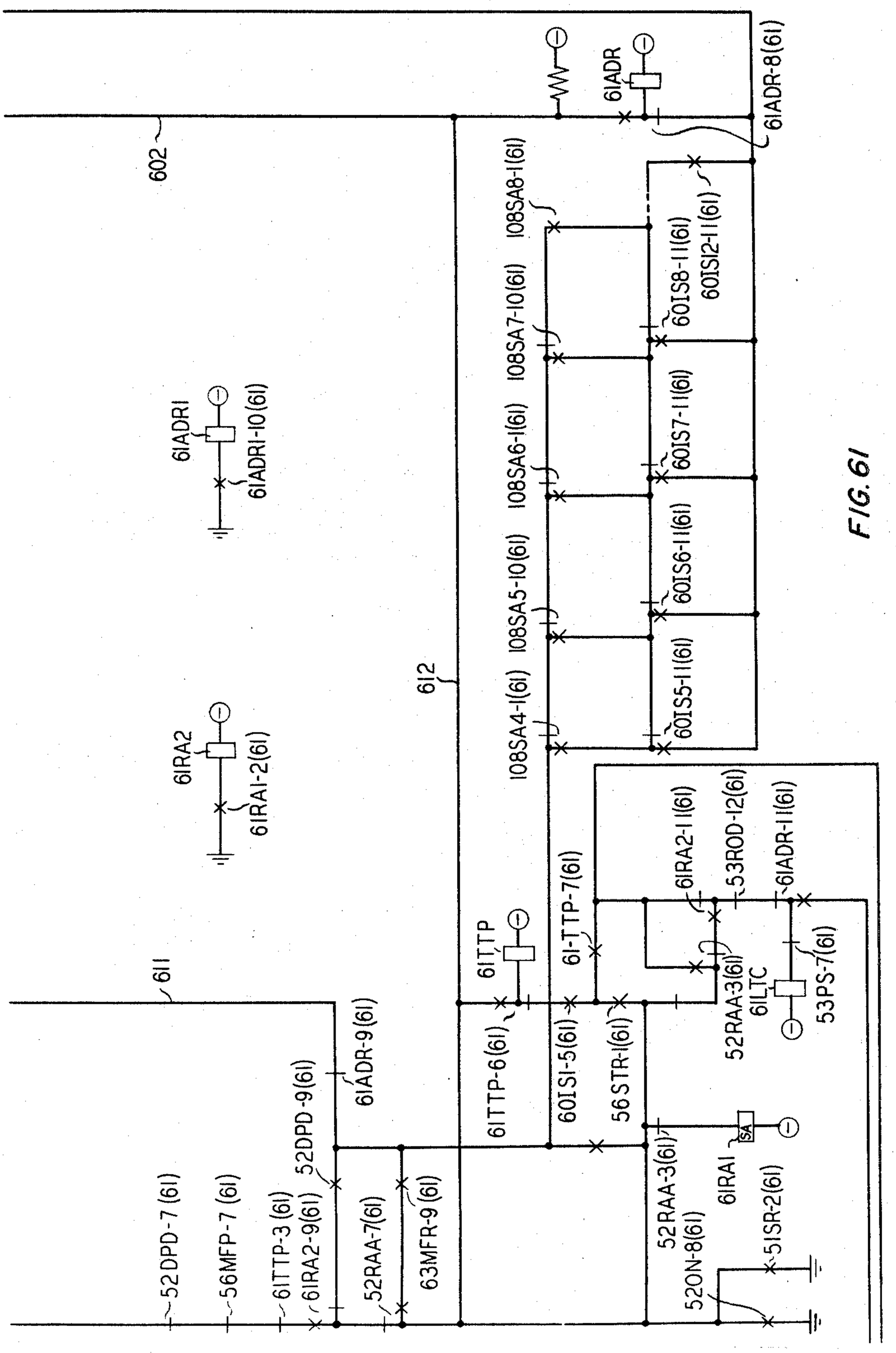

FIG. 61

July 23, 1968 R. J. JAEGER, JR., ET AL 3,394,232

TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 64

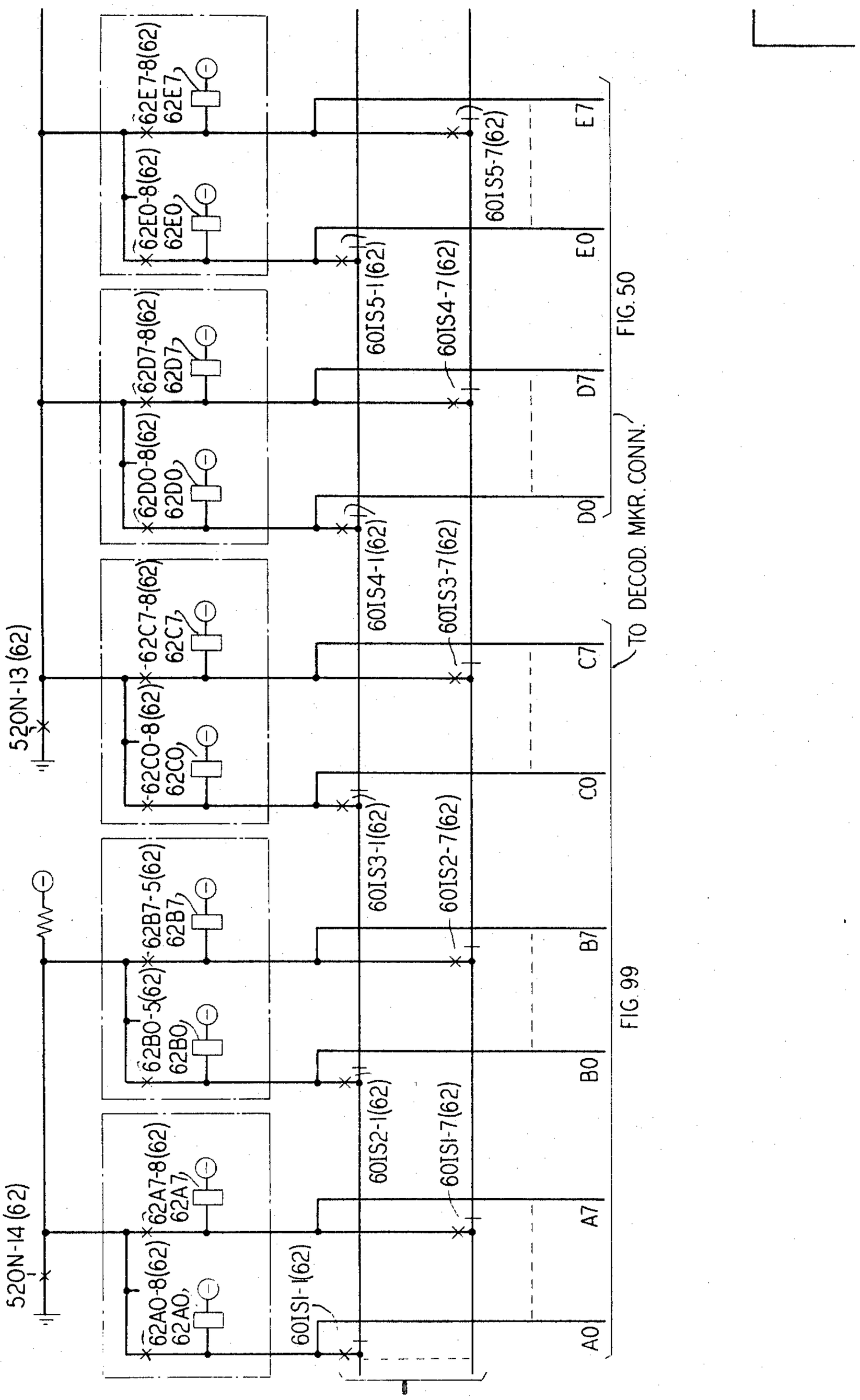

FIG. 62

TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 65

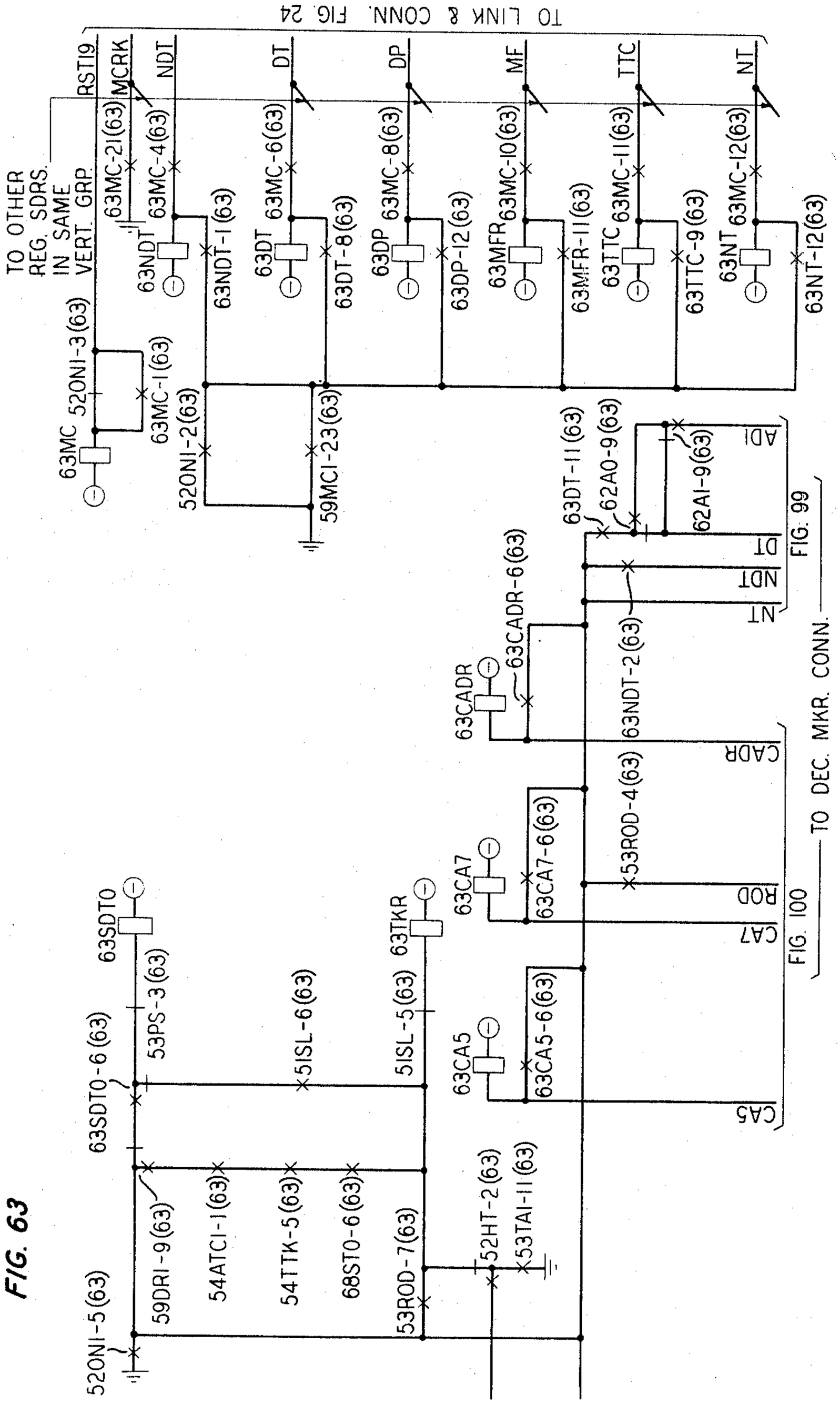

FIG. 63

July 23, 1968 R. J. JAEGER, JR., ET AL 3,394,232

TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 66

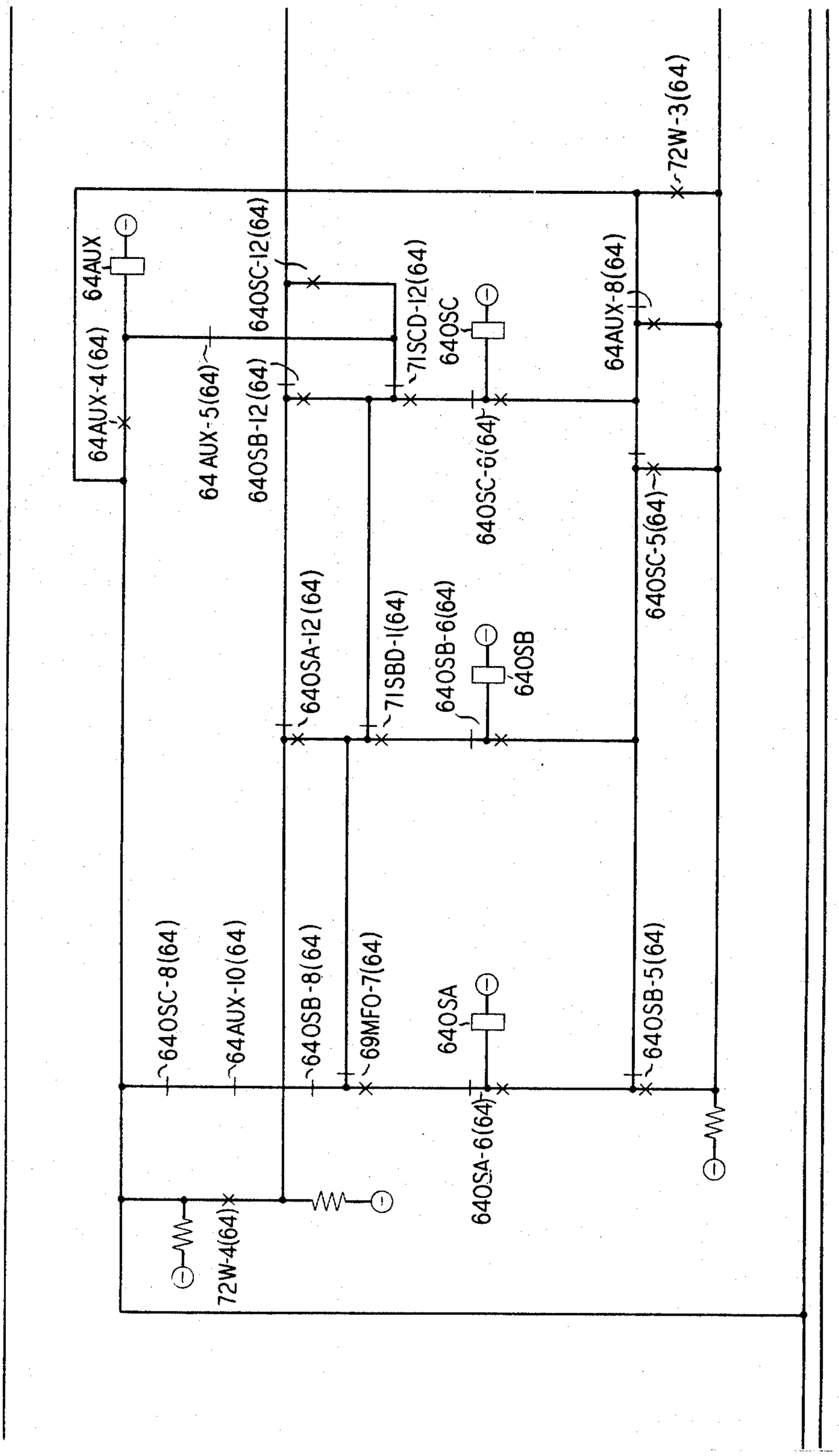

FIG. 64

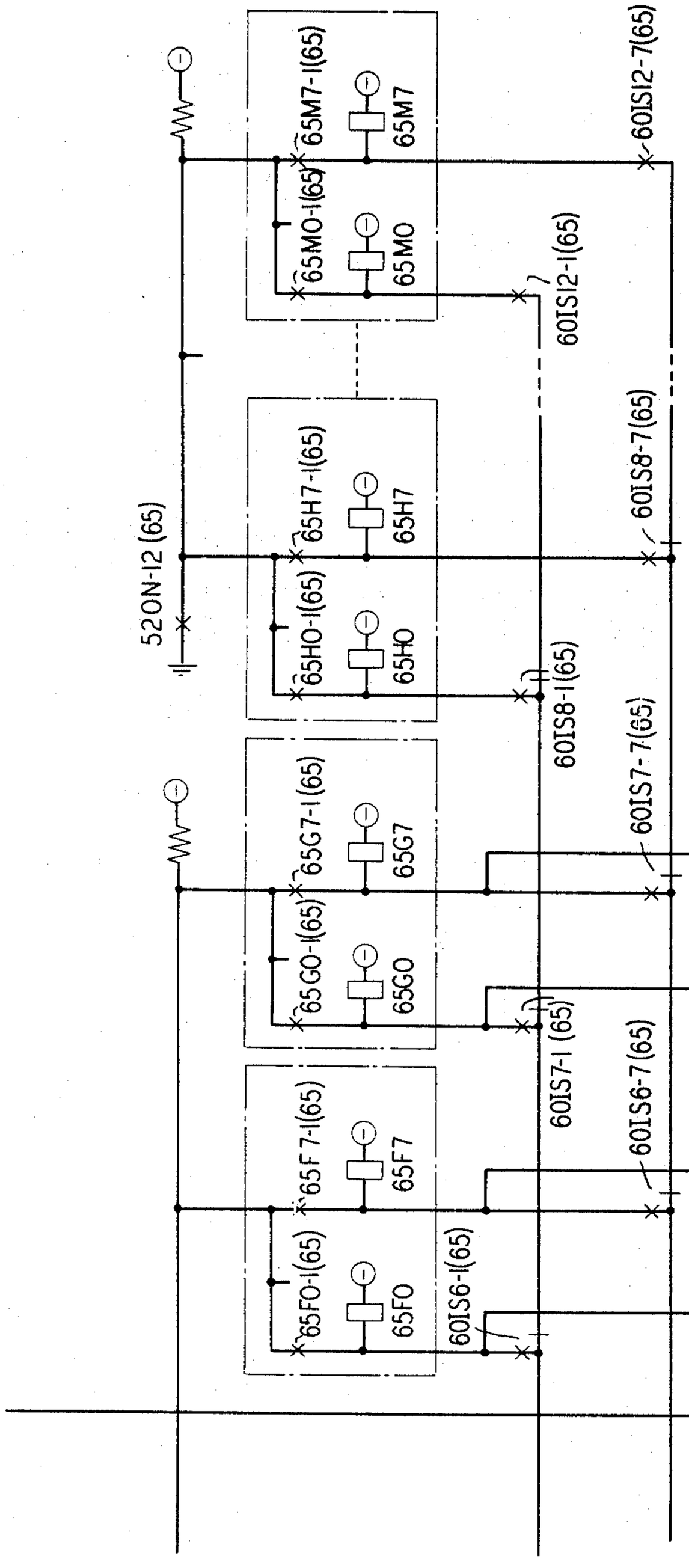
520N-12 (65)
65HO-1(65)
65HO
65H7-1(65)
65H7
65FO-1(65)
65FO
65F7-1(65)
65F7
65GO-1(65)
65GO
65G7-1(65)
65G7
65MO-1(65)
65MO
65M7-1(65)
65M7
60IS6-1(65)
60IS7-1(65)
60IS8-1(65)
60IS6-7(65)
60IS7-7(65)
60IS8-7(65)
60IS12-1(65)
60IS12-7(65)
F0
F7
G0
G7
TO DECODER MKR. CONN.
FIG.50

FIG. 65

TELEPHONE SYSTEM

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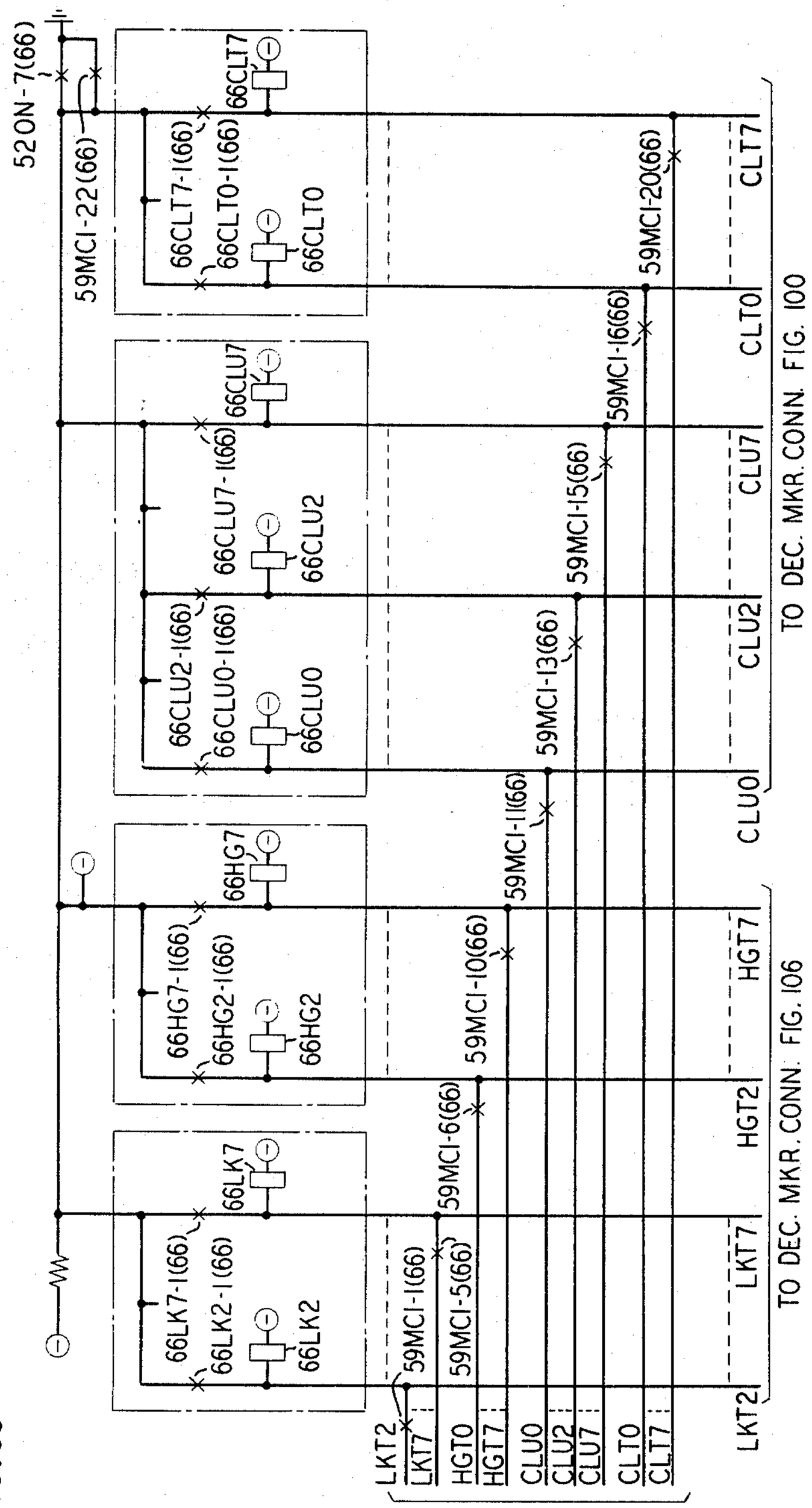

FIG. 66

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TELEPHONE SYSTEM

Filed March 9, 1965 111 Sheets-Sheet 69

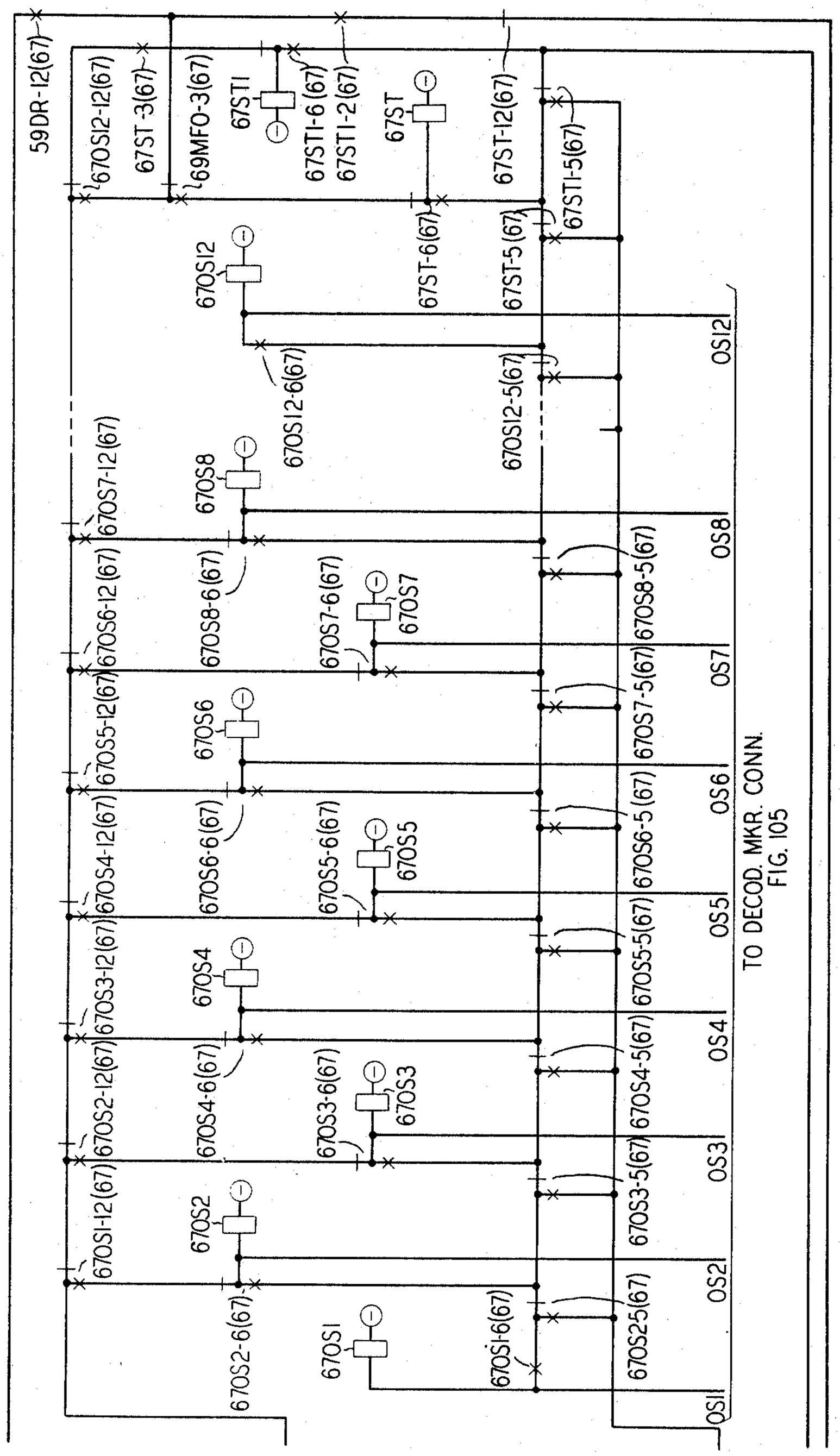

FIG. 67

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TELEPHONE SYSTEM

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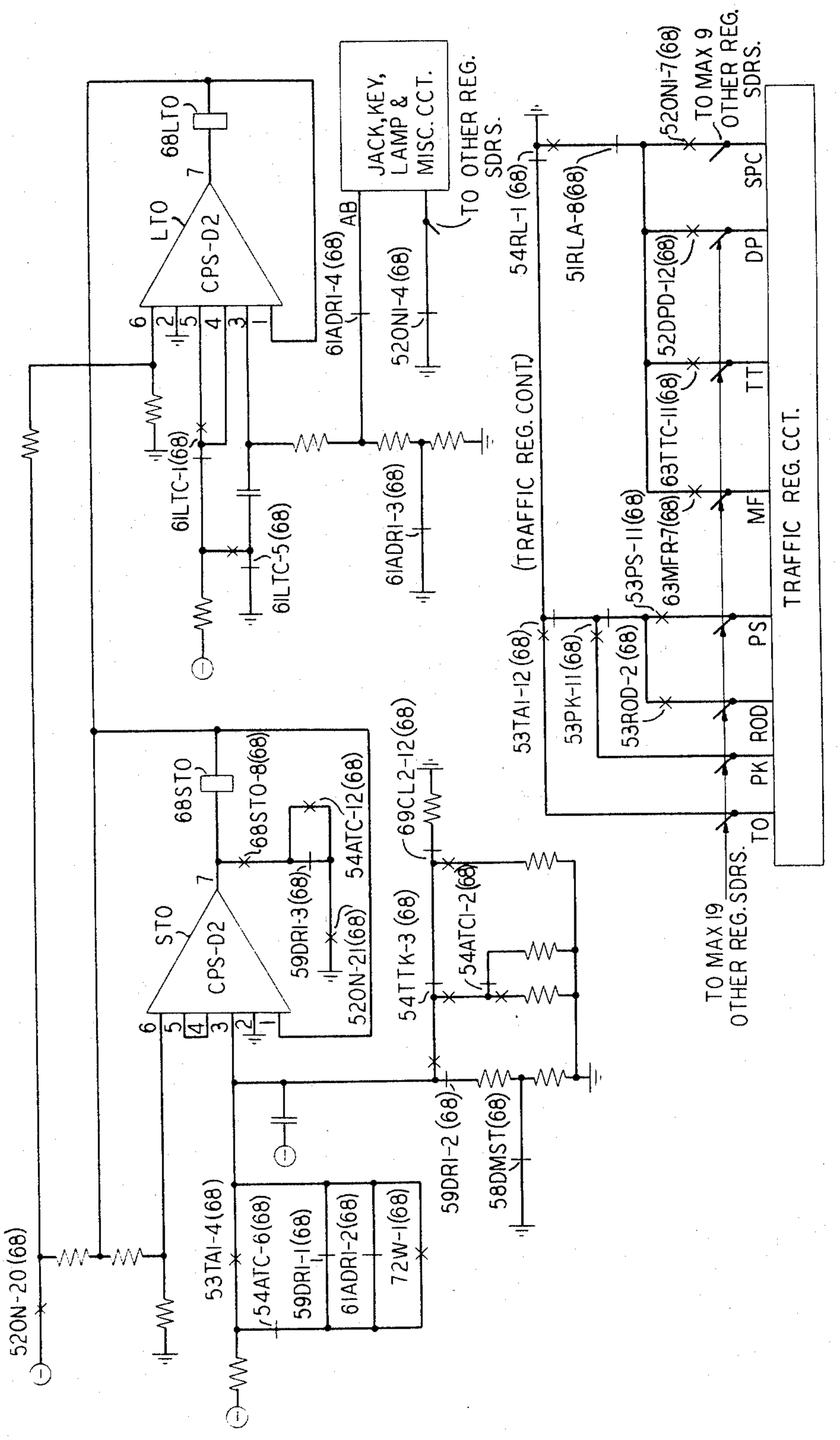

FIG 68

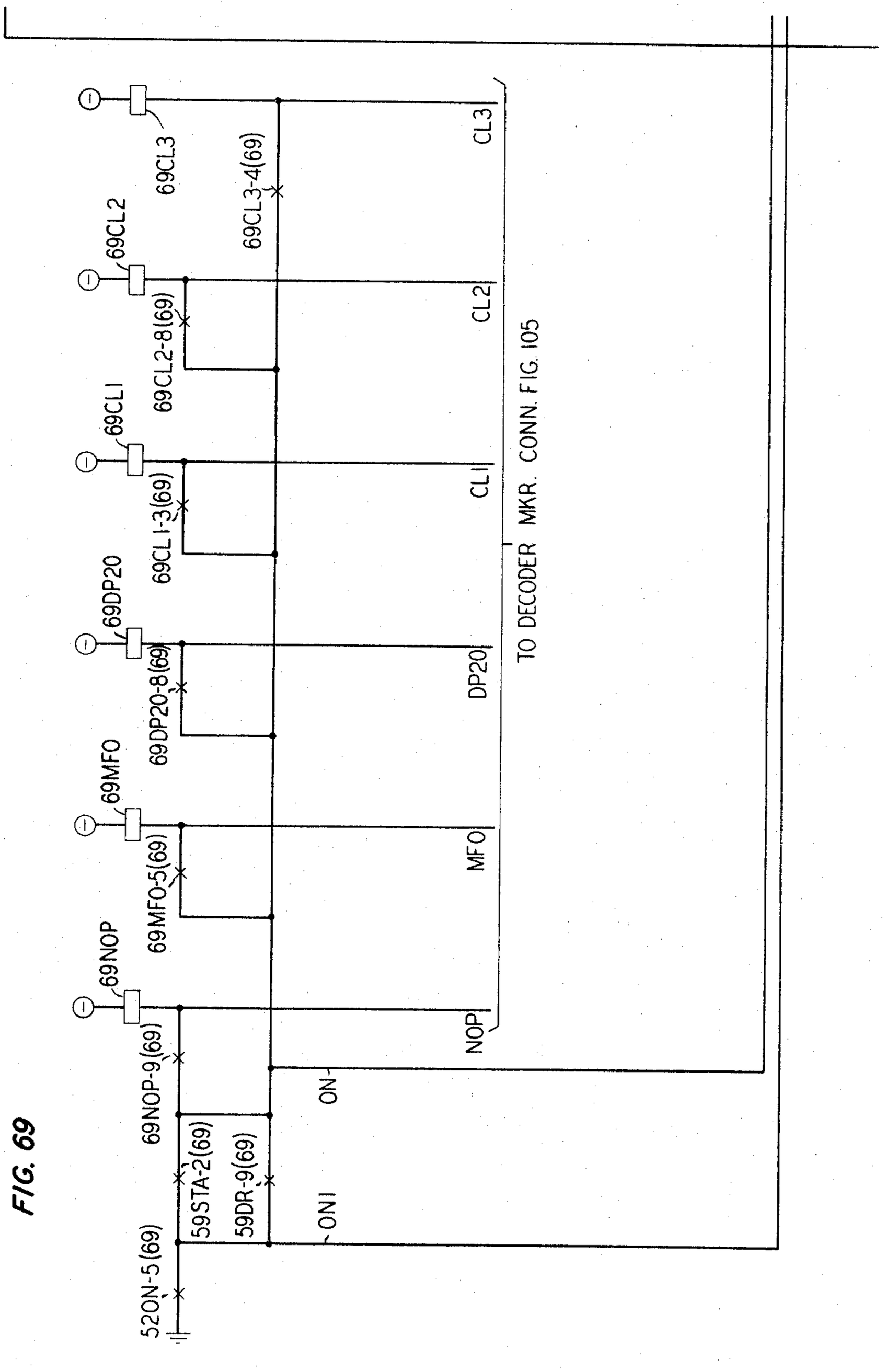
69CL3
69CL3-4(69)
CL3
69CL2
69CL2-8(69)
CL2
69CL1
69CL1-3(69)
CL1
69DP20
69DP20-8(69)
DP20
69MFO
69MFO-5(69)
MFO
69NOP
69NOP-9(69)
NOP
ON
59STA-2(69)
59DR-9(69)
ONI
52ON-5(69)
TO DECODER MKR. CONN. FIG. 105

FIG. 69

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TELEPHONE SYSTEM

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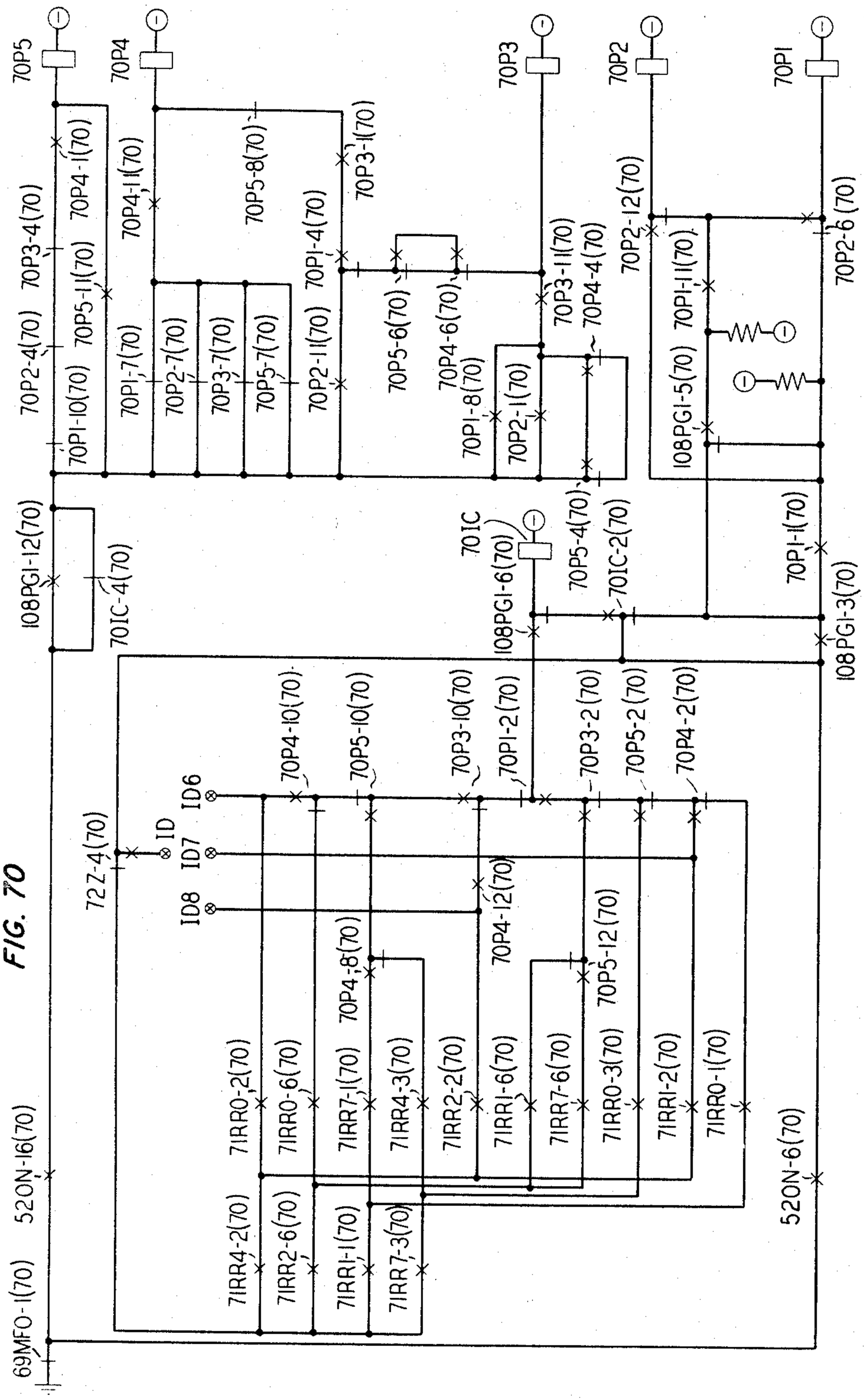

FIG. 70

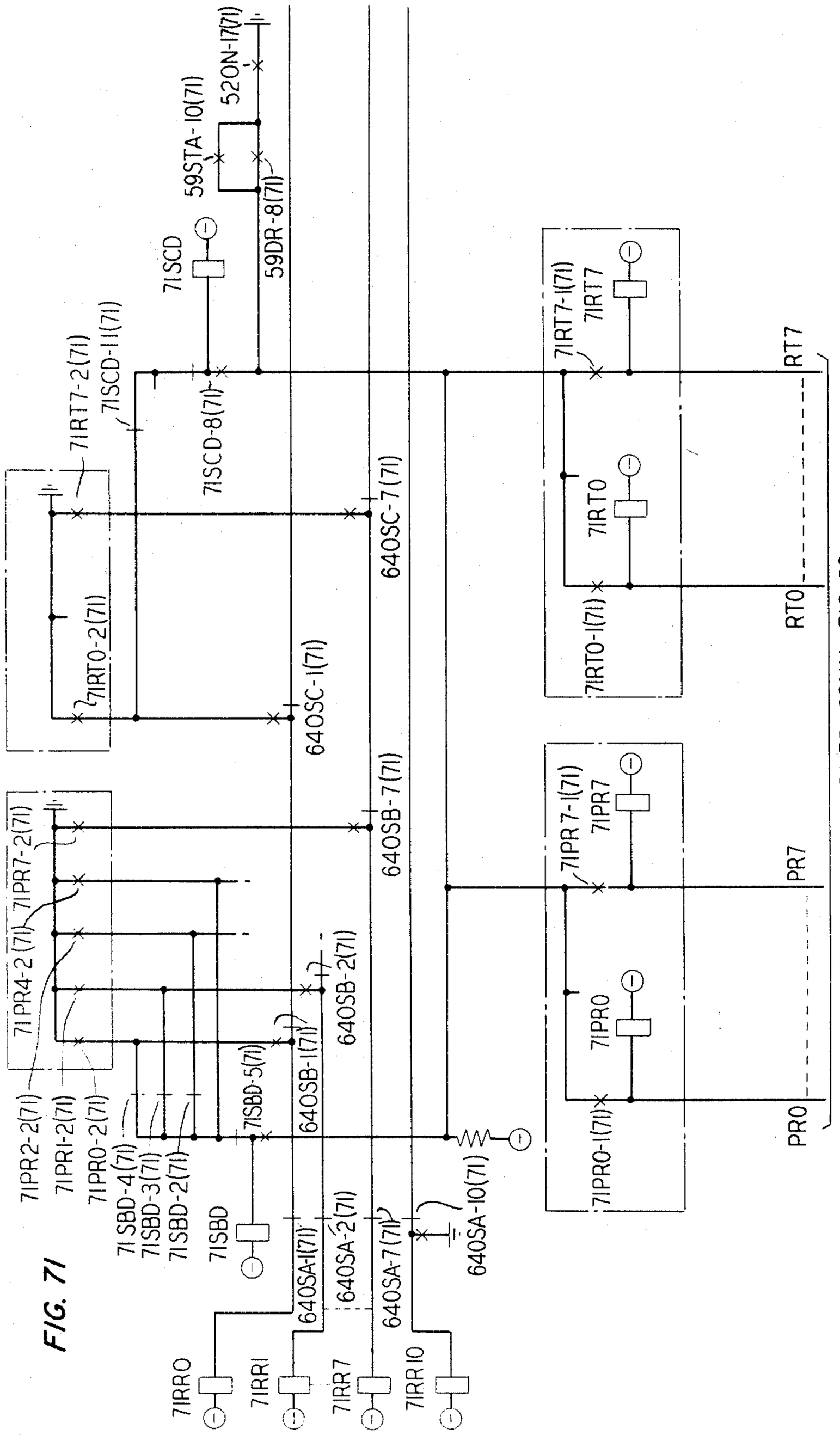
59STA-10(71)
520N-17(71)
59DR-8(71)
71SCD
71SCD-8(71)
71SCD-11(71)
71RT7-2(71)
71RT0-2(71)
640SC-7(71)
640SC-1(71)
71RT7-1(71)
71RT7
71RT0
71RT0-1(71)
RT7
RT0
TO DECODER MARKER CONN. FIG. 50
71PR4-2(71)
71PR7-2(71)
71PR2-2(71)
71PR1-2(71)
71PR0-2(71)
71SBD-5(71)
640SB-1(71)
640SB-2(71)
640SB-7(71)
71PR7-1(71)
71PR7
71PR0
71PR0-1(71)
PR7
PR0
71SBD-4(71)
71SBD-3(71)
71SBD-2(71)
71SBD
640SA-1(71)
640SA-2(71)
640SA-7(71)
640SA-10(71)
71IRR0
71IRR1
71IRR7
71IRR10

FIG. 71

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TELEPHONE SYSTEM

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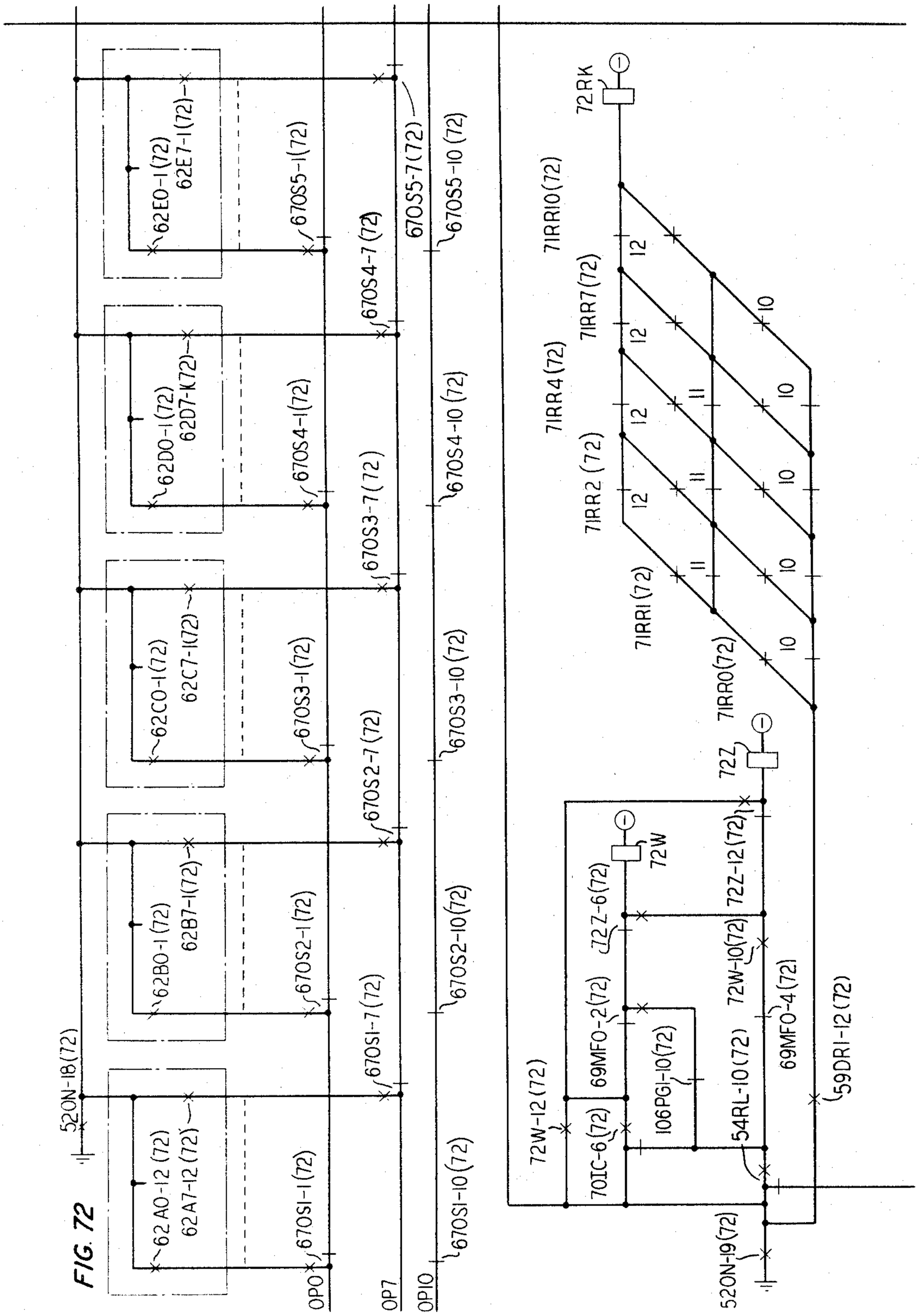

FIG. 72

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TELEPHONE SYSTEM

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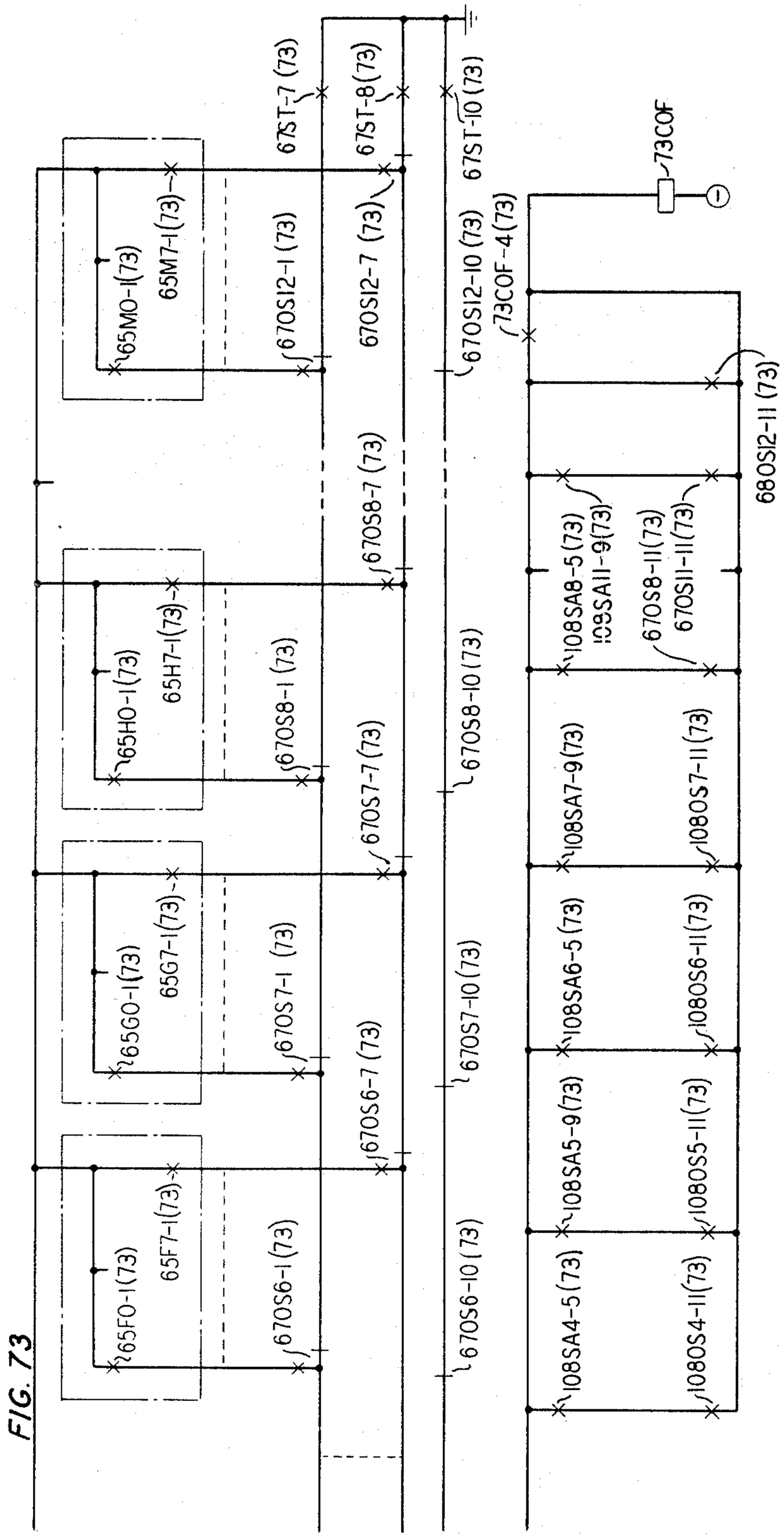

FIG. 73

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TELEPHONE SYSTEM

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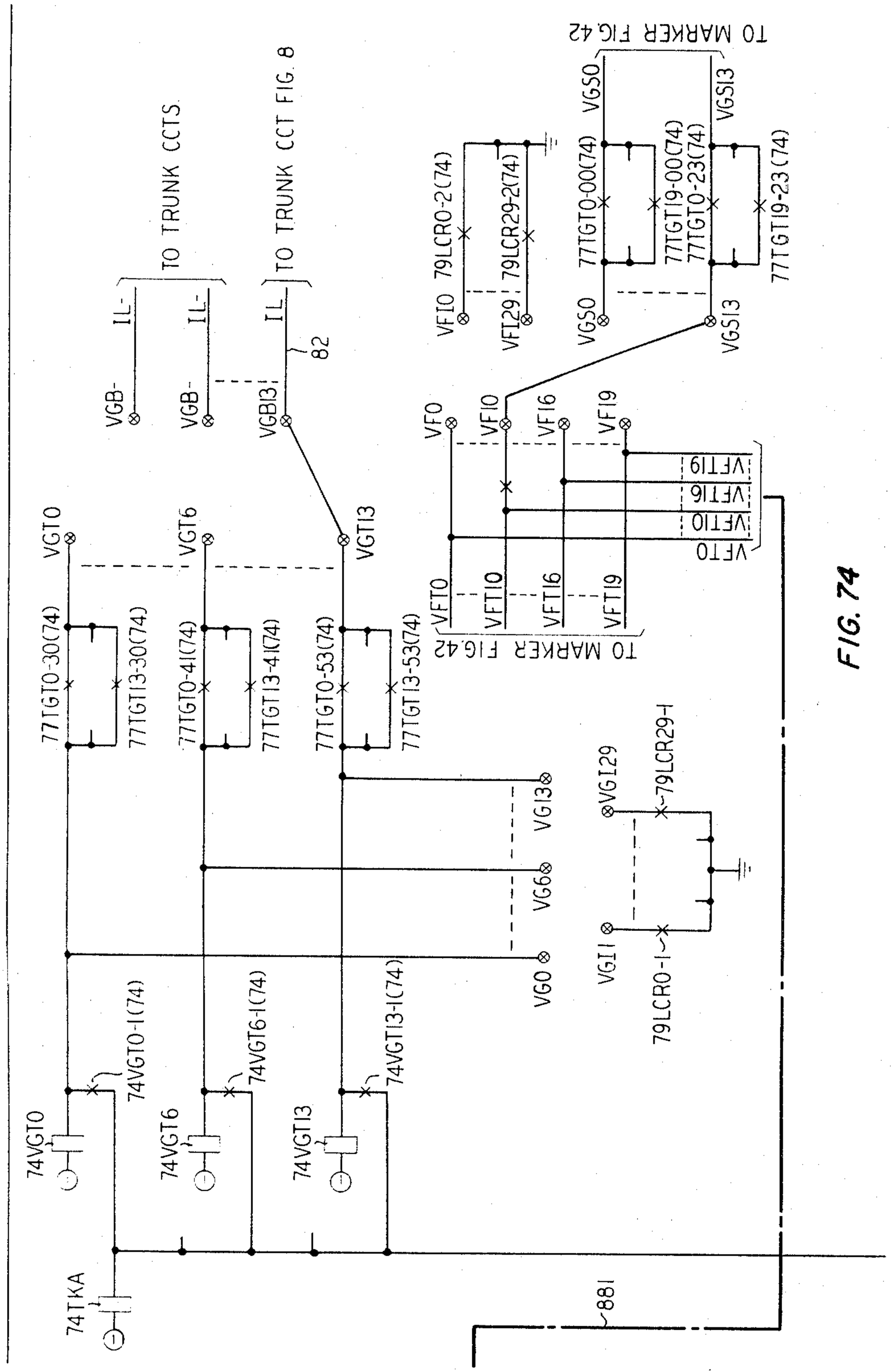


FIG. 74

FIG. 75

FIG. 76

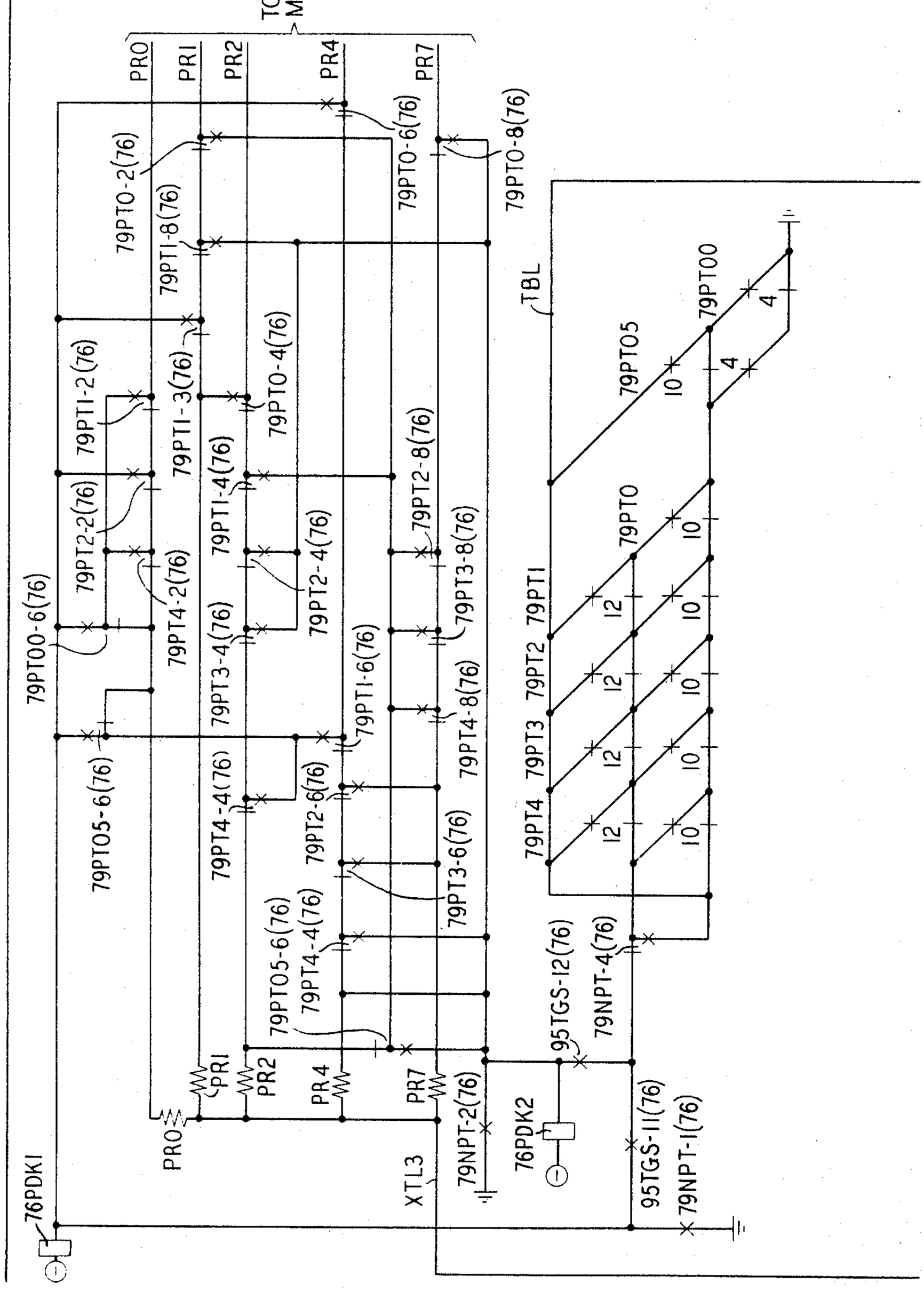

TO DECODER MKR. CONN. FIG. 50
PR0
PR1
PR2
PR4
PR7
79PTO-2(76)
79PTO-6(76)
79PTO-8(76)
79PTI-8(76)
79PTI-2(76)
79PTI-3(76)
79PTO-4(76)
79PTI-4(76)
79PTI-6(76)
79PT2-8(76)
79PT2-2(76)
79PT4-2(76)
79PT3-4(76)
79PT2-4(76)
79PT3-8(76)
79PTO0-6(76)
79PTO5-6(76)
79PT4-4(76)
79PT2-6(76)
79PT4-8(76)
79PT3-6(76)
TBL
79PTO5
10
79PTO0
4
4
79PT4
79PT3
79PT2
79PT1
79PTO
12
12
12
12
10
10
10
10
95TGS-12(76)
79NPT-4(76)
PR0
PR1
PR2
PR4
PR7
XTL3
79NPT-2(76)
76PDK2
95TGS-11(76)
79NPT-1(76)
76PDK1

FIG. 77

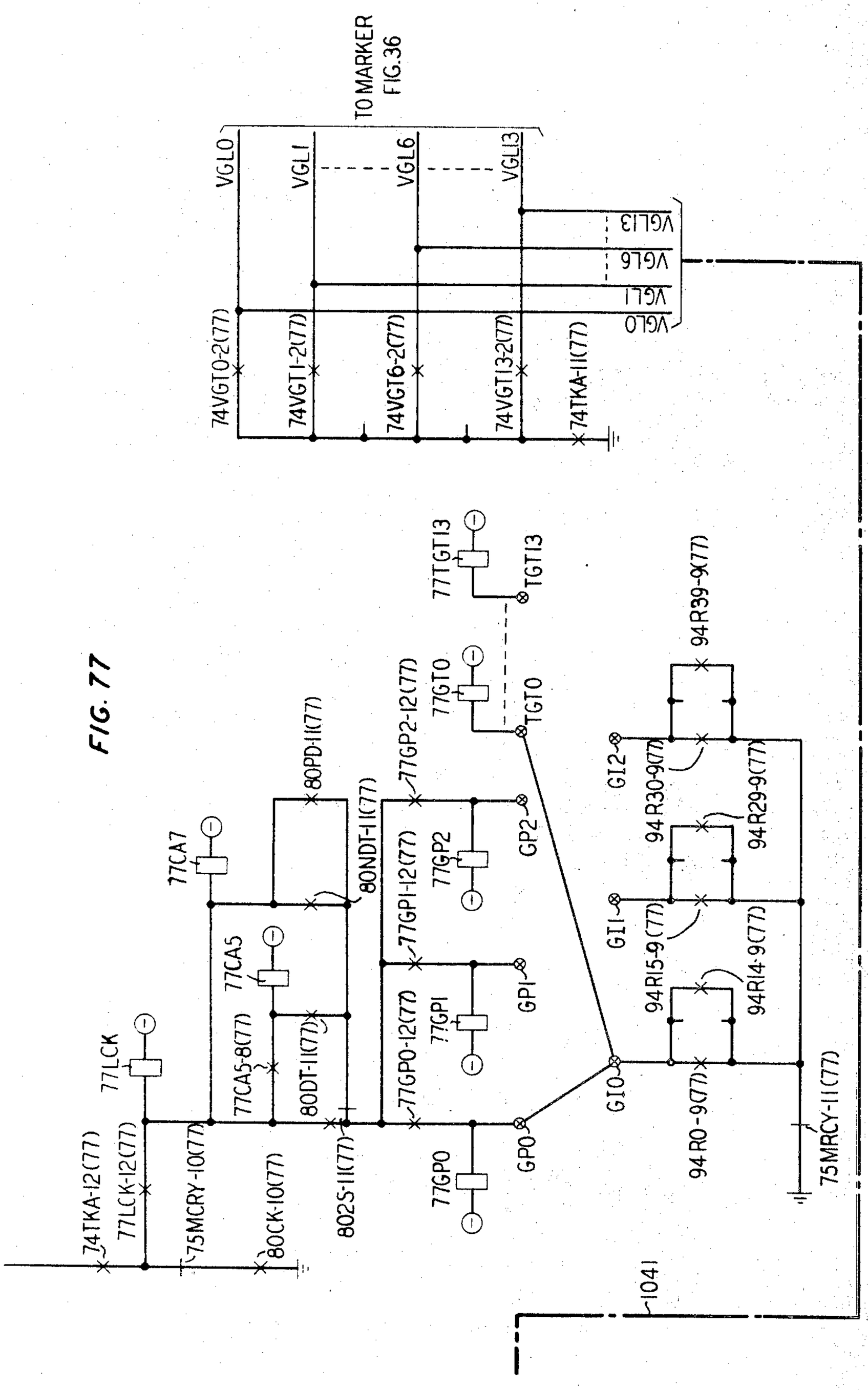
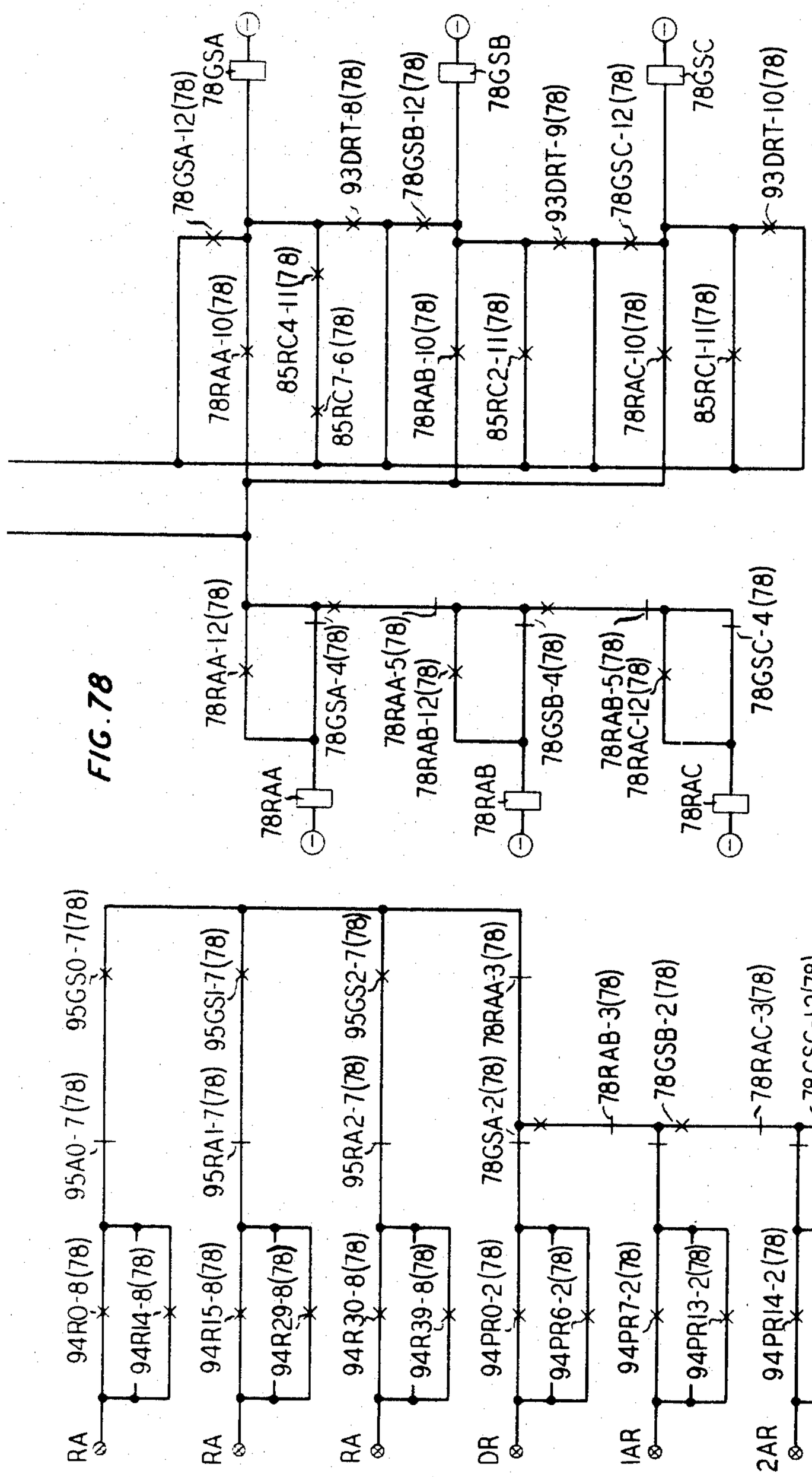

74TKA-12(77)
77LCK
77LCK-12(77)
75MCRY-10(77)
80CK-10(77)
80OS-11(77)
77CA7
77CA5
77CA5-8(77)
80DT-11(77)
80PD-11(77)
80NDT-11(77)
77GP0-12(77)
77GP1-12(77)
77GP2-12(77)
77GP0
77GP1
77GP2
77GT0
GP0
GP1
GP2
TGT0
GI0
GI1
GI2
94R0-9(77)
94R15-9(77)
94R14-9(77)
94R30-9(77)
94R29-9(77)
75MRCY-11(77)
1041
74VGT0-2(77)
74VGT1-2(77)
74VGT6-2(77)
74VGT13-2(77)
74TKA-11(77)
VGL0
VGL1
VGL6
VGL13
77TGT13
TGT13
TO MARKER FIG.36

FIG. 78


78RAA
78RAB
78RAC
RA
DR
IAR
2AR
OFL
OFR
95A0-7(78)
95GS0-7(78)
95RA1-7(78)
95GS1-7(78)
95RA2-7(78)
95GS2-7(78)
78GSA-2(78)
78RAA-3(78)
78RAB-3(78)
78GSB-2(78)
78RAC-3(78)
78GSC-12(78)
780FL
94R0-8(78)
94R14-8(78)
94R15-8(78)
94R29-8(78)
94R30-8(78)
94R39-8(78)
94PR0-2(78)
94PR6-2(78)
94PR7-2(78)
94PR13-2(78)
94PR14-2(78)
94PR19-2(78)
94PRB-1(78)
780FL-2(78)
78RAA-12(78)
78GSA-4(78)
78RAA-5(78)
78RAB-12(78)
78GSB-4(78)
78RAB-5(78)
78RAC-12(78)
78GSC-4(78)
78GSA-12(78)
78RAA-10(78)
85RC4-11(78)
85RC7-6(78)
93DRT-8(78)
78GSB-12(78)
78RAB-10(78)
85RC2-11(78)
93DRT-9(78)
78GSC-12(78)
78RAC-10(78)
85RC1-11(78)
93DRT-10(78)

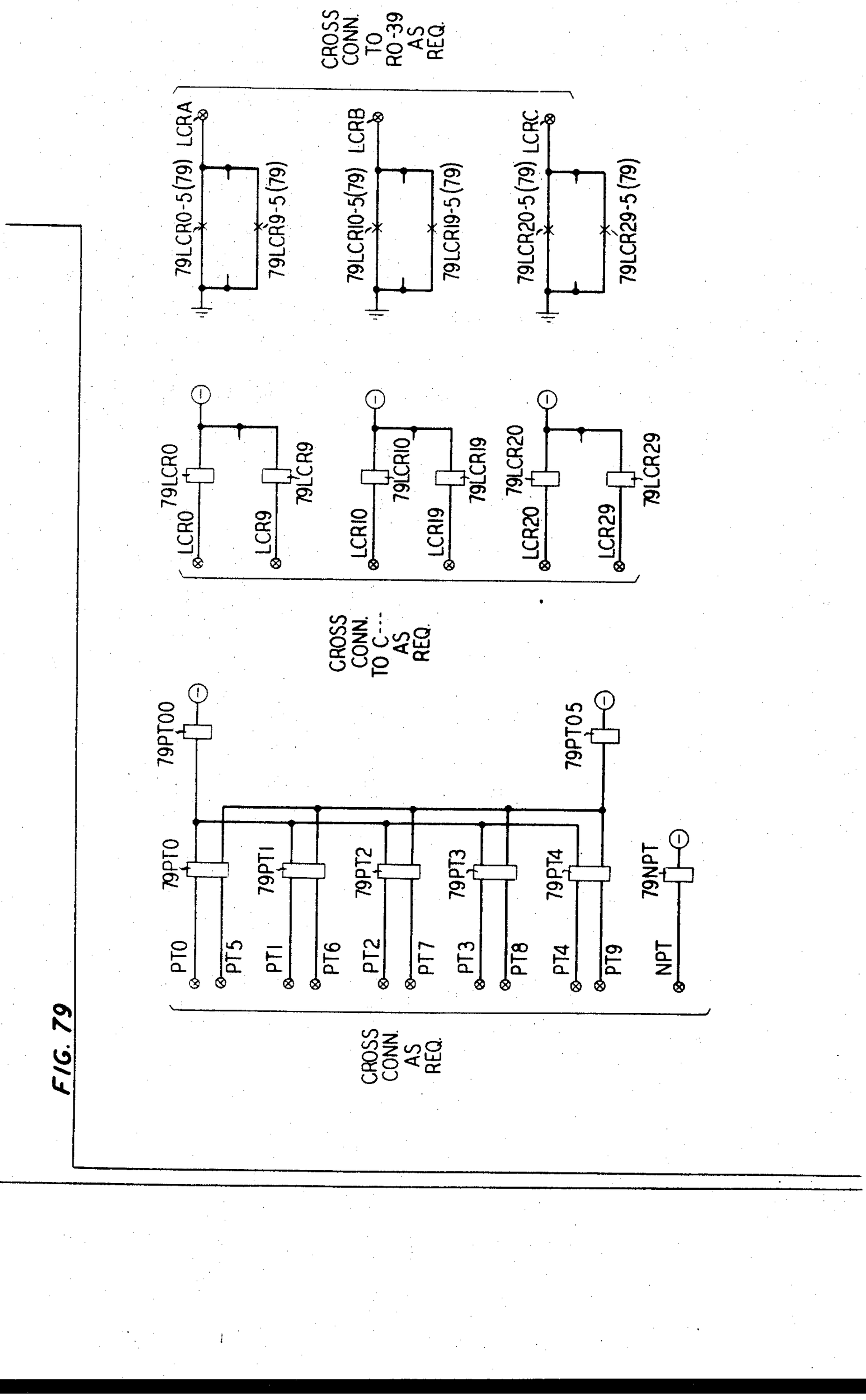

CROSS CONN. TO RO-39 AS REQ.
79LCR0-5(79) LCRA
79LCR9-5(79)
79LCR10-5(79) LCRB
79LCR19-5(79)
79LCR20-5(79) LCRC
79LCR29-5(79)
79LCR0
LCR0
LCR9
79LCR9
79LCR10
LCR10
LCR19
79LCR19
79LCR20
LCR20
LCR29
79LCR29
CROSS CONN. TO C--- AS REQ.
79PT00
79PT05
79PT0
79PT1
79PT2
79PT3
79PT4
79NPT
PT0
PT5
PT1
PT6
PT2
PT7
PT3
PT8
PT4
PT9
NPT
CROSS CONN. AS REQ.

FIG. 79

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TELEPHONE SYSTEM

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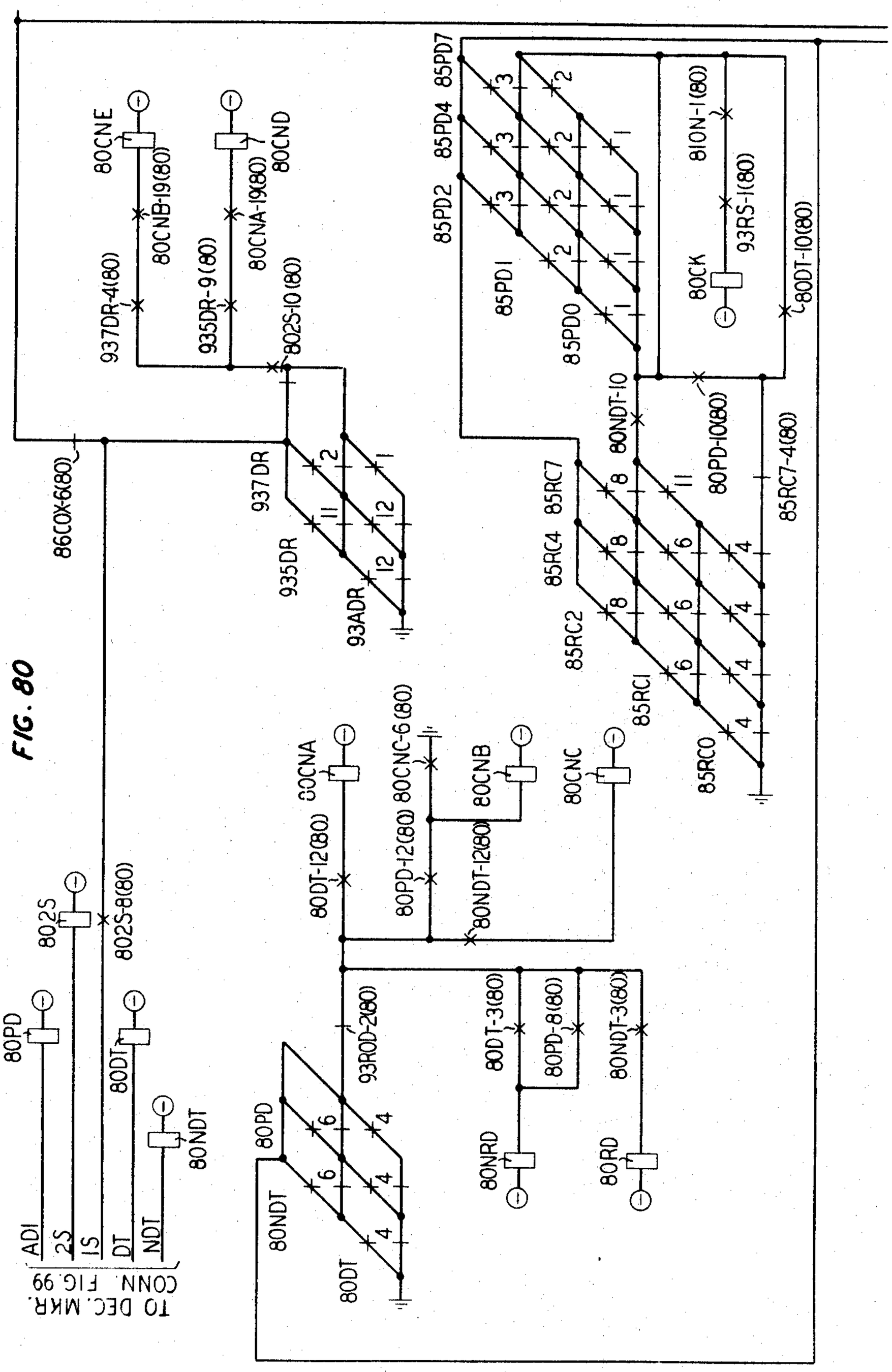
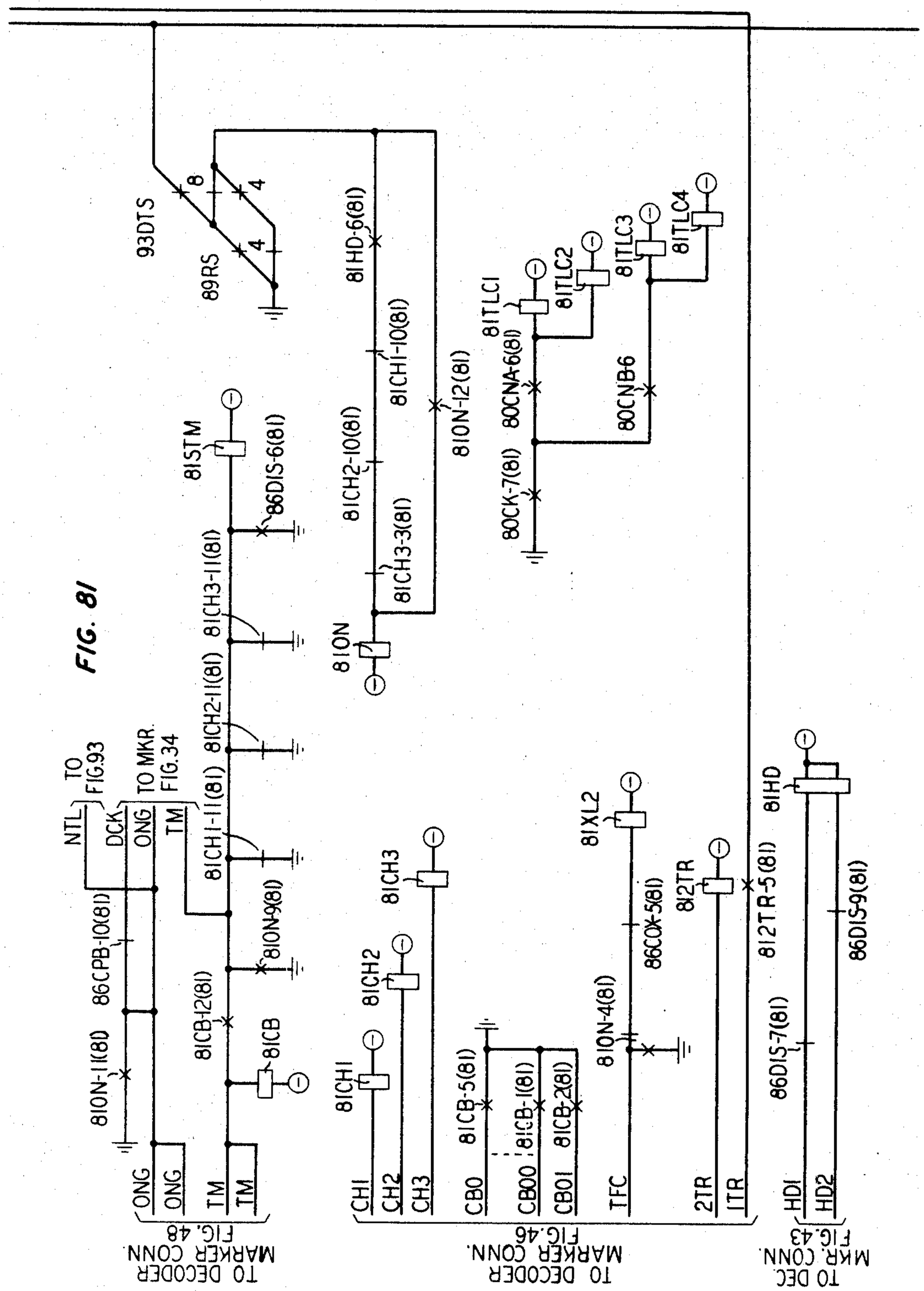


FIG. 80

FIG. 81


93DTS
8
4
4
89RS
81HD-6(81)
81CH1-10(81)
81ON-12(81)
81CH2-10(81)
81CH3-3(81)
81ON
81STM
86DIS-6(81)
81CH3-11(81)
81CH2-11(81)
81ITLC1
80CNA-6(81)
80CK-7(81)
81ITLC2
81ITLC3
80CNB-6
81ITLC4
NTL
DCK
ONG
TM
TO FIG.93
TO MKR. FIG.34
86CPB-10(81)
81ON-11(81)
81CH1-11(81)
81CH2-11(81)
81ON-9(81)
81CB-12(81)
81CB
81CH1
81CH2
81CH3
81CB-5(81)
81CB-1(81)
81CB-2(81)
81XL2
81ON-4(81)
86COX-5(81)
812TR
812TR-5(81)
81HD
86DIS-7(81)
86DIS-9(81)
ONG
ONG
TM
TM
TO DECODER MARKER CONN. FIG. 48
CH1
CH2
CH3
CB0
81CB00
81CB01
TFC
2TR
1TR
TO DECODER MARKER CONN. FIG. 46
HD1
HD2
TO DEC. MKR. CONN. FIG. 43

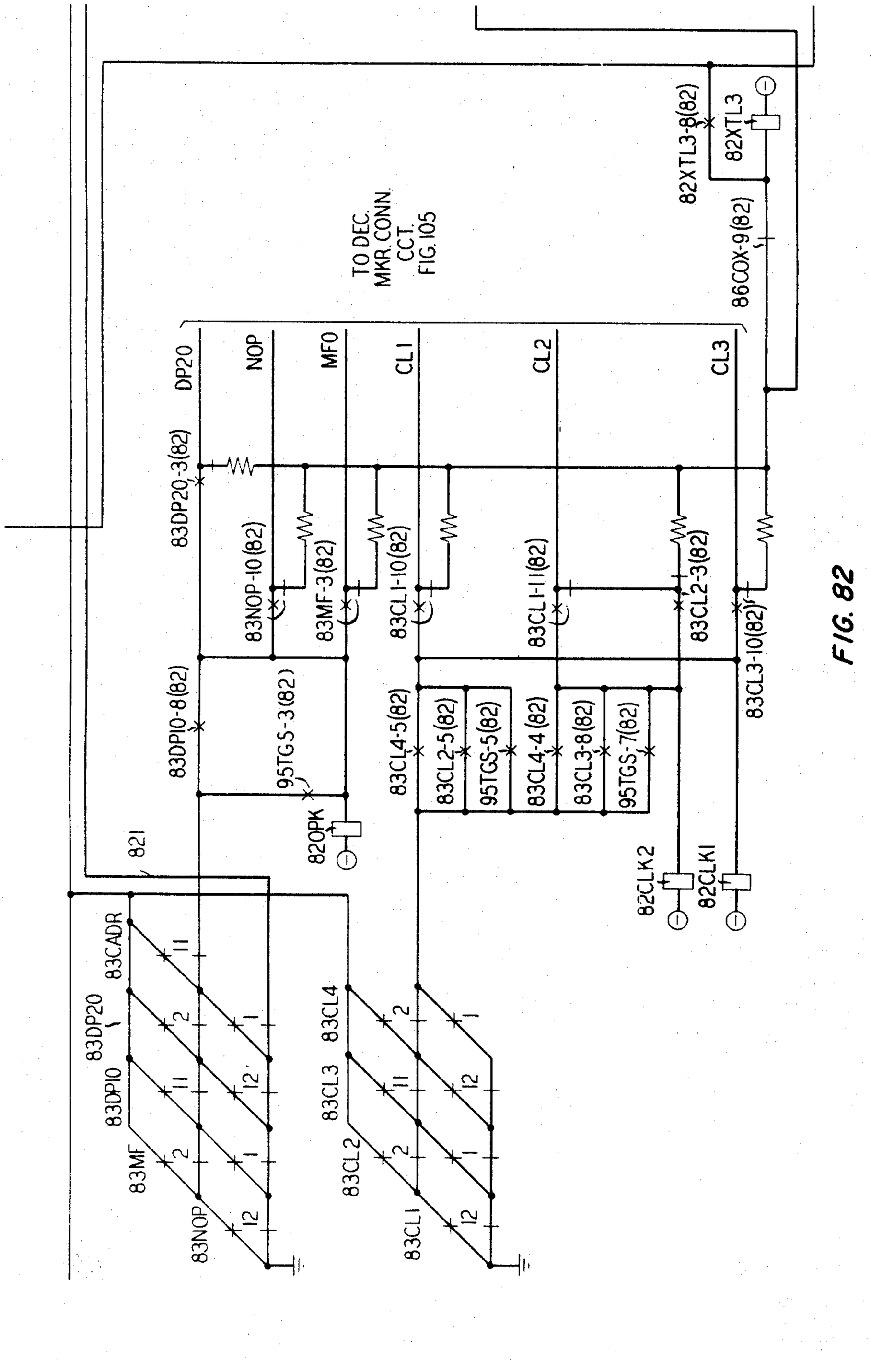

82XTL3-8(82)
82XTL3
86COX-9(82)
TO DEC. MKR. CONN. CCT. FIG. 105
DP20
NOP
MFO
CL1
CL2
CL3
83DP20-3(82)
83NOP-10(82)
83MF-3(82)
83CL1-10(82)
83CL1-11(82)
83CL2-3(82)
83CL3-10(82)
83DP10-8(82)
95TGS-3(82)
820PK
821
83CL4-5(82)
83CL2-5(82)
95TGS-5(82)
83CL4-4(82)
83CL3-8(82)
95TGS-7(82)
82CLK2
82CLK1
83CL3-11(82)
83DP20
83CADR
83DP10
83MF
83NOP
83CL4
83CL3
83CL2
83CL1
11
12
1
2

FIG. 82

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TELEPHONE SYSTEM

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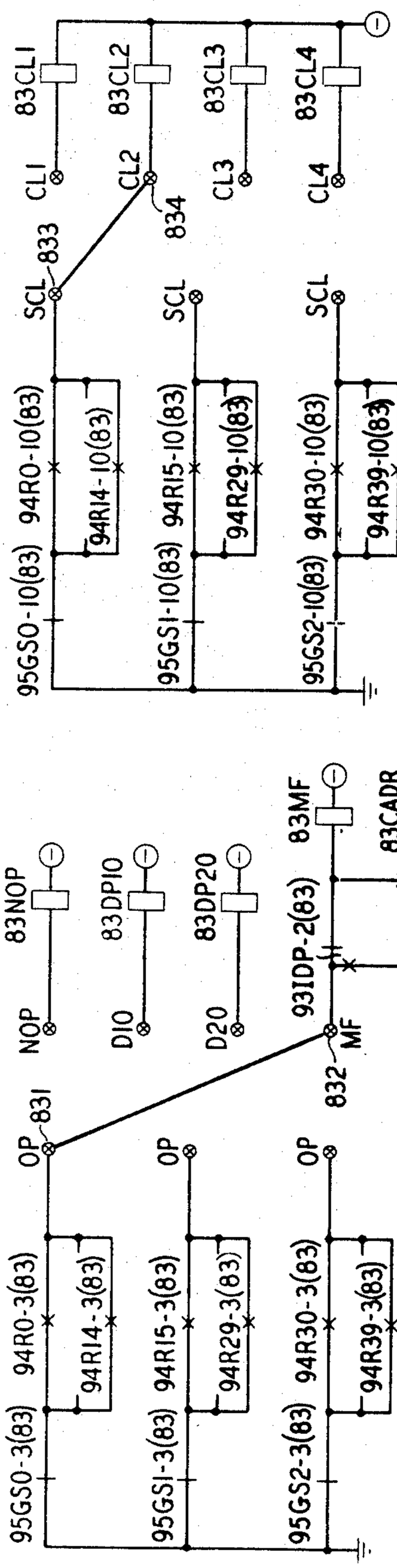
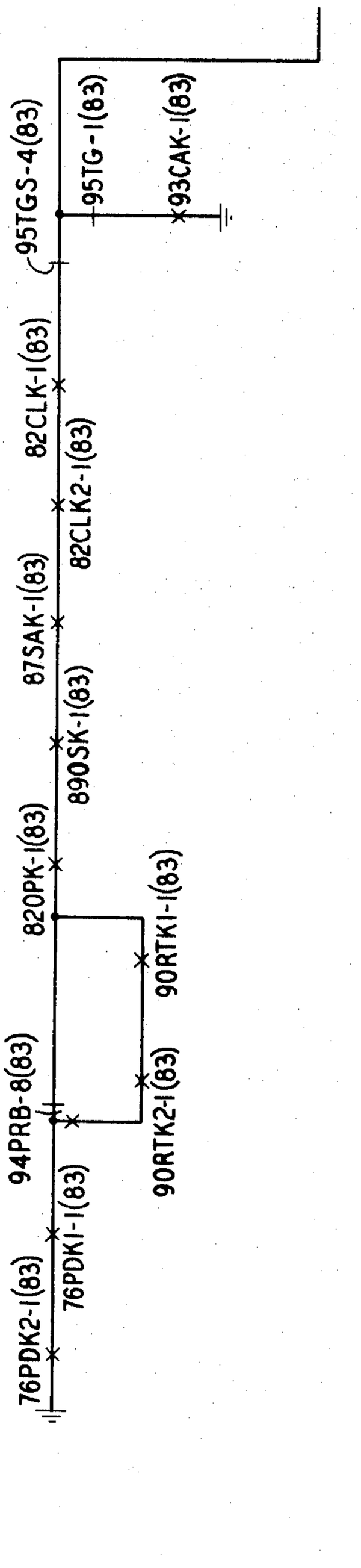
FIG. 83





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TELEPHONE SYSTEM

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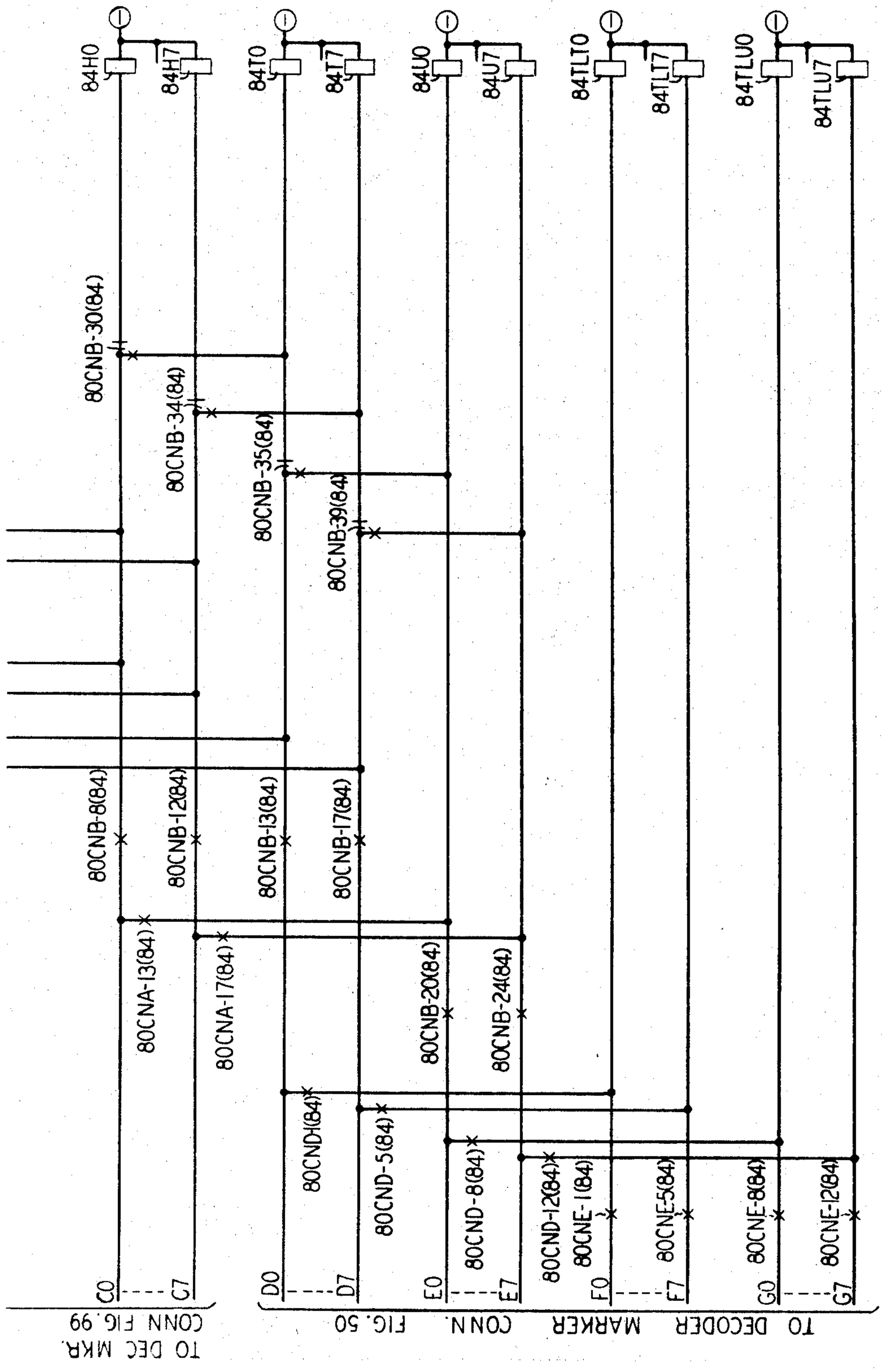

FIG. 84

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TELEPHONE SYSTEM

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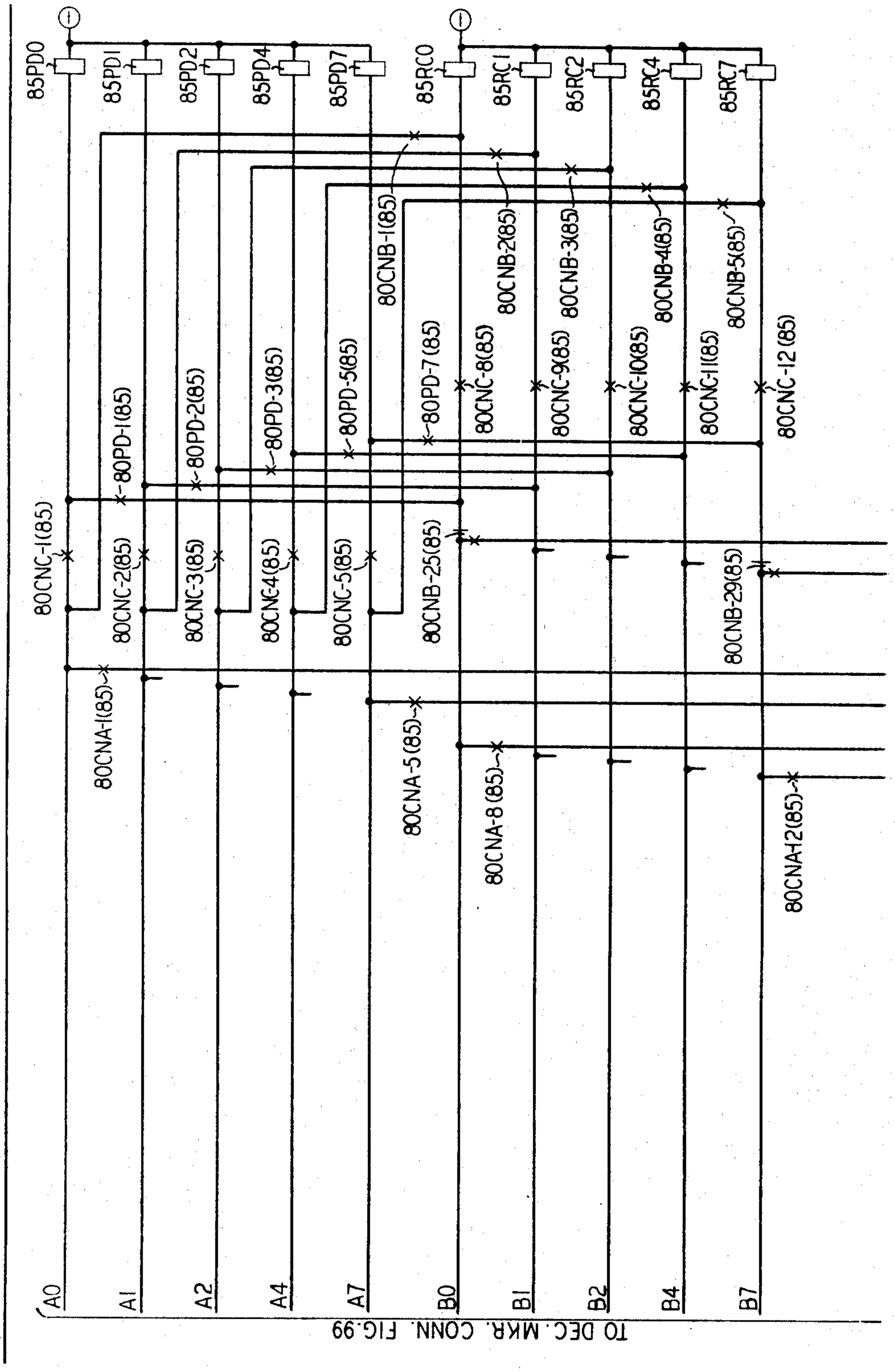
FIG. 85



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TELEPHONE SYSTEM

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FIG. 86

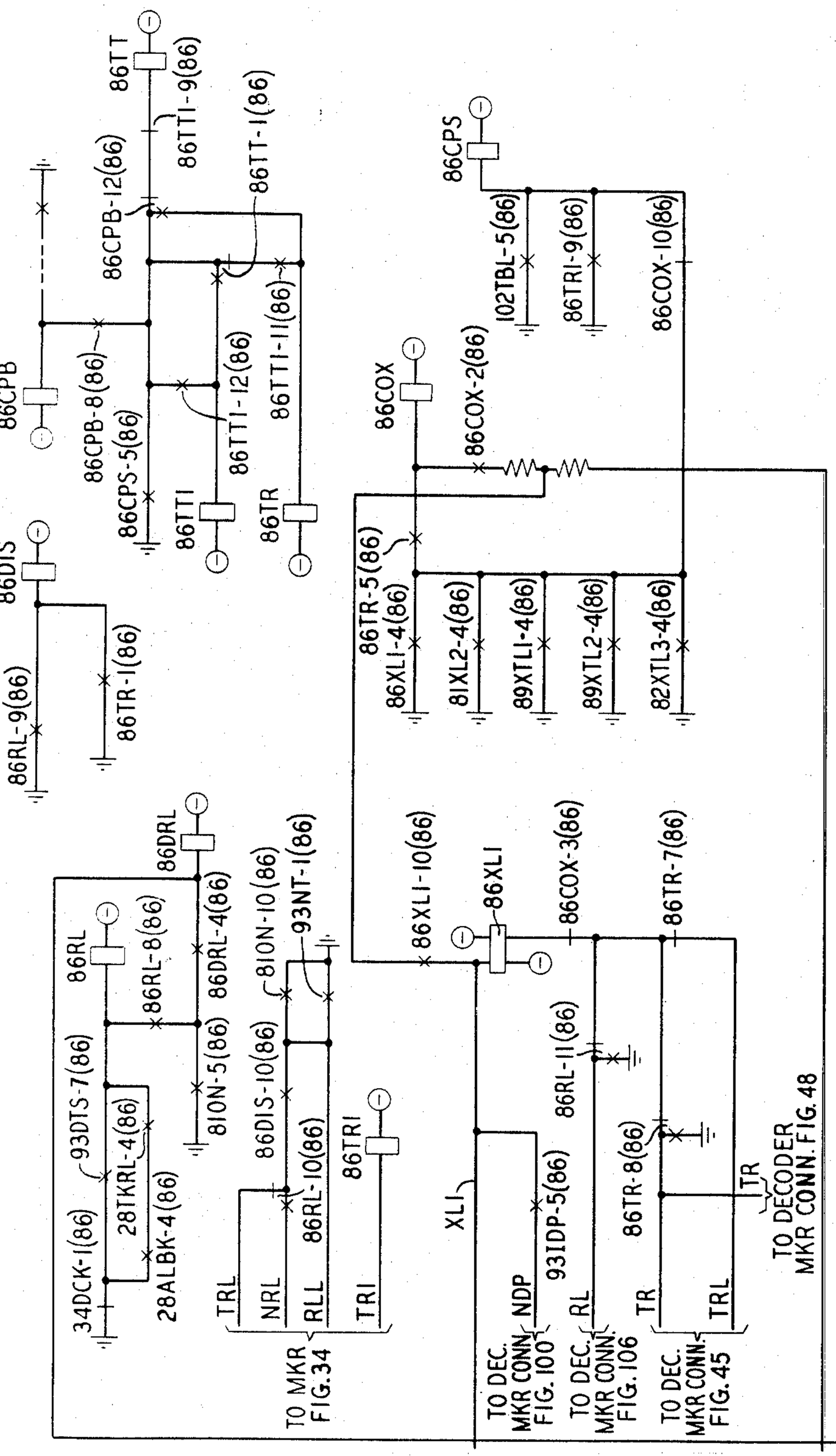
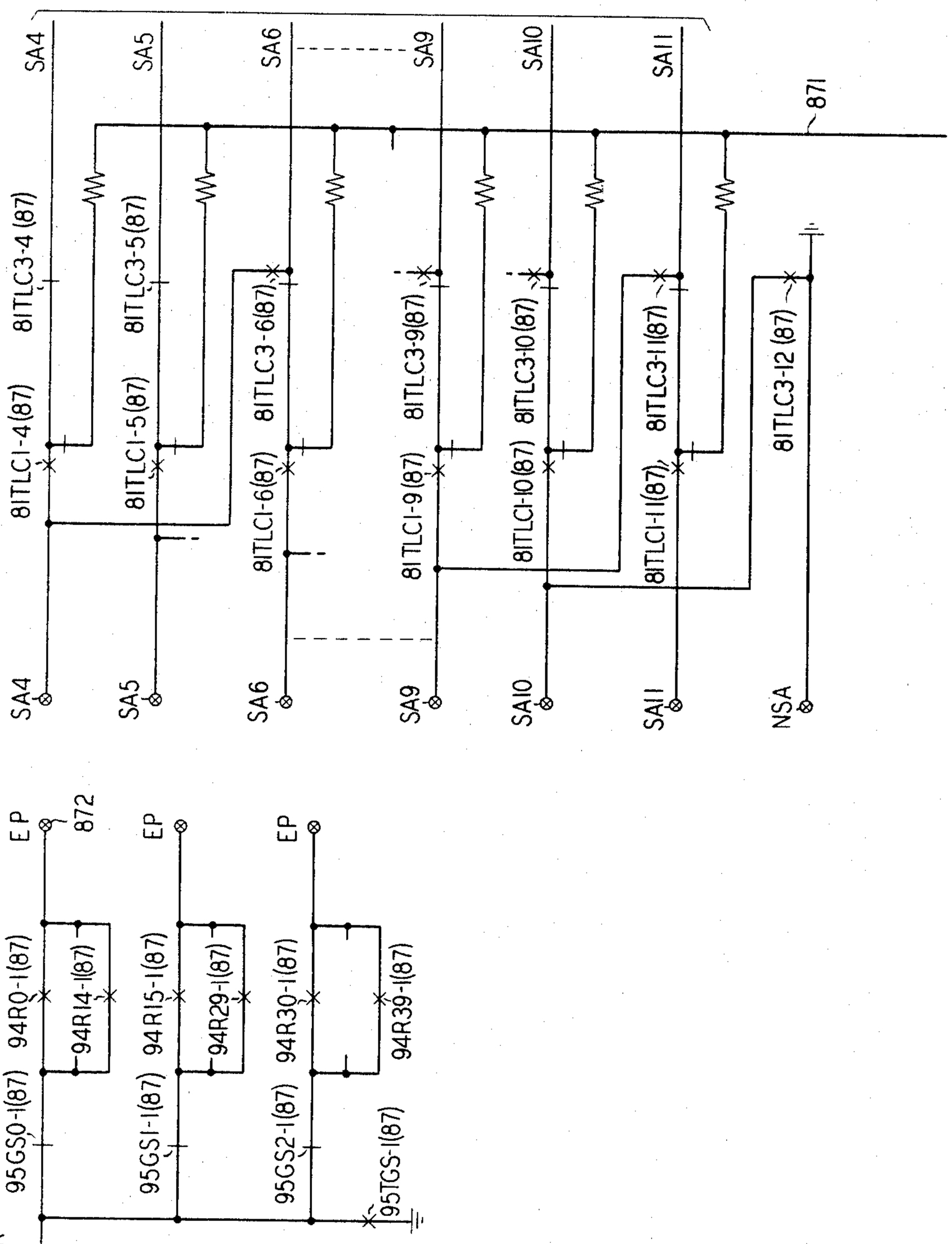


FIG. 87


TO DEC. MKR. CONN. CCT. FIG. 105
SA4
SA5
SA6
SA9
SA10
SA11
871
8ITLC3-4 (87)
8ITLC3-5(87)
8ITLC3-6(87)
8ITLC3-9(87)
8ITLC3-10 (87)
8ITLC3-11(87)
8ITLC3-12 (87)
8ITLC1-4(87)
8ITLC1-5(87)
8ITLC1-6(87)
8ITLC1-9 (87)
8ITLC1-10(87)
8ITLC1-11(87)
SA4
SA5
SA6
SA9
SA10
SA11
NSA
EP
872
94R0-1(87)
94R14-1(87)
94R15-1(87)
94R29-1(87)
94R30-1(87)
94R39-1(87)
95GS0-1(87)
95GS1-1(87)
95GS2-1(87)
95TGS-1(87)
87SAK

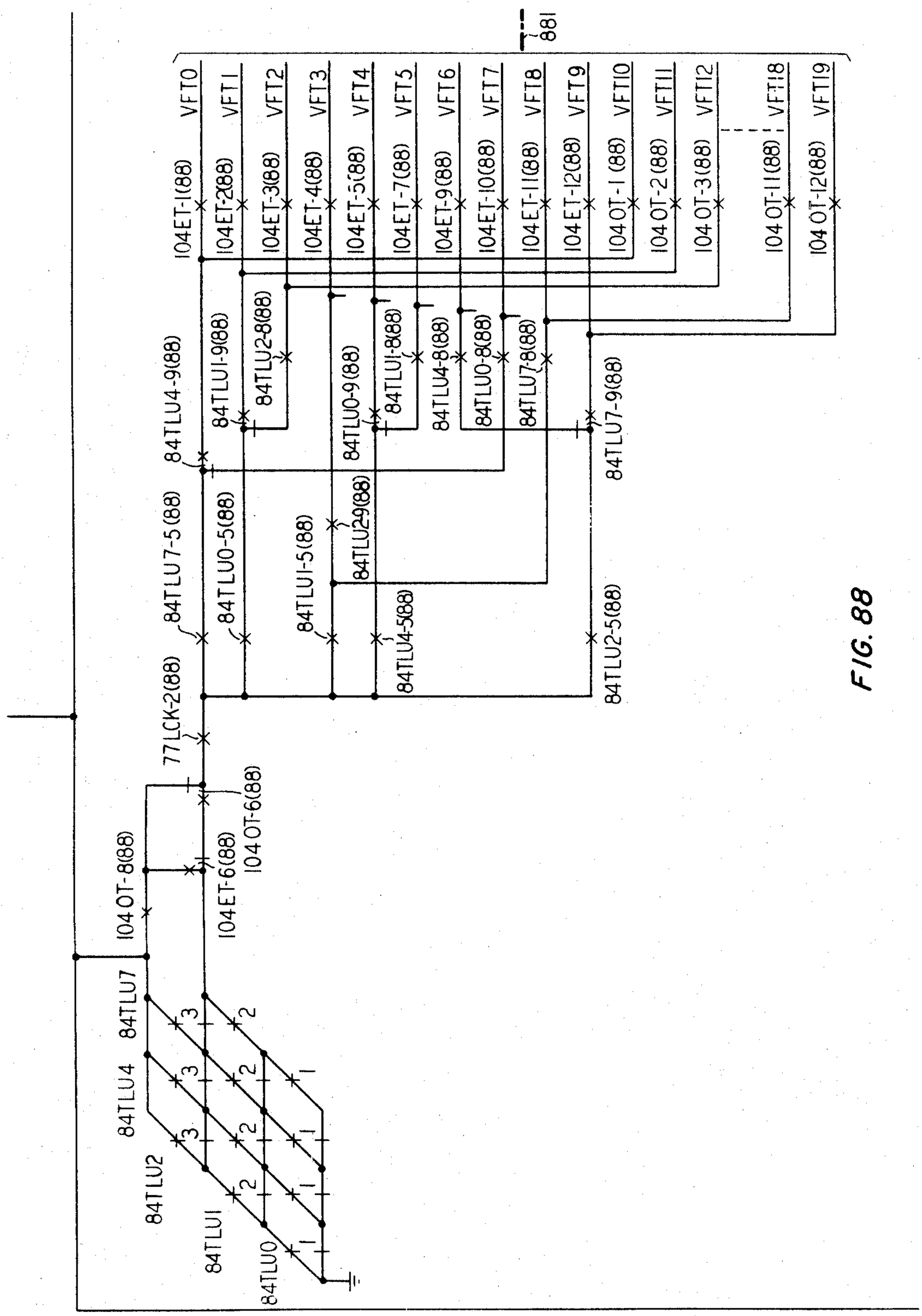
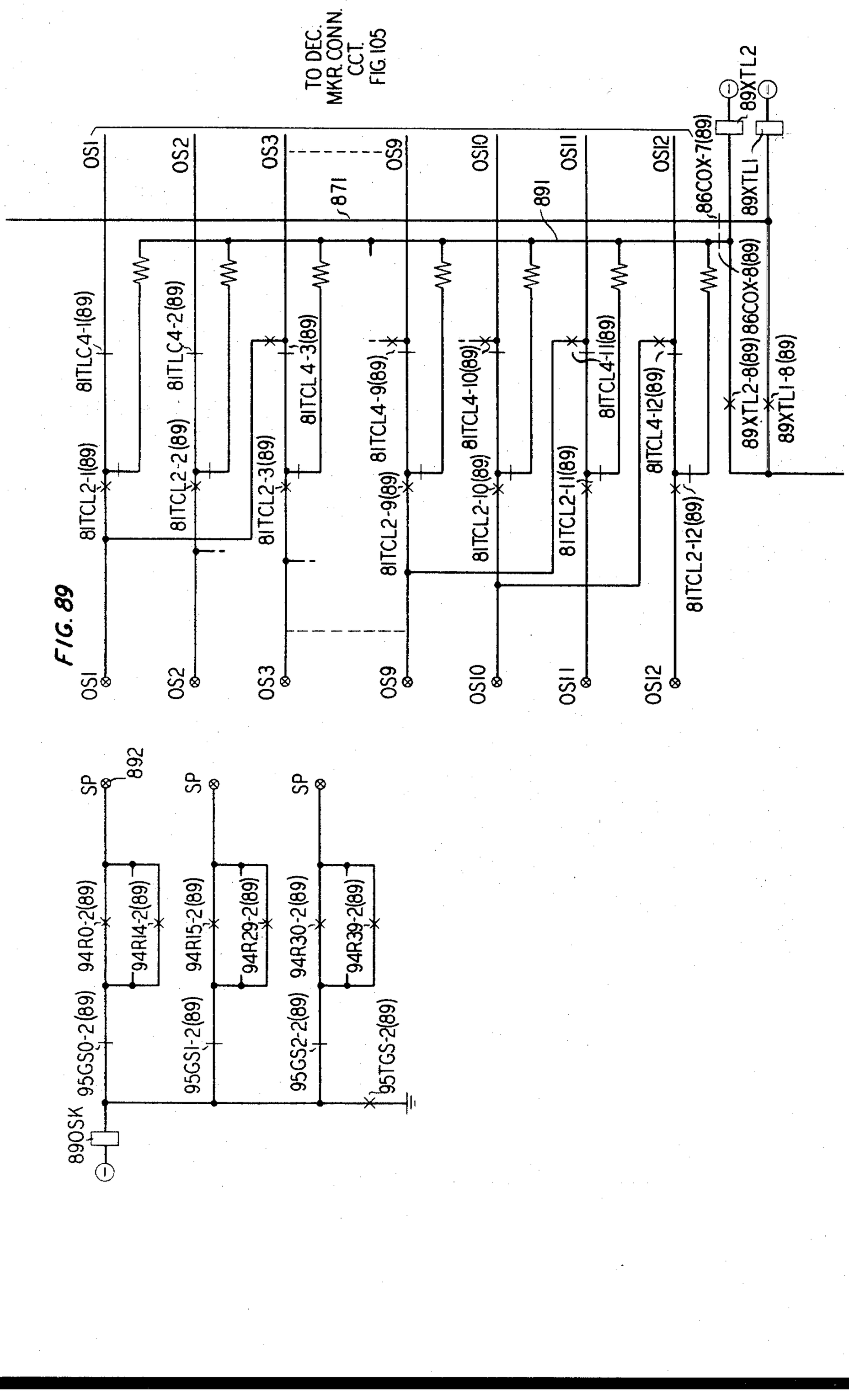

881
VFT0
VFT1
VFT2
VFT3
VFT4
VFT5
VFT6
VFT7
VFT8
VFT9
VFT10
VFT11
VFT12
VFT18
VFT19
104ET-1(88)
104ET-2(88)
104ET-3(88)
104ET-4(88)
104ET-5(88)
104ET-7(88)
104ET-9(88)
104ET-10(88)
104ET-11(88)
104ET-12(88)
104OT-1 (88)
104OT-2(88)
104OT-3(88)
104OT-11(88)
104OT-12(88)
84TLU4-9(88)
84TLU1-9(88)
84TLU2-8(88)
84TLU0-9(88)
84TLU1-8(88)
84TLU4-8(88)
84TLU0-8(88)
84TLU7-8(88)
84TLU7-5(88)
84TLU0-5(88)
84TLU1-5(88)
84TLU29(88)
84TLU4-5(88)
84TLU2-5(88)
84TLU7-9(88)
77LCK-2(
104OT-8(88)
104ET-6(88)
104OT-6(88)
84TLU7
84TLU4
84TLU2
84TLU1
84TLU0
3
2
1

FIG. 88

FIG. 89


TO DEC. MKR. CONN. CCT. FIG. 105
OS1
OS2
OS3
OS9
OS10
OS11
OS12
871
891
86COX-7(89)
89XTL2
89XTL1
8ITLC4-1(89)
8ITLC4-2(89)
8ITLC4-3(89)
8ITLC4-9(89)
8ITLC4-10(89)
8ITLC4-11(89)
8ITLC4-12(89)
8ITCL2-1(89)
8ITCL2-2(89)
8ITCL2-3(89)
8ITCL2-9(89)
8ITCL2-10(89)
8ITCL2-11(89)
8ITCL2-12(89)
89XTL2-8(89)
86COX-8(89)
89XTL1-8(89)
SP
892
94RO-2(89)
94RI4-2(89)
94RI5-2(89)
94R29-2(89)
94R30-2(89)
94R39-2(89)
89OSK
95GS0-2(89)
95GS1-2(89)
95GS2-2(89)
95TGS-2(89)

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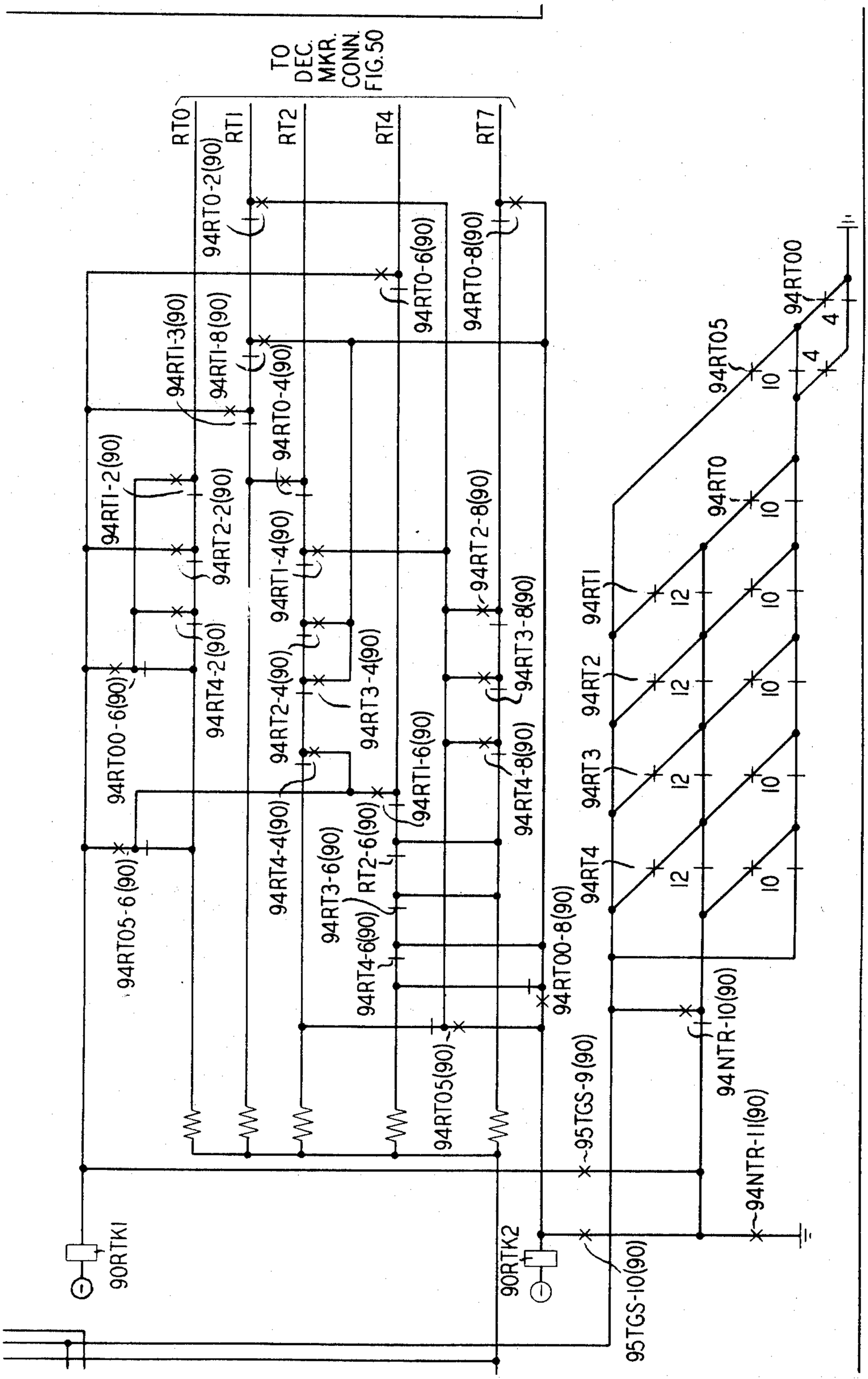


FIG. 90

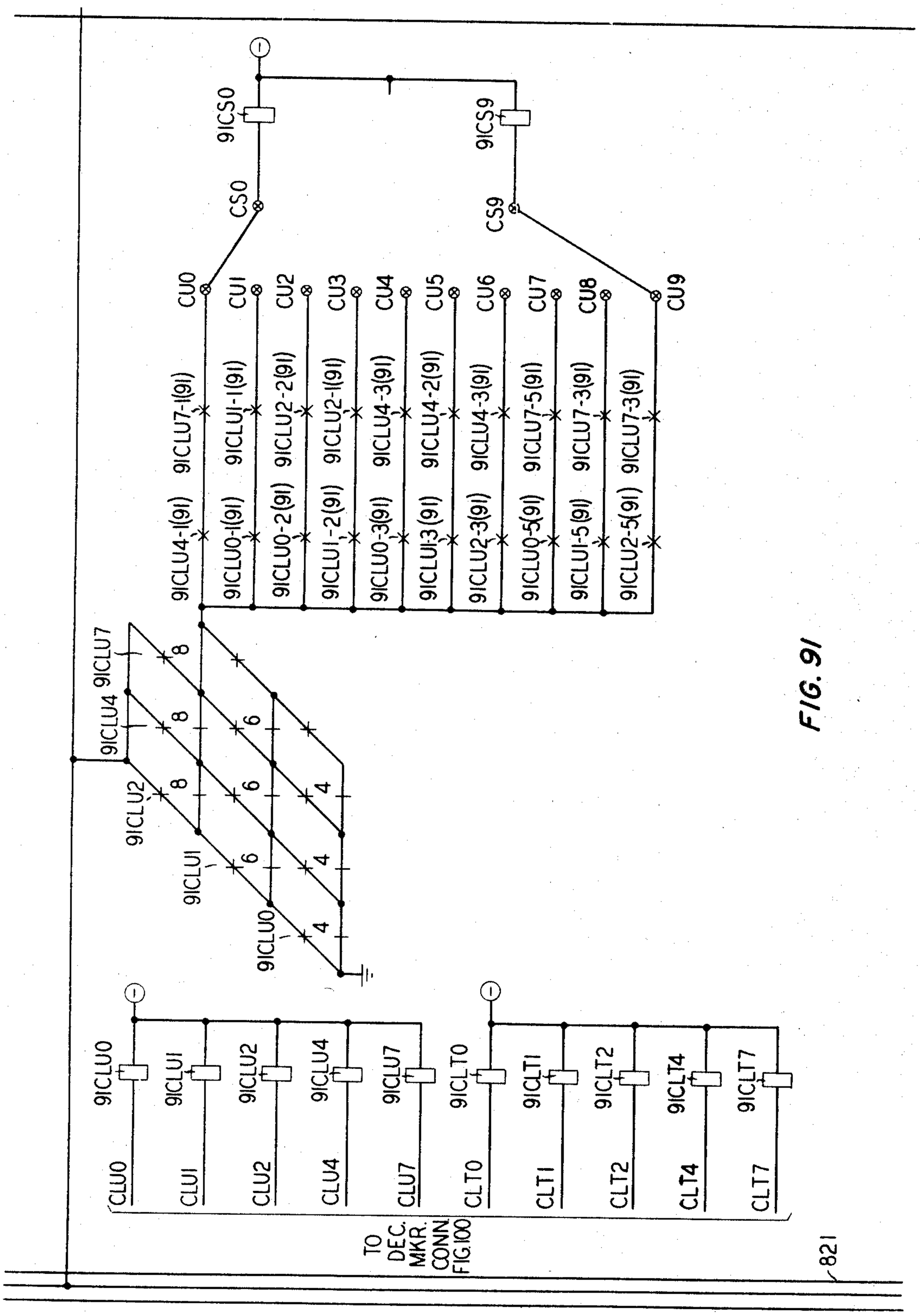
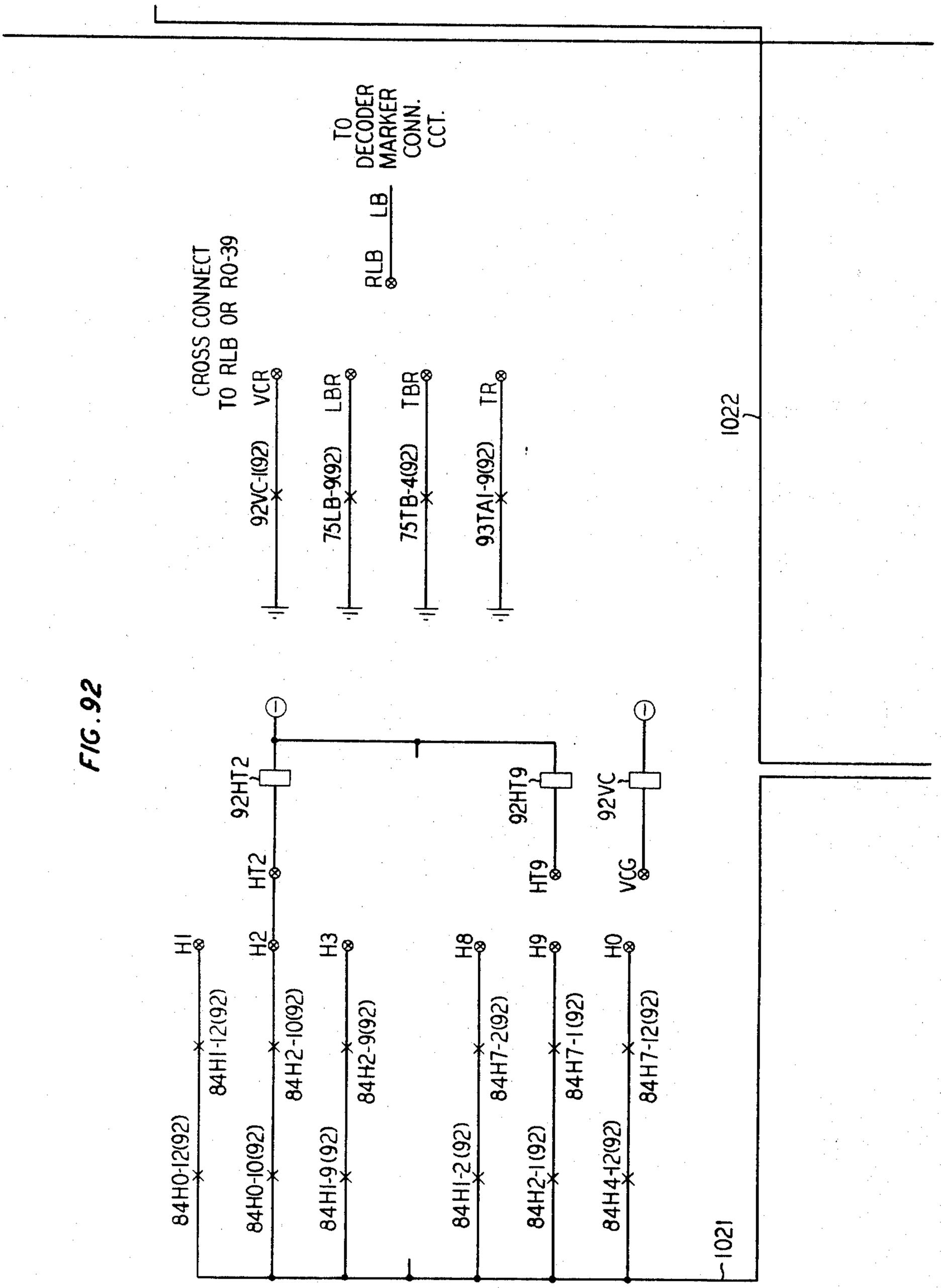

91CS0
91CS9
CS0
CS9
CU0
CU1
CU2
CU3
CU4
CU5
CU6
CU7
CU8
CU9
91CLU4-1(91)
91CLU7-1(91)
91CLU0-1(91)
91CLU1-1(91)
91CLU0-2(91)
91CLU2-2(91)
91CLU1-2(91)
91CLU2-1(91)
91CLU0-3(91)
91CLU4-3(91)
91CLU1-3(91)
91CLU4-2(91)
91CLU2-3(91)
91CLU4-3(91)
91CLU0-5(91)
91CLU7-5(91)
91CLU1-5(91)
91CLU7-3(91)
91CLU2-5(91)
91CLU7-3(91)
91CLU7
91CLU4
91CLU2
91CLU1
91CLU0
8
6
4
91CLU0
91CLU1
91CLU2
91CLU4
91CLU7
91CLT0
91CLT1
91CLT2
91CLT4
91CLT7
CLU0
CLU1
CLU2
CLU4
CLU7
CLT0
CLT1
CLT2
CLT4
CLT7
TO DEC. MKR. CONN FIG 100
821

FIG. 91

FIG. 92


TO DECODER MARKER CONN. CCT.
CROSS CONNECT TO RLB OR RO-39
RLB
LB
92VC-1(92)
VCR
75LB-9(92)
LBR
75TB-4(92)
TBR
93TA1-9(92)
TR
1022
92HT2
92HT9
92VC
H1
H2
H3
H8
H9
H0
HT2
HT9
VCG
84H1-12(92)
84H2-10(92)
84H2-9(92)
84H7-2(92)
84H7-1(92)
84H7-12(92)
84H0-12(92)
84H0-10(92)
84H1-9(92)
84H1-2(92)
84H2-1(92)
84H4-12(92)
1021

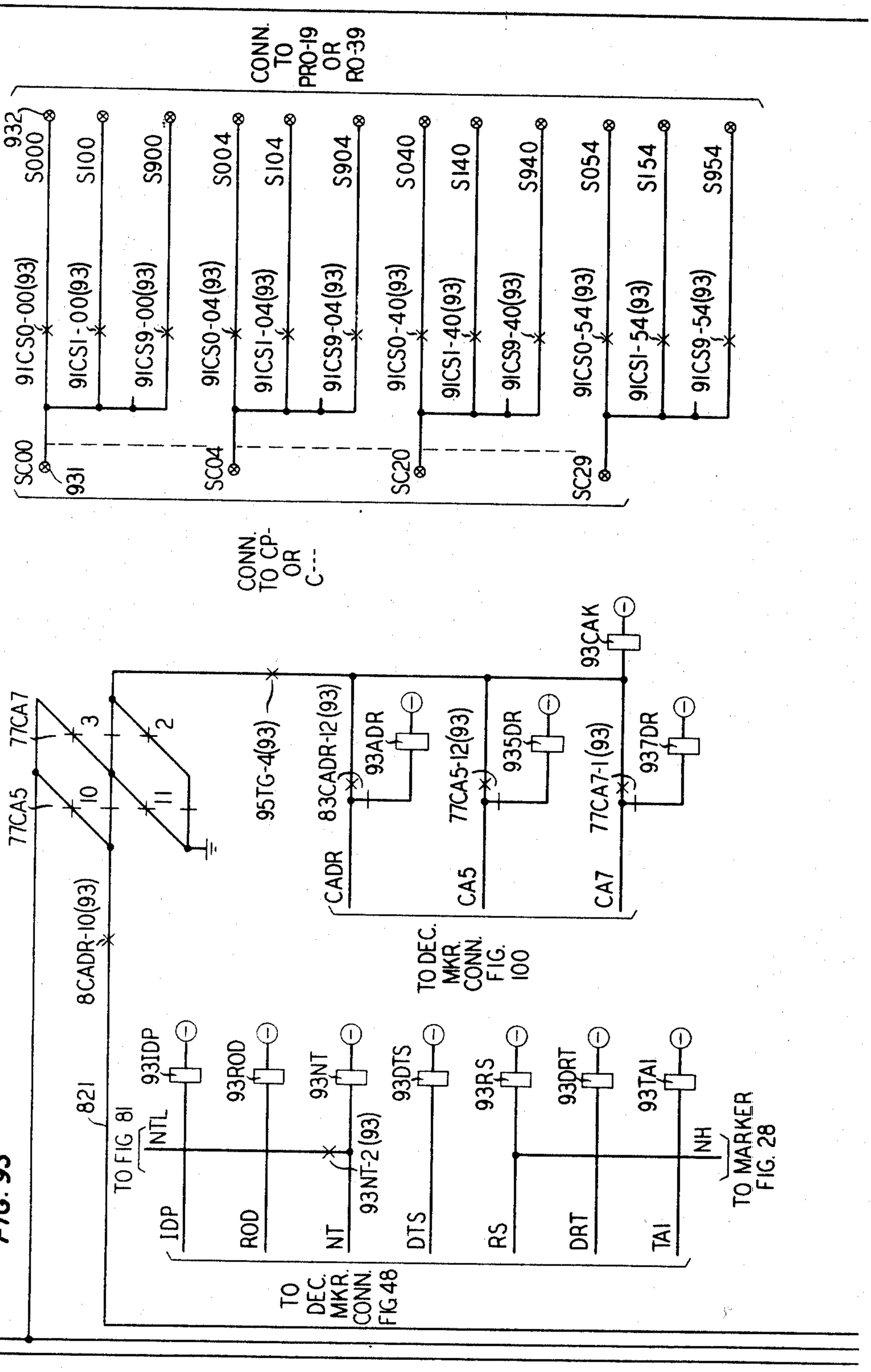

CONN. TO PRO-19 OR RO-39
932
S000
S100
S900
S004
S104
S904
S040
S140
S940
S054
S154
S954
91CS0-00(93)
91CS1-00(93)
91CS9-00(93)
91CS0-04(93)
91CS1-04(93)
91CS9-04(93)
91CS0-40(93)
91CS1-40(93)
91CS9-40(93)
91CS0-54(93)
91CS1-54(93)
91CS9-54(93)
SC00
SC04
SC20
SC29
931
CONN. TO CP- OR C--
77CA7
77CA5
3
2
10
11
95TG-4(93)
8CADR-10(93)
821
TO FIG 81
83CADR-12(93)
93ADR
77CA5-12(93)
935DR
77CA7-1(93)
937DR
93CAK
CADR
CA5
CA7
TO DEC. MKR. CONN. FIG. 100
93IDP
93ROD
93NT
93DTS
93RS
93DRT
93TAI
93NT-2(93)
IDP
ROD
NT
DTS
RS
DRT
TAI
NH
TO MARKER FIG. 28
TO DEC. MKR. CONN. FIG 48

FIG. 93

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FIG. 94

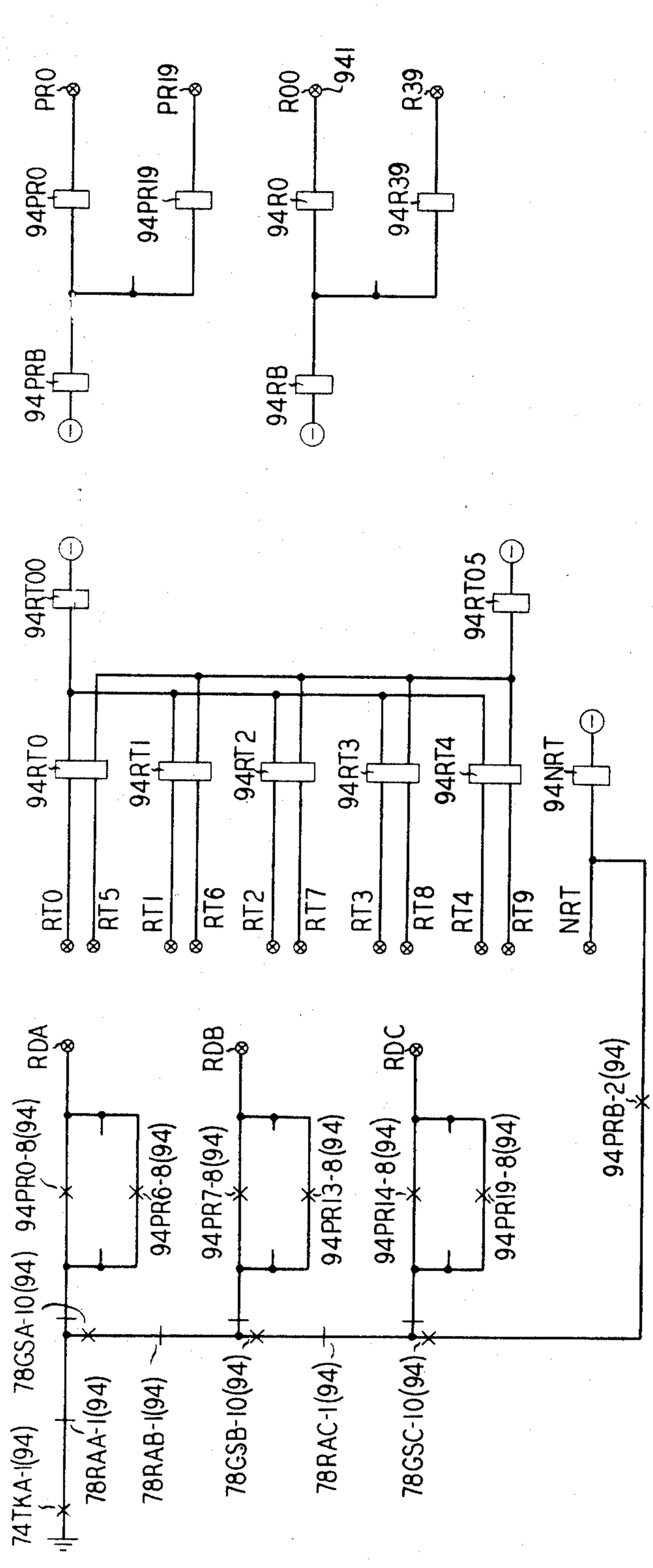

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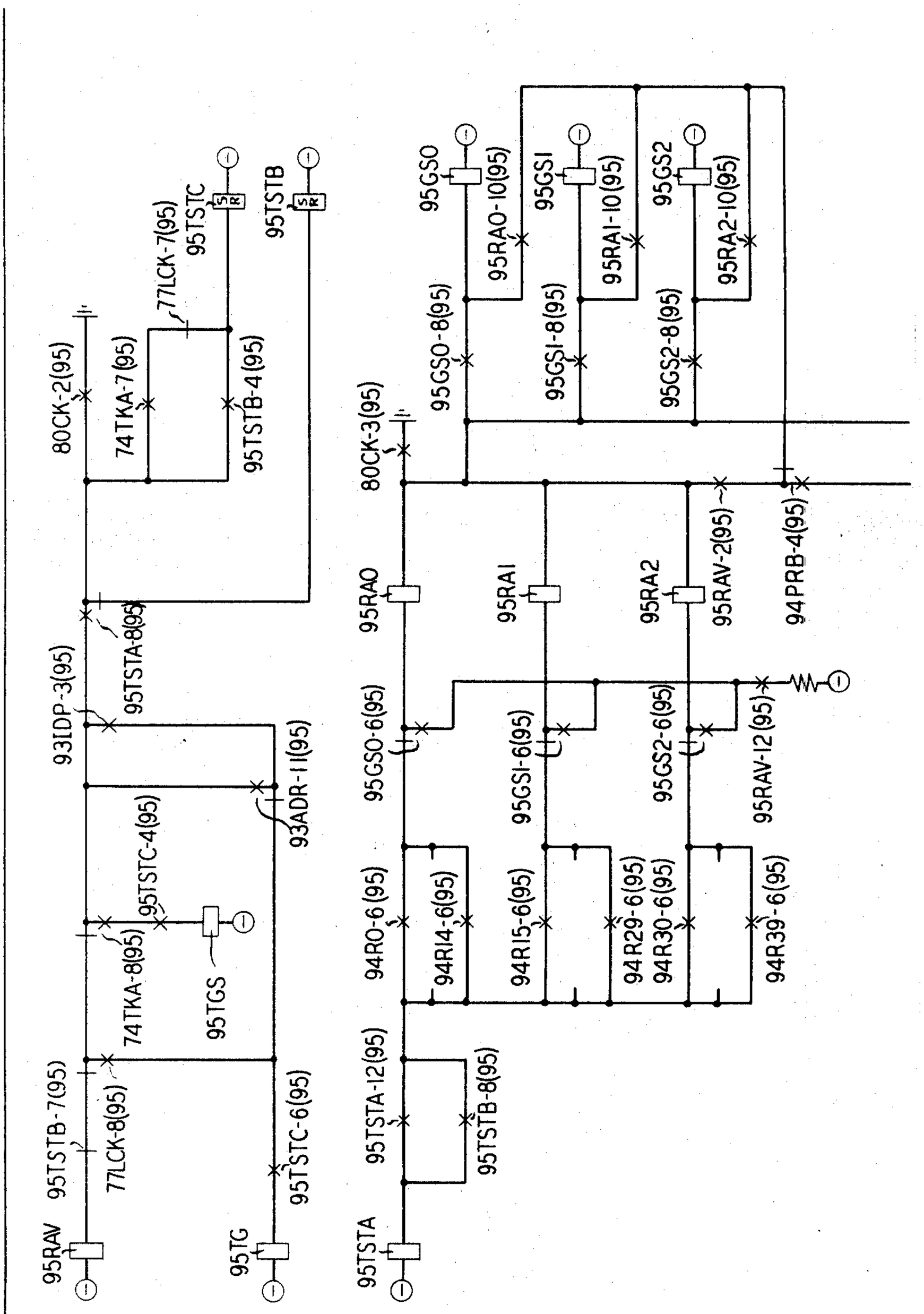
FIG. 95



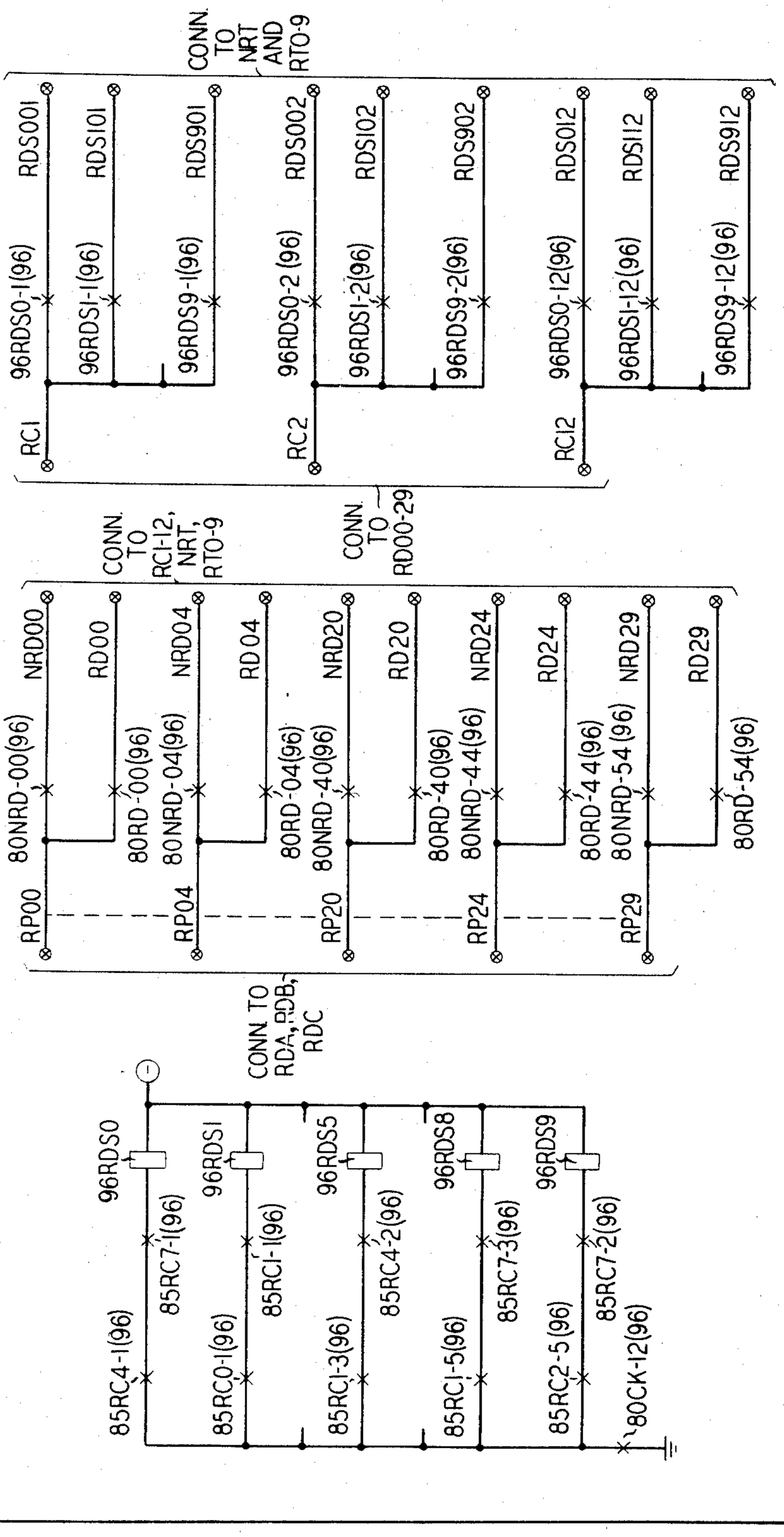

CONN. TO NRT AND RTO-9
RDS001
RDS101
RDS901
RDS002
RDS102
RDS902
RDS012
RDS112
RDS912
96RDS0-1(96)
96RDS1-1(96)
96RDS9-1(96)
96RDS0-2 (96)
96RDS1-2(96)
96RDS9-2(96)
96RDS0-12(96)
96RDS1-12(96)
96RDS9-12(96)
RC1
RC2
RC12
CONN. TO RC1-12, NRT, RTO-9
CONN. TO RD00-29
NRD00
RD00
NRD04
RD04
NRD20
RD20
NRD24
RD24
NRD29
RD29
80NRD-00(96)
80RD-00(96)
80NRD-04(96)
80RD-04(96)
80NRD-40(96)
80RD-40(96)
80NRD-44(96)
80RD-44(96)
80NRD-54(96)
80RD-54(96)
RP00
RP04
RP20
RP24
RP29
CONN TO RDA, RDB, RDC
96RDS0
96RDS1
96RDS5
96RDS8
96RDS9
85RC4-1(96)
85RC7-1(96)
85RC0-1(96)
85RC1-1(96)
85RC1-3(96)
85RC4-2(96)
85RC1-5(96)
85RC7-3(96)
85RC2-5(96)
85RC7-2(96)
80CK-12(96)

FIG. 96

TELEPHONE SYSTEM

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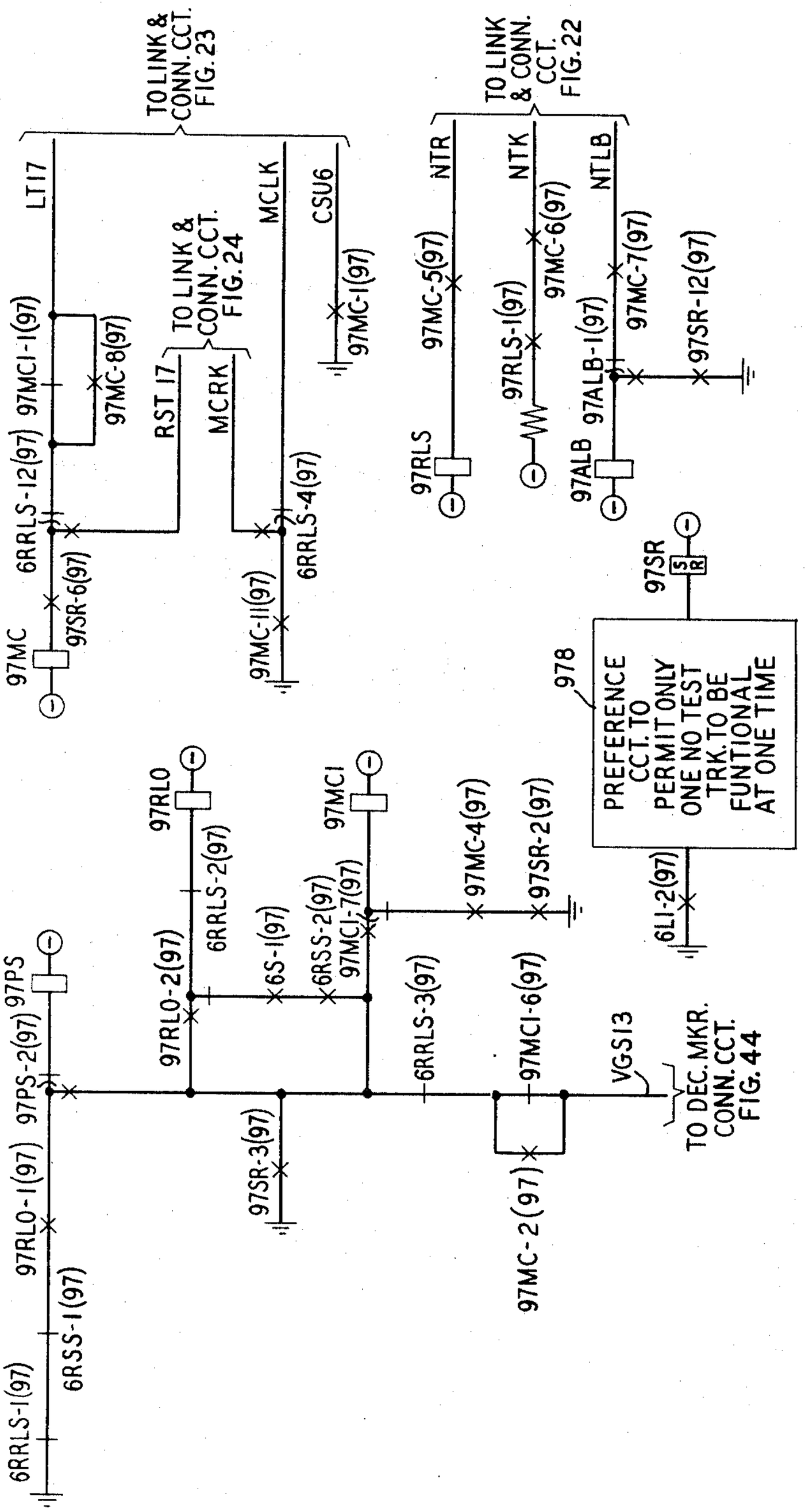

FIG. 97

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TELEPHONE SYSTEM

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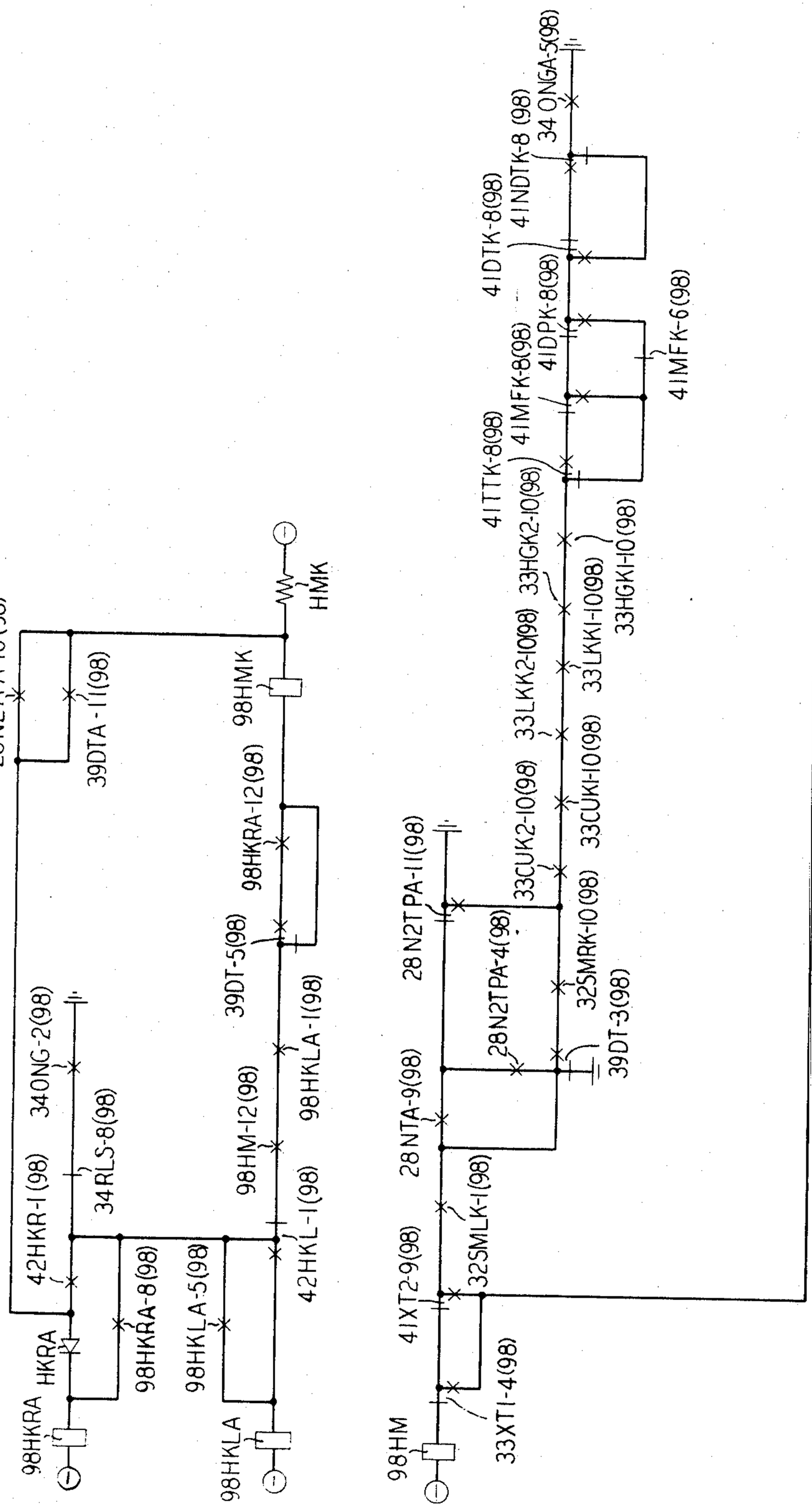

FIG. 99

TELEPHONE SYSTEM

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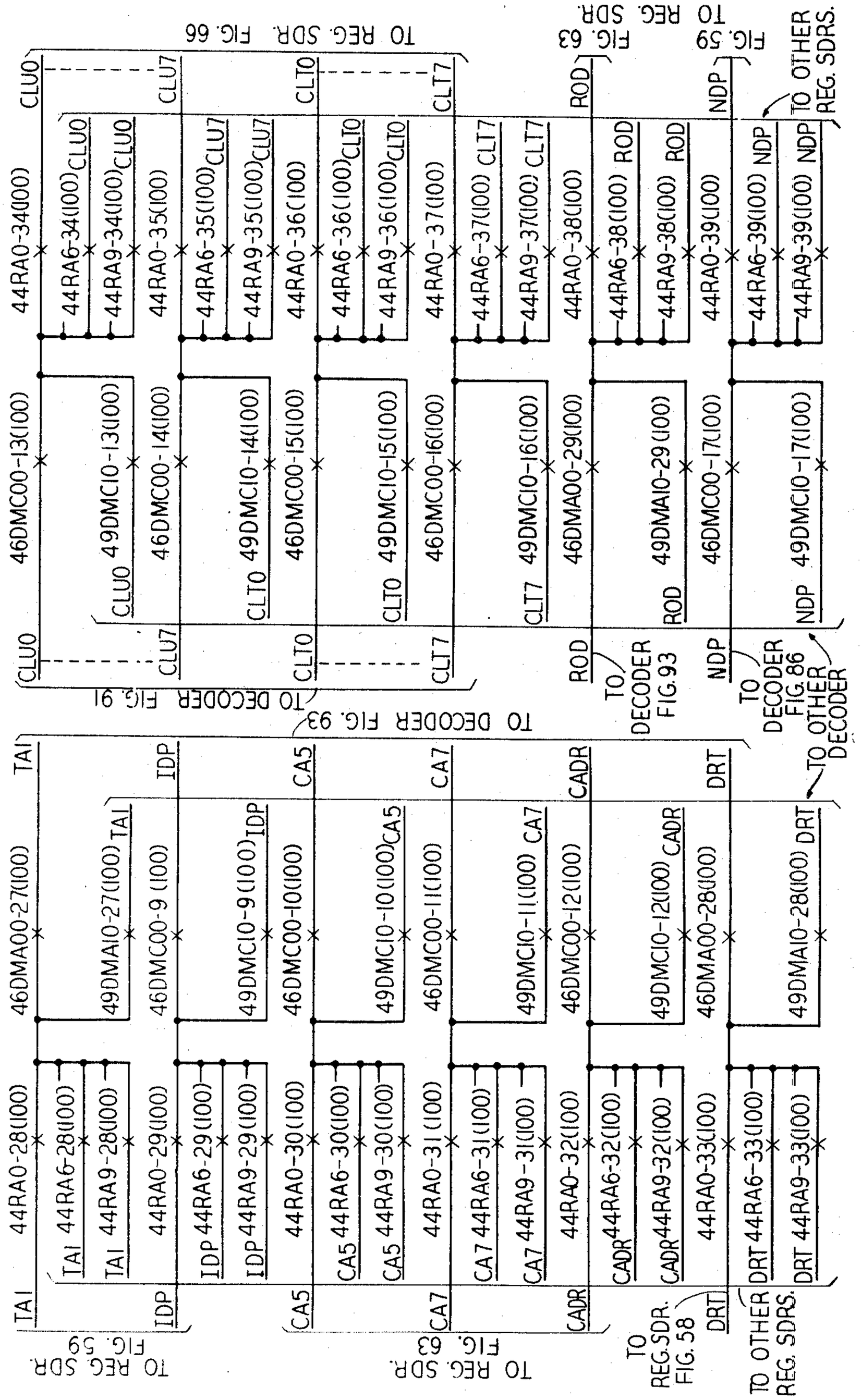
FIG. 100



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TELEPHONE SYSTEM

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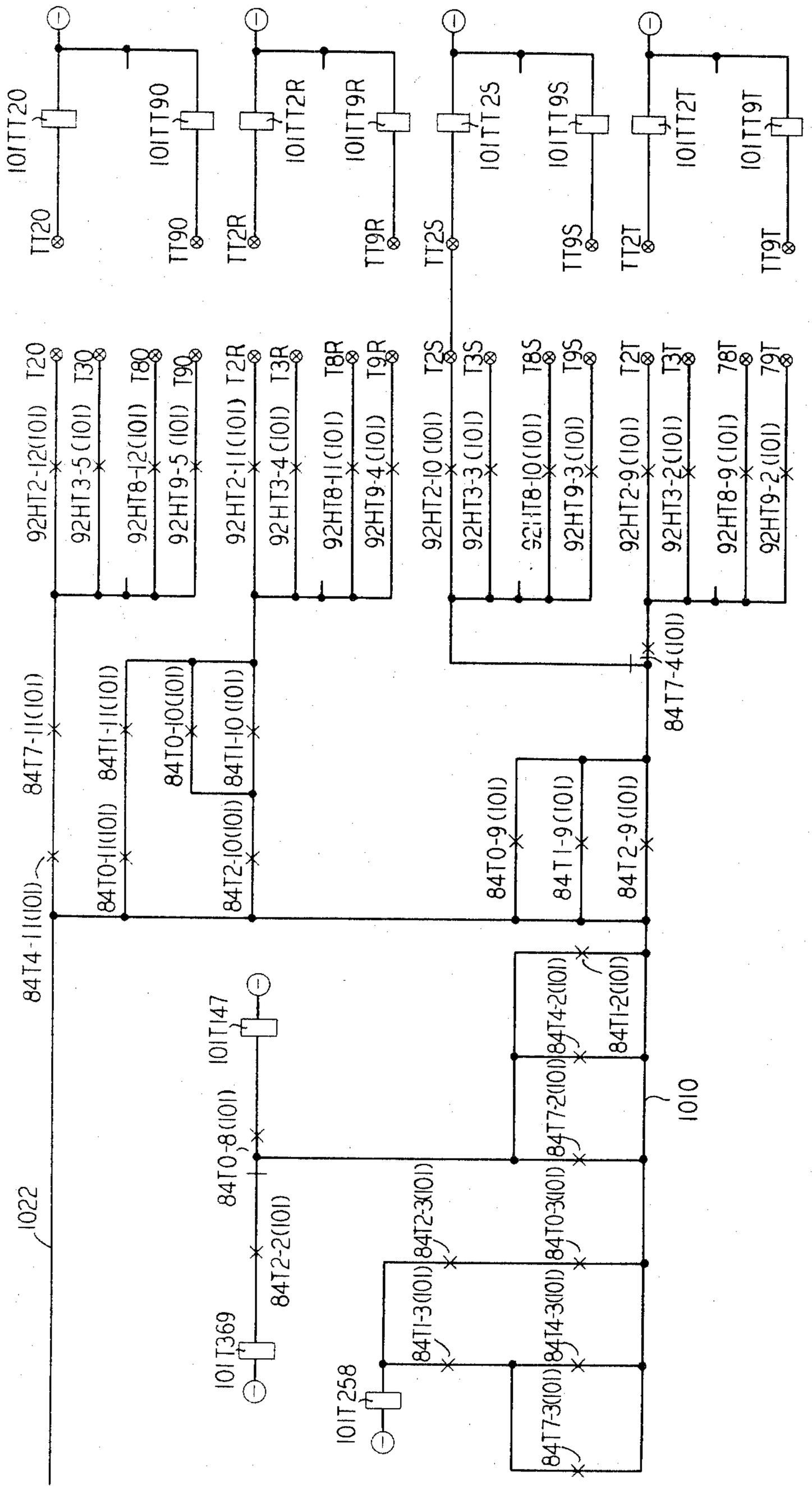


FIG. 101

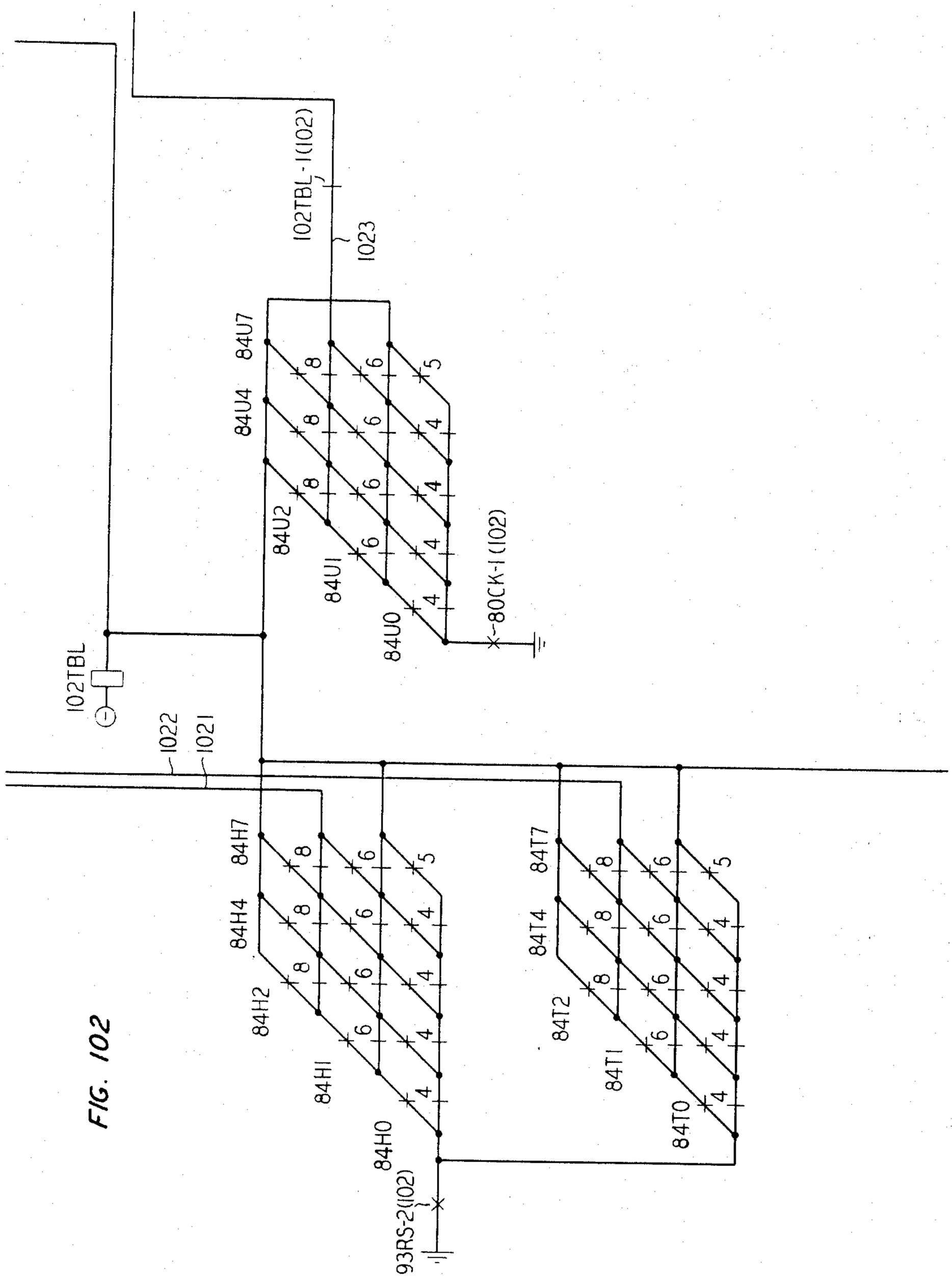
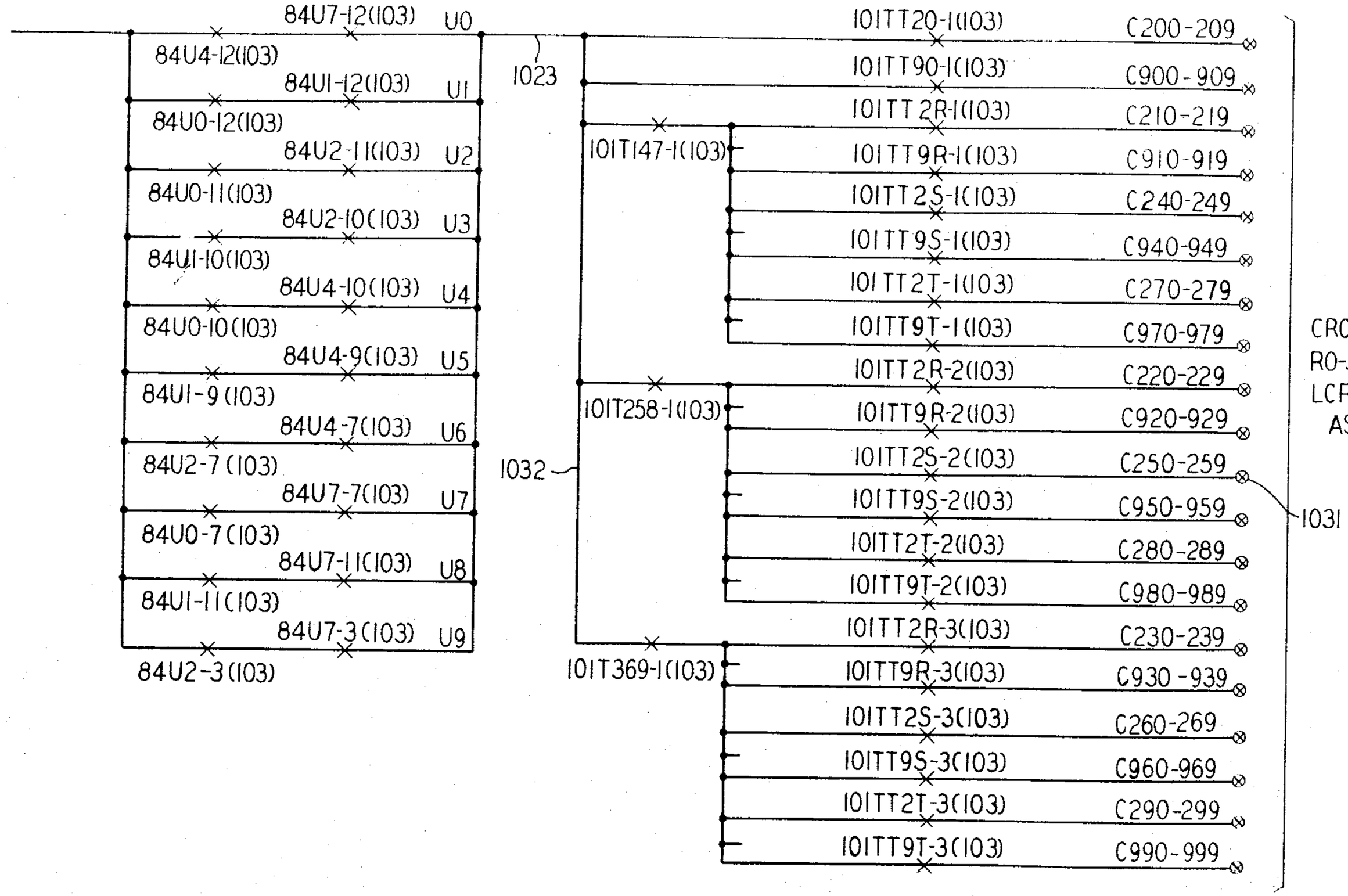

102TBL
1022
1021
102TBL-1(102)
1023
84U7
84U4
84U2
84U1
84U0
80CK-1(102)
84H7
84H4
84H2
84H1
84H0
84T7
84T4
84T2
84T1
84T0
93RS-2(102)
8
6
5
4

FIG. 102

FIG. 103


84U7-12(103) U0
84U4-12(103)
84U1-12(103) U1
84U0-12(103)
84U2-11(103) U2
84U0-11(103)
84U2-10(103) U3
84U1-10(103)
84U4-10(103) U4
84U0-10(103)
84U4-9(103) U5
84U1-9(103)
84U4-7(103) U6
84U2-7(103)
84U7-7(103) U7
84U0-7(103)
84U7-11(103) U8
84U1-11(103)
84U7-3(103) U9
84U2-3(103)
1023
1032
101T147-1(103)
101T258-1(103)
101T369-1(103)
101TT20-1(103) C200-209
101TT90-1(103) C900-909
101TT2R-1(103) C210-219
101TT9R-1(103) C910-919
101TT2S-1(103) C240-249
101TT9S-1(103) C940-949
101TT2T-1(103) C270-279
101TT9T-1(103) C970-979
101TT2R-2(103) C220-229
101TT9R-2(103) C920-929
101TT2S-2(103) C250-259
101TT9S-2(103) C950-959
101TT2T-2(103) C280-289
101TT9T-2(103) C980-989
101TT2R-3(103) C230-239
101TT9R-3(103) C930-939
101TT2S-3(103) C260-269
101TT9S-3(103) C960-969
101TT2T-3(103) C290-299
101TT9T-3(103) C990-999
1031
CROSS CONNECT TO
RO-39, RRO-19, SCO-29,
LCRO-29 OR VCG
AS REQUIRED

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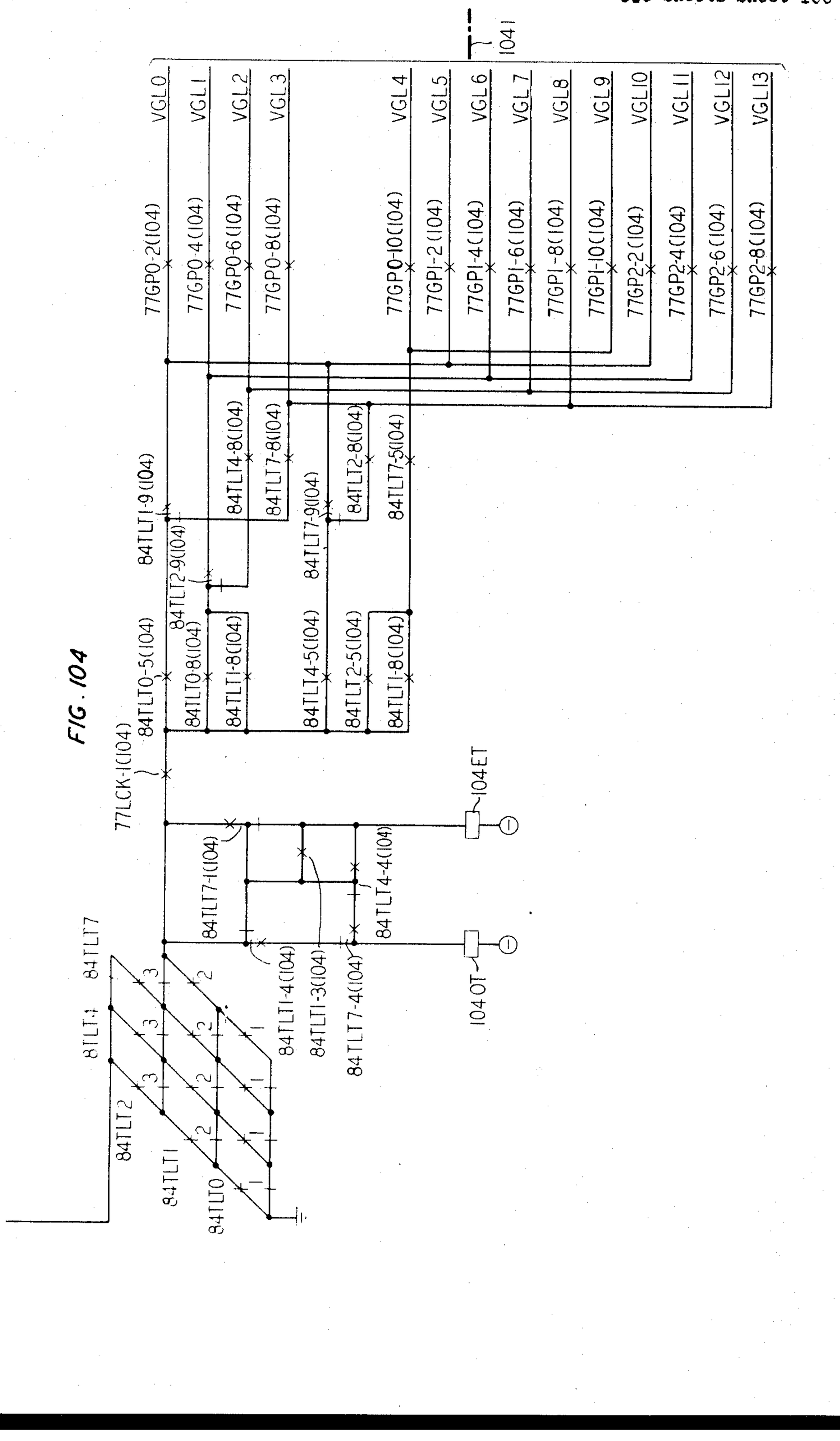

FIG. 104

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FIG. 105

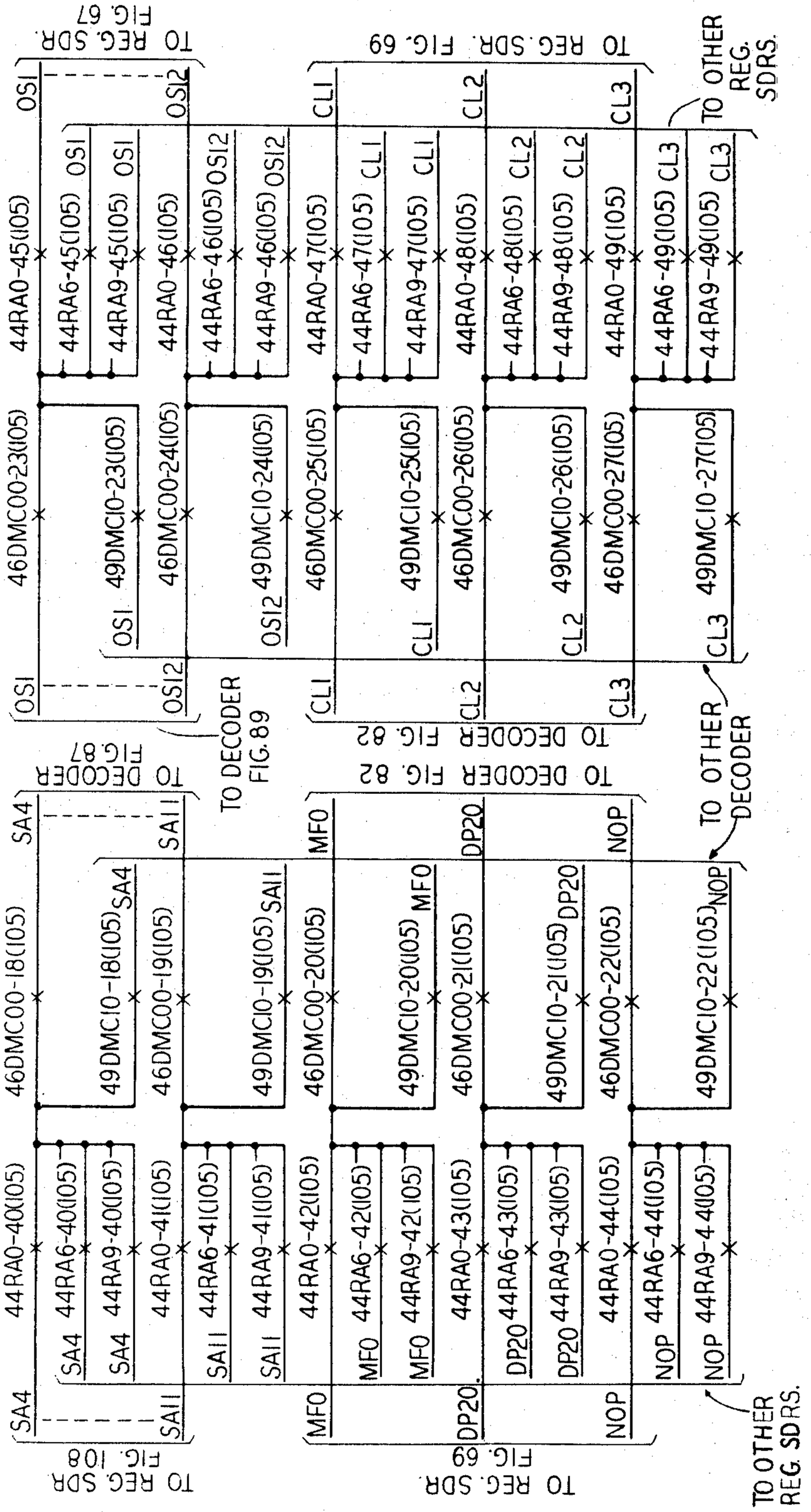
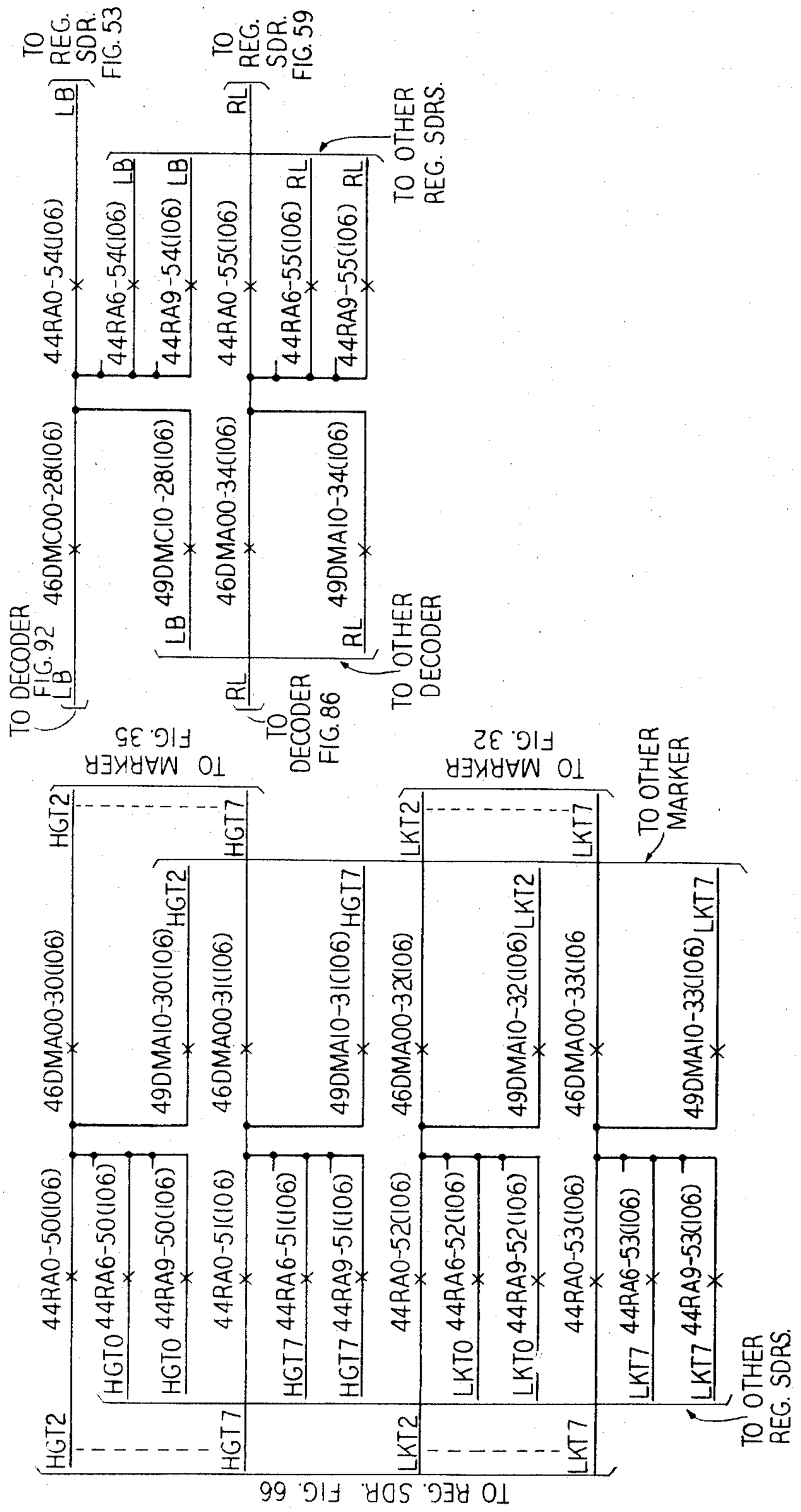


FIG. 106


TO REG. SDR. FIG. 53
LB
RL
TO REG. SDR. FIG. 59
TO OTHER REG. SDRS.
TO DECODER FIG. 92
46DMC00-28(106)
49DMC10-28(106)
46DMA00-34(106)
49DMA10-34(106)
44RA0-54(106)
44RA6-54(106)
44RA9-54(106)
44RA0-55(106)
44RA6-55(106)
44RA9-55(106)
TO DECODER FIG. 86
TO OTHER DECODER
TO MARKER FIG. 35
TO MARKER FIG. 32
HGT2
HGT7
LKT2
LKT7
46DMA00-30(106)
49DMA10-30(106)
46DMA00-31(106)
49DMA10-31(106)
46DMA00-32(106)
49DMA10-32(106)
46DMA00-33(106)
49DMA10-33(106)
TO OTHER MARKER
44RA0-50(106)
44RA6-50(106)
44RA9-50(106)
44RA0-51(106)
44RA6-51(106)
44RA9-51(106)
44RA0-52(106)
44RA6-52(106)
44RA9-52(106)
44RA0-53(106)
44RA6-53(106)
44RA9-53(106)
HGT0
HGT7
LKT0
LKT7
TO REG. SDR. FIG. 66
TO OTHER REG. SDRS.

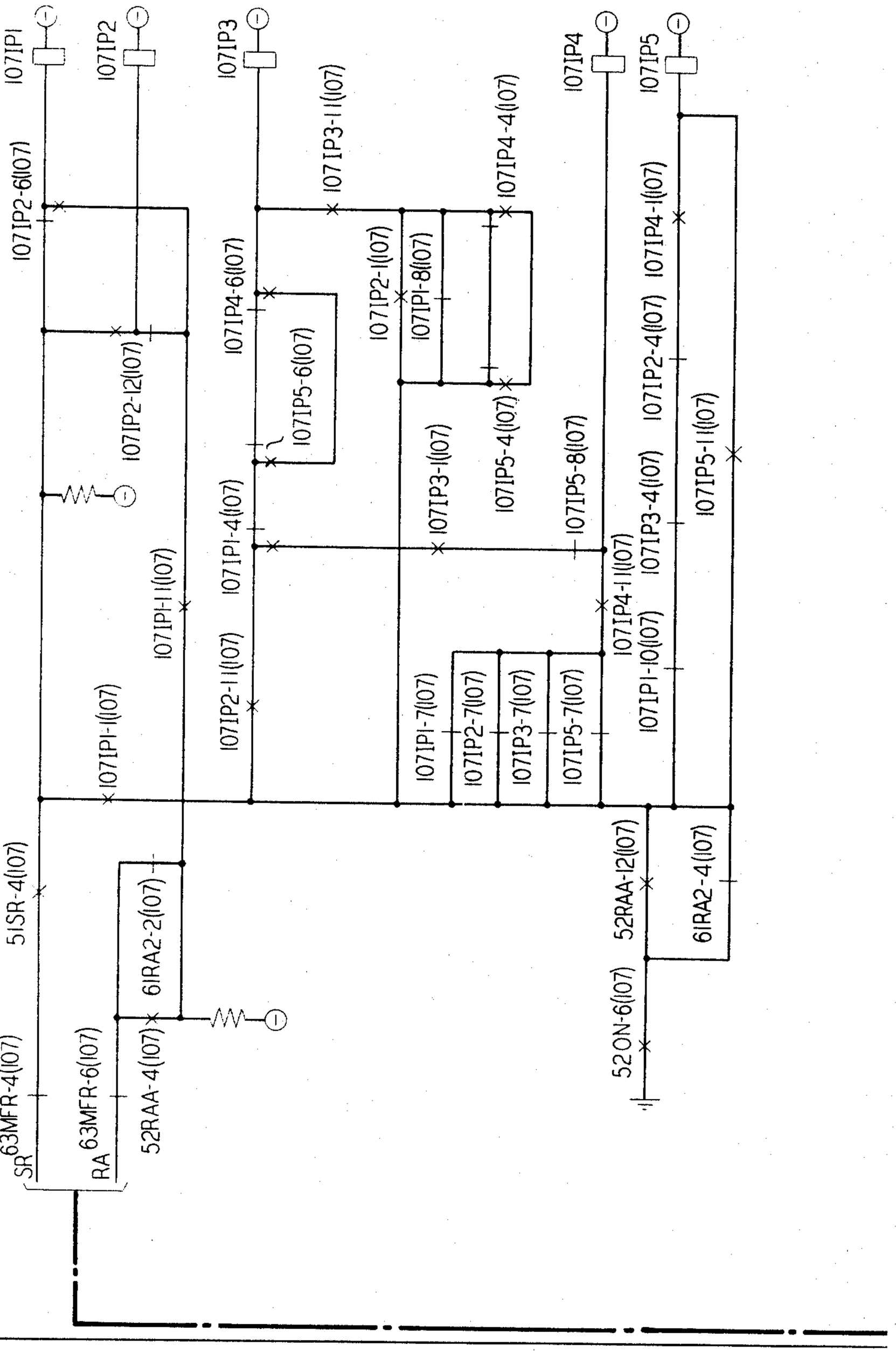

107IP1
107IP2
107IP3
107IP4
107IP5
107IP2-6(107)
107IP2-12(107)
107IP1-1(107)
107IP1-11(107)
107IP2-11(107)
107IP3-11(107)
107IP4-6(107)
107IP5-6(107)
107IP1-4(107)
107IP3-1(107)
107IP2-1(107)
107IP1-8(107)
107IP4-4(107)
107IP5-4(107)
107IP5-8(107)
107IP1-7(107)
107IP2-7(107)
107IP3-7(107)
107IP5-7(107)
107IP4-1(107)
107IP3-4(107)
107IP2-4(107)
107IP1-10(107)
107IP5-11(107)
51SR-4(107)
63MFR-4(107)
SR
63MFR-6(107)
RA
52RAA-4(107)
61RA2-2(107)
52RAA-12(107)
61RA2-4(107)
52ON-6(107)

FIG. 107

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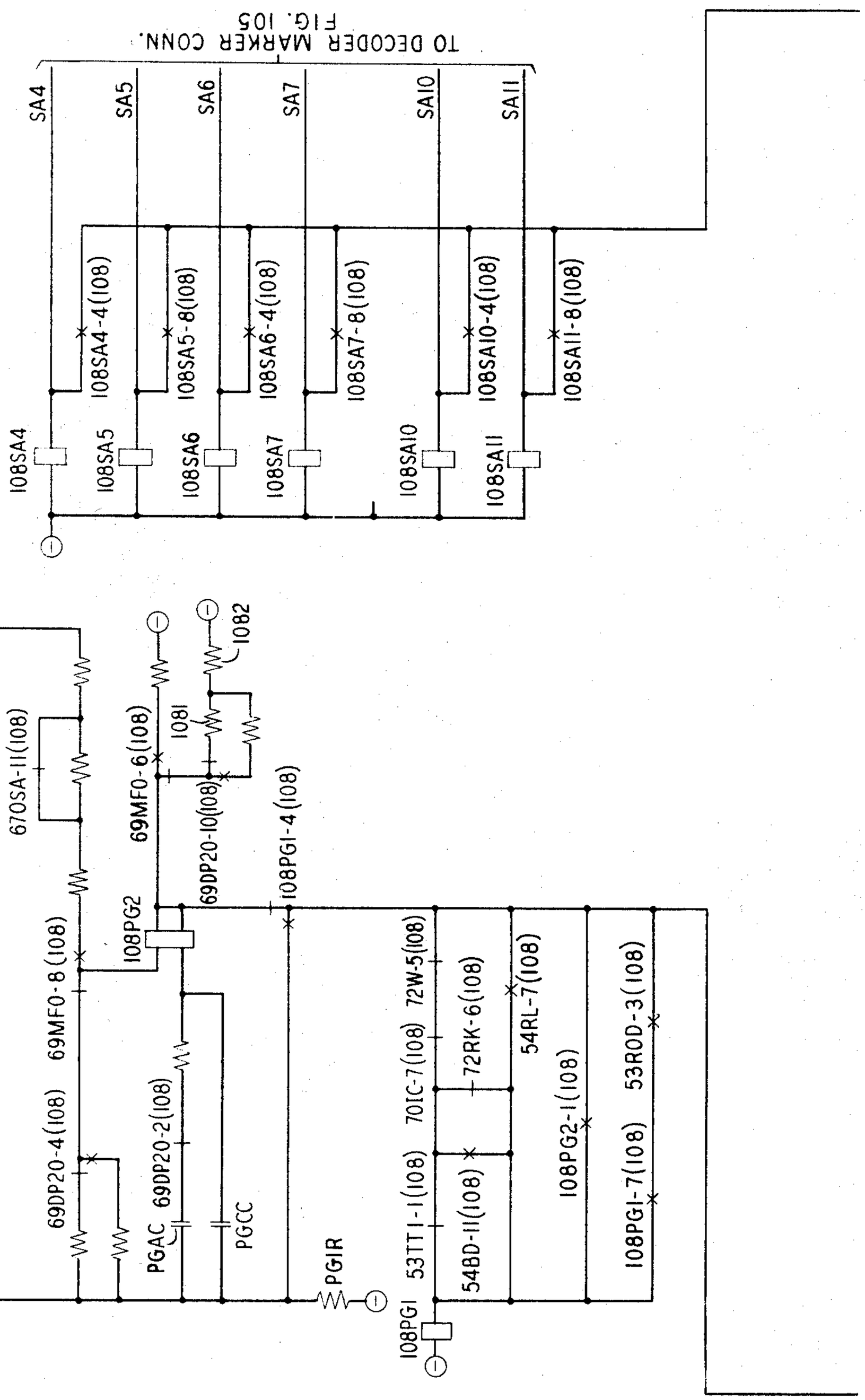
FIG. 108



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TELEPHONE SYSTEM

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FIG. 109

FIG.2	FIG.3	FIG.6	FIG.7	FIG.9	FIG.13	FIG.16	FIG.19	FIG.22	FIG.25		
FIG.4	FIG.5	FIG.97	FIG.10	FIG.8	FIG.12	FIG.15	FIG.18	FIG.21	FIG.24		
					FIG.11	FIG.14	FIG.17	FIG.20	FIG.23		

FIG.64	FIG.67	FIG.43	FIG.46	FIG.49	FIG.100					FIG.75	FIG.86	FIG.96
FIG.73	FIG.68	FIG.44	FIG.47	FIG.50	FIG.105							
FIG.66	FIG.60	FIG.45	FIG.48	FIG.99	FIG.106							
FIG.58	FIG.61	FIG.80	FIG.85	FIG.95	FIG.76							
FIG.59	FIG.63	FIG.81	FIG.84	FIG.78	FIG.79							
FIG.35	FIG.39	FIG.92	FIG.101	FIG.87	FIG.93							
FIG.36	FIG.40	FIG.102	FIG.103	FIG.89	FIG.91							
FIG.37	FIG.41	FIG.88	FIG.74	FIG.82	FIG.90							
FIG.38	FIG.42	FIG.104	FIG.77	FIG.83	FIG.94							
FIG.108	FIG.70	FIG.69									
FIG.107	FIG.71	FIG.72									
FIG.57	FIG.62	FIG.65									
FIG.55	FIG.51	FIG.53									
FIG.56	FIG.52	FIG.54									
FIG.26	FIG.29	FIG.31									
FIG.27	FIG.30	FIG.32									
FIG.28	FIG.98	FIG.33									
		FIG.34									

United States Patent Office

3,394,232

Patented July 23, 1968

3,394,232

TELEPHONE SYSTEM

Richard J. Jaeger, Jr., Colts Neck, and George Riddell, Lincroft, N.J., assignors to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Filed Mar. 9, 1965, Ser. No. 438,229
11 Claims. (Cl. 179—18)

ABSTRACT OF THE DISCLOSURE

A switching assembly of ten horizontal rows of fourteen crossbar switches is provided for tandem switching of four-wire trunks in a PBX. This makes 280 vertical terminations available, each having access to 100 horizontal links. Two trunk circuits and a register sender are simultaneously interconnected by a single link for concurrent inpulsing and outpulsing. The outgoing channel of the call originating trunk circuit is disabled during outpulsing and enabled when the talking connection is cut through. The incoming channel of the call completing trunk circuit is disabled during inpulsing and enabled when the talking connection is cut through. When pulsing is completed, the channels of the completing trunk are reversed to provide proper alignment for through communication.

This invention relates to a private branch exchange telephone system and more particularly to a private branch exchange telephone system providing switching of four-wire lines and trunks.

In instances where a telephone customer, for example a business firm, a government agency, or the like, requires a relatively large number of extensions, it is the usual practice to provide on the premises, or conveniently located thereto, a private branch exchange commonly referred to as a PBX. The larger PBX's are usually served by one or more attendants from a console or attendant's position and function, essentially, as a small telephone central office in that intrastation calls between extensions on the premises are completed, as well as calls from extensions to scribers through remote central offices and calls from such subscribers to extensions served by the PBX. An automatic private branch exchange of a type capable of serving a relatively large number of extensions and providing many advanced features is discolsed in Patent 2,904,637, issued Sept. 15, 1959, to R. D. Williams.

An automatic private branch exchange system of the type contemplated by the present invention may be used also for switching tandem calls between two-wire and four-wire private branch exchanges. Such application of the PBX presents many problems with regard to trunk termination, registering incoming pulses and subsequently outpulsing the information, switching the respective two-wire channels of the respective four-wire trunks, and so on.

Accordingly, it is an object of the present invention to improve the operation of automatic private branch exchange systems.

A more specific object of the invention is to attain concurrent inpulsing and outpulsing in a register sender during establishment of a connection between two four-wire, two-way trunk circuits.

In accordance with a specific embodiment of our invention, a four-wire, crossbar, common control PBX is provided with a switching assembly comprising ten horizontal rows of fourteen six-wire crossbar switches arranged in a vertical stack, thus providing 280 vertical terminations each having access to 100 horizontal links. The links are multiplied across all switches in the same horizontal row. Lines, trunks, register senders and other

facilities are terminated on the vertical appearances and may be selectively interconnected by any one of the 100 horizontal links.

Two of the four-wire, two-way trunk circuits and a selected register sender are simultaneously interconnected for concurrent inpulsing and outpulsing by a single continuous link and three controllable crosspoint switches. The outgoing channel of the call originating two-way trunk circuit is disabled during outpulsing and enabled when the talking connection is cut through. The incoming channel of the call completing two-way trunk circuit is disabled during inpulsing and enabled when the talking connection is cut through. When inpulsing and outpulsing have been completed and the talking connection has been cut through, the connection between the link and the incoming and outgoing channels of the call completing two-way trunk circuit is transposed to provide proper directional alignment for through communication.

A feature of the present invention is the connection of a selected register sender directly to the link which interconnects the incoming or originating trunk and the outgoing or terminating trunk.

Another feature of the invention is an interconnection of the register sender and respective channels of the originating and terminating trunks which permits digits to be simultaneously received at the register unit and transmitted by the sender unit of the register sender.

A full understanding of the arrangement contemplated by the present invention as well as an appreciation of the various advantageous features thereof may be gained from consideration of the following detailed description in connection with the accompanying drawing, in which:

FIG. 1A shows schematically the relationship of certain of the basic individual circuits which comprise one specific illustrative embodiment of the PBX system contemplated by the invention;

FIG. 1B shows schematically the manner in which the two four-wire tie trunks and a register sender are simultaneously interconnected by a single continuous link and three controllable switch crosspoints;

FIG. 1C shows schematically the manner in which the register sender is bridged across the trunks whereby to attain simultaneous inpulsing and outpulsing;

FIGS. 2 and 4 show a first four-wire station line circuit;

FIGS. 3 and 5 show a second four-wire station line circuit;

FIGS. 6 and 97 show a no-test circuit facility;

FIGS. 7 and 10 show a first two-way, four-wire tie trunk circuit;

FIGS. 8 and 9 show a second two-way, four-wire tie trunk circuit;

FIGS. 11 to 25 show the link and connector circuit including the crossbar switch;

FIGS. 26 to 42 and 98 show the marker;

FIGS. 43 to 50 and 99, 100, 105, and 106 show the decoder-marker connector;

FIGS. 51 to 73 and 107 and 108 show the register sender;

FIGS. 74 to 96 and 101 to 104 show the decoder; and

FIG. 109 shows the manner in which FIGS. 2 to 108 should be arranged to show the specific illustrative embodiment of the invention.

General description

The arrangement and operation of the various components of the illustrative embodiment of the invention will be described in detail subsequently with reference to FIGS. 2 to 108 inclusive. However, in order to first gain a general overall understanding of the arrangement contemplated, a brief general description will be given at this point with reference particularly to FIGS. 1A, 1B and

1C. Referring first, therefore, to FIG. 1A there is illustrated schematically a four-wire, crossbar, common control PBX of a type intended for location on customer premises. The PBX may be used for switching tandem calls among two-wire and four-wire PBX's and also for switching locally terminated four-wire stations. It is capable of serving other switching centers, and will ordinarily have access to neighboring central offices, PBX's and private lines, being able to receive and process calls to and from any of these sources. The system is capable of receiving dial pulses, TOUCH-TONE, or multifrequency pulsing and of outpulsing on a dial pulse or multifrequency basis as required.

In an effort to simplify the description so far as possible consistent with adequate disclosure of the invention, there are shown in FIG. 1A only two four-wire station line circuits, circuit A designated **151** and circuit B designated **152**, and only two-way, four-wire tie trunk circuits, circuit A designated **153** and circuit B designated **154**. In an actual installation the PBX would ordinarily be designed to directly serve about 200 lines and/or tie trunks. A system of such capability would ordinarily include two decoders each with associated marker, although in the specific illustrative embodiment a single decoder **155** with associated marker **156** are disclosed. It will be assumed for purposes of description that the tie trunks **153** and **154** are used to provide PBX terminations for four-wire line facilities employing E and M lead signaling from distant PBX's.

Link and connector **157** includes a single-stage rectangular crossbar switch array (not separately shown in FIG. 1A, but shown in detail in the figures provided in connection with the detailed description). In the switch array a one-switch-wide vertical column is referred to as a vertical group and contains twenty vertical file positions, while a horizontal band of switches is referred to as a horizontal group and contains ten links. The switch array can be varied in size in accordance with local requirements; in the instance described it will be assumed to comprise fourteen vertical groups and ten horizontal groups. The link and connector, as will be apparent from subsequent description, provides for connecting any line or trunk in the system to any other line or trunk in the system and to any register sender.

Lines or trunks may be assigned to any of the vertical file positions, while register senders, as register sender **158** illustrated, are also assigned to vertical file positions but are ordinarily confined to the last three positions in any vertical group. No-test trunk circuits, as circuit **159**, are ordinarily also confined in their connection to the switch in the same manner as the register senders. Links are the horizontal connecting paths by means of which any vertical file can be connected to any other vertical file of the system.

The total number of register senders which the system can accommodate is controlled by the decoder-marker connector; in the present instance provision of twenty register senders will be assumed. The register senders are designed to accept dial pulsing, TOUCH-TONE signals and multifrequency signals, and to outpulse ten pulses per second, twenty pulses per second, or multifrequency signaling; they are arranged to function with the central office-type TOUCH-TONE receiver.

The system is capable of recognizing a large number of classes of service but in the present instance the provision of ten classes is assumed. Each line or trunk is assigned a class of service from which the common control can identify an originating circuit as a line or as a trunk, and can determine the type of pulsing that will be forthcoming. The system preferably will have the capability of accepting a call address consisting of from three to eleven digits. After a predetermined number of the digits of an address have been received by a register sender, the decoder is engaged and, from a translation of certain of these digits, the total number of digits expected in the call address and the portion, if any, to be outpulsed is determined.

There are two basic functions handled by the common control of the system. The first function is designated an originating connection and refers to a line or trunk connection to a register sender, while the second function is designated a terminating connection and refers to the completion of a register-sender request to a specific line or trunk. A third connection, a no-test connection, refers to the connection of a special trunk to any line or trunk regardless of a busy condition thereon.

The first of the two connector-type circuits, that is the link and connector **157**, provides marker **156** with access to the crossbar switches, while the second circuit of such type, that is decoder-marker connector **161**, connects the lines and trunks (originating connection) or the register sender (terminating connection) to a decoder-marker combination after a start signal has been received.

It might be of interest here to point out that certain portions of the overall operation of the present system are in general accord with the operation of systems known in the art and fully described in prior patents. In order to prevent undue complication of the present disclosure those operations which are described in earlier patents will be referred to here, and also in the subsequent detailed description, only to the extent necessary for a full and complete understanding of the presently contemplated novel arrangement. For example, certain of the switching operations and control thereof, particularly with regard to marker operation, are generally similar to corresponding operations and controls embodied in the No. 5 crossbar system as disclosed, for example, in Patent 2,585,904 issued Feb. 19, 1952 to A. J. Busch. Also of similar interest are Patent 2,868,884, issued Jan. 13, 1959 to J. W. Gooderham et al.; Patent 3,099,719, issued July 30, 1963 to A. E. Gerbore et al.; and Patent 2,981,804, issued Apr. 25, 1961 to H. H. Abbott et al.

It will be understood that in the general description immediately below, operations referred to but not described in detail either are considered to be well known as disclosed in prior patents such as those mentioned above or that detailed descriptions will be provided subsequently in the specification.

The originating connection, that is the initiation of a call, is started by a line or tie trunk signaling the decoder-marker connector; in the present instance it will be assumed that the distant station associated with four-wire tie trunk A (**153**), goes off hook whereby to initiate a call. Decoder-marker connector **161** assigns the request for a call connection to an available decoder-marker combination; in the present instance it will be assumed that decoder **155** and associated marker **156** are "idle" and that the request is assigned to that combination.

Marker **156** begins to process the call and first signals the link and connector **157** to "reserve" the vertical group from which the call initiation originated. This prevents interference from the other marker, which as stated above would be provided in an actual installation. Marker **156** then proceeds to perform three operations simultaneously, namely to select a link, to select a register sender, and to operate a connector in four-wire trunk circuit A, **153**.

The process of selecting a link involves signaling link and connector **157** to connect the horizontal group testing leads. A horizontal group is selected and a test performed on all the links within the selected horizontal group. From these links an idle one is selected for use on the present call.

Decoder-marker connector **161** provides an indication for each vertical group of the crossbar switch in which there is at least one idle register sender. One vertical group is selected and is reserved by signaling link and connector **157**. A test is then performed through a path provided by link and connector **157** and a particular regis-

ter sender selected; it will be assumed in the present instance that register sender **158** is selected.

The marker, in completing the third simultaneous operation referred to above, utilizes a path provided by link and connector **157** for testing all lines or trunks located within the starting vertical group; the marker operates connectors in four-wire tie trunk circuit A. The novel system contemplated is so arranged that only a single link is required per talking connection. All connections are established by the marker.

A class-of-service digit assigned to and pertinent to, tie trunk **153** is now transmitted to marker **156** and translated thereby into data necessary for the proper handling of the call. The translated data and the class-of-service digit are transmitted by marker **156** to register sender **158**.

The proper select and hold magnets of the crossbar switch of link and connector **157** necessary for completing the connection are now operated through action of marker **156**. When the hold magnets have been checked "operated," marker **156** starts to release, signaling decorder **155** and link and connector **157** to release. A signal is thereupon sent to decoder-marker connector **161** indicating that the marker and decoder circuits are available for a new connection.

When the register sender is ready to receive pulses, a "start" signal is transmitted to the distant pulsing circuit which is connected by way of the four-wire tie trunk A (**153**). Pulsing is accordingly started of the code of the desired station which, we will assume, is to be reached through four-wire tie trunk B (**154**) after the two tie trunks have been connected as subsequently described. The terminating connection starts with the connection of decoder **155** and its associated marker **156** through decoder-marker connector **161** to register sender **158** after a predetermined number of digits have been pulsed. In the instance of a line-initiated call the number of digits controlling is three, while in the instance of a trunk-initiated call, the number of digits controlling is four. Since in the present instance the connection was initiated by way of tie trunk **153**, the connection of the decoder and marker takes place upon the pulsing of four digits.

Upon its connection register sender **158** transmits to the decoder **155** information concerning the transmitted digits which represent an area and office code; the class of service of the calling line or trunk; the location of the link used on the originating connection; and the route control digit (if received). Decorder **155** registers and checks the information and then proceeds to translate the three-digit area and office code information into one out of a possible 800 code point outputs. Each code point is cross connected to eventually supply routing information to register sender **158** and to the marker **156**.

In its determination of the routing, decoder **155** may find all trunks in the preferred route in a busy condition. In such event the decoder hunts for a first or second alternate route until a route is found with an available idle trunk; if the alternate routes are also busy the decoder advances to a reorder route. When the routing has been determined, decoder **155** transmits the routing information to marker **156** in the form of vertical group or groups in which the connection can be terminated. Marker **156** records the preferred vertical group and signals link and connector **157** to reserve this vertical group. At approximately this same time register sender **158** transmits the horizontal group and level information which identifies the link used earlier on the connection. This information, which was passed to register sender **158** by marker **156** during the originating connection, identifies the link to be used in completing the connection. It will be apparent that, in accordance with the novel arrangement provided, the originating and terminating elements will be connected to the same register sender. This connection is shown schematically in FIG. 1B wherein the originating and terminating trunks and the selected register sender are shown connected via a common link and three crosspoints of the link and connector switch.

With the above functions completed and checked, marker **156** signals decoder **155** to return identity of the lowest numbered vertical file position of the crossbar switch for the selected vertical group. When this information has been returned, marker **156** signals link and connector **157** to return information for all the vertical file positions associated with the one vertical file position just identified by decoder **155**. Since in the present instance we are concerned with a trunk circuit (rather than a line) link and connector **157** returns information on all vertical files for the trunk group. Marker **156** tests the group of trunks, selects an idle one and operates a connector relay in the selected trunk.

When the particular trunk has been selected, marker **156** operates a select magnet in the switch array, using the link information supplied by register sender **158**, and begins the recycle of the sequence memory circuit. Recycling this circuit changes the preferred position for the preference chains in the marker circuit for the next connection. The preferred position is determined by the vertical file position of the terminating trunk. After the select magnet has been checked "operated," the hold magnet is operated. With the hold magnet checked and the sequence memory circuit recycled, a release signal is transmitted to decoder **155**. When marker **156** and decoder **155** have returned to normal a signal is sent to decoder-marker connecter **161** indicating that these circuits are ready for use in connection with additional calls.

Calls initiated by the no-test facility **159** are handled in a manner generally similar to that prevailing in the instance of line or trunk initiated calls. The no-test facility provides the ability to connect to a busy line, for example for the purpose of verifying the apparently busy condition of a particular line. When a call is initiated by no-test circuit **159**, a "no-test" class is translated by marker **156** from the class-of-service digit and passed to register sender **158**. On the terminating connection this class mark is passed back to marker **156** whereby to cause the marker to ignore the normal busy test and to complete the call by way of a link other than that used in an existing call connection and a multiple occurrence of the busy line. Each line and trunk has a multiplied termination in each horizontal group of the plurality of horizontal groups of the crossbar switch array. Marker **156** selects an idle link for the no-test connection and examines the operative state of the crosspoint through which the selected link has access to the busy line. If the crosspoint examined is found to be already closed, marker **156** recycles and selects another idle link in a different horizontal group for the no-test connection.

Each register sender, as register sender **158**, is used to store incoming information from lines or trunks on a multifrequency, dial pulse (ten pulses per second or twenty pulses per second), or TOUCH-TONE basis, and to outpulse this information in a modified form. The register sender is designed to accept any number of digits up to a maximum of eleven call address digits and to outpulse any quantity of these digits as instructed by decoder **155**. Register sender **158** is so arranged that it is possible for decoder **155** to control by signal to the register sender the start and stop points of the outpulse train. In addition, the type of outpulsing to be used is controlled by the decoder.

After the terminating connection has been completed, register sender **158** remains connected in a bridging manner across the originating and terminating trunks. This connection is shown schematically in FIG. 1C and it will be clear that the incoming channels of the originating trunk, the terminating trunk and the register sender are connected to a first channel of the link and that the outgoing channels of the originating trunk, the terminating trunk and the register sender are connected to a second channel of the link. Subsequently, the outgoing channel

of the originating trunk and the incoming channel of the terminating trunk are opened in the respective circuits. In this way, incoming digits are received at the register unit of the register sender and transmitted by the sender unit of the register sender simultaneously. (It will be obvious, of course, that each link includes a plurality of conductors corresponding respectively to the individual conductors of the connected trunks and register sender. The link is considered to comprise two channels corresponding respectively to the channels of the connected trunks and register sender.)

When all digits have been transmitted to the connecting office, register sender **158** signals the originating circuit (in the illustrative described example, four-wire tie trunk A, **153**) to close the outgoing channel and signals the terminating circuit (tie trunk B) to close the incoming channel and to reverse the transmit and receive channels. When these functions have been completed, register sender **158** releases from the bridged connection.

Coming now to a more detailed description of the specific illustrative embodiment of the invention with particular reference to FIGS. 2 to 108 of the drawing, the circuits illustrated are arranged in the so-called "detached contact" type of representation wherein, generally speaking. relay contacts are shown separated from the relay winding which controls the respective contact. This type of disclosure permits functional groups of circuitry to be shown separately, thus facilitating an understanding of the operational features involved. Each designation of a relay winding is preceded by a numeral indicating the figure of the drawing in which the apparatus appears, for example the winding of relay **2L1** appearing in FIG. 2. Further, each contact designation is followed by a numeral in parentheses which indicates the figure of the drawing in which the contact appears, for example, the designation "**2L1–2(4)**" indicates that contact No. **2** of relay **2L1** appears in FIG. 4 while the relay winding, as pointed out above, appears in FIG. 2. In accord with usual circuit design, transfer contact pairs may be either Early Make-Break (continuity) or Early Break-Make (sequence transfer) as dictated by the particular circuit operational requirements.

As indicated above, steps have been followed to limit the size of the present disclosure so far as possible consistent with adequate disclosure of the invention. In this connection the practice has been followed in general of showing only representative relays of a group where the group comprises a relatively large number of relays all of similar design and all operating in a generally similar manner. For example, in a group of ten such relays, the first (**–0**), middle (**–4**) and last (**–9**) of the group will often be the only ones of the group which are actually shown, strategically located dotted or broken lines being utilized to indicate the existence of intervening units. This same procedure has been followed in connection with other equipment units, for example, certain groups of the crossbar switch. Also, for purposes of simplifying and reducing the size of the drawing, only one marker and associated decoder are completely shown in the detailed circuits (as also in FIG. 1A), although, since it is recognized that in an actual installation two decoder-marker combinations would be provided, circuit features may be referred to form time to time which may be concerned in part with the operation of more than the single marker-decoder combination illustrated.

As basis of a detailed description of the various inventive aspects involved, there will be described in detail the circuit functions and operations involved in the completion of a typical connection which is initiated by a distant facility associated with a first four-wire tie trunk of the PBX and completed to a similar distant facility associated with a second four-wire tie trunk of the PBX, the connection being accomplished by connecting the two tie trunks through the PBX. The completion of a station line initiated call and the completion of a no-test connection will not be described in detail herein since such connections are described in the copending application of E. L. Erwin, A. E. Gerbore, G. C. Hobbs and H. J. Walsh, Ser. No. 438,182, filed Mar. 9, 1965.

Tie trunk-to-tie trunk call

Accordingly, for purposes of further detailed description, it will be assumed now that the distant station associated with the four-wire tie trunk A (FIG. 7) transmits an off-hook signal which causes ground to be applied to the E lead **101** whereby to operate relay **10E**. Relay **10E**, operated, closes at make contact **10E–1(10)** paths for operating relays **10E1** and **10ST** and, closes at make contact **10E–2(7)** a path for applying simplex ground to the transmitting loop.

Relay **10E1**, operated, closes a path at the make contact of transfer pair **10E1–10(10)** for aplying battery to the M lead **102** as a stop signal to the distant pulsing circuit; opens at break contact **10E1–4(10)** the IL lead to the decoder as a busy indication; opens at break contact **10E1–6(10)** the BT16 lead to the marker as a busy indication; closes a path at make contact **10E1–1(10)** for operating relay **10SR**; and closes at make contact **10E1–2(10)** a locking path to ground for relay **10ST.**

Relay **10E1** is slow to release so that it will remain operated during pulsing. Relay **10ST**, operated, applies ground through make contact **10ST–2(10)** to lead **VGS0** to the decoder-marker connector, whereby to indicate that tie trunk A requires the services of a marker, and also switches through the make contact of transfer pair **10ST–4(10)** control of relay **8MC** to the marker lead **LT16.**

It should be pointed out here that the four-wire tie trunk A is terminated in vertical group **0** of the crossbar switch, being in fact connected to vertical file **16** of that group.

The ground applied to lead VGS0 as described above acts as a "start" signal and is transmited over lead **VGS0** to operate vertical group start relay **44VGS0** of the decoder-marker connector.

Decoder-marker connector

In general, the decoder-marker connector comprises two basic connector units and a common traffic control unit. One connector unit connects lines or trunks requesting service to a decoder-marker combination which assigns and connects an idle register sender to the line or trunk. The register-sender connector unit connects register-sender circuits to the decoder-marker combination to obtain routing information and for control of the connection to the terminating line or trunk.

The line and trunk connector contains the vertical group start relays and the preference and connector relays for the decoder-marker combination. This circuit is used to connect vertical group information for lines and trunks requesting service and for available register-sender circuits into the marker.

The register-sender connector contains the register-sender preference and connector relays, and the decoder-marker preference and connector relays. A maximum of ten register senders are associated with the connector, which connects to two-decoder-marker combinations.

Relays with similar designations in the connector include in the respective designations (R) or (L), indicating respectively that the connector is serving register senders or lines.

Relay **44VGS0**, operated as above described, closes a path through a make contact for application of battery either to terminal DMA or DMB depending upon the condition (operated or released) of the connector relay combination **48(L)W** and **48(L)Z**; it will be assumed that relay **48(L)Z** is released whereby battery is applied to terminal DMA through make contact **44VGS0–2(43)**, break contact **48(L)TFC–9(43)**, break contacts of respective transfer pairs **48(L)Z–2(43)** and **47(L)TRS–5(43)** and break contact **48(L)OSL–7(43).**

The DMA terminal is cross connected to terminal DM0 (FIG. 46) while the DMB terminal is cross connected to terminal DM1 (FIG. 46). Since battery has been connected to terminal DMA as above described, relay 46DMS0 now operates. Relay 46DMS0 is included in a preference chain and will not operate and remain operated if another of the 46DMS– relays has previously been operated and remains in that condition.

Relay 46DMS0, operated, releases decoder relays 81CH2 and 81CH3 by removing the ground from leads CH2 and CH3 at the break contacts of respective transfer pairs 46DMS0–1(46) and 46DMS0–11(46) respectively, while connector relays 46DMG0 and 46DMH0 operate from ground through the respective make contacts of these same transfer pairs.

Relay 46DMG0, operated, connects ground through make contact 46DMG0–2(48) to lead TM (FIG. 48); this operates decoder circuit relay 81CB to battery through the winding of that relay. Relay 81CB, operated, connects ground through make contact 81CB–5(81) to lead CB0 whereby to operate relay 46CB0 to battery through the winding of that relay. Other 46CB– relays are operated over similar circuits, as relay 46CB00 operated over lead CB00 through make contact 81CB–1(81). Relay 81CB is held operated through its make contact 81CB–12(81).

Relay 46DMH0, operated as above described, connects ground to lead DTS through make contact 46DMH0–0(48) and this operates relay 93DTS to battery through the winding of that relay. Also, relay 46DMH0 operated extends the "vertical group start" lead VGS0 through make contact 46DMH0–1(44) over lead VGL0 to the marker (FIG. 36).

Marker operations

When 46DMH0 relay operated as above described a circuit was completed for operating relay 81HD over lead HD1 from the ground at point DMA (FIG. 43) and through make contact 46DMH0–3(43) and break contact 86DIS–7(81) through the upper winding of relay 81HD to battery. Relay 81ON now operates from ground, break contact of transfer pair 89RS–4(81), make contacts 93DTS–4(81) and 81HD–6(81), break contacts 81CH1–10(81), 81CH2–10(81) and 81CH3–3(81), winding of relay 81ON to battery and, upon operating, locks to the same ground through its make contact 81ON–12(81). Ground is now applied through make contact 81ON–11(81) to lead ONG and thereover to the marker (FIG. 34), through respective break contacts of various functioning relays of the marker, and finally through the winding of relay 34DCK to battery; relay 34DCK operates and locks through its make contact 34DCK–12(34) and respective break contacts of a number of other marker function relays to ground on lead DCK.

It can be seen that when the various program relays of the marker, whose break contacts are included in the hold path of relay 34DCK, are all operated, a complete marker operation is indicated and relay 34DCK will release. Thus relay 34DCK provides both a check that the marker is in its normal condition when it (relay 34DCK) operates and that the marker has completed its proper functions when the relay releases.

Relay 34DCK, operated, closes a path at make contact 34DCK–9(34) for operating relays 34ONG and 34ONGA to the ground on lead ONG; relays 34ONG and 34ONGA upon operating lock to the same ground through make contact 34ONGA–7(34). Relays 34ONG and 34ONGA, while operated, supply through their several respective make contacts ground for other relay circuits of the marker which will be referred to from time to time below. The marker is now set up to start processing the call.

Relay 34ONG, operated as above described, closes at make contact 34ONG–3(36) an operate path for relay

36VGE; relay 36VGE upon operating closes at its several make contacts, as 36VGE–1(36); 36VGE–7(36); and 36VGE–14(36), paths for operating the particular relay, 36VGL0, 36VGL6 or 36VGL13 corresponding to the particular 44VGS– relay (FIG. 44) previously operated. Accordingly, relay 36VGL0 (corresponding to relay 44VGS0, operated,) now operates from the ground applied to lead VGL0 through make contact 46DMH0–1(44) closed when relay 46DMH0 operated as previously described. Relay 36VGL0, operated, locks to ground through the make contact of transfer pair 36VGL0–12(36), and closes at make contact 36VGL0–8(36) an operate path for relay 36VGR. Relay 36VGR upon operating releases relay 36VGE by interrupting the operate path thereof at break contact 36VGR–4(36); release of relay 36VGE in turn removes at make contacts 36VGE–1(36); 36VGE–7(36); 36VGE–14(36) the operating grounds from relays 36VGL0; 36VGL6; 36VGL13.

Due to the preference circuit provided, only a single 36VGL– relay will remain operated following release of the 36VGE relay; in the present illustrative example relay 36VGL0 will be held operated to the ground at make contact 36ONG–1(36) as previously described. (More than one 36VGL– relay may initially operate but only the "preferred" relay will remain operated following release of relay 36VGE.)

The circuit of relay 36VGK provides a check at this point that only one of the 36VGL– relays is operated. Relay 36VGK operates over a path which includes a one-up-only chain comprising contacts of the 36VGL– relays, and the path for operating relay 36VGK is closed only when all but one of the 36VGL– relays are released. For example, in the present instance relay 36VGK is operated over a path which includes the make contact of transfer pair 36VGL0–10(36) and the respective break contacts of the transfer pairs of the other 36VGL– relays, all released; make contact 36VGR–12(36) is included in this operate path.

The operation of relay 36VGK initiates two separate sequences of operation. The vertical group in which the marker is to operate has now been selected and the marker now proceeds to reserve that vertical group in the link and connector circuit so that no other marker can work therein. This is accomplished by operating the appropriate relay in the 19VP– group; in the present illustrative example battery is applied to lead VG0 (FIG. 36) through make contact 36VGK–1(36) and the make contact of transfer pair 36VGL0–1(36) and transmitted over that lead to operate relay 19VP0.

As pointed out above the operation of relay 36VGK indicates that the selection of a vertical group has been completed for a call which has been started by the tie trunk. Similarly the operation of relay 39VRK indicates the completion of the selection of a vertical group for a call originated by a register. The operate path of the 39VRK relay includes a chain of 40VGR– relay contacts in a one-up-only circuit. (It will be understood that in the instance of certain check relays, as relays 36VGK and 39VRK, the operate paths may be shown to include contacts of "intervening" relays of a group of similar relays where typical relays of the group, such as the first, middle and last, are the only ones shown, the intervening relays of the group being indicated by the use of dotted lines.)

The function of the 19VP– relays is to afford a preference to a marker in a situation where more than one marker is attempting to work within the same vertical group. In the present illustrative embodiment it is assumed that the single marker disclosed operates in vertical group 0.

Relay 19VP0, operated as described above, closes at make contact 19VP0–2(19) an operate path for relay 19CC0 of the link and connector circuit. Relay 19CC0, operated, closes at make contact 19CC0–52(19) a path for operating relay 19CA0, and relay 19CCA0 upon oper-

ating closes in turn at make contact 19CCA0–14(22) a path for connecting ground to lead KL0 for operating relay 39VLCK of the marker through the make contact of transfer pair 36VGL0–4(39) and make contact 36VGK–10(39).

Relay 39VLCK, operated, closes a path for applying battery through break contacts 38RCY–11(39) and 34RLS–11(39), make contact 39VLCK–1(39) and the make contact of transfer pair 36VGLO–7(39) to lead TC0 for transmission thereover to operate relays 19TC0 and 19TCA0 of the link and connector circuit.

The operation of a 19TC– relay indicates that the marker is seeking to connect to a line or a trunk, in this instance a trunk, in the vertical group associated with the operated 19TC– relay, in the present instance vertical group 0 since relay 19TC0 operated. The operation of a 19RC– relay would indicate that the marker is seeking to connect to a register in the vertical group associated with the operated relay.

The other marker sequence referred to above as initiated by operation of relay 36VGK starts with operation of relays 39DT and 39DTA. Relay 93DTS of the decoder, operated as previously described above, closes a path at make contact 93DTS–6(75) for applying ground to lead DT for transmission to the marker and through make contact 36VGK–11(39) for operating relays 39DT and 39DTA. The operation of relays 39DT and 39DTA initiates two other sequences, namely, the location of an idle register sender and the selection of a horizontal group and a link with which to connect the originating tie trunk and the selected register sender; these operations are described immediately below.

Relay 39DTA, operated, closes a path for operating relay 39VRE from ground, make contacts 39DTA–6(39) and 36VGK–7(39), break contacts 39VRR–7(39) and 39VRK–2(39), winding of relay 39VRE to battery. Relay 39VRE, operated, connects the operating winding of relay 40VGR0 through make contact 39VRE–1(40) to lead VGR0; connects the operating winding of relay 40VGR6 through make contact 39VRE–7(40) to lead VGR6; and connects the operating winding of relay 40VGR13 through make contact 39VRE–14(40) to lead VGR13; these leads are extended through make contacts of relay 46DMG0 (FIG. 44) to register senders. Since the particular register sender to be referred to in this portion of the description is terminated in vertical group 6 on vertical file 19 of the crossbar switch, lead RA6 is grounded by that register sender through break contact 51SR–6(59) whereby to indicate that that particular register sender is available. Other available register senders in other vertical groups ground RA– leads (FIG. 44) corresponding to their respective vertical group whereby to indicate the availability of an idle register sender therein. Thus the 40VGR– relays corresponding to vertical groups including idle register senders will operate.

In the present instance relay 40VGR6 is operated by the ground over lead VGR6 and through make contact 39VRE–7(40); other 40VGR– relays may be operated also if other register senders are available. The operation of relay 40VGR6, or any of the other 40VGR– relays, closes a path for operating relay 39VRR from ground, make contact 39DTA–6(39), the break contact of transfer pair 28N2TP–4(39), make contact of the operated 40VGR– relay, or relays, winding of relay 39VRR to battery. In accordance with the functioning of the preference circuit only one 40VGR– relay will remain operated; in the present illustrative example relay 40VGR6 is held operated. As pointed out above, check relay 39VRK will operate when only a single 40VGR– relay is operated; in the present illustrative example relay 39VRF will operate from ground through make contact 34ONG–4(39), break contacts of respective transfer pairs 40VGR0–10(39) and 40VGR2–10(39), make contact of transfer pair 40VGR6–10(39), break contact 40VGR13–9(39), break contact of transfer pair 40VGR1–10(39), break contact

34RLS–9(39), make contact 39VRR–12(39), winding of relay 39VRK to battery.

In the event the register sender is in a different vertical group than the trunk which originated the call, the marker must now reserve that vertical group so that other markers cannot interfere with the operation therein. Accordingly, another of the 19VP– relays is operated. Relay 39VRK, operated as just described, connects battery to lead VG6 through make contact 39VRK–3(36), break contact of transfer pair 40VGR0–1(36), and make contact of transfer pair 40VGR6–1(36), and is transmitted over lead VG6 to operate relay 19VP6 of the link and connector circuit. Relay 19VP6, operated, closes at make contact 19VP6–2(19) a path for operating relay 19CC6. Relay 19CC6, operated, closes at make contact 19CC6–52(19) an operate path for relay 19CCA6; relay 19CCA6 operates and closes in turn a path at make contact 19CCA6–13(22) for application of ground to lead KR6 and operation of marker relay 39VRCK through the make contact of transfer pair 40VGR6–4(39), break contact of transfer pair 40VGR0–4(39) and make contact 39VRK–1(39). Relay 39VRCK, operated, closes a path for connecting battery to lead RC6 through break contacts 38RCY–10(39) and 34RLS–10(39), make contact 39VRCK–1(39), the break contact of transfer pair 40VGR0–7(39) and the make contact of transfer pair 40VGR6–7(39). The battery on lead RC6 operates relays 19RC6 and 19RCA6 of the link and connector circuit whereby to provide through make contact 19RCA6–54(18) a connection to vertical group 6 of the crossbar switch by way of which the marker can test for the vertical file of an idle register sender.

The appropriate vertical file within the selected vertical group 6 of the crossbar switch should now be selected as the next step in completing the connection. Relay 39VRCK, operated as just described, closes a path for operating relay 31RTE from ground, make contact 34ONG–5(31), break contacts 34RLS–12(31), 31RTR–2(31) and 31RTK–2(31), make contact 39VRCK–5(31), winding of relay 31RTE to battery. Relay 31RTE, operated, closes through at make contacts of transfer pairs 31RTE–10(40), 31RTE–11(40) and 31RTE–12(40) the operate paths of relays 40RT17, 40RT18 and 40RT19 of the marker. Since the selected register sender of the illustrative embodiment is assigned to vertical file 19, vertical group 6 of the crossbar switch, battery is applied from that register sender to lead RST19; this battery is applied through the winding of relay 63MC of the register sender and through break contact 52ON1–3(63) to lead RST19 and thereover to the link and connector circuit through make contact 19RC6–52(24) and on to operate relay 40RT19 of the marker through the make contact of transfer pair 31RTE–12(40). Application of battery to the RST19 lead at the register sender defines the vertical file location thereof. Relay 63MC does not operate at this time due to the relatively high resistance of the operating circuit.

If the register senders terminated on vertical files 17 and 18 of vertical group 6 of the crossbar switch are also idle, relays 40RT17 and 40RT18 will also be operated over respective leads RST17 and RST18.

The operation of any of the 40RT– relays completes an operate path for relay 31RTR of the marker; for example operation of relay 40RT19 as described above closes an operate path for relay 31RTR from ground through make contacts 34ONG–5(31) and 40RT19–11(31). Relay 31RTR, operated, releases relay 31RTE by interrupting the operate path at break contact 31RTR–2(31); relay 31RTE, released, interrupts the operate paths of relays 40RT17, 40RT18 and 40RT19 at the make contacts of respective transfer pairs 31RTE–10(40), 31RTE–11(40) and 31RTE–12(40). The locking paths for the 40RT– relays are arranged in a sequence chain which permits only one of the relays to be held operated after the respective operate paths have been interrupted; in the pres-

ent illustrative instance relay 40RT19 is held operated to battery through the make contact of transfer pair 40RT19–8(40), break contacts of transfer pairs 40RT18–8(40) and 40RT17–8(40) and make contact 39VRCK–2(40).

With relay 31RTE released as just described a path is closed for operating relay 31RTK provided one, and only one, of the 40RT– relays is operated; with relay 40RT19 operated, as just described, the path is closed from ground, break contact 31RTE–9(31), break contacts of transfer pairs 40RT17–2(31) and 40RT18–2(31), make contact of transfer pair 40RT19–2(31), break contact 34RLSA–1(31), make contact 31RTR–1(31), winding of relay 31RTK to battery. The operation of relay 31RTK indicates that a particular vertical file within the selected group has now been selected.

A path is now closed for operating relay 63MC of the selected register sender from ground, break contact 34RLSC–3(40), make contact 31RTK–11(40), break contacts of transfer pairs 40RT17–6(40) and 40RT18–6(40), make contact 40RT19–6(40), break contact of transfer pair 31RTE–12(40) to lead RST19, make contact 19RC6–52(24) in the link and connector circuit, break contact 52ON1–3(63), winding of relay 63MC to battery. Relay 63MC, operated, applies ground through make contact 63MC–21(63) to lead MCRK for transmission thereover to the link and connector, through make contact 19RC6–14(24) at the point to the marker and through the make contact of transfer pair 31RTK–10(32) to operate relay 32MCRK.

The operation of relay 32MCRK indicates to the marker that the marker connect relay 63MC of the register sender has been operated. Relay 63MC, operated, cuts through a number of information transfer leads as will be described subsequently. As will also be described subsequently, one of the relays 63TTC, 63MFR or 63DP will operate through a make contact of the 63MC relay depending upon the class mark indication obtained from the originating trunk. Also, the 63NDT or 63DT relays will operate depending upon whether or not dial tone is to be returned.

Relay 32XT3 is a cross detection relay which monitors for false grounds; one operate path is connected to lead MCRK over lead MCRK and the break contact of transfer pair 31RTK–10(32).

At the same time as the vertical file was being selected immediately following the operation of relay 39DT, horizontal group selection was being performed by the marker. Relay 39DT, operated as previously described, closes at make contact 39DT–1(35) a path for applying battery to lead HS through break contacts 34RLSC–2(35) and 35HCK–2(35) and over lead HS to operate relay 20HGP of the link and connector circuit. Relay 20HGP, operated, connects the battery on lead HS through make contact 20HGP–2(20) to lead HGE and back over that lead to operate relay 35HGE through break contacts 26HGK–2(35) and 31HGR–9(35) and make contact 34ONG–11(35) to ground.

Relay 35HGE, operated, closes through at make contacts, as 35HGE–1(35), 35HGE–6(35), and 35HGE–10(35) operate paths for relays 35HG0, 35HG5 and 35HG9; these relays are operated to indicate horizontal groups having available links therein.

Each link is supplied with a standing test relay as 14H0L0–14H0L9; 11H5L0–11H5L9; 11H9L0–11H9L9 which relays are held operated whenever the associated link is busy. The make contacts of all standing test relays within a horizontal group are connected in series to the HG– lead associated with that particular horizontal group; thus when all standing test relays within one horizontal group are operated, indicating an all-links-busy condition, a 20HGB– relay associated with that horizontal group is operated. When the 20HGB– relay is released, on the other hand, ground is applied to the HG– lead corresponding to the horizontal group; this ground is extended into the marker to operate the 35HG– relay which defines that horizontal group.

Accordingly, assuming an available link in horizontal group 0 of the crossbar switch, ground will be applied to lead HG0 through break contacts 20HC0–8(20) and 20HGB0–6(20) to the marker and through make contact 35HGE–1(35) and break contact 35HGT7–4(35) to battery through the winding of relay 35HG0 whereby to operate that relay.

The operation of any 35HG– relay will close an operate path for relay 31HGR; for example relay 35HG0, operated, will close an operate path for relay 31HGR from ground through make contacts 34ONG–8(31) and 35HG0–8(31). Relay 31HGR, operated, releases relay 35HGE by interrupting the operate path at break contact 31HGR–9(35); relay 35HGE upon releasing interrupts the operate paths of all 35HG– relays at make contacts as 35HGE–1(35), 35HGE–6(35) and 35HGE–10(35). Due to the provision of the preference circuit only one 35HG– relay will now remain operated; this is checked by the operation of relay 35HGK.

In the illustrative example being described, it is assumed that the only 35HG– relay remaining operated is 35HG0 and we have therefore selected horizontal group 0 of the crossbar switch for establishing a connection between the originating trunk and the selected register sender. Relay 20HC0 of the link and connector circuit now operates from battery applied to lead HC0 through make contacts 26HGK–1(35) and 39DT–2(35), break contact 34RLSA–7(35), the make contact of transfer pair 35HG0–1(35) and over lead HC0 to operate relay 20HC0. Relay 20HC0, operated, applies ground through make contact 20HC0–6(20) to lead HCK for transmission thereover to operate marker relay 35HCK through make contact 39DT–1(35) to battery; relay 35HCK upon operating locks through its make contact 35HCK–11(35) to ground at make contact 34ONG–9(35). Relay 35HCK, operated, releases relay 20HGP by removing battery from lead HS at break contact 35HCK–2(35).

Also, relay 35HCK operated closes an operate path for relay 30LKSE from ground, make contacts 34ONGA–23(30) and 35HCK–9(30) and break contacts 30LKK–2(30) and 32LKR–2(30), winding of relay 30LKSE to battery. Relay 30LKSE, operated, cuts through at respective make contact 30LKSE–1(30); 30LKSE–6(30), and 30LKSE–10(30) leads LK0; LK5 and LK9 to the link and connector circuit (FIG. 14); a particular link within the selected horizontal group will be selected over these leads. These test leads LK0, LK5, LK9 are connected through respective make contacts of relay 20HC0, to each link of the selected horizontal group 0. An idle link is indicated by the presence of only the battery potential supplied through the winding of the associated standing test relay, as relays 14H0L0, 14H0L5, and 14H0L9, to the sleeve lead of the link. The idle links thus indicated cause the operation of the corresponding 30LKS– relay.

Several different potentials may be applied to the link sleeve leads, and correspondingly to the test leads LK0, LK5, LK9, under different call conditions. The marker must distinguish the link idle indicating potential from all others. The detecting arrangement, including the 30LKS– relays must respond only to potentials within a given range of potentials and not to potentials above or below that range. Each detecting relay, as 30LKS0, associated with link 0, is of the differentially wound, marginal type, the primary, or lower, winding of which is connected through a dropping resistor to the associated test or hunting lead, as lead LK0. The relay is operated through its primary winding when the voltage applied to the hunting lead is equal to or greater than a predetermined value. A Zener diode, as diode 30ZNP, is connected in shunt to the primary or lower winding of each relay whereby to maintain the voltage across the primary winding at a predetermined level. Another Zener diode, as diode 30ZNS, is connected in series with the secondary,

or upper, winding of each relay, which winding is connected directly to the test or hunting lead, as lead LK0. When the voltage applied to the hunting lead exceeds another predetermined value, the series Zener diode becomes conductive and allows the secondary relay winding to be energized; the secondary winding opposes the primary winding. Therefore, when the applied voltage exceeds the upper level of the desired range of voltages, the secondary winding of the differentially wound relay is energized and the respective relay is prevented from operating.

The operation of any 30LKS– relay will be followed by operation of the corresponding 30LK– relay; for example, relay 30LKS0, operated, will close a path for operation of relay 30LK0 (link 0) from battery, winding of relay 30LK0, make contacts 30LKS0–1(30) and 35HCK–3(30) to ground. The operated 30LK– relay then locks to ground through a preference circuit, for example relay 30LK0 upon operating would lock to ground through the make contact of transfer pair 30LK0–11(30), the break contacts of respective transfer pairs 30LK9–11(30) and 30LK5–11(30), break contact 28NRCY–7(30), make contact 34ONG–15(30) to ground.

The operation of any 30LK– relay will be followed by operation of relay 32LKR; for example relay 36LK0, operated, will close an operate path for relay 32LKR from ground through make contacts 34ONG–16(32) and 30LK0–8(32). Relay 32LKR, operated, releases relay 30LKSE by interrupting the operate path therefor at break contact 32LKR–2(30). Relay 30LKSE upon releasing releases the 30LKS– relays, as relay 30LKS0, which, in turn, opens the operate paths of relays 30LK0, 30LK5 and 30LK9. As mentioned above the last-mentioned group of relays are provided with a preference locking circuit and one, and only one, of the relays will now remain operated. When all but one of the 30LK– relays are released relay 30LKK will operate to ground at break contact 20HGP–5(21) in the link and connector circuit, the operate path including the make contact of the transfer pair of the operated 30LK– relay and the break contacts of the transfer pairs of the released 30LK– relays. Link 0, horizontal group 0, is now established as relay 30LK0 holds operated.

There now remains the determination of the vertical file from which the call originated, this phase being sometimes referred to as the equipment test operation. The operation of relay 39DT, as described above, closed an operate path for relay 27LTC of the marker from ground, make contact 39VLCK–5(27), break contacts 26BSY–3(27), 34RLSB–5(27), make contact of transfer pair 39DT–7(27), winding of relay 27LTC to battery. (It will be recalled that relay 39VLCK operated previously to indicate the operation of the appropriate connector relays and the reservation of a vertical group in the link.) Operation of the 27LTC relay indicates that the common connectors in the link and connector circuit have operated and that testing for lines or trunks that are requesting register sender service can begin. The test is made by connecting the operate windings of relays 26ET– to the "marker connector" (MC) relay windings of lines and trunks requesting service; in the present illustrative example the 10MC relay of tie trunk A is involved.

The operation of relay 27LTC, as just described, closes the operate path for relay 26ET0 through lead LT0 at make contact 27LTC–1(26); the operate path for relay 26ET16 through lead LT16 at make contact 27LTC–17(26); and the operate path for relay 26ET19 through lead LT19 at make contact 27LTC–20(26).

Since tie trunk A, which originated the call in the illustrative embodiment described, is terminated in vertical file 16 of vertical group 0, a path is closed from relay 26ET16 through make contact 27LTC–17(26) over lead LT16, make contact 19TCA0–81(23) of the link and connector, through the winding of relay 10MC to battery, make contact of transfer pair 10ST–4(10) being included in this path. (Relay 10ST operated at the initiation of the connection following operation of relay 10E.) Relay 26ET16 operates over this path whereby to identify termination of the call initiating trunk as vertical file 16; relay 10MC does not operate at this point due to the relatively high resistance of the path.

Relay 27ETH operated previously (when the marker was seized) from ground at make contact 34ONG–20(27). Accordingly, upon operation of relay 26ET16 a path is closed for operation of relay 27ETM16 from ground at make contact 34ONG–20(27), break contacts 38RCY–6(27), 34RLSB–6(27), break contacts of respective transfer pairs 32MCLK–8(27) and 32MCTK–5(27), make contact 27ETH–2(27), break contacts 27ETR–9(27), 27ETK–2(27), break contact of transfer pair 26ET0–2(27), break contact 27ETM0–6(27), break contact of transfer pair 26ET10–7(27), break contact 27ETM10–6(27), make contact of transfer pair 26ET16–2(27), winding of relay 26ETM16 to battery; relay 27ETM16 locks operated through a preference circuit which includes the make contact of transfer pair 27ETM16–10(27) to ground at make contact 27ETH–1(27).

Relay 27ETM16, operated, closes an operate path for relay 27ETR from ground at make contacts 34ONG–20(27) through make contact 27ETM16–11(27). Relay 27ETR, operated, interrupts at break contact 27ETR–9(27) the operate path for the 27ETM– relays; all but one of the relays will now release and it will be assumed that the one relay remaining operated over the preference circuit is relay 27ETM16. Since only relay 27ETM16 of the 27ETM– relays is operated, relay 27ETK now operates from ground, make contact 27LTC–21(27), break contacts 34RLSB–4(27) and 26BSY–2(27), break contact of transfer pair 27ETM0–8(27), make contact of transfer pair 27ETM16–8(27), break contact of transfer pair 27ETM19–8(27), make contact 27ETR–8(27), winding of relay 27ETK to battery.

Relay 27ETH, which is slow release, starts to release following operation of relay 27ETK as the operate path is interrupted at break contact 27ETK–7(27). Relay 27ETK, operated, connects ground to the LT– leads at make contact 27ETK–1(26); with relay 27ETM16 operated this ground shunts the operate winding of relay 26ET16 at the make contact of transfer pair 27ETH16–2(27) and relay 26ET16 releases. Also, this ground extended over lead LT16 operates relay 10MC of tie trunk A since the resistance of the 26ET16 relay winding is now removed from the path. Ground is now connected over lead MCTK through make contact 10MC–4(10); this ground is applied to marker relay 32MCTK through the make contact of transfer pair 27ETK–8(32) and relay 32MCTK operates.

Relay 32MCTK (or relay 32MCLK on a line initiated call) must operate before slow-release relay 27ETH has fully released. Provided relay 32MCTK has operated before release of relay 27ETH, a holding ground will be supplied for relay 27ETM16 from make contact 34ONG–20(27) through the make contact of transfer pair 32MCTK–5(27) before the original holding ground at make contact 27ETH–1(27) has been lost by release of relay 27ETH. If relay 27ETM16 is permitted to release the circuit returns to its testing condition described above and repeats the test for locating the vertical file of the calling trunk.

The situation just referred to, that is a "repeat test" condition assumes a disconnect or faulty line or trunk functioning where neither the 32MCTK nor the 32MCLK relay operates. For the majority of calls, however, at least excepting disconnects, the 32MCTK or 32MCLK relay will operate according to plan.

Class-of-service indication

The operation of relay **10**MC in the tie trunk circuit as described above closes through the leads by way of which trunk class-of-service information is forwarded to the marker. Among other information the class of srevice of a trunk indicates the type of signaling for which the trunk is equipped, that is dial pulsing, multi-frequency or TOUCH-TONE; whether or not dial tone is required to be returned to the trunk; the type of call treatment to be accorded the call by the marker; and so on. While the marker in actual practice may be equipped to handle as many as one hundred classes of service it will be assumed for present purposes that ten classes of service are provided for. Further, it is assumed that the class of service assigned to the trunk which initiated the connection in class-of-service 9, an arbitrarily assigned number.

Operation of relay **10**MC as previously described connects ground through make contact **10**MC–**1**(**10**) to lead CSU**9** and through the link and connector to the marker for operation of relay **37**CU**9**. "One-only-operated" check relay **37**CUK now operates from ground, make contacts **39**DTA–**8**(**37**), break contacts of respective transfer pairs **37**CU**0**–**12**(**37**) and **37**CU**5**–**1**(**37**), make contact of transfer pair **37**CU**9**–**1**(**37**), winding of relay **37**CUK to battery.

Class-of-service registered in register sender

A path is now closed for connection of ground to lead DP (FIG. 41) through make contacts **32**MCRK–**12**(**41**), **37**CUK–**4**(**41**) and **37**CU**9**–**5**(**41**), and terminal CU**9** cross connected to terminal TDP. This same ground is applied also to lead NDT, diode **41**TDP**1**D being included in the first path and diode **41**TDP**2**D being included in the second path. Leads DP and NDT extend the ground through respective make contacts **19**RC**6**–**22**(**24**) and **19**RC**6**–**21**(**24**) of the link and connector operate relays **63**DP and **63**NDT of the register sender; relays **63**DP and **63**NDT upon operation lock to ground at make contact **59**MC**1**–**23**(**63**), relay **59**MC**1** having operated following operation of relay **63**MC as described above. The locking ground is now transmitted back over leads DP and NDT through the paths previously traced and causes relays **41**DPK and **41**NDTK to operate. The operation of marker relays **41**DPK and **41**NDTK indicates the registration of the class of service in the register sender as evidenced by operation of relays **63**DP and **63**NDT.

Operation of relay **37**CUK as just described, with relay **32**MCRK operated, closes an operate path for relay **41**CSG from ground, make contact **37**CUK–**2**(**41**), break contact **34**RLS–**11**(**41**), make contact **32**MCRK–**2**(**41**), winding of relay **41**CSG to battery. Paths are now closed for transmitting various information such as class of service, the selected link and the horizontal group from the marker to the register sender. For example, respective ground applying paths are closed through make contacts **41**CSG–**1**(**33**) and **37**CUK–**3**(**33**) and through make contacts **41**CSG–**2**(**33**) and **37**CUK–**1**(**33**) and through the 2-out-of-5 translator to leads CLU**2** and CLU**7**, and through make contacts **19**RC**6**–**42**(**25**) and **19**RC**6**–**44**(**25**) of the link and connector to the register sender whereby to operate relays **66**CLU**2** and **66**CLU**7**. Upon operation these relays lock to ground at make contact **52**ON–**7**(**66**). In turn, this locking ground is returned over leads CLU**2** and CLU**7** whereby to operate marker relay **33**CUK**1** through the left winding to battery and to operate marker relay **33**CUK**2** through the right winding to battery. Relays **33**CUK**1** and **33**CUK**2** are check relays for the "class units" relays of the register sender and indicate by their operation the registration in the register sender of the transmitted information.

Also, in a manner similar to that just described, a path is closed at make contact **41**CSG–**7**(**37**) through the 2-out-of-5 translator to leads CLT**0** and CLT**7** for operation of relays **66**CLT**0** and **66**CLT**7** of the register sender.

(These relays are included for illustrative purposes but would not be provided in an actual embodiment designed for only ten class-of-service possibilities.) Relays **66**CLT**0** and **66**CLT**7** upon operating lock to ground at make contact **52**ON–**7**(**66**) and this ground is returned to operate the respective checking relays **37**CSTK**0** and **37**CSTK**7** in the marker.

The 1-out-of-10 to 2-out-of-5 translators are not shown in detail since such circuits are well known in automatic switching systems and are disclosed in the art. For example, a generally similar translator arrangement is disclosed in P. H. Arnold et al. Patent 3,151,220, issued Sept. 29, 1964. In general, selected outgoing leads (2-out-of-5) are energized according to operation of a contact matrix comprising contacts of 10 "incoming" leads.

Paths are completed through make contacts **41**CSG–**5**(**33**) and **26**HGK–**9**(**33**) and make contacts **41**CSG–**6**(**33**) and **26**HGK–**3**(**33**) and through the 2-out-of-5 translator to leads HGT**2** and HGT**7**, and through make contacts **19**RCA**6**–**33**(**25**) and **19**RCA**6**–**34**(**25**) of the link and connector for operating register-sender relays **66**HG**2** and **66**HG**7**; these relays lock to the ground at make contact **52**ON–**7**(**66**) and the ground is returned over the leads to operate check relay **33**HGK**1** through the left winding to battery and to operate check relay **33**HGK**2** through the right winding to battery.

Also, paths are completed through make contacts **41**CSG–**3**(**33**) and **30**LKK–**6**(**33**) and make contacts **41**CSG–**4**(**33**) and **30**LKK–**4**(**33**) and through the 2-out-of-5 translator to leads LKT**2** and LKT**7** for operation of relays **66**LK**2** and **66**LK**7** of the register sender. As in the previously-described examples the relays lock to ground at make contact **52**ON–**7**(**66**) and this ground is transmitted back over the leads to operate marker check relay **33**LKK**1** through the left winding to battery and to operate check relay **33**LKK**2** through the right winding to battery.

At this point all required information has been transmitted from the marker to the register sender and the marker now proceeds to operate the select and hold magnets in the link and connector circuit which will connect the call-initiating trunk to the selected register sender. The operation of the register sender will be described in detail subsequently.

Paths are now closed, and will be described immediately below for operating relays **21**VG**0**HG**0** and **21**VG**6**HG**0**; the first-mentioned relay defines the vertical group in which the trunk which initiated the call appears and the horizontal group selected by the marker and the second-mentioned relay defines the vertical group **6** in which the selected register sender appears.

Marker battery is applied to lead VH**0** through break contacts **38**RCY–**5**(**30**) and **34**RLSA–**5**(**30**), make contacts **26**HGK–**11**(**30**) and **39**VLCK–**4**(**30**) make contact of transfer pair **39**DT–**11**(**30**), make contact **39**VRCK–**4**(**30**), make contact of transfer pair **35**HG**0**–**7**(**30**) to lead VH**0**. Since relay **19**CC**0** defining vertical group **0** and relay **19**CC**6** defining vertical group **6** were previously operated as described above, a path is now completed from lead VH**0** through make contact **19**CC**0**–**20**(**21**) for operating relay **21**VG**0**HG**0** and a second path is completed from lead VH**0** through make contact **19**CC**6**–**20**(**21**) for operating relay **21**VG**6**HG**0**.

Paths are now closed, described immediately below, for operating relays **42**VHL and **42**VHR whereby to verify the operation of relays **21**VG**0**HG**0** and **21**VG**6**HG**0** in the link and connector circuit.

The operate path for relay **42**VHL extends from ground, make contact **32**MCTK–**2**(**42**), winding of relay **42**VHL, resistor VHL, break contact of transfer pair **98**HM–**10**(**42**), make contact **27**ETM**16**–**4**(**42**) to lead HM**16** and thereover to the link and connector through make contacts **19**TC**0**–**51**(**17**) and **21**VG**0**HG**0**–**51**(**17**) and the winding of hold magnet **17**HM**0016** to battery. Relay **42**VHL operates over this path but the hold mag-

net 17HM0016 does not operate at this point due to the relatively high resistance of the path.

The operate path for relay 42VHR extends from ground, make contacts 31RTK–4(42) and 39DTA–12(42), winding of relay 42VHR, resistor VHR, break contacts of transfer pairs 98HM–11(29), 40RT17–10(42) and 40RT18–10(42), make contact 40RT19–10(42), to lead RHM19, make contact 19RCA6–54(18) and cross connection, through make contact 21VG6HG0–19(18) and winding of hold magnet 18HM6019 to battery. (In order to avoid undue complication of the drawing, the crossbar switch and associated hold magnet circuits are shown in detail only with regard to vertical group 0; it will be understood that the details of those portions shown only as captioned boxes are generally similar to the portions shown in detail.) Relay 42VHR operates over the path traced but hold magnet 18HM6019 does not operate at this point due to the relatively high resistance of the path.

Now, with relays 42VHL and 42VHR operated, verification is provided of the availability of operating paths for the hold magnets which define the proper vertical files in the selected horizontal group. (It will be clear from the designations that hold magnet 17HM0016 is associated with vertical group 0, horizontal group 0 and vertical file 16 while hold magnet 18HM6019 is associated with vertical group 6, horizontal group 0 and vertical file 19.)

An operate path for relay 32VHCK is now completed by operation of relays 42VHL and 42VHR traced from ground, make contact 34ONG–17(32), break contacts 34RLSA–11(32), 38RCY–12(32), and 28N2TP–5(32), break contact of transfer pair 28N2TP–3(32), make contact 42VHR–3(32), make contact of transfer pair 39DT–10(32), make contact 42VHL–3(32), break contact of transfer pair 32XT3–4(32), winding of relay 32VHCK to battery; relay 32VHCK operates and locks to ground through its make contact 32VHCK–1(32).

Select magnets operate

Now with operation of relay 32VHCK as just described, operate paths are closed for the select magnets defining the selected link in the selected horizontal group that is link 0 in horizontal group 0. Battery is connected through break contacts 38RCY–4(30) and 34RLSA–4(30), the make contact of transfer pair 39DTA–3(30), make contacts 32VHCK–11(30) and 30LKK–11(30), the make contact of transfer pair 30LK0–1(30) to lead SM0 (relay 30LK0 defines the selected link). The battery is extended over lead SM0 to the link and connector circuit, through make contacts 19CC6–0(16) and 21VG6HG0–0(16) and the winding of relay 16SM600 to ground; relay (select magnet) 16SM600 operates. Also, the battery on lead SM0 is extended through make contacts 19CC0–0(16) and 21VG0HG0–0(16) and through the operate winding of relay 16SM000 to ground; relay (select magnet) 16SM000 operates.

Verification in the marker of the proper operation of the select magnets 16SM600 and 16SM000 is given by operation of check relays 32SMLK and 32SMRK. The path for operating relay 32SMLK is traced from ground, off-normal contact 16SM000–1(13) of the select magnet, make contacts 19TC0–12(13) and 19VP0–1(13), lead SMLK0 to the marker, the make contact of transfer pair 36VGL0–2(32), make contact 36VGK–2(32), the make contact of transfer pair 32VHCK–8(32) through the winding of relay 32SMLK to battery; relay 32SMLK operates. The path for operating relay 32SMRK is traced from ground, off-normal contact 16SM600–1(13) of select magnet, make contacts 19RC6–12(13) and 19VP6–5(13) to lead SMRK6 and thereover to the marker, through the make contact of transfer pair 40VGR6–2(32), break contact of transfer pair 40VGR0–2(32), make contact 39VRK–5(32), make contact of transfer pair

32VHCK–6(32), winding of relay 32SMRK to battery; relay 32SMRK operates.

As pointed out above the operation of relays 32SMRK and 32SMLK provides verification of the proper operation of the select magnets in the link circuit. The next step is to operate the appropriate hold magnets in the link circuit.

Relay 98HM is now operated from battery, winding of relay 98HM, break contacts of transfer pairs 33XT1–4(98) and 42XT2–9(98), make contact 32SMLK–1(98), make contact of transfer pair 39DT–3(98), make contact 32SMRK–10(98), make contacts 33CUK2–10(98), 33CUK1–10(98), 33LKK2–10(98), 33LKK1–10(98), 33HGK2–10(98), and 33HGK1–10(98), break contact of transfer pair 41TTK–8(98), break contact 41MFK–6(98), make contacts of transfer pairs 41DPK–8(98) and 41DTK–8(98), break contact of transfer pair 41NDTK–8(98), make contact 34ONGA–5(98) to ground; relay 98HM operates and provides indication that all necessary information has been registered in the register sender and that all prior marker operations have been completed before operating the hold magnet in the link circuit.

Hold magnets operate

Relay 98HM, operated, releases relay 42VHR and 42VHL by interrupting the respective operate paths at the break contacts of respective transfer pairs 98HM–11(42) and 98HM–10(42); the previously-described check paths over leads RHM19 and HM16 are transferred through the make contacts of the transfer pairs just referred to from the windings of relays 42VHR and 42VHL to the windings of relays 42HKR and 42HKL respectively and to the respective leads RHM19 and HM16. It will be recalled that lead RHM19 is connected through to the winding of hold magnet 18HM6019 and to battery and that lead HM16 is connected through to the winding of hold magnet 17HM0016 and to battery, and it will be noted that paths of lower resistance are now provided since the respective resistors VHR and VHL are no longer included. Accordingly, hold magnet 17HM0016 (trunk) and hold magnet 18HM6019 (register sender) now operate together with relays 42HKR and 42HKL which are connected in series with the hold magnets over the respective leads RHM19 and HM16.

Relay 42HKR, operated, completes an operate path for relay 98HKRA from ground, make contact 34ONG–2(98), break contact 34RLS–8(98), make contact 42HKR–1(98), winding of relay 98HKRA to battery, and relay 42HKL, operated, completes an operate path for relay 98HKLA from ground, make contact 34ONG–2(98), break contact 34RLS–8(98), make contact of transfer pair 42HKL–1(98), winding of relay 98HKLA to battery. Relay 98HKRA operates and locks through its make contact 98HKRA–8(98) to the ground at make contact 34ONG–2(98); relay 98HKLA operates and locks to the same ground through its make contact 98HKLA–5(98).

When the hold magnet (17HM0016) for the call-initiating trunk and the hold magnet (18HM6019) for the selected register sender operate as above described, the trunk and the register sender are connected together through the link wiring; the hold magnets are now held operated to ground over paths described below. As these paths to ground are closed, relays 42HKR and 42HKL are shunted down and release.

It will be recalled from the preceding description that hold magnet 17HM0016 is associated with vertical file 16 of vertical group 0 of the crossbar switch and with horizontal group 0 thereof and that the call-initiating trunk is connected to vertical file 16 of vertical group 0 of the switch. It will be recalled further that hold magnet 18HM6019 is associated with vertical file 19 of vertical group 6 of the switch and with horizontal group 0 thereof. Accordingly, when the crosspoints are closed the initiat-

ing trunk and the selected register sender are connected by link 0 through horizontal level 0 of the switch.

Now with relays 98HKRA and 98HKLA operated and relays 42HKR and 42HKL released, relay 98HMK is operated from ground, make contact 34ONG–2(98), break contact 34RLS–8(98), break contact of transfer pair 42HKL–1(98), make contacts 98HM–12(98) and 98HKLA–1(98), make contact of transfer pair 39DT–5(98), make contact 98HKRA–12(98), winding of relay 98HMK, resistor HMK to battery. The manner of inclusion of contacts of relays 42HKR and 42HKL in the operate path of relay 98HMK is such that relay 98HMK will not operate unless both relays 42HKR and 42HKL have released. For example, if relay 42HKL has released but relay 42HKR is still operated the operate battery for relay 98HMK will be shunted by ground through make contacts 39DTA–11(98), 42HKR–1(98) and 34ONGA–2(98). On the other hand, if relay 42HKR is released and relay 42HKL is operated, the ground path for operating relay 98HMK is open at the break contact of transfer pair 42HKL–1(98). Diode HKRA acts to prevent the locking ground for relay 98HKRA from shunting the 98HMK relay.

Operation of relay 98HMK provides verification that the marker functions in establishing the connection have been completed and that the marker should be released. The release functions will be described below.

When a connection has been established as described above between the call-initiating trunk and the selected register sender, the register sender indicates the completion of the connection through operation of relay 51L. (Relay 63MC was operated as previously described above to connect the marker to the register sender and to facilitate transmittal of call information from the marker to the register sender.) The operate path for relay 51L comprises a simplex circuit from battery, upper winding of relay 51L (polarized), resistors RL1 and RL2, make contact of transfer pair 63TTC–3(51), one winding of repeat coil TTC, make contact 63TTC–51(51) to lead TT, through the operated crosspoints of the link, to the tie trunk A (FIG. 7) which initiated or originated the call, the break contact of transfer pair 10RV–2(7), break contact 100TS–4(7), through a portion of the TR repeater (not shown in detail), upper winding of relay 7RSS, make contact of transfer pair 10E–2(7) to ground; relay 51L operates over this path whereby to indicate the connection of the register sender to the tie trunk circuit but relay 7RSS does not operate at this point due to the relatively high resistance of the path.

Relay 51L, operated, closes an operate path for relay 51SR from ground, make contact 51L–1(52), winding of relay 51SR to battery. Relay 51SR upon operating closes at make contact 51SR–10(52) an obvious operate path for relay 52ON, which, upon operating, closes at make contact 52ON–24(52) an operate path for relay 52ON1.

Relay 51SR, operated, connects ground through make contact 51SR–8(51), break contact 51RLA–6(51), and the break contact of transfer pair 53TA1–1(51) to lead HMH19 for transmission thereover to the link and connector circuit (FIG. 18) whereby to provide holding ground for hold magnet 18HM6019 (register sender) through off-normal contact 18HM6019–2(18).

Relay 52ON, operated, connects ground through make contact 52ON–10(51) to the S lead (sleeve), which ground is extended through the operated crosspoints of the link and connector circuit to the winding of relay 7SL of the call-initiating tie trunk circuit and therethrough to battery; relays 7SL and 51SL both operate over this path. Relay 7SL, operated, connects ground through make contact 7SL–1(7) to lead HMH16 for transmission to the link and connector circuit (FIG. 17) whereby to provide holding ground for hold magnet 17HM0016 (line) through off-normal contact 17HM0016–2(17). The holding paths referred to above for hold magnets 18HM6019 and 17HM0016 have now been established.

Relay 61RA1 now operates from ground at make contact 51SR–2(61) through break contact 52RAA–3(61); this in turn closes an operate path for relay 61RA2 at make contact 61RA1–2(61). Relay 60ISI now operates from ground, make contact 51SR–2(61), break contact of transfer pair 52RAA–7(61), make contact of transfer pair 61RA2–9(61), break contacts 61TTP–3(61), 56MFP–7(61) and 52DPD–7(61), the break contact of transfer pair 60IS1–6(60), winding of relay 60ISI to battery. Relays 61RA1, 61RA2 and 60ISI are operated, as just described, to prepare for receiving digital information in the register sender when pulsing is started.

As mentioned above, at the time the holding grounds ars supplied to hold magnets 17HM0016 and 18HM6019, check relays 42HKR and 42HKL are shunted down and release; this indicates to the marker that the line circuit and the register sender are now under control of the link connection and that the marker may now remove its operating potentials from the windings of the hold magnets. In other words, the marker should now proceed to release.

When relay 98HMK operated, as previously described above, relay 34DCK released since the hold path was interrupted at break contact 98HMK–2(34). Relay 34DCK, released, closes ground through break contact 34DCK–1(86), and make contact 93DTS–7(86), winding of relay 86RL to battery; relay 86RL operates as an indication to the decoder that a disconnect connection should be initiated. Relay 86RL locks to ground through make contacts 86RL–8(86) and 81ON–5(86).

Relay 86DIS now operates from ground through make contact 86RL–9(86) whereby to apply ground to lead NRL through make contacts 81ON–10(86) and 86DIS–10(86) and the make contact of transfer pair 86RL–10(86); the ground on lead NRL is applied through break contact 34DCK–10(34) to the windings of relays 34RLS, 34RLSA, 34RLSB and 34RLSC in parallel to battery; these four relays operate and lock to ground through make contact 34RLS–5(34) and break contact 34DCK–11(34).

Relays 34RLS, 34RLSA, 34RLSB and 34RLSC, operated, release relay 34ONG by interrupting the holding path at break contact 34RLSC–1(34). The release of relay 34ONG removes the operate and hold grounds from previously-operated marker and link and connector circuit relays which now release. Also the operation of relay 34RLSC closes at make contact 34RLSC–4(38) an operate path for relay 38DCKA.

Operation of relay 38DCKA closes a path for reoperating relay 34DCK when all other relays in the marker have released; the reoperate path for relay 34DCK includes make contact 38DCKA–12(34), the make contact of transfer pair 34RLSB–10(34) and the intervening break contacts of the indicated marker relays. When relay 34DCK reoperates, a hold path for relay 38DCKA is closed through make contact 38DCKA–8(38) and the make contact of transfer pair 34DCK–8(38).

The operation of relay 34DCK opens lead NRL at break contact 34DCK–10(34) thereby opening the operate path for relay 34RLS; similarly one hold path for the relay is interrupted at break contact 34DCK–11(34). A remaining hold path for relay 34RLS extends over lead RLL to the decoder circuit and to ground at make contact 81ON–10(86).

Operation of relay 86DIS, as described above, opens leads HD1 and HD2 to the decoder-marker connector at break contacts 86DIS–7(81) and 86DIS-9(81) whereby to remove holding battery from these leads; relay 81HD of the decoder and relay 46DMSO of the connector are released by removal of the holding battery.

Release of relay 46DMSO allows the decoder-marker connector to release and also recloses the chain check

leads to operate relays 81CH1, 81CH2 and 81CH3 of the decoder.

Release of the decoder-marker connector removes ground from DTS, TM, ONG and TFC leads (FIG. 48); removal of the ground from lead DTS releases relay 93DTS of the decoder. Release of relay 93DTS releases in turn relay 81ON by interrupting the operate path at make contact 93DTS–4(81). Relay 81ON, released, releases in turn relay 86RL by interrupting the hold path at make contact 81ON–5(86), and relay 86RL upon releasing releases relay 86DIS by interrupting the operate path at make contact 86RL–9(86). Release of relay 81ON also releases marker relays 34RLS; 34RLSA; 34RLSB; 34RLSC by removing the holding ground from lead RLL at make contact 81ON–10(86); and releases marker relay 34DCK by removing holding ground from leads DCK and ONG at make contact 81ON–11(81). Relay 34DCK, released, releases in turn relay 38DCKA.

Relay 86DIS, released as above described, releases relays 81CB and 81STM by interrupting the operate ground at make contact 86DIS–6(81). Release of relay 81CB removes ground at make contacts 81CB–(81), 81CB–2(81) and 81CB–5(81) from leads CBO, CBOO and CBO1 to the connector whereby to release relays 49CB1, 49CB10 and 49CB11.

The decoder and marker combination has now been restored to normal condition and is available for further calls.

Further description of register sender operations

Returning now to further description of the register-sender operation, the operation of relay 51SL, as previously described above, completes an operate path for relay 52STG from ground, make contact 52ON–24(52), break contacts 63MC–7(52) and 53PS–12(52), make contacts 63DP–8(52) and 51SL–8(52), winding of relay 52STG to battery; relay 52STG operates and locks to the same ground through its make contact 52STG–3(52).

Relay 52STG, operated, completes a path through make contact 52STG–11(51) which shunts resistor RL1 and effectively removes it from the previously-traced path over lead TT to relay 7RSS of the tie trunk circuit. Through removal of resistor RL1 the overall resistance of the path is reduced sufficiently to result in operation of relay 7RSS.

Relay 7RSS, operated, closes at make contact 7RSS–8(10) an operate path for relay 10RSSA which locks through its make contact 10RSSA–8(10) to the ground at break contact 7RRLS–8(10). Relay 10RSSA, operated, closes ground through the make contact of its transfer pair 10RSSA–10(10) to lead M; this ground is transmitted to the distant station as a "go" or "start" signal to the distant pulsing circuit.

After the first pulsed digit has been received in the register sender as described immediately below, a simplex signal is transmitted over the receive loop which causes operation of relays 7S; this is followed, in turn, by operation of relay 10S1. Relay 10IRS now operates from ground, make contacts 10S1–10(10), 10RSSA–11(10), winding of relay 10IRS to battery.

Relay 10IRS, operated, opens the receive loop of the tie trunk at break contacts 10IRS–2(7) and 10IRS–4(7); this releases relay 7S which is followed by release of relay 10S1. Also, relay 10IRS, operated, closes at makes contact 10IRS–11(10) an operate path for relay 10OR which operates and locks to ground through its make contact 10OR–9(10). Relay 10OR, operated, opens at break contact 10OR–11(10) the operate path of relay 10RV and opens at break contact 10OR–10(7) the operate path of relay 7SA.

Pulsing of called station code

Upon receipt of the "start" signal, pulsing of the called station is started by the distant which is connected through tie trunk A; the register sender awaits the pulses which it expects to receive. Relay 10E operates in step with the pulses from the distant station; relay 51L of the register sender follows the pulses in the usual way accordingly as ground is applied to the transmitting channel at the make contact of transfer pair 10E–2(7).

Relay 51L, operating in step with relay 10E of the tie trunk circuit, drives a pulse-counting chain of five relays, 107IP1–107IP5. These relays are used to count the number of dial pulses generated on a digit, and translate the combinations of operated relays to the 2-out-of-5 code required for digit registration.

On the first release of relay 51L, lead SR obtains ground through break contact 51L–3(52) and relay 107IP1 operates from this ground through break contact 63MFR–4(107), make contact 51SR–4(107), break contact of transfer pair 107IP2–6(107), winding of relay 107IP1 to battery; relay 107IP1 operates and locks through its make contact 107IP1–1(107) to ground at make contact 52ON–6(107). When relay 10E operates at the end of the pulse, relay 51L reoperates and lead RA obtains ground through make contact 51L–2(52). Relay 107IP2 operates from this ground through break contacts 63MFR–6(107), 61RA2–2(107), make contact 107IP1–11(107), break contact of transfer pair 107IP2–12(107), winding of relay 107IP2 to battery; relay 107IP2 operates and locks through the make contact of its transfer pair 107IP2–12(107) and make contact 107IP1–1(107) to the ground at make contact 52ON–6(107). Relay 107IP2, operated, also transfers at the make contact of its transfer pair 107IP2–6(107) the operate path of relay 107IP1 to lead RA.

On the next pulse with ground removed from lead RA, relay 107IP1 releases but relay 107IP2 holds to the ground now connected to lead SR through break contact 51L–3(52). This cycle of 107IP1–107IP2 relays is repeated for every two cycles of relay 51L.

When relay 107IP1 releases at the end of the first cycle, with relay 107IP2 operated, relay 107IP3 operates from ground through make contact 52ON–6(107), break contact 61RA2–4(107), make contact 107IP2–11(107), respective break contacts of transfer pairs 107IP1–4(107), 107IP5–6(107) and 107IP4–6(107), winding of relay 107IP3 to battery; relay 107IP3 upon operating locks to the same ground through its make contact 107IP3–11(107) and 107IP2–1(107).

With relays 107IP1, 107IP2 and 107IP3 operated during the third pulse cycle, relay 107IP4 operates and remains operated until the ninth pulse cycle. Relay 107IP3 releases at the start of the fifth pulse cycle but reoperates during the sixth pulse cycle. For convenience the sequence of these operations is listed below:

Pulse:,	Counting relays remaining operated
1	107IP1, 107IP2.
2	107IP3.
3	107IP1, 107IP2, 107IP3, 107IP4.
4	107IP3, 1071P4.
5	107IP1, 107IP2, 107IP4.
6	107IP4, 107IP5.
7	107IP1, 107IP2, 107IP4, 107IP5.
8	107IP3, 107IP4, 107IP5.
9	107IP1, 107IP2, 107IP3, 107IP5.
10	107IP3, 107IP5.
11	107IP1, 107IP2, 107IP5.
12	107IP5.

In addition to the pulse counting function just described, relay 51L also controls the operations of the 52RAA, 61RA2, 52RA, and 61RA1 relays. On the first release of relay 51L, relay 52RA operates from ground, break contact 51L–5(52), make contact 52ON1–8(52), break contacts 56MFP–10(52) and 61ADR1–7(52), winding of relay 52RA to battery; upon operating relay 52RA closes at make contact 52RA–2(52) a shunting path for the secondary winding whereby to give the relay a slow-release characteristic. Relay 52RA, operated, closes at make contact 52RA–4(52) an operate path for relay 52RAA. At this same time, since relay 52RAA has op-

erated, relay **61**RA**1** starts its release as the operate path is interrupted at break contact **52**RAA–**3**(**61**). When relay **61**RA**1** has fully released, relay **67**RA**2** releases as the operate path is interrupted at make contact **61**RA**1**–**2**(**61**).

Relay **52**RAA, when operated as just described, removes at break contacts **52**RAA–**1**(**57**) and **52**RAA–**2**(**57**) the ground from the 2-out-of-5 matrix of contacts of the **107**IP**1**–**107**IP**5** relays (FIG. 57). However, at the end of a digit when relays **52**RAA and **61**RA**2** are released ground is then supplied through the matrix according to the released-operated condition of the respective **107**IP**1**–**107**IP**5** relays and through the make contacts of transfer pairs **60**IS**1**–**1**(**62**) and **60**IS**1**–**7**(**62**) whereby to operate a particular two of the **62**A– relays of the "A" digit register in accordance with the well-known 2-out-of-5 translation and registration procedure. (Relay **60**IS**1** is operated as described immediately below.)

Relay **61**RA**1**, which is slow both to operate and to release, starts to operate but permits the **62**A– relays to fully operate before closing the operate path of relay **61**RA**2**; operation of relay **61**RA**2** removes the ground from the 2-out-of-5 matrix (FIG. 57) and permits advance of the insteering chain described below.

On the operation of relay **61**RA**2**, the operated **107**IP– relays release as their holding ground is interrupted at break contact **61**RA**2**–**4**(**107**). The first release of relay **51**L for the next digit re-establishes the locking ground path whereby to permit pulse counting. The pulse counting translation and storage of digits continues until all digits are received and stored on the register units **62**A–**62**E and **65**F–**65**M as required.

Insteering control includes the following operations. Relay **60**IS**1** operated when the register sender was seized from ground, make contact **52**ON–**8**(**61**), break contact of transfer pair **52**RAA–**7**(**61**), make contact of transfer pair **61**RA**2**–**9**(**61**), intervening break contacts, break contact of transfer pair **60**IS**1**–**6**(**60**), winding of relay **60**IS**1** to battery. On receipt of the first pulse of the first dialed digit, relay **52**DPD operates following operation of relay **52**RAA from ground, make contacts **51**SR–**10**(**52**), **52**RAA–**8**(**52**), **60**IS**1**–**8**(**52**), break contact **56**MFP–**12**(**52**), make contact of transfer pair **52**DPD–**6**(**52**), winding of relay **52**DPD to battery; relay **52**DPD operates and locks to the ground through the make contact of its transfer pair **52**DPD–**6**(**52**).

Relay **52**DPD, operated, opens the operate path of relay **60**IS**1** at break contact **52**DPD–**7**(**61**) in preparation for the advance of the steering chain. Relay **60**IS**1** holds operated through the make contact of its transfer pair **60**IS**1**–**6**(**60**) and through the break contacts of respective transfer pairs of succeeding steering relays.

At the end of the first digit when relay **51**L holds operated, relay **52**RAA releases, after a delay of about 100 milliseconds, and closes an operate path for relay **60**IS**2** from ground at make contact **52**ON–**8**(**61**), break contacts of transfer pairs **52**RAA–**7**(**61**) and **61**RA**2**–**9**(**61**), make contact **52**DPD–**9**(**61**), break contact **61**ADR–**9**(**61**) leads **611** and **601**, make contact of transfer pair **60**IS**1**–**9**(**60**), break contact of transfer pair **60**IS**2**–**6**(**60**), winding of relay **60**IS**2** to battery; relay **60**IS**2** operates and locks through the make contact of its transfer pair **60**IS**2**–**6**(**60**) and leads **602** and **612** to the ground at make contact **52**ON–**8**(**61**).

With relay **60**IS**2** operated, digital information received is stored in the **62**B– digit register since the 0–7 digit leads are connected thereto through make contacts of the respective transfer pairs **60**IS**2**–**1**(**62**) and **60**IS**2**–**7**(**62**). After the third digit is received, relay **60**IS**3** is operated and relay **60**IS**2** releases, and so on. The steering chain advances in this manner until all digits have been received.

The outsteering chain of the register sender is provided to permit the simultaneous outpulsing of digits while the insteering chain is controlling the registration of digits being received. On decoder release, as subsequently described, the operation of relay **59**DR causes the operation of relay **64**OSA if multifrequency outpulsing is required or operation of relay **64**OSB if a priority digit is to be outpulsed without multifrequency. If no priority digit or multifrequency pulsing is required, relay **64**OSC will be operated on outgoing tandem calls and relay **64**AUX on terminating calls.

Assuming, merely by way of illustration, operation of relays **64**OSB and **67**OSC by the decoder, advance of the outsteering chain is under control of make contact **72**W–**4**(**64**) of relay **72**W. On dial outpulsing calls, relay **72**W operates during the interdigital interval and releases prior to outpulsing of the next digit. On multifrequency outpulsing, relay **72**W operates each time a digit is being transmitted and releases at the end of the digit. The locking path of relay **64**OSB is transferred to be under control of relay **72**W. Operation of relay **64**OSC opens the original operate path of relay **64**OSB and the registered digit information is available for outpulsing. When relay **72**W operates as or after the next digit is outpulsed, relay **64**AUX operates and locks to an off-normal ground. The locking path for relay **64**OSC is transferred to be under control of relay **72**W; when relay **72**W releases, the release of relay **64**OSC follows. Release of relay **64**OSC leaves the outsteering circuit with relays **64**AUX and **64**OS**3** operated with the information in the C digit position available for outpulsing. When the information in the C digit position is next outpulsed, relay **72**W operates whereby to operate relay **67**OS**4**; steering advances in this described manner until the last digit to be outpulsed has been processed.

A steering circuit for selectively controlling the outpulsing of digital information which embodies features similar to those of the presently disclosed arrangement is disclosed in the copending application of G. Riddell, Ser. No. 327,979, filed Dec. 4, 1963, now Patent No. 3,290,657, issued Dec. 6, 1966.

"Dialing" by register sender

The "dialing" of each digit from the register sender is under control of the dial pulse generator (relays **108**PG**1**–**108**PG**2**), the pulse counting relays (**70**P**1**–**70**P**5**), and the digit control relays. When a stored digit is to be outpulsed the read-out relays **71**RR**0**–**71**RR**10** operate. A 2-out-of-5 check is made of the stored digits and the check relay **72**RK is operated. The pulse generator is enabled, as described below, and starts to pulse the digit. The pulse counting relays count pulses and match against the digit on the **71**RR– relay; when a match is reached the **70**IC relay operates to terminate the digit.

When relay **51**SR operates, relay **108**PG**1** operates from the ground at make contact **51**SR–**10**(**52**), break contacts **72**W–**5**(**108**), **70**IC–**7**(**108**), **53**TT**1**–**1**(**108**), winding of relay **108**PG**1** to battery. Relay **108**PG**1**, operated, connects this same ground through the make contact of transfer pair **108**PG**1**–**4**(**108**) to one side of the parallel capacitors PGAC and PGCC and to the PG1R resistor thus shunting out the battery and connecting ground to the left terminal of the upper, secondary, winding of relay **108**PG**2**. At this point the right terminal of the windings of relay **108**PG**2** is connected to battery through resistors **1081** and **1082**. The current in the upper, secondary, winding is in a direction to release the relay but the current in the secondary winding is in a direction to operate the relay. Initially the primary ampere turns are the more powerful and the relay operates, but as the capacitors become charged, the secondary winding ampere turns become controlling and cause relay **108**PG**2** to release.

The circuit remains in this condition until the auxiliary circuit to relay **108**PG**1** is opened and that relay releases. Relay **108**PG**1**, released, disconnects the ground from the PG– capacitors and the PG1R resistor allowing

the battery through resistor PG1R to become effective; ground is connected through the break contact of transfer pair 108PG1–4(108) to the right terminal of the 108PG2 relay windings. This causes the current in the upper, secondary winding of the relay to reverse and flow in a direction to cause operation of the relay; also a path is now established for discharging, and charging in the opposite direction, the PGAC and PGCC capacitors through the primary, lower, winding of relay 108PG2. The primary winding ampere turns are at first controlling and relay 108PG2 remains unoperated. However, as the capacitors become charged, the primary winding ampere turns decrease and the secondary winding again assumes control causing relay 108PG2 to operate. Relay 108PG2, operated, operates relay 108PG1 by closing the ground path at make contact 108PG2–1(108); the paths through both windings of relay 108PG2 are now again reversed. This cycle is repeated so long as relay 108PG1 remains under control of relay 108PG2. When it is desired to stop the interrupter function, auxiliary circuit to relay 108PG1 is closed whereby to prevent the release of that relay.

The frequency of operation of the interrupter circuit just described is determined by the values of capacitors and resistors included in the circuit and it will be apparent from inspection that the novel circuit illustrated provides for three respective frequencies, one when relay 69DP20 is released [break contact 69DP20–2(108) and transfer pair 69DP20–4(108)], a second when relay 69DP20 is operated (same contacts), and a third when relay 69MF0 is operated [transfer pairs 69MF0–8(108) and 69MF0–6(108)].

When relay 108PG1 has released in the above-described cycle of operations, relay 70P1 operates from ground at break contact 69MF0–1(70), make contact 52ON–6(70), break contact of transfer pair 70IC–2(70), break contacts of transfer pairs 108PG1–5(70) and 70P2–6(70), winding of relay 70P1 to battery; relay 70P1, operated, locks to this same ground through its make contact 70P1–1(70). One-half cycle later, relay 108PG1 reoperates and operates relay 70P2 from the previous ground, make contact 108PG1–3(70), make contact of transfer pair 108PG1–5(70), make contact 70PI–11(70), break contact of transfer pair 70P2–12(70), winding of relay 70P2 to battery; relay 70P2 operates and locks to the ground through the make contact of its transfer pair 70P2–12(70). At the end of the pulse cycle, relay 108PG1 releases and releases relay 70P1; relay 70P2 holds. On the next reoperation of relay 108PG1, relay 70P2 releases. This cycle of relays 70P1 and 70P2 is then repeated for every two cycles of relay 108PG1.

It should be pointed out here that relays 108PG1 and 108PG2 are preferably mercury contact relays each provided with a single armature spring which closes with two separate back contacts and with two separate front contacts. The actual contact is made through a film of mercury. The two front contacts are wired in parallel and the two back contacts are unused. The relays are polarized and are not biased so that, with no current flowing, the armature takes no definite position; that is, it may close with the front contacts or it may close with the back contacts. The current reversals are under control of relay 108PG1 which in turn is under control of relay 108PG2 thus completing the self-interrupting circuit.

The pulse-counting relays 70P1–70P5 are used to count the number of dial pulses generated and are then recycled and used to count the interdigital interval pulses. Relays 70P1 and 70P2 are wired as a pulse divider and relays 70P3, 70P4 and 70P5 are used to differentiate between the different pairs of pulses.

The other pulse-counting relays operate in a generally similar manner; the following table shows the sequence of operations:

Pulse:	Counting relays remaining operated
1	70P1, 70P2.
2	70P3.
3	70P1, 70P2, 70P3, 70P4.
4	70P3, 70P4.
5	70P1, 70P2, 70P4.
6	70P4, 70P5.
7	70P1, 70P2, 70P4, 70P5.
8	70P3, 70P4, 70P5.
9	70P1, 70P2, 70P3, 70P5.
10	70P3, 70P5.
11	70P1, 70P2, 70P5.
12	70P5.

The digit-control relays include the between-digit relay 54BD, the interdigital-control relay 70IC and the function-dividing relays 72W and 72Z. In summary, these relays function as follows, the cycle of events being repeated for each digit.

Relay 54BD releases and the digit is pulsed; relay 70IC operates to terminate the digit and operate relay 72W whereby to recycle the counting relays. Relay 70IC releases and operates relay 72Z; this sets the counting relay to count the interdigital interval and operates relay 54BD. One and one-half cycles from the end of the interdigital interval, relay 70IC operates, releasing relay 72W and recycling the counting relays. Relay 70IC releases releasing relay 72Z; this places relay 70IC under control of the counting relays and the 71RR– relays and releases relay 54BD whereby to count the next digit to be pulsed.

When a fourth digit has been received and stored in the register sender, relay 60IS4 is in operated position and a path is closed for operating relay 60IS5. For a short transition interval between the receipt of the fourth digit and the start of the fifth digit, both relays 60IS4 and 60IS5 will be operated. Immediately following the registration of the fourth digit a path is completed for operating relay 58DMST, the path being traced from ground, make contact 52ON–22(58) break contact of transfer pair 59DR1–4(58), break contacts 59DMTR–2(58), 52DPD–5(58), 63CA5–1(58), 63CA6–7(58), 63CADR–1(58), make contact 63NDT–5(59), make contacts 60IS4–10(59) and 60IS5–10(59), break contact 59STA–7(58), break contacts of transfer pairs 58DMST–5(58) and 53TA1–10(58), winding of relay 58DMST to battery; relay 58DMST operates and locks to the same ground through the make contact of its transfer pair 58DMST–5(58). An obvious operate path for relay 59STA is closed at make contact 58DMST–12(59). Upon operation, relay 59STA assumes a slow-release characteristic by virtue of the short-circuiting path applied to the lower winding through make contact 59STA–4(59).

Register sender bids for decoder

As previously set forth, the register sender requires the services of a decoder and its associated marker in order to determine the routing of a call, to connect to an outgoing trunk, and to receive information concerning the number of digits expected, the number of digits to be outpulsed, type and class of outpulsing, and so on. Accordingly, after the register sender has receievd three, four, or five digits, depending on system requirements, it makes a bid for a decoder. This bid is made through operation of the 58DMST relay, and in the described example, since the call was initiated by a tie trunk circuit, the bid is made after registration of the fourth digit as described above.

Relay 58DMST, operated, closes at make contact 58DMST–7(59) the connection of battery to lead ST0 which is transmitted thereover to the decoder-marker connector circuit whereby to operate relay 44RS0 to ground at break contact 44RS9–8(44); upon operation relay 44RS0 locks to ground through its make contact 44RS0–8(44).

Each register sender provided in the system has an associated 44RS– relay; the system may in actual practice include as many as thirty register senders which would preferably be arranged in connector groups each including ten register senders. Accordingly, in such instance there would be three sets of 44RS– relays, each set including ten relays. However, since only one group of register senders is disclosed in the illustrative embodiment of the invention, only one set of 44RS– relays is illustrated.

Each 44RS– relay has a 44RA– relay associated therewith; relay 44RS0, operated, closes at the make contact of transfer pair 44RS0–12(44) an operate path for relay 44RA0 which, upon operating, locks to ground through make contact 44RA0–1(44).

Relay 58DMST, operated as above described, also completes a start circuit for initiating the connection of a register sender to the marker. Battery connected to leads SBA and SBB (FIG. 43) is extended respectively through make contact 58DMST–9(59) to lead STA and through make contact 58DMST–10(59) to lead STB at the register sender and back over these leads to the decoder-marker connector (FIG. 43); in accordance with the condition of the traffic control circuit lead STA is cross-connected to lead DM0 whereby to operate relay 46DMS0 through the break contact of transfer pair 46CB0–6(46).

The above-described operation of relays 44RS0 and 44RA0 established this register sender in a preferred position in its register-sender group. The operating and locking paths for the respective 44RS– relays are arranged in a "double work chain" wherein the operate path extends through break contacts of all "more preferred" 44RS– relays whereas the locking path extends only through make contacts of the individual 44RS– relays. The preference of the 44RA– relays is the opposite of that of the 44RS– relays as in the instance of the 44RA– relays the operating paths extend through break contacts of the "less preferred" 44RS– relays. Accordingly, relay 44RS0 operated through break-contacts of all other 44RS– relays in that connector group where as relay 44RA0 did not have to operate through break contacts of any 44RA– relays.

Relay 46DMS0, operated as above described, initiates the preference selection in the decoder-marker connector whereby connector relays are operated to connect a preferred marker and decoder to the register sender. This operation is a duplicate of that described above with regard to trunk connection and will not be again described in detail at this point. As a result of the circuit sequences at this time, relay 46DMG0 is operated, this relay being associated with the preferred marker and decoder. The operation of relays 44RA0 and 46DMG0 establishes connection between the marker and the register sender and information is passed in both directions between the marker and register sender through make contacts of those two relays.

Decoder operations

It will be recalled from the above description that the first four digits pulsed by the distant station associated with the tie trunk circuit of FIG. 7 were received and registered in the register sender prior to seizure of the marker. These four digits are now transferred to the decoder which will detemine, as described subsequently, whether or not the four digits represent sufficient information for the required purposes and will also determine whether or not an outgoing trunk should be seized at this point. Included in the information previously registered in the register sender is the indication that the call was initiated by a trunk (not a line); this information was derived from operation of relay 63NDT (no dial tone) in the register sender.

The decoder is arranged to process calls from a local calling station, with no route control digits, and from a trunk with a route control digit preceding the called

number. If the call is initiated by a local calling station the register sender grounds the DT lead indicating that dial tone was returned and identifying the call as one which does not have a route control digit registered. On the other hand, if the call is initiated by a trunk, as in the present illustrative example, the register sender grounds the NDT lead indicating that dial tone was not returned and identifying the call as one which has a route control digit transmitted from the register sender over the "A" digit leads.

In the present instance, relay 80NDT of the decoder operates from the ground applied to lead NDT through make contacts 63NDT–2(63), 44RA0–19(99) and 46DMA–19(99) and closes at make contact 80NDT–12(80) an operate path for relay 80CNC; since relay 80NDT is the only relay in the 80DT, 80NDT, 80PD group which is operated, relay 80CNC now operates from ground, the break contact of transfer pair 80DT–4(80), make contact of transfer pair 80NDT–4(80), break contact of transfer pair 80PD–6(80), break contact 93ROD–2(80), make contact 80NDT–12(80), winding of relay 80CNC to battery. Relay 80CNC, operated, closes at make contact 80CNC–6(80) an operate path for relay 80CNB. With relay 80CNB operated, and with relay 80CK subsequently operated as described below, relays 81TLC3 and 81TLC4 operate from ground through make contacts 80CK–7(81) and 80CNB–6(81).

Relay 80CNB, one of the digit connector relays, upon operating closes at make contacts 80CNB–1(85), 80CNB–2(85), 80CNB–3(85), 80CNB–4(85) and 80CNB–5(85) leads A0–A7 to route control digit registration relays 85RC0–85RC7, and closes at the respective make contacts of transfer pairs 80CNB–25(85) and 80CNB–29(85); transfer pairs 80CNB–30(84) and 80CNB–34(84); and transfer pairs 80CNB–35(34) and 80CNB–39(34) digit leads B0–B7, C0–C7 and D0–D7 to digit register relays 84H0–84H7 (hundreds), 84T0–84T7 (tens) and 84U0–84U7 (units). These digit register relays now operate in accordance with the information stored in the digit registers of the register sender, now transmitted therefrom to the decoder over the A–, B–, C–, and D– leads.

The route control digit, if transmitted, is registered in the decoder on the 85RC0–85RC7 relays on the usual 2-out-of-5 basis, for example in the event route control digit 0 is received, relays 85RC4 and 85RC7 will operate. The route control digit received governs the choice of routing and the route control digit to be transmitted to the next switching center.

Now that the three digits of the area and office code have been registered as described above, which three digits will be assumed to be "256" for illustrative purposes, the decoder first checks to be certain that only two of the five digit register relays for any one digit are operated; in the event it be found that in any instance either less than two or more than two of the relays are operated, a path will be closed for operation of relay 102TBL which, when operated, blocks the translation as subsequently described. Assuming first that in the hundreds group, only one relay, 84H0, is operated, it will be seen that a path is closed for operating relay 102TBL from ground, make contact 93RS–2(102), the make contact of transfer pair 84H0–4(102), the respective break contacts of transfer pairs 84H1–6(102), 84H2–6(102), 84H4–6(102), 84H7–6(102), winding of relay 102TBL to battery. On the other hand, if a second relay of the group, say 84H2, be operated in addition to relay 84H0, it will be seen that the operate path of relay 102TBL is not closed as the ground path is diverted to lead 1021 through the make contact of transfer pair 84H2–6(102), and the respective break contacts of transfer pair 84H4–8(102) and 84H7–8(102).

Now as a further example, if three of the relays, 84H0, 84H2 and 84H7 be operated, it will be seen that an operate path for relay 102TBL is again closed, being traced

from ground, make contact 93RS–2(102), make contact of transfer pair 84H0–4(102), break contact of transfer pair 84H1–6(102), make contact of transfer pair 84H2–6(102), break contact of transfer pair 84H4–8(102), make contact of transfer pair 84H7–8(102), winding of relay 102TBL to battery.

From inspection of the matrices of transfer contact pairs of the 84T– and 84U– relays, it will be seen that there, as in the instance of the 84H– relays, a path will be closed for operation of the 102TBL relay when only a single one of the relays is operated or when more than two of the relays are operated.

In the event relay 102TBL does operate, translator lead 1023 is opened at break contact 102TBL–1(102) and a path is closed through make contact 102TBL–5(86) for operating relay 86CPS. Relay 86CPS, operated, closes at make contact 86CPS–5(86) a path through the break contact of transfer pair 86CPB–12(86) and break contact 86TT1–9(86) for operating relay 86TT; relay 86TT, operated closes at the make contact of transfer pair 86TT–1(86) a path for operating relay 86TT1 which, upon operating, locks through its make contact 86TT1–12(86) to ground at make contact 86CPS–5(86), and releases relay 86TT by interrupting the operate path at break contact 86TT1–9(86). A path is now closed for operating relay 86TR (trouble release) from ground, make contact 86CPS–5(86), the break contact of transfer pair 86TT–1(86), make contact 86TT1–11(86), winding of relay 86TR to battery. Relay 86TR, operated, closes at make contact 86TR–1(86) an operate path for relay 86DIS (disconnect) which operates and releases the circuits in a manner which will be described subsequently.

Assuming now that the hundreds, tens and units digits of the three-digit code to be translated, i.e., "256," are properly registered on the 84H–, 84T–, and 84U– relays and that trouble relay 102TBL does not operate during the above-described check, grounds will be applied to the proper translating relays so that a code point is grounded; this code point will correspond to the area and office code represented by the digits "256."

The contact network of the 84H– relays operates a relay in the 92HT– translator group which corresponds to the hundreds digit of the three-digit code and the contact network of the 84T– relays operates one of the relays of the group 101T147, 101T258, 101T369 depending on the tens digit of the three-digit code; the tens digit 1, 4 or 7 operates relay 101T147, the tens digit 2, 5 or 8 operates relay 101T258 and the tens digit 3, 6 or 9 operates relay 101T369. In addition, the tens digit in conjunction with the operated 92HT2–92HT9 relays determines which specific 101TT(2–9)–R, S, T group of relays is operated corresponding to the hundreds and tens digit of the three-digit code. The operated 92HT– relay will determine which numeral of the eight possible in the 101TT– group of relays is required for a given code while the tens digit will determine which suffix letter, R, S, or T is required. The R suffix denotes tens digits 1, 2 and 3; S denotes tend digits 4, 5 and 6; and T denotes tens digits 7, 8 and 9. The particular code point corresponding to the three-digit code is grounded finally through contacts of the operated 84U– relay (units) in addition to contacts of the relays just mentioned.

Now with our specifically selected illustrative code "256," digit register relays 84H0 and 84H2; 84T1 and 84T4; and 84U2 and 84U4 will be operated by the information transmitted over the B–, C– and D– leads from the register sender; this in turn will cause operation of decoder-translator relays 92HT2, 101T258 and 101TT2S over the paths described immediately below.

First, with digit register relays 84H0 and 84H2 (hundreds) operated as previously described, a path is closed for operating decoder-translator relay 92HT2 which path is traced from ground, make contact 93RS–2(102), make contact of transfer pair 84H0–4(102), break contact of transfer pair 84H1–6(102), make contact of transfer pair

84H2–6(102), respective break contacts of transfer pairs 84H4–8(102) and 84H7–8(102), lead 1021, make contacts 84H0–10(92) and 84H2–10(92), cross connection to terminal HT2, winding of relay 92HT2 to battery; relay 92HT2 operates.

Second with digit register 84T1 and 84T4 (tens) operated, a path is closed for operating decoder-translator relay 101T258 which path is traced from ground, make contact 93RS–2(102), the break contact of transfer pair 84T0–4(102), make contact of transfer pair 84T1–4(102), break contact of transfer pair 84T2–6(102), make contact of transfer pair 84T4–6(102), break contact of transfer pair 84T7–8(102), leads 1022 and 1010, make contacts 84T4–3(101) and 84T1–3(101), winding of relay 101T258 to battery; relay 101T258 operates.

Also at this point, a path is closed for operating decoder-translator relay 101TT2S which path is traced from the ground applied to lead 1022 as just described, make contact 84T1–9(101), break contact of transfer pair 84T7–4(101), make contact 92HT2–10(101), cross-connection path between terminals T2S and TT2S, winding of relay 101TT2S to battery; relay 101TT2S operates.

Now with digit register relays 84U2 and 84U4 (units) and the tens and hundreds register relays operated as previously described and with decoder-translator relays 92HT2, 101T258 and 101TT2S operated as just described, ground is applied to code point 1031 (FIG. 103) which corresponds to the particular three-digit code with which we are concerned, that is "256." The ground path is closed only in the event relay 102TBL does not operate and it is traced from ground, make contact 80CK–1(102), respective break contacts of transfer pairs 84U0–4(102) and 84U1–4(102), respective make contacts of 84U2–4(102) and 84U4–6(102), break contact of transfer pair 84U7–8(102), lead 1023, break contact 102TBL–1(102), make contacts 84U2–7(103) and 84U4–7(103), lead 1032, make contacts 101T258–1(103) and 101TT2S–2(103) to cross-connection terminal 1031; the code point corresponding to code 256 is accordingly grounded. (Relay 80CK operated previously as a result of a "two-up-only" check of the 85RC– relays; specifically in the illustrative example, assuming operation of route control relays 85RC4 and 85RC7, the operate path for relay 80CK is traced from ground, break contacts of transfer pairs 85RC0–4(80), 85RC1–4(80), 85RC2–4(80), make contacts of transfer pairs 85RC4–4(80) and 85RC7–11(80), makes contacts 80NDT–10(80), 81ON–1(80) and 93RS–1(80), winding of relay 80CK to battery.)

The H0 and H1 terminals (FIG. 92) for the hundreds digits may be cross connected to terminal VCG for operating relay 92VC when required for a vacant code routing. Similarly, the H2–H9 terminals may be cross connected to operate the proper 92HT– relay for translation of the area and office code as required. These terminals may also be cross connected to terminal VCG for unassigned area digits. While the T2R, T3S . . . T9T terminals (FIG. 101) are cross connected to relays of the 101TT– – group when translation for the associated codes is required, certain of these terminals may be cross connected to terminal VCG if the associated codes be unassigned.

Cross conections made to the grounded code point determine the disposition of a particular call. For assigned code points, a cross connection is made to ultimately operate a route relay while unassigned code points are cross connected to a VCG terminal for a vacant code routing. In the present illustrative instance, terminal 1031 (FIG. 103) will be assumed to be cross connected to terminal 941(R00) (FIG. 94) whereby route relay 94R0 is operated from the ground at the code point. Ensuing circuit functions will be described below.

As pointed out above, it is being assumed for present purposes of description that ten classes of service are provided and, further, that the class of service assigned to the trunk which originated the call is class-of-service "9," an arbitrarily assigned number indicating the "serv-

ice" required by the trunk. This class-of-service indication is stored in the register sender awaiting later use by the decoder.

The class-of-service information is passed to the decoder by the register sender over leads CLU0 to CLU7 (FIG. 91) and over leads CLT0 to CLT7 (when required) in a 2-out-of-5 code; for class "9" ground would be transmitted over leads CLU2 and CLU7 whereby to operate decoder class-of-service relays 91CLU2 and 91CLU7.

The class-of-service terminals CU0–CU9 (FIG. 91) are cross connected to terminals CS0–CS9 whereby to operate the proper class screening relays 91CS0–91CS9; in the present illustrative example terminals CU9 and CS9 are cross connected so that with relays 91CLU2 and 91CLU7 operated as just described, class screening relay 91CS9 will be operated from ground, respective break contacts of transfer pairs 91CLU0–4(91) and 91CLU1–4(91), make contact of transfer pair 91CLU2–4(91), break contact of transfer pair 91CLU4–6(91), make contact of transfer pair 91CLU7–8(91), make contacts 91CLU2–5(91) and 91CLU7–3(91), cross connected terminals CU9 and CS9, winding of relay 91CS9 to battery.

In some instances, such as that described, where route relay 94R0 operated from ground applied to terminal 941 by the grounded code point, the route may be identified by the grounded code point alone. However, in other instances, complete route identification may require a combination of code point and class of service. The arrangement contemplated provides a process of combining code point and class of service whereby to identify a route which process may be referred to as "servivce treatment." To illustrate, it will be assumed that for proper identification of the route by operation of route relay 94R0, both code point and class-of-service information are required. Accordingly, grounded code point 1031 (FIG. 103) is now cross connected to terminal 931 (FIG. 93) and terminal 932 is cross connected to terminal 941 (FIG. 94) whereby a class-of-service control is interposed in the route relay control path; in the present instance, since class screening relay 91CS9 is operated as described above, the operate path for route relay 94R0 is now extended through make contact 91CS9–00(93).

It will be clear from the above that through inclusion of the class-of-service screening relays with cross connection field, an effective arrangement has been provided whereby when required, the route selected is determined not alone by the grounded code point but by a combination of grounded code point and operated class-of-service screening relay. In the cross-connection field, the SC– (FIG. 93) terminals may be considered as inputs for service treatment; they are connected to code points or code groups. The S– terminals may be considered as the outputs; they connect to route or program relays.

Considering now for the moment the operation of the route relay 94R0 as described above, operation of this relay closes a path for operating relays 95TSTA and 95RA0 in series; relay 95TSTB is operated from ground, make contact 80CK–2(95), break contact of transfer pair 95TSTA–8(95), winding of relay 95TSTB to battery so that, with relay 94R0 operated, a path is closed from ground, make contact 80CK–3(95), winding of relay 95RA0, break contact of transfer pair 95GS0–6(95), make contacts 94R0–6(95) and 96TSTB–8(95), winding of relay 95TSTA to battery; relays 95TSTA and 95RA0 both operate and are held over the same path with make contact 95TSTA–12(95) substituted for make contact 95TSTB–8(95). Relay 95TSTB, slow to release, starts to release at this point since its operate path is interrupted at the break contact of transfer pair 95TSTA–8(95). Relay 95TSTC, also slow release, which operated following operation of relay 95TSTB, starts to release when relay 95TSTB has fully released and has interrupted the operate path for relay 95TSTC at make contact 95TSTB–4(95).

In order to establish a connection between the register sender and the terminating or outgoing tie trunk, the marker requires that the decoder supply the link location of the trunk in terms of vertical group and vertical file.

Following operation of route relay 94R0 as described above, trunk group test relay 77TGT0 operates from ground, break contact 75MRCY–11(77), make contact 94R0–9(77), terminal G10 cross connected to terminal TGT0, winding of relay 77TGT0 to battery. Any tie trunks in the trunk group that are idle ground their associated VGB– terminals (FIG. 74) which are multiplied to all trunks in the same trunk group and in the same vertical group. In the present illustrative example, it is being assumed as stated above that the call is to be completed through tie trunk B (FIG. 9). Accordingly, since this tie trunk is assumed to be idle, ground is applied to IL lead 82 (FIG. 8) and transmitted thereover to terminal VGB13; terminals VGB13 and VGT13 are cross connected and the ground on IL lead 82 is now applied through make contact 77TGT0–53(74) to the winding of relay 74VGT13 whereby to operate that relay. The same ground is now applied through make contact 74VGT13–1(74) to the winding of relay 74TKA which operates.

Ground is now applied to lead VGL13 (FIG. 77) through make contacts 74TKA–11(77) and 74VGT13–2(77); this ground is applied to marker relay 36VGL13 whereby to operate that relay. With relay 36VGL13 operated, ground is applied through make contacts 36VGK–3(42) and 39VLCK–3(42), the break contacts of transfer pairs 36VGL0–3(42) and 36VGL6–3(42), and make contact 36VGL13–3(42) to lead VGS13 and transmitted thereover to the decoder and through make contact 77TGT0–23(74) to terminal VGS13. Terminal VGS13 is cross connected to terminal VF10 and the ground is accordingly returned over lead VFT10 to the marker whereby to operate relay 42VFT10. This provides one vertical file position of the trunk subgroup, in the present illustrative example, vertical file 10 for tie trunk B.

With relay 42VFT10 operated, relay 27BT operates from ground, make contact 39VLCK–5(27), break contacts 26BSY–3(27) and 34RLSB–5(27), break contact of transfer pair 39DT–7(27), break contact 28NT–3(27), make contact 42VFT10–4(27), winding of relay 27BT to battery. Relay 27BT, operated, closes through the BT0–BT19 leads to the 26ET– relays at make contacts as 27BT–1(26), 27BT–17(26), 27BT–20(26), and 27BT–21(26).

Idle line and trunk circuits extend their marker connect (MC) relays toward the marker over the respective "BT" leads. In the present instance involving the idle tie trunk B, a path is closed from battery, winding of relay 8MC, break contacts 8PS–2(8), 8TM–4(8), 8E1–6(8), lead BT10, through the link and connector circuit to the marker, through make contacts 27BT–21(26) and 42VFT10–5(26), winding of relay 26ET10 to ground; relay 26ET10 operates over this path but marginal relay 8MC does not operate at this point due to the relatively high resistance of the path.

Relay 27ETM10 operates following operation of relay 26ET10 from ground, make contact 34ONG–20(27), break contacts 38RCY–6(27) and 34RLSB–6(27), the break contacts of transfer pairs 32MCLK–8(27) and 32MCTK–5(27), make contact 27ETH–2(27) break contacts 27ETR–9(27) and 27ETK–2(27), the break contact of transfer pair 26ETO–2(27), break contact 27ETM0–6(27), make contact of transfer pair 26ET10–7(27), winding of relay 27ETM10 to battery; relay 27ETM10 upon operating locks to ground through the make contact of its transfer pair 27ETM10–10(27), break contact of transfer pair 27ETM0–10(27), make contact 27ETH–1(27). Relay 27ETR now operates from ground, make contacts 34ONG–20(27) and 27ETM10–11(27), winding of relay 27ETR to battery. This is followed by operation of relay 27ETK through the one-up-only chain of 27ETM– relay

contacts, the operate path being traced from ground, make contact 27BT–21(27), break contacts 34RLSB–4(27) and 26BSY–2(27), break contact to transfer pair 27ETM0–8(27), make contact 27ETM10–8(27), break contact 27ETM16–12(27), break contact of transfer pair 27ETM19–8(27), make contact 27ETR–8(27), winding of relay 27ETK to battery.

Relay 27ETK, operated, opens at break contact 27ETK–7(27) the holding path of slow-release relay 27ETH, which starts to release, and closes a path to ground at make contact 27ETK–1(26) whereby to shunt the winding of relay 26ET10. Relay 8MC of the tie trunk circuit now operates as the resistance of the path previously traced above through lead BT10 has been reduced by the effective removal therefrom of the winding of relay 26ET10.

When relay 8MC operates ground is applied to lead MCTK through make contact 8MC–4(8) and applied through the link and connector to operate marker relay 32MCTK through the make contact of transfer pair 27ETK–8(32). A path to ground to hold the 27ETM10 relay is now established through the make contact of transfer pair 32MCTK–5(27) to the ground at make contact 34ONG–20(27), this path being completed before the previous holding ground is lost by full release of relay 27ETH.

It will be recalled that during the originating phase of this call connection, information identifying the horizontal group and level used in establishing the link between the call originating trunk and the register sender was transmitted to the register sender. This stored information is transmitted back to the marker on the terminat- connection; the marker completes the connection to the completing trunk using this link identifying information previously stored in the register sender.

When relay 74TKA operated as described above a path was closed for operating marker relay 42TT traced from ground, make contact of transfer pair 74TKA–10(75), break contact of transfer pair 77LCK–10(75), make contacts 93RS–9(75) and 74TKA–4(75), lead TT to the marker, break contacts 34RLSC–11(42) and 38RCYA–2(42), winding of relay 42TT to battery; relay 42TT operates and locks through its make contact 42TT–10(42) to the ground at make contact 34DCK–5(42).

Relay 42TT, operated, closes at make contact 42TT–12(31) an obvious operate path for relay 31HTC and closes at make contact 42TT–2(29) an obvious operate path for relay 29LKTC. Relay 31HTC, operated, connects the respective 35HGT0–35HGT7 relays through to the corresponding leads HGT0–HGT7.

The connector relays in the decoder-marker connector circuit connect these leads to the register sender to be served; for example with connector relays 46DMA00 and 44RA0 operated, lead HTG0 will be cut through to the register sender through make contacts 46DMA00–30(106) and 44RA0–50(106) and lead HGT7 will be cut through to the register sender through make contacts 46DMA00–31(106) and 44RA0–51(106). Other HGT– leads will be similarly cut through by operation of other respective connector relays.

The register sender, operating as subsequently described, grounds a combination of two of the HGT– leads in accordance with the horizontal group information previously stored therein; this operates the associated two 35HGT– relays of the marker. It will be recalled that horizontal group 0 was originally selected for establishing the connection and that this information was recorded in the register sender. Accordingly, ground is applied to leads HGT4 and HGT7 whereby to operate relays 35HGT4 and 35HGT7 which are the associated relays for that particular horizontal level.

Relay 31HGTK now operates from ground, make contact 34ONG–13(31) and 42TT–12(31), break contact 34RLSA–3(31), break contacts of respective transfer pairs 35HGT0–10(31), 35HGT1–10(31) and 35HGT2–10(31), make contacts of respective transfer pairs

35HGT4–8(31) and 35HGT7–10(31), winding of relay 31HGTK to battery; relay 31HTGK operates and locks to the same ground through its make contact 31HGTK–8(31). Relay 35HG0 (corresponding to horizontal group 0) now operates from ground, make contacts 34ONG–10(35) and 31HGTK–12(35), break contact 28NT2T–10(35), make contacts 35HGT4–1(35) and 35HGT7–1(35), winding of relay 35HG0 to battery; relay 35HG0 operates and locks to ground at make contact 34ONG–7(35) through the make contact of its transfer pair 35HG0—12(35).

Relay 31HGR now operates from ground, make contacts 34ONG–8(31) and 35HG0–8(31), winding of relay 31HGR to battery; relay 31HGR, operated, closes at make contact 31HGR–12(26) a common point in the operate path of relay 26HGK. The remaining portion of the operate path of relay 26HGK comprises a one-up-only chain of 35HG– relay transfer contact pairs and since relay 35HG0 alone is operated, relay 26HGK now operates from ground, break contact of transfer pair 35HGE–12(26), make contact of transfer pair 35HG0–10(26), break contacts of respective transfer pairs 35HG5–10(26) and 35HG1–10(26), make contact 31HGR–12(26), winding of relay 26HGK to battery. Operation of relay 26HGK indicates that the horizontal group identification information has been recorded in the marker.

The horizontal level information is recorded in a manner generally similar to that just described in reference to the recording of the horizontal group information. Relay 29LKTC, operated as above described, connects the LKT0–LKT7 leads through to the decoder-marker connector circuit where the connector relays connect the leads to the register sender to be served. A combination of two of the leads is grounded through the register sender whereby to operate the two associated 29LKT– relays. For example in the instance of the prior selection of horizontal level 0, leads LKT4 and LKT7 would be grounded whereby to operate the associated relays 29LKT4 and 29LKT7. Relay 29LKTK now operates from ground, make contact 34ONG–14(29), break contact 34RLSA–12(29), make contact 42TT–2(29), break contacts of respective transfer pairs 29LKT0–10(29), 29LKT1–10(29), and 29LKT2–10(29), make contacts of transfer pairs 29LKT4–10(29) and 29LKT7–10(29), winding of relay 29LKTK to battery; relay 29LKTK operates and locks to the same ground through its make contact 29LKTK–12(29).

Relay 30LK0 (associated with horizontal level 0) now operates from ground, make contacts 34ONG–18(30), 29LKTK–8(30), 29LKT7–1(30), 29LKT4–1(30), winding of relay 30LK0 to battery; relay 30LK0 upon operating, and following subsequent operation of relay 30LKK, locks to ground through the make contact of its transfer pair 30LK0–11(30), break contacts of respective transfer pairs 30LK9–11(30) and 30LK5–11(30), make contact 34ONG–15(30) to ground. Relay 32LKR now operates from ground, make contacts 34ONG–16(32) and 30LK0–8(32), winding of relay 32LKR to battery. A path is now closed for operating relay 30LKK through a one-up-only chain of 30LK– relay contacts, this path being traced from the ground on lead HCR, break contacts 28NRCY–6(30), make contact of transfer pair 30LK0–10(30), break contacts of transfer pairs 30LK5–10(30) and 30LK9–10(30), break contact 34RLSA–10(30), make contact 32LKR–1(30), winding of relay 30LKK to battery. Operation of relay 30LKK indicates that the horizontal level indication has been recorded in the marker.

As pointed out above, ground has been applied over leads VFT10 and VGL0 from the decoder, the ground on lead VFT10 having operated relay 42VFT10 of the marker.

Select magnet operates on terminating connection

With relay 32MCTK operated, as described above, a test is performed to determine the continuity of the path

to the hold magnet before beginning the select magnet operation. Relay 42VHL operates in series with the VHL resistor and through make contact 27ETM10–4(42) and over lead HM10 to hold magnet 18HM13010 of the completing tie trunk B; the hold magnet does not operate at this point. Relay 42VHL, operated, closes at make contact 42VHL–3(32) an operate path for relay 32VHCK, to the ground at make contact 34ONG–17(32), relay 32VHCK operates and locks to this same ground through its make contact 32VHCK–1(32).

The 30LKK relay, operated as previously described, and the 32VHCK relay, operated as just described, close a path to operate select magnet 16SM1300, the path being traced from the battery at break contacts 38RCY–4(30) and 34RLSA–4(30), make contacts 42TT–8(30) and 32MCTK–9(30), the break contact of transfer pair 39DTA–3(30), make contacts 32VHCK–11(30) and 30LKK–11(30), the make contact of transfer pair 30LK0–1(30), lead SM0, and through make contacts 19CC13–0(16) and 21VG13HG0–0(16) to operate select magnet 16SM1300. When the select magnet operates, off-normal ground is applied through make contacts 16SM1300–1(13) and 19VP13–1(13) to lead SMLK13 whereby to operate relay 32SMLK through make contact 36VGL13–2(32). Relay 32SMLK, operated, verifies the operation of the select magnet.

Hold magnet operates on terminating connection

Relay 32SMLK, operated, closes a path at make contact 32SMLK–1(98) to extend ground to operate relay 98HM. Relay 98HM, operated, releases relay 42VHL by interrupting the operate path at the break contact of transfer pair 98HM–10(42) and operates hold magnet 18HM13010 and relay 42HKL through the make contact of the same transfer pair, the break contact of transfer pair 27ETM0–4(42) and the make contact of transfer pair 27ETM10–4(42) to lead HM10.

Relay 42HKL, operated, closes a path at the make contact of transfer pair 42HKL–1(98) for operating relay 98HKLA from the ground at make contact 34ONG–2(98); relay 98HKLA upon operating locks to this same ground through its make contact 98HKLA–5(98). Relay 98HKLA, operated, prepares at make contact 98HKLA–1(98) an operate path for relay 98HMK when relay 42HKL releases.

Originating trunk and terminating trunk now connected

Hold magnet 18HM13010, operated following operation of select magnet 16SM1300, connects the terminating tie trunk B to the originating tie trunk A; it will be recalled that the originating tie trunk A is connected to horizontal link 0 at vertical file 16 of vertical group 0 through operation of hold magnet 17HM0016, and the terminating tie trunk G is now connected to this same horizontal link at vertical file 10 of vertical group 13 through operation of hold magnet 18HM13010. It will be recalled, further, that the selected register sender was connected to this same link at vertical group 6, vertical file 19, through operation of hold magnet 18HM6019. As a result of the connection referred to, the terminating trunk places a ground on the HMH10 lead to the link and connector circuit; this ground locks the hold magnet through make contact 18HM13010–10(18) and also shunts relay 42HKL of the marker. With relay 42HKL released, relay 98HMK operates through the path from the ground at make contact 34ONG–2(98), break contact 34RLS–8(98), break contact of transfer pair 42HKL–1(98), make contacts 98HM–12(98) and 98HKLA–1(98), break contact of transfer pair 39DT–5(98), winding of relay 98HMK through resistor HMK to battery. The 98HMK relay is the last relay to operate on a normal terminating connection; accordingly relay 34DCK releases as the operate path is interrupted at break contact 98HMK–2(34).

Operations at terminating trunk circuit

As pointed out above relay 8MC of the terminating tie trunk circuit operated following operation of relay 27ETK. Relay 8MC, operated, closed at make contact 8MC–8(8) operate paths for relays 8TM and 80TS and interrupted at break contact 8MC–10(8) the operate path of relay 8ST. When the switch crosspoints were closed as above described whereby the tie trunk is connected to the register sender, relay 9S operates over the simplex circuit. This is followed in turn by operation of relay 8S1, [operate path closed at make contact 9S–1(8)], by operation of relay 9SA [operate path closed at make contact 8S1–4(9)], by operation of relay 8SA1 [operate path closed at make contact 8SA–10(8)], by operation of relay 9SL [operate path closed at make contact 9SA–4(9)], and by operation of relay 8SL1 [operate path closed at make contact 9SL–12(8)]. Also, at this point relay 8MC releases.

Relay 9SL, operated, closes at make contact 9SL–1(9) the ground path to lead HMH10 for supplying the holding ground to hold magnet 18HM13010; provides at make contact 9SL–2(8) holding ground for relay 80TS; provides at make contact 9SL–10(9) holding battery for relay 9RRLS; interrupts at break contact 9SL–6(8) the operate path of relay 8ST; interrupts at break contact 9SL–7(8) the IL lead 82 to the decoder as a busy indication; while relay 8SL1, operated, interrupts at break contact 8SL1–11(8), lead LT10 to the marker as a busy indication.

Relay 8TM, operated sets up at break contact 8TM–4(8) an interrupting point in the operate path of relay 8MC after that relay has released and interrupted the operate path at make contact 8MC–12(8). Also, relay 8TM, operated, closes at make contact 8TM–2(8) the operate path for relay 8E1A.

Relay 80TS, operated, splits the transmitting loop TT–TR of the terminating trunk at break contacts 80TS–4(9) and 80TS–2(9). Relay 8S1, operated, applies direct ground to lead M through the make contact of transfer pair 8S1–8(8) whereby to signal the distant end, but until that end is ready to receive pulses, a "stop" signal is received by tie trunk B as a ground on the E lead. This ground on the E lead operates relay 8E and this is followed by operation of relays 8E1 and 8E1A [operate paths closed at make contact 8E–1(8)]. Relay 8S now operates from ground through make contact 8E1–1(8).

While relay 8E1A remains operated, it closes a path through make contact 8E1A–4(9) which is effective to shunt S resistor 91 out of the simplex path; this is effective to stop the register sender from outpulsing.

When the distant end is ready to receive pulses relays 8E, 8E1, 8E1A and 8SR release; removal of the shunt at make contact 8E1A–4(9) causes the register sender to start outpulsing as described above and further described subsequently. Relays 9S and 8S1 "follow" the pulses while relays 9SA and 8SA1, both slow to release, hold operated during the pulsing. The 9SA and 8SA1 relays holding operated apply holding ground for the 9SL and 7SL relays on both sides of the link switch.

When the outpulsing has been completed, the register sender applies battery to the 1D lead as previously described and this is effective to operate relay 9RRLS. Operation of relay 9RRLS is followed by operation of relay 8RRLS1 from ground at make contact 9RRLS–11(8). Relay 9RRLS upon operating locks to battery through its make contact 9RRLS–9(9) and make contact 9SL–10(9). Relay 9RRLS, operated, operates relay 8RV by closing the operate path at make contact 9RRLS–10(8) and relay 8RRLS1, operated, releases relay 80TS by interrupting the operate path at break contact 8RRLS1–1(8).

Relay 80TS, released, recloses the transmitting loop TT–TR of the terminating trunk at break contacts 80TS–4(9) and 80TS–2(9), while relay 8RV, operated, reverses the transmitting and receiving loops at transfer pairs 8RV–2(9) and 8RV–4(9) and at transfer pairs

8RV–8(9) and 8RV–10(9). Also, relay 8RV, operated, interrupts at break contact 8RV–6(8) the operate path of relay 80TS whereby to prevent reoperation of that relay while relay 8RV remains operated.

Résumé of closures and reversals in trunk circuits

It will be apparent from the foregoing description that plurality of individual conductors corresponding, rearrangement are such that simultaneous inpulsing and outpulsing by the selected register sender is facilitated.

As pointed out previously and as clearly shown in the drawing, for example FIG. 7, each link comprises a plurality of individual conductors corresponding, respectively, to the respective individual conductors of the connected elements, that is trunks, lines and register senders. Each link is considered to comprise two channels, a first channel connecting the individual conductors of the incoming channels of the connected elements and a second channel connecting the outgoing channels of the same elements. Obviously if a channel of a connected element is interrupted, for example, when receive channel of trunk A is interrupted or split by operation of relay IRS, that channel is in effect disconnected from the corresponding channel of the link.

The second channel of the link is used by the register sender to outpulse while the first channel is used for inpulsing. Accordingly, the originating tie trunk A holds its outgoing channel open during the register sender holding interval to insure that the dial pulses transmitted by the register sender to the terminating circuit will not be mutilated, while the terminating tie trunk B opens its incoming channel so that the register sender pulse detecting circuits are not bridged by the terminating circuit.

As previously pointed out above, when the register sender is ready to receive pulses, relay 7RSS of the tie trunk A is operated causing, in turn, operation of relay 10RSSA. After the first digit is received in the register, a simplex signal over the receive loop operates the 7S relay and operation of relay 10S1 follows. With relays 10S1 and 10RSSA operated, an operate path is closed for relay 10IRS which operates and locks. Relay 10IRS, operated, opens the outgoing channel of originating tie trunk A at break contacts 10IRS–2(7) and 10IRS–4(7); this is a part of the functions referred to just above.

Referring now for the moment to terminating tie trunk B, it will be recalled that relay 80TS operated following operation of relay 8MC whereby to open at break contacts 80TS–4(9) and 80TS–2(9) the incoming channel of terminating tie trunk B; this is a further part of the functions referred to just above.

Now after pulsing has been completed the register sender applies battery to the ID lead of originating tie trunk A whereby to operate relay 7RRLS; this is followed by operation of relay 10RRLS1. Relay 10IRS now releases as its hold path is interrupted at break contact 7RRLS–8(10). The outgoing channel of originating tie trunk A is now reclosed at break contacts 10IRS–2(7) and 10IRS–4(7). Also, when the pulsing has been completed, the register sender, before releasing, applies battery to lead ID of terminating tie trunk B whereby to operate relay 9RRLS which is followed in turn by operation of relay 8RRLS1. Relay 8RV operates following operation of relay 9RRLS and relay 80TS releases following operation of relay 8RRLS1. Relay 80TS, released, recloses the incoming channel of terminating tie trunk B at break contacts 80TS–4(9) and 80TS–2(9) while relay 8RV, operated, transposes the incoming and outgoing channels of that tie trunk whereby to align the incoming and outgoing channels properly for through voice transmission.

Called station answers—Disconnect functions

When the distant called station answers and closes the local station loop by going off hook, relay 7S of tie trunk A operates over the simplex circuit and this is followed by operation of relay 10S1. In the terminating tie trunk B "answer" by the called station is followed by operation of relays 8E, 8E1 and 8SR.

When the call has been completed and the distant called station goes on hook, relays 8E, 8E1 and 8SR release but the remainder of the relays which are operated hold in that position until the calling station goes on hook. During this period the circuit is held busy to a subsequent seizure. When the calling party does go on hook the 9S, 8S1, 9SA, 8SA1, 9SL, 8SL1, 8RV, 8TM, 9RRLS and 8RRLS1 relays all release and restore the circuit to normal, releasing the link circuit and removing the busy blocks to permature reseizure.

In the originating tie trunk A, even following hangup by the called station, all of the operated relays hold in that position until the calling party has gone on hook. When the calling party does go on hook, relays 10E, 10E1, 10SR, 7S, 10S1, 7SL, 10SL1, 100R, 7RRS and 10RRSL1 release and restore the circuit to normal.

Outpulsing control to register sender

When a route relay operates in the decoder as above described, corresponding routing and outpulsing information is transmitted to the register sender.

As pointed out above, relay 80CNB operated following seizure of the decoder and this was followed by operation of relay 80CK. Transmitting lead connector relays 81TLC3 and 81TLC4 now operate as mentioned above from ground, make contacts 80CK–7(81) and 80CNB–6(81) and to battery through the respective relay windings. Operation of relay 81TLC3 connects the SA6 to SA11 leads to terminals SA4 to SA9 while operation of relay 81TLC4 connects the OS3 to OS12 leads to terminals OS1 to OS10. Prior to operation of the 81TLC–relays the SA– leads are connected over lead 871 to the winding of relay 89XTL1 and the OS– leads are connected over lead 891 to the winding of relay 89XTL2. The 89XTL1 and 89STL2 relays, therefore, will operate if a "trouble" ground should appear on any of these leads and will operate relay 86CPS through make contact 89XTL1–4(86) or 89XTL2–4(86) whereby to initiate operation of relay 89DIS as previously referred to above.

The SP (start pulsing) terminal (FIG. 89) will be cross connected to a selected "OS–" terminal whereby to indicate to the register sender at which digit of the called number outpulsing is to start, while the EP (end pulsing) terminal (FIG. 87) associated with the same relay, that is terminal 872, will be cross connected to a selected "SA–" terminal whereby to indicate to the register sender at which digit of the called number outpulsing is to stop. These two cross connections indicate to the register sender how many digits to expect and which, if any, to delete during outpulsing.

The type of outpulsing from the register sender is controlled by the cross connection of the particular OP–terminal associated with the respective relay, in this instance terminal 831 (FIG. 83), with the terminals NOP; D10; D20; MF. The respective leads DP20; NOP; MFO; are grounded accordingly as the relays 83NOP; 83DP10, 83DP20, 83MF are operated by the cross connection selected. For example, in the instance where a route requires multifrequency outpulsing and the called number is being inpulsed into the register sender on a dial pulse basis, relay 93IDP will be operated over lead IDP as previously described. With terminal 831 cross connected to terminal 832, a path is closed for operating relay 83CADR traced from ground, make contact 94R0–3 (83), terminals 831 and 832, make contact of transfer pair 93IDP–2(83), break contact of transfer pair 93ADR–10(83), winding of relay 83CADR to battery.

With relay 83CADR operated, ground is applied to lead CADR (FIG. 93) through the break contacts of respective transfer pairs 83NOP–12(82), 83MF–1(82), 83DP10–12(82), 83DP20–1(82), lead 821, make contact

83CADR–10(93), break contacts of respective transfer pairs 77CA5–10(93) and 77CA7–3(93), make contact 95TG–4(93), make contact of transfer pair 83CADR–12(93) to lead CADR; this ground on lead CADR operates relay 63CADR of the register sender whereby to signal the register sender to reseize the decoder when all digits have been received.

On the second seizure of the decoder, after all digits have been registered and relay 83CADR has released, relay 93ADR is operated by ground from the register sender over lead CADR. Relay 83MF now operates from the ground applied to terminal 832, make contacts of respective transfer pairs 93IDP–2(83) and 93ADR–10(83), winding of relay 83MF to battery. Relay 83MF, operated, applies ground to lead MF0 (FIG. 82) through the break contact of transfer pair 83NOP–12(82), make contact of transfer pair 83MF–1(82), break contacts of respective transfer pairs 83DP10–11(82), 83DP20–2(82) and 83CADR–11(82), make contact 95TGS–3(82), make contact of transfer pair 83MF–3(82) to lead MF0. The ground on lead MF0 operates relay 69MF0 of the register sender whereby to signal the register sender that multifrequency outpulsing is required.

It will be noted that through the novel arrangement just described, the multifrequency outpulsing is held up until all of the dialed-in digits have been registered. This prevents a wasteful early seizing of the incoming register at the terminating end; if the called number were multifrequency outpulsed forward before all of the digits had been registered the incoming register would be seized before the start of the outpulsing and would of necessity be held for a longer period.

The outpulsing class is determined by the cross connection of the SCL terminal (FIG. 83) associated with the route to the CL1–CL4 terminals; in the present illustrative example terminal 833 may be cross connected to terminal 834 whereby to close a path for operating relay 83CL2 from ground, break contact 95GS0–10(83), make contact 94R0–10(83), terminals 833 and 834, winding of relay 83CL2 to battery. Relay 83CL2, operated, closes a path for connecting ground to lead CL2 (FIG. 82), through the break contact of transfer pair 83CL1–12(82), make contact of transfer pair 83CL2–1(82), break contacts of respective transfer pairs 83CL3–11(82) and 83CL4–2(82), make contacts 95TGS–7(82), make contact of transfer pair 83CL2–3(82), break contact of transfer pair 83CL1–11(82) to lead CL2.

Permanent signal operation

In connection with discussion of the originating tie trunk circuit, it should be pointed out that the "off-hook" signal from the distant station may occasionally be in the nature of a "permanent signal" resulting, for example, from an inadvertent "receiver off-hook" condition. When the 7RSS and 10S1 relays have operated, as described previously, the register sender expects to receive and forward the indicated number of digits. However, when the register sender times out due to no digits being received, it will release relay 7RSS as a signal to the trunk circuit to operate relay 10PS. Relay 10PS operates following release of relay 7RSS over a path from ground, break contact 7RSS–7(10), make contacts 10RSSA–12(10) and 10IRS–10(10), winding of relay 10PS to battery; relay 10PS upon operation locks to ground through its make contact 10PS–12(10).

Relay 10PS, operated, interrupts at break contact 10PS–2(10) the BT16 lead to the marker and interrupts at break contact 10PS–4(10) the IL lead to the decoder as busy indications; interrupts at break contact 10PS–8(10) the operate path of relay 10ST; and applies tone through make contacts 10PS–1(7) and 10PS–11(7) to the receive channel of the trunk as a "paths-busy" indication; and closes at make contact 10PS–10(10) an engizing path for the PS lamp associated with tie trunk A. Also, relay 10PS, operated, closes at make contact

10PS–12(10) an energizing path for permanent signal alarm 103 (not shown in detail).

Calls initiated by the no-test facility are handled in a manner generally similar to that prevailing in the instance of trunk and line initiated calls. The no-test facility provides the ability to connect to a busy line, for example for the purpose of verifying the apparently busy condition of a particular line. The completion of a no-test connection and the completion of a station-line-to-station-line connection are not described in detail herein since, as pointed out above, these types of connections are described in detail in the copending application of Messrs. E. L. Erwin, A. E. Gerbore, G. C. Hobbs and H. J. Walsh, Ser. No. 438,182, filed Mar. 9, 1965.

It will be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A telephone system comprising a first transmission circuit having an incoming channel and an outgoing channel; a second transmission circuit having an incoming channel and an outgoing channel; a register sender having an incoming channel and an outgoing channel for storing call information received over said last-mentioned incoming channel and for transmitting call information over said last-mentioned outgoing channel; a link comprising a first channel and a second channel; connecting means operable to connect said incoming channels of said first transmission circuit, said second transmission circuit, and said register-sender circuit to said first channel of said link and to connect said outgoing channels of said first transmission circuit, said second transmission circuit and said register-sender circuit to said second channel of said link; first switching means in each of said transmission circuits responsive to an incoming call signal to disconnect said outgoing channel thereof from said second channel of said link; and second switching means in each of said transmission circuits responsive to an outgoing call signal to disconnect said incoming channel thereof from said first channel of said link.

2. A telephone system in accordance with claim 1 wherein said first switching means is further responsive to a cut-through signal to reconnect said outgoing channel to said second channel of said link and wherein said second switching means is further responsive to a cut-through signal to reconnect said incoming channel to said first channel of said link; and further comprising third switching means in each of said transmission circuits responsive to said cut-through signal and said outgoing call signal for switching said incoming channel thereof from said first channel of said link to said second channel of said link and for switching said outgoing channel thereof from said second channel of said link to said first channel of said link.

3. A telephone system comprising a first two-way trunk circuit having a first incoming channel and a first outgoing channel; a second two-way trunk circuit having a second incoming channel and a second outgoing channel; a link comprising a first communications channel and a second communications channel; a first switching means selectively operable to connect said first incoming channel to said first communications channel and to connect said first outgoing channel to said second communications channel; second switching means selectively operable to connect said second incoming channel to said first communications channel and to connect said second outgoing channel to said second communications channel; a register sender having an input path and an output path, means for connecting said input path to said first communications channel and for connecting said output path to said second communications channel, means for disconnecting said second incoming

channel from said first communications channel and for disconnecting said first outgoing channel from said second communications channel whereby to permit simultaneous inpulsing to said register sender from said first communications channel and outpulsing from said register sender to said second communications channel.

4. A telephone system in accordance with claim 3 further characterized in means responsive to a cut-through signal to reconnect said second incoming channel to said first communications channel and to reconnect said first outgoing channel to said second communications channel.

5. A telephone system in accordance with claim 4 further characterized in means also responsive to a cut-through signal to switch said first incoming channel from said first communications channel to said second communications channel and to switch said first outgoing channel from said second communications channel to said first communications channel.

6. A telephone system comprising a first four-wire trunk having an incoming channel and an outgoing channel, a second four-wire trunk also having an incoming channel and an outgoing channel, a plurality of links each having a first two-wire channel and a second two-wire channel, a register sender, means for connecting said first and second trunks by a selected one of said links with the respective incoming channels connected to said first two-wire channel and the respective outgoing channels connected to said second two-wire channel, means for connecting the input of said register sender to said first two-wire channel and for connecting the output of said register sender to said second two-wire channel, means for interrupting the connection of the outgoing channel of said first trunk and the incoming channel of said second trunk to the respective two-wire channels whereby pulses incoming to said register sender from said first trunk are outpulsed only to the outgoing channel of said second trunk, and means effective upon completion of pulsing for restoring said interrupted connections.

7. In a telephone system, the combination defined by claim 6 further characterized in means also effective upon completion of pulsing for connecting said incoming channel of said first trunk to said second two-wire channel and for connecting said outgoing channel of said first trunk to said first two-wire channel.

8. A telephone system comprising a first four-wire trunk having an incoming channel and an outgoing channel, a second four-wire trunk also having an incoming channel and an outgoing channel, a plurality of four-wire links, a register sender, means for simultaneously interconnectnig said first and said second trunks and said register sender by a single selected one of said links for concurrent impulsing to said register sender from said first trunk and outpulsing from said register sender to said second trunk, means effective during pulsing for disabling the outgoing channel of said first trunk and the incoming channel of said second trunk, means effective upon completion of pulsing for enabling said outgoing channel and said incoming channel, and means also effective upon completion of pulsing for transposing the connections between said selected link and said incoming and outgoing channels of one of said trunks whereby to provide proper directional alignment of both channels of both trunks for through talking connections.

9. In a four-wire telephone switching system, crossbar switching means having switches arranged in horizontal and vertical arrays, a link circuit including link means multipled to all switches in each horizontal array, a plurality of trunk means, a plurality of register sender means, each said trunk means and each said register sender means connected to individual ones of said vertical arrays, each of said link means, trunk means and register sender means including incoming and outgoing channels, means for interconnecting similar channels of a pair of trunk means and one of said register sender means for pulsing therebetween, and means for transposing the connections of said channels of said pair of trunk means to provide the talking connection therebetween.

10. In a four-wire telephone switching system, a plurality of four-wire two-way trunk circuits, a plurality of register senders, a plurality of four-wire links, means for simultaneously interconnecting two of said trunk circuits and one of said register senders to the same one of said links for concurrent inpulsing and outpulsing between said trunk circuits and said register sender, and means for subsequently transposing the interconnection of said trunk circuits to provide the talking connection therebetween.

11. In a four-wire telephone switching system, the combination of claim 10 wherein said interconnecting means includes crossbar switching means and wherein all of said trunks and register senders have access through said crossbar switching means to each of said links.

No references cited.

WILLIAM C. COOPER, *Primary Examiner.*