Nov. 12, 1968 E. L. ERWIN ET AL 3410,960
NO-TEST OR BUSY VERIFICATION IN A PRIVATE
BRANCH EXCHANGE TELEPHONE SYSTEM
Filed March 9, 1965 109 Sheets-Sheet 1

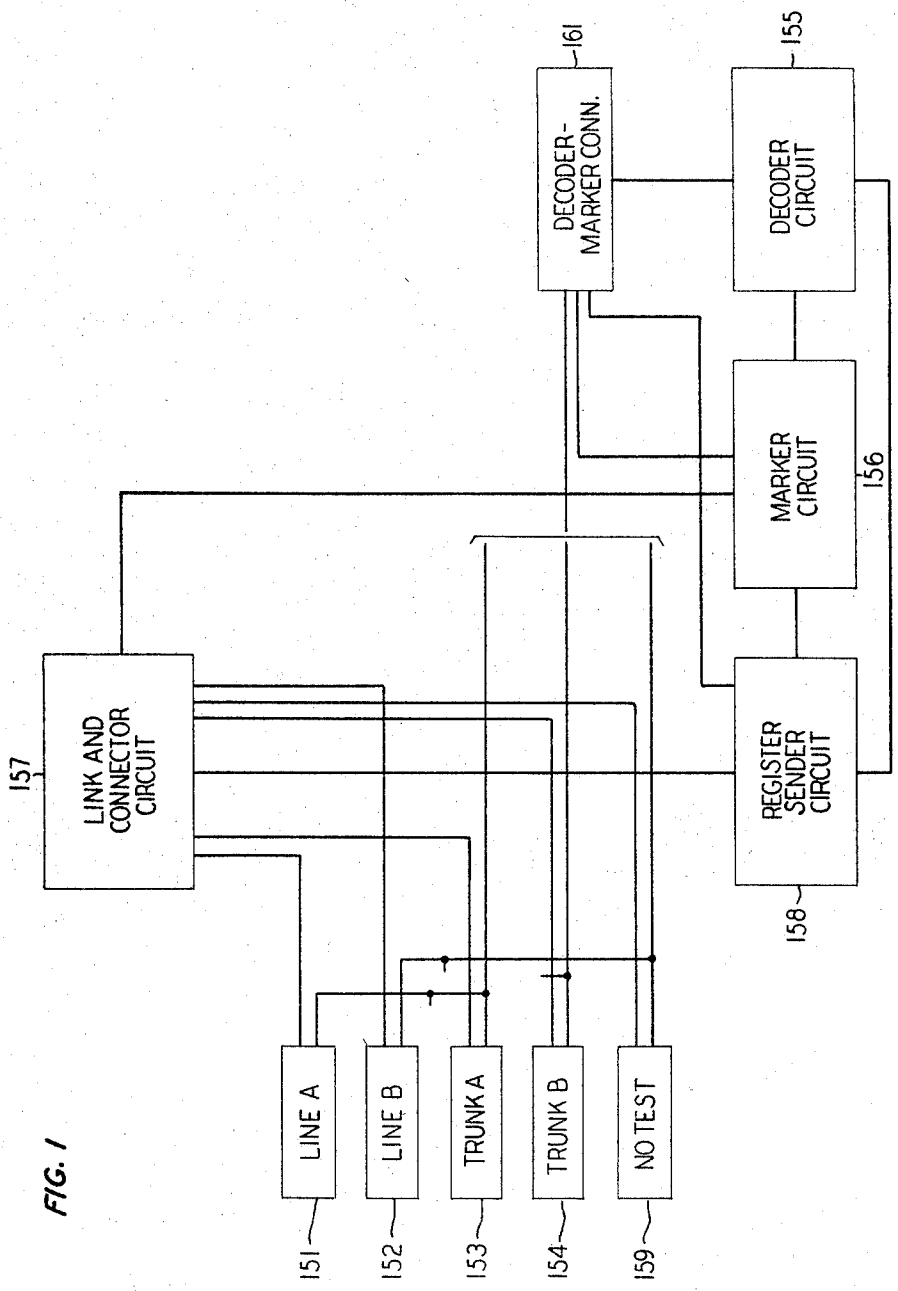


FIG. 1

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ATTORNEY

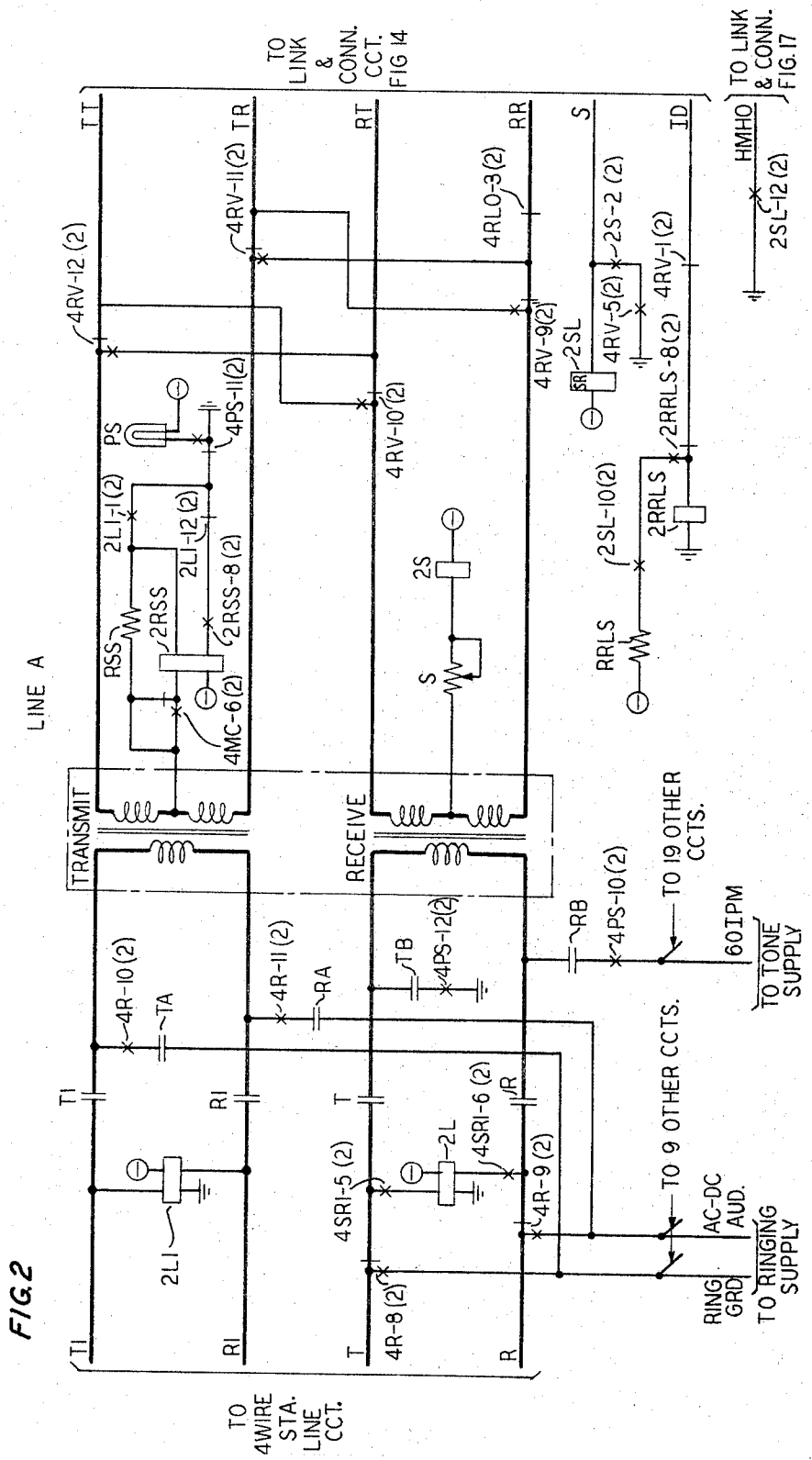
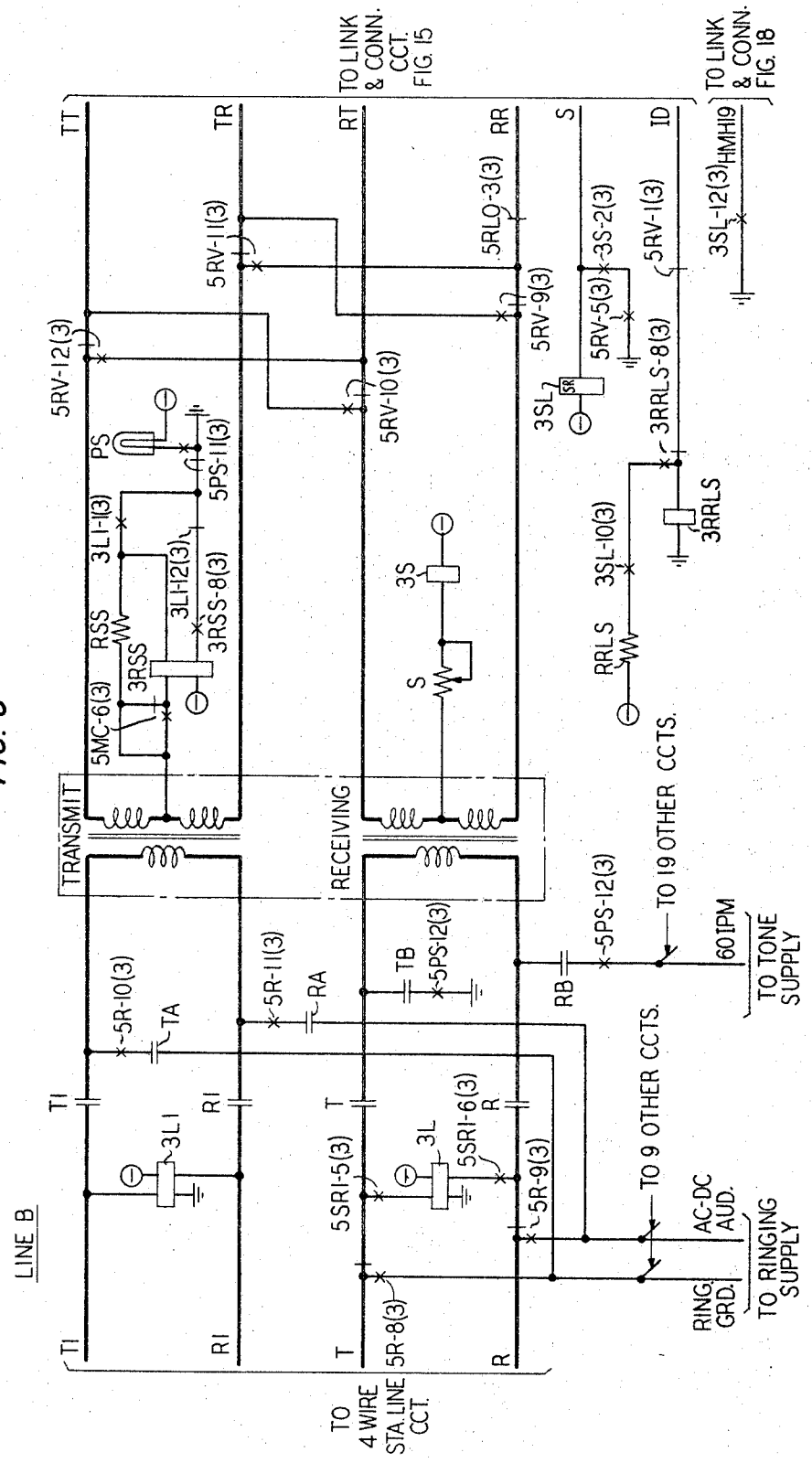

TO LINK & CONN. CCT. FIG 14
TO LINK & CONN. FIG. 17
TI
TR
RT
RR
S
ID
HMHO
4RV-12 (2)
4RV-11 (2)
4RLO-3 (2)
2S-2 (2)
4RV-1 (2)
2SL-12 (2)
4RV-5 (2)
4RV-9 (2)
2SL
4RV-10 (2)
4PS-11 (2)
PS
2LI-1 (2)
2LI-2 (2)
2RSS-8 (2)
2RSS
RSS
4MC-6 (2)
2S
S
2SL-10 (2)
2RRLS-8 (2)
2RRLS
RRLS
LINE A
TRANSMIT
RECEIVE
4R-10 (2)
TA
4R-11 (2)
RA
TB
4PS-12 (2)
RB
4PS-10 (2)
TO 19 OTHER CCTS.
60IPM
TO TONE SUPPLY
TI
RI
T
R
2LI
4SRI-5 (2)
2L
4SRI-6 (2)
4R-9 (2)
4R-8 (2)
TO 9 OTHER CCTS.
AC-DC AUD.
RING GRD
TO RINGING SUPPLY
TO 4WIRE STA. LINE CCT.

FIG 2

FIG. 3


LINE B
TI
RI
TT
TR
RT
RR
S
ID
T
R
TO LINK & CONN. CCT. FIG. 15
TO LINK & CONN. FIG. 18
TRANSMIT
RECEIVING
5RV-12(3)
5RV-11(3)
5RV-10(3)
5RV-9(3)
5RV-5(3)
5RV-1(3)
5RLO-3(3)
3S-2(3)
3SL-12(3)HMH19
3SL
SR
3RRLS-8(3)
3RRLS
3SL-10(3)
RRLS
3S
S
PS
5PS-11(3)
3LI-1(3)
3LI-12(3)
3RSS-8(3)
RSS
3RSS
5MC-6(3)
5R-10(3)
TA
5R-11(3)
RA
TB
5PS-12(3)
RB
5SRI-5(3)
3L
5SRI-6(3)
5R-9(3)
5R-8(3)
3LI
TO 19 OTHER CCTS.
TO 9 OTHER CCTS.
601PM
TO TONE SUPPLY
AC-DC AUD.
RING GRD.
TO RINGING SUPPLY
TO 4 WIRE STA. LINE CCT.

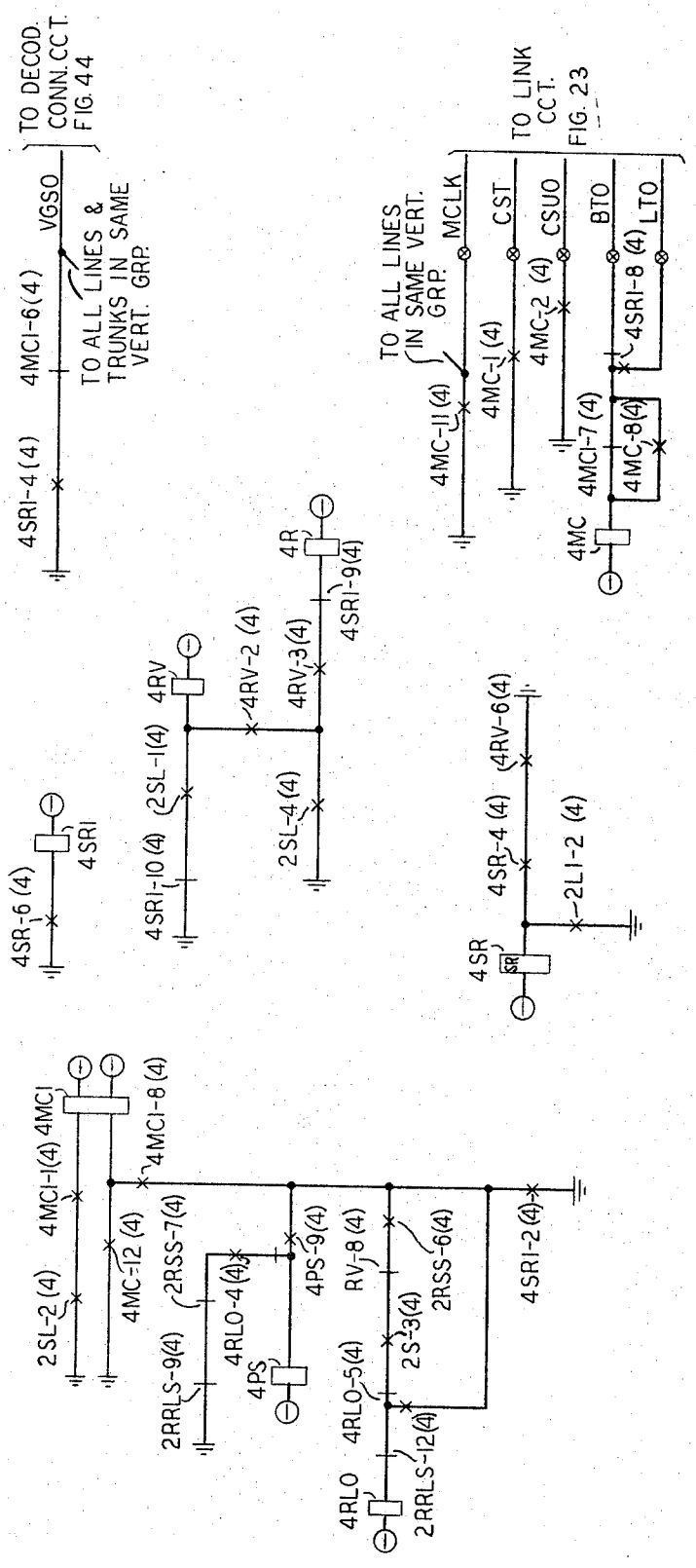

TO DECOD. CONN. CCT. FIG 44
VGSO
4MCI-6(4)
4SRI-4(4)
TO ALL LINES & TRUNKS IN SAME VERT. GRP.
TO LINK CCT. FIG. 23
MCLK
CST
CSUO
BTO
LTO
TO ALL LINES IN SAME VERT. GRP.
4MC-11(4)
4MC-1(4)
4MC-2(4)
4SRI-8(4)
4MCI-7(4)
4MC-8(4)
4MC
4R
4SRI-9(4)
4RV-2(4)
4RV-3(4)
4RV
2SL-1(4)
2SL-4(4)
4SRI-10(4)
4SRI
4SR-6(4)
4SR
4SR-4(4)
4RV-6(4)
2LI-2(4)
LINE A
4MCI
4MCI-1(4)
4MCI-8(4)
2SL-2(4)
4MC-12(4)
2RSS-7(4)
4RLO-4(4)
4PS-9(4)
2RRLS-9(4)
4PS
RV-8(4)
2RSS-6(4)
4SRI-2(4)
4RLO-5(4)
2S-3(4)
4RLO
2RRLS-12(4)

FIG. 4

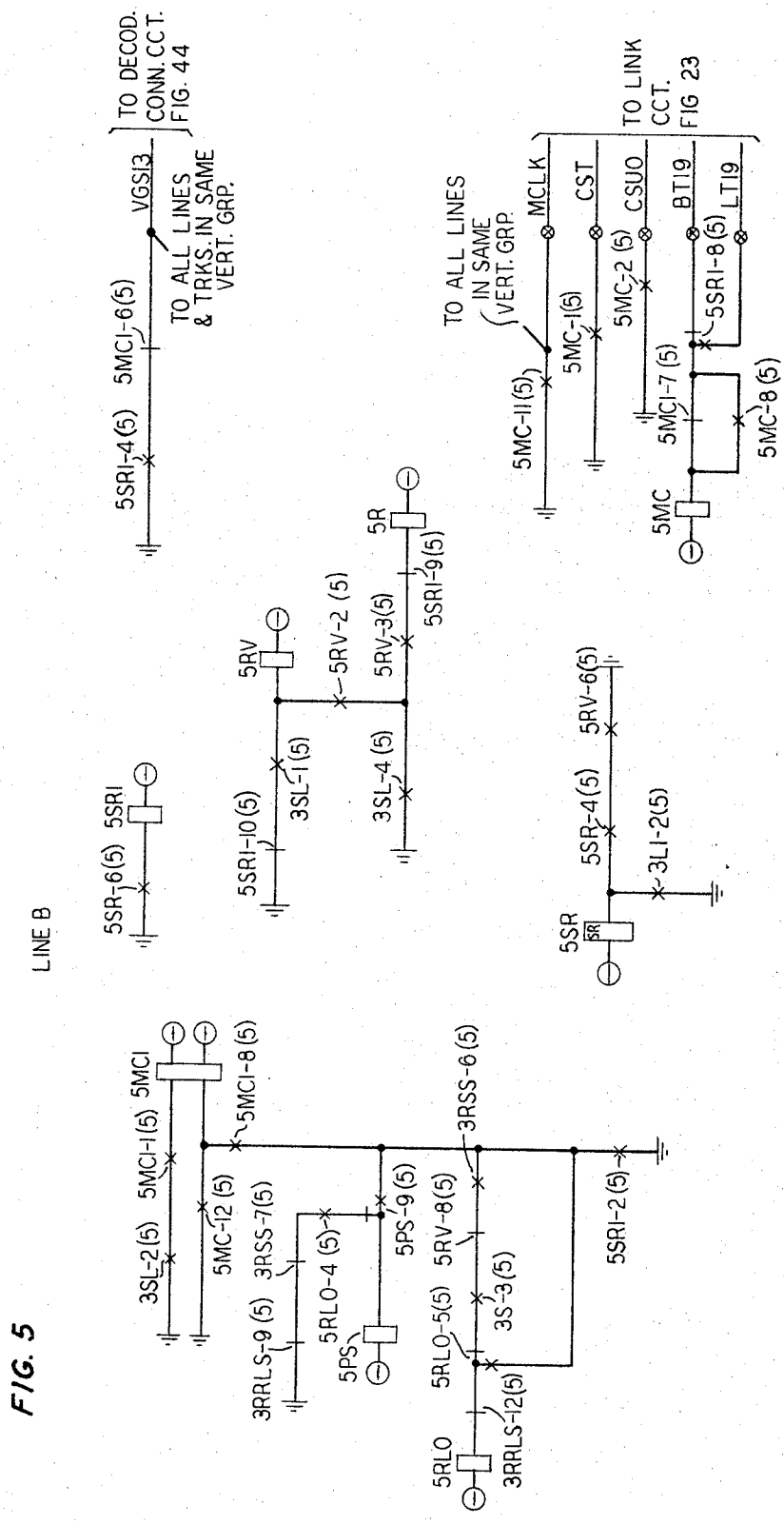

LINE B
5SR-6(5)
5SRI
5SRI-10(5)
3SL-1(5)
5RV
5RV-2 (5)
5RV-3(5)
3SL-4 (5)
5R
5SRI-9(5)
5SR-4(5)
5RV-6(5)
3LI-2(5)
5SR
5SRI-4(5)
5MCI-6(5)
VGSI3
TO ALL LINES & TRKS. IN SAME VERT. GRP.
TO DECOD. CONN. CCT. FIG. 44
5MC-11(5)
TO ALL LINES IN SAME VERT. GRP.
MCLK
5MC-1(5)
CST
5MC-2 (5)
CSUO
5MCI-7 (5)
BTI9
5SRI-8(5)
LTI9
TO LINK CCT. FIG 23
5MC
5MC-8 (5)
3SL-2(5)
5MCI-1(5)
5MCI
5MCI-8 (5)
5MC-12 (5)
3RSS-7(5)
3RRLS-9 (5)
5RLO-4 (5)
5PS
5PS-9 (5)
5RV-8(5)
3RSS-6(5)
5RLO-5(5)
3S-3(5)
5SRI-2(5)
5RLO
3RRLS-12(5)

FIG. 5

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NO-TEST OR BUSY VERIFICATION IN A PRIVATE BRANCH EXCHANGE TELEPHONE SYSTEM
Filed March 9, 1965 109 Sheets-Sheet 6

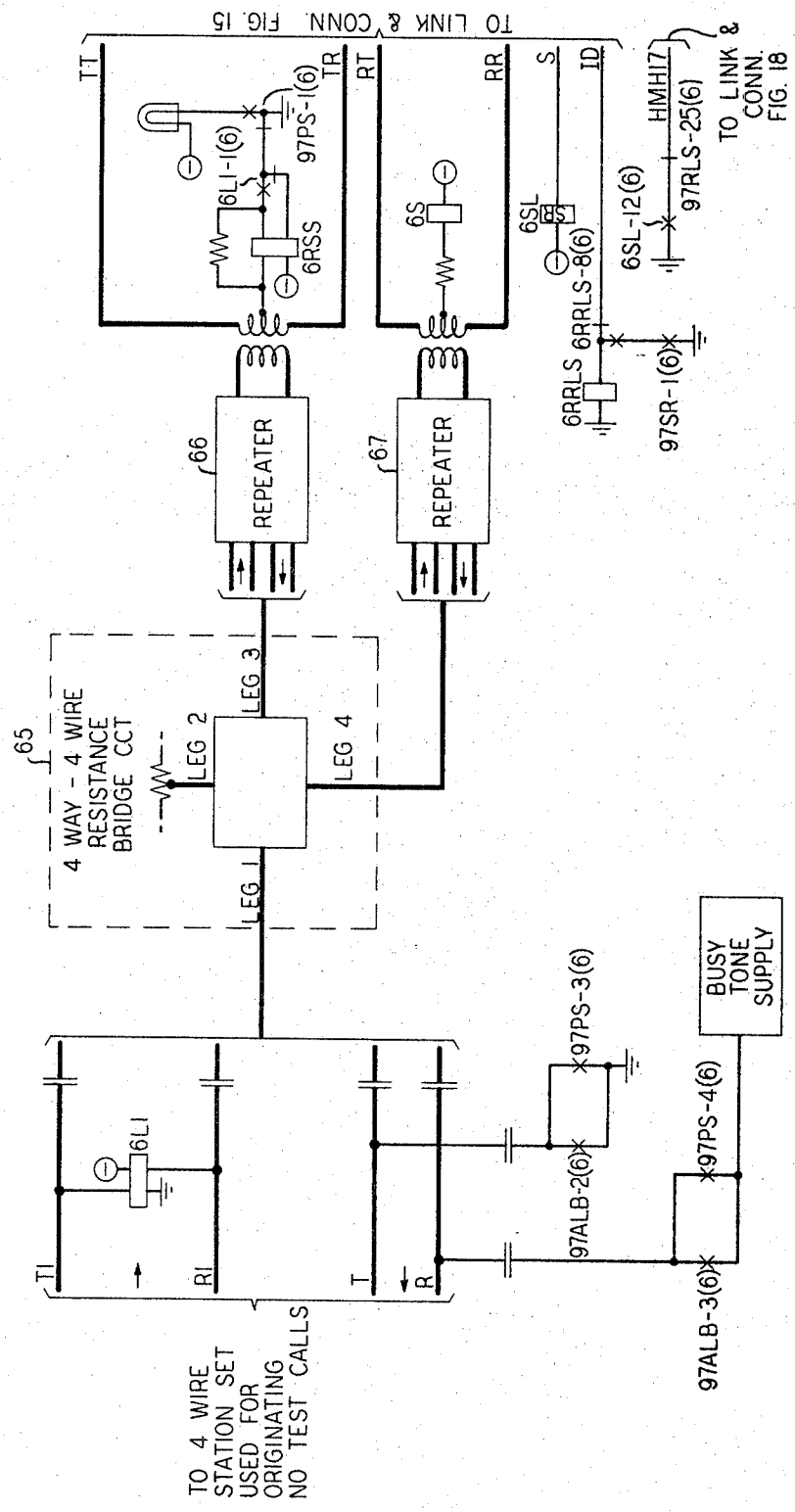


FIG. 6

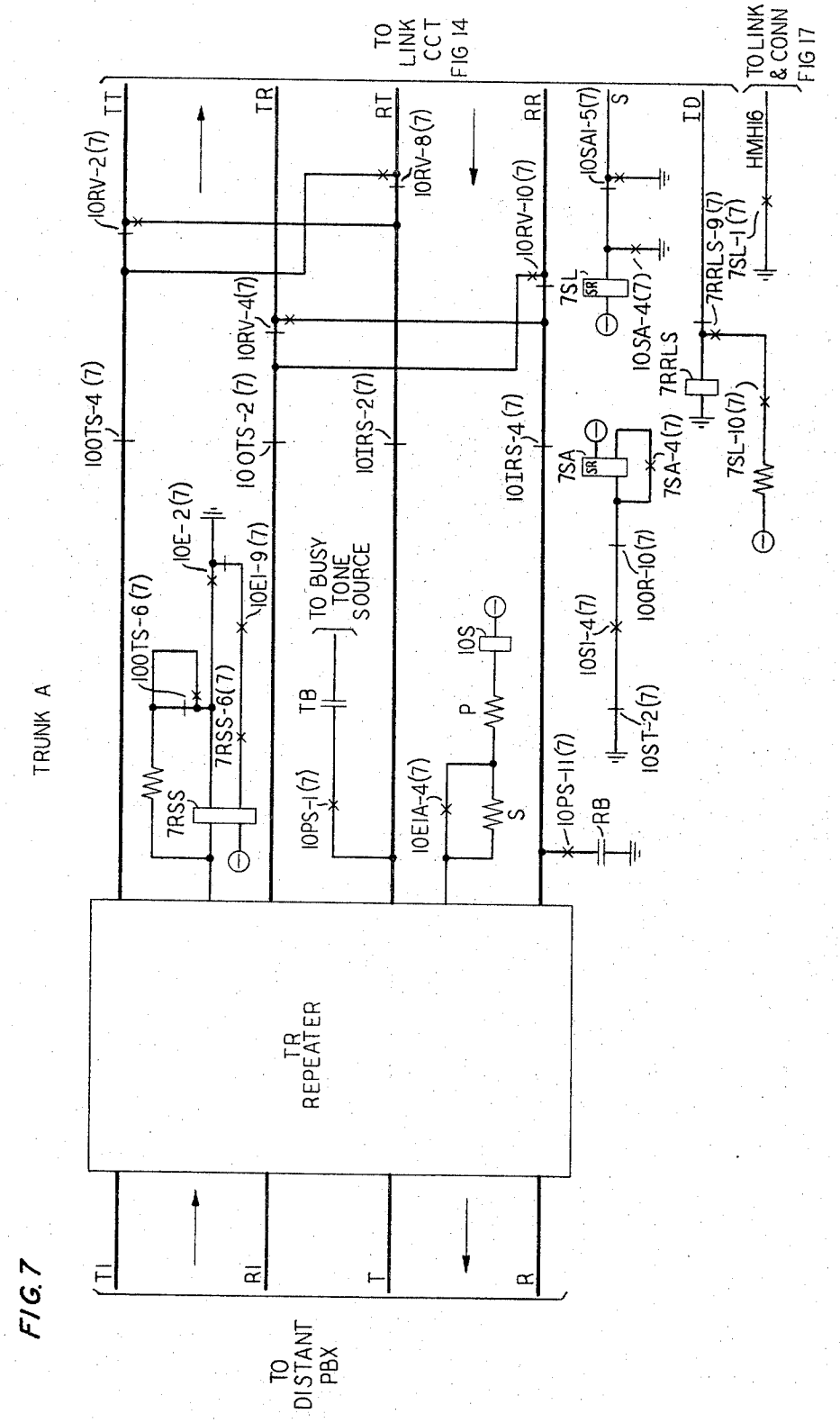

TRUNK A
TO LINK CCT FIG 14
TO LINK & CONN FIG 17
TT
TR
RT
RR
S
ID
10RV-2(7)
10RV-8(7)
10RV-10(7)
10SAI-5(7)
HMH16
10RV-4(7)
7SL
7RRLS-9(7)
7SL-1(7)
10SA-4(7)
10TS-4(7)
10 OTS-2(7)
10IRS-2(7)
10IRS-4(7)
7RRLS
7SA
7SA-4(7)
7SL-10(7)
10E-2(7)
10EI-9(7)
10TS-6(7)
TO BUSY TONE SOURCE
TB
10S
P
S
7RSS-6(7)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

FIG. 7

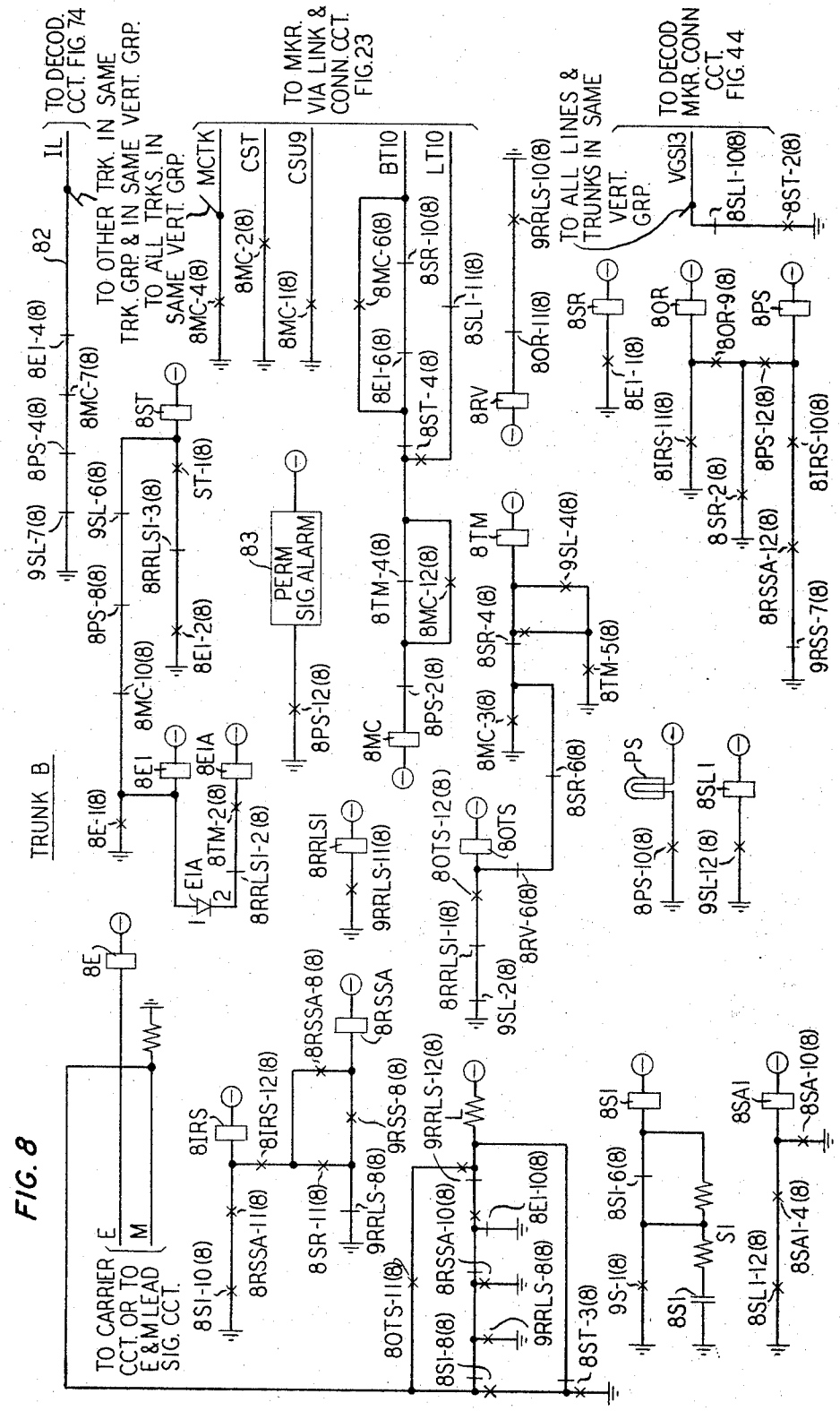

TRUNK B
TO CARRIER CCT. OR TO E & M LEAD SIG. CCT.
E
M
8E
8E-1(8)
8E1
8E1A
8TM-2(8)
8RRLSI-2(8)
8RRLSI
9RRLS-11(8)
8RSSA-8(8)
8RSSA
8IRS
8IRS-12(8)
8SI-10(8)
8RSSA-11(8)
8SR-11(8)
9RRLS-8(8)
9RSS-8(8)
8OTS-11(8)
8SI-8(8)
8RSSA-10(8)
9RRLS-12(8)
9RRLS-8(8)
8EI-10(8)
8ST-3(8)
8MC-10(8)
8RRLSI-3(8)
8ST
ST-1(8)
8EI-2(8)
9SL-7(8)
8PS-4(8)
8EI-4(8)
82
IL
TO DECOD. CCT. FIG. 74
8MC-7(8)
8PS-8(8)
9SL-6(8)
TO OTHER TRK. IN SAME TRK. GRP. & IN SAME VERT. GRP.
TO ALL TRKS. IN SAME VERT. GRP.
MCTK
8MC-4(8)
8MC-2(8)
CST
8MC-1(8)
CSU9
TO MKR. VIA LINK & CONN. CCT. FIG. 23
83
PERM SIG. ALARM
8PS-12(8)
8MC
8TM-4(8)
8MC-12(8)
8PS-2(8)
8MC-6(8)
BT10
8EI-6(8)
8ST-4(8)
8SR-10(8)
LT10
8SLI-11(8)
8RV
8TM
8SR-4(8)
9SL-4(8)
8MC-3(8)
8TM-5(8)
8SR-6(8)
8OTS
8OTS-12(8)
8RRLSI-1(8)
9SL-2(8)
8RV-6(8)
8PS
8PS-10(8)
9SL-12(8)
8SLI
8SI
8SI-6(8)
9S-1(8)
8SI
SI
8SAI
8SA-10(8)
8SLI-12(8)
8SAI-4(8)
9RRLS-10(8)
8OR-11(8)
8SR
8EI-1(8)
TO ALL LINES & TRUNKS IN SAME VERT. GRP.
VGSI3
TO DECOD MKR. CONN CCT. FIG. 44
8SLI-10(8)
8ST-2(8)
8OR
8OR-9(8)
8IRS-11(8)
8SR-2(8)
8PS
8PS-12(8)
8RSSA-12(8)
8IRS-10(8)
9RSS-7(8)

FIG. 8

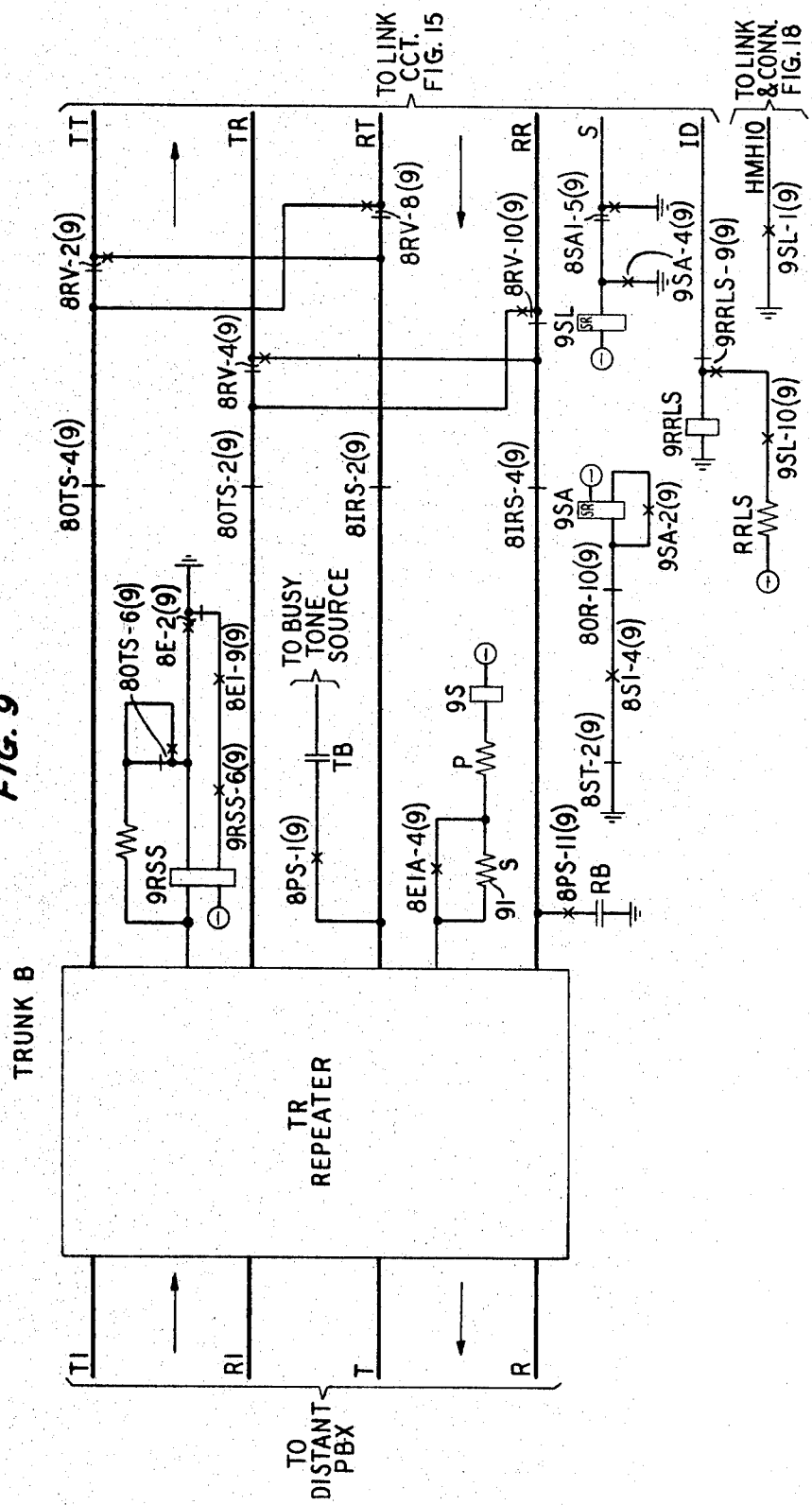

TO LINK CCT. FIG. 15
TO LINK & CONN. FIG. 18
TT
TR
RT
RR
S
ID
HMH10
8RV-2(9)
8RV-8(9)
8RV-10(9)
8SA1-5(9)
9SA-4(9)
9SL-1(9)
9RRLS-9(9)
9SL
8RV-4(9)
8OTS-4(9)
8OTS-2(9)
8IRS-2(9)
8IRS-4(9)
9RRLS
9SL-10(9)
9SA
9SA-2(9)
RRLS
8OTS-6(9)
8E-2(9)
8EI-9(9)
TO BUSY TONE SOURCE
8OR-10(9)
8SI-4(9)
9RSS
9RSS-6(9)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

FIG. 9

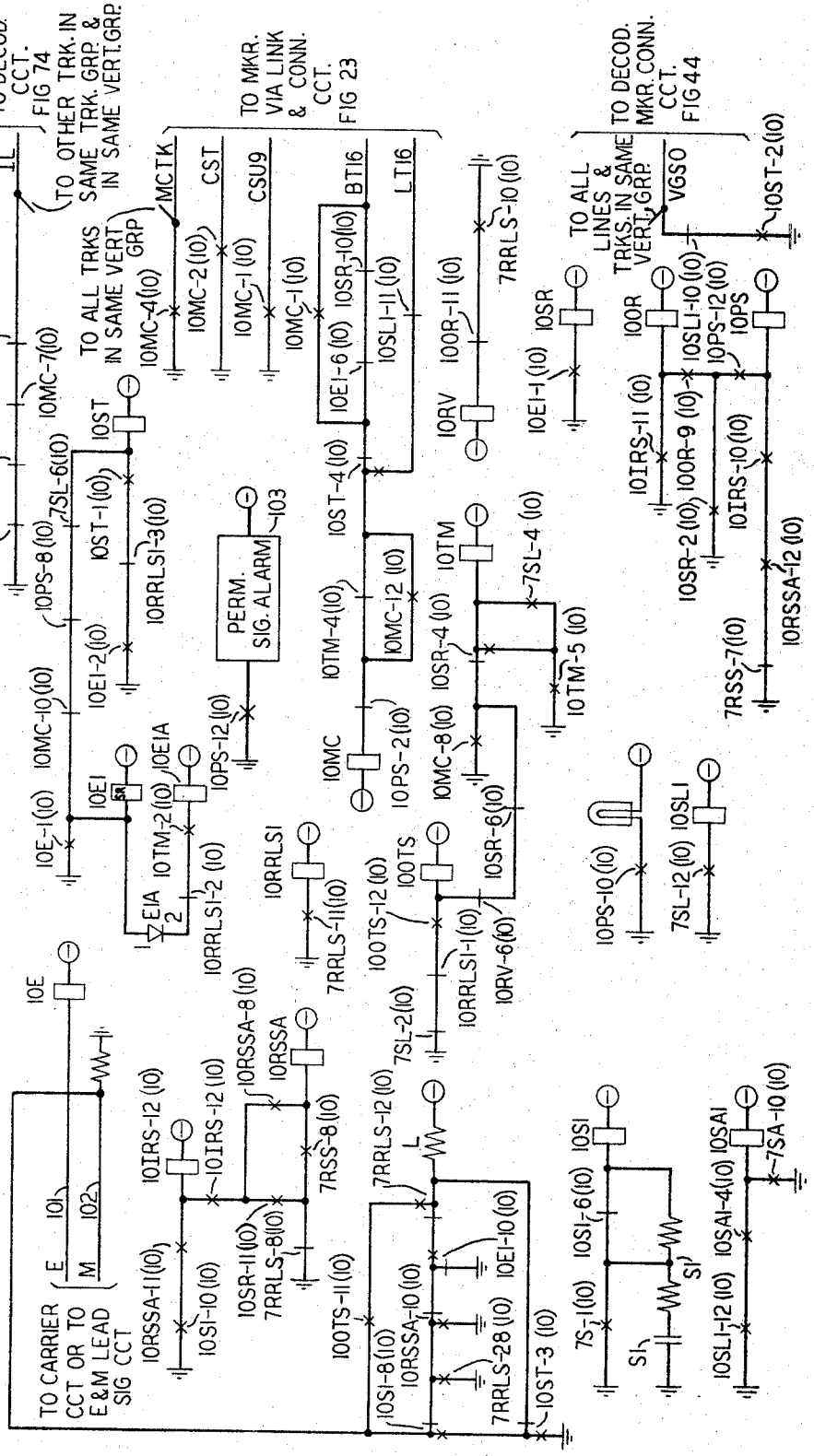

TRUNK A
TO CARRIER CCT OR TO E&M LEAD SIG CCT
E
M
101
102
10E
10E-1(10)
10E1-4 (10)
10E1-2(10)
10E1-6 (10)
10E1-1 (10)
10EI
10EIA
EIA
2
10TM-2(10)
10ORRLSI-2 (10)
10ORRLSI-3(10)
10ORRLSI-1(10)
10ORV-6(10)
10ORV
10OR-11 (10)
10OR
10OR-9 (10)
10OR-11 (10)
10OR-2 (10)
10IRS-11 (10)
10IRS-12 (10)
10IRS-10(10)
10SI-10 (10)
10SI-8 (10)
10SI-6(10)
10SI
10SR-11(10)
10SR-8(10)
10SR-6(10)
10SR-4 (10)
10SR-10(10)
10SR
10SR-2 (10)
10ORSSA-11(10)
10ORSSA-8 (10)
10ORSSA-10 (10)
10ORSSA
10ORSSA-12 (10)
10TS-11(10)
10TS-12 (10)
10TS
10TM
10TM-4(10)
10TM-5 (10)
10PS-4 (10)
10PS-8 (10)
10PS-12(10)
10PS-2(10)
10PS-10(10)
10PS
10PS-12(10)
10MC-10(10)
10MC-7(10)
10MC-4(10)
10MC-2(10)
10MC-1(10)
10MC-8(10)
10MC
10MC-12 (10)
10MC-1 (10)
10ST
10ST-1(10)
10ST-4(10)
10ST-3 (10)
10ST-2(10)
10SLI-11(10)
10SLI-10(10)
10SLI-12 (10)
10SLI
10SAI-4(10)
10SAI
10SAI-12 (10)
7SL-7 (10)
7SL-6(10)
7SL-4 (10)
7SL-2(10)
7SL-12 (10)
7SL-1(10)
7SA-10 (10)
7RRLS-11(10)
7RRLS-12 (10)
7RRLS-8(10)
7RRLS-28 (10)
7RRLS-10 (10)
7RSS-8(10)
7RSS-7(10)
PERM. SIG. ALARM
103
IL
TO DECOD. CCT. FIG 74
TO OTHER TRK. IN SAME TRK. GRP. & IN SAME VERT. GRP.
TO ALL TRKS IN SAME VERT GRP
MCTK
CST
CSU9
TO MKR. VIA LINK & CONN. CCT. FIG 23
BT16
LT16
TO ALL LINES & TRKS. IN SAME VERT. GRP.
VGSO
TO DECOD. MKR. CONN. CCT. FIG 44
L
SI
SI'

FIG. 10

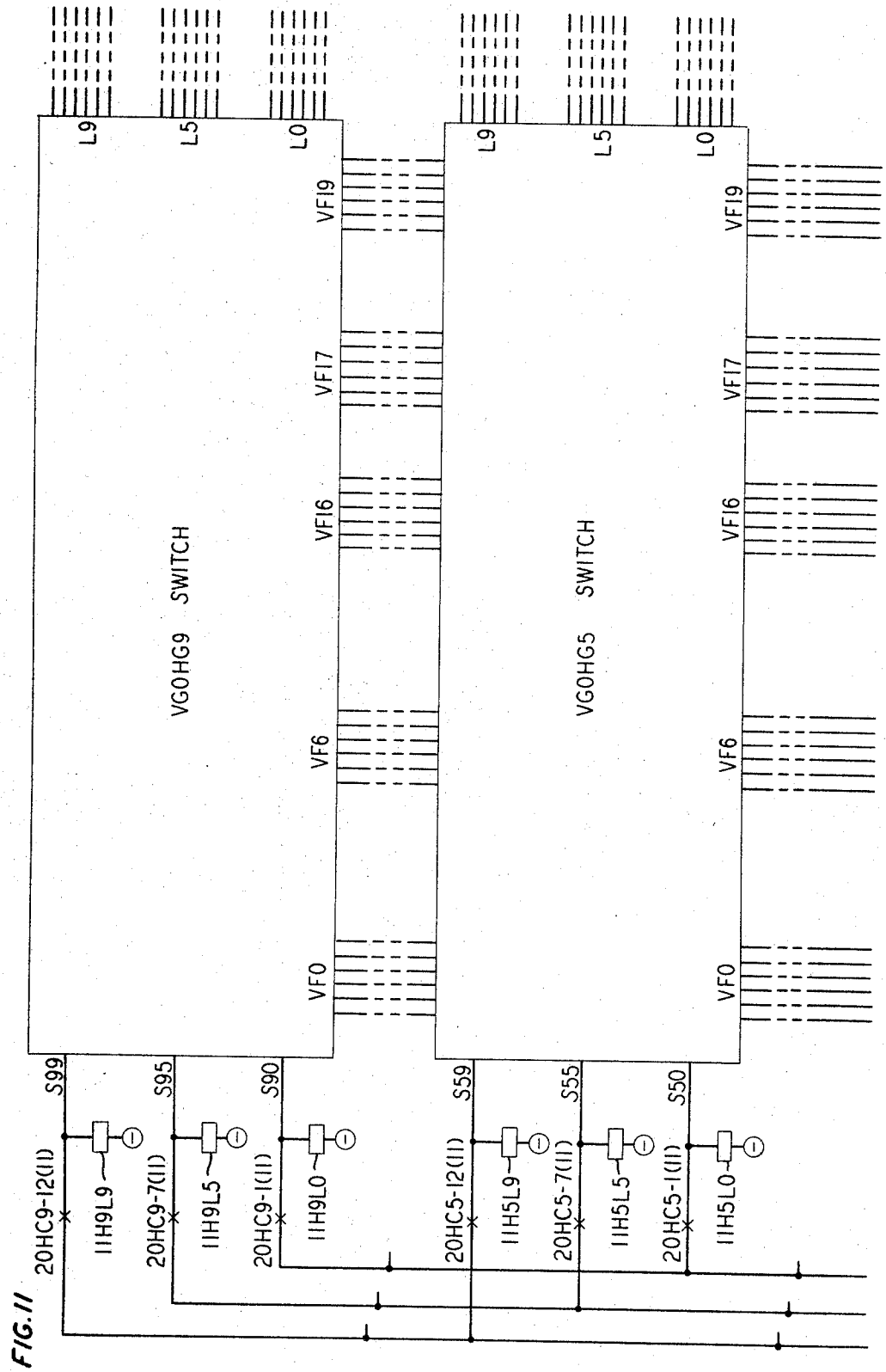

L9
L5
L0
VF19
VF17
VF16
VF6
VF0
VGOHG9 SWITCH
VGOHG5 SWITCH
S99
S95
S90
S59
S55
S50
20HC9-12(11)
11H9L9
20HC9-7(11)
11H9L5
20HC9-1(11)
11H9L0
20HC5-12(11)
11H5L9
20HC5-7(11)
11H5L5
20HC5-1(11)
11H5L0

FIG. 11

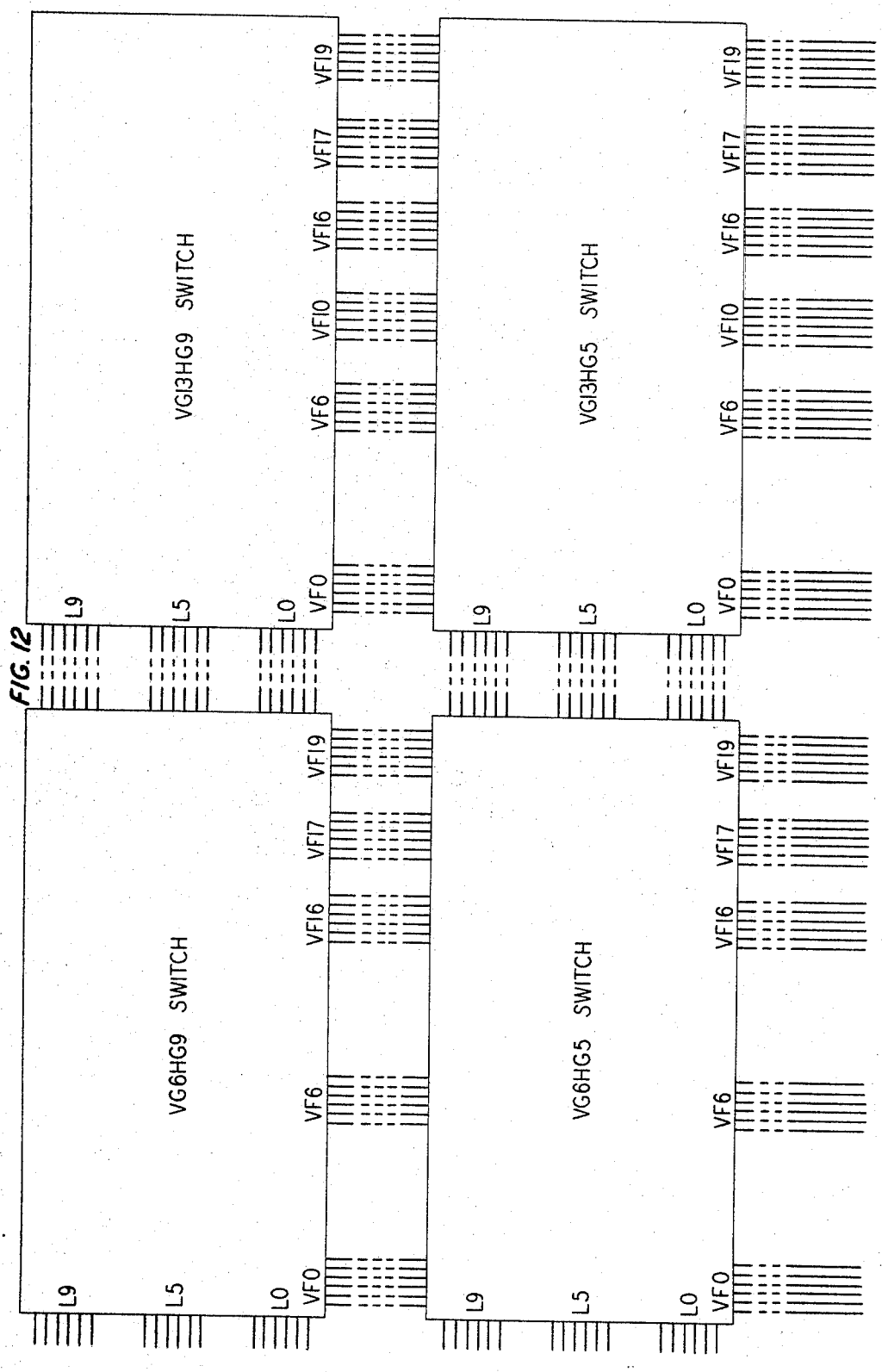

VG13HG9 SWITCH
VG13HG5 SWITCH
VG6HG9 SWITCH
VG6HG5 SWITCH
VF19
VF17
VF16
VF10
VF6
VF0
L9
L5
L0

FIG. 12

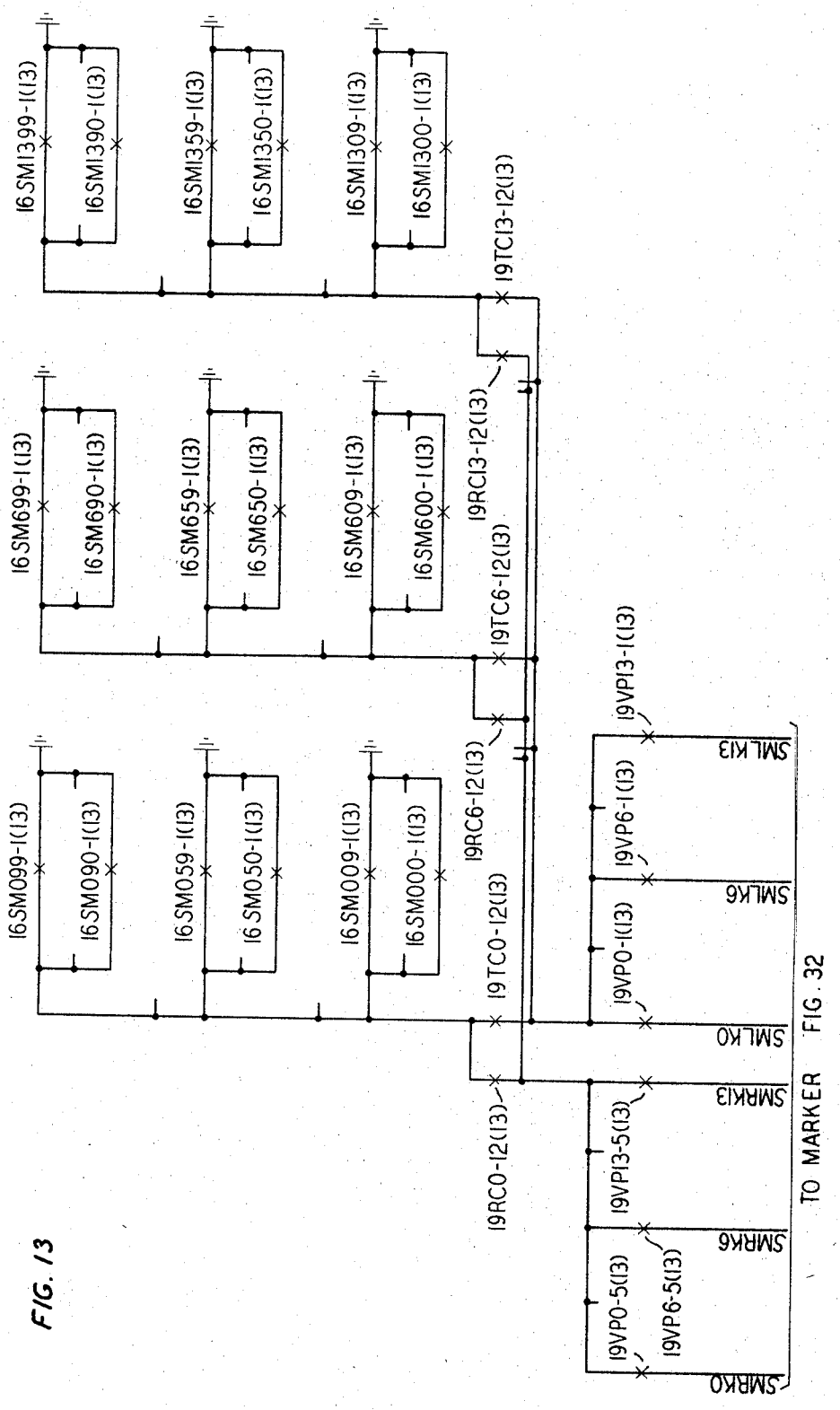

16SM1399-1(13)
16SM1390-1(13)
16SM1359-1(13)
16SM1350-1(13)
16SM1309-1(13)
16SM1300-1(13)
19TC13-12(13)
16SM699-1(13)
16SM690-1(13)
16SM659-1(13)
16SM650-1(13)
16SM609-1(13)
16SM600-1(13)
19RC13-12(13)
19TC6-12(13)
16SM099-1(13)
16SM090-1(13)
16SM059-1(13)
16SM050-1(13)
16SM009-1(13)
16SM000-1(13)
19RC6-12(13)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

FIG. 13

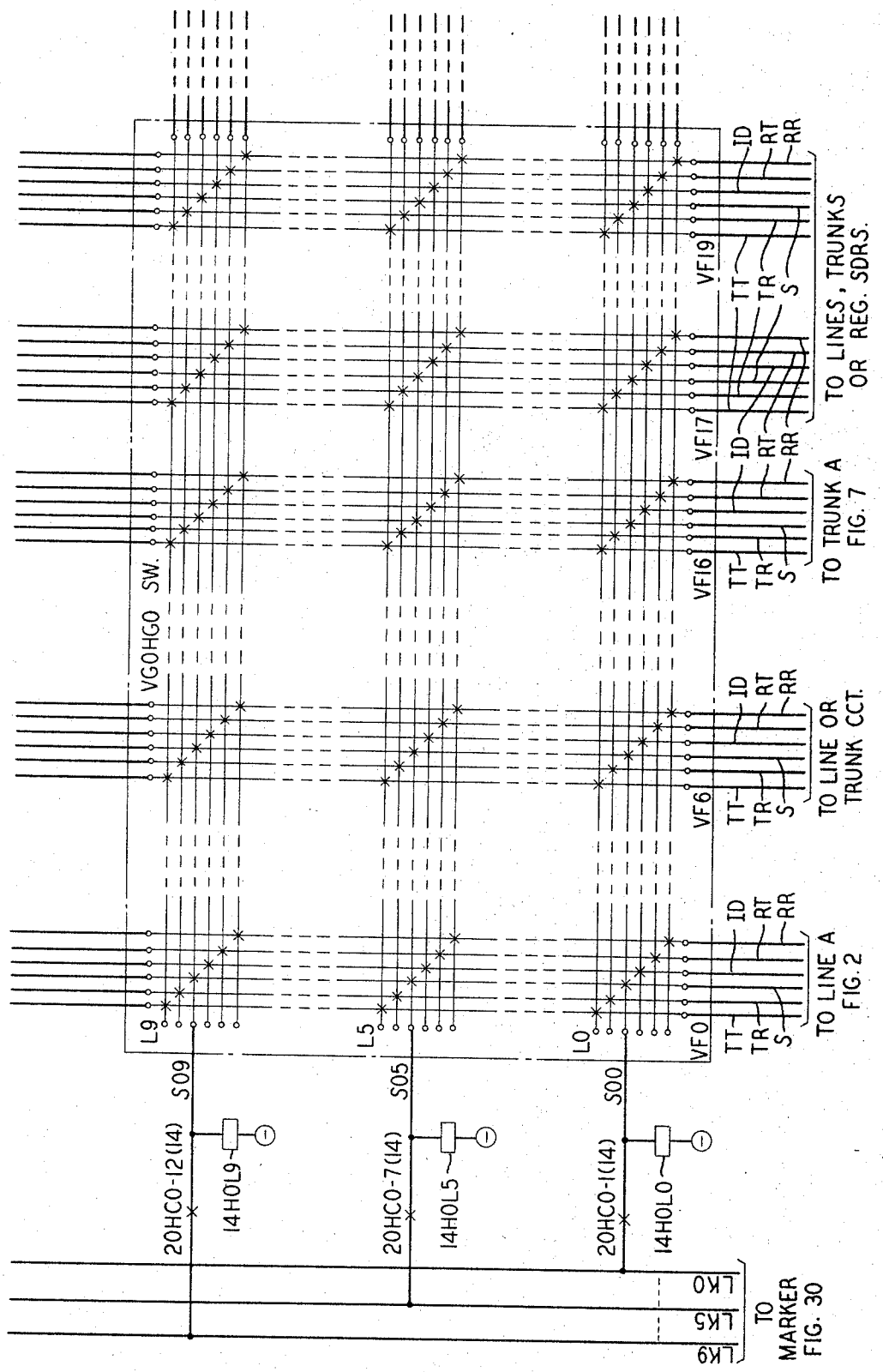

VGOHGO SW.
L9
L5
L0
S09
S05
S00
20HCO-12(14)
20HCO-7(14)
20HCO-1(14)
14HOL9
14HOL5
14HOL0
VF19
VF17
VF16
VF6
VF0
ID
RT
RR
TT
TR
S
TO LINES, TRUNKS OR REG. SDRS.
TO TRUNK A FIG. 7
TO LINE OR TRUNK CCT.
TO LINE A FIG. 2
LK0
LK5
LK9
TO MARKER FIG. 30

FIG. 14

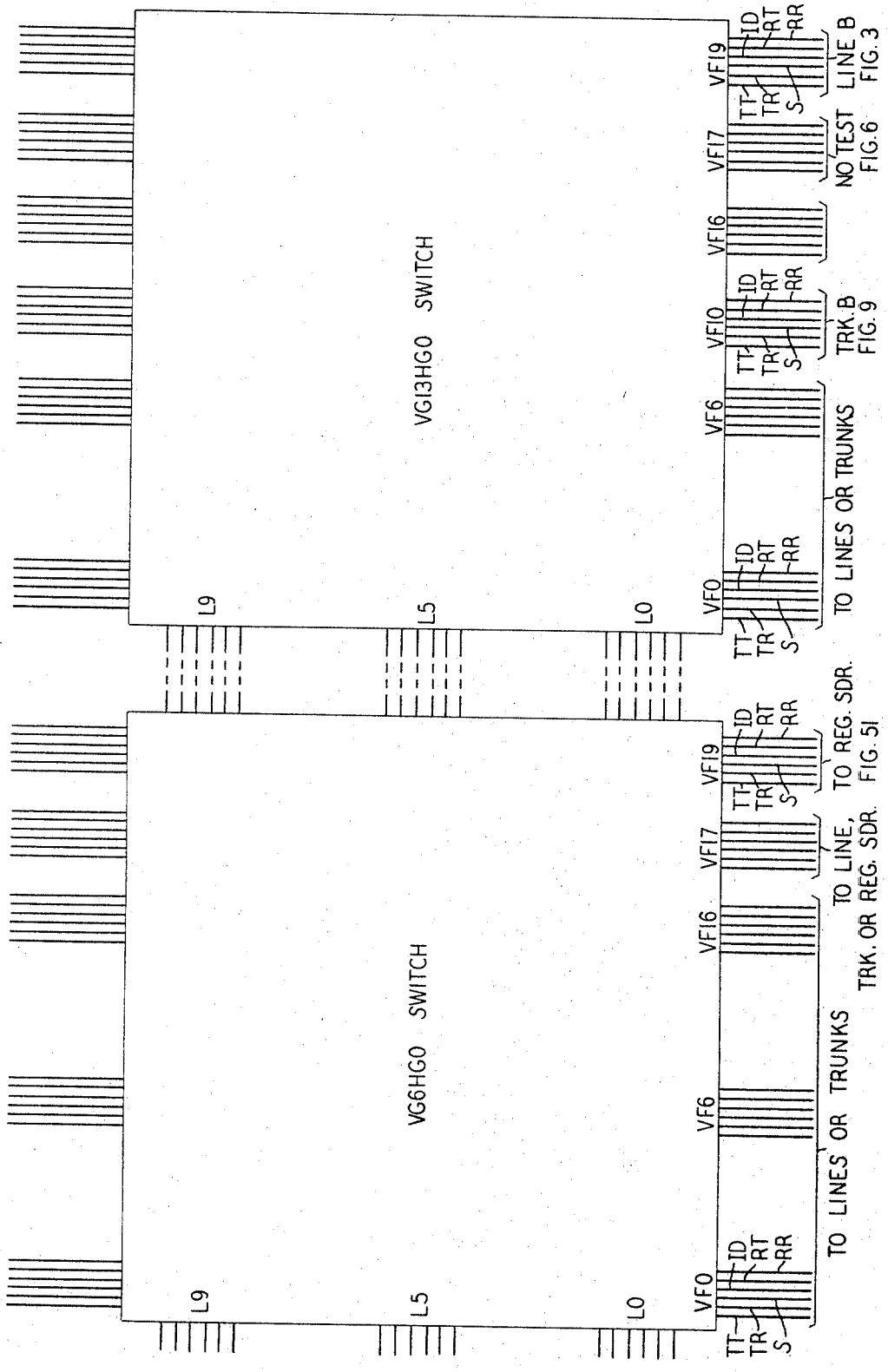

VG13HGO SWITCH
VG6HGO SWITCH
L9
L5
L0
VF19
VF17
VF16
VF10
VF6
VF0
ID
RT
RR
TT
TR
S
LINE B FIG.3
NO TEST FIG.6
TRK.B FIG.9
TO LINES OR TRUNKS
TO REG. SDR. FIG.51
TO LINE, TRK. OR REG. SDR.
TO LINES OR TRUNKS

FIG. 15

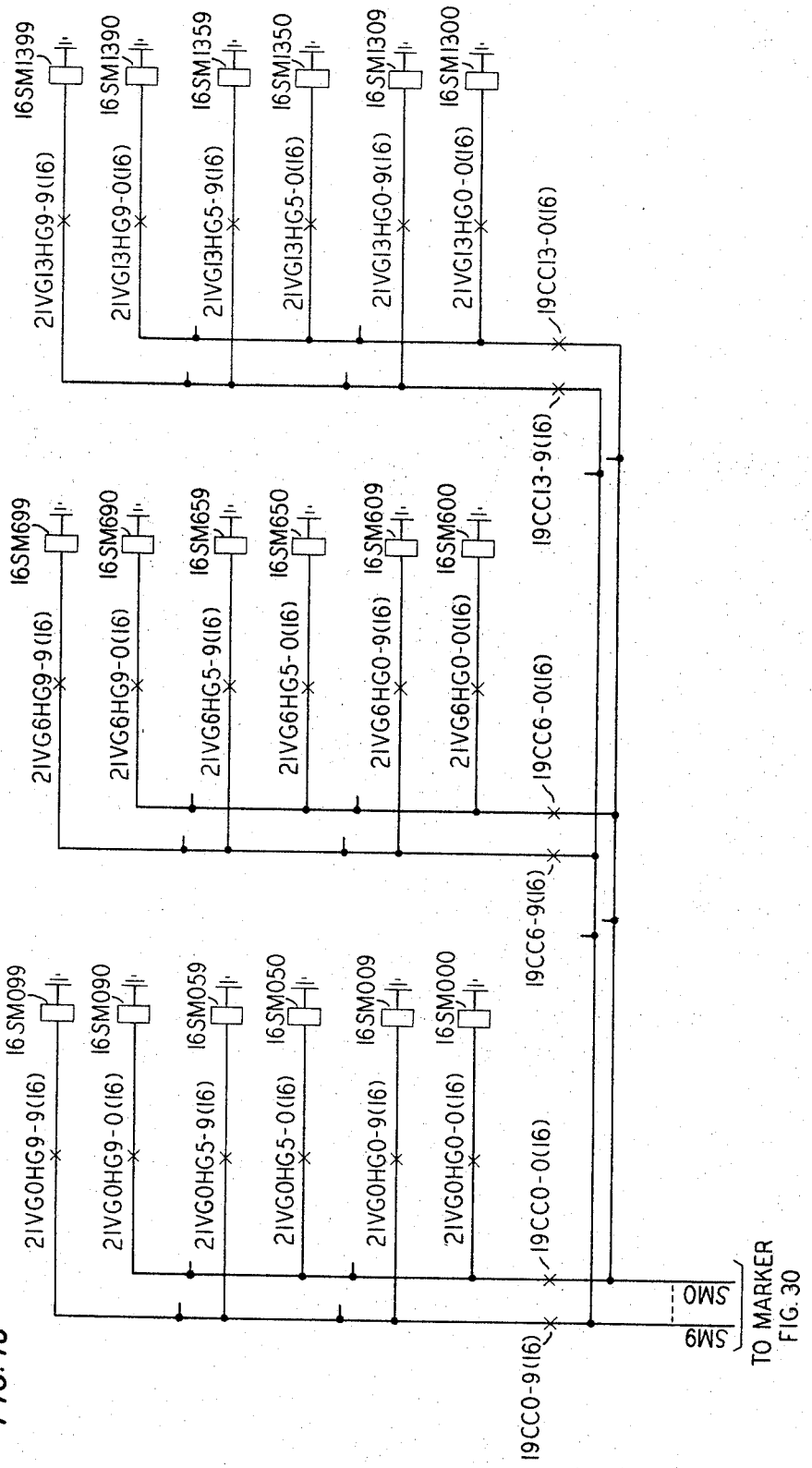

16SM1399
16SM1390
16SM1359
16SM1350
16SM1309
16SM1300
21VGI3HG9-9(16)
21VGI3HG9-0(16)
21VGI3HG5-9(16)
21VGI3HG5-0(16)
21VGI3HGO-9(16)
21VGI3HGO-0(16)
19CCI3-0(16)
19CCI3-9(16)
16SM699
16SM690
16SM659
16SM650
16SM609
16SM600
21VG6HG9-9(16)
21VG6HG9-0(16)
21VG6HG5-9(16)
21VG6HG5-0(16)
21VG6HGO-9(16)
21VG6HGO-0(16)
19CC6-0(16)
19CC6-9(16)
16SM099
16SM090
16SM059
16SM050
16SM009
16SM000
21VGOHG9-9(16)
21VGOHG9-0(16)
21VGOHG5-9(16)
21VGOHG5-0(16)
21VGOHGO-9(16)
21VGOHGO-0(16)
19CCO-0(16)
19CCO-9(16)
SM0
SM9
TO MARKER FIG. 30

FIG. 16

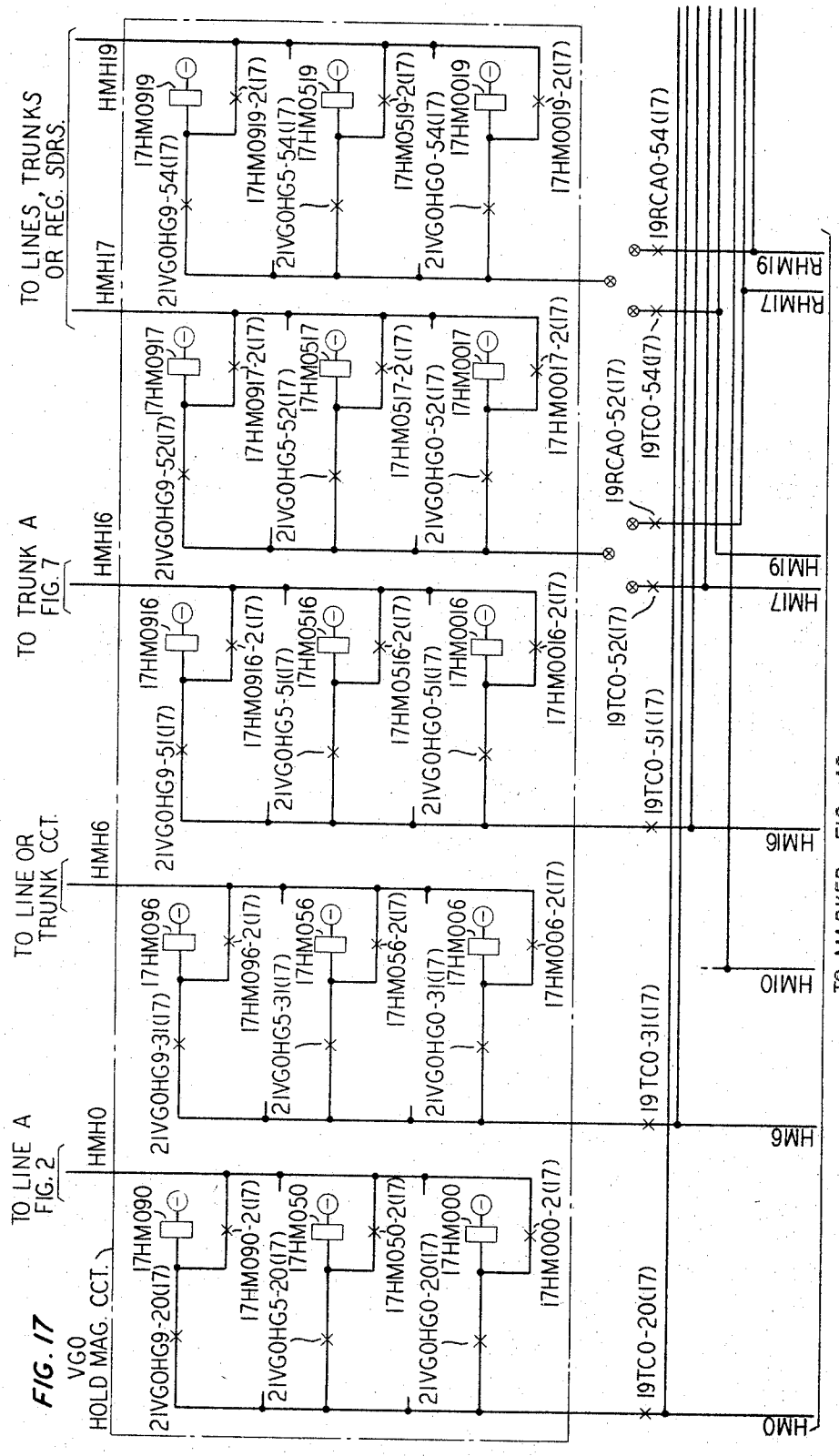

TO LINES, TRUNKS OR REG. SDRS.
TO TRUNK A FIG. 7
TO LINE OR TRUNK CCT.
TO LINE A FIG. 2
VGO HOLD MAG. CCT.
HMH19
HMH17
HMH16
HMH6
HMH0
17HM0919
17HM0917
17HM0916
17HM096
17HM090
17HM0519
17HM0517
17HM0516
17HM056
17HM050
17HM0019
17HM0017
17HM0016
17HM006
17HM000
21VG0HG9-54(17)
21VG0HG9-52(17)
21VG0HG9-51(17)
21VG0HG9-31(17)
21VG0HG9-20(17)
21VG0HG5-54(17)
21VG0HG5-52(17)
21VG0HG5-51(17)
21VG0HG5-31(17)
21VG0HG5-20(17)
21VG0HG0-54(17)
21VG0HG0-52(17)
21VG0HG0-51(17)
21VG0HG0-31(17)
21VG0HG0-20(17)
19RCA0-54(17)
19RCA0-52(17)
19TC0-54(17)
19TC0-52(17)
19TC0-51(17)
19TC0-31(17)
19TC0-20(17)
RHM19
RHM17
HM19
HM17
HM16
HM10
HM6
HM0
TO MARKER FIG. 42

FIG. 17

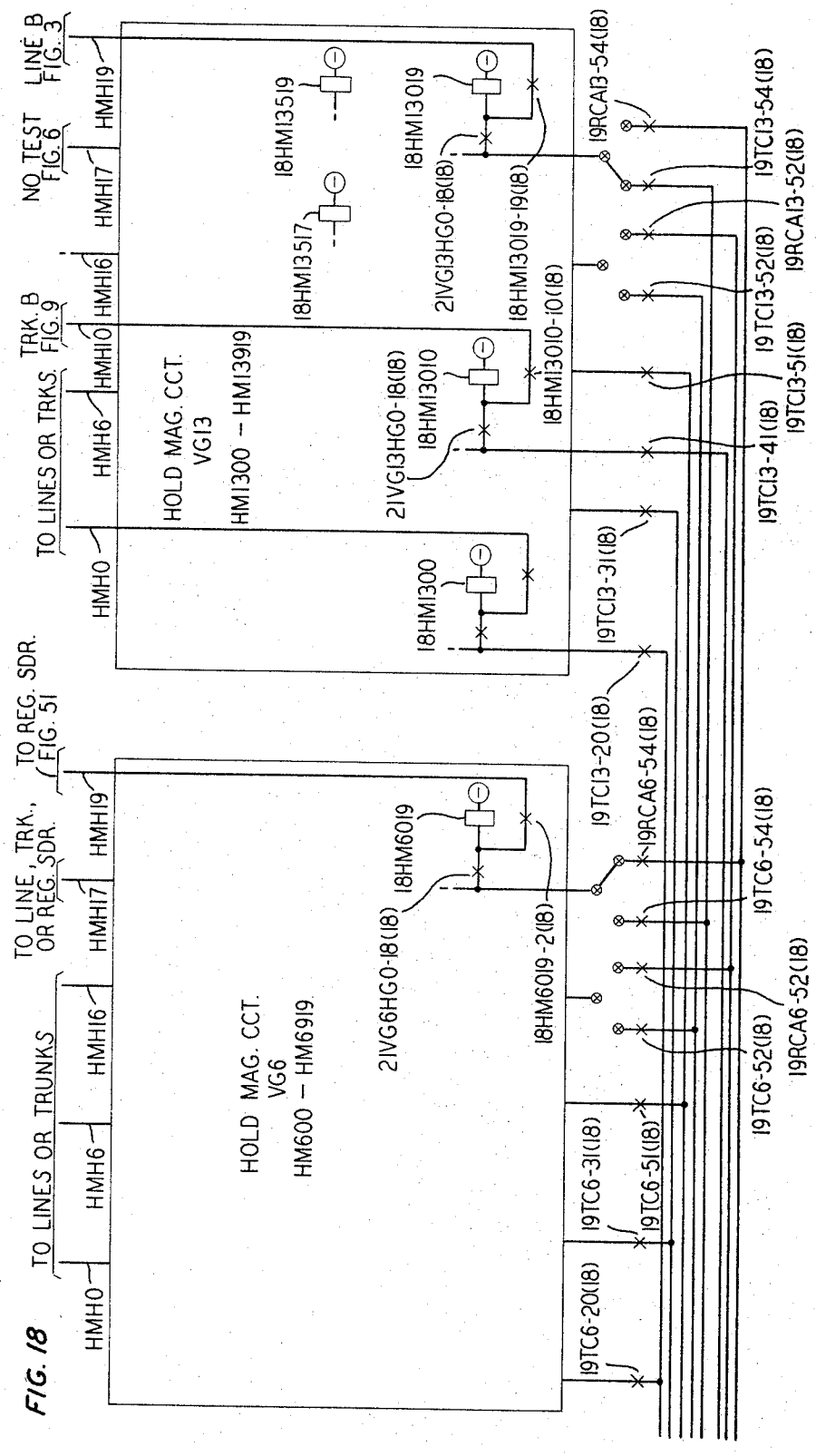

TO LINES OR TRUNKS
HMH0
HMH6
HMH16
HMH17
HMH19
TO LINE, TRK., OR REG. SDR.
TO REG. SDR. FIG. 51
HOLD MAG. CCT.
VG6
HM600 – HM6919
21VG6HG0-18(18)
18HM6019
18HM6019-2(18)
19TC6-20(18)
19TC6-31(18)
19TC6-51(18)
19TC13-20(18)
19RCA6-54(18)
19TC6-54(18)
19TC6-52(18)
19RCA6-52(18)
TO LINES OR TRKS.
TRK. B FIG. 9
NO TEST FIG. 6
LINE B FIG. 3
HMH0
HMH6
HMH10
HMH16
HMH17
HMH19
HOLD MAG. CCT.
VG13
HM1300 – HM13919
21VG13HG0-18(18)
18HM1300
18HM13010
18HM13010-10(18)
18HM13517
18HM13519
18HM13019
18HM13019-19(18)
19TC13-31(18)
19TC13-41(18)
19TC13-51(18)
19TC13-52(18)
19RCA13-52(18)
19TC13-54(18)
19RCA13-54(18)

FIG. 18

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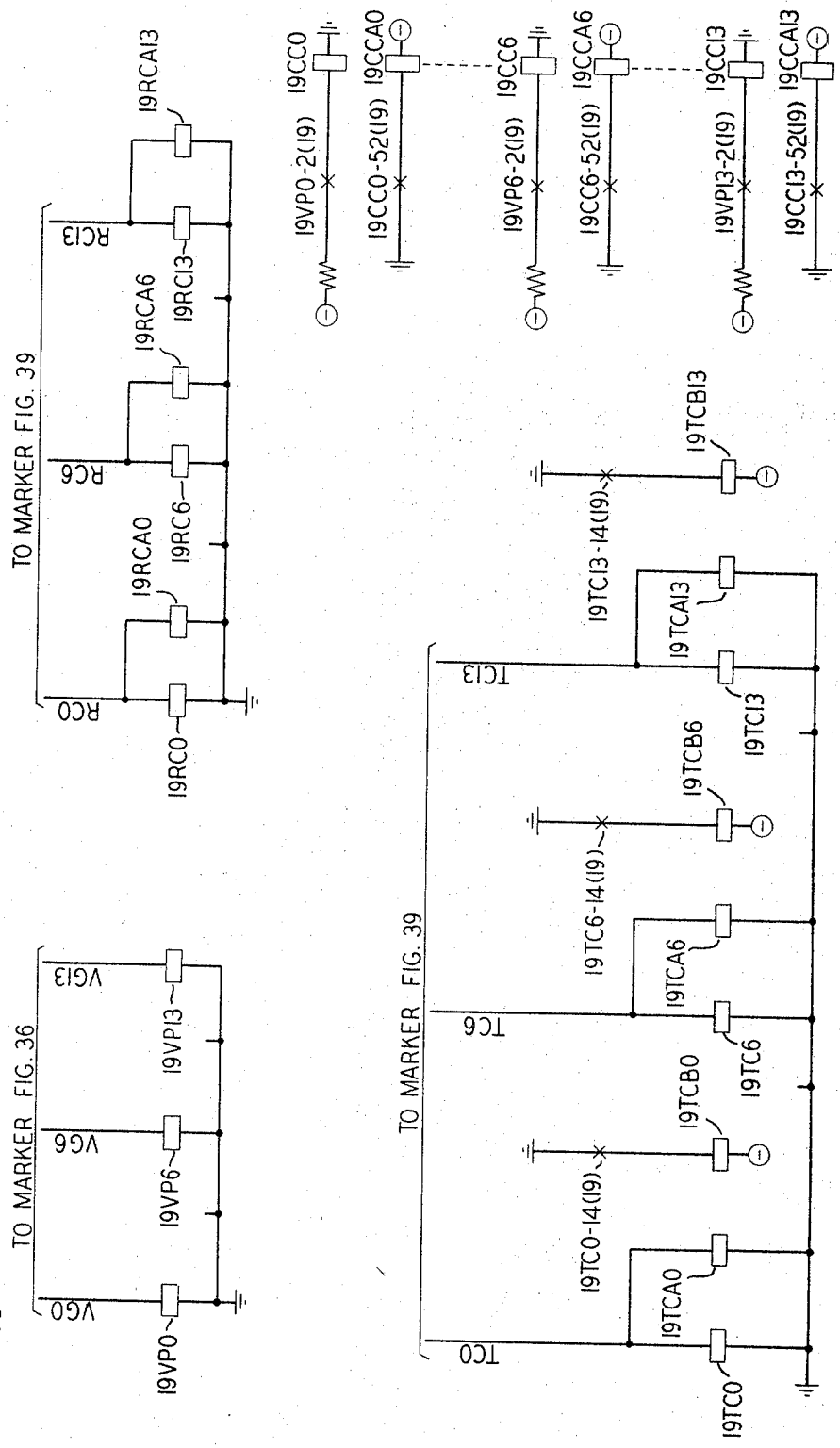


FIG. 19

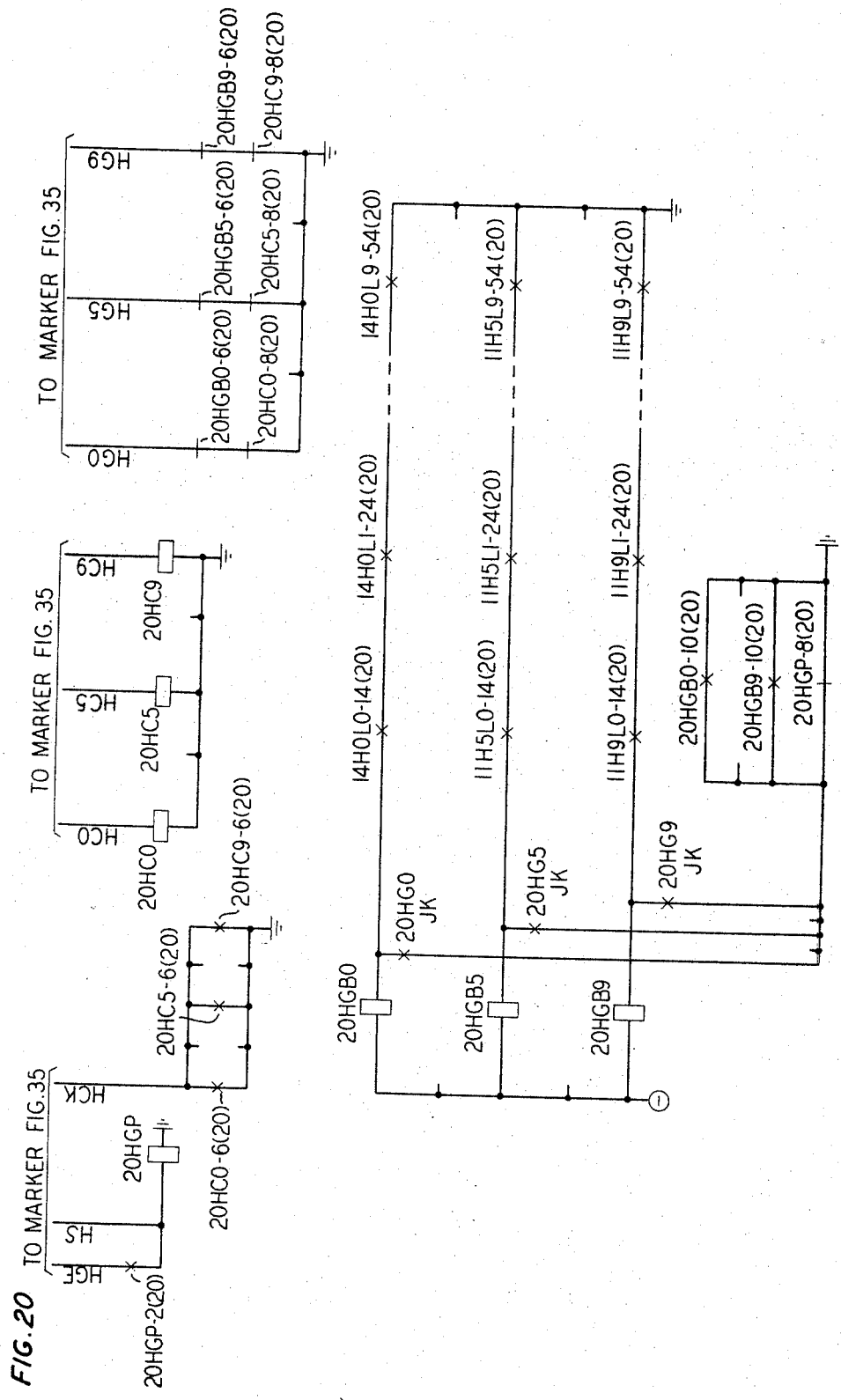

TO MARKER FIG. 35
HG9
HG5
HG0
20HGB9-6(20)
20HGB5-6(20)
20HGB0-6(20)
20HC9-8(20)
20HC5-8(20)
20HC0-8(20)
TO MARKER FIG. 35
HC9
HC5
HC0
20HC9
20HC5
20HC0
20HC9-6(20)
20HC5-6(20)
20HC0-6(20)
TO MARKER FIG. 35
HCK
HGE
HS
20HGP
20HGP-2(20)
14H0L9-54(20)
11H5L9-54(20)
11H9L9-54(20)
14H0LI-24(20)
11H5LI-24(20)
11H9LI-24(20)
14H0L0-14(20)
11H5L0-14(20)
11H9L0-14(20)
20HG0 JK
20HG5 JK
20HG9 JK
20HGB0
20HGB5
20HGB9
20HGB0-10(20)
20HGB9-10(20)
20HGP-8(20)
1

FIG. 20

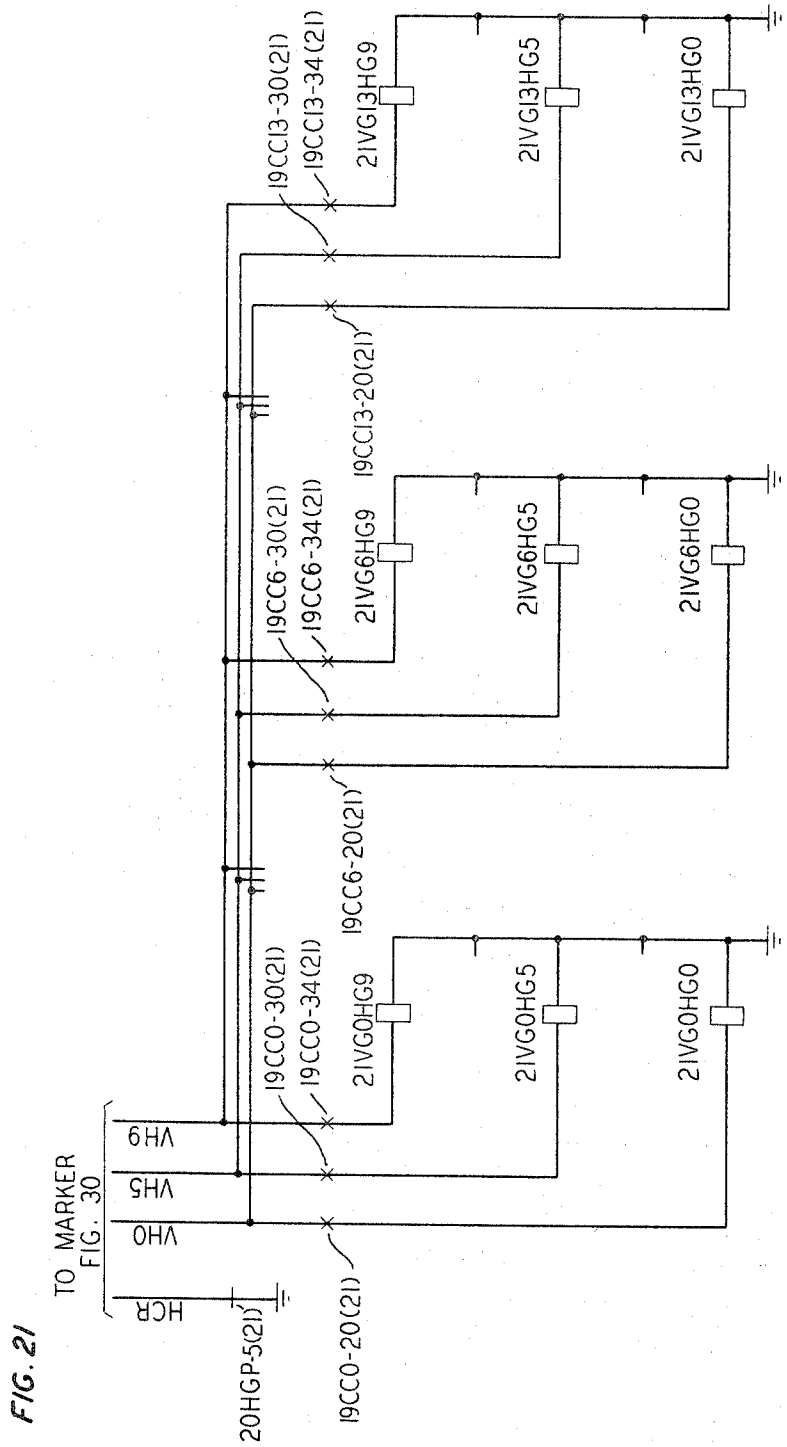
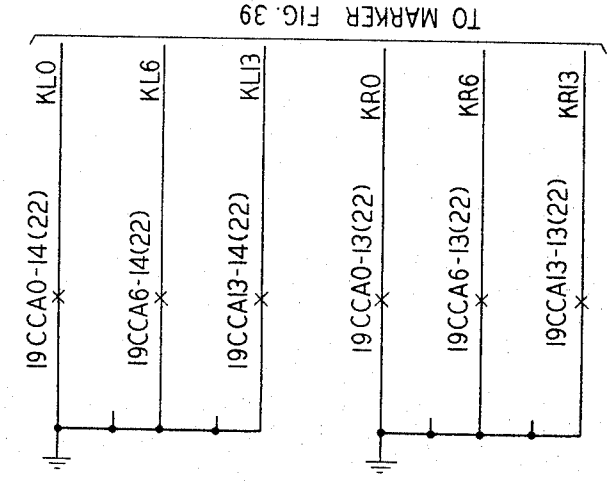

TO MARKER FIG. 30
VH9
VH5
VH0
HCR
20HGP-5(21)
19CC0-20(21)
19CC0-30(21)
19CC0-34(21)
21VG0HG9
21VG0HG5
21VG0HG0
19CC6-20(21)
19CC6-30(21)
19CC6-34(21)
21VG6HG9
21VG6HG5
21VG6HG0
19CC13-20(21)
19CC13-30(21)
19CC13-34(21)
21VG13HG9
21VG13HG5
21VG13HG0

FIG. 21


TO MARKER FIG. 39
KL0
KL6
KL13
KR0
KR6
KR13
19CCA0-14(22)
19CCA6-14(22)
19CCA13-14(22)
19CCA0-13(22)
19CCA6-13(22)
19CCA13-13(22)

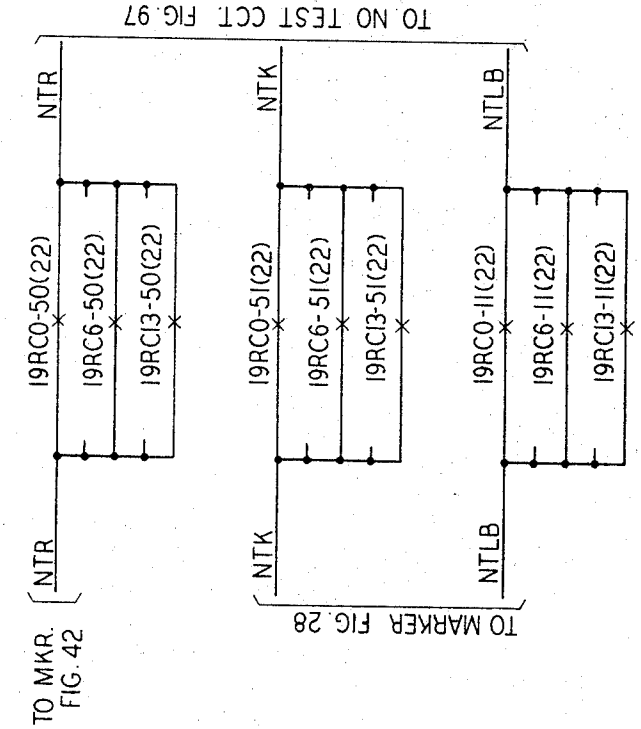

TO NO TEST CCT FIG. 97
NTR
NTK
NTLB
19RC0-50(22)
19RC6-50(22)
19RC13-50(22)
19RC0-51(22)
19RC6-51(22)
19RC13-51(22)
19RC0-11(22)
19RC6-11(22)
19RC13-11(22)
NTR
NTK
NTLB
TO MKR. FIG. 42
TO MARKER FIG. 28

FIG. 22

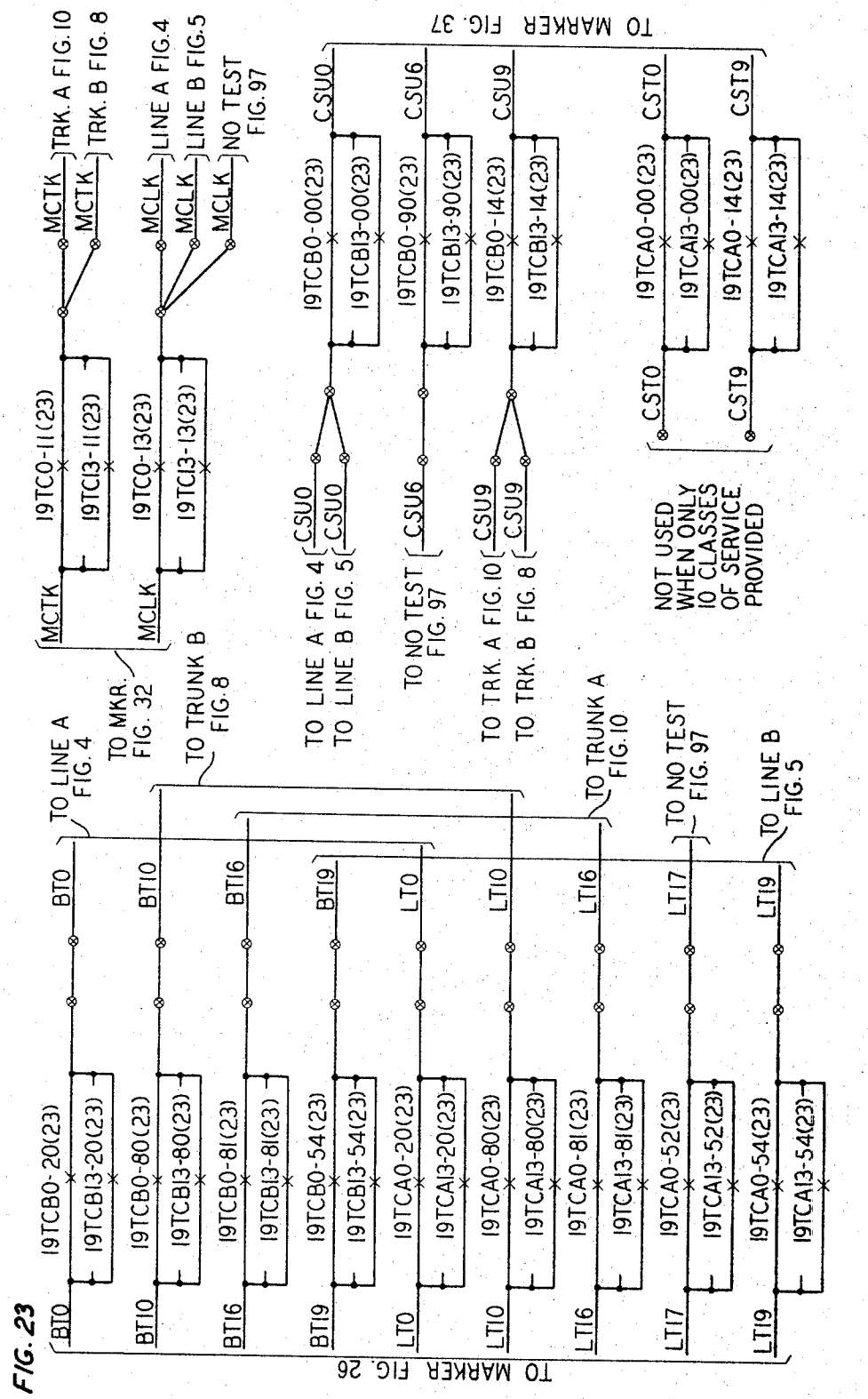

TO MARKER FIG. 26
BT0
BT10
BT16
BT19
LT0
LT10
LT16
LT17
LT19
19TCB0-20(23)
19TCB13-20(23)
19TCB0-80(23)
19TCB13-80(23)
19TCB0-81(23)
19TCB13-81(23)
19TCB0-54(23)
19TCB13-54(23)
19TCA0-20(23)
19TCA13-20(23)
19TCA0-80(23)
19TCA13-80(23)
19TCA0-81(23)
19TCA13-81(23)
19TCA0-52(23)
19TCA13-52(23)
19TCA0-54(23)
19TCA13-54(23)
TO LINE A FIG. 4
TO MKR. FIG. 32
TO TRUNK B FIG. 8
TO TRUNK A FIG. 10
TO NO TEST FIG. 97
TO LINE B FIG. 5
19TC0-11(23)
19TC13-11(23)
19TC0-13(23)
19TC13-13(23)
MCTK
MCLK
TRK. A FIG. 10
TRK. B FIG. 8
LINE A FIG. 4
LINE B FIG. 5
NO TEST FIG. 97
TO LINE A FIG. 4
TO LINE B FIG. 5
TO NO TEST FIG. 97
TO TRK. A FIG. 10
TO TRK. B FIG. 8
19TCB0-00(23)
19TCB13-00(23)
19TCB0-90(23)
19TCB13-90(23)
19TCB0-14(23)
19TCB13-14(23)
CSU0
CSU6
CSU9
TO MARKER FIG. 37
19TCA0-00(23)
19TCA13-00(23)
19TCA0-14(23)
19TCA13-14(23)
CST0
CST9
NOT USED WHEN ONLY 10 CLASSES OF SERVICE PROVIDED

FIG. 23

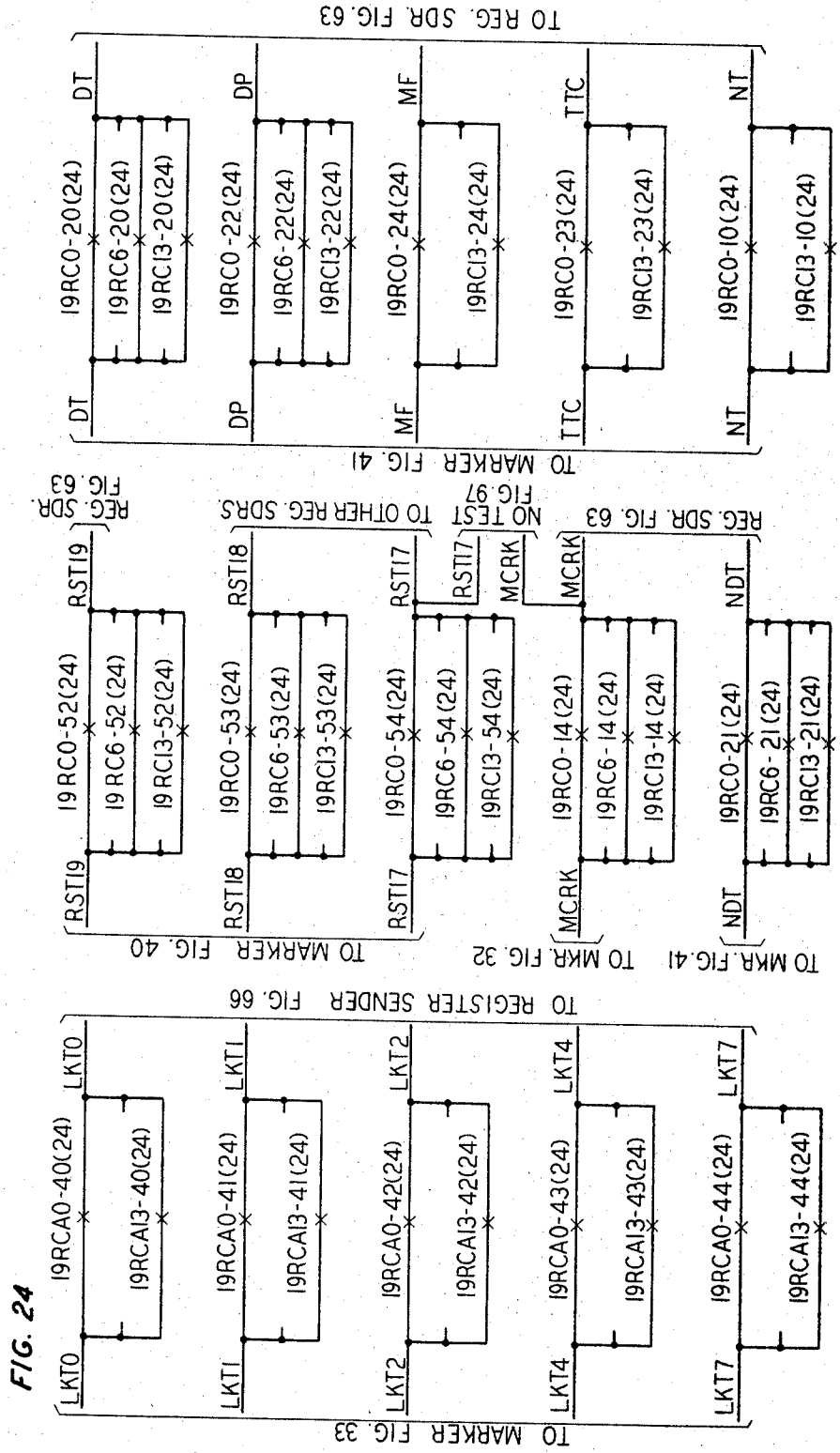

TO REG. SDR. FIG. 63
DT
DP
MF
TTC
NT
19RC0-20(24)
19RC6-20(24)
19RC13-20(24)
19RC0-22(24)
19RC6-22(24)
19RC13-22(24)
19RC0-24(24)
19RC13-24(24)
19RC0-23(24)
19RC13-23(24)
19RC0-10(24)
19RC13-10(24)
TO MARKER FIG. 41
REG. SDR. FIG. 63
TO OTHER REG. SDRS.
NO TEST FIG. 97
RST19
RST18
RST17
MCRK
NDT
19RC0-52(24)
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

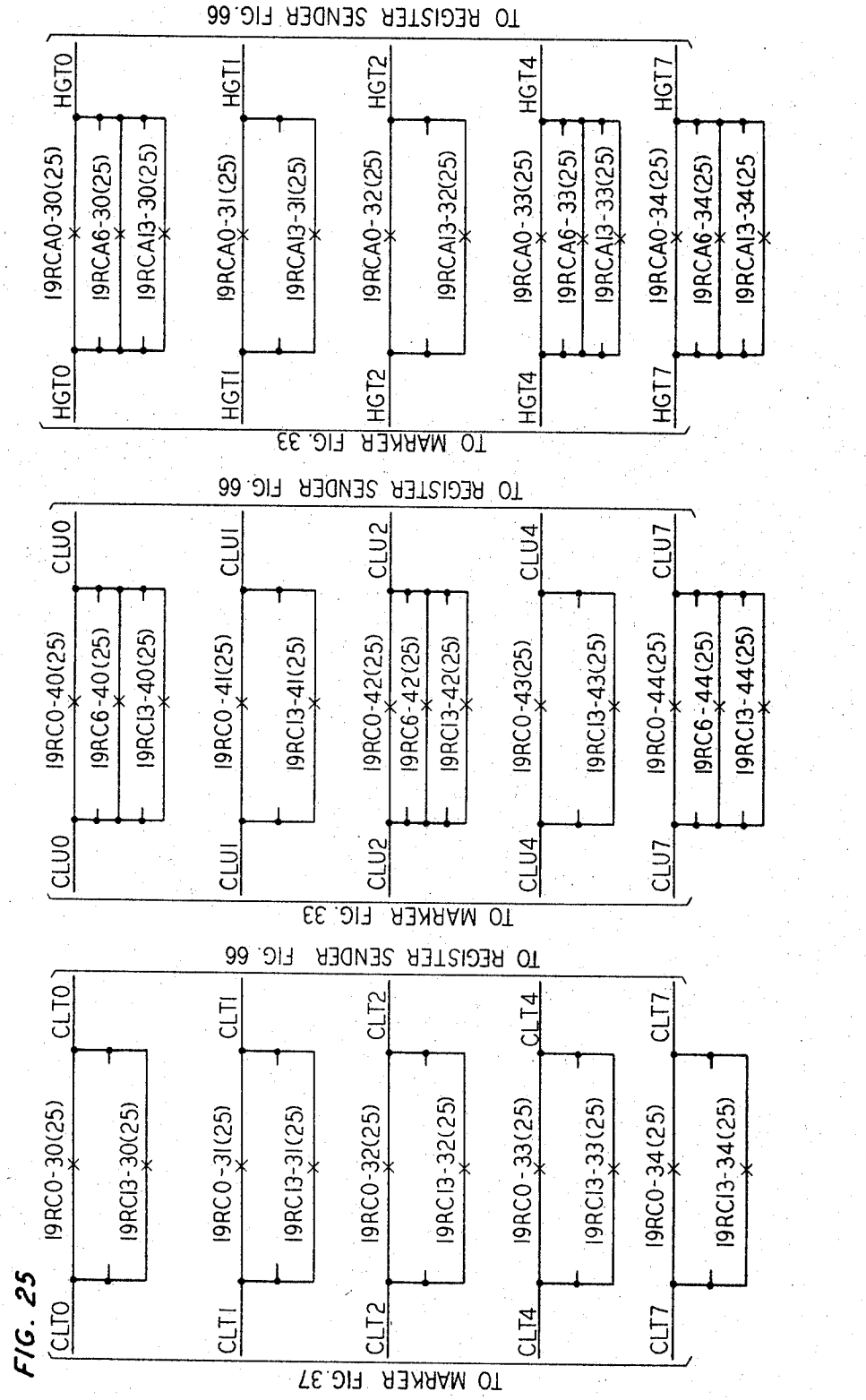

TO REGISTER SENDER FIG. 66
HGT0
HGT1
HGT2
HGT4
HGT7
19RCA0-30(25)
19RCA6-30(25)
19RCA13-30(25)
19RCA0-31(25)
19RCA13-31(25)
19RCA0-32(25)
19RCA13-32(25)
19RCA0-33(25)
19RCA6-33(25)
19RCA13-33(25)
19RCA0-34(25)
19RCA6-34(25)
19RCA13-34(25
TO MARKER FIG. 33
TO REGISTER SENDER FIG. 66
CLU0
CLU1
CLU2
CLU4
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

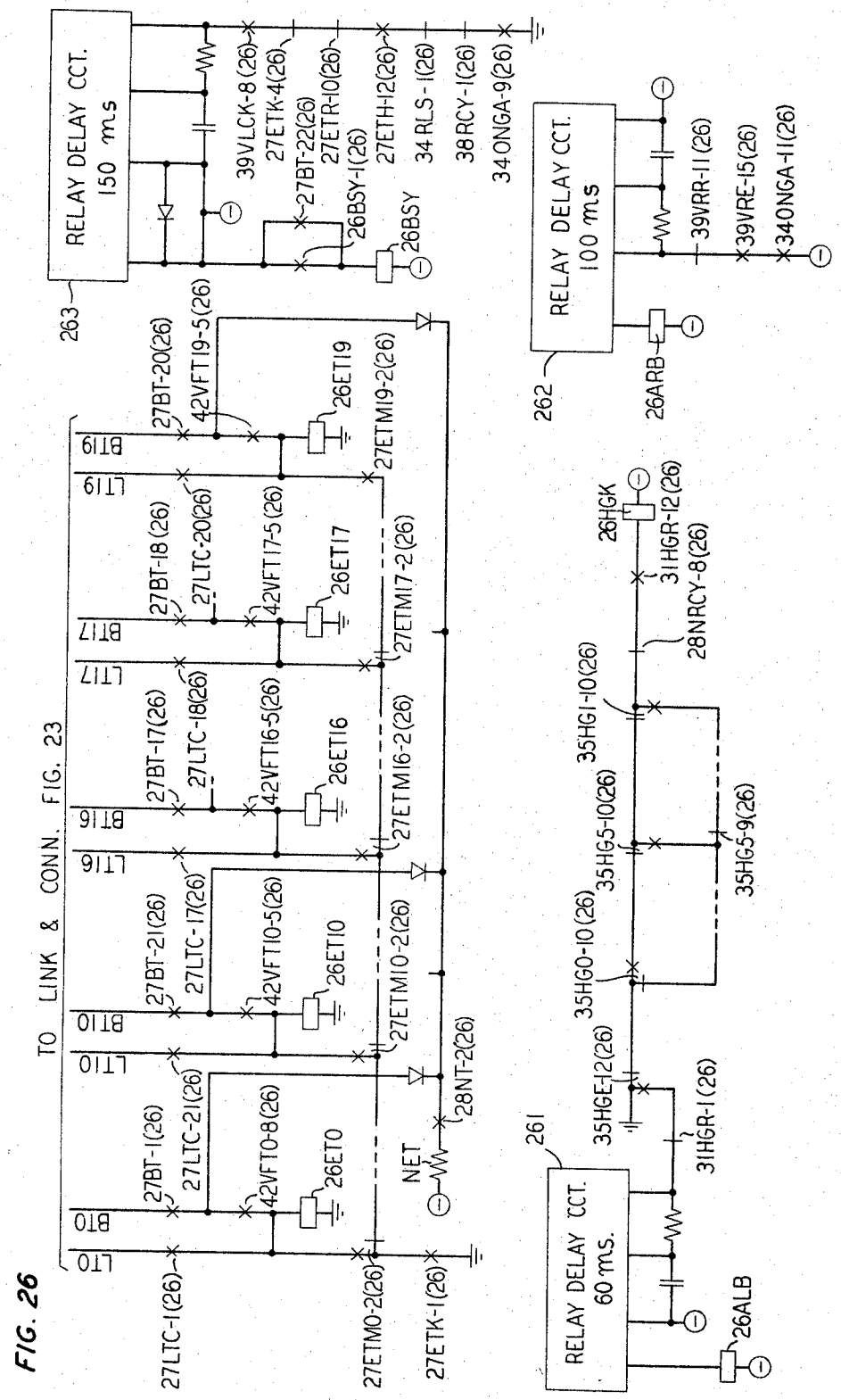

RELAY DELAY CCT. 150 ms
263
39VLCK-8(26)
27ETK-4(26)
27BT-22(26)
27ETR-10(26)
26BSY-1(26)
26BSY
27ETH-12(26)
34 RLS-1(26)
38RCY-1(26)
34ONGA-9(26)
RELAY DELAY CCT. 100 ms
262
26ARB
39VRR-11(26)
39VRE-15(26)
340NGA-11(26)
TO LINK & CONN. FIG. 23
BT19
LT19
27BT-20(26)
42VFT19-5(26)
26ET19
27ETM19-2(26)
BT17
LT17
27BT-18(26)
27LTC-20(26)
42VFT17-5(26)
26ET17
27ETM17-2(26)
BT16
LT16
27BT-17(26)
27LTC-18(26)
42VFT16-5(26)
26ET16
27ETM16-2(26)
BT10
LT10
27BT-21(26)
27LTC-17(26)
42VFT10-5(26)
26ET10
27ETM10-2(26)
BT0
LT0
27BT-1(26)
27LTC-21(26)
42VFT0-8(26)
26ET0
NET
28NT-2(26)
27LTC-1(26)
27ETM0-2(26)
27ETK-1(26)
26HGK
31HGR-12(26)
28NRCY-8(26)
35HG1-10(26)
35HG5-10(26)
35HG5-9(26)
35HG0-10(26)
35HGE-12(26)
31HGR-1(26)
261
RELAY DELAY CCT. 60 ms.
26ALB

FIG. 26

FIG. 27

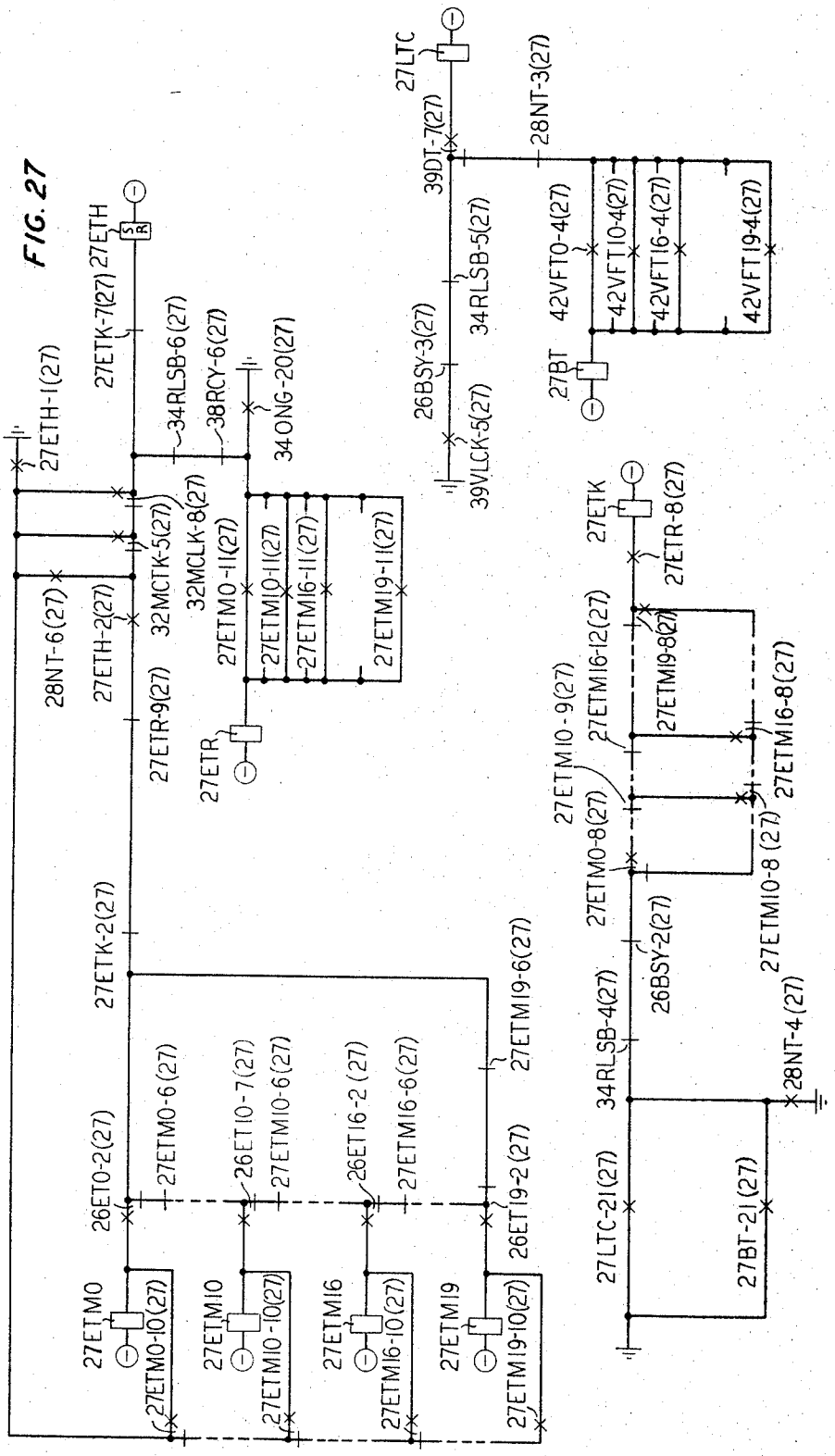
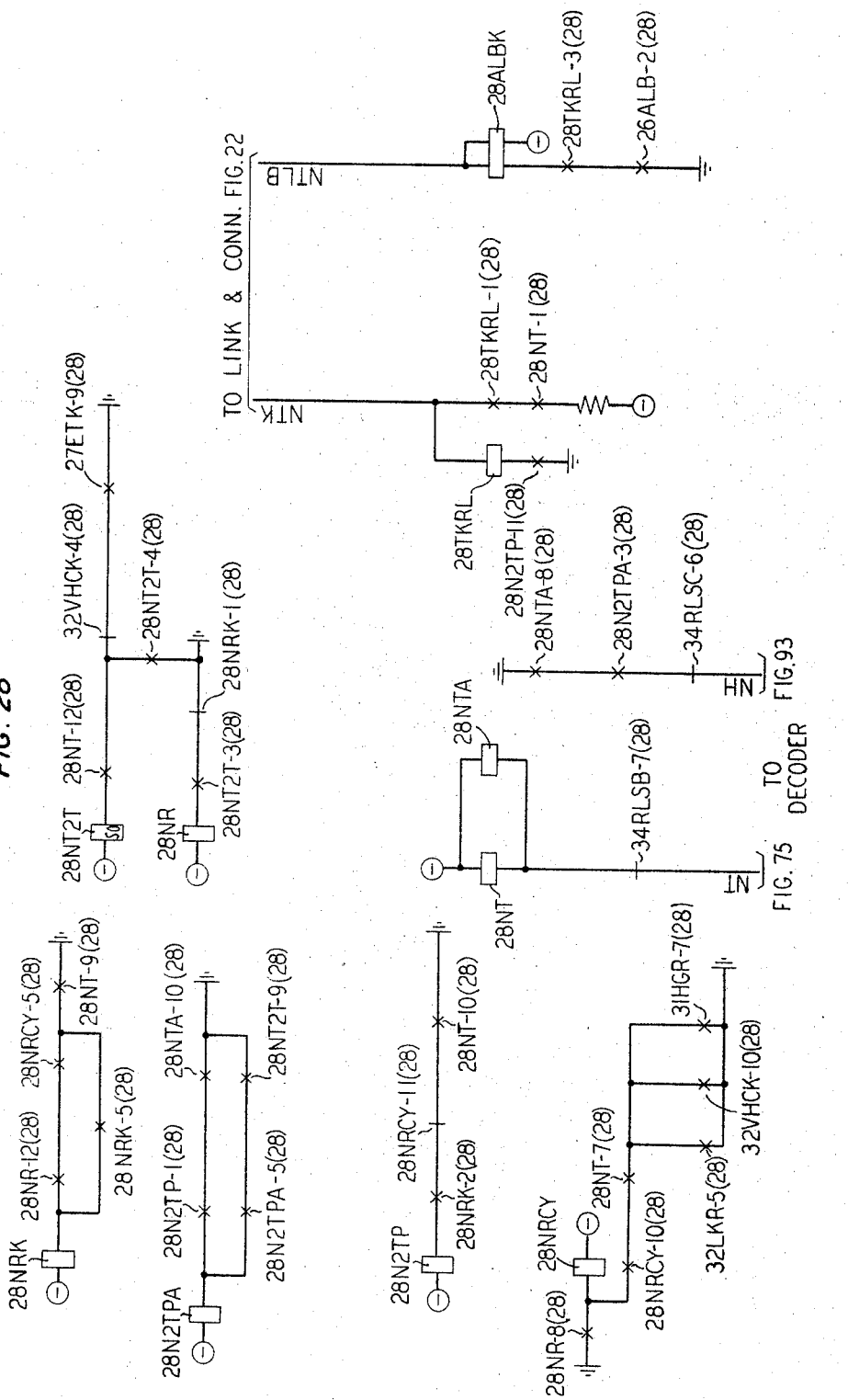

27ETH-1(27)
27ETH
27ETK-7(27)
34RLSB-6(27)
38RCY-6(27)
34ONG-20(27)
28NT-6(27)
27ETH-2(27)
32MCTK-5(27)
32MCLK-8(27)
27ETR-9(27)
27ETR
27ETM0-11(27)
27ETM10-11(27)
27ETM16-11(27)
27ETM19-11(27)
27ETK-2(27)
26ET0-2(27)
27ETM0-6(27)
26ET10-7(27)
27ETM10-6(27)
26ET16-2(27)
27ETM16-6(27)
27ETM19-6(27)
26ET19-2(27)
27ETM0
27ETM0-10(27)
27ETM10
27ETM10-10(27)
27ETM16
27ETM16-10(27)
27ETM19
27ETM19-10(27)
27LTC
39DT-7(27)
28NT-3(27)
26BSY-3(27)
34RLSB-5(27)
39VLCK-5(27)
27BT
42VFT0-4(27)
42VFT10-4(27)
42VFT16-4(27)
42VFT19-4(27)
27ETK
27ETR-8(27)
27ETM10-9(27)
27ETM16-12(27)
27ETM19-8(27)
27ETM0-8(27)
27ETM16-8(27)
34RLSB-4(27)
26BSY-2(27)
27ETM10-8(27)
28NT-4(27)
27LTC-21(27)
27BT-21(27)

FIG. 28


TO LINK & CONN. FIG. 22
NTK
NTLB
28ALBK
28TKRL-3(28)
26ALB-2(28)
28TKRL-1(28)
28NT-1(28)
28TKRL
28N2TP-11(28)
28NTA-8(28)
28N2TPA-3(28)
34RLSC-6(28)
HN
FIG. 93
27ETK-9(28)
32VHCK-4(28)
28NT2T-4(28)
28NT-12(28)
28NT2T
28NR
28NRK-1(28)
28NT2T-3(28)
28NTA
34RLSB-7(28)
NT
FIG. 75
TO DECODER
28NT
28NRCY-5(28)
28NT-9(28)
28NR-12(28)
28NRK
28NRK-5(28)
28NTA-10(28)
28N2TP-1(28)
28N2TPA
28NT2T-9(28)
28N2TPA-5(28)
28N2TP
28NRCY-11(28)
28NT-10(28)
28NRK-2(28)
31HGR-7(28)
28NRCY
28NT-7(28)
28NRCY-10(28)
32VHCK-10(28)
32LKR-5(28)
28NR-8(28)

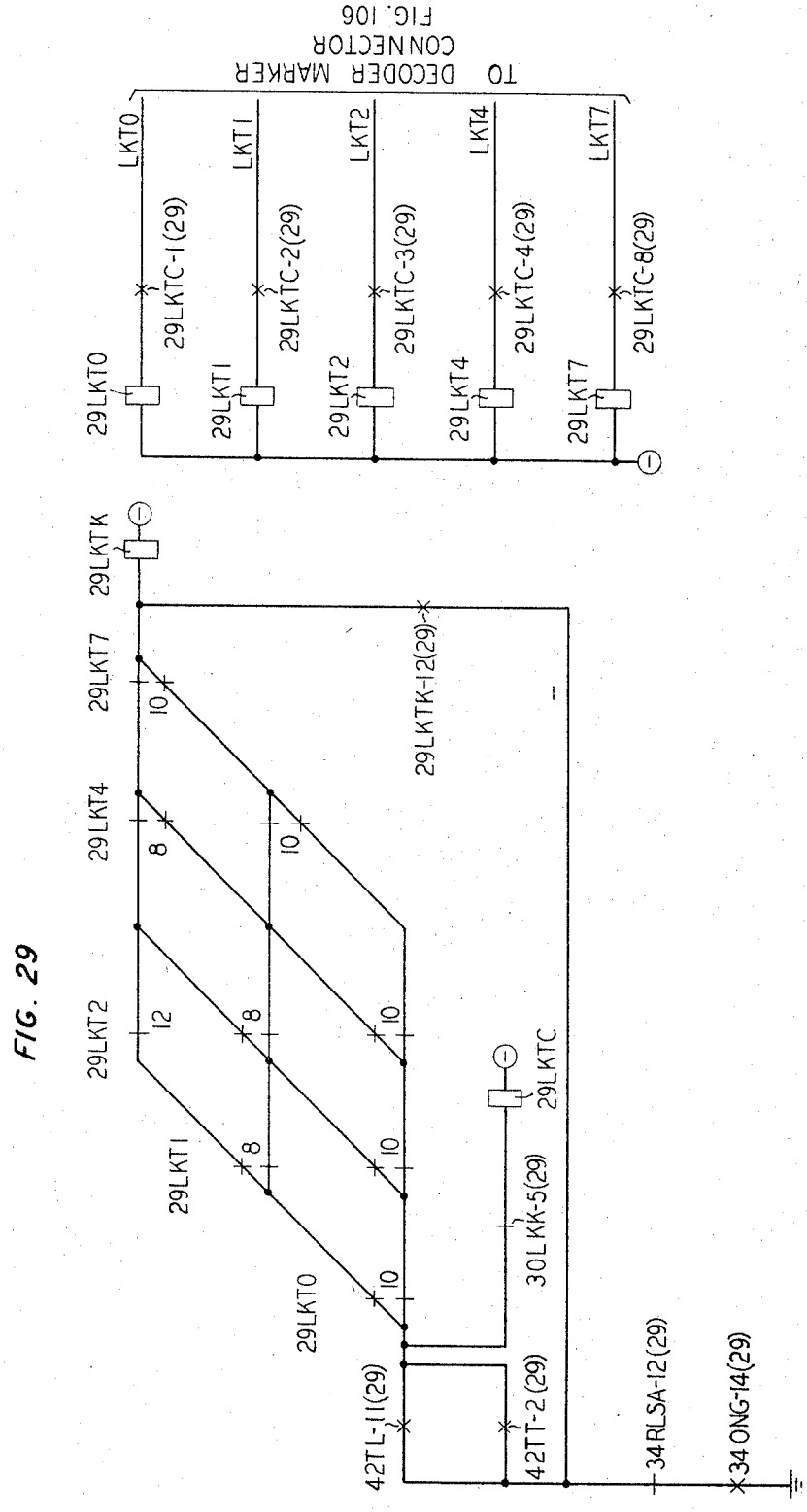

TO DECODER MARKER CONNECTOR FIG. 106
LKT0
LKT1
LKT2
LKT4
LKT7
29LKTC-1(29)
29LKTC-2(29)
29LKTC-3(29)
29LKTC-4(29)
29LKTC-8(29)
29LKT0
29LKT1
29LKT2
29LKT4
29LKT7
29LKTK
29LKTK-12(29)
29LKTC
30LKK-5(29)
42TL-11(29)
42TT-2(29)
34RLSA-12(29)
34ONG-14(29)
12
10
8

FIG. 29

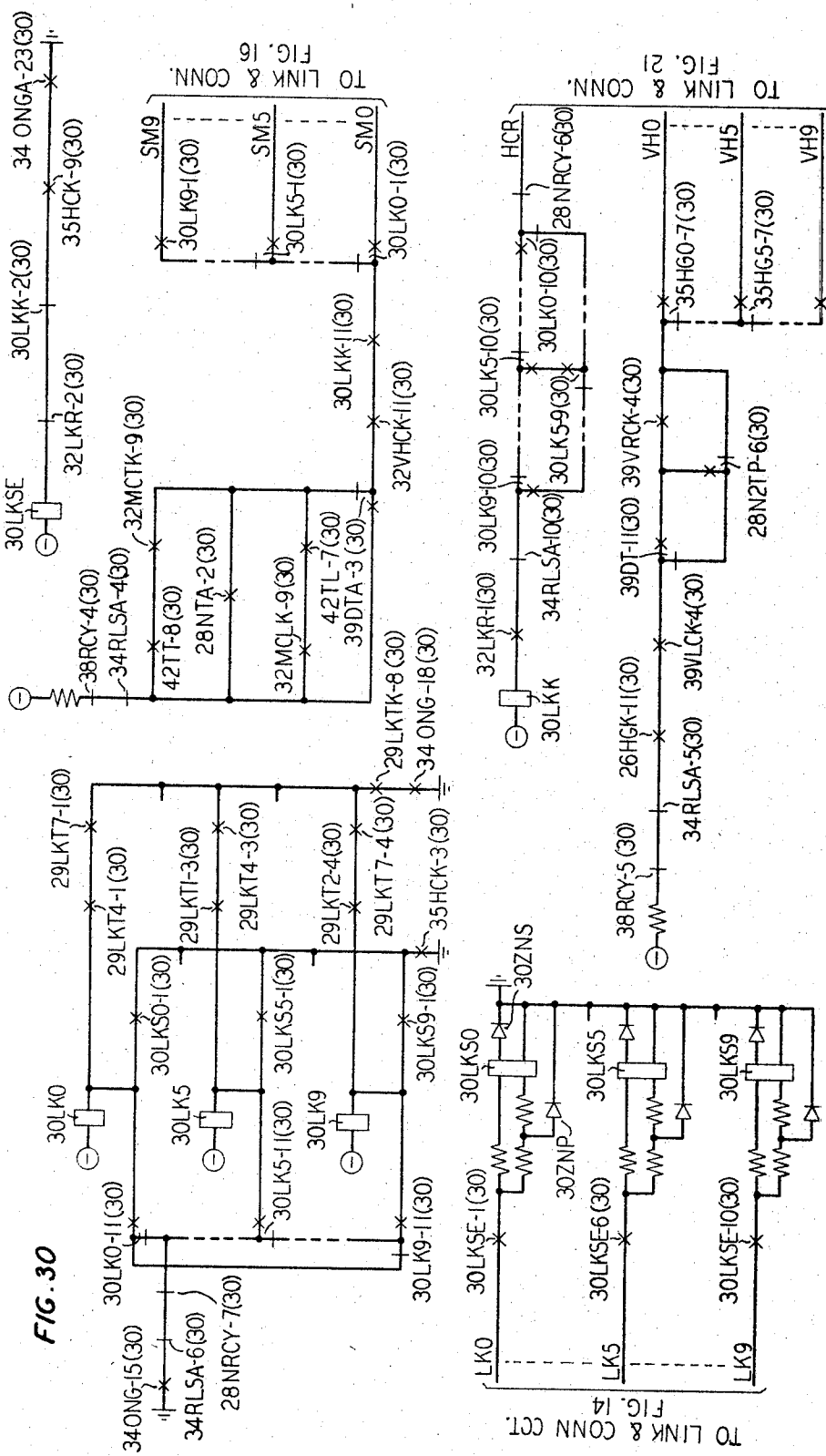
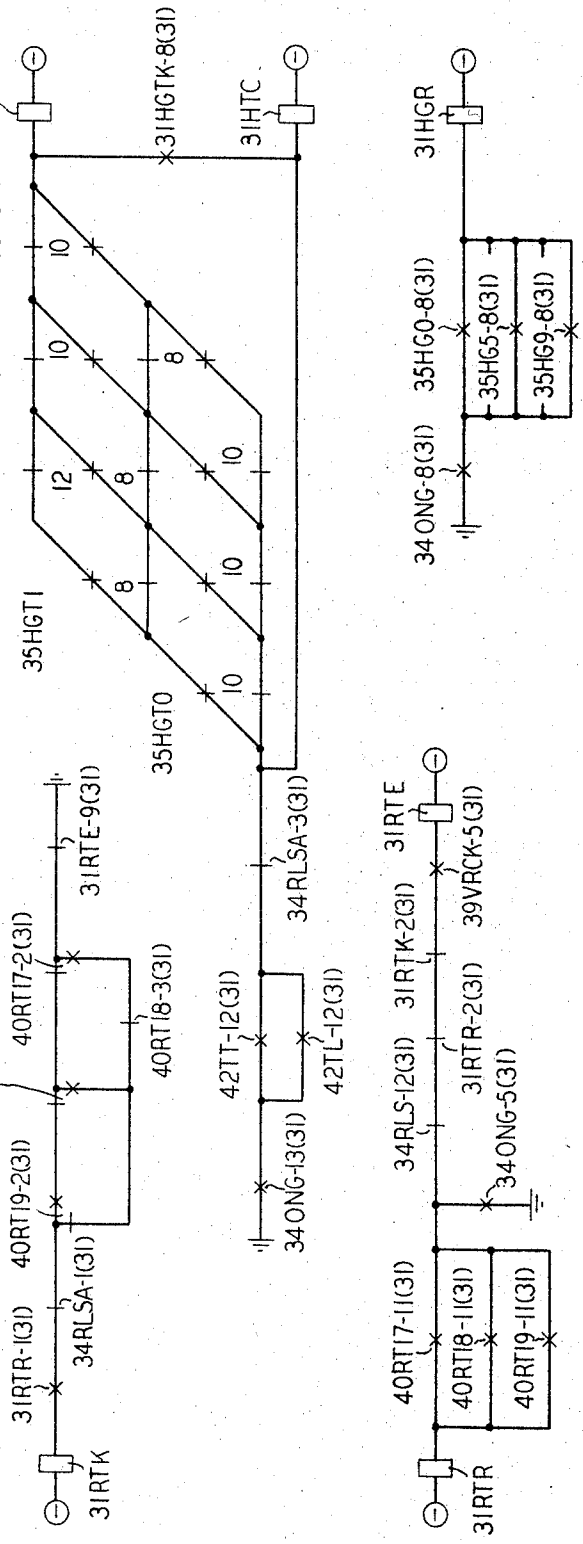

TO LINK & CONN. FIG. 16
TO LINK & CONN. FIG. 21
TO LINK & CONN CCT. FIG. 14
30LKSE
34 ONGA-23(30)
30LKK-2(30)
35HCK-9(30)
32LKR-2(30)
38RCY-4(30)
34RLSA-4(30)
32MCTK-9(30)
42TT-8(30)
28NTA-2(30)
32MCLK-9(30)
42TL-7(30)
39DTA-3(30)
30LKK-11(30)
32VHCK-11(30)
SM9
SM5
SM0
30LK9-1(30)
30LK5-1(30)
30LK0-1(30)
29LKTK-8(30)
34 ONG-18(30)
29LKT7-1(30)
29LKT4-1(30)
29LKTI-3(30)
29LKT4-3(30)
29LKT2-4(30)
29LKT7-4(30)
35HCK-3(30)
30LKS0-1(30)
30LKS5-1(30)
30LKS9-1(30)
30LK0
30LK5
30LK9
30LK0-11(30)
30LK5-11(30)
30LK9-11(30)
34ONG-15(30)
34RLSA-6(30)
28NRCY-7(30)
FIG. 30
HCR
28 NRCY-6(30)
VH0
VH5
VH9
35HG0-7(30)
35HG5-7(30)
35HG9-7(30)
30LK0-10(30)
30LK5-10(30)
30LK5-9(30)
30LK9-10(30)
32LKR-1(30)
34RLSA-10(30)
30LKK
39VRCK-4(30)
39DT-11(30)
28N2TP-6(30)
26HGK-11(30)
39VLCK-4(30)
34RLSA-5(30)
38RCY-5(30)
30ZNS
30LKS0
30LKS5
30LK59
30ZNP
30LKSE-1(30)
30LKSE-6(30)
30LKSE-10(30)
LK0
LK5
LK9

FIG. 31


31HGTK
31HGTK-8(31)
31HTC
31HGR
35HGT7
35HGT4
35HGT2
35HGT1
35HGT0
10
12
8
34ONG-8(31)
35HG0-8(31)
35HG5-8(31)
35HG9-8(31)
34RLSA-3(31)
42TT-12(31)
42TL-12(31)
34ONG-13(31)
40RTI8-2(31)
40RTI7-2(31)
40RTI9-2(31)
40RTI8-3(31)
31RTE-9(31)
31RTR-1(31)
34RLSA-1(31)
31RTK
31RTE
31RTK-2(31)
39VRCK-5(31)
34RLS-12(31)
31RTR-2(31)
34ONG-5(31)
40RTI7-11(31)
40RTI8-11(31)
40RTI9-11(31)
31RTR

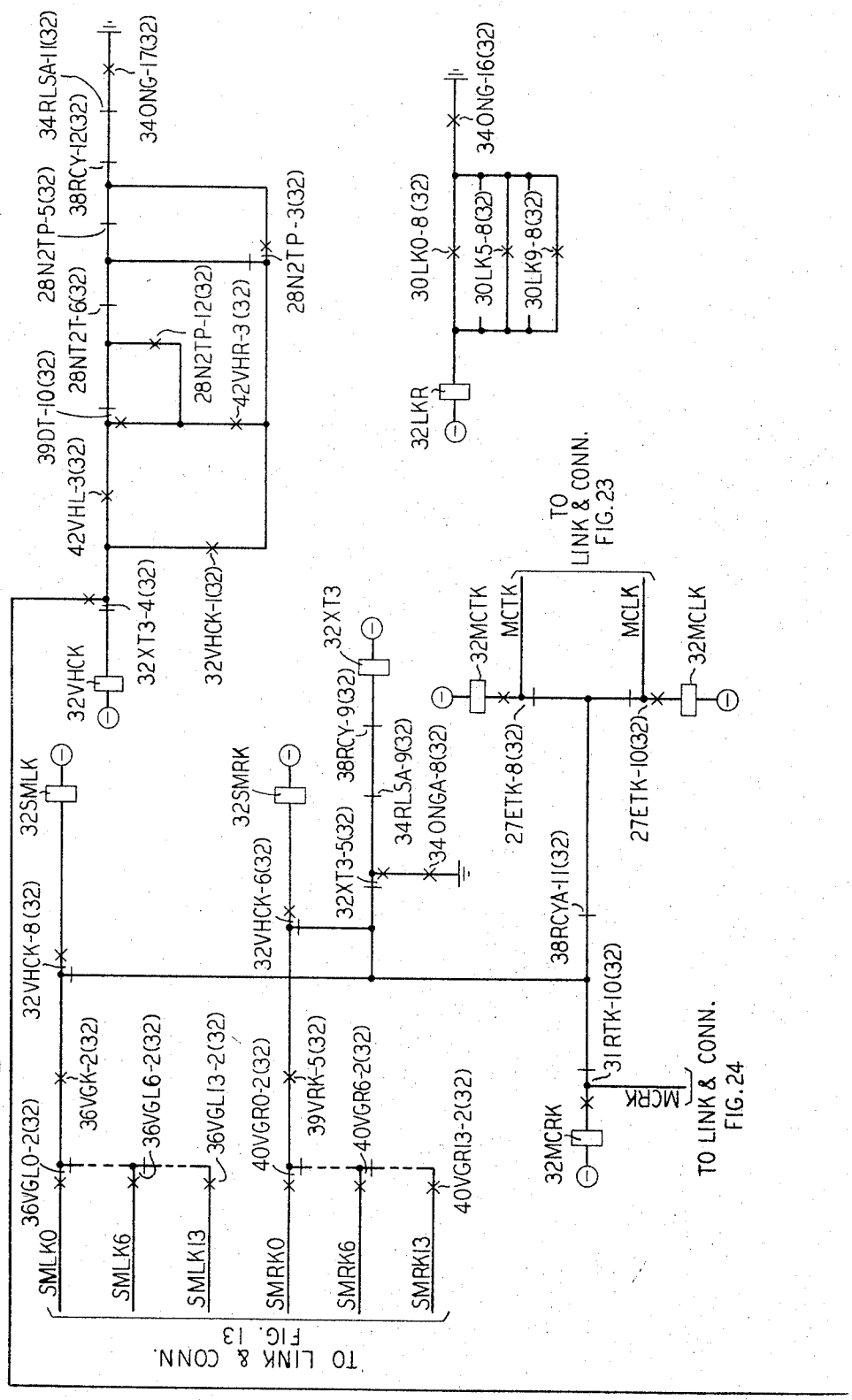

32VHCK
32XT3-4(32)
42VHL-3(32)
39DT-10(32)
28NT2T-6(32)
28N2TP-5(32)
38RCY-12(32)
34RLSA-11(32)
34ONG-17(32)
28N2TP-12(32)
42VHR-3(32)
28N2TP-3(32)
32VHCK-1(32)
32LKR
30LK0-8(32)
30LK5-8(32)
30LK9-8(32)
34ONG-16(32)
TO LINK & CONN. FIG.23
32MCTK
MCTK
MCLK
32MCLK
27ETK-8(32)
27ETK-10(32)
38RCYA-11(32)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

FIG. 32

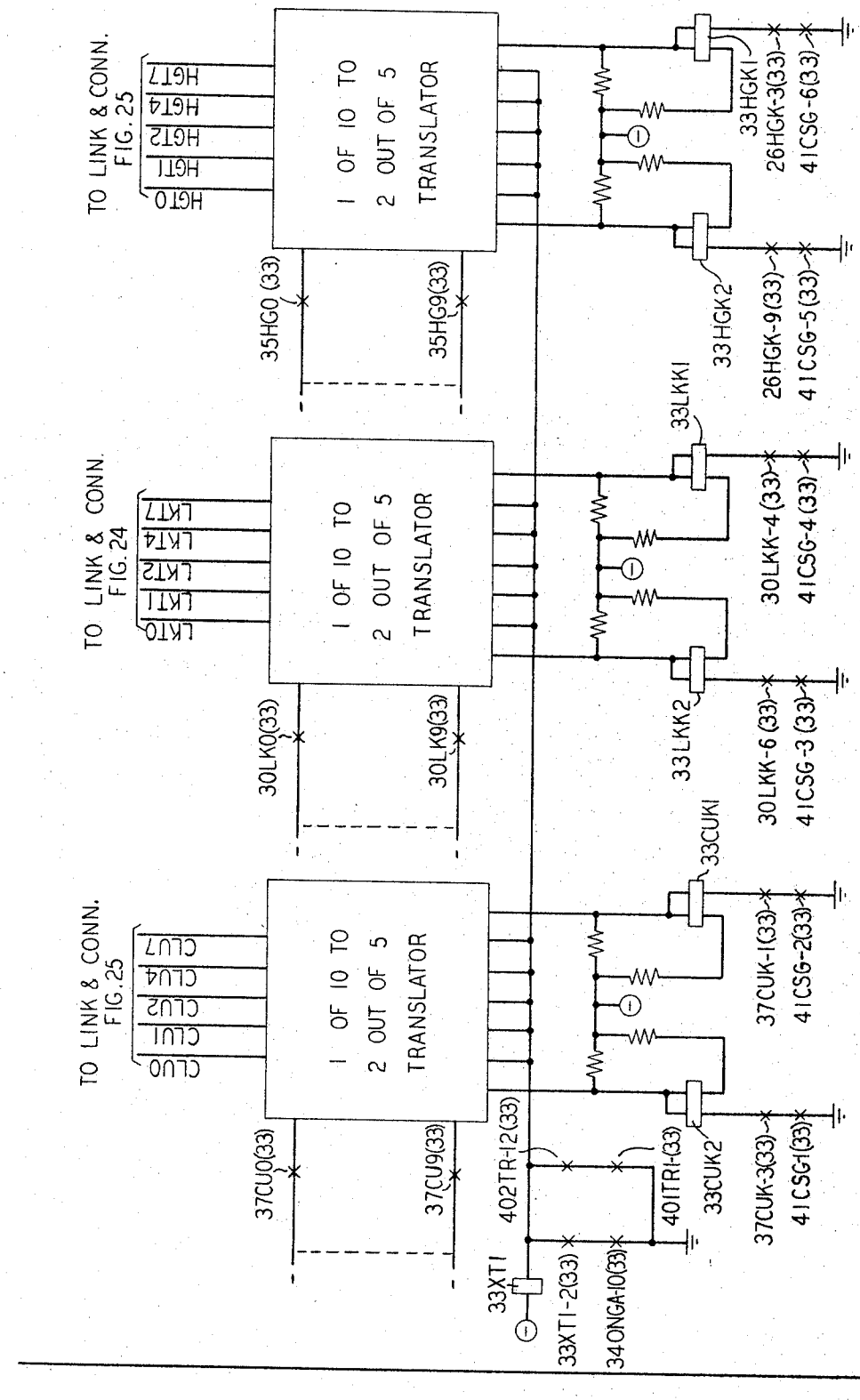
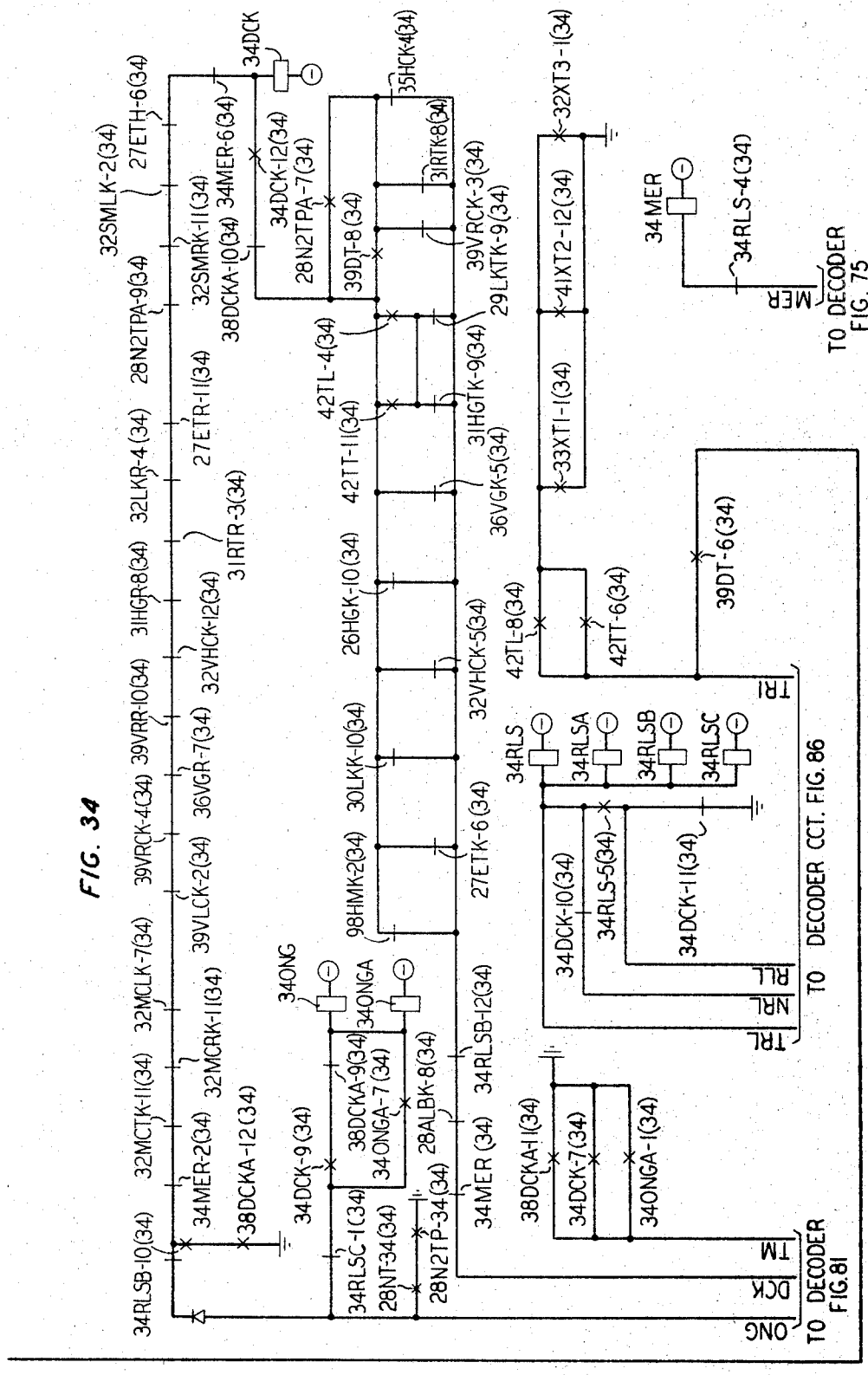

TO LINK & CONN. FIG. 25
HGT7
HGT4
HGT2
HGT1
HGT0
1 OF 10 TO 2 OUT OF 5 TRANSLATOR
35HG0 (33)
35HG9(33)
33HGK1
33HGK2
26HGK-3(33)
41CSG-6(33)
26HGK-9(33)
41CSG-5(33)
TO LINK & CONN. FIG. 24
LKT7
LKT4
LKT2
LKT1
LKT0
1 OF 10 TO 2 OUT OF 5 TRANSLATOR
30LK0(33)
30LK9(33)
33LKK1
33LKK2
30LKK-4(33)
41CSG-4(33)
30LKK-6(33)
41CSG-3(33)
TO LINK & CONN. FIG. 25
CLU7
CLU4
CLU2
CLU1
CLU0
1 OF 10 TO 2 OUT OF 5 TRANSLATOR
37CU0(33)
37CU9(33)
33CUK1
33CUK2
37CUK-1(33)
41CSG-2(33)
37CUK-3(33)
41CSG-1(33)
402TR-12(33)
401TR1-(33)
33XT1
33XT1-2(33)
34ONGA-10(33)

FIG. 33

FIG. 34


34RLSB-10(34)
32MCTK-11(34)
32MCLK-7(34)
39VRCK-4(34)
39VRR-10(34)
31HGR-8(34)
32LKR-4(34)
28N2TPA-9(34)
27ETH-6(34)
32SMLK-2(34)
34MER-2(34)
32MCRK-11(34)
39VLCK-2(34)
36VGR-7(34)
32VHCK-12(34)
27ETR-11(34)
32SMRK-11(34)
34MER-6(34)
34DCK
38DCKA-12(34)
38DCKA-10(34)
34DCK-12(34)
28N2TPA-7(34)
35HCK-4(34)
31RTK-8(34)
39DT-8(34)
39VRCK-3(34)
29LKTK-9(34)
31IRTR-3(34)
42TL-4(34)
42TT-11(34)
31HGTK-9(34)
36VGK-5(34)
26HGK-10(34)
32XT3-1(34)
41XT2-12(34)
33XTI-1(34)
34MER
34RLS-4(34)
MER
TO DECODER FIG. 75
34ONG
34DCK-9(34)
38DCKA-9(34)
34ONGA-7(34)
28ALBK-8(34)
98HMK-2(34)
30LKK-10(34)
32VHCK-5(34)
42TL-8(34)
42TT-6(34)
39DT-6(34)
34RLS
34RLSA
34RLSB
34RLSC
34RLSB-12(34)
27ETK-6(34)
34RLS-5(34)
34DCK-10(34)
34DCK-11(34)
34RLSC-1(34)
28NT-34(34)
28N2TP-34(34)
34MER (34)
38DCKA-11(34)
34DCK-7(34)
34ONGA-1(34)
TRI
TRL
NRL
RLL
TM
DCK
ONG
TO DECODER CCT. FIG. 86
TO DECODER FIG. 81

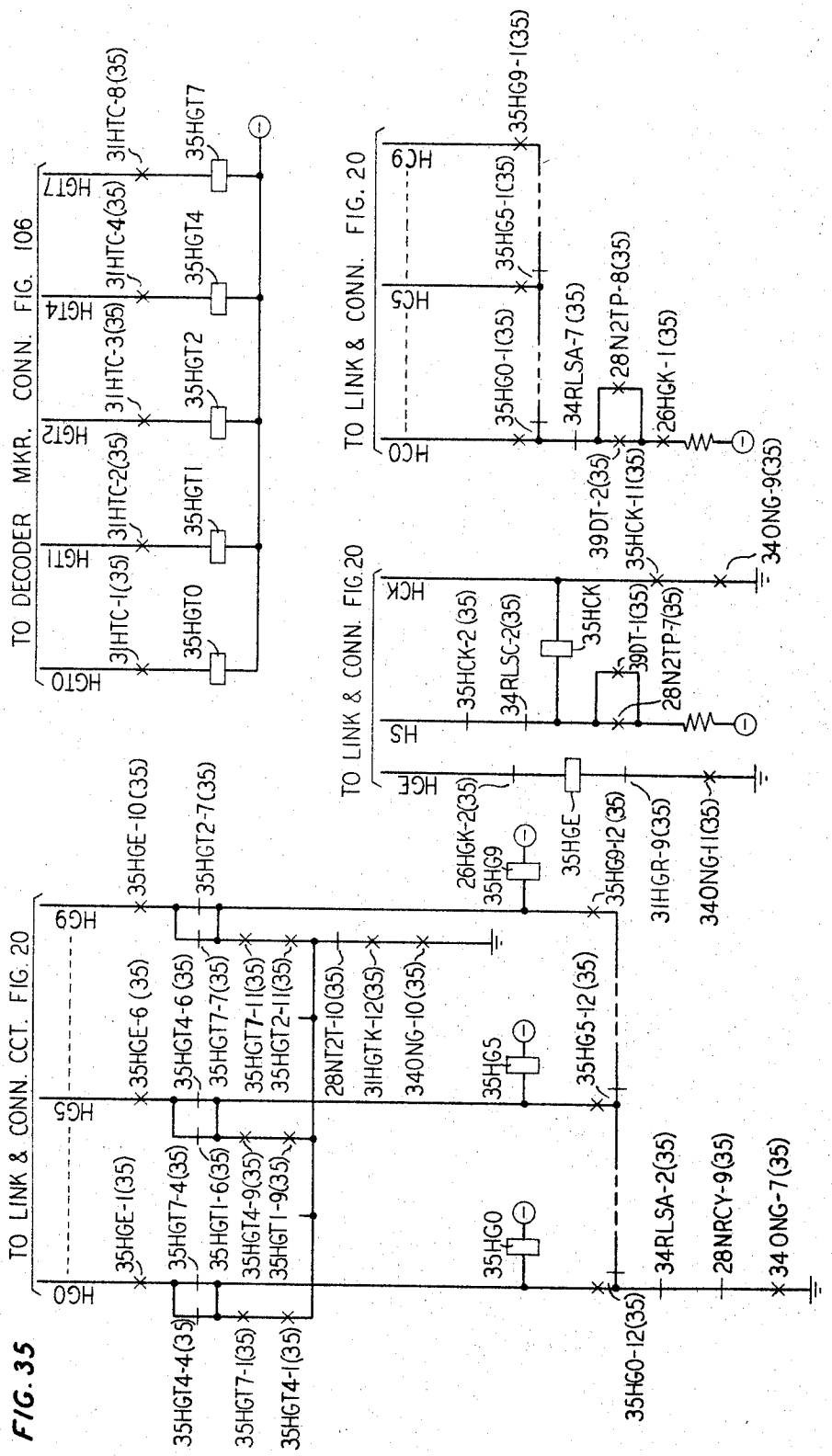
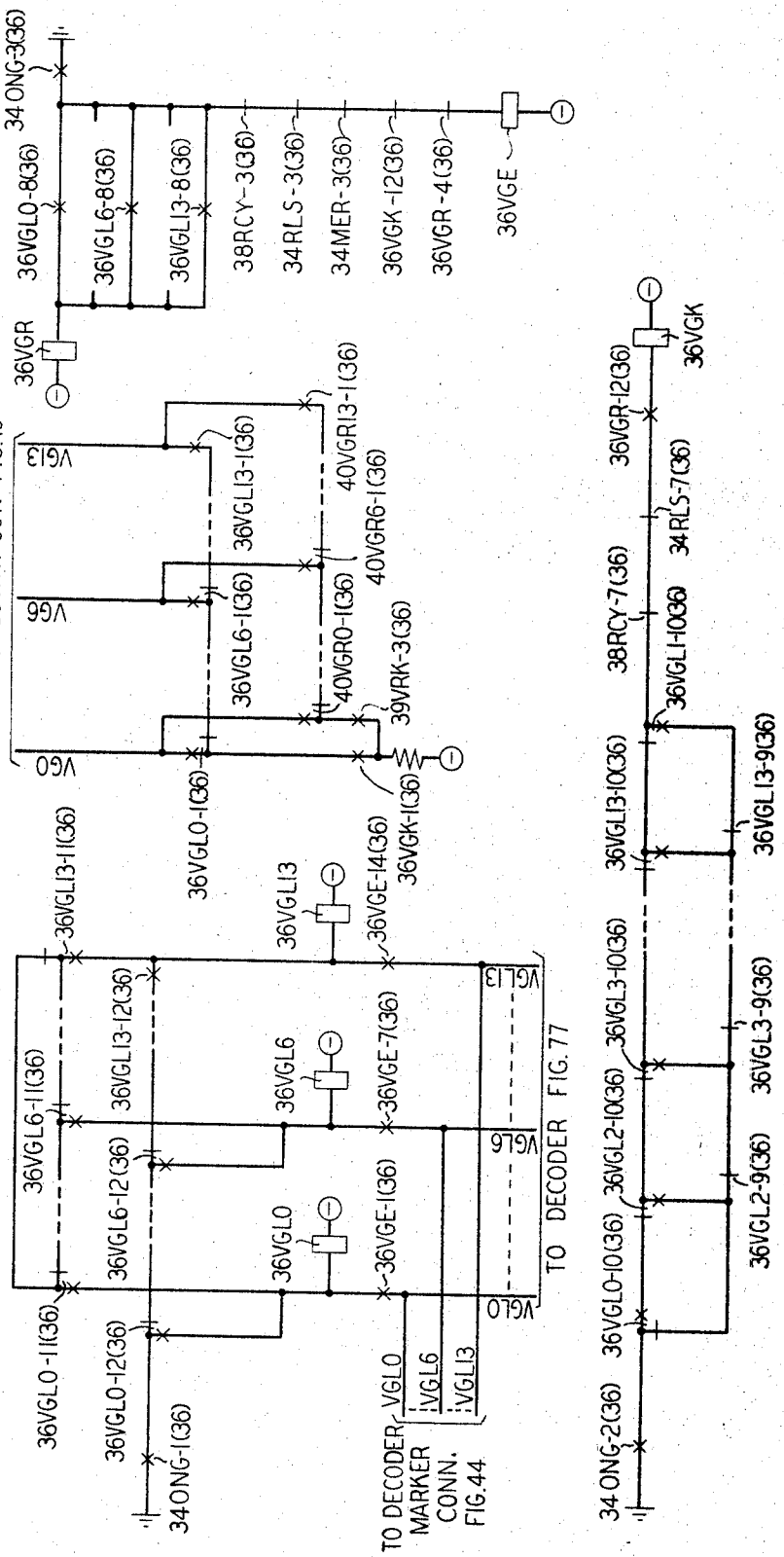

TO DECODER MKR. CONN. FIG. 106
HG10
HG11
HG12
HG14
HG17
3IHTC-1(35)
3IHTC-2(35)
3IHTC-3(35)
3IHTC-4(35)
3IHTC-8(35)
35HGT0
35HGT1
35HGT2
35HGT4
35HGT7
TO LINK & CONN. FIG. 20
HC0
HC5
HC9
35HG0-1(35)
35HG5-1(35)
35HG9-1(35)
34RLSA-7(35)
28N2TP-8(35)
26HGK-1(35)
39DT-2(35)
35HCK-11(35)
34ONG-9(35)
TO LINK & CONN. FIG.20
HCK
HS
HGE
35HCK-2(35)
34RLSC-2(35)
35HCK
39DT-1(35)
28N2TP-7(35)
26HGK-2(35)
35HG9
35HGE
35HG9-12(35)
31HGR-9(35)
34ONG-11(35)
TO LINK & CONN. CCT. FIG. 20
HG0
HG5
HG9
35HGE-1(35)
35HGE-6(35)
35HGE-10(35)
35HGT7-4(35)
35HGT4-6(35)
35HGT2-7(35)
35HGT1-6(35)
35HGT7-7(35)
35HGT4-9(35)
35HGT7-11(35)
35HGT1-9(35)
35HGT2-11(35)
28NT2T-10(35)
31HGTK-12(35)
34ONG-10(35)
35HG0
35HG5
35HG5-12(35)
35HGT4-4(35)
35HGT7-1(35)
35HGT4-1(35)
35HG0-12(35)
34RLSA-2(35)
28NRCY-9(35)
34ONG-7(35)

FIG. 35

FIG. 36


34 ONG-3(36)
36VGLO-8(36)
36VGL6-8(36)
36VGLI3-8(36)
38RCY-3(36)
34RLS-3(36)
34MER-3(36)
36VGK-12(36)
36VGR-4(36)
36VGE
36VGR
TO LINK & CONN. CCT. FIG. 19
VGI3
VG6
VG0
36VGLI3-1(36)
36VGL6-1(36)
40VGRI3-1(36)
40VGR6-1(36)
40VGRO-1(36)
39VRK-3(36)
36VGLO-1(36)
36VGK-1(36)
36VGE-14(36)
36VGLI3
36VGL6
36VGLO
36VGE-7(36)
36VGE-1(36)
36VGLO-11(36)
36VGL6-11(36)
36VGLI3-11(36)
36VGLO-12(36)
36VGL6-12(36)
36VGLI3-12(36)
34ONG-1(36)
TO DECODER MARKER CONN. FIG. 44
VGLO
VGL6
VGLI3
TO DECODER FIG. 77
36VGR-12(36)
36VGK
34RLS-7(36)
38RCY-7(36)
36VGLI-10(36)
36VGLI3-10(36)
36VGLI3-9(36)
36VGL3-10(36)
36VGL3-9(36)
36VGL2-10(36)
36VGL2-9(36)
36VGLO-10(36)
34ONG-2(36)

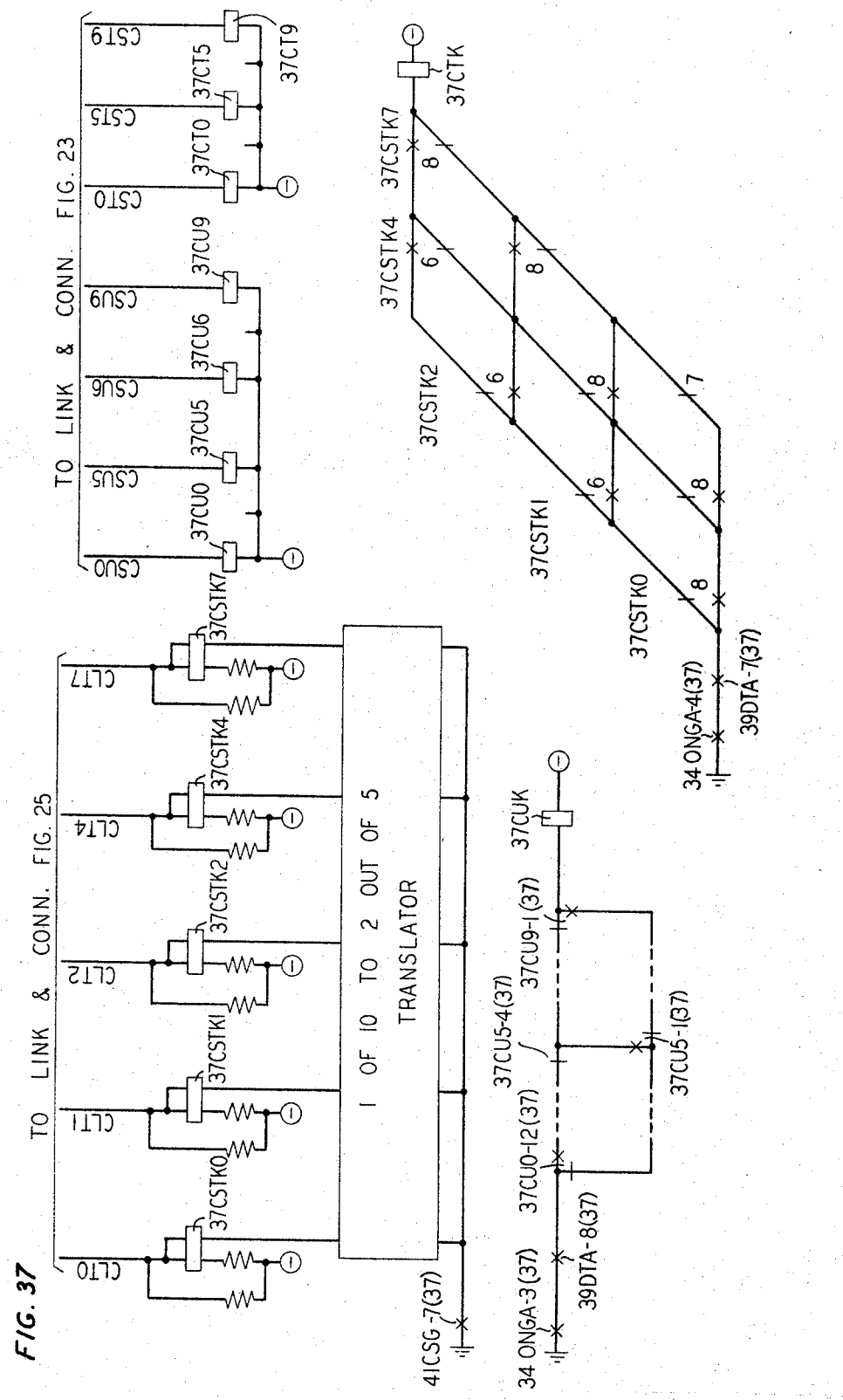

TO LINK & CONN. FIG. 23
CSU0
CSU5
CSU6
CSU9
CST0
CST5
CST9
37CU0
37CU5
37CU6
37CU9
37CT0
37CT5
37CT9
37CSTK7
37CSTK4
37CSTK2
37CSTK1
37CSTK0
37CTK
8
6
7
TO LINK & CONN. FIG. 25
CLT0
CLT1
CLT2
CLT4
CLT7
1 OF 10 TO 2 OUT OF 5
TRANSLATOR
41CSG-7(37)
34 ONGA-4(37)
39DTA-7(37)
37CUK
37CU9-1(37)
37CU5-4(37)
37CU0-12(37)
37CU5-1(37)
34 ONGA-3(37)
39DTA-8(37)

FIG. 37

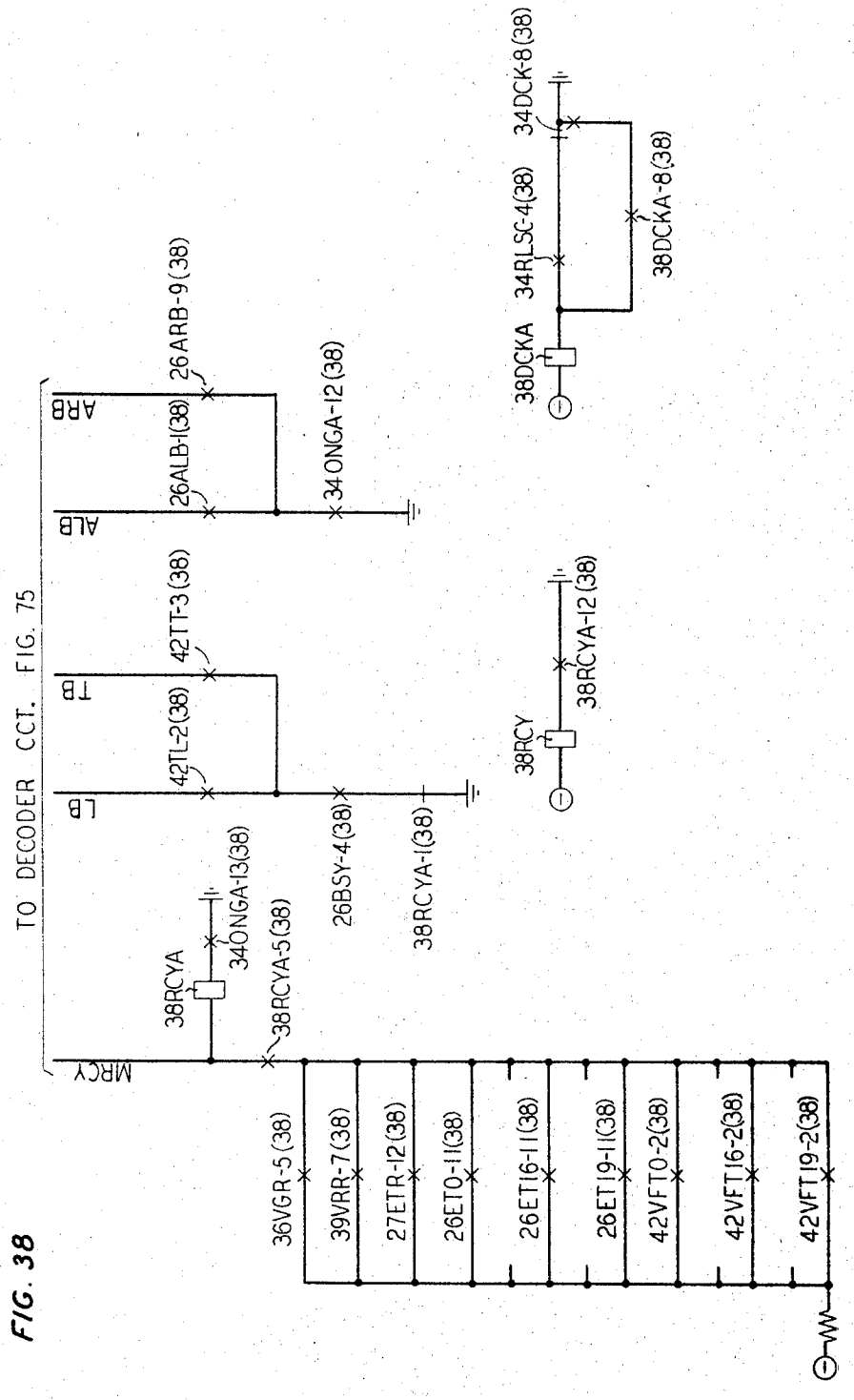
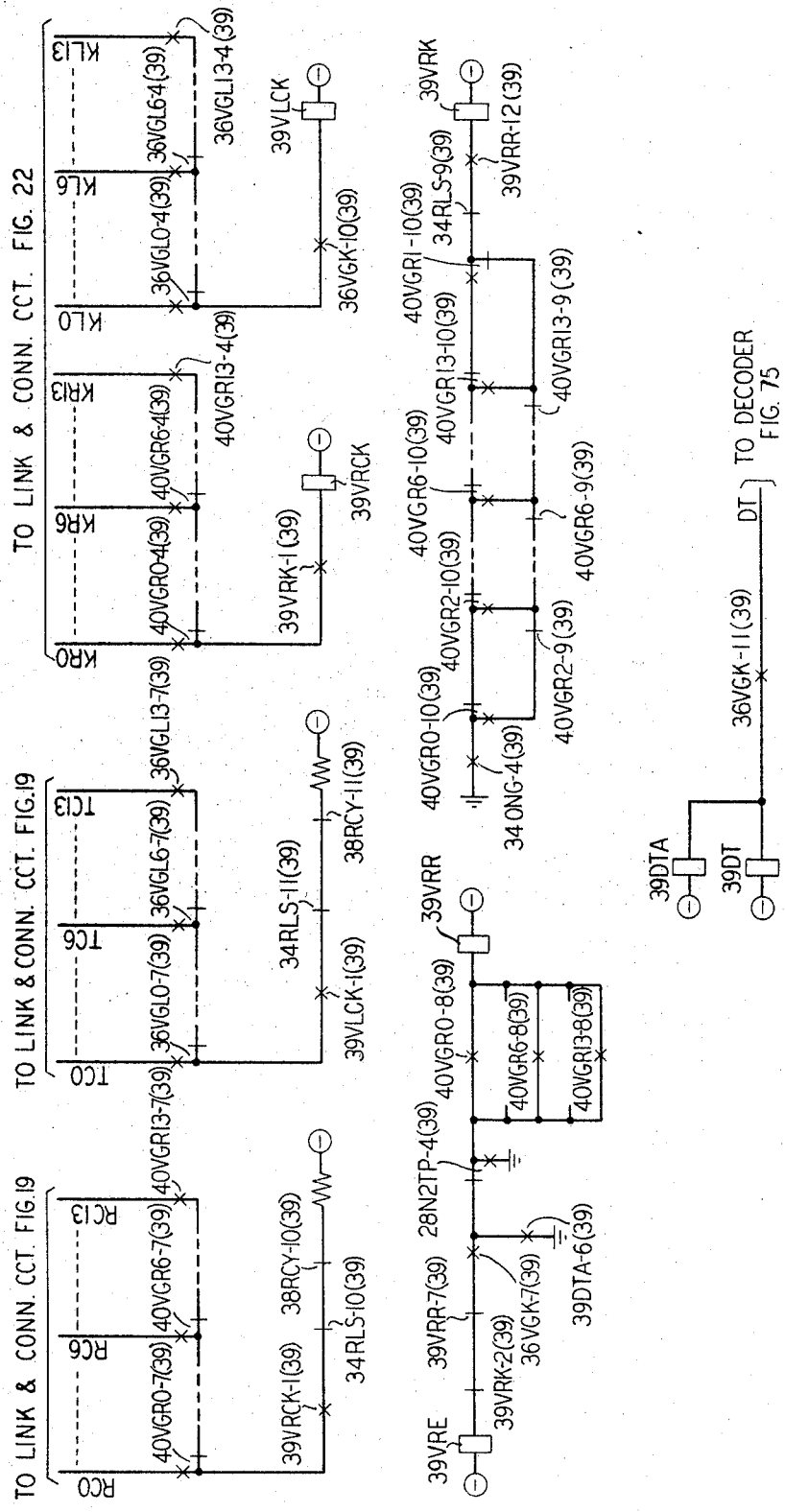
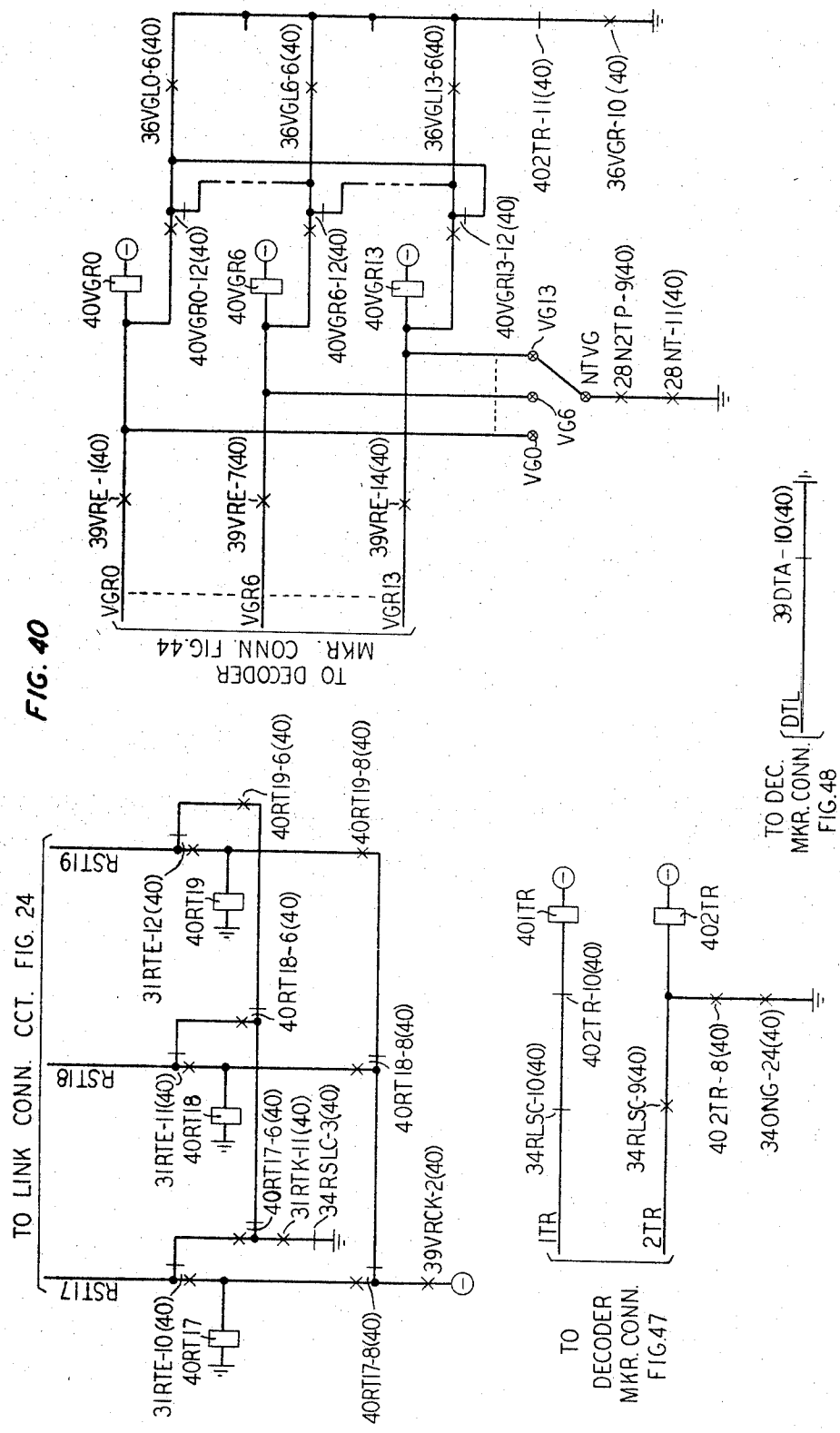

TO DECODER CCT. FIG. 75
MRCY
ARB
ALB
TB
LB
26ARB-9(38)
26ALB-1(38)
34ONGA-12(38)
42TT-3(38)
42TL-2(38)
34ONGA-13(38)
38RCYA
38RCYA-5(38)
26BSY-4(38)
38RCYA-1(38)
34DCK-8(38)
34RLSC-4(38)
38DCKA
38DCKA-8(38)
38RCY
38RCYA-12(38)
36VGR-5(38)
39VRR-7(38)
27ETR-12(38)
26ETO-11(38)
26ETI6-11(38)
26ETI9-11(38)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

FIG. 38

FIG. 39


TO LINK & CONN. CCT. FIG. 22
KR0
KR6
KR13
KL0
KL6
KL13
40VGRO-4(39)
40VGR6-4(39)
40VGRI3-4(39)
36VGLO-4(39)
36VGL6-4(39)
36VGLI3-4(39)
39VRK-1(39)
39VRCK
39VLCK
36VGK-10(39)
TO LINK & CONN. CCT. FIG.19
TC0
TC6
TC13
36VGLO-7(39)
36VGL6-7(39)
36VGLI3-7(39)
34RLS-11(39)
39VLCK-1(39)
38RCY-11(39)
TO LINK & CONN. CCT. FIG.19
RC0
RC6
RC13
40VGRO-7(39)
40VGR6-7(39)
40VGRI3-7(39)
39VRCK-1(39)
38RCY-10(39)
34RLS-10(39)
39VRE
39VRR-7(39)
39VRK-2(39)
28N2TP-4(39)
36VGK-7(39)
39DTA-6(39)
39VRR
40VGRO-8(39)
40VGR6-8(39)
40VGRI3-8(39)
40VGRO-10(39)
40VGR2-10(39)
34ONG-4(39)
40VGR2-9(39)
40VGR6-10(39)
40VGRI3-10(39)
40VGR6-9(39)
40VGRI3-9(39)
40VGRI-10(39)
34RLS-9(39)
39VRR-12(39)
39VRK
39DTA
39DT
36VGK-11(39)
DT
TO DECODER FIG. 75


36VGL0-6(40)
36VGL6-6(40)
36VGL13-6(40)
402TR-11(40)
36VGR-10(40)
40VGR0
40VGR0-12(40)
40VGR6
40VGR6-12(40)
40VGR13
40VGR13-12(40)
VG13
NTVG
28N2TP-9(40)
28NT-11(40)
VG6
VG0
39VRE-1(40)
39VRE-7(40)
39VRE-14(40)
VGR0
VGR6
VGR13
TO DECODER MKR. CONN. FIG.44
FIG. 40
TO LINK CONN. CCT. FIG. 24
RST19
RST18
RST17
40RT19-6(40)
40RT19-8(40)
31RTE-12(40)
40RT19
40RT18-6(40)
31RTE-11(40)
40RT18
40RT18-8(40)
40RT17-6(40)
31RTK-11(40)
34RSLC-3(40)
39VRCK-2(40)
31RTE-10(40)
40RT17
40RT17-8(40)
401TR
402TR-10(40)
34RLSC-10(40)
1TR
402TR
34RLSC-9(40)
2TR
402TR-8(40)
340NG-24(40)
TO DECODER MKR. CONN. FIG.47
TO DEC. MKR. CONN. FIG.48
DTL
39DTA-10(40)

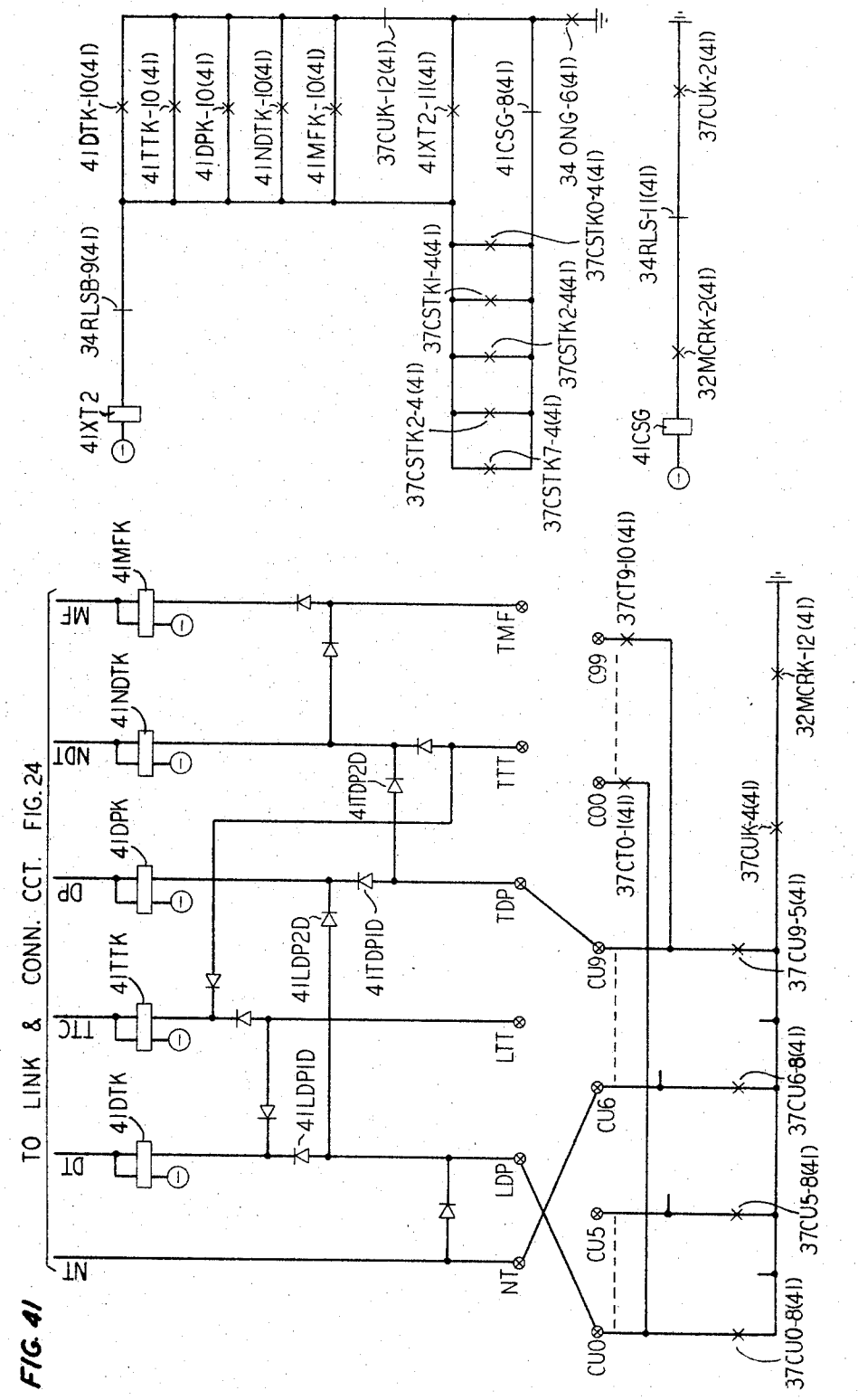

41DTK-10(41)
41TTK-10(41)
41DPK-10(41)
41NDTK-10(41)
41MFK-10(41)
37CUK-12(41)
41XT2-11(41)
41CSG-8(41)
34 ONG-6(41)
34RLSB-9(41)
41XT2
37CSTK1-4(41)
37CSTK2-4(41)
37CSTK2-44(41)
37CSTK7-4(41)
37CSTKO-4(41)
34RLS-11(41)
37CUK-2(41)
41CSG
32MCRK-2(41)
TO LINK & CONN. CCT. FIG. 24
41MFK
41NDTK
41DPK
41TTK
41DTK
MF
NDT
DP
TTC
DT
NT
41TDP2D
41LDP2D
41TDPID
41LDPID
TMF
TTT
TDP
LTT
LDP
NT
C99
C00
CU9
CU6
CU5
CU0
37CT9-10(41)
37CTO-1(41)
37CUK-44(41)
32MCRK-12(41)
37CU9-5(41)
37CU6-8(41)
37CU5-8(41)
37CU0-8(41)

FIG. 41

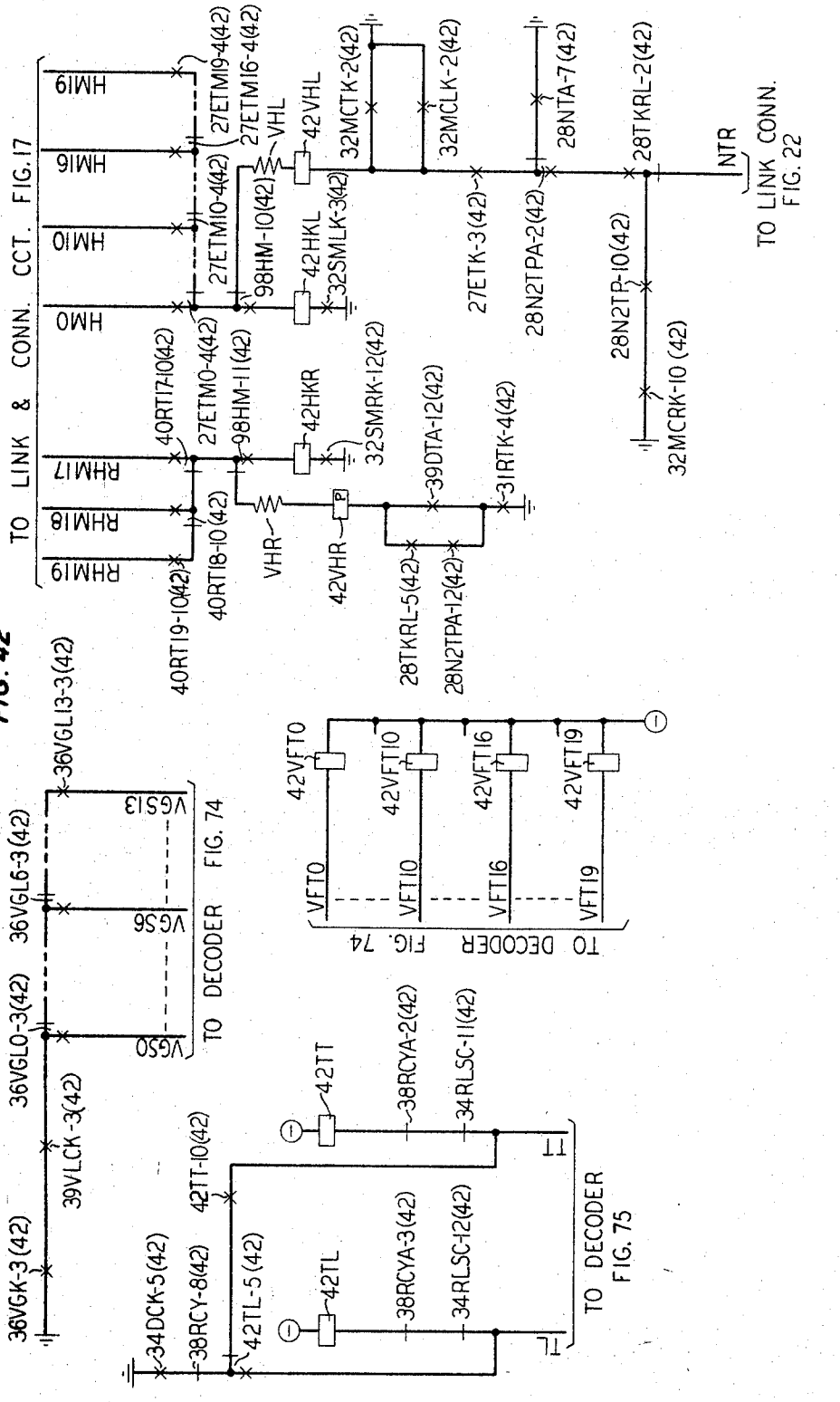

TO LINK & CONN. CCT. FIG. 17
HM19
HM16
HM10
HM0
RHM17
RHM18
RHM19
40RT17-10(42)
40RT18-10(42)
40RT19-10(42)
27ETM0-4(42)
98HM-11(42)
42HKR
VHR
42VHR
32SMRK-12(42)
28TKRL-5(42)
28N2TPA-12(42)
39DTA-12(42)
31RTK-4(42)
27ETM10-4(42)
98HM-10(42)
42HKL
32SMLK-3(42)
27ETM19-4(42)
27ETM16-4(42)
VHL
42VHL
32MCTK-2(42)
32MCLK-2(42)
27ETK-3(42)
28N2TPA-2(42)
28NTA-7(42)
28TKRL-2(42)
28N2TP-10(42)
32MCRK-10(42)
NTR
TO LINK CONN. FIG. 22
42VFT0
42VFT10
42VFT16
42VFT19
VFT0
VFT10
VFT16
VFT19
TO DECODER FIG. 74
36VGL13-3(42)
36VGL6-3(42)
36VGL0-3(42)
VG S13
VG S6
VG S0
TO DECODER FIG. 74
36VGK-3(42)
39VLCK-3(42)
34DCK-5(42)
38RCY-8(42)
42TL-5(42)
42TT-10(42)
42TT
42TL
38RCYA-2(42)
38RCYA-3(42)
34RLSC-11(42)
34RLSC-12(42)
TT
TL
TO DECODER FIG. 75

FIG. 42

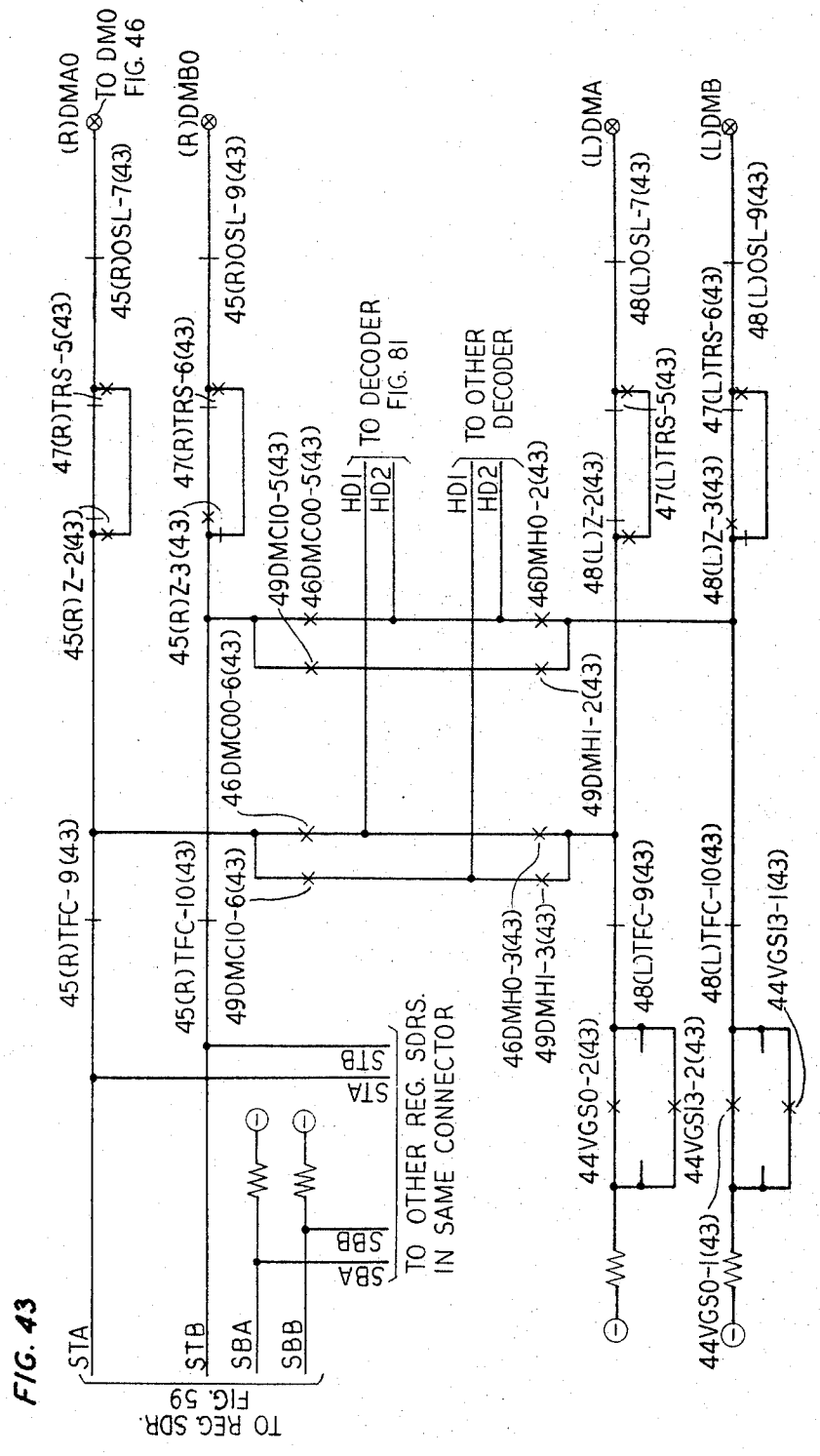

(R)DMA0
TO DMO FIG. 46
(R)DMB0
45(R)OSL-7(43)
45(R)OSL-9(43)
47(R)TRS-5(43)
47(R)TRS-6(43)
45(R)Z-2(43)
45(R)Z-3(43)
49DMC10-5(43)
46DMC00-5(43)
HD1
HD2
TO DECODER FIG. 81
TO OTHER DECODER
46DMH0-2(43)
46DMC00-6(43)
49DMH1-2(43)
45(R)TFC-9(43)
45(R)TFC-10(43)
49DMC10-6(43)
46DMH0-3(43)
49DMH1-3(43)
STB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

FIG. 43

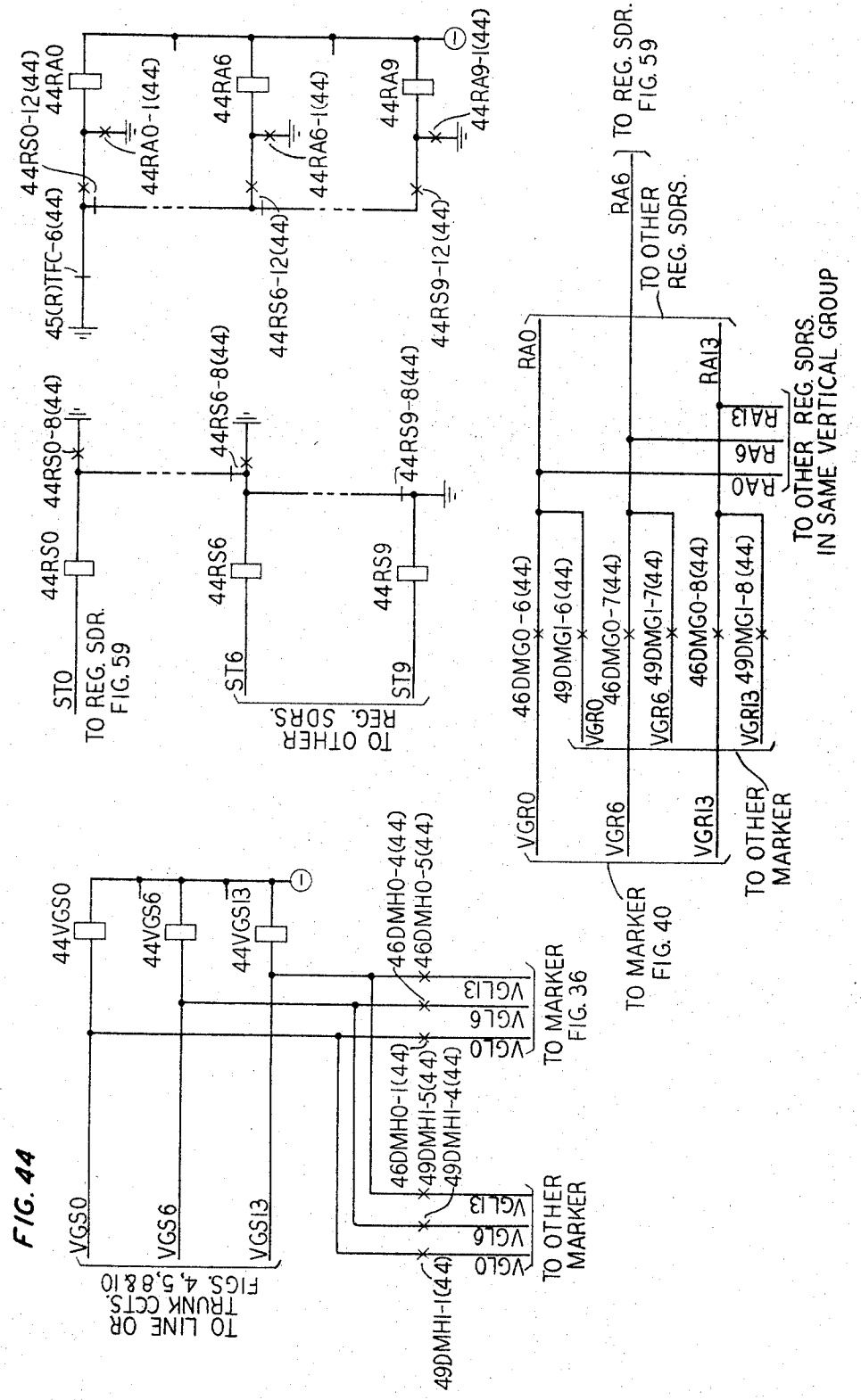
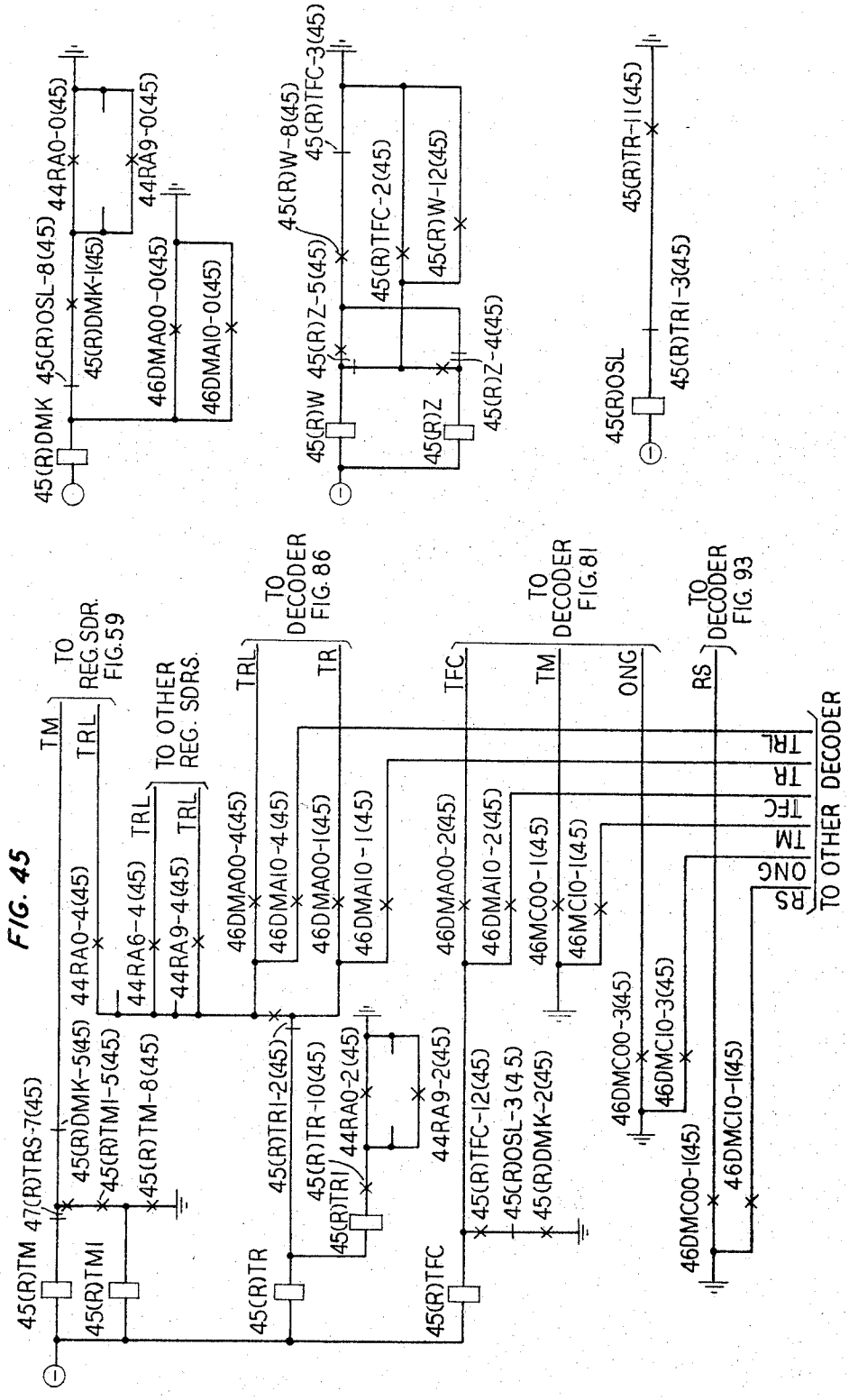

44RS0-12(44)
44RA0
44RA0-1(44)
44RA6
44RA6-1(44)
44RA9
44RA9-1(44)
45(R)TFC-6(44)
44RS6-12(44)
44RS9-12(44)
44RS0-8(44)
44RS6-8(44)
44RS9-8(44)
44RS0
44RS6
44RS9
ST0
TO REG. SDR. FIG. 59
ST6
ST9
TO OTHER REG. SDRS.
RA0
RA6
RA13
TO REG. SDR. FIG. 59
TO OTHER REG. SDRS.
TO OTHER REG. SDRS. IN SAME VERTICAL GROUP
46DMG0-6(44)
49DMGI-6(44)
46DMG0-7(44)
49DMGI-7(44)
46DMG0-8(44)
49DMGI-8(44)
VGR0
VGR6
VGR13
TO MARKER FIG. 40
TO OTHER MARKER
44VGS0
44VGS6
44VGS13
46DMH0-4(44)
46DMH0-5(44)
VGL13
VGL6
VGL0
TO MARKER FIG. 36
46DMH0-1(44)
49DMHI-5(44)
49DMHI-4(44)
VGL13
VGL6
VGL0
TO OTHER MARKER
49DMHI-1(44)
VGS0
VGS6
VGS13
TO LINE OR TRUNK CCTS. FIGS. 4, 5, 8 & 10

FIG. 44


45(R)DMK
45(R)OSL-8(45)
44RA0-0(45)
45(R)DMK-1(45)
44RA9-0(45)
46DMA00-0(45)
46DMA10-0(45)
45(R)W
45(R)W-8(45)
45(R)TFC-3(45)
45(R)Z-5(45)
45(R)TFC-2(45)
45(R)W-12(45)
45(R)Z
45(R)Z-4(45)
45(R)OSL
45(R)TR-11(45)
45(R)TRI-3(45)
FIG. 45
45(R)TM
47(R)TRS-7(45)
45(R)TMI
45(R)DMK-5(45)
45(R)TMI-5(45)
45(R)TM-8(45)
44RA0-4(45)
44RA6-4(45)
44RA9-4(45)
TRL
TM
TO REG. SDR. FIG. 59
TO OTHER REG. SDRS.
45(R)TR
45(R)TRI-2(45)
45(R)TR-10(45)
45(R)TRI
44RA0-2(45)
46DMA00-4(45)
46DMA10-4(45)
46DMA00-1(45)
46DMA10-1(45)
TR
TO DECODER FIG. 86
45(R)TFC
44RA9-2(45)
45(R)TFC-12(45)
45(R)OSL-3(45)
45(R)DMK-2(45)
46DMA00-2(45)
46DMA10-2(45)
TFC
46MC00-1(45)
46MC10-1(45)
TO DECODER FIG. 81
46DMC00-3(45)
46DMC10-3(45)
46DMC00-1(45)
46DMC10-1(45)
ONG
RS
TO DECODER FIG. 93
TO OTHER DECODER

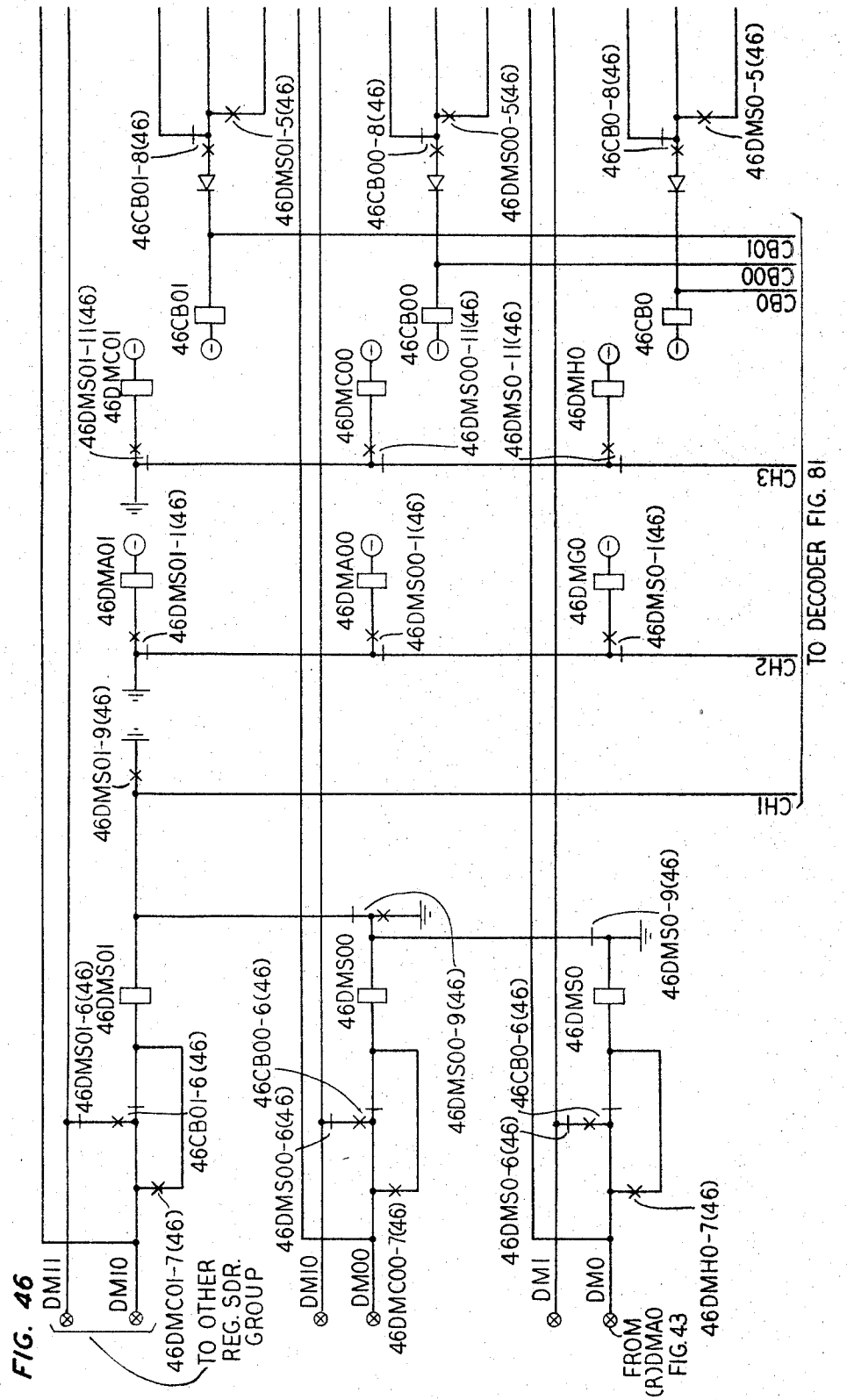

DMII
DMI0
DMI0
DMO0
DMI
DMO
46DMC01-7(46)
TO OTHER REG. SDR. GROUP
46DMS01-6(46)
46DMS01
46CB01-6(46)
46DMC00-7(46)
46DMS00-6(46)
46CB00-6(46)
46DMS00
46DMS00-9(46)
46DMS0-6(46)
46CB0-6(46)
46DMS0
46DMS0-9(46)
46DMH0-7(46)
FROM (R)DMA0 FIG. 43
46DMS01-9(46)
46DMA01
46DMS01-1(46)
46DMS01-11(46)
46DMC01
46CB01
46DMS01-5(46)
46CB01-8(46)
46DMA00
46DMS00-1(46)
46DMC00
46CB00
46DMS00-11(46)
46DMS00-5(46)
46CB00-8(46)
46DMG0
46DMS0-1(46)
46DMS0-11(46)
46DMH0
46CB0
46DMS0-5(46)
46CB0-8(46)
CH1
CH2
CH3
CB0
CB00
CB01
TO DECODER FIG. 81

FIG. 46

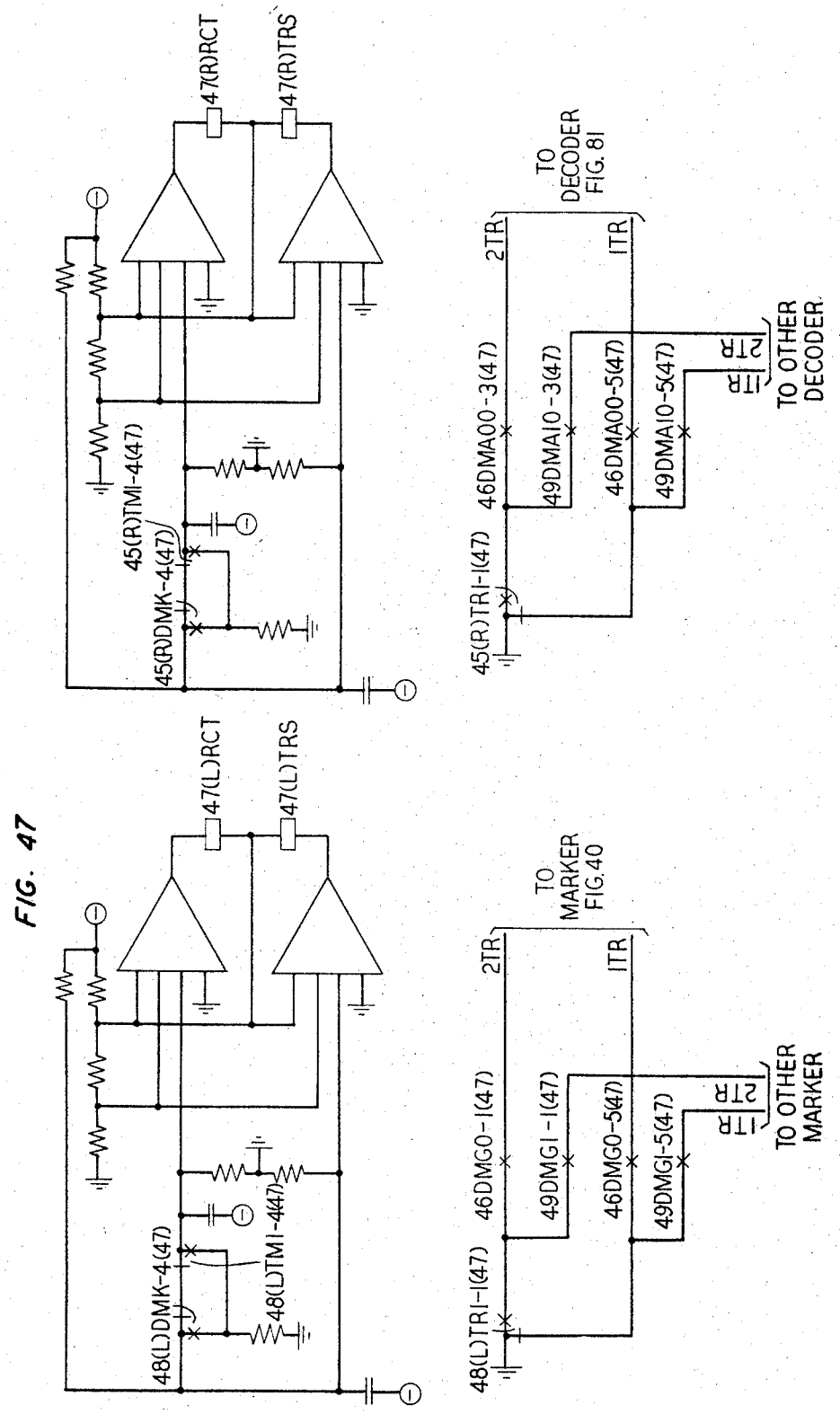

47(R)RCT
47(R)TRS
45(R)TMI-4(47)
45(R)DMK-4(47)
TO DECODER FIG. 81
2TR
1TR
46DMA00-3(47)
49DMA10-3(47)
46DMA00-5(47)
49DMA10-5(47)
45(R)TRI-1(47)
TO OTHER DECODER
47(L)RCT
47(L)TRS
48(L)TMI-4(47)
48(L)DMK-4(47)
TO MARKER FIG. 40
46DMG0-1(47)
49DMG1-1(47)
46DMG0-5(47)
49DMG1-5(47)
48(L)TRI-1(47)
TO OTHER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

FIG. 47

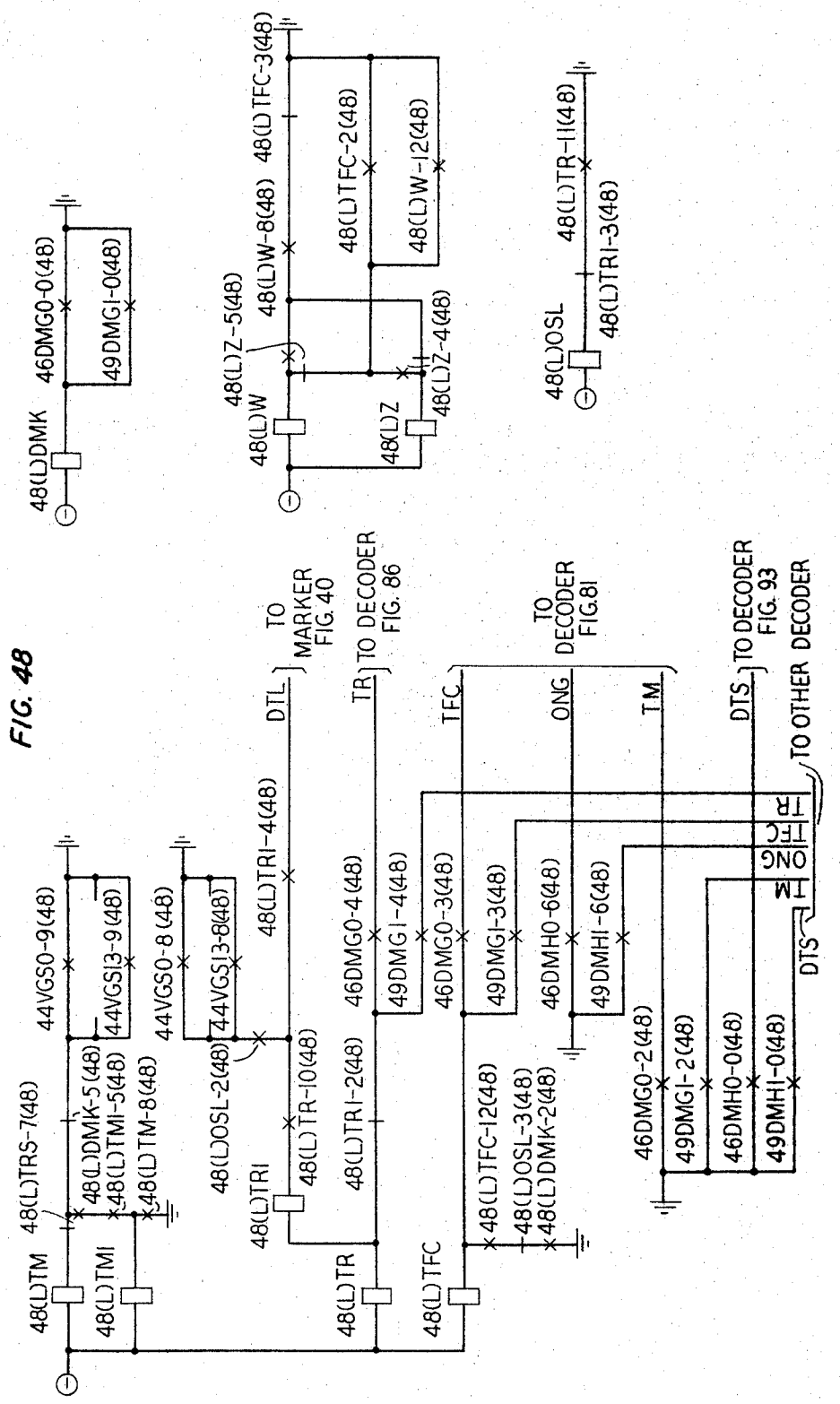
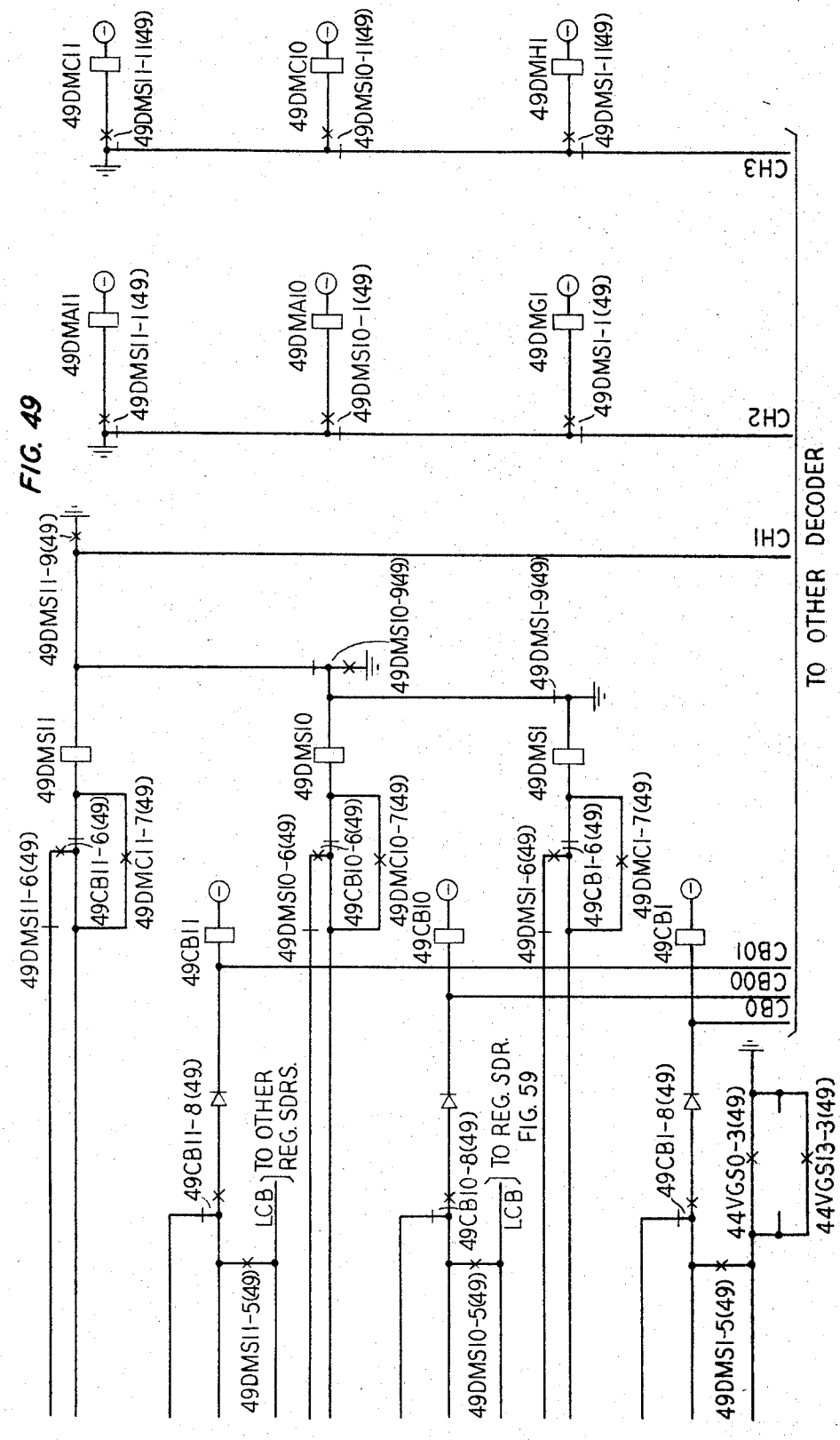

48(L)DMK
46DMG0-0(48)
49DMG1-0(48)
48(L)W
48(L)Z-5(48)
48(L)W-8(48)
48(L)TFC-3(48)
48(L)TFC-2(48)
48(L)W-12(48)
48(L)Z
48(L)Z-4(48)
48(L)OSL
48(L)TR-11(48)
48(L)TRI-3(48)
48(L)TM
48(L)TMI
48(L)TRS-7(48)
48(L)DMK-5(48)
48(L)TMI-5(48)
48(L)TM-8(48)
44VGS0-9(48)
44VGSI3-9(48)
44VGS0-8(48)
44VGSI3-8(48)
48(L)OSL-2(48)
48(L)TRI
48(L)TRI-4(48)
48(L)TR-10(48)
48(L)TRI-2(48)
48(L)TR
48(L)TFC
48(L)TFC-12(48)
48(L)OSL-3(48)
48(L)DMK-2(48)
46DMG0-4(48)
49DMG1-4(48)
46DMG0-3(48)
49DMG1-3(48)
46DMH0-6(48)
49DMH1-6(48)
46DMG0-2(48)
49DMG1-2(48)
46DMH0-0(48)
49DMH1-0(48)
DTL
TO MARKER FIG. 40
TR
TO DECODER FIG. 86
TFC
ONG
TM
TO DECODER FIG. 81
DTS
TO DECODER FIG. 93
TO OTHER DECODER
TR
TFC
ONG
TM
DTS

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
TO OTHER DECODER
49DMSI1-9(49)
49DMSI0-9(49)
49DMSI-9(49)
49DMSI1
49DMSI0
49DMSI
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)

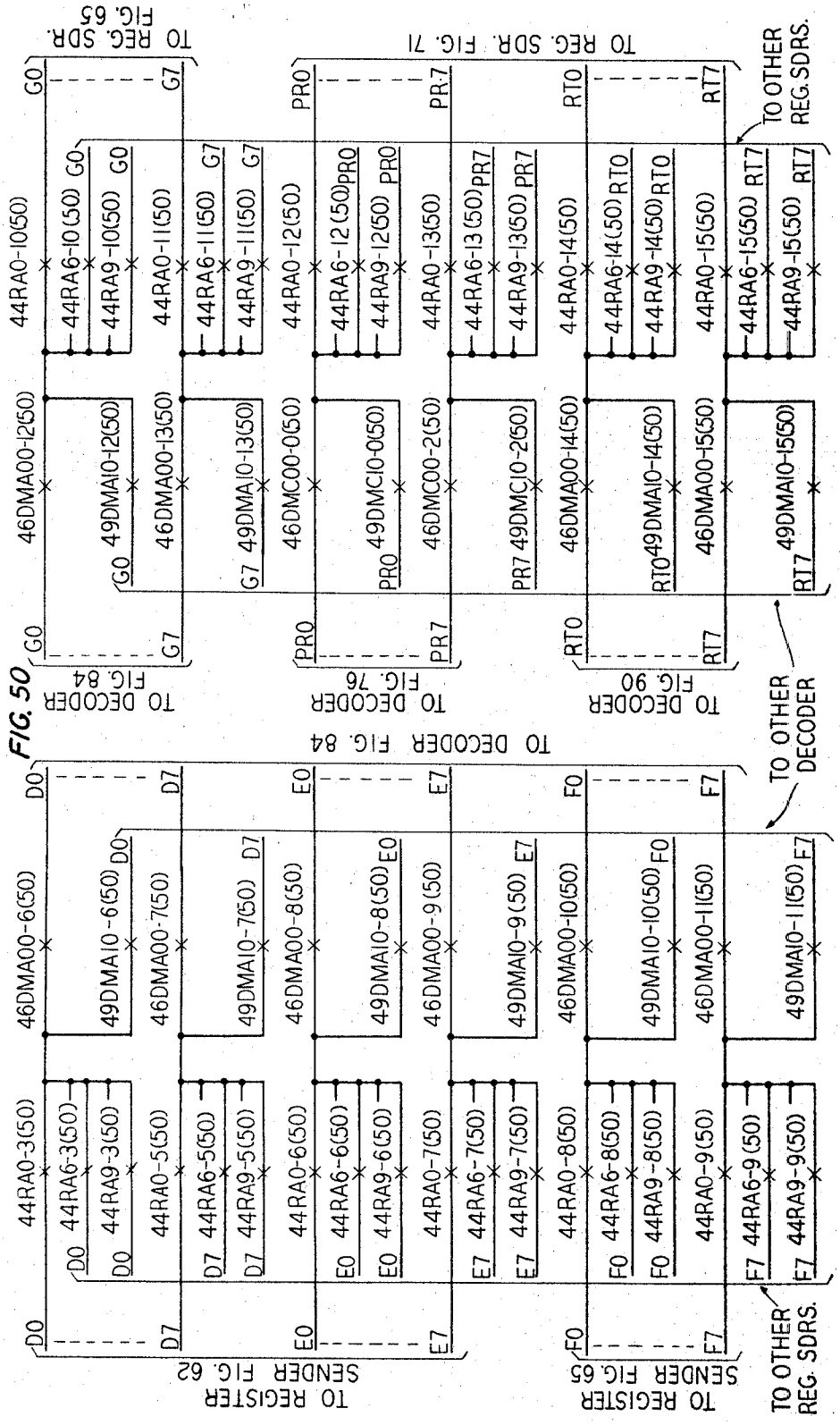

TO REG. SDR. FIG. 65
TO REG. SDR. FIG. 71
TO OTHER REG. SDRS.
TO DECODER FIG. 84
TO DECODER FIG. 76
TO DECODER FIG. 90
TO OTHER DECODER
TO DECODER FIG. 84
TO REGISTER SENDER FIG. 62
TO REGISTER SENDER FIG. 65
TO OTHER REG. SDRS.

FIG. 50

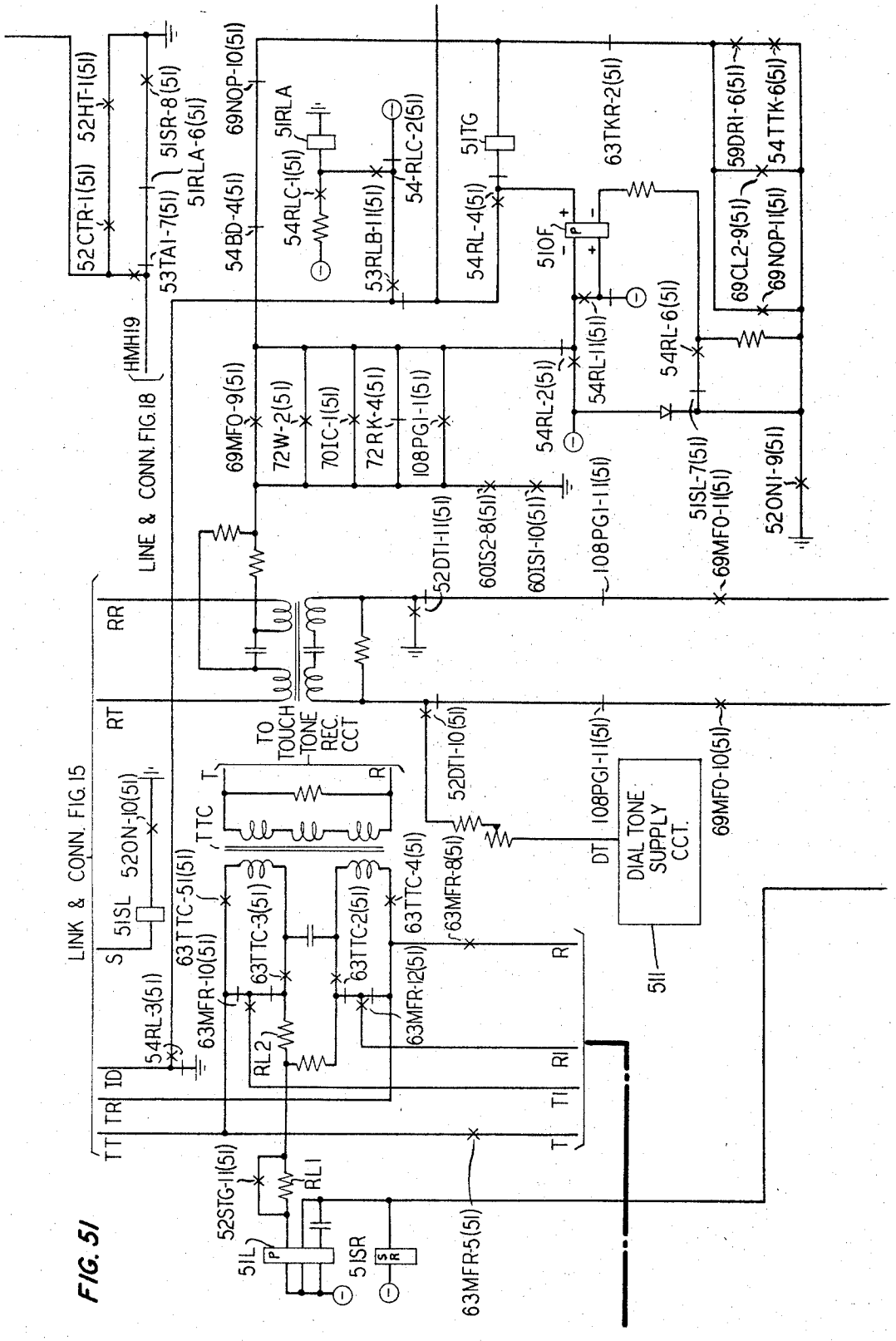

52CTR-1(51)
52HT-1(51)
53TA1-7(51)
51SR-8(51)
51RLA-6(51)
54BD-4(51)
69NOP-10(51)
54RLC-1(51)
51RLA
53RLB-11(51)
54RLC-2(51)
54RL-4(51)
51TG
51OF
63TKR-2(51)
59DRI-6(51)
54TTK-6(51)
69CL2-9(51)
69NOP-11(51)
54RL-6(51)
54RL-11(51)
54RL-2(51)
HMH19
LINE & CONN. FIG. 18
69MFO-9(51)
72W-2(51)
70IC-1(51)
72RK-4(51)
108PGI-1(51)
52DTI-11(51)
60IS2-8(51)
60ISI-10(51)
108PGI-11(51)
51SL-7(51)
69MFO-11(51)
52ONI-9(51)
RR
RT
TO TOUCH TONE REC. CCT
52DTI-10(51)
69MFO-10(51)
DIAL TONE SUPPLY CCT.
DT
108PGI-11(51)
511
LINK & CONN. FIG. 15
52ON-10(51)
51SL
63TTC-5(51)
TTC
63TTC-3(51)
63TTC-2(51)
63TTC-4(51)
63MFR-8(51)
63MFR-10(51)
63MFR-12(51)
54RL-3(51)
RL2
RL1
TT
TR
ID
TI
RI
52STG-11(51)
51L
51SR
63MFR-5(51)

FIG. 51

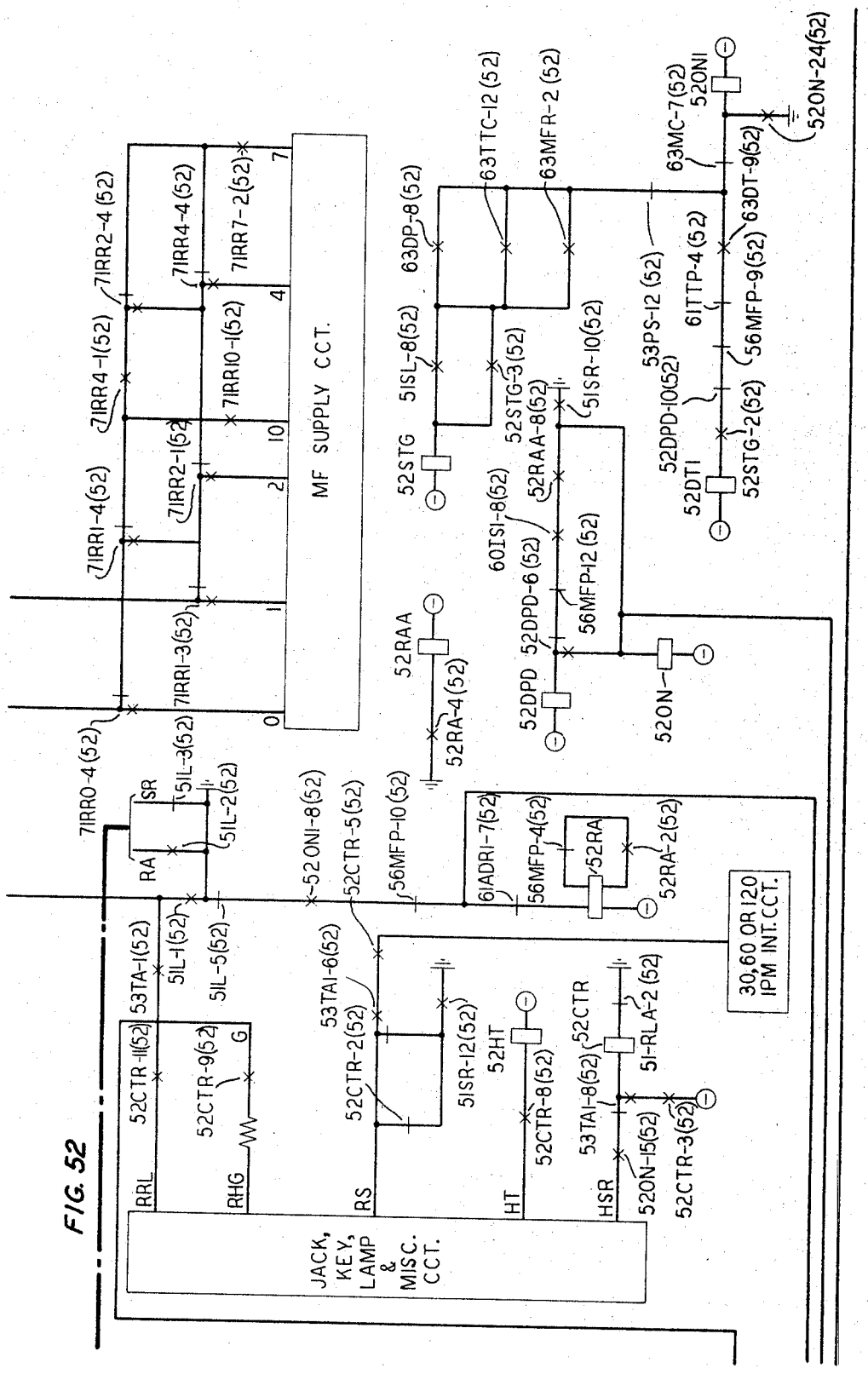

7IRR0-4(52)
7IRR1-4(52)
7IRR1-3(52)
7IRR2-1(52)
7IRR4-1(52)
7IRR2-4(52)
7IRR4-4(52)
7IRR10-1(52)
7IRR7-2(52)
MF SUPPLY CCT.
0
1
2
10
4
7
RA
SR
51IL-3(52)
51IL-2(52)
52ONI-8(52)
52CTR-5(52)
56MFP-10(52)
52RAA
52RA-4(52)
61ADRI-7(52)
56MFP-4(52)
52RA
52RA-2(52)
52DPD
52DPD-6(52)
60ISI-8(52)
52RAA-8(52)
56MFP-12(52)
52STG
51SL-8(52)
63DP-8(52)
52STG-3(52)
51SR-10(52)
63TTC-12(52)
63MFR-2(52)
52DPD-10(52)
53PS-12(52)
52DTI
61TTP-4(52)
52STG-2(52)
56MFP-9(52)
63MC-7(52)
52ONI
63DT-9(52)
52ON-24(52)
52ON-
30,60 OR 120
IPM INT.CCT.
51IL-1(52)
53TA-1(52)
51IL-5(52)
52CTR-11(52)
52CTR-9(52)
RRL
RHG
G
53TAI-6(52)
52CTR-2(52)
51SR-12(52)
52HT
52CTR-8(52)
RS
HT
53TAI-8(52)
52CTR
51-RLA-2(52)
HSR
52ON-15(52)
52CTR-3(52)
JACK,
KEY,
LAMP
&
MISC.
CCT.

FIG. 52

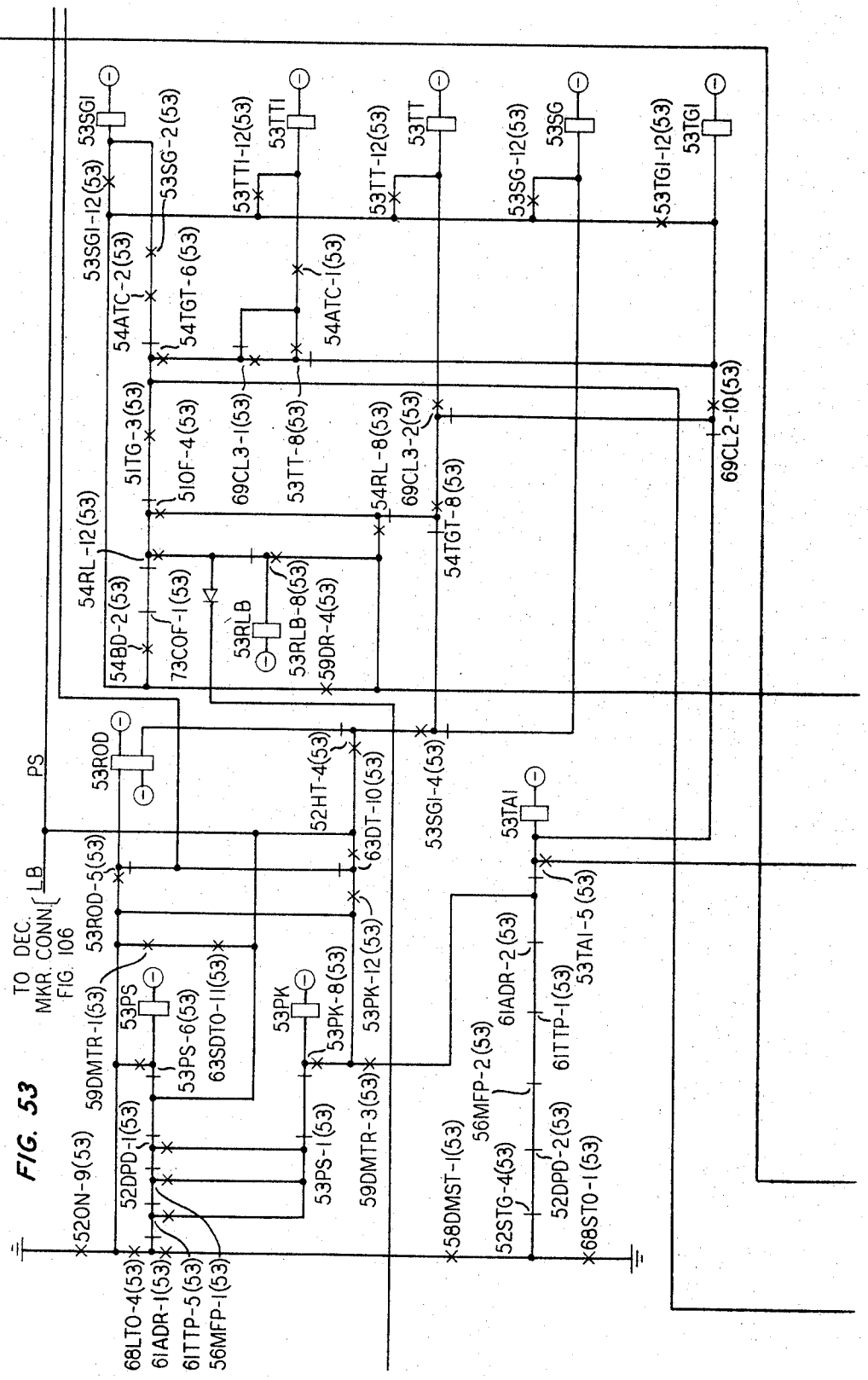

TO DEC. MKR. CONN. FIG. 106
LB
PS
53ROD
53ROD-5(53)
59DMTR-1(53)
53PS
53PS-6(53)
63SDTO-11(53)
52DPD-1(53)
52ON-9(53)
53PS-1(53)
53PK
53PK-8(53)
53PK-12(53)
59DMTR-3(53)
52HT-4(53)
63DT-10(53)
53SGI-4(53)
53TAI
53TAI-5(53)
61ITTP-1(53)
61ADR-2(53)
56MFP-2(53)
52DPD-2(53)
68STO-1(53)
52STG-4(53)
58DMST-1(53)
68LTO-4(53)
61ADR-1(53)
61ITTP-5(53)
56MFP-1(53)
54RL-12(53)
54BD-2(53)
73COF-1(53)
53RLB
53RLB-8(53)
59DR-4(53)
51TG-3(53)
51OF-4(53)
69CL3-1(53)
53TT-8(53)
54RL-8(53)
69CL3-2(53)
54TGT-8(53)
54ATC-2(53)
54TGT-6(53)
54ATC-1(53)
53SGI-12(53)
53SGI
53SG-2(53)
53TTI-12(53)
53TTI
53TT-12(53)
53TT
53SG-12(53)
53SG
53TGI-12(53)
53TGI
69CL2-10(53)

FIG. 53

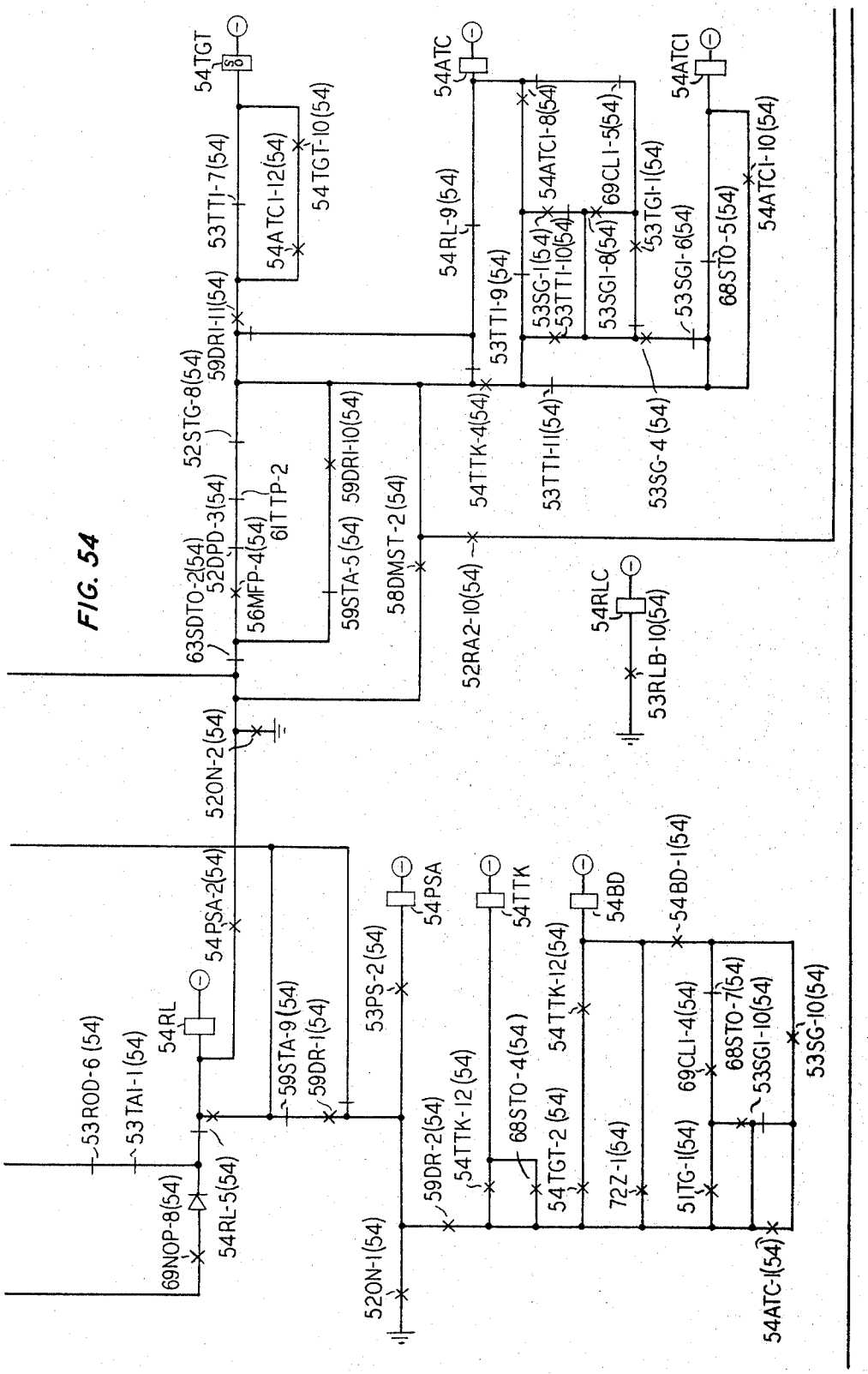

54TGT
54ATC
54ATCI
53TTI-7(54)
54TGT-10(54)
54ATCI-12(54)
59DRI-11(54)
52STG-8(54)
54RL-9(54)
53TTI-9(54)
53SG-1(54)
53TTI-10(54)
54ATCI-8(54)
69CLI-5(54)
53TGI-1(54)
53SGI-8(54)
53SGI-6(54)
68STO-5(54)
54ATCI-10(54)
63SDTO-2(54)
52DPD-3(54)
56MFP-4(54)
61TTP-2
59STA-5(54)
59DRI-10(54)
58DMST-2(54)
54TTK-4(54)
53TTI-11(54)
53SG-4(54)
52RA2-10(54)
54RLC
53RLB-10(54)
52ON-2(54)
53ROD-6(54)
53TAI-1(54)
54RL
54PSA-2(54)
69NOP-8(54)
54RL-5(54)
59STA-9(54)
59DR-1(54)
53PS-2(54)
54PSA
54TTK
54BD
54BD-1(54)
59DR-2(54)
54TTK-12(54)
68STO-4(54)
54TGT-2(54)
54TTK-12(54)
72Z-1(54)
51TG-1(54)
69CLI-4(54)
68STO-7(54)
53SGI-10(54)
53SG-10(54)
52ON-1(54)
54ATC-1(54)

FIG. 54

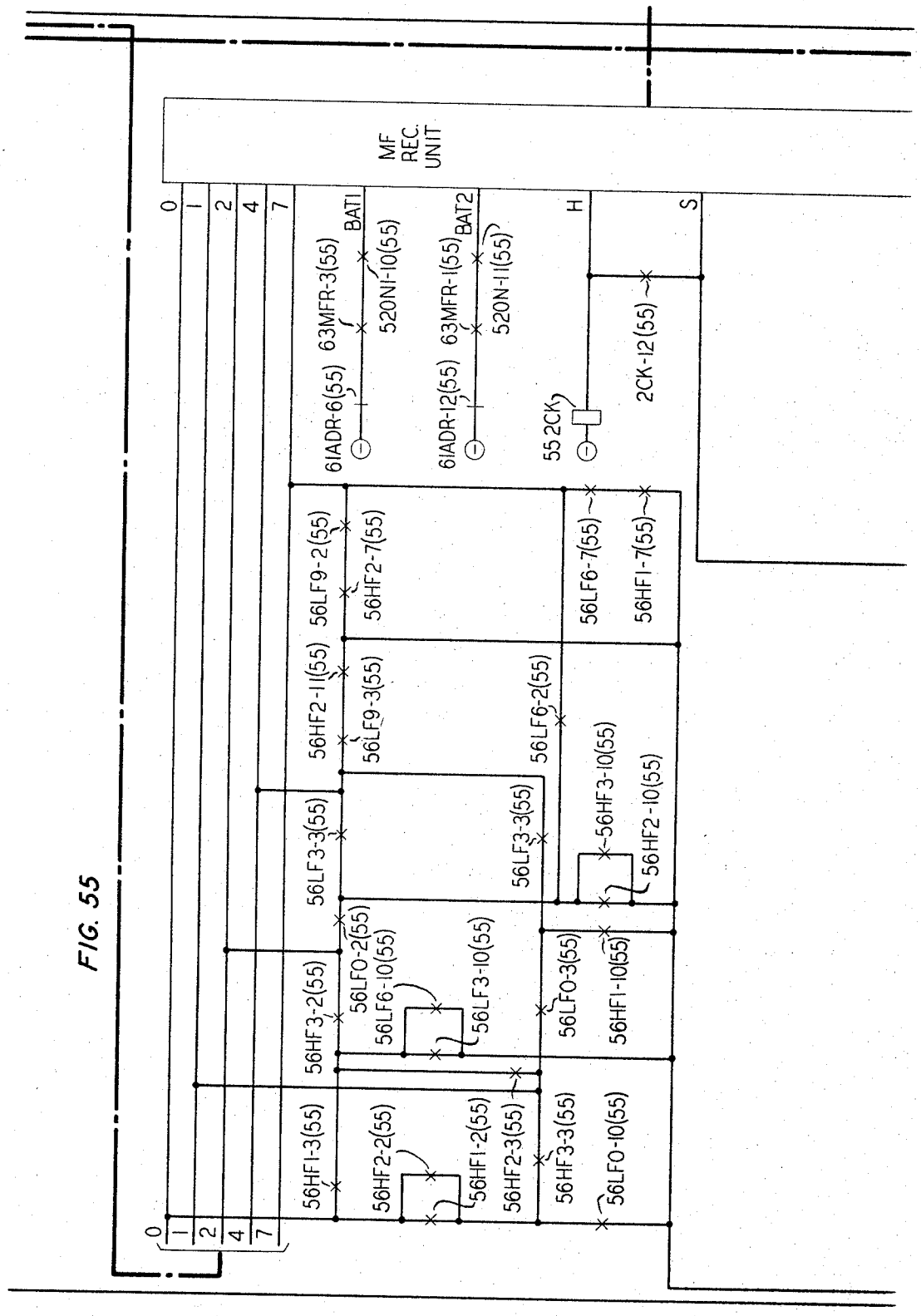

MF REC. UNIT
0
1
2
4
7
H
S
BAT1
BAT2
63MFR-3(55)
63MFR-1(55)
520NI-10(55)
520N-11(55)
6IADR-6(55)
6IADR-12(55)
55 2CK
2CK-12(55)
56LF9-2(55)
56HF2-7(55)
56LF6-7(55)
56HF1-7(55)
56HF2-11(55)
56LF9-3(55)
56LF6-2(55)
56LF3-3(55)
56HF3-10(55)
56HF2-10(55)
56LFO-2(55)
56HF3-2(55)
56LF6-10(55)
56LF3-10(55)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

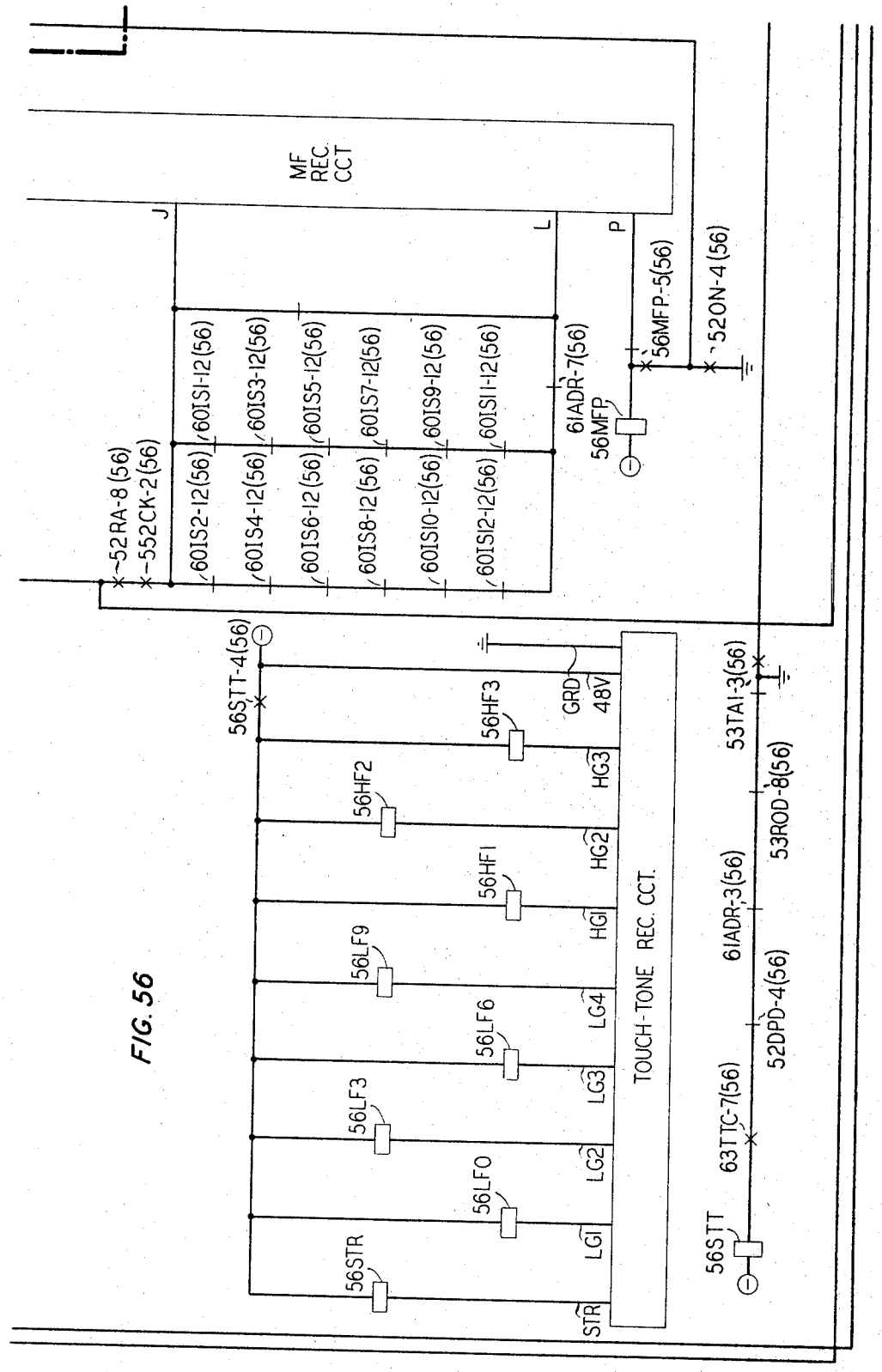

MF REC. CCT
J
L
P
56MFP-5(56)
52ON-4(56)
61ADR-7(56)
56MFP
60IS1-12(56)
60IS3-12(56)
60IS5-12(56)
60IS7-12(56)
60IS9-12(56)
60IS11-12(56)
60IS2-12(56)
60IS4-12(56)
60IS6-12(56)
60IS8-12(56)
60IS10-12(56)
60IS12-12(56)
52RA-8(56)
552CK-2(56)
56STT-4(56)
56HF3
56HF2
56HF1
56LF9
56LF6
56LF3
56LF0
56STR
GRD
48V
HG3
HG2
HG1
LG4
LG3
LG2
LG1
STR
TOUCH-TONE REC. CCT.
53TAI-3(56)
53ROD-8(56)
61ADR-3(56)
52DPD-4(56)
63TTC-7(56)
56STT

FIG. 56

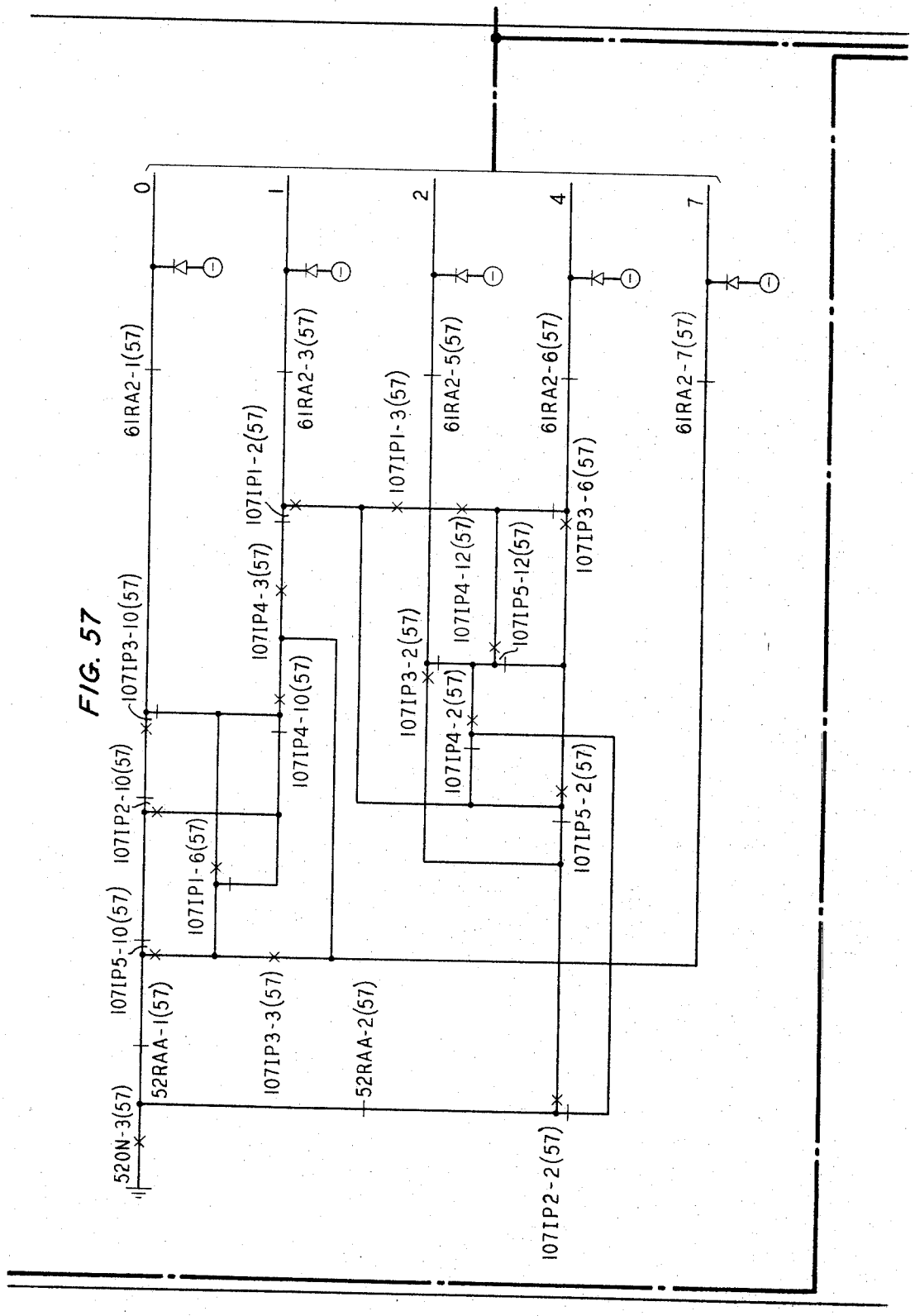

0
1
2
4
7
61RA2-1(57)
61RA2-3(57)
61RA2-5(57)
61RA2-6(57)
61RA2-7(57)
107IP1-2(57)
107IP1-3(57)
107IP3-6(57)
107IP4-3(57)
107IP5-12(57)
107IP4-12(57)
107IP3-2(57)
107IP3-10(57)
107IP4-10(57)
107IP4-2(57)
107IP5-2(57)
107IP2-10(57)
107IP1-6(57)
107IP5-10(57)
52RAA-1(57)
107IP3-3(57)
52RAA-2(57)
520N-3(57)
107IP2-2(57)

FIG. 57

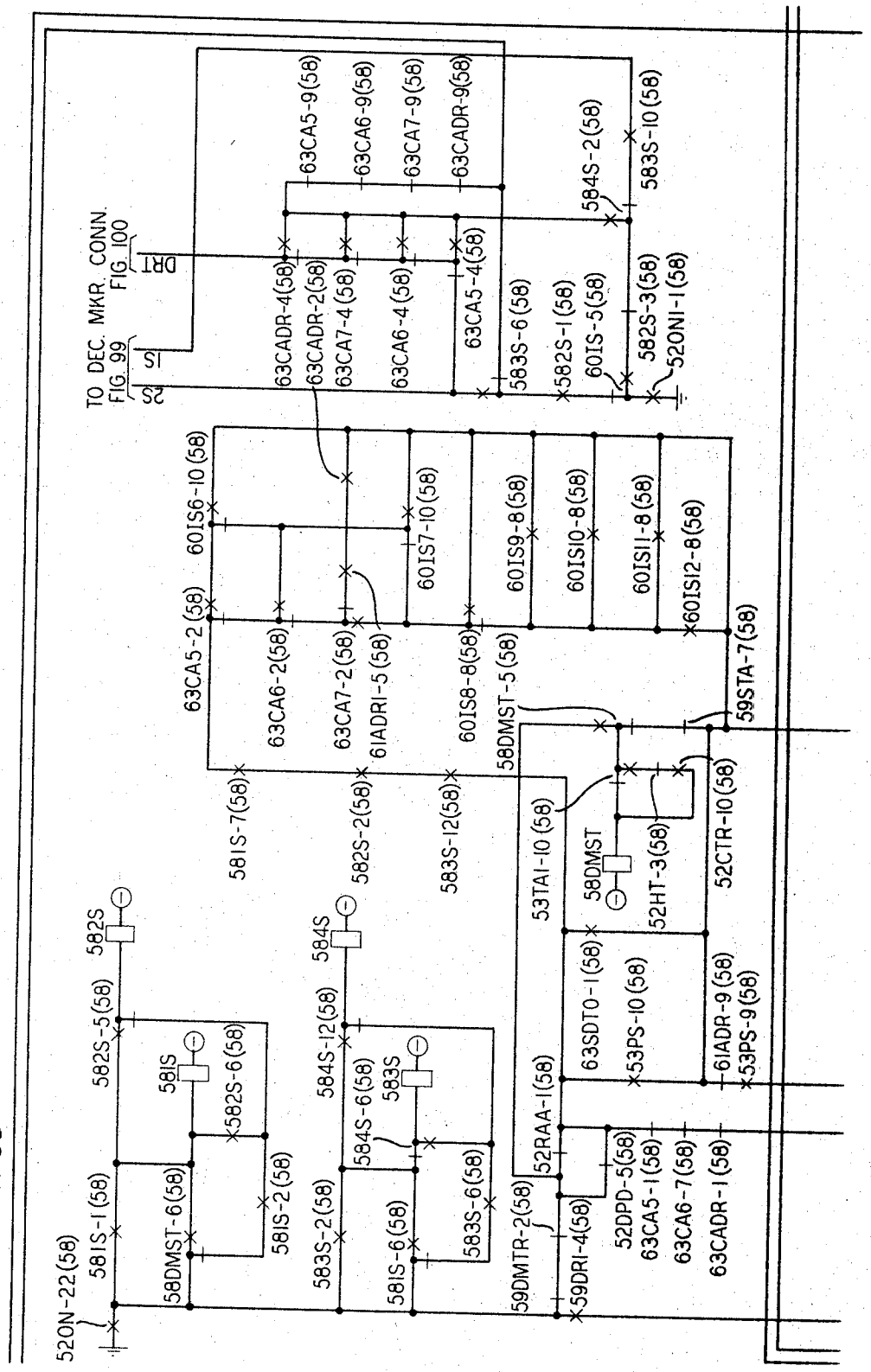

TO DEC. MKR. CONN. FIG. 99
S1
S2
DRT
FIG. 100
63CADR-4(58)
63CADR-2(58)
63CA7-4(58)
63CA6-4(58)
63CA5-4(58)
583S-6(58)
582S-1(58)
60IS-5(58)
582S-3(58)
520NI-1(58)
584S-2(58)
583S-10(58)
63CA5-9(58)
63CA6-9(58)
63CA7-9(58)
63CADR-9(58)
60IS6-10(58)
60IS7-10(58)
60IS9-8(58)
60IS10-8(58)
60IS11-8(58)
60IS12-8(58)
59STA-7(58)
63CA5-2(58)
63CA6-2(58)
63CA7-2(58)
61ADRI-5(58)
60IS8-8(58)
58DMST-5(58)
581S-7(58)
582S-2(58)
583S-12(58)
53TAI-10(58)
58DMST
52HT-3(58)
52CTR-10(58)
582S
584S
582S-5(58)
581S
582S-6(58)
581S-2(58)
584S-12(58)
584S-6(58)
583S
583S-6(58)
581S-6(58)
63SDTO-1(58)
53PS-10(58)
61ADR-9(58)
53PS-9(58)
52RAA-1(58)
59DMTR-2(58)
59DRI-4(58)
52DPD-5(58)
63CA5-1(58)
63CA6-7(58)
63CADR-1(58)
520N-22(58)
581S-1(58)
58DMST-6(58)
583S-2(58)

FIG. 58

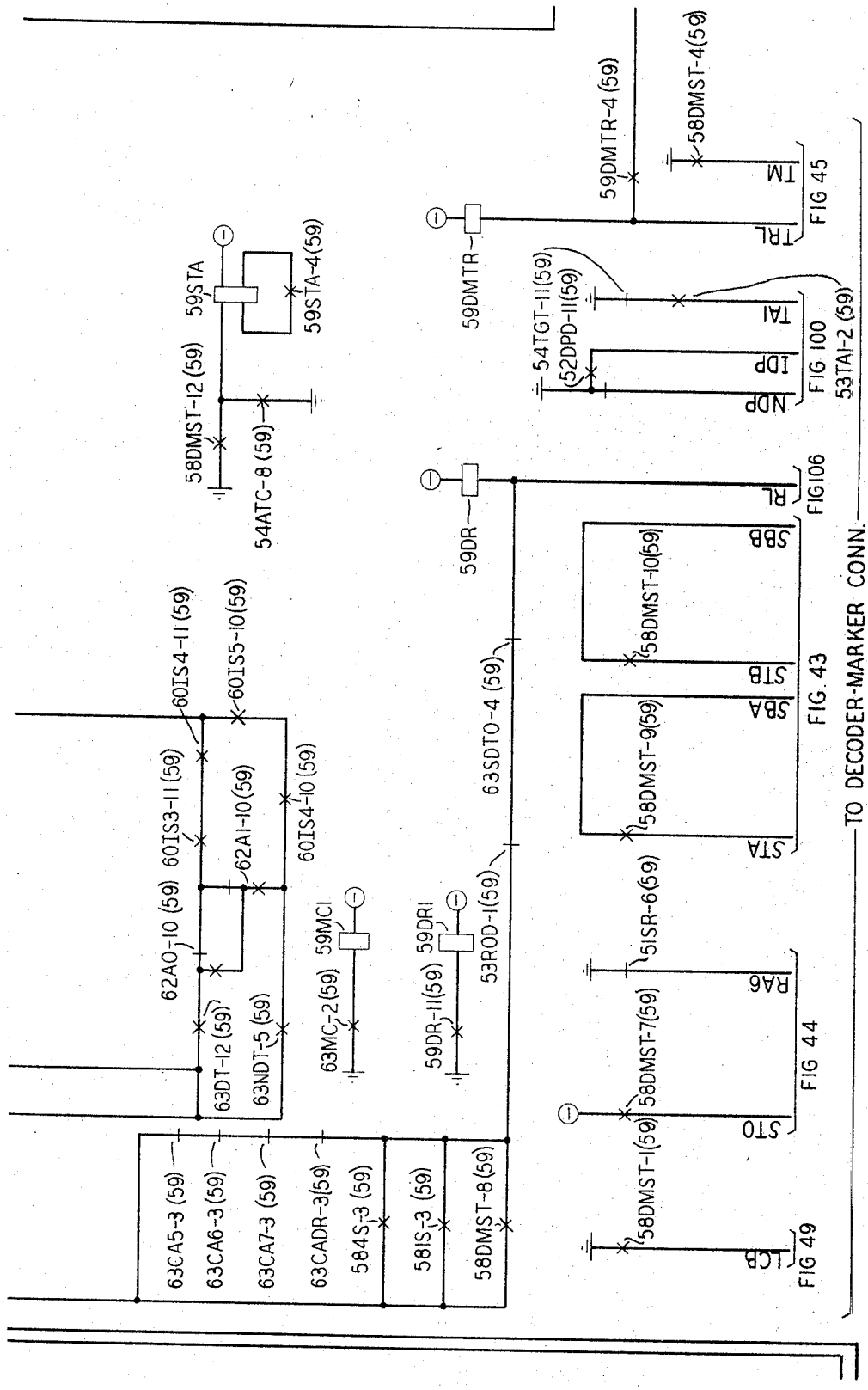

59DMTR-4(59)
58DMST-4(59)
TM
TRL
FIG 45
59DMTR
54TGT-11(59)
52DPD-11(59)
TAI
IDP
NDP
FIG 100
53TAI-2 (59)
59STA
59STA-4(59)
58DMST-12(59)
54ATC-8 (59)
59DR
RL
FIG106
SBB
SBA
STB
STA
58DMST-10(59)
58DMST-9(59)
FIG. 43
63SDTO-4 (59)
60IS4-11(59)
60IS5-10(59)
60IS3-11(59)
62AI-10(59)
60IS4-10 (59)
62AO-10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

FIG. 59

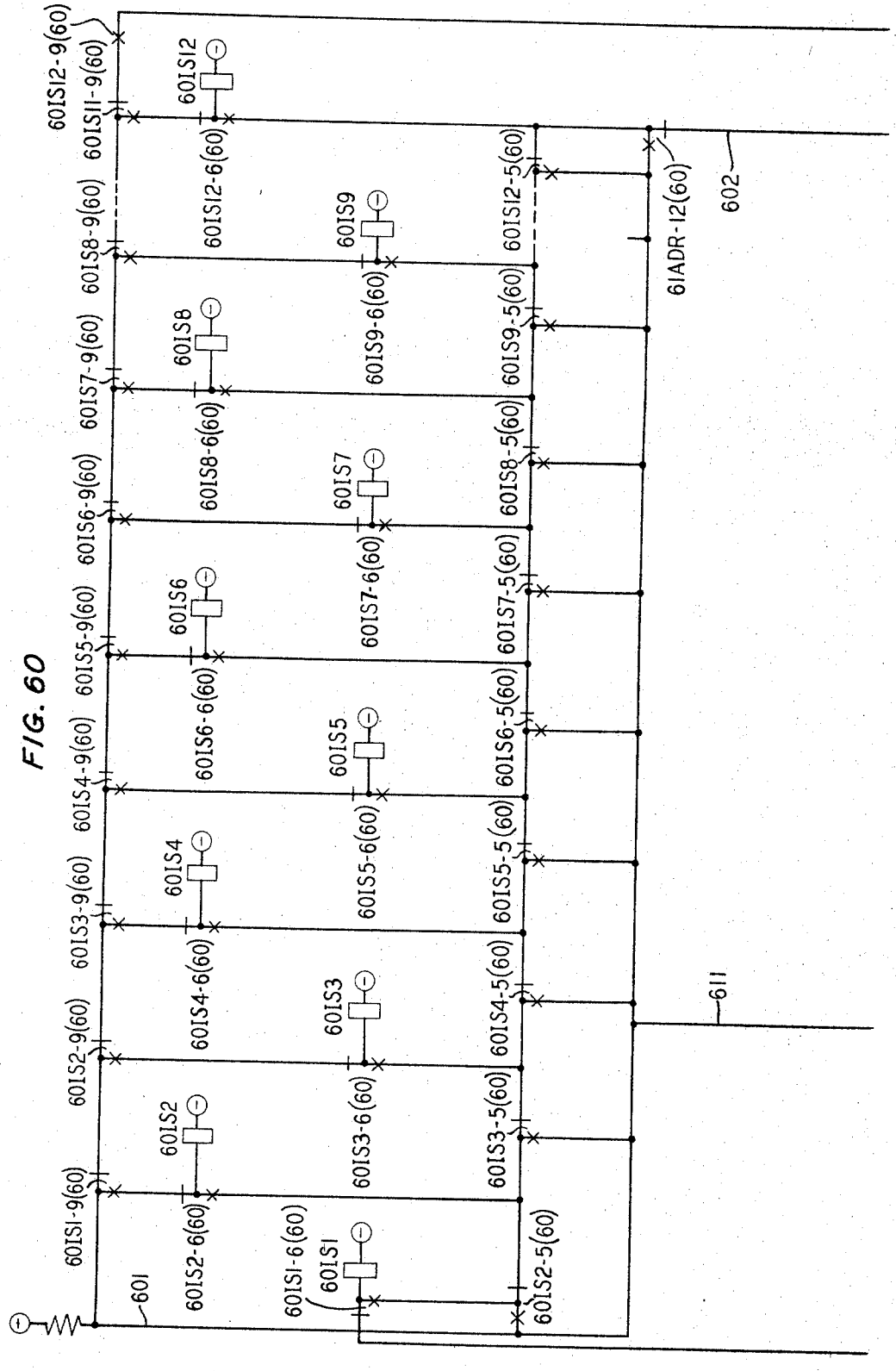

60IS12-9(60)
60IS11-9(60)
60IS8-9(60)
60IS7-9(60)
60IS6-9(60)
60IS5-9(60)
60IS4-9(60)
60IS3-9(60)
60IS2-9(60)
60ISI-9(60)
60IS12
60IS12-6(60)
60IS9
60IS9-6(60)
60IS8
60IS8-6(60)
60IS7
60IS7-6(60)
60IS6
60IS6-6(60)
60IS5
60IS5-6(60)
60IS4
60IS4-6(60)
60IS3
60IS3-6(60)
60IS2
60IS2-6(60)
60ISI-6(60)
60ISI
60IS12-5(60)
60IS9-5(60)
60IS8-5(60)
60IS7-5(60)
60IS6-5(60)
60IS5-5(60)
60IS4-5(60)
60IS3-5(60)
60IS2-5(60)
61ADR-12(60)
602
611
601

FIG. 60

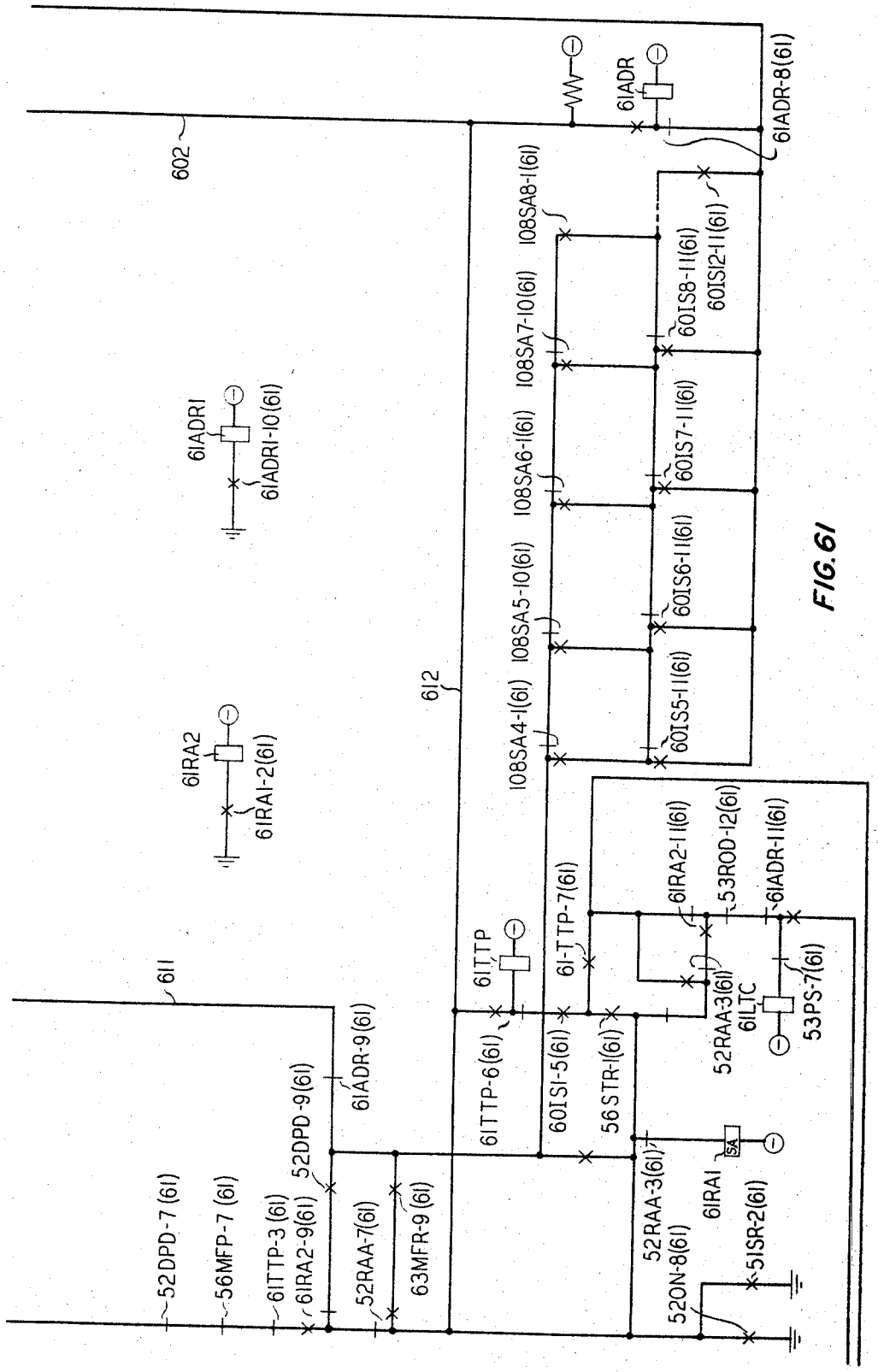

602
612
611
61ADR
61ADR-8(61)
108SA8-1(61)
108SA7-10(61)
108SA6-1(61)
108SA5-10(61)
108SA4-1(61)
60IS8-11(61)
60IS12-11(61)
60IS7-11(61)
60IS6-11(61)
60IS5-11(61)
61ADRI
61ADRI-10(61)
61IRA2
61IRAI-2(61)
61ITTP
61-TTP-7(61)
61IRA2-11(61)
53ROD-12(61)
61ADR-11(61)
61ILTC
53PS-7(61)
52RAA-3(61)
61IRAI
SA
52ON-8(61)
51SR-2(61)
61ITTP-6(61)
60ISI-5(61)
56STR-1(61)
61ADR-9(61)
52DPD-9(61)
52RAA-7(61)
63MFR-9(61)
61ITTP-3(61)
61IRA2-9(61)
56MFP-7(61)
52DPD-7(61)

FIG. 61

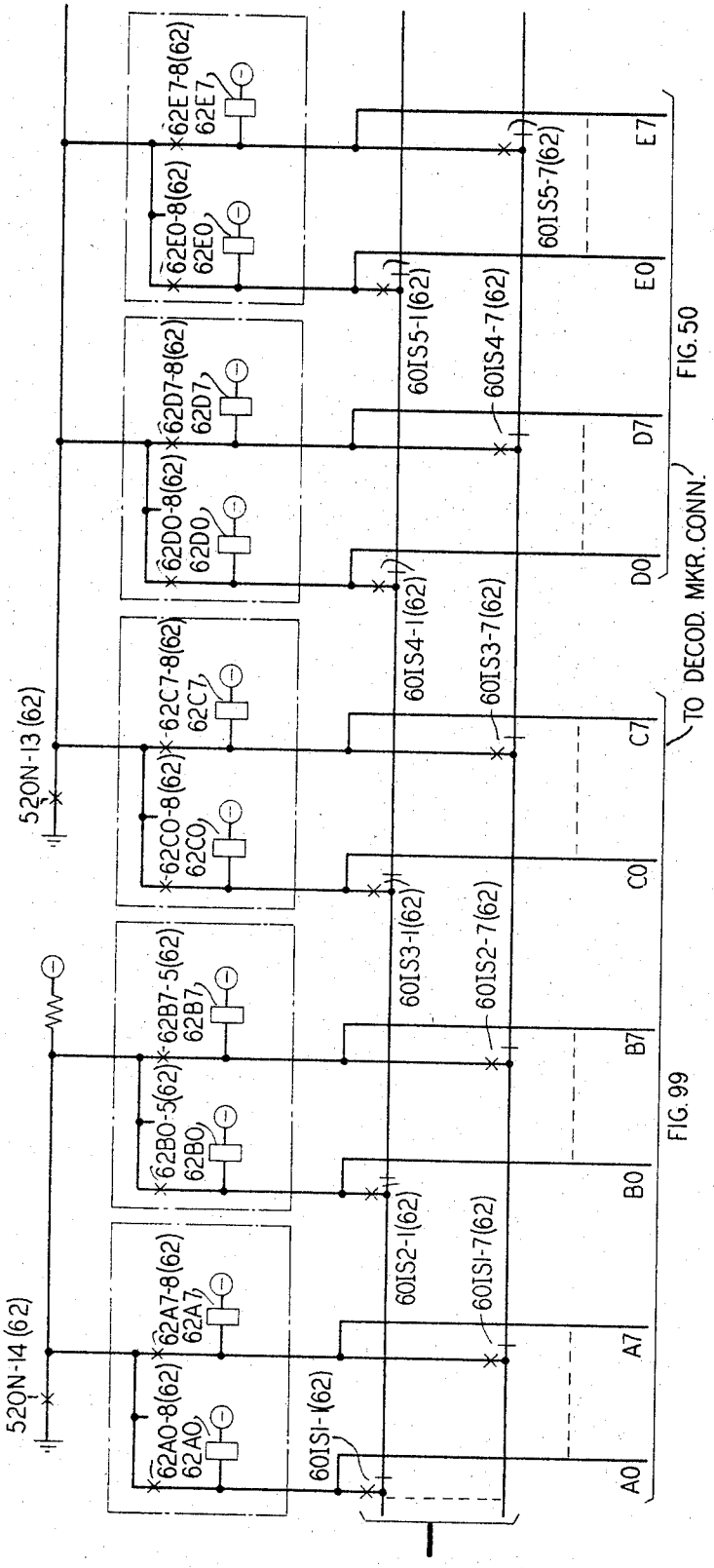

62E7-8(62)
62E7
62E0-8(62)
62E0
62D7-8(62)
62D7
62D0-8(62)
62D0
62C7-8(62)
62C7
62C0-8(62)
62C0
62B7-5(62)
62B7
62B0-5(62)
62B0
62A7-8(62)
62A7
62A0-8(62)
62A0
60IS1-1(62)
60IS2-1(62)
60IS3-1(62)
60IS4-1(62)
60IS5-1(62)
60IS1-7(62)
60IS2-7(62)
60IS3-7(62)
60IS4-7(62)
60IS5-7(62)
520N-13(62)
520N-14(62)
E7
E0
D7
D0
C7
C0
B7
B0
A7
A0
TO DECOD. MKR. CONN.
FIG. 50
FIG. 99

FIG. 62

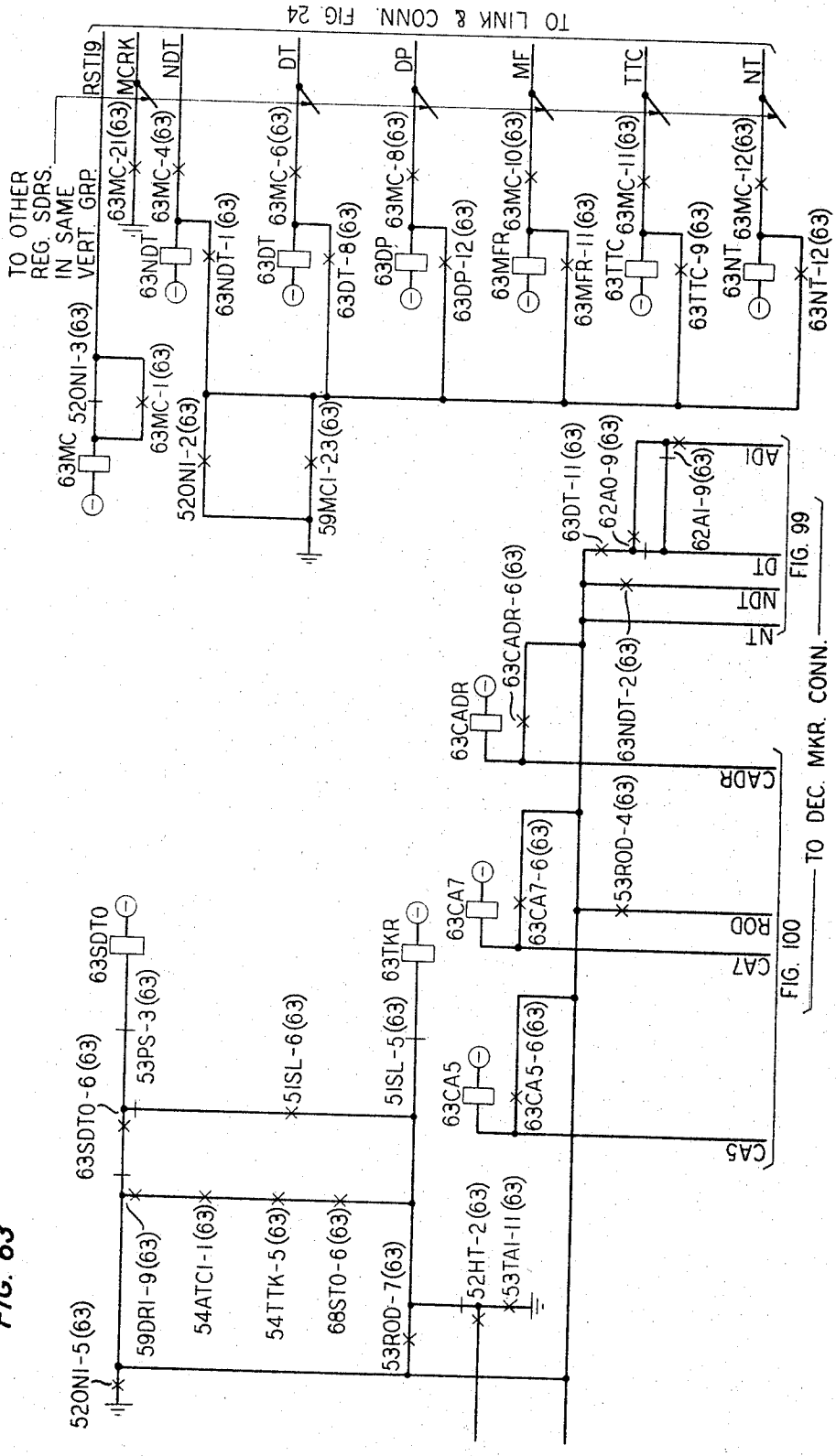
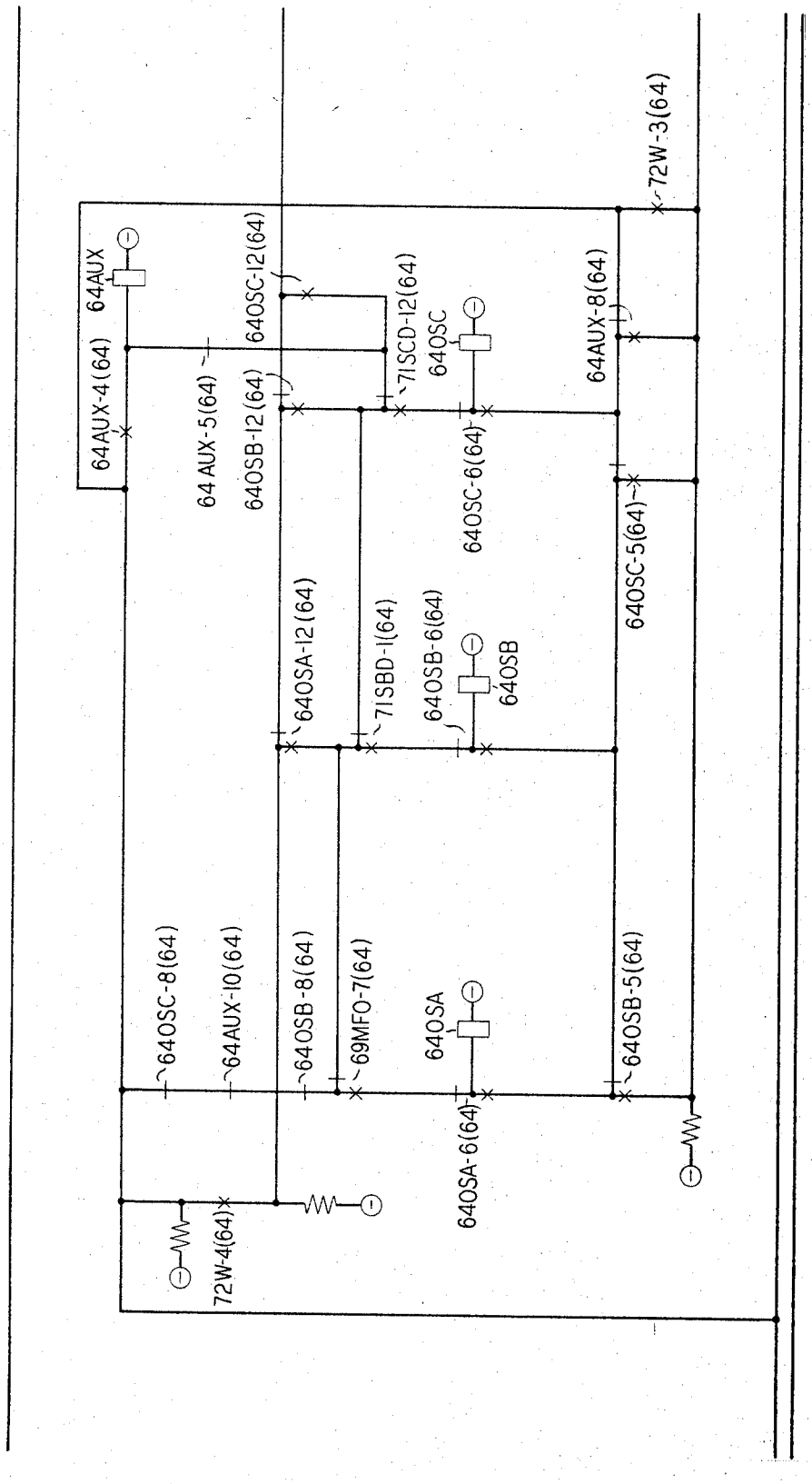

TO LINK & CONN. FIG 24
RSTI9
MCRK
NDT
DT
DP
MF
TTC
NT
TO OTHER REG. SDRS. IN SAME VERT. GRP.
63MC-21(63)
63MC-4(63)
63MC-6(63)
63MC-8(63)
63MC-10(63)
63MC-11(63)
63MC-12(63)
63NDT
63NDT-1(63)
63DT
63DT-8(63)
63DP
63DP-12(63)
63MFR
63MFR-11(63)
63TTC
63TTC-9(63)
63NT
63NT-12(63)
63MC
52ONI-3(63)
63MC-1(63)
52ONI-2(63)
59MCI-23(63)
63DT-11(63)
62AO-9(63)
62AI-9(63)
ADI
DT
NDT
NT
FIG. 99
63CADR-6(63)
63CADR
63NDT-2(63)
CADR
53ROD-4(63)
63CA7-6(63)
63CA7
ROD
CA7
FIG. 100
TO DEC. MKR. CONN.
63CA5-6(63)
63CA5
63SDTO
63TKR
53PS-3(63)
63SDTO-6(63)
51SL-6(63)
51SL-5(63)
59DRI-9(63)
54ATCI-1(63)
54TTK-5(63)
68STO-6(63)
53ROD-7(63)
52HT-2(63)
53TAI-11(63)
52ONI-5(63)

FIG. 63

FIG. 64


64AUX
64AUX-4(64)
64 AUX-5(64)
64OSB-12(64)
64OSC-12(64)
71SCD-12(64)
64OSC
64OSC-6(64)
64AUX-8(64)
72W-3(64)
64OSC-5(64)
64OSA-12(64)
71SBD-1(64)
64OSB-6(64)
64OSB
64OSC-8(64)
64AUX-10(64)
64OSB-8(64)
69MFO-7(64)
64OSA
64OSA-6(64)
64OSB-5(64)
72W-4(64)

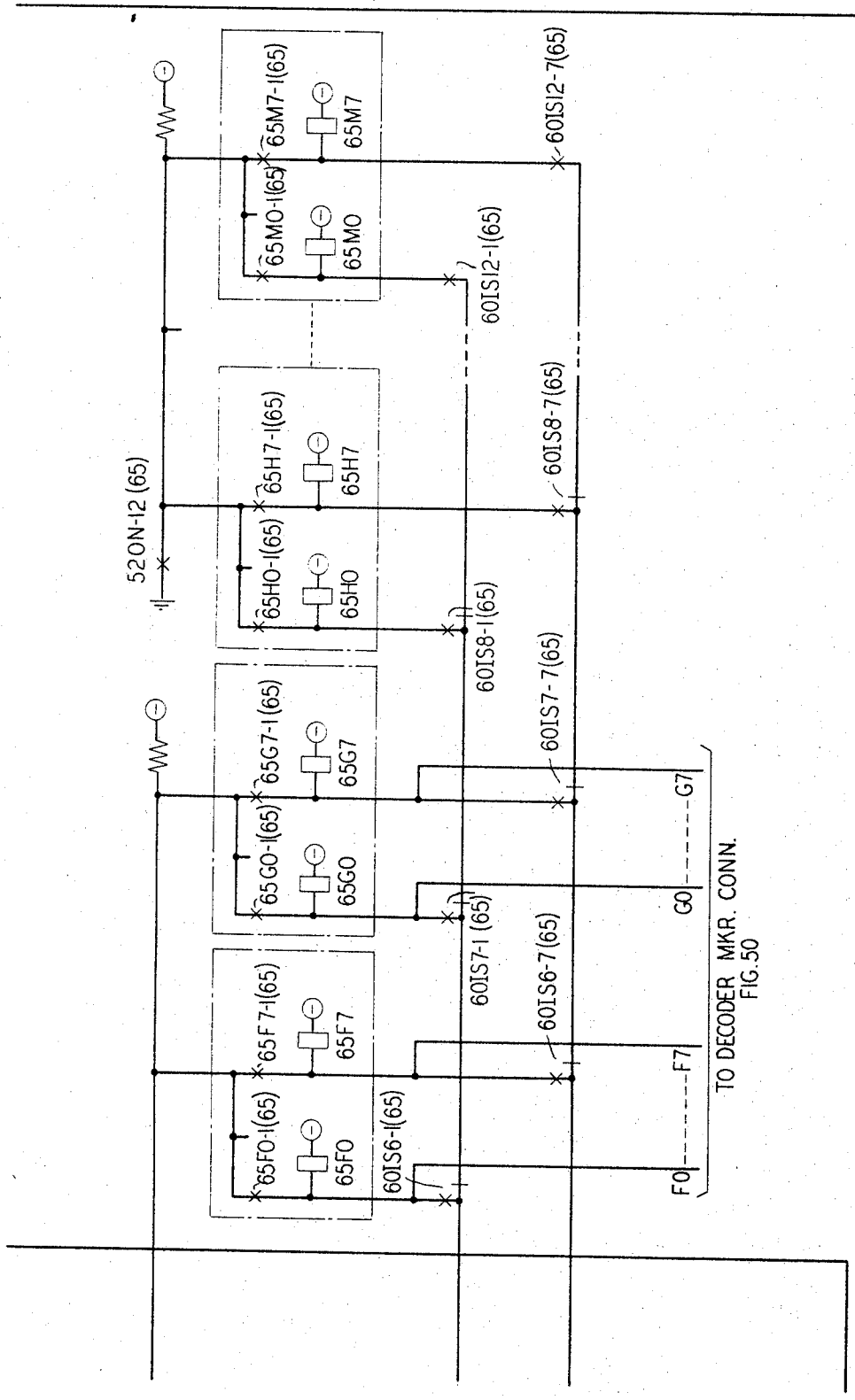

52ON-12 (65)
65M7-1(65)
65M7
65MO-1(65)
65MO
65H7-1(65)
65H7
65HO-1(65)
65HO
65G7-1(65)
65G7
65GO-1(65)
65GO
65F7-1(65)
65F7
65FO-1(65)
65FO
60IS12-7(65)
60IS12-1(65)
60IS8-7(65)
60IS8-1(65)
60IS7-7(65)
60IS7-1(65)
60IS6-7(65)
60IS6-1(65)
G7
GO
F7
FO
TO DECODER MKR. CONN.
FIG.50

FIG.65

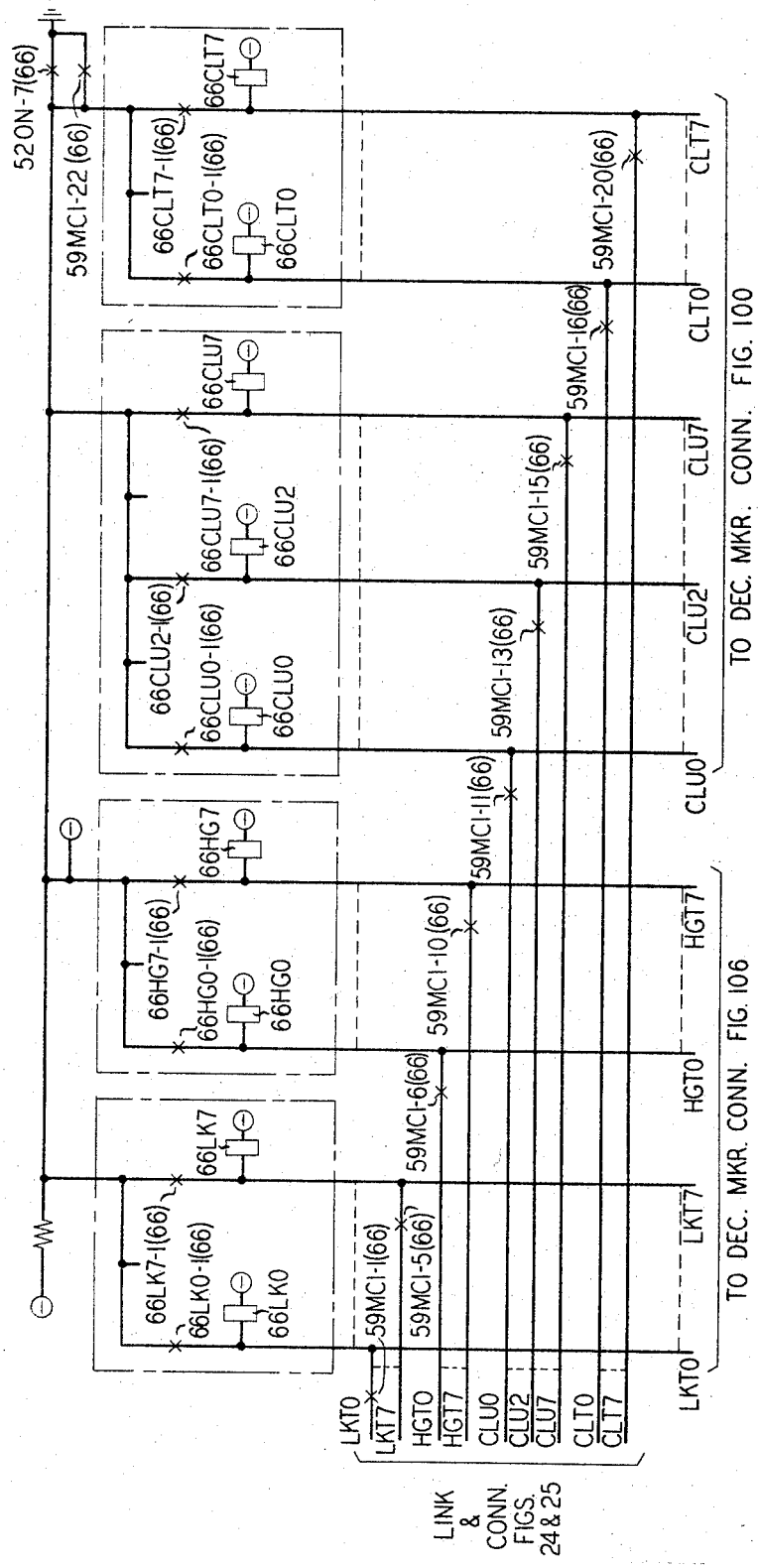
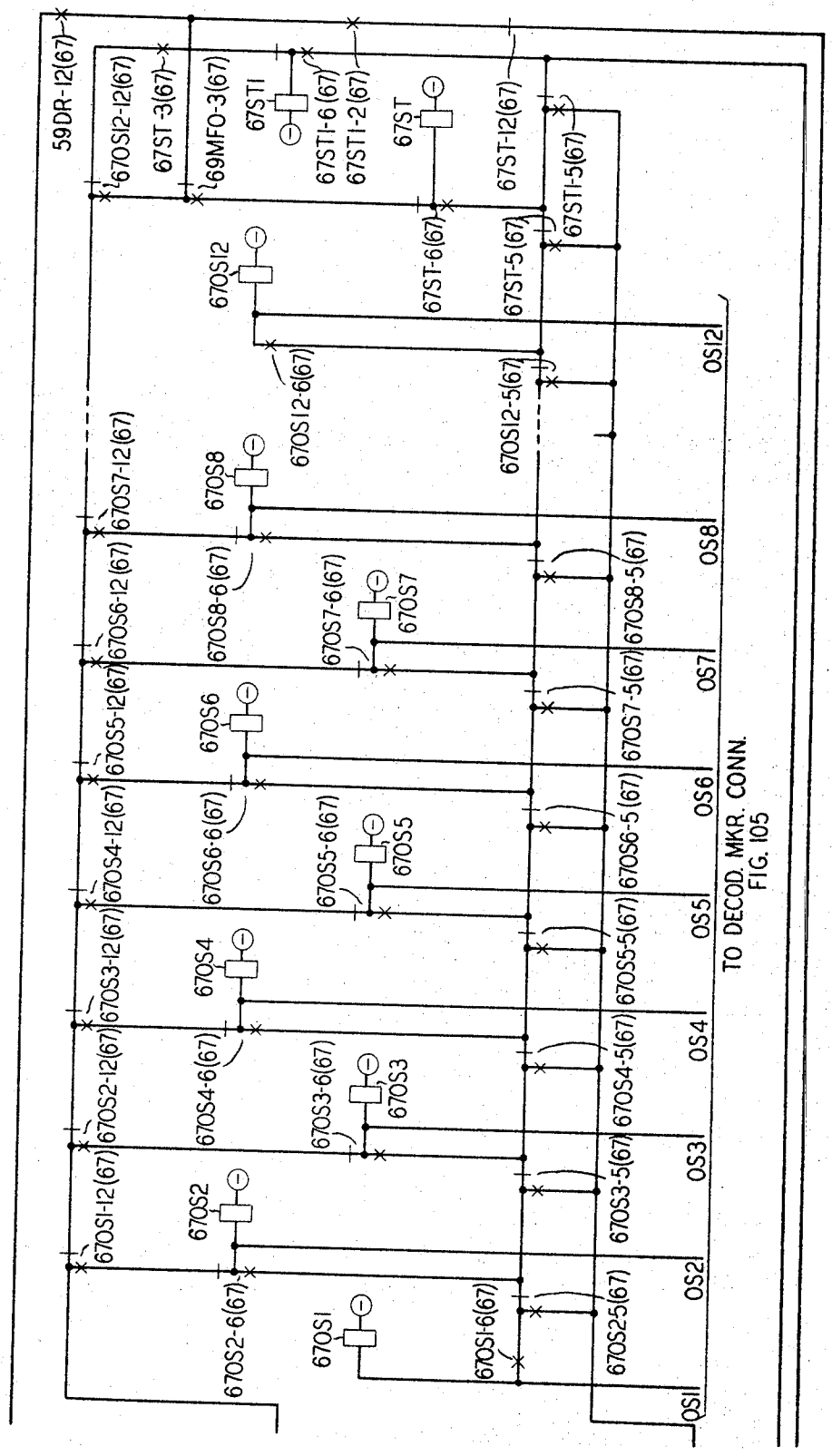

52ON-7(66)
59MC1-22(66)
66CLT7
66CLT7-1(66)
66CLT0-1(66)
66CLT0
59MC1-20(66)
CLT7
CLT0
66CLU7
66CLU7-1(66)
66CLU2
66CLU2-1(66)
66CLU0-1(66)
66CLU0
59MC1-16(66)
59MC1-15(66)
59MC1-13(66)
CLU7
CLU2
CLU0
TO DEC. MKR. CONN. FIG. 100
66HG7
66HG7-1(66)
66HG0-1(66)
66HG0
59MC1-11(66)
59MC1-10(66)
HGT7
HGT0
66LK7
66LK7-1(66)
66LK0-1(66)
66LK0
59MC1-6(66)
59MC1-5(66)
59MC1-1(66)
LKT7
LKT0
TO DEC. MKR. CONN. FIG. 106
LKT0
LKT7
HGT0
HGT7
CLU0
CLU2
CLU7
CLT0
CLT7
LINK & CONN. FIGS. 24 & 25

FIG. 66

FIG. 67


59DR-12(67)
67OSI2-12(67)
67ST-3(67)
69MFO-3(67)
67STI
67STI-6(67)
67STI-2(67)
67ST
67ST-12(67)
67STI-5(67)
67OSI2
67ST-6(67)
67ST-5(67)
67OSI2-6(67)
67OSI2-5(67)
OSI2
67OS8
67OS7-12(67)
67OS8-6(67)
67OS7-6(67)
67OS7
67OS8-5(67)
OS8
67OS6-12(67)
67OS6
67OS6-6(67)
67OS5-6(67)
67OS5
67OS7-5(67)
OS7
67OS5-12(67)
67OS4-12(67)
67OS4
67OS4-6(67)
67OS3-6(67)
67OS3
67OS6-5(67)
OS6
67OS3-12(67)
67OS2-12(67)
67OS2
67OS2-6(67)
67OS1
67OS1-6(67)
67OS25(67)
67OS5-5(67)
OS5
67OS1-12(67)
67OS4-5(67)
OS4
67OS3-5(67)
OS3
OS2
OS1
TO DECOD. MKR. CONN. FIG. 105

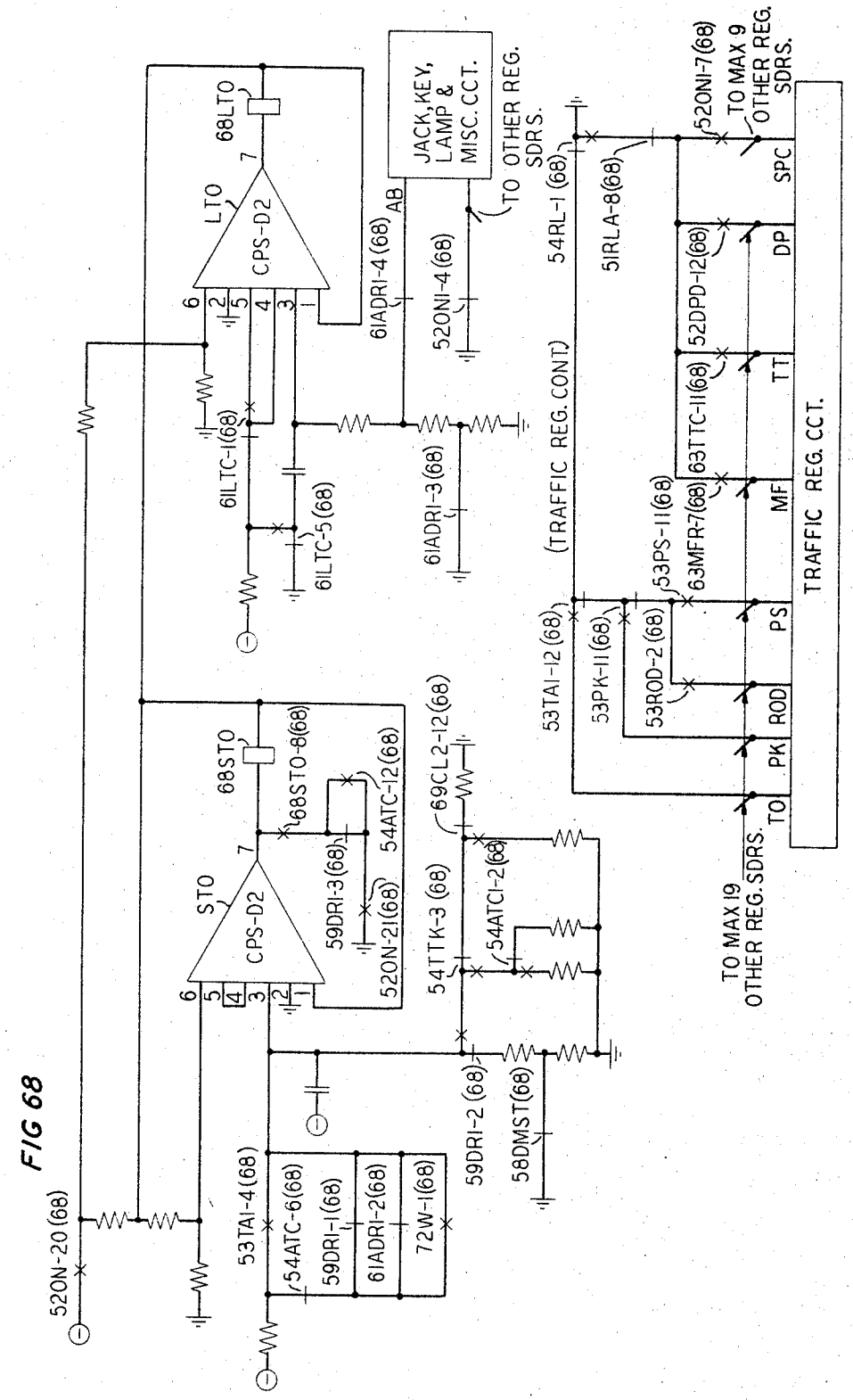

68LTO
LTO
CPS-D2
JACK, KEY, LAMP & MISC. CCT.
TO OTHER REG. SDRS.
61ADRI-4(68)
AB
52ONI-4(68)
61LTC-1(68)
61LTC-5(68)
61ADRI-3(68)
54RL-1(68)
(TRAFFIC REG. CONT.)
51RLA-8(68)
52ONI-7(68)
TO MAX 9 OTHER REG. SDRS.
SPC
DP
TT
MF
PS
ROD
PK
TO
TRAFFIC REG. CCT.
52DPD-12(68)
63TTC-11(68)
53PS-11(68)
63MFR-7(68)
53TAI-12(68)
53PK-11(68)
53ROD-2(68)
68STO
STO
CPS-D2
68STO-8(68)
54ATC-12(68)
69CL2-12(68)
59DRI-3(68)
52ON-21(68)
54TTK-3(68)
54ATCI-2(68)
TO MAX 19 OTHER REG. SDRS.
59DRI-2(68)
58DMST(68)
53TAI-4(68)
54ATC-6(68)
59DRI-1(68)
61ADRI-2(68)
72W-1(68)
52ON-20(68)

FIG 68

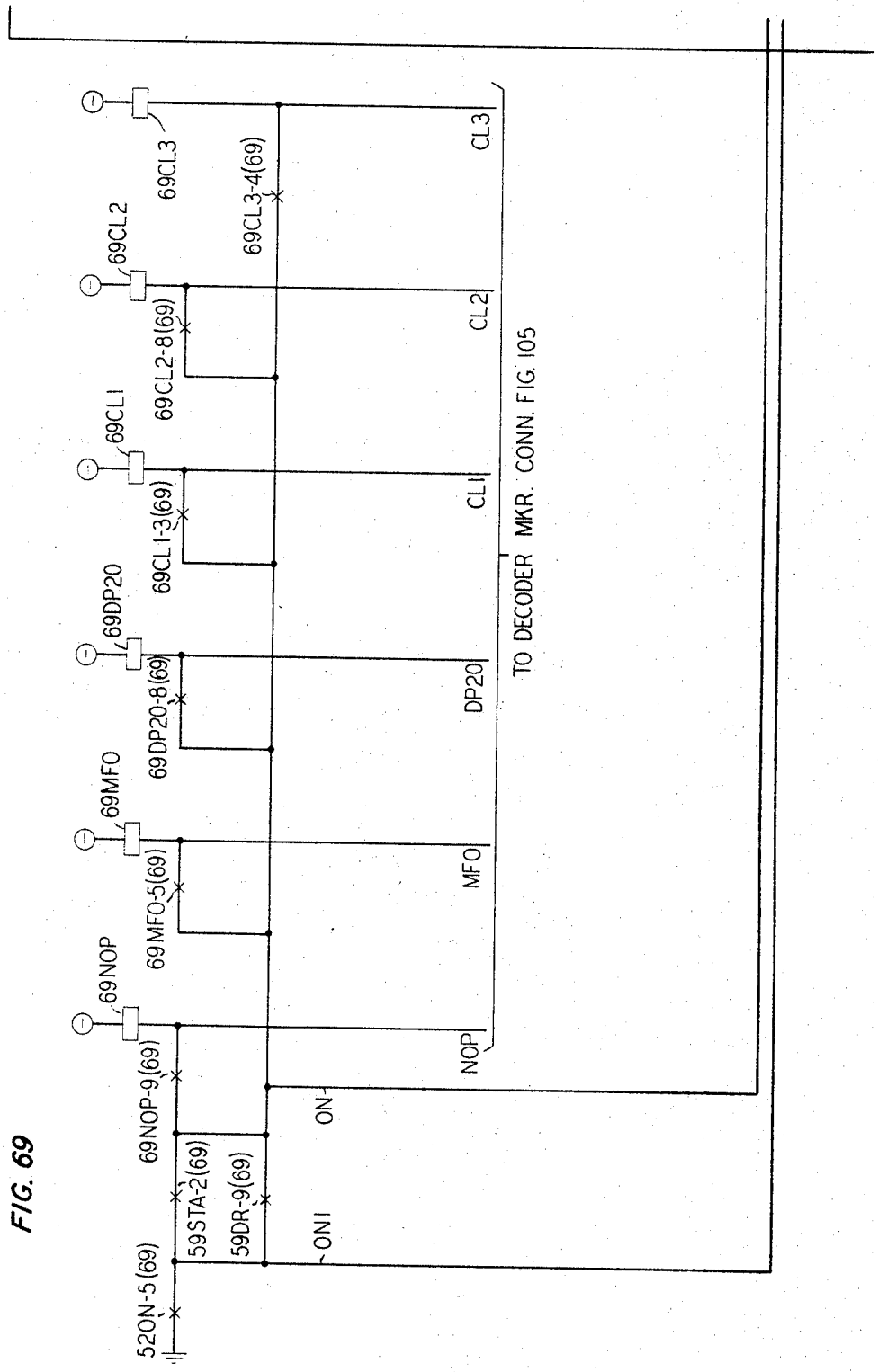

69CL3
69CL3-4(69)
CL3
69CL2
69CL2-8(69)
CL2
69CL1
69CL1-3(69)
CL1
69DP20
69DP20-8(69)
DP20
69MFO
69MFO-5(69)
MFO
69NOP
69NOP-9(69)
NOP
ON
59STA-2(69)
59DR-9(69)
ONI
52ON-5(69)
TO DECODER MKR. CONN. FIG. 105

FIG. 69

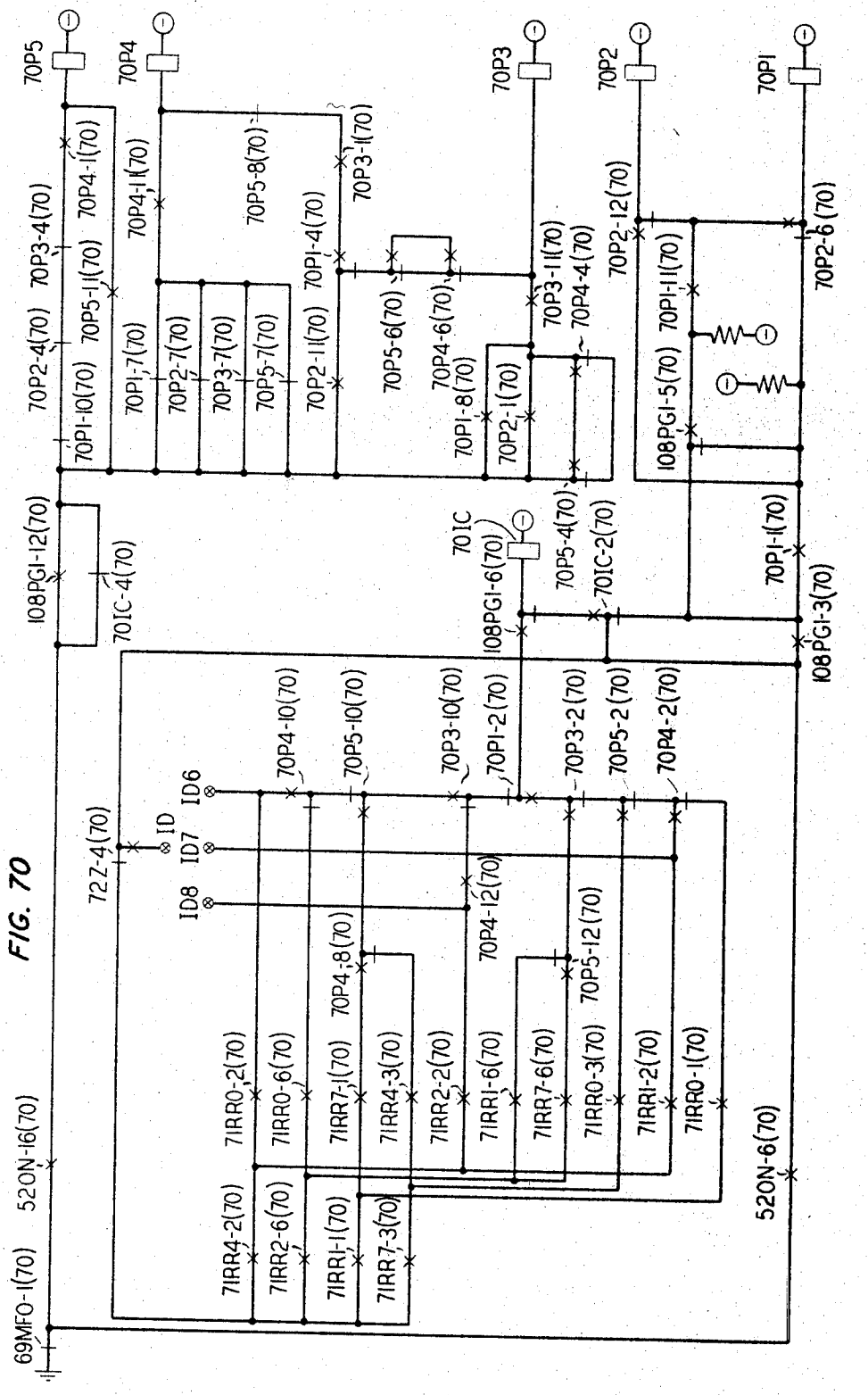

70P5
70P4
70P3
70P2
70P1
70P2-4(70)
70P3-4(70)
70P4-1(70)
70P1-10(70)
70P5-11(70)
70P1-7(70)
70P4-11(70)
70P2-7(70)
70P3-7(70)
70P5-7(70)
70P5-8(70)
70P2-11(70)
70P1-4(70)
70P3-11(70)
70P5-6(70)
70P4-6(70)
70P1-8(70)
70P2-1(70)
70P4-4(70)
70P2-12(70)
70P1-11(70)
108PGI-5(70)
70P2-6(70)
108PGI-12(70)
70IC-4(70)
70IC
108PGI-6(70)
70P5-4(70)
70IC-2(70)
70P1-11(70)
108PGI-3(70)
72Z-4(70)
ID
ID6
ID7
ID8
70P4-10(70)
70P5-10(70)
70P3-10(70)
70P1-2(70)
70P3-2(70)
70P5-2(70)
70P4-2(70)
70P4-12(70)
70P5-12(70)
71IRR0-2(70)
71IRR0-6(70)
71IRR7-1(70)
70P4-8(70)
71IRR4-3(70)
71IRR2-2(70)
71IRR1-6(70)
71IRR7-6(70)
71IRR0-3(70)
71IRR1-2(70)
71IRR0-1(70)
71IRR4-2(70)
71IRR2-6(70)
71IRR1-1(70)
71IRR7-3(70)
520N-6(70)
520N-16(70)
69MFO-1(70)

FIG. 70

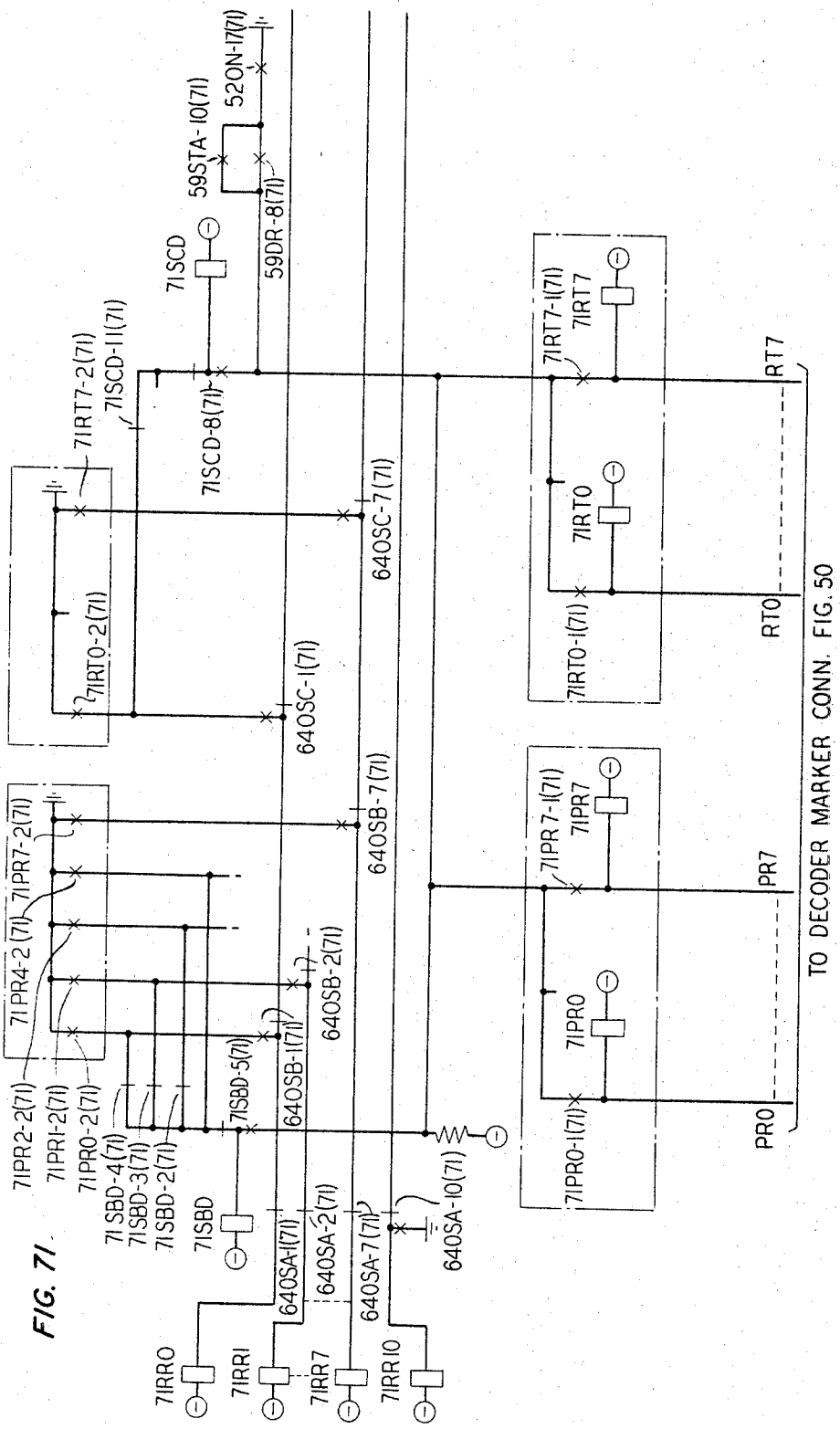

71PR4-2(71)
71PR7-2(71)
71PR2-2(71)
71PR1-2(71)
71PR0-2(71)
71SBD-4(71)
71SBD-3(71)
71SBD-2(71)
71SBD
71SBD-5(71)
640SA-1(71)
640SA-2(71)
640SA-7(71)
640SA-10(71)
640SB-1(71)
640SB-2(71)
640SB-7(71)
640SC-1(71)
640SC-7(71)
71IRT7-2(71)
71IRT0-2(71)
71SCD-11(71)
71SCD-8(71)
71SCD
59STA-10(71)
52ON-17(71)
59DR-8(71)
71IRR0
71IRR1
71IRR7
71IRR10
71IRT7-1(71)
71IRT7
71IRT0
71IRT0-1(71)
71IPR7-1(71)
71IPR7
71IPR0
71IPR0-1(71)
RT7
RT0
PR7
PR0
TO DECODER MARKER CONN. FIG. 50

FIG. 71.

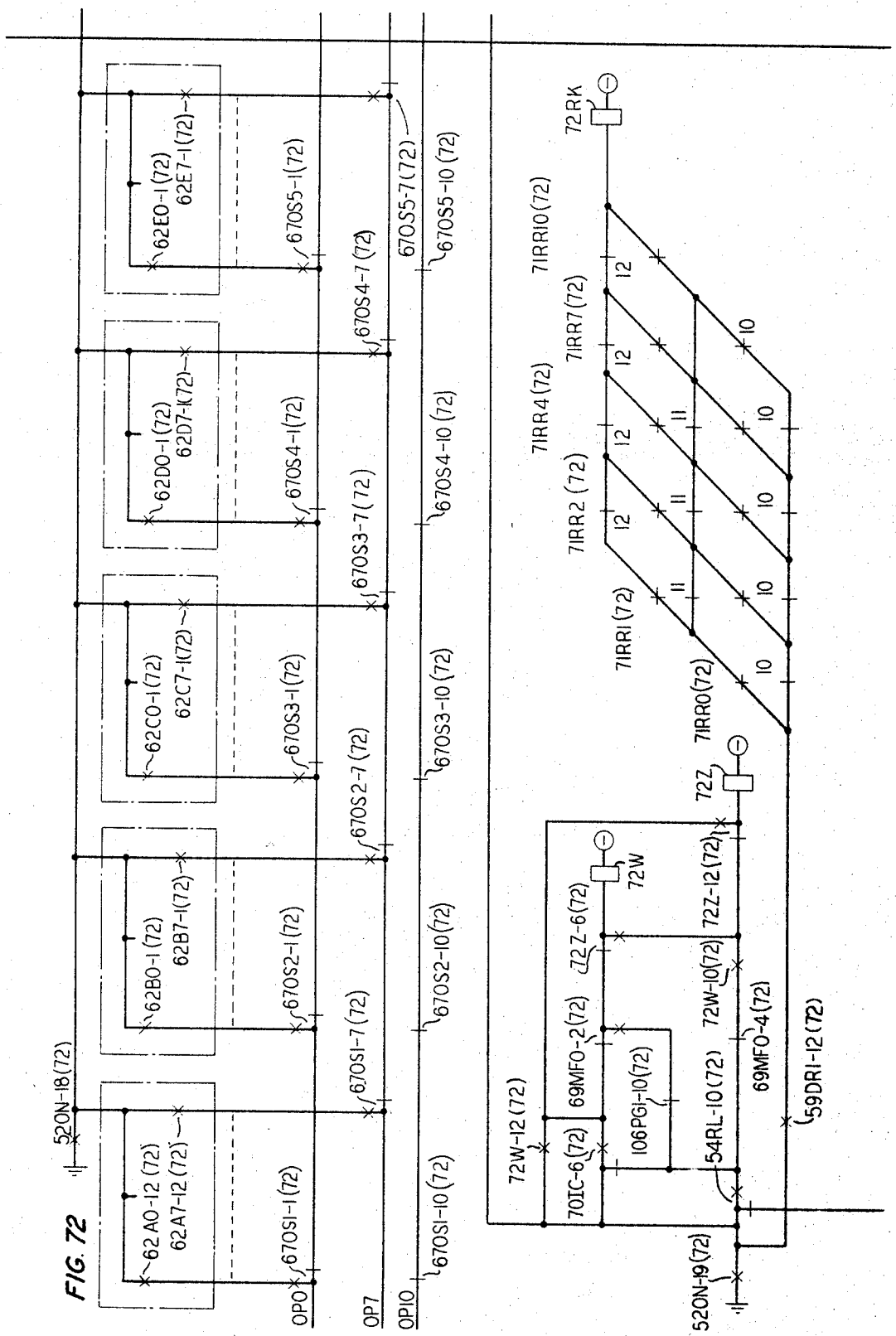

520N-18(72)
62AO-12(72)
62A7-12(72)
62BO-1(72)
62B7-1(72)
62CO-1(72)
62C7-1(72)
62DO-1(72)
62D7-1(72)
62EO-1(72)
62E7-1(72)
670SI-1(72)
670S2-1(72)
670S3-1(72)
670S4-1(72)
670S5-1(72)
670SI-7(72)
670S2-7(72)
670S3-7(72)
670S4-7(72)
670S5-7(72)
670SI-10(72)
670S2-10(72)
670S3-10(72)
670S4-10(72)
670S5-10(72)
OP0
OP7
OP10
72RK
71IRR10(72)
71IRR7(72)
71IRR4(72)
71IRR2(72)
71IRR1(72)
71IRR0(72)
72Z
72W
72Z-6(72)
72Z-12(72)
72W-12(72)
72W-10(72)
69MFO-2(72)
69MFO-4(72)
70IC-6(72)
106PGI-10(72)
54RL-10(72)
59DRI-12(72)
520N-19(72)

FIG. 72

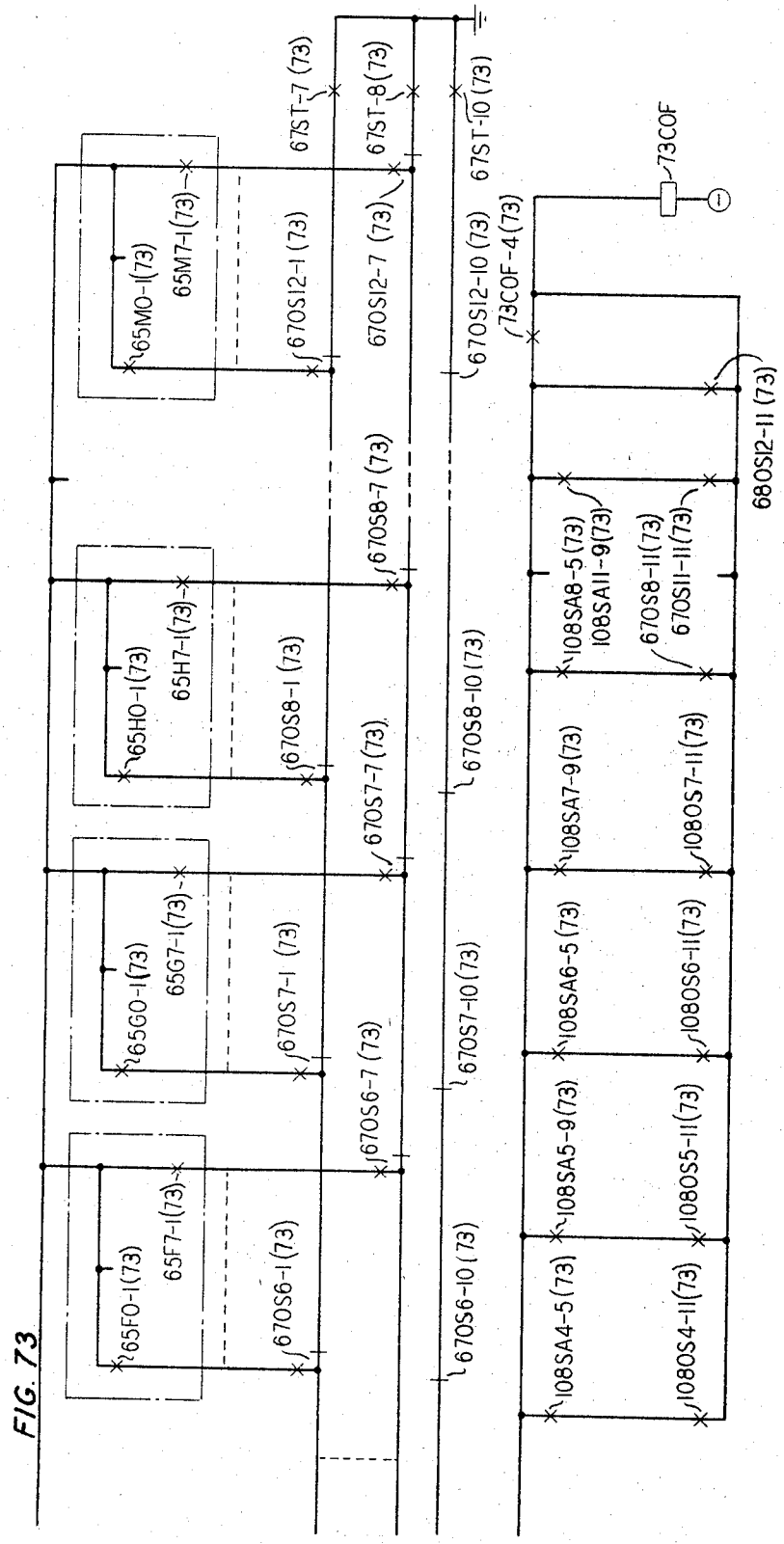
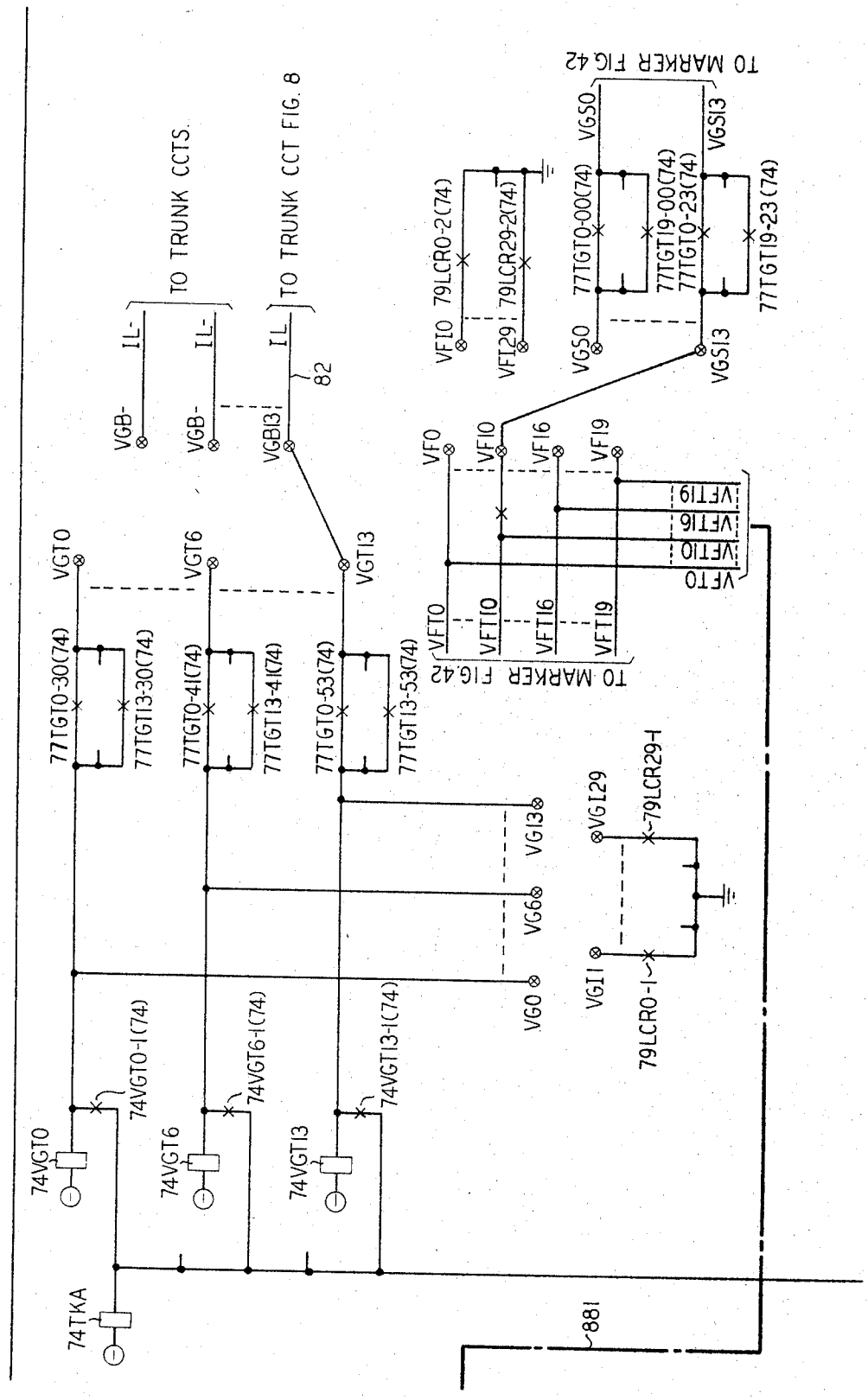

65FO-1(73)
65F7-1(73)
65GO-1(73)
65G7-1(73)
65HO-1(73)
65H7-1(73)
65MO-1(73)
65M7-1(73)
670S6-1(73)
670S7-1 (73)
670S8-1 (73)
670S12-1 (73)
670S6-7 (73)
670S7-7(73)
670S8-7 (73)
670S12-7 (73)
67ST-7 (73)
67ST-8(73)
670S6-10 (73)
670S7-10(73)
670S8-10(73)
670S12-10 (73)
67ST-10 (73)
73COF-4(73)
73COF
108SA4-5(73)
108SA5-9(73)
108SA6-5 (73)
108SA7-9(73)
108SA8-5 (73)
108SA11-9(73)
1080S4-11(73)
1080S5-11(73)
1080S6-11(73)
1080S7-11(73)
670S8-11(73)
670S11-11(73)
680S12-11 (73)

FIG. 73

FIG. 74


TO MARKER FIG 42
VGS0
VGSI3
77TGTI9-23(74)
77TGTO-23(74)
77TGTI9-00(74)
77TGTO-00(74)
VGS0
VGSI3
VFI0 79LCRO-2(74)
VFI29 79LCR29-2(74)
TO TRUNK CCTS.
VGB- IL-
VGB- IL-
TO TRUNK CCT FIG. 8
VGBI3 IL
82
VF0
VFI0
VFI6
VFI9
VFTI9
VFTI6
VFTI0
VFT0
TO MARKER FIG 42
VFT0
VFTI0
VFTI6
VFTI9
VGT0
VGT6
VGT13
77TGTO-30(74)
77TGTI3-30(74)
77TGTO-4I(74)
77TGTI3-4I(74)
77TGTO-53(74)
77TGTI3-53(74)
VGI3
VG6
VG0
VGI29
79LCR29-I
VGI1
79LCRO-I
74VGTO
74VGTO-I(74)
74VGT6
74VGT6-I(74)
74VGTI3
74VGTI3-I(74)
74TKA
881

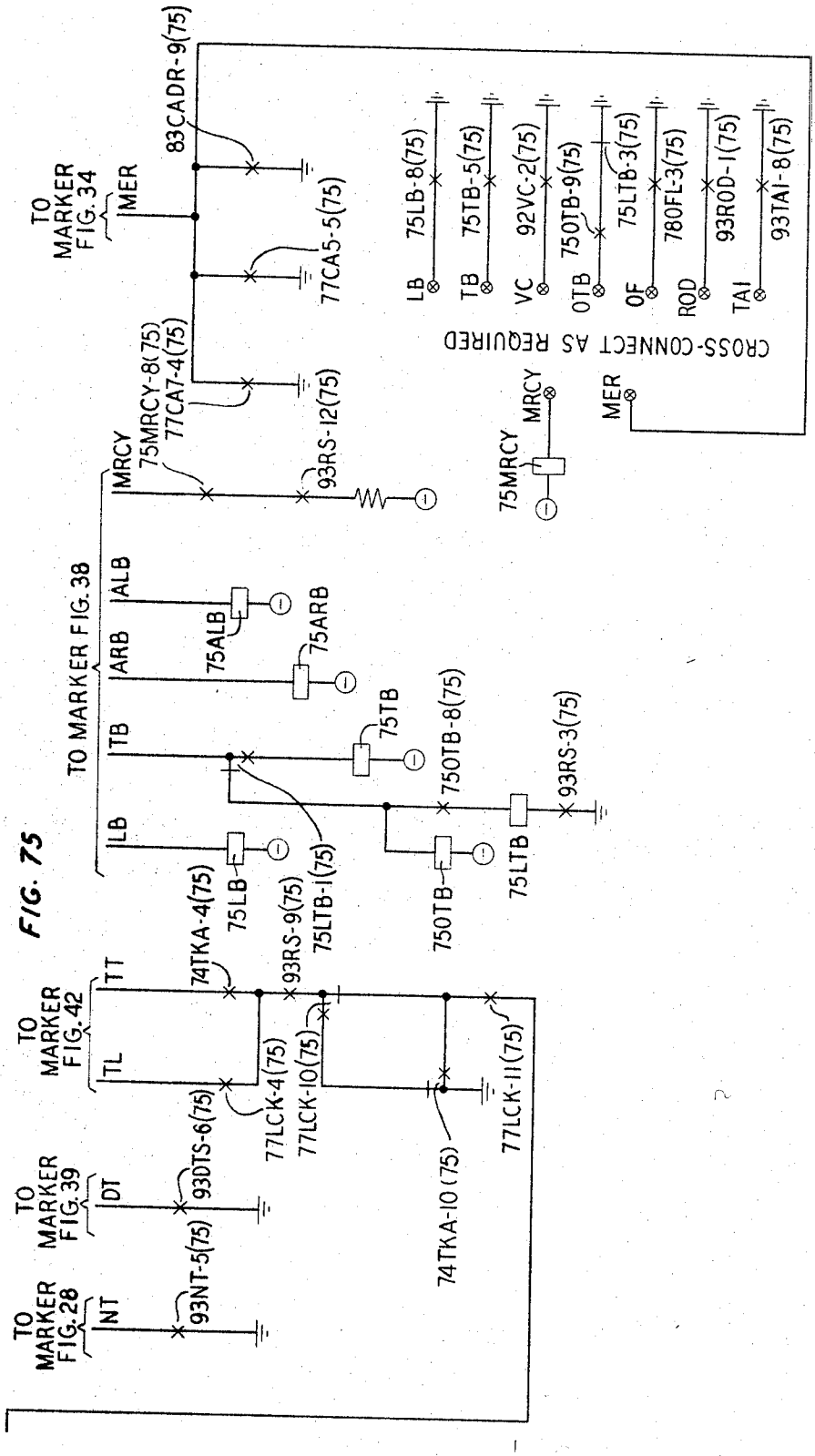

TO MARKER FIG. 28
NT
93NT-5(75)
TO MARKER FIG. 39
DT
93DTS-6(75)
TO MARKER FIG. 42
TL
TT
77LCK-4(75)
74TKA-4(75)
93RS-9(75)
77LCK-10(75)
74TKA-10(75)
77LCK-11(75)
TO MARKER FIG. 38
LB
75LB
75LTB-1(75)
TB
75TB
75OTB-8(75)
75LTB
93RS-3(75)
ARB
75ARB
ALB
75ALB
MRCY
75MRCY-8(75)
77CA7-4(75)
93RS-12(75)
MER
83CADR-9(75)
77CA5-5(75)
TO MARKER FIG. 34
MER
CROSS-CONNECT AS REQUIRED
LB 75LB-8(75)
TB 75TB-5(75)
VC 92VC-2(75)
OTB 75OTB-9(75)
OF 75LTB-3(75)
ROD 780FL-3(75)
TAI 93ROD-1(75)
93TAI-8(75)
75MRCY
MRCY

FIG. 75

FIG. 76

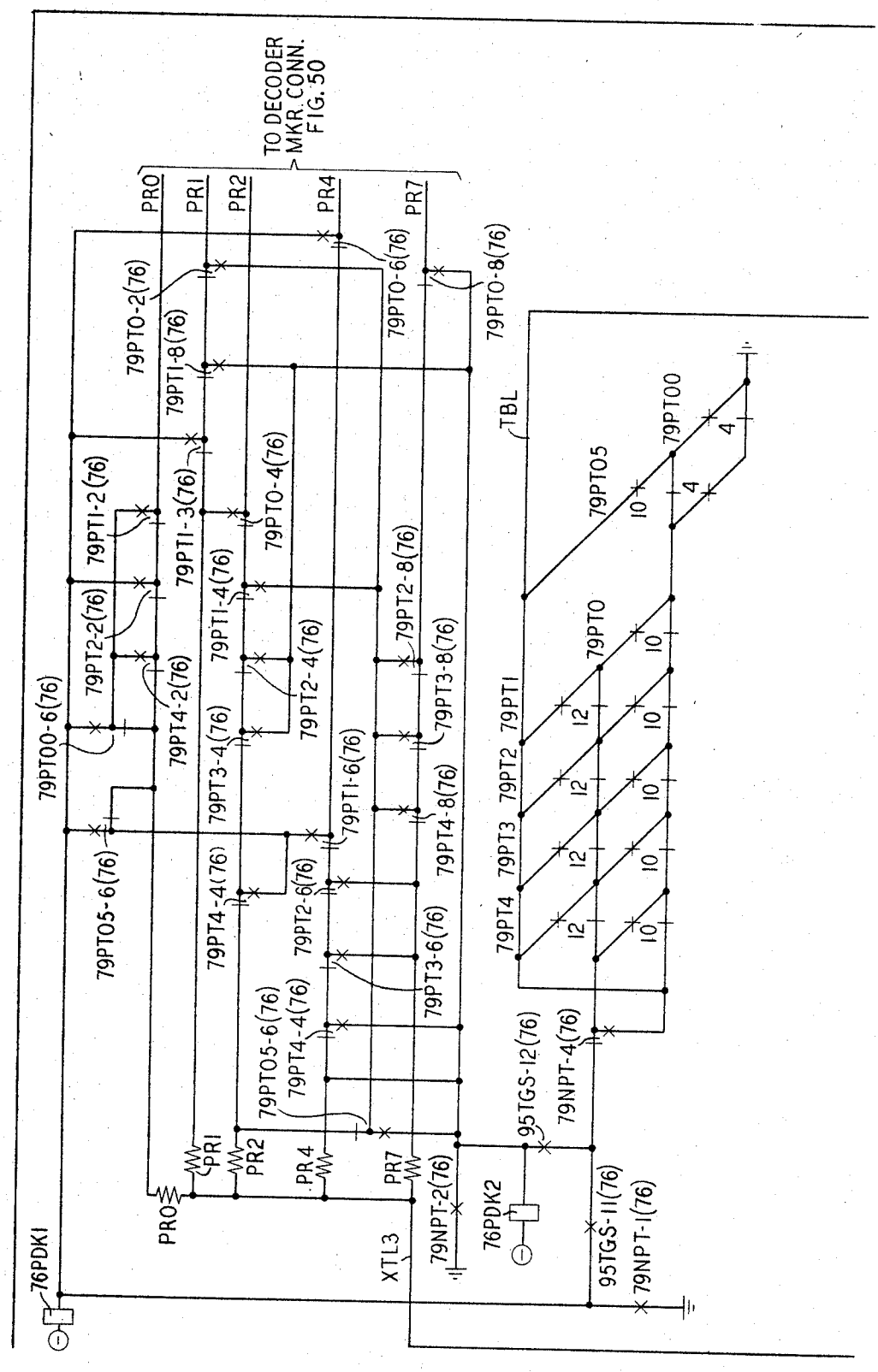
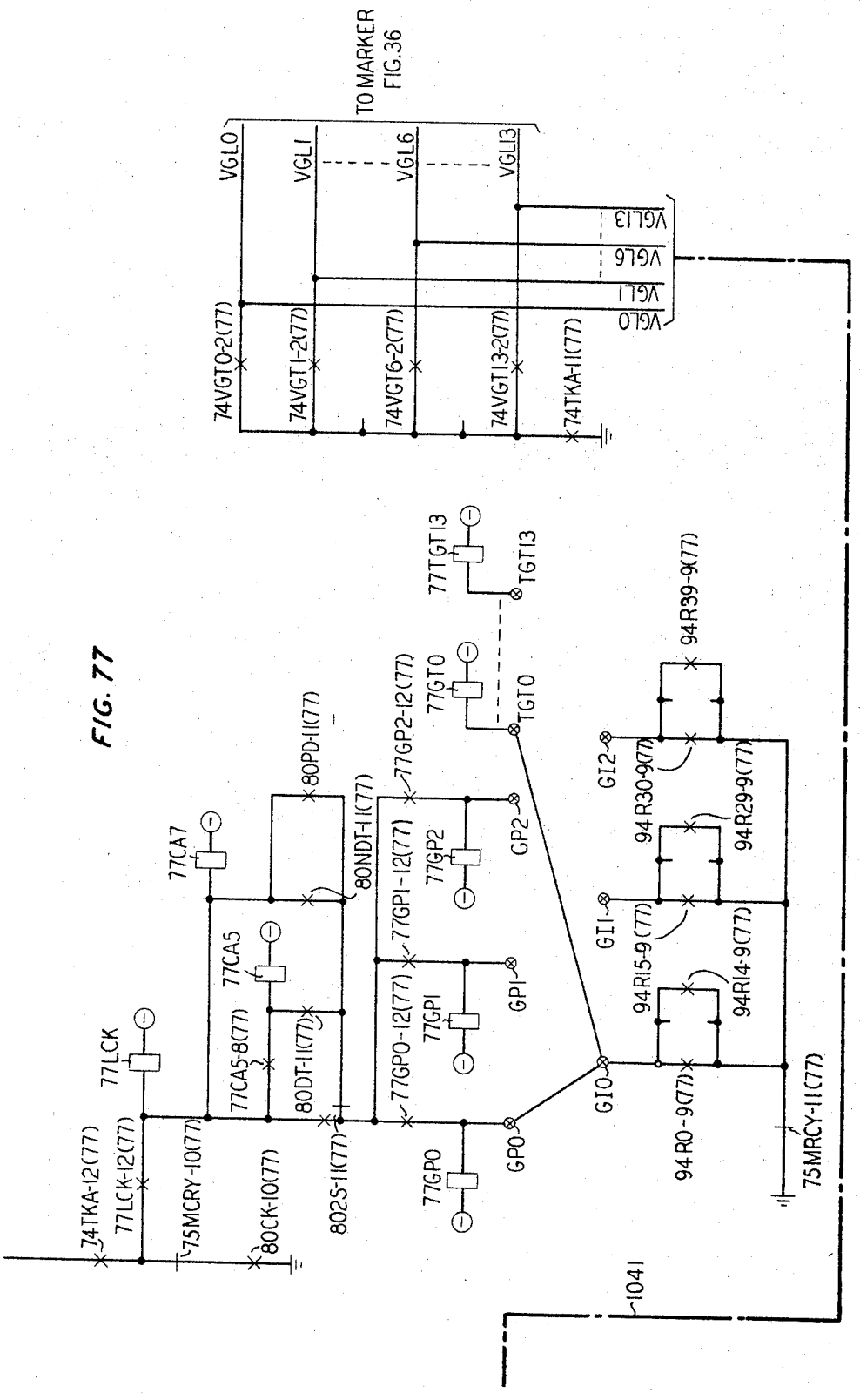

TO DECODER MKR. CONN. FIG. 50
PR0
PR1
PR2
PR4
PR7
79PTO-2(76)
79PTO-6(76)
79PTO-8(76)
79PTI-8(76)
79PTI-2(76)
79PTI-3(76)
79PTO-4(76)
79PT2-2(76)
79PTI-4(76)
79PT2-8(76)
79PT4-2(76)
79PT2-4(76)
79PT3-8(76)
79PT00-6(76)
79PT3-4(76)
79PTI-6(76)
79PT4-8(76)
79PTO5-6(76)
79PT4-4(76)
79PT2-6(76)
79PT3-6(76)
79PTO5-6(76)
79PT4-4(76)
95TGS-12(76)
79NPT-4(76)
TBL
79PTO5
79PTO0
79PTI
79PTO
79PT2
79PT3
79PT4
10
12
4
76PDK1
76PDK2
79NPT-2(76)
95TGS-11(76)
79NPT-1(76)
XTL3
PR0
PR1
PR2
PR4
PR7

FIG. 77


TO MARKER FIG.36
VGL0
VGL1
VGL6
VGL13
74VGT0-2(77)
74VGT1-2(77)
74VGT6-2(77)
74VGT13-2(77)
74TKA-11(77)
77TGT13
TGT13
77TGT0
TGT0
77GP2-12(77)
80PD-11(77)
80NDT-11(77)
77GP1-12(77)
77GP0-12(77)
80DT-11(77)
80S-11(77)
77CA7
77CA5
77CA5-8(77)
77LCK
74TKA-12(77)
77LCK-12(77)
75MCRY-10(77)
80CK-10(77)
77GP2
77GP1
77GP0
GP2
GP1
GP0
GI2
GI1
GI0
94R39-9(77)
94R30-9(77)
94R29-9(77)
94R15-9(77)
94R14-9(77)
94RO-9(77)
75MRCY-11(77)
1041

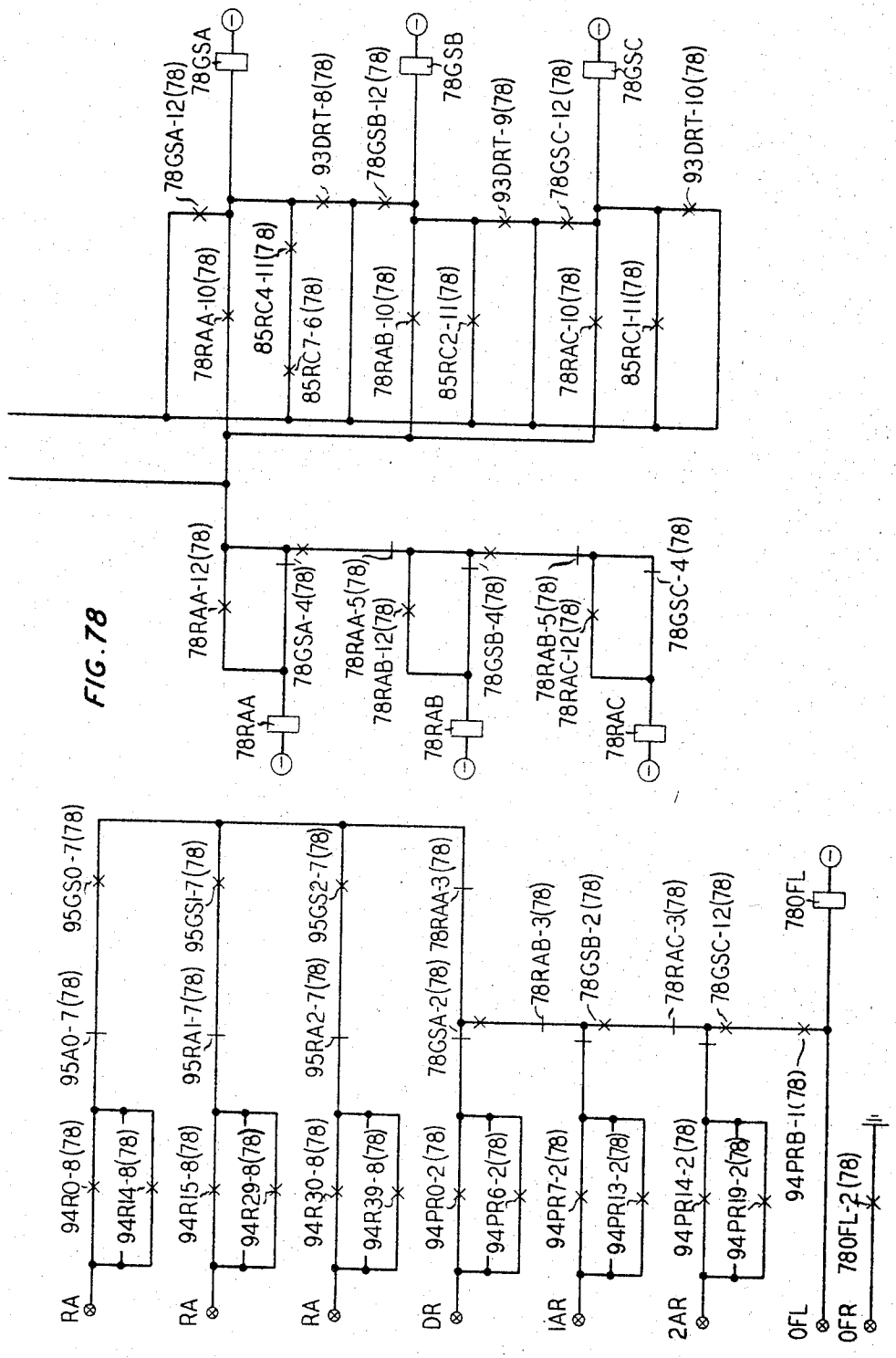

78GSA
78GSB
78GSC
78GSA-12(78)
93DRT-8(78)
78GSB-12(78)
93DRT-9(78)
78GSC-12(78)
93DRT-10(78)
78RAA-10(78)
85RC4-11(78)
85RC7-6(78)
78RAB-10(78)
85RC2-11(78)
78RAC-10(78)
85RC1-11(78)
78RAA-12(78)
78GSA-4(78)
78RAA-5(78)
78RAB-12(78)
78GSB-4(78)
78RAB-5(78)
78RAC-12(78)
78GSC-4(78)
78RAA
78RAB
78RAC
95GS0-7(78)
95A0-7(78)
95GSI-7(78)
95RAI-7(78)
95GS2-7(78)
95RA2-7(78)
78GSA-2(78)
78RAA-3(78)
78RAB-3(78)
78GSB-2(78)
78RAC-3(78)
78GSC-12(78)
780FL
94RO-8(78)
94RI4-8(78)
94RI5-8(78)
94R29-8(78)
94R30-8(78)
94R39-8(78)
94PR0-2(78)
94PR6-2(78)
94PR7-2(78)
94PRI3-2(78)
94PRI4-2(78)
94PRI9-2(78)
94PRB-1(78)
780FL-2(78)
RA
RA
RA
DR
IAR
2AR
OFL
OFR

FIG. 78

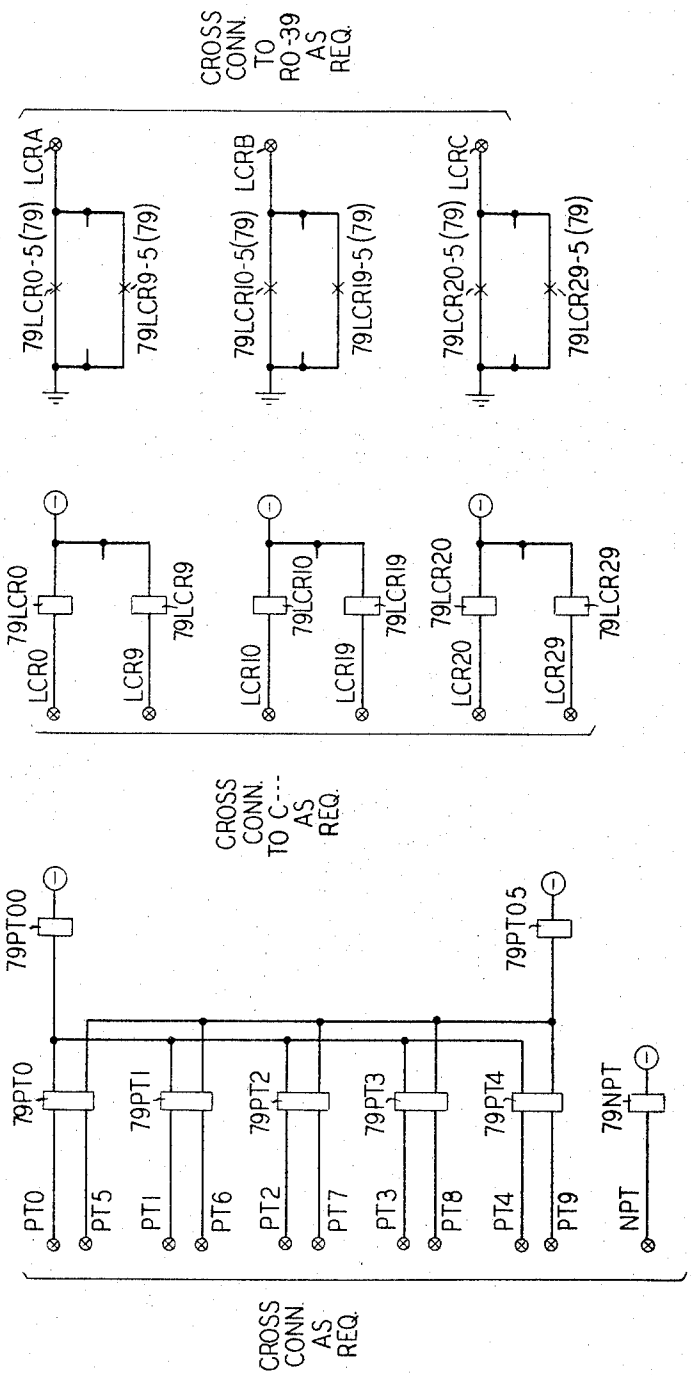

CROSS CONN. TO RO-39 AS REQ.
LCRA
LCRB
LCRC
79LCR0-5(79)
79LCR9-5(79)
79LCR10-5(79)
79LCR19-5(79)
79LCR20-5(79)
79LCR29-5(79)
79LCR0
79LCR9
79LCR10
79LCR19
79LCR20
79LCR29
LCR0
LCR9
LCR10
LCR19
LCR20
LCR29
CROSS CONN. TO C--- AS REQ.
79PT00
79PT05
79PT0
79PT1
79PT2
79PT3
79PT4
79NPT
PT0
PT5
PT1
PT6
PT2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

FIG. 79

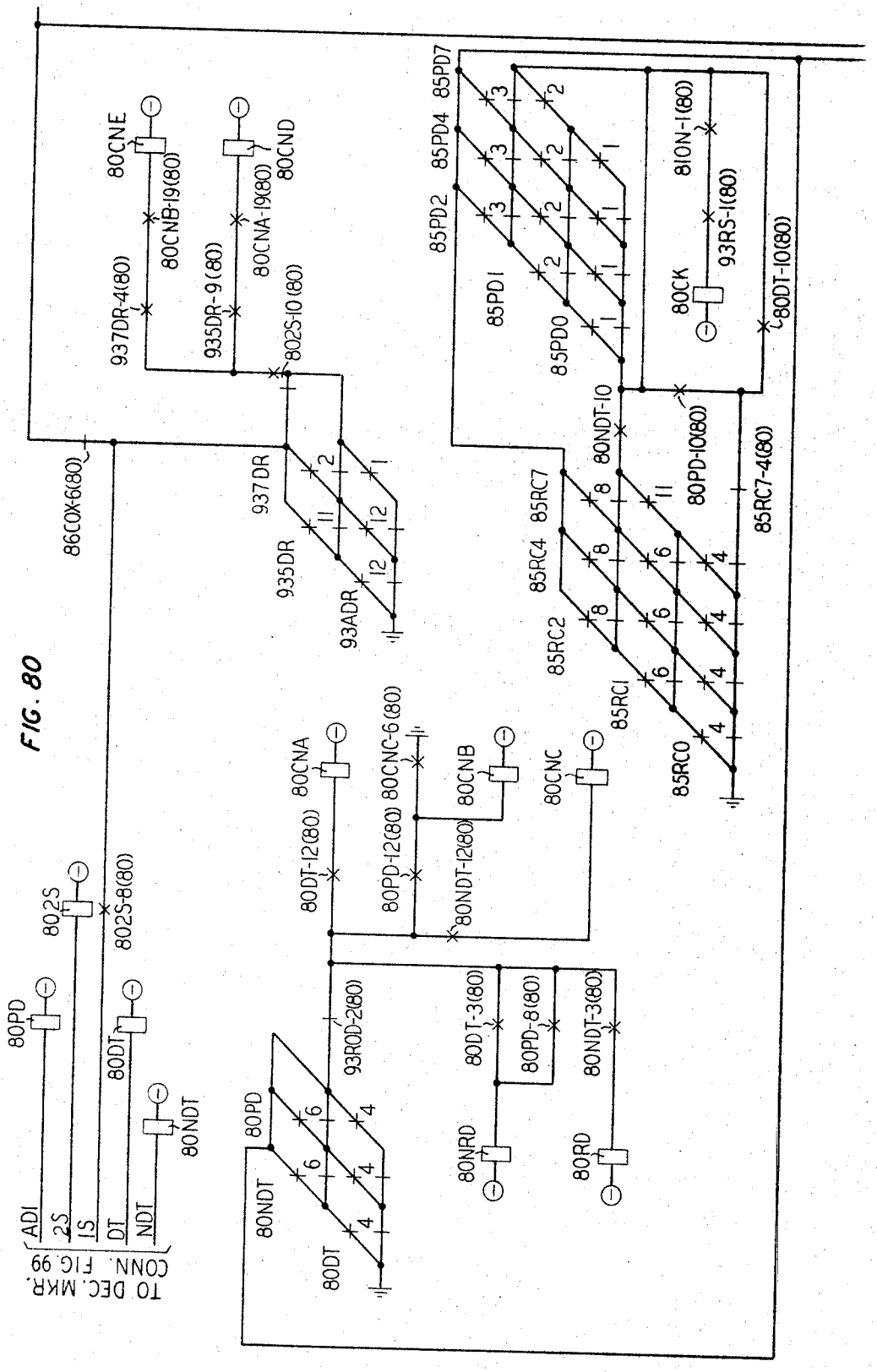

80CNE
80CNB-19(80)
937DR-4(80)
80CND
80CNA-19(80)
935DR-9(80)
802S-10(80)
86COX-6(80)
937DR
935DR
93ADR
85PD7
85PD4
85PD2
85PD1
85PD0
810N-1(80)
93RS-1(80)
80CK
80DT-10(80)
80NDT-10
80PD-10(80)
85RC7-4(80)
85RC7
85RC4
85RC2
85RC1
85RC0
80CNA
80CNC-6(80)
80CNB
80CNC
80DT-12(80)
80PD-12(80)
80NDT-12(80)
93ROD-2(80)
80PD
80NDT
80DT
80DT-3(80)
80PD-8(80)
80NDT-3(80)
80NRD
80RD
80PD
80DT
80NDT
802S
802S-8(80)
ADI
2S
IS
DT
NDT
TO DEC. MKR. CONN. FIG. 99

FIG. 80

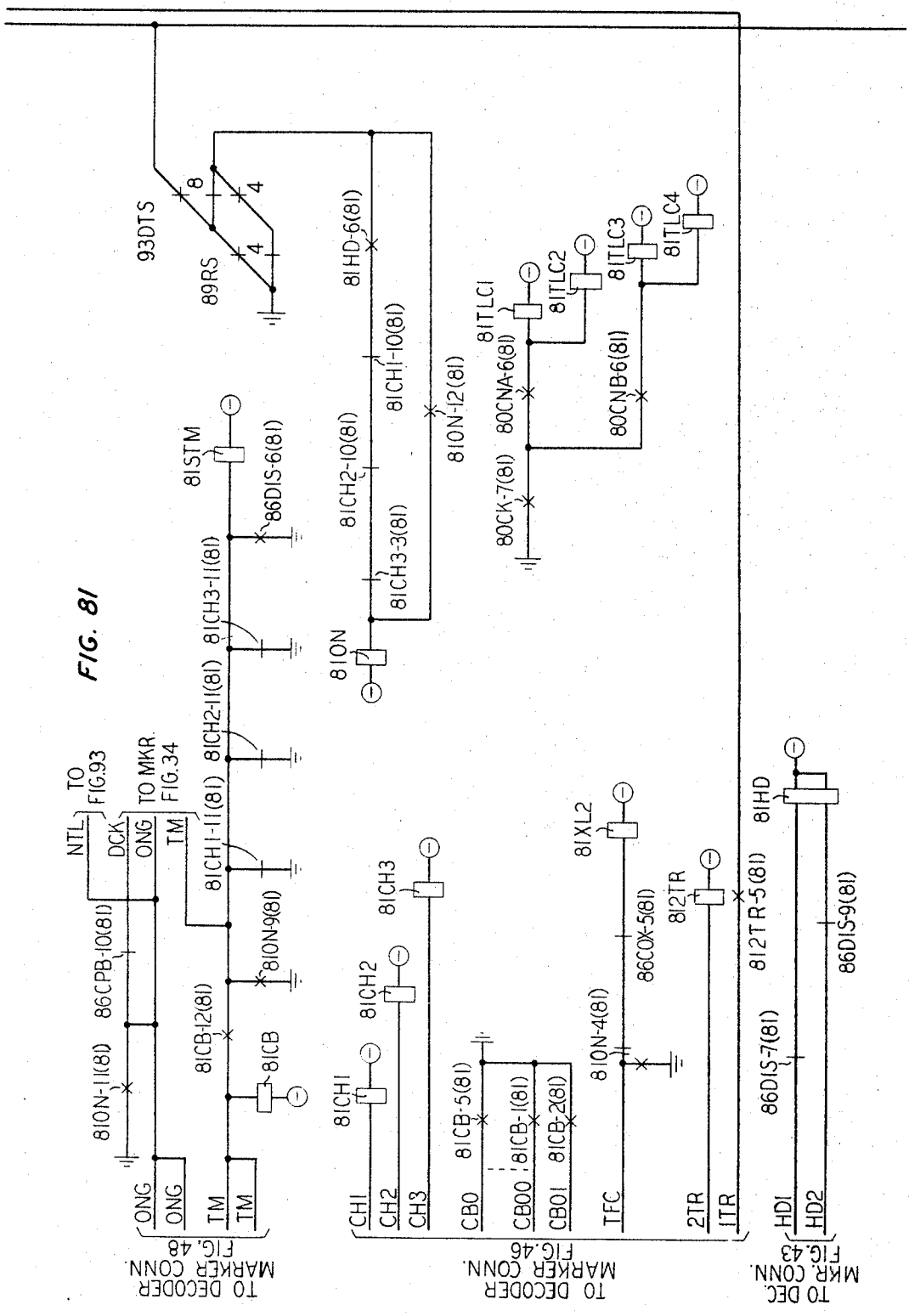

93DTS
89RS
8
4
4
8ISTM
86DIS-6(81)
8ICH3-11(81)
8ICH2-11(81)
8ICH1-11(81)
8ION-9(81)
8ICB
8ICB-12(81)
8ION-11(81)
86CPB-10(81)
NTL
TO FIG.93
DCK
ONG
TO MKR FIG.34
TM
ONG
ONG
TM
TM
FIG. 48
TO DECODER MARKER CONN.
8ION
8ICH3-3(81)
8ICH2-10(81)
8ICH1-10(81)
8ION-12(81)
8IHD-6(81)
8ITLC1
80CNA-6(81)
80CK-7(81)
8ITLC2
8ITLC3
80CNB-6(81)
8ITLC4
8ICH1
8ICH2
8ICH3
CH1
CH2
CH3
8ICB-5(81)
8ICB-1(81)
8ICB-2(81)
CB0
CB00
CB01
8IXL2
8ION-4(81)
86COX-5(81)
8I2TR
TFC
2TR
1TR
8I2TR-5(81)
8IHD
86DIS-7(81)
86DIS-9(81)
HDI
HD2
FIG. 46
TO DECODER MARKER CONN.
FIG. 43
TO DEC. MKR. CONN.

FIG. 81

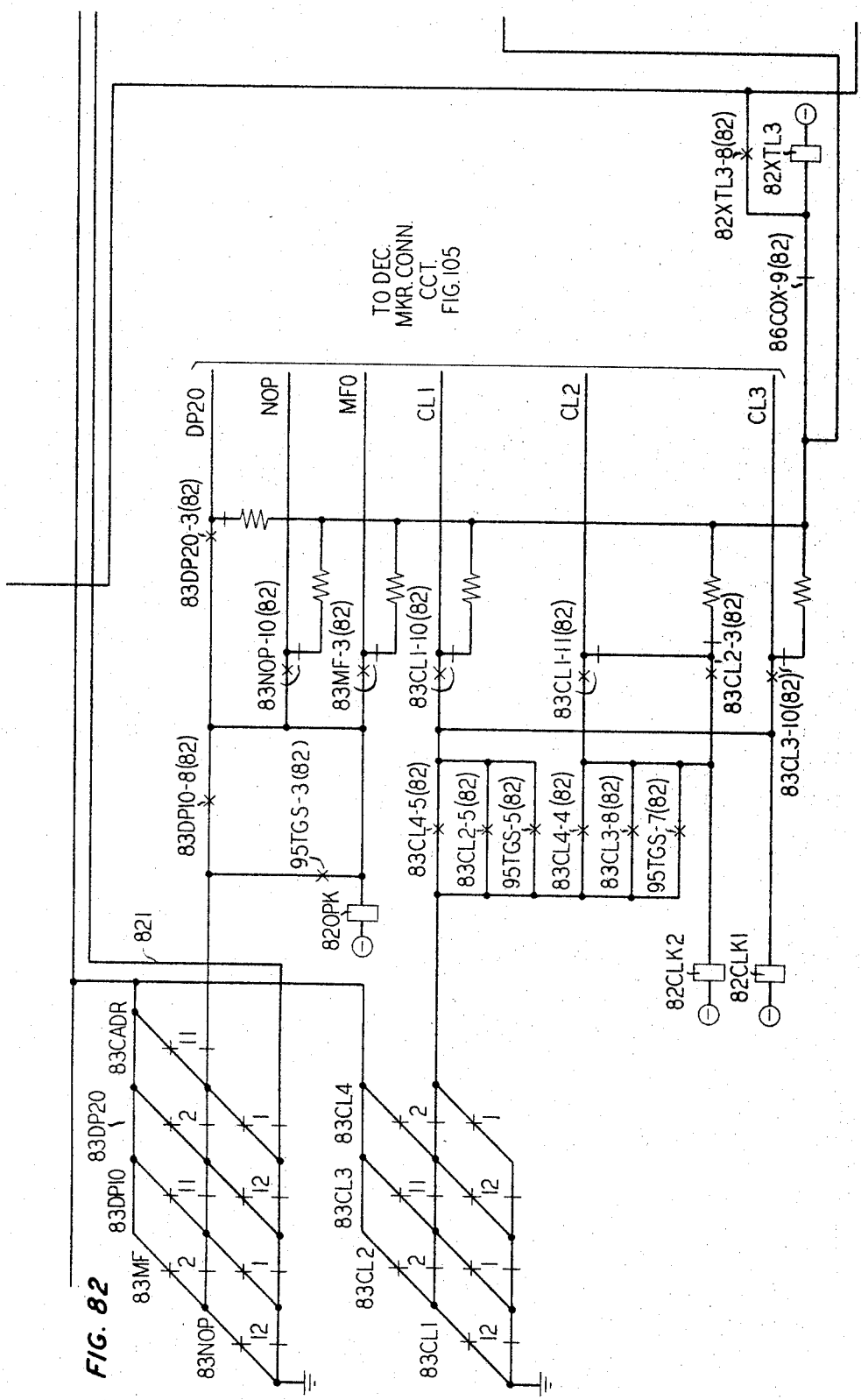
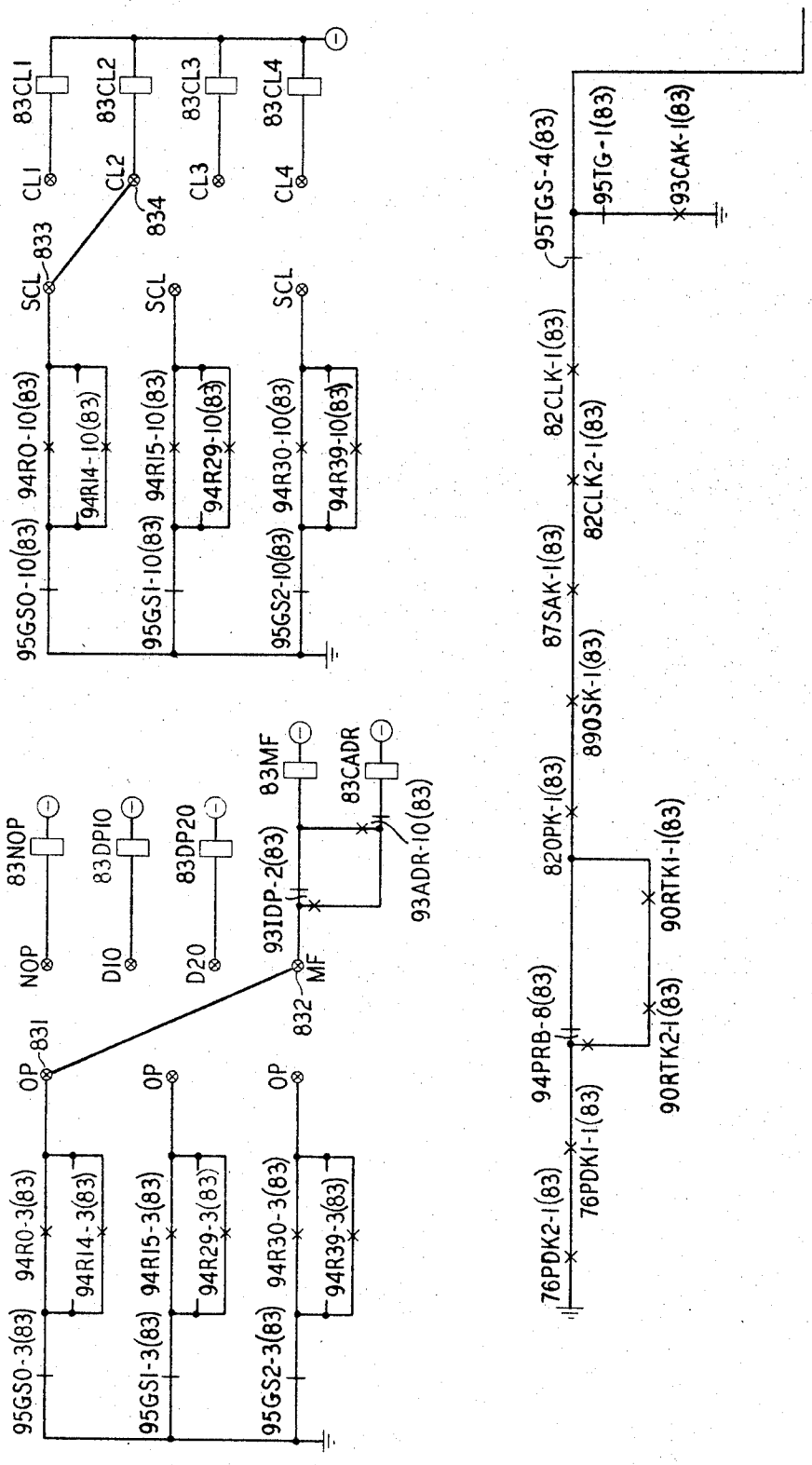

TO DEC. MKR. CONN. CCT. FIG. 105
82XTL3-8(82)
82XTL3
86COX-9(82)
DP20
NOP
MFO
CL1
CL2
CL3
83DP20-3(82)
83NOP-10(82)
83MF-3(82)
83CL1-10(82)
83CL1-11(82)
83CL2-3(82)
83CL3-10(82)
83DP10-8(82)
95TGS-3(82)
83CL4-5(82)
83CL2-5(82)
95TGS-5(82)
83CL4-4(82)
83CL3-8(82)
95TGS-7(82)
820PK
821
82CLK2
82CLK1
83CADR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

FIG. 82

FIG. 83


83CL1
83CL2
83CL3
83CL4
CL1
CL2
CL3
CL4
834
SCL
833
94RO-10(83)
94RI4-10(83)
94R29-10(83)
94R30-10(83)
94R39-10(83)
95GSO-10(83)
95GS1-10(83)
95GS2-10(83)
83NOP
83DPIO
83DP20
83MF
83CADR
NOP
DIO
D20
MF
832
93IDP-2(83)
93ADR-10(83)
OP
831
94RO-3(83)
94RI4-3(83)
94R29-3(83)
94R30-3(83)
94R39-3(83)
95GSO-3(83)
95GSI-3(83)
95GS2-3(83)
95TGS-4(83)
95TG-1(83)
93CAK-1(83)
82CLK-1(83)
82CLK2-1(83)
87SAK-1(83)
89OSK-1(83)
82OPK-1(83)
94PRB-8(83)
90RTKI-1(83)
90RTK2-1(83)
76PDKI-1(83)
76PDK2-1(83)

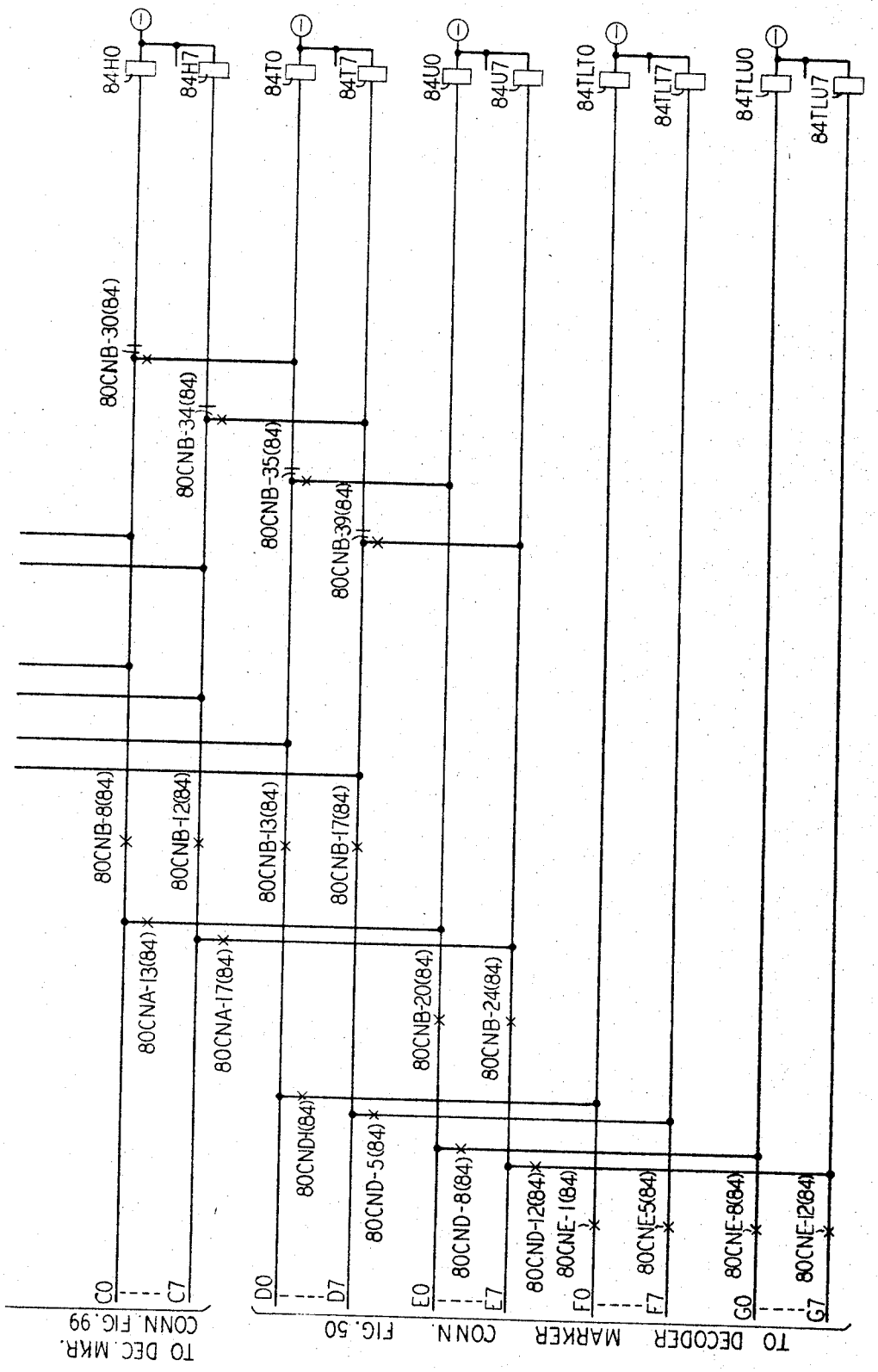

84H0
84H7
84T0
84T7
84U0
84U7
84TLT0
84TLT7
84TLU0
84TLU7
80CNB-30(84)
80CNB-34(84)
80CNB-35(84)
80CNB-39(84)
80CNB-8(84)
80CNB-12(84)
80CNB-13(84)
80CNB-17(84)
80CNA-13(84)
80CNA-17(84)
80CNB-20(84)
80CNB-24(84)
80CND-4(84)
80CND-5(84)
80CND-8(84)
80CND-12(84)
80CNE-1(84)
80CNE-5(84)
80CNE-8(84)
80CNE-12(84)
C0
C7
D0
D7
E0
E7
F0
F7
G0
G7
TO DEC. MKR. CONN. FIG. 99
TO DECODER MARKER CONN. FIG. 50

FIG. 84

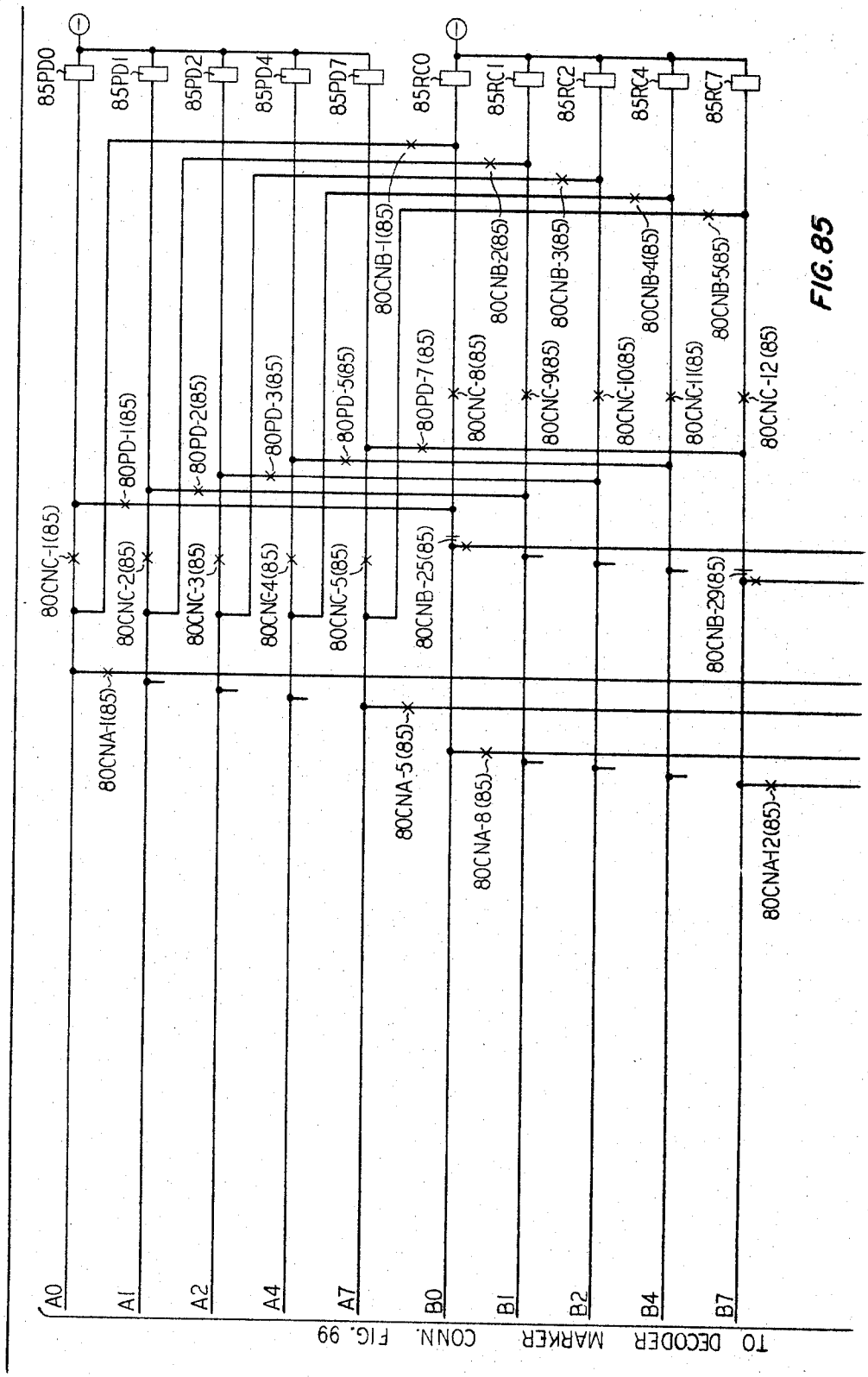

85PD0
85PD1
85PD2
85PD4
85PD7
85RC0
85RC1
85RC2
85RC4
85RC7
80CNB-1(85)
80CNB-2(85)
80CNB-3(85)
80CNB-4(85)
80CNB-5(85)
80PD-7(85)
80CNC-8(85)
80CNC-9(85)
80CNC-10(85)
80CNC-11(85)
80CNC-12(85)
80PD-1(85)
80PD-2(85)
80PD-3(85)
80PD-5(85)
80CNC-1(85)
80CNC-2(85)
80CNC-3(85)
80CNC4(85)
80CNC-5(85)
80CNB-25(85)
80CNB-29(85)
80CNA-1(85)
80CNA-5(85)
80CNA-8(85)
80CNA-12(85)
A0
A1
A2
A4
A7
B0
B1
B2
B4
B7
TO DECODER MARKER CONN.

FIG. 85

FIG. 99

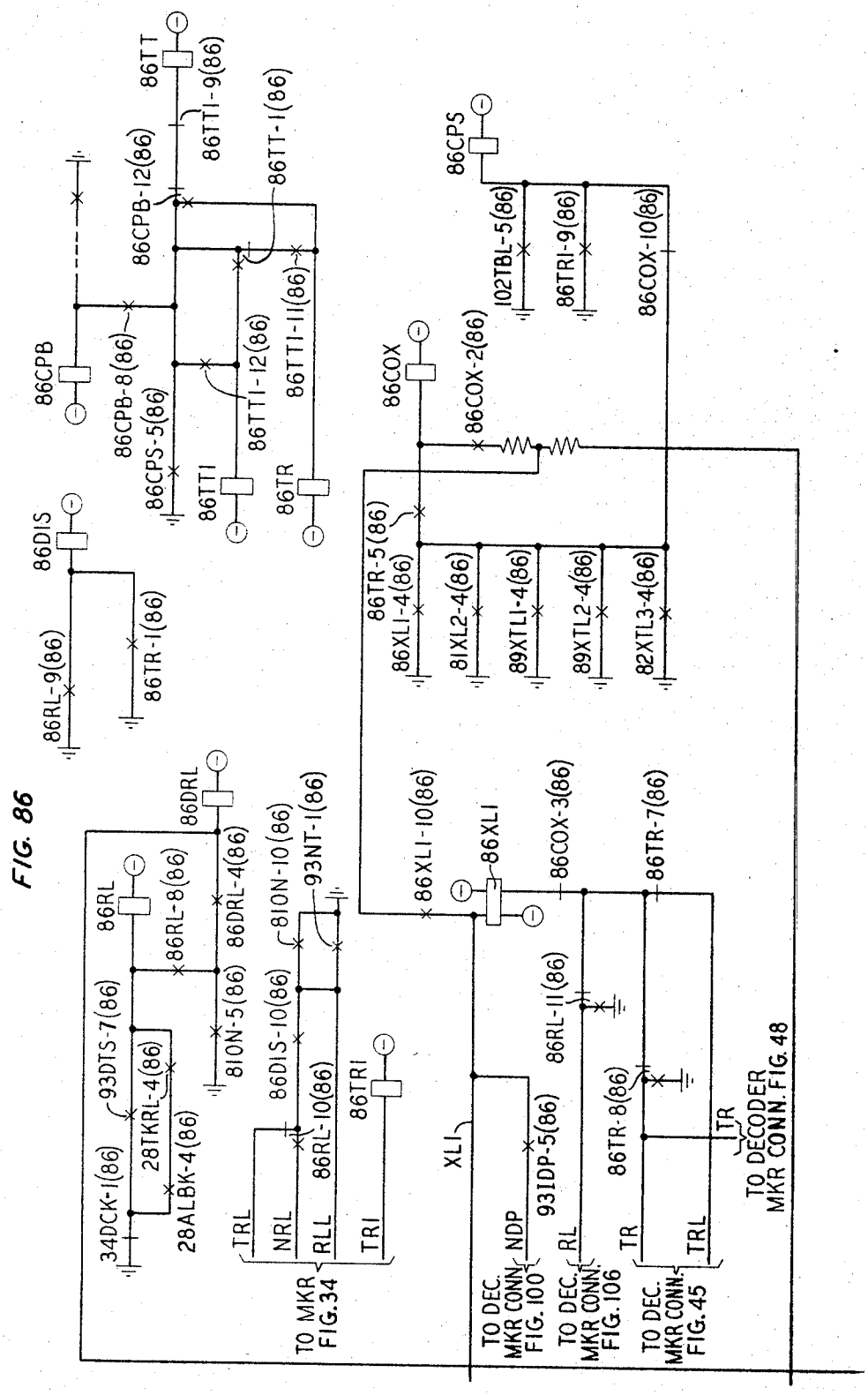
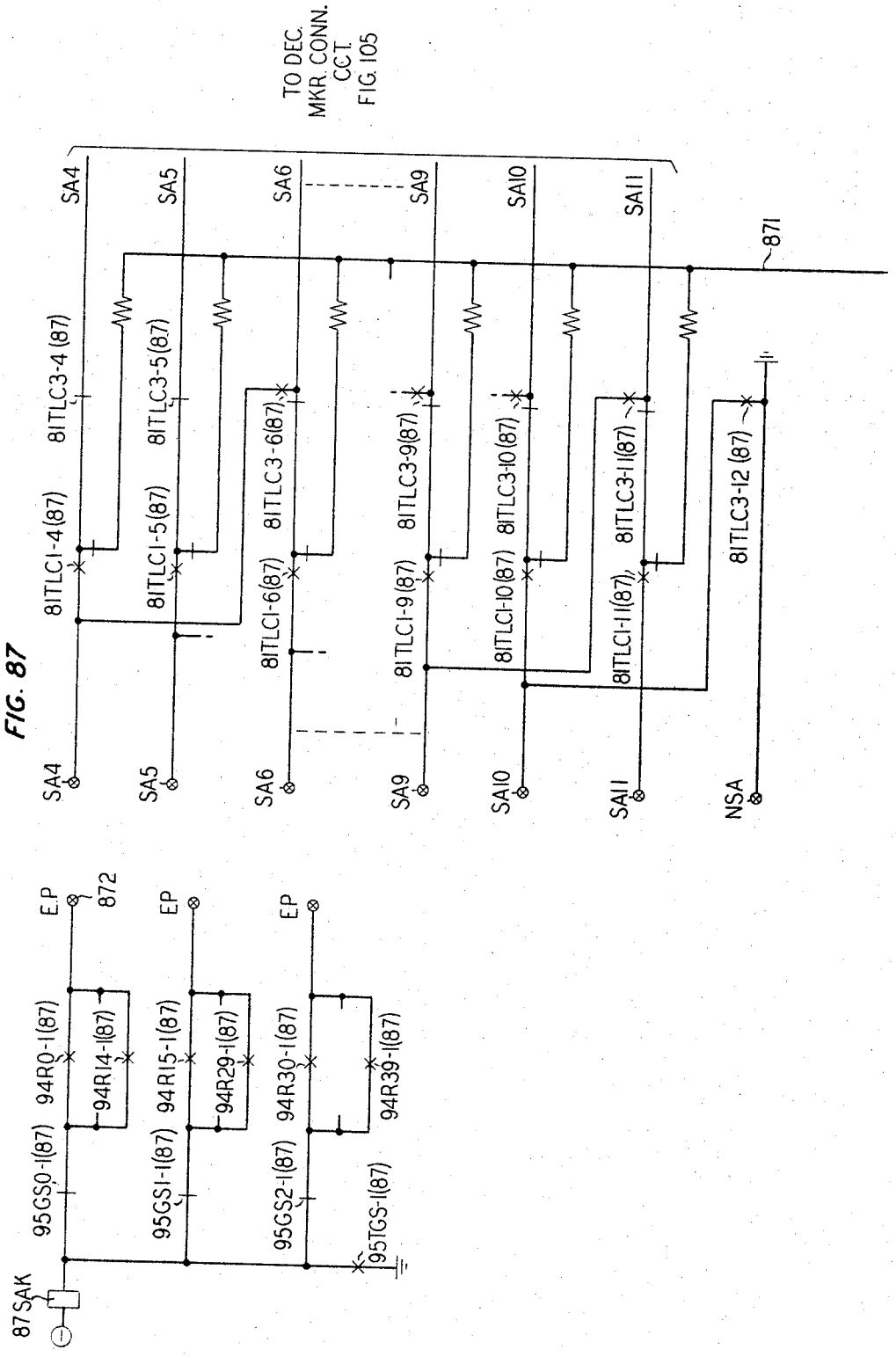

86TT
86TT-9(86)
86TT-1(86)
86CPB-12(86)
86CPB
86CPB-8(86)
86CPS-5(86)
86TTI
86TTI-12(86)
86TTI-11(86)
86TR
86CPS
102TBL-5(86)
86TRI-9(86)
86COX-10(86)
86COX
86COX-2(86)
86TR-5(86)
86XLI-4(86)
81XL2-4(86)
89XTLI-4(86)
89XTL2-4(86)
82XTL3-4(86)
86DIS
86RL-9(86)
86TR-1(86)
86DRL
86RL
86RL-8(86)
86DRL-4(86)
81ON-10(86)
93NT-1(86)
86XLI-10(86)
86XLI
86COX-3(86)
86TR-7(86)
93DTS-7(86)
81ON-5(86)
86DIS-10(86)
86RL-10(86)
86TRI
86RL-11(86)
34DCK-1(86)
28TKRL-4(86)
28ALBK-4(86)
TRL
NRL
RLL
TRI
XLI
NDP
93IDP-5(86)
RL
86TR-8(86)
TR
TRL
TO MKR FIG.34
TO DEC. MKR CONN FIG. 100
TO DEC. MKR CONN. FIG. 106
TO DEC. MKR CONN. FIG. 45
TO DECODER MKR CONN. FIG. 48

FIG. 86

FIG. 87


TO DEC. MKR. CONN. CCT. FIG. 105
SA4
SA5
SA6
SA9
SA10
SA11
87I
81TLC3-4 (87)
81TLC3-5(87)
81TLC3-6(87)
81TLC3-9(87)
81TLC3-10 (87)
81TLC3-11(87)
81TLC3-12 (87)
81TLC1-4(87)
81TLC1-5(87)
81TLC1-6(87)
81TLC1-9 (87)
81TLC1-10(87)
81TLC1-11(87)
NSA
87SAK
95GS0-1(87)
95GS1-1(87)
95GS2-1(87)
95TGS-1(87)
94R0-1(87)
94R14-1(87)
94R15-1(87)
94R29-1(87)
94R30-1(87)
94R39-1(87)
E.P
872

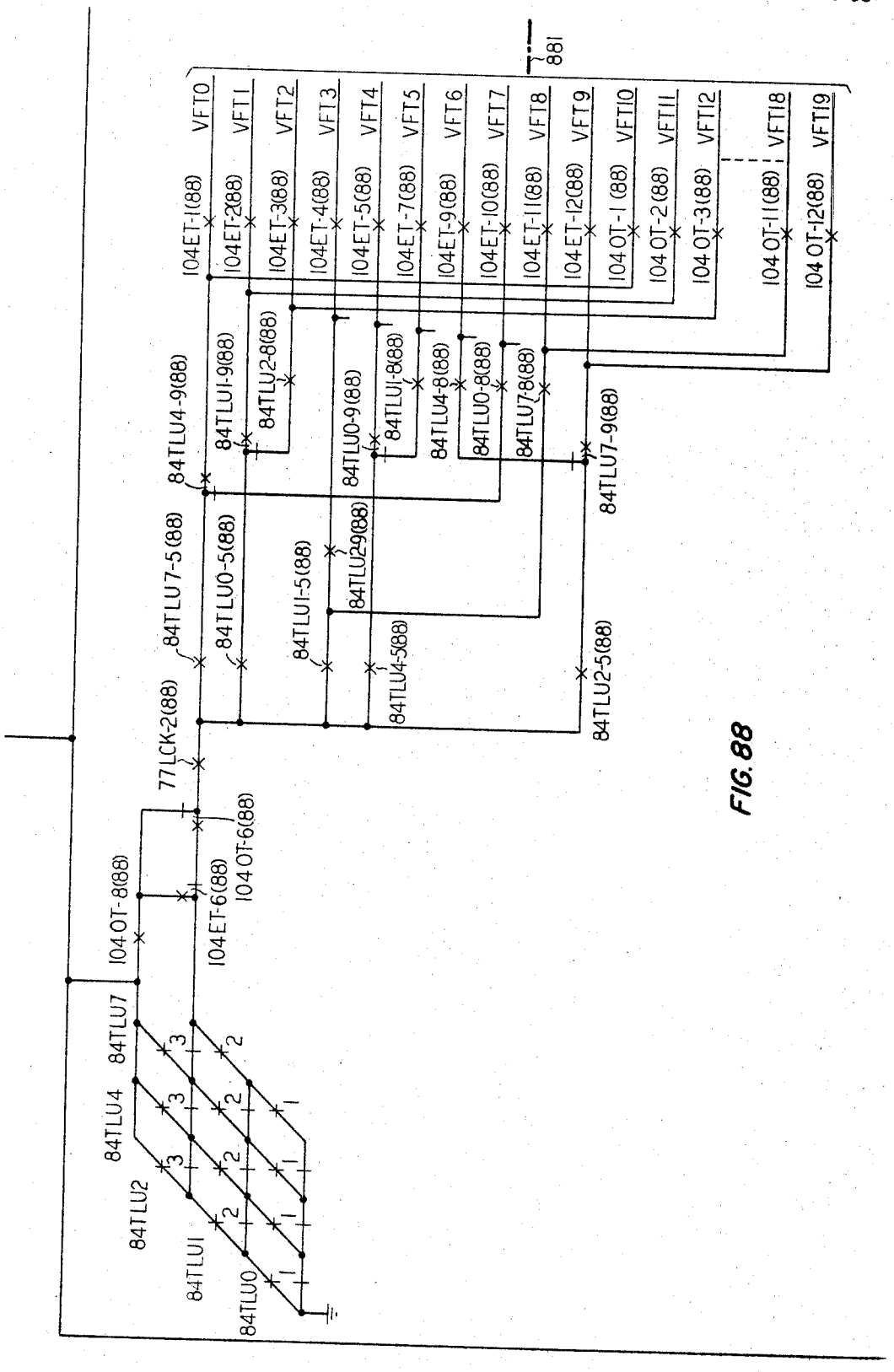

881
104ET-1(88) VFT0
104ET-2(88) VFT1
104ET-3(88) VFT2
104ET-4(88) VFT3
104ET-5(88) VFT4
104ET-7(88) VFT5
104ET-9(88) VFT6
104ET-10(88) VFT7
104ET-11(88) VFT8
104ET-12(88) VFT9
104OT-1(88) VFT10
104OT-2(88) VFT11
104OT-3(88) VFT12
104OT-11(88) VFT18
104OT-12(88) VFT19
84TLU4-9(88)
84TLU1-9(88)
84TLU2-8(88)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

FIG. 88

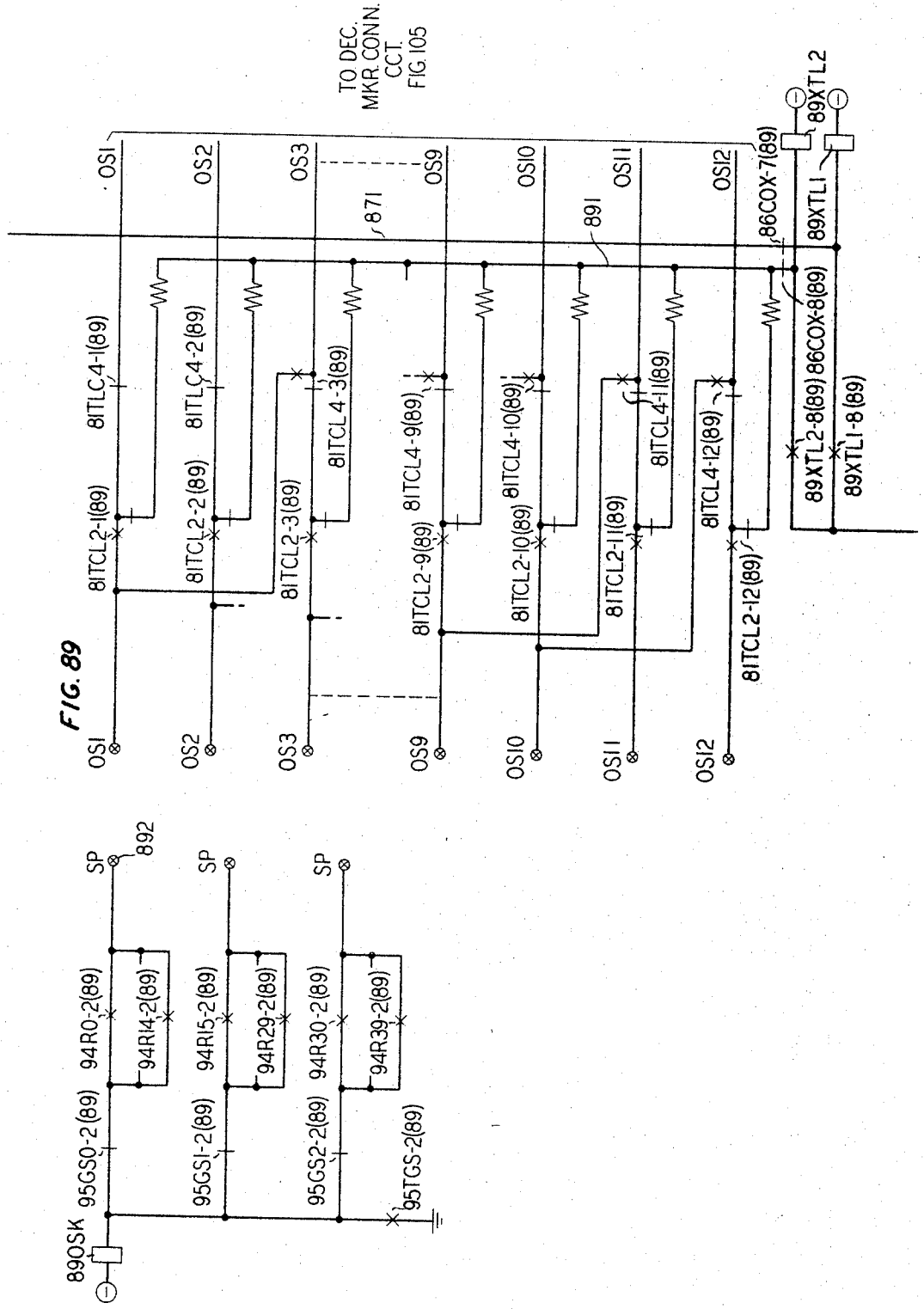

TO DEC. MKR. CONN. CCT. FIG. 105
OS1
OS2
OS3
OS9
OS10
OS11
OS12
871
891
86COX-7(89)
89XTL2
89XTL1
81TLC4-1(89)
81TLC4-2(89)
81TLC4-3(89)
81TCL4-9(89)
81TCL4-10(89)
81TCL4-11(89)
81TCL4-12(89)
81TCL2-1(89)
81TCL2-2(89)
81TCL2-3(89)
81TCL2-9(89)
81TCL2-10(89)
81TCL2-11(89)
81TCL2-12(89)
89XTL2-8(89)
86COX-8(89)
89XTL1-8(89)
SP
892
94RO-2(89)
94RI4-2(89)
94RI5-2(89)
94R29-2(89)
94R30-2(89)
94R39-2(89)
95GSO-2(89)
95GSI-2(89)
95GS2-2(89)
95TGS-2(89)
89OSK

FIG. 89

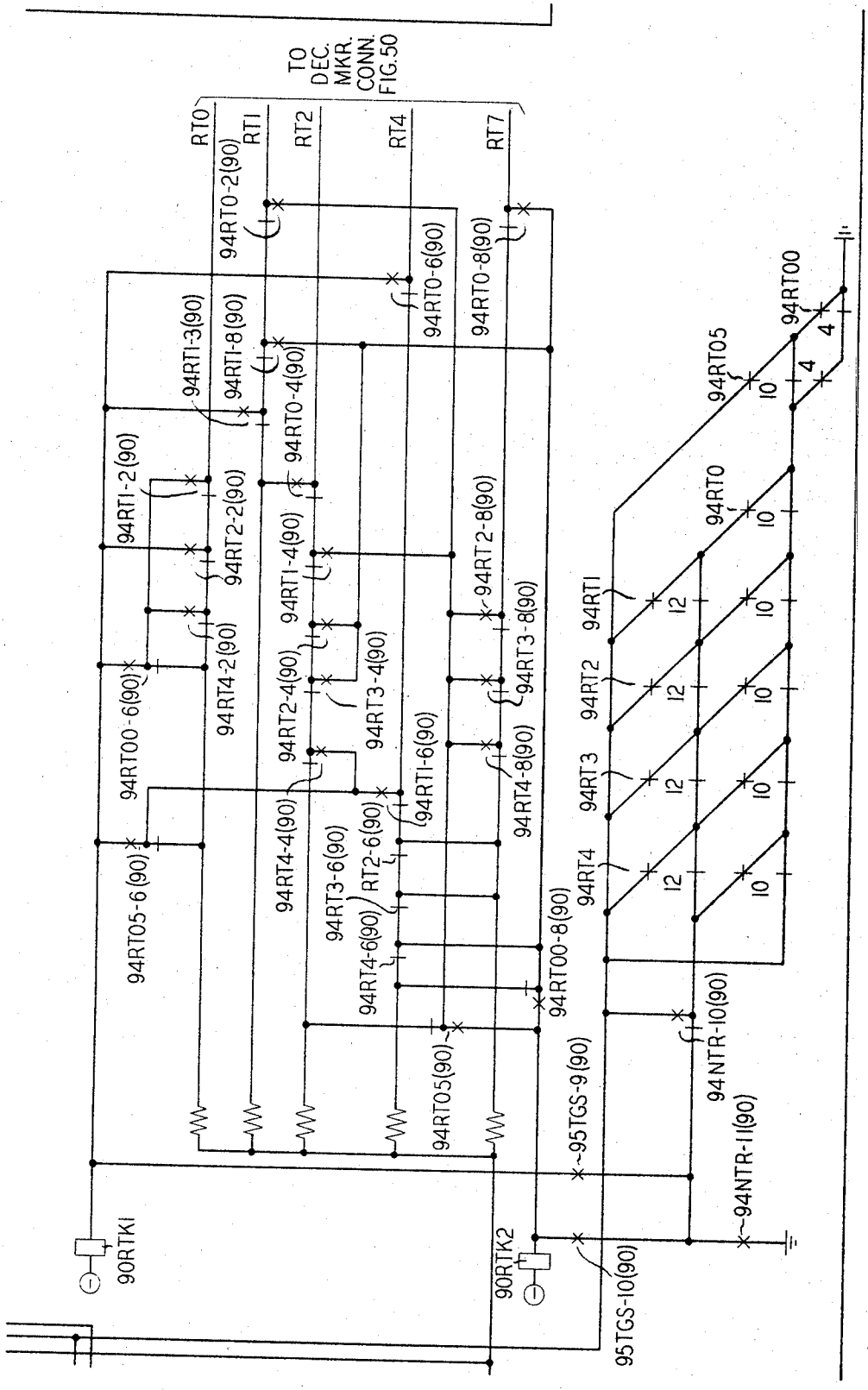

TO DEC. MKR. CONN. FIG.50
RT0
RT1
RT2
RT4
RT7
94RT0-2(90)
94RT0-6(90)
94RT0-8(90)
94RT1-3(90)
94RT1-8(90)
94RT0-4(90)
94RT1-2(90)
94RT2-2(90)
94RT1-4(90)
94RT2-8(90)
94RT4-2(90)
94RT2-4(90)
94RT3-4(90)
94RT3-8(90)
94RT00-6(90)
94RT1-6(90)
94RT4-8(90)
94RT05-6(90)
94RT3-6(90)
RT2-6(90)
94RT4-4(90)
94RT4-6(90)
94RT00-8(90)
94RT05(90)
95TGS-9(90)
94NTR-10(90)
94NTR-11(90)
95TGS-10(90)
90RTK1
90RTK2
94RT05
94RT00
94RT0
94RT1
94RT2
94RT3
94RT4
10
12
4

FIG. 90

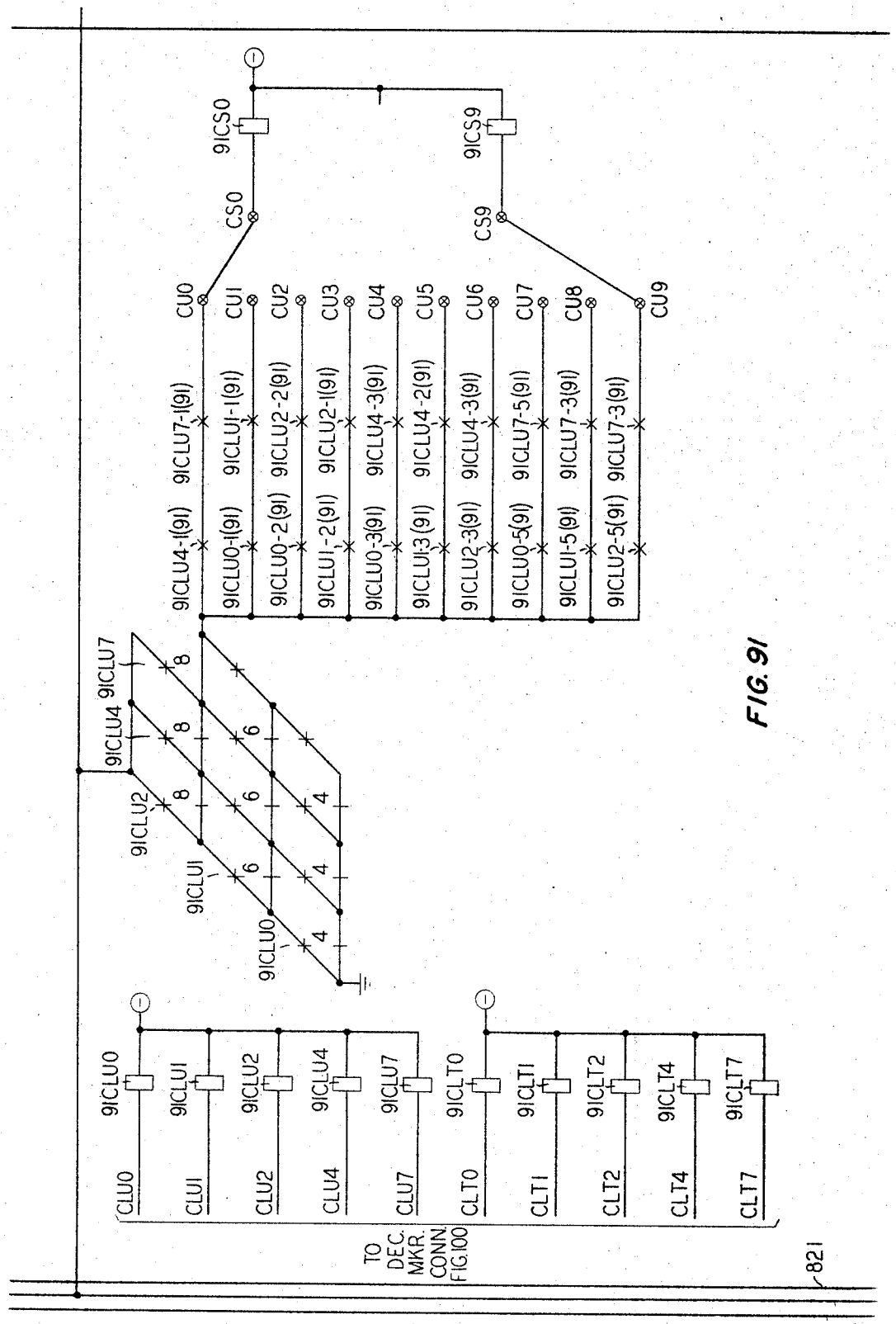

91CS0
91CS9
CS0
CS9
CU0
CU1
CU2
CU3
CU4
CU5
CU6
CU7
CU8
CU9
91CLU4-1(91)
91CLU7-1(91)
91CLU0-1(91)
91CLU1-1(91)
91CLU0-2(91)
91CLU2-2(91)
91CLU1-2(91)
91CLU2-1(91)
91CLU0-3(91)
91CLU4-3(91)
91CLU1-3(91)
91CLU4-2(91)
91CLU2-3(91)
91CLU4-3(91)
91CLU0-5(91)
91CLU7-5(91)
91CLU1-5(91)
91CLU7-3(91)
91CLU2-5(91)
91CLU7-3(91)
91CLU4
91CLU7
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

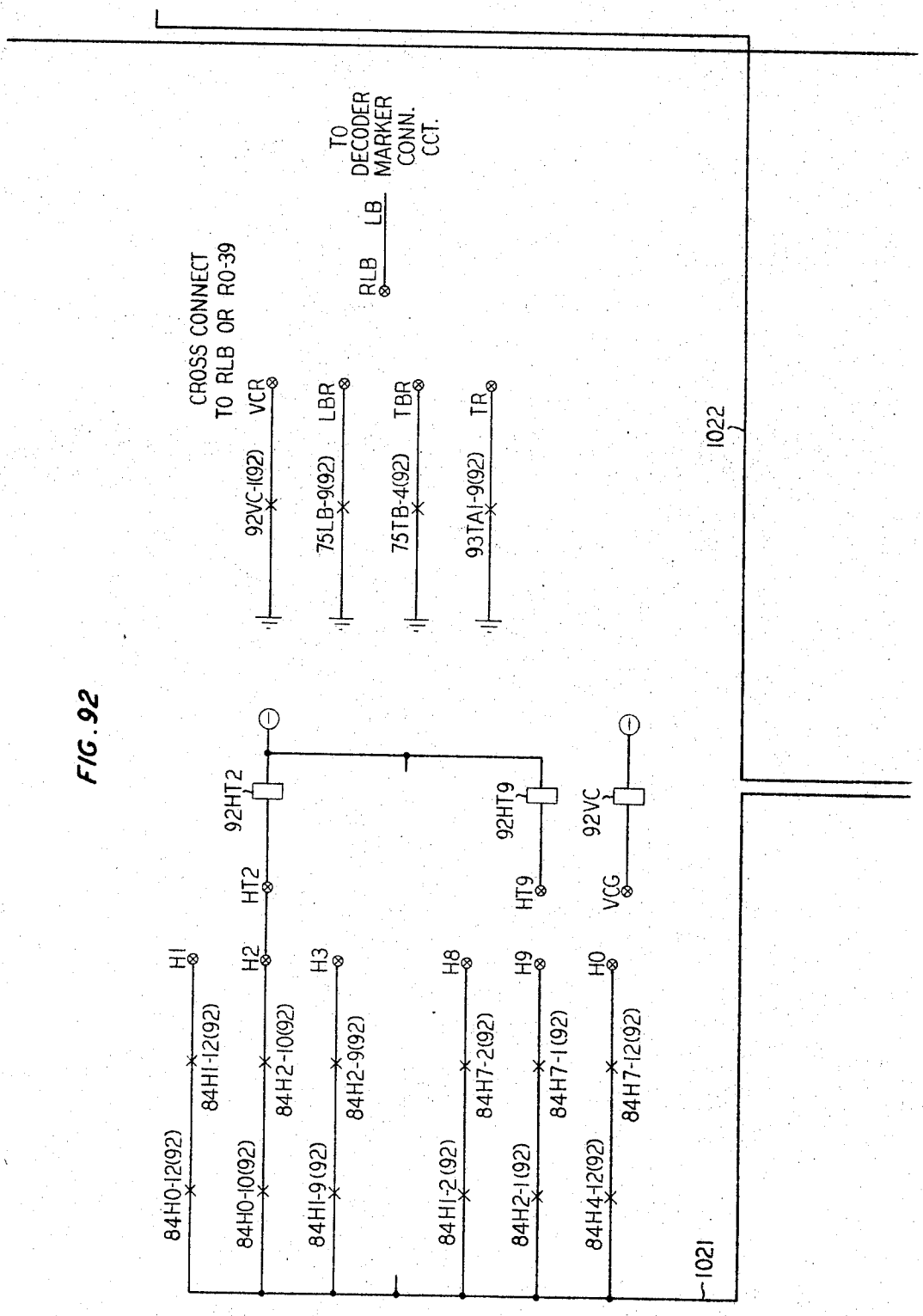

TO DECODER MARKER CONN. CCT.
RLB
LB
CROSS CONNECT TO RLB OR RO-39
VCR
LBR
TBR
TR
92VC-1(92)
75LB-9(92)
75TB-4(92)
93TA1-9(92)
1022
92HT2
92HT9
92VC
HT2
HT9
VCG
H1
H2
H3
H8
H9
H0
84H0-12(92)
84H1-12(92)
84H0-10(92)
84H2-10(92)
84H1-9(92)
84H2-9(92)
84H1-2(92)
84H7-2(92)
84H2-1(92)
84H7-1(92)
84H4-12(92)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

FIG. 92

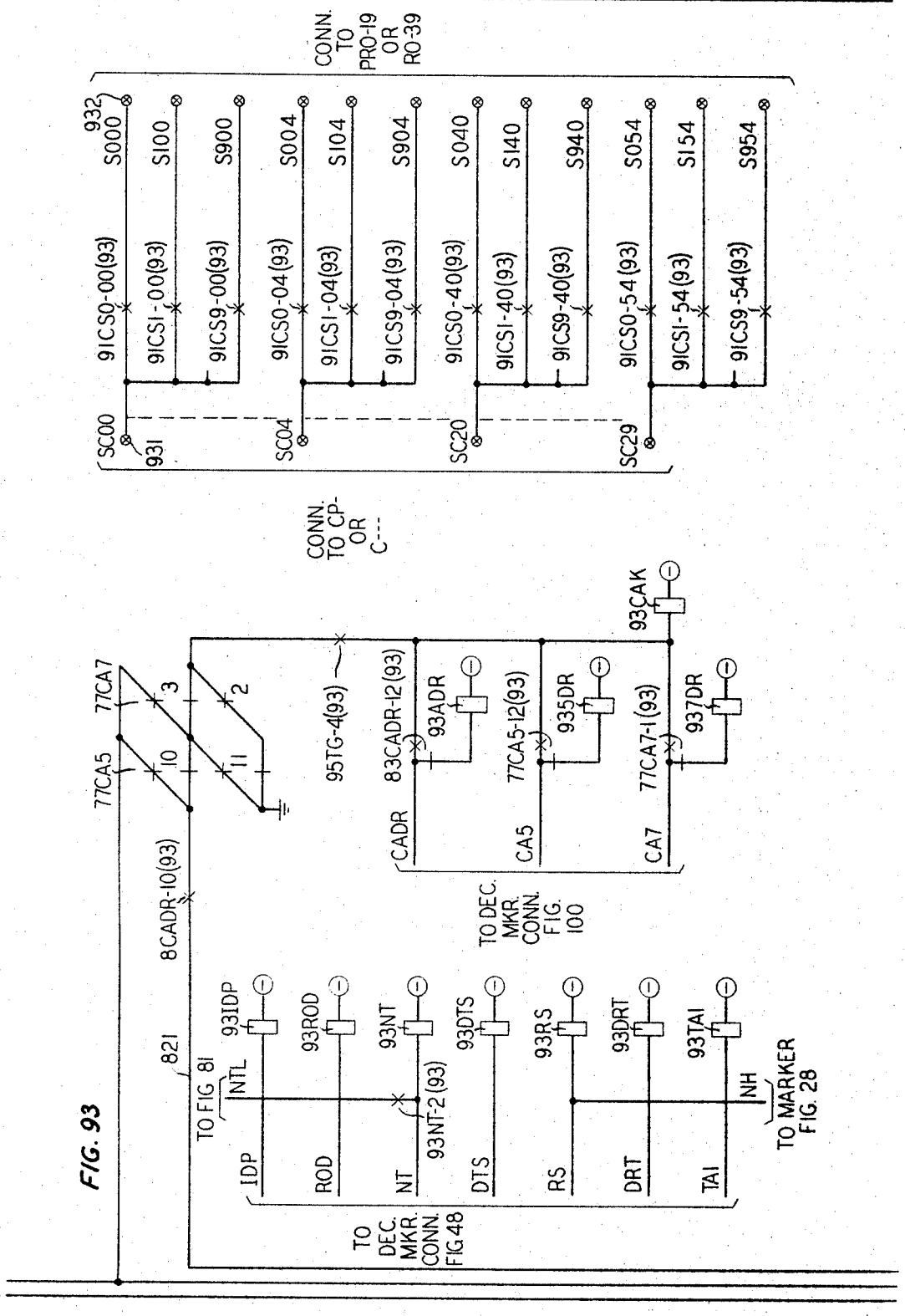
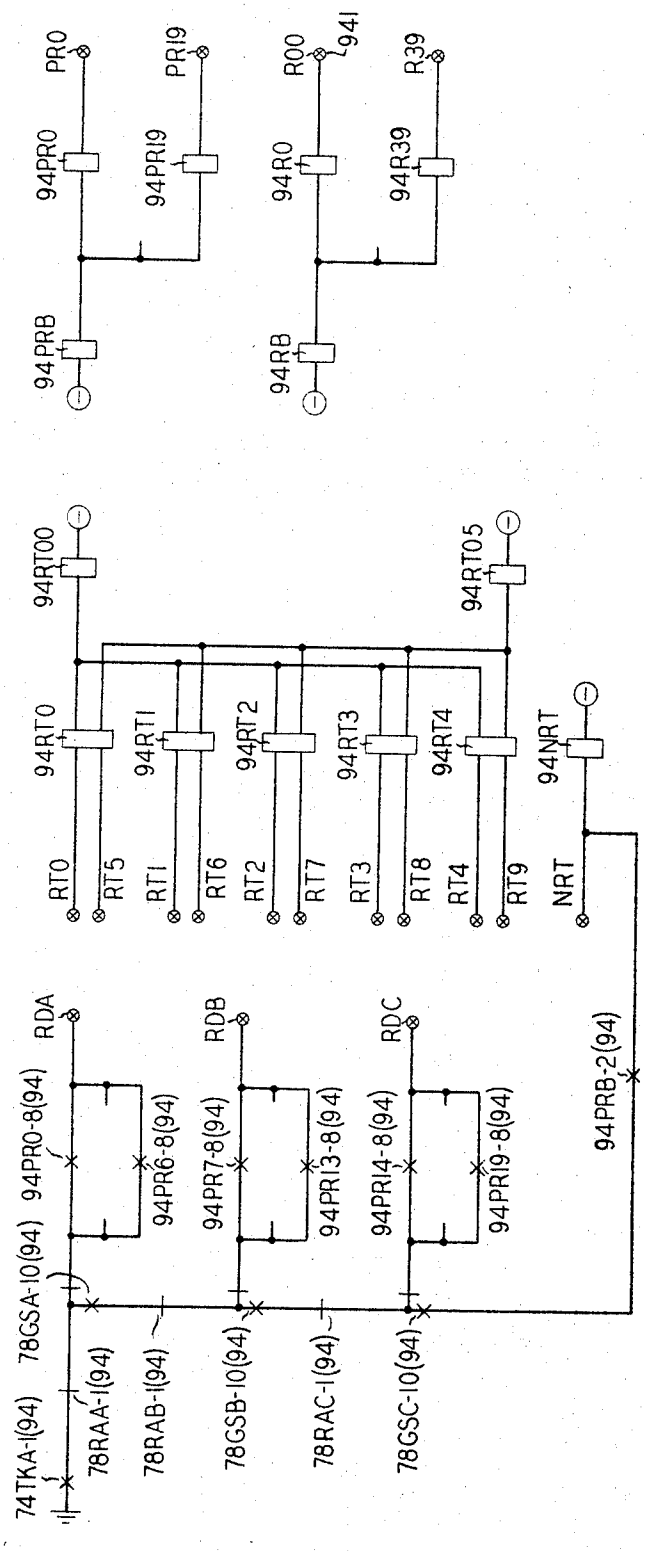

CONN. TO PRO-19 OR RO-39
932
S000
S100
S900
S004
S104
S904
S040
S140
S940
S054
S154
S954
91CS0-00(93)
91CS1-00(93)
91CS9-00(93)
91CS0-04(93)
91CS1-04(93)
91CS9-04(93)
91CS0-40(93)
91CS1-40(93)
91CS9-40(93)
91CS0-54(93)
91CS1-54(93)
91CS9-54(93)
SC00
931
SC04
SC20
SC29
CONN. TO CP- OR C---
95TG-4(93)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

FIG. 93

FIG. 94


PR0
PR19
R00
941
R39
94PR0
94PR19
94R0
94R39
94PRB
94RB
94RT00
94RT05
94RT0
94RT1
94RT2
94RT3
94RT4
94NRT
RT0
RT5
RT1
RT6
RT2
RT7
RT3
RT8
RT4
RT9
NRT
RDA
RDB
RDC
94PR0-8(94)
94PR6-8(94)
94PR7-8(94)
94PR13-8(94)
94PR14-8(94)
94PR19-8(94)
94PRB-2(94)
78GSA-10(94)
74TKA-1(94)
78RAA-1(94)
78RAB-1(94)
78GSB-10(94)
78RAC-1(94)
78GSC-10(94)

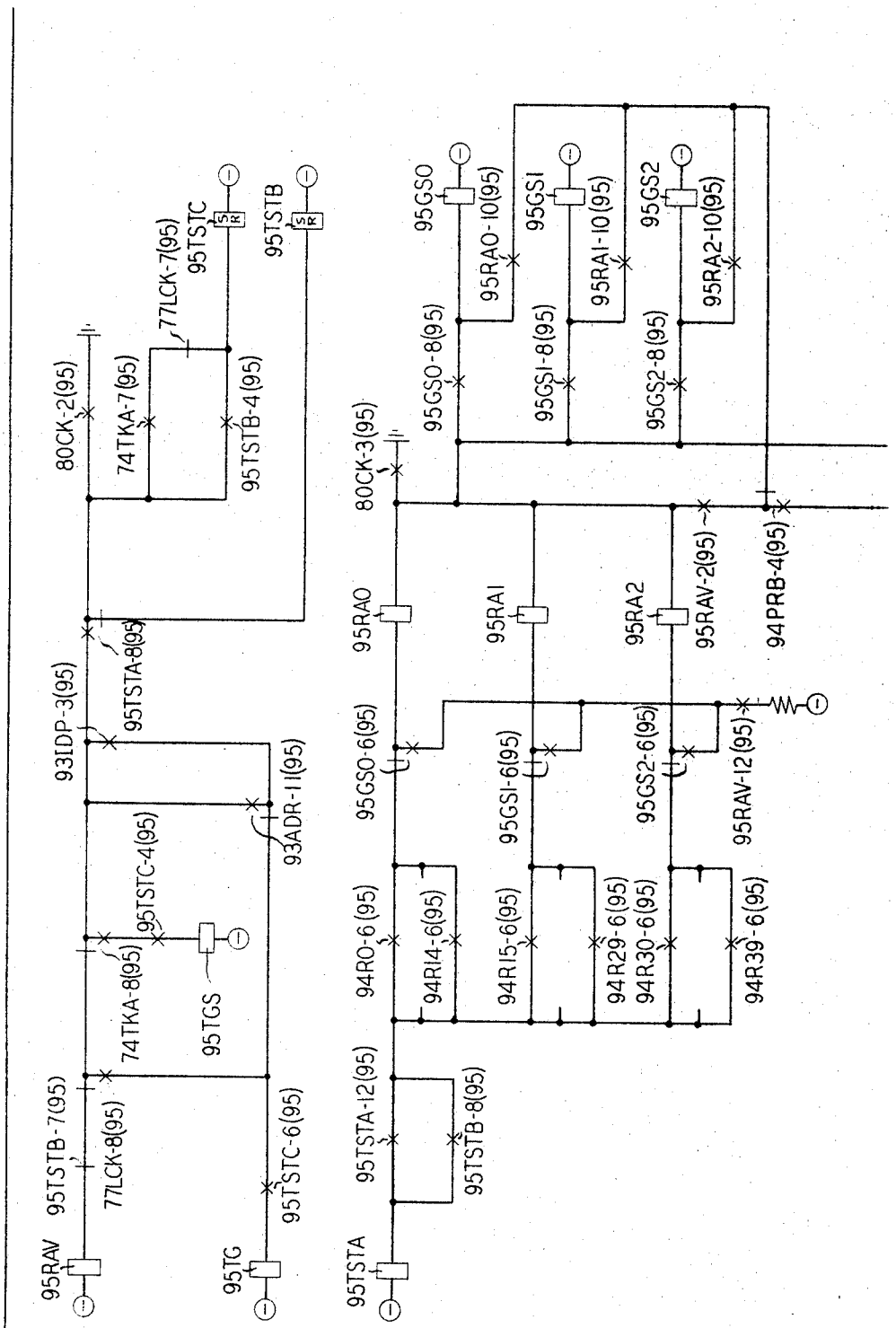

95RAV
95TSTB-7(95)
77LCK-8(95)
74TKA-8(95)
95TSTC-4(95)
95TGS
93IDP-3(95)
95TSTA-8(95)
80CK-2(95)
74TKA-7(95)
77LCK-7(95)
95TSTC
95TSTB-4(95)
95TSTB
93ADR-11(95)
95TSTC-6(95)
95TG
95TSTA
95TSTA-12(95)
95TSTB-8(95)
94RO-6(95)
94RI4-6(95)
94RI5-6(95)
94R29-6(95)
94R30-6(95)
94R39-6(95)
95GSO-6(95)
95GSI-6(95)
95GS2-6(95)
95RAO
95RAI
95RA2
80CK-3(95)
95GSO-8(95)
95GSI-8(95)
95GS2-8(95)
95GSO
95GSI
95GS2
95RAO-10(95)
95RAI-10(95)
95RA2-10(95)
95RAV-2(95)
95RAV-12(95)
94PRB-4(95)

FIG. 95

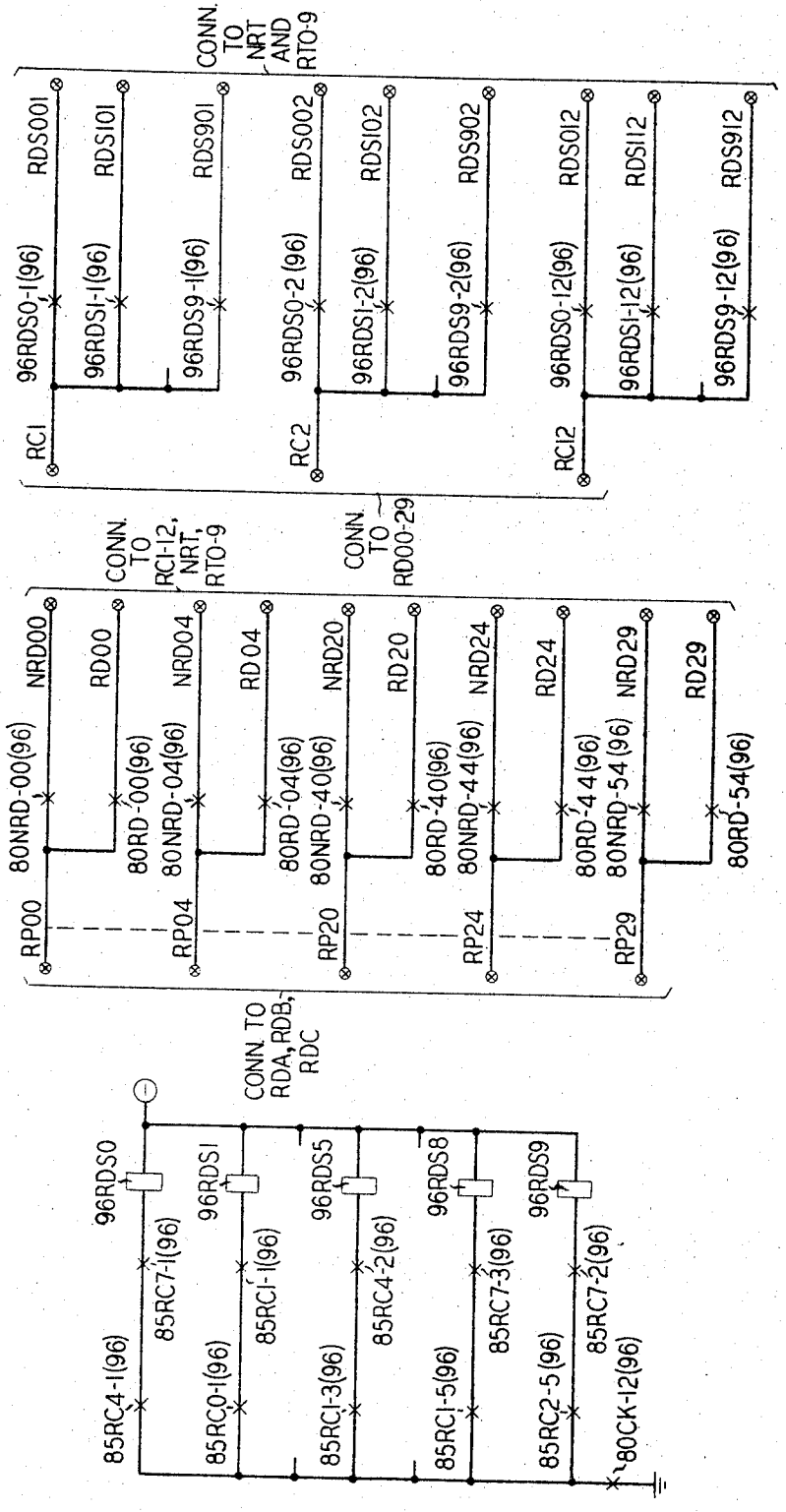
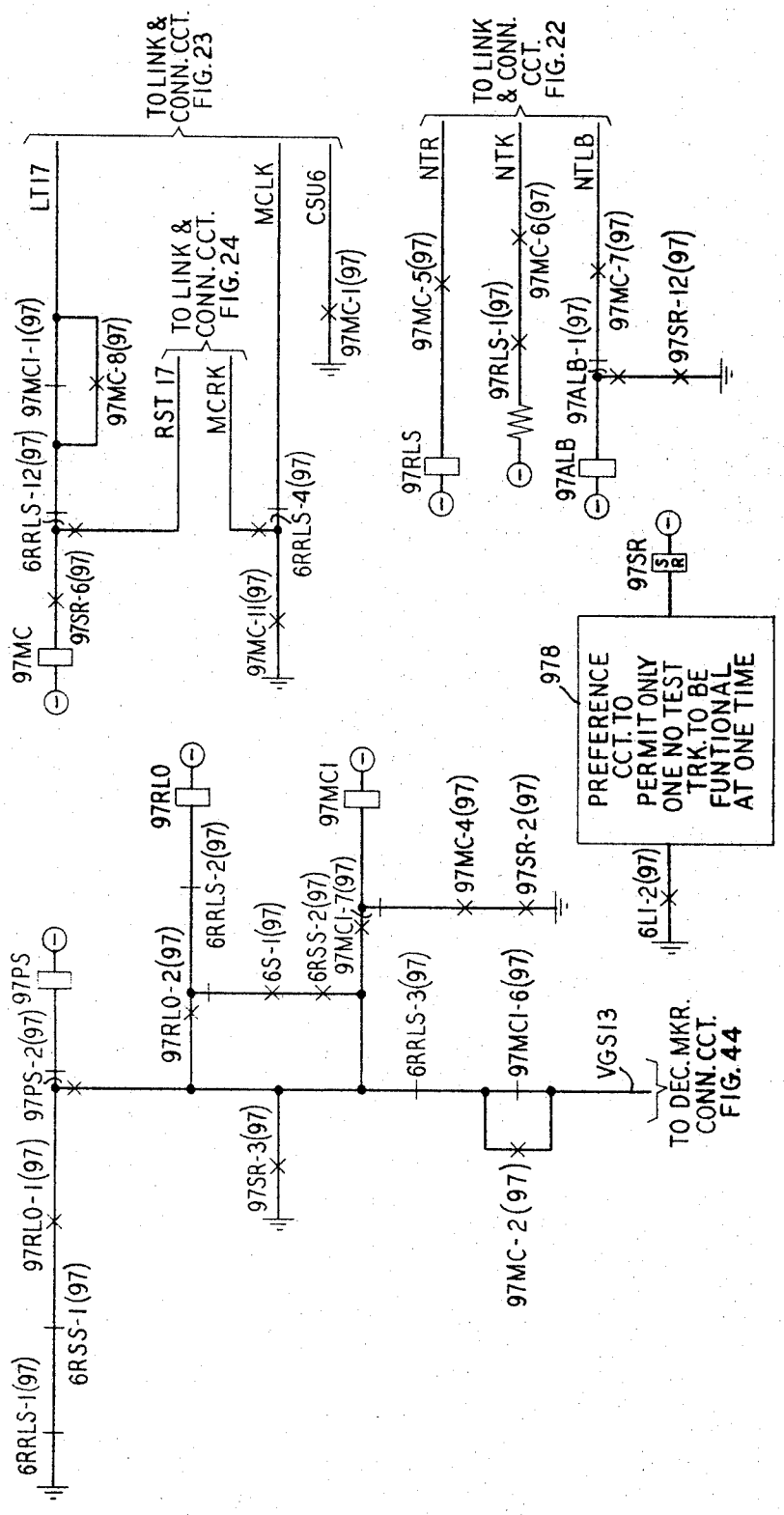

CONN. TO NRT AND RTO-9
RDS001
RDSI01
RDS901
RDS002
RDSI02
RDS902
RDSO12
RDSI12
RDS912
96RDSO-1(96)
96RDSI-1(96)
96RDS9-1(96)
96RDSO-2(96)
96RDSI-2(96)
96RDS9-2(96)
96RDSO-12(96)
96RDSI-12(96)
96RDS9-12(96)
RC1
RC2
RC12
CONN. TO RDO0-29
CONN. TO RCI-12, NRT, RTO-9
NRD00
RD00
NRD04
RD04
NRD20
RD20
NRD24
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
96RDSI
96RDS5
96RDS8
96RDS9
85RC4-1(96)
85RC7-1(96)
85RC0-1(96)
85RCI-1(96)
85RCI-3(96)
85RC4-2(96)
85RCI-5(96)
85RC7-3(96)
85RC2-5(96)
85RC7-2(96)
80CK-12(96)

FIG. 96

FIG. 97


TO LINK & CONN. CCT. FIG. 23
TO LINK & CONN. CCT. FIG. 24
TO LINK & CONN. CCT. FIG. 22
LT17
RST 17
MCRK
MCLK
CSU6
NTR
NTK
NTLB
97MCI-1(97)
97MC-8(97)
97MC-1(97)
97MC-5(97)
97MC-6(97)
97MC-7(97)
97SR-12(97)
97RLS-1(97)
97ALB-1(97)
97RLS
97ALB
6RRLS-12(97)
6RRLS-4(97)
97SR-6(97)
97MC-11(97)
97MC
97SR
S
R
978
PREFERENCE CCT. TO PERMIT ONLY ONE NO TEST TRK. TO BE FUNTIONAL AT ONE TIME
6LI-2(97)
97RLO
97MCI
6RRLS-2(97)
97MC-4(97)
97SR-2(97)
6S-1(97)
6RSS-2(97)
97MCI-7(97)
97RLO-2(97)
97PS
97PS-2(97)
6RRLS-3(97)
97MCI-6(97)
VGS13
97SR-3(97)
97MC-2(97)
97RLO-1(97)
6RSS-1(97)
6RRLS-1(97)
TO DEC. MKR. CONN. CCT. FIG. 44

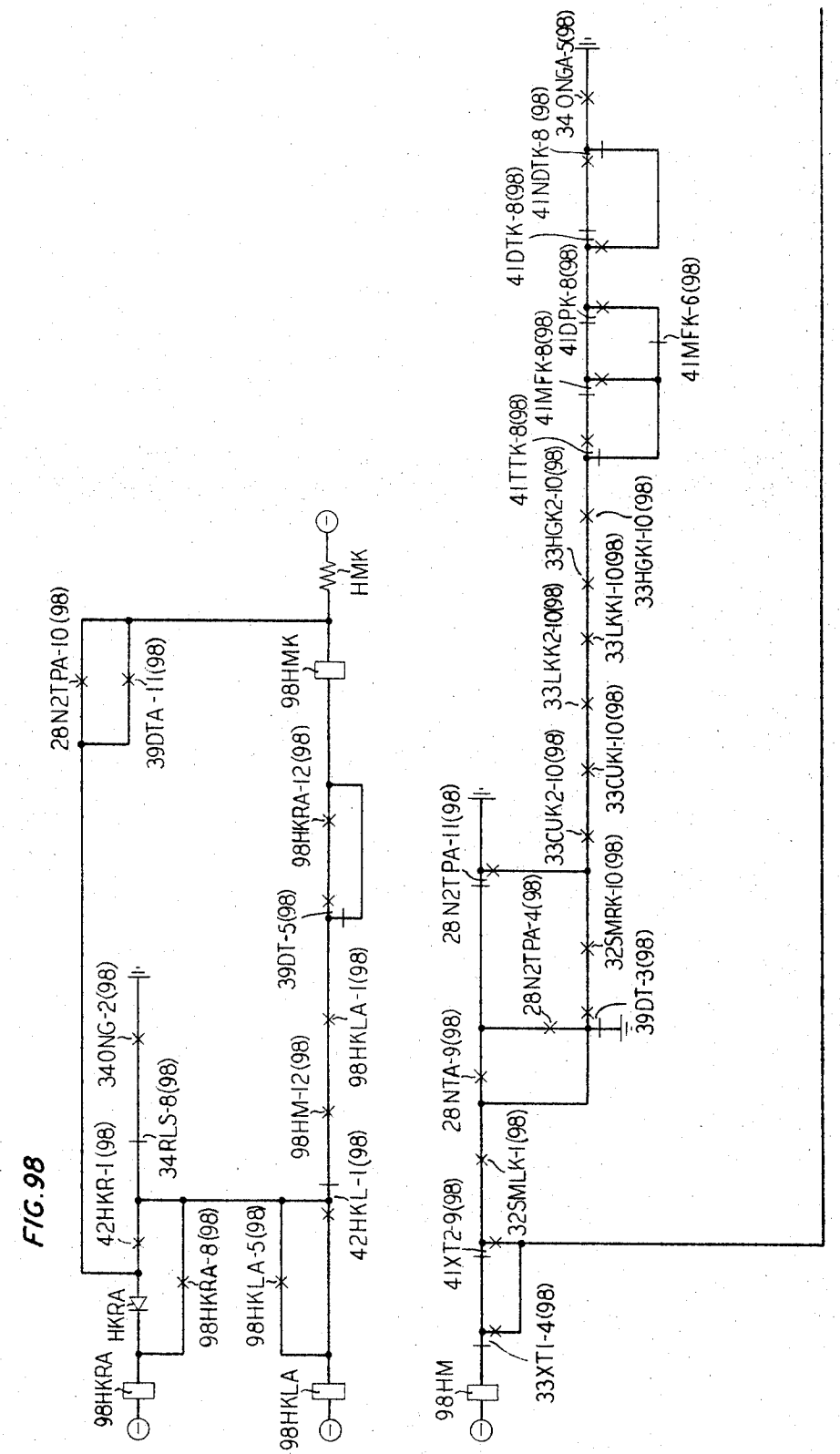

98HKRA
HKRA
42HKR-1(98)
340NG-2(98)
34RLS-8(98)
98HKRA-8(98)
98HKLA-5(98)
98HKLA
42HKL-1(98)
98HM-12(98)
98HKLA-1(98)
39DT-5(98)
98HKRA-12(98)
98HMK
HMK
28N2TPA-10(98)
39DTA-11(98)
98HM
41XT2-9(98)
28NTA-9(98)
28N2TPA-11(98)
32SMLK-1(98)
33XT1-4(98)
28N2TPA-4(98)
33CUK2-10(98)
32SMRK-10(98)
33CUKI-10(98)
33LKK2-10(98)
39DT-3(98)
33LKKI-10(98)
33HGK2-10(98)
33HGKI-10(98)
41TTK-8(98)
41MFK-8(98)
41DPK-8(98)
41DTK-8(98)
41NDTK-8(98)
34ONGA-5(98)
41MFK-6(98)

FIG. 98

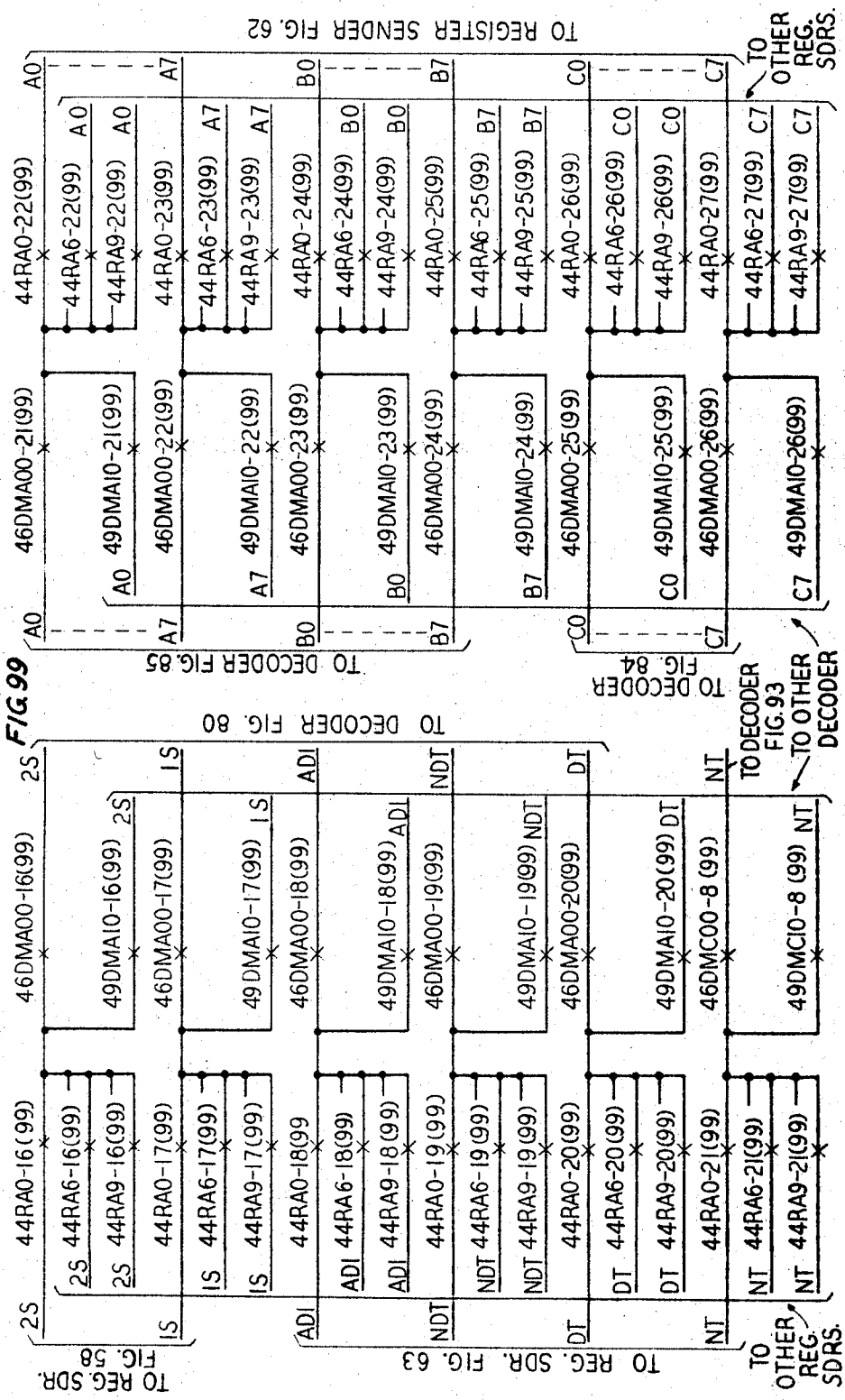
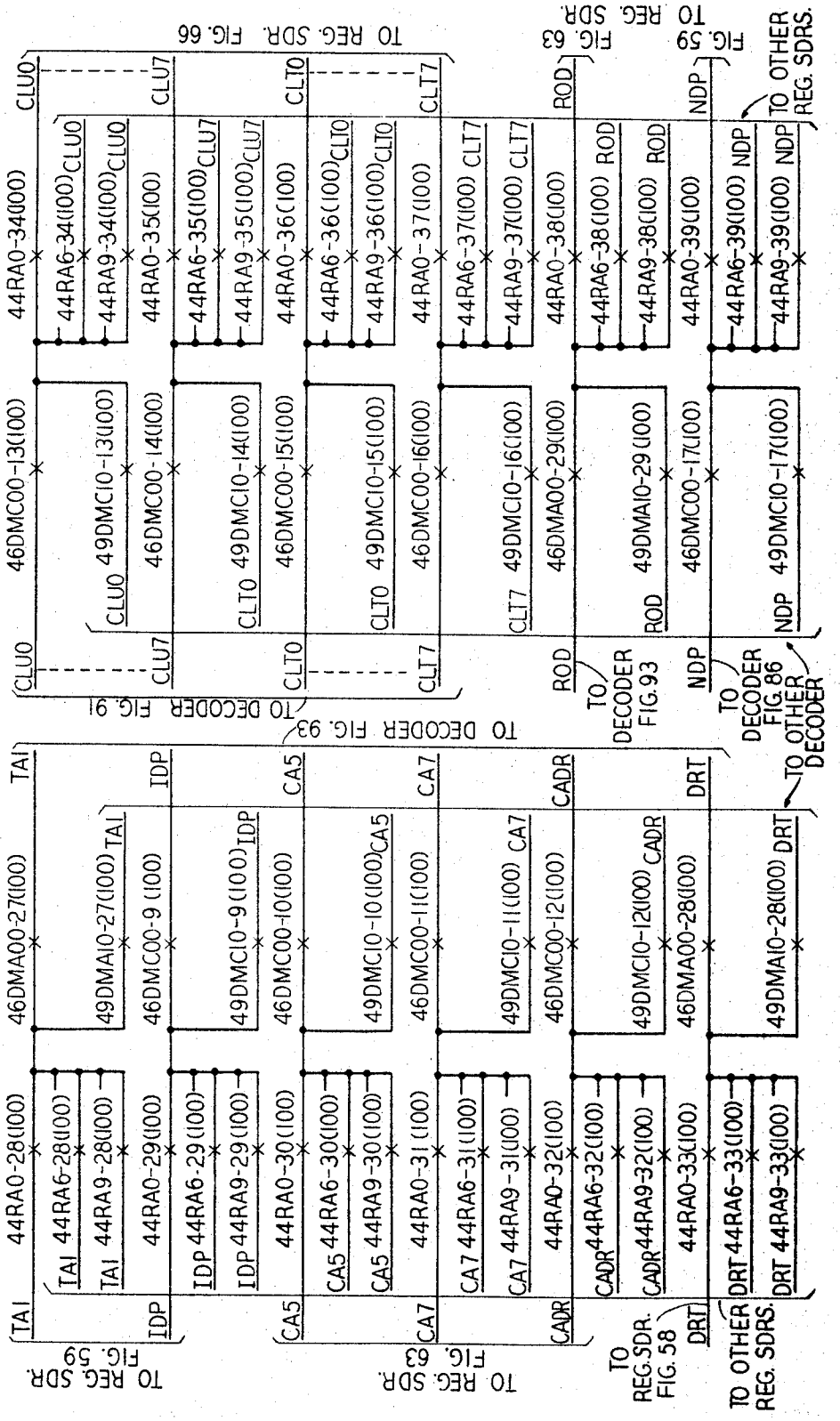

FIG 99
TO REGISTER SENDER FIG. 62
TO DECODER FIG. 85
TO DECODER FIG. 84
TO OTHER REG. SDRS.
TO OTHER DECODER
TO DECODER FIG. 93
TO DECODER FIG. 80
TO REG. SDR. FIG. 63
TO REG. SDR. FIG. 58
TO OTHER REG. SDRS.
46DMA00-21(99)
49DMA10-21(99)
44RA0-22(99)
44RA6-22(99)
44RA9-22(99)
46DMA00-22(99)
49DMA10-22(99)
44RA0-23(99)
44RA6-23(99)
44RA9-23(99)
46DMA00-23(99)
49DMA10-23(99)
44RA0-24(99)
44RA6-24(99)
44RA9-24(99)
46DMA00-24(99)
49DMA10-24(99)
44RA0-25(99)
44RA6-25(99)
44RA9-25(99)
46DMA00-25(99)
49DMA10-25(99)
44RA0-26(99)
44RA6-26(99)
44RA9-26(99)
46DMA00-26(99)
49DMA10-26(99)
44RA0-27(99)
44RA6-27(99)
44RA9-27(99)
46DMA00-16(99)
49DMA10-16(99)
44RA0-16(99)
44RA6-16(99)
44RA9-16(99)
46DMA00-17(99)
49DMA10-17(99)
44RA0-17(99)
44RA6-17(99)
44RA9-17(99)
46DMA00-18(99)
49DMA10-18(99)
44RA0-18(99)
44RA6-18(99)
44RA9-18(99)
46DMA00-19(99)
49DMA10-19(99)
44RA0-19(99)
44RA6-19(99)
44RA9-19(99)
46DMA00-20(99)
49DMA10-20(99)
44RA0-20(99)
44RA6-20(99)
44RA9-20(99)
46DMC00-8(99)
49DMC10-8(99)
44RA0-21(99)
44RA6-21(99)
44RA9-21(99)

FIG. 100


TO REG. SDR. FIG. 66
TO REG. SDR. FIG. 63
FIG. 59
TO OTHER REG. SDRS.
TO DECODER FIG. 91
TO DECODER FIG. 93
TO DECODER FIG. 93
TO DECODER FIG. 86
TO OTHER DECODER
TO REG. SDR. FIG. 59
TO REG. SDR. FIG. 63
TO REG. SDR. FIG. 58
TO OTHER REG. SDRS.
CLU0
CLU7
CLT0
CLT7
ROD
NDP
TAI
IDP
CA5
CA7
CADR
DRT
46DMA00-27(100)
46DMC00-13(100)
46DMC00-14(100)
46DMC00-15(100)
46DMC00-16(100)
46DMA00-29(100)
46DMC00-17(100)
46DMC00-9 (100)
46DMC00-10(100)
46DMC00-11(100)
46DMC00-12(100)
46DMA00-28(100)
44RA0-28(100)
44RA0-29(100)
44RA0-30(100)
44RA0-31 (100)
44RA0-32(100)
44RA0-33(100)
44RA0-34(100)
44RA0-35(100)
44RA0-36(100)
44RA0-37(100)
44RA0-38(100)
44RA0-39(100)
44RA6-28(100)
44RA9-28(100)
44RA6-29(100)
44RA9-29(100)
44RA6-30(100)
44RA9-30(100)
44RA6-31(100)
44RA9-31(100)
44RA6-32(100)
44RA9-32(100)
44RA6-33(100)
44RA9-33(100)
44RA6-34(100)
44RA9-34(100)
44RA6-35(100)
44RA9-35(100)
44RA6-36(100)
44RA9-36(100)
44RA6-37(100)
44RA9-37(100)
44RA6-38(100)
44RA9-38(100)
44RA6-39(100)
44RA9-39(100)
49DMA10-27(100)
49DMC10-9 (100)
49DMC10-10(100)
49DMC10-11(100)
49DMC10-12(100)
49DMA10-28(100)
49DMC10-13(100)
49DMC10-14(100)
49DMC10-15(100)
49DMC10-16(100)
49DMA10-29(100)
49DMC10-17(100)

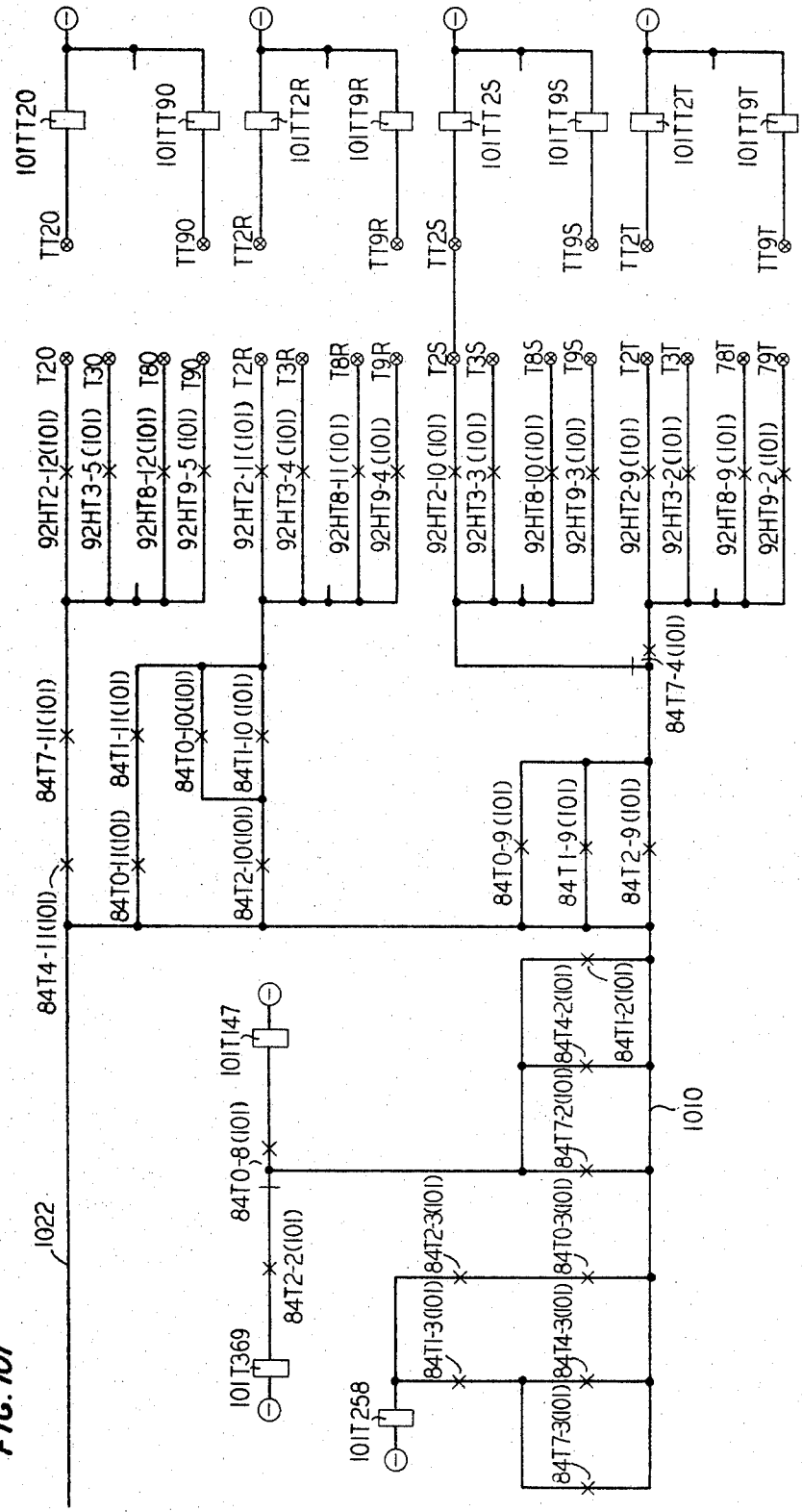

101TT20
101TT90
101TT2R
101TT9R
101TT2S
101TT9S
101TT2T
101TT9T
TT20
TT90
TT2R
TT9R
TT2S
TT9S
TT2T
TT9T
92HT2-12(101) T20
92HT3-5(101) T30
92HT8-12(101) T80
92HT9-5(101) T90
92HT2-11(101) T2R
92HT3-4(101) T3R
92HT8-11(101) T8R
92HT9-4(101) T9R
92HT2-10(101) T2S
92HT3-3(101) T3S
92HT8-10(101) T8S
92HT9-3(101) T9S
92HT2-9(101) T2T
92HT3-2(101) T3T
92HT8-9(101) T8T
92HT9-2(101) T9T
84T7-11(101)
84TI-11(101)
84TO-11(101)
84TO-10(101)
84TI-10(101)
84T2-10(101)
84T4-11(101)
84T7-4(101)
84TO-9(101)
84TI-9(101)
84T2-9(101)
101T147
84TO-8(101)
84T4-2(101)
84TI-2(101)
84T7-2(101)
84T2-3(101)
84TI-3(101)
84T0-3(101)
84T4-3(101)
84T7-3(101)
84T2-2(101)
101T369
101T258
1022
1010

FIG. 101

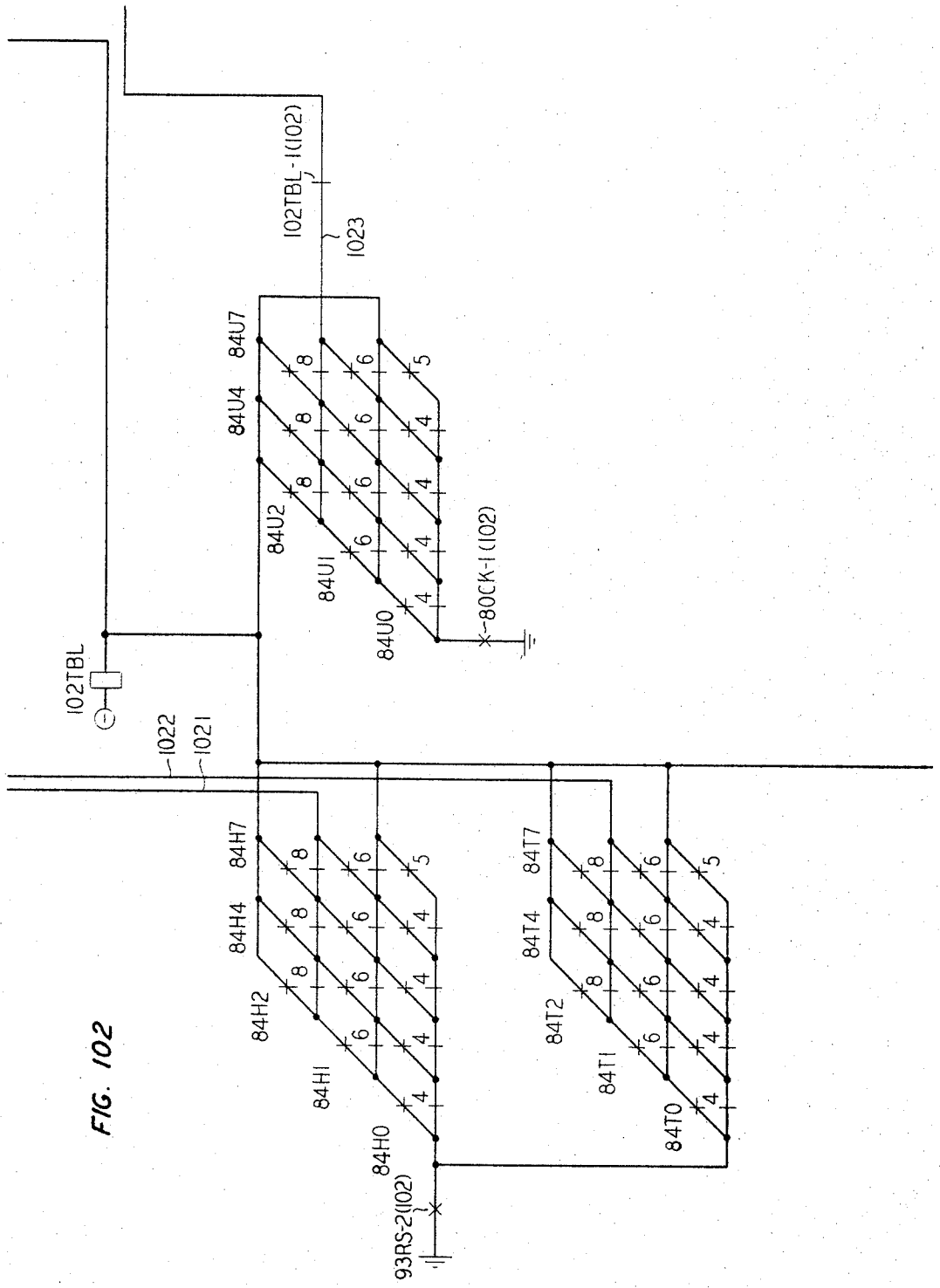

102TBL-1(102)
1023
84U7
84U4
84U2
84U1
84U0
80CK-1(102)
102TBL
1022
1021
84H7
84H4
84H2
84H1
84H0
93RS-2(102)
84T7
84T4
84T2
84T1
84T0

FIG. 102

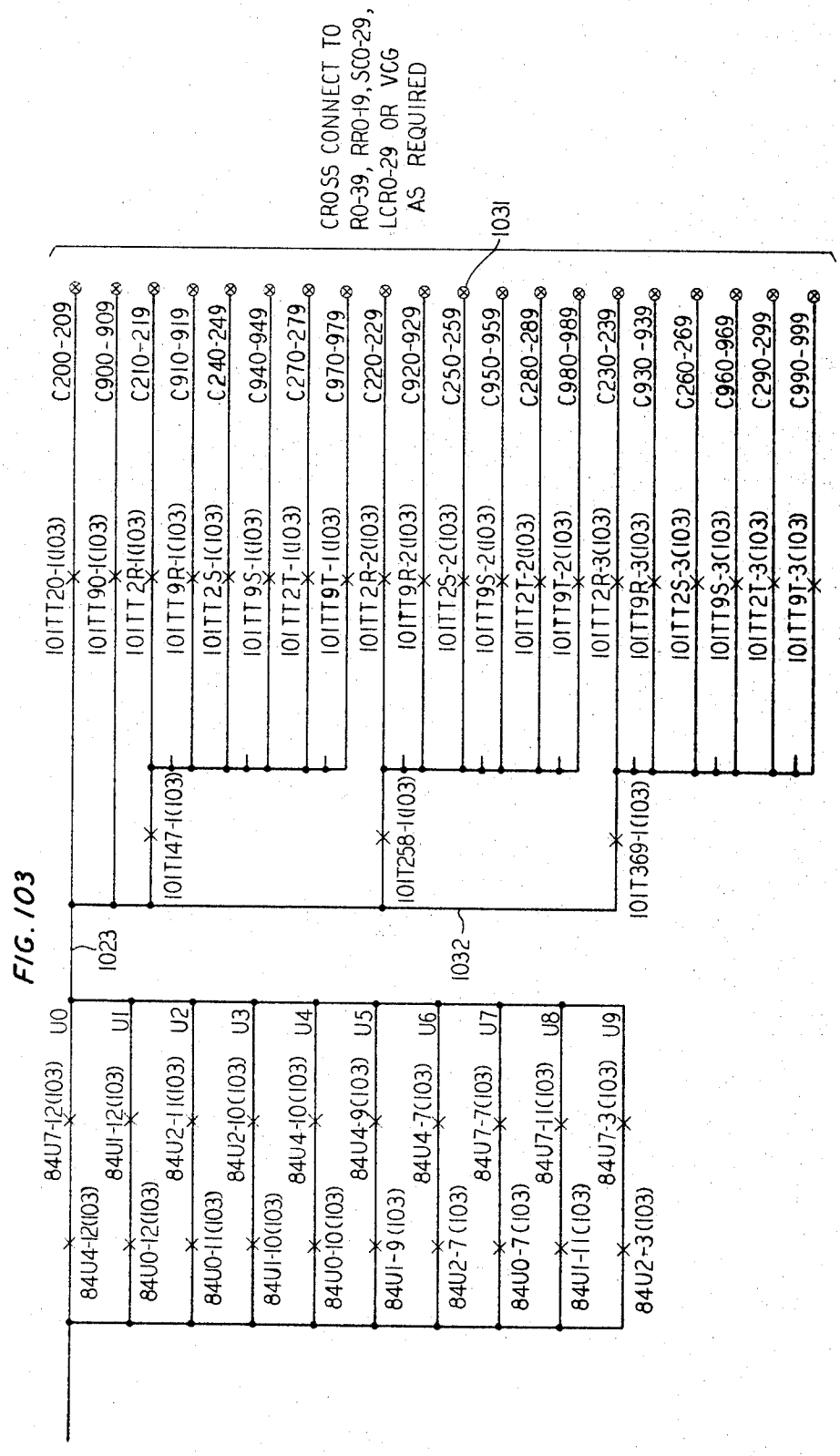

CROSS CONNECT TO
RO-39, RRO-19, SCO-29,
LCRO-29 OR VCG
AS REQUIRED
1031
1032
1023
101T20-1(103)
101T90-1(103)
101T2R-1(103)
101T9R-1(103)
101T2S-1(103)
101T9S-1(103)
101T2T-1(103)
101T9T-1(103)
101T2R-2(103)
101T9R-2(103)
101T2S-2(103)
101T9S-2(103)
101T2T-2(103)
101T9T-2(103)
101T2R-3(103)
101T9R-3(103)
101T2S-3(103)
101T9S-3(103)
101T2T-3(103)
101T9T-3(103)
C200-209
C900-909
C210-219
C910-919
C240-249
C940-949
C270-279
C970-979
C220-229
C920-929
C250-259
C950-959
C280-289
C980-989
C230-239
C930-939
C260-269
C960-969
C290-299
C990-999
101T147-1(103)
101T258-1(103)
101T369-1(103)
U0
U1
U2
U3
U4
U5
U6
U7
U8
U9
84U7-12(103)
84U4-12(103)
84U1-12(103)
84U0-12(103)
84U2-11(103)
84U0-11(103)
84U2-10(103)
84U1-10(103)
84U4-10(103)
84U0-10(103)
84U4-9(103)
84U1-9(103)
84U4-7(103)
84U2-7(103)
84U7-7(103)
84U0-7(103)
84U7-11(103)
84U1-11(103)
84U7-3(103)
84U2-3(103)

FIG. 103

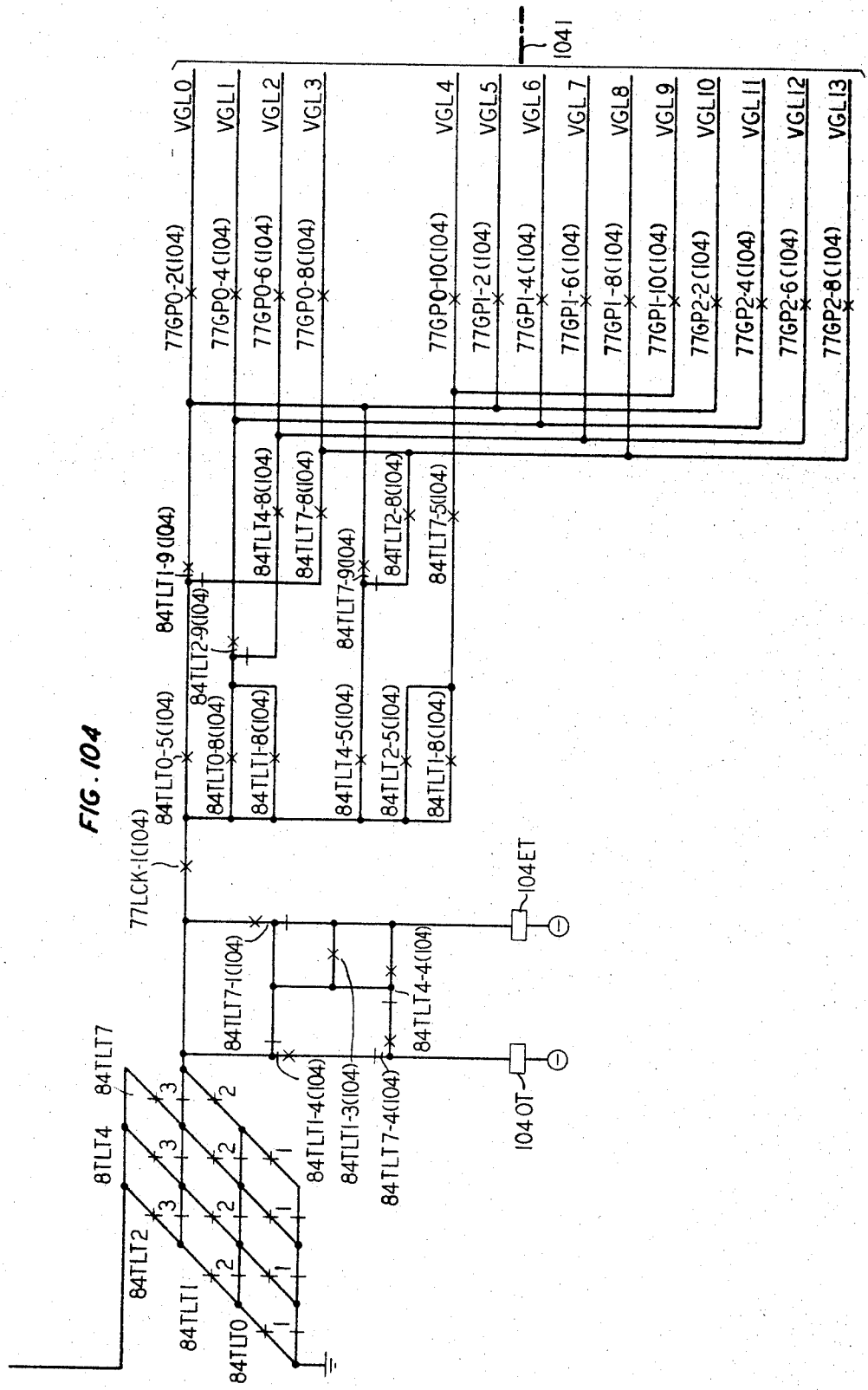

1041
VGL0
VGL1
VGL2
VGL3
VGL4
VGL5
VGL6
VGL7
VGL8
VGL9
VGL10
VGL11
VGL12
VGL13
77GP0-2(104)
77GP0-4(104)
77GP0-6(104)
77GP0-8(104)
77GP0-10(104)
77GP1-2(104)
77GP1-4(104)
77GP1-6(104)
77GP1-8(104)
77GP1-10(104)
77GP2-2(104)
77GP2-4(104)
77GP2-6(104)
77GP2-8(104)
84TLT1-9(104)
84TLT2-9(104)
84TLT4-8(104)
84TLT7-8(104)
84TLT7-9(104)
84TLT2-8(104)
84TLT7-5(104)
84TLT0-5(104)
84TLT0-8(104)
84TLT1-8(104)
84TLT4-5(104)
84TLT2-5(104)
84TLT1-8(104)
77LCK-1(104)
104ET
104OT
84TLT7-1(104)
84TLT4-4(104)
84TLT1-4(104)
84TLT1-3(104)
84TLT7-4(104)
84TLT4
84TLT7
84TLT2
84TLT1
84TLT0

FIG. 104

FIG. 105

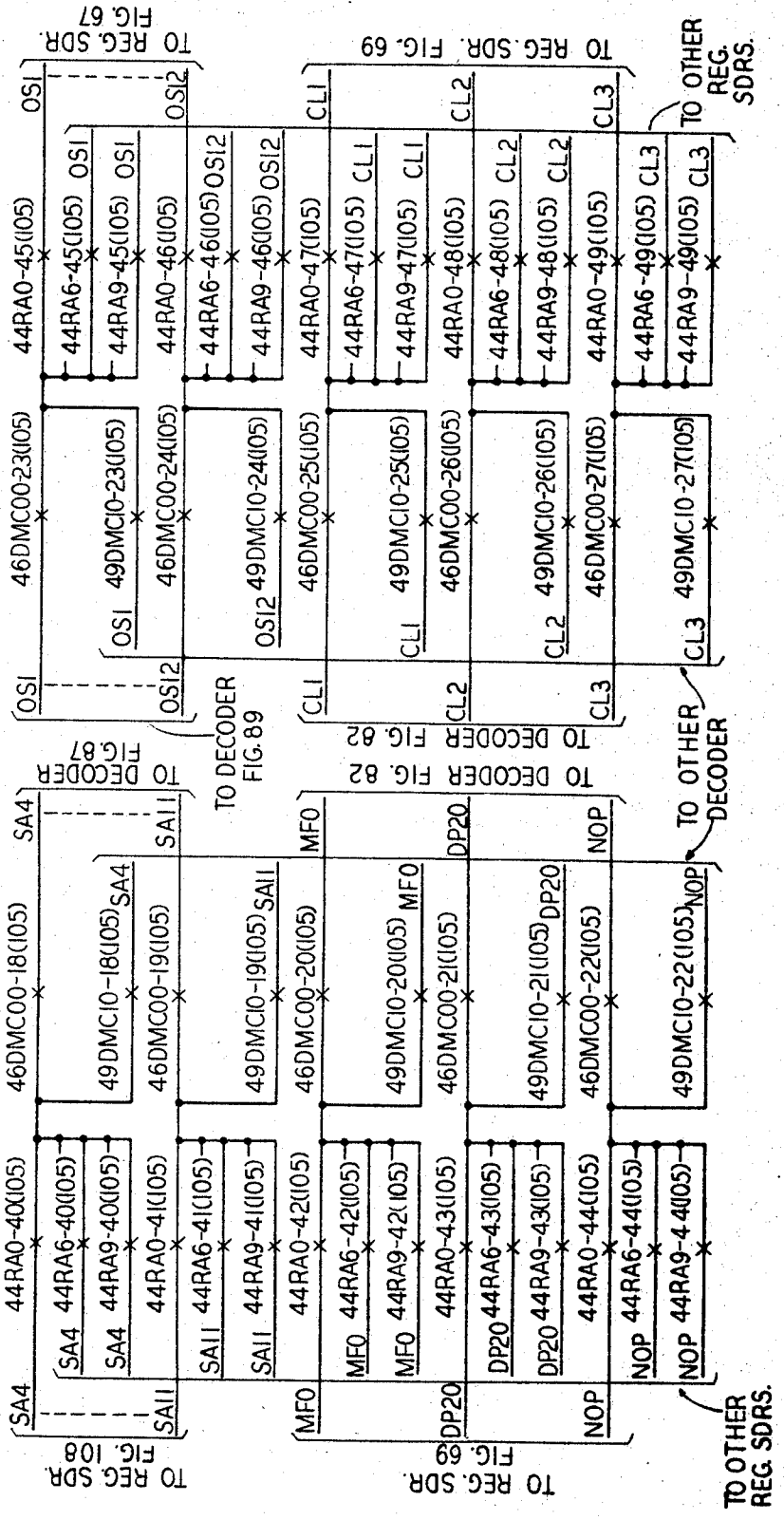
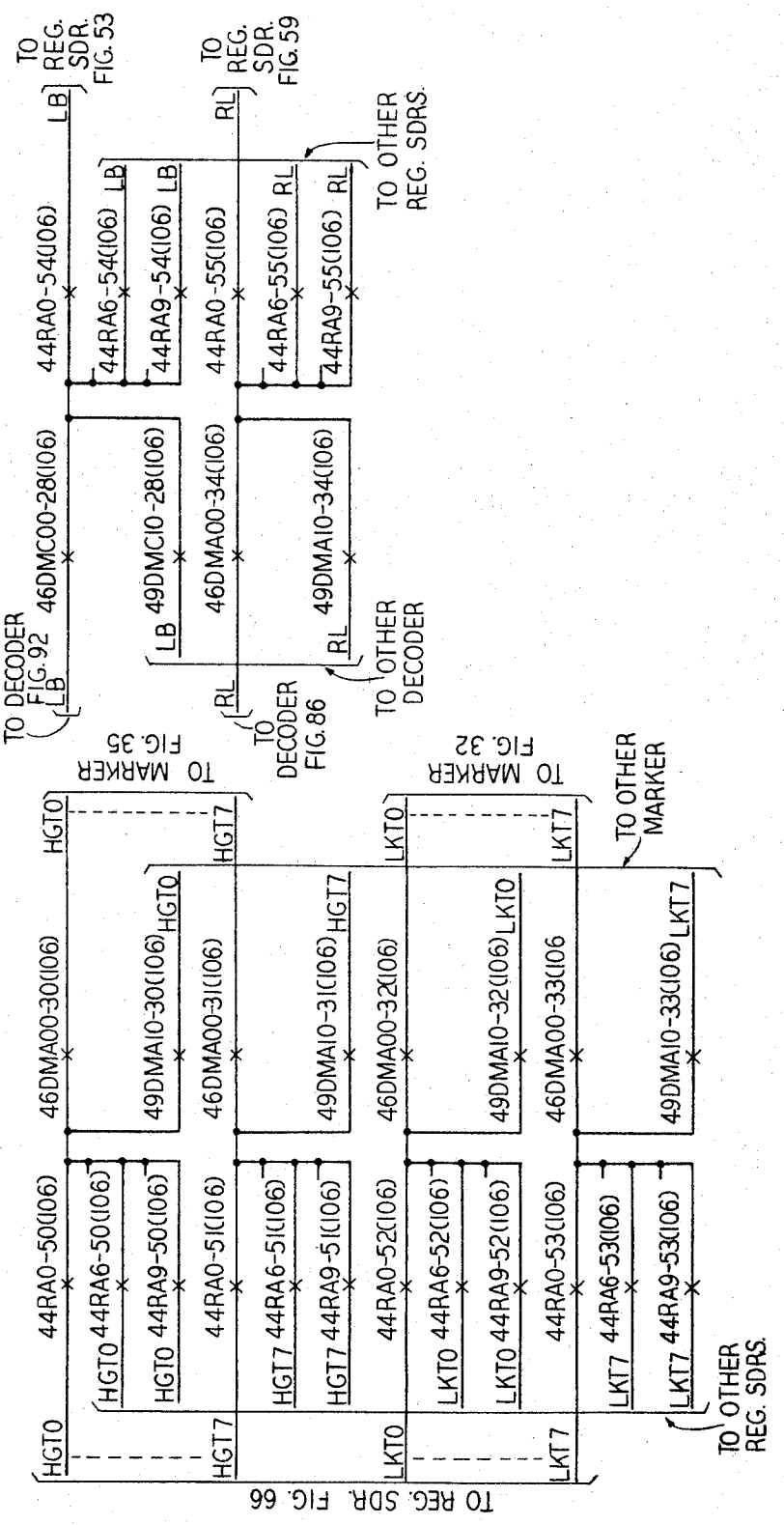

TO REG. SDR. FIG. 67
TO REG. SDR. FIG. 69
TO OTHER REG. SDRS.
TO DECODER FIG. 89
TO DECODER FIG. 82
TO OTHER DECODER
TO DECODER FIG. 87
TO DECODER FIG. 82
TO REG. SDR. FIG. 108
TO REG. SDR. FIG. 69
TO OTHER REG. SDRS.
OSI
OSI2
CLI
CL2
CL3
SA4
SAII
MFO
DP20
NOP
44RA0-45(105)
44RA6-45(105)
44RA9-45(105)
44RA0-46(105)
44RA6-46(105)
44RA9-46(105)
44RA0-47(105)
44RA6-47(105)
44RA9-47(105)
44RA0-48(105)
44RA6-48(105)
44RA9-48(105)
44RA0-49(105)
44RA6-49(105)
44RA9-49(105)
46DMC00-23(105)
49DMC10-23(105)
46DMC00-24(105)
49DMC10-24(105)
46DMC00-25(105)
49DMC10-25(105)
46DMC00-26(105)
49DMC10-26(105)
46DMC00-27(105)
49DMC10-27(105)
46DMC00-18(105)
49DMC10-18(105)
46DMC00-19(105)
49DMC10-19(105)
46DMC00-20(105)
49DMC10-20(105)
46DMC00-21(105)
49DMC10-21(105)
46DMC00-22(105)
49DMC10-22(105)
44RA0-40(105)
44RA6-40(105)
44RA9-40(105)
44RA0-41(105)
44RA6-41(105)
44RA9-41(105)
44RA0-42(105)
44RA6-42(105)
44RA9-42(105)
44RA0-43(105)
44RA6-43(105)
44RA9-43(105)
44RA0-44(105)
44RA6-44(105)
44RA9-44(105)

FIG. 106


TO REG. SDR. FIG. 53
TO REG. SDR. FIG. 59
TO DECODER FIG. 92
TO DECODER FIG. 86
TO OTHER DECODER
TO OTHER REG. SDRS.
TO MARKER FIG. 35
TO MARKER FIG. 32
TO OTHER MARKER
TO REG. SDR. FIG. 66
TO OTHER REG. SDRS.
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)
46DMA00-30(106)
49DMA10-30(106)
46DMA00-31(106)
49DMA10-31(106)
46DMA00-32(106)
49DMA10-32(106)
46DMA00-33(106)
49DMA10-33(106)
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)
HGT0
HGT7
LKT0
LKT7
LB
RL

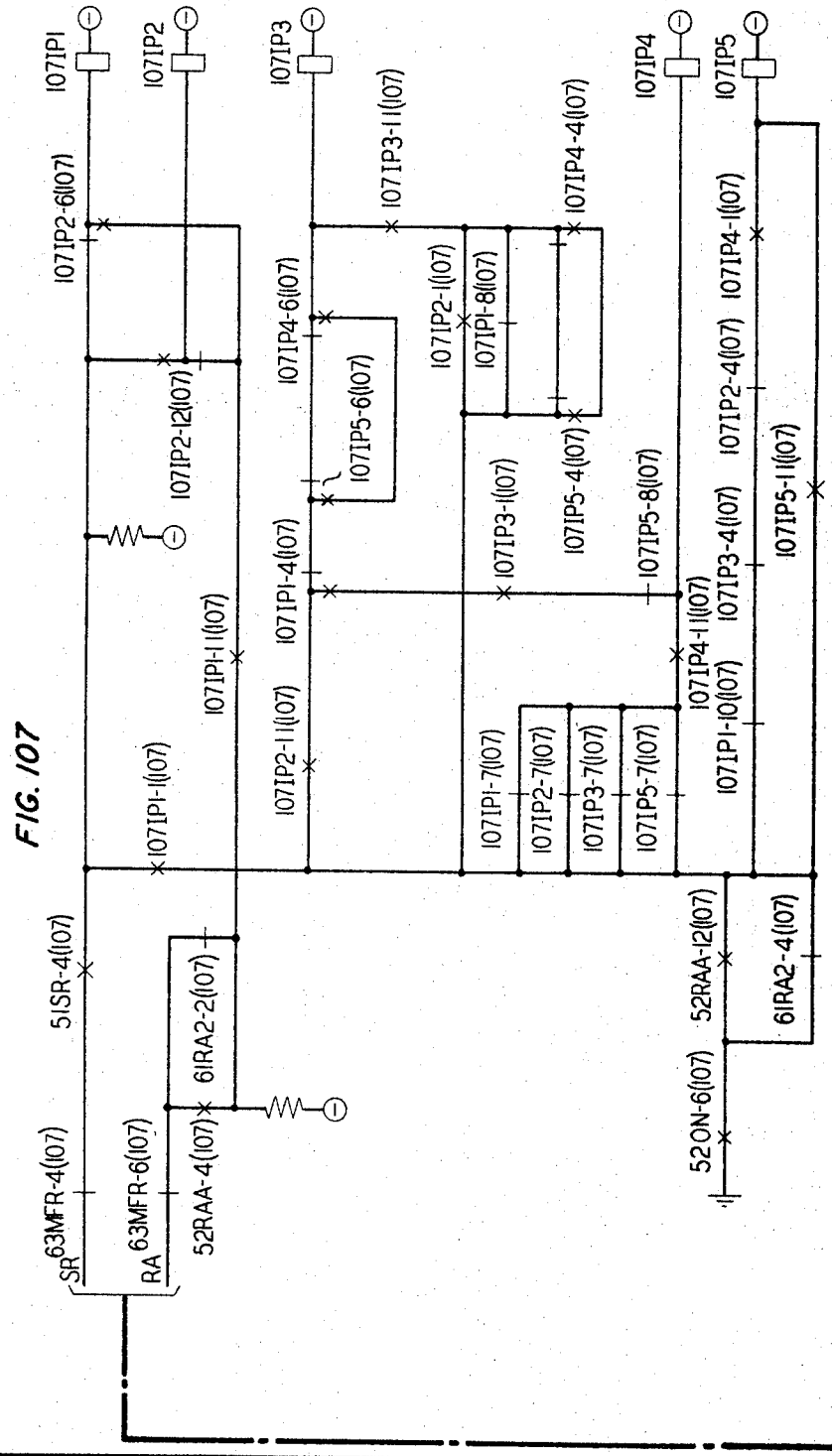

107IP1
107IP2
107IP3
107IP4
107IP5
107IP2-6(107)
107IP2-12(107)
107IP4-6(107)
107IP5-6(107)
107IP3-11(107)
107IP2-11(107)
107IP1-8(107)
107IP4-4(107)
107IP5-4(107)
107IP1-4(107)
107IP3-1(107)
107IP5-8(107)
107IP1-11(107)
107IP2-11(107)
107IP1-7(107)
107IP2-7(107)
107IP3-7(107)
107IP5-7(107)
107IP4-11(107)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

FIG. 107

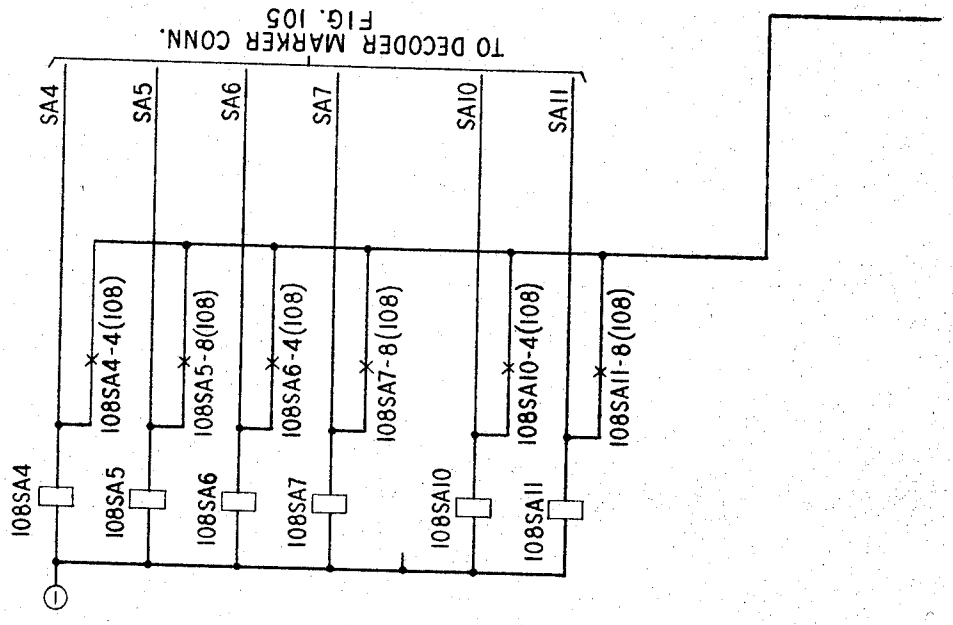

TO DECODER MARKER CONN.
FIG. 105
SA4
SA5
SA6
SA7
SA10
SA11
108SA4-4(108)
108SA5-8(108)
108SA6-4(108)
108SA7-8(108)
108SA10-4(108)
108SA11-8(108)
108SA4
108SA5
108SA6
108SA7
108SA10
108SA11

FIG. 108

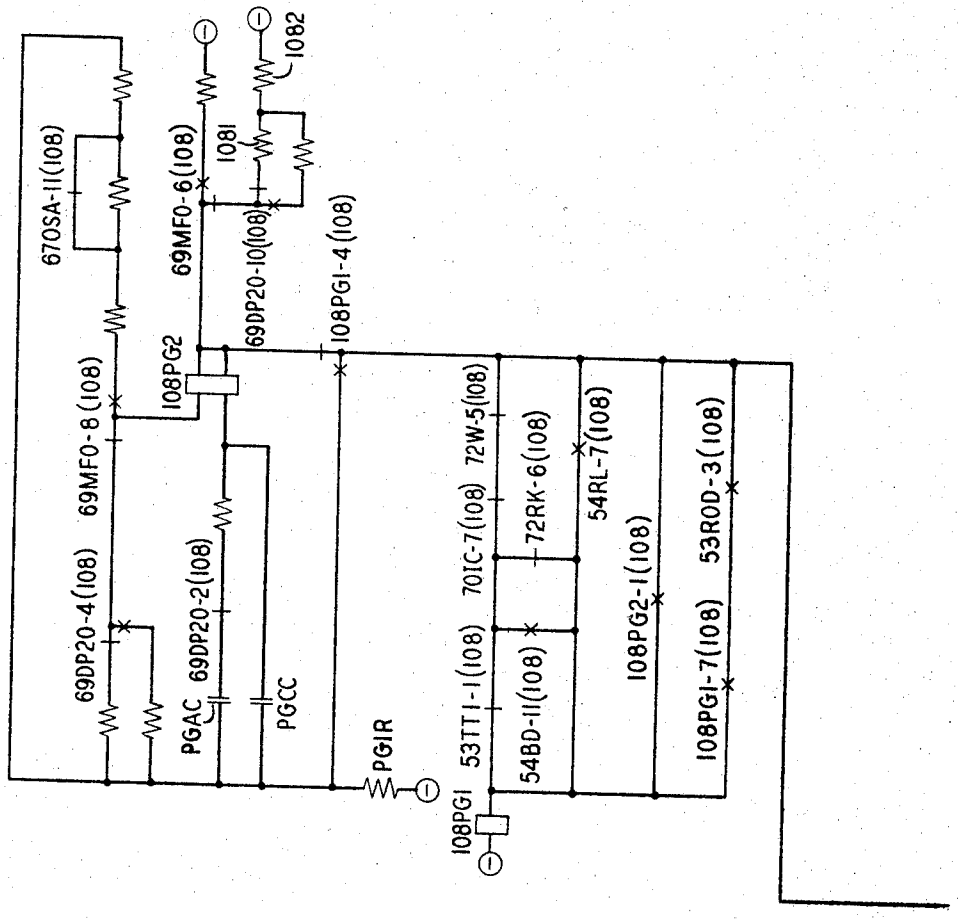

670SA-11(108)
69MF0-6(108)
1081
1082
69DP20-10(108)
108PG1-4(108)
108PG2
69MF0-8(108)
69DP20-4(108)
69DP20-2(108)
PGAC
PGCC
PGIR
108PG1
53TT1-1(108)
701C-7(108)
72W-5(108)
72RK-6(108)
54RL-7(108)
54BD-11(108)
108PG2-1(108)
53ROD-3(108)
108PG1-7(108)

FIG. 109

FIG.4	FIG.2																							
FIG.5	FIG.3	FIG.108	FIG.70	FIG.69	FIG.64	FIG.67	FIG.43	FIG.46	FIG.49	FIG.100														
FIG. 97	FIG.6	FIG.107	FIG.71	FIG.72	FIG.73	FIG.68	FIG.44	FIG.47	FIG.50	FIG.105														
FIG.10	FIG.7	FIG.57	FIG.62	FIG.65	FIG.66	FIG.60	FIG.45	FIG.48	FIG.99	FIG.106														
FIG.8	FIG.9	FIG.55	FIG.51	FIG.53	FIG.58	FIG.61	FIG.80	FIG.85	FIG.95	FIG.76														
FIG.12	FIG.13	FIG.56	FIG.52	FIG.54	FIG.59	FIG.63	FIG.81	FIG.84	FIG.78	FIG.79														
FIG.15	FIG.16	FIG.26	FIG.29	FIG.31	FIG.35	FIG.39	FIG.92	FIG.101	FIG.87	FIG.93														
FIG.18	FIG.19	FIG.27	FIG.30	FIG.32	FIG.36	FIG.40	FIG.102	FIG.103	FIG.89	FIG.91	FIG.75													
FIG.21	FIG.22	FIG.28	FIG.98	FIG.33	FIG.37	FIG.41	FIG.88	FIG.74	FIG.82	FIG.90	FIG.86													
FIG.24	FIG.25			FIG.34	FIG.38	FIG.42	FIG.104	FIG.77	FIG.83	FIG.94	FIG.96													
FIG.23																								

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3,410,960

NO-TEST OR BUSY VERIFICATION IN A PRIVATE BRANCH EXCHANGE TELEPHONE SYSTEM

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ABSTRACT OF THE DISCLOSURE

We disclose a crossbar automatic private branch exchange telephone system in which no-test or busy verification connections are established from a no-test facility to a busy line or trunk by way of a link other than that used in an existing call connection and a multiple occurrence of the busy line or trunk. The network is arranged in a plurality of horizontal groups of crossbar switches, each line and trunk circuit having a multiple termination in each horizontal group. When a no-test connection is to be made the marker treats the no-test facility as an originating line, selects an idle link and attempts to establish the connection. If the line to be verified is idle, the connection is thus established as a normal originating connection. When the marker examines the operative state of the crosspoint through which the selective link has access to the line or trunk to be verified and finds it to be already closed, then the marker recycles and selects another idle link in a different horizontal group for the no-test connection.

This invention relates to a private branch exchange telephone system and more particularly to a private branch exchange telephone system which includes facilities for establishing no-test connections.

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 through the PBX, as well as calls from the extensions to subscribers served 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 disclosed in Patent 2,904,637, issued Sept. 15, 1959 to R. D. Williams.

It is common practice to provide in the larger central offices means whereby so-called "no-test" connections can be completed to an existing, i.e., a "busy," call connection. Such connections may be completed, for example, for "busy verification" purposes, that is to permit an attendant to cut in on an apparently busy connection in order to determine whether a call is actually in progress or that the busy indication has resulted from a "trouble" condition. It has been recognized that there is a need for this type of facility in connection with automatic private branch exchanges of the larger type and, indeed, such arrangements have been provided in that environment to some extent. However, since there is inherent in such facilities the ability of an attendant or a repairman to cut in on a busy line, a function ordinarily denied to personnel of an automatic private branch exchange, it will be apparent that the provision of these facilities in such environment involves major problems in connection with circuit and equipment design.

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 facilitate the completion of no-test connections in an automatic private branch exchange system.

In accordance with a specific embodiment of our invention a four-wire, crossbar, common control PBX is used for switching tandem calls among two-wire and four-wire PBX's and also for switching locally terminated four-wire stations. Ten horizontal rows of fourteen six-wire crossbar switches are arranged in a vertical stack, thus providing 280 vertical terminations each having access to 100 horizontal links. The links are multipled across all switches in the same horizontal row. Lines, trunks, register senders and no-test facilities are terminated on the vertical appearances and may be selectively interconnected by any of the 100 horizontal links.

Since the network termination of each line and trunk of the PBX is multipled through all horizontal groups of switches, whereby all links are accessible to each line or trunk, it follows that each horizontal group of switches includes a hold magnet which is discrete to each line or trunk terminated on the network. Accordingly, more than a single connection can be made to any line or trunk by operating hold magnets discrete thereto in more than one horizontal group thereby connecting two separate links to the same line or trunk. (Of course, the select magnets defining the links must also be momentarily operated.)

The no-test facility is terminated, as are all other functional circuits of the system, on a vertical multiple of the network thus giving it access to all links. A no-test connection is initiated similarly to origination of a regular call, that is by establishing a connection from the no-test facility through a link to a register sender. A specific address code is then dialed into the register sender; the dialed code includes the number of the busy line or trunk to which the no-test connection is desired. A marker is seized to control the establishment of the no-test connection, and, as in the instance of a normal call connection, the marker attempts to reuse the link previously utilized to connect the no-test facility to the register sender. However, as a no-test connection involves a further connection to a busy line or trunk already in use for an existing call, one of the hold magnets discrete to the busy line or trunk is already operated and cannot be used to complete the no-test connection. Accordingly, after the marker has selected an idle link for the no-test connection, it examines the operative state of the switch crosspoints through which the selected link has access to the busy line or trunk. If the crosspoints are found to be already closed, the marker recycles and selects another idle link in a different horizontal group for completion of the no-test connection.

In the above type of connection the original calling line and the no-test facility may be considered as "call initiating circuits," the busy called line as a "call completing circuit" and the holding magnets associated with the terminations of the busy called line as "means for indicating whether or not a connection is established with said termination."

A feature of the invention is the termination of a no-test facility on a vertical multiple of the switch network whereby to give access by the facility to all horizontal links of the network.

A further feature of the invention is the provision of a plurality of links for establishing a connection between a no-test facility and a busy terminal and means for selecting and closing an idle one of said links.

A still further feature of the invention is means for determining the operative state of crosspoints included in a tentative link between a no-test facility and a busy terminal and for releasing the link if the crosspoints be found to be already closed.

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. 1 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;

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 over-all understanding of the arrangement contemplated, a brief general description will be given at this point with reference particularly to FIG. 1. Referring therefore to FIG. 1 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 multi-frequency 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. 1 only two four-wire station line circuits, circuit A designated **151** and circuit B designated **152**, and only two 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.

Link and connector **157** includes a single-stage rectangular crossbar switch array (not separately shown in FIG. 1 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. In the system being described it will be assumed that the first three digits of the address define the area and office code of the destination of the call. When the first three digits of an address have been received by a register sender, the decorder is engaged and, from a translation of these three 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 of particular significance in the present instance and which will be further discussed subsequently is a no-test connection. The 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 over-all 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 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 operations, 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 in-

terest are Patent 2,868,884 issued Jan. 13, 1959 to J. W. Gooderham et al.; Patent 2,981,804 issued Apr. 25, 1961 to H. H. Abbott et al.; and Patent 3,099,719 issued July 30, 1963 to A. E. Gerbore 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 station associated with four-wire station line circuit A (**151**), goes off hook whereby to initiate a call. Decoder-marker connector **161** assigns the "dial tone" request 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 line circuit A, **151**.

The process of selecting a link involves signaling link and connector **157** to connect the horizontal group testing leads. An idle 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 register 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 station line 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, line circuit **151** 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 decoder **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 call-initiating station has received dial tone over station line circuit A, **151**, the customer starts dialing the code of the desired station which station will be assumed for present purposes to be "locally terminated" that is either locally served by the same PBX or by an-PBX which "homes" on the presently described PBX. 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 dialed. In the instance of a trunk initiated call the number of digits controlling is four while in the instance of a line-initiated call the number of digits controlling is three; in the present instance since the call was initiated by a line, **151**, the connection of the decoder and marker to the register sender takes place upon the dialing of three digits.

Upon its connection register sender **158** transmits to the decodder **155** information concerning the dialed 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; in the event of a "locally originated" call there will be no route control digit). Decoder **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 dial tone 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.

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 line circuit (rather than a trunk), link and connector **157** returns information on all vertical files which are in the hunting group. Marker **156** tests the group of lines, selects an idle one and operates a connector relay in the selected line.

When the particular line 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 line. 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 connector **161** indicating that these circuits are ready for use in connection with additional calls.

In accordance with the novel arrangement contemplated, 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 regis-

ter 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 different than the link already used in the existing connection. Each line and trunk has a multipled 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 lines. While this connection prevails, the receive channel of the originating circuit (four-wire) and the transmit channel of the terminating circuit (four-wire) are opened in the respective circuits. In this way, incoming digits are received at the register and transmitted by the sender (both units of the register sender) simultaneously. When all digits have been transmitted to the connecting office, register sender **158** signals the originating circuit (in the illustrative described example, four-wire station line circuit A, **151**) to close the receive channel and signals the terminating circuit to close the receive channel and reverse the transmit and receive channel. 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. 1), although, since it is recognized that in an actual installation two decoder-marker combinations would be provided, circuit features may be referred to from 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 inventive aspects involved in the establishment of a no-test connection, there will first be described in detail the circuit functions and operations involved in the completion of a typical call which is initiated by an extension associated with one of the four-wire station line circuits of the PBX and which is directed to (and completed to) an extension associated with another four-wire station line circuit of the system. Subsequently, the completion of a no-test connection will be described with particular regard to the specific functions involved which are peculiar to establishment of such connection. Such method of disclosure appears best since many of the basic functions involved in establishment of the no-test connection are inherent in the station line-to-station line connection.

While some reference will be made from time to time to functions involved particularly in completion of tandem calls involving the two-way, four-wire, trunk circuits which are illustrated, such functions will not be described completely in detail since this particular type of connection is described in detail in the copending application of R. J. Jaeger and G. Riddell, Ser. No. 438,229, filed Mar. 9, 1965, now Patent No. 3,394,232, issued July 23, 1968.

It is believed that understanding of the following description will be furthered if there is supplied at this point a brief schedule of the existing involved terminations and the subsequently completed terminations. Specifically, the calling station line A is terminated on vertical file 0, vertical group 0 and horizontal group 0 of the switch while the called station line B, to which the connection is subsequently completed, is terminated on vertical file 19, vertical group 13 and horizontal group 0 of the switch. The register sender selected for the call is terminated on vertical file 19, vertical group 6 and horizontal group 0 of the switch and the link utilized for connecting the calling line to the register sender and subsequently to the called line is link 0 of horizontal group 0.

With regard to the subsequently described no-test connection, the no-test facility is terminated on vertical file 17, vertical group 13 and horizontal group 0 of the switch and the "first" link utilized, that is for connecting the no-test facility and the selected register sender, is assumed to be link 5, horizontal group 0. Since, as subsequently described, this "first" link cannot be utilized for the connection of the no-test facility to the "busy" called line, a "second" link is established which is assumed to be link 9, horizontal group 5.

Station line-to-station line call

Accordingly, for purposes of further detailed description, it will be assumed now that the station associated with four-wire station line circuit A (FIG. 2) goes off hook whereby to initiate a call; at this point we are concerned, of course, with the "originating connection." Relay **2L1** operates over the **T1** and **R1** leads of the transmit side or channel of the line and through the station loop, now closed as the station is off hook. Relay **2L1**, operated, closes at make contact **2L1–2(4)** an operate path for relay **4SR**.

Relay **4SR**, operated, closes at make contact **4SR–6(4)** an operate path for relay **4SR1**; relay **4SR1** operates and

transfers the operate path of relay 4MC to lead LT at the make contact of transfer pair 4SR1–8(4), connects battery and ground through the windings of relay 2L to the T and R leads of the receive channel of the line at make contacts 4SR1–6(2) and 4SR1–5(2), and closes at make contact 4SR1–4(4) the connection of ground to lead VGS0; this ground acts as a "start" signal and is transmitted over lead VGS0 to operate vertical start group relay 44VGS0 of the decoder-marker connector circuit.

It should be pointed out here that the four-wire station line circuit A referred to above is assumed to be connected to vertical group 0 of the crossbar switch, being in fact connected to vertical file 0 of that group.

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 (FIG. 48) 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 leads" 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 relay 34ONG to the ground on lead ONG; relay 34ONG upon operating locks to the same ground through make contact 34ONG–7(34). Relay 34ONG, while operated, supplies through its several 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(31) and the respective break contacts of the transfer pairs of the other 36VGL– relays, all released.

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 line. 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 19CCA0, and relay 19CCA0 upon operating 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 36VLCK–1(39) and the make contact of transfer pair 36VGL0–7(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 a line or 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 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 calling line 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 position of the description is terminated in vertical group 6 on vertical file 19 of the crossbar switch, lead DA6 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; other 40VGR– relays may be operated also if other register senders are available. The operation of relay 40VGR6, or of 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. Relay 39VRR operated as above described releases relay 39VRE by interrupting the operate path at break contact 39VRR–7(39). With relay 39VRE released the VGR0–VGR13 leads are disconnected from the operate windings of the respective 40VGR– relays; relay 40VGR6, however, is held operated to ground through make contact 36VGL6–6(40). As pointed out above check relay 39VRK will operate when only a single 40VGR– relay is operated; in the present illustrative example relay 39VRK 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 line 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 con-

tacts 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 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 present 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 vertical 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 19RC6–98(24) at that 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 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 orignating line. 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 through 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 14HOL0–14HOL9; 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 difines 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 26HGK.

In the illustrative example being described, it is assumed that the only 35HG– relay remaining operated

in 35HG0 and we have therefore selected horizontal group 0 of the crossbar switch for establishing a connection between the calling line 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 contacts 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 14HOL0, 14HOL5, and 14HOL9, 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 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 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 contacts 34RLSA–6(30) and 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 30LK0, 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 therefore 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 relay 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.

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 4MC or 5MC relay windings of lines and trunk requesting service; in the present illustrative example the 4MC relay 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 the line originating the call in the illustrative embodiment described is terminated in vertical file 0 of vertical group 0, a path is closed from relay 26ET0 over lead LT0 through make contact 19TCA0–20(23) at the link and connector circuit to battery at the winding of relay 4MC of the station line circuit, break contact 4MC1–7(4) of released relay 4MC1 and make contact of transfer pair 4SR1–8(4) being included in the path. (Relay 4SR1 operated following operation of relay 4SR when the station went off hook at the initiation of the call.) Relay 26ET0 operates over the above path whereby to identify termination of the call initiating line circuit as vertical file 0; relay 4MC 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 26ET0 a path is closed for operation of relay 27ETM0 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), make contact of transfer pair 26ET0–2(27), winding of relay 27ETM0 to battery; relay 27ETM0 locks operated through a preference circuit which includes the make contact of transfer pair 27ETM0–10(27) to the ground at make contact 27ETH–1(27).

Relay 27ETM0, operated, closes an operate path for relay 27ETR from ground at make contact 34ONG–20(27) through make contact 27ETM0–11(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 remaining operated over the preference circuit is relay 27ETM0. Since only relay 27ETM0 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), the make contact of transfer pair 27ETM0–8(27), break contact 27ETM16–12(27), the 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 lead LT0 at make contact 27ETK–1(26); with relay 27ETM0 operated this ground shunts the operate winding of relay 26ET0 which releases. Also, this ground extended over lead LT0 operates relay 4MC of the station line circuit since the resistance of the relay 26ET0 is now removed from the path. Ground is now connected to lead MCLK through make contact 4MC–11(4); this ground is applied to marker relay 32MCLK through make contact 27ETK–10(32), and relay 32MCLK operates.

Relay 32MCLK (or relay 32MCTK on a trunk initiated call) must operate before slow-release relay 27ETH has fully released. Provided relay 32MCLK has operated before release of relay 27ETH, a holding ground will be provided for relay 27ETM0 from make contact 34ONG–20(27) through the make contact of transfer pair 32MCLK–8(27) before the original holding ground at make contact 27ETH–1(27) has been lost by release of relay 27ETH. If relay 27ETM0 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 line.

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

Class-of-service indication

The operation of relay 4MC in the station line circuit as described above closes through the leads by way of which line class-of-service information is forwarded to the marker. Among other information, the class of service of a line indicates the type of signaling for which the line is equipped, that is dial pulsing, multifrequency or TOUCH-TONE; whether or not dial tone is required to be returned to the line; 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 line which initiated the call in the illustrative example is class of service 0; this indicates that the station associated with the line requires dial tone and is equipped for dial pulsing.

Operation of relay 4MC as previously described connects ground through make contact 4MC–2(4) to lead CSU0 and through make contact 19TCB0–00(23) of the link and connector to operate marker relay 37CU0. "One-only-operated" check relay 37CUK now operates from ground, make contacts 34ONGA–3(37) and 39DTA–8(37), the make contact of transfer pair 37CU0–12(37), break contact 37CU5–4(37), break contact of transfer pair 37CU9–1(37), winding of relay 37CUK to battery.

Class of service registered in register sender

A path is now closed for connection of ground to lead DT (FIG. 41) through make contacts 32MCRK–12(41), 37CUK–4(41) and 37CU0–8(41), diode 41LDP1D being included in this path; the same ground is also applied to lead DP through diode 41LDP2D. Lead DT and DP extend the ground through respective make contacts 19RC6–20(24) and 19RC6–22(24) of the link and connector circuit to operate relays 63DT and 63DP of the reigster sender; relays 63DT and 63DP upon operation lock to ground at make contact 59MC1–23(63), relay 59MC1 having operated following operation of relay 63MC as described above. The locking ground is now transmitted back over leads DT and DP through the paths previously traced and causes relays 41DTK and 41DPK to operate. The operation of relays 41DTK and 41DPK indicates the registration of the class of service in the register sender as evidenced by operation of relays 63DT and 63DP.

Operation of relay 37CUK as just described, with relay 32MCRK previously operated, closes an operate path for relay 41CSG from ground, make contact 37CUK–2(41), break contact 34RLS–11(41), make contact 32MCRK–2(41), winding of relay 41CSG 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 41CSG–1(33) and 37CUK–3(33) and through make contacts 41CSG–2(33) and 37CUK–1(33) and through the 2-out-of-5 translator to leads CLU0 and CLU7, through make contacts 19RC6–40(25) and 19RC6–44(25) of the link and connector for operating relays 66CLU0 and 66CLU7 of the register sender. Upon operation, relay 66CLU0 locks through make contact 66CLU0–1(66) to ground at make contact 52ON–7(66) and relay 66CLU7 locks to the same ground through make contact 66CLU7–1(66). In turn, this locking ground is returned over leads CLU0 and CLU7 whereby to operate marker relay 33CUK1 through the left winding to battery and to operate marker relay 33CUP2 through the right winding to battery. Relays 33CUK1 and 33CUK2 are the "check" relays for relays 66CLU0 and 66CLU7 respectively 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 41CSG–7(37) through the 2-out-of-5 translator to leads CLT0 and CLT7 for operation of relays 66CLT0 and 66CLT7 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 66CLT0 and 66CLT7 upon operating lock to ground at make contact 52ON–7(66) and this ground is returned to operate the respective checking relays 37CSTK0 and 37CSTK7 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 ten "incoming" leads.

Paths are completed through make contacts 41CSG–5(33) and 26HGK–9(33) and make contacts 41CSG–6(33) and 26HGK–3(33) and through the 2-out-of-5 translator to leads HGT0 and HGT7, and through make contacts 19RCA6–30(25) and 19RCA6–34(25) of the link and connector for operating register-sender relays 66HG0 and 66HG7; these relays lock to the ground at make contact 52ON–7(66) and the ground is returned over the leads to operate check relay 33HGK1 through the left winding to battery and to operate check relay 33HGK2 through the right winding to battery.

Also, paths are completed through make contacts 41CSG–3(33) and 30LKK–6(33) and make contacts

41CSG–4(33) and 30LKK–4(33) and through the 2-out-of-5 translator to leads LKT0 and LKT7 for operation of relays 66LK0 and 66LK7 of the register sender. As in the previously described examples the relays lock to ground at make contact 52ON–7(66) and this ground is transmitted back over the leads to operate marker check relay 33LKK1 through the left winding to battery and to operate check relay 33LKK2 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 line 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 21VG0HG0 and 21VG6HG0; the first-mentioned relay defines the vertical group in which the line which initiated the call appears and the horizontal group selected by the marker and the second-mentioned relay defines the vertical group 6.

Marker battery is applied to lead VH0 through break contacts 38RCY–5(30) and 34RLSA–5(30), make contacts 26HGK–11(30) and 39VLCK–4(30), make contact of transfer pair 39DT–11(30), make contact 39V–RCK–4(30), make contact of transfer pair 35HG0–7(30) to lead VH0. Since relay 19CC0 defining vertical group 0 and relay 19CC6 defining vertical group 6 were previously operated as described above, a path is now completed from lead VH0 through make contact 19–CC0–20(21) for operating relay 21VG0HG0 and a second path is completed from lead VH0 through make contact 19CC6–20(21) for operating relay 21VG6HG0.

Paths are now closed, described immediately below, for operating relays 42VHL and 42VHR whereby to verify the operation of relays 21VG0HG0 and 21VG6–HG0 in the link and connector circuit.

The operate path for relay 42VHL extends from ground, make contact 32MCLK–2(42), winding of relay 42VHL, resistor VHL, break contact of transfer pair 98HM–10(42), make contact 27ETM0–4(42) to lead HM0 and thereover to the marker, through make contacts 19TC0–20(17) and 21VG0HG0–20(17) and the winding of hold magnet 17HM000 to battery. Relay 42VHL operates over this path but the hold magnet 17HM000 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 contacs 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 21VG6HG0–18(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 18HM600 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 designation that hold magnet 17HM000 is associated with vertical group 0, horizontal group 0, and file 0 while hold magnet 18HM6019 is associated with vertical group 6, horizontal group 0 and 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), 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 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 horizontal group 0. Battery is connected through break contacts 38RCY–4(30) and 34RLS–4(30), the make contact of 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) 16SM–000 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, make contacts 36VGL0–2(32) and 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 37XT1–4(98) and 41XT2–9(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 34ONG–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 HM0 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 HM0. It will be recalled that lead RHM19 is connected through to the winding of hold magnet 18HM6019 and to battery and that lead HM0 is connected through to the winding of hold magnet 17HM000 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 17HM000 (line) 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 HM0.

Relay 42HKR, operated, completes an operate path for relay 98HKRA from ground, make contact 34ONGA–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 34ONGA–2(98), break contact 34RLS–8(33), 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 34ONGA–2(98); relay 98HKLA operates and locks to the same ground through its make contact 98HKLA–5(98).

When the hold magnet (17M000) for the call-initiating line and the hold magnet (18HM6019) for the selected register sender operate as above described, the line 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 17HM000 is associated with vertical file 0 of vertical group 0 of the crossbar switch and with horizontal group 0 thereof and that the call-initiating line is connected to vertical file 0 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 initiating line 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(33) 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 line 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 63TTTC–51(51) to lead TT, through the operated cross-points of the link, to the station line cicuit (FIG. 2) which initiated the call, the break contact of transfer pair 4RV–12(2), one winding of the repeat coil, make contact 4MC–6(2), upper winding of relay 2RSS, make contact 2L1–1(2), break contact of transfer pair 4PS–11(2) to ground, relay 51L operates over this path whereby to indicate the connection of the register sender to the line circuit but relay 2RSS 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 53TA1–7(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 2SL of the call-initiating line circuit and therethrough to battery; relays 2SL and 51SL both operate over this path. Relay 2SL, operated, connects ground through make contact 2SL–12(2) to lead HM0 for transmission to the link and connector circuit (FIG. 17) whereby to provide holding ground for hold magnet 17HM000 (line) through off-normal contact 17HM000–2(17). The holding paths referred to above for hold magnets 18HM6019 and 17HM000 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), 56 MFP–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 dialing is started.

As mentioned above, at the time the holding grounds are supplied to hold magnets 17HM000 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" 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).

Relay 34RLS, operated, releases 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 46DMS0 of the connector are released by removal of the holding battery.

Release of relay 46DMS0 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–1(81), 81CB–2(81) and 81CB–5(81) from leads CB0, CB00 and CB01 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 contact 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 resistors RL1 and effectively removes it from the previously-traced path over lead TT to relay 2RSS of the station line circuit. Through removal of resistor RL1 the overall resistance of the path is reduced sufficiently to result in operation of relay 2RSS.

In the event the call being described had been trunk-initiated, the operation of relay 2RSS would serve as a "go" signal to the incoming trunk. However, as here the call was initiated by a station line circuit, the operation of relay 2RSS merely indicates that relay 52STG in the register sender has operated.

As previously described above, relay 63DT was operated from the marker whereby to indicate that the initiated call was a "dial tone" call, that is that dial tone should be returned to the initiating source. Accordingly, an operate path for relay 52DT1 is now closed from ground, make contacts 52ON–24(52) and 63DT–9(52), break contacts 63MC–7(52), 61TTP–4(52), 56MFP–9(52) and 52DPD–10(52), make contact 52STG–2(52), winding of relay 52DT1 to battery. Dial tone from the tone source 511 is now applied through the make contact of transfer pair 52DT1–10(51) and the make contact of transfer pair 52DT1–11(51) and through the transformer windings to leads RT and RR for return to the extension connected to station line circuit A (FIG. 2).

Dialing of called party code

Upon receipt of the "go" signal in the way of dial tone, the originating customer will proceed to dial the code of the desired party; the register sender awaits the dial pulses which it expects to receive. (As previously described above, relay 63DP was operated from the marker to indicate that dial pulses are expected from the intiating line.)

As the initiating-station user proceeds to dial, relay 2L1 will follow the dial pulses in the usual manner, and sender relay 51L will operate in step with relay 2L1.

Relay 51L, operating in step with relay 2L1 of the station line 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 or 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 2L1 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 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, 107IP4
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, 10IP2, 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 operated, relay **61RA1** starts its release as the operate path is interrupted at break contact **52RAA–3(61)**. When relay **61RA1** has fully released, relay **61RA2** releases as the operate path is interrupted at make contact **61RA1–2(61)**.

Relay **52RAA**, when operated as just described, removes at break contacts **52RAA–1(57)** and **52RAA–2(57)** the ground from the 2-out-of-5 matrix of contacts of the **107IP1–107IP5** relays (FIG. 57). However, at the end of a digit when relays **52RAA** and **61RA2** are released, ground is then supplied through the matrix according to the released-operation condition of the respective **107IP1–107IP5** relays and through the make contacts of transfer pairs **60IS1–1(62)** and **60IS1–7(62)** whereby to operate a particular two of the **62A–** relays of the "A" digit register in accordance with the well-known 2-out-of-5 translation and registration procedure. (Relay **60IS1** is operated as described immediately below.)

Relay **61RA1**, which is slow both to operate and to release, starts to operate but permits the **62A–** relays to fully operate before closing the operate path of relay **61RA2**; operation of relay **61RA2** 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 **61RA2**, the operated **107IP–** relays release as their holding ground is interrupted at break contact **61RA2–4(107)**. The first release of relay **51L** 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 **62A–62E** and **65F–65M** as required.

Insteering control includes the folowing operations. Relay **60IS1** operated when the register sender was seized from ground, make contact **52ON–8(61)**, break contact of transfer pair **52RAA–7(61)**, make contact of transfer pair **61RA2–9(61)**, intervening break contacts, break contact of transfer pair **60IS1–6(60)**, winding of relay **60IS1** to battery. On receipt of the first pulse of the first dialed digit, relay **52DPD** operates following operation of relay **52RAA** from ground, make contacts **51SR–10(52)**, **52RAA–8(52)**, **60IS1–8(52)**, break contact **56MFP–12(52)**, make contact of transfer pair **52DPD–6(52)**, winding of relay **52DPD** to battery; relay **52DPD** operates and locks to the ground through the make contact of its transfer pair **52DPD–6(52)**.

Relay **52DPD**, operated, opens the operate path of relay **60IS1** at break contact **52DPD–7(61)** in preparation for the advance of the steering chain. Relay **60IS1** holds operated through the make contact of its transfer pair **60IS1–6(60)** and through the break contacts of respective transfer pairs of succeeding steering relays.

At the end of the first digit when relay **51L** holds operated, relay **52RAA** releases, after a delay of about 100 milliseconds, and closes an operate path for relay **60IS2** from ground at make contact **52ON–8(61)**, break contacts of transfer pairs **52RAA–7(61)** and **61RA2–9(61)**, make contact **52DPD–9(61)**, break contact **61ADR–9(61)**, leads **611** and **601**, make contact of transfer pair **60IS1–9(60)**, break contact of transfer pair **60IS2–6(60)**, winding of relay **60IS2** to battery; relay **60IS2** operates and locks through the make contact of its transfer pair **60IS2–6(60)** and leads **602** and **612** to the ground at make contact **52ON–8(61)**.

With relay **60IS2** operated, digital information received is stored in the **62B–** digit register since the 0–7 digit leads are connected thereto through make contacts of the respective transfer pairs **60IS2–1(62)** and **60IS2–7(62)**. After the third digit is received, relay **60IS3** is operated and relay **60IS2** 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 **59DR** causes the operation of relay **64OSA** if multifrequency outpulsing is required or operation of relay **64OSB** if a priority digit is to be outpulsed without multifrequency. If no priority digit or multifrequency pulsing is required, relay **64OSC** will be operated on outgoing tandem calls and relay **64AUX** on terminating calls.

Assuming, merely by way of illustration, operation of relays **64OSB** and **67OSC** by the decoder, advance of the outsteering chain is under control of make contact **72W–4(64)** of relay **72W**. On dial outpulsing calls, relay **72W** operates during the interdigital interval and releases prior to outpulsing of the next digit. On multifrequency outpulsing, relay **72W** operates each time a digit is being transmitted and releases at the end of the digit. The locking path of relay **64OSB** is transferred to be under control of relay **72W**. Operation of relay **64OSC** opens the original operate path of relay **64OSB** and the registered digit information is available for outpulsing. When relay **72W** operates as or after the next digit is outpulsed, relay **64AUX** operates and locks to an off-normal ground. The locking path for relay **64OSC** is transferred to be under control of relay **72W**; when relay **72W** releases, the release of relay **64OSC** follows. Release of relay **64OSC** leaves the outsteering circuit with relays **64AUX** and **64OS3** operated with the information in the C digit position available for outpulsing. When the information in the C digit position is next outpulsed, relay **72W** operates whereby to operate relay **67OS4**; 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 **108PG1–108PG2**), the pulse counting relays (**70P1–70P5**), and the digit control relays. When a stored digit is to be outpulsed the read-out relays **71RR0–71RR10** operate. A 2-out-of-5 check is made of the stored digits and the check relay **72RK** is operated. The pulse generator is enabled, as described below, and starts to pulse the digit. The pulsing counting relays count pulses and match against the digit on the **71RR–** relay; when a match is reached the **70IC** relay operates to terminate the digit.

When relay **51SR** operates, relay **108PG1** operates from the ground at make contact **51SR–10(52)**, break contacts **72W–5(108)**, **70IC–7(108)**, **53TT1–1(108)**, winding of relay **108PG1** to battery. Relay **108PG1**, operated, connects this same ground through the make contact of transfer pair **108PG1–4(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 **108PG2**. At this point the right terminal of the windings of relay **108PG2** 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 this 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 **108PG2** to release.

The circuit remains in this condition until the auxiliary circuit to relay **108PG1** is opened and that relay releases. Relay **108PG1**, 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, an 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 **69MFO–1(70)**, make contact **52ON–6(70)**, of 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.

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 out-

going 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 received 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 line circuit, the bid is made after registration of the third digit.

When a third digit has been received and stored in the register sender, relay 60IS3 is in operated position and a path is closed for operating relay 60IS4. For a short transition interval between the receipt of the third digit and the start of the fourth digit, both relays 60IS3 and 60IS4 will be operated. Immediately following the registration of the C 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 63DT–12(59), break contact of transfer pair 62A0–10(59), make contacts 60IS3–11(59) and 60IS4–11(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 appled to the lower winding through make contact 59STA–4(59).

Relay 58DMST, operated as just described, closes at make contact 58DMST–7(59) the connection of battery of 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 DM1 whereby to operate relay 46DMS0 through the break contact of transfer pair 46CBO–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 whereas 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 line connection and will not be again described in detail at this point. As a result of the circuit sequences at this time, relays 46DMA00 and 46DMC00 are operated, these relays being associated with the preferred marker and decoder. The operation of relays 46DMA00 and 46DMC00 establish 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.

As pointed out above the originating circuit in the presently described situation has been indicated to be a local completing type. Local completing routes are routes that do not go out to other tandem switching centers; the decoder is arranged to handle such routes in three different ways dependent upon the number of trunks, the vertical group assignment and the identifying three-digit code.

In the situation where the three-digit code identifies the route and the trunk group is assigned in more than one vertical group on the link, a separate route relay is required for each route. The route relay contacts are then cross-connected to give the proper outpulsing information to the register sender for routing the call. A trunk group test relay would be provided to supply vertical group and vertical file information to the marker and to make a "trunk available" check. Four digits of the called number may be pulsed forward to control the terminating connection.

In another situation where the three-digit code identifies the route and the trunk group is assigned in only one vertical group, a 79LCR– (local completing route) relay may be used as a preroute relay. The 79LCR– relay then supplies the vertical group and vertical file information to the marker and operates a route relay which is common to all 79LCR– relays for the trunk groups with the same outpulsing information. The route relay contacts are cross-connected to give the outpulsing information to the register sender circuit. With this arrangement, a trunk group test and trunk-available check is not made. Four digits of the called number may be pulsed forward in this case also to control the terminating connection.

In yet another situation the three-digit code may be used for a number of local completing routes in which event the vertical group and vertical file are identified by the three-digit code and thousands and hundreds digits of the called digits. The three-digit code will indicate whether the trunk is assigned to vertical Group 0, 1, 2, 3 or 4 (Group 0), vertical Group 5, 6, 7, 8 or 9 (Group 1), or vertical Group 10, 11, 12, or 13 (Group 2). The particular vertical group and vertical file information is obtained from the thousands and hundreds digits of the called digits and from the Group 0, 1 or 2 indication.

Additional decoder operations

It will be recalled from the above description that the first three digits dialed by the calling station associated with the four-wire station line circuit of FIG. 2 had been received and registered in the register sender prior to seizure of the marker. These three digits are now transferred to the decoder which will determine, as described subsequently, whether or not the three digits represents 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 line (not a trunk); this information was derived from operation of relay 63DT in the register sender during establishment of a dial tone connection as described above.

The decoder is arranged to process calls from a calling station, with no route control digit, and from an incoming trunk with a route control digit preceding the called number. If the call is initiated by a local calling station, as in the present illustrative example, 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. If the call had been initiated by an incoming trunk, on the other hand, 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.

In the present instance, relay 80DT of the decoder operates from the ground applied to lead DT through make contact 63DT–11(63), and through make contacts 44RA0–20(99) and 46DMG0–20(99), and closes at make contact 80DT–12(80) and operate path for relay 80CNA; since relay 80DT is the only relay in the 80DT, 80NDT and 80PD group which is operated, relay 80CNA now operates from ground, the make contact of transfer pair 80DT–4(80), the respective break contacts of transfer pairs 80NDT–6(80) and 80PD–6(80), break contact 93ROD–2(80), make contact 80DT–12(80), winding of relay 80CNA to battery.

Relay 80CNA, one of the digit connector relays, upon operating, closes at make contacts as 80CNA–1(85), 80CNA–5(85), 80CNA–8(85), 80CNA–12(85), 80CNA–13(84) and 80CNA–17(84), leads A0–A7, B0–B7 and C0–C7 through to the digit register relays 84H0–84H7 (hundreds), 84T0–84T7 (tens) and 84U0–84U7 (units). The digit register relays now operate in accordance with the information stored in the digit registers of the register sender and now transmitted therefrom to the decoder over the A–, B– and C– leads.

Having registered the digits in the decoder, and since this is a call initiated by a local calling station with no route contol digit registered, an "all-down" check of the 85RC– relays is now carried out. With all 85RC– relays released, check relay 80CK now operates from ground, the respective break contacts of transfer pairs 85RC0–4(80), 85RC1–4(80), 85RC2–4(80), 85RC4–4(80), 85RC7–4(80), make contacts 80DT–10(80), 81ON–1(80), 93RS–1(80), winding of relay 80CK to battery; operation of relay 80CK indicates proper registration of the digits in the decoder.

Now that the three digits of the area and office code have been registered, 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 pairs 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 the 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 tens 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– relays (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 A–, B– and C– 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 101TT27 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 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.

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 connections 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 line which initiated the call is class of service "0"; this class indicated that the station associated with the line referred to requires dial tone and is equipped for dial pulsing. This class of service indication is stored in the register sender for 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 two-out-of-five code; for class "0," ground would be transmitted over leads CLU4 and CLU7 whereby to operate decoder class-of-service relays 91CLU4 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 CU0 and CS0 are cross connected so that with relays 91CLU4 and 91CLU7 operated, as just described, class screening relay 91CS0 will be operated from ground, respective break contacts of transfer pairs 91CLU0–4(91), 91CLU1–4 (91), 91CLU2–4(91), respective make contacts of transfer pairs 91CLU4–4(91) and 91CLU7–6(91), make contacts 91CLU4–1(91) and 91CLU7–1(91), winding of relay 91CS0 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 novel 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 "service 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 91CS0 is operated as described above, the operate path for route relay 94R0 is now extended through make contact 91CS0–00(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 screen 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 95TSTB–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, starts to release when relay 95TSTB has fully released and interrupted the operate path for relay 95TSTC at make contact 95TSTB–4(95).

Relay 77TGT0 operates following operation of route relay 94R0 from ground, break contact 75MRCY–11(77), make contact 94R0–9(77), terminal GI0 cross connected to terminal TGT0, winding of relay 77TGT0 to battery; relay 77TGT0 operates and closes through at make contacts 77TGT0–00(74) and 77TGT0–23(74), leads VGS0 and VGS13 to the marker.

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 80CNA operated follow-

ing seizure of the decoder and this was followed by operation of relay 80CK. Transmitting leads connector relays 81TLC1 and 81TLC2 now operate from ground, make contacts 80CK–7(81) and 80CNA–6(81) and to battery through the respective relay windings. Operation of relay 81TLC1 connects "SA4"–"SA11" terminals (FIG. 87) to corresponding leads SA4–SA11 while operation of relay 81TCL2 connects terminals "OS1"–"OS12" (FIG. 89) to corresponding leads OS1–OS12. Prior to operation of the 81TLC1 relay the SA4–SA11 terminals are connected over lead 871 to the winding of relay 89XTL1, and prior to operation of relay 81TCL2 the OS1–OS12 terminals are connected over lead 891 to the winding of relay 89XTL2. The 89XTL1 and 89XTL2, 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 previously referred to above.

The SP (start pulsing) terminal (FIG. 89) associated with route relay 94R0, that is terminal 892, 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 respective relay, in this instance terminal 831, with the terminals NOP; D10; D20; MF. The respective leads DP20; NOP; MF0; 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 impulsed 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 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 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 contact 95TGS–7(82), make contact of transfer pair 83CL2–3(82), break contact of transfer pair 83CL1–11(82) to lead CL2.

In the instance of the establishment of a connection between the register sender and a terminating trunk, the marker requires that the decoder supply the link location of the trunk in terms of vertical group and vertical file. In such a situation a trunk group test relay, 77TGT–, is operated. In the presently described call, however, a connection is being completed to a station associated with a four-wire station line circuit as line circuit B, FIG. 5.

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 initiating line and the register sender was transmitted to the register sender. This stored information is transmitted back to the marker on the terminating connection; the marker completes the connection to the called line using this link identifying information previously stored in the register sender.

When the proper number of digits were registered in the register sender, as previously described, the decoder was reseized with a second seizure indication and a signal on one of the "CA–" leads to indicate the proper number of digits registered. Relay 80CNE then operates whereby to cut through the proper digit leads as F0–F7 and G0–G7 to the 84TLT0–84TLT7 and 84TLU0–84TLU7 relays. The thousands digit of the called number is registered on the terminating line tens relays 84TLT0–84TLT7 and the hundreds digit of the called number is registered on the terminating line units relays 84TLU0–84TLU7 on a two-out-of-five basis.

When the 77GP– relay operates on the second seizure, relay 77LCK operates from ground, break contact 74MRCY–11(77), make contact 94R0–9(77), terminal G10 cross connected to terminal GP0, make contact 77GP0–12(77), make contact of transfer pair 802S–11(77), winding of relay 77LCK to battery; relay 77LCK operates and locks to ground through make contact 77LCK–12(77), break contact 75MRCY–10(77) and 80CK–10(77). Operation of relay 77LCK completes a path for translation of the thousands and hundreds digits of the called number into vertical group and vertical file information for the marker as follows.

It will be assumed that the information received from the register sender is such that relays 84TLT0 and 84TLT1 of the terminating line tens relays are operated and that relays 84TLU2 and 84TLU7 of the terminating line units relays are operated. It will be recalled from previous description that relay 77GP0 is operated. Relay 1040T (odd tens) now operates from ground, the respective make contacts of transfer pairs 84TLT0–1(104) and 84TLT1–2(104), the respective break contacts of transfer pairs 84TLT2–3(104), 84TLT4–3(104) and 84TLT7–3(104),

make contact of transfer pair 84TLT1–4(104), break contact of transfer pair 84TLT7–4(104), winding of relay 1040T to battery. Ground is also applied from the contact matrix just referred to, make contacts 77LCK–1(104) and 84TLT0–5(104), make contact of transfer pair 84TLT1–9(104), make contact 77GP0–2(104) to lead VGL0.

At the same time ground is applied through the respective break contacts of transfer pairs 84TLU0–1(88) and 84TLU1–1(88), make contact of transfer pair 84TLU2–1(88), break contact of transfer pair 84TLU4–2(88), make contact 84TLU7–2(88), break contact of transfer pair 104ET–6(88), make contact of transfer pair 1040T–6(88), make contacts 77LCK–2(88), and 84TLU2–5(88), make contact of transfer pair 84TLU7–9(88), make contact 1040T–12(88) to lead VFT–19.

Further operations of marker

Ground is now applied to lead VGL0 and VFT19 for transmission to the marker. (In order to simplify the drawing the leads are schematically shown as included in respective cables 1041 and 881 which are simulated by heavy dash-dot lines.)

It should be pointed out here that when relay 77LCK of the decoder operates, as above described, an operate path was closed for operating relay 42TL of the marker, this operate path being traced from ground, break contact of transfer pair 74TKA–10(75), make contact of transfer pair 77LCK–10(75), make contacts 93RS–9(75) and 77LCK–4(75) to lead TL to the marker and through break contacts 34RLSC–12(42) and 38RCYA–3(42), winding of relay 42TL to battery; relay 42TL operates and locks to ground through the make contact of its transfer pair 42TL–5(42), break contact 38RCY–8(42) and make contact 34DCK–5(42).

Relay 42TL, operated, closes an operate path for relay 31HTC traced from ground, make contacts 34ONG–13(31) and 42TL–12(31), break contact 34RLSA–3(31), winding of relay 31HTC to battery. 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 HGT0 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 46DWA00–31(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 contacts 34ONG–13(31) and 42TL–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 31HGTK 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 35HK0 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) and make contact 31HGTK–4(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) at 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 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, 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 32LKT– 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 32LKT7. Relay 29LKTK now operates from ground, make contact 34ONG–14(29), break contact 34RLS–12(29), make contact 42TL–11(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(39).

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 with 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 contact 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 identification has been recorded in the marker.

As pointed out above, ground is applied over leads VFT19 and VGL0 from the decoder; the ground on lead VFT19 operates relay 42VFT19 of the marker. Each 42VFT– relay corresponds to the vertical files of the crossbar switch and the decoder determines the vertical file through translation of the dialed digit as described above. Relay 27BT now 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 42VFT19–4(27), winding of relay 27BT to battery; operation of relay 27BT permits the marker to test each line

associated with an operated 42VFT– relay in the following manner.

In order to facilitate the description of the calling procedure at this point, it will be assumed that the called line is the illustrated four-wire station line circuit B, FIG. 3; it will be understood that other similar line circuits may be associated in a line-hunting group in accordance with the normal practice. Ground through the winding of relay 26ET19 is now connected through make contacts 42VFT19–5(26) and 27BT–20(26) to lead BT19, through the link and connector matrix (FIG. 23) to the winding of relay 5MC of the station line circuit, the break contact of transfer pair 5SR1–8(5) and break contact 5MC1–7(5) being included in this path.

Relay 26ET19 operates over this path from the battery on relay 5MC; relay 5MC, which is marginal in operation, does not operate at this time. Operation of the 26ET– relay operates the 27ETM– relay associated with the lowest number 26ET– relay which is operated. In the present instance relay 27ETM19 operates from ground, make contact 34ONG–20(27), break contacts 38RCY–6(27) and 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) and 27ETK–2(27), break contacts of transfer pairs 42TT–5(27) and 26ET0–2(27), break contact 27ETM0–6(27), break contact of transfer pair 26ET16–2(27), break contact 27ETM16–6(27), make contact of transfer pair 26ET19–2(27), winding of relay 27ETM19 to battery; relay 27ETM19 upon operating locks through its make contact 27ETM19–10(27) to ground at make contact 27ETH–1(27).

Relay 27ETR now operates from ground, make contact 34ONG–20(27), make contact 27ETM19–11(27), winding of relay 27ETR to battery. Relay 27ETR, operated, closes the operate path of relay 27ETK through to a one-up-only chain of 27ETM–relay contacts and relay 27ETK now operates from ground, make contact 27BT–21(27), break contacts 34RLSB–4(27) and 26BSY–2(27), break contacts of respective transfer pairs 27ETM0–8(27) and 27ETM16–8(27), make 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 operate path of relay 27ETH which starts to release. (Relay 27ETH has a slow-release characteristic.) Also, relay 27ETK upon operating closes ground through make contact 27ETK–1(26), break contacts of respective transfer pairs 27ETM0–2(26), and 27ETM16–2(26), and make contact 27ETM19–2(26) whereby to shunt relay 26ET19 from its connection to line BT19 and to relay 5MC of the selected line. In view of the lower resistance path to ground now prevailing, marginal relay 5MC operates and connects ground through its make contact 5MC–11(5) to lead MCLK at the station line. This ground operates relay 32MCLK through the make contact of transfer pair 27ETK–10(26) to the battery on the winding of the relay. Relay 32MCLK, operated, provides through the make contact of its transfer pair 32MCLK–8(27) a second locking path for relay 27ETM19 to the ground at make contact 34ONG–20(27).

Select magnet operates on terminating connection

With relay 32MCLK operated, 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 27ETM19–4(42) to hold magnet 18HM13019 of the called line; the hold magnet does not operate at this time. 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 upon operating 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 above, close the path from the battery at break contacts 38RCY–4(30) and 34RLSA–4(30), through make contacts 32MCLK–9(30), 42TL–7(30), break contact of transfer pair 39DT–3(30), make contacts 32VHCK–11(30), 30LKK–11(30), make contact of transfer pair 30LK0–1(30), lead SM0, 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 18HM13019 and relay 42HKL through the make contact of the same transfer pair. 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.

Calling line and called line now connected

Hold magnet 18HM13019, operated, following operation of select magnet 16SM1300, connects the called line to the calling line; it will be recalled that the calling line is connected to horizontal link 0 at vertical file 0 of vertical group 0, horizontal group 0, through operation of hold magnet 17HM000, and the called line is now connected to this same horizontal link at vertical file 19 of vertical group 13, horizontal group 0, through operation of hold magnet 18HM13019. It will be recalled, further, that the selected register sender was connected to this same horizontal link at vertical file 19 of vertical group 6, horizontal group 0, through operation of hold magnet 18HM6019. As a result of the connection referred to, the called line places a ground on the HMH–19 lead to the link and connector circuit; this ground locks the hold magnet operated through make contact 18HM13019–19(18) and also shunts relay 42–HKL in 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 connector; accordingly relay 34DCK releases as the operate path is interrupted at break contact 98HMK–2(34).

As pointed out above, when the marker completed the connection to the four-wire station line circuit B as a terminating call, relay 5MC was operated from ground on lead BT19. Relay 5MC, operated, connected ground to lead MCLK as described above and also connected ground to leads CST and CSU0 through respective make contacts 5MC–1(5) and 5MC–2(5). Also, relay 5MC upon operating closed at make contact 5MC–8(5) an alternate connection to lead BT19, and closed at make contact 5MC–12(5) an operate path for relay 5MC1 through the lower winding thereof.

Relay 5MC1, operated, interrupts one leg of the operate path of relay 5MC at break contact 5MC1–7(5), closes at make contact 5MC1–1(5) a path towards ground at make contact 3SL–2(5), and closes at make contact

5MC1–8(5) a path towards ground at make contact 5SR1–2(5).

The marker operates the hold magnet of the link switch to close the crosspoints as described above and holds the hold magnet until ground is connected to lead HM19 through operation of relay 3SL and closure of make contact 3SL–12(3). Relay 3SL operates from the ground on lead S and connects ground to lead HMH19 as just discussed. Also, relay 3SL, operated, closes the hold path for relay 5MC1 at make contact 3SL–2(5), partially completes at make contact 3SL–4(5) an operate path for relay 5R, and closes at make contact 3SL–1(5) an operate path for relay 5RV, this path also including break contact 5SR1–10(5). Relay 5RV upon operating locks through its make contact 5RV–2(5) to the ground at make contact 3SL–4(5).

Relay 5RV, operated, reverses at transfer pairs 5RV–9(3), 5RV–10(3), 5RV–11(3) and 5RV–12(3) the transmit channel TT–TR and the receive channel RT–RR whereby to operate relay 3S from the ground on the simplex circuit previously discussed above. Also relay 5RV upon operating opens lead ID at break contact 5RV–1(3) whereby to prevent operation of relay 3RRLS, closes at make contact 5RV-3(5) the operate path for relay 5R, prepares at make contact 5RV–6(5) a hold path for relay 5SR, connects ground to lead S through its make contact 5RV–5(3) and make contact 3S–2(3), and opens at break contact 5RV–8(5) the operate path of relay 5RLO.

Relay 3S, operated as above described, completes at make contact 3S–2(3) the above-mentioned path for connecting ground to lead S whereby to hold the 2SL (originating) and 3SL (terminating) relays, and to signal the marker to release in the normal manner.

Called line is rung

Relay 5R, operated, closes at the make contacts of respective transfer pairs 5R–8(3) and 5R–9(3) a path for connecting ringing current to receive channel T–R for operation of the ringer at the associated called station; ringing current is also connected to the transmit channel T1–R1 through capacitor TA and make contact 5R–10(3) and capacitor RA and make contact 5R–11(3) for transmission over the TT–TR channel as audible ringing tone to the originating or calling station.

Called line responds to ringing

When the called station responds to the ringing current by going off hook, relay 3L1 operates through the closed station loop. Relay 3L1, operated, closes at make contact 3L1–2(5) an operate path for relay 5SR which operates and locks to ground through its make contact 5SR–4(5) and make contact 5RV–6(5). Also, relay 3L1 upon operating connects ground through the break contact of transfer pair 5PS–11(3), make contact 3L1–1(3) and resistor RSS, to the transmit channel simplex as an "answer" signal to the originating circuit.

Relay 5SR upon operating closes an obvious operate path for relay 5SR1; relay 5SR1, operated, interrupts the operate path of relay 5R at break contact 5SR1–9(5) and relay 5R releases and removes the ringing current from the called station and the ringing tone from the calling station.

If at the conclusion of the call, the called station associated with four-wide station line circuit B disconnects first, relay 3L1 releases and removes the ground from the transmit channel [at make contact 3L1–1(3)] as a disconnect signal to the origination station. When the originating station subsequently goes on hook relay 2S releases which is followed by release of both relay 2SL (originating) and relay 3SL (terminating).

Relay 3SL, released, releases relay 5RV and also removes ground from lead HMH19 at make contact 3SL–12(3) whereby to release terminating hold magnet 18HM13019 and open the crosspoints. Relay 5RV, released, releases relay 5SR; relays 5SR1 and 5MC1 release in sequence.

If the calling station associated with four-wire station line circuit A had disconnected first, the removal of ground from the receiving channel releases relay 3S; this is turn releases relay 3SL which, in turn, releases the terminating hold magnet and opens the crosspoints. Relay 3SL, released, also releases relay 5RV by interrupting the operate path at make contact 3SL–1(5). When the called station subsequently goes on hook, relay 3L1 releases which, in turn, releases relay 5SR. Relay 5SR, released, releases relay 5SR1 which, in turn, releases relay 5MC1.

Permanent signal operation

In connection with the discussion of the four-wire station line circuits, it should be pointed out that the line relay, as relay 2L1, may occasionally be operated by a "permanent signal" resulting, for example, from an inadvertent "receiver off-hook" condition. Assuming that relay 2L1 is operated under such condition the register sender first operates relay 2S as described above for a regular dial tone connection thereby closing an operate path for relay 4RL0 at make contact 2S–3(4). The register sender subsequently releases relay 2RSS since no digits are received, as a signal to the station line circuit to operate relay 4PS. (Relay 2RSS is also released on a regular dial tone connection if the marker cannot find an idle circuit, i.e., trunk or local station, this being a signal to the station line circuit to return busy tone.)

Relay 4RL0, operated as just described following operation of relay 2S, is held to ground through break contact 2RRLS–12(4) and the make contact of its transfer pair 4RL0–5(4). Accordingly, as relay 2RSS is released an operate path for relay 4PS is closed from ground, break contacts 2RRLS–(4) and 2RSS–7(4), make contact 4RL0–4(4), break contact of transfer pair 4PS–9(4), winding of relay 4PS to battery; relay 4PS operates and locks to ground through the make contact of its transfer pair 4PS–9(4).

Relay 4PS, operated, connects busy tone to the receive channel through make contacts 4PS–10(2) and 4PS–12(2) and respective capacitors RB and TB, and interrupts at break contact of transfer pair 4PS–11(2) the transmit channel simplex as a release signal. At the same time an energizing path for indicator lamp PS is closed at the make contact of transfer pair 4PS–11(2). As soon as the switch crosspoints open, the station line circuit will be isolated from the system until the permanent signal condition is removed.

No-test connections

As pointed out above, for example in the discussion of the showing of FIG. 1, the novel arrangement contemplated is such that calls initiated by the no-test facility are handled in a manner generally similar to that prevailing in the instance of line and 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.

As previously described above, the network termination of each line and trunk is multiplied through all horizontal groups of the crossbar switches so that all the links are accessible to each of the lines and trunks. Therefore, each horizontal group includes a hold magnet which is discrete to each line or trunk terminated on the network. More than a single connection can be made to any line or trunk, therefore, by operating hold magnets discrete thereto in more than one horizontal group thereby connecting two separate links to the same line or trunk. Of course, the select magnets defining the links must also be momentarily operated.

No-test calls are originated in the same general manner as any other call, for example the station-to-station connection described above; that is by establishing a con-

nection from the no-test facility through a link to a register sender. For convenience of description, the no-test facility is assumed to be generally similar to the four-wire station line circuits previously described and is so illustrated in FIGS. 6 and 97. It will be noted, however, that the no-test facility does differ in certain specific details from the four-wire station line circuits previously described. For example, a four-way, four-wre resistance bridge circuits, shown schematically as captioned box **65**, and two four-wire repeaters, shown schematically captioned boxes **66** and **67**, are provided as coupling elements in the transmission path so that the no-test facility user is able to talk to and to listen to both parties on a busy connection after the no-test facility has been connected thereto. These elements may be any one of a number of such devices well known in the communications field; for example the resistance bridge may be of the general type described in the above-referred-to A. E. Gerbore et al, Patent 3,099,719 (FIG. 12).

Ideally, in order to assure against possible interference, only one no-test trunk should be in use in a system at any given time. Accordingly, only one no-test trunk may be provided for each system, or, in the event more than a single no-test trunk is provided, a preference circuit should be used. This circuit, shown schematically as captioned box **987** (FIG. 97), may be any one of a number of such circuits well known in the communications field which will be effective upon activation of one no-test facility of the system to prevent activation of a second no-test facility of the same system until the first has been returned to normal. Relay **97SR** operates following operation of relay **6L1** when the no-test call or connection is initiated; make contacts of this relay are included in the holding paths of various of the relays of the no-test facility including relays **97MC1**, **6RRLS** and **97ALB**.

Break contact **97RLS–25(6)** included in the HMH lead of the no-test facility, FIG. 6, serves to "drop" the register sender and the original dial tone link when the marker "recycles" on the no-test call. In the marker, a path to ground is provided through make contacts **28NT–34(34)** and **28N2TP–34(34)** whereby to maintain this circuit in off-normal condition when the register sender is dropped on the no-test connection.

Each no-test facility is terminated on a vertical file of the crossbar switch similar to the termination of the lines, trunks and register senders. This termination may be at random, with the provision however, that the termination must be on vertical files 17, 18, and 19, and that register senders and no-test facilities should not be terminated in the same vertical group. For purposes of description the no-test facility of FIGS. 6 and 97 is shown terminated on vertical file 17, vertical group 13, of the switch; this termination gives the no-test facility access to all links as described above.

After the connection has been completed to a register sender and dial tone returned to the no-test facility, a special "address code" is then dialed into the register sender; this code includes the number of the busy line or trunk to which the no-test connection is desired, it will be assumed that the "busy line" involved is line "B" referred to above. Ground is applied to class-of-service lead **CSU6** at this time through make contact **97MC–1(97)** and transmitted over lead **CSU6** to the marker whereby to operate the proper class-of-service relay. The no-test call is identified as such by a class-of-service transmission in the register sender. The register sender passes an NT class mark to the decoder which, in turn, passes the no-test mark to the marker along with the normal route information. The no-test class mark signals the marker to ignore the normal busy test and to connect to the busy line.

As in usual call completion, as above described, the marker will attempt to reuse the link previously used for connecting the no-test facility to the register sender. However, as the no-test connection involves a further connection to a busy line already in use on an existing call connection, one of the hold magnets discrete to the busy line is already operated and cannot be used to complete the no-test connection. It is necessary, therefore, for the marker to examine the operative state of the hold magnet discrete to the busy line through which the link used for the register sender connection has access to the busy line. If the marker finds the hold magnet to be released it proceeds to initiate the operation thereof thereby connecting the no-test facility and the busy line to the same link. However, if the hold magnet is found to be already operated, the marker proceeds differently. Both situations are described in detail immediately below.

The no-test call is completed to the dialed terminal, assumed to be four-wire station line circuit B, in a manner generally similar to that described above in the terminating connection of the regular call.

Relay **28NT** is operated by ground on lead NT from the decoder; relay **28NTA** operates over this same path. Accordingly, relay **27BT** does not operate following operation of the **42VFT19** relay as in the instance of the regular connection since the operate path is interrupted at break contact **28NT–3(27)**. Connection of the **26ET19** relay to the line under test is prevented therefore as make contact **27BT–20(26)** is not closed. When the **42VFT19** relay operates, batteary applied through resistor NET and make contacts **28NT–2(26)** and **42VFT 19–5(26)** to the winding of the **26ET19** relay simulates the idle-line condition for the dialed terminal. The remaining action is as described above in connection with the completion of the regular call connection except for the facts that neither the **32MCLK** nor the **32MCTK** relay operates and that the holding path for the operated **27ETM19** relay is completed through make contact **28NT–6(27)**.

The test to determine whether the busy line is connected in the same horizontal group as the group used on the originating portion of the call is initiated when relay **27ETK** operates; it will be recalled that link 0, horizontal group 0 was used in the original connection to line B, and it will be assumed that link 5, horizontal group 0 has been used in the no-test-register-sender connection. As previously described, the hold magnet check begins by connecting the **42VHL** relay through the VHL resistor and over the **HM0–HM19** leads to the hold magnet in the link and connector circuit. In this instance, the ground to the **42VHL** relay is connected through make contacts **27ETK–3(42)** and **28NTA–7(42)** since neither the **32MCTK** relay nor the **32MCLK** relay is operated. Also, relay **27ETK** when operated applies ground through its make contact **27ETK–9(28)**, break contact **32VHCK–4((28)** and make contact **28NT–12(28)** to the operate winding of relay **28NT2T** which has a slow-operate characteristic; when relay **28NT2T** has reached its fully operated position, it locks to ground through its make contact **28NT2T–4(28)** and make contact **28NT–12(28)**.

If the line to be connected were not busy in this horizontal group and the hold magnet path were connected properly, the **42VHL** and **32VHCK** relays would operate in sequence as previously described. If, within the operate period of the slow-to-operate relay **28NT2T**, the **42VHL** relay does not cause the **32VHCK** relay to operate because a holding ground is present on the hold magnet, or the path to the hold magnet is opened, a particular action is initiated by the then operated **28NT2T** relay; this is described immediately below. On the other hand, if the **42VHL** relay does operate before the **28NT2T** relay reaches its operated position, then the connection is completed as in the instance of the normal call completion previously described.

New link selected

The 28NT2T relay, as indicated above, operates when the horizontal group used on the originating connection to the register sender, i.e., horizontal group 0, cannot be extended to the dialed line because the line is busy and is holding one of the hold magnets for this line corresponding to this horizontal group; in the illustrative example the "held" hold magnet is the 18HM13019. Since this hold magnet cannot be released without disturbing the connection, an attempt to connect to the line must be made in a new horizontal group utilizing a different hold magnet appearance of the line; i.e., the connection must be via a link other than link 5, horizontal group 0. The marker must locate the no-test facility, select a new link and make the connection thereover to the busy line.

Relay 28NT2T, operated, opens the operate path of relay 32VHCK at break contact 28NT2T–6(32), and closes at make contact 28NT2T–3(28) an obvious operate path for relay 28NR. Relay 28NR, operated, closes at make contact 28NR–8(28) an operate path for relay 28NRCY which operates and locks to ground through its make contact 28NRCY–10(28), and make contacts 28NT–7(28), 32VHCK–10(28) and 31HGR–7(28). Relay 28NRCY, operated, closes at make contact 28NRCY–5(28) an operate path for relay 28NRK which operates and locks to ground through its make contact 28NRK–5(28). Also, relay 28NRCY upon operating releases relay 30LK5 by interrupting the hold path at break contact 28NRCY–7(30); releases relay 30LKK by interrupting the operate path at break contact 28NRCY–6(30); releases the 35HG0 relay by interrupting the hold path at break contact 28NRCY–9(35); and releases relay 26HGK by interrupting the operate path at break contact 28NRCY–8(26).

When the 35HGO relay and the 30LK5 relay have released, the 31HGR relay will release since its operate path is interrupted at make contact 35HG0–8(31), and the 32LKR relay will release since its operate path is interrupted at make contact 30LK5–8(32). The 31HGR relay and the 32LKR relay, released, will release relay 28NRCY by interrupting the hold path at make contacts 32LKR–5(28) and 31HGR–7(28); relay 28NRCY, in turn, upon releasing closes the operate path for relay 28N2TP from ground, make contact 28NT–10(28), break contact 28NRCY–11(28), make contact 28NRK–2(28), winding of relay 28N2TP to battery; relay 28N2TPA operates following operation of relay 28N2TP. Operation of relay 28N2TP initiates the selection of a new link and starts the marker whereby to find the no-test facility as now described.

The selection of a new link is generally similar in procedure to that prevailing in the instance of an originating connection as described in detail earlier in the specification. It should be noted, however, that this marker operation during a terminating connection introduces the possibility of two markers testing for links at the same time.

Relay 28N2TP, operated, connects battery through make contact 28N2TP–7(35) over lead HS to the link and connector circuit from whence it is returned through make contact 20HGP–2(20) and over lead HGE to operate relay 35HGE to ground at make contact 34ONG–11(35). Relay 35HGE, operated, extends the leads HG0–HG9 to the link and connector circuit. Dependent upon the horizontal group attempted earlier, in the illustrative example, horizontal group 0, a combination of two 35HGT0–35HGT7 relays will be operated; in the present instance it is assumed that relays 35HGT4 and 35HGT7 are operated whereby to open lead HG0 at break contacts 35HGT4–4(35) and 35HGT7–4(35) whereby to prevent the operation of relay 35HG0. The link and connector circuit returns ground whereby to operate the relays of the 35HG– group, excepting the 35HG0 just referred to, in order to indicate idle horizontal groups.

Relay 31HGR operates following the operation of any one of the 35HG– relays; operation of the 31HGR relay releases the 35HGE relay by interrupting the operate path at break contact 31HGR–9(35). Relay 35HGE upon releasing opens the operate paths of the respective 35HG– relays whereby to release all the relays of this group except the single one which has the preferred position through the locking paths. It will be assumed for purposes of present description that relay 35HG5 remains operated, that is that the connection is to be completed through horizontal group 5.

Relay 26HGK now operates over the one-up-only chain of 35HG– relay contacts, the operate path in this instance including the make contact of transfer pair 35HG5–10(26). Relay 26HGK, operated, closes a path for applying battery through make contacts 26HGK–1(35) and 28N2TP–8(35), break contact 34RLSA–7(35) and the make contact of transfer pair 35HG5–1(35) to lead HC5 for operating horizontal group access relay 20HC5 of the link and connector circuit. With relay 20HC5 operated, ground is applied through make contact 20HC5–6(20) to lead HCK whereby to operate relay 35HCK to ground through make contact 28N2TP–7(35); relay 35HCK operates and locks to ground through its make contact 35HCK–11(35) and make contact 34ONG–9(35). Relay 35HCK, operated, starts the selection of a link within the selected horizontal group, the method of operation being generally similar to that previously described above in reference to a normal originating connection. It will be assumed that link 9, horizontal group 5 is selected; relay 30LK9 will be operated.

The 28N2TP relay in its operated condition starts the marker searching for the no-test connection by reusing the circuitry normally employed (as previously described) during originating connections when selecting register senders. This is possible since in accordance with the novel arrangement contemplated the no-test facilities are assigned to vertical files of the switch within one vertical group just as register senders are assigned. As pointed out above, the no-test facilities must not be assigned in the same vertical group with register senders. It will be recalled that in the specific illustrative example the no-test facility is assigned to vertical group 13, vertical file 17.

Through the particular cross connection established in tse present instance, relay 40VGR13 is operated under control of relay 28N2TP, the operate path being traced from ground, make contacts 28NT–11(40) and 28N2TP–9(40), cross-connection path, winding of relay 40VGR13 to battery. Relay 39VRR operates from ground, make contact of transfer pair 28N TP–4(39), make contact 40VGR13–8(39), winding of relay 39VRR to battery; this is followed by operation of relay 39VRK over a path which includes make contact 34ONG–4(39), the make contact of transfer pair 40VGR13–10(39), the break contact of transfer pair 40VGR1–10(39) and make contact 39VRR–12(39).

Relay 39VRK, operated, connects battery through make contact 39VRK–3(36), the break contacts of transfer pairs 40VGR0–1(36) and 40VGR6–1(36) and make contact 40VGR13–1(36) to lead VG13 and thence to the link and connector to operate vertical preference relay 19VP13; relays 19CC13 and 19CCA13 operate in sequence following operation of relay 19VP13. The link and connector circuit applies ground through make contact 19CCA13–13(22) to lead KR13 whereby to operate relay 39VRCK through make contact 40VGR13–4(39), the break contacts of transfer pairs 40VGR6–4(39) and 40VGR0–4(39), make contact 39VRK–1(39), winding of relay 39VRCK to battery. Relay 39VRCK, operated, closes an operate path for relay 31RTE at make contact 39VRCK–5(31) whereby to start the vertical file test, and extends battery through the break contacts of transfer pairs 40VGR0–7(39) and 40VGR6–7(39) and make contact 40VGR13–7(39) over lead RC13 to operate connector relays 19RC13 and 19RCA13 in the link and connector.

Relay 31RTE, operated, closes at the make contacts of respective transfer pairs 31RTE–10(40), 31RTE–11(40) and 31RTE–12(40) the operate paths of relays 40RT17, 40RT18 and 40RT19 whereby to test for the no-test facility.

Relay 40RT17 operates from ground, make contact of transfer pair 31RTE–10(40), lead RST17, make contact 19RC13–54(24), make contact of transfer pair 6RRLS–12(97), make contact 97SR–6(97), winding of relay 97MC to battery; marginal relay 97MC of the no-test facility does not operate at this point. Relays 31RTR and 31RTK operate following operation of relay 40RT17; relay 31RTE releases following operation of relay 31RTR as the operate path is interrupted at break contact 31RTR–2(31); relay 40RT17 holds to battery through the make contact of its transfer pair 40RT17–8(40) and make contact 39VRCK–2(40). Relay 31RTK, operated, connects ground through its make contact 31RTK–11(40), make contact of transfer pair 40RT17–6(40), and break contact of transfer pair 31RTE–10(40) of the released 31RTE relay to lead RST17 whereby to close a lower resistance operate path for relay 97MC of the no-test facility. Relay 97MC, operated, connects ground through its make contact 97MC–11(97) to lead MCRK whereby to operate relay 32MCRK.

Relay 32MCRK, operated, applies ground through make contacts 32MCRK–10(42) and 28N2TP–10(42) to lead NTR whereby to operate relay 97RLS of the no-test facility. The 97RLS relay, operated, opens the connection established to the register sender through the link by releasing its hold magnet. When the no-test facility is normal it returns battery through make contacts 97RLS–1(97) and 97MC–6(97) over lead NTK whereby to operate relay 28TKRL of the marker; relay 28TKRL upon operating locks to the ground at make contact 28N2TP–11(28) from battery through its make contact 28TKRL–1(28) and make contact 28NT–1(28). Relay 28TKRL, operated, closes at make contact 28TKRL–5(42) the operate path of relay 42VHR whereby to operate that relay and start the test for the hold magnets.

Relay 42VHL operates to indicate that the busy line hold magnet in this horizontal group, that is hold magnet 18HM13519, is available for connection. Relay 32VHCK operates when both relays 42VHR and 42VHL have operated. Relay 32VHCK, operated, operates the select magnet as described below.

At this point, it appears in order to discuss in greater detail the operations of the link and connector circuit which are involved in the no-test connection and which have been referred to in a general manner above. This will include the operation of the select magnet just mentioned above. Related operations of the marker not already described will be included in the forthcoming description.

As described above in connection with the marker functions, relays 36VGK, 30LKK and 26HGK operate as indication that the vertical group and the horizontal group in the link which were used in the originating connection have been registered. Operation of the 36VGK relay places battery on lead VG13 which operates vertical preference relay 19VP13 of the link and connector circuit. Relay 19VP13, operated, closes at make contact 19VP13–2(19) an operate path for connector relay 19CC13 which operates and closes in turn at make contact 19CC13–52(19) an operate path for relay 19CCA13. Relay 19CCA13, operated, closes ground to lead KL13 through make contact 19CCA13–14(22) whereby to operate relay 39VLCK of the marker; as described above, operation of relay 39VLCK provides indication that access to the vertical group of the called terminal has been attained.

Operation of the 26HGK and the 39VLCK relays closes battery through make contacts 26HGK–11(30) and 39VLCK–4(30) and the make contact of transfer pair 35HG0–7(30) to lead VHO to the link and connector circuit and through make contact 19CC13–20(21) to operate relay 21VG13HG0 representing the vertical group of the no-test termination and the horizontal group of the link used to connect the no-test facility to the register sender.

As described above in reference to marker functions, operation of relay 21VG13HG0 will be followed by operation of relay 42VHL of the marker in the event the terminal under test is using a link that is in a different horizontal group than the link used by the no-test facility-to-register-sender connection. However, it will be assumed for purposes of further description that the link being used by the terminal under test is in the same horizontal group as the link used to connect the no-test facility to the register sender and that marker relay 28N2TP operates.

Relay 28N2TP closes at make contact 28N2TP–7(35) a path connecting ground to lead HS whereby to operate relay 20HGP of the link and connector, and, as described above, causes the marker to select a new horizontal group and the no-test facility vertical group, after which relays 26HGK and 39VRK operate. Horizontal group 5 is the "new" horizontal group and the no-test vertical file is, of course, file 17.

Relay 26HGK, operated, closes battery through make contact 26HGK–1(35) and the make contact of transfer pair 35HG5–1(35) to lead HC5 whereby to operate horizontal connector relay 20HC5 of the link and connector circuit. Relay 20HC5, operated, closes ground through make contact 20HC5–6(20) to lead HCK whereby to operate relay 35HCK of the marker as described above. Operation of relay 35HCK releases relay 20HGP by interrupting the operate path at break contact 35HCK–(35); the marker now proceeds to test and select an idle link following which relay 30LKK operates as above described; as pointed out above, link 9 of horizontal group 5 is selected.

Had the terminal under test and the no-test facility been in different vertical groups, for example had the no-test facility been terminated in vertical group 6, operation of relay 39VRK of the marker would close battery through make contact 39VRK–3(36) to lead VG6 whereby to operate vertical preference relay 19VP6 of the link and connector which relay would in the assumed example be associated with the no-test facility terminal. Relay 19VP6, operated, is followed by operation of relay 19CC6 and, in turn, by operation of relay 19CCA6. Relay 19CCA6, operated, closes ground through make contact 19CCA6–13(22) to lead KR6 whereby to operate relay 39VRCK of the marker. Relay 39VRCK, operated, connects battery through make contact 39VRCK–1(39) to lead RC6 whereby to operate register connect relays 19RC6 and 19RCA6 of the link and connector; operation of these relays permits the marker to seize the no-test facility.

Switch connector relay 21VG13HG5 associated with the terminal under test and the no-test facility operates following operation of relays 26HGK and 39VRK of the marker. This is followed by operation of relay 42VHL in the marker which operation, in turn, prepares for operation of relay 42VHR.

Marker relay 28TKRL, operated as above described, closes at make contact 28TKRL–5(42) the operate path of relay 42VHR whereby to test for the no-test hold magnet appearance in the horizontal group to be connected; operation of relay 42VHR indicates that the busy terminal hold magnet in this horizontal group is available for connection. Relay 32VHCK operates after relays 42VHL and 42VHR have operated and a path is thus closed for operating select magnet 16SM1359 over lead SM9, make contact 32VHCK–11(30) and 30LK9–1(30) being included in the path; select magnet 16SM1359 is associated with link 9, horizontal group 5, vertical group 13, selected for connecting the no-test facility and the busy terminal under test.

Relays 32SMRK and 32SMLK of the marker now operate from ground through off-normal contacts of select magnet 16SM1359; the operate path for relay 32SMRK is traced from ground, make contacts 16SM1359–1(13), 19RC13–12(13), 19VP13–5(13) and 40VGR13–2(32), break contacts of transfer pairs 40VGR6–2(32) and 40VGR0–3(32), make contact 39VRK–5(32), make contact of transfer pair 32VHCK–6(32), winding of relay 32SMRK to battery, while the operate path for relay 32SMLK is traced from ground, make contacts 16SM1359–1(13), 19TC13–12(13), 19VP13–1(13), 36VGL13–2(32), break contacts of transfer pairs 36VGL6–2(32) and 36VGL0–2(32), make contact 36VGK–2(32), make contact of transfer pair 32VHCK–8(32), winding of relay 32SMLK to battery.

Relay 98HM now operates over a path from ground, which path includes make contacts 32SMRK–10(98) and 32SMLK–1(98), whereby to close at make contact 98HM–10(42) the hold magnet operating circuit for the no-test and busy-line appearance, that is, specifically, the operate paths for hold magnets 18HM13517 and 18HM13519. Relays 42HKL and 42HKR operate in series with the hold magnets and, in turn, close operate paths for relays 98HKRA and 98HKLA.

Operation of the hold magnets, following operation of the select magnet as described, closes the switch crosspoints which connect the no-test facility to the terminal under test and the no-test facility assumes control of the circuit; the original connection between lines A and B via link 0, horizontal group 0, remains undisturbed. Marker relays 42HKR and 42HKL release following operation of the hold magnets and a path is thus closed for operating relay 98HMK.

Normal release sequence for the marker follows operation of relay 98HMK as described above. Release of the marker is followed by release of all link and connector circuit equipment which was used to establish this no-test connection except the hold magnets.

No-test connection—all links busy

In the course of the above-described establishment of a no-test connection it might happen, of course, that no links were available for the connection. In such event, relay 26ALB would operate in case no 35HG– relay operated within the delay interval of 60 ms. established by relay delay circuit 261. (Relay delay circuit 261, as well as delay circuits 262 and 263, may be any one of the various different types of delay circuits well known in the art. Such a delay circuit is disclosed, for example in United States Patent 3,001,027, issued Sept. 19, 1961 to J. M. Armstrong and M. C. Goddard.)

After the register sender has released and release relay 97RLS of the no-test facility has operated, marker relay 27TKRL operates from battery, make contacts 97RLS–1(97) and 97MC–6(97), lead NTK, make contact 19RC6–51(22), winding of relay 28TKRL, make contact 28N2TP–11(28) to ground; relay 28TKRL upon operating locks to battery through make contacts 28TKRL–1(28) and 28NT–1(28). The left-hand, or primary, winding of relay 28ALBK is now grounded through make contacts 28TKRL–3(28) and 26ALB–2(28). Relay 97ALB of the no-test facility now operates from battery, winding of relay 97ALB, make contact 97MC–7(97), lead NTLB, make contact 19RC–11(22), left winding of relay 28ALBK, make contacts 28TKRL–3(28) and 26ALB–2(28) to ground. Relay 97ALB operates over this path and locks to ground through make contact of transfer pair 97ALB–1(97) and make contact 97SR–12(97); differentially wound marker relay 28ALBK operates from this same ground to battery through its right-hand or secondary winding. (Relay 28ALBK did not operate from the ground on the primary winding at make contact 26ALB–2(28) due to the relatively high impedance of that path.)

With relay 97ALB operated, "reorder" tone from source 61 is returned to the originator through make contacts 97ALB–2(6) and 97ALB–3(6). Relay 28ALBK, operated, releases relay 34DCK by interrupting the hold path at break contact 28ALBK–8(34). Now, with relay 34DCK released and relays 28TKRL and 28ALBK operated, relay 86RL of the decoder operates from ground, break contact 34DCK–1(86), make contacts 28ALBK–4(86) and 28TKRL–4(86), winding of relay 86RL to battery; relay 86RL operates and initiates normal release sequence as previously described above. It will be noted that, while decoder relay 93NT is held operated by the ground on lead NTL through its make contact 93NT–2(93), the "release" ground applied to lead NRL (FIG. 86) following operation of relay 86DIS is supplied through make contact 93NT–1(86).

While there has been desrcibed above the steps involved in establishing a connection between two specifically selected station lines, it will be understood that connections between other terminations are accomplished in a generally similar manner. The establishment of a connection between certain types of terminations, particularly four-wire trunks, has not been described in detail in the present application since this type of connection is described in detail in the above-referred-to pending application of Messrs. R. J. Jaeger and G. Riddell.

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. In an automatic private branch exchange system, a plurality of call-iniating circuits, a cell-completing circuit, a plurality of links, a plurality of switch means controllable to connect terminations of said call-initiating circuits with terminations of said call-completing circuit through said links, said call-completing circuit having a termination in each of said switch means, each of said call-initiating circuits having a termination in each of said switch means, means discrete to each termination of said call-completing circuit for indicating whether or not a connection is established with said termination, and means controlled by said indicating means for controlling said switch means concurrently to connect terminations of different call-initiating circuits with different terminations of said call-completing circuit through different links.

2. In an automatic private branch exchange system, a first call-initiating circuit and a second call-initiating circuit, a call-completing circuit, a switch means including a plurality of horizontal groups of switching elements, a plurality of links included in each of said horizontal groups, said call-initiating circuits and said call-completing circuit each having a plurality of terminations on said switch means, means for controlling said switch means whereby to connect terminations of said call-initiating circuits and terminations of said call-completing circuit through said links, means, discrete to each termination of said call-completing circuit for indicating whether or not a connection is established between said termination and one of said call-initiating circuits through one of the links of the respective horizontal group, and means controlled by said indicating means for controlling said switch means to connect the other of said call-initiating circuits to a termination of said call-completing circuit.

3. In an automatic private branch exchange system, the switching arrangement defined by claim 2 wherein said switch controlling means includes means effective upon indication that such connection between said termination and said one of said call-initiating circuits is established for causing the connection with the other of said call-initiating circuits to be completed to a different termination of said call-completing circuit through a link of another respective horizontal group.

4. In an automatic private branch exchange system, a plurality of customer's lines, a no-test circuit, switch

means including a plurality of horizontal groups of switching elements, a plurality of links included in each of said groups, means for connecting each of said lines and said no-test circuit to respective sections of said switch means, each of said lines and said no-test circuit having a plurality of terminations on their respective sections of said switch means, means for controlling said switch means whereby to connect a first of said lines to a second of said lines through one of said links, means discrete to each termination of said second of said lines for indicating whether or not a connection is established between said respective termination and said first of said lines through one of the links of the respective horizontal group, means for connecting said no-test circuit to said second of said lines, and means controlled by said indicating means whenever a connection exists between said respective termination and said first line for causing said no-test circuit connection to be completed through a link of another horizontal group to a different one of the terminations of said second line.

5. In an automatic private branch exchange system, a switch means including a plurality of horizontal groups of switching elements, a plurality of horizontal links in each of said horizontal groups, a first line and a second line each having a plurality of terminations in respective sections of said switch means, switch control means for selectively controlling said switch means to effect a connection between said lines over a selected link of one of said horizontal groups, means discrete to each termination of said second line for indicating whether or not said switch means is operated to effect a connection with said termination, a no-test facility also having a plurality of terminations in a section of said switch means, means for effecting a connection between said no-test facility and said second line, and means responsive to indication by said indicating means of existence of a connection to a respective one of said second line terminations by a link in a respective one of said horizontal groups for causing the no-test facility connection to be completed to a different termination of said second line by a link in a different horizontal group.

6. In an automatic private branch exchange system, the combination defined by claim 5 wherein said indicating means includes the respective switch hold magnets associated with the terminations of said second line.

7. In an automatic private branch exchange system, a switching arrangement including a plurality of horizontal groups of switching elements, a plurality of links in each of said groups, a line having a plurality of terminations in each of said groups each accessible through a different one of said links, a no-test facility also having a plurality of terminations in each of said groups each accessible through a different one of said links, means individual to each termination of said line for indicating whether a connection is established between said termination and a respective one of said links, and means controlled by said indicating means whenever such a connection exists for effecting a connection between said no-test facility and a different one of said line terminations through a link in a different horizontal group.

8. In a telephone system having lines, and a no-test circuit, means for establishing connections between lines, means for attempting to establish a first connection between said no-test circuit and a busy line as if said no-test circuit were an originating line, and means responsive to failure to establish said first connection for establishing a second connection between said no-test circuit and said busy line.

9. In a telephone system having lines, a no-test circuit, a register sender, and a marker, means including said register sender and said marker responsive to signals from an originating one of said lines for establishing a connection between said originating line and another of said lines, means including said register sender and said marker and responsive to signals from said no-test circuit for treating said no-test circuit as if it were an originating line and attempting to establish a first connection between said no-test circuit and a busy one of said lines, and means including said marker and responsive to failure to establish said first connection for establishing a second connection between said no-test circuit and said busy line.

10. In a telephone system in accordance with claim 9 further comprising switching means including a plurality of groups of links, each of said lines being terminated on each of said groups of links and said no-test circuit having access to all of said links, said first connection including the link employed by said busy one of said lines and said second connection including a link in a group other than the group including said link employed by said busy one of said lines.

11. In a telephone system, a switching network comprising groups of links, a plurality of lines and trunks each having access to a link in each of said groups, a no-test circuit, means providing access for said no-test circuit to all of said links, means for establishing a connection between one line and one trunk through one of said links, means for causing said establishing means to attempt to connect said no-test circuit to said one line using said one link, and means responsive to the busy condition of said one link for connecting said no-test circuit to said one line through a link in a group other than the group including said one link.

12. In a telephone system, a plurality of lines, a plurality of groups of links, a no-test circuit, means for establishing a connection between a first and a second of said lines through a first link included in a first of said groups, means for preparing a tentative connection between said no-test circuit and one of said first and second lines through a second link included in said first of said groups, and means responsive to a busy condition of a link in said first group for releasing said tentative connection and establishing a second connection between said no-test circuit and said line through a link included in a group other than said first group.

13. In a telephone system, switching means including a plurality of vertical files and a plurality of horizontal groups, a plurality of links, included in each of said horizontal groups, a plurality of lines, a no-test circuit, means for terminating said lines and said no-test circuit on respective ones of said vertical files whereby said lines and said no-test circuit have access to all of said links, means for establishing a connection between two of said lines through a link included in a first of said horizontal groups, means for preparing a tentative connection between said no-test circuit and one of said two last-mentioned lines through another link also included in said first horizontal group, and means responsive to a busy condition of a link included in said first group for releasing said tentative connection and establishing a second connection between said no-test circuit and said line through a link included in a horizontal group other than said first horizontal group.

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