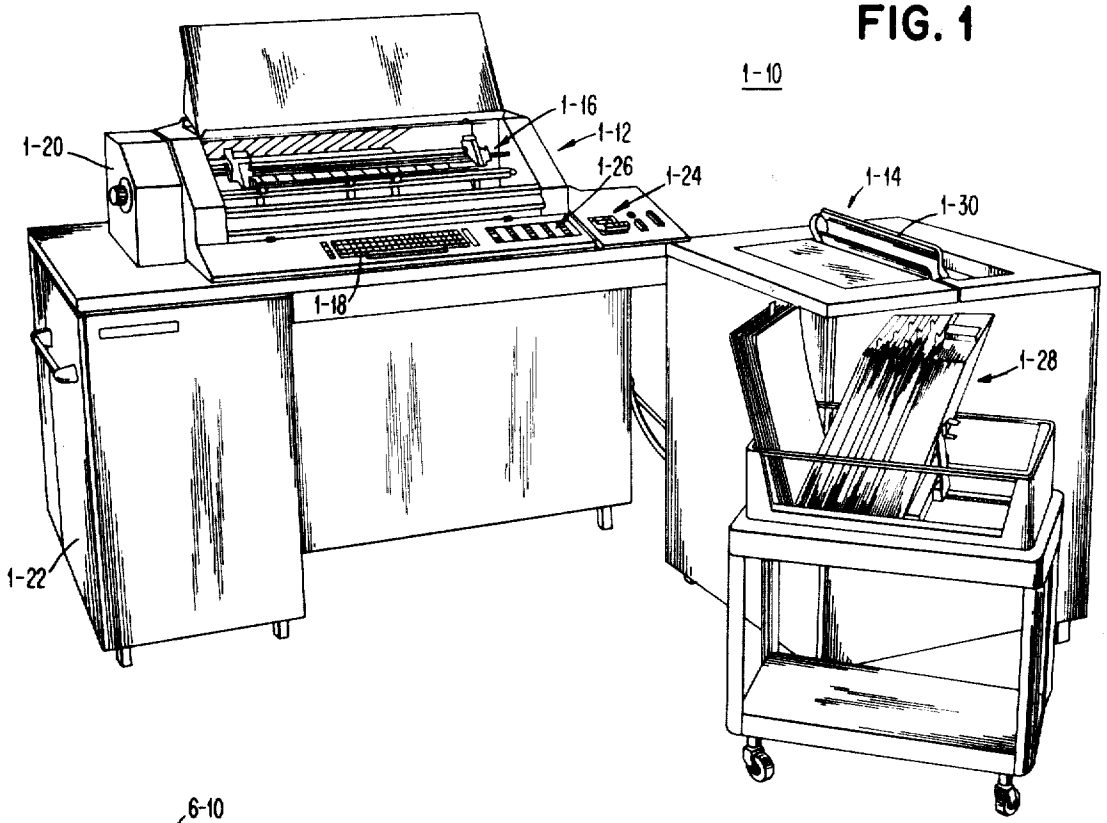
ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 1

FIG. 1



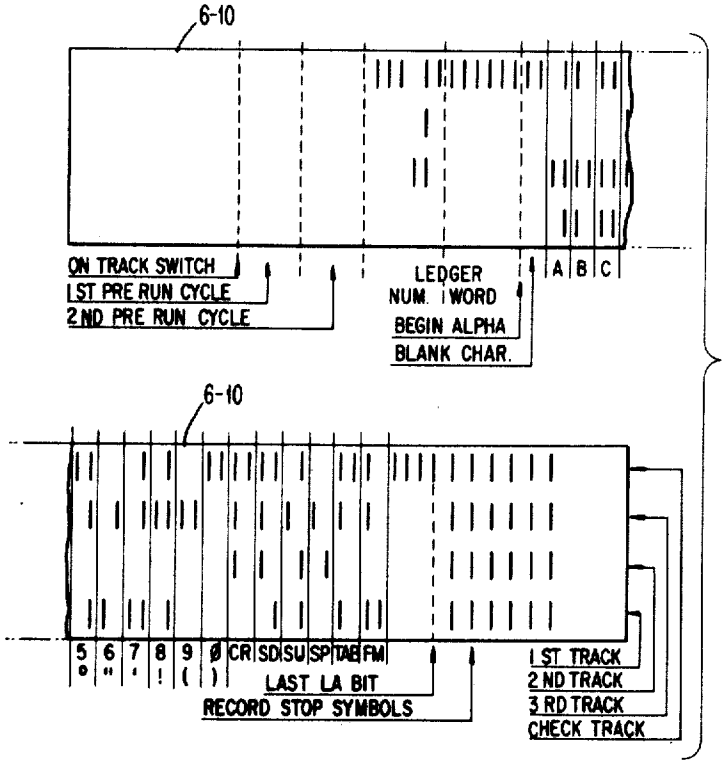
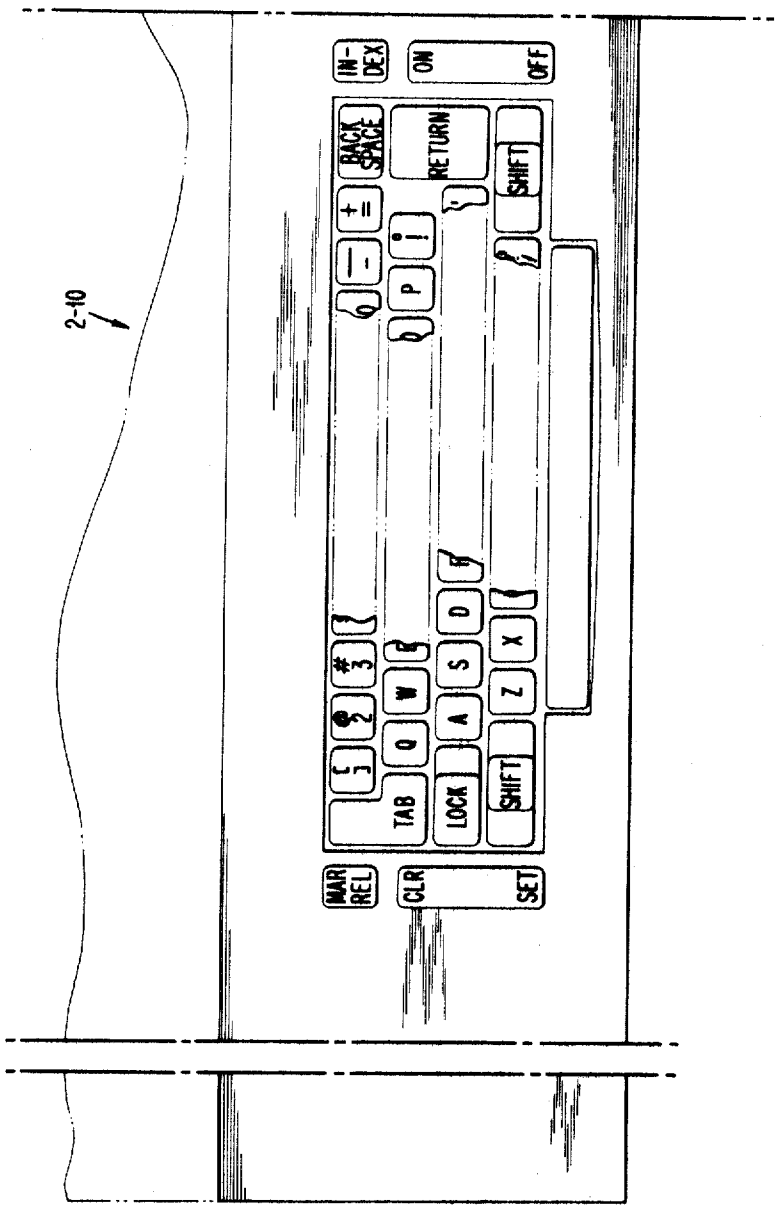


FIG. 6

INVENTORS.
WILLIAM L. MC DONALD
PETER J. DeGEORGE
JOSEPH R. STEWART
EVERETT C. CLAY
WILSON I. LOCKETT

FIG. 2a


2-10
IN-DEX
ON
OFF
BACK SPACE
RETURN
SHIFT
TAB
LOCK
SHIFT
MAR REL
CLR
SET

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 3

FIG. 2b

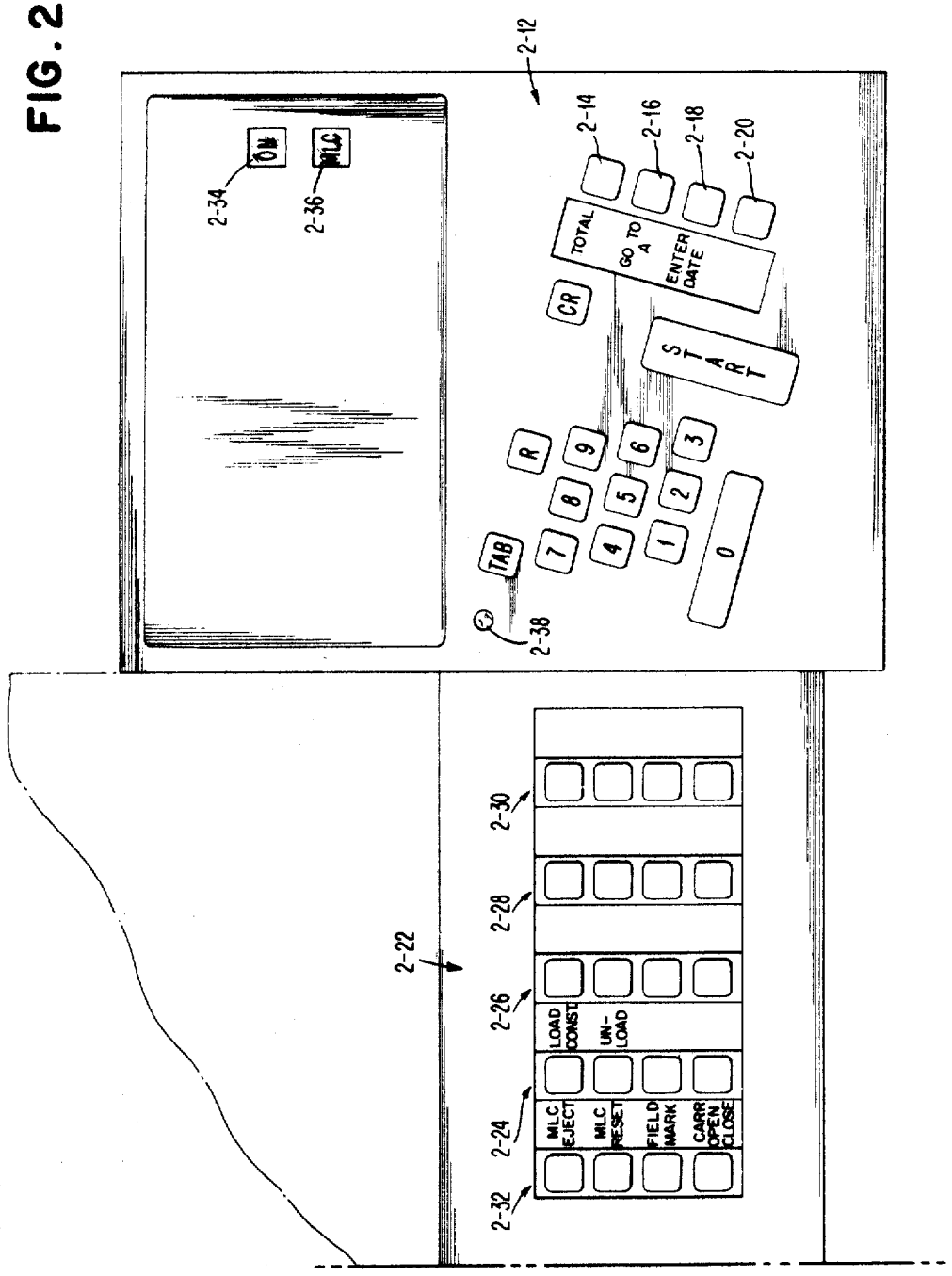


FIG. 3a

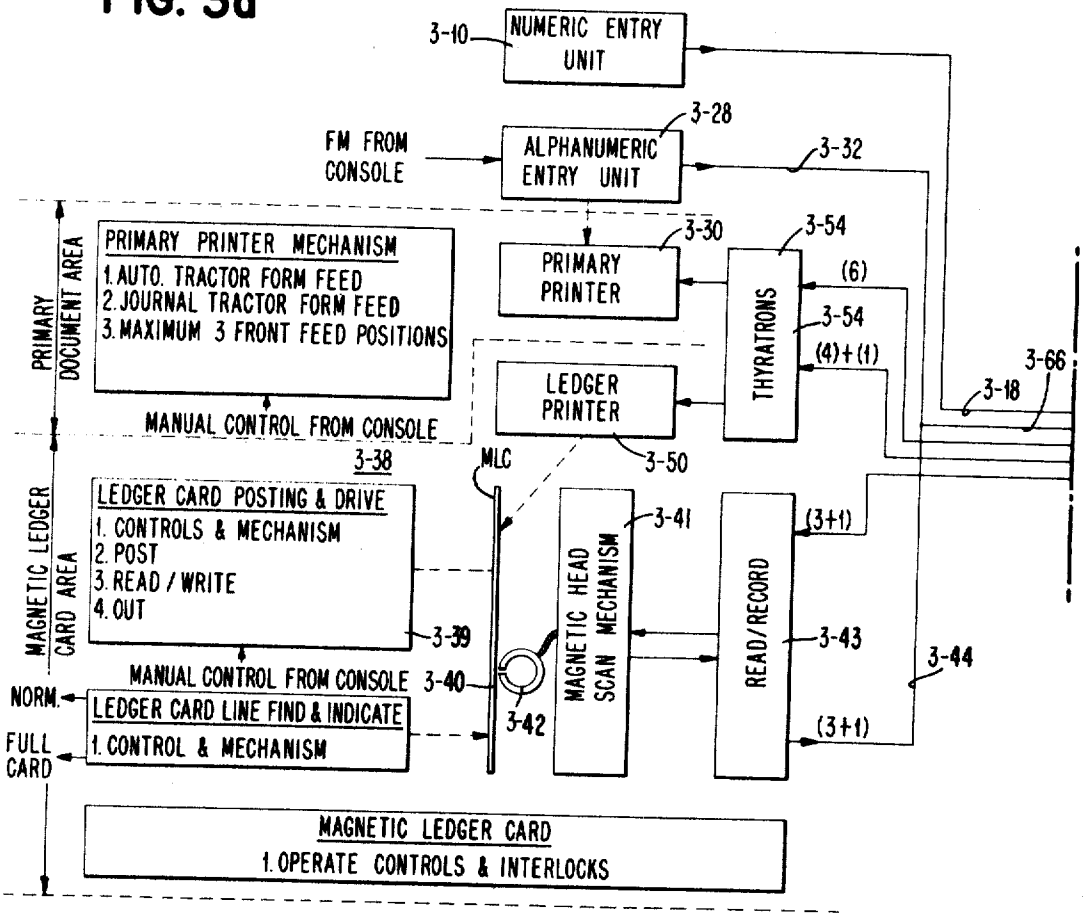
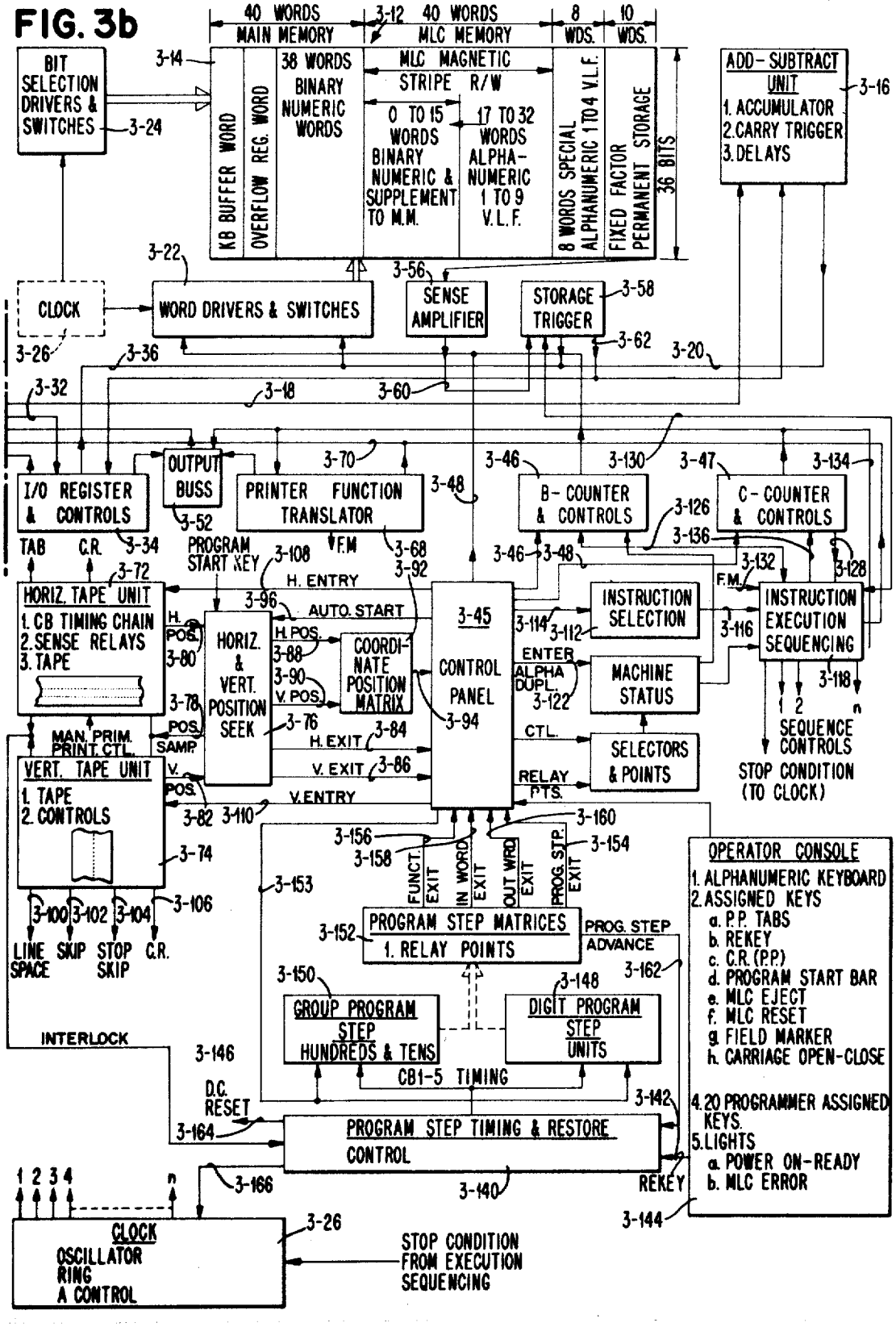

3-10
NUMERIC ENTRY UNIT
FM FROM CONSOLE
3-28
ALPHANUMERIC ENTRY UNIT
3-32
PRIMARY DOCUMENT AREA
PRIMARY PRINTER MECHANISM
1. AUTO. TRACTOR FORM FEED
2. JOURNAL TRACTOR FORM FEED
3. MAXIMUM 3 FRONT FEED POSITIONS
3-30
PRIMARY PRINTER
3-54
THYRATRONS
(6)
3-54
(4)+(1)
LEDGER PRINTER
3-66
3-18
MANUAL CONTROL FROM CONSOLE
3-38
3-50
MLC
MAGNETIC LEDGER CARD AREA
LEDGER CARD POSTING & DRIVE
1. CONTROLS & MECHANISM
2. POST
3. READ / WRITE
4. OUT
3-39
3-41
MAGNETIC HEAD SCAN MECHANISM
READ/RECORD
(3+1)
3-43
3-44
MANUAL CONTROL FROM CONSOLE 3-40
3-42
NORM.
LEDGER CARD LINE FIND & INDICATE
1. CONTROL & MECHANISM
FULL CARD
(3+1)
MAGNETIC LEDGER CARD
1. OPERATE CONTROLS & INTERLOCKS

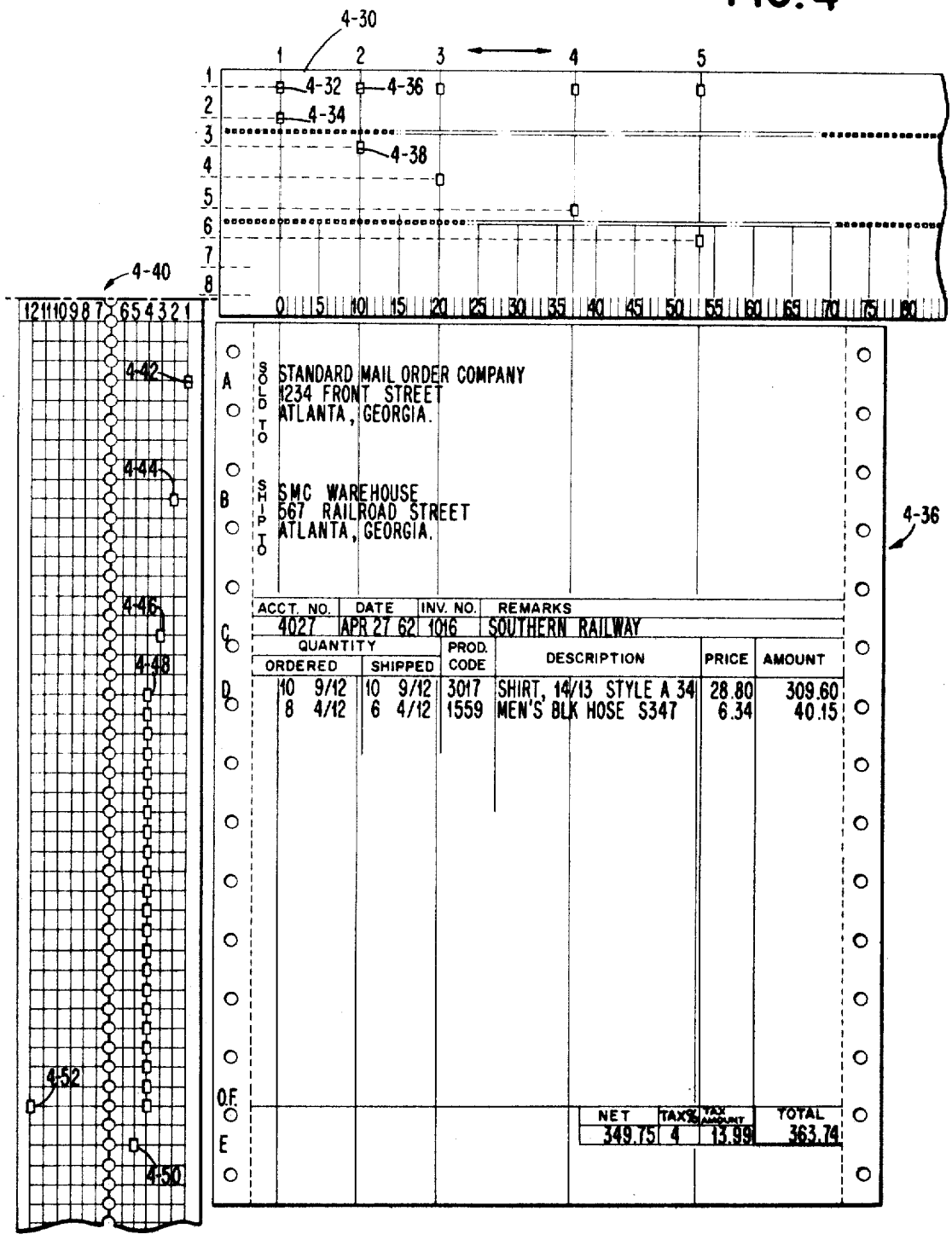
FIG. 3b


40 WORDS MAIN MEMORY
3-12 40 WORDS MLC MEMORY
8 WDS.
10 WDS.
BIT SELECTION DRIVERS & SWITCHES
3-24
3-14
KB BUFFER WORD
OVERFLOW REG. WORD
38 WORDS BINARY NUMERIC WORDS
MLC MAGNETIC STRIPE R/W
0 TO 15 WORDS BINARY NUMERIC & SUPPLEMENT TO M.M.
17 TO 32 WORDS ALPHA-NUMERIC 1 TO 9 V.L.F.
8 WORDS SPECIAL ALPHANUMERIC 1 TO 4 V.L.F.
FIXED FACTOR PERMANENT STORAGE
36 BITS
ADD-SUBTRACT UNIT
1. ACCUMULATOR
2. CARRY TRIGGER
3. DELAYS
3-16
3-22
CLOCK
3-26
WORD DRIVERS & SWITCHES
3-36
3-56
SENSE AMPLIFIER
STORAGE TRIGGER
3-58
3-62
3-20
3-32
3-18
3-60
I/O REGISTER & CONTROLS
TAB
C.R.
3-34
OUTPUT BUSS
3-52
PROGRAM START KEY
3-70
PRINTER FUNCTION TRANSLATOR
F.M.
3-68
3-48
3-46
B-COUNTER & CONTROLS
3-130
3-47
C-COUNTER & CONTROLS
3-134
3-126
3-136
3-132
3-128
3-72
HORIZ. TAPE UNIT
1. CB TIMING CHAIN
2. SENSE RELAYS
3. TAPE
3-108
H. ENTRY
3-96
AUTO. START
3-92
3-45
CONTROL PANEL
3-94
INSTRUCTION SELECTION
3-114
3-112
INSTRUCTION EXECUTION SEQUENCING
3-116
3-118
1 2 n
SEQUENCE CONTROLS
STOP CONDITION (TO CLOCK)
ENTER
ALPHA DUPL.
3-122
MACHINE STATUS
CTL.
SELECTORS & POINTS
RELAY PTS.
H. POS.
3-80
HORIZ. & VERT. POSITION SEEK
3-88
3-90
V. POS.
COORDINATE POSITION MATRIX
3-78
POS.
SAMP.
MAN. PRIM. PRINT. CTL.
3-76
H. EXIT
3-84
V. EXIT
3-86
V. ENTRY
3-110
VERT. TAPE UNIT
1. TAPE
2. CONTROLS
3-74
V. POS.
3-82
3-100
3-102
3-104
3-106
LINE SPACE
SKIP
STOP SKIP
C.R.
3-156
3-158
FUNCT. EXIT
IN WORD EXIT
OUT WRD EXIT
PROG. STP. EXIT
3-154
3-160
3-153
PROGRAM STEP MATRICES
1. RELAY POINTS
3-152
PROG. STEP ADVANCE
3-162
3-150
GROUP PROGRAM STEP HUNDREDS & TENS
3-148
DIGIT PROGRAM STEP UNITS
CB1-5 TIMING
INTERLOCK
3-146
D.C. RESET
3-164
3-142
PROGRAM STEP TIMING & RESTORE CONTROL
REKEY
3-140
3-144
OPERATOR CONSOLE
1. ALPHANUMERIC KEYBOARD
2. ASSIGNED KEYS
a. P.P. TABS
b. REKEY
c. C.R. (P.P.)
d. PROGRAM START BAR
e. MLC EJECT
f. MLC RESET
g. FIELD MARKER
h. CARRIAGE OPEN-CLOSE
4. 20 PROGRAMMER ASSIGNED KEYS.
5. LIGHTS
a. POWER ON-READY
b. MLC ERROR
1 2 3 4 n
3-166
CLOCK
OSCILLATOR
RING
A CONTROL
3-26
STOP CONDITION FROM EXECUTION SEQUENCING

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 6

FIG. 4



ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 7

FIG. 5

4027
ACC'T. NO.

.04
TAX

SOUTHERN RAILWAY
SHIPPER

STANDARD MAIL ORDER COMPANY
1234 FRONT STREET
ATLANTA, GEORGIA

5-10

SMC WAREHOUSE
567 RAILROAD STREET
ATLANTA, GEORGIA

5-14

DATE	REF.	THIS TRANSACTION	BALANCE	REMARKS
JAN 10 62		.00	.00	
FEB 21 62	1006	39.94	39.94	
MAR 8 62	1007	141.55	181.49	
MAR 12 62	427	39.94 CR	141.55	
APR 9 62	922	141.55 CR	.00	
APR 27 62	1016	363.74	363.74	

5-12

5-16

3017 28.80 SHIRT, 14/31 STYLE A 34

DATE	REF.	RECEIVED	AMT. SOLD	BALANCE
DEC 12 61				80
MAR 8 62	4027		4 8/12	75 4/12
APR 17 62	9036		5 6/12	69 10/12
APR 27 62	4027		10 9/12	59 1/12

5-18

1559 6.34 MENS BLACK HOSE S347

DATE	REF.	RECEIVED	AMT. SOLD	BALANCE
FEB 14 62				20
MAR 8 62	1234		6 4/12	13 8/12
MAR 19 62	4728		6 8/12	6 4/12
APR 27 62	4027		6 4/12	

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 8

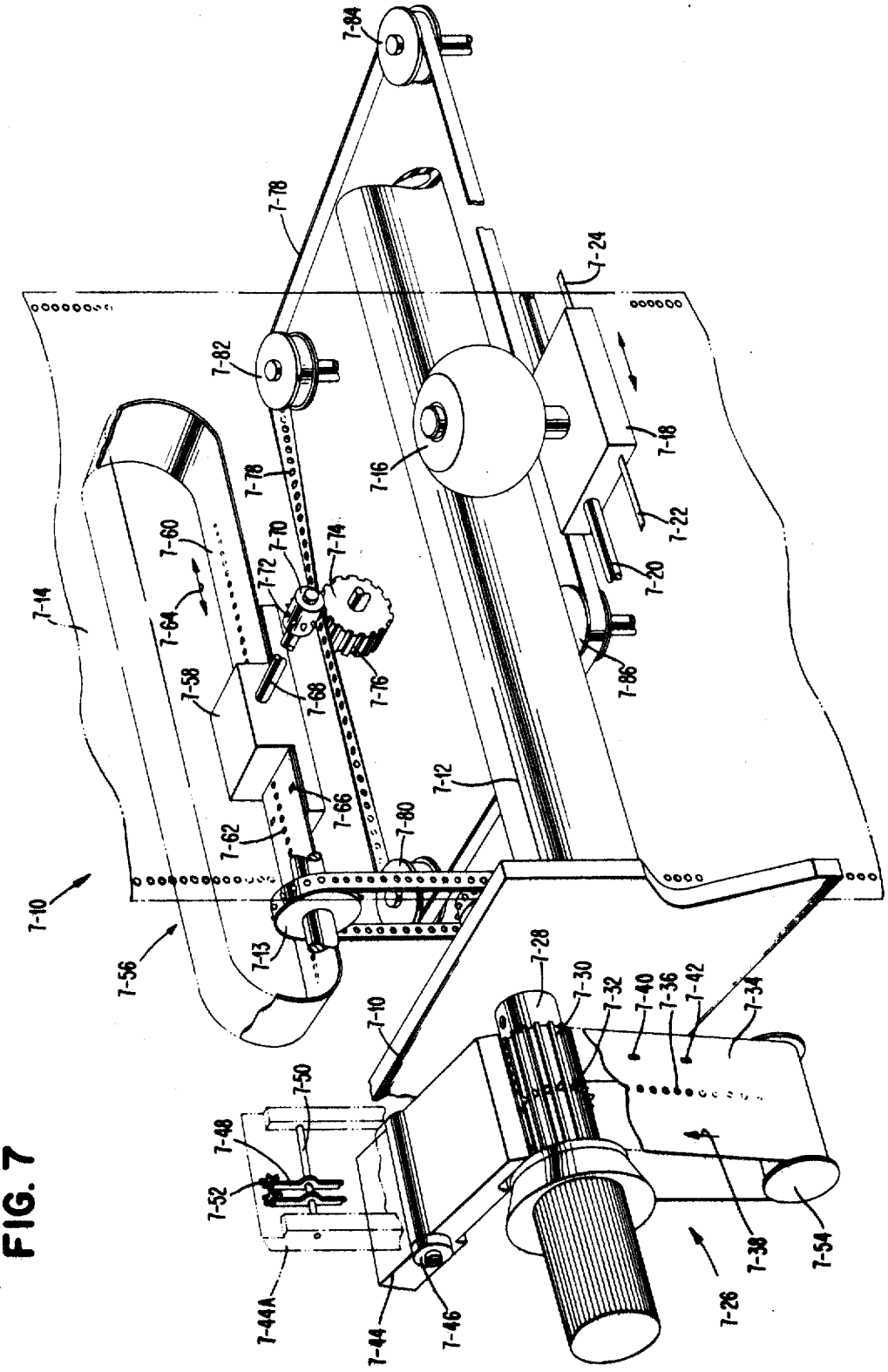


FIG. 7

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 9

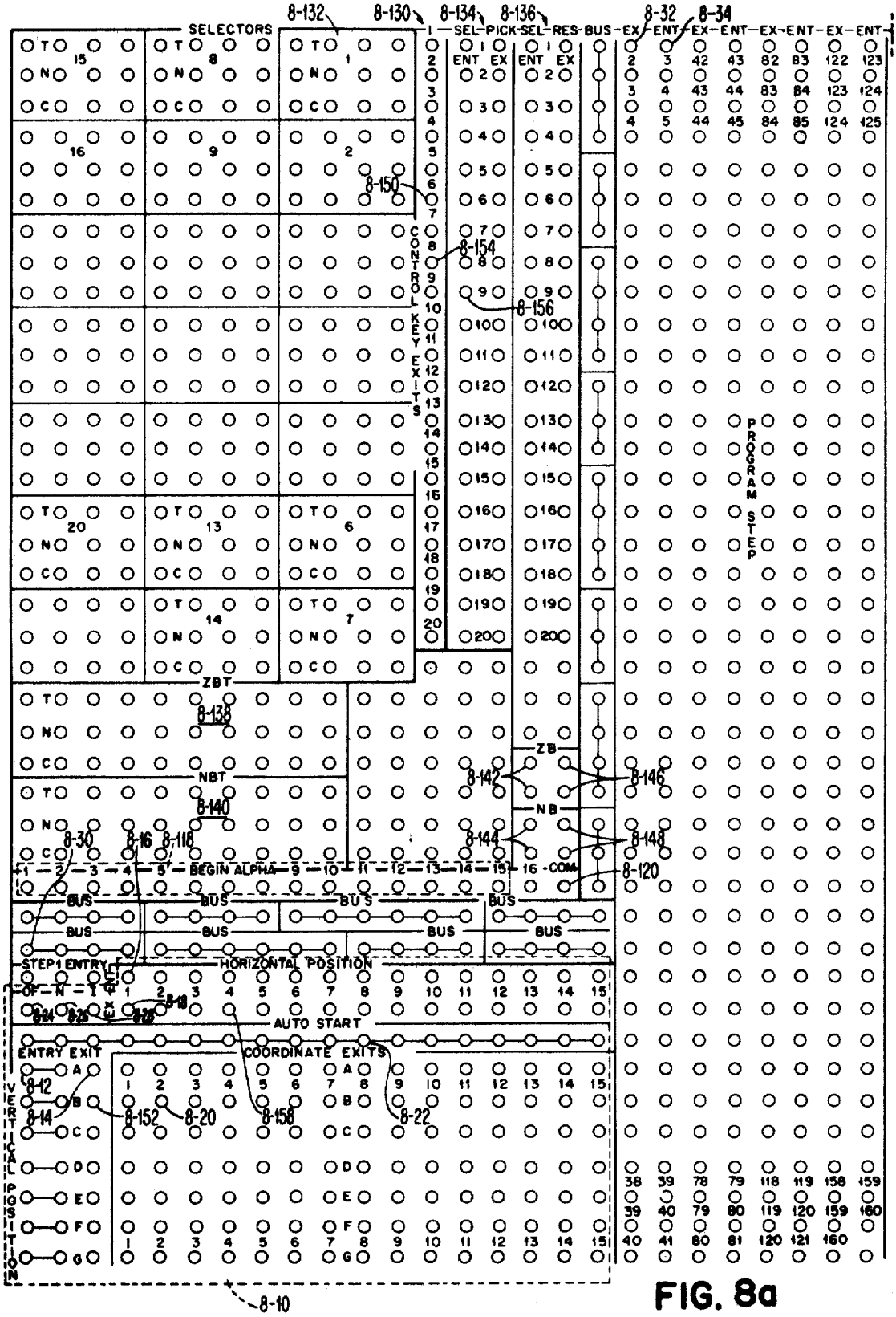


FIG. 8a

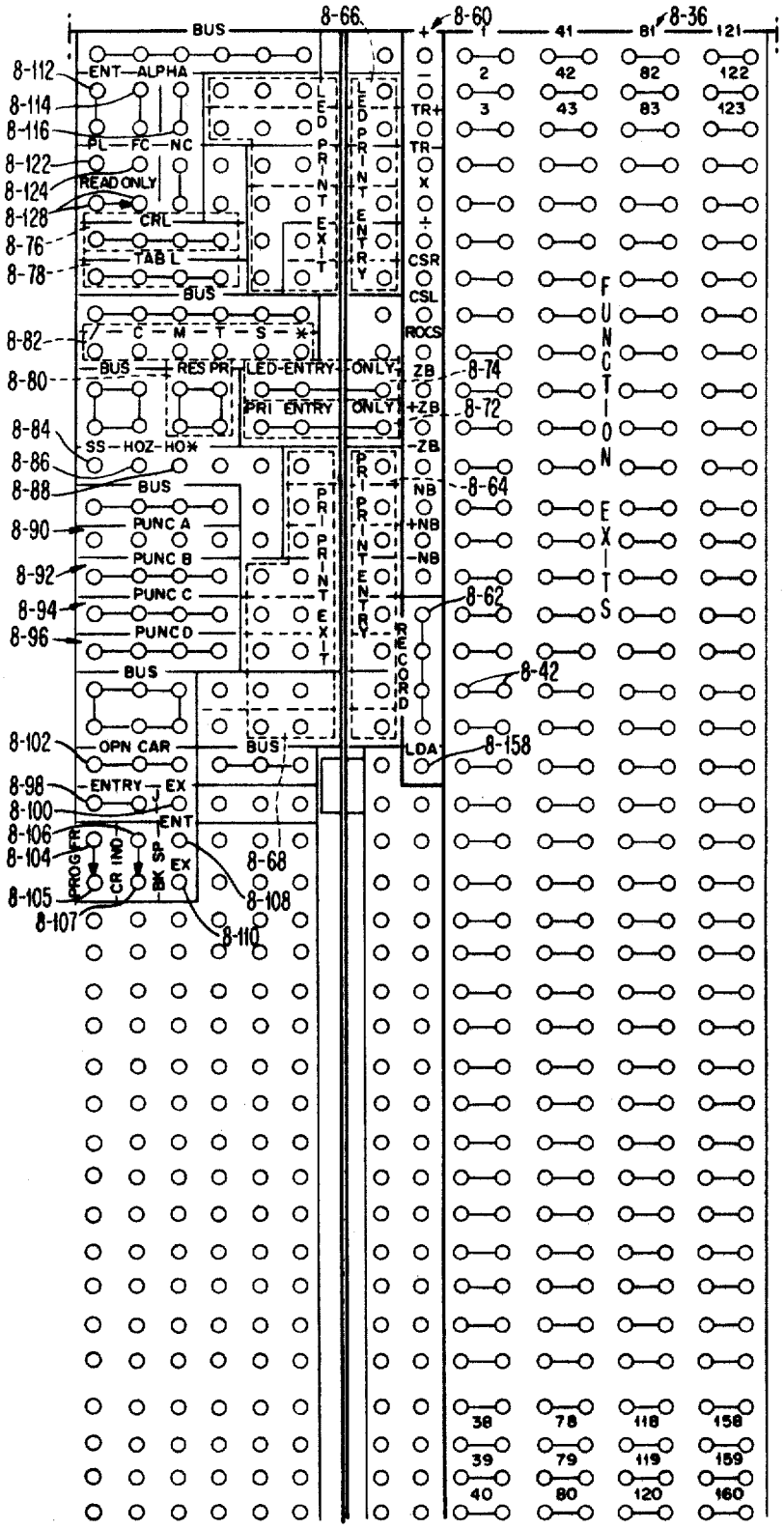

8-66
8-60
8-36
BUS
ENT—ALPHA
PL FC NC
READ ONLY
CRL
TABL
LED PRINT EXIT
LED PRINT ENTRY
TR+
TR−
X
÷
CSR
CSL
ROCS
ZB
+ZB
−ZB
NB
+NB
−NB
RECORD
LOA
FUNCTION EXITS
2 42 82 122
3 43 83 123
38 78 118 158
39 79 119 159
40 80 120 160
8-112
8-114
8-116
8-122
8-124
8-128
8-76
8-78
8-82
8-80
8-84
8-86
8-88
8-90
8-92
8-94
8-96
8-102
8-98
8-100
8-106
8-104
8-105
8-107
8-74
8-72
8-64
8-62
8-42
8-158
8-68
8-108
8-110

FIG. 8b

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 11

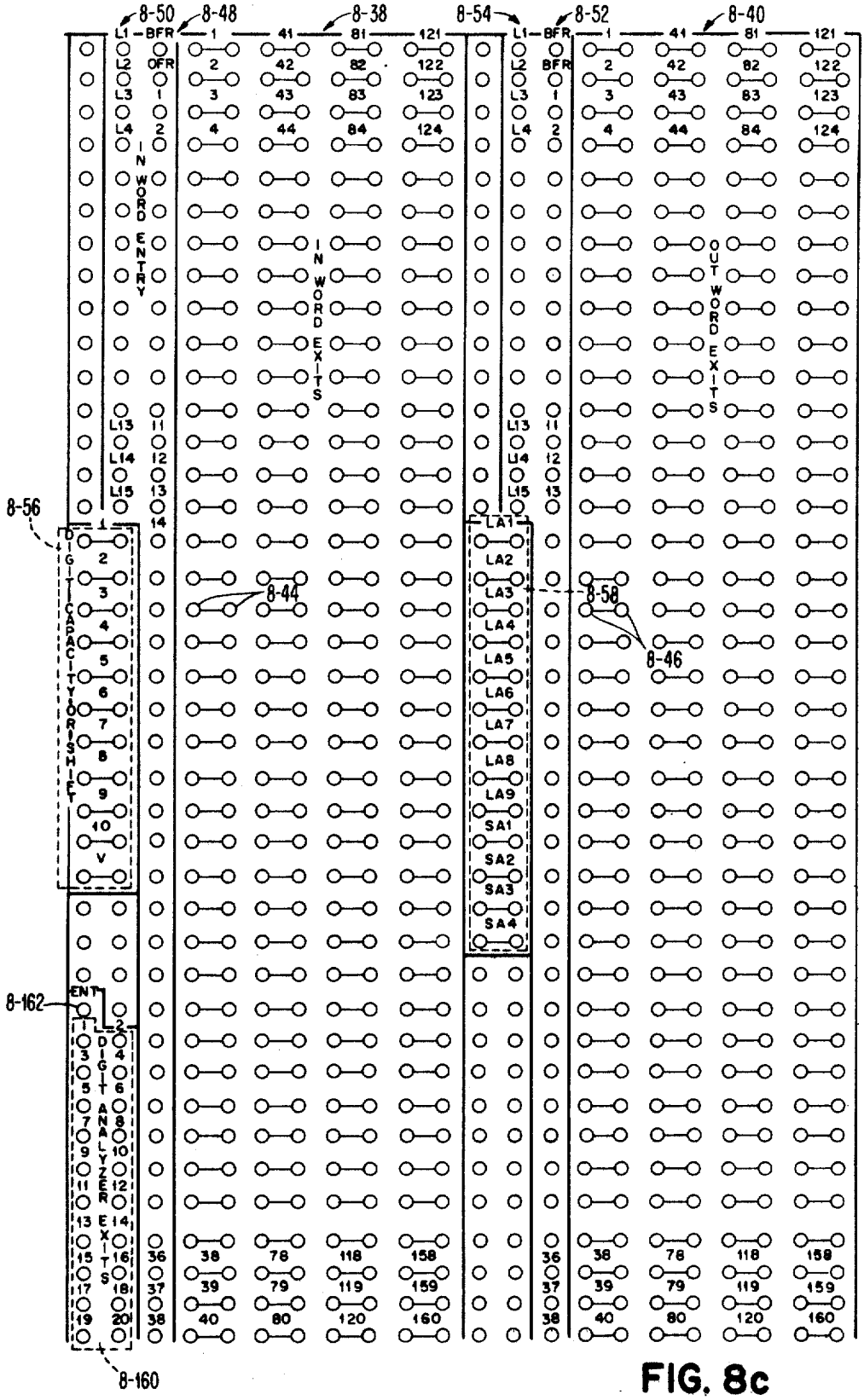


FIG. 8c

FIG. 9a

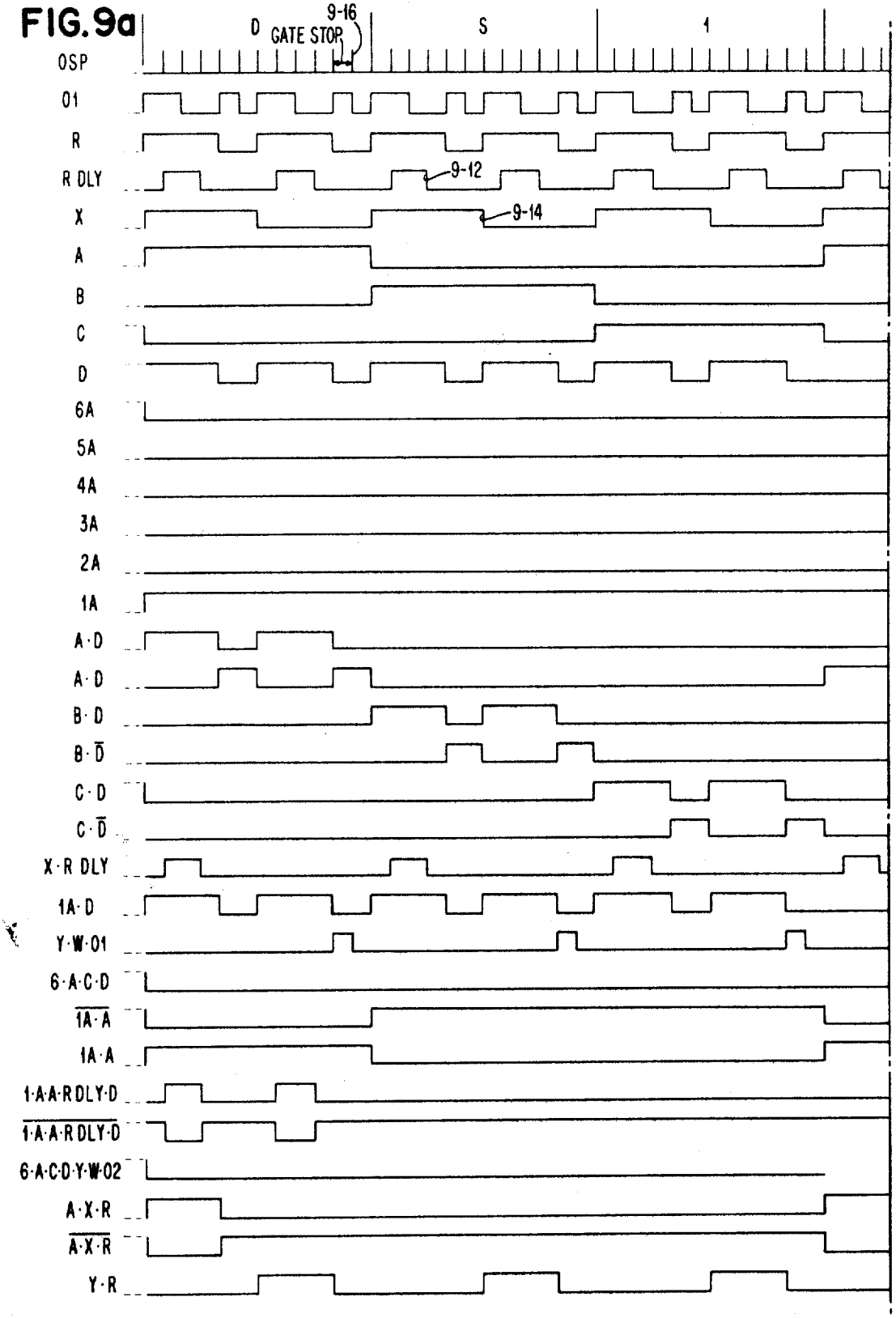

D
GATE STOP
9-16
S
1
OSP
01
R
R DLY
9-12
X
9-14
A
B
C
D
6A
5A
4A
3A
2A
1A
A·D
A·D
B·D
B·D̄
C·D
C·D̄
X·R DLY
1A·D
Y·W·01
6·A·C·D
1A·A
1A·A
1·A·A·R DLY·D
1·A·A·R DLY·D
6·A·C·D·Y·W·02
A·X·R
A·X·R
Y·R

FIG. 9b

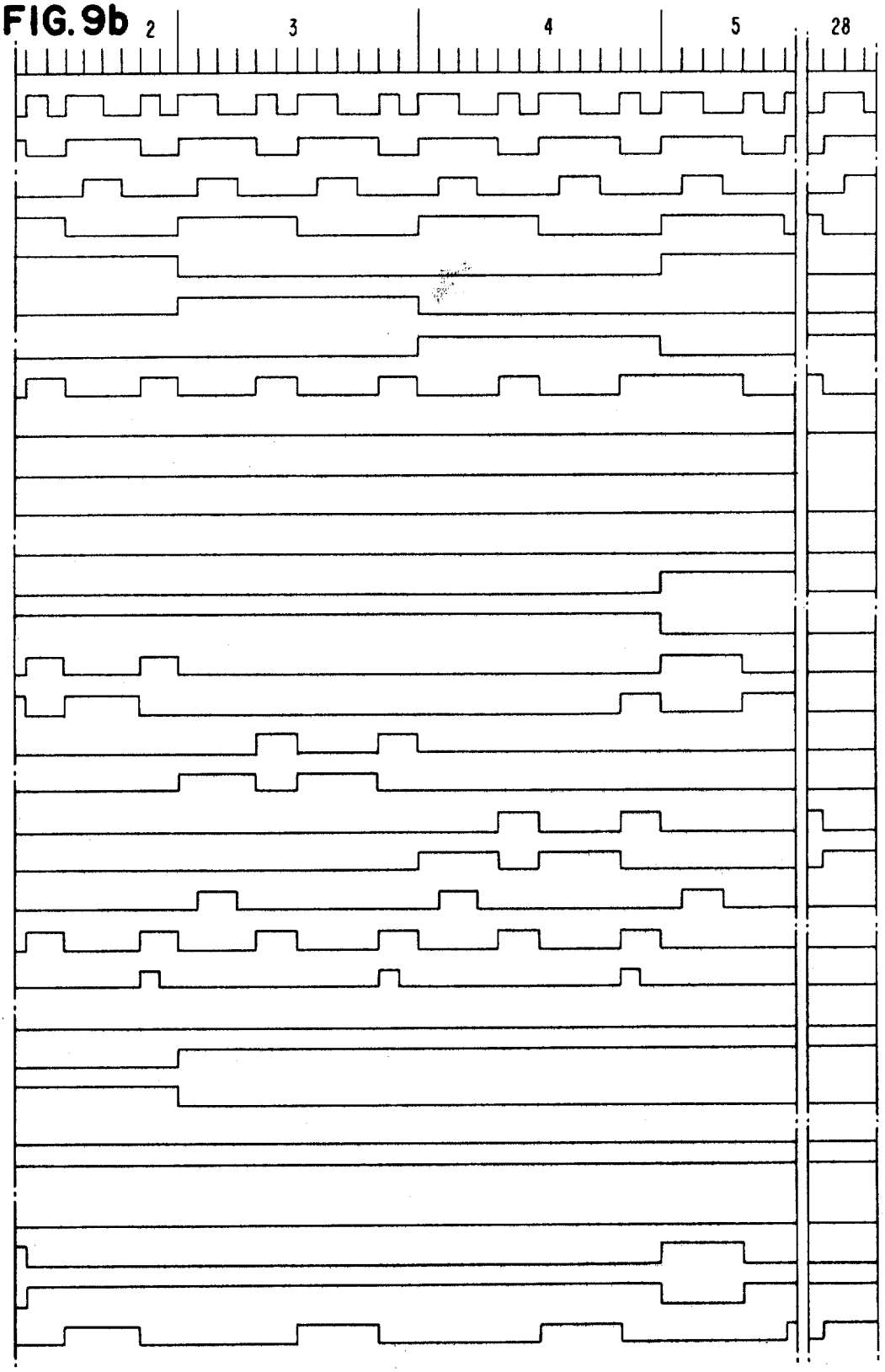


FIG. 9c

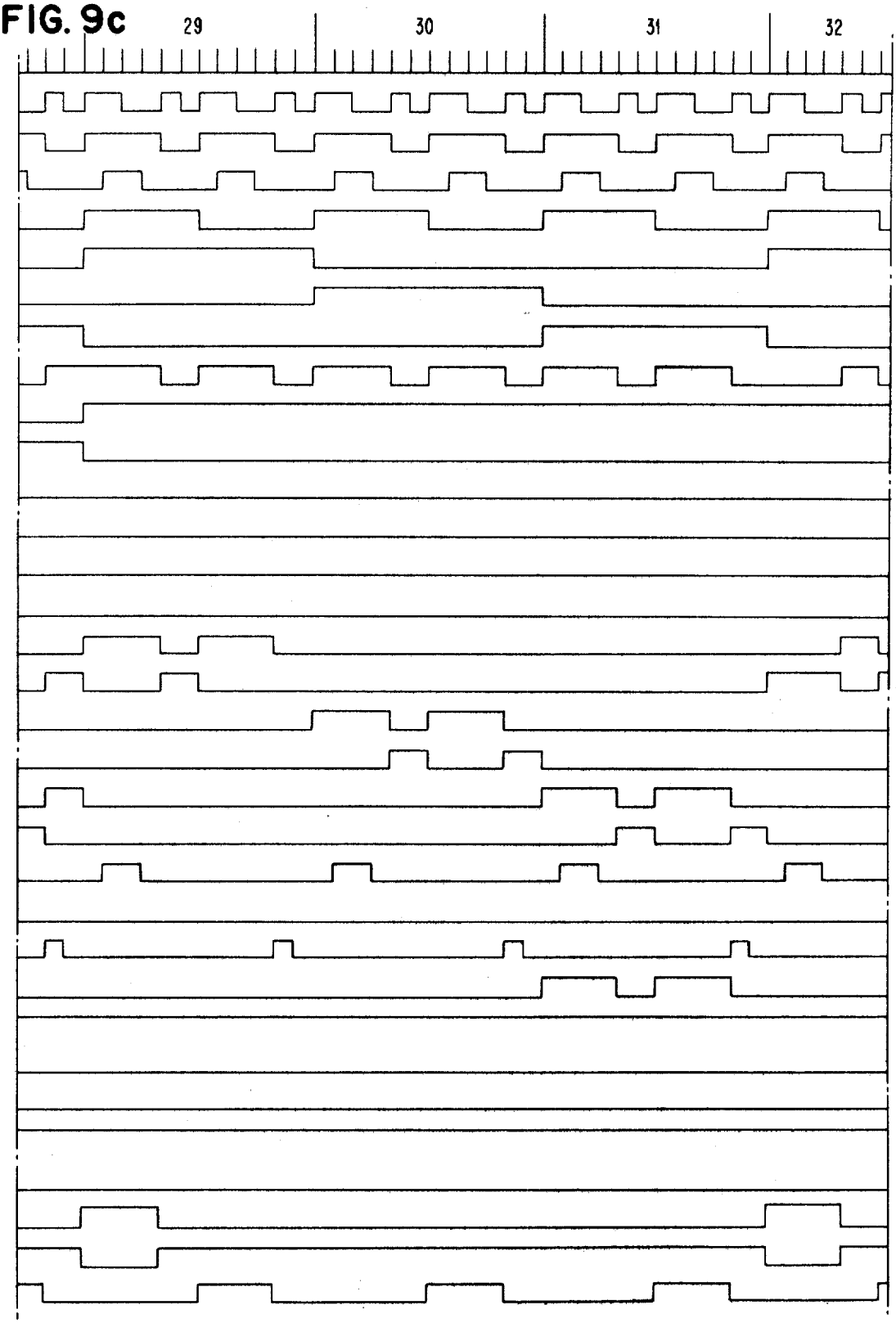


FIG. 9d

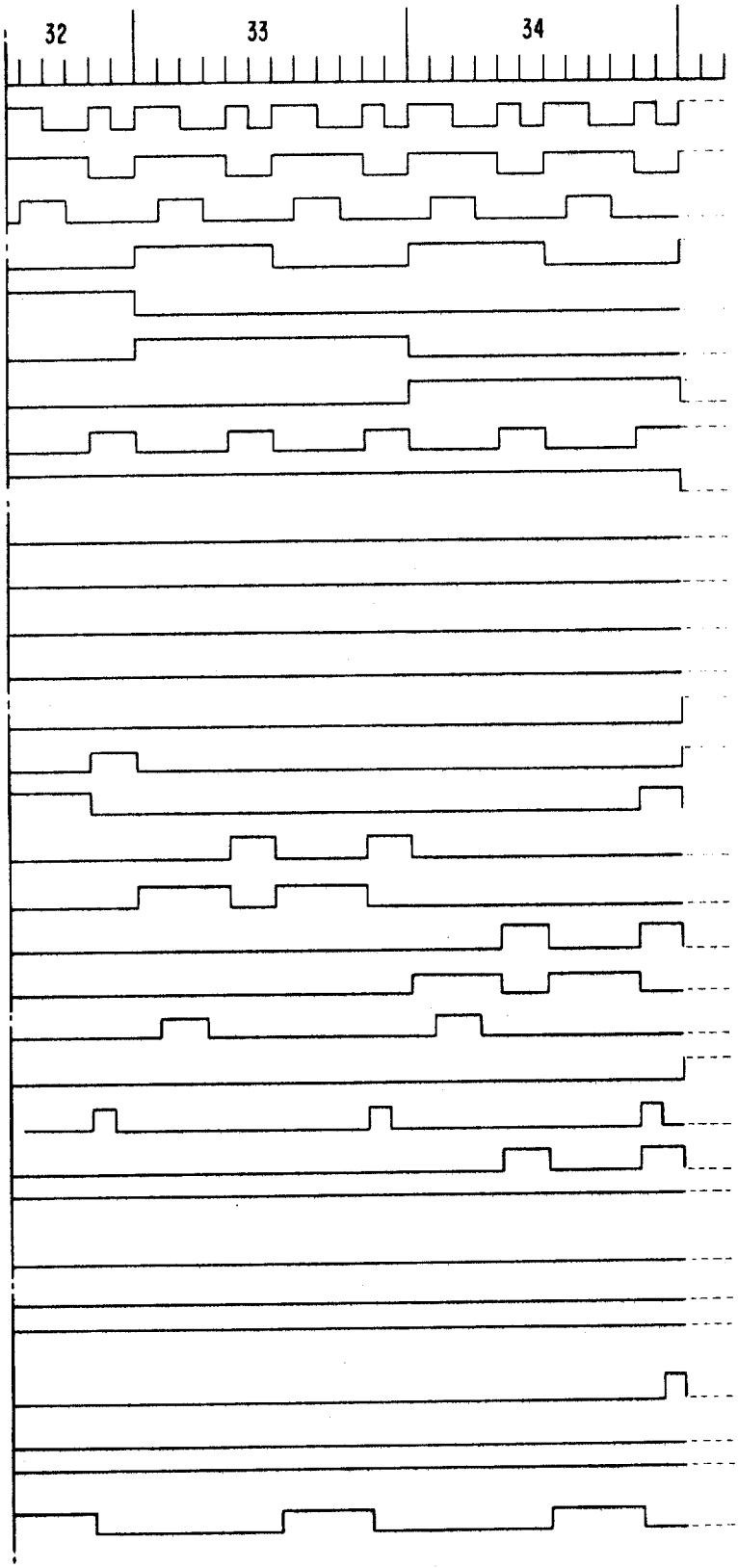


FIG. 9e

FIG. 9a	FIG. 9b	FIG. 9c	FIG. 9d

FIG.10a

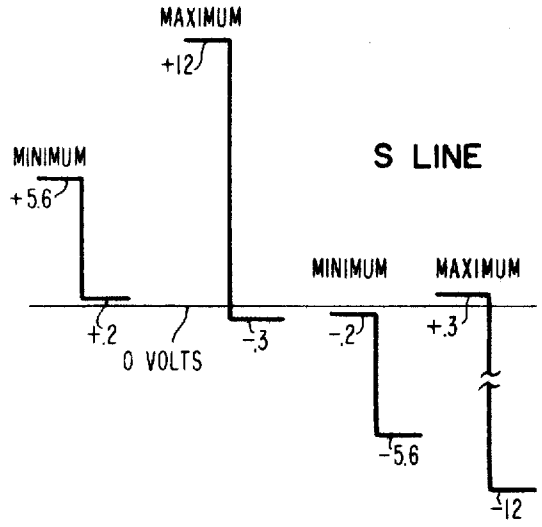


FIG.11

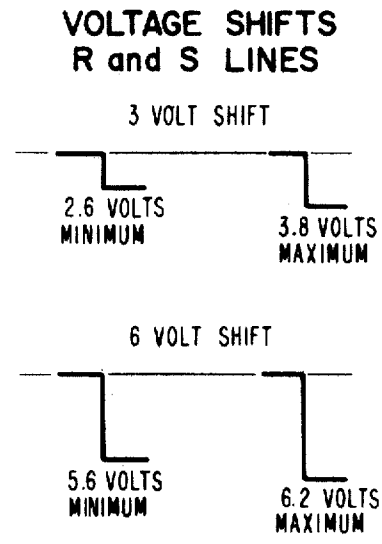


FIG.10b

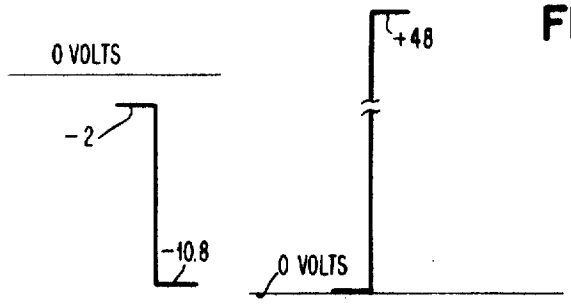


FIG.12

S to S INVERTER, + AND, - OR

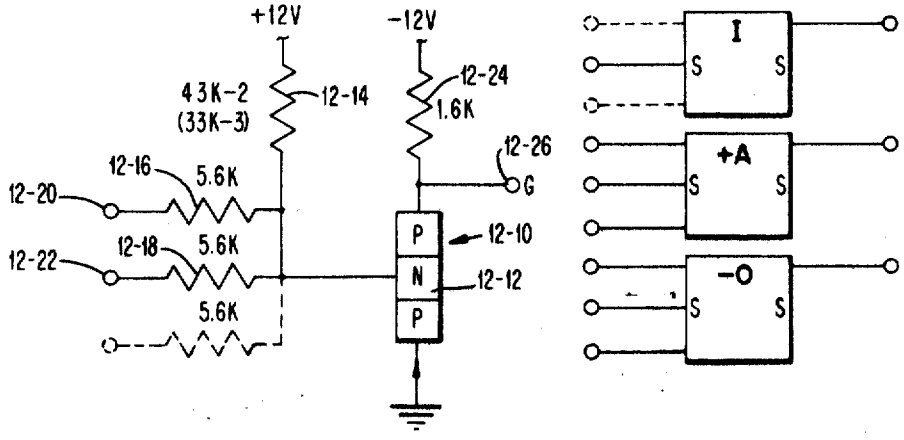


FIG.13

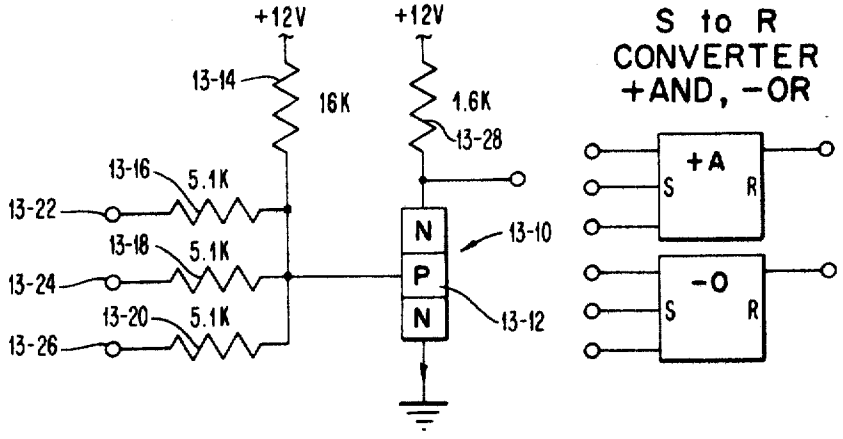
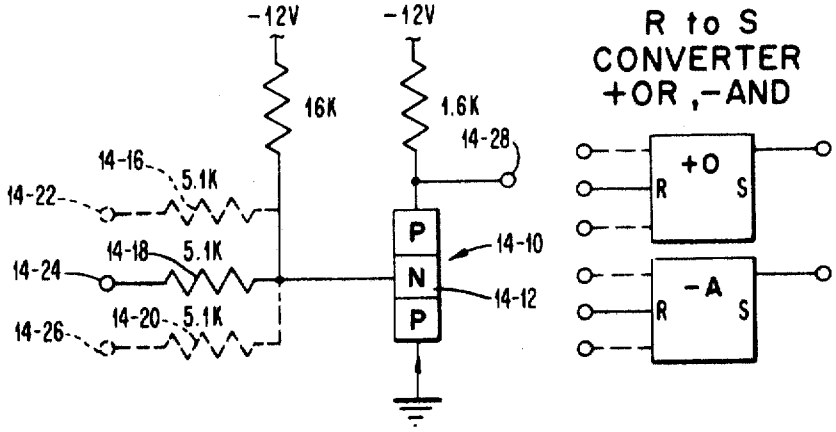

+12V
+12V
13-14
16K
1.6K
13-28
13-16
5.1K
13-22
13-18
5.1K
13-24
13-20
5.1K
13-26
N
P
N
13-10
13-12
S to R
CONVERTER
+AND, -OR
+A
S
R
-O
S
R

FIG.14


-12V
-12V
16K
1.6K
14-28
14-16
5.1K
14-22
14-18
5.1K
14-24
14-20
5.1K
14-26
P
N
P
14-10
14-12
R to S
CONVERTER
+OR ,-AND
+O
R
S
-A
R
S

S LINE POWER INVERTER

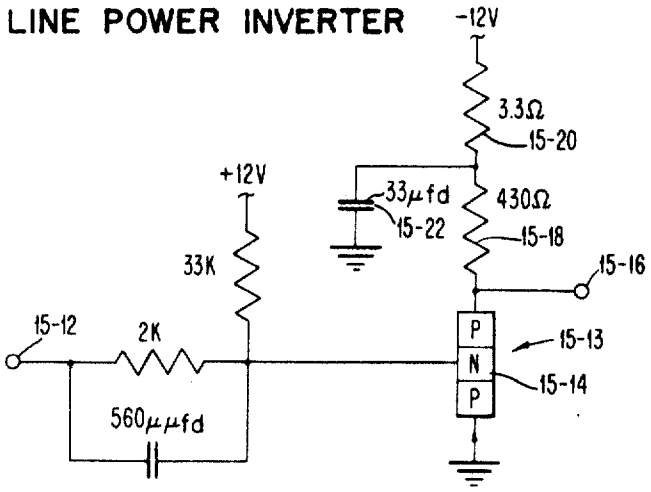
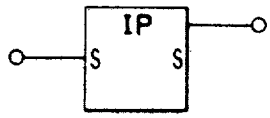


FIG.15



S to R LINE POWER INVERTER

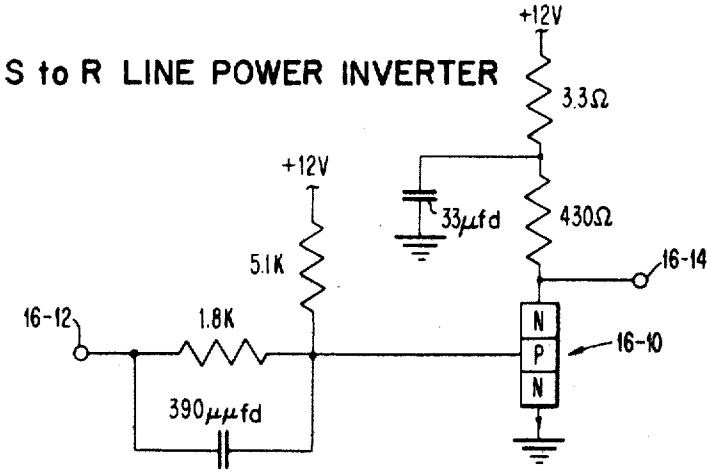
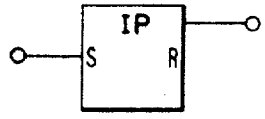


FIG.16



S LINE EMITTER FOLLOWER

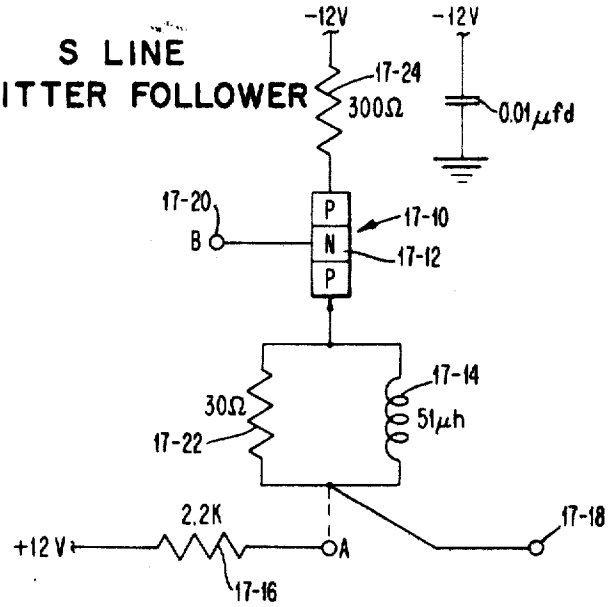
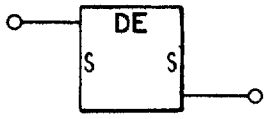


FIG.17



R LINE EMITTER FOLLOWER

FIG.18

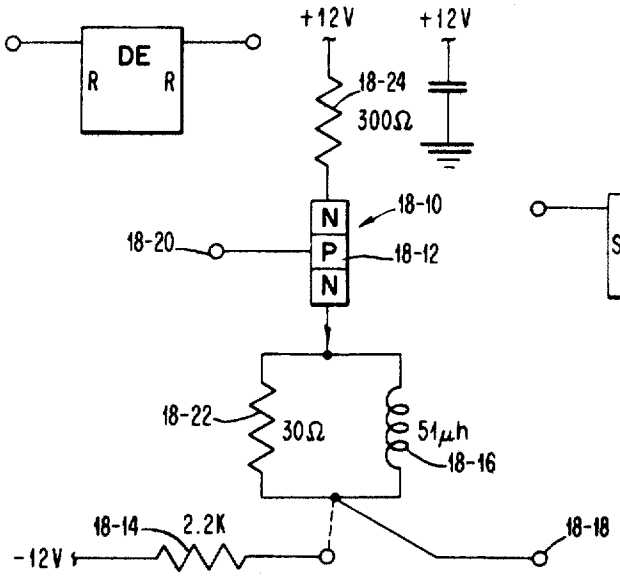
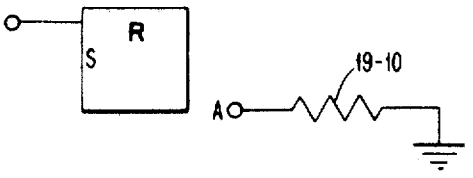


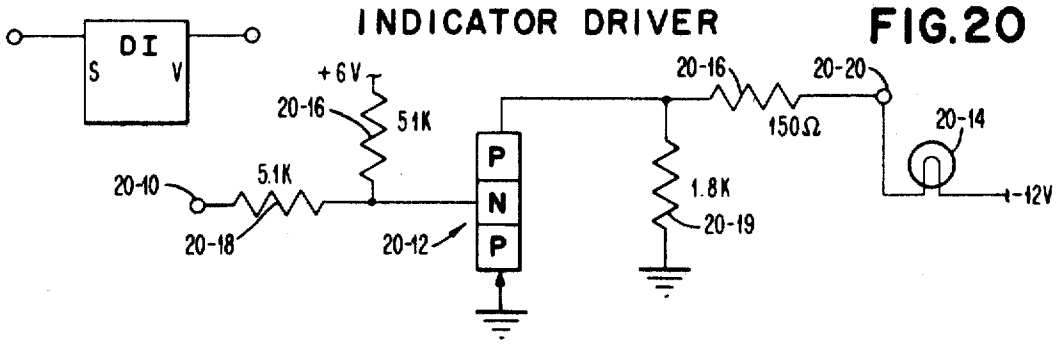
FIG.19

REMOTE LOAD



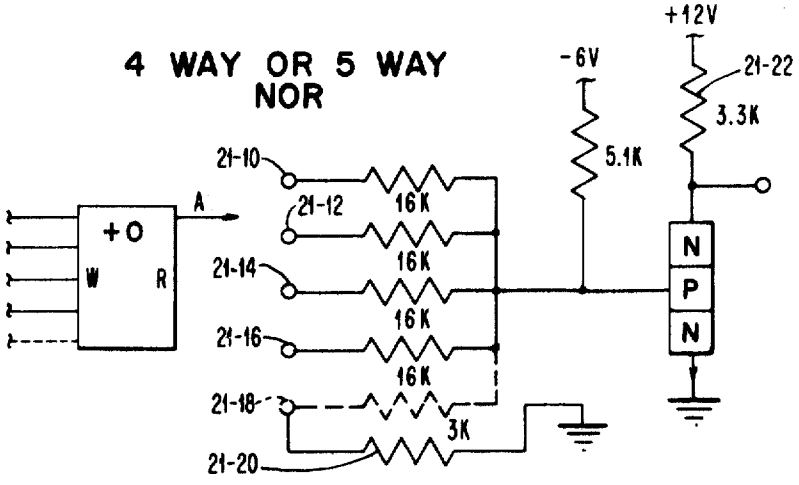
INDICATOR DRIVER

FIG.20



4 WAY OR 5 WAY NOR

FIG.21



DIODE ISOLATOR

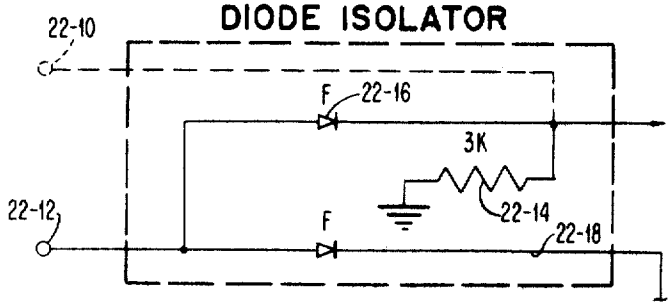
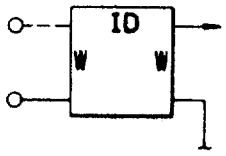
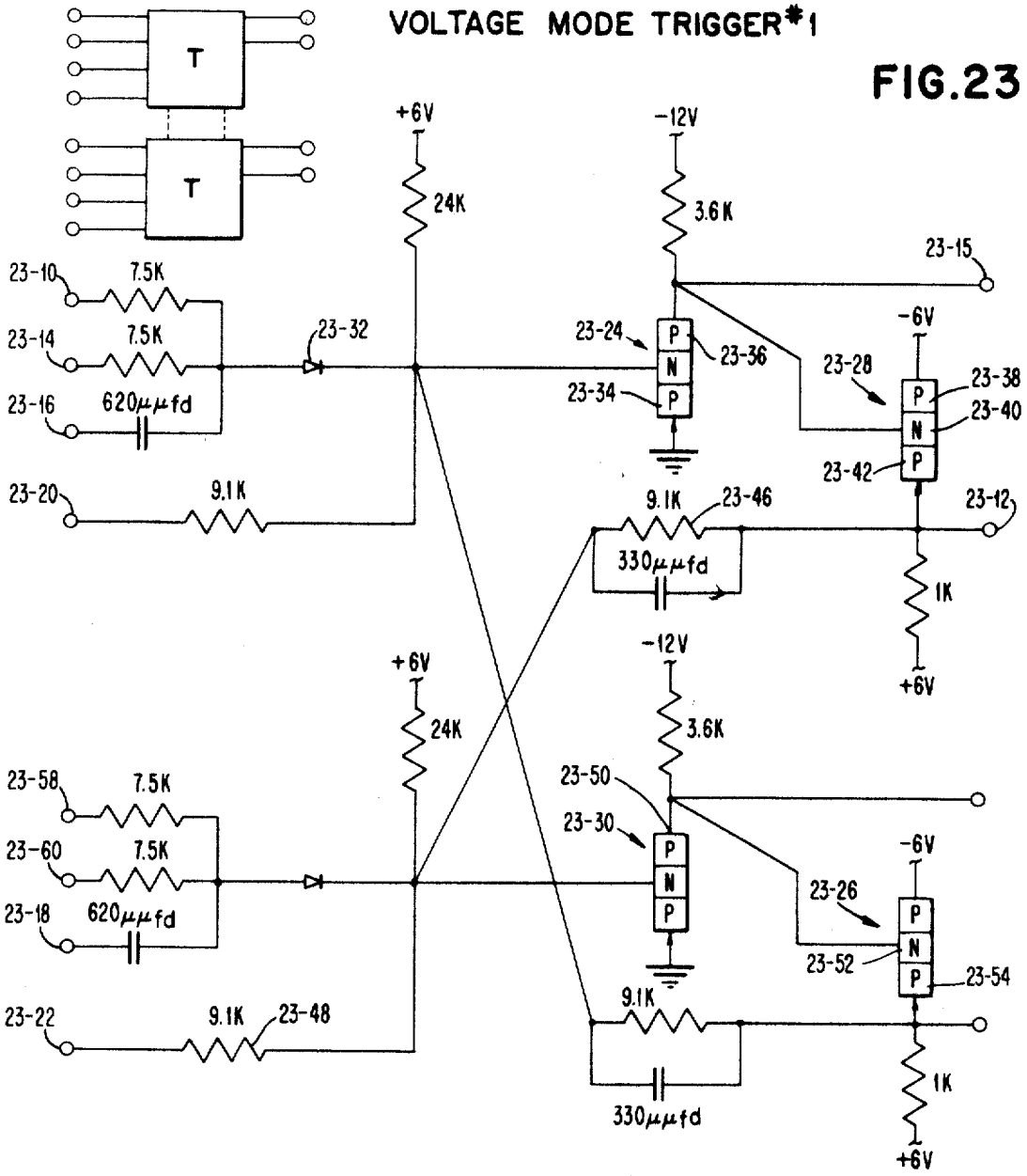


FIG.22



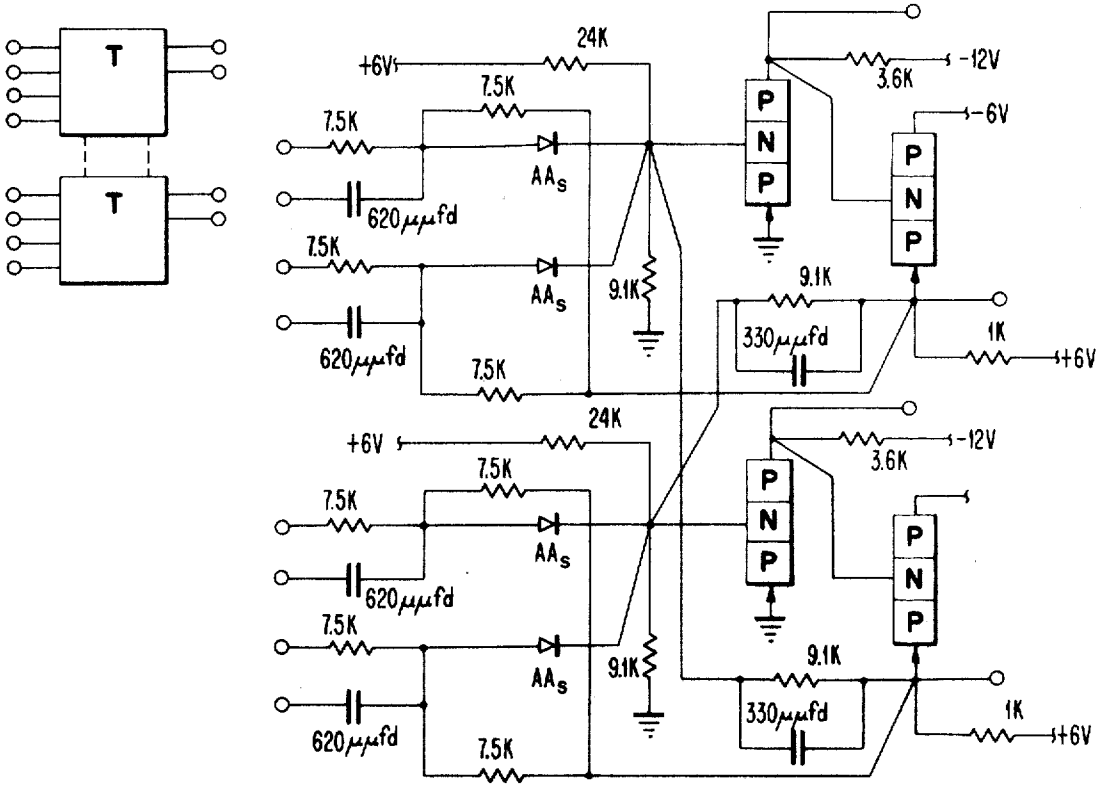
VOLTAGE MODE TRIGGER*1

FIG.23



VOLTAGE MODE TRIGGER #2

FIG. 24



GATED SAMPLE PULSE DRIVER

FIG. 25

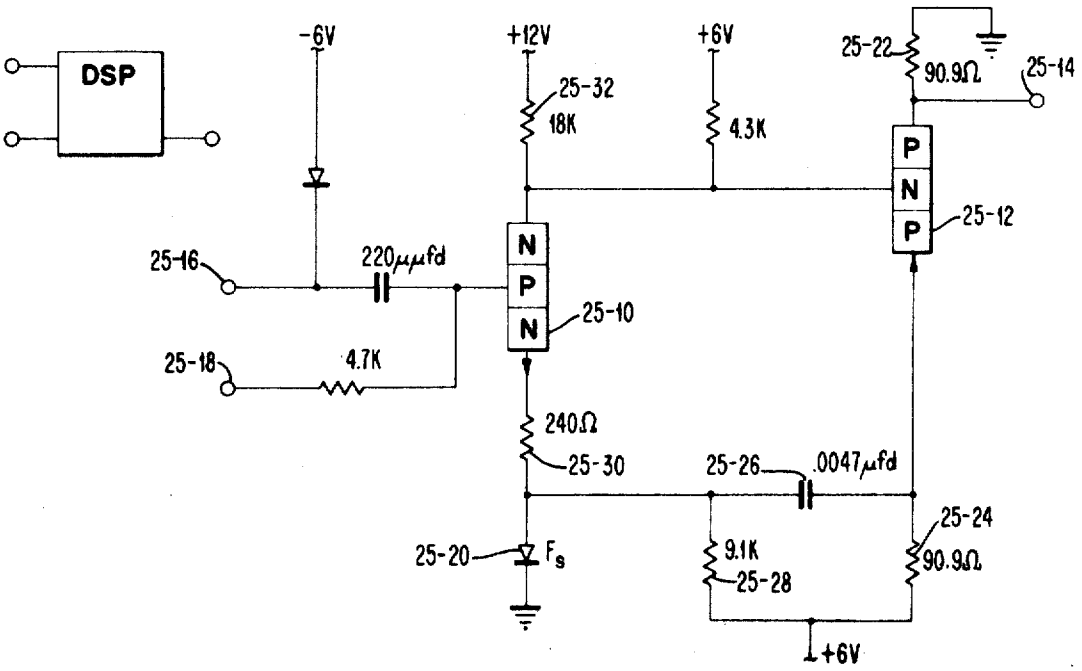


FIG.26

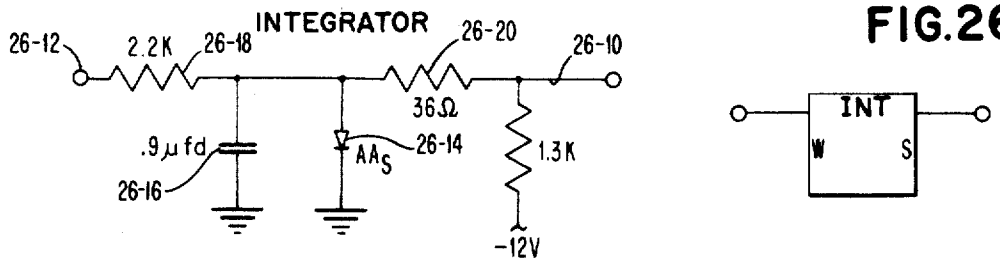


FIG.27

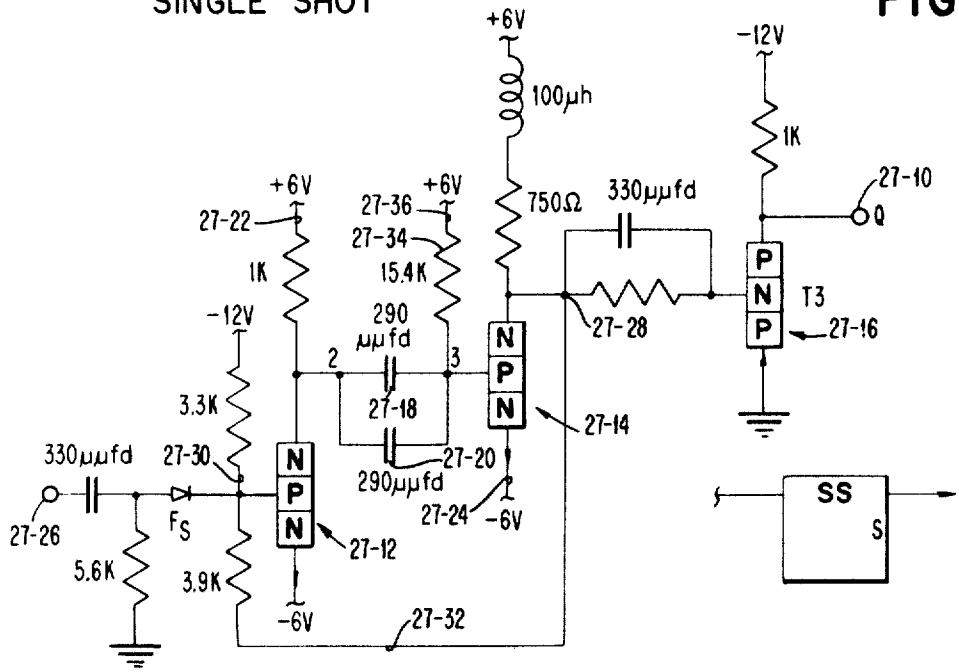
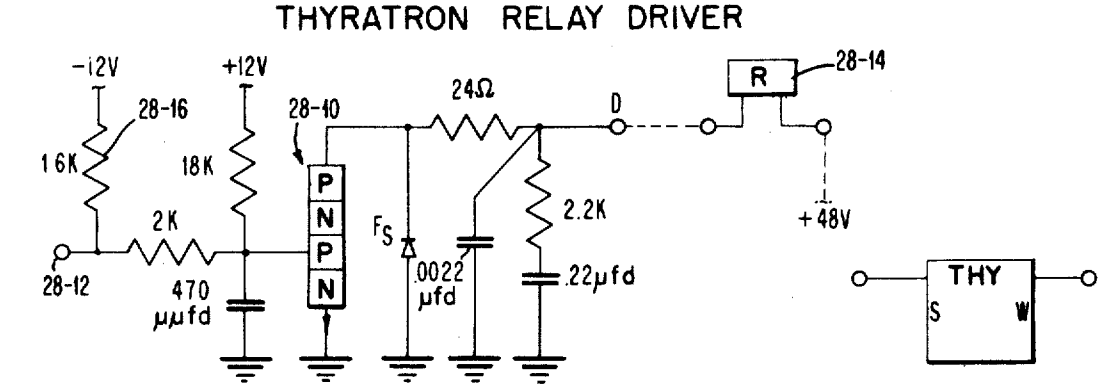
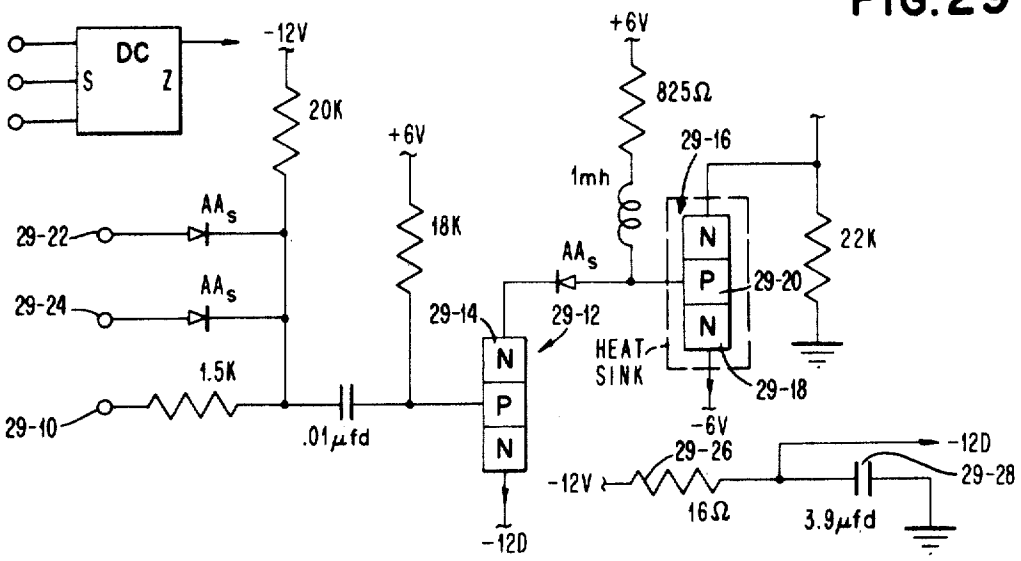


FIG.28



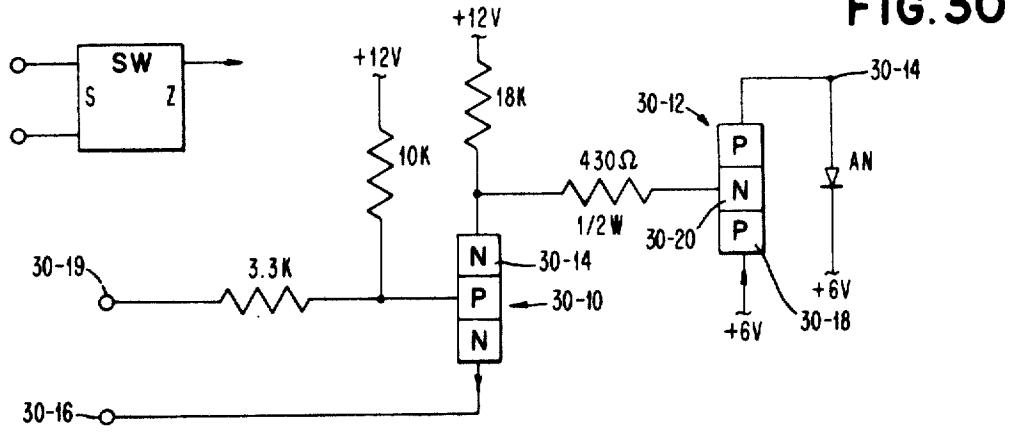
MEMORY DRIVER

FIG.29



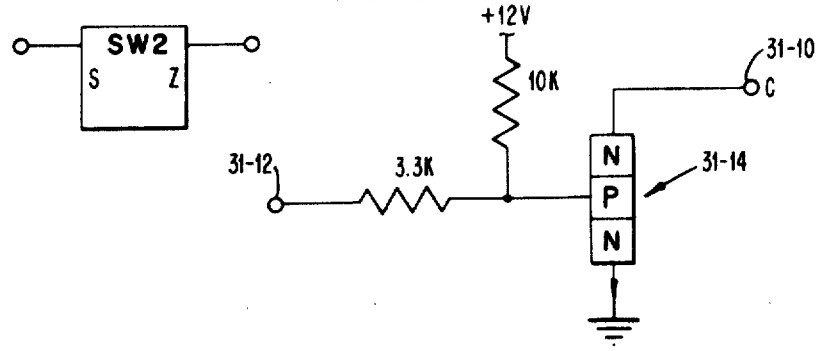
MEMORY SWITCH #1

FIG.30



MEMORY SWITCH #2

FIG.31



DELAY LINE

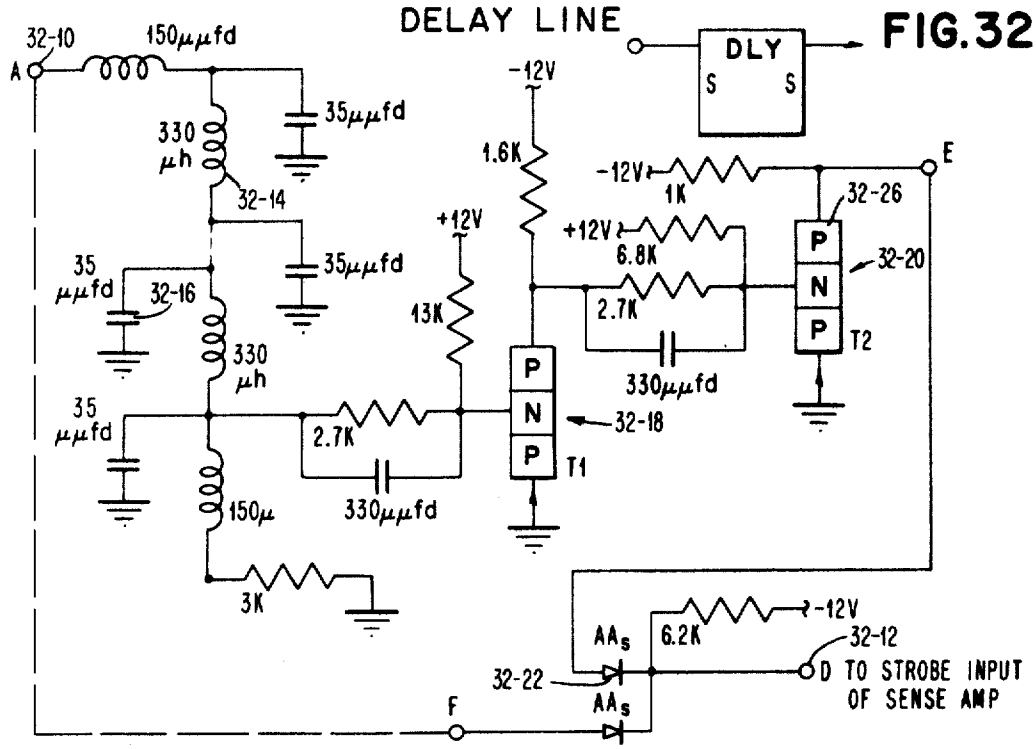


FIG.32

SENSE AMP SHAPER

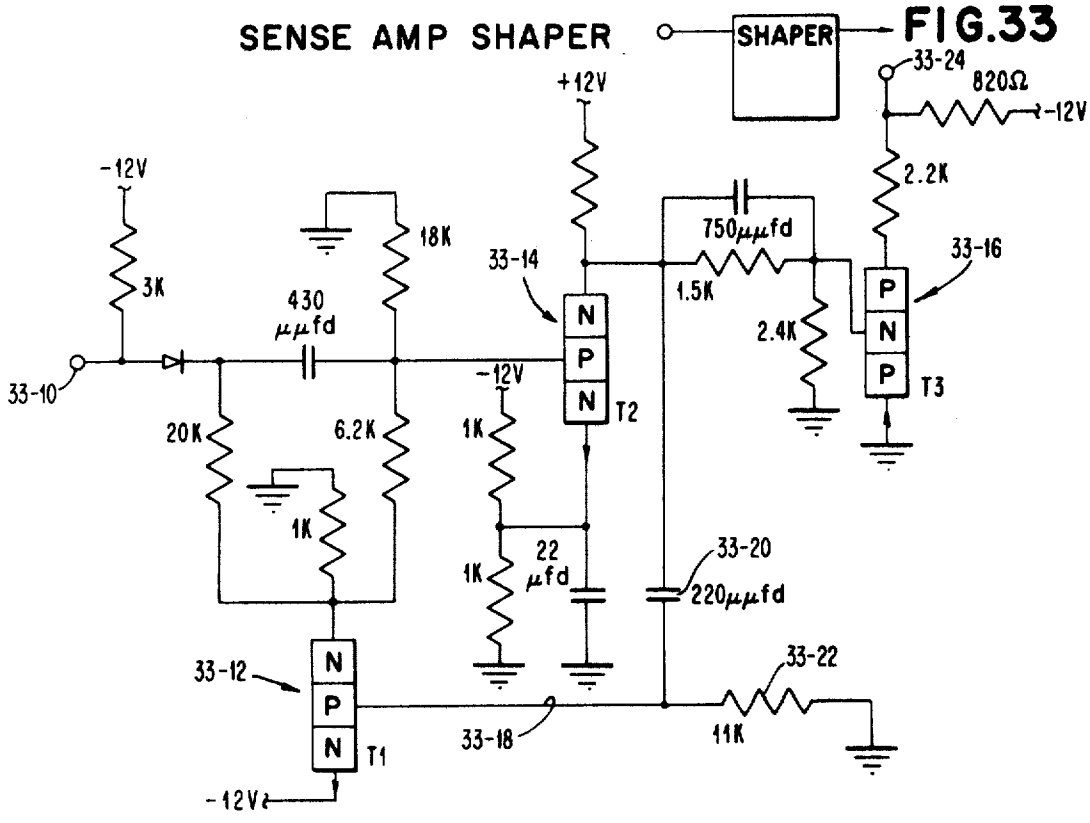
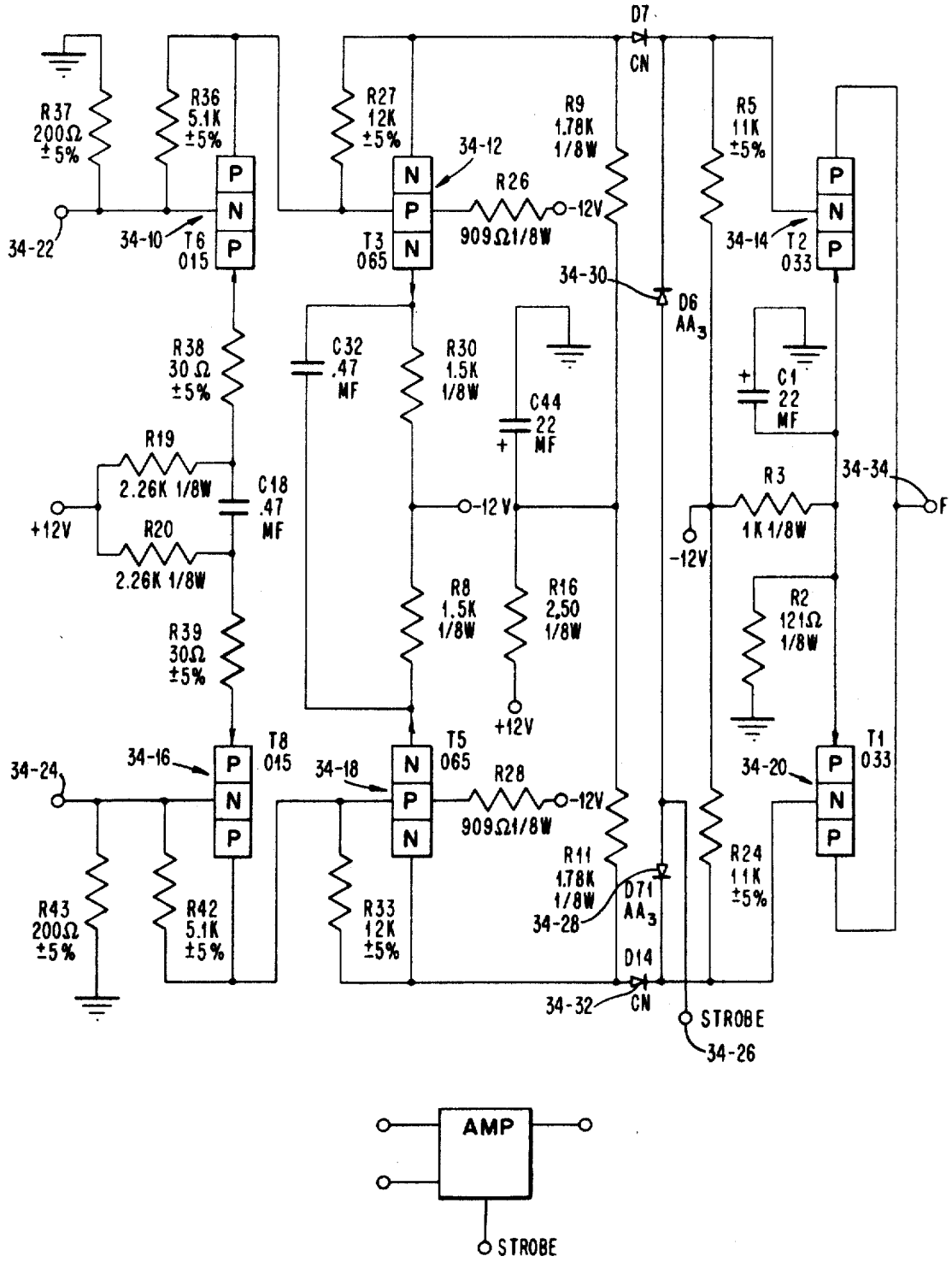


FIG.33

FIG. 34

SENSE AMPLIFIER



DOT FUNCTION BLOCKS

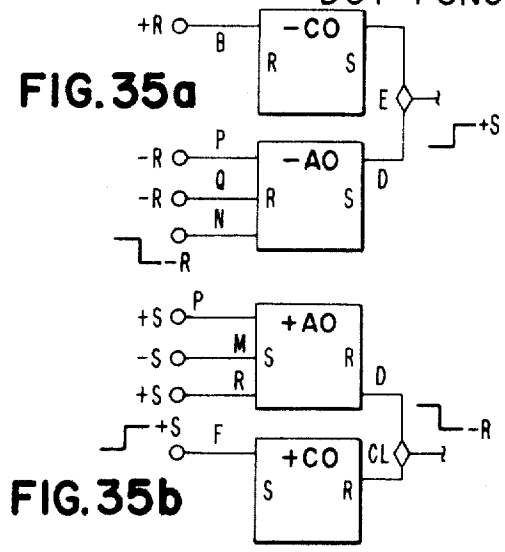


FIG.35a

FIG.35b

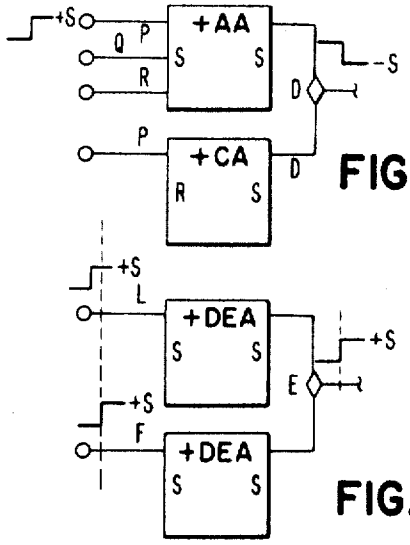


FIG.35c

FIG.35d

DOT FUNCTION DETAILS

FIG.36a

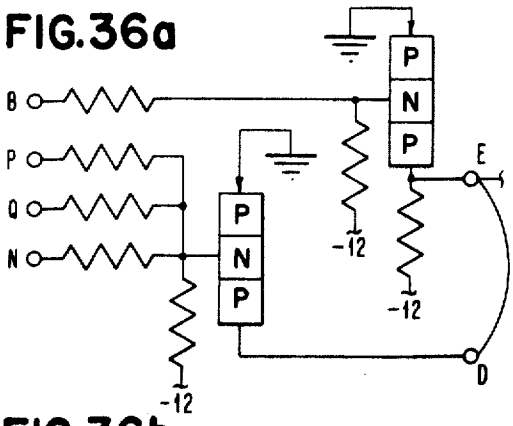


FIG.36b

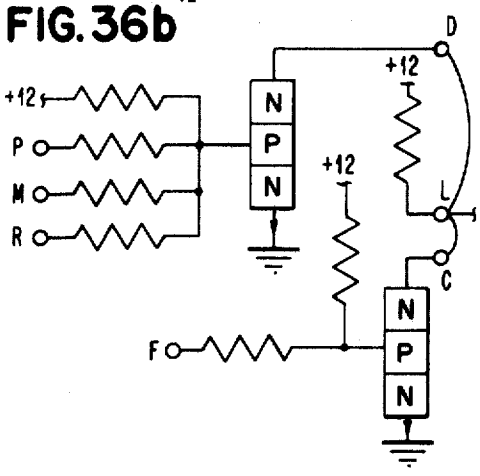


FIG.36c

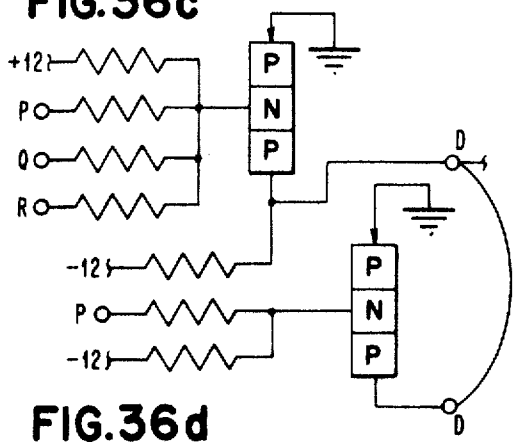
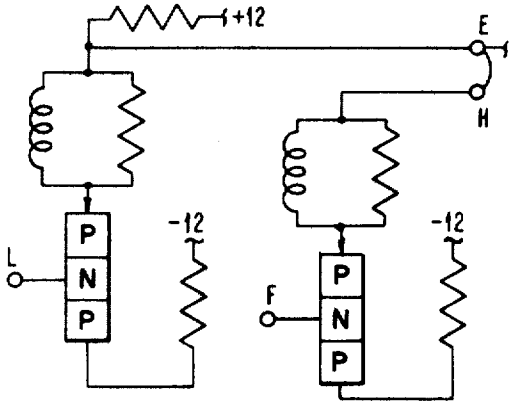


FIG.36d



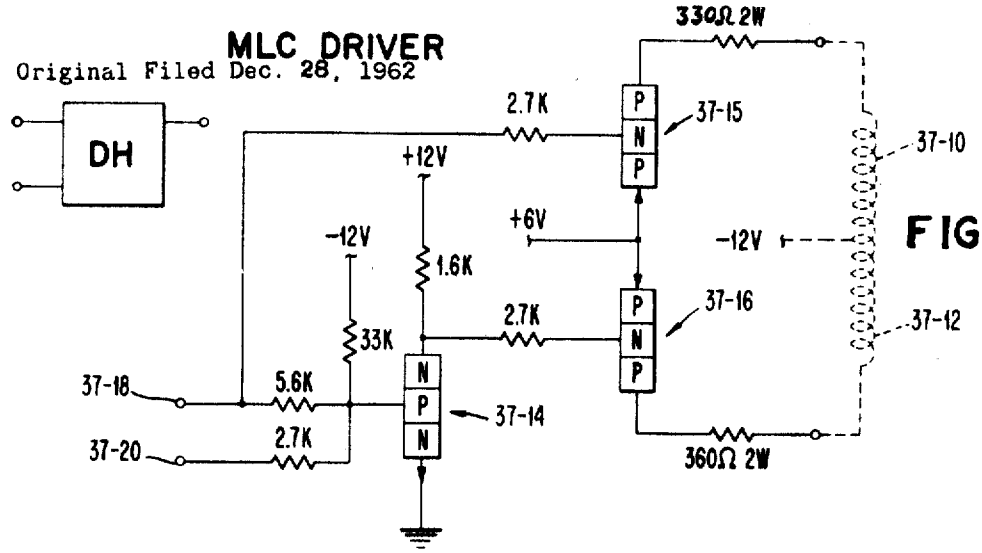


FIG. 37

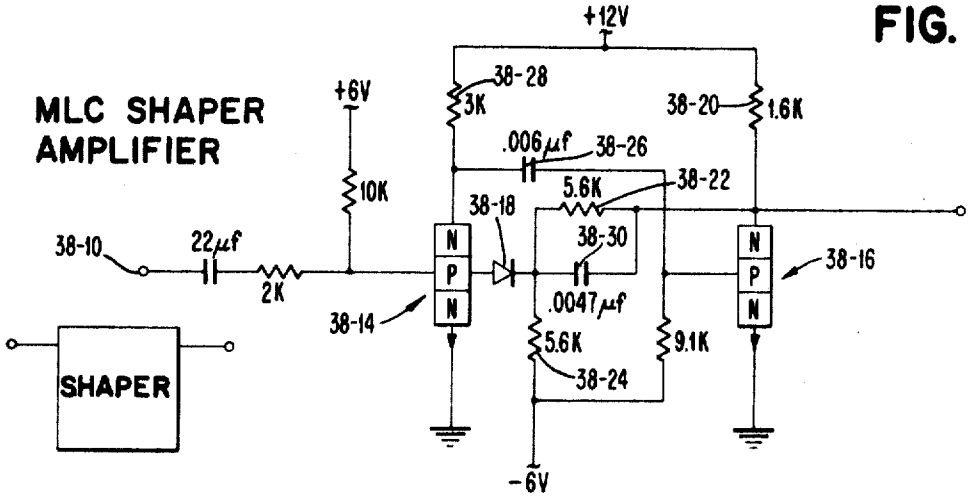


FIG. 38

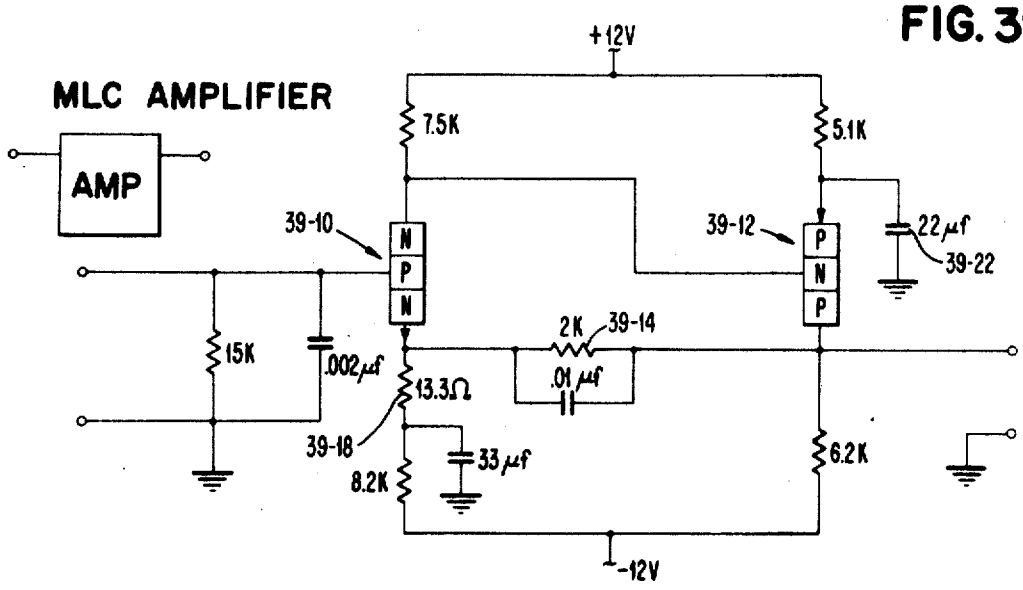


FIG. 39

FIG. 40

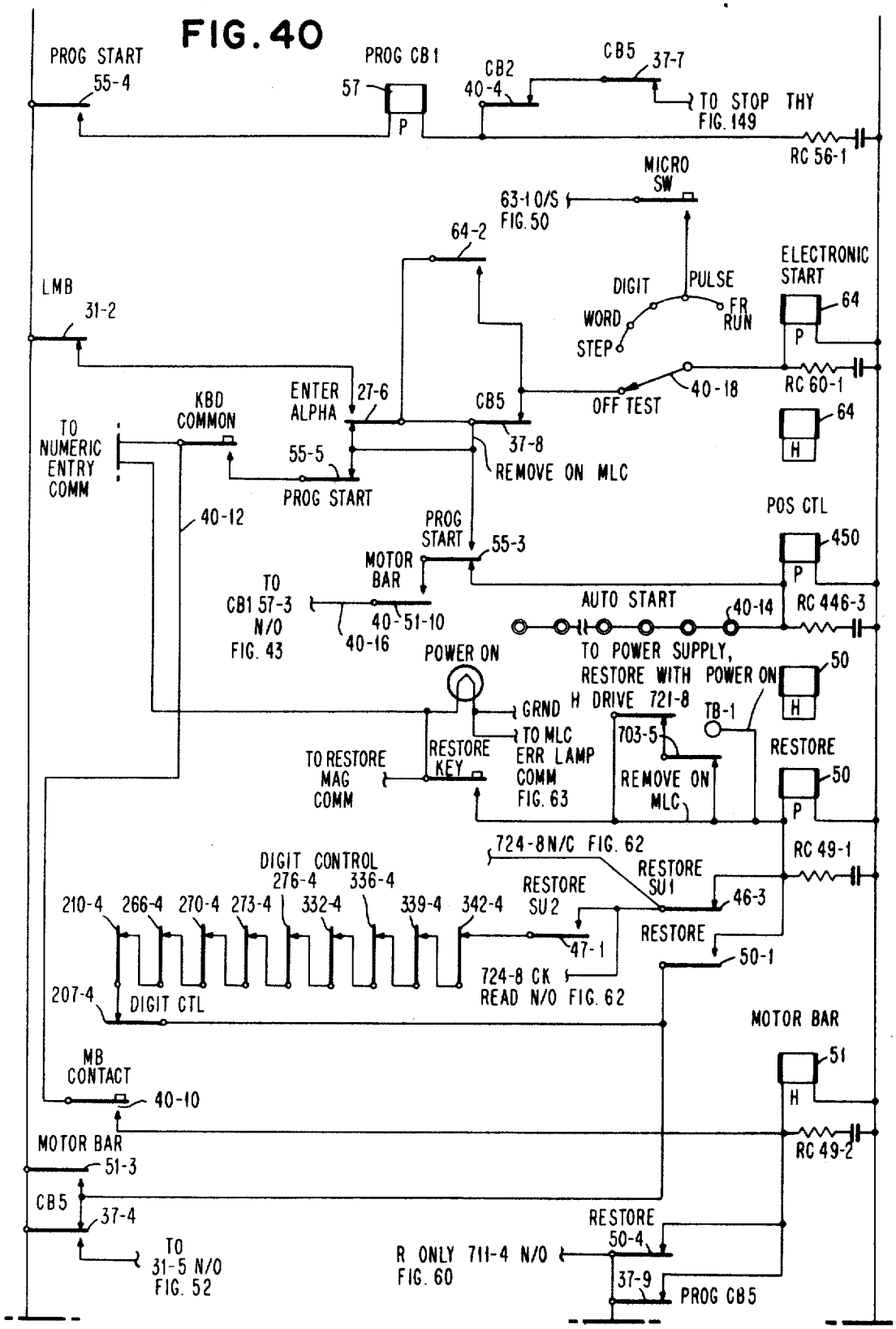
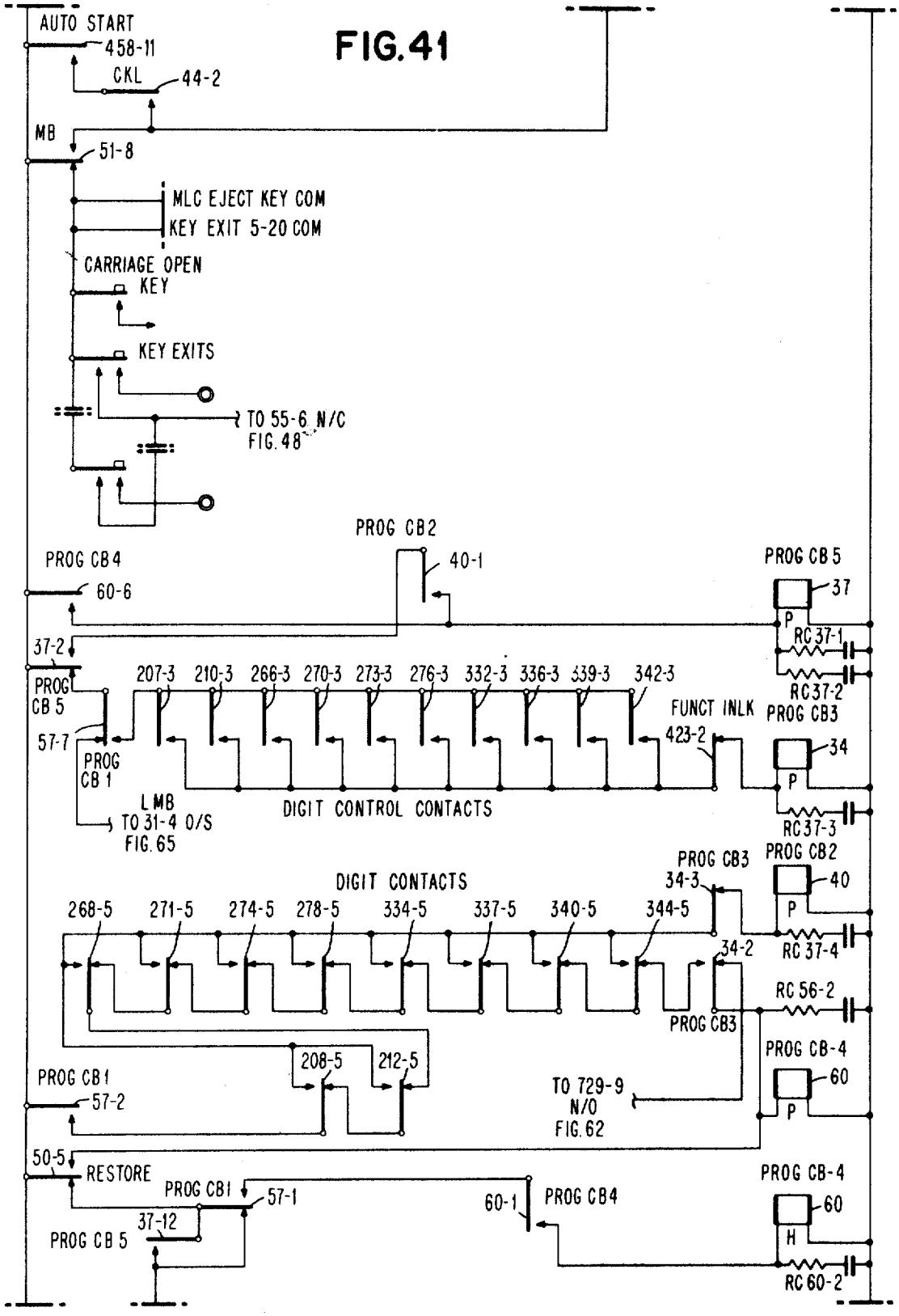

PROG START
55-4
PROG CB1
57
P
CB2
40-4
CB5
37-7
TO STOP THY
FIG. 149
RC 56-1
MICRO SW
63-1 O/S
FIG. 50
64-2
LMB
31-2
DIGIT
PULSE
WORD
STEP
FR RUN
ELECTRONIC START
64
P
RC 60-1
OFF TEST
40-18
ENTER ALPHA
27-6
CB5
37-8
KBD COMMON
TO NUMERIC ENTRY COMM
55-5
PROG START
REMOVE ON MLC
64
H
40-12
PROG START
55-3
MOTOR BAR
POS CTL
450
P
TO CB1 57-3 N/O FIG. 43
40-51-10
40-16
AUTO START
40-14
RC 446-3
POWER ON
TO POWER SUPPLY, RESTORE WITH POWER ON
50
H
GRND
TO MLC ERR LAMP COMM FIG. 63
H DRIVE 721-8
TB-1
703-5
TO RESTORE MAG COMM
RESTORE KEY
REMOVE ON MLC
RESTORE
50
P
724-8 N/C FIG. 62
RC 49-1
DIGIT CONTROL
276-4
336-4
RESTORE SU1
RESTORE SU2
46-3
210-4
266-4
270-4
273-4
332-4
339-4
342-4
47-1
RESTORE
50-1
724-8 CK READ N/O FIG. 62
207-4
DIGIT CTL
MOTOR BAR
51
H
MB CONTACT
40-10
RC 49-2
MOTOR BAR
51-3
CB5
37-4
TO 31-5 N/O FIG. 52
RESTORE
50-4
R ONLY 711-4 N/O FIG. 60
37-9
PROG CB5

FIG. 41


AUTO START
458-11
CKL
44-2
MB
51-8
MLC EJECT KEY COM
KEY EXIT 5-20 COM
CARRIAGE OPEN KEY
KEY EXITS
TO 55-6 N/C FIG. 48
PROG CB2
40-1
PROG CB4
60-6
PROG CB5
37
P
RC 37-1
RC 37-2
37-2
PROG CB 5
207-3 210-3 266-3 270-3 273-3 276-3 332-3 336-3 339-3 342-3
FUNCT INLK
423-2
PROG CB3
34
P
RC 37-3
57-7
PROG CB 1
LMB
TO 31-4 O/S FIG. 65
DIGIT CONTROL CONTACTS
PROG CB3
34-3
PROG CB2
40
P
RC 37-4
DIGIT CONTACTS
268-5 271-5 274-5 278-5 334-5 337-5 340-5 344-5
34-2
RC 56-2
PROG CB3
208-5 212-5
PROG CB-4
60
P
PROG CB1
57-2
TO 729-9 N/O FIG. 62
50-5
RESTORE
PROG CB1
57-1
37-12
PROG CB 5
60-1
PROG CB4
PROG CB-4
60
H
RC 60-2

PROGRAM FUNCTION EXITS FIG. 42

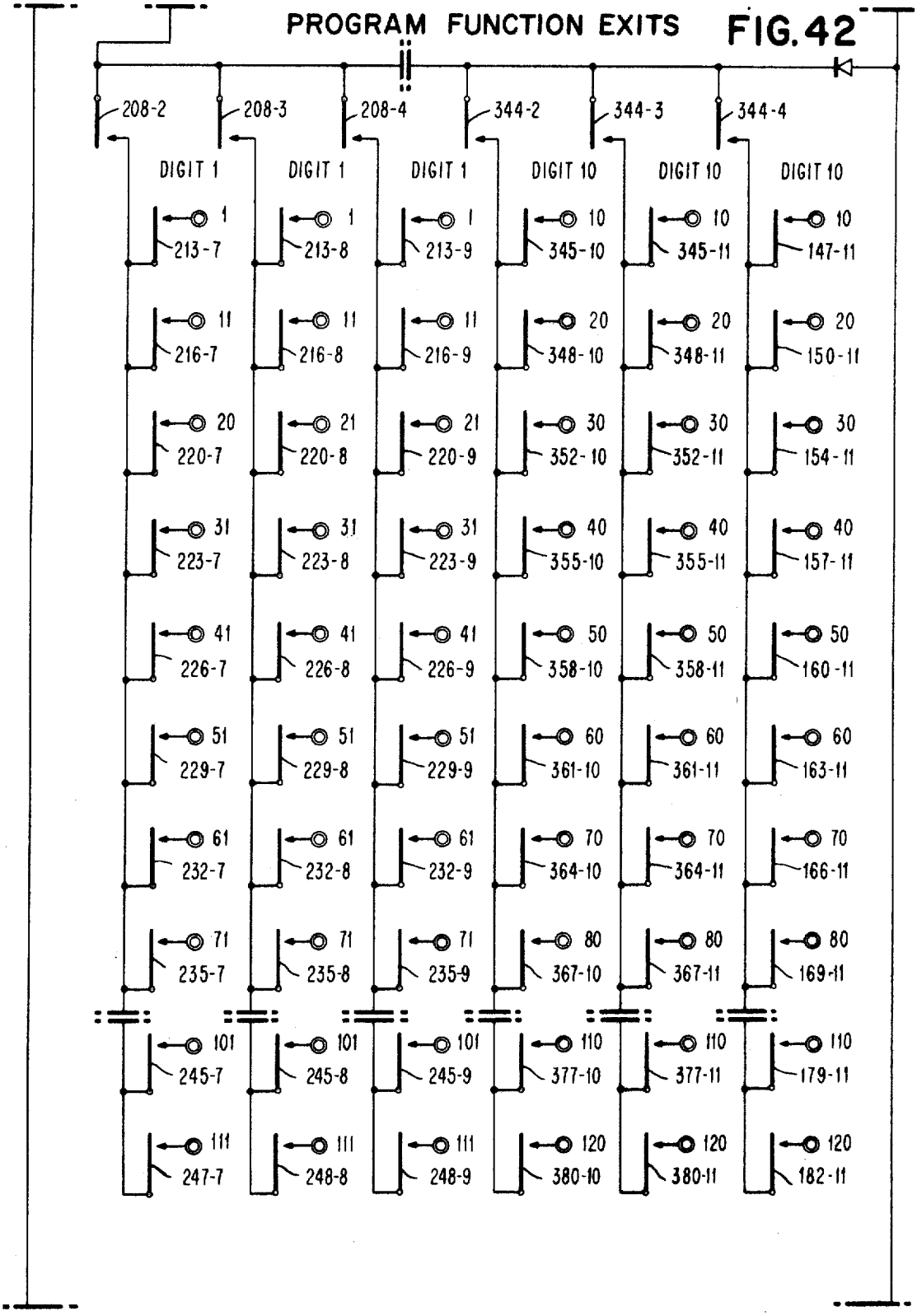


FIG. 43 PROGRAM STEP EXITS

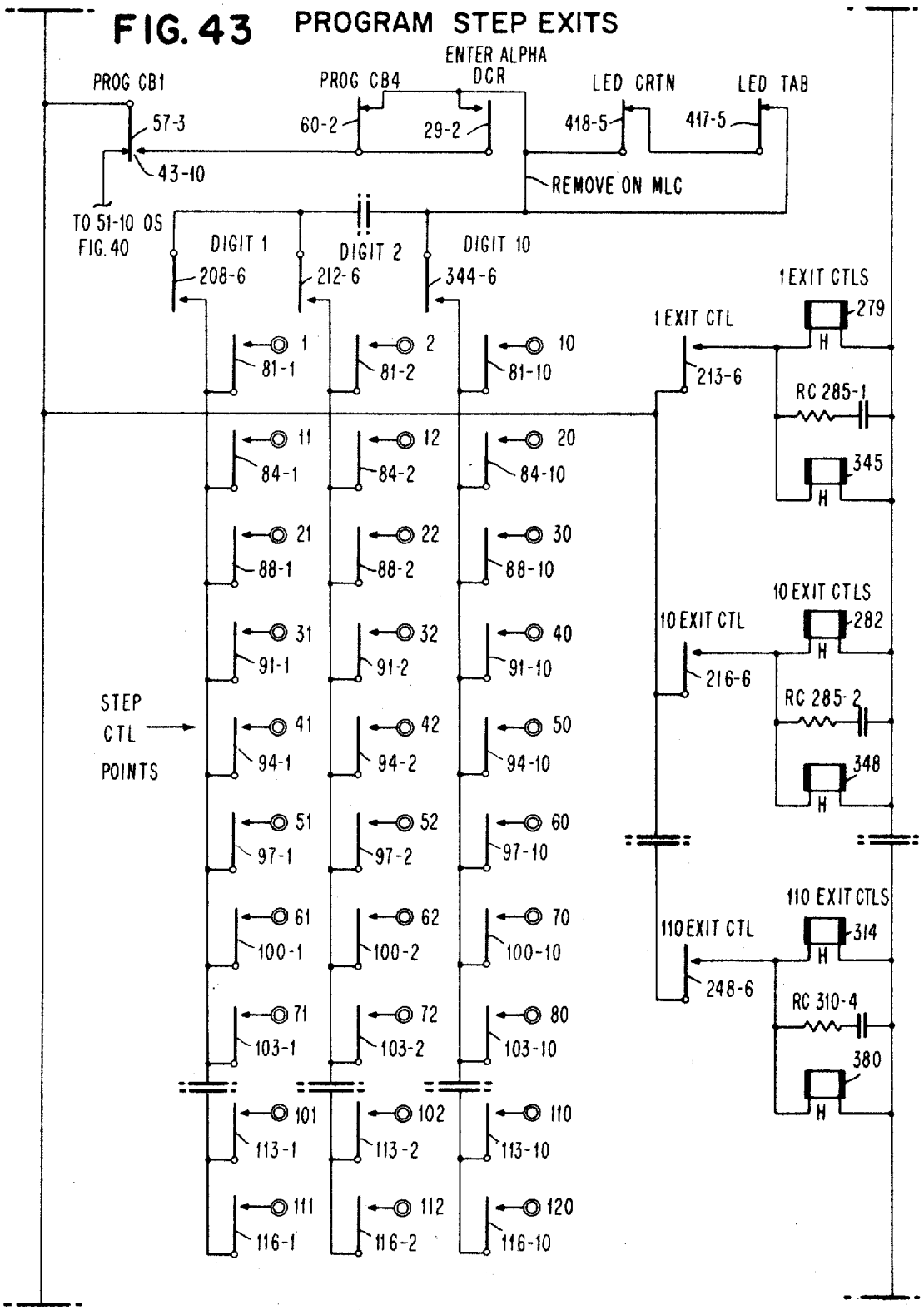
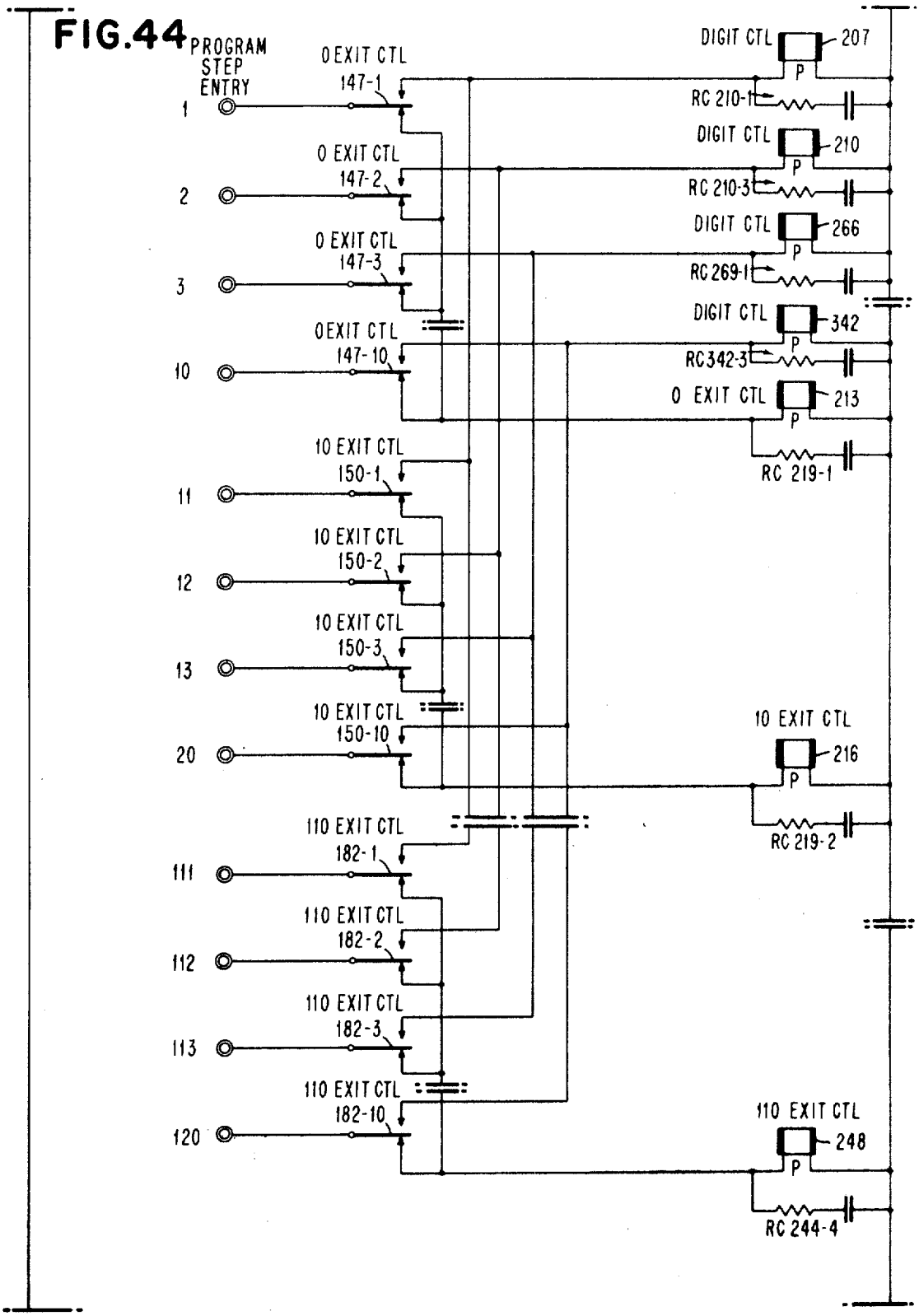


FIG.44


PROGRAM STEP ENTRY
1
2
3
10
11
12
13
20
111
112
113
120
0 EXIT CTL 147-1
0 EXIT CTL 147-2
0 EXIT CTL 147-3
0 EXIT CTL 147-10
10 EXIT CTL 150-1
10 EXIT CTL 150-2
10 EXIT CTL 150-3
10 EXIT CTL 150-10
110 EXIT CTL 182-1
110 EXIT CTL 182-2
110 EXIT CTL 182-3
110 EXIT CTL 182-10
DIGIT CTL 207
RC 210-1
DIGIT CTL 210
RC 210-3
DIGIT CTL 266
RC 269-1
DIGIT CTL 342
RC 342-3
0 EXIT CTL 213
RC 219-1
10 EXIT CTL 216
RC 219-2
110 EXIT CTL 248
RC 244-4
P

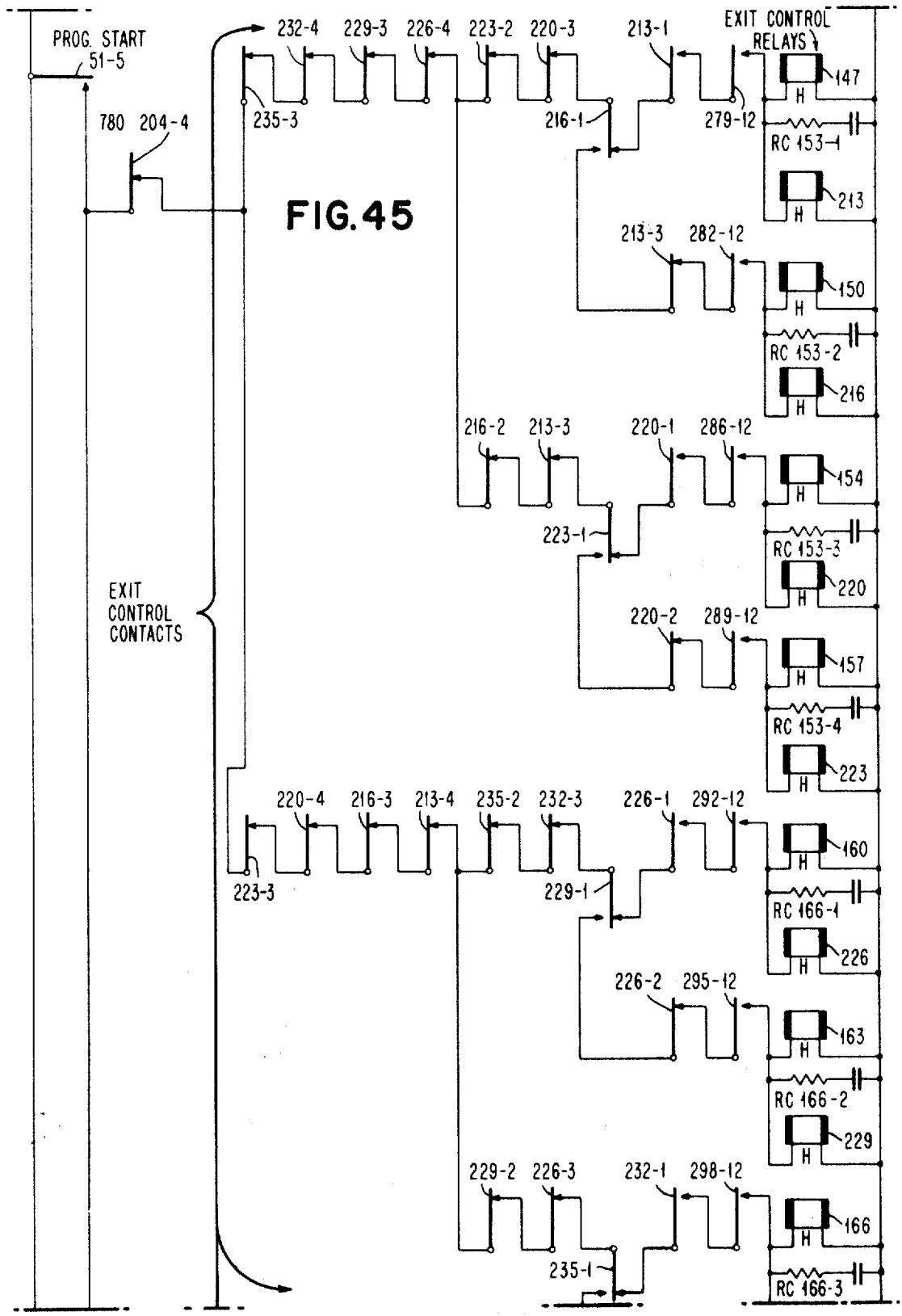

PROG. START
51-5
780 204-4
EXIT CONTROL CONTACTS
232-4 229-3 226-4 223-2 220-3 213-1
EXIT CONTROL RELAYS
235-3
216-1
279-12
147
H
RC 153-1
213
213-3 282-12
150
RC 153-2
216
216-2 213-3 220-1 286-12
154
223-1
RC 153-3
220
220-2 289-12
157
RC 153-4
223
220-4 216-3 213-4 235-2 232-3 226-1 292-12
223-3
229-1
160
RC 166-1
226
226-2 295-12
163
RC 166-2
229
229-2 226-3 232-1 298-12
235-1
166
RC 166-3

FIG. 45

FIG. 46

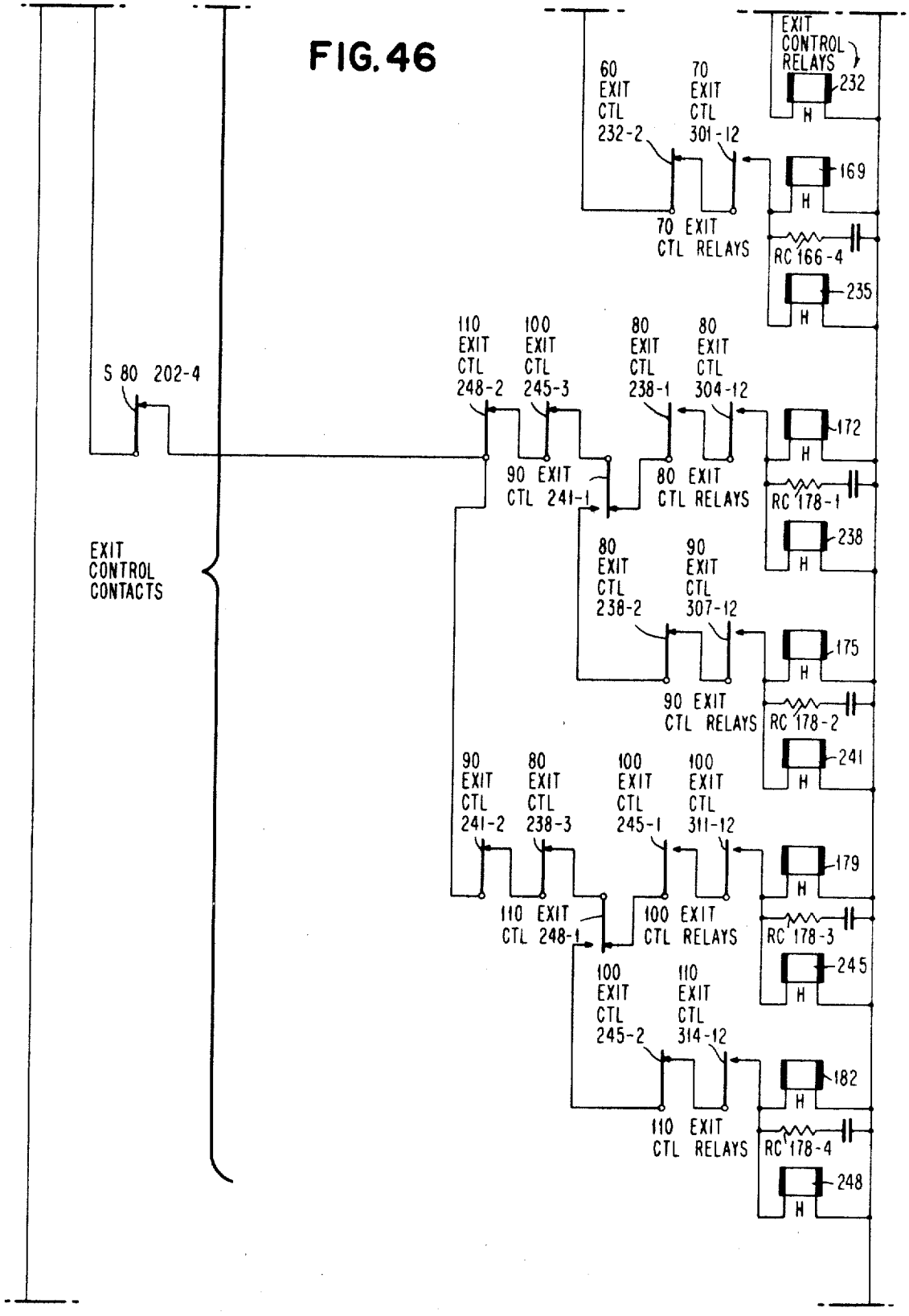

EXIT CONTROL CONTACTS
S 80 202-4
60 EXIT CTL 232-2
70 EXIT CTL 301-12
70 EXIT CTL RELAYS
EXIT CONTROL RELAYS
232
H
169
RC 166-4
235
110 EXIT CTL 248-2
100 EXIT CTL 245-3
90 EXIT CTL 241-1
80 EXIT CTL 238-1
80 EXIT CTL 304-12
80 EXIT CTL RELAYS
172
RC 178-1
238
80 EXIT CTL 238-2
90 EXIT CTL 307-12
90 EXIT CTL RELAYS
175
RC 178-2
241
90 EXIT CTL 241-2
80 EXIT CTL 238-3
110 EXIT CTL 248-1
100 EXIT CTL 245-1
100 EXIT CTL 311-12
100 EXIT CTL RELAYS
179
RC 178-3
245
100 EXIT CTL 245-2
110 EXIT CTL 314-12
110 EXIT CTL RELAYS
182
RC 178-4
248

FIG. 47

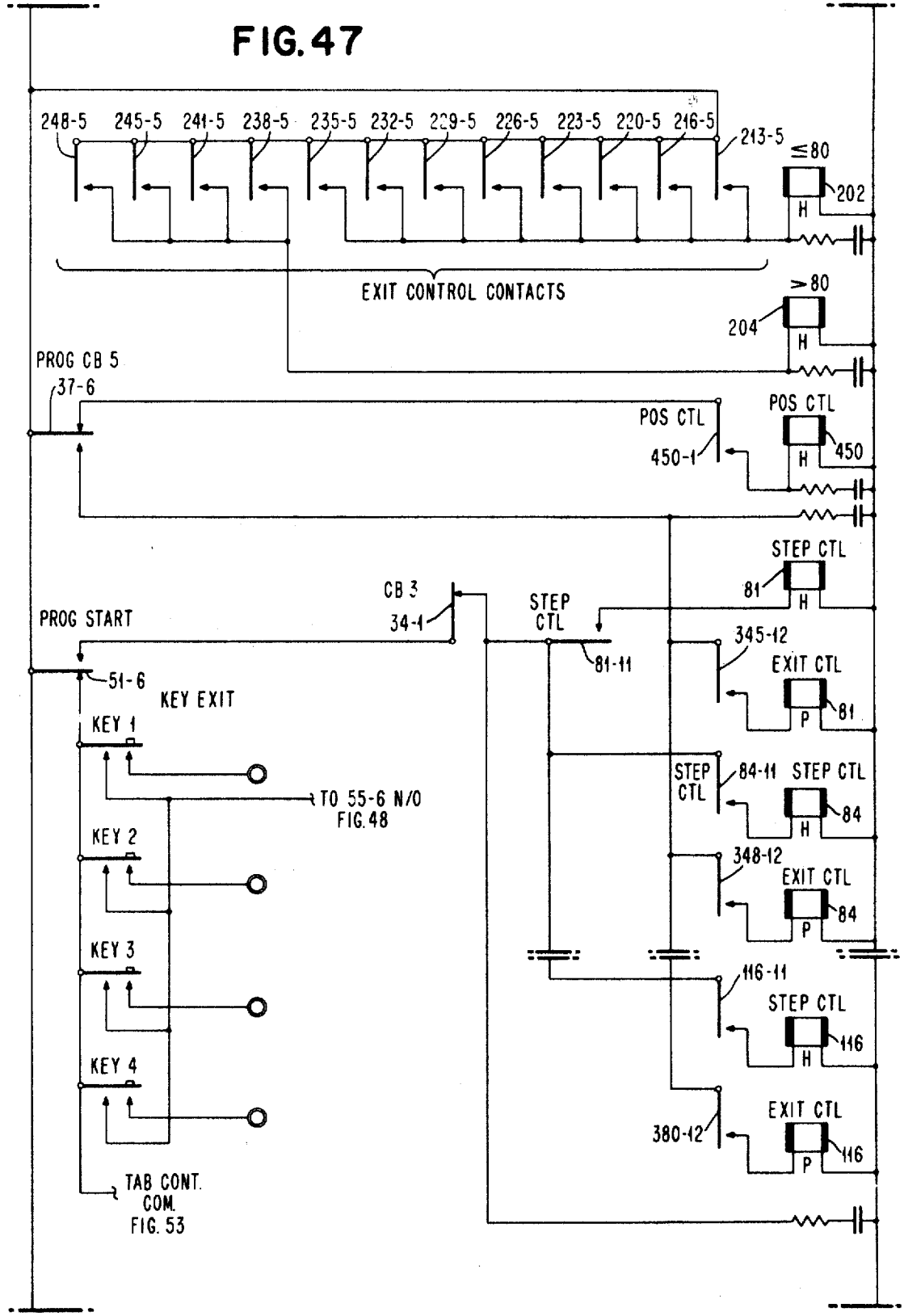

248-5
245-5
241-5
238-5
235-5
232-5
229-5
226-5
223-5
220-5
216-5
213-5
≤80
202
H
EXIT CONTROL CONTACTS
>80
204
H
PROG CB 5
37-6
POS CTL
450-1
POS CTL
H
450
STEP CTL
81
H
CB 3
34-1
PROG START
STEP CTL
81-11
345-12
EXIT CTL
P
81
51-6
KEY EXIT
KEY 1
TO 55-6 N/O
FIG. 48
STEP CTL
84-11
STEP CTL
H
84
KEY 2
348-12
EXIT CTL
P
84
KEY 3
116-11
STEP CTL
H
116
KEY 4
380-12
EXIT CTL
P
116
TAB CONT.
COM.
FIG. 53

FIG. 48

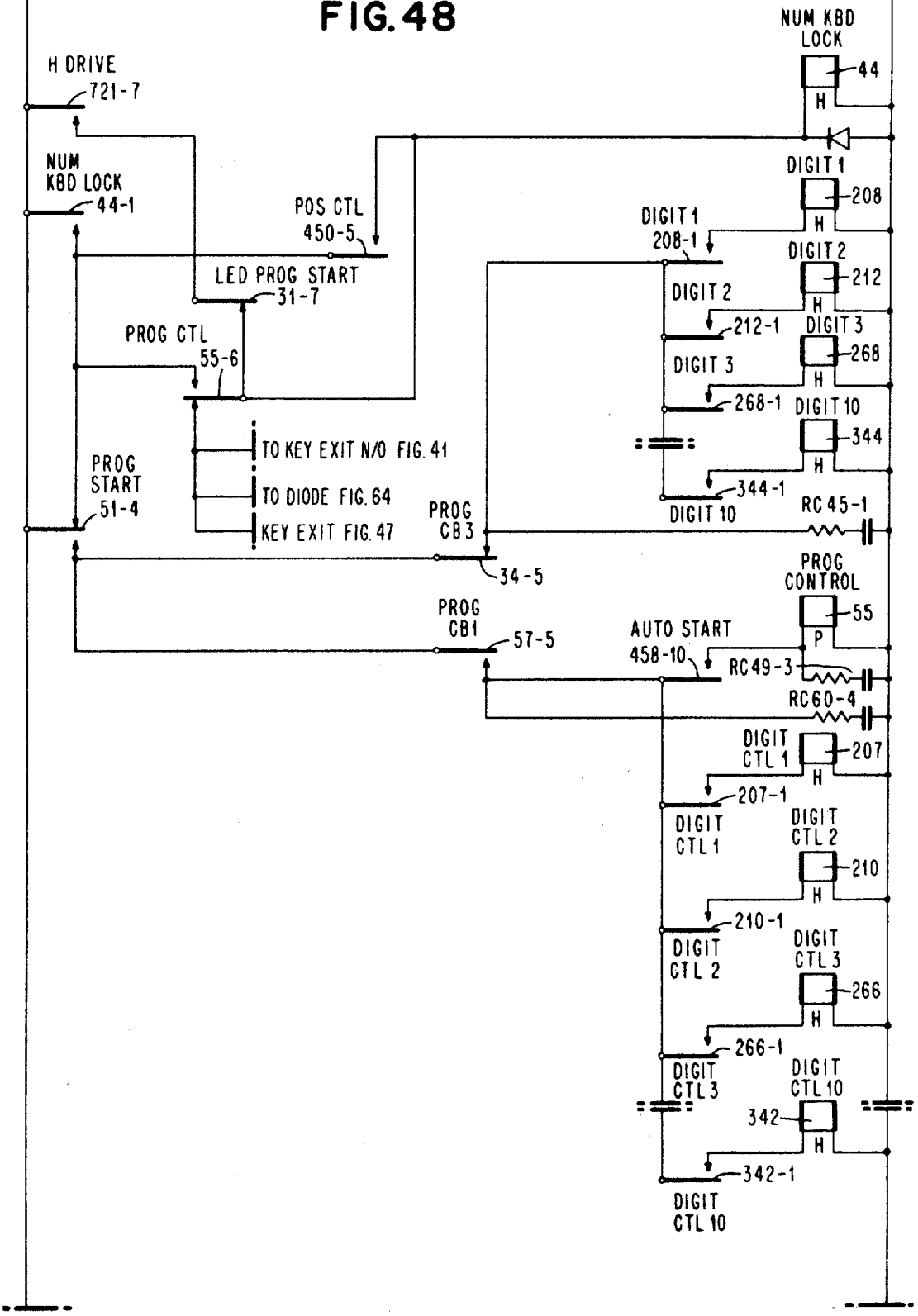

H DRIVE
721-7
NUM KBD LOCK
44-1
POS CTL
450-5
LED PROG START
31-7
PROG CTL
55-6
TO KEY EXIT N/O FIG. 41
TO DIODE FIG. 64
KEY EXIT FIG. 47
PROG START
51-4
PROG CB3
34-5
PROG CB1
57-5
NUM KBD LOCK
44
H
DIGIT 1
208
DIGIT 1
208-1
DIGIT 2
212
DIGIT 2
212-1
DIGIT 3
268
DIGIT 3
268-1
DIGIT 10
344
DIGIT 10
344-1
RC 45-1
PROG CONTROL
55
P
AUTO START
458-10
RC 49-3
RC 60-4
DIGIT CTL 1
207
DIGIT CTL 1
207-1
DIGIT CTL 2
210
DIGIT CTL 2
210-1
DIGIT CTL 3
266
DIGIT CTL 3
266-1
DIGIT CTL 10
342
DIGIT CTL 10
342-1

FIG. 49

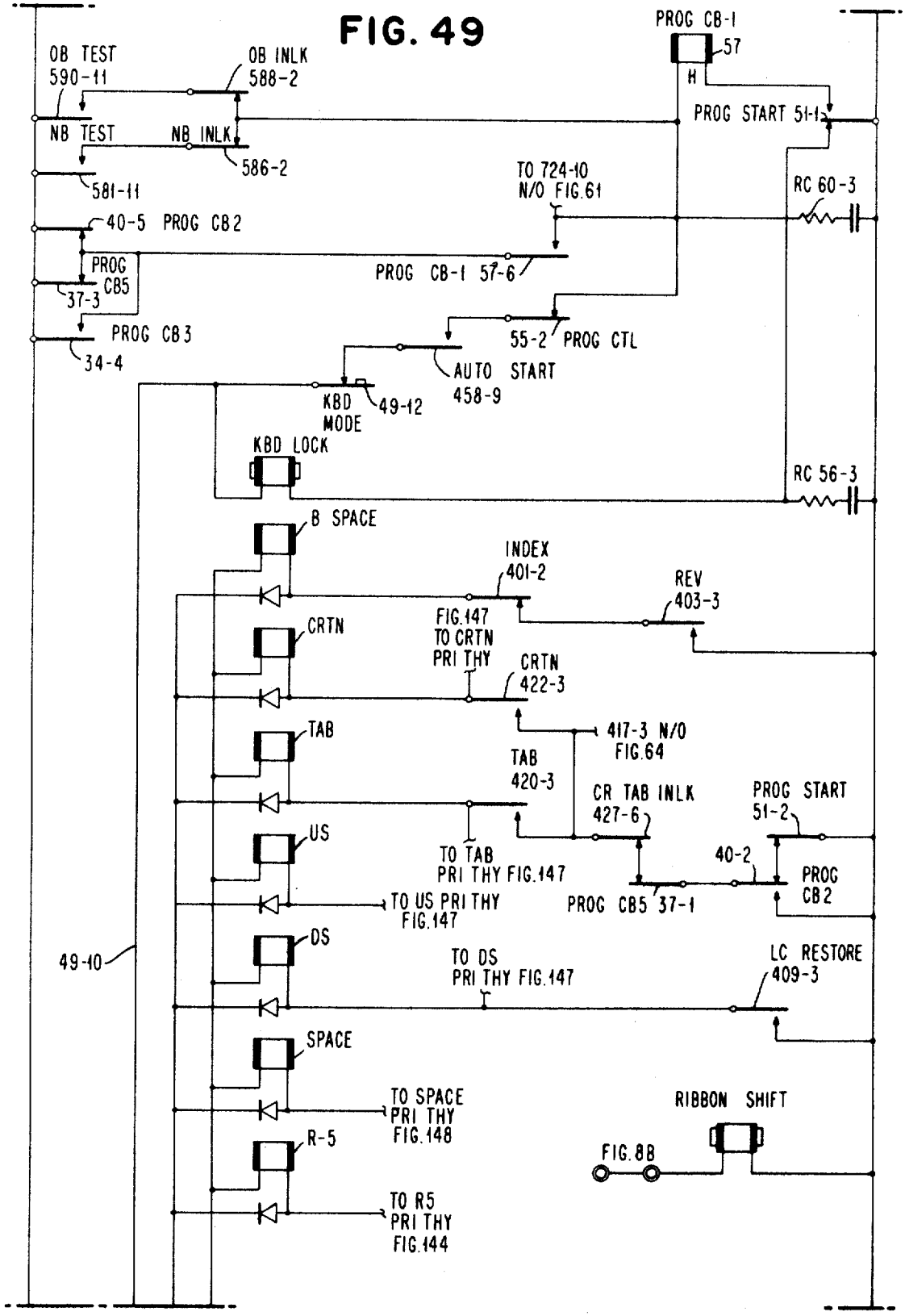

OB TEST 590-11
OB INLK 588-2
NB TEST
NB INLK
586-2
581-11
40-5 PROG CB2
PROG CB5 37-3
PROG CB3 34-4
PROG CB-1 57
H
PROG START 51-1
TO 724-10 N/O FIG.61
RC 60-3
PROG CB-1 57-6
55-2 PROG CTL
AUTO START 458-9
KBD MODE 49-12
KBD LOCK
RC 56-3
B SPACE
INDEX 401-2
REV 403-3
FIG.147 TO CRTN PRI THY
CRTN
CRTN 422-3
TAB
417-3 N/O FIG.64
TAB 420-3
CR TAB INLK 427-6
PROG START 51-2
US
TO TAB PRI THY FIG.147
40-2
PROG CB2
TO US PRI THY FIG.147
PROG CB5 37-1
DS
49-10
TO DS PRI THY FIG.147
LC RESTORE 409-3
SPACE
TO SPACE PRI THY FIG.148
RIBBON SHIFT
R-5
FIG.8B
TO R5 PRI THY FIG.144

FIG. 50

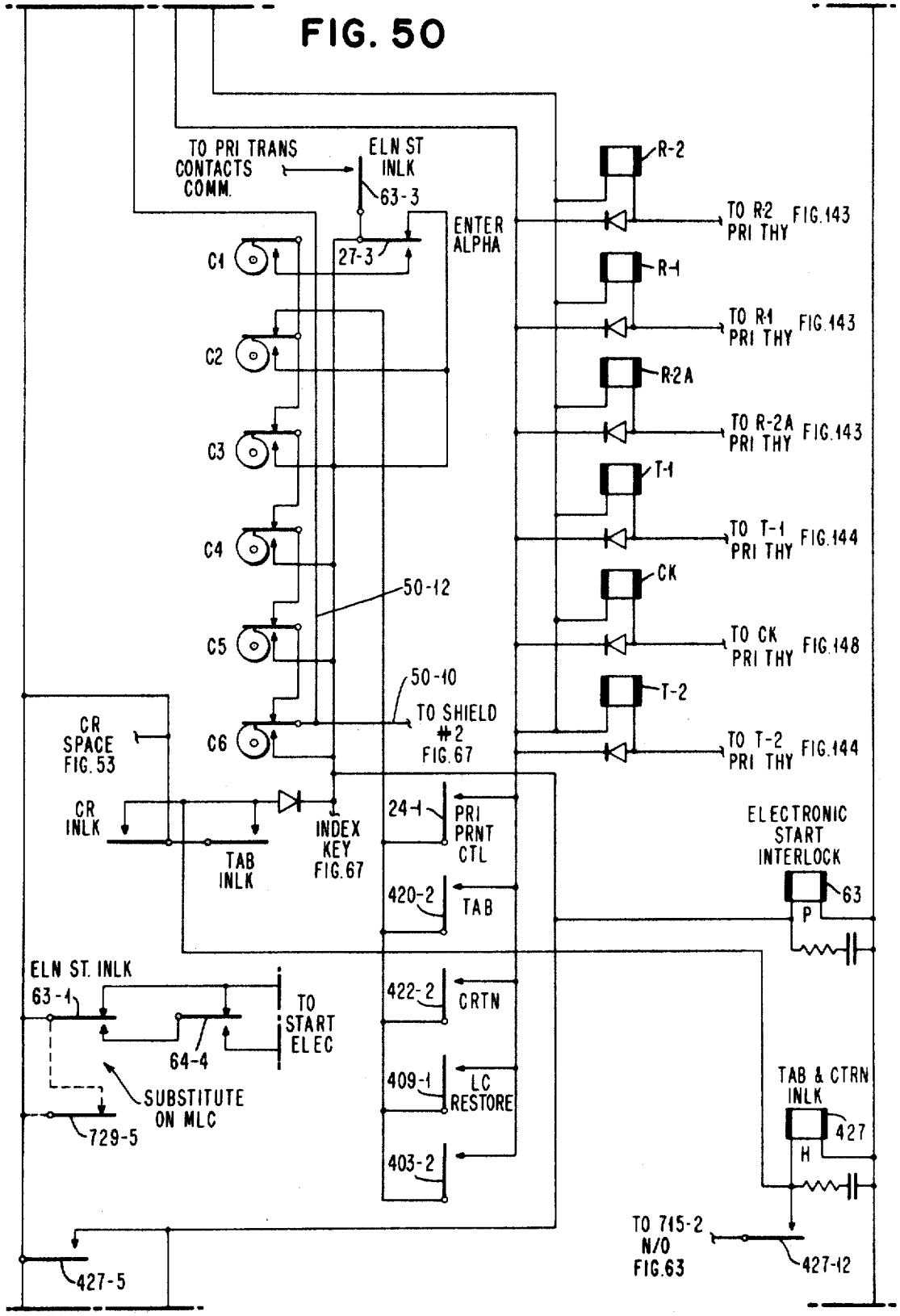

TO PRI TRANS CONTACTS COMM.
ELN ST INLK
63-3
27-3
ENTER ALPHA
C1
C2
C3
C4
C5
C6
50-12
50-10
TO SHIELD #2 FIG. 67
CR SPACE FIG. 53
CR INLK
TAB INLK
INDEX KEY FIG. 67
24-1
PRI PRNT CTL
420-2
TAB
422-2
CRTN
409-1
LC RESTORE
403-2
ELN ST. INLK
63-1
64-4
TO START ELEC
SUBSTITUTE ON MLC
729-5
427-5
R-2
TO R2 PRI THY FIG. 143
R-1
TO R1 PRI THY FIG. 143
R-2A
TO R-2A PRI THY FIG. 143
T-1
TO T-1 PRI THY FIG. 144
CK
TO CK PRI THY FIG. 148
T-2
TO T-2 PRI THY FIG. 144
ELECTRONIC START INTERLOCK
63
P
TAB & CTRN INLK
427
H
TO 715-2 N/O FIG. 63
427-12

FIG. 51

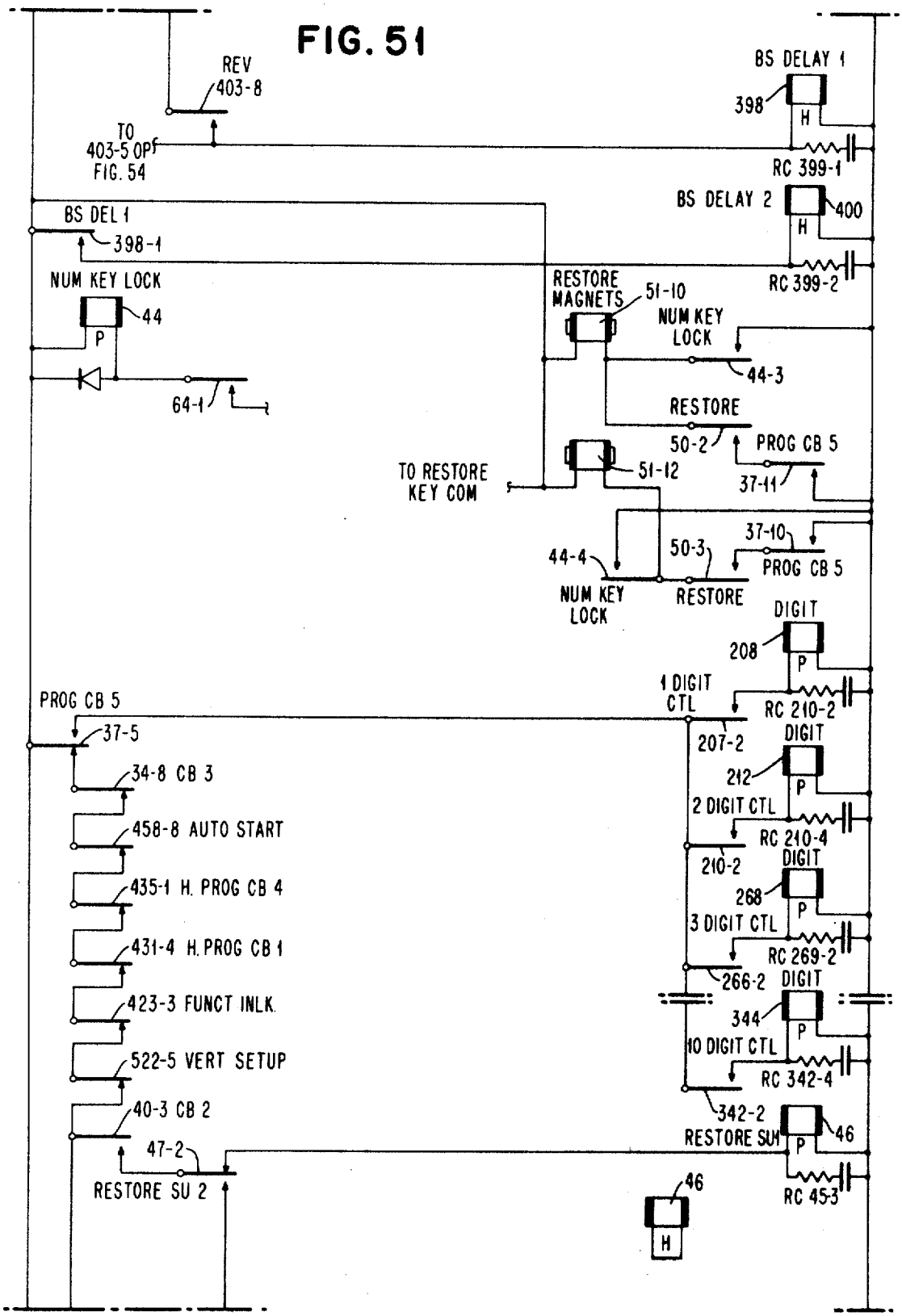

REV
403-8
TO
403-5 OF
FIG. 54
BS DEL 1
398-1
NUM KEY LOCK
44
P
64-1
BS DELAY 1
398
H
RC 399-1
BS DELAY 2
400
H
RC 399-2
RESTORE MAGNETS
51-10
NUM KEY LOCK
44-3
RESTORE
50-2
PROG CB 5
37-11
TO RESTORE KEY COM
51-12
44-4
NUM KEY LOCK
50-3
RESTORE
37-10
PROG CB 5
DIGIT
208
P
RC 210-2
1 DIGIT CTL
207-2
DIGIT
212
P
2 DIGIT CTL
RC 210-4
210-2
DIGIT
268
P
3 DIGIT CTL
RC 269-2
266-2
DIGIT
344
P
10 DIGIT CTL
RC 342-4
342-2
RESTORE SU
46
P
RC 453
PROG CB 5
37-5
34-8 CB 3
458-8 AUTO START
435-1 H. PROG CB 4
431-4 H. PROG CB 1
423-3 FUNCT INLK.
522-5 VERT SETUP
40-3 CB 2
47-2
RESTORE SU 2
46
H

FIG. 52

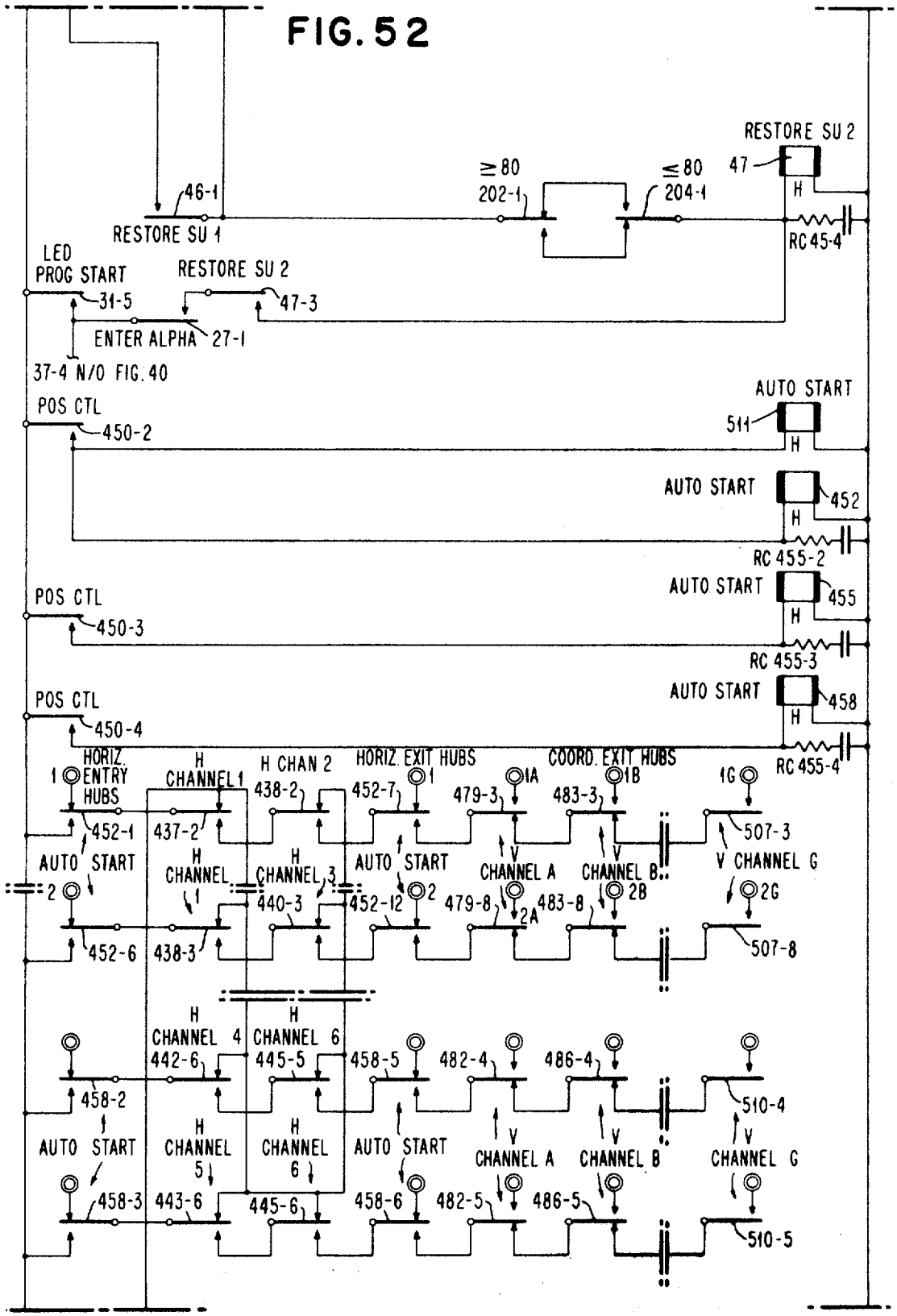

RESTORE SU 2
47
H
≥80
202-1
≤80
204-1
46-1
RESTORE SU 1
RC 45-4
LED
PROG START
31-5
RESTORE SU 2
47-3
ENTER ALPHA
27-1
37-4 N/O FIG. 40
AUTO START
POS CTL
450-2
511
AUTO START
452
RC 455-2
POS CTL
450-3
AUTO START
455
RC 455-3
POS CTL
450-4
AUTO START
458
RC 455-4
HORIZ. ENTRY HUBS
H CHANNEL 1
H CHAN 2
HORIZ. EXIT HUBS
COORD. EXIT HUBS
1
1A
1B
1G
452-1
437-2
438-2
452-7
479-3
483-3
507-3
AUTO START
H CHANNEL 1
H CHANNEL 3
AUTO START
V CHANNEL A
V CHANNEL B
V CHANNEL G
2
2A
2B
2G
452-6
438-3
440-3
452-12
479-8
483-8
507-8
H CHANNEL 4
H CHANNEL 6
458-2
442-6
445-5
458-5
482-4
486-4
510-4
AUTO START
H CHANNEL 5
H CHANNEL 6
AUTO START
V CHANNEL A
V CHANNEL B
V CHANNEL G
458-3
443-6
445-6
458-6
482-5
486-5
510-5

FIG. 53

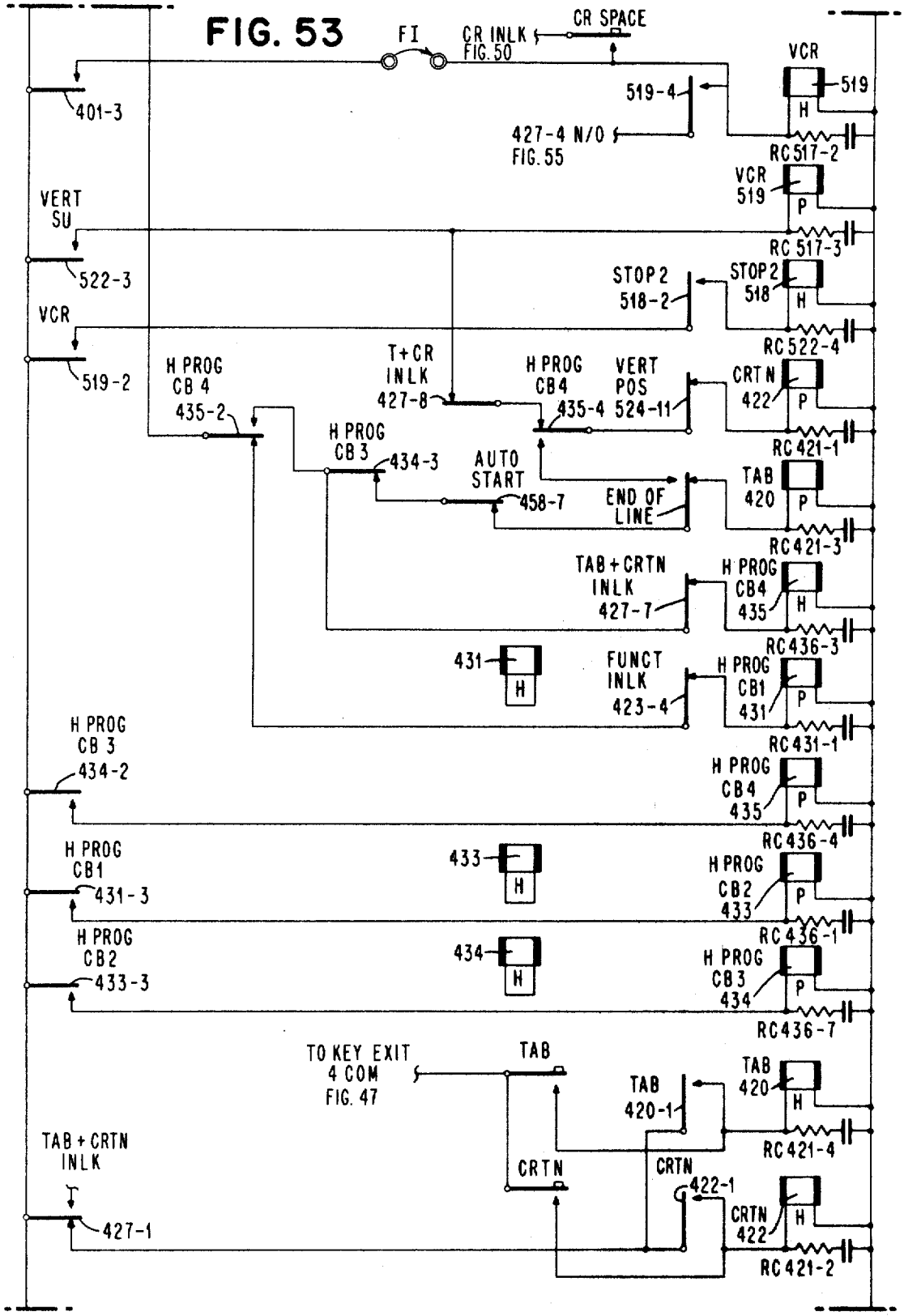

FI
CR INLK FIG. 50
CR SPACE
VCR
519
519-4
427-4 N/O FIG. 55
RC 517-2
VCR 519
RC 517-3
VERT SU
522-3
STOP 2 518-2
STOP 2 518
RC 522-4
VCR
519-2
H PROG CB 4 435-2
T+CR INLK 427-8
H PROG CB4 435-4
VERT POS 524-11
CRT N 422
RC 421-1
H PROG CB 3 434-3
AUTO START 458-7
END OF LINE
TAB 420
RC 421-3
TAB+CRTN INLK 427-7
H PROG CB4 435
RC 436-3
431
FUNCT INLK 423-4
H PROG CB1 431
RC 431-1
H PROG CB 3 434-2
H PROG CB4 435
RC 436-4
H PROG CB1 431-3
433
H PROG CB2 433
RC 436-1
H PROG CB2 433-3
434
H PROG CB3 434
RC 436-7
TO KEY EXIT 4 COM FIG. 47
TAB
TAB 420-1
TAB 420
RC 421-4
TAB+CRTN INLK
427-1
CRTN
CRTN 422-1
CRTN 422
RC 421-2

FIG. 54

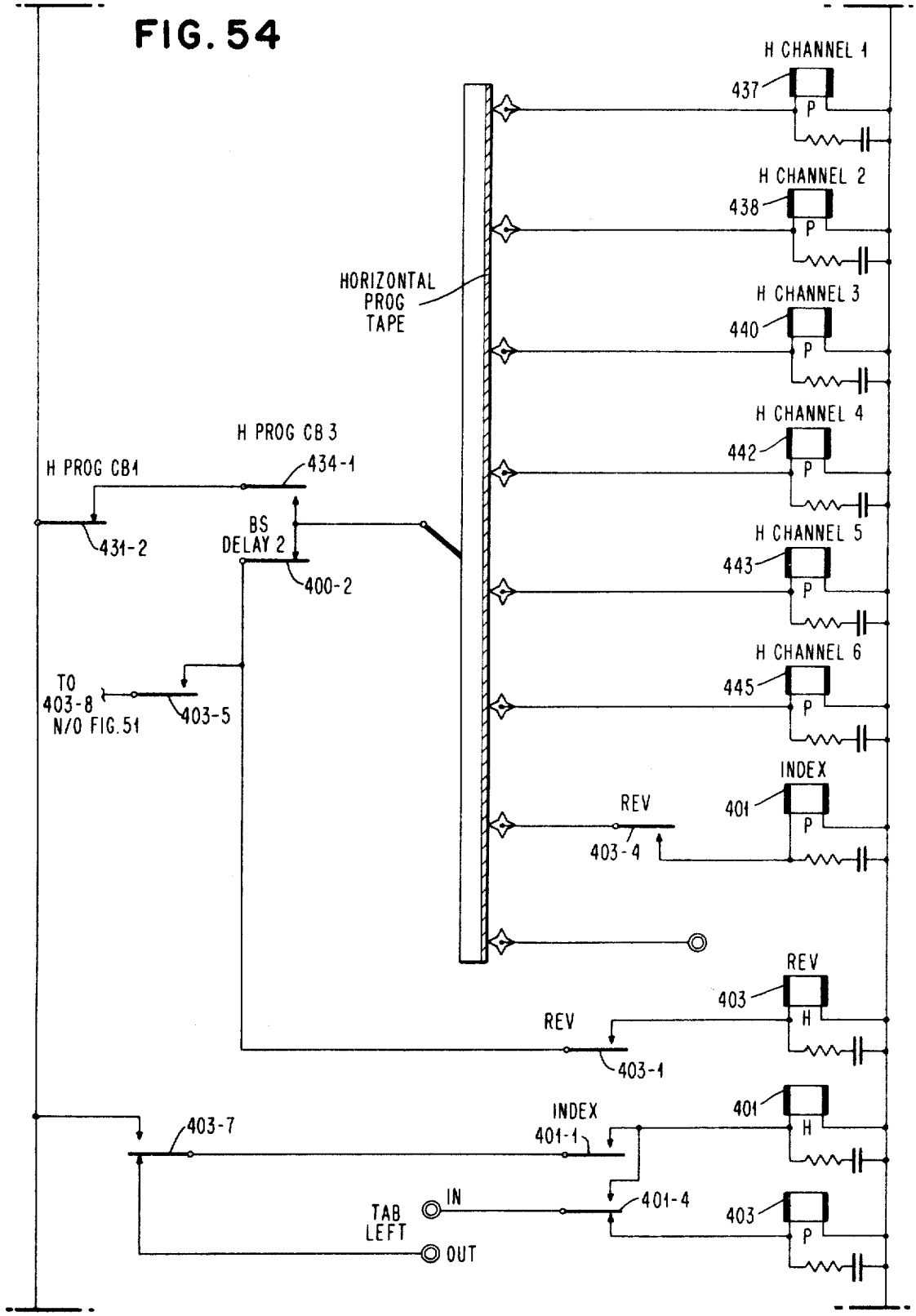

H CHANNEL 1
437
P
H CHANNEL 2
438
P
HORIZONTAL PROG TAPE
H CHANNEL 3
440
P
H CHANNEL 4
442
P
H PROG CB 3
H PROG CB 4
434-1
BS DELAY 2
431-2
400-2
H CHANNEL 5
443
P
H CHANNEL 6
445
P
TO 403-8 N/O FIG. 51
403-5
INDEX
401
P
REV
403-4
REV
403
H
REV
403-1
403-7
INDEX
401-1
401
H
TAB LEFT
IN
OUT
401-4
403
P

FIG. 55

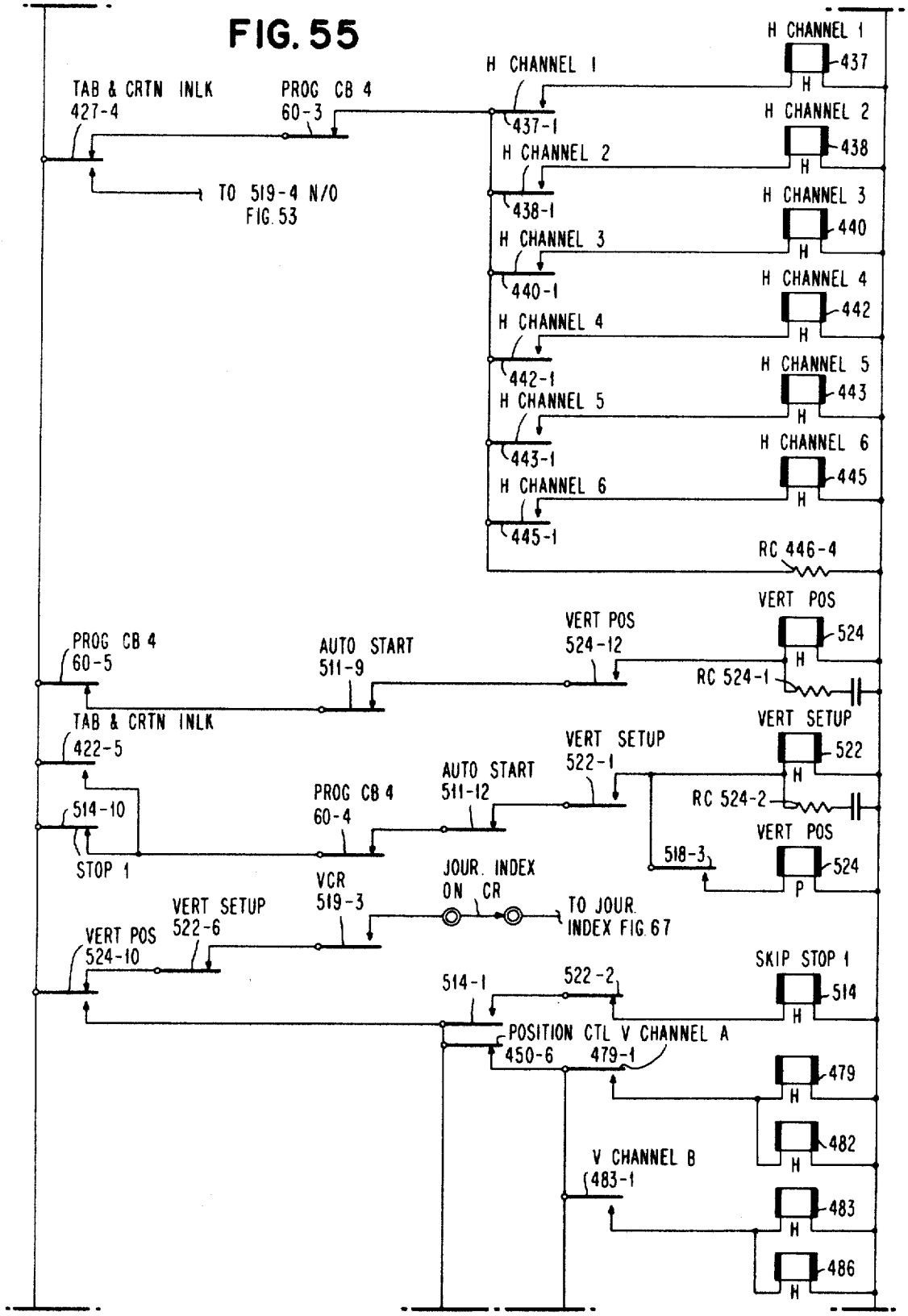

TAB & CRTN INLK
427-4
PROG CB 4
60-3
TO 519-4 N/O
FIG. 53
H CHANNEL 1
437-1
H CHANNEL 2
438-1
H CHANNEL 3
440-1
H CHANNEL 4
442-1
H CHANNEL 5
443-1
H CHANNEL 6
445-1
H CHANNEL 1
437
H CHANNEL 2
438
H CHANNEL 3
440
H CHANNEL 4
442
H CHANNEL 5
443
H CHANNEL 6
445
RC 446-4
PROG CB 4
60-5
AUTO START
511-9
VERT POS
524-12
VERT POS
524
RC 524-1
TAB & CRTN INLK
422-5
514-10
STOP 1
PROG CB 4
60-4
AUTO START
511-12
VERT SETUP
522-1
VERT SETUP
522
RC 524-2
518-3
VERT POS
524
VCR
519-3
JOUR. INDEX
ON CR
TO JOUR.
INDEX FIG. 67
VERT SETUP
522-6
VERT POS
524-10
514-1
522-2
SKIP STOP 1
514
POSITION CTL V CHANNEL A
450-6
479-1
479
482
V CHANNEL B
483-1
483
486

FIG. 56

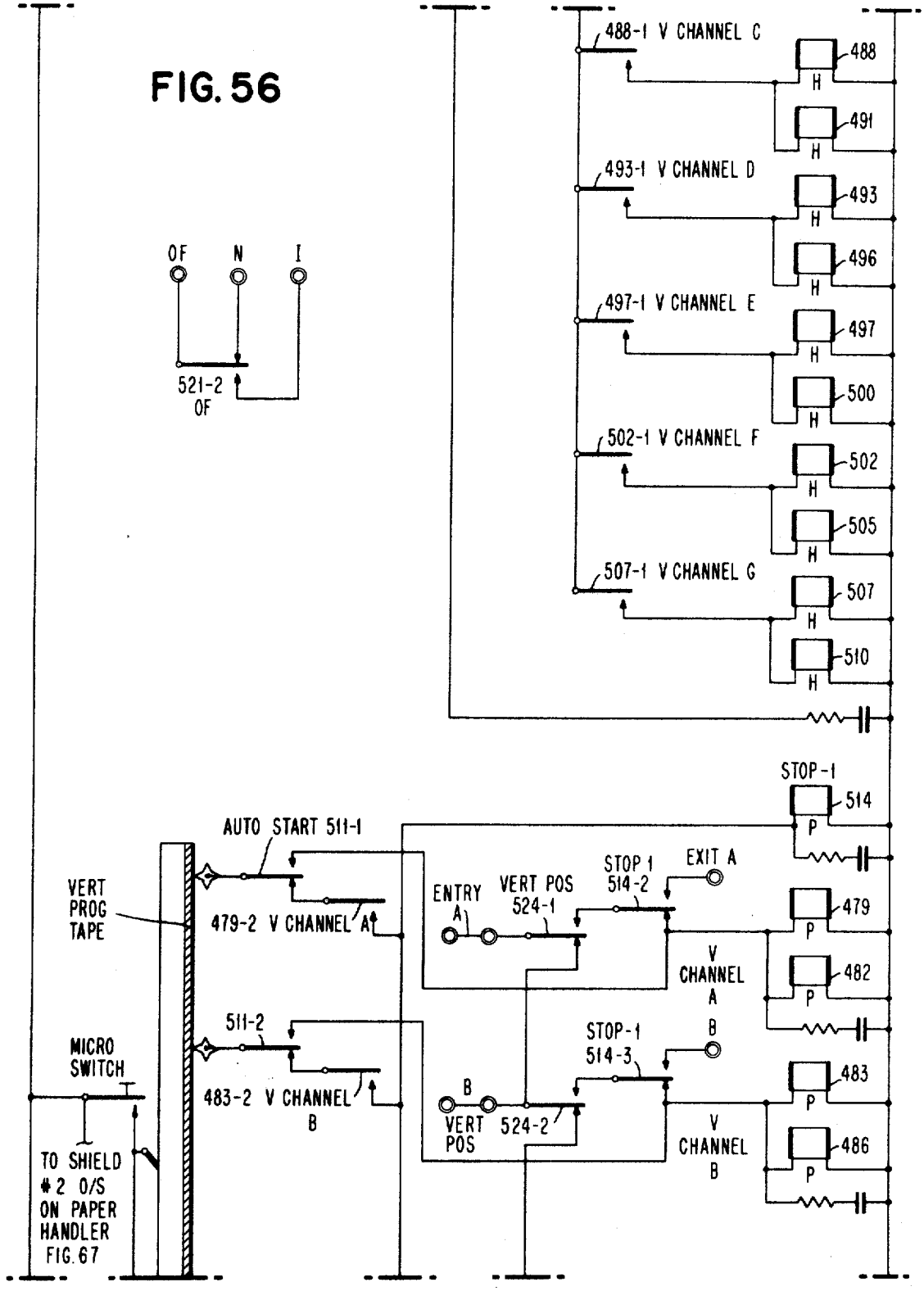

OF
N
I
521-2
OF
488-1 V CHANNEL C
488
491
493-1 V CHANNEL D
493
496
497-1 V CHANNEL E
497
500
502-1 V CHANNEL F
502
505
507-1 V CHANNEL G
507
510
H
STOP-1
514
P
AUTO START 511-1
VERT PROG TAPE
479-2 V CHANNEL A
ENTRY A
VERT POS 524-1
STOP 1 514-2
EXIT A
V CHANNEL A
479
482
511-2
MICRO SWITCH
483-2 V CHANNEL B
B
VERT POS
524-2
STOP-1 514-3
V CHANNEL B
483
486
TO SHIELD #2 O/S ON PAPER HANDLER FIG. 67

FIG. 57

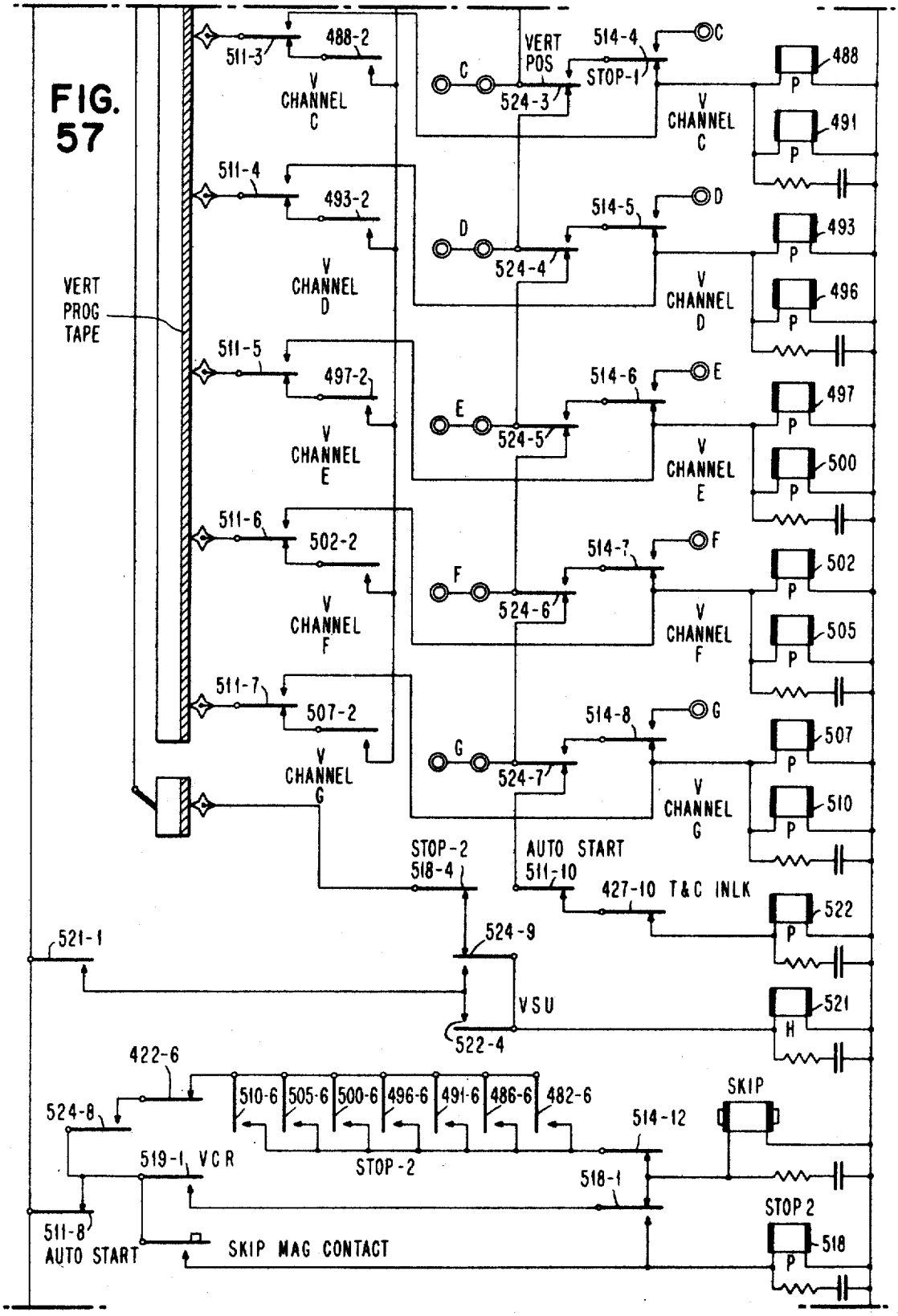

VERT PROG TAPE
511-3
488-2
V CHANNEL C
511-4
493-2
V CHANNEL D
511-5
497-2
V CHANNEL E
511-6
502-2
V CHANNEL F
511-7
507-2
V CHANNEL G
C
524-3
VERT POS
514-4
STOP-1
V CHANNEL C
D
524-4
514-5
V CHANNEL D
E
524-5
514-6
V CHANNEL E
F
524-6
514-7
V CHANNEL F
G
524-7
514-8
V CHANNEL G
488
491
493
496
497
500
502
505
507
510
P
STOP-2 518-4
AUTO START 511-10
427-10 T&C INLK
522
524-9
VSU
522-4
521-1
521
H
422-6
524-8
510-6
505-6
500-6
496-6
491-6
486-6
482-6
514-12
SKIP
519-1 VCR
STOP-2
518-1
511-8 AUTO START
SKIP MAG CONTACT
STOP 2
518

FIG. 58

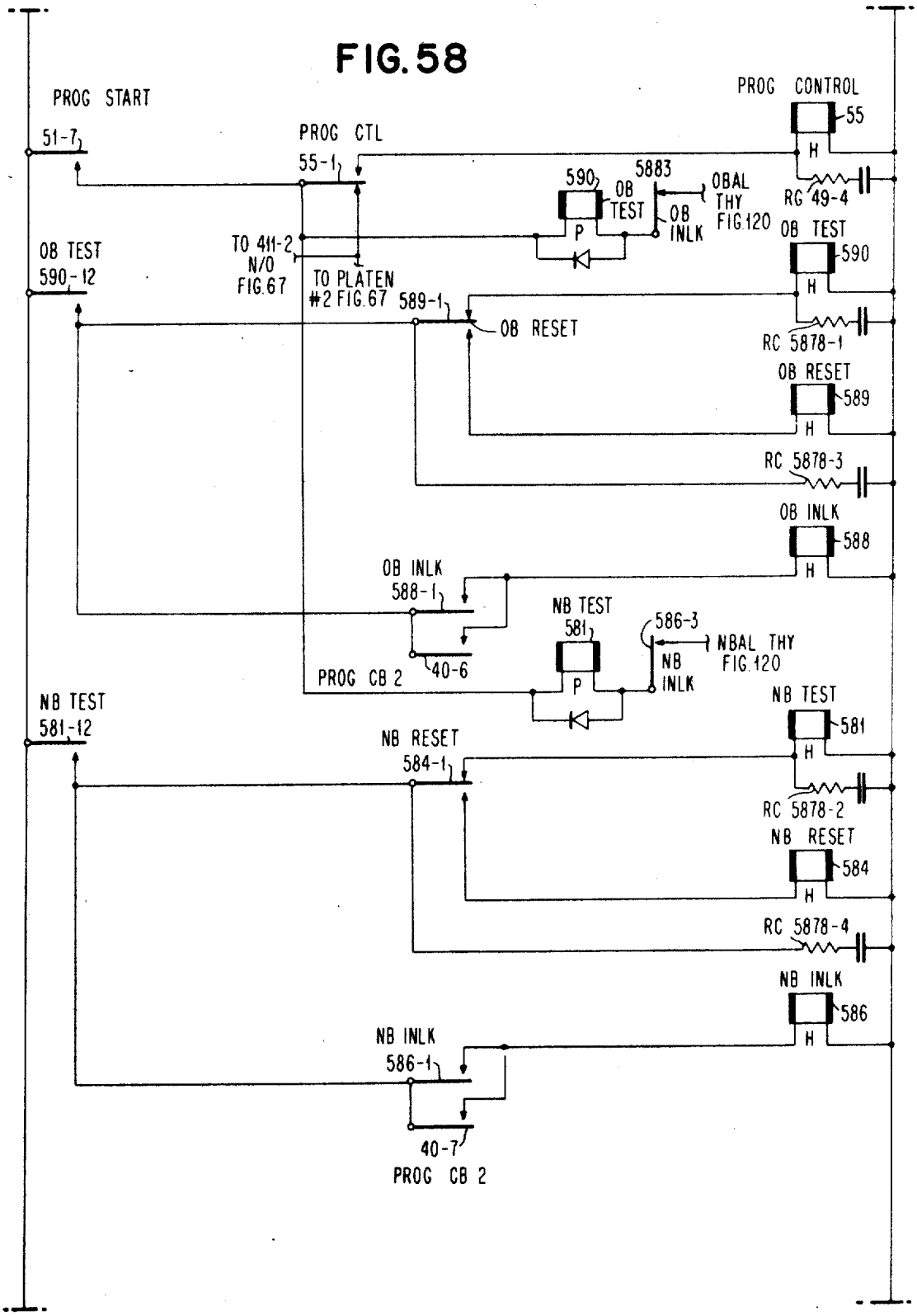
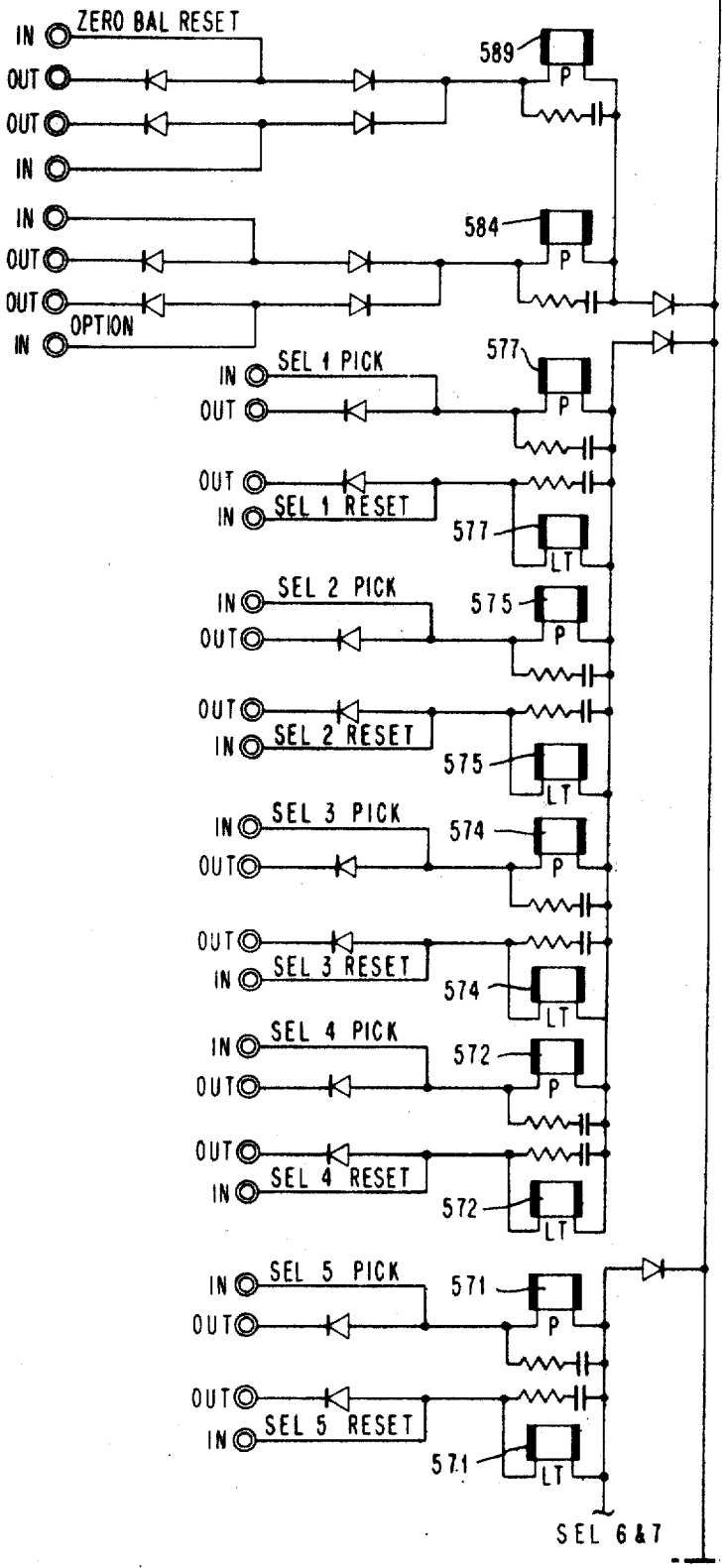

PROG START
51-7
PROG CTL
55-1
PROG CONTROL
55
H
590
OB TEST
5883
OBAL THY FIG.120
OB INLK
P
RG 49-4
OB TEST
590
H
OB TEST
590-12
TO 411-2 N/O FIG.67
TO PLATEN #2 FIG.67
589-1
OB RESET
RC 5878-1
OB RESET
589
H
RC 5878-3
OB INLK
588
H
OB INLK
588-1
40-6
PROG CB 2
NB TEST
581
586-3
NBAL THY FIG.120
NB INLK
P
NB TEST
581-12
NB TEST
581
H
NB RESET
584-1
RC 5878-2
NB RESET
584
H
RC 5878-4
NB INLK
586
H
NB INLK
586-1
40-7
PROG CB 2

FIG. 59


IN
ZERO BAL RESET
OUT
OUT
IN
589
P
IN
OUT
OUT
OPTION
IN
584
P
IN
SEL 1 PICK
OUT
577
P
OUT
IN
SEL 1 RESET
577
LT
IN
SEL 2 PICK
OUT
575
P
OUT
IN
SEL 2 RESET
575
LT
IN
SEL 3 PICK
OUT
574
P
OUT
IN
SEL 3 RESET
574
LT
IN
SEL 4 PICK
OUT
572
P
OUT
IN
SEL 4 RESET
572
LT
IN
SEL 5 PICK
OUT
571
P
OUT
IN
SEL 5 RESET
571
LT
SEL 6 & 7

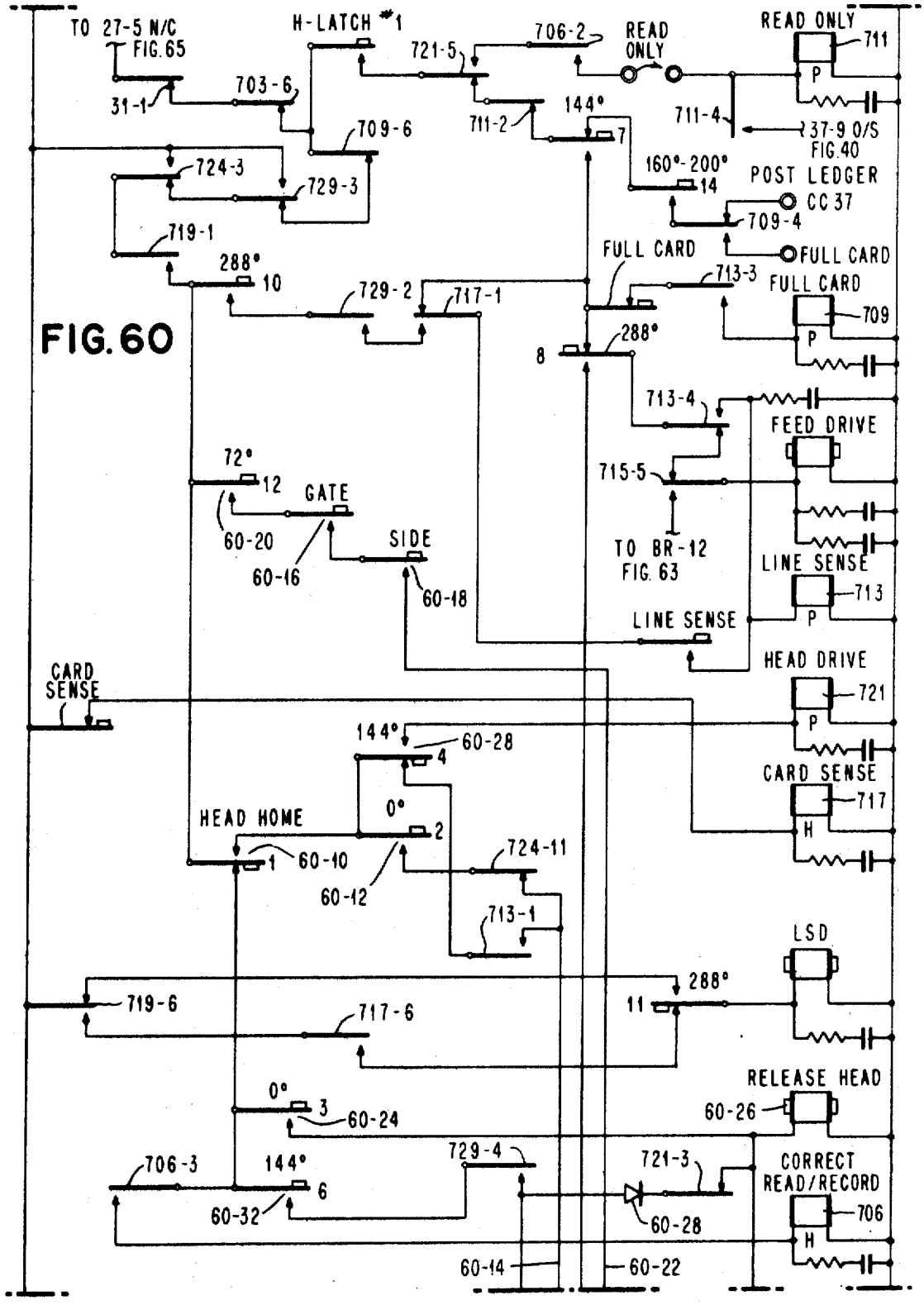

TO 27-5 N/C FIG. 65
H-LATCH #1
706-2
READ ONLY
READ ONLY
711
721-5
703-6
31-1
709-6
711-2
144°
7
711-4
37-9 O/S FIG. 40
724-3
729-3
160°-200°
14
POST LEDGER
CC 37
709-4
719-1
288°
10
729-2
717-1
FULL CARD
713-3
FULL CARD
FULL CARD
709
FIG. 60
288°
8
713-4
FEED DRIVE
72°
12
GATE
715-5
60-20
SIDE
60-16
60-18
TO BR-12 FIG. 63
LINE SENSE
713
LINE SENSE
CARD SENSE
HEAD DRIVE
721
144°
60-28
4
CARD SENSE
717
HEAD HOME
0°
2
1
60-10
60-12
724-11
713-1
LSD
719-6
717-6
288°
11
RELEASE HEAD
60-26
0°
3
60-24
706-3
144°
6
60-32
729-4
721-3
60-28
CORRECT READ/RECORD
706
60-14
60-22

FIG. 61

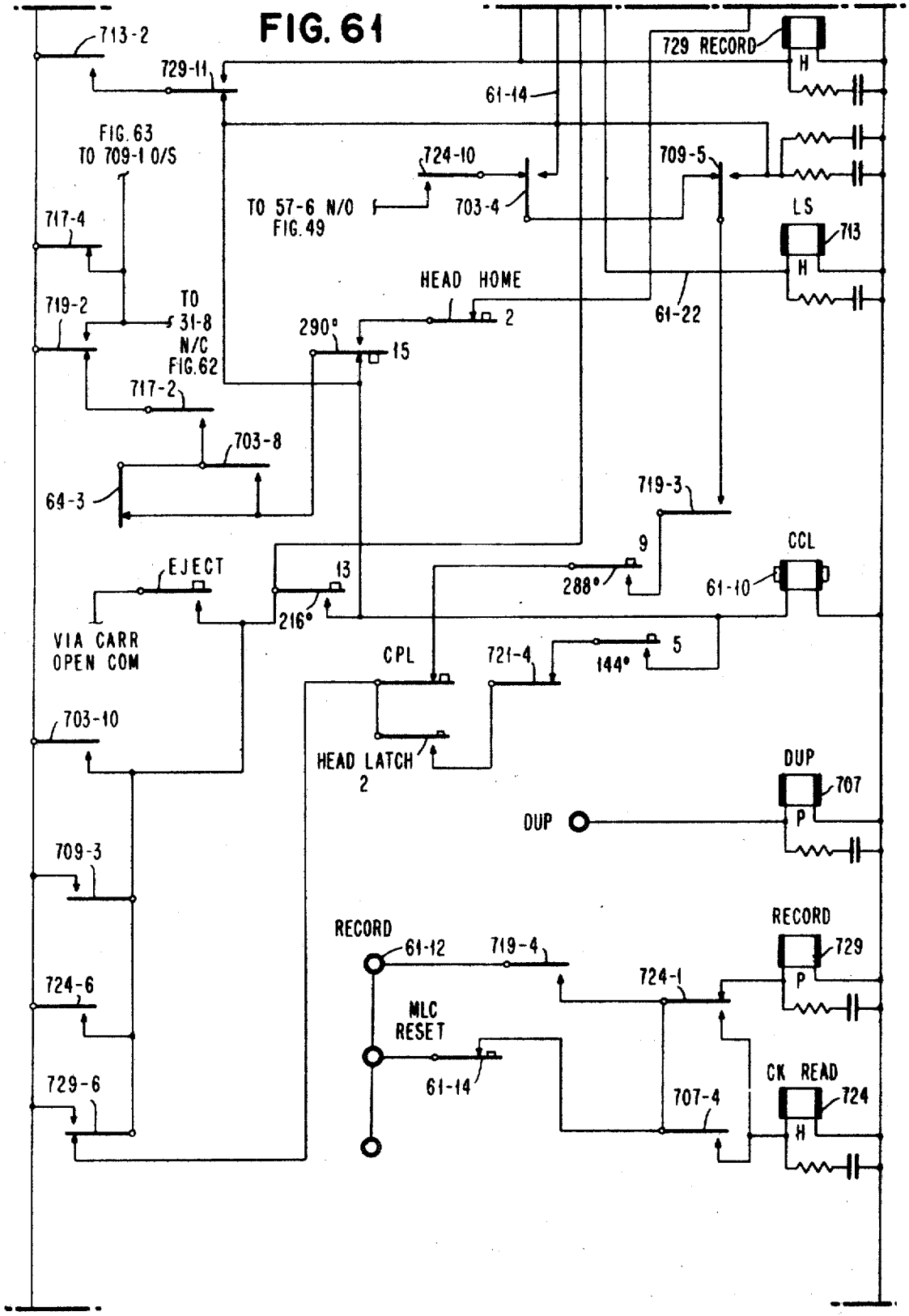

713-2
729-11
FIG. 63
TO 709-1 O/S
717-4
719-2
TO
31-8
N/C
FIG. 62
717-2
703-8
64-3
EJECT
VIA CARR
OPEN COM
703-10
709-3
724-6
729-6
61-14
724-10
TO 57-6 N/O
FIG. 49
703-4
HEAD HOME
2
290°
15
13
216°
9
288°
CPL
HEAD LATCH
2
721-4
144°
5
729 RECORD
H
709-5
LS
713
61-22
719-3
CCL
61-10
DUP
707
P
DUP
RECORD
61-12
719-4
MLC
RESET
61-14
724-1
RECORD
729
P
CK READ
724
H
707-4

FIG. 62

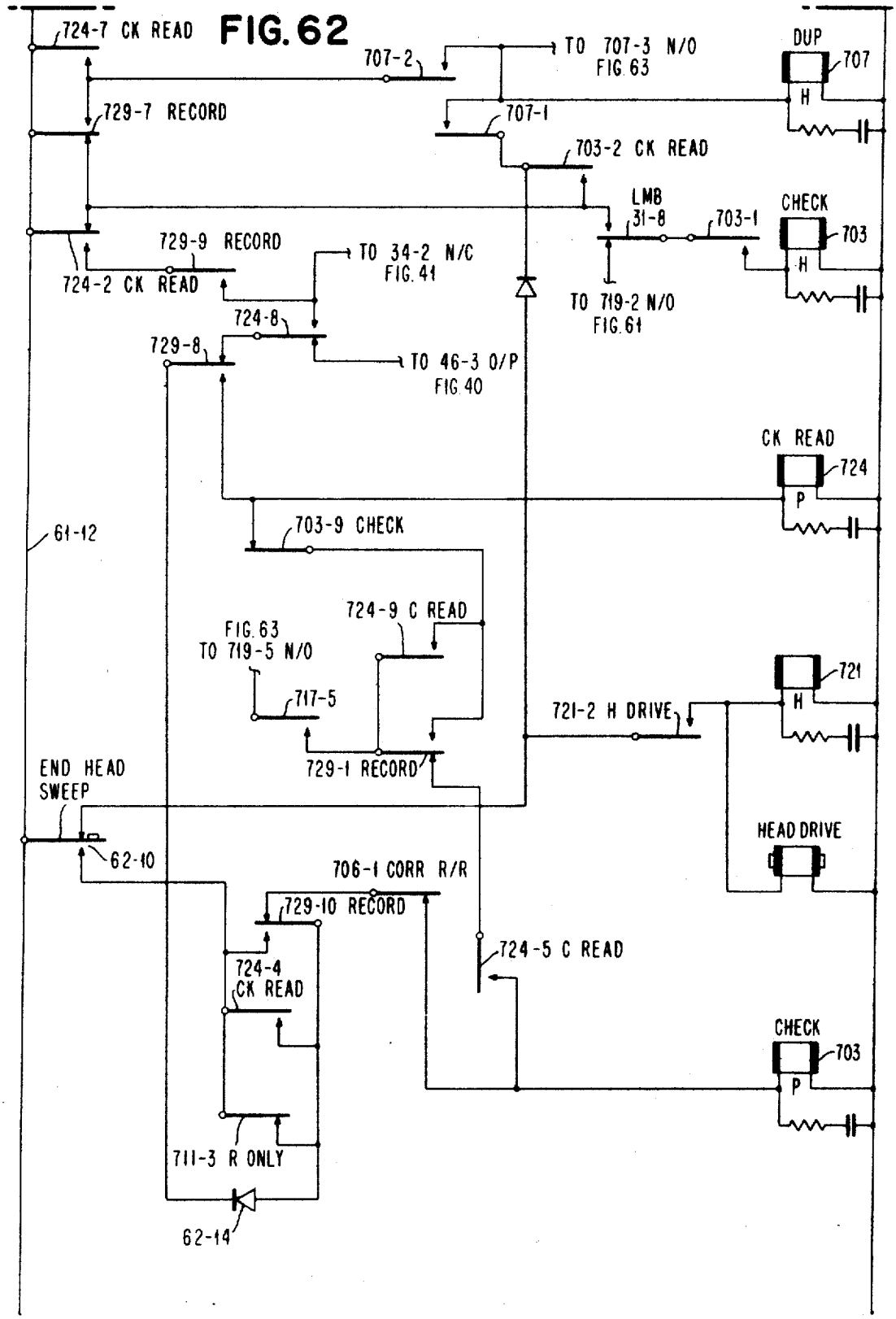

724-7 CK READ
707-2
TO 707-3 N/O FIG. 63
DUP
707
H
729-7 RECORD
707-1
703-2 CK READ
LMB 31-8
703-1
CHECK
703
H
729-9 RECORD
724-2 CK READ
TO 34-2 N/C FIG. 41
TO 719-2 N/O FIG. 61
724-8
729-8
TO 46-3 O/P FIG. 40
CK READ
724
P
703-9 CHECK
61-12
724-9 C READ
FIG. 63 TO 719-5 N/O
717-5
721
H
721-2 H DRIVE
729-1 RECORD
END HEAD SWEEP
HEAD DRIVE
62-10
706-1 CORR R/R
729-10 RECORD
724-5 C READ
724-4 CK READ
CHECK
703
P
711-3 R ONLY
62-14

FIG. 63

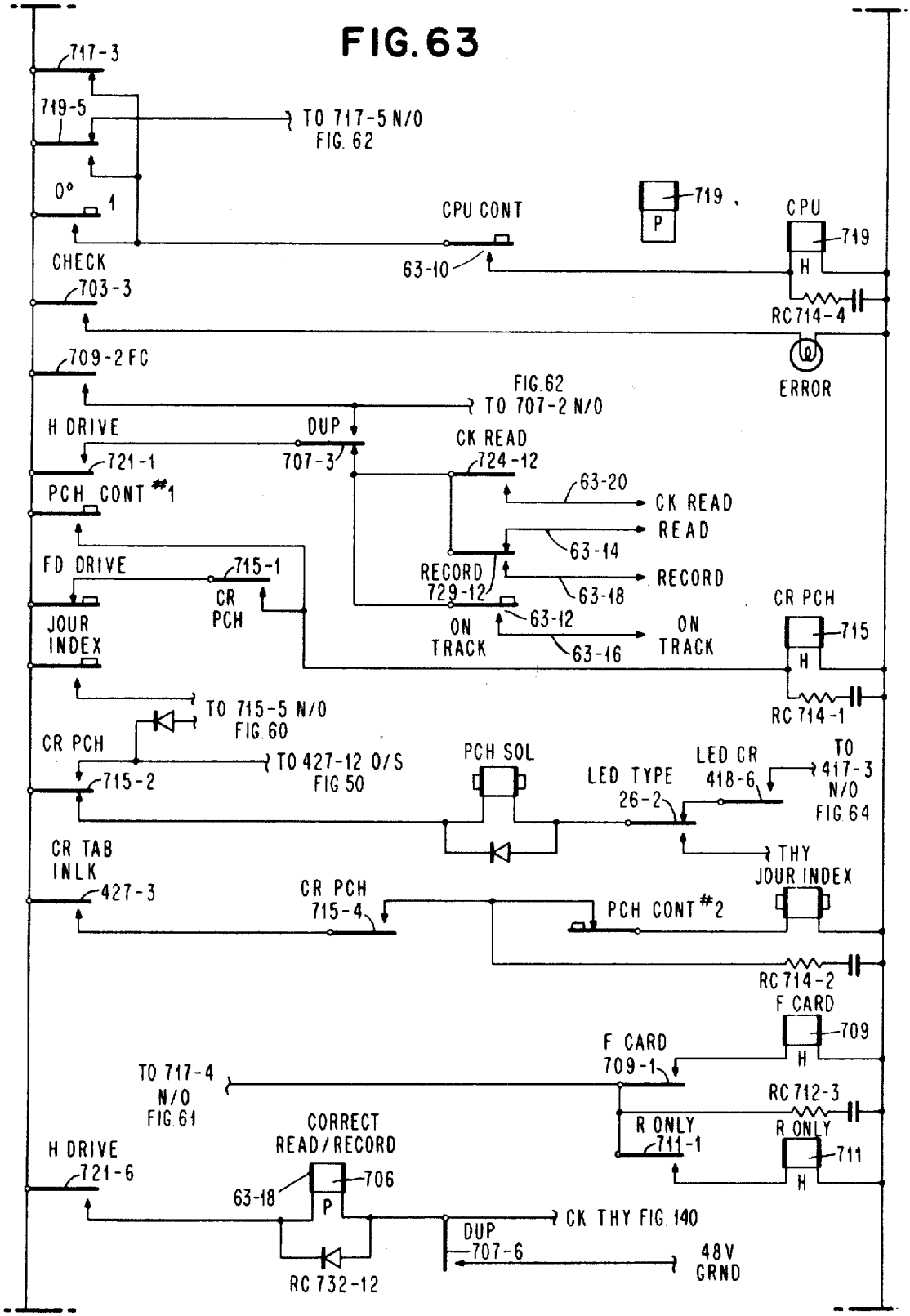

717-3
719-5
TO 717-5 N/O FIG. 62
0°
1
CHECK
703-3
CPU CONT
63-10
719
P
CPU
719
H
RC 714-4
709-2 FC
FIG. 62 TO 707-2 N/O
ERROR
H DRIVE
721-1
DUP
707-3
CK READ
724-12
63-20
CK READ
READ
63-14
RECORD
729-12
RECORD
63-18
PCH CONT #1
FD DRIVE
715-1
CR PCH
JOUR INDEX
ON TRACK
63-12
63-16
ON TRACK
CR PCH
715
H
RC 714-1
TO 715-5 N/O FIG. 60
CR PCH
715-2
TO 427-12 O/S FIG. 50
PCH SOL
LED TYPE
26-2
LED CR
418-6
TO 417-3 N/O FIG. 64
CR TAB INLK
427-3
CR PCH
715-4
PCH CONT #2
THY JOUR INDEX
RC 714-2
F CARD
709
H
F CARD
709-1
TO 717-4 N/O FIG. 61
RC 712-3
R ONLY
711-1
R ONLY
711
H
H DRIVE
721-6
CORRECT READ/RECORD
63-18
706
P
CK THY FIG. 140
DUP
707-6
48V GRND
RC 732-12

FIG. 64

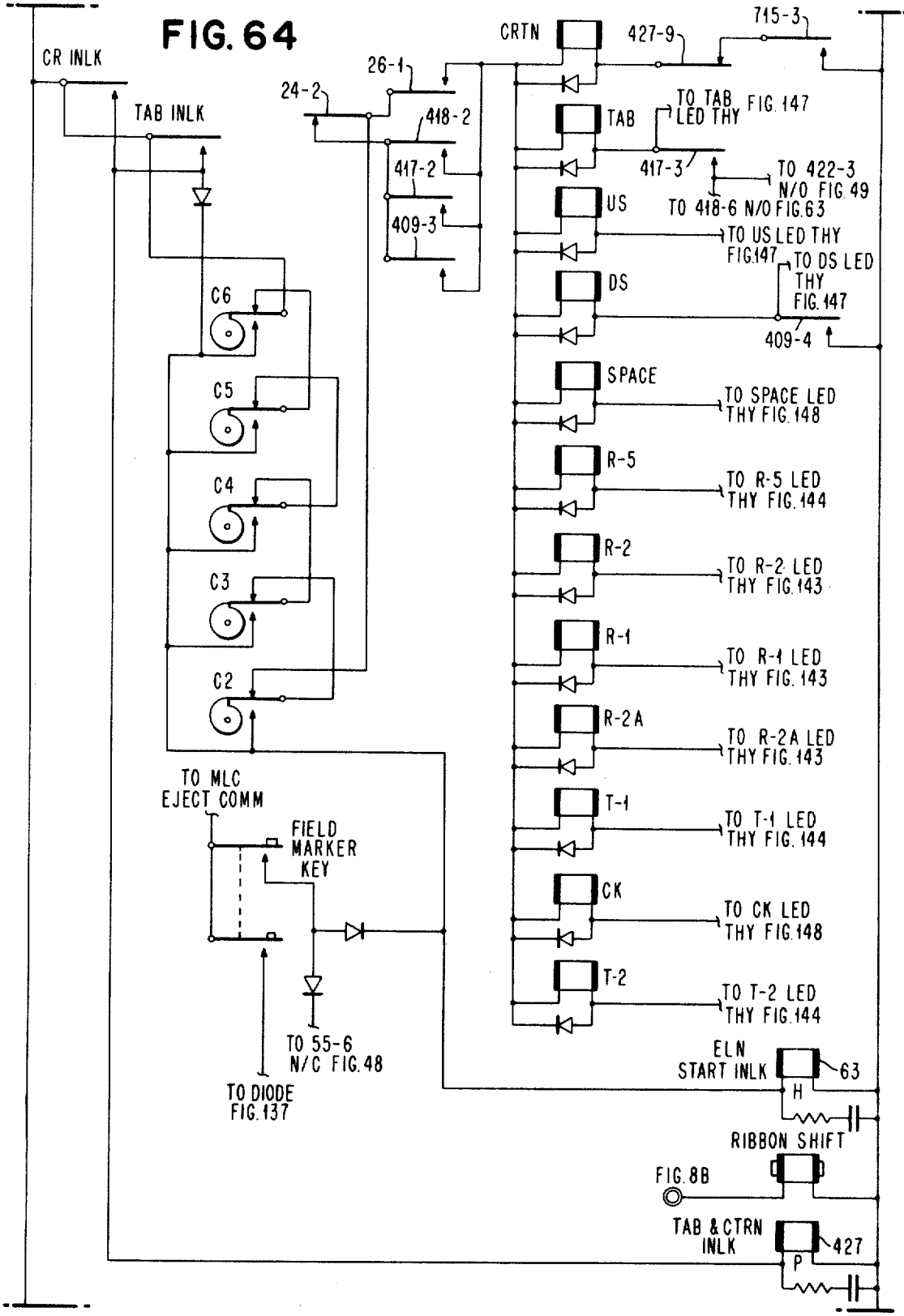

CR INLK
TAB INLK
24-2
26-1
418-2
417-2
409-3
C6
C5
C4
C3
C2
TO MLC EJECT COMM
FIELD MARKER KEY
TO 55-6 N/C FIG. 48
TO DIODE FIG. 137
CRTN
427-9
715-3
TAB
TO TAB LED THY FIG. 147
417-3
TO 422-3 N/O FIG. 49
US
TO 418-6 N/O FIG. 63
TO US LED THY FIG. 147
DS
TO DS LED THY FIG. 147
409-4
SPACE
TO SPACE LED THY FIG. 148
R-5
TO R-5 LED THY FIG. 144
R-2
TO R-2 LED THY FIG. 143
R-1
TO R-1 LED THY FIG. 143
R-2A
TO R-2A LED THY FIG. 143
T-1
TO T-1 LED THY FIG. 144
CK
TO CK LED THY FIG. 148
T-2
TO T-2 LED THY FIG. 144
ELN START INLK
63
H
RIBBON SHIFT
FIG. 8B
TAB & CTRN INLK
427
P

FIG. 65

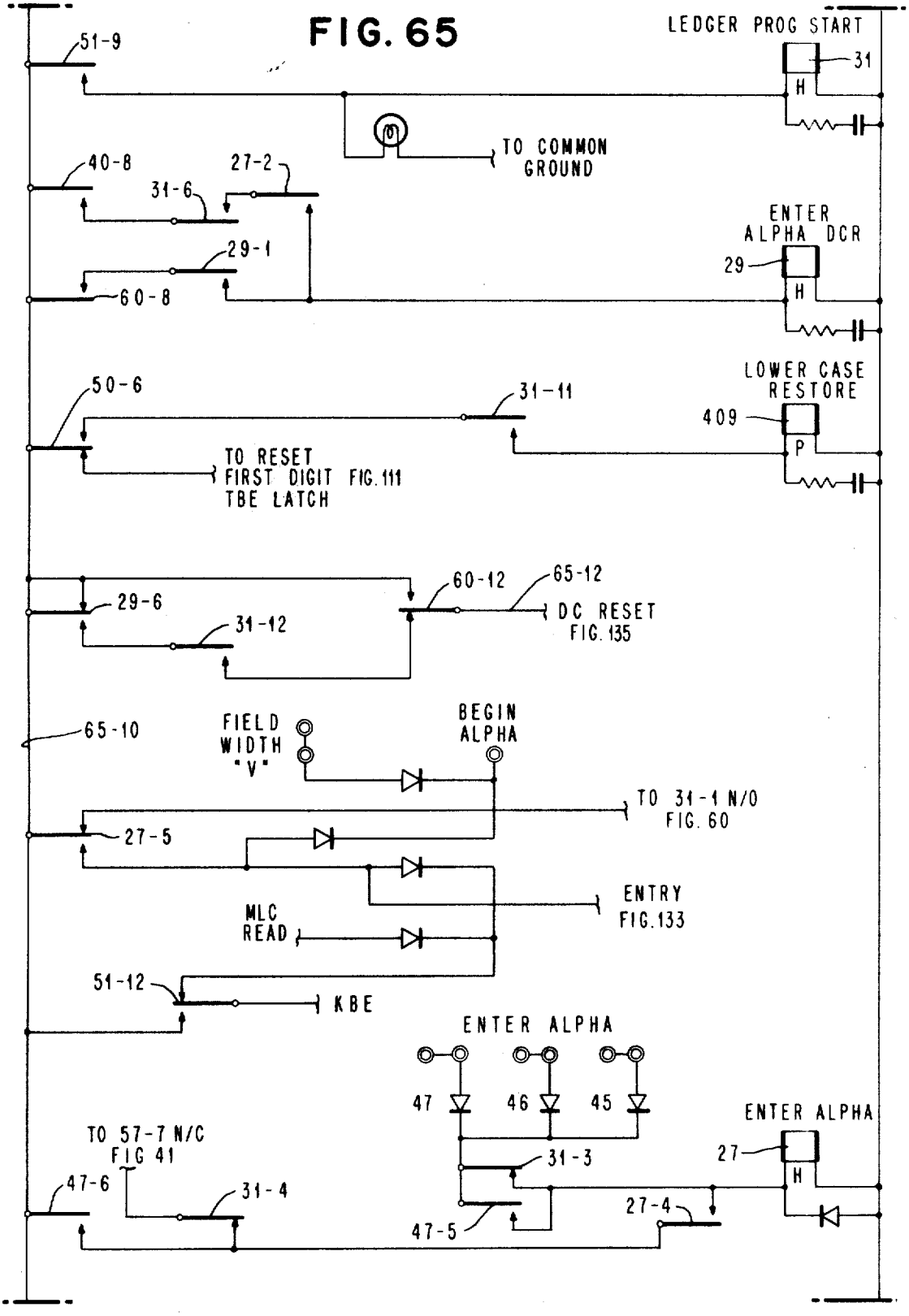

51-9
LEDGER PROG START
31
H
TO COMMON GROUND
40-8
27-2
31-6
ENTER ALPHA DCR
29
29-1
60-8
H
50-6
31-11
LOWER CASE RESTORE
409
P
TO RESET FIRST DIGIT FIG. 111 TBE LATCH
60-12
65-12
29-6
31-12
DC RESET FIG. 135
65-10
FIELD WIDTH "V"
BEGIN ALPHA
TO 31-1 N/O FIG. 60
27-5
ENTRY FIG. 133
MLC READ
51-12
KBE
ENTER ALPHA
47
46
45
ENTER ALPHA
TO 57-7 N/C FIG 41
27
31-3
47-6
31-4
27-4
47-5
H

FIG. 66

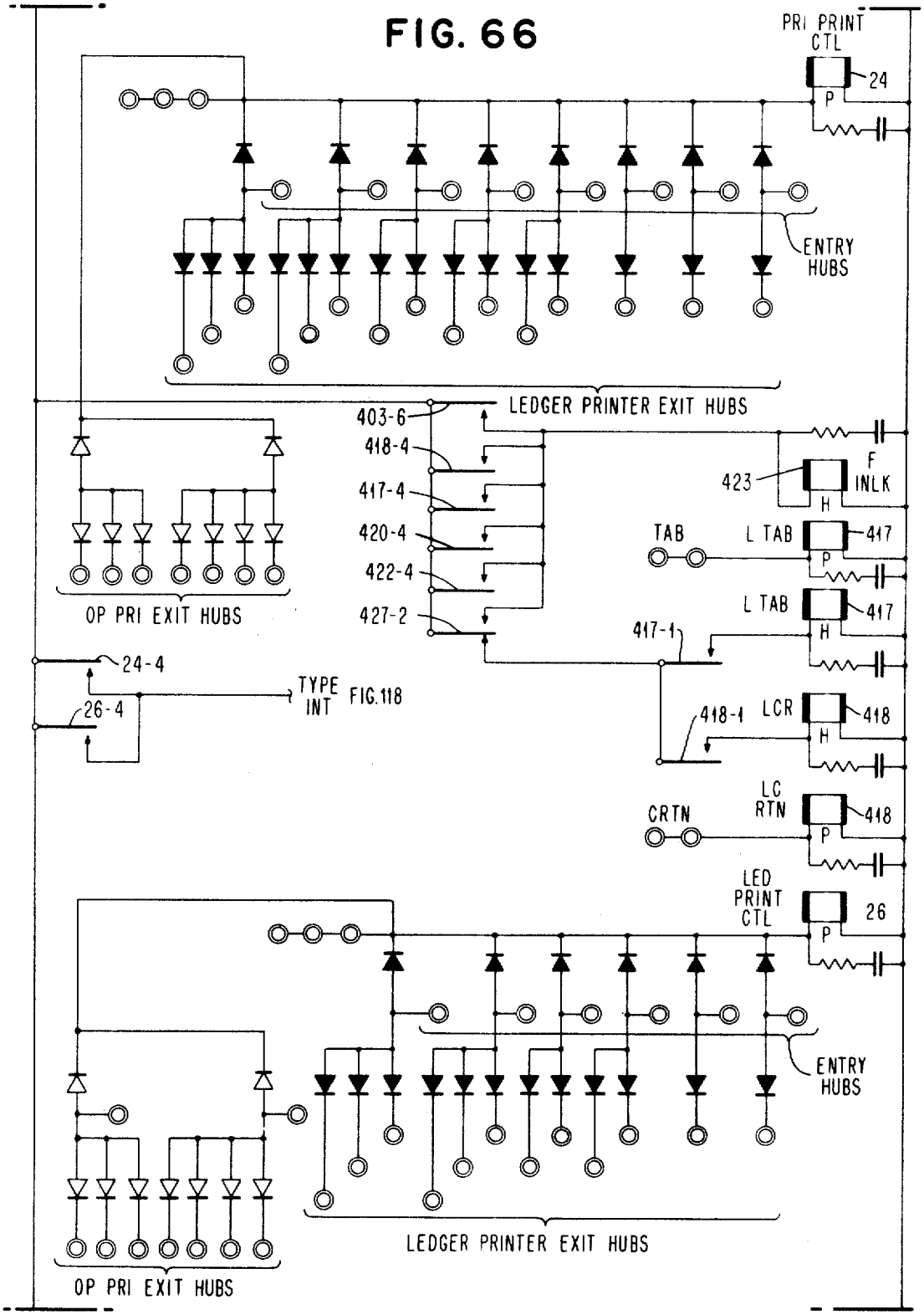

PRI PRINT CTL
24
P
ENTRY HUBS
LEDGER PRINTER EXIT HUBS
403-6
418-4
417-4
420-4
422-4
427-2
OP PRI EXIT HUBS
423
F INLK
H
TAB
L TAB
417
P
L TAB
417
H
417-1
24-4
26-4
TYPE INT
FIG. 118
418-1
LCR
418
H
CRTN
LC RTN
418
P
LED PRINT CTL
26
P
ENTRY HUBS
LEDGER PRINTER EXIT HUBS
OP PRI EXIT HUBS

FIG. 67

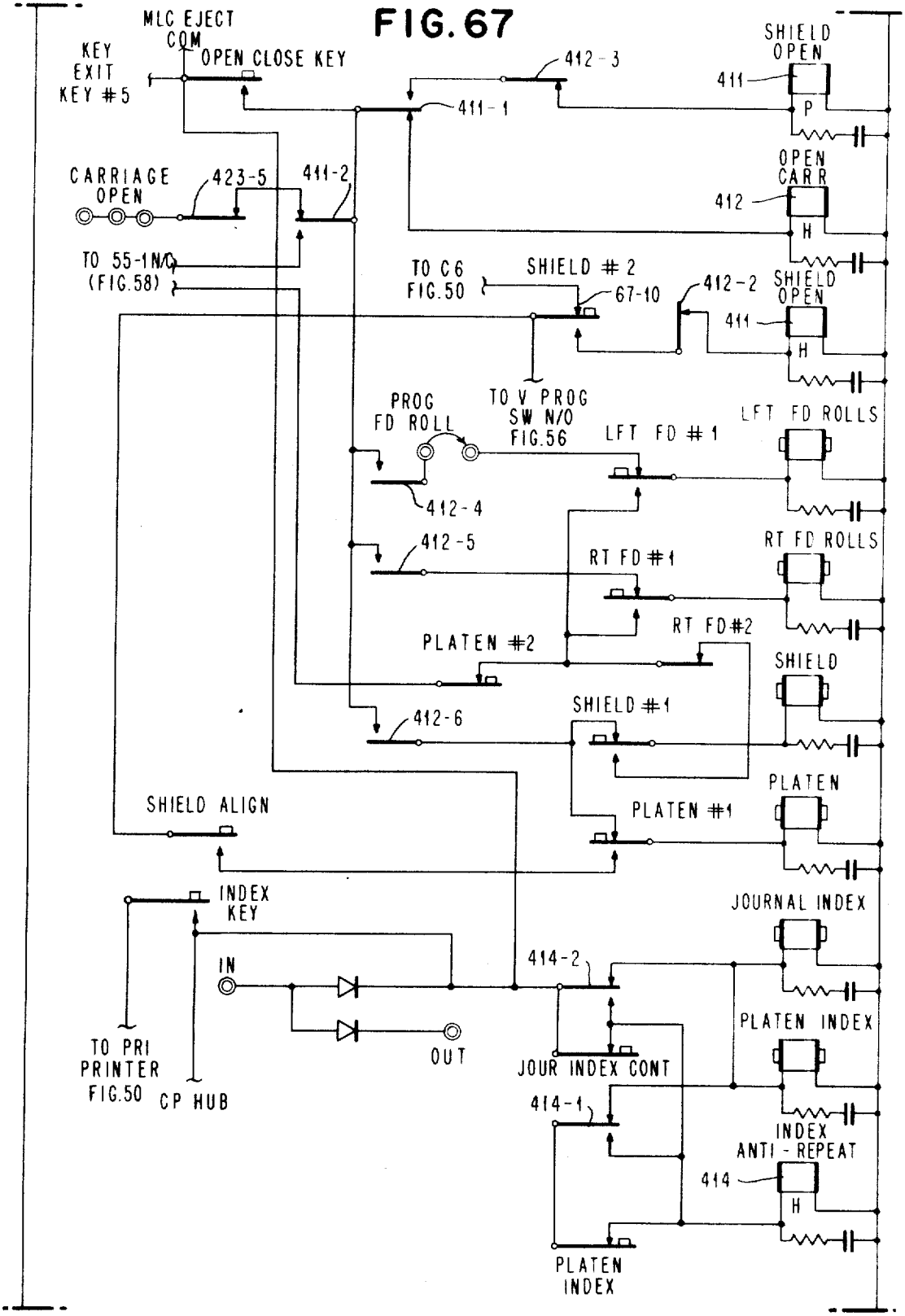
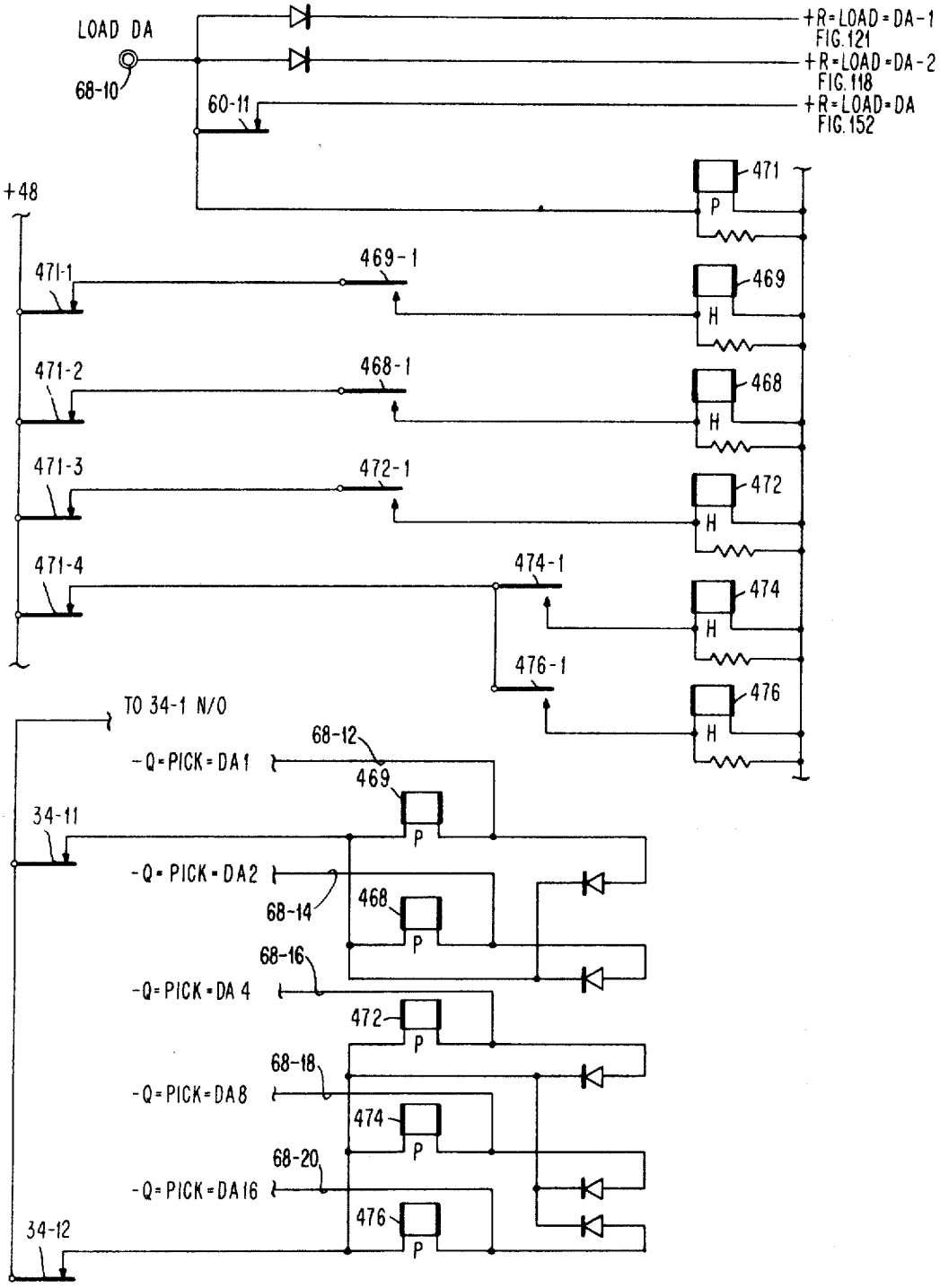

MLC EJECT COM
KEY EXIT KEY #5
OPEN CLOSE KEY
412-3
411-1
SHIELD OPEN
411
P
CARRIAGE OPEN
423-5
411-2
OPEN CARR
412
H
TO 55-1N/C (FIG.58)
TO C6 FIG.50
SHIELD #2
67-10
412-2
SHIELD OPEN
411
H
PROG FD ROLL
TO V PROG SW N/O FIG.56
LFT FD #1
LFT FD ROLLS
412-4
412-5
RT FD #1
RT FD ROLLS
RT FD #2
PLATEN #2
SHIELD
412-6
SHIELD #1
PLATEN
SHIELD ALIGN
PLATEN #1
INDEX KEY
JOURNAL INDEX
IN
414-2
OUT
PLATEN INDEX
TO PRI PRINTER FIG.50
CP HUB
JOUR INDEX CONT
414-1
INDEX ANTI-REPEAT
414
H
PLATEN INDEX

FIG. 68 DIGIT ANALYZER



DIGIT ANALYZER

FIG. 69

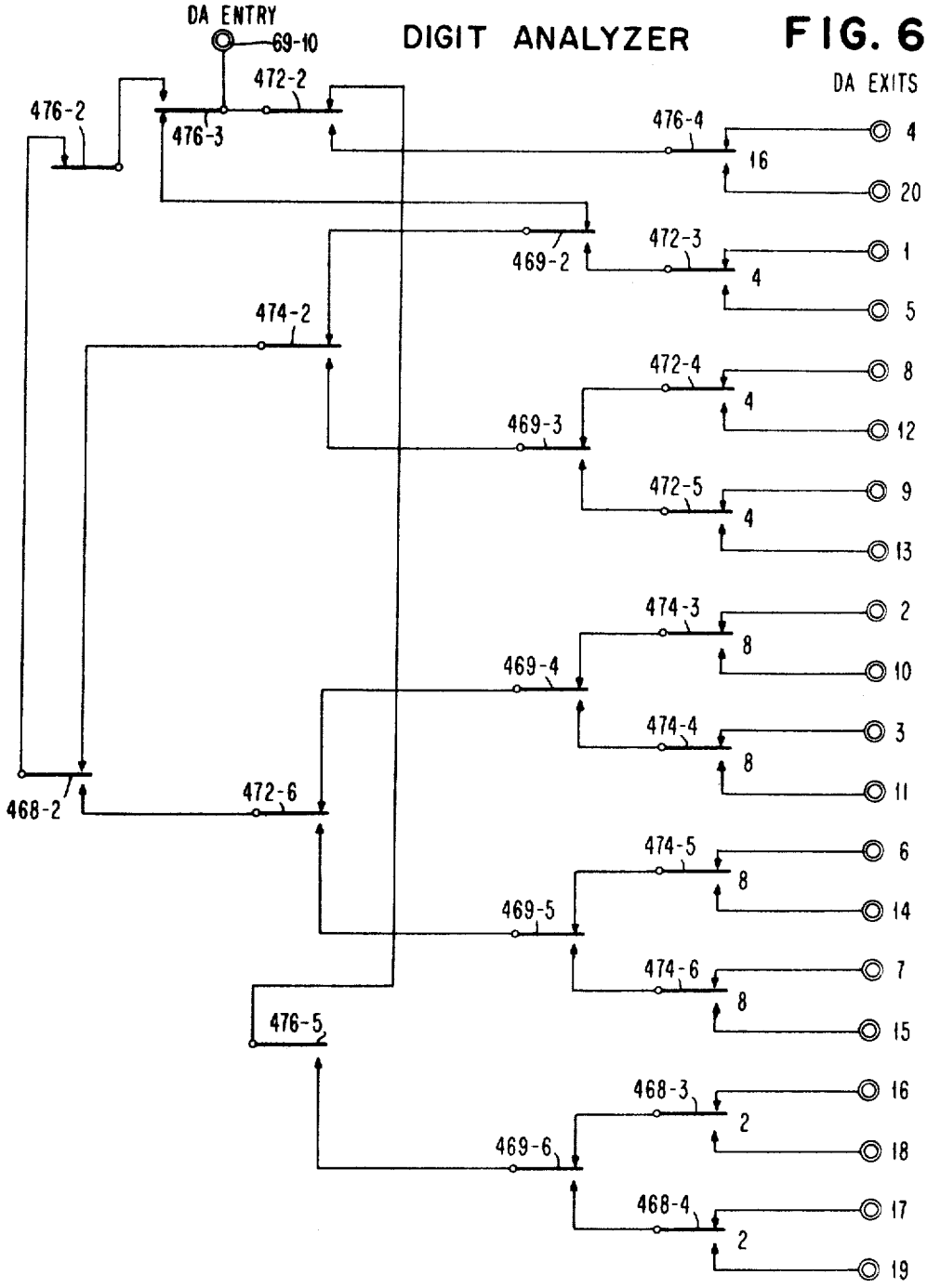


FIG. 70

POWER SUPPLY

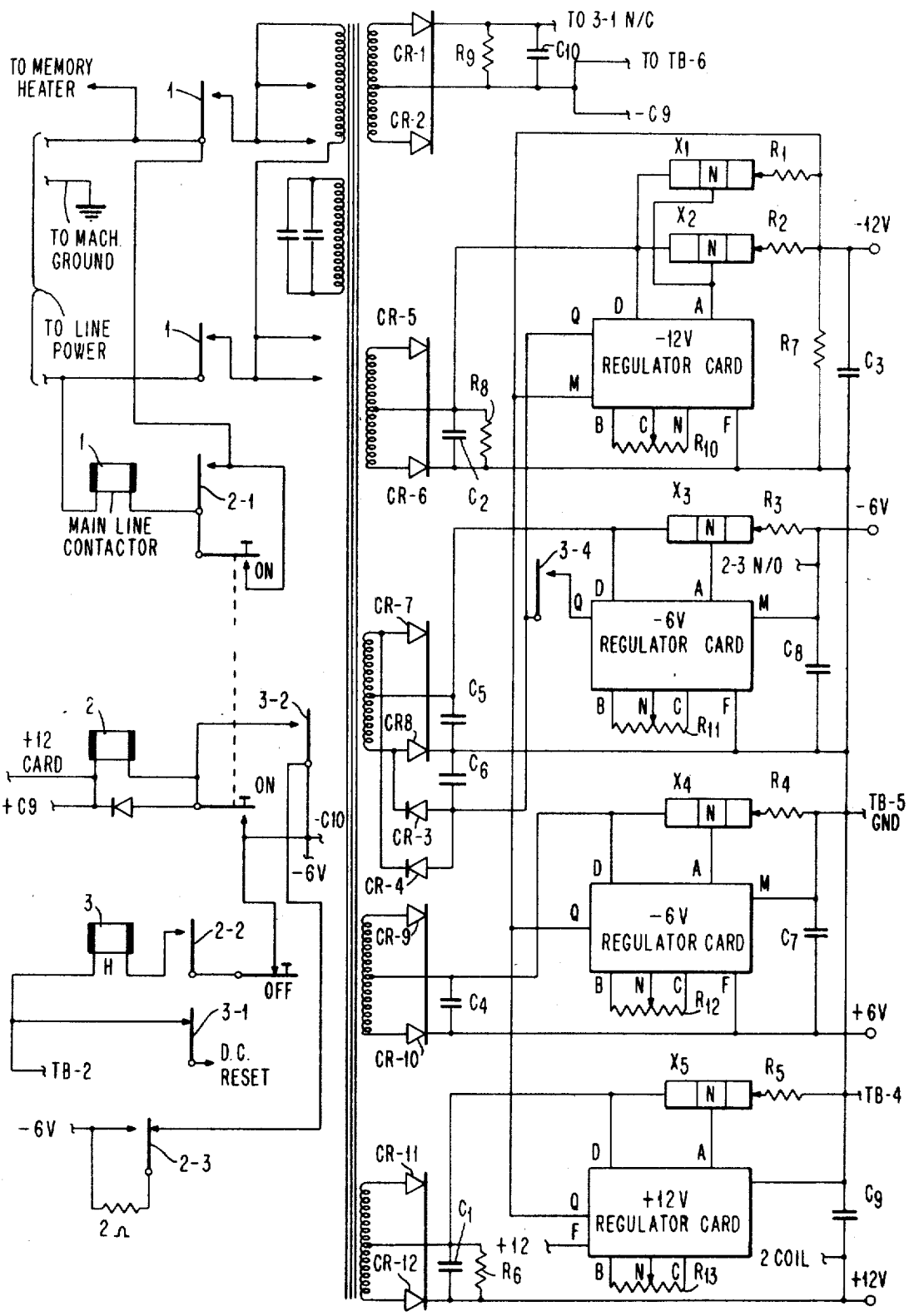
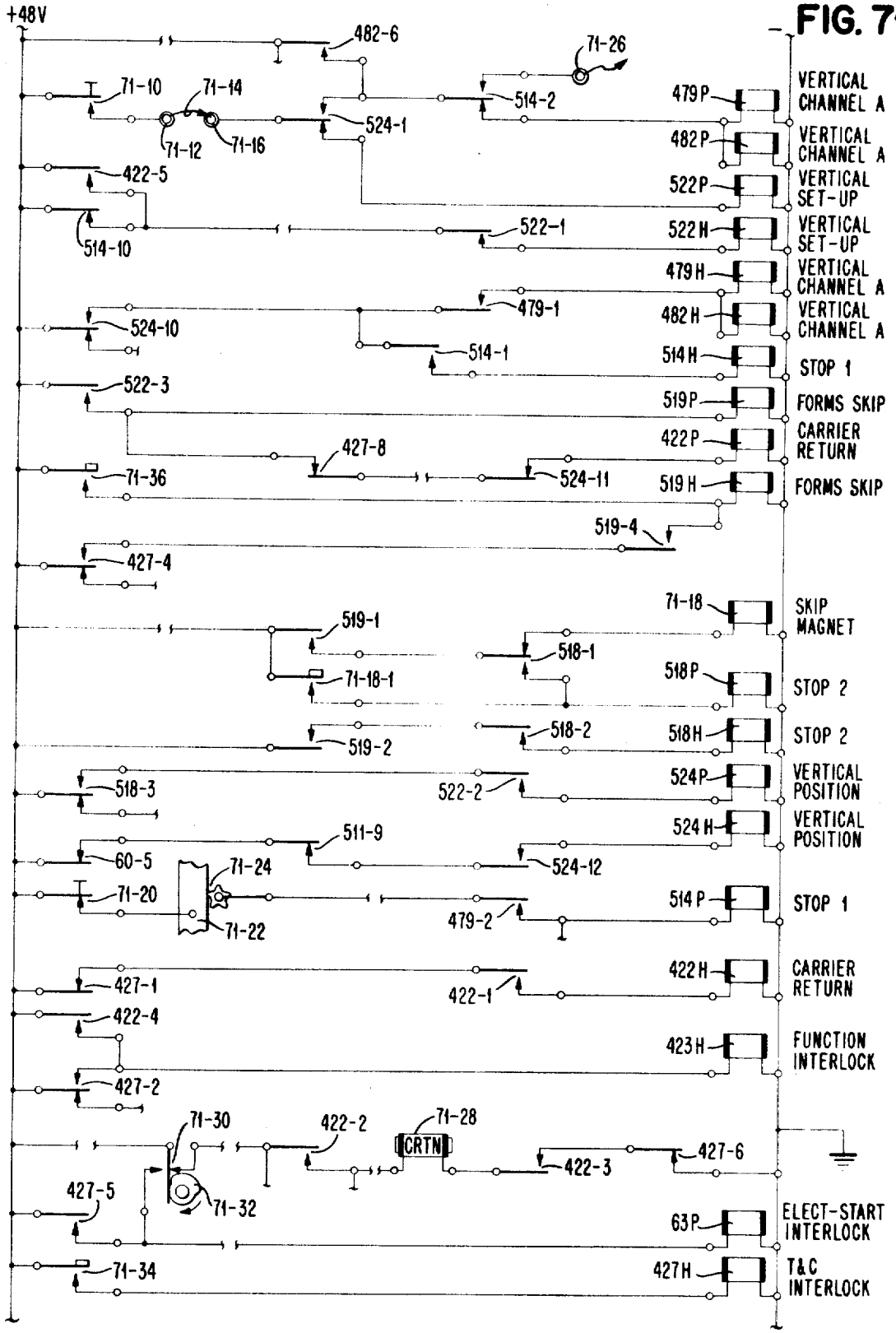


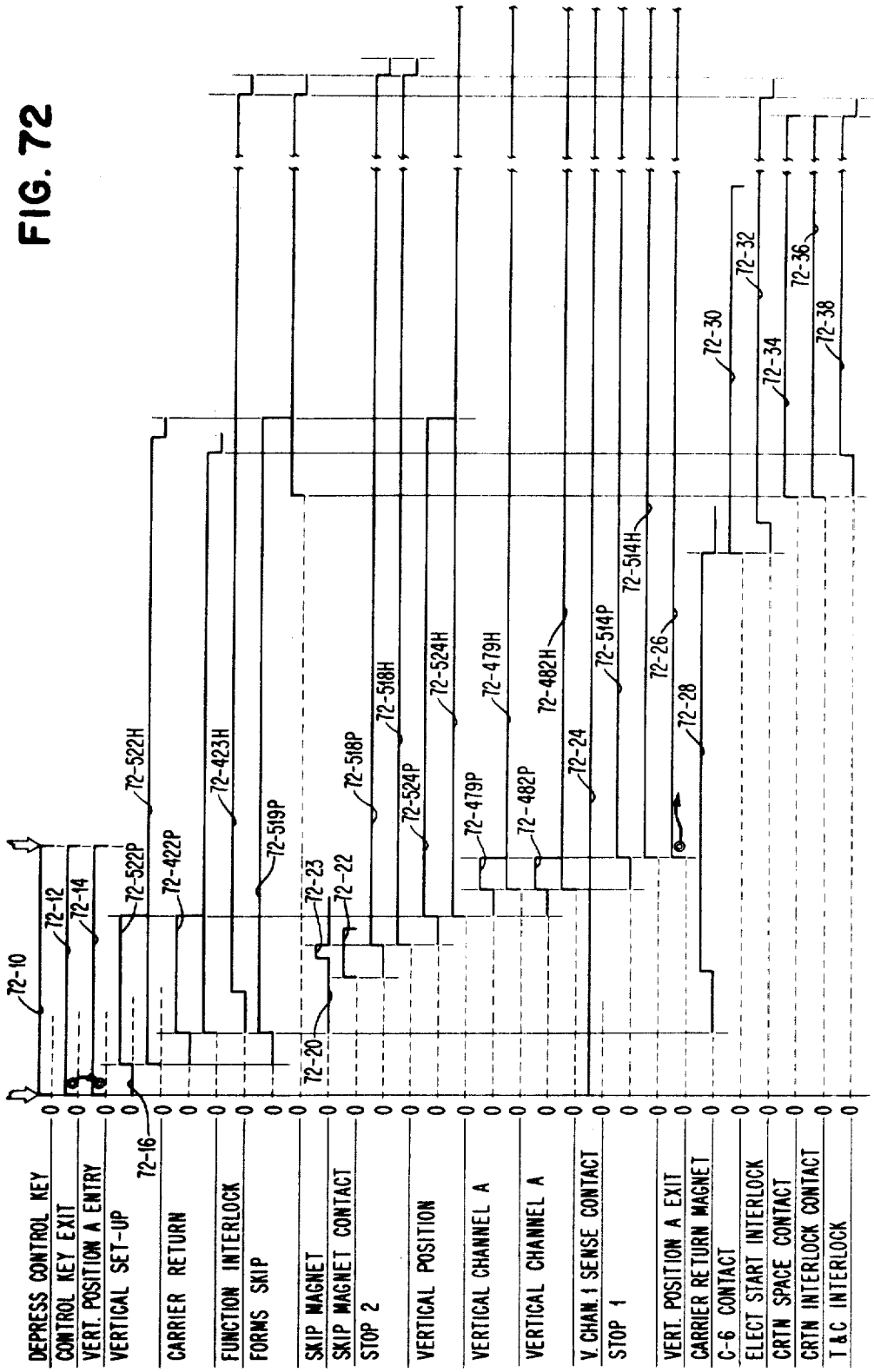
FIG. 71


+48V
482-6
71-26
71-10
71-14
514-2
479P
VERTICAL CHANNEL A
524-1
71-12
71-16
482P
VERTICAL CHANNEL A
422-5
522P
VERTICAL SET-UP
514-10
522-1
522H
VERTICAL SET-UP
479H
VERTICAL CHANNEL A
479-1
524-10
482H
VERTICAL CHANNEL A
514-1
514H
STOP 1
522-3
519P
FORMS SKIP
422P
CARRIER RETURN
427-8
71-36
524-11
519H
FORMS SKIP
519-4
427-4
71-18
SKIP MAGNET
519-1
518-1
71-18-1
518P
STOP 2
519-2
518-2
518H
STOP 2
518-3
522-2
524P
VERTICAL POSITION
511-9
524H
VERTICAL POSITION
60-5
71-24
524-12
71-20
514P
STOP 1
479-2
71-22
427-1
422-1
422H
CARRIER RETURN
422-4
423H
FUNCTION INTERLOCK
427-2
71-30
422-2
71-28
CRTN
422-3
427-6
427-5
71-32
63P
ELECT-START INTERLOCK
71-34
427H
T&C INTERLOCK

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 60

FIG. 72



ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 61

FIG. 73

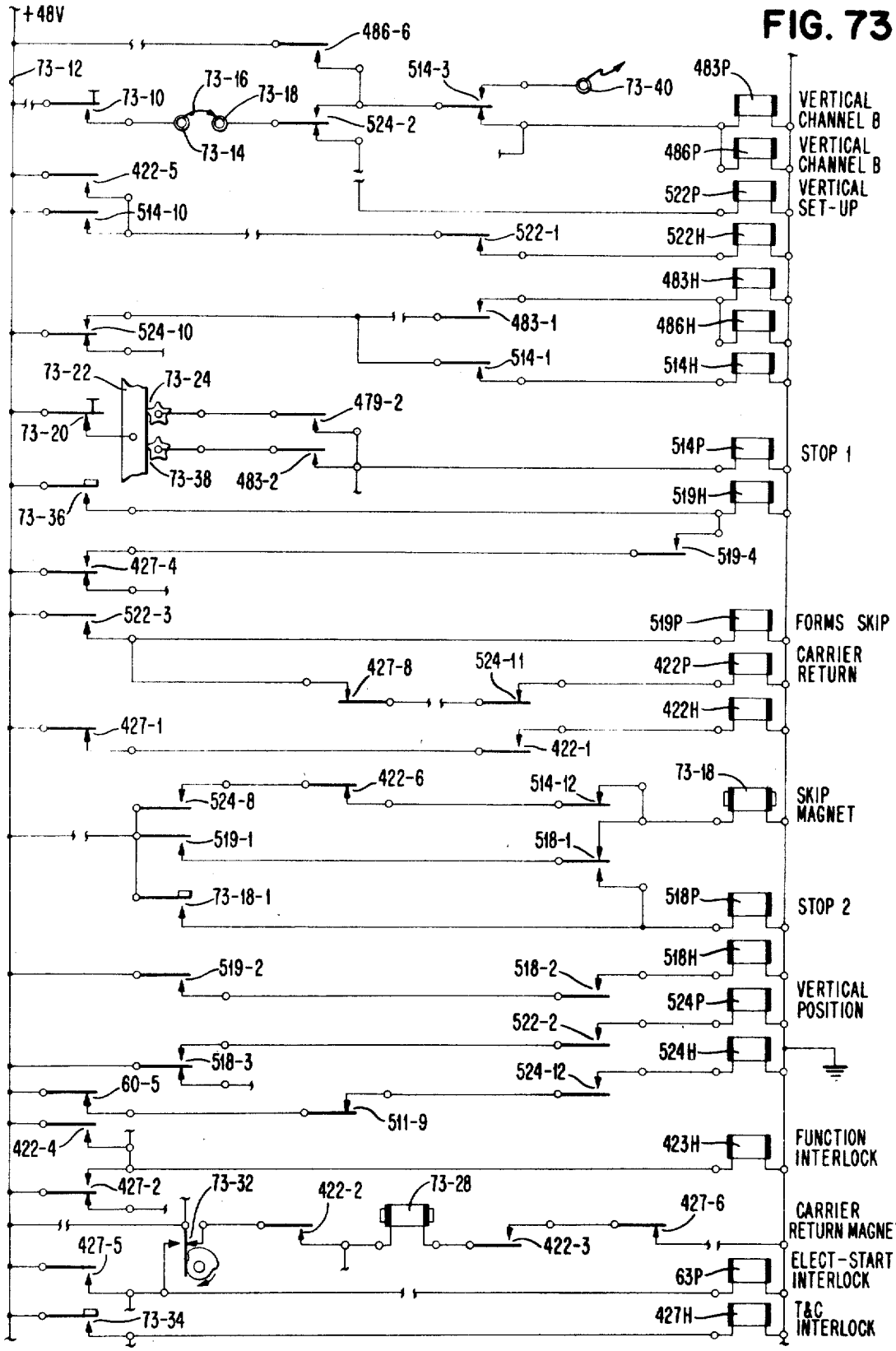


FIG. 74

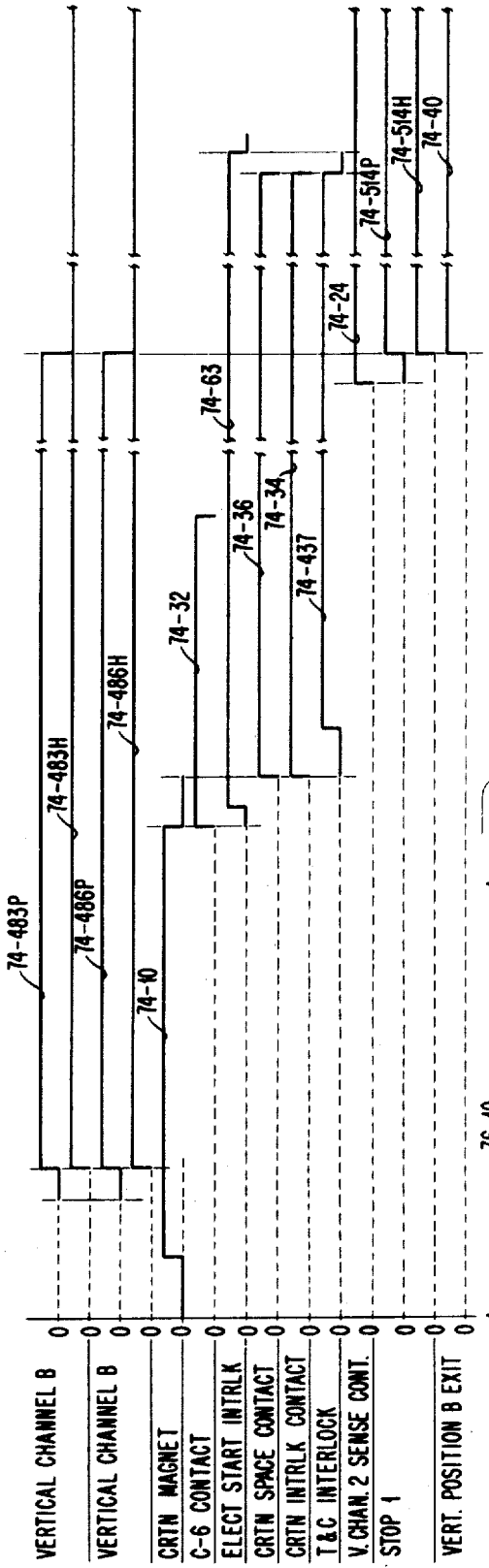

VERTICAL CHANNEL B
VERTICAL CHANNEL B
CRTN MAGNET
C-6 CONTACT
ELECT START INTRLK
CRTN SPACE CONTACT
CRTN INTRLK CONTACT
T&C INTERLOCK
V.CHAN.2 SENSE CONT.
STOP 1
VERT. POSITION B EXIT
74-483P
74-483H
74-486P
74-486H
74-10
74-32
74-63
74-36
74-34
74-437
74-24
74-514P
74-514H
74-40

FIG. 76

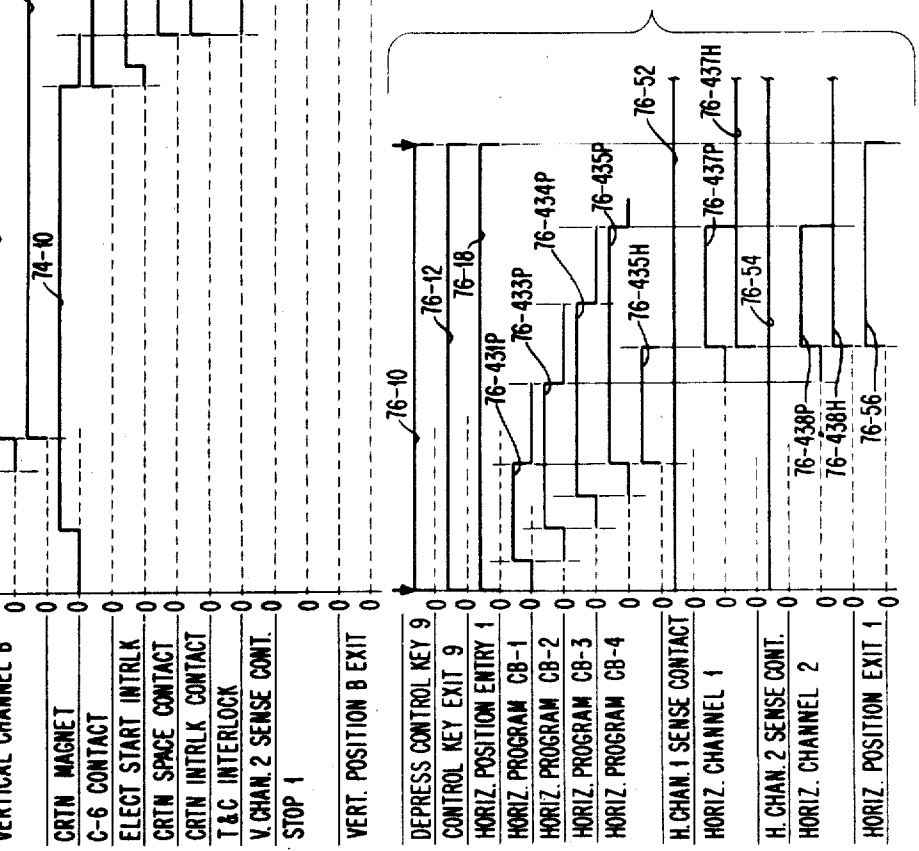

DEPRESS CONTROL KEY 9
CONTROL KEY EXIT 9
HORIZ. POSITION ENTRY 1
HORIZ. PROGRAM CB-1
HORIZ. PROGRAM CB-2
HORIZ. PROGRAM CB-3
HORIZ. PROGRAM CB-4
H.CHAN.1 SENSE CONTACT
HORIZ. CHANNEL 1
H.CHAN.2 SENSE CONT.
HORIZ. CHANNEL 2
HORIZ. POSITION EXIT 1
76-10
76-12
76-18
76-431P
76-433P
76-434P
76-435P
76-435H
76-52
76-437H
76-437P
76-54
76-438P
76-438H
76-56

FIG. 75

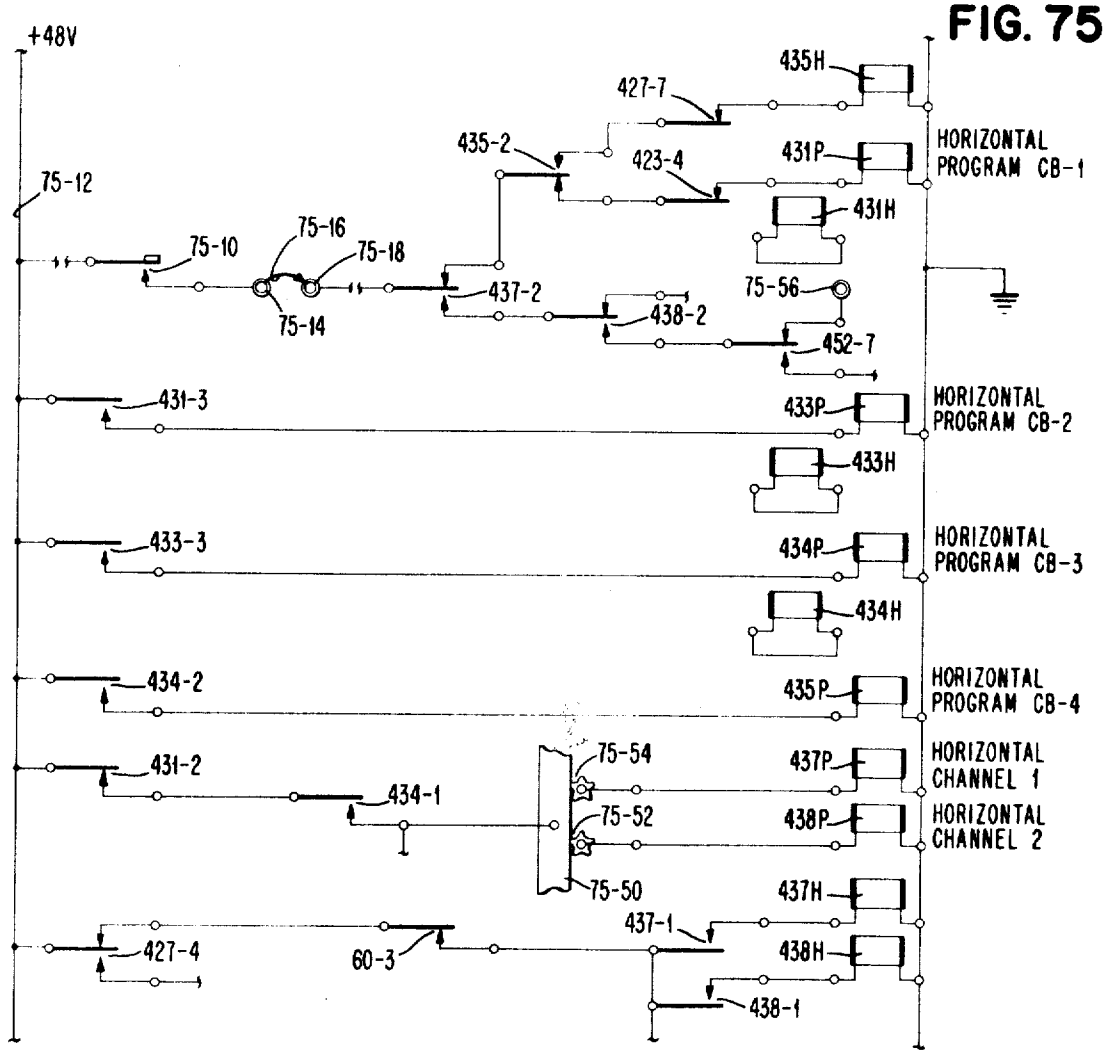

+48V
75-12
75-10
75-16
75-18
75-14
435H
427-7
435-2
423-4
431P
431H
HORIZONTAL PROGRAM CB-1
437-2
438-2
75-56
452-7
431-3
433P
HORIZONTAL PROGRAM CB-2
433H
433-3
434P
HORIZONTAL PROGRAM CB-3
434H
434-2
435P
HORIZONTAL PROGRAM CB-4
431-2
434-1
75-54
437P
HORIZONTAL CHANNEL 1
75-52
438P
HORIZONTAL CHANNEL 2
75-50
437H
437-1
427-4
60-3
438H
438-1

FIG. 77a

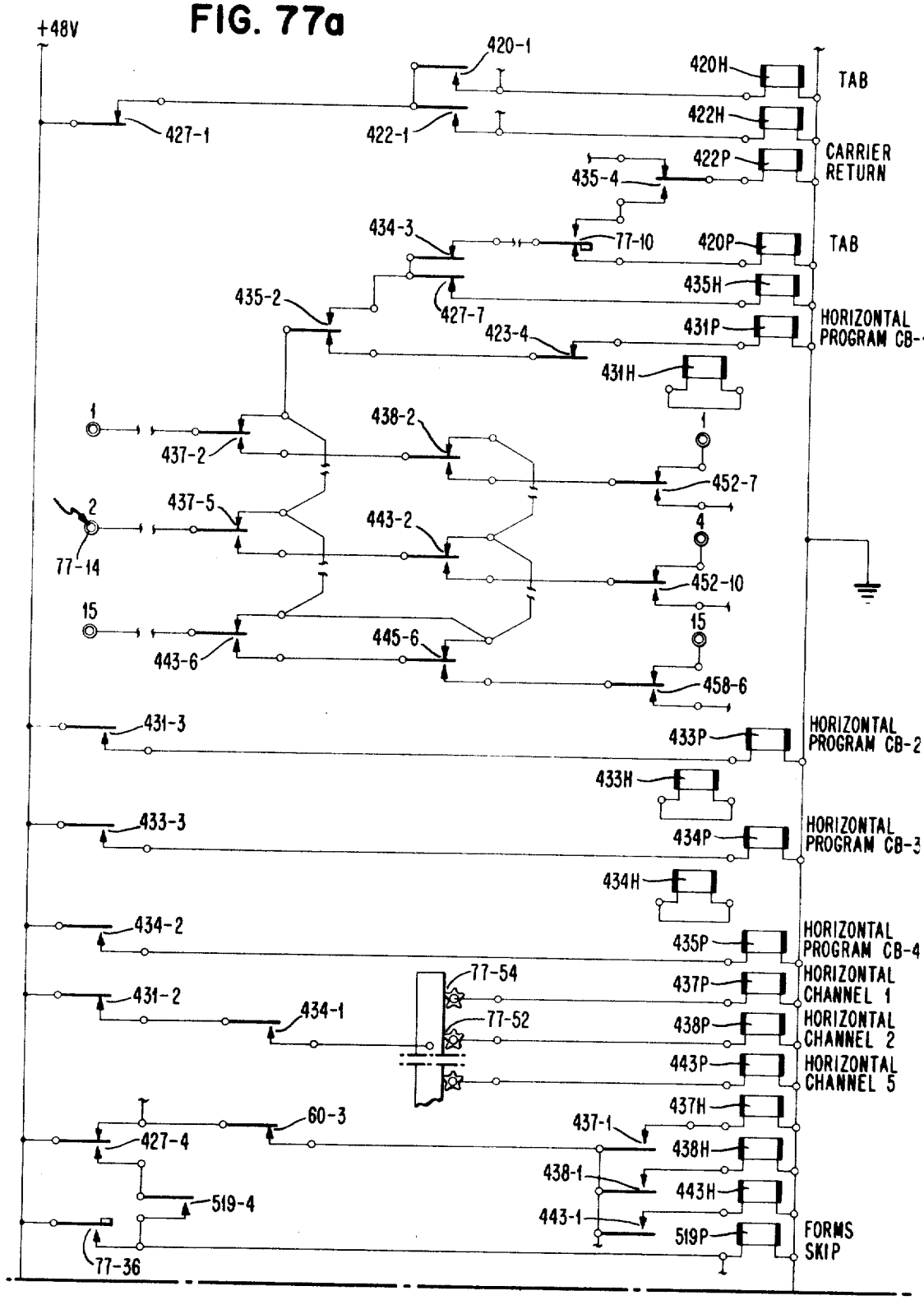
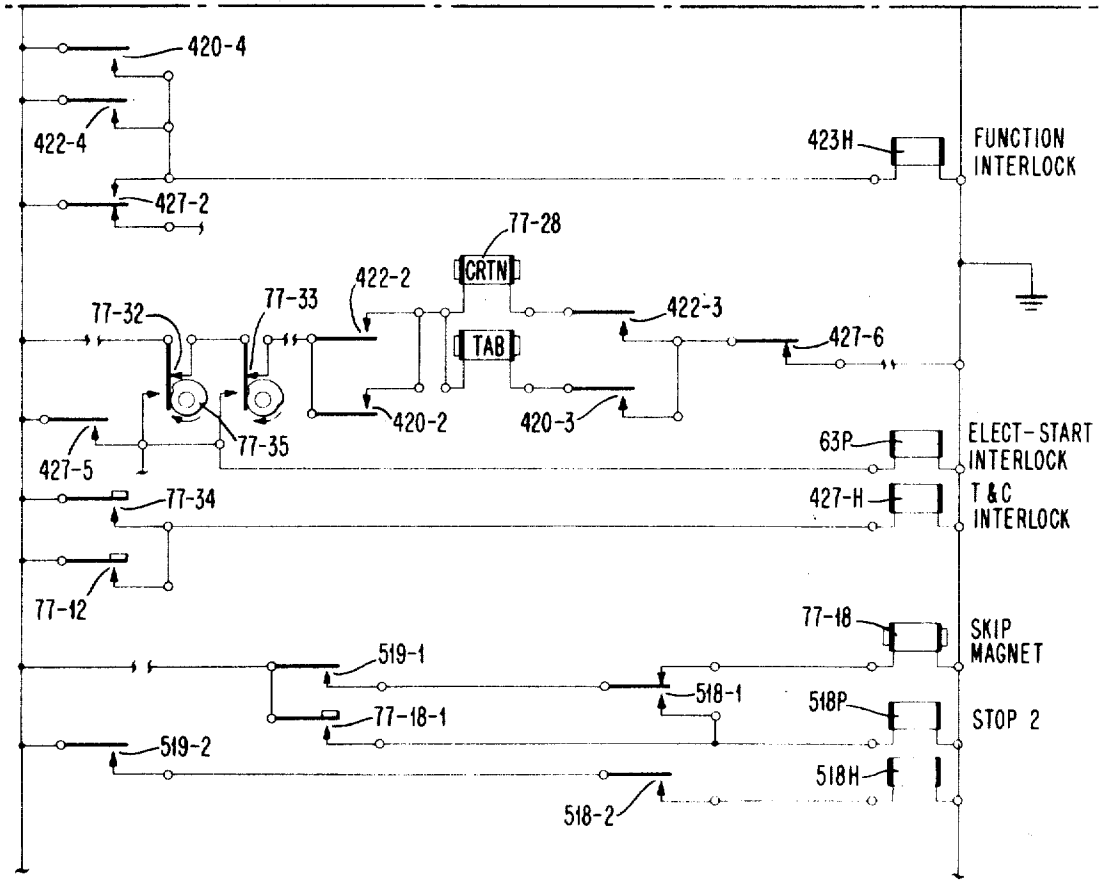

+48V
420-1
420H
TAB
427-1
422-1
422H
CARRIER RETURN
422P
435-4
434-3
77-10
420P
TAB
435H
435-2
427-7
HORIZONTAL PROGRAM CB-1
423-4
431P
431H
1
438-2
437-2
452-7
437-5
2
443-2
4
77-14
452-10
15
15
445-6
443-6
458-6
431-3
433P
HORIZONTAL PROGRAM CB-2
433H
433-3
434P
HORIZONTAL PROGRAM CB-3
434H
434-2
435P
HORIZONTAL PROGRAM CB-4
77-54
437P
HORIZONTAL CHANNEL 1
431-2
434-1
77-52
438P
HORIZONTAL CHANNEL 2
443P
HORIZONTAL CHANNEL 5
437H
60-3
437-1
427-4
438H
438-1
519-4
443H
443-1
519P
FORMS SKIP
77-36

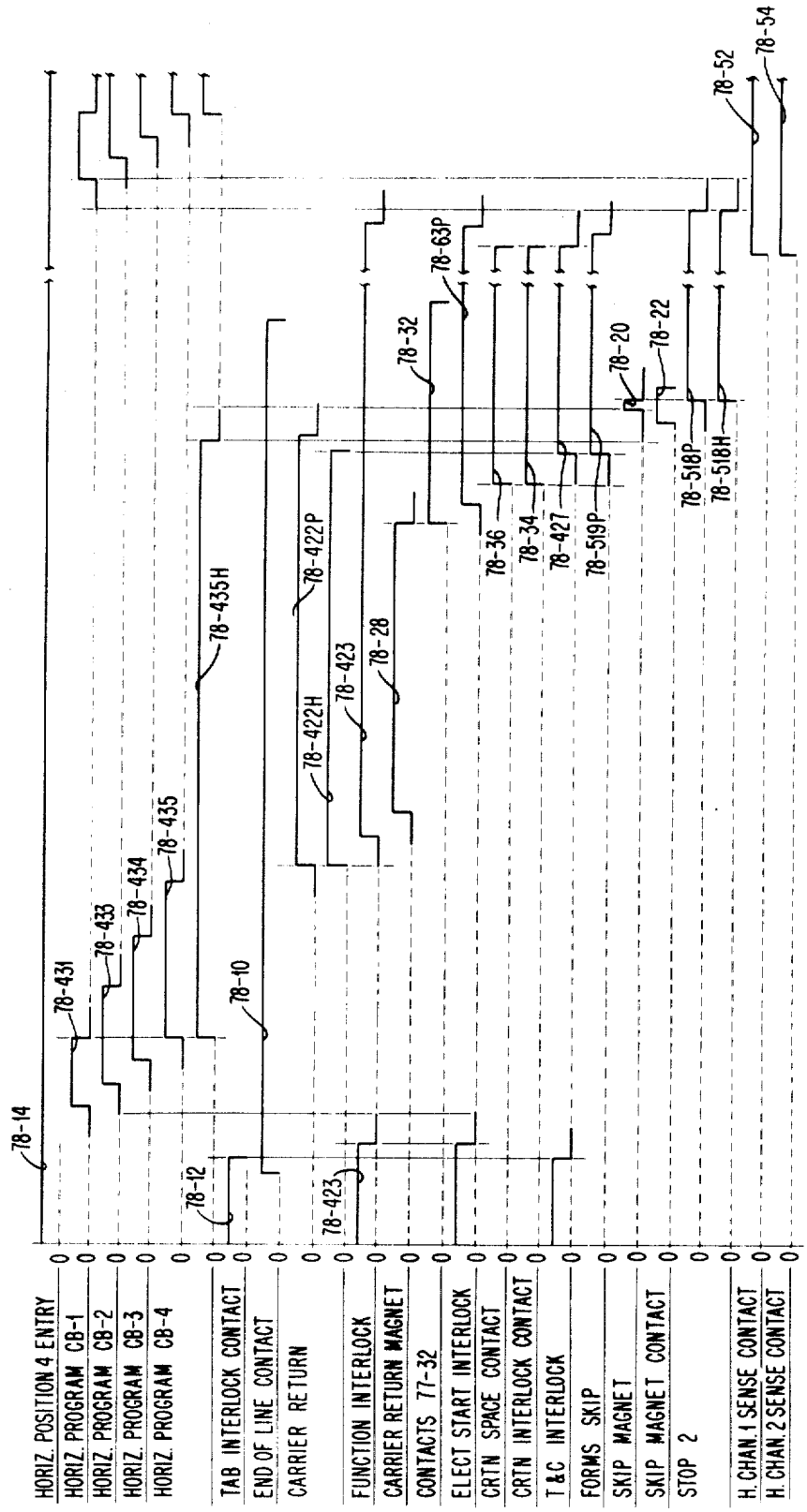
FIG. 77b


420-4
422-4
427-2
423H
FUNCTION INTERLOCK
77-28
CRTN
422-2
77-32
77-33
TAB
422-3
427-6
420-2
420-3
77-35
427-5
63P
ELECT-START INTERLOCK
77-34
427-H
T&C INTERLOCK
77-12
77-18
SKIP MAGNET
519-1
518-1
77-18-1
518P
STOP 2
519-2
518H
518-2

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 66

FIG. 78



ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 67

FIG. 79a

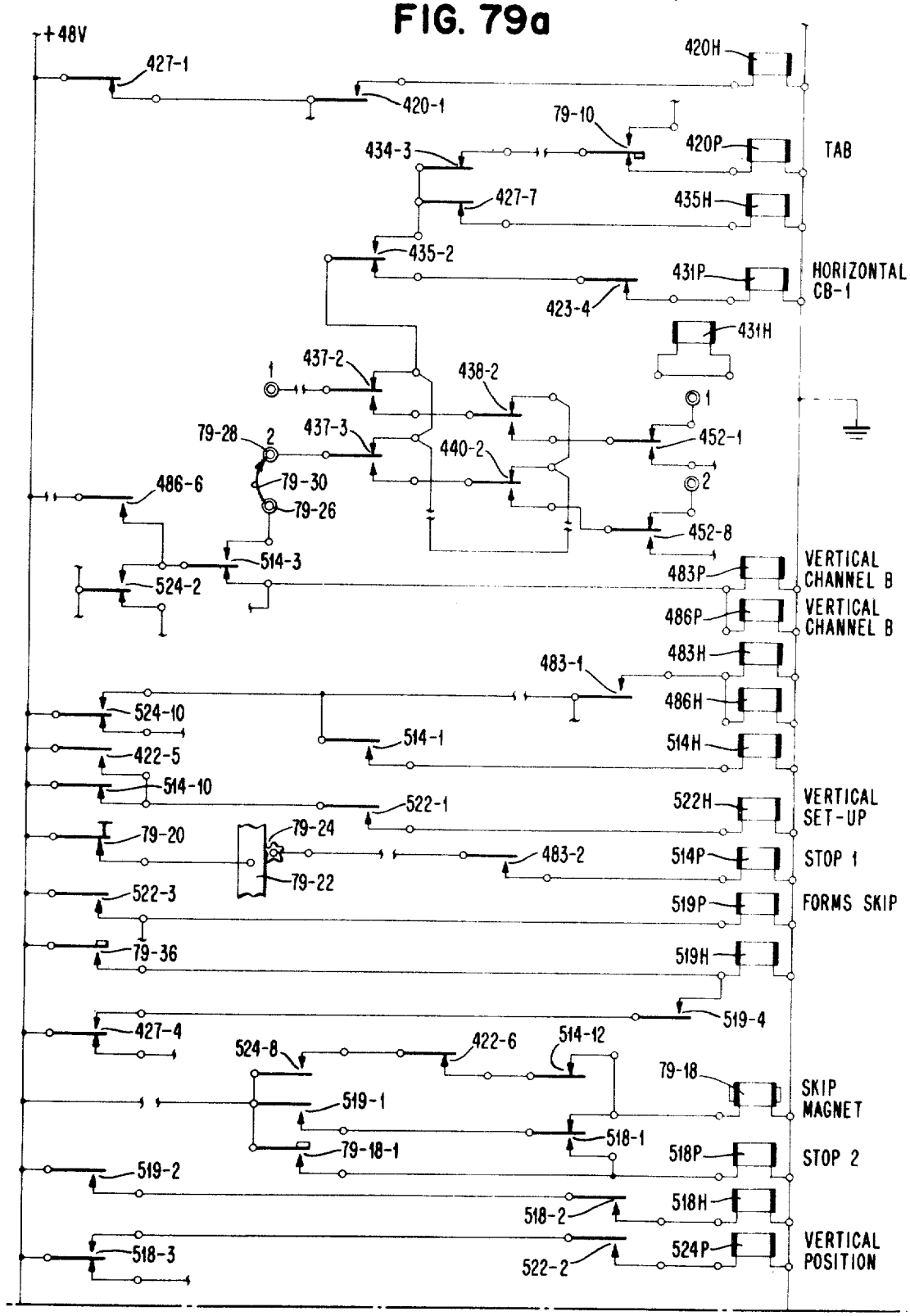


FIG. 79b

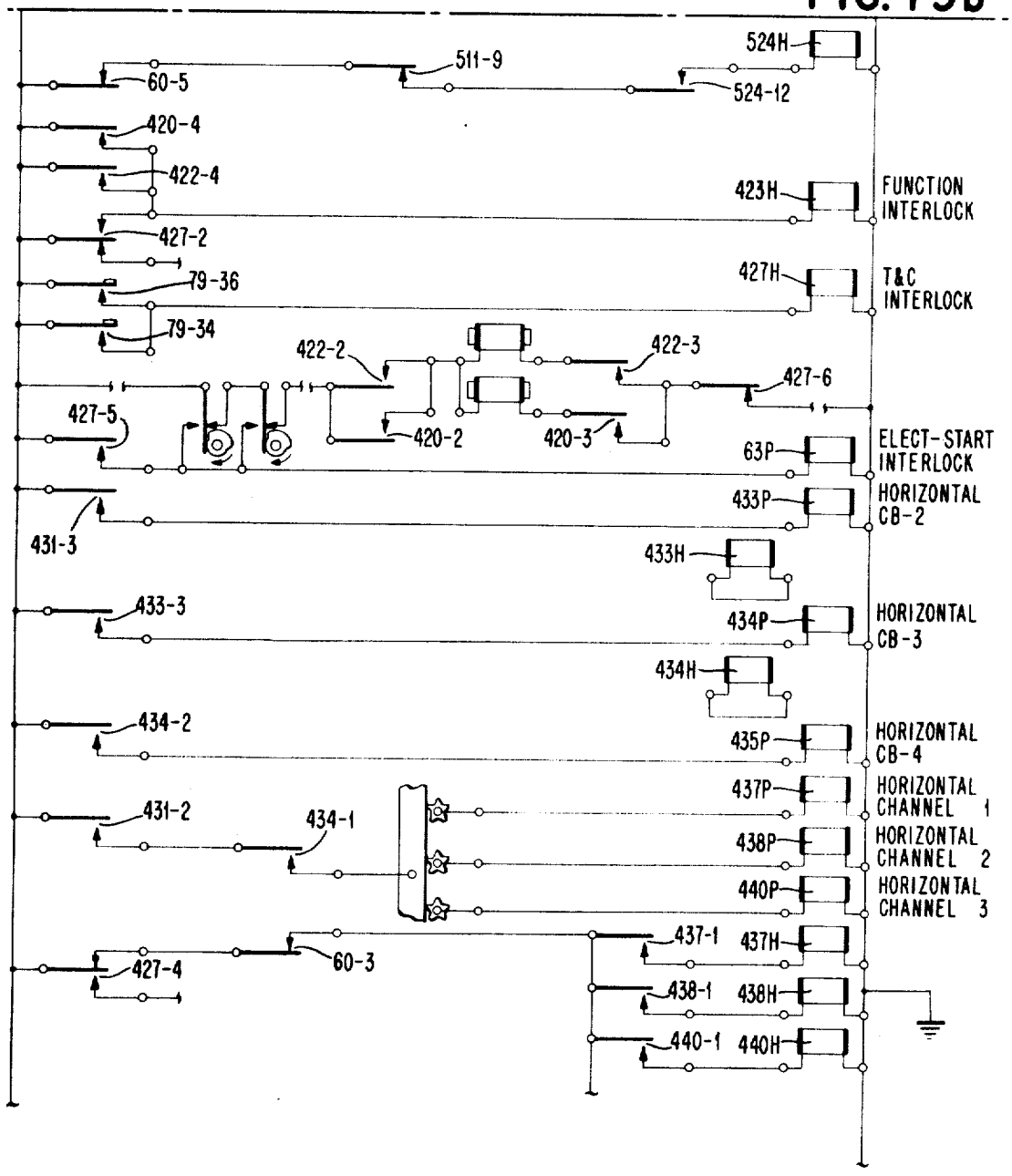

524H
511-9
60-5
524-12
420-4
422-4
423H
FUNCTION INTERLOCK
427-2
427H
79-36
T&C INTERLOCK
79-34
422-2
422-3
427-6
427-5
420-2
420-3
63P
ELECT-START INTERLOCK
433P
HORIZONTAL CB-2
431-3
433H
433-3
434P
HORIZONTAL CB-3
434H
434-2
435P
HORIZONTAL CB-4
437P
HORIZONTAL CHANNEL 1
431-2
434-1
438P
HORIZONTAL CHANNEL 2
440P
HORIZONTAL CHANNEL 3
437-1
437H
60-3
427-4
438-1
438H
440-1
440H

FIG. 80

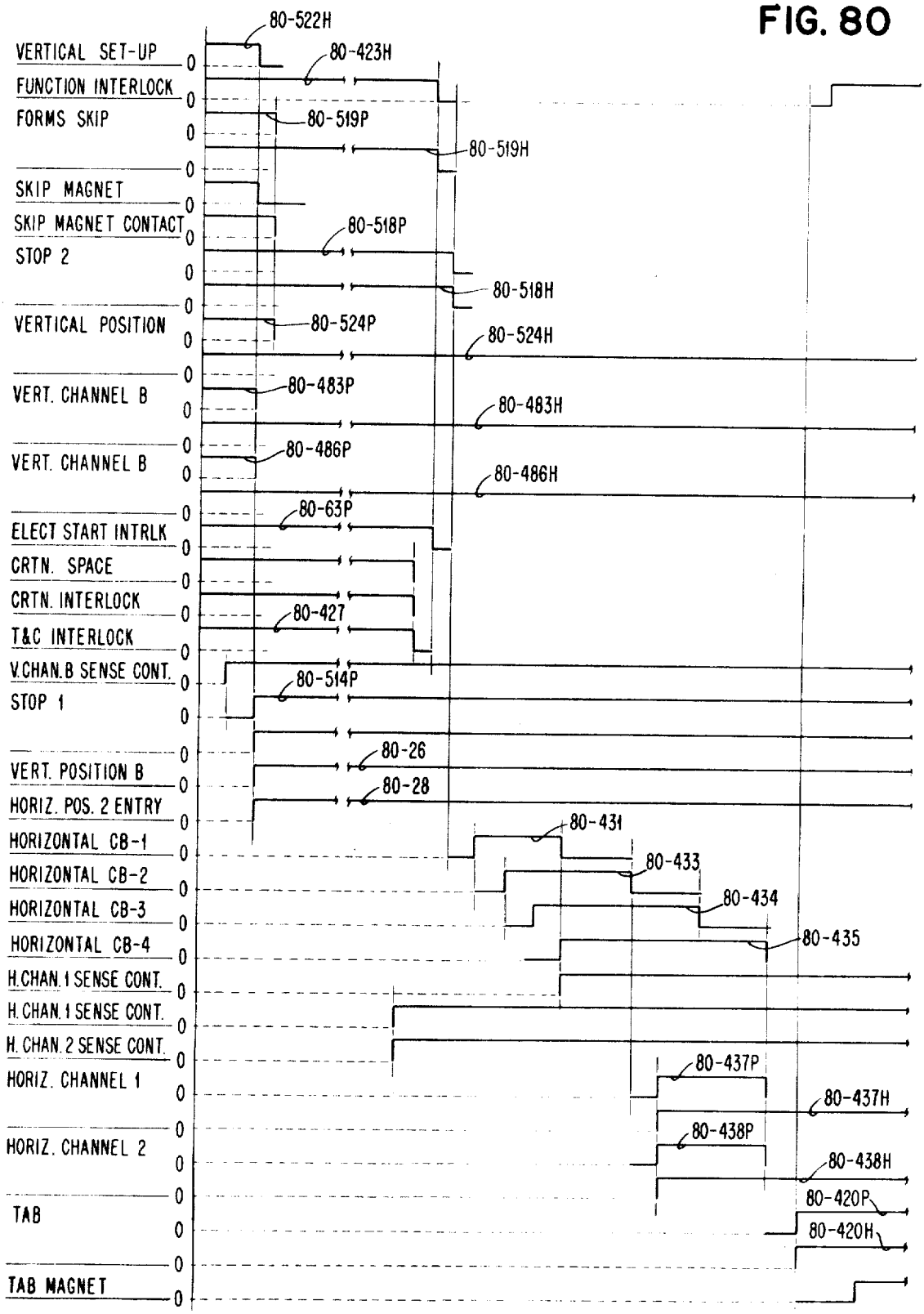

80-522H
VERTICAL SET-UP
80-423H
FUNCTION INTERLOCK
FORMS SKIP
80-519P
80-519H
SKIP MAGNET
SKIP MAGNET CONTACT
80-518P
STOP 2
80-518H
VERTICAL POSITION
80-524P
80-524H
VERT. CHANNEL B
80-483P
80-483H
VERT. CHANNEL B
80-486P
80-486H
80-63P
ELECT START INTRLK
CRTN. SPACE
CRTN. INTERLOCK
80-427
T&C INTERLOCK
V.CHAN.B SENSE CONT.
80-514P
STOP 1
80-26
VERT. POSITION B
80-28
HORIZ. POS. 2 ENTRY
80-431
HORIZONTAL CB-1
80-433
HORIZONTAL CB-2
80-434
HORIZONTAL CB-3
80-435
HORIZONTAL CB-4
H.CHAN.1 SENSE CONT.
H.CHAN.1 SENSE CONT.
H. CHAN. 2 SENSE CONT.
80-437P
HORIZ. CHANNEL 1
80-437H
80-438P
HORIZ. CHANNEL 2
80-438H
80-420P
TAB
80-420H
TAB MAGNET

FIG. 81a

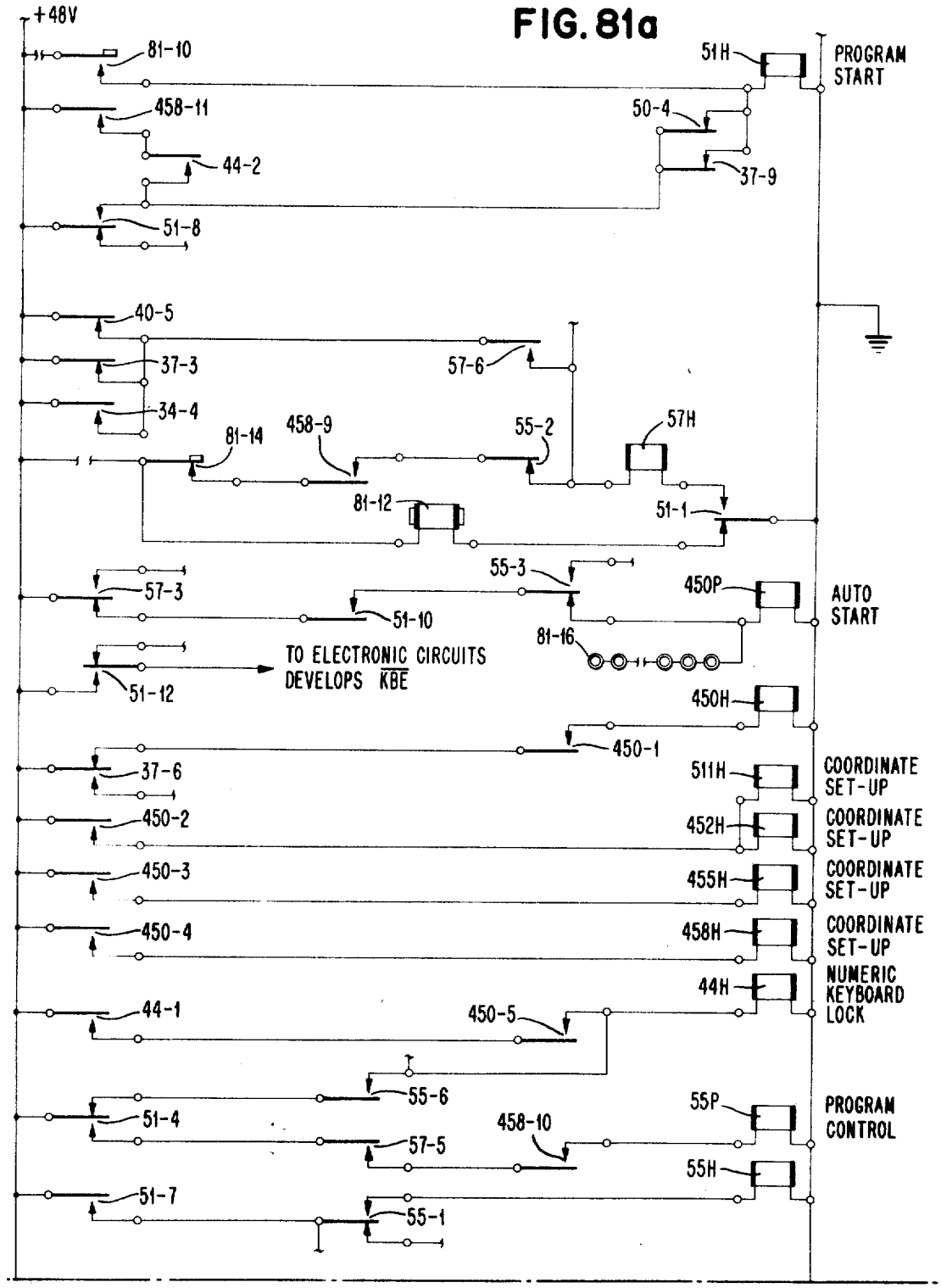

+48V
81-10
458-11
44-2
51-8
40-5
37-3
34-4
81-14
458-9
81-12
57-6
55-2
57H
51-1
51H
PROGRAM START
50-4
37-9
55-3
57-3
51-10
450P
AUTO START
81-16
TO ELECTRONIC CIRCUITS DEVELOPS $\overline{KBE}$
51-12
450H
450-1
37-6
511H
COORDINATE SET-UP
450-2
452H
COORDINATE SET-UP
450-3
455H
COORDINATE SET-UP
450-4
458H
COORDINATE SET-UP
44H
NUMERIC KEYBOARD LOCK
44-1
450-5
55-6
51-4
57-5
458-10
55P
PROGRAM CONTROL
55H
51-7
55-1

FIG. 81b

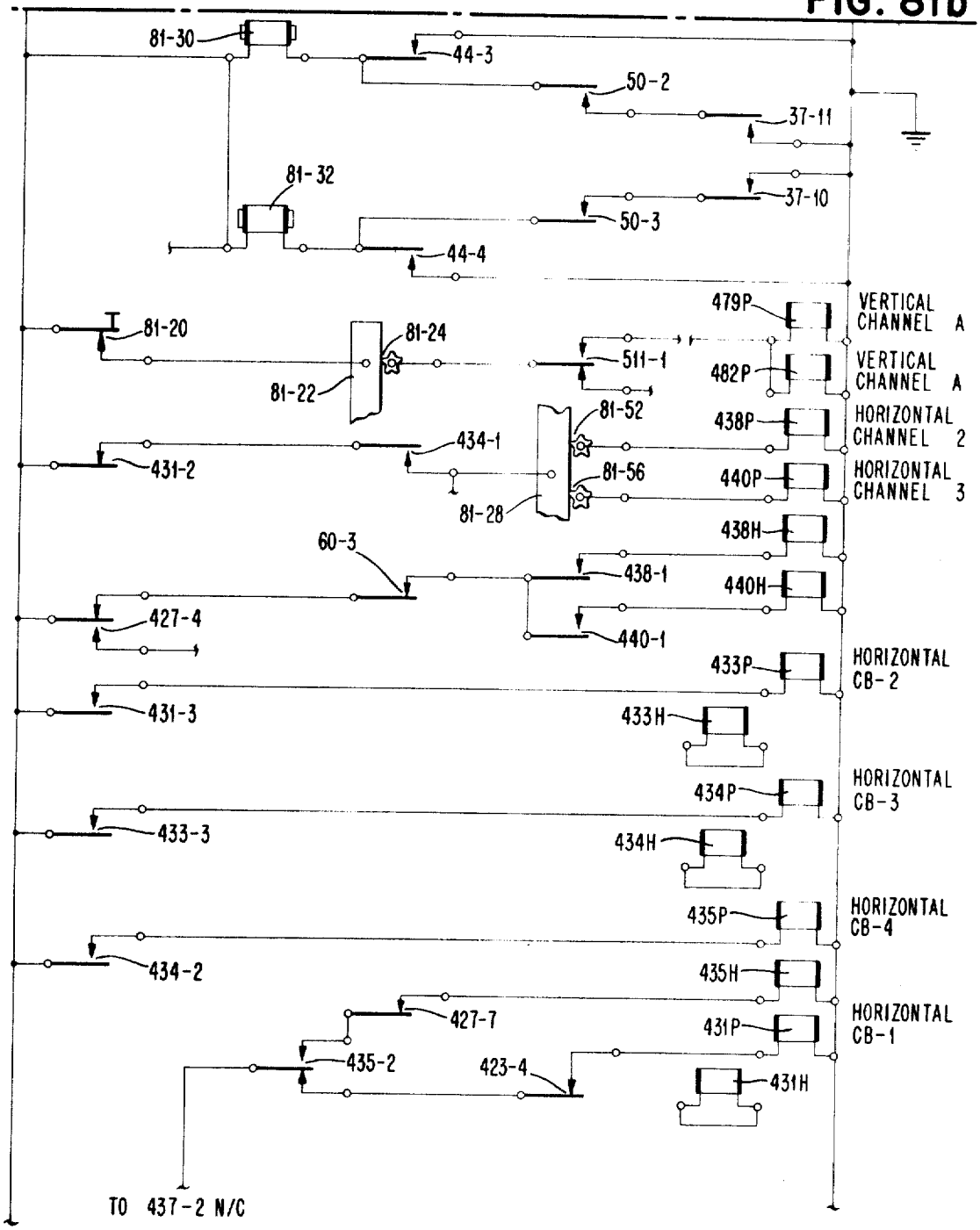

81-30
44-3
50-2
37-11
81-32
37-10
50-3
44-4
479P
VERTICAL CHANNEL A
81-20
81-24
511-1
482P
VERTICAL CHANNEL A
81-22
81-52
438P
HORIZONTAL CHANNEL 2
434-1
431-2
81-56
440P
HORIZONTAL CHANNEL 3
81-28
438H
60-3
438-1
440H
427-4
440-1
433P
HORIZONTAL CB-2
431-3
433H
434P
HORIZONTAL CB-3
433-3
434H
435P
HORIZONTAL CB-4
434-2
435H
427-7
431P
HORIZONTAL CB-1
435-2
423-4
431H
TO 437-2 N/C

FIG. 82

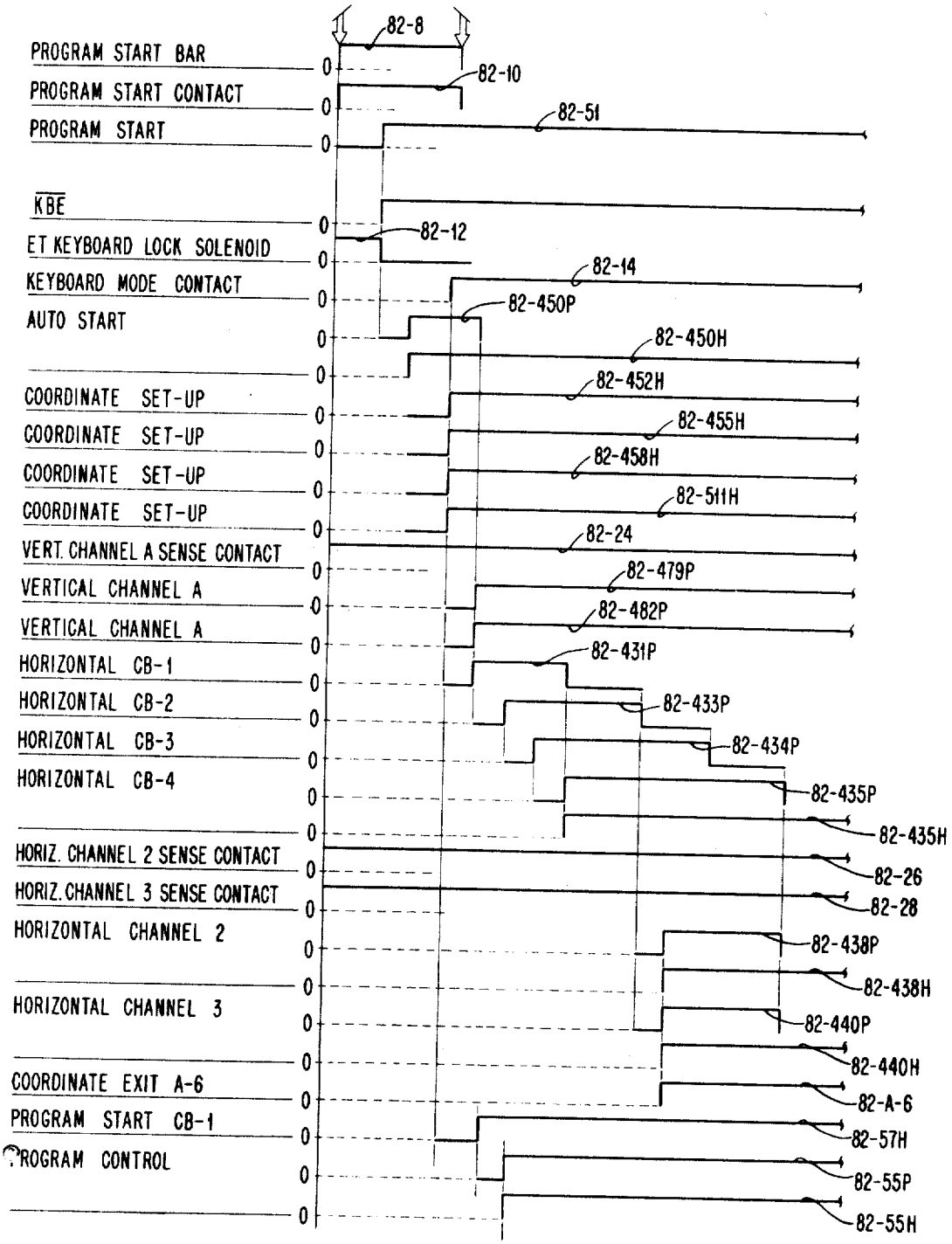

82-8
PROGRAM START BAR
82-10
PROGRAM START CONTACT
82-51
PROGRAM START
KBE
82-12
ET KEYBOARD LOCK SOLENOID
82-14
KEYBOARD MODE CONTACT
82-450P
AUTO START
82-450H
82-452H
COORDINATE SET-UP
82-455H
COORDINATE SET-UP
82-458H
COORDINATE SET-UP
82-511H
COORDINATE SET-UP
82-24
VERT. CHANNEL A SENSE CONTACT
82-479P
VERTICAL CHANNEL A
82-482P
VERTICAL CHANNEL A
82-431P
HORIZONTAL CB-1
82-433P
HORIZONTAL CB-2
82-434P
HORIZONTAL CB-3
82-435P
HORIZONTAL CB-4
82-435H
82-26
HORIZ. CHANNEL 2 SENSE CONTACT
82-28
HORIZ. CHANNEL 3 SENSE CONTACT
82-438P
HORIZONTAL CHANNEL 2
82-438H
82-440P
HORIZONTAL CHANNEL 3
82-440H
82-A-6
COORDINATE EXIT A-6
82-57H
PROGRAM START CB-1
82-55P
PROGRAM CONTROL
82-55H

FIG. 83

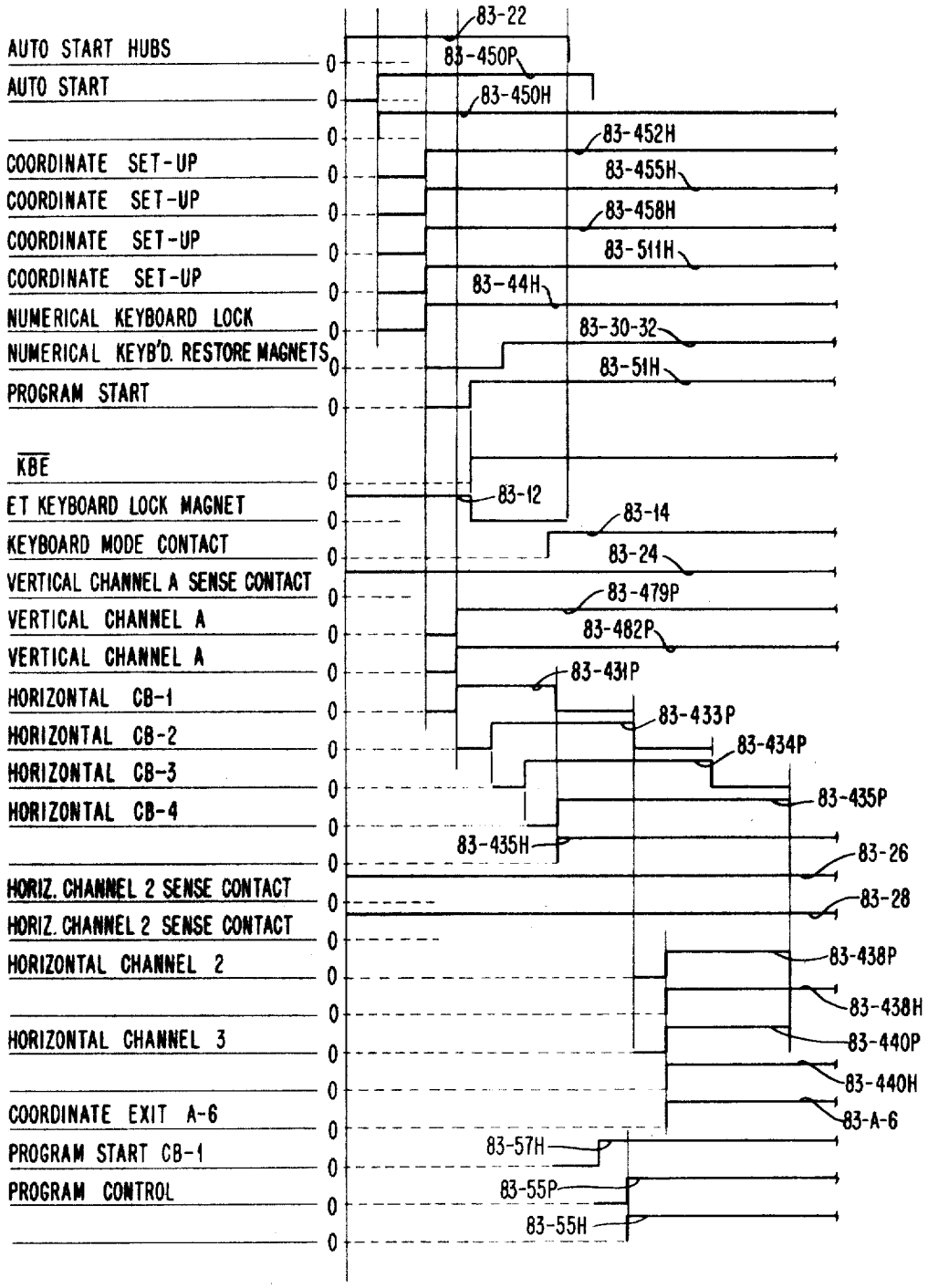
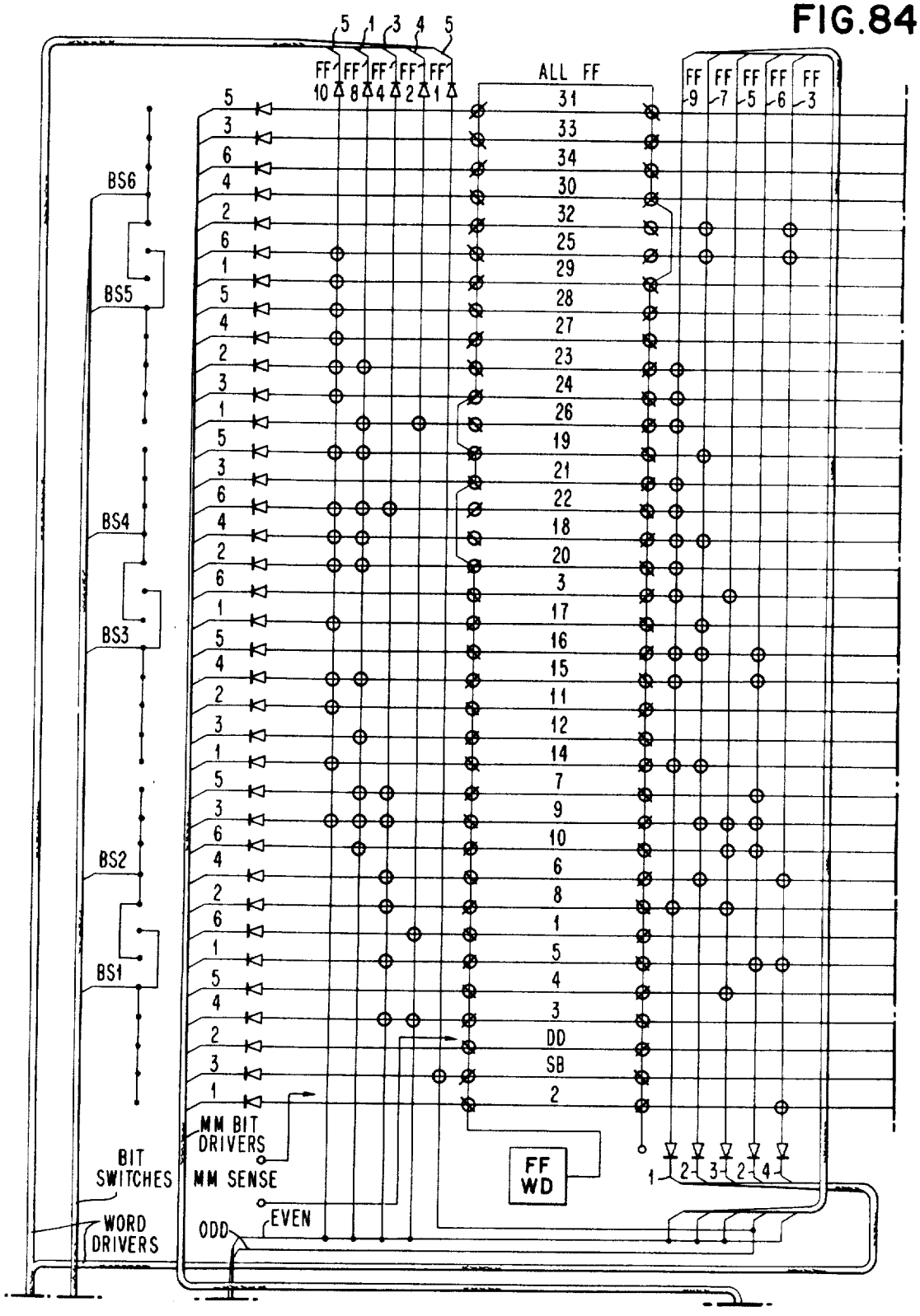

AUTO START HUBS
AUTO START
COORDINATE SET-UP
COORDINATE SET-UP
COORDINATE SET-UP
COORDINATE SET-UP
NUMERICAL KEYBOARD LOCK
NUMERICAL KEYB'D. RESTORE MAGNETS
PROGRAM START
KBE
ET KEYBOARD LOCK MAGNET
KEYBOARD MODE CONTACT
VERTICAL CHANNEL A SENSE CONTACT
VERTICAL CHANNEL A
VERTICAL CHANNEL A
HORIZONTAL CB-1
HORIZONTAL CB-2
HORIZONTAL CB-3
HORIZONTAL CB-4
HORIZ. CHANNEL 2 SENSE CONTACT
HORIZ. CHANNEL 2 SENSE CONTACT
HORIZONTAL CHANNEL 2
HORIZONTAL CHANNEL 3
COORDINATE EXIT A-6
PROGRAM START CB-1
PROGRAM CONTROL
0
83-22
83-450P
83-450H
83-452H
83-455H
83-458H
83-511H
83-44H
83-30-32
83-51H
83-12
83-14
83-24
83-479P
83-482P
83-431P
83-433P
83-434P
83-435P
83-435H
83-26
83-28
83-438P
83-438H
83-440P
83-440H
83-A-6
83-57H
83-55P
83-55H

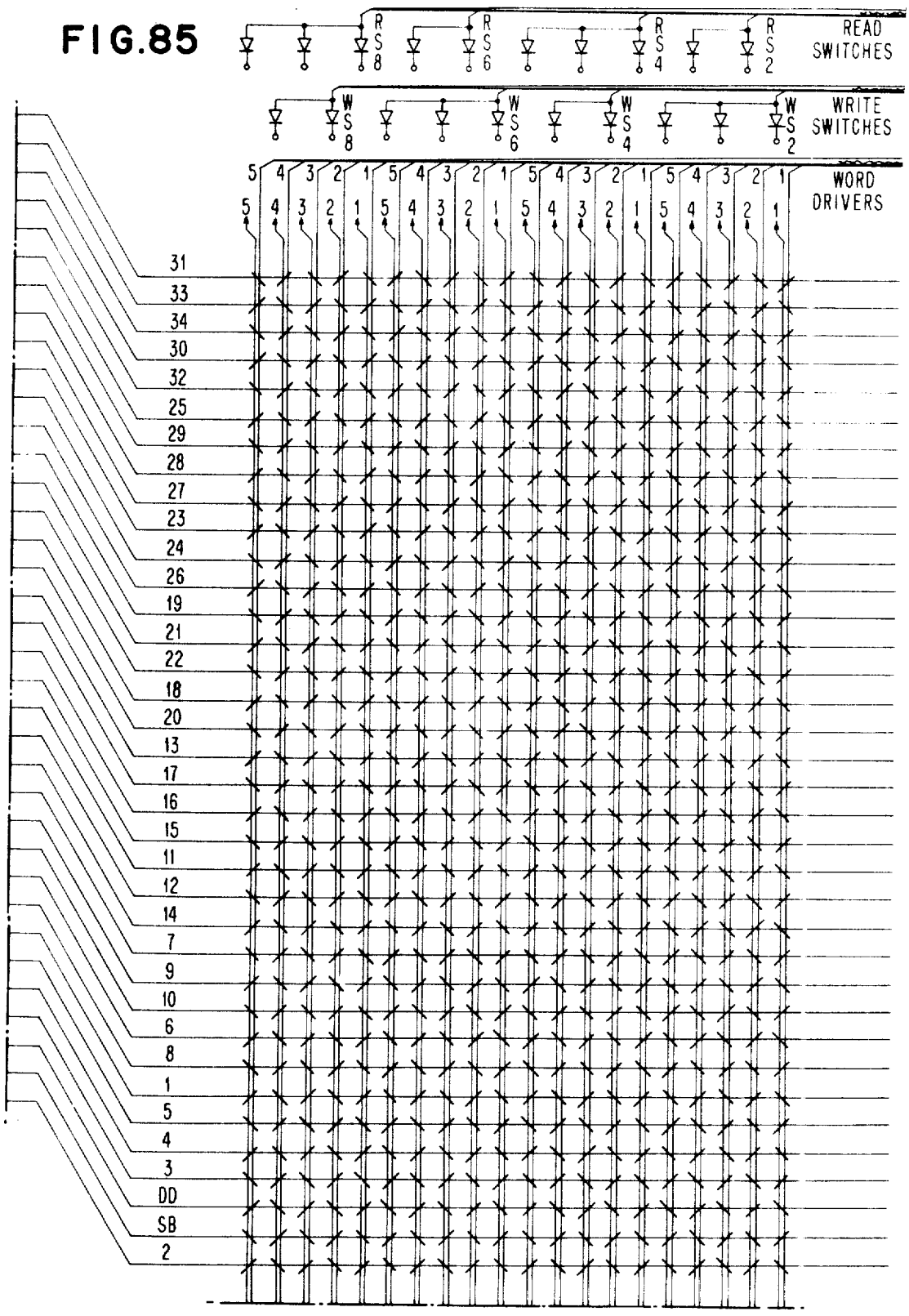
FIG.84


5 1 3 4 5
FF FF FF FF FF
10 8 4 2 1
ALL FF
FF FF FF FF FF
9 7 5 6 3
BS6
BS5
BS4
BS3
BS2
BS1
31
33
34
30
32
25
29
28
27
23
24
26
19
21
22
18
20
3
17
16
15
11
12
14
7
9
10
6
8
1
5
4
3
DD
SB
2
MM BIT DRIVERS
MM SENSE
BIT SWITCHES
WORD DRIVERS
ODD
EVEN
FF WD
1 2 3 2 4

ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 75

FIG.85



ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 78

FIG. 86

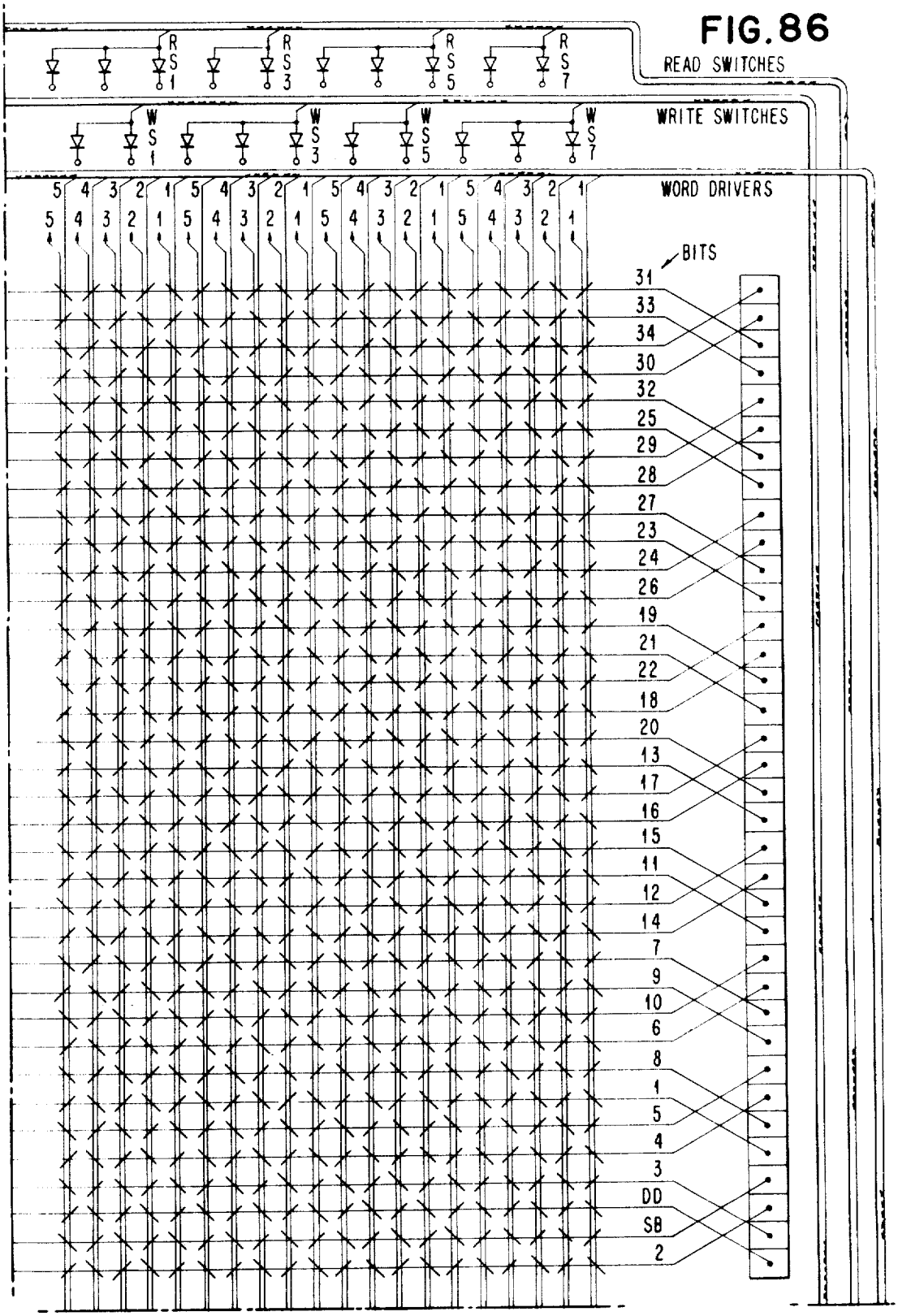


FIG.87

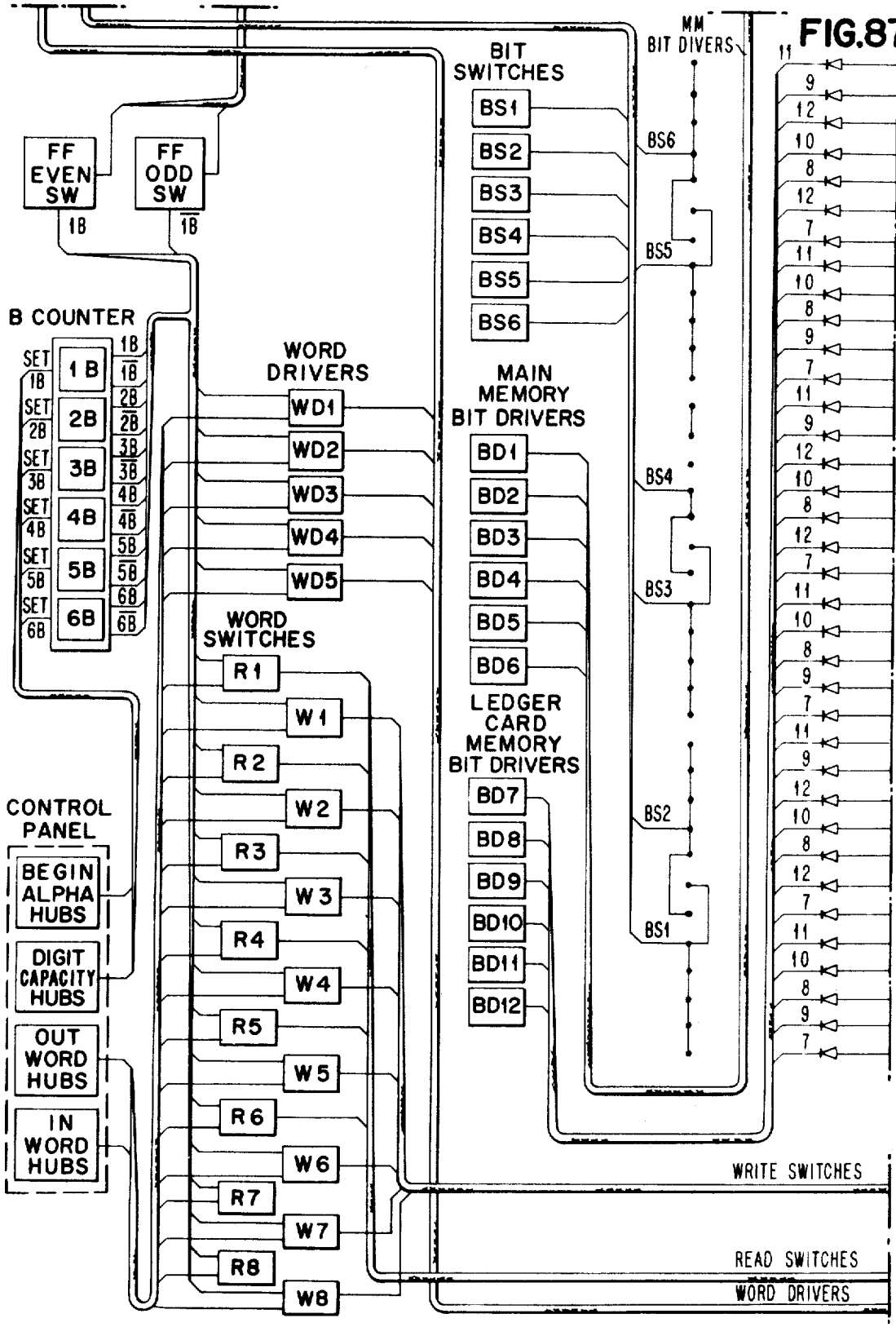

FF EVEN SW
FF ODD SW
1B
1B
B COUNTER
SET 1B
1 B
SET 2B
2B
SET 3B
3B
SET 4B
4B
SET 5B
5B
SET 6B
6B
WORD DRIVERS
WD1
WD2
WD3
WD4
WD5
WORD SWITCHES
R1
W1
R2
W2
R3
W3
R4
W4
R5
W5
R6
W6
R7
W7
R8
W8
CONTROL PANEL
BEGIN ALPHA HUBS
DIGIT CAPACITY HUBS
OUT WORD HUBS
IN WORD HUBS
BIT SWITCHES
BS1
BS2
BS3
BS4
BS5
BS6
MAIN MEMORY BIT DRIVERS
BD1
BD2
BD3
BD4
BD5
BD6
LEDGER CARD MEMORY BIT DRIVERS
BD7
BD8
BD9
BD10
BD11
BD12
MM BIT DIVERS
BS6
BS5
BS4
BS3
BS2
BS1
WRITE SWITCHES
READ SWITCHES
WORD DRIVERS

FIG.88

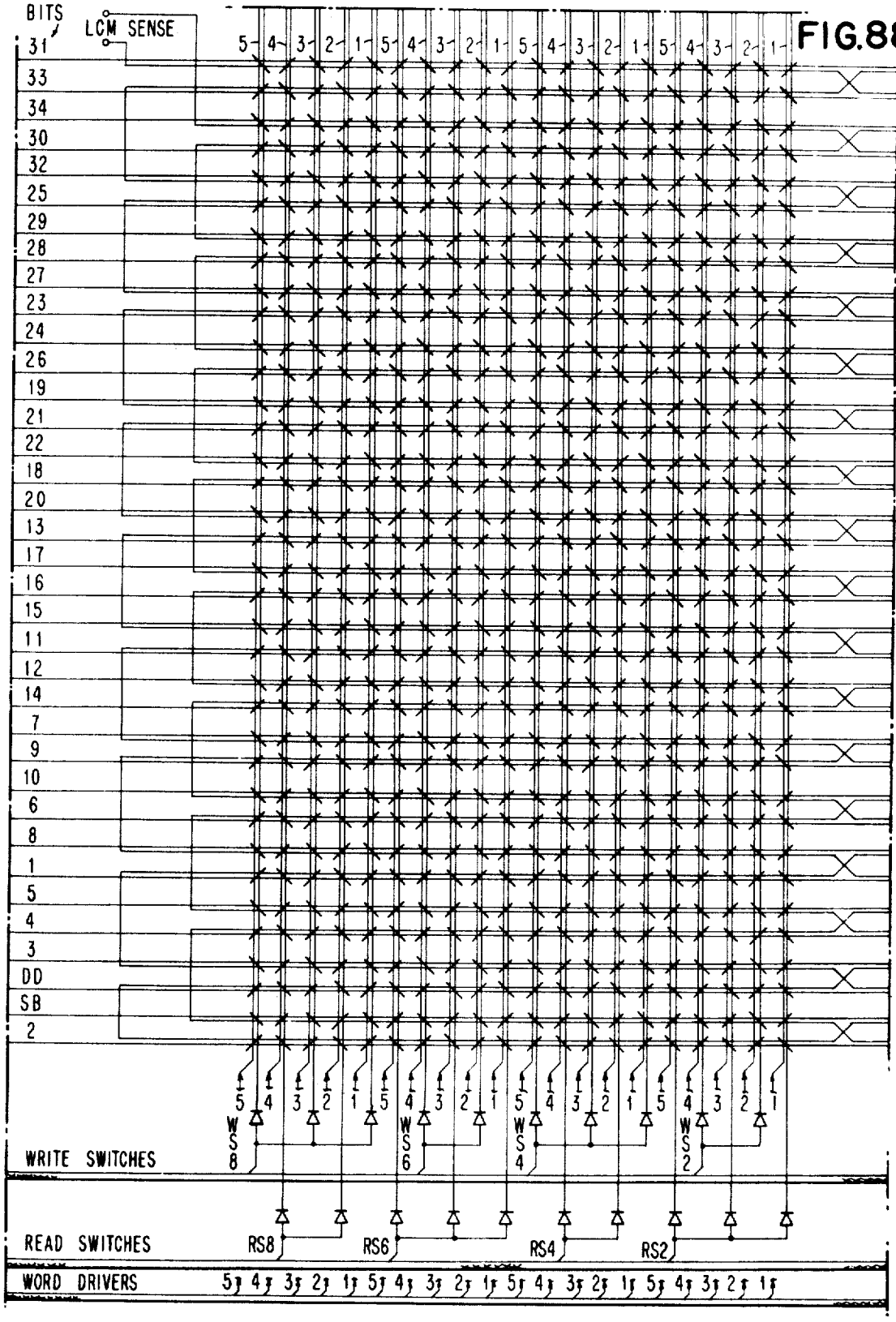

BITS
LCM SENSE
31
33
34
30
32
25
29
28
27
23
24
26
19
21
22
18
20
13
17
16
15
11
12
14
7
9
10
6
8
1
5
4
3
DD
SB
2
WRITE SWITCHES
READ SWITCHES
WORD DRIVERS
WS8
WS6
WS4
WS2
RS8
RS6
RS4
RS2

FIG.89

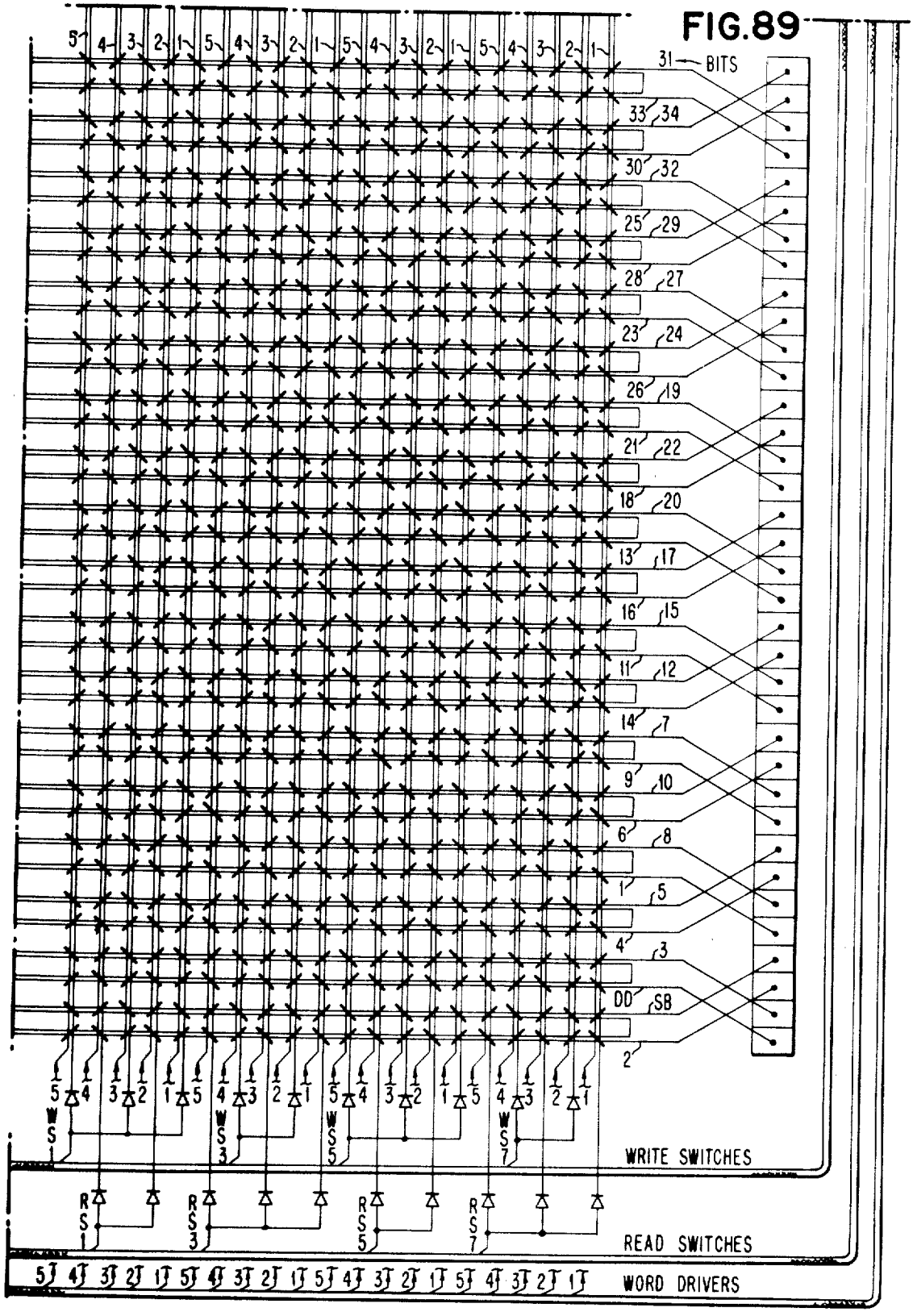

31 BITS
33 34
30 32
25 29
28 27
23 24
26 19
21 22
18 20
13 17
16 15
11 12
14 7
9 10
6 8
1 5
4 3
DD SB
2
WS1
WS3
WS5
WS7
WRITE SWITCHES
RS1
RS3
RS5
RS7
READ SWITCHES
WORD DRIVERS

FIG.84	FIG.85	FIG.86
FIG.87	FIG.88	FIG.89

FIG.90

FIG.91

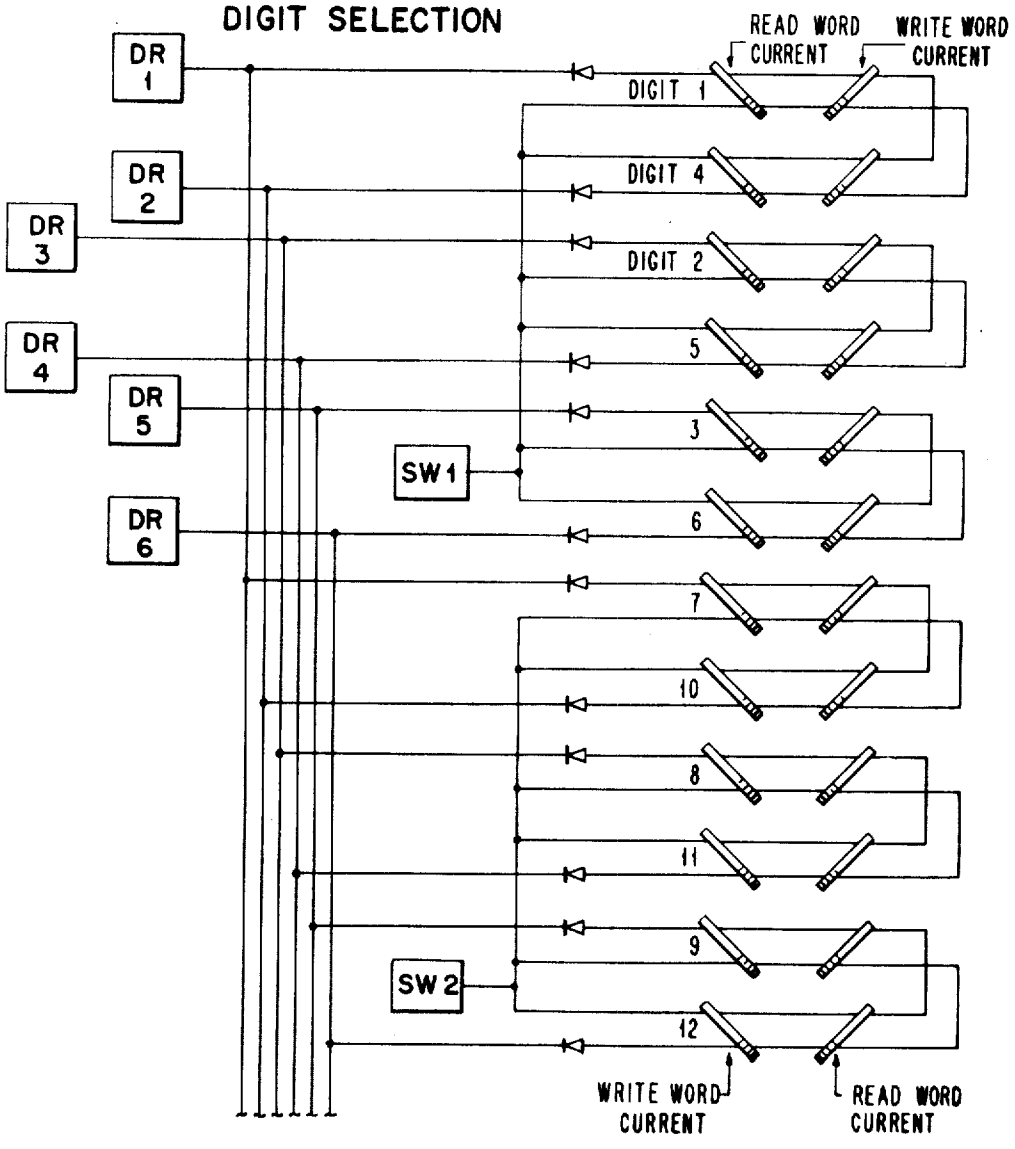
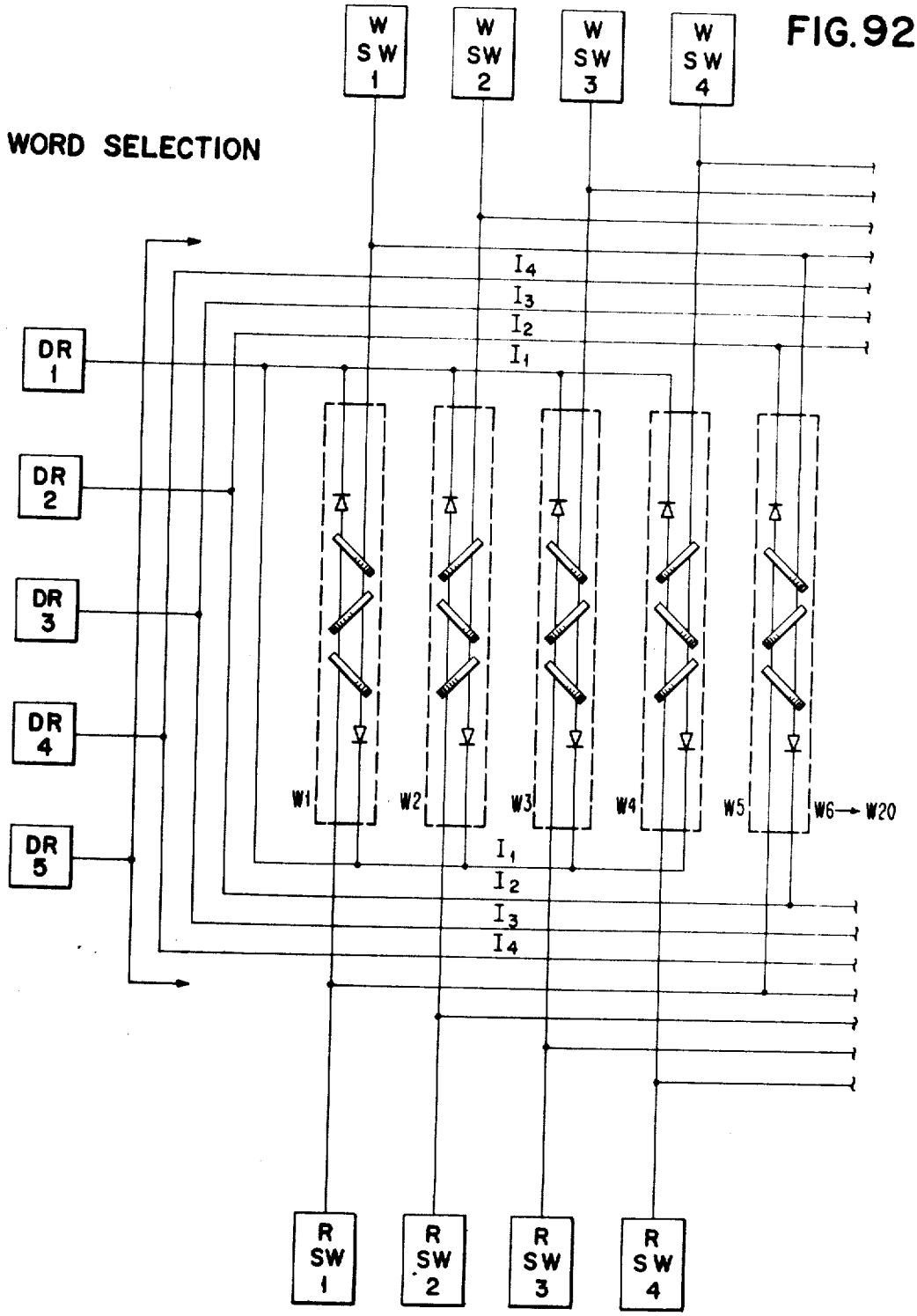


FIG. 92


WORD SELECTION
W SW 1
W SW 2
W SW 3
W SW 4
DR 1
DR 2
DR 3
DR 4
DR 5
I4
I3
I2
I1
W1
W2
W3
W4
W5
W6→W20
R SW 1
R SW 2
R SW 3
R SW 4

START TRIGGER

FIG. 93

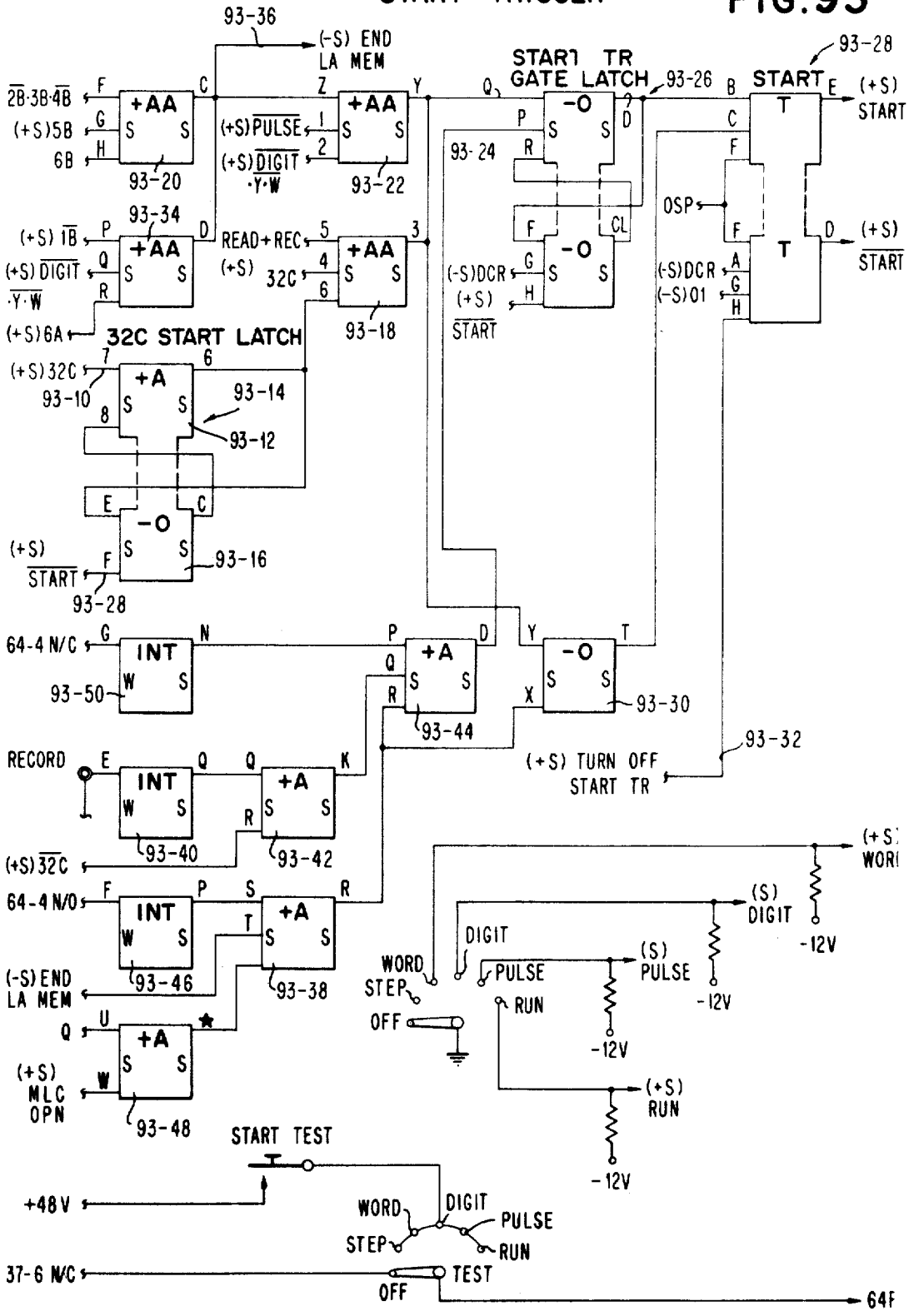
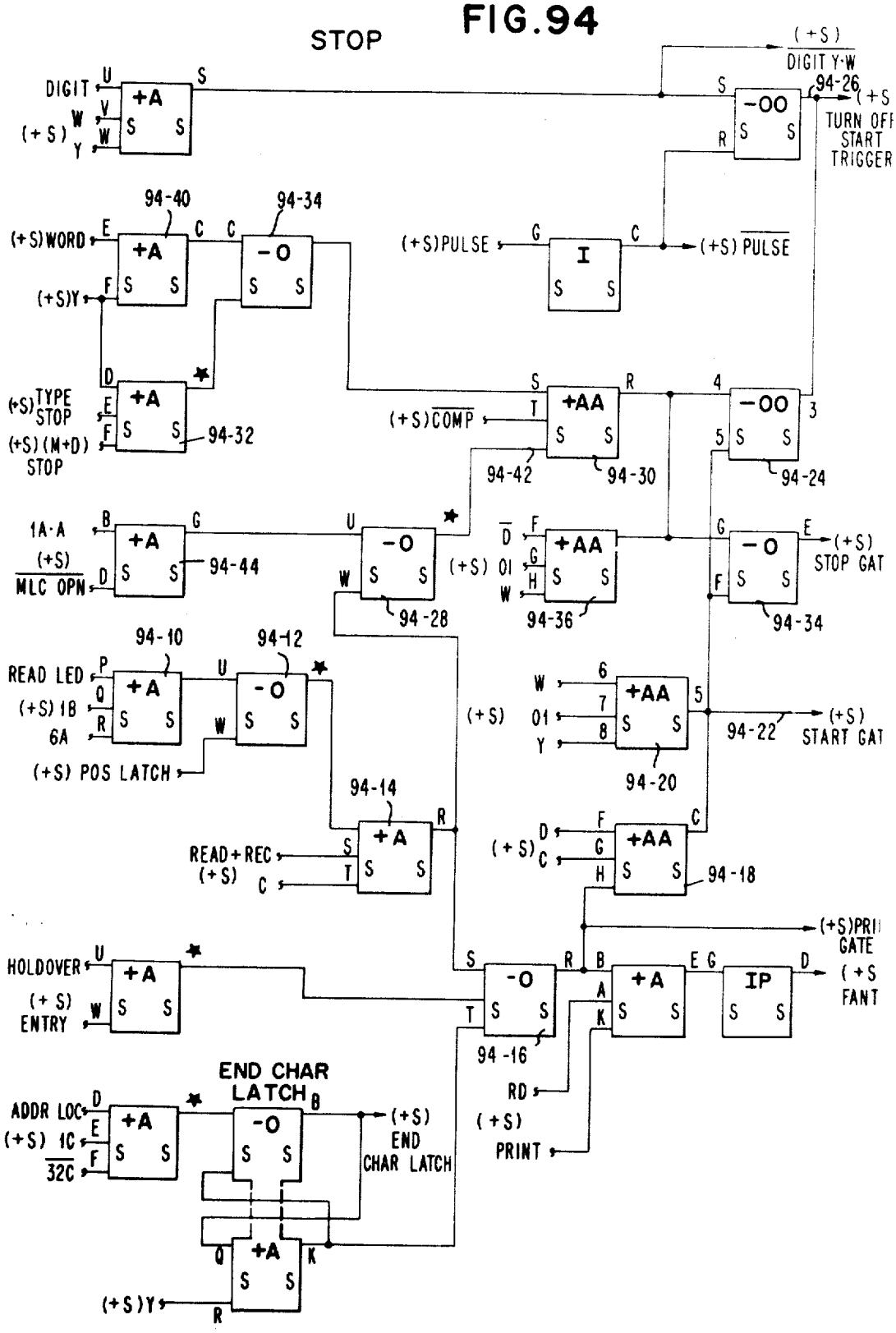
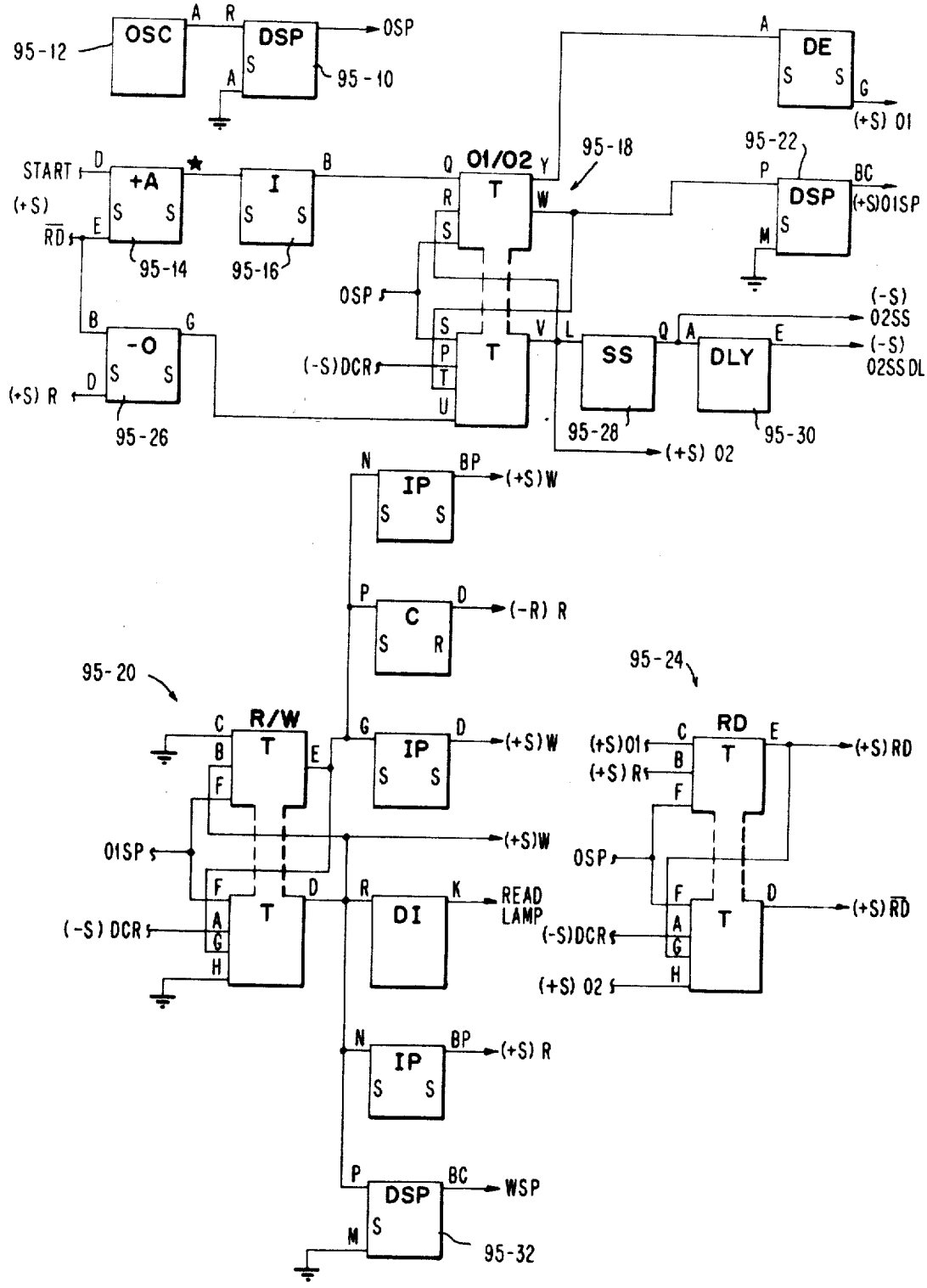


FIG. 94


STOP
DIGIT
(+S)
+A
-OO
(+S) DIGIT Y-W
94-26
TURN OFF START TRIGGER
94-40
94-34
(+S)WORD
(+S)Y
(+S)PULSE
I
(+S) PULSE
(+S)TYPE STOP
(+S)(M+D) STOP
94-32
+AA
(+S)COMP
94-42
94-30
94-24
1A·A
(+S) MLC OPN
94-44
(+S) 01
94-36
94-28
94-34
(+S) STOP GAT
94-10
94-12
READ LED
(+S) 18
6A
(+S) POS LATCH
(+S)
94-22
(+S) START GAT
94-20
94-14
READ+REC
(+S)
94-18
(+S)PRI GATE
HOLDOVER
(+S) ENTRY
IP
(+S) FANT
94-16
RD
(+S)
PRINT
END CHAR LATCH
ADDR LOC
(+S) 1C
32C
(+S) END CHAR LATCH
(+S)Y

01 READ AND READ DELAY

FIG. 95



X/Y ABC

FIG. 96

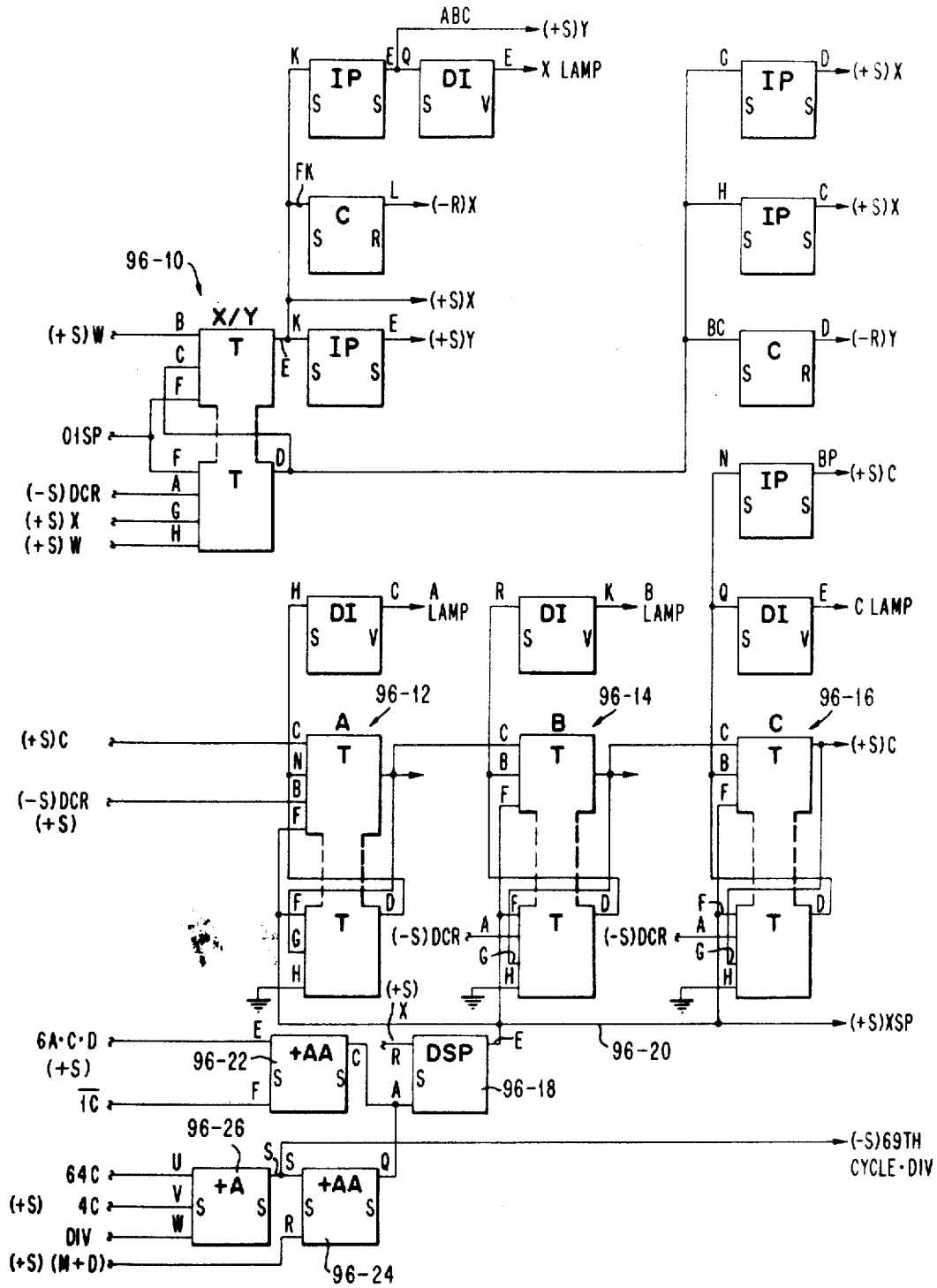
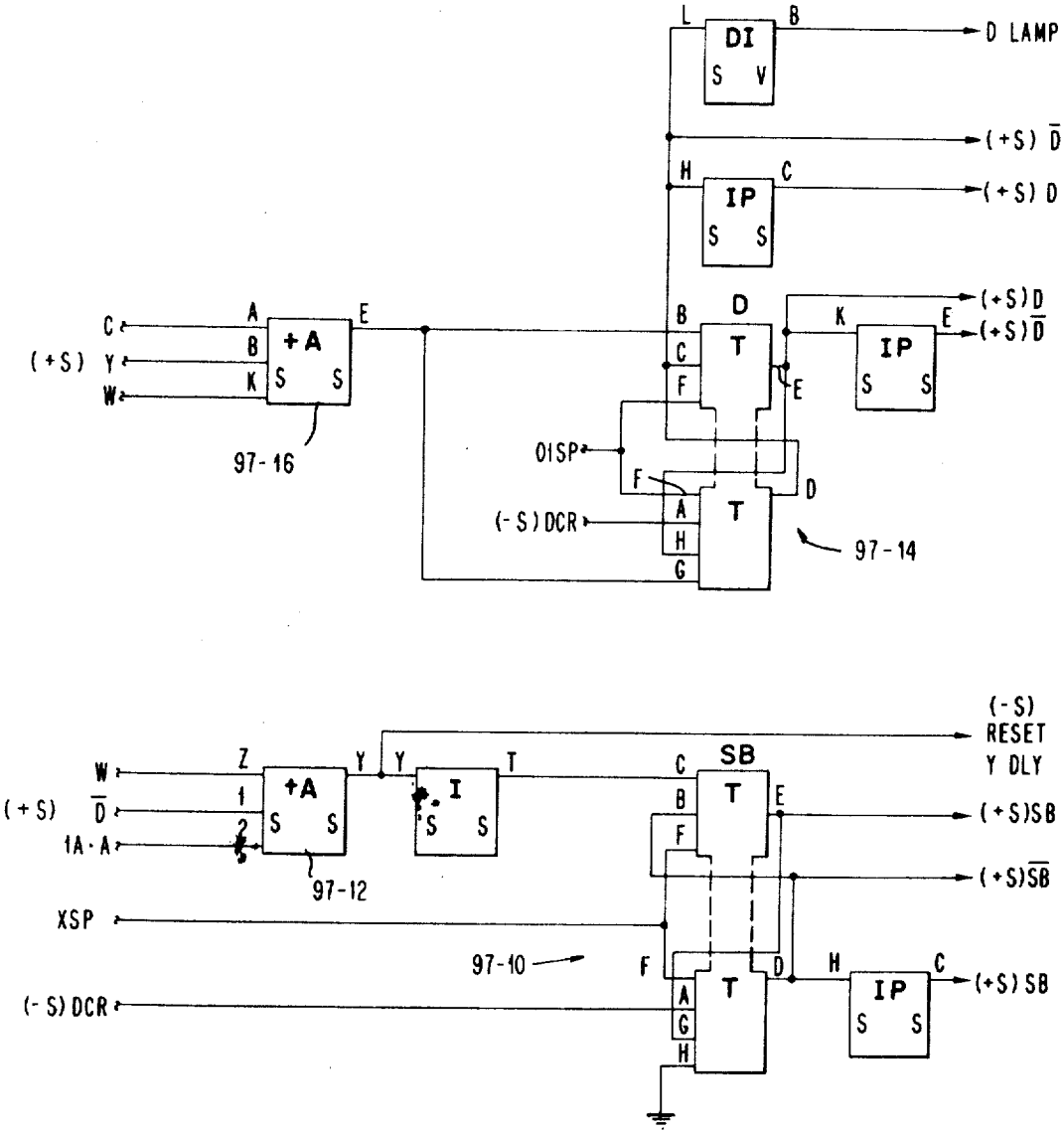

ABC
(+S)Y
IP
DI
X LAMP
(+S)X
(-R)X
C
96-10
X/Y
(+S)W
T
(+S)Y
01SP
(-S)DCR
(+S)X
(+S)W
BP
(+S)C
A LAMP
B LAMP
C LAMP
96-12
96-14
96-16
(-S)DCR (+S)
(-S)DCR
(+S)XSP
6A·C·D (+S)
1C
96-22
+AA
DSP
96-18
96-20
96-26
+A
64C
4C
DIV
(+S) (M+D)
96-24
(-S)69TH CYCLE·DIV

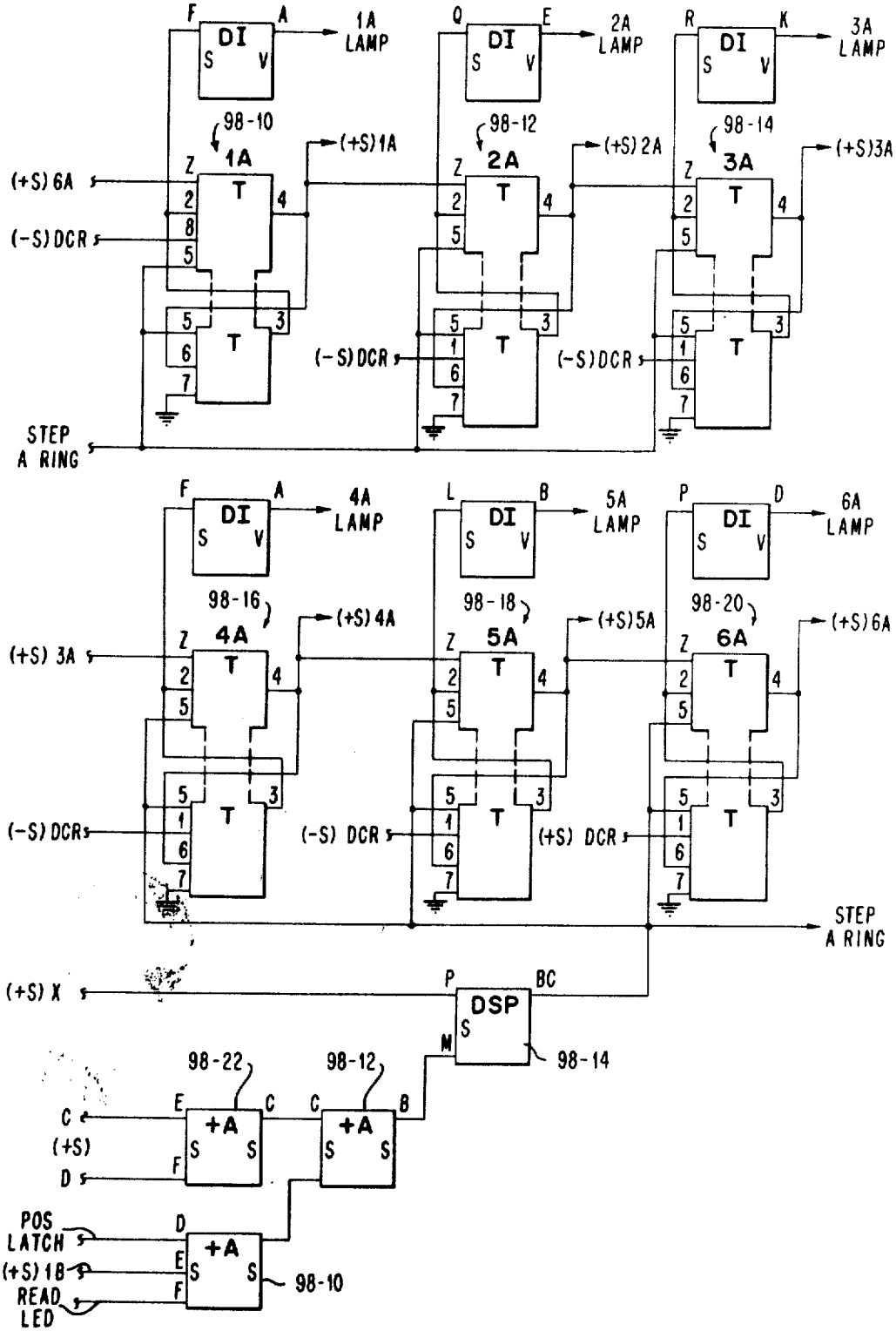
FIG. 97

D, SIGN BIT



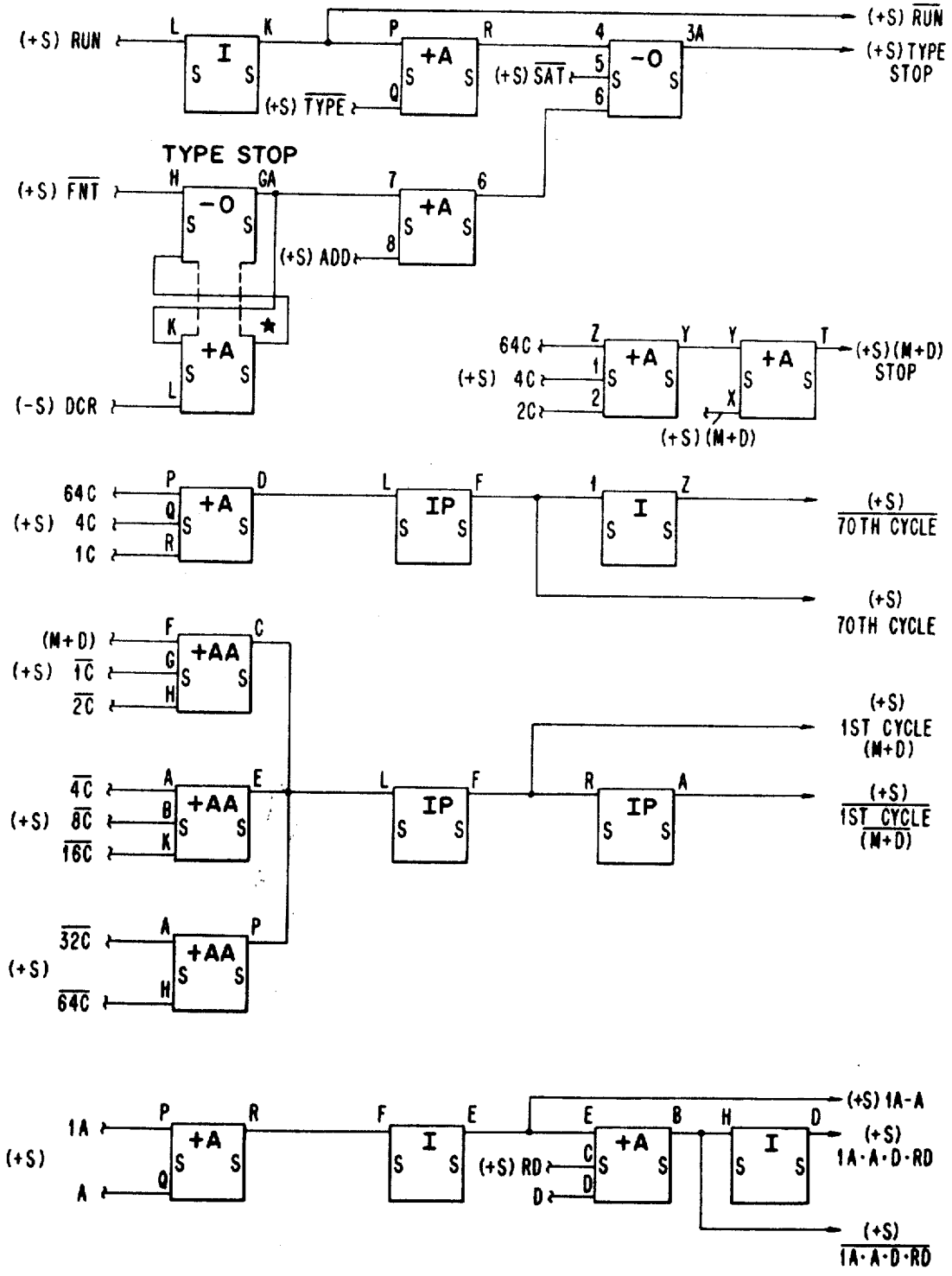
1A – 6A RING

FIG. 98



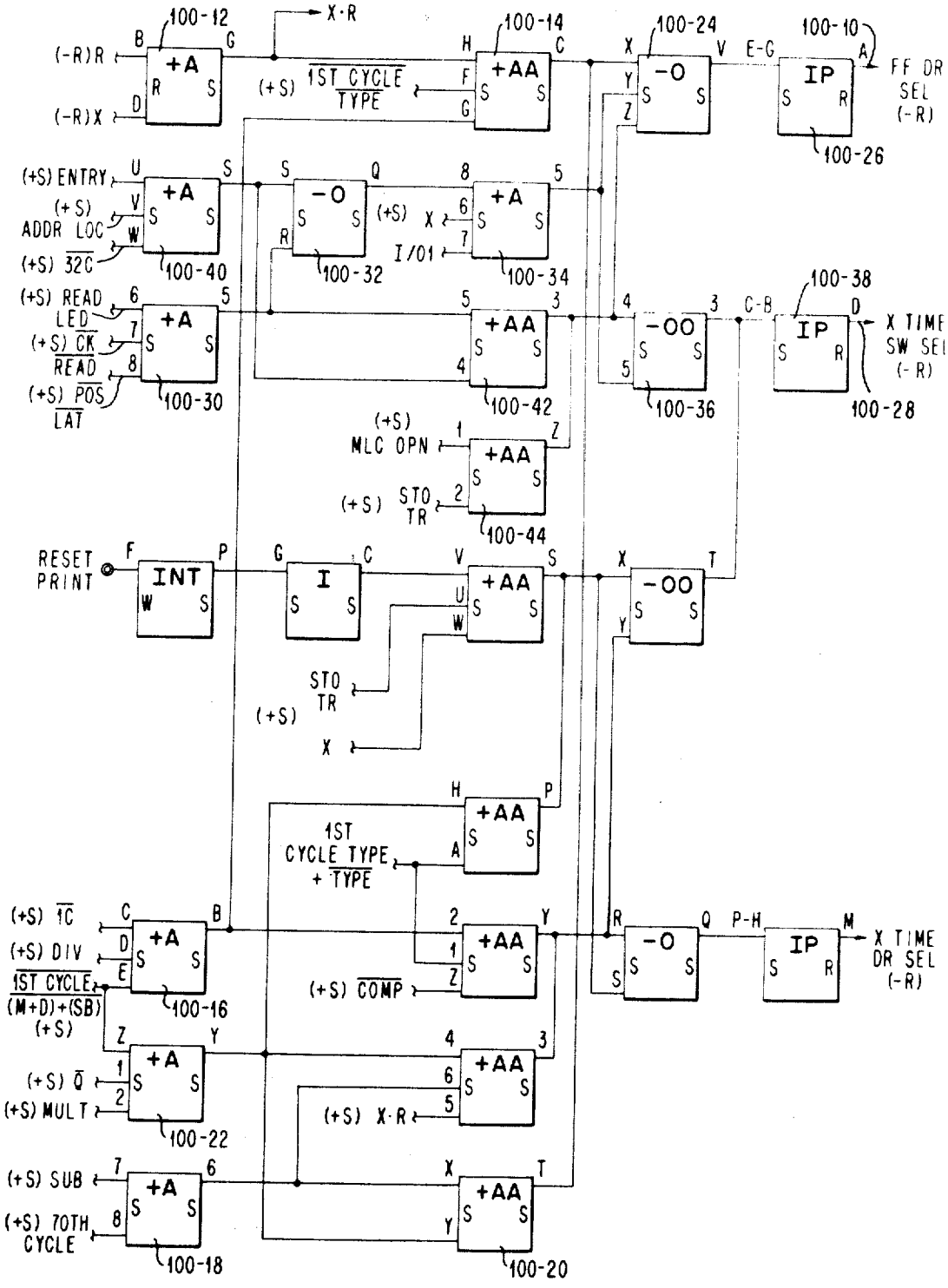
TYPE STOP, MULT OR DIVIDE STOP

FIG. 99



FIXED FACTOR DRIVER SELECT, X TIME SWITCH AND DRIVER SELECT

FIG.100

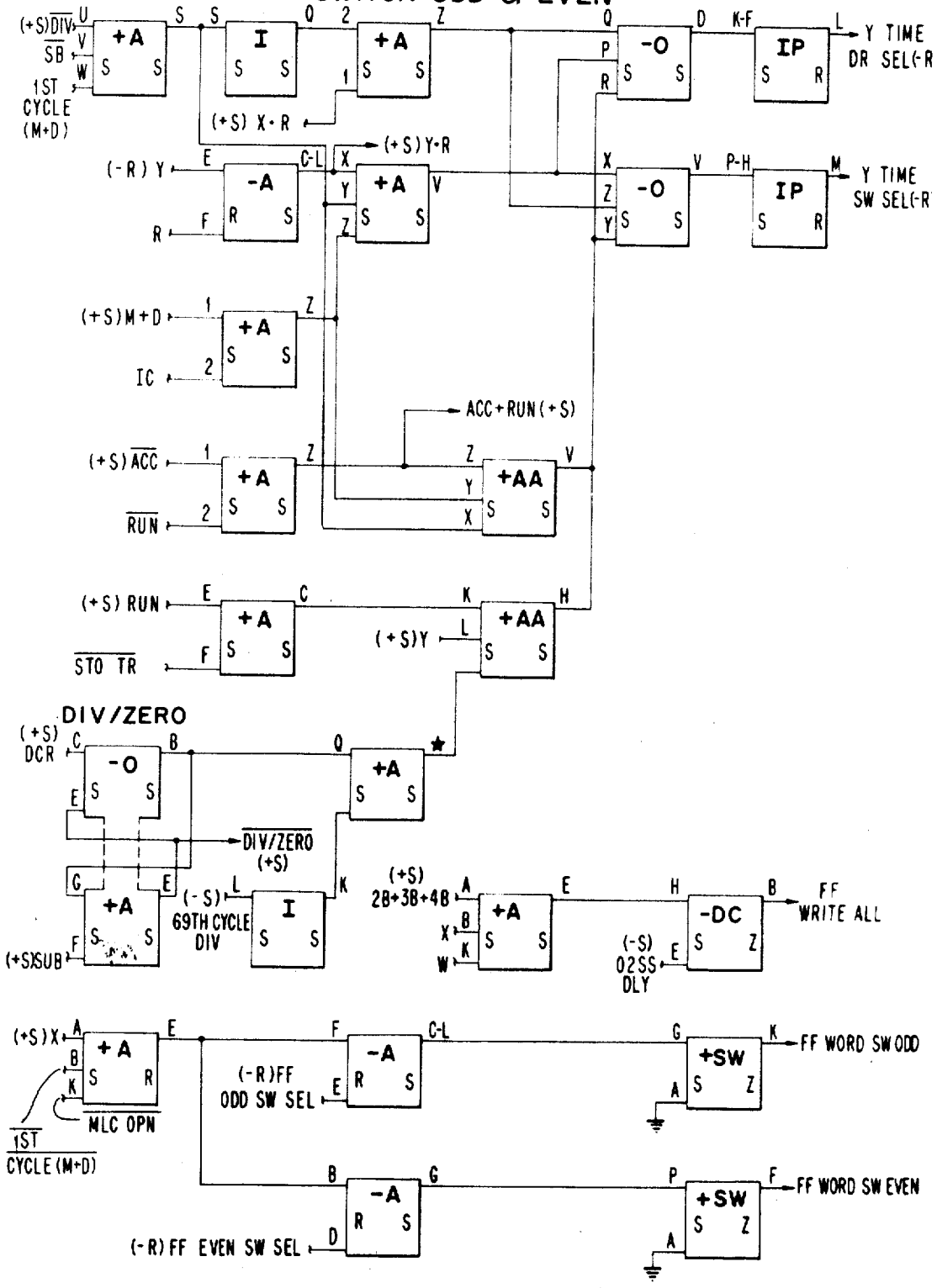


ELECTRONIC COMPUTING BUSINESS MACHINE

Original Filed Dec. 28, 1962 141 Sheets-Sheet 90

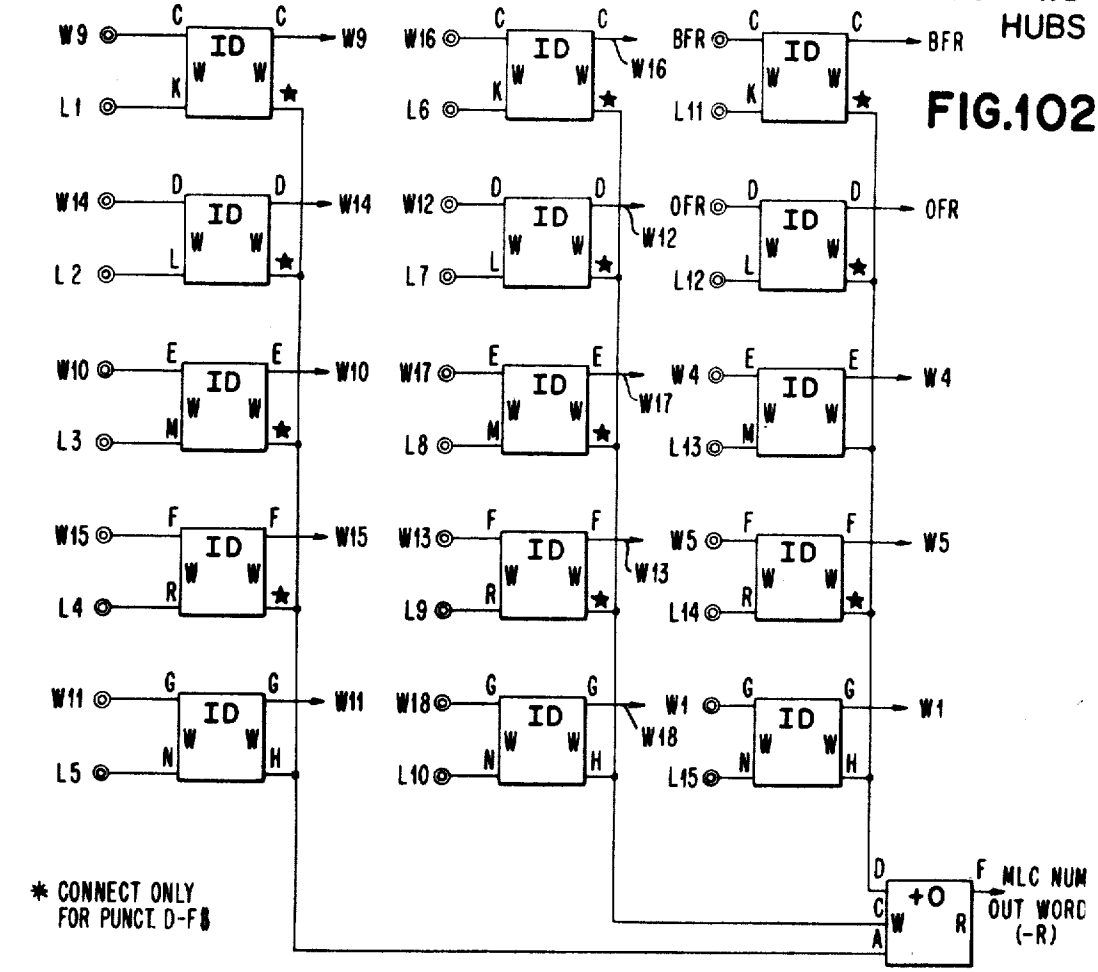
Y TIME DRIVER & SWITCH SELECT FIXED FACTOR WORD SWITCH ODD & EVEN

FIG. 101



NUM & MLC NUM OUT WORD HUBS—OFR SW SEL X GROUP OUT WD HUBS

FIG.102



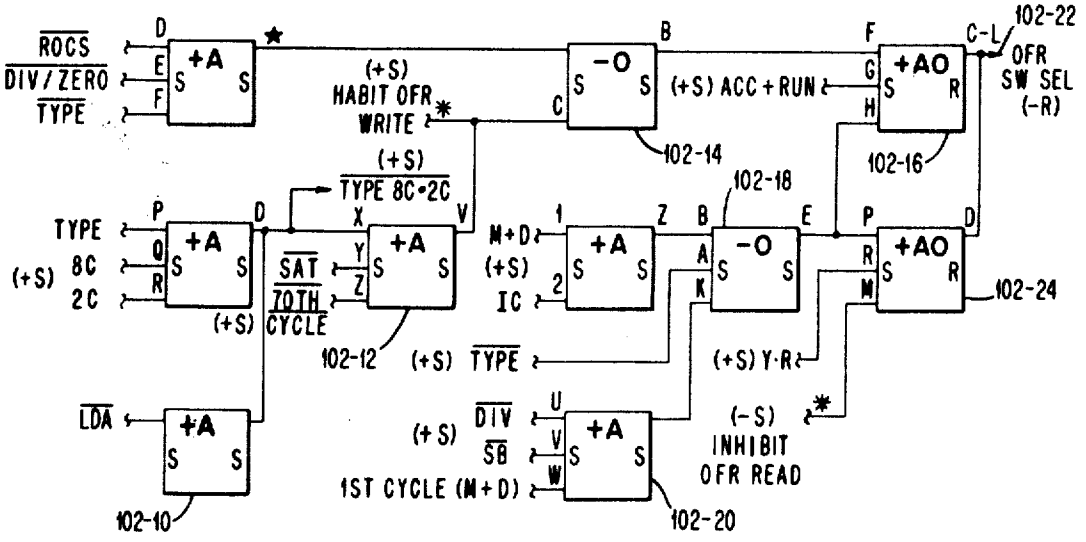
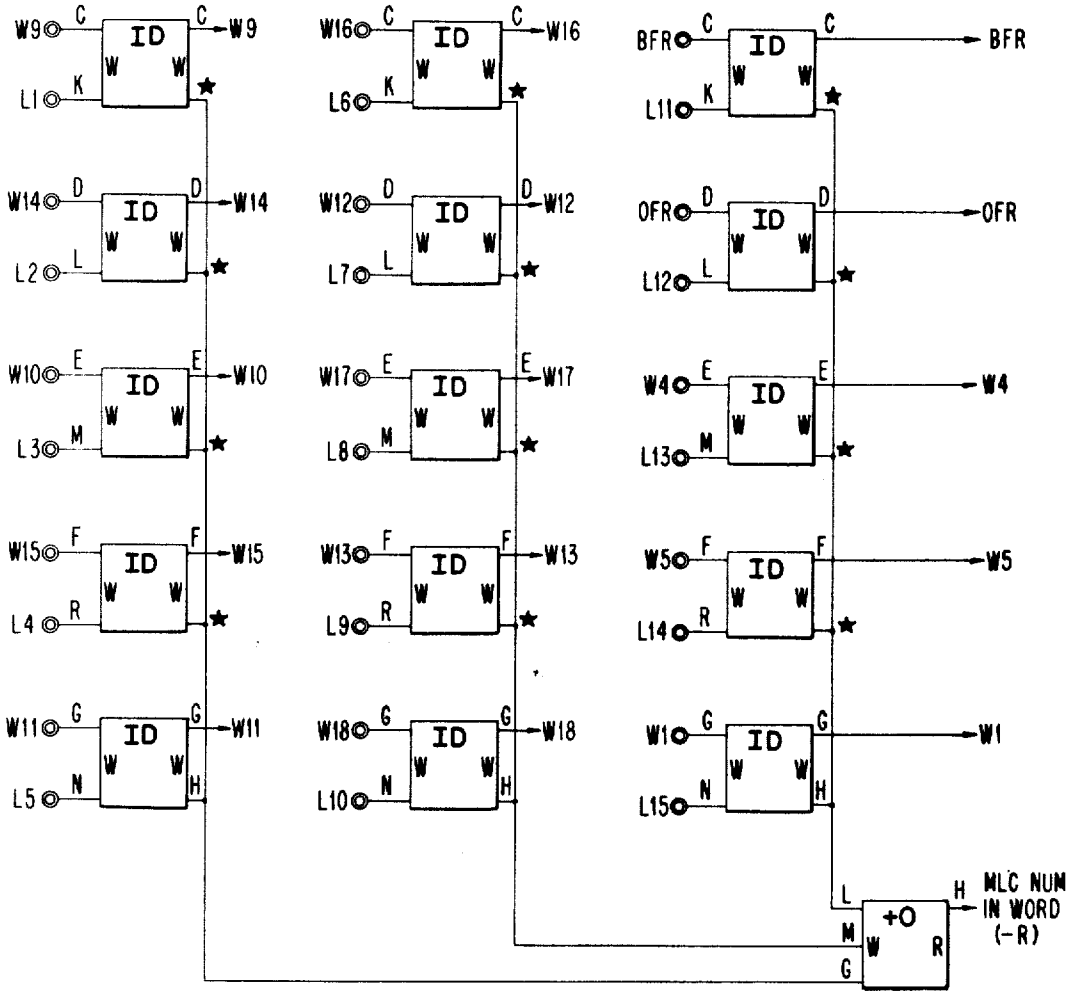


FIG.103

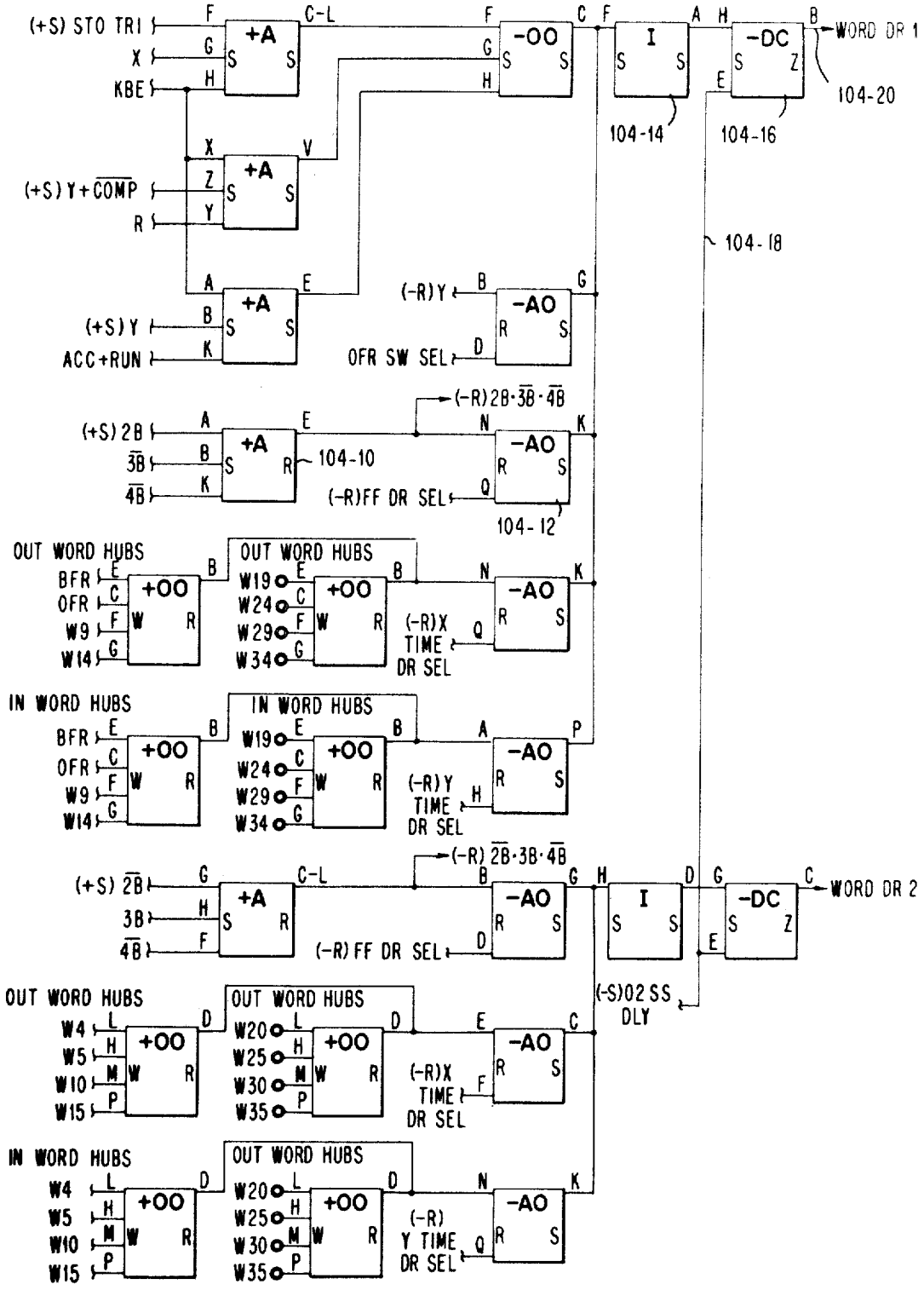
NUM AND MLC NUM IN WORD HUBS

Y GROUP IN WORD HUBS



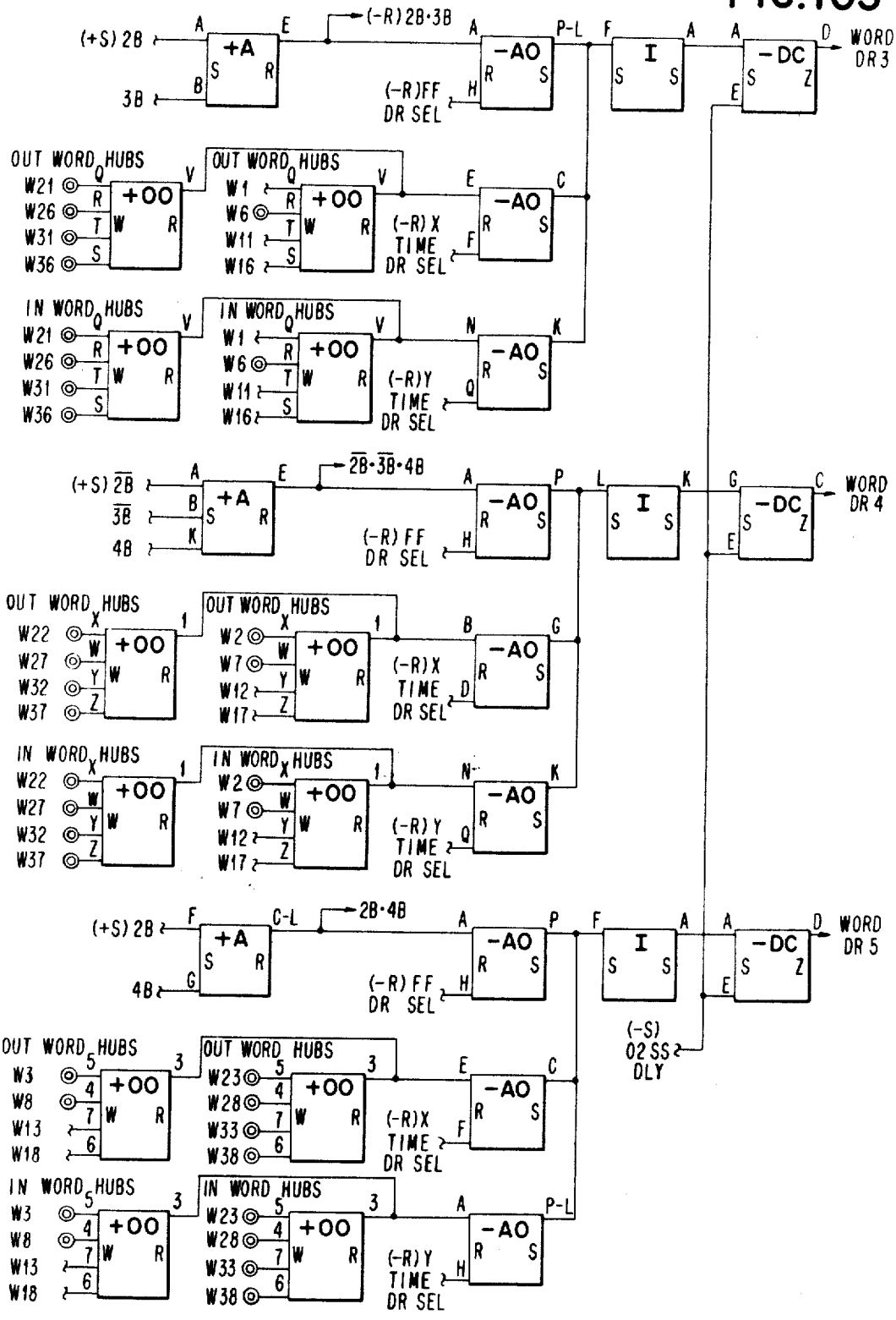
WORD DRIVERS 1 & 2

FIG. 104



WORD DRIVERS 3, 4 & 5

FIG. 105



READ & WRITE SWITCHES 1,2 & 3 FIG.106

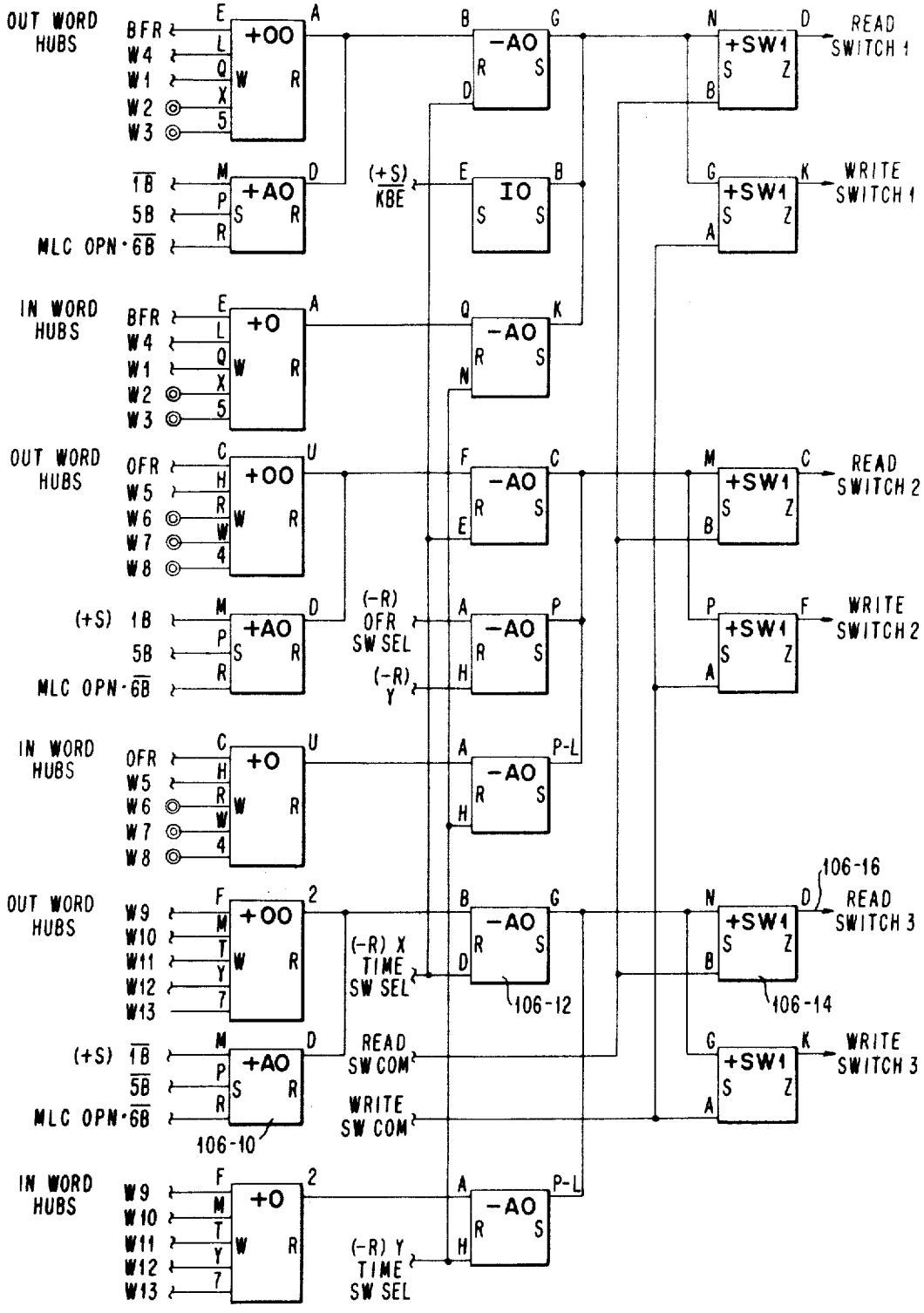
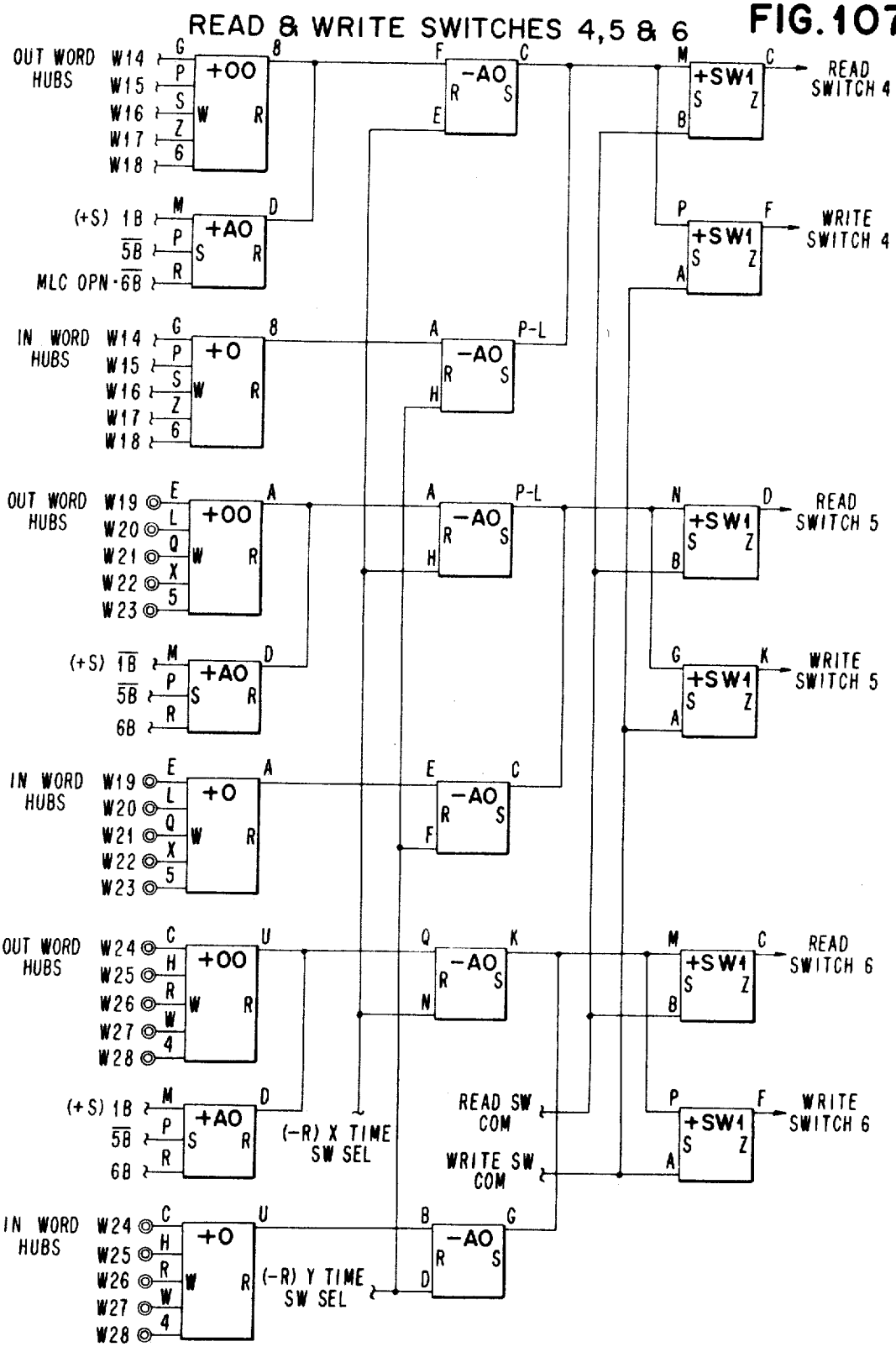
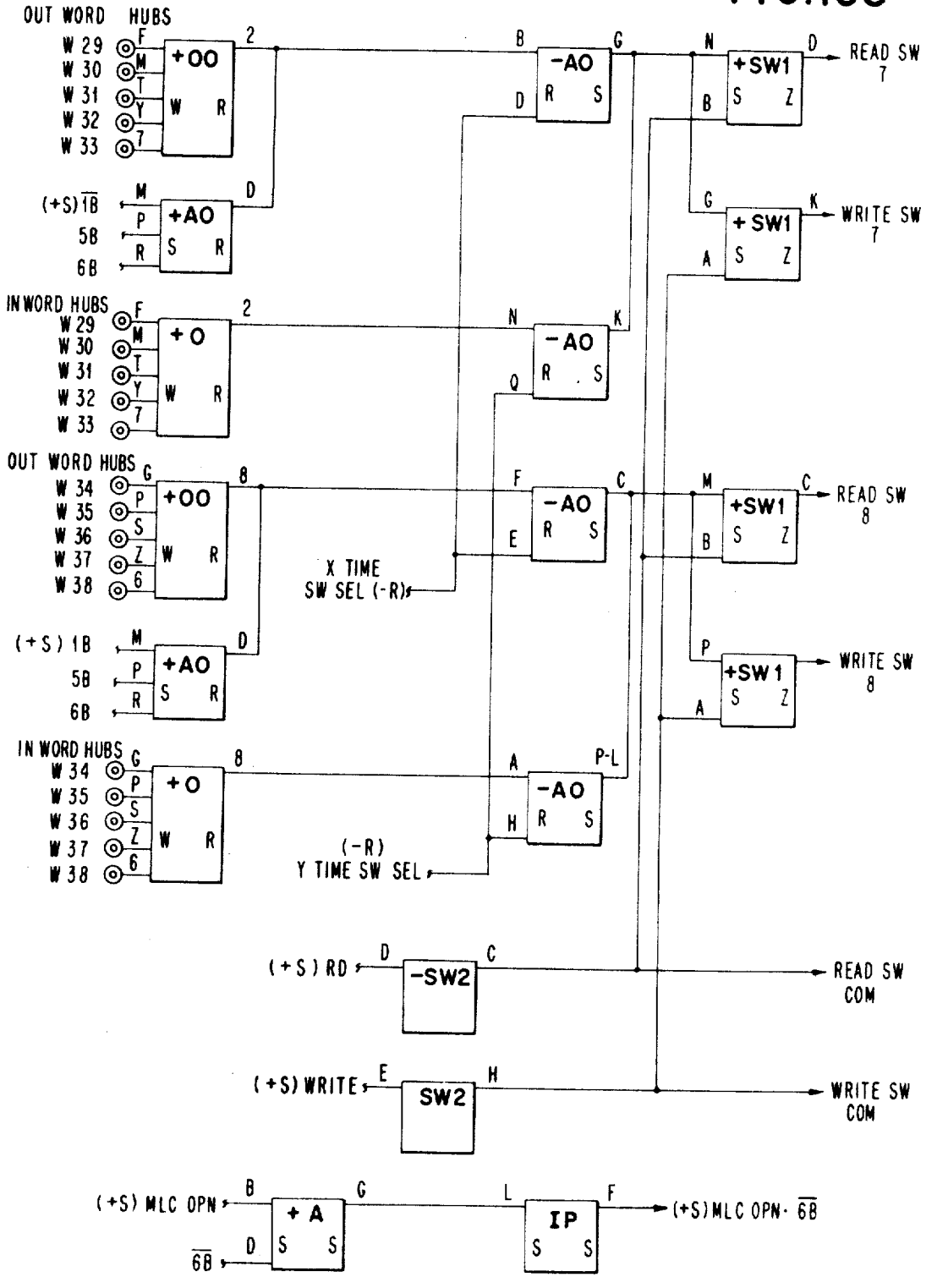


FIG. 107


READ & WRITE SWITCHES 4,5 & 6
OUT WORD HUBS
W14
W15
W16
W17
W18
+OO
(+S) 1B
5B
MLC OPN·6B
+AO
IN WORD HUBS
+O
-AO
+SW1
READ SWITCH 4
WRITE SWITCH 4
OUT WORD HUBS
W19
W20
W21
W22
W23
(+S) 1B
5B
6B
IN WORD HUBS
READ SWITCH 5
WRITE SWITCH 5
OUT WORD HUBS
W24
W25
W26
W27
W28
(+S) 1B
5B
6B
(-R) X TIME SW SEL
READ SW COM
WRITE SW COM
IN WORD HUBS
(-R) Y TIME SW SEL
READ SWITCH 6
WRITE SWITCH 6

READ & WRITE SWITCHES 7 & 8

FIG. 108



BIT DRIVERS & SWITCHES MAIN MEMORY & MAGNETIC LEDGER CARD DRIVERS 1, 2, & 3

FIG.109

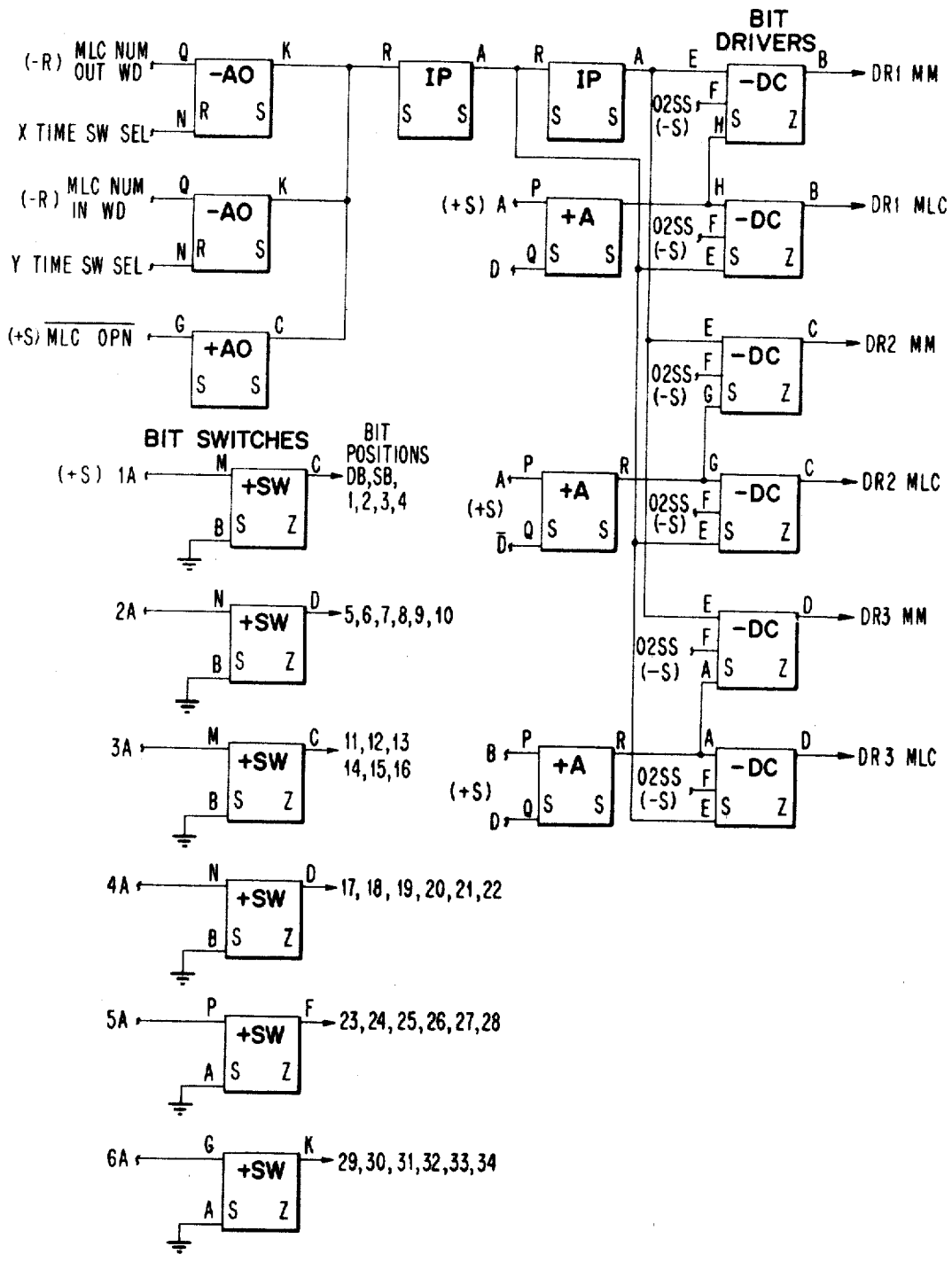
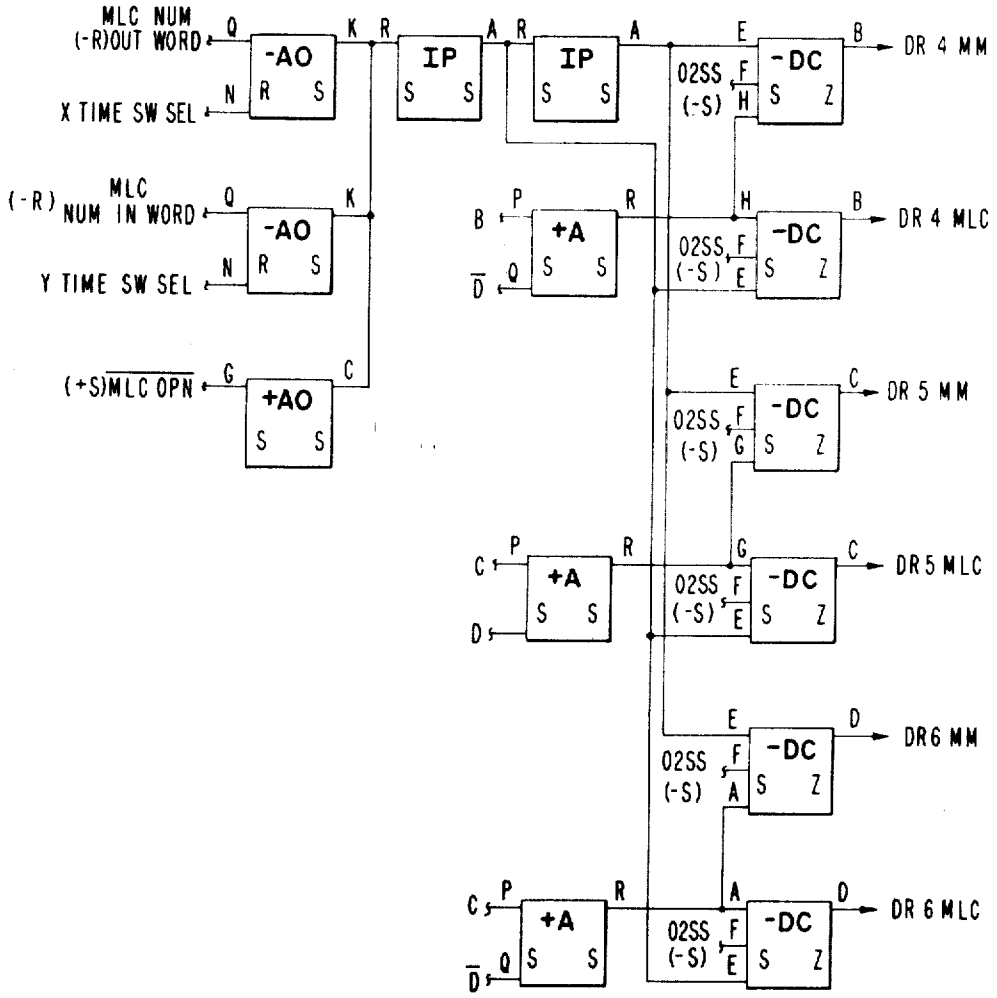
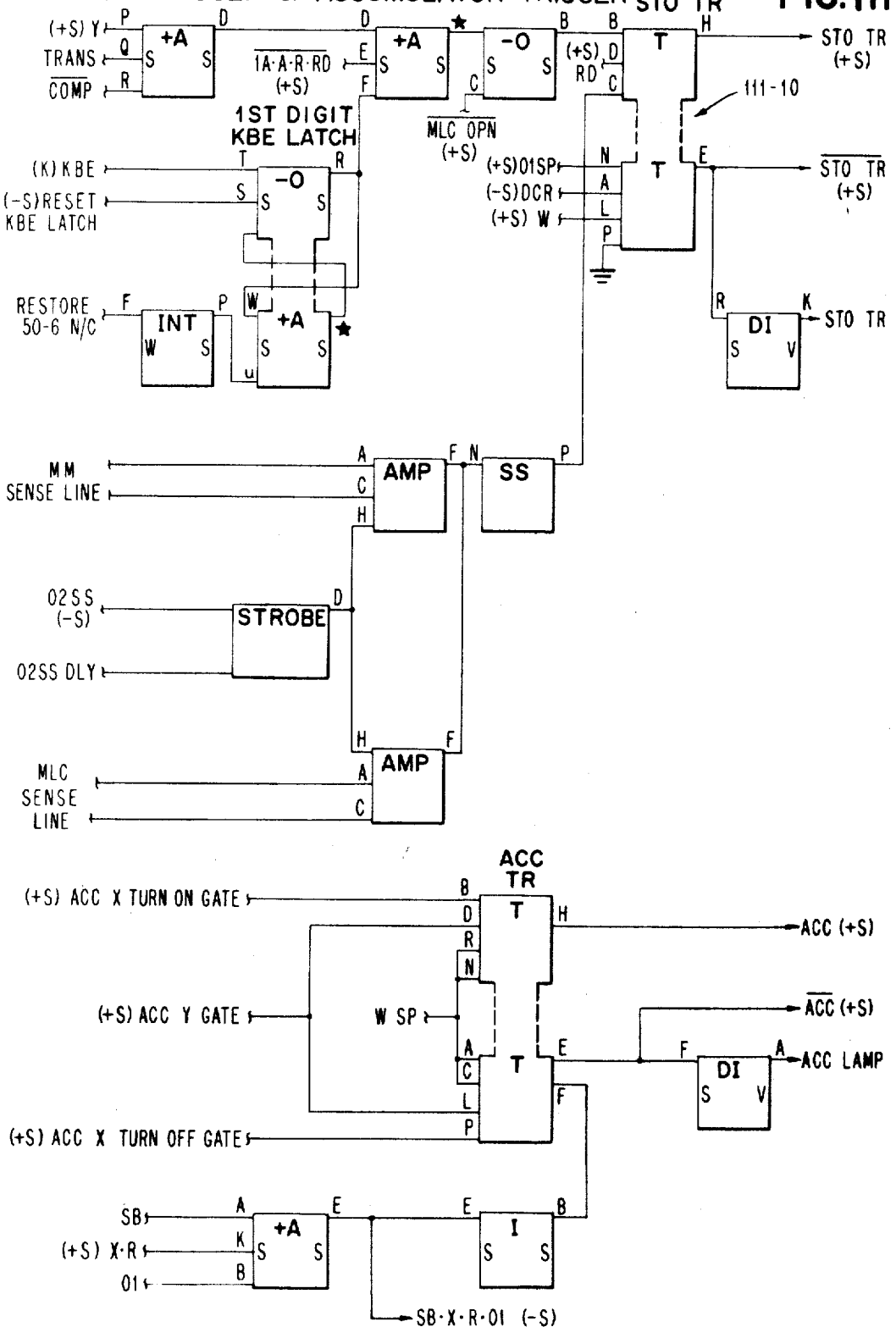


FIG. 110

MAIN MEMORY & MAGNETIC LEDGER
CARD DRIVERS 4,5 & 6

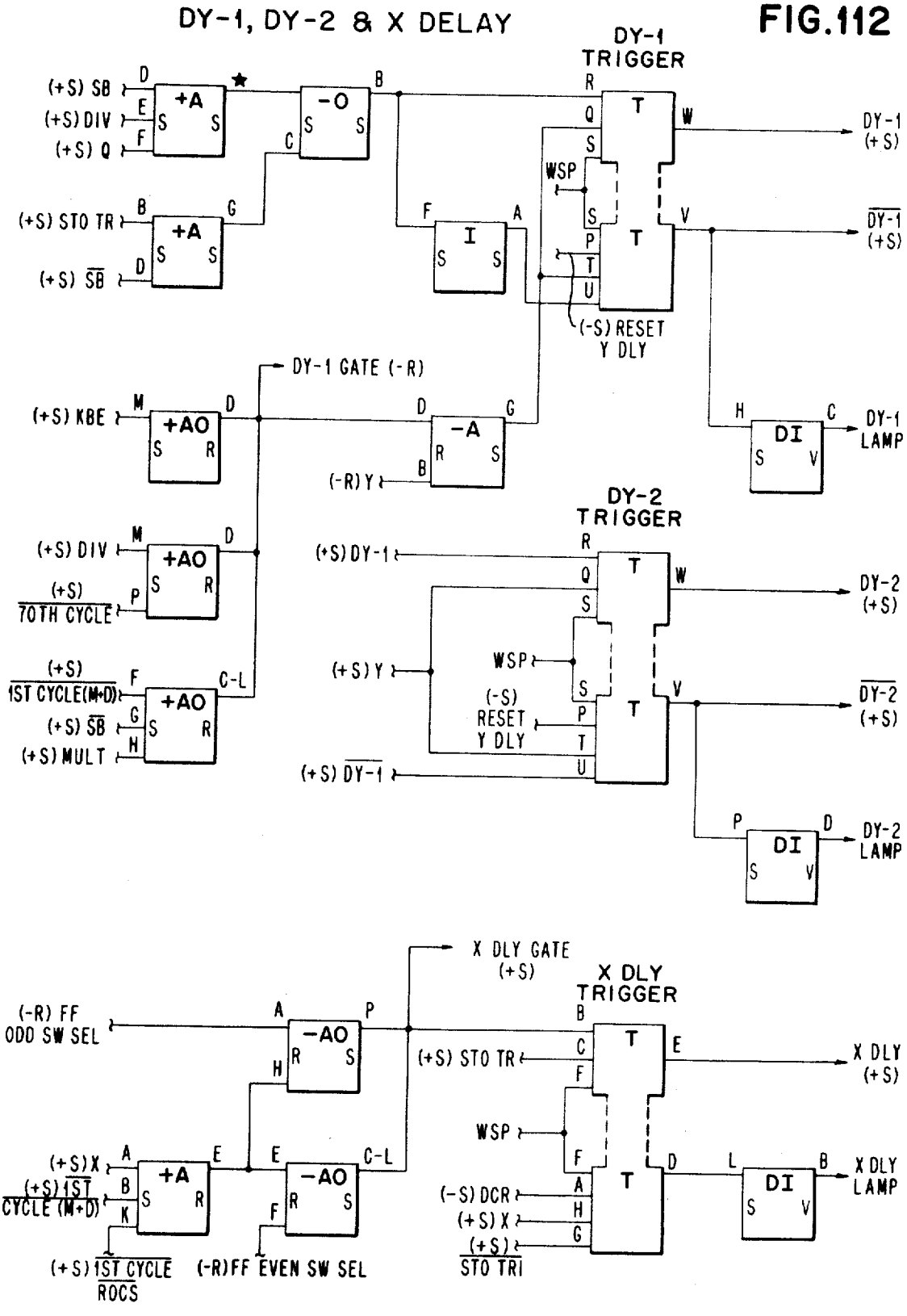


STORAGE TRIGGER & ACCUMULATOR TRIGGER STO TR **FIG. 111**



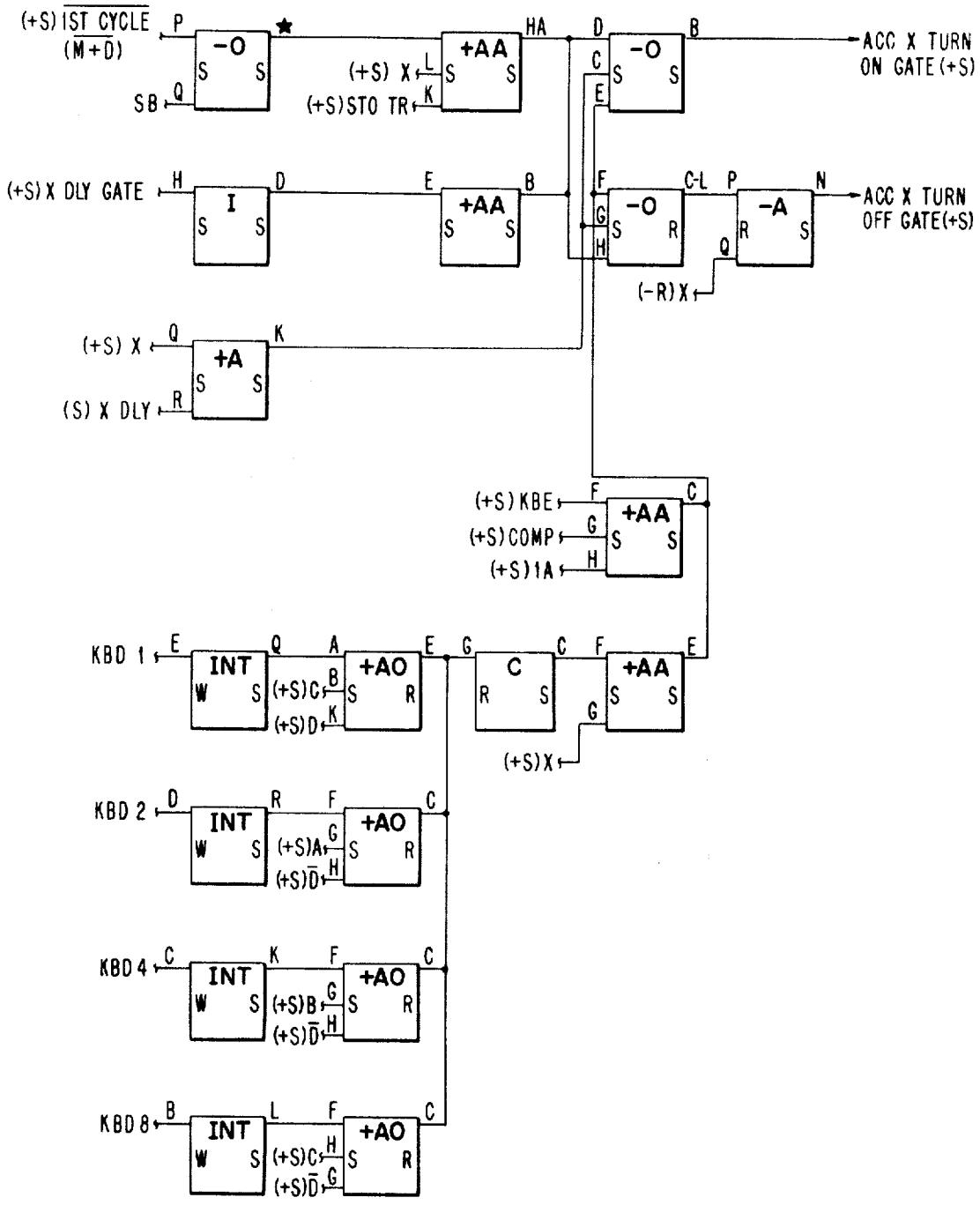
DY-1, DY-2 & X DELAY

FIG.112



ACCUMULATOR X GATE

FIG.113



ACCUMULATOR Y GATE

FIG. 114

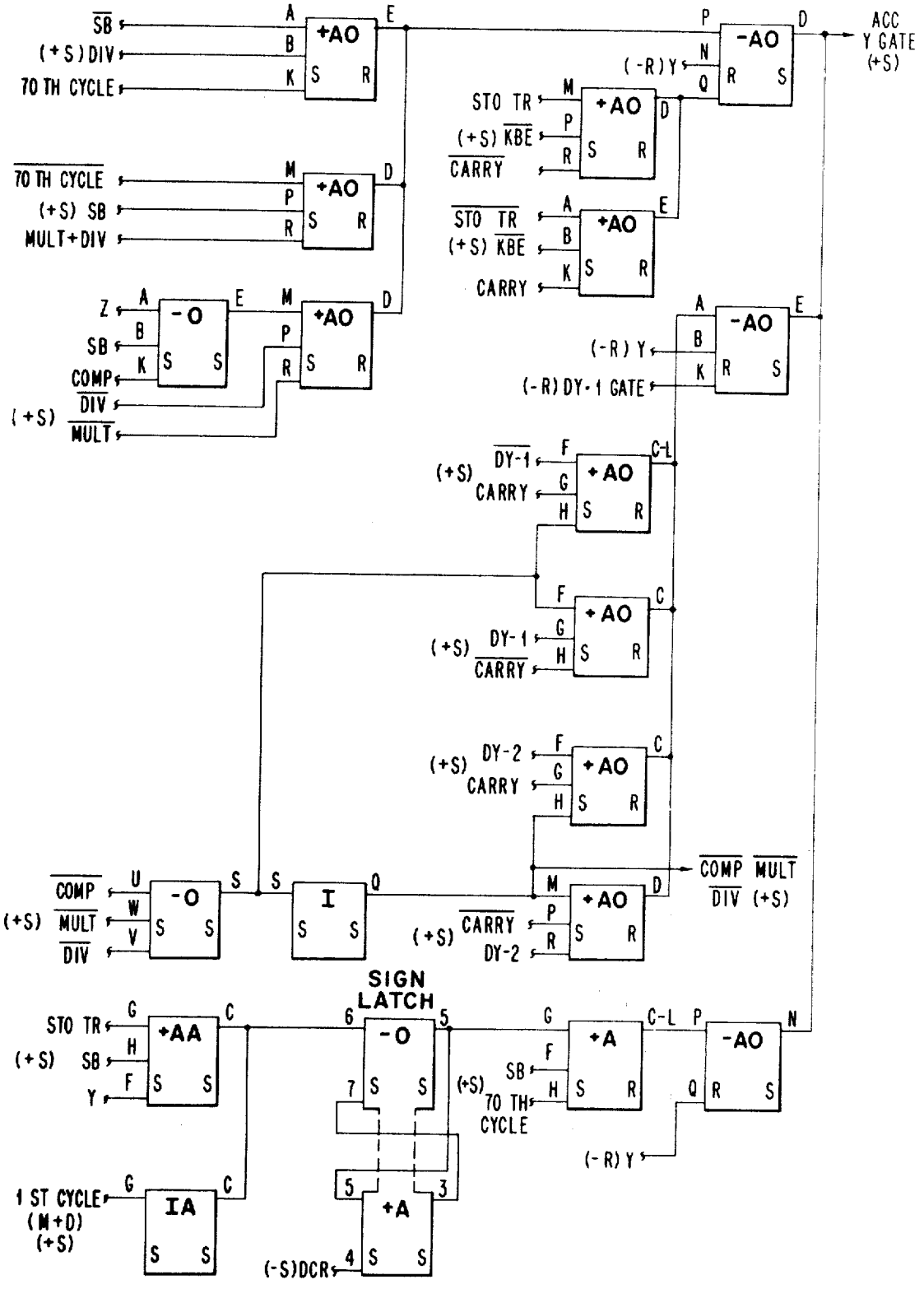
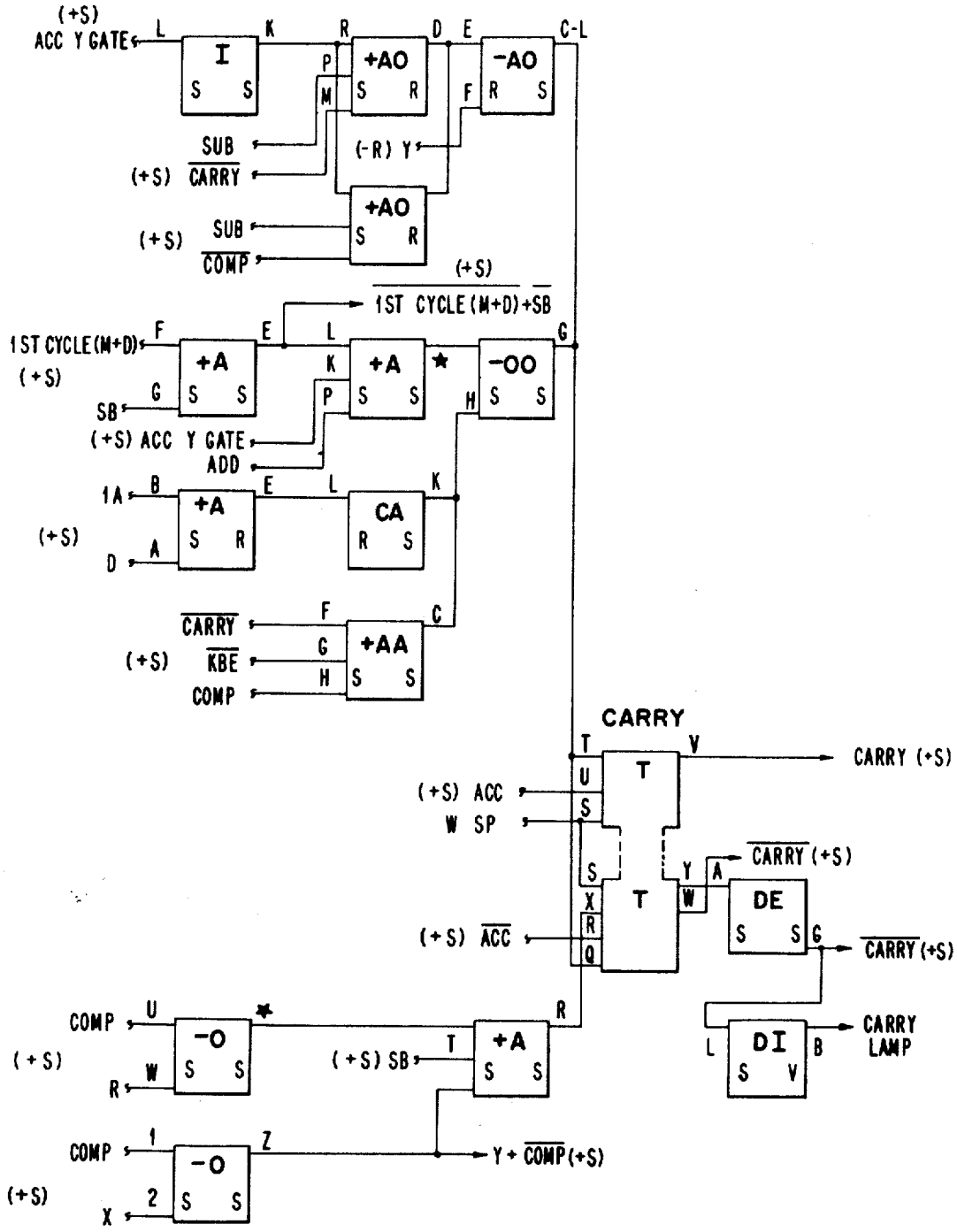


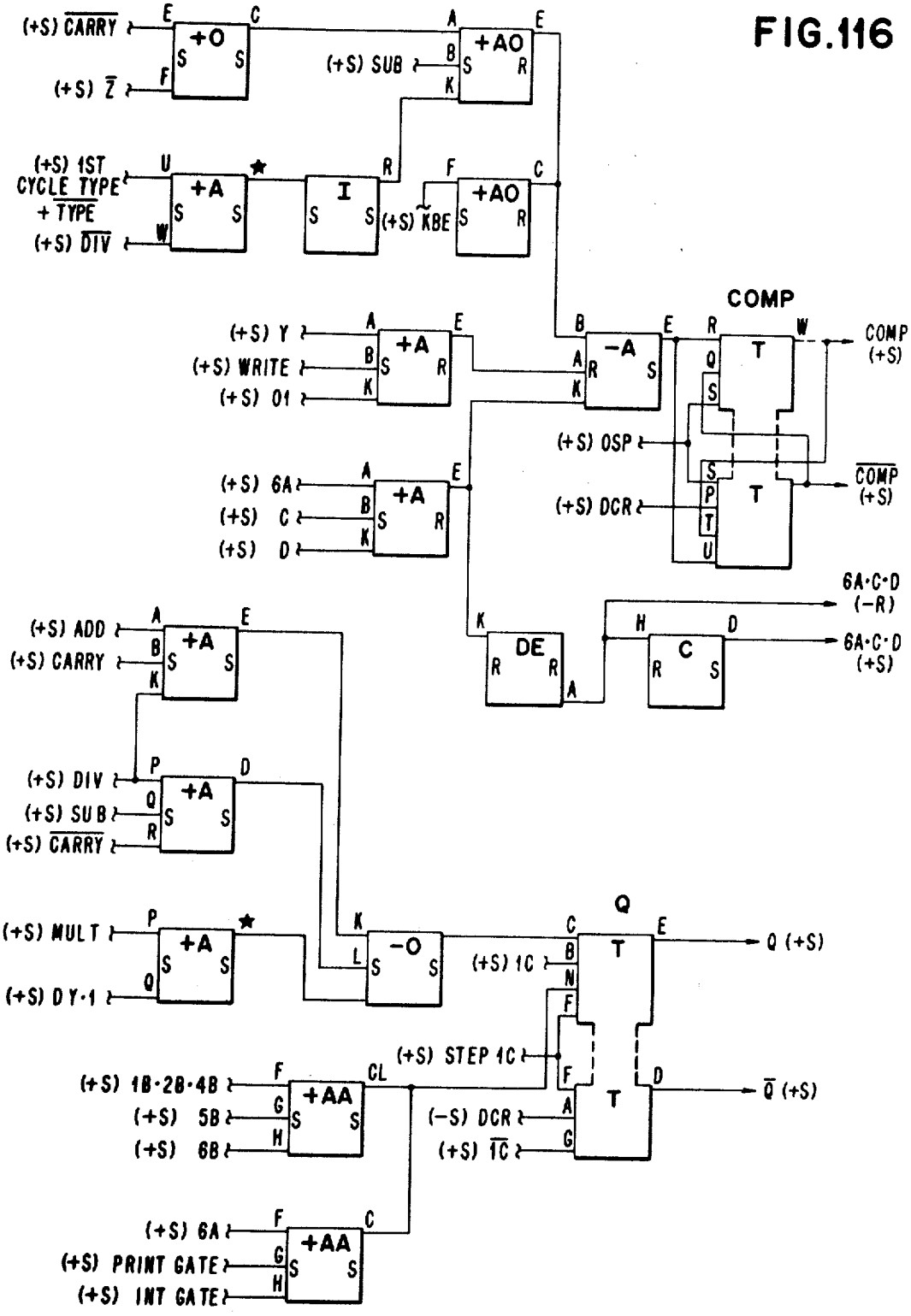
FIG. 115

CARRY TRIGGER



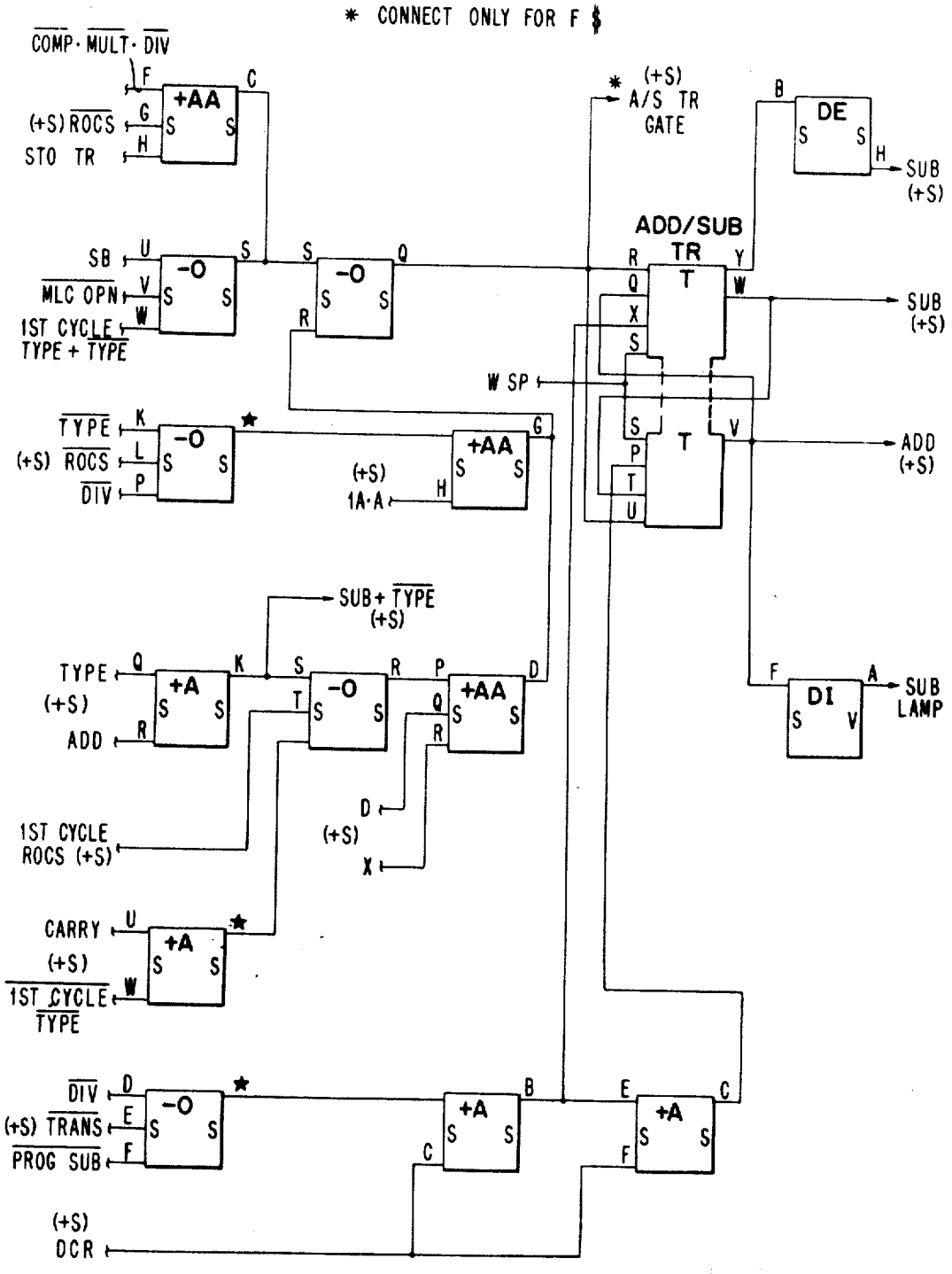
COMP TRIGGER AND Q TRIGGER

FIG.116



ADD-SUBTRACT TRIGGER

FIG.117



ARITHMETIC FUNCTION HUBS

FIG.118

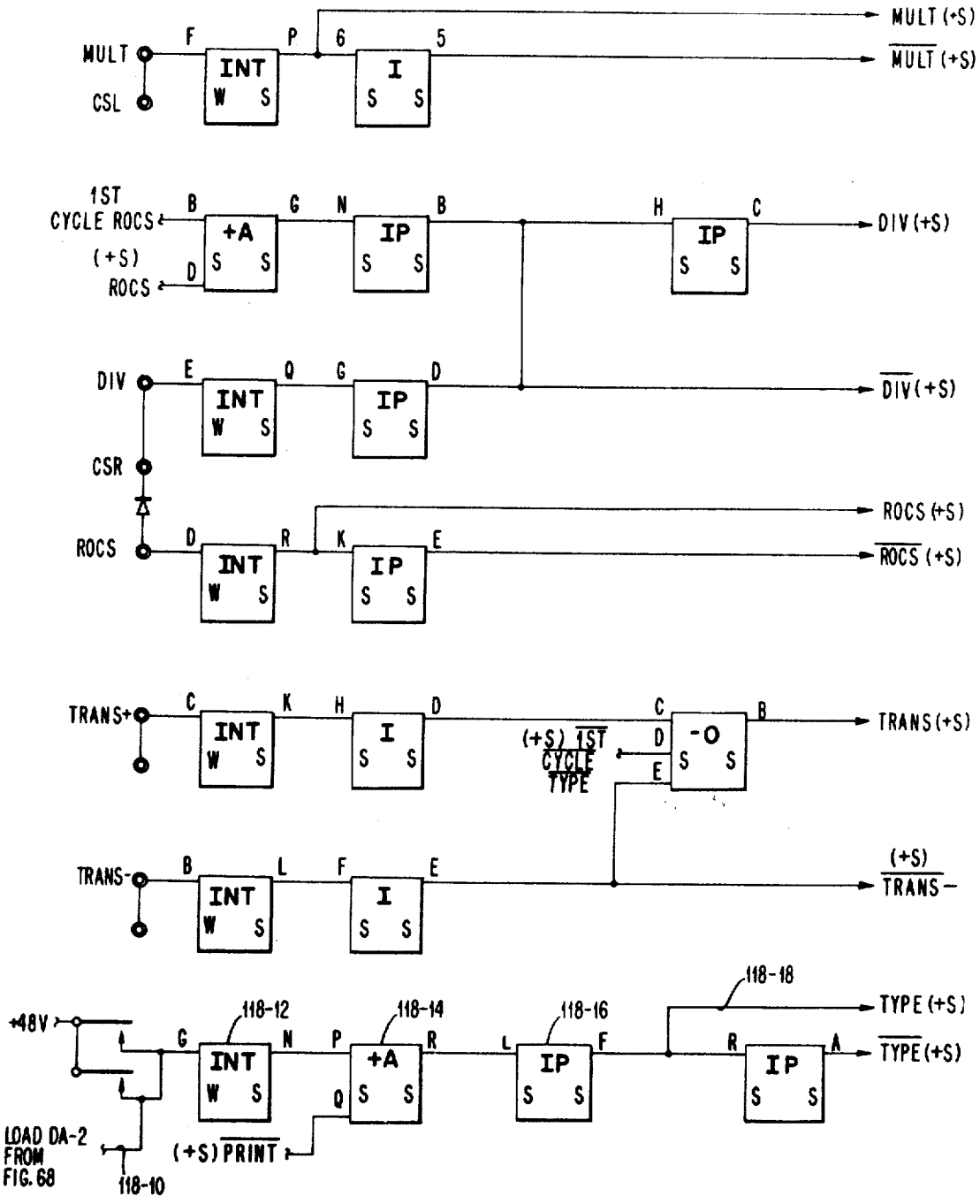
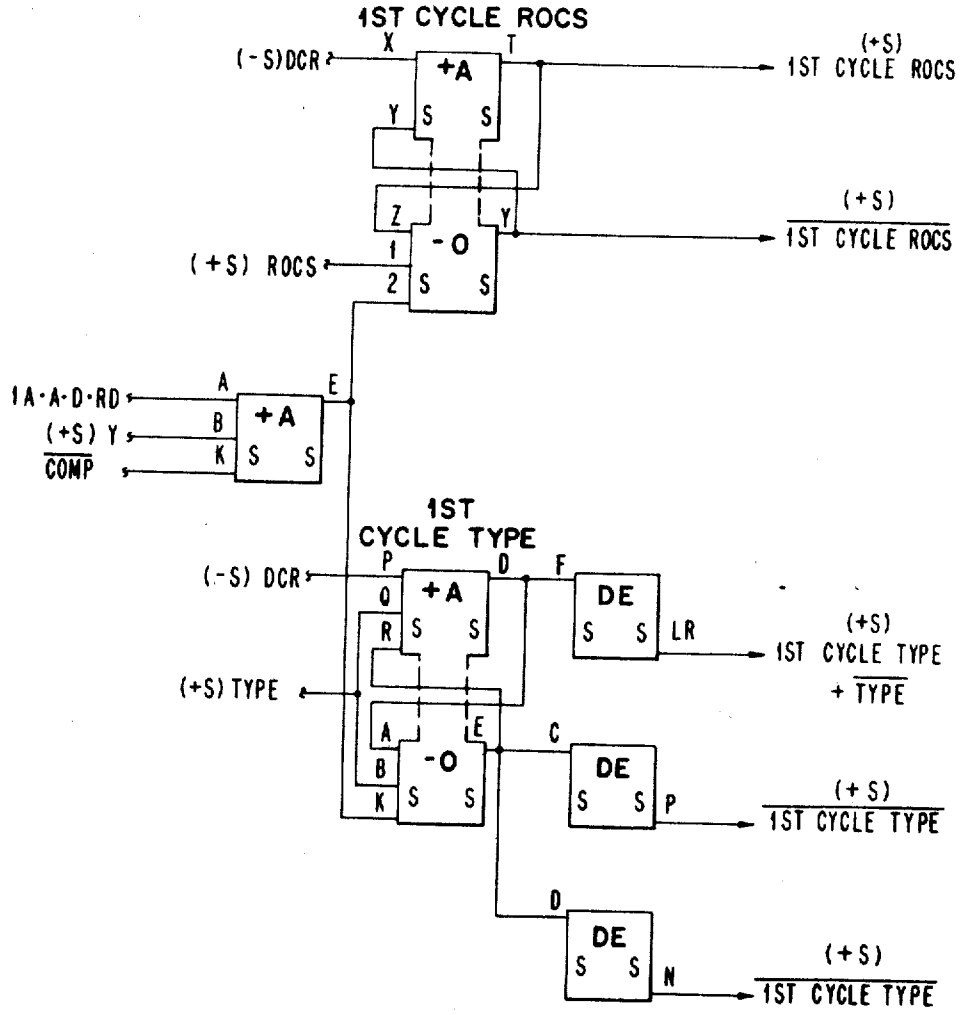
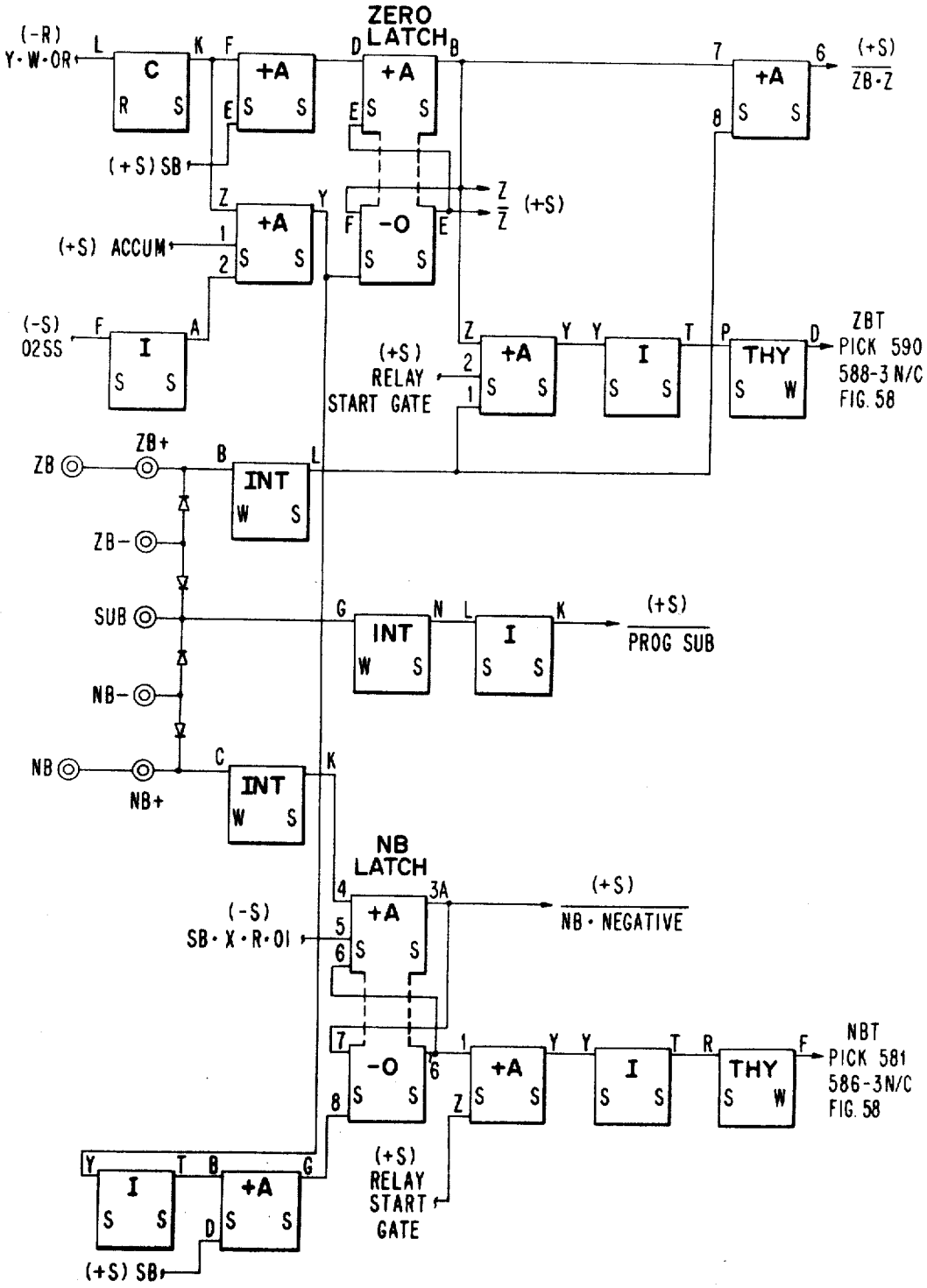


FIG.119

1ST CYCLE ROCS LATCH 1ST CYCLE TYPE LATCH



ZERO BALANCE NEGATIVE BALANCE **FIG.120**



DC SET 1B, 2B, 3B & 4B

FIG.121

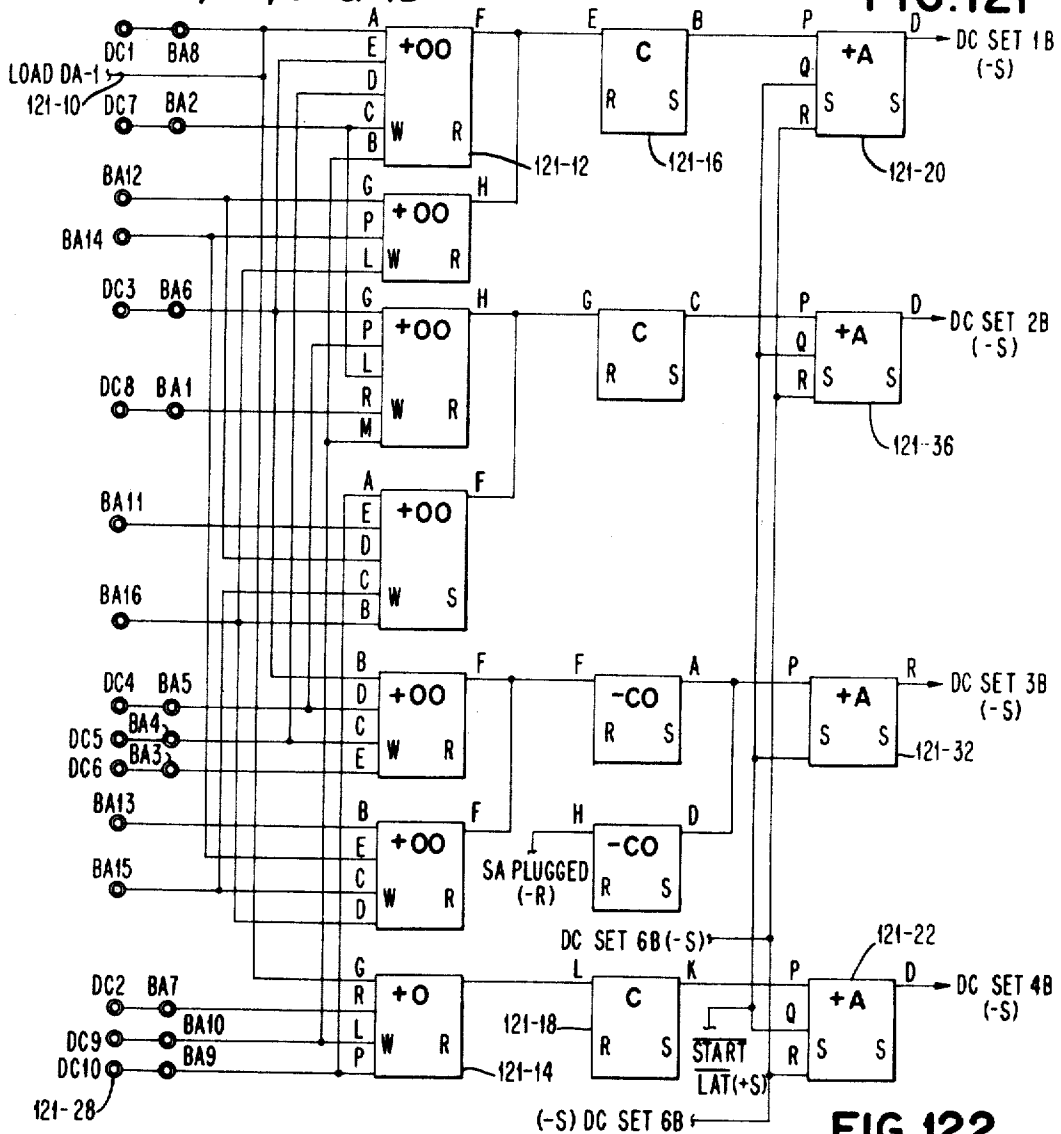


FIG.122

DIGIT CAPACITY	DIGIT TO TYPE	FIXED FACTOR	FF SWS. ODD/EVEN	WORD DRIVER	1B	2B	3B	4B	R/W SWITCHES 6B 5B		6B 5B		MLC MEM WD 6B 5B		6B 5B	
9	10	$.5 \times 10^9$	EVEN	5	1	1	0	1	4	2	6	8	10	20	30	40
8	9	$.5 \times 10^8$	ODD	1	0	1	0	0	3	1	5	7	1	11	21	31
7	8	$.5 \times 10^7$	EVEN	1	1	1	0	0	4	2	6	8	2	12	22	32
6	7	$.5 \times 10^6$	ODD	2	0	0	1	0	3	1	5	7	3	13	23	33
5	6	$.5 \times 10^5$	EVEN	2	1	0	1	0	4	2	6	8	4	14	24	34
4	5	$.5 \times 10^4$	ODD	3	0	1	1	0	3	1	5	7	5	15	25	35
3	4	$.5 \times 10^3$	EVEN	3	1	1	1	0	4	2	6	8	6	16	26	36
2	3	$.5 \times 10^2$	ODD	4	0	0	0	1	3	1	5	7	7	17	27	37
1	2	$.5 \times 10^1$	EVEN	4	1	0	0	1	4	2	6	8	8	18	28	38
10	1	$.5 \times 10^0$	ODD	5	0	1	0	1	3	1	5	7	9	19	29	39
X	SAT	$.5 \times 10^9$	EVEN	5	1	1	0	1	4	2	6	8	10	20	30	40

FIG.123

DC SET 5B & 6B, SAT TR

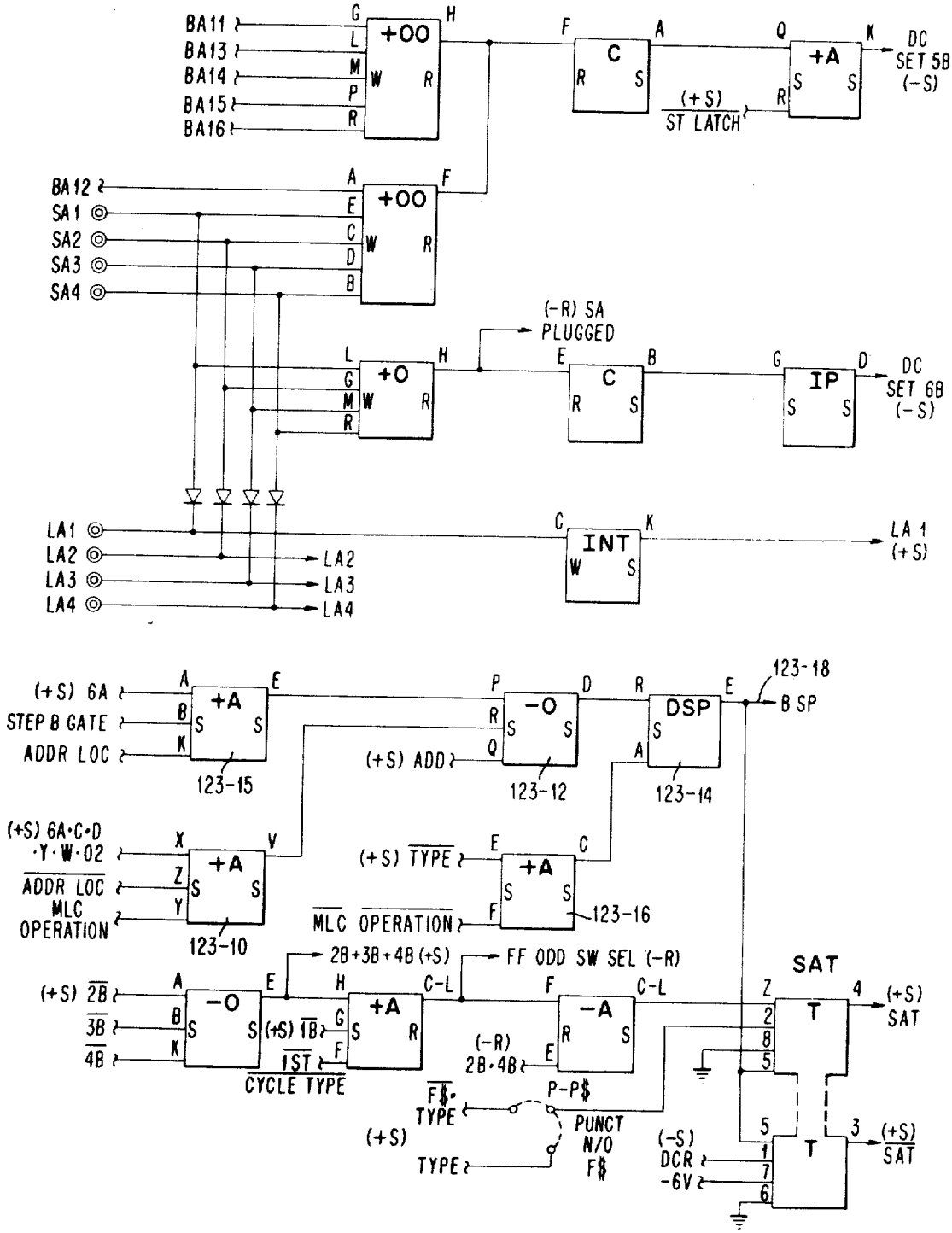
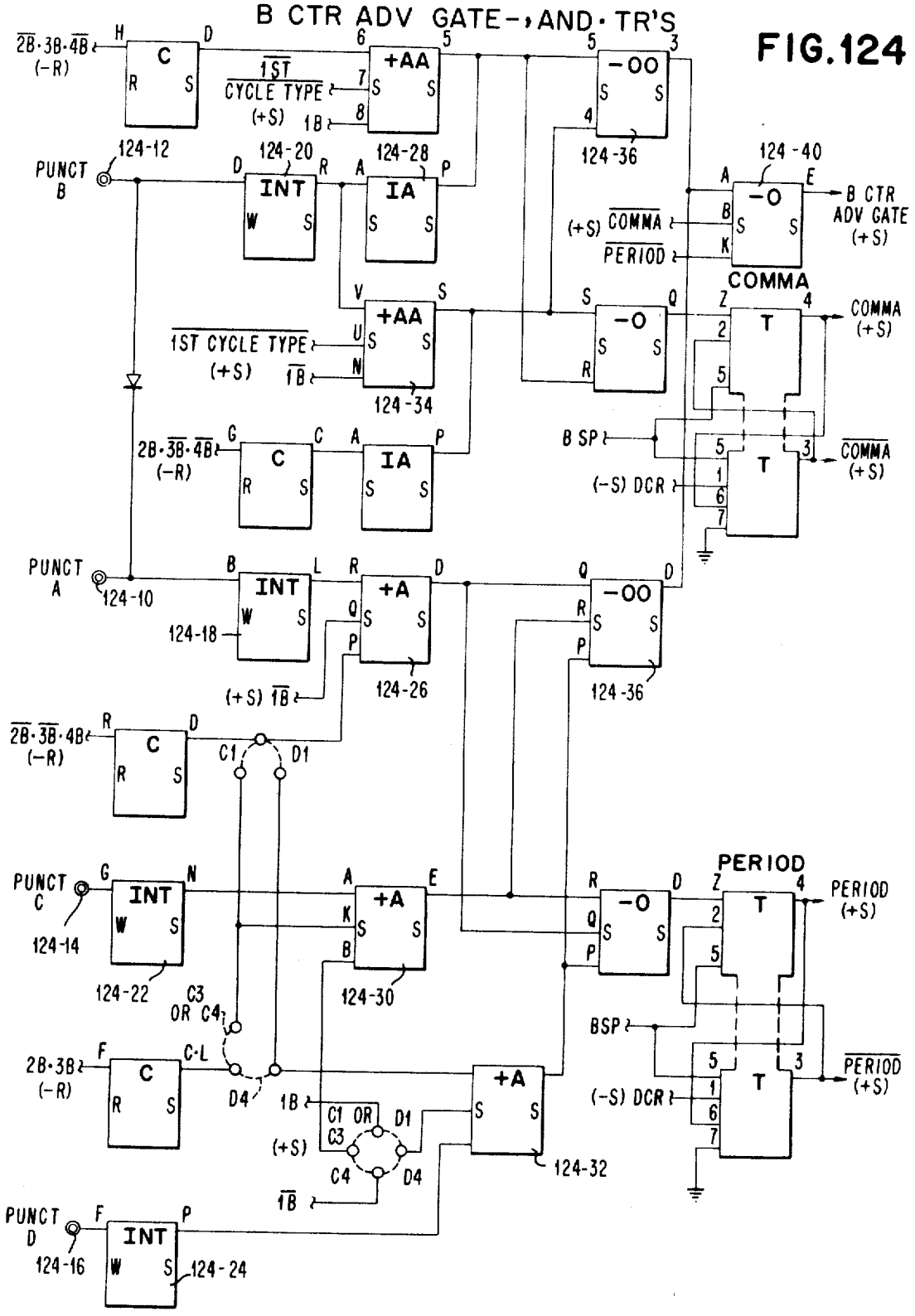
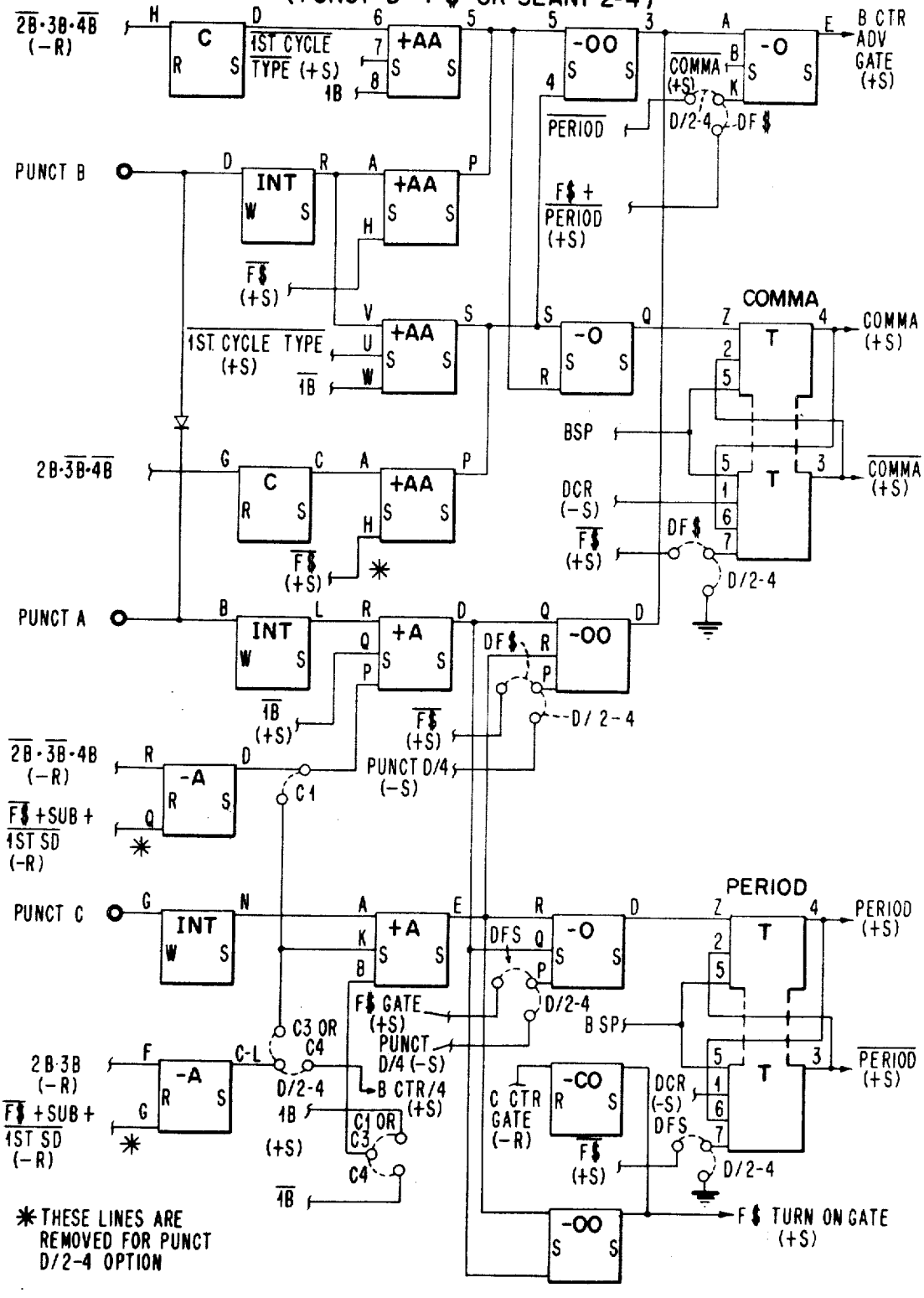


FIG.124

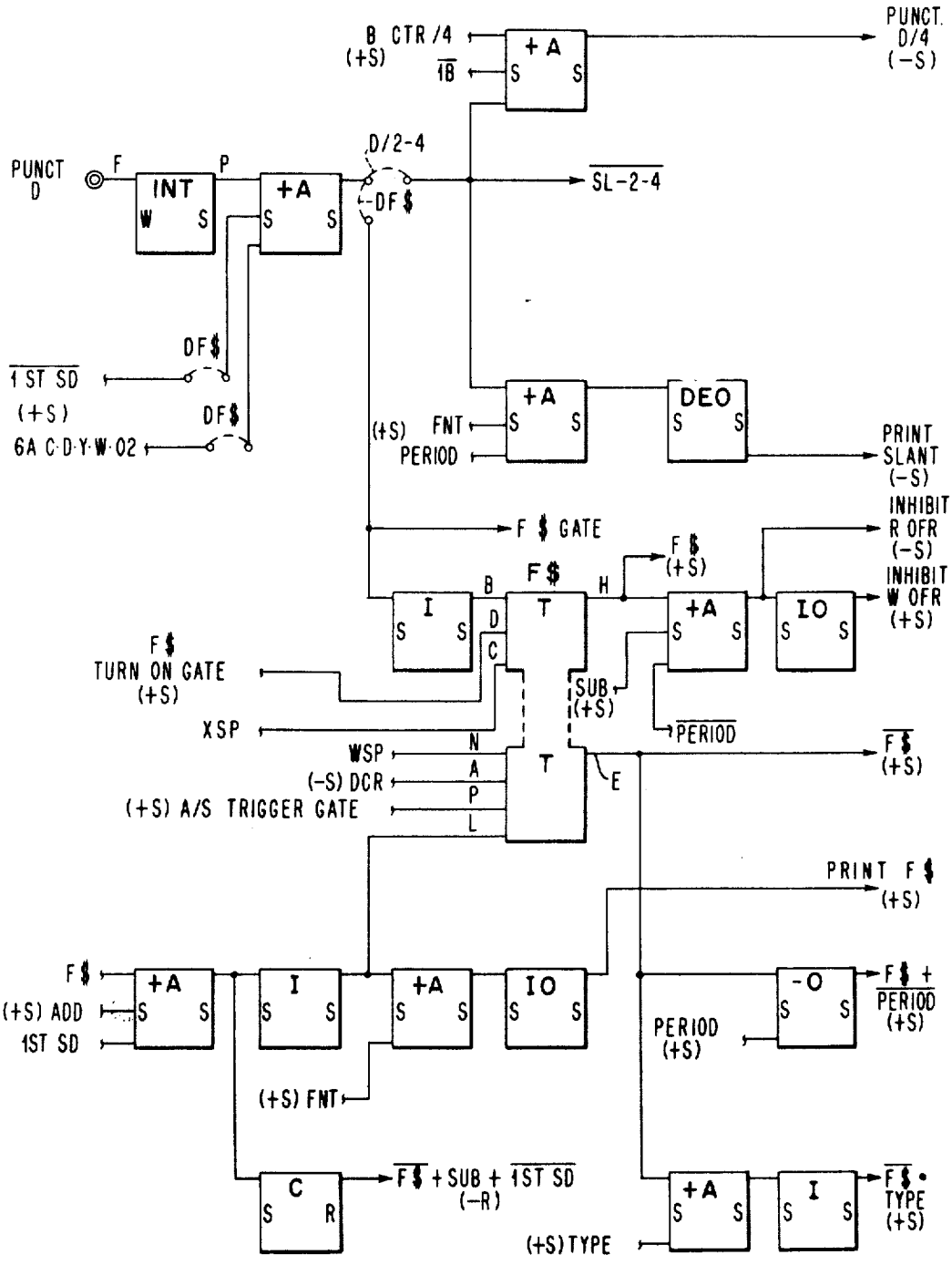

B CTR ADV GATE-AND TR'S
2B·3B·4B (-R)
C
1ST CYCLE TYPE (+S)
1B
+AA
-OO
124-36
PUNCT B
124-12
INT
124-20
IA
124-28
-O
124-40
B CTR ADV GATE (+S)
(+S) COMMA
PERIOD
COMMA
T
COMMA (+S)
1ST CYCLE TYPE (+S)
124-34
B SP
(-S) DCR
PUNCT A
124-10
+A
124-18
124-26
(+S) 1B
PERIOD
PERIOD (+S)
PUNCT C
124-14
124-22
C3 OR C4
124-30
C1 OR C3
D1
D4
C4
124-32
PUNCT D
124-16
124-24

B CTR ADV GATE-, AND- TRIGGERS FIG. 125
(PUNCT D F$ OR SLANT 2-4)



PUNCT D-F $ OR SLANT 2-4

FIG. 126



B CTR 1B, 2B, 3B, 4B

FIG. 127

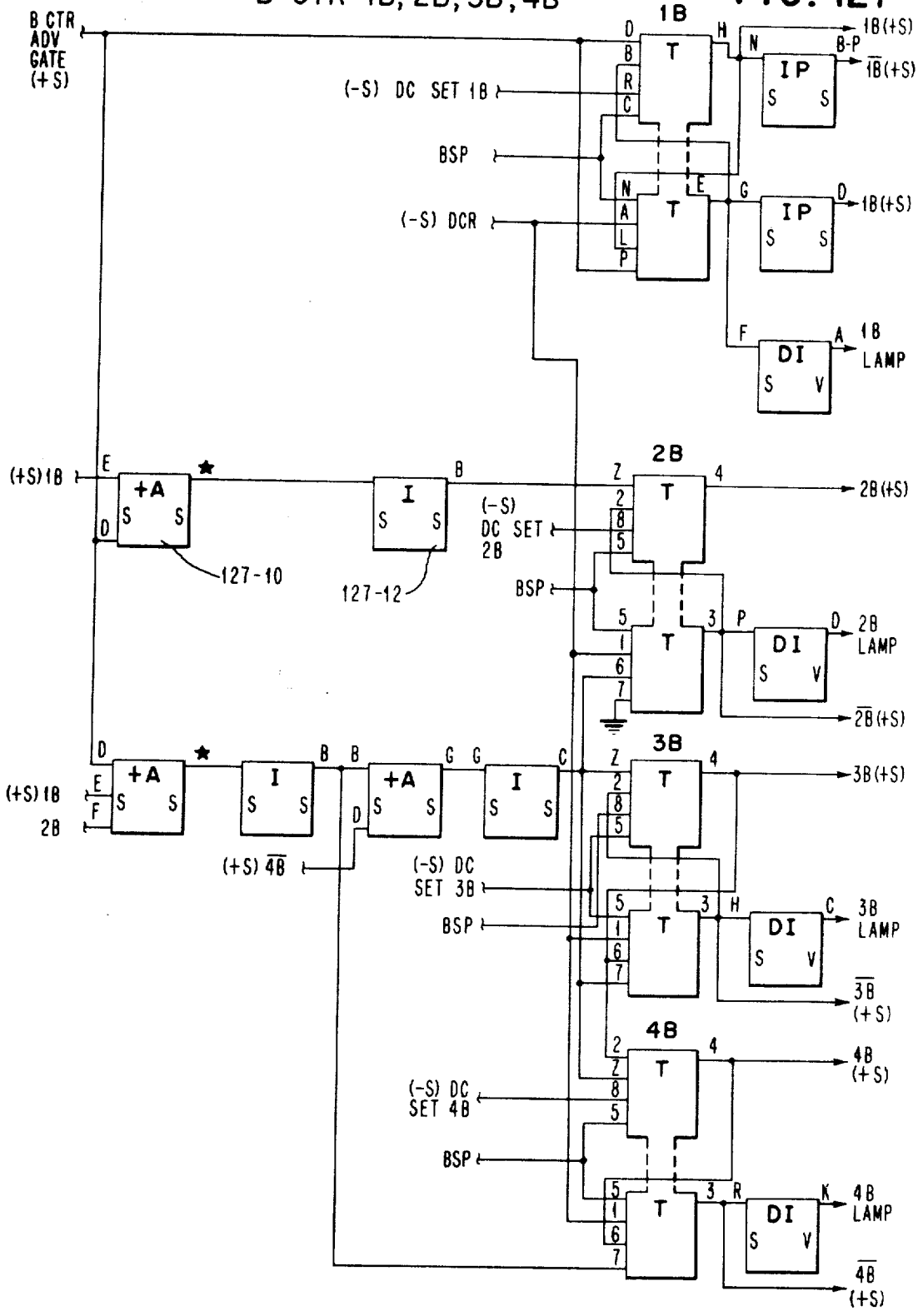
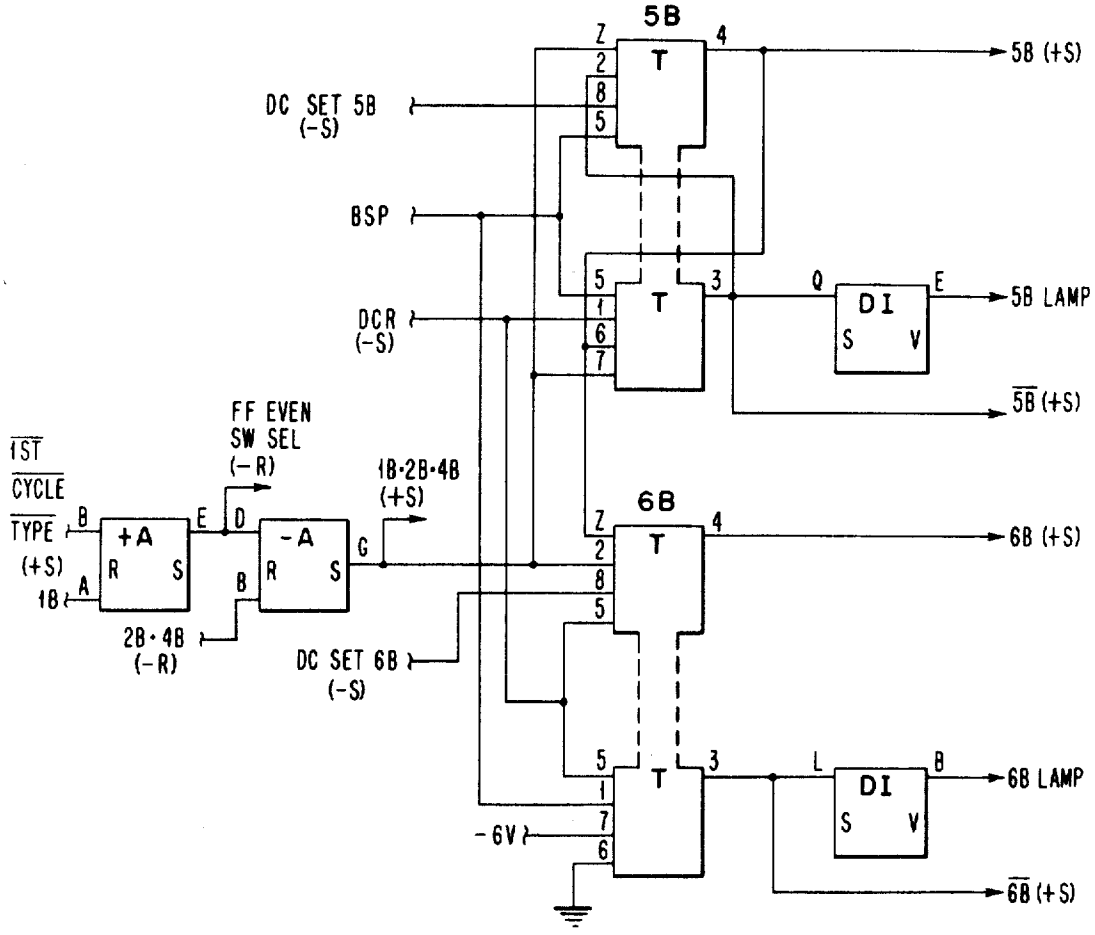


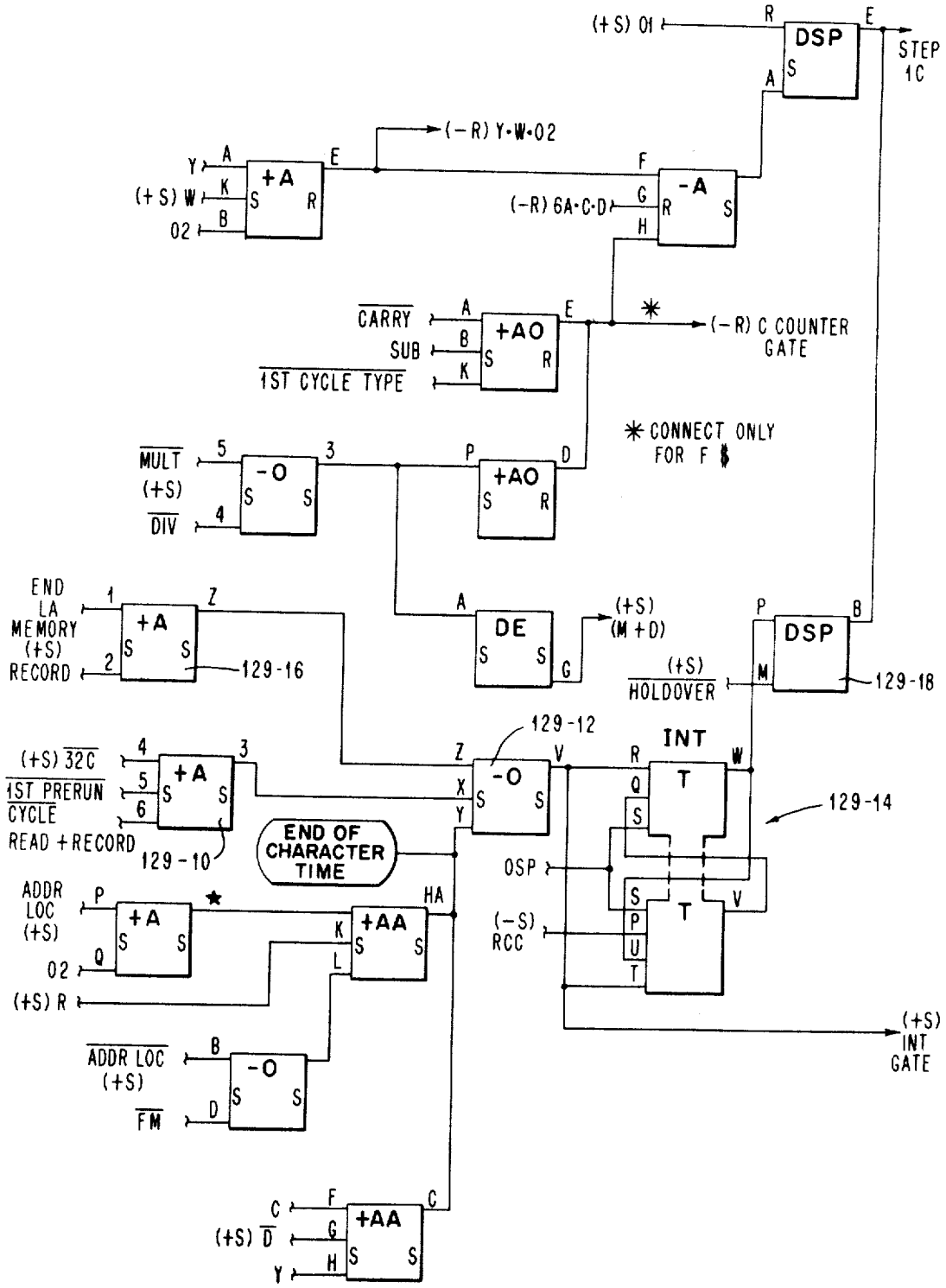
FIG. 128

B CTR-5B & 6B



STEP 1C, INT TR

FIG. 129



RESET C COUNTER, 1C

FIG. 130

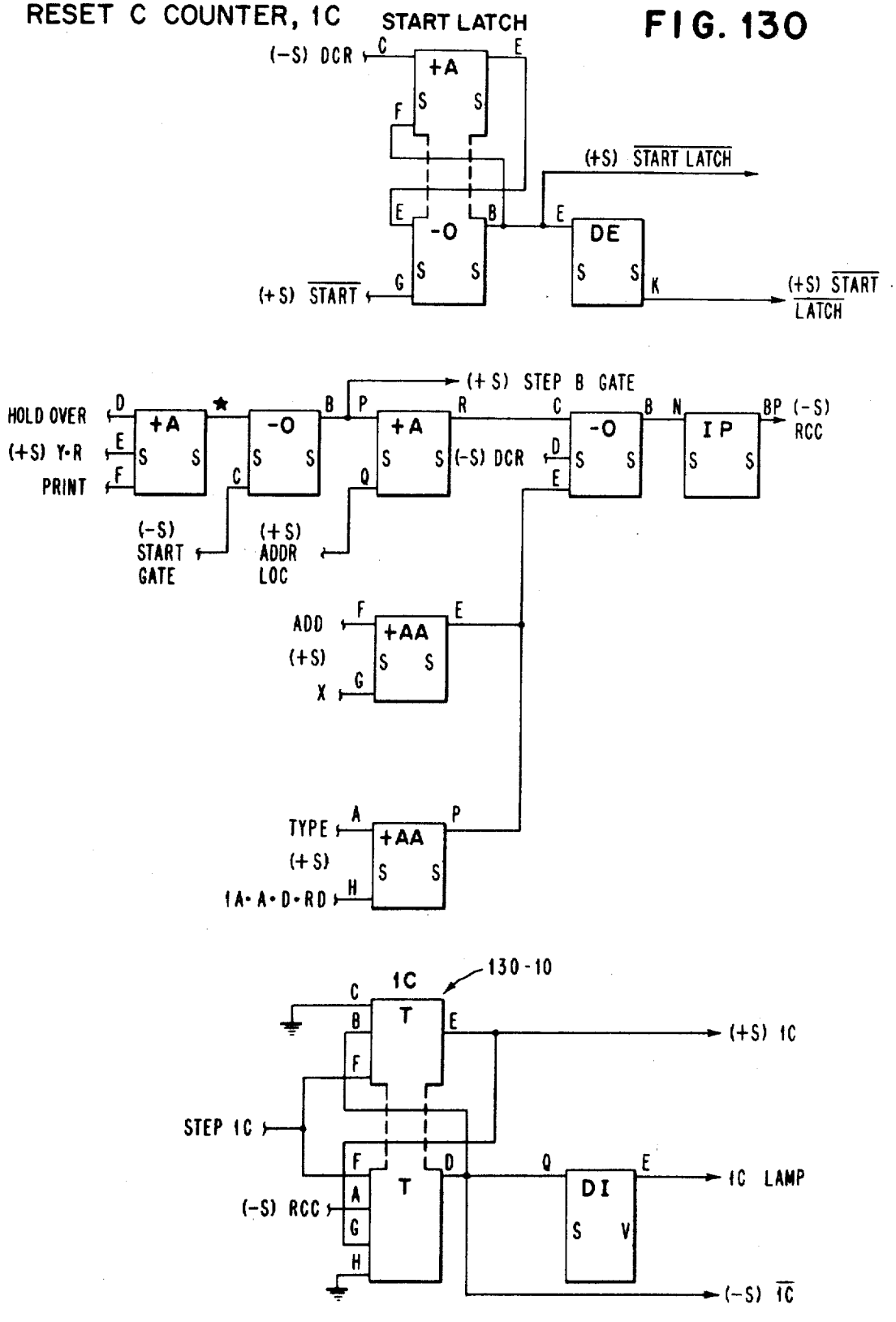
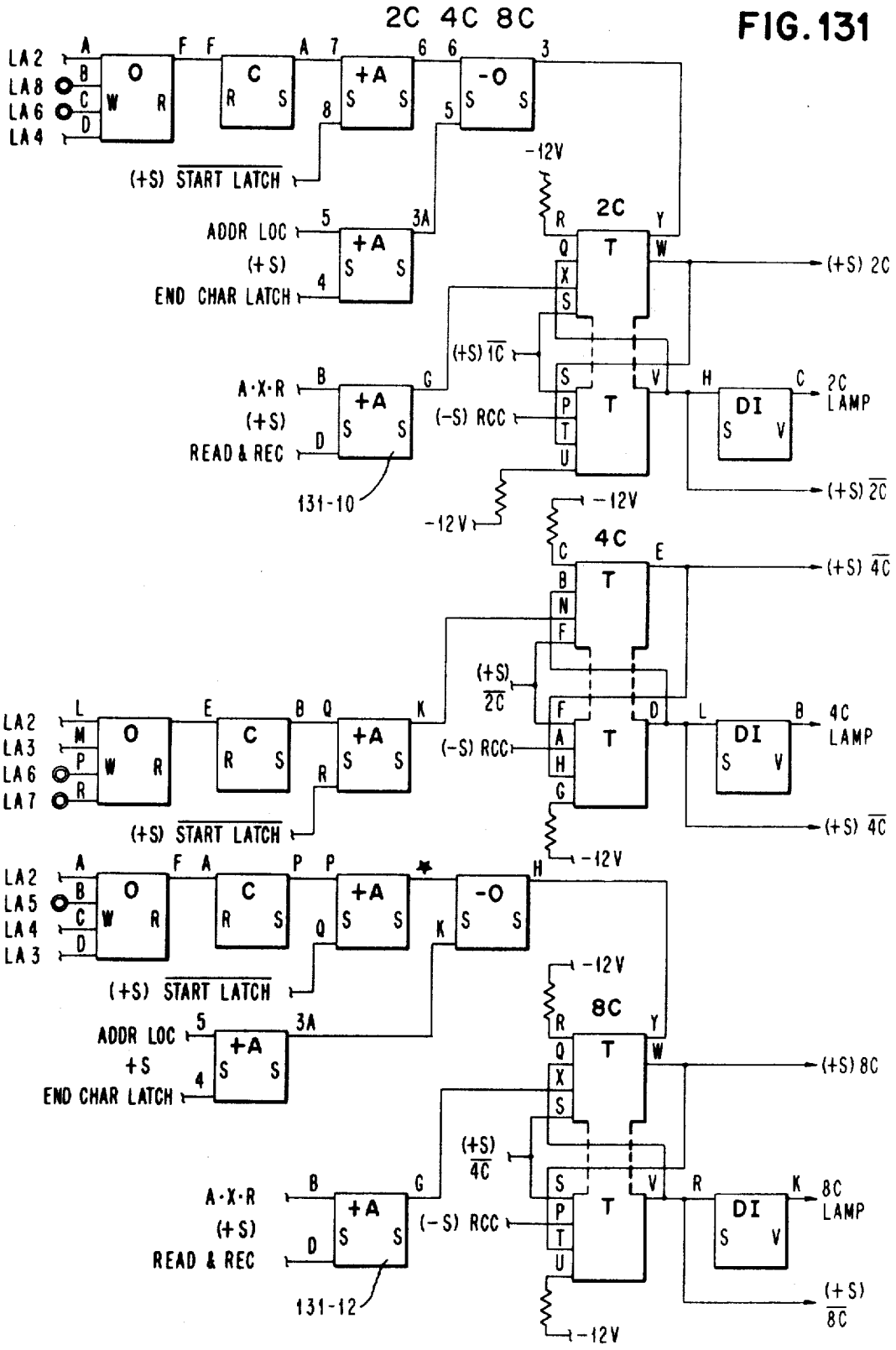
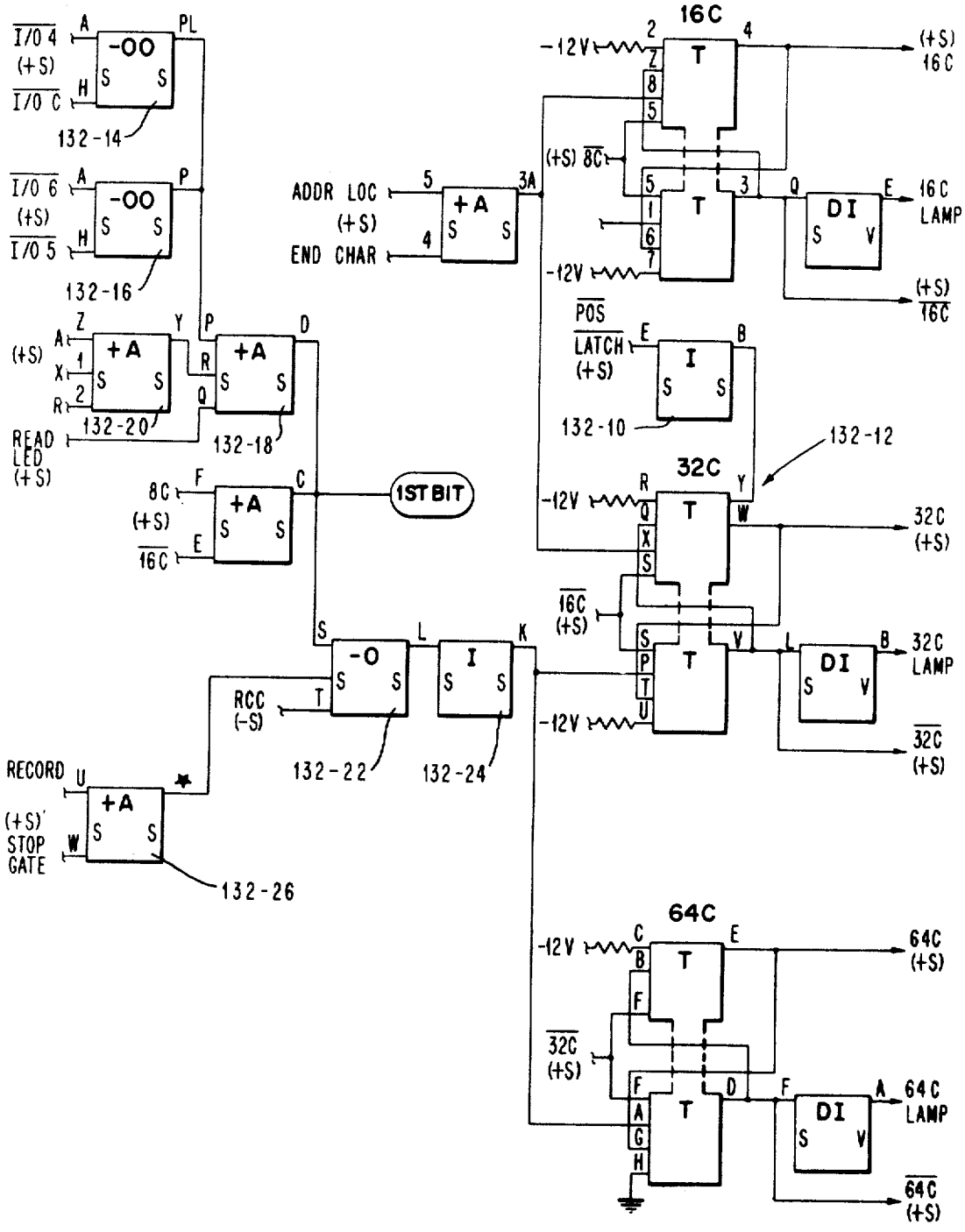


FIG. 131


2C 4C 8C
LA2
LA8
LA6
LA4
O
C
+A
-O
(+S) START LATCH
ADDR LOC
(+S)
END CHAR LATCH
-12V
2C
(+S) 2C
(+S) 1C
A·X·R
READ & REC
131-10
(-S) RCC
DI
2C LAMP
(+S) 2C
4C
(+S) 4C
LA3
(+S) 2C
4C LAMP
LA5
8C
(+S) 8C
(+S) 4C
131-12
8C LAMP
(+S) 8C

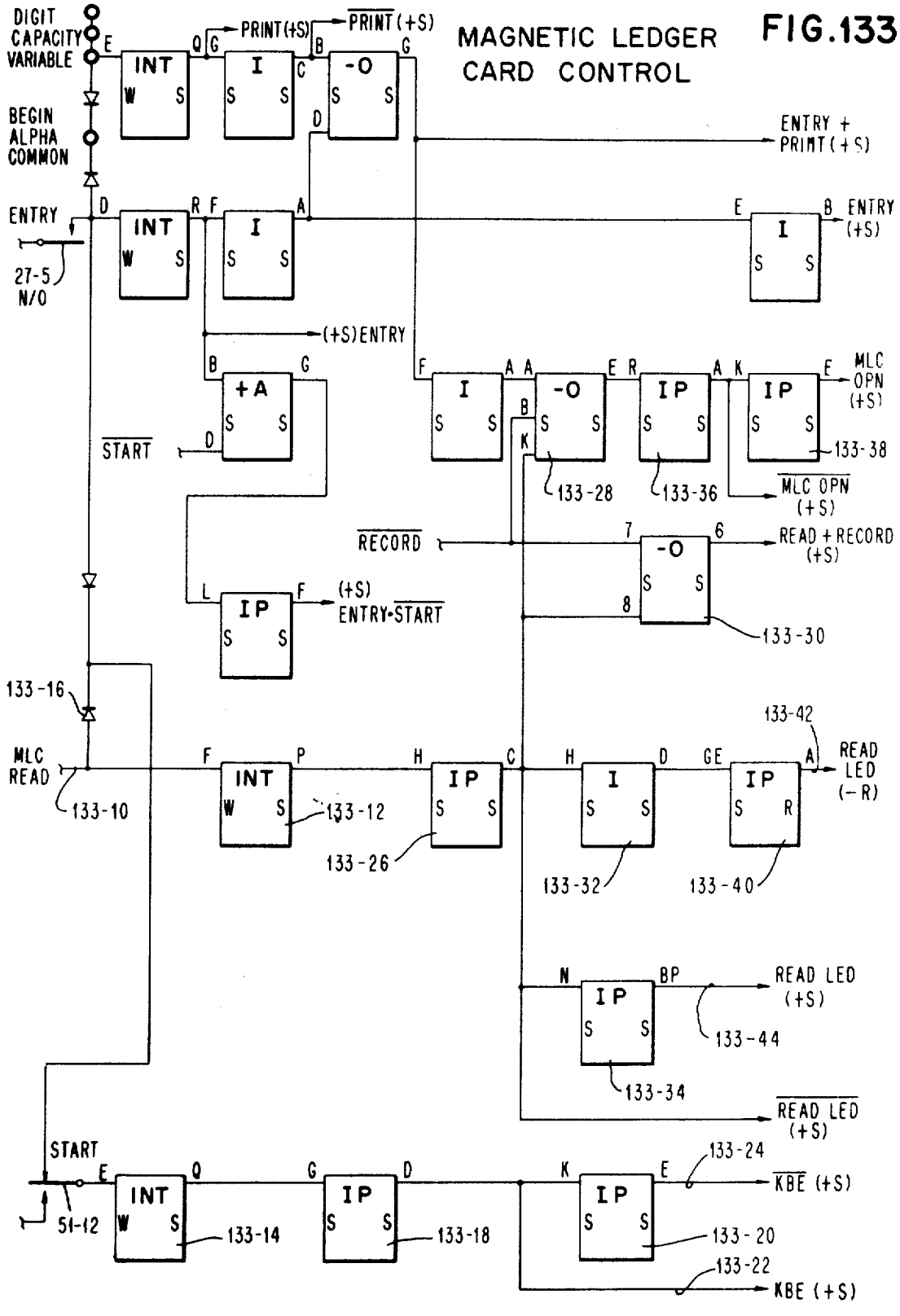
16C 32C 64C

FIG.132



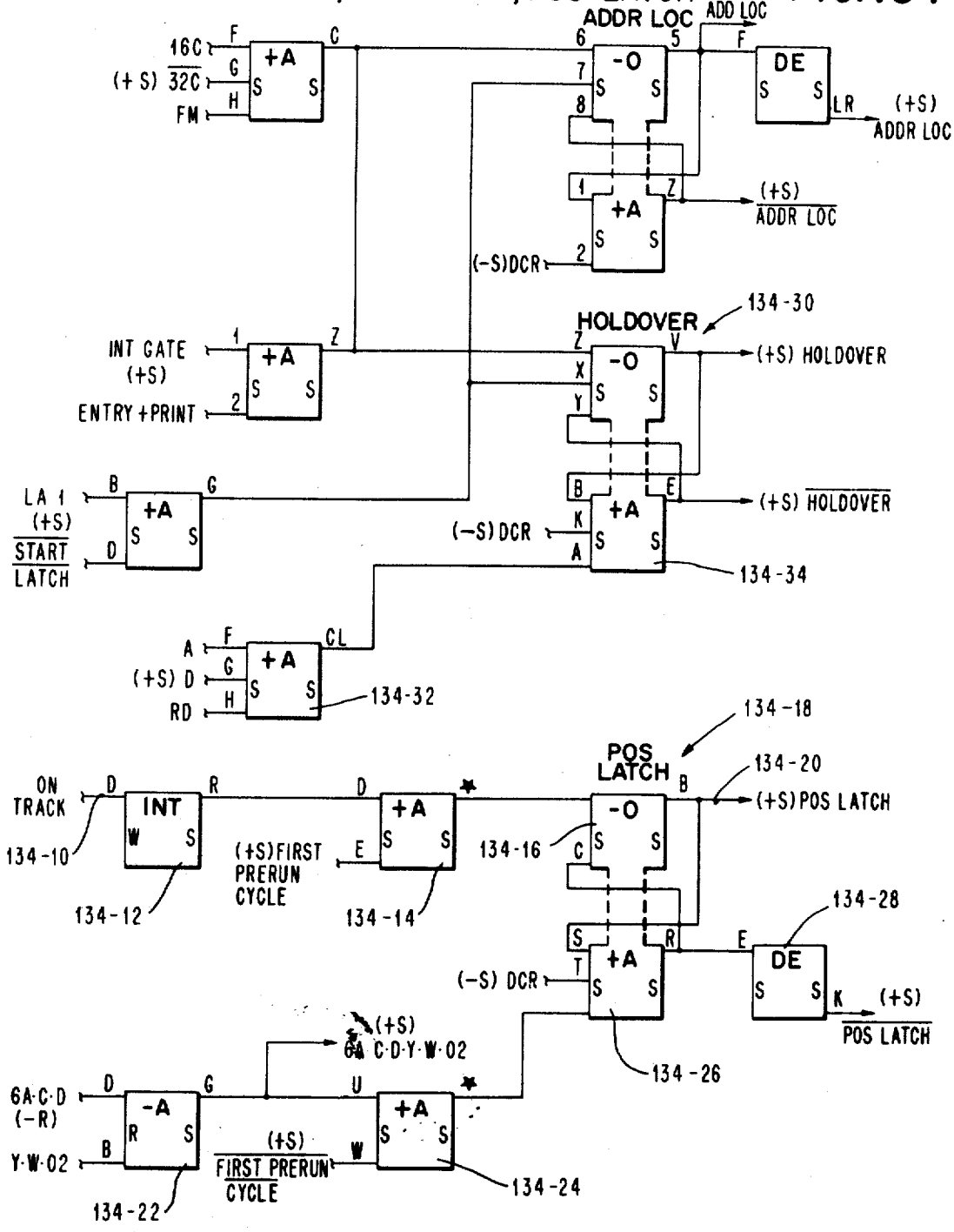
MAGNETIC LEDGER CARD CONTROL

FIG.133



ADDR LOC, HOLDOVER, POS LATCH

FIG. 134



1ST PRERUN CYCLE, RECORD, CHECK READ, DCR

FIG.135

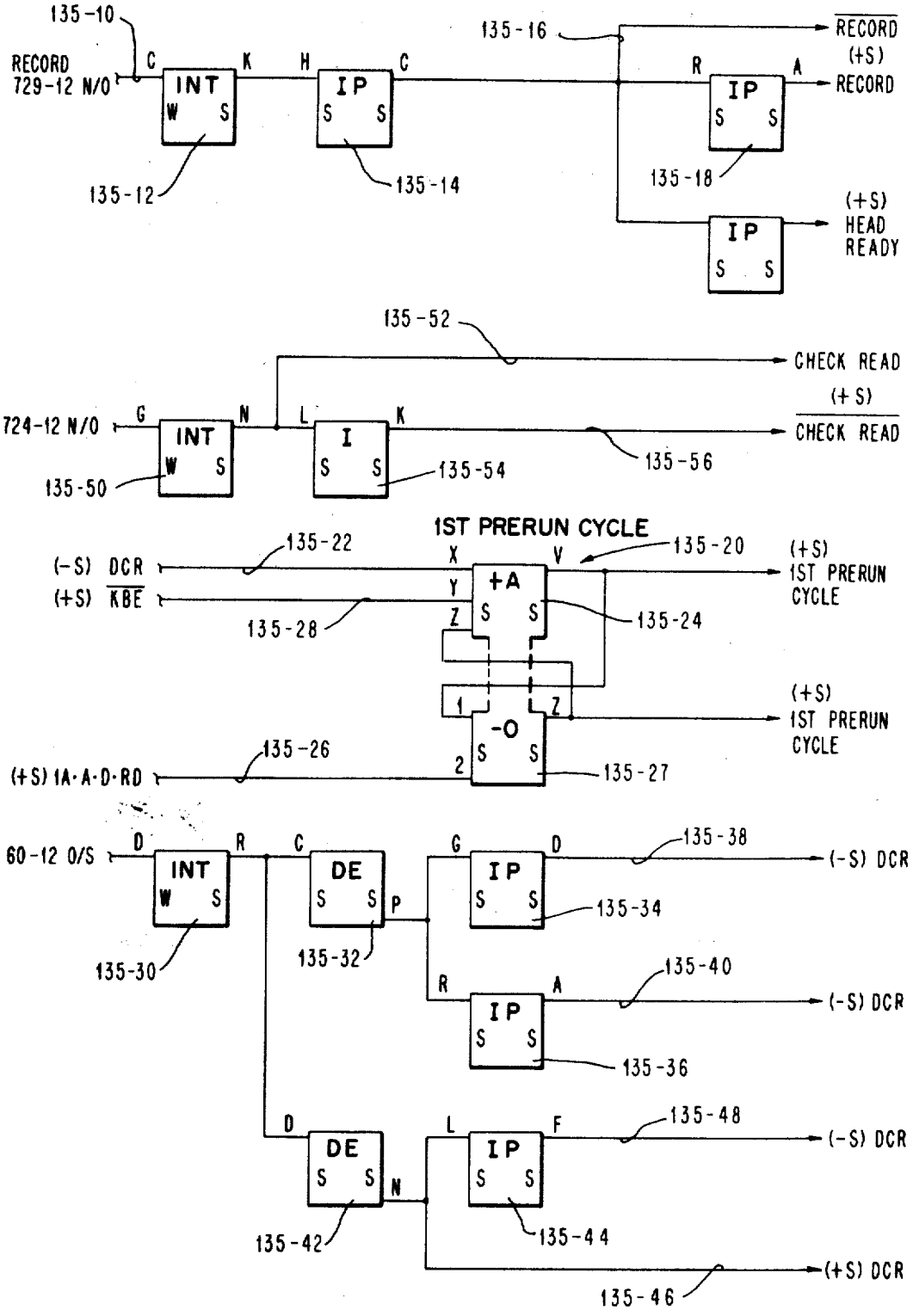
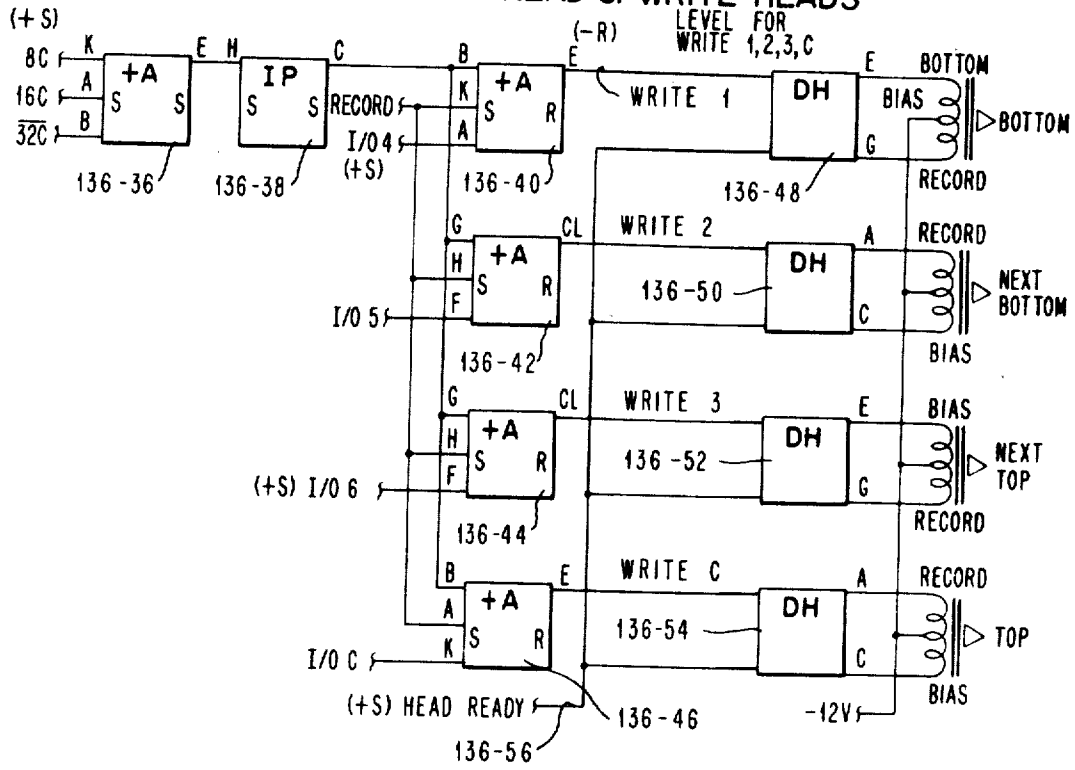


FIG. 136

MAGNETIC LEDGER CARD READ & WRITE HEADS



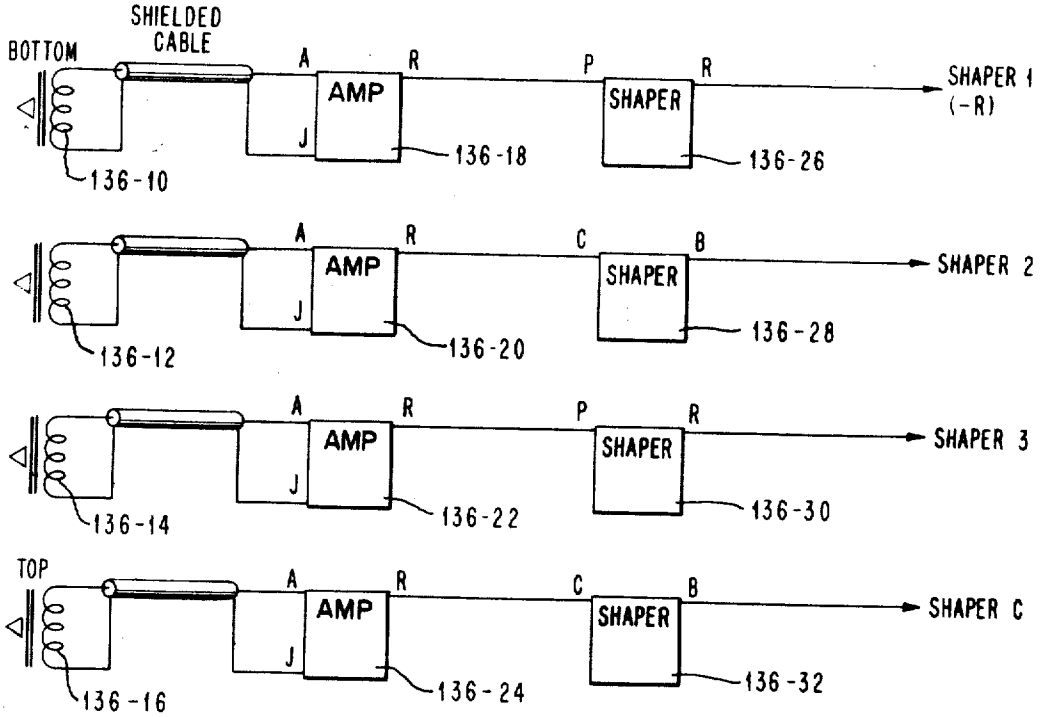
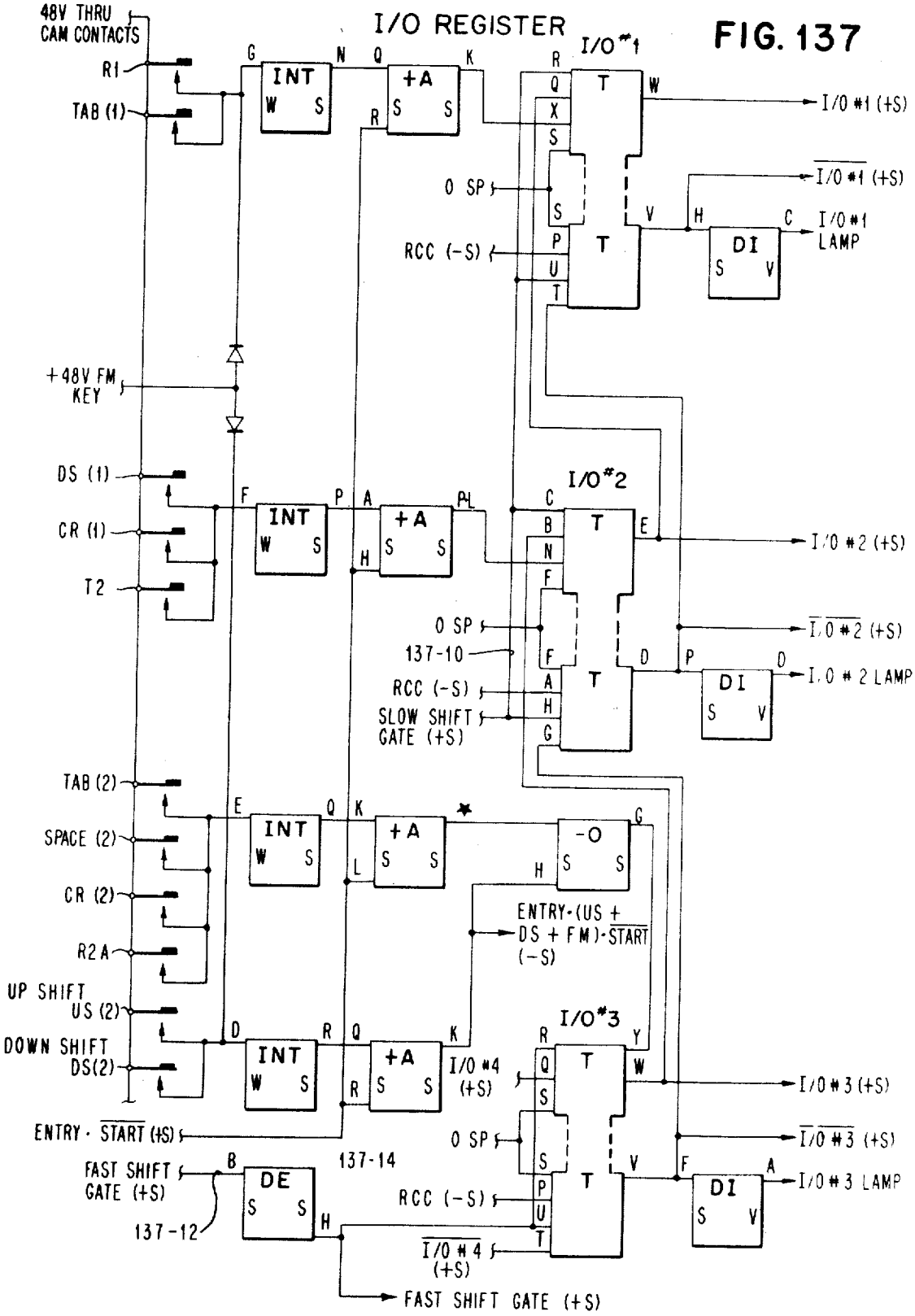
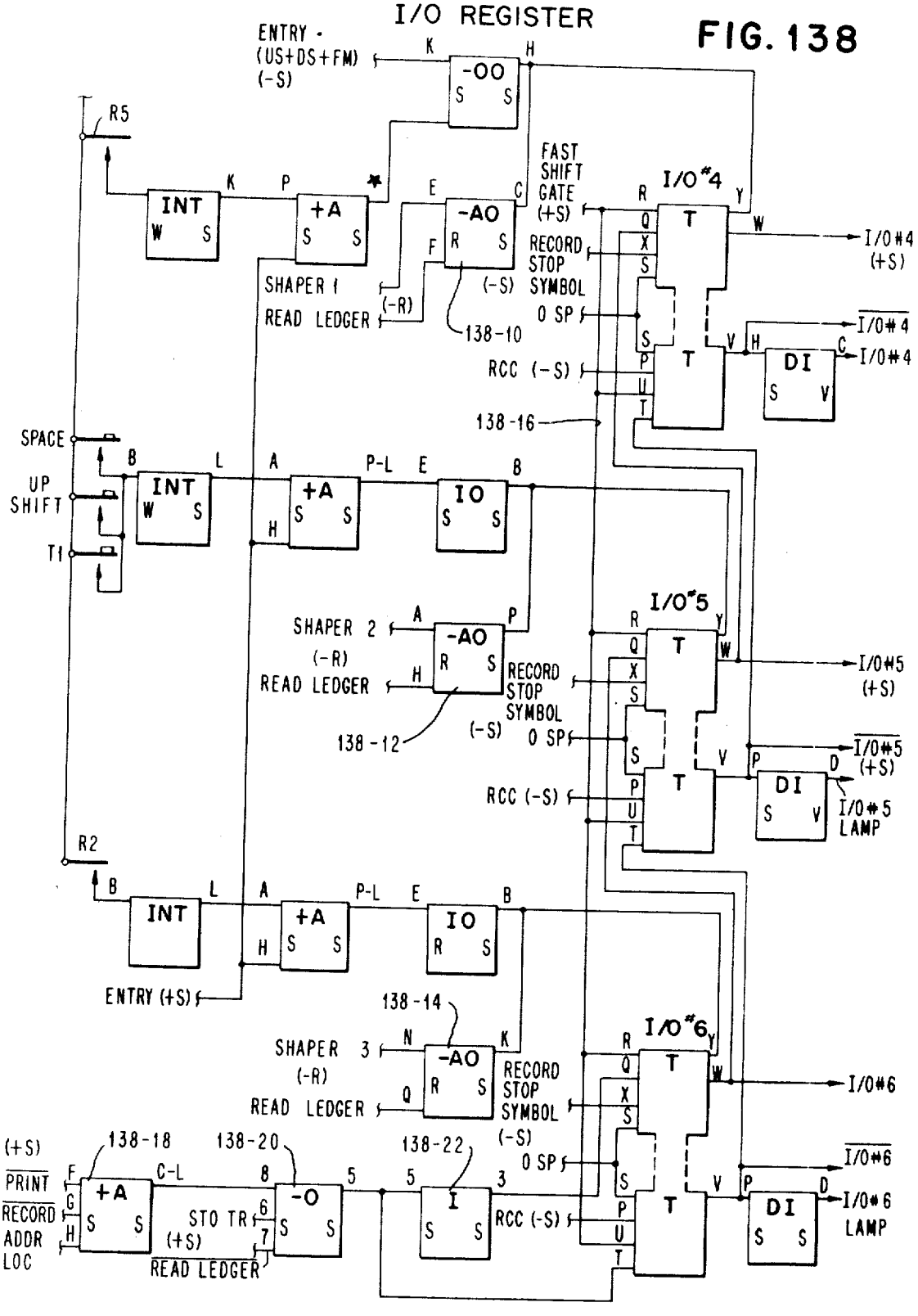


FIG. 137


I/O REGISTER
48V THRU CAM CONTACTS
R1
TAB (1)
+48V FM KEY
DS (1)
CR (1)
T2
TAB (2)
SPACE (2)
CR (2)
R2A
UP SHIFT US (2)
DOWN SHIFT DS(2)
ENTRY · START (+S)
FAST SHIFT GATE (+S)
137-12
137-14
INT
+A
-O
DE
DI
T
I/O #1
I/O #2
I/O #3
0 SP
RCC (-S)
137-10
SLOW SHIFT GATE (+S)
I/O #4 (+S)
ENTRY·(US + DS + FM)·START (-S)
I/O #1 (+S)
I/O #1 (+S)
I/O #1 LAMP
I/O #2 (+S)
I/O #2 (+S)
I/O #2 LAMP
I/O #3 (+S)
I/O #3 (+S)
I/O #3 LAMP
I/O #4 (+S)
FAST SHIFT GATE (+S)

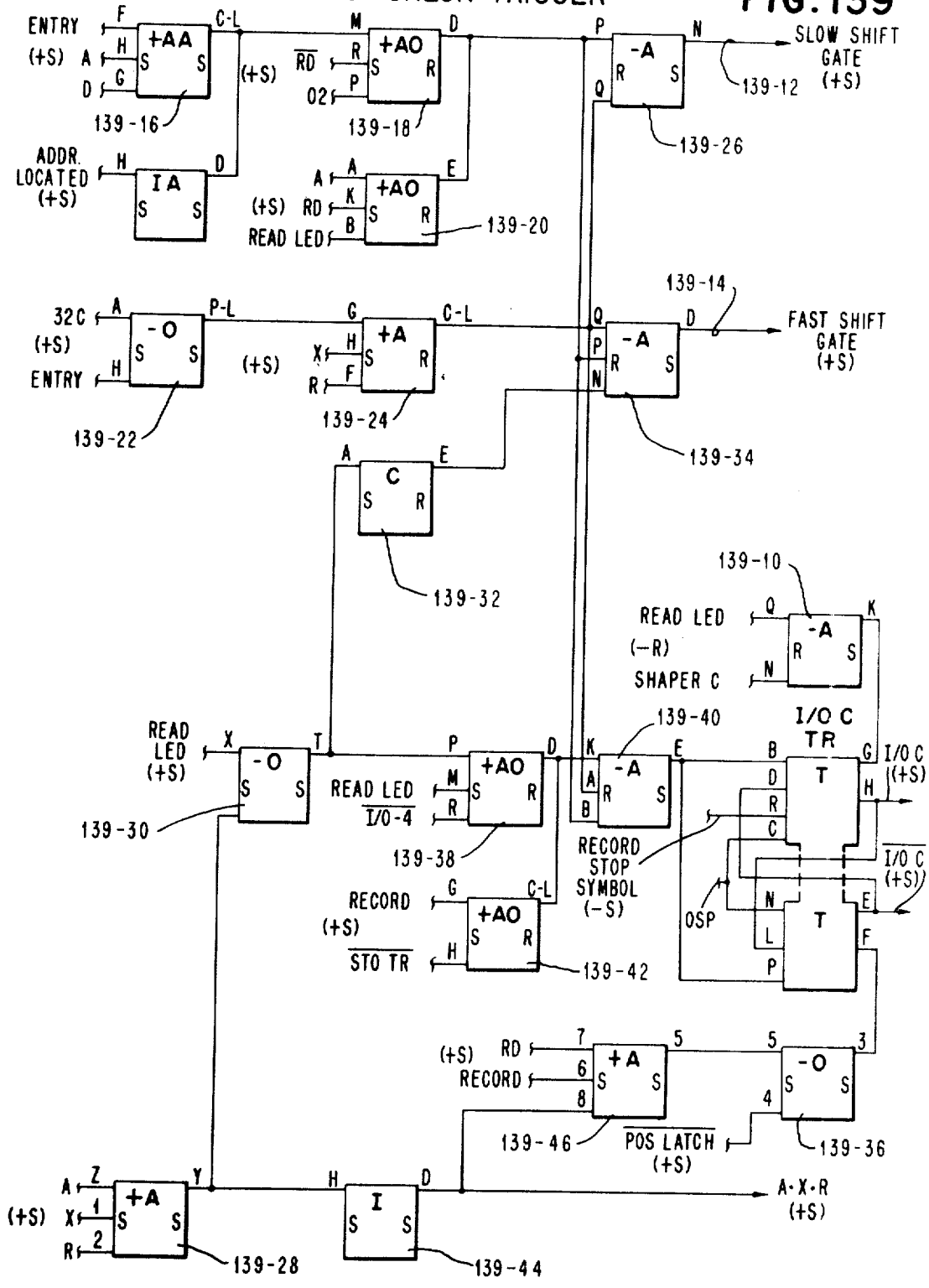
I/O REGISTER

FIG. 138



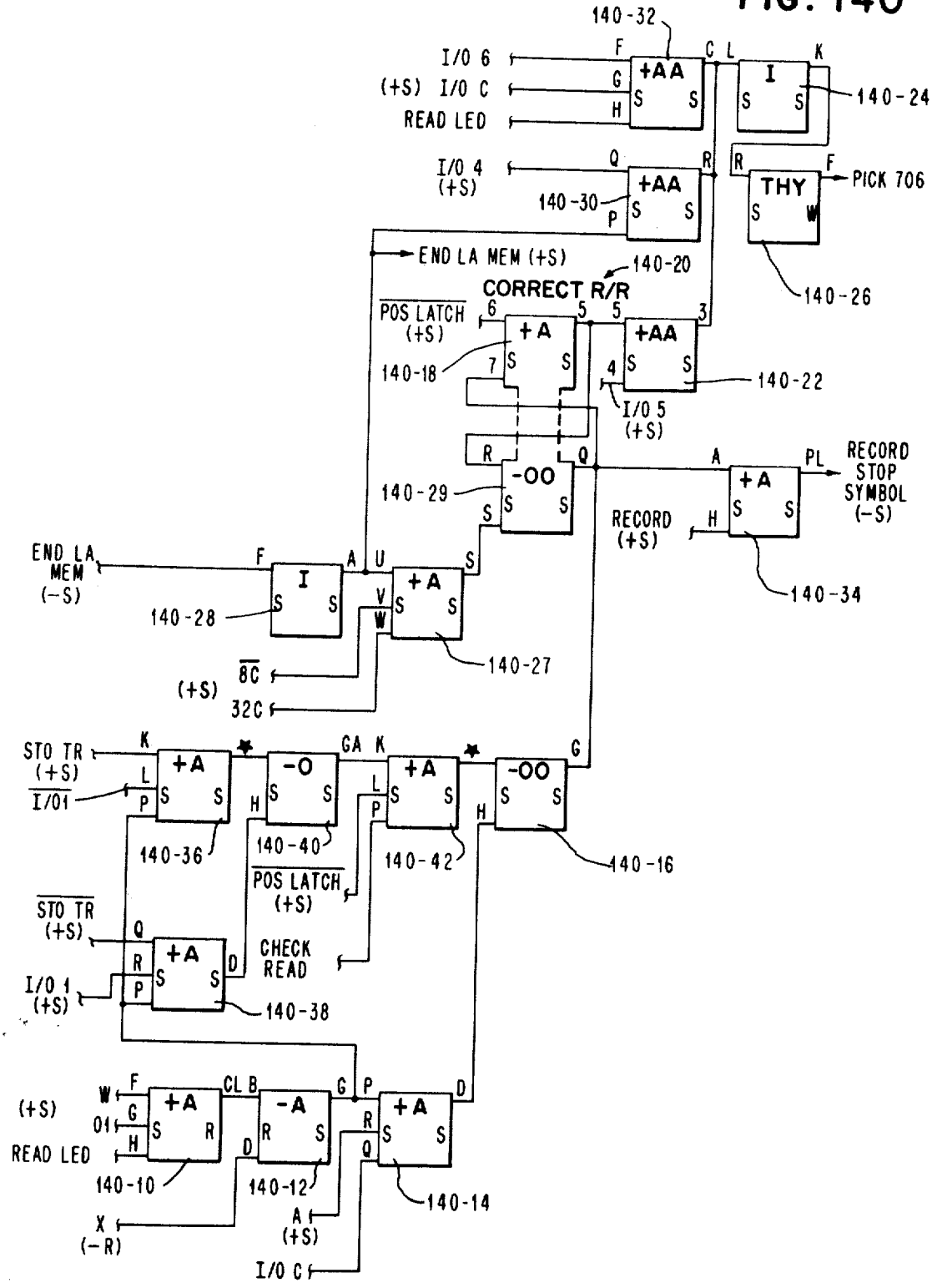
I/O CHECK TRIGGER

FIG. 139



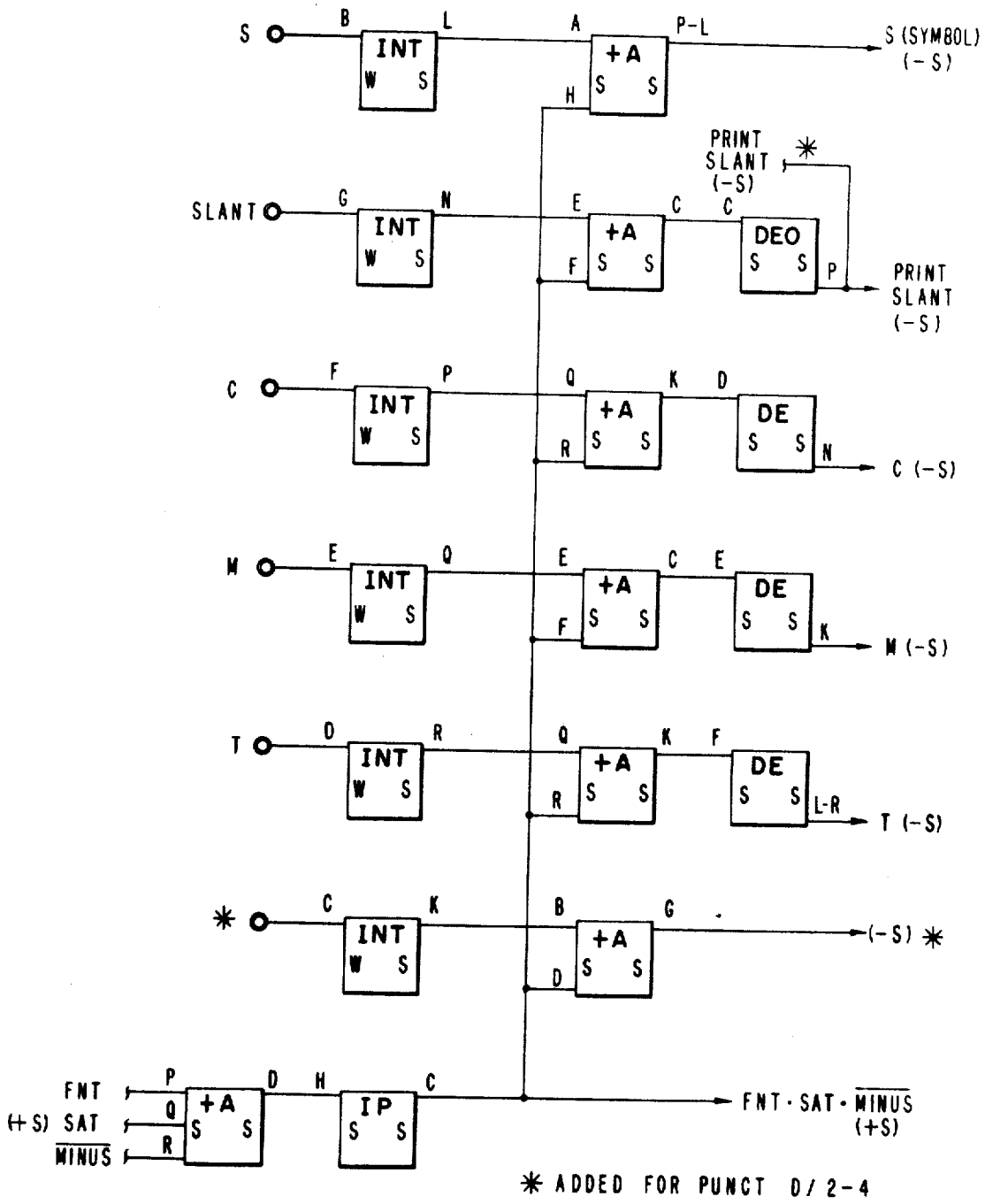
LEDGER ERROR

FIG. 140

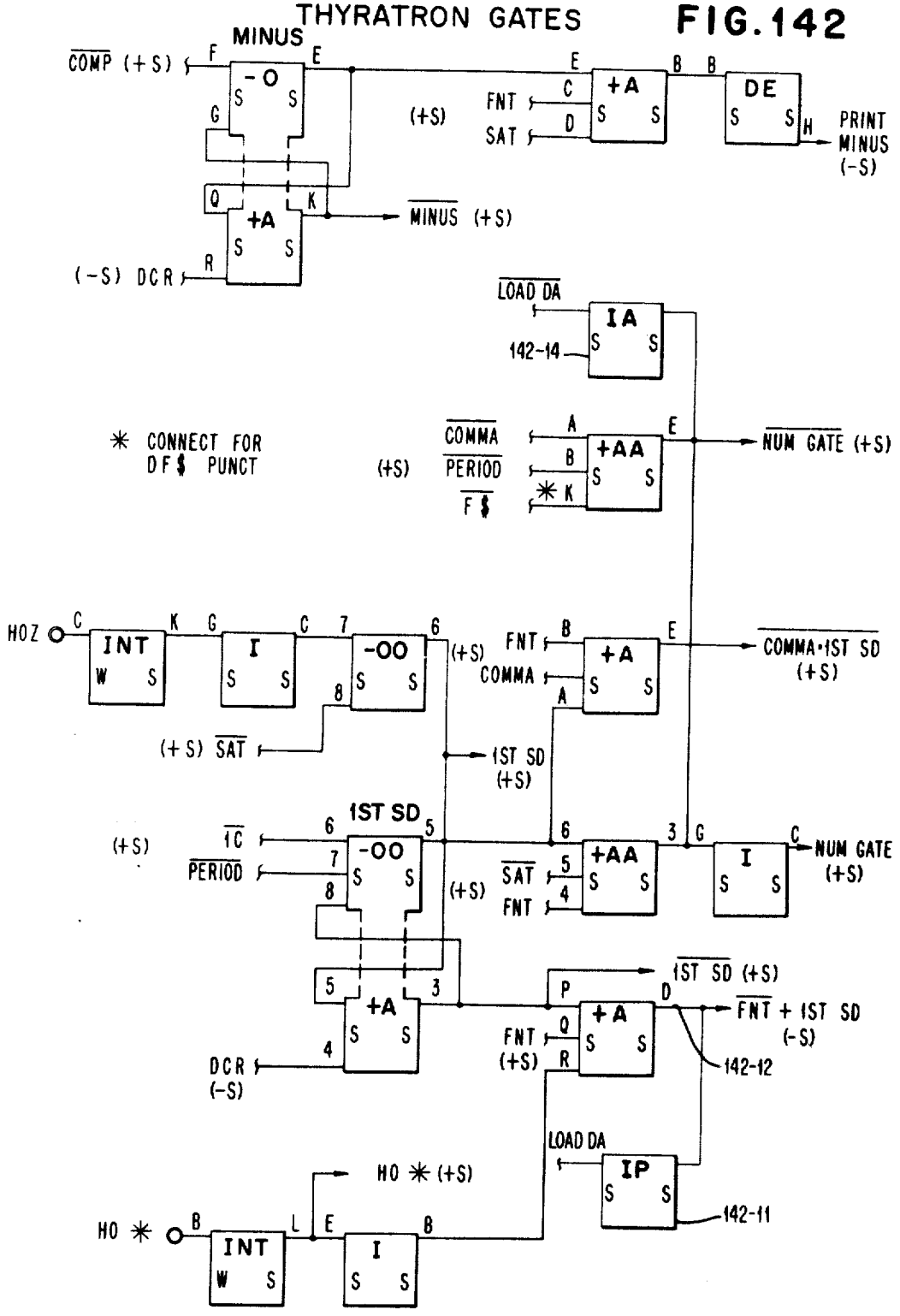


SYMBOLS

FIG. 141

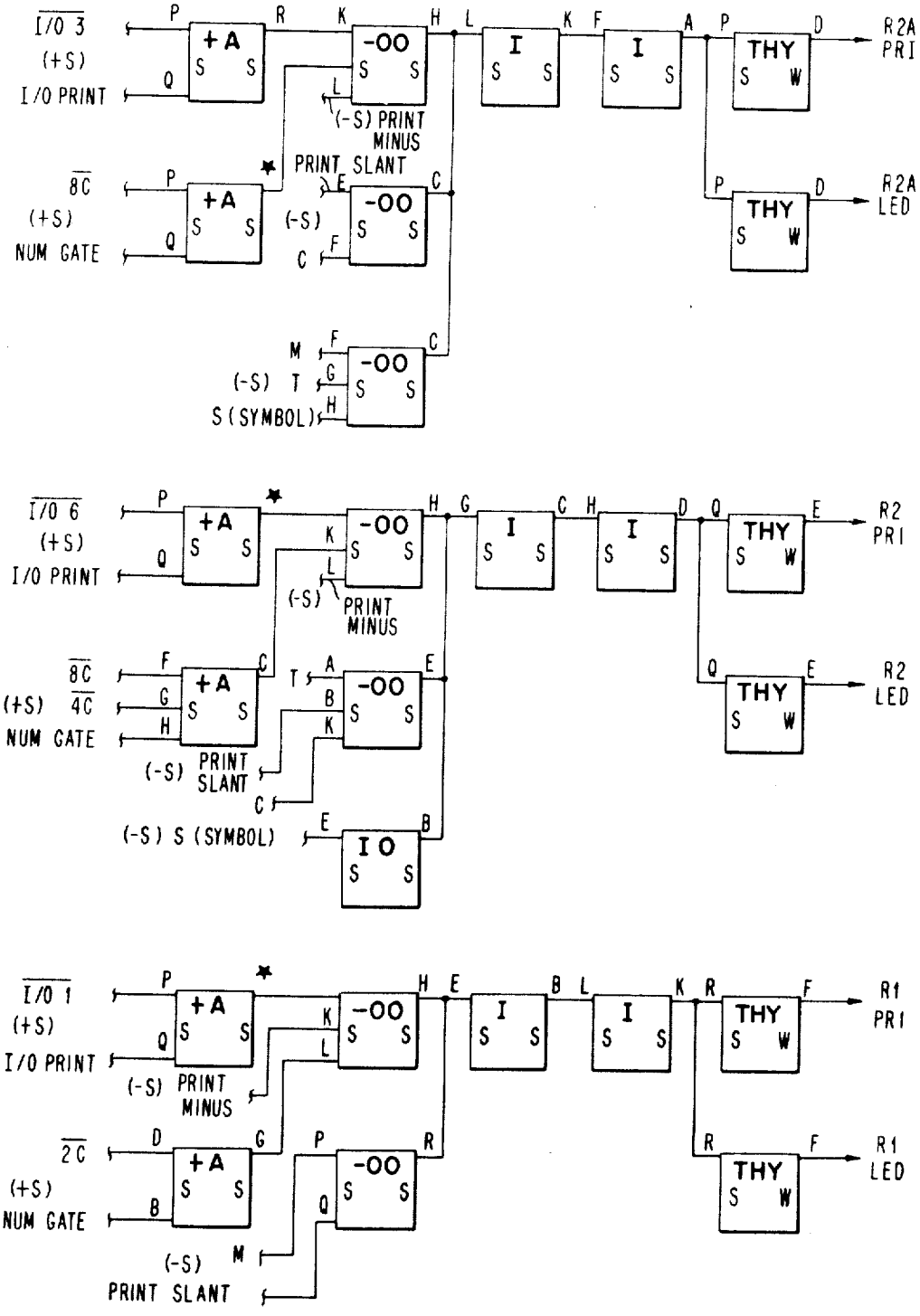


THYRATRON GATES FIG. 142



R1 R2 R2A THYRATRONS

FIG. 143



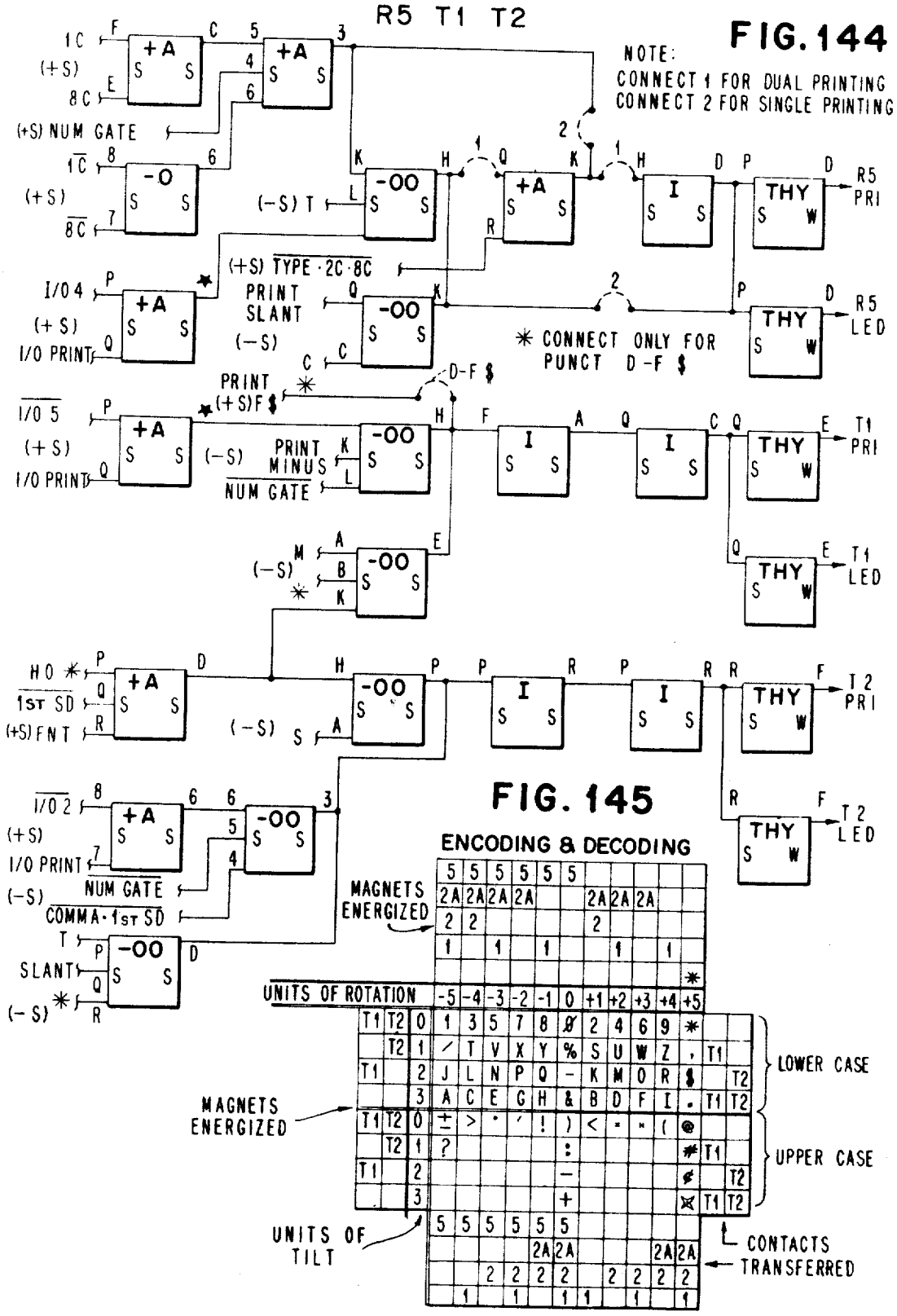


FIG. 144

FIG. 145

ENCODING & DECODING

FIG. 146

I/O REGISTER CODES

CHARACTER		I/O REG TRIGGERS						
LOWER CASE	UPPER CASE	1	2	3	4	5	6	
A		0	1	0	1	1	0	FUNCTION CODES
B		1	1	0	0	1	0	
C		1	1	0	1	1	0	
D		0	1	0	0	1	1	
E		0	1	0	1	1	1	
F		1	1	0	0	1	1	
G		1	1	0	1	1	1	
H		0	1	1	1	1	1	
I		0	1	1	0	1	1	
J		0	1	0	1	0	0	
K		1	1	0	0	0	0	
L		1	1	0	1	0	0	
M		0	1	0	0	0	1	
N		0	1	0	1	0	1	
O		1	1	0	0	0	1	
P		1	1	0	1	0	1	
Q		0	1	1	1	0	1	
R		0	1	1	0	0	1	
S		1	0	0	0	1	0	
T		1	0	0	1	1	0	
U		0	0	0	0	1	1	
V		0	0	0	1	1	1	
W		1	0	0	0	1	1	
X		1	0	0	1	1	1	
Y		0	0	1	1	1	1	
Z		0	0	1	0	1	1	
.	☐	1	1	1	0	1	1	
,	#	1	0	1	0	1	1	
/	?	0	0	0	1	1	0	
%	:	1	0	1	1	1	1	
$	¢	1	1	1	0	0	1	
¥	@	1	0	1	0	0	1	
		R	T	R	R	T	R	
		1	2	2A	5	1	2	

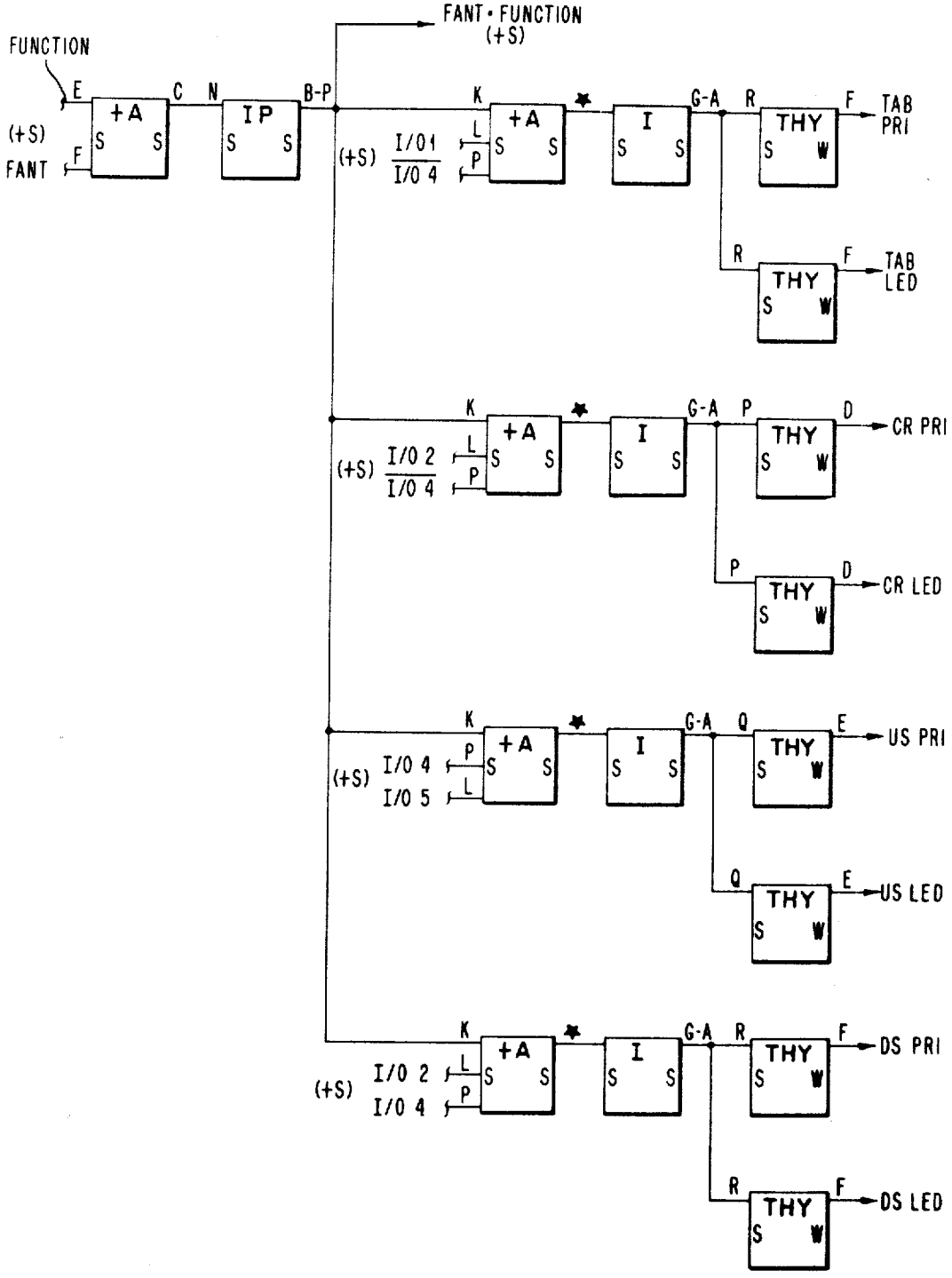
"O" INDICATES MAGNET PICKED EXCEPT R-5

CHARACTER		I/O REG TRIGGERS						
LOWER CASE	UPPER CASE	1	2	3	4	5	6	
&	+	1	1	1	1	1	1	FUNCTION CODES
-	_	1	1	1	1	0	1	
1	±	0	0	0	1	0	0	
2	<	1	0	0	0	0	0	
3	>	1	0	0	1	0	0	
4	=	0	0	0	0	0	1	
5	°	0	0	0	1	0	1	
6	"	1	0	0	0	0	1	
7	'	1	0	0	1	0	1	
8	!	0	0	1	1	0	1	
9	(	0	0	1	0	0	1	
Ø	)	0	0	0	0	0	0	
CARR.	RETURN	0	1	1	0	0	0	FUNCTION CODES
SHIFT	DOWN	0	1	1	1	0	0	
SHIFT	UP	0	0	1	1	1	0	
SPACE		0	0	1	0	1	0	
TAB		1	0	1	0	0	0	
FIELD	MARK	1	0	1	1	0	0	
ELECT. LOCK UP		0	0	1	0	0	0	
ELECT. LOCK UP		0	0	1	1	0	0	
%	:	0	0	0	0	1	0	
-	_	0	1	0	0	0	0	
&	+	0	1	0	0	1	0	
Ø	)	1	0	1	1	0	1	
CR	SP	0	1	1	0	1	0	REDUNDANT CODES
TAB	CR	1	1	1	0	0	0	
TAB CR	SP	1	1	1	0	1	0	
TAB	SP	1	0	1	0	1	0	
US	DS	0	1	1	1	1	0	
US DS	FM	1	1	1	1	1	0	
US	FM	1	1	1	1	0	0	
US	FM	1	0	1	1	1	0	
		R	T	R	R	T	R	
		1	2	2A	5	1	2	

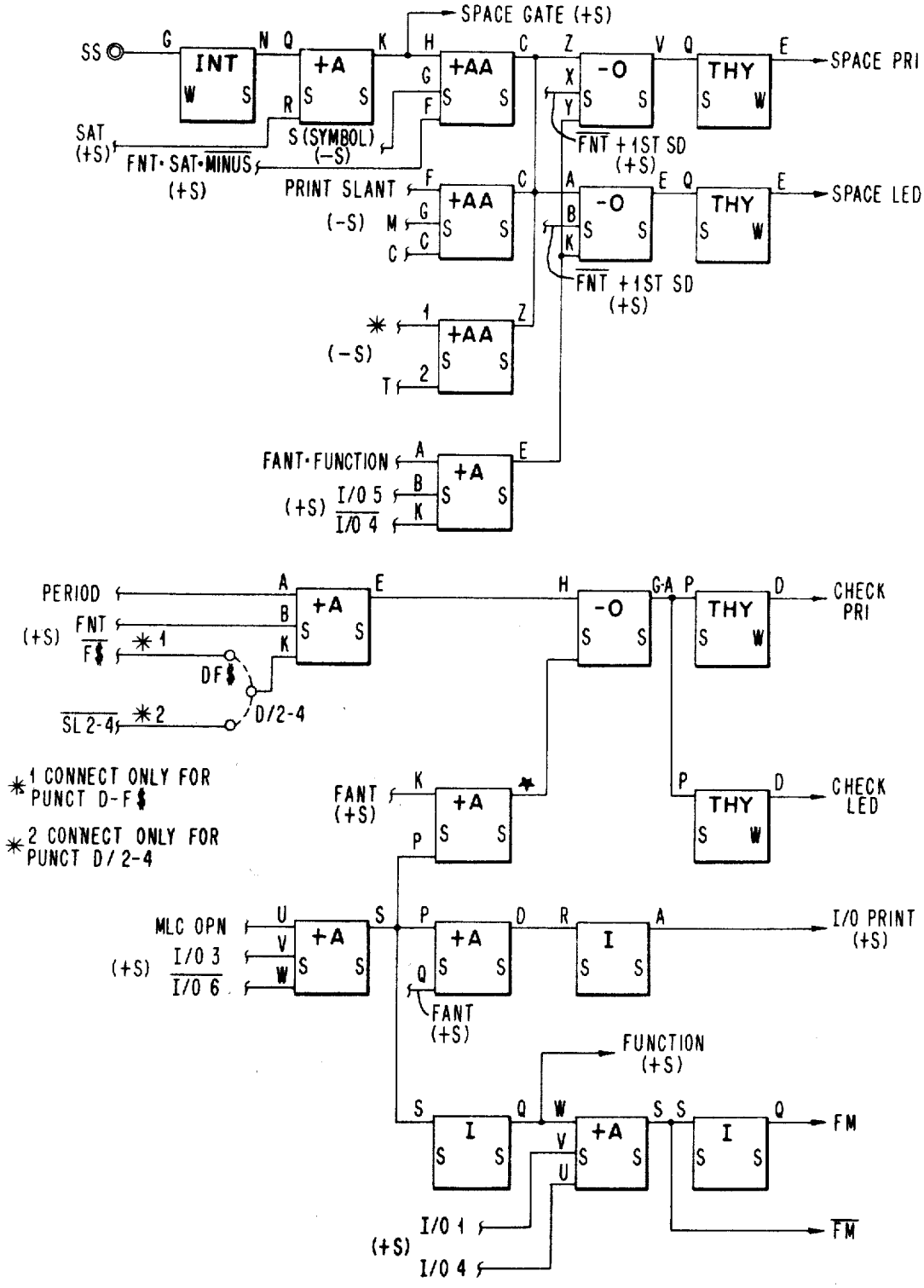
"O" INDICATES MAGNET PICKED EXCEPT R-5

FUNCTION THYRATRONS

FIG. 147



SPACE CHECK I/O PRINT FIELD MARK **FIG. 148**



FNT - RELAY START GATE - KBR

FIG. 149

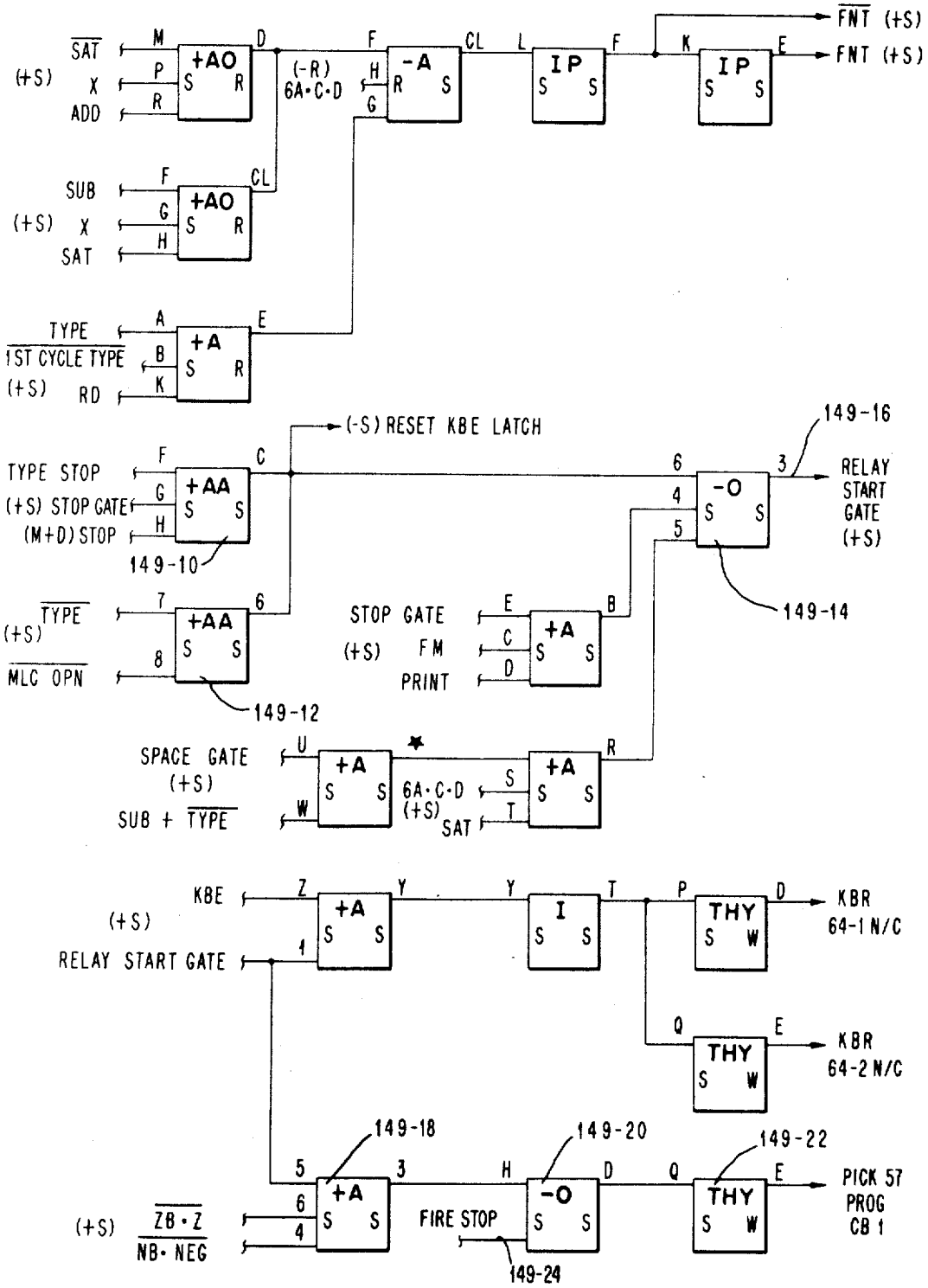


FIG. 150

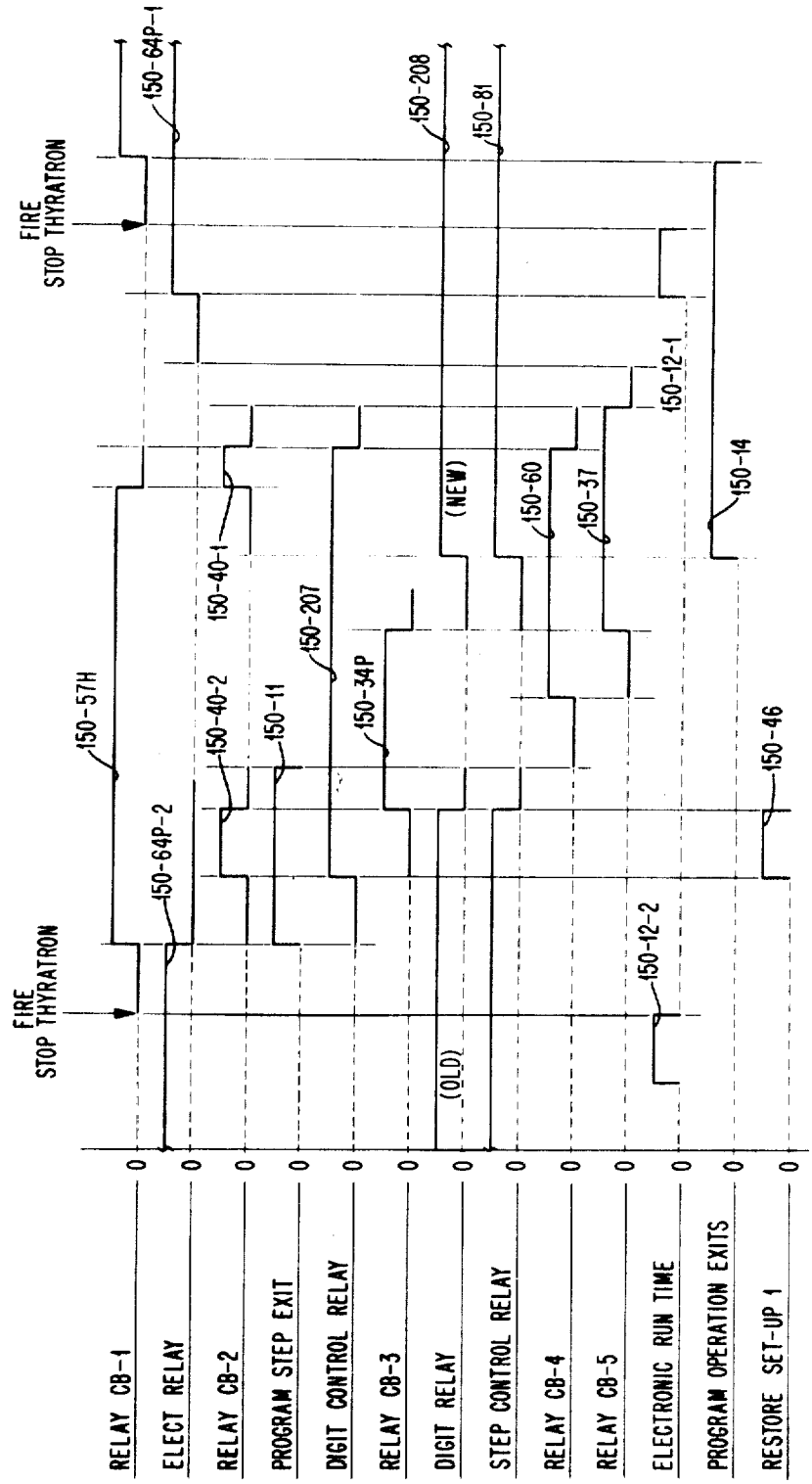
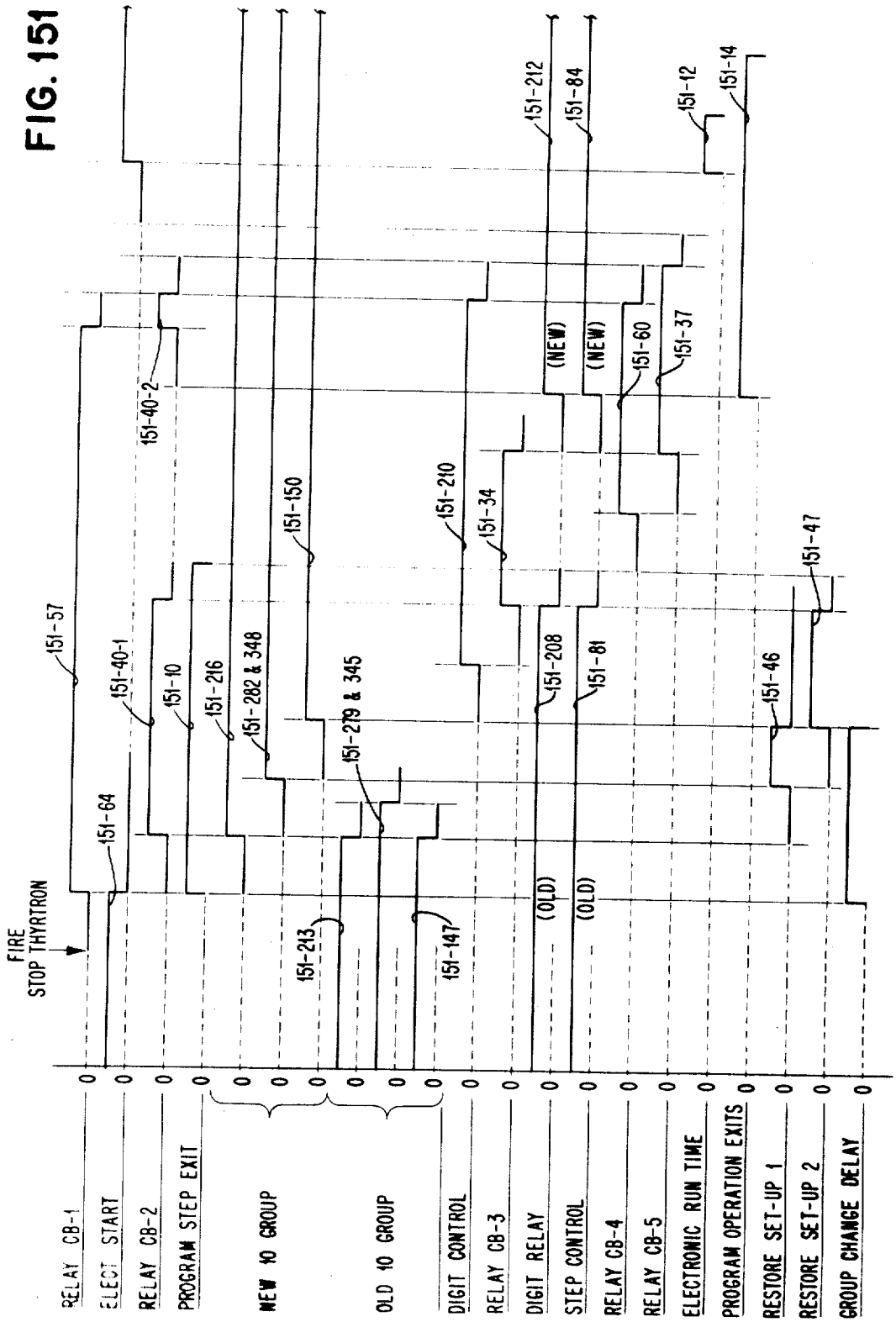

FIRE STOP THYRATRON
FIRE STOP THYRATRON
150-64P-1
150-208
150-81
150-12-1
150-14
150-60
150-37
(NEW)
150-40-1
150-207
150-57H
150-40-2
150-11
150-34P
150-64P-2
150-46
150-12-2
(OLD)
RELAY CB-1
ELECT RELAY
RELAY CB-2
PROGRAM STEP EXIT
DIGIT CONTROL RELAY
RELAY CB-3
DIGIT RELAY
STEP CONTROL RELAY
RELAY CB-4
RELAY CB-5
ELECTRONIC RUN TIME
PROGRAM OPERATION EXITS
RESTORE SET-UP 1
0

FIG. 151


FIRE
STOP THYRTRON
151-57
151-64
151-40-1
151-10
151-216
151-282 & 348
151-279 & 345
151-213
151-150
151-40-2
151-210
151-34
151-147
151-208
151-81
151-212
151-84
151-12
151-14
151-60
151-37
151-47
151-46
(NEW)
(NEW)
(OLD)
(OLD)
RELAY CB-1
ELECT START
RELAY CB-2
PROGRAM STEP EXIT
NEW 10 GROUP
OLD 10 GROUP
DIGIT CONTROL
RELAY CB-3
DIGIT RELAY
STEP CONTROL
RELAY CB-4
RELAY CB-5
ELECTRONIC RUN TIME
PROGRAM OPERATION EXITS
RESTORE SET-UP 1
RESTORE SET-UP 2
GROUP CHANGE DELAY

DIGIT ANALYZER

FIG. 152

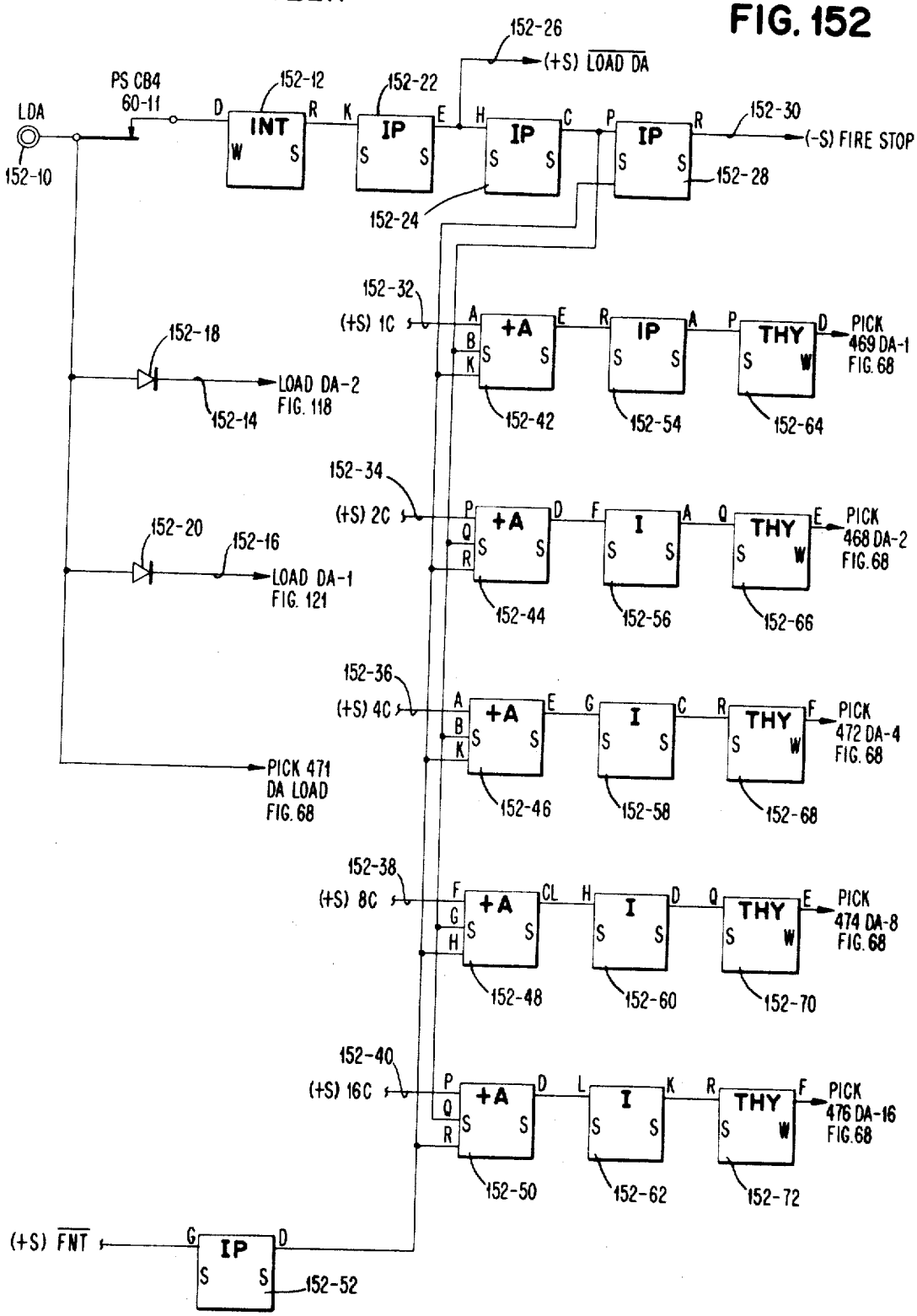


FIG. 153

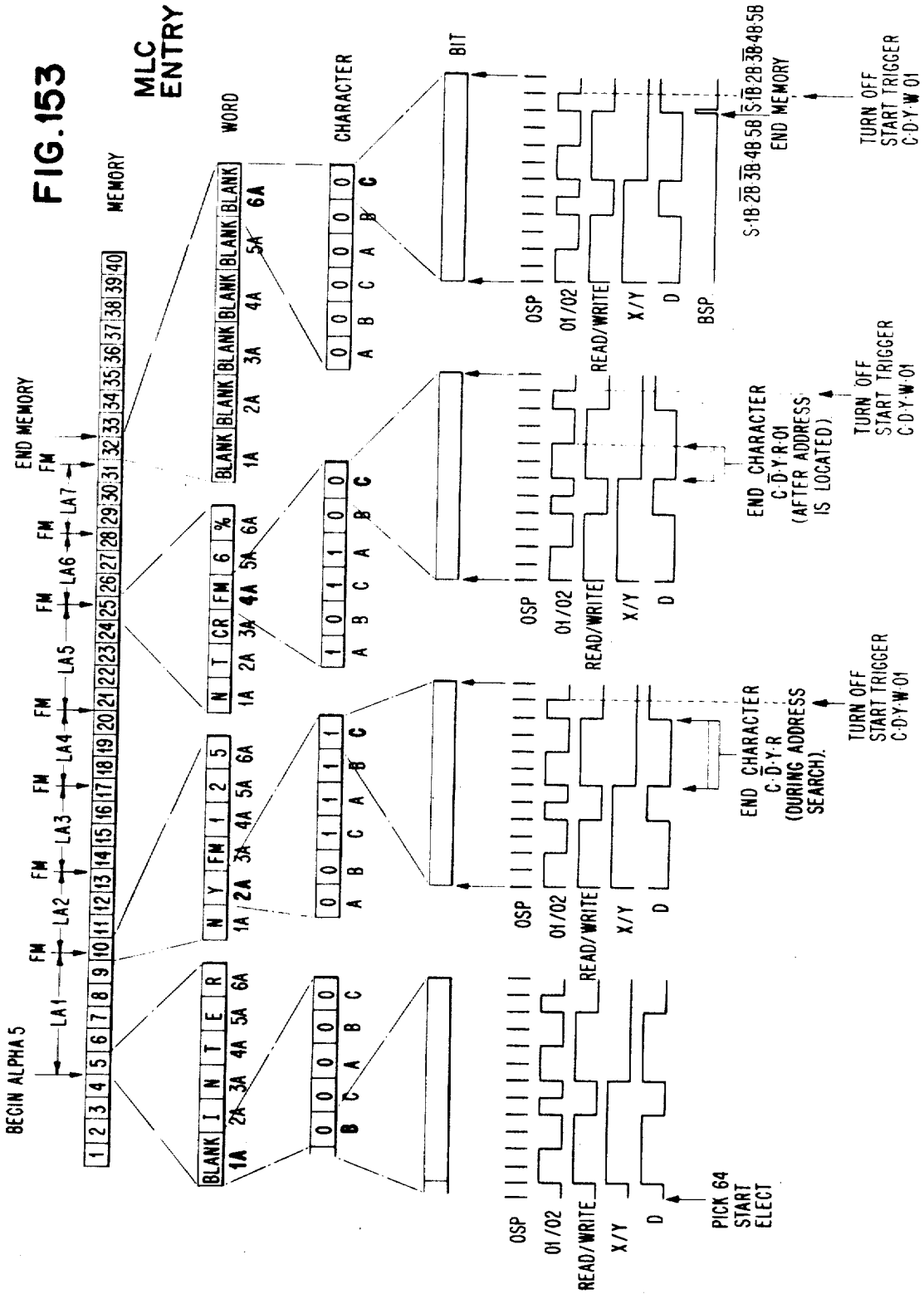
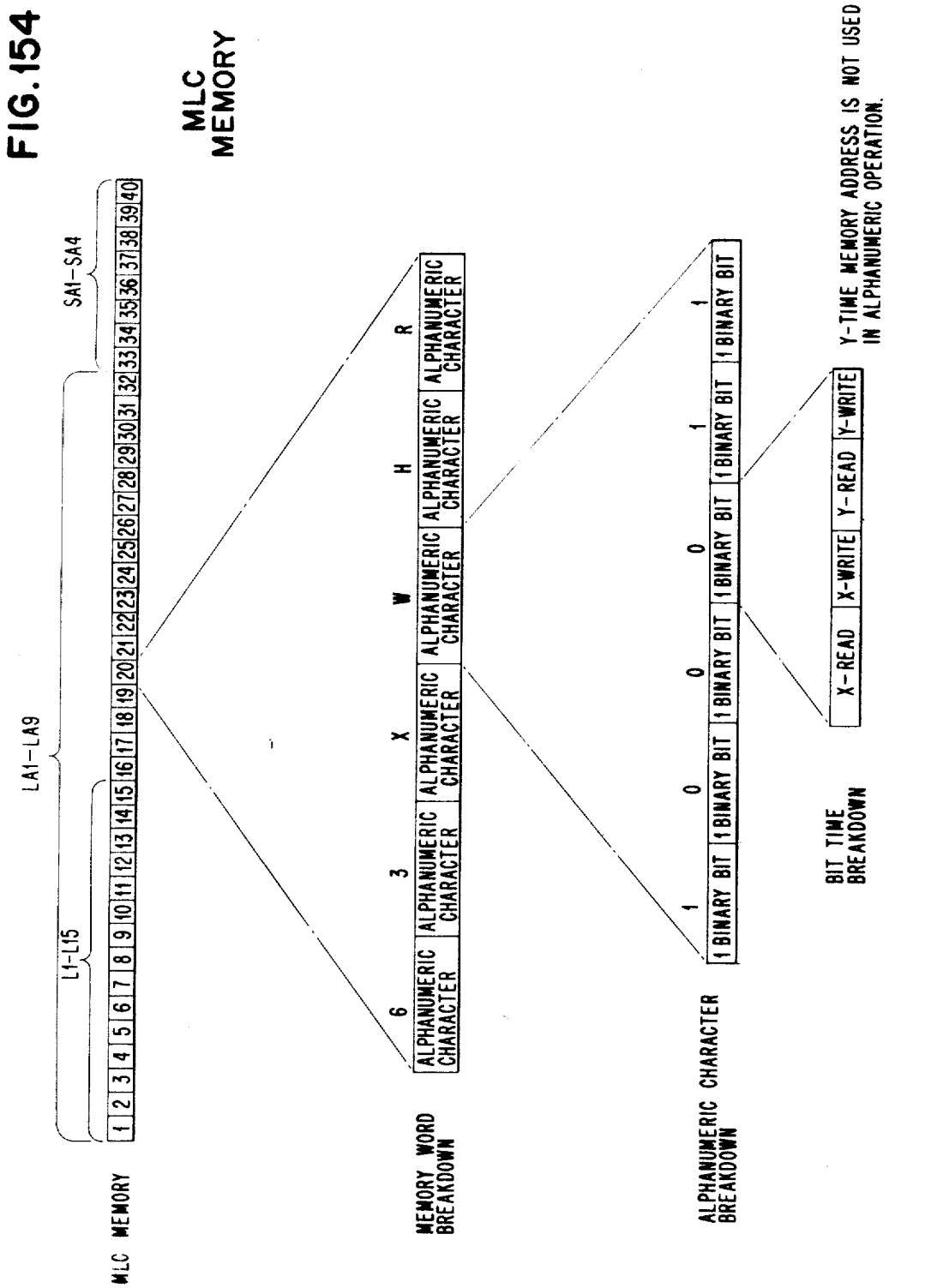

MLC ENTRY
MEMORY
WORD
CHARACTER
BIT
BEGIN ALPHA 5
END MEMORY
BLANK I N T E R
BLANK BLANK BLANK BLANK BLANK
N T CR FM 6 %
N Y FM 1 2 5
0 0 0 0 0
1 0 1 1 1 0
0 0 1 1 1 1
A B C
1A 2A 3A 4A 5A 6A
LA1 LA2 LA3 LA4 LA5 LA6 LA7
FM
OSP
01/02
READ/WRITE
X/Y
D
BSP
PICK 64 START ELECT
END CHARACTER C·D·Y·R (DURING ADDRESS SEARCH).
END CHARACTER C·D·Y·R·01 (AFTER ADDRESS IS LOCATED)
TURN OFF START TRIGGER C·D·Y·W·01
S·1B 2B 3B 4B 5B

FIG. 154


MLC MEMORY
LA1-LA9
L1-L15
SA1-SA4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
MLC MEMORY
MEMORY WORD BREAKDOWN
6 ALPHANUMERIC CHARACTER
3 ALPHANUMERIC CHARACTER
X ALPHANUMERIC CHARACTER
W ALPHANUMERIC CHARACTER
H ALPHANUMERIC CHARACTER
R ALPHANUMERIC CHARACTER
ALPHANUMERIC CHARACTER BREAKDOWN
1 BINARY BIT
0
0
0
1
1
BIT TIME BREAKDOWN
X-READ
X-WRITE
Y-READ
Y-WRITE
Y-TIME MEMORY ADDRESS IS NOT USED IN ALPHANUMERIC OPERATION.

United States Patent Office 3,525,984 Patented Aug. 25, 1970

3,525,984

ELECTRONIC COMPUTING BUSINESS MACHINE

Everett C. Clay, Peter J. De George, Wilson I. Lockett, and William L. McDonald, Lexington, Ky., and Joseph R. Stewart, Rockville, Md., assignors to International Business Machines Corporation, Armonk, N.Y., a corporation of New York

Original application Dec. 28, 1962, Ser. No. 248,110. Divided and this application Sept. 18, 1967, Ser. No. 668,413

Int. Cl. G06f *15/04, 15/24*

U.S. Cl. 340—172.5 5 Claims

ABSTRACT OF THE DISCLOSURE

A business machine having an electronic data processing unit including storage and calculator units for the preparation of a primary document on a primary printer having a keyboard and for updating a secondary source document on a ledger card printer a magnetic ledger card unit for recording and reading information on and from a magnetic stripe on the secondary document and a pluggable probram unit responsive to the coordinate position of the primary document with respect to the primary printer and to the ledger card unit for sequencing the following operations: entering information into the storage unit from the ledger card unit and keyboard unit, specifying the operation to be performed by the calculator unit, and outputting of information to the magnetic ledger card unit, primary printer, and ledger card printer.

CROSS REFERENCES TO OTHER APPLICATIONS

This is a division of application Ser. No. 248,110, filed Dec. 28, 1962.

This invention relates to business machines and more particularly to electronic computing business machines of the type capable of preparing various business forms such as invoices, bills, paychecks and for performing various accounting functions.

In many businesses it is necessary to periodically prepare many groups of similar documents such as invoices and paychecks. In the preparation of each of these forms, it is necessary to aggregate and process certain raw data and to print certain information, either the raw data, or as determined from the processing, on the blank document. Purely as an example, in the preparation of an invoice, it is necessary to aggregate certain information such as number of items shipped, description of item, price per item or per group of items, tax rates, shipping rates, discounts, etc. In addition to printing this information on the invoice, it is necessary to perform certain arithmetic operations with certain parts of such data to arrive at a final total of charges and to print the information resulting at various stages of processing, including the total charges.

Clearly, processing of data by "pencil and paper" calculation procedures or even with the use of desk calculators, is grossly inadequate in very many present day businesses. In recent years, enormous progress has been made in developing large data processing machines and systems which are capable of preparing documents of the type mentioned above at a very rapid rate. In many such large machines and systems, in preparation for processing, large quantities of raw data and program instruction data are entered into the system in any one of several ways such as through card readers, magnetic or paper tapes or other media which are pre-prepared as, for example, by manual operation of card punching machines and the data is stored within the machine or system for quicker

access. Thereafter, the machine or system processes the data and prints the final document without any further operator attention.

While the large systems of the type described are very versatile and fast in their operations, they are far too large and expensive for many relatively small businesses or for certain operations of larger businesses, especially in view of the fact that in addition to the processing unit itself there are required relatively large input/output machines such as card readers and punches, tape readers and other auxiliary equipment.

In addition to the large processing systems described, other operator oriented machines or systems of intermediate or small size, capabilities and cost have been developed particularly for smaller business data processing. In these machines a human operator maintains overall control of the machine although many of the operations are performed automatically in accordance with a pre-established program. Many of these machines are well adapted for the purposes intended but in many cases they lack the additional versatility and effectiveness desired and require too much control and activity on the part of the operator for reliability, accuracy and speed. These machines are also inflexible with regard to programming and format control. Programming, controlled by the horizontal position of the carrier has been effected, such as by program bars or racks or even program tapes but there is no facility for program changes along the horizontal printing line which is dependent also on the vertical position of the form.

In the larger and relatively expensive systems of the type above mentioned wherein the system operating instructions, as well as raw data, are entered as a program into the machine storage, the additional expense required for the convenience and flexibility achieved by this feature, is relatively great. Simpler and less expensive programming of machine operation has been achieved by program tapes as above mentioned, which have operating instructions coded thereon and which instructions are sensed and detected continually during the machine operation. In other cases simple and inexpensive programming is achieved by control panels which must be prewired in accordance with the machine operation desired and which are connected into the circuitry of the machine during its operation. Each of these programming techniques are relatively simple and inexpensive, but yet are very effective and in certain respects afford considerable flexibility in that they are readily and easily replaced or changed so as to provide an altogether different machine program of instructions.

In the cases of machines programmed by coded program tapes in accordance with the prior art, a severe limitation is the requirement to perform the coded instructions of the tape which depends on the horizontal position of the printer irrespective of the vertical position of the output document. For example, the program instructions required in one line item of an invoice wherein the charge for a single group of items is determined is quite different from the program instructions required for processing data to determine the final line entries wherein gross amount, tax (discount, and other similar factors must be taken into account and processed.

In many typical business operations, a typical procedure is to periodically prepare documents of a certain type and wherein data is processed, much of which is invariable. Purely as an example, invoices for steady customers are prepared periodically and in the preparation of each invoice, certain data such as customer's name, shipping address, account number, the tax rates, discount rates and shipping rates which apply to a particular customer remain invariable from month to month. Also, in response to any shipment or sale of goods, it is necessary

to update various records such as accounts receivable wherein the new charges are added to an old balance, an inventory record wherein the amount of the current sale is subtracted from the quantity of such items in stock, and others. Also, the updating of such additional documents is appropriately and most effectively performed immediately after a sale or shipment of items so that the records will be current at the beginning of the preparation of the next invoice or other such form. Furthermore such documents are best updated substantially simultaneously with the preparation of forms such as invoices, etc. inasmuch as much of the information in storage at the end of an invoicing operation is also required for direct application to a ledger card or must be used for processing to obtain a result for entry on a ledger card. Accordingly, the substantially simultaneous or "on line" preparation of such ledger cards obviate the re-entry of the needed information.

In accordance with the prior art, various arrangements have been provided for non-manually introducing repetitive, invariable data of the type described above but these systems involve relatively complex and expensive accessories such as tape readers, resulting in a system impractical for a small business operation or small operations of a larger business. In addition to the auxiliary apparatus described for entering such data, ledger cards capable of magnetically storing only numeric information have been proposed, and these in cooperation with suitable magnetic reproducing apparatus have been utilized for introducing numeric information into intermediate or small size machines. However, since relatively large amounts of alphabetic or alphanumeric information is required in many document preparation procedures these prior arrangements are limited in improvement.

In the preparation of business forms, it is frequently necessary to cause an output printing element to be placed in a particular new position relative to the document being prepared and which new position may be either vertically or horizontally or both vertically and horizontally different from the initial position of the printing element relative to the document. It is further necessary for expedient preparation of business forms to enable such position seeking and relocation to be conditioned upon some circumstance resulting from the data processing or in other words, to enable branching to either of two printer locations, both of which may be at new horizontal and vertical locations.

Accordingly, it is a principal object of this invention to exploit the advantages of both program tape and control panel programming in a simple and inexpensive manner without suffering the disadvantages described hereinabove to provide more versatile and effective operation of a business machine.

It is another object of this invention to facilitate faster, more effective and reliable preparation of business forms with an operator-oriented business machine.

It is another object of this invention to facilitate simple, effective and flexible program branching control in an operator-oriented business machine, in accordance with both dimensions of format or in response to operator or key manipulation.

It is another object of this invention to provide in a small business machine, simple, inexpensive and effective means for automatically entering both numeric and alphanumeric data into storage of the machine for ready access for processing.

It is another object of this invention to facilitate complete program change and control in an operator-oriented business machine, based upon either operator decision, the input data, results of a calculation or upon any combination of such factors.

It is another object of this invention to quickly, easily and effectively transfer both numeric and alphanumeric data in both directions between a record medium and the storage unit of a business machine.

It is another object of this invention to facilitate the transfer of numeric and alphanumeric data between a record medium and a storage unit without any transmission thereof being required.

It is another object of this invention to facilitate visible and magnetic recording of both numeric and alphanumeric information on a card from the storage unit of a business machine.

It is another object of this invention to facilitate magnetic ledger card operation in a business machine and to provide facilities for conditioning the machine and card for magnetic reading and recording and for visible printing.

It is another object of this invention to avoid complex control features in a small business machine and to facilitate easy and rapid program changing according to the type of form to be prepared.

It is still another object of this invention to provide a business machine of the operator-oriented type which is simple but yet incorporates many features of versatility of larger, more expensive machines and which also is capable of performing a wide variety of arithmetic, data handling and form preparation functions.

It is still another object of this invention to provide a novel business machine capable of performing a complete accounting operation by not only preparing documents such as invoices and bills but also in an on-line operation taking into consideration old balances of items such as customer accounts receivable, inventory records, new information as from order forms, the number of new items sold and sent, the charges therefor and with this information readily and easily update the documents such as accounts receivable card, inventory card, to enter new balances as a result of the transaction.

It is still another object of this invention to facilitate the on-line preparation of multiple documents including unit records of different kinds in one operation of accounting by the selective or simultaneous activation of a pair of printer units under program control.

It is still another object of this invention to facilitate error correction and duplication of magnetically recorded information on a record card having a magnetic stripe thereon for the recordation of information.

Pursuant to the foregoing objects and advantages, the business machine in accordance with this invention includes a computer incorporating a control panel prewired in accordance with a predetermined program of operating instructions and further includes provisions for sensing the vertical position of the output form and horizontal position of the output printer to supply an electrical impulse indicative of these respective positions and which impulse may be used to initiate a particular program routine which is appropriate under the conditions of the form and printer positions. These sensing means include a first loop program tape associated with the output document and having holes punched therein which identify and bear a one to one relationship to vertical fields of the output document. The output document is one of a series on a continuous form and delineated as by perforations. As the continuous form rolls through the printer, the vertical tape also rolls and the loop length of the tape is the same as the length of one output document form or some multiple of it. Thus, a sensing device for sensing the position of the vertical tape in effect senses the position of the output document in the printer. The different lines of the printer are represented on the tape by coded positions of punched holes in the tape.

For sensing the horizontal position of the carrier, a horizontal, open-ended tape mechanically linked to the printer carrier so as to be movable in unison with it, is provided. The horizontal tape has coded pairs of punched holes along its length which are positioned to correspond directly to the beginnings of horizontal fields on the output document. A sensing device, senses the horizontal position of the horizontal tape and thus, in

effect, senses the horizontal position of the printer carrier. The signals sensed by the two sensing devices for vertical and horizontal tapes are utilized individually to provide an electrical impulse to the control panel which is effective to initiate a printer function, initiate a computer program routine or for other purposes. Also, the outputs of these devices are combinable by computer circuitry to provide a single electrical impulse at a control panel hub which is indicative of both the vertical position of the document form and the horizontal position of the printer carrier. This impulse is similarly useful to initiate printer control functions, program routines, etc.

It is significant to note that in accordance with the briefly described format programming arrangement, each coordinate matrix point of an output document, i.e., each combination of vertical and horizontal positions of document and carrier is unique and is usable to initiate a different action from any other such coordinate point. The different vertical positions of the output document may have a different significance even if the horizontal position of the printer carrier remains the same or conversely, each horizontal position of the printer carrier may have a different significance in the same vertical position of the output document. Thus, an appropriate program routine or other action may be initiated in accordance with the coordinate position of format.

As another feature of the invention, the vertical and horizontal tapes, sensing devices and computer circuitry are effective and responsive to an electrical impulse applied in accordance with suitable prewiring of a control panel, to cause the output document of the printer to be moved to a predetermined vertical field position and similarly, the printer carrier to be moved to a predetermined horizontal field. In these operations, the document or carrier position is first sensed. If the same is not in the sought location, movement of the unit is initiated and successive positions are sensed by the associated tape until the sought position is found at which position movement is terminated. Upon the arrival of document or carrier at the sought position, an impulse indicative of such arrival is produced at the control panel and further machine operation may be initiated by such impulse.

Pursuant to another object of the business machine of this invention is a simplified, compact and versatile structure capable of performing many arithmetic and printer functions enabling performance of a complete accounting operation. By the provision of a primary printer and a magnetic ledger card handling unit with an associated printer and facilitating selective printing on the output document in the primary printer, on the card in the ledger card printer or on both simultaneously, together with the further provision of a magnetic stripe on ledger cards, such as accounts receivable or journal cards, on which numeric and alphanumeric information may be recorded or from which it may be reproduced by the ledger card unit, great data handling and processing capabilities are provided in the machine. The ledger card unit is capable of reading information magnetically stored on the card, entering into storage without any translation processes involved, and thereafter the computer is capable of utilizing such information in arithmetic computations if it is numeric, printing the information on either printer and processing it in other ways. Following the processing of information in the wide variety of ways possible, information may not only be printed at various stages of processing but also, pertinent "on line" operations such as updating of an accounts receivable or journal card including the recording of updated information on the magnetic stripe may be performed.

In accordance with the novel interrelationship and correlation between the many components of the present business machine, a high degree of versatility in data handling capability is provided. By the novel provision of vertical and horizontal tape units cooperative with a prewired control panel to facilitate the seeking and location of vertical position of forms, the horizontal position of carrier of a printer, or both, and by initiating a unique program sequence as predetermined by the prewired control panel in accordance with such unique coordinate position of forms and carrier, great programming versatility is incorporated in the system. Furthermore, by the provision of a magnetic ledger card section of memory correlated with the magnetic ledger card handling unit to enable the simple entry of both numeric and alphanumeric information into memory and the facility for arithmetically processing the numeric information entered through the ledger card unit together with numeric information manually keyed into the machine and for typing or printing any part of the arithmetically processed information or the alphanumeric information as desired and programmed, on either primary or ledger printers provides extreme data handling and processing capabilities in a small business machine.

GENERAL

The business machine in accordance with this invention includes a computer together with input/output apparatus. For manually entering alphanumeric information, a primary typewriter is provided and has a keyboard available to the operator. In certain modes of the machine, the typewriter is operable independently of the machine and without any relation thereto so as to facilitate manual typing without affecting the machine. For entering numeric information into the machine, a ten key companion keyboard unit capable of entering decimal digits 0 through 9 is provided. The primary typewriter serves as a primary output printer for both numeric and alphanumeric information. Numeric and alphanumeric information can also be entered into the machine through a magnetic ledger card unit having a magnetic recording and reproducing apparatus for transferring information between a magnetic stripe and the storage unit of the machine. The magnetic ledger card unit also contains a typewriter serving as a magnetic ledger card printer. The keyboard of the magnetic ledger card printer is not available to the machine operator and the typewriter serves only as an output apparatus. The two printers are operable under program control either independently or jointly as output printers.

The basic electronic timing of the system is determined by a 100 kilocycle per second square wave oscillator. Oscillator sample pulses at the same rate are derived from the oscillator. The bit read time for each core of the memory is 40 microseconds and the bit regeneration time is twenty microseconds. Accordingly the read and regeneration times of the two operand words are each equal to 60 microseconds. Also, a complete electronic cycle time is 4.32 milliseconds ($72\times60\times10^{-6}$).

The machine when power is turned on, has three different major modes. As it is first turned on, or after being restored, it is in the input mode wherein it is receptive to numeric information keyed into the ten key companion keyboard unit. It translates the decimal numeric digits so entered and stores the numeric numbers in the machine memory in pure binary form. Also, in the input mode, the machine may be conditioned either by operator choice or by program control to be responsive to manual typing to enter alphanumeric information into machine memory. In another form of input mode called alpha entry mode, the machine is responsive to manipulation of keys of the primary printer to encode the characters corresponding thereto and enter these encoded characters into magnetic ledger card section of memory. Exit from this mode can be accomplished by actuating the restore or program start keys. In another form of input mode, called read ledger mode, the magnetic ledger card unit is responsive to the entry of a magnetic ledger card with a magnetic stripe, to position the card, and cause a magnetic head to scan the magnetic stripe to read

the magnetic information recorded on the stripe and enter this information into 32 words of the magnetic ledger card portion of machine storage. In the latter form of input mode, the machine may be conditioned to put a new card into use by recording the contents of alphanumeric section of memory on the magnetic stripe of the new card. In this circumstance, since the new card has not been in previous use, the magnetic stripe of the new card is scanned by the head but is not read on its insertion into the machine.

The second major mode of the machine is the automatic mode which it assumes, for example, during processing operations such as addition, subtraction and the like. That is, it is under control of the program step sequencer. At the end of a sequence of program steps in the automatic mode of operation, the machine may be conditioned to record on the magnetic ledger card stripe the contents of MLC memory. Following the record, the memory is again read as the information just recorded on the stripe is checked for accuracy. The automatic mode may be modified by conditioning which is responsive to new card and error signals or by program errors. As modified by new card condition, a signal to the machine indicating a new magnetic ledger card is to be prepared after a read ledger operation, the machine treats the sensing of such signal during automatic mode as a signal to eject the card. With regard to the sensing of an error during a check read operation wherein the magnetic card unit checks the information read from a stripe of a ledger card for accuracy, the machine is "dead" to the operator with the exception that depression of a magnetic ledger card error key on the console and re-insertion of the card or insertion of a new card will cause the card to be recorded, checked and ejected automatically.

In the case of program error in automatic mode, the machine is characterized by locking of the numeric and alphanumeric keyboards and the machine is taken out of this mode by manipulation of the "restore" key.

The third major mode of the machine may be termed the "Not Ready" mode and exists under conditions such as when the paper guide of the carriage is open to any degree. The guide of the carriage may be opened to a half open or a full open position. At half open position, a program start control signal causes the guide to close and the machine to assume the automatic mode, while in the full open position of the guide, the machine is not so responsive.

The internal data storage of the machine is described in detail in the copending application of William L. McDonald, Peter J. DeGeorge, Joseph R. Stewart and Ray H. Thurmond, Ser. No. 248,098, filed concurrently herewith, now U.S. 3,297,992 issued Jan. 10, 1967, assigned to the present assignee, and hereinafter referred to as application "A." A brief description of this unit is included herein, however, reference is made to the above mentioned application for the details of this unit and its control. This storage unit includes a two-dimensional core plane having two sections representing main memory and magnetic ledger card memory, each comprising forty words of 36 cores for 36 binary bits of information per word. One core of each word of main memory is used as a dummy bit, one is used as a sign bit and the other 34 are used for storing only numeric information in pure binary form.

A main memory word forms a keyboard buffer word and in the numeric input mode of the machine, the numeric information entered in the numeric keyboard unit is routed to the keyboard buffer word. The first key entry in this manner clears the keyboard buffer word. Another word of main memory is termed the overflow register and is used in multiply and divide operations to contain the high order digits of the dividend and product, respectively.

A specified 15 words of magnetic ledger card memory may be used in two different manners. These words may be used simply as a 15 word addition to main memory for storing numeric information in pure binary form or, alternatively, these 15 words (1–15) may be used together with another 17 words (16–32) of the magnetic ledger card memory for storing alphanumeric information in accordance with a 6-bit-per-character code wherein all 36 bit cores of each word are used and no sign nor dummy bits are used. Any portion including all of these 32 words of the alphanumeric section of memory, irrespective of its beginning location, may be divided into as many as nine variable length fields each separated from adjacent ones or from beginning or end by a field marker, which is also a coded character occupying 6 core bits. These 32 words of memory are transferable to and from the magnetic stripe of the magnetic ledger card.

Another 8 words (33–40) of magnetic ledger card section of memory is the special alphanumeric section. Alphanumeric information may be stored in this section of memory in accordance with the mentioned 6 bit code and these 8 words may be divided into as many as 4 variable length fields, each delineated at beginning and end by a field marker as described above. This portion of memory is not transferable to and from the magnetic stripe of the magnetic ledger card.

A last adjunct section of memory comprises a group of cores useful for storing fixed factors. A group of matrix lines are provided, each selectively inductively coupling certain ones of the cores. With a 1 bit stored in each core, the numbers which are read out on the respective lines are represented by the expression, 5×10^{n}, wherein n may be any integral value from -1 to $+8$, including 0. By a one digit time delay, these factors can be doubled to produce powers of 10.

The internal handling of data by the machine is serial by bit, serial by character alternating between bits of operands, herein referred to as "In" word and "Out" word. For alphanumeric input and for print-out, data is handled parallel by bit, serial by character. For operator simplicity, the numeric entry and output print of numeric information is in decimal digit form, however, all internal handling and processing of numeric data is in pure binary form.

The arithmetic functions of which the computer is capable include addition, subtraction, multiplication and division. In an addition operation, the programmed "Out" word is algebraically added to the programmed "In" word and a single addition requires one complete electronic cycle. If the signs of the operands are different, the addition is regarded as a subtraction. In subtraction a programmed "Out" word is subtracted from a programmed "In" word, the difference taking the sign of the "In" word. The subtraction requires a single electronic cycle if the minuend or "In" word exceeds the subtrahend or the "Out" word. If the subtrahend exceeds the minuend, a second complementing electronic cycle is required.

In multiplication, a programmed "Out" word is multiplied by a programmed "In" word the product appearing in the "In" word with high order digits appearing in the overflow register word which is automatically cleared prior to the multiplication operation. The sign of the product follows algebraic rules and the operation requires 70 electronic cycles. A product of 19 decimal digits is obtainable and may be printed out.

In a divide operation, a programmed "In" word is taken as a dividend and is divided by a programmed "Out" word taken as a divivsor. The quotient appears in the "In" word with the remainder appearing in the overflow register which must be cleared prior to the division. The divide operation requires 70 electronic cycles and the sign of the quotient follows algebraic rules.

Functions which involve addition and subtraction, respectively, are transfer plus (TR+) and transfer minus (TR−). In the transfer plus operation, a programmed "In" word is cleared and a programmed "Out" word is added to the cleared "In" word following the rules for addition. One electronic cycle is required for a positive

"Out" word and two electronic cycles are required for a negative "Out" word since it is subtracted from zero "In" word and must be complemented. If no "Out" word is specified the "In" word is cleared to positive zero. In the transfer minus operation a programmed "In" word is cleared and a programmed "Out" word is subtracted from the cleared "In" word. One electronic cycle is required for a negative "Out" word and two electronic cycles are required for a positive "Out" word because a complementing cycle is again required.

Another function involving multiplication is column-shift-left (CSL). In the column-shift-left operation, a programmed "In" word, except the overflow register, is shifted left the number of spaces specified by prior control panel wiring and which may vary from 1 to 10 places. Seventy electronic cycles are required and the result of the shift is contained, low order digits in the "In" word and high order digits in the overflow register word. The sign is unchanged. A fixed factor word selected by a prior control panel wiring is treated as the multiplicand and the shifted word is treated as the multiplier. The contents of the overflow register word is cleared prior to the shift operation and thus, cannot be included in the shift.

Functions involving a division operation are column shift right (CSR) and round off column shift (ROCS). In the column shift right operation a programmed "In" word, except the overflow register is shifted right the number of places specified by prior control panel wiring, and which may be from 1 to 10. Seventy cycles are required and the high order digits of the shifted result appear in the "In" word and low order shifted digits are in the overflow register. Prior to the start of the column shift right operation, it is necesary to have cleared the overflow register unless the contents thereof are considered as part of the operation. The sign is unchanged. In the round-off-column-shift operation, the quantity $5\times10^{n-1}$ is added to the selected word, except the overflow register and the word is shifted right, in places. Frequent use of this function is for rounding a billing charge to the nearest cent.

Additional arithmetic functions of which the computer is capable are zero balance, zero balance plus or minus, negative balance and negative balance plus or minus. The zero balance function is useful to test a programmed "In" word to determine if its value is zero. No arithmetic function is involved and if the word is equal to zero a selector is energized and its contacts transferred. This balance test operation facilitates changing of the program routine based on the condition of the tested word. The negative balance test function is useful to test the sign of a programmed "In" word to determine if its value is negative. A negative balance test selector is energized with its contacts transferred if the word tested is negative. The zero balance plus or minus operations will cause the computer to perform a corresponding add or subtract operation, as the case may be, and to then test the result to determine if its value is zero. The negative balance plus or minus operations will cause the computer to perform a corresponding add or subtract operation, as the case may be, and to then test the result to determine if it is of a negative value.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a perspective view of a physical embodiment of the business machine of this invention incorporating the magnetic ledger card unit.

FIGS. 2*a* and 2*b* show the primary printer keyboard and the numeric and special function keyboards on the console of the machine shown in FIG. 1,

FIGS. 3*a* and 3*b* are block diagrams which, taken together, show the interrelationship of the major electronic and other components of the machine of FIG. 1,

FIG. 4 shows a representative invoice form of the type forming a typical output document on the machine together with vertical and horizontal program tapes at the left of and above the document, respectively.

FIG. 5 shows a typical accounts receivable ledger card and two typical inventory ledger cards of the type handled by the magnetic ledger card unit of the machine,

FIG. 6 shows the organization of the magnetic stripe on the ledger cards of FIG. 5 and the disposition of bits of information magnetically recorded thereon in a 6 bit binary code to represent different numeric and alphanumeric characters,

FIG. 7 shows schematically, in a broken away view, the vertical and horizontal tape sensing mechanisms as associated with the primary printer of the system of FIG. 3.

FIGS. 8*a*, 8*b*, and 8*c* taken together shows the organization of the control panel and the assignment to the several control panel hubs,

FIGS. 9*a*, 9*b*, 9*c*, 9*d*, and 9*e* taken together show the clock timing pulses and also certain combination therof,

FIGS. 10*a*, 10*b*, and 11 show potential ranges of signals used in the electronic logic circuitry.

FIG. 12 shows an Inverter circuit having S level inputs and outputs in which performs the logic functions +And and —Or,

FIG. 13 shows a Converter circuit having S level inputs and R level outputs and which performs the logic function +And and —Or,

FIG. 14 shows a Converter having R level inputs and S level outputs and which performs the logic functions +OR and —And,

FIG. 15 shows the Power Inverter circuit having S level inputs and outputs,

FIG. 16 shows a Power Inverter circuit having S level inputs and R level outputs,

FIG. 17 shows an Emitter Inverter circuit having S level inputs and outputs,

FIG. 18 shows an Emitter Follower circuit having R level inputs and outputs,

FIG. 19 shows an Indicator Driver circuit for driving lamp indicators and having S level inputs and V level outputs,

FIG. 20 shows a Remote Load circuit forming essentially a resistor to which S level signals are appiled,

FIG. 21 shows a 4 or 5 way Nor circuit having W level inputs and R level outputs and performing the functions +Or and —And,

FIG. 22 shows a Diode Isolator circuit having W level inputs and outputs,

FIG. 23 shows a Voltage Mode Trigger 1 having And turn On and And turn off gates,

FIG. 24 shows a Voltage Mode Trigger 2 having Or turn on gates and Or turn off gates,

FIG. 25 shows a gated Sample Pulse driver,

FIG. 26 shows an Integrator having W level inputs and S level outputs,

FIG. 27 shows a Single Shot Multivibrator circuit having S level outputs,

FIG. 28 shows a Thyratron Relay Driver circuit having S level inputs and W level outputs,

FIG. 29 shows a Memory Driver circuit having S level inputs,

FIG. 30 shows a Memory Switch 1 circuit having S level inputs,

FIG. 31 shows a Memory Switch 2 circuit having S level inputs,

FIG. 32 shows a Delay Line circuit having S level inputs and outputs,

FIG. 33 shows a Sense Amplifier shaper circuit,

FIG. 34 shows a Sense Amplifier circuit,

FIGS. 35*a*, 35*b*, 35*c* and 35*d* show certain Dot Function combinations of logic circuits,

FIGS. 36*a*, 36*b*, 36*c* and 36*d* show the details of the corresponding circuits in FIG. 35 of the drawing,

FIG. 37 shows a Magnetic Ledger Card Driver circuit for driving the record and erase coils of the magnetic ledger card unit,

FIG. 38 shows a Magnetic Ledger Card Shaper Amplifier circuit for shaping signals produced by reading magnetically recorded information on the stripe of the magnetic ledger card,

FIG. 39 shows a Magnetic Ledger Card Amplifier circuit,

FIGS. 40 through 69 show certain relay circuitry for involved in various functions of the machine including horizontal and vertical tape sensing and control operations, and for enabling program step sequencing,

FIG. 70 shows the Power Supply of the machine shown in FIG. 1,

FIG. 71 shows certain circuitry involved in a one line indexing operation of the output document,

FIG. 72 is a timing chart indicating the chronological operating sequence of the components of FIG. 71,

FIG. 73 shows certain circuitry involved in a multi-line vertical position search operation utilizing the vertical tape apparatus,

FIG. 74 is a timing chart indicating the chronological operating sequence of the components of FIG. 73,

FIG. 75 shows certain circuitry involved in a horizontal position sense operation,

FIG. 76 is a timing chart indicating the chronological operating sequence of the components of FIG. 75,

FIGS. 77*a* and 77*b* show certain circuitry involved in a horizontal position search operation including a carrier return,

FIG. 78 is a timing chart indicating the chronological operating sequence of the components of FIGS. 77*a* and 77*b*,

FIGS. 79*a* and 79*b* show certain circuitry involved in a combined vertical and horizontal position search an involving the transfer operations from vertical to horizontal position search,

FIG. 80 is a timing chart indicating the chronological operating sequence of the components in FIGS. 79*a* and 79*b*,

FIGS. 81*a* and 81*b* show certain circuitry involved in beginning operation of the machine shown in FIG. 1,

FIG. 82 is a timing chart indicating the chronological operating sequence of the components in FIGS. 81*a* and 81*b* in starting the machine in FIG. 1 by depressing the console start bar,

FIG. 83 is a timing chart indicating the chronological operating sequence of the components in FIGS. 81*a* and 81*b* in starting the machine in FIG. 1 by impulsing a control panel Autostart hub,

FIGS. 84 through 92 show the details of the memory unit and memory word and bit selection circuitry in the machine of FIG. 1,

FIGS. 93 through 150 show the electronic logic circuitry of the machine in FIG. 1,

FIGS. 151 and 152 are timing charts indicating the chronological operating sequence of certain relays involved in program stepping in the machine of FIG. 1,

FIG. 153 shows a typical organization of variable length fields in the Magnetic Ledger Card portion of memory and the clock pulses most directly involved in address searching, and,

FIG. 154 shows a typical organization of fields in the Special Alphanumeric portion of memory.

Referring now to the drawings for a more detailed description of the invention in FIG. 1, **1–10** represents in perspective view, the business machine according to this invention. The machine includes the basic computer and primary input/output unit **1–12** and a magnetic ledger card handling unit **1–14**. The unit **1–12** incorporates a paper handling apparatus shown generally at **1–16**, the keyboard **1–18** of an input/output typewriter serving as a primary printer, and which keyboard is available to the operator of the machine, a vertical paper tape handling unit at **1–20**, and a panel **1–22** for manually inserting or removing a prewired control panel for programming the machine. In addition, the main body of the unit **1–12** includes all of the electronics and relay circuitry of the computer. A numeric entry keyboard unit is shown at **1–24** and a number of specially assignable control keys are shown at **1–26**. The latter two console keyboard arrangements are shown in greater detail in FIGS. 2*a* and 2*b* of the drawings. The magnetic ledger card unit **1–14** incorporates the ledger printer and other mechanism for handling magnetic ledger cards as shown stacked at **1–28** on a mobile cart. It is noted that the keyboard of the ledger printer is not accessible to the operator of the machine.

A hopper **1–30** on the magnetic ledger card unit is receptive to ledger cards as shown at **1–28** and the unit **1–14** is effective under computer control to read information magnetically recorded on the card, to visibly print information on the card, to magnetically record information on the card and to eject it to the mouth of the hopper.

All arithmetic operations are binary arithmetic operations, since all manipulated numeric words are stored in pure binary form. While the machine uses alphanumeric data as input and output, the alphanumeric data is never arithmetically manipulated, and further is never transposed to any other code but the six bit code in which it is entered. The forms carriage has two pin feed primary document tractor units in front of which there is room for front feeding of unit document forms; that is, docucents which are unit records by themselves.

CONSOLE

In FIG. 2*a* of the drawings, the arrangement of the keys of keyboard unit **1–18** of the primary printer unit **1–10** is shown in greater detail at **2–10**. In FIG. 2*b*, the key arrangement of the numeric entry unit **1–24** is shown in greater detail at **2–12** and at **2–14** is shown the arrangement of specially program assignable function keys.

The keyboard **2–10** is shown to be that of a typical typewriter type of input/output unit. The keyboard **2–12** shows keys with numbers **0** through **9** for entering these digits into the machine and further shows keys marked "TAB," "R," "CR" which are operative to cause the carrier of a ledger card printer to tabulate, the machine to be reset and the carrier of the ledger printer to return to its left margin. A "START" key is manipulatable to cause the machine to begin a program routine.

Four keys shown at **2–14**, **2–16**, **2–18**, and **2–20** are specially assignable control keys. The functions assigned to these keys are the more frequently called for functions in any particular operation and thus, are situated in proximity to the numeric entry keys and start bar which are also more frequently required. Typical assignments to some of these keys are shown in the drawing. Sixteen further specially assignable control keys are shown on a keyboard **2–22** in four columns **2–24**, **2–26**, **2–28** and **2–30** and two additional typical assignments are indicated in FIG. 2*b*. Four additional keys in a column **2–32** are permanently assigned the respective functions "MLC EJECT" for ejecting a ledger card in the ledger card printer, "MLC RESET" for resetting the magnetic ledger card unit, "FIELD MARK" for entering a coded field mark into memory and "CARR OPEN-CLOSE" which is responsive to open or close a front-fed paper document handling carriage. These functions will be made clear hereinbelow.

As also shown in FIG. 2*b* a pair of lights **2–34** and **2–36** labeled "on" and "MLC" are provided and indicated, respectively, an on condition of the machine and a magnetic ledger card unit error. Still another light, **2–38**, is provided which is lit during the automatic mode of operation

of the machine and thus, serves as an indication to the operator that the keys on the console are not to be manipulated.

GENERAL SYSTEM ARRANGEMENT

The business machine according to this invention is arranged generally as shown in FIGS. 3*a* and 3*b* of the drawings. The numeric keyboard unit is shown at **3–10** and has keys designated at **0–9** as shown more clearly in FIG. 2*b*, and these are manipulatable to enter these digits serially into the machine. This key unit is effective by mechanical interposers to translate each decimal digit, 0 through 9, by combinations of electrical potentials, successively sampled during the first four bit times of an electronic cycle of the machine. That is, a binary coded decimal translation is effected by the unit. By a translating procedure as disclosed more fully in the copending application for Method and Means for Translating Decimal Numbers Into Equivalent Binary Numbers by William L. McDonald and Raymond H. Thurmond, Ser. No. 112,116, filed May 23, 1961, now U.S. 3,185,825, issued May 25, 1965, assigned to the present assignee and hereinafter referred to as application "B," the digits of a multidigit number, successively entered into unit **3–10**, high order first, are placed into storage of memory unit **3–12** of the system shown in FIG. 3*b*, in pure binary form. The detailed construction of memory unit **3–12** and associated control circuitry is shown in FIGS. 84–92, however, for a detailed description thereof, reference is made to application A. As explained more fully in application "B," such translation takes place in a two electronic cycle procedure. Upon the key entry of the very first digit into unit **3–10**, the first cycle of the translation is not used and during the second cycle, the binary equivalent of the number is entered into a keyboard buffer word, **3–14**, of memory which was automatically cleared on key entry of the decimal digit. The binary coded digits from unit **3–10** are applied directly to an arithmetic add-substract unit **3–16** which is shown in detail in the drawings herein but is described in detail in copending application for Serial Binary Adder-Subtracter of William L. McDonald, Ser. No. 219,860 filed Aug. 28, 1962, now U.S. 3,209,132, issued Sept. 28, 1965, hereinafter referred to as application "C." This circuit includes delay circuits effective during the first cycle of the mentioned two cycle translation operation for digit entries after the first, to delay the information bits already in the keyboard buffer word, two digit times and write the same back into memory two cores higher in order. According to binary arithmetic, this effectively multiplies the number by 4. Also during this first cycle, the product so derived by the 2 digit delay is added to the number itself whereby the total effect of the first cycle is to produce a resultant number equal to a multiplication by 5 of the number keyed in. During a second cycle of this translation, this resultant number is delayed one bit time, to effectively multiply it by 2 and to this latter product is added the binary equivalent of the digit newly keyed into unit **3–10**. It is clear therefore, that upon the entry of a second digit, the number already in storage is multiplied by 10 and the second digit is added thereto. Moreover, on the entry of any subsequent decimal digit, the contents of keyboard buffer word of memory is effectively multiplied by 10 and the binary equivalent of the newly entered decimal digit is added thereto. Since the number of binary digits per numeric number is 34, the capacity of any numeric word of storage is the equivalent of ten decimal digits.

The data flow path from the numeric entry unit **3–10** to the add-subtract unit is represented by the bus **3–18** which extends from this unit to the arithmetic unit **3–16** and the output of this unit is applied along a bus **3–20** to a unit **3–22** representing the memory core word drivers and switches. Another unit, **3–24** represents the bit selection drivers and switches for the memory unit **3–12** and each of the units **3–22** and **3–24** has clock pulses applied thereto from a clock unit **3–26** which provides the basic timing pulses for the entire electronic circuitry of the computer. The numeric information so entered into the keyboard buffer word is transferrable to other numeric words of main memory or numeric portion of magnetic ledger card memory.

For entering alphanumeric information into the alphanumeric section of the memory unit **3–12**, i.e., into any of the words **1–32** of this section of memory, an alphanumeric entry unit **3–28** shown is greater detail in FIG. 2*a* is provided which consists essentially of the keyboard of an input/output typewriter unit **3–30** forming a primary printer. This unit **3–30** comprises a typewriter substantially as shown and described in Pat. No. 2,919,002 granted Dec. 29, 1959 to L. E. Palmer for Selection Mechanism for Single Printing Element Typewriter, assigned to the present assignee and further incorporates features shown and described in detail in copending application of F. E. Becker, D. M. Bingham and R. J. Young, Ser. No. 109,704, filed May 12, 1961 for Typewriter Input Checking Mechanism and assigned to the present assignee. In the numeric entry condition of the keyboard entry mode of the machine 1–10, the alphanumeric entry unit **3–28** is available to the operator of the machine as a manually operable typewriter for typical typing on an output document or other form in the primary printer. In this condition, the use of the alphanumeric entry unit as a typewriter does not enter information into the machine nor affect any other part of the system, and thus, facilitates the manual typing required incidental to the preparation of business forms or for other purposes. In the alphanumeric entry condition of input mode of mchine **10** which is established by proper control panel wiring, however, manipulation of any key of the keyboard of the alphanumeric entry unit **3–28** causes the character represented by the keylever, to be coded into a 6 bit binary code as shown in FIG. 146 and the signals so produced are applied in parallel along a 6 line bus **3–32**, to respective triggers of a 6 trigger input/output register represented at **3–34**. The information so entered into the input/output register is subsequentially transferred serially by bit from one trigger of this register to a programmed field of the alphanumeric portion of memory unit **3–12** along bus **3–36**; the input/output register shifting 6 times to perform the serialization to enter information into memory one bit at a time. At the completion of any field of alphanumeric memory, it is demarcated by a "field marker" which is a special 6 bit coded character and entered into memory from the console by pressing a control key having a corresponding hub on the control panel. At completion of alphanumeric entry the machine is restored by another "restore" control key on the console.

In accordance with a certain aspect of this invention, numeric and alphanumeric may also be entered into alphanumeric section of memory **3–12** through the magnetic ledger card unit **3–38** in FIG. 3*a* and in FIG. 1 at **1–14**. The details of this unit are set forth in the copending application of Charles Jenkins and Kenneth Perkins for Magnetic Ledger Card Machine, Ser. No. 248,117, filed concurrently herewith, now U.S. 3,294,956, issued Dec. 27, 1966, assigned to the present assignee and hereinafter referred to as application "D." In this unit, a ledger card posting and drive mechanism **3–39** is responsive to the entry of a magnetic ledger card represented at **3–40**, to initially drive the card to a magnetic read-record station at which time under the control of a magnetic head scan mechanism **3–41**, a magnetic head **3–42** is swept across the magnetic ledger stripe such as shown in FIG. 6, on the back of the card. Under the control of a read-record apparatus **3–43**, the information previously recorded on the magnetic stripe of the card is transmitted along a four line bus **3–44** to input/output register **3–34**. As shown

more clearly in FIG. 6 of the drawings, three longitudinal channels on the magnetic ledger stripe of the magnetic ledger card are information tracks and a fourth longitudinal channel is provided for redundancy check bits to make the number bits in each vertical column odd. The three lines of bus which transmit information bits are coupled to a first three of the input/output register triggers numbered **4**, **5** and **6** and one line of bus **3–50** which carries the parity check bits is applied to a parity check trigger associated with the input/output register. All of the input/output register triggers and the parity check triggers are restored prior to the arrival of any group of bits and a one bit on any of the lines sets the corresponding trigger and a zero bit on any line allows the corresponding trigger to remain reset. The information after arrival into triggers **4**, **5** and **6** of the input/output register are serially shifted to another three triggers of the register numbered **1**, **2**, and **3** and as the shift takes place the zero bits passing through trigger **4** of the input/outpt register are used to change the state of the parity check trigger. Thus, in the absence of any error the parity check trigger will be reset after this complete shift operation takes place. Following the shift of the information from input/output triggers **4**, **5**, **6** into triggers **1**, **2**, and **3**, a serialization takes place wherein the information is written into the first 32 words of magnetic ledger card memory from input/output trigger number **1** along bus **3–36** as in the case of manual entry of alphanumeric information.

It is noted that the information that appears on the stripe of the magnetic ledger card as shown in FIG. 6 of the drawings is placed into the magnetic ledger card section of memory without any translation or other changing whatsoever. The three bits of information in the very first column on the card are placed in the **1**, **2**, and **3** cores of the first word of magnetic ledger card memory, the second three bits of information on the stripe in the next three cores, etc., until all of the cores of the first word of this section of memory are utilized, the next three bits are placed in the first three cores of the second word of magnetic ledger card section of memory, etc., until the first 32 words of memory store the information that appears on the magnetic ledger card. Fields of information may again be demarcated by field marks. It is also significant to note at this point that information may be in pure binary numeric form in one or more of the first 15 words of this section of memory and that in words 17 through 32 the information is in alphabetic or alphanumeric form six cores or bits per character.

Controls for the entry of alphanumeric information into memory include a control panel **3–45**, a B counter **3–46** which is set forth and described in detail in the above mentioned copending application A and a C counter **3–47**. The B counter is a 6 trigger counter which serves to address memory and the C counter is a 7 trigger pure binary counter. The control panel is connected through a control bus **3–48** directly to the word drivers and switches unit **3–22**, through the control bus to the B counter **3–46** and the control bus to the C counter **3–47** which are prewired so as to select the respective sections of magnetic ledger card memory which are assignable to numeric information and to alphanumeric information.

The numeric information stored in memory in the respective manners hereinabove described may be processed by the add-subtract unit **3–16** in predetermined manners as directed by the prewired control panel **3–45**. Numeric information in any portion of numeric memory may be printed out on either the primary printer **3–30** or one the ledger card printer **3–50**. To facilitate this type-out, the number of digits of such a numeric word is considered and the control panel is prewired so as to select a fixed factor portion of memory under the control of the B counter so that doubling of this fixed factor produces a power of 10 having the same number of digits as the numeric word to be typed out. Again under control of the control panel, B counter and C counter, this power of 10 with the aid of the add-subtract arithmetic unit **3–16** is successively subtracted from the numeric number until an overdraw occurs and the power of 10 is then added back. The number of successive subtractions is stored in the C counter and under the proper controls, the C counter through an output bus circuit **3–52**, applies this information to a set of thyratron circuits **3–54** effective to actuate printing circuitry of either the primary printer **3–30**, the ledger printer **3–50** or both, as programmed in the prewired control panel to cause the first digit to be typed. The B counter is stepped to select the next lower order fixed factor, this is subtracted from the remainder of the number to be typed out and in similar manner this digit and the lower order digits are typed. In the handling of the information, a sense amplifier **3–56** receives the information directly from the memory unit **3–12** and applies it to a storage trigger **3–58** along a bus **3–60**. The storage trigger along bus **3–62** may apply this information to the add-subtract unit **3–16** or to memory **3–12** along bus **3–36**. Information from the add-subtract unit **3–16** is applied to memory along bus **3–36**.

In the print out of alphanumeric information from the magnetic ledger card section of memory, the information is passed through the sense amplifier **3–56**, through the storage trigger **3–58** and into the input/output register **3–34** along bus **3–62**. The information is applied to trigger **6** of the input/output register and is serially shifted from this trigger through the other input/output register triggers to input/output trigger **1** as successive bits of information arrive at trigger **6**. Thereafter, the information is presented to the thyratron circuit **3–54** in parallel form through bus unit **3–52** and along a six line bus, **3–66**, and either the primary printer **3–30** or the ledger printer **3–50** may be caused, under control of control panel **3–45** to print out the alphanumeric information.

In addition to print out of numeric or alphanumeric information, the printers **3–30** and **3–50** are further controllable so as to tab, carrier return, upshift, downshift, etc., by a printer function translator unit represented at **3–68**. Provision is made in the unit for taking into account the condition of the respective triggers of the input/output register as well as the triggers of the C counter **3–47** to apply an input on bus **3–52** and produce a properly coded signal along a five line bus **3–70** through the thyratron circuit **3–54**. Again under proper control of the prewired control panel **3–45**, the printer or printers selected may be controlled.

In FIG. 3, the horizontal and vertical tape units are shown at **3–72** and **3–74**. The horizontal tape unit includes mechanism for handling the tape **4–30** shown in FIG. 4, the sensing mechanism and relays for sensing the holes such as **4–32** and **4–34** in the tape and further includes a set of relays herein called a horizontal CB timing chain in that these relays perform certain timing functions associated with horizontal position search and tab operations. The vertical tape unit **3–74** includes the mechanism for handling the tape **4–40** and sensing mechanism and controls responsive to the sensing of holes in the tape such as **4–42**.

The tape units **3–72** and **3–74** are responsive to a position sample electrical impulse, applied by a horizontal and vertical position seek unit **3–76** along a line **3–78** to cause the tapes to be sampled for punched holes and to cause the tape units to apply signals along respective buses **3–80** and **3–82**, indicative of horizontal position of the printer carrier and vertical position of the output document, respectively.

The unit **3–76** is a relay circuit arrangement receptive to the signals applied on buses **3–80** and **3–82** to produce on busses **3–84** and **3–86** and hence on appropriate control panel hubs, impulses indicative of the horizontal position of the carrier and the vertical position of the output document. For indicating the coordinate position of the carrier relative to the output document, pulses representing respective horizontal and vertical positions are applied along buses **3–88** and **3–90** to a coordinate position matrix

unit 3–92 comprising relay circuitry and from which matrix circuit an output bus 3–94 applies the coordinate position electrical impulses to the control panel. The position sample pulse on line 3–78 can be initiated by impulsing the unit 3–76 through an auto start line 3–96 under program control from the control panel or by impulsing it through line 3–98 which is energized by manipulation of the start key on the control panel of the machine. Thus, it is seen in a general way, that at the times that the positions of the horizontal and vertical tapes are sampled, these tapes, if in position corresponding to holes punched in the tapes, provide the control panel with impulses indicative of horizontal and vertical positions of carrier and output form. Still further, these control panel pulses, either horizontal position, vertical position or coordinate position may be used for initiating any operation of the machine which can be initiated by such an impulse.

In addition to the foregoing, the vertical tape unit provides further control for the handling of the output document. As shown at the output buses 3–100, 3–102, 3–104, 3–106, control is provided for line spacing or indexing of the output document one line, for starting a high speed skip of the output document, for stopping the high speed skip and for carrier return. The line space or indexing signal is applicable for indexing only the auto form output document.

Provision is also made for causing either the printer carrier or output document, each with corresponding tape, to seek a position pursuant to a signal from the control panel to do so. A bus, 3–108 extends between the control panel and horizontal tape unit 3–72 and this tape unit is responsive to impulses applied along this bus to cause the horizontal tape to be sampled and if not in the desired or programmed horizontal position, to thereafter tab to the next tape punched hole position, sample the tape and so on until the sought location is found. Similarly, a bus 3–110 extends from the control panel to the vertical tape unit 3–74 and this unit is receptive to impulses from the control panel applied along this line to cause the vertical tape unit to index the output document form, return the carriage and sample vertical tape 4–40. Of course, if the tape and output document are at the sought location, no further action takes place, however, if the vertical tape and output document are not at the sought position, it is indexed one line and if not in the desired vertical location a high speed skip of the form is instituted, the vertcial tape is sampled while it is in motion and the tape and document stopped as the sought vertical position is located.

The control panel 3–45 is of the wire pluggable type which may be prewired by plugging and which may be mounted into a panel receptacle of the machine to essentially complete the machine wiring as the situation may require. In addition to the interrelationship with the circuitry already described, the control panel by a prewired condition is responsive to pulses applied there to provide impulses to an insrtuction selection unit shown 3–112 through a bus 3–114. This unit is responsive to such pulses to activate lines of an output bus 3–116 extending to an instruction execution unit 3–118. Typical instructions as may be provided by the instruction selector are the various machine functions such as add, subtract, etc.

A machine status unit 3–120 comprises many of the triggers and latches of the electronic logic circuitry and some of the relay points and represents the condition of the machine. This unit in effect stores information indicative of machine modes and establishes gates that on recognition of conditions throughout, the machine continues to perform. A bus, 3–122, extends from the control panel 3–45 to unit 3–120 to provide information regarding control panel wiring to cause the machine to assume the enter alphanumeric mode or new card mode. A bus 3–124 from instruction execution unit 3–118 also provides status information to the unit 3–120 as the program execution progresses.

The instruction execution unit 3–118 is a large one that is receptive not only to the instruction selection block 3–112, but also to the machine status as applied from machine status unit 3–120 through bus 3–124, to the condition of the B counter 3–46 applied through a bus 3–126, the C counter 3–47, as applied through a bus 3–128, the storage trigger 3–58 as applied through a bus 3–130 as well as the field marker signal on a bus 3–132 from unit 3–68 and to the clock 3–26. The instruction execution unit 3–118 is responsive to signal impulses applied through different combinations of these busses and bus lines to control the automatic operation of the machine. Control signals are passed from this unit 3–118 to the storage trigger through lines of the bus 3–130, to the thyratron circuits 3–54, and through a bus 3–134 for certain printer functions such as thyratron firing for print or printer functions. Sample pulses are applied to the B counter through lines of bus 3–126, certain set-up conditions of the C counter are facilitated by the unit 3–118 through a bus 3–136 between these units and stop control of the clock 3–26 is enabled through a bus 3–138 from instruction execution unit 3–118. In addition, other control lines represented by the busses numbered 1, 2 . . . *n* are provided for numerous other controls.

The program step control and word selection is controlled by relay circuitry including a program step timing and restore unit 3–140. This unit includes a plurality of 5 basic relays interrelated so as to follow a predetermined sequence of actuation and de-actuation and being actuated or deactuated for certain periods of time in each case, to provide an orderly stepping of the machine from one program step to the next. In cases wherein the last program step of a sequence is reached, this condition is detected and this unit is automatically restored. Restoration also follows an impulse provided on bus 3–142 extending from the machine console, represented at 3–144, to this unit 3–140 and which impulse is produced by manipulation of a suitable restore key on the console. For placing the unit 3–140 in a suspended condition during horizontal and vertical tape operations, a bus 3–146 extends from the tape units 3–72 and 3–74 and to the unit 3–140 and provides a control signal to interrupt the relay operations at these times.

A pair of program step units 3–148 and 3–150 comprising groups of relays are provided. The contacts of these units are in the Program Step Matrices unit 3–152. These units are responsive to the condition of the contacts of relays of the Program Step Timing and Restore Control unit 3–140 to close certain of their contacts. Other relays of these units are connected to control panel hubs and are controlled so as to be actuated by impulses applied thereto to close certain relay contacts. In the Program Step Matrices unit 3–152, these contact sets are arranged in certain series circuit forms so as to provide an impulse at a Program Step Exit line 3–154 selected by the program step entry line of the bus 3–153 extending from the control panel Entry hubs to the units 3–148 and 3–150. Thus, at the completion of a program step and further to provide concurrent potentials during the program step at each of three lines, 3–156, 3–158 and 3–160 and designated Function exit, In Word exit and Out Word exit, certain of the relays of units 3–148 and 3–150 are selected by the particular Program Step Entry hub of the Control Panel which is impulsed. A bus 3–153 interconnects these hubs with units 3–148 and 3–150, and thus, the Function, Out Word and In Word lines are selected. For re-initiating the program step timing, at the completion of any program step, an impulse is applied from unit 3–152, along line 3–162 to the Program Step Timing and Restore unit 3–140. In case the program is not to be continued, the absence of a signal on line 3–162 is "recognized" by unit 3–140 and a restore sequence is initiated and the stepping sequence is terminated.

Prior to the beginning of the electronic operations of any program step and during the CB relay timing sequence, the unit 3–140 provides a reset signal along a line 3–164

which is utilized in the electronic circuitry of the machine. Also, at a time that the relay timing sequence is finished, a signal is applied along the line **3–166** to the electronic clock of the electronic circuitry to start the clock timing.

In the primary printer of the present invention, the printing element is movable horizontally from left to right on a carrier to print on any one of the positions of a horizontal writing line. Associated with the motion of the printer carrier and as shown more clearly in FIG. 4 of the drawings, is a horizontal tape, shown at **4–30**. This tape is movable in unison with the carrier and is open ended since the carrier will move only at limits left and right. This tape is provided with eight longitudinal channels as shown at the left margin thereof in FIG. 4. By properly coding these eight channels by combinations of punched holes as shown for example at **4–32**, and **4–34** specific positions along the tape and consequently along the horizontal field of the typical output document **4–36** are also defined. In FIG. 4 of the drawings these horizontal fields are shown as beginning at writing lines **0**, **10**, **20**, **37** and **53**.

In the horizontal tape, the respective horizontal positions are represented by holes in the tape according to the following code:

Horizontal position:	Holes in channels
1	1 and 2
2	1 and 3
3	1 and 4
4	1 and 5
5	1 and 6
6	2 and 3
7	2 and 4
8	2 and 5
9	2 and 6
10	3 and 4
11	3 and 5
12	3 and 6
13	4 and 5
14	4 and 6
15	5 and 6

In addition to the movement of the carrier left to right, the output paper document is also movable in an upward direction from one writing line to the next. For control of this movement, a vertical tape shown at **4–40** is provided and this tape as shown at the upper extremity thereof in FIG. 4, is provided with 12 longitudinal channels. Each of these channels may be provided with a punched hole for defining a vertical field of the output document.

In the vertical tape, the respective vertical positions are represented by holes in the tape according to the following code:

Vertical position:	Hole in channel
A	1
B	2
C	3
D	4
E	5
F	6
G	7
Overflow	12

Thus, the holes **4–42**, **4–44**, **4–46**, **4–48** and **4–50** represent respective vertical positions A, B, C, D and E.

It is noted that in the tape **4–40** and at locations corresponding to the body of the invoice, a succession of punched holes such as **4–48** occur in channel **4** to define a succession of the same kinds of writing lines. In channel **12** of the vertical tape at a vertical position corresponding to the last writing line of the body of the invoice is a punched hole **4–52** which represents the overflow condition in the preparation of the invoice. Thus, during the preparation of the invoice, if it should occur that the body thereof is filled with line items and a continuation thereof is required, the hole **4–52** will be sensed and the invoice forms will be skipped to the heading of the next invoice document. Thus, it is seen that if it is desired to skip to a particular writing line or to seek it, a particular one of the holes that is uniquely identifiable with it is used to find the particular writing line. By a combination of vertical tapes and horizontal tapes, a particular matrix point on the output document is defined which is a particular coordinate position of the carrier and of the writing line of the document. This coordinate position information is continually sensed and together with the program instructions incorporated in the prewired control panel, a particular program instruction for each coordinate position as described is facilitated. Purely as an example, the combinations of holes **4–32** and **4–34** in the horizontal tape define the horizontal field, **1**, beginning at the left margin of the output document **4–36** and the punched hole **4–42** in the vertical tape defines the vertical position, A, on the tape at the start of the heading. Thus, when the printer is at coordinate position A–1, the horizontal and vertical tape units are effective in response to sampling, to impulse a coordinate exit hub on the control panel corresponding to this location and this impulse may be used for initiating various functions and operations such as printing of "Sold To" information. Also, the same two punched holes **4–32** and **4–34** in the horizontal tape **4–30** and the hole **4–44** in channel **4** of the vertical tape at vertical position D, define the beginning of the main body of the invoice and with the carrier at horizontal position **1** and document **4–36** at vertical position D, sampling of the tapes produces an impulse at a control panel hub which may be used to condition the machine to be responsive to the key entry of numbers indicative of the quantity ordered. A multiplicity of coordinate positions equal to the product of the number of horizontal field positions and vertical field positions is therefore defined, each usable in a different way or to effect a different program instruction.

For a better appreciation of the horizontal-vertical programming feature of the present invention, it is assumed that numeric information has been entered in the numeric keyboard **1–24** and that the program start button is touched to initiate an automatic mode of operation. This is a signal to the machine to sample the position of the carrier and of the writing line to detect the cordinate position hereinabove described. The particular horizontal and vertical tape positions are sampled and depending upon the location of the carrier and the writing line, the units will activate and generate an exit pulse at what is termed a coordinate exit position of the control panel shown and described herein. The exit pulse so generated may be applied by control panel wiring to another control panel hub receptive to pulses to produce an automatic start of the machine. If the printer carrier or the output document paper is at a location so that no hole exists in either of the corresponding tapes at these positions, no such exit pulse is developed. In this case it would be necessary to cause the printer carrier of the typewriter to relocate at a horizontal field beginning such as by being tabbed to the next horizontal field beginning and to again touch the start bar of the machine. It is noted that in the case of both the horizontal and vertical tapes, the holes therein are sampled as the carrier of the printer is tabulated and as the paper format is indexed.

The horizontal and vertical tapes as disclosed are also useful in conducting a seek operation whereby the carrier of the printer may be relocated with respect to the output document in any position "subsequent" to that in which it may be at any time. For purposes of seeking only a horizontal position, an instruction to so seek occurs through an electrical impulse to a hub on the con-

trol panel designated a certain horizontal position, corresponding to a coded set of punched holes on the horizontal tape. In this case the horizontal tape is sampled and if the position of the carrier with respect to the is such that it is at the location desired, the carrier does not move and an electrical impulse is produced at a horizontal exit hub of the control panel indicating the presence of the carrier at such location. However, if the location of the carrier should be other than that which is sought, an automatic tab operation is begun whereby the carrier is automatically moved to the next, horizontal field defined, it is stopped and the holes in the horizontal tape sampled at this location. If the carrier is at the position sought, it remains in this location and an electrical impulse is produced at the hub of the control panel corresponding to this horizontal position. Again, if such position is not the one sought, the carrier is tabulated again, etc., until the desired horizontal position is found. If the carrier is moved to the extreme right hand margin without finding the desired horizontal position, an automatic carrier return operation is performed by the printer and the output document is automatically indexed one line and the tab-sample operation is continued until the desired location is found.

Similarly, a vertical position seek operation may be conducted with the aid of the vertical tape. In this case, an impulse in a hub of the control panel corresponding to a particular vertical position causes first the printer carrier to be returned to its left margin, the output document indexed one line, and the position of the tape sampled. If the new position is that sought, the output document is stopped in this position. However, if it is not the position sought, a high-speed line skip operation is conducted and during this operation the vertical tape holes are sampled during the movement of the tape and at the vertical position desired, the vertical tape together with the output document are stopped. Arrival at the desired vertical location also results in an electrical impulse being produced at a control panel hub corresponding to this vertical position.

Conjunctive with the automatic horizontal position and vertical position seek operations, is a coordinate position seek operation in which both a new horizontal and a new vertical position of the carrier with respect to the output document may be sought. In this case, the respective horizontal and vertical position are found in an entirely similar manner to that described hereinabove with respect to the individual horizontal and vertical position seek operations.

The sampling procedures with respect to both the horizontal and vertical tapes is performed by star wheel sensing devices of a known type, wherein an individual star wheel mounted at the end of a lever is in contact with each channel of each of the tapes. The presence of a punched hole causes the star wheel lever to be pivoted to close a contact at its remote end. Closures of these contacts are effective to cause energization of certain relays of a relay system shown in detail in FIGS. 40 through 83, and which are operative in a manner to be described hereinafter to control and effect the sensing of horizontal position of the printer carrier with respect to the output document and the vertical position of the output document with respect to the printer carrier. The sensing star wheels are further effective to cause the operation of relay circuitry to search for new horizontal and vertical positions.

In the case of the hole **4–52** punched in the vertical tape and indicative of an overflow condition, it is noted that a star wheel sensing this hole causes the transfer of a selector within the machine by virtue of which a program branching is effected whereby the output document is vertically skiped to a new specified location on the next form. Purely as an example, it is noted that if the main body of the invoice **4–36** shown in FIG. 4 is filled with items ordered and it is required to have more space for additional items being sold and shipped to a particular customer, the sensing of the hole **4–52** by a star wheel causes the vertical forms feed to skip the output documents to any line of the next output document form such as the next D–1 position of the next invoice form so that additional items may be entered. Alternatively, the sensing of this hole may be used to cause the forms and carrier to go to coordinate position A–1 of the next document and the word "continued" printed in this line.

For an understanding of the manner in which the magnetically recorded information on the stripe of the ledger card is organized, reference is made to FIG. 6 of the drawings. In this figure, it is noted that there are four longitudinal tracks designated 1st track, 2nd tarck, 3rd track and check track. In the reading and recording of information, the magnetic head moves from left to right across the strip and since it is shown in two sections in this figure, it should be noted that the upper portion is scanned first and the lower portion therefore represents the latter portion of the stripe.

As represented by the first dotted line labelled On Track Switch, at the point in its travel that the magnetic head reaches this line, a switch designated On Track and disclosed more particularly in application D, is closed to produce a potential useful for properly conditioning the circuitry to perform the respective read and record operations. Another dotted line to the right of the On Track Switch line is designated 1st Pre Run Cycle and represents the position at which the magnetic head is located when the first pre-run cycle of electronics is completed. Still further along the track is another line designated 2nd Pre Run cycle and represents the position along the track that the second pre run cycle of electronic operations is performed.

After the second pre run cycle appear the bits of information representing the numeric information on the card and which is read from the recorded in the numeric portion of magnetic ledger card memory.

Following the numeric information is a line designated Begin Alpha indicating the end of numeric information and the beginning of alphanumeric information. Immediately following this line is a blank character which is regarded as a field mark by the machine and which delineates the variable length fields of the magnetic ledger card portion of memory.

Following the blank character are the information bits for the alphanumeric characters and the code for several of these characters is shown. Near the end of this alphanumeric information are the codes for several of the printer functions such as tab and carrier return and the last legitimate character is shown to be a field mark.

Near the end of the stripe appear a succession of columns of four bits each which according to the odd parity checking arrangement of the present system are illegitimate characters, however, these characters are used for checking purposes in a manner subsequently described.

In accordance with one feature of this invention, provision is made for continually sensing and detecting the vertical position of the output document and the horizontal position of the carrier of the primary printer, **1–16**. The organization and structure of apparatus for performing such sensing is shown in a fragmentary view of the input/output apparatus in FIG. 7 of the drawings. In this view, a broken away portion of the frame of the input/output apparatus is shown at **7–10** and this supports, among other structure, a platen **7–12**. The platen **7–12** is rotatable in the usual manner of a typewriter platen in a suitable journal, not shown, in frame **7–12** and a similar frame member, not shown, at the other end of the platen. A typical output document of the type which may be used is shown in phantom at **7–14**. This document form is provided with a row of holes along each longitudinal edge and for driving this form in the upward direction

only in this figure, suitable tractors one of which is shown at 7–13 engage a group of each of these rows of holes.

For typing on the form 7–14, a single head printing element 7–16 is provided. This single element head is orientable and tiltable to print any one of the characters on its surface and is supported on a head carrier 7–18. For moving the head horizontally to and fro, the carrier 7–18 is slidable relative to a supporting shift 7–20 which in turn is mounted at its ends, in the frame of the machine. A pair of steel straps 7–22 and 7–24 are connected to respective sides of the carrier to pull it in respective directions. Suitable mechanism and apparatus, not shown, appropriately applies tension to that strap of the pair which is required to move the carrier and head at the proper time.

A vertical tape unit is shown generally at 7–26 and includes a spindle 7–28 which is coupled to the tractors, such as 7–13, so as to be rotatable in unison therewith. The spindle 7–28 is provided with spaced longitudinal grooves such as at 7–30 in the manner of a spline and is further provided sprocket teeth as at 7–32 completely around its circumference.

A vertical programming tape is shown at 7–34 which is formed in a closed loop with a series of holes, as at 7–36, along its length for engagement with the teeth, as at 7–32, so that the tape 7–34 is driven by rotation of spindle 7–28 and effectively rolls in unison with the form 7–14. The tape 7–34 moves only in the direction of the arrow shown at 7–38.

As explained hereinabove with respect to the description of the vertical program tape shown in FIG. 4, the tape 7–34 has 12 longitudinal channels and information is represented on the tape by holes punched in different ones of the channels at certain longitudinal locations. Typical punched holes are shown at 7–40 and 7–42.

A vertical tape sensing unit includes a member 7–44 made of insulating material and pivotal about a rod 7–46 in a manner represented by the dotted form 7–44A, and which is supported by frame member 7–10. The member 7–44 contains a plurality of arms such as shown at 7–48 which are loosely pivotal about a rod 7–50 mounted in the member 7–44. At the end of each arm is a star wheel such as shown at 7–52 and in a closed position of member 7–44, shown in full lines, the star wheels engage the tape 7–34, each member such as 7–48 being biased in a direction to cause the corresponding star wheel to firmly contact the tape 7–34. At the remote end of each arm, such as 7–48, is a switch not shown, which is open when the star wheel at the remote end of the arm contacts with an unpunctured portion of the tape 7–34 and which switch is closed by pivotal movement of the arm as the star wheel drops into a punched hole on the tape. Thus, as the tape 7–34 rolls over the spindle 7–28 in unison with the document form 7–14, certain vertical positions of the document relative the printing head 7–16 or carrier 7–18 are detectable by the closure of a switch corresponding to a star wheel which drops into a punched hole on the program tape. A suitable, round ballast member 7–54 flanged at each end is supported at the lower end of tape 7–34 purely as a means of maintaining the tape in proper position as it rolls.

A horizontal tape unit is shown generally at 7–56 and includes a sensing and drive unit 7–58 through which a horizontal tape 7–60 extends. Internally, the unit 7–58 contains a suitable sprocket drive wheel engageable with holes in the tape such as shown at 7–62 for driving the tape to and fro as indicated by the arrow 7–64 and this unit further includes a plurality of arms with sensing star wheels, not shown, but similar to those as shown at 7–48 and 7–52 in the vertical tape unit. The star wheels are biased into engagement with the tape 7–60 and drop into programmed punched holes in the tape, such as shown at 7–66 in a position of the tape wherein the hole is under the star wheel. The dropping of a star wheel into a hole is effective to close a switch at a remote end of the arm, which closure is used to condition further circuitry as explained in detail hereinbelow.

Rotation of the sprocket within unit 7–58 to drive the tape 7–60 is achieved through a shaft 7–68 which is coupled to the sprocket within unit 7–58 and which has another sprocket type member 7–70 mounted at its other end. The member 7–70 has radially projecting teeth such as at 7–72 and a gear type member 7–74 idly rotatable about its center is provided with longitudinal grooves 7–76 about its periphery. The member 7–74 is mounted to circumferentially engage the teeth as at 7–72.

For driving the tape 7–60 longitudinally in unison with the movement of carrier 7–18, a tape 7–78, preferably of metal, has its respective ends connected to respective ends of carrier 7–18 and the tape extends tautly about four fixed axis pulleys 7–80, 7–82, 7–84 and 7–86, mounted on the apparatus frame. The tape 7–78 extends between members 7–70 and 7–74 and it is perforated with a plurality of holes such as shown at 7–88 along a portion of its length and these holes are spaced so as to receive the teeth such as at 7–72. Thus, as the carrier 7–18 moves back and forth along the width of the primary printer apparatus, the tape 7–78 is driven about the pulleys 7–80, 7–82, 7–84 and 7–86 and by virtue of the engagement between the perforated portion of tape 7–78, the member 7–70 and shaft 7–68 are rotated. The sprocket within unit 7–58 is driven by shaft 7–68 and thus, the tape 7–60 is also driven. The sprocket within unit 7–58 and the tape 7–60 is disposed relative to each other so that the tape is driven in the same direction as the carrier 7–18 moves.

CONTROL PANEL

The control panel of the machine 1–10 of the present invention is an apparatus that may be prewired by a programmer to direct the machine through the desired program steps and to perform functions of a routine for processing data and producing a printed output document. The panel is of the self-contacting type control and consists essentially of three assemblies which are a manual control panel which is wired by the programmer, a closure receptacle which supports the manual control panel in the machine and a stationary control panel which forms a part of the machine into which machine wiring extends and terminates. The control panel as shown in FIGS 8*a*, 8*b*, and 8*c* is the manual control panel which consists of holes called hubs which serve as locating guides for the control panel wires. The control panel wires are inserted into the holes and protrude through the back of the panel and make contact with a corresponding paddle contact on a stationary control panel of the machine. With the control panel in the machine and the respectacle closed, the extension on the control panel wire is in touching contact with the paddle contact of the machine control panel. Therefore, an electrical circuit is completed from the paddle contact through the control panel wire plugged by the programmer into the manual control panel to another paddle contact at the other end of the wire. The control panel hubs are of two basic types which include Exit hubs at which 48 volt direct potential pulses appear at certain times depending on the operation of the machine and which are controlled by the machine relay circuits that control the timing and sequencing through the program steps. The other type of control panel hub is the Entry which is receptive to the 48 volt potential pulses from other exit hubs to apply these potentials to machine circuitry that causes the machine to respond and perform some function. In addition, the control panel contains several bus hubs which are groups of three or more hubs electrically connected to one another. The bus hubs are used as junctions to connect two or more exit hubs to one entry hub. These hubs provide no direct connection to the machine circuitry in any way.

The control panel hubs can be divided into nine general categories which are as follows; (1) format control, (2)

program step control, (3) cooperational exits, (4) operational entries, (5) primary printer controls, (6) control key exits, (7) selectors, (8) ledger printer control, (9) digit analyzer.

The format control hubs shown within the dotted enclosure **8–10** in FIG. 8*a* provide a means of starting a particular program routine based on the vertical position of the output document and the horizontal position of the carrier. This is accomplished by using the coordinate positions of the vertical and horizontal program tapes.

There are seven pairs of veritcal position entry hubs labeled A through G such as shown at **8–12** which are responsive to 48 volt pulses to initiate a carrier return and form search for the programmed positions. Once a vertical position entry hub is impulsed the output document will advance until the vertical sense wheel corresponding to the programmed entry hub falls into a hole in the vertical programmed tape. The sense mechanism will then indicate to the system that the proper vertical position is reached and stop the movement of the form. If no punched hole exists in the appropriate channel of the vertical tape, the machine must be restored by manual manipulation of a restore key on the console to stop the forms skip.

After the sought vertical position is reached, an exit hub such as shown at **8–14** emits a pulse. There are seven vertical position hubs, one corresponding to each vertical positions entry hub.

A set of 15 horizontal position entry hubs, such as shown as **8–16**, are provided and these hubs are receptive of 48 volt pulses to cause the carrier of the printer to initiate a search for the desired printing position or field, corresponding to the hub. When a horizontal position entry hub is impulsed, the horizontal sense mechanism will first check the position of the carrier. If the carrier is in a position corresponding to the impulsed hub a tab search operation will not be initiated. However, if the carrier is not in this position the carrier will tab to each following tab stop, checking each position until the proper horizontal position is reached. If the carrier tabs to the right margin without locating the sought horizontal position an automatic carrier return is initiated and the tab search operation will continue from the left margin. It is of course necessary to code the horizontal program tape in a manner that is described with respect to FIG. 4 and set a tab stop at the beginning of each field that will be used for program control. When a sought horizontal position is reached, the search operation is complete and a corresponding horizontal position exit hub such as shown at **8–18** for example, will emit an electrical impulse.

A group of 105 (7×15) exit hubs, such as that shown at **8–20**, are provided and these are productive of electrical impulses for selecting a program routine based on both the vertical position of the form and the horizontal position of the printing element. A coordinate exit hub exists for each coordinate position of the vertical and horizontal positions. That is for each intersection of vertical field beginning and each horizontal field beginning. Since there are 7 vertical positions and 15 horizontal positions, it is possible to select 105 different program routines.

A coordinate exit hub will emit an electrical impulse when the program start bar is depressed or when an auto start hub such as shown at **8–22** is impulsed. Only one coordinate exit hub which corresponds to the coordinate position will emit a pulse at any given time since the output document and the printer element can be at only one horizontal and one vertical position, respectively.

It is clear therefore, that by using this format control feature any point on the form can be defined by a coordinate position. For example, the "tax amount" field near the bottom of the form **4–36** in FIG. 4 of the drawings may be defined as coordinate position **E5** since it corresponds to vertical position E and horizontal position **5**. With the form at vertical position E and the carrier at horizontal position **5** when the program start bar is depressed or one of the auto start hubs is impulsed, exit **E–5** will emit a pulse. This pulse may be used to select a programmed routine to print the tax amount.

There are 18 auto start hubs such as shown at **8–22** which are electrically joined to one another. These hubs are responsive to electrical impulses to automatically start a program routine of the machine without the need of depressing the program start bar. The auto start hubs and the program start bar perform the same function. When an auto start hub is impulsed, the machine will sample the vertical and horizontal position and emit a pulse from the coordinate exit hub corresponding to the vertical position of the form and the horizontal position of the carrier. If the vertical format document is not a coded position, that is, not in a coded position, that is, not in a position that corresponds to one of the vertical fields A through G or horizontal fields **1** through **15** when an auto start hub is impulsed or the program start bar is depressed, the machine will lock. The restore key must be depressed in this case to unlock the machine.

A set of three hubs **8–24**, **8–26** and **8–28** are provided for indicating an overflow condition of the output document. As noted in FIG. 4 at the bottom of the D field of the output document, a punched hole **4–52** exists in channel **12** of the vertical tape **4–40**. This punched hole upon being sensed by the vertical tape sensing mechanism energizes and actuates a relay termed the overflow relay which transfers points from contact between the I and N terminals **8–28** and **8–26** to make contact between the OF and I terminals **8–24** and **8–26** to facilitate branching such as may be desired to cause the form sheet to be skipped to the heading of the next form rather than following the normal routine of entering the final line of the net amount, tax rate, tax amount and total amount as would be required in the E field of the output document. It is clear that the OF hub, **8–38** is an entry hub while the N and I hubs **8–34** and **8–26** are exit hubs under different circumstances.

The control panel of the machine according to this invention has a plurality of program step entry and program step exit hubs, the program step entry hubs being responsive to an electrical impulse to cause the machine to initiate a program step while the program step exit hubs are interconnected with the machine circuitry so that at the completion of any step the corresponding program step exit hub emits an impulse. For initiating program step one, three program step one entry hubs such as that at **8–30** are provided in the area of the control panel proximate to the format control hubs. Program step **1** exit hub is shown at **8–32** in a column headed by "EX" in FIG. 8*a* and also in this figure in the same column with exit hub **8–32** are shown the program step exit hubs for progressively higher program steps. Entry hubs, such as program step **2** entry hub **8–34**, for the respective program steps are in a column headed by "ENT" and are numbered according to the program step. Other program step entry and exit hubs are shown in other columns headed "ENT" and "EX" respectively. Although all of the program step hubs are shown, only a representative number are indicated by program step number. It is noted that although there are three program step **1** entry hubs there is only one entry hub and only one exit hub in all other cases.

Once the machine is started into a program step sequence in the automatic mode, it will advance from program step to program step in any order in which the control panel is prewired, until the sequence is interrupted or terminated. When the program step sequence is interrupted it cannot be restarted until an auto start hub is impulsed or until the program start bar is manipulated.

As shown in FIGS. 8*b* and 8*c* for each program step there are three corresponding operational exit hubs. These are divided into three groups called function exits **8–36**, "IN" word exits **8–38** and "OUT" word exits, **8–40**. For each program step there are a pair of function exit hubs, a pair of IN word exit hubs and a pair of OUT word

exit hubs, the pairs being joined in each case. As shown in a representative number of cases, these sets of hubs are numbered similarly to the program step hubs. In the operation of the machine in the automatic mode, the pair of function exit hubs, IN word, exit hubs and OUT word exit hubs corresponding to the program step being performed have an energizing potential applied thereto equal to +48 volts. Purely as an example, if the machine should be performing program step **18**, the function exit **8–42**, the IN word exits **8–44** and the OUT word exits **8–46** which correspond to program step **18** are all at a positive direct potential, while all other hubs of the operational group are at substantially zero potential. In their typical use, the function exit hubs are used for selecting the function to be performed such as the arithmetic operation or the input output unit operation desired in a particular program step. The IN word exit hubs are used to select one of the operands in an arithmetic or related function, the digit capacity of the printed word, the number of spaces to be shifted right or left as the case may be or for other purposes and the OUT word exits are generally used to select another operand or to select a particular field of the variable length fields of the magnetic ledger card portion of memory or to select one of the special fields of the magnetic ledger card portion of memory.

The IN word Entry hubs for selecting any word of the main portion of memory are shown in the column **8–48**. The first two hubs in this column represent keyboard buffer word and overflow register word and the following 38 hubs represent the other 38 words of main memory and numbered **1** through **38**. In an adjacent column **8–50**, the first 15 hubs are labeled **L1** to **L15**, respectively, and represent the first 15 words of alphanumeric section of memory. An identical pair of hub groups for selecting these respective sections of memory are shown in columns **8–52** and **8–54** which are adjacent to the "Out" word exit hubs **8–40**.

For programming either the digit capacity of a word on type-out or the number of spaces on a column shift operation, a group of dual hubs are contained in a dotted rectangle **8–56** and are numbered **1** to **10** and V. An impulse to any of the hubs **1** to **10** is effective to condition the machine to print out a field of the same number of digits or to condition it to shift a programmed word the number of places so designated. A fixed factor word is selected by impulsing such hub and effectively a multiplication or division operation is performed. In the case of digit capacity selection the same fixed factor is selected as in the case of column shift operations, however, to obtain the proper digit to print, the electronic circuits automatically step down to the next lower order fixed factor which will allow printing the proper number of digits. If a digit capacity is programmed which is greater than the content of the word to be printed out, the printer merely spaces over the high order digits and prints out the programmed number. If a digit capacity is programmed which is less than the content of the word to be printed the machine recognized the error, prints an asterisk followed by all zeros.

The last hub of the group **8–56** which is labeled V, may be impulsed to condition the machine for typing variable length fields as for print out of the variable length field of alphanumeric section of memory.

In a dotted enclosure **8–58** are groups of hubs designated **LA1** through **LA15** to cause the corresponding variable length field in magnetic ledger card section of memory to be located for alphanumeric entry or print out and similarly the machine is responsive to an impulse applied to any one of the hubs **SA1** through **SA4** to cause the corresponding variable length field of special alpha memory to be located, also for alphanumeric entry or print out.

Referring now to FIG. 8*b* of the drawings, in column **8–60** are sixteen successive arithmetic function hubs designated +, —, TR+, TR—, etc. to —NB. These hubs are responsive to electrical impulses to cause the corresponding function as described hereinabove, to be performed. In such case, the IN word and OUT word designated during the corresponding program step are made the operands in the function.

In the column **8–60** and below the last arithmetic function hubs, are four interconnected hubs such as that at **8–62** which are responsive to an electrical impulse to cause the magnetic ledger card unit **1–14** to perform a record operation on the stripe of a magnetic ledger card in this unit.

In the dotted rectangle designated **8–64** are eight entry hubs which are receptive to potential impulses to cause the primary printer of the system to print or type the programmed word or field. Similarly, a group of six entry hubs within a dotted rectangle designated **8–66** are receptive to potential impulses to cause the ledger printer to print the programmed word or field. Each of these sets of printer entry hubs has a corresponding printer exit hub or group of exit hubs which produce an impulse following the impulse applied to the printer entry hub. In the case of the primary printer, the printer exit hubs are shown within a dotted enclosure **8–68** and in he case of the ledger printer, the exit hubs are shown within a dotted enclosure **8–70**. In each case, the exit hub or hubs on the same horizontal level as an entry hub, is connected through an isolating diode to that entry hub with the diode anode connected to the entry hub and thus, produces an electrical impulse in response to impulsing of the entry hub. Three primary print only and three ledger print only hubs are contained in respective dotted rectangles **8–72** and **8–74** and these hubs may be impulsed to initiate respective primary and ledger print operations. However, no corresponding exit hubs for these two groups of entry hubs are presented.

The normal machine operation is to print the addressed word, with the programmed digit capacity and automatically take one space after printing called the symbol space. This operation can be altered by programming various minor functions of the print command. The print command is programmed within a program step and the operational exits are used to select the desired word, digit capacity and print function within the program step. Typically, the function exits are used to program the print command, the digit capacity is programmed by the IN word exits and the OUT word to be printed is printed from the OUT word exits.

The print operation on the machine of this invention can be considered as nondestructive. That is, the printed OUT word will contain the same information at the completion of the operation as it did before. This is accomplished automatically by the machine when the print is programmed by transferring the contents of the programmed OUT word to the overflow register. Therefore the actual printing is performed from the overflow register. When a word is transferred in such a manner, the receiving word, in this case the overflow register, will be cleared to zero to accept the transferred information. If the overflow register contains information which is to be used later in the program, it will be necessary to transfer it to another word prior to programming a print operation. At the completion of the print operation the overflow register is reset to zero.

The primary printer exit hubs are useful to program the various desired minor functions of the printer. These minor functions and the entry hub or hubs on the control panel which are receptive to impulses to obtain the minor function involved are as follows: carrier return on the ledger printer is obtained by impulsing any one of the four hubs enclosed in the dotted rectangle **8–76**, tab ledger carrier which may be obtained by impulsing any one of the four hubs within the dotted rectangle **8–78**, reset print which may be obtained by impulsing any one of the four hubs within the dotted rectangle **8–80**, the symbols /, C, M, T, S, * which may be obtained by impulsing the hubs which have the corresponding symbol in proximity therewith and which are in the dotted rec-

tangle **8–82**, space suppress at **8–84** and which when impulsed will cause the machine to suppress the normal space which occurs after a typeout, high order zeros **8–86** which when impulsed will cause high order zeros of the number typeout to be printed, high order asterisks **8–88** which when impulsed will cause asterisks to be printed in high order positions higher than the first significant digit.

To prevent back circuits when programming the minor functions of printing, diode isolation is used as shown in FIG. 66 of the drawings. The primary printer entry hubs are diode isolated from the primary printer entry only hubs and the primary printer exit hubs are diode isolated from the primary printer entry hubs. Each group of hubs in the primary printer exits are also diode isolated from one another. Therefore, a minor function can be programmed from more than one group of primary printer exit hubs without having back circuits. In programming a symbol as a minor function, the symbol will be printed in the symbol space which follows the typed word unless the word printed is negative. In this case a minus sign (—) will be printed in the symbol space, superseding the programmed symbol. Similarly, the space suppress symbol is overridden by the minus sign attaching to a negative number.

Several choices of puctuation are available. There are four groups of punctuation at hubs **8–90**, **8–92**, **8–94**, and **8–96** labeled punc. A, punc. B, punc. C and punc. D, respectively. Each group has four hubs which are electrically joined to one another. The punctuate A hubs at **8–90** are receptive to impulses as a minor function, to cause the machine to print a decimal between the second and third order digit positions. If the word to be printed contains no information and the punctuate A hub is impulsed, the decimal will be printed followed by two zeros. One extra space must be provided on the form to print the decimal.

The punctuate B hubs at **8–92** are receptive to impulses to cause a decimal and a comma punctuation to be printed. That is, a decimal will be printed between the second and third order digits, a comma will be printed between the fifth and sixth order digits and between the eighth and ninth order digits. The commas are printed only if they are required. If the digit capacity of ten is programmed with a word containing six digits, the commas normally printed between the eighth and ninth digit positions will not be printed. The printed will space 5 times and print the significant digits. As in punctuate A, the demical will be printed followed by zeros, if the word contains no information. Again, space must be provided on the form to accommodate the decimal and comma punctuation.

In the punctuate C minor function, the decimal may be placed between the first and second order digits, or as an alternative may be placed between the third and fourth order digits and as still another alternative, the decimal may be placed between the fourth and fifth order digits. Again, the decimal will be printed and followed by zeros if the word contains no information. One extra space must be provided for printing the decimal.

Punctuate D hubs **8–96** are receptive to impulses to cause the machine to print a decimal between the first and second order digits or between the fourth and fifth order digits.

Slant punctuation is also available for punctuation D programming. When punctuate D slant punctuation is programmed, a diagonal symbol (/) is automatically printed between the fourth and fifth digits and the second and third digits. This punctuation is normally used for printing dates. It may be desired to print two digits in the month column. This can be accomplished by programming print of high order zeros with a digit capacity of 6, on the word used to store the date. When this punctuation is programmed, two extra spaces are required to print the information.

Additional hubs in the primary printer control area of the control panel are used for program control of the forms handling devices and the backspace feature. These hubs are not programmed as a minor function of printing.

The primary printer is capable of handling and preparing three different forms simultaneously. These forms are the vertical format output document which is the main output document, a journal form and a front feed form. The vertical format output document and journal are continuous forms but are driven by separate forms tractors. When the journal index entry hub, **8–98**, is impulsed, the journal tractor and platen are indexed one line. The journal exit hub **8–100** emits an impulse on the completion of the journal indexing to continue a program routine.

To insert a front feed form in the primary printer, a carriage must be opened. This carriage can be opened by impulsing one of three hubs such as **8–102** or manually depressing a "carriage open," located on the console near the primary printer keyboard. When a "carriage open" hub is programmed, a form aligning bail pivots forward to provide easy access to a form chute in the carriage. The platen is also raised and the feed rolls are lowered. Impulsing the carriage open hubs must be the terminating function in a program sequence, because the machine locks when the aligning bail pivots forward.

After the front feed forms are inserted, the aligning bail is manually restored to the aligning position, the platen is lowered. The forms chute mechanism can be closed by starting the machine or depressing the forms chute, open-close key. When the machine is started or the key depressed, the feed rolls will raise, gripping the front feed form against the platen and then the aligning bail will pivot rearwardly to its restored position. The forms chute, open-close key will open the front feed mechanism if it is closed and will close the mechanism if it is in the aligning position.

Left feed roll control hubs are shown **8–104** and **8–105** and control the operation of a left set of feed rolls on the primary printer, when the open carriage hubs are impulsed. If the left feed roll hubs are wired together and a carriage open hub is impulsed, the left feed rolls will be lowered. However, if the left feed roll hubs are not wired together when a carriage open hub is pulsed, the left feed rolls will remain against the platen. The right feed rolls are not programmed and will be lowered in both cases.

A pair of hubs **8–106** and **8–107** are provided and as indicated by the arrow therebetween may be interconnected by control panel wire. Such interconnection is effective to cause the journal tractor of the primary printer to index a journal form, one line at each carrier return operation.

A backspace entry hub **8–108** provides a means of backspacing the printing element to a predetermined position. The horizontal program tape must also be programmed when using this feature. When the backspace entry hub is impulsed, a backspace operation is initiated. The printing element carrier will then backspace until a 7 punch is sensed by the horizontal sensing mechanism. When the 7 punch is located, the backspace operation is completed and the printing element will stop one space to the left of the 7 punch. When the backspace operation is completed, a backspace exit hub **8–110** will emit a pulse. This pulse can be used to continue the program routine.

One of a pair of three pairs of hubs designated Enter Alpha are shown at **8–112**, **8–114**, and **8–116** and each hub is receptive to potential pulses to condition the circuitry for entering alphanumeric information into memory. Associated with such entry, are a plurality of 15 hubs in the dotted rectangle **8–118** shown in FIG. 8*a*, numbered **1** through **15** and designated "Begin Alpha." Another hub **8–120** is designated a Begin Alpha common hub and to choose the word of magnetic ledge card memory in which alphanumeric information is to begin, the common hub **8–120** is wired to that hub of the group **8–118** having a number corresponding to the chosen word num-

ber. This has the effect internally of establishing a certain B counter count to begin addressing the chosen word of memory.

Associated with the magnetic ledger card unit are hubs **8–122**, **8–124**, and a pair of joined **8–126**. Hub **8–122** labeled PL is impulsed at magnetic ledge card in unit **1–14** reaches the posting line for printing thereon. Hub **8–124** is impulsed in recognition of the fact that a ledger card is full or in other words will accommodate no more printed information. Hubs joined at **8–126** are receptive to electrical impulses to condition the circuitry of the machine to prepare a new ledge card.

A pair of hubs shown at **8–128** may be interconnected by a control panel wire as indicated by the arrow therebetween. The interconnection of these hubs by control panel wire is effective to cause the magnetic read/record head of the magnetic ledger card unit to be swept along the magnetic stripe but the information so read is not placed into the memory unit of the machine. This action, in the absence of any other influence, is followed by an impulse being automatically, i.e., by internal machine wiring, applied to an auto start hub.

The control keys on the console have respective exit hubs as shown in the column **8–130**. Depression of a control key causes the corresponding control key exit to produce a potential pulse. The control key exits may be used to change the program routine, such as an error correction routine.

The machine selectors which are of the branching type and blance test type facilitate changing of a program routine. Twenty branching selectors are latch relays. Each has four sets of hubs such as shown for selector **1** in the enclosure **8–137** and these are labeled C (common), N (normal), and T (transfer). The C hub can be considered the operating point, the N hub as the normally closed point and the T hub as the normally open point. When the selector is in the reset condition, a circuit is completed from C to N. When the selector is picked a circuit is completed from C to T. Each set of points within a selector is insulated from the others. Therefore, each set of points can be used to branch into a separate routine or function based on the condition of the selector as a whole.

The conditions of the selectors are controlled by the seceltor pick (Sel Pick) or selector reset (Sel Res) hubs shown in respective groups **8–134** and **8–136**. Each of these groups has a pair of columns of hubs designated ENT for entry and EX for exit. A Selector Pick Entry hub is receptive to pulses to cause its corresponding selector points to transfer. Since the branching selectors are latch relays, they will remain picked irrespective of the machine condition on or off, until a Selector Reset hub is impulsed which will cause the selector to reset to its original condition. Both the Selector Pick and Reset, have exit hubs, which produce an impuse in response to impulsing of the entry hub. This latter impulse may be used to continue the program routine. To prevent back circuits to the pick or reset of a selector, the entry and exit hubs are diode isolated from one another.

The balance test selectors including zero balance test (ZBT) and negative balance test (NBT), are used in the same manner as the branching selectors. These are ten position relays which have hubs as shown at **8–138** and **8–140** in FIG. 8*a*, one set of hubs is designated C for common, another N for normal and the last set T for transfer. In the unpicked condition a connection exists between C terminals and corresponding N terminals. In a picked condition, a connection is made between the C terminals and corresponding T terminals. Each C, N and T terminal is insulated from others so designated. The zero balance test and negative balance test selectors may be picked as a result of the performance of an arithmetic function invloving a balance test of a programmed IN word, at the completion of a given program step. If a zero balance test is performed and the programmed IN word is zero, the zero balance test selector will be picked. If a negative balance test is performed and the IN word is negative, the negative balance test selector will be picked. Therefore, the balance test selectors can be used to change the program routine, based on the condition of the IN word.

The balance test selectors can be reset by impulsing their reset entry hubs. Pairs of reset entry hubs for these respective selectors are shown at **8–142** and **8–144** and pairs of reset exit hubs are shown at **8–146** and **8–148**. The entry hubs are responsive to impulses to reset the respective selectors and the exit hubs produce impulses in response to the reset function and such pulses can be used to continue a program routine. Both the balance test selectors can be reset at once. Since the balance test selectors are not latch relays, they will also be reset when the machine power is turned off.

BASIC CIRCUITS POTENTIAL SWINGS

Complemented transistor resistor (CTRL) logic circuits are used in the machine. They are characterized by large signal swings and saturating transistors.

FIGS. 10*a* and 10*b* show fundamental potential swings and line levels of CTRL circuits. Maximum and minimum signals are stated as a guide to levels that are used.

Four sets of potential swings or lines are encountered. These are:

	−R Level	+R Level
R Line:		
Minimum	+.2 volts to	+5.6 volts.
Maximum	−.3 volts to	+12.0 volts.
	−S Level	+S Level
S Line:		
Minimum	−5.6 volts to	−.2 volts.
Maximum	−12.0 volts to	+.3 volts.
	−V Level	+V Level
V Line	−10.8 volts to	−2.0 volts.
	−W Level	+W Level
W Line	0 volts to	+48.0 volts.

In all cases, potentials substantially zero, that is, within the tolerances noted, represent logical 1 and potentials significantly positive or negative with respect to zero, represent logical 0. Thus, −R, +S, +V and +W are potentials representing logical 1 and +R, −S, −W and −V, represent logical 0.

These circuits are characterized by resistor input networks and inverted signal outputs. The transistors are usually operated in saturation, when conducting. The logic of the block functional symbol is performed by the resistor input network; the transistor inverts and amplifies the resistor network output. Some CTRL circuits operate from the potential mode operation and employ potential shifts shown in FIG. 11.

S to S inverter (+And, −Or)

The PNP transistor nontranlating circuit in FIG. 12 is used for repowering and level setting of CTRL signals. This circuit is sometimes called the NOR circuit. It performs any one of three basic logic functions: +And, −Or, Invert. The logic function is performed by the input resistor network; the invert function, by the common emitter transistor configuration.

With the component values and potential levels shown, the functions of the circuits of FIG. 12 are obtained in the following manner:

Function	Inputs	Outputs
Complemented +And	All inputs zero volts	−6 to −12 volts.
Complemented −Or	One or more imputs, −6 to −12 volts.	Zero volts.
Inventor	Single input, −6 to −12 volts.	Zero volts.
	Single input, zero volts.	−6 to −12 volts. Remaining inputs, being disconnected are also at a zero level.

The transistor **12–10** has a base **12–12** biased by the potential developed across the input divider network including resistor **12–14** and resistors **12–16** and **12–18**. The exact level of this bias depends on the number of inputs used and their level. Input levels at input terminals **12–20** and **12–22** may vary at their low levels (−S), but all will reach ground potential at the +S level. When +S levels exist at all the input terminals the base of transistor **12–10** is at +0.65 v. The transistor is reverse-biased off since its emitter is returned to ground. This causes a −S level output to exist at pin **12–26**. The exact output level is developed upon circuit loading.

Dropping any input to the −S level causes the base of transistor **12–10** to decrease toward −3.15 v. It becomes forwardly-biased on and clamps the base at −0.2 v. Saturation current flows through the transistor and quickly raises the output to the +S level (−0.2 v.).

Coincidence of more than one −S level at the input drives the transistor farther into saturation and increases the turn-off delay of the circuit.

S to R converter (+And, −Or)

The NPN translating circuit shown in FIG. 13 is used for repowering and level setting of CTRL signals. It performs any one of the three basic logic functions, +And, −Or, convert and inverts an S input level to an R output level. The logic function is performed by the input resistor network; the invert function, by the common emitter transistor configuration.

In the +And, invert logic application illustrated in FIG. 13, a −R output is obtained only when all the inputs are up (+S).

The transistor **13–10** has its base **13–12** biased by the potential developed across the input divider network including resistor **13–14** and resistors **13–16**, **13–18** and **13–20**. The exact level of this bias depends on the number of inputs used and their levels. Input levels at inputs terminals **13–22**, **13–24** and **13–26** may vary at their low levels, but all will reach ground potential (+S) when up. A −S level at any input holds the base of transistor **13–10** below the emitter potential and keeps the transistor off, causing a +R output to exist at output terminal **13–28**. The exact output level is dependent on the circuit loading.

When all the inputs used are at the +S level, current flow into the divider network to the +12 volt supply raises the base potential of transistor **13–10** above ground-potential. Transistor **13–10** is forwardly biased into saturation and drops the output to the −R level.

R to S converter (+Or, −And)

The PNP translating circuit shown in FIG. 14 is used for repowering and level setting of CTRL signals. It performs the basic logical functions, +Or, −And, convert and inverts an R input level to an S output level. The logical function is performed by the input resistor network and the invert function is accomplished by the common emitter transistor configuration. In the −And, invert logic application illustrated in FIG. 14, a +S output is obtained only when all the inputs are down (−R).

The transistor **14–10** has its base **14–12** biased by the potential developed across the input divider network including resistor **14–14**, and any combination of resistors **14–16**, **14–18** and **14–20**. The exact level of this bias depends on the number of inputs used and their levels. Input levels may vary at their high levels, but all will drop to ground (−R) when down. A +R level at any one of the input terminals **14–22**, **14–24** and **14–26** holds the base of transistor **14–10** above the emitter potential and keeps the transistor **14–10** on, causing a +S level to exist at output terminal **14–28**. The exact output level is dependent on the circuit loading.

When all inputs used are at the −R level, current flow from the −12 v. supply decreases the base potential of transistor **14–10** below ground potential. The transistor is cut off, causing a −S level to exist at output **14–28**. The exact output level depends on circuit loading.

S Line power inverter

The power inverter shown in FIG. 15 provides a large power output to drive branching circuits or transmission lines. A relatively small S input results in an amplified and inverted S output.

This circuit includes a PNP type transistor **15–10** and a +S input to terminal **15–12** and base **15–14** reverse biases transistor **15–12** to cut it off. The output terminal **15–16** is near −12 v.; the exact level depends on the load connected thereto. When the input falls to −S level, the base **15–14** tends to drop below ground. The emitter clamps the base at about −2 v. The transistor **15–12** goes into saturation. Output terminal **15–16** rises to a +S level (near ground) because of the potential drop across resistors **15–18** and **15–20**.

The 3.3 ohm resistor **15–20** and 33 μf. capacitor **15–22** decouple the collector load resistor from the −12 v. supply to prevent the sudden current demand from affecting other nearby circuits.

S to R line power inverter

This power inverter shown in FIG. 16 is similar in operation to the S− line power inverter. An NPN transistor **16–10** is used and the collector is returned to a positive supply potential. An S input at terminal **16–12** results in an inverted R output at terminal **16–14**.

S line emitter follower

The PNP emitter follower circuit shown in FIG. 17 serves as a non-translating current amplifier that drives additional logic or branching circuits. Emitter followers also serve as buffer devices to match impedances or provide isolation. A slight direct potential shift results between the input and output signals. Circuit design permits many variations in input and output loading connections of these emitter followers.

With base **17–12** of transistor **17–10** at about −0.2 volt the transistor is in partial conduction. Thus, current flows through the low resistance inductor **17–14** into the 2.2K emitter follower resistor **17–16** to the +12 v. supply. The base-emitter drop (0.2 v. to 0.4 v.) causes a slight potential shift between the input and output signals. A +S output exists at terminal **17–18**.

When the input potential drops toward −12 volts, the forward bias on transistor **17–10** is increased. Current through the transistor starts to increase but is momentarily resisted by the inductor, **17–14**. Then the output drops sharply to the −S level and the transistor **17–10** is in full conduction.

The circuit is returned to its original status by a +S level applied to input **17–20**. The rise to the +S level is similarly resisted by the inductor **17–14** and again a sharp shift results.

Because of the relatively low impedance offered by the emitter follower the output level is little affected by the output loading (within limits). The 300 ohm collector resistor **17–24** limits the power dissipation in the transistor.

R line emitter follower

The NPN emitter follower circuit shown in FIG. 18 serves as a non-translating current amplifier that drives additional logic or branching circuits. Emitter followers also serve as buffers to match impedances or provide isolation. A slight direct potential shift results between the input and output signals.

With base **18–12** of transistor **18–10** at about +0.2 volt it is in partial conduction. Most of the current from the load and the 2.2K resistor **18–14** flows through the low resistance inductor **18–16** into the transistor. The base-emitter drop (0.2 v. to 0.4 v.) gives a slight potential shift between the input and output signals. A −R output exists at terminal **18–18**.

When the input line rises toward +12 volts, the forward bias on transistor **18–10** increases. Although the current through this transistor initially increases it is

momentarily resisted by the inductor **18–16**. The potential drop developed across the parallel LR **18–16** and **18–22** network holds the output terminal **18–18** near ground level until the counter —EMF is overcome. Then, the output increases sharply to the +R level and the transistor is in full conduction.

The circuit is returned to its original status by —R level to input **18–20**. The drop to the —R level is similarly resisted by the inductor and again a sharp shift results.

Because of the relatively low impedance offered by the emitter follower, the output level is little affected by the output loading (within limits). The 300 ohm collector resistor **18–24** limits the power dissipation in the transistor.

Remote load

The output of any transistor is basically an electric current. Each transistor is connected to a suitable potential through a load device such as the resistor **19–10** in FIG. 19. The purpose of this load device (usually a resistor) is twofold: first to limit the current through the transistor, and second, to provide a potential level based on the amount of current flow so that other transistors can be controlled. A potential pulse with little current demand tends to degenerate because of line capacitance and resistance. Therefore, when the output transistor is separated from the input network of the next transistor by a considerable distance, it is desirable to develop the controlling potential near the input network.

Indicator driver

The indicator driver circuit shown in FIG. 20 supplies up to 20 ma. to an incandescent lamp connected to its out-of-phase output terminal. A +S input level at input terminal **20–10** is required to turn on the transistor **20–12** and light the lamp **20–14**. The indicator driver can be driven by CTRL, or potential trigger circuits.

With a —S input at input terminal **20–10**, the potential at base **20–16** of transistor **20–12** clamps at —0.3 volt as transistor **20–12** is forwardly biased on. The output at **20–20** increases toward ground potential and supplies sufficient current to light the lamp **20–14**.

When the input increases to the +S level, the base **20–22** of transistor **20–12** increases to +1.2 v. and holds the transistor reversely biased off. Only a pre-energizing current of 5.5 ma. flows through resistors **20–16** and **20–19**, and the lamp **20–14** to the —12 volt supply; this current is not sufficient to light the lamp. An output potential of —10.8 volts exists at pin **20–20**.

4 or 5-way nor

The 4-way and 5-way-nor block shown in FIG. 21 was designed to be driven by 48 v. from the control panel and produce —R level signals. The inputs **21–10** through **21–16** and **21–18** in the case of a 5-way block are either returned to ground through a 3K bleeder resistor as at **21–20** or connected to +48 v. through control panel wires. Only one input at a time is permitted to be returned to +48 v. With all inputs returned to ground through the 3K resistors the output will be returned to +12 v. through a 3.3K resistor **21–22**. If any one leg is returned to +48 v., the output is equal to the saturation potential which is 0 v. to +0.2 v.

Diode isolator

The diode isolator circuit shown in FIG. 22 is designed to carry +48 v. from the plugboard through either of two inputs **22–10** and **22–12** to a common load resistor **22–14**. Inputs **22–10** serves also as an output terminal. Input **22–12** is isolated from the first terminal by diode **22–16**, but will connect the input/output terminal **22–10** and an additional output line **22–18** to +48 v. when 48 volts is applied to input **22–12**.

Voltage mode trigger 1

The voltage mode trigger circuit shown in FIG. 23 is used in clock and ring circuits and as an isolated binary bit memory. The trigger circuit uses two inverters and two emitter followers and operates at a frequency near 150 kilocycles per second. The trigger may be connected to be operated by many input configurations. It may be operated as a binary input, a single gated AC input, a dual gated AC input, or a DC set input. Both in-phase and out-of-phase outputs are available.

Binary Operation: The trigger may be connected for binary operation (gated or not gated) by connecting one of the gate input resistors **23–10** to the emitter follower output terminal **23–12** on the same side of the trigger. The other gate input **23–14** may be then used as an external gate or connected to ground. The two AC inputs **23–16** and **23–18** are connected together and driven from a sample pulse driver to form the binary operation.

AC SET INPUT: For gated input operation, the AC set pulse applied to the AC inputs may be either a 3 v. or a 6 v. positive shift.

DC Set Input: A signal of —5.56 v. (or more negative) is applied to the DC set input terminals **23–20** or **23–22** of the trigger circuit. The negative set signal may go as far negative as —12.48 volts. The down input pulse must be at least 3.0 microseconds in duration.

A typical starting condition includes transistors **23–24** and **23–26** conduction, transistor **23–28** in minimum conduction, and transistor **23–30** cut-off. One gate input terminal **23–10** is connected to ground and the other input gate **23–14** is impulsed from —6 v. to 0 v. for 4.5 microseconds before the AC input shift is applied and a positive going 3 v. pulse of 0.5 microsecond is applied to the AC set input **23–16**. The output of the gate at diode **23–32** causes the base **23–34** of transistor **23–34** to become more positive than its emitter (ground potential). This transistor becomes reversely-biased off and the potential at its collector **23–36** falls toward —12 v. Because of the diode action between the collector **23–38** and base **23–40** of transistor **23–28**, the collector **23–36** of transistor **23–34** falls only to —6 v. This negative —6 v. forwardly biases transistor **23–28** into full conduction. The emitter **23–42** of the emitter follower follows the base to —6 v. The output of the emitter follower is coupled to the base **23–44** of transistor **23–30** through the potential divider including resistor **23–46**, **23–62** and **23–48** forwardly biasing transistor **23–30**. The conduction of transistor **23–30** causes its collector **23–50** to rise from —6 v. to 0 v. This collector potential rise to 0 v. is applied to the base **23–52** of transistor **23–26** and reduces its forward bias. The reduced bias on the emitter follower transistor **23–26** reduces its conduction so that its emitter **23–54** rises to 0 v. This emitter output of 0 v. at terminal **23–56** is coupled back to the base **23–34** and reversely biases transistor **23–24**, thus, providing latch back to the circuit. If gating of terminals **23–58** and **23–60** and an AC set pulse to terminal **23–18** are applied, the trigger is returned to its original state.

The turn-on and turn-off delays are a function of circuit loading.

Voltage mode trigger 2

This trigger differs from voltage mode trigger **1** only in the input wiring indicated by heavy lines in FIG. 24. It may be operated as a binary input at on terminals **24–10** and **24–12** or off terminals **24–14** and **24–16** or AC set input at pairs of terminals **24–18**, **24–20** and **24–22** and **24–24**. Two gated AC set inputs per state are available.

Binary Operation: The trigger may be connected for binary operation (gated or non-gated). When it is used as a non-gated trigger, the gate inputs are connected to ground and the AC set inputs are connected together and driven by a sample pulse driver.

AC Set Input: For gated input operation, the AC set pulse may be either a 3 v. or a 6 v. positive going pulse. Because there are two AC set gates per state in this circuit, the trigger can be driven from either gate input as gated or non-gated, or the gates may be connected together and operated as a single AC set input.

Gated sample pulse driver

The normal status of the circuit is with transistors **25–10** and **25–11** off and output pin **25–12** at approximately ground level. There is a single set input **25–13** and a gating input **25–14**. The gate **25–14** must be up to 0 v. before a signal to input **25–13** can operate the circuit. The output expected in a 3 v. positive, 1 ms. pulse regardless of input duration in excess of 1 ms.

With the input gate **25–14** at 0 v. for more than 5 ms., a positive shift at input pin **25–13** turns transistor **25–10** on. The emitter of **25–10** is clamped to approximately +0.5 v. by diode **25–15**. The collector of **25–10** approaches +0.5 v. and turns transistor **25–11** on. The two resistors **25–16** and **25–17** form a voltage divider with transistor **25–11** is conduction and an output voltage of approximately +3 volts is produced at terminal **25–12**.

The emitter of transistor **25–11** is now at approximately +3 v. The 3 volt negative shift on resistor **25–17** is coupled through capacitor **25–18** and reduces the emitter voltage of transistor **25–10** to approximately —2.5 volts. Diode **25–15** is now reverse biased. Capacitor **25–18** will charge through resistor **25–19** and resistors **25–21, 25–20** and transistor **25–10** toward a positive voltage.

As the emitter of transistor **25–10** becomes more positive than 0 v. (applied at terminal **25–14**) transistor **25–10** will be turned off. The collector of transistor **25–10** will then go toward +12 v. This shift will turn transistor **25–11** off and return the output to ground level. The emitter of transistor **25–11** will return to +6 volts, and the circuit resumes its quiescent state.

The input signal must extend beyond the 1 ms. period to allow the circuit to time out.

Integrator

The integrating circuit, FIG. 26 is driven by a W line and provides an S level that is relatively free of the noise and bounce generally found on circuit breaker or relay lines. With the input opened the capacitor **26–14** charges to a —S level and the output at terminal **26–10** is at a —S level from terminal **26–12**.

With an applied input of +48 volts, the capacitor **26–16** charges to ground level where it is clamped by the action of diode **26–14**. Current flow through the resistors **26–18** and **26–20** and raises the output to about ground (+S). Capacitor **26–16** smooths out potential fluctuations due to contact bounce.

Single Shot

The Single Shot circuit, FIG. 27 will provide a +S output at pin **27–10** until triggered, when the output will drop to a —S level (—12 volts). The duration of the output signal is 6 microseconds. The output duration is independent of the input signal duration.

When the Single Shot is off, transistor **27–12** is off, transistor **27–14** is on, and transistor **27–16** is on.

Capacitors **27–18** and **27–20** have approximately +6 volts applied to them from terminal **27–22**. Transistor **27–14** being on at this time results in —6 volts being applied on the right extremities of these capacitors.

Capacitors **27–18** and **27–20** are then charged with about 12 volts by virtue of the +6 volts from terminal **27–22** to the —6 volts at terminal **27–24**.

A positive A-C signal at pin **27–26** turns transistor **27–12** on. The collector of **27–12** approaches —6 volts. This is a negative shift which is applied through capacitors **27–18** and **27–20** to the base of transistor **27–14**, turning it off. As **27–14** turns off, its collector shifts positive and is coupled to the base of **27–16**, turning it off. The output becomes —12 volts.

A feedback loop is provided from terminal **27–28** to —12 volts at terminal **27–30** by line **27–32**. This results in the base of **27–12** approaching —3 volts. Base **27–12** will clamp to —6 volts and transistor **27–12** remains on. The collector of **27–12** is at —6 volts at this time.

Transistor **27–12** remains off until its base becomes more positive than —6 volts.

The collector of transistor **27–12** will be clamped to —6 volts, so the capacitors **27–18** and **27–20** are charged through resistor **27–34** toward +6 volts at terminal **27–36**.

The R-C time constant of capacitors **27–18** and **27–20** and resistor **27–34** determines the timing of the Single Shot. As the base of **27–14** changes from approximately —18 volts toward +6 volts, it will become more positive than —6 volts and **27–14** will turn on.

As **27–14** turns on, **27–16** turns on, and the potential at the collector of **27–14** (which is clamped to about —6 volts) is coupled by line **27–32** to terminal **27–30**, resulting in —9 volts being applied to the base of **27–12** turning it off. As transistor **27–12** turns off, its collector approaches +6 volts and is coupled as a positive shift to drive **27–14** even more into saturation.

Capacitors **27–18** and **27–20** charge as before.

Thyratron Relay Driver

The Thyratron Relay Driver circuits as shown in FIG. 28, include germanium switches of the PNPN type which are designed to drive +48 volt relays with a maximum steady state current of 200 ma. A "thyratron" as at **28–10** is turned on by returning the input **28–12** to ground for a period of no less than 9 microseconds. In conduction, the thyratron energizes a relay as at **28–14**. The thyratron is cut off by opening the collector circuit and reducing the current to zero. The 16K resistor **28–16** to —12 v. is to lower the collector resistor of a PNPN or which is used to drive the thyratrons.

Memory driver

A memory coreline driver circuit is shown in FIG. 29. In this circuit, in the absence of an input potential at the gate terminal **29–10**, transistor **29–12** is normally conducting. The collector **29–14** of this transistor is therefore at approximately —12 volts. Transistor **29–16** has the junction of its emitter **29–18** and base **29–20** reversely biased, thus rendering it nonconductive. With the gate input terminal **29–10** held at —6 volts, and one of the pulse inputs **29–22** and **29–24** held at ground level, transistor **29–12** will remain in conduction. With one pulse input held negative, transistor **29–12** will be cut-off when the second pulse input has a negative potential applied thereto. This tends to bring the collector of transistor **29–12** towards +6 volts and causes transistor **29–16** to conduct through an array of cores, the switch circuit transistor and a 42.2 ohm precision resistor at the other end of the line. For stability a heat sink is disposed about transistor **29–16** and is represented by the dotted enclosure.

Transistor **29–12** is normally on and transistor **29–16** is normally off.

Input **29–10** is a gate to which gating signals of longer duration are applied. Inputs **29–22** and **29–24** are normal pulse inputs.

This circuit will fire when all inputs are —12 volts —S. If either diode input **29–22** or **29–24** is at ground, the joint input to the .01 mfd. capacitor will be ground (+S).

If input **29–10** is —12 and **29–22** is —12, an input from a single shot at input **29–24**, for example, will cause an A-C negative shift to the base of transistor **29–12**.

This negative shift turns transistor **29–12** off, and its collector voltage will approach +6v. The base of transistor **29–16** is connected to the collector of **29–12** through a diode and the base of **29–16** approaches +6 v. As the

base of 29–16 becomes more positive than —6 v., transistor 29–16 is turned on, and the base clamps to —6 v. Transistor 29–16 will remain on as long as 29–12 remains off. The output at the collector of 29–16 is coupled in series through a diode matrix, a 42.2 ohm current limiting resistor, the core plane, another diode matrix and a memory switch to +6 volts, not shown.

As either diode input 29–22 or 29–24 is returned to zero volts, a positive shift will be coupled through capacitor 29–28 to the base of 29–12. Transistor 29–12 will be turned on and its collector will be held at approrimately —12 v. This will be coupled to the base of 29–16 through the diode. Transistor 29–16 will then be turned off.

Resistor 29–26 and capacitor 29–28 form an RC network that tends to turn 29–12 back on after it has been turned off. This time constant is large in comparison to the input signal, and permits the driver to remain under control of normal input signals.

Memory Switches 1 and 2

These switches are used in conjunction with the core memory driver circuits of FIG. 29.

Two transistors are provided, in Switch 1, FIG. 30, designated 30–10 and 30–12. The emitter of 30–12 is connected to +6 volts. When 30–12 is on, a path is completed from terminal 30–14 through a diode matrix, through the core plane, through another diode matrix, through a 42.2 ohm resistor, and back to the Driver as discussed in connection with FIG. 29.

Terminal 30–16 is connected to terminal 30–18 of the Memory Switch 2, FIG. 31. Switch 2 is used to connect the emitter of the Main Memory transistor 30–10, FIG. 30, to ground. With Switch 2 off, no current can pass through Switch 1. Terminals 30–18 of Switch 1 and 31–12 of Switch 2 are input terminals, both of which control Switch 1. Essentially, this arrangement comprises an AND circuit. Both 30–18 and 31–12 must be properly gated in order to get switch 1 on.

If either input 30–18 or 31–12 is volts, the bases of transistors 30–10 or 31–14 will be maintained negative so that it remains off. As the input signals to 30–18 and 31–12 go to +S, the bases are made positive turning 30–10 and 31–14 on. A shift occurs at the collector of 30–10 to about ground level which is applied to the base of 30–12. This is more negative than the +6 volt emitter potential of 30–12 and this transistor conducts, going deeply into saturation for driving the core plane.

The timing is set up so that the Memory Switch 1, FIG. 30 is turned on considerably before the Memory Driver of FIG. 29.

The Driver is turned on by the Single Shot, FIG. 27, for about 6 microseconds. The Driver is turned off, and the Switch is then turned off.

A delay line circuit is shown in FIG. 32. The function of this circuit is to provide a discrete delay between the input 32–10 and output 32–28. The output shall have sufficient potential and current levels to permit control of the memory drivers in the machine. A strobe circuit is also included. The delay line consists of a lumped constant delay line of 3K nominal impedance and including inductors as at 32–14 and capacitors as at 32–16, an inverter circuit including transistor 32–18, a power driver including transistor 32–20, and a diode AND circuit including diodes 32–22 and 32–24 to perform a strobe function. With an input of zero volts, transistor 32–18 is off and transistor 32–20 is turned on and the output is ground potential. As the input drops to —12 v., the signal will be delayed through the line and will turn on transistor 32–18. Transistor 32–20 is turned off as 32–18 comes on and the output becomes —12 volts. The signal output produced at collector 32–26 is applied to diode 32–22 of the diode AND circuit connected such that with both of its inputs at —12 v., the output will be —12 v. As the input signal returns to 0 v., transistor 32–18 is turned off and transistor 32–20 is turned on giving a 0 v. output.

Sense Amplifier Shaper

Pin 34–34 of the Sense Amplifier, FIG. 34 is applied to pin 33–10 of the Sense Amplifier Shaper. The Shaper is essentially a Single Shot circuit.

The Shaper has three transistors 33–12, 33–14 and 33–16. With no input pulse at terminal 33–10, transistor 33–12 will be on, 33–14 will be off and 33–16 will be off.

A positive going pulse at terminal 33–10 (—12 to —2 volts) will cause 33–14 to conduct. The emitter of transistor 33–14 is about —6 volts and when it conducts its collector will become —6 volts. This negative shift turns 33–12 off by line 33–18 and turns 33–16 on causing a —9 volt output at terminal 33–24. The collector of 33–12 approaches ground and keeps 33–14 on. The —6 volts on the collector of 33–14 will be coupled to the base of 33–16, turning it on. The output at pin 33–24 will become approximately —9 volts.

The capacitor 33–20 and resistor 33–22 from an RC network which allows the base of 33–12 to slowly become more positive so 33–12 turns on at the end of about 3.5 microseconds. When 33–12 turns on, its collector will shift to —12 volts and turn 33–14 off and as 33–14 turns off a positive shift occurs at its collector which is applied to 33–16 to turn it off and return output terminal 33–24 to —12 volts. The positive shift of the collector of 33–14 will be coupled to the base of 33–16, turning it off. The output at pin 33–24 will approach —12 volts.

Sense amplifier

This circuit is shown in FIG. 34. The circuit comprises six transistors 34–10 through 34–20. Terminals 33–22 and 33–24 are connected to the respective ends of one of the core plane sense windings.

Either end of a sense winding may become positive with respect to the other depending on the direction it takes through the core plane. This requires differential amplification. When the core drivers are fired a potential of a few millivolts is developed between terminals 34–22 and 34–17. Transistors 34–10 and 34–16 are amplifiers operating in a non-saturated mode for amplifying the difference signal. Transistors 34–12 and 34–18 are also non-saturated. Transistors 34–10 and 34–12 or 34–16 and 34–18 amplify the input signal to a few volts.

A strobe pulse of —12 volts is applied at terminal 34–26 when both word Driver and Bit Driver are firing. Normally the Strobe input is at ground level. In this case the bases of 34–14 and 34–20 are at ground through the diodes 34–28 and 34–30. As the strobe goes to —12 volts, the diodes 34–28 and 34–30 become reverse biased so the sense winding signal from 34–12 and 34–18 can be connected to 34–14 or 34–20, respectively.

If terminal 34–24 is more negative than terminal 34–22, a negative voltage will be developed through diode 34–32 to the base of 34–20. The potential of the emitter of 34–20 is at about —1.5 volts and the signal from diode 34–32 will turn 34–20 on. Output 34–34, which was —12 v. volts before, will be effectively connected through 34–20 to the emitter of 34–20 and become —1 or —2 volts.

A voltage swing in the other direction will turn on 34–14 rather than 34–20. Either transmitter coming on will result in a positive shifting signal at terminal 34–34. This output must be shaped by the Shaper circuit in FIG. 33.

DOT functions

Many of the basic CTRL circuits can be connected to provide a logical function without the use of additional transistors. The connection is shown as a dot (.) and the logical function is known as a DOT function. The output transistors of the circuits that enter into the DOT function are connected to a common load. Any one of the transistors involved can conduct and cause a potential drop to occur across the common load, thereby changing the

output level. In this sense, all DOT functions are OR logic circuits. However, if the line level sought is possible only when none of the transistors conducts, the DOT function can be considered as AND circuitry. The sign of a DOT OR function is opposite to the sign of the same circuitry performing a DOT AND function. FIG. 35 gives examples of DOT functions. FIG. 36 shows the circuit details of each. The sign and function of the circuits feeding the DOT function must be considered in determining the DOT output. In those functional blocks (A, O, or C) that are normally signed, the sign refers to the individual block. The DOT function, owing to signal inversion, is of the opposite sign. For example, the —CO and —AO blocks in FIG. 35A are —C and —A blocks, respectively, and the DOT function is +O. In those blocks not normally signed, (DE, DSP, etc.) the sign refers to the DOT function.

The MLC driver circuit shown in FIG. 37 provides bias and write currents to the magnetic head of the MLC unit. The respective coils of this head are shown at **37–10** and **37–12**. The circuit includes a logic stage with transistor **37–14** and two driver stages with respective transistors **37–15** and **37–16** are effective in their conductive conditions to supply write current to head coil **37–10** and to supply bias/erase current to the head coil **37–12**, respectively.

At the input of transistor **37–14** an information input **37–18** and gate input **37–20** are provided. The information line varies from +12 (+R) volts to 0 (—R) volts and the gate varies from —12 (—S) volts to 0 (+S) volts.

In the non-MLC operation condition of the circuit, +12 volts is applied at terminal **37–18** and, —12 volts is applied at terminal **37–20** and all transistors are biased to cut-off. For MLC operation and no input information, at the information input +12 volts is applied and at the gate input **37–20**, zero volts is applied. Transistor **37–14** is made conductive, its collector drops to substantially ground potential whereby transistor **37–16** is rendered conductive. The +12 information input cuts off transistor **37–14**. This is the bias condition of the circuit during MLC operation wherein transistor **37–16** drives bias current through the bias coil **37–12** of the head. This is a saturating current which also erases all previously recorded information.

To record information, the gate input **37–20** has zero volts applied to it and similarly zero volts is applied to the information input. Transistor **37–14** is cut off whereby its collector rises to +12 volts and this is applied to the base of transistor **37–16** to render it nonconductive. Also, the 0 volts at the information input is applied to the base of transistor **37–14** and is less than the +6 applied at its emitter and transistor **37–14** is rendered conductive to drive record current through the record winding **37–10**.

The MLC shaper amplifier is shown in FIG. 38 and is responsive to the output of the MLC amplifier shown in FIG. 39.

The input terminal **38–10** to this shaper amplifier is coupled for alternating currents through a capacitor **38–12** to the base of transistor **38–14**.

In the quiescent condition of the circuit, transistor **38–14** is biased to saturation and transistor **38–16** is biased to cutoff and the diode **38–18** is reversely biased from +12 volts through the potential divider including resistors **38–20**, **38–22** and **38–24** and potential —6 volts at one end of resistor **38–24**. The collector of transistor **38–14** is coupled through a capacitor **38–26** to the base of transistor **38–16**.

In response to a negative input pulse, transistor **38–14** is cut off, its collector rises in potential rapidly, this is applied to the base of transistor **38–16** to render it conductive. Capacitor **38–26** charges rapidly through the base-emitter junction of transistor **38–16** and resistor **38–28**.

During a charging time of capacitor **38–26**, the collector of transistor **38–16** is at ground potential and a negative pulse is applied to base of transistor **38–14** through resistor **38–22** and capacitor **38–30**. As capacitor **38–20** charges, a negative potential will then be applied to the base of transistor **38–14** through diode **38–18** from the potential divider formed by resistors **38–22** and capacitor **38–24**. This holds transistor **38–14** cut-off during this period. When capacitor **38–26** charges, the —6 v. applied to the base of transistor **38–16** cuts it off and the diode **38–18** is again reversely biased by the potential at collector of transistor **38–16**. Transistor **38–14** is again biased into conduction and the circuit will return to its quiescent state.

MLC amplifier

The MLC amplifier circuit in FIG. 39 has as its input, the output of the read coil of the magnetic head of the MLC unit. The circuit is a two stage direct coupled amplifier. In its quiescent state with no input applied, transistors **39–10** and **39–12** are biased to partial conduction. A typical input signal is approximately a sine wave with leading edge negative and with maximum swing of 15 to 40 mv. The input signal to the base of transistor **39–10**, first reduces conduction therein and then increases conduction therein but not to cut-off nor to saturation. When transistor **39–10** is driven to lesser conduction, its collector potential rises. This is applied to base of transistor **39–12** and this reduces its conduction and drives its collector negatively.

With a positive input signal, transistor **39–10** increases conduction, its collector drops, and this potential change is applied to transistor **39–12** and increases its conduction to saturation.

Resistor **39–14**, capacitor **39–16** and resistor **39–18**R3–C2 and R2 provide negative feedback and provide stabilization. Capacitors **39–20** and **39–22** are alternating current by-pass capacitors.

ILLUSTRATIVE PROGRAM

For the purpose of illustrating in a functional way, the versatility and effectiveness of the machine **1–10** in preparing business forms and the many operations of which it is capable in performing a complete "on line" accounting operation, a typical invoice preparing operation program is herein presented and a description of various of the program steps involved is herein included. Subsequent to the general description of this program, a detailed description of relay and electronic logic circuitry involved in performing certain of the programmed operations is presented.

The operating program is shown in accompanying Table 1, a loading program is shown in Table 2, certain storage assignments are shown in Table 3, certain selector and control key assignments are shown in Table 4 and certain load assignments for words are shown in Table 5. In the program presented in Table 1, the first column designated "operator instructions" indicates the operations to be manually performed by the human machine operator. The second column designated "Prog. Step" refers to the number of the program step involved, the third and fourth columns designated "Exit" and "Entry" respectively, refer to the program step entry and exit hubs and in the blocks below these headings are indicated the locations to which other hubs the respective program step exit and entry hubs are wired. The fifth column designated "Function' indicates the function to be performed during the corresponding program step and thus, the function to which the "Function Exit hub" corresponding to this program step, is to be wired. The sixth and seventh columns designated "In Word" and "Out Word" indicate the respective words to be used as operands or the fields of words to be selected or in some cases, other functions to be performed by impulses from these hubs. The eighth column designated "Comments" is available to explain the purpose of the corresponding program step or for other explanatory comments.

In the explanation of the invoicing operation, it is assumed that a going business is established, that customer's accounts receivable files have been established and that inventory records of goods in stock have also been established. The accounts receivable records for individual customers exist on ledger cards of the type shown at **5–10** in FIG. 5 of the drawings. At the heading of this card is indicated the customer or account number 4027, the sales tax rate and the usual shipper. Also indicated are the customer's name and address and below it, the location to which this customer desires delivery of goods purchased. In the body of the card are listed the entries of billings, including the dates thereof, the reference number which indicates the number of the seller's invoice, the amount of the billing for any individual transaction, the balance involved and a last line for comments. It is noted that a "transaction" may be a billing resulting in a debit amount, or alternatively, may be a payment by the customer, resulting in a credit entry. In either case, the amount involved in any transaction is used to determine a new balance. This is done by either adding the debit transaction amount to the old balance or subtracting a credit transaction amount from the old balance.

In addition to the visibly printed information on the card **5–10**, the heading in formation and the last line entry in the body thereof is magnetically recorded on a magnetic stripe **5–12** extending across the card on the rear side of it and represented by the dotted horizontal lines.

The manner in which the information is recorded on the magnetic stripe **5–12** is indicated in FIG. 6 wherein the vertical lines represent "1" bits of information and the absence thereof represents a "0" bit of information. Three bits of each column represent information bits and a fourth bit for odd parity checking, is recorded. For purposes of facilitating proper posting of the card in the Magnetic Ledger Card unit for printing thereon, the last entry on the card is indicated by the lowest punched hole, such as **5–14** along one edge thereof. These holes are sensed by a line sense mechanism set forth and described more fully in the above mentioned application D and will not be described in detail herein.

Representative inventory cards are shown at **5–16** and **5–18**. Each of the inventory cards has certain information visibly printed on it which includes a heading such as a product code number 3017, a price 28.80 indicative of the price per dozen of items represented by the card and a brief description of the items, namely, shirts of a certain size and style. Below the heading information are entries indicative of original amount on hand, withdrawals from stock including the date of the withdrawal, the customer number indicative of the customer to whom such items were shipped on the date indicated, the number of items withdrawn and finally the new balance, due consideration being given to the old balance and amount shipped. The heading information and the last balance are also recorded magnetically on a magnetic stripe on the rear of the card in the manner of card **5–10**. The inventory card **5–18** is entirely similar to card **5–16** but represents a different product, here Men's Black Hose.

In FIG. 5 of the drawings, **5–12** represents a typical accounts receivable card of the type useable in the magnetic ledger card unit **1–14** of the system **1–10**. The accounts receivable card is made of a relatively rigid, yet flexible material on which the ledger printer can readily, legibly imprint information and further, has along the back side thereof a magnetic stripe, **5–12**, shown in greater detail in FIG. 6 of the drawings.

For facilitating the positioning of the card at the proper posting line or, in other words, at the proper line on which the ledger printer is to print information, the card has a plurality of punched holes such as shown at **5–14**, one corresponding to each writing line and the lowest punched hole corresponding to the lowest writing line on the card. As explained in greater detail in co-pending application D the lowest hole of the series of holes as shown at **5–14** is co-operable with a sensing element as the card is being driven to the posting line in the magnetic ledger card unit so as to cause the posting drive mechanism to be stopped at the proper writing line.

A typical inventory ledger card of the type useable in the magnetic ledger card unit **1–14** and representing the inventory of items typically representing shirts is shown at **5–16** and another inventory ledger card similar to that shown at **5–16** is shown at **5–18** and in the latter case is a card that represents the inventory of men's black hose.

In the case of the accounts receivable card **5–10**, certain heading information including the customer's account number, the tax rate applicable to sales to this customer, and the common shipper are listed and also as part of the heading information is listed the customer's name and address and the usual shipping address. The heading information as herein described and the last line entry as well as being visibly imprinted on the front side of the card are also recorded on the magnetic stripe such as **5–12** in a manner shown more clearly in FIG. 6 of the drawings and described hereinbelow. In the case of the inventory ledger cards, certain heading information including the product code number such as 3017 on the card **5–16**, the price per dozen items such as the figure $28.80 and a brief description such as "shirt, 14/31 style A 34" are listed at the top of the card and further are recorded magnetically on a magnetic stripe similar to that shown at **5–12** on the rear of the card together with the last line item on the front side of the card.

In the magnetic ledger card unit **1–14**, a magnetic read/record head having four gaps for reading or recording information magnetically is provided and as a magnetic ledger card of the types shown in FIG. 5 of the drawings is positioned at a read/record station, the magnetic head is moved across the card longitudinally along the magnetic stripe on the back side thereof. As shown in FIG. 6 of the drawings, the head is capable of recording or reading four different channels of magnetically recorded bits of information. In this figure, a typical organization of bits is shown wherein the solid lines in any one of the channels represents a binary one bit and the absence of such a line represents a binary zero bit. It is to be noted that such showing of bits on the drawing is only for purposes of explanation herein and that in actuality the recordation of bits of information on the stripe does not result in any visibly discernible mark on the stripe.

The four channels of recorded bits on the stripe comprise first, second and third tracks of information bits and a fourth track representing check bits wherein the "odd" parity check of the system requires a check bit in the check bit track so as to make the number of bits in each column odd.

As the read/record head of the magnetic ledger card unit is swept across the card, its movement is first indicated to the system by a switch which is closed at a position on the stripe designated "on track switch" and thereafter first and second prerun cycles of the electronics of the system are performed to allow contacts and other similar elements to settle, after which the information bits on the stripe are read or recorded.

The number of 3 bit columns of recorded information is 384 and the last of such columns is designated "Last LA bit." Subsequent to the recordation of the last information column during a recorded operation, the four gaps of the magnetic head are each driven so as to write "one" bits for the remainder of the length of the stripe across which the head passes. Clearly these columns violate the "odd" parity checking provision. As pointed out hereinbelow this recordation of four bit columns is useful for a further error checking arrangement to assure that the end of memory is reached concurrently with the end of recorded information on the stripe, such as **5–12**.

INITIAL PREPARATION AND RECORDING OF NEW LEDGER CARD

The ledger cards, such as ledger card **5–10** may be preprinted with certain of the significant information, such as customer name and address, account number, and other similar information. This applies also to the inventory card **5–16** and **5–18**.

Ordinarily, however, each ledger card will be printed and recorded initially by a loading routine, as explained in connection with the typical program set forth herein. During the routine, the ledger card can be inserted in the forms handling device of the primary printer and the visible printed information can then be printed on the card concurrently with an alphanumeric entry operation into MLC Memory. The desired area of LA memory for the storage of binary numeric information is determined as usual under control of the Begin Alpha circuits. After the required information has been stored in MLC Memory, the newly printed card can then be removed from the primary printer, inserted in the ledger card handling unit **1–14** and have the corresponding information from MLC Memory transferred to its magnetic stripe by a Record operation.

Once the loading routine has been completed, the card can then be removed, placed in a file of similar cards for use in a normal program routine shortly after its preparation, or at some future date.

Upon completion of the initial loading routine, each card required in an accounting application will then have visible printed information, as well as magnetically stored information which is primarily permanent in nature, but which can be altered as required as the card is used in future program sequences.

From the standpoint of efficiency, all accounts receivable cards, all inventory cards, and all other types of cards required during a particular program routine would usually be prepared as a group, in order that the particular program routine in which the cards are involved would not be interrupted unnecessarily to prepare individual accounts receivable cards, and inventory cards during the course of the operation. Once, the entire group of cards has been prepared by the loading routine, the use of the loading routine therafter should be infrequent, since the only time that it would be necessary would be to prepare accounts receivable cards for new customers, or to prepare inventory cards for newly stocked items of inventory.

But during the normal course of a typical program or accounting application sequence, such as the preparation of the invoices previously indicated, the accounts receivable cards as well as the inventory cards would already have been preprinted and have been magnetically recorded for use during the sequence.

In the typical sequence therefore, the usual order of events is that the ledger card required at a particular step of the program is inserted in the ledger card unit **1–14**, the card is positioned at the first station, the contents of its magnetic stripe are transferred into MLC Memory during a read ledger operation, and the card is then fed to the second station for a printing operation as required. Following this various program operations will be carried out automatically by the machine, the ledger card may then be returned to the first station, the contents of MLC Memory will be transferred back to the Magnetic Stripe by a record ledger operation, and the subsequent scan of the stripe in order to check that the information is accurate. Following this the card would usually be ejected from the magnetic ledger card unit **1–14**.

In preparing an invoice of the type shown in FIG. 4 of the drawings, the continuous invoice form would be extended through the primary printer tractor on the main printer of the machine **1–10**, the horizontal and vertical tapes would have been prepunched in the manner shown in FIG. 4 of the drawings so as to delineate the respective horizontal and vertical positions of the invoice form, and a key numbered **2**, for example, on the console representing a control function key would have been prewired on the control panel to vertical position A entry hub so that depression of this key would direct the machine to move the invoice form to vertical position A. In preparing for the invoicing operations, the operator would aline the forms vertically and horizontally so as to assure printing in the proper places and then depress key to move the invoice forms to vertical position A.

The next operator function would be to drop an accounts receivable card of the type shown at **5–10** in FIG. 5 of the drawings into the hopper of the magnetic ledger card unit **1–14**. As explained more fully in co-pending application D filed concurrently herewith, the magnetic ledger card unit causes the read/record head therein to sweep across the magnetic ledger stripe on the back of the accounts receivable card and to load into the memory unit of the machine **1–10** the contents recorded on such stripe. As shown in the accompanying Table 3, the specific words of the magnetic ledger card portion of memory **L1**, **L2** and **L3**, in the case of the accounts receivable card contain respectively the account number, account balance and percentage tax. Also, of the variable length fields of the magnetic ledger card portion of memory L, **LA1** contains the name and description of the customer, **LA2** contains the address of the customer, **LA3** contains the "Ship to" address of this customer and field **LA4** contains the shipping instructions as, for example, the shipper desired by the customer.

After the accounts receivable card is read by the magnetic ledger card unit, it is driven to the posting line of this unit although no posting is done at this stage and upon arrival at such posting line an impulse is produced at a hub of the control panel, **8–122**, indicative of such arrival. As shown in Table 4, this hub is wired to the pick entry hub of selector No. **1** and the pick exit hub of this selector is wired to an autostart hub such as shown at **8–22**. Impulsing the autostart hub causes the machine to sample the vertical and horizontal tapes and to emit an impulse from the co-ordinate exit hub corresponding to the vertical position of the invoice and the horizontal position of the carrier. In this case, the co-ordinate exit hub **A–1** emits such an impulse and this hub is wired to program step 1 entry hub so as to initiate the stepping sequence of the program. During program step 1, a transfer plus operation is performed and the number in ledger word **1** is transferred to main memory word **3**. The purpose of this operation is to save the account number for future use.

As indicated by the straight line extending from program step 1 exit block to program step 2 entry block, program step 2 is initiated at the completion of program step 1 by a direct wiring connection between the exit and entry hubs. The function programmed in program step 2 is a ledger record operation in which case the accounts receivable card is driven to the read/record station and the information contained in the magnetic ledger card section of memory is recorded back on the magnetic ledger stripe of the card and the card is ejected. The operator then lays the card aside conveniently for future re-entry into the unit. Also, during this program step the selector **1** is reset by a connection from the INword hub to the reset selector **1** entry hub. In progressing from program step 2 to program step 3, the wiring connection is via reset selector **2** entry and exit hubs whereby selector **2** is reset during this progression.

In program step 3 a print function is programmed and in this case the Out word is designated **LA1** and the digit capacity is designated variable by the letters DCV. In this case, the contents of variable length field **LA1** is printed out on the primary printer. Again reference is made to

Table 3 wherein is designated that in variable length field, LA1, the name and description of the customer is contained.

After the completion of the printing of the customer's name and description in program step 3, in program step 4 the customer's address is printed from variable length field LA2.

Program step exit hub 4 is wired to vertical position B entry hub so that upon the completion of the printing of the name and address of the customer, the form is indexed to vertical position B and the carrier is returned to the left margin. The vertical position B exit hub is used to initiate program step 5 and in this program step the function, Print on the primary printer, is programmed. In this case the contents of variable length field LA3 is printed which contains the "Ship to" name and address.

Program step 5 exit hub is wired to vertical position C entry hub which causes the invoice document to be moved to vertical position C and since the vertical position C exit hub is wired to program step 6 entry hub, program step 6 is initiated. In this program step the customer's account number is printed on the line C of the invoice. It is noted at this point that the digit capacity 6 is programmed for the INword designation. The purpose of programming digit capacity 6 is to cause the last digit of the account number to be printed at the last horizontal space of the account number field and to cause the next digit to be printed to be part of the information for printing the date. In this way, the necessity of spacing from the account number field to the date field is eliminated. The completion of program step 6 initiates program step 7 during which, on the primary printer, the date is printed from special alphanumeric field, SA1, represented in Table No. 5.

As shown in Table No. 2, indicating the loading routine, the contents of word 4 includes the invoice number. Thus, in program step 8 of the main operating program, the contents of word 4 is printed out on the primary printer and this is the invoice number.

At the completion of the printing of the invoice number during program step 8, program step 9 is initiated during which the primary printer is caused to print. The field from which the primary printer prints is dependent upon the condition of the selector 2. As shown in Table 4 selector 2 is picked or transferred by an overflow indication which results from a star wheel on the vertical tape unit sensing a hole in channel 12 of the tape to indicate that a vertical position E has been reached, that the present invoice form is filled and that a new invoice form is required to continue the invoicing operation. Thus, in the absence of an overflow indication, during program step 9 the primary printer prints from the variable length field LA4 and under the conditions of an overflow indication, the primary printer prints from special alpha field SA2. Referring to Table 3, it is noted that variable length field LA4 contains the shipping instructions and that special alpha 2 field contains the word "continued." Thus, if it is a continued form, this is indicated by the word "continued" in the field established for shipping instructions.

In program step 10, it is required of the operator to key in the number of whole dozens of the articles being sold and shipped to a customer. Upon keying in this number, the start key is depressed and as seen in Table 4, co-ordinate exit D1 which is now the location of the printer element of the primary printer, produces an impulse in response to the depression of the start key. Since selector 1 has been reset in program step 2, an impulse is produced at the normal hub of the selector 1 and since program step 10 entry hub is connected to this normal hub of the selector, program step 10 is initiated. The function performed during this program step is a Transfer Plus (TR+) of the keyboard buffer word into Word 1. Since keyboard entry places numeric information into the Keyboard Buffer word, the number of whole dozens of articles is now contained in word 1 of main memory. Also during this program step the zero balance selector is reset for subsequent use.

As indicated by the slant line between program step 10 exit to program step 11 entry, program step 11 is initiated at the completion of program step 10. The function performed in program step 11 is a Transfer Plus operation from no designated Outword to the keyboard buffer. This has the effect of clearing the Keyboard Buffer word. Also, during this program step, the Negative Balance selector is reset for future use.

The next operation to be performed by the operator of the machine is to key into the numeric entry unit, the number of 12ths less than a dozen of the articles to be sold to the customer and then to insert the inventory ledger card corresponding to the items listed in this line item. Again the magnetic stripe on the ledger card is read by the magnietic ledger card unit, the contents thereof is loaded into the magnetic ledger card section of memory and the card is driven to the posting lines of the magnetic ledger card unit. Again referring to Table 4, it is noted that selector 1 is picked whenever the magnetic ledger card is driven to the posting line. In this case, therefore, the impulse that is emitted from co-ordinate exit D1 is applied to the transfer hub, T, of selector 1 and since it is wired to program step 12 entry hub, program step 12 is initiated. In this program step, a Zero Balance test is performed on the Keyboard Buffer word which will indicate whether any fractional dozens have been entered into the numeric key unit.

Also, during program step 12, the invoice is tested for an overflow condition. In the event that no overflow condition exists, program step 13 is initiated because the normal hub of the overflow indicate selector is connected to program step 13 entry hub. On the other hand, if an overflow condition should exit as sensed by the star wheel in channel 12 of the vertical program tape, the Overflow Indicate selector will be picked and the impulse provided to the common hub thereof from program step 12 exit hub is applied to its transfer contact I, for Indicate, hub which as shown in Table 4 is used to pick selector 2. The selector 2 pick exit hub is wired to vertical position C entry as shown in Table 4 and under this overflow condition, the forms skip mechanism of the primary printer is effective to cause the forms to skip to a vertical position C of the next invoice form. This again corresponds to program step 6 and under this circumstance, the program followed under the transferred condition of selector 2 follows program steps 6, 7, and 8 in the manner hereinabove described.

Following these program steps, program step 9 is initiated. However, in this case it is observed that the Outword rather than being word LA4 of the variable length field of magnetic ledger card section of memory is rather SA2 field of the Special Alpha section of memory. Thus, as also hereinabove described, the word "Continued" is printed in the field normally reserved for shipping instructions.

The completion of program step 9 causes an impulse from the exit hub of program step 9 to be applied to vertical position D entry hub and since, as noted in Table 4, the vertical position D exit hub is connected to the common hub of selector 2 and since selector 2 is now in the transferred condition, the pulse applied to the common hub appears at transfer hub T of selector 2 and this in turn is applied to program step 13 entry hub as indicated in this table. Thus upon the completion of the overflow routine, the program step 13 is entered and program steps 10, 11 and 12 are not repeated.

The function programmed in program step 13 is Print on the primary printer and since the Outword is desig-

nated W1, from program step 10 is noted that the number of whole dozens is printed on the invoice form. In program step 14, the number of whole dozens is converted to units by multiplying the number of dozens in word 1 by the contents of word 6, which, as noted in Table number 5, is the constant 12.

At this point it is assumed that fractional dozens or twelfths were entered following the entry into the numeric keyboard unit of the whole number of dozens and the condition wherein no fractional dozens were entered will be considered later.

Program step 14 exit hub is connected to the common hub 1 of the Zero Balance Test selector and the Normal hub of this selector is connected to program step 15 entry hub. Thus, since the Zero Balance selector is picked if a zero balance condition exits, the failure of this selector to be picked indicates that the condition was not zero and that therefore fractional dozens exist in the Keyboard Buffer word. During program step 15, therefore, the fractional number of dozens or, in other words, the units are added to the number of units obtained in program step 14 by multiplying the number of dozens times twelve whereby a total of individual units of items sold is produced and contained in word 1.

In program step 16, a Primary Print function is programmed and since the Keyboard Buffer word is designated as the Outword, the number of twelfths is printed. Also, noted in this program step in the function block, the printing of a slash indicative of a fraction is programmed as a minor function of the printing operation. In this case, the Ledger Printer exit hub would be connected by wire to the control panel hub of the group 8–82 which is designated the symbol (/). Also, noted is the Reset Print as indicated on the control panel by one of the hubs in the group 8–80 is programmed as a minor function. Thus, in response to printing from the Keyboard Buffer word, this word is reset or cleared.

In program step 17, the denominator, namely, 12, is printed since the Outword is designated W6 and from Table No. 5 it is observed that In Word 6 is contained the constant 12. A digit capacity of 2 is selected by the INword hub wiring since the constant 12 contains 2 digits.

At this point the condition wherein there were no fractional dozens or twelfths involved in this item is considered, and in this case, it is noted that the Zero Balance Test selector would have been picked in program step 12. In this case, in program step 14 the impulse applied by the program step 14 exit hub to the Zero Balance Test selector common-1 hub would have been applied through the Zero Balance Test selector transfer or T hub, as shown in Table No. 4. This impulse is used to cause the carrier of the primary printer to seek and locate horizontal position 2 since the T hub of the Zero Balance test selector is connected to horizontal position 2 entry hub. As noted in FIG. 4, horizontal position 2 corresponds to the field designated "quantity shipped." That is to say if no fractional dozens were involved in this line item, it is appropriate to enter the quantities shipped immediately after printing the number of whole dozens in the "quantity ordered" field.

In program step 18, a Transfer Plus function is performed and the contents of word L2 is transferred to word W2. Referring to Table No. 3 it is seen that the contents of word L2 is the quantity in stock in the case of the inventory ledger card.

In program step 19, a test is made to determine whether there is sufficient quantity in stock to meet the order and thus a Negative Balance Minus test operation is performed wherein the quantity ordered is subtracted from the quantity in stock and the result tested to see whether it is negative. Thus, the contents of W1 is subtracted from the contents of L2, both quantities being in units and the result tested for sign. Bearing in mind that this seelctor is picked only if the result is negative, program step 19 exit hub is connected to the Negative Balance Test or common 1 hub and the transfer 1 hub of this selector is connected to the program step 20 entry hub. In program step 20 a Transfer Plus operation is performed wherein the quantity in word W2 is transferred to the word W1. That is to say if there is an insufficient quantity to meet the order, the total quantity in stock is transferred to the quantity shipped or, in other words, the total quantity in stock is shipped. To update the word L2 which represents the quantity in stock, in program step 21 a Transfer Plus operation is performed wherein a zero quantity is transferred into word L2 to indicate that the quantity in stock is zero.

In program step 22 the contingency wherein the quantity in stock is greater than the quantity ordered is taken into account and thus, the program step 22 entry hub is connected to the normal or N hub of the Negative Balance Test selector. Thus, in this contingenecy the program would step from program step 19 to program step 22. In program step 22 a Transfer Plus operation is performed wherein the quantity in word W1 representing the quantity shipped is transferred to word W2.

In program step 23 to determine the number of dozens, the number of units shipped is divided by the constant 12 since word W2 contains the number of units and the word W6 contains the constant 12.

At this point it is noted that in a divide operation of the machine, 1–10, that the quotient resulting from the division is contained in the INword and that the remainder is contained in the Overflow Register word. Thus, in program step 23, the divide operation results in the number of whole dozens being contained in word W2 and the remainder, that is, the number of units less than a dozen, is contained in the Overflow Register word. Thus, in program step 24, the Zero Balance Plus operation, which is an add operation followed by a zero balance test of the INword, results in a transfer from the Overflow Register to the Keyboard Buffer word, of the number of units less than a dozen and a recognition of whether this value is zero or greater than zero by the test operation.

In program steps 25 and 26, a Print function on the ledger printer is programmed so as to print the contents of a field SA1 and Word W3 out on the inventory ledger card so as to print the date and the account number thereon and in program step 27 a Print function on both the primary and ledger printers is programmed so as to print the number whole dozens shipped on both the invoice and the ledger card.

In program step 28, since the contents of the Keyboard Buffer word is the number of twelfths less than a whole dozen, the number of twelfths is printed on both the invoice and the ledger card and since the Zero Balance Test selector is not picked if the quantity in the Keyboard Buffer word is other than zero a "/" symbol is typed as a minor function of the Print function of program step 28 and this symbol type instruction is directed via the contacts 2 common to 2 normal of the Zero Balance Test selector.

In program step 29, the number 12 is printed if appropriate. This is determined by the condition of the Zero Balance test selector again wherein the common —4 hub is connected to program step 29 Outword and the normal —4 hub of this selector is connected to Outword 6 hub. If the selector is picked, this number is not printed.

In program step 30 the product code is printed from a word L1 on the invoice and in program step 31 the product description is typed after which, by reason of the connection between program step 31 exit and horizontal position 5 entry hub, the carrier of the primary printer is caused to tab to the horizontal position 5 where-

in the program step 32 the price per dozen is printed from word L3. In this program step, as a minor function, Punctuation B is programmed which places the decimal between the second and third order digits.

In program step 33 the quantity in stock is saved by a Transfer Plus operation wherein the contents of word L2 is transferred to word W2. At the same time, the Zero Balance Test selector is reset.

In program step 34, since the Word W2 contains the units in stock, the quantity in stock in dozens is obtained by dividing the contents of word W2 by 12 which is contained in word 6.

In program step 35, since the Overflow Register word contains the remainder as a result of the division in program step 34, the remainder is placed in the Keyboard Buffer word by a Zero Balance Plus operation which is an addition of the Outword to the Inword, followed by a balance test operation.

In program step 36, the quantity shipped in units which is contained in word W1 is multiplied by the price per dozen which is contained in word L3. The product so obtained is twelve times the correct figure since the price used was not the price per unit but rather the price per dozen. In proceeding to determine the final price for this line entry, in program step 37, to obtain greater accuracy, a Column Shift Left operation is programmed wherein the contents of word W1, which is now the price multiplied by 12, is shifted left one place since the Outword is wired to Digit Capacity 1 hub and it is noted that this has the effect of multiplying the word W1 effectively by 10. In program step 38, this final figure which is the final price multiplied by 10 and 12 is divided by the contents of word W6 which is the number 12.

In program step 39, on the ledger printer is printed the number of dozens from word W2. The program step exit hub of program step 39 is connected to the Zero Balance Test selector common —5 hub and the normal —5 hub of this selector is connected to program step 40 entry. Thus, if this selector is not picked, program step 40 is initiated and in this program step, the contents of Keyboard Buffer word are printed on the ledger printer followed by a "/" as a minor function. Again if the contents of Keyboard Buffer word are other than zero, in program step 41 the contents of word W6 which is the number 12 is printed as a denominator to indicate the fractional part of the quantity.

In program step 42 the line amount is determined to the nearest cent by a Round Off Column Shift (ROCS) function wherein to the lowest order to the contents of word W1 is added the number 5 followed by a shift right of the contents of this word, one place, as designated by the Outward connection to digit capacity 1. In the event that there are no fractional dozens, the program would have proceeded from program step 39 to program step 42 via the transfer —5 hub of the Zero Balance Test selector.

In program step 43, the line amount is printed on the primary printer so as to give the final line amount on the invoice and as minor functions are programmed, Punctuate B, which has the effect of placing the decimal point between the second and third orders of this number and a Carrier Return operation on the ledger printer. At this point, the inventory ledger card is updated to reflect the line item just determined for the invoice and during the Carrier Return operation on the ledger printer, a new line find hole as shown at 5–14 in FIG. 5, is punched by the Magnetic Ledger card unit as described in application D.

As noted in Table 3, word 7 is reserved to contain the invoice total. Thus, in program step 44 an add operation is performed wherein the contents of word W1 which is the line amount total, is added to word 7.

The inventory ledger card having been updated with visible information, in program step 45 it is updated by recording on the magnetic ledger stripe the heading information and the last line item just printed thereon. This is done under program control by wiring a Record operation as a function.

At this point the magnetic ledger inventory card has been updated completely to reflect this entire transaction and it is ejected and placed back into its file by the operator. This, therefore, completes the one line item on the invoice and at this point a procedure similar to that described hereinabove is performed for entering other line items for other products sold to the same customer. The exit hub of program step 45 is wired to vertical position D entry and thus, as shown in FIG. 4, the invoice is moved to the next line item. Of course, if the next line item results in an overflow indication the overflow routine described hereinabove is followed. Otherwise, a repetition of line items in vertical positions D is followed until it is found necessary to complete line E of the form which is the final line item including the total amount.

When it is desired to determine the total line, that is, line E of the invoice form, control key 1 is depressed and as indicated in Table No. 4, the exit hub on the control panel corresponding to this control key is wired vertical position E entry hub whereby the impulse is effective to cause the invoice form to be moved to vertical position E. As shown in Table 3, vertical position E exit hub is connected by control panel wire to horizontal position 4 entry hub. Thus, subsequent to the indexing of the forms the carrier is tabbed to horizontal position 4. At the arrival of the carrier at this position coordinate exit hub E–4 emits an impulse which is used to continue the program since this hub is wired to program step 46 entry hub. At this point, the operator having laid aside the accounts receivable card originally inserted at the beginning of the program, re-inserts this accounts receivable card into the hopper of the magnetic ledger card unit. The card is read and the contents from the magnetic ledger stripe on the rear thereof is loaded into the magnetic ledger card portion of memory. After the card is read, it is driven to the posting line at which point an impulse is provided as also described hereinabove which is used to impulse an autostart hub, now producing an impulse from co-ordinate exit position E4, since this is now the position of the carrier. This co-ordinate exit hub is wired to the entry hub of program step 46 and now initiates this program step.

Since word 7 was designated "Invoice Total" and as each line amount was determined it was added to the contents of word 7, it is appropriate to print the contents of word 7 in the field beginning at horizontal position 4 and a digit capacity of 7 is programmed. As a minor function of this printing operation, Punctuate B is designated.

As shown in Table number 3, for the accounts receivable card, word L3 contains the tax percentage applicable to this customer. Thus, in program step 47 the contents of word L3 are printed with a Digit Capacity of 2 and in program step 48 in preparation for multiplication of the net amount by the tax percentage, the contents of word 7 is saved by Transfer Plus operation of the contents to word W2.

In program step 49, the amount of tax is determined by multiplying the tax rate times the net amount.

In program step 50 the amount of tax to the nearest cent is determined by Round Off Column Shift operation as explained hereinabove.

In program step 51, the contents of word 7 which is the net amount of the current invoice, is added to word 8 which represents a "Running" total for the succession of invoices prepared during an invoicing operation and in program step 52, the amount of tax which is contained in word No. 9.

In program step 53, the gross total is determined by adding the contents of word **2** which is tax amount of the current invoice to word **7** which contains the net total of the current invoice.

In program step 54, the tax amount is printed on the primary printer with a minor function of Punctuate B and the Outword is W2 and the Digit Capacity is 6 whereby after the printing of this operation, the carrier is in a position to print the gross total. In program step 55, the gross total of the current invoice which is in word **7** is added to the "Running" total which is in word **10** and in program step 56 the invoice gross total is printed out from Word **7**. A Digit Capacity of 7 is programmed and Punctuate B is also programmed as a minor function.

At this point in the program, the invoice has been completely prepared and it remains only to update the accounts receivable card which is now at the posting line in the ledger printer. In program step 57, a Print Ledger operation is programmed and from field **SA1**, the date is printed on the accounts receivable card after which in program step 58 the invoice number is printed from word **W4**. A Digit Capacity of 7 is programmed so as to avoid any tab operations that would be required to properly position the invoice or reference number.

In program step 59 the invoice gross total which is contained in word **7** is added to the account balance which is now contained in the word **L2**. In program step 60, the gross total as determined by the current invoice preparation is printed in the "This transaction" column of the accounts receivable card and in this case word **7** is printed out, minor functions of Punctuate B, Reset Type and Tab are also programmed.

In program step 61, the contents of word **L2**, which now represents the new balance, is printed on the ledger card, a Punctuate B and Carrier Return ledger are programmed as minor functions. On the ledger card, the new balance is printed under the column "balance."

In program step 62 the accounts receivable card is further updated by magnetically recording the heading information and the last line item of the information on the magnetic stripe on the back thereof. Finally, in program step 63 the contents of word **5** which is the number, "1," is added to the contents of word **4** which is the invoice number so that the next invoice may be numbered one higher than the current invoice being prepared. Program step 63 exit hub is wired to vertical position A entry hub whereby at the completion of this program the invoice is skipped to the vertical position A on the next invoice form in readiness for preparation of the next invoice form.

Prior to the performance of the sequence of steps in the above described program, it is necessary to load certain constants, such as 1 for incrementing the invoice number, into the machine memory. Similarly, it is necessary or at least desirable at the completion of the invoicing operation to print out and "clear" the various "running" totals, such as "running" tax total and "running gross total." In Table 2 is presented a dual purpose program including load and clear routines.

Prior to the performance of this program routine, certain information will have been loaded into the machine memory by manual operation of the keyboards on the console and with the machine in respective keyboard entry and alphanumeric entry modes, as the case may be. This information includes the constants such as "1," "12," and beginning invoice number. These are then recorded on the magnetic stripe of the "load and clear," ledger card.

In the program in Table 2, the operator first inserts the "load and clear" card into the hopper of the magnetic ledger card unit, it is read and its contents placed in MLC storage. The control key **5** is depressed and as seen in Table 4, this directs the output form to vertical position **F–1**. In this step, a transfer plus operation is performed wherein the contents of word **L1** containing the beginning invoice number, is transferred to word **W4**.

Should the machine be in a condition for clearing storage and reading out "running" totals, the operator would depress control key **6** directing the vertical tape unit to vertical position **G–1** and the card would be inserted. In this case, the contents of word **4**, which at this point would contain the last invoice number, would be transferred to word **L1**. This now represents the beginning invoice number for the next invoicing operation.

From either program step 64 or 73, the program procedes next to program step 65 at which the contents of word **L2**, which is the number "1," is transferred to word **W6**.

For the benefit of the total routine, in program step 67, the invoice number is printed, and in program steps 68, 69, 70, the Net Total, Tax Total and Gross Totals are printed and the storage words are reset for future use. In program step 71, word **W7** is cleared by TR+ operation, using "Out" word and in program step 72, the load card is recorded with the contents of magnetic ledger card section of memory.

The card is ejected by the ledger card unit. For the benefit of a load routine at the beginning of an invoice operation, the operator depresses control key **3** to condition the machine for alphanumeric entry of information and the date and the word "Continued" by manual operation of the primary printer keyboard are entered into fields **SA1** and **SA2** of special alphanumeric storage. Each is delineated by an appropriate field mark as shown in Table 5, by the operator's depression of the "Field Mark" key on the console corresponding to the appropriate position of storage.

OPERATE

Operator Instructions	Prog. Step	Exit	Entry	Function	In Word	Out Word	Comments
Depress Key 2-Align Forms							Form Skips to Beginning
Insert First Accounts Recbl. Card				Read Ledger			Machine will Start Automatic-
	1		C E A-1	TR+	W3	LI	Save Acct. No.
	2	Reset Sel 2 Entry		Record	Reset Sel 1 Entry		Eject Card. Reset line item and overflow Selectors.
Remove Card; Lay aside & Begin looking for first inventory card.	3		Reset Sel 2 Exit	Print P	DCV	LA1	Name
	4	Vert. Pos. B Entry		Print P	DCV	LA2	Address Go to ship to position.
	5	Vert. Pos. C Entry	Vert. Pos. B Exit	Print P	DCV	LA3	Ship to & Address Go to heading line.
	6		Vert. Pos. C-Exit	Print P	DC6	W3	Acct. No. begin here for form overflow skip.
	7			Print P	DCV	SA1	Date
	8			Print P	DC7	W4	Invoice No.
	9	Vert. Pos. D Entry		Print P	DCV	2 C 1 N / T LA4 / SA2	Normally Print Shipping Instr. If Form Overflow Print the Word- "Continued" In Both Cases Go to Vert. Pos. D, Stop Normally.
							Go to Step 13 if Form overflow.
Key Dozens Depress Start Key	10		1 N 1	TR+Reset ZB	W1	KB	Save Dozens
	11			TR+Reset NB	BFR		Reset BFR in case there are no 12ths stop.
Key 12ths. Insert inventory card.				Read Ledger			
	12	OFC	2 T 1	ZB	BFR		Test for entry of 12ths. Test for Form overflow.
	13	14	OFN 2 T 2	Print P	DC3	W 1	Print Dozens

OPERATE

Opr. Inst.	Prog. Step	Exit	Entry	Function	In Word	Out Word	Comments
	14	ZC1	15	X	W1	W6	Dozens X 12.
	15		ZN1	+	W1	BFR	If 12ths were entered add 12ths.
	16			PrintP / ,Reset	DC2	BFR	If 12ths entered Print 12ths
	17	18		Print P	DC2	W6	Denominator
	18		17 HP2EX	TR+ Re-set ZB	W2	L2	Re-entry for no 12ths save quantity in stock
	19	NC1		NB-	L2	W1	Qty in stock minus Qty ordered Test for insufficient
	20		NT1	TR+	W1	W2	If insufficient stock: TR Qty in stock to Qty ordered
	21	22		TR+	L2		Zero Qty in stock
	22		NN1 21	TR+	W2	W1	Save Qty Shipped
	23			÷	W2	W6	Qty shipped ÷ 12 = Dozens shpd.
	24			ZB+	BFR	OFR	Add 12ths to BFR(cleared on step 11 or 16). Test for O
	25			Print L	DCV	SA1	Print Date on Ledger
	26			Print L Tab	DC8	W3	Print Account Number on Ledger.
	27			Print P, L	DC3	W2	Print Dozens Shipped on both
	28			Print P, L Reset/via ZB2	DC2	BFR	Print 12ths on both. Print / if not zero.
	29			Print P, L	DC2	ZC4 W6if N	Print denominator. In PS 28 & 29, if zero, printers space over
	30			Print P	DC6	L1	Prod Code
	31	Horiz. Pos.5 Entry		Print P	DCV	LA1	Prod Description tab to price
	32		Horiz. Pos.5 Exit	Print P PB	DC5	L3	Price per Doz.
	33			TR+ re-set ZB	W2	L2	Save Qty in stock
	34			÷	W2	W6	Qty. in stock ÷ 12
	35			ZB+	BFR	OFR	Add 12ths to BFR(cleared on step 28). Test for zero
	36			X	W1	L3	Qty shipped x price
	37			CSL	W1	DC1	Shift left one - place for accuracy
	38			÷	W1	W6	Divide(units x price x 10) by 12
	39	ZC5		Print L	DC3	W2	Print dozens on Ledger
	40		ZN5	Print L/	DC2	BFR	Print 12ths on Ledger if not 0
	41	42		Print 1	DC2	W6	Denominator

TABLE 2

LOAD - TOTAL

Opr. Inst.	Prog. Step	Exit	Entry	Function	In Word	Out Word	Comments
Depress Control Key 5. Insert Load Card				Read Ledger			Prepare to load constants from MLC "Load" card
							Machine starts automatically
	64	65	CE F1	TR+	W4	L1	Load beginning invoice no.
	65		64 73	TR+	W5	L2	Load constant 1
	66			TR+	W6	L3	Load constant 12
	67			Print P	DC7	L1	Print beginning inv. no.
	68			Print P PB, RES	DC10	W8	Print- Net Total & Reset
	69			Print P PB, RES	DC10	W9	Print - Tax Total & Reset
	70			Print P PB, RES	DC10	W10	Print- Gross Total & Reset
	71			TR+	W 7		Clear Storage for Inv. Total
	72			RECORD			EJECT CARD. STOP
Remove Card- Depress Control Key 3. Type: Date as "Jan--1-62", Field Mark, "Continued" Field Mark. REKEY							
TOTAL							
Depress control Key 6. Insert Load Card				Read Ledger			Machine Starts Automatically
	73	65	CE G-1	TR+	L1	W4	Transfer next invoice number to storage for beginning invoice number
Remainder of Total Same As Load							
No need to Enter Date							

TABLE 1

OPERATE

Opr. Inst.	Prog Step	Exit	Entry	Function	In Word	Out Word	Comments
	42		41 Z T5	ROCS	W1	DC1	Round off Line amount
	43			Print P PB, CRL	DC7	W1	Line Amount
	44			+	W7	W1	Invoice Total + Line Amount
End of line start over at PS 10, or	45	Vert. Pos.D Entry		Record	Reset Sel 1		New Data → Magnetic stripe
Depress Key 1 for total.				Read Ledger			
Form positions to total. Insert A/R card	46		CE E-4	Print P PB	DC7	W7	Invoice Net
	47			Print P	DC2	L3	Tax %
	48			TR+	W2	W7	Save Net
	49			X	W2	L3	Net X Tax
	50			ROCS	W2	DC2	Round off Tax
	51			+	W8	W7	Net Total Plus invoice net
	52			+	W9	W2	Tax Total Plus invoice tax
	53			+	W7	W2	Net Total Plus tax amount
	54			Print P PB	DC6	W2	Tax Amount
	55			+	W10	W7	Gross Total Plus invoice gross
	56			Print P PB	DC7	W7	Print invoice gross
	57			Print L	DCV	SA1	Date on A/R
	58			Print L	DC7	W4	Invoice Number
	59			+	L2	W7	Add invoice gross to Account Balance
	60			Print L PB, reset, TAB	DC7	W7	Print and Reset invoice gross Tab to "Balance" Col.
	61			Print L PB CRL	DC8	L2	NEW BALANCE
	62			Record			
End of Invoice Start Over	63	Vert. Pos A Entry		+	W4	W5	Add 1 to invoice number

TABLE 3

(Storage Assignments)

1. Working Storage	2. Working Storage	3. Save Account Number	4. Invoice Number	5. Constant 1
6. Constant 12	7. Invoice Total	8. Net Total	9. Tax Total	10. Gross Total

L Words	L-1 Account No.	L-2 Acct. Balance	L-3 % TAX	→ Accounts Receivable	
	Product Code	Qty. in Stock	Price	→ Inventory	
LA Words	LA-1 Name	Max	LA-2 Address	Max Size	LA-3 Ship to: Address

LA-4 Shipping Instructions	Max Size	→ Accounts Receivable	
Description		→ Inventory	

SPECIAL STORAGE

SA-1 X J A N p P 1 p 2 F M

SA-2 O N T I N U E D C

POSITION EXITS

Vertical	Horizontal		
A	1	2 PS 18	3
B PS 5	4	5 PS32	6
C PS6	OVERFLOW INDICATE Common PS 12EX	Normal PS 13ENT	Indicate SEL 2 Pick
D 2 C 2	Post Line Sel 1 Pick Read Only	Full Card	New Card
E Horiz. Pos. 4 Entry	N O		
Selected Coordinate Exits			
A-1 PS 1	D -1 1 C 1	E-4 PS 46	

Begin Alpha	L Words	Alpha Characters
1	0	192
2	1	186
3	2	180
4	3	174
5	4	168
6	5	162
7	6	156

LEDGER STORAGE

TABLE 4

(Control Keys)

CONTROL KEYS		Line Item								
Invoice Total	Vert Pose Entry	Pick PLE ent	AS ex	Reset PS2 IN PS45 IN ent	ex	Pick ent	ex	Reset ent	ex	
Begin	Vert Pos A Entry	PS12 Entry T	1			T	5			
Enter Date	Enter Alpha and SA1	PS10 Entry N				N				
		CE D-1 c 1	2	3	4	c 1	2	3	4c	
Load	Vert Pos F Entry	Pick 1 of OF 1 ent	(overflow) Vert. Pos G Ent ex	Reset PS 2 EX ent	PS3 ENT ex	Pick ent	ex	Reset ent	ex	
Total	Vert Pos G Entry	SA2 T	PS13 Ent 2			T	6			
		LA4 N				N				
		PS9 OUT c 1	Vert Pos D EXIT 2	3	4	c 1	2	3	4c	
		Pick 12,24,35				FUNCT ent	10,18,33	Reset	ex	T
		Horiz Pos2 T Ent				PS 42 Ent	ZBT			
		PS15 N Ent				W6 OUT	PS 4D-Ent			
		PS 14 EX c 1	Minor Funct. PS28 2	3		PS 29 OUT	PS 39 EX 5	6	7	8
	19	Pick		FUNCT ent		Reset ex	TR+			
	PS 20 T Ent				NBT					
	PS 22 N Ent									
10	PS 19 c Ex 1	2	3	4	5	6	7	8	9	10

TABLE 5

LOAD - TOTAL

Storage Assignments

	1	2	3	4 Invoice Number	5 Constant 1
	6 Constant 12	7 Invoice Total	8 Net Total	9 Tax Total	10 Gross Total
L Words	L-1 Invoice Number	L-2 Constant 1	L-3 Constant 12	L-4	Begin Alpha / Common to 4

Special Storage

SA	SA-1 X J A N P F L P 6 2 M	Post Line Sel 1 PICK EX Read Only NO
W		
O		
R		
D		
S	SA-2	
	C O N T I N U E D	
SA		

Selected Coordinate Exits

F 1 PS 64			
G 1 PS 73			

L E D G E R	Begin Alpha	L Words	Alpha Characters
		0	192
	1	1	186
S	3	2	180
T	4	3	174
O	5	4	168
R	6	5	162
A	7	6	156
G	8	7	150
E	9	8	144
	10	9	138
D	11	10	132
1	12	11	126
S	13	12	120
T	14	13	114
R	15	14	108
1	16	15	102
B			
U			
T			
1			
O			
N			

ONE LINE INDEX

The paper document handling apparatus of the computer **1–10** is capable of continuously sensing and indicating the format, i.e., the vertical position of the document and horizontal position of the carrier and under prewired conditions of the control panel to cause the output document in the primary printer to be moved to any desired vertical field as designated by the programmed punch holes in the vertical tape or to cause the printer element to be moved to any desired horizontal position as determined by the punched horizontal tape. A representative field is A, as shown in FIG. 4. To illustrate the ability of the apparatus to sense and seek, it is first assumed that the output document is in a position one line removed from vertical field A, that the star wheel on the vertical tape sensing apparatus is in a hole in channel **1**, that the vertical position A is represented by a hole in channel **1** and the control panel hub **8–150**, corresponding to control key **7** on the console shown in FIG. 2*b*, is connected by program wire to vertical position A entry hub **8–12**.

While various relays and their contacts points utilized in the machine of this invention are shown in FIGS. 40 through 70, for purposes of simplicity and ease of description and explanation, certain of the relays and the associated contacts which are required or affected by the operation about to be described, are consolidated in simplified FIG. 71 of the drawings. It should be understood that many of the components of this figure are shown in different figures of the drawings and that certain relay contacts especially of the normally closed type which remain closed during the described operations and are in actual circuit with the relay coils and contacts shown in FIG. 71 but which play no part in the indexing operation being described, for simplicity, are omitted.

In the drawings of this application which show the relays used, a vertical line along the left side of each figure represents a +48 volt power line and a vertical line along the right hand side of each figure represents a ground line. Also, in several of the figures of the drawings, the sensing star wheels of the vertical and horizontal sense units are shown as contacting the common bar. In this case it should be understood that this is a simplified showing of the actual arrangement wherein the sensing star wheels merely sense the presence or absence of a hole in one of the tapes and that the sensing of a hole results in the pivotal movement of the arm to which the star wheel is attached and that the actual contact involved in closing a circuit is at the remote end of the arm from the star wheel.

When control key **7** is depressed, its corresponding contact **71–10**, shown in FIG. 71, applies a 48 volt potential to the hub **71–12** corresponding to control key **7** exit hub **8–150** on the control panel. By control panel wire **71–14**, the hub **71–12** is connected to a vertical position entry hub **71–16** corresponding to hub **8–12** on the control panel. The lines **72–10**, **72–12** and **72–14** in FIG. 72 of a timing diagram illustrate this condition graphically wherein the ordinate represents action of closure of the key contact in the case of line **72–10**, the key contact exit hub potential and potential applied to vertical position entry hub in the case of lines **72–12** and **72–14**, and the abscissa in each case represents time elapsed. Thus, the vertical position A entry hub **71–16** is energized. This completes a circuit through contacts **524–1N/C** and energizes the pick coil **522P** of a vertical set up relay. This action is represented at **72–522P** in FIG. 72. Although potential is applied to the pick coil **522** at the time that the hub (Vert. A) is impulsed, a time represested by the horizontal line **72–16** in FIG. 72 is required for this relay's contacts to transfer. The hold coil **522H** is energized through normally closed contacts **514–10** of a stop **2** relay **514** and contacts **522–1** of relay **522**. This action is represented at **72–522H** in FIG. 72.

The transfer of contacts of relay **522** initiates both a one line index of the primary printer document and a

simultaneous carrier return on the primary printer. The closure of its contacts 522–3 establishes an energizing circuit for the pick coil 519P of a forms skip relay 519 and a circuit is also completed to the pick coil 422P of a carrier return relay 422 through contacts 427–8 of tab and carrier return interlock relay 427 and contacts 524–11 of a vertical position relay 524. In FIG. 72, these actions are represented at 72–519P and 72–422P.

The actuation of relay 422 is also effective as represented at 72–423H to complete the energizing circuit of a function interlock relay 423H through normally open contacts 422–4. The function interlock relay has contacts effective to prevent conflicting operations such as tab and carrier return during this operation.

For simplicity of explanation, the forms skip or index operations will be described first followed by the description of the carrier return operation, it being understood, however, that both functions occur simultaneously.

As the forms skip relay 519 is picked, a circuit is completed through its normally open contacts 519–1 and the normally closed contacts 518–1 of a Stop 2 relay, 518, to energize a skip magnet, 71–18. The energization of the skip magnet is represented at 72–20 and the closure time of its contacts is represented at 72–22. The actual period of sealing of the armature of this magnet is represented at 72–23. This skip magnet is located on the primary printer and in the energized condition, releases a vertical drive clutch to vertically index the primary output document. To prevent indexing more than one line, the skip magnet must be timely released.

As the skip magnet armature is actuated, its contacts 71–18–1 close and this completes a circuit through the skip magnet contacts to pick stop 2 relay coil 518P. This action is represented at 72–518P. The picking of this relay transfers its contacts 518–1 to open the skip magnet relay circuit and energizes the hold coil 518H by shunting the skip magnet contacts 71–18–1 through forms skip relay contacts 519–1. The stop 2 relay 518 establishes a hold circuit through the normally open contacts 519–2 of the forms skip relay and the normally open contacts 518–2 of stop 2 relay 518 and this action is represented at 72–518H.

In the actuated condition of stop 2 relay 518, a circuit is also completed through its normally open contacts 518–3 and the normally open contacts 522–2 of the vertical set up relay, to energize the pick coil of vertical position relay 524. The transfer of contacts of this relay completes its hold circuit through normally closed program CB4 relay, contacts 60–5, normally closed contacts 511–9 of an auto start relay 511 and the normally open contacts 524–12 of vertical position relay 524, now actuated. Since the program CB4 and auto start relays will not be picked until a program sequence is initiated, the vertical position relay 524 will remain actuated during the remainder of this operation. The picking and holding actions of relay 524 are represented at 72–524P and 72–524H.

The actuation of relay 524 causes its contacts 524–1 to transfer and through the normally closed contacts 514–2 of stop 1 relay 514, to energize the pick coils 479P and 482 of vertical channel A relays 479 and 482. This circuit is completed through the control key contact 71–10, the wire 71–14, the transferred contacts 524–1 and normally closed contacts 514–2 and this action is represented at 72–479 and 72–482.

The transfer of contacts 524–1 also operates to open the pick coil of vertical set up relay 522 but its hold coil remains energized to maintain actuation of its relay contacts. Also, the opening of normally closed contacts 524–11 of the vertical position relay 524, operates to open the energizing circuits for pick coil 422P of the carrier return relay 422 but the hold coil 422H of this relay remains energized through contacts 427–1 of tab and carrier return relay 427 and the normally open contacts 422–1 of the carrier return relay itself. These actions are represented at the transfer time of relay 524 in FIG. 72.

The picking of vertical position relay 524 transfers its contacts 524–10 to close the hold circuit to vertical channel A relays 479 and 482 through contacts 524–10 and contacts 479–1 to the hold coils 479H and 482H. The actuation of these vertical channel relays establishes an energizing hold circuit to vertical set up relays through contacts 482–6 in shunt with the control key contact 71–10 and renders its further actuation unnecessary. The respective pick and hold actions are represented chronologically at 72–479P, 72–479H, 72–482P, 72–482H.

The vertical channel relays 479 and 482 serve to condition a vertical sense contact associated with channel 1 of the vertical tape and further to condition circuitry to select the proper coordinate exit hub of the control panel to receive an impulse indicative of arrival of the form at the sought address.

In the present example, the vertical channel sense star wheel was positioned in a punched hole of the vertical program tape prior to the indexing operation and a search for vertical position A was conducted. Since a hole is punched in the next line of channel 1, the vertical channel 1 sense contact will effectively not open when the indexing operation occurs. This condition is represented at 72–24. Normally open contacts 479–2 of vertical channel A relay close and a circuit is completed through the position switch 71–20 which is closed in the lowered position of the vertical tape sensing unit to a vertical program common bar 71–72 through the vertical channel sense contact 71–24, through contacts 479–2 to energize the pick coil 514P of stop 1 relay 514. A hold circuit for this coil is established through transferred contacts 524–10 and normally open contacts 514–1 to hold coil 514H. These actions are represented at 514P and 514H.

The purpose of the stop 1 relay 514 in this operation is to provide the pulse to the vertical position A exit hub 71–26 corresponding to hub 8–14 on the control panel. When this relay is picked in this operation, a circuit is completed through the parallel circuits of control key contact 71–10 and contacts 482–6 through transferred contacts 514–2 of the stop 1 relay to provide a 48 volt pulse to the vertical A exit hub. This is represented at 72–26. As hereinabove described, if this hub is wired to another function hub, such as horizontal position entry hub the circuits to perform horizontal position seek will be conditioned. However, due to an interlock circuit, this further function will not be initiated until the carrier return operation is completed. The transfer of contacts 514–2 to supply an exit pulse results in opening of circuits of pick coils 479 and 482. The hold coils of these relays are, at this point, maintained energized.

The normally closed contacts 514–10 of stop 1 relay are now opened whereby vertical setup relay hold coil 522H is open circuited and this relay is deactuated.

At this point in time the one line index operation is completed and a potential pulse is emitted from vertical position A hub indicating the arrival of the form at the desired location.

The carrier return operation initiated simultaneously with the forms index will now be described. At the beginning of the sequence, the actuation of vertical setup relay 522 completed the circuit to carrier return relay pick coil 422P through vertical setup relay contacts 522–3. The hold coil 422H of this relay is energized through its own contacts 422–1, now closed, and through the contacts 427–1 of tab and carrier return interlock relay 427. Normally open contacts 422–4 of the carrier return relay are closed to energize the hold coil of a function interlock relay 423H which has contacts such as shown in FIGS. 41, 51, 53, and 67, effective when actuated, to prevent program step sequencing and other conflicting operations before the carrier return operation is completed.

The normally open sets of contacts 422–2 and 422–3 of carrier return relay 422 are closed and an energizing circuit is established for carrier return magnet 71–82 through normally closed contacts 71–30 which are con-

tacts transferred by the cam **71–31** during return of the carrier to the left hand margin, and normally closed contacts **427–6** of the tab and carrier return relay **427**. This action is represented by **72–28** in FIG. 72. This unlatches a mechanical mechanism effective to return the carrier of the primary printer to the left hand margin. During the carrier return, contacts **71–30** are transferred, as represented at **72–30** and thus, the carrier return magnet circuit is de-energized. However, the carrier continues its return motion. At the same time, the energizing circuit of the pick coil **63P** of the electronic start interlock relay is completed which has contacts effective to prevent the start of electronic operations during carrier return. This is represented at **72–32**.

The carrier return action is also effective to close carrier return interlock contacts **71–34** and carrier return space contacts **71–36** during its return. These actions are represented at **72–34** and **72–36**. The effect of the closure of contacts **71–34** is to energize the hold coil **427H** of the tab and carrier return interlock relay. This action is represented at **72–34** and the closure of contacts **71–36** is of no added significance inasmuch as the forms skip relay is already energized through an alternate path. The contacts of relay **427** prevent certain simultaneous operations, such as a tab and carrier operation, from being attempted simultaneously, by opening its normally closed contacts **427–1** to open circuit the carrier return relay which is therefore de-energized. Since the stop **1** relay **514** is picked, its normally closed contacts **514–10** are open and since carrier return relay **422** is de-energized, its contacts **422–5** are open and thus, the hold coil of vertical set-up relay **522** is de-energized. As it is de-actuated, its contacts **522–3** will open the pick circuit to the forms skip relay **519** and the normally open contacts **522–2** open the energizing circuit to the pick coil of vertical position relay **524**. This condition is maintained until the carrier is returned to the left margin at which time the carrier return interlock contact **71–34** and carrier return space contact **71–36** are opened. Accordingly, the tab and carrier return interlock relay hold coil **427H** is opened and de-energized. Its contacts **427–5** resume a normally open position to open the electronic start interlock relay **63**. Since the carrier return relay **422** was de-energized the opening of contacts **427–2** of the tab and carrier return interlock relay opens the energizing circuit of the function interlock relay. The opening of contacts **71–36** also opens the hold coil of the energizing circuit for the forms skip relay **519H**.

The normally open contacts **519–1** and **519–2** are opened by virtue of de-energization of forms skip relay **519** and thus, the pick and hold coils **518P** and **518H** of the stop **2** relay are opened and these relays are de-energized. The contacts of stop **2** relay resume normal conditions and this sequence is terminated. The form has been indexed one line and the carrier returned to the left margin. The vertical position A exit hub **71–26** has emitted a 48 volt pulse after this index operation and may be used for further program operations if desired.

VERTICAL POSITION SEARCH

For further illustrating the versatility of the machine **1–10** in searching for new format positions, it is next assumed that the output document is at a certain vertical line and that it is desired to move the form to a location several lines removed from the present location. For a specific example, it is assumed that the vertical position B entry hub **8–152** on the control panel is impulsed and that the form is several lines removed from vertical position B. In this sequence, the machine is instructed to return the carrier to the left margin and to initiate a high speed forms skip to vertical position B. This sequence is initiated as, for example, by depressing control key **8** on the console.

Referring to FIG. 73, this key depression closes a set of contacts such as **73–10** and applies a potential from 48 volt line **73–12** to a hub **73–14** corresponding to hub **8–154** on the control panel. Through a control panel wire **73–16**, this hub is wired to vertical position B entry hub **73–18**, corresponding to hub **8–152** on the control panel. It is assumed that the vertical channel **1** sense wheel is resting in a hole of another channel prior to this sequence. Thus, by the depression of control key **8** a potential is applied through the hubs. This initiates both the forms skip and carrier return operations. The initial operation indexes the form one line. In this sequence vertical position B is not located after the one line index operation. Once the carrier return operation begins, the forms skip mechanism is restarted. This time the forms will drive at a continuous rate, searching for vertical position B. When vertical position B is located, the feeding of the forms is terminated and a pulse is emitted by the vertical position B exit hub. During the vertical search, the carrier is returning to the left margin. As explained, hereinabove, interlock relays prevent the starting of the next program sequence until the carrier is at the left margin and the forms are skipped. When these occur, the interlock circuits remove the interlock and the pulse emitted by the vertical B exit hub can be used to continue the program routine.

Certain beginning steps of the relay sequence involved in a search operation are identical to the steps involved in a single line index operation as described hereinabove. These steps include all of the steps in relay actions as represented in FIG. 72 of the drawings from the top of the figure down through the actuation of vertical position relay **524**. Accordingly, for the sake of brevity and simplicity, these steps will not be repeated, it being assumed that in response to the impulse from control key contacts **73–10**, these steps have taken place.

In response to the actuation of vertical position relay **524**, its contacts **524–2** are transferred to complete the energizing circuit of the pick coils of vertical channel relays **483–486**. This is represented in FIG. 74 at **74–483P** and **74–486P**. Hold circuits for these relays are established through contacts **524–10** and contacts **483–1**. This is represented at **74–483H** and **74–486H**. When the vertical channel relays are actuated, a circuit is established which shunts the control key contact **73–10**. This circuit is completed by the contacts **486–6**. As in the single index operation, at this point it is no longer necessary to hold the control key depressed.

The hold coils to the vertical channel relays **483** and **486** are energized through contacts **524–10** of the vertical position relay and the transferred contacts **483–1**. The contacts **483–2** close to partially complete the circuit to pick the stop **1** relay **514**. Prior to this time, the skip magnet **73–18** was picked and dropped, mechanically initiating an index operation. However, at this time due to the mechanical delay involved, the forms have not begun to move in an index operation. Therefore, the vertical channel **2** sense contact **73–38** is open and the vertical channel **1** sense contact is still closed. It can be seen in FIG. 73, that the circuit to the pick coil of stop **1** relay **514**, cannot be completed through the closed vertical channel **1** sense contact **73–24**, since the vertical channel A relay **479** pick coil is not energized and its contacts **479–2** remain open. Thus, by the selective connection to the sense contacts, the programmed vertical position search is initiated. That is, the programmed vertical position entry hubs select corresponding vertical channel relays. The vertical channel relays then establish the circuit to a vertical channel sense contact, corresponding to the programmed vertical position. Therefore, only that sense contact having corresponding vertical channel relay circuitry energized will recognize a hole in the vertical program tape. Other sense wheels may roll through a hole in the program tape, closing their sense contact, but will not be recognized as the vertical programmed position since corresponding vertical channel relay circuitry is not energized. Once the output document begins to move, the vertical channel **1** sense wheel is forced out of the hole in the vertical tape, opening its contact **73–24**.

Energization of the carrier return magnet **73–28** is effective in the manner of magnet **71–28** to cause the carrier to be returned as hereinabove described and as represented at **74–10** results in the transfer of the contacts **73–32** as represented at **74–32**. Later in time, the carrier return interlock contacts **73–34** and carrier return space contacts **73–36** are also closed. These actions are represented at **74–34** and **74–36**, respectively. When the contacts **73–32** transfer, the energization circuit to the carrier return magnet **73–28** is opened and a circuit to the electronic start interlock relay is completed as represented at **74–63**. In this sequence the electronic start interlock relay points are of no consequence.

The carrier return space contacts **73–36** complete the energizing circuit for the hold coil of the forms skip relay **519**. When the carrier return interlock contacts **73–34** close, the tab and carrier return interlock relay **427** is picked through its hold coil **427H**, is indicated at **74–427**. Thus, on actuation of this relay a parallel hold circuit to the forms skip relay **519**, is established by contacts **427–4** and contacts **519–4** which maintains the forms skip relay **519** actuated until the tab and carrier return relay drops and its contacts **427–4** open.

The actuation of tab and carrier return relay **427** opens its contacts **427–1** and this opens the circuit of the hold coil **422H** of the carrier return relay which drops. To prevent dropping the function interlock relay **423**, energization thereof is maintained through contacts **427–2** which parallel the contacts **422–4**. Therefore, this parallel circuit is completed just prior to the drop of relay **422** to maintain the energization circuit to the function interlock relay.

The de-actuation of the carrier return relay **422** in the present circumstances results in the repicking of the skip magnet **73–18**; the energization circuit is completed through the contacts **524–8** and the now closed contacts **422–6** and the normally closed points **514–12** of the stop **1** relay. The skip magnet **73–18** will now remain energized until the programmed vertical position is reached. This results in the feeding of the forms at a continuous rate of approximately 5 inches per second.

Since the stop **2** relay **518** is maintained energized, the operation of the skip magnet contacts **73–18–1** will have no effect when the skip magnet is actuated.

In this example, the programmed vertical position B is reached before the carrier reaches the left margin. The proper vertical position is located when the vertical channel **2** sense wheel falls into a punched hole in channel **2** of the vertical program tape at **73–38**. As this occurs, the vertical drive mechanism must be stopped to prevent an excessive feeding of the forms. When the vertical channel **2** sense wheel falls into a hole its sense contact **73–38** closes as represented at **74–24**. This completes an energization circuit through the position switch **73–20**, the vertical channel **2** sense contact **73–38** and the vertical channel B relay contacts **483–2** to energize the pick coil **514P** of the stop **1** relay as indicated at **74–514P**. The actuation of the stop **1** relay **514** is effective to complete its own hold circuit through contacts **524–10** and **514–1** as shown at **74–514H** and to open the energization circuit to the skip magnet **73–18** since the contacts **514–12** open. Thus, the movement of the output document is stopped and the vertical channel B sense wheel maintains contact with the vertical program common bar **73–22** as it remains in the punched hole.

In these circumstances, the vertical position B exit hub which is reproduced at **73–40** emits a potential pulse indicative of the arrival of the forms at vertical position B. This potential pulse is produced by virtue of the closed condition of contacts **486–6** and contacts **514–3**. An incident of the transfer of contacts **514–3** is the de-energization of pick coils of vertical channel B relays **483** and **486**. However, these relays are maintained actuated by reason of the maintained energization of their hold coils. The hold coil **514H** of stop **1** relay is maintained energized through the transferred contacts **524–10** and its own contacts **514–1**.

Since the carrier return relay, **422**, is de-actuated and its contacts **422–5** are opened, the opening of contacts **514–10** de-energizes the hold coil of vertical setup relay **522**. Consequently, the vertical setup relay is deactuated and the opening of its contacts **522–3** and **522–2**, opens the energization circuits to the pick coils of the forms skip relay **519** and the vertical position relay **524**. These relays, however, remain actuated because their respective hold coils are maintained energized.

The condition, as thus far described, will be maintained until the carrier reaches the left hand margin. The return of the carrier to the left hand margin results in the opening of carrier return space contacts **73–36** and the carrier return interlock contacts **73–34**. Thus, the carrier return interlock relay **427** is de-energized and de-actuated whereby its contacts **427–4** are opened and the hold coil **519H** of the forms skip relay is de-energized. This results in opening the energization circuits of both the pick and hold coils of stop **2** relay **518**.

Since the contacts **73–32** are now in the normal condition shown in FIG. 73, the opening of contacts **427–5** of the tab and carrier return interlock relay results in de-energization of the pick coil of the electronic start interlock relay **63**. Also, the hold coil **423** of the function interlock relay is de-energized since under these circumstances the carrier return relay **422** is de-actuated and its points **422–4** are opened. The de-actuation of the function interlock relay removes the inhibiting influence of the output pulse applied to vertical position B exit hub **73–40** on circuitry for starting another program sequence.

The de-actuation of the stop **2** relay, **518**, completes the sequence herein described. At the completion of the sequence, the vertical position relay **524**, the vertical channel B relays **483** and **486** and the stop **1** relay **514** are maintained actuated to indicate at which vertical position the output document is located by providing an output pulse at the vertical position exit hub B, **73–40** as indicated at **74–40**.

HORIZONTAL POSITION SENSE

The horizontal position hubs on the control panel provide control over the movement of the carrier of the printer. When a horizontal position entry hub is impulsed, a horizontal search for the programmed position occurs. The first operation that takes place in this sequence is the checking of the position of the carrier prior to its movement. If the carrier is located in the programmed position, a search operation is not initiated. Therefore, the carrier is already in the correct location and the corresponding horizontal position exit hub will emit a pulse. However, if the carrier is not in the programmed horizontal position, a tab operation will be initiated. The carrier will then tab to the next tab stop and again check its position by the horizontal position sensing tape unit. This tab and check operation will continue until the carrier locates the programmed horizontal position. When the programmed horizontal position is located, the horizontal position exit hub corresponding to this position will emit an electrical impulse.

One other condition that may exist in the horizontal search operation is the search for a lower number field than the present field of the carrier. In this circumstance, if the carrier is tablulated to the right margin before the horizontal position is located, an automatic carrier return is initiated. Once the carrier reaches the left margin, the horizontal search continues.

To provide an automatic carrier return in a horizontal search operation, the right margin stop for the carrier must be positioned at a tab stop location. If the right margin stop is not located at a tab stop, it would not be recognized as the right hand margin. In this case, if the programmed position was not located the carrier would

tab to the extreme right position and the machine would lock.

In the next described sequence of the horizontal search operation, it is assumed that the machine is instructed to locate horizontal position **1** and that the control key exit hub **8–156** on the control panel, corresponding to control key **9** is wired to horizontal position **1** entry hub **8–16**. It is also assumed in this example that the horizontal channel sense wheels **1** and **2** are resting in respective holes prior to the initiation of the search sequence. As pointed out hereinabove the code represented by punched holes in the horizontal tape in channels **1** and **2** represents horizontal position **1**.

As shown in FIG. 75 of the drawings, the depression of control key **9** closes corresponding contacts **75–10** and applies a 48 volt potential from line **75–12** to control key exit hub **75–14** corresponding to control panel hub **8–16**. These actions and results are represented at **76–10**, **76–12** and **76–18**. Impulsing this horizontal position entry hub is effective to energize the pick coil **431P** of horizontal program CB **1** relay, **431** through the normally closed contacts **437–2** of horizontal channel **1** relay, the normally closed contacts **435–2** of horizontal program CB**4** relay and contacts **423–4** of the function interlock relay. This action is represented at **76–431P**. The actuation of horizontal program CB**1** relay closes its points **431–3** to energize the pick coil **433P** of horizontal program CB**2** relay. As this latter relay is actuated, as indicated at **76–433P**, it, in utrn, is effective to energize the pick coil **434P** of the horizontal program CB**3** relay through the contacts **433–3** of the horizontal program CB**2** relay as represented at **76–434P**. At this point, it is observed that as the contacts **434–1** of horizontal program CB**3** relay are closed, the contacts **431–2** in series therewith are, at this interval, maintained open by virtue of the energization of horizontal program CB**1** delay. Therefore, the circuit to the horizontal channel relays **437** and **438** through the horizontal program common bar **75–50** and respective sense contacts **75–52** and **75–54** is not complete. The closure of contacts **434–2** of horizontal program CB**3** relay, however, is effective to energize the pick coil **435P** of horizontal program CB**4** relay as represented at **76–435P**. In the successive energization and actuation of these horizontal program CB relays as represented in FIG. 76 of the drawings, it is again noted that a certain time delay occurs between the appliaction of energization potential to these relays and the actual actuation thereof at which time the contacts are transferred.

The actuation of horizontal program CB**4** relay, **435**, results in the transfer of its contacts **435–2** and as a consequence, its hold coil **435H** is energized as represented at **76–435H** through the tab and carrier return interlock relay contacts **427–7** and the energization circuit to pick coil of horizontal program CB**1** relay **431** is opened whereby this relay is deactuated. This action is shown at the pick time of relay **435** in FIG. 76. The deactuation of horizontal program CB**1** relay opens its contacts **431–3** to de-energize the pick coil **433P** of horizontal program CB**2** relay and this in turn opens contacts **433–3** to de-energize the pick coil **434P** of horizontal program CB**3**. Still further as a consequence, this results in the opening of contacts **434–2** to de-energize the pick coil **435P** of horizontal program CB**4**.

It is noted at this point that the hold coils **431H**, **433H**, and **434H** are short circuited whereby the drop time of these relays is considerably prolonged as represented in FIG. 76. However, prior to the completion of the de-actuation of this series of relays, at the de-actuation of horizontal program CB**1** relay **431** and before the de-actuation of horizontal CB**3** relay **434**, contacts **431–2** are closed to complete the energization circuit to horizontal channel **1** and **2** relay pick coils, **437P** and **438P** through the now closed contacts **434–1**, the horizontal program common bar **75–50** and the respective sensing star wheel contacts **75–52** and **75–54**. The contacts made by the sense wheels are represented at **76–52** and **76–54**, respectively, the actuation of relays **437** and **438** is represented at **76–437** and **76–438**, respectively. The actuation of horizontal channel **1** and **2** relays results in the transfer of their respective contacts **437–2** and **438–2** to complete an energization circuit from the 48 volt line **75–12** through the control key contacts, the control panel hubs and wire, through the transferred contacts sets **437–2** and **438–2** and through the normally closed contacts **452–7** of the autostart relay and to the horizontal position exit hub **76–56** corresponding to control panel hub **8–18**. Thus, a horizontal exit impulse as represented at **76–56**, is provided, indicative of the fact that the carrier is at the sought or programmed horizontal position.

In response to the transfer of the contacts **437–2**, it is noted that the energization circuit of hold coil **435H** of horizontal program CB**4** was interrupted whereby this relay is de-energized and de-actuated completing the drop out sequence of the horizontal program CB relay. It is noted that the contacts **433–3** to de-energize and de-actuate the pick coil of horizontal program CB**3** relay, **434**, and the this in turn, opens its contacts **434–2** to drop out horizontal program CB**4** relay **435**. Furthermore, contacts **434–1** of horizontal CB**3** relay are opened whereby the horizontal channel **1** and **2** relay pick coils **437P** and **438P** are de-energized. At this point of time the sequence is completed but the horizontal channel relays remain actuated by virtue of the energization of their hold coils **437H** and **438H** through the normally closed contacts **427–4** of the tab and carrier return interlock relay, the normally closed contacts **60–3** of the horizontal program CB**4** relay and the respective contacts **437–1** and **438–1** to these hold coils. Accordingly, the pulse emitted by the horizontal position **1** exit hub **75–56** will remain as long as the control key **9** is depressed and will be terminated when this control key is released.

HORIZONTAL POSITION SEARCH

For a more complete understandinng of the capabilities of the machine **10** in conducting a horizontal carrier position search involving a carrier return step during a tab search for a programmed horizontal position, it is assumed that a tab operation has been initiated and that the carrier is in motion. The next tab stop is designated as the right margin and the right margin stop mechanism is set at the same position as the tab stop.

When the carrier stops at the next tab stop, several events occur. As in all horizontal search operations, the horizontal position is checked. In this example, horizontal position **4** is sought. Since the machine circuits determine that the carrier is not located at horizontal position **4**, the search operation must continue. Since the carrier is at the right margin, a carrier return operation rather than a tab operation is initiated. With the carrier return operation, the output document is indexed one line as explained hereinabove. When the carrier is returned to the left margin, the normal tab-search operation continues for horizontal position **4**.

In this sequence, it is assumed that the tab mechanism is latched to initiate a tab-search operation and that the carrier is moving toward the tab stop designated as the right margin. Referring to FIG. 77*a* of the drawings it is noted that as the carrier reaches the tab stop, and end of line contact **77–10**, which is activated by the right margin stop mechanism, transfers and the tab mechanism unlatches, the tab interlock contacts **77–12**, shown in FIG. 77*b*, open. The end of line contact opens the circuit to the pick coil **420P** of the tab relay **420** and conditions an energizing circuit to the pick coil **422P** of the carrier return relay **422**. Tab interlock contact **77–12**, as indicated at **78–12** was closed during the tab operation and maintained the tab and carrier return interlock relay **427** energized through its hold coil **427H** and when the tab inter-

lock contact 77–12 opens at the end of the tab operation, the tab and carrier return interlock relay 427 is de-actuated as shown at 78–427 since its hold coils opened. The dropping of relay 427 in turn de-energizes the pick coil 63P of the electronic start interlock relay and also the hold coil 423H of the function interlock relay as shown at 78–423 since the contacts 427–5 and 427–2 are opened.

In this example, it is assumed that a pulse is being applied to the horizontal position 4 entry hub 77–14 corresponding to the horizontal position entry hub 8–158 in FIG. 8. This is represented at 78–14. Therefore, when the function interlock relay 423 is de-actuated, its contacts 423–4 are closed and an energizing circuit is completed through the contacts 437–5 of the horizontal channel 1 relay, through the contacts 435–2 of the horizontal program CB4 relay and through the contacts 423–4 to energize the pick coil 431P of the horizontal programs CB1 relay. The picking of this relay begins the pick sequence of the horizontal CB relays and they will sequence in their normal manner as shown at 78–431, 78–433, 78–434 and 78–435 and as described hereinabove. That is, horizontal program CB1 relay 431 when actuated, picks horizontal program CB2 relay, 433 and this in turn picks horizontal program CB3 relay 434 which finally when actuated picks horizontal program CB4 relay 435. The actuation of horizontal program CB3 relay 434, through its contact 434–1 establishes an energizing circuit to the horizontal channel relays 437, 438, etc., to check the horizontal position of the carrier. Since in this example, there are no holes in the program tape at the right margin, the horizontal sense contacts will remain open and the horizontal channel relays will not be picked.

As explained hereinabove, the actuation of horizontal program CB4 relay 435 causes its contacts 435–2 to transfer and establish an energizing circuit to its own hold coil 435H through circuitry including the contacts 437–5 427–7 of the tab and carrier return interlock relay. The actuation of the relay 435 also transfers its contacts 435–4 to condition an energizing circuit for the pick coil of the carrier return relay 422 through circuitry including the transferred contacts of relay 435–4, the normally open end of line contacts of 77–10, to the normally closed contacts 434–3 of horizontal program CB3 relay 434. Therefore, when horizontal program CB3 relay, 434 is de-actuated as represented in FIG. 78 at 78–434, since the end of line contacts 77–10 are transferred, an energized circuit is completed to the pick coil of the carrier return relay 422, instead of the tab relay 420. This initiates the carrier return operation. The energization of the pick coil of the carrier return relay 422 is represented at 78–422P. When the carrier return relay is actuated, an energizing circuit is completed through contacts 427–1 and now closed contacts 422–1 to energize the hold coil 422H of this relay as indicated at 78–422H and another energizing circuit is completed through transferred contacts 422–4 to the hold coil 423H of the function interlock relay 423 which is re-actuated. This action is represented at 78–423.

The actuation of the carrier return relay completes a circuit to energize the carrier return magnet 77–28 through the normally closed contacts 77–32 and the normally closed contacts 77–33, the normally open contacts 422–2 of the carrier return relay, the normally open contacts 422–3 and the normally closed contacts 427–6 of the tab and carrier return interlock relay. This action is indicated at 78–28. This energization of the carrier return magnet initiates an electromechanical sequence which returns the carrier to the left margin. During this sequence, the contacts 77–32 are transferred by the rotating cam 77–35 to open the energizing circuit of the carrier return magnet and to complete the circuit to the pick coil 63P of the electronic start interlock relay. During his return of the carrier, the carrier return space contacts 77–36 and the carrier return interlock contacts 77–34 are closed as represented at 78–36 and 78–34 whereby the hold coil 427 of the tab and carrier return interlock relay is energized and the pick coil 519P of the forms skip relay is also energized. These actions are represented at 78–427 and 78–519P.

Actuating the tab and carrier return interlock relay opens its contacts 427–1 and opens the energizing circuit to the hold coil 422H of the carrier return relay and further opens its contacts 427–7 to open the circuit of the hold coil 435H of the horizontal program CB4 relay. The drop of relay 435, in turn, transfers contacts 435–4 and opens the circuit to the pick coil 422P of the carrier return relay.

It is also necessary in a carrier return operation to index the forms one line. As mentioned above this operation is initiated when the carrier return space contacts 77–36 close, to complete the energization circuit to the pick coil of the forms skip relay 519. When the forms skip relay picks, its contacts 519–1 close and complete an energizing circuit through contacts 518–1 of stop 2 relay to the skip magnet 77–18. As in a normal operation, when the skip magnet is energized, the skip magnet contacts 77–18–1 close to energize the pick coil 518P of the stop 2 relay which establishes a hold circuit through its contacts 518–2 and contact 519–2. The skip magnet energization and the closure of its contacts are represented at 78–20 and 78–22. The stop 2 relay 518 in turn transfers its contacts 518–1 to drop the skip magnet. As this occurs, the forms are indexed one line.

When the carrier begins to return to its left margin, the end of line contacts 77–10 are transferred back to normal position. This conditions a curcuit for energizing the pick coil 420P of the tab relay for the next operation.

In this example, the horizontal program tape has holes punched in channels 1 and 2 at the left margin corresponding to horizontal position 1. Therefore, when the carrier reaches the left margin, the sense contacts 77–52 and 77–54 corresponding to horizontal channels 1 and 2 will close. This action is represented at 78–52 and 78–54. As the carrier returns to the left margin, the carrier return space contacts 77–36 and carrier return interlock contacts 77–34 open whereby the forms skip relay 519P and tab and carrier return interlock relays 427 are de-energized and de-actuated since their energizing circuits are opened. The contacts 427–5 of this relay open to drop the electronic start interlock relay 63 since its pick coil is opened. When the tab and carrier return interlock relay contacts 427–4 transfer, the forms skip relay 519 will drop. The contacts 519–1 and the contacts 519–2 of this relay will in turn open the pick and hold circuits to the stop 2 relay 518 and de-actuate this relay. The tab and carrier return interlock relay contacts 427–2 will also open the circuit to the function interlock relay 423 which will also be de-actuated. When the function interlock relay 423 drops, the carrier return operation is complete and the horizontal search operation again begins.

The function interlock relay contacts 423–4 complete the same circuit which started the horizontal program CB timing sequence at the beginning of this described operation as indicated the the inner right hand region of FIG. 78. That is, through the horizontal position 4 entry hub to the horizontal program CB1 relay 431. The circuits will now check the horizontal position of the carrier and when the position sensed is not horizontal position 4, it will initiate another tab operation. This tab search operation will continue until horizontal position 4 is found and the search operation will be terminated in the manner hereinabove described with respect to the location of the sought horizontal address.

It is often desirable to program the machine to search for a given writing line and then to tab to a particular field within the writing line. This sequence is programmed by wiring first into a vertical position entry hub. This will initiate a vertical search for the programmed writing line. When the writing line is reached, the vertical position exit hub will emit a pulse. With this pulse applied to a horizontal position entry hub by control panel wiring, a

horizontal search for the programmed position will result.

This sequence pertains to the circuits required to transfer from a vertical to a horizontal search. The programming in this example is from a suitable control panel exit hub into a vertical position B entry hub and a wire from vertical position B exit hub into horizontal position 2 entry hub. Thus, co-ordinate position B-2 is sought. The horizontal position 2 exit hub can be appropriately wired to continue the program routine.

It is assumed that a vertical search has been initiated in a manner hereinabove set forth and that the forms are being driven to locate vertical position B. Also at this time the carrier return operation has been initiated as also hereinabove described. When vertical position B is located, the output decument forms stop feeding and the vertical position B exit hub emits an electrical impulse. Since the vertical position B exit hub is wired to the horizontal position 2 entry hub, the exit pulse is available to initiate a horizontal search. However, in this example, the carrier has not yet reached the left margin. To prevent initiating a horizontal search, the carrier return operation provides an interlock which prevents a horizontal search until the carrier is at the left margin.

Since a vertical and horizontal search operation have been described, only the circuits required to transfer from a vertical to a horizontal search will be discussed in this sequence. Therefore, this explanation assumes to the vertical search operation already in progress. The beginning of the sequence diagram in FIG. 80 shows which relays are energized while the forms are being driven to vertical position B. The events which occur prior to this time are illustrated in FIG. 74.

Referring now to FIG. 79 of the drawings, it is noted that when the vertical channel B sense wheel **79–24** falls into a hole into the vertical program tape, its sense contact closes to the vertical program common bar **79–22**. This completes a circuit through the position switch **79–20**, the common bar **79–22**, the vertical channel B sense contact **79–24**, the contact **483–2** of the vertical channel B relay to energize the pick coil of the stop **1** relay **514** as represented at **80–514P**. One purpose of the stop **1** relay is to release the skip magnet **79–18** by the opening of contacts **514–12**. This will stop the feeding of the forms and complete the circuit to the vertical position B exit hub, **79–26** as indicated at **80–26**.

The vertical position B exit hub circuit is completed through the contacts **486–6** of the vertical channel B relay and the contacts **514–3** of stop **1** relay to the exit hub **79–26**. In this example, the vertical position B exit hub **79–26**, and the horizontal position **2** entry hub **79–28** are connected together with a control panel wire **79–30**. Therefore, the vertical position B exit circuit continues into the horizontal position **2** entry hub through contacts **437–3** of the horizontal channel **1** relay as indicated at **80–28** and through the contacts **435–2** of horizontal program CB4 relay to the operating strap of contacts **423–4** of the functional interlock relay **423** which is picked. The circuit to the horizontal position **2** entry hub is terminated at the opening strap of contacts **423–4**. This prevents picking of horizontal CB1 relay **431** until the carrier is returned. However, when the carrier reaches the left margin, the carrier return space and carrier return interlock contacts **79–36** and **79–34** are opened. The carrier return interlock contacts open the hold circuit of the tab and carrier return interlock relay **427** which is de-actuated. The de-actuation of the tab and carrier return interlock relay in turn opens its contacts **427–5** to open the circuits to the pick coil of the electronic start interlock relay **63**, and opens its contacts **427–4** to open the hold coil of the form skip relay **519** and further open its contacts **427–2** to open the hold circuit of the functional interlock relay **423**.

When the functional interlock relay drops, its contacts **423–4** will close and complete the circuit to the horizontal CB1 relay **431** as represented at **80–431P**. The pick of horizontal CB1 relay starts the horizontal CB relay sequence as shown at **80–433**, **80–434** and **80–435** and thus, begins the horizontal search operation.

In the present example, the vertical position was located before the carrier return operation was complete. The completion of the vertical search resulted in an exit emits pulse after carrier reaches left hand margin. In this the contacts **423–4** of functional interlock relay are necessary to delay the picking of horizontal CB relay **431** to prevent starting the horizontal search operation before the carrier has reached the left hand margin. However, if the carrier had reached the left margin before the vertical search operation was completed, the functional interlock relay contact **422–4** would not be needed. Since the vertical search circuits control the time that the exit pulse becomes available, the vertical position B exit hub will not emit a pulse after carrier reaches left hand margin. In this case the functional interlock relay **423** would be de-energized and its contacts **423–4** would be closed for conditioning the energizing circuit to the horizontal CB1 relay **431**.

Once the vertical search and carrier return operations are complete, horizontal CB1 relay is picked to start a horizontal search for the programmed position. The circuit operation that follows and which is required to perform a horizontal search was discussed hereinabove.

COORDINATE EXIT IMPULSING

When the program start bar on the console is depressed or an autostart hub such as **8–22** on the control panel is impulsed, the machine is transferred from the keyboard entry condition of input mode to the automatic mode. In accordance with one aspect of this invention, two functions occur when the machine enters the automatic mode. Firstly, the position of the output document and carrier are choked. In this function, a pulse is emitted from the co-ordinate exit hub which corresponds to the format co-ordinate position, i.e., the vertical position of the document and the horizontal position of the carrier. With this co-ordinate exit hub wired to a programmed step entry hub, a conditioning sequence is initiated to select the operational exit hub, and to start the electronic operations of the machine. The following discussion will pertain to the co-ordinate checking features of the machine.

The co-ordinate exit hub which is so impulsed is controlled by the vertical and horizontal sense mechanisms. Therefore, when the machine is started, the vertical and horizontal sense wheels must be in coded positions. If either the vertical sense wheels or the horizontal sense wheels or both are not in a coded position when the machine is started, the machine will lock. The machine can then be restored to its original state, the keyboard entry mode, by depressing the restore key button.

In this sequence when the machine is started, it is instructed to check the co-ordinate position of the form and carrier and to emit a pulse from the proper coordinate exit hub corresponding to these positions. One of the major considerations in this circuit discussion is the selection of the proper co-ordinate exit hub. As previously described, there are 105 co-ordinate exit hubs, and only the one corresponding to the format position can be impulsed at a given time. As also described hereinabove in the horizontal position circuit description, the horizontal channel relays, controlled by the sense contacts, are used to define the programmed horizontal position. The contacts of these same relays, in conjunction with the vertical channel relay contacts are used to define the 105 co-ordinate exit positions.

Each horizontal position requires two corresponding punched holes in horizontal program tape and each vertical position is defined by one punch in the vertical program tape, each hole or holes being in appropriate channels.

By closing the vertical and horizontal sense contacts, the corresponding channel relays will be picked. The vertical and horizontal channel relay contacts complete the circuits to select and impulse one of the co-ordinate exit hubs. Assuming that the vertical position of the output document is such that the vertical channel A sense wheel is resting in a hole and the carrier is positioned so that the horizontal channel **1** and **2** sense wheels are resting in punched holes, then as the machine is started, the vertical channel B relay and the horizontal channel **1** and **2** relays will be picked. When these relays are picked, as seen in FIGS. 81*a*, 81*b*, and 52, a circuit is completed from the 48 volt line to the A1 co-ordinate exit hub if the autostart relay is actuated.

As, another example, if a carrier was located at horizontal position **13** and the form at vertical position F, co-ordinate exit F–**13** would emit a pulse when the machine is started. The co-ordinate exit hubs can be wired to any desired program step entry hubs so as to initiate a program stepping sequence. Therefore, in accordance with one feature of this invention, it is possible to select the desired program step routine, based on the vertical position of the form and the horizontal position of the carrier.

The machine may be started by depressing the program start bar or by impulsing an autostart hub. Since the circuitry involved in these alternatives is different, both sequences will be described.

When the program start bar or motor bar, on the console of the machine is depressed, a set of contacts shown at **81–10** are closed which complete the energization circuit for the hold coil of a program start relay **51H**. At the same time, the program start bar is mechanically latched down, locking the numeric keyboard. The program start relay locks the primary printed keyboard and also picks the autostart relay **450**. The autostart relay picks a co-ordinate setup relay which initiates a sequence to check the vertical position of the form and the horizontal position of the carrier. If both the form and carrier are located in coded positions of their respective program tapes, the co-ordinate check is valid and the co-ordinate exit hub corresponding to the vertical and horizontal positions will emit an electrical impulse. If the co-ordinate check is not valid, the machine will lock.

One other function must be performed when the machine is started by impulsing an autostart hub. Since the numeric keyboard is not mechanically locked when the machine is automatically started, another means is employed to accomplish this function. When an autostart hub is impulsed on the control panel, the autostart relay is picked. The autostart relay picks the numeric keyboard lock relay and co-ordinate setup relays. The numeric keyboard lock relay energizes the numeric keyboard restore magnets. The numeric keyboard restore magnets prevent a numeric key button or the program start bar from latching. If a key button latched during the automatic mode, a digit would be entered into machine memory at the completion of the automatic mode.

The numeric keyboard lock relay in conjunction with the co-ordinate setup relay, picks the program start relay, which locks the primary printer keyboard. Again the co-ordinate setup relays initiate the sequence to check the vertical and horizontal position.

For a detailed description of this aspect of the invention, in the first sequence, it is assumed that the machine **1** is started by depressing the program start bar. Referring to FIG. 81*b*, the vertical channel A sense wheel **81–24** is resting in a hole in the vertical program tape and the horizontal channel **2** and **3** sense wheels **81–52** and **81–56** are resting in holes in the horizontal program tape. Therefore, the vertical channel A and horizontal **2** and **3** sense contacts are closed.

When the program start bar shown at **81–10** is depressed, a circuit is completed to the hold coil of the program start relay, **51**. The action of depressing the program start bar is represented at **82–8** in FIG. 82 and the sequence of energization, actuation, de-energization and de-actuation of relays for this operation is represented in FIG. 82 of the drawings wherein the action of each relay is indicated by the corresponding relay number preceded by the figure number viz., **82**. The program start relay **51** provides its own hold circuit through the contacts **51–8** and the parallel connected contacts of the restore relay, **50–4**, and program step CB5 relay contacts **37–9**. In the keyboard entry mode, a lock solenoid **81–12**, associated with the keyboard of the primary printer is energized, since its energization circuit is completed through the normally closed contacts **51–1**. When this solenoid is energized, the keyboard mode contact **81–14** is opened. Therefore when the contacts **51–1** transfer, the circuit to the keyboard lock solenoid is de-energized. When the solenoid de-energizes, the keyboard is locked and the keyboard mode contact **81–14** closes. The contacts **51–1** condition the circuit to the hold coil **57H** of program step CB1 relay **57**.

The contacts **51–12** of the program start relay are used to provide potentials for conditioning the electronic circuits. When the contacts **51–12** transfer, a Not Keyboard Entry signal is developed in the electronic circuits as shown in FIG. 133 of the drawings. Therefore the electronic circuits recognize that the machine is in the keyboard entry mode. When contacts **51–12** are in normal position a Keyboard Entry signal is developed and the electronic circuits recognize that the machine is not in the keyboard entry mode.

The program start relay **51** also closes its contacts **51–10** to complete a circuit to pick the autostart relay **450**. This circuit is completed through the contacts **57–3** of program step CB1 relay, contacts **51–10** and the contacts **55–3** of the program control relay. The autostart relay provides its hold circuit through the contacts **37–6** of program step CB5 relay **37** and the contacts **450-1** of the autostart relay.

When the autostart relay picks, the circuits are completed to the hold coils of the four co-ordinate setup relays **511, 452, 455,** and **458**. The contacts **450–2** close a circuit to pick the co-ordinate setup relays **452** and **511** and the contacts **450–3** and **450–4** close to pick relays **455** and **458** respectively. The co-ordinate setup relay **458**, through its contacts **458–9** in conjunction with keyboard mode contact **81–14** completes a circuit through the contacts **55–2** of the program control relay to the hold coil **57H** of program step CB1 relay. The ground circuit of program step CB1 relay is completed through the contacts **51–1**. The program start relay **51** is actuated and thus, the keyboard mode contact **81–14** and the contacts **458–9** in a closed condition establish an energizing circuit for program step CB1 relay **57**. The program step CB1 relay establishes a hold circuit through its contacts **57–6** and the parallel connected contacts **40–5** of the program step CB2 relay **40** and the contacts **37–3** of the program step CB5 relay.

When the program step CB1 relay **57** picks, a circuit is completed through the contacts **51–4**, contacts **57–5** of program start relay **51** and the contacts **458–10** of the co-ordinate setup relay to pick the program control relay **55**. A hold circuit is provided to the program control relay through the contacts **51–7** and its contacts **55–1** to the hold coil **55H**.

The primary purposes of the co-ordinate setup relay are to initiate the vertical and horizontal check functions and to condition the circuits to the co-ordinate exit hubs. The co-ordinate exit circuits are illustrated in FIG. 52. Two vertical rows of co-ordinate setup contacts, using contacts of co-ordinate setup relays **452, 455,** and **458** are shown to condition the co-ordinate exit circuits. With the co-ordinate setup relay contacts closed, it is necessary to pick the vertical channel and horizontal channel relays corresponding to the vertical position of the document and horizontal position of the carrier which will complete the circuit to the proper co-ordinate exit hub.

The co-ordinate setup relay **511**, conditions the circuits to check the vertical position of the form. Since the vertical channel A sense wheel **81–84** is in a hole, its sense contact is closed. Therefore, when relay **511** picks, a circuit is completed through the position switch **81–20**, the vertical program common bar **81–22**, the vertical channel A sense contact **81–24** and the contacts **511–1** to pick the vertical channel A relays **479** and **482**. The vertical channel relays are held through this circuit until the co-ordinate setup relay **511** drops.

When the verical channel A relays pick, all of the vertical channel A contacts in the co-ordinate exit circuits shown in FIG. 52 transfer. These are shown in the column headed by contacts **479–31**, it is therefore necessary to pick the horizontal channel relays which will complete the circuit through the proper co-ordinate exit hub. The left column of co-ordinate setup relay contact sets in the co-ordinate exit circuit, headed by contacts **452–1** are used to initiate the horizontal position check. When these contacts are transferred, a circuit is completed from the 48 volt line through the contacts such as **452–1**, the horizontal channel relay points **437–2** in FIGS. 53 and 81*b*, the contacts **435–2** of horizontal CB4 relay and the contacts **423–4** of the functional interlock relay to pick horizontal CB1 relay **431**. When this horizontal CB1 relay picks, a normal horizontal CB sequence is initiated. During the horizontal CB sequence, when horizontal CB1 drops, a circuit is completed through the contacts **431–2** and the contacts **434–1** of horizontal CB3 relay to the horizontal program common bar **81–28**. Since the horizontal channel **2** and **3** sense wheels are resting in holes in the horizontal program tape, the horizontal channel **2** and **3** sense contacts are closed and an energizing circuit is completed to pick horizontal channel **2** and **3** relays, **438** and **440** respectively.

When horizontal channel **2** and **3** relays pick, the circuit is completed to the co-ordinate exit hub, **52–10** in FIG. 52 of the drawings, at co-ordinate position A–6 through the contacts **452–6** of co-ordinate setup relay **452**, the contacts **438–3** of the horizontal channel **2** relay, the contacts **440–3** of the horizontal channel **3** relay, the contacts **452–12** of the co-ordinate setup relay and the contacts **479–8** of the vertical channel relay to the co-ordinate exit hub.

The exit pulse emitted by the co-ordinate exit hub **52–10** may be used in various ways such as to select the desired program step in the routine to be performed at this co-ordinate position. The co-ordinate exit pulse by being wired to a program step entry hub, conditions the control relays which select that program step.

As described hereinabove, the machine may be started by impulsing an autostart hub as well as by depressing the program start bar. The sequence of relay energization, actuation, de-energization and de-actuation is represented in FIG. 83 of the drawings wherein the action of each relay is indicated by a corresponding relay number preceded by the figure number viz., 83. When the machine is started by impulsing an autostart hub, the numeric keyboard is not mechanically locked. The most significant difference in starting the machine by impulsing an autostart hub rather than by depressing the program start bar is the provision for rendering the numeric keyboard inoperative. In the case of starting the machine by impulsing the autostart hub, this is accomplished by energizing the numeric keyboard restore magnets during the automatic mode of the machine. With the numeric keyboard restore magnets maintained energized, the numeric keybutton or program start bar will not latch down. Therefore, if a keybutton is depressed during the automatic mode, it will return to its normal position when released.

Referring to FIG. 81*a* of the drawings, the application of a 48 volt pulse to an autostart hub **81–16** corresponding to a hub **8–22** on the control panel, the pick coil **450P** of the autostart relay is energized. The autostart relay provides its own hold circuit through the program step CB5 relay contacts **37–6** and the contacts **450–1**. This relay picks the four coordinate setup relays, and again these relays initiate the vertical and horizontal checking function. In addition to picking the co-ordinate setup relays, the autostart relay picks the numeric keyboard lock relay, **44**, through its hold coil **44H**. This circuit is completed through the contacts **51–4** of the program start relay and the contacts **450–5** of the autostart relay to the numeric keyboard lock relay hold coil. When the numeric keyboard lock relay picks, a hold circuit is established through its contacts **44–1** and the contacts **450–5**. Also, when the numeric keyboard lock relay picks, its contacts **44–3** and **44–4** complete the ground circuits to the numeric keyboard restore magnets **81–30** and **81–32**. With the numeric keyboard restore magnets energized, the numeric keybuttons and program start bar will not latch if they are depressed. The contacts **458–11** of the co-ordinate setup relay and the contacts **44–2** of the numeric keyboard lock relay complete the circuit to pick the program start relay **51** through its hold coil. The program start relay, as before completes the circuit to the electronics circuitry to develop the not keyboard entry signal and drops the lock magnet **81**. The keyboard mode contacts **81–14** close when the lock magnet **81–12** is de-energized. Since the co-ordinate setup relay **458** picks before the keyboard mode contact **81–14** closes, the keyboard mode contact will complete the circuit to the program step CB1 relay **57**. The remaining circuit operations occur in the same manner as was described hereinabove with respect to the starting of the machine by depressing the program start bar and accordingly, will not be repeated.

MEMORY ORGANIZATION

As already noted, the details of the B counter and the memory and associated circuitry are set forth in copending application A, however, a brief description thereof is herein set forth.

As already pointed out, the memory unit contains a main memory portion of 40 words. The 40 columns of cores representing these words are shown in FIGS. 85 and 86 of the drawings and it is observed that each column contains 36 cores representing the dummy bit, the sign bit and the 34 information bits. The bit positions of the respective cores are indicated along the column designated "BITS" in FIG. 86. The Read Switches and Write Switches are shown at the tops of FIGS. 85 and 86, it is being understood that lines from the free ends of the diodes, connect to the free ends of vertical core lines terminating in arrows.

The Magnetic Ledger Card portion of memory is shown in FIGS. 88 and 89 wherein again 40 columns are shown and each column contains 36 cores. In these figures, the sense winding threading the cores is shown in addition to the Word and Bit, Read and Write lines.

The Word Drivers and Switches are shown in FIG. 87 of the drawings and it is noted that there are 5 drivers and 8 switches. This provides 40 different combinations. Since the word lines extend through both the Main Memory and the Magnetic Ledger Card Memory, a total of 80 different combinations are provided.

The 6 Bit Switches, the 6 Main Memory Bit Drivers and the 6 Ledger Card Memory Bit Drivers are also shown. Since there are **36** cores in each word, the combination of 6 drivers and 6 switches enables the bit addressing of the 36 cores.

In FIG. 87 is also shown schematically, the B Counter. The B Counter is settable by impulsing Control Panel hubs designated Begin Alpha or Digit Capacity, as indicated.

The Fixed Factor portion of memory is shown in detail in FIG. 84 of the drawings. It is observed in this figure that 2 columns of cores are shown. However, the respective Fixed Factors are obtained by threading the respective Fixed Factor lines through only those cores which

are required to obtain the proper number. Thus, for purposes of illustrating the cores through which the lines are threaded, on the left and on the right of these respective lines are circles indicating that the line on which the circle appears, is threaded through the core on the same horizontal level.

FIG. 91 shows in detail the arrangement of Digit or Bit Drivers and Switches and illustrates the manner in which the loopback principle is utilized in selecting cores.

In FIG. 91 is shown the detailed arrangement of the Word Drivers and the respective Read and Write Switches.

B COUNTER

The details of the B counter are set forth in copending application A, however, a brief description thereof is set forth immediately following.

The B counter directly controls the sequencing (addressing) of word lines in memory. This occurs during two basic types of operations in the machine.

One is an operation involving the use of fixed factors such as the decoding required during the TYPE operation. As noted, the fixed factors are physical words of memory. They must be sequenced in a predetermined order during a type operation. The B counter performs this function.

The other general type of operation which involves sequential addressing occurs during an Alphanumeric Entry or Alphanumeric Print Operation. This involves searching for a desired field of MLC memory, and the B counter plays a primary role in the operation. The B counter, therefore, is used to sequence words of memory in the two basic types of operations where words of memory must be sequenced and not addressed directly from the control panel.

The B counter, is initially set up under control of the control panel depending on the type of operation as will be subsequently described in detail. As a preliminary example, however, the B counter may be wired from the digit capacity or shift hubs, FIGS. 8 and 129 for sequentially selecting fixed factors for use during Type or Shift operations. The B counter may also be set up from the control panel by means of a wire into a Begin Alpha hub, FIGS. 8 and 129, and depending on its initial status, establishes where numeric information ends and the alphabetic information begins in the MLC section of the memory.

The B counter comprises six trigers respectively designated **1B**, **2B**, **3B**, **4B**, **5B**, and **6B**. Positions **1B** through **4B** are shown in FIG. 127; and positions **5B** and **6B** are shown in FIG. 128. A chart showing the various possible conditions of the B counter appears in FIG. 122.

Positions **1B**, **2B**, **3B** and **4B** comprise a basic counter which can assume ten count conditions with the four positions having respective binary weighted values of 1–2–4–8. In each of the ten conditions, it is specified that the B counter have a 1 bit in at least one position. Therefore, if the B counter is left in a completely reset condition, it will have no effect on the memory selection circuitry.

Rather than counting 1 through 10 with the basic positions **1B–4B**, the counter will count from 2 through 11 as can be seen in the table. The outputs of the B counter during these ten basic count conditions are used to select the ten fixed factors.

In order to be able to address the forty words of MLC memory, the basic counter is expanded by the addition of triggers **5B** and **6B**. These have a value of 10 and 20 respectively. Positions **1B–4B** can be used to address words 1–10 in MLC memory. Trigger **5B** is then set "on" and with positions **1B–4B** being sequenced as before, permits addressing words 11–20. Trigger **6B** being "on" in connection with positions **1B–4B** results in addressing words 21–30.

Both **5B** and **6B** "on" in connection with triggers **1B–4B** enable selection of words 31–40 of MLC memory.

Positions **2B**, **3B** and **4B** control selection of the five word drivers. Position **1B** controls selection of the two Fixed Factor Odd and Even Switches, thus giving the ten (5×2) combinations necessary for accessing Fixed Factor memory.

Positions **5B** and **6B** together with position **1B** provide eight possible combinations each of which serves to select a particular Read-Write Switch combination for cooperation with the five word drivers. These combinations are as follows:

STATUS

1B-5B-6B	MLC Words	Read-Write Switch Combinations
$\overline{1B}$ $\overline{5B}$ $\overline{6B}$	1–10	3
1B $\overline{5B}$ $\overline{6B}$		4
$\overline{1B}$ 5B $\overline{6B}$	11–20	1
1B 5B $\overline{6B}$		2
$\overline{1B}$ $\overline{5B}$ 6B	21–30	5
1B $\overline{5B}$ 6B		6
$\overline{1B}$ 5B 6B	31–40	7
1B 5B 6B		8

A single set of hubs, FIGS. 121 and 123, enables setting up the B counter for selection of fixed factors as required for the TYPE operation, and column shift operations. Reference to the table FIG. 122 will clarify this. If the machine is programmed for a column shift of two places, it is necessary to address the fixed factor which can be converted to 100 for use as a divisor. On the other hand, if a field width for digit capacity for type-out of two places is programmed, this means that the fixed factor 10, which is one corresponding to the second position, is required. The B counter is set up for a type operation just as if the machine were going to do a shift operation, but prior to manipulation of data, it is stepped down once so that the proper fixed factor is initially addressed.

The B counter code was set up in order to minimize the amount of switching required for selecting any driver-switch combination needed to address memory. **2B**, **3B** and **4B** address the five word drivers in whatever driver-switch combination they appear whether with fixed factor memory, main memory, or MLC memory.

C COUNTER

The C counter, like the B counter, plays a significant role in machine operations. This counter comprises seven trigger positions **1C**, **2C**, **4C**, **8C**, **16C**, **32C**, and **64C**. The **1C** trigger is shown in FIG. 130; triggers **2C**, **4C**, and **8C** in FIG. 131; and triggers **16C**, **32C** and **64C** in FIG. 132.

The C counter is used in a number of ways. It is primarily used to control the address and arithmetic circuits. In Multi-Cycle operations, multiply or divide, the C counter is used to count cycles. The counter outputs can be used to determine if the cycle being performed is odd or even, which words are to be addressed in the cycle and when the operation has been completed. The C counter is used in a Type Operation to count the number of successful subtractions made in the determination of the Digit to be typed. The C counter is used to count Field Markers between variable length fields of MLC memory and further, it is used during MLC Read and Record operations to time the character gate, that is, the time for reading and recording one column of bits on the magnetic ledger card stripe.

Triggers of this counter are identified by their binary value. The usual arrangement used in the operations is to start the clock when **32C** turns on and stop the clock either from its own condition or from **32C** turning off. **32C** may or may not be turned off when the clock stops. In the ledger operations, **32C** being off permits the C counter to be stepped. For all timing, the C counter is set up so that at the end of the desired count **32C** will turn on.

The C counter is also used for address searching and timing of delays during the operations of Alphanumeric Entry and Alphanumeric Print.

Address search is the same for both ENTRY and PRINT. The B counter is set through control panel wiring to the beginning of the LA section of memory and the C counter is preset through the LA1–LA9 Address hubs so that counting fields will cause 16C to be on when the desired field is encountered. LA–1 is a special case since the desired address will always be in the B counter at the beginning of an operation. Therefore, the LA–1 hub is connected to turn on the address located latch at the end of six bit times. On Entry the clock is stopped at this time. For Print the stop is at the end of the twelfth bit time.

For addresses other than LA–1, the clock runs and the B counter steps each cycle scanning memory. Every time a Field Marker is encountered the C counter is stepped. When 16C is on and a Field Mark is encountered, the Address Located Latch is turned "on." In the Entry operation, the clock is stopped. For Print the clock runs for six more bit times. Address search takes a maximum of 138 milliseconds. During Entry, when the search has been completed, the machine awaits the first typewriter cycle. When a key is struck the transmitting contacts which are closed, set the corresponding triggers in the Input-Output register to their "on" state. The end of the typewriter cycle starts the clock and sets the C counter to count six idle cycles. Idle cycles are necessary here to allow the transmitting contacts to open before shifting is begun. The delay amounts to about 21 milliseconds. At the end of the fifth cycle the clock continues to run for six bit times during which the contents of the Input-Output Register is shifted into memory. The calculator now awaits the next typewriter cycle. The INDEX key on the typewriter will write the Field Marker symbol into memory.

The Entry operation is terminated when the START bar is depressed.

During the PRINT operation, the clock continues to run for six bit times after the Address Located Latch is turned on. During this time, six bits from memory shift into the Input-Output Register. The contents of the register are decoded to condition thyratrons. The stopping of the clock is accompanied by firing those thyratrons which have been conditioned. The typewriter will cycle as a result of firing the thyratrons. Near the end of the cycle the clock will be started by the typewriter contacts. At the same time, the C counter will be set up to time one idle cycle. This cycle is necessary to allow the typewriter cam contacts in the return path for the thyratrons to settle and stop bouncing. At the end of the idle cycle the clock continues to run for six bit times to shift out the next character, then stops with associated firing of the thyratrons. Thus, the cycle continues until a Field Marker is decoded. When this happens, instead of firing a set of print thyratrons, the thyratron to advance the program unit is fired.

ELECTRONIC CLOCK

As already noted, the Clock **3–26** in FIG. 3 of the drawings provides the basic timing signals for the electronic operations of the machine **1–10**. The detailed structure of the Clock and the manner in which it operates is described immediately following.

In FIG. 93, a Start Trigger **93–28** is provided. It is necessary to turn on the Start Trigger in order to start the Clock. A signal to do this is supplied from the relay section of the machine. The signal originates from +48 volts and is directed by a **64–4** N/C relay point, reproduced in FIG. 93. It is applied to Integrator **93–50**. The +48 volts is translated to a +S level by the Integrator **93–50**, and applied to one input of +And **93–44**.

The other inputs of +And **93–44** are conditioned by other logic having to do with Magnetic Ledger Card operations. For example, a +48 volt signal to the "Record" hub on the control panel is integrated by another Integrator **93–40** and applied to the Q input of a +And **93–42**. At the moment, it is assumed that the machine is not in a Magnetic Ledger Card operation. The input at pin E of Integrator **93–40** is therefore at a −W (ground) level, and its output is a −S level, which is applied to the Q input of +And **93–42**. The +And **93–42** supplies a +S level to the Q input of +And **93–44**.

The third input R of the +And **93–44** is conditioned by the output of a +And **93–46**. This +And, in turn, has three inputs. One is pin S from an Integrator **93–46**. Relay **64–4** N/O point, is open at this time, so the input of Integrator **93–46** is −W (ground or zero), and its output is −S. This is applied at pin S of +And **93–38**, so its pin R output is +S. This is applied to input pin R of **93–44**. All inputs of +And **93–44** are +S at this time, so its output at pin D is −S. This −S level is applied to pin P of the Start Trigger Gate Latch **93–26**. This sets the Latch to the ON condition. The output pin D of the latch **93–26** is +S. This +S is fed back to pin F of the latch. Pin G of the latch will be −S only for reset. This is a relay signal which is applied during the relay cycle. Originally, latch **93–26** was restored to the Off state. At the present time the DC Reset line has returned to its +S level. Pin H of the latch is +S on Not Start, and is derived from the Start Trigger itself. This line is therefore +S. Pin CL of the latch **93–26** is now −S which gives a −S input to pin R thereof to keep the Latch set on.

The +S output of the Start Latch on pin D, is applied to pin B of the Start Trigger **93–28**. The Start Trigger has an And circuit gating arrangement. The pin C input to **93–28** comes from the ountput of a —O at **93–30**.

The X input of −Or **93–30** comes from the +And **93–38** whose output at this time is +S. The input at pin Y is also +S at this time.

Starting the clock

Start Relay **64**, which is the Electronic Start relay, is now energized. When in its de-energized condition, the Start Latch was set On.

The energization of Relay **64** normally results from a signal from some other machine operation, such as where the machine indicates that it is ready for an arithmetic operation. However, starting the Electronics during Print Out is initiated under control of the typewriter. The typewriter contacts are Ored with the **64–4** point and come into the same Integrator circuit **93–46**.

To summarize, the **64–4** N/O signal comes into Integrator **93–46**, is changed to a +S level, and conditions the +And **93–38**. Another input T of **93–38** is +S, being −S only at End LA Memory. The other input of **93–38** comes from another +And **93–48**. Its inputs are Q trigger and MLC operation. The latter is −S, so the +And **93–48** output is +S to the first mentioned +And **93–38**. The +And **93–38** output of −S goes to the −Or **93–20** input X, which gives a +S output. This is applied to pin C of the Start Trigger **93–28**.

The Sample Pulse (OSP) input to the Start Trigger **93–28** comes from the Oscillator Sample Pulse Driver, **95–10**, FIG. 95. The Oscillator **95–12** is constantly operating at 100 kilocycles per second whenever power is on the machine.

Referring to the Timing Chart FIG. *9a*, the turn On state of the Start Trigger is indicated at **9–10**. Various triggers, 01/02, etc., are set to the conditions shown in FIG. *9a* immediately prior to the turn On state of the Start Trigger by the DC Reset interval which preceded the energization of Relay **64**.

In FIG. 95, an output from the Start Trigger **93–28** is applied to one input of the +And at **95–14**. A +S level signal, Not Read Delay is applied to the other input. The output of this +And becomes −S, is inverted by Inverter **95–16** through internal wiring as indicated by the star. Inverter **95–16** output is +S. This is one of the gates to the 01/02 Trigger at **95–18**. The other gate **95–18** is con-

ditioned from the Off side of the same trigger. Thus, the 01/02 Trigger turns on at the occurrence of the next Sample pulse from the Oscillator.

Referring to the Read/Write Trigger **95–20**, lower left FIG. 95, one gate (pin C) is at ground and is therefore +S at all times. Gate B of **95–20** comes from the off side of the trigger, which is off at this time. The Read/Write trigger is turned on to the Read state by the first 01 Sample pulse. This comes from the Sample Pulse Driver **95–22** which gets a +S signal from pin W of the 01/02 Trigger. Considering now the turn on of the Read Delay Trigger **95–24**, FIG. 95, pin C is +S on an 01 output, while the input pin B is +S when the Read Trigger turns On. The next Oscillator Sample Pulse (OSP) turns on the Read Delay Trigger.

Looking at the 01/02 Trigger again, gate T is gated +S from the On side of 01/02. The other gate at pin U comes from a —Or **95–26**. This —Or has an input at pin B which was +S. It is now —S since Read Delay is on. The output of the —Or **95–26** is now +S, so the 01/02 Trigger turns Off with the next Oscillator Sample Pulse.

A Single Shot at **95–28** is driven from pin V of the 01/02 Trigger. As pin V goes to +S, the Single Shot **95–28** supplies an output at pin Q. This output is split into a first line labelled 02 Single Shot, and a second line which goes through a Delay line **95–20**, and becomes 02 Single Shot Delay. These lines are subsequently used for firing the Memory Drivers.

In the Timing Chart 9*a*, the next action is the turn off of the Read Delay (RD) trigger at **9–12**. In FIG. 95, the Read Delay trigger **95–24** is gated by its own On side output at input G. Input H is +S from the Off side of the 01/02 Trigger, which has just turned off. The next Oscillator Sample Pulse (OSP) turns the Read Delay Trigger off.

The 01/02 Trigger **95–18** is gated to turn on once more from the +And **95–14** pins D and E. Pin D is +S (Start Trigger). Pin E is now +S with the Read Delay trigger off. The —S output of the +And **95–14** after inversion is applied as a +S level at pin Q of the 01/02 Trigger to turn it on with the next Oscillator Sample Pulse (OSP).

The output of the 01/02 Sample Pulse Driver **95–22** sets the Read/Write Trigger **95–20** Off, or to its Write state, since pins G and H are at +S.

A +S Write Sample Pulse is supplied at this time from the Sample Pulse Driver at **95–32**. This is used in the memory section of the machine.

With the next Oscillator Sample Pulse, the 01/02 Trigger **95–18** goes to its Off, or 02 state. The circuit for turn-off is somewhat different from that which occurred during the Read part of the cycle. Input pin D of the —Or **95–26** is +S at Read time. Since the Read/Write Trigger **95–20** is now in the Write state, this input is —S. The output of the —Or **95–26** is +S and conditions the 01/02 Trigger **95–18** to be turned Off or to its 02 state with the next Oscillator Sample Pulse. This bypasses the Read Delay (RD) input to the —Or **95–26** which was used earlier. This establishes a shorter 01/02 cycle for the 01/02 Trigger during Write time than that established during Read time. The reason for making the 01/02 cycles longer for Read than for Write time, is that more logic is performed during Read Time and more time is required by the arithmetic portion of the machine.

As the 01/02 Trigger **95–18** changes to its 02 state, the 02 Single Shot **95–28** is fired and provides a signal for firing the Write Drivers to write a bit into memory.

The Read Delay trigger **95–24** being Off, in conjunction with +S Start at +And **95–14** provides a gate so that the 01/02 Trigger **95–18** will turn On with the next Oscillator Sample Pulse, as previously described.

When turned On, the 01/02 Trigger causes the 01 Sample Pulse Driver **95–22** to fire. The output of **95–22** is again applied to the Read/Write trigger to change to its Read state.

Normally, during X time, the programmed operator word of memory will be addressed for reading and writing, while during Y time, the programmed operand word of memory will be addressed for reading and writing.

Referring to FIG. 96, and X/Y Trigger **96–10** is provided for this purpose. This trigger was initially reset to its X/Y Trigger will change to its Y state upon application of the 01 Sample Pulse at pin F.

Referring to the timing chart FIG. 9*a*, when the X/Y Trigger changes to its Y state at **9–14**, it will be noted that the other triggers mentioned, 01/02, Read/Write etc., will proceed through cycles similar to those which occurred when the X/Y Trigger was in its X state. The same 01 Sample Pulse that just changed the State of the Read/Write Trigger to the Read state, will also change the state of the X/Y Trigger to the Y state. Both the Read/Write Trigger and the X/Y Trigger are changing state at the same instant, with the same 01 Sample Pulse. It should be noted that one of the gates (pin H) to the X/Y Trigger **96–10** is the Write output of the Read/Write Trigger, which was the state of the latter up to the time of the present change in state. The Read/Write Trigger is changing to its +S Read state at the same time that its +S Write output is being used to gate the X/Y Trigger.

There is no race condition however, due to the fact that the gate input H of the X/Y Trigger is through a resistor gate. The 01 Sample Pulse is applied through capacitor, gates (pins F). The RC time constant is such that the 01 Sample Pulse rises at the F input of the X/Y Trigger long before the +S output of the Read/Write Trigger at pin H of the X/Y Trigger has dropped.

At the end of Y time, the X/Y Trigger is conditioned for changing again to its X state. The turn On gate, pin B is +S during Write time, Y time. Pin C is +S when the X/Y trigger is Off, Y state is at present. The X/Y Trigger will change to its X state with next 01 Sample Pulse.

The X/Y Trigger is converted in a binary fashion, since the inputs to both sides are identical.

At the end of each Write time with the occurrence of the 01 Sample Pulse, the X/Y Trigger will change its state in a similar manner.

At the beginning of each X time, the ABC ring shown in FIG. 96 will be advanced, as can be seen in the timing chart, FIG. 9. The ring was initially reset with A On. B was turned On at the first X time. C is now turned On. The ring comprises an A trigger **96–12**, a B Trigger **96–14** and a C Trigger **96–16**. Trigger B is considered On at the present time. A Sample Pulse Driver **96–18** supplies pulses for stepping the ABC ring. This driver delivers X Sample pulses on line **96–20**. These are used in various other logic, as well as the ABC ring. Driver **96–18** is gated by Dot Ands **96–22** and **96–24**. The A input of the Sample Pulse Driver **96–18** requires a +S level. This will occur if any input of the two +AA blocks **96–22** and **96–24** is —S. There are a number of possible conditions for this.

This circuit is better thought of as an inhibit circuit. Firing of the Sample Pulse Driver **96–18** will be inhibited, for example, during Multiplication or Division under certain conditions. Input R of +AA **96–24** will be +S. Also the +And **96–26** will provide a —S to the +AA **96–24** during a particular interval of the Divide sequence.

The +AA **96–22** will inhibit stepping of the ABC ring for other Divide conditions. Inputs of +AA **96–22** and +And **96–26** include outputs of the C Counter which is used during Multiply and Divide operations. Input **6A** and C and D is a clock input.

The gate (pin A) to the DSP **96–18** is normally +S. Therefore, when the X/Y Trigger changes to its X state, the A-C input R **96–18** receives a positive shift, and the Sample Pulse Driver will deliver a pulse.

As assumed, Trigger B was in its On state. It is gated to turn off by its own On output at pin G. Also pin H is gated to ground. Therefore, the X Sample Pulse at pin

F will turn B Trigger off. At the same time, Trigger C will turn On. Trigger C was gated by the +S On output of Trigger B at pin C.

The clock started with trigger A On. This was near the beginning of the Dummy Digit time. B turns on at the end of Dummy Digit Time. When B is on, the Sign Bit Trigger **97–10**, FIG. 97, is turned on. This trigger is gated on by +And **97–12**. This +And is gated by Write, Not D, 1A, and A. 1A is the first position of the **1A–6A** ring, FIG. 98. The Sign Bit Trigger turns On at the same time as the B Trigger. This is the time during an arithmetic operation when the Sign bits of the programmed words in the memory are brought out and analyzed in order to determine the sign of the operation programmed.

The Sign Bit Trigger will turn back off again with the next X Sample Pulse, which occurs when the B Trigger turns Off.

The D Trigger **97–14** at the top of FIG. 97 cooperates with the Read/Write Trigger **95–20**, FIG. 95, in addressing the bits of the memory. The D Trigger is in phase with the Read/Write Trigger during the first cycle of the ABC ring, and out of phase during the next cycle of the ABC ring, as shown in timing chart, FIG. 9. Initially, the D trigger is off, it is gated On by a +And **97–14** which receives C, Y, and Write signals. C is trigger C of the ABC ring, Y is the Off side output of the X/Y Trigger, and Write is the Off side output of the Read/Write Trigger.

Pin B of the D Trigger is +S at all times except when the inputs of +And **97–16** are all +S. This occurs when the C Trigger is turning Off. At all other times the D Trigger changes state regularly under control of the 01 Sample Pulse, just as the Read/Write Trigger changes state with the 01 Sample Pulse. The D Trigger will therefore step except when C, Y and Write are +S, when it will not step. This causes a phase change of the D Trigger with respect to the Read/Write Trigger.

Having noted the operation of the primary Clock triggers, that is, the 01/02 Trigger the Read/Write Trigger, the Read Delay Trigger, the X/Y Trigger, the D Trigger, and the ABC ring, the A Counter will now be discussed.

The A Counter, FIG. 98, is a ring Counter with six triggers, **1A–6A**, respectively designated **98–10** through **98–20**. The DC Reset is applied to the A Counter in a manner to set 1A on at the beginning of the Start sequence.

Referring to the Timing Chart, FIG. 9, the **1A–6A** status can be observed. The 1A Trigger is On from Dummy Digit through Digit **4** time. At the end of Digit **4** time the Sample Pulse Driver **98–14** is conditioned to supply a pulse to step the A Counter.

The input M of the DSP **98–14** is gated by a +S output from the +And **98–12**. This +And in turn is conditioned by a +And **98–22** and a +And **98–10**. Triggers C and D condition the +And **98–22**. Position Latch, Trigger 1B in the B Counter, and Read Ledger inputs condition the +And **98–10**. At this time +And **98–22** is of interest. Trigger C of the ABC ring has supplied +S outputs at two different times while the 1A Trigger **98–10** was on. Referring to FIGS. *9a* and *9b* Trigger C is On during Digit **4** time.

The Sample pulse applied to Sample Pulse Driver **98–14** is from the X/Y Trigger when it changes to its X state. It will be seen that the D Trigger is Off at the end of Digit **1** time, so that +And **98–22** output is +S. The D Trigger is On at the end of Digit **4** time, so that the +And **98–22** output is —S. This results in a +S to gate M of Sample Pulse Driver **94–14** and the Driver fires to step the **1A–6A** ring. Trigger **1A** turns off, and **2A** turns on. Trigger **1A** On side output (pin **4**) gates Trigger **2A**. The A counter steps in this manner, each individual step **1A**, **2A**, etc. defining 6 bit times in memory, and the entire stepping sequence, or cycle, **1A** through **6A**, defining 36 bit times or 1 word in memory. In FIG. 9 the normal Start time is near the end of the Dummy Digit time. This is the actual time that the clock starts, and it also stops at this time, i.e., the end of Dummy Digit time. For an MLC operation, the clock will start at the beginning of Dummy Digit time and may stop at various times to be described.

The clock may run for a multiplicity of word cycles, depending on the type of operation. For example, a normal Addition takes only one word time. Subtraction normally takes only one word time unless the algebraic sign is changed. In that case, the machine goes through another word time to recomplement the number. Multiplication and Division takes seventy (70) cycles or seventy (70) word times.

In the case of Type or Print the speed is determined by the speed of the output printer, so the machine runs a while, supplies the printer with a character, stops the clock, and waits for the printer to cycle. The printer itself then restarts electronics.

Stopping the clock

This part of the electronics is in FIG. 94. There are a number of ways to stop the clock. The signal used is +S Turn Off Start Trigger output on line **94–26**. This line goes back to FIG. 93, to line **93–32**. The signal in FIG. 94 comes from two —OO blocks at **94–24** and **94–38**, outputs at Q and **3**. There are four input conditions to these blocks which will stop the clock.

The first condition is at pin **4**, at **94–24**. A —S at pin **4** will stop the clock. Two +AA blocks at **94–30** and **94–36** cooperate to produce this signal. Each of these blocks has three input lines. Therefore, six conditioins must be satisfied in order to produce a —S level at pin **4** of the —OO **94–24**.

Pin S of +AA **94–30** comes from a —Or **94–34** which has two inputs. These originate at a +And **94–40** and a +And **94–32**. Pin F of +And **94–40** and pin D of +And **94–32** are +S when the X/Y Trigger is in its Y state. Pin E of +And **94–32** is +S on Type Stop. This is +S during a Numeric Type operation and will stop the clock. Pin F of +And **94–32** is marked Multiply or Divide Stop. Except for certain conditions, pins E and F at **94–32** will be +S during the times mentioned. When the X/Y Trigger is in its Y state, the output of the +And **94–32** will be —S. A +S is derived from the —Or **94–34** to the pin S of the +AA block **94–30**. This will occur at each Y time except when the machine has to go through a number of cycles as in Type, Multiply or divide.

Pin T to a +AA **94–30** is +S Not Complement. This refers to the Complement trigger. This trigger is in the arithmetic logic. It turns on when a Subtract operation has occurred and the sign has changed in the Y time (In) word, and indicates that it is necesary to take an additional cycle to recomplement the number before the clock is stopped. Input T of **94–30** will inhibit stopping of the clock under those conditions.

The input **94–42** to +AA **94–30** originates at a —Or **94–28** with inputs at U and W. These inputs originate under certain Magnetic Ledger Card conditions. For example, feeding pin U is a +And **94–44** with inputs **1A** and A. These are trigger **1A** of the **1A–6A** ring, and trigger A of the ABC ring. The other input is +S on Not MLC Operation. Under these conditions, the input at pin U of **94–28** is —S at **1A** and A time. The input at pin **94–92** of a +AA **94–30** is +S.

During MLC operations, it is necessary to analyze the other logic feeding pin W of the —Or **94–28**. This logic concerns Read Ledger and Record Ledger. The stopping then would be at times other than **1A** and A, as required during transversing of the magnetic reading/recording head across the ledger card.

It will be assumed that stopping at the present time will be at **1A**–A time. In order to Stop, the +AA **94–36** must be conditioned. Pin F of **94–36** is +S when the D Trigger is off. Pin G is +S when the 01/02 trigger is in its 01

state. Pin H is +S when the Read/Write Trigger is in its Write state.

In the timing chart, of FIG. 9*a*, it can be seen that these conditions are satisfied near the end of Dummy Digit time during the second to last oscillator interval marked Gate Stop. At this time the +S Turn Off Start Trigger Signal is available on line **94–26**, FIG. 94. This is applied to pin H of the Start Trigger, FIG. 93 as one of conditions to stop it. Pin G of the Start Trigger will have a +S level from the 01/02 Trigger when in its 01 state. The clock is atcually Stopped with the next occurring oscillator Sample Pulse, pin F of the Start Trigger. This pulse is designated Stop in FIG. 9*a* at **9–16**.

The Clock stops as indicated under normal conditions including all Arithmetic operations and Numeric Print Operations. The other conditions for Stopping the Clock occur during Magnetic Ledger operations. It should be noted that the clock does not necessarily stop on each cycle during normal operations, but may be inhibited from stopping during Multiply or Divide, or Print operations by appropriate inputs to pins E and F of +And **94–32**.

The MLC operation sets up stopping of the clock under various conditions and at various times. These include Read Ledger, Record Ledger, Alphabetic Print and Alphabetic Entry. A servicing switch in FIG. 93, permits manual starting and stopping of the clock.

READ LEDGER

In the program described hereinabove, several of the many machine functions were required. For a complete understanding of the machine and its operation, certain of these operations will be described in considerable detail hereinbelow. As shown at the beginning of the operating program in Table 1, the first step in the program is the insertion of the Accounts Receivable Card into the hopper of the Magnetic Ledger Card Unit. This initiates a sequence of events which results in the reading of the card and placing the information recorded on the Magnetic Ledger Card Stripe into Memory.

The dropping of the card into the hopper is effective to close the set of contacts **63–10** shown in FIG. 63 of the drawing and named CPU for Card Present Upper and the closure of these contacts is effective to pick a Card Present Upper relay **719** through the normally closed contacts **717–3** and the Card Present Upper contacts. Referring to FIG. 60 of the drawings, the actuation of relay **719** is effective to close its contacts **719–1** and since the read-record head of the magnetic ledger card unit is at its home position, the contacts **60–10** will be transferred, the contacts **60–12** which are actuated by the cam at the 0 degree position of the cam line are closed since the cam line is in its initial or 0 degree position. Thus, an energizing circuit for the Cycle Cam line magnet, CCL, shown in FIG. 61 at **61–10** is completed through a circuit beginning at 48 volt line **65–10** in FIG. 65 of the drawings, through the normally closed contacts **27–5**, through the normally closed contacts **31–1** in FIG. 60 of the drawings, through the normally closed sets of contacts **703–6, 709–6, 729–3, 724–3**, the now closed contacts **719–1**, the transferred contacts **60–10**, the closed contacts **60–12**, the normally closed contacts **724–11**, along the line **60–14** to the line **61–14** in FIG. 61 and directly to the coil **61–10**. Energization of this coil is effective to rotate the cam line to its 72 degree position and is also effective to cause the card align wheel to engage the card and drive it to one side and the bottom of the hopper at which aligned location the switches **60–16** and **60–18** are closed by the card engaging the arms thereof. In these circumstances, the contacts of the 72 degree cam, **60–20**, are closed and an energizing circuit is established from the 48 volt line through the series of now closed contacts hereinabove described, through the operating arm of the switch **60–20**, the closed switch **60–16**, the closed switch **60–18**, through the line **60–22**, the line **61–22**, to the hold coil of the Line Sense relay **713** in FIG. 61 of the drawings. The contacts **713–2** of the Line Sense relay **61–10** is again completed through the normally closed contacts **729–11** and directly to the coil **61–10**. Energization of this Cycle Cam Line relay is effective to rotate the cam line to 144 degrees.

At the 144 degree position of the cam line, an energiding circuit for the Head Drive relay **721** in FIG. 60, is established from the 48 volt line through the series of normally closed contacts beginning with **31–1**, to the operating arm of the head home contacts **60–10**, through the operating arm of the 144 degree —4 contact **60–28** to the pick coil of the relay **721**. Energization of this relay initiates the drive of the magnetic head across the magnetic stripe on the back of the ledger card.

Referring now to FIG. 63 of the drawings, with the position of the read-record head at the begininng of its travel along the stripe on the back of the card, an On Track switch **63–12** is closed and since the contacts **721–1** of the Head Drive relay are now closed, a 48 volt potential is applied to the read line **63–14** and to the On Track line **63–16**. As described hereinbelow, these signals are effective in conditioning the electronic circuitry for the performance of the Read Ledger operation.

Referring now to FIG. 133 of the drawing, Magnetic Ledger Card Read line **133–10** having 48 volts applied thereto, produces 48 volts on the input to the Integrator circuit **133–12** and **133–14**, the latter through a diode **133–16** and the normally closed contacts **51–12** of the start relay **51**. This is effective to produce a +S level at output Q of integrator **133–14**, which is inverted to a —S by Inverter **133–18**, the output D of which is connected to both the input of Power Inverter **133–20** and a line **133–22** designated KBE for keyboard entry. Power Inverter **133–20** thus produces a +S level at its output pin E to a line **133–24** designated Not KBE. The signal on line **133–22** is appropriately applicable to other circuitry to take the machine out of keyboard entry mode. The +S level produced at pin P of Integrator **133–12** is inverted to a —S level at the output pin C of Power Inverter **133–26**. This —S level is applied to each of pin K of —Or circuit **133–28**, pin **8** of —Or circuit **133–30** pin H of Inverter **133–32** and to pin N of Power Inverter **133–34**.

Referring again to FIG. 133 of the drawings, the —S level input to pin K of —Or circuit **133–28** is inverted to a +S level at its output pin E and this signal is applied to input pin R of Power Inverter **133–36**, which inverts the signal to a —S level and applies it to the input pin K of another Power Inverter **133–38**. The output of Power Inverter **133–38** at pin E is thus a +S level and this line is designated MLC operation to indicate that the machine is in a magnetic ledger card operation mode. This signal is applied appropriately in other circuitry to condition the same, to place the machine in this mode.

The —S level signal applied to pin **8** of —Or circuit **133–30** is inverted to a +S level at its output pin **6** and since the other input at pin **7** or this —Or circuit is designated Not Record, the output line of this —Or circuit is designated Read or Record, and under these circumstances, it as a +S level since the machine is in a ledger card Read mode. The —S level applied to pin H of the inverter **133–32** produces a +S level at its output pin D which is applied to input pin GE of Power Inverter **133–40**. The input is inverted by this circuit to produce a —R level at its output pin A and the line **133–42** designated Read Ledger. Thus, this line produces in the R range of signals, an indication that the machine is in a read ledger operation. The —S level at input pin N of Power Inverter **133–34** appears at its output BP as a +S level to indicate on the output line **133–34** that the machine is in a Read Ledger operation. The —S level at input pin N of Power Inverter **133–34** appears at its output BP as a +S level to indicate on the output line **133–34** that the machine is in a Read

Ledger operation. A Not Read Ledger signal may be derived from line **133–46** which is taken directly from the output pin C of Power Inverter **133–26**.

As the head drive apparatus of the magnetic ledger card unit **63–12** is energized, the On Track switch is closed producing a 48 volt potential on the line **63–16**. Referring now to FIG. 135 of the drawings in conjunction with the timing diagram in FIG. 9*a* of the drawings, it is noted that the First Pre-Run Cycle latch, **135–20**, is set to an On condition at the time that the DC reset line **135–22** has a —S level applied thereto prior to the beginning of the electronic operations, and that during the first electronic cycle, the line **135–26**, having the signal Not (1AAD and Read Delay) applied thereto, is at a +S level from the beginning of the electronic cycle, which is at Sign Bit time, until the end of the cycle at Dummy Digit time. Accordingly, the "on" condition of this latch indicates the first pre-run cycle. As the line **135–26** receives a —S level signal, the latch is turned off indicating that the first pre-run cycle has been completed. Referring next to FIG. 134 of the drawings, it is noted that the On Track line reproduced at **134–10** and supplying the input to pin D of Integrator **134–12**, under the present circumstances, produces a +S level at output pin R and that this +S level signal is applied to the input pin D of +And circuit **134–14**. The other input at pin E of this +And circuit is also at a +S level since the signal First Pre-Run Cycle is applied thereto and thus, the output of this +And circuit is at a —S level. This supplies an input to the —Or circuit **134–16** of Position Latch **134–18**, whereby its output at pin B and designated Position Latch is at a +S level. 6ACDY Write 02 time occurs near the end of the electronic cycle, the —And circuit **134–22** having respective inputs 6ACD and Y Write and 02 at its pins D and B, respectively, produces a —S signal at its output pin G at 6ACDY Write 02 time. This —S level signal is applied to input pin U of +And circuit **134–24** and produces at its output a +S level near the end of the electronic cycle. Thus, all of the input lines to +And circuit **134–24** of the Position Latch **134–18** are, under these circumstances, at a +S level and its output at pin R is at a —S level. This output is applied as an input of —Or **134–16** to produce a +S level signal at its output. That is, the Position Latch is turned "on." This signal is applied to the Emitter Follower **134–28** and produces at its output pin K the signal Not Position Latch.

Referring now to FIG. 132, it is noted that the signal Not Posiiton Latch, which is at a —S level under these circumstances, is applied to the input pin E of inverter **132–10** and thus, produces at its output pin B a +S level signal applied to the collector terminal Y of the 32C trigger **132–12**. By a "collector pullover" action, the 32C trigger is set to its "on" state and thus a +S level is maintianed at its output pin which is designated 32C.

The setting of the 32C trigger to its On state is effective to cause the electronic operation of the system to be started. Referring now to FIG. 93 of the drawings, it is noted that the line, 32C, is reproduced at **93–10** and supplies an input to pin **7** of the +And circuit **93–12** of a 32C Trigger Start Latch **93–14**. Before the 32C trigger was set to its On state, the output of this +And circuit was at a +S level by reason of the —S level at the input pin **7**. Therefore, the inputs pins E and F of —Or circuit **93–16** are both at a +S level since the Not Start signal applied to pin S is also at a +S level. Accordingly, the output pin C of —Or circuit **93–16** is at a —S level and is applied to pin **8** of +And circuit **93–12**. Thus, the application of the +S signal from 32C at input pin **7** is of no immediate consequence since the output of tihs +And circuit **93–12** remains at a +S level.

The inputs **4**, **5** and **6** to +AA circuit **93–18** are now all at a +S level since the machine is in a Read condition, 32C is On and the output of 32C Start Latch is also at a +S level. Thus, the output pin **3** of +AA **93–18** is at a —S level. Since all of the triggers of the B counter under the present circumstances are in a reset condition, the inputs to +AA circuit **93–20** are at a —S level and at the output pin C of this circuit, a +S level signal appears. This signal is applied to input pin Z of +AA circuit **93–22**. The other inputs to this +AA circuit at pins **1** and **2** are lines designated Not Pulse and Not (Digit Y and Write). These are for the purposes of testing and repair of the machine and under all operating conditions of the machine are at a +S level. Thus, the output of +AA circuit **93–22** is also at a —S level. Accordingly, the outputs of +AA circuits **93–18** and **93–22** are each at a —S level and these circuits supply the input to pin Q of —Or circuit **93–24** of the Start Trigger Gate Latch **93–26**. The latch is therefore set to its On state whereby pin D at the output of —Or circuit **93–24** is at a +S level. This, therefore, sets the gate at input B of the Start Trigger **93–28** to the On state. The other input at pin C of the And on gate of the start trigger is also set at a +S level since one input at pin Y of —Or circuit **93–30** is at a —S level producing a +S level at its output pin P which is applied to input C of the Start Trigger. As a consequence, the Start Trigger will be set to its on state at the next oscillator sample pulse producing a +S level at its output pin E, designated Start. The setting of the Start Trigger to its On state starts the electronic operations of the machine.

Referring now to FIG. 123 of the drawings, the +A circuit **123–10** has at its inputs X, Y and Z the signals 6ACDY Write 02, Not Address Located and MLC Operation. In these circumstances, the signal Not Address Located and MLC Operation would be at +S level and therefore, at each 6ACDY Write 02 time, or in other words, at the end of each electronic cycle, all of the inputs to this +A circuit would be at a +S level and its output at pin V would be at a —S level. Thus, the output signal —S applied to the input pin R of —Or circuit **123–12** would produce at the output pin D of this —Or circuit, a +S level. This is applied to input pin R of the Sample Pulse Driver **123–14**, the other input pin A of which receives the output from pin C of a +And circuit **123–16**. Since the input pin F of the +And circuit **123–16** is Not Magnetic Ledger Card Operation, and this is at a —S level under these circumstances, both inputs of the Sample Pulse Driver are at a +S level. Accordingly, at each 6ACDY Write 02 time, a B sample pulse at line **123–18** is produced for stepping the B counter as described in the copending application A.

Referring now to FIG. 124 of the drawings, it is noted that during the Read Ledger operation, none of the punctuation hubs reproduced at **124–10**, **124–12**, **124–14**, and **124–16** are impulsed, whereby each of the Integrator circuits **124–18**, **124–20**, **124–22**, and **124–24** to which these hubs are connected as inputs, have 0 volt inputs thereto, producing —S levels at their respective output pins L, R, N and P. These —S level signals are inverted, respectively, by +And circuit **124–32**. Also, +AA circuit **124–34** receives at its input pin V the —S level signal from output pin R of Integrator **124–20** and this +AA circuit therefore produces at its output pin S, a +S level signal. Thus, the inputs **4** and **5** to —OO circuit **124–36** and the inputs to pins Q, R and P to —OO circuit **124–36** are all at a +S level producing at the respective output pins **3** and D of these latter two —OO circuits, a —S level signal which is applied to input A of —Or circuit **124–40**. This produces a +S level signal at its output pin E designated B Counter Advance Gate.

Referring now to FIG. 127 of the drawings and noting from the description immediately hereinabove, that the B counter advance gate is at a +S level and that the **1B** trigger is in its "off" condition whereby at its output pin E indicative of a Not **1B** condition is a +S level signal which is applied to its "on" gate input line **B**. Thus, both input "on" gates of the **1B** trigger are at a +S level and at the occurrence of the B sample pulse, as also described

hereinabove, the 1B trigger is set to its On state producing a +S level signal at its output pin H designated 1B.

Referring now to FIG. 98 of the drawings, it is noted near the bottom thereof that the +A circuit **98–10** has at its inputs D, E and F, the respective signals Position Latch, 1B, and Read Ledger. Since under the present circumstances all of these lines are at a +S level, the output pin of the +A circuit **98–10** is at a —S level and is applied as one input to the +A circuit **98–12**. Accordingly, the output pin B of +A **98–12** is at a +S level, conditioning the Sample Pulse Driver **98–14**. Thus, at each change from each Y time to X time since the input M of **98–14** is conditioned, the input pin P of the sample pulse driver **98–14** is brought to a +S level and the sample pulse driver produces a signal for stepping the **1A–6A** ring of the clock shown in this figure. It is observed from FIGS. *9a* and *9b* therefore, that the **1A–6A** ring is stepped at each X time or in other words six times as fast as its normal stepping rate. This is different from the pre-run cycle during Record operation, wherein the **1A–6A** ring is stepped at its normal rate. Therefore, during the Read operation, the Read gate is conditioned and waiting for the first bits of information to be read from the card sufficiently in advance to assure that the first bit will not be missed.

Near the end of the first electronic pre-run cycle, the condition **1AAD** Read Delay occurs, at which time the complement of this condition as applied to the line **135–26** of FIG. **135** of tre drawing is at a —S level. Accordingly, at this time the output pin Z of —OR circuit **135–27** of the first pre-run cycle latch **135–20** produces a +S level signal whereby all of the inputs X, Y and Z of the +And circuit **135–24** are at a +S level since the DC reset line **135–22** when not in the Reset condition is at a +S level and the machine is not in a Keyboard Entry mode, whereby the line **135–28** is also at a +S livel. Thus, output pin Z of the +And circuit **135–24** of the first pre-run cycle latch **135–20**, is at a —S level, or stated otherwise, the First Pre-Run Cycle latch is turned off. Thus, electronics operations continue under similar conditions and near the end of the second cycle of electronics, the time **6ACDY** Write and 02 is reached and referring to FIG. 134 of the drawings, it is noted that —And circuit **134–22** at this time has —R level signals applied to its input pins D and B and thus, produces a +S signal at its output pin G. Since the first pre-run cycle latch was turned off, Not First Pre-Run Cycle is at a +S level and thus +And circuit **134–24** has +S level signals applied to both inputs U and W producing a —S level at its output. The output of this +And circuit **134–24** is applied to one input of +And circuit **134–26** of the Position Latch, **134–18**, producing a —S level at its output pin R and, therefore, a +S level at the output pin B of the —Or circuit **134–16** of this latch. Since the First Pre-Run Cycle signal is now at a —S level at the input pin E of +And circuit **134–14**, the On Track signal at **134–10** has been effectively disabled and both inputs to the —Or circuit **134–16** of the Position Latch are at +S levels, latching back a —S level from output pin B to the pin S +And circuit **134–26**, and turning the latch "off." For stepping the B counter, **6ACDY** Write and 02 time, B sample pulse will again be produced, as hereinabove described. The input pin D of +And circuit **127–10** in FIG. **127** of the drawings is conditioned by B counter advance gate signal and since the 1B trigger is now in an "on" condition, the input pin E of this +And circuit is also conditioned whereby a —S level signal is produced at the output of this circuit. This is applied to the input of inverter **127–12** producing a +S level at its output pin B to condition the Z input to the On And gate of the 2B trigger. Since the **2B** trigger has been reset off, the Not **2B** output is at a +S level and since this is applied to the other leg of the On And gate input pin **2**, the 2B trigger is turned on at the next occurring B sample pulse. It is also noted that both inputs L and P of the Off And gate of the **1B** trigger are also at a +S level since the input L derives a signal from the **1B** output and the other input, P, is impulsed by the B counter advance gate which is now at a +S level. Thus, the **1B** trigger will turn off. The B counter is now in a condition to address the first word of memory.

For an explanation of certain action that occurs during the stepping of the B counter, reference is made to FIG. 94 of the drawing. In this figure it is noted that +And circuit **94–10** has at its inputs P, Q and R the respective signals, Read Ledger, **1B** and **6A**. Just prior to the stepping of the B counter to **2B**, each of these lines are at a +S level, producing a —S level at output pin U of this circuit which forms the input to —Or circuit **94–12**. Accordingly, the output of this —Or circuit is at a +S level. Therefore, the inputs to +And circuit **94–14** are all at a +S level since the machine is in a Read condition and the line to input T and marked C will be at a +S level since as observed in FIGS. *9a–9b*, it is C time at the end of each **6A** time. The —S level produced at output pin R of this +And circuit is applied to the input pin S of —Or circuit **94–16** producing a +S level at its output pin R which is applied to input pin H of +AA **94–18**. The inputs to pins F and G of this +AA circuit are D and C and the input at pins **6**, **7** and **8** of the +AA **94–20** are Write, 01 and Y respectively. Thus, at **6ACDY** Write and 01 time, which is at the end of the 34th bit of an electronic cycle, the +AA circuits **84–18** and **94–20** produce a —S level at their output which is applied to the line **94–22** and designated Start Gate. The —S level signal on **94–22** is applied to —OO circuit **94–24** to produce a +S level at its output pin **3** which is connected to the line **94–26** and designated Turn Off Start Trigger.

Referring now to FIG. 93 of the drawing, the line Turn Off Start Trigger is reproduced at **93–32** and is applied to one input pin H of the And turn off gate of the Start Trigger. The other pin G of this gate is connected to the line having applied thereto the signal 01 and thus, at the next oscillator sample pulse which occurs when the 01–02 trigger proceeds from 01 to 02 since the 01 signal would still be at a +S level, the Start Trigger is turned off, and thus, the electronic clock will be stopped in **6ACDY** Write and 02 time.

Referring ot FIG. 131 of the drawings for an explanation of the manner in which the C counter is reset to a count of 10 during the aforedescribed operation, it is observed that the +And circuits **131–10** and **131–12** have the signals AX Read and Read or Record applied to their respective inputs B and D. Thus, since the machine is in a Read Ledger Mode, at AX Read time, the outputs of these respective +And circuits will be at a —S level and applied to the DC set input of triggers 2C and 8C of the C counter. Thus, these triggers are set "on" at this time. Accordingly, the C counter will be set at a count of 10 at the time that the electronic clock stops after the two pre-run cycles described hereinabove.

The condition of the electronic circuitry which exists at this point as thus far described is that it is ready to receive the first column of information which is read from the magnetic stripe of the magnetic ledger card. That is, the first two pre-run cycles have taken place, hte B counter has been set for addressing the first word of memory, and the C counter has been pre-set to a count of 10 when the electronic clock has been turned "off" at **6ACDY** Write and 02 time. The Magnetic read-record head is moving along the magnetic stripe on the ledger card.

Referring to FIG. 136 of the drawings, it is observed that in response to the reading of the first recorded bit on any one of the three information tracks or in the parity check track, one of the read coils, **136–10**, **136–12** and **136–16** of the magnetic head will produce a pulse which will be amplified by the corresponding amplifier **136–18**, **136–20**, **136–22** and **136–24** and properly shaped by the corresponding shaper, **136–26**, **136–28**, **136–30** and **136–32**. It is clear that because of the odd parity utilized in

the present system, at least one of the shapers above-mentioned will produce a —R signal at the output thereof indicative of the occurrence of a one bit in one of the recorded tracks on the card.

Referring now to FIGS. 138 and 139 of the drawings, it is observed that the —AO circuits **138–10**, **138–12**, **138–14** and **139–10** have respective inputs E, A, N, and N connected to lines designated Shaper **1**, Shaper **2**, Shaper 3, and Shaper C, respectively. The other inputs, F, H, Q and Q, respectively, have the real Read Ledger applied thereto. Accordingly, in response to reading of the first column on the magnetic ledger card, one of these —AO circuits will produce at its output, a +S level signal. These outputs are connected to the collectors of respective I/O Triggers, **4**, **5**, **6** and I/O Trigger C. Accordingly, one of these triggers will be turned on by a "collector pullover" action in response to the reading of the first column on the ledger card.

Referring now to the FIG. 132 of the drawings, it is noted that the —OO circuits **132–14** and **132–16** have applied at respective inputs A the signals Not I/O **4** and Not I/O **6** and at respective inputs H have applied Not I/O C and Not I/O **5**, respectively. Thus, since one of these I/O triggers **4**, **5** or **6** or the check trigger will be turned on during the reading of the first column on the card, one of these input lines will be at a —S level producing at either the output pin PL of —OO **132–14** or at the output pin P of —OO **132–16**, a +S level signal. This is applied to pin P of +A circuit **132–18**. Since at this time the clock is "off" it is not at AX and Read time and the output of +A circuit **132–20** is at a +S level producing a +S input at pin R of +A circuit **132–18**. Since the machine is in a Read Ledger mode of operation, the input pin Q of +A circuit **132–18** is also at a +S level. Thus, the output pin D of this circuit reflects the +S condition of the Not I/O output of any one of the I/O triggers **4**, **5**, **6** or C and is at a —S level. This is indicated by the legend "1st bit" on this output line. The —S level of this output line is indicative of the reading of the first bit on the card and is applied to the S input of —Or circuit **132–22** producing at its output L a +S signal which is inverted by Inverter **132–24** to a —S level and is applied to the DC Reset Input of the **32C** trigger at pin P to set the **32C** trigger off.

The off condition of the **32C** trigger is effective to initiate the timing of the Character Gate for allowing the bits read in any column of the magnetic ledger card to be admitted to memory. The turning off of the **32C** Trigger is effective to cause it to be stepped from its preset count of 10 to a count of 32 at which the **32C** trigger is again turned on. For an understanding of the manner in which this is accomplished, reference is made to FIG. 129 of the drawings wherein it is observed that the +A circuit **129–10** has at its input **4**, **5** and **6** the signals Not **32C**, Not First Pre-run Cycle, and Read or Record, respectively. Each of these signals is at a +S level in the present circumstances whereby at output pin **3**, this +A circuit produces a —S level signal. This is applied to input pin S of —Or circuit **129–12** producing at its output pin Y, a +S level signal. This is applied to one leg of both the On and the Off And gates of the Intermediate Trigger **129–14** at respective pins R and T and since the other legs of both On and Off gates are connected to respective Off and On outputs, V and W of the trigger, the trigger changes state on the occurrence of each oscillator sample pulse as long as the Intermediate gate signal produced at the output pin V is present. The Intermediate Trigger output pin W is connected to pin P of the Sample Pulse Driver **129–16** and at the input pin M of this Sample Pulse Driver, is applied the signal Not Holdover. This is also at a +S level since the holdover latch shown at **134–30** in FIG. 134 was reset at clock time AD and Read Delay since these signals are applied to respective inputs FG and H of +And circuit **134–32**, producing at its output pin **C1**, a —S level which is applied to pin A of +And circuit **134–34** of the Holdover Latch. This is effective to reset the latch producing a +S level at the Not Holdover line.

Referring then again to FIG. 129, it is observed that with the Intermediate Gate line at a +S level, the Intermediate Trigger is stepped at each oscillator sample pulse producing a step **1C** pulse at the output pin B of the Sample Pulse Driver **129–16**. Referring to FIG. 130 of the drawings, it is noted that the **1C** trigger **130–10** has one of its And On gates and one of its And Off gates connected to ground, thus applying a +S level signal thereto and that the other lines of both the On and Off And gates are connected to Not **1C** and **1C** lines, respectively, whereby the Trigger is effective to change its state upon the reception of each step **1C** pulse applied to pin SF. Since the respective C counter Triggers, **1C**, **2C**, **4C**, etc., are connected to count in a purely binary fashion, the stepping of the Intermediate trigger is effective to step the **1C** trigger, the **1C** Trigger steps the **2C** Trigger, the **2C** Trigger steps the **4C** Trigger, etc., until the **32C** Trigger is again turned on. It is noted that the initial condition of the C Counter in these circumstances was a count of 10. The C Counter will therefore advance from this count to a count of 32. Since the Intermediate Trigger is stepped at each oscillator sample pulse, and the oscillator sample pulses occur at each **10** microseconds, and since the Sample Pulse Driver **129–16** produces a step **1C** signal for every two changes at state of the Intermediate Trigger, the C Counter is stepped every 20 microseconds. Thus, to advance from a count of 10 to a count of 32 requires 22 times 20, or 440 microseconds. This is the time of the Character Gate.

At this point in time, i.e., the end of the Character Gate, therefore, to accommodate the incoming information from the stripe of the magnetic ledger card, it is necessary to begin the electronic operation of the machine for writing the information bits into the proper memory location. Accordingly, reference is now made to FIG. 93 of the drawings and the **32C** Start Latch **93–14**. The **32C** Start Latch is now in an "on" state since the Start Trigger has been "on" and is now in an "off" state whereby the Not Start signal at Input **93–28** to —Or circuit **93–16** is at a +S level. The **32C** trigger has been "off" and is now in an "on" state. In the "off" state of the **32C** Trigger, the output of +And circuit **93–12** is at a +S level whereby both inputs to —Or circuit **93–16** are at a +S level producing a —S level at its output which is applied to the input pin **8** of the +And circuit **93–12**. Accordingly, the turn on of the **32C** Trigger does not affect the latch and the +S level is maintained at output pin **6** of +And circuit **93–12**. Thus, all of the inputs **4**, **5** and **6** of +AA circuit **92–18** are at a +S level and as explained hereinabove, all of the inputs to +AA circuit **93–22** will also be at a +S level whereby a —S level is produced at the outputs Y and **3** of the two +AA circuits turning "on" the Start Trigger Gate Latch **93–26** and also bringing the turn "on" gate of the Start Trigger **93–22** to a +S level whereby the Start Trigger is turned on at the next Oscillator Sample Pulse. The electronic clock in these circumstances will be started and the transfer of information read from the card into memory will commence and take place in a manner described hereinbelow.

Referring now to FIG. 9 of the drawings, it is noted that before the electronic clock is turned "on," the electronic circuitry was stopped at the end of the **34**th bit in **6**ACDY Write and 02 time and thus, as soon as the electronic clock is started by the Start Trigger, as has been explained, the clock will progress into AX and Read time of the first bit.

Referring now to FIG. 132 of the drawings, it is noted that at A, X, and Read time, all of the inputs Z, **1**, and **2** to +And circuit **132–20** are at a +S level whereby its output is at a —S level and is applied to the input pin R of +And circuit **132–18**. Accord-

ingly, the output of this latter +And circuit is at a +S level and it is therefore clear that this circuitry has the effect of degating the circuits which generate the first bit. This prevents the shift in the C counter or any extraneous information from disturbing the 32C Trigger.

While the details of the memory circuit construction and the manner in which the B counter addresses memory are set forth in the above mentioned copending application A, the manner in which the word drivers and switches are conditioned during a read ledger operation will be briefly set forth herein. Thus, referring to FIG. 100 of the drawings for an explanation in which the line Fixed Factor Driver Select, **100–10**, is conditioned, it is noted that at X and Read time the inputs to pins B and D of +And circuit **100–12** are at a −R level producing a +S level at output pin G which is applied to input pin H of +AA circuit **100–14**. Also, since the machine is not in the First Cycle Type operation, the input to pin F of this AA circuit will be at a +S level and still further since the machine is not in a Divide operation the input to pin D of +And circuit **100–16** will be at a −S level producing a +S level at its output pin B which is applied to input pin G of +AA circuit **100–14**. It is also noted that the machine is not in a Subtract operation and therefore the input to pin **7** of +And circuit **100–18** is at a −S level, producing a +S level output at its pin **6** which is applied to the input X of +AA **100–20**. Since the machine is not in a Multiply operation the input pin **2** of +And circuit **100–22** has a −S level signal applied thereto producing a +S level signal at its output pin Y which in turn is applied to input pin Y of +AA **100–20**. Thus, the output pin T of +AA **100–20** is at a −S level and therefore both this circuit and +AA **100–14** apply a −S level to the input X of −Or circuit **100–24**, whereby it produces a +S level signal at its output pin V. This +S level signal is applied to input E–G of Power Inperter **100–26** which produces a −R level output at its pin A to condition the line **100–10** for memory word addressing.

For an understanding of the manner in which X time switch select line **100–28** is conditioned, it is observed that the inputs **6**, **7**, and **8** to +And circuit **100–30** are all at a +S level since the machine is in a Read Ledger operation, is not in a Check Read operation and the Position Latch is in its "off" state. Accordingly, output pin **5** of this +And circuit is at a −S level and is applied to input pin R of −Or circuit **100–32** to produce a +S level signal at its output pin Q. Accordingly, if at X time I/O Trigger **1** is in its "on" state representing a 1 bit of information, the +And circuit **100–34** has its inputs **6**, **7**, and **8** +S level producing a −S level at its output pin **5**. This is applied to input pin **5** of −Or **100–36**, producing a +S level signal at its output pin **3** which in turn is applied to input C–B of Power Inverter **100–38**. This Power Inverter applies a −R signal to line **100–28** whereby the X time switch select circuitry is conditioned. As described hereinbelow, the information bits read from the card and applied to I/O triggers **4**, **5**, and **6** is shifted to triggers **1**, **2**, and **3** and from these triggers are shifted serially into memory from I/O **1**. Thus, the condition of I/O **1** represents the presence or absence of an information bit to be written in memory.

The manner in which word driver **1** is conditioned is shown in FIG. 104 of the drawings. It is noted that in the present B counter conditions for addressing word **1**, i.e., 2B, Not 3B and Not 4B, the −And circuit **104–10** produces a −R level signal at its output E to the input pin N of −AO circuit **104–12** and that with the Fixed Factor Driver Select line conditioned, a −R level signal is applied to input pin Q of this circuit whereby its output at pin K is at a −S level. This signal is applied to input pin F of Inverter **104–14** producing a −S level signal at its output pin H, which is applied to the Core Driver **104–16**, Thus, at the time that the other input pin E of this Core Driver circuit is at a −S level as applied on line **104–18** from the 02 Single Shot Delay circuit, the word driver **1** line **104–20** is conditioned and a core current is passed through this line.

As explained in the above mentioned co-pending application A, for completing the word **1** driver circuit, read switch **3** must be conditioned and reference is made to FIG. 106 of the drawings for an explanation of the manner in which this is accomplished. It is noted that the input pins M, P, and R to +AO circuit **106–10** are Not **1**B, Not **5**B, and MLC operation and Not **6**B. Since this is the present condition, the output pin D of this circuit has a −R level signal produced thereat which is applied to input pin B of −AO circuit **106–12**. Since the other input pin D of this −AO circuit **106–12** has X Time Switch Select signal applied thereto which is presently at a −R level, the output pin G of the circuit is at a +S level to condition the line at input N of switch circuit +SW**1**, **106–14**. Since the other input of this switch is derived from the line labeled Read Switch Common which is also at a +S level under these circumstances, the Switch **1** circuit gate is open to condition Read Switch **3** line **106–16** to address Word **1** of memory. Further details of memory word and bit addressing may be found in the abovementioned copending application A.

The manner in which the information bits and check bit from the stripe of the magnetic ledger card are placed into the Input/Output Register Triggers I/O**4**, I/O**5**, I/O**6**, and I/OC, has been described and the manner in which drivers and switches are conditioned for writing bits of described. For an explanation of the manner in which the information bits in Triggers I/O**4**, **5**, and **6**, are shifted into Triggers I/O**1**, **2**, and **3** into I/O**1**, reference is made to FIG. 139 of the drawings, and to FIG. 9 of the drawings showing the timing shart of the Electronic Clock of the machine. For shifting the I/O triggers, a Slow Shift gate line **139–12** and a Fast Shift Gate line **139–14** are provided. As shown in FIG. 137 of the drawings, the slow shift gate line is reproduced at **137–10** and provides 1 input to each of the "on" and "off" And gates of each of the I/O Triggers **1** and **2** and the line Fast Shift Gate is reproduced at **137–12** and is applied through an Emitter Follower circuit **137–14** to be applied to an "on" And and "off" And Gate of Trigger I/O**3**. As shown in FIG. 138 of the drawings, the Fast Shift Gate line, reproduced at **138–16**, is applied to both an "on" and an "off" And gate to each of the I/O Triggers **4**, **5**, and **6**.

For an understanding of the manner in which the Slow Shift Gate and Fast Shift Gate lines are activated, in FIG. 139 of the drawings, it is noted that the +AA circuit **139–16** has the signal Entry applied to its input pin F which under the present circumstances is at a −S level since the machine is in a Read rather than Entry mode and thus, a +S level is produced at output pin C–L of this circuit. This is applied to input pin M of +AO circuit **139–18**. The inputs to the other input pins R and P of the +AO circuit **139–18** are Not Read Delay and 02 and thus, at the time of the electronic cycle when these conditions exist, the output pin D of this circuit is at a −R level. The inputs at pins A, K, and B of +AO circuit **139–20** are A, Read Delay, and Read Ledger, respectivxely. Thus, when these conditions exist in the electronic cycle, a −R level is produced at output pin E of this circuit.

Since the machine is not in Entry mode, the input to pin H of −Or circuit **139–22** is at a −S level, producing a +S level at its output pin P–L which is applied to input pin G and +And circuit **139–24**. Thus, at X and Read time, the respective pins H and F of this latter +And circuit are also at a −S level whereby a −R level output is produced at its Output pin C–L. This is applied

to input pin Q of —And circuit **139–26** and the other input pin P of this —And circuit receives the outputs of the +AO circuits **139–18** and **139–20**. Accordingly the Slow Shift Gate at the output of —And circuit **139–26** is conditioned or at +S level at either A, X, Read and Read Delay time or at XR Not Read Delay and 02 time. The Slow Shift Gate line **139–12** is therefore conditioned at these times.

For producing the signal for the Fast Shift Gate line **139–14**, it is noted that the +And circuit **139–28** has at its unputs Z, **1** and **2**, the respective signals A, X, and Read, and thus, as these conditions exist, its output pin Y has a —S signal produced therat. This is applied to the input pin T of —Or circuit **139–30**, the other input at pin X of which is Read Ledger. At A, X, and Read time, therefore, the output pin T of the —Or circuit **139–30** produces a +S level signal to the input pin A of Converter circuit **139–32**, the output of which is at a —R level and is applied to input pin N of —And circuit **139–34**. The other input pins Q and P of the —And circuit **139–34** receive signals from the output pins C–L of +And circuit **139–24** and the outputs of +AO circuits **139–18** and **139–20**. From the foregoing, it is seen that during A, X, and Read time, of a digit time both the Slow Shift Gate and Fast Shift Gate lines are conditioned. During the B time following A time, however, the Fast Shift Gate is not conditioned but the Slow Shift Gate will be conditioned for the period of one oscillator sample pulse at the coincidence of Not Read Delay and 02 times. As seen in FIGS. 137 and 138, this selective conditioning of the Slow and Fast Shift Gates is effective during A, X, and Read time to shift the contents of I/O Triggers **4**, **5**, and **6** into Triggers **1**, **2**, and **3**. During A, X, and Write time, however, the contents of Trigger I/O1 is written into memory as hereinabove described and thereafter, during Not Read Delay 02 X and Read time of the next B time, the contents of I/O Trigger **2** is shifted into I/O Trigger **1** and the contents of I/O Trigger **3** is shifted into I/O Trigger **2**. The contents of I/O Trigger **1** is again written into memory and thereafter, at Not Read Delay 02, X, and Read time of C time, the contents of I/O Trigger **2** is shifted to I/O Trigger **1** and this is written into memory, finally serializing all three bits read from the stripe into memory.

During the shifting operation just described, the conditions of I/O Trigger **4** and Trigger I/OC are utilized for parity checking purposes. In FIG. 139, it is observed that after the Position Latch is reset at the end of the second prerun cycle the condition Not Position Latch is at a —S level and therefore, the input pin **4** of —Or circuit **139–36** is at a —S level producing at +S level at its output pin **3**. By a "collector pullover" action, the trigger I/OC is reset to its "off" state. It should be noted that this action occurs prior to the reading of the first column of bits recorded on the magnetic ledger stripe, since the Position Latch is reset after the Second Prerun Cycle. During the reading of a column of bits of information, the Trigger I/OC is either set or not set acccording to the presence or absence of a check bit on the card in the column. At +AO circuit **139–38**, it is noted that at its input pins P, M, and R are effectively applied the respective signals A, X, and Read, Read ledger, and Not I/O4. Therefore, if the Trigger I/O4 is in an "off" state during A, X, and Read time, all of the inputs will be at a +S level since a Read Ledger operation is being performed. The output of this +AO circuit is at a —R level, and is applied to input pin K of —And circuit **139–40**. The other input pins A and B of this —And circuit are conditioned by the outputs of +And circuit **139–24** and the joint outputs of +AO circuits **139–18** and **139–20**. Therefore, during the Fast Shift operation as each bit is shifted out of Trigger I/O4, the "off" state of this trigger is effective to produce at the output pin E of this —And circuit a +S level signal which is applied to one of the on gates and one of the off gates of the Trigger I/OC. The other on gate of this trigger is conditioned by the output Not I/OC and the other "off" gate of the trigger is conditioned by I/OC. Thus, this trigger with its on and off gates B and P, respectively, conditioned, acts as a binary trigger, and changes state in response to the occurrence of an Oscillator Sample Pulse. It is seen therefore that if the check trigger is initially in its on state, representing the occurrence of a parity check bit in a column which in turn requires the presence of one or 3 zero information bits, during the shift operation the Check Trigger will change an odd number of times, either 1 or 3. As a consequence, for proper parity, it should be "off" at the end of the shift operation. Similarly, if the check trigger is initially "off," representing the condition wherein no parity check bit is written or in other words either no zero information bits or two zero information bits occur, the Check Trigger will change state twice or not at all whereby again it is in its "off" state at the end of the shift operation. The output of the Check Trigger is utilized to determine error by the parity checking means.

For an understanding of the manner in which the condition of the I/OC trigger at the end of the shift operation is utilized for determining the existence of a proper parity, reference is made to FIG. 140 of the drawings showing +And circuit **140–10**, the —And circuit **140–12** and a +And circuit **140–14**. The inputs to +And **140–10** at pins F, G, and H are Write 01 and Read Ledger, the inputs to —And circuit **140–12** are X and the output of +And circuit **140–10** and the inputs to +And circuit **140–14** are I/OC, A and the output of —And circuit **140–12**. Thus, at the concurrence of AX Write and 01 time, during a Read Ledger operation the on condition of the Trigger I/OC at this time which indicates an error is effective to produce a —S level signal at the output pin D of +And circuit **140–14**. This is applied to the input pin H of —OO circuit **140–16**, producing a +S level signal at its output pin G which is applied to the input pin **7** of +And circuit **140–18** of the Correct Read/Record Latch **140–20**. The other input **6** of this circuit, **140–18**, receives the signal Not Position Latch and since under these circumstances the Position Latch should be reset producing a +S level at this input. The combination of +S level input signals to this circuit is effective to turn "off" the Correct Read Record Latch. This latch can not be set on again during this Read operation. The output pin **5** of this latch is applied to an input pin **5** of a +AA circuit **140–22** whereby the "off" condition of the latch is effective to produce a +S level signal at the output pin **3** of this +AA circuit. Since this output is applied to the input pin L of an Inverter circuit **140–24**, the +S level signal applied to this Inverter results in a —S level produced at its output pin K which is applied to a thyratron circuit **140–26**. The —S level signal fails to cause the thyratron to fire whereby at its output pin F no signal appears and the relay **706** shown at **63–18** in FIG. 63 of the drawings is not picked, indicating an incorrect read or record operation.

Referring to FIG. 94 of the drawings and to the clock timing diagram in FIG. 9, it will be recalled that at the time that the clock stopped and was waiting for the first bit from the Magnetic Ledger stripe, the Clock condition was CDY write and 01 which went to 02 as the machine stopped. At the conclusion of the first ABC time of the Electronic Clock cycle, the first three bits from the stripe were transferred to memory and the Electronic Clock at the end of C time will be in the condition C Not DY Write and 01. For an understanding of the manner in which the electronic operations are turned "off" at this time, it is observed in FIG. 94 that at this time the 3 inputs to +And circuit **94–14** are at a +S level. Since the Position Latch is "off" and a —S level is applied to input

W of —Or circuit **94–12**, its output is at a +S level producing one of the inputs to +And circuit **94–14**. Also, the machine is in a Read condition and the clock is at C time producing +S levels at inputs S and T of the +And circuit **94–14**. The output at R of this +And circuit is therefore at a —S level which is applied to the input pin W of —Or circuit **94–28** producing a +S level at its output and therefore, at one of the inputs of +AA circuit **94–30**. Also, the 3 inputs D, E, and F of +And circuit **94–32** are at +S levels since it is Y time of the Electronic Clock, Type Stop and Multiply or Divide stop are at +S levels when these conditions do not exist. Accordingly, the output of this +And circuit is at a —S level and is applied to one input of —Or circuit **94–34**. Thus, the output of this —Or circuit which is applied to input S +AA circuit **94–30** is at a +S level. Since the machine is not in a Complement condition, the input T to +AA **94–30** is also in a +S state rendering all inputs of this circuit at a +S level whereby at output R of this circuit a —S level signal is produced. The 3 inputs at pins F, G, and H of +AA circuit **94–36** are also at a +S level at the clock time Not D 01 and Write. Accordingly, at this time a —S level is produced at output pins C and since both of the +AA circuits **94–30** and **94–36** have —S levels at their outputs, a —S level signal is applied to input pin **4** of —OO **94–24** producing a +S level at its output pin **3** which conditions the Turn Off Start Trigger line **94–26**.

It is apparent from a review of FIG. 94 and the clock timing diagram in FIG. 9 of the drawings that the successive columns of information bits read from the Magnetic Ledger Stripe of the Ledger Card are recorded into memory during alternate A, B, C times and that the pair of +AA circuits **94–18** and **94–20** and the pair of +AA circuits **94–30** and **94–36** alternate in turning "off" the Electronic Clock.

As pointed out hereinabove, during every A, X, and Read time during the Read Ledger operation, the C Counter will be set to a count of 10 in the preparation for timing the Character Gate and as observed in FIG. 132 of the drawings, as soon as A, X, the Read Time is past, the gate is opened for +And circuit **132–18** to transmit another first bit read from the card to turn "off" **32C** and start another Character Gate. It is to be noted that the running of the Electronic Clock can overlap the timing of the Character Gate. Although in the absence of skew or in other words gross misalignment of the magnetic Read Record Head with respect to the columns of bits on the card, the recording of bits into memory will have been completed and the clock will have stopped prior to the beginning of the next Character Gate. To turn "off" the 32C Trigger, the Character Gate will have been timed and completed and the clock will be turned back on for the storage of information which was read during the Character gate. This alternate Character Gate and Electronic Clock operation will continue as long as information comes from the card until such time as the end of memory is reached.

The end of Magnetic Ledger Card portion of memory or in other words the beginning of word **33** is represented by the B Counter condition shown as forming the inputs to the +AA circuit **93–20** in FIG. 93 of the drawings. At the respective inputs F, G, and H are **2B**, **3B** Not **4B**, **5B** and **6B**. The B Counter conditions at this time produce +S levels on all 3 inputs whereby a —S level is produced at output pin C. At +AA circuit **93–34**, the inputs P, Q, and R have applied there Not **1B**, Not Digit Y and Write and **6A**. These lines are also at +S levels at word **33** whereby the output pin D of this +AA circuit is at a —S level. Accordingly, at input pin Z of +AA circuit **93–22** is a —S level signal producing a +S level signal at its output. It is also noted that a line **93–36** emanating from the output of +AA circuit **93–20** is designated End LA Memory. Since this line is at a —S level at the End of LA Memory and it is applied to input pin Z of +AA **93–22**, the output at pin Y of +AA **93–22** is at a +S level. Therefore all inputs to pins Q, P, and R of —Or circuit **93–24** of the Start Trigger Gate Latch are at a +S level. This is clear because contact **64–4** N/C of the Electronic Start Relay are open to produce a —S level at output pin N of Integrator **93–50** resulting in a +S level at output pin D of +A **93–44** which is applied to pin P of —Or **93–24**. Also, since latch **93–16** was reset at the start of the electronic operations and was not since set on, the output at pin D of the latch which is applied to input pin S is at a —S level. Accordingly a +S level signal is produced at output pin CL of the latch and all input pins Q, P, and R are at +S levels and the latch remains reset. Therefore, the Start Trigger does not turn on.

In a Read operation as herein-above described, provision is made for checking the correlation between the machine memory and the contents of the Magnetic Ledger Card stripe. That is, a check is made to determine if the end of the legitimately recorded bits on the stripe correspond to the end of the Ledger Alpha memory. For an understanding of the manner in which this is accomplished, reference is made to FIG. 140 of the drawings. In this figure, the Correct Read Record latch, **140–20**, is shown, and as described hereinabove, the "on" condition of the trigger I/OC at the end of any serialization of bits from the I/O register into memory will cause the Correct Read Record latch to be turned off. Provision is also made for turning "off" the Correct Read Record latch just after the reading of the first presented column of check characters. That is, the first column of four bits following the normal information on the stripe of the magnetic ledger card. To this end, the line End Ledger Alpha memory is applied to input pin F of Invertor **140–28**, and the output of this Invertor is applied to input pin P of +AA circuit **140–30** and to one input of +And circuit **140–27**. Assuming that a correct read operation has been performed, at the end of Word **32** of Ledger Alpha Memory, all inputs to the +AA circuits **140–22**, **140–30** and **140–32** are at +S levels. This is clear since the correct Read/Record latch **140–20** is still set "on," the signal End La Memory at input pin P of +AA **140–30** is at a +S level and all I/O Triggers read 1 bits in the first column following the legitimate information on the stripe. Accordingly, each of these circuits produces a —S level output which is inverted by Inverter **140–24** to fire Thyratron **140–26** to pick the correct Read/Record relay **706**. Immediately following this first check character, the Correct Read/Record Latch is turned "off" for the remainder of the Read operation as described immediately following.

The other two inputs to +And circuit **140–27** are Not **8C** applied to input pin V and **32C** applied to input pin W. Thus, it is seen that as the Character Gate for the first column of check bits is being timed, and as the end of this period is reached and the **32C** Trigger is turned "on" and all other C Counter triggers are turned "off," the End Ledger Alpha Memory line being at a —S level, all of the inputs to the +And circuit **140–27** are at a +S level producing a —S level at its output pin S. This signal is applied to the input pin S of —OO circuit **140–29** of the Correct Read Record Latch and produces at its output Q, a +S level signal which is applied to input pin **7** of + circuit **140–18** of this latch. Accordingly, both inputs **6** and **7** of +And circuit **140–18** are at a +S level producing a —S level at its output pin **5**. This is applied to pin R of —OO, **140–29**, to maintain the "off" condition of this latch. As pointed hereinabove, the "off" condition of the Correct Read Record Latch is effective to prevent the firing of thyratron **140–26** and thus, to consequently prevent the picking of the Correct Read Record relay **706**. In review, therefore, it is observed that if an improper parity check in any one of the columns of the legitimately recorded information on the stripe of the magnetic ledger

card occurs, the Correct Read Record Latch will be turned "off," and at the end of the first check character, the Read Record Latch will also be turned off." Thus, if the end of the legitimately recorded information on the stripe of the card is reached before the end of memory, the I/OC trigger causes the Correct Read Record Latch to be turned off whereby the Correct Read Record relay **706** is not picked, or if the End of Ledger Alpha Memory is reached before the magnetic head reaches the end of the legitimately recorded information, the condition of the End Ledger Alpha Memory line and the C Counter triggers are effective to turn "off" the Correct Read Record Latch whereby the Correct Read Record relay **706** is again not picked. In the latter case, it is observed that the picking of this coil is conditioned upon the simultaneous occurrence of the "on" states of I/O triggers **4**, **5**, **6** and C. Once the correct Read Record Latch is turned "off," a subsequent check character cannot turn it "on," and the incorrect indication persists. Thus, it is seen that if the first character after the End of Ledger Alpha Memory is the first check character, a correct operation will be signaled, and if it is any other than the first check character, an error will be indicated and the appropriate action will be taken in the MCL paper handling mechanism. Coil **706** would not be picked.

Brief review of read ledger operation

The read ledger operation includes the following steps:

(1) The B Counter is reset and an impulse to the Read Ledger hub steps the B Counter to Count **1**.

(2) Closure of the On Track switch results in setting the Position Latch and the clock circuits will run for an abbreviated idle cycle. This cycle is produced by stepping the **1A–6A** counter at the beginning of each X time rather than at the beginning of each sixth X time. The reason for this is to insure that a reading operation starts about 5 milliseconds ahead of a recording operation in order that the first recorded bits of information are not lost.

(3) The first bit of information recognized controls the C counter in such a manner that it will time out a particular predetermined Character Gate interval. At the end of this time all bits of the first set of bits should have been received in the Input/Output Register.

(4) When the C Counter times out, the clock is again started, the three bits of information just received are shifted by the first three oscillator pulses so that they now are positioned in the first three trigger locations of the input/output register. As the data is shifted, a check is made for odd redundancy.

(5) As soon as a shifting of the set of three bits is completed, the character gate is again set up under control of the C Counter in order that the next set of three information bits and the associated redundancy bit may be received in the Shift Register. Also the first three positions of the Shift Register are shifted during three bit time intervals by the clock into memory, at which time the clock stops.

(6) The Stop Symbols at the end of the magnetic stripe are recognized as the head nears the end of its scan, the electronics is reset, and the Magnetic Ledger unit supplies an impulse which results in the initiation of a following program step.

RECORD LEDGER

In Table No. 1, it is noted that the second program step involved a magnetic ledger card Record operation, and that also selector **1** is reset. The selector is reset as soon as the operation exit is impulsed.

For the details of the manner in which the electronic circuitry performs the Record operation, reference is first made to FIG. 93 of the drawings which shows the start circuitry for the electronic clock. In this figure, the Integrator, **93–40**, has the hub "RECORD" connected to its input pin E and in the present circumstances, this hub will apply a **48** volt potential to the Integrator input, whereby its output produces a +S level signal at Pin Q. This is applied to input pin Q of +And circuit **93–42** and since the **32C** Trigger of the C Counter is "off," the line to input pin R of +And circuit **93–42** will also be at a +S level. Accordingly, at output pin K of this circuit, a −S level signal appears and is applied to input pin Q of +And circuit **93–44**, producing at its output pin D a +S level signal. In turn, this is applied to input pin P of −Or circuit **93–24** of the Start Trigger Gate Latch. Input pin Q of this latch is also at a +S level since input pin **4** of +AA circuit **93–18** is also at a −S level, producing a +S level at its output pin **3** which is applied to this pin Q of the Start Trigger Gate Latch. Since the latch is reset before electronics operations begin, the input pin R of −Or circuit **93–24** is also at a +S level, and thus, at output pin D of this latch, a −S level signal appears. Since it forms one of the input lines to the "on" And gate of the Start Trigger, the trigger fails to turn on.

When the electronic start relay **64** is actuated, its normally open contacts **64–4** are closed whereby as seen in FIGS. 50 and 93 of the drawings, a 48 volt potential is applied to the input pin F of integrator **93–46**, producing a +S level signal at its output pin P which is applied to input pin S of +And circuit **93–38**. Since End Ledger Alpha Memory is at a +S level under these circumstances, the input pin T of this +And circuit is at a +S level. Also, since the Q trigger, used in arithmetic operations, is reset, the input pin U of +And circuit **93–48** is at a −S level producing a +S level at its output which is applied as the other input of +And circuit **93–38**. Thus, the output at pin R and this +And circuit is at a −S level. It is noted that this does not alter the circumstances in regard to starting the electronics operations and the Electronic Clock is not started. The purpose of inhibiting the starting of the Electronic Clock as herein described will allow time for the magnetic ledger card to be positioned for the Record operation and to allow the magnetic head to be positioned to record. This will occur under control of the Magnetic Ledger Card relay unit, and at such time as the card is in position and the head is at the proper speed, the "On Track" switch **63–12** in FIG. 63 of the drawings is closed and in a manner described with regard to the Read operation, will turn on the Position Latch shown in FIG. 134 of the drawings. The two pre-run electronic cycles as described herein above with regard to the Read operation will occur in a similar manner, however, during the record operation, the second pre-run cycle will not be abbreviated but rather will be a full electronic cycle. As shown in FIG. 98 of the drawings, during the Read operation by virtue of the fact that all three inputs, namely Position Latch, **1B**, and Read Ledger to the +And circuit **93–10** were all at a +S level, the sample pulse driver **98–14** produced a stepping pulse at every X time. In the present circumstances, however, the input to +And circuit **98–14** does not include Record and thus, this +And circuit is not conditioned and the **1A–6A** ring is stepped in the normal manner to time a full electronic cycle. It is clear therefore that during the Record operation, the actual recording of bits will occur later than during the Read operation since the second Pre-Run Cycle is a full cycle during Record and an abbreviated cycle during Read.

The stopping of the electronic operations which takes place as the Position Latch is turned "off" is also different in the Record operation from that in Read. Referring to FIG. 94 of the drawings, it is noted that the +And circuit **94–10** has a −S level signal applied to its input pin P since the machine is not in a Read Ledger operation, thus, producing a +S level signal at its output which is applied to input pin U of −Or circuit **94–12**. The output of this −Or circuit will become a +S level as the Position Latch is turned "off" which occurs immediately subsequent to **6ACDY** Write 02 time. At this time, however, the other circuitry which is cooperative to produce the Stop Gate for the Electronic Clock, namely +And circuit

94–32, +AA circuit 94–36, +AA circuit 94–20 and +AA circuit 94–18, are deconditioned. Accordingly, the Stop Gate is not produced and the clock continues to run for three more digit times whereby at C Not DY Write 01 time, the Start Trigger is turned "off." This occurs since the inputs to +And circuit 94–32 are at a +S levels and therefore, the inputs to +AA circuit 94–30 and +AA circuit 94–36 are also at a +S level producing a −S level at its output which is applied to input pin 4 of −OO circuit 94–24 producing a +S level at its output. This is effective to produce the Turn Off Start Trigger Gate at line 94–26. Also, Stop Gate is produced by −Or circuit 94–34 since the −S level signal applied to its input pin G produces a +S level signal at its output pin E to produce Stop Gate on line 94–36.

This continued operation of the clock for three digit times is effective to read out three bits of information from memory into I/O triggers 4, 5 and 6 and to produce a parity check bit in I/O trigger C in preparation for recording this information on the stripe of the magnetic ledger card. For an understanding of the manner in which this is accomplished, reference is made to FIG. 138 of the drawings wherein it is observed that +And circuit 138–18 has at its input pin G the signal Not Record applied thereto. Under the present circumstances, this signal would be at a −S level producing a +S level signal at its output C–L which is applied to input pin 8 of −Or circuit 138–20. The other inputs to pins 6 and 7 of this −Or circuit are Storage Trigger and Not Read Ledger. Since a Record operation is being described, Not Read Ledger is at a +S level. It is therefore clear that the output of −Or circuit 138–20 at pin 5 reflects the inverse condition of the Storage Trigger throughout the Record operation. The output of −Or circuit 138–20 is applied directly to one internal turn off gate, labeled T, of I/O Trigger 6 and is further applied to input pin 5 of Invertor 138–22, the output of which is applied to one turn on gate at pin Q of this Trigger. The other turn on and turn off gates at pins R and U are connected to the Fast Shift Gate hereinabove described.

Referring now to FIG. 139 of the drawings, it is observed with regard to +AO circuits 139–18 and 139–20 that since the line Read Ledger is at a −S level, the line shift gate inputs are activated only in response to the inputs Not Read Delay and 02 applied to +AO circuit 139–18. Thus it is clear that since +And circuit 139–24 is conditioned at X and Read time and that the output thereof conditions −And circuits 139–26 and 139–24, shift gate signals are produced at the end of every X and Read time. Therefore, the I/O register will shift at the end of AX Read, BX Read and CX Read and it follows that at the end of AX Read time, the first bit will be read out of Memory, at the end of BX Read time, the second bit will be read out of Memory, at the end of CX Read time, the third bit will be read out of Memory. Therefore, the first three bits of Memory will appear in I/O triggers 4, 5 and 6 and Check Trigger C will also be appropriately conditioned.

For an understanding of the manner in which the Check Trigger is conditioned, it is noted in FIG. 139 of the drawings that +AO circuit 139–42 has at is respective inputs G and H the signals, Record and Not Storage Trigger. Since the +AO circuit 139–38 is an S to R block, the input to pin K of −And circuit 139–40 is conditioned on the concurrence of the signals Record and Not Storage Trigger. The other two inputs to pins A and B of −And circuit 139–40 are conditioned by the outputs of +AO circuits 139–18 and 139–20 and by +And circuit 139–24, respectively. Thus, the I/O Check Trigger will change its state for every zero bit which is transferred from the Storage Trigger into I/O Trigger 6.

It is observed that the Check Trigger is reset in the Record Operation at every AX Read and Read Delap time. To accomplish this, the signal Not AX Read appearing at output pin Y of +And circuit 139–28 is inverted by Inverter 139–44 and applied to input pin 8 of +And circuit 139–46. Other inputs 6 and 7 of this +And circuit have the signals Record and Read Delay applied thereto and in the present circumstances, at AX Read and Read Delay time, the output at pin 5 of this +And circuit is at a −S level which is inverted by −Or circuit 139–36 to a +S level. By a collector pullover action, the I/OC trigger is reset. At every beginning of read out from Memory, the Check Trigger will be reset in the manner described. By the circuitry described hereinabove including +AO circuit 139–42, the I/OC trigger will change state in response to each zero bit read from Memory and transferred from the Storage Trigger to I/O6. Thus, it is clear that an odd number of zeros from the Storage Trigger which implies an even number of ones, will cause the I/O Check Trigger to be left in the "on" state at the completion of the read out from Memory.

During a Record operation as observed in FIG. 131, and as described hereinabove with respect to the Read operation, the C Counter triggers 8C and 2C are reset at every AX and Read Time during a Read or Record operation.

Referring now to FIG. 132 of the drawings, it is observed that the 32C Trigger is reset at the time that the Electronic Clock stops by virtue of the fact that +And circuit 132–26 has applied at the inputs thereto, the signal Record and Stop Gate. At the occurrence of Stop Gate, both inputs ase at a +S level, producing a −S level at the output thereof which causes −Or circuit 132–22 to produce a +S level signal at its output which, in turn, is inverted to a −S level signal by Inverter 132–24 and applied to the DC Reset input terminal P of the 32C Trigger 132–12.

As soon as the 32C Trigger is turned "off," the C Counter will be caused to free run by the circuitry shown in FIG. 129 of the drawings and described hereinabove with regard to the Read Operation. Thus, the C Counter run time for this operation plus the electronic clock run time will measure the character pitch of the columns of information on the magnetic ledger card stripe.

For an understanding of the manner in which the record coils of the magnetic ledger recording head are activated, reference is made to FIG. 136 of the drawings. In this figure, the +And circuit 136–36 has applied to its respective inputs K, A and B, the signals 8C, 16C and Not 32C. The time defined by these signals is just prior to the end of the run time of the C Counter during a normal Character Gate. At this time, the +And circuit 136–36 produces a −S level signal at its output pin E which is applied to input pin H of Power Inverter 136–38, producing a −S level signal at its output C. This is applied in parallel to +And circuits 136–40, 136–42, 136–44 and 136–46. Another input applied in parallel to each of these +And circuits is the signal Record and a third input signal applied to these respective And circuits are the signals I/O4, I/O5, I/O6 and I/OC. Thus, at this time, these respective And circuits are either conditioned or not conditioned according to the "on" or "off" state of the respective I/O triggers and in the circumstance wherein all inputs lines of the +And circuit are conditioned, a −R level output signal is produced whic is effective to cause a Write current to be driven through the Write coil of the magnetic Record head. The outputs of these respective And circuits are designated Write 1, Write 2, Write 3 and Write C. The simultaneous conditioning of all three inputs on any one of the +And circuits, that is, the application of a +S level signal to each input, results in a −R level signal at its output pin. The outputs of these respective circuits are connected to one input of respective head driver circuits 136–48, 136–50, 136–52, and 136–54. A second input to each of these head driver circuits is derived from the line 136–56 and designated Head Ready. The −R condition of any one of

the outputs of these +And circuits causes a current to flow through the designated Record portion of the head coil and the simultaneous conditioning of both the output line from the +And circuit and the Head Ready lines is effective to cause a current to flow through the bias section of the coil. After the C Counter completes its timing for these purposes, the Electronic Clock will be restarted in the manner as described hereinabove for the Read Ledger operation and the alternate counting of the C Counter and electronic operations proceeds to the end of Memory.

After the last valid character corresponding to the last three bits of Memory is recorded, the **32C** Trigger will turn "on" as before but because of the operation of the End of Memory circuits in FIG. 93, the Electronic Clock will not restart. Referring to FIG. 140 of the drawings and recognizing that at this point in time, the condition **32C** and Not **8** prevails and End of Ledger Alpha Memory has been reached, the +And circuit **140–27** has +S level signals applied to its 3 inputs U, V, and W producing a −S level signal at its output S which has the effect of turning off the Correct Read/Record latch **140–20**. The effect of so turning the latch off is to produce a Record Stop Symbol signal at a −S level at the output of +And circuit **140–34** since its two inputs at pins A and H are now at a +S level, the machine being in a Record Mode.

Referring now to FIGS. 138 and 139 of the drawings, it will be noted that the DC set input at pins X of I/O triggers **4**, **5**, and **6** and at pin R of I/O trigger C all have the line Record Stop Symbol connected thereto. Thus, as the line Record Stop Symbol assumes the −S level condition as when the Correct Read/Record latch is turned off after the contents of memory are recorded, these Triggers will all be turned "On."

Referring now to FIG. 129 of the drawings, it is observed that at the End of Ledger Alpha Memory in the Record condition, both of the inputs to +And circuit **129–16** will be at a +S level producing a −S level output at its pin Z which is applied to the pin Z of −Or circuit **129–12** producing a +S level signal at its output pin V. This conditions the Intermediate Trigger which will then be stepped at every Oscillator Sample pulse and in a manner described hereinabove causes the C Counter to free run. Referring again to FIG. 136 of the drawings, it is observed that as C Counter free runs, the input to +And circuit **136–36** will be conditioned at **8C**, **16C** and Not **32C** whereby the +And circuits **136–40** through **136–46** will be conditioned to write a bit on the magnetic ledger card stripe, to write a 1 bit in each track of each column on the card stripe. This writing of illegal characters continues to the end of the recording operation.

Following a Record operation in the magnetic ledger card unit, a Check Read operation is immediately performed wherein the contents of the magnetic ledger card portion of Memory is compared with the information just recorded on the stripe of the magnetic ledger card to assure that the information on the stripe was accurately reproduced from the Memory. During this operation, the information on the card is read and simultaneously the information from MLC portion of Memory is read and checked bit for bit for comparison. A failure of this comparison check produces an error indication whereby the card may be recorded to correct the error.

The Check Read operation occurs automatically without operator attention at the end of the Record operation. At the end of the head sweep of a Record operation, the End Head Sweep contact **62–10** in FIG. 62 of the drawings is transferred by the magnetic Read/Record head as it completes the end of its sweep across the stripe of the ledger card. An energizing circuit for the Check Read relay **724** is thereby completed from the 48 volt line **62–12** through the transferred End Head Sweep contacts, through the normally closed contacts **711–3** through the diode **62–14**, through the transferred contacts **729–8** of the Record relay and to the Check Read relay pick coil **724P** shown in FIG. 61 of the drawings. The hold coil **724H** of this relay is then energized through the impu'se applied to the Record hub **61–12** through the MLC reset contacts **61–14**, through the now transferred contacts **724–1** of the Check Read relay to the hold coil **724H** of this relay. Also, as shown in FIG. 62 of the drawings, the hold coil **721H** of the Head Drive relay is open circuited by the transfer of the End Head Sweep contacts whereby the drive of the head is terminated.

For reasons made clear in copending application D, at the end of the head sweep, the head is mechanically latched, however, under the present circumstances, it is released by the energization of a Release Head relay shown at **60–26** in FIG. 60 of the drawings. The circuit for energizing this relay includes the now transferred contacts **724–3** of the Check Read relay, the transferred contacts **719–1** of the Card Present Upper relay, the Head Home contacts **60–10**, the 144° −6 contacts since the cam line is presently at this angle, the now closed contacts **729–4** of the Record relay, the diode **60–29** and the now closed contacts **721–3** of the Head Drive relay. Thus, the head is released and in a manner explained in application D, is returned to its home position whereupon at its arrival there, it transfers the Head Home contacts **60–10**. This transfer of the Head Home contacts is effective to energize the pick coil of the Head Drive relay **721** through these transferred contacts, and the now transferred contacts **60–28** of the 144° cam. The transfer of the head home contacts **60–10** is also effective to open circuit the hold coil of the Record relay **729** shown in FIG. 61 of the drawings since its energizing circuit through the Head Home contacts, the contacts **60–32** of the 144° cam, the contacts **729–4** of the Record relay, has been opened.

Referring now to FIG. 63 of the drawings and noting that the Head Drive relay contacts **721–1** have been closed and further that the contacts **724–12** of the Check Read relay have been closed and the contacts **729–12** of the Record relay have been returned to their normal condition, it is noted that the lines Check Read **63–20** and the line Read **63–14** are at +48 volt potentials conditioning these lines for producing Read and Check Read signals in the electronic circuitry. The Check Read line **63–20** is applied to the input of Integrator **135–50** in FIG. 135 of the drawings and under the present circumstances, produces a +S level at its output pin N which is applied to the Check Read line **135–52** conditioning the Check Read line in this case. Also, the output of this Integrator is applied to the input pin L of Inverter **135–54** producing, in the present circumstances, a −S level signal at its output pin K which is applied to the line **135–56** and indicated Not Check Read. The manner in which the signal Read is produced for electronic relay circuitry has been described hereinabove and accordingly, will not be repeated here.

It is further noted in FIG. 63 of the drawings that under the present circumstances, the Head Drive relay has been energized and the head is moving along the magnetic stripe of the magnetic ledger card. At a position prior to the reading of information on the card the "On Track" switch, **63–12** is closed producing an "On Track" signal on the line **63–16**, as also described hereinabove. Thus, the machine is conditioned for a Check Read operation wherein the Check Read, Read, and On Track signals are produced.

For purposes of the Check Read operation, the Fixed Factor Driver Select line **100–10** in FIG. 100 of the drawings and the X Time Switch Select line **100–28** are conditioned at every X and Read time. Also, the Word Drivers shown in FIGS. 104 and 105 are conditioned in a manner described hereinabove and also the Read Switches such as **106–14** in FIG. 106 of the drawings are conditioned for reading the contents of Magnetic Ledger Card portion of Memory.

The information so read from MLC portion of Memory is placed into the Storage Trigger shown at **111–10** in FIG. 111 of the drawings. As shown in FIG. 100 of the drawings, for regenerating this information in Memory during

a Check Read operation, the Fixed Factor Driver Select line **100–10** and the X Time Switch Select line **100–28** are selectively conditioned by the "on" state of the Storage Trigger. During a Check Read operation, the input to pin **7** of +And circuit **100–30** is at a −S level producing a +S level at its output and the input pin U of +And circuit **100–40** is also at a −S level producing a +S level at its output pin S. These respective outputs are applied to input pins **5** and **4** of +And circuit **100–42** producing a −S level signal at its output pin **3**. The input pins **1** and **2** of +AA circuit **100–44** are conditioned by the signals Magnetic Ledger Card operation and Storage Trigger. Accordingly, when the Storage Trigger is "on," a −S level signal appears at output pin Z of the circuit. With the Storage Trigger in its "on" state a −S level signal is applied to pin Z of −OO circuit **100–24** and to input pin **4** of −OO circuit **100–36**. These signals are inverted to condition the Power Inverters **100–26** and **100–38** to condition the lines Fixed Factor Driver Select and X Time Switch Select. This is effective to regenerate this information in the Magnetic Ledger Card portion of Memory. Simultaneous with the reading and regenerating of information from the Magnetic Ledger Card portion of Memory, the stripe on the magnetic ledger card is read and in the manner described hereinabove with respect to the Read operation, this information is loaded into I/O Triggers **4**, **5**, and **6** and at every AX and Read time. As also hereinabove described, the contents of these triggers is shifted to I/O Triggers **1**, **2** and **3**. Thus, since the Read Ledger operation takes place as hereinabove described at every X and Read time, at every X, Write and 01 time during which the contents of the Storage Trigger is regenerated in Memory, the condition of the Storage Trigger may be checked against the condition of the I/O Register Trigger **1** as a test of the Record operation.

Referring to FIG. 140 of the drawings, it is noted that to the inputs K, L and P of +And circuit **140–36** are applied the signals Storage Trigger, Not I/O1, and X Write and 01 from the output of −And circuit **140–12**. The +And circuit **140–38** on the other hand has applied to its respective input pins Q, R and P, the signals Not Storage Trigger, I/O1 and X Write 01. Accordingly, the concurrence of the Storage Trigger with I/O1 will produce +S levels at the outputs of both of these +And circuits, **140–36** and **140–38** since either the true condition, Storage Trigger or I/O1, or the inverse of these will be a −S level. These outputs are applied to the two inputs of −Or circuit **140–40**. Accordingly, at the concurrence of the Storage Trigger and I/O1, −Or circuit **140–40** produces a −S level at its output GA. In the present Check Read condition of the machine, the Position Latch is reset after the second Prerun Cycle and thus, the two input lines L and P to +And circuit **140–42** are at a +S level. The output of this circuit therefore reflects the concurrence of the Storage Trigger and I/O1 Trigger since input line K is at a −S level producing a +S level at its output.

It is also noted in FIG. 140 that at AX Write and 01 time, the output of +And circuit **140–14** reflects the condition of Trigger I/OC at this time. In the absence of parity check error, the Trigger I/OC should be "off" whereby a −S level potential is applied to input pin Q of +And circuit **140–14** producing a +S level at its output. This in turn, is applied to input pin H of −OO circuit **140–16**. Thus, both inputs to this circuit are at a +S level producing a −S level output, which as hereinabove described, maintains the Correct Read/Record latch **140–20** in its set condition.

In the manner described hereinabove with respect to the MLC Read operation, the contents of I/O Triggers **1**, **2**, and **3** are successively shifted during Not Read Ledger, 02, A, X and Read time which occur during each digit time and thus, at B time the I/O Trigger **1** is again compared with the Storage Trigger as also hereinabove described. The same comparison is made at C time at which the 3rd bit is compared. Thereafter 3 more bits are read from the card, placed into I/O Triggers **4**, **5**, and **6** and the parity bit is placed into parity check trigger I/OC. The contents is shifted into Triggers I/O1, **2**, and **3** and the same comparison hereinabove described is made.

Assuming that during the reading and checking of the bits as described results in no error, the Correct Read/Record latch is maintained in its set condition. Should an error occur, by reason of the fact that a concurrence does not exist between the Storage Trigger and I/O Trigger No. **1**, the output of one of the +And circuits **140–36** and **140–38** would be at a −S level producing a +S level at the output of −Or circuit **140–40** resulting in a −S level at the output of +And circuit **140–42** and a +S level at the output of −OO **140–16**. This signal would have the effect of resetting the Correct Read/Record Latch whereby at the end of the Check Read operation the −S level produced at output pin **5** of +And circuit **140–18** of the Correct Read/Record Latch would prevent the picking of the Correct Read/Record relay **706** in a manner previously described.

Assuming that a correct Check Read operation was performed, the Correct Read/Record relay **706** is picked at reaching the end of Ledger Alpha Memory. Also, the first 4 bit character read from the card resets the Correct Read/Record Latch to prevent picking of the relay **706** at any subsequent time, as previously described with respect to the Read operations.

BRIEF SUMMARY OF RECORD LEDGER OPERATION

Briefly, the record ledger operation includes the following steps:

(1) Prior to initiation, the B Counter is reset with all positions in the off state. An impulse to the Record hub on the Control Panel results in the B Counter being advanced one count level from its reset condition.

(2) Closure of the On Track switch initiates one complete idle cycle by the clock. At the end of this idle cycle, the B Counter is advanced again and is then properly set up to address word location **1** in MLC Memory. At this time the C Counter is also preset to a count level of 10 in order to establish a predetermined Write delay.

(3) Additional delay is provided by First Prerun Cycle and Second Prerun Cycle indications in order to insure proper scanning speed and as a consequence proper Read/Write spacing.

(4) Three bits of information are shifted into the Input/Output Register from the MLC Memory and are accompanied by the generation of a Check bit.

(5) A predetermined amount of write delay time is established under control of the C Counter.

(6) The first three bits of information from MLC Memory together with the associated check bit are written on the Magnetic Stripe and another three bits are read from memory into the Input/Output register accompanied again by appropriate checking. Write delay under control of the C Counter and writing proceeds as before.

(7) When the last bit of the 32nd word of LA Memory is read, the fact that the end of LA Memory has been reached has been recognized.

(8) A predetermined number of Stop symbols is recorded, comprising a 1 bit in each track of the magnetic stripe.

(9) The contents of the ledger stripe just recorded is read for checking purposes.

PROGRAM STEPPING

Stepping within tens group

For a more complete understanding of the program stepping sequence of the machine **1–10** in the automatic mode of operation, reference is made to FIG. 150 of the drawings showing the timing of relay actuation and deactuation, together with certain figures of the relay drawings. The action of relays and other circuitry are repre-

sented graphically in this figure for both the situation wherein the automatic mode of operation is initiated by depressing the program start or motor bar and the action occurring when the machine is in automatic mode and progressing from one program step to another.

As the first step of beginning a program stepping sequence in the automatic mode of operation of the machine, the motor bar contact **40–10** in FIG. 40 is depressed completing the energizing circuit from keyboard common line **40–12**, to which a direct potential of 48 volts is applied when the machine is in operating condition, to the motor bar relay hold coil **51H**. As this relay **51** is picked, an energizing circuit is completed through the normally closed contacts **57–3** shown in FIG. 43, through the line **43–10**, the line **40–16**, and the now closed contacts **40–51–10**, shown in FIG. 40, through the normally closed contacts **55–3** to the pick coil of auto start relay **450**. It is noted at this point that the relay **450** may be alternatively picked by impulsing any one of the auto start hubs reproduced at **40–14** since these hubs are also connected to the pick coil **450**. As shown in FIG. 52 of the drawings, the closure of contacts **450–4** of the auto start relay is effective to complete the energization circuit of coordinate set up relay **458** through its hold coil. The contacts **458–9** of this relay, shown in FIG. 49 of the drawings, are now closed, whereby a circuit originating from the 48 volt line in FIG. 56 thence through the shield No. 2 contact **67–10** in FIG. 67 and to the line **50–10** in FIG. 50 of the drawings through the line **50–12** to the line **49–10** in FIG. 49 of the drawings, through the keyboard mode contacts **49–12**, the now closed contacts **458–9**, the closed contacts **55–2** to the hold coil **57** and finally through the transferred contacts **51–1** of the motor bar relay. Thus, the program CB1 relay **57** is picked through its hold coil. This is represented in FIG. 150 wherein it is also shown that during the automatic mode of operation, a program step may be begun by firing the Stop Thyratron explained hereinabove.

At this point, it is assumed that one of the program step hubs of the control panel has been impulsed and for simplicity, it is assumed that program step **1** hub is the impulsed hub. As shown in FIG. 44 of the drawings, the effect of such an impulse is to pick the zero exit control relay **213**, closing its contacts **213–6** in FIG. 43 of the drawings to pick the exit control relays **279** and **345**. Thus, it is seen in FIG. 45 of the drawings that the closure of contacts **213–1** and **279–12**, in response to the actuation of these relays, is effective to complete an energization circuit including the now closed contacts **51–5**, the now closed contacts **213–1** and **279–12** to the relays **147** and **213**. As shown in in FIG. 44 of the drawings, the contacts **147–1** through **147–10** are transferred to energize the digit control relay coil **207** since it is only program step entry hub **1** that is impulsed. This is indicated at **150–207** in FIG. 150.

CB1 relay **57** having been actuated, in FIG. 41 of the drawings it is noted that its contacts **57–7** are transferred and an energization circuit is completed from the 48 volt line through the closed contacts **37–2**, the transferred contacts **57–7**, the closed contacts **207–3**, and the normally closed contacts **423–2** to the pick coil **34P** of program CB3. This is represented in FIG. 150 of the drawings at **150–34P**. The transfer of program CB3 relay contacts **34–2** shown in FIG. 41 of the drawings is effective to complete an energizing circuit to program CB4 relay **60** through the now closed contacts **57–2** of program CB1, the series of digit points and the transferred contacts **34–2**. The CB4 relay **60** is actuated as represented at **150–60** in FIG.150. Following the actuation of CB4 relay **60**, its contacts **60–6** are closed to pick program CB5 relay **37**, shown in FIG. 41 of the drawings. In FIG. 150 this is indicated at **150–37**.

As shown in FIG. 51, the transfer of contacts **37–5** of program CB5 is effective to complete the energizing circuit to one of the digit relays, here relay **208**, since digit control relay **207** corresponds to program step entry **1**. As shown in FIG. 47 of the drawings, the transfer of contacts **37–6** of program CB5 relay is effective to complete the energization circuit to the pick coil of a step control relay, here relay **81**, since the contacts **345–12** are now closed. These actions are represented at **150–208** and **150–81**, respectively in FIG. 150.

It is seen in FIGS. 41 and 42 of the drawings that the combination of actuation of program CB5, closing its contacts **37–12**, relay **208**, closing its contacts **208–2**, **208–3**, and **208–4**, and relay **213** closing its contacts **213–7**, **213–8**, and **213–9**, is effective to produce an output potential at the 3 output hubs numbered 1 in this figure of the drawings for Function, IN word and OUT word exit purposes. In FIG. 43 of the drawings, it is noted that the actuation of relay **81** is effective to produce an electrical impulse at program step exit hub 1 since contacts **81–1** are closed, together with contacts **417–5**, **418–5**, **60–2** and transferred contacts **57–3**.

As shown also in FIG. 41 of the drawings the transfer of contacts **208–5** is effective to complete an energization circuit to program CB2 relay **40**, through the now closed program CB1 contacts **57–2**, the transferred contacts **208–5**, and the now closed contacts **34–3** of program CB3 relay. This is represented at **150–40–1** in FIG. 150.

At this point, it is noted that the energization of program CB5 relay was effective to transfer its contacts **37–2** in FIG. 41 whereby the energization circuit for program CB3 relay was broken. At this point in time, program CB relays **2** and **5** are actuated and CB3 relay is de-actuated. Thus, as shown in FIG. 49 of the drawings, in these circumstances, the energizing circuit for program CB1 relay **57** is broken and this relay is accordingly, de-actuated. The dropping of this relay is effective to drop CB2 and CB4 relays as shown in FIG. 41 of the drawings, since the energizing circuit for these relays is broken by CB1 contact **57–2**.

Referring to FIG. 48 of the drawings, it is observed here that as contacts **57–5** of program CB1 relay are opened, the hold coil for digit control relay **207** is opened and accordingly, this relay drops. In FIG. 41 of the drawings, it is noted that the de-actuation of CB4 relay causes its contacts **60–6** to open whereby the energizing circuit for CB5 relay **37** is also opened, and this relay also drops.

From FIGS. 43 and 40, it is observed that as program CB1 relay is de-actuated, its contacts **57–3** apply 48 volts to line **43–10**, which line is reproduced in FIG. 40 at **40–16**, and that under the present circumstances, the contacts **40–51–10** of the motor bar relay are closed and the contacts **55–3** of the program control relay are closed. Therefore, an energizing circuit is completed through these contacts, the closed contacts **37–8** of CB5 relay, through the closed switch contacts **40–18** since this switch is used only for test purposes, and is closed during machine use, to the pick coil of the electronic start relay **64**. Accordingly, electronic operations of the circuit at this point are started as represented at **150–64P–1**. This initiates the electronic clock timing and the time of electronic operations is represented at **150–12–1**.

It is next assumed that the machine is in the automatic mode of operation wherein it advances from one program step to another and that electriconic start relay **64** is energized and that electronic operations have just been completed. The completion of electronic operations under these circumstances is represented at **150–12–2**. Referring to FIG. 149 of the drawings, it is observed that at the completion of electronic operations, the lines forming the inputs to +AA circuits **149–10** and **149–12**, namely, Type Stop, Stop Gate, Multiply or Divide Stop, Not Type, and Not Magnetic Ledger Card Operation will all be at a +S level since any of these operations that may have taken place will have been completed. Thus, a −S level signal is applied to the outputs C and **6** of these circuits which is applied to input pin **6** of −Or circuit **149–14**. Thus, at the output pin 3 of this

—Or circuit is produced a +S level signal applied to the line **149–16** and designated Relay Start Gate. The Relay Start gate line is applied to input pin **5** of +And circuit **149–18** and at pin **6** of this +And circuit is applied the signal (Not Zero Balance and Zero derived from the Zero) Balance selector and Zero Latch, respectively, and at input pin **4** is applied the signal (Not Negative Balance and Negative) derived from the Negative Balance selector and Negative Latch, respectively. These latter two inputs are introduced for purposes of suitable delay required by these circuits. Accordingly, if the proper conditions exist, namely the Relay Start gate is at a +S level and the inputs at pin **6** and pin **4** of +And circuit **149–18** are at a +S level, a —S signal is produced at pin **3** thereof which is inverted to a +S level signal at the output pin D of Inverter **149–20**. This in turn is applied to the input pin Q of the thyratron circuit **149–22**. This signal causes the thyratron to fire as indicated in FIG. 150.

As seen in FIGS. 40 and 150 of the drawings, the firing of this thyratron completes the ground circuit for program CB1 relay **57** through the Program Start Relay contacts **55–4** which are closed under these circumstances, and through the normally closed contacts **40–4** of program CB2 and contacts **37–7** of CB5 relay. Under the present circumstances, the actuation of program CB1 relay causes its contacts **57–3** in FIG. 43 of the drawing to be transferred whereby the energizing circuit for the electronic start relay **64** in FIG. 40 of the drawings is opened and this relay accordingly is de-actuated. The action of the electronic Start relay is represented at **150–64P–2**. In FIG. 43 it is seen that the actuated condition of program CB1 relay and the de-actuated condition of program CB4 relay together with the actuated condition of a digit control relay such as **208** and a step control relay such as **81**, results in a closed circuit from the 48 volt line to one of the program step exit hubs as indicated at **150–1**. It is noted also that at this time the digit control relay, for example, relay **208** as described hereinabove remains energized and further, the step control relay such as **81** also remains energized during the initial period of program step relay sequencing. Thus, one of the sets of contacts such as **208–5** in FIG. 41 of the drawings remains transferred whereby at the closure of contacts **57–2** of program CB1 relay, an energizing circuit is completed through the transferred contacts **208–5**, the normally closed contacts **34–3** of program CB3 relay to pick the program CB2 relay **40**. This action is represented at **150–40–2** in FIG. 150 of the drawings. It is noted that this relay is not actuated during a corresponding period when the relay sequencing occurs responsive to motor bar actuation. At this point, it should be noted that the relay sequence as described hereinabove as initiated by impulsing the program step **1** is the same in the present sequence with the further exception that as relay CB3 is picked, it is effective to open its contacts **34–3** shown in FIG. 41 of the drawings to drop program CB2 relay **40**.

During the relay CB timing sequence, the picking of CB2 relay **40** is effective to pick a relay, **202**, for example, shown in FIG. 47 of the drawings, which represents program steps equal to or less than **80**. The picking of this relay results from the closure of contacts as, for example, **213–5** in this figure.

As shown in FIG. 51 of the drawings, as contacts **40–3** of CB2 relay are closed, an energizing circuit is completed from the **48** volt line through the normally closed contacts **34–8**, **458–8**, etc., the now closed contacts **40–3**, the normally closed contacts **47–2** to the Restore Setup **1** relay **46**. As indicated at **150–46** in FIG. 150 of the drawings, the restore action is terminated by the actuation of a digit control relay which picks relay CB3 since its contacts **34–8** in FIG. 51 opens the energizing circuit for the Restore Set up relay **46**.

Referring now to FIG. 40 of the drawings, it is noted that the Restore Setup **1** and restore setup **2** relays **46** and **47** have contacts **46–3** and **47–1** in series with the normally closed contacts of the digit control relays including contacts **207–4** through **342–4** and the normally open contacts **51–3** of the Motor Bar relay and the restore relay pick coil **50**. Thus, as the Motor Bar relay **51** is picked as would be the condition during automatic mode of operation of the machine, if none of the digit control relays are energized, whereby none of the contacts **207–4** through **342–4** are opened and the Restore Set Up relays **46** and **47** complete their action resulting in relay **46** de-actuated and relay **47** actuated, a circuit to the restore relay **50** is completed and this relay is energized and actuated. It is significant to note that the digit control relays are picked only if a program step entry hub is impulsed. Thus, without the continuation of the program step sequence, the digit control relay points shown in FIG. 40 will all be closed, signifying the end of the program steps.

As shown in FIG. 51 of the drawings, a pair of restore magnets **51–10** and **51–12** are energized by the actuation of restore relay **50**. Hence, the circuit through these magnet coils is completed from the 48 volt line and through the respective contacts **50–2** and **37–11** in one case **50–3** and **37–10** in the other case. The effect of energization of these magnets is to restore the keyboards on the console. In the event, however, that one of the digit control relays is picked and the restore relay remains de-energized, the restore action is prevented. The brief actuation of Restore Set up **1** relay **46** is shown at **150–46**.

It should also be noted that during the actuation of program CB4 relay **60**, its contacts **60–12** in FIG. 65 of the drawings, are transferred to impulse the line **65–12** to provide a potential for electronic circuitry reset purposes. As observed in FIG. 135 of the drawings this line is connected to the input of Integrator **135–30** to apply a +**48** volt potential thereto, resulting in a +S signal at its output. This is applied to the input of emitter follower circuit **135–32** resulting in a +S level potential at its output which is applied to the inputs of power inverters **135–34** and **135–36**. These circuits invert these inputs to —S level output signals which are applied to respective lines **135–38** and **135–40**, each labeled DCR for DC Reset. The output of integrator **135–30** is also applied to the input of emitter follower circuit **135–42** producing a +S level output which is applied to the input of power inverter **135–44** and directly to a line **135–46**. The line **135–48** connected to the output of power inverter **135–44** and line **135–46** are each labeled DCR for reset purposes, however, the signals differ in that the reset line **135–48** applies a —S level signal and line **135–46** applies a +S level signal.

Stepping between tens groups

The basic program step timing from tens group to tens group is shown in FIG. 151 of the drawings. The energization, actuation, de-energization and de-actuation of the various relays involved in this sequence is represented in this figure of the drawings wherein the action is represented by the corresponding relay number preceeded by the figure number, namely, **151**. In the description that follows it is first assumed that the machine is in the automatic mode of operation stepping from program step to program step and that one program step has been completed and the next program step that is to be performed is in a different tens group from that which has just been performed. More specifically to illustrate a concrete example, it is assumed that the zero exit control relay **213** in FIG. 44, has been energized, that the one exit control relays **279** and **345** in FIG. 43 have also been energized and that the exit control relay **147** in FIG. 45 has been energized. It is still further assumed that pro-

gram step entry hub **12** in FIG. 44 has been impulsed and that it is desired to perform program step **12**.

In this case, as shown in FIG. 151 of the drawings, the firing of the stop thyratron to pick CB**1** relay **57** starts this sequence. The effect of picking this relay is to drop out the electronic start relay **64** since the contacts **57–3** in FIG. 43 of the drawings are now opened and further to pick relay CB**2** by virtue of the closure of contacts **57–2** shown in FIG. 41 of the drawings. As shown in FIG. 43 of the drawings, the transfer of contacts **57–3** of CB**1** relay, **57**, and the closed contacts of the old digit relay and step control relays, used in a previous program step, provides a program step exit pulse as represented at **151–10** in FIG. 151 of the drawings. Thus, the old digit relay **208** and the old step control relay **81** provide an impulse from program step exit **1**.

This potential may be applied to a suitable entry hub such as in this case, program step entry hub **12**. As shown in FIG. 44, this results in the picking of exit control relay **216** which in a sense corresponds to relay **213**. Picking this relay will cause the energization of relays **282** and **348** shown in FIG. 43 since its contacts **216–6** are now closed. Referring now to FIG. 45 of the drawings, it is noted that the transfer of the contacts **216–1** and the closure of the contacts **282–12** results in the picking of relay **150** through its hold coil and establishing a hold circuit for relay **216** through its hold coil **216** H.

At this point it should be noted that the closure of contacts **40–3** of CB**2** relay causes the Restore Set Up **1** relay **46** shown in FIG. 51 of the drawings to be picked and that closure of its contacts **46–1** as shown in FIG. 52 of the drawings, results in the picking of restore setup **2** relay **47** through its hold coil since the contacts **202–1** have been transferred by reason of the closure of contacts **216–5** in FIG. 47 of the drawings to pick the relay **202**H, designated less than 80. The actuation of restore setup relay **47** causes its contacts **47–2** shown in FIG. 51 of the drawings to be transferred whereby Restore Setup relay **46** is dropped. It is noted, however, that no restore action takes place since at the time that the restore setup **2**, relay **47** closes its contacts the Restore Set-up relay **46** is still actuated by reason of the long drop out time effected by its shorted hold coil to prevent picking of the restore relay **50** in FIG. 40.

The energization of relay **216** is effective as shown in FIG. 45 of the drawings to open the energization circuit for relay **213** since the contacts **216–1** have been transferred. The dropping of relay **213** is effective to drop relays **279** and **345**, as clearly shown in FIG. 43 of the drawings, since the hold circuits of these relays is through the contact **213–6**. The picking of relay **216** also interrupts the hold circuit for relay **147** in FIG. 45.

As relay **150** is picked as represented at **151–150**, it is effective to pick digit control relay **210** since the impulsing of hub **12** in FIG. 44 of the drawings completes a circuit through the transferred contacts **150–2** to the pick coil of relay **210**. The transfer of contacts **210–3**, shown at FIG. 41 of the drawings, now completes a circuit to program CB**3** relay, **34**, since the contacts **57–7** are also transferred and the contacts **37–2** are in their normally closed position. Referring to FIG. 51, it is also noted that the opening of contacts **34–8** relay CB**3** drops the restore relay **47** in FIG. 52.

It is also noted in FIG. 41 of the drawings that the opening of contacts **34–3** of CB**3** relay **34** is effective to open the energization circuit of program CB**2** relay **40** whereby this relay is deactuated. In FIG. 48 of the drawings, it is also noted that the opening of contacts **34–5** of program CB**3** relay is effective to de-energize the hold coil of digit relay **208** which was used in a previous program step and contacts **34–1** in FIG. 47 of the drawings are effective to de-energize the step control relay **81** also used in the previous program step.

Referring now to FIG. 41 of the drawings, it is noted that the transfer of contacts **208–5** to their normal position and the normal condition of all of the other digit points and the normally closed contacts **34–3** of CB**3** relay, provides a closed energization circuit for picking program CB**4** relay **60**. Also, it is noted in this figure that the hold coil of this relay is energized through its own contacts **60–1**, the transferred contacts **57–1** and the normally closed restore relay contacts **50–5**. The actuation of relay CB**4** is effective also to pick program CB**5** relay **37** by reason of the closure of contacts **60–6** shown in this figure of the drawings.

As seen in FIG. 51 of the drawings, the transfer of contacts **37–5** of program CB**5** relay is effective to energize a new digit relay, in this case, relay **212**, by reason of the fact that the digit control relay points **210–2** are closed. It is noted at this point that digit control relay **210** was previously picked and is still in an energized condition as represented in FIG. 151 of the drawings at **151–210**. Referring now to FIG. 47 of the drawings, it is noted that the transfer of program CB**5** contacts **37–6** is effective to energize one of the step control relays, in this case, **84**, since exit control contacts **348–12** are now closed.

As shown in FIG. 41 of the drawings, the pick of digit relay **212** is effective to transfer its contacts **212–5** and thus, since relay CB**3** was dropped upon the picking of relay CB**5** by virtue of the transfer of contacts **37–2** in FIG. 41 of the drawings an energizing potential to program CB**2** relay **40** is completed through the contacts **57–2**, **208–5**, the transferred contacts **212–5** and the now closed contacts **34–3** of relay CB**3**.

Referring now to FIG. 49 of the drawings, it is noted that since the hold coil of program CB**1** relay **57**, is through the normally closed contacts **40–5**, of program CB**2**, the energization of relay CB**2** in this circumstance, is effective to interrupt the energization circuit of program CB**1** and, as a consequence, this relay drops. The dropping of program CB**1** relay is also effective to drop program CB**2** relay as noted in FIG. 41 of the drawings since program CB**1** relay contacts **57–2** are now opened. Also, referring to FIG. 48 of the drawings, it is seen that program CB**1** contacts **57–5** are opened whereby the digit control relay **210** is de-energized. In FIG. 41 of the drawings, it is noted that the opening of program CB**1** contacts **57–1** is also effective to interrupt the energizing circuit of the hold coil of program CB**4** relay whereby this relay also drops. The drop of program CB**4** opens its contacts **60–6** shown in FIG. 41 and thus, drops program CB**5** relay **37** since it does not have a hold coil.

The drop of program CB**5** as seen in FIG. 40 of the drawings is effective to energize electronic start relay coil **64**P. This takes place through the start contact **55–3**, the motor bar contact **51–10** and CB**1** contact **57–3** shown in FIG. 43.

After the electronic start relay **64** is energized, the electronic run time takes place as represented at **151–12** in FIG. 151 of the drawings. It should be observed that program operation exits shown in FIG. 42 are such as to provide an output potential from the pick times of any digit relay until the pick of CB**1** relay shown having contacts **57–1** in FIG. 41 which are transferred on the pick of program CB**1**.

It is also significant to note that upon the pick of the new digit relay and the new step control relay program function exits such as shown in FIG. 42 of the drawings are properly activated and this is represented in FIG. 151 at **151–14**.

DIGIT ANALYZER

Under certain circumstances, it may be desirable to make certain selections according to a word number, as an example, it may be desirable to aggregate in certain words of Memory, "Running" totals or to select certain columns on a printer by horizontal position control, to compile different columns of information each pertaining to some designated number. Provision is made in the machine **1–10** for facilitating this operation and the appa-

ratus called the Digit Analyzer. In FIGS. 68 and 69 of the drawings is shown certain relay circuitry involved in the Digit Analyzer and in FIG. 152 of the drawings are shown certain electronic logic blocks involved in the Digit Analyzer.

On the control panel, as shown in FIG. 8B of the drawings is a hub **8–158** designated LDA for Load Digit Analyzer. Impulsing this hub conditions the electronic and relay circuitry for operation of the Digit Analyzer of the machine. Shown in FIG. 8C of the drawings is a hub **8–162** designated ENT for Entry into Digit Analyzer and within the dotted enclosure **8–160** are 20 Digit Analyzer Exit hubs, one of which is uniquely interconnected with the Entry hub **8–162** by a selection which takes place by selective energization of certain relay circuits shown in FIGS. 68 and 69 of the drawings. That is, a number contained in a word of Memory and representing a salesman's number, for example, is used to cause the unique connection of the Entry hub to one of the Digit Analyzer Exit hubs.

Referring now to FIG. 152 of the drawings, it is noted that an impulse applied to the load Digit Analyzer hub reproduced at **152–10**, is effective to apply a 48 volt potential to the input of Integrator **152–12** and also to each of the lines **152–14** and **152–16** through the respective diodes **152–18** and **152–20**.

In the case of the potential applied to the Integrator, its output produces a +S level signal which is applied to the input pin K of the Power Inverter **152–22**. The output of this Power Inverter at pin E is applied to the input of Power Inverter **152–24** and also is connected to the line **152–26** designated Not LDA. The +S level signal at the input of Power Inverter **124** produces a −S level signal at its output which is inverted by the +And circuit **152–28** to produce at its output pin R, a −S level signal on the line **152–30**, designated "Fire Stop."

In FIG. 149 of the drawings, this line is reproduced at **149–24** and is applied to the input of −Or circuit **149–20**. Thus, as the −S level signal is applied to this line, a +S signal is produced at output pin D of this −Or circuit which is effective to cause the Thyratron **149–22** to be fired and, as pointed out hereinabove, is effective to begin the relay program stepping machine.

The 48 volt potential on line **152–14** is effective to place the machine in a Type mode of operation. For an understanding of the manner in which this is accomplished, reference is made to FIG. 118 of the drawings wherein the line **152–14** is reproduced at **118–10** and is applied to this line produces a +S level signal at the output pin N of this Integrator circuit which is applied to the input pin P of the +And circuit **118–14**. Since the machine is not in Print operation, the input pin Q this +And circuit will also be at a +S level thus producing a −S level at output pin R. This signal is inverted by the Power Inverter **118–16** producing a +S level at its output pin F which is connected to the line **118–18** designated TYPE. This signal is appropriately applied to other circuitry to condition the machine for a Type operation. However, actual type out does not occur for reasons explained hereinbelow.

The +48 volt potential applied to line **152–16** is effective to set the B counter to a condition comparable to that used for typing numeric information with a digit capacity of 1. For an understanding of the manner in which this is accomplished, reference is made to FIG. 12 of the drawings wherein the line **152–16** is reproduced at **121–10**. This line is applied to the input pin A of +OO circuit **121–12** and to the input pin G of +Or circuit **121–14**. The outputs of these respective circuits are thus at a −R level which signals are converted to a +S level by respective converter circuits **121–16** and **121–18** and applied to pins P of respective +And circuits **121–20** and **121–22**. The other inputs to pins Q and R of these respective And circuits are +S from the DC set **6B** line **121–24** and +S from the line **121–26** designated Not Start Latch. Accordingly, the outputs of these +And circuits are at −S levels which are the required condition for DC set of B Counter triggers **1B** and **4B**. In a manner described in co-pending application A, this is effective to select a fixed factor equal to one-half which is required for typeout of a digit capacity of 1.

During a numeric type operation, as explained in co-pending application A, fixed factors of descending powers of ten are successively subtracted from the number to be typed, the first fixed factor having a power equal to the highest order digit of the number. Thus, a number of successful subtractions less than ten can be made and are counted by the C counter. Provision is made in such case to inhibit the C counter from counting to or beyond ten. An indication of an overflow condition by inhibiting rewrite of the overflow register by deconditioning the overflow register switch select line **102–22**, is produced. In the present circumstances, however, the C Counter is enabled to count to numbers greater than 10 and to prevent the normal inhibiting action, the +And circuit **102–10** in FIG. 102 of the drawings has the signal Not Load Digit Analyzer from line **152–26**, FIG. 152 of the drawings, applied to its input. When the circuitry is condition for loading the Digit Analyzer, this line will be at −S level producing a +S level at the output of +And **102–10** which is applied to input pin X of +And circuit **102–12**. Thus, since Not Space After Type and Not 70th cycle signals which are applied to the other input pins Y and Z, respectively, of +And circuit **102–12** are +S, the output of this +And circuit at pin V will be at a −S level. This is applied to input pin C of −Or circuit **102–14** producing at its output pin B a +S level signal. If the accumulator trigger is set so as to indicate that a "1" bit is to be re-written, input pin G of +AO circuit **102–16** will be at a +S level since input pin F of this circuit receives the +S level from output pin B of −Or **102–14**, and input pin H of circuit **102–16** is also at a +S level since input pin A of −Or circuit **102–18** is at a −S level produced by the line Not Type since the machine is not in a type operation. Accordingly, the output pin C–L of +AO circuit **102–16** reflects the condition of the accumulator.

As shown in FIG. 142 of the drawings, the signal Not Load Digit Analyzer is also applied to the input of Power Inverter circuit **142–10**, the output of which is connected to the line **142–12** designated Not fire numeric thyratron or First Significant Digit. Also, inverter circuit **142–14** receives a +S signal Not L.D.A. applied thereto and the output of this circuit is applied to the line **142–16**, designated Not Numeric Gate. An inverter circuit **142–18** receives this signal and produces Numeric Gate at **142–20**. Accordingly, these lines which must be conditioned for a Type operation to be performed, are deconditioned and no typing occurs. However, in other respects, the fixed factor word is selected and successive subtractions from the programmed Inword are performed and after the overdraw and add back operations that normally take place in a numeric printout have been performed, the C Counter is set with its triggers representing the number to be analyzed.

As seen in FIG. 152 of the drawings, the respective lines **152–32**, **152–34**, **152–36**, **152–38**, and **152–40** are designated, respectively, 1C, 2C, 4C, 8C and 16C. These are outputs of the respective C Counter triggers and are applied to respective input pins A, P, A, F, and P of +And circuits **152–42**, **152–44**, **152–46**, **152–48** and **152–50**. The respective input pins B, Q, B, G, and O of these +And circuits and have the signal Load Digit Analyzer applied thereto from the output pin C of power inverter **152–24**. The respective input pins K, R, K, H, and R of these +And circuits are conditioned by the signal Fire Numeric Thyratron applied thereto from the output of Power Inverter **152–52** which has at its input the signal Not Fire Numeric Thyratron applied thereto. Thus, under the conditions wherein the machine is in a Load Digit Analyzer condition and a pseudo Type oper-

ation is performed, the Fire Numeric Thyratron signal is applied and the C Counter has a selected group of triggers in the On state. Certain +And circuits of the group **152–42** through **152–50** will have their inputs conditioned producing a −S level at the output thereof. These outputs are inverted by corresponding ones of the Power Inverter **152–54** and Inverters **152–56, 152–58, 152–60** and **152–62**. The outputs of these are applied to respective thyratron circuits of the group **152–64, 152–66, 152–68, 152–70** and **152–72** to selectively apply ground potential to the output lines thereof.

The output lines of these thyratron circuits are connected to the respective lines **68–12, 68–14, 68–16, 68–18** and **68–20** in FIG. 68 of the drawings. Accordingly, the firing of these thyratrons is effective to apply ground potential to one side of the relay pick coils **469, 468, 472, 474** and **476**.

It is noted that as the Load Digit Analyzer hub reproduced at **68–10** in FIG. 68 of the drawings is impulsed, the pick coil of relay **471** is energized whereby its contacts **471–1** through **471–4** are opened, opening the energizing circuits of the hold coils for relays **479** through **476** to effectively reset these relays. However, although the hub **68–10** is impulsed from the program step exit hub, for example, and such signal persists during the entire program step to maintain these hold coils de-energized, the pick coils thereof are nevertheless effective to be energized to transfer the respective sets of contacts of these relays, on removal of the impulse from the hub, the hold coils may be energized through contacts of the same relay since relay **471** will be de-energized and its contacts are normally closed. As shown in FIG. 69 of the drawings, the relays **469** through **476** have contact sets arranged in a "Christmas Tree" fashion between Entry hub **69–10** and the respective Digit Analyzer exit hubs reproduced along the right margin of this figure and designated Nos. **1** through **20**. Thus, as a selected combination of these relays is activated, the contacts of the corresponding relays and shown in FIG. 69 are transferred. In a well known manner, one of the Digit Analyzer exit hubs is uniquely interconnected with the Digit Analyzer Entry hub **69–18**. Thus, an impulse applied to Digit Analyzer Entry hub **69–10** is effective to activate one of the digit analyzer Exit hubs which may be used to select a word of Memory, a horizontal position of the printers or for other purposes.

FORMS OVERFLOW

As explained hereinabove, if, during an invoicing operation for example, the body of an invoice is filled and there are more items to be sold and listed, at the indexing of the form from the last line of the body of the invoice, the sensing star wheel in channel **12** of the vertical tape falls into the hole in this channel and initiates an Overflow routine. For an understanding of the manner in which this routine is established and carried out, reference is made to FIG. 57 of the drawings. In this figure, it is seen that as the vertical tape is indexed one line along with the output document in the described manner, the star wheel in channel **12** establishes an energizing circuit for the Hold coil **521** H of the Overflow relay through the normally closed contacts **518–4** of Stop **2** relay and the contacts **524–9** of the Vertical Position relay. In FIG. 56, it is observed that the contacts **521–2** of the Overflow relay transfer. In Table 4, it is shown that the result of this transfer of contacts is the picking of Selector **2** and the program change as described with respect to this table, occurs.

It should be noted that in case of the Overflow relay, it is not sampled while the document and vertical tape are in motion as is the case for the other channels of the tape. That is, the actual movement of the tape to the overflow vertical position and stopping at this position, is required.

As a provision for imparting versatility to the machine **1–10**, it should be understood that although a particular Overflow routine was illustrated and described in the illustrative program tables herein, various other routines initiated by the sensing of the hole in channel **12** of the tape and the picking of appropriate selectors enables branching to be carried out.

FULL CARD ROUTINE

In the course of any operation of the machine **1–10** involving a Magnetic Ledger Card, it may occur that the ledger card is fully posted and that there is no further space for posting additional information. In this case it becomes necessary to alter the usual program routine and to place a new ledger card into use. For an explanation of the manner in which this is accomplished, the usual routine involving a card that is not filled, will be described briefly, followed by the explanation of the full card routine.

In the case wherein the card is not full and has space for additional posting, after the card is dropped into the hopper and is read at the Read/Record station, it is driven to the posting line. As it is so driven, the punched holes along the left side thereof are sensed in a manner described in copending application D by the Line Sensing mechanism. On the sensing of the first punched hole, the sensing arm drops into the hole and causes the Line Sense contacts in FIG. 60 of the drawings to close. This is effective to complete a circuit to pick relay **713**. This energizing circuit is from the 48 volt line, via contacts **27–5** in FIG. 65, contact **31–1**, contacts **703–6**, Head Latch contacts **#1** which are closed by virtue of the fact that the head is latched at the end of its sweep after the read operation, contacts **711–2**, contacts 144° −7 transferred, contacts **717–1** and Line Sense contacts to the coil **713P**. The energization of this relay causes its contacts to be actuated. Contacts **713–2**, shown in FIG. 61, are closed to complete an energizing circuit to cycle cam line relay **61–10**, from the +48 volt line, via contacts **713–2**, contacts **729–11** directly to the cam line relay **61–10**. Since the cam line is at 144° during a read operation, it is now cycled to 216°.

As the cam line is advanced, its contacts 160°–200° are closed and an impulse is momentarily applied to the Post Ledger exit hub shown in FIG. 60 of the drawings from the +48 volt line through the sets of contacts **27–5, 31–1, 706–3**, H. Latch **#1, 721–5, 711–2**, 144° −7 in their normal condition, the now closed contacts 160°–200° and contacts **709–4**.

It is to be noted that as the card is driven to the posting line, if any space is available on the card for posting, the card is driven down far enough to open the Full Card contacts shown in FIG. 60. This prevents the picking of the Full Card relay **709** shown.

Assuming on the other hand that the ledger card is fully posted and that no more space is available for posting, it is noted that the Full Card contacts are not open as the ledger card is driven to the posting line. This is because the posting line is sensed before the card is driven down far enough to open these contacts. Thus, in this case, as the Line Sense relay **713** is picked as before, the Full Card relay **709** is energized from the contacts **27–5** in FIG. 65, contacts **31–1**, etc., the Full Card contacts, the transferred contacts **713–3** to energize the Full Card relay. Its contacts are actuated and contacts **709–4**, in FIG. 60 apply an electrical impulse to the Full Card hub, F. C. rather than to the Post Ledger hub as was previously the case.

As the cam line is at 216°, the actuation of the Full Card relay and the closure of its contacts **709–3**, shown in FIG. 61, is effective to energize the cycle cam line relay **61–10** via these contacts and the now closed contacts 216° −13. The cam line is consequently rotated to 288°. As this occurs in FIG. 60, the 144° −7 contacts transfer back to the normal position shown and coil

713P is therefore de-energized. The closure of contacts 709–3 in FIG. 61 is also effective to energize the Card Feed drive relay shown in FIG. 60. This is from +48 volts in FIG. 61, through contacts 709–3, to the transferred contacts 288° —8 in FIG. 60, contacts 713–4 and contacts 715–5. This drives the card out and as it passes under the Card Present Upper contacts CPU, 63–10, Card Present Upper relay 719 will be picked from +48 volts, via contacts 717–3 and the CPU contacts 63–10.

Now the contacts 719–3 in FIG. 61 are closed and complete a circuit to the cam line magnet 61–10 from +48 volts via contacts 709–3, contacts 729–6, Card Present Lower contacts CPL, 288° —9 contacts, contacts 719–3 and transferred contacts 709–5 to the magnet. The cam line is therefore rotated to the 0° position.

At this point the card has been driven out and returned to the operator of the machine and the F. C. hub has been impulsed to provide a machine indication that the ledger card is full. This impulse may be appropriately applied by prewiring of the Control Panel to indicate that a new card should be placed into use and to place the machine in a mode so as to facilitate the preparation of such a new card.

For facilitating the preparation of a new card, the machine is automatically placed in a New Card or Duplicate mode. The contacts 709–2, shown in FIG. 63 of the drawings, are closed to apply +48 volts to the Duplicate (Dup) relay 707 shown in FIG. 62. This places the machine in a Duplicate mode for the preparation of the new ledger card.

A new bank card may now be inserted into the hopper of the ledger card unit. In the usual way, the Read/Record head is swept along the magnetic stripe on the card, however, since the Dup relay 707 is energized, its contacts 707–3 in FIG. 63 are transferred and none of the lines 63–20, 63–14, 63–18 and 63–16 can be conditioned. Consequently, any matter on the new card can not be read and the contents of memory is not altered by head sweep. That is, neither the contents of the magnetic stripe nor contents of MLC Memory is altered.

As the card is moved to the posting line the F.C. hub which was impulsed to indicate a full card condition, may be prewired to pick a selector as shown in FIG. 69 to cause branching of the program routine so as to cause a selected word or field of the Ledger Alpha Memory which contains heading information, to be printed out on the card. After this posting, the information in the MLC portion of memory may be recorded on the magnetic stripe of the new card by a usual Record instruction to complete its preparation.

It is possible to enter the Duplicate mode by impulsing the Dup hub 8–128 of the control panel, which hub is reproduced in FIG. 61. This picks Duplicate relay 707 and its hold coil 707H shown in FIG. 62 is energized through its contacts 707–2 and either of contacts 724–7 of the Record relay or contacts 729–7 of the Check Read relay. Alternatively, relay 707 is energized through its contacts 707–1 and the End Head Sweep contacts 62–10. Thus, the Duplicate relay hold coil will remain energized until the next Read ledger sweep of the magnetic head at the end of which sweep the circuit of the relay will be opened and the relay deactuated.

Various of the functions of the machine 1–10 as described herein with respect to the control panel, the illustrative program or otherwise are described in detail in copending application A. These include numeric and alphanumeric entry and type or print, column shift operations, various punctuation options and others. Also, the manner in which the Magnetic Ledger Card unit 1–14 is effective in handling a ledger card for posting, reading and recording, etc., is set forth and described in detail in copending application D. For a more complete understanding of the entire system herein set forth, the disclosures of these applications are herein incorporated by reference.

It is clear from the foregoing description that in accordance with the present invention a novel, effective and advantageous business machine that is versatile and capable of performing many functions for the preparation of many types of forms or documents is provided. The ability of a human operator to exercise overall control of the machine but with automatic means for entry of numeric and alphanumeric information, print-out of the same and data processing with program control by output document together with horizontal and vertical tape units and a control panel is unique and provides a decided improvement in data entry and processing in the business machine field. The ability of the machine to be controlled by the coordinate position of the printing means relative to the form of the output document, to sense both horizontal and vertical positions and to provide impulses indicative of these positions and further to be responsive to electrical impulses to different horizontal and vertical position entry hubs to seek new horizontal or vertical positions imparts great versatility to the machine. The automatic means for starting the operations of the machine, viz., the impulsing of an autostart hub to produce an electrical impulse from the coordinate exit position corresponding to the horizontal and vertical positions of the carrier with respect to the output document is a very effective aid in facilitating control of the machine. It is also noted that by integrating the prewirable control panel with its great programming flexibility with the horizontal and vertical tape units many different program routines may be initiated and performed in accordance with the relative positions of the carrier and the output document. The magnetic ledger card unit in conjunction with the other parts of the machine facilitates accurate and speedy entry of both numeric and alphanumeric information into the storage unit from which it is available either for calculations if numeric of for print-out on either primary or ledger printer or both if either numeric or alphanumeric. The facility and simplicity with which ledger cards can be updated with both visible (printed) information and magnetically recorded information is also noted.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A business machine for the preparation of documents on a printer comprising: a printer having means for accommodating an output document, actuable printing means and actuable means for establishing relative movement between the printing means and an output document located in the means for accommodating an output document in each of two orthogonal directions to facilitate printing on the document along a plurality of lines thereon; an electronic data processing unit having a selectively operable information storage means for storing coded data representations, selectively operable electronic means for arithmetically processing stored data, selectively operable means for actuating said means for establishing relative movement to establish a unique co-ordinate relative position and selectively operable means for transferring selected coded data representations from said storage means to said printing means to actuate said printing means; means for cotnrolling the operation of the processing unit including a control panel having program control terminal hubs being interconnectable to control the sequence of operations of the selectively operable means of the processing unit; a card unit for entering information into said storage means and including a magnetic head unit for magnetically reproducing in the form of electrical potentials the information recorded on a magnetic stripe on a card, said card unit including means for positioning the card for posting and means for producing

an electrical impulse at a control panel hub indicative of the arrival of the card at its posting station, said electrical impulse when applied to a second one of the hubs of the control panel initiating a particular program sequence of operations of the processing unit.

2. An electronic computing machine comprising: an electronic data processing unit having an information storage unit for storing coded data information; a printer for accommodating an output document and having actuable printing means responsive to the information storage unit for printing representations of selected stored coded data along a plurality of lines on said document, actuable means for establishing relative movement between said document and said printing means in a first direction and for moving said document in a second direction perpendicular to said first direction to facilitate multiple line printing thereon; a control panel having a plurality of terminal hubs for controlling the operation of said machine, a first portion of said hubs and means responsive to an electrical impulse applied to any single one thereof for actuating said means for establishing relative movement to establish a predetermined relative position of said document and said printing means in said first direction, a second portion of said hubs and means responsive to an electrical impulse applied to any single one thereof for actuating said means for establishing relative movement to establish a predetermined relative position of said document and said printing means in said second direction; said machine including a card unit having a magnetic head unit for magnetically reproducing coded data information recorded on a magnetic stripe on a card and for entering said reproduced information into said storage means, said card unit including means for positioning the card for posting at a posting station and means for producing an electrical impulse at one of said control panel hubs indicative of the arrival of the card at its posting station, said impulse actuating said means for establishing relative movement.

3. A business machine comprising a data processing unit having storage means for the storage of binary information, a primary printer for the preparation of documents having actuable printing means, a manipulatable alphabetic and numeric keyboard for actuating the printing means, and means for encoding alphabetic and decimal numeric characters in a binary code as the corresponding keys thereof are manipulated; means to enter said coded alphanumeric characters from said primary printer into said storage means; a manipulatable decimal and numeric key unit; means responsive to actuation of keys of said key unit for translating decimal numbers into equivalent binary coded numbers; means for entering said equivalent binary coded numbers into said storage means; an actuable arithmetic unit for performing arithmetic operations with coded numbers entered into said storage means; a ledger card unit having an actuable ledger printer for printing on a ledger card entered in said card unit, means for reading information magnetically recorded in binary form on a magnetic stripe on said ledger card, and means for entering the coded information into said storage unit; actuable means responsive to said storage means for selectively actuating either or both of said printers to print representations of the stored coded information; actuable positioning means for establishing relative positions in each of two orthogonal dimensions between the printing means of the primary printer and a document accommodated by the primary printer; an actuable impulse generating means; means responsive to an impulse produced by the impulse generating means for sensing said relative positions and for producing an electrical impulse indicative of said relative positions; program means responsive to said electrical impulse for sequentially actuating said actuable means, said actuable positioning means, said impulse generating means; and said arithmetic unit: means for controlling the sequence of actuation of said program means whereby said machine initiates arithmetic functions in response to relative positions of said printing means and an output document in said primary printer and prints stored information in various stages of processing on documents in said primary and ledger unit printers.

4. A business machine comprising a data processing unit having storage means for the storage of binary information; a primary printer for the preparation of documents having actuable printing means, a manipulatable alphabetic and numeric keyboard for actuating the printing means, said primary printer having means for representing alphabetic and decimal numeric characters in a six bit binary code as the corresponding keys thereof of the keyboard are manipulated; a six stage register in said data processing unit and means for entering the alphanumeric characters of information from said primary printer into said register in parallel to set the stages thereof according to the code of the character entered into the keyboard, means for serializing and entering the information in the register into said memory unit; a manipulatable numeric key unit and means responsive to actuation of keys of said key unit for translating decimal numbers into equivalent binary numbers and means for entering said equivalent binary numbers into said storage means; an arithmetic unit for performing arithmetic operations with numbers entered into said storage means; a ledger card unit having an actuable ledger printer for printing on a ledger card entered in said card unit and having means for reading information magnetically recorded in binary form on a magnetic stripe on said ledger card and for entering the same into said storage unit through said register and means for recording on a magnetic stripe, information stored in a selected portion of said storage means; actuable means responsive to said storage means for selectively actuating either or both of said printers, to print representations of the stored coded information; actuable positioning means for establishing relative positions between the printing means of the primary printer and a document accommodated by the printer in each of two dimensions; an actuable impulse generating means; means responsive to an impulse generated by said generating means for sensing said relative positions and for producing an electrical impulse indicative of a particular combination of said relative positions; program means responsive to said electrical impulse for sequentially actuating said positioning means, said actuable means, said ledger card unit, said impulse generating means and said arithmetic unit; and means for controlling the sequence of actuation of said program means whereby said machine initiates arithmetic functions in response to relative positions of said printing means and an output document in said primary printer to print information on a document in said primary printer and on a ledger card in said ledger printer, and to record processed data and other data on a magnetic stripe on said ledger card in said ledger card unit.

5. A business machine including a data processing unit having storage means for storing coded information, a primary printer with actuable printing means for the preparation of an output document, said primary printer having manipulatable keys for actuating the printing means to print alphanumeric information on a document in the primary printer, means associated with said printer for producing electrical potentials representative of alphanumeric characters in response to the manipulation of keys of said printer, means for storing coded representations of said characters in said storage means, a numeric key unit having manipulatable keys and means responsive to the manipulation of keys of said key unit for entering into said storage means a coded representation of a multidigit number keyed into said key unit, a ledger card unit having an actuable ledger printer and means for positioning a ledger card having a magnetic stripe thereon for reading information magnetically recorded

on said stripe and for magnetically recording information on said stripe, means for positioning said card for printing thereon, said ledger card unit having means for reading coded numeric and alphanumeric information magnetically recorded on a stripe on a ledger card positioned therein and means for entering into storage the information read from a stripe, said data processing unit arithmetically processing the numeric information entered into said storage unit through said key unit and through said ledger card unit, print control means for selectively actuating either or both of said printers to print on an output document in said primary printer and on a ledger card in said ledger card unit, representations of the coded data entered into said storage means, and of information resulting from the processing of information by said data processing unit, means for recording on a magnetic stripe on a ledger card, the coded information stored in a portion of said storage means.

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