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AUTOMATIC CIRCUIT GENERATION PROCESS AND APPARATUS

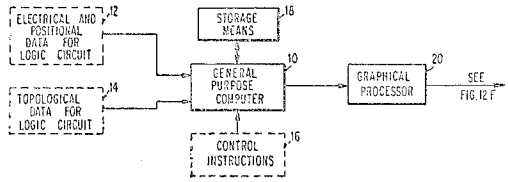
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Continuation of abandoned application Ser. No. 213,695, Dec. 29, 1971. This application Apr. 17, 1974, Ser. No. 461,774

Int. Cl. G06f *15/20*

U.S. Cl. 444—1

10 Sheets Drawing. 38 Pages Specification



Apparatus and method for automatically generating a topology for a logic circuit to be embodied in a semiconductor wafer. Fixed data, designer originated data and control data are generated as an input to a computer. The fixed data provides electrical, and topological qualities of each logical element in the logic circuit to be embodied in the semiconductor wafer. The designer originated data provides location in an ordered grid layout. The control data describes (1) combinations of logical elements in the logic circuit by type of combination, start and end in the grid array descriptive of the semiconductor wafer and (2) electrically common combinations. A program employs the fixed, designer originated and control data to generate coordinate data for each logical element in the grid array as an input to a graphical processor which translates the coordinates into a topological pattern descriptive of the logic circuit to be embodied in the semiconductor wafer.

FIG.1

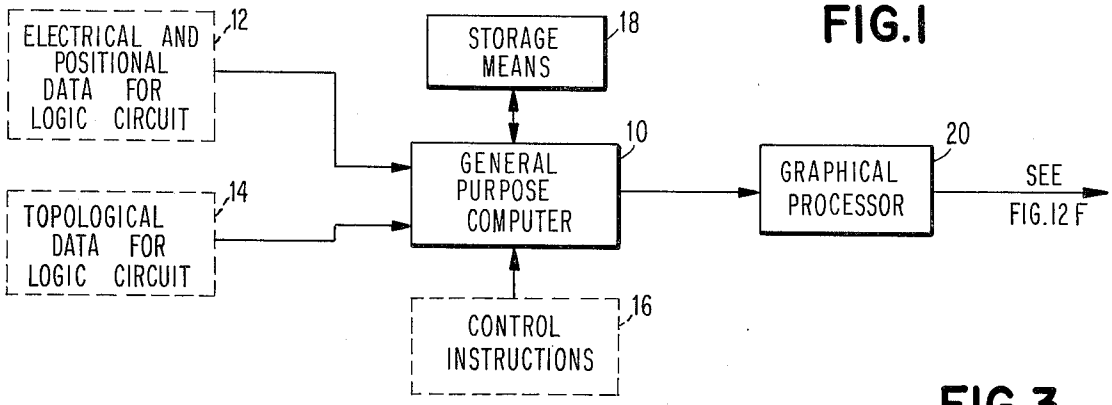


FIG.3

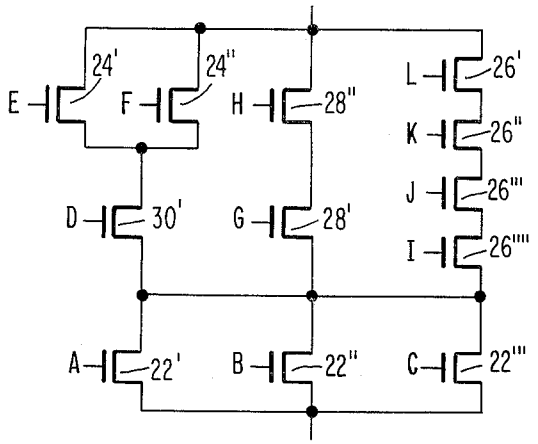


FIG.2

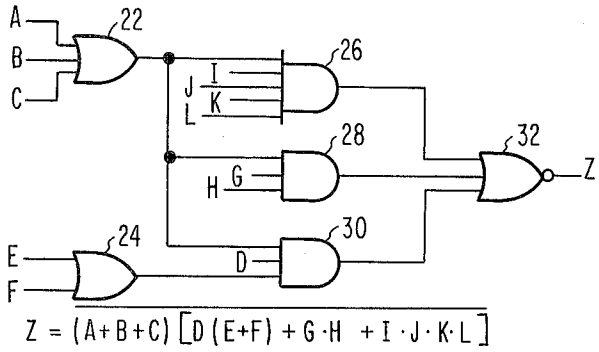


TABLE I

DEV.	LOCATION	WLR	RAILS
X=1	CHAN.(C)-D	5	Y=1-2
2	C-E	5	
3	C-G	5	
X=1	C-C	4	Y=3-4
2	C-F	3	
3	C-I	5	
4	C-J	5	
5	C-M	5	
X=1	C-A	4	Y=5-6
2	C-D	4	
3	C-G	3	
4	C-L	5	

FIG.5

TABLE III

NET	DEV.	
	X=1	SEGMENT (S) 11
N_S=1	2	S 12
	3	S 13
N_E=2	X=1	S 21
	X=1	S 31
N_S=2	2	S 32
	3	S 33
N_E=3	X=1	S 41
	X=1	S 51
N_S=3	2	S 52
	X=1	S 61
N_E=4	2	S 62
	3	S 63
N_E=5	X=1	S 45
N_S=5	X=1	S 54

FIG.8

FIG.4

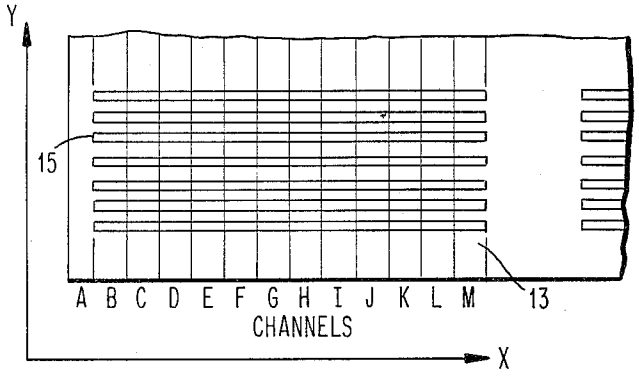


FIG.7B

FIELD	1	2	3	4	5	6
SUB-GROUP	TYPE OF GROUP*	STARTING RAIL No.	ENDING RAIL No.	No. OF FET'S IN GROUP	GROUP START NET No.	GROUP END NET No.
1	1	1	2	3	1	2
2	0	3	4	1	2	3
3	1	5	6	2	3	4
4	0	3	6	2	2	4
5	2	3	4	3	2	5
6	0	5	6	1	5	4

* 0 = SERIES 1 = PARALLEL 2 = ALT. SERIES 3 = DIFFUSION

SUB-GROUP	INPUTS
1	A,B,C
2	D
3	E,F
4	G,H
5	I,J,K
6	L

FIG.7A

TABLE II

INSTR.						
i=1	1	1	2	3	1	2
2	0	3	4	1	2	3
3	1	5	6	2	3	4
4	0	3	6	2	2	4
5	2	3	4	3	2	5
6	0	5	6	1	5	4
7	9	9	9	9	9	9

FIG.7C

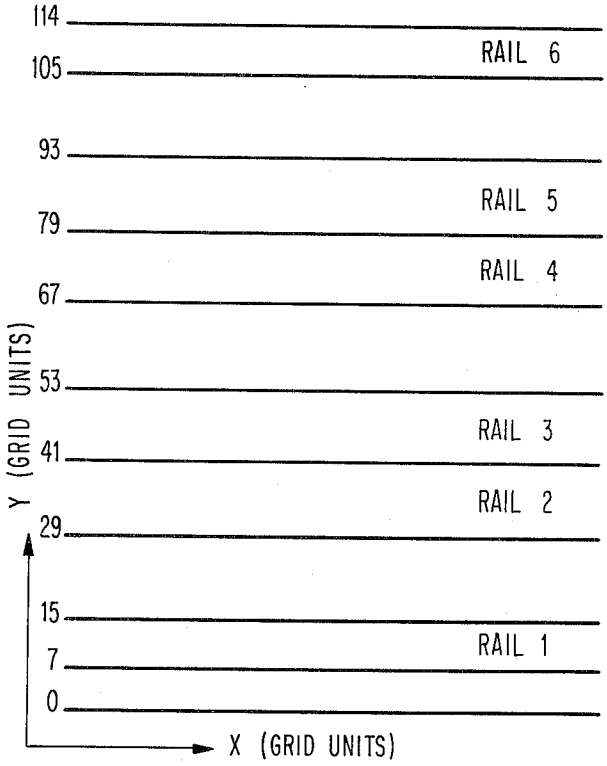


FIG.6A

RAIL	START Y COORD. (GRID UNITS)	RAIL WIDTH (GRID UNITS)
1	7	8
2	29	12
3	41	12
4	67	12
5	79	12
6	105	8

FIG.6B

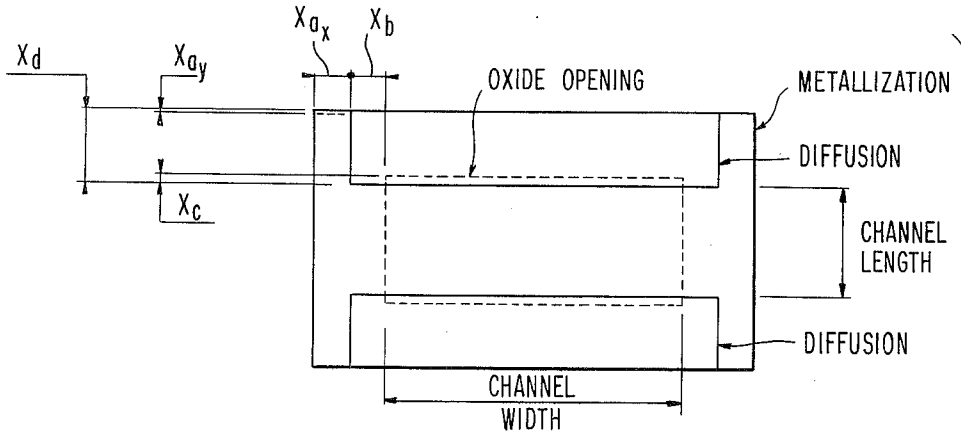


FIG.6C

X_{a_x} - METAL / DIFFUSION OVERLAP (4 GRID UNITS)

X_b - DIFFUSION / OXIDE OVERLAP (4 GRID UNITS)

X_c - OXIDE / DIFFUSION OVERLAP (1 GRID UNIT)

X_{a_y} - DIFFUSION / METAL OVERLAP (0 GRID UNIT)

X_d - DIFFUSION WIDTH (8 GRID UNITS)

FIG. 9

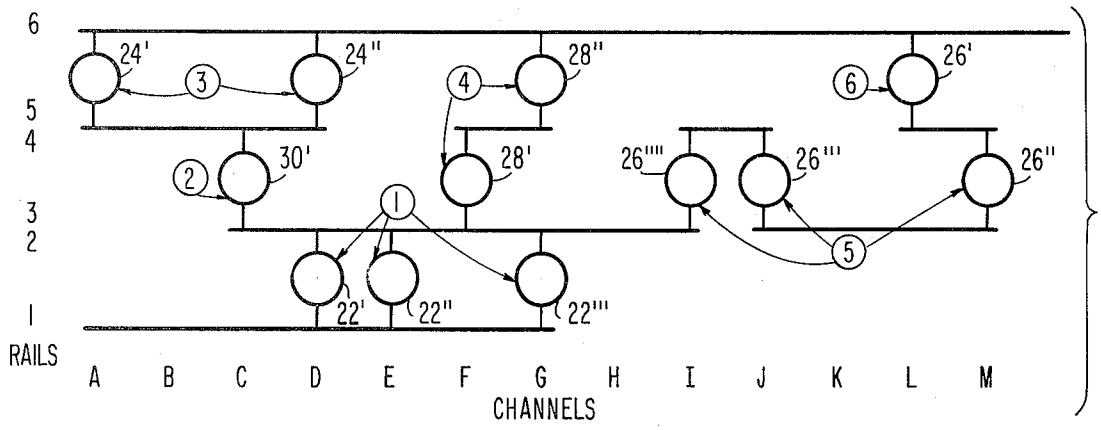


FIG. 10

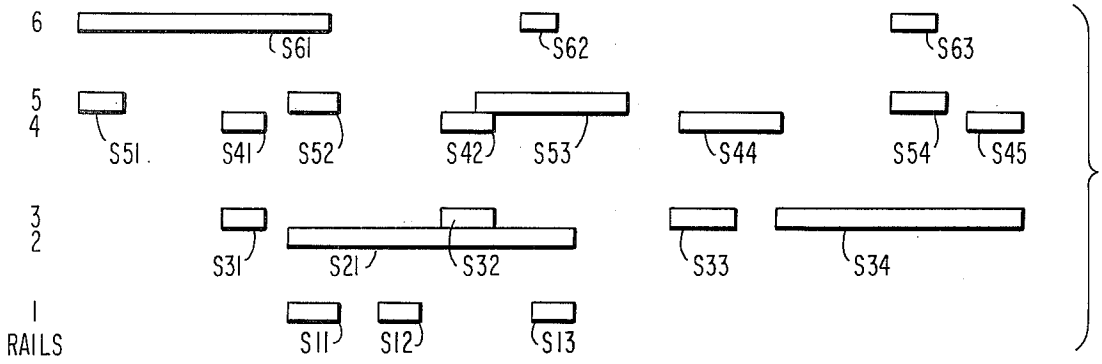


FIG. 11

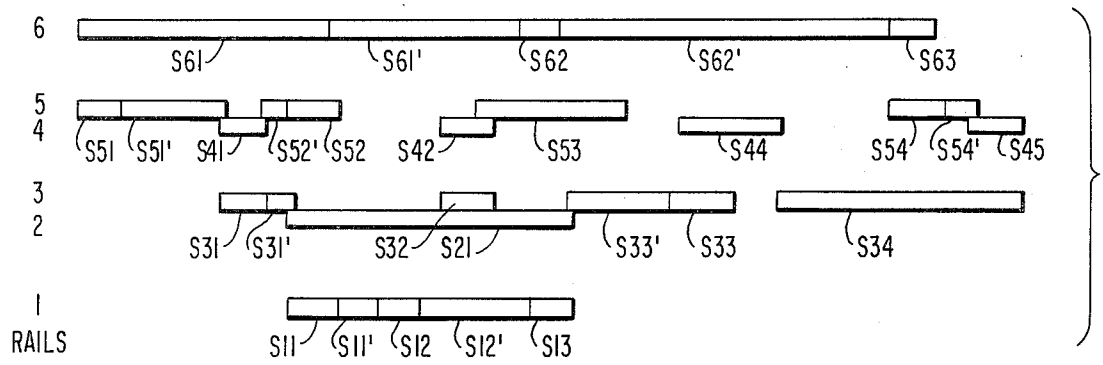
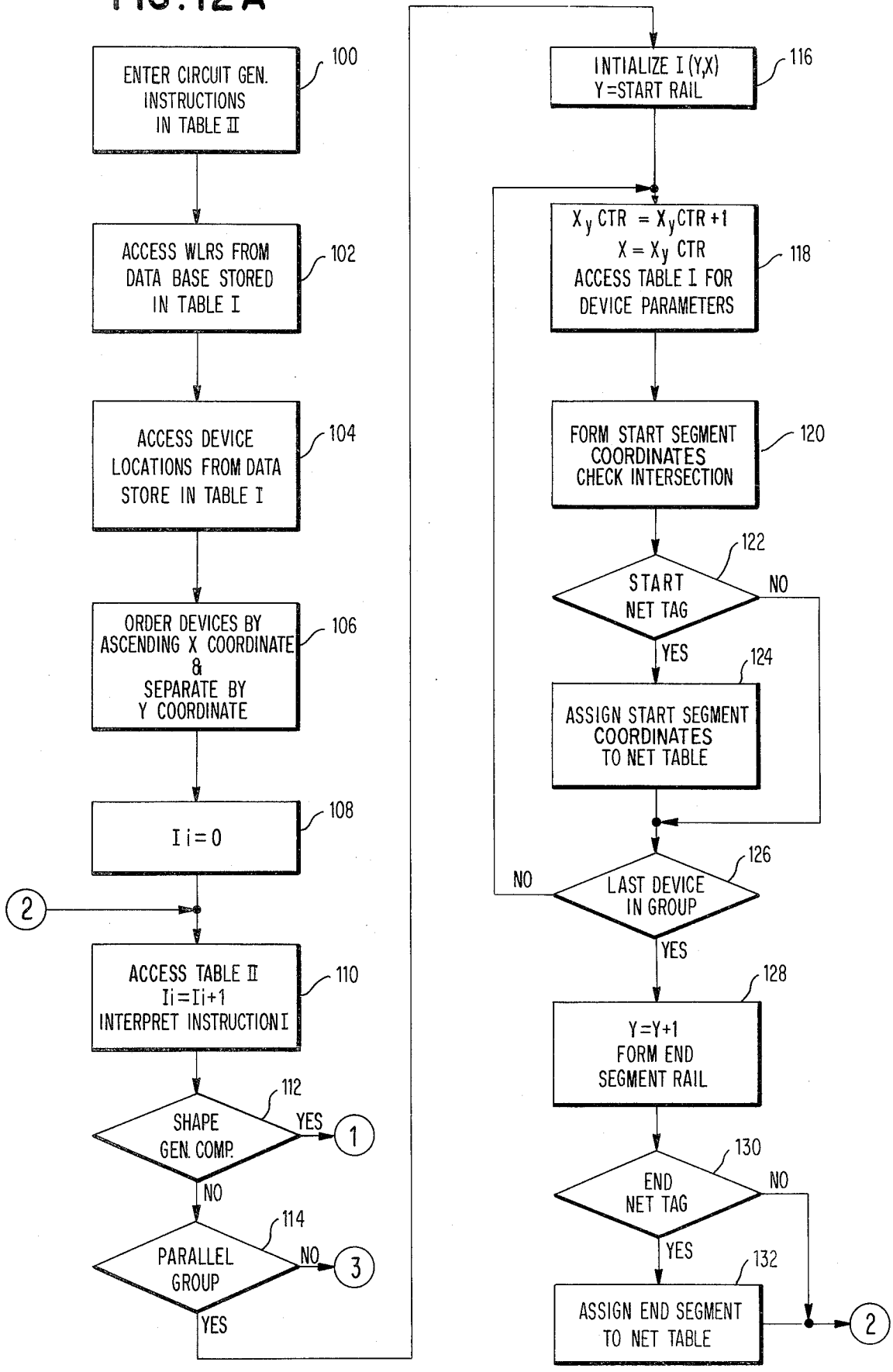


FIG. 12A


ENTER CIRCUIT GEN. INSTRUCTIONS IN TABLE II
100
ACCESS WLRS FROM DATA BASE STORED IN TABLE I
102
ACCESS DEVICE LOCATIONS FROM DATA STORE IN TABLE I
104
ORDER DEVICES BY ASCENDING X COORDINATE & SEPARATE BY Y COORDINATE
106
I i = 0
108
2
ACCESS TABLE II Ii=Ii+1 INTERPRET INSTRUCTION I
110
SHAPE GEN. COMP.
112
YES
1
NO
PARALLEL GROUP
114
NO
3
YES
INTIALIZE I (Y,X) Y=START RAIL
116
Xy CTR = XyCTR +1 X = Xy CTR ACCESS TABLE I FOR DEVICE PARAMETERS
118
FORM START SEGMENT COORDINATES CHECK INTERSECTION
120
START NET TAG
122
NO
YES
ASSIGN START SEGMENT COORDINATES TO NET TABLE
124
LAST DEVICE IN GROUP
126
NO
YES
Y=Y+1 FORM END SEGMENT RAIL
128
END NET TAG
130
NO
YES
ASSIGN END SEGMENT TO NET TABLE
132
2

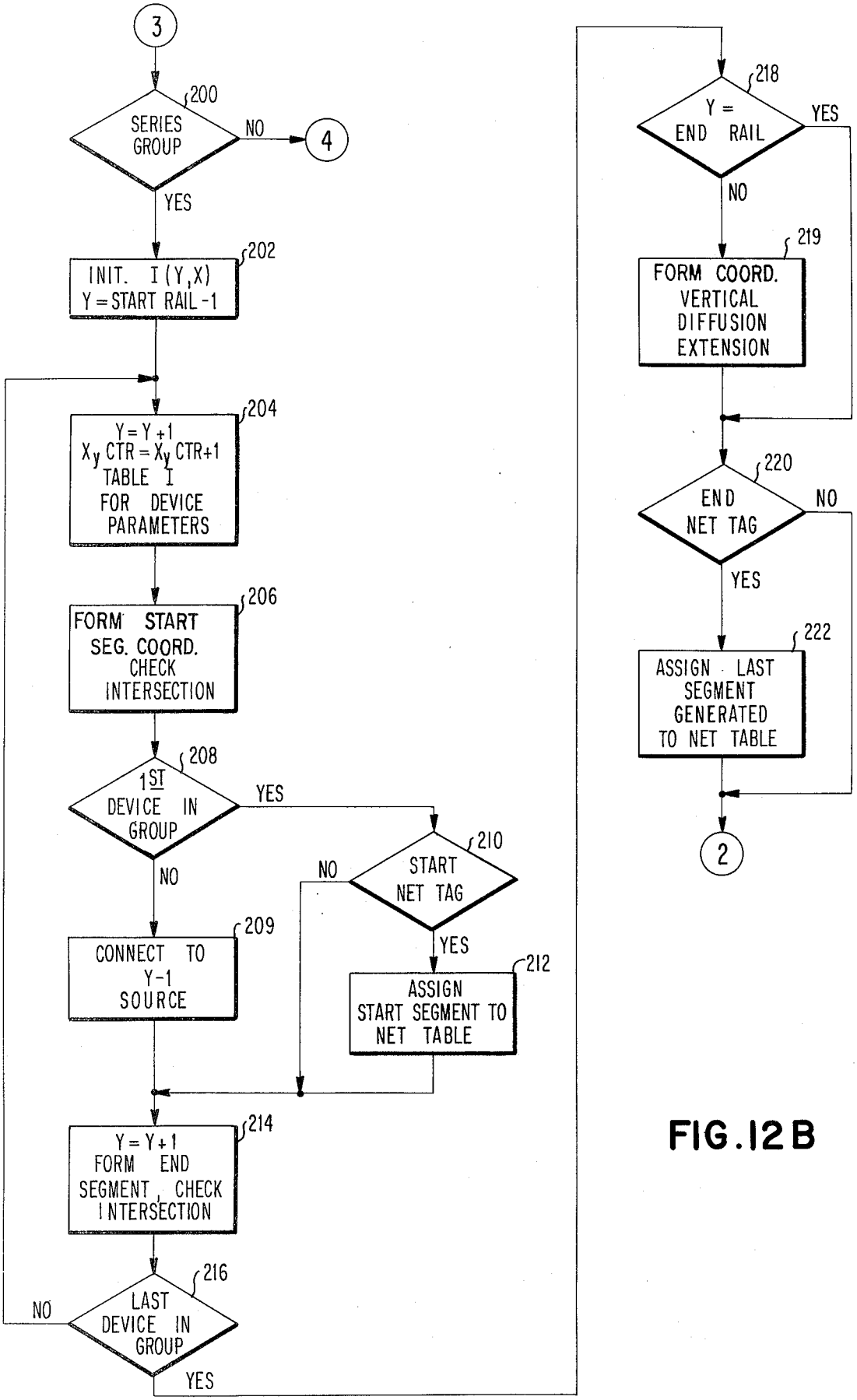

3
200
SERIES GROUP
NO
4
YES
202
INIT. I(Y,X)
Y=START RAIL-1
204
Y=Y+1
Xy CTR=Xy CTR+1
TABLE I
FOR DEVICE PARAMETERS
206
FORM START SEG. COORD.
CHECK INTERSECTION
208
1ST DEVICE IN GROUP
YES
NO
210
START NET TAG
NO
YES
209
CONNECT TO Y-1 SOURCE
212
ASSIGN START SEGMENT TO NET TABLE
214
Y=Y+1
FORM END SEGMENT, CHECK INTERSECTION
216
LAST DEVICE IN GROUP
NO
YES
218
Y = END RAIL
YES
NO
219
FORM COORD. VERTICAL DIFFUSION EXTENSION
220
END NET TAG
NO
YES
222
ASSIGN LAST SEGMENT GENERATED TO NET TABLE
2

FIG. 12B

FIG.12 C

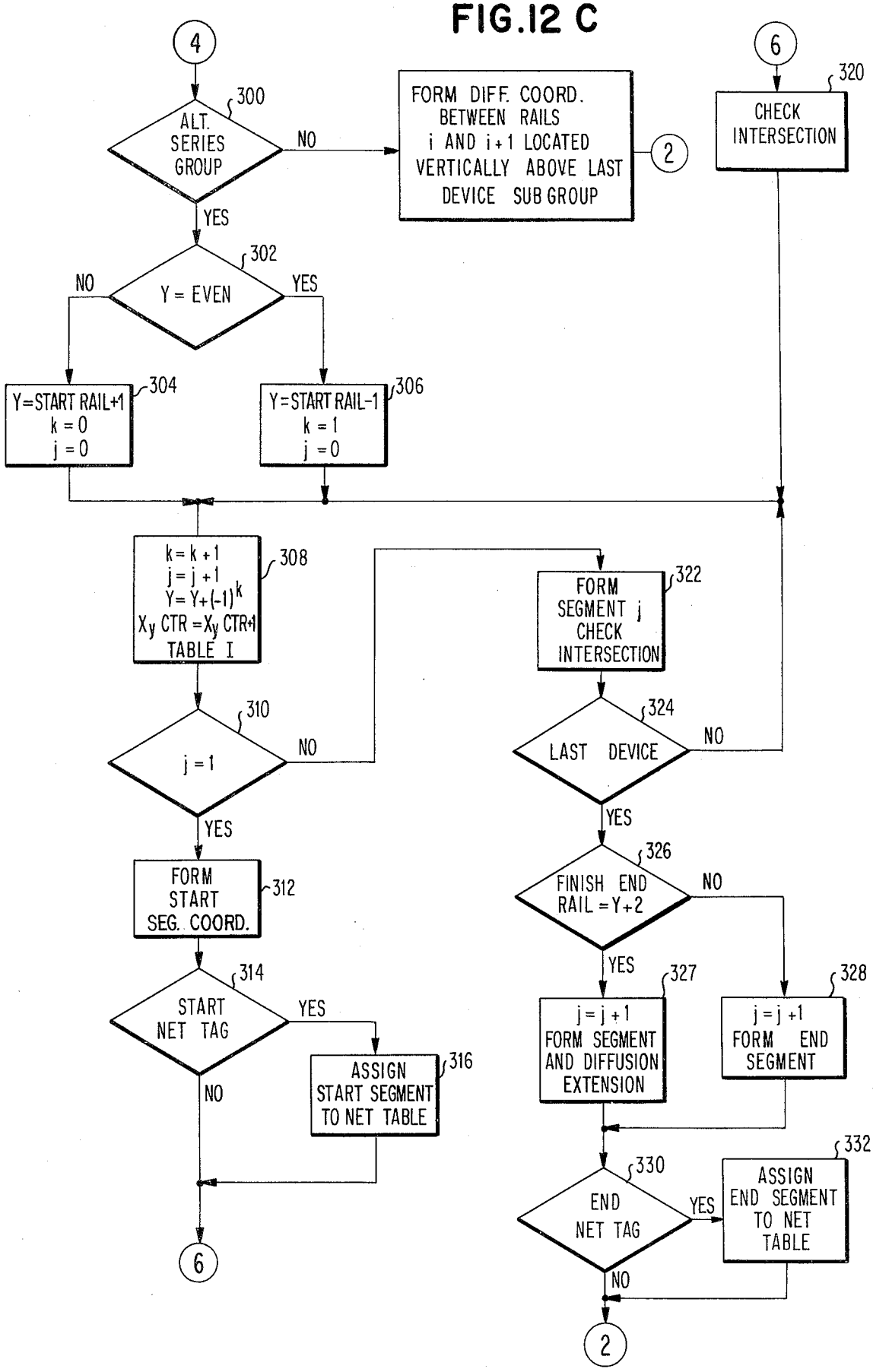

4
300
ALT. SERIES GROUP
NO
FORM DIFF. COORD. BETWEEN RAILS i AND i+1 LOCATED VERTICALLY ABOVE LAST DEVICE SUB GROUP
2
YES
302
Y = EVEN
NO
YES
Y=START RAIL+1 k = 0 j = 0
304
Y=START RAIL-1 k = 1 j = 0
306
k = k + 1 j = j + 1 Y = Y+(-1)^k Xy CTR = Xy CTR+1 TABLE I
308
310
j = 1
NO
YES
FORM START SEG. COORD.
312
314
START NET TAG
YES
NO
ASSIGN START SEGMENT TO NET TABLE
316
6
6
320
CHECK INTERSECTION
FORM SEGMENT j CHECK INTERSECTION
322
324
LAST DEVICE
NO
YES
326
FINISH END RAIL = Y+2
NO
YES
327
j = j + 1 FORM SEGMENT AND DIFFUSION EXTENSION
328
j = j + 1 FORM END SEGMENT
330
END NET TAG
YES
NO
332
ASSIGN END SEGMENT TO NET TABLE
2

FIG. 12D

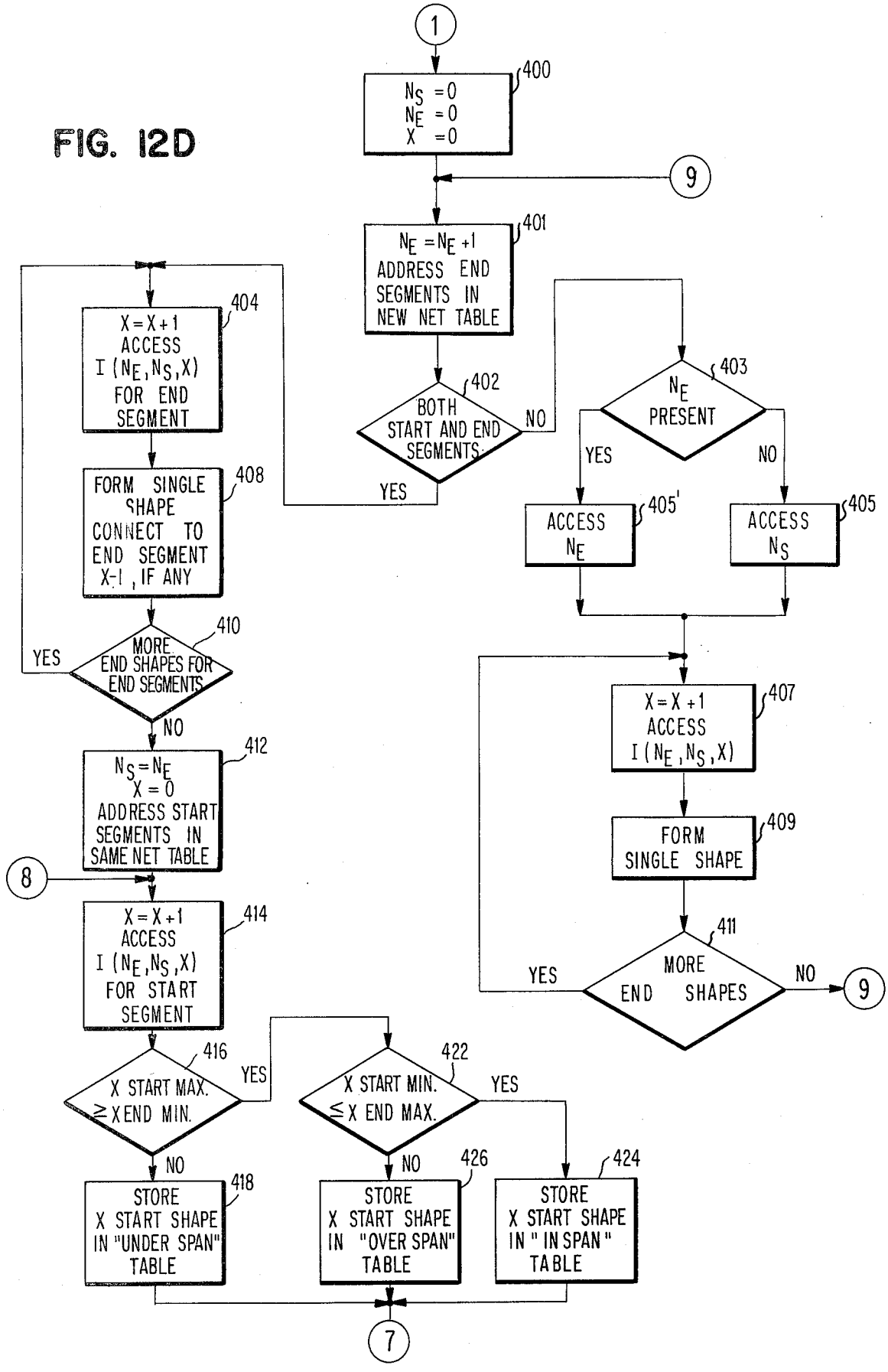

1
400
$N_S = 0$
$N_E = 0$
$X = 0$
9
401
$N_E = N_E + 1$
ADDRESS END SEGMENTS IN NEW NET TABLE
402
BOTH START AND END SEGMENTS
NO
YES
403
N_E PRESENT
YES
NO
405'
ACCESS N_E
405
ACCESS N_S
404
$X = X + 1$
ACCESS $I(N_E, N_S, X)$ FOR END SEGMENT
408
FORM SINGLE SHAPE CONNECT TO END SEGMENT X-1, IF ANY
410
MORE END SHAPES FOR END SEGMENTS
YES
NO
407
$X = X + 1$
ACCESS $I(N_E, N_S, X)$
409
FORM SINGLE SHAPE
411
MORE END SHAPES
YES
NO
9
412
$N_S = N_E$
$X = 0$
ADDRESS START SEGMENTS IN SAME NET TABLE
8
414
$X = X + 1$
ACCESS $I(N_E, N_S, X)$ FOR START SEGMENT
416
X START MAX. $\geq$ X END MIN.
YES
NO
422
X START MIN. $\leq$ X END MAX.
YES
NO
418
STORE X START SHAPE IN "UNDER SPAN" TABLE
426
STORE X START SHAPE IN "OVER SPAN" TABLE
424
STORE X START SHAPE IN "IN SPAN" TABLE
7

FIG. 12E

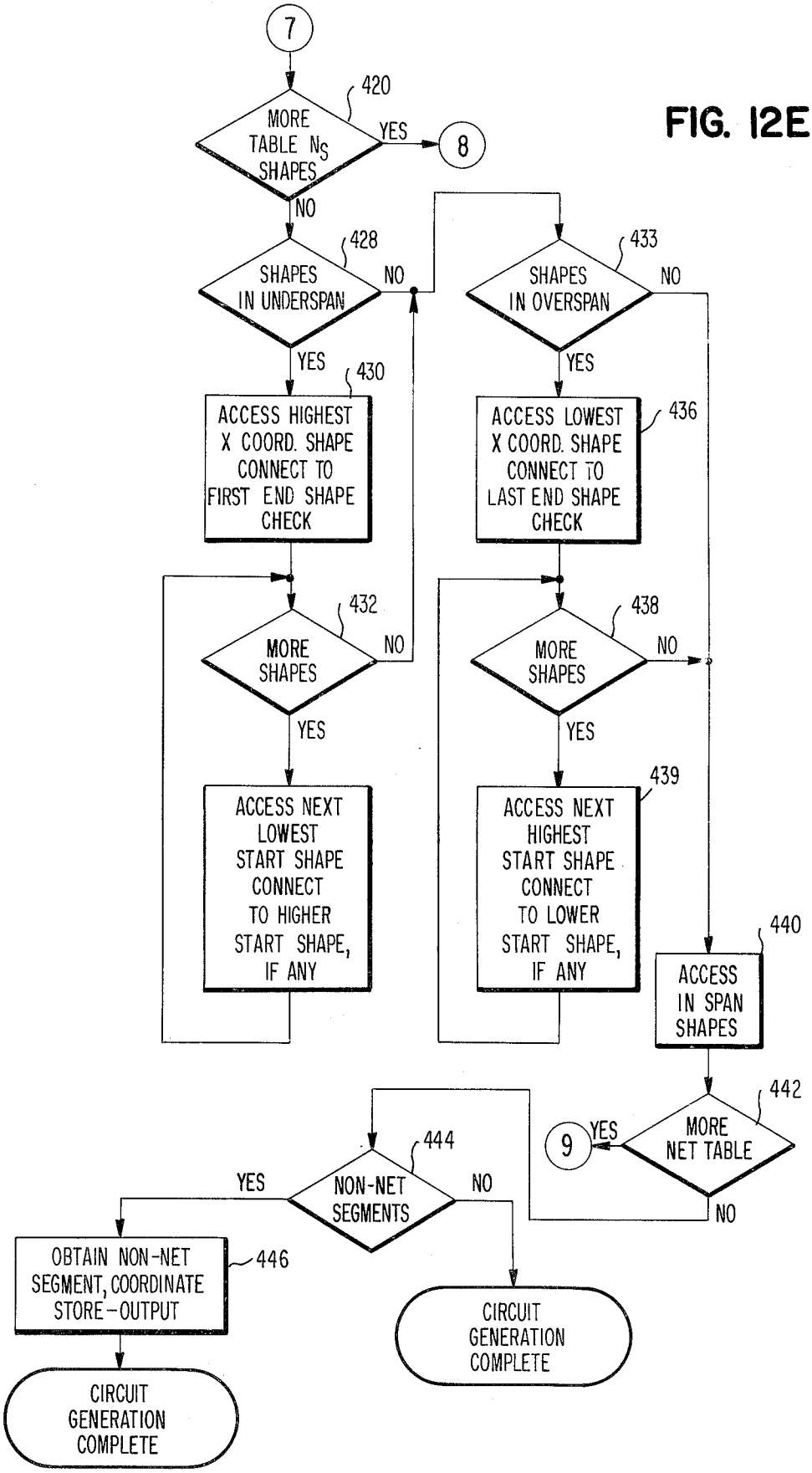

7
420
MORE TABLE N_S SHAPES
YES
8
NO
428
SHAPES IN UNDERSPAN
NO
YES
430
ACCESS HIGHEST X COORD. SHAPE CONNECT TO FIRST END SHAPE CHECK
432
MORE SHAPES
NO
YES
ACCESS NEXT LOWEST START SHAPE CONNECT TO HIGHER START SHAPE, IF ANY
433
SHAPES IN OVERSPAN
NO
YES
436
ACCESS LOWEST X COORD. SHAPE CONNECT TO LAST END SHAPE CHECK
438
MORE SHAPES
NO
YES
439
ACCESS NEXT HIGHEST START SHAPE CONNECT TO LOWER START SHAPE, IF ANY
440
ACCESS IN SPAN SHAPES
442
MORE NET TABLE
9
YES
NO
444
NON-NET SEGMENTS
YES
NO
446
OBTAIN NON-NET SEGMENT, COORDINATE STORE-OUTPUT
CIRCUIT GENERATION COMPLETE
CIRCUIT GENERATION COMPLETE

FIG. 12F

