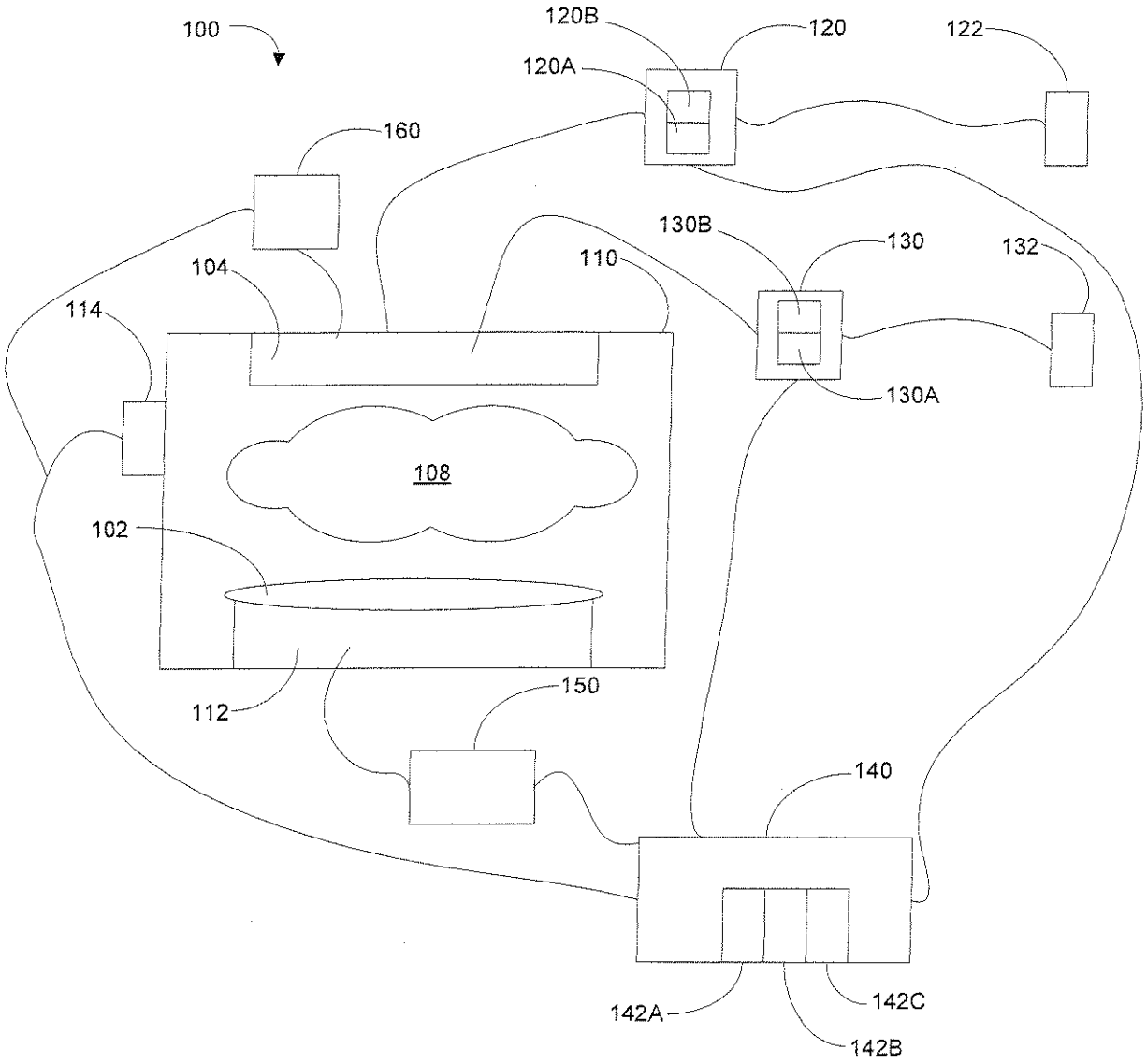

100
120B
120
122
120A
160
130B
130
132
110
104
114
130A
108
102
112
150
140
142A
142C
142B

FIGURE 1

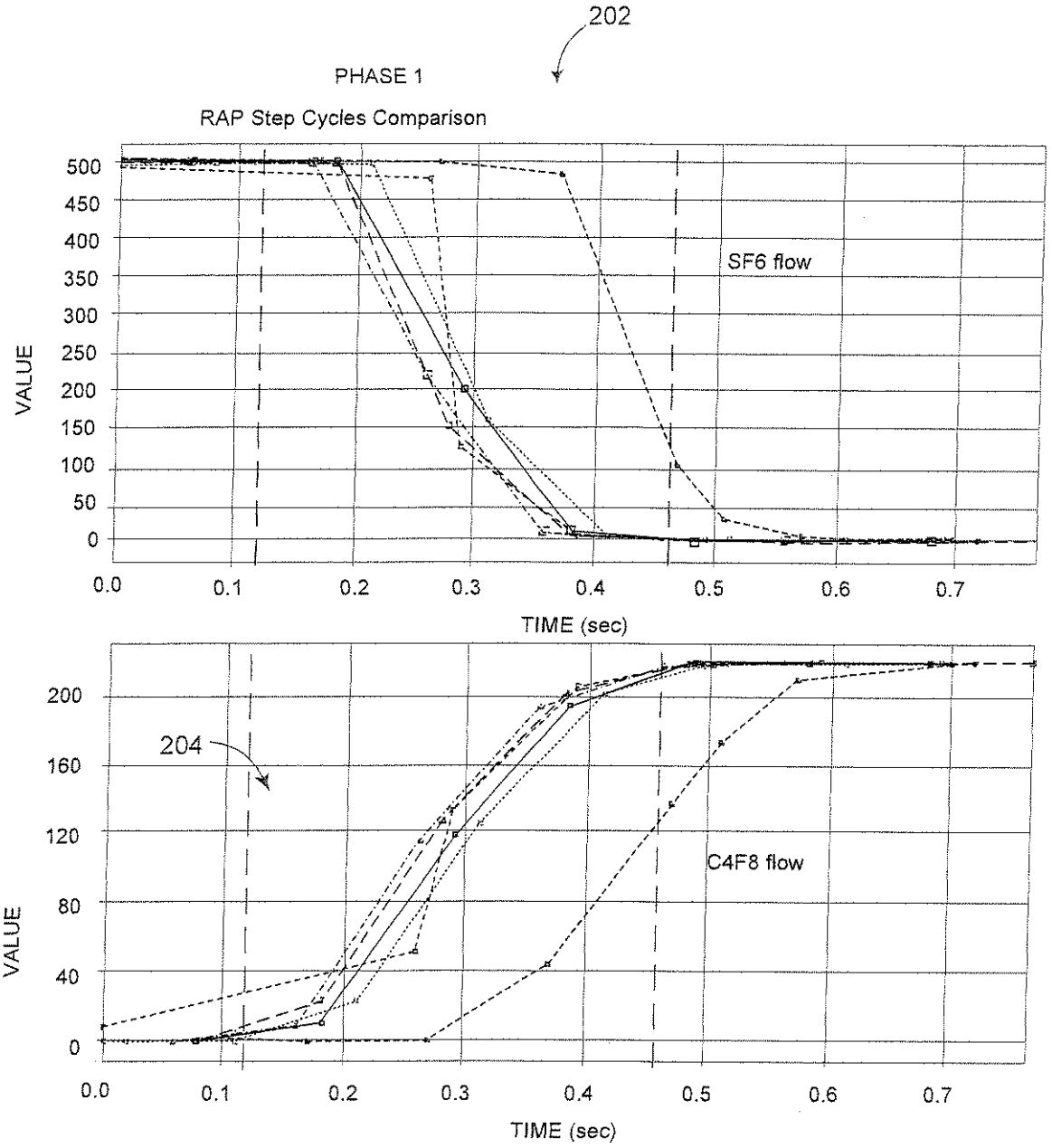

202
PHASE 1
RAP Step Cycles Comparison
500
450
400
350
300
250
200
150
100
50
0
VALUE
SF6 flow
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
TIME (sec)
200
160
120
80
40
0
204
C4F8 flow
VALUE
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
TIME (sec)

FIGURE 2A

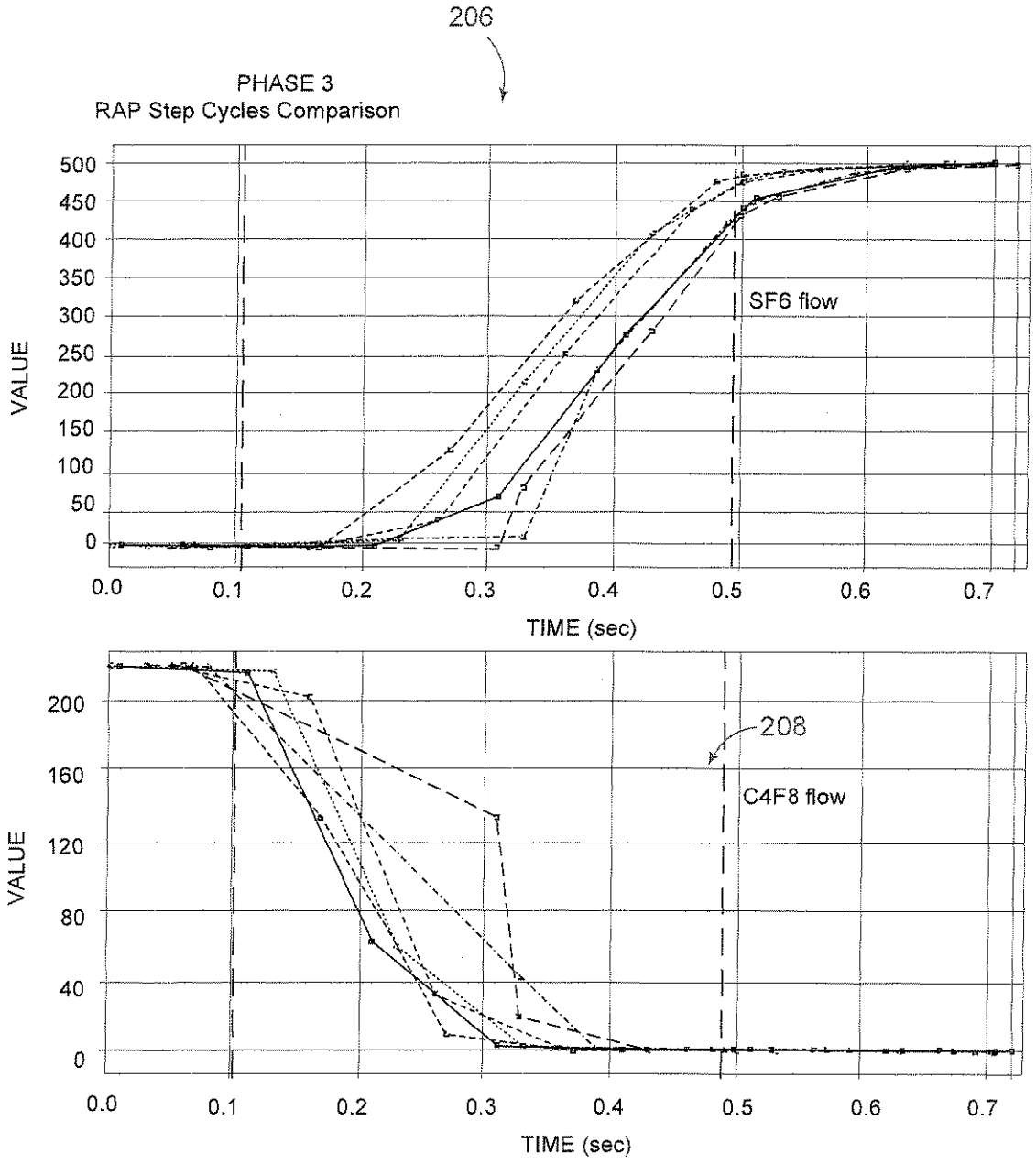

206
PHASE 3
RAP Step Cycles Comparison
VALUE
500
450
400
350
300
250
200
150
100
50
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
TIME (sec)
SF6 flow
208
C4F8 flow
VALUE
200
160
120
80
40
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
TIME (sec)

FIGURE 2B

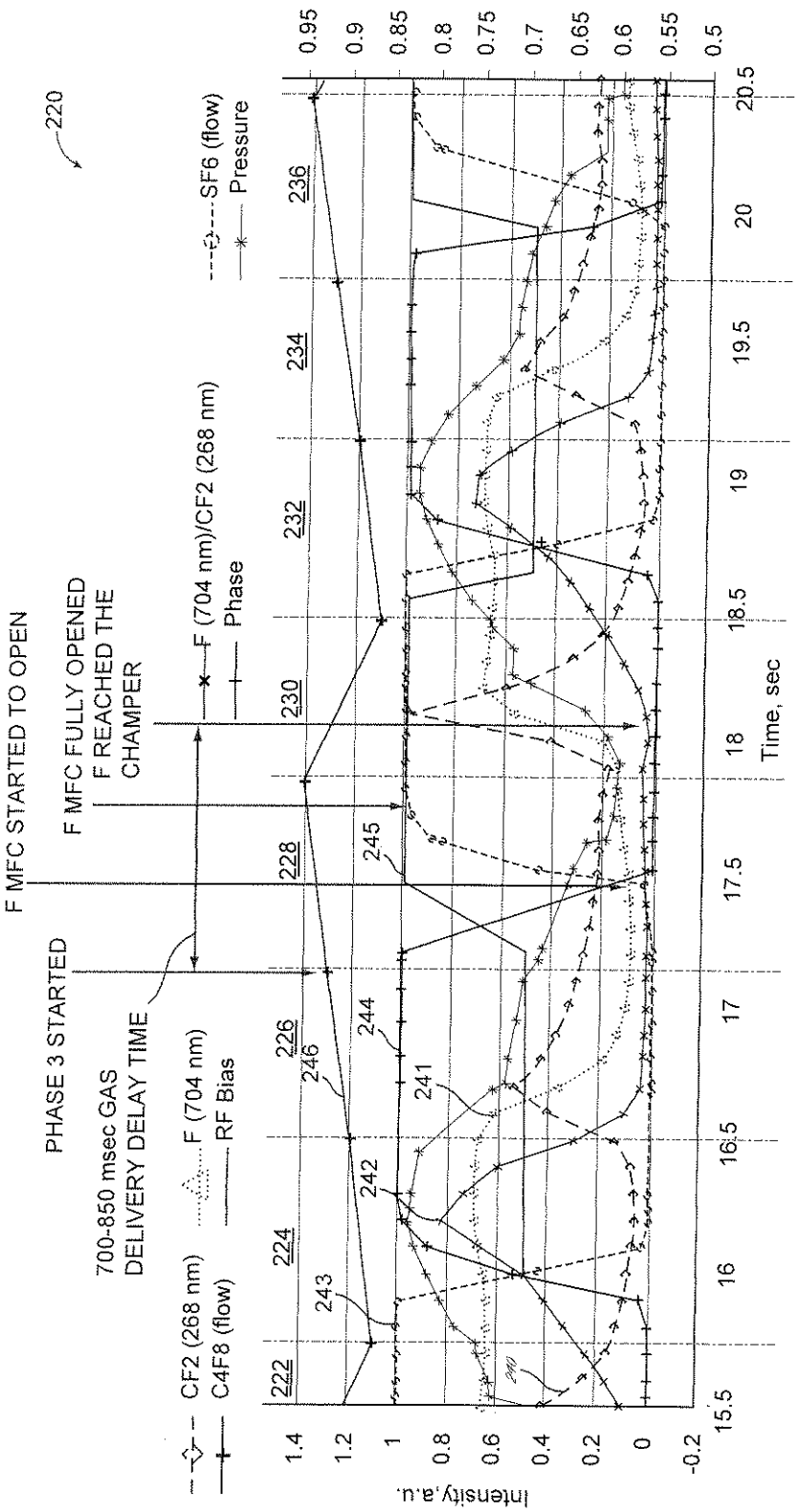

220
F MFC STARTED TO OPEN
F MFC FULLY OPENED
F REACHED THE
CHAMPER
PHASE 3 STARTED
700-850 msec GAS
DELIVERY DELAY TIME
CF2 (268 nm)
C4F8 (flow)
F (704 nm)
RF Bias
F (704 nm)/CF2 (268 nm)
Phase
SF6 (flow)
Pressure
Intensity,a.u.
Time, sec
222
224
226
228
230
232
234
236
241
242
243
244
245
246

FIGURE 2C

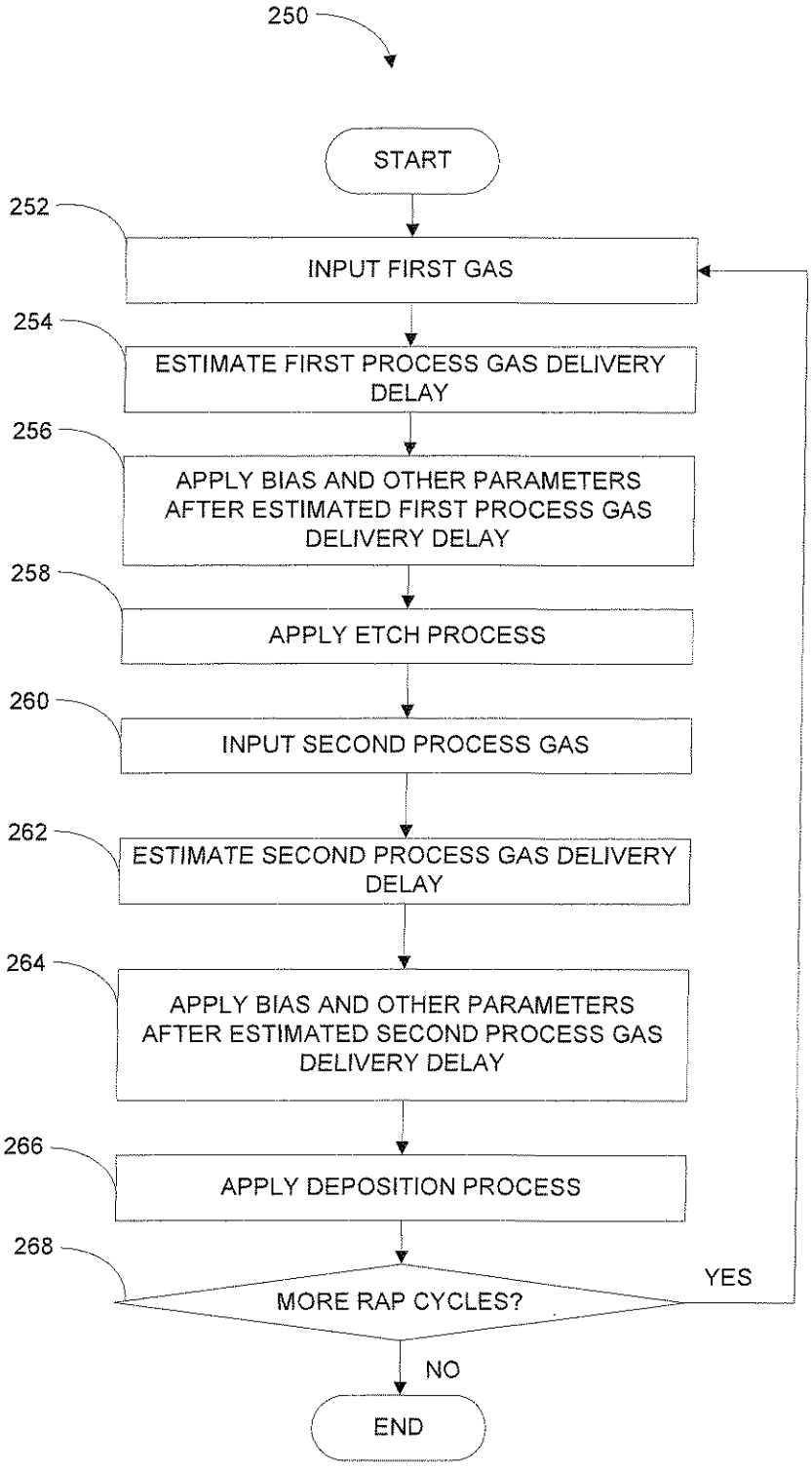

250
START
252
INPUT FIRST GAS
254
ESTIMATE FIRST PROCESS GAS DELIVERY DELAY
256
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED FIRST PROCESS GAS DELIVERY DELAY
258
APPLY ETCH PROCESS
260
INPUT SECOND PROCESS GAS
262
ESTIMATE SECOND PROCESS GAS DELIVERY DELAY
264
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED SECOND PROCESS GAS DELIVERY DELAY
266
APPLY DEPOSITION PROCESS
268
MORE RAP CYCLES?
YES
NO
END

FIGURE 2D

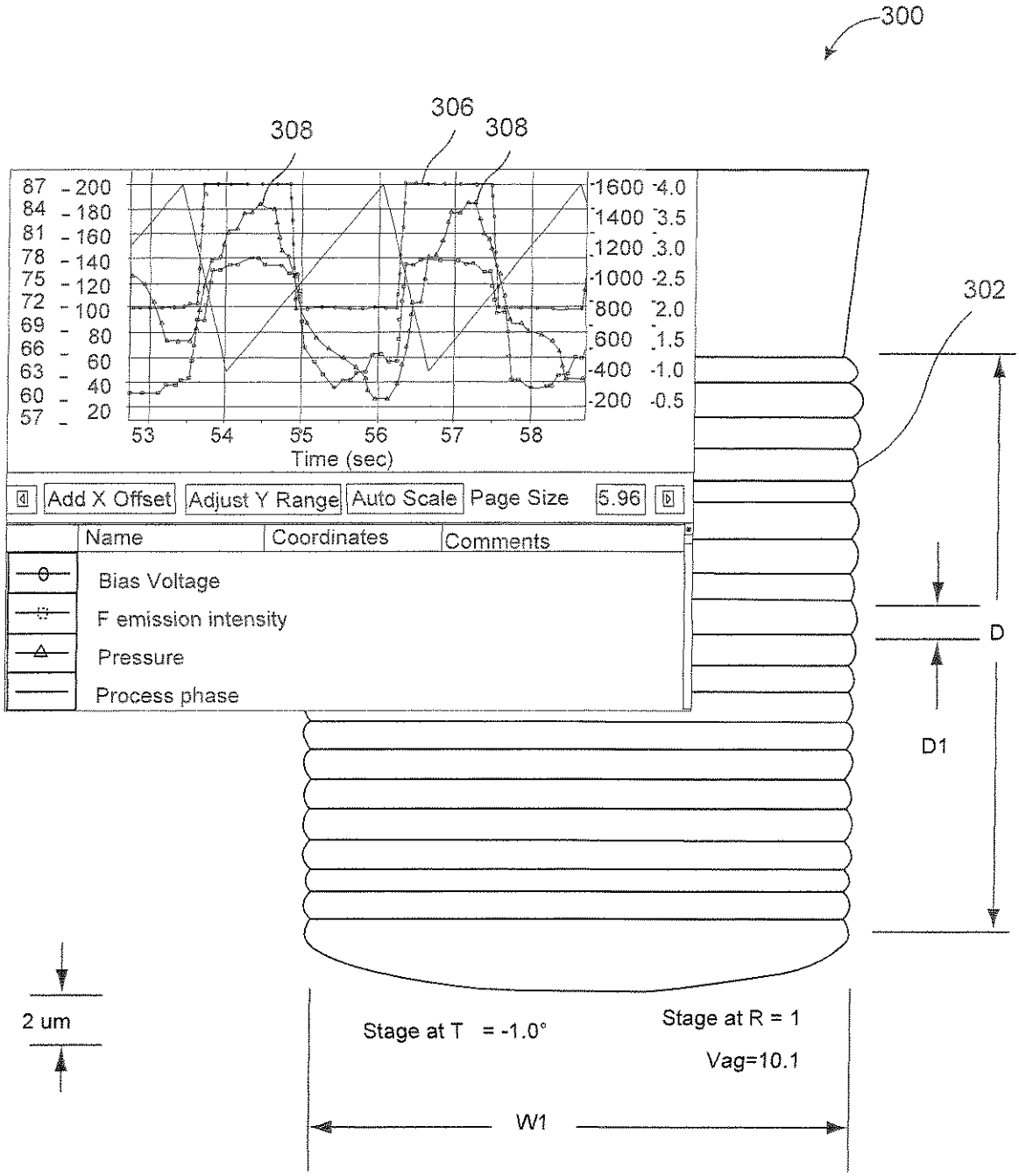

300
308
306
308
87 - 200
84 - 180
81 - 160
78 - 140
75 - 120
72 - 100
69 - 80
66 - 60
63 - 40
60 - 20
57 -
1600 -4.0
1400 3.5
1200 3.0
1000 -2.5
800 2.0
600 1.5
400 -1.0
200 -0.5
53 54 55 56 57 58
Time (sec)
Add X Offset
Adjust Y Range
Auto Scale
Page Size
5.96
Name
Coordinates
Comments
Bias Voltage
F emission intensity
Pressure
Process phase
302
D
D1
2 um
Stage at T = -1.0°
Stage at R = 1
Vag=10.1
W1

FIGURE 3A

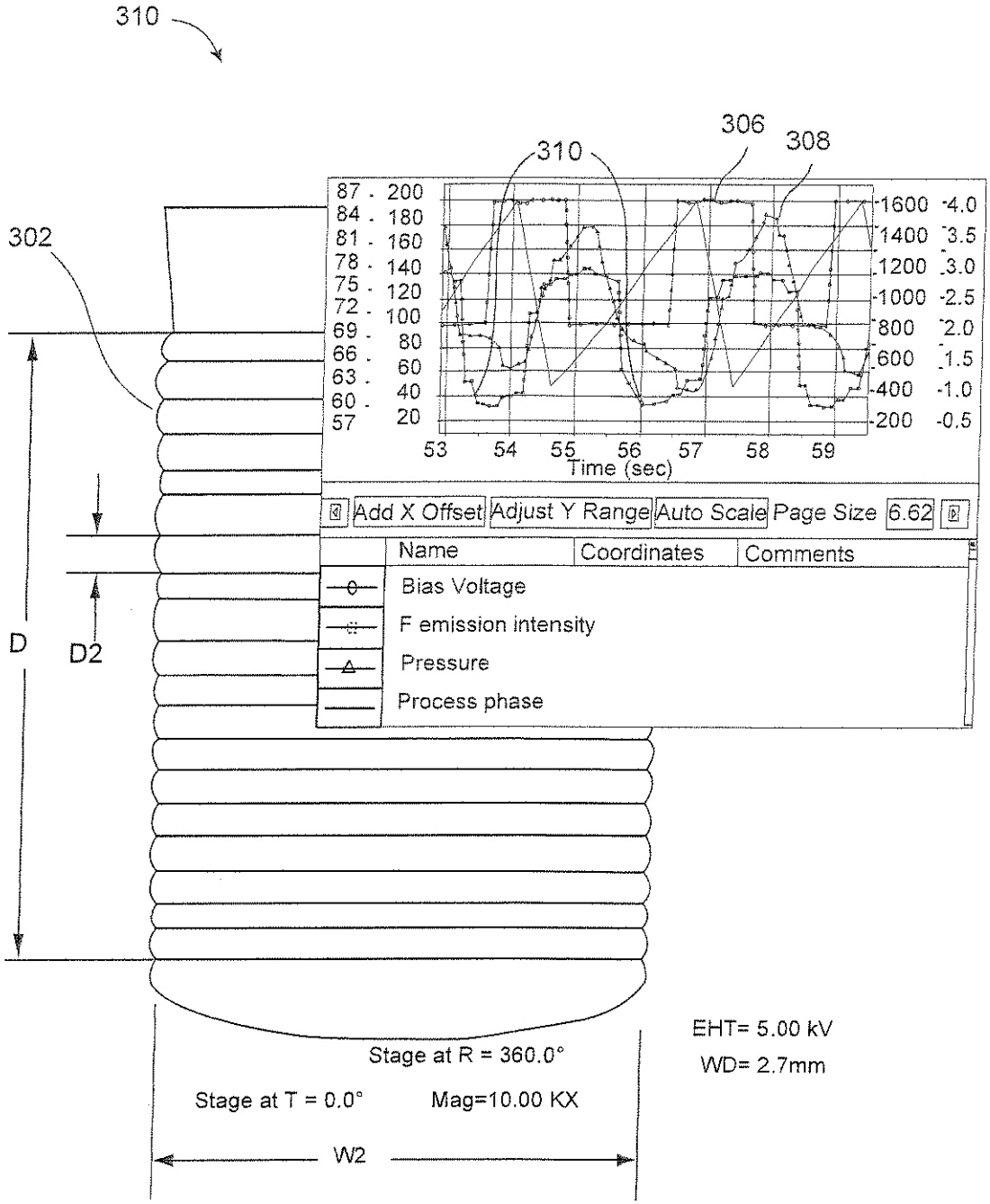

310
306
308
310
302
87 . 200
84 . 180
81 . 160
78 . 140
75 . 120
72 . 100
69 . 80
66 . 60
63 . 40
60 . 20
57
1600 -4.0
1400 -3.5
1200 -3.0
1000 -2.5
800 -2.0
600 -1.5
400 -1.0
200 -0.5
53 54 55 56 57 58 59
Time (sec)
Add X Offset
Adjust Y Range
Auto Scale
Page Size
6.62
Name
Coordinates
Comments
Bias Voltage
F emission intensity
Pressure
Process phase
D
D2
Stage at R = 360.0°
Stage at T = 0.0°
Mag=10.00 KX
EHT= 5.00 kV
WD= 2.7mm
W2

FIGURE 3B

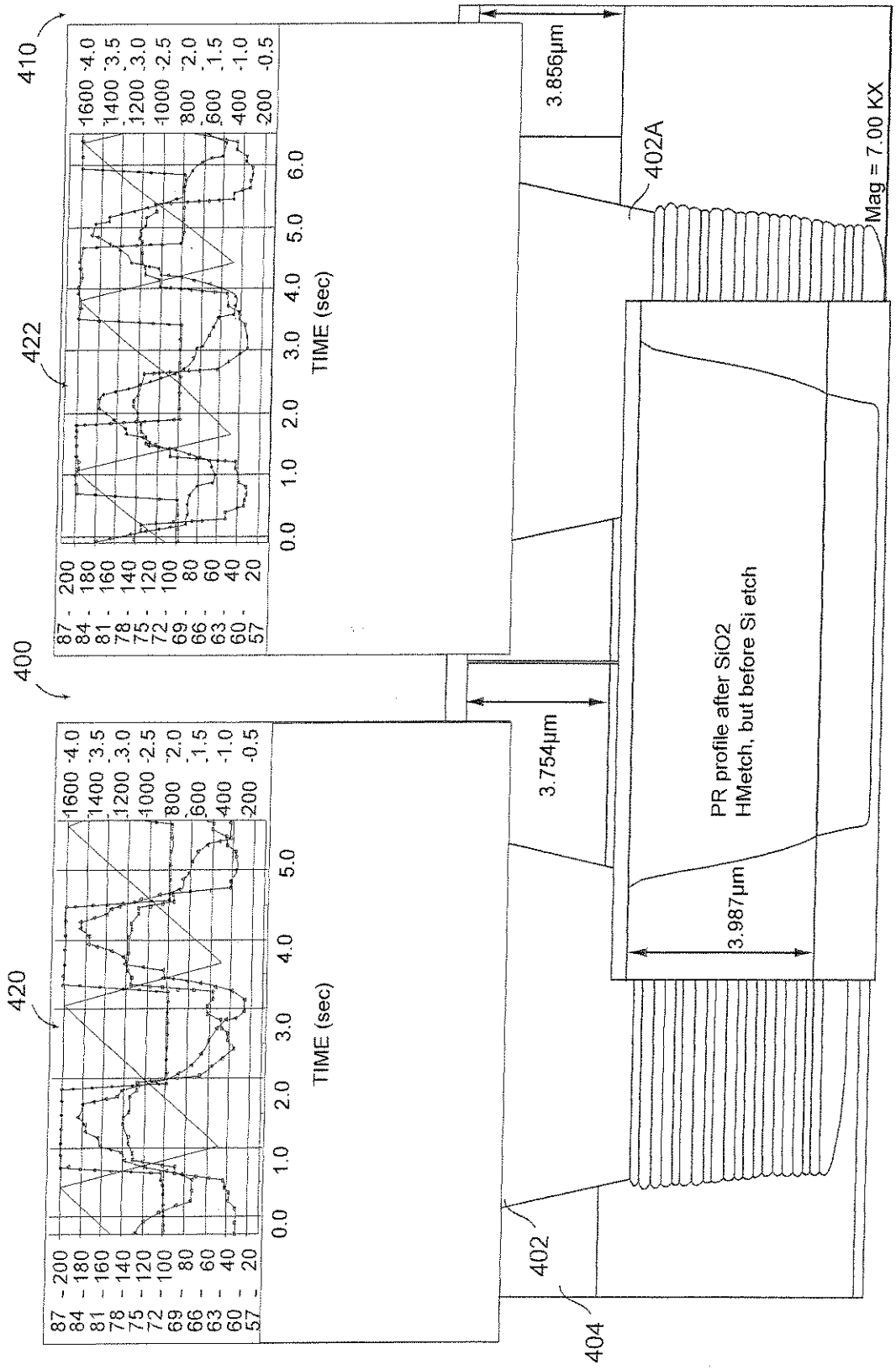

410
422
400
420
402
404
402A
3.856µm
3.754µm
3.987µm
PR profile after SiO2
HMetch, but before Si etch
Mag = 7.00 KX
TIME (sec)
TIME (sec)

FIGURE 4

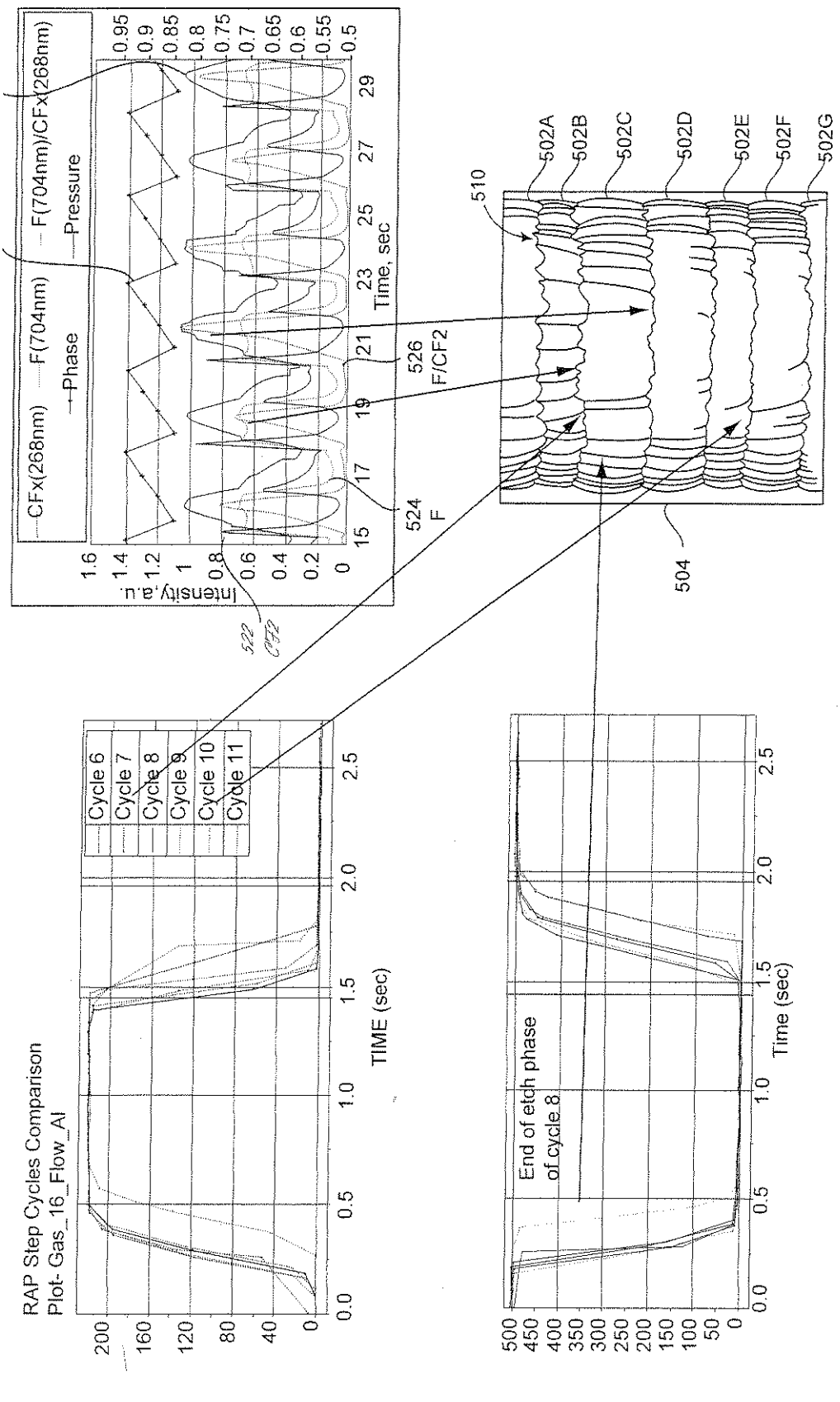


FIGURE 5A

FIGURE 5B

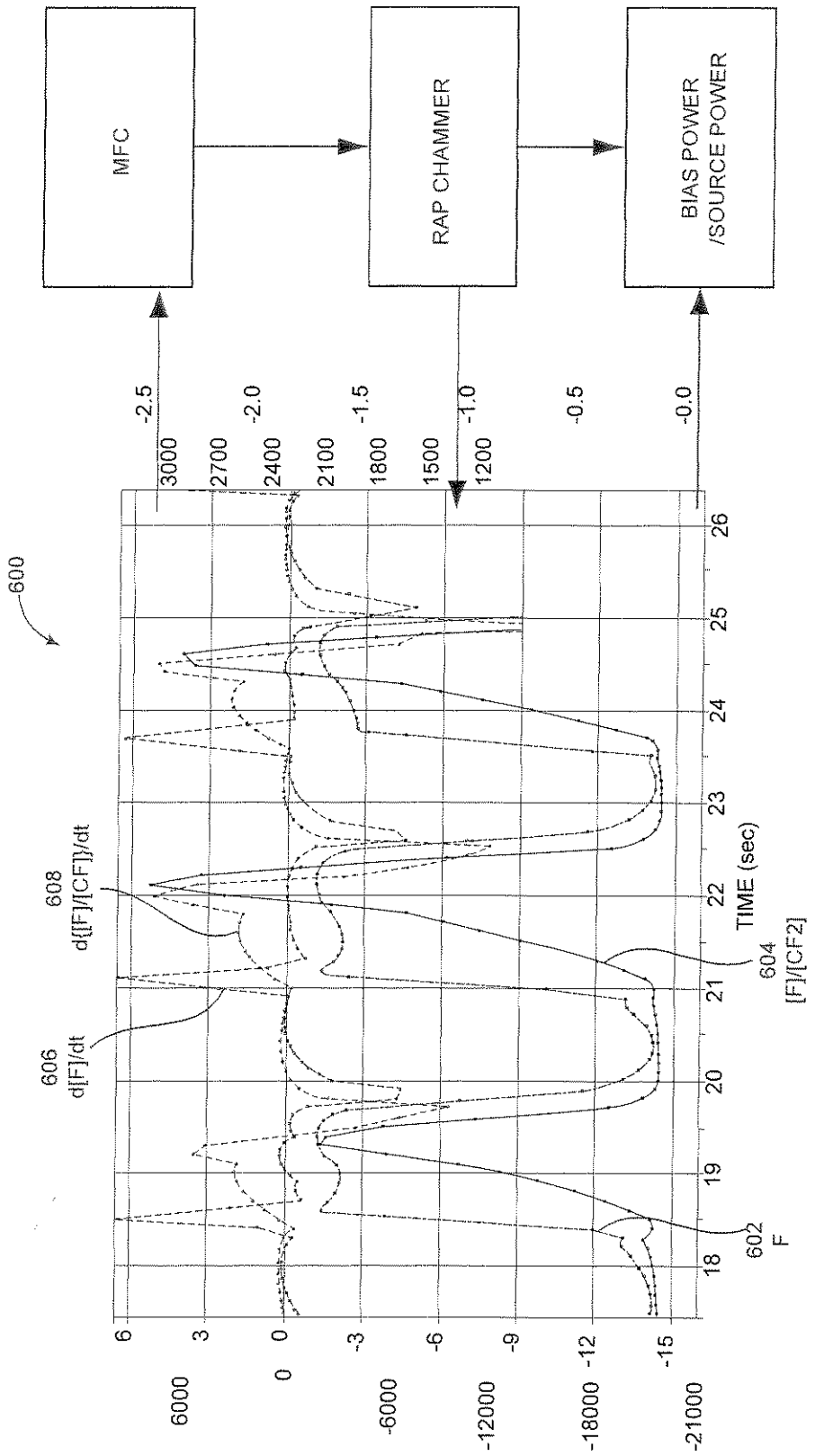

MFC
RAP CHAMMER
BIAS POWER
/SOURCE POWER
600
608
d([F]/[CF])/dt
606
d[F]/dt
602
F
604
[F]/[CF2]
TIME (sec)

FIGURE 6

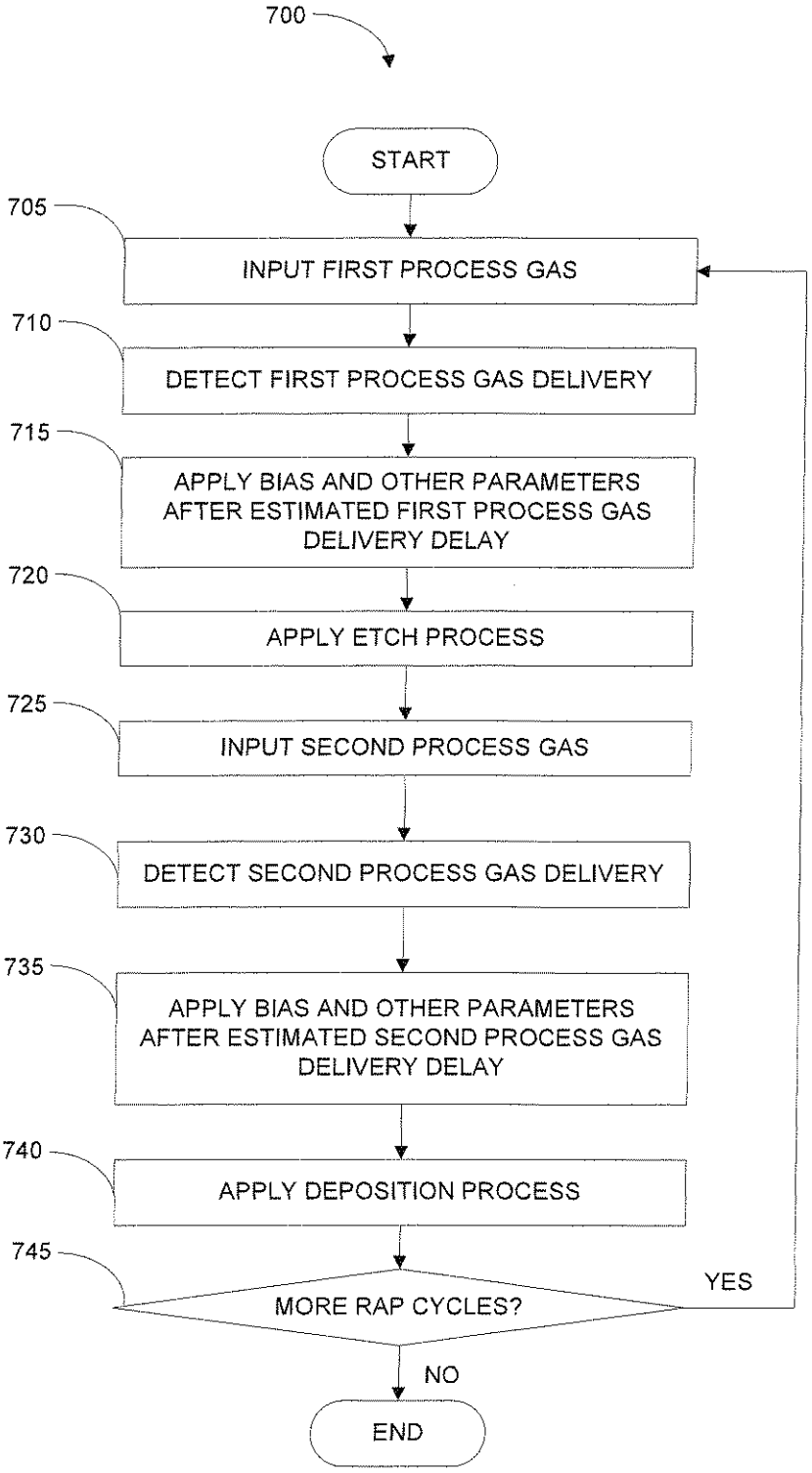

700
START
705
INPUT FIRST PROCESS GAS
710
DETECT FIRST PROCESS GAS DELIVERY
715
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED FIRST PROCESS GAS DELIVERY DELAY
720
APPLY ETCH PROCESS
725
INPUT SECOND PROCESS GAS
730
DETECT SECOND PROCESS GAS DELIVERY
735
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED SECOND PROCESS GAS DELIVERY DELAY
740
APPLY DEPOSITION PROCESS
745
MORE RAP CYCLES?
YES
NO
END

FIGURE 7

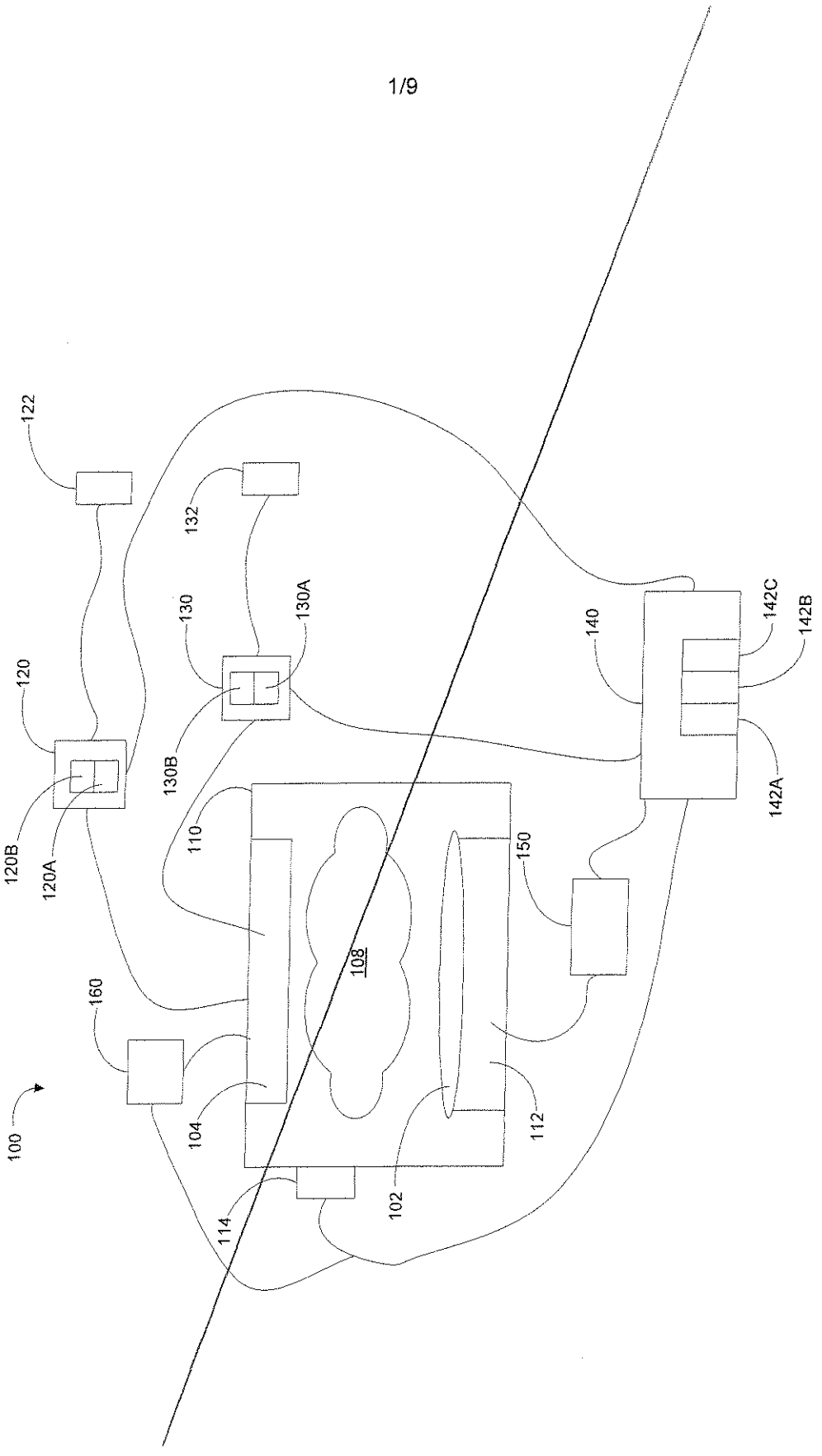

100
102
104
108
110
112
114
120
120A
120B
122
130
130A
130B
132
140
142A
142B
142C
150
160

FIGURE 1

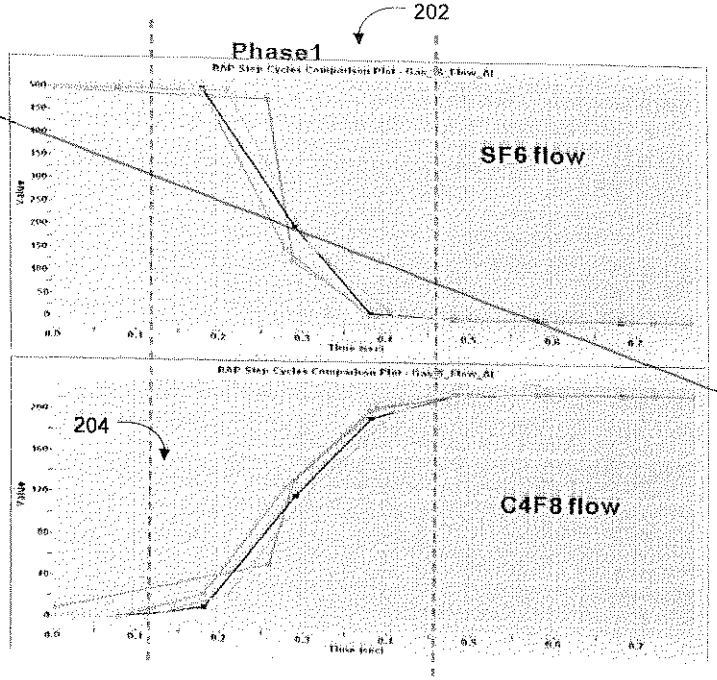


FIGURE 2A

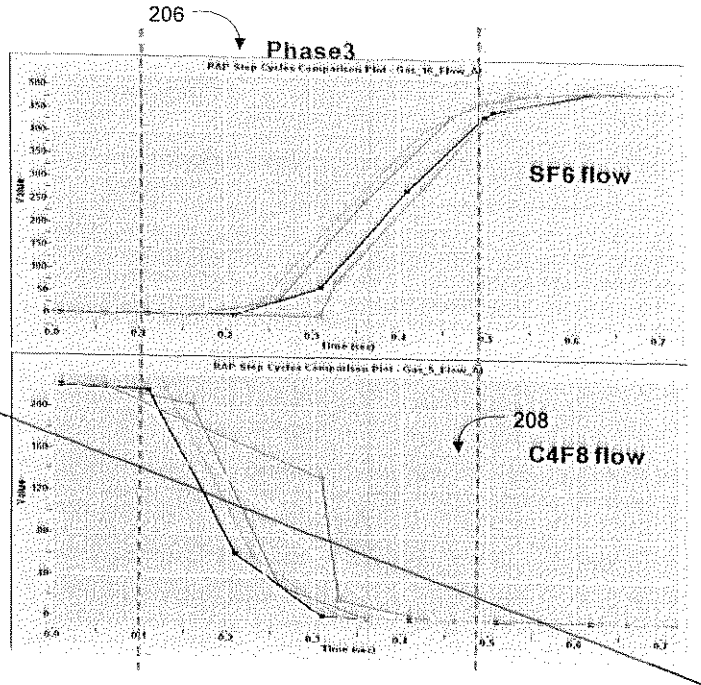


FIGURE 2B

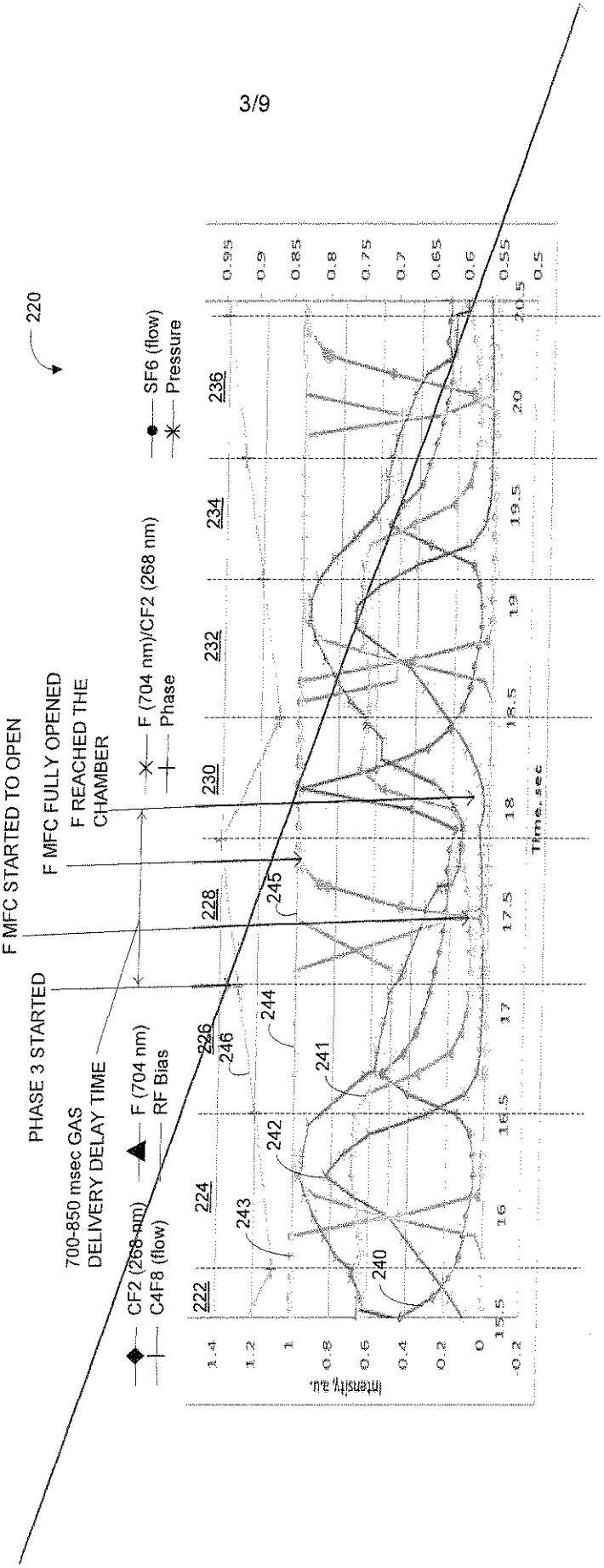

220
F MFC STARTED TO OPEN
F MFC FULLY OPENED
F REACHED THE CHAMBER
PHASE 3 STARTED
700-850 msec GAS DELIVERY DELAY TIME
CF2 (268 nm)
C4F8 (flow)
F (704 nm)
RF Bias
F (704 nm)/CF2 (268 nm) Phase
SF6 (flow)
Pressure
Intensity, a.u.
Time, sec
222
224
226
228
230
232
234
236
240
241
242
243
244
245
246

FIGURE 2C

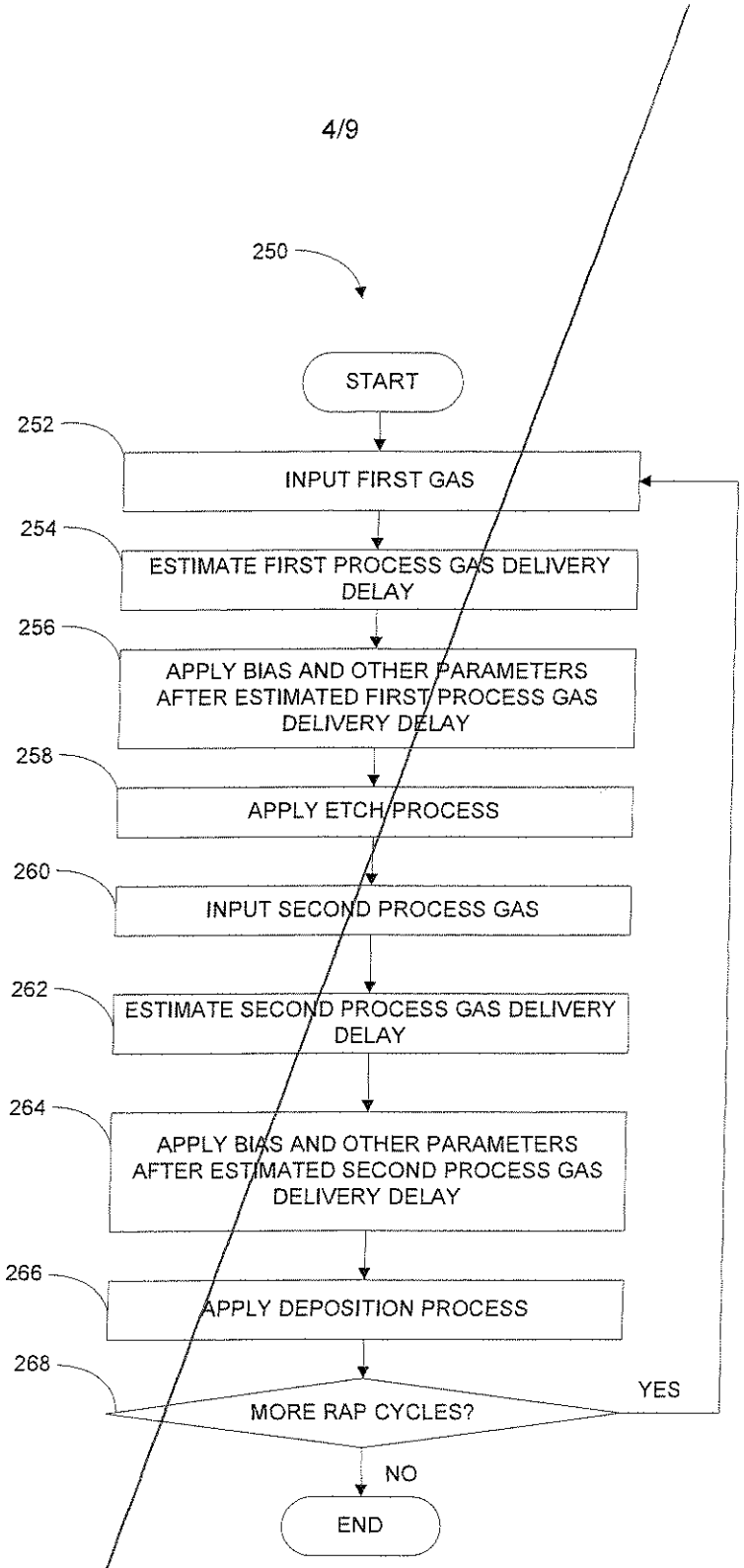

250
START
252
INPUT FIRST GAS
254
ESTIMATE FIRST PROCESS GAS DELIVERY DELAY
256
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED FIRST PROCESS GAS DELIVERY DELAY
258
APPLY ETCH PROCESS
260
INPUT SECOND PROCESS GAS
262
ESTIMATE SECOND PROCESS GAS DELIVERY DELAY
264
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED SECOND PROCESS GAS DELIVERY DELAY
266
APPLY DEPOSITION PROCESS
268
MORE RAP CYCLES?
YES
NO
END

FIGURE 2D

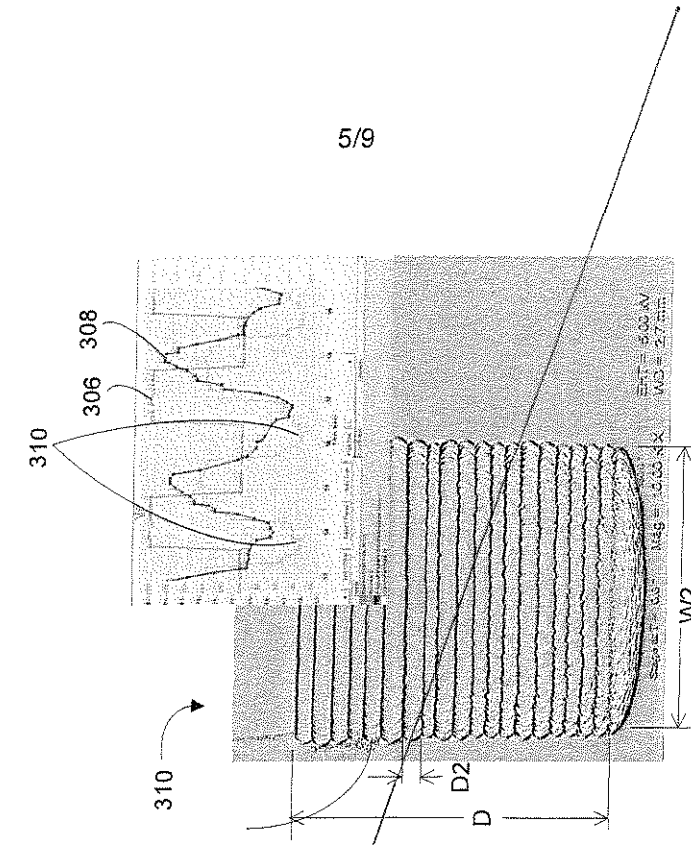


FIGURE 3B

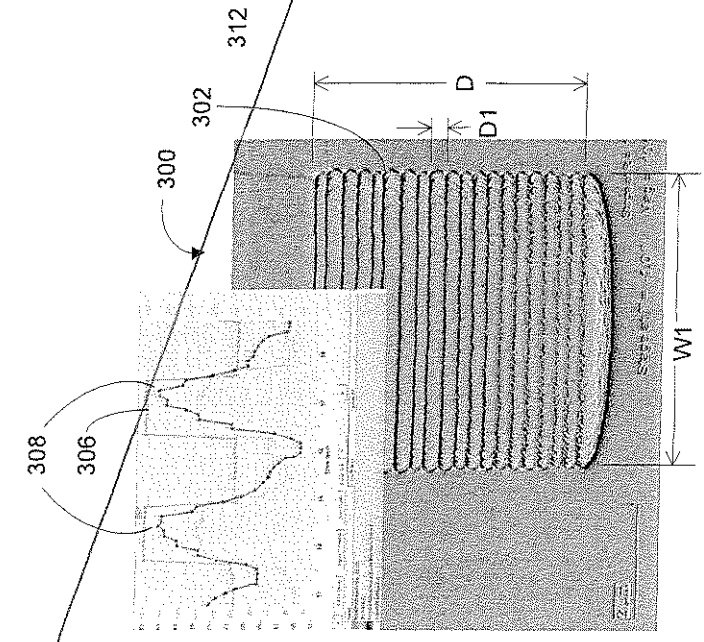


FIGURE 3A

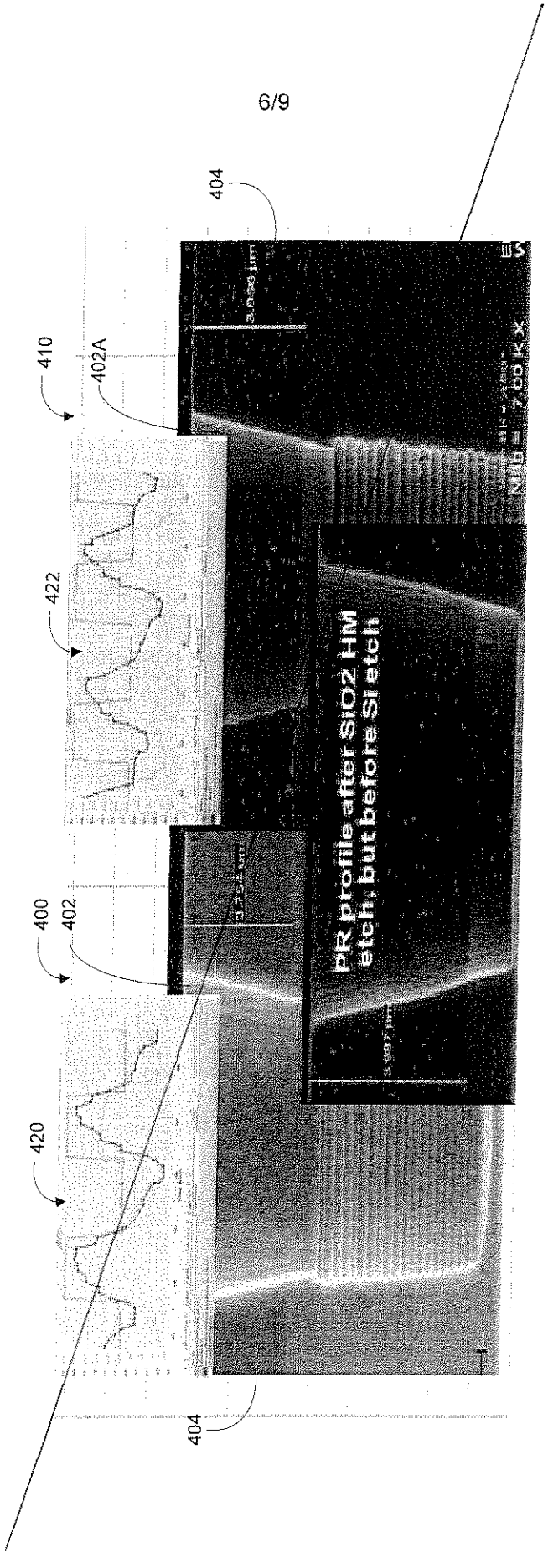

404
410
402A
422
400
402
420
404
PR profile after SiO2 HM etch, but before Si etch

FIGURE 4

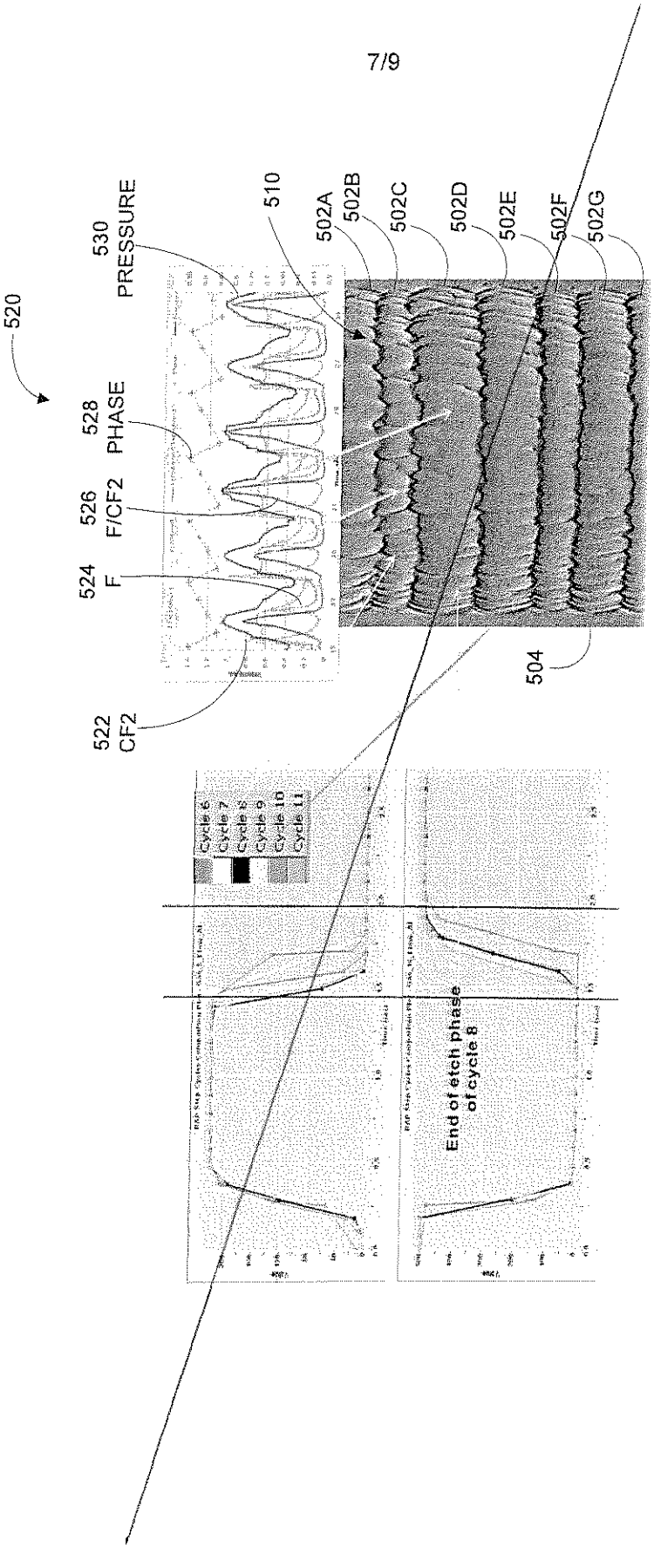


FIGURE 5A

FIGURE 5B

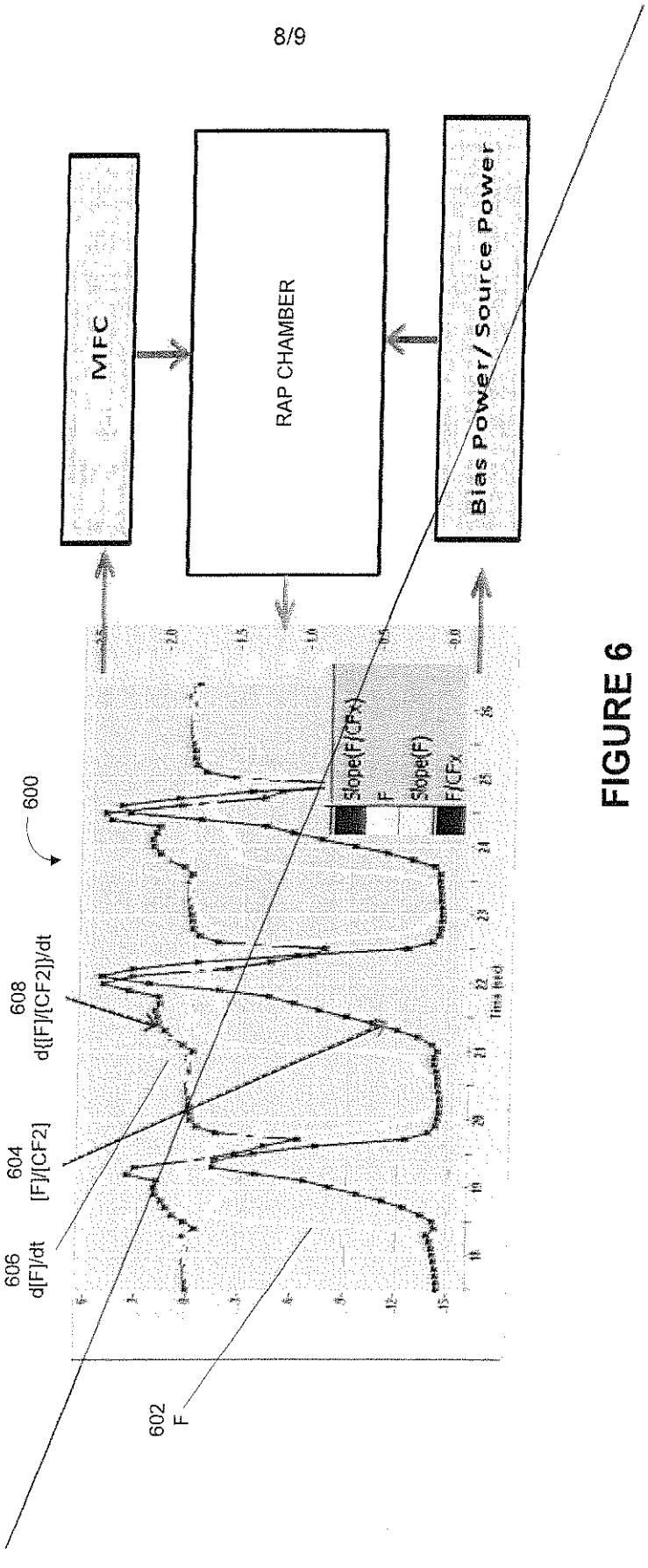

MFC
RAP CHAMBER
Bias Power/ Source Power
600
608
d{[F]/[CF2]}/dt
604
[F]/[CF2]
606
d[F]/dt
602
F
Slope(F/CFx)
F
Slope(F)
F/CFx

FIGURE 6

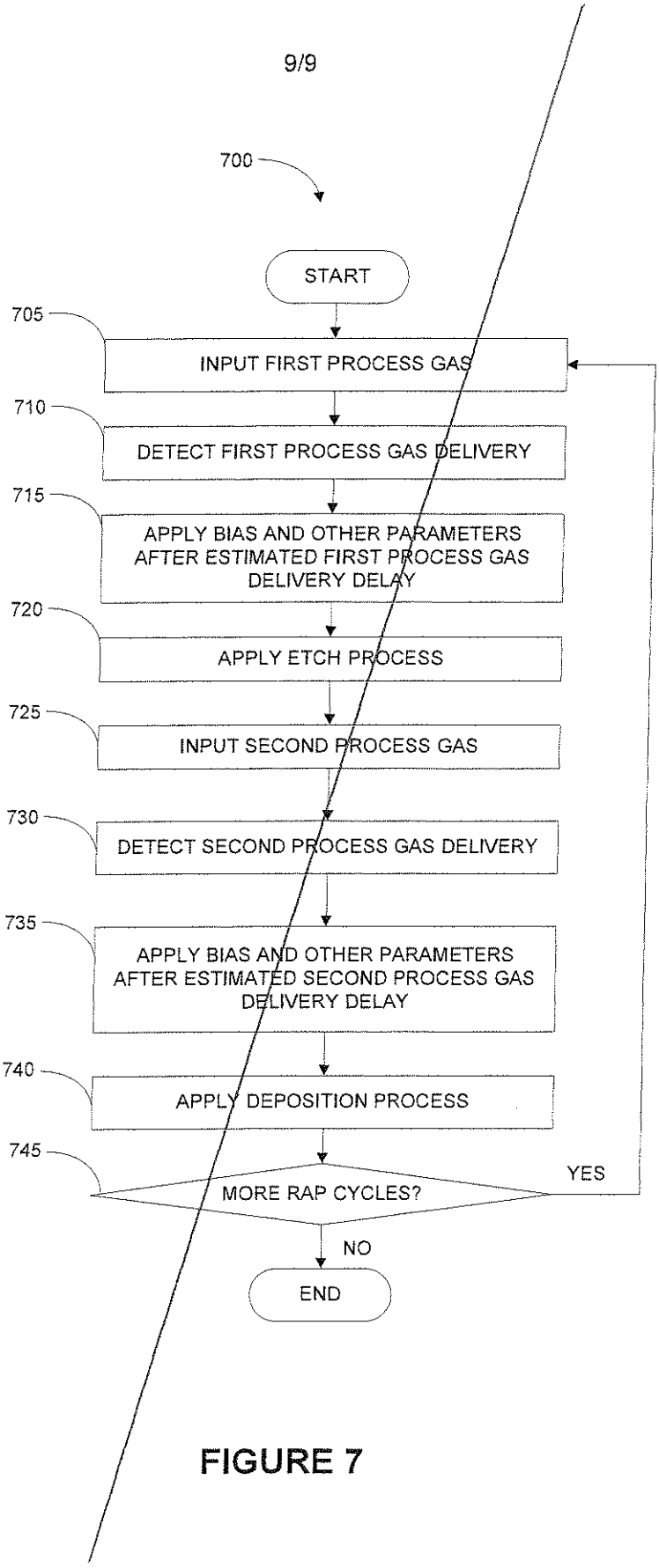

700
START
705
INPUT FIRST PROCESS GAS
710
DETECT FIRST PROCESS GAS DELIVERY
715
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED FIRST PROCESS GAS DELIVERY DELAY
720
APPLY ETCH PROCESS
725
INPUT SECOND PROCESS GAS
730
DETECT SECOND PROCESS GAS DELIVERY
735
APPLY BIAS AND OTHER PARAMETERS AFTER ESTIMATED SECOND PROCESS GAS DELIVERY DELAY
740
APPLY DEPOSITION PROCESS
745
MORE RAP CYCLES?
YES
NO
END

FIGURE 7