FIG. 1

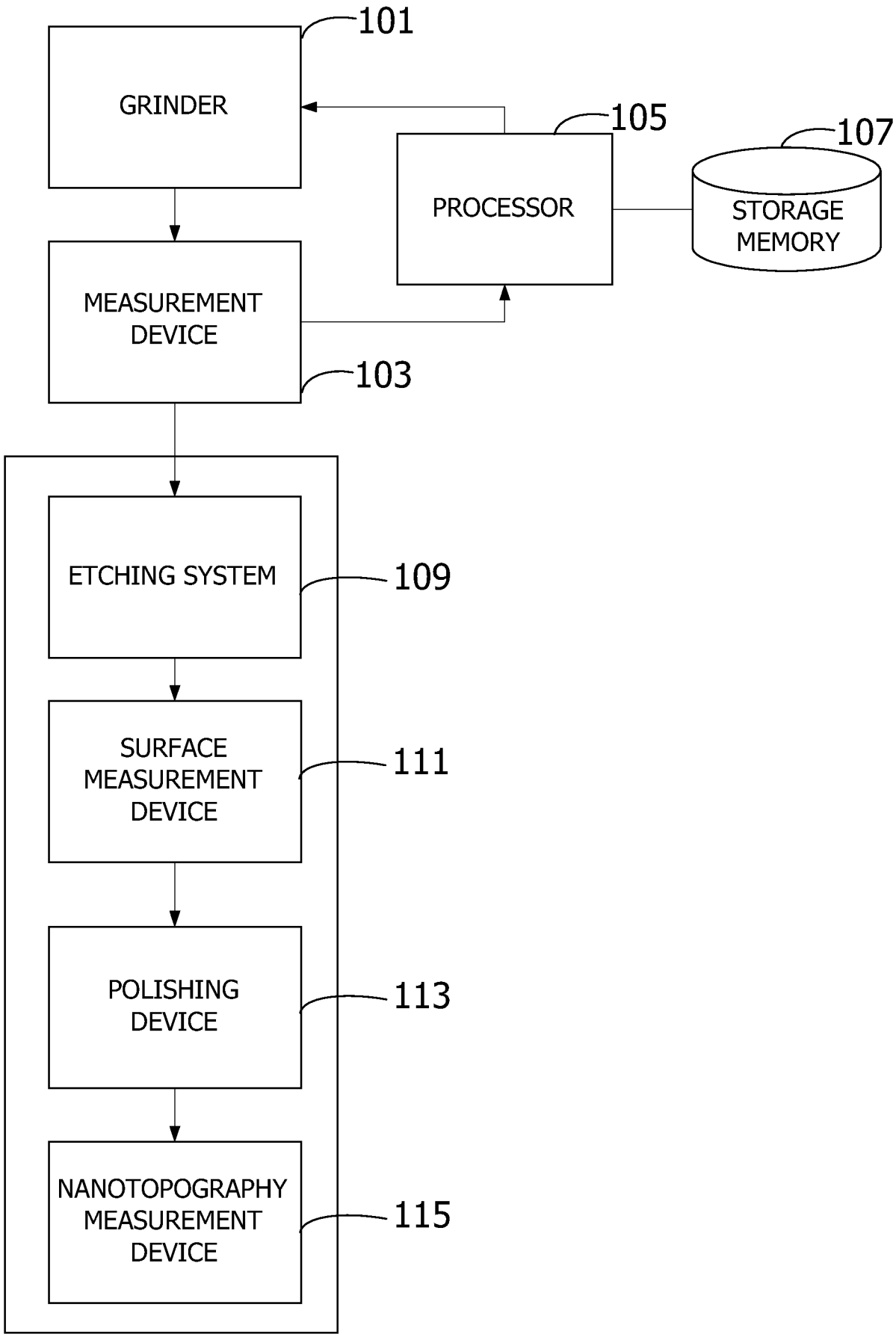

101
GRINDER
105
107
PROCESSOR
STORAGE MEMORY
MEASUREMENT DEVICE
103
ETCHING SYSTEM
109
SURFACE MEASUREMENT DEVICE
111
POLISHING DEVICE
113
NANOTOPOGRAPHY MEASUREMENT DEVICE
115

FIG. 2

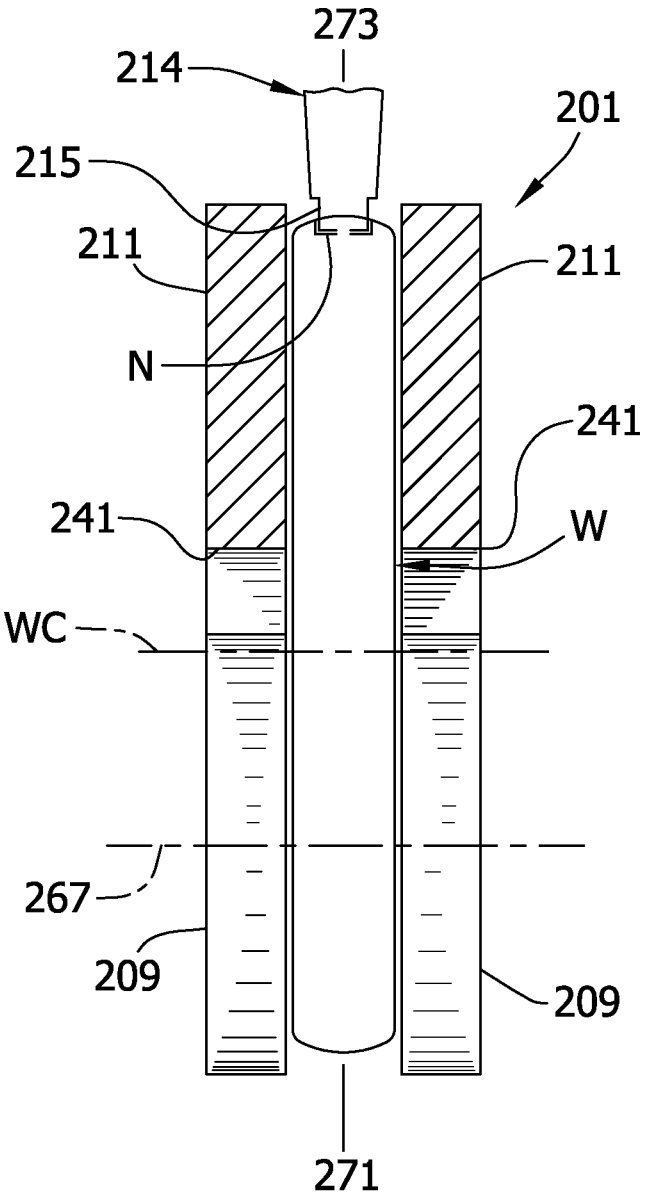


FIG. 3

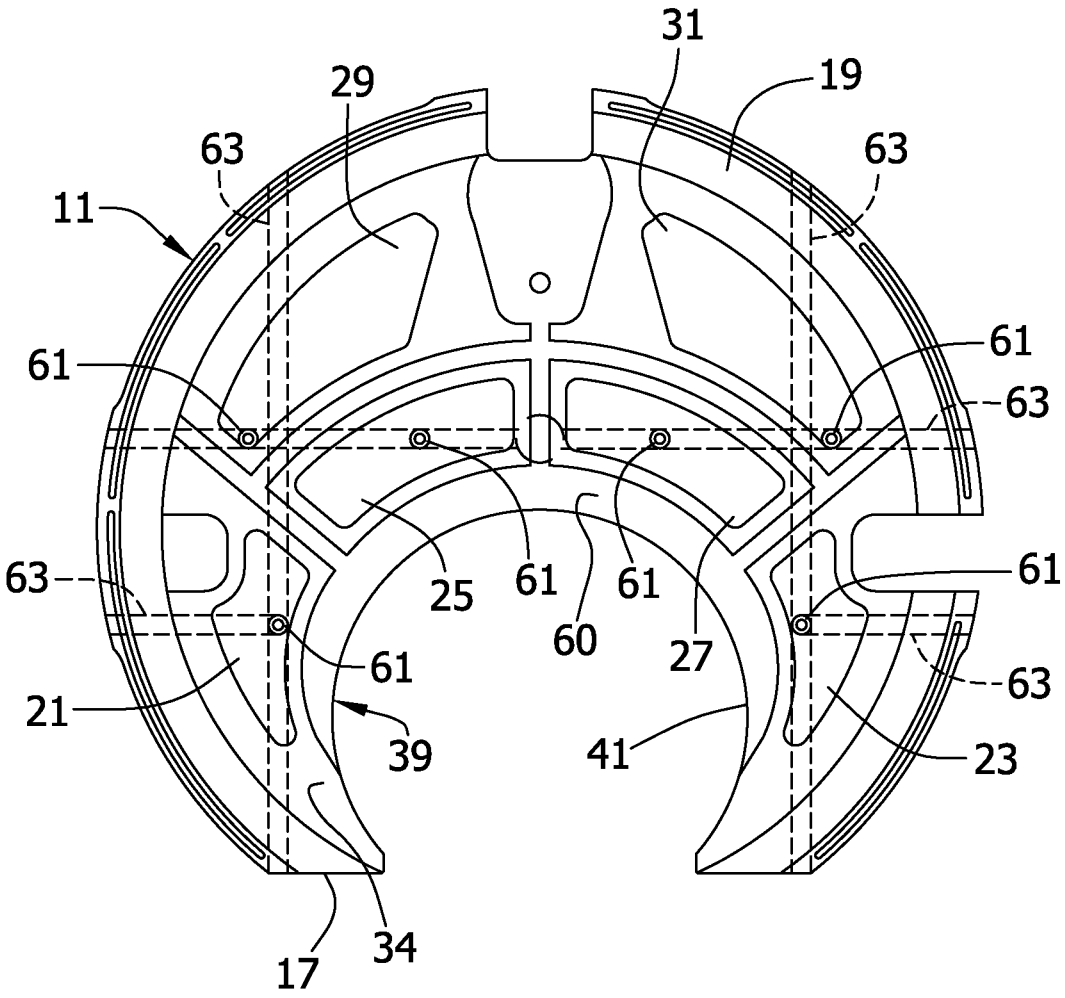


FIG. 4

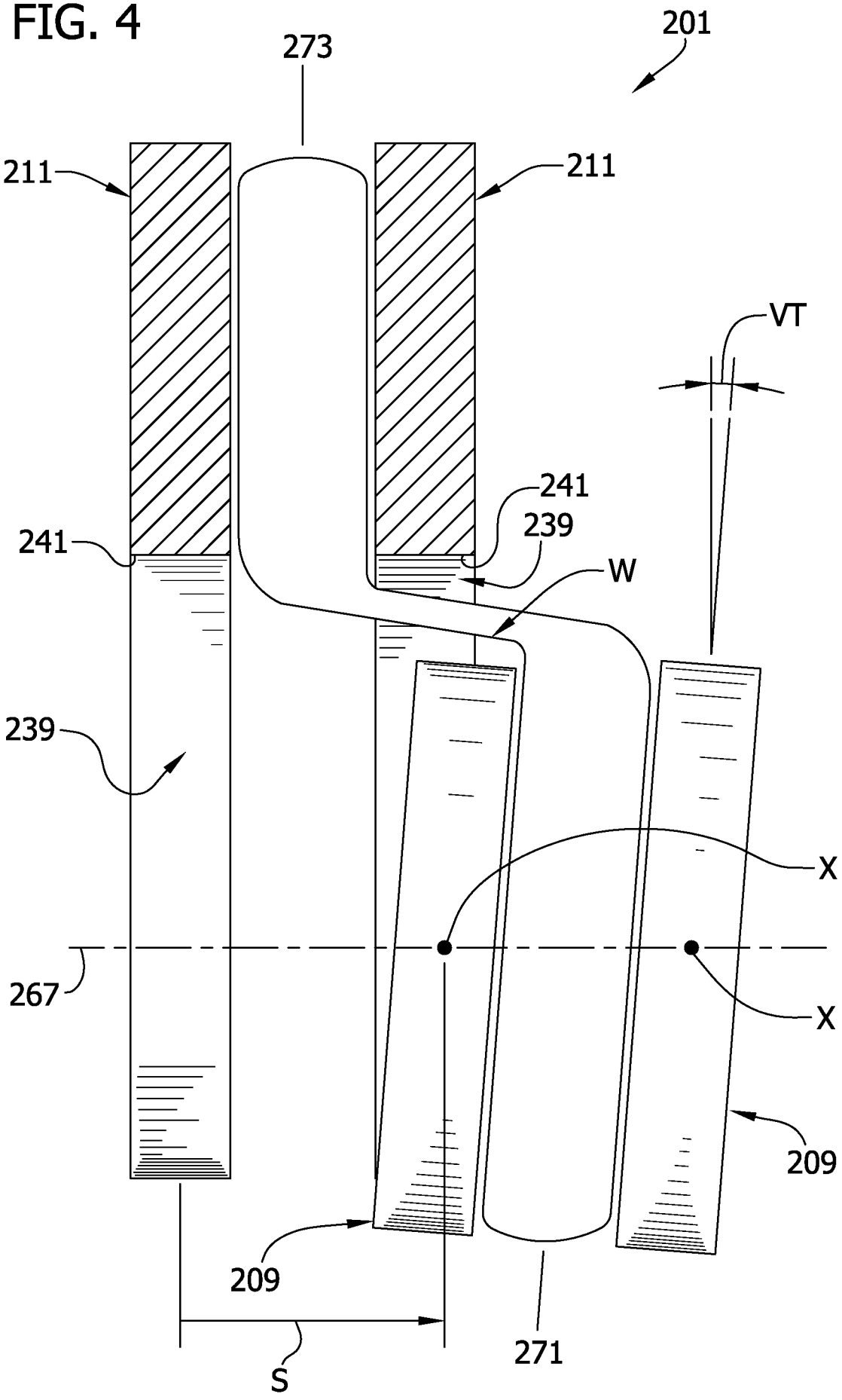


FIG. 5A

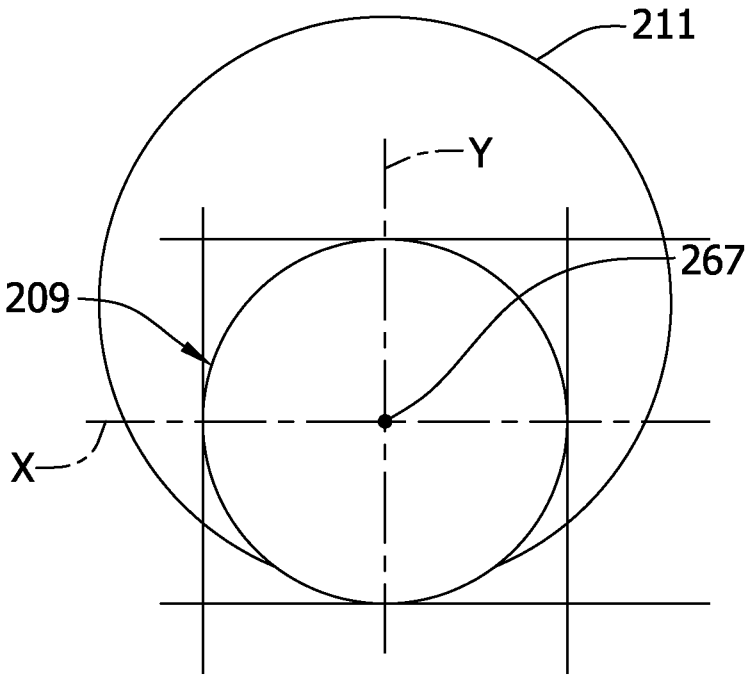


FIG. 5C

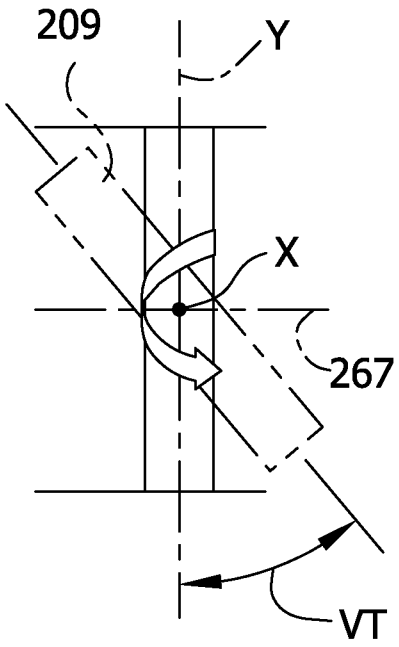


FIG. 5B

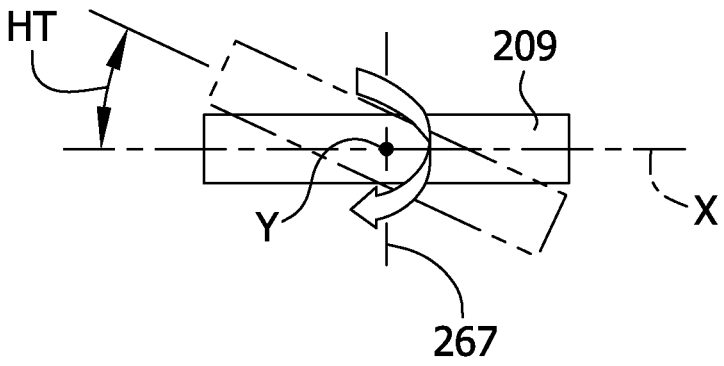


FIG. 6

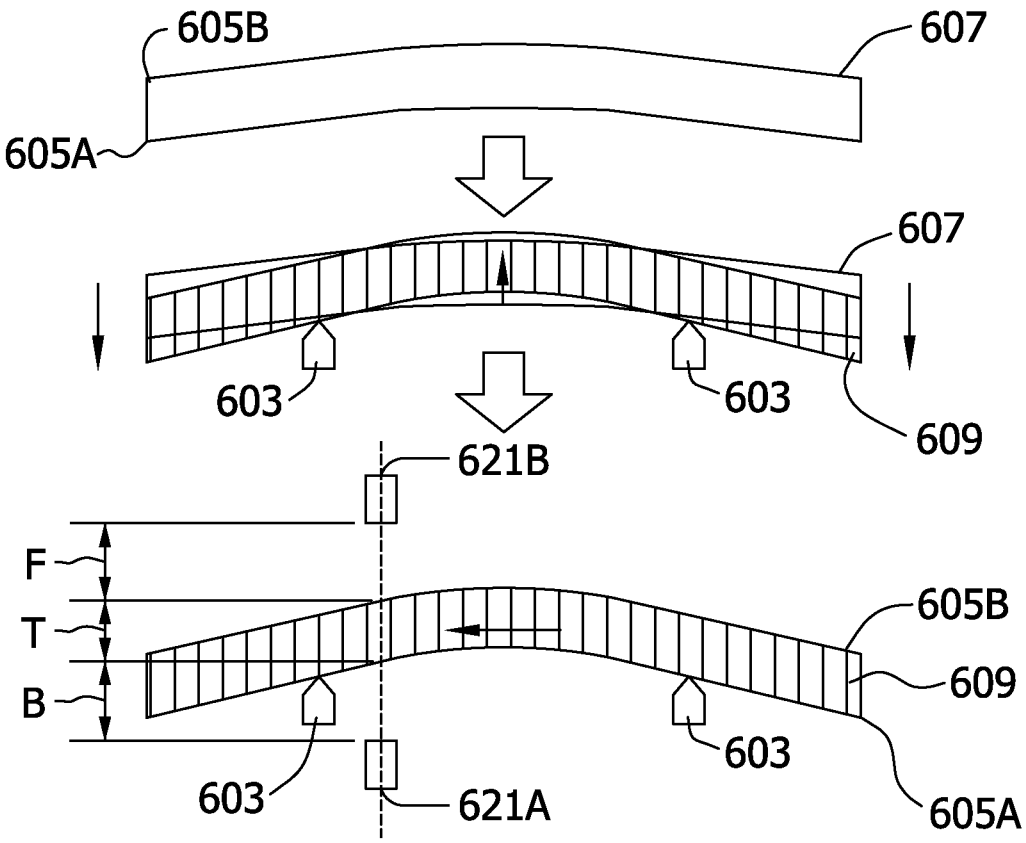

605B
607
605A
607
603
603
609
621B
F
T
B
605B
609
603
603
621A
605A

FIG. 7A

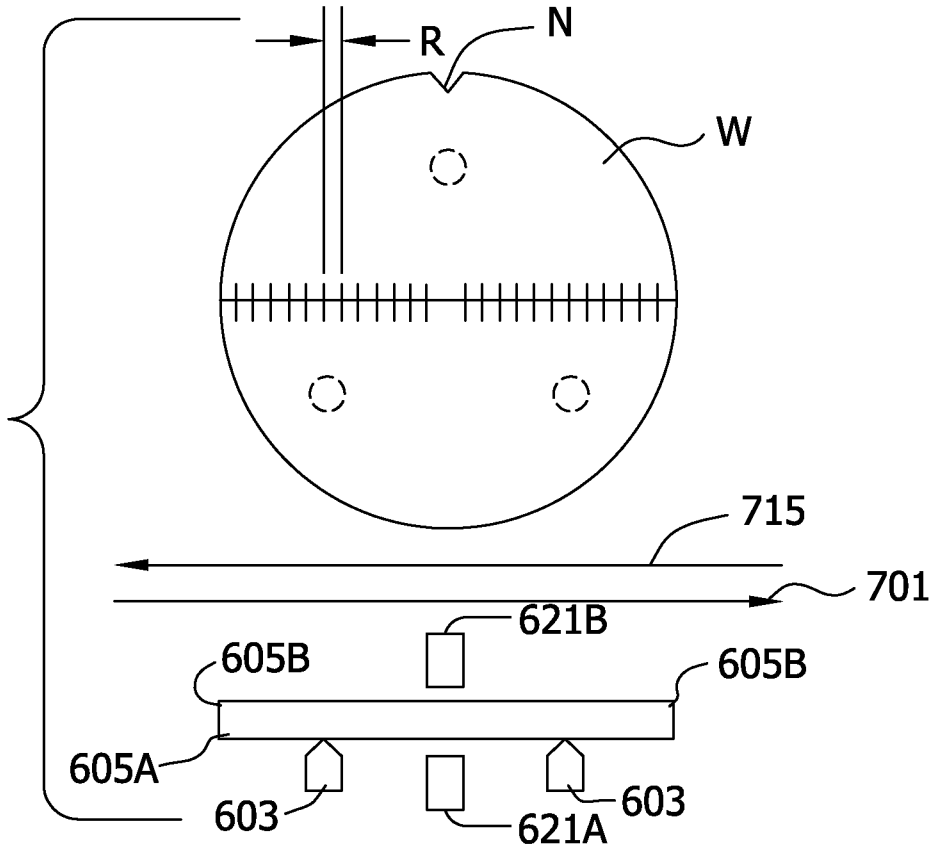

R
N
W
715
701
621B
605B
605B
605A
603
603
621A

FIG. 7B

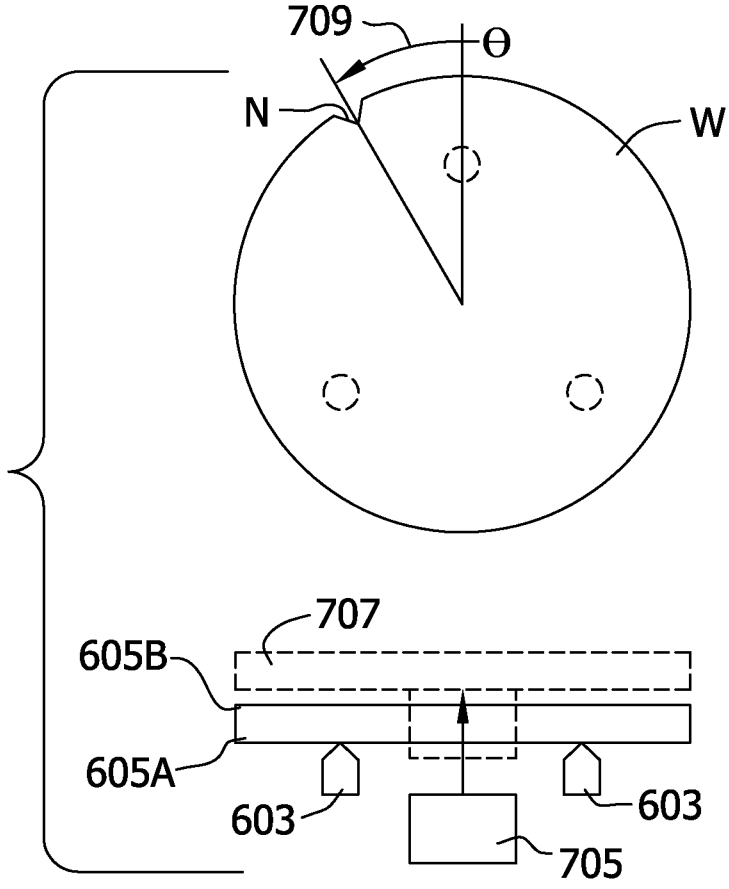

709
Θ
N
W
707
605B
605A
603
603
705

FIG. 8A

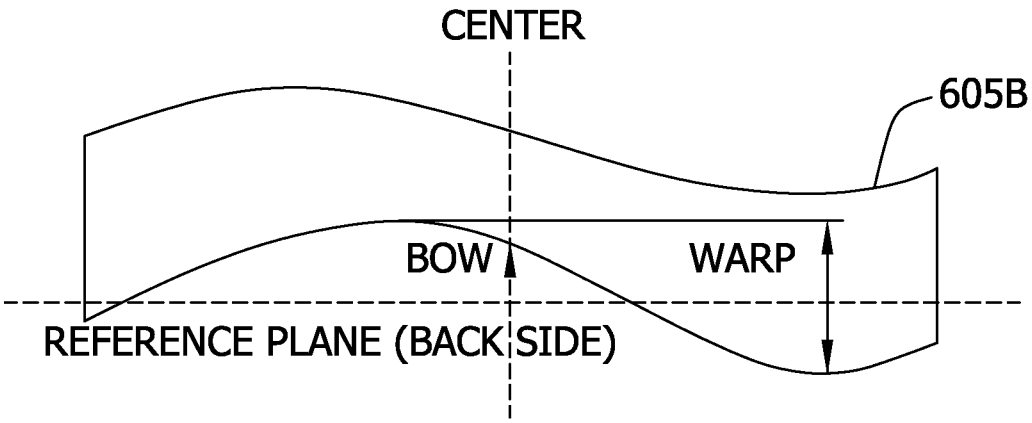
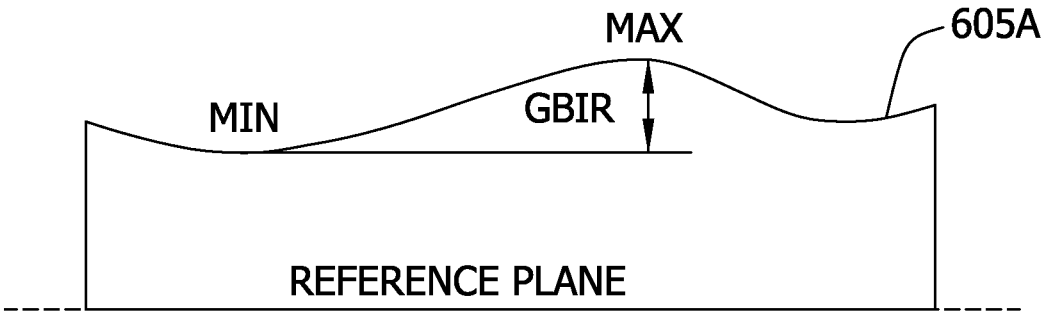

CENTER
605B
BOW
WARP
REFERENCE PLANE (BACK SIDE)

FIG. 8B


MAX
605A
MIN
GBIR
REFERENCE PLANE

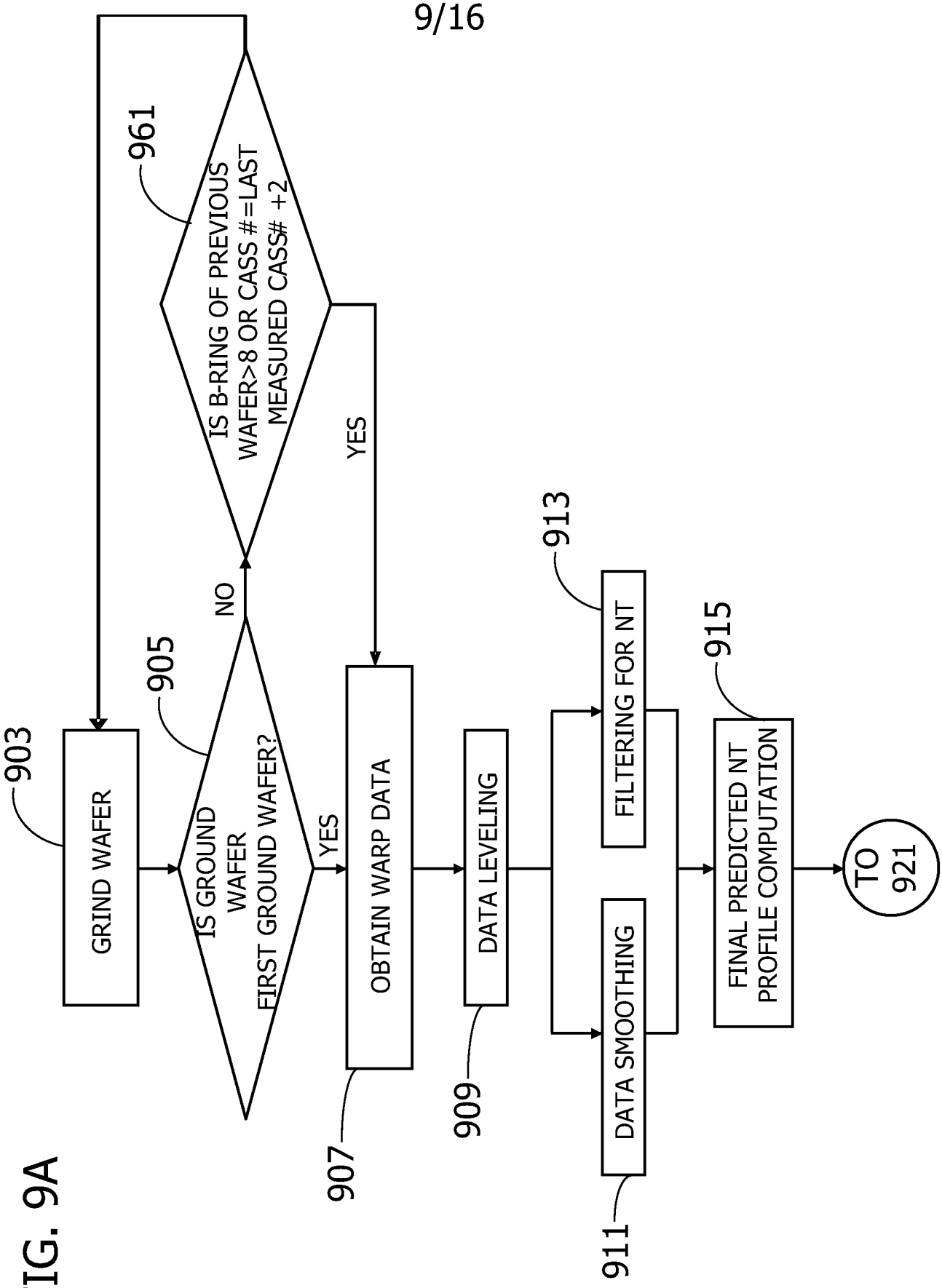

903
GRIND WAFER
905
IS GROUND WAFER FIRST GROUND WAFER?
NO
961
IS B-RING OF PREVIOUS WAFER>8 OR CASS #=LAST MEASURED CASS# +2
YES
YES
907
OBTAIN WARP DATA
909
DATA LEVELING
913
FILTERING FOR NT
911
DATA SMOOTHING
915
FINAL PREDICTED NT PROFILE COMPUTATION
TO 921

FIG. 9A

FIG. 9B

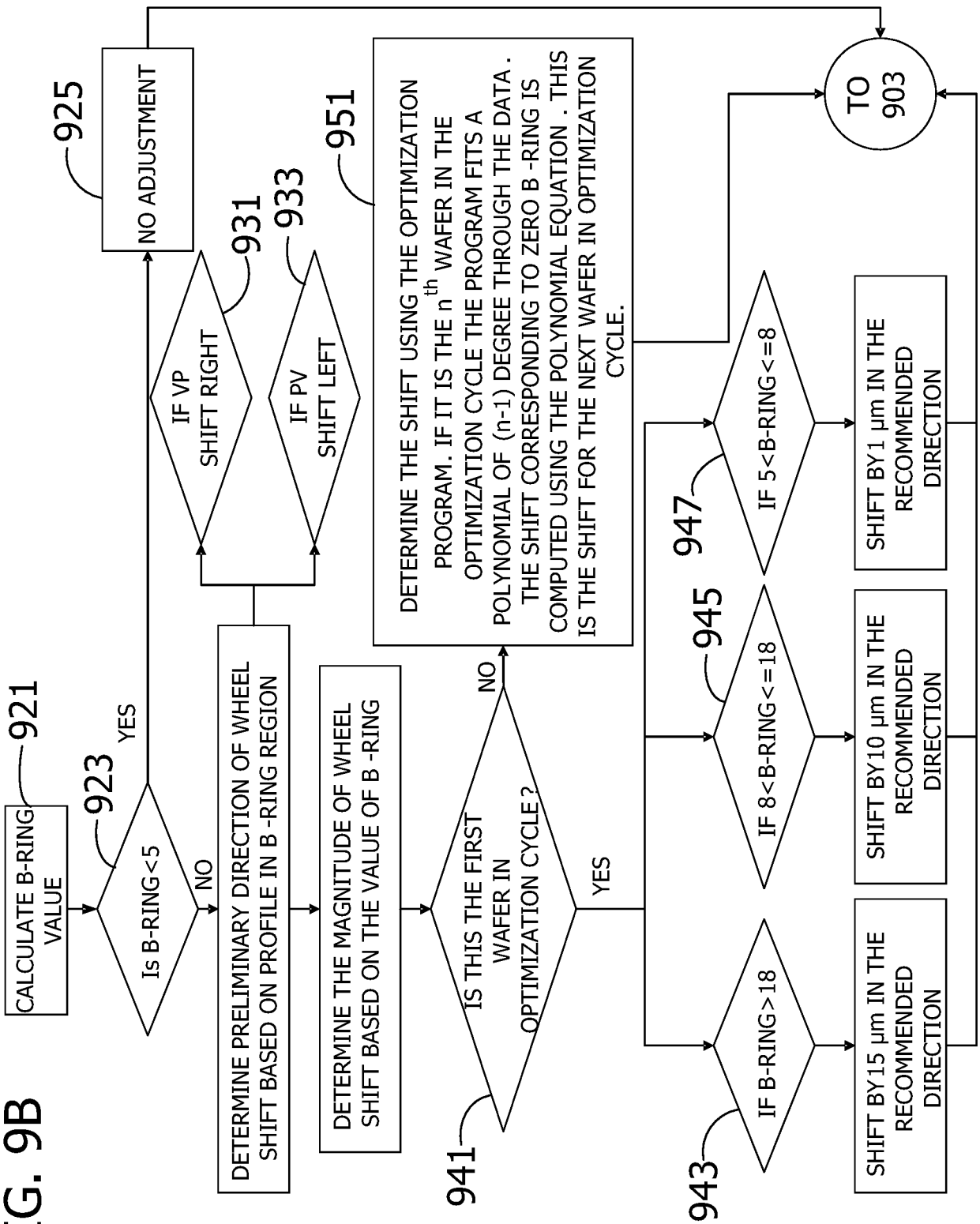

921
CALCULATE B-RING VALUE
923
Is B-RING<5
YES
NO
925
NO ADJUSTMENT
931
IF VP SHIFT RIGHT
933
IF PV SHIFT LEFT
DETERMINE PRELIMINARY DIRECTION OF WHEEL SHIFT BASED ON PROFILE IN B-RING REGION
DETERMINE THE MAGNITUDE OF WHEEL SHIFT BASED ON THE VALUE OF B-RING
941
IS THIS THE FIRST WAFER IN OPTIMIZATION CYCLE?
NO
YES
951
DETERMINE THE SHIFT USING THE OPTIMIZATION PROGRAM. IF IT IS THE nth WAFER IN THE OPTIMIZATION CYCLE THE PROGRAM FITS A POLYNOMIAL OF (n-1) DEGREE THROUGH THE DATA. THE SHIFT CORRESPONDING TO ZERO B-RING IS COMPUTED USING THE POLYNOMIAL EQUATION. THIS IS THE SHIFT FOR THE NEXT WAFER IN OPTIMIZATION CYCLE.
943
IF B-RING>18
945
IF 8<B-RING<=18
947
IF 5<B-RING<=8
SHIFT BY15 µm IN THE RECOMMENDED DIRECTION
SHIFT BY10 µm IN THE RECOMMENDED DIRECTION
SHIFT BY1 µm IN THE RECOMMENDED DIRECTION
TO 903

FIG. 10

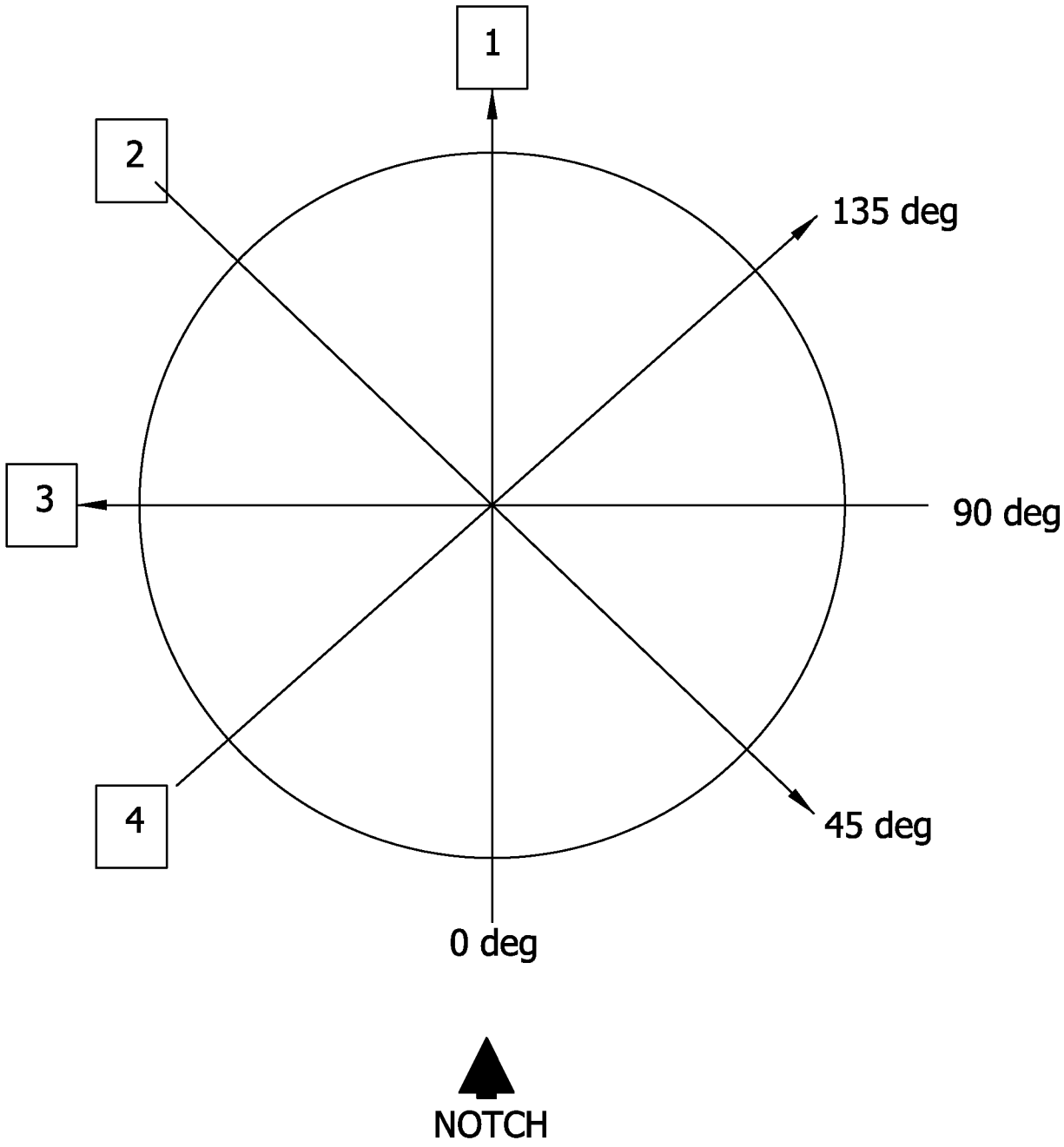


FIG. 11

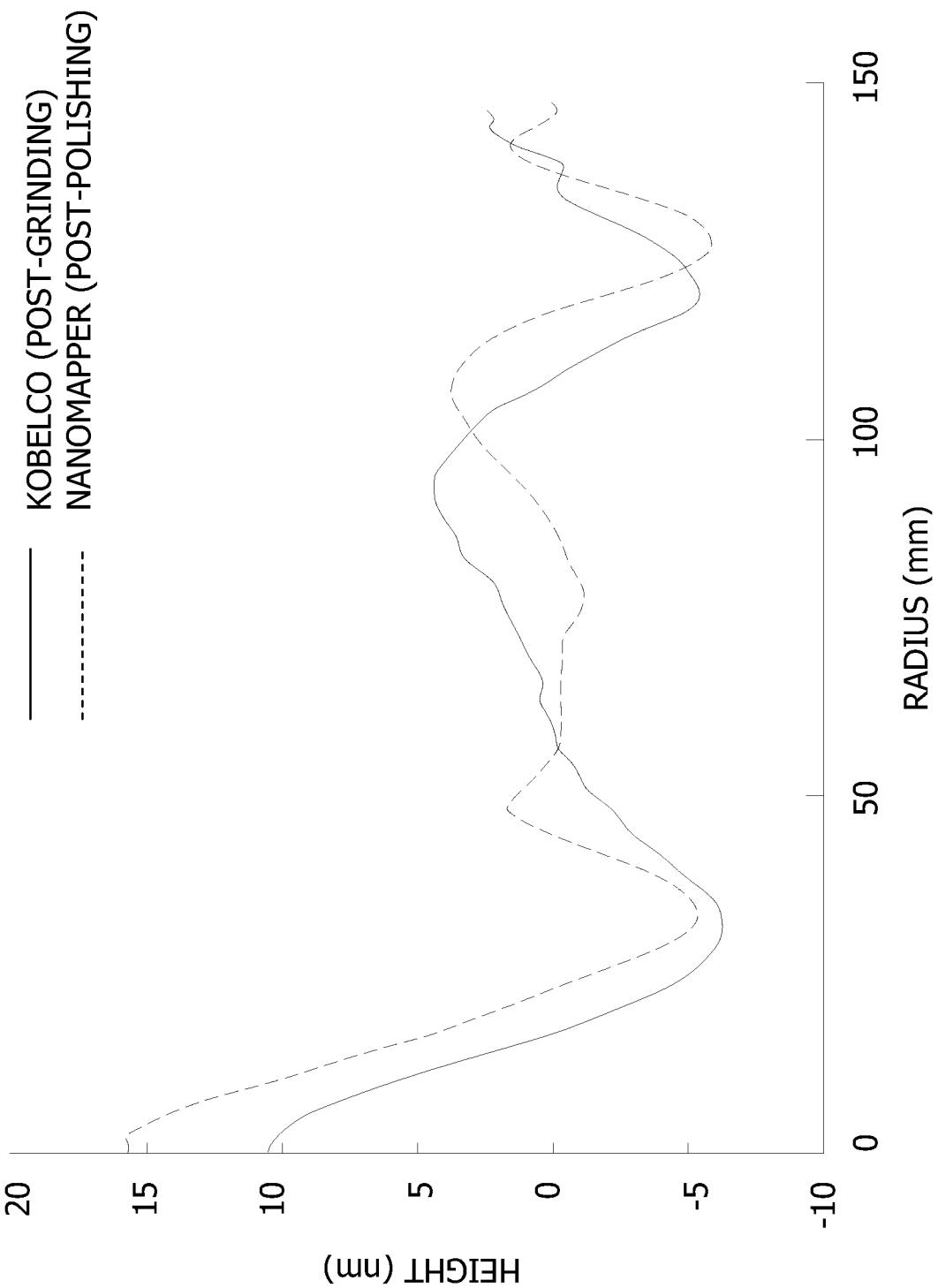

KOBELCO (POST-GRINDING)
NANOMAPPER (POST-POLISHING)
HEIGHT (nm)
20
15
10
5
0
-5
-10
0
50
100
150
RADIUS (mm)

FIG. 12

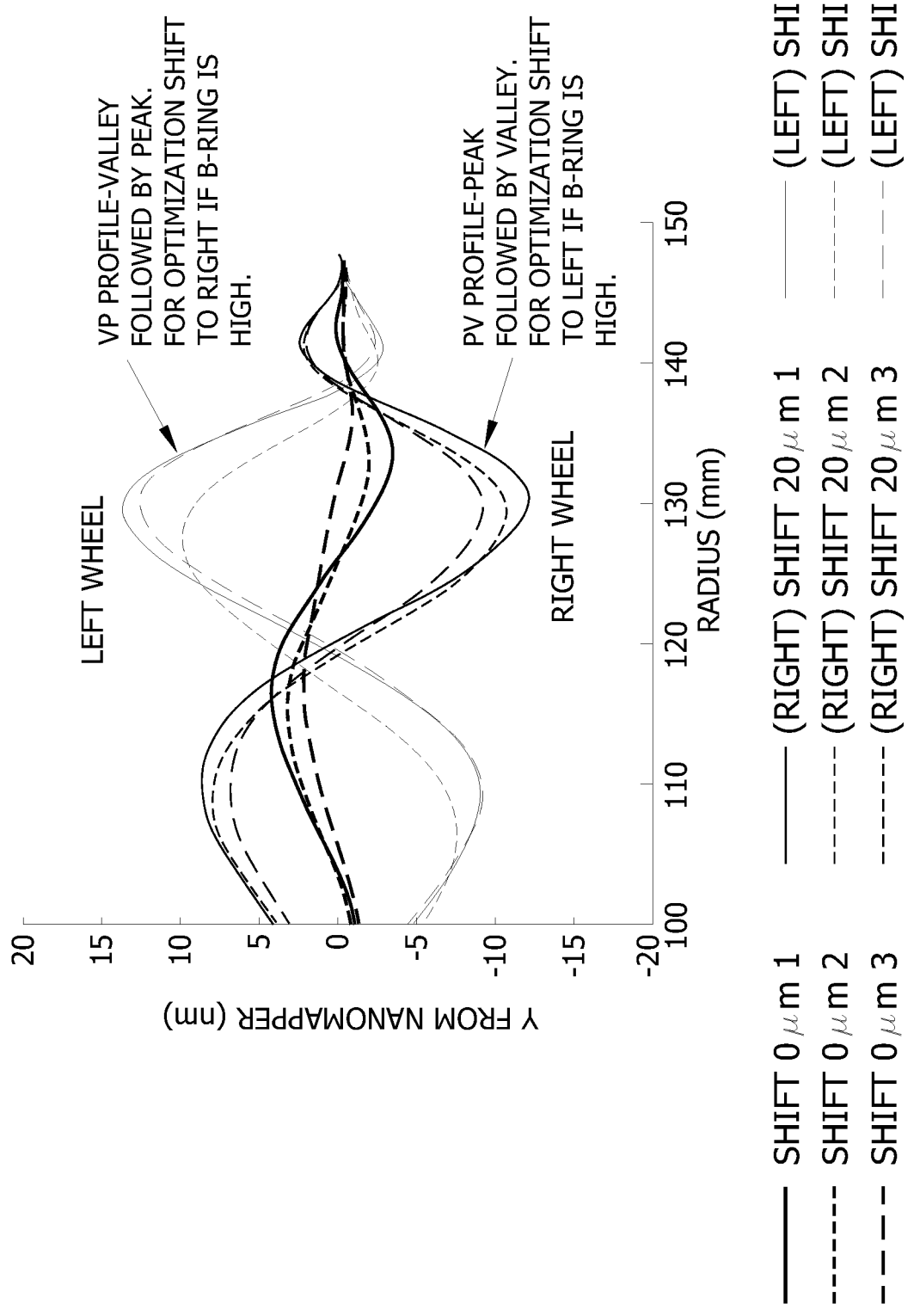

LEFT WHEEL
RIGHT WHEEL
VP PROFILE-VALLEY FOLLOWED BY PEAK. FOR OPTIMIZATION SHIFT TO RIGHT IF B-RING IS HIGH.
PV PROFILE-PEAK FOLLOWED BY VALLEY. FOR OPTIMIZATION SHIFT TO LEFT IF B-RING IS HIGH.
Y FROM NANOMAPPER (nm)
RADIUS (mm)
20
15
10
5
0
-5
-10
-15
-20
100
110
120
130
140
150
SHIFT 0 μm 1
SHIFT 0 μm 2
SHIFT 0 μm 3
(RIGHT) SHIFT 20 μm 1
(RIGHT) SHIFT 20 μm 2
(RIGHT) SHIFT 20 μm 3
(LEFT) SHIFT 20 μm 1
(LEFT) SHIFT 20 μm 2
(LEFT) SHIFT 20 μm 3

FIG. 13

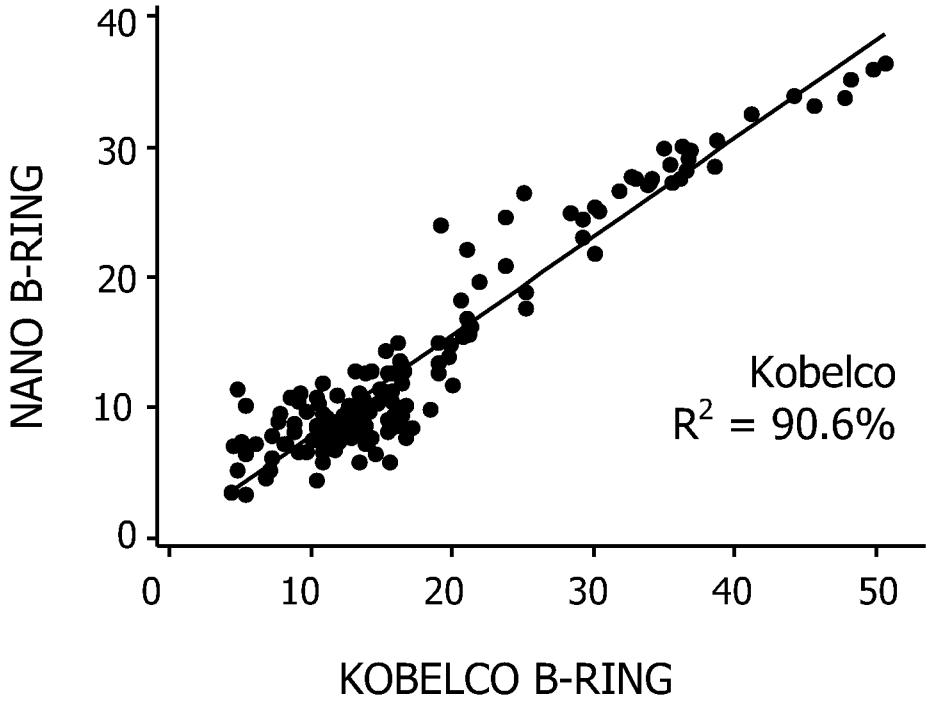

40
30
20
10
0
NANO B-RING
0
10
20
30
40
50
KOBELCO B-RING
Kobelco
R2 = 90.6%

FIG. 14

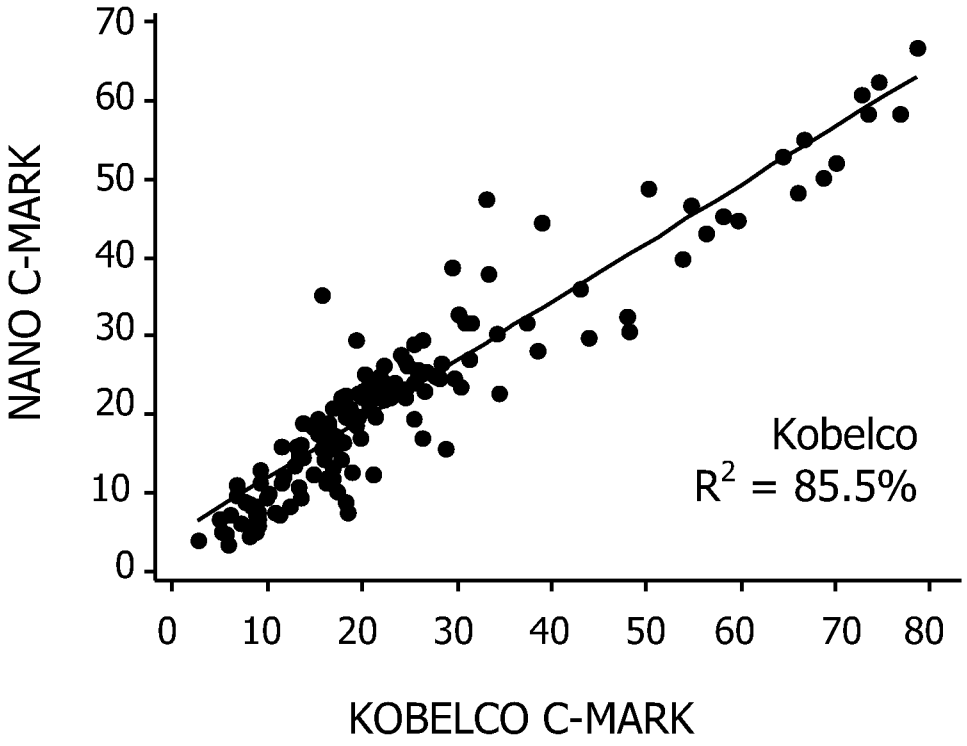

NANO C-MARK
KOBELCO C-MARK
Kobelco
R2 = 85.5%
0
10
20
30
40
50
60
70
80

FIG. 15

