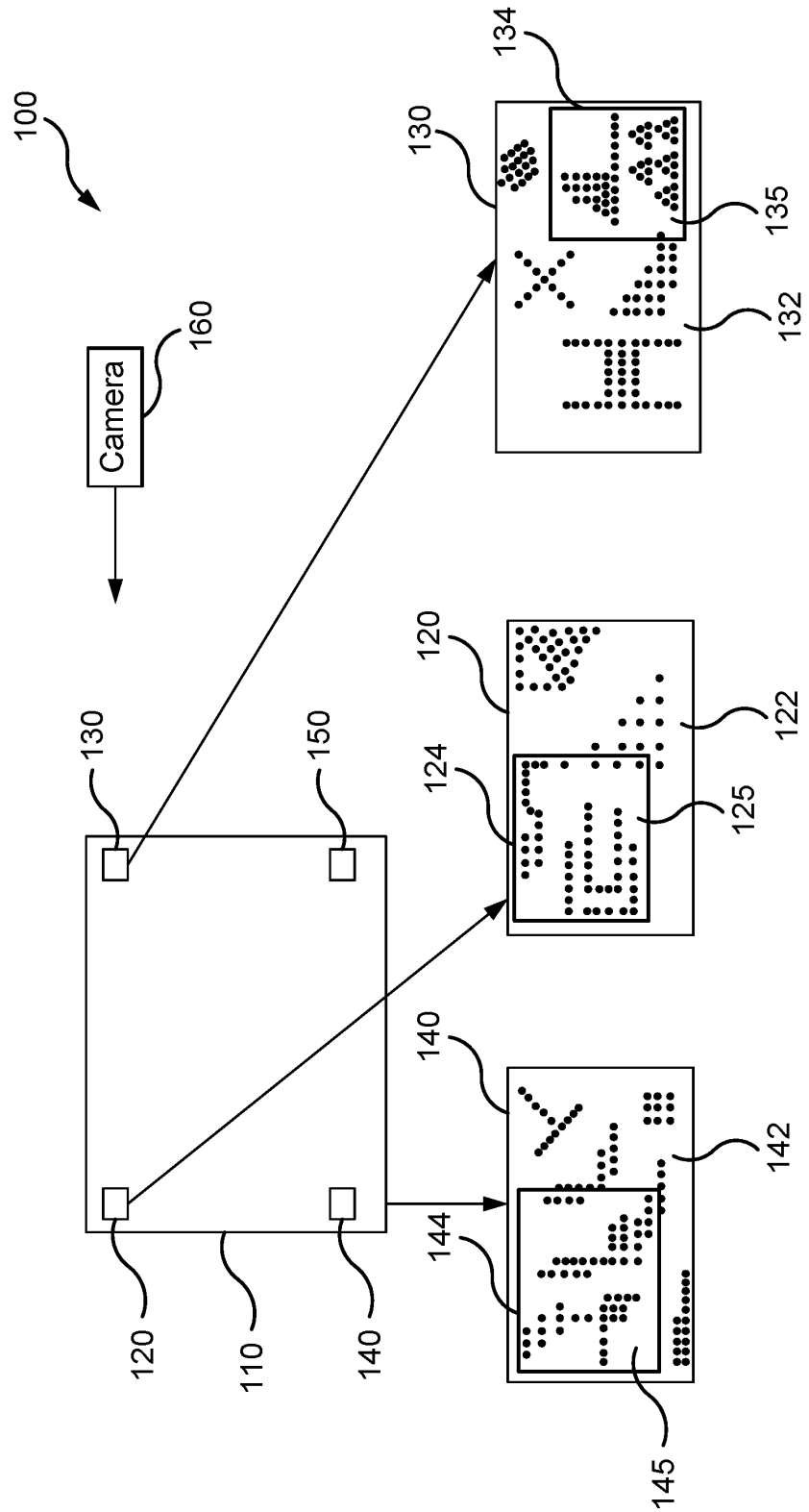

100
Camera
160
130
150
120
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142
144
145

FIG. 1A

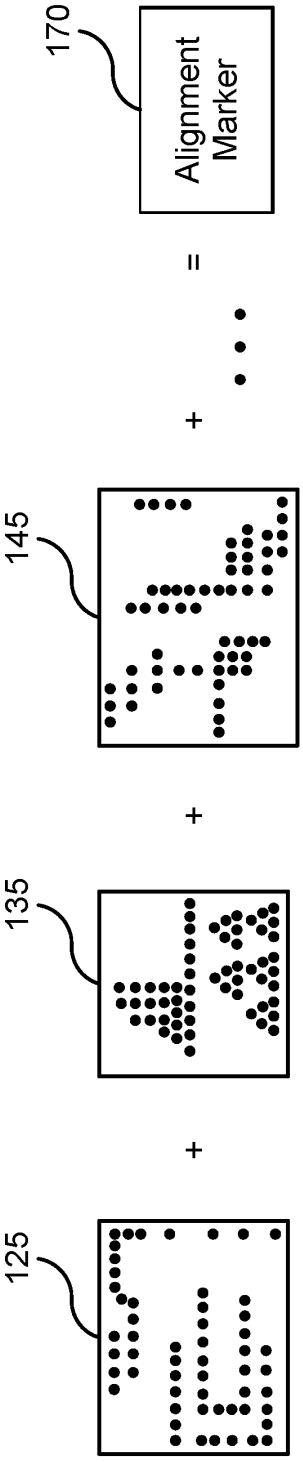


FIG. 1B

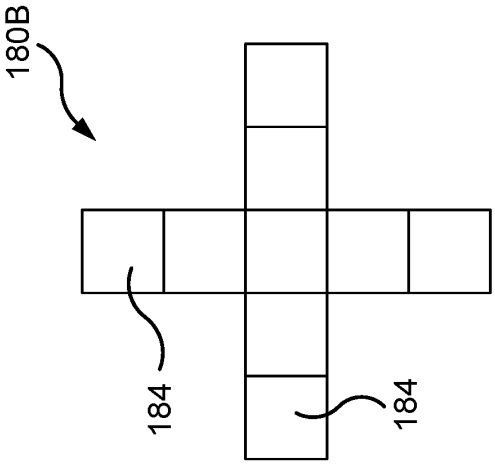


FIG. 1E

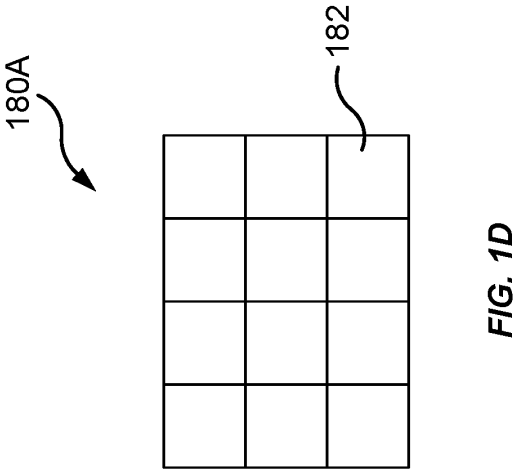


FIG. 1D

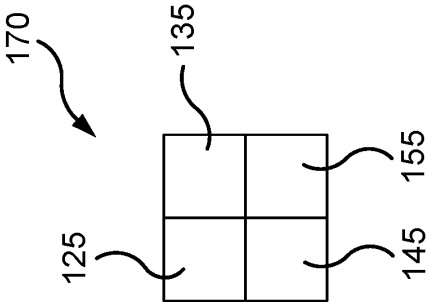


FIG. 1C

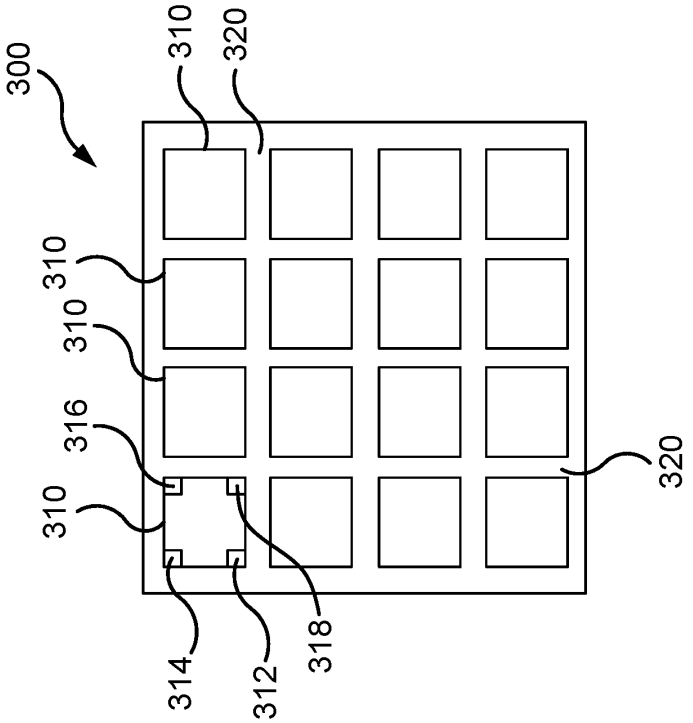

300
310
320
310
310
316
310
320
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312
318

FIG. 3

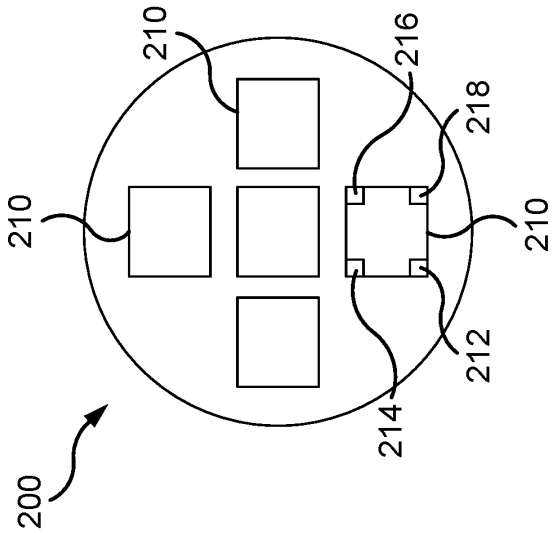

210
216
218
210
210
212
214
200

FIG. 2

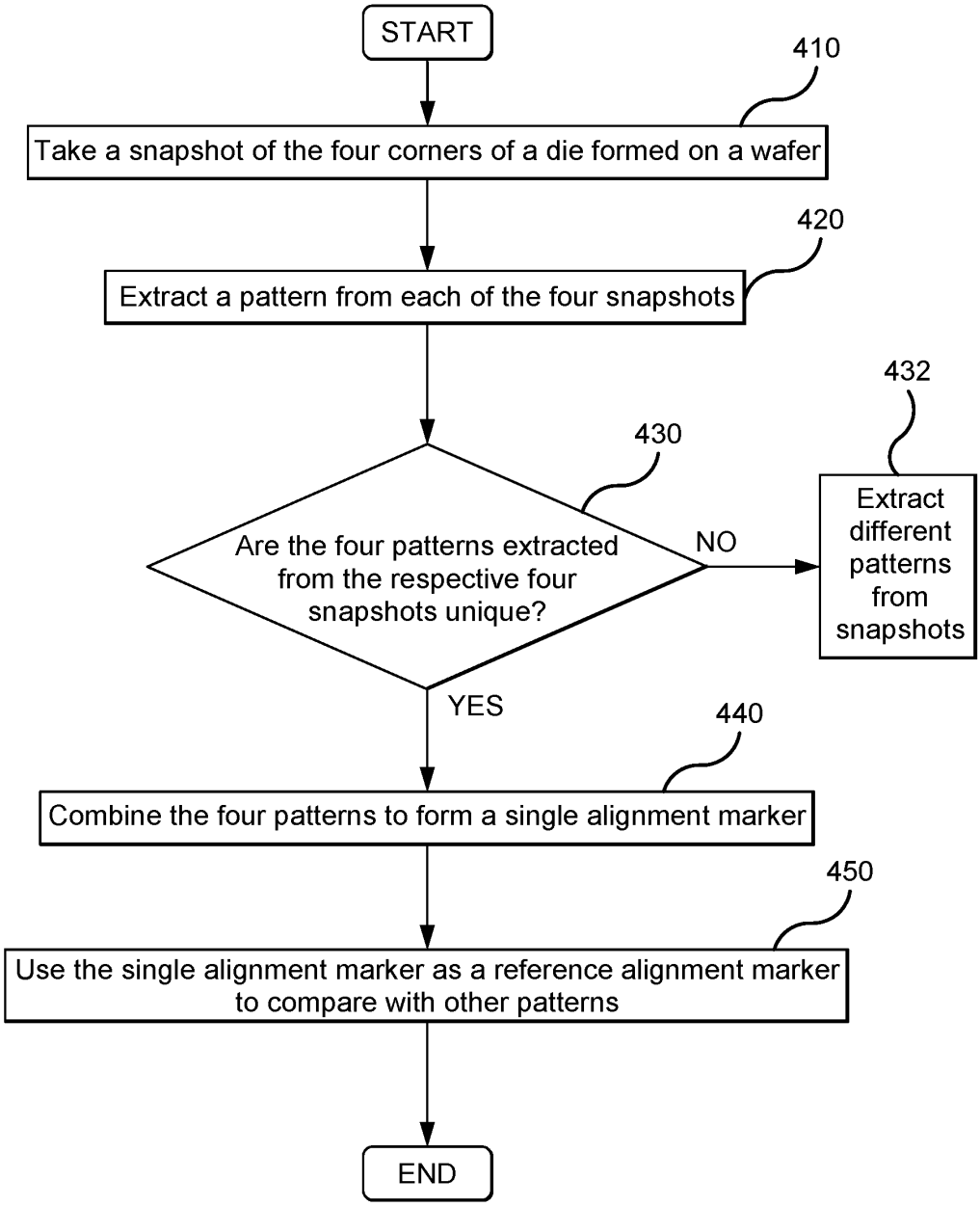

START
410
Take a snapshot of the four corners of a die formed on a wafer
420
Extract a pattern from each of the four snapshots
432
430
Are the four patterns extracted from the respective four snapshots unique?
NO
Extract different patterns from snapshots
YES
440
Combine the four patterns to form a single alignment marker
450
Use the single alignment marker as a reference alignment marker to compare with other patterns
END

FIG. 4

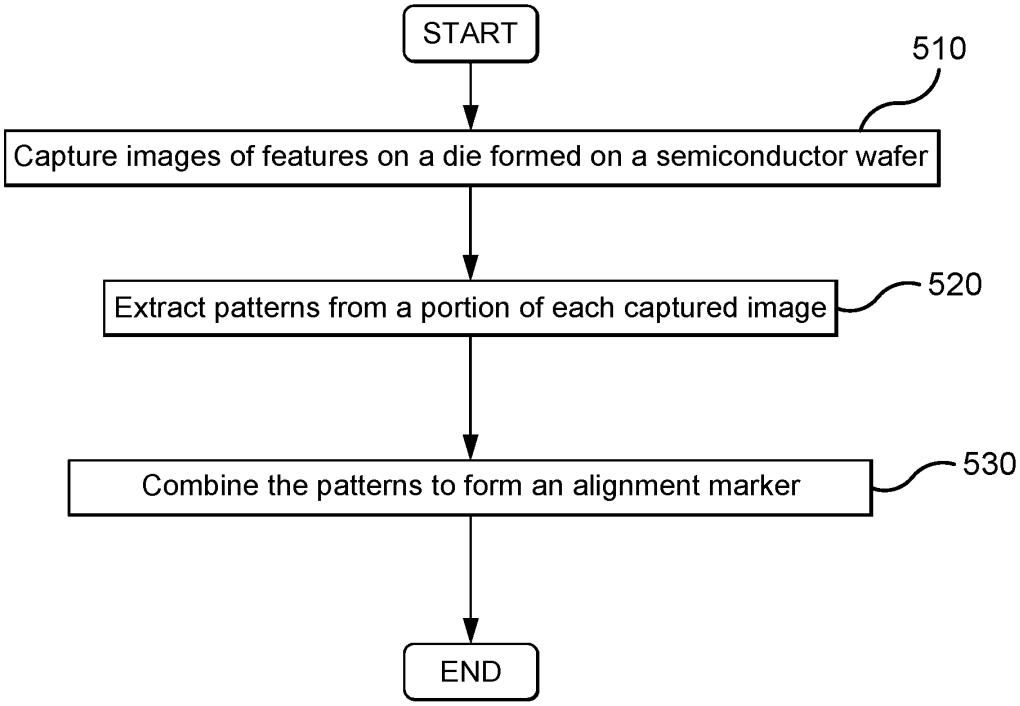

START
510
Capture images of features on a die formed on a semiconductor wafer
Extract patterns from a portion of each captured image
520
Combine the patterns to form an alignment marker
530
END

FIG. 5

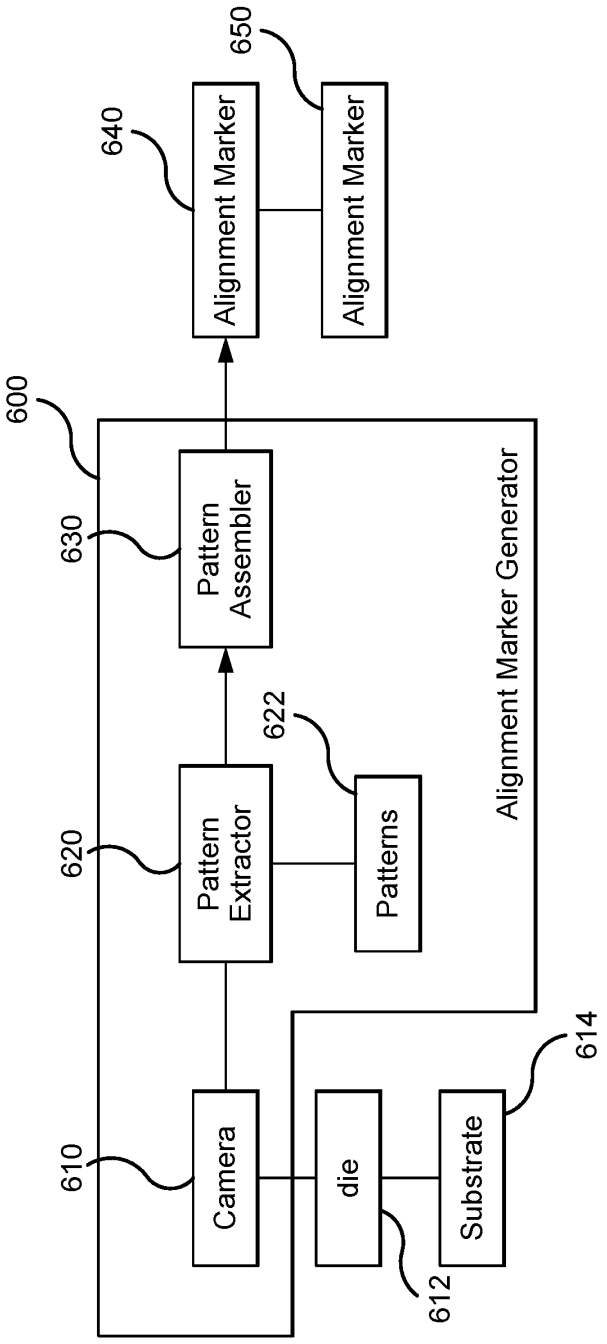

650
640
Alignment Marker
Alignment Marker
600
630
Pattern Assembler
622
620
Pattern Extractor
Patterns
Alignment Marker Generator
610
Camera
die
Substrate
614
612

FIG. 6

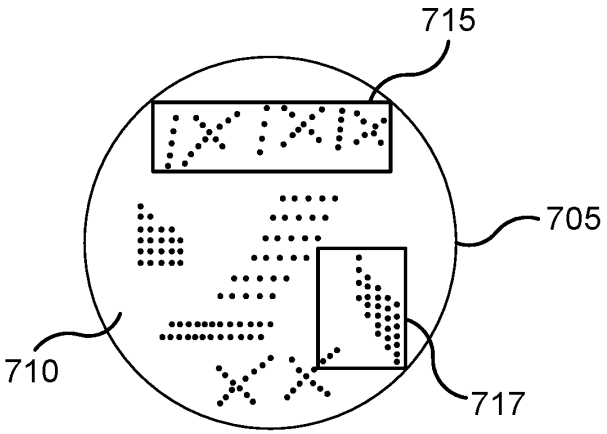


FIG. 7A

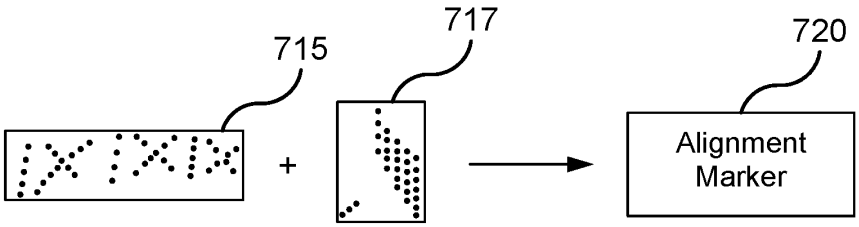


FIG. 7B

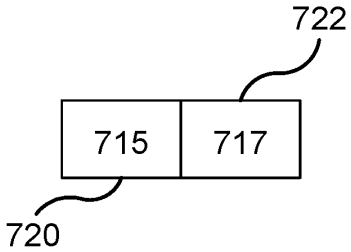


FIG. 7C

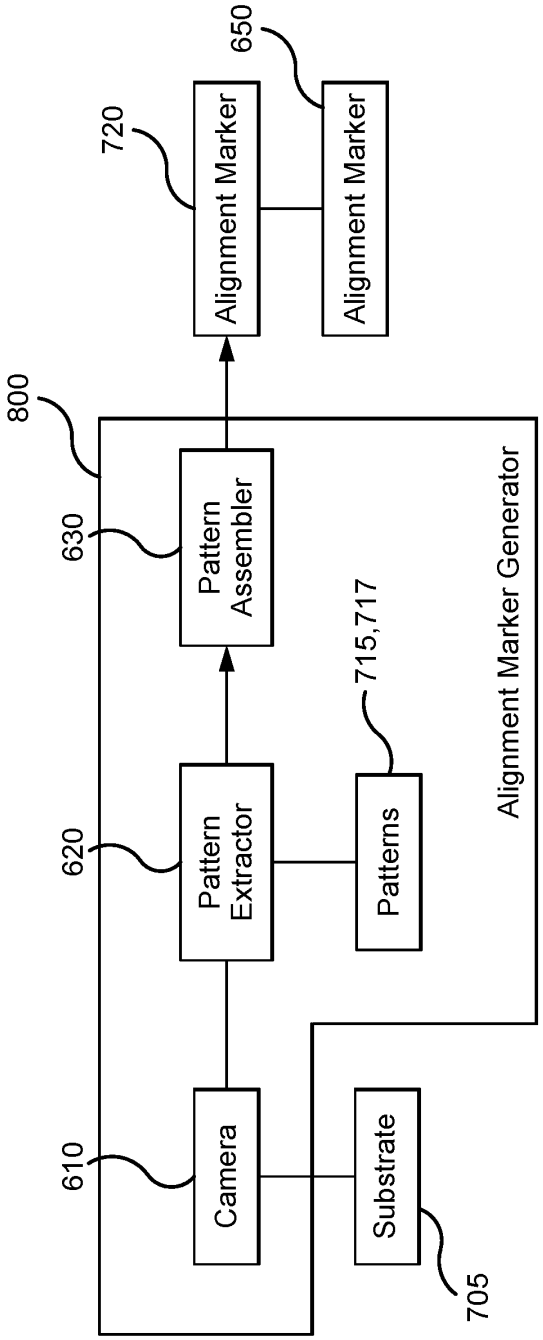

650
720
Alignment Marker
Alignment Marker
800
630
Pattern Assembler
715,717
620
Pattern Extractor
Patterns
Alignment Marker Generator
610
Camera
Substrate
705

FIG. 8

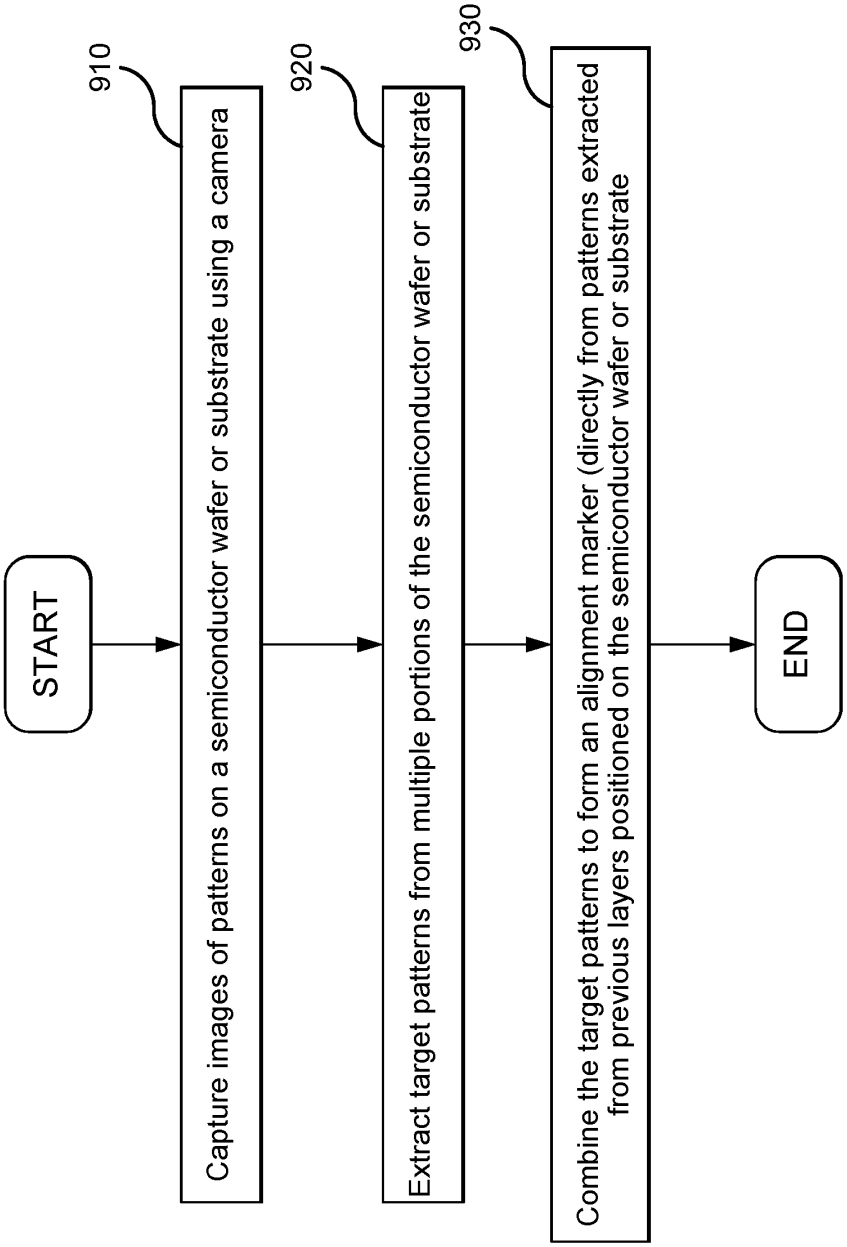

START
910
Capture images of patterns on a semiconductor wafer or substrate using a camera
920
Extract target patterns from multiple portions of the semiconductor wafer or substrate
930
Combine the target patterns to form an alignment marker (directly from patterns extracted from previous layers positioned on the semiconductor wafer or substrate
END

FIG. 9