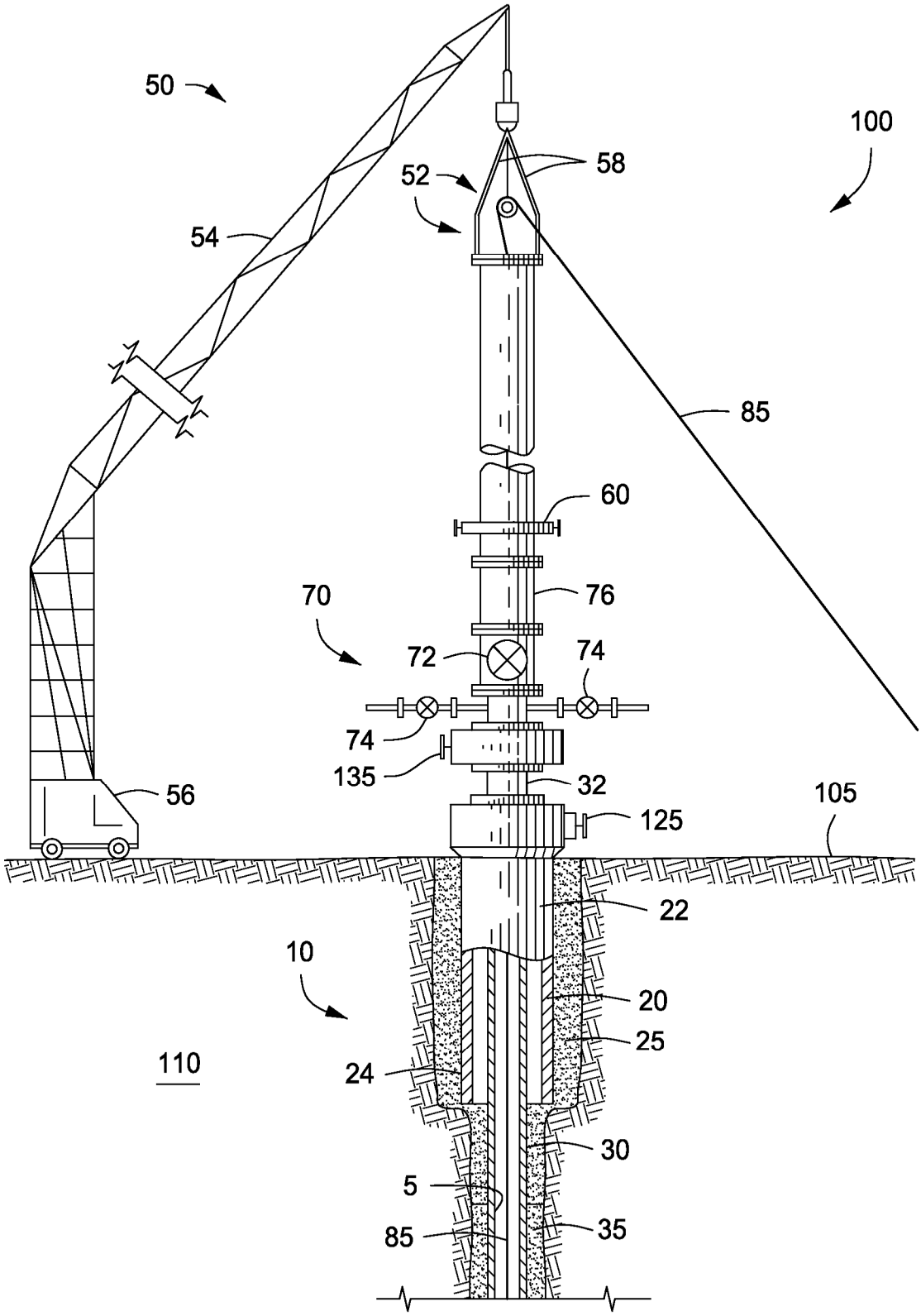


FIG. 1
(PRIOR ART)

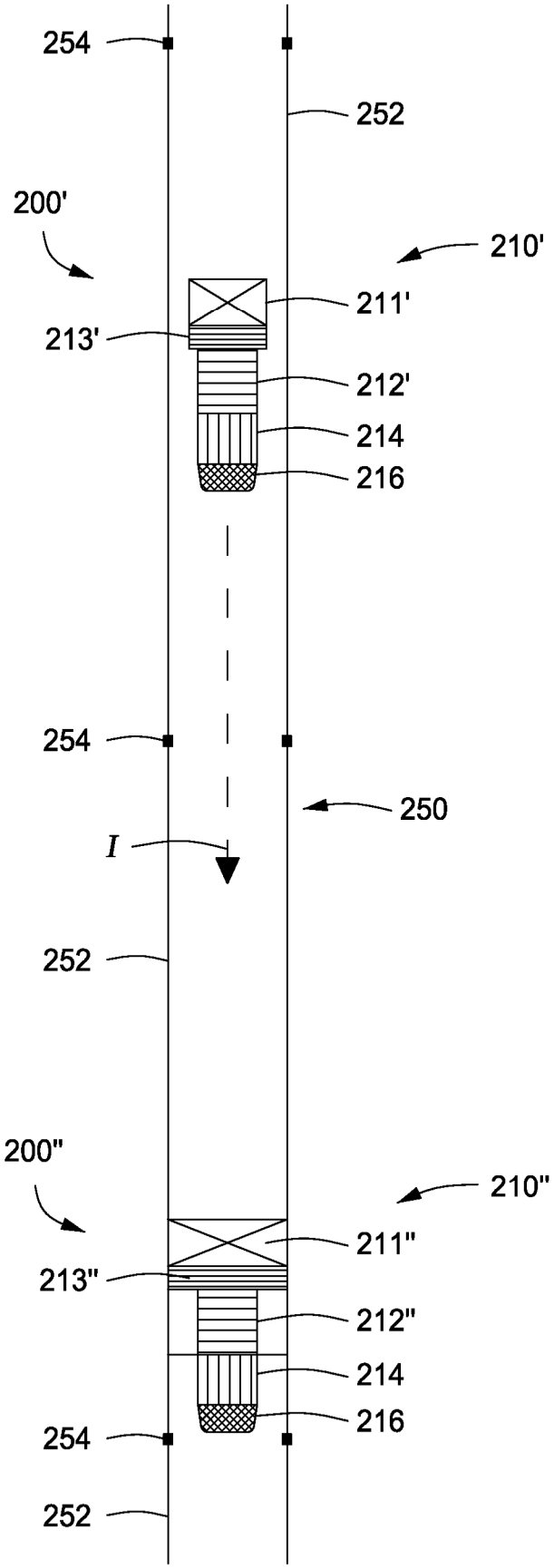

254
252
200'
210'
211'
213'
212'
214
216
254
250
I
252
200"
210"
211"
213"
212"
214
216
254
252

FIG. 2

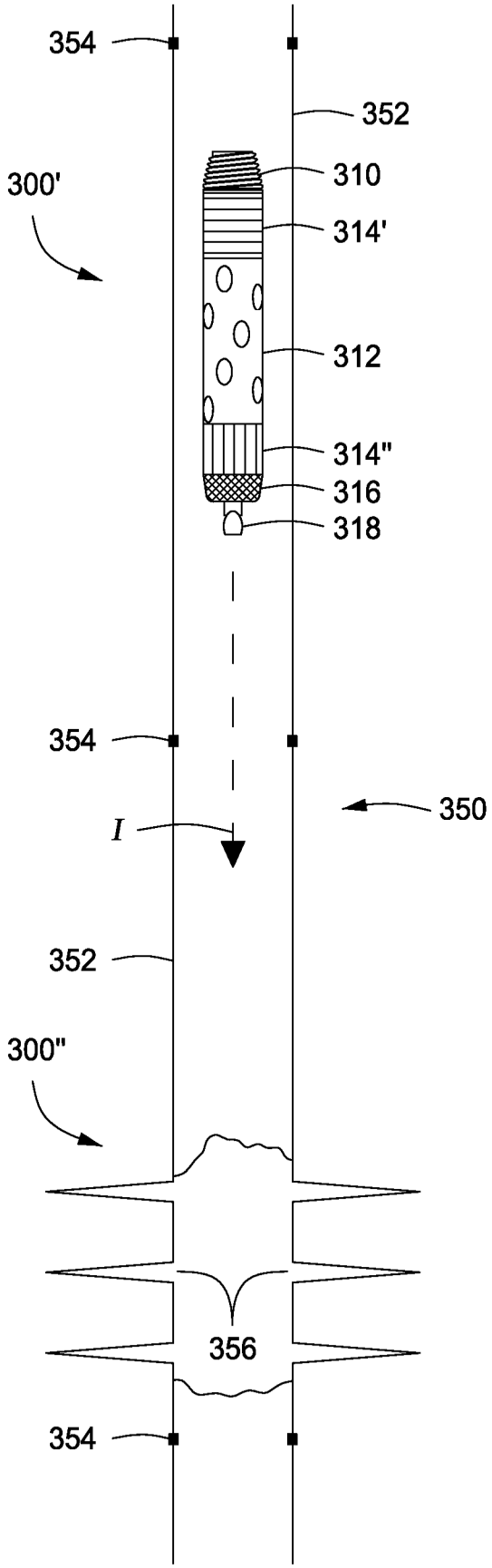

354
352
300'
310
314'
312
314"
316
318
354
350
I
352
300"
356
354

FIG. 3

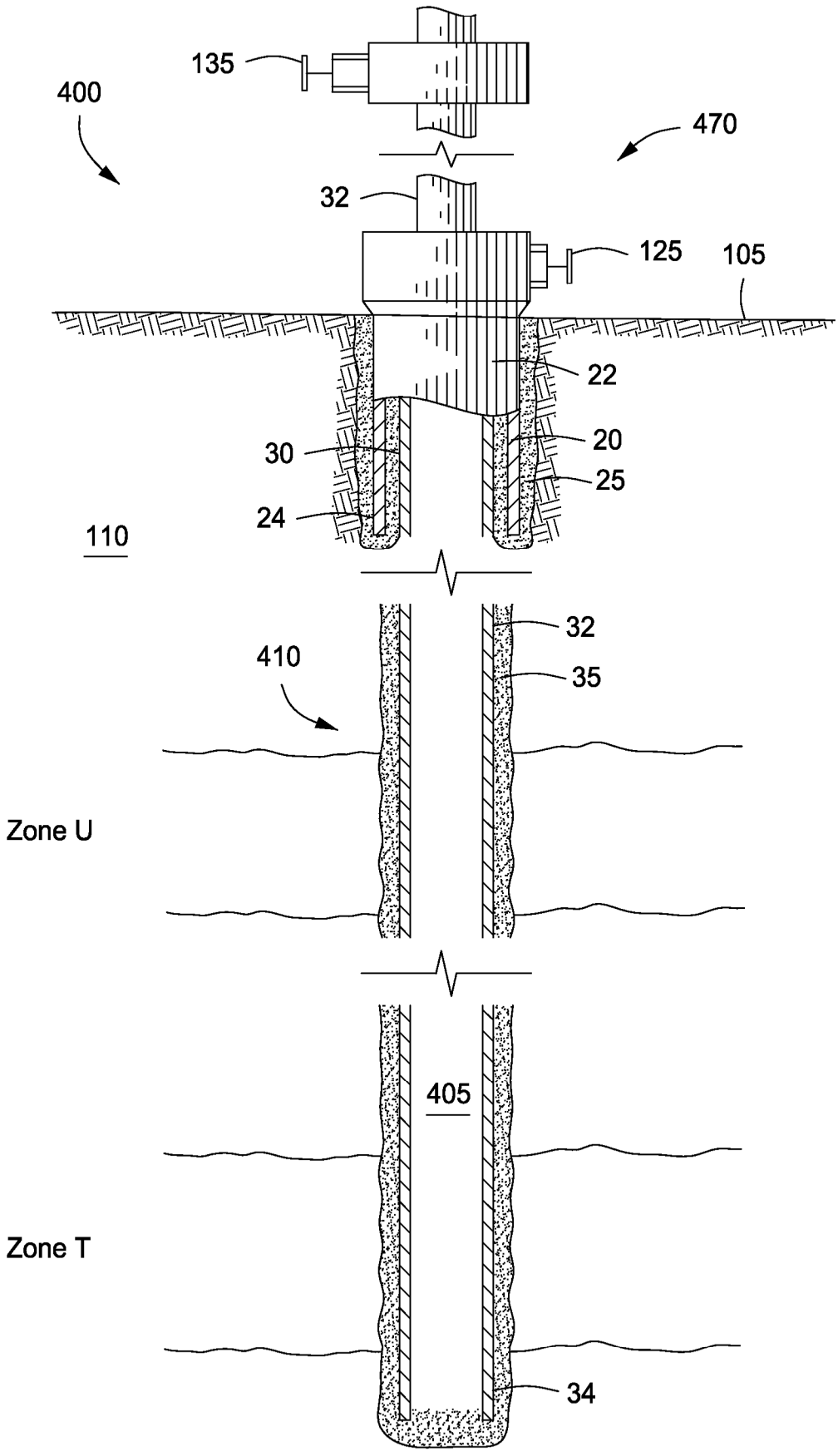

135
400
470
32
125
105
22
30
20
25
24
110
32
410
35
Zone U
405
Zone T
34

FIG. 4A

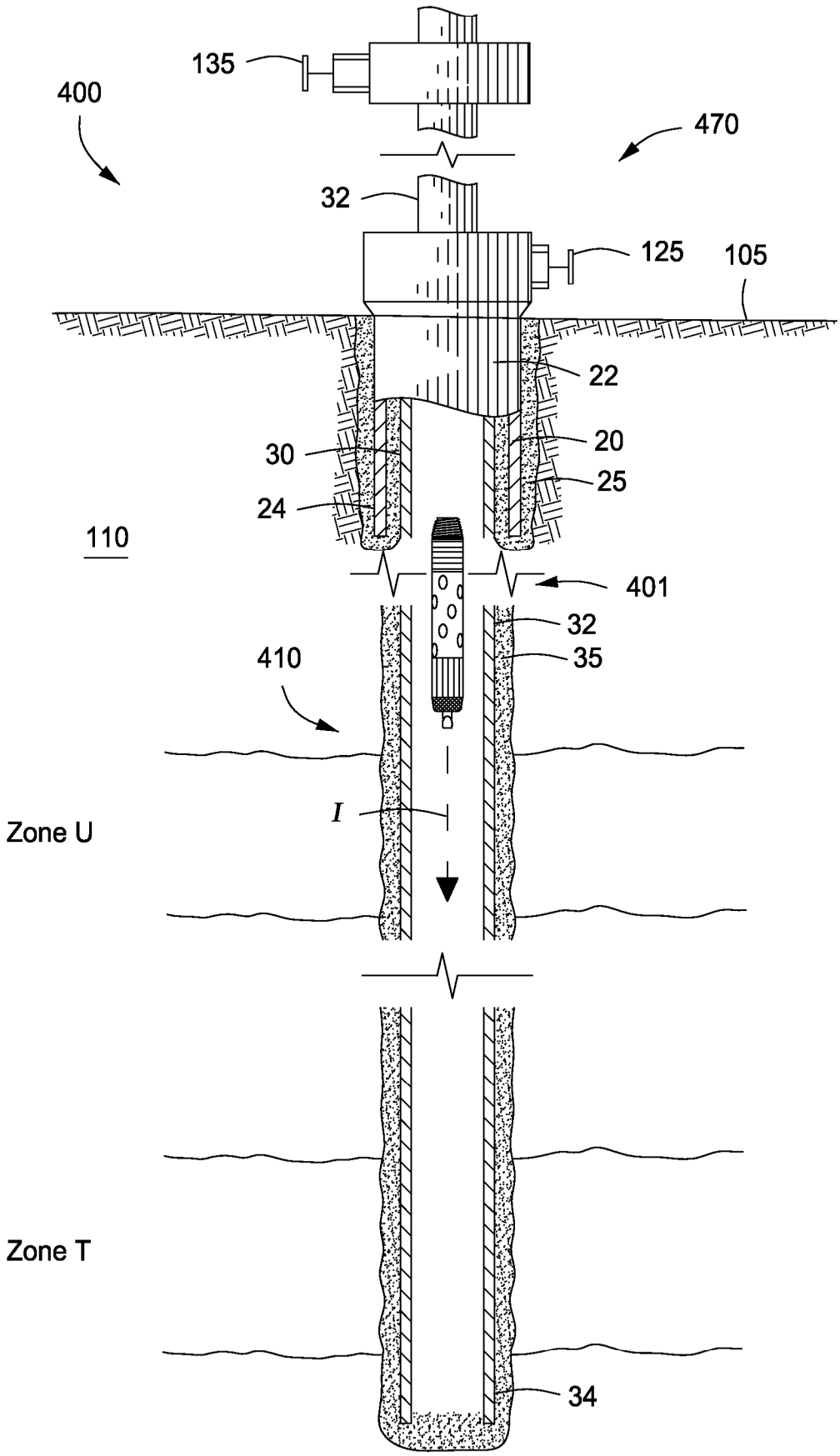

135
400
470
32
125
105
22
30
20
25
24
110
401
32
410
35
I
Zone U
Zone T
34

FIG. 4B

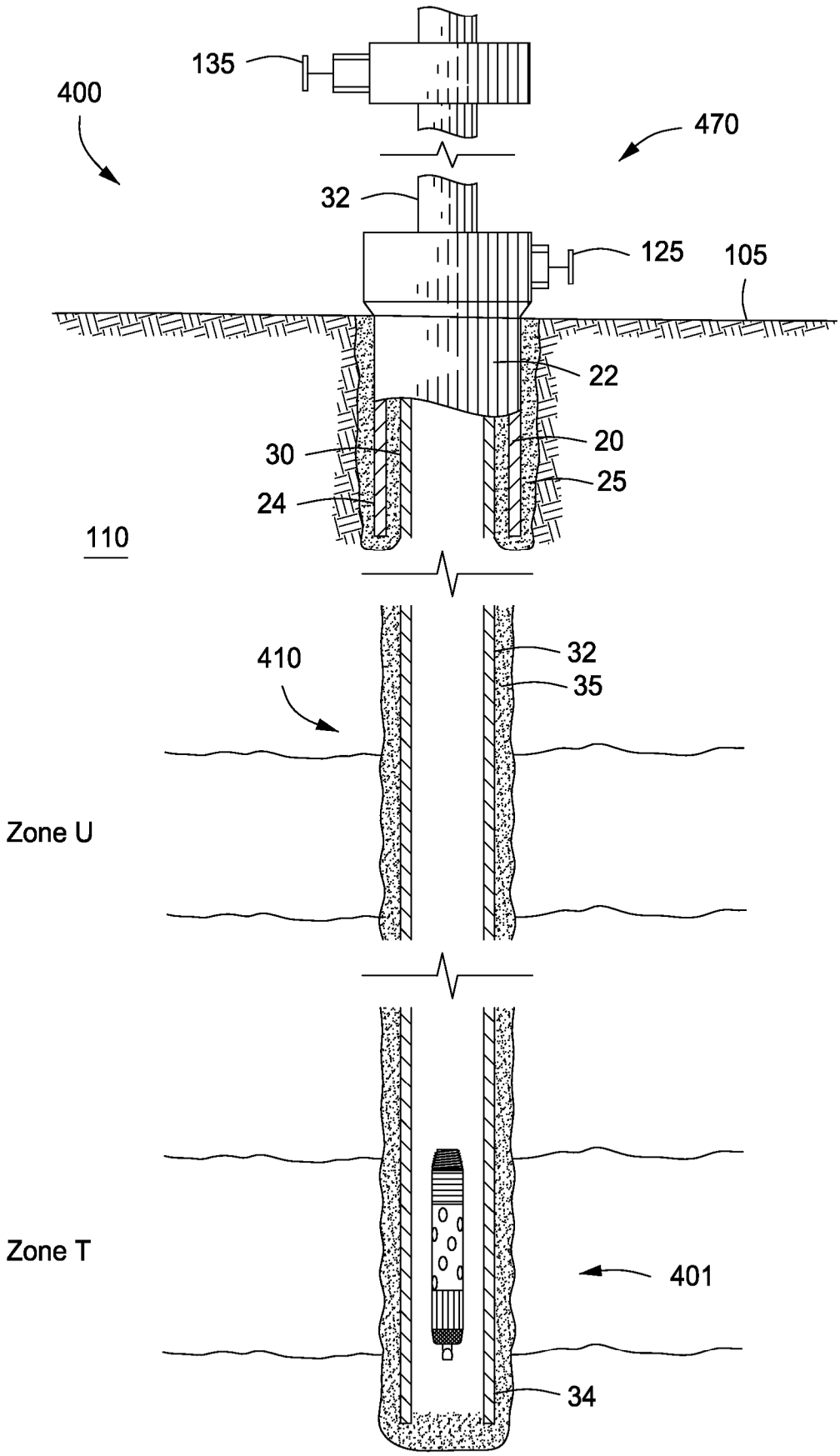

135
400
470
32
125
105
22
30
20
25
24
110
410
32
35
Zone U
Zone T
401
34

FIG. 4C

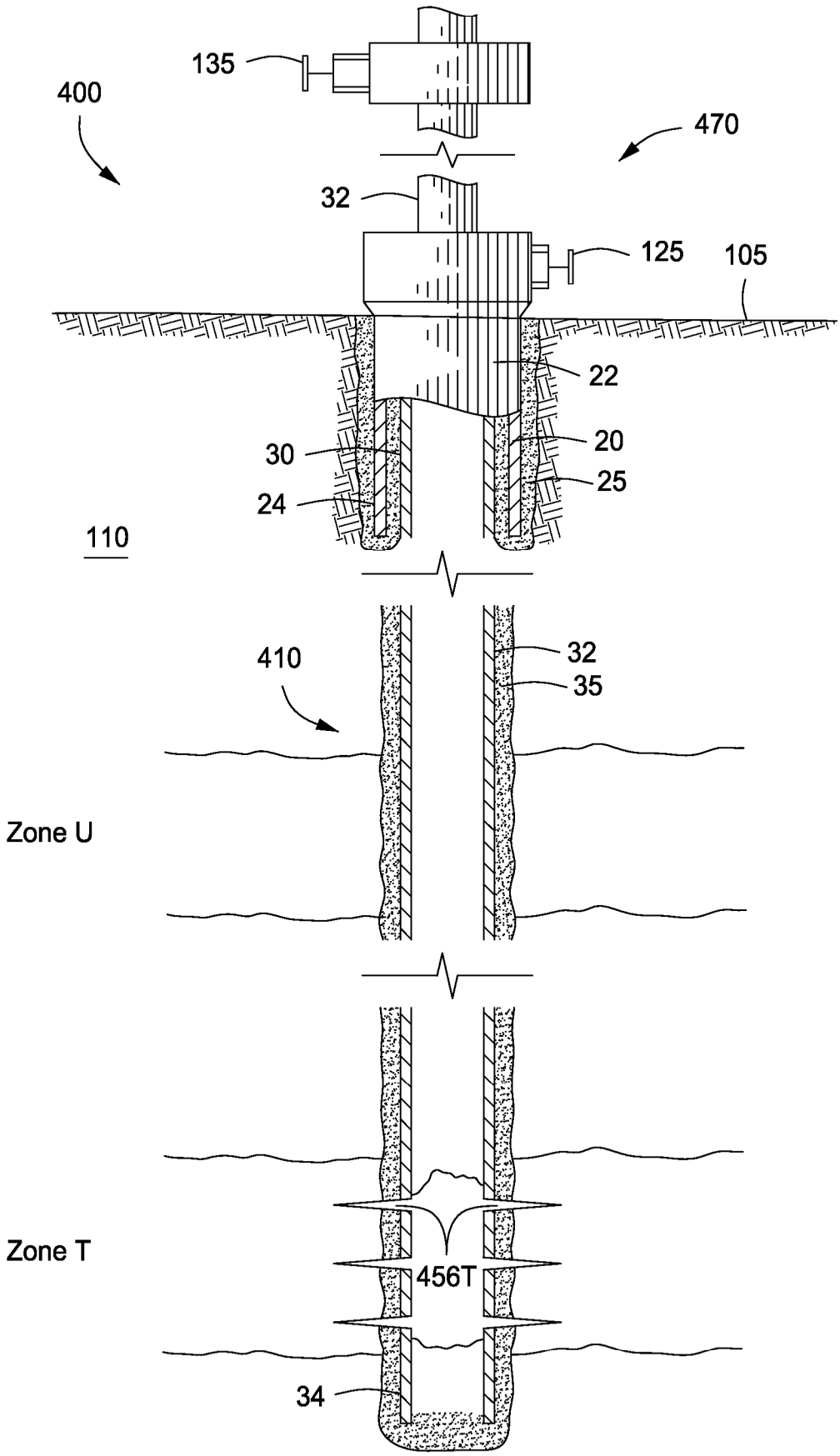

135
400
470
32
125
105
22
30
20
25
24
110
410
32
35
Zone U
Zone T
456T
34

FIG. 4D

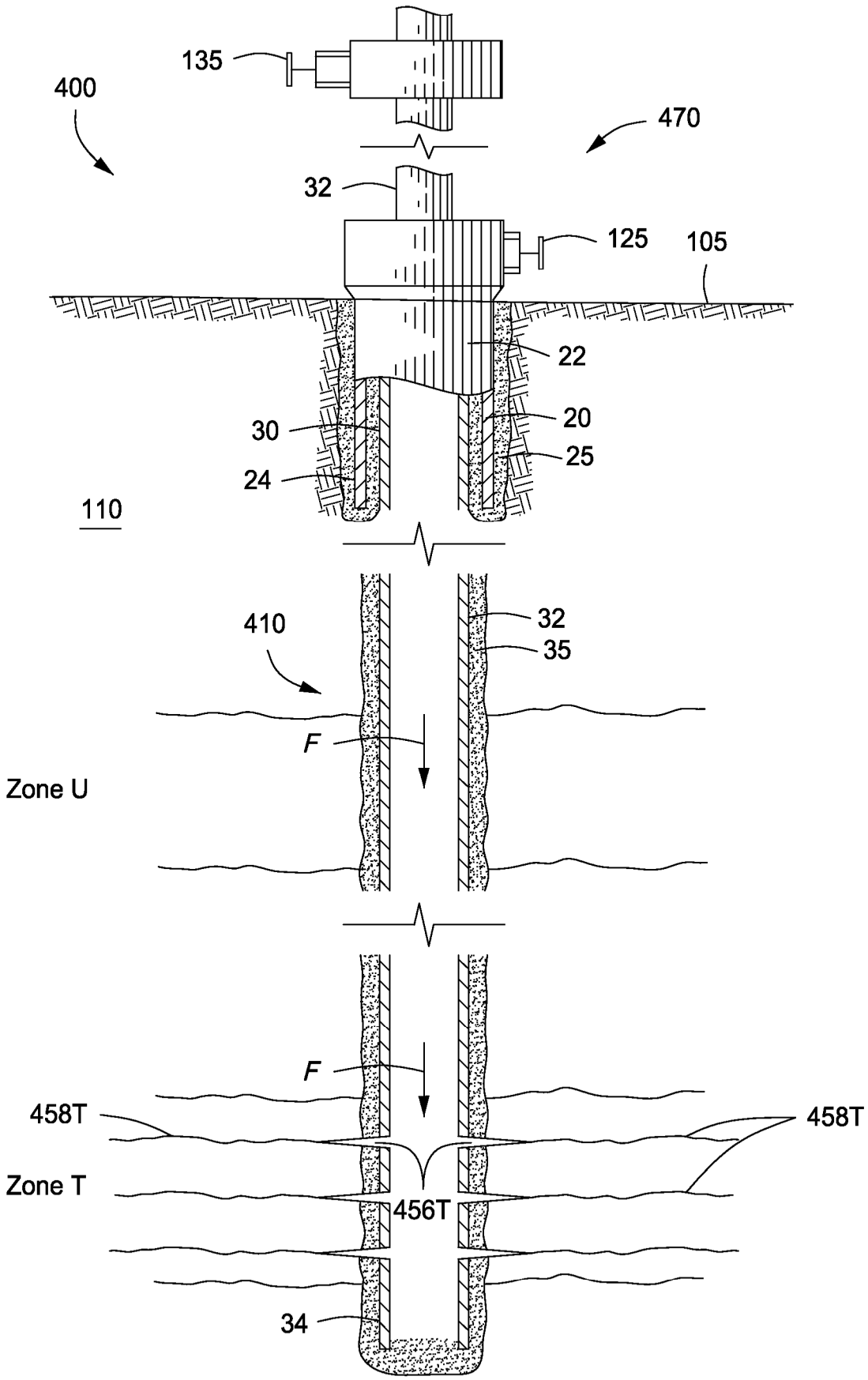

135
400
470
32
125
105
22
30
20
25
24
110
410
32
35
F
Zone U
F
458T
458T
Zone T
456T
34

FIG. 4E

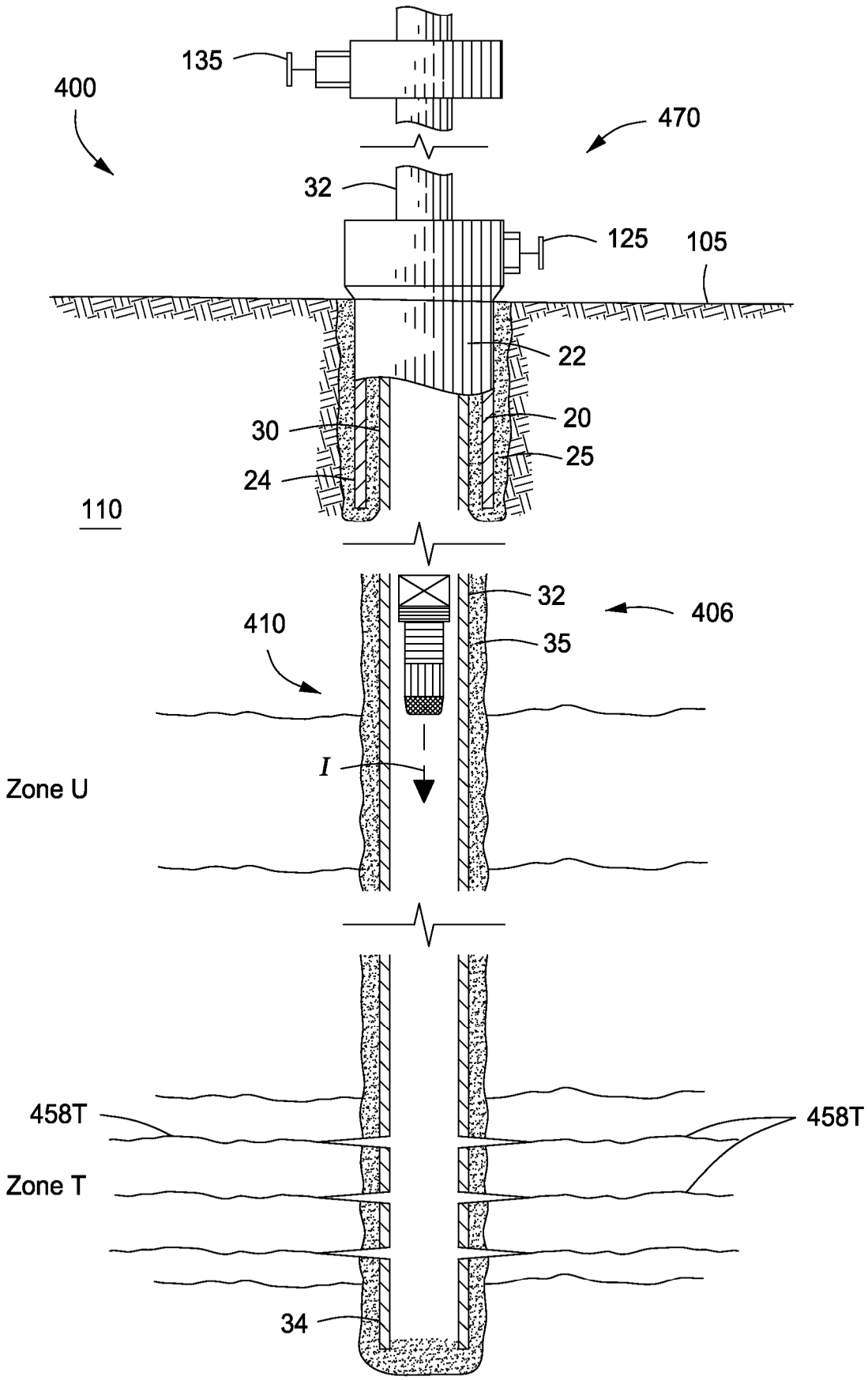

135
400
470
32
125
105
22
30
20
25
24
110
32
406
410
35
I
Zone U
458T
458T
Zone T
34

FIG. 4F

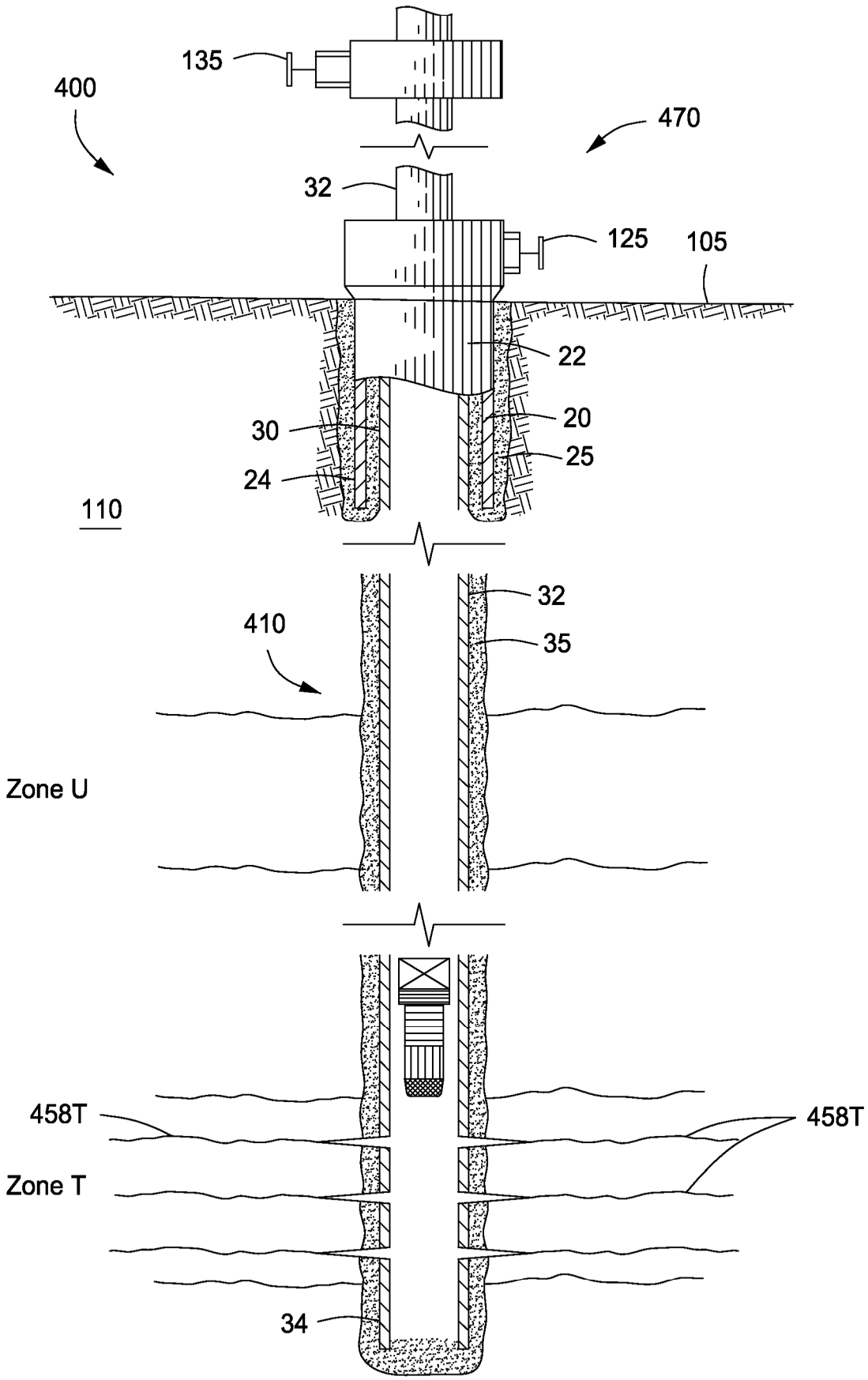

135
400
470
32
125
105
22
30
20
25
24
110
32
410
35
Zone U
458T
458T
Zone T
34

FIG. 4G

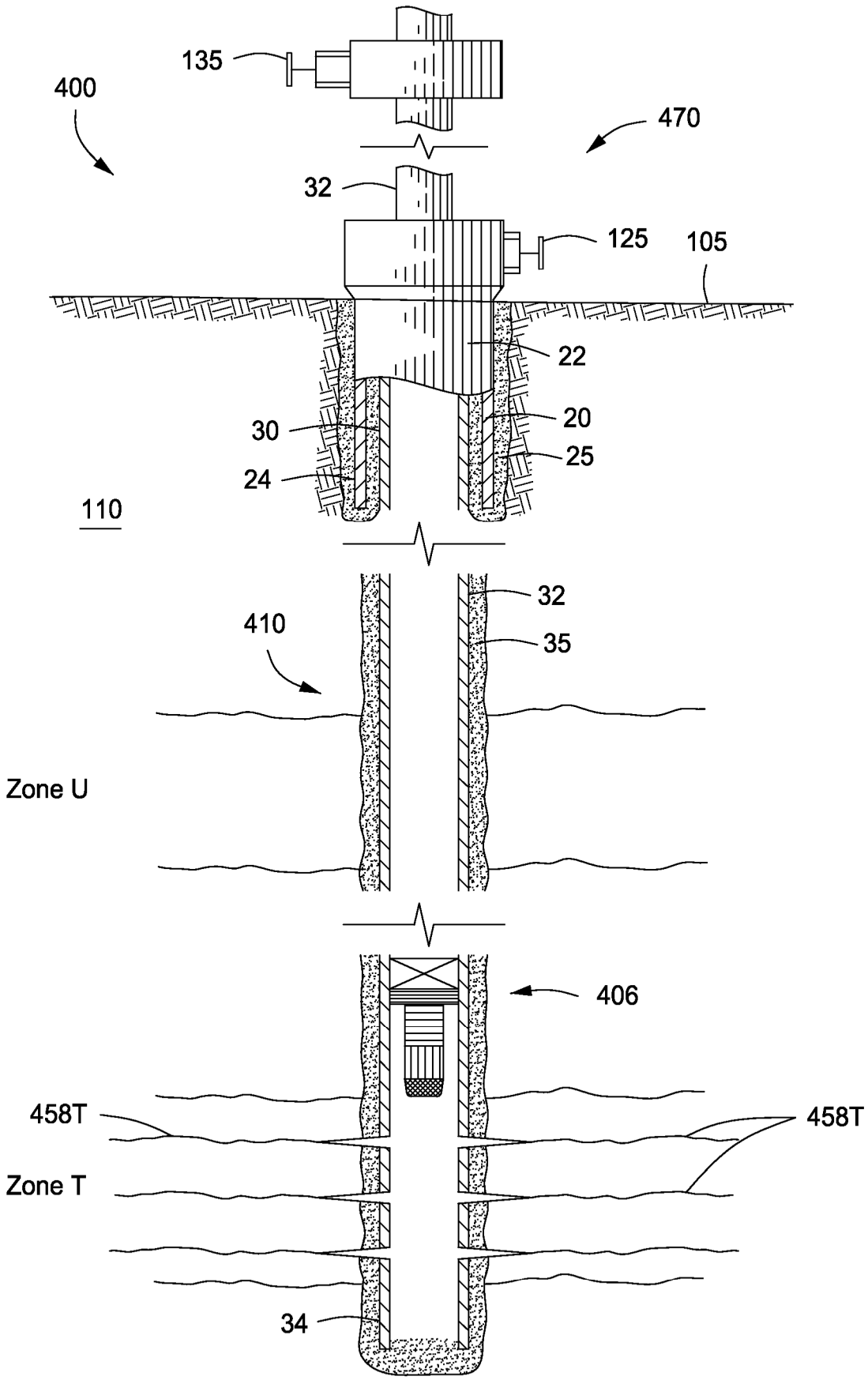

135
400
470
32
125
105
22
30
20
25
24
110
32
410
35
Zone U
406
458T
458T
Zone T
34

FIG. 4H

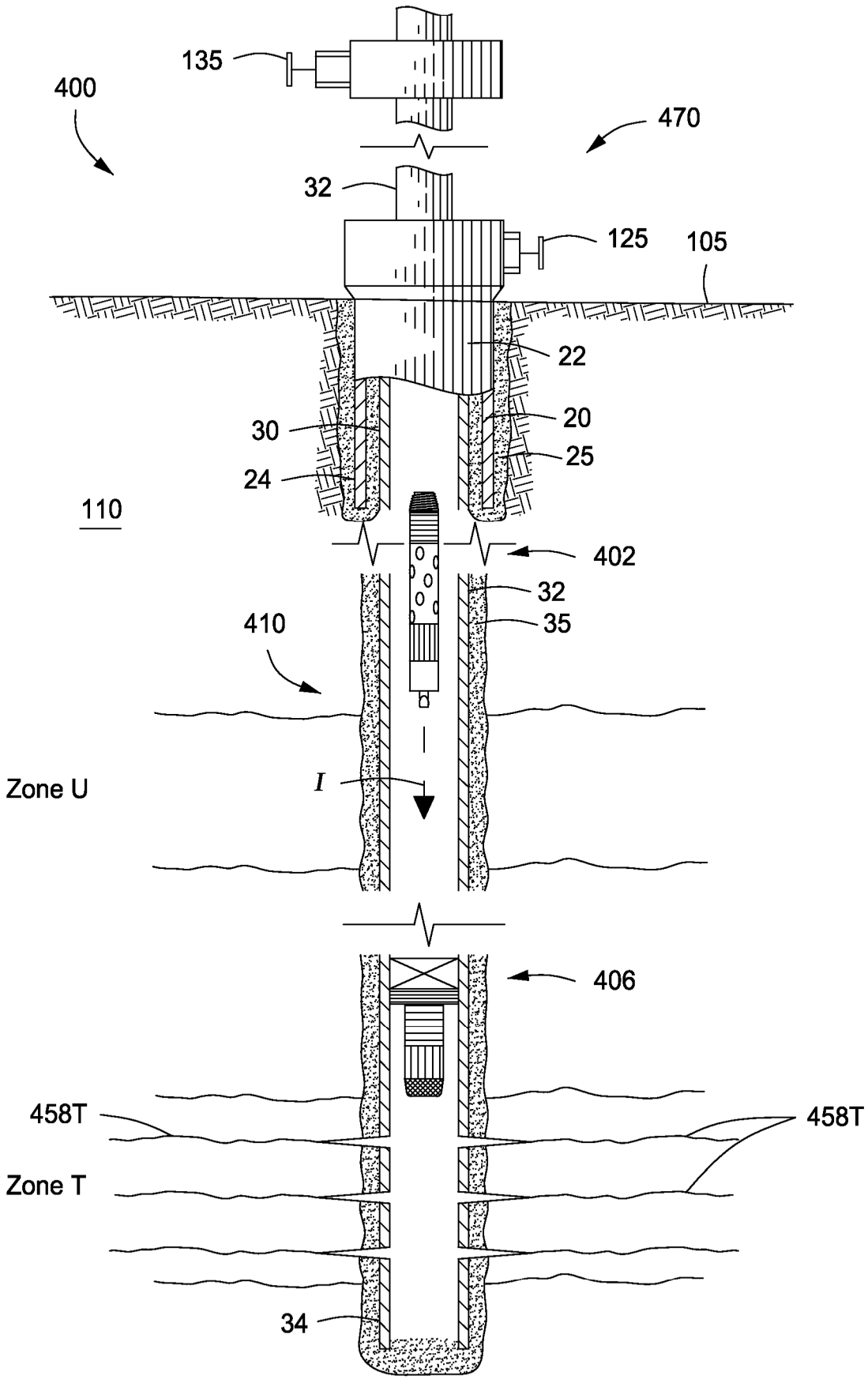

135
400
470
32
125
105
22
30
20
25
24
110
402
32
410
35
Zone U
I
406
458T
458T
Zone T
34

FIG. 4I

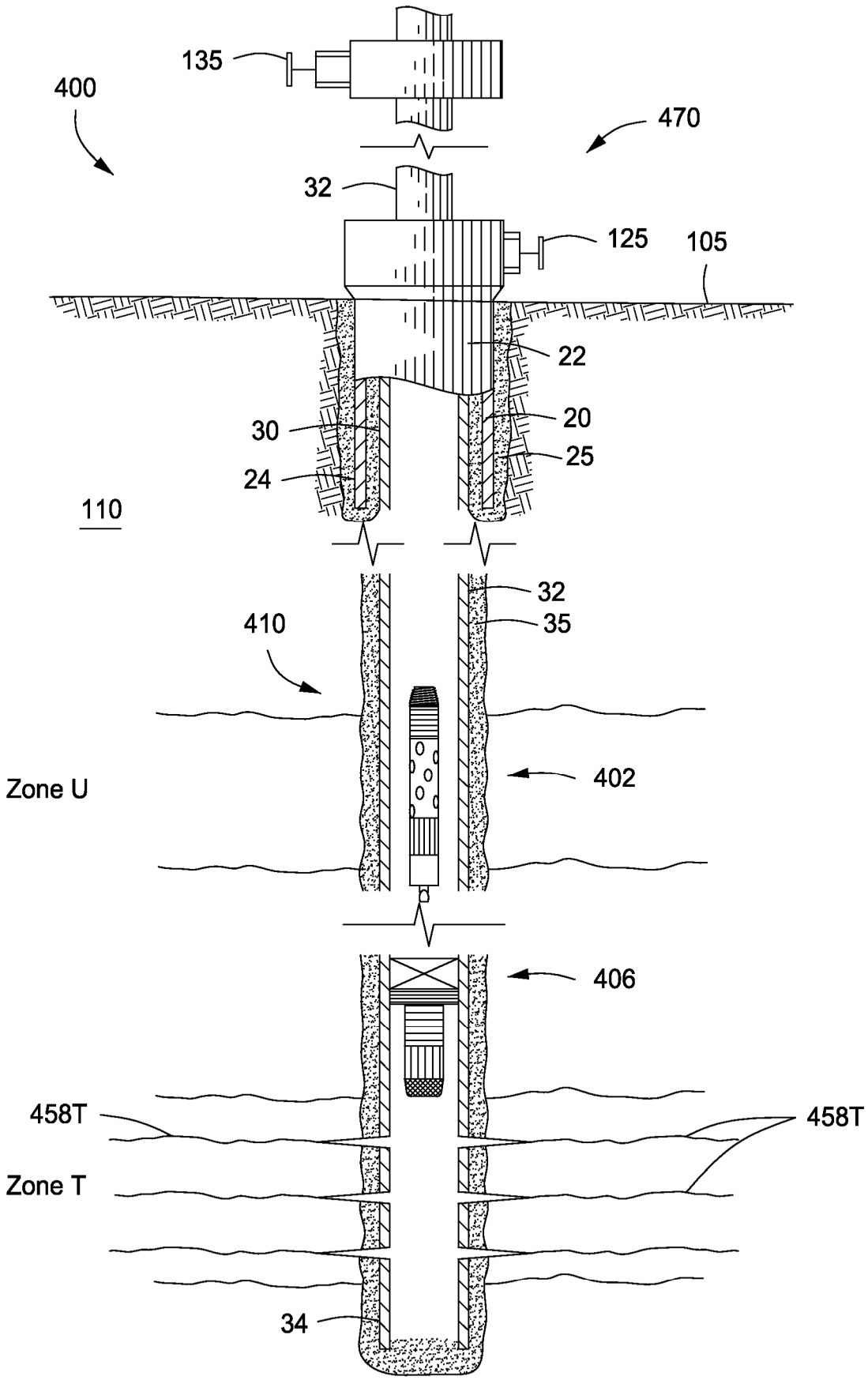

135
400
470
32
125
105
22
30
20
25
24
110
32
410
35
Zone U
402
406
458T
458T
Zone T
34

FIG. 4J

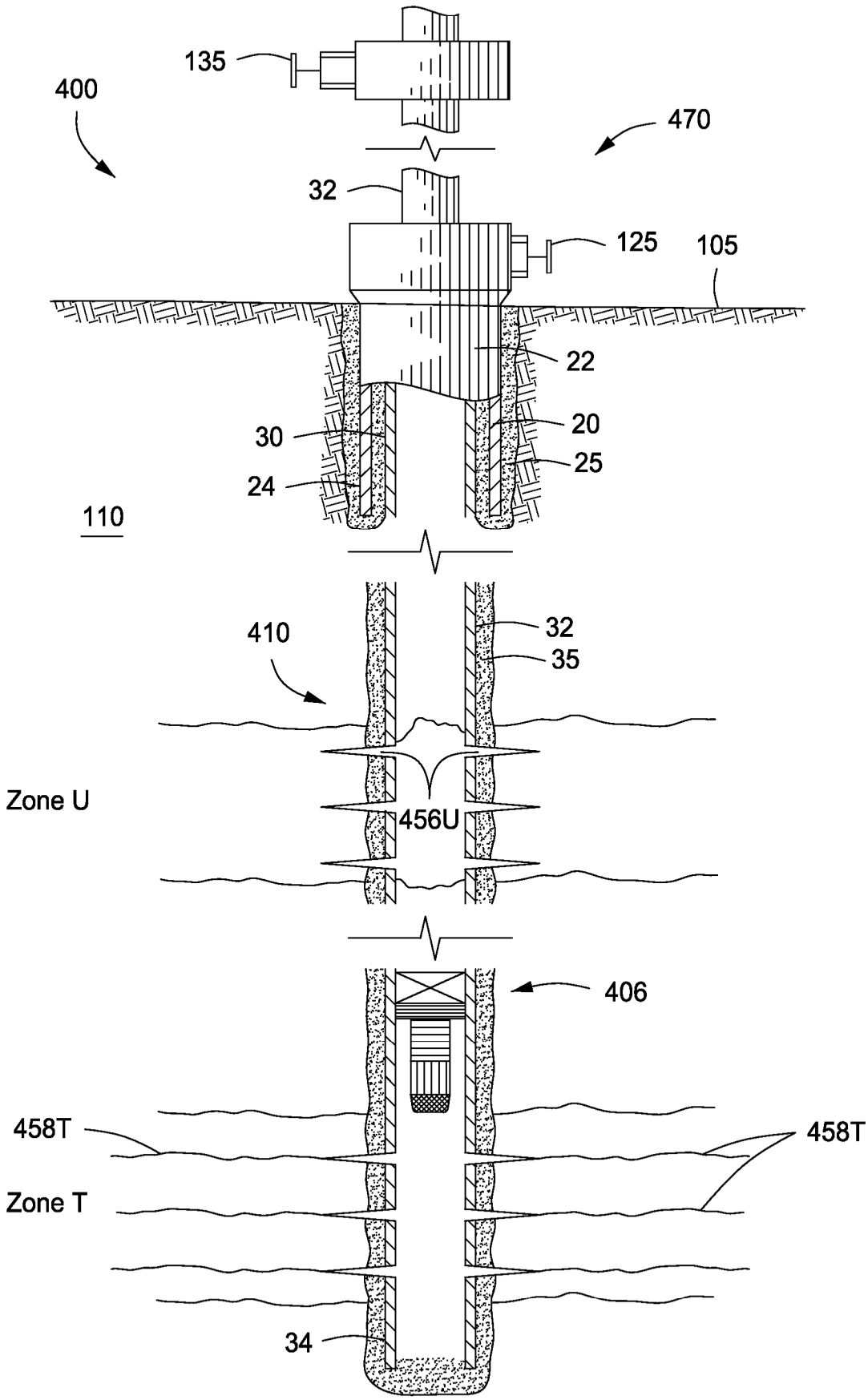

135
400
470
32
125
105
22
30
20
25
24
110
410
32
35
Zone U
456U
406
458T
458T
Zone T
34

FIG. 4K

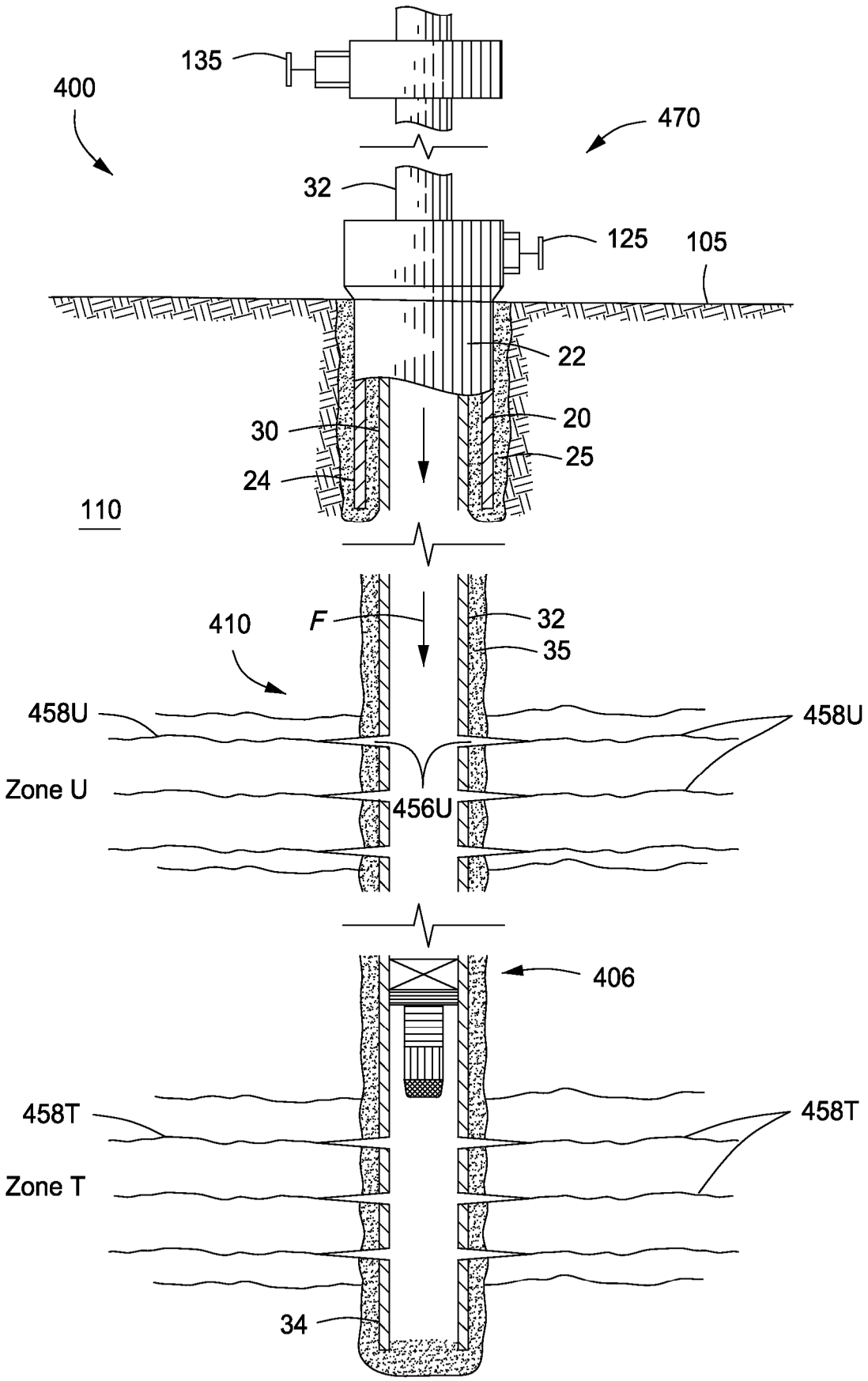

135
400
470
32
125
105
22
30
20
25
24
110
410
F
32
35
458U
458U
Zone U
456U
406
458T
458T
Zone T
34

FIG. 4L

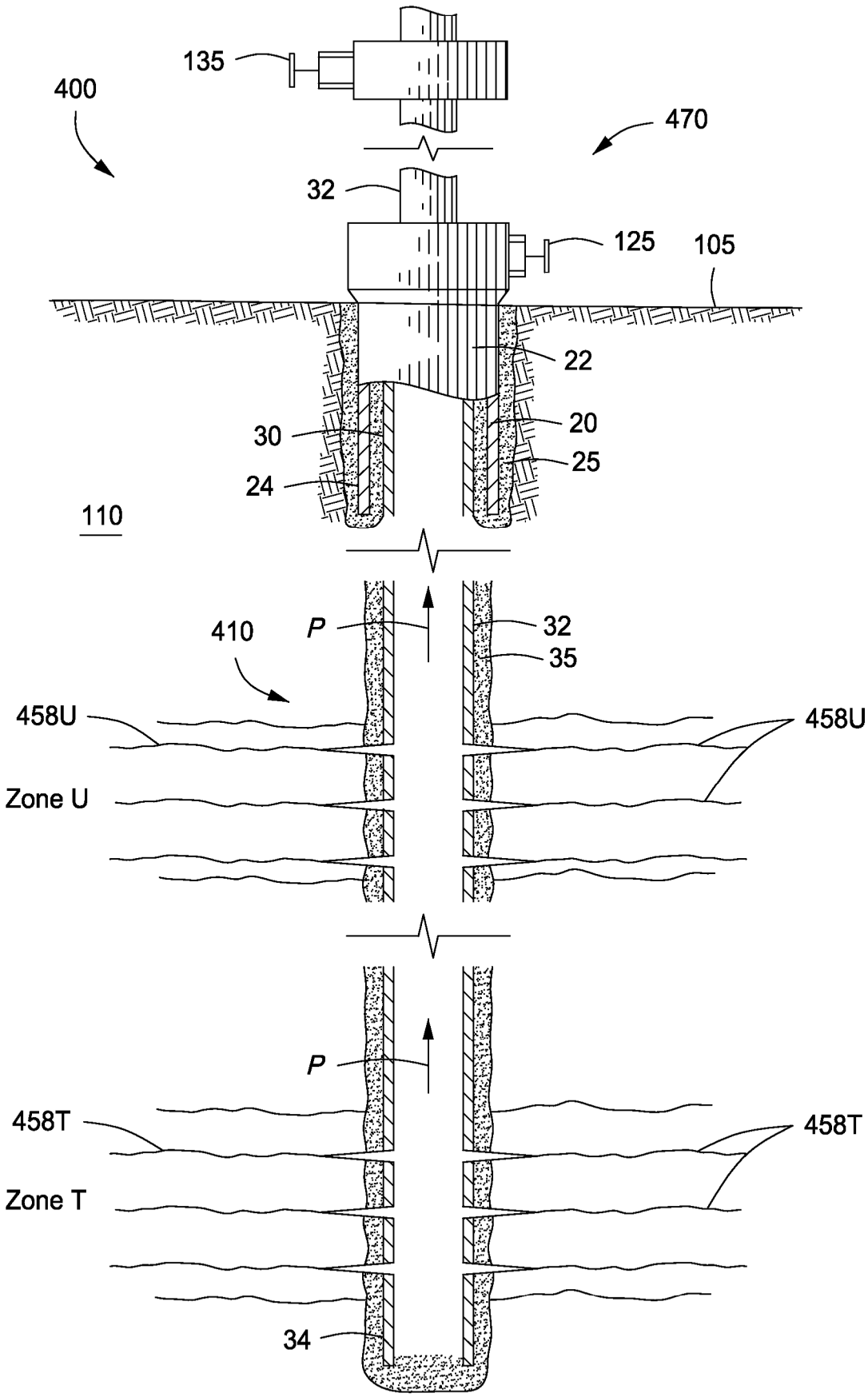

135
400
470
32
125
105
22
30
20
25
24
110
410
P
32
35
458U
458U
Zone U
P
458T
458T
Zone T
34

FIG. 4M

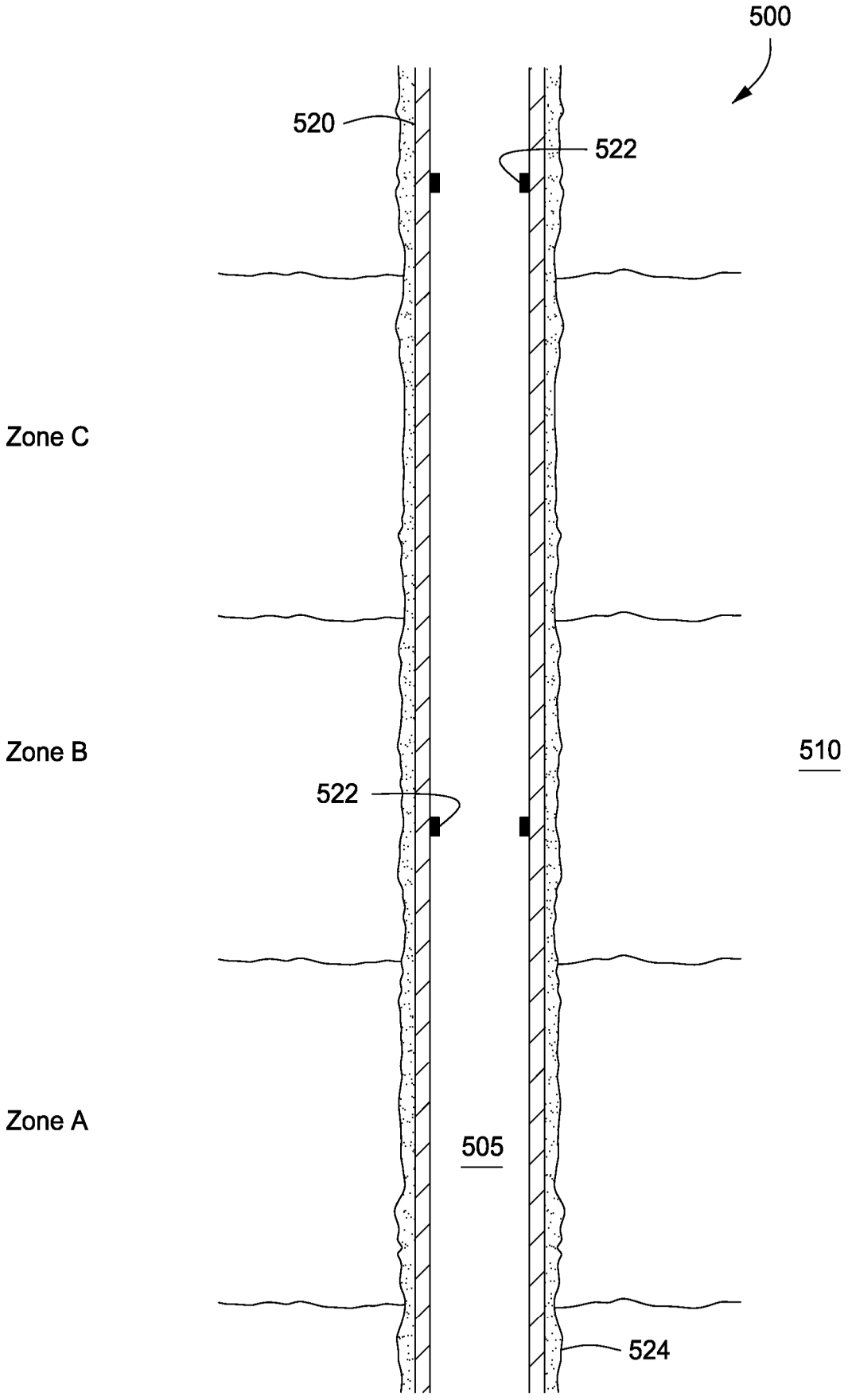


FIG. 5A

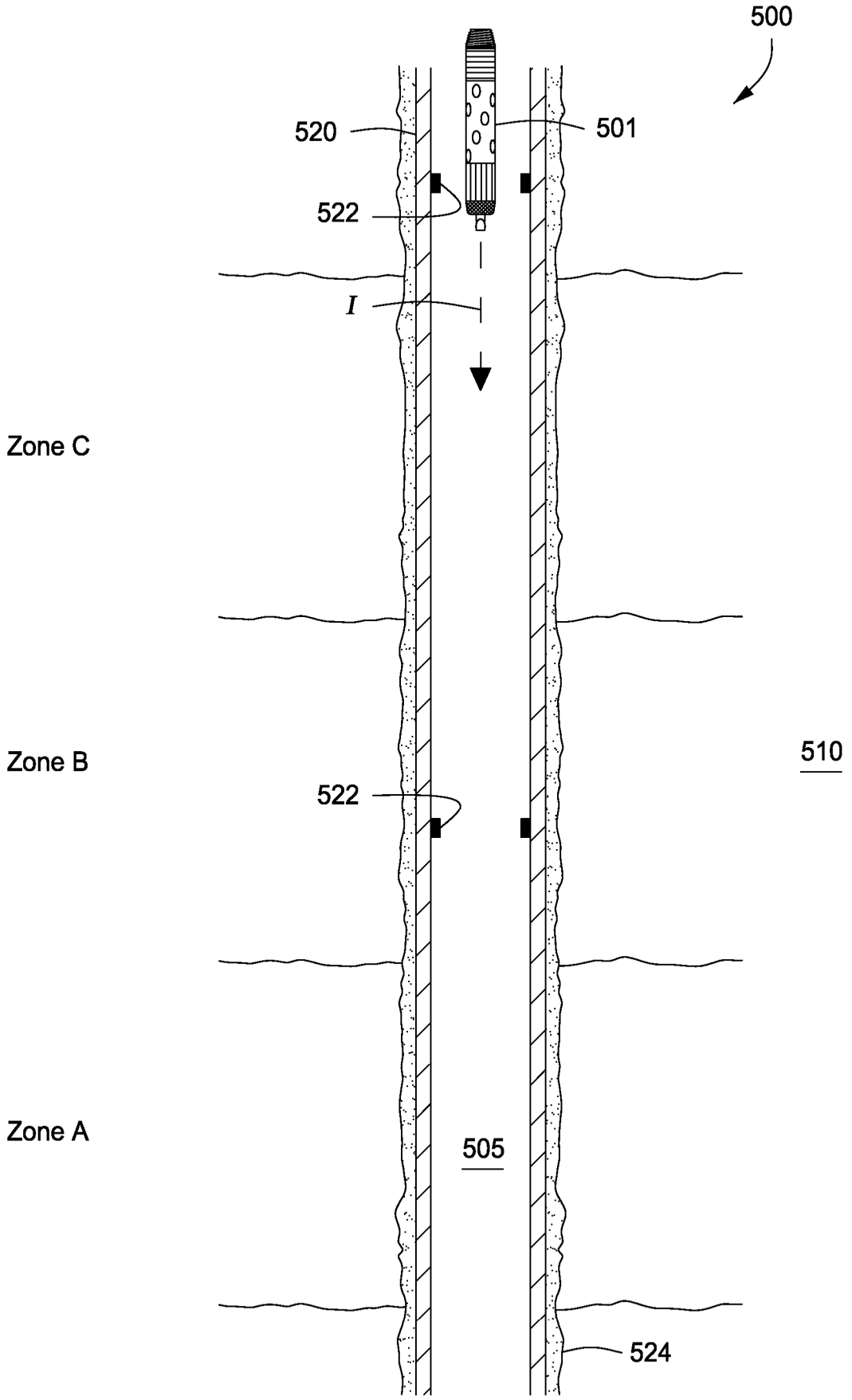


FIG. 5B

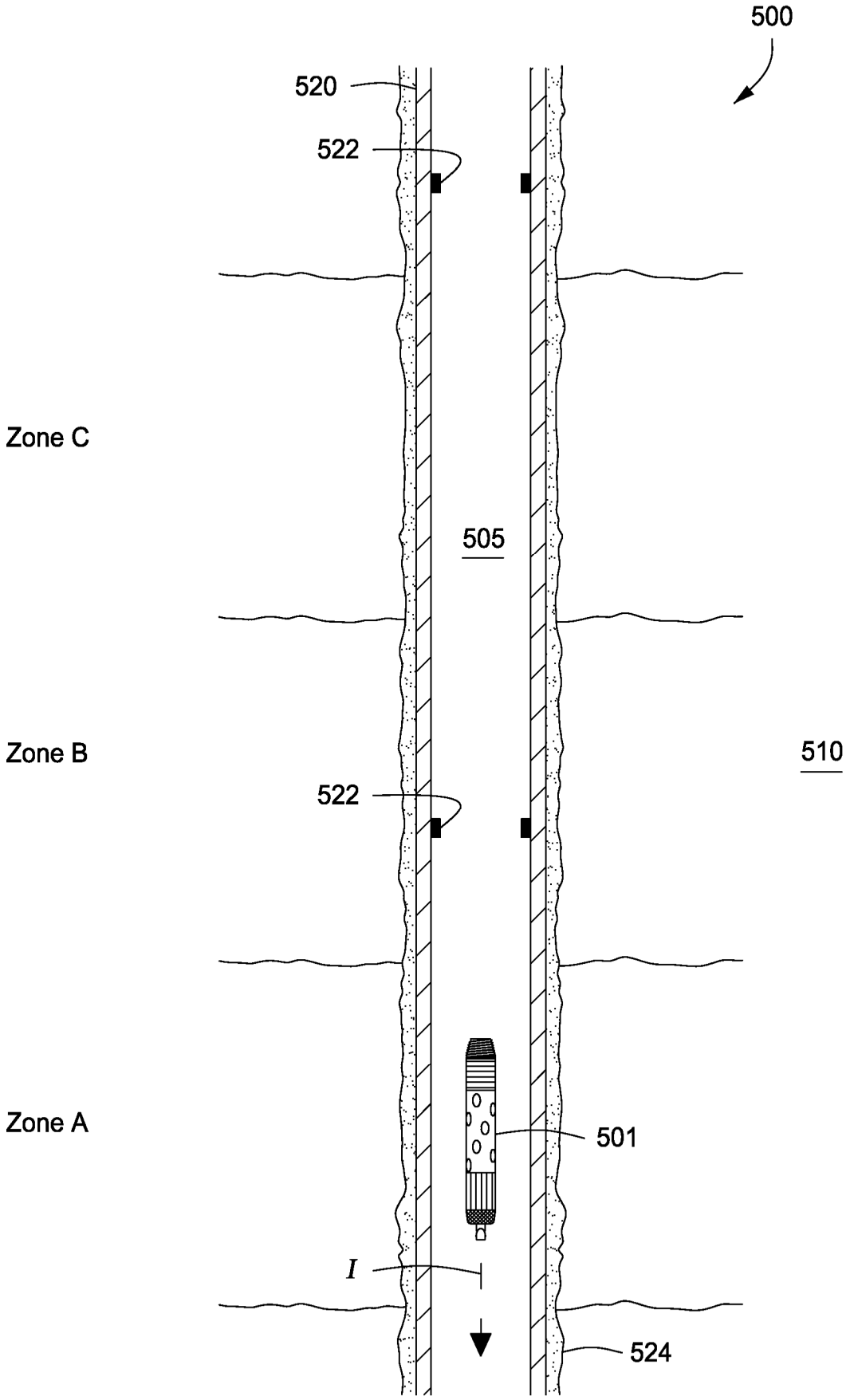


FIG. 5C

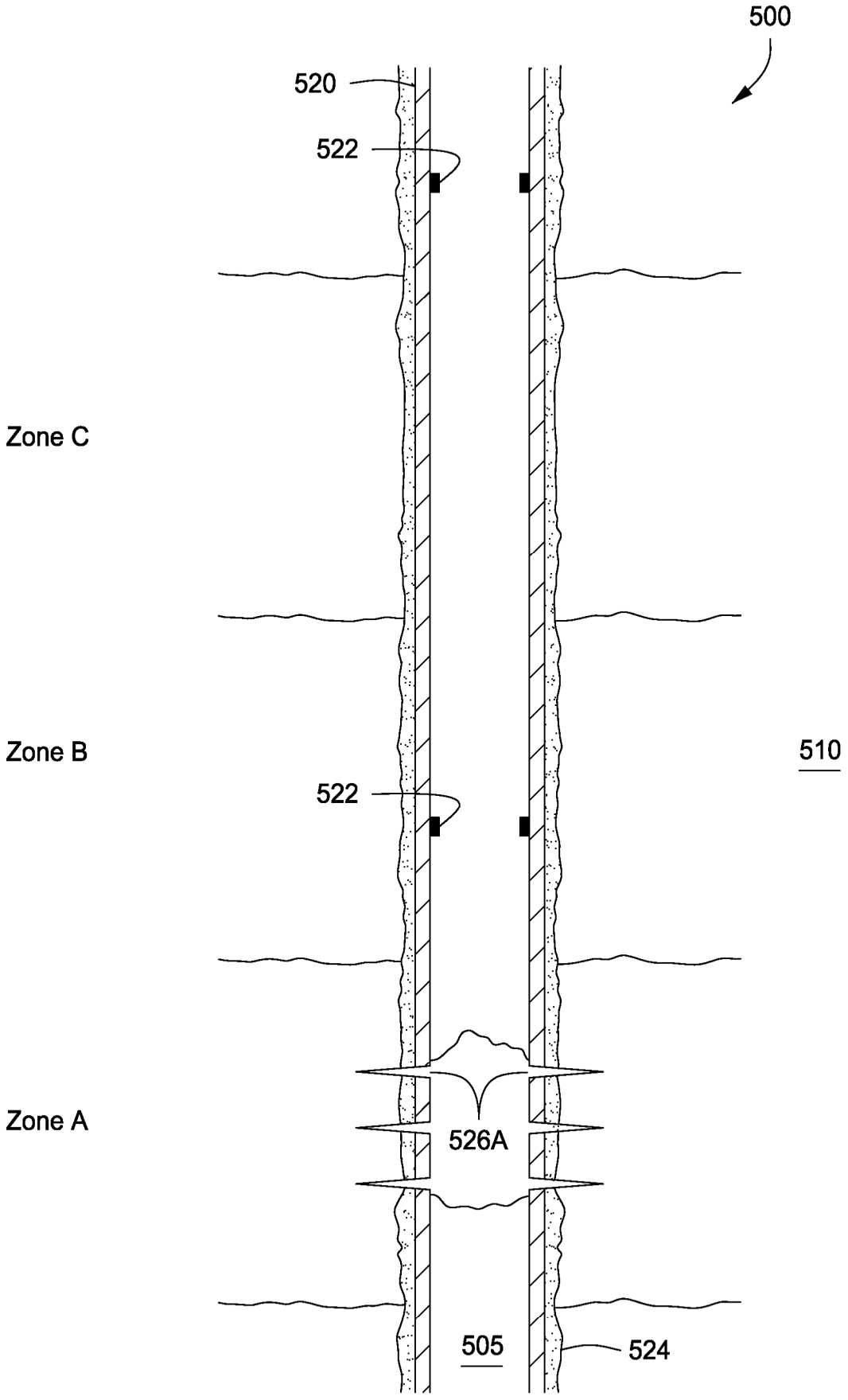


FIG. 5D

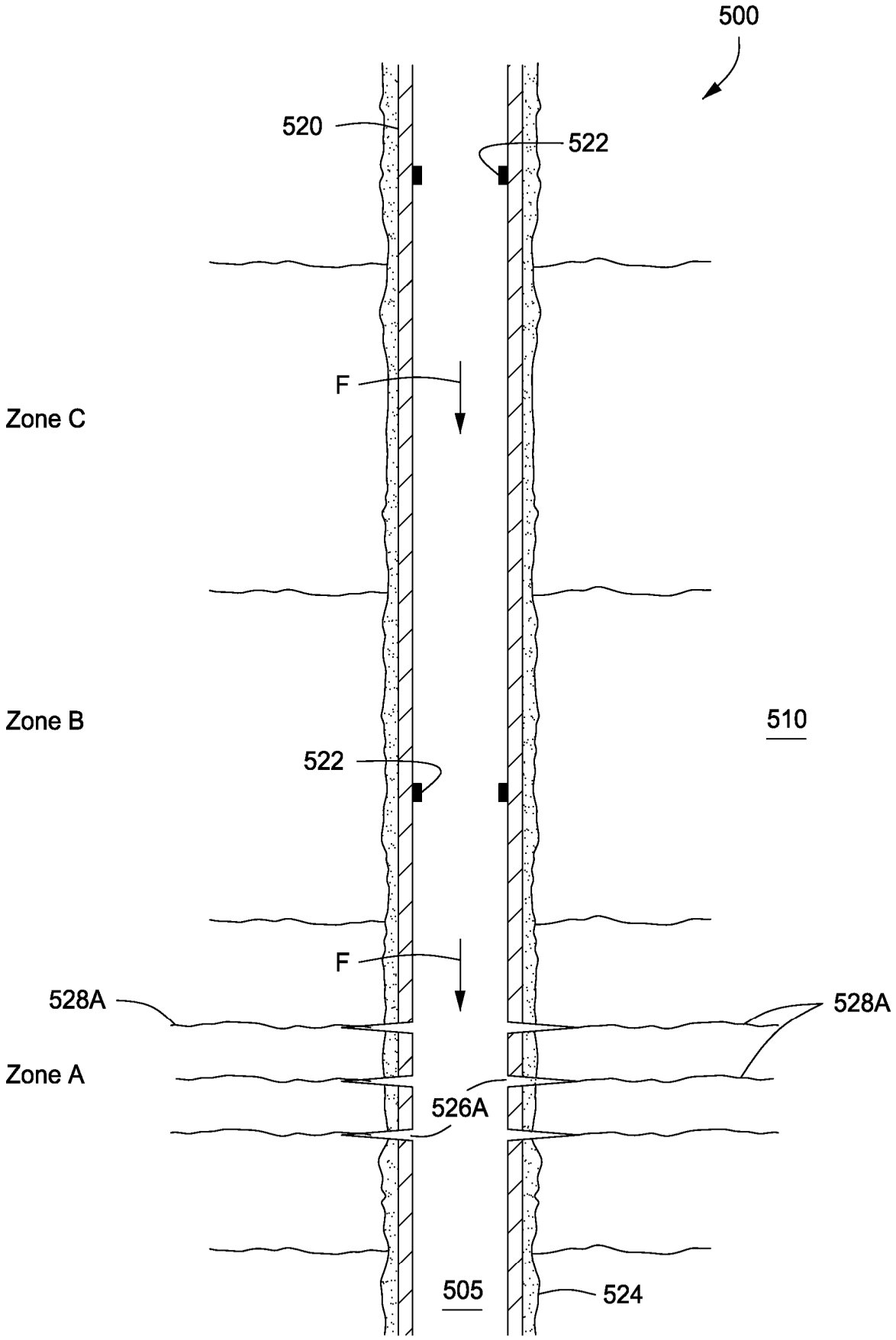

500
520
522
F
Zone C
Zone B
510
522
F
528A
528A
Zone A
526A
505
524

FIG. 5E

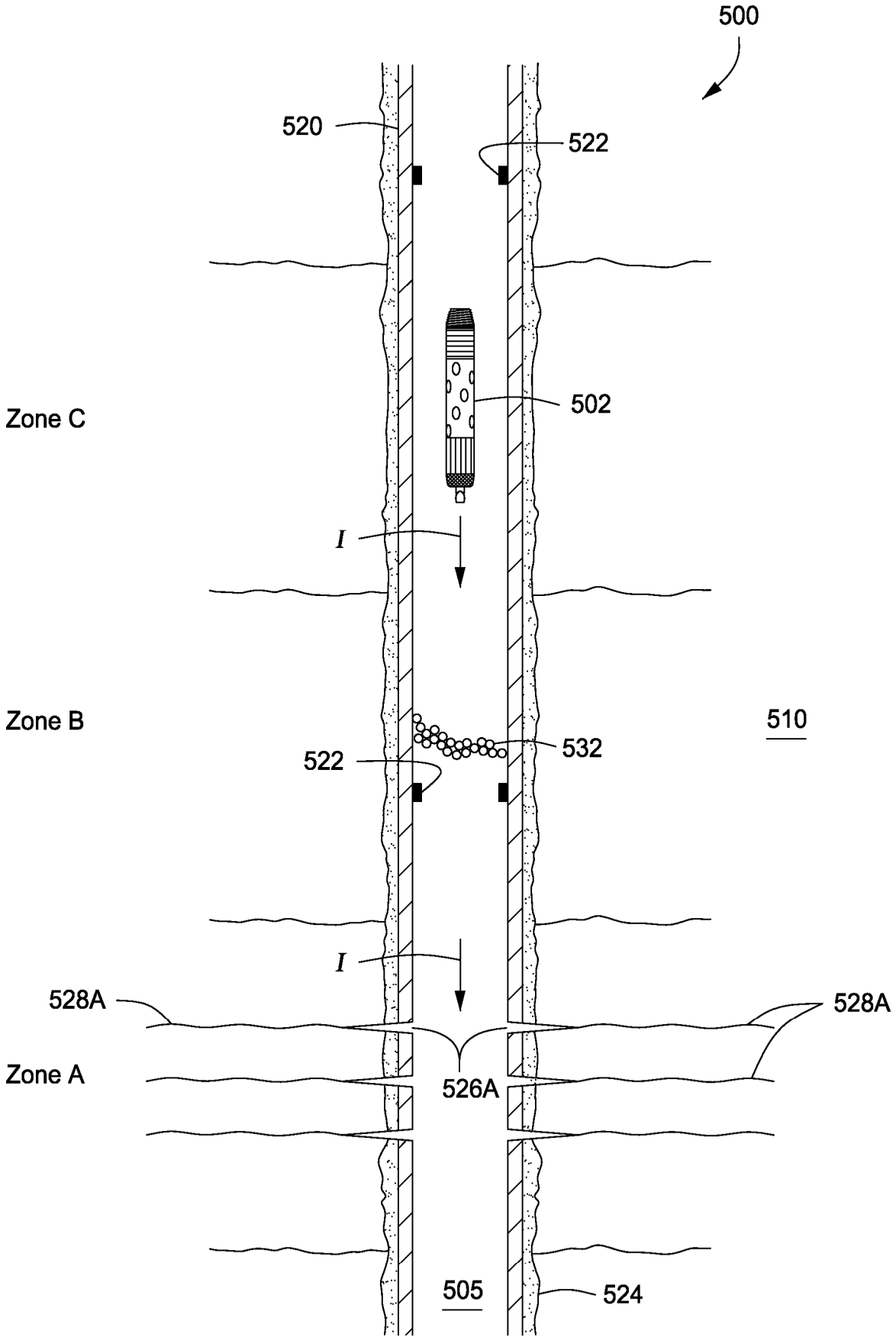

500
520
522
502
Zone C
I
Zone B
510
532
522
I
528A
528A
Zone A
526A
505
524

FIG. 5F

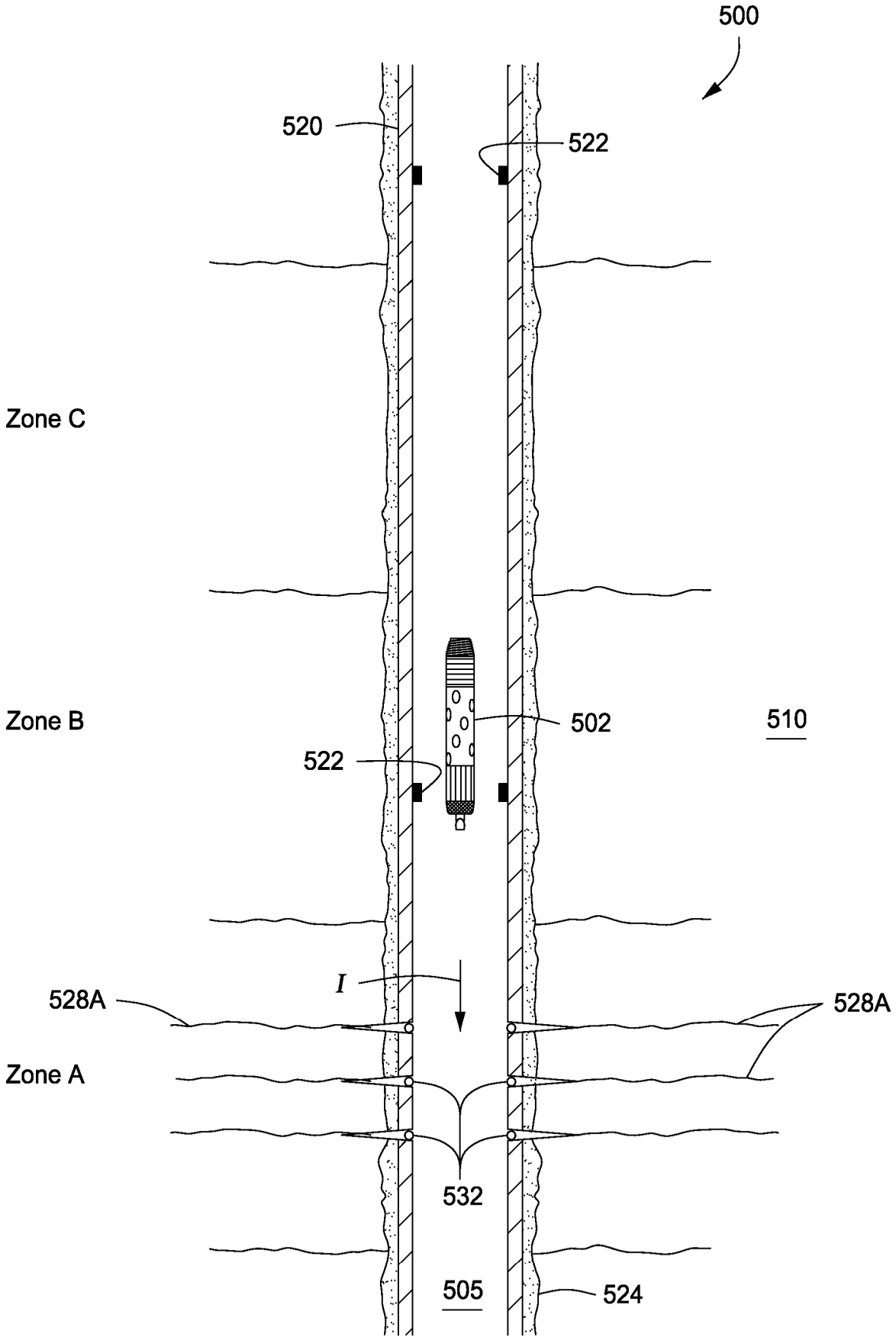

500
520
522
Zone C
Zone B
502
510
522
I
528A
528A
Zone A
532
505
524

FIG. 5G

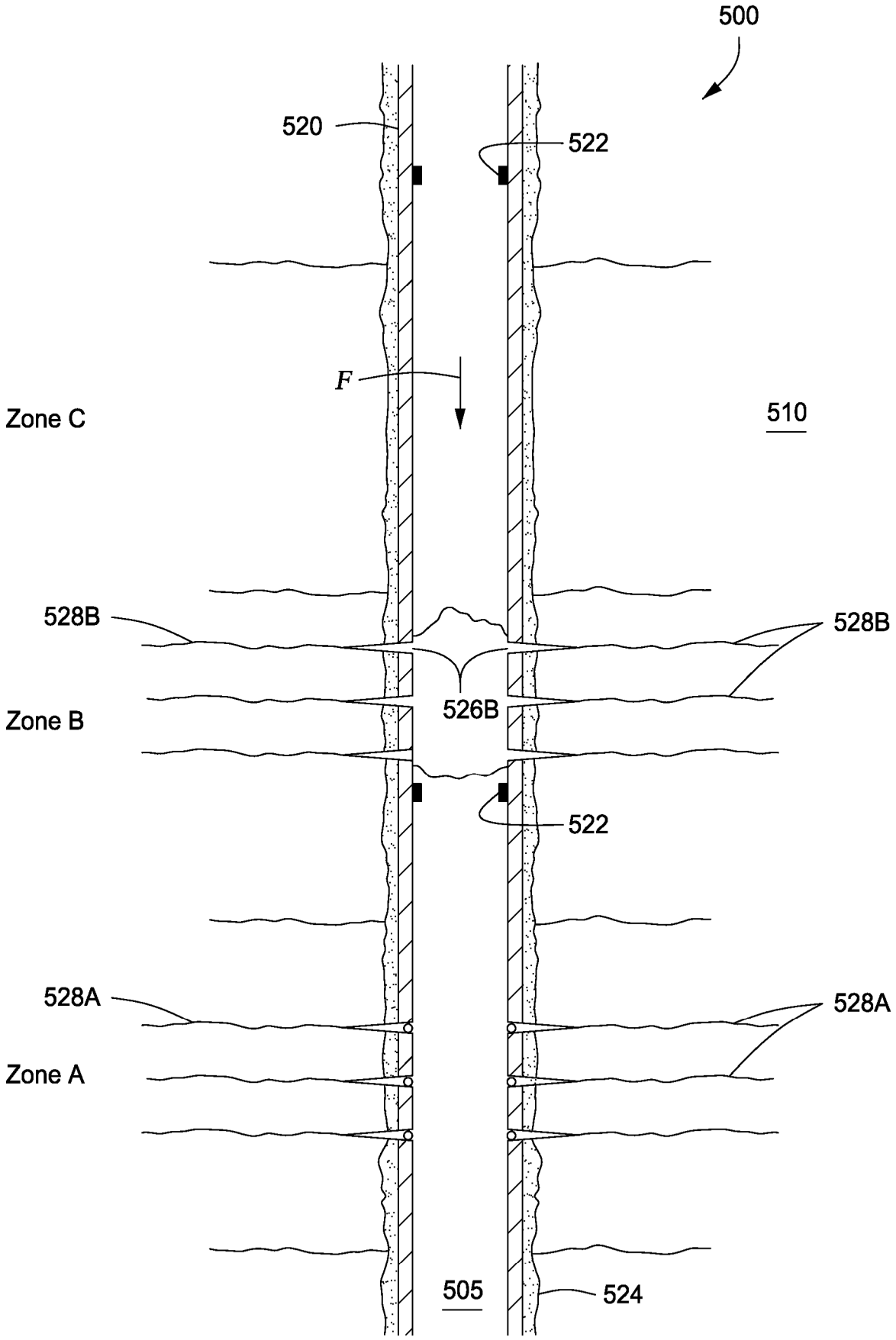

500
520
522
F
Zone C
510
528B
528B
526B
Zone B
522
528A
528A
Zone A
505
524

FIG. 5H

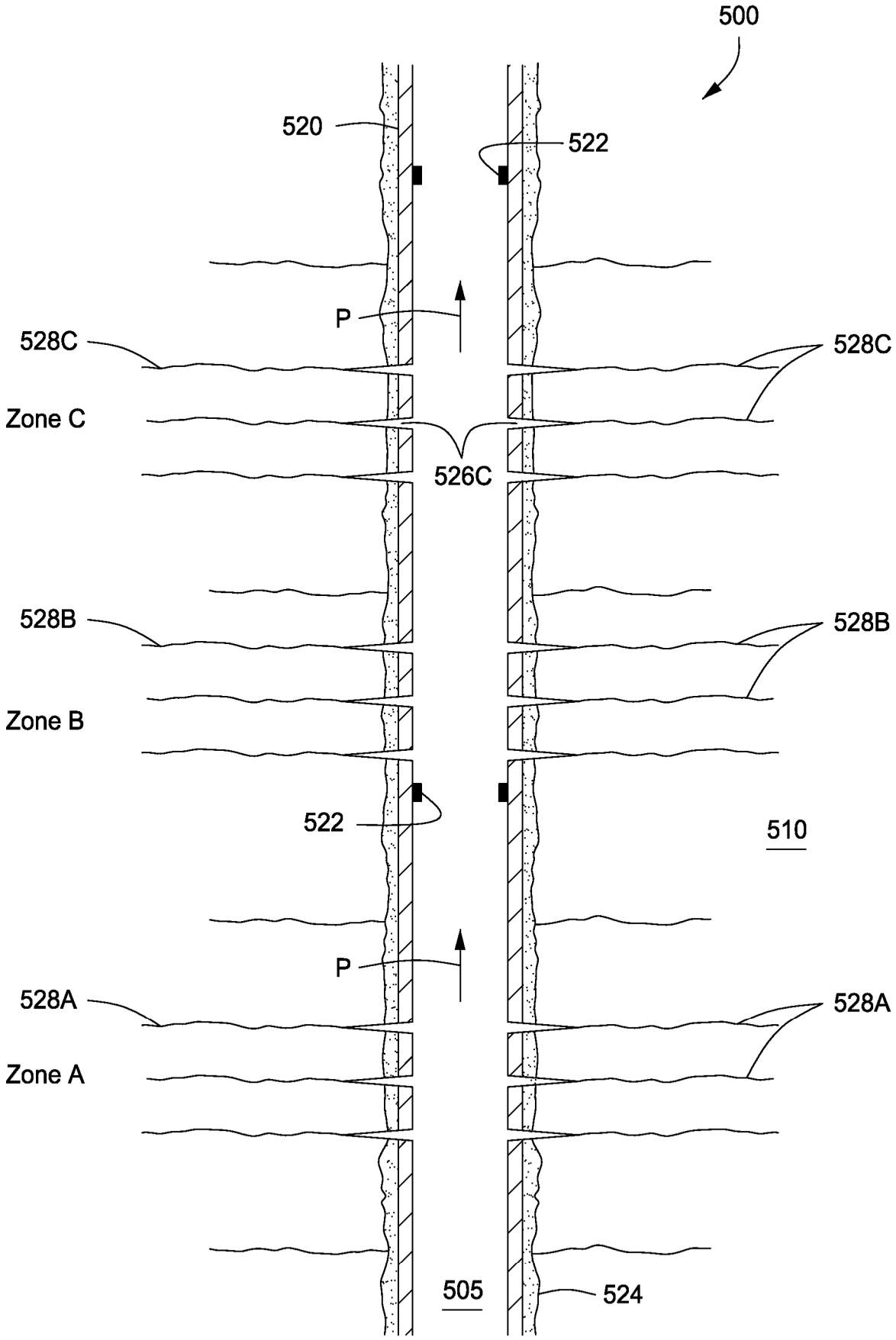

500
520
522
P
528C
528C
Zone C
526C
528B
528B
Zone B
522
510
P
528A
528A
Zone A
505
524

FIG. 5I

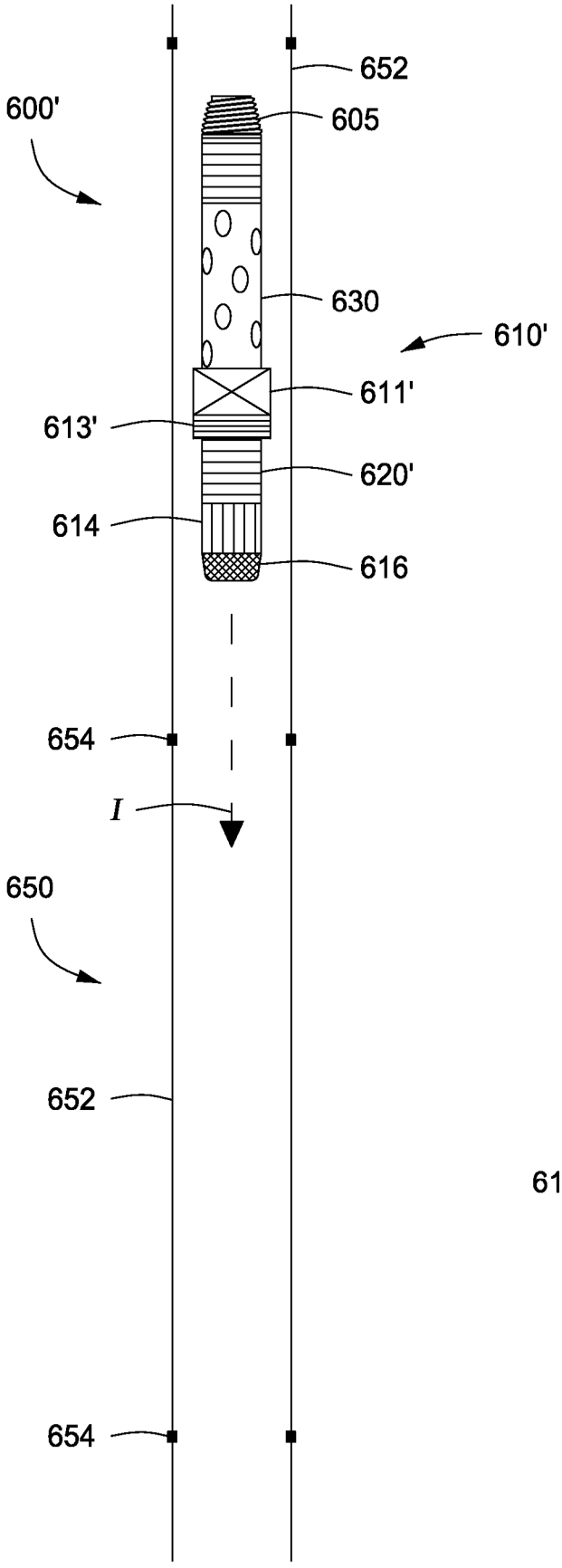

600'
652
605
630
610'
611'
613'
620'
614
616
654
I
650
652
654

FIG. 6A

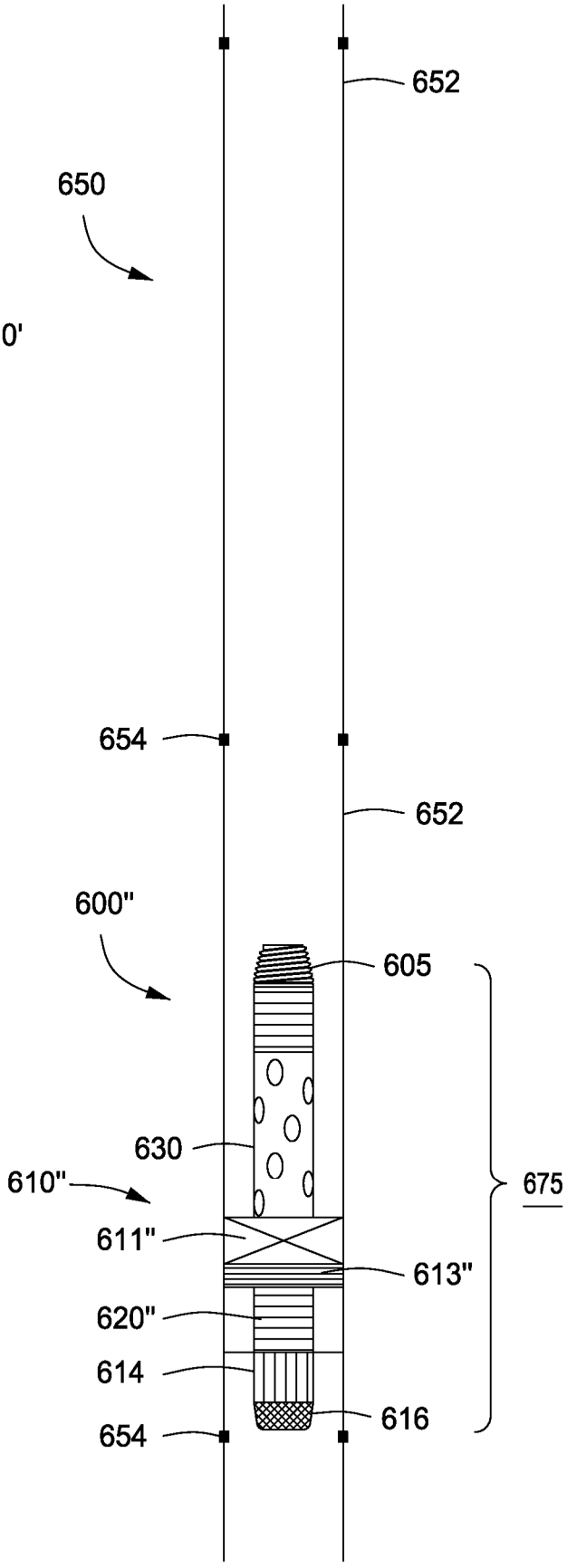

652
650
654
652
600"
605
630
610"
611"
613"
620"
614
616
654
675

FIG. 6B

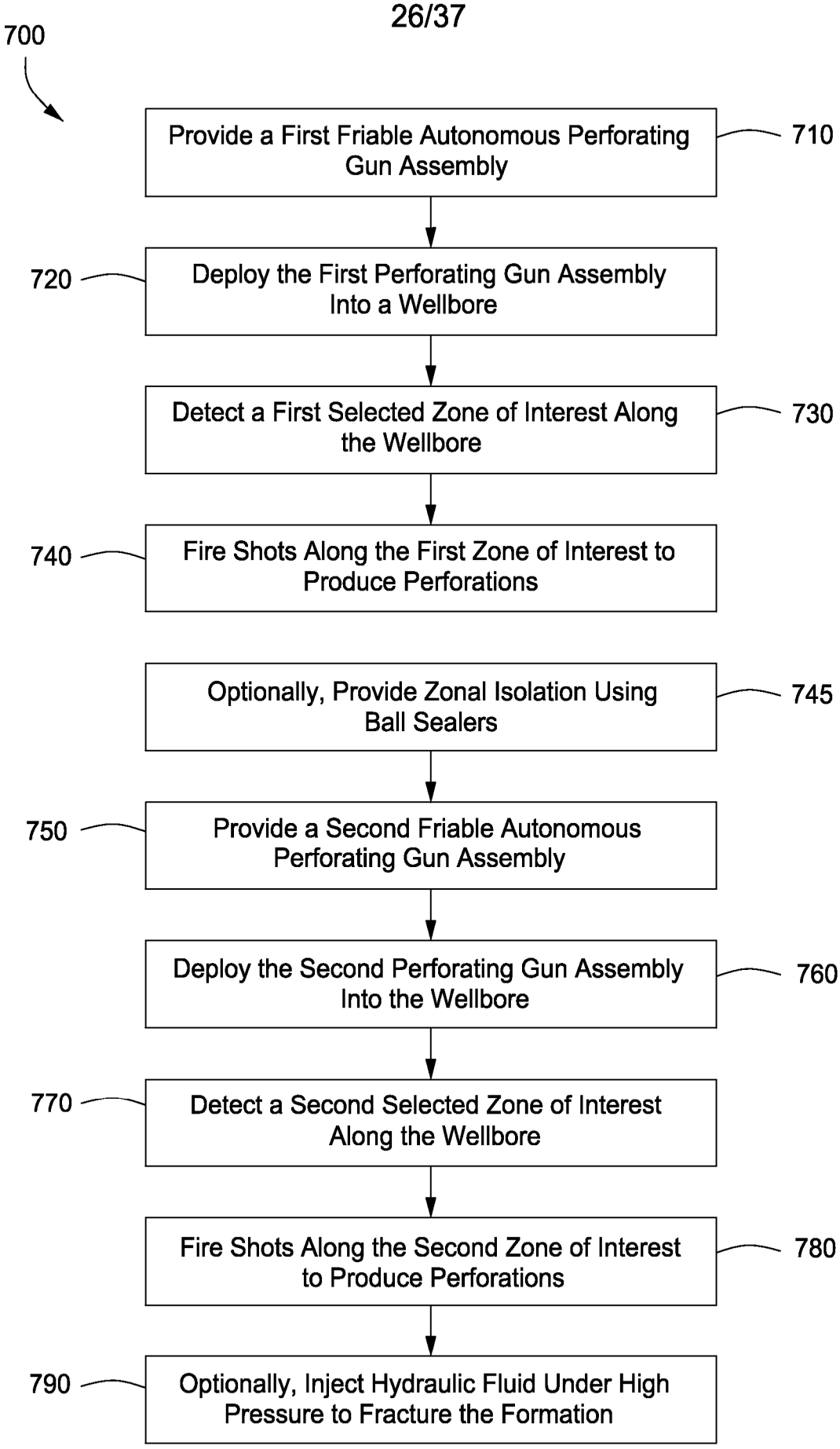

700
Provide a First Friable Autonomous Perforating Gun Assembly
710
720
Deploy the First Perforating Gun Assembly Into a Wellbore
Detect a First Selected Zone of Interest Along the Wellbore
730
740
Fire Shots Along the First Zone of Interest to Produce Perforations
Optionally, Provide Zonal Isolation Using Ball Sealers
745
750
Provide a Second Friable Autonomous Perforating Gun Assembly
Deploy the Second Perforating Gun Assembly Into the Wellbore
760
770
Detect a Second Selected Zone of Interest Along the Wellbore
Fire Shots Along the Second Zone of Interest to Produce Perforations
780
790
Optionally, Inject Hydraulic Fluid Under High Pressure to Fracture the Formation

FIG. 7

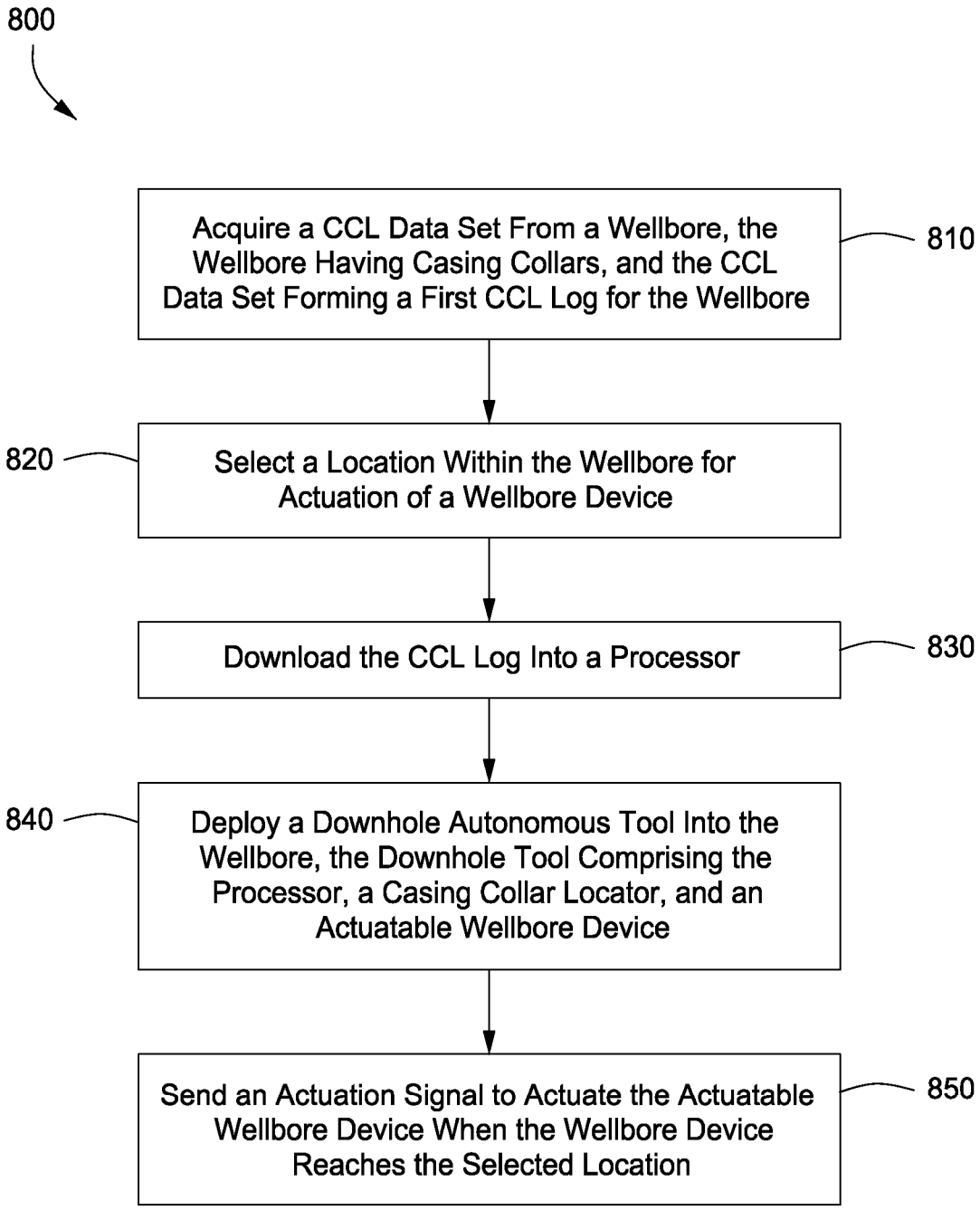

800
Acquire a CCL Data Set From a Wellbore, the Wellbore Having Casing Collars, and the CCL Data Set Forming a First CCL Log for the Wellbore
810
820
Select a Location Within the Wellbore for Actuation of a Wellbore Device
Download the CCL Log Into a Processor
830
840
Deploy a Downhole Autonomous Tool Into the Wellbore, the Downhole Tool Comprising the Processor, a Casing Collar Locator, and an Actuatable Wellbore Device
Send an Actuation Signal to Actuate the Actuatable Wellbore Device When the Wellbore Device Reaches the Selected Location
850

FIG. 8

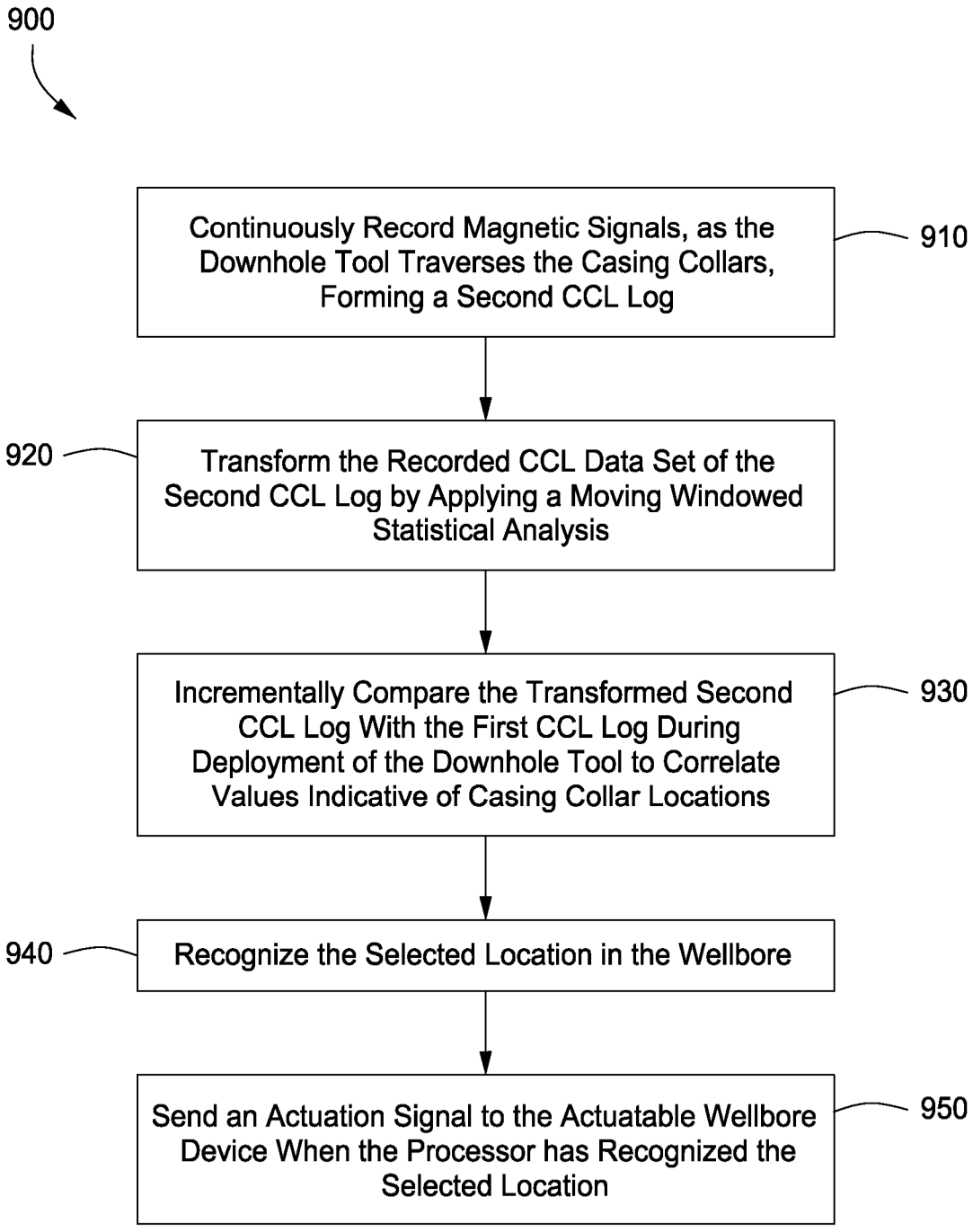

900
Continuously Record Magnetic Signals, as the Downhole Tool Traverses the Casing Collars, Forming a Second CCL Log
910
920
Transform the Recorded CCL Data Set of the Second CCL Log by Applying a Moving Windowed Statistical Analysis
Incrementally Compare the Transformed Second CCL Log With the First CCL Log During Deployment of the Downhole Tool to Correlate Values Indicative of Casing Collar Locations
930
940
Recognize the Selected Location in the Wellbore
Send an Actuation Signal to the Actuatable Wellbore Device When the Processor has Recognized the Selected Location
950

FIG. 9

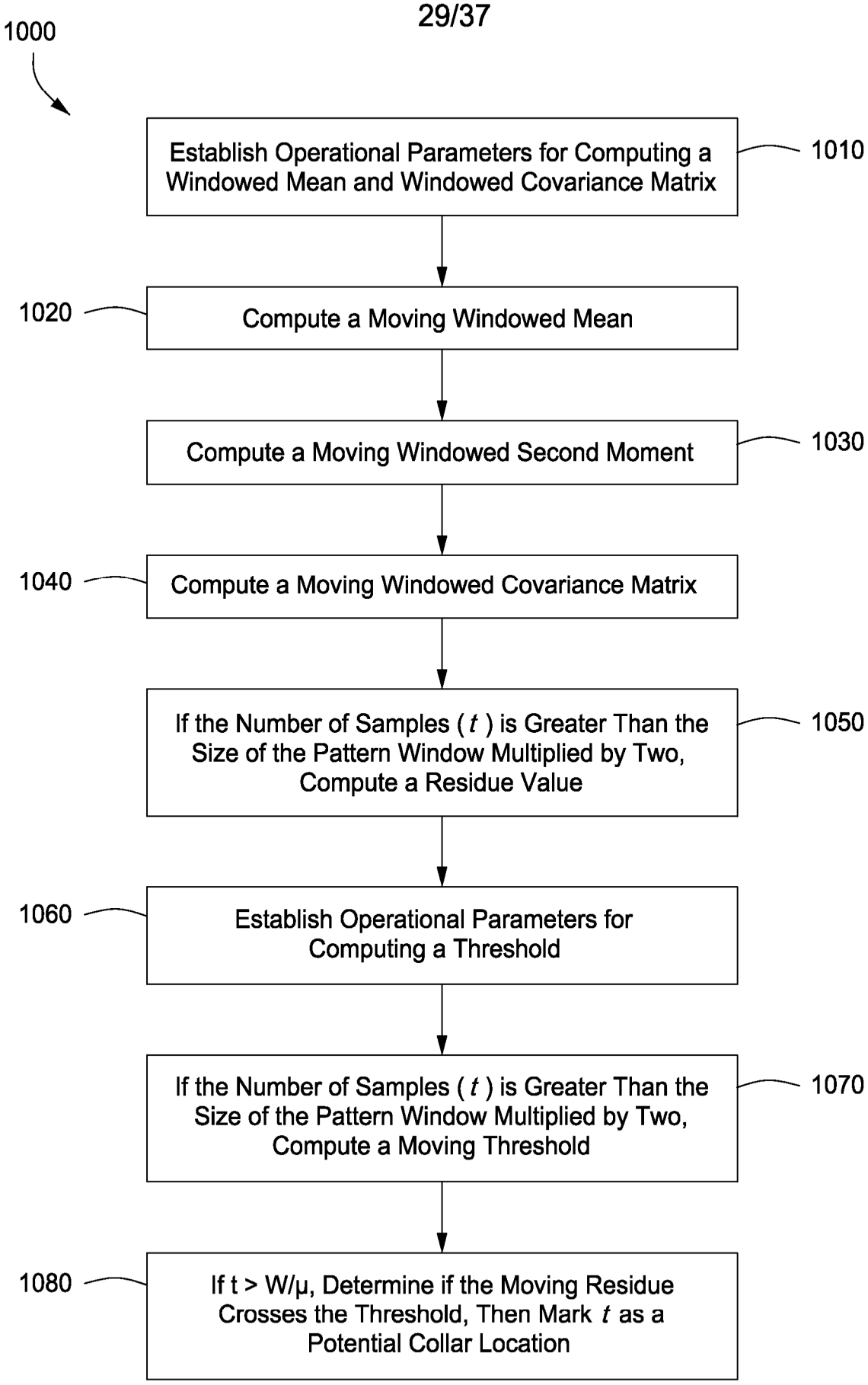

1000
Establish Operational Parameters for Computing a Windowed Mean and Windowed Covariance Matrix
1010
1020
Compute a Moving Windowed Mean
Compute a Moving Windowed Second Moment
1030
1040
Compute a Moving Windowed Covariance Matrix
If the Number of Samples (t) is Greater Than the Size of the Pattern Window Multiplied by Two, Compute a Residue Value
1050
1060
Establish Operational Parameters for Computing a Threshold
If the Number of Samples (t) is Greater Than the Size of the Pattern Window Multiplied by Two, Compute a Moving Threshold
1070
1080
If t > W/μ, Determine if the Moving Residue Crosses the Threshold, Then Mark t as a Potential Collar Location

FIG. 10

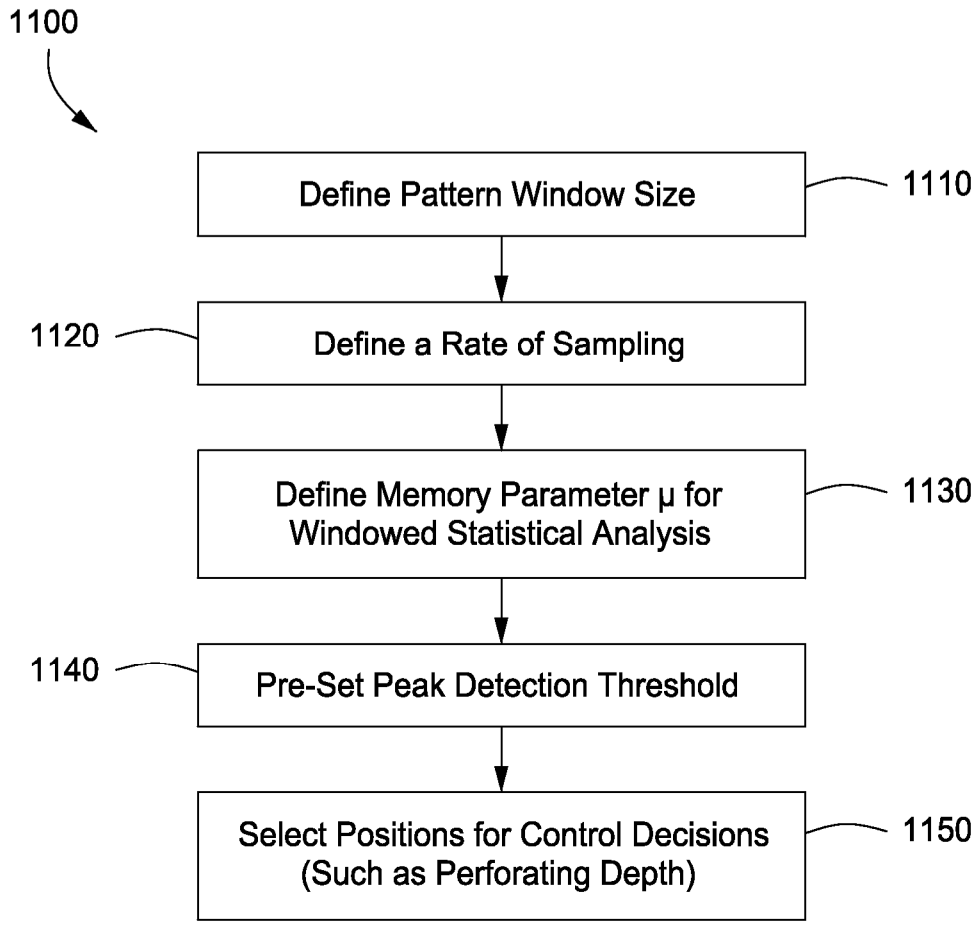

1100
Define Pattern Window Size
1110
1120
Define a Rate of Sampling
Define Memory Parameter μ for Windowed Statistical Analysis
1130
1140
Pre-Set Peak Detection Threshold
Select Positions for Control Decisions (Such as Perforating Depth)
1150

FIG. 11

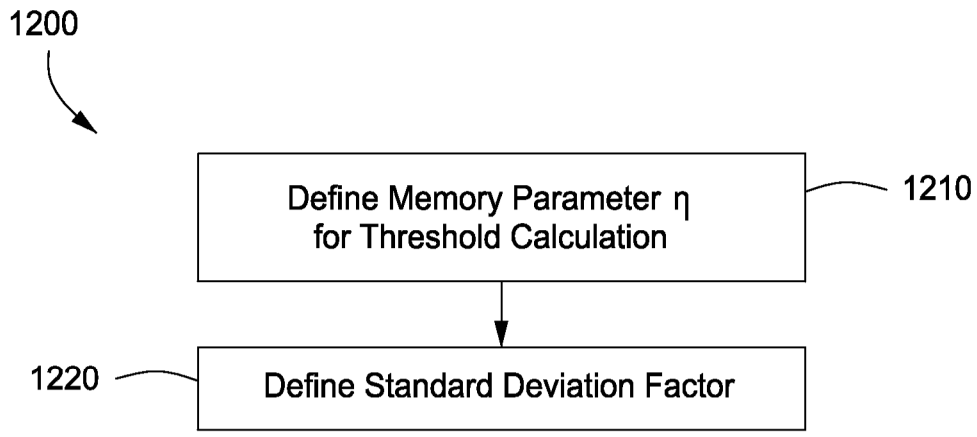

1200
Define Memory Parameter η for Threshold Calculation
1210
1220
Define Standard Deviation Factor

FIG. 12

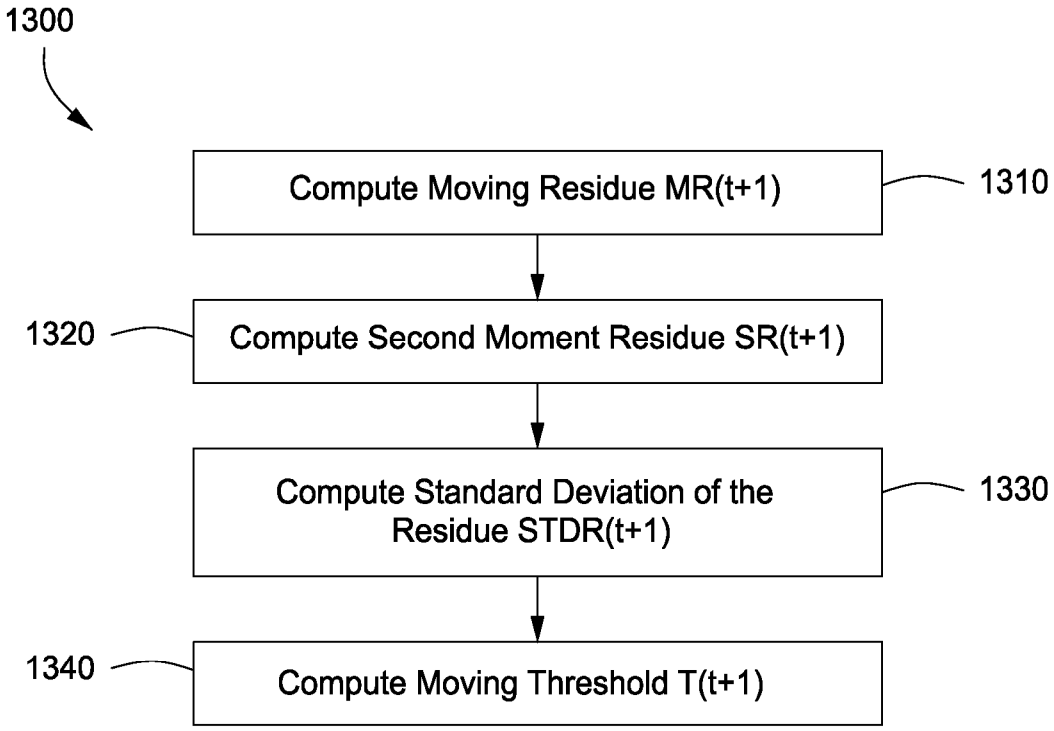

1300
Compute Moving Residue MR(t+1)
1310
1320
Compute Second Moment Residue SR(t+1)
Compute Standard Deviation of the Residue STDR(t+1)
1330
1340
Compute Moving Threshold T(t+1)

FIG. 13

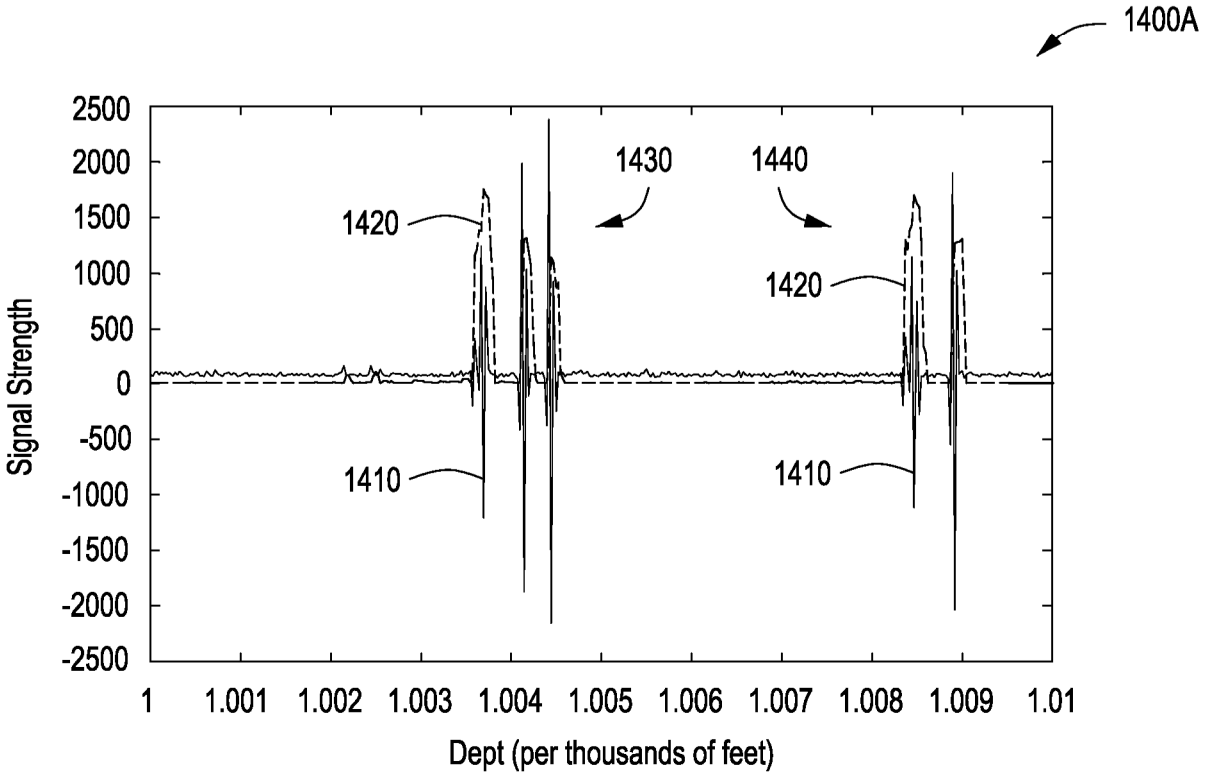


FIG. 14A

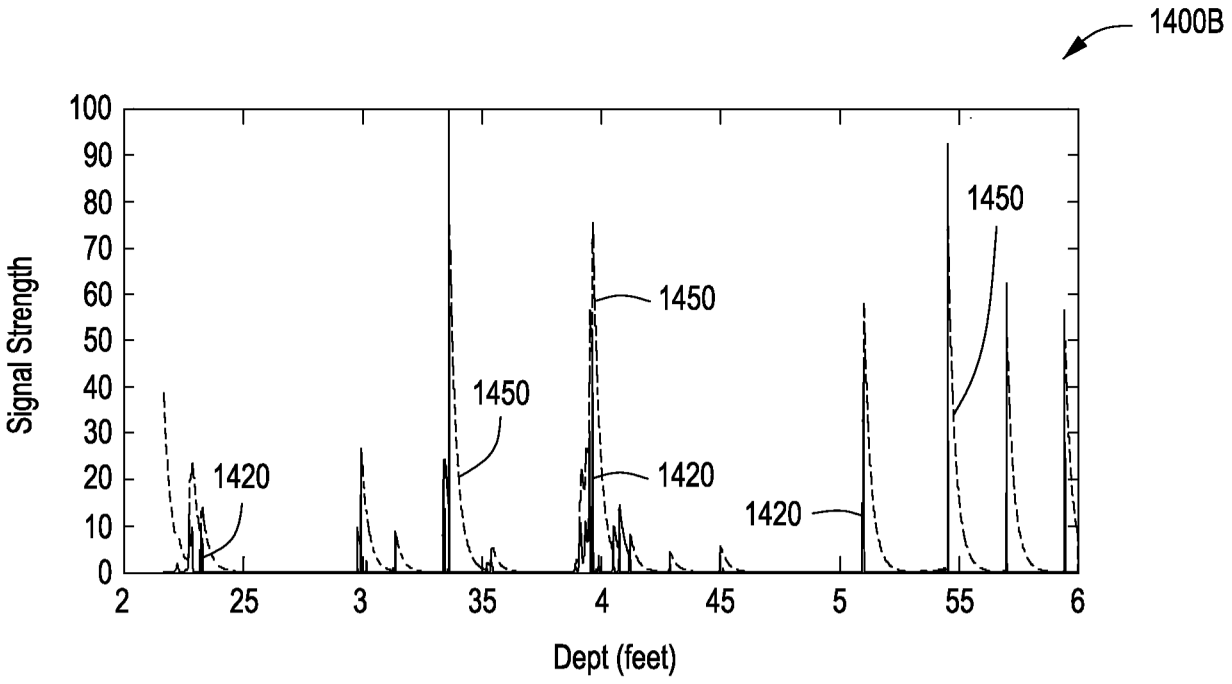


FIG. 14B

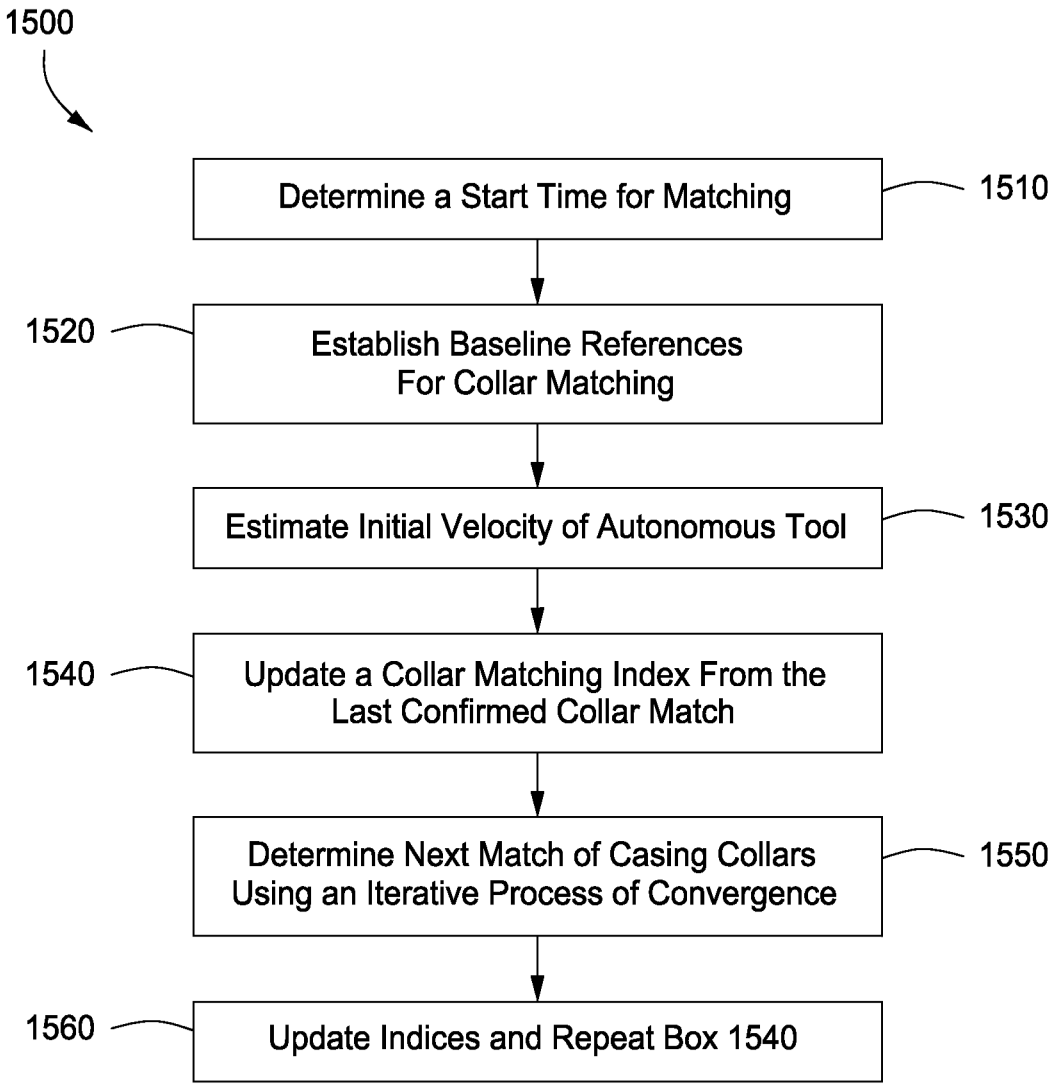

1500
Determine a Start Time for Matching
1510
1520
Establish Baseline References For Collar Matching
Estimate Initial Velocity of Autonomous Tool
1530
1540
Update a Collar Matching Index From the Last Confirmed Collar Match
Determine Next Match of Casing Collars Using an Iterative Process of Convergence
1550
1560
Update Indices and Repeat Box 1540

FIG. 15

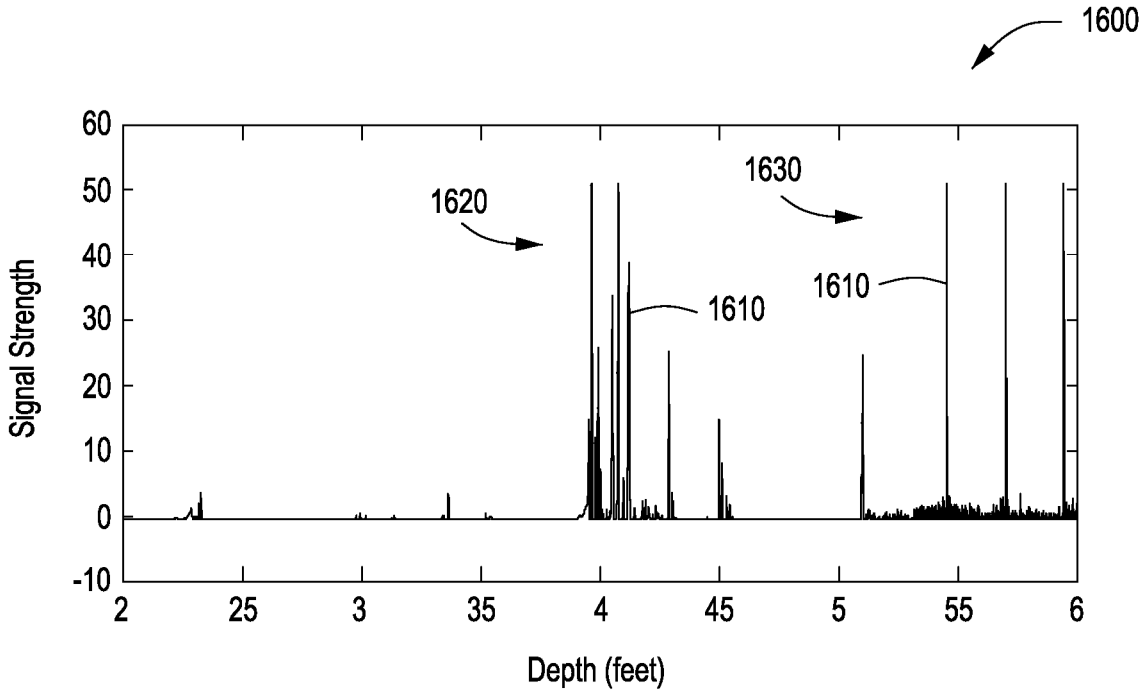

1600
60
50
40
30
20
10
0
-10
Signal Strength
1620
1630
1610
1610
2
25
3
35
4
45
5
55
6
Depth (feet)

FIG. 16

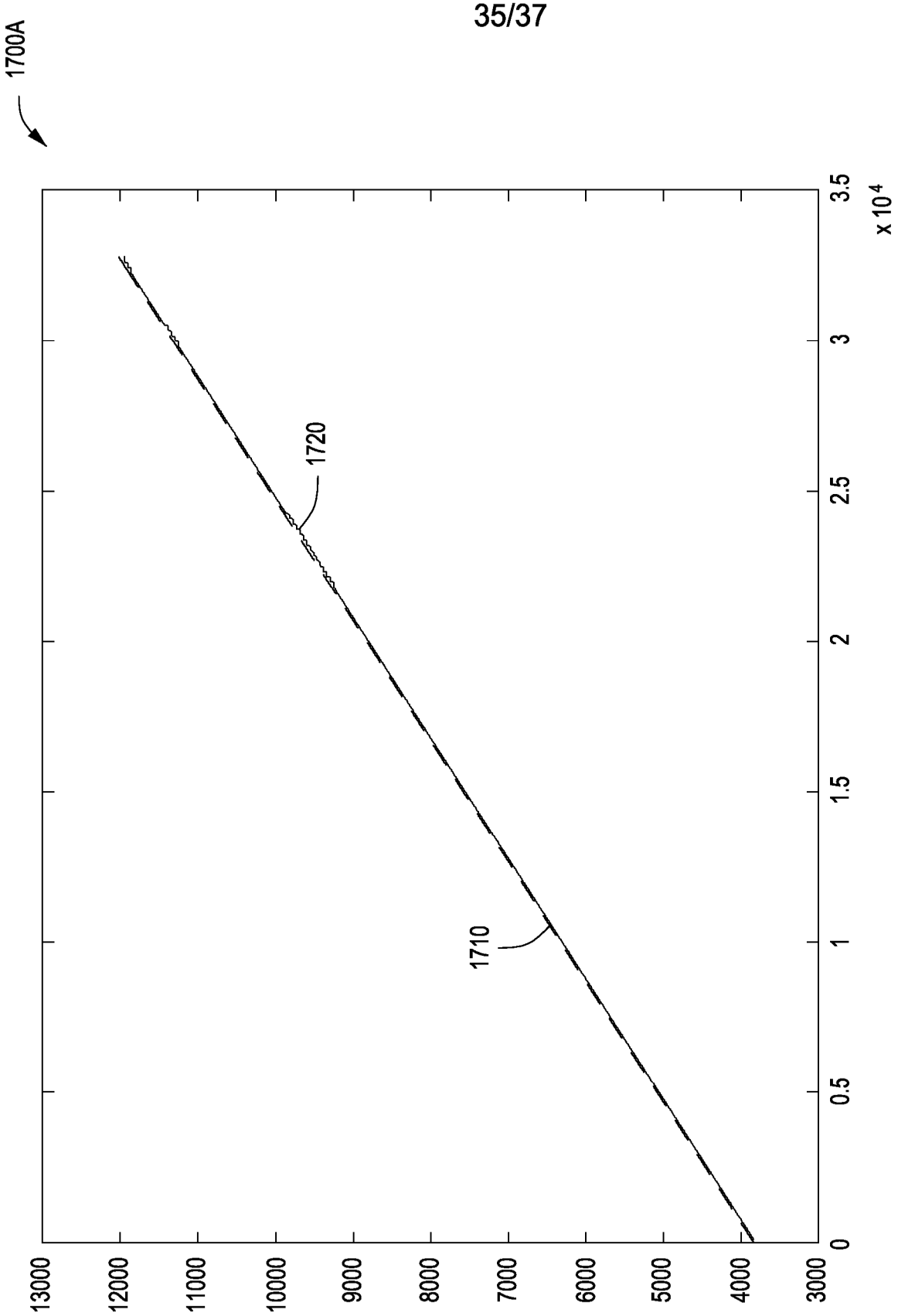

1700A
1720
1710
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4

FIG. 17A

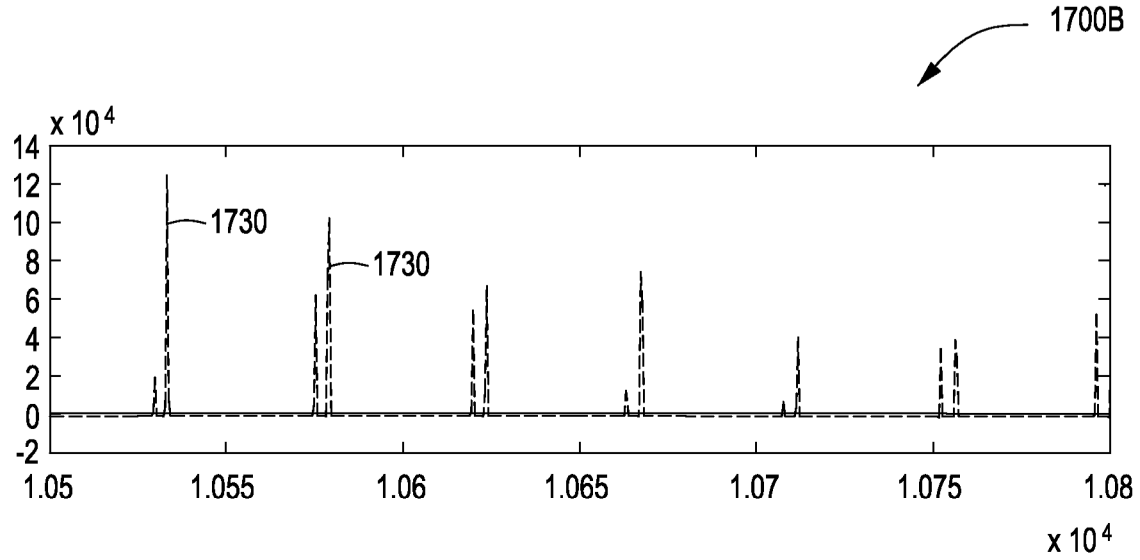


FIG. 17B

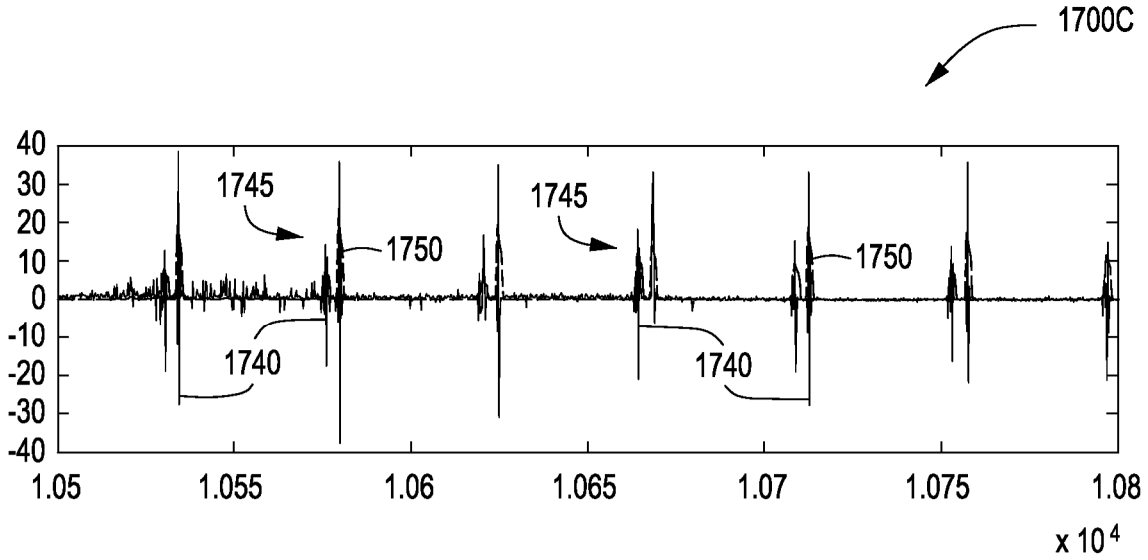


FIG. 17C

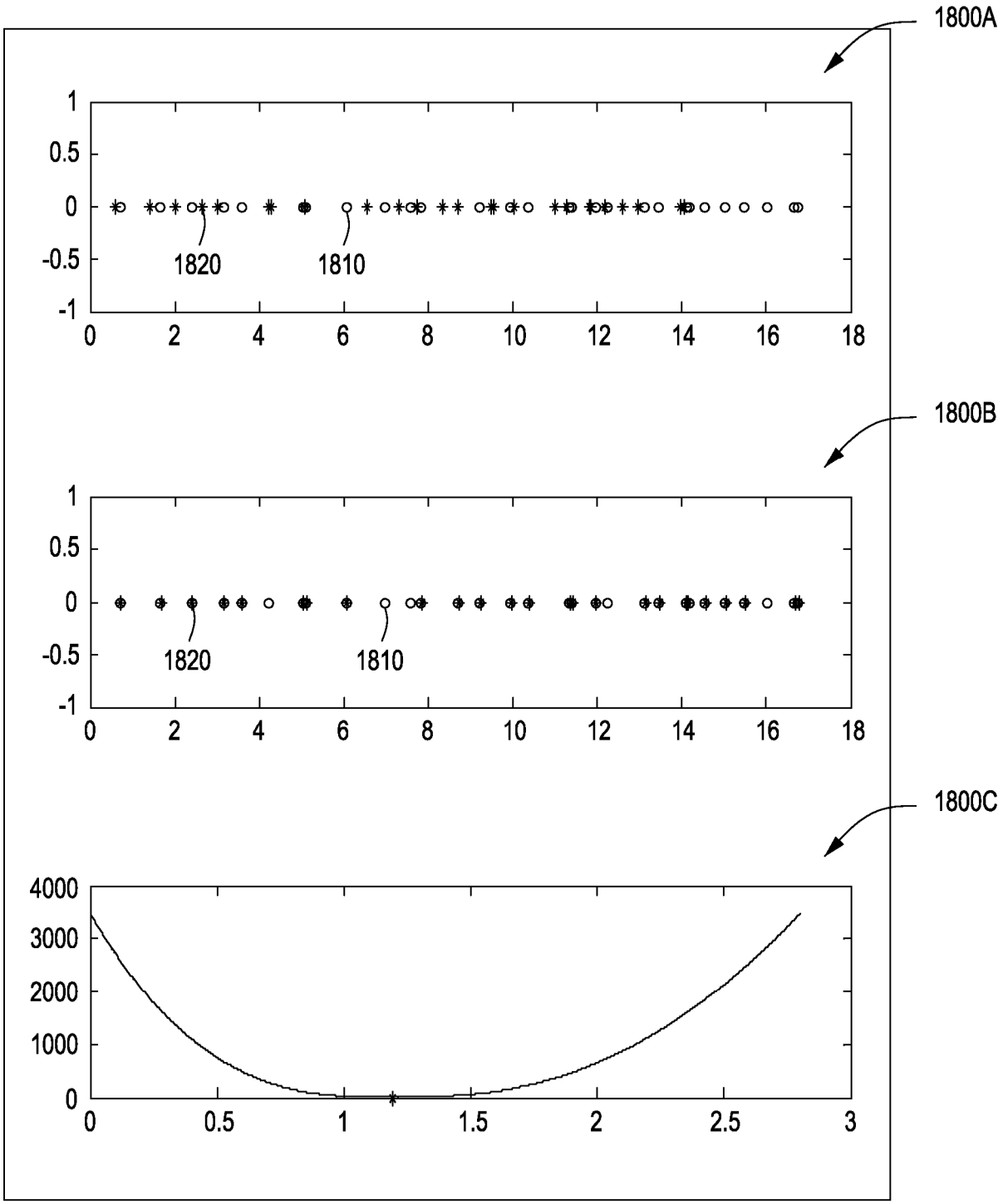

1800A
1
0.5
0
-0.5
-1
0
2
4
6
8
10
12
14
16
18
1820
1810
1800B
1
0.5
0
-0.5
-1
0
2
4
6
8
10
12
14
16
18
1820
1810
1800C
4000
3000
2000
1000
0
0
0.5
1
1.5
2
2.5
3

FIG. 18