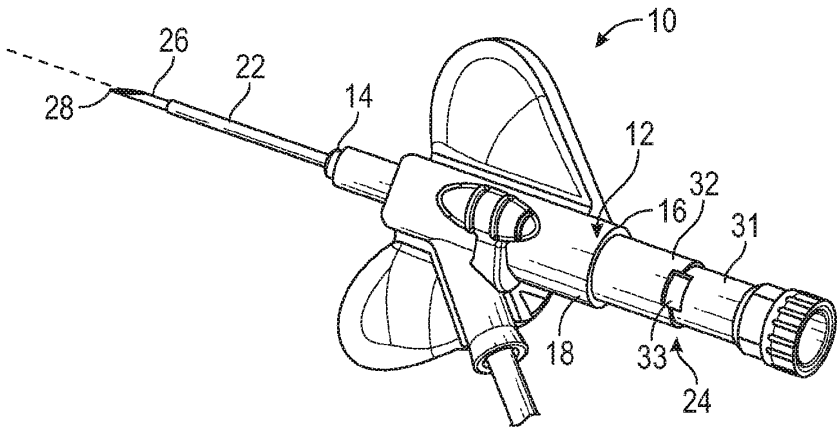


FIG. 1

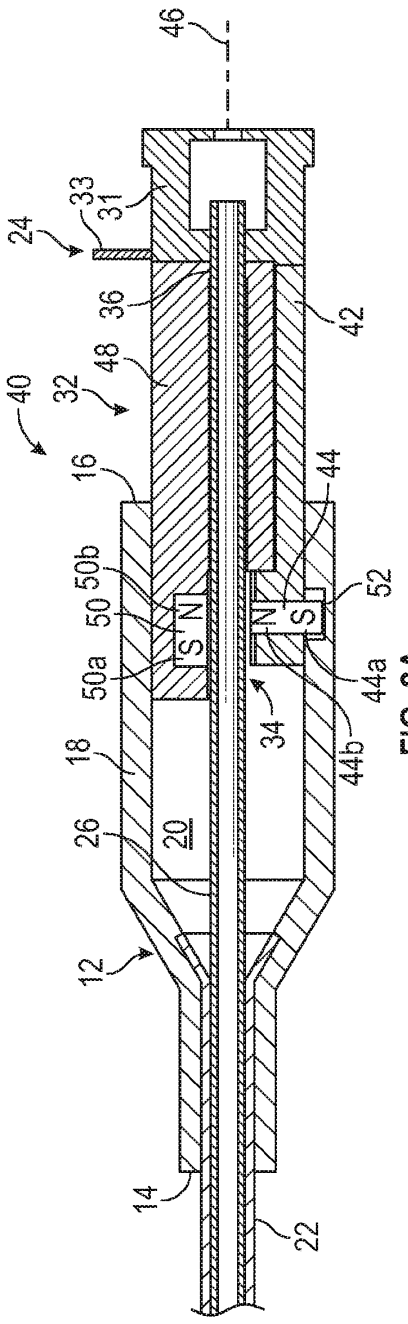

46
33
31
24
36
42
48
40
32
16
44
50b
50
52
S
N
N
S
50a
44a
34
44b
18
20
26
12
14
22

FIG. 2A

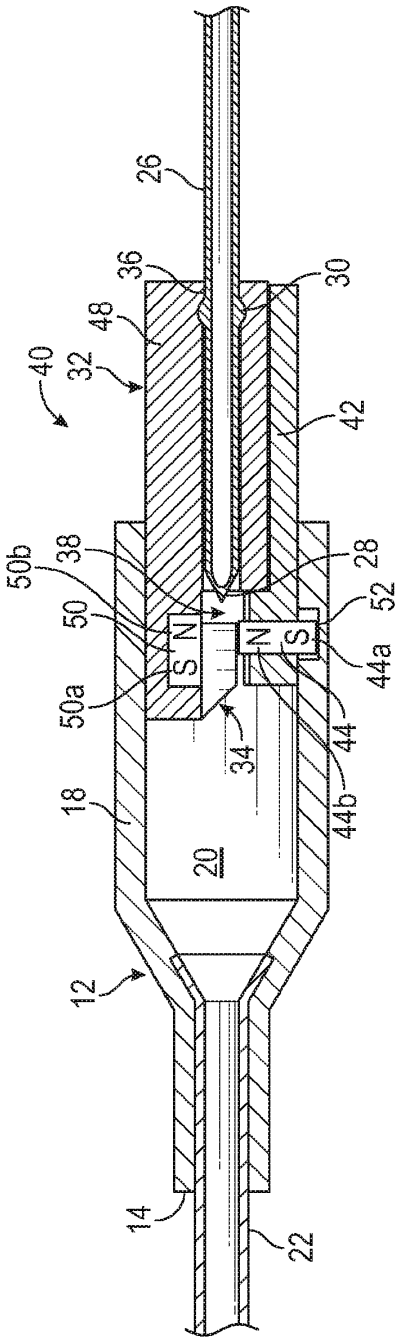
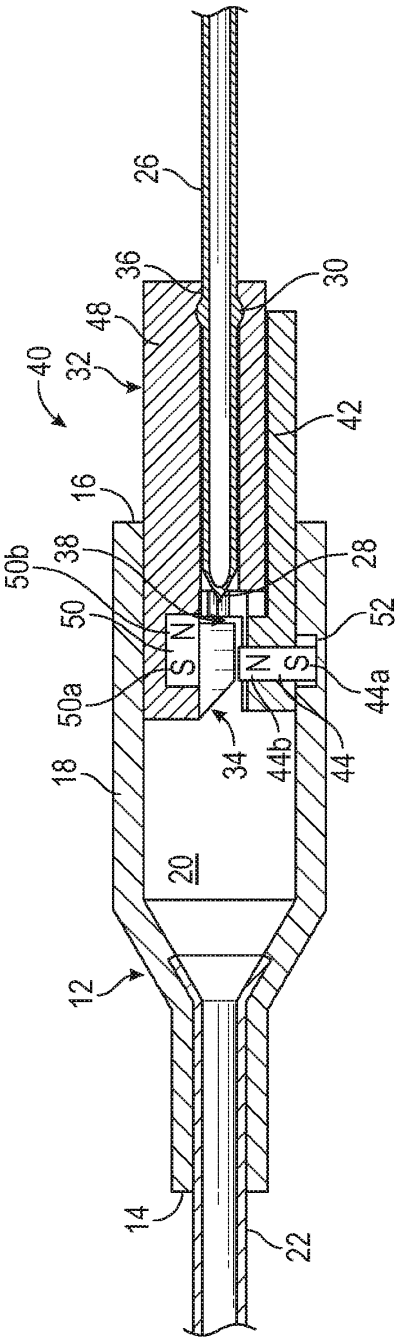

26
36
30
48
40
32
42
50b
38
28
50
52
S
N
N
S
50a
44a
34
44
44b
18
20
12
14
22

FIG. 2B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36
30
48
40
32
42
16
50b
38
28
50
52
S
N
N
S
50a
44a
34
44b
44
18
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14
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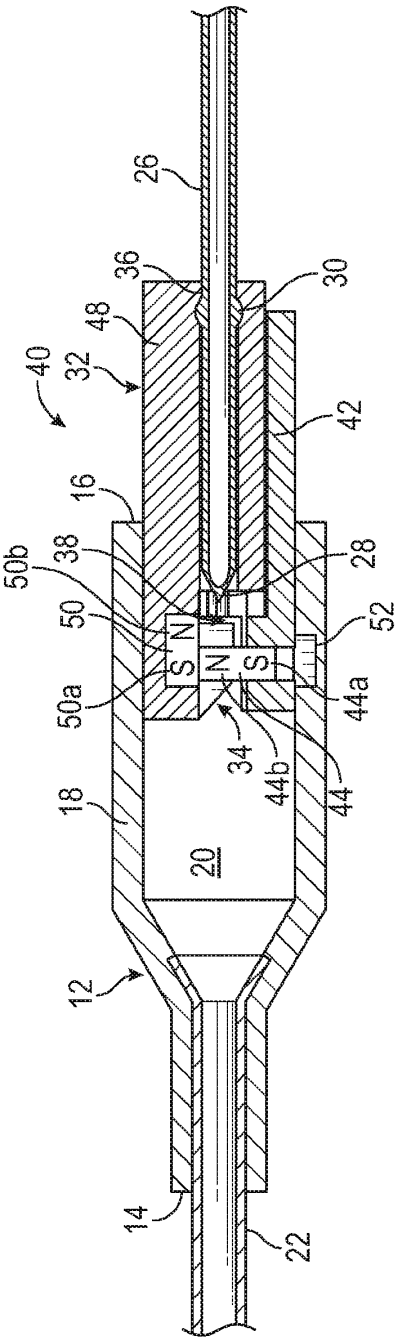
FIG. 2C


26
36
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48
40
32
42
16
50b
38
28
50
52
S
N
N
S
50a
44a
34
44b
44
18
20
12
14
22

FIG. 2D

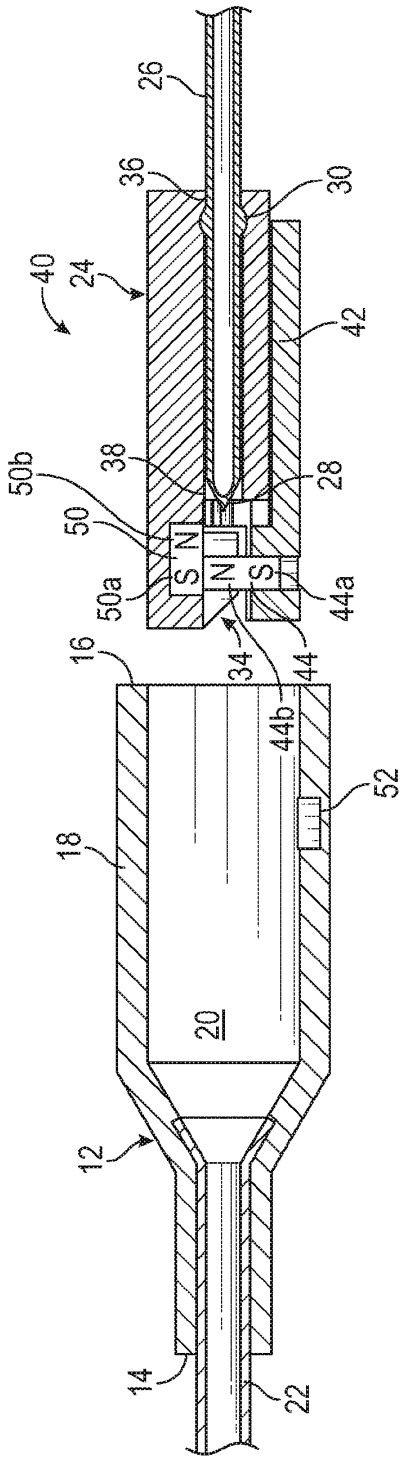

26
36
30
40
24
42
38
28
50b
50
N
S
N
S
50a
44a
34
44
16
44b
52
18
20
12
14
22

FIG. 2E

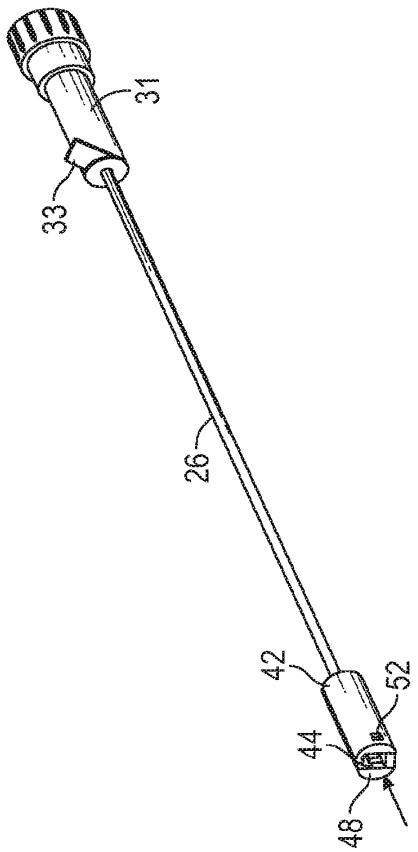
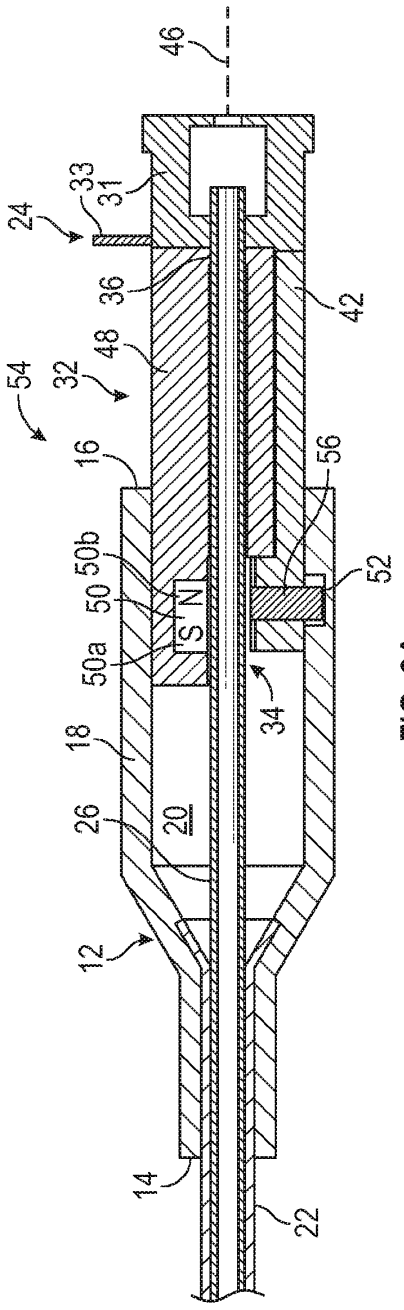

31
33
26
42
52
44
48

FIG. 2F


46
33
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36
42
54
32
48
16
56
50b
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52
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50a
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20
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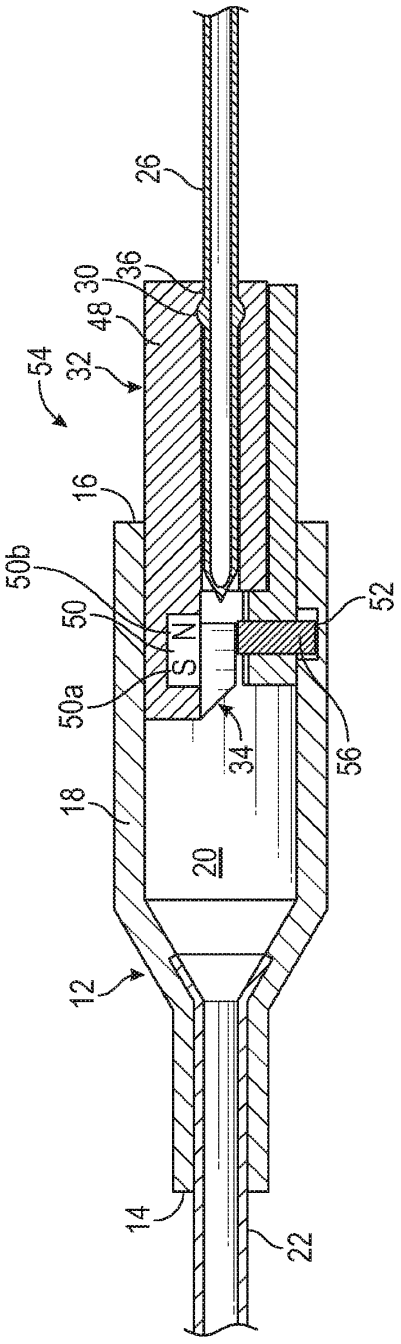
FIG. 3A


26
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32
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50b
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52
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N
50a
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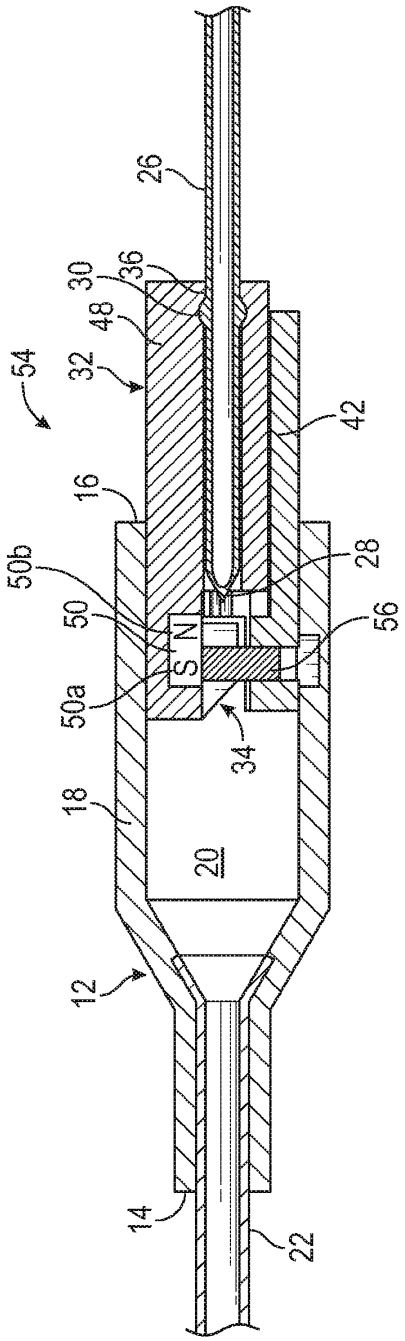
22

FIG. 3B


54
32
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50b
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50a
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FIG. 3C

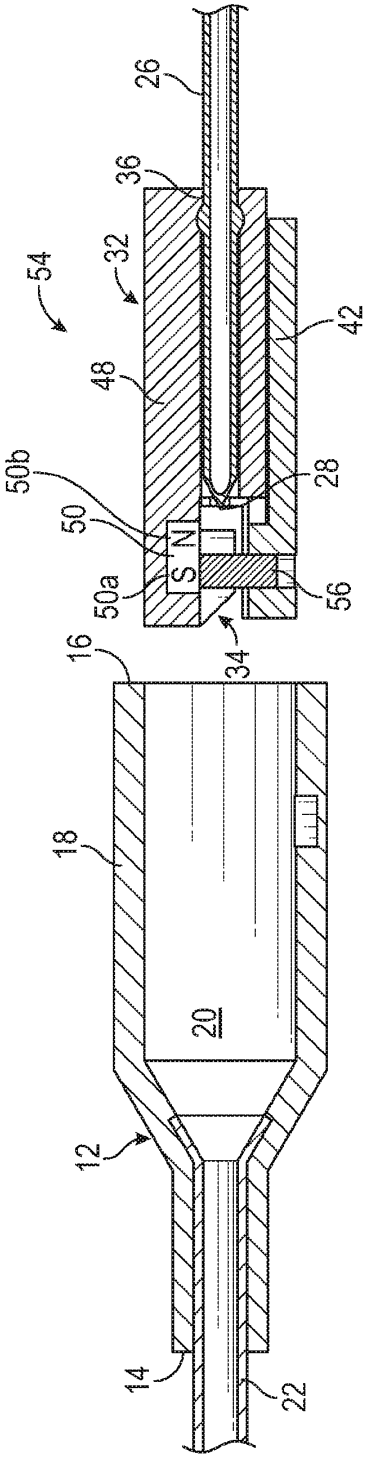
54
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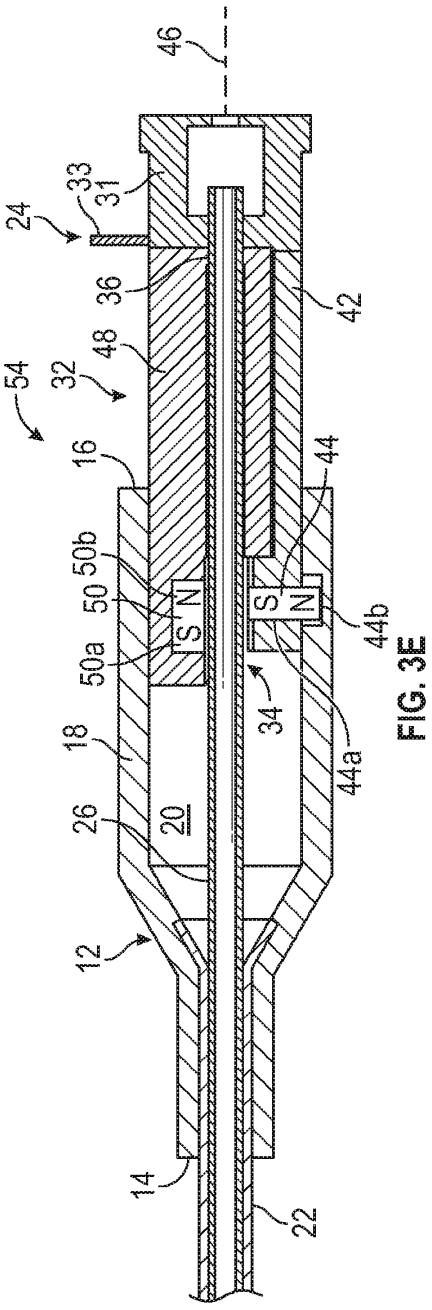
FIG. 3D


46
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44b
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18
44a
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FIG. 3E

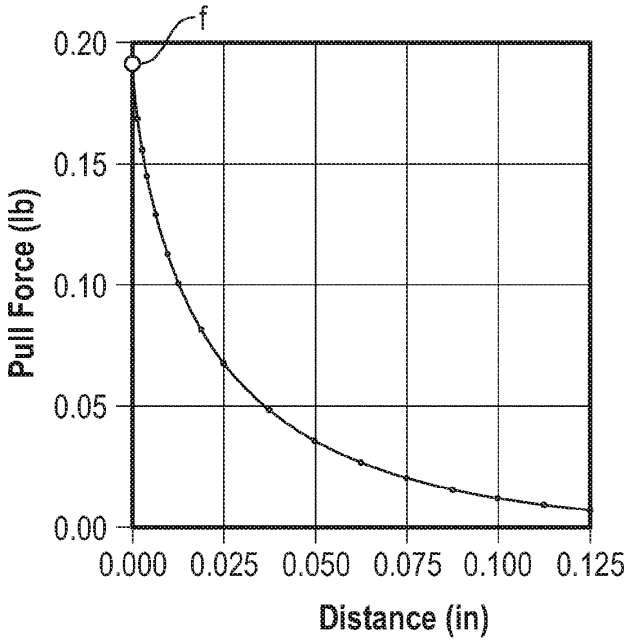
f
0.20
0.15
0.10
0.05
0.00
Pull Force (lb)
0.000
0.025
0.050
0.075
0.100
0.125
Distance (in)

FIG. 4A

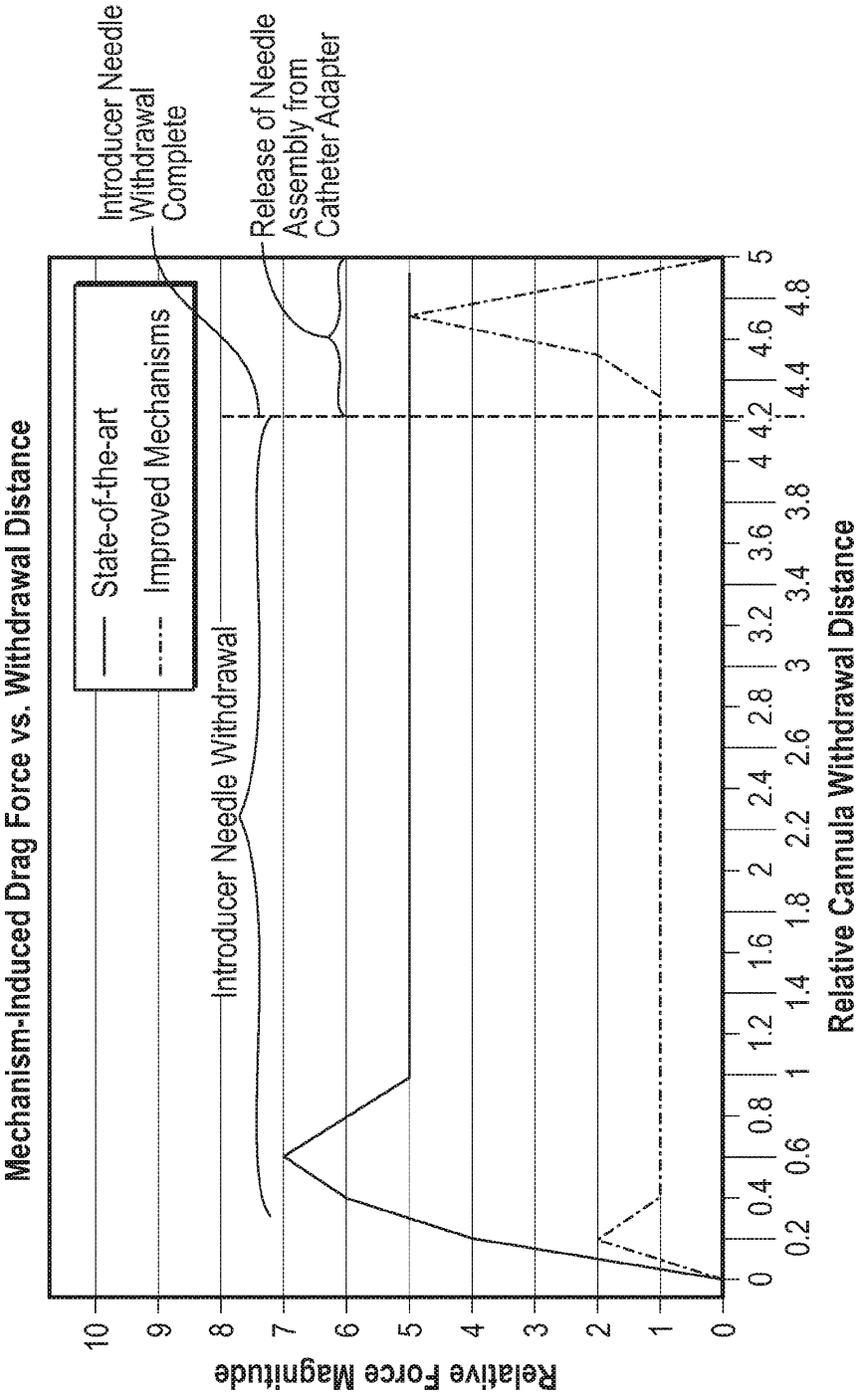
Mechanism-Induced Drag Force vs. Withdrawal Distance
State-of-the-art
Improved Mechanisms
Introducer Needle Withdrawal Complete
Release of Needle Assembly from Catheter Adapter
Introducer Needle Withdrawal
Relative Force Magnitude
Relative Cannula Withdrawal Distance
0
1
2
3
4
5
6
7
8
9
10
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
5

FIG. 4B