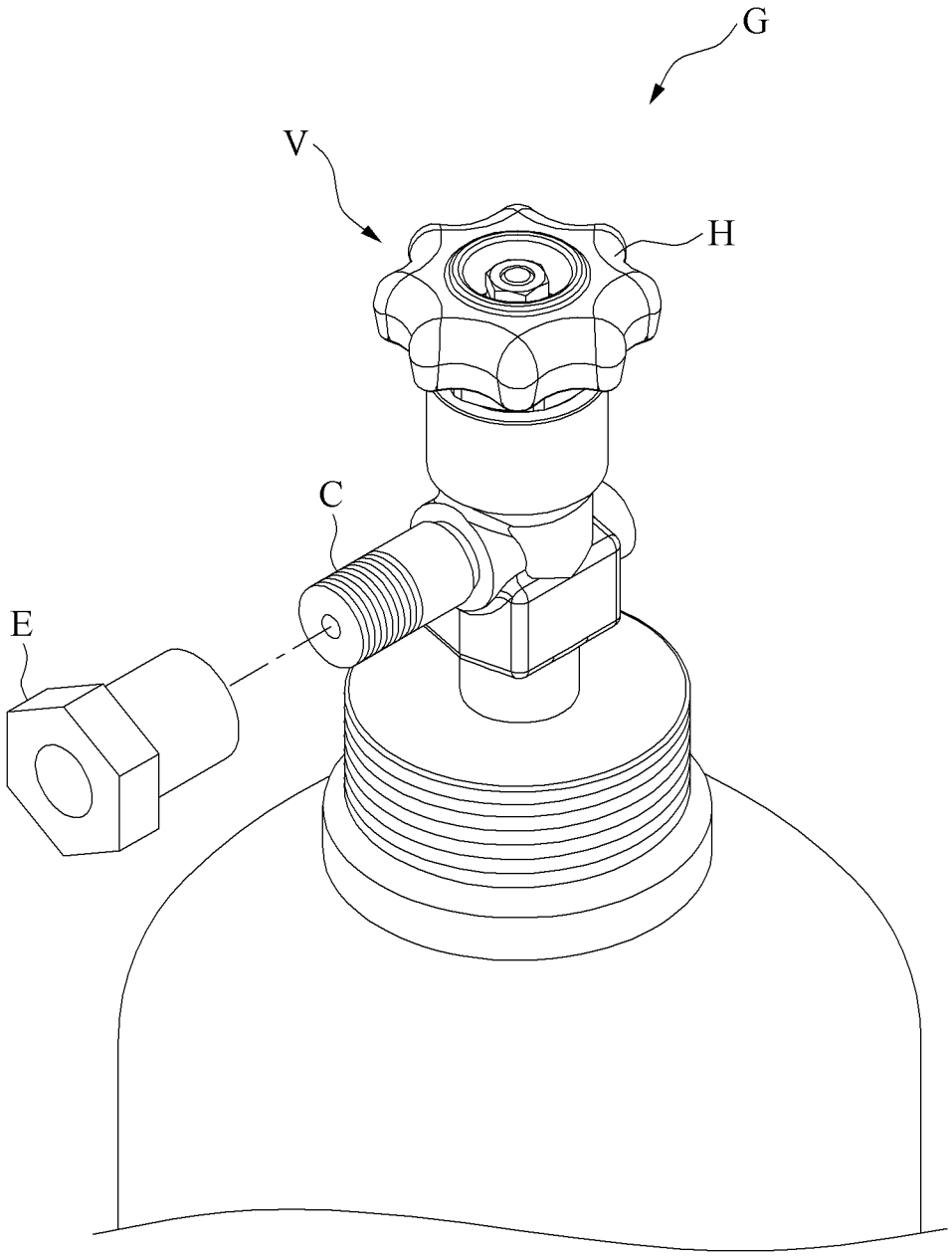


FIG. 1

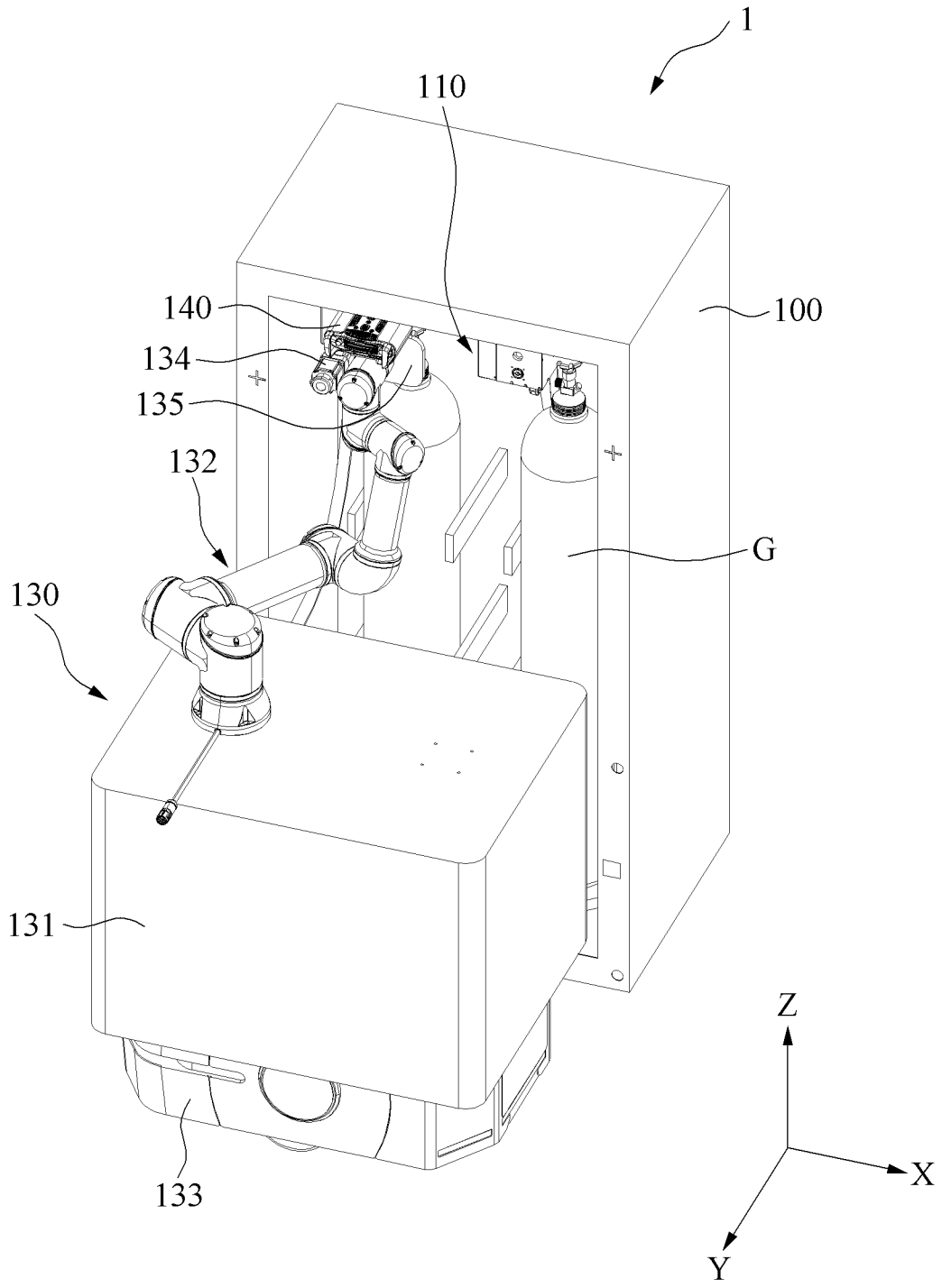


FIG. 2

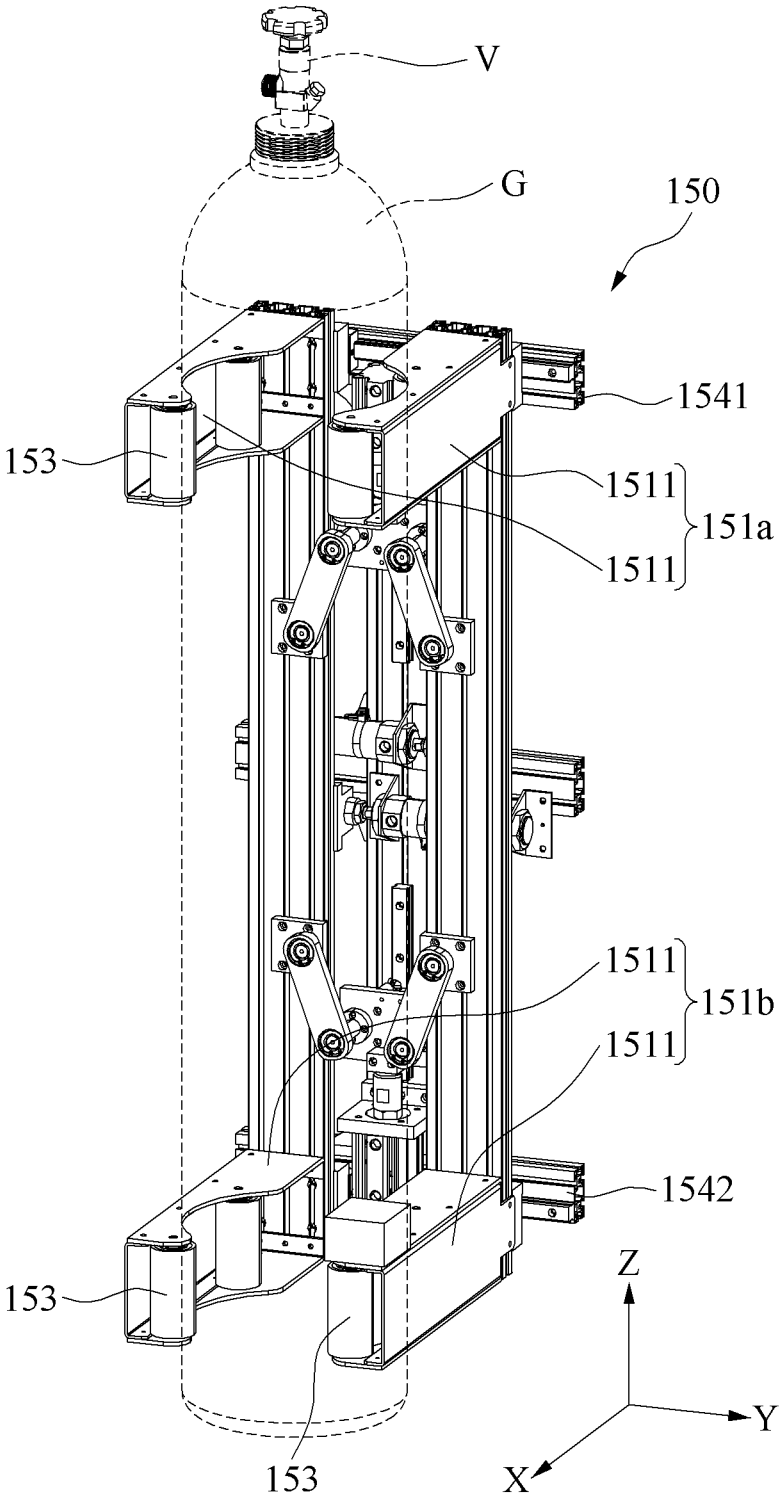


FIG. 3

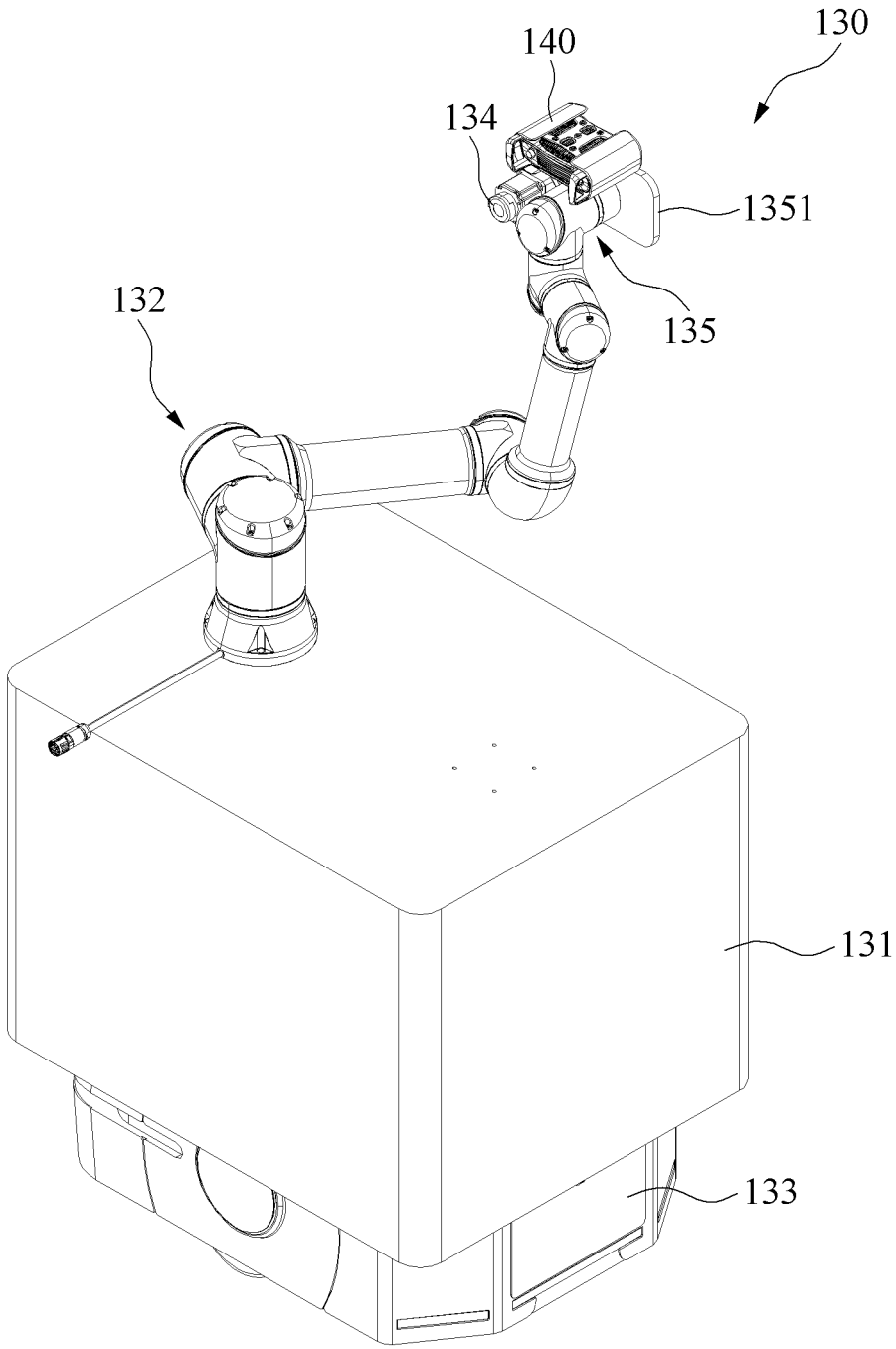


FIG. 4

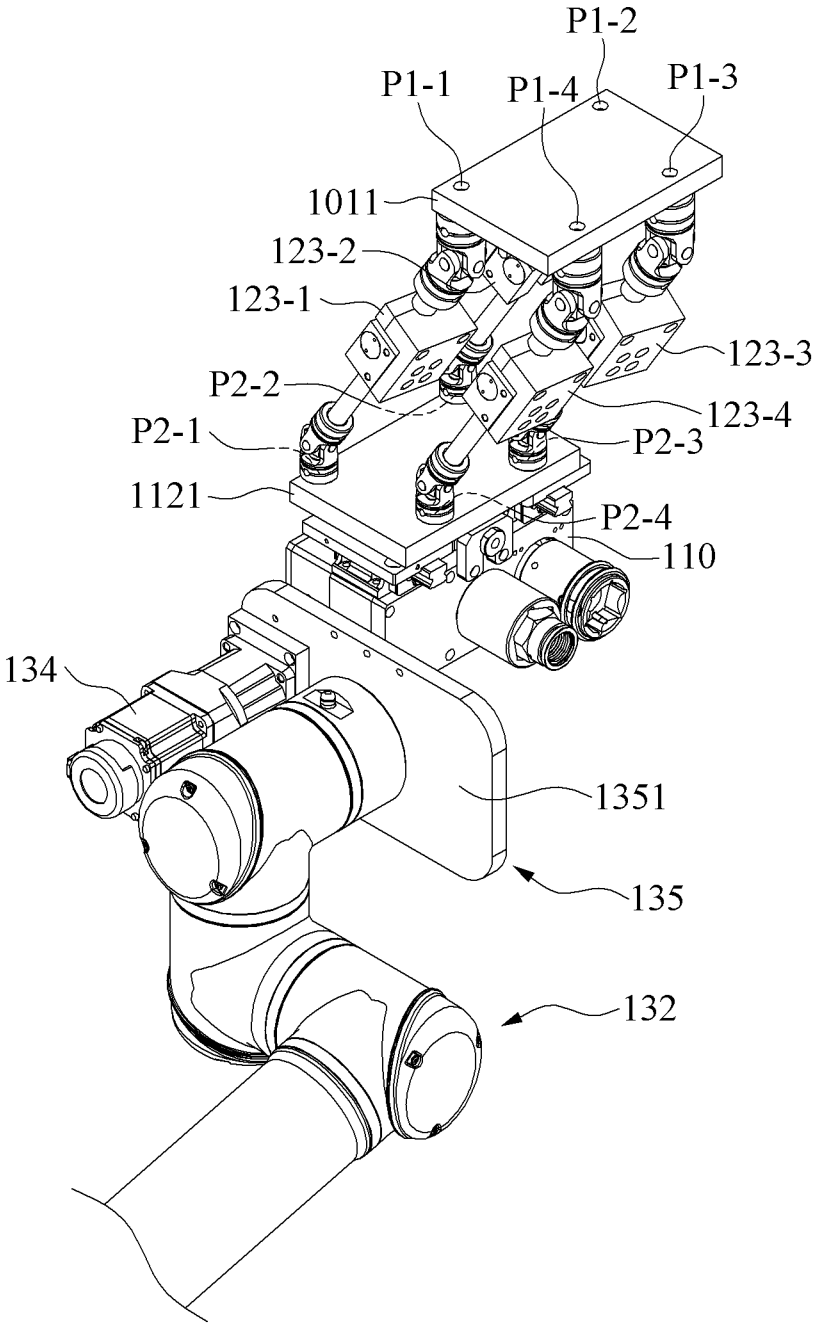

P1-2
P1-1
P1-4
P1-3
1011
123-2
123-1
123-3
P2-2
123-4
P2-1
P2-3
1121
P2-4
110
134
1351
135
132

FIG. 5A

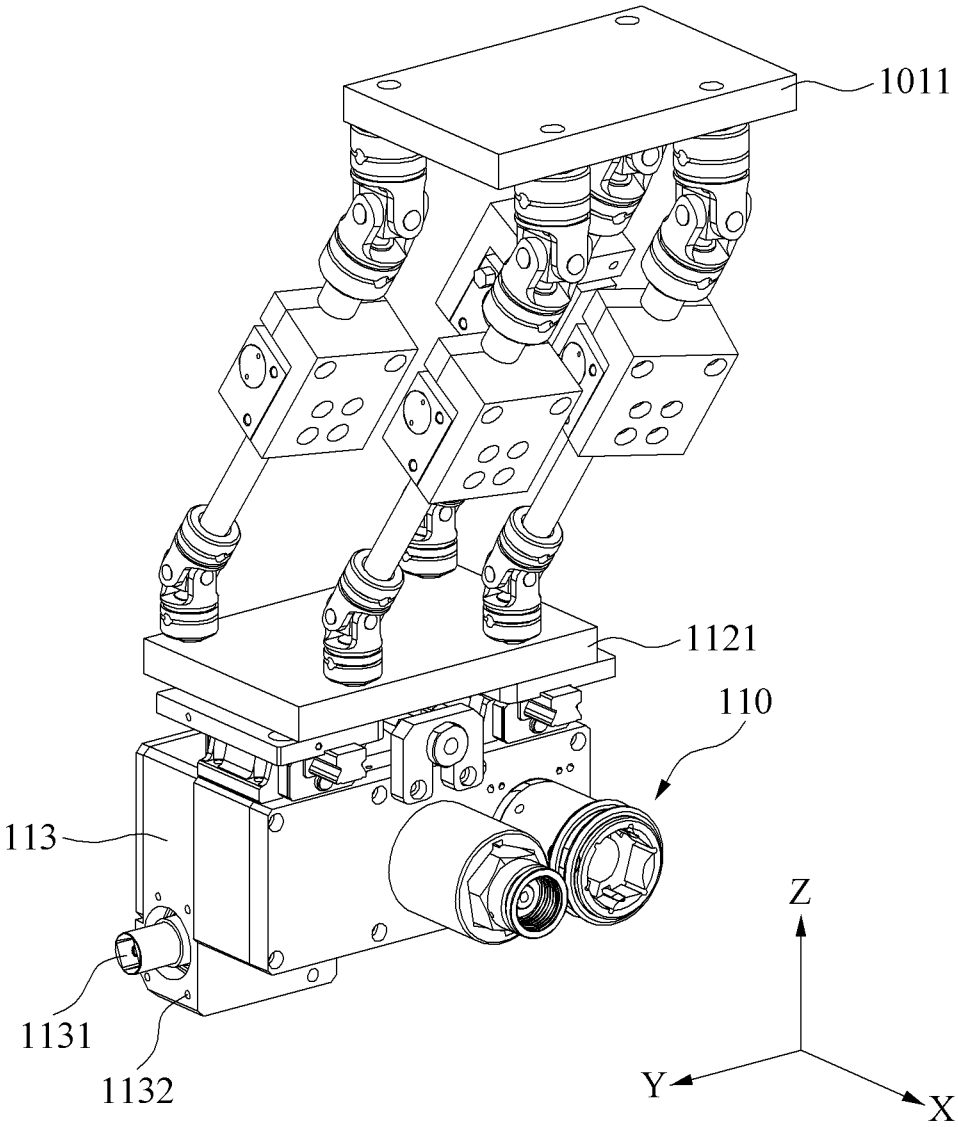


FIG. 5B

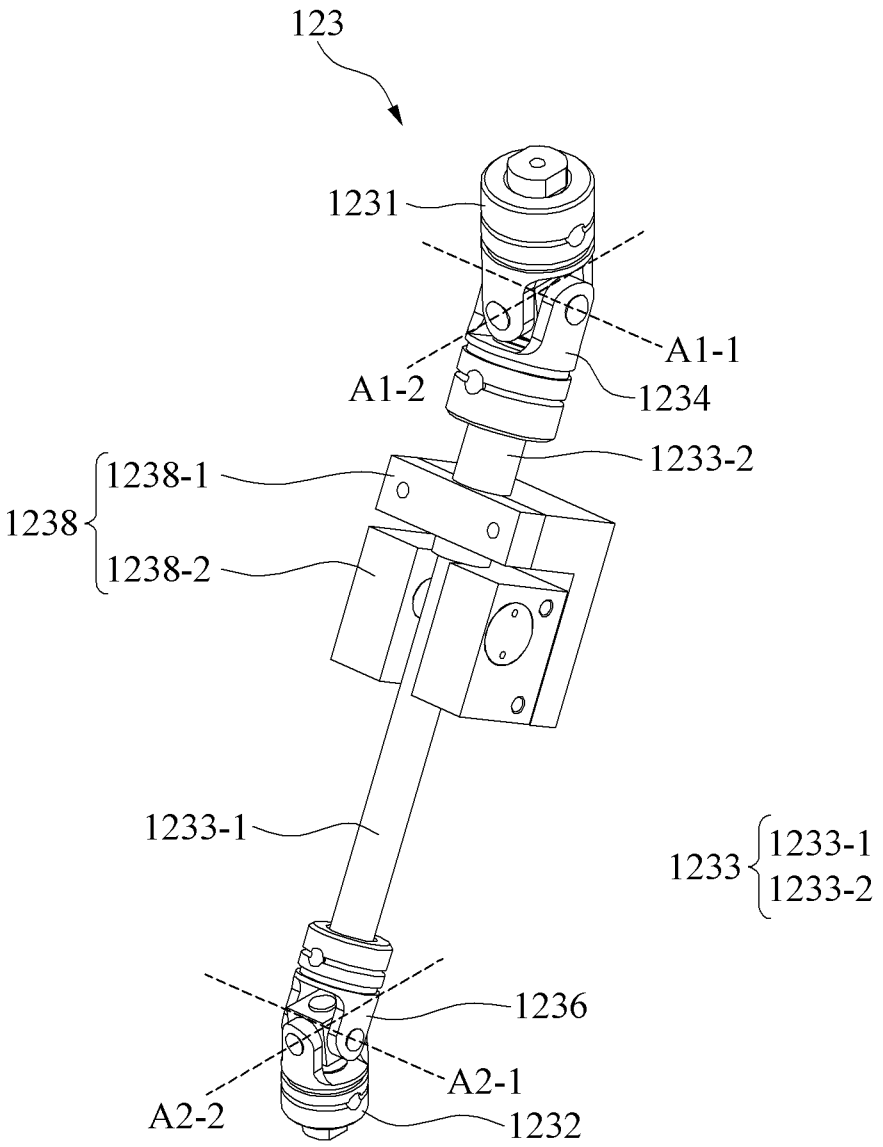

123
1231
A1-1
A1-2
1234
1233-2
1238
1238-1
1238-2
1233-1
1233
1233-1
1233-2
1236
A2-1
A2-2
1232

FIG. 5C

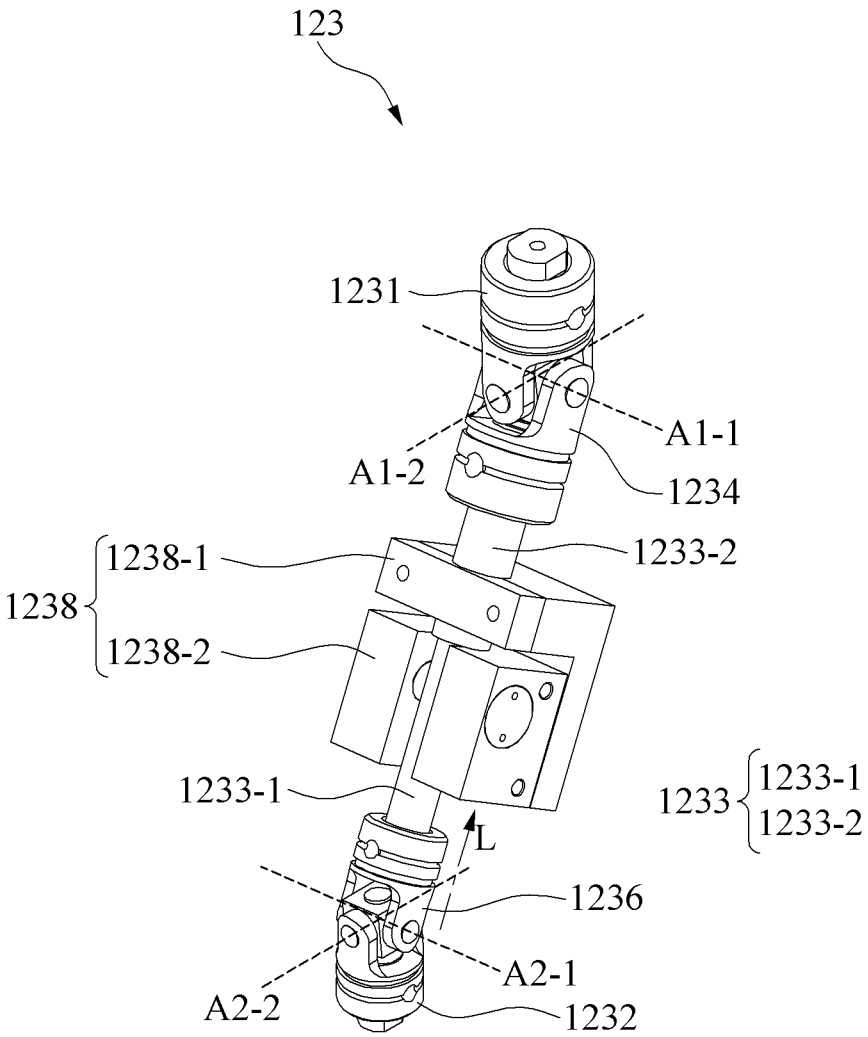

123
1231
A1-1
A1-2
1234
1233-2
1238
1238-1
1238-2
1233-1
1233
1233-1
1233-2
L
1236
A2-1
A2-2
1232

FIG. 5D

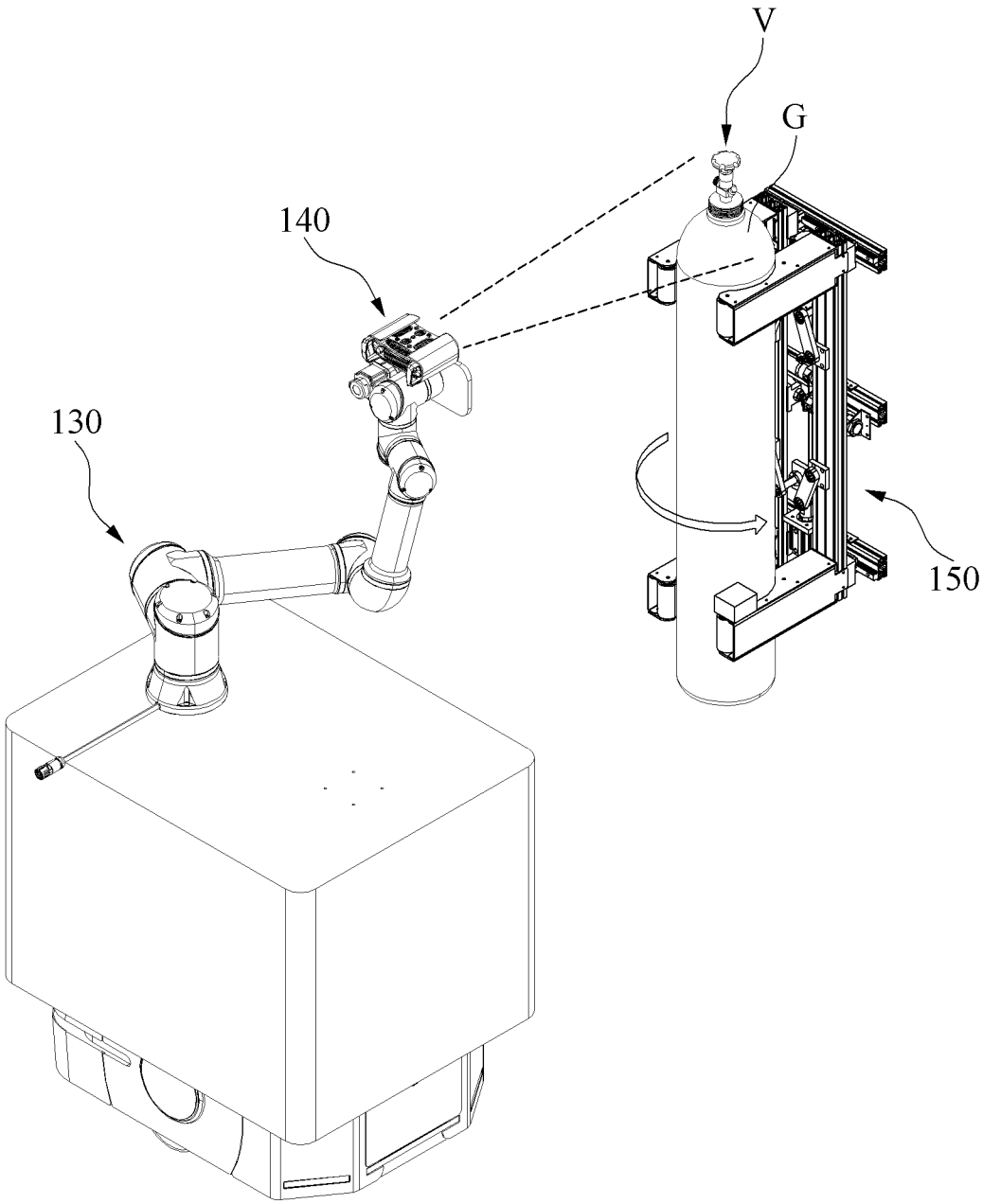


FIG. 6

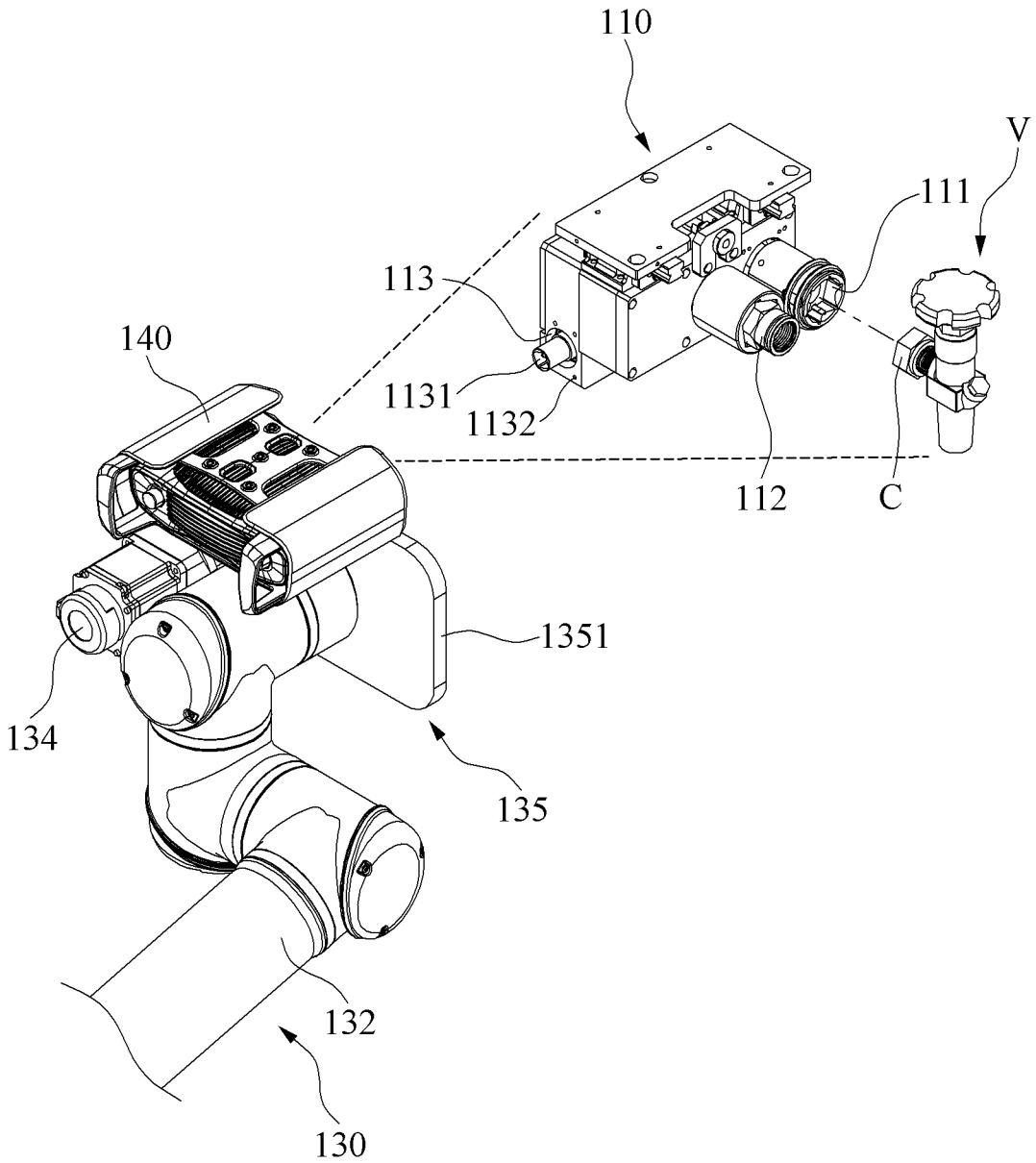


FIG. 7A

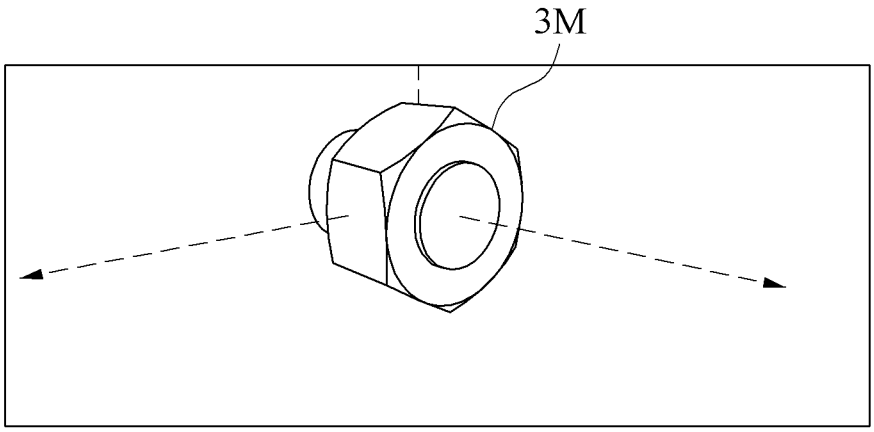


FIG. 7B

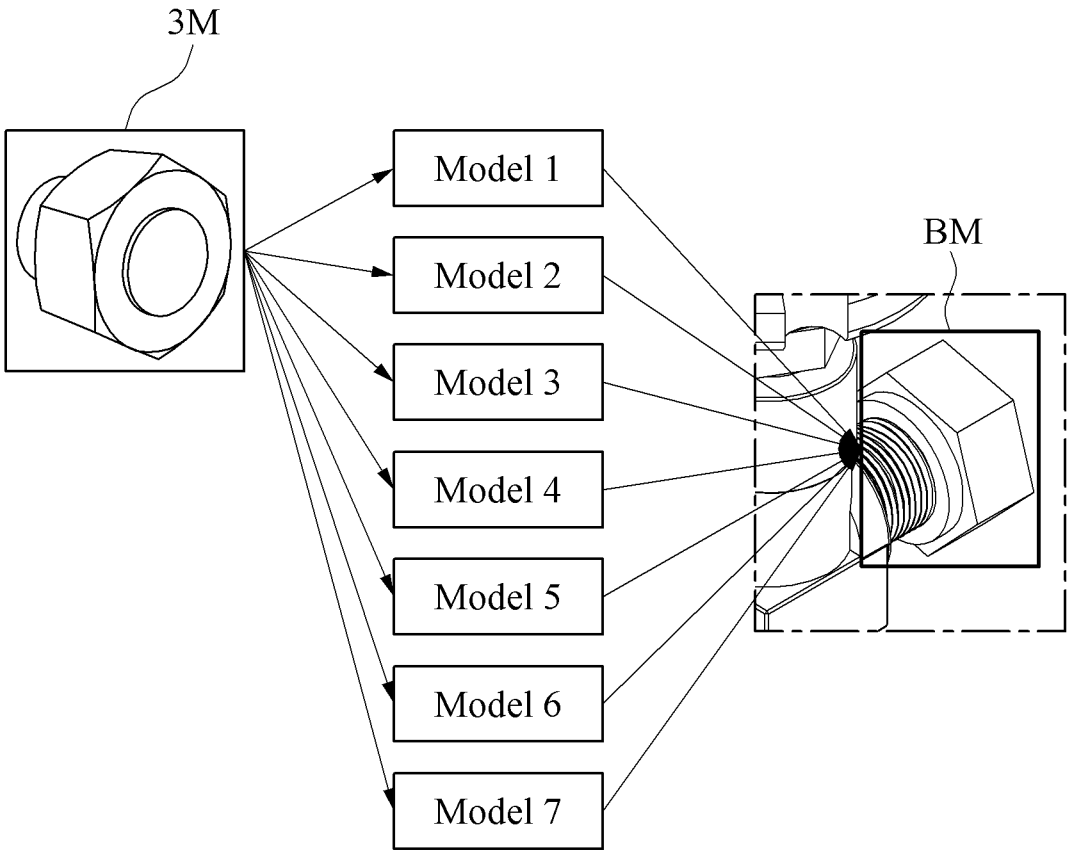


FIG. 7C

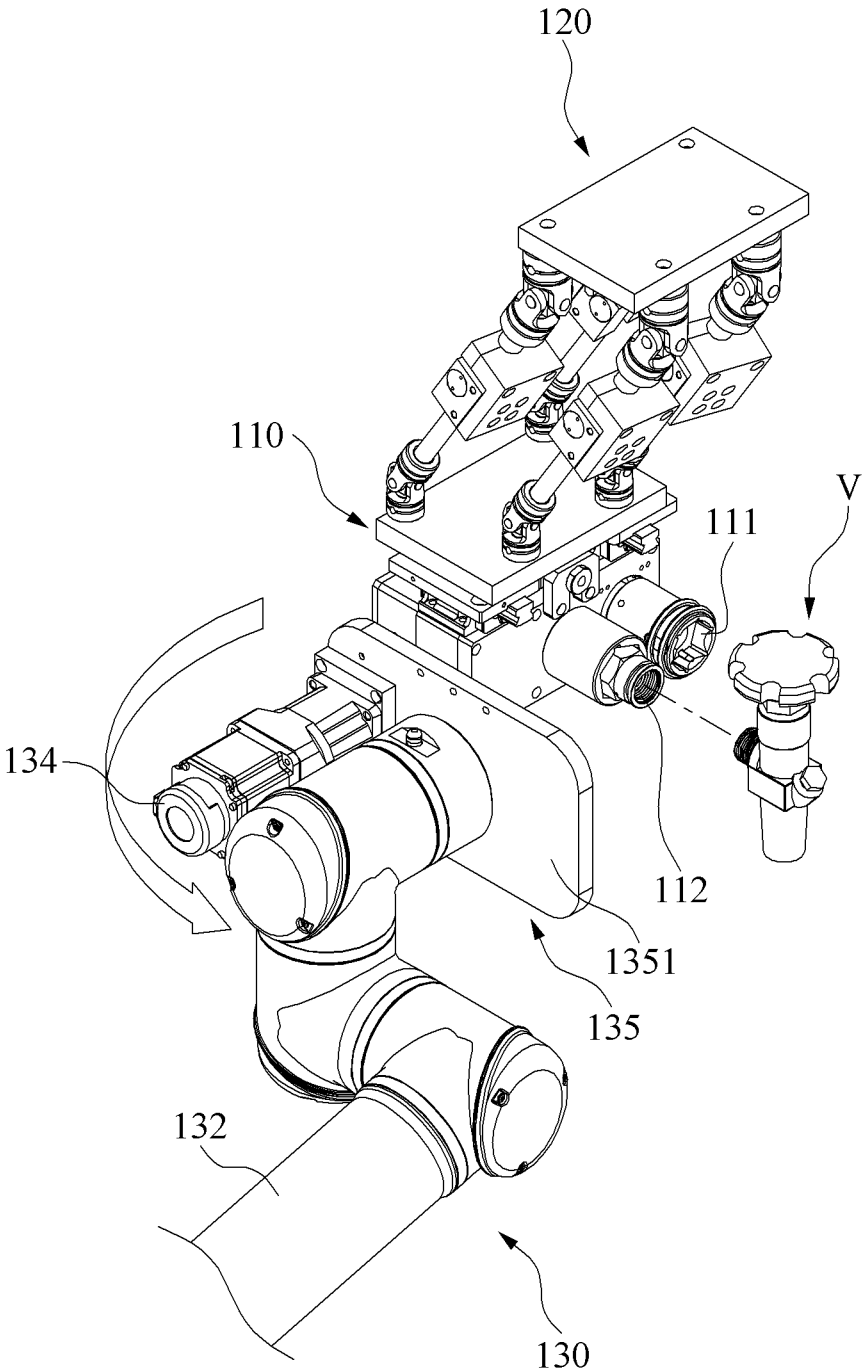


FIG. 8

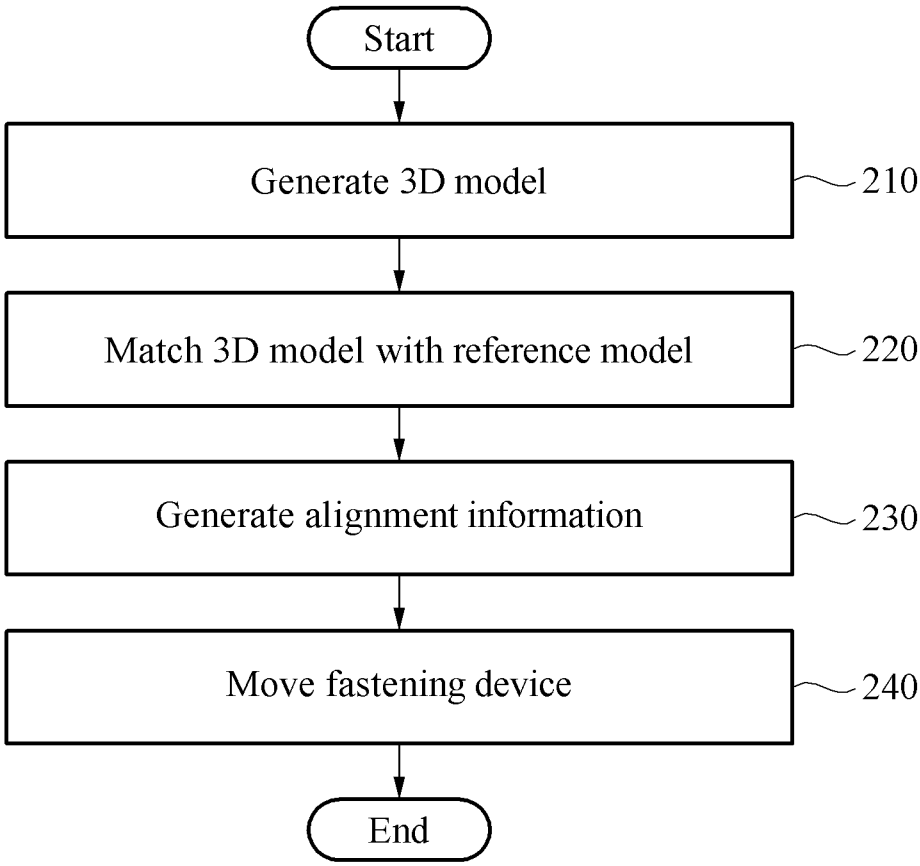

Start
Generate 3D model
210
Match 3D model with reference model
220
Generate alignment information
230
Move fastening device
240
End

FIG. 9

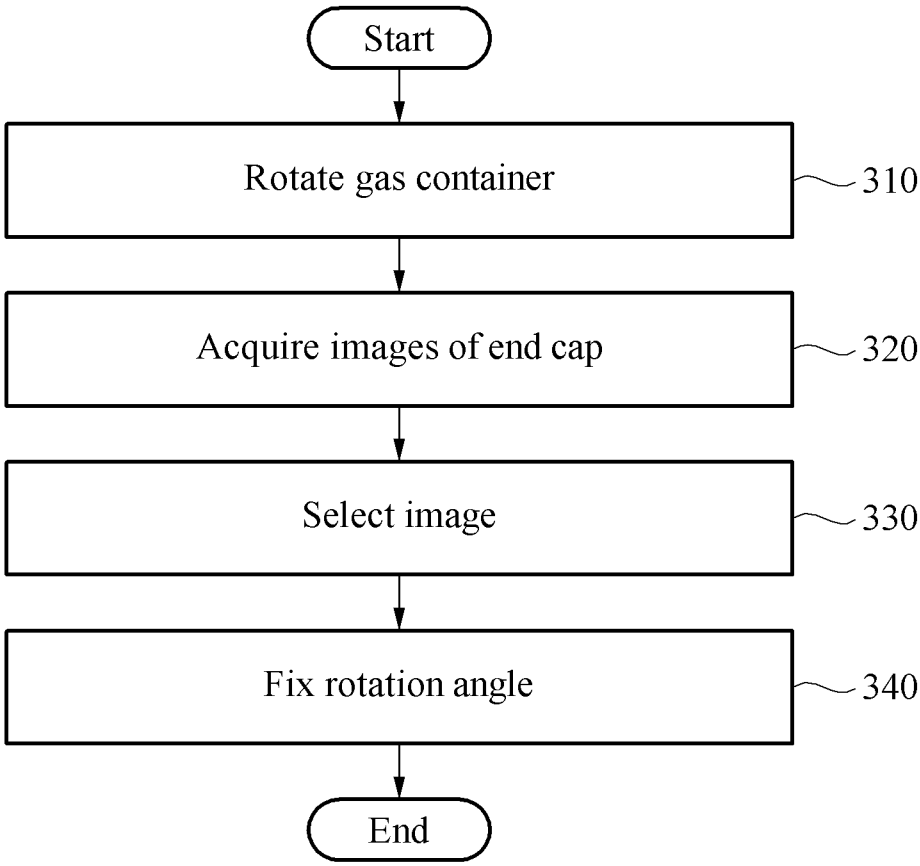

Start
Rotate gas container
310
Acquire images of end cap
320
Select image
330
Fix rotation angle
340
End

FIG. 10

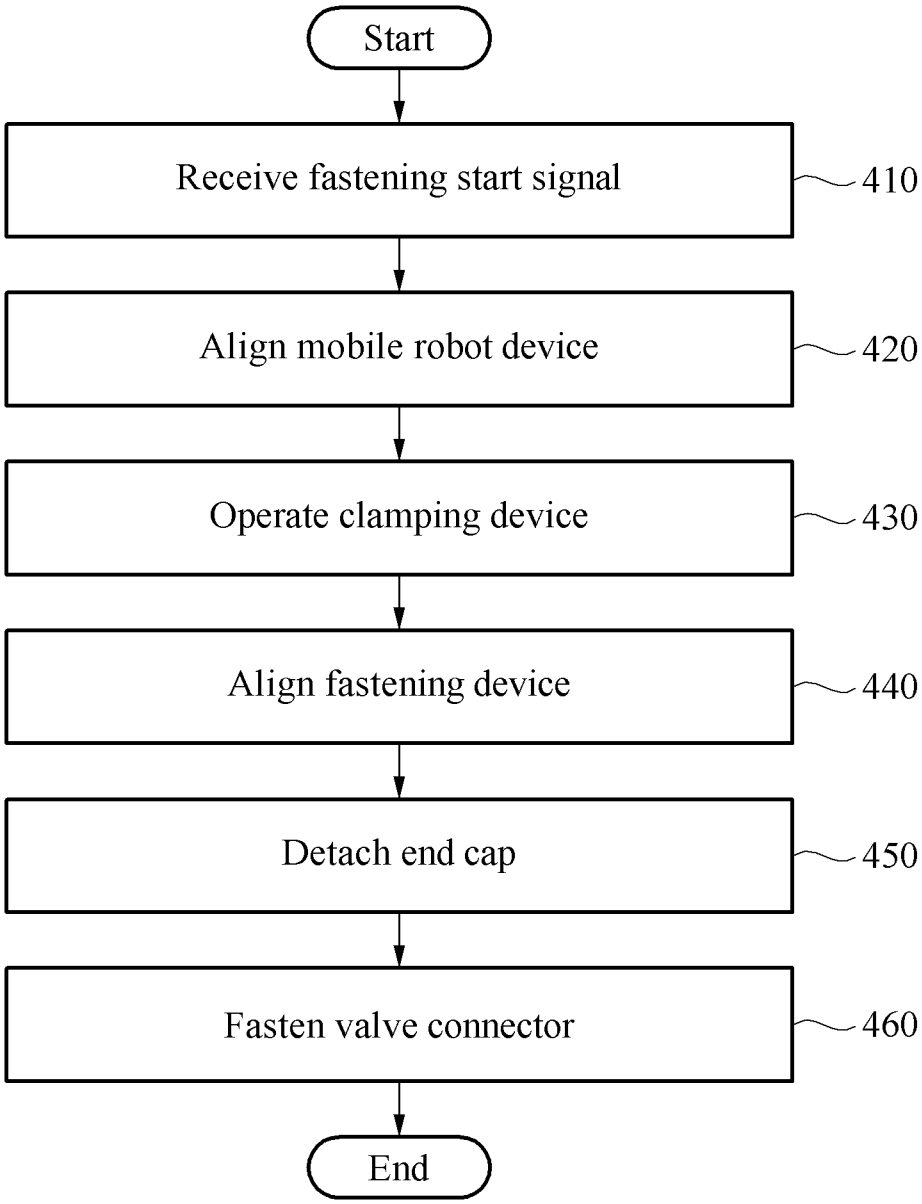

Start
Receive fastening start signal
410
Align mobile robot device
420
Operate clamping device
430
Align fastening device
440
Detach end cap
450
Fasten valve connector
460
End

FIG. 11