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(54) SLAVE-SIDE EXECUTION APPARATUS AND MEDICAL SYSTEM

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(21) Appl. No.: **19/191,375**

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(30) **Foreign Application Priority Data**

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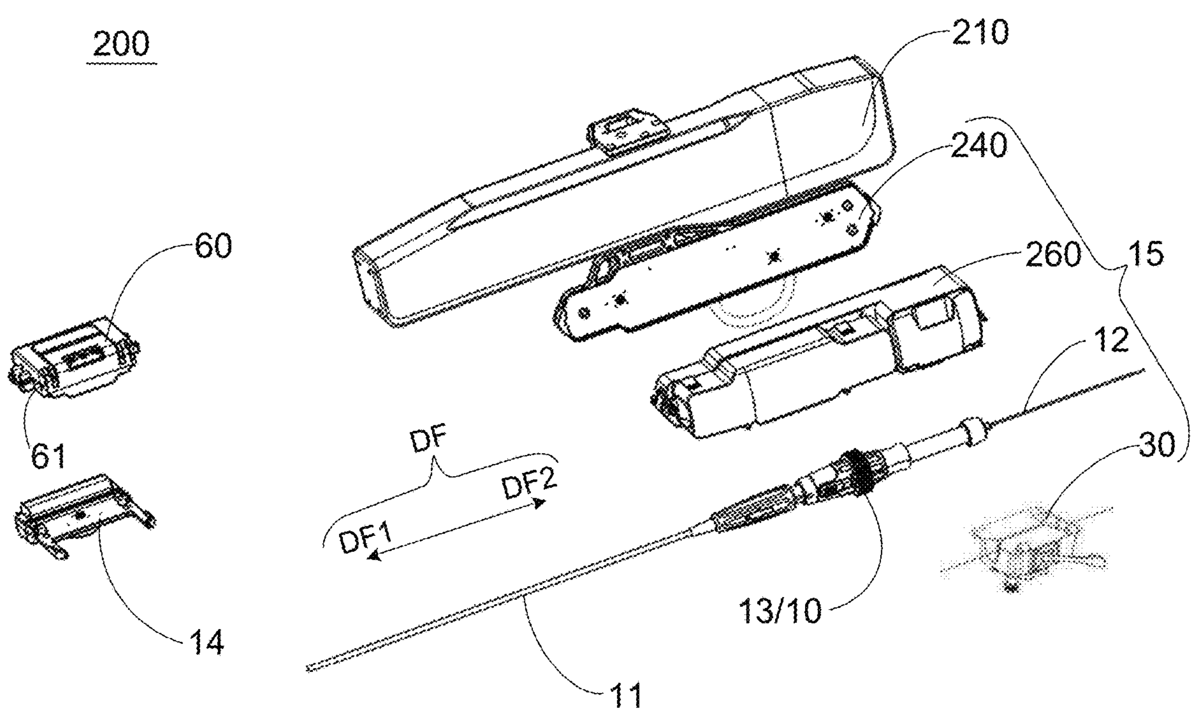
A61M 25/02	(2006.01)

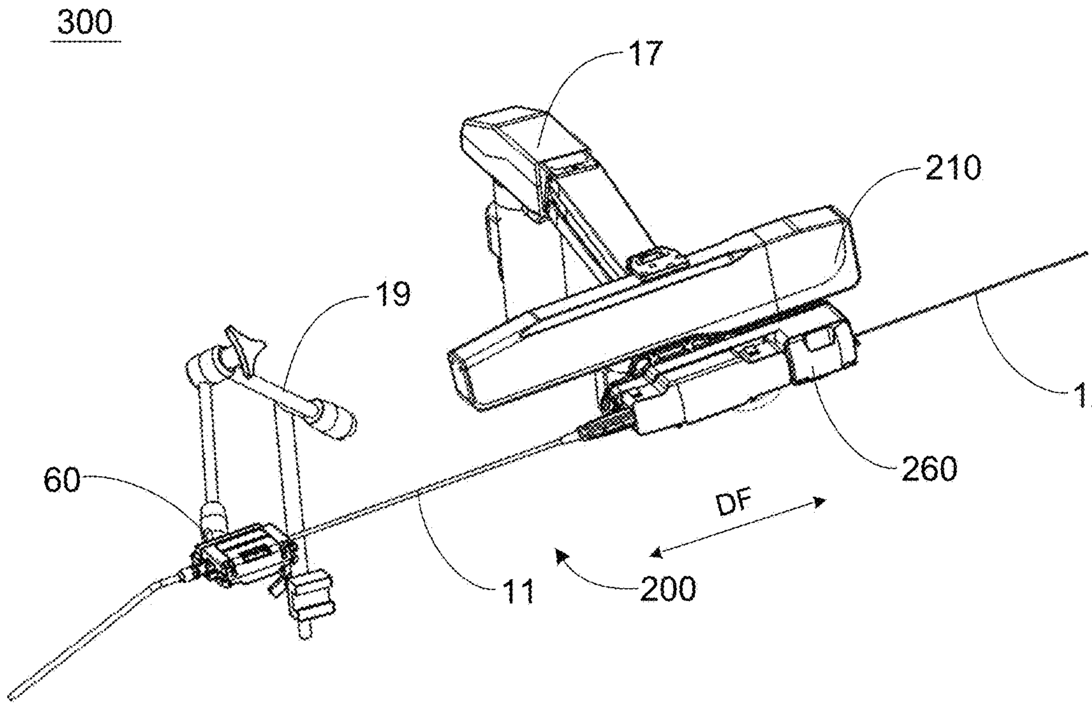
(52) **U.S. Cl.**

CPC *A61B 34/37* (2016.02); *A61M 25/0113* (2013.01); *A61M 25/02* (2013.01); *A61M 2025/0293* (2013.01)

(57) **ABSTRACT**

A slave-side execution apparatus and a medical system are provided. The slave-side execution apparatus is used to convey a guidewire and/or a catheter, and includes a main body power device, a movable power device, a first carrying device and a first manipulation device. The main body power device includes a main body driving device. The movable power device includes a first driving device and is used to move forward and backward along a conveying direction under the driving of the main body driving device. The first carrying device is moved synchronously with the movable power device and is used to carry a medical apparatus having a catheter. The first manipulation device is disposed on the first carrying device, and is used to control the guidewire to move forward and backward along the conveying direction under the driving of the first driving device.

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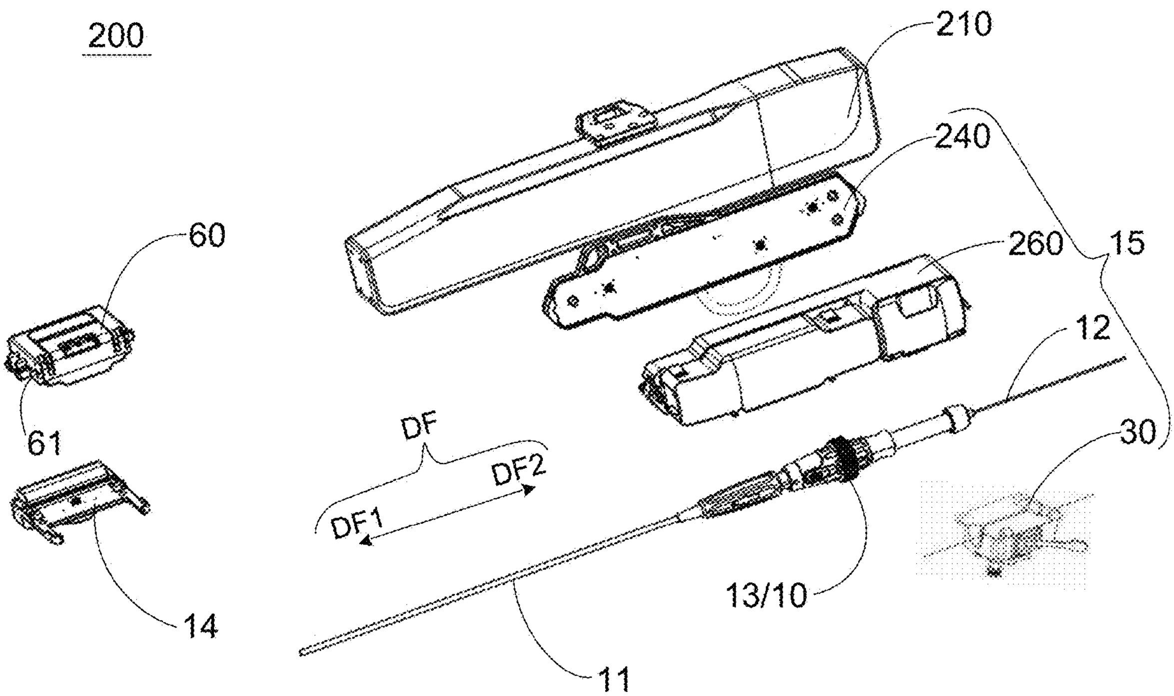
19
12
60
260
DF
11
200

FIG. 1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210
240
60
260
15
12
61
30
DF
DF2
DF1
13/10
14
11

FIG. 2

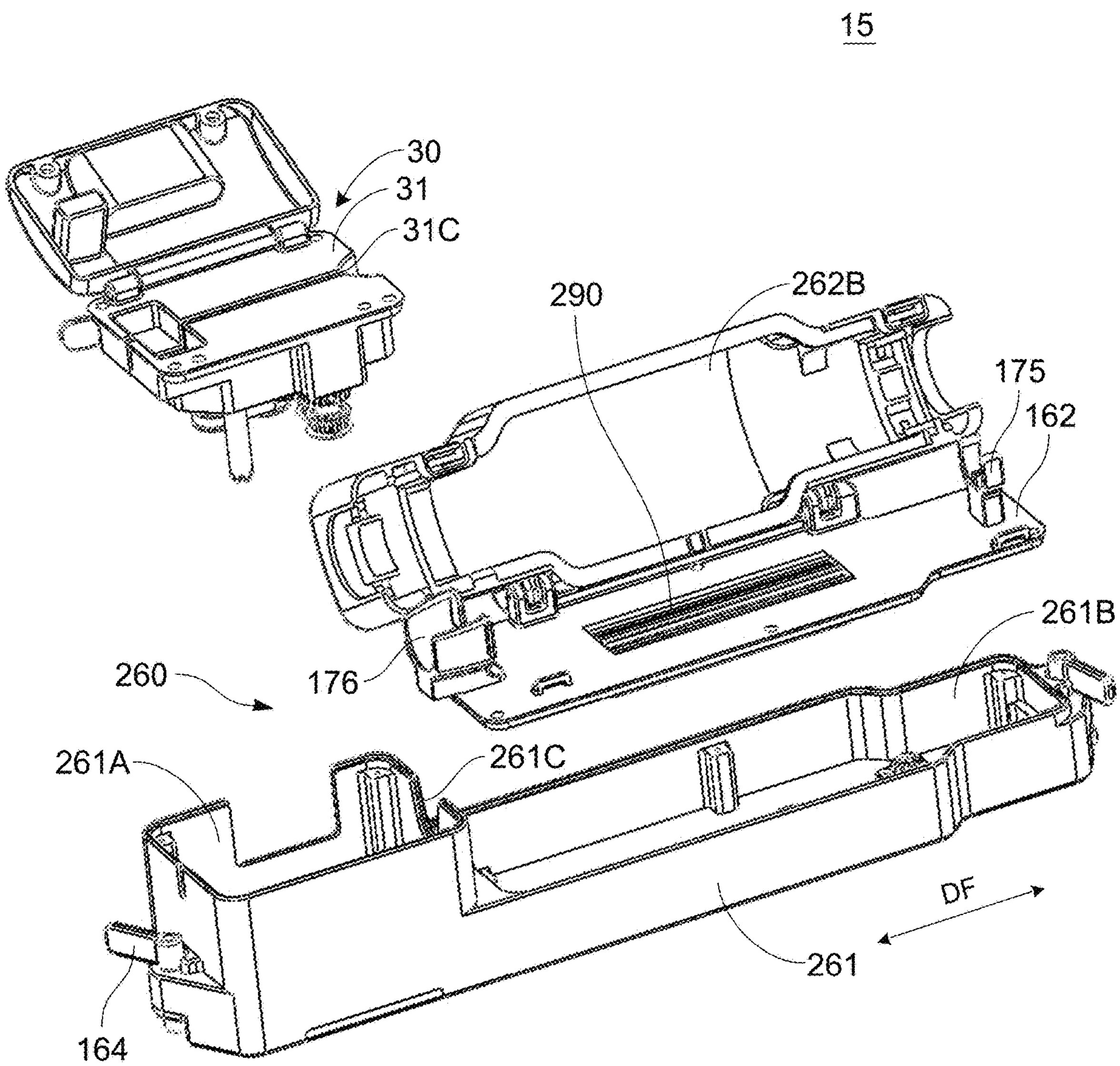


FIG. 3

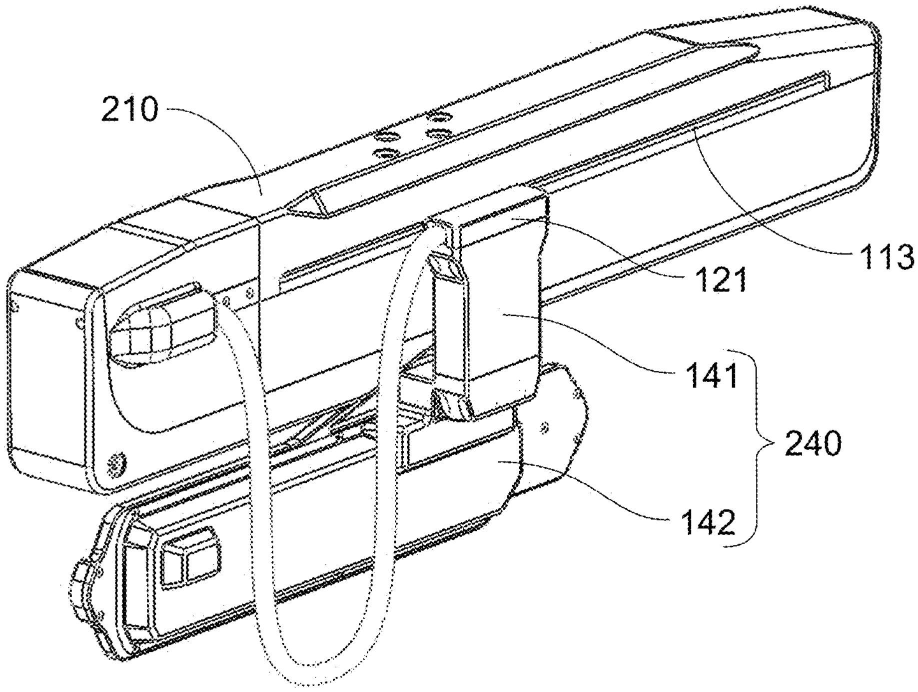


FIG. 4

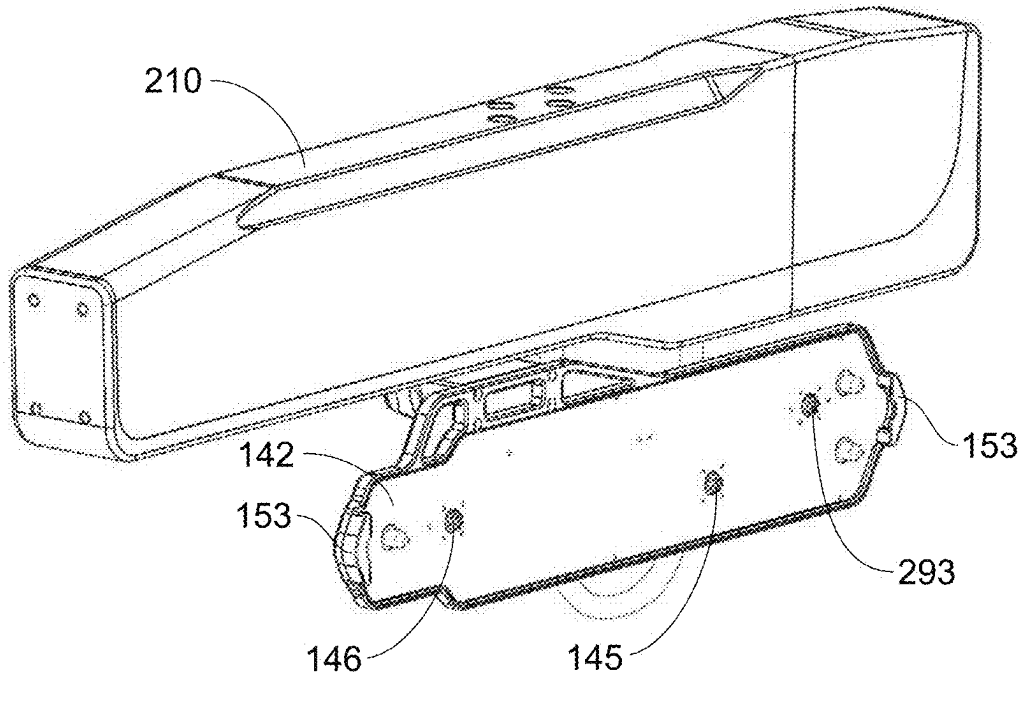


FIG. 5

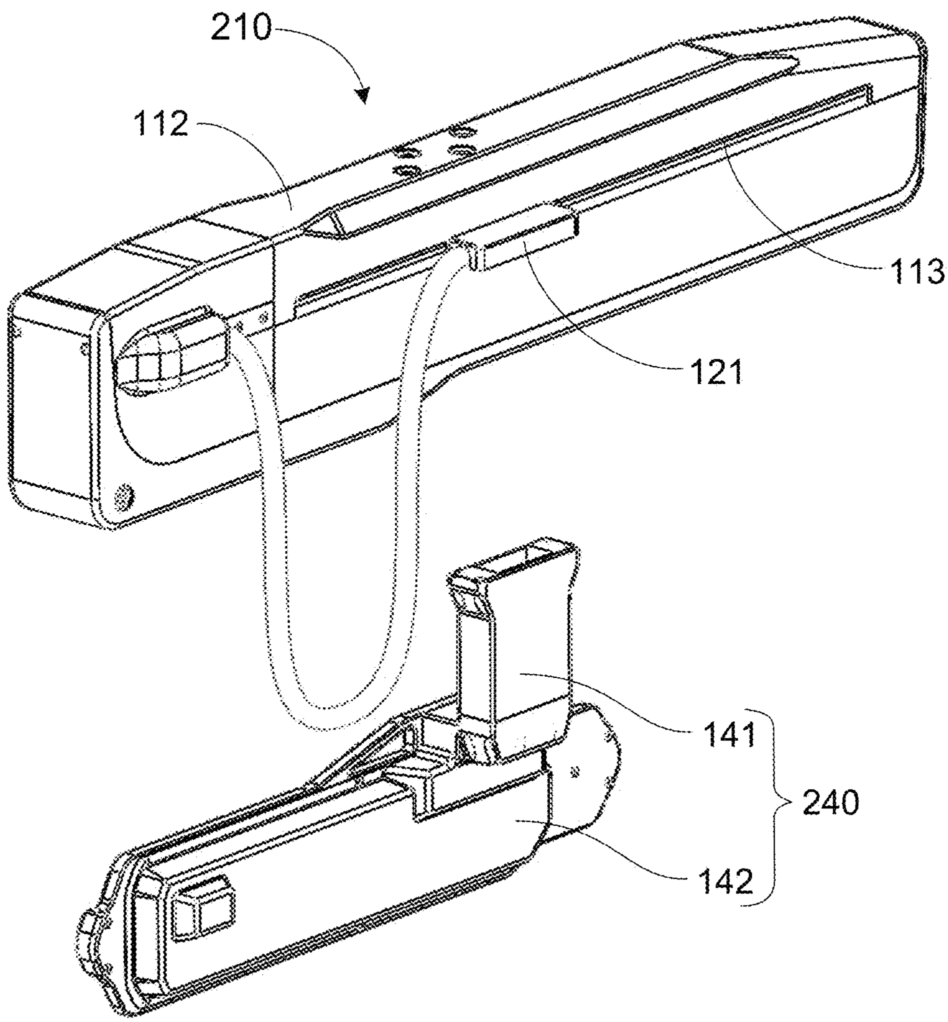


FIG. 6

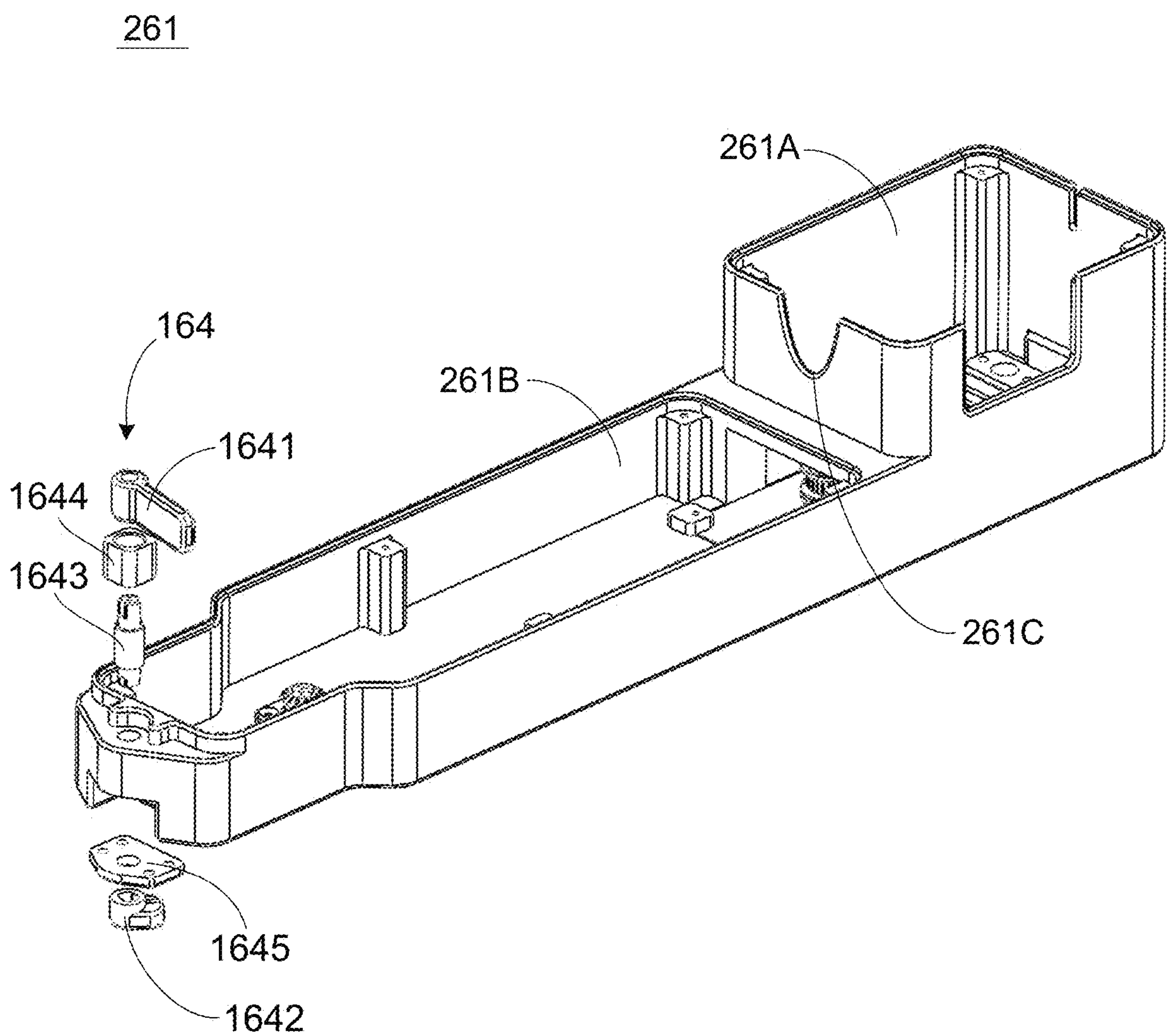
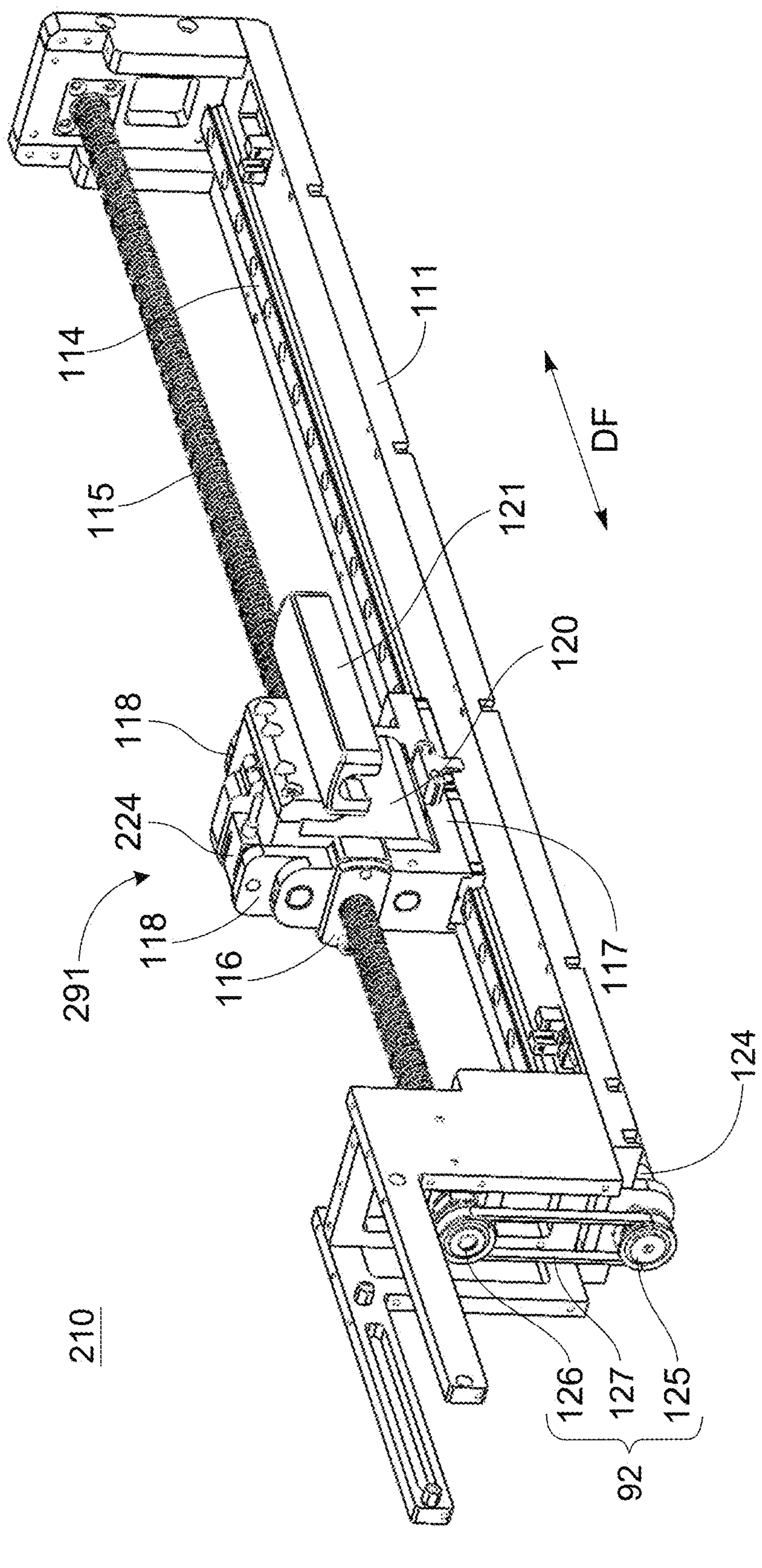


FIG. 7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291
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116
118
224
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115
121
120
117
111
DF
124
126
127
125
92

FIG. 8

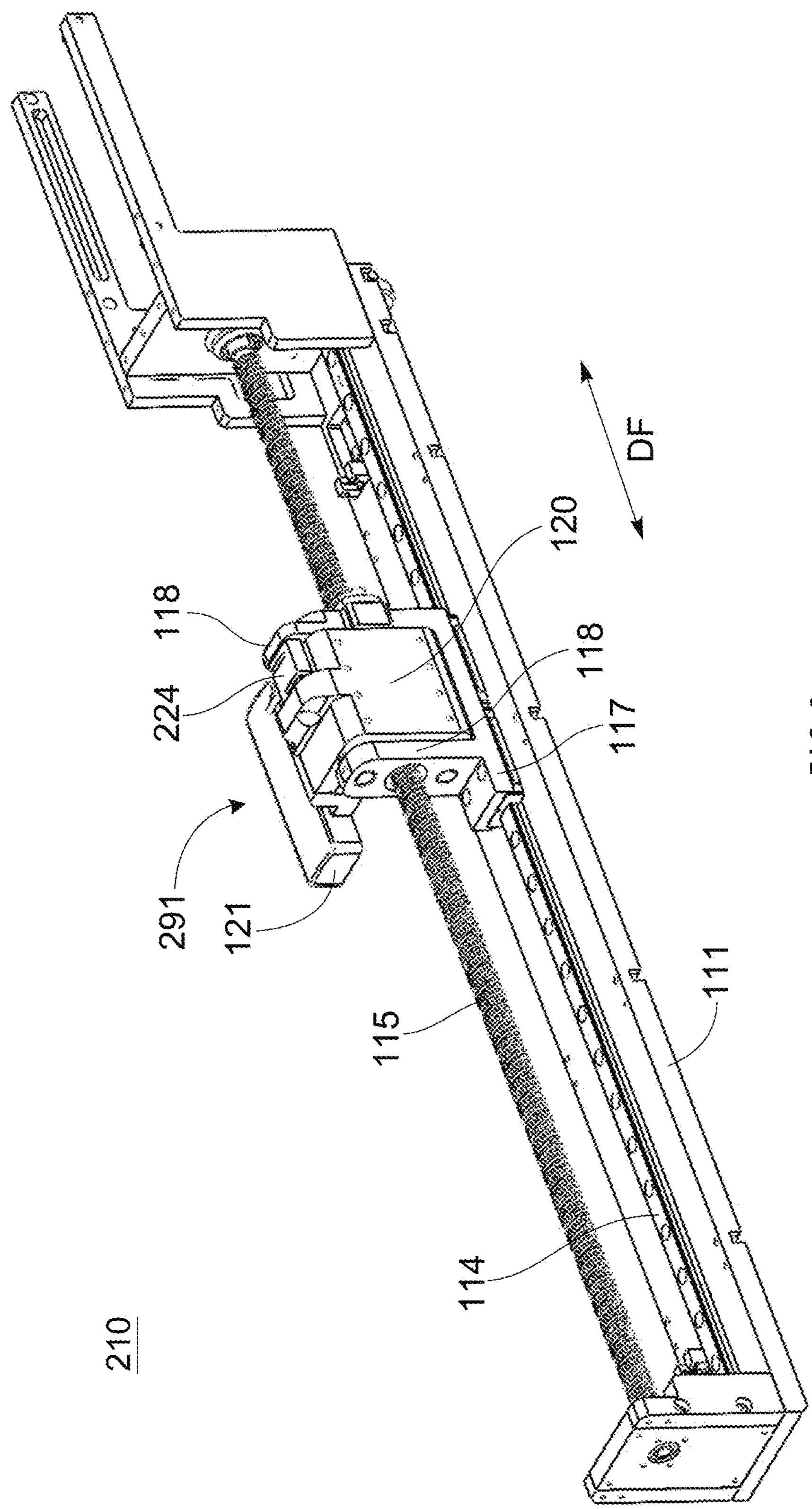


FIG. 9

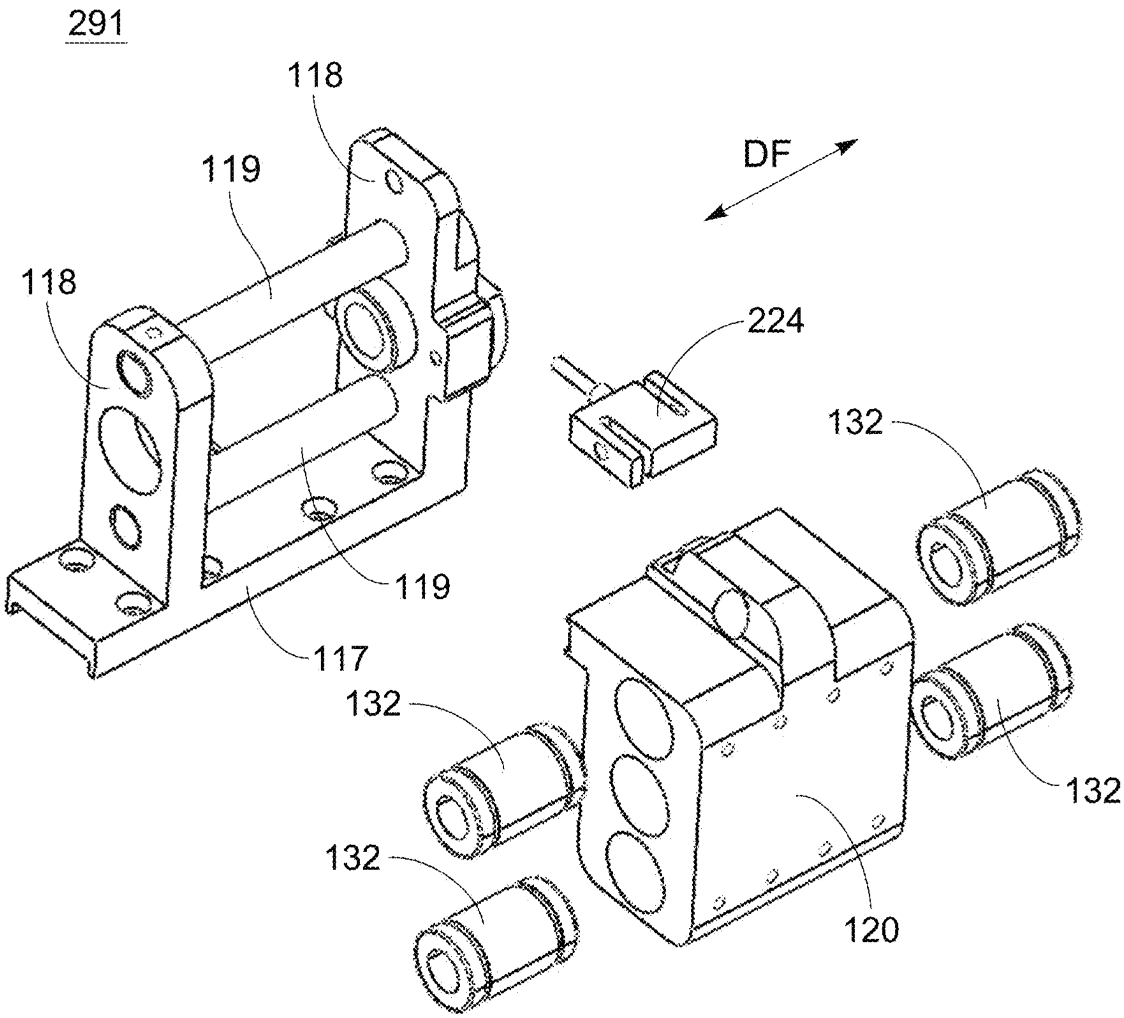


FIG. 10

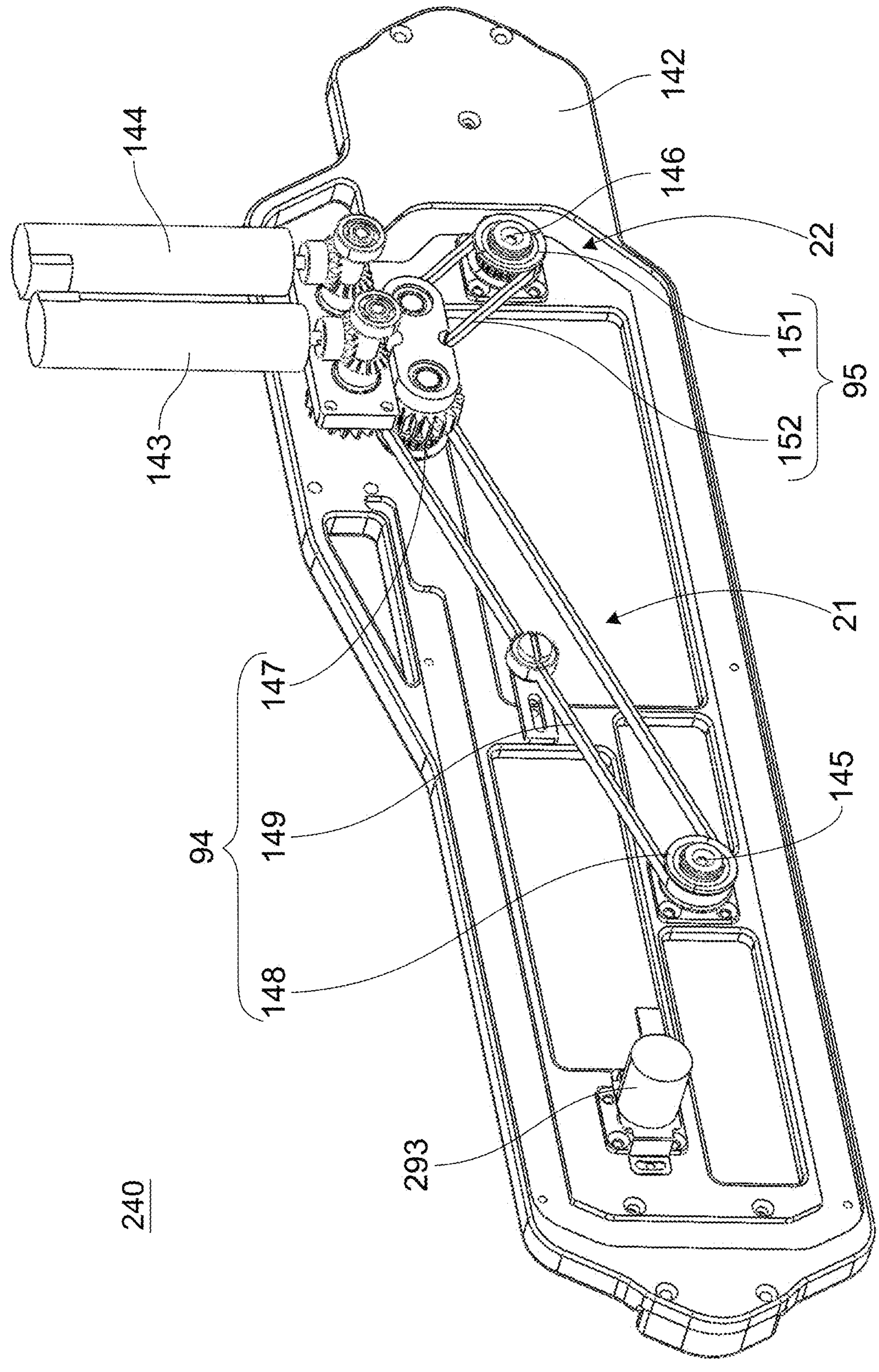


FIG. 11

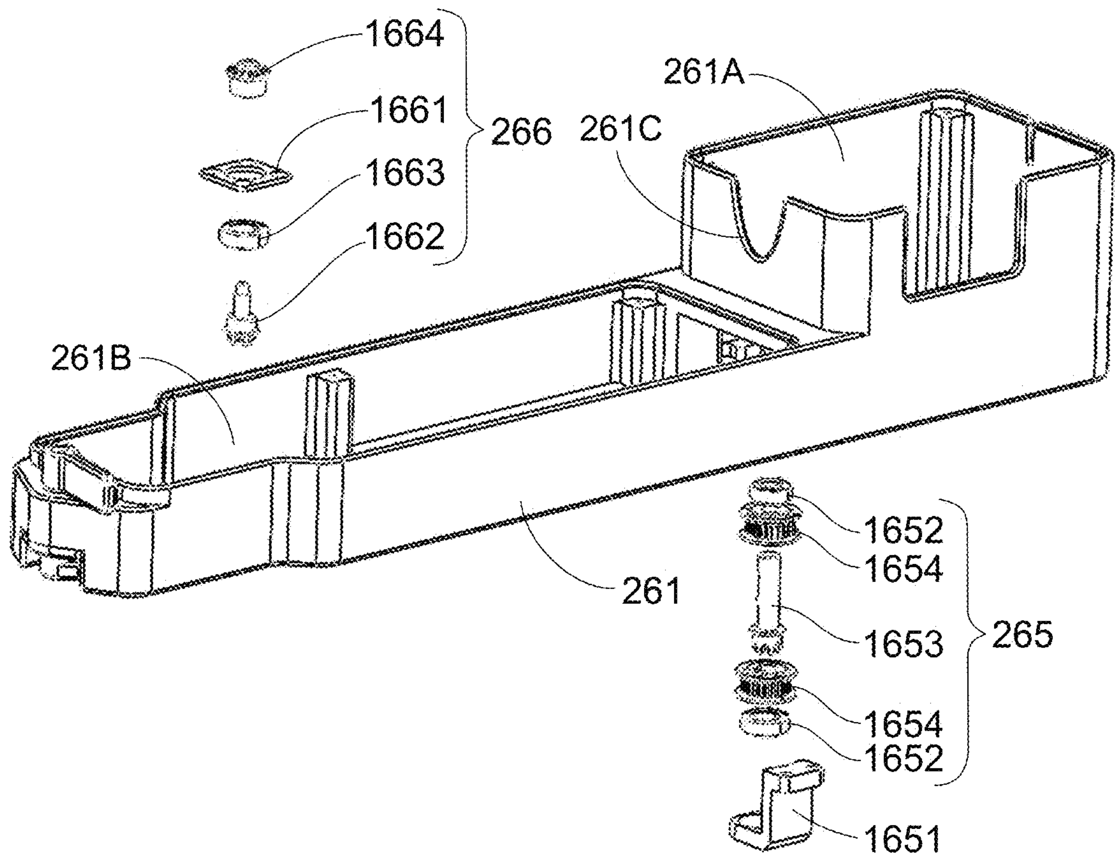

1664
1661
1663
1662
266
261C
261A
261B
261
1652
1654
1653
1654
1652
265
1651

FIG. 12

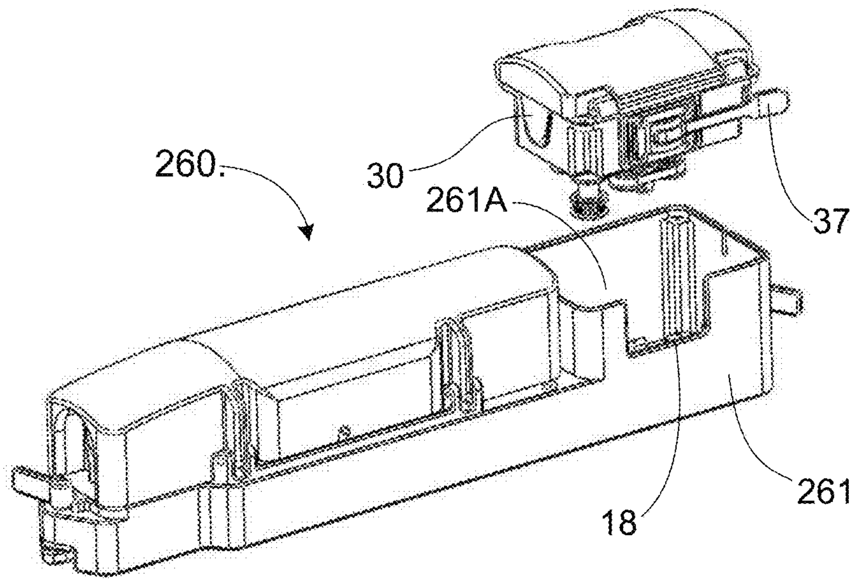


FIG. 13

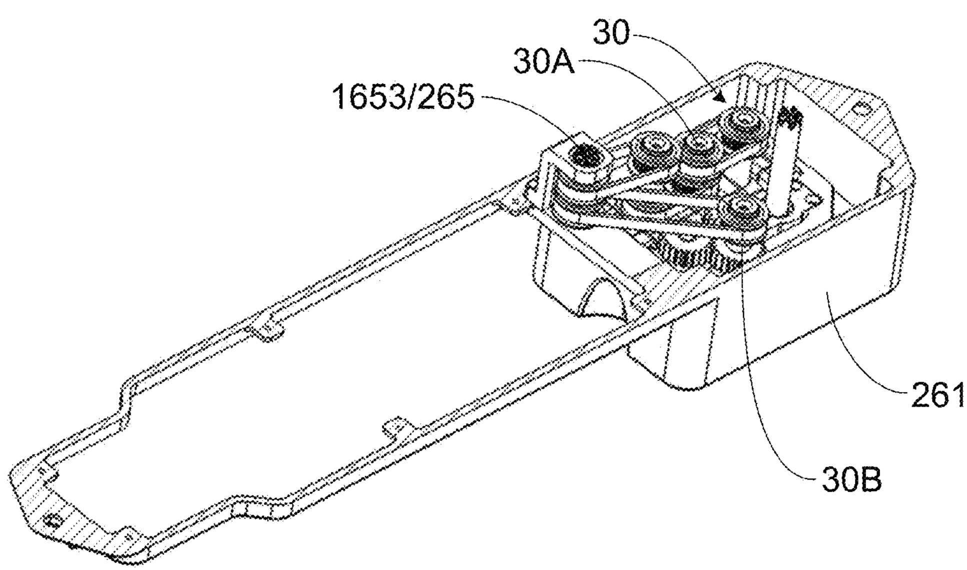
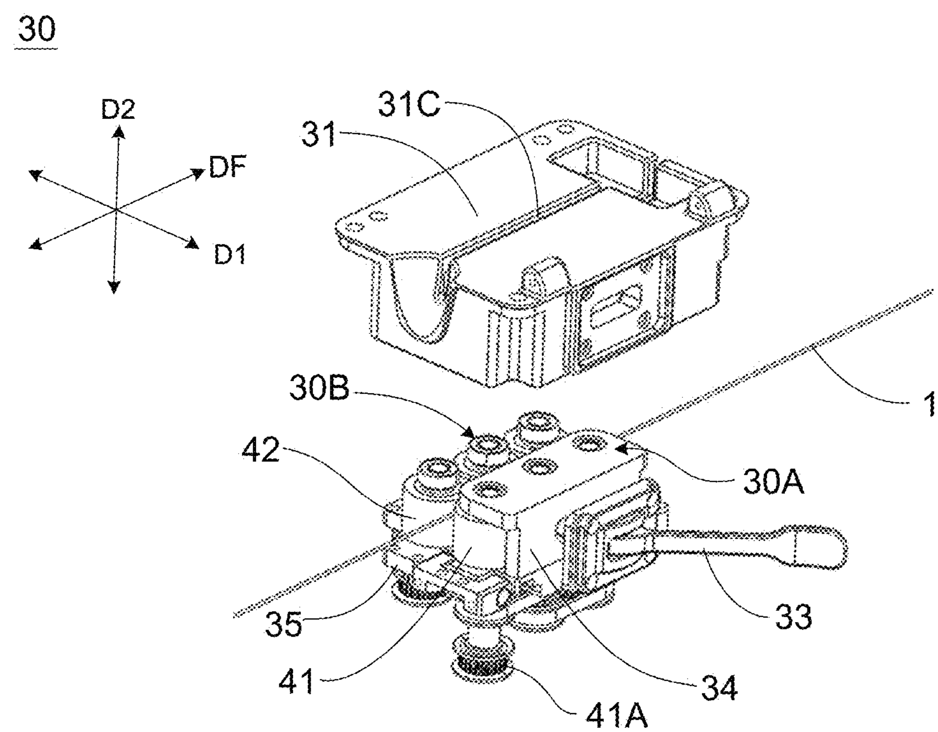


FIG. 14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D2
DF
D1
31C
31
12
30B
42
30A
33
35
41
34
41A

FIG. 15

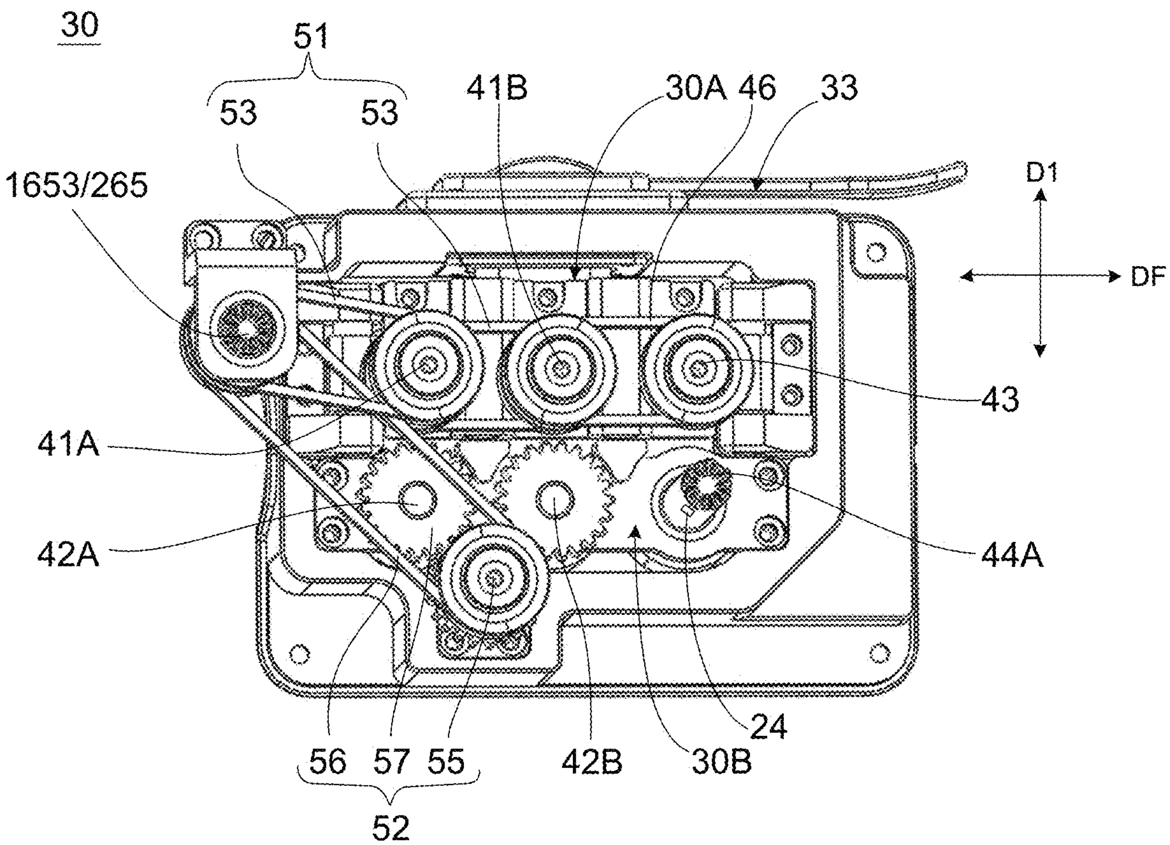
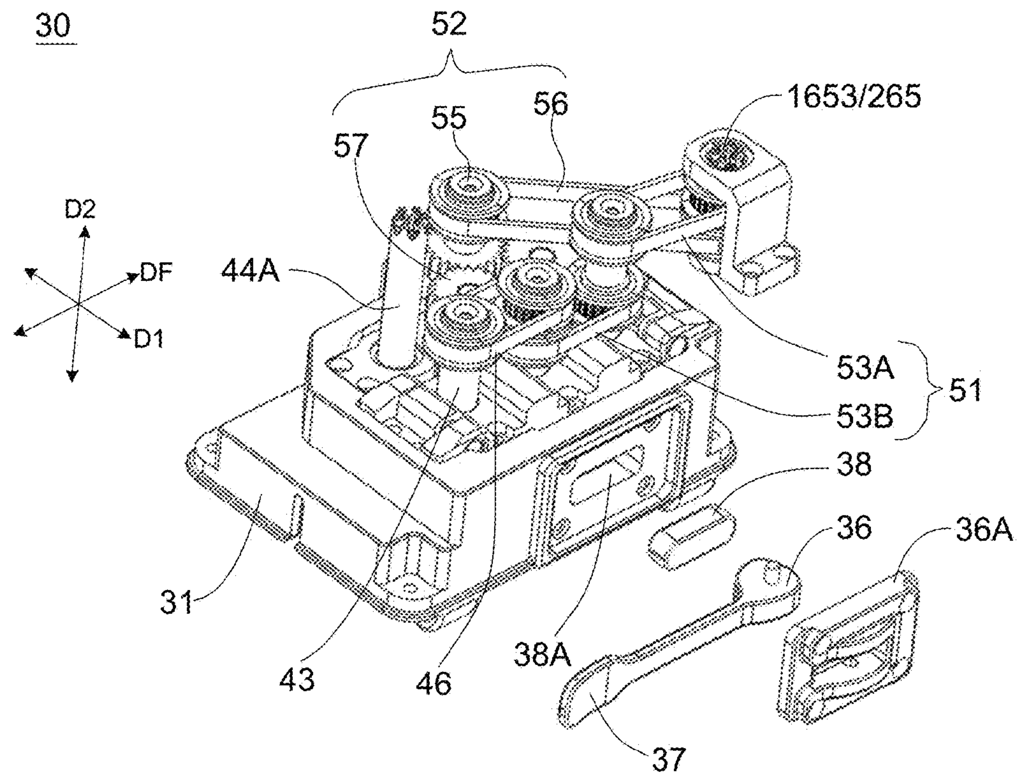
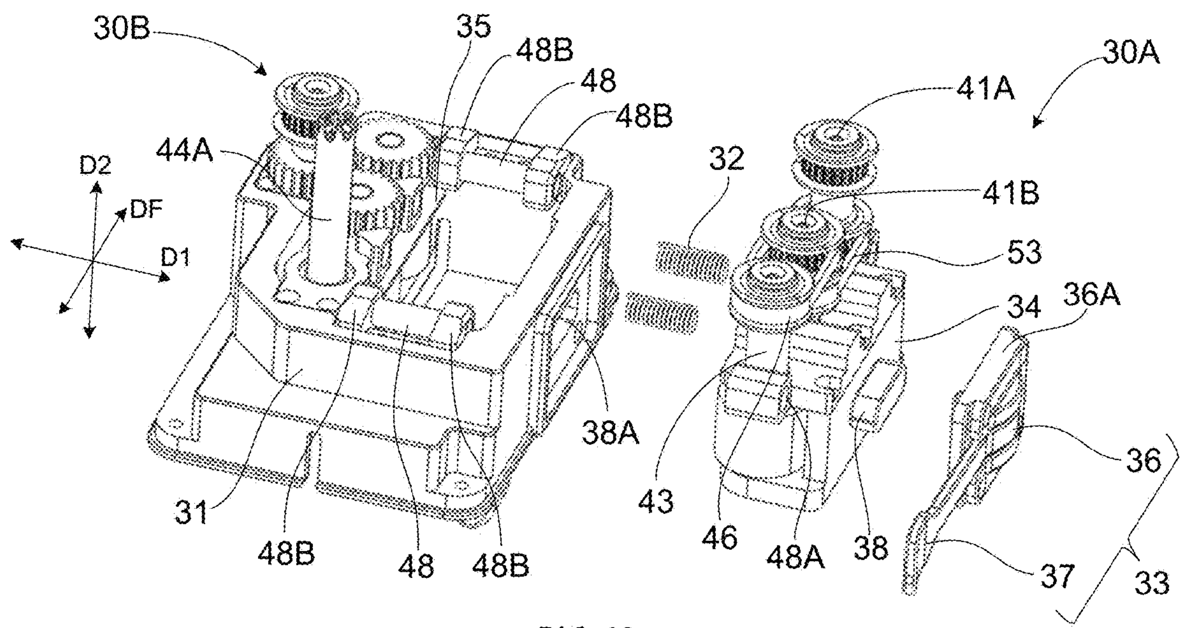

30
51
53
53
41B
30A 46
33
1653/265
D1
DF
43
41A
42A
44A
24
56 57 55
42B
30B
52

FIG. 16



30
52
56
55
57
1653/265
D2
DF
D1
44A
53A
51
53B
38
36
36A
31
38A
43
46
37

FIG. 17



30
30B
35
48B
48
48B
30A
41A
44A
D2
DF
D1
32
41B
53
34
36A
38A
36
31
43
46
48A
38
48B
48
48B
37
33

FIG. 18

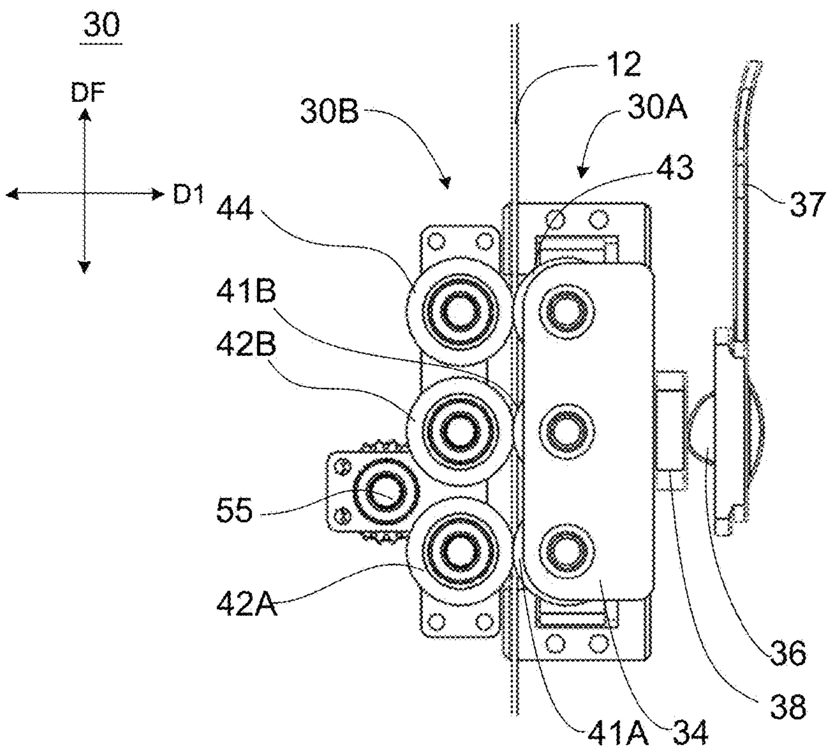

30
DF
D1
30B
12
30A
43
37
44
41B
42B
55
42A
36
38
41A
34

FIG. 19

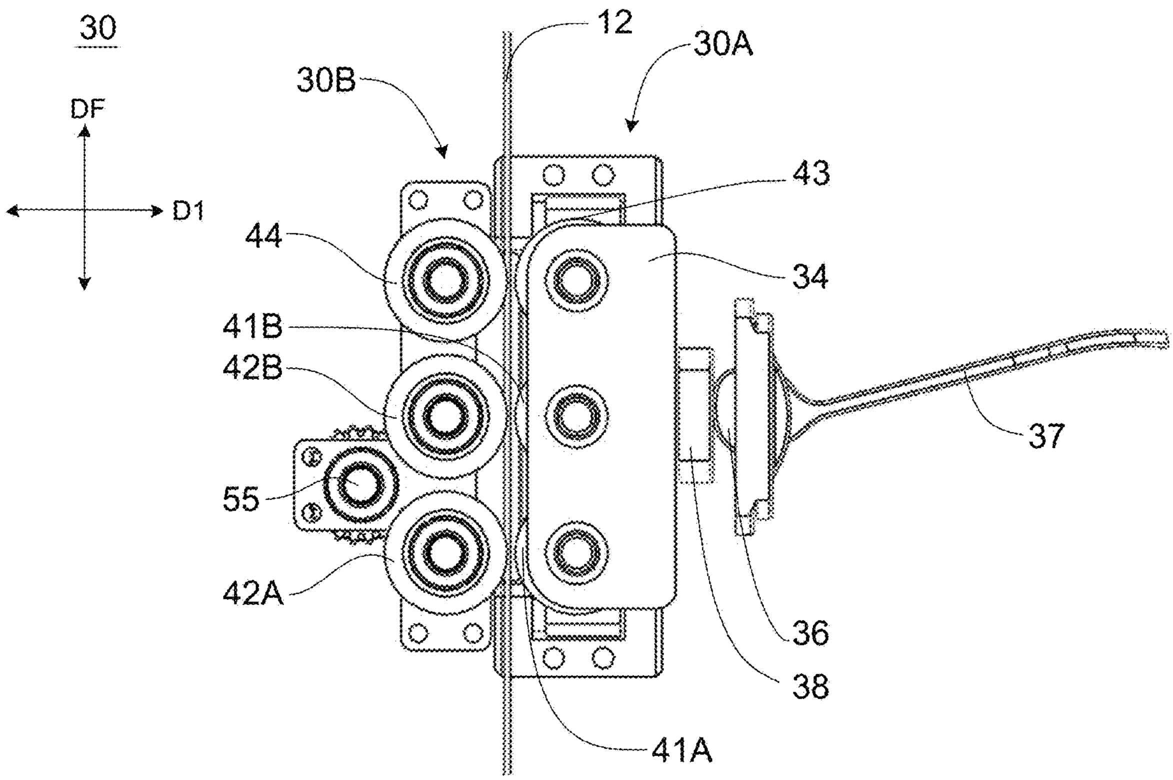

30
DF
D1
30B
12
30A
43
44
34
41B
42B
37
55
42A
36
38
41A

FIG. 20

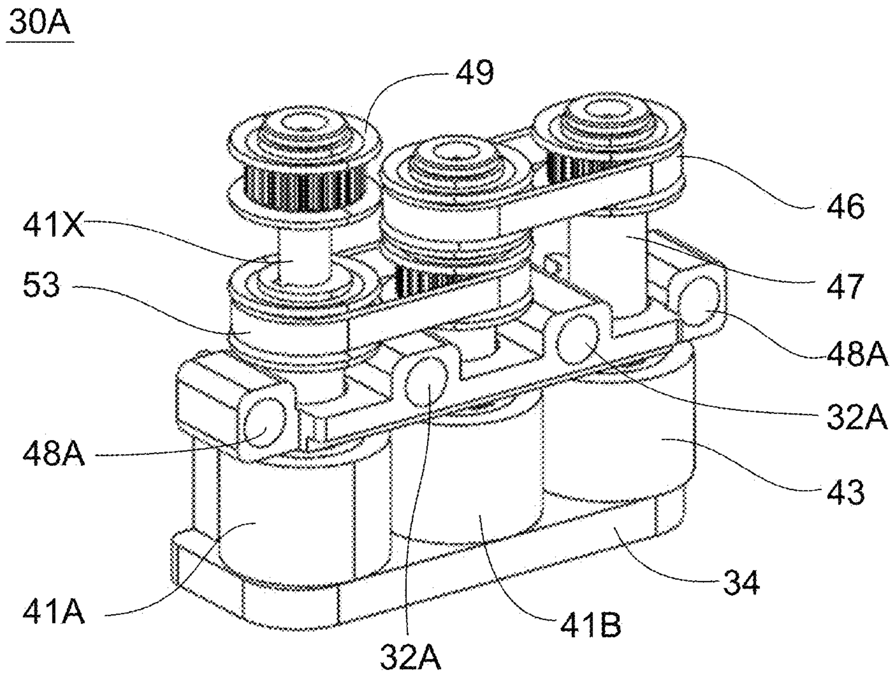

30A
49
41X
53
46
47
48A
32A
48A
43
41A
41B
34
32A

FIG. 21

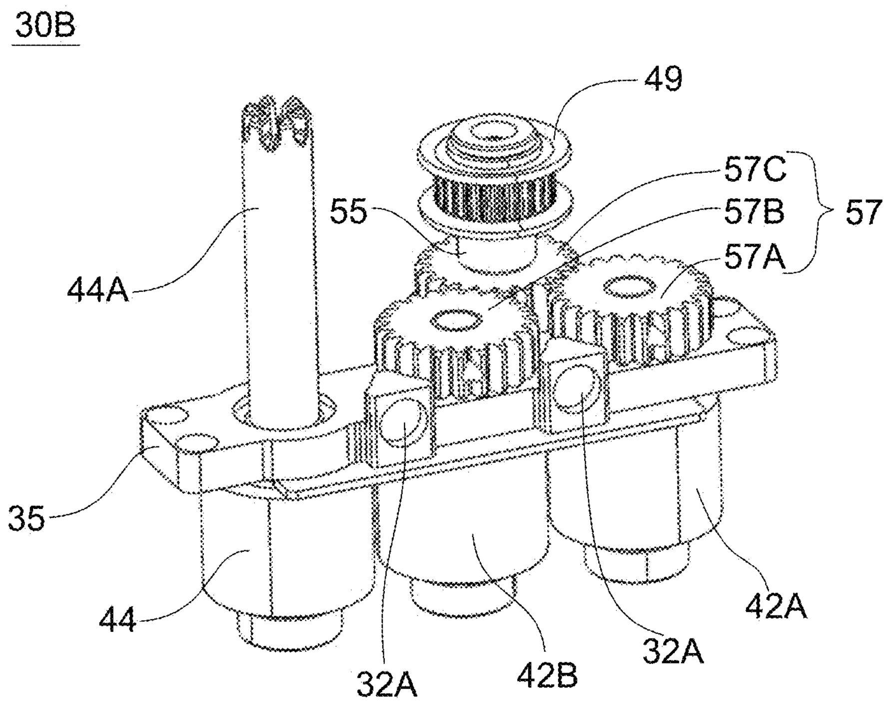

30B
49
57C
55
57B
57
57A
44A
35
44
42B
42A
32A
32A

FIG. 22

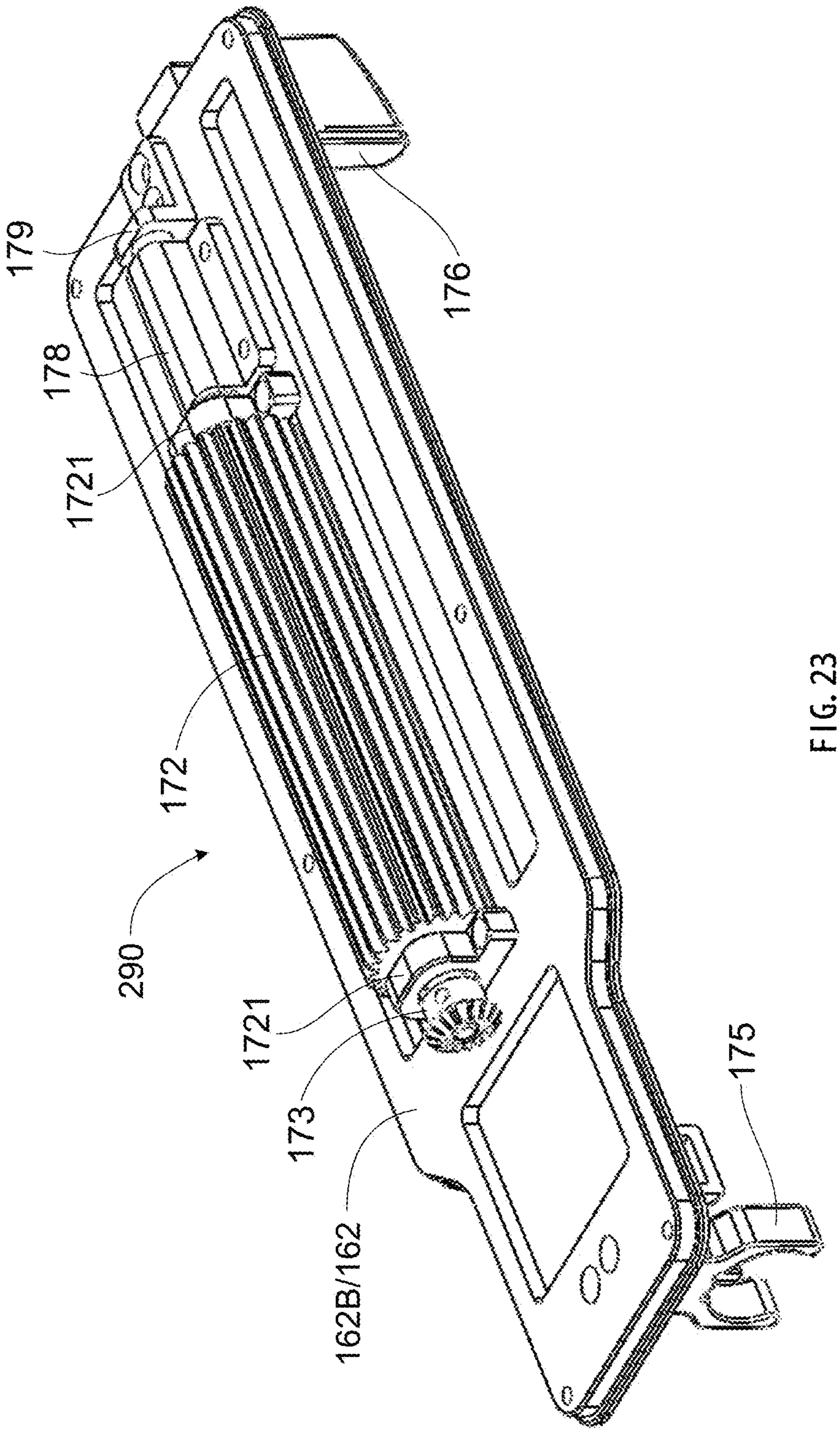


FIG. 23

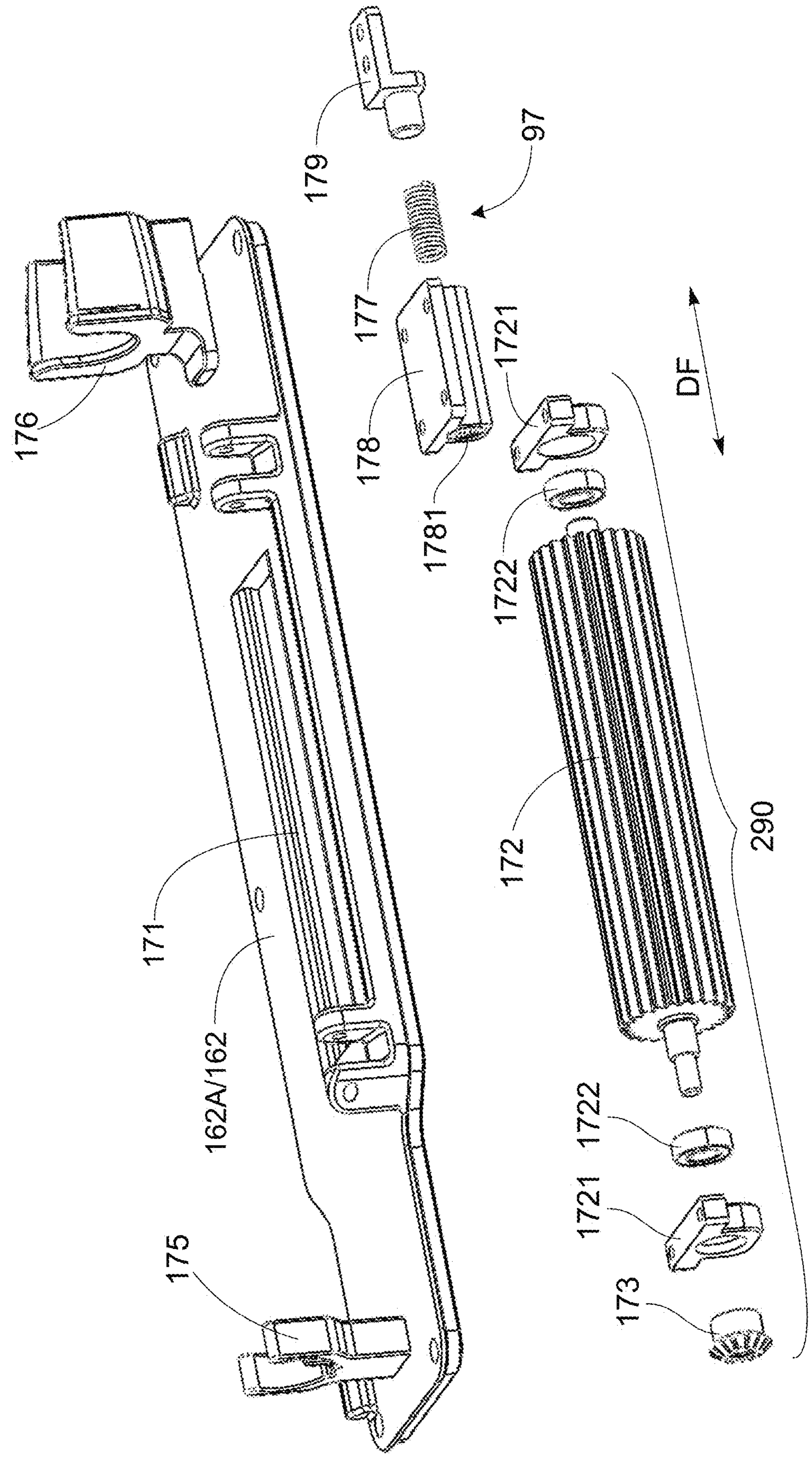

179
97
176
177
1721
DF
178
1781
1722
172
290
171
162A/162
1722
1721
175
173

FIG. 24

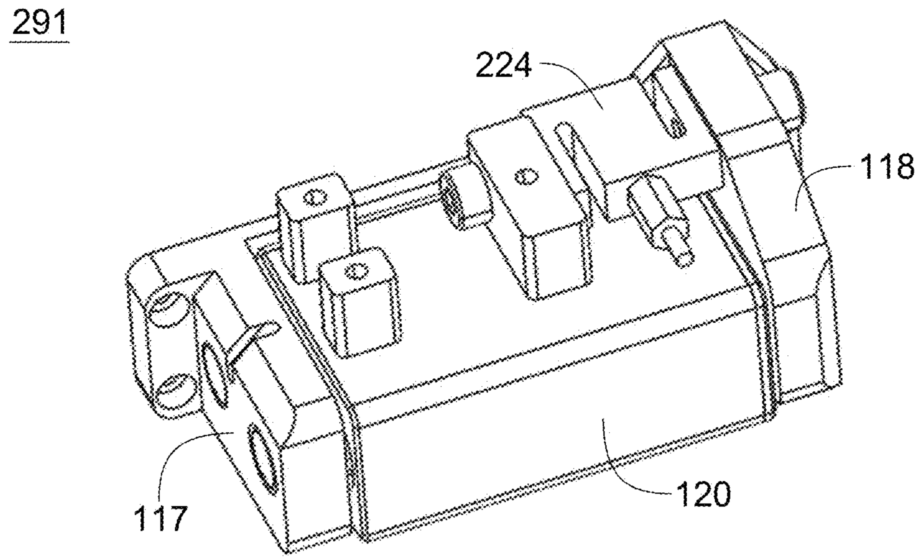


FIG. 25

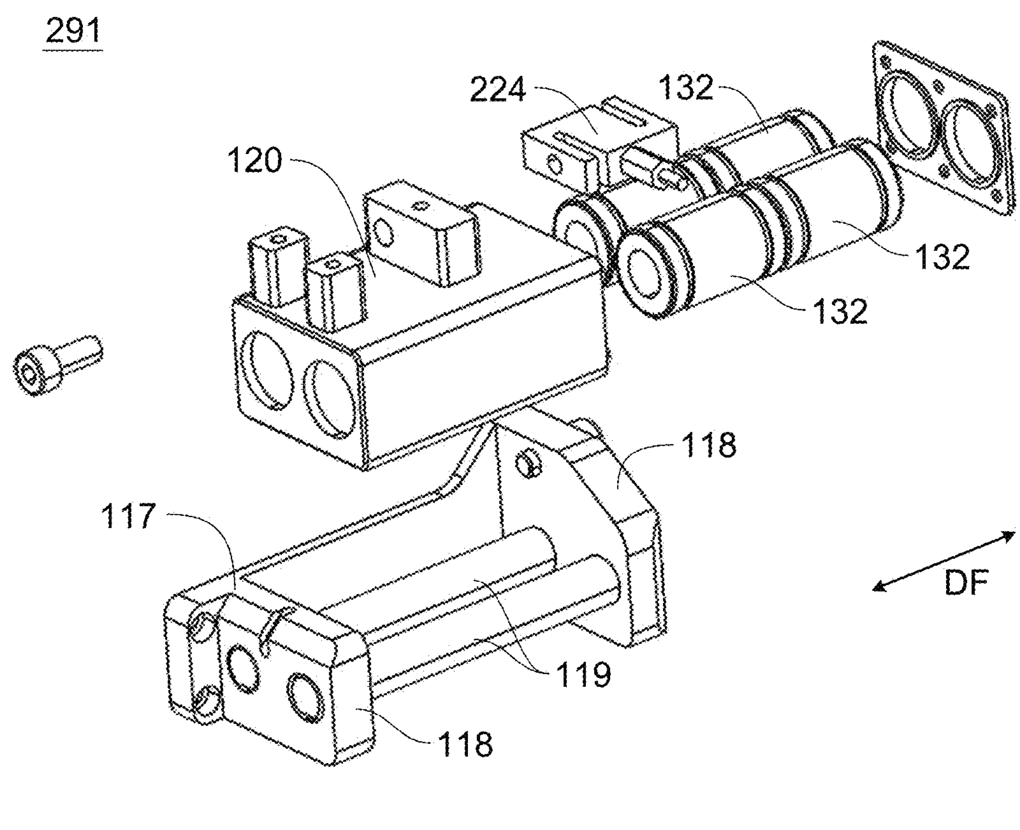


FIG. 26

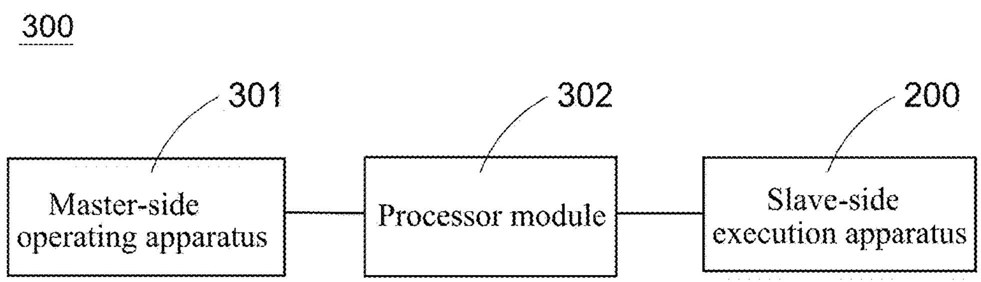

300
301
302
200
Master-side operating apparatus
Processor module
Slave-side execution apparatus

FIG. 27

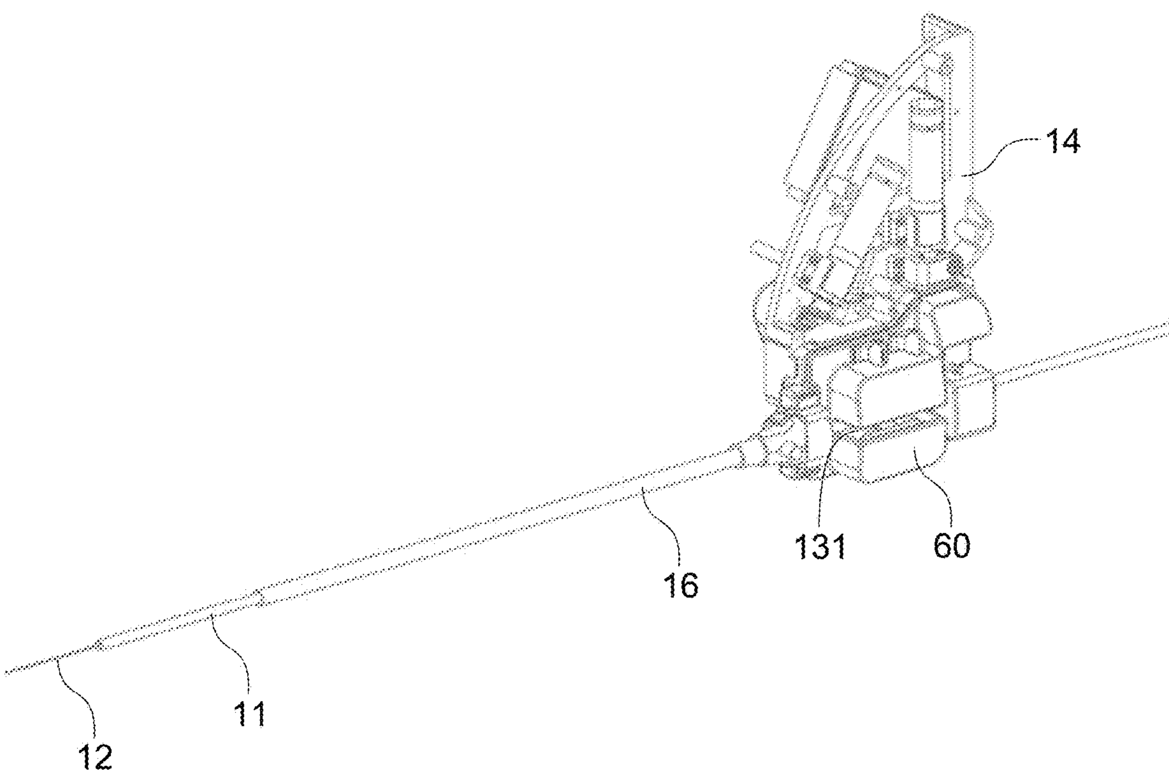

14
131
60
16
11
12

FIG. 28

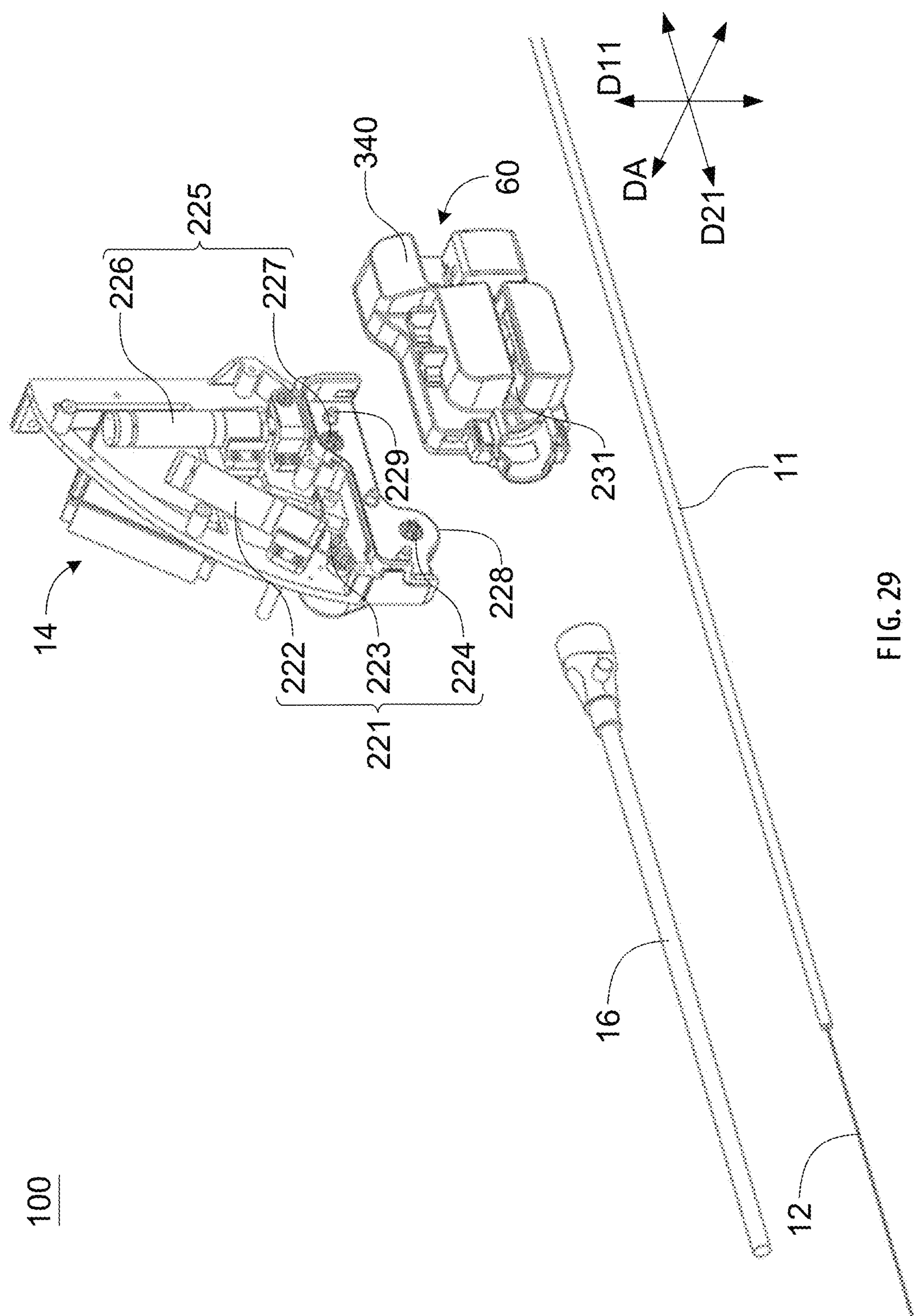

100
14
225
226
227
229
228
222
223
224
221
340
60
231
11
16
12
D11
DA
D21

FIG. 29

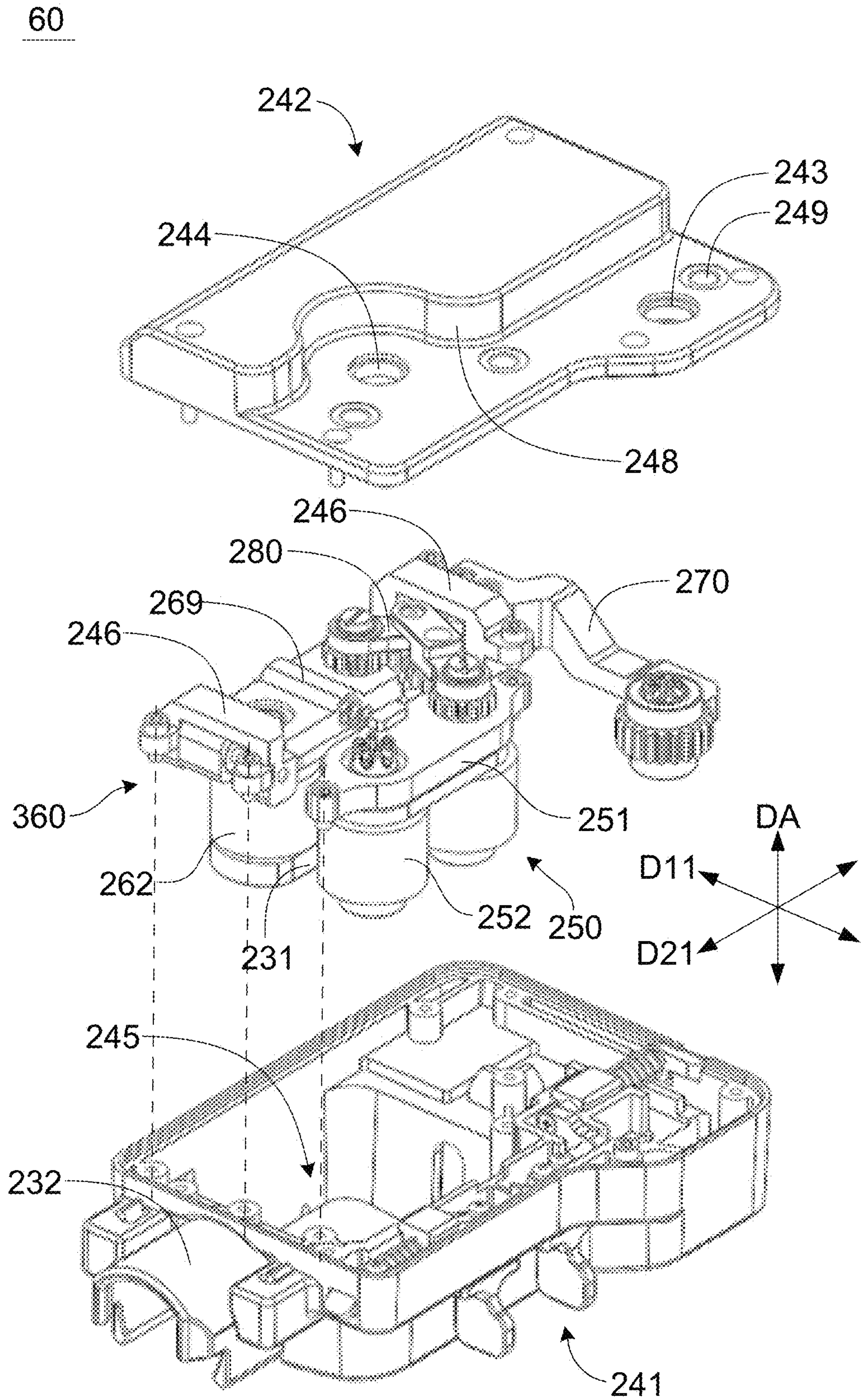

60
242
243
249
244
248
246
280
270
269
246
360
251
DA
D11
262
252
250
231
D21
245
232
241

FIG. 30

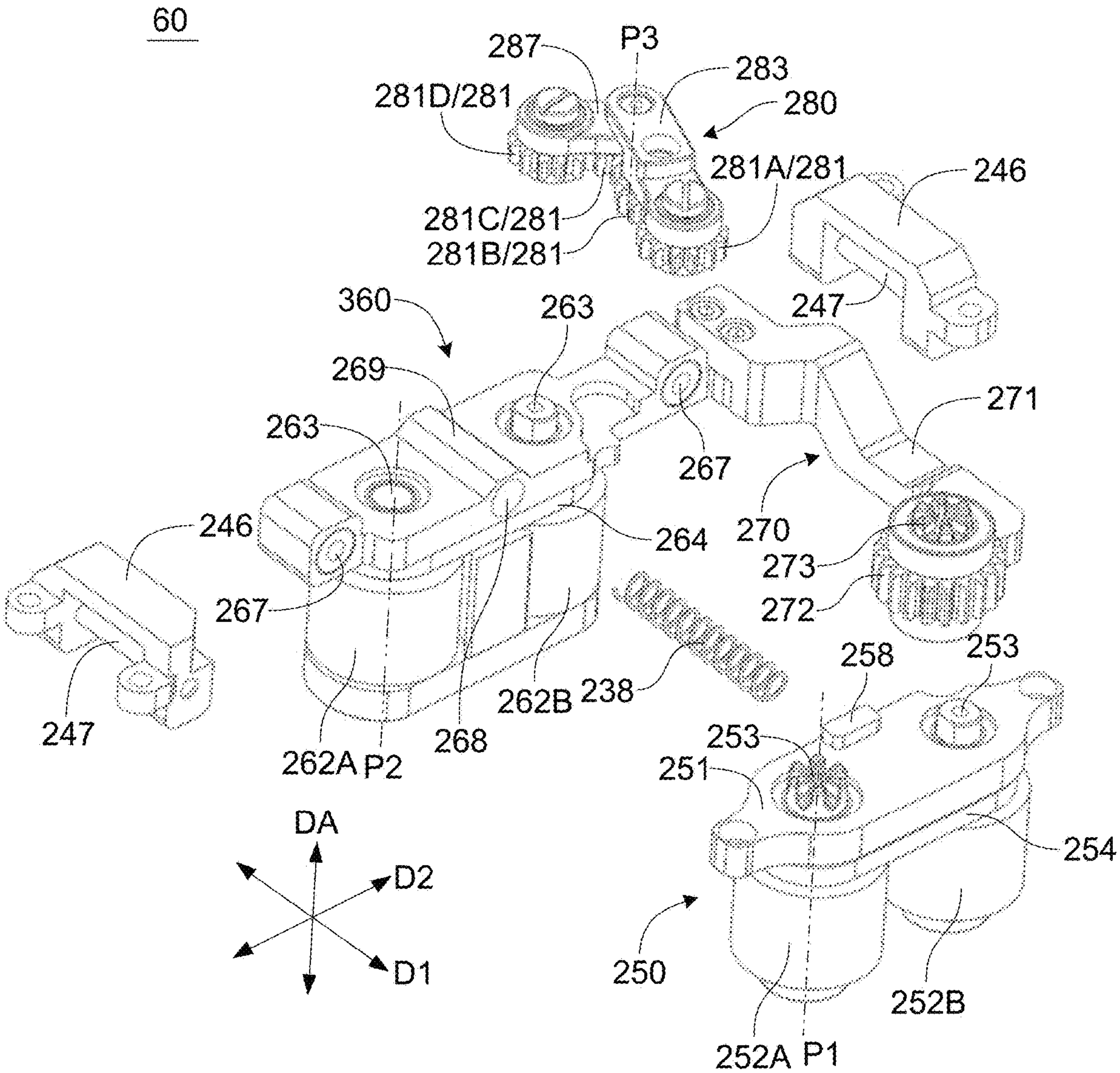

60
287
P3
283
280
281D/281
281A/281
246
281C/281
281B/281
360
263
247
269
271
263
267
270
246
264
273
267
272
253
258
238
247
262B
253
251
268
262A
P2
254
DA
D2
D1
250
252B
252A
P1

FIG. 31

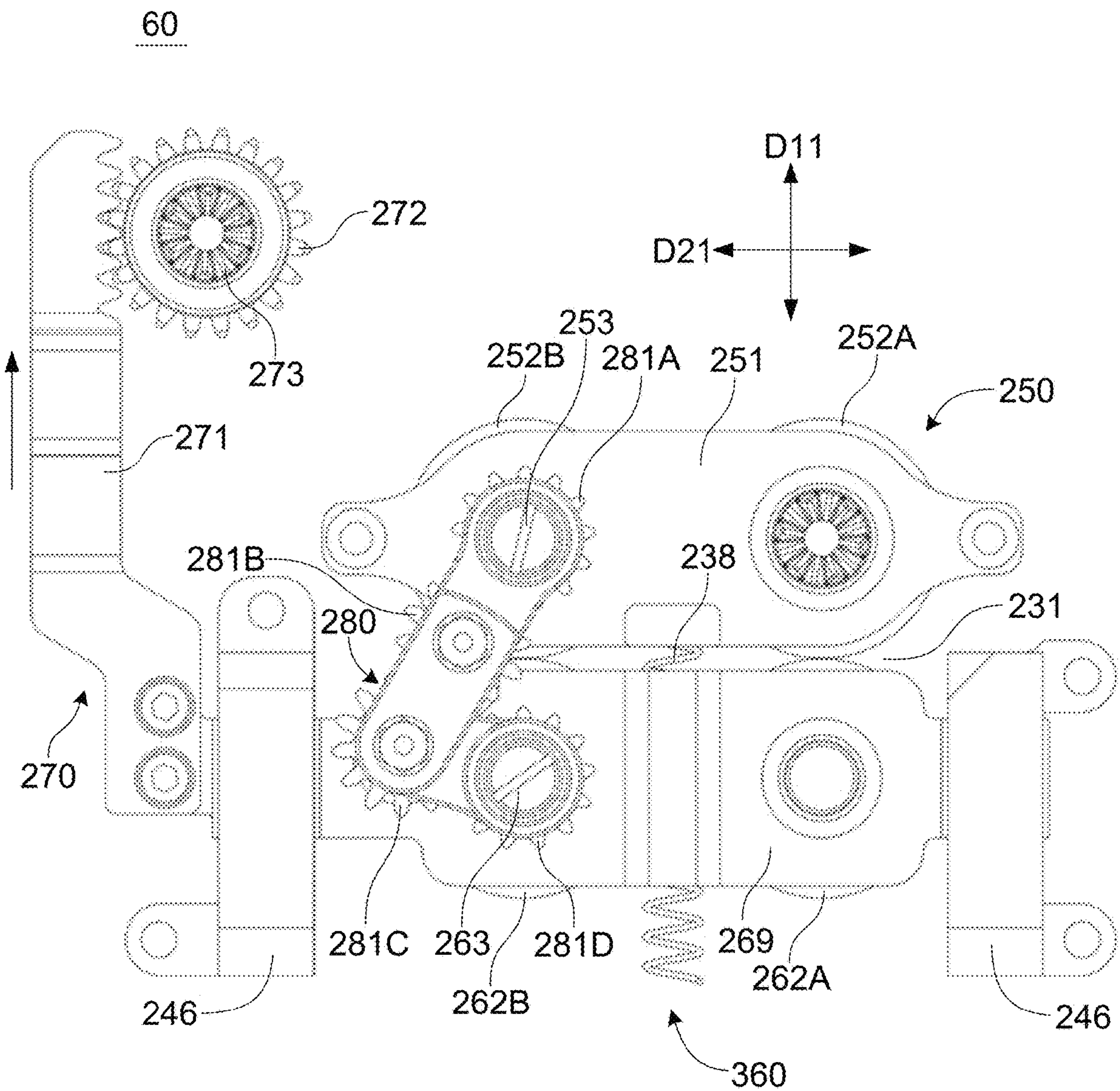
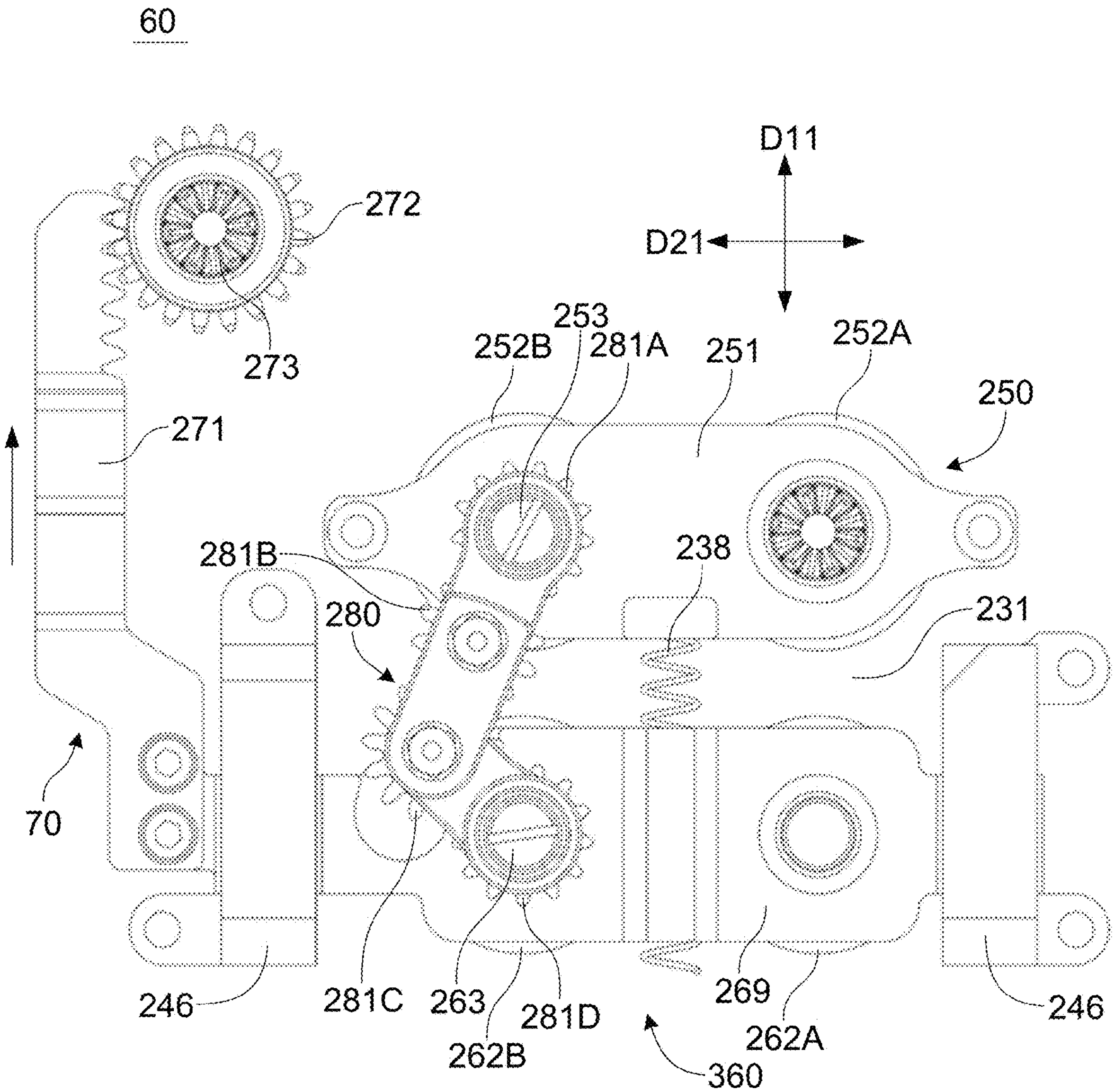

60
D11
D21
272
273
271
253
252B
281A
251
252A
250
281B
238
231
280
270
281C
263
281D
269
262A
262B
246
246
360

FIG. 32


60
D11
D21
272
273
271
70
253
252B
281A
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252A
250
281B
280
238
231
246
281C
263
262B
281D
269
262A
360
246

FIG. 33

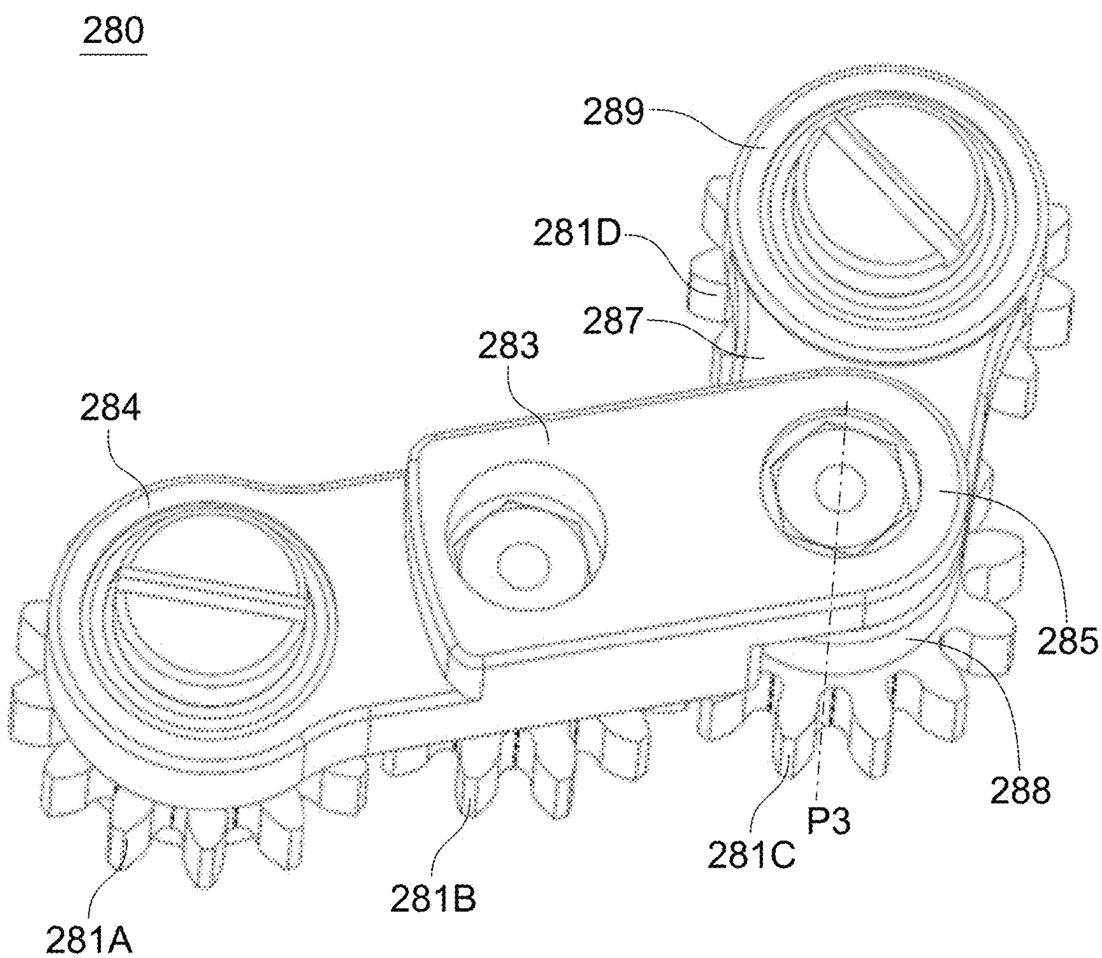
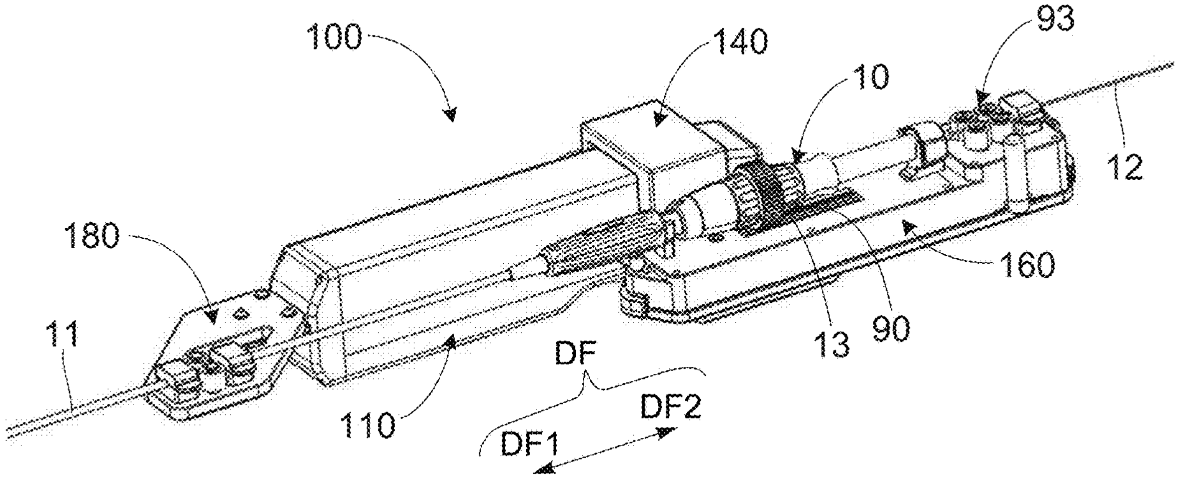


FIG. 34


100
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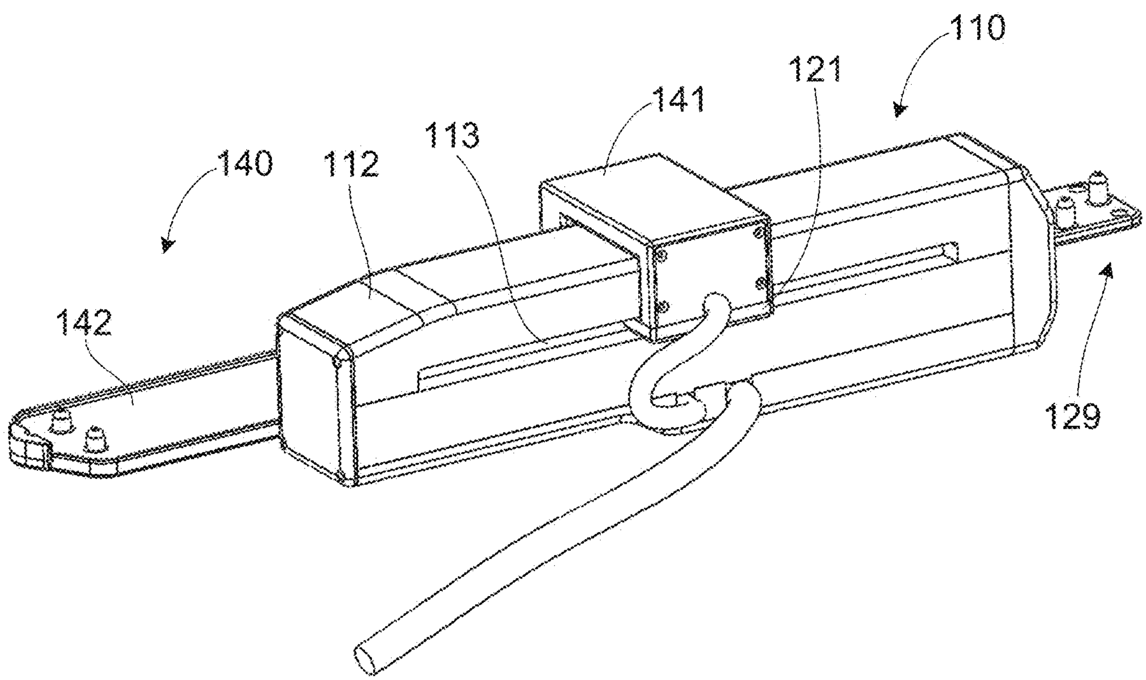
10
93
12
180
160
11
13
90
110
DF
DF2
DF1

FIG. 35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112
142
129

FIG. 36

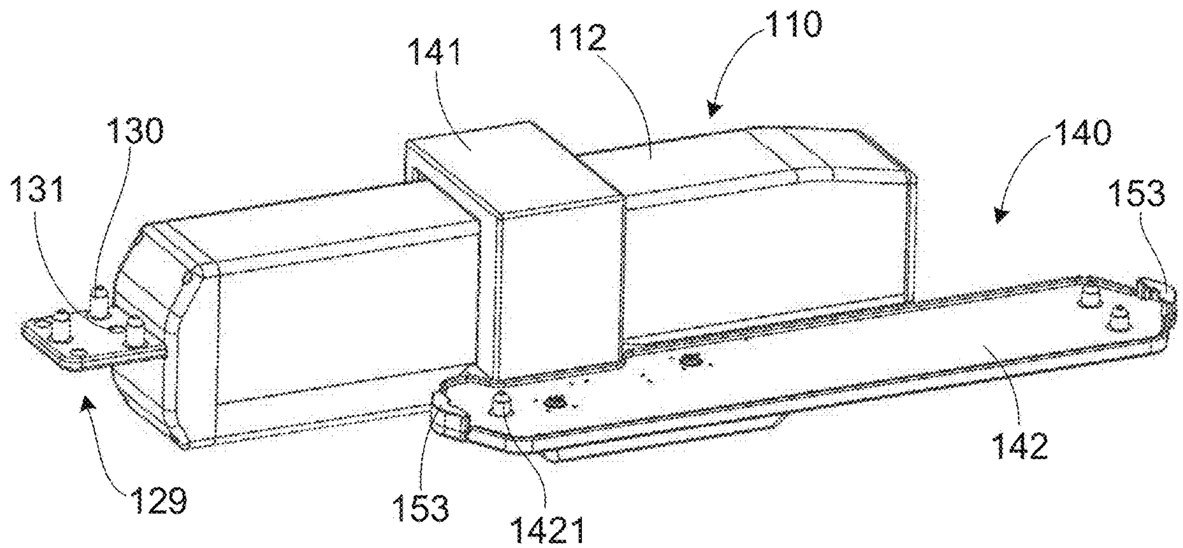
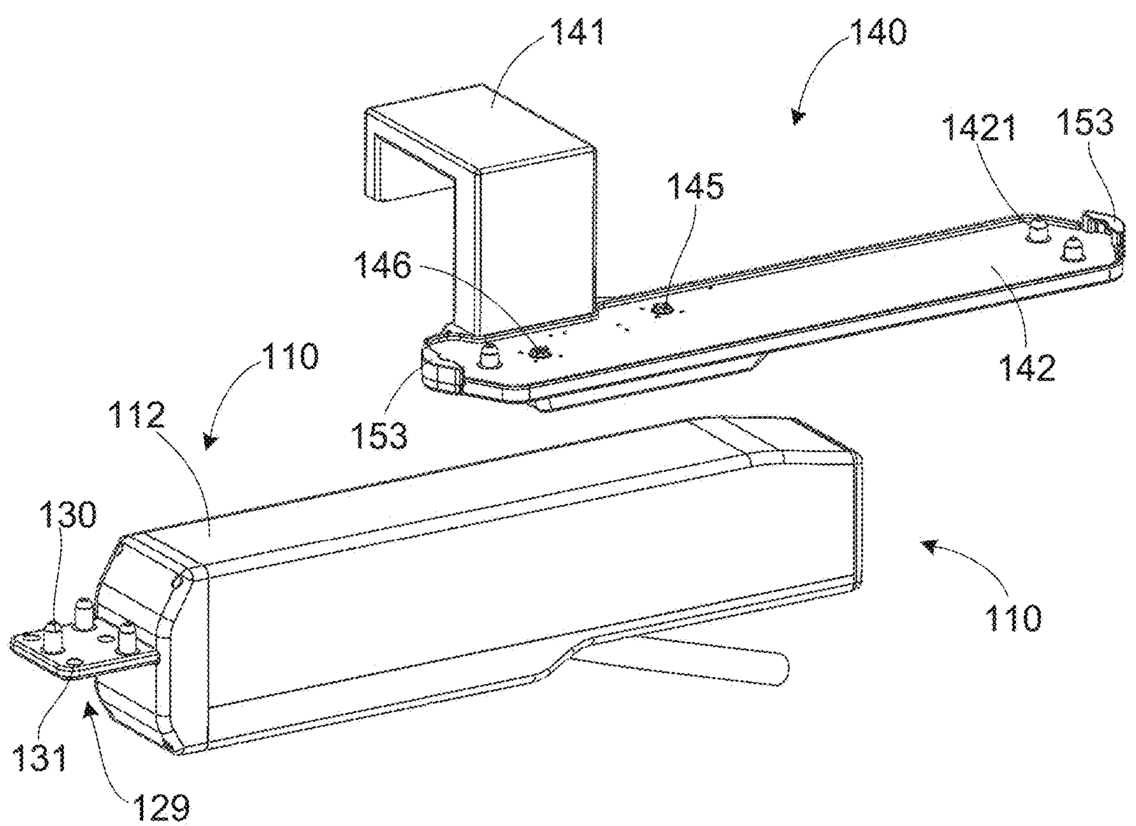

110
112
141
130
131
140
153
142
129
153
1421

FIG. 37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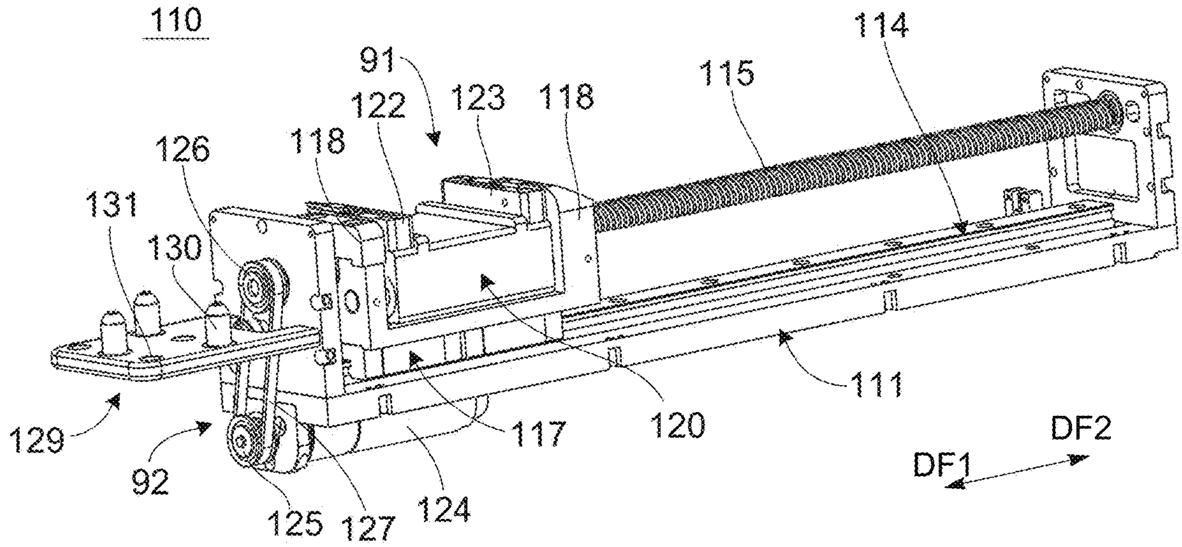
140
1421
153
145
146
142
110
153
112
130
110
131
129

FIG. 38


110
91
114
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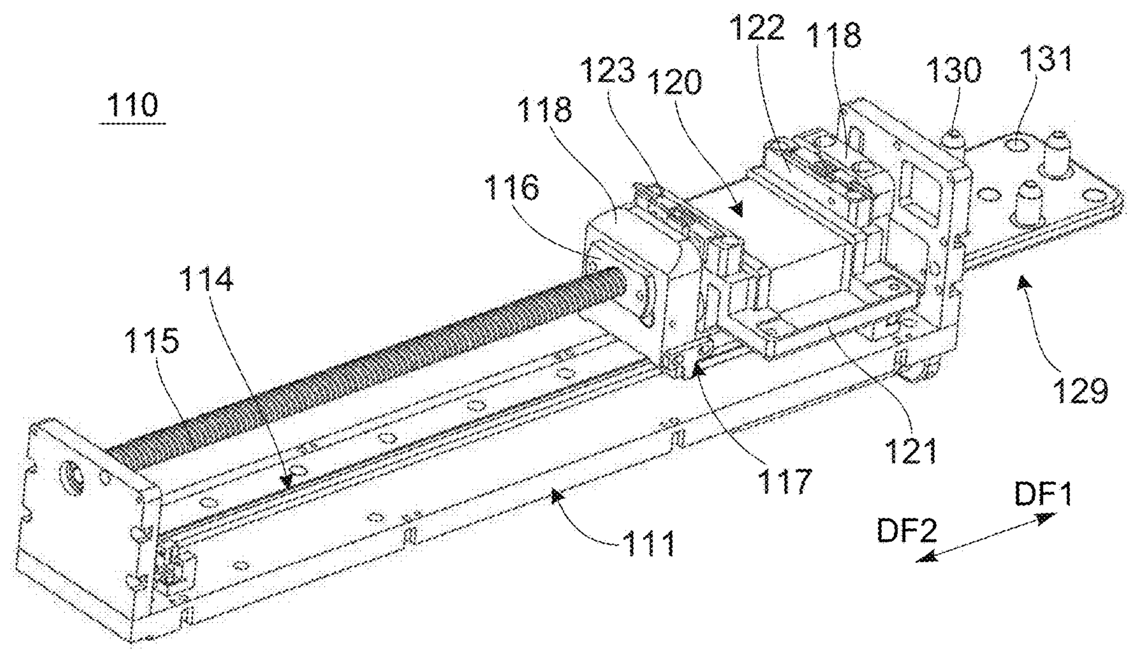
92
124
125
127
DF2
DF1

FIG. 39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117
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111
DF1
DF2

FIG. 40

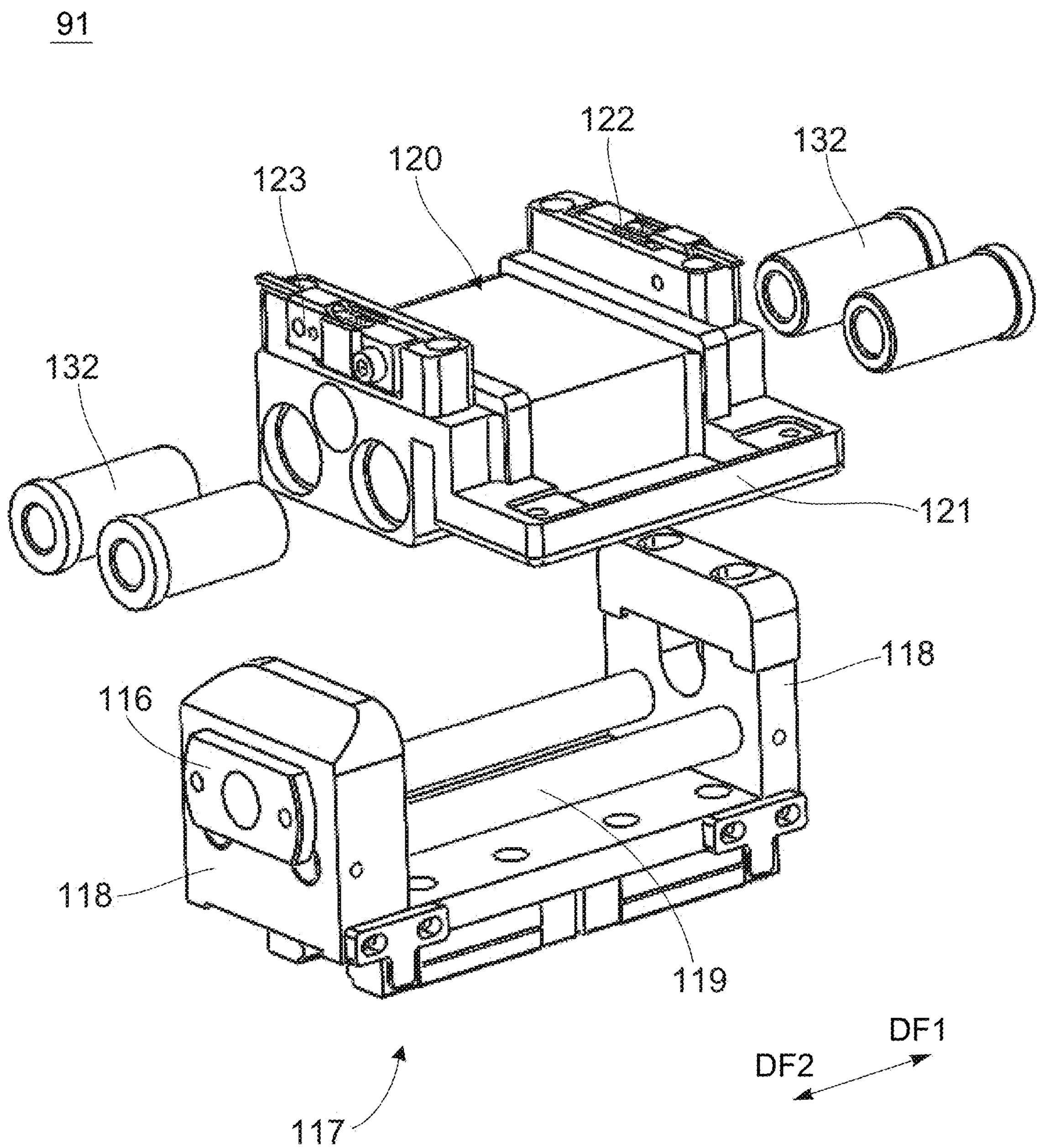


FIG. 41

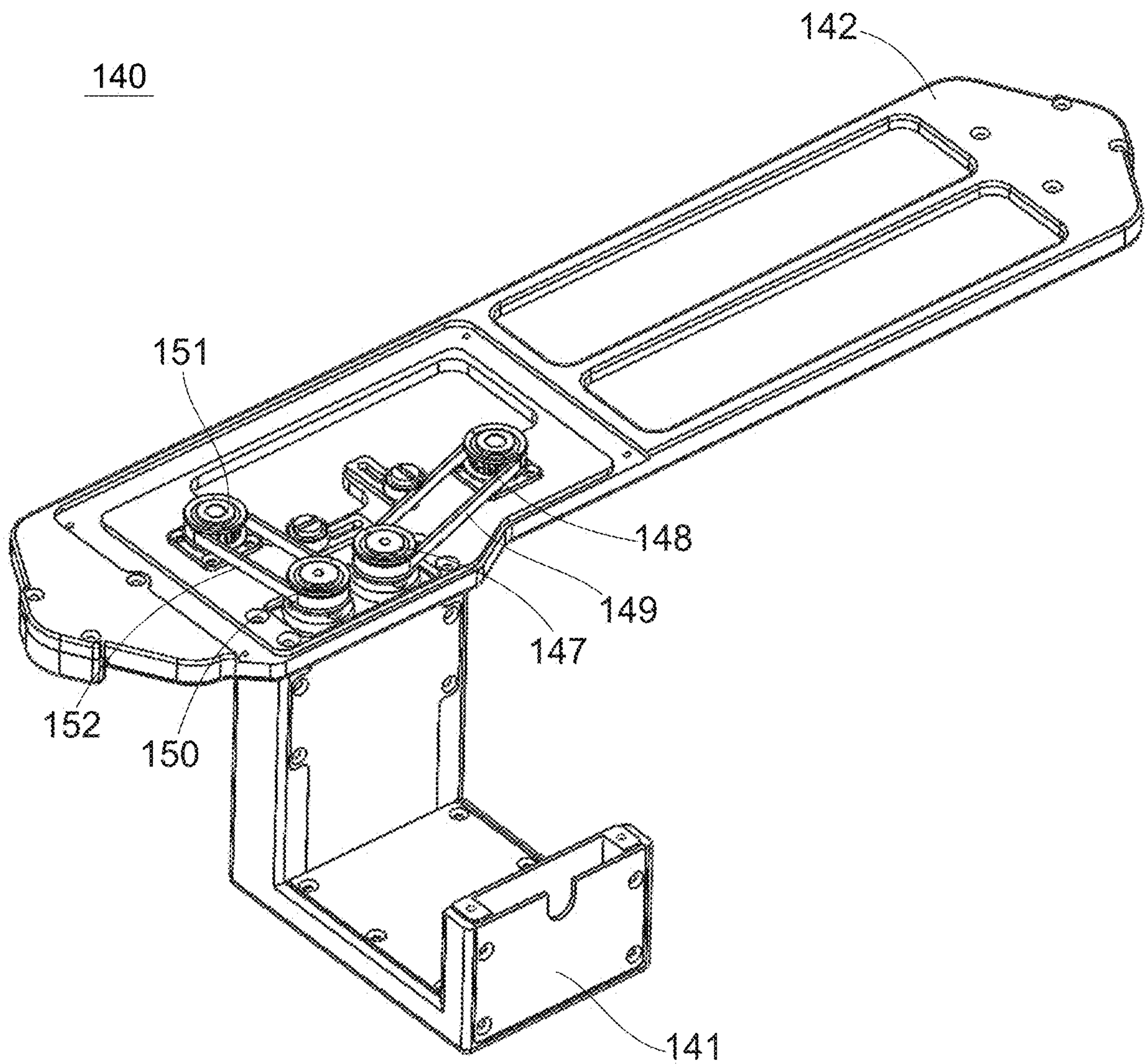
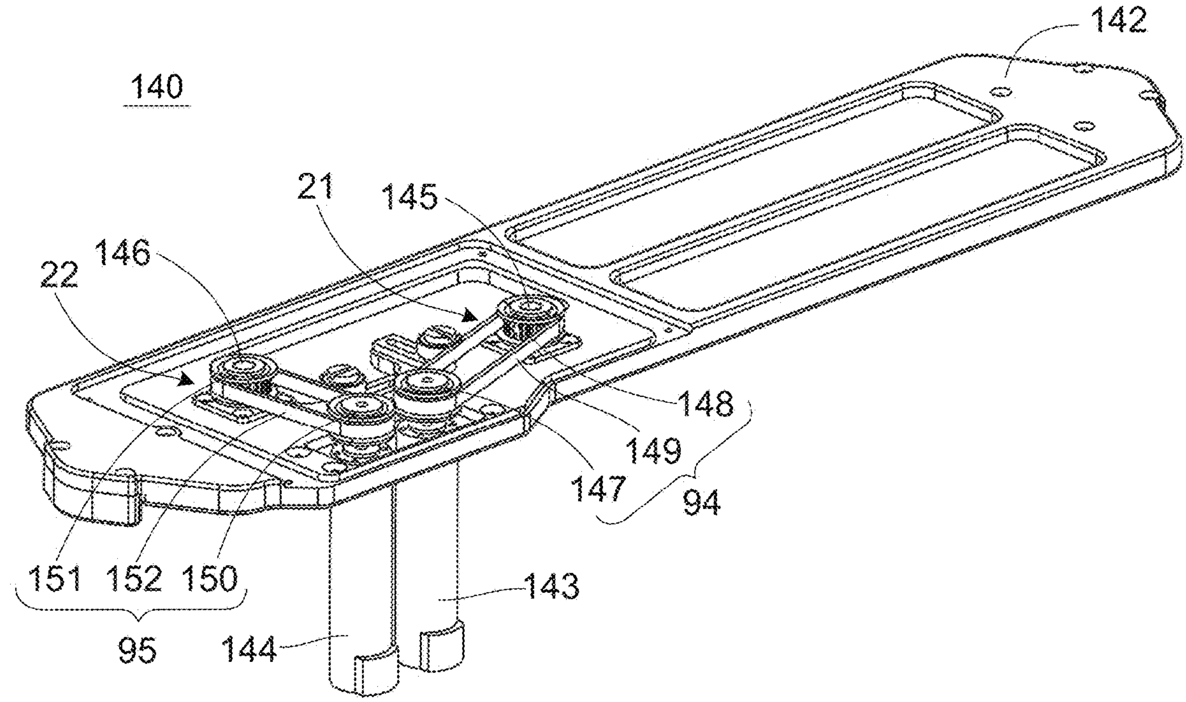


FIG. 42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142
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22
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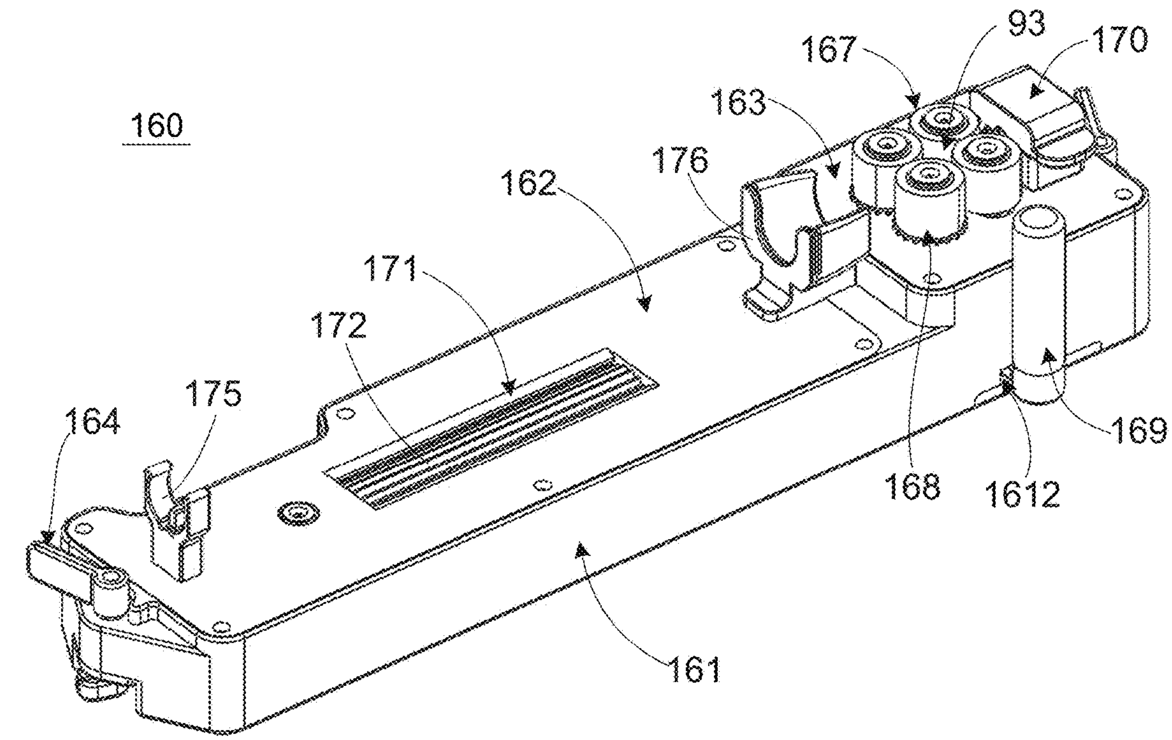
95
144

FIG. 43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175
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169
168
1612
161

FIG. 44

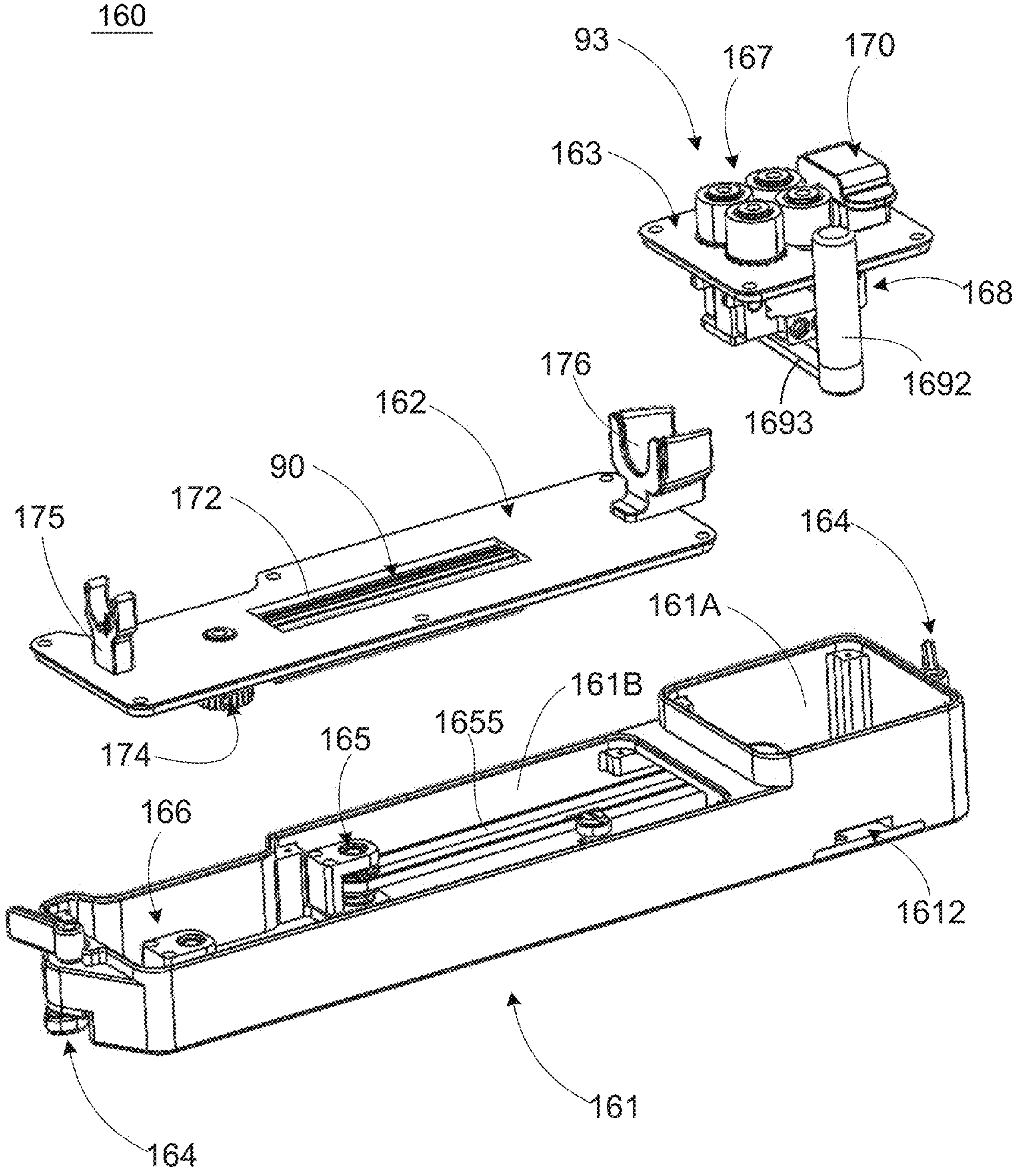
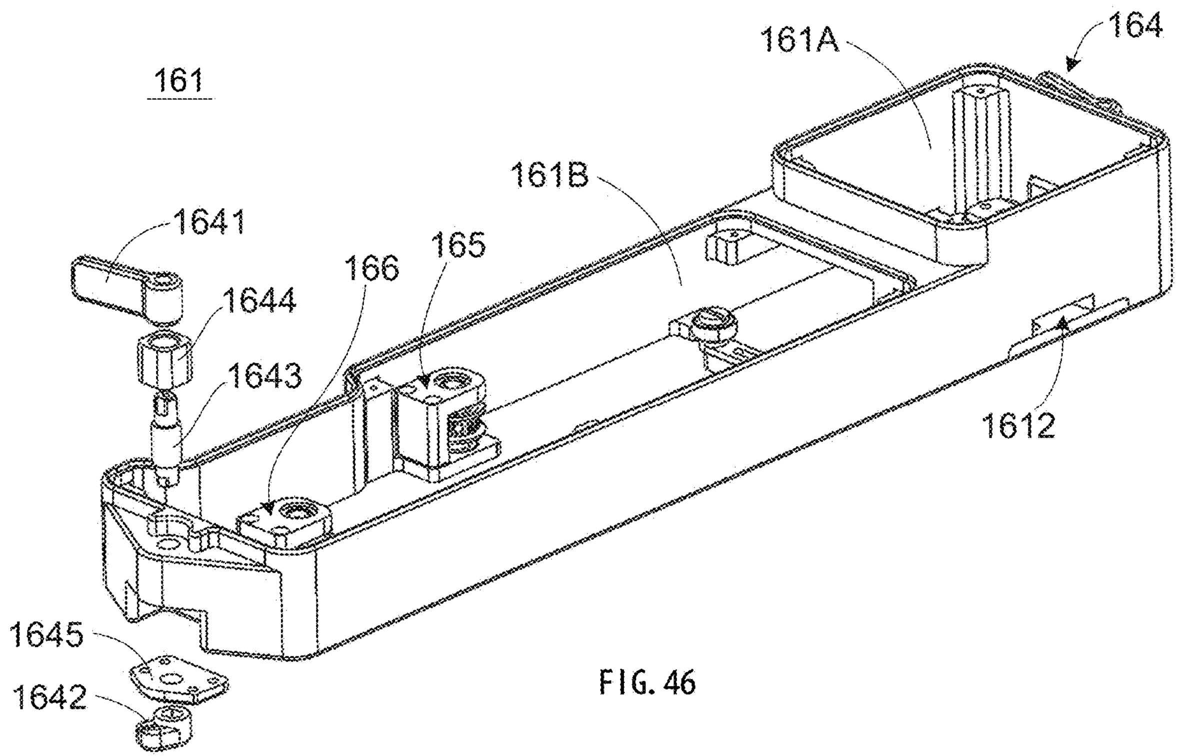

160
93
167
170
163
168
1692
1693
176
162
90
172
175
164
161A
161B
1655
165
174
166
1612
161
164

FIG. 45


161
161A
164
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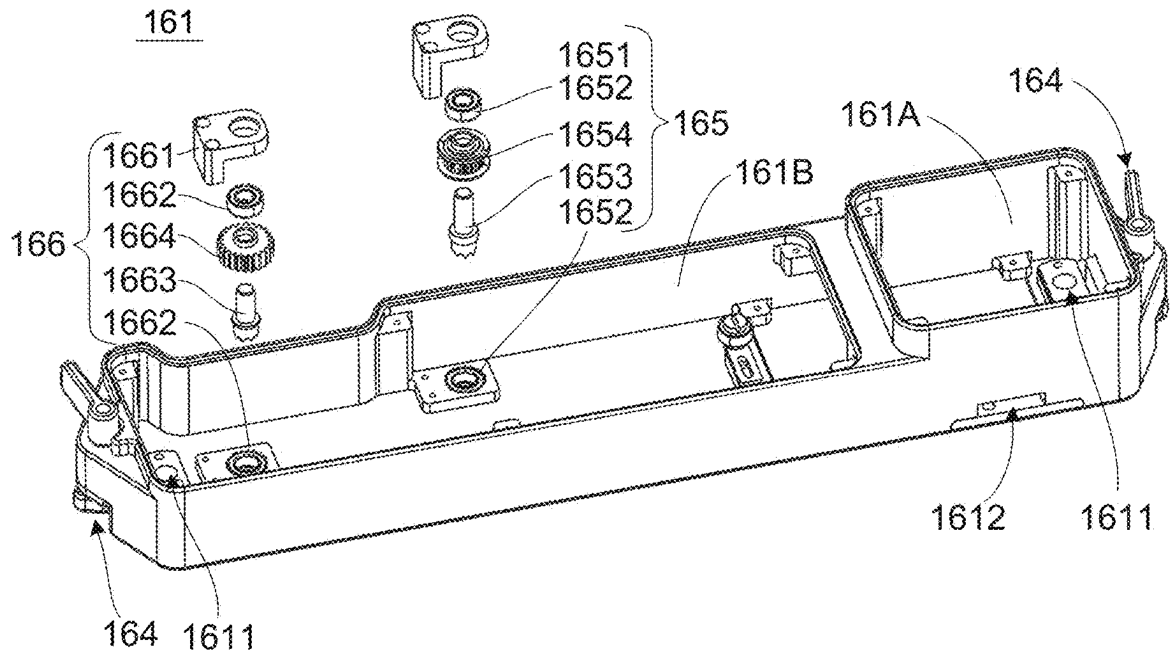
1641
165
166
1644
1643
1612
1645
1642

FIG. 46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1651
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166
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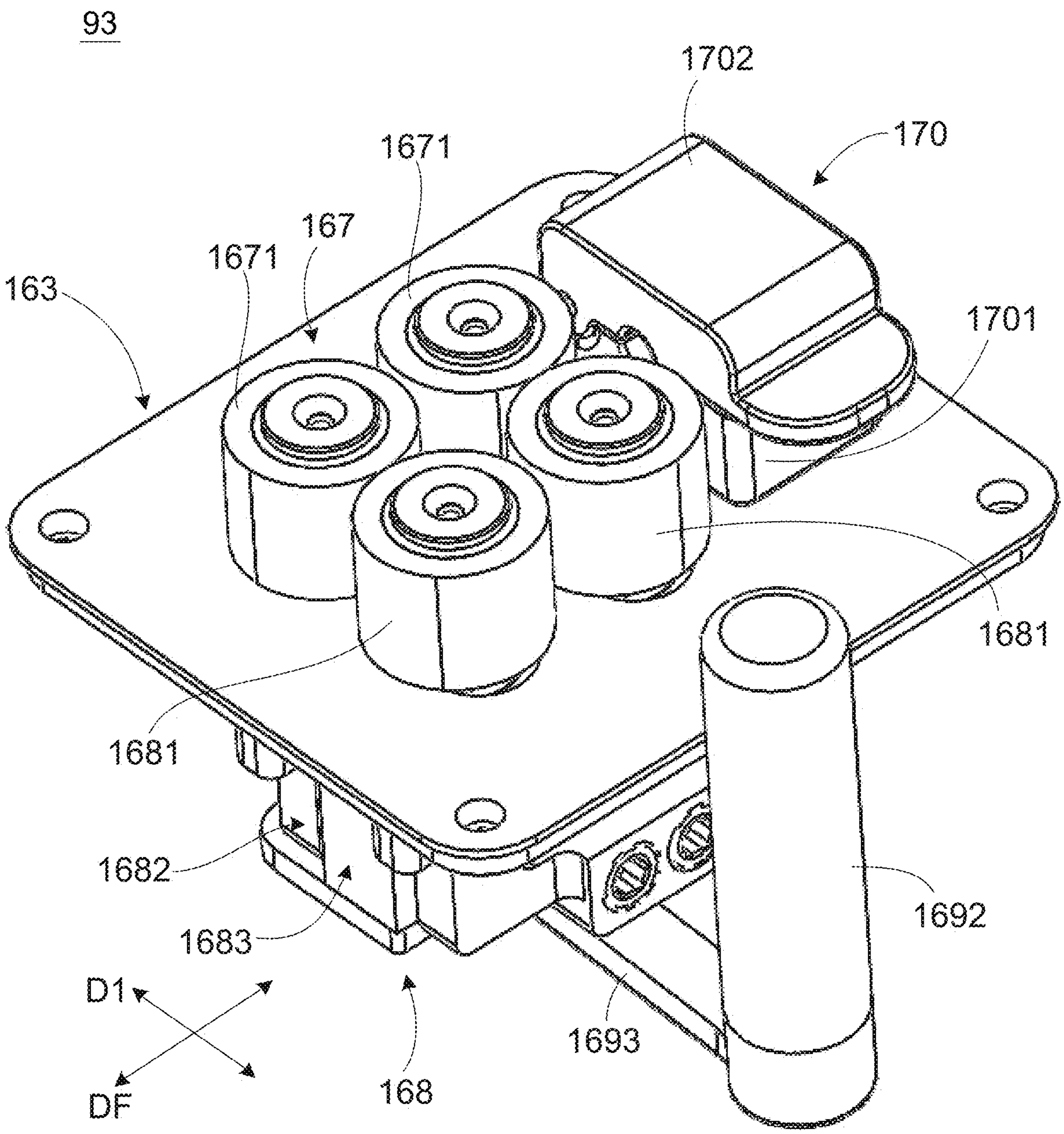
1662
1612
1611
164
1611

FIG. 47


93
1702
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1671
167
1671
163
1701
1681
1681
1682
1683
1692
D1
DF
1693
168

FIG. 48

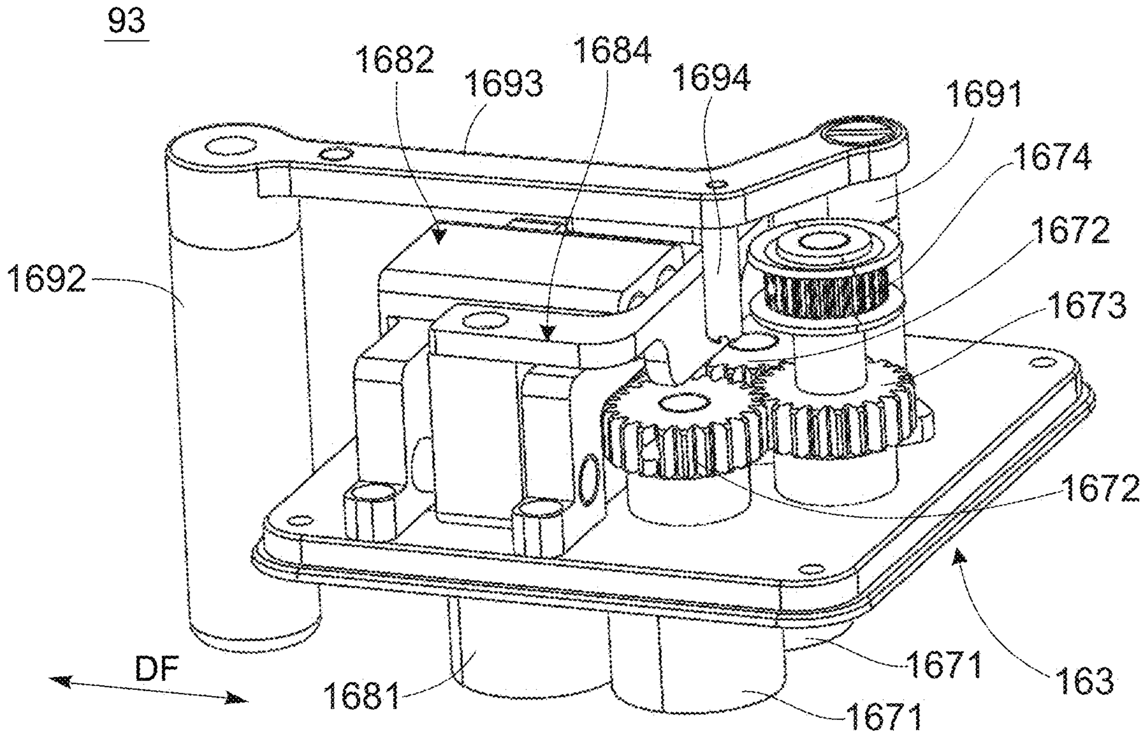
93
1682
1693
1684
1694
1691
1674
1672
1673
1692
1672
1671
163
DF
1681
1671

FIG. 49

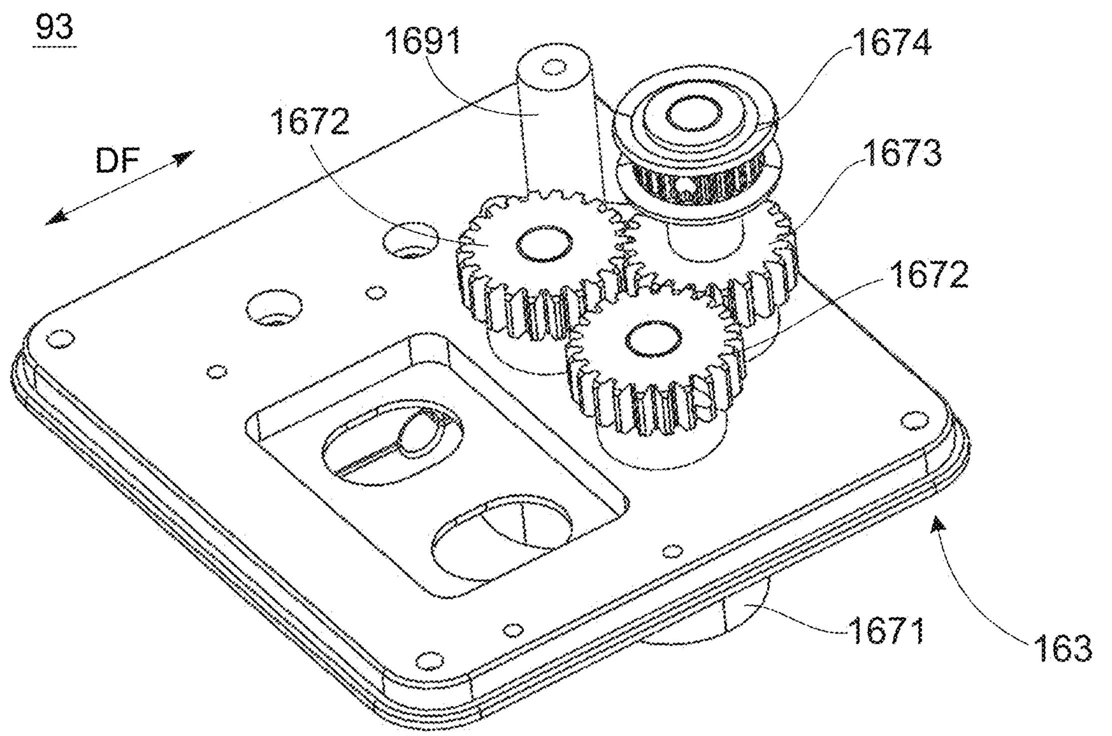
93
1691
1674
1672
1673
DF
1672
1671
163

FIG. 50

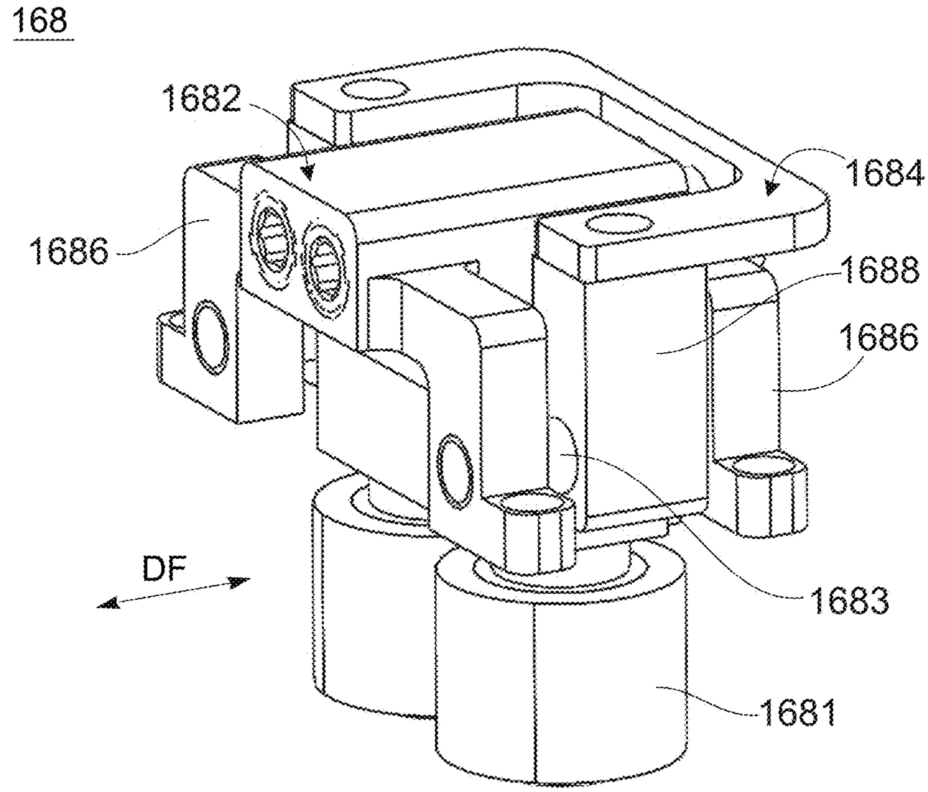
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FIG. 51

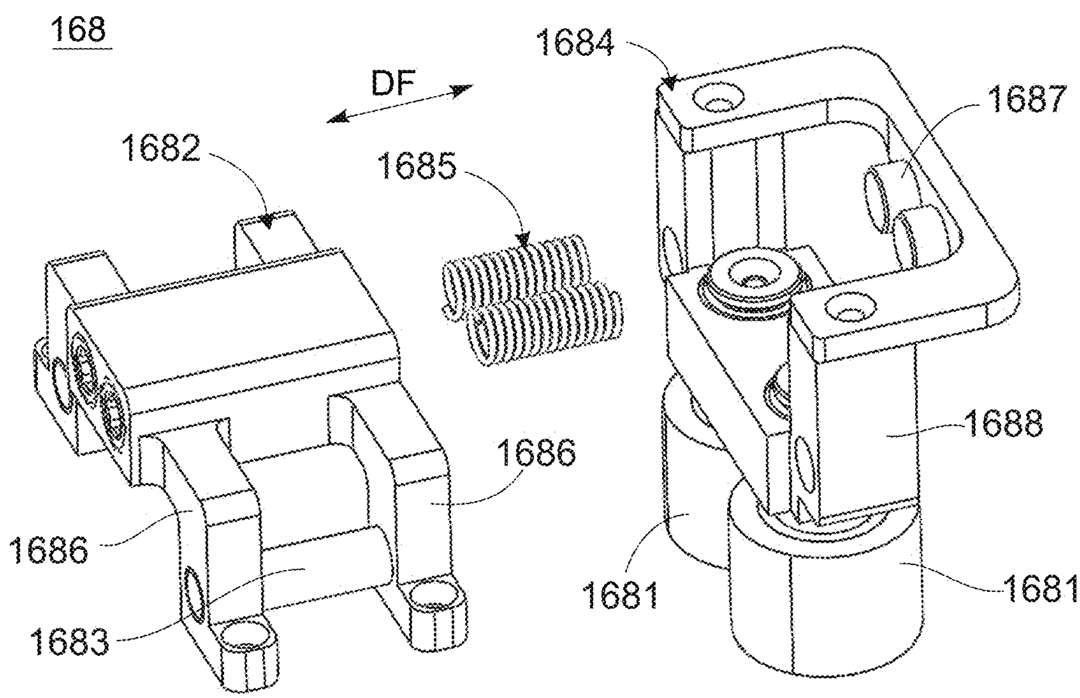
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FIG. 52

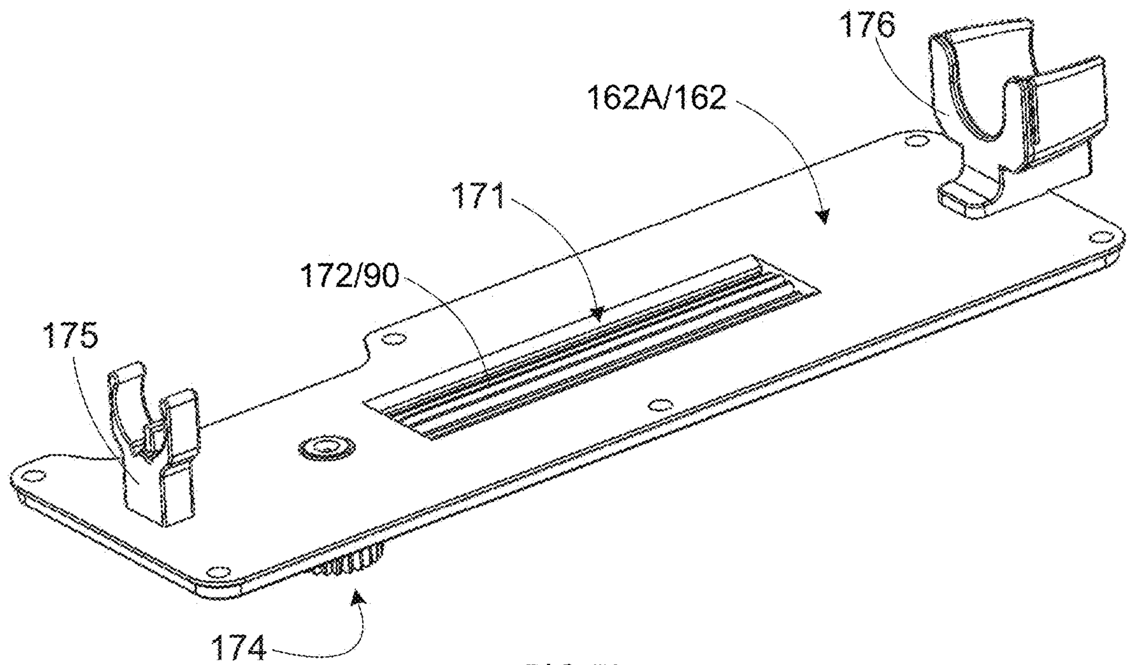
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FIG. 53

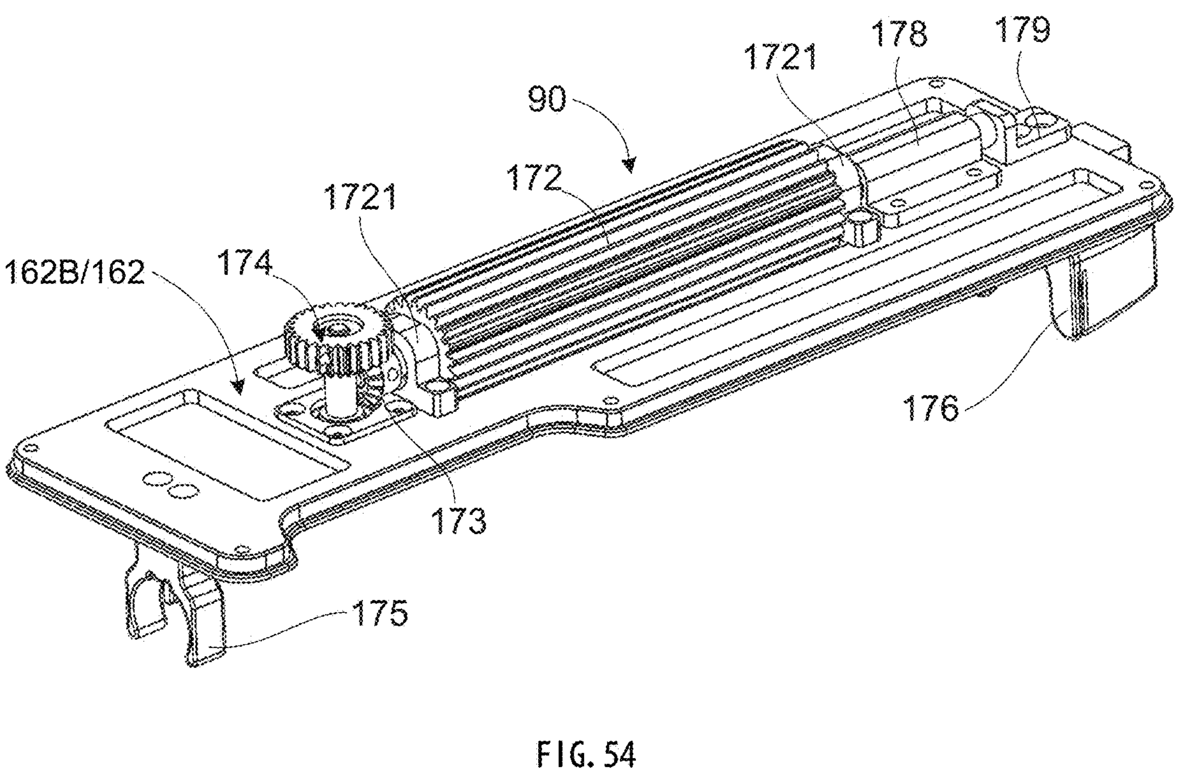
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FIG. 54

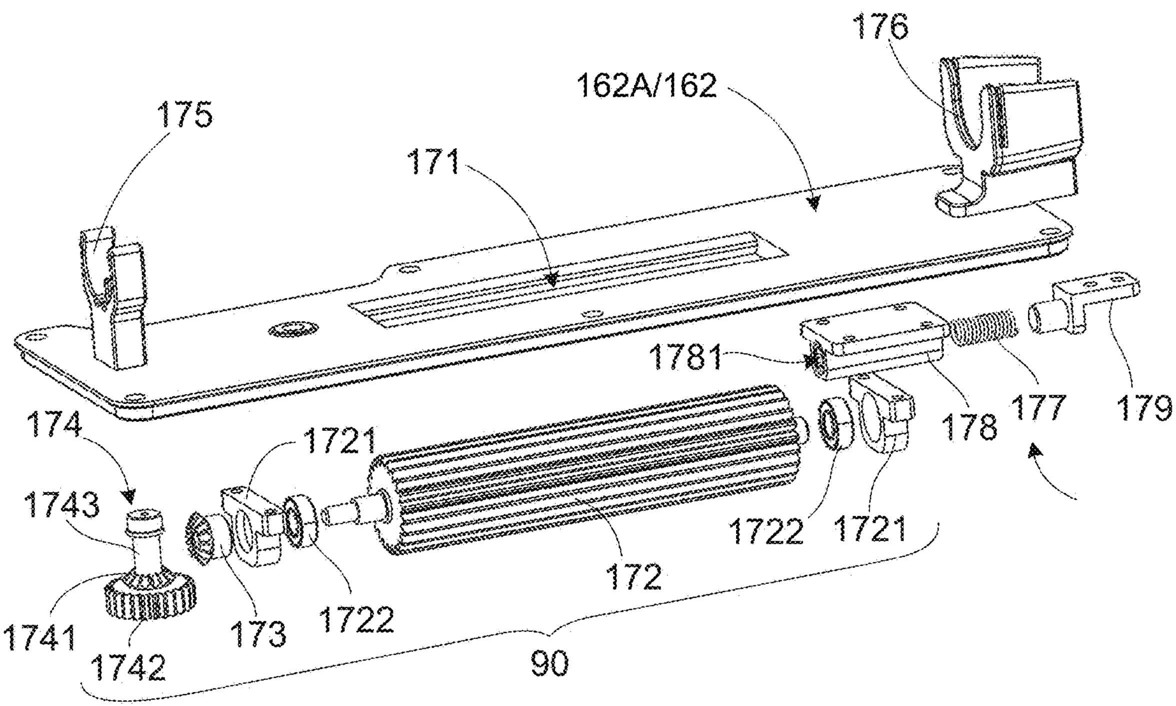
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FIG. 55

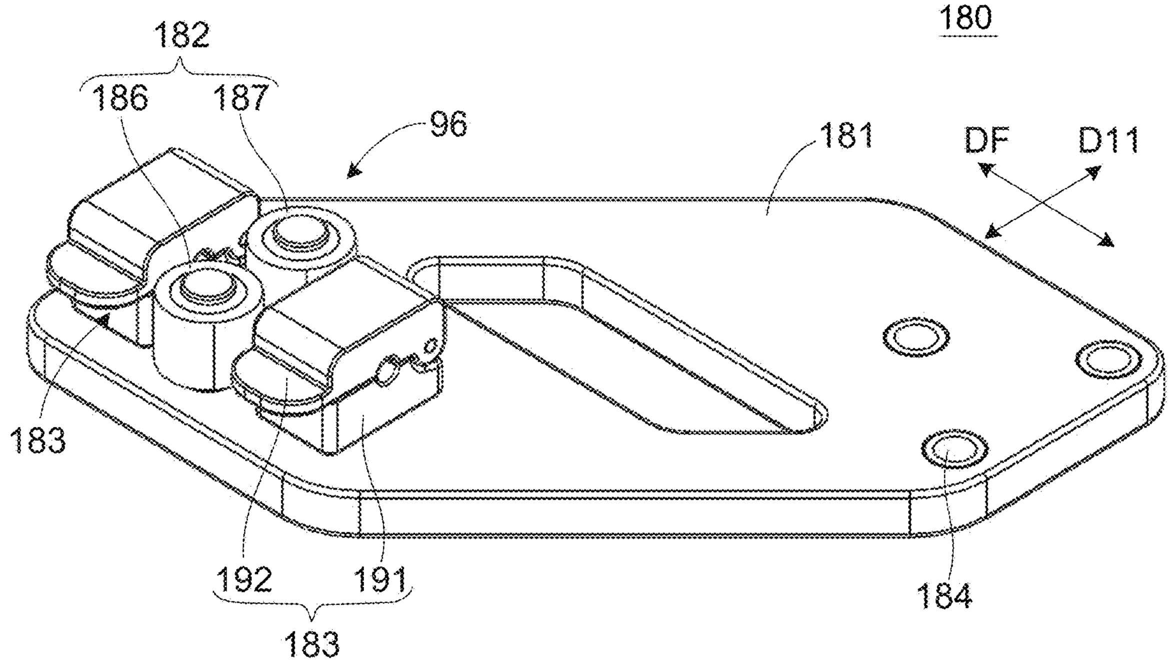
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FIG. 56

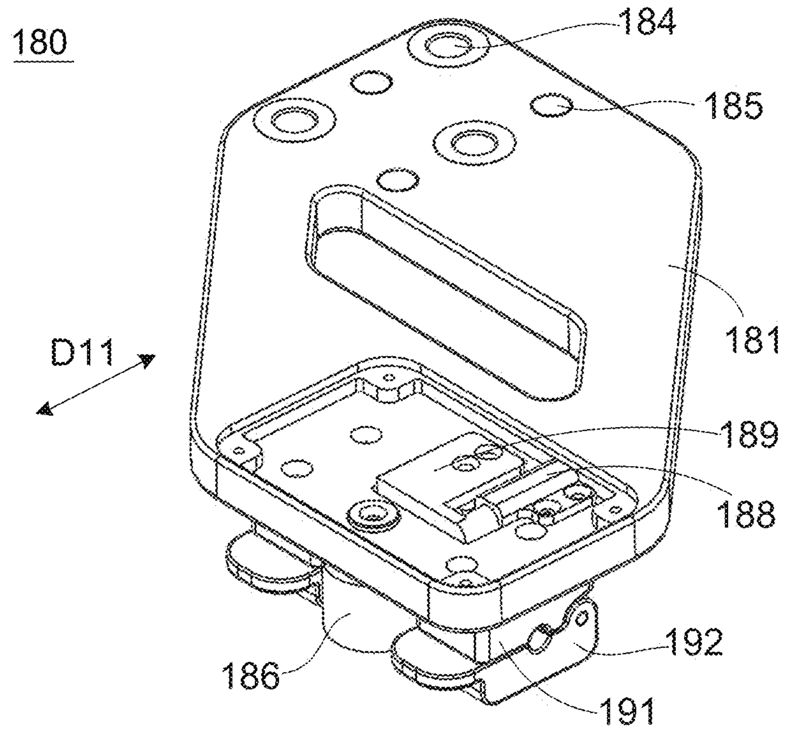
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FIG. 57

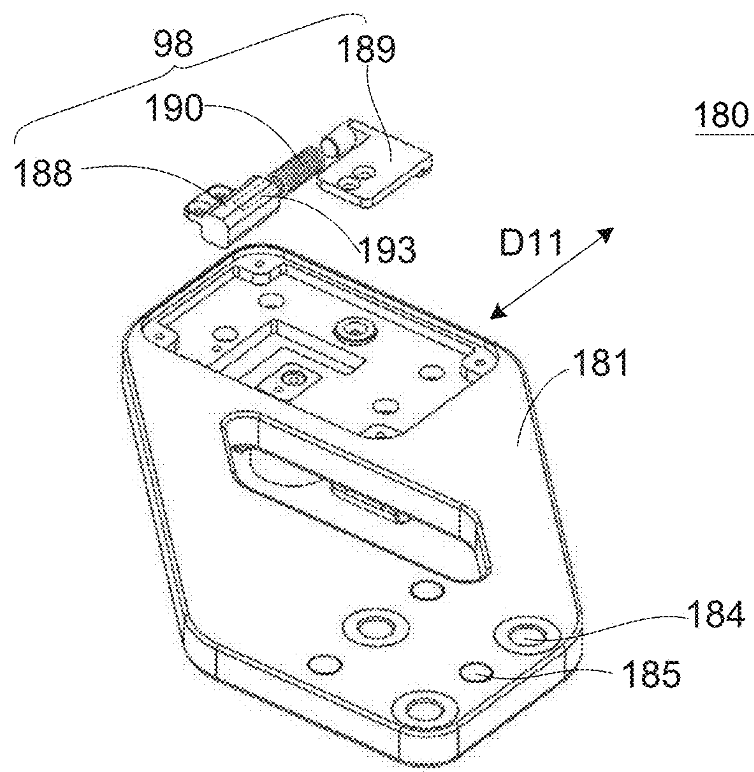
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FIG. 58

SLAVE-SIDE EXECUTION APPARATUS AND MEDICAL SYSTEM

CROSS REFERENCE

[0001] The present application is a bypass continuation-in-part application claiming priority from International Application No. PCT/CN/2023/126853, filed on Oct. 26, 2023, pending, entitled “Slave-side Execution Apparatus and Medical System”, and a Chinese Patent Application No. CN202411379141.9 filed on Sep. 30, 2024, pending, entitled “Conveying Device, Conveying Apparatus and Surgical Robotic System”, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] The present application generally relates to the technical field of surgical robots, and more particularly to a slave-side execution apparatus for conveying a guidewire and/or a catheter and a medical system having the same.

[0003] With the continuous development of science and technology, various types of minimally invasive cardiovascular implant intervention surgeries have emerged.

[0004] During the surgery, DSA (Digital Subtraction Angiography) will emit X-rays, and the lead protective clothing worn by doctors cannot completely protect the doctors. Doctors are prone to cancer and other diseases if they are exposed to radiation for a long time. Another situation is that the lead protective clothing is relatively heavy, and the doctors wearing it for a long time will also cause a certain load on the body, affecting the surgical operation. In addition, some implant intervention surgeries (such as aortic valve replacement) are complex in operation, and require the cooperation of several doctors, and sometimes require doctors to operate by experience and feeling, which makes the surgery difficult and risky.

SUMMARY

[0005] A series of simplified concepts are introduced into the portion of Summary, which would be further illustrated in the portion of the Detailed Description. The Summary of the present application does not mean attempting to define the key features and essential technical features of the technical solution claimed to be protected, let alone determining the protection scope of the technical solution claimed to be protected.

[0006] In order to at least partially solve the above problems, a first aspect of the present application provides a slave-side execution apparatus for conveying a guidewire and/or a catheter, the slave-side execution apparatus comprising:

[0007] a main body power device used to be installed beside a surgical bed and being immovable relative to the surgical bed, the main body power device comprising a main body driving device for providing a driving force;

[0008] a movable power device connected to the main power device and used to move forward and backward relative to the main power device along a conveying direction of the guidewire and/or the catheter under the driving of the main body driving device, the movable power device comprising a first driving device for providing driving force;

[0009] a first carrying device detachably connected to the movable power device and being movable synchronously with the movable power device along the conveying direction relative to the main body power device, the first carrying device being used to carry a medical apparatus comprising the catheter; and

[0010] a first manipulation device disposed on the first carrying device and used to control the guidewire to move forward and backward relative to the first carrying device along the conveying direction under the driving of the first driving device.

[0011] According to the present application, the slave-side execution apparatus of the slave-side may be controlled to operate by the doctors in the main control room, thereby preventing the doctors form being exposed to radiation of the ray. The components of the slave-side execution apparatus for contacting the guidewire and/or the catheter are passive components (without the need to connect to a power source), may be configured as consumables, are easy to install, and infection may be avoided.

[0012] Optionally, the movable power device comprises a second driving device for providing a driving force; and

[0013] the first carrying device comprises a second manipulation device used to contact the medical apparatus, and the second manipulation device being connected to the second driving device to manipulate the medical apparatus to perform a medical function under the driving of the second driving device.

[0014] According to the present application, the components of the slave-side execution apparatus for contacting the guidewire and/or the catheter are passive components (without the need to connect to a power source), may be configured as consumables, are easy to install, and infection may be avoided.

[0015] Optionally, the slave-side execution apparatus further comprises:

[0016] a movable assembly disposed on the main body power device and configured to be movable forward and backward relative to the main body power device along the conveying direction under the driving of the main body driving device, wherein the movable power device is connected to the movable assembly;

[0017] a first transmission device connected between the first driving device and the first manipulation device for transferring the driving force of the first driving device to the first manipulation device;

[0018] a second transmission device connected between the second driving device and the second manipulation device for transferring the driving force of the second driving device to the second manipulation device.

[0019] According to the present application, the passive components of the slave-side execution apparatus are in transmission connection to the driving device via a transmission structure.

[0020] Optionally, the first manipulation device comprises at least one pair of rollers which are arranged oppositely, the axes of the rollers are parallel to each other and the rollers are configured to be rotatable about their own axes, and the pair of the rollers are used to jointly clamp the guidewire;

[0021] the first transmission device is connected between the first driving device and at least one of the pair of the rollers to rotate the at least one of the pair of the rollers.

[0022] According to the present application, the guidewire is clamped by a pair of rollers and is conveyed by the rolling of the rollers.

[0023] Optionally, the first transmission device comprises:

[0024] a first power shaft disposed on the movable power device and configured to be rotatable about its own axis relative to the movable power device;

[0025] a first transmission assembly disposed on the movable power device and connected between the first driving device and the first power shaft such that the first power shaft is rotatable under the driving of the first driving device; and

[0026] a first power transfer device disposed on the first carrying device and connected between the first manipulation device and the first power shaft such that the first manipulation device is driven to operate by the first power shaft drives.

[0027] According to the present application, the first transmission device comprises the first power shaft, which is simple to control.

[0028] Optionally, the first manipulation device comprises:

[0029] a first manipulation device base connected to the first carrying device;

[0030] at least one first roller disposed on the first manipulation device base, an axis of the first roller being not parallel to the conveying direction, the first roller being configured to be rotatable about its axis relative to the first manipulation device base; and

[0031] at least one second roller disposed on the first manipulation device base and arranged opposite to the first roller so as to clamp the guidewire along with the first roller, the second roller being configured to be rotatable about its axis relative to the first manipulation device base;

[0032] wherein the first roller and the second roller are both used to be connected to the first transmission device so as to rotate under the driving of the first transmission device, and the slave-side execution apparatus is configured such that an rotation direction of the first roller is opposite to an rotation direction of the second roller.

[0033] According to the present application, the first roller and the second roller are both configured as driving rollers, so that the slave-side execution apparatus has sufficient driving force to convey the guidewire. Moreover, the first roller and the second roller are driven by the same driving device, which may ensure that they are rotated synchronously.

[0034] Optionally, the first manipulation device further comprises:

[0035] a second fixed seat disposed on the first manipulation device base, wherein the second roller is disposed on the second fixed seat; and

[0036] a first movable seat disposed on the first manipulation device base and being movable between a first position and a second position relative to the second fixed seat along a first direction, wherein the first roller is disposed on the first movable seat;

[0037] wherein the first direction is perpendicular to a plane determined by the conveying direction and the axis of the first roller, and a distance between the first movable seat and the second fixed seat when the first movable seat is in the first position is less than a distance between the first movable seat and the second fixed seat when the first movable seat is in the second position.

[0038] According to the present application, the distance between the first roller and the second roller is adjustable. When the distance between them is far, it is convenient to take and place the guidewire, and when the distance between them is close, the guidewire may be clamped.

[0039] Optionally, the first manipulation device further comprises:

[0040] a first biasing assembly connected between the second fixed seat and the first movable seat for providing a force to move the first movable seat away from the second fixed seat along the first direction; and

[0041] a first pressing device disposed on the first manipulation device base and connected to the first movable seat for operation by a user to bring the first movable seat close to the second fixed seat along the first direction.

[0042] According to the present application, the distance between the first roller and the second roller is adjusted by the first biasing assembly and the first pressing device.

[0043] Optionally, the first pressing device comprises:

[0044] a cam connected to the first manipulation device base and being rotatable relative to the first manipulation device base about a rotation axis extending along a second direction, wherein the second direction is perpendicular to the first direction and parallel to a plane determined by the conveying direction and the axis of the first roller, and a circumferential surface of the cam is connected to a side of the first movable seat facing away from the second fixed seat;

[0045] a wrench connected to the cam for operation by the user to rotate the cam relative to the first manipulation device base.

[0046] According to the present application, the first pressing device is simple in structure and stable in performance.

[0047] Optionally, the first power transfer device comprises a first transmission shaft used to be connected to the first driving device so as to rotate under the driving of the first driving device;

[0048] the first manipulation device further comprises:

[0049] a first roller transmission device used to connect the first transmission shaft and the first roller so that the rotation direction of the first roller is the same as a rotation direction of the first transmission shaft, and

[0050] a second roller transmission device used to connect the first transmission shaft and the second roller so that the rotation direction of the second roller is opposite to the rotation direction of the first transmission shaft.

[0051] According to the present application, the first roller and the second roller are respectively driven by different transmission devices, so that even if one of the transmission devices fails, the roller of the fault party can also be passively rotated under the action of frictional force, without affecting the convey of the guidewire and thereby greatly ensuring the stable performance of the apparatus.

[0052] Optionally, the first roller transmission device comprises at least one first manipulation synchronous belt, the first transmission shaft and the first roller are both connected with a structure for connecting the first manipulation synchronous belt, and the slave-side execution apparatus is configured such that the first transmission shaft drives all the first rollers to rotate via the first manipulation synchronous belt.

[0053] According to the present application, the first roller transmission device has a simple structure, low cost and stable performance.

[0054] Optionally, the first manipulation device comprises N first rollers and N first manipulation synchronous belts, where N is an integer greater than or equal to 1, wherein,

[0055] each of the first rollers is connected to the first transmission shaft via one first manipulation synchronous belt; or

[0056] each of one part of the N first rollers is connected to the first transmission shaft via one first manipulation synchronous belt, and each of the other part of the N first rollers is connected to another first roller via one first manipulation synchronous belt.

[0057] According to the present application, the first roller transmission device is flexibly arranged.

[0058] Optionally, the first manipulation device comprises N first rollers and N first manipulation synchronous belts, where N is an integer greater than or equal to 1, wherein,

[0059] the first one of the N first rollers is connected to the first transmission shaft via one first manipulation synchronous belt, and each of the other first rollers is connected to the previous first roller via one first manipulation synchronous belt.

[0060] According to the present application, the first transmission shaft and all the first rollers are driven one by one in sequence, and thus the specification of each first roller may be unified to reduce costs.

[0061] Optionally, the first manipulation device further comprises:

[0062] a first additional roller disposed on the first movable seat, the first additional roller being configured to be rotatable about its axis relative to the first movable seat;

[0063] a second additional roller disposed on the second fixed seat and arranged opposite to the first additional roller so as to clamp the guidewire along with the first additional roller, the second additional roller being configured to be rotatable about its axis relative to the second fixed seat;

[0064] a first additional roller transmission device used to connect the first additional roller and the Nth one of the first rollers so that the first additional roller is rotated in the same direction as a rotation direction of the first transmission shaft under the driving of the Nth one of the first rollers; and

[0065] an encoder connected to the second additional roller and used to detect a rotation angle of the second additional roller.

[0066] According to the present application, when the first transmission shaft and all the first rollers are driven one by one in sequence, the rotation angle detected by the encoder may be used to detect whether the first manipulation synchronous belt is slipping or damaged.

[0067] Optionally, the second additional roller has a second additional roller axle;

[0068] the movable power device also comprises a third rotating shaft disposed on the movable power device, the third rotating shaft being used to be connected to the second additional roller axle and rotate synchronously with the second additional roller axle, wherein the encoder is disposed on the third rotating shaft.

[0069] According to the present application, the encoder is connected to the passive component via the third rotating shaft, so that the passive component may serve as a consumable.

[0070] According to the present application, the first additional roller transmission device has a simple structure, low cost and stable performance. The axis of the first additional roller is parallel to the axis of the first roller, and thus the design may be simplified.

[0071] Optionally, the second roller transmission device comprises:

[0072] a fourth transmission shaft disposed on the first manipulation device base;

[0073] a first transmission device for the second roller used to connect the first transmission shaft and the fourth transmission shaft so that the fourth transmission shaft is rotated under the driving of the first transmission shaft; and

[0074] a second transmission device for the second roller used to connect the fourth transmission shaft and the second roller so that the second roller is rotated under the driving of the fourth transmission shaft.

[0075] According to the present application, by designing the fourth transmission shaft so that the first transmission shaft drives the fourth transmission shaft to rotate, and the fourth transmission shaft then drives the second roller to rotate, it is convenient to make the rotation direction of the second roller different from the rotation direction of the first transmission shaft.

[0076] Optionally, one of the first transmission device for the second roller and the second transmission device for the second roller is configured to be driven by a synchronous belt, and the other of the first transmission device for the second roller and the second transmission device for the second roller is configured to be driven by a gear.

[0077] According to the present application, the synchronous belt transmission allows the rotation direction of the driven member the same as the rotation direction of the driving member, and the gear transmission allows the rotation direction of the driven member different from the rotation direction of the driving member, thereby allowing the rotation directions of the second roller and the first transmission shaft different.

[0078] Optionally, a component of the first roller transmission device for connecting the first transmission shaft and a component of the second roller transmission device for connecting the first transmission shaft are both synchronous belts.

[0079] According to the present application, the first transmission shaft is connected to the first roller transmission device and the second roller transmission device through the synchronous belt, which helps to simplify the design of the first transmission shaft.

[0080] Optionally, the first manipulation device comprises:

[0081] a driving roller member disposed on the first carrying device, the driving roller member comprising a driving roller and a driving gear coaxially connected, wherein the driving gear is in transmission connection with the first power transfer device so as to rotate about its own axis relative to the first carrying device under the action of the first power transfer device; and

[0082] a driven roller member disposed on the first carrying device, the driven roller member comprising a driven roller arranged opposite to the driving roller, the driven roller being configured to be rotatable about its own axis relative to the first carrying device and movable relative to the driving roller along a first direction, so as to be able to clamp or release the guidewire with the driving roller, wherein the first direction is perpendicular to a plane determined by the conveying direction and an axis of the driven roller.

[0083] According to the present application, among the pair of rollers clamping the guidewire, one is the driving roller that is rotated under the driving of the driving device, and the other is the driven roller that is rotated under the action of frictional force.

[0084] Optionally, the driven roller member further comprises:

[0085] a fixed frame disposed on the first carrying device, the fixed frame having a third guide rail extending along the first direction;

[0086] an extrusion frame disposed on the third guide rail and being movable along the third guide rail, the driven roller being disposed on the extrusion frame; and

[0087] a first elastic member connected between the fixed frame and the extrusion frame, the first elastic member extending along the first direction for providing a force that brings the extrusion frame close to the driving roller along the first direction.

[0088] According to the present application, the driven roller member is moved towards the driving roller member under the action of the first elastic member so that the guidewire is clamped by the driving roller along with the driven roller.

[0089] Optionally, the first manipulation device further comprises a manipulation rod assembly comprising:

[0090] a manipulation portion used for being operated by a user and exposed from the first carrying device;

[0091] a pivoting portion connected to the first carrying device and configured to be rotatable about its own axis relative to the first carrying device;

[0092] an extension portion connected between the pivoting portion and the manipulation portion so that the manipulation portion is capable of rotating synchronously with the pivoting portion about an axis of the pivoting portion;

[0093] a pushing portion provided to the extension portion for contacting the extrusion frame to enable the pushing portion to push the extrusion frame away from the driving roller along the first direction when the pivoting portion is rotated.

[0094] According to the present application, the manipulation rod assembly is used to move the driven roller member away from the driving roller member so that the guidewire may be taken and placed.

[0095] Optionally, a position of the first power transfer device corresponds to a position of the first power shaft, and the first power transfer device is engaged with the first power shaft, the first power transfer device comprises a transfer synchronous roller, and a synchronous belt transmission is formed between the first power transfer device and the first manipulation device.

[0096] According to the present application, the connection between the first power transfer device and the first power shaft is stable.

[0097] Optionally, the second transmission device comprises:

[0098] a second power shaft disposed on the movable power device and configured to be rotatable about its own axis relative to the movable power device;

[0099] a second transmission assembly disposed on the movable power device and connected between the second driving device and the second power shaft so that the second power shaft is rotated under the driving of the second driving device; and

[0100] a second power transfer device disposed on the first carrying device and connected between the second manipulation device and the second power shaft so that the second power shaft drives the second manipulation device to operate.

[0101] According to the present application, the second transmission device comprises the second power shaft, and the control of the second transmission device is simple.

[0102] Optionally, the first power shaft is arranged to penetrate through the movable power device, and an end of the first power shaft facing the first carrying device is in transmission connection with the first manipulation device;

[0103] the first transmission assembly is connected between the first driving device and an end of the first power shaft facing away from the first carrying device;

[0104] the second power shaft is arranged to penetrate through the movable power device, and an end of the second power shaft facing the first carrying device is in transmission connection with the second manipulation device;

[0105] the second transmission assembly is connected between the second driving device and an end of the second power shaft facing away from the first carrying device.

[0106] According to the present application, the first power shaft is stably connected to the first transmission assembly, and the second power shaft is stably connected to the second transmission assembly.

[0107] Optionally, the first carrying device comprises a functional manipulation seat for mounting the medical apparatus, the functional manipulation seat comprising a first side of the functional manipulation seat and a second side of the functional manipulation seat which are arranged opposite to each other, wherein the medical apparatus is detachably connected to the first side of the functional manipulation seat, and the functional manipulation seat is provided with an operation opening;

[0108] the second manipulation device comprises:

[0109] a functional gear rotatably disposed at the second side of the functional manipulation seat and at least partially exposed from the operation opening to the first side of the functional manipulation seat, so as to be able to form an engagement with the medical apparatus, and

[0110] a bevel gear coaxially connected with the functional gear and used to be connected to the second power transfer device.

[0111] According to the present application, the second manipulation device has a compact structure.

[0112] Optionally, the first carrying device further comprises:

[0113] a first bracket disposed on the first side of the functional manipulation seat;

[0114] a second bracket disposed on the first side of the functional manipulation seat and spaced apart from the first bracket along the conveying direction so as to support the medical apparatus along with the first bracket, the second bracket being configured to be movable relative to the functional manipulation seat along the conveying direction;

[0115] a second elastic member connected to the second bracket for applying a force to the second bracket to move the second bracket away from the first bracket along the conveying direction.

[0116] According to the present application, the supporting structure of the slave-side execution apparatus for carrying the medical apparatus is compact.

[0117] Optionally, a position of the second power transfer device corresponds to a position of the second power shaft, and the second power transfer device is engaged with the second power shaft, the second power transfer device comprises a transfer gear, and a gear engaging transmission is formed between the second power transfer device and the second manipulation device.

[0118] According to the present application, the second power transfer device is stably connected to the second power shaft.

[0119] Optionally, the main body power device further comprises:

[0120] a machine frame on which the main body driving device and the movable assembly are both provided; and

[0121] a first guide rail disposed on the machine frame and extending along the conveying direction;

[0122] wherein the movable assembly is connected to the first guide rail and is configured to move along the first guide rail under the driving of the main body driving device.

[0123] According to the present application, the first guide rail may cause the movable assembly to stably move along the conveying direction.

[0124] Optionally, the movable assembly comprises:

[0125] a movable frame configured to be moved along the first guide rail under the driving of the main body driving device, the movable frame having a second guide rail extending along the conveying direction;

[0126] a movable seat disposed on the second guide rail and being movable along the second guide rail, the movable power device being connected to the movable seat; and

[0127] a force sensor disposed between the movable seat and the movable frame to sense a force experienced by the movable seat when the catheter is conveyed.

[0128] According to the present application, the forces such as resistance and tension experienced by the catheter may be measured by the force sensor, allowing the user to better control the convey of the catheter.

[0129] Optionally, the slave-side execution apparatus further comprises a guide assembly disposed in front of the first manipulation device along the conveying direction;

[0130] the guide assembly comprises at least one pair of rollers arranged opposite to each other, the axes of the rollers are parallel to each other and the rollers are configured to be rotatable about their own axes, and one pair of rollers is used to jointly clamp the guidewire and/or the catheter.

[0131] According to the present application, the guide assembly has a guiding effect on the convey of the guidewire and/or the catheter.

[0132] Optionally, wherein the slave-side execution apparatus also comprises a second carrying device disposed on the main body power device and located in front of the first carrying device along the conveying direction, and the second carrying device has a guide assembly for guiding the guidewire and/or the catheter.

[0133] According to the present application, the guide assembly is arranged in front of the first manipulation device to guide the convey of the guidewire and/or the catheter.

[0134] Optionally, the second carrying device further comprises a supporting seat connected to the movable power device;

[0135] the guide assembly comprises:

[0136] a catheter guiding device disposed on the supporting seat so as to be able to clamp or release the guidewire and/or the catheter, and

[0137] a catheter supporting device disposed on the supporting seat and configured to allow the guidewire and/or the catheter to pass through to support the guidewire and/or the catheter.

[0138] According to the present application, the guide assembly has the dual functions of guiding and supporting.

[0139] Optionally, the catheter guiding device comprises:

[0140] a first guide roller disposed on the supporting seat and configured to be rotatable about its own axis relative to the supporting seat; and

[0141] a second guide roller disposed on the supporting seat and arranged opposite to the first guide roller, the second guide roller being configured to be rotatable about its own axis relative to the supporting seat and configured to be movable relative to the first guide roller along a first additional direction so as to be able to release or clamp the guidewire and/or the catheter with the first guide roller, wherein the first additional direction is perpendicular to a plane determined by the conveying direction and an axis of the second guide roller.

[0142] According to the present application, the guidance is performed by the catheter guiding device via a pair of rollers that clamp the guidewire and/or the catheter.

[0143] Optionally, the second carrying device further comprises:

[0144] a fixed block disposed on the supporting seat and having a guide groove extending along the first additional direction;

[0145] a pushing block at least partially extending into the guide groove, the second guide roller being provided on the pushing block;

[0146] a third elastic member disposed in the guide groove and connected between the fixed block and the pushing block, the third elastic member extending along the first additional direction to apply a force to the pushing block that causes the pushing block to move close to the first guide roller along the first additional direction.

[0147] According to the present application, the third elastic member enables the two guide rollers to clamp the guidewire and/or the catheter.

[0148] Optionally, the slave-side execution apparatus further comprises:

[0149] a second power assembly used to be installed beside a surgical bed and being immovable relative to the surgical bed, the second power assembly comprising a fourth driving device for providing a driving force; and

[0150] a second conveying assembly detachably connected to the second power assembly for conveying the guidewire and/or the catheter under the driving of the fourth driving device;

[0151] wherein the second power assembly is used to be installed in front of the main body power device along the conveying direction of the guidewire and/or the catheter.

[0152] According to the present application, the second conveying assembly is used to support and assist in the convey of the guidewire and/or the catheter at the front end.

[0153] Optionally, the second conveying assembly comprises:

[0154] a second conveying assembly base detachably connected to the second power assembly;

[0155] at least one third roller disposed on the second conveying assembly base, an axis of the third roller being not parallel to the conveying direction; and

[0156] at least one fourth roller disposed on the second conveying assembly base and arranged opposite to the third roller, so as to clamp the guidewire and/or the catheter along with the third roller;

[0157] wherein the third roller is used for rotating about its own axis under the driving of the fourth driving device.

[0158] According to the present application, the third roller may be the driving roller, and the fourth roller may be the driven roller.

[0159] Optionally, the second conveying assembly comprises:

[0160] a third roller assembly disposed on the second conveying assembly base and comprising at least one the third roller;

[0161] a fourth roller assembly comprises:

[0162] a fifth movable seat disposed on the second conveying assembly base and being movable relative to the second conveying assembly base along a first additional direction, wherein the first additional direction is perpendicular to the axis of the third roller, and

[0163] at least one the fourth roller disposed on the fifth movable seat, the fourth roller being arranged opposite to the corresponding third roller along the first additional direction; and

[0164] a position adjustment assembly connected to the fifth movable seat for driving the fifth movable seat to move along the first additional direction under the driving of a third driving device, so as to change a distance the fourth roller and the third roller.

[0165] According to the present application, the third roller and the fourth roller are arranged opposite each other to jointly clamp and convey the guidewire and/or the catheter, and the distance between the third roller and the fourth roller is adjustable so that the guidewire and/or the catheter of different diameters may be accommodated. The distance between the third roller and the fourth roller is controlled by the driving device, which allows the distance between them to be kept constant, i.e., a sufficient clamping force may be provided by the driving device. At the same time, the third roller from the fourth roller may be separated by the driving device, which facilitates the installation of the guidewire and/or the catheter.

[0166] Optionally, the position adjustment assembly comprises:

[0167] an adjusting gear disposed on the second conveying assembly base and used for rotating relative to the second conveying assembly base under the driving of the third driving device; and

[0168] an adjusting rack engaged with the adjusting gear, the adjusting rack extending along the first additional direction and connected to the fifth movable seat.

[0169] According to the present application, the position adjustment assembly is simple in structure, easy to control, and stable in performance.

[0170] Optionally, the third roller assembly comprises a plurality of the third rollers,

[0171] the third roller assembly is configured such that a part of the third rollers are used for rotating about their own axes under the driving of the fourth driving device and the other third rollers are rotated about their own axes under the driving of another third roller.

[0172] According to the present application, the connection between the third roller assembly and the fourth driving device is simple.

[0173] Optionally, the second conveying assembly further comprises a roller transmission assembly, a first end of the roller transmission assembly is connected to the third roller and a second end of the roller transmission assembly is connected to the fourth roller so that the third roller drives the fourth roller to rotate in an opposite direction at the same rotational speed,

[0174] wherein the roller transmission assembly is configured such that the second end of the roller transmission assembly is movable relative to the first end of the roller transmission assembly along the first additional direction, so as to adapt to the movement of the fifth movable seat along the first additional direction.

[0175] According to the present application, the fourth roller may also be a driving roller, thereby increasing the conveying capacity of the second conveying assembly. The fourth roller is driven by the third roller, and the connection between the second conveying assembly and the driving device may be reduced, so that the second conveying assembly is more convenient to use.

[0176] Optionally, the roller transmission assembly comprises N transmission gears that are engaged sequentially, N being an even number greater than or equal to 4,

[0177] wherein the first one of the transmission gears is disposed at the first end of the roller transmission assembly and is rotated synchronously with the third roller, the last one of the transmission gears is disposed at the second end of the roller transmission assembly and is rotated synchronously with the fourth roller, and the last one of the transmission gears is movable relative to the first one of the transmission gears along the first additional direction.

[0178] According to the present application, the roller transmission assembly is simple in structure, easy to control, and stable in performance.

[0179] Optionally, the third roller is configured as the same roller as the fourth roller, and the roller transmission assembly has a transmission ratio of 1:1.

[0180] According to the present application, the component specifications are unified, which is conducive to cost saving.

[0181] Optionally, the roller transmission assembly further comprises:

[0182] a first connecting arm comprising a first end of the first connecting arm and a second end of the first connecting arm arranged oppositely, the first one of the transmission gears being disposed on the first end of the first connecting arm; and

[0183] a second connecting arm comprising a first end of the second connecting arm and a second end of the second connecting arm arranged oppositely, the last one of the transmission gears being disposed on the second end of the second connecting arm,

[0184] wherein the first end of the second connecting arm is rotatably connected to the second end of the first connecting arm about a third axis, the third axis is parallel to an axis of the third roller, and N transmission gears are disposed on the first connecting arm and the second connecting arm.

[0185] According to the present application, the way of realizing the extension and retraction of the roller transmission assembly in the first additional direction is simple, easy to implement and stable in performance.

[0186] Optionally, the third axis coincides with an axis of one transmission gear other than the first one of the transmission gears and the last one of the transmission gears.

[0187] According to the present application, the distance between the adjacent transmission gears is always kept constant, which is conducive to the good engagement of all transmission gears at all times.

[0188] Optionally, the fourth roller assembly comprises a plurality of the fourth rollers,

[0189] the fourth roller assembly is configured such that a part of the fourth rollers are used for rotating about their own axes under the driving of the third roller and the other fourth rollers are rotated about their own axes under the driving of another fourth roller.

[0190] According to the present application, the roller transmission assembly only needs to connect a part of the fourth roller, and the connection between the roller transmission assembly and the fourth roller assembly is simplified.

[0191] Optionally, the fourth roller assembly further comprises:

[0192] a plurality of second rotating shafts disposed corresponding to the fourth roller and coaxially connected with the corresponding fourth roller, wherein a part of the second rotating shafts are used for rotating about their own axes under the driving of the third roller; and

[0193] at least one second transmission belt, each of which is connected with two second rotating shafts.

[0194] According to the present application, the method by which the second conveying assembly makes all the fourth rollers rotate simultaneously is simple, stable in performance and easy to implement.

[0195] Optionally, the third roller assembly comprises a plurality of the third rollers, and the fourth roller assembly comprises a plurality of the fourth rollers,

[0196] wherein the Pth one of the third rollers is used for rotating about its own axis under the driving of the fourth driving device, the first end of the roller transmission assembly is connected to the Qth one of the third rollers, the second end of the roller transmission assembly is connected to the Qth one of the fourth rollers, and P is not equal to Q.

[0197] According to the present application, the fourth driving device and the roller transmission assembly are respectively connected with different third rollers, which can avoid mutual interference and is also conducive to simplifying the connection structure. The roller transmission assembly is nearby connected to the third and fourth rollers which are opposite to each other to save material and avoid the interference between the rollers.

[0198] Optionally, the second conveying assembly further comprises a biasing member for applying a force to the fifth movable seat to move away from the third roller along the first additional direction.

[0199] According to the present application, the biasing member assists the position adjustment assembly to hold the fourth roller in a stable position with respect to the third roller. The biasing member also facilitates opening the channel between the fourth and third rollers, allowing for the installation of the guidewire and/or the catheter. The biasing member also makes it difficult for the fourth roller to contact the third roller, which helps to protect the fourth roller, the third roller, the guidewire and the catheter.

[0200] A second aspect of the present application provides a medical system comprising:

[0201] a first supporting frame used to be disposed beside a surgical bed;

[0202] the slave-side execution apparatus of any one of the aforesaid technical solutions, wherein the main body power device is connected to the first supporting frame; and

[0203] a medical apparatus detachably connected to the first carrying device.

[0204] According to the present application, the slave-side execution apparatus of the slave-side may be controlled to operate by the doctors in the main control room, thereby preventing the doctors form being exposed to radiation of the ray. The components of the slave-side execution apparatus for contacting the guidewire and/or the catheter are passive components (without the need to connect to a power source), may be configured as consumables, are easy to install, and infection may be avoided.

[0205] Optionally, the first supporting frame is configured as a robotic arm, the robotic arm being configured to be movable relative to the surgical bed in at least one spatial dimension.

[0206] According to the present application, the first supporting frame is configured as the robotic arm so that the position and angle of the slave-side execution apparatus may be adjusted.

[0207] A third aspect of the present application provides a medical system, comprising:

[0208] a first supporting frame used to be disposed beside a surgical bed;

[0209] a second supporting frame used to be disposed beside the surgical bed and located in front of the first supporting frame along the conveying direction of the guidewire and/or the catheter;

[0210] the slave-side execution apparatus of any one of the aforesaid technical solutions comprising the second conveying assembly, wherein the main body power device is connected to the first supporting frame, and the second power assembly is connected to the second supporting frame; and

[0211] a medical apparatus detachably connected to the first carrying device.

[0212] According to the present application, the slave-side execution apparatus of the slave-side may be controlled to operate by the doctors in the main control room, thereby preventing the doctors form being exposed to radiation of the ray. The components of the slave-side execution apparatus for contacting the guidewire and/or the catheter are passive components (without the need to connect to a power source), may be configured as consumables, are easy to install, and infection may be avoided.

[0213] Optionally, the first supporting frame and/or the second supporting frame is configured as a robotic arm, the robotic arm being configured to be movable relative to the surgical bed in at least one spatial dimension.

[0214] According to the present application, the first supporting frame and/or the second supporting frame is configured as the robotic arm so that the position and angle of the slave-side execution apparatus may be adjusted.

[0215] Optionally, the medical system further comprises:

[0216] a master-side operating apparatus; and

[0217] a processor module signal-connected to both the master-side operating apparatus and the slave-side execution apparatus.

[0218] According to the present application, the slave-side execution apparatus may be controlled by the doctors at the master-side operating apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0219] The following drawings of the present application are used as a part of the present application for understanding the present application. The drawings show the embodiments of the present application and the descriptions thereof, and are used to explain the principles of the present application.

[0220] In the drawings:

[0221] FIG. **1** is a perspective schematic view of a medical system according to a first embodiment of the present application;

[0222] FIG. **2** is a perspective exploded schematic view of a slave-side execution apparatus according to the first embodiment of the present application;

[0223] FIG. **3** is an exploded schematic view of a rear consumable box shown in FIG. **2**;

[0224] FIGS. **4** and **5** are schematic views of some components of the slave-side execution apparatus shown in FIG. **2**, wherein a main body power device and a movable power device are shown;

[0225] FIG. **6** is an exploded schematic view of some components of the slave-side execution apparatus shown in FIG. **2**, wherein a main body power device and a movable power device are shown;

[0226] FIG. **7** is an exploded schematic view of a carrying base shown in FIG. **3**, wherein a snapping assembly is shown;

[0227] FIGS. **8** and **9** are schematic views of an internal structure of the main body power device shown in FIG. **2**;

[0228] FIG. **10** is an exploded schematic view of a movable assembly shown in FIG. **8**;

[0229] FIG. **11** is a schematic view of an internal structure of the movable power device shown in FIG. **6**;

[0230] FIG. **12** is another exploded schematic view of the carrying base shown in FIG. **3**, wherein a first power transfer device and a second power transfer device are shown;

[0231] FIG. **13** is a schematic view of a first manipulation device shown in FIG. **2** being removed from a first carrying device;

[0232] FIG. **14** is a schematic view of the first manipulation device shown in FIG. **2** being placed in the first carrying device;

[0233] FIG. **15** is a perspective exploded schematic view of the first manipulation device shown in FIG. **2**;

[0234] FIG. **16** is a schematic bottom view of the first manipulation device shown in FIG. **2**;

[0235] FIG. **17** is another perspective exploded schematic view of the first manipulation device shown in FIG. **2**;

[0236] FIG. **18** is yet another perspective exploded schematic view of the first manipulation device shown in FIG. **2**;

[0237] FIG. **19** is a schematic bottom view of some components of the first manipulation device shown in FIG. **2**, wherein a first movable roller group has been pressed by a pressing device to a first fixed roller group;

[0238] FIG. **20** is a schematic bottom view of some components of the first manipulation device shown in FIG. **2**, wherein the first movable roller group is not pressed by the pressing device to the first fixed roller group;

[0239] FIG. **21** is a perspective schematic view of the first movable roller group of the first manipulation device shown in FIG. **2**;

[0240] FIG. **22** is a perspective schematic view of the first fixed roller group of the first manipulation device shown in FIG. **2**;

[0241] FIG. **23** is a schematic view of some components of the rear consumable box shown in FIG. **3**, wherein a functional manipulation seat and a second manipulation device are shown;

[0242] FIG. **24** is an exploded schematic view of the components shown in FIG. **23**;

[0243] FIG. **25** is a schematic view of a specific example of the movable assembly shown in FIG. **8**;

[0244] FIG. **26** is an exploded schematic view of the movable assembly shown in FIG. **25**;

[0245] FIG. **27** is a structural block view of a medical system according to a specific embodiment of the present application;

[0246] FIG. **28** is a schematic view of a second power assembly and a second conveying assembly of the slave-side execution apparatus according to the specific embodiment of the present application;

[0247] FIG. **29** is a perspective exploded schematic view of the components shown in FIG. **28**;

[0248] FIG. **30** is a perspective exploded schematic view of the second conveying assembly shown in FIG. **28**;

[0249] FIG. **31** is a perspective exploded schematic view of an internal structure of the second conveying assembly shown in FIG. **30**;

[0250] FIG. **32** is a side view of the internal structure of the second conveying assembly shown in FIG. **30**, wherein a fourth roller is close to a third roller;

[0251] FIG. **33** is a side view of the internal structure of the second conveying assembly shown in FIG. **30**, wherein the fourth roller is away from the third roller;

[0252] FIG. **34** is a schematic view of a roller transmission assembly of the second conveying assembly shown in FIG. **30**;

[0253] FIG. **35** is an overall schematic view of a slave-side execution apparatus according to a second embodiment of the present application;

[0254] FIGS. **36** and **37** are schematic views of some components of the slave-side execution apparatus shown in FIG. **35**, wherein a main body power device and a movable power device are shown;

[0255] FIG. **38** is an exploded schematic view of some components of the slave-side execution apparatus shown in FIG. **35**, wherein the main body power device and the movable power device are shown;

[0256] FIGS. **39** and **40** are schematic views of an internal structure of the main body power device of the slave-side execution apparatus shown in FIG. **35**;

[0257] FIG. **41** is an exploded schematic view of a movable assembly shown in FIG. **39**;

[0258] FIGS. **42** and **43** are schematic views of an internal structure of the movable power device shown in FIG. **35**;

[0259] FIG. **44** is an overall schematic view of the first carrying device shown in FIG. **35**;

[0260] FIG. **45** is an exploded schematic view of the first carrying device shown in FIG. **35**;

[0261] FIG. **46** is an exploded schematic view of the carrying base shown in FIG. **45**, wherein a snapping assembly is shown;

[0262] FIG. **47** is another exploded schematic view of the carrying base shown in FIG. **45**, wherein a first power transfer device and a second power transfer device are shown;

[0263] FIGS. **48** to **50** are schematic views of a first manipulation device shown in FIG. **45**;

[0264] FIG. **51** is a schematic view of a driven roller member shown in FIG. **49**;

[0265] FIG. **52** is an exploded schematic view of the driven roller member shown in FIG. **51**;

[0266] FIGS. **53** and **54** are schematic views of a functional manipulation seat shown in FIG. **45**;

[0267] FIG. **55** is an exploded schematic view of a functional manipulation seat shown in FIG. **45**;

[0268] FIGS. **56** and **57** are schematic views of a second carrying device shown in FIG. **35**; and

[0269] FIG. **58** is a partial exploded schematic view of the second carrying device shown in FIG. **56**.

DETAILED DESCRIPTION

[0270] In the following description, numerous specific details are set forth in order to provide a more thorough understanding of the present application. However, it is obvious to those skilled in this art that the present application may be implemented without one or more of these details. In other examples, some technical features well-known in this art are not described in order to avoid confusion with the present application.

[0271] In order to thoroughly understand the present application, a detailed description will be provided in the following description. It should be understood that these embodiments are provided to make the disclosure of the present application thorough and complete and the concept of these exemplary embodiments be completely delivered to those of ordinary skill in the art. Obviously, the implementing of the embodiments of the present application is not limited to the specific details familiar to those skilled in the art. The preferred embodiments of the present application are described in detail as follows. However, in addition to these detailed descriptions, the present application may have other embodiments.

[0272] The ordinals such as "first" and "second" recited in the present application are merely identifiers and do not have any other meaning, such as a specific order and the like. Moreover, for example, the term "first component" itself does not imply the presence of "second component", and the term "second component" itself does not imply the presence of "first component." The use of the terms "first", "second" and "third" does not indicate any order, and these terms may be interpreted as names.

[0273] It should be noted that the terms "up", "down", "front", "back", "left", "right", "inside", "outside" and similar expressions used herein are for illustrative purposes only and are not restrictive.

[0274] The present application provides a slave-side execution apparatus (slave-side conveying device) of a surgical robot for conveying a guidewire and/or a catheter, and a medical system (surgical robot system) using the slave-side execution apparatus.

[0275] The exemplary embodiments of the present application will now be explained in further details with reference to the accompanying drawings.

[0276] As shown in FIGS. **1** and **2**, in a first embodiment of the present application, a medical system **300** includes a first supporting frame **17**, a slave-side execution apparatus **200** according to a preferred embodiment of the present application, and a medical apparatus **10**. Optionally, the medical system **300** also includes a second supporting frame **19**. The second supporting frame **19** is located in front of the first supporting frame **17** along a conveying direction DF of a guidewire **12** and/or a catheter **11**. During use, the first supporting frame **17** and the second supporting frame **19** are arranged beside a surgical bed for installing the slave-side execution apparatus **200**. For example, the first supporting frame **17** and the second supporting frame **19** may be configured as robotic arms, such as passive robotic arms. The slave-side execution apparatus **200** is used for conveying the guidewire **12** and/or the catheter **11**. The robotic arm has joints and may move in multiple spatial dimensions relative to the surgical bed, so that the position and angle of the slave-side execution apparatus **200** may be adjusted.

[0277] In the present application, the direction in which the guidewire **12** and/or the catheter **11** enters the blood vessel is the front (front end), and the direction in which the guidewire **12** and/or the catheter **11** exits the blood vessel is the back (rear end).

[0278] Optionally, the medical system **300** further includes a master-side operating apparatus **301** and a processor module **302** (see FIG. **27**). The master-side operating apparatus is arranged in the doctor's working room for manual operation by the doctor. For example, the master-side operating apparatus may be a doctor's operating table. The processor module is signal-connected to both the master-side operating apparatus and the slave-side execution apparatus **200**. The processor module may be a control device such as a central processing unit or a computer. After receiving a command signal from the master-side operating apparatus, the processor module processes the command signal and then sends it to the slave-side execution apparatus **100**, or directly sends the command signal to the slave-side execution apparatus **200**. After receiving the signal transmitted by the processor module, the slave-side execution apparatus **200** performs a corresponding action in response to an action of the master-side operating apparatus, so that the doctor may control the slave-side execution apparatus **200** at the master-side operating apparatus.

[0279] As shown in FIGS. **1** and **2**, in a preferred embodiment, the slave-side execution apparatus **200** includes a main body power device **210**, a movable power device **240**, a first carrying device **260** and a first manipulation device **30**.

[0280] Wherein, the main body power device **210** is used to be installed beside the surgical bed and is immovable relative to the surgical bed. For example, the main body power device **210** may be installed to the first supporting frame **17** so that it is immovable relative to the surgical bed. The main body power device **210** includes a main body driving device for providing a driving force. The movable power device **240** is connected to the main body power device **210** and is used to move forward and backward relative to the main body power device **210** along the conveying direction DF of the guidewire **12** and/or the catheter **11** under the driving of the main body driving device. The movable power device **240** includes a first driving device for providing a driving force. The first carrying device **260** is used to carry the medical apparatus **10** that has the catheter **11**. The first carrying device **260** is detachably connected to the movable power device **240** and is synchronously movable with the movable power device **240** along the conveying direction DF relative to the main body power device **210**. The first manipulation device **30** is connected to the first carrying device **260** and is used to control the convey of the guidewire **12** under the driving of the first driving device, i.e., to control the guidewire **12** to move forward and backward relative to the first carrying device **260** along the conveying direction DF. The first manipulation device **30** is located at a rear end of the first carrying device **260** along the conveying direction DF, or in other words, the first manipulation device **30** is disposed at a rear of the medical apparatus **10**.

[0281] It may be understood that the conveying direction DF is a bidirectional direction, which includes a first conveying direction DF**1** (forward direction) and a second conveying direction DF**2** (backward direction), and the forward direction DF**1** is opposite to the backward direction DF**2**.

[0282] The movable power device **240** includes a second driving device for providing a driving force. The medical apparatus **10** is detachably connected to the first carrying device **260**. As shown in FIG. **3**, the first carrying device **260** includes a second manipulation device **290** that is used to contact the medical apparatus **10**. The second manipulation device **290** is connected to the second driving device to manipulate the medical apparatus **10** to perform a medical function under the driving of the second driving device.

[0283] The medical apparatus **10** is, for example, configured to convey an artificial valve, which may provide a catheter **11**. For example, the medical apparatus **10** is a functional handle of a valve conveyor, which is used for performing functions such as releasing or retrieving the artificial valve and to achieve relative movement and bending of the inner and outer shaft sheaths. As shown in FIG. **2**, the medical apparatus **10** has at least one set of medical function mechanisms **13**. When the medical function mechanisms **13** are in operation, the intended medical functions are performed by the medical apparatus **10**. For example. The medical function mechanism **13** is configured as an operating gear **13** disposed on the periphery of the medical apparatus **10**. When the operating gear **13** is rotated, the mechanism inside the medical apparatus **10** is driven by the operating gear **13** to operate, so as to achieve the intended medical functions.

[0284] Optionally, the slave-side execution apparatus **200** further includes a second power assembly **14** and a second conveying assembly **60**. The second power assembly **14** is used to be installed beside the surgical bed and is immovable relative to the surgical bed. For example, the second power assembly **14** may be mounted to the second supporting frame **19** so that it is immovable relative to the surgical bed. The second power assembly **14** includes a fourth driving device for providing a driving force. The second conveying assembly **60** is detachably connected to the second power assembly **14**, and is used for conveying the guidewire **12** and/or the catheter **11** under the driving of the fourth driving device.

[0285] As shown in FIG. **3**, the first carrying device **260** is configured in the shape of a box. The medical apparatus **10** and the first manipulation device **30** are arranged in the first carrying device **260**. The first carrying device **260** includes a carrying base **261**, a functional manipulation seat **162** and a flip cover **262**A. Wherein the carrying base **261** is used to be connected to the movable power device **240**. The carrying base **261** includes a first part **261**A of the carrying base and a second part **261**B of the carrying base. The first part **261**A of the carrying base and the second part **261**B of the carrying base are arranged along the conveying direction DF. The first part **261**A of the carrying base and the second part **261**B of the carrying base are both configured in the shape of a box. The first part **261**A of the carrying base is used to accommodate the first manipulation device **30**. The first manipulation device **30** may be stably maintained in the first part **261**A of the carrying base. The second part **261**B of the carrying base is used to accommodate the second manipulation device **290**. Specifically, the second manipulation device **290** is disposed on the functional manipulation seat **162** that covers the second part **261**B of the carrying base. The medical apparatus **10** is mounted on the functional manipulation seat **162**. For example, the functional manipulation seat **162** is provided with brackets **175** and **176** for mounting the medical apparatus **10**. The flip cover **262**B is pivotally connected to the functional manipulation seat **162** to cover the functional manipulation seat **162** and thereby cover the medical apparatus **10**.

[0286] The first part **261**A of the carrying base is provided with a notch **261**C so that the guidewire located in the first part **261**A of the carrying base may pass through the notch **261**C and extend to the medical apparatus **10** corresponding to the position of the second part **261**B of the carrying base.

[0287] In the present application, both the first carrying device **260** and the first manipulation device **30** do not include a driving device or a driving device for providing a driving force and are passive components. Therefore, the first carrying device **260** and the first manipulation device **30** may be used as consumables, both of which may be collectively referred to as a rear consumable box **15**. The medical apparatus **10** is also a passive component, which is used for installation in the first carrying device **260** for use and may also be considered as a part of the rear consumable box **15**. Similarly, the second conveying assembly **60** is also a passive component, which serve as a consumable and may be referred to as a front consumable box.

[0288] During the surgery, firstly, the guidewire **12** is fed into the blood vessel by the first manipulation device **30** under the action of the first driving device and reaches a desired position. The catheter **11** is sleeved on the guidewire **12** from the rear end so that the guidewire **12** runs through the catheter **11**. Under the action of the main body driving device, the movable power device **240** and the first carrying device **260** are moved forward along the conveying direction DF, thereby driving the medical apparatus **10** to move forward, i.e., driving the catheter **11** to move forward into the blood vessel. That is, the catheter **11** enters the blood vessel under the support and guidance of the guidewire **12**. At this time, the rear consumable box **15** also drives the first manipulation device **30** to move forward. In order to prevent the guidewire **12** from deviating from the desired position, while the catheter **11** is being conveyed, the first driving device acts on the first manipulation device **30** so that the guidewire **12** is moved backward along the conveying direction DF by the first manipulation device **30**. It may be understood that the medical system **300** includes a control module (e.g., disposed in the master-side operating apparatus) that controls the main body driving device in cooperation with the first driving device such that only the catheter **11** is moved forward, but the guidewire **12** remains relatively stationary. The second conveying assembly **60** is located relatively at the front end and functions to support and assist in the convey of the guidewire **12** and/or the catheter **11**. When the catheter **11** is conveyed in place, the second driving device controls the medical apparatus **10** to operate to complete the release of the artificial valve.

[0289] Optionally, at least one selected from the main body driving device, the first driving device, the second driving device and the fourth driving device includes a motor. Alternatively, the main body driving device, the first driving device, the second driving device and the fourth driving device all adopt the motor to output a driving force.

[0290] As shown in FIGS. **4** to **6**, the movable power device **240** is connected to the main body power device **210** and is used to be moved forward and backward relative to the main body power device **210** along the conveying direction DF of the guidewire **12** and/or the catheter **11** under the driving of the main body driving device.

[0291] The main body power device **210** includes a housing **112** inside which a movable assembly and the main body driving device are provided. The movable assembly is configured to move forward and backward relative to the main body power device **210** along the conveying direction DF under the driving of the main body driving device, wherein the movable power device **240** is connected to the movable assembly. Specifically, the housing **112** has a long hole **113** extending along the conveying direction DF. The movable assembly has a protrusion **121** extending out of the housing **112** from the long hole **113**. The movable power device **240** is connected to the protrusion **121**. For example, the movable power device **240** includes a connecting frame **141** and a base **142**. One end of the connecting frame **141** is connected to the protrusion **121**, and the other end of the connecting frame **141** is connected to the base **142**. Wherein the first carrying device **260** is detachably connected to the base **142**.

[0292] Specifically, the carrying base **261** of the first carrying device **260** is detachably connected to the base **142**. As shown in FIG. **7**, a snapping assembly **164** is provided at an end of the carrying base **261**. A buckle seat **153** is provided at an end of the base **142** of the movable power device **240** (as shown in FIG. **5**). The snapping assembly **164** is configured to connect to the buckle seat **153** in a snap-fit manner so that the carrying base **261** is detachably connected to the base **142**.

[0293] For example, the snapping assembly **164** includes a knob **1641**, a buckle **1642**, and a rotating shaft **1643**. The rotating shaft **1643** is disposed at the end of the carrying base **261** and penetrates through the carrying base **261**. The knob **1641** is used for user operation. The knob **1641** is disposed at an end of the rotating shaft **1643** facing away from the base **142**, and is synchronously rotatable with the rotating shaft **1643** about an axis of the rotating shaft **1643**. The buckle **1642** is disposed at an end of the rotating shaft **1643** facing the base **142**, and is synchronously rotatable with the rotating shaft **1643** about the axis of the rotating shaft **1643**. When the knob **1641** is rotated by the user, the buckle **1642** is rotated synchronously with the knob **1641** through the rotating shaft **1643**, and for example, it may be rotated into a groove of the buckle seat **153**, so that the carrying base **261** is connected to the base **142** in a snap-fit manner. When the buckle **1642** is rotated out of the groove of the buckle seat **153**, the carrying base **261** is disconnected from the base **142**.

[0294] Optionally, the snapping assembly **164** further includes a damping member **1644** and a cover plate **1645**. The damping member **1644** is sleeved on the rotating shaft **1643** and embedded in the carrying base **261**. That is, the damping member **1644** is arranged between the rotating shaft **1643** and the carrying base **261**. The cover plate **1645** is connected to the carrying base **261** to limit the position of the damping member **1644** and the rotating shaft **1643**.

[0295] The first carrying device **260** may also be connected to the movable power device **240**, for example, by magnetic attraction, suspension, etc.

[0296] As shown in FIGS. **8** and **9**, the main body power device **210** also includes a machine frame **111**. The housing **112** covers the machine frame **111**. The main body driving device **124** and the movable assembly **291** are both disposed on the machine frame **111**. The main body power device **210** further includes a first guide rail **114**, a lead screw pair and a main body transmission assembly **92**. The first guide rail **114** is disposed on the machine frame **111**. The first guide rail **114** extends along the conveying direction DF. The lead screw pair includes a lead screw **115** and a lead screw nut **116**. The lead screw **115** is disposed on the machine frame **111** and also extends along the conveying direction DF. The main body transmission assembly **92** is connected between the main body driving device **124** and the lead screw **115** so that the lead screw **115** is rotatable about its own axis under the driving of the main body driving device **124**. The movable assembly **291** is connected to the lead screw nut **116** and the first guide rail **114**, and is configured to be movable along the first guide rail **114**. The main body driving device **124** is in transmission connection with the lead screw **115** so that the lead screw nut **116** may be driven to move along an extension direction of the lead screw **115**, and the movable assembly **291** is thereby driven to move along the extension direction of the lead screw **115**. Furthermore, the movable assembly **291** drives the movable power device **240** to move through its protrusion **121**.

[0297] Optionally, the bottom of a movable frame **117** is connected to the first guide rail **114**.

[0298] As shown in FIGS. **8** to **10**, the movable assembly **291** includes a movable frame **117**, a movable seat **120** and a tension-compression sensor **224**. The movable frame **117** is fixedly connected to the lead screw nut **116**. The movable frame **117** has two end walls **118** spaced apart along the conveying direction DF and a second guide rail **119** disposed between the two end walls **118**. The second guide rail **119** extends along the conveying direction DF. The movable frame **117**, for example, has two second guide rails **119** extending parallel to each other in the same horizontal plane. The movable seat **120** is disposed on the second guide rail **119** and is movable along the second guide rail **119**. For example, the second guide rail **119** extends through the movable seat **120**. Wherein the movable seat **120** is preferably disposed on the second guide rail **119** via linear bearing(s) **132**. In other words, the linear bearing(s) **132** is sleeved outside the second guide rail **119**, and the movable seat **120** is disposed outside the linear bearing(s) **132**. Moreover, the lead screw **115** preferably integrally passes through the movable frame **117** and the movable seat **120**, and preferably does not interfere with the movable frame **117** and the movable seat **120**. The protrusion **121** is disposed on the movable seat **120**. The tension-compression sensor **224** is disposed between the movable seat **120** and one of the two end walls **118**, and abuts against both the movable seat **120** and the one of the two end walls **118** to sense the force experienced by the movable seat **120** when the catheter **11** is conveyed, i.e., to sense the conveying resistance.

[0299] It may be understood by those skilled in the art that the tension-compression sensor **224** is configured to be tension-compression integrated, and may read the force in the positive and negative directions. The tension-compression sensor **224** is electrically connected to the control module so that the doctor may be aware of the resistance experienced by the medical apparatus **10** in conveying the guidewire and make timely adjustments. After the components of the slave-side execution apparatus **200** are assembled and the main body power device **210** is mounted to the supporting frame **17** (at this point, the medical apparatus **10** has been mounted on the first carrying device **260**), the measured value of the tension-compression sensor **224** needs to be set to zero first, and then it may be directly used to reflect the conveying resistance.

[0300] The slave-side execution apparatus **200** further includes a first transmission device **21** connected between the first driving device and the first manipulation device **30** and used to transfer the driving force of the first driving device to the first manipulation device **30**.

[0301] As shown in FIGS. **5**, **11** and **12**, the first transmission device **21**, for example, includes a first power shaft **145**, a first transmission assembly **94** and a first power transfer device **265**.

[0302] The first power shaft **145** is connected to the first manipulation device **30** and disposed on the movable power device **240**. The first power shaft **145** is configured to be rotatable about its own axis relative to the movable power device **240**. The first power shaft **145** is, for example, disposed on the base **142** and penetrates through the base **142**. An end of the first power shaft **145** facing the first carrying device **260** is in transmission connection with the first manipulation device **30**.

[0303] The first driving device **143** is, for example, disposed on the connecting frame **141** of the movable power device **240**. The first transmission assembly **94** is disposed on the movable power device **240**, e.g., on the base **142**. The first transmission assembly **94** is connected between the first driving device **143** and an end of the first power shaft **145** facing away from the first carrying device **260**, so that the first power shaft **145** is rotatable under the driving of the first driving device **143**. For example, the first transmission assembly **94** includes a first driving roller **147**, a first driven roller **148**, and a first synchronous belt **149**. The first driving roller **147** is connected to a driving end of the first driving device **143**. The first driven roller **148** is connected to the end of the first power shaft **145** facing away from the first carrying device **260**. The first synchronous belt **149** is connected between the first driving roller **147** and the first driven roller **148** to transfer the power generated by the first driving device **143** to the first power shaft **145** so as to cause it to rotate.

[0304] The first power transfer device **265** is disposed on the first carrying device **260**, e.g., in the second part **261**B of the carrying base. The first power transfer device **265** is connected between the first manipulation device **30** and the first power shaft **145**, so that the first manipulation device **30** is driven to operate by the first power shaft **145**. The position of the first power transfer device **265** corresponds to the position of the first power shaft **145**, and the first power transfer device **265** is engaged with the first power shaft **145**. Wherein the first power transfer device **265** includes a transfer synchronous roller **1654**, and a synchronous belt transmission is formed between the first power transfer device **265** and the first manipulation device **30**.

[0305] For example, the first power transfer device **265** includes a first bearing **1652**, a first transmission shaft **1653**, a transfer synchronous roller **1654** and a transfer synchronous belt. A hole corresponding to the first power shaft **145** is provided at the bottom of the carrying base **261**. A first limiting frame **1651** is provided at a position corresponding to the hole on the carrying base **261**, and two first bearings **1652** corresponding to each other are provided at the hole and on the first limiting frame **1651**. The first transmission shaft **1653** is connected between the inner rings of the two first bearings **1652**, and an end of the first transmission shaft **1653** facing the movable power device **240** is engaged with the first power shaft **145**. The first transmission shaft **1653** is also fixedly connected to the two transfer synchronous rollers **1654**. The transfer synchronous belt is connected between the transfer synchronous roller **1654** and the first manipulation device **30**, so that a synchronous belt transmission is formed between the first power transfer device **265** and the first manipulation device **30**.

[0306] The structure of the first manipulation device **30** will be described below.

[0307] As shown in FIGS. **13** and **14**, the first manipulation device **30** is removably disposed in the first part **261**A of the carrying base, and it is driven by the first power transfer device **265**.

[0308] As shown in FIG. **15**, the first manipulation device **30** includes a first manipulation device base **31**, at least one first roller **41** and at least one second roller **42**. Wherein the first manipulation device base **31** is used to be detachably connected to the first carrying device **260** (specifically the first part **261**A of the carrying base). The first roller **41** is disposed on the first manipulation device base **31**, and an axis of the first roller **41** is not parallel to the conveying direction DF. Optionally, the axis of the first roller **41** is perpendicular to the conveying direction DF, for example, in a second direction D2. The second roller **42** is also disposed on the first manipulation device base **31** and disposed opposite to the first roller **41** (one by one opposite to each other), so as to clamp the guidewire **12** along with the first roller **41**. It may be understood that an axis of the second roller **42** is parallel to the axis of the first roller **41**. Wherein the first roller **41** and the second roller **42** are both used to be connected to the first transmission device **21** so as to rotate under the driving of the first transmission device **21**, and the slave-side execution apparatus **200** is configured such that an rotation direction of the first roller **41** is opposite to an rotation direction of the second roller **42**.

[0309] It may be understood that when the first roller **41** and the second roller **42** are rotated, the guidewire **12** clamped therebetween is moved along the conveying direction DF under the action of frictional force. Therefore, both the first roller **41** and the second roller **42** are capable of actively rolling under the driving of the driving device, which enables the first manipulation device **30** to have sufficient conveying force. Moreover, since both the first roller **41** and the second roller **42** are capable of rolling actively, even if the structure used to drive the rotation of one of the first roller **41** and the second roller **42** fails, the one may also be passively rotated under the action of frictional force, and it is also possible to achieve that the guidewire **12** is clamped and conveyed jointly by the two sets of rollers.

[0310] Optionally, the first manipulation device **30** includes a plurality of first rollers **41** and a plurality of second rollers **42**. In the illustrated embodiment, the first manipulation device **30** includes two first rollers **41**A, **41**B and two second rollers **42**A, **42**B (see FIG. **16**). Optionally, the plurality of first rollers **41** are arranged flush, and/or the plurality of second rollers **42** are also arranged flush. Optionally, the plurality of first rollers **41** are arranged at equal intervals, and/or the plurality of second rollers **42** are also arranged at equal intervals. Optionally, the diameter of the first roller **41** is the same as the diameter of the second roller **42**, or the first roller **41** and the second roller **42** are configured as the same roller.

[0311] Specifically, as shown in FIGS. **15** to **18**, the first manipulation device **30** is divided into two major parts: a first movable roller group **30**A and a first fixed roller group **30**B. The first movable roller group **30**A and the first fixed roller group **30**B are arranged along a first direction D**1**. Wherein the first direction D**1** is perpendicular to a plane determined by the conveying direction DF and the axis of the first roller **41**. For example, the first direction D**1** is perpendicular to a plane determined by the conveying direction DF and the second direction D**2** (the conveying direction DF, the first direction D**1**, and the second direction D**2** are perpendicular to each other).

[0312] The first roller **41** is included in the first movable roller group **30**A, and the second roller **42** is included in the first fixed roller group **30**B. The first fixed roller group **30**B includes a second fixed seat **35**. The second fixed seat **35** is disposed on the first manipulation device base **31** and is immovable relative to the first manipulation device base **31**, and the second roller **42** is disposed on the second fixed seat **35**. The first movable roller group **30**A includes a first movable seat **34**. The first movable seat **34** is also disposed on the first manipulation device base **31** and is movable between a first position and a second position relative to the second fixed seat **35** (or the first manipulation device base **31**) along the first direction D**1**. The first roller **41** is disposed on the first movable seat **34**. A distance between the first movable seat **34** and the second fixed seat **35** when the first movable seat **34** is in the first position is less than a distance between the first movable seat **34** and the second fixed seat **35** when the first movable seat **34** is in the second position.

[0313] Therefore, the distance between the first movable seat **34** and the second fixed seat **35** along the first direction D**1** may be changed. That is, the distance between the first movable roller group **30**A and the first fixed roller group **30**B may be changed. That is, the distance between the first roller **41** and the second roller **42** may be changed. As such, the guidewire **12** may be clamped by the first roller **41** and the second roller **42** when they are close to each other and released when they are far away from each other. As shown in FIGS. **3** and **15**, the first manipulation device base **31** is provided with a first base channel **31**C for allowing the guidewire **12** to pass through. The first movable roller group **30**A and the first fixed roller group **30**B are respectively located on both sides of the first base channel **31**C, and may clamp the guidewire **12** in the channel **31**C.

[0314] As shown in FIG. **18**, the first manipulation device base **31** is provided with a first guide rod **48** extending along the first direction D**1**, and the first movable seat **34** is provided with a first guide hole **48**A extending along the first direction D**1**. The first guide rod **48** extends through the first guide hole **48**A, so that the first movable seat **34** may be stably moved along the first direction D**1** relative to the second fixed seat **35**.

[0315] As shown in FIGS. **17** and **18**, in order to make the distance between the first roller **41** and the second roller **42** changeable, the first manipulation device **30** further includes a first biasing assembly **32** and a first pressing device **33**. The first biasing assembly **32** is connected between the second fixed seat **35** and the first movable seat **34** for providing a force to move the first movable seat **34** away from the second fixed seat **35** along the first direction D**1**. The first pressing device **33** is disposed on the first manipulation device base **31** and is connected to the first movable seat **34** for operation by the user to bring the first movable seat **34** close to the second fixed seat **35** along the first direction D**1**.

[0316] Specifically, the first biasing assembly **32** includes an elastic member that is deformable along the first direction D**1**. For example, the first biasing assembly **32** is configured as at least one spring **32** extending along the first direction D**1**. The first movable seat **34** and the second fixed seat **35** are both provided with a first spring blind hole **32**A for accommodating both ends of the spring **32** (see FIGS. **21** and **22**), so that the spring **32** is stably clamped between the first movable seat **34** and the second fixed seat **35**.

[0317] The first pressing device **33** includes a cam **36** and a wrench **37**. The cam **36** has different radial dimensions. The cam **36** is connected to the first manipulation device base **31** and is rotatable relative to the first manipulation device base **31** about a rotation axis extending along the second direction D**2**. For example, the cam **36** is mounted to a cam seat **36**A, and the cam seat **36**A is mounted to the first manipulation device base **31**, so that the cam **36** is mounted to the first manipulation device base **31**. The cam **36** has different radial dimensions, and its circumferential surface is used to be connected to a side of the first movable seat **34** facing away from the second fixed seat **35**. The wrench **37** is connected to the cam **36** for operation by the user to cause the cam **36** to rotate relative to the first manipulation device base **31**. It may be understood that in a case where the position of the rotation shaft of the cam **36** is unchanged relative to the first manipulation device base **31**, the distance between the first movable seat **34** and the rotation shaft of the cam **36** is changed when different positions of the circumferential surface of the cam **36** contact the first movable seat **34**. That is to say, the first movable seat **34** is moved along the first direction D**1**.

[0318] As shown in FIGS. **17** and **18**, in order to make it easier for the cam **36** to act on the first movable seat **34**, a projection **38** extending along the first direction D**1** is connected to a side of the first movable seat **34** facing the cam **36**, and is used to contact the circumferential surface of the cam **36**. The projection **38** may serve as a part of the first movable seat **34**, for example, it may be integrally formed with the first movable seat **34**. The projection **38** may also form a separate component from the first movable seat **34**. In the illustrated embodiment, the first manipulation device base **31** is provided with a projection groove **38**A for accommodating the projection **38**. The cam **36** may be at least partially located in the projection groove **38**A to contact the projection **38**.

[0319] As shown in FIG. **19**, when a part of the cam **36** with a larger radius contacts the projection **38**, the cam **36**

squeezes the first movable seat **34** along the first direction D**1** via the projection **38**, so that the first movable seat **34** is moved towards the first fixed roller group **30**B, and thus the first roller **41** and the second roller **42** are close to each other. At this time, the spring **32** is compressed. As shown in FIG. **20**, when a part of the cam **36** with a smaller radius contacts the projection **38**, the squeezing force of the cam **36** on the projection **38** is decreased, and then the squeezing force experienced by the spring **32** is decreased. The spring **32** rebounds to push the first movable seat **34** away from the first fixed roller group **30**B along the first direction D**1** so that the first roller **41** and the second roller **42** are away from each other. The position of the first movable seat **34** in FIG. **19** may be construed as the first position, and the position of the first movable seat **34** in FIG. **20** may be construed as the second position.

[0320] As shown in FIG. **17**, in order to prevent the first movable roller group **30**A from being excessively moved along the first direction D**1**, optionally, first blocking members **48**B are respectively provided at both ends of the first guide rod **48**. The first blocking member **48**B protrudes in a radial direction of the first guide rod **48**, and its radial dimension is larger than the aperture of the first guide hole **48**A, thereby preventing the excessive movement of the first guide hole **48**A at both ends, that is, the first movable seat **34** will not be excessively moved along the first direction D**1**. It may be understood that the length of the first guide rod **48** between the two first blocking members **48**B will not affect the movement of the first movable seat **34** between the first position and the second position. In other words, the portion of the length of the first guide rod **48** between the two first blocking members **48**B which is longer than the length of the first guide hole **48**A is not less than the distance between the first position and the second position.

[0321] Optionally, the wrench **37** is exposed from the outer surface of the rear consumable box **15**, thereby facilitating the user's operation. As shown in FIG. **13**, the first carrying device **260** is provided with a window **18** for exposing the wrench **37**.

[0322] In order to rotate the first roller **41** and the second roller **42**, as shown in FIGS. **16** and **17**, the first manipulation device **30** further includes a first roller transmission device **51** and a second roller transmission device **52**. The first roller transmission device **51** is used to connect the first transmission shaft **1653** and all the first rollers **41** so that the rotation direction of all the first rollers **41** is the same as the rotation direction of the first transmission shaft **1653**. The second roller transmission device **52** is used to connect the first transmission shaft **1653** and all the second rollers **42** so that the rotation direction of the second rollers **42** is opposite to the rotation direction of the first transmission shaft **1653**. Thus, the rotation directions of the first roller **41** and the second roller **42** are opposite.

[0323] Optionally, as shown in FIG. **21**, the first roller transmission device **51** includes at least one first manipulation synchronous belt **53**, and the first transmission shaft **1653** and the first roller **41** are both connected with a structure (e.g., a synchronous belt clamping ring **49**, also referred to as a synchronous roller **49**) for connecting the first manipulation synchronous belt **53**. The slave-side execution apparatus **200** is configured such that the first transmission shaft **1653** drives all the first rollers **41** to rotate via the first manipulation synchronous belt **53**, so that the rotation direction of all the first rollers **41** is the same as the rotation direction of the first transmission shaft **1653**. For example, the first roller **41** has a first roller shaft **41**X, and the synchronous belt clamping rings **49** are respectively sleeved on the first transmission shaft **1653** and the first roller shaft **41**X (the synchronous belt clamping ring **49** sleeved on the first transmission shaft **1653** is also the transfer synchronous roller **1654**; since the first transmission shaft **1653** is to drive the first roller **41** and the second roller **42** respectively, the first transmission shaft **1653** is provided with two transfer synchronous rollers **1654**). The first manipulation synchronous belt **53** is tightened by two synchronous belt clamping rings **49** so that the first roller shaft **41**X is driven to rotate by the first transmission shaft **1653** via the first manipulation synchronous belt **53**, causing the first roller **41** to rotate.

[0324] It may be understood that the first manipulation synchronous belt **53** is elastic. During the movement of the first movable seat **34** along the first direction D**1**, the first manipulation synchronous belt **53** may always be tensioned by the two synchronous belt clamping rings **49** of the first transmission shaft **1653** and the first roller shaft **41**X due to its elasticity.

[0325] For example, the first manipulation device **30** includes N first rollers **41** and N first manipulation synchronous belts **53** (N is an integer greater than or equal to 1). The slave-side execution apparatus **200** may be configured such that each of the first rollers **41** is connected to the first transmission shaft **1653** via one first manipulation synchronous belt **53**. That is, each of the first rollers **41** is directly driven by the first transmission shaft **1653**. Alternatively, the slave-side execution apparatus **200** may be configured such that each of one part (one or more first rollers **41**) of the N first rollers **41** is connected to the first transmission shaft **1653** via one first manipulation synchronous belt **53**, and each of the other part of the N first rollers **41** is connected to another first roller **41** via one first manipulation synchronous belt **53**. That is, only a part of the first rollers **41** are driven by the first transmission shaft **1653**, and the other first rollers **41** are driven to rotate by another first roller **41**.

[0326] Optionally, the slave-side execution apparatus **200** may be configured such that the first one of the N first rollers **41** is connected to the first transmission shaft **1653** via one first manipulation synchronous belt **53**, and each of the other first rollers **41** is connected to the previous first roller **41** via one first manipulation synchronous belt **53**. That is, the first one of the first rollers **41** is driven by the first transmission shaft **1653**, the second one of the first rollers **41** is driven by the first one of the first rollers **41**, the third one of the first rollers **41** is driven by the second one of the first rollers **41**, and so on. For example, as shown in FIG. **17**, the first manipulation device **30** includes two first rollers **41**, i.e., a first roller **41**A and a first roller **41**B. The first first roller **41**A is connected to the first transmission shaft **1653** via one first manipulation synchronous belt **53**A, and the second first roller **41**B is connected to the first first roller **41** via one first manipulation synchronous belt **53**B. In this way, the first manipulation synchronous belts **53** may be evenly distributed. For example, the first manipulation synchronous belts **53** may be made into the same specification, and each of first roller shafts **41**X may also have a similar size (each of first roller shafts **41**X basically needs to be connected with two synchronous belt clamping rings **49** only), thereby reducing processing difficulty and costs.

[0327] The first manipulation synchronous belt **53**A is also a transfer synchronous belt in the first power transfer device **265**.

[0328] With such a connection configuration, in order to detect the slipping of the first manipulation synchronous belt **53**, as shown in FIGS. **16** to **22**, the first manipulation device **30** is further provided with a first additional roller **43**, a second additional roller **44**, a first additional roller transmission device **46** and an encoder **24**. Wherein the first additional roller **43** is disposed on the first movable seat **34**, for example, with the N first rollers **41** being disposed side by side on the first movable seat **34**. The second additional roller **44** is disposed on the second fixed seat **35**, for example, with the N second rollers **42** being disposed side by side on the second fixed seat **35**. The second additional roller **44** is disposed opposite to the first additional roller **43**, so as to be able to clamp the guidewire **12** along with the first additional roller **43**. The first additional roller transmission device **46** is used to connect the first additional roller **43** with the Nth one of the first rollers **41**, so that the first additional roller **43** is rotated in the same direction as the rotation direction of the first transmission shaft **1653** under the driving of the Nth one of the first rollers **41**. The encoder **24** is connected to the second additional roller **44** for detecting the rotation angle of the second additional roller **44**. The encoder **24** is electrically connected to the control module so that the rotation angle of the second additional roller **44** may be obtained by the control module.

[0329] In this way, in a case where the first manipulation synchronous belt **53** does not slip, all the first rollers **41** are rotated normally. Under the action of the first additional roller transmission device **46**, the first additional roller **43** rotates actively. The guidewire **12** is clamped by the first additional roller **43** along with the second additional roller **44** so that the second additional roller **44** is passively rotated under the action of frictional force, and thereby the rotation angle detected by the encoder **24** will change continuously. Since the first transmission shaft **1653** forms a one-by-one driving connection relationship with the N first rollers **41**, if any one of the first manipulation synchronous belts **53** slips or breaks, the Nth one of the first rollers **41** (the last one of the first rollers **41**) cannot be rotated, so that the first additional roller **43** and the second additional roller **44** cannot be rotated, and the rotation angle recorded by the encoder **24** will not change. The failure of the apparatus can thus be detected by the control module.

[0330] Optionally, as shown in FIGS. **16** to **18**, the encoder **24** is connected to an axle **44**A of the second additional roller **44**, and is configured to detect the rotation of the second additional roller **44** by detecting the rotation of the second additional roller axle **44**A.

[0331] As shown in FIGS. **5** and **11**, the movable power device **240** further includes a third rotating shaft **293** for connecting to the second additional roller axle **44**A and rotating synchronously with the second additional roller axle **44**A. Wherein the encoder **24** is provided to the third rotating shaft **293**. The third rotating shaft **293** is, for example, disposed on the base **142** and penetrates through the base **142**, and an end of the third rotating shaft **253** facing the first carrying device **260** is in transmission connection with the second additional roller axle **44**A, e.g., by a gear engagement connection.

[0332] Optionally, the first additional roller transmission device **46** is configured as a synchronous belt. For example, in the illustrated embodiment, the second one of the first rollers **41** is connected to the axle **47** of the first additional roller **43** via the second manipulation synchronous belt **46** to drive the first additional roller **43** to rotate.

[0333] Optionally, the diameter of the first additional roller **43** is the same as that of the first roller **41**, and the diameter of the second additional roller **44** is the same as that of the second roller **42**. Optionally, the diameter of the first additional roller **43** is the same as that of the second additional roller **44**. In other words, the first roller **41**, the second roller **42**, the first additional roller **43** and the second additional roller **44** are configured as the same roller. Optionally, an axis of the first additional roller **43** is parallel to the axis of the first roller **41**, and an axis of the second additional roller **44** is parallel to the axis of the second roller **42**. In other words, the first roller **41**, the second roller **42**, the first additional roller **43** and the second additional roller **44** are configured to be arranged parallel to each other.

[0334] As shown in FIGS. **16** and **17**, the second roller transmission device **52** includes a fourth transmission shaft **55**, a first transmission device **56** for the second roller, and a second transmission device **57** for the second roller. The fourth transmission shaft **55** is disposed on the first manipulation device base **31**. The first transmission device **56** for the second roller is used to connect the first transmission shaft **1653** and the fourth transmission shaft **55** so that the fourth transmission shaft **55** is rotated under the driving of the first transmission shaft **1653**. The second transmission device **57** for the second roller is used to connect the fourth transmission shaft **55** and all the second rollers **42** so that all the second rollers **42** are rotated under the driving of the fourth transmission shaft **55**.

[0335] Optionally, one of the first transmission device **56** for the second roller and the second transmission device **57** for the second roller is configured to be driven by a synchronous belt, and the other thereof is configured to be driven by a gear. It may be understood that the synchronous belt transmission mode does not change the rotation direction (the rotation direction of the driven member is the same as that of the driving member), while the gear transmission mode may change the rotation direction. Thus, with such a configuration, the rotation direction of all the second rollers **42** may be opposite to that of the first transmission shaft **1653**.

[0336] Optionally, the first manipulation device **30** is configured such that the component of the first roller transmission device **51** for connecting the first transmission shaft **1653** and the component of the second roller transmission device **52** for connecting the first transmission shaft **1653** are both synchronous belts. That is, the component of the first roller transmission device **51** for connecting the first transmission shaft **1653** and the first roller **41** is a synchronous belt (the first manipulation synchronous belt **53**), and the first transmission device **56** for the second roller is also configured as a synchronous belt (the third synchronous belt **56**). That is, the first transmission shaft **1653** is connected to the fourth transmission shaft **55** through the third synchronous belt **56**. In this way, the first roller **41** and the second roller **42** are driven by the first transmission shaft **1653** with the same driving mode, which is conducive to simplifying the design. The third synchronous belt **56** is also the transfer synchronous belt in the first power transfer device **265**.

[0337] Therefore, as shown in FIG. **22**, the second transmission device **57** for the second roller is configured as a gear assembly. In the illustrated embodiment, the first manipulation device **30** includes two second rollers **42**, i.e., a second roller **42**A and a second roller **42**B. The gear assembly **57** includes a gear **57**C coaxially connected to the fourth transmission shaft **55**, a gear **57**A coaxially connected to the second roller **42**A and a gear **57**B coaxially connected to the second roller **42**B. The gear **57**C is engaged with the gear **57**A and gear **57**B respectively. Thus, the rotation direction of the fourth transmission shaft **55** is opposite to the rotation direction of the first transmission shaft **1653**, and the rotation direction of the second roller **42** is opposite to the rotation direction of the fourth transmission shaft **55**. That is, the rotation direction of the second roller **42** is opposite to the rotation direction of the first transmission shaft **1653**.

[0338] In the present application, the first additional roller **43** and the second additional roller **44** also participate in the conveying of the guidewire **12**, and may also be considered as a part of the first manipulation device **30**. The first additional roller **43** may also be considered as one first roller **41**. The second additional roller **44** may also be considered as one second roller **42** that does not have self-driving force and cannot rotate actively.

[0339] It is to be understood that in the above-mentioned device of transmission via the synchronous belt, the transmission may be completed by arranging the synchronous belt clamping rings **49** on the driving shaft and the driven shaft so that the synchronous belt is tightened by the two synchronous belt clamping rings **49**. During operation, the shaft and the synchronous belt clamping rings **49** are connected, for example, by a key and a keyway, so that they are synchronously rotatable, and the synchronous belt clamping rings **49** and the synchronous belt are rotated synchronously by frictional force.

[0340] In the present application, the first manipulation device **30** may also be referred to as a first conveying assembly **30**, and the first driving device **143** may be referred to as a first power assembly **143**.

[0341] In actual application, the base **142** of the movable power device **240** extends substantially along a vertical plane, and the first power shaft **145** and the first transmission shaft **1653** extend substantially along a horizontal direction. This allows the first carrying device **260** to be connected to the side of the movable power device **240**, and the first roller **41** and the second roller **42** of the first manipulation device **30** both extend substantially along the horizontal direction, that is, the first roller **41** and the second roller **42** are opposite to each other along a vertical direction.

[0342] In the present application, the specific structure of the first transmission device **21** is not limited. It may be understood that the first transmission device **21** includes a portion disposed in the movable power device **240** and a portion disposed in the first carrying device **260**.

[0343] The following describes how the second manipulation device **290** is controlled by the slave-side execution apparatus **200**.

[0344] The slave-side execution apparatus **200** further includes a second transmission device **22** connected between the second driving device and the second manipulation device **290** and configured to transfer the driving force of the second driving device to the second manipulation device **290**.

[0345] The second transmission device **22** is similar to the first transmission device **21**, and includes a portion disposed in the movable power device **240** and a portion disposed in the first carrying device **260**. As shown in FIGS. **5**, **11** and **12**, the second transmission device **22** includes a second power shaft **146**, a second transmission assembly **95** and a second power transfer device **266**.

[0346] The second power shaft **146** is used to connect the second manipulation device **290** and is disposed on the movable power device **240**. The second power shaft **146** is configured to be rotatable about its own axis relative to the movable power device **240**. The second power shaft **146** is, for example, disposed on the base **142** and penetrates through the base **142**, and an end of the second power shaft **146** facing the first carrying device **260** is in transmission connection with the second manipulation device **290**.

[0347] The second driving device **144** is, for example, disposed on the connecting frame **141** of the movable power device **240**. The second transmission assembly **95** is disposed on the movable power device **240**, e.g., on the base **142**. The second transmission assembly **95** is connected between the second driving device **144** and an end of the second power shaft **146** facing away from the first carrying device **260**, so that the second power shaft **146** is rotated under the driving of the second driving device **144**. For example, the second transmission assembly **95** includes a second driving roller **150** (referring to FIGS. **42** and **43**), a second driven roller **151** and a second synchronous belt **152**. The second driving roller **150** is connected to a driving end of the second driving device **144**. The second driven roller **151** is connected to an end of the second power shaft **146** facing away from the first carrying device **260**. The second synchronous belt **152** is connected between the second driving roller **150** and the second driven roller **151** to transfer the power generated by the second driving device **144** to the second power shaft **146** so as to cause it to rotate.

[0348] The second power transfer device **266** is disposed in the first carrying device **260**, e.g., in the second part **261**B of the carrying base. The second power transfer device **266** is connected between the second manipulation device **290** and the second power shaft **146** so that the second power shaft **146** drives the second manipulation device **290** to operate. The position of the second power transfer device **266** corresponds to the position of the second power shaft **146**, and the second power transfer device **266** is engaged with the second power shaft **146**. Wherein the second power transfer device **266** includes a transfer gear **1664**, and a gear engaging transmission is formed between the second power transfer device **266** and the second manipulation device **290**.

[0349] For example, the second power transfer device **266** includes a second limiting frame **1661**, a second bearing **1663**, a second transmission shaft **1662** and the transfer gear **1664**. A hole corresponding to the second power shaft **146** is provided at the bottom of the carrying base **261**. The second limiting frame **1661** is disposed on the carrying base **261** and corresponds to the hole, and the second bearing **1663** is provided on the second limiting frame **1661**. The second transmission shaft **1662** is connected to the inner ring of the second bearing **1663**, and an end of the second transmission shaft **1662** facing the movable power device **240** is engaged with the second power shaft **146**. An end of the second transmission shaft **1662** facing away from the movable power device **240** is fixedly connected with the transfer gear **1664**. The transfer gear **1664** is configured to connect the second manipulation device **290** so that a gear engaging transmission is formed between the second power transfer device **266** and the second manipulation device **290**. The transfer gear **1664** is configured, for example, as a bevel gear.

[0350] As shown in FIGS. **23** and **24**, as described above, the carrying base **261** is provided with the functional manipulation seat **162** for mounting the medical apparatus **10**. The functional manipulation seat **162** includes a first side **162**A of the functional manipulation seat and a second side **162**B of the functional manipulation seat arranged opposite to each other. Wherein the medical apparatus **10** is detachably connected to the first side **162**A of the functional manipulation seat. The functional manipulation seat **162** is provided with an operation opening **171**.

[0351] The second manipulation device **290** includes a functional gear **172** and a bevel gear **173**. The functional gear **172** is rotatably disposed on the second side **162**B of the functional manipulation seat, and at least partially exposed from the operation opening **171** to the first side **162**A of the functional manipulation seat, so as to be able to form an engagement with the operating gear **13** of the medical apparatus **10**. The bevel gear **173** is coaxially connected to the functional gear **172**, and thus synchronously rotatable with the functional gear **172**. The bevel gear **173** is engaged with the transfer gear **1664** of the second power transfer device **266**. When the transfer gear **1664** is rotated, the transfer gear **1664** drives the bevel gear **173** to rotate, which in turn drives the functional gear **172** to rotate and finally drives the operating gear **13** to rotate.

[0352] Specifically, the second side **162**B of the functional manipulation seat is provided with two gear seats **1721** at both ends of the operation opening **171**. One third bearing **1722** is provided on each of the two gear seats **1721**, and two ends of the rotating shaft of the functional gear **172** are fixedly connected to the inner rings of two third bearings **1722**, respectively. One end of the rotating shaft of the functional gear **172** is also fixedly connected to the bevel gear **173** so that the functional gear **172** and the bevel gear **173** are coaxially rotatable. The second side **162**B of the functional manipulation seat is used to face the inside of the second part **261**B of the carrying base, and the transmission device **266** is disposed in the second part **261**B of the carrying base, so that it is easy for the bevel gear **173** to engage with the transfer gear **1664**.

[0353] The first carrying device **260** also includes a supporting structure **97** for supporting the medical apparatus **10**. The supporting structure **97** is disposed on the functional manipulation seat **162**, and includes a first bracket **175**, a second bracket **176** and a second elastic member **177**. The first bracket **175** is disposed on the first side **162**A of the functional manipulation seat. The second bracket **176** is also disposed on the first side **162**A of the functional manipulation seat and is spaced apart from the first bracket **175** along the conveying direction DF to support the medical apparatus **10** along with the first bracket **175**. The second bracket **176** is configured to be movable relative to the functional manipulation seat **162** along the conveying direction DF. The second elastic member **177** is connected to the second bracket **176** for applying a force to the second bracket **176** to move the second bracket **176** away from the first bracket **175** along the conveying direction DF.

[0354] Specifically, the functional manipulation seat **162** is provided with an opening (not shown) extending along the conveying direction DF, and a portion of the second bracket **176** is disposed in the opening and is movable in the opening along the conveying direction DF. The supporting structure **97** further includes a connecting seat **178** and a bottom bracket **179**. The connecting seat **178** is disposed at the second side **162**B of the functional manipulation seat, and is closer to the first bracket **175** relative to the opening. The connecting seat **178** has a channel **1781** extending along the conveying direction DF. The bottom bracket **179** is connected to the portion of the second bracket **176** located in the opening, and at least partially extends into the channel **1781**. Wherein the second elastic member **177** is disposed in the channel **1781** and connected between the connecting seat **178** and the bottom bracket **179**. The second elastic member **177** is, for example, a spring. Thus, the first bracket **175** and the second bracket **176** may be used for mounting the medical apparatus **10**, and the medical apparatus **10** may be conveniently clamped and removed by using the movable second bracket **176**.

[0355] In an embodiment not shown in the present application, the first carrying device **260** is provided with a plurality of second manipulation devices **290** for respectively operating different medical apparatuses **10** to achieve different medical functions. Alternatively, the plurality of second manipulation devices **290** are respectively used to operate different medical function mechanisms **13** of the medical apparatus **10**.

[0356] FIGS. **25** and **26** show another example of a movable assembly **291** in which the movable frame **117** has two second guide rails **119** arranged vertically at intervals and extending parallel to each other. In addition, the movable assembly **291** is also driven to move by a drive structure other than the lead screw pair. For example, the movable frame **117** is provided with a rack extending along the conveying direction DF. The main body power device **210** includes a gear that engages with the rack. The main body driving device **124** drives the gear to rotate, the gear transfers power to the rack, and the rack drives the movable frame **117** to move.

[0357] The structure of the second conveying assembly **60** is described below.

[0358] As shown in FIG. **2**, the second conveying assembly **60** includes a second conveying assembly base **61**, at least one third roller and at least one fourth roller. Wherein the second conveying assembly base **61** is detachably connected to the second power assembly **14**. The third roller is disposed on the second conveying assembly base. An axis of the third roller is not parallel to the conveying direction DF. Optionally, the axis of the third roller is perpendicular to the conveying direction DF, e.g., is a second additional direction D**21**. The fourth roller is disposed on the second conveying assembly base **61**, and is arranged opposite to the third roller (one by one opposite to each other), so as to clamp the guidewire **12** and/or the catheter **11** along with the third roller. It may be understood that the axis of the fourth roller is parallel to the axis of the third roller.

[0359] In the second conveying assembly **60**, the third roller may be a driving roller (driven to rotate by the fourth driving device), and the fourth roller may be a driven roller.

[0360] According to the aforementioned method of using the slave-side execution apparatus **200** in surgery, even if the fourth driving device fails, the third roller and the fourth roller may be passively rotated under the action of frictional force to achieve the clamping and supporting of the guidewire **12** and/or the catheter **11**. Accordingly, in the present application, the first roller **41** and the second roller

42 are designed as driving rollers, which may ensure the stable operating performance of the slave-side execution apparatus **200** to a great extent. Of course, it is also possible to control whether the fourth driving device outputs the driving force according to needs of the surgery, i.e., to flexibly control the third roller as a driving roller or a driven roller.

[0361] Optionally, the diameter of the third roller is the same as that of the fourth roller. In other words, the third roller is configured as the same roller as the fourth roller.

[0362] The second conveying assembly base **61** is connected to the second power assembly **14** by, for example, locking, magnetic attraction, etc.

[0363] In the embodiments shown in FIGS. **1** and **2**, the axial direction D**21** of the fourth roller and the third roller is an up-down direction. The fourth and third rollers are spaced apart along a horizontal first additional direction D**11**. Optionally, the distance between the fourth roller and the third roller is adjustable to accommodate the guidewires **12** and/or the catheters **11** of different diameters.

[0364] FIGS. **28** to **34** show the second power assembly **14** and the second conveying assembly **60** of another example.

[0365] As shown in FIGS. **29** and **30**, the second conveying assembly **60** includes at least one pair of third rollers **252** and fourth rollers **262** arranged oppositely, and the axes of the third rollers **252** and the axes of the fourth rollers **262** are parallel and are spaced apart along the first additional direction D**11** so that a channel **231** extending along the second additional direction D**21** is formed therebetween. Preferably, the axis of the third roller **252** (extending along an axial direction DA), the first additional direction D**11**, and the second additional direction D**21** are perpendicular to each other. The guidewire **12** and/or the catheter **11** pass through the channel **231**, and the third roller **252** and the fourth roller **262** arranged opposite each other are used to jointly clamp the guidewire **12** and/or the catheter **11**. The third roller **252** is rotatable about its own axis under the driving of the fourth driving device **221** of the second power assembly **14**. Even if only one third roller **252** is rotated about its own axis under the driving of the fourth driving device **221** of the second power assembly **14**, the second conveying assembly **60** may cause all the third rollers **252** and all the fourth rollers **262** to rotate by frictional force. Thus, the guidewire **12** and/or the catheter **11** are clamped and conveyed jointly by the third roller **252** and the fourth roller **262** arranged opposite each other.

[0366] In the present application, a driving device refers to a device that includes an active component that may output a driving force, such as a component that operates with a power source and outputs torque, for example an electric control component such as a motor, cylinder, etc. The active component, also known as an active drive component, usually operates under the control of the control module (e.g., a processor module **302**). The control module controls the operation of the drive components according to the signal monitored by the sensor or the operating parameters of the drive components, so that the device may operate in a controlled manner.

[0367] When the second conveying assembly **60** includes a plurality of pairs of third rollers **252** and fourth rollers **262** arranged opposite each other along the first additional direction D**11**, the plurality of pairs of the third rollers **252** and the fourth rollers **262** are arranged in parallel along the second additional direction D**21**. Alternatively, a plurality of third rollers **252** are arranged in parallel along the second additional direction D**21**, and a plurality of fourth rollers **262** are arranged in parallel along the second additional direction D**21**. The third rollers **252** and the fourth rollers **262** are arranged in one-to-one correspondence. Preferably, the third roller **252** and the fourth roller **262** are configured as the same rollers (at least the same diameter). In the present application, the direction in which the guidewire **12** and/or the catheter **11** enter the blood vessel is forward, and the direction in which the guidewire **12** and/or the catheter **11** exit the blood vessel is rear. It may also be understood that the second additional direction D**21** is a bidirectional direction, where one direction is the forward and the other direction is the rear. The guidewire **12** and/or the catheter **11** is allowed to be conveyed more stably by providing a plurality of pairs of third rollers **252** and fourth rollers **262**.

[0368] The second conveying assembly **60** may also be used to mount a large sheath **16** through which the catheter **11** extends. The guidewire **12** extends through the catheter **11**.

[0369] Specifically, as shown in FIGS. **29** and **30**, the second conveying assembly **60** includes a box **340**, a third roller assembly **250**, and a fourth roller assembly **360**. The third roller assembly **250** includes the third roller **252**. The fourth roller assembly **360** includes the fourth roller **262**. The third roller assembly **250** and the fourth roller assembly **360** are both disposed in the box **340**. The box **340** is detachably connected to the second power assembly **14**.

[0370] The box **340** constitutes the housing of the second conveying assembly **60**, including, for example, a box body **241** and a box cover **242**. The box body **241** has an accommodation space **245** for accommodating respective components of the second conveying assembly **60**. The box cover **242** is, for example, connected to the box body **241** by bolts, thereby enclosing the accommodation space **245** to a certain extent.

[0371] The second power assembly **14** may be detachably connected to the box cover **242**. For example, the second power assembly **14** is provided with a pin **229**, and the box cover **242** is provided with a mounting hole **249** to accommodate the pin **229**. Thus, the second conveying assembly **60** may be mounted to the second power assembly **14** (the second conveying assembly **60** is hung on the side wall of the second power assembly **14**) by holding the box **340** with hands and fitting the mounting hole **249** over the pin **229** so that the pin **229** is inserted into the mounting hole **249**, and the second conveying assembly **60** may be detached from the second power assembly **14** by the reverse operation of removing the pin **229** from the mounting hole **249**. The end of the pin **229** and/or the wall of the mounting hole **249** may be provided with a guide surface so that the pin **229** may be easily inserted into the mounting hole **249**. The second power assembly **14** may also be provided with a second power assembly limiting surface **228**, and the box cover **242** may also be provided with a second conveying assembly limiting surface **248**. The second power assembly limiting surface **228** matches the shape of the second conveying assembly limiting surface **248** to guide the mounting of the second conveying assembly **60** through mutual contact and to position the second conveying assembly **60** relative to the second power assembly **14**. The second power assembly limiting surface **228** and the second conveying assembly limiting surface **248** include, for example, a feature shape (e.g., an arc) by which they are positioned relative to each other.

[0372] The box body **241** is equivalent to the second conveying assembly base, also referred to as a second conveying assembly base **241**. The third roller assembly **250** and the fourth roller assembly **360** are both disposed on the second conveying assembly base **241**. A large sheath mounting portion **232** for mounting the large sheath **16** is also provided on the second conveying assembly base **241**.

[0373] The third roller assembly **250** includes a fifth fixed seat **251** located in the accommodation space **245** and disposed at the second conveying assembly base **241**. The position of the fifth fixed seat **251** relative to the second conveying assembly base **241** is maintained unchanged, for example they are connected by bolts. The third roller **252** is disposed on the fifth fixed seat **251**. The fourth roller assembly **360** includes a fifth movable seat **269** located in the accommodation space **245** and disposed at the second conveying assembly base **241**. The fourth roller **262** is disposed on the fifth movable seat **269**. The fifth fixed seat **251** and the fifth movable seat **269** are arranged along the first additional direction D**11**.

[0374] The third roller assembly **250** may include a plurality of third rollers **252**. The third roller assembly **250** is configured such that one of the third rollers **252** is used for rotating about its own axis under the driving of the fourth driving device **221**, and each of the other third rollers **252** is rotated about its own axis under the driving of another third roller **252**. Thus, the fourth driving device **221** only needs to be connected with one third roller **252**, the connection between the fourth driving device **221** and the second conveying assembly **60** is simple.

[0375] For example, as shown in FIG. **31**, the third roller assembly **250** may further include a plurality of first rotating shafts **253** and at least one first transmission belt **254**. The first rotating shaft **253** is correspondingly arranged with the third roller **252** and is coaxially connected with the corresponding third roller **252**. That is, each third roller **252** has its own first rotating shaft **253**, and the two share a first axis P**1**. The third roller **252** may, for example, be sleeved on the periphery of the first rotating shaft **253**, and they are connected by the key and the keyway so that they are synchronously rotatable. The third roller **252** may also be integrally formed with the first rotating shaft **253**. The first rotating shaft **253** may be connected in a shaft hole of the fifth fixed seat **251** via a bearing, so that the third roller **252** is connected to the fifth fixed seat **251** through the first rotating shaft **253** and then connected to the second conveying assembly base **241** through the fifth fixed seat **251**. Wherein a part of the first rotating shafts **253** are used for rotating about its own axis Pl under the driving of the fourth driving device **221**, each first transmission belt **254** is connected to two first rotating shafts **253**, and the other rotating shafts are all rotated under the driving of the first transmission belt **254**. For example, a clamping ring is disposed around the periphery of the first rotating shaft **253**, and the first transmission belt **254** is tensioned by the clamping rings of two first rotating shafts **253**, so that the two first rotating shafts **253** are connected through the first transmission belt **254** to rotate synchronously. Thus, a part of the third rollers **252** are rotated under the driving of the fourth driving device **221**, and the remaining third rollers **252** are each driven to rotate by another third roller **252** via the first transmission belt **254**.

[0376] In the illustrated embodiment, one first rotating shaft **253** is used for rotating about its own axis Pl under the driving of the fourth driving device **221**. The number of the first transmission belts **254** is one less than the number of the third rollers **252**, that is, one less than the number of the first rotating shafts **253**. Thus, one third roller **252** is rotated under the driving of the fourth driving device **221**, and the remaining third rollers **252** are each driven to rotate by another third roller **252** through the first transmission belt **254**.

[0377] Specifically, as shown in FIG. **29**, the fourth driving device **221** includes a fourth driving component **222**, a fourth transmission device **223** and a fourth driving shaft **224**. The fourth driving component **222** is, for example, configured as a motor, e.g., a fourth servomotor. The fourth transmission device **223** may be configured as a gear assembly, which is connected between an output shaft of the fourth servomotor and the fourth driving shaft **224**, so that the fourth driving shaft **224** may be driven to rotate by the fourth servomotor. When the second conveying assembly **60** is mounted to the second power assembly **14**, the fourth driving shaft **224** is coaxially connected with one first rotating shaft **253** so that the one first rotating shaft **253** may be rotated synchronously with the fourth driving shaft **224**. The fourth driving shaft **224** and the one first rotating shaft **253** may form a snap-fit connection with each other by the spline at the end.

[0378] As shown in FIG. **30**, the box cover **242** is provided with a first through hole **244** through which the fourth driving shaft **224** passes.

[0379] In the illustrated embodiment, the second conveying assembly **60** includes two third rollers **252** (i.e., the second conveying assembly **60** includes two first rotating shafts **253**) and one first transmission belt **254**. The two third rollers **252** are the first third roller **252**A and the second third roller **252**B, respectively. The fourth driving shaft **224** is connected to the first rotating shaft **253** of the first third roller **252**A. The two first rotating shafts **253** are connected via the first transmission belt **254**.

[0380] The fifth movable seat **269** is configured to be movable relative to the second conveying assembly base **241** along the first additional direction D**11** so that the fifth movable seat **269** is movable relative to the fifth fixed seat **251** along the first additional direction D**11**, and the fourth roller **262** is movable relative to the third roller **252** along the first additional direction D**11**. The distance between the fourth roller **262** and the third roller **252** is changeable, that is, the width of the channel **231** is changeable, so that the second conveying assembly **60** may clamp the guidewires **12** and/or the catheters **11** of different diameters.

[0381] For example, the second conveying assembly **60** further includes a guide member **246** located in the accommodation space **245** and disposed at the second conveying assembly base **241**, e.g., mounted to the second conveying assembly base **241** by bolts. The guide member **246** extends along the first additional direction D**11**. The fifth movable seat **269** is connected to the guide member **246** and is movable relative to the guide member **246** along the first additional direction D**11**. For example, the guide member **246** includes a guide rod **247** extending along the first additional direction D**11**. The fifth movable seat **269** includes a guide rod through hole **267**. The guide rod **247**

extends through the guide rod through hole **267**, and is movable in the guide rod through hole **267** along the first additional direction D**11** relative to the guide rod through hole **267**. When the position of the guide member **246** is unchanged relative to the second conveying assembly base **241**, the fifth movable seat **269** is connected to the second conveying assembly base **241** via the guide member **246** and is movable relative to the second conveying assembly base **241**.

[0382] In the illustrated embodiment, in order to allow the fifth movable seat **269** to move stably, one guide rod through holes **267** is provided at each of the opposite ends of the fifth movable seat **269** along the second additional direction D**21**, and two guide members **246** are correspondingly disposed in the accommodation space **245**.

[0383] To enable the fifth movable seat **269** to move, as shown in FIG. **30** to FIG. **33**, the second conveying assembly **60** further includes a position adjustment assembly **270**. The position adjustment assembly **270** is located in the accommodation space **245** and is connected to the fifth movable seat **269** for driving the fifth movable seat **269** to move along the first additional direction D**11** under the driving of the third driving device **225** of the second power assembly **14** so as to change the distance between the fourth roller **262** and the third roller **252**. The third driving device may be configured to, for example, allow the fifth movable seat stay at any position within a continuous position range along the first additional direction D**11**. That is, the position of the fifth movable seat may be adjusted infinitely, so that the distance between the fourth roller **262** and the third roller **252** may be adjusted infinitely, and the guidewires or the catheters of different diameters may be better adapted.

[0384] The position adjustment assembly **270** includes, for example, an adjusting gear **272** and an adjusting rack **271**. The adjusting gear **272** is located in the accommodation space **245** and is disposed at the second conveying assembly base **241** for rotating relative to the second conveying assembly base **241** under the driving of the third driving device **225** of the second power assembly **14**. A rotation axis of the adjusting gear **272** is perpendicular to the first additional direction D**11**, e.g., parallel to the axial direction DA. The adjusting rack **271** is engaged with the adjusting gear **272**, and the adjusting rack extends along the first additional direction D**11** and is connected to the fifth movable seat **269**. When the adjusting gear **272** is rotated, the adjusting rack **271** is moved along the first additional direction D**11**, and thus the fifth movable seat **269** is driven to move along the first additional direction D**11**.

[0385] The adjusting rack **271** is, for example, connected to a hole wall of one of the guide rod through holes **267**, so that the position adjustment assembly **270** is located on one side of the fifth movable seat **269** and the fifth fixed seat **251**, and does not interfere with the fifth movable seat **269** and the fifth fixed seat **251**.

[0386] As shown in FIG. **29**, the third driving device **225** includes a third driving component **226**, a third transmission device (not shown) and a third driving shaft **227**. The third driving component **226** is, for example, configured as a motor, e.g., a third servomotor. The third transmission device may be configured as a gear assembly, which is connected between an output shaft of the third servomotor and the third driving shaft **227**, so that the third driving shaft **227** may be driven to rotate by the third servomotor may. When the second conveying assembly **60** is mounted to the second power assembly **14**, the third driving shaft **227** is coaxially connected with the third rotating shaft **273** of the adjusting gear **272**, so that the adjusting gear **272** is synchronously rotatable with the third driving shaft **227**. The third rotating shaft **273** and the third driving shaft **227** may form a snap-fit connection with each other by the spline at the end. The third rotating shaft **273** may be disposed in a shaft bore of the second conveying assembly base **241** via a bearing. The adjusting gear **272** may be sleeved on the periphery of the third rotating shaft **273**, and they are connected by the key and the keyway, so that they are coaxial and rotated synchronously. The adjusting gear **272** may also be integrally formed with the third rotating shaft **273**.

[0387] The output shaft of the servomotor may rotate continuously and infinitely so that the position of the adjusting rack **271** may be infinitely adjusted to achieve a stepless adjustment of the distance between the fourth roller **262** and the third roller **252**. Although the servomotor has been generally digitally controlled, the rotation angle of the servomotor has a high control accuracy (for example, relative to the stepper motor), so that the displacement of the rack **271** may be controlled at the micron level, and may be regarded as a stepless adjustment relative to the diameter of the guidewire or the catheter at the millimeter level in the present application.

[0388] The position adjustment assembly **270** is composed of rigid elements that, and may be located in a stable position under the action of the third driving device **225** so that a stable distance is maintained between the fourth roller **262** and the third roller **252**, thus indicating that a sufficient clamping force may be provided by the third driving device **225** to clamp the guidewire and/or the catheter more firmly. The second conveying assembly **60** has more stable operating performance compared to the solution of using spring to pull the roller closer in the prior art. As shown in FIG. **30**, the box cover **242** is provided with a second through hole **243** through which the third driving shaft **227** passes.

[0389] Thus, the first rotating shaft **253** is a first component of the third roller assembly **250** for connecting the fourth driving device **221**, and the third rotating shaft **273** is a third component of the position adjustment assembly **270** for connecting the third driving device **225**. Preferably, the first component and the third component are connected to the second power assembly **14** on the same side of the second conveying assembly **60**. Preferably, the channel **231** (i.e., the gap between the third roller **252** and the fourth roller **262**) and the ends of the first component (**253**) and the third component (**273**) connected to the second power assembly **14** are respectively located on different sides of the second conveying assembly **60**, e.g., on opposite sides of the second conveying assembly **60** (the channel **231** is located on a side of the second conveying assembly **60** facing away from the second power assembly **14**, and the ends of the first and third components connected to the second power assembly **14** are located on a side of the second conveying assembly **60** facing the second power assembly **14**), thereby facilitating the installation of the guidewire **12** and/or the catheter **11**. Preferably, the first rotating shaft **253** and the third rotating shaft **273** are arranged in parallel so that both of them may be connected to their respective driving devices at the same time, which is convenient for users to operate.

[0390] The second conveying assembly **60** may further include a biasing member **238** for applying a force to the fifth movable seat **269** to move away from the third roller **252** (i.e., the fifth fixed seat **251**) along the first additional direction D**11**. The biasing member **238** may be disposed between the fifth movable seat **269** and the fifth fixed seat **251**. In the illustrated embodiment, the biasing member **238** is configured as an elastic member, such as a spring. For example, the fifth movable seat **269** is provided with a mounting groove **268** for placing a spring **238**, and the mounting groove **268** extends along the first additional direction D**11**. The fifth fixed seat **251** is provided with an acting portion **258**, and the spring **238** abuts against or is connected to the acting portion **258** so as to be clamped by the fifth movable seat **269** and the fifth fixed seat **251**.

[0391] The biasing member **238** assists the position adjustment assembly **270** to hold the fifth movable seat **269** in a stable position relative to the fifth fixed seat **251**. The biasing member **238** also makes it difficult for the fourth roller **262** to contact the third roller **252**. For example, it is possible for the biasing member **238** to make the channel **231** have a minimum width, that is, there may always be a gap between the third roller **252** and the fourth roller **262** to avoid direct contact between the third roller **252** and the fourth roller **262**. This may protect the third roller **252** and the fourth roller **262**, as well as the guidewire **12** and/or the catheter **11** in the channel **231**. The biasing member **238** is used to increase the width of the channel **231**, which facilitates the installation of the guidewire **12** and/or the catheter **11**. For example, when the apparatus is not powered on, the fifth movable seat **269** may be pushed away from the fifth fixed seat **251** by the biasing member **238** to open the channel **231** and facilitate the installation of the guidewire **12** and/or the catheter **11**.

[0392] In the embodiments not shown in the present application, the biasing member **238** includes a first magnet and a second magnet. The first magnet is disposed on a side of the fifth fixed seat **251** facing the fifth movable seat **269**, and the second magnet is disposed on a side of the fifth movable seat **269** facing the fifth fixed seat **251**. The first magnet and the second magnet are magnetically repulsive.

[0393] As described previously, the third roller **252** is configured as a driving roller. Preferably, the fourth roller **262** is also configured as a driving roller so that the second conveying assembly **60** may have sufficient conveying force. Preferably, the fourth roller **262** is driven by the third roller **252** to rotate about its own rotation axis rather than being driven by the second power assembly **14**, which can simplify the transmission connection between the second conveying assembly **60** and the second power assembly **14**.

[0394] In order to drive the fourth roller **262** to rotate, the second conveying assembly **60** further includes a roller transmission assembly **280**. A first end of the roller transmission assembly **280** is connected to the third roller **252**, and a second end thereof is connected to the fourth roller **262**, so that the third roller **252** drives the fourth roller **262** to rotate in the opposite direction at the same rotational speed. In other words, the driving force provided by the third roller **252** is transferred to the fourth roller by the roller transmission assembly **280**.

[0395] In a case where all the third rollers **252** are driving rollers, the first end of the roller transmission assembly **280** may be connected to any one of the third rollers **252**. The fourth roller assembly **360** may include a plurality of fourth rollers **262**, and the fourth roller assembly **360** is configured such that one of the fourth rollers **262** is used for rotating about its own axis under the driving of the third roller **252**, and each of the other fourth rollers **262** is rotated about its own axis under the driving of another fourth roller **262**. Thus, the roller transmission assembly **280** only needs to be connected with one fourth roller **262**, and it is possible to simplify the connection between the roller transmission assembly **280** and the fourth roller assembly **360**. At the same time, the first end of the roller transmission assembly **280** is also connected to only one third roller **252**, which simplifies the connection between the roller transmission assembly **280** and the third roller assembly **250**.

[0396] For example, as shown in FIG. **31**, similar to the third roller assembly **250**, the fourth roller assembly **360** may further include a plurality of second rotating shafts **263** and at least one second transmission belt **264**. The second rotating shaft **263** is correspondingly arranged with the fourth roller **262** and is coaxially connected with the corresponding fourth roller **262**. That is, each fourth roller **262** has its own second rotating shaft **263**, and the two share a second axis P**2**. The fourth roller **262** may, for example, be sleeved on the periphery of the second rotating shaft **263**, and they are connected by the key and the keyway so that they are synchronously rotatable. The fourth roller **262** may also be integrally formed with the second rotating shaft **263**. The second rotating shaft **263** may be connected in a shaft hole of the fifth movable seat **269** via a bearing, so that the fourth roller **262** is connected to the fifth movable seat **269** through the second rotating shaft **263** and then connected to the second conveying assembly base **241** through the fifth movable seat **269**. Wherein a part of the second rotating shafts **263** are used for rotating about its own axis P**2** under the driving of the third roller **252**, each second transmission belt **264** is connected to two second rotating shafts **263**, and the other second rotating shafts **263** are driven to rotate by the second transmission belt **264**. For example, a clamping ring is disposed around the periphery of the second rotating shaft **263**, and the second transmission belt **264** is tensioned by the clamping rings of two second rotating shafts **263**, so that the two second rotating shafts **263** are connected through the second transmission belt **264** to rotate synchronously. Thus, a part of the fourth rollers **262** are rotated under the driving of the third roller **252** through the roller transmission assembly **280**, and the remaining fourth rollers **262** are each driven to rotate by another fourth roller **262** through the second transmission belt **264**.

[0397] In the illustrated embodiment, one second rotating shaft **263** is used for rotating about its own axis P**2** under the driving of the third roller **252**, and the other second rotating shafts **263** are each driven to rotate through the second transmission belt **264**. The number of the second transmission belts **264** is one less than the number of the fourth rollers **262**, that is, one less than the number of the second rotating shafts **263**. Thus, one fourth roller **262** is rotated under the driving of the third roller **252** through the roller transmission assembly **280**, and the remaining fourth rollers **262** are each driven to rotate by another fourth roller **262** through the second transmission belt **264**.

[0398] In the illustrated embodiment, the second conveying assembly **60** includes two fourth rollers **262** (i.e., the second conveying assembly **60** includes two second rotating shafts **263**) and one second transmission belt **264**. The two second rotating shafts **263** are connected by the second transmission belt **264**. The two fourth rollers **262** are the first fourth roller **262**A and the second fourth roller **262**B, respectively. The second end of the roller transmission assembly **280** is connected to the second rotating shaft **263** of the second fourth roller **262**B. Since the rotating shaft of the first third roller **252**A is connected to the driving shaft **224**, the roller transmission assembly **280** is more conveniently connected to the rotating shaft of the second third roller **252**B. Further, the roller transmission assembly **280** is connected to the rotating shaft of the second fourth roller **262**B in the vicinity. In other words, the Pth one of the third rollers **252** is used for rotating about its own axis P**1** under the driving of the fourth driving device **221**, the first end of the roller transmission assembly **280** is connected to the Qth one of the third rollers **252**, the second end of the roller transmission assembly **280** is connected to the Qth one of the fourth rollers **262** (the Qth one of the third rollers **252** and the Qth one of the fourth roller **262** are a pair), and P is not equal to Q.

[0399] As shown in FIG. **30** to FIG. **34**, the roller transmission assembly **280** may include N transmission gears **281** that are engaged sequentially. Wherein the first one of the transmission gears **281** is disposed at the first end of the roller transmission assembly **280** and is rotated synchronously with the third roller **252** (such as the second third roller **252**B); the last one of the transmission gears **281** is disposed at the second end of the roller transmission assembly **280** and is rotated synchronously with the fourth roller **262** (such as the second third roller **252**B). Since it is necessary for the second conveying assembly **60** to rotate the fourth roller **262** in the opposite direction to the third roller **252**, the number N of the transmission gears **281** is an even number.

[0400] For example, similar to the adjusting gear **272**, each transmission gear **281** has its own rotating shaft. A rotating shaft of the first one of the transmission gears **281** is coaxially connected to the first rotating shaft **253** of the third roller **252**, and a rotating shaft of the last one of the transmission gears **281** is coaxially connected to the second rotating shaft **263** of the fourth roller **262**, so that the power is transferred form the third roller **252** to the fourth roller **262** via a gear set.

[0401] In the case where the third roller **252** and the fourth roller **262** are configured as the same roller, the roller transmission assembly **280** has a transmission ratio 1:1. For example, all transmission gears **281** are configured as the same gear.

[0402] As described previously, the fifth movable seat **269** is movable along the first additional direction D**11** relative to the fifth fixed seat **251**. In order to allow the roller transmission assembly **280** to always be well connected to the fourth roller **262** and the third roller **252**, the roller transmission assembly **280** is configured such that the second end of the roller transmission assembly **280** is movable relative to the first end of the roller transmission assembly **280** along the first additional direction D**11**, so as to adapt to the movement of the fifth movable seat **269** along the first additional direction D**11**. Specifically, the roller transmission assembly **280** is configured such that the last one of the transmission gears **281** is movable relative to the first one of the transmission gears **281** along the first additional direction D**11**. Since the relative position between the last one of the transmission gears **281** and the first one of the transmission gears **281** is not fixed, it cannot be guaranteed that the two are well connected at all times. Thus, the last one of the transmission gears **281** and the first one of the transmission gears **281** need to be connected through other transmission gears **281**, and thus the number N of the transmission gears **281** is at least 4.

[0403] In order to achieve the extension and retraction of the roller transmission assembly **280** along the first additional direction D**11**, as shown in FIG. **34**, the roller transmission assembly **280** also includes a first connecting arm **283** and a second connecting arm **287**. The first connecting arm **283** includes a first end **284** of the first connecting arm and a second end **285** of the first connecting arm arranged in the opposite direction. The first end **284** of first connecting arm is the first end of the roller transmission assembly **280**. The first one of the transmission gears **281** is disposed at the first end **284** of the first connecting arm. The second connecting arm **287** includes a first end **288** of the second connecting arm and a second end **289** of the second connecting arm arranged in the opposite direction. The second end **289** of the second connecting arm is the second end of the roller transmission assembly **280**. The last one of the transmission gears **281** is disposed at the second end **289** of the second connecting arm. The N transmission gears **281** are disposed at the first connecting arm **283** and the second connecting arm **287**. Wherein the first end **288** of the second connecting arm is rotatably connected to the second end **285** of the first connecting arm about a third axis P**3**, and the third axis P**3** is parallel to the axis P**1** of the third roller **252** (also parallel to the axis P**2** of the fourth roller **262**).

[0404] The first connecting arm **283** and the second connecting arm **287** are rotatably connected so that the roller transmission assembly **280** may be bent, thereby changing the distance between the first end and the second end of the roller transmission assembly **280**.

[0405] The rotating shaft of each transmission gear **281** is mounted into a shaft hole of the first connecting arm **283** or the second connecting arm **287**, for example via a bearing, so that the transmission gear **281** is rotatable relative to the respective connecting arms.

[0406] In order to ensure that N transmission gears **281** are always well connected, it is necessary to ensure that the distance between the axes of two adjacent transmission gears **281** is constant during the bending of the roller transmission assembly **280**. Therefore, the roller transmission assembly **280** is configured such that the third axis P**3** coincides with an axis of one transmission gear **281** other than the first one of the transmission gears **281** and the last one of the transmission gears **281**. In other words, one transmission gear **281** other than the first one of the transmission gears **281** and the last one of the transmission gears **281** is simultaneously positioned at the second end **285** of the first connecting arm and the first end **288** of the second connecting arm. The second end **285** of the first connecting arm and the first end **288** of the second connecting arm may be rotatably connected through the rotating shaft of the one transmission gear **281**, so that the second end **285** of the first connecting arm and the first end **288** of the second connecting arm are rotatable relative to each other about the axis of the one transmission gear **281**.

[0407] In the illustrated embodiment, the roller transmission assembly **280** includes four transmission gears **281**, which are the first transmission gear **281**A, the second transmission gear **281**B, the third transmission gear **281**C and the fourth transmission gear **281**D, respectively. The fourth transmission gear **281**D is also the last one of the transmission gears. The four transmission gears **281** are engaged sequentially. Wherein the first transmission gear **281**A and the second transmission gear **281**B are disposed at the first connecting arm **283**, the third transmission gear **281**C is simultaneously positioned at the second end **285** of the first connecting arm and the first end **288** of the second connecting arm, and the second end **285** of the first connecting arm and the first end **288** of the second connecting arm are rotatably connected through the rotating shaft of the third transmission gear **281**C. Thus, the first transmission gear **281**A, the second transmission gear **281**B and the third transmission gear **281**C are all disposed at the first connecting arm **283**, and the relative positions of the three transmission gears **281** are fixed. The third transmission gear **281**C and the fourth transmission gear **281**D are both disposed at the second connecting arm **287**, and the relative positions of the two transmission gears **281** are fixed. In this way, the distance between the two adjacent transmission gears **281** is always constant when the first connecting arm **283** and the second connecting arm **287** are rotated relatively, and all the transmission gears **281** may be well engaged all the time.

[0408] Of course, the second end **285** of the first connecting arm and the first end **288** of the second connecting arm may also be rotatably connected by the rotating shaft of the second transmission gear **281**B.

[0409] In the illustrated embodiment, the first additional direction D**11** is an up-down direction so that the third roller **252** and the fourth roller **262** are placed horizontally. When the guidewire and/or the catheter is installed, the roller located below may act as a support for the guidewire and/or the catheter, facilitating the placement of the guidewire and/or the catheter in the channel **231**. The rollers are horizontally placed so that the second power assembly **14** (or the driving device) may be disposed on the side of the second conveying assembly **60** (also the rollers). Compared to the solution in the prior art where the roller is placed vertically and the driving device is located below the roller, the second conveying assembly **60** is more convenient to be close to the surgical patient. Thus, it is possible to reduce the lengths of the guidewire and the catheter. In particular, when the second conveying assembly **60** is mounted with the large sheath **16**, the second conveying assembly **60**, for example, is used for artificial heart valve implantation surgery. Reducing the lengths of the guidewire and the catheter to facilitate the surgery operation is of great significance for ensuring the quality of the surgery.

[0410] In the illustrated embodiment, the third roller **252** is located above the fourth roller **262** so that it may be designed such that the second conveying assembly **60** is connected only with the lower half of the second power assembly **14** and not extend to the upper half of the second power assembly **14**. In this way, most of the structure of the second power assembly **14** is located above the second conveying assembly **60**, and it is possible to dispose a detachable cover of the housing of the second power assembly **14** above the second conveying assembly **60** and facilitate the overhaul of the second power assembly **14**. Furthermore, the second power assembly **14** is only connected to the upper half of the second conveying assembly **60** and does not extend to the lower half of the second conveying assembly **60**, which facilitates the second conveying assembly **60** to be closer to the surgical bed. At the same time, when the apparatus is not powered on, the fourth roller **262** may, to a certain extent, rely on its own gravity to move the fifth movable seat **262** downward, assisting the biasing member **238** to open the channel **231**.

[0411] Of course, the fourth roller **262** may also be located above the third roller **252**. In this way, when the guidewire or the catheter is installed, the guidewire or the catheter is supported by the third roller **252**, and the third roller **252** does not move, which facilitates the guidewire and the catheter to stay stably in the channel **231**.

[0412] In actual use, the second power assembly **14** is first mounted to the second supporting frame **19** by the user, the second conveying assembly **60** is then mounted to the second power assembly **14**, the catheter **11** and/or the guidewire **12** are then installed to the second conveying assembly **60**, and then the apparatus is started. The catheter **11** and/or the guidewire **12** are first clamped by the second conveying assembly **60**. Specifically, the third driving device **225** further includes a third servomotor driver for controlling the operation of the third servomotor. The third servomotor driver is configured to drive the third servomotor to rotate under the control of the host computer (control module) and monitor the operating current of the third servomotor. After the third servomotor is rotated, the fifth movable seat **269** is moved towards the fifth fixed seat **251**, and the channel **231** is gradually narrowed (as shown in FIG. **32**). When the channel **231** is subjected to the resistance from the catheter **11** and/or guidewire **12**, it indicates that the catheter **11** and/or guidewire **12** have been clamped, and the operating current of the third servomotor has increased significantly at this time. The medical system **300** is configured to stop the operation of the third servomotor and complete the clamping step when the operating current of the third servomotor reaches a preset threshold.

[0413] The preset threshold of the operating current of the third servomotor may be obtained from a large number of tests by clamping various types of guidewires and/or catheters. Also, different preset thresholds may be set depending on the diameter and/or material of various guidewire (or catheter). For example, for a catheter of the same caliber, when the material of the catheter is soft, a clamping force output by the third servomotor is relatively small (the preset threshold is relatively low) to avoid the catheter being over-clamped and deformed; when the material of the catheter is hard, the clamping force output by the third servomotor is relatively large (the preset threshold is relatively high) to avoid insufficient clamping force.

[0414] After the guidewire **12** and/or the catheter **11** are clamped, the convey operation may be performed. The slave-side execution apparatus **200** is configured to cause the fourth driving device **221** to operate after the third servomotor is stopped from operating. Similarly, for example, the fourth driving device **221** further includes a fourth servomotor driver for controlling the operation of the fourth servomotor. After the third servomotor is stopped from operating, the host computer controls the fourth servomotor driver to rotate the fourth servomotor to allow the fourth driving device **221** to operate and the fourth driving shaft **224** to rotate.

[0415] During the normal convey of the guidewire **12** and/or the catheter **11**, the guidewire **12** and/or the catheter **11** are interacted with the rollers through static friction, and the cumulative rotation distance of the outer surface of the roller shall be equivalent to the conveyed length of the guidewire **12** and/or the catheter **11**. The apparatus may be provided with a sensor to monitor the conveyed length of the guidewire **12** and/or the catheter **11**, or to estimate the conveyed length of the guidewire **12** and/or the catheter **11** by imaging. When the rotation distance of the outer surface of the roller corresponding to the cumulative rotation angle of the fourth servomotor does not match the conveyed length of the guidewire **12** and/or the catheter **11**, it indicates that the guidewire **12** and/or the catheter **11** are not clamped. At this time, the rotation angle or output power of the third servomotor may be increased to clamp the guidewire **12** and/or the catheter **11**.

[0416] The third driving device **225** is used for controlling the distance between the fifth movable seat **269** and the fifth fixed seat **251**. It may be understood that when the guidewire **12** and/or the catheter **11** need to be detached, the third driving shaft **227** is rotated to move the fifth movable seat **269** away from the fifth fixed seat **251** (as shown in FIG. **33**). When the fifth movable seat **269** is moved away from the fifth fixed seat **251**, the spring **238** is elongated. When the length of the spring **238** exceeds the free length, the spring **238** applies a force to the fifth movable seat **269** to bring it close to the fifth fixed seat **251**. At this time, the resistance of the fifth movable seat **269** to move away from the fifth fixed seat **251** increases, causing the operating current of the third servomotor to increase. Therefore, in the reverse rotation, it is also possible to determine whether the channel **231** has been opened to a suitable degree based on the operating current of the third servomotor, and for example, the third servomotor may be stopped from operating when the operating current of the third servomotor reaches a reverse preset threshold. Of course, the channel **231** may also be fully opened by the biasing member **238** when the apparatus is powered off.

[0417] As shown in FIG. **35**, in a second embodiment of the present application, the configuration of the slave-side execution apparatus **100** differs from that of the slave-side execution apparatus **200**. The following highlights only the differences between the two embodiments.

[0418] The slave-side execution apparatus **100** includes a main body power device **110**, a movable power device **140**, and a first carrying device **160**.

[0419] The main body power device **110** has a main body driving device and a movable assembly. The movable assembly is configured to be movable in the first conveying direction DF**1** or the second conveying direction DF**2** under the action of the main body driving device. The first conveying direction DF**1** is the advancing direction of the guidewire **12** or the catheter **11**, and the second conveying direction DF**2** is the retracting direction of the guidewire **12** or the catheter **11**. In other words, the movable assembly is drivingly connected to the main body driving device to be movable forward and backward along the conveying direction DF under the action of the main body driving device **124**.

[0420] The movable power device **140** is connected to the movable assembly and is configured to be movable with the movable assembly along the first conveying direction DF**1** or the second conveying direction DF**2**. Moreover, the movable power device **140** has a first driving device. The first carrying device **160** is disposed on the movable power device **140** and is used to carry the medical apparatus **10**. Thus, the first carrying device **160** is capable of carrying the medical apparatus **10** to move with the movable power device **140** along the first conveying direction DF**1** or the second conveying direction DF**2** to perform the advancing action or the retracting action of the catheter **11**.

[0421] The first carrying device **160** is provided with a first manipulation device **93**. Different form the first embodiment, the first manipulation device **93** is integrated with the first carrying device **160**. Therefore, in the second embodiment, the first manipulation device **93** may be regarded as a part of the first carrying device **160**. That is, the first carrying device **160** has the first manipulation device **93**. The first manipulation device **93** is in transmission connection with the first driving device so that the advancing action or retracting action of the guidewire **12** may be manipulated by the first manipulation device **93** under the action of the first driving device.

[0422] The first carrying device **160** further includes a second manipulation device **90** for acting on the medical function mechanism **13** of the medical apparatus **10**. The movable power device **140** further includes a second driving device for driving the second manipulation device **90** to operate.

[0423] As shown in FIG. **36** to FIG. **38**, the main body power device **110** further includes a machine frame housing **112**. The housing **112** has a long hole **113** extending along the first conveying direction DF**1** or the second conveying direction DF**2**. The protrusion **121** of the movable assembly extends from the long hole **113**. The movable power device **140** further includes a connecting frame **141** and a base **142**. The connecting frame **141** may be substantially configured in a U shape to be sleeved on the upper side of the housing **112**. Wherein one end of the connecting frame **141** is connected to the base **142**, and the other end is connected to the protrusion **121** of the movable assembly, so that the connecting frame **141** is movable across the housing **112**.

[0424] The first carrying device **160** is detachably connected to the base **142**. In the second embodiment, the base **142** is used to extend substantially along a horizontal plane, and the first carrying device **160** is mounted to the upper side of the base **142**, which may also be understood that the first carrying device **160** is used horizontally.

[0425] As shown in FIGS. **39** and **40**, similar to the first embodiment, the main body power device **110** further includes a machine frame **111**, a first guide rail **114**, a lead screw pair (the lead screw pair includes a lead screw **115** and a lead screw nut **116**) and a main body transmission assembly **92**. The housing **112** covers the machine frame **111**. The main body driving device **124**, the movable assembly **91**, the first guide rail **114**, the lead screw pair and the main body transmission assembly **92** are all disposed on the machine frame **111**.

[0426] The movable frame **117** has two end walls **118** and a second guide rail **119** disposed between the two end walls **118**. The movable seat **120** is preferably disposed on the second guide rail **119** via linear bearing(s) **132**. The movable seat **120** has the protrusion **121**. In the second embodiment, the configuration of the movable assembly **91** is different from that of the movable assembly **291**. As shown in FIG. **41**, a first force sensing member **122** and a second force sensing member **123** are respectively disposed at both ends of the movable seat **120**. The first force sensing member **122** and the second force sensing member **123** are respectively disposed facing the sides of the two end walls **118** of the movable frame **11** and respectively abut against the corresponding end wall **118**. Wherein the first force sensing member **122** is closer to the end (front end) of the main body power device **110** along the first conveying direction DF**1** than the second force sensing member **123**. Therefore, when the advancing action of the catheter **11** is performed, the first force sensing member **122** may sense the resistance experienced by the movable seat **120**. Wherein the first force sensing member **122** and the second force sensing member **123** are preferably pressure sensors or weighing sensors.

[0427] As shown in FIGS. **42** and **43**, similar to the first embodiment, the movable power device **140** further includes a first power shaft **145**, a first transmission assembly **94**, a second power shaft **146**, and a second transmission assembly **95**.

[0428] The first driving device **143** and the second driving device **144** are disposed on the base **142**. Preferably, the first driving device **143** and the second driving device **144** are at least partially located in the connecting frame **141**, and the driving ends of the two may extend to the bottom of the base **142**.

[0429] The first power shaft **145** and the second power shaft **146** are arranged to penetrate through the base **142**. The top end of the first power shaft **145** is in transmission connection with the first manipulation device **93**, and the bottom end is connected to the first transmission assembly **94**. Moreover, the first transmission assembly is also connected to the driving end of the first driving device **143** so as to transfer power from the first driving device **143** to the first power shaft **145** and then to the first manipulation device **93**. The top end of the second power shaft **146** is in transmission connection with to the second manipulation device **90**, and the bottom end is connected to the second transmission assembly **95**. Moreover, the second transmission assembly **95** is also connected to the driving end of the second driving device **144** so as to transfer power from the second driving device **144** to the second power shaft **146** and then to the second manipulation device **90**.

[0430] Wherein, the first transmission assembly **94** includes the first driving roller **147**, the first driven roller **148** and the first synchronous belt **149**. The second transmission assembly **95** includes the second driving roller **150**, the second driven roller **151** and the second synchronous belt **152**. The first transmission assembly **94** and the second transmission assembly **95** are configured in the same manner as in the first embodiment, which will not be described in detail herein.

[0431] The structure of the first carrying device **160** will be described below in conjunction with FIGS. **44** to **47**.

[0432] The first carrying device **160** includes a carrying base **161**, a guidewire manipulation seat **163** and a functional manipulation seat **162**. Wherein the carrying base **161** is used to be mounted to the base **142** of the movable power device **140**. The carrying base **161** is substantially configured in the shape of a box, including a first part **161**A of the carrying base for mounting the first manipulation device **93** and a second part **161**B of the carrying base for mounting the second manipulation device **90**. The first part **161**A of the carrying base and the second part **161**B of the carrying base are both box-shaped. The guidewire manipulation seat **163** is disposed on the carrying base **161**. The guidewire manipulation seat **163** is substantially plate-shaped for covering the first part **161**A of the carrying base, and the first manipulation device **93** is disposed on the guidewire manipulation seat **163**. The functional manipulation seat **162** is disposed on the carrying base **161**. The functional manipulation seat **162** is substantially plate-shaped for covering the second part **161**B of the carrying base, and the second manipulation device **90** is disposed on the functional manipulation seat **162**.

[0433] In the second embodiment, the structure of the carrying base **161** is different from that of the carrying base **261**, and the first manipulation device **93** and the medical apparatus **10** are in an exposed state during use.

[0434] Similar to the first embodiment, the snapping assembly **164** disposed at the end of the carrying base **161** is connectable to the buckle seat **153** (as shown in FIG. **37**) disposed at the end of the base **142** of the movable power device **140**, so that the carrying base **161** is detachably connected to the base **142**.

[0435] In order to further facilitate the rapid mounting and positioning of the first carrying device **160**, a connecting mating part **1611** is provided on the carrying base **161**, and a connecting part **1421** is provided on the base **142** of the movable power device **140** (as shown in FIGS. **37** and **38**), wherein the connecting part **1421** is capable of forming a mating connection with the connecting mating part **1611**. Exemplarily, the connecting part **1421** may be a connecting column, and the connecting mating part **1611** may have a corresponding connecting hole. When the first carrying device **160** is mounted, the mounting may be quickly completed by simply positioning the connecting column and the connecting hole.

[0436] With reference to FIGS. **46** and **47**, a first power transfer device **165** and a second power transfer device **166** are disposed in the carrying base **161**. Wherein the first power transfer device **165** is located at a position corresponding to the position of the first power shaft **145** and is engaged with the first power shaft **145** so as to transfer the rotational motion of the first power shaft **145** to the first manipulation device **93**. The second power transfer device **166** is located at a position corresponding to the position of the second power shaft **146** and is engaged with the second power shaft **146** so as to transfer the rotational motion of the second power shaft **146** to the second manipulation device **90**.

[0437] Specifically, the first power transfer device **165** includes the first limiting frame **1651**, the first bearing **1652**, the first transmission shaft **1653**, the transfer synchronous roller **1654**, and a transfer synchronous belt **1655**. A hole corresponding to the first power shaft **145** is provided at the bottom of the carrying base **161**, the first limiting frame **1651** is provided on the carrying base **161** and corresponds to the hole, and two first bearings **1652** corresponding to each other are provided at the hole and on the first limiting frame **1651**. The first transmission shaft **1653** is connected between the inner rings of the two first bearings **1652**, and the bottom end of the first transmission shaft **1653** is engaged with the first power shaft **145**, the upper part of the first transmission shaft **1653** is fixedly connected to the transfer synchronous roller **1654**. The transfer synchronous belt **1655** is connected between the transfer synchronous roller **1654** and the first manipulation device, so that a synchronous belt transmission is formed between the first power transfer device **165** and the first manipulation device **93**.

[0438] The second power transfer device **166** includes a second limiting frame **1661**, a second bearing **1663**, a second transmission shaft **1662**, and a transfer gear **1664**. A hole corresponding to the second power shaft **146** is also provided at the bottom of the carrying base **161**. The second limiting frame **1661** is provided on the carrying base **161** and corresponds to the hole, and two second bearings **1663** corresponding to each other are provided at the hole and on the second limiting frame **1661**. The second transmission shaft **1662** is connected between the inner rings of the two second bearings **1663**, and the bottom end of the second transmission shaft **1662** is engaged with the second power shaft **146**, the upper part of the second transmission shaft **1662** is fixedly connected to the transfer gear **1664**. A gear engaging transmission is formed between the second power transfer device **166** and the second manipulation device **90**.

[0439] The specific structure of the first manipulation device **93** will be described below in conjunction with FIGS. **48** to **52**.

[0440] The first manipulation device **93** includes a driving roller member **167** and a driven roller member **168**. The driving roller member **167** and the driven roller member **168** are arranged opposite to each other. The driving roller member **167** includes a driving roller **1671** disposed on the upper side of the guidewire manipulation seat **163** and a driving gear **1672** disposed on the lower side of the guidewire manipulation seat **163**. The driving roller **1671** and the driving gear **1672** are coaxially fixedly connected, and the driving gear **1672** is in transmission connection with the first power transfer device **165** so as to rotate about its own axis relative to the first carrying device **160** under the action of the first power transfer device **165**.

[0441] Wherein, a transmission gear **1673** is also provided on the bottom side of the guidewire manipulation seat **163**, and the driving gear **1672** corresponding to the driving roller **1671** is engaged with the transmission gear **1673**. A transmission synchronous roller **1674** is coaxially provided with the transmission gear **1673**. A synchronous belt transmission is formed between the transmission synchronous roller **1674** and the transfer synchronous roller **1654**, thereby realizing a transmission connection between the driving gear **1672** and the first power transfer device **165**. Preferably, the driving rollers **1671** are also set to two, and the two driving gears **1672** of the two driving rollers **1671** are both engaged with the transmission gear **1673**.

[0442] The driven roller member **168** is disposed on the guidewire manipulation seat **163** and includes a driven roller **1681** located on the upper side of the guidewire manipulation seat **163**. The driven roller **1681** is substantially parallel to the driving roller **1671**. The driven roller **1681** is arranged opposite to the driving roller **1671** along the first direction D**1**, and the first direction D**1** is perpendicular to a plane determined by the conveying direction DF and an axis of the driven roller **1681**. The driven roller **1681** is configured to be movable in a direction close to the driving roller **1671** or away from the driving roller **1671**. That is, the driven roller **1681** is movable relative to the driving roller **1671** along the first direction D**1**, so as to be able to clamp or release the guidewire **12** with the driving roller **1671**. The number of the driven rollers **1681** corresponds to that of the driving rollers **1671**. For example in a preferred embodiment, the driven rollers **1681** are also set to two.

[0443] With reference to FIGS. **49** to **52**, the driven roller member **168** further includes a fixed frame **1682**, an extrusion frame **1684**, and a first elastic member **1685**.

[0444] Wherein, the fixed frame **1682** is connected to the guidewire manipulation seat **163** and has a pair of arm portions **1686** extending out, and the pair of arm portions **1686** are separated from each other. Preferably, a third guide rail **1683** is provided between the pair of the two arm portions **1686**, and the third guide rail **1683** extends along the first direction D**1**. Further preferably, two pairs of arm portions **1686** extending in opposite directions are provided on both sides of the fixed frame **1682**, and one third guide rail **1683** is provided between the two arm portions **1686** of each pair.

[0445] The extrusion frame **1684** has a sliding portion **1688** on which the driven roller **1681** is provided, and the sliding portion **1688** is disposed on the fixed frame **1682**. Wherein the third guide rail **1683** is arranged to penetrate through the sliding portion **1688** so that the extrusion frame **1684** is movable along the third guide rail **1683**. Wherein the sliding portion **1688** is located between the pair of arm portions **1686** of the fixed frame **1682**. Preferably, the two sliding portions **1688** are respectively located between the two pairs of arm portions **1686**. When the extrusion frame **1684** is mounted on the fixed frame **1682**, the fixed frame **1682** is semi-enclosed by the extrusion frame **1684**.

[0446] The first elastic member **1685** is connected between the fixed frame **1682** and the extrusion frame **1684**, and extends along the first direction D**1** to provide an elastic force to the extrusion frame **1684**. The elastic force causes the extrusion frame **1684** to tend to move in the direction close to the driving roller **1671**. That is, the first elastic member **1685** is used to provide a force that brings the extrusion frame **1684** close to the driving roller **1671** along the first direction D**1**. In the illustrated embodiment, the first elastic member **1685** is configured as a spring and may be disposed in a cavity within the fixed frame **1682**. An extrusion portion **1687** is provided on the extrusion frame **1684** at a position corresponding to the cavity. When the extrusion frame **1684** is mounted to the fixed frame **1682**, the extrusion portion **1687** may partially extend into the cavity, and the first elastic member **1685** abuts against both the extrusion portion **1687** and the fixed frame **1682** in the cavity.

[0447] With reference to FIGS. **48** and **49**, a manipulation rod assembly **169** is also provided on the guidewire manipulation seat **163**. The manipulation rod assembly **169** includes a pivoting portion **1691**, a manipulation portion **1692**, an extension portion **1693**, and a pushing portion **1694**.

[0448] Wherein, the pivoting portion **1691** is pivotally connected to the guidewire manipulation seat **163**. That is, the pivoting portion **1691** is connected to the guidewire manipulation seat **163** and is rotatable about its own axis relative to the guidewire manipulation seat **163**. An adjustment opening **1612** (see FIG. **44**) is provided on the carrying base **161**. The extension portion **1693** is located at the lower side of the guidewire manipulation seat **163**, one end of which is connected to the pivoting portion **1691**, and the other end passes through the adjustment opening **1621** and extends to the outside of the carrying base **161**. In the illustrated embodiment, the extension portion **1693** may have a certain bending angle, for example, between 50° and 130°, or 90°, etc. The manipulation portion **1692** is used for being operated by a user, which is located outside the carrying base **161** and connected to the other end of the extension portion **1693**. The extension portion **1692** is connected between the pivoting portion **1691** and the manipulation portion **1692** so that the manipulation portion **1692** is capable of rotating synchronously with the pivoting portion **1691** about an axis of the pivoting portion **1691**.

[0449] The pushing portion **1694** is provided to the extension portion **1693** for contacting the extrusion frame **1684** to enable the pushing portion **1694** to push the extrusion frame **1684** away from the driving roller **1671** along the first direction D**1** when the pivoting portion **1691** is rotated. For example, the pushing portion **1694** is located in the carrying base **161** and extends from the extension portion **1693** towards the guidewire manipulation seat **163**. In the illustrated embodiment, the pushing portion **1694** is connected to the bend of the extension portion **1693**. Along a moving direction of the extrusion frame **1684** under the action of the first elastic member **1685**, the pushing portion **1694** is located at the downstream side relative to the extrusion frame **1684**, so that when the pivoting portion **1691** is pivoted, the pushing portion **1694** is able to push the extrusion frame **1684** to cause the driven roller **1681** to move away from the driving roller **1671**. Exemplarily, when the manipulation portion **1692** is manipulated by an operator, the extrusion frame **1684** may be pushed by the pushing portion **1694** to move in a direction close to the fixed frame **1682**. This enables the driven roller **1681** to move away from the driving roller **1671**, thereby releasing the clamping of the driven roller **1681** and the driving roller **1671** on the guidewire **12**.

[0450] In a second embodiment, the upper side of the guidewire manipulation seat **163** is further provided with a guidewire supporting device **170**, which is configured to allow the guidewire **12** to pass through to support the guidewire **12**. As shown in FIG. **48**, the guidewire supporting device **170** includes a guidewire supporting portion **1701** and a guidewire cover portion **1702**. The guidewire supporting portion **1701** is connected to the guidewire manipulation seat **163**. A semi-guidewire groove is provided on the guidewire supporting portion **1701**. The guidewire cover portion **1702** may be connected to the guidewire supporting portion **1701** in an openable and closable manner, and a semi-guidewire groove is also provided on the guidewire cover portion **1702**. When the guidewire cover portion **1702** covers the guidewire supporting portion **1701**, the two semi-guidewire grooves form a complete guidewire groove to support the guidewire **12** and allow the guidewire **12** to pass through. Preferably, a snapping structure may be provided on the guidewire supporting portion **1701** and the guidewire cover portion **1702** to form a snap-fit connection when the guidewire cover portion **1702** covers the guidewire supporting portion **1701**.

[0451] The specific structures of the functional manipulation seat **162** and the second manipulation device **90** will be introduced below in conjunction with FIGS. **53** to **55**.

[0452] The first carrying device **160** has a supporting structure **97** capable of supporting the medical apparatus **10**. Specifically, similar to the first embodiment, the supporting structure **97** includes the first bracket **175**, the second bracket **176**, the second elastic member **177**, the connecting seat **178** and the bottom bracket **179**, which will not be described in detail herein.

[0453] The second manipulation device **90** includes a functional gear **172**, a bevel gear **173** and a bevel spur gear **174**. Wherein the functional gear **172** is rotatably disposed on the functional manipulation seat **162** and is at least partially located on the upper side of the functional manipulation seat **162** (the first side **162**A of the functional manipulation seat). Exemplarily, the functional gear **172** is disposed on the lower side of the functional manipulation seat **162** (the second side **162**B of the functional manipulation seat). The functional manipulation seat **162** is provided with an operation opening **171** through which the functional gear **172** is partially exposed to the upper side of the functional manipulation seat **162**. Thus, when the medical apparatus **10** is mounted to the first carrying device **160**, the medical function mechanism **13** of the medical apparatus **10** is engageable with the functional gear **172**.

[0454] In an optional embodiment, the bottom side of the functional manipulation seat **162** is provided with two gear seats **1721** at both ends of the operation opening **171**. The two gear seats **1721** are respectively provided with one third bearing **1722**, and the two ends of the rotating shaft of the functional gear **172** are fixedly connected to the inner rings of the two third bearings **1722**, respectively. Moreover, one end of the rotating shaft of the functional gear **172** is also fixedly connected to the bevel gear **173** so that the functional gear **172** and the bevel gear **173** are coaxially rotatable. The bevel spur gear **174** is rotatably connected to the functional manipulation seat **162**, and its axial direction is preferably perpendicular to the functional manipulation seat **162**. The bevel spur gear **174** has a gear rotation shaft **1743**, a bevel gear portion **1741** and a spur gear portion **1742**. Wherein the gear rotation shaft **1743** is rotatably disposed to the functional manipulation seat **162** along the vertical direction. The spur gear portion **1742** is horizontally fixed to the bottom end of the gear rotation shaft **1743** and is engaged with the transfer gear **1664**. The bevel gear portion **1741** is disposed on the upper side of the spur gear portion **1742** around the gear rotation shaft **1743** and is engaged with the bevel gear **173**. Thus, the power from the second driving device **144** transferred through the second transmission assembly **95** may be transferred to the functional gear **172**.

[0455] Please refer to FIGS. **35**, **36** and **56** to **58** below, the slave-side execution apparatus **100** further includes a second carrying device **180** disposed on the main body power device **110** and located in front of the first carrying device **160** along the conveying direction DF. For example, the end of the machine frame **111** of the main body power device **110** is provided with a mounting portion **129** (see FIG. **39**), which may extend out of the housing **112**. The second carrying device **180** includes a supporting seat **181** detachably mounted on the mounting portion **129**. In a preferred embodiment, a positioning portion **184** is provided on the supporting seat **181**, and a positioning mating portion **130** is provided on the mounting portion **129** of the main body power device **110**. The positioning portion **184** is connectable to the positioning mating portion **130**, e.g., a column-hole mating. In this embodiment, a magnetic member **185** is also provided on the supporting seat **181**, a magnetic attraction member **131** is provided on the mounting portion **129**, and they may be connected in docking. For example, after the positioning is completed using the positioning portion **184** and the positioning mating portion **130**, a stable connection is formed under the corresponding attraction effect between the magnetic member **185** and the magnetic attraction member **131**.

[0456] The second carrying device **180** further has a guide assembly **96** for guiding the guidewire **12** and/or the catheter **11**. The guide assembly **96** is disposed in front of the first manipulation device **93** and the second manipulation device **90** along the conveying direction DF. Specifically, the guide assembly **96** includes a catheter guiding device **182** and a catheter supporting device **183**, both of which are provided on the supporting seat **181**. The catheter guiding device **182** is used to clamp or release the guidewire **12** and/or the catheter **11**, and the catheter supporting device **183** is configured to allow the guidewire **12** and/or the catheter **11** to pass through so as to support the guidewire **12** and/or the catheter **11**.

[0457] Wherein, the catheter guiding device **182** includes a first guide roller **186**, a second guide roller **187**, and a second biasing assembly **98**.

[0458] The first guide roller **186** and the second guide roller **187** are disposed opposite to each other, and the axes of the two are substantially parallel to each other and the two are rotatable about their own axes relative to the supporting seat **181**.

[0459] The second biasing assembly **98** includes a fixed block **188**, a pushing block **189** and a third elastic member **190**. The fixed block **188** is disposed on the bottom side of the supporting seat **181**, and a guide groove **193** communicating with the outside is provided in the fixed block **188**. The guide groove **193** extends along the first additional direction D**11**, wherein the first additional direction D**11** is perpendicular to the plane determined by the conveying direction DF and the axis of the second guide roller **187**. The pushing block **189** at least partially extends into the guide groove **193**. The third elastic member **190** is located in the guide groove **193** and connected between the fixed block **188** and the pushing block **189**. The third elastic member extends along the first additional direction D**11** for providing a force to the pushing block **189** that causes the pushing block **189** to tend to move in a direction close to the fixed block **188**, i.e., causes the pushing block **189** to move towards the fixed block **188** along the first additional direction D**11**.

[0460] The first guide roller **186** is fixedly disposed on the upper side of the supporting seat **181**. The second guide roller **187** is located on the upper side of the supporting seat **181** and is connected to the pushing block **189** so that the second guide roller **187** is movable along a direction close to or away from the first guide roller **186**. The elastic force of the third elastic member **190** causes the second guide roller **187** to tend to move closer to the first guide roller **186** so as to clamp the guidewire **12** and/or the catheter **11**. That is, under the action of the second biasing assembly **98**, the second guide roller **187** is movable relative to the first guide roller **186** along the first additional direction D**11** so as to be able to release or clamp the guidewire **12** and/or the catheter **11** with the first guide roller **186**. Therefore, when the pushing block **189** is manipulated by the operator, the second guide roller **187** may be moved close to or away from the first guide roller **186**, thereby clamping or releasing the guidewire **12** and/or the catheter **11**.

[0461] The catheter supporting device **183** includes a catheter supporting portion **191** and a catheter cover portion **192**. The catheter supporting portion **191** is connected to the supporting seat **181**. A semi-catheter groove is provided on the catheter supporting portion **191**. The catheter cover portion **192** may be connected to the catheter supporting portion **191** in an openable and closable manner, and a semi-catheter groove is also provided on the catheter cover portion **192**. When the catheter cover portion **192** covers the catheter supporting portion **191**, the two semi-catheter grooves form a complete catheter groove to support the guidewire **12** and/or the catheter **11** and allow the guidewire **12** and/or the catheter **11** to pass through. Preferably, a snapping structure may be provided on the catheter supporting portion **191** and the catheter cover portion **192** to form snap-fit connection when the catheter cover portion **192** covers the catheter supporting portion **191**.

[0462] In addition, in this embodiment, the first carrying device **160** and/or the second carrying device **180** may be configured as passive consumable components. For example, the first carrying device **160** and the second carrying device **180** may both be configured as passive consumables made of plastic. Preferably, an isolation component such as a sterile bag or a sterile curtain may be provided between the first carrying device **160** and the movable power device **140**, and between the second carrying device **180** and the main body power device **110**. In this way, each patient may correspond to a set of disposable passive consumables, and thus the workload of sterilization and disinfection is reduced. Moreover, the main body power device **110** and the movable power device **140** may be reused, thereby reducing the use cost of the hospital.

[0463] During the use of the slave-side execution apparatus **100** of the present application, it is preferably obliquely disposed, wherein the end (front end) of the slave-side execution apparatus **100** along the first conveying direction DF**1** is lower than the end (rear end) of the slave-side execution apparatus **100** along the second conveying direction DF**2**. In other words, the slave-side execution apparatus **100** is disposed obliquely in the direction toward the patient, and the end of the slave-side execution apparatus **100** along the first conveying direction DF**1** faces the patient. Wherein the oblique angle of the slave-side execution apparatus **100** is θ. That is, the conveying direction DF and the horizontal plane have an included angle of θ.

[0464] Therefore, the total gravity of the movable seat **120**, the movable power device **140** and the first carrying device **160** has a component force F along the oblique direction of the slave-side execution apparatus **100**, and $F=mg\sin\theta$, wherein m is the total mass of the movable seat **120**, the movable power device **140** and the first carrying device **160**, and g is the gravitational acceleration.

[0465] The processor module is signal-connected to the first force sensor **122** and the second force sensor **123**, and is configured to calculate a resistance F_R experienced by the catheter **11** based on the component force F and the pressure sensed by the first force sensor **122** and/or the second force sensor **123**.

[0466] Exemplarily, the pressure sensed by the first force sensor **122** is F_1, and the pressure sensed by the second force sensor **123** is F_2. When the movable power device **140** is stationary, the first force sensor **122** has a reading due to the obliquity of the slave-side execution apparatus **100**, and at this time $F_1=F$.

[0467] When the catheter **11** is resisted during a uniform advancement, if the first force sensor **122** has a reading, $F_R=F-F1$. If the second force sensor **123** has a reading, $F_R=F+F2$.

[0468] When the catheter **11** is resisted during an acceleration advancement or a deceleration advancement at the acceleration a, the movable seat **120** has inertia, and the inertial force $F_i=ma$. In this case, if it is during the acceleration advancement and the first force sensor **122** has a reading, $F_R=F-F_i-F_1$. If it is during the acceleration advancement and the second force sensor **123** has a reading, $F_R=F-F_i+F_2$. If it is during the deceleration advancement and the first force sensor **122** has a reading, $F_R=F+F_i-F_1$. If it is during the deceleration advancement and the second force sensor **123** has a reading, $F_R=F+F_i+F_2$.

[0469] As a result, the resistance experienced by the catheter **11** when advancing and retracting and its changes may be accurately obtained, which is conducive to achieving more accurate control of the advancing and retracting speeds and improving safety.

[0470] Reference is made to the description of the first embodiment for the parts which are not introduced in the second embodiment.

[0471] The processes and steps described in all the above preferred embodiments are only examples. Unless adverse effects occur, various processing operations may be performed in a sequence different from the sequence of the above processes. The sequence of steps in the above processes may also be added, merged or deleted according to actual needs.

[0472] In understanding the scope of the present application, the term "including" and its derivatives as used herein are intended to be open terms, which specify the presence of stated features, elements, components, groups, wholes and/or steps, but do not exclude the presence of other unstated features, elements, components, groups, wholes and/or steps. This concept also applies to words with similar meanings such as the terms "comprising", "having" and their derivatives.

[0473] The term "attached" or "attaching" as used herein includes: a configuration in which an element is directly fixed to another element by fixing the element directly to another element; a configuration in which the element is indirectly fixed to another element by fixing the element to the intermediate element(s) which in turn are fixed to another element; and a configuration in which one element is integrated with another element, that is, one element is essentially a part of another element. This definition also applies to words having similar meanings such as "connected", "joined", "coupled", "mounted", "bonded", and "fixed" and their derivatives. Finally, terms of degree such as "substantially", "about" and "approximately" as used herein mean an amount of deviation of the modified term such that the end result is not significantly changed.

[0474] Unless otherwise defined, the technical and scientific terms used herein have the same meanings as commonly understood by those skilled in the technical field of the present application. The terms used herein are only for describing specific implementation purposes, and are not intended to limit the present application. Feature(s) described in one embodiment herein may be applied to another embodiment alone or in combination with other features, unless the feature(s) are not applicable in the other embodiment or otherwise stated.

[0475] The present application has been described through the above-mentioned embodiments, but it should be understood that the above-mentioned embodiments are only for the purpose of illustrations and descriptions, and are not intended to limit the present application to the scope of the described embodiments. Moreover, those skilled in the art may understand that the present application is not limited to the above-mentioned embodiments. Various changes and modifications may be made based on the enlightenment of the present application, and these changes and modifications fall within the protection scope claimed by the present application.

What is claimed is:

1. A slave-side execution apparatus for conveying a guidewire and/or a catheter, comprising:

a main body power device used to be installed beside a surgical bed and being immovable relative to the surgical bed, the main body power device comprising a main body driving device for providing a driving force;

a movable power device connected to the main power device and used to move forward and backward relative to the main power device along a conveying direction of the guidewire and/or the catheter under the driving of the main body driving device, the movable power device comprising a first driving device for providing a driving force;

a first carrying device detachably connected to the movable power device and being movable synchronously with the movable power device along the conveying direction relative to the main body power device, the first carrying device being used to carry a medical apparatus having the catheter; and

a first manipulation device disposed on the first carrying device and used to control the guidewire to move forward and backward relative to the first carrying device along the conveying direction under the driving of the first driving device.

2. The slave-side execution apparatus of claim **1**, wherein,

the movable power device comprises a second driving device for providing a driving force; and

the first carrying device comprises a second manipulation device used to contact the medical apparatus, and the second manipulation device being connected to the second driving device to manipulate the medical apparatus to perform a medical function under the driving of the second driving device.

3. The slave-side execution apparatus of claim **2**, wherein the slave-side execution apparatus further comprises:

a movable assembly disposed on the main body power device and configured to be movable forward and backward relative to the main body power device along the conveying direction under the driving of the main body driving device, wherein the movable power device is connected to the movable assembly;

a first transmission device connected between the first driving device and the first manipulation device for transferring the driving force of the first driving device to the first manipulation device; and

a second transmission device connected between the second driving device and the second manipulation device for transferring the driving force of the second driving device to the second manipulation device.

4. The slave-side execution apparatus of claim **3**, wherein,

the first manipulation device comprises at least one pair of rollers which are arranged oppositely, the axes of the rollers are parallel to each other and the rollers are configured to be rotatable about their own axes, and the pair of the rollers are used to jointly clamp the guidewire; and

the first transmission device is connected between the first driving device and at least one of the pair of the rollers to rotate the at least one of the pair of the rollers.

5. The slave-side execution apparatus of claim **3**, wherein the first transmission device comprises:

a first power shaft disposed on the movable power device and configured to be rotatable about its own axis relative to the movable power device;

a first transmission assembly disposed on the movable power device and connected between the first driving device and the first power shaft such that the first power shaft is rotatable under the driving of the first driving device; and

a first power transfer device disposed on the first carrying device and connected between the first manipulation device and the first power shaft such that the first manipulation device is driven to operate by the first power shaft drives.

6. The slave-side execution apparatus of claim **5**, wherein the first manipulation device comprises:

a first manipulation device base connected to the first carrying device;

at least one first roller disposed on the first manipulation device base, an axis of the first roller being not parallel to the conveying direction, the first roller being configured to be rotatable about its axis relative to the first manipulation device base; and

at least one second roller disposed on the first manipulation device base and arranged opposite to the first roller so as to clamp the guidewire along with the first roller, the second roller being configured to be rotatable about its axis relative to the first manipulation device base;

wherein the first roller and the second roller are both used to be connected to the first transmission device so as to rotate under the driving of the first transmission device, and the slave-side execution apparatus is configured such that an rotation direction of the first roller is opposite to an rotation direction of the second roller.

7. The slave-side execution apparatus of claim **6**, wherein the first manipulation device further comprises:

a second fixed seat disposed on the first manipulation device base, wherein the second roller is disposed on the second fixed seat; and

a first movable seat disposed on the first manipulation device base and being movable between a first position and a second position relative to the second fixed seat along a first direction, wherein the first roller is disposed on the first movable seat;

wherein the first direction is perpendicular to a plane determined by the conveying direction and the axis of the first roller, and a distance between the first movable seat and the second fixed seat when the first movable seat is in the first position is less than a distance between the first movable seat and the second fixed seat when the first movable seat is in the second position.

8. The slave-side execution apparatus of claim **7**, wherein the first manipulation device further comprises:

a first biasing assembly connected between the second fixed seat and the first movable seat for providing a force to move the first movable seat away from the second fixed seat along the first direction; and

a first pressing device disposed on the first manipulation device base and connected to the first movable seat for operation by a user to bring the first movable seat close to the second fixed seat along the first direction.

9. The slave-side execution apparatus of claim **8**, wherein the first pressing device comprises:

a cam connected to the first manipulation device base and being rotatable relative to the first manipulation device base about a rotation axis extending along a second direction, wherein the second direction is perpendicular to the first direction and parallel to a plane determined by the conveying direction and the axis of the first roller, and a circumferential surface of the cam is connected to a side of the first movable seat facing away from the second fixed seat; and

a wrench connected to the cam for operation by the user to rotate the cam relative to the first manipulation device base.

10. The slave-side execution apparatus of claim **7**, wherein,

the first power transfer device comprises a first transmission shaft used to be connected to the first driving device so as to rotate under the driving of the first driving device; and

the first manipulation device further comprises:

a first roller transmission device used to connect the first transmission shaft and the first roller so that the rotation direction of the first roller is the same as a rotation direction of the first transmission shaft, and

a second roller transmission device used to connect the first transmission shaft and the second roller so that the rotation direction of the second roller is opposite to the rotation direction of the first transmission shaft.

11. The slave-side execution apparatus of claim **10**, wherein the first roller transmission device comprises at least one first manipulation synchronous belt, the first transmission shaft and the first roller are both connected with a structure for connecting the first manipulation synchronous belt, and the slave-side execution apparatus is configured such that the first transmission shaft drives all the first rollers to rotate via the first manipulation synchronous belt.

12. The slave-side execution apparatus of claim **11**, wherein the first manipulation device comprises N first rollers and N first manipulation synchronous belts, where N is an integer greater than or equal to 1, wherein,

each of the first rollers is connected to the first transmission shaft via one first manipulation synchronous belt; or

each of one part of the N first rollers is connected to the first transmission shaft via one first manipulation synchronous belt, and each of the other part of the N first rollers is connected to another first roller via one first manipulation synchronous belt.

13. The slave-side execution apparatus of claim **11**, wherein the first manipulation device comprises N first rollers and N first manipulation synchronous belts, where N is an integer greater than or equal to 1, wherein,

the first one of the N first rollers is connected to the first transmission shaft via one first manipulation synchronous belt, and each of the other first rollers is connected to the previous first roller via one first manipulation synchronous belt.

14. The slave-side execution apparatus of claim **13**, wherein the first manipulation device further comprises:

a first additional roller disposed on the first movable seat, the first additional roller being configured to be rotatable about its axis relative to the first movable seat;

a second additional roller disposed on the second fixed seat and arranged opposite to the first additional roller so as to clamp the guidewire along with the first additional roller, the second additional roller being configured to be rotatable about its axis relative to the second fixed seat;

a first additional roller transmission device used to connect the first additional roller and the Nth one of the first rollers so that the first additional roller is rotated in the same direction as a rotation direction of the first transmission shaft under the driving of the Nth one of the first rollers; and

an encoder connected to the second additional roller and used to detect a rotation angle of the second additional roller.

15. The slave-side execution apparatus of claim **14**, wherein,

the second additional roller has a second additional roller axle;

the movable power device also comprises a third rotating shaft disposed on the movable power device, the third rotating shaft being used to be connected to the second additional roller axle and rotate synchronously with the second additional roller axle, wherein the encoder is disposed on the third rotating shaft.

16. The slave-side execution apparatus of claim **10**, wherein the second roller transmission device comprises:

a fourth transmission shaft disposed on the first manipulation device base;

a first transmission device for the second roller used to connect the first transmission shaft and the fourth transmission shaft so that the fourth transmission shaft is rotated under the driving of the first transmission shaft; and

a second transmission device for the second roller used to connect the fourth transmission shaft and the second roller so that the second roller is rotated under the driving of the fourth transmission shaft.

17. The slave-side execution apparatus of claim **16**, wherein one of the first transmission device for the second roller and the second transmission device for the second roller is configured to be driven by a synchronous belt, and the other of the first transmission device for the second roller and the second transmission device for the second roller is configured to be driven by a gear.

18. The slave-side execution apparatus of claim **10**, wherein a component of the first roller transmission device for connecting the first transmission shaft and a component of the second roller transmission device for connecting the first transmission shaft are both synchronous belts.

19. The slave-side execution apparatus of claim **5**, wherein the first manipulation device comprises:

a driving roller member disposed on the first carrying device, the driving roller member comprising a driving roller and a driving gear coaxially connected, wherein the driving gear is in transmission connection with the first power transfer device so as to rotate about its own axis relative to the first carrying device under the action of the first power transfer device; and

a driven roller member disposed on the first carrying device, the driven roller member comprising a driven roller arranged opposite to the driving roller, the driven roller being configured to be rotatable about its own axis relative to the first carrying device and movable relative to the driving roller along a first direction, so as to be able to clamp or release the guidewire with the driving roller, wherein the first direction is perpendicular to a plane determined by the conveying direction and an axis of the driven roller.

20. The slave-side execution apparatus of claim **19**, wherein the driven roller member further comprises:

a fixed frame disposed on the first carrying device, the fixed frame having a third guide rail extending along the first direction;

an extrusion frame disposed on the third guide rail and being movable along the third guide rail, the driven roller being disposed on the extrusion frame; and

a first elastic member connected between the fixed frame and the extrusion frame, the first elastic member extending along the first direction for providing a force that brings the extrusion frame close to the driving roller along the first direction.

21. The slave-side execution apparatus of claim **20**, wherein the first manipulation device further comprises a manipulation rod assembly comprising:

a manipulation portion used for being operated by a user and exposed from the first carrying device;

a pivoting portion connected to the first carrying device and configured to be rotatable about its own axis relative to the first carrying device;

an extension portion connected between the pivoting portion and the manipulation portion so that the manipulation portion is capable of rotating synchronously with the pivoting portion about an axis of the pivoting portion; and

a pushing portion provided to the extension portion for contacting the extrusion frame to enable the pushing portion to push the extrusion frame away from the driving roller along the first direction when the pivoting portion is rotated.

22. The slave-side execution apparatus of claim **5**, wherein a position of the first power transfer device corresponds to a position of the first power shaft, and the first power transfer device is engaged with the first power shaft, the first power transfer device comprises a transfer synchronous roller, and a synchronous belt transmission is formed between the first power transfer device and the first manipulation device.

23. The slave-side execution apparatus of claim **5**, wherein the second transmission device comprises:

a second power shaft disposed on the movable power device and configured to be rotatable about its own axis relative to the movable power device;

a second transmission assembly disposed on the movable power device and connected between the second driving device and the second power shaft so that the second power shaft is rotated under the driving of the second driving device; and

a second power transfer device disposed on the first carrying device and connected between the second manipulation device and the second power shaft so that the second power shaft drives the second manipulation device to operate.

24. The slave-side execution apparatus of claim **23**, wherein,

the first power shaft is arranged to penetrate through the movable power device, and an end of the first power shaft facing the first carrying device is in transmission connection with the first manipulation device;

the first transmission assembly is connected between the first driving device and an end of the first power shaft facing away from the first carrying device;

the second power shaft is arranged to penetrate through the movable power device, and an end of the second power shaft facing the first carrying device is in transmission connection with the second manipulation device; and

the second transmission assembly is connected between the second driving device and an end of the second power shaft facing away from the first carrying device.

25. The slave-side execution apparatus of claim **23**, wherein,

the first carrying device comprises a functional manipulation seat for mounting the medical apparatus, the functional manipulation seat comprising a first side of the functional manipulation seat and a second side of the functional manipulation seat which are arranged opposite to each other, wherein the medical apparatus is detachably connected to the first side of the functional manipulation seat, and the functional manipulation seat is provided with an operation opening; and

the second manipulation device comprises:

a functional gear rotatably disposed at the second side of the functional manipulation seat and at least partially exposed from the operation opening to the first side of the functional manipulation seat, so as to be able to form an engagement with the medical apparatus, and

a bevel gear coaxially connected with the functional gear and used to be connected to the second power transfer device.

26. The slave-side execution apparatus of claim **25**, wherein the first carrying device further comprises:

a first bracket disposed on the first side of the functional manipulation seat;

a second bracket disposed on the first side of the functional manipulation seat and spaced apart from the first bracket along the conveying direction so as to support the medical apparatus along with the first bracket, the second bracket being configured to be movable relative to the functional manipulation seat along the conveying direction; and

a second elastic member connected to the second bracket for applying a force to the second bracket to move the second bracket away from the first bracket along the conveying direction.

27. The slave-side execution apparatus of claim **23**, wherein a position of the second power transfer device corresponds to a position of the second power shaft, and the second power transfer device is engaged with the second power shaft, the second power transfer device comprises a transfer gear, and a gear engaging transmission is formed between the second power transfer device and the second manipulation device.

28. The slave-side execution apparatus of claim **3**, wherein the main body power device further comprises:

a machine frame on which the main body driving device and the movable assembly are both provided; and

a first guide rail disposed on the machine frame and extending along the conveying direction;

wherein the movable assembly is connected to the first guide rail and is configured to move along the first guide rail under the driving of the main body driving device.

29. The slave-side execution apparatus of claim **3**, wherein the movable assembly comprises:

a movable frame configured to be moved along the first guide rail under the driving of the main body driving device, the movable frame having a second guide rail extending along the conveying direction;

a movable seat disposed on the second guide rail and being movable along the second guide rail, the movable power device being connected to the movable seat; and

a force sensor disposed between the movable seat and the movable frame to sense a force experienced by the movable seat when the catheter is conveyed.

30. The slave-side execution apparatus of claim **1**, wherein,

the slave-side execution apparatus further comprises a guide assembly disposed in front of the first manipulation device along the conveying direction; and

the guide assembly comprises at least one pair of rollers arranged opposite to each other, the axes of the rollers are parallel to each other and the rollers are configured to be rotatable about their own axes, and one pair of rollers is used to jointly clamp the guidewire and/or the catheter.

31. The slave-side execution apparatus of claim **1**, wherein the slave-side execution apparatus also comprises a second carrying device disposed on the main body power device and located in front of the first carrying device along the conveying direction, and the second carrying device has a guide assembly for guiding the guidewire and/or the catheter.

32. The slave-side execution apparatus of claim **31**, wherein,

the second carrying device further comprises a supporting seat connected to the movable power device;

the guide assembly comprises:

a catheter guiding device disposed on the supporting seat so as to be able to clamp or release the guidewire and/or the catheter, and

a catheter supporting device disposed on the supporting seat and configured to allow the guidewire and/or the catheter to pass through to support the guidewire and/or the catheter.

33. The slave-side execution apparatus of claim **32**, wherein the catheter guiding device comprises:

a first guide roller disposed on the supporting seat and configured to be rotatable about its own axis relative to the supporting seat; and

a second guide roller disposed on the supporting seat and arranged opposite to the first guide roller, the second guide roller being configured to be rotatable about its own axis relative to the supporting seat and configured to be movable relative to the first guide roller along a first additional direction so as to be able to release or clamp the guidewire and/or the catheter with the first guide roller, wherein the first additional direction is perpendicular to a plane determined by the conveying direction and an axis of the second guide roller.

34. The slave-side execution apparatus of claim **33**, wherein the second carrying device further comprises:

a fixed block disposed on the supporting seat and having a guide groove extending along the first additional direction;

a pushing block at least partially extending into the guide groove, the second guide roller being provided on the pushing block; and

a third elastic member disposed in the guide groove and connected between the fixed block and the pushing block, the third elastic member extending along the first additional direction to apply a force to the pushing block that causes the pushing block to move close to the first guide roller along the first additional direction.

35. The slave-side execution apparatus of claim **1**, further comprising:

a second power assembly used to be installed beside a surgical bed and being immovable relative to the surgical bed, the second power assembly comprising a fourth driving device for providing a driving force; and

a second conveying assembly detachably connected to the second power assembly for conveying the guidewire and/or the catheter under the driving of the fourth driving device;

wherein the second power assembly is used to be installed in front of the main body power device along the conveying direction of the guidewire and/or the catheter.

36. The slave-side execution apparatus of claim **35**, wherein the second conveying assembly comprises:

a second conveying assembly base detachably connected to the second power assembly;

at least one third roller disposed on the second conveying assembly base, an axis of the third roller being not parallel to the conveying direction; and

at least one fourth roller disposed on the second conveying assembly base and arranged opposite to the third roller, so as to clamp the guidewire and/or the catheter along with the third roller;

wherein the third roller is used for rotating about its own axis under the driving of the fourth driving device.

37. The slave-side execution apparatus of claim **36**, wherein the second conveying assembly comprises:

a third roller assembly disposed on the second conveying assembly base and comprising at least one the third roller;

a fourth roller assembly comprises:

a fifth movable seat disposed on the second conveying assembly base and being movable relative to the second conveying assembly base along a first additional direction, wherein the first additional direction is perpendicular to the axis of the third roller, and

at least one the fourth roller disposed on the fifth movable seat, the fourth roller being arranged opposite to the corresponding third roller along the first additional direction; and

a position adjustment assembly connected to the fifth movable seat for driving the fifth movable seat to move along the first additional direction under the driving of a third driving device, so as to change a distance the fourth roller and the third roller.

38. The slave-side execution apparatus of claim **37**, wherein the position adjustment assembly comprises:

an adjusting gear disposed on the second conveying assembly base and used for rotating relative to the second conveying assembly base under the driving of the third driving device; and

an adjusting rack engaged with the adjusting gear, the adjusting rack extending along the first additional direction and connected to the fifth movable seat.

39. The slave-side execution apparatus of claim **37**, wherein the third roller assembly comprises a plurality of the third rollers,

the third roller assembly is configured such that a part of the third rollers are used for rotating about their own axes under the driving of the fourth driving device and the other third rollers are rotated about their own axes under the driving of another third roller.

40. The slave-side execution apparatus of claim **39**, wherein the second conveying assembly further comprises a roller transmission assembly, a first end of the roller transmission assembly is connected to the third roller and a second end of the roller transmission assembly is connected to the fourth roller so that the third roller drives the fourth roller to rotate in an opposite direction at the same rotational speed, and

wherein the roller transmission assembly is configured such that the second end of the roller transmission assembly is movable relative to the first end of the roller transmission assembly along the first additional direction, so as to adapt to the movement of the fifth movable seat along the first additional direction.

41. The slave-side execution apparatus of claim **40**, wherein the roller transmission assembly comprises N transmission gears that are engaged sequentially, N being an even number greater than or equal to 4,

wherein the first one of the transmission gears is disposed at the first end of the roller transmission assembly and is rotated synchronously with the third roller, the last one of the transmission gears is disposed at the second end of the roller transmission assembly and is rotated synchronously with the fourth roller, and the last one of the transmission gears is movable relative to the first one of the transmission gears along the first additional direction.

42. The slave-side execution apparatus of claim **41**, wherein the third roller is configured as the same roller as the fourth roller, and the roller transmission assembly has a transmission ratio of 1:1.

43. The slave-side execution apparatus of claim **41**, wherein the roller transmission assembly further comprises:

a first connecting arm comprising a first end of the first connecting arm and a second end of the first connecting arm arranged oppositely, the first one of the transmission gears being disposed on the first end of the first connecting arm; and

a second connecting arm comprising a first end of the second connecting arm and a second end of the second connecting arm arranged oppositely, the last one of the transmission gears being disposed on the second end of the second connecting arm,

wherein the first end of the second connecting arm is rotatably connected to the second end of the first connecting arm about a third axis, the third axis is parallel to an axis of the third roller, and N transmission gears are disposed on the first connecting arm and the second connecting arm.

44. The slave-side execution apparatus of claim **43**, wherein the third axis coincides with an axis of one transmission gear other than the first one of the transmission gears and the last one of the transmission gears.

45. The slave-side execution apparatus of claim **40**, wherein the fourth roller assembly comprises a plurality of the fourth rollers, and

the fourth roller assembly is configured such that a part of the fourth rollers are used for rotating about their own axes under the driving of the third roller and the other fourth rollers are rotated about their own axes under the driving of another fourth roller.

46. The slave-side execution apparatus of claim **40**, wherein the third roller assembly comprises a plurality of the third rollers, and the fourth roller assembly comprises a plurality of the fourth rollers,

wherein the Pth one of the third rollers is used for rotating about its own axis under the driving of the fourth driving device, the first end of the roller transmission assembly is connected to the Qth one of the third rollers, the second end of the roller transmission assembly is connected to the Qth one of the fourth rollers, and P is not equal to Q.

47. The slave-side execution apparatus of claim **37**, wherein the second conveying assembly further comprises a biasing member for applying a force to the fifth movable seat to move away from the third roller along the first additional direction.

48. A medical system, comprising:

a first supporting frame used to be disposed beside a surgical bed;

the slave-side execution apparatus of claim **1**, wherein the main body power device is connected to the first supporting frame; and

a medical apparatus detachably connected to the first carrying device.

49. A medical system, comprising:

a first supporting frame used to be disposed beside a surgical bed;

a second supporting frame used to be disposed beside the surgical bed and located in front of the first supporting frame along the conveying direction of a guidewire and/or a catheter;

the slave-side execution apparatus of claim **35**, wherein the main body power device is connected to the first supporting frame, and the second power assembly is connected to the second supporting frame; and

a medical apparatus detachably connected to the first carrying device.

50. The medical system of claim **48**, further comprising:

a master-side operating apparatus; and

a processor module signal-connected to both the master-side operating apparatus and the slave-side execution apparatus.

51. The medical system of claim **49**, further comprising:

a master-side operating apparatus; and

a processor module signal-connected to both the master-side operating apparatus and the slave-side execution apparatus.

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