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(54) **SENSORIZED TRASLO-ROTARY MACHINE**

(57) A translational-rotary machine (40) comprising a housing (3), a shaft (4) hinged to the housing (3), drive means (5) operatively connected to the shaft (4), two rods (6), wireless communication means (14) configured to communicate data and/or electric power with each other, comprising a first electronic transceiver board (10) placed to be integral with the housing (3), and a second electronic transceiver board (11) placed to be integral with the rod (6).

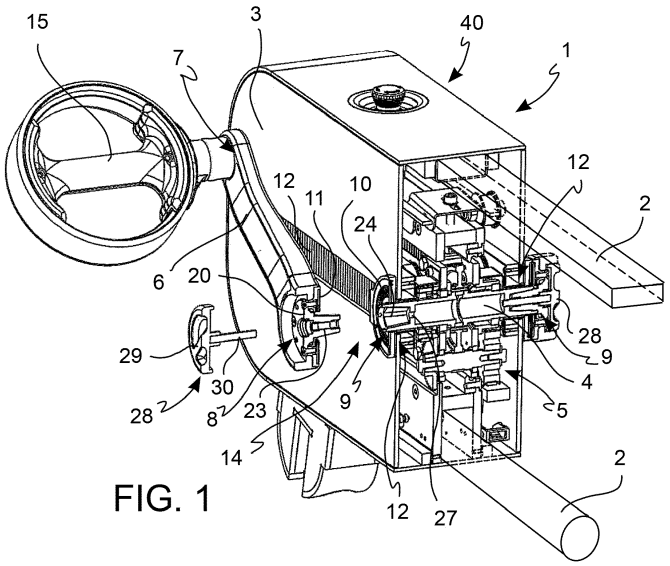

FIG. 1

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(52) Cooperative Patent Classification (CPC): (Cont.)
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Description

[0001] The present invention relates to a sensorized translational-rotary machine, and in particular to a rehabilitation machine for the exercise and rehabilitation of the upper limbs comprising such a translational-rotary machine, for both passive and active techniques.

[0002] The rehabilitation therapy of the upper limbs is a highly important clinical practice aimed at restoring the motor skills of a patient affected by paresis or hemiparesis of various etiology.

[0003] There are various techniques which can be used for motor rehabilitation; one of the most effective is certainly that including the use of appropriate rehabilitation devices.

[0004] Rehabilitation can be either passive or active.

[0005] In passive rehabilitation, the machine works on the limb, which is thus induced to perform special movements or functions the purpose of which is to restore the heavily compromised motility.

[0006] Active rehabilitation instead requires the direct effort of the patient's limb, while the mechanical aid follows the movements thereof opposing a resistance.

[0007] Rehabilitation devices are known, which are provided with electronic components, such as sensors, adapted to detect parameters indicative of the performance of the patient undergoing rehabilitation therapy, and to transmit the detected data to further electronic components, such as receivers or a central computer, inside the device.

[0008] Such mutually communicating electronic components are generally arranged in parts of the device which are in relative motion with each other during normal use of the device.

[0009] For example, the sensors are often arranged at the moving parts of the device in direct contact with the user, such as rods or pedals, for example, while the receivers are arranged in the housing of the rehabilitation device.

[0010] The connection between sensors and receivers, which allows to power the sensors and transmit data between the sensors and the receivers, is generally obtained by electrical wiring.

[0011] However, such wirings extending through components in mutual relative motion are structurally complex and subject to undesirable stresses.

[0012] Furthermore, these wirings require collapsible and cumbersome configurations to accommodate for the relative movement and provide the necessary protection.

[0013] These solutions are expensive, unreliable in the long run, and require frequent maintenance.

[0014] Therefore, it is the object of the present invention to provide a translational-rotary machine having features such as to obviate at least some of the drawbacks of the prior art.

[0015] It is a particular object of the present invention to provide a translational-rotary machine having electronic components placed in machine components in mutual relative motion, which communicate data and/or electric power through a structural configuration which is simpler, more efficient, more reliable, less cumbersome, and less susceptible to possible damage.

[0016] These and other objects are achieved by a translational-rotary machine according to claim 1. The dependent claims relate to advantageous and preferred embodiments of the invention.

[0017] Further advantageous aspects of the invention will become apparent from the following description of some embodiments thereof given by way of non-limiting example, with reference to the accompanying drawings, in which:

- figure 1 is a perspective view of a cross-section of a partially disassembled component of a translational-rotary machine according to an embodiment of the invention;
- figure 2 is a detail view of the partially disassembled component in figure 1;
- figure 3 is a perspective view of a cross-section of the component in figure 1 in an assembled configuration;
- figure 4 is a detail view of the assembled component in figure 3;
- figure 5 is a further detail view of the assembled component in figure 3;
- figure 6 is a detail view of a further component, in the disassembled configuration, of the translational-rotary machine in figure 1;
- figure 7 is a view of the component in figure 6 in an assembled configuration;
- figure 8 is a perspective view of a further component, in a partially disassembled configuration, of the translational-rotary machine in figure 1;
- figure 9 is a detail view of the component in figure 8;
- figure 10 is a front longitudinal section view of a further component of the translational-rotary machine in figure 1;
- figure 11 is a side view of a component of the translational-rotary machine in figure 1;
- figure 12 is a perspective view of the component in figure 11;
- figure 13 is a front longitudinal section view of a further component of the translational-rotary machine in figure 1;
- figure 14 is a longitudinal section perspective view of the component in figure 13.

[0018] With reference to the figures, a sensorized translational-rotary machine 40 comprises a housing 3 forming two

housing openings 12 facing each other.

[0019] The translational-rotary machine 40 further comprises a shaft 4 which forms two shaft ends 9.

[0020] The shaft 4 is placed through the two housing openings 12.

[0021] Optionally, each opening 12 may be covered by a bellows.

[0022] The translational-rotary machine 40 further comprises drive means 5.

[0023] The shaft 4 is connected to the housing 3 so as to translate and/or rotate with respect to the housing 3, through the drive means 5.

[0024] The translational-rotary machine 40 further comprises two rods 6. Each of the two rods 6 forms a gripping end 7 and a coupling end 8 opposite to the gripping end 7.

[0025] Each of the two rods 6 is removably connected, at the coupling end 8, to a respective shaft end 9.

[0026] According to an aspect of the invention, the translational-rotary machine 40 further comprises wireless communication means 14 configured to communicate data and/or electric power to each other.

[0027] The wireless communication means 14 comprise a first electronic transceiver board 10 and a second electronic transceiver board 11.

[0028] The first electronic transceiver board 10 is placed at each shaft end 9, integral with the shaft 4.

[0029] The second electronic transceivers 11 is placed at each coupling end 8, integral with the rod 6.

[0030] Advantageously, a translational-rotary machine 40 thus configured ensures a simpler, more efficient, and more reliable communication of data and/or electric power between electronic components, i.e., the first and second electronic transceiver boards 10, 11, placed in components of the translational-rotary machine in mutual relative motion.

[0031] Indeed, the use of a complex and cumbersome system of sliding electrical contacts is avoided by the wireless communication means 14.

[0032] Furthermore, such wireless communication means 14 are less susceptible to damage than a sliding electrical contact system, which is instead exposed to the risk of deformations, damage, and wear.

[0033] According to an embodiment, the wireless communication means 14 further comprise a sensor 16 placed at the gripping end 7 of each rod 6.

[0034] Alternatively, the sensor 16 is placed in axis with the shaft 4.

[0035] According to an embodiment, the sensor 16 is configured to detect a force and/or a displacement.

[0036] Preferably, the sensor 16 is configured to detect parameters indicative of the movement of each rod 6, such as the force or torque acting on the rod 6 and the linear and/or angular displacement of the rod 6, for example.

[0037] Advantageously, the information detected by the sensor 16 can be used to set, adapt, and verify the parameters of the rehabilitation therapy to which the user of the translational-rotary machine 40 is subjected.

[0038] According to an embodiment, the sensor 16 is configured to communicate data and/or electric power with the second electronic transceiver board 11.

[0039] Advantageously, such a configuration simplifies the collection and transmission, between moving parts of the translational-rotary machine 40, of data related to the exercise performed by the user using the translational-rotary machine 40.

[0040] Such a configuration also has a smaller size and less risk of damage.

[0041] According to an embodiment, the wireless communication means 14 further comprise an intermediary electronic transceiver board 17 placed within each rod 6, in a substantially intermediate position between the gripping end 7 and the coupling end 8.

[0042] The intermediary electronic transceiver board 17 is configured to communicate data and/or electric power with the second electronic transceiver board 11 and with the sensor 16 of the same rod 6.

[0043] According to this embodiment, the sensor 16 is configured to communicate data and/or electric power with the intermediary electronic transceiver board 17, and the intermediate electronic transceiver board 17 is configured to communicate such data and/or electric power with the electronic transceiver board 11.

[0044] Advantageously, the intermediary electronic transceiver board 17 acts as a "mediator" ("buffer") between the sensor 16 and the second electronic transceiver board 11, thus increasing the efficiency and reliability of data and/or electric power transmission between the sensor 16 and the second electronic transceiver board 11.

[0045] According to an embodiment, the translational-rotary machine 40 comprises two grips 15 hinged to a respective gripping end 7 of the rods 6, preferably by means of a pin 18 which is integral with the rod 6, and one or more ball bearings 19 interposed between the pin 18 and the respective grip 15.

[0046] According to a preferred embodiment, the sensor 16 comprises a plurality of strain gauges adapted to detect deformations of each respective pin 18.

[0047] Advantageously, by means of the plurality of strain gauges, the sensor 16 detects data related to the force, energy, and power used by the user to move the rods 6.

[0048] According to an embodiment, each rod 6 comprises a coupling element 20 connected to the rod 6 at the coupling end 8.

[0049] The coupling element 20 has a substantially truncated-pyramid shape with a polygonal base, which defines an

abutting head portion 21 and a truncated-pyramid portion 22.

[0050] The coupling element 20 further forms a through-hole 23 extending through the abutting head portion 21 and the truncated-pyramid portion 22.

[0051] According to this embodiment, the shaft 4 forms a coupling seat 24 at each shaft end 9.

[0052] The coupling seat 24 forms a contrast wall 25, shaped so as to accommodate the truncated-pyramid portion 22 of the coupling element 20, and a bottom wall 26.

[0053] A threaded hole 27 is defined on the bottom wall 26.

[0054] The translational-rotary machine 40 further comprises two knobs 28.

[0055] Each knob 28 comprises a screwing head 29 and a threaded pin 30 connected to the screwing head 29.

[0056] The screwing head 29 is shaped, on the one hand, so as to be adapted to abut against the abutting head portion 21 of the coupling element 20, and on the other hand, to be grippable and screwable by a user.

[0057] The threaded pin 30 is sized to be insertable into the through-hole 23 of the coupling element 20.

[0058] In the configuration where each rod 6 is connected to a respective shaft end 9, the coupling element 20 is received in the coupling seat 24.

[0059] Furthermore, the knob 28 is coupled to the coupling element 20 so that the screwing head 29 abuts with the abutting head portion 21, and the threaded pin 30 is inserted through the through-hole 23 and screwed into the threaded hole 27 of the coupling seat 24.

[0060] Advantageously, such a removable connection between the knob 28, the coupling seat 24 of the shaft end 9, and the coupling element 20 interposed between the knob 28 and the shaft end 9, is structurally simple and ensures a quick and firm connection.

[0061] According to an advantageous embodiment, the truncated-pyramid portion 22 of the coupling element 20 and the contrast wall 25 of the coupling seat 24 are deformed to obtain a shape connection.

[0062] The connection between the coupling element 20 and the coupling seat 24 thus configured is advantageously less noisy and firmer.

[0063] With added advantage, this results in a finite number of possible coupling orientations between the truncated-pyramid portion 22 and the contrast wall 25.

[0064] For example, if the truncated-pyramid portion 22 and the contrast wall 25 have a square cross-section, the truncated-pyramid portion 22 is insertable into the contrast wall 25 according to only four possible coupling timings.

[0065] This facilitates and increases the assembly speed between the rod 6 and the shaft end 9.

[0066] According to an embodiment, the first electronic transceiver board 10 has a discoidal shape which forms a central hole, so that, in an assembled configuration, the shaft end 9 passes through the central hole of the first electronic transceiver board 10.

[0067] According to an embodiment, the second electronic transceiver board 11 has a discoidal shape which forms a central hole 32 delimited by a hole edge 33, so that the hole edge 33 surrounds the shaft end 9 in an assembled configuration.

[0068] According to this embodiment, four magnetic detectors 31 are placed on each second electronic transceiver board 11 at the hole edge 33, at 90° from one another.

[0069] Preferably, the four magnetic detectors 31 are arranged on one side of the second electronic transceiver board 11 facing away from the housing 3 (in an assembled configuration).

[0070] Two magnets 34 are placed on each shaft end 9, at 90° from each other, so that when the rod 6 is assembled to the shaft end 9, two of the four magnetic detectors 31 face the two magnets 34, respectively.

[0071] Advantageously, such a configuration with four magnetic detectors 31 and two magnets 34 allows to determine the timing with which the rod 6 is coupled into the shaft end 9.

[0072] Indeed, the timing with which the rod 6 is coupled into the shaft end 9 can be determined according to whether or not each of the four magnetic detectors 31 detects the presence of one of the two magnets 34.

[0073] For example, indicating by "1" the case of detection of the presence of a magnet 34 by a single magnetic detector 31, and by "0" the non-detection, four possible combinations occur as a function of the coupling timing of the rod 6 in the shaft end 9, shown in the following table:

	Magnetic Detector #1	Magnetic Detector #2	Magnetic Detector #3	Magnetic Detector #4
0° timing	1	1	0	0
90° timing	0	1	1	0
180° timing	0	0	1	1
270° timing	1	0	0	1

[0074] Advantageously, by determining the coupling timing of the rod 6 to the shaft end 9, it is possible to determine and adjust more closely the rehabilitation therapy to which the user of the translational-rotary machine 40 is subjected.

[0075] According to an embodiment, different timing angles are determinable in the configuration where the coupling element 20 and the contrast wall 25 have prismatic shapes with a number of sides other than four, and a corresponding number of magnetic detectors 31 placed on each second electronic transceiver board 11 at the hole edge 33, and a corresponding number of magnets 34 placed on each shaft end 9.

[0076] According to a further aspect of the invention, a rehabilitation machine 1 comprises a translational-rotary machine 40 as described above.

[0077] According to a preferred embodiment, the rehabilitation machine 1 comprises at least one track 2 extending along a longitudinal direction.

[0078] According to this embodiment, the housing 3 is slidingly connected to the at least one track 2 and is configured to slide along the longitudinal direction.

[0079] Furthermore, the drive means 5 are operatively connected to the shaft 4 and are configured to translate and/or rotate the shaft 4 with respect to the at least one track 2.

[0080] Advantageously, a rehabilitation machine 1 thus configured has at least all of the previously highlighted advantages.

[0081] Obviously, in order to satisfy contingent specific needs, those skilled in the art can make further changes and variations all contained within the scope of protection defined by the following claims.

Claims

1. A translational-rotary machine (40), comprising:

- a housing (3), forming two housing openings (12) facing each other;
- a shaft (4) forming two shaft ends (9);
said shaft (4) being placed through the two housing openings (12) ;
- drive means (5);
said shaft (4) being connected to the housing (3) so as to translate and/or rotate with respect to the housing (3), through the drive means (5);
- two rods (6), each of the two rods (6) forming a gripping end (7) and a coupling end (8) opposite to the gripping end (7),
each of the two rods (6) being removably connected, at the coupling end (8), to a respective shaft end (9);
- wireless communication means (14) configured to communicate data and/or electric power with each other, comprising:

    - a first electronic transceiver board (10) placed at each shaft end (9), integral with the shaft (4);
    - a second electronic transceiver board (11) placed at each coupling end (8), integral with the rod (6).

2. A translational-rotary machine (40) according to claim 1, wherein the wireless communication means (14) further comprise a sensor (16),
said sensor (16) being placed at the gripping end (7) of each rod (6), or in axis with the shaft (4).

3. A translational-rotary machine (40) according to claim 2, wherein the sensor (16) is configured to detect parameters indicative of the movement of each rod (6), preferably including the force or torque acting on the rod (6) and the linear and/or angular displacement of the rod (6).

4. A translational-rotary machine (40) according to claim 2 or 3, wherein the sensor (16) is configured to communicate data and/or electric power with the second electronic transceiver board (11).

5. A translational-rotary machine (40) according to one of claims 2 to 4, wherein the wireless communication means (14) further comprise an intermediary electronic transceiver board (17) placed within each rod (6), in an intermediate position between the gripping end (7) and the coupling end (8),
said intermediary electronic transceiver board (17) being configured to communicate data and/or electric power with the second electronic transceiver board (11) and with the sensor (16) of the same rod (6).

6. A translational-rotary machine (40) according to any one of the preceding claims, comprising two grips (15) hinged to a respective gripping end (7) of the rods (6), optionally by means of a pin (18) which is integral with the rod (6).

7. A translational-rotary machine (40) according to claims 2 and 6, wherein the sensor (16) comprises a plurality of strain gauges adapted to detect deformations of each respective pin (18).

8. A translational-rotary machine (40) according to any one of the preceding claims, wherein each rod (6) comprises a coupling element (20) connected to the rod (6) at the coupling end (8).

9. A translational-rotary machine (40) according to claim 8, wherein the coupling element (20) has a truncated-pyramid shape with a polygonal base, which defines an abutting head portion (21) and a truncated-pyramid portion (22), said coupling element (20) forming a through-hole (23) extending through the abutting head portion (21) and the truncated-pyramid portion (22).

10. A translational-rotary machine (40) according to claim 9, wherein the shaft (4) forms a coupling seat (24) at each shaft end (9),
said coupling seat (24) forming:

- a contrast wall (25) shaped so as to accommodate the truncated-pyramid portion (22) of the coupling element (20);
- a bottom wall (26),

and wherein a threaded hole (27) is defined on the bottom wall (26).

11. A translational-rotary machine (40) according to claim 10, comprising two knobs (28), wherein each knob (28) comprises a screwing head (29) and a threaded pin (30) connected to the screwing head (29),
wherein the screwing head (29) is shaped, on the one hand, so as to be adapted to abut against the abutting head portion (21) of the coupling element (20), and on the other hand, to be grippable and screwable by a user,
and wherein the threaded pin (30) is sized to be insertable into the through-hole (23) of the coupling element (20).

12. A translational-rotary machine (40) according to claim 11, wherein, in the configuration where each rod (6) is connected to a respective shaft end (9):

- the coupling element (20) is accommodated in the coupling seat (24);
- the knob (28) is coupled to the coupling element (20) so that the screwing head (29) abuts with the abutting head portion (21);
- the threaded pin (30) is inserted through the through-hole (23) and screwed into the threaded hole (27) of the coupling seat (24) .

13. A translational-rotary machine (40) according to one of claims 10 to 12, wherein the truncated-pyramid portion (22) of the coupling element (20) and the contrast wall (25) of the coupling seat (24) are deformed to obtain a shape connection.

14. A translational-rotary machine (40) according to any one of the preceding claims, wherein the second electronic transceiver board (11) has a discoidal shape forming a central hole (32), said central hole (32) being delimited by a hole edge (33) so that the hole edge (33) surrounds the shaft end (9),
and wherein, optionally, four magnetic detectors (31) are placed on each second electronic transceiver board (11), at the bore edge (33), at 90° from one another, and wherein two magnets (34) are placed on each shaft end (9), at 90° from each other, so that when the rod (6) is assembled to the shaft end (9), two of the four magnetic detectors (31) face the two magnets (34), respectively.

15. A rehabilitation machine (1), comprising a translational-rotary machine (40) according to any one of claims 1 to 14, and at least one track (2) extending along a longitudinal direction;
wherein the housing (3) is slidingly connected to said at least one track (2), and is configured to slide along the longitudinal direction;
and wherein the drive means (5) are operatively connected to the shaft (4) and configured to translate and/or rotate the shaft (4) with respect to the at least one track (2).

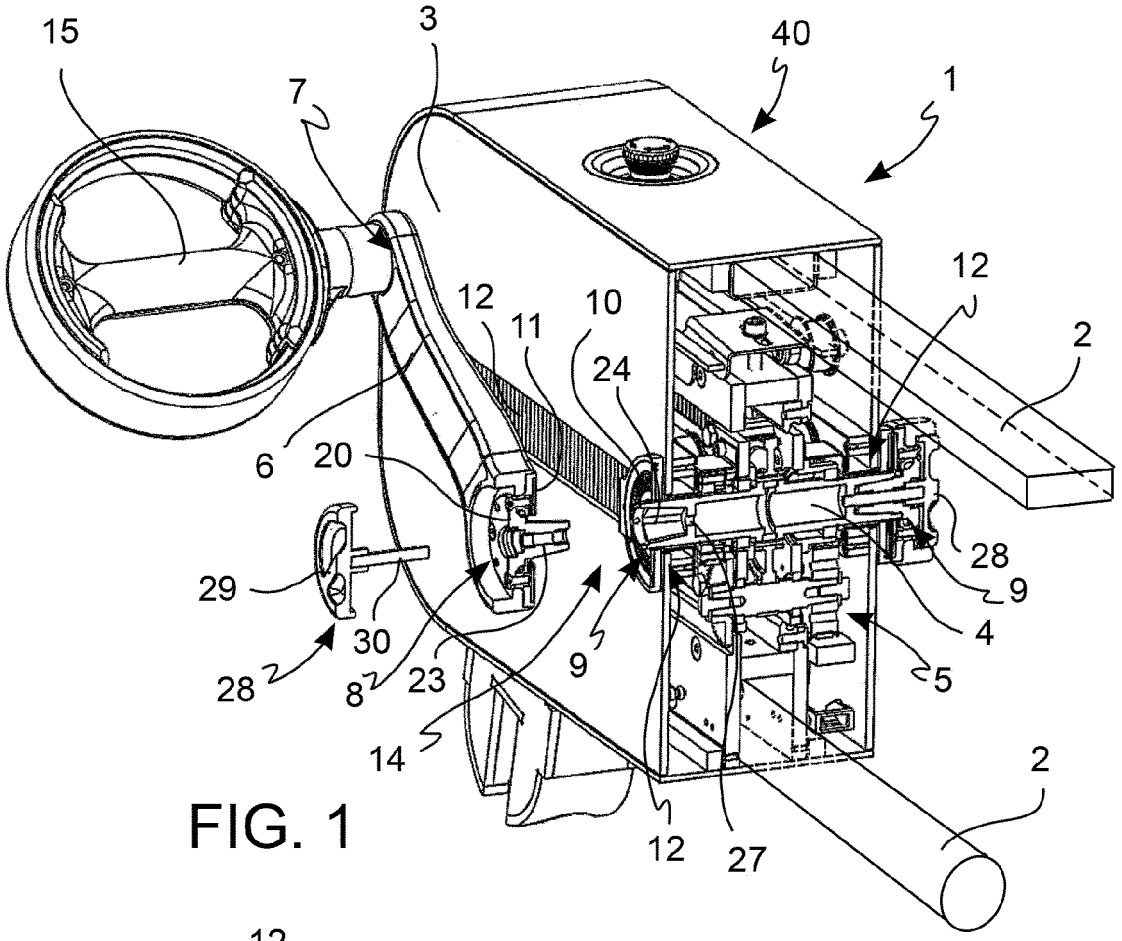
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FIG. 1

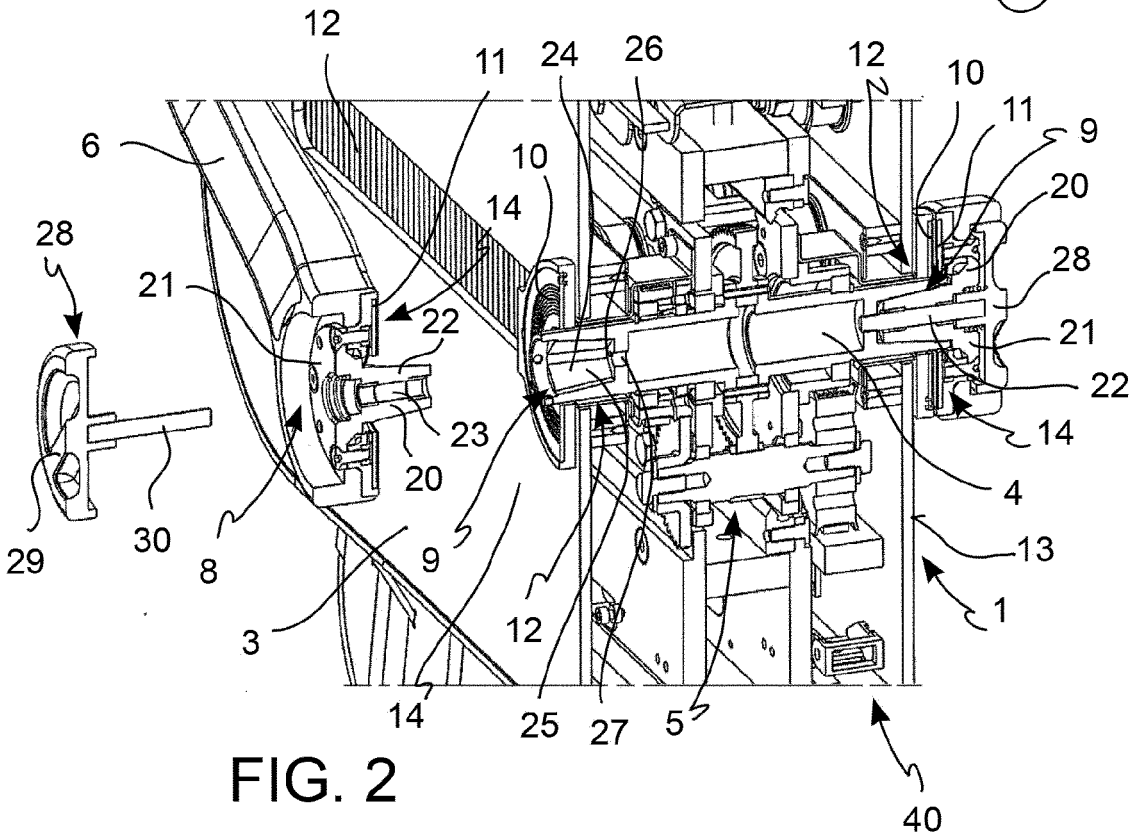
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FIG. 2

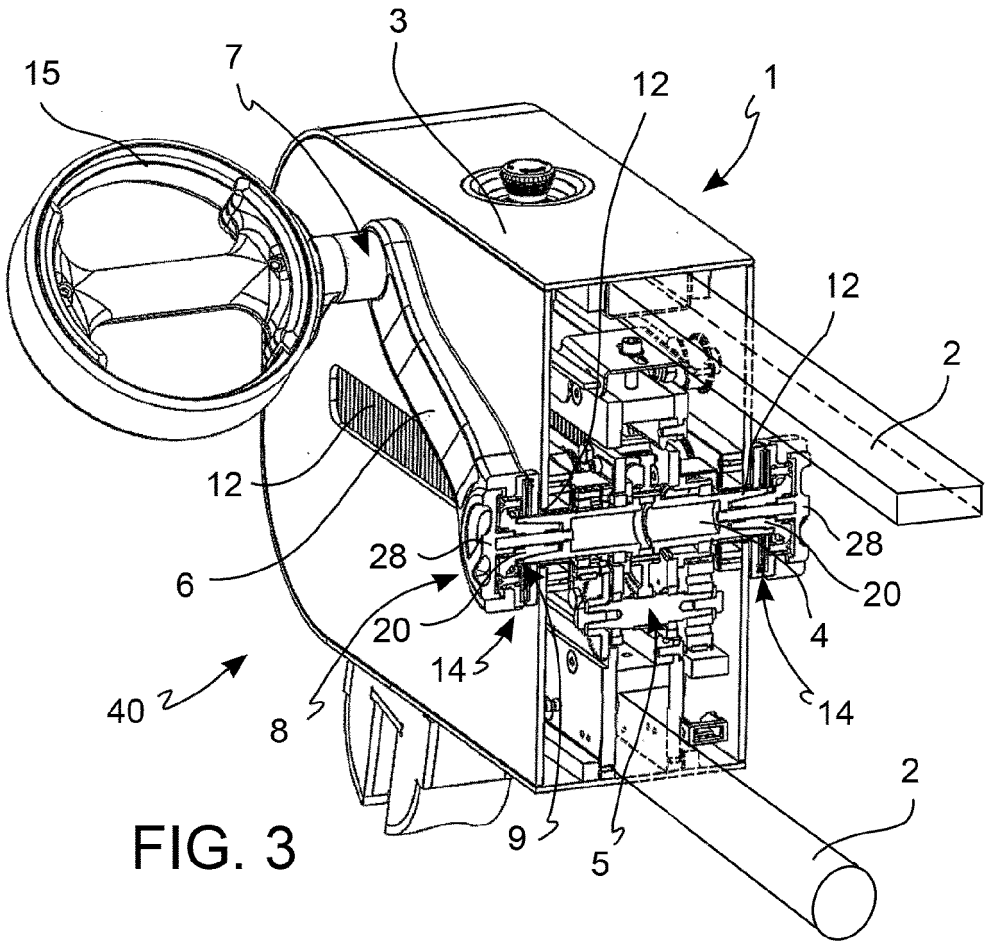
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FIG. 3

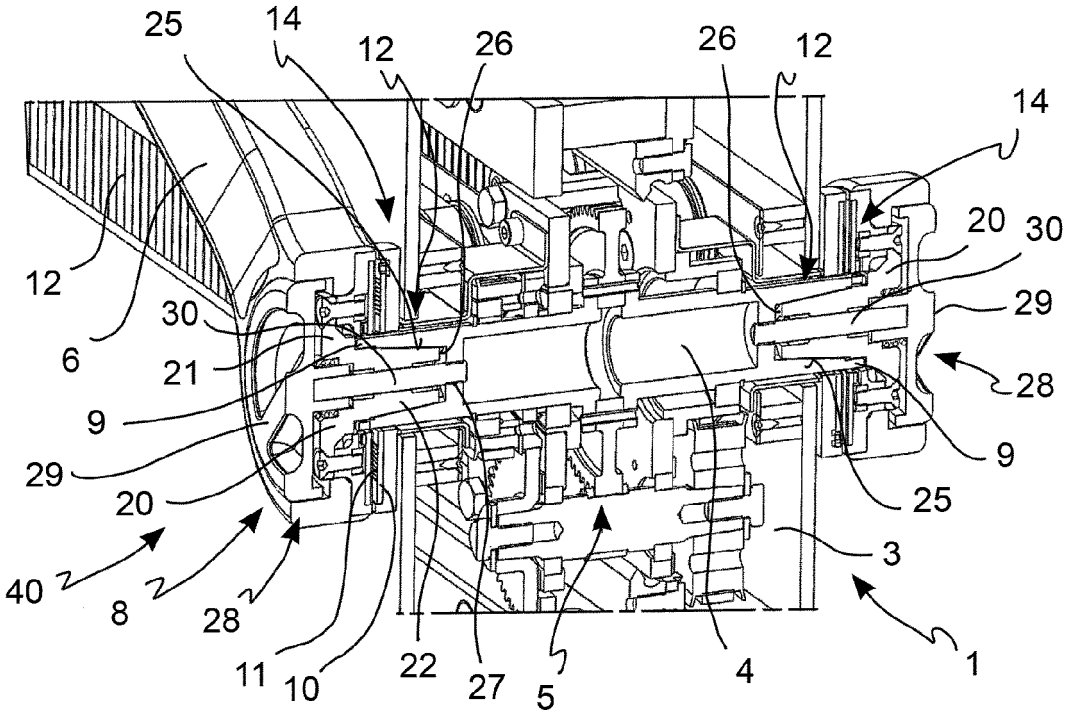
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FIG. 4

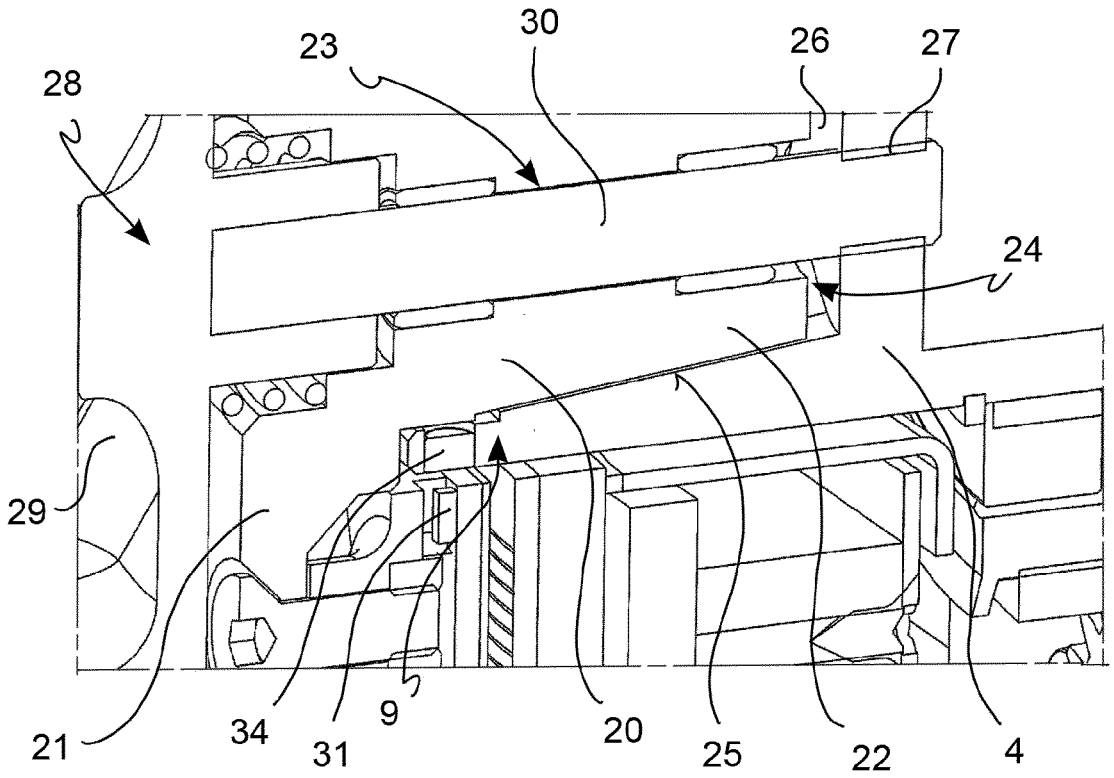
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FIG. 5

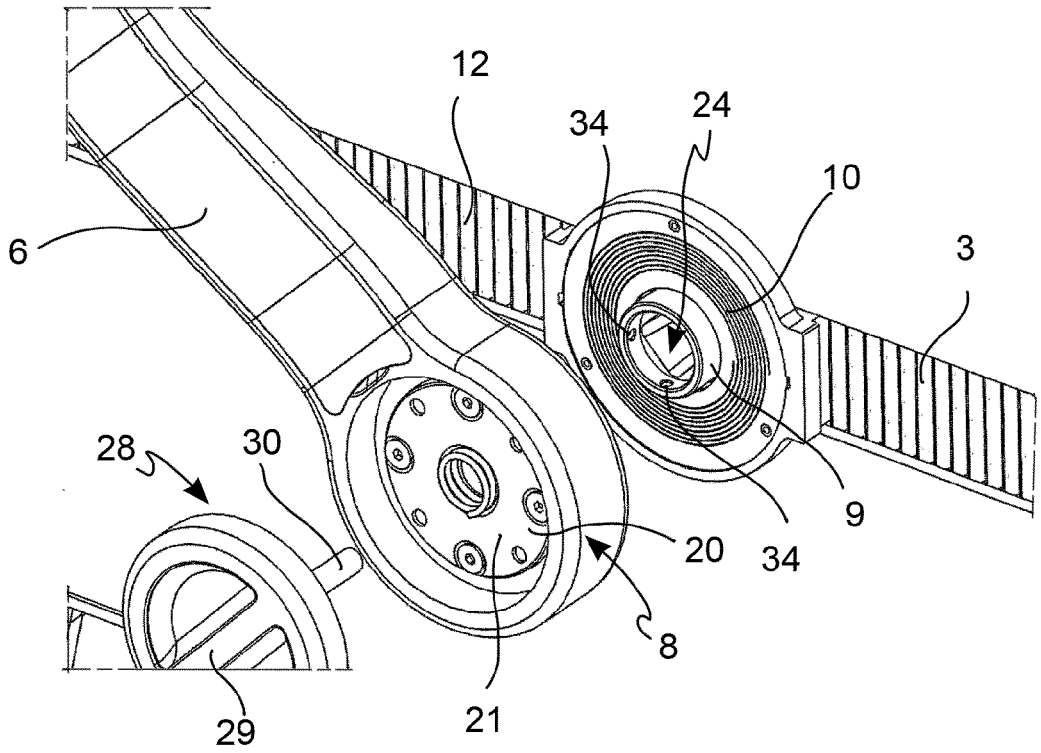
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FIG. 6

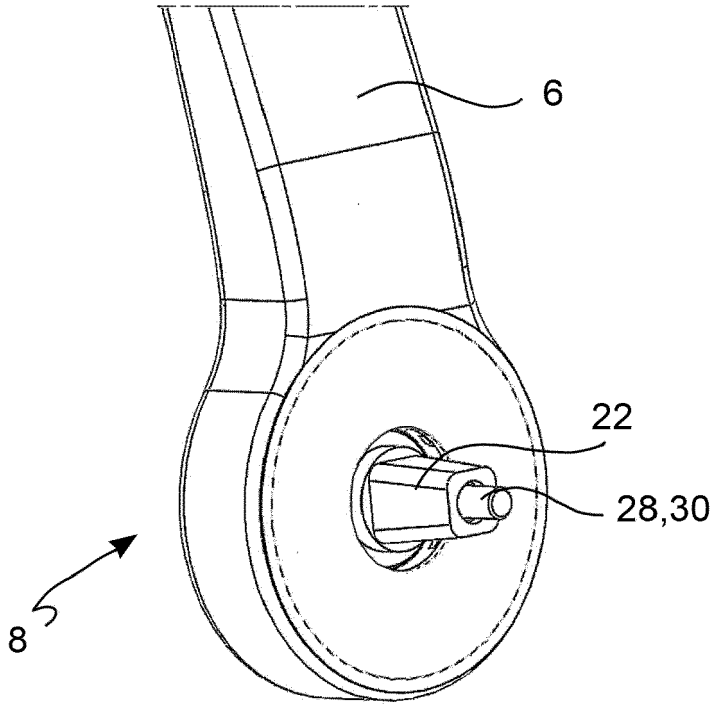

FIG. 7

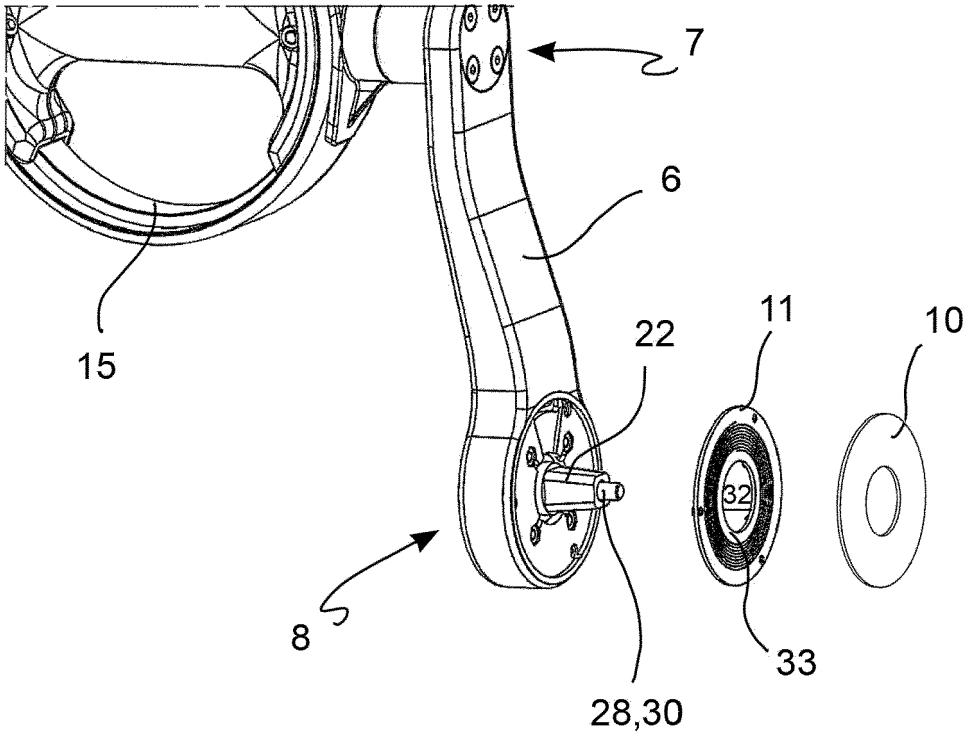

FIG. 8

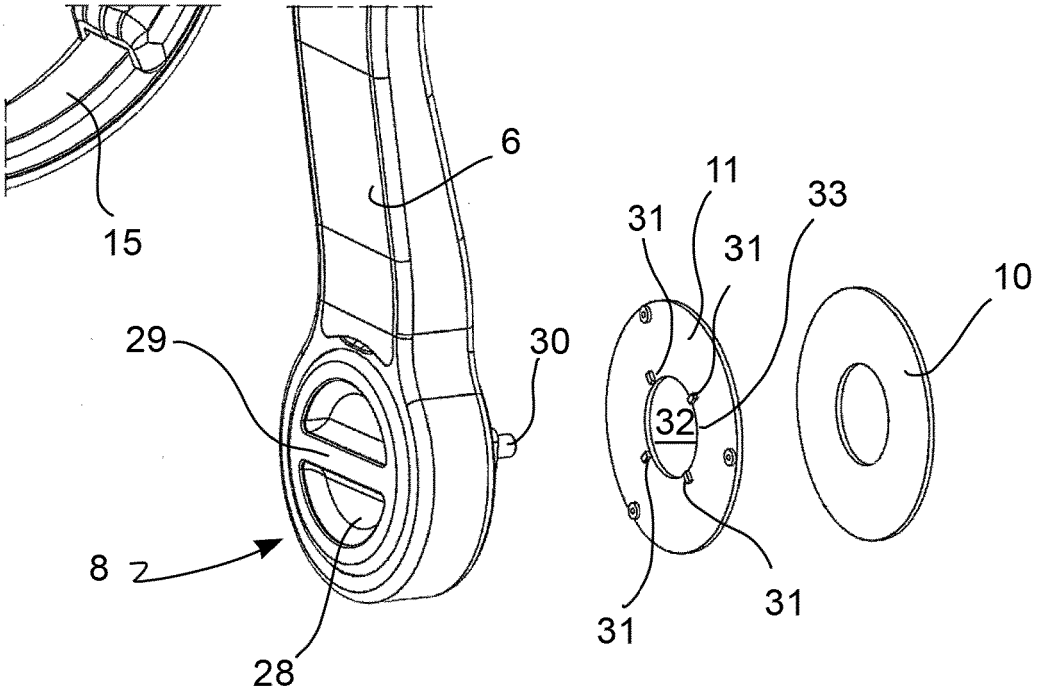
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FIG. 9

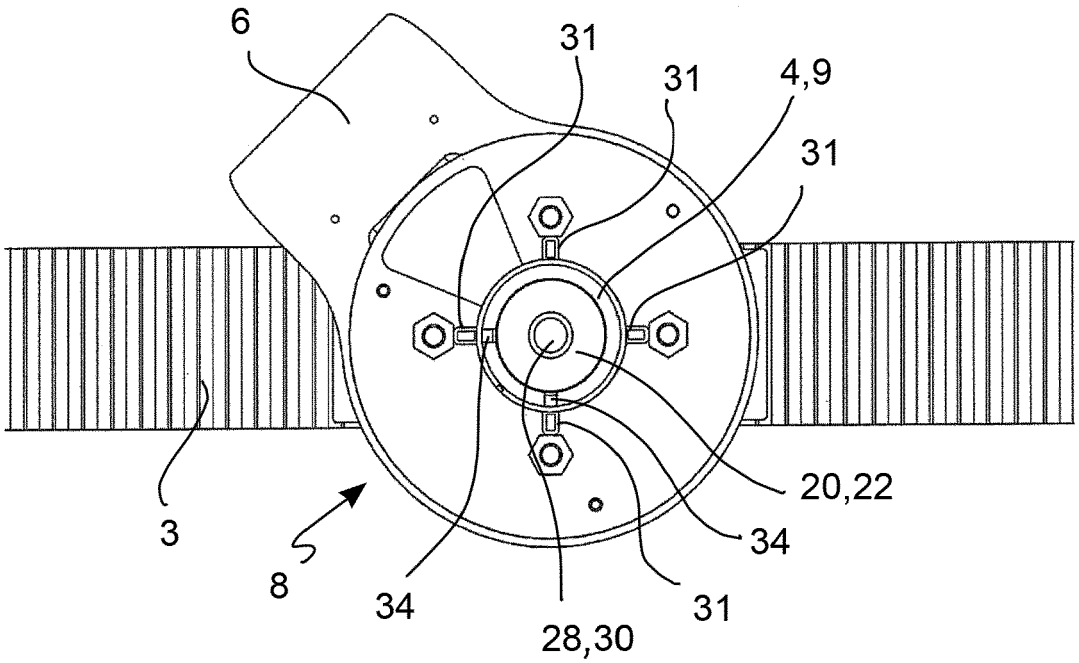
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FIG. 10

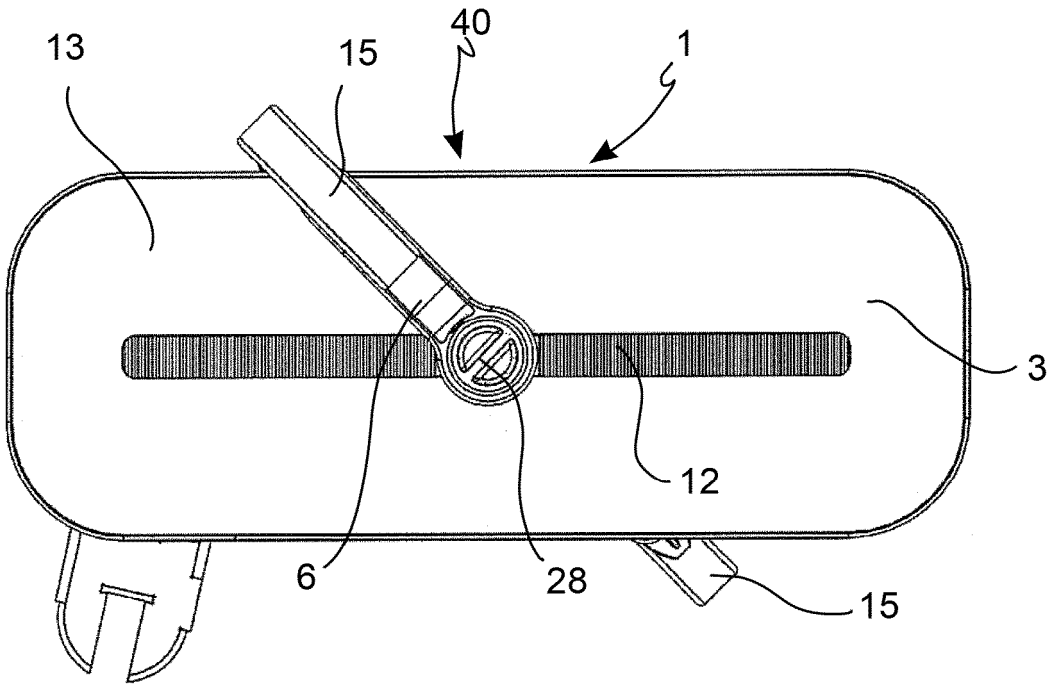

FIG. 11

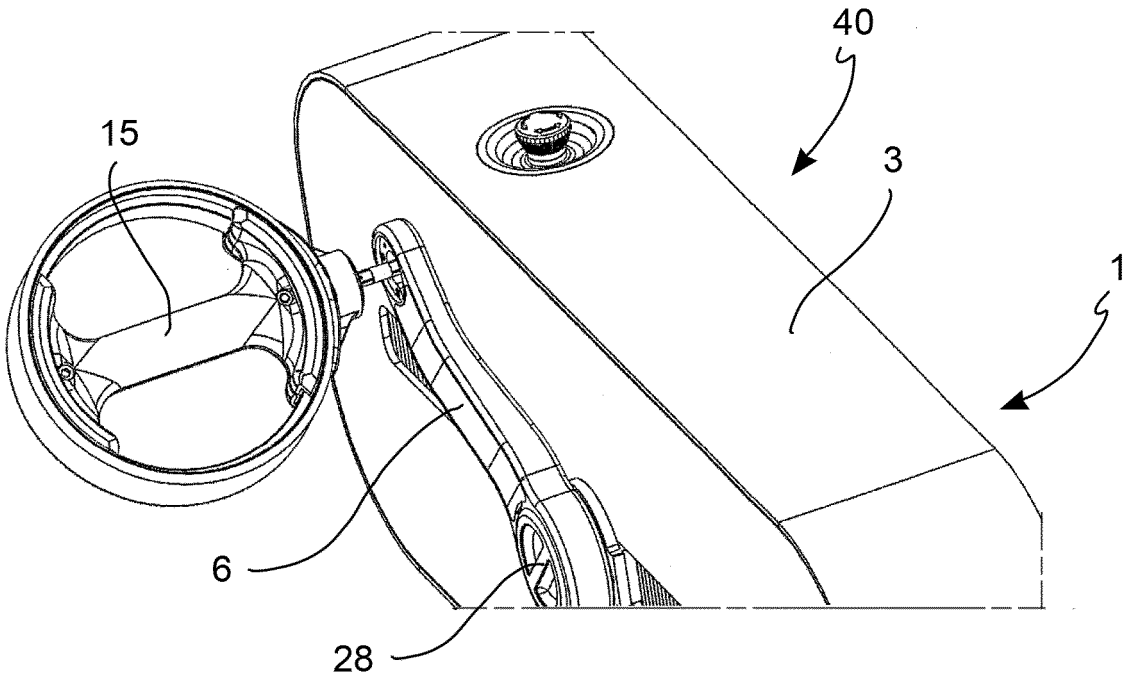

FIG. 12

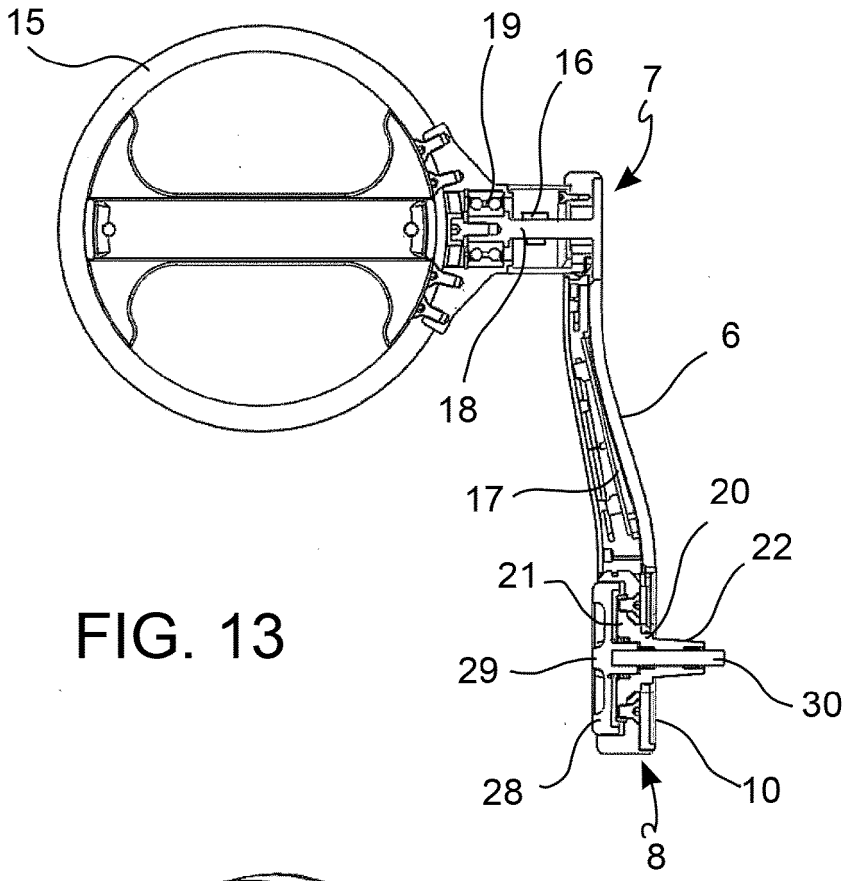
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FIG. 13

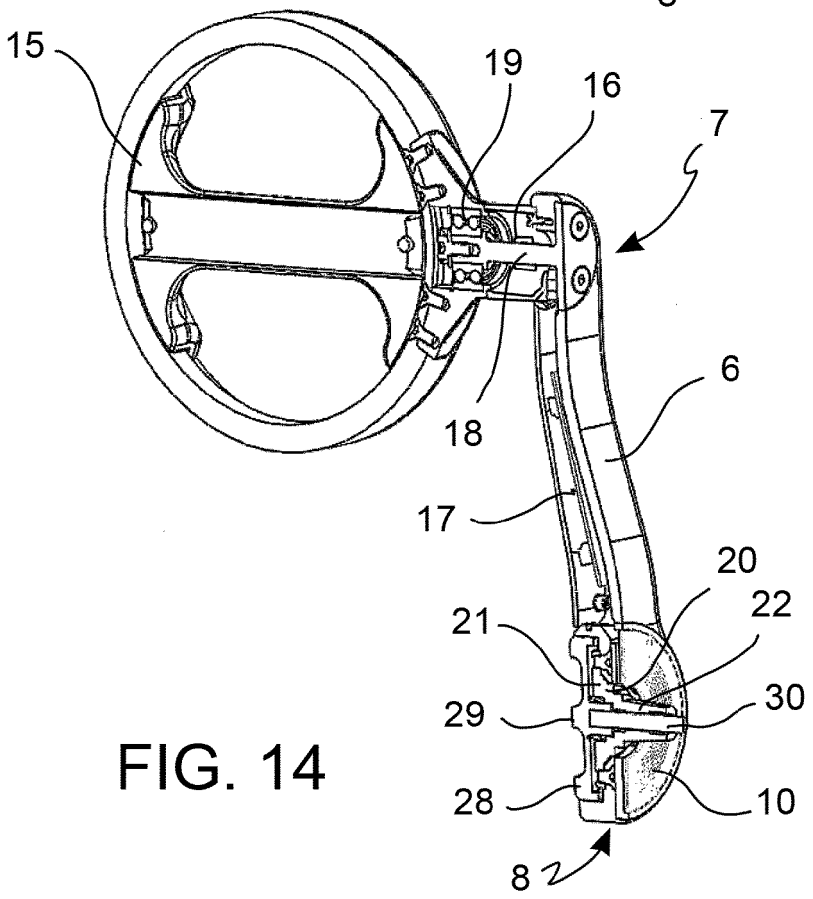
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FIG. 14

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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
Munich	23 December 2021	Squeri, Michele

CATEGORY OF CITED DOCUMENTS

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