



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.04.2015 Bulletin 2015/18

(51) Int Cl.:
A61H 1/02 (2006.01)

(21) Application number: **13425141.2**

(22) Date of filing: **25.10.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

- **Antonini, Massimo**
I-25100 Brescia (IT)
- **Petrogalli, Gianluigi**
I-25100 Brescia (IT)
- **MOR, Maurizio**
I-25100 Brescia (IT)
- **Vertuan, Angelo**
I-25100 Brescia (IT)

(71) Applicant: **Polibrixia S.r.l.**
25100 Brescia (IT)

(74) Representative: **Long, Giorgio et al**
Jacobacci & Partners S.p.A.
Via Senato, 8
20121 Milano (IT)

(72) Inventors:
• **Faglia, Rodolfo**
I-25100 Brescia (IT)
• **Fausti, Davide**
I-25100 Brescia (IT)

(54) **Physical exercise machine**

(57) The present invention relates to a physical exercise machine, particularly for the rehabilitation or training of limbs, which may be adapted to both the lower and the upper limbs, for both passive and active therapies.

Particularly the present invention relates to a machine (1) for the physical exercise of limbs, comprising a frame (2) on which translational-rotational members (3) of an upper or lower limb are mounted, said translational-rotational members (3) being operatively connected to motorization means (4, 4'), characterized in that said translational-rotational members (3) comprise:

- a first pair of pulleys (11, 11') arranged in the proximity of an end of the frame (2), the pulleys (11, 11') of said first pair being arranged along a substantially vertical axis;

- a second pair of pulleys (12, 12') arranged in the proximity of the opposite end of the frame (2), the pulleys (12, 12') of said second pair being arranged along a substantially vertical axis;

- a carriage (13) mobile along a longitudinal axis (X);
- a third pair of pulleys (14, 14') arranged on said carriage (13), the pulleys (14, 14') of said third pair being arranged along an axis substantially parallel to the axis (X);
- a driving member (15) operatively connecting said first (11, 11'), second (12, 12'), and third pairs of pulleys (14, 14'),

and wherein at least one pulley (11', 12) of each of said first (11, 11') and second (12, 12') pairs of pulleys is operatively connected to the respective motorization means (4, 4').

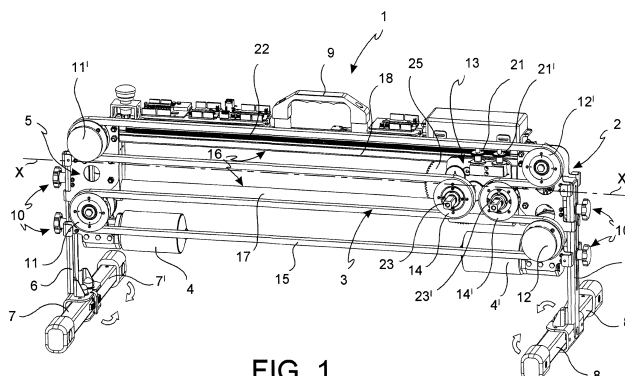


FIG. 1

Description

[0001] The present invention relates to a physical exercise machine, particularly for the rehabilitation or training of limbs, which may be adapted to both the lower and the upper limbs, both for passive and active therapies.

[0002] The rehabilitation therapy of the lower and upper limbs is a major clinical practice aimed to give back to a patient, for example, affected by a paresis or hemiparesis of various etiology and degree, or affected by an orthopedic damage, his/her motor capabilities.

[0003] Several techniques exist, which may be used for a motor rehabilitation, but one of the most efficient ones is certainly the one that uses special rehabilitation devices. The rehabilitation may be of either a passive or an active type. In the passive rehabilitation (CPM, Continuous Passive Motion), it is the machine that works on the limb, which is brought to perform particular functions aimed to restore a heavily impaired motility. On the contrary, active rehabilitation requires the direct strain of the patient's limb, while the mechanic aid follows the movements thereof while operating. A possible example of a device of the latter type is the so-called "exercise bike", of the conventional or elliptical type.

[0004] In either case, rehabilitation devices are generally bulky, expensive, and difficult to be transported. Particularly, the passive rehabilitation devices are specifically designed for use in a rehabilitative clinical center and, with suitable modifications, they are usable also in a domestic setting. This requires the transport of the patient to these rehabilitative centers, where the physiotherapist will be able to use such mechanical aids.

[0005] Furthermore, most of the known rehabilitation devices are built to be used only on the lower limbs or the upper limbs. Therefore, for a global therapy, he/she will have to use a number of different machines, once again making the presence of the patient at the motor rehabilitation center mandatory.

[0006] Therefore, it will be desirable to provide a physical exercise machine that allows the rehabilitation of both the lower and upper limbs, which is easily transportable for a domestic use by the physiotherapist or the same patient, which has reduced overall dimensions, and is light-weighted, and which allows implementing a passive or active therapy according to the needs.

[0007] This and other objects are achieved by a physical exercise machine for the limbs as set forth in the appended claims, the definitions of which are an integral of the present description.

[0008] The characteristics and advantages of the present invention will be more clearly apparent from the description of some preferred implementation versions, given herein below by way of indicative, non-limiting example, with reference to the appended Figures:

Fig. 1 represents a perspective view of the physical exercise machine of the invention;

Fig. 2 represents a perspective view of the machine

of Fig. 1, taken on the opposite side;

Fig. 3 represents a longitudinal sectional view of the machine of Fig. 1;

Fig. 4 represents a perspective view of a detail of the machine of Fig. 1;

Fig. 5 represents a perspective view of the detail of Fig. 4, taken on the opposite side;

Fig. 6A represents a cross-sectional view of the detail of Fig. 4;

Fig. 6B represents a sectional view according to the direction IV of Fig. 4 of a detail of the invention;

Fig. 7 represents a cross-sectional perspective view of a detail of the machine of Fig. 1;

Fig. 8 represents a top perspective view of the machine of the invention according to a first embodiment;

Fig. 9 represents a perspective view of a detail of the machine of the invention according to a second embodiment;

Fig. 10 represents a perspective view of a detail of the machine of the invention according to a third embodiment;

Fig. 11A represents a perspective view of a detail of the machine of the invention according to a fourth embodiment;

Fig. 11B represents the embodiment of Fig. 11A in a different configuration;

Fig. 11C represents the embodiment of Fig. 11A in a still different configuration;

Fig. 12 represents a perspective view of the machine of the invention according to a fifth embodiment;

Fig. 13 represents a perspective view of the machine of the invention according to a sixth embodiment;

Fig. 14 represents a perspective view of the machine of the invention according to a seventh embodiment;

Fig. 15 represents a perspective view of a different configuration of use of a detail of the equipment of Fig. 11A.

[0009] Referring to the Figures, the physical exercise machine for limbs, generally indicated with the numeral 1, comprises a frame 2 on which translational-rotational members 3 are mounted, which are intended to the movement of an upper or lower limb, said translational-rotational members 3 being operatively connected to motorization means 4, 4' and actuatable in an active or passive manner.

[0010] By the phrase "actuatable in an active manner", is meant that the translational-rotational members 3 are actuated by the motorization means 4, 4' which they are connected to, thus transmitting the movement to the limb or limbs of the machine's user.

[0011] Vice versa, by the phrase "actuatable in a passive manner" is meant that the translational-rotational members 3 oppose a preset resistance to the motion imposed by the user. Therefore, to a situation in which the translational-rotational members operate in an active manner, a so-called passive exercise on the user would

correspond, and vice versa.

[0012] The frame 2 comprises a support structure 5 for the translational-rotational members 3, extending along a longitudinal axis X, and two legs 6, 6', inferiorly ending with small retractile feet 7, 7', 8, 8'.

[0013] The small retractile feet 7, 7', 8, 8' extend perpendicularly to the axis X, as shown in Fig. 1, but they may be closed again in the direction shown by the arrows, in order to limit the overall dimensions thereof when the machine is not used, or during the transport thereof. An end of each of the small feet 7, 7', 8, 8' is, to this aim, hinged to the lower end of the corresponding legs 6, 6'.

[0014] In certain embodiments, as the one shown in the Figures, the legs 6, 6' are disassemblable and/or height adjustable. To this aim, the legs 6, 6' are secured to the short sides of the support structure by screw systems 10 that are made more easily actuatable by handles. By sliding the legs 6, 6' on special guides on the support structure 5, it will be possible to select the desired height, thus the legs 6, 6' will be able to be secured by the screws 10 at the selected height.

[0015] The frame 2 further comprises a handle 9 arranged on the upper side of the machine 1, so as to facilitate the transport thereof.

[0016] The translational-rotational members 3 comprise:

- a first pair of pulleys 11, 11' arranged in the proximity of an end of the support structure 5, the pulleys 11, 11' of said first pair being arranged along a substantially vertical axis;
- a second pair of pulleys 12, 12' arranged in the proximity of the opposite end of the support structure 5, the pulleys 12, 12' of said second pair being arranged along a substantially vertical axis;
- a carriage 13 mobile along the axis X;
- a third pair of pulleys 14, 14' arranged on said carriage 13, the pulleys 14, 14' of said third pair being arranged along an axis substantially parallel to the axis X;
- a driving member 15 operatively connecting said first 11, 11', second 12, 12', and third pairs of pulleys 14, 14'.

[0017] A pulley 11', 12 of each of said first 11, 11' and second pairs of pulleys 12, 12' is operatively connected, by means of suitable gearmotors, to the respective motorization means 4, 4'. For example, a helicoidal screw gearmotor system will be able to be advantageously used. On the contrary, the other two pulleys 11, 12' are mounted idle.

[0018] It is preferred, without limitation, that the pulleys 11', 12 connected to the motorization means 4, 4' are arranged transversally on the support structure 5, i.e., if in the first pair of pulleys the upper pulley 11' is directly connected to the respective motorization means 4, in the second pair of pulleys, the lower pulley 12 will be connected to the respective motorization means 4', or vice

versa.

[0019] In the embodiment shown in the Figures, in which both the motorization means 4, 4' are located below the support structure 5, the upper pulley 11' of the first pair of pulleys is connected, for example by a drive belt, to first motorization means 4, while the lower pulley 12 of the second pair of pulleys is connected to second motorization means 4'.

[0020] The carriage 13 is slidable on a track 16 arranged on a vertical plane and along the axis X. The track 16 comprises a lower rail 17 and an upper rail 18. In the embodiment of the Figures, the lower rail 17 is of a tubular shape, while the upper rail 18 has a rectangular section, but nothing prevents to invert them or to use sections having a different shape.

[0021] Therefore, the carriage 13 is provided with a first sliding seat 19 for the lower rail 17 and with a second sliding seat 20 for the upper rail 18 (Fig. 6A). In the embodiment of the Figures, the first sliding seat 19 is, in turn, of a tubular shape with shape matching with the lower rail 17.

[0022] In the proximity of the upper edge of the carriage 13, two toothed castors 21 are shrunk on, 21' having a vertical axis. The toothed castors 21, 21' engage a rack 22 arranged above the upper rail 18 and parallel hereto, and they are connected to a detection system of the translating position of the carriage, for example, by a potentiometer system, to send a control signal to the driving and control unit, which will be described herein below.

[0023] The third pair of pulleys 14, 14' is mounted on the carriage 13. The pulleys 14, 14' of the third pair are not motorized.

[0024] The pulleys 14, 14' are associated to respective shafts 23, 23'. The shafts 23, 23' pass through the body 24 of the carriage 13 and are associated, at the opposite face, with a first transmission wheel 25 and with a second transmission wheel 25', respectively. The first transmission wheel 25 has a diameter that is larger than the second transmission wheel 25', and the two wheels are operatively connected so as to compose a gearmotor system.

[0025] However, in other embodiments, it will be possible to arrange transmission wheels 25, 25' with the same diameter, thus resulting in a 1:1 ration, or to invert the larger wheel with the smaller wheel, thus obtaining a multiplication of the motion instead of a reduction.

[0026] In certain embodiments, the transmission wheels 25, 25' are mutually engaging toothed wheels.

[0027] In other embodiments, the two transmission wheels 25, 25' are connected by flexible transmission means, such as, for example a chain or a belt.

[0028] The pulley 14, associated to the same shaft 23 on which the first transmission wheel 25 having the largest diameter is mounted, is mounted onto the shaft 23 by bearings 26 that free it from the shaft 23 rotation. Vice versa, the two transmission wheels 25, 25' and the pulley 14' are integral to the respective shafts 23, 23'. In fact, the two pulleys 14, 14', being actuated by the same driv-

ing member 15, rotate at the same angular speed, while the transmission wheels 25, 25' with a different diameter, secured onto the shafts 23, 23', rotate at a different speed, depending on the transmission ratio between the two toothed wheels. Therefore, it is necessary that the pulley 14 associated to the large wheel 25, is released from the shaft 23. In this manner, there will be a shaft 23 with a lower angular speed and a shaft 23' with a higher angular speed, which allows better adapting the equipment to the different therapeutic or gymnastic needs of the users.

[0029] The driving member 15 is composed of a double-toothed drive belt, a chain, a flexible transmission, or the like. The belt, chain, or flexible transmission winds, in the order:

- about the lower pulley 11 of the first pair of pulleys 11, 11',
- about the lower pulley 12 of the second pair,
- about the pulley 14' of the third pair proximal to said second pair of pulleys 12, 12',
- about the upper pulley 12' of the second pair,
- about the upper pulley 11' of the first pair, and, finally,
- about the pulley 14 of the third pair proximal to said first pair of pulleys 11, 11'.

[0030] In this manner, it will be possible to implement the following movements of the machine of the invention:

- a) when the motorization means 4, 4' have a concordant angular speed (rotation of both in the clockwise or counterclockwise direction) and with equal module, the **shafts 23, 23' rotate** at a different speed as a function of the reduction ratio, and the **carriage 13 is stationary**;
- b) when the motorization means 4, 4' have discordant angular speed (one rotates clockwise, and the other one rotates counterclockwise, or vice versa) and with equal module, the **shafts 23, 23' do not rotate**, and the **carriage 13 translates**;
- c) when the motorization means 4, 4' have a concordant or discordant angular speed and with a different module, the **shafts 23, 23' rotate** and the **carriage 13 translates**, i.e., there is a translational-rotational movement.

[0031] The translation along the axis X in a direction or the opposite one is therefore obtained either by inverting the angular speeds of the motorization means 4, 4', or by inverting the rotation direction thereof.

[0032] Therefore, in this manner, the user may be subjected to a physical activity of a passive type, particularly advisable in the case of rehabilitative therapies, as it will be explained herein below.

[0033] Fig. 7 shows a detail of the motion engaging-disengaging system of the lower pulley 12 of the second pair of pulleys, but a similar mechanism is also used for the upper pulley 11' of the first pair of pulleys.

[0034] The pulley 12 is mounted on the drive shaft 27, taking the motion from the motorization means 4', by the bearings 28. In this manner, the pulley 12 is freed from the drive shaft 27.

5 **[0035]** The pulley 12 comprises a cup member 29 facing outwardly, having recesses 30 arranged along a circumference thereof.

[0036] A push button 32 is arranged externally to the cup member 29 and comprises a centering stem 33.

10 **[0037]** The drive shaft 27 comprises a hollow head portion 27a, in which a seat 27b is obtained, for the centering stem 33 of the push button 32. Between the surface of the push button 32 facing the cup member 29 and a shoulder 35 that is present on the seat 27b walls, coaxially to the centering stem 33, a spring 34 insists, typically a coil spring, which allows the elastic return of the push button 32, as it will be described herein below.

[0038] On the surface of the push button 32 facing the cup member 29, an engaging member 31 is arranged, having a central hole in which the drive shaft 27 is inserted, and which, in turn, is coaxially inserted into the cup member 29. The engaging member 31 comprises one or more barbs 36 intended to insert into the recesses 30 of the cup member 29.

25 **[0039]** The outer surface of the head portion 27a of the drive shaft 27 comprises two or more reliefs 27c that insert in corresponding recesses that are present on the engaging member 31. In this manner, the engaging member 31 is mobile longitudinally with respect to the drive shaft 27, but it is integral thereto in rotation.

30 **[0040]** The engaging-disengaging mechanism operates as follows. When the push button 32 is released (the position shown in Fig. 7), the barbs 36 of the engaging member 31 insert into the recesses 30 of the cup member 29 and the reliefs 27c of the drive shaft 27 insert in the corresponding recesses of the engaging member 31, thereby becoming integral with the latter and the pulley 12 with the drive shaft 27. Therefore, it is an engaging position of the motorization means 4'.

35 **[0041]** Vice versa, when the push button 32 is pressed and it is rotated by a suitable angular portion, both the barbs 36 and the reliefs 27c disengage from the respective recesses and the drive shaft 27 is disengaged from the pulley 12.

40 **[0042]** By repeating the inverse operation, i.e., rotating the push button 32 in the opposite direction or the same direction by a suitable angular amount, the push button automatically goes back to the engaging condition by virtue of the return of the spring 34.

45 **[0043]** The disengaging system described above has the function to allow initially positioning the patient, setting the machine, or arranging the mechanism for the adjustment of the motion by the therapist (self-learning function).

50 **[0044]** Figs. 8-14 show several types of tool that can be applied to the shafts 23, 23' of the machine of the invention for carrying out physical exercises of the passive or active type.

[0045] Fig. 8 shows the application of a pair of pedals 40, 40' connected through corresponding cranks 41, 41' to the shaft 23' that rotates at a higher speed. This application allows the conventional foot thrust to the user, usually implementable by a so-called "exercise bike", both passive and active. The passive foot thrust is obtained by applying a law of motion of the type a) described above. In a type of actuation of the motorization means with a law of motion of the type c) described above, a passive movement will be able to be obtained, miming the elliptical foot thrust. According to the needs, it will be possible to connect the cranks 41, 41' to the fast shaft 23' or the slow shaft 23.

[0046] Fig. 9 shows the application of a pair of pedals 40, 40' directly connected to the fast shaft 23', without the interposition of the cranks 41, 41'. It will be equally possible to connect them to the slow shaft 23. In this case, the application provides for a partial rotation with an alternating tilting movement of the shaft 23', optionally combined with a translation of the carriage 13 (according to the laws of motion described above), so as to train a user's ankles. This type of exercise is particularly advisable in rehabilitative therapies, mainly of the orthopedic type.

[0047] Fig. 10 shows the application of two handles 42, 42' directly to one of the two shafts 23, 23' of the machine of the invention. This application provides for a paddle movement for a user's arms, therefore it may be carried out by a law of motion according to the type b) described above.

[0048] Figs. 11A, 11B, and 11C show the application of two handles 43, 43' connected through corresponding crank handles 44, 44', to the slow shaft 23 of the machine. The crank handles 44, 44' may be alternatively connected to the fast shaft 23'.

[0049] The handles 43, 43' comprise a grip 43a and an annular holding structure 43b surrounding the grip 43a and in which a user's hand may be introduced. In the embodiment of Figs. 11A-11C, the grip 43a is horizontally arranged, while in the embodiment of Fig. 15, the grip 43a is vertically arranged.

[0050] This application allows a "foot thrust" of the arms, and it is typically carried out by a law of motion of the type a) described above. In this case also, as in the other cases, a passive or active exercise by the user will be able to be achieved.

[0051] This application further allows three different positions: i) an arrangement staggered by 180° of the crank handles 44, 44' (Fig. 11A); ii) a symmetrical arrangement (0° displacement) of the crank handles 44, 44' (Fig. 11B); iii) an arrangement staggered by 90° of the crank handles 44, 44' (Fig. 11C). The three different arrangements will be able to be selected according to the rehabilitative or gymnastic needs of the user.

[0052] Fig. 12 shows the application of a tool 45 for the flexion-extension of knee and hip.

[0053] The tool 45 comprises a platform 46 comprising end-folded bars 47 for securing to the support structure

5 of the machine. The end-folded bars 47 are height/length adjustable via a telescopic system with securing screws 48 provided with handles.

[0054] Thus the equipment is adjustable to the aims of the proper therapy, in order to center the support on the same physiological rotational axis.

[0055] The platform 46 comprises an elongated loop 49 in which a slide 50 is slidable, which may be secured in the desired position along the loop 49 by means of a securing screw 51 provided with a handle.

[0056] An exoskeleton 52 for a user's leg is hinged to the slide 50. The exoskeleton 52 comprises a first supporting half-shell 53 for the thigh, a junction member 54 at the knee, a second supporting half-shell 55 for the calf muscle, and a board 56 on which the foot may rest. The board 56 is arranged at about 90° to the axis of the calf muscle supporting half-shell 53. The board 56 further comprises a pin (not visible in the drawings) for coupling it to one of the shafts 23, 23' of the machine.

[0057] This application provides for the use of a law of motion only of the translational type, i.e., a law of motion of the type b) described above, which allows an exercise with only one degree of freedom. As will be understood from the tool 45 structure, it comprises articulation points at the level of the hip (hinging of the exoskeleton 52 on the platform on the slide 50) and of the knee (junction member 54), and it is particularly advisable in the case of a both passive and active rehabilitation therapy.

[0058] Fig. 13 shows an application similar to the one described in Fig. 12, with the difference that it allows performing a knee and hip flexion-extension exercise of both the legs of a user.

[0059] In this case, the platform 46 comprises two side members 46b and a connecting bar 46a. Two exoskeletons 52, one for each leg, are hinged on a slide (not shown) that is slidable in an adjustable manner on the side members 46b, as described in the application of Fig. 12. The operation is the same, but for the fact that it allows exercising both legs of the user.

[0060] The application of a tool 45' for the flexion-extension of the knee with two degrees of freedom and of the hip is shown in Fig. 14.

[0061] The tool 45' comprises a supporting half-shell 57 for the calf muscle of a user, on which a board 58 is secured to support the foot. The board 58 is arranged at about 90° to the supporting half-shell 57 axis. The board 58 further comprises a pin (not shown in the drawings) to couple it to one of the shafts 23, 23' of the machine.

[0062] The tool 45' provides for a translational-rotational law of motion, i.e., according to the type c) described above, so as to perform an exercise with two degrees of freedom for the knee.

[0063] The tool described above in relation to the Figs. 8-14 may be coupled to the shafts 23, 23' of the machine of the invention by means of conventional systems, which are known to those skilled in the art, such as stop screw systems, screwing, clamping, bayonet systems, etc.

[0064] The machine of the invention further comprises

a driving and control unit controlling the operativeness of the motorization means 4, 4' and that may be programmable so as to perform a series of preset exercises. Further functions that are performed by the driving and control unit are:

- monitoring the user's functions (pressure, heart rate, and other parameters) by special sensors;
- creating audiovisual feedbacks for rehabilitations in the neurological field;
- storing the patient's data and the performed exercises on non-volatile memory or a data storage device;
- statistically processing the stored data;
- self-learning modes in which an exercise performed by the user on the equipment with the motors 4, 4' disengaged, or with the aid of the physiotherapist with the user's limb in a passive state, is repeated in sequence in a passive manner (CPM) by the machine;
- wireless-mode driving and controlling.

[0065] The driving and control unit detects the following parameters:

- translational position of the carriage 13 by a detection system, for example, a potentiometer, associated to the castors 21, 21', and
- data relating to the angular speed and torque of the third pair of pulleys 14, 14' by a suitable detection system associated thereto.

[0066] The machine of the invention achieves the predetermined objects since it is of reduced dimensions, it is easily transportable, and it does not require much space for storing it. All of this is achieved by virtue of the compact structure, comprising small retractile feet and a handle for facilitate the transport thereof. The machine of the invention may therefore be used both at rehabilitation centers, and directly at the user's home.

[0067] Furthermore, the driving and control unit allows performing by the user exercises in the active or passive modes, by virtue of setting a preset resistance or a preset law of motion, respectively. Therefore, the equipment of the invention is embodied as a tool for both the motor rehabilitation and for physical training.

[0068] The possibility to install tools of several types, both for the lower and the upper limbs, allows a wide diversification of the possible exercises.

[0069] The driving and control unit allows programming the machine with both preset exercises, and exercises devised *ad hoc* for the user.

[0070] It is apparent that the embodiment that has been described is only a particular embodiment of the present invention, to which those skilled in the art will be able to make all those modifications that are necessary for the adaptation thereof to particular applications, without anyhow departing from the protections scope of the present finding. For example, it is possible to couple two appa-

ratues according to the invention, so that the patient may arrange between the two apparatuses by applying a limb to the first equipment and the other limb to the second one. In this manner, it is possible to perform different exercises with the two limbs, each being performed by the respective equipment.

Claims

1. A machine (1) for the physical exercise of the limbs, comprising a frame (2) on which translational-rotational members (3) of an upper or lower limb are mounted, said translational-rotational members (3) being operatively connected to motorization means (4, 4'), **characterized in that** said translational-rotational members (3) comprise:

- a first pair of pulleys (11, 11') arranged in the proximity of an end of the frame (2), the pulleys (11, 11') of said first pair being arranged along a substantially vertical axis;
- a second pair of pulleys (12, 12') arranged in the proximity of the opposite end of the frame (2), the pulleys (12, 12') of said second pair being arranged along a substantially vertical axis;
- a carriage (13) mobile along a longitudinal axis (X);
- a third pair of pulleys (14, 14') arranged on said carriage (13), the pulleys (14, 14') of said third pair being arranged along an axis substantially parallel to the axis (X);
- a driving member (15) operatively connecting said first (11, 11'), second (12, 12'), and third pairs of pulleys (14, 14'), and wherein at least one pulley of said first (11, 11') and/or second pairs of pulleys (12, 12') is operatively connected to the respective motorization means (4, 4').

2. The machine (1) according to claim 1, wherein the pulleys (11', 12) connected to the motorization means (4, 4') are arranged transversally on the frame (2), i.e., if in the first pair of pulleys the upper pulley (11') is directly connected to the respective motorization means (4), in the second pair of pulleys the lower pulley (12) is connected to the respective motorization means (4'), or vice versa.

3. The machine (1) according to claim 1 or 2, wherein the frame (2) comprises a support structure (5) for the translational-rotational members (3), extending along said longitudinal axis (X), and legs (6, 6') ending inferiorly with small retractile feet (7, 7', 8, 8').

4. The machine (1) according to claim 3, wherein the legs (6, 6') are disassemblable and/or height adjustable.

5. The machine (1) according to any of the claims 1 to 4, wherein the frame (2) comprises at least one handle (9).
6. The machine (1) according to any of the claims 1 to 5, wherein the carriage (13) is slidable on at least one track (16) arranged on a vertical plane and along the axis (X), the track (16) comprising a lower rail (17) and an upper rail (18).
7. The machine (1) according to any of the claims 1 to 6, wherein, in the proximity of the upper edge of the carriage (13), two toothed castors (21, 21') with a vertical axis are mounted, and wherein said toothed castors (21, 21') engage a rack (22) arranged above the upper rail (18) and parallel thereto, said toothed castors (21, 21') being connected to a detection system of the translational position of the carriage (13).
8. The machine (1) according to any of the claims 1 to 7, wherein the pulleys (14, 14') of the third pair of pulleys are associated to respective shafts (23, 23'), said shafts (23, 23') being in turn connected, with a first transmission wheel (25) and with a second transmission wheel (25'), respectively, wherein the two transmission wheels (25, 25') are operatively connected so as to compose a system for the transmission, reduction, or multiplication of the motion.
9. The machine (1) according to claim 8, wherein the first transmission wheel (25) has a diameter that is larger than the second transmission wheel (25').
10. The machine (1) according to claim 9, wherein the pulley (14) is mounted on the shaft (23), to which the first transmission wheel (25) having a larger diameter is associated, by means of bearings (26) that free it from the shaft (23) rotation, while the two transmission wheels (25, 25') and the other pulley (14') are integral to the respective shafts (23, 23').
11. The machine (1) according to any of the claims 1 to 10, wherein the driving member (15) is composed of a double-toothed drive belt, a chain, or a flexible transmission, wherein said belt, chain, or flexible transmission winds, in the order:
 - about the lower pulley (11) of the first pair of pulleys (11, 11'),
 - about the lower pulley (12) of the second pair,
 - about the pulley (14') of the third pair proximal to said second pair of pulleys (12, 12'),
 - about the upper pulley (12') of the second pair,
 - about the upper pulley (11') of the first pair, and, finally
 - about the pulley (14) of the third pair proximal to said first pair of pulleys (11, 11').
12. The machine (1) according to any of the claims 1 to 11, said machine (1) being actuatable according to the following laws of motion:
 - a) when the motorization means (4, 4') have a concordant angular speed, i.e., a rotation of both in the clockwise or counterclockwise direction, and with equal module, the **shafts (23, 23') rotate** at a different speed as a function of the reduction ratio of the transmission wheels (25, 25'), and **the carriage (13) is stationary**;
 - b) when the motorization means (4, 4') have a discordant angular speed, i.e., one of them rotates in the clockwise direction and the other one in the counterclockwise direction, or vice versa, and with equal module, the **shafts (23, 23') do not rotate**, and the **carriage (13) translates**;
 - c) when the motorization means (4, 4') have a concordant or discordant angular speed and with a different module, the **shafts (23, 23') rotate** and the **carriage (13) translates**, i.e., there is a translational-rotational movement.
13. The machine (1) according to any of the claims 1 to 12, wherein said machine (1) comprises an engaging-disengaging mechanism of the motorization means (4, 4').
14. The machine (1) according to claim 13, wherein each of the motorized pulleys (11', 12) is mounted on a drive shaft (27), taking the motion from the respective motorization means (4, 4'), by means of bearings (28), so as to free said pulley (11', 12) from the drive shaft (27), said pulley (11', 12) comprising a cup member (29) facing outwardly and having recesses (30) arranged along a circumference thereof, a push button (32) being arranged externally to the cup member (29), and comprising an engaging member (31) having a central hole wherein the drive shaft (27) is inserted, and which in turn is coaxially inserted in the cup member (29), wherein the engaging member (31) comprises one or more barbs (36) intended to insert into the recesses (30) of the cup member (29) when the push button (32) is released and to disengage from the recesses (30) when the push button (32) is pressed, so as to engage on and, respectively, disengage the motorization means (4, 4') from said pulleys (11', 12).
15. The machine (1) according to any of the claims 1 to 14, comprising at least one of the following accessory tools:
 - 1) a pair of pedals (40, 40') connectable through respective cranks (41, 41') to one of said shafts (23, 23'), with which the machine (1) is actuatable according to a law of motion of the type a) for a conventional foot thrust, or of the type c)

for an elliptical foot thrust;

2) a pair of pedals (40, 40') directly connectable to one of said shafts (23, 23'), with which the machine (1) is actuatable according to a law of motion of the type a) or c), providing for a partial rotation with an alternating tilting movement of the shaft (23, 23'), optionally combined with a translation of the carriage (13);

3) two handles (42, 42') directly connectable to one of said shafts (23, 23'), with which the machine (1) is actuatable according to a law of motion of the type b);

4) two handles (43, 43') connectable, through respective crank handles (44, 44'), to one of said shafts (23, 23'), with which the machine (1) is actuatable according to a law of motion of the type a) and wherein the crank handles (44, 44') may be displaced by 180°, 90°, or 0°;

5) a tool (45) for the flexion-extension of knee and hip, said tool (45) being height- and length-adjustable, and comprising at least one exoskeleton (52) for a user's leg, wherein the exoskeleton (52) comprises a first supporting half-shell (53) for the thigh, a junction member (54) at the knee, a second supporting half-shell (55) for the calf muscle, and a board (56) on which the foot may rest, the board (56) being connectable to one of said shafts (23, 23'), and with which the machine (1) is actuatable according to a law of motion of the type b);

6) a tool (45') for the flexion-extension of the knee with two degrees of freedom and of the hip, said tool (45') comprising a supporting half-shell (57) for a user's calf muscle, on which a board (58) is secured to support the foot, the board (58) being connectable to one of said shafts (23, 23'), and with which the machine (1) is actuatable according to a law of motion of the type c).

16. The machine (1) according to claim 15, wherein said accessory tools are couplable to the shafts (23, 23') by means of securing systems selected from stop screw systems, screwing, clamping, bayonet systems, or equivalent.

17. The machine (1) according to any of the claims 1 to 16, comprising a driving and control unit controlling the operativeness of the motorization means (4, 4') according to the laws of motion of the type a), b), c) or combinations thereof, said driving and control unit being programmable so as to perform a series of preset exercises, and, optionally, the following functions:

- monitoring the user's functions such as pressure, heart rate and temperature, by means of special sensors;

- creating audiovisual feedbacks for rehabilitations in the neurological field;

- storing the patient's data and the performed exercises on non-volatile memory or data storage device;

- statistically processing the stored data;

- self-learning modes in which an exercise performed in an active manner by the user is repeated in a passive manner (CPM);

- wireless-mode driving and controlling or equivalents,

and wherein the driving and control unit detects the following parameters:

- translational position of the carriage (13) by a detection system, for example a potentiometer, associated to the castors (21, 21'), and

- data relating to the angular speed and/or torque of the third pair of pulleys (14, 14') by a suitable detection system associated thereto.

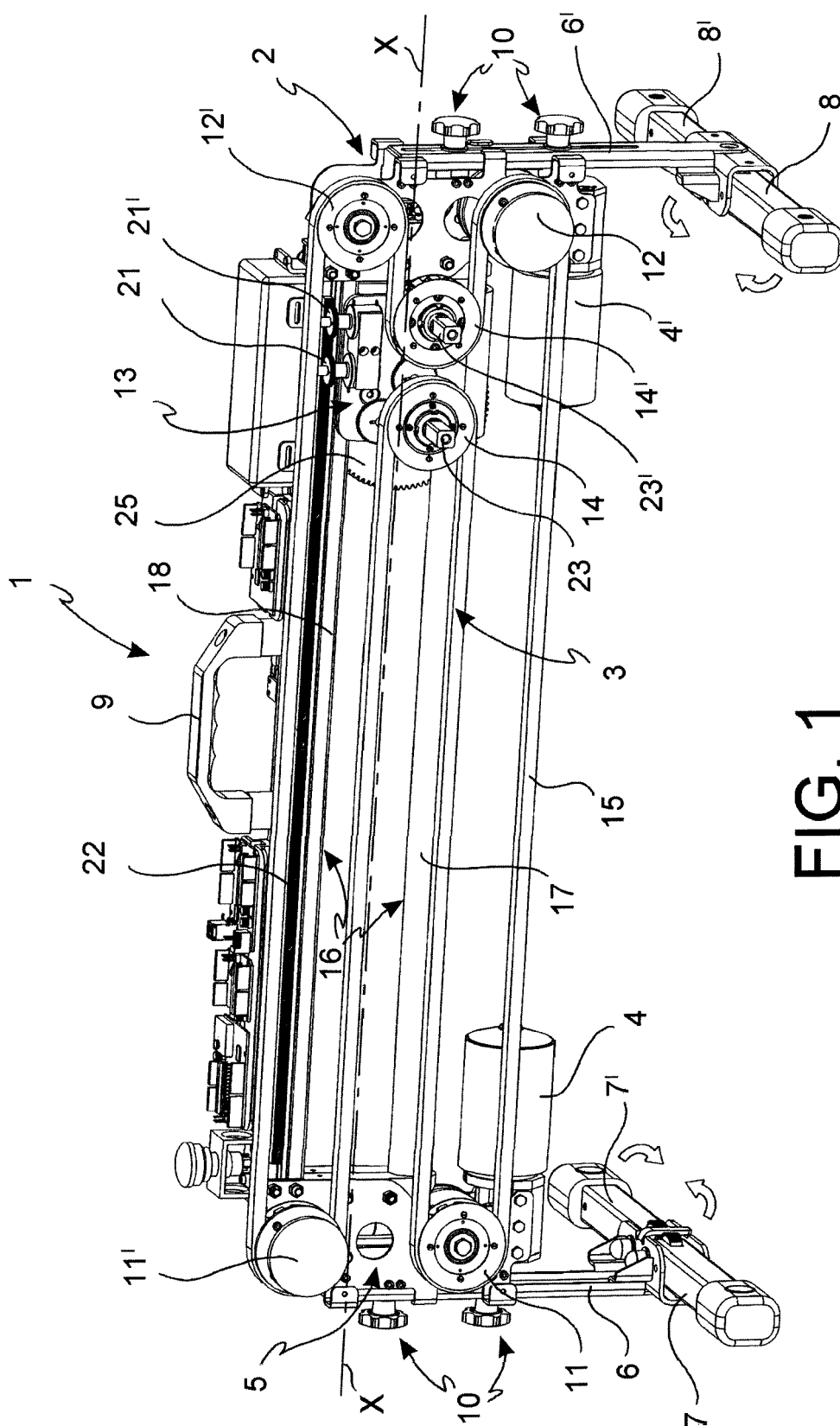


FIG. 1

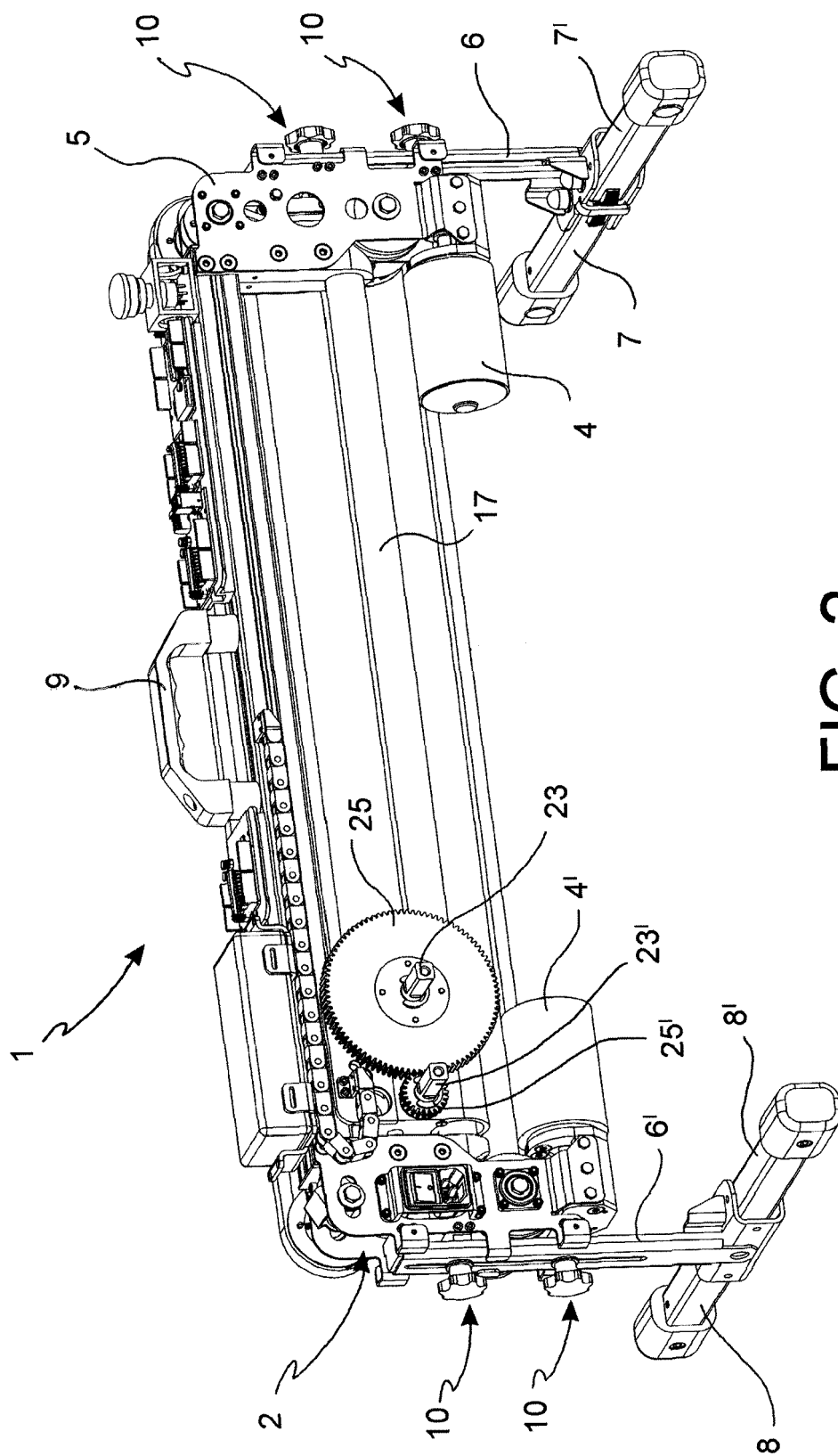


FIG. 2

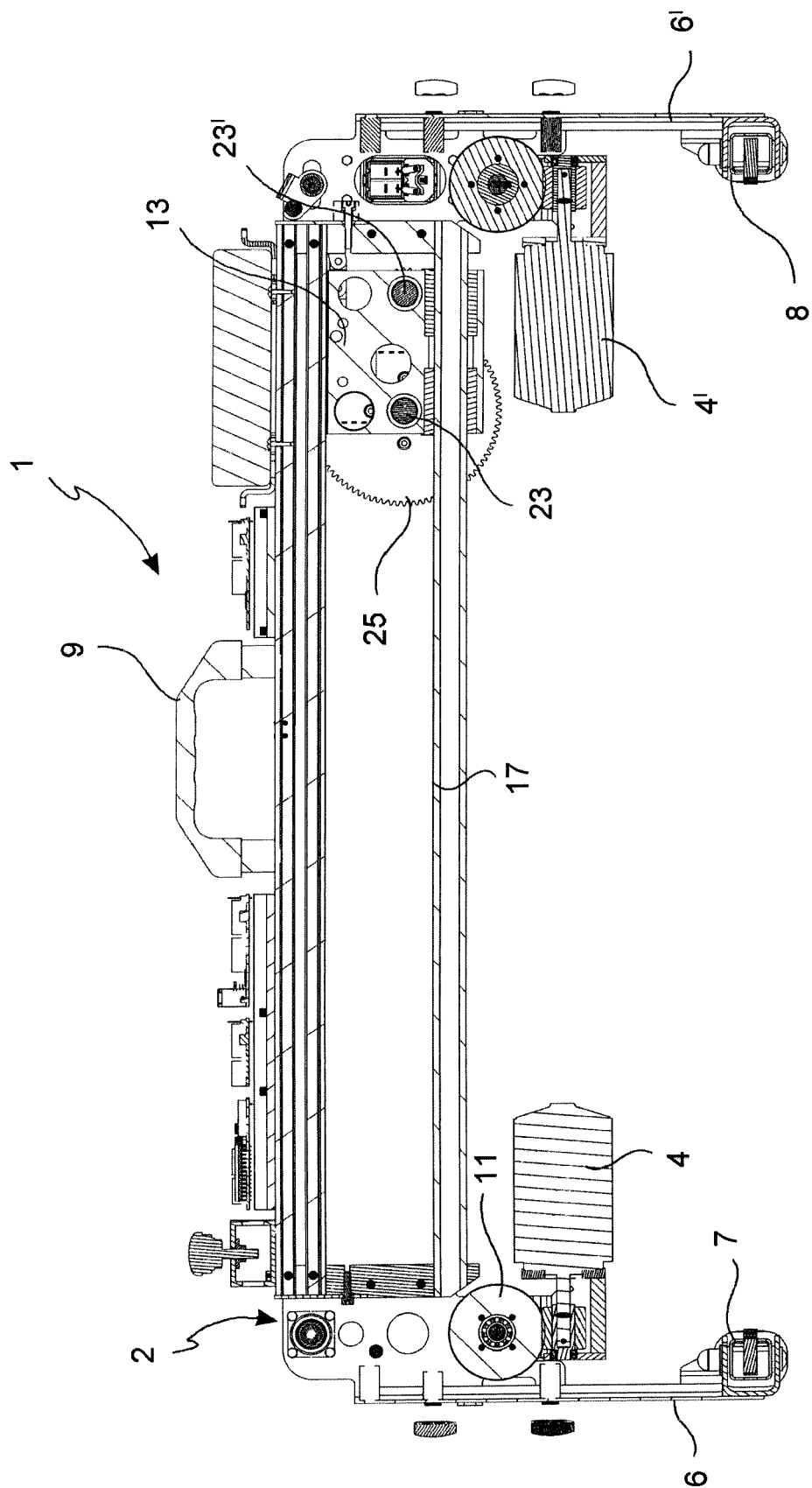


FIG. 3

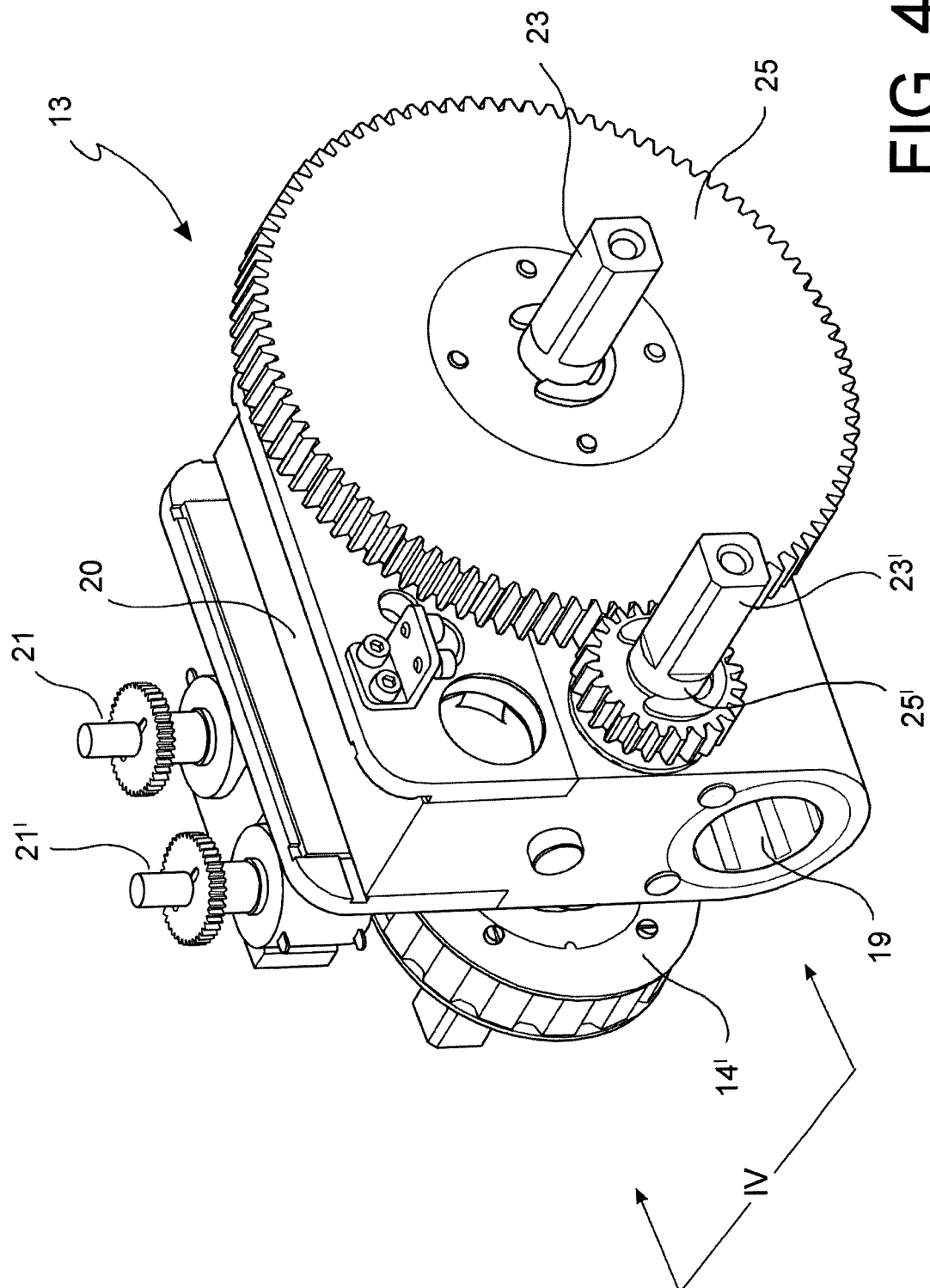


FIG. 4

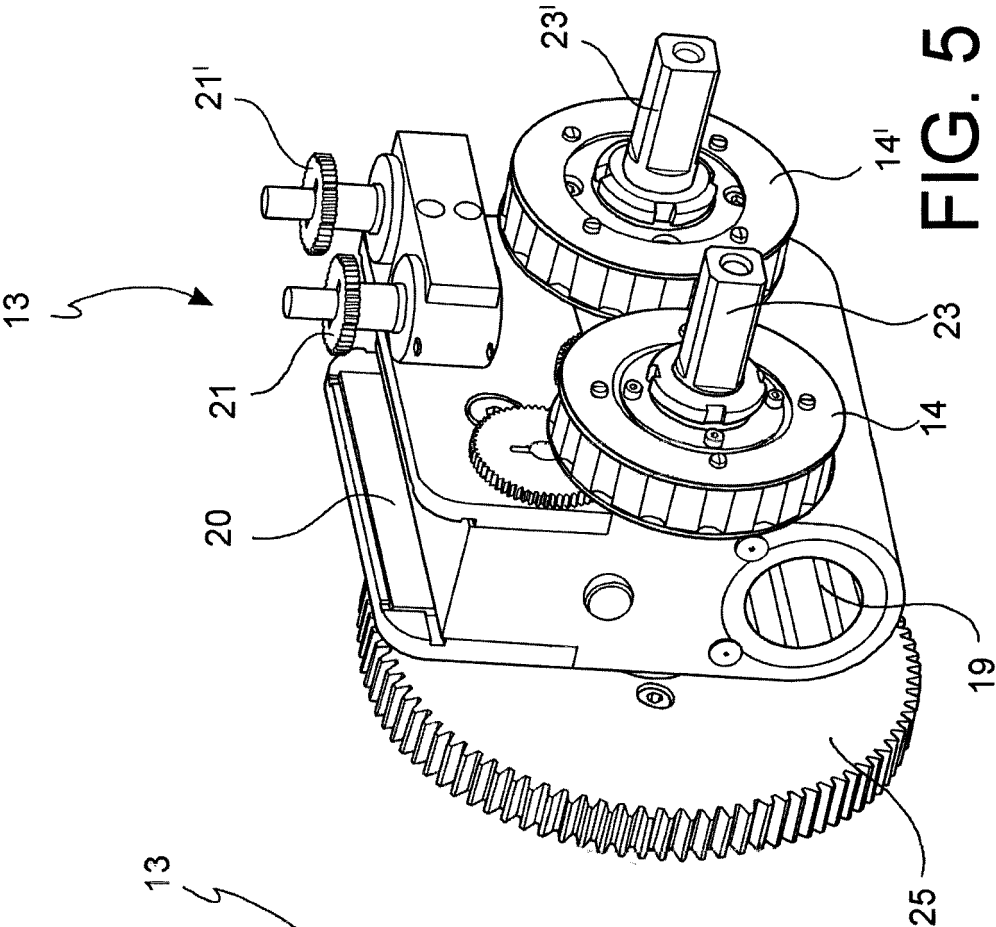


FIG. 5

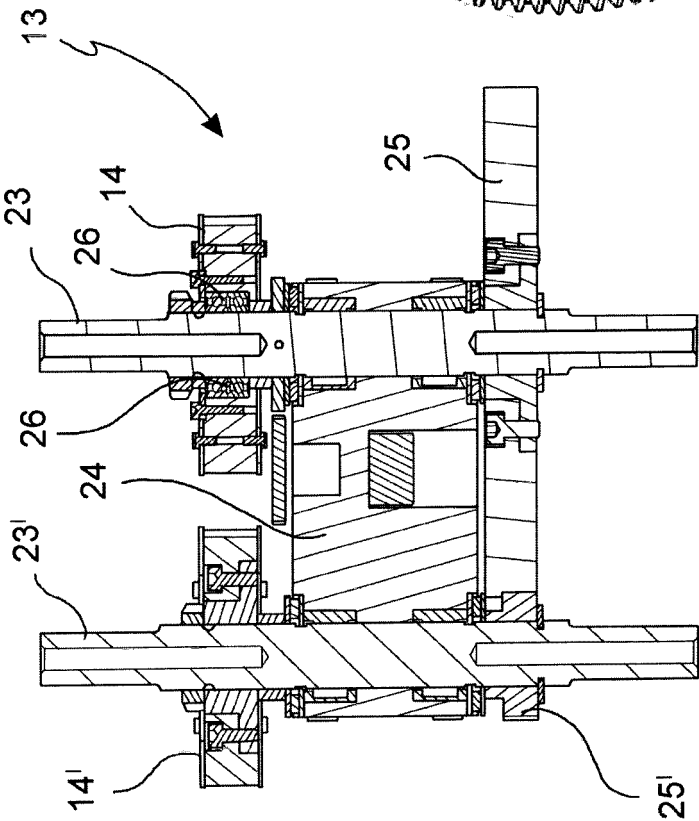


FIG. 6B

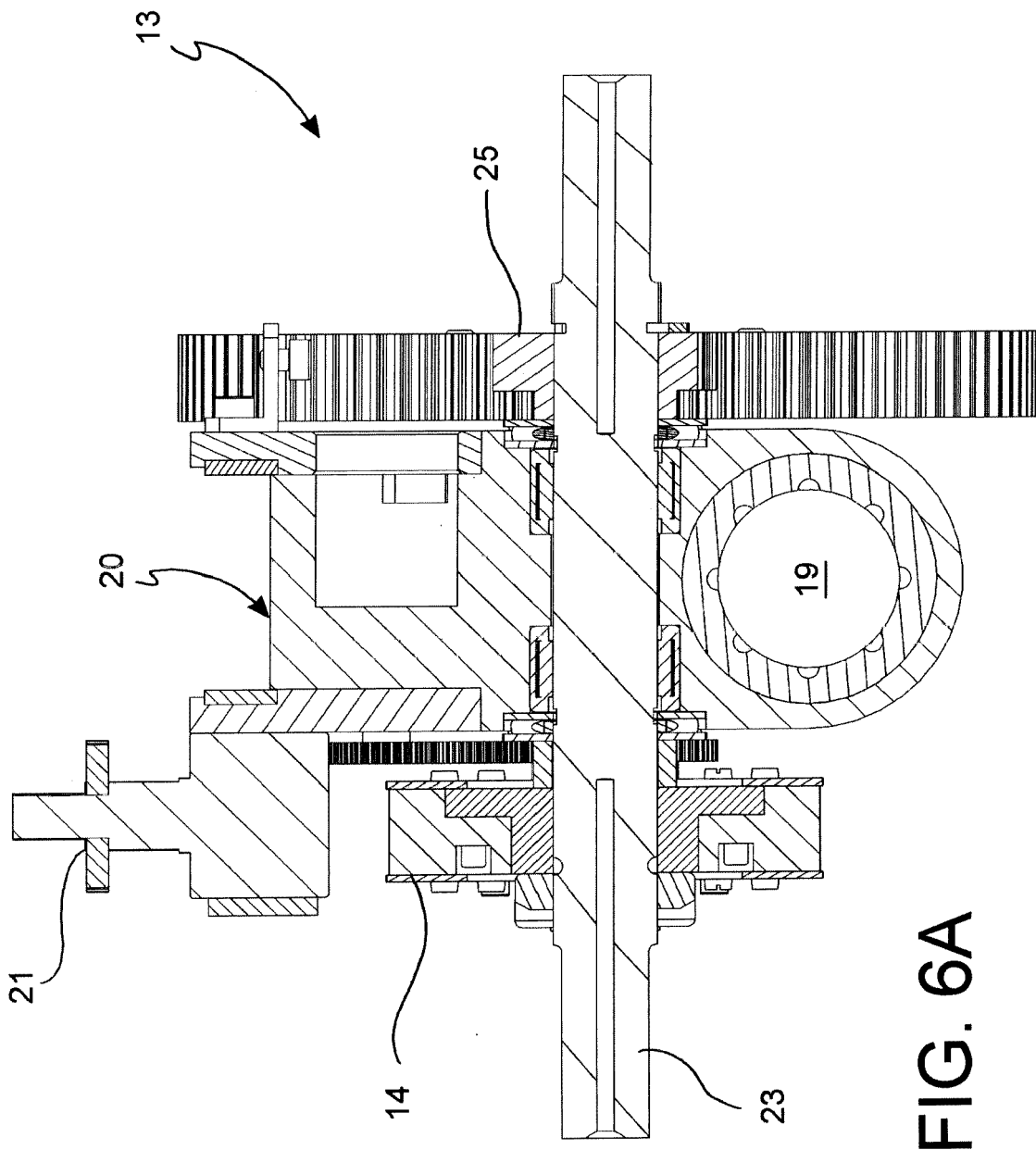


FIG. 6A

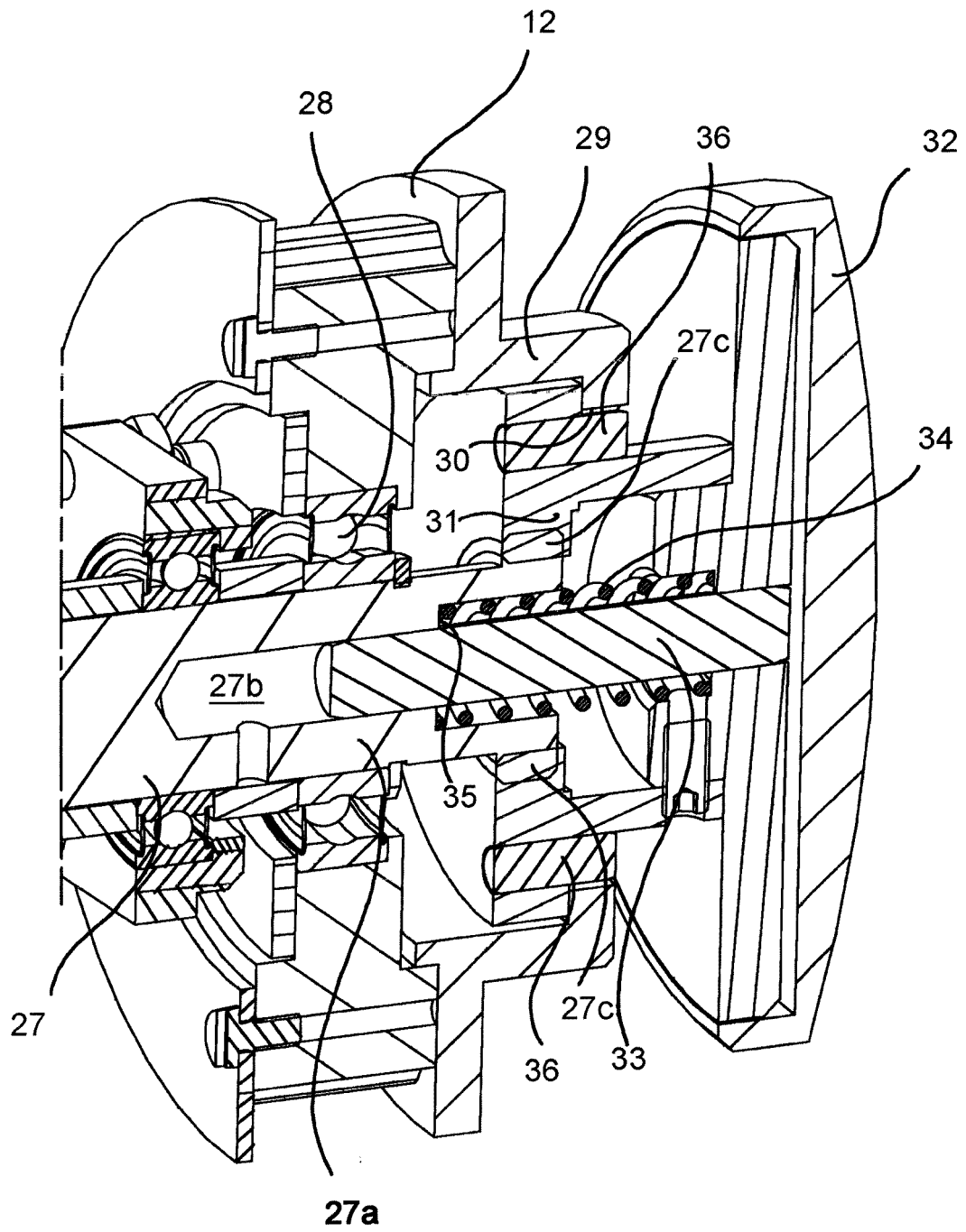


FIG. 7

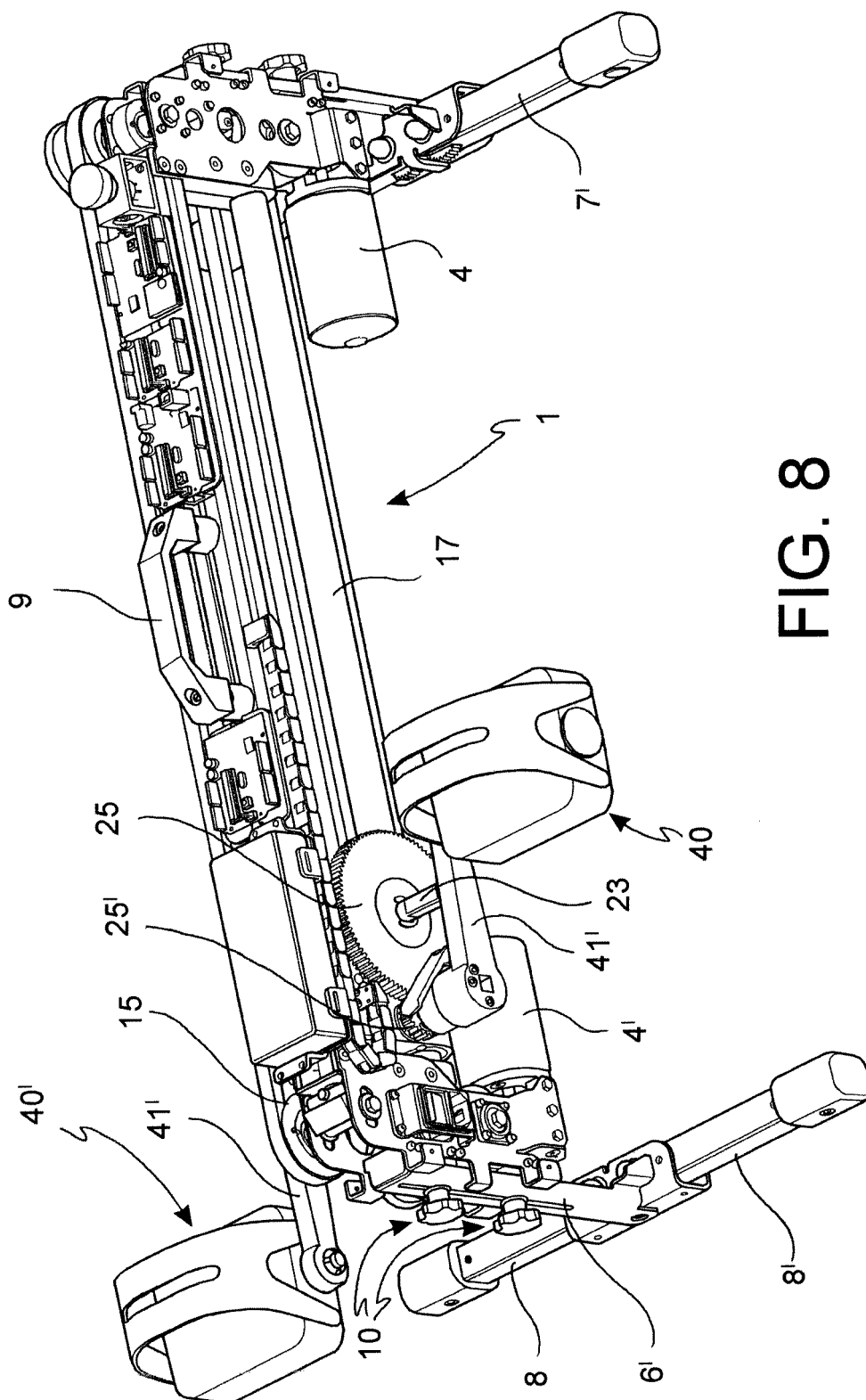


FIG. 8

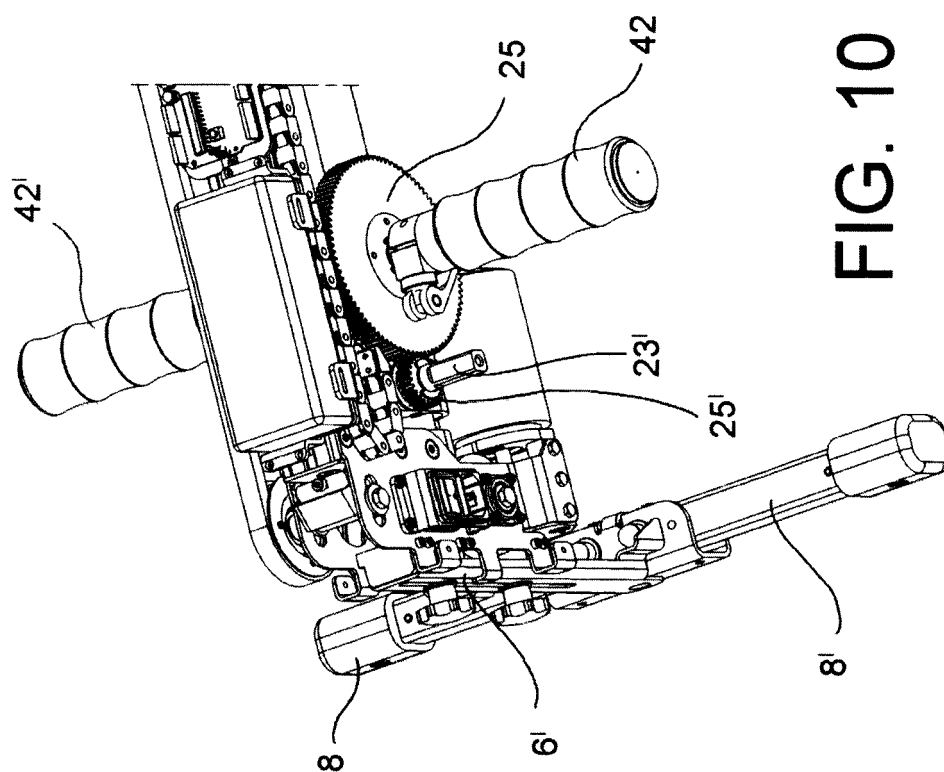


FIG. 10

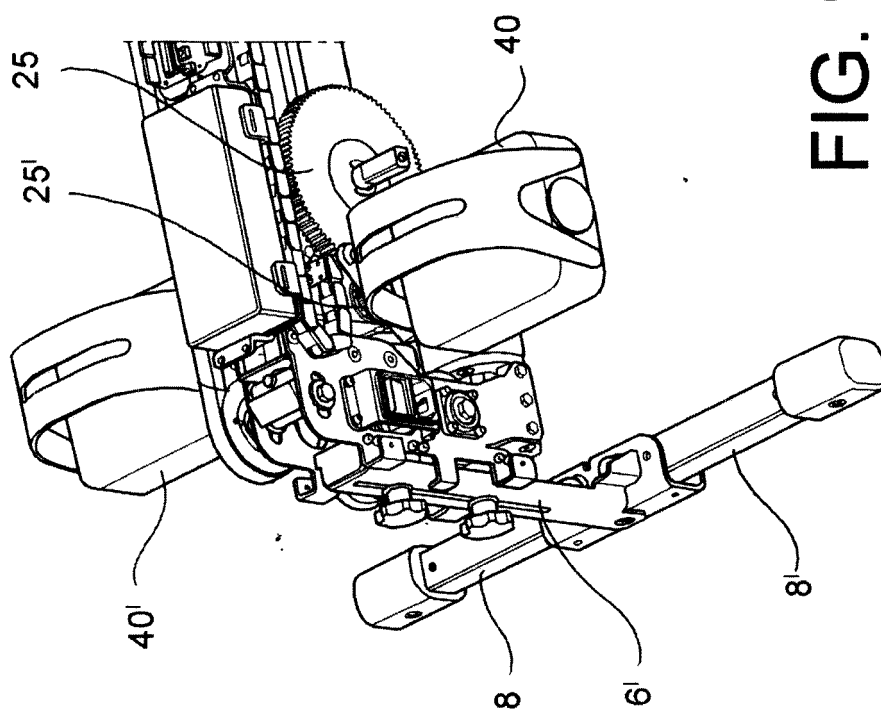


FIG. 9

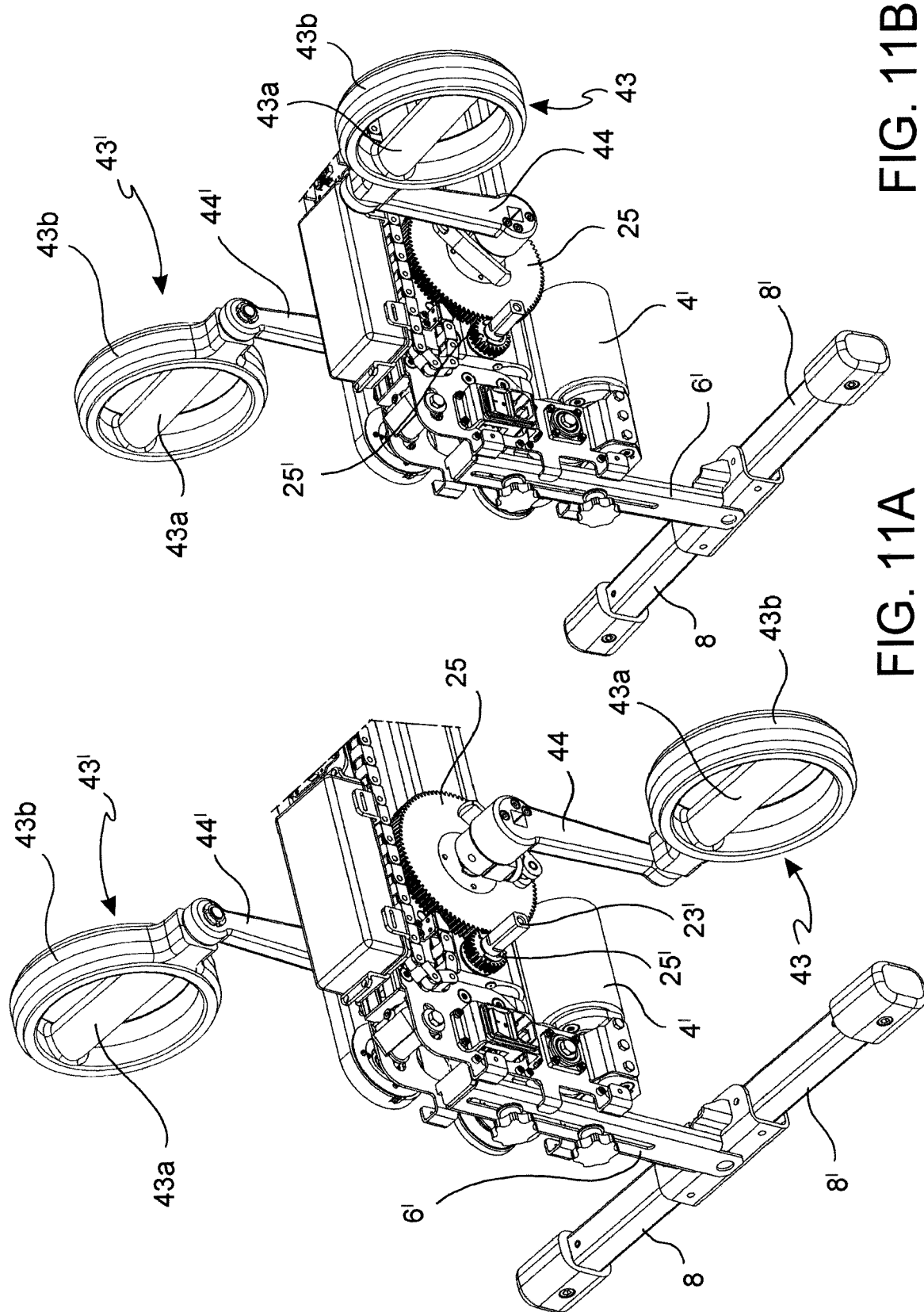


FIG. 11B

FIG. 11A

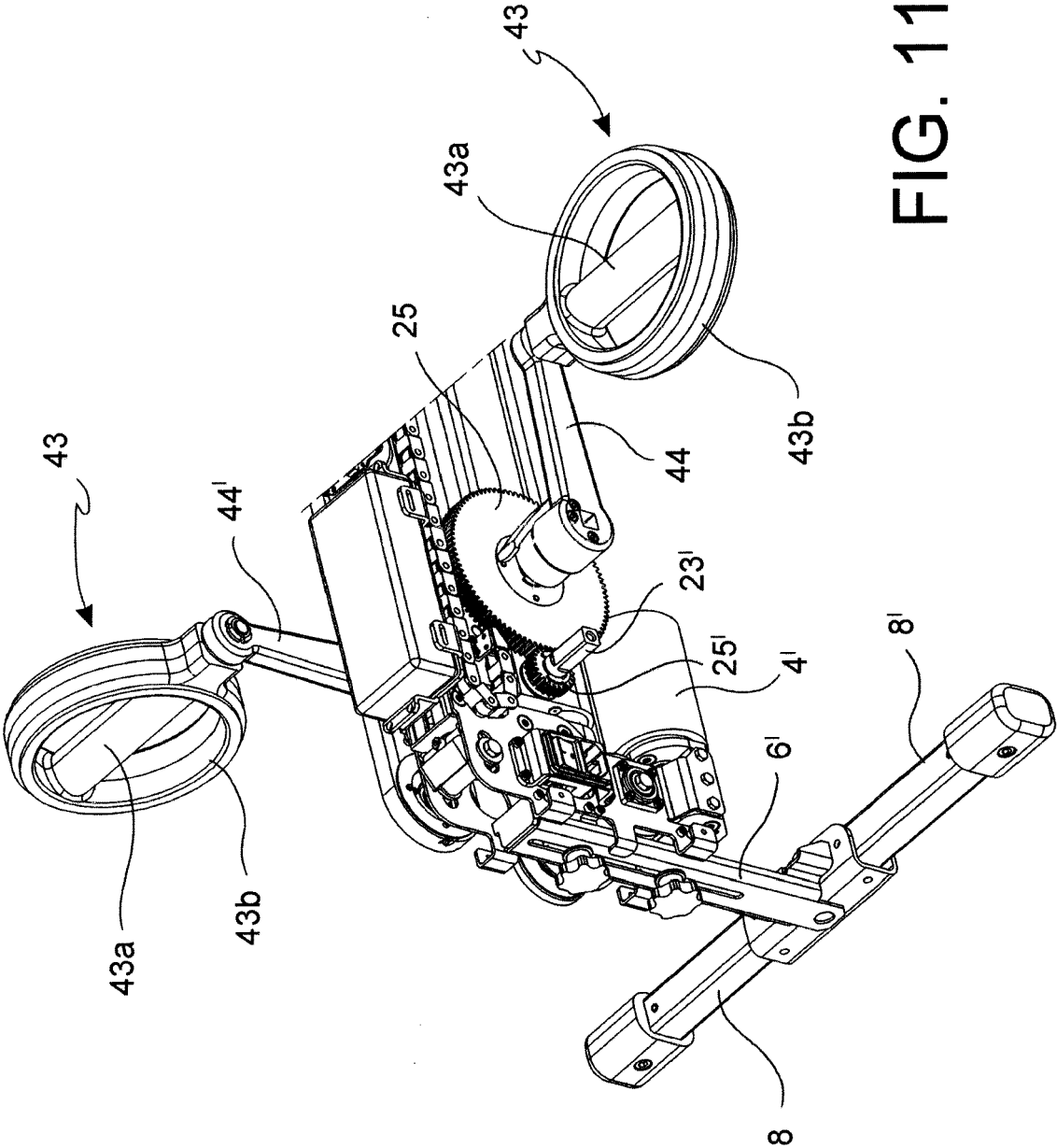


FIG. 11C

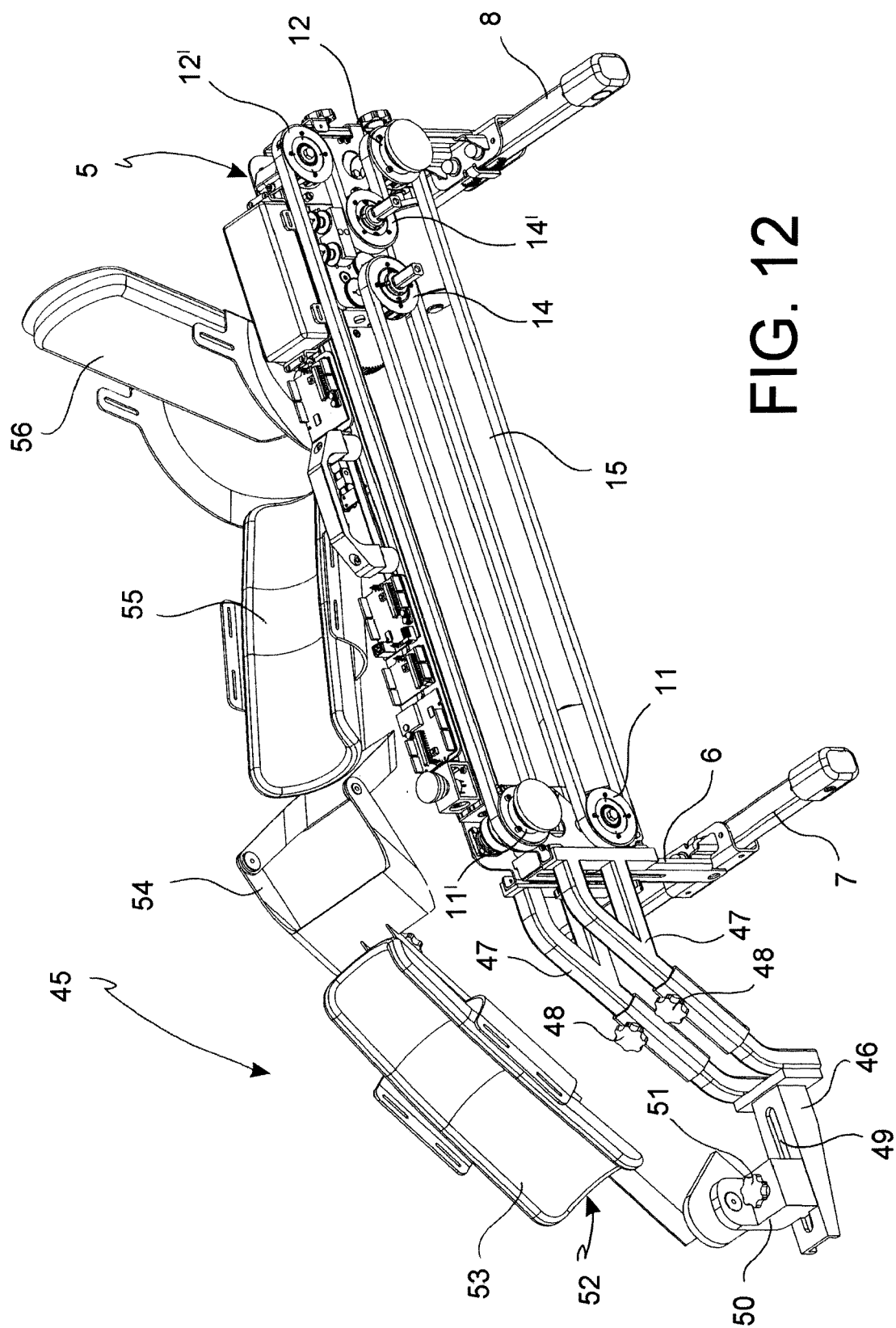


FIG. 12

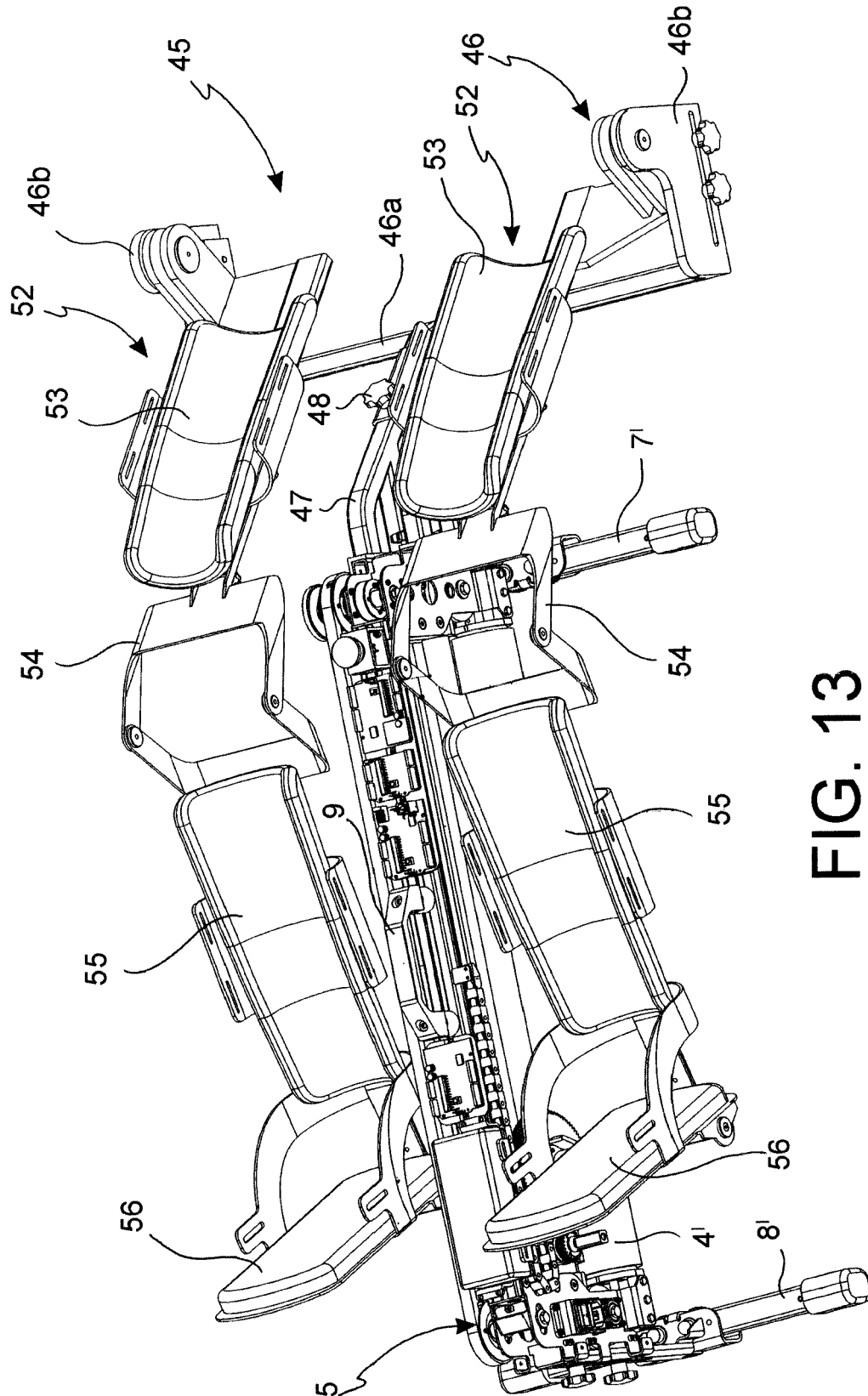


FIG. 13

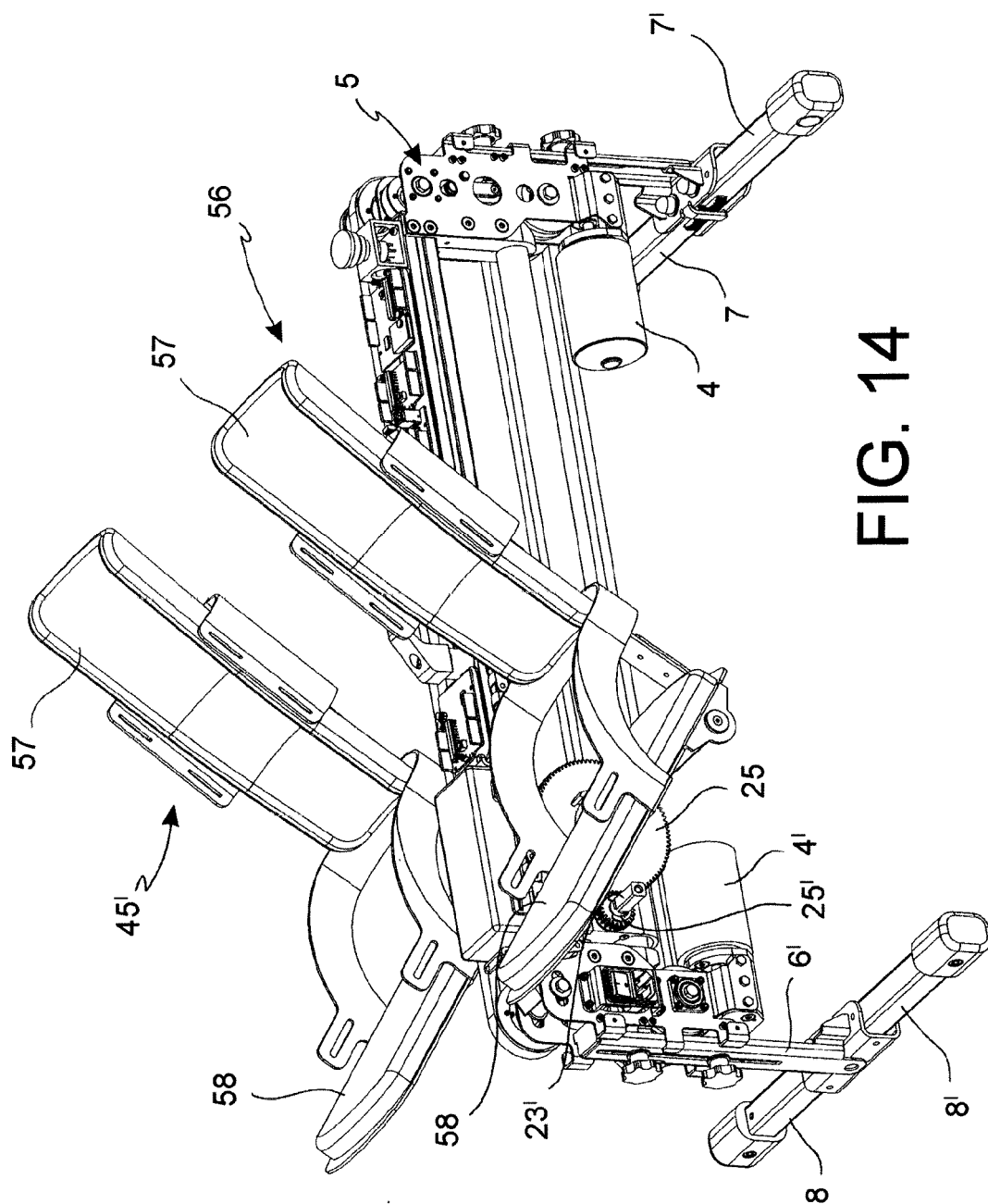


FIG. 14

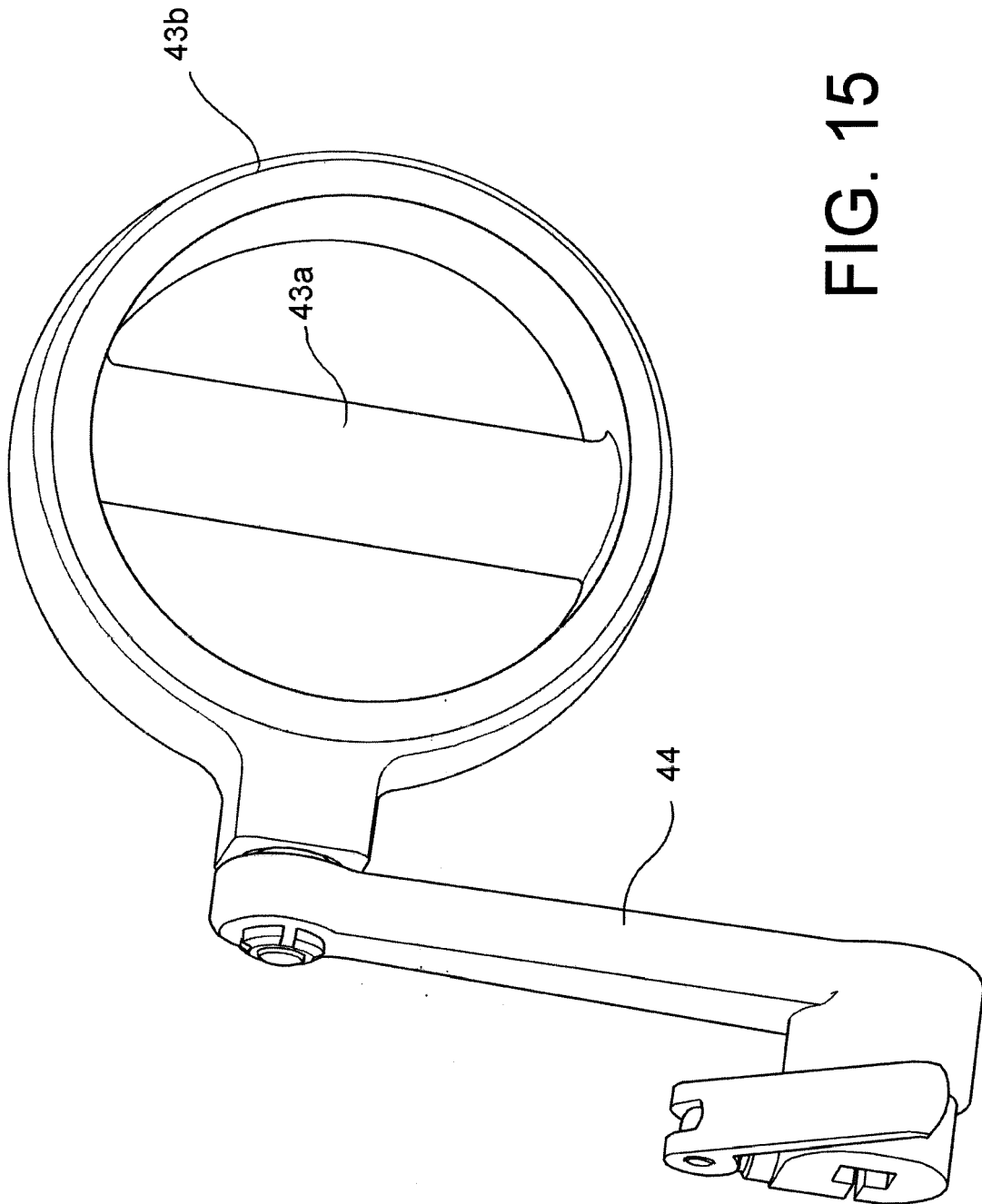


FIG. 15



EUROPEAN SEARCH REPORT

 Application Number
EP 13 42 5141

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 920 748 A1 (FYSIOPARTNER AS [NO]) 14 May 2008 (2008-05-14) * figures *	1	INV. A61H1/02
A	US 3 824 993 A (GRANT J) 23 July 1974 (1974-07-23) * figures *	1	
A	DE 20 2007 015508 U1 (STUEHRENBERG HARALD [FR]) 20 March 2008 (2008-03-20) * figures *	1	
A	EP 0 155 629 A1 (PORTABLE ISOKINETICS INC [US]) 25 September 1985 (1985-09-25) * figures *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			A61H A63B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 15 May 2014	Examiner Knoflachner, Nikolaus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03/82 (P04/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 42 5141

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-05-2014

10

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 1920748	A1	14-05-2008	NONE			

US 3824993	A	23-07-1974	NONE			

DE 202007015508	U1	20-03-2008	NONE			

EP 0155629	A1	25-09-1985	CA	1239158	A1	12-07-1988
			DE	3566614	D1	12-01-1989
			EP	0155629	A1	25-09-1985

15

20

25

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82