(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 June 2017 (22.06.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/103722 A1

(51) International Patent Classification:
A63B 22/02 (2006.01) *A63B 24/00* (2006.01)

(21) International Application Number:
PCT/IB2016/057323

(22) International Filing Date:
2 December 2016 (02.12.2016)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:
102015000083493
15 December 2015 (15.12.2015) IT

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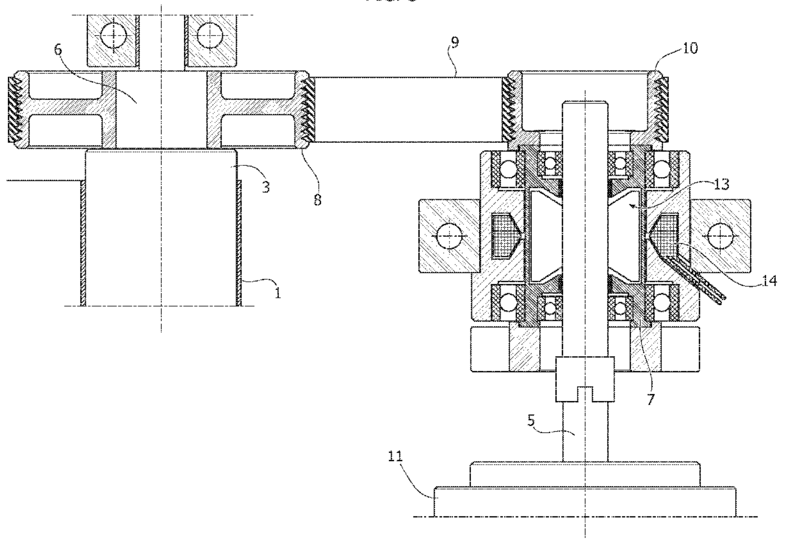
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: MOTORISED TREADMILL WITH SLIPPING TORQUE LIMITER

FIG. 3



(57) Abstract: A motorised treadmill comprising a closed loop belt (1), a motor (11) that actuates a driving shaft (5), and a driven shaft (6) actuated by the driving shaft (5) to move the belt (1). A slipping torque limiter (13) adjustable between a minimum value and a maximum value of the driving torque transmitted by the driving shaft (5) to the driven shaft (6) is provided for, and the value of the driving torque can initially be set at a maximum value proximal to the one required by a user for the first start motion of the belt (1). The rotational speed of the motor (11) is electronically maintained at a value constantly higher than the rotational speed imparted by the user of the belt (1) to the driven shaft (6) so as to always maintain the torque at the set value, thus the belt (1) keeps up with the speed imparted by the user without dragging or slowing down the user.

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MOTORISED TREADMILL WITH SLIPPING TORQUE LIMITER

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Field of the invention

The present invention regards physical exercise apparatus, and in particular treadmills for walking and running.

Treadmills thus made may be of two types: non-motorised or motorised.

In case of non-motorised treadmills, the belt is driven by the movement of the user, whose effort may be varied through the adjustment of a brake of the belt, which however - due to the strong frictions that occur - may only be used for belts of small dimensions, even inclined to simulate an uphill movement. In motorised treadmills, examples of which are described in CN-2272310Y and US-2012/108392A1, the belt is instead driven by an electric motor at the speed that can be pre-set by the user, who should walk or run constantly keeping up with such speed, which can be varied through a special control so that the belt can follow possible accelerations or decelerations by the user.

The motorised treadmills also reveal the drawback lying in the fact that the user, should he/she want or be forced to slow down or stop while the belt continues running at the set speed, risks falling even with serious consequences.

In addition, walking or running using either of the two types of treadmills does not correspond to actual walking or running on the road or track, in that the non-motorised type requires an effort considerably higher than the actual one, while the motorised type even drags the legs of the user with an unnatural movement.

The invention explicitly refers to a motorised treadmill generally conventionally comprising a closed loop belt, a motor that actuates a driving shaft, and a driven shaft actuated by the driving shaft to move the belt.

State of the prior art

A motorised treadmill of the type defined above is for example known from document US-5,431,612, which addresses the technical problem of automatically enabling an increase of pace i.e. the speed of the user without this leading to the need of a corresponding increase of the speed of the motor. According to this document, the solution to this problem lies in making the driven shaft decouplable in rotation from the driving shaft through a one-directional coupling, for example of the freewheel type which should be able to enable the user to move the belt at speeds higher than that imparted by the motor, on condition that the user is able to overcome the strong friction resistances.

However, this solution is inappropriate given that - on the one hand - it does not overcome the problem typical of motorised treadmills regarding the case where the user wants to slow down or stop while the belt is still being driven by the motor, and - on the other - when the pace of the user is greater than the set speed, the belt should be dragged like in the case of a non-motorised treadmill, with the aforementioned drawbacks.

Summary of the invention

The object of the present invention is to overcome the aforementioned drawbacks and specifically providing a motorised treadmill of the type defined above capable of enabling obtaining a neutral action of the belt, i.e. where the user is neither the one dragging or being dragged, so as to faithfully simulate the actual action of a walker or runner on the road or track.

According to the invention, this object is attained due to the fact that the treadmill comprises a slipping torque limiter adjustable between a minimum value and a maximum value of the driving torque transmitted by the driving shaft to the driven shaft, in that the value of the driving torque can be initially set at a value proximal to the one required by a user for the first start motion of the belt, and in that the rotation of the motor that actuates the driving shaft is electronically set and maintained at a value constantly higher than the rotational speed imparted by the user of the belt to the driven shaft so as to always maintain the torque at the set value, thus the belt keeps up with the speed imparted by the user without dragging or slowing down the user.

Thanks to this solution idea, upon setting the desired driving torque for example as a function of the user's weight, the motor actuates the belt - regardless of the speed at which it is moved by the user - still only at the driving torque required to overcome any passive resistance of the belt, i.e. the transmission frictions between the motor and the belt and the resistance to sliding of the latter on the relative sliding plane due to the user's weight. Basically, regardless of the walker's or the runner's pace the effort required will be substantially equivalent to the one that would have been actually required on the road or track. The belt speed faithfully follows the one imparted by the legs of the user who can thus accelerate, sprint, slow down or even stop without any risk, in that it is the user who controls the belt in real time, and not vice versa: the belt neither opposes resistance to motion nor increases it, the effort against the movement thereof being made neutral. In other words, the user controls and the motorisation follows, contrary to what occurs in the conventional motorised treadmills.

The slipping torque limiter can be constituted by a coupling for example of the magnetic powder type or of the permanent magnet type or of the friction clutch type and the like.

The value of the maximum driving torque can be set manually or automatically following the detection of the user's weight by means of a special sensor, and it can be automatically varied as function of the user's position on the belt. In order to obtain this, there is conveniently provided for a sensor for detecting the distance of the user on the belt with respect to a front console of the treadmill. In use, the user almost obliviously finds the torque and/or the distance from the console suitable for the pace thereof.

The slipping torque limiter may be provided in axis with the shaft of the motor or in axis with the driven shaft, or in any other part of the transmission between the motor and the belt.

Brief description of the drawings

The invention will now be described in detail, purely by way of non-limiting example, with reference to the attached drawings, wherein:

- figure 1 is schematic lateral elevational and partly sectioned view of a motorised treadmill according to the invention,
- figure 2 is a vertical section and in larger detail according to line II-II of figure 1,
- figure 3 shows a first variant of figure 2,
- figures 4 and 5 show further variants,
- figure 6 is a diagram of the electronic control system of the treadmill, and
- figure 7 is a diagram showing examples of adjustment of the driving torque as a function of the

position of the user on the belt.

Detailed description of the invention

Initially referring to figures 1 and 2 a treadmill according to the invention comprises a closed loop belt 1 which is wound on a pair of rollers 2, 3 and whose upper branch rests on a sliding plane 4.

The roller 3 is coupled to a driven shaft 6 laterally projecting and actuated by a hollow shaft 7 with methods to be clarified hereinafter.

The hollow shaft 7, coaxial to the driven shaft 6, is in turn actuated by a driven pulley 8 on which there is wound a transmission belt 9 driven by a driving pulley 10 carried by a driving shaft 5 rotatably actuated by an electric motor 11.

A cooling fan 12 is conveniently to the hollow shaft 7.

According to the invention, between the hollow shaft 7, and thus between the driven shaft 6, and the driving shaft 5, there is interposed an adjustable torque limiter, according to the methods described hereinafter, between a minimum value equivalent to zero and a maximum value basically corresponding to the complete transmission of motion between the two shafts 5 and 6.

In the case of the illustrated example, the torque limiter is constituted by a slipping coupling, for example a magnetic powder coupling 13 of the generally conventional type, whose adjustment is actuated through an excitation coil 14.

It should be observed that the torque limiter could alternatively be constituted by any equivalent mechanism, such as for example a friction clutch coupling or a permanent magnet coupling of the type described hereinafter, as long as it is adjustable.

The adjustment of the slipping torque limiter 13, i.e. the setting of the driving torque transmitted by the driving shaft 5 to the driven shaft 6, may be carried out by the user through a special manual control, not illustrated, for example provided on a front console 15 of the treadmill, or automatically through the detection of the weight of the user positioned on the belt. For this purpose, there may be used a suitable transducer of any conventional type, arranged beneath the sliding plane 4 and indicated with 16 in the diagram of figure 6 (regarding a variant to be addressed hereinafter), operatively connected to an electronic control unit indicated with 17 in the same figure through which, in the embodiment described herein, the current supplied to the excitation coil 14 is regulated.

This enables decoupling the electric motor 11 from the belt 1 so that the effort upon the movement of the latter by the user can be made neutral, i.e. substantially similar to the one that the user should apply in actual conditions when walking or running on the road or track. Such effect derives from the fact that the user should neither drag the belt 1, as it instead occurs in the case of non-motorised treadmills, nor be forced to keep up with the set speed of the belt 1 like it usually occurs in the case of conventional motorised treadmills. In other words, the belt 1 neither opposes resistance to the motion nor increases it, this being attained due to the fact that the rotational speed of the electric motor 11 and the initially set driving torque, this once the user starts the treadmill, only overcome the passive resistance of the belt 1, i.e. the friction of the belt transmission 9 and the shafts 5 and 6 plus the resistance generated by the weight of the user on the sliding plane 4, regardless of the speed the belt 1 is subjected to by the user. The electronic control 17 of the treadmill operates so that the rotational speed of the motor 11, and thus that of the driving shaft 5, is set and increased to a value constantly higher than the rotational speed of the driven shaft 6 so that the driving torque is always maintained and matches a maximum value proximal to the one required for the first start motion of the belt by the user. Such maximum value is maintained constantly unvaried when the user is walking or running, or more conveniently, it can be automatically varied as a function of the position of the user on the belt 1. For example, when walking or running, the more the user moves away from the console 15, the lesser the value of the driving torque applied to the belt 1 will be in a proportional fashion, for example as exemplified in a simplified manner with A, B, C in the diagram of figure 7, which represents the percentage reduction of the driving torque as the distance expressed in mm increases. The detection of the user's position may be carried out through an optical sensor 18 of the conventional type, for example applied to the console 15 and connected to the control unit 17.

The treadmill according to the invention operates as follows.

Upon starting the electric motor 11 it begins rotating at a speed for example at about 100 revolutions/min: the driven shaft 6 and thus the belt 1 remain stationary in that the driving torque transmitted by the torque limiter 13 remains at zero.

When the user steps into the belt 1 there follows the adjustment of the driving torque transmitted by the driving shaft 5 to the driven shaft 6: such adjustment can be carried out manually or automatically, by detecting the user's weight as mentioned. The driving torque is thus adjusted up to a maximum value, the so-called standstill, corresponding to the limit between the overcoming of the frictions and mechanical resistances and the starting of the advancement of the belt 1.

Should the user start walking or running, the rotational speed of the electric motor 11 and thus the speed of the belt 1 will increase, but the previously set difference will be maintained at any regime: thus, to a rotational speed of the driving shaft 5 from 100 to 3000 revolutions/min there will correspond an advancement speed of the belt 1 equivalent to a rotational speed of the driven shaft 6 from 0 to 2900 revolutions/min, and vice versa. The belt 1 will thus keep up with the speed imparted by the user without dragging and without being dragged the user: thus in neutral conditions.

The rotational speed of the driving shaft 5 or the electric motor 11, and that of the driven shaft 6 or the advancement speed of the belt 1, will be continuously detected by suitable conventional transducers such as tone wheels, for example indicated with 19 and 20 with reference to the diagram represented in figure 6 (regarding the variant of the treadmill to be described hereinafter with reference to figure 4), operatively connected to the electronic control unit 17 of the treadmill which will constantly carry out the comparison thereof, so that there is always an automatic correction between the speed imparted by the user and the one to be taken by the electric motor 11, in real time.

Should the user stop, even remaining on the belt 1, the latter stops while the electric motor 11 continues to rotate at the initial speed of 100 revolutions/min. This enables the user to step down from the treadmill very easily and without the risk of falling.

As explained, the set driving torque may be varied, through the sensor 18, depending on the position of the user on the belt 1, i.e. the distance thereof from the console 15.

In the case of the example represented in the figure 2, as mentioned, the torque limiter 13 is arranged coaxially to the driven shaft 6 that actuates the belt 1. In the case of the variant represented in figure 3, in which parts identical or similar to those previously described are indicated with the same reference numbers, the torque limiter 13 is instead positioned in axis with the electric motor 11, on the driving shaft 5. In this case, the hollow shaft 7 is thus axial to the driving shaft 5 coupled with the driving pulley 10.

Figures 4 and 5 schematically illustrate two variants of the treadmill according to the invention, in which the slipping torque adjuster, indicated with 13a in both cases. is of the permanent magnets type.

In the case of figure 4, the torque adjuster 13a includes a permanent magnet 21 carried by the driven pulley 8 mounted on the driven shaft 6, axially faced to a permanent magnet 22 carried by a wheel 23 slidingly coupled in rotation on a grooved shaft 24 which constitutes an axial appendage of the driven shaft 6. The wheel 23 with the permanent magnet 22 can be axially displaced on the shaft 24 so as to approach or move away with respect to the permanent magnet 21, for example through an electric stepper motor 25 which rotatably drives a screw 26 coupled with a holder nut 27. The translation of the holder nut 27 driven by the rotation imparted to the screw 26 by the stepper motor 25 drives a corresponding translation of the wheel 23.

Naturally, the displacement system to vary the gap between the permanent magnets 21 and 22, and thus the driving torque transmitted by the driving shaft 5 to the driven shaft 6 through the pulleys 8, 10 and the belt 9, could be obtained using other different and functionally equivalent systems.

The difference of the variant of figure 5, in which parts identical or similar to those described with reference to figure 4 are indicated with the same reference numbers, solely lies in the fact that the permanent magnets 21 and 22 of the slipping torque adjuster 13a are faced to each other radially instead of axially.

Figure 6 exemplifies the diagram of the entirely automatic electronic control system of the treadmill applied to the embodiment of figure 4: it should be observed that it is substantially identically applied to all the previously described embodiments.

The weight 16 and position 18 sensors and the speed sensors 19, 20 send their signals to the control unit 17 which adjusts both the driving torque through the stepper motor 25 and the rotational speed of the motor 11, for example through a tension variator 28.

In addition, there may be provided, should the belt 1 be of the variable inclination type to simulate uphill movement, an inclination sensor 29 operatively connected to the control unit 17, which will provide for reducing the maximum torque proportionally to the increase of the inclination up to zeroing it when the inclination angle equals the friction angle between the belt 1 and the sliding plane 4, so as to prevent the user from slipping backwards.

The repositioning of the torque limiter 13 to zero value, after stopping upon using it, may be carried out automatically or manually.

The motor 11 may be power supplied by direct current, or by alternating current with variable frequency.

The torque limiter, regardless of the type, will be conveniently provided with a cooling system, same case applying to the electric motor;

The possible weight sensor can be of the disinsertable type, but with an intentional and never unintentional action (for example by disinserting a locking key).

If the user wants to know the time and speed required to cover a distance or follow a therapeutic programme or predefined training, it will be sufficient to introduce - on a special display of the treadmill - a route plan previously memorised in the archive on-board and display a light track of the speed that the user is maintaining over time, so that the user can correct the pace thereof up to matching the light track with the pre-established one.

In brief, the distinctive characteristics and the relative advantageous effects of the treadmill according to the invention are summarised below:

- after starting the treadmill, the user starts walking or running without any limitation beyond the intentions thereof. The user may stop at any time and may resume the exercise at any time at will: the belt will neither oppose resistance nor drag the user: it is entirely neutral, thus creating the feeling of actually walking or running on the road;

- the motor has the sole purpose of following, in real time, the user's intentions as concerns the dynamic part, and overcome any passive resistance due to mechanical frictions and the friction generated by the user's weight on the sliding plane of the belt. Basically, the user controls and the motorisation follows, contrary to what occurs in conventional motorised treadmills;

- the slipping torque adjuster is adjusted, even automatically, according to the personal characteristics of each user (weight, position);

- the electronic adjustment of the motor enables dynamically following the intentions of the user constantly and continuously in real time, so as to always guarantee the driving torque set and transmitted to the shaft of the belt;

- the motor 11-belt 1 decoupling enables the user to be able to follow possible training programmes pre-set on the electronic control unit 17, with a normal walking effort, possibility of stopping at any time without being exposed to any risk even with the motor running and without any risk of falling, as well as free programmes also possibly with a slight inclination of the belt and with a pace that can be varied at will even stopping and restarting, without the risk of falling in this case too.

Obviously, the construction details and the embodiments may widely vary with respect to what has been described and illustrated, without departing from the scope of protection of the present invention as defined in the claims that follow.

Thus, given that the torque transmitted by the limiter does not depend on the slipping value (it is sufficient that it be positive), the speed of the motor could theoretically be always maintained at the maximum number of revolutions.

CLAIMS

1. A motorized treadmill comprising a closed loop belt (1), a motor (11) that actuates a driving shaft (5), and a driven shaft (6) operated by the driving shaft (5) to move the belt (1), wherein the driven shaft (6) can be rotatably decoupled from the driving shaft (5), characterised in that it comprises a slipping torque limiter (13; 13a) adjustable between a minimum value and a maximum value of the driving torque transmitted by the driving shaft (5) to the driven shaft (6), in that the value of the driving torque can be initially set at a value proximal to the one required by a user for the first start motion of the belt (1), and in that the rotation of the motor (11) that actuates the driving shaft (5) is electronically set and maintained at a value constantly higher than the rotational speed imparted by the user of the belt (1) to the driven shaft (6) so as to always maintain the torque at the set value, thus the belt (1) keeps up with the speed imparted by the user without dragging or slowing down the user.

2. Treadmill according to claim 1, characterised in that the torque limiter is selected from among a magnetic powder slipping coupling (13), a permanent magnet slip coupling (13a) a friction clutch coupling and the like.

3. Treadmill according to claim 1, characterised in that said value of the driving torque can be set manually.

4. Treadmill according to claim 1, characterised in that said value of the driving torque can be set automatically by means of a sensor (16) for detecting the user's weight.

5. Treadmill according to one or more of the preceding claims, characterised in that said value of the driving torque can vary as a function of the user's position on the belt (1).

6. Treadmill according to claim 5, characterised in that it comprises a sensor (18) for detecting the distance of the user on the belt (1) with respect to a front console (15) of the treadmill.

7. Treadmill according to claims 4 and 6, characterised in that it comprises means (19, 20) for detecting the rotational speed of the driving shaft and the driven shaft (5, 6), and an electronic control unit (17) operatively connected to said sensors (16, 18) and to said detector means (19, 20) for the automatic adjustment of said torque value and the rotational speed of the motor (11).

8. Treadmill according to claim 7, wherein the belt (1) is of the adjustable inclination type, characterised in that a sensor (29) for detecting the inclination of the belt (1) is also operatively connected to said electronic control unit (17).

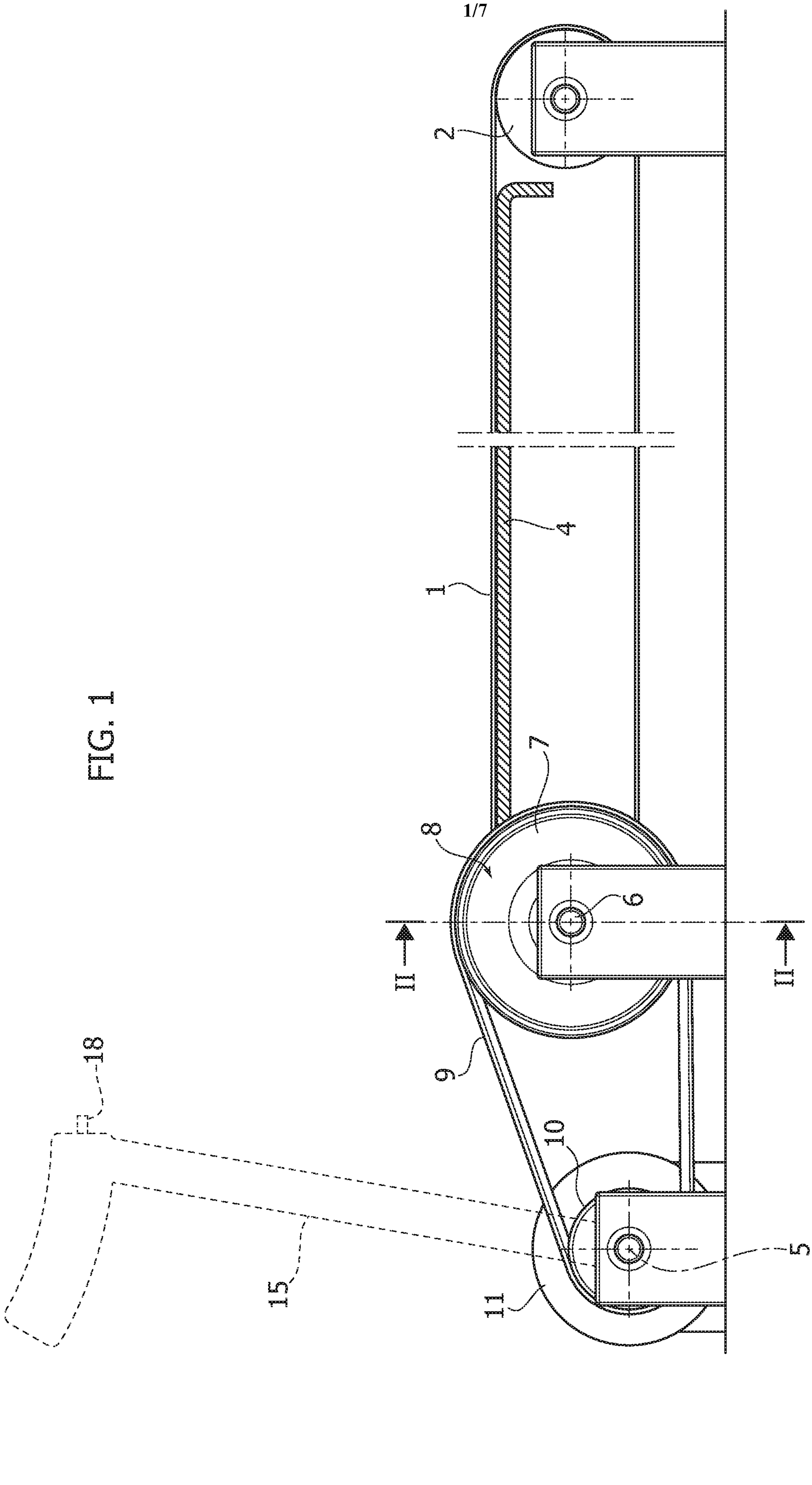


FIG. 1

FIG. 2

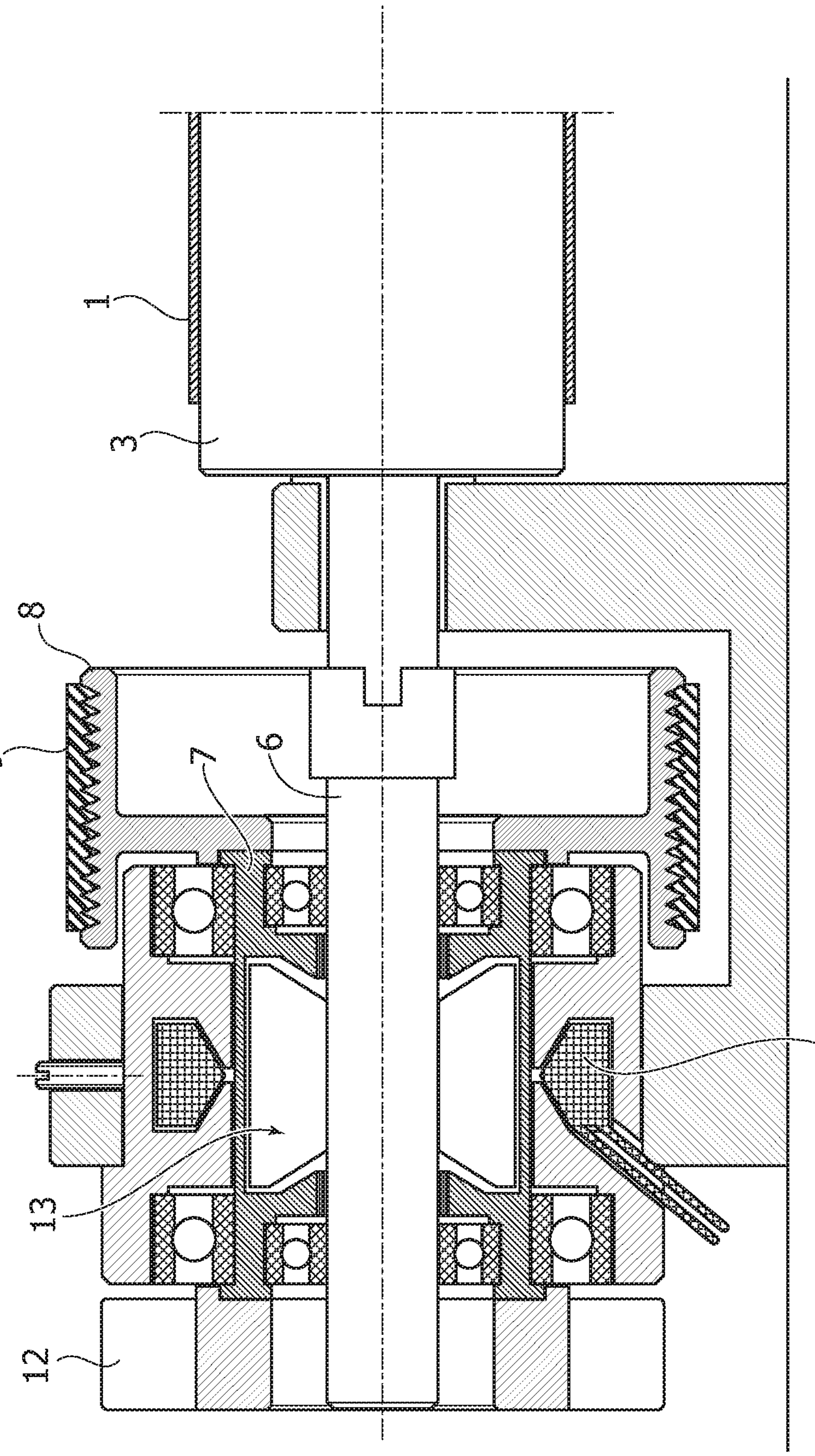


FIG. 3

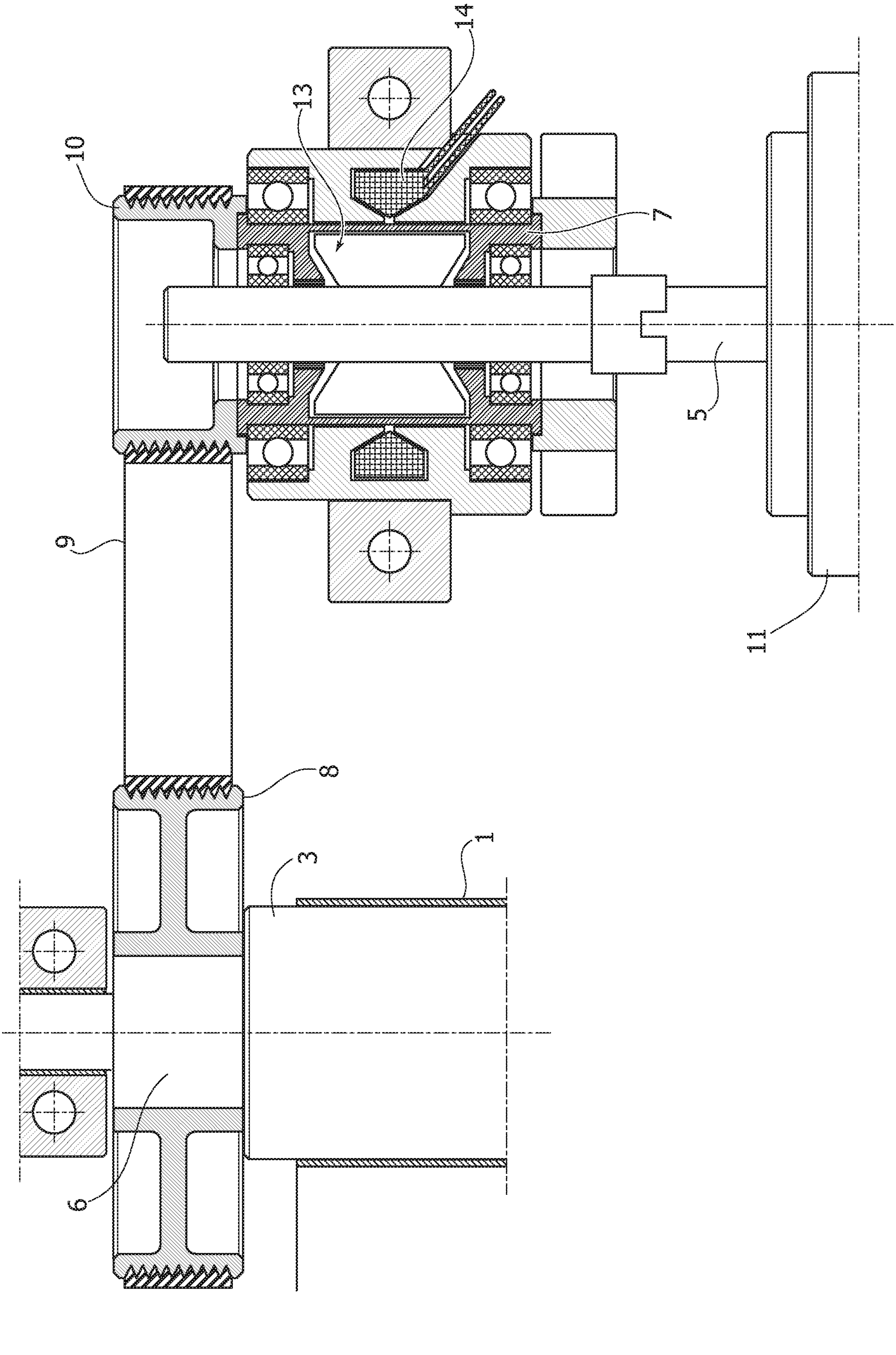
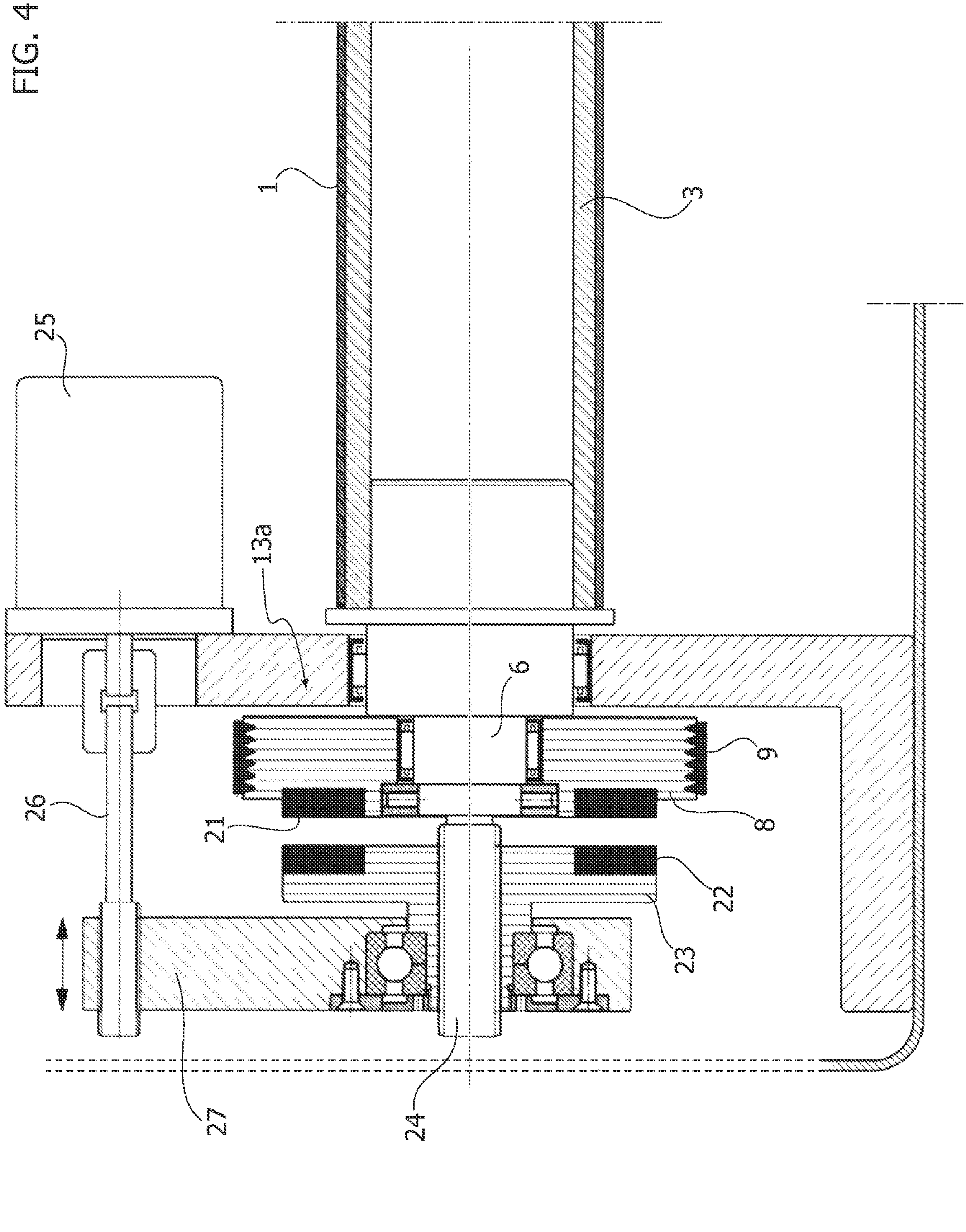


FIG. 4



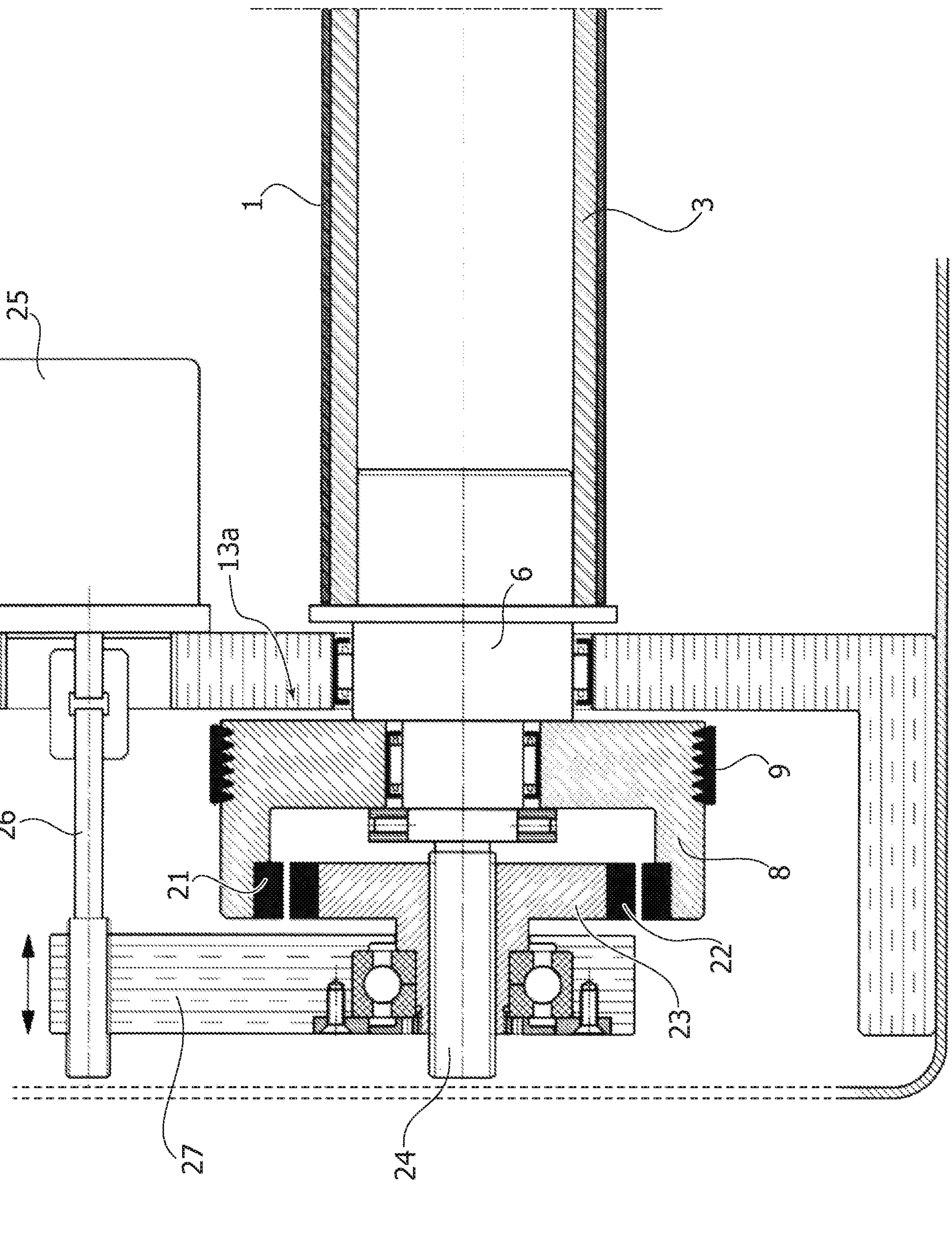


FIG. 5

FIG. 6

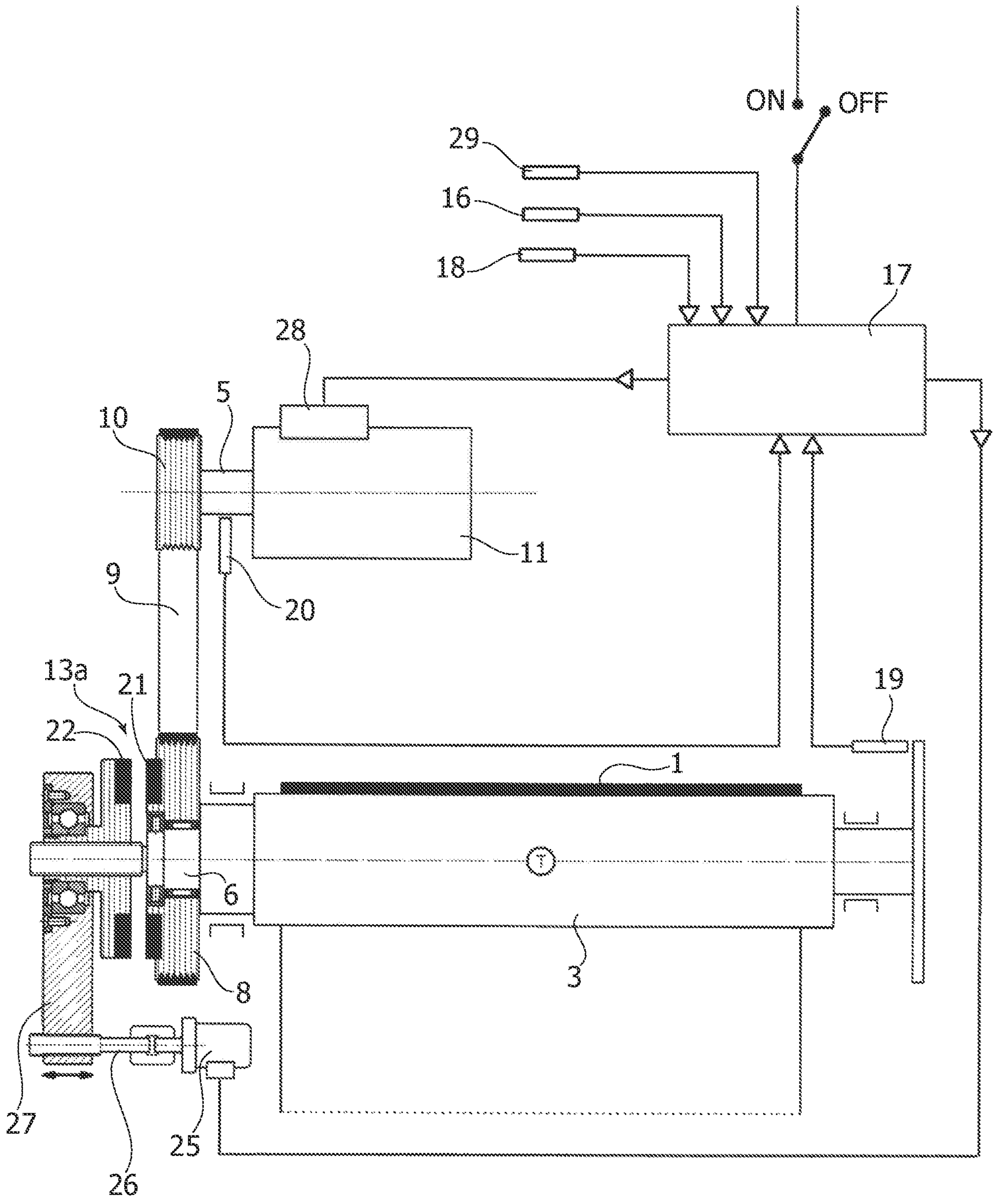
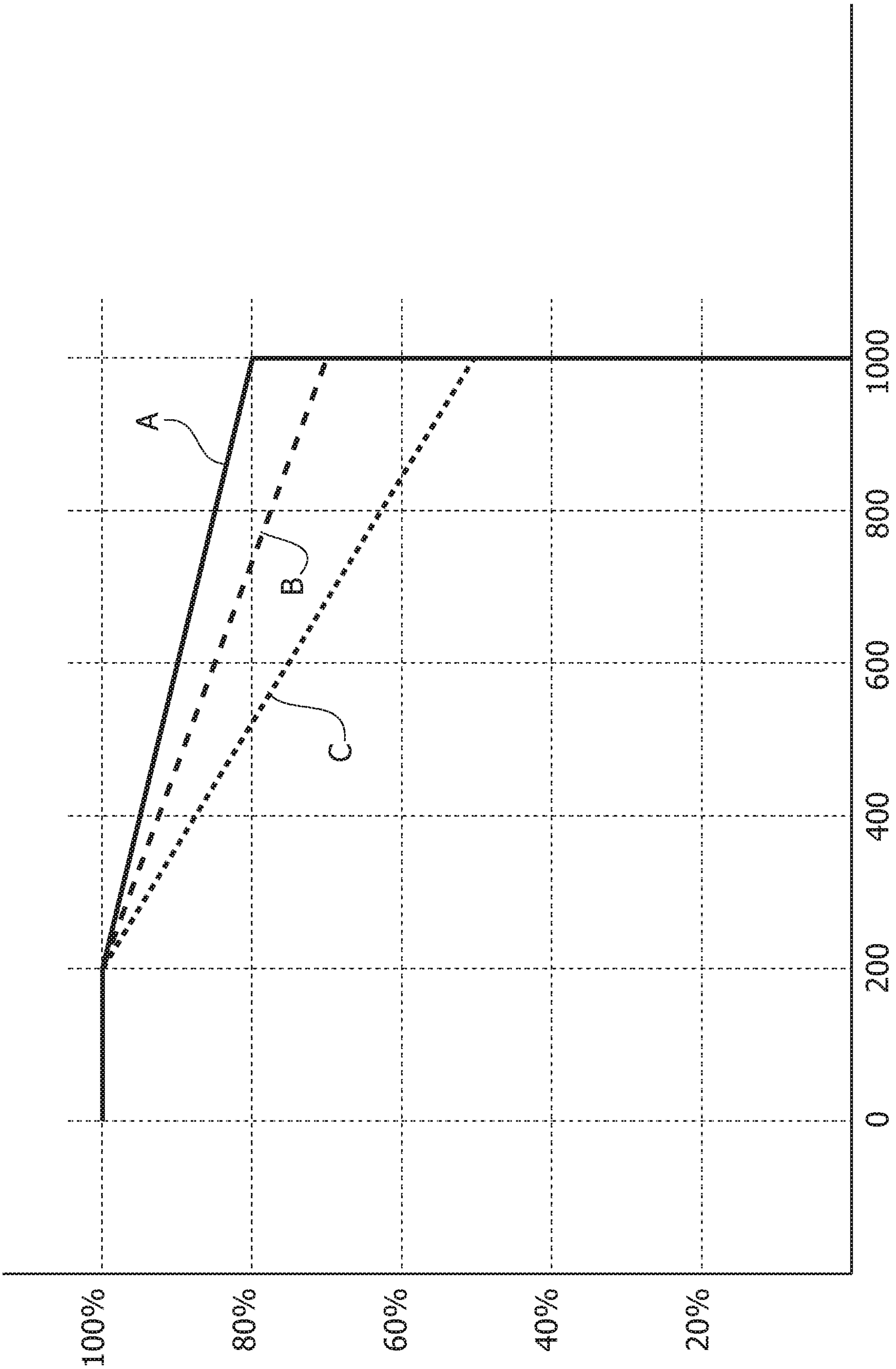


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/057323

A. CLASSIFICATION OF SUBJECT MATTER
INV. A63B22/02 A63B24/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 2 272 310 Y (XIUFU PLASTIC CO LTD [CN]) 14 January 1998 (1998-01-14) figures	1-4
A	US 2012/108392 A1 (CHU JEFFREY J [US] ET AL) 3 May 2012 (2012-05-03) paragraph [0146]; figures	1-4
A	WO 94/17863 A1 (DIVERSIFIED PROD [US]) 18 August 1994 (1994-08-18) the whole document	5-7
A	US 2002/016235 A1 (ASHBY DARREN C [US] ET AL) 7 February 2002 (2002-02-07) paragraph [0048] paragraph [0062]; figures	1,8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
2 March 2017	15/03/2017

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2016/057323

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
CN 2272310	Y	14-01-1998	NONE			
US 2012108392	A1	03-05-2012	US	2011312473	A1	22-12-2011
			US	2012108392	A1	03-05-2012
WO 9417863	A1	18-08-1994	US	5368532	A	29-11-1994
			WO	9417863	A1	18-08-1994
US 2002016235	A1	07-02-2002	AU	2618701	A	14-08-2001
			US	6447424	B1	10-09-2002
			US	2002016235	A1	07-02-2002
			US	2005209052	A1	22-09-2005
			WO	0156661	A1	09-08-2001