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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 December 2011 (15.12.2011)

PCT

(10) International Publication Number
WO 2011/154981 A1

(51) International Patent Classification:
F16H 1/32 (2006.01) *F16H 3/72* (2006.01)

(21) International Application Number:
PCT/IT2010/000264

(22) International Filing Date:
11 June 2010 (11.06.2010)

(25) Filing Language: English

(26) Publication Language: English

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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, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, 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, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

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

(54) Title: KINEMATISM WITH ORBITAL MOVEMENT WITH FIXED ORIENTATION

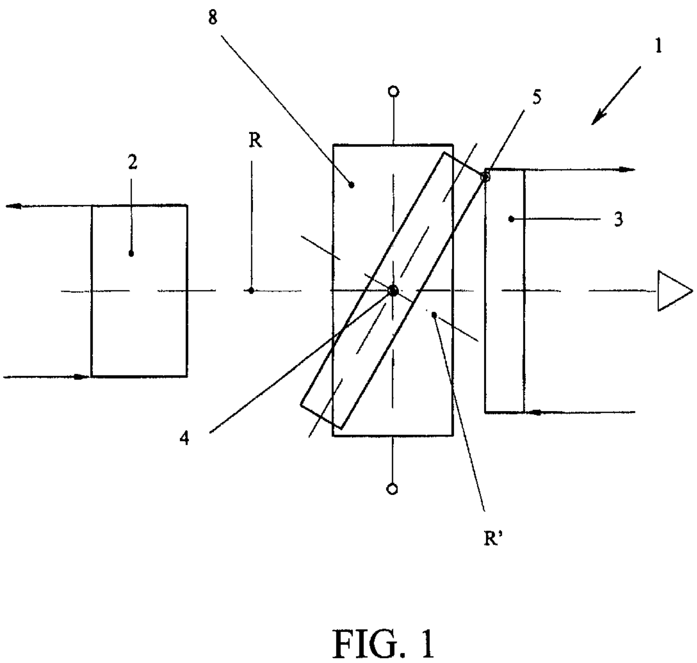

FIG. 1

(57) Abstract: A kinematism is described with orbital movement (1) with fixed orientation comprising at least one first (2) and one second (3) motion transmitting means, respectively connected to a thrust system (4) and to a driven system (5), mutually facing and mutually frontally cooperating through respectively a first (6) and a second (7) mechanically cooperating means, at least the first transmitting means (2) rotating around a main rotation axis (R-R), the first mechanically cooperating means (6) being adapted to apply a series of points of force to the second mechanically cooperating means (7) so that a set of positions, instant by instant occupied in the space by each one of such points of force, individually considered, substantially describes a Lemniscate curve as Mobius ring, the thrust system (4) being slanted with respect to the main rotation axis (R-R) and symmetrical and coaxial with a slanted axis (R' -R') around which the curves of such points of force are symmetrically distributed, further comprising rotation-preventing means (8) adapted to prevent the rotation of the single point of force with respect to the main rotation axis (R-R).

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KINEMATISM WITH ORBITAL MOVEMENT WITH FIXED ORIENTATION

The present invention refers to a kinematism with orbital movement with fixed orientation, that can be used in particular for making a revolution variator, reducer or multiplier in a mechanical transmission.

In the field of transmissions with continuous revolution variation of a mechanical type, the only known systems are based on friction (variable pulleys and trapezoidal belts like the Variomatic gearbox marketed by Company DAF, or the motion transmitting system with continuous revolution variation in Fischer turns, that used alternate current motors, therefore with a constant number of revolutions), with a limitation, for obvious known reasons, on values of transmitted torque.

In the field of torque and revolution variators of the oil-dynamic type, there are gearboxes equipped with torque converter, that however similarly have step-type transmission ratios and absorb a not neglected part of power that is dissipated in internal frictions due to blows-by of viscous liquid in the interface areas of the impellers.

In the field of reducers, the prior art instead provides various solutions, that range from worm screws to the cascade of gears, till bevel torques, always anyway based on gear-type transmissions and consequently always constrained to fixed ratios. It is therefore not possible to change the number of revolutions apart from a change of ratio.

Therefore, object of the present invention is solving the above prior art problems by providing a kinematism with orbital movement with fixed orientation that can be adapted to situations providing in particular for the use of motors with constant number of revolutions or with a reduced variability range.

Another object of the present invention is providing a kinematism with orbital movement with fixed orientation that, differently from known automatic gearboxes, allows keeping constant the number of revolutions of the engine to which it is coupled, that, for this reason, can indifferently be, in addition to an explosion engine as normally known, an endothermic, electric, hydraulic, pneumatic or permanent magnet engine, of the type with constant rotation.

Moreover, an object of the present invention is providing a kinematism with orbital movement with fixed orientation that, differently from known devolution variators, allows transmitting even very high powers.

The above and other objects and advantages of the invention, as will appear from the following description, are obtained with a kinematism with orbital movement with fixed orientation as claimed in claim 1. Preferred embodiments and non-trivial variations of the present invention are the subject matter of the dependent claims.

It will be immediately obvious that numerous variations and modifications (for example related to shape, sizes, arrangements and parts with equivalent functionality) can be made to what is described, without departing from the scope of the invention as appears from the enclosed claims.

The present invention will be better described by some preferred embodiments thereof, provided as a non-limiting example, with reference to the enclosed drawings in which:

- Figure 1 shows a schematic diagram of a side section of a preferred embodiment of the kinematism according to the present invention;
- Figures 2a, 2b and 2c show side perspective views of the kinematism of Figure 1 in different positions assumed during its operation;
- Figure 3 shows a schematic diagram of a side section of an alternative embodiment of the kinematism according

to the present invention;

- Figures 4a, 4b and 4c shows side perspective views of the kinematism of Figure 3 in different positions assumed during its operation;

- Figures 5a and 5b show side perspective views of another preferred embodiment of the kinematism according to the present invention in different positions assumed during its operation; and

- Figure 6 shows a front perspective view of the kinematism of Figures 5a and 5b.

With reference to the Figures, it is possible to note that the kinematism 1 with orbital movement with fixed orientation according to the present invention comprises at least one first and one second motion transmitting means, respectively 2 and 3, preferably and respectively representing a motion entry shaft and a motion output shaft in/from the kinematism with orbital movement 1, respectively connected to a thrust system 4 and to a driven system 5 that are mutually facing, and described below, and mutually frontally cooperating through respectively first 6 and second 7 mechanically cooperating means, at least such first transmitting means 2 being rotating around a main rotation axis R-R. Advantageously, the first mechanically cooperating means 6 are adapted to apply a series of points of force on the second mechanically cooperating means 7 in such a way that the set of positions occupied instant by instant in the space by such singularly considered point of force describe a closed or open curve, having a behaviour that can substantially be assimilated to a Lemniscate curve; moreover, the thrust system 4 and, consequently, the first mechanically cooperating means 6, is slanted with respect to such main rotation axis R-R and is symmetrical and coaxial with a slanted axis R′-R′ around which the curves of the points of force are symmetrically distributed.

The point of force is a point arranged on the second mechanically cooperating means 7 in which, instant by instant, the force vector is applied, where the term force vector means a vector characterised by:

- MODULE (measured in Newton);
- VERSE (positive if in agreement with the movement, thrust, negative if in disagreement, braking)
- DIRECTION (measured in the three angular components with reference to Cartesian axes X, Y, Z).

Moreover, the kinematism 1 according to the present invention comprises rotation-preventing means 8 adapted to prevent the rotation of the single point of force with respect to the main rotation axis R-R and to compel the above point to move in space along the previously defined curve of the point of force. Such geometry therefore performs a coupling that combines an orbital movement of the support system 4 with respect to the slanted axis R′-R′ conferring a movement in space, and a traditional rotary movement around the main rotation axis R-R that confers a movement in a plane; such two above-described movements are then transmitted to the driven system 5, through the second mechanically cooperating means supported by the second transmission shaft 3 that is rotated around such main rotation axis R-R.

In general, therefore, the operating principle of the kinematism 1 according to the present invention can be described as follows; considering a transfer of forces between the motion entry shaft 2 and the motion output shaft 3, it is possible to obtain a reduction or multiplication (with the same verse or a contrary verse) of the entry torque with respect to the output torque, and a related revolution variation, by placing suitable rotation-preventing constraints through the rotation-preventing means 8 to the points of force symmetrically arranged with respect to the slanted axis R′-R′ intersecting the main rotation axis R-R. Such points of force will then be compelled to orbit in space keeping a fixed orientation. The curve of the point of force described by such orbiting can be assimilated to a

Lemniscate curve with behaviour as a Mobius ring through which the entry torque is transmitted to the driven system 5 by applying the points of force on the second mechanically cooperating means 7 by the first mechanically cooperating means 6 of the thrust system 4.

With particular reference to Figures 1 to 2c, it is possible to note a first preferred embodiment of the kinematism 1 according to the present invention functioning as devolution reducer, namely the case in which the following conditions occur:

- output torque > entry torque with respect to the main rotation axis R-R;
- number of revolutions as output from the second transmission shaft 3 < number of revolutions as entry in the first rotation shaft 2.

In such preferred embodiment of the kinematism 1 according to the present invention, the thrust system 4 is composed of a pair of disks opposed and coaxial with the slanted axis R'-R', a first one 9 of such disks being equipped with the first mechanically cooperating means 6, preferably made as a first system with undulated teeth, and a second one 10 of such disks being equipped with a second system with undulated teeth 11: the rotation-preventing means 8 preferably comprise a third fixed system with undulated teeth 12 coaxial with the main rotation axis R-R and cooperating with the second system with undulated teeth 11 of the second disk 10 of the thrust system 4. Obviously, the rotation-preventing means 8 can be made with any other system suitable for such purpose, such as, for example, rings with fixed fulcrums with respect to the main rotation axis R-R, tangential contact points between surfaces, etc., without departing from the scope of the present invention.

The driven system 5 instead is composed of a third disk 13 facing and cooperating with the first disk 9 of the thrust system 4 in which the second mechanically cooperating means 7 comprise a fourth system with undulated teeth integral with the second rotation shaft 3 and cooperating with the first system with undulated teeth. Obviously, also the mechanically cooperating means can be made through any other force transmitting system deemed suitable for rotating the output shaft 3, such as, for example, hinges with articulated joint, the use of magnetic fields, etc, without thereby departing from the scope of the present invention.

The thrust system 4 can be connected to the first motion transmitting means, and in particular to the first rotation shaft 2, by interposing a cylindrical slanted portion of such shaft 2 coaxial with the slanted axis R'-R' or by keying-in a bush with slanted hole coaxial with the slanted axis R′-R′, or any other mechanical working system suitable for such purpose. Orthogonally to the slanted axis R′-R′, and at a distance of interest defined by the rays of disks 9, 13, by rotating the first rotation shaft 2 around the main rotation axis R-R, the points of force are symmetrically distributed, and can be located as tangential contact points between the first and the fourth system with undulated teeth, or any other force transferring means suitable for such purpose to realise mechanically cooperating means. The points of force are then subjected to rotation-preventing constraints imposed by the rotation-preventing means 8, and in particular by the cooperation between the second 11 and the third system 12 with undulated teeth. Due thereby to the rotation of the first entry rotation shaft 2, the slanted axis R′-R′, since it is integral with and intersecting such first rotation shaft 2, is compelled to rotate: since the points of force are constrained with a fixed orientation with respect to the main rotation axis R-R and, due to the action of the rotation-preventing means, cannot rotate by following the rotation of the slanted axis R′-R′, they are compelled to orbit by drawing in the space a Lemniscate curve with behaviour as Mobius ring. By instantaneously taking the force in the above points through the contact between the first and the fourth system with undulated teeth, the second output rotation shaft 3 is rotated and, taking into account that this latter one is coaxial with the main rotation axis R-R, a reduction of revolutions and an increase of torque are obtained. Some example operation positions assumed by the kinematism 1 as described above are shown, in particular, in Figures 2a, 2b and 2c.

Instead, with particular reference to Figures 3 to 4c, it is possible to note a first preferred embodiment of the kinematism 1 according to the present invention working as speed multiplier, namely the case in which the following conditions occur:

- output torque < entry torque with respect to the main rotation axis R-R;
- number of revolutions as output from the second transmission shaft 3 > number of revolutions as entry in the first motion transmitting means 2.

In such preferred embodiment of the kinematism 1 according to the present invention, the first motion transmitting means comprise at least one ring 14 rotating around the main rotation axis R-R equipped on its perimeter with at least one groove 15 shaped as a sinusoid, or any force transmitting means deemed suitable, inside which at least one pin 16 slides, integral on its perimeter with the first disk 9 of the thrust system 4: also in this case, the driven system 5 is composed of the third disk 13 facing and cooperating with the first disk 9 of the thrust system 4 and equipped with the fourth system with undulated teeth integral with the second rotation shaft 3 and cooperating with the first system with undulated teeth of the thrust system 4: also in this case, by applying a torque through the ring 14 in points subjected to rotation-preventing constraints, the points located by the applied forces are distributed on a line of the points of force in the space according to a Lemniscate curve with behaviour as Mobius ring. Such orbiting with fixed orientation of the points of force generates a pair of forces orthogonal to the main rotation axis R-R that will rotate the output transmission shaft 3 with a number of revolutions greater than the number of revolutions as entry and a reduced torque. Some example operating positions assumed by the kinematism 1 as described above are shown, in particular, in Figures. 4a, 4b and 4c.

Obviously, the continuous kinematism 1 can be subjected to further modifications or variations as well as further applications not explicitly described, wholly within the grasp of an average technician in the field, though remaining within the same inventive principle: for example, the combination of a reducer kinematism 1 with a multiplier kinematism 1, as previously described, allows making a complex kinematism 1 operating as variator. Or, as can be noted in Figures 5a, 5b and 5c, if the orbital kinematism 1 with fixed orientation according to the present invention is exploited to perform a work instead of increasing a torque, it can for example be used for generating a compressed fluid: in such case, it can be noted that the rotation-preventing means 8 are made of the same interference existing between a plurality of radially arranged pistons 17, that make the second motion transmitting means and the respective cylinders 18, and the mechanically cooperating means are represented by the articulated joints 19 connecting the connecting rods 20 of such pistons to the thrust system 4, through which the points of force are transmitted.

CLAIMS

1. Kinematism with orbital movement (1) with fixed orientation characterised in that it comprises at least one first (2) and one second (3) motion transmitting means, respectively connected to a thrust system (4) and to a driven system (5), mutually facing and mutually frontally cooperating through respective first (6) and second (7) mechanically cooperating means, at least said first transmitting means (2) being rotating around a main rotation axis (R-R), said first mechanically cooperating means (6) being adapted to apply a series of points of force to said second mechanically cooperating means (7) in such a way that a set of positions, instant by instant occupied in the space by each one of said points of force, individually considered, substantially describes a Lemniscate curve as Mobius ring, said thrust system (4) being slanted with respect to said main rotation axis (R-R) and symmetrical with and coaxial to a slanted axis (R'-R') around which said curve of said points of force are symmetrically distributed, and in that it further comprises rotation-preventing means (8) adapted to prevent a rotation of said single point of force with respect to said main rotation axis (R-R).

2. Kinematism with orbital movement (1) according to claim 1, characterised in that said first (2) and said

second (3) motion transmitting means are respectively a motion entry shaft and a motion output shaft in/from said kinematism with orbital movement (1).

3. Kinematism with orbital movement (1) according to claim 1, characterised in that said thrust system (4) is composed of a pair of disks opposed to and coaxial with said slanted axis (R'-R'), a first one (9) of said disks being equipped with said first mechanically cooperating means (6).

4. Kinematism with orbital movement (1) according to claim 1, characterised in that said thrust system (4) is composed of a disk (9) equipped with said first mechanically cooperating means (6).

5. Kinematism with orbital movement (1) according to claim 3 or 4, characterised in that said first mechanically cooperating means (6) comprise a first system with undulated teeth.

6. Kinematism with orbital movement (1) according to claim 3, characterised in that a second one (10) of said disks is equipped with a second system with undulated teeth (11), and said rotation-preventing means (8) comprise a third fixed system with undulated teeth (12) coaxial with said main rotation axis (R-R) and cooperating with said second system with undulated teeth (11) of said second disk (10) of said thrust system (4).

7. Kinematism with orbital movement (1) according to claim 3 or 4, characterised in that said driven system (5) is composed of a third disk (13) facing and cooperating with said disk (9) of said thrust system (4), said second mechanically cooperating means (7) comprising a fourth system with undulated teeth cooperating with said first system with undulated teeth.

8. Kinematism with orbital movement (1) according to claim 1, characterised in that said first motion transmitting means comprise at least one ring (14) rotating around said main rotation axis (R-R) equipped on its perimeter with at least one groove (15) shaped as a sinusoid inside which at least one pin (16) slides, integral on its perimeter with the disk (9) of the thrust system (4).

9. Kinematism with orbital movement (1) according to claim 1, characterised in that said rotation-preventing means (8) comprise a plurality of pistons (17) and respective cylinders (18) and said mechanically cooperating means comprise articulated joints (19) for connecting the connecting rods (20) of said pistons (19) to said thrust system (4).

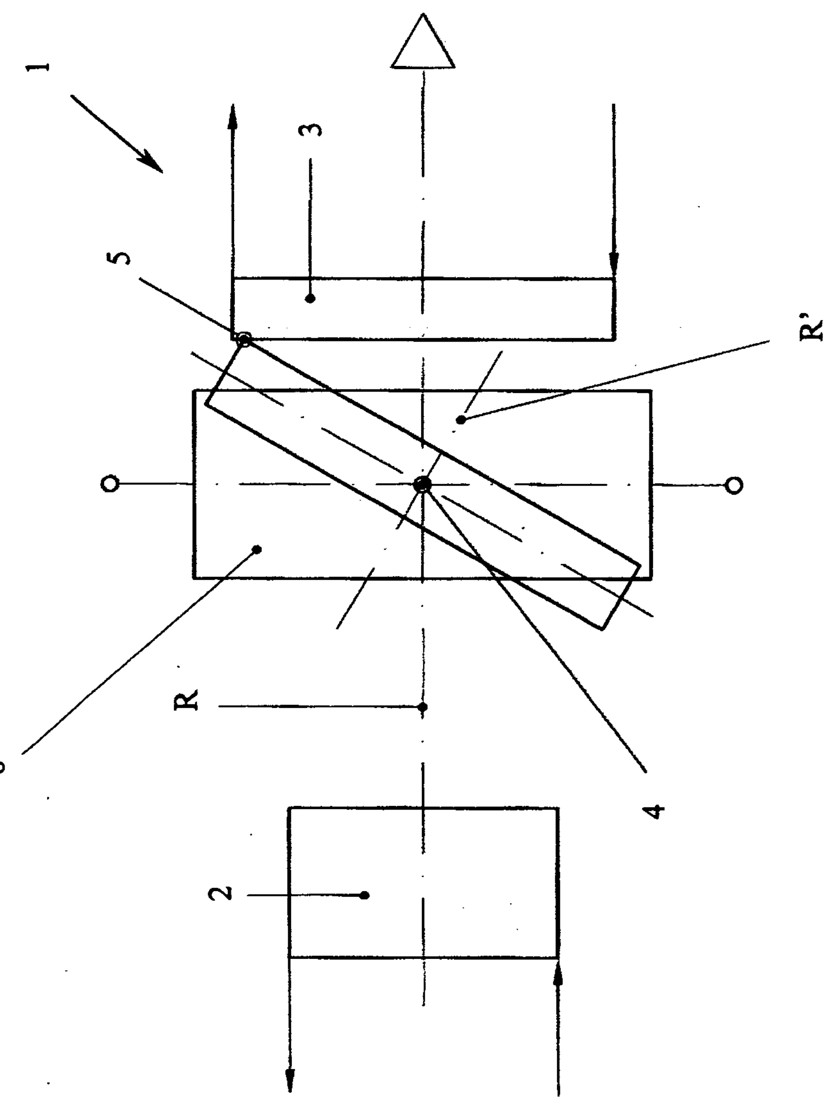

FIG. 1

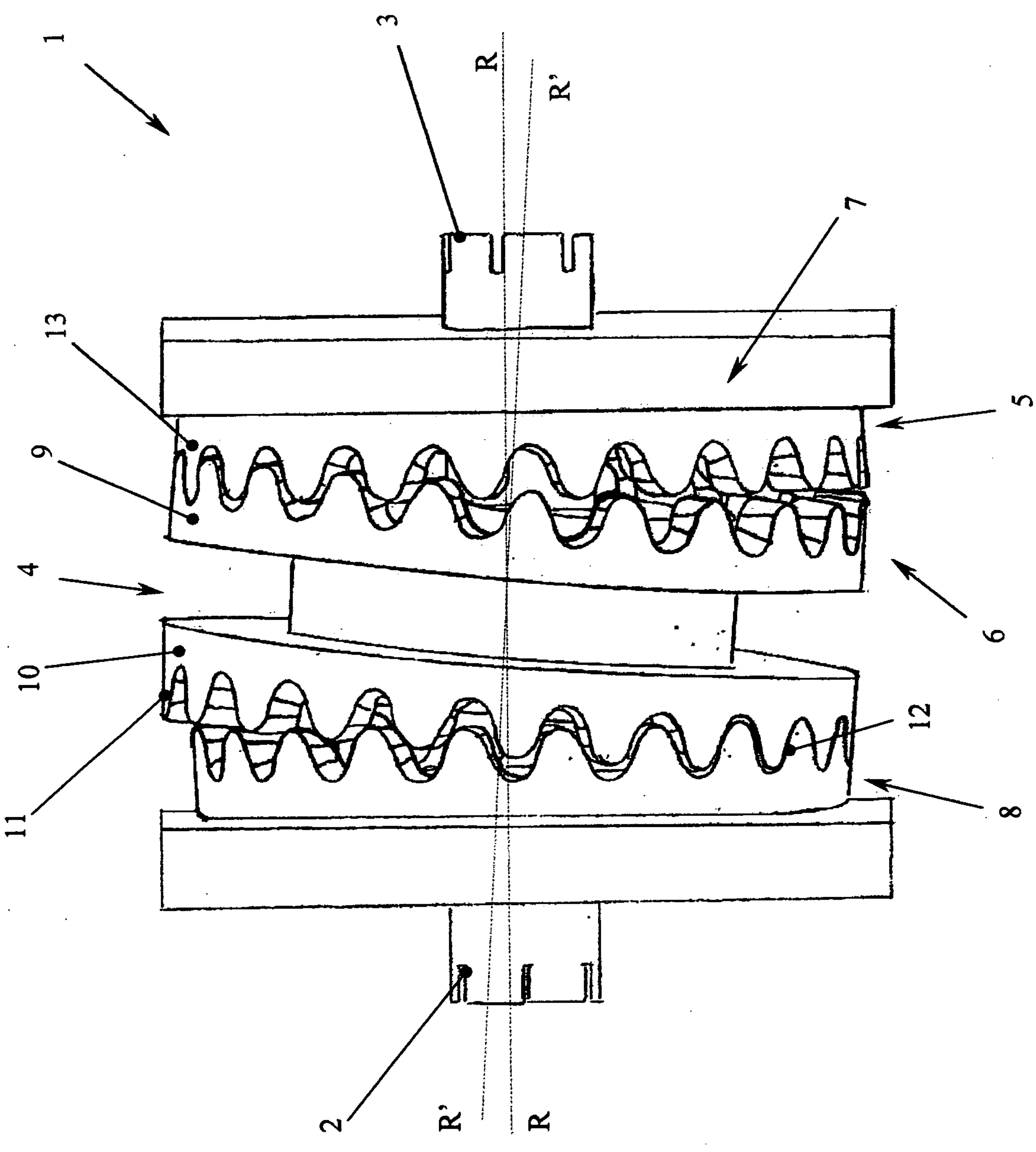

FIG. 2a

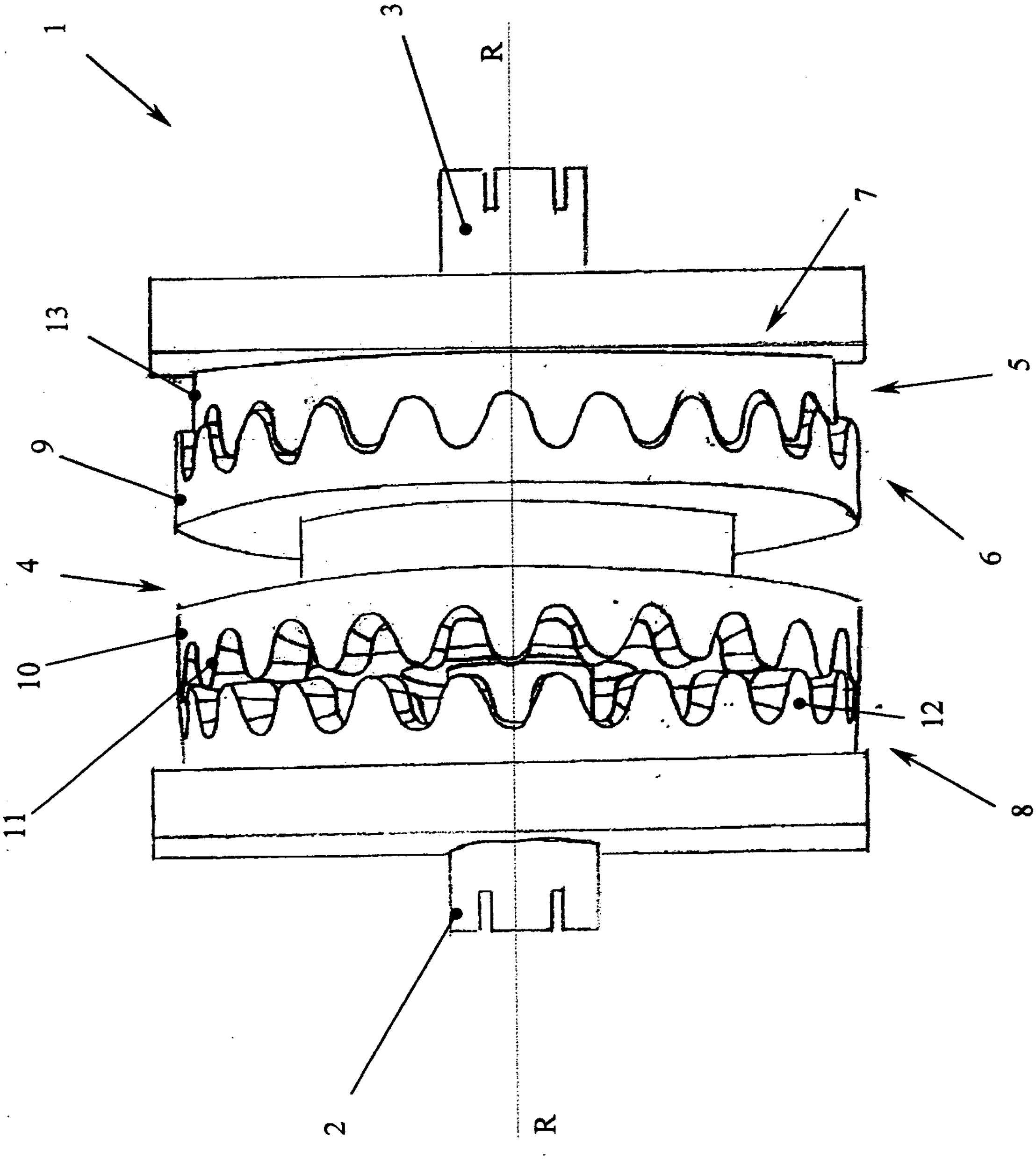

FIG. 2b

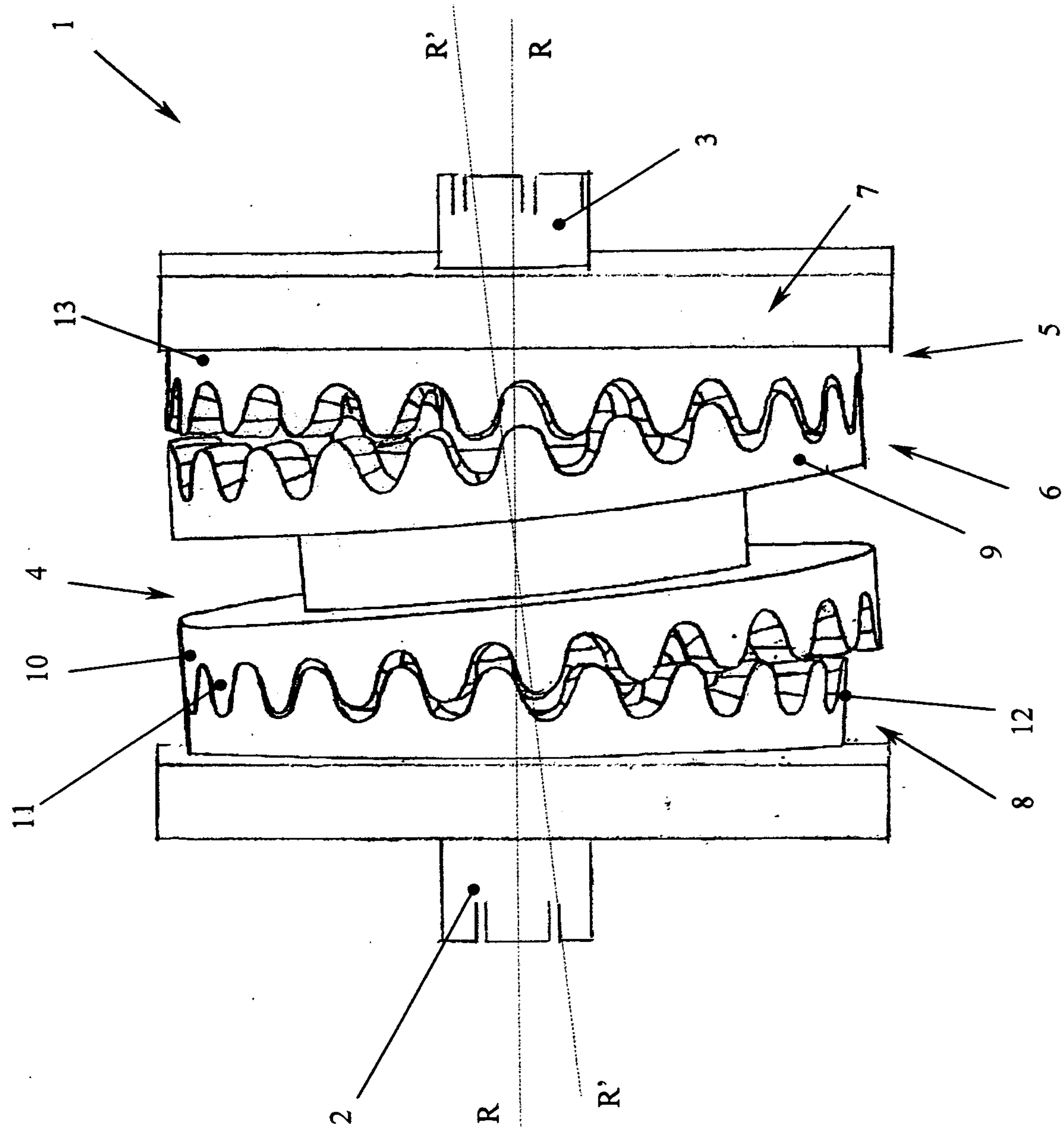

FIG. 2c

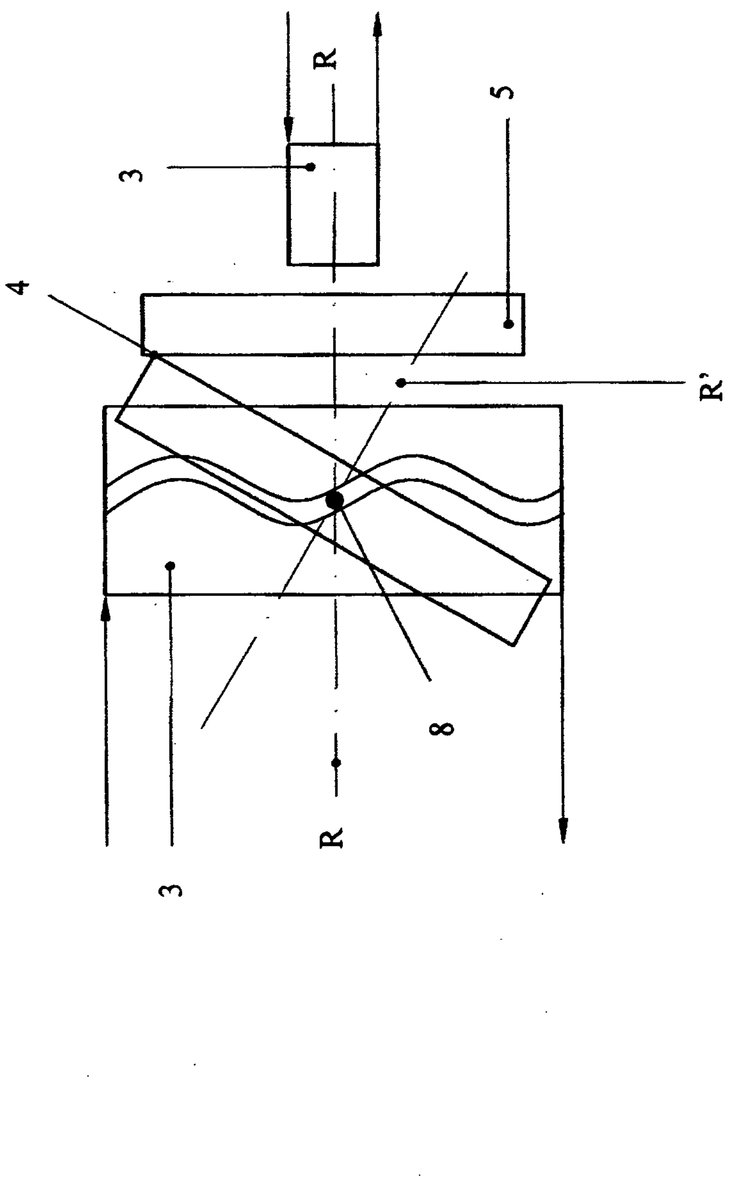

FIG. 3

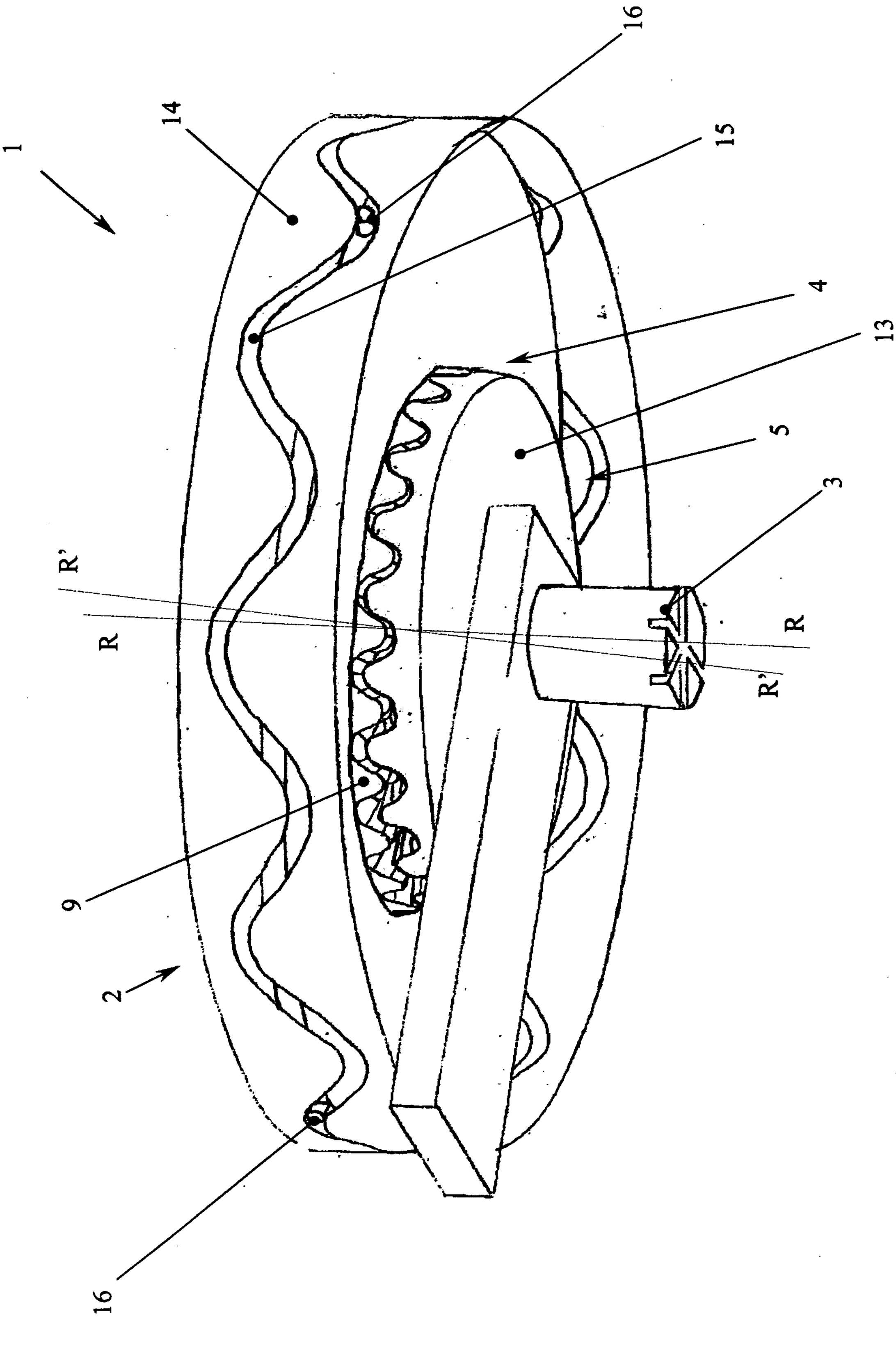

FIG. 4a

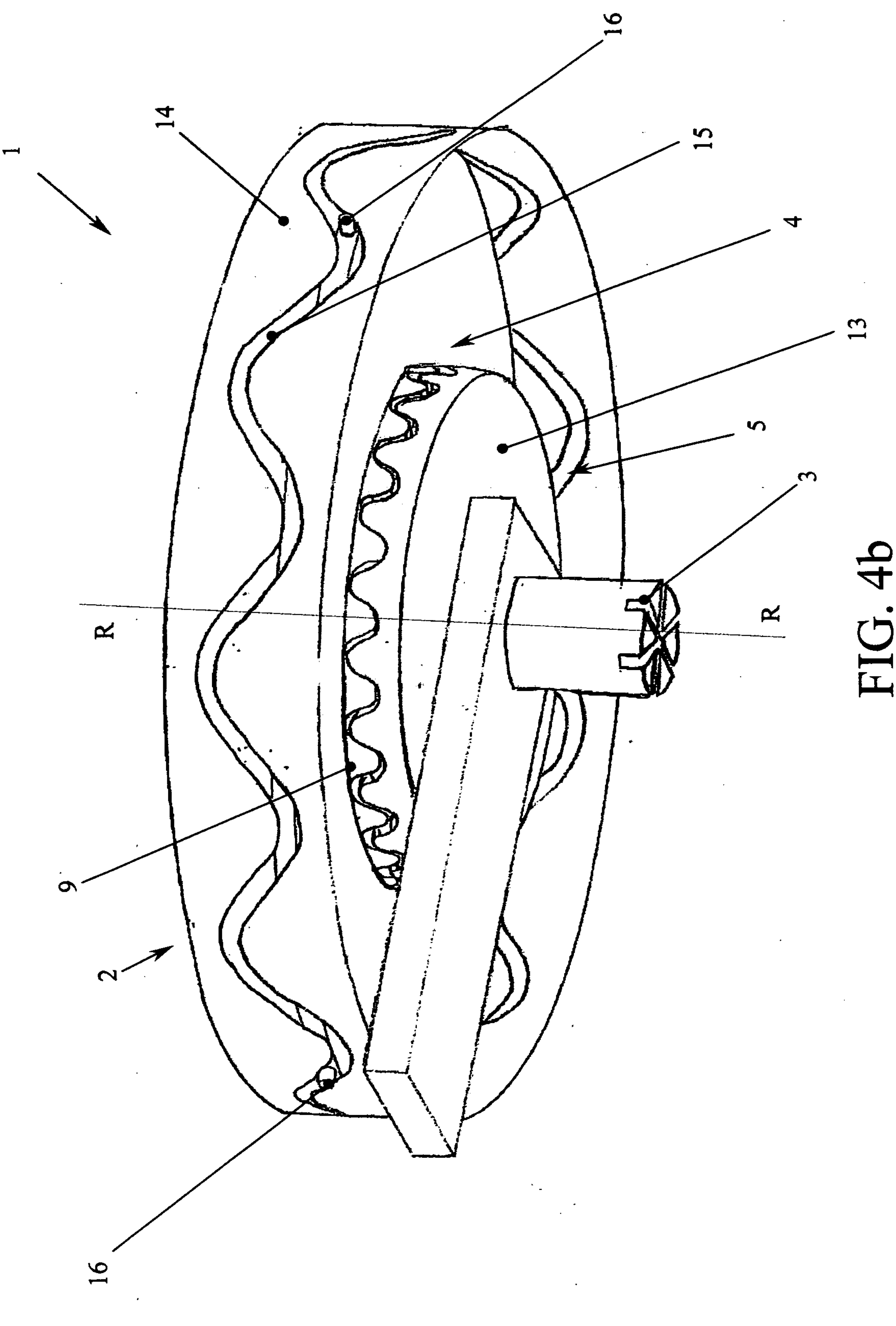

FIG. 4b

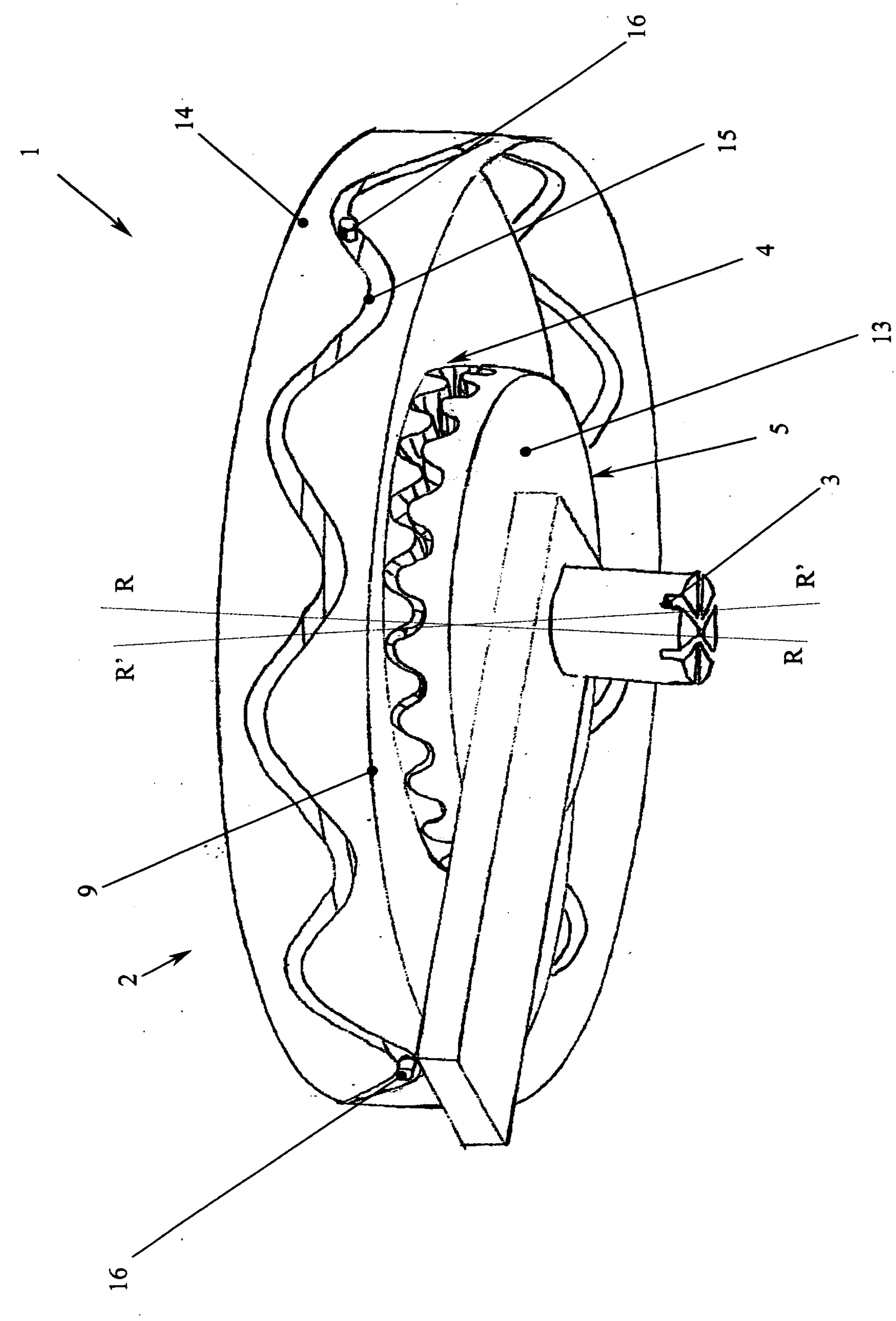

FIG. 4c

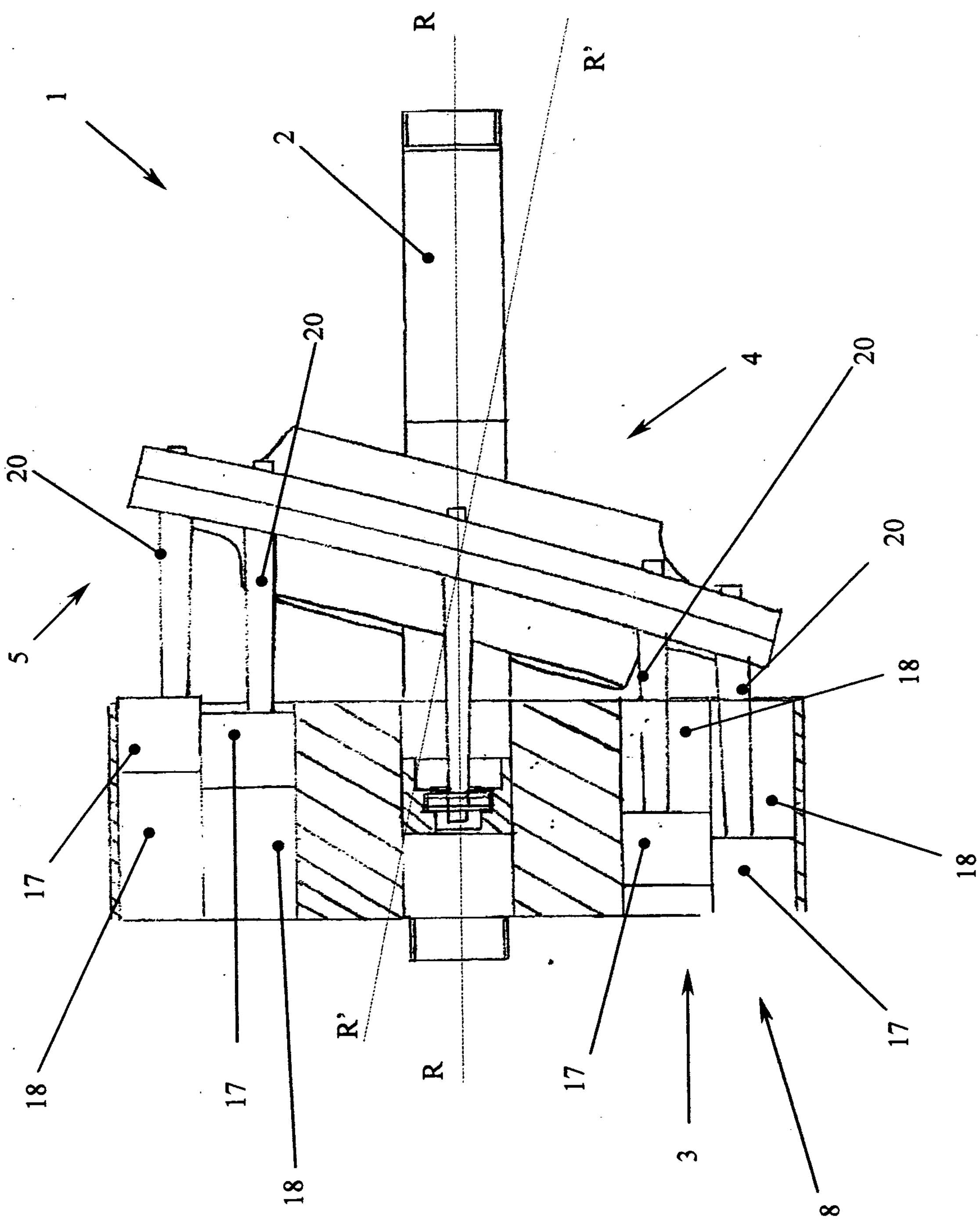

FIG. 5a

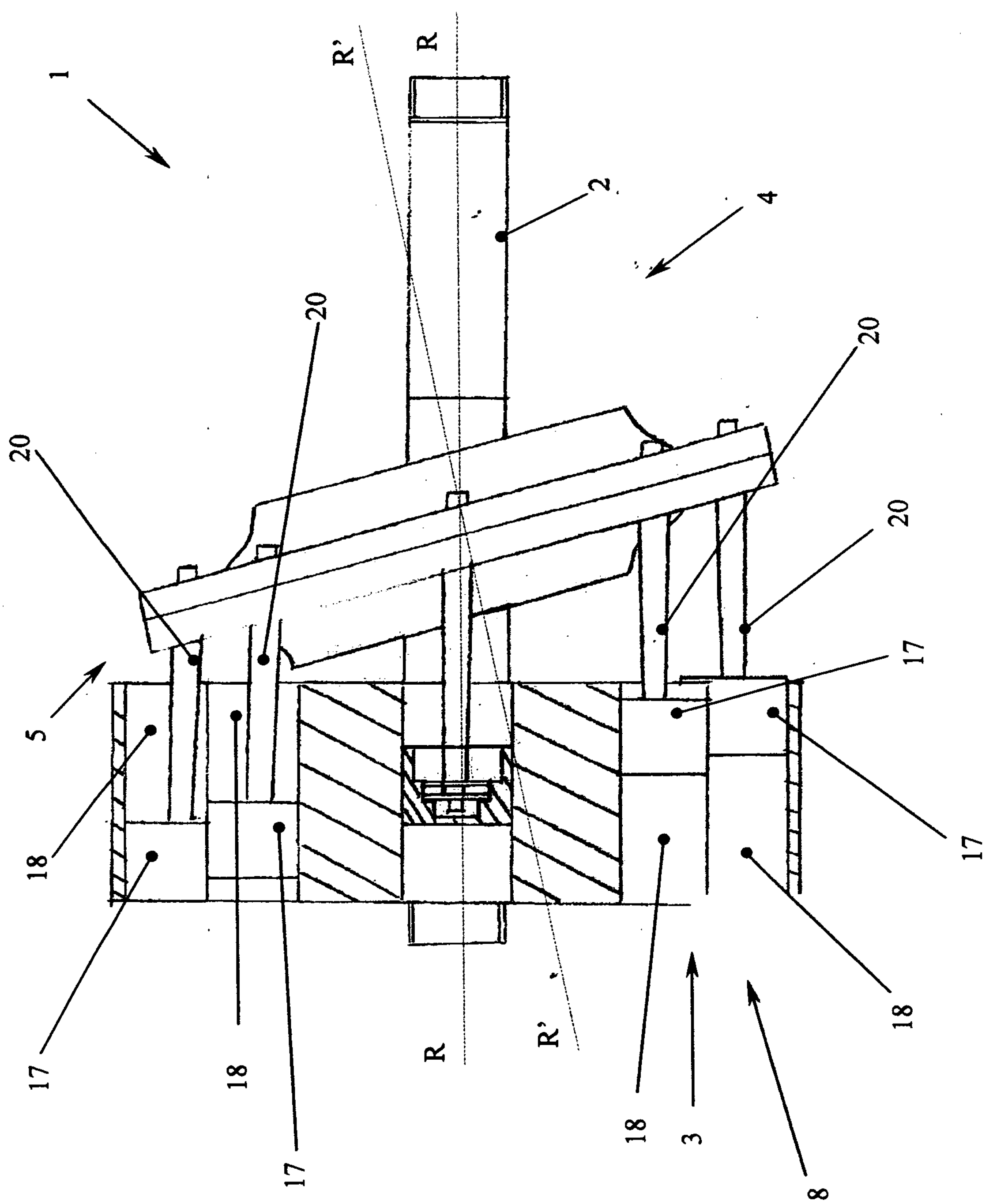

FIG. 5b

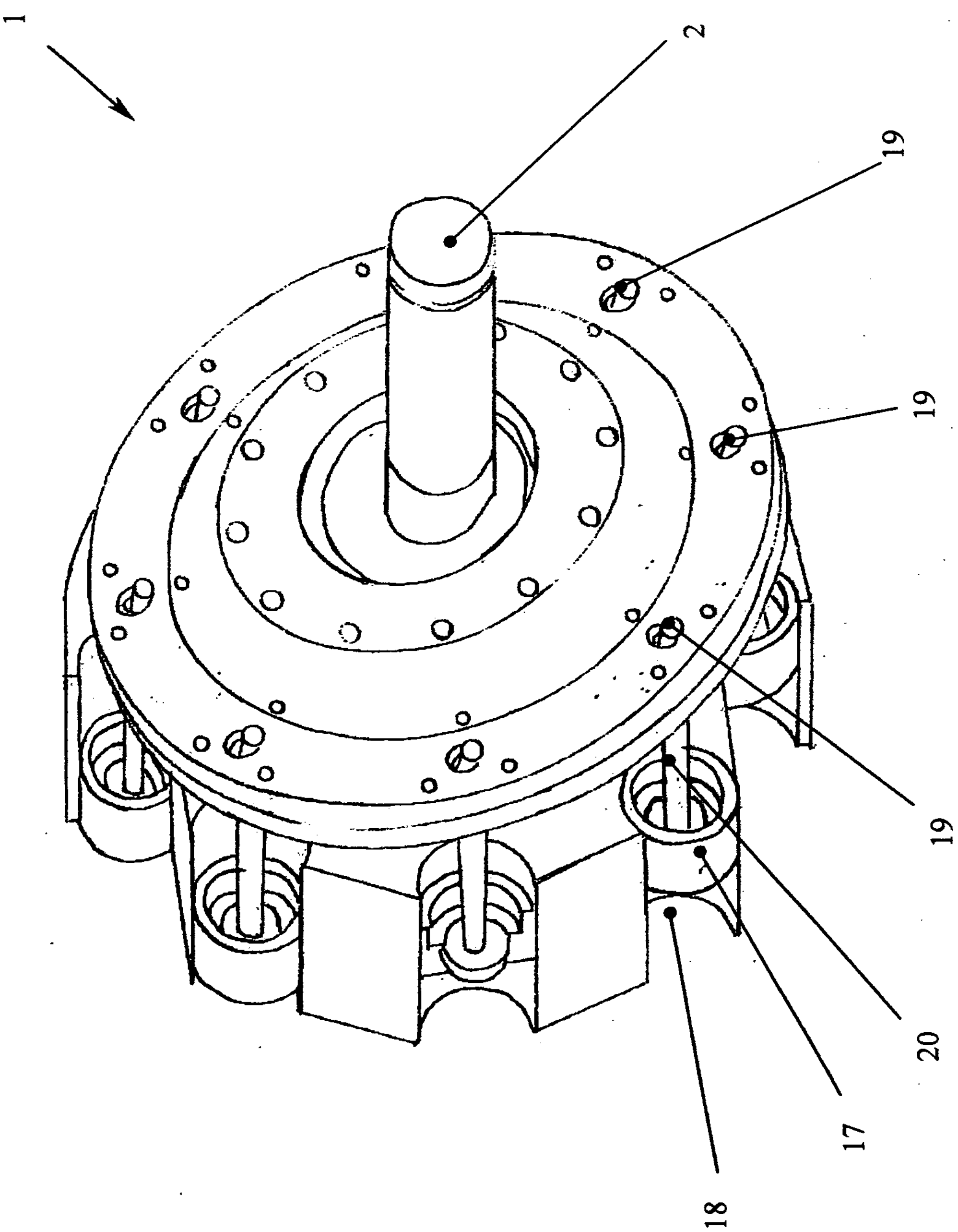

FIG. 5c

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2010/000264

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16H1/32 F16H3/72
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)
F16H

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	figure 3	5-7
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X	KEDROWSKI D K ET AL: "NUTATING GEAR DRIVETRAIN FOR A CORDLESS SCREWDRIVER", MECHANICAL ENGINEERING, ASME. NEW YORK, US, vol. 116, no. 1, 1 January 1994 (1994-01-01), pages 70-74, XP000439367, ISSN: 0025-6501	1-4
Y	the whole document	5-7
A		8,9

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 January 2011	14/02/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Szodfridt, Tamas

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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