



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

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| <b>(51) International Patent Classification 5 :</b><br><br><b>F16H 1/16, 1/20</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>A1</b> | <b>(11) International Publication Number:</b> <b>WO 90/04117</b><br><br><b>(43) International Publication Date:</b> 19 April 1990 (19.04.90)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>(21) International Application Number:</b> PCT/IT89/00064<br><b>(22) International Filing Date:</b> 3 October 1989 (03.10.89)<br><br><b>(30) Priority data:</b><br>22240 A/88                      7 October 1988 (07.10.88)                      IT<br><br><b>(71) Applicant (for all designated States except US):</b> A.T. AVANZATA TECNOLOGIA S.R.L. [IT/IT]; Via della Vittoria, 64, I-06065 Passignano sul Trasimeno (IT).<br><br><b>(72) Inventor; and</b><br><b>(75) Inventor/Applicant (for US only) :</b> GAGLIANO, Vitaliano [IT/IT]; Via della Rinascita, 17, I-06065 Passignano sul Trasimeno (IT).<br><br><b>(74) Agent:</b> DR. ING. A. RACHELI & C.; Viale San Michele del Carso, 4, I-20144 Milan (IT). |           | <b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.<br><br><b>Published</b><br><i>With international search report.</i><br><i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> |
| <b>(54) Title:</b> REDUCTION GEAR WITH HIGH REDUCTION RATIO<br><br><div style="text-align: center;"> </div><br><b>(57) Abstract</b><br><br><p>The object of the invention is a reduction gear comprising a worm screw driving shaft (3) engaging with a first portion (6a) shaped so as to obtain a gear wheel mating the driving means (3), at least one worm screw shaped second portion (6b), connected to said at least one first portion (6a) engaging with a rack (13b, 15b) integral with a gear wheel, which acts as a power take-off (30, 31). The gear wheel shaped first portion (6a) and the worm screw shaped second portion (6b) can be provided on the body of a pinion or spool (6).</p>                    |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

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"REDUCTION GEAR WITH HIGH REDUCTION RATIO"

The present invention relates to a mechanical reduction gear.

Mechanism are known which, when inserted between a driving shaft and a driven shaft, reduce the speed of the second with respect to that of the first at a fixed ratio (reduction ratio).

Reduction gears already known generally consist of gear wheels with different diameters. In reduction gears, usually the high-speed elements, that is the first drive elements are subjected to low stress, while the low-speed elements, that is the last drive elements, are subjected to high stress. In known reduction gears, in order to avoid the said high stress being borne by one gear only, the number of gears is increased, with a consequent increase in the dimension of the reduction gear. All the return forces are released on one first transmission element only, for example a worm screw.

The aim of the invention is to produce a reduction gear, with a sturdy structure which will allow high reduction ratios.

The above aim has been achieved by providing a reduction gear comprising a driving means, preferably a worm screw driving shaft engaging with at least a first portion, shaped so as to provide a gear wheel mating to the driving means, at least one worm screw shaped second portion, connected to said at least first portion, engaging with a rack integral with a gear wheel, which acts as a power take-off.

The first portion and the second portion can be connected by means of a clutch plate.

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Preferably the gear wheel shaped first portion mating with the driving means, suitable for engaging with the driving means, and the worm screw shaped second portion, suitable for engaging with the rack, are provided on the body of a spool or pinion. A spool may also be provided with a gear wheel shaped central portion and two worm screw shaped side portions.

The worm screw shaped side portions of the spool are tapered at the ends, having a spindle-shaped form, whose larger base is adjacent to the central portion.

Preferably the rack is provided on the inner surface of an element, which surrounds the unit consisting of the driving means and at least one spool

The element which surrounds the unit consisting of the driving means and at least one spool can be a cup-shaped element, with a rack-shaped cylindrical inner surface, while its closed base supports a small gear wheel acting as a power take-off.

In a different embodiment, the element surrounding the unit consisting of the driving means and said at least one spool is a ring, having an inner rack and an external gear wheel shape which acts as a peripheral power take-off.

A preferred embodiment of the reduction gear according to the invention foresees two spools, diametrically opposed with respect to the worm screw driving means, whose central portions engage with the driving means, while the two side portions of each spool engage with the rack.

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In the embodiment with two spools, the reduction gear according to the invention allows high reduction ratios without excessive loading of the mechanical drive parts. The problem of extension of action and reaction forces from fast motion to slow motion is, in fact, solved by increasing the mechanical parts in the passage from fast to slow motion, without any considerable increase in the dimension of the structure. The passage is from a driving means, for example a worm screw shaft, to two joined toothed portions, and the transmission to the rack finally takes place through four worm screw shaped portions.

The particular structure of the reduction gear according to the invention has the additional advantage of not allowing inversed stress on the mechanical parts.

The invention will now be more clearly explained with the aid of the enclosed drawings, in which:

figure 1 shows a perspective view of a first reduction gear;

figure 2 shows an exploded perspective view of the reduction gear in figure 1;

figure 3 shows a section of the reduction unit in figure 1, along the line 3-3 in figure 1;

figure 4 shows an exploded perspective view of a second exemplary embodiment the reduction unit;

figure 5 shows a section of the reduction unit in figure 4, along the line 5-5 in figure 6;

figure 6 shows a section along the line 6-6 in figure 5;

figure 7 shows the shaping of a spool.

In the figures from 1 to 3, a geared motor is shown comprising a motor 1 which transmits the motion to a worm screw driving shaft 3.

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The worm screw driving shaft 3 engages with central portions 6a, which are shaped so as to obtain gear wheels mating with the worm screw consisting of the shaft 3, of two spools or pinions 6 positioned diametrically opposed with respect to the said shaft 3. The spools 6, which are shown in greater detail in figure 7, have two worm screw shaped portions 6b, positioned laterally to the central portion 6a, which mesh with the cylindrical inner rack-shaped surface 13b of a cup element 13. As can be seen from the drawings, the lateral portions 6b of spools 6 are tapered toward the ends of the spool, allowing the mesh between the projections of the said portions 6b and the teeth of the rack 13b. The cup element 13 supports a gear wheel 30, which protrudes from a crankcase 14 and acts as a power take-off.

As is clearly seen, in the reduction gear described the rotation transmitted to the driving shaft 3 is transmitted to the counter-rotating spools 6, which, meshing with the rack 13b, rotate the cup element 13 and in consequence the gear wheel 30.

In the reduction gear described, the mechanical transmission or drive parts increase in the passage from fast motion to slow motion: the passage is from a worm screw shaft 3 to two joined portions 6a, and the transmission to the rack 13b finally takes place through four worm screw shaped portions 6b. From the point of view of the load, this solves the problem of the extension of the forces of action and of reaction, from fast motion to slow motion.

In the figures from 4 to 6 a second example of a reduction gear is shown, which differs from the one previously described, substantially in that the rack 13b is provided on the inner surface of a ring element 15, on the outer surface of which a toothed shaping 31 is

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provided, which acts as a power take-off.

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CLAIMS

1. A reduction gear comprising a worm screw driving shaft or at any rate a driving means, characterized in that the worm screw driving means (3) engages with at least one first portion (6a), shaped so as to provide a gear wheel mating with the driving means (3), at least one worm screw shaped second portion (6b), connected to said at least one first portion (6a) engaging with a rack (13b, 15b) integral with a gear wheel, which acts as a power take-off (30, 31).
2. A reduction gear according to claim 1, characterized in that the first gear wheel shaped portion (6a) mating with the driving means (3), suitable for engaging with the driving means (3), and the second worm screw shaped portion (6b), suitable for engaging with the rack (13b, 15b) are provided the body of a spool (6).
3. A reduction gear according to claim 2, characterized in that the spool (6) has a central first portion (6a) engaging with the driving means (3) and two side portions (6b) engaging with the rack (13b, 15b).
4. A reduction gear according to claim 3, characterized in that the side portions (6b) of the spool are tapered towards the ends of the spool (6).
5. A reduction gear according to claims 3 or 4, characterized in that it comprises two spools (6) positioned diametrically opposed with respect to the driving means (3).
6. A reduction gear according to any one of the claims from 2 to 5,

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characterized in that the rack (13b, 15b) is provided on the inner surface of an element (13, 15) which surrounds the unit consisting of the driving means (3) and said at least one spool (6).

7. A reduction gear according to claim 6, characterized in that the element which surrounds the unit consisting of the driving means (3) and of at least one spool (6) is a cup element (13), whose cylindrical inner surface is rack-shaped (13b), while the closed base supports a small gear wheel (30) which acts as a power take-off.

8. A reduction gear according to claim 6, characterized in that the element which surrounds the unit consisting of the driving motor (3) and of at least one spool (6) is a ring (15) with an inner rack (15b) and an external gear wheel shaping (31), which acts as a peripheral power take-off.

9. A reduction gear according to any one of the previous claims, characterized in that the driving means is a worm screw driving shaft (3).

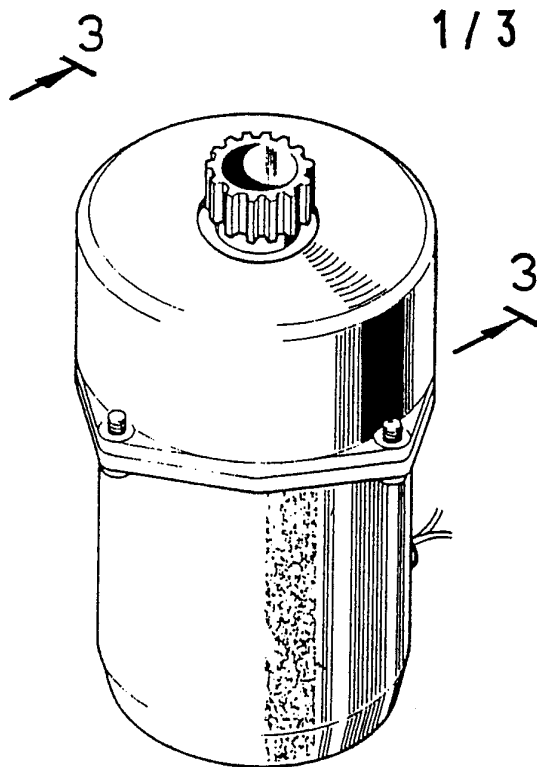


FIG. 1

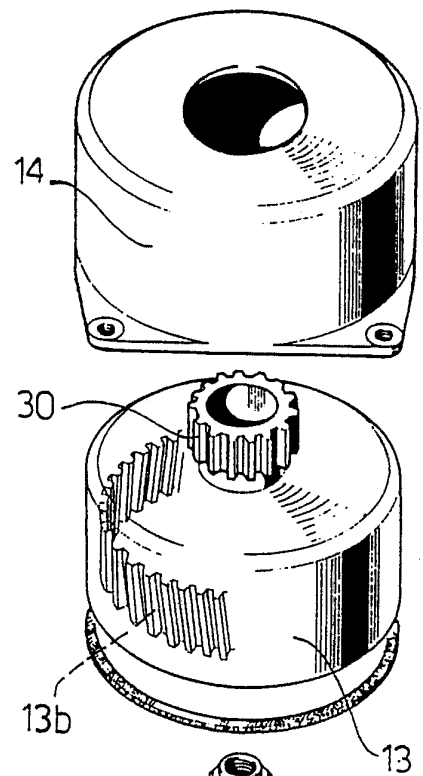
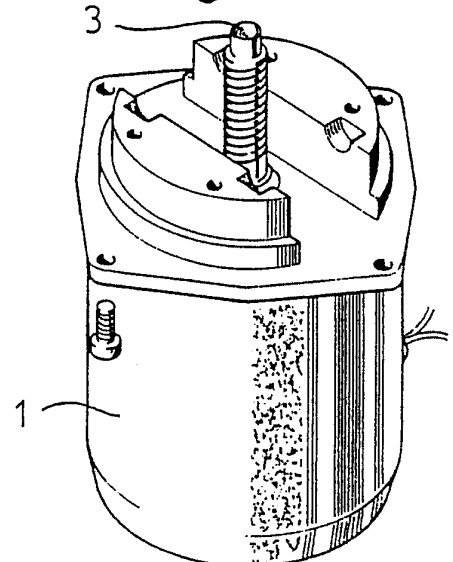
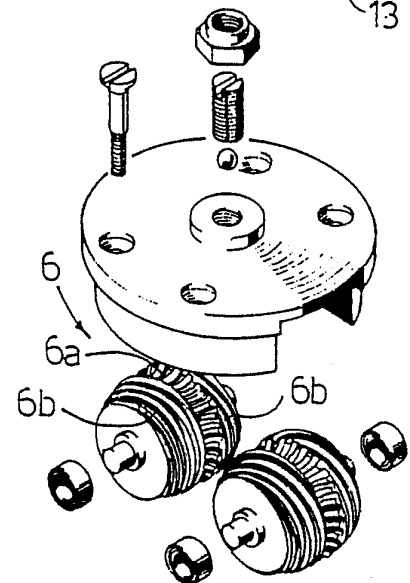
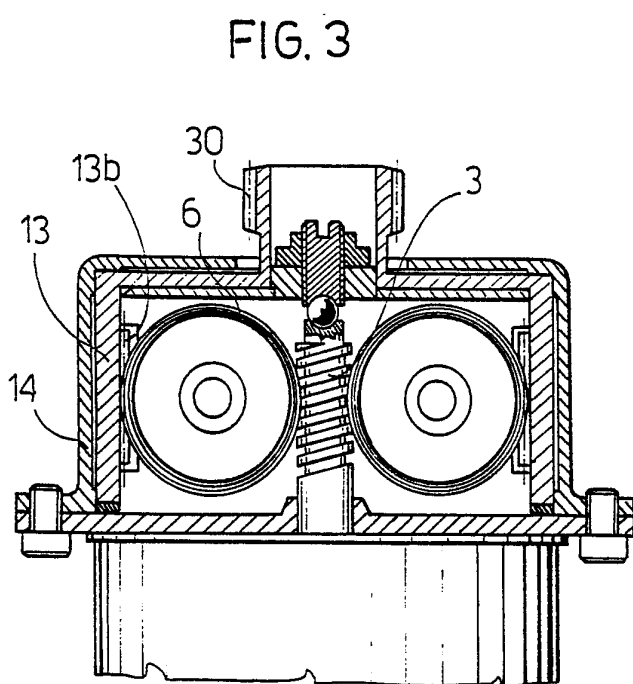


FIG. 2



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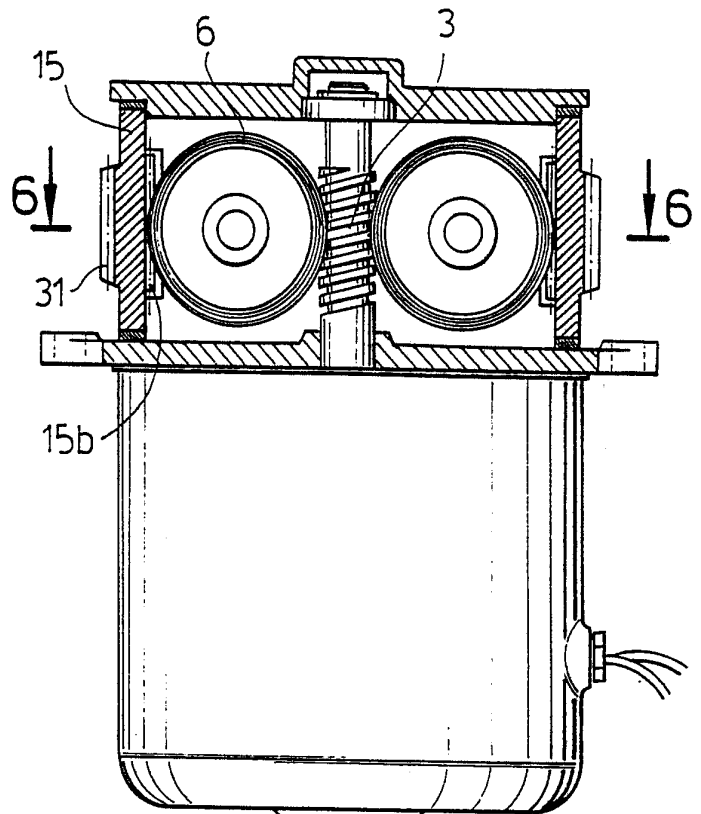
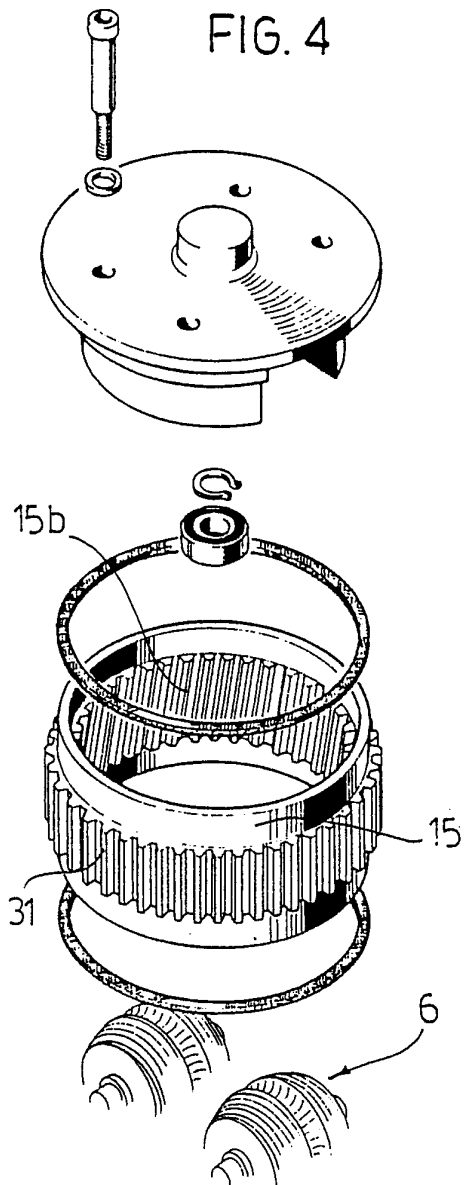
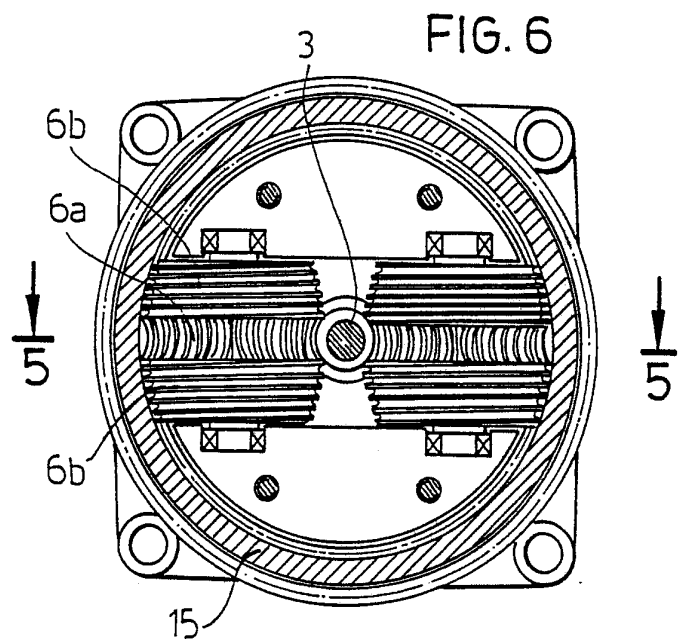


FIG. 5



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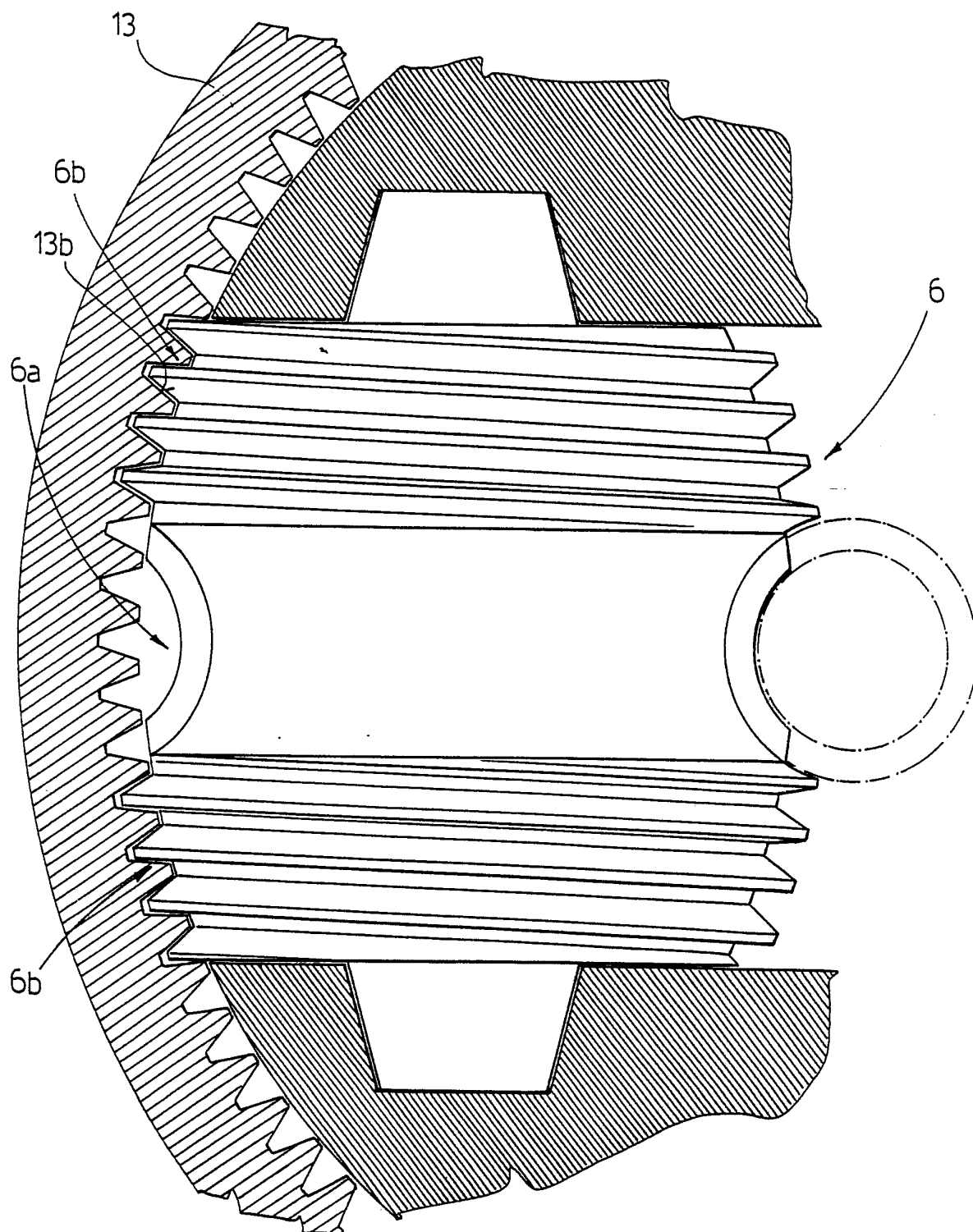


FIG. 7

# INTERNATIONAL SEARCH REPORT

International Application No PCT/IT 89/00064

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| <b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup><br>According to International Patent Classification (IPC) or to both National Classification and IPC<br>IPC <sup>5</sup> : F 16 H 1/16, F 16 H 1/20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                           |                                                                    |
| <b>II. FIELDS SEARCHED</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                           |                                                                    |
| Minimum Documentation Searched <sup>7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                           |                                                                    |
| Classification System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Classification Symbols                                                                                                    |                                                                    |
| IPC <sup>5</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | F 16 H                                                                                                                    |                                                                    |
| Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                           |                                                                    |
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| <b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>9</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                           |                                                                    |
| Category <sup>9</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>            | Relevant to Claim No. <sup>13</sup>                                |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | US, A, 4697476 (MAXWELL) 6 October 1987, see column 10, claims 1,2,4,6; column 9, lines 24-40; figures 1,2,5,16,16a<br>-- | 1-6,9                                                              |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | GB, A, 887835 (RENNIE) 24 January 1902, see the whole document<br>--                                                      | 1,2,6,9                                                            |
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| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | GB, A, 1180431 (HISASHI KABURAGI) 4 February 1970, see the whole document<br>--                                           | 1                                                                  |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | US, A, 3552225 (VAN VOORHIS) 5 January 1971, see the whole document<br><br>-----                                          | 1                                                                  |
| <div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><sup>10</sup> Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Z" document member of the same patent family</p> </div> </div> |                                                                                                                           |                                                                    |
| <b>IV. CERTIFICATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                           |                                                                    |
| Date of the Actual Completion of the International Search<br>27th December 1989                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                           | Date of Mailing of this International Search Report<br>05 FEB 1990 |
| International Searching Authority<br><br>EUROPEAN PATENT OFFICE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                           | Signature of Authorized Officer<br><br>G.D.v.d. Vliet              |

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
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SA 31604

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 29/01/90  
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| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| US-A- 4697476                             | 06-10-87            | None                       |                     |
| GB-A- 887835                              |                     | None                       |                     |
| US-E- 17704                               |                     | None                       |                     |
| GB-A- 1180431                             | 04-02-70            | None                       |                     |
| US-A- 3552225                             | 05-01-71            | None                       |                     |