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(12) # EUROPEAN PATENT APPLICATION

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(54) **Worm screw jack apparatus and method of making same.**

(57) A worm screw jack having a worm (2) meshing with a worm gear (4) that is drivingly connected to a lifting screw (9) is provided with an antibacklash device. The anti-backlash device comprises a sleeve (6) positioned axially along the lifting screw (9) from the worm geat (4), the sleeve (6) being secured to the worm gear (4) by a shoulder fromed on the worm gear (4) and a mating recess provided on the sleeve (6). The axial length of the sleeve (6) is preferably 8% less than the pitch of the lifting screw (9).

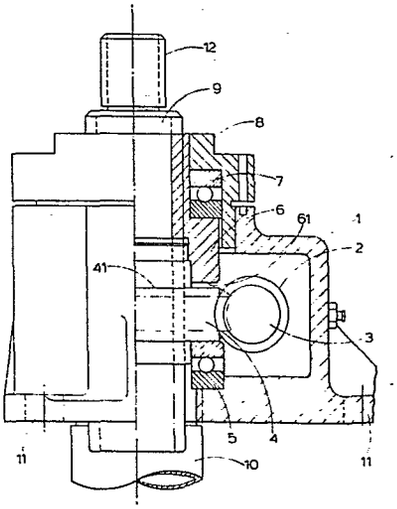

Fig.1

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WORM SCREW JACK APPARATUS & METHOD OF MAKING SAME

This invention relates to a worm screw jack.

Known worm screw jacks generally have a housing in which is provided a worm rotatively arranged to be driven by means outside the housing, the worm being connected to meshingly engage with a worm gear which is constrained against axial movement within the housing and which, in turn, meshingly engages with a lifting screw. In operation the lifting screw is normally secured to a load so that the lifting screw is unable to rotate and rotation of the worm causes rotation of the worm gear which, since it is constrained against axial movement raises the lifting screw and hence the load.

In use, with such screw jack, wear results between the meshing threads of the worm gear and the lifting screw so that backlash occurs when changing the mode of use from lifting to lowering of the lifting screw, or vice versa.

The present invention seeks to provide a worm screw jack in which backlash is substantially eliminated.

According to one aspect of this invention a worm screw jack includes a worm meshing with a worm gear which is drivingly connected to a lifting screw, and a sleeve positioned axially along the lifting screw from the worm gear, said sleeve being secured to the worm gear by a shoulder member and a mating recess arrangement so as to be rotatable therewith, wherein the shoulder member is elongate in a direction

transverse to the lifting screw axis.

Preferably, the shoulder member is formed on the worm gear and the mating recess is provided on the sleeve. The axial length of the sleeve is preferably less than the pitch of the lifting screw and conveniently is 8% less.

Conveniently, the shoulder member is a quadrilateral protrusion diametrically extending across the lifting screw axis formed by substantially parallel flat surfaces in the plane of the lifting screw axis with partially circular end faces, and the sleeve recess is arranged to mate with the quadrilateral protrusion.

Advantageously, a circularly cross-sectioned extension is provided on the shoulder member, having a smaller diameter than that of the partially circular end faces, which is arranged to be an interference fit inside a bore of the sleeve thereby assisting to maintain the worm gear and sleeve in axial alignment.

Preferably, the sleeve and worm gear and pre-determinably spaced in manufacture by a distance given by $\left[\frac{\text{screw pitch}}{\frac{2}{\text{safety factor}}}\right]$ safety factor X 0.5 where safety factor is 1.

According to a further aspect of this invention a method of making a screw jack having a worm meshing with a worm gear which is drivingly connected to a lifting screw and a sleeve positioned axially along the lifting screw from the worm gear, said sleeve being secured to the worm gear by a shoulder member and mating recess arrangement so as to be rotatable therewith includes the step of axially aligning the worm gear and sleeve a pre-determined distance apart and cutting an internal screw thread through the worm gear and sleeve combination.

In a preferred embodiment, the pre-determined distance is provided by a split spacer of thickness given by $\left[\frac{\frac{\text{screw pitch}}{2}}{\text{safety factor}}\right]$ safety factor X 0.5 which is secured between adjacent faces of the worm gear and sleeve.

Preferably, the method includes the further steps of mounting the assembly of worm gear, split spacer and the sleeve on the lifting screw, removing the split spacer, engaging the worm gear with the worm and loading the sleeve so that the internal threads of the sleeve and worm gear apply opposing axial forces on the lifting screw threads.

In use wear will inevitably result between the meshing threads of the sleeve/lifting screw and worm gear/lifting screw and advantageously the loading applied to the sleeve is increased to take up the wear and conveniently the loading is applied by screwing down a shell cap known per se.

The invention will now be described with reference to the accompanying drawings in which :-

Figure 1 shows a partly broken away view of a partially sectioned worm screw jack in accordance with this invention,

Figure 2 and Figure 3 are mutually orthogonal view of a worm gear used in the jack of Figure 1,

and Figures 4 and 5 are mutually orthogonal views of a sleeve used in the embodiment of Figure 1.

In the Figures like reference numerals denote like parts.

The worm screw jack shown in Figure 1 has a housing 1 in which is a worm 2 mounted on a shaft 3, the shaft 3 being supported within the housing 1 by bearings (not shown). The worm 2 engages concave external worm threads of a worm gear 4 which is rotatable upon a lower thrust bearing 5 comprising bearing elements caged in any suitable manner, the bearing being restrained within an annular recess in a base portion of the housing 1. The worm gear 4 is drivingly connected to a sleeve 6 which is mounted in an upper thrust bearing 7 which is similar to the lower thrust bearing 5 and is restrained within an annular recess in a shell cap 8, the shell

cap 8 being threadably engaged within a top, neck portion, of the housing 1. Upon assembly at least there is a gap later defined herein between adjacent faces 41, 61 of the worm gear and sleeve respectively. Extending perpendicularly to the axes of the worm 2 and worm gear 4 is a lifting screw 9, having a trapezoidal thread, which meshingly engages with an internal thread in both the worm gear 4 and sleeve 6. The lifting screw 9, at its upper end, as shown in Fig. 1, has a screw threaded portion 12 of smaller pitch circle diameter than the screw thread engaging with the lifting screw and worm gear which portion 12 is normally screwed and fixed to a plate member (not shown) for supporting a load. The housing additionally has an aperture in the base portion through which the lifting screw is able to move in a vertical direction and a tubular extension 10 of the housing (shown broken away). shield the lifting screw in its lowered position. Two mounting apertures 11 are provided in the base portion of the housing 1.

The worm gear 4 is shown in detail in Figures 2 and 3 and from these Figures it will be seen that the axially upper part of the worm gear has a shoulder 20 formed from a quadrilateral protrusion which extends diametrically across the lifting screw axis, the quadrilateral being shaped by substantially parallel flat surfaces 21 in the plane of the lifting screw axis and with partially circular end faces 22. The axial length of the shoulder 20 is arranged to be less than the pitch of the lifting screw and is preferably 8% less. A circularly cross-sectioned extension 23 is provided on the shoulder 20 having a smaller diameter than that of the partially circular end faces 22.

The detail of the sleeve 6 is shown in Figures 4 and 5 and this sleeve, which is made from phosphor bronze, has a stepped outside circular cross-section dimensioned so that the upper thrust bearing is fitted around the upper, smaller diameter of the sleeve and abuts the step in

the sleeve. The sleeve has a coaxial recess 30 in the larger diameter portion which is of similar shape to the quadrilateral shoulder 20 of the worm gear and is arranged to be an interference fit with the shoulder 20. A bore 31, coaxial with the recess 30 is also provided in the sleeve and the bore 31 is an interference fit with the circularly cross-sectioned extension 23 of the worm gear, the purpose of the bore 31 and extension 23 being to assist the alignment of the worm gear 4 inside the sleeve 6.

In manufacture the worm gear and sleeve are made separately until the internal screw thread for mating with the lifting screw is provided. The worm gear and sleeve are then axially aligned and spaced apart by a split spacer having a thickness given by $\left[\frac{\text{screw pitch}}{\text{safety factor}}\right]$ safety factor X 0.5, where the safety factor is normally unity. The combination of worm gear, split spacer and sleeve are then machined with an internal screw thread which will mesh with the trapezoidal screw thread of the lifting screw 9. The machined combination is then assembled on the lifting screw, the split spacer is removed and the assembly together with the worm and shaft 2, 3 and the bearings 5, 7 is mounted in the housing and the shell cap 8 screwed into place. By screwing the shell cap into the housing a load is applied to the upper thrust bearing 7 which forces the sleeve downwardly against the screw threads of the lifting screw with the result that a corresponding upward force is applied by the internal screw threads of the worm gear 4 upon the lifting screw. Thus, the lifting screw threads have opposite forces applied by the sleeve 6 and worm gear 4 so that backlash is at least upon assembly, substantially eliminated.

When the desired amount of loading is provided by the shell cap holes 13 are drilled through the shell cap into the housing 1 and

these holes are then tapped to receive a grub screw for preventing relative movement between the shell cap 8 and housing 1.

In operation of the screw jack, the plate fixed to the threaded portion 12 is secured to a load and since the load does not rotate there is no rotational movement between the housing 1 and the lifting screw 9 and so rotation of the worm 2 causes rotation of the worm gear 4 and sleeve 6 combination thereby resulting in vertical drive to the lifting screw 9.

With use, wear will inevitably result between the meshing threads of the sleeve/lifting screw and worm gear/lifting screw and this is taken up by screwing down the shell cap 8 until there is no longer a gap between adjacent faces 41 and 61 of the worm gear and sleeve respectively; the initial distance between the faces 41 and 61 therefore determines the maximum permitted amount of wear with the threads of the lifting screw 9.

The quadrilaterally shaped protrusion on the shoulder of the worm gear 4 and mating recess in the sleeve 6 has the advantage that a substantial driving area of contact is provided. Furthermore, by machining the internal trapezoidal screw thread on the worm gear 4 and sleeve 6 with these two members combined together it is ensured that the angular relationship between these members is maintained and that the only manner by which backlash may be taken up is by screwing down the shell cap 8, it being remembered that the length of the shoulder 20 is preferably less than the screw pitch. Thus the present invention has the great safety advantage in that the maximum amount of wear permitted with the screw threads of the lifting screw which may be eliminated is governed by the initial distance between the faces 41, 61, i.e. 0.25 screw pitch.

CLAIMS

1. A worm screw jack including a worm (2) meshing with a worm gear (4) which is drivingly connected to a lifting screw (9), characterised by a sleeve (6) positioned axially along the lifting screw from the worm gear, the sleeve being secured to the worm gear (4) by a shoulder member (20) and a mating recess (30) arrangement so as to be rotatable therewith, the shoulder member (20) being elongate in a direction transverse to the lifting screw axis.

2. A worm screw jack according to Claim 1 characterised in that the shoulder member (20) is formed on the worm gear (4) and the mating recess (30) is provided on the sleeve (6).

3. A worm screw jack according to claim 1 or 2 characterised in that the axial length of the sleeve (6) is less than the pitch of the lifting screw.

4. A worm screw jack according to claim 3 characterised in that the axial length of the sleeve is 8% less than the pitch of the lifting screw.

5. A worm screw jack according to any of claims 2 to 4 characterised in that the shoulder member (20) is a quadrilaterial protrusion diametrically extending across the lifting screw axis formed by substantially parallel flat surfaces (21) in the plane of the lifting screw axis with partially circular end faces (22), and the sleeve recess (30) is arranged to mate with the quadrilaterial protrusion.

6. A worm screw jack according to claim 5 characterised in that a circularly cross-sectioned extension (23) is provided on the shoulder member (20), having a smaller diameter than that of the partially circular end faces (22), which is arranged to be an interference fit inside a bore (31) of the sleeve thereby assisting to maintain the worm gear and sleeve in axial alignment.

7. A worm screw jack according to any preceding claim characterised in that the sleeve and worm gear and pre-determinably spaced in manufacture by a distance given by $\frac{\text{screw pitch}}{2}$ safety factor $\times$ 0.5 where safety factor is 1.

8. A method of making a screw jack having a worm (2) meshing with a worm gear (4) which is drivingly connected to a lifting screw (9) is characterised by a sleeve (6) being positioned axially along the lifting screw (9) from the worm gear (4), the sleeve being secured to the worm gear (4) by a shoulder member (20) and mating recess (30) arrangement so as to be rotatable therewith, said method including the step of axially aligning the worm gear (4) and sleeve (6) a pre-determined distance apart and cutting an internal screw thread through the worm gear and sleeve combination.

9. A method according to claim 8 characterised in that the pre-determined disance is provided by a split spacer of thickness given by $\frac{\frac{\text{screw pitch}}{2}}{\text{safety factor}}$ safety factor X 0.5 which is secured between adjacent faces of the worm gear and sleeve.

10. A method according to claims 8 or 9 characterised by the further steps of mounting the assembly of worm gear, split spacer and the sleeve on the lifting screw, removing the split spacer, engaging the worm gear with the worm and loading the sleeve so that the internal threads of the sleeve and worm gear apply opposing axial forces on the lifting screw threads.

11. A method according to any of claims 8 to 10 characterised in that the loading applied to the sleeve is increased to take up the wear.

12. A method according to claim 11 characterised in that the loading is applied by screwing down a shell cap (8) known per se.

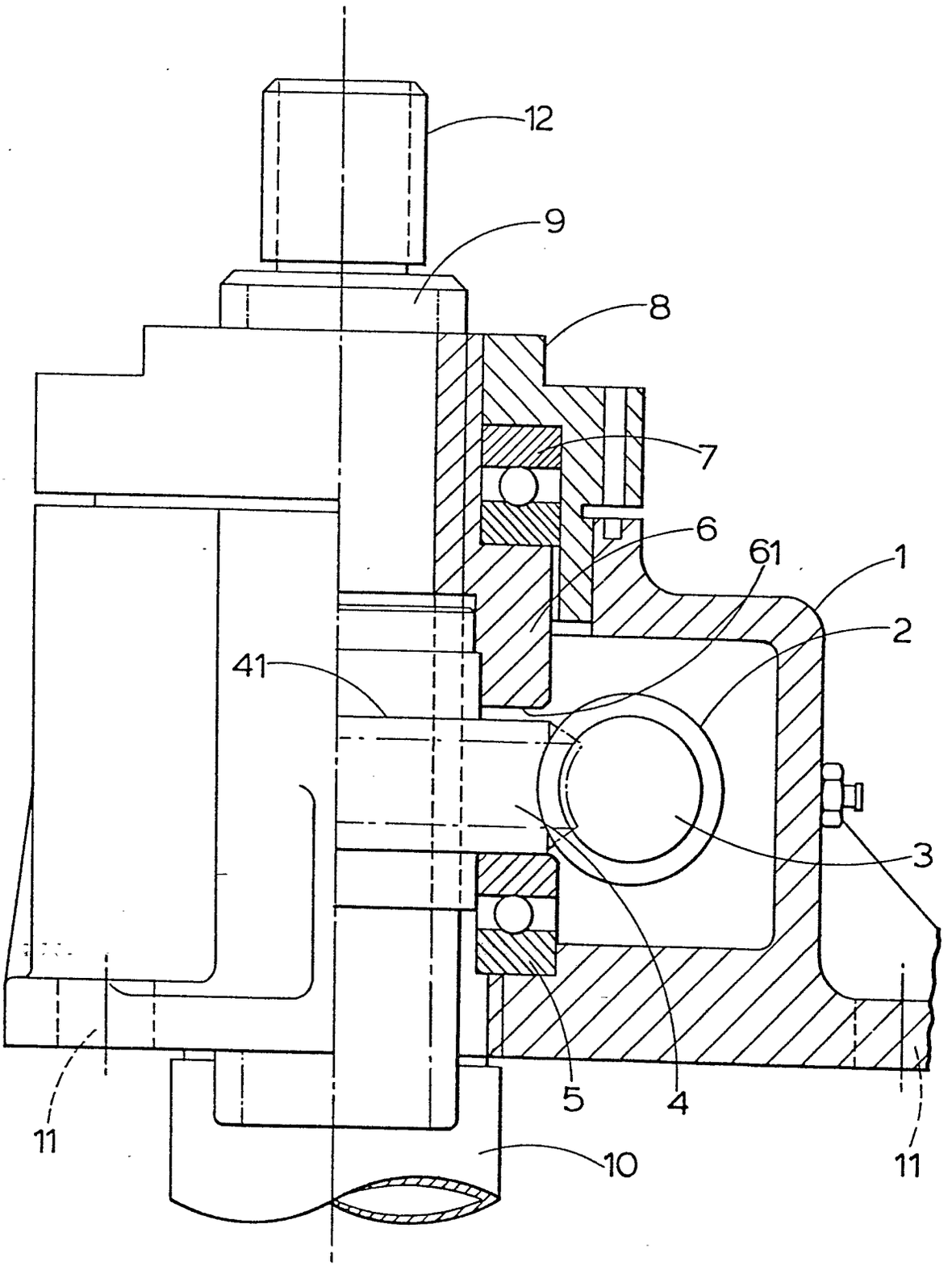

Fig.1

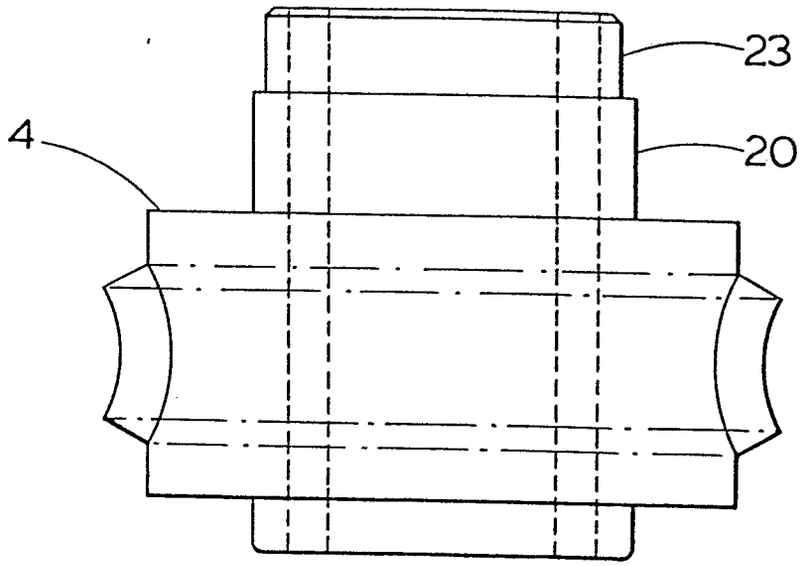

Fig. 2

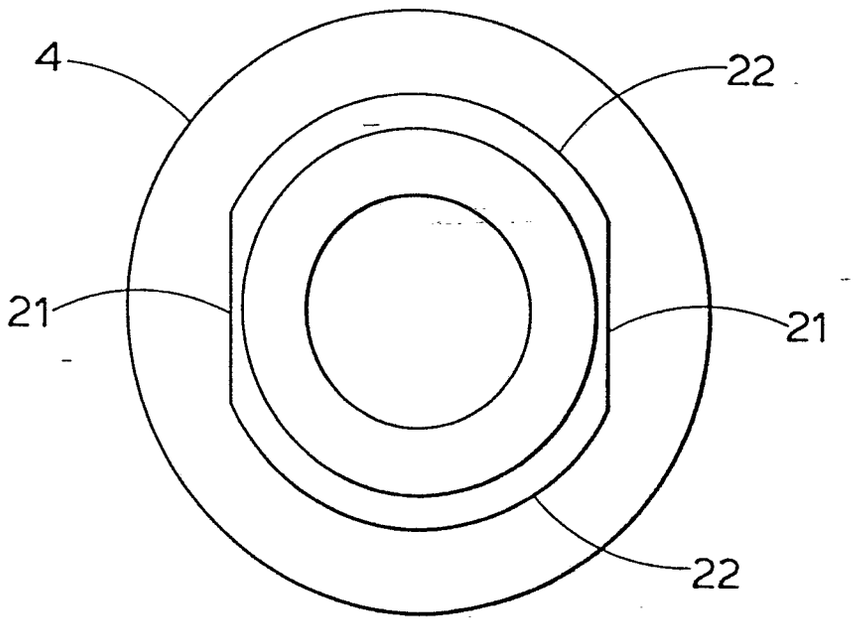

Fig. 3

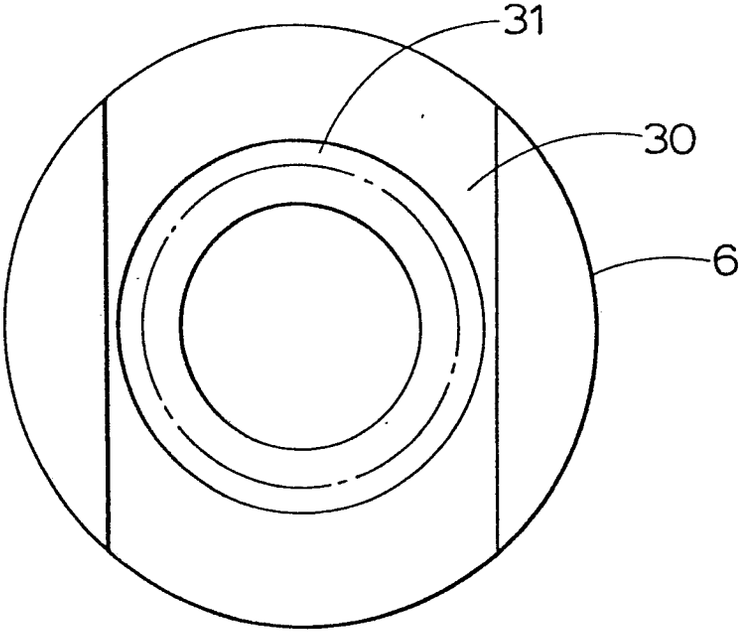

Fig.4

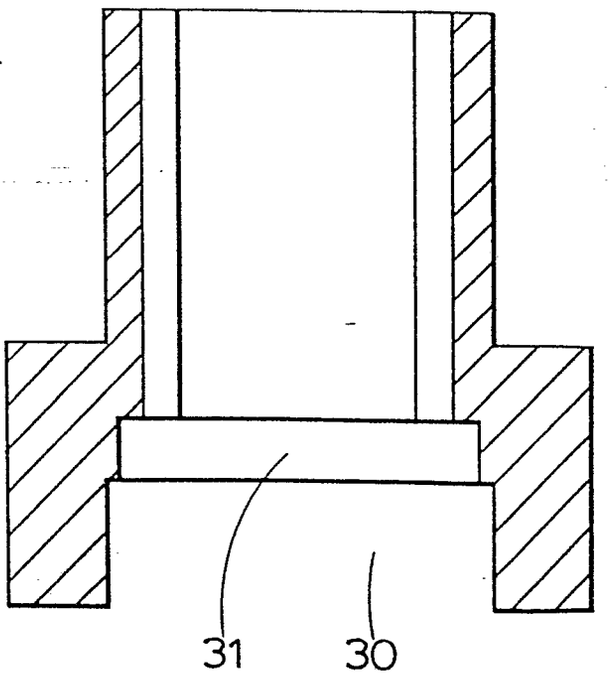

Fig.5

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EUROPEAN SEARCH REPORT

Application number

EP 80 30 1809.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	DE - B - 1 258 573 (DUFF-NORTON CO.) * claims 1 to 4; fig. 3 *	1,6
X	GB - A - 1 291 260 (SHACKLETON ENGINEERING) * claim 1; fig. *	1,6
X	GB - A - 1 345 136 (PHILADELPHIA GEAR) * claims 1, 5; fig. 1 *	1,2
	GB - A - 956 958 (JOYCE-CRIDLAND CO.) * claim 1; fig. 2 *	1
	US - A - 3 176 963 (R.M. STURM) * fig. 2 to 4 *	1
A	DE - C - 38 503 (A. BROSIG) * claim; fig. 1 *	1
A	DE - C - 341 834 (K. URBAHN) * claims 1 to 3; fig. *	1
A	DE - C - 956 804 (A. SCHRÖDER) * fig. 1 *	1
A	DE - B - 1 550 657 (R. BLOHM) * claim 1; fig. *	1

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CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

B 66 F 3/18

TECHNICAL FIELDS SEARCHED (Int.Cl.³)

B 66 F 3/00
B 66 F 7/00
F 16 H 25/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

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X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	05-09-1980	KANAL

EPO Form 1503.1 06.78

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EUROPEAN SEARCH REPORT

Application number

EP 80 30 1809.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	FR - A - 2 128 112 (S.A.T.A.M. STE ANONYME POUR TOUS APPAREILLAGES MECANIQUES) * fig. 2 *	1
A	US - A - 2 919 596 (G. KUEHL) * claim 1; fig. 1 to 3 *	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

TECHNICAL FIELDS SEARCHED (Int. Cl.³)