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(71) Applicant: **Lift Tek Elecar S.r.l.**
29015 Castelsangiovanni (PC) (IT)

(72) Inventors:
- **Mondani, Luciano**
  29100 Piacenza PC (IT)
- **Colombi, Diego**
  29100 Piacenza PC (IT)

(74) Representative: **La Ciura, Salvatore**
Via Francesco Sforza, 3
20122 Milano (IT)

(54) **Sealed hydraulic lifting cylinder with internal oil recovery**

(57) This invention relates to a lifting cylinder of the sealed type, characterised in that it includes means designed to collect and drain the oil that leaks from the pressurised chamber and collects in chamber (40) between the cylinder and the rod, and convey it to collection systems (11, 28) located inside the cylinder.

Moreover, the cylinder according to the invention has a braking system which acts on the last sector of the rod stroke; two different embodiments of the invention are presented in this respect: one with a retracted-rod braking system, and one with an extended-rod braking system.

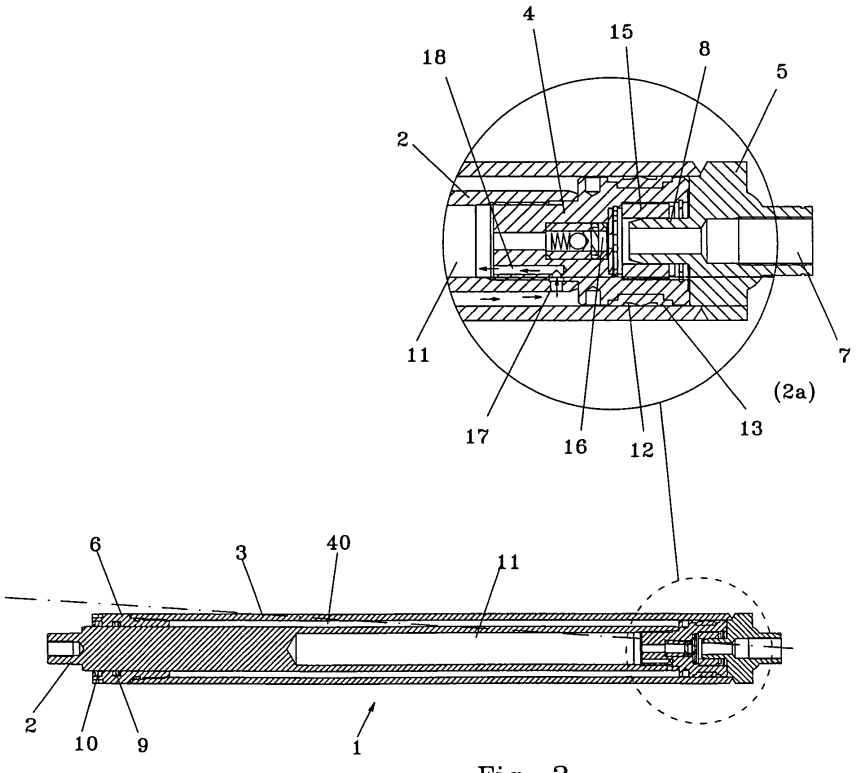

Fig. 2

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Description

[0001] This invention relates to a sealed hydraulic lifting cylinder with internal oil recovery, in particular a hydraulic lifting cylinder designed for the masts of fork-lift trucks.

[0002] Two main types of hydraulic lifting cylinder are normally used in these trucks: "immersion" cylinders and "sealed" cylinders. This invention relates to the second type.

[0003] In particular, this invention relates to a hydraulic lifting cylinder which possesses the advantages of both the above-mentioned solutions: it does not have an external drainage system, is smaller than the immersion type (thrust diameter being equal), and does not have a bleed screw.

[0004] Moreover, the cylinder according to the invention has a braking system which acts on the last sector of the rod stroke. Two different embodiments of the invention are presented in this respect: one with a retracted-rod braking system, and one with an extended-rod braking system.

[0005] As stated, hydraulic lifting cylinders are currently divided into two types: "immersion" cylinders and "sealed" cylinders.

[0006] The former have the seal on the rod only, and consequently do not present the problem of draining the oil that accumulates in the cylinder casing.

[0007] The main drawback of these cylinders is that during operation, oil permeates the entire cylinder chamber, thus creating a counterthrust effect which reduces the actual lifting force of the actuator.

[0008] Another drawback in terms of the cost/manufacture of this type of cylinder is the presence of a bleed screw, which is required to evacuate the air that accumulates at the top of the cylinder, between the rod and the casing.

[0009] The second ("sealed") type of cylinder has the seal on the piston at the base of the rod.

[0010] In this way, oil only remains in the rear chamber of the cylinder, and does not permeate the whole chamber as in the previous case.

[0011] A further advantage of the sealed system over the immersion system is that the counterthrust effect does not arise, so the entire operating area of the piston can be exploited, with the result that smaller devices can be made with the same thrust diameter.

[0012] The disadvantage of this type of cylinder is that with time, the small amount of oil that leaks from the piston seal accumulates in the chamber between the rod and the cylinder.

[0013] It is therefore necessary to instal a drainage system that conveys the excess oil to an external collection basin.

[0014] This makes the unit more complicated, and can also cause premature deterioration of the cylinder.

[0015] The drainage pipes that connect the chamber between the cylinder and the rod with the external environment allow a certain quantity of damp air to enter the cylinder, and with time, this can lead to rusting of the inner wall of the cylinder.

[0016] Another drawback is incorrect suction of returning oil through the drainage system.

[0017] To eliminate said problems, the present invention offers an improved hydraulic lifting cylinder of the sealed type, characterised in that it has no external oil drainage system, which is replaced by a different recovery system, and that the rod braking device operates in the last sector of the rod stroke, in both the extended and the retracted positions.

[0018] This invention will now be described in detail, by way of example but not of limitation, by reference to the annexed figures wherein:

- Figure 1 is a perspective view of a lifting cylinder with a retracted-rod braking system according to the invention;
- Figure 2 is a cross-section of a lifting cylinder with a retracted-rod braking system according to the invention;
- Figures 2a and 2b are enlarged details of figure 2, with the piston in different positions;
- Figure 3 is a perspective view of a lifting cylinder with an extended-rod braking system according to the invention;
- Figure 4 is a cross-section of a lifting cylinder with an extended-rod braking system according to the invention;

[0019] As shown in the annexed figures 1 and 2, the improved hydraulic lifting cylinder according to the invention comprises a cylinder assembly 1 and a rod 2 mounted on a piston 4 designed to run inside it.

[0020] Cylinder 1 comprises a cylindrical casing 3 closed at either end by a base 5 secured to the ends, and by a cap 6.

[0021] Base 5, which is secured to one end of the casing, is designed to allow the entry of oil into the cylinder through a duct 7 (in the axial position, as shown in the figure, or the radial position); the inner surface of said base has a projecting shank 8, also hollow, which places the oil inlet in communication with the rear chamber of the cylinder.

[0022] Cap 6 substantially consists of a hollow cylinder in which rod 2 slides; gaskets 9 and 10 are housed on the inner surface of said cap.

[0023] Rod 2 consists of a cylindrical rod characterised in that unlike the devices according to the prior art it is not completely solid, but axially perforated for a portion of its length.

[0024] Said perforation constitutes a cavity in the rod, shown in the figure as 11.

[0025] Rod 2 is mounted on a piston 4 which slides in the cylinder, allowing the extension and retraction of the rod.

[0026] The first section of said piston has an outer di-

ameter equal to the inner diameter of the cylinder, while the remainder has a smaller diameter.

[0027] A seating 12 in the first part houses a gasket 13 between the piston and the cylinder; the second part is externally threaded and screws onto rod 2.

[0028] The interior of the piston contains a duct 14 which has two sections of different diameters.

[0029] A bushing 15, whose inner diameter is slightly larger than the outer diameter of shank 8, is inserted in the first section, while the other section has a smaller diameter.

[0030] A one-way valve 16, fitted at the point where the diameter changes, allows the fluid to flow in one direction only.

[0031] The device operates as follows.

[0032] When the oil is pressurised it passes into duct 7 and begins to fill the rear chamber of the cylinder, pressing on the bottom of the piston, which slides away from the base as shown in figure 2b, thus allowing the rod to extend.

[0033] When the rod retracts, the piston compresses the oil, which starts to flow outwards, again through duct 7, from which it entered.

[0034] When the descending piston reaches the level of shank 8 (fig. 2b), an annular chamber full of oil remains between the cylinder and the outer wall of said shank.

[0035] In order to flow to the exterior, this remaining oil must necessarily pass between the inner surface of bushing 15 and the outer wall of shank 8, which is designed in such a way as to leave a small annular passage.

[0036] This reduction of the hydraulic cross-sectional area creates the damping effect which brakes the rod in the last portion of its stroke, thus preventing it from colliding violently with base 5.

[0037] As already mentioned, sealed cylinders present the problem that the small amount of oil which seeps from the gasket accumulates in the casing between the cylinder and the rod, and must be drained off.

[0038] This invention eliminates the problem of installing a drainage system by using the innovative system described below.

[0039] If a certain quantity of leaked oil is present in the annular chamber between the cylinder and the rod, when the rod begins to extend the volume of said chamber will be reduced, thus pressurising the oil in the chamber.

[0040] The pressurised oil is then forced to flow through a hole 17 in the wall of the rod, which faces a corresponding channel 18 in the piston.

[0041] Said channel allows the oil to flow from the chamber between the rod and the cylinder into cavity 11 in the rod.

[0042] When the leaked oil which has collected in cavity 11 reaches a certain amount, the inner pressure increases and, when it reaches a pre-set value, causes the opening of one-way valve 16, which discharges the oil through piston duct 14 and subsequently into duct 7, through which it is expelled from the cylinder.

[0043] A second embodiment of the invention, wherein the braking system operates on the extended rod, will now be described, by reference to figures 3 and 4.

[0044] As shown in said figures, the improved hydraulic lifting cylinder according to the invention comprises a cylinder assembly 19, a rod 20 and a piston 21.

[0045] Cylinder 19 consists of a cylindrical casing 22, closed at either end by a base 23 and a cap 24.

[0046] Base 23 (fig. 4a) which, as in the preceding embodiment, is secured to one end of the casing, contains a duct 25 through which oil enters the cylinder.

[0047] Cap 24 consists of a hollow cylinder inside which rod 20 slides.

[0048] Gaskets 26 and 27 are housed on the inner surface of said base.

[0049] Rod 20 consists of a cylindrical rod which is perforated for part of its length; said perforation forms a cavity inside the rod, shown as 28.

[0050] Piston 21 has a first section with an outer diameter equal to the inner diameter of the cylinder, which contains a seating 29 designed to house gasket 30; the second section, which has a smaller diameter, is screwed to rod 20.

[0051] A duct 31 formed in said piston leads on one side into rod cavity 28 and on the other side into the rear chamber of the cylinder.

[0052] A one-way valve 32, fitted on said duct, near the bottom, allows the fluid to flow in only one direction.

[0053] A tube 33, which acts as an extension for duct 31, is also fitted to duct 31 near the outlet towards rod cavity 28.

[0054] The device operates as follows.

[0055] During the extension of the rod, the piston begins to rise, compressing the oil which has leaked into the chamber between the cylinder and the rod.

[0056] Due to the presence of two ducts 34 formed on the wall of the rod, the oil can flow into cavity 28.

[0057] When the piston is in the upper part of the cylinder, the part of the rod in which ducts 34 are formed is inserted into cap 24, which obstructs said ducts. Thus the oil remaining in the annular chamber in the upper part of the cylinder is forced to flow through a hole 35, and then through a small duct 36 formed in the piston.

[0058] As in the preceding embodiment, the damping effect created by this hydraulic constriction brakes the ascent of the rod in the last sector of its stroke, preventing it from colliding with cap 24.

[0059] As in the preceding case, the leaked oil which has accumulated in cavity 28 is expelled through one-way valve 32, which opens when the pre-set pressure value is reached in the cavity.

[0060] The special feature of this solution is that in order for the braking system to operate satisfactorily, there must always be a minimum quantity of oil in the chamber between the cylinder and the rod.

[0061] For this purpose, tube 33 ensures that not all the oil in cavity 28 is expelled through the valve, and that a minimum quantity remains to guarantee the operation

of the braking system.

Claims

1. Lifting cylinder of the sealed type, **characterised in that** it includes means designed to collect and drain the oil that leaks from the pressurised chamber and collects in chamber (40) between the cylinder and the rod, and convey it to collection systems (11, 28) located inside the cylinder.

2. Sealed lifting cylinder as claimed in claim 1, **characterised in that** said collection means consist of a blind axial hole (11, 28) in the rod (2, 20).

3. Sealed lifting cylinder as claimed in claim 2, **characterised in that** piston (4) contains a channel (18) which, through a hole (17) in the wall of rod (2), places chamber (40) between the rod and the cylinder in communication with the cavity (11) in the rod.

4. Sealed lifting cylinder as claimed in claim 2, **characterised in that** piston (4) contains a duct (14) which places cavity (11) in communication with pressurised chamber (40) and that said duct (14) is fitted with a one-way valve (16) which allows oil to flow only from cavity (11) towards pressurised chamber (40).

5. Sealed lifting cylinder as claimed in claim 1, **characterised in that** it includes means designed to brake the rod in the last portion of its retraction stroke.

6. Sealed lifting cylinder as claimed in claim 5, **characterised in that** base (5) presents a shank (8) projecting into the cylinder; when piston (4) is at the end of its stroke, said shank is inserted with a degree of play into the section of channel (14) with the largest diameter, so that the passage of oil into said channel causes a damping effect that brakes the rod stroke.

7. Sealed lifting cylinder as claimed in claim 2, **characterised in that** one or more passages (34) formed in the wall of rod (20) place chamber (40) between the rod and the cylinder in communication with cavity (28) in rod (20), and that said passages have a position on the rod such that when the rod is in the position of maximum extension, said passages are obstructed by the inner surface of cap (24).

8. Sealed lifting cylinder as claimed in claim 7, **characterised in that** piston (21) contains a duct (31) which places rod cavity (28) in communication with pressurised chamber (40) and that said duct (31) is fitted with a one-way valve (32) which allows oil to flow only from cavity (28) towards pressurised chamber (40).

9. Sealed lifting cylinder as claimed in claim 8, **characterised in that** it includes means designed to brake the rod in the last portion of its retraction stroke, said means being constituted by a hole (35) in the wall of rod (20) and a duct (36) formed in piston (21), which place chamber (40) between the rod and the cylinder in communication with cavity (28) and, when oil flows into them, generate the damping effect that brakes the rod stroke.

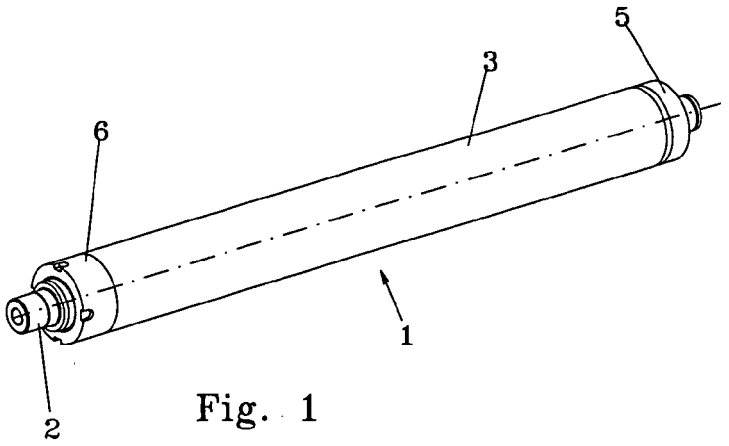

Fig. 1

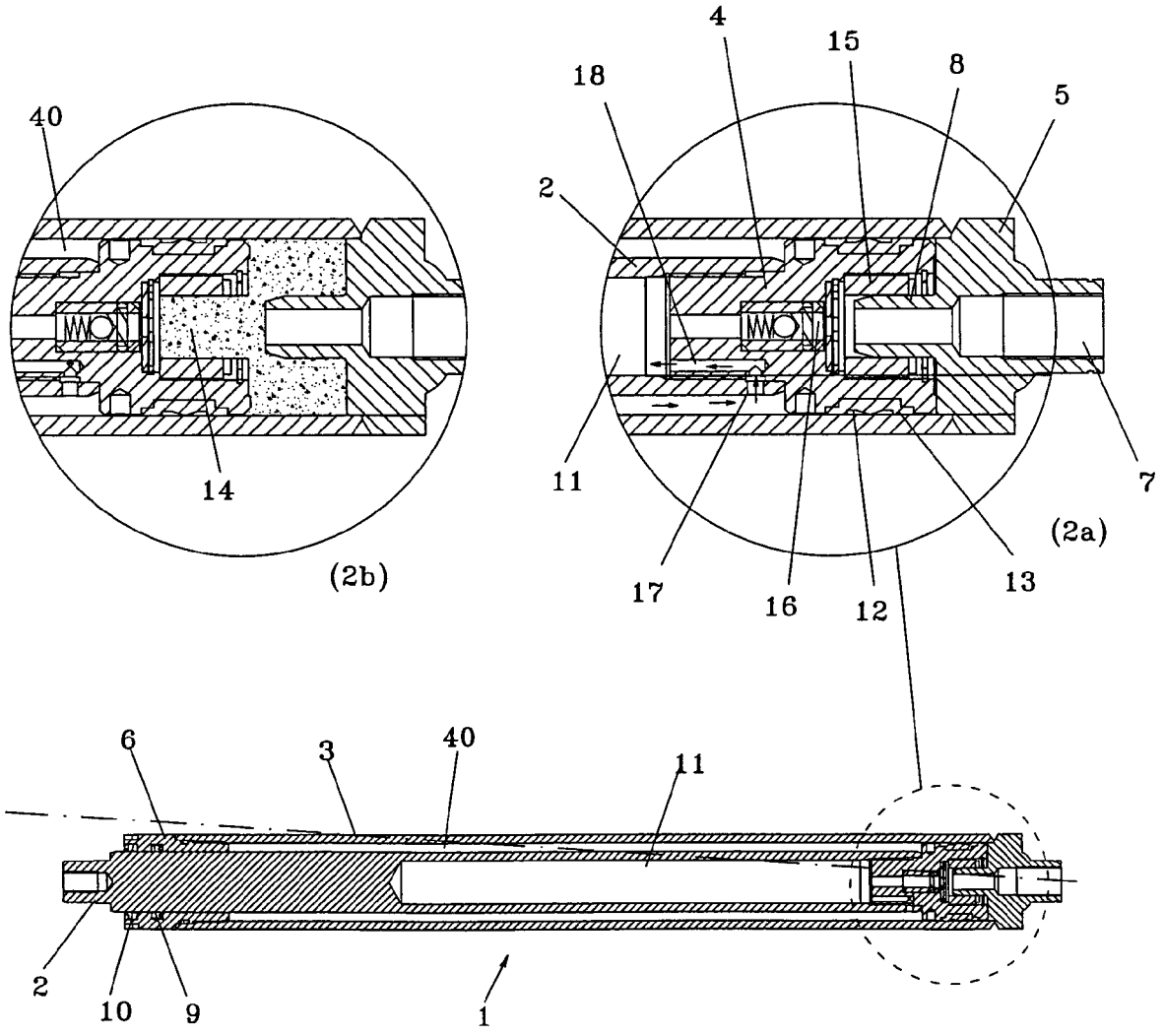

Fig. 2

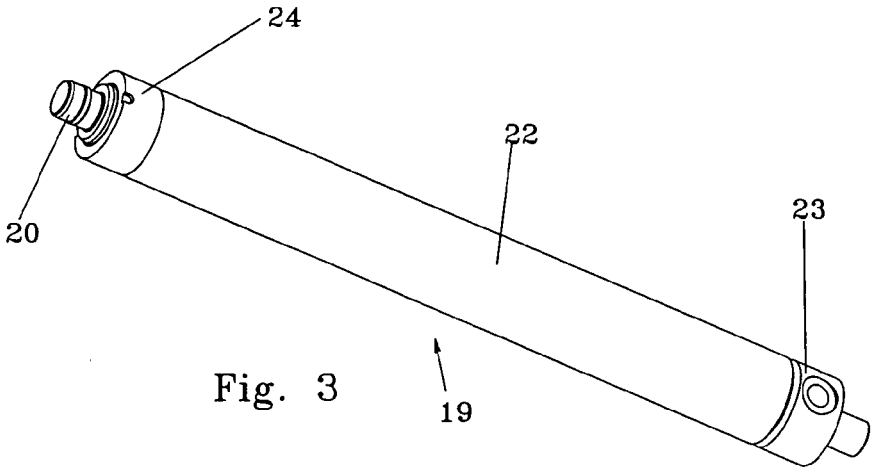
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Fig. 3

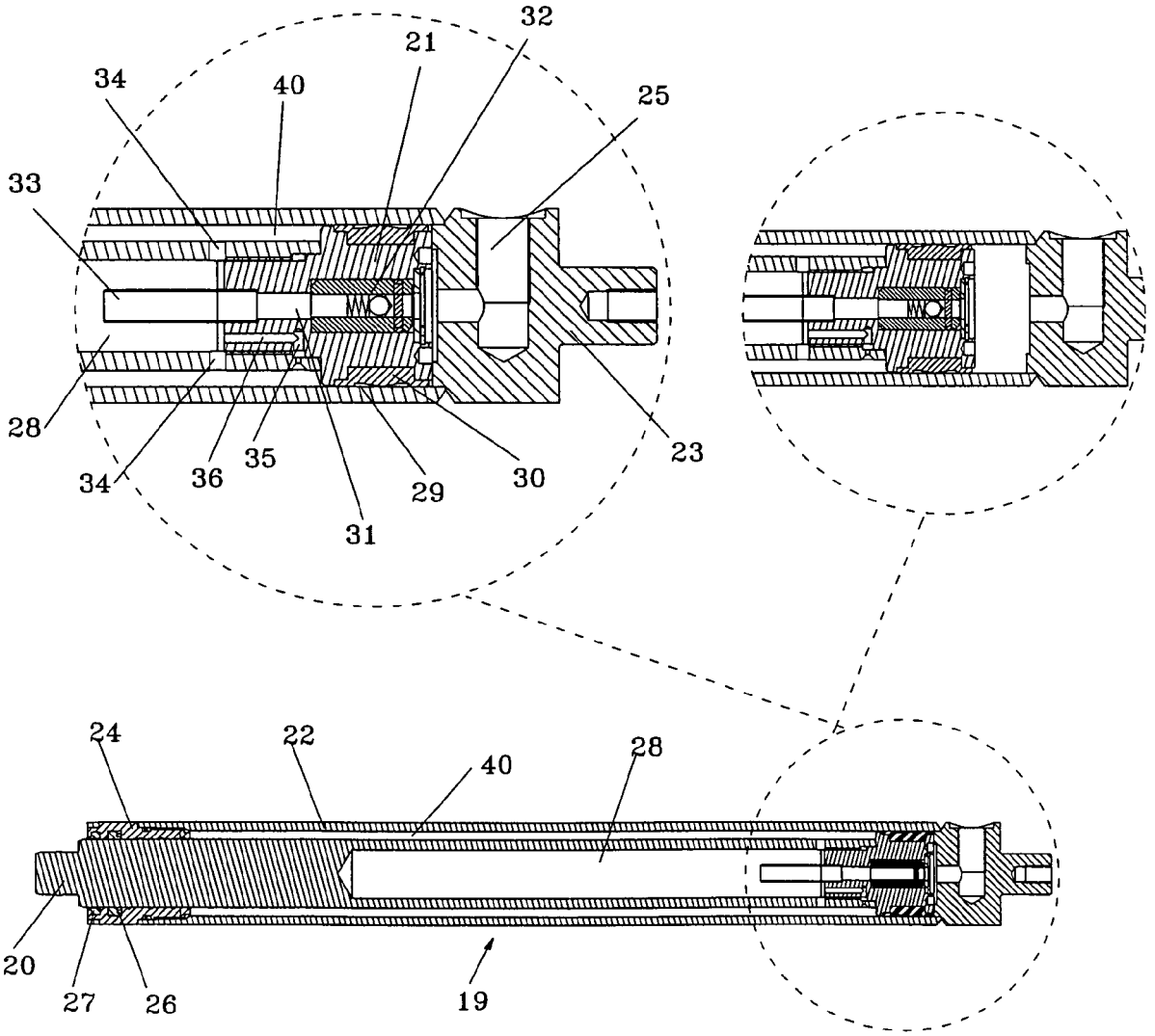
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Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 07 01 2567

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F16B
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 January 2008	Ferrien, Yann

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