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(54) Improvements relating to cylinders.

(57) A method of manufacturing a fluid cylinder comprises screw threading (20 and 18) opposite ends of a barrel (5), engaging a cylinder head (6) and a cylinder cap (2) with the screw threads (20, 18) of the barrel (6) and, after inserting a piston (7) and a piston rod (8), inserting a member (10, 11) in the open end of the barrel (5) to set the length of the stroke of the piston (7). Preferably said member is a gland (10) screwed into the cylinder head (6) and preceded by an axial spacer (11).

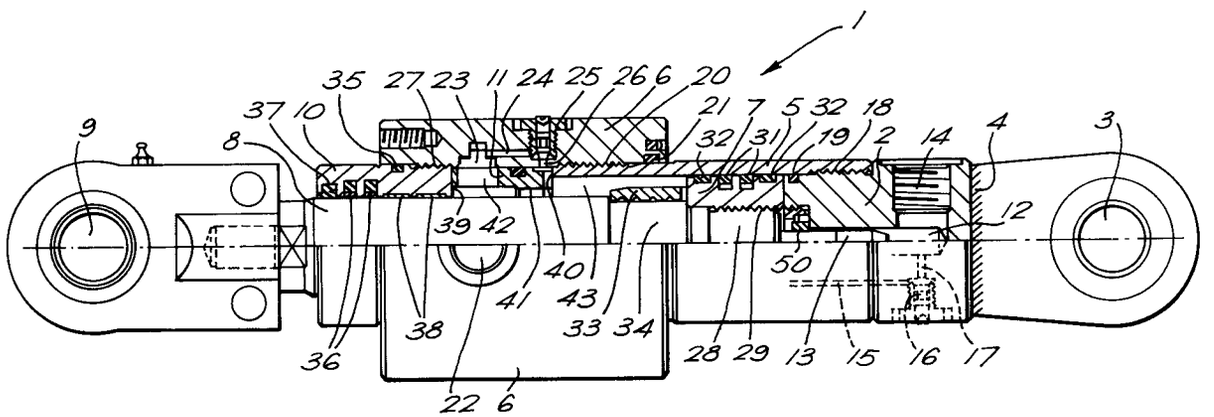

FIG.1.

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This invention concerns improvements relating to cylinders.

A pneumatic or hydraulic cylinder essentially comprises a piston, a piston rod, a cylinder cap, a cylinder head and a cylinder barrel between the cap and the head. Machining the cap, the head and the barrel in one piece from solid material is prohibitively expensive except in very special circumstances. The barrel is advantageously formed from stock tube and there are basically three different methods of securing it to the head and the cap. A first method is by welding, that is to say forming a peripheral weld to join a forged or cast and machined head to one end of the barrel and a forged or cast and machined cap to the other end of the barrel. Distortion is likely to be caused by the heat of the welding and once put together the components cannot thereafter be separated. This first method is only used for low precision applications. A second method comprises pulling the head and cap onto opposite ends of the barrel by means of four longitudinally extending tie rods which pass through apertures in the head and cap and cooperate with nuts. By selective angular positioning of the head and the cap prior to insertion of the tie rods, inlet and outlet ports in the head and the cap can be provided at a required alignment or 90° or 180° misalignment without such relative rotation of the head and cap affecting the stroke of the cylinder. Such a rod construction is not suitable for some applications. The third method comprises screw threading the ends of the barrel and screwing the cap and head thereto. This is increasingly popular since modern CNC machine tools can readily screwthread quite large diameter work pieces. There is the disadvantage however that with uncertainties regarding the start position of the screwthread on both the ends of the barrel and the cap and the head it is difficult precisely to set the stroke of the cylinder with the ports in the cap and the head in a determined alignment or misalignment and any change in alignment or misalignment of the ports in the head and the cap results in a change in length of stroke of the cylinder which may well be unacceptable.

According to the invention in a fluid cylinder a cylinder head and a cylinder cap are each joined by a respective screw thread to a cylinder barrel but the stroke length is set by a member inserted into a free end of the cylinder head whereby a relative twisting movement of the cylinder head and cylinder cap need not affect stroke length.

The cylinder head and cylinder cap can thus be preported, that is to say provided with ports prior to their engagement with the cylinder barrel, and can be screwed with respect to the cylinder barrel until the ports are at a desired alignment or degree of misalignment and at a desired spacing. The piston and piston rod can then be inserted in the cylinder and said member, preferably a gland screwed into the free end of the cylinder head, inserted to set by its inner end, or by the inner end of a spacer which precedes it, the precise length of stroke which can be effected by the piston.

All components of the hydraulic cylinder can thus be firmly locked with all internal faces pressed into contact, i.e. not spaced apart with gaps therebetween.

On larger bore cylinders, provision for cushioning at the head end can be provided in the spacer which precedes the gland rather than in the head. This can permit delicate machining operations necessary to form cushioning passages to be effected on small low cost relatively otherwise unmachined parts rather than as a final machining operation on large expensive components which require considerable previous machining, whereby if the cushioning machining goes wrong, only an inexpensive component is scrapped.

A cylinder formed according to this aspect of the invention can be relatively inexpensive to manufacture since the barrel, the cap, the gland and the spacer can all be formed from standard tube and require only relatively small amounts of machining.

Trunnions can be provided on the cylinder barrel by forming the trunnions on a split block which can be clamped around the cylinder barrel, forming annular projections on the bore of the clamp block, forming annular grooves in the wall of the cylinder barrel and engaging the annular projections in the annular grooves before tightening clamp means of the split block thereby to lock the split block axially on the cylinder barrel.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:-

Figure 1 is a half sectional elevation of one embodiment of a cylinder according to the invention;

Figure 2 shows a part of Figure 1 to a greater scale;

Figures 3 & 4 are details taken from Figure 1 and showing the relative positions of a cushioning collar and a piston rod respectively at the beginning of cushioning movement towards the end of an expansion stroke of the cylinder and at the beginning of a contraction stroke of the cylinder;

Figure 5 is a detail from Figure 1 to a greater scale showing a cap end cushioning arrangement;

Figure 6 is a detail taken from Figure 1 again to a greater scale showing an alternative seal arrangement for a gland;

Figure 7 is a fragmentary view of an alternative embodiment of cylinder according to the invention in which head end cushioning is effected through a spacer;

Figure 8 is an axial elevation of a trunnion block; and

Figure 9 is a sectional view taken along the line A-A of Figure 8 and showing the trunnion block cooperating with a cylinder barrel.

Referring to the drawings and firstly to Figure 1, a hydraulic cylinder 1 comprises a cylinder cap 2 with a mounting 3 welded thereto at a position 4, a cylinder barrel 5, a cylinder head 6, a piston 7, a piston rod 8 secured to a mounting 9, a gland 10 and an axial spacer 11.

The cylinder cap 2 can be formed from a length of bar stock, has a blind bore 12 therein to receive a cushioning spear 13 of the piston rod 8, has a main port 14 in communication with the bore 12 and a pilot bore 15 in communication with the bore 12 and thus the port 14 by way of an adjustable cushioning valve 16 and a radial port 17. On its outer face the cylinder cap 2 is screwthreaded at 18 so that it can be screwed into the end of the cylinder barrel 5 with the provision of an environmental seal 19.

The cylinder barrel 5 is formed of standard tube only the bore of which needs to be finished machined and at its other end to the screwthread 18 is provided with an external screwthread 20 by means of which it is screwed into the cylinder head 6 with provision of an environmental seal 21.

The cylinder head 6 has a main port 22 which as shown is offset 90° from the port 14 of the cylinder cap 2, the port 22 being connected to a circumferential gallery 23 in the head 6 and the head 6 including a pilot bore 24, an adjustable cushioning valve 25 and a radial bore 26. At its free outer end the cylinder head 6 is internally screwthreaded at 27.

The piston 7 is an annular piston screwed onto a portion 28 of the piston rod 8 by a screwthread 29 and including piston seals 31 and bearings 32. A cushioning sleeve 33 is received on a portion 34 of the piston rod 8 so as to be axially and radially moveable thereon.

The gland 10 is screwed into the cylinder head 6 by means of the screwthread 27 with the provision of an environmental seal 35 and is provided with sealing rings 36, seals 37 and bearings 38 which contact the outer face of the piston rod 8 and seal thereagainst. Between the inner end face 39 of the gland 10 and the cylinder head end 40 of the cylinder barrel 5 the axial spacer 11 is located. A radially inner face 41 of the spacer 11 cooperates with the radially outer face of the sleeve 33 to effect cushioning upon final movements of expansion of the cylinder 1 by closing off the communication between a radial bore 42 in the spacer 11, which radial bore 42 is in communication with the gallery 23, and a space 43 in the barrel 5 provided between the spacer 11 and the piston 7. Once such communication is closed off, fluid in the space 43 can only be ejected from the cylinder by way of a cutaway 44 formed by flats at the sides of the end of the spacer 11, the radial bore 26, the valve 25 and the bore 24, a sealing ring 45 being provided in the outer face of the spacer 11 to cooperate with the bore of the cylinder head 6.

One parameter of a fluid cylinder which is usually required to be accurately determined is the maximum stroke and this is the distance S indicated in Figure 2 and is the travel of the piston between the position at which it is hard up against the cylinder cap 2 to a position where it is hard up against the end face of the spacer 11 which abuts the end face 40 of the cylinder barrel 5 minus the piston width. If in a previously proposed fluid cylinder formed by screwing the components together, adjustment is made in the alignment of the ports, the cylinder head moves axially towards or away from the cylinder cap 2 and thus the length of the stroke of the piston is changed. In the cylinder of the invention and as shown in the drawings, the stroke length is unaffected by the angular position of the cylinder head 6 which can be rotated a whole turn if desired to obtain the required relative angular positions of the ports 14 and 22 without in any way affecting the stroke of the piston and thus of the cylinder. The stroke can be adjusted if required by rotating the cap 2 with respect to the barrel 5.

The spacer 11 need not be a separate component to the gland 10 ie it could be a forward projection thereof but it is more convenient for it to be a separate component.

The construction of the cylinder shown can have the advantage that without disturbing the relative axial or relatively rotated positions of the cap 2, barrel 5 and head 6 nor pipework connected to the ports 14 and 22, the piston rod 8 and the piston 7 can be removed from within the barrel 5 and head 6, for example to replace the seals 31 and bearings 32 on the piston, merely by unscrewing the gland 10 from the head 6 and sliding out the spacer 11.

Figures 3 and 4 show that the cushioning sleeve 33 at the head end is relatively axially movable on the portion 34 of the piston rod on which it is mounted so that when the piston rod is moving from right to left as indicated in Figure 3 and the cushioning sleeve 33 overlaps with the spacer 11, hydraulic pressure applied to the right-hand end of the sleeve 33 as indicated by arrows 46 will press the lefthand end (as viewed in Figures 3 and 4) of the sleeve 33 against a shoulder 8a of the piston rod 8 to form a seal so that the fluid can

only exit the space 43 through the cutaway 44, the radial bore 26, the cushioning valve 25 and the bore 24. However on compression movement from a fully expanded position as indicated in Figure 4, the force of the fluid applied through the port 22 acts on the cushioning sleeve 33 to move it rightwardly to open up a gap 47 between the shoulder 8a and lefthand end of the cushioning sleeve 33, such fluid then flowing through a spiral duct 48 formed by a spiral groove in the bore of the cushioning sleeve 33 to pass outwardly through a cutaway 49 at the righthand end of the sleeve so that the recompression of the cylinder 1 can be more rapidly effected than it would be if the compressing fluid had to pass solely through the cushion valve 25 and between the cushion sleeve 33 outside diameter and the cushion bore of the spacer 11. The cushioning sleeve 33 thus in conjunction with the piston 7 and the shoulder 8a acts as a check valve.

Similarly at the righthand end of the cylinder as shown in Figure 5, a cushioning ring 50 is engaged in a recess in the cap 2 and is axially movable by fluid pressure applied to its opposite sides so that a face 51 of the ring 50 cooperates with a face of the cap 2 to form a seal therewith after the spear 13 of the piston rod 8 enters the ring 5 so that there is effective cushioning but the face 51 moves away from the abutting face of the cap 2 to open up a space for rapid expansion of the cylinder when pressure is applied to the port 14. The ring 50 has vanes 52 at its radially outer part which are retained by a securing ring 53 screwed into the recess in the cap 2 in which the ring 50 is mounted so as to allow free flow of fluid past the ring 50 when it is not in its sealing position.

Figure 6 shows that the seals 36 on the gland 10 can be replaced by a chevron-type seal 54 and a cast iron bearing ring 55 if desired.

In the embodiment shown in Figure 7, the arrangement of piston, piston rod 8, cap 2, barrel 5, head 6 and gland 10 is the same as in Figures 1 and 2 except that the bore 24, cushioning valve 25 and radial bore 26 are omitted. A modified spacer 11a is provided which includes a longitudinal bore in two parts 56, 57 with an adjustable cushioning valve 58 between the portions 56 and 57. A circumferential seal 59 is provided additionally to the seal 45 and spaced therefrom with the valve 58 located between the seals 45 and 59 and also located in axial and circumferential alignment with a radial bore 60 in the head 6. Means (not shown) is provided to prevent relative rotation between the head 6 and the spacer 11a. By means of the bore 60 a tool, such as a Allen key 61, can be inserted to engage an adjusting screw of the valve 58 to adjust the size of an aperture therein and thus the rate at which fluid can flow therethrough. One advantage of providing the relatively small bore 56, 57 in two parts in the spacer 11a rather than the bores 24 and 26 in the head 6 is that a somewhat risky operation of drilling small bores, which operation may result in the component being drilled having to be scrapped can be effected in the small spacer 11a rather than the large head 6. Even if the spacer 11a has had its other machining effected before the boring of the bores 56, 57, it is still a relatively cheap component compared with the head 6 and thus the loss in scrapping it is considerably less than that involved in scrapping the head 6.

Figures 8 and 9 show a trunnion clamp 62. If a trunnion mounting is required for the cylinder 1 then instead of welding the mounting 3 thereto by the weld 4, the trunnion clamp 62 can be provided comprising two halves 62a and 62b boltable together with a joint line 63 by bolts 64 and having trunnions 65 thereon. The cylinder barrel 5 is machined on its outer surface to form at least one circumferential groove 66 therein and a bore 67 of the trunnion clap 62 is formed with a matching number of projections extending circumferentially therearound and to engage in the at least one groove 66. Once the projection or projections are engaged in the groove or grooves, the bolts 64 can be tightened to clamp the trunnion clamp around the barrel 5 and mount the trunnions at an accurately determined axial position on the cylinder with only a very small reduction in wall thickness of the barrel 5 and virtually no reduction in strength due to the banding of the trunnion clamp 62 therearound.

Claims

1. A method of manufacturing a fluid cylinder (1) comprising joining a cylinder head (6) and a cylinder cap (2) by respective screw threads (18,20) to a cylinder barrel (5) and setting the stroke length (S) by inserting a member (10) into a free end of the cylinder head (6) such that relative twisting movement of the cylinder head (6) and the cylinder cap (2) need not affect stroke length (S).

2. A method according to claim 1, including preporting the cylinder head (6) and cylinder cap (2), prior to their engagement with the cylinder barrel (5), and screwing them with respect to the cylinder barrel (5) until the ports are at a desired alignment or degree of misalignment and at a desired spacing.

3. A method according to claim 2, including subsequently inserting a piston (7) and a piston rod (8) in the cylinder (1) and inserting said

member (10) to set the precise length of stroke (S) which can be effected by the piston (7).

4. A method according to any one of claims 1 to 3, in which said member is a gland (10) screwed into the free end of the cylinder head (6) and sets by its inner end (39) the length of stroke (S).

5. A method according to any one of claims 1 to 3, in which said member is a spacer (11) preceding a gland (10) screwed into the free end of the cylinder head (6).

6. A method according to any one of claims 1 to 5, in which all components (2,5,6,10,11) of the cylinder are firmly locked with all internal faces pressed into contact.

7. A method according to claim 5, including provision for cushioning (33,41,42,43) at the head end provided in the spacer (11) which precedes the gland (10).

8. A method according to claim 1, comprising providing trunnions (65) on the cylinder barrel (5) by forming the trunnions (65) on a split block (62a, 62b) which can be clamped around the cylinder barrel (5), forming an annular projection on the bore of the split block (62a,62b), forming an annular groove (66) in the wall of the cylinder barrel (5) and engaging the annular projection in the annular groove (66) before tightening clamp means (64) of the split block (62a,62b) thereby to lock the split block axially on the cylinder barrel (5).

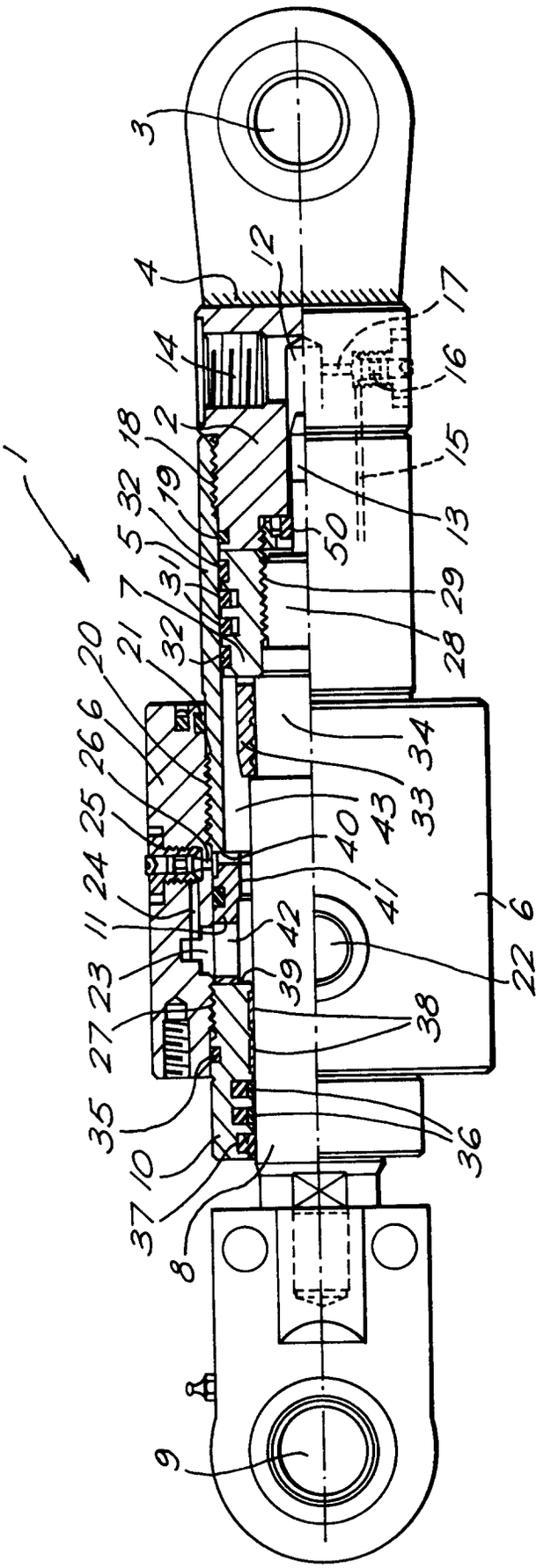
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FIG.1.

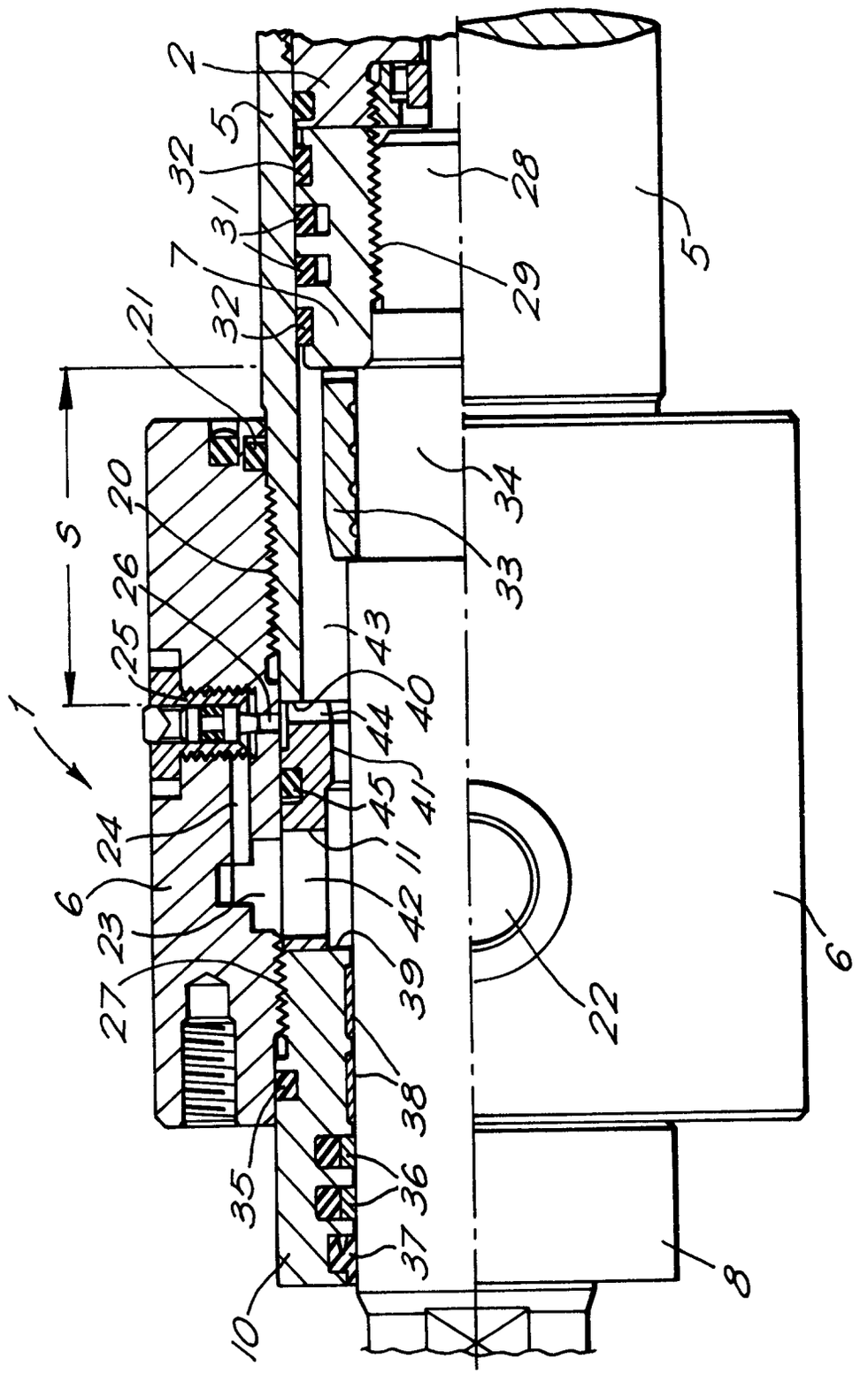
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FIG. 2.

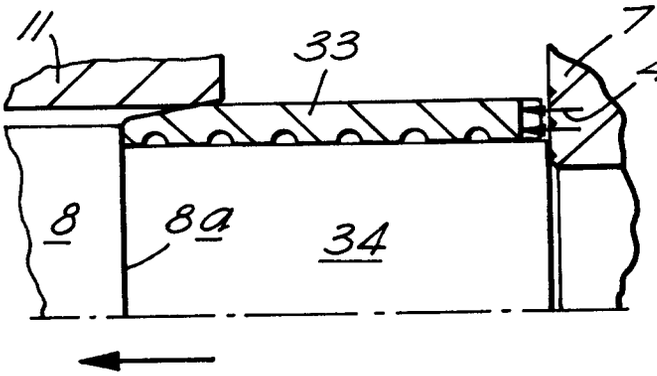


FIG.3.

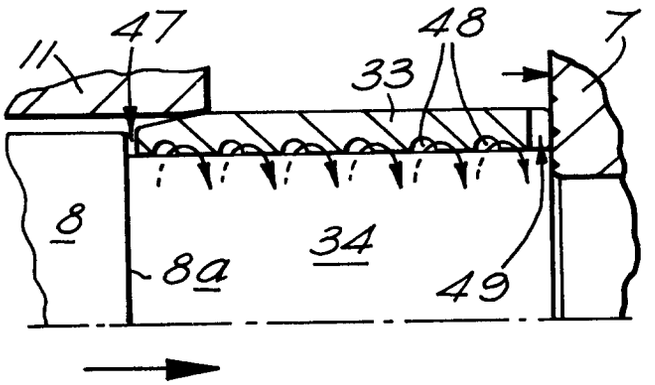


FIG.4.

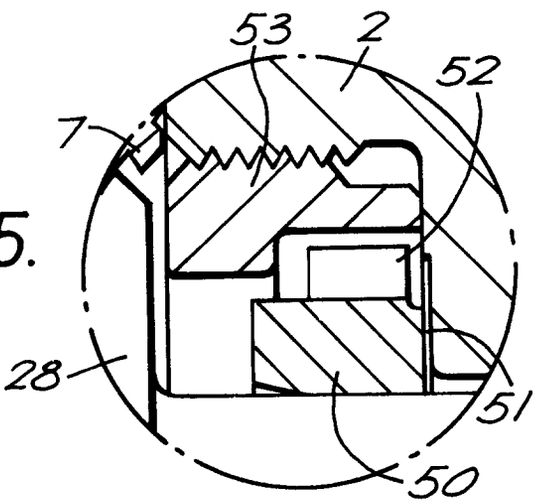


FIG.5.

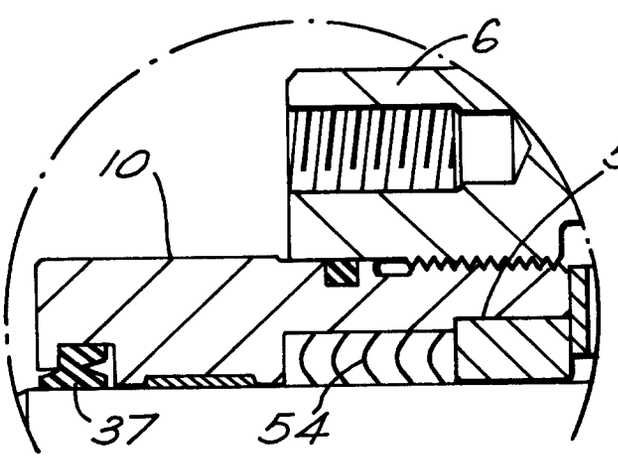


FIG.6.

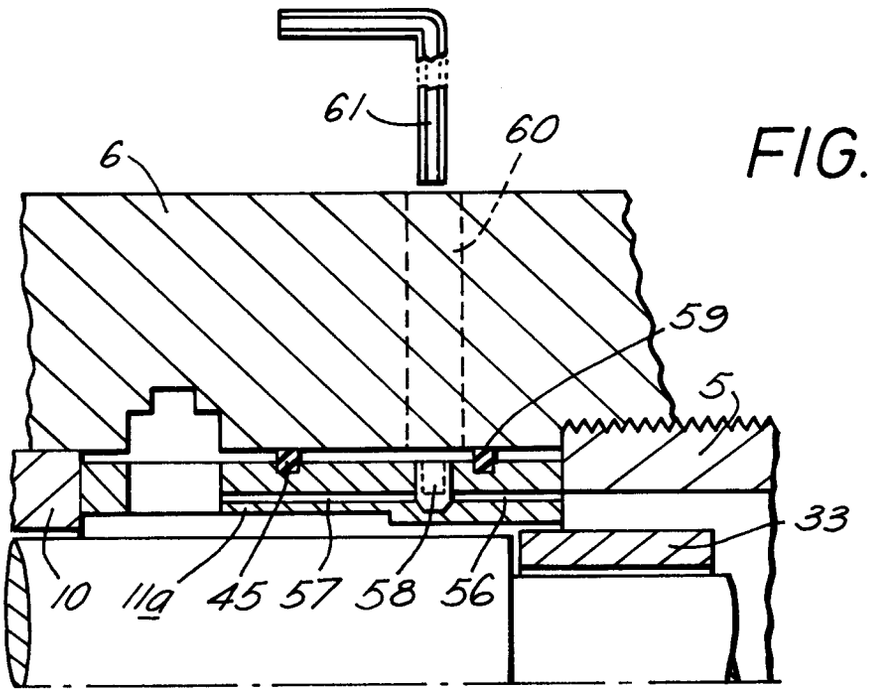
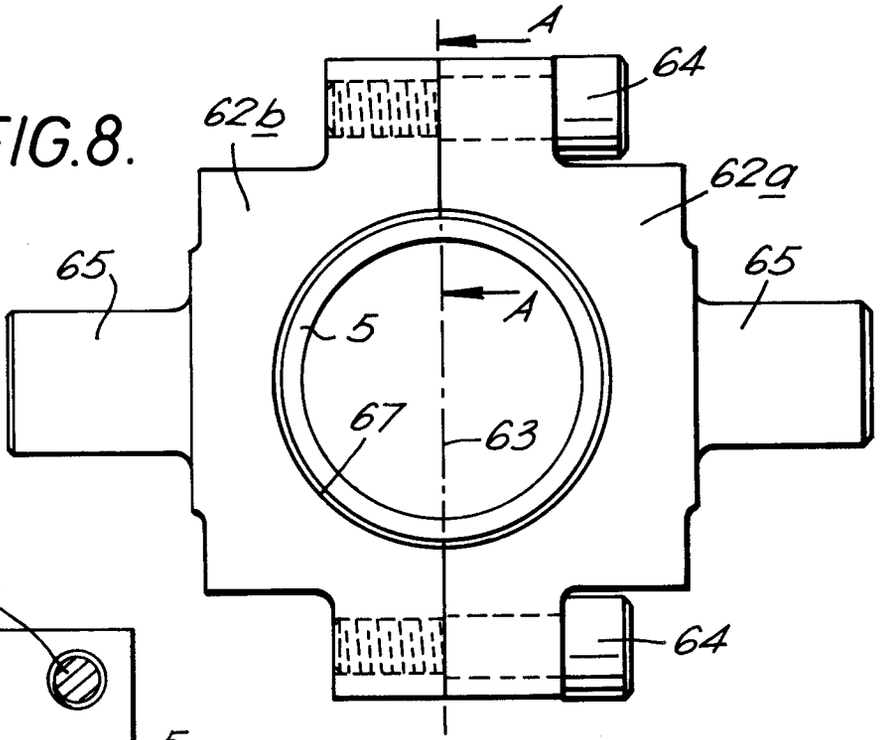


FIG.7.

FIG.8.



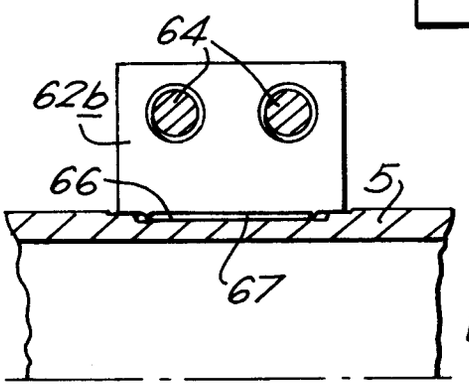


FIG.9.

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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 9366

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	EP-A-0 135 386 (HILLIER) * the whole document * ---	1-8	F15B15/14 F15B15/22
A	US-A-4 384 511 (MEFFERD) * the whole document * ---	1-8	
A	DE-A-25 57 307 (NEUMANN) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

F15B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 March 1994	Christensen, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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