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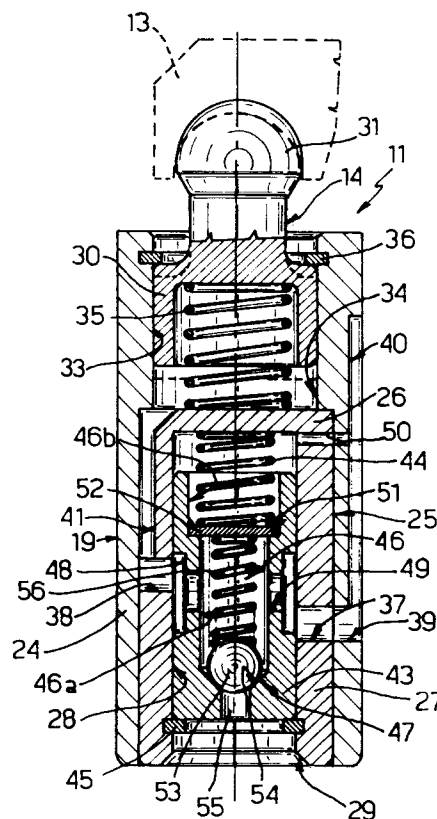
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A hydraulic actuating unit, in particular for controlling a valve of an internal-combustion engine.

A hydraulic actuating unit comprising a control member (11) formed by a first tubular member (19) defining a pair of cavities (38, 48) accommodating slidably respectively a second member (14) and a third member (43); the third member (43) incorporates a non-return valve communicating with a chamber (34), formed between the first member (19) and the second member (14), and with a supply duct (60) for hydraulic fluid, and is movable under the pressure of the hydraulic fluid and against the action of resilient means (44) from a rest position, in which it connects said chamber (34) with an outlet opening (37, 39) of the first member (19), into a second operating position in which said chamber (34) is isolated from the outlet opening (37, 39).

Fig.2



The present invention relates to a hydraulic actuating unit; advantageously, said unit can be used in a valve control assembly for an internal-combustion engine, in particular for the actuation of an auxiliary decompression valve.

Devices are known, normally termed "hydraulic tappets", which essentially comprise two members which are telescopically interconnected and which define a chamber connected with a supply of pressurised operating fluid through a non-return valve; the operating fluid, which is substantially incompressible, transmits the actuating forces from one member to the other. Any possible loosening between the two members, caused by an increase in play, is automatically compensated for by the admission of fresh fluid into said chamber through the non-return valve.

The aforementioned devices can transmit actuating forces between a driving member, for example a rocker arm of a valve control assembly, and a driven member for example, a valve stem, thus taking up the relevant play in the manner described above. These devices essentially behave like rigid elements and do not enable the transmission of actuating forces between the driving member and the driven member to be eliminated, in the event of this function being required; therefore, the known devices can be effectively used, for example, for controlling the inlet and exhaust valves of an engine, which have to be actuated in all operating conditions, but not for controlling an auxiliary decompression valve which has to be actuated only in particular operating conditions.

The object of the present invention is to devise a hydraulic actuating unit which does not have the drawbacks associated with the above-described known devices.

This object is achieved by the present invention in that it relates to a hydraulic actuating unit of the type comprising:

- a first member and a second member which are telescopically interconnected and which define a chamber adapted to contain a hydraulic fluid; and
 - a non-return valve communicating with said chamber and adapted to be connected with a supply duct for said hydraulic fluid so as to allow said fluid to flow towards said chamber but to prevent it from flowing back towards said supply duct;
- characterised by comprising a third member telescopically connected to said first member and provided with hydraulic connecting means, said first member defining an outer casing in which are accommodated said second member and said third member and being provided with an outlet opening, said third member being movable under the pressure

of said hydraulic fluid and against the action of first resilient means from a first rest position, in which said hydraulic connecting means connect said chamber with said outlet opening, into a second operating position in which said chamber is isolated from said outlet opening.

According to a preferred embodiment of the present invention, which is particularly suitable for controlling an auxiliary decompression valve of an internal-combustion engine, the unit comprises a rocker arm having one end attached to the second member, the other end attached to the valve and a central portion adapted to co-operate with a respective cam of a camshaft.

With a view to a better understanding of the present invention, a preferred embodiment thereof will be described below, non-restrictively by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a partial section through an internal-combustion engine provided with a hydraulic actuating unit designed in accordance with the present invention;

Figure 2 and Figure 3 are axial sections, on an enlarged scale, of a control member of the unit in Figure 1, in two different operating positions, and

Figure 4 illustrates schematically an internal-combustion engine of different type, provided with an actuating unit analogous to that in Figure 1.

Referring now to Figure 1, the reference numeral 1 generally designates an internal-combustion engine, only part of which is shown, comprising a crankcase 2 and a head 3. The crankcase defines a plurality of cylinders 4, only one of which is partly illustrated; each cylinder is associated with respective inlet and exhaust valves 4', only one of which is partly illustrated in dashed line in Figure 1. The valves 4' are controlled by a camshaft 5 accommodated in the head 3.

Each cylinder 4 is additionally associated with an auxiliary decompression valve 6 normally co-operating in a fluidtight manner, under the action of a spring 6a, with a decompression port 7 connecting a combustion chamber 8 of the cylinder itself to an auxiliary exhaust duct 9. The valve 6 is adapted to be opened at the end of the compression stroke of the associated cylinder 4, when required by the operating conditions of the vehicle, so as to dissipate the compression energy before the subsequent expansion (working) stroke and, therefore, to provide a braking action.

The auxiliary valve 6 is controlled by the camshaft 5, to which it can be selectively connected by means of an hydraulic actuating unit 10 which will be described in detail below.

The unit 10 essentially comprises a control member 11 and a rocker 12, one end 13 of which is attached to a movable member 14 of the control member 11 and the opposite end 15 of which co-operates with a stem 16 of the valve 6. An intermediate part 17 of the rocker arm 12 is maintained in contact with a respective cam 18 of the camshaft 5 and is of arcuate shape, with its convexity facing the shaft 5.

The control member 11 is illustrated in Figures 2 and 3, to which reference will be made in the following.

Said member 11 comprises a fixed outer casing 19 accommodated in a seating 20 provided in the head 3. The casing 19 comprises an outer tubular body 24 and a cup-shaped body 25 provided with a base wall 26 and with a cylindrical wall 27 defining an inner cavity 28 and having an end opening 29; the cup-shaped body 25, the axial length of which is smaller than that of the body 24, is securely accommodated inside the body 24 so that the base wall 26 defines an intermediate transverse wall of the casing 19 and so that an end section of the wall 27 is coplanar with an end section of the body 24 itself.

Therefore, the wall 26 axially separates the cavity 28 from a cavity 33 defined by the portion of the body 24 not occupied by the body 25. The above-mentioned movable element 14 is slidably mounted inside the cavity 33 and essentially comprises a hollow piston 30 provided with a spherical head 31 integral therewith and extending axially to project towards the outside of the cylindrical body 24; said spherical head engages a corresponding seating 32 provided in the end 13 of the rocker arm 12 and forms a ball joint therewith.

The piston 30 axially delimits with the wall 26 of the body 25 a chamber 34 and is urged towards the end of the body 24 by a helical spring 35 accommodated in the chamber 34 itself, the stiffness of which is much lower than the spring 6a of the valve 6; a resilient ring 36 mounted inside the body 24 serves as an axial stop for the movable member 14. In Figure 2 the position of the movable member 14 is indicated in solid line in the absence of external loads or constraints, whereas there is indicated in dashed line the position effectively assumed in operation, when the head 31 is connected with the rocker arm 12.

Two radial holes 37, 38 are provided in the cylindrical wall 27 of the body 25 and are respectively disposed a lesser and greater distance from the end opening 29 in the body 25 itself. The hole 37 communicates with a corresponding outlet hole 39 provided in the cylindrical body 24; an outer longitudinal slot 40 extends from the hole 39 and is extended to the outside of the seating 20. The hole 38 communicates through an outer longitudinal slot

41 of the body 25 with the above-mentioned chamber 34.

The interior of the cavity 28 of the body 25 accommodates a cylindrical member 43 so that it can slide axially therein; said cylindrical member is urged by a spring 44 compressed between itself and the wall 26 of the body 25 towards the end opening 29 of the cavity 38; a resilient ring 45 mounted inside the wall 27 in the vicinity of the opening 29 forms an axial stop for the member 43.

Said member 43 has an axial cavity 46 communicating with the opening 29 through a non-return valve 47, and an intermediate circumferential slot 48 which communicates with the axial cavity 46 by means of a plurality of radial holes 49. In particular, the cavity 46 has two sections 46a, 46b of different diameter, of which the section of larger diameter (46b) opens towards the wall 26, and forming between them an axial shoulder 51, the sections 46a, 46b of the cavity are separated from one another by a disc 52 clamped against the shoulder 51 and forming a support for the above-mentioned spring 44. The section 46a is connected with the slot 40 by a radial through-hole 50 of the casing 19.

The non-return valve 47 comprises a ball 53 urged by a spring 56 into contact with a conical seating 54 provided between the cavity 46 and an axial hole 55 of the member 43 communicating with the opening 29; the spring 56 is compressed between the ball 53 and said disc 52. The member 43 is movable under the pressure of a hydraulic fluid, as will be described below, and against the action of the spring 44 from a first rest position, shown in Figure 2, in which it is in contact with the ring 45, and a second position, shown in Figure 3, in which it is in contact with the wall 26.

In said first position, the circumferential slot 48 of the member 43 communicates with both the holes 37 and 38 and, therefore, the chamber 34 and the cavity 46a are connected with the outlet hole 39; in the second position, the slot 48 communicates with the hole 38 but not with the hole 37.

Referring still to Figure 1, the opening 29 of the body 25 of the member 11 communicates with a duct 60 provided in the engine head 3 and connected to a lubricating circuit of the engine itself by a solenoid valve, which is normally closed. Therefore, the engine oil constitutes the operating fluid for the control member 11.

The mode of operation of the actuating unit 10 is the following.

When the duct 60 is not pressurised, the member 43 is situated in the rest position shown in Figure 2, under the action of the spring 44. The movable member 14 maintains the rocker arm 12 in contact with the camshaft 5 under the action of the spring 35, with a suitably reduced contact load

defined by the low stiffness of the spring itself. During the rotation of the camshaft 5, the movable member 14 is free to oscillate along the tubular body 24 under the pressure of the rocker arm 12, since the chamber 34 communicates, as indicated above, with the outlet hole 39. The valve 6 remains closed, since the stiffness of the associated spring is much greater than that of the spring 35.

When the duct 60 is pressurised, thus opening the associated solenoid valve, the membrane 43 is displaced under the hydraulic pressure from the first position to the second position (Figure 3) and the oil contained in the member 11 is isolated from the outlet hole 39. At this point, the oil flows from the duct 60 through the non-return valve 47 until it completely fills the cavity 46a and the chamber 34, after which, because of the incompressibility of oil, the movable member 14 constitutes a rigid restraint for the rocker arm 12. Consequently, the actuating force exerted by the cam 18 induces rotation of the rocker arm 12 about the head 31 of the member 14 and, therefore, the opening of the valve 6 under the pressure of the end 15 of the rocker arm 12.

The cam 18 is timed so that the opening of the valve 6 takes place at the end of the compression stroke in the cylinder, so as to discharge the air compressed during said stroke and thus prevent the compression energy from being returned during the expansion stroke, thus producing engine work.

The control of the unit 10 and any subsequent utilisation of the compressed air are not described, since they do not form part of the subject-matter of the present invention.

Figure 4 illustrates schematically an actuating unit 10 used in an engine 1' provided with a camshaft 5' in the crankcase. The unit 10 is substantially equal to that described but is mounted inverted and the end 15 of the rocker arm actuates a transmission rod 61 which controls in known manner a rocker arm 62 of conventional type which, in turn, actuates the valve 6. The mode of operation of the unit 10 is entirely analogous to that described.

The advantages which can be obtained by the present invention are evident from a study of the features of the unit 10 designed in accordance therewith. Above all, the control member 11 not only performs all the controlled of a conventional hydraulic tappet, in particular the automatic take-up of play, but can also be operated hydraulically in such a way so to activate or deactivate selectively the actuation of the valve; moreover, the use of a rocker arm 12, the member 11 of which, when activated, constitutes a rigid fulcrum, enables the actuating loads to be transmitted mechanically and, therefore, to obtain an optimum dynamic response, particularly in an embodiment using an overhead

camshaft.

Finally, it is evident that modifications and variations can be made to the unit 10, without thereby departing from the scope of protection of the present invention. In particular, the rocker arm 12 may be omitted or replaced with another suitable transmission member and the control member can be interposed directly between a driving member and a driven member.

Additionally, the unit 10 and, in particular, the control member 11 can be used not only to control a valve of an engine but also in any other engineering application, in which there is the requirement of interconnecting a driving member and a driven member in a selective manner and of automatically taking up the play between said members.

Claims

1. A hydraulic actuating unit (10) of the type comprising:
 - a first member (19) and a second member (14) which are telescopically interconnected and which define a chamber (34) adapted to contain a hydraulic fluid; and
 - a non-return valve (47) communicating with said chamber (34) and adapted to be connected with a supply duct (60) for said hydraulic fluid so as to allow said fluid to flow towards said chamber (34) but to prevent it from flowing back towards said supply duct (60);
 characterised by comprising a third member (43) telescopically connected to said first member (19) and provided with hydraulic connecting means (46a, 48, 49), said first member (19) defining an outer casing in which are accommodated said second member (14) and said third member (43) and being provided with an outlet opening (37, 39), said third member (43) being movable under the pressure of said hydraulic fluid and against the action of first resilient means (44) from a first rest position, in which said connecting means (46a, 48, 49) connect said chamber with said outlet opening (37, 39), into a second operating position in which said chamber (34) is isolated from said outlet opening (37, 39).
2. A unit according to Claim 1, characterised in that said non-return valve (47) is provided inside said third member (43).
3. A unit according to Claim 1 or 2, characterised in that said outer casing (19) has an intermedi-

ate transverse wall (26) interposed between said chamber (34) and a first cavity (28) accommodating said third member (43) and adapted to be connected with said supply duct (60).

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and exhaust valves (4'), characterised in that said auxiliary valve (6) is connected with a respective cam (18) of said shaft (5) by means of a hydraulic actuating unit (10) according to any one or the preceding Claims.

4. A unit according to Claim 3, characterised in that said first resilient means (44) are interposed between said transverse wall (26) and said third member (43).

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5. A unit according to Claim 3 or 4, characterised in that said hydraulic connecting means for said third member (43) comprise a second cavity (46a) communicating with said first cavity (28) of said casing (19) through said non-return valve (47), an outer circumferential slot (48) and at least one radial hole (49) communicating with said second cavity (46a) and with said slot (48); said outer casing having a passage (38, 41) connecting said first cavity with said chamber (34) and axially spaced apart along said first cavity (28) with respect to said outlet opening (37, 39), so that said slot (48) communicates with said passage (38) and with said outlet opening (37) in said first position of said third member (43) and only with said passage (38) in said second position of said third member (43).

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6. A unit according to any one of the preceding Claims, characterised by comprising second resilient means (35) urging said second member (14) in the opposite direction to said third member (43), and axial stop means (36) for said second member (14).

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7. A unit according to any one of the preceding Claims for controlling a valve (6) of an internal-combustion engine (1), characterised by comprising a rocker arm (12) having a first end portion (13) connected to said second member (14), a second end portion (15) connected to said valve (6) and an intermediate portion adapted to co-operate with a cam (18) of a camshaft (5) of said engine (1).

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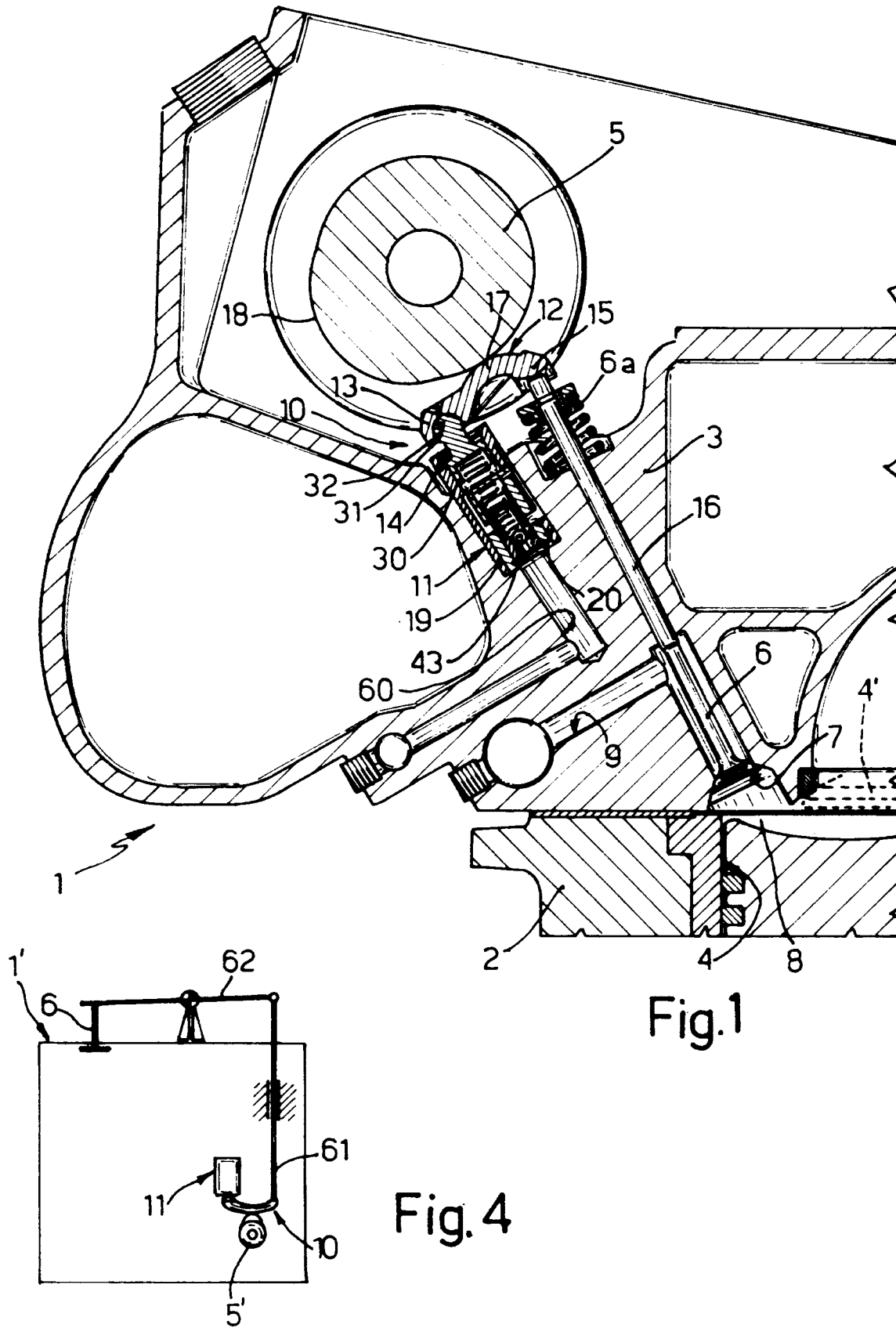
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8. A unit according to Claim 7, characterised in that said first end portion (13) of said rocker arm (12) and said second member are connected to one another by means of ball-joint means (31, 32).

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9. An internal-combustion engine comprising a plurality of cylinders (4) provided with respective inlet and exhaust valves (4') and with an auxiliary decompression valve (6), and with a camshaft (5) for operating at least said inlet

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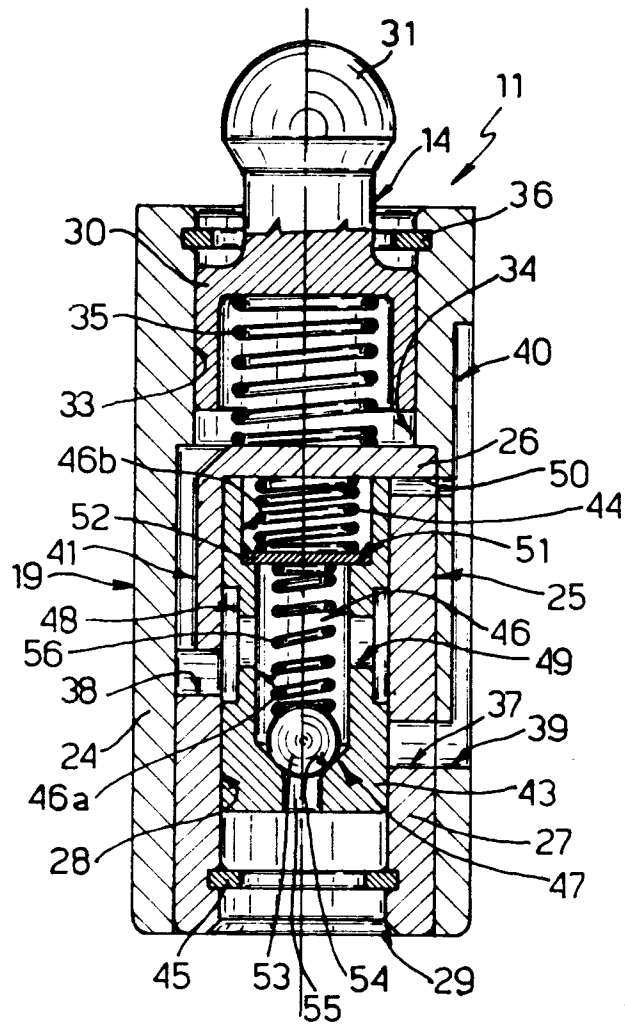
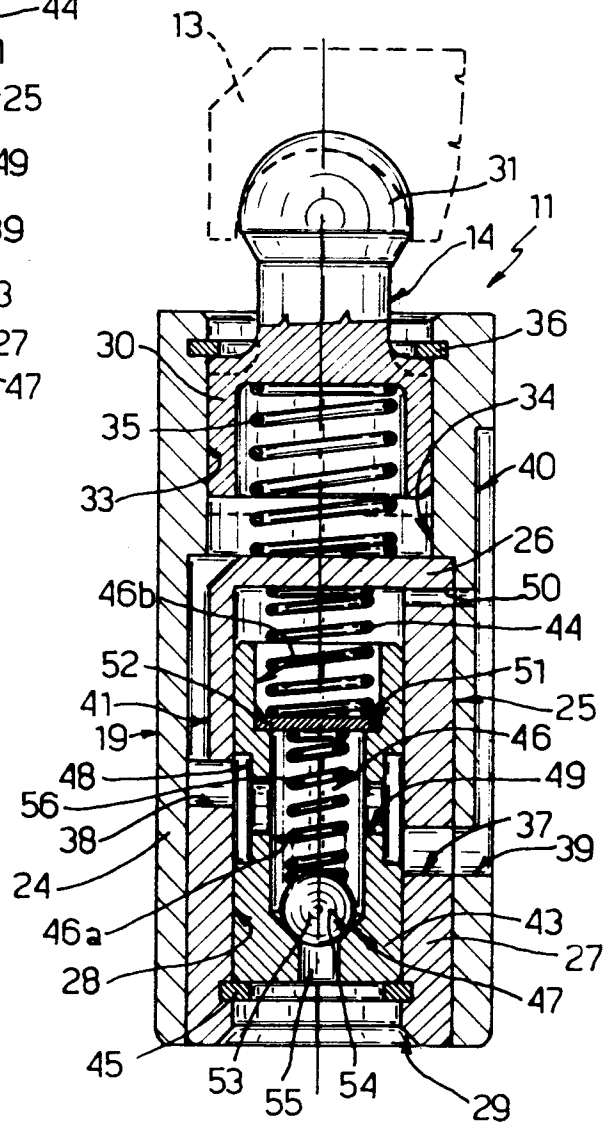


Fig.3

Fig.2





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 93 11 9034

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	US-A-4 337 739 (JORDAN) * column 3, line 24 - column 5, line 37 * * figures 1-4 * ---	1,3,7	F01L13/00 F01L1/24
A	US-A-4 050 435 (FULLER) * abstract * * figures 1-5 * ---	1	
A	DE-A-40 00 531 (SCHMIDT) -----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			F01L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 28 February 1994	Examiner Klinger, T
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